



Natural Resources Commission

Final report

Review of the water sharing plans for the Greater Metropolitan region

February 2021



Acknowledgement of Country

The Natural Resources Commission acknowledges and pays respect to traditional owners and Aboriginal peoples. The Commission recognises and acknowledges that Aboriginal peoples have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. We value and respect their knowledge in natural resource management and the contributions of many generations, including Elders, to this understanding and connection.

In the Greater Metropolitan area, the Commission pays its respects to the Yuin, Tharawal, Eora, Dharug, Gundungurra Traditional Owners past, present and future, as well as other Aboriginal peoples for whom these waterways are significant. The Commission hopes that the involvement of Aboriginal peoples and Local Aboriginal Land Councils throughout the review process will help to shape collaborative water planning and sharing that is beneficial to Aboriginal peoples and their Country.

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Acronyms and units of measurement

Act	the <i>Water Management Act 2000</i> (NSW)
AWD	Available water determination
Commission	the Natural Resources Commission
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI	Department of Primary Industries
DPIE	Department of Planning, Industry and Environment
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
EC	Electrical conductivity (measured in microsiemens per centimetre)
GDE	Groundwater dependent ecosystem
Groundwater Plan	<i>Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011</i>
GRP	Gross Regional Product
GSP	Gross State Product
HEVAE	High Ecological Values Aquatic Ecosystems
IDEL	Individual daily extraction limit
IETPC	The Independent Expert Panel for Mining in the Catchment
LALC	Local Aboriginal Land Council
LGA	Local government area
LTAEL	Long-term annual average extraction limit
MER	Monitoring, evaluation and reporting
ML	Megalitre (unit of volume equivalent to one million (1×10^6) litres)
NARClM	NSW and ACT Regional Climate Modelling Project
NRAR	The Natural Resource Access Regulator
NSW	New South Wales
Plans/plan area	The Plans manage different, but connected, water sources in the same geographic region. The term ‘the Plans’ is used when speaking

broadly across the Surface Water and Groundwater Plans and 'plan area' refers to the geographic region covered by both Plans.

R/ SA

Recommendation/ Suggested action

SMART

Specific, measurable, achievable, relevant and time-bound

Surface Water Plan

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011

TDEL

Total daily extraction limit

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Executive summary

The Natural Resources Commission (the Commission) has reviewed the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*¹ (the Surface Water Plan) and the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*² (the Groundwater Plan),³ as required under Section 43A of the *Water Management Act 2000* (the Act).

The plan area contains arguably one of the most important water management systems in the country. Greater Sydney is the most populous and fastest growing region in Australia,⁴ with population expected to grow from 4.7 million (in 2016) to 6.6 million by 2036.⁵ Currently, around 70 percent of all water supplied in Greater Sydney is used by residential households, which is likely to increase given socio-demographic trends. The Sydney area is internationally recognised for its natural beauty, including its harbor and rivers. As such, it continues to retain its title as one of the most liveable global cities, with tourism within the plan area generating billions of dollars annually.⁶

The Plans include significant environmental values, including 128 national parks, world heritage areas, reserves and conservation areas. Aboriginal people hold profound knowledge, understanding, obligation and custodianship of this area, often expressed as connection to Country. This is embedded and alive in the plan area, demonstrated in a diverse range of culturally significant surface water and groundwater values.

Following an analysis of available evidence and public consultation, the Commission has assessed the extent to which the provisions of the Plans have contributed to achieving environmental, social, cultural and economic outcomes, and advised where changes to provisions are warranted.

The Commission recognises the current Plans are the first water sharing plans for this region and reflect a considerable amount of effort to design rules reflective of the complexity of water management in the Plan area.

There is now significant new information, as well as the benefit of experience with operating the Plans. From this, it has become clear that the Plans are flawed. They are not appropriate to manage the region's water given the significance of the region to the state and national economy, and the criticality of the water supply for maintaining this demographic and

¹ Parliament of NSW (2009) *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Available at: <https://www.legislation.nsw.gov.au/view/html/inforce/current/sl-2011-0112>.

² Parliament of NSW (2009) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. Available at: <https://www.legislation.nsw.gov.au/view/whole/html/inforce/current/sl-2011-0111>.

³ The Plans manage different, but connected, water sources in the same geographic region, so were reviewed together (the term 'the Plans' is used when speaking broadly across the Surface Water and Groundwater Plans and 'plan area' refers to the geographic region covered by both Plans).

⁴ Australian Bureau of Statistics (2020) *Regional population*. Available at: [https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20\(113%2C500\)%20and%20Sydney%20\(,had%20the%20highest%20growth%20rates](https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20(113%2C500)%20and%20Sydney%20(,had%20the%20highest%20growth%20rates).

⁵ DPIE (2020) *Population projections*. Available at: <https://www.planning.nsw.gov.au/Research-and-Demography/Population-projections>.

⁶ Sydney was ranked fifth in Monocle's 2015 Quality of Life Survey and third in the 2019 survey (see: www.monocle.com). Sydney was ranked eleventh by Mercer in the 2016 and 2019 Mercer Quality of Living ranking (see: <https://mobilityexchange.mercer.com/Insights/quality-of-living-rankings>) and fifth in The Economist's 2015 Liveability surveys and third in the 2019 survey (see: <https://www.eiu.com/topic/liveability>).

economic growth. There is now opportunity to leverage lessons learned and vastly improve the Plans. **Figure 1** below outlines the five most critical issues that should be addressed to improve the Plans. The Commission's recommendations (discussed in the following sections) detail the proposed steps necessary to address these issues, as well as some more detailed issues identified in the review.

The Commission has consulted with the Department of Planning, Industry and Environment – Water (DPIE-Water) in developing this report and understands that it is aware of the complexities and issues with the Plans and is already working to identify solutions.

Set sustainable, numeric extraction limits	<p>Current extraction limits are not based on sound evidence of sustainability, are not comparable or easily calculated to assess compliance</p> <p>Without these, extraction cannot be managed</p>
Define environmental water requirements	<p>Requirements for groundwater protection and environmental flows (particularly for estuaries) are not clear or based on sound evidence of ecosystem requirements</p> <p>These should be developed to inform environmental flow and access rules and be reflected in the Greater Sydney Water Strategy</p>
Consider water management holistically	<p>Water extraction and returned flows managed outside the Plans, such as recycled water, have not been adequately considered and impact on water availability</p> <p>The Greater Sydney Water Strategy covers many of these flows - the Plans and the Strategy need to recognise each other</p>
Make the Plans fit for purpose	<p>Surface Water Plan is overly complex, sometimes contradictory and often unimplementable - resulting in an unreasonable number of exemptions</p> <p>Once environmental water requirements are defined, access rules should be redesigned to focus on simple and practical rules to deliver water consistent with the priorities under the Act</p>
Make the Plans equitable	<p>Some rules create inequities inconsistent with the intent of Act and do not support outcomes for Aboriginal people</p> <p>The Plans should define equitable sharing and transparently allocate water to support the range of community benefits</p>

Figure 1: Critical issues in the Plans

The Plans should be replaced once further foundational work is done

Overall, the Commission recommends replacing the Plans after an extension period of two years to allow time to undertake important foundational work.

Managing the overall water balance strategically across government programs and policies, including the water sharing plans, is critical to protect the region's increasingly stretched water resources. The *Greater Sydney Water Strategy*, which covers different aspects than the Plans and has a different focus, is due to be released by mid-2021. This strategy should help address and provide context for some of the issues covered in this review. While there is significant water, such as recycled water, that sits outside of the Plan rules, the Plans need to adequately consider these inputs and ensure appropriate flexibility to any changes to those flows. Further, the Plans should set the requirements for environmental water, which the *Greater Sydney Water Strategy* should accommodate.

Recommendation (R) 1

The Surface and Groundwater Plans should be:

- a) Extended for a further two years until 30 June 2023, to allow time to complete data collection, analysis and modelling.
- b) Replaced by 1 July 2023 supported by the completion of the recommendations of this review. The replacement process should ensure the Plans consider the *Greater Sydney Water Strategy* to ensure water management is integrated across the region.

Extraction volumes cannot be managed

Establishing clear, sustainable extraction limits is the most fundamental requirement of a water sharing plan. Many long-term average annual extraction limits (LTAAELs) in the Plans cannot be calculated to assess compliance, cannot be compared across catchments, or are not based on sound evidence. Some limits may be increased with no assessment of sustainability. Several forms of extraction both within and outside the regulation of the Plans are not accounted for.

The overall water balance for the Greater Metropolitan region has not been comprehensively assessed and therefore cannot be adequately managed by the Plans. There are currently several detailed models designed for specific purposes such as yield analysis, assessing water quality or changes in catchment runoff. However, to understand overall water balance and the effectiveness of Plan rules, a more comprehensive modelling framework (for example, a linked suite of models) covering all elements of extraction, changes in runoff from land use and climate change, and estuary hydrodynamics is required.

<p>R 2</p>	<p>To inform the replacement Plans by 1 July 2022, DPIE-Water should develop a comprehensive water balance. This should be developed using an overarching modelling framework, which includes:</p> <ul style="list-style-type: none"> a) reviewing and addressing gaps in current modelling and model inputs b) all surface water and groundwater extraction c) inflows (including treated wastewater and recycled water discharges) and induced recharge (internal and external to the Plans) d) up to date evidence regarding recharge, hydrogeology, connectivity, and climate (the hydrological model should use the climatic data developed for the <i>Greater Sydney Water Strategy</i>). <p>The modelling framework should be used to inform revised provisions and assess their ability to achieve outcomes.</p>
<p>R 3</p>	<p>By 1 July 2023, DPIE-Water should ensure all extraction in the Greater Metropolitan region is managed to protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems by:</p> <ul style="list-style-type: none"> a) using the modelling framework to establish and publish numeric values for comparable, catchment-scale LTAAELs for the Surface Water and Groundwater Plans that include all forms of extraction managed under the Plans b) using the modelling framework to ensure the Surface Water and Groundwater Plans can function, protect values and achieve objectives under a representative range of climatic conditions over the medium to long term c) basing LTAAELs on sound evidence of ecosystem requirements, recharge, hydrogeological boundaries, and connectivity d) ensuring the water acquired through the Hawkesbury-Nepean River Recovery Project is adequately protected e) ensure mining activities are licenced f) removing clauses 41(7) and 41(8) allowing the LTAAEL to be increased through high flow conversions g) including an amendment provision allowing LTAAELs and Available Water Determinations (AWDs) to be adjusted should volumes managed external to the Plans change significantly.

Suggested Action (SA) A	Finalise the reasonable use guidelines for domestic and stock use by 1 July 2022 and include the agreed standards as part of the replacement Plans.
SA B	Policies around exempt and externally managed extraction should be finalised to inform the replacement Plans' development, for example stormwater harvesting and construction and maintenance dewatering.

The Plans do not manage extraction equitably

The Plans do not define what equitable sharing would mean or explicitly outline how they support community benefits or incorporate those values into their objectives. Despite the lack of a specific definition of equitable outcomes, there are several aspects of the Plans that clearly result in inequity across the plan area. The Surface Water Plan does not transparently allocate wastewater discharges, which contribute significantly to river flows, and exemptions mean licensees may have variable access to environmental and drinking water releases.

R 4	<p>By 1 July 2023, DPIE-Water should ensure the Plans facilitate equitable sharing of water by:</p> <ul style="list-style-type: none"> a) clearly defining equity objectives consistent with the Act's requirements b) assessing plan provisions against (a), including access to environmental, drinking water and wastewater releases and LTAAEL compliance provisions c) ensuring that planned Warragamba Dam environmental releases, which have been replaced by wastewater releases, continue to be met by either wastewater releases or dam releases.
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Dam releases and transfers need improvement

Many release and transfer rules for the major dams under the Surface Water Plan have not been developed, optimised, or adequately implemented. Releases are not managed in a holistic way to maximise outcomes. Contributing factors include a poor evidence base, the need for additional monitoring infrastructure, unclear responsibilities, and lack of resources. The Surface Water Plan allows for an Environmental Flows Reference Group, which could provide strategic guidance for environmental flows, but which has been disbanded. Reconvening this group would help address these issues and drive coordinated management of releases. The Surface Water Plan does not transparently allocate treated wastewater and recycled water discharges, which contribute significantly to river flows, and exemptions mean licensees may have variable access to environmental and drinking water releases.

<p>R 5</p>	<p>DPIE-Water should improve outcomes achieved from environmental and utility releases and transfers by:</p> <ul style="list-style-type: none"> a) immediately reconvening the Environmental Flows Reference Group to advise on relevant aspects of recommendations (b)-(e), and by 1 July 2023, expanding their role in the Plan to advise on a coordinated and adaptive approach to setting and managing environmental releases b) by 1 July 2023, reviewing release provisions for the Upper Nepean weirs and revising them to be less prescriptive and more outcomes-focused c) by 1 July 2023, make currently discretionary environmental releases mandatory and establish clear responsibilities for their implementation, including the environmental contingency allowance, high flow releases from Woronora Dam and water recovered under the Hawkesbury-Nepean River Recovery Program d) by 1 July 2023, set environmental release rules for other utilities in consultation with stakeholders based on the findings of required and other relevant studies, which should be overseen by DPIE-Water e) by 1 July 2027 (Year 5 of the replacement Surface Water Plan), using the modelling framework (Recommendation 2) in conjunction with the estuary model to review the transfer and release rules from the Shoalhaven River/Tallowa Dam to optimise environmental outcomes (including estuarine needs) and water security, considering a broader range of scenarios f) completing a public report outlining the environmental releases undertaken and the outcomes achieved every two years to improve transparency.
<p>SA C</p>	<p>The NSW Government should undertake planned upgrades allowing environmental releases from Warragamba Dam to ensure the Surface Water Plan can deliver environmental outcomes downstream of Warragamba Dam.</p>

Plans do not limit timing of extraction to protect flows and manage drought

There are several issues limiting the effectiveness of provisions governing the timing of water extraction. There are a significant number of exemptions to daily access rules, which allows extraction of low flows meant to be protected. Daily access rules are often inappropriate or unnecessary, adding complexity and limiting or reducing outcomes. AWDs are ineffective in their current role to ensure extraction limit compliance and should be used to ration water during drought. Carryover provisions increase the risk of extraction during low flows and operate counter to AWD rationing provisions.

R 6	By 1 July 2023, DPIE-Water should review all exemptions and simplify daily access rules in the Surface Water Plan and connected Groundwater Plan water sources to minimise the time and volume of exempt extraction.
R 7	<p>By 1 July 2023, DPIE-Water should develop simple and transparent access rules for the Surface Water Plan and connected Groundwater Plan water sources to manage extraction consistent with the priorities of the Act. This should include:</p> <ul style="list-style-type: none"> a) using instantaneous cease to pump rules to protect very low flows, connectivity, and basic landholder rights, ensuring rules are practical to implement, comply with and are enforceable b) develop simple, outcome-focused rules to protect environmental releases recommended by the Environmental Flows Reference Group (Recommendation 5) and town water supply c) strategic use of active management rules and developing and implementing practical total daily extraction limits (TDELs) and individual daily extraction limits (IDELs) only where required d) installing required infrastructure to implement provisions, including required gauging stations and notification system e) addressing drafting errors.
R 8	<p>By 1 July 2023, DPIE-Water should ensure that, if licensees are unable to comply with access licences at any time, extraction is appropriately mitigated, including:</p> <ul style="list-style-type: none"> a) amend Clause 57(3) parts (a) and (b) of the Surface Water Plan on planned environmental water, which allow for cease to pump exemptions for aquifer interference activities that are either approved by the <i>Environment, Planning and Assessment Act 1979</i> or the Minister, to require 100 percent mitigation of any exemptions b) link Groundwater Plan daily access exemption provisions to Surface Water Plan provisions where appropriate and consider including mitigation requirements c) in the Surface and Groundwater Plans, account for mitigation daily (the timescale at which cease to pump rules operate).
R 9	<p>By 1 July 2023, DPIE-Water should:</p> <ul style="list-style-type: none"> a) estimate extraction each year to ensure compliance with LTAAELs to determine if adjustments are necessary b) include rules following DPIE-Water's consideration of how AWDs can be used to manage extraction during drought, including under predicted climate change c) examine and simplify the combined role of the AWDs and carryover activities.

The Plans can better account for spatial variation in values and risks

The Department of Planning, Industry and Environment – Environment, Energy and Science (DPIE-EES) has carried out significant work in recent years to map high value surface and groundwater ecosystems in the plan area as part of the broader work to manage Sydney’s growth. This evidence should be used to build and test robust, effective rules for the Plans. The Plans consideration of socioeconomic values and future change can improve.

The Surface Water Plan does not use the standard management hierarchy for water sharing plans. As a result, trading rules that would normally be managed over a larger area are restricted to small river lengths, limiting trade activity. The Plans do not adequately manage all types of connectivity, and the protection of groundwater dependent ecosystems (GDEs) would be improved through clarification. There is limited understanding of ecological requirements for the estuaries and the protection of their outcomes, including community values, is therefore uncertain.

R 10	<p>By 1 July 2023, DPIE-Water should use best available evidence, to reassess the socioeconomic, cultural and environmental value of all management zones/water sources in the Plans including:</p> <ul style="list-style-type: none"> a) fine scale High Ecological Values Aquatic Ecosystems (HEVAE) mapping consistent with data used for other NSW Government planning processes b) reviewing trade limitations with a view to manage trade across broader areas provided environmental outcomes can be maintained c) the full range of economic benefits and impacts of water extraction and presence of water in-stream when considering the economic dependence of water sources, such as: <ul style="list-style-type: none"> i) benefits and impacts of secure water supply and time on water restrictions for town water supplies including residential and industrial uses ii) benefits and impacts of flow and water quality on industries and water uses such as tourism, ecosystem services and recreation and community activities. <p>Where necessary, DPIE-Water should then amend both Plans’ rules to address any changes to classifications and ensure that the high value environmental ecosystems are protected by the Plan rules, without unnecessarily inhibiting trade.</p>
R 11	<p>By 1 July 2023, DPIE-Water should:</p> <ul style="list-style-type: none"> a) better define connectivity terminology with respect to spatial and temporal variation and needs of different aquifer types b) strengthen the evidence base across the plan area regarding the extent and spatial variability of connectivity through on ground studies and mapping c) specifically refer to known areas of high connectivity and lower connectivity, and distinguish between discharging and receiving groundwater systems, and gaining and losing streams to better manage the Surface and Groundwater Plans as a whole.

<p>R 12</p>	<p>DPIE-Water should:</p> <ul style="list-style-type: none"> a) by 1 July 2021, establish clear objectives for estuaries across the Surface Water Plan area b) by 1 July 2021, initiate detailed data collection in the Hawkesbury and Shoalhaven estuaries (including but not limited to the studies identified in 78(9) of the Surface Water Plan) and use this in the estuary model described in Section 4.7 to model estuary behaviour c) by 1 July 2022, use (b) to develop estuarine flow requirements in consultation with the Environmental Flows Reference Group (Recommendation 5) – as part of this, the Hawkesbury-Nepean tidal pool should be managed as a discrete area d) by 1 July 2023, include provisions to achieve the estuarine flow requirements defined in (c), including clear agency responsibilities.
<p>R 13</p>	<p>By 1 July 2023, to improve Groundwater Plan clarity and protection of GDEs to achieve environmental outcomes, DPIE-Water should:</p> <ul style="list-style-type: none"> a) Clearly define groundwater terms and their relevance to the Groundwater Plan, including GDEs, high priority (to include culturally significant sites), groundwater type, and connectivity – connectivity should include both discharge of groundwater to surface water and surface water recharge to groundwater systems. b) Include known values relating to culturally significant groundwater dependent sites in the revised Plan and ensure these are protected by the Plan provisions. c) Ground-truth updated DPIE-EES HEVAE mapping for the presence and extent of GDEs, including estuarine ecosystems. Identify and clearly refer to high priority ecosystems (considering defined factors such as cultural significance, presence of endangered ecological communities, period of groundwater dependence, suitability of water quality, representativeness). d) Review setback distances for work near identified GDEs and standardise these based on the NSW <i>Aquifer Interference Policy 2012</i>.
<p>R 14</p>	<p>By 1 July 2023, DPIE-Water should define specific ‘high’ flow thresholds where appropriate in the Surface Water Plan area, with cease to pump thresholds at levels that do not increase hydrological stress or impact environmental outcomes but will allow some trade into high flows.</p>

The Plans do not support outcomes for Aboriginal people

The Plans do not fully recognise all native title claims and Indigenous Land Use Agreements or identified culturally significant groundwater dependent sites. State-wide issues relating to Aboriginal water values, right and uses (marked with *) remain. The lack of Aboriginal stakeholder engagement during plan development and implementation means that Aboriginal water values are poorly understood and protected in the plan area. There is a significant need to focus on opportunities to develop and resource proactive involvement of Aboriginal people in coastal water planning and management. There was no evidence of Aboriginal specific purpose licences being applied for or issued under the Plans. The complexity and limitations on these licences inhibit any meaningful uses by Aboriginal people.

R 15	Amend the Plans to reflect all current native title claimants and Indigenous Land Use Agreement holders comprehensively and reflect this consistently across both Plans. Undertake detailed engagement with these Native Title groups to determine water allocations and access options.
R 16	Undertake subsequent work with Aboriginal stakeholders and Traditional Owners to further understand all water-related values (for surface and groundwater) and better protect them through Plan provisions.
R 17	Reserve unallocated water for Aboriginal specific licences or other Aboriginal water access options, before being offered to the market on commercial terms.
R 18*	<p>Finalise a NSW Aboriginal Water Strategy in 2021 to provide consistent, transparent guidelines and resourcing for Aboriginal water management across NSW, comprising the following at a minimum:</p> <ul style="list-style-type: none"> a) Improve recognition of native title by including a common provision to undertake preliminary amendments to a plan within six months of a native title determination or other agreement that includes water allocation. b) Allow additional time to undertake detailed engagement with Traditional Owners, make water allocations and final plan amendments; considering native title claims proactively as part of water sharing planning. c) Identify Aboriginal water values and uses, objectives and outcomes by undertaking extensive engagement with Aboriginal stakeholders in all plan areas; prioritising allocations to protect values; adopting cultural landscape-scale principles; integrating identified values into ongoing water planning and management. d) Co-design Aboriginal specific licences or other water access options with key Aboriginal stakeholders that meet identified needs for a range of cultural, environmental, social and economic uses.

There are issues with Plan delivery

As with other water sharing plans, the Plans have limited monitoring, evaluation and reporting (MER), making it difficult to measure outcomes and to effectively review them. There are several issues relating to the development and implementation of the Plans (many of which are consistent with state-wide issues – marked with *). DPIE-Water is currently addressing gaps in MER for coastal and inland water sharing plans, including funding strategic monitoring and implementation projects. Such improvements are critical to ensuring accountability for the replacement Plans.

R 19	<p>By 1 July 2022, DPIE-Water should improve MER to increase transparency and support the achievement of Plan outcomes in line with the water management principles and priorities of the Act. This should include:</p> <ul style="list-style-type: none"> a) Completing relevant studies identified in the 2011 Plans. b) Developing a publicly available research plan for the completion of further studies required to improve the knowledge base and for adaptive management – required studies should also be included in the Plans. c) Developing Plan-specific, publicly available MER frameworks consistent with the coastal and state-wide guidelines. The framework should include linked and specific, measurable, achievable, relevant and time-bound (SMART) objectives, strategies and performance indicators, define roles and responsibilities, set timely public reporting requirements and include adaptive management processes.
SA D*	<p>Continue to develop state-wide evaluation framework and monitoring plan, considering and addressing key gaps and prioritising MER activities based on values and risk. The framework, monitoring plans and reporting should be publicly available to improve transparency.</p>
SA E*	<p>Adopt additional mechanisms to support metering and measure water extraction and movement across the plan area, such as remote sensing, to improve calculation of LTAAEL compliance and support adaptive management.</p>
SA F*	<p>DPIE-Water should adopt state-wide processes that support the Plan remake and implementation by:</p> <ul style="list-style-type: none"> a) enhancing communication of water sharing plans through active, simple, and consistent language and modes of communication b) improving implementation using clear and consistent governance, roles and responsibilities, and timelines.
SA G	<p>By 1 July 2023, DPIE-Water should liaise with WaterNSW and the Natural Resource Access Regulator (NRAR) to ensure that Surface and Groundwater Plan provisions are practical, enforceable, and can readily be placed on access licences where relevant. Access licences should reflect Plan provisions.</p>
SA H*	<p>As part of the Plan replacement, DPIE-Water should develop well-evidenced and resourced processes for stakeholder engagement in the plan area. This should be part of a strengthened state-wide stakeholder engagement strategy.</p>
SA I*	<p>By 1 July 2023, DPIE-Water should adopt integrated catchment management approaches that support the Plans’ replacement and implementation.</p>

1 Review background

1.1 Water sharing plans and the Commission's role

Water sharing plans are statutory instruments under the Act. They prescribe how water is managed to support sustainable environmental, social, cultural and economic outcomes. They intend to provide certainty for water users regarding how available water will be shared over the life of the water sharing plan, which is typically 10 years, unless it is extended.

The Surface Water Plan and Groundwater Plan commenced on 1 July 2011 and are due for extension or replacement on 1 July 2021.

The Plans were reviewed together as they manage different, but connected, water sources in the same geographic region (the term 'the Plans' is used when speaking broadly across the Surface Water and Groundwater Plans and 'plan area' refers to the geographic region covered by both Plans).

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 the plan's water sharing provisions have materially contributed to the achievement of, or failure to achieve, environmental, social and economic outcomes
- if changes to plan provisions are warranted.

The Commission may recommend extending or replacing plans depending on its review findings. Section 43A(3A) of the Act requires the Commission to consider some potential compensation requirements resulting from recommended changes to a plan.⁷ Under the Act, compensation is payable by the state to access licence holders only in certain circumstances⁸ where water allocations under a water sharing plan are reduced.

The Commission must also consider the water management principles,⁹ including the water sharing principles, when reviewing plans. The Act is clear that water sharing is not about balancing uses and values – it is about first providing for the environment and second recognising basic landholder rights above other uses. It specifies that the:

- 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

⁷ 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 of the Act, 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.

⁸ As set out in sections 87 and 87AA of the Act. Section 87 states 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. 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.

⁹ Section 5 of the Act.

- c) sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b).¹⁰

Further, the water management principles should be prioritised in the order that they are set out above.¹¹ Water sharing plans must be based on evidence to achieve these outcomes.

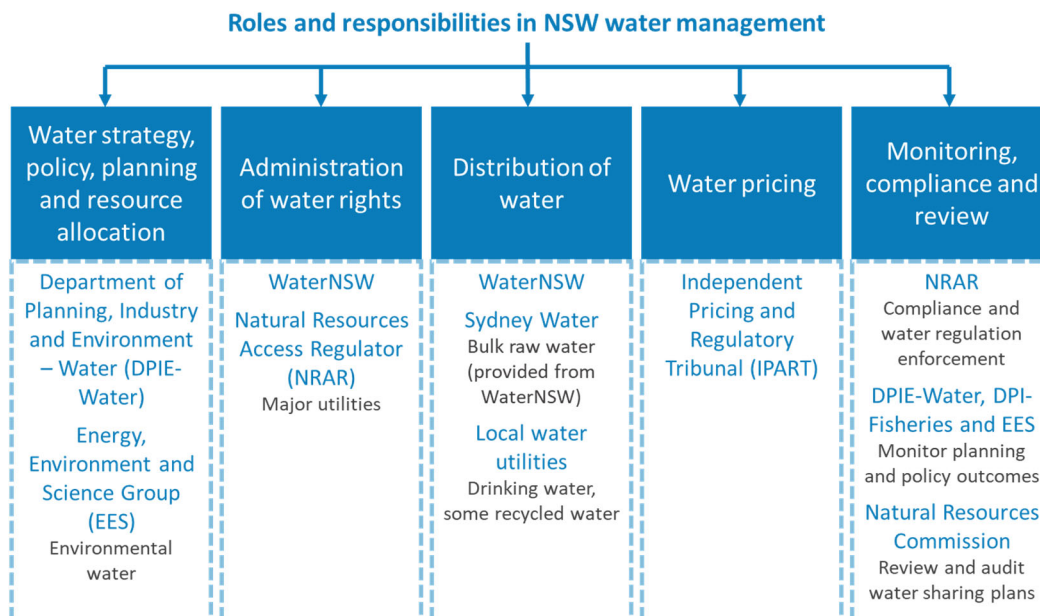


Figure 2: Agency roles in water management in the plan area

1.2 Review approach

The Commission’s review was informed by a range of evidence, including:

- **Consultation** – with government agencies, community, and industry organisations.¹²
- **Consultation with Aboriginal stakeholders** – the Commission provided the opportunity for input to relevant Local Aboriginal Land Councils and government agencies. Consultation has been undertaken with NSW Aboriginal Land Council, Indigenous Land and Sea Corporation, Aboriginal Affairs NSW and several other peak Aboriginal groups. One Local Aboriginal Land Council (LALC) in the area nominated to be involved in consultation and were engaged.
- **Document review** – the Commission reviewed the Plans and their background documents. It also obtained publicly available information and unpublished reports from water management agencies, including DPIE-Water. As required, the Commission considered other relevant state-wide and regional government policies and agreements that apply to the plan area.
- **Technical advice** – a range of consultants provided expert analysis on plan provisions and opportunities for improvement, as well as peer review.
- **Submissions** – the Commission called for and considered public submissions via letters and calls to key stakeholders and advertising on the Commission’s website. Stakeholders

¹⁰ Section 5(3) of the Act.

¹¹ Section 9(1) of the Act.

¹² Interviews carried out as part of targeted consultation were documented in comprehensive notes, but not recorded and transcribed, hence quotes are reported as ‘indirect’ rather than “direct” quotes.

were asked to respond to the following five questions to assess the contribution of the Plans to environmental, social, cultural and economic outcomes:

- To what extent do you feel the Plan has contributed to social outcomes?
- To what extent do you feel the Plan has contributed to environmental outcomes?
- To what extent do you feel the Plan has contributed to economic outcomes?
- To what extent do you feel the Plan has contributed to meeting its objectives?
- What changes do you feel are needed to the Plan to improve outcomes?

The Commission received 29 submissions overall. This was across two rounds of submissions. In the initial round of submissions in August-September 2019, 14 submissions were received on the Surface Water Plan, and eight on the Groundwater Plan. A second round of submissions was called in April-May 2020. The Commission received seven submissions in this secondary round (six on the Surface Water Plan, one on the Groundwater Plan). Non-confidential submissions are published on the Commission's website.¹³

The Commission evaluated each Plan's performance against its stated objectives, strategies and performance indicators, which were linked to each of the broader outcome categories required as part of the review (environmental, social, cultural and economic outcomes). These are provided in **Appendix A**.

As found in Section 44 implementation audits of the Plans,¹⁴ the Plans' vision, objectives, strategies and performance indicators, used to measure the Plans' success in meeting their objectives, were not being given effect.¹⁵ The lack of clearly linked objectives, strategies and indicators, and limited MER made it difficult to determine the Plans' performance. This report presents the Commission's findings using the best available evidence.

¹³ Natural Resources Commission (2021) *2019-2020 Water sharing plan reviews*. Available at: <https://www.nrc.nsw.gov.au/2019-2020-wsp-reviews>.

¹⁴ Section 44 of the Act requires auditing to ascertain whether the Plans have been given effect, within 5 years of the making of a plan.

¹⁵ Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf; Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/289478/Greater-Metropolitan-Region-Groundwater-Sources-2011.pdf.

2 Greater Metropolitan context

The area covered by the Plans is complex, unique and internationally valued. The Sydney area is internationally recognised for its natural beauty including its harbor and rivers and the Plans manage water supporting significant environmental values, including world heritage areas.

Greater Sydney is the most populous and one of the fastest growing regions in Australia.¹⁶ The plan area contains the catchment area supplying all of Sydney, the Illawarra, Blue Mountains, Shoalhaven, Goulburn and Southern Highlands. While the management of Greater Sydney's water supply is a key focus for policy and stakeholders, the Plans also manage water for high value agriculture such as market gardens, turf farms and chicken farms. Compared with other water sharing plans, the Plans also manage a significant amount of urban and peri-urban waterways (outside of utility supply).

Aboriginal people hold profound knowledge, understanding, obligation and custodianship of this area, often expressed as connection to Country. This is embedded and alive in the plan area, demonstrated in a diverse range of culturally significant surface water and groundwater values.

This chapter gives an overview of the plan area and its water-dependent environmental, social and economic values.

2.1 Plan area

The Plans cover 32,500 square kilometres on the south-east coast of NSW, from Shoalhaven Heads in the south, Broken Bay in the north, Singleton to the north-west, Lithgow to the west and Queanbeyan-Palerang to the south-west (see **Figure 2**). The Plans cover or partially cover 50 Local Government Areas (LGAs).¹⁷

¹⁶ Australian Bureau of Statistics (2020) *Regional population*. Available at: [https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20\(113%2C500\)%20and%20Sydney%20,\(had%20the%20highest%20growth%20rates](https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20(113%2C500)%20and%20Sydney%20,(had%20the%20highest%20growth%20rates).

¹⁷ LGAs include: Bayside, Blacktown, Blue Mountains, Burwood, Camden, Campbelltown, Canada Bay, Canterbury-Bankstown, Central Coast, Cessnock, Cumberland, Eurobodalla, Fairfield, Georges River, Goulburn Mulwaree, Hawkesbury, Hornsby, Hunters Hill, Inner West, Kiama, Ku-Ring-Gai, Lane Cove, Lithgow, Liverpool, Mid-Western Regional, Mosman, Muswellbrook, North Sydney, Northern Beaches, Oberon, Parramatta, Penrith, Queanbeyan-Palerang Regional, Randwick, Ryde, Shellharbour, Shoalhaven, Singleton, Snowy Monaro Regional, Strathfield, Sutherland Shire, Sydney, The Hills Shire, Upper Lachlan Shire, Waverley, Willoughby, Wingecarribee, Wollondilly, Wollongong, Woollahra.

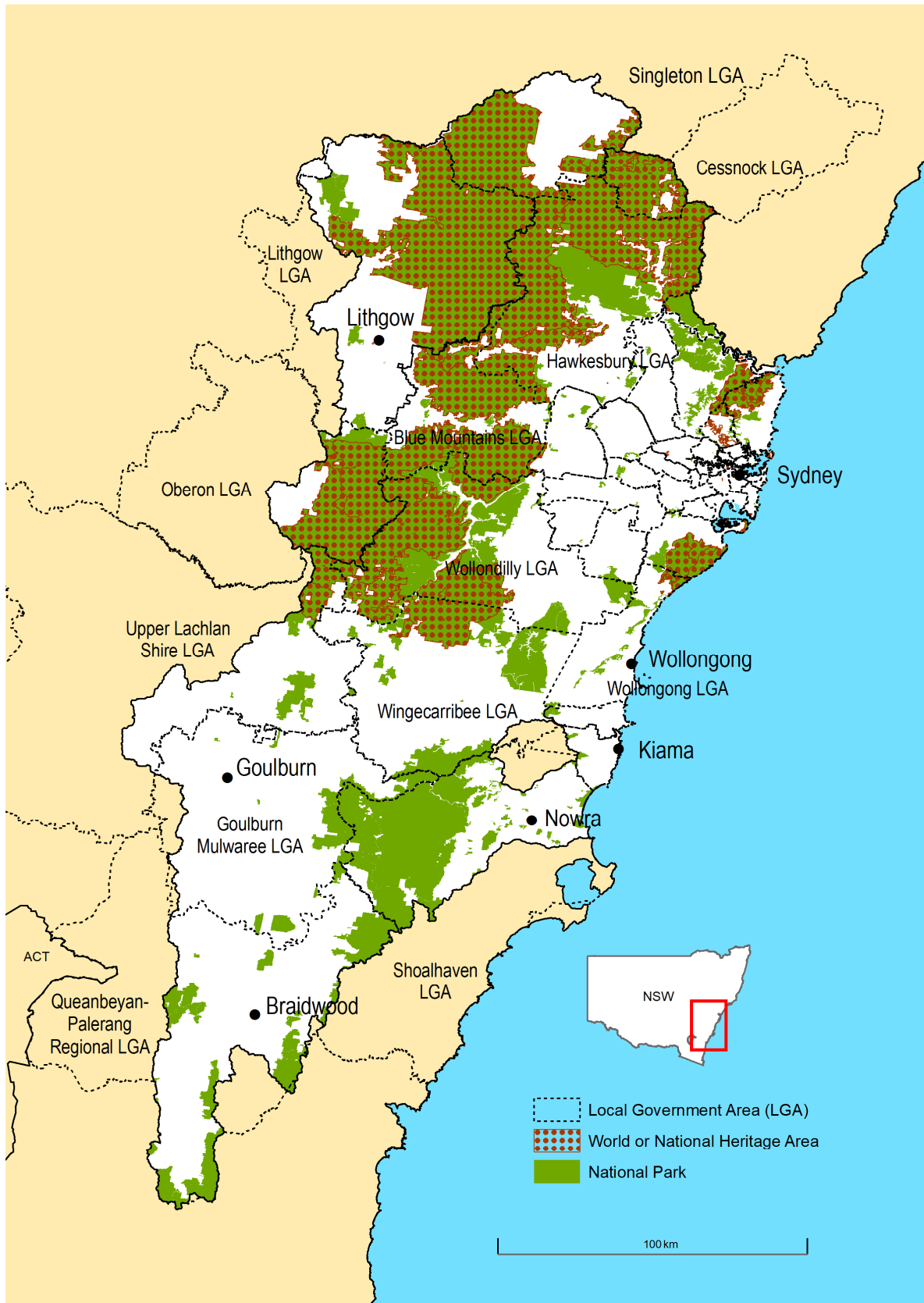


Figure 3: Plan area showing LGAs, national parks and national heritage areas¹⁸

¹⁸ Map developed by the Commission from publicly available NSW and Australian government data.

2.1.1 Surface Water Plan

The Surface Water Plan includes six extraction management units. These correlate to equivalent water sources in the Hawkesbury-Nepean, Illawarra, Shoalhaven and Sydney Basin catchments, which are divided into 88 management zones.¹⁹

The Kangaroo River Management Zone under the previous *Water Sharing Plan for the Kangaroo River Water Source 2003* was brought under the Surface Water Plan in 2016 and amalgamated into the Shoalhaven River Water Source.²⁰ The Surface Water Plan extends to the mangrove limit.²¹

Figure 4 and **Table 1** summarises the major reservoirs in the plan area and their purposes, largely for urban water supply. There are also numerous weirs, including:

- Pheasants Nest and Broughtons Pass weirs in the Upper Nepean and Upstream Warragamba Water Source
- Menangle, Camden, Sharpes, Cobbity, Mount Hunter Rivulet, Brownlow Hill, Theresa Park, Wallacia weirs in the Hawkesbury and Lower Nepean Rivers Water Source.²²

The urban water supply network relies on ten major dams operated by WaterNSW, transported through a network of pipes, canals and along rivers to water filtration plants operated largely by Sydney Water (see **Figure 5**).²³

Warragamba Dam is Australia's largest water supply dam and captures inflows from the Coxs and Wollondilly rivers. It supplies water for over 3.4 million people in Greater Sydney, environmental releases (see **Section 6.2**) and irrigator access. There are pipelines to transfer water and top up the Warragamba system from the Shoalhaven (see **Section 6.1**). Water can also be piped between the Avon and Nepean dams to transfer water from the Shoalhaven to the Illawarra.²⁴ Sydney Water's urban water supply is also supported by the desalination plant at Kurnell which can produce 250 megalitres (ML) of water per day.²⁵ This desalination plant is intended to be used if the total WaterNSW dam storage drops below 60 percent until dam levels to recover to 70 percent overall.²⁶

¹⁹ The Surface Water Plan uses different terminology to other water sharing plans. The Surface Water Plan uses the term 'management zone' to refer to a single area unit of management that would be called a 'water source' in other water sharing plans. In the Surface Water Plan, 'water source' refers to a larger area that contains a group of smaller management zones (this is equivalent to an 'extraction management unit' in other water sharing plans).

²⁰ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

²¹ Clause 4(4) of the Surface Water Plan.

²² Australian Government (2019) *Bioregional assessment program – Sydney Basin bioregion – Environmental flows*. Available at: <https://www.bioregionalassessments.gov.au/assessments/11-context-statement-sydney-basin-bioregion/1174-environmental-flows>.

²³ WaterNSW (2020) *Water Supply System Schematic*. Available at: <https://www.watnsw.com.au/supply/Greater-Sydney/schematic>.

²⁴ *Ibid.*

²⁵ Sydney Desalination Plant (2020) *Water Supply*. Available at: <https://www.sydneydesal.com.au/what-we-do/water-supply/>.

²⁶ WaterNSW (2018) *Greater Sydney's water supply system yield*. Available at: https://www.watnsw.com.au/__data/assets/pdf_file/0014/132035/Greater-Sydneys-water-supply-system-yield-2018.pdf.



Figure 4: Location of major dams in the plan area²⁷

²⁷ Map developed by the Commission using publicly available data.

Table 1: Major storage reservoirs in the plan area²⁸

Reservoir	Water source	Total storage (ML)	Purpose
Lake Wallace		4,004	Power generation from Mt Piper and Wallerawang power stations (note the Plans have not been amended to reflect the closure and demolition of Wallerawang)
Thomsons Creek		27,500	
Lake Lyell		34,192	
Sooley	Upper Nepean and Upstream	6,250	Urban water supply to Goulburn Mulwaree Council area
Pejar		9,000	
Warragamba	Warragamba	2,031,000	Urban water supply to Sydney metropolitan region
Wingecarribee		25,880	
Nepean		69,810	
Cordeaux		93,640	
Cataract		97,370	
Avon		214,400	
Prospect	Southern Sydney Rivers	48,200	
Woronora		71,790	
Fitzroy Falls		22,920	
Tallowa		90,000	
Bamarang	Shoalhaven River	3,800	Urban water supply to the Shoalhaven City Council area
Danjera		7,800	
Bundanoon		1,170	Urban water supply to Wingecarribee Shire Council area
Medway		2,046	

²⁸ Bureau of Meteorology (n.d.) *National Water Account - Sydney - Physical information*. Available at: <http://www.bom.gov.au/water/nwa/2010/sydney/physical.html>.

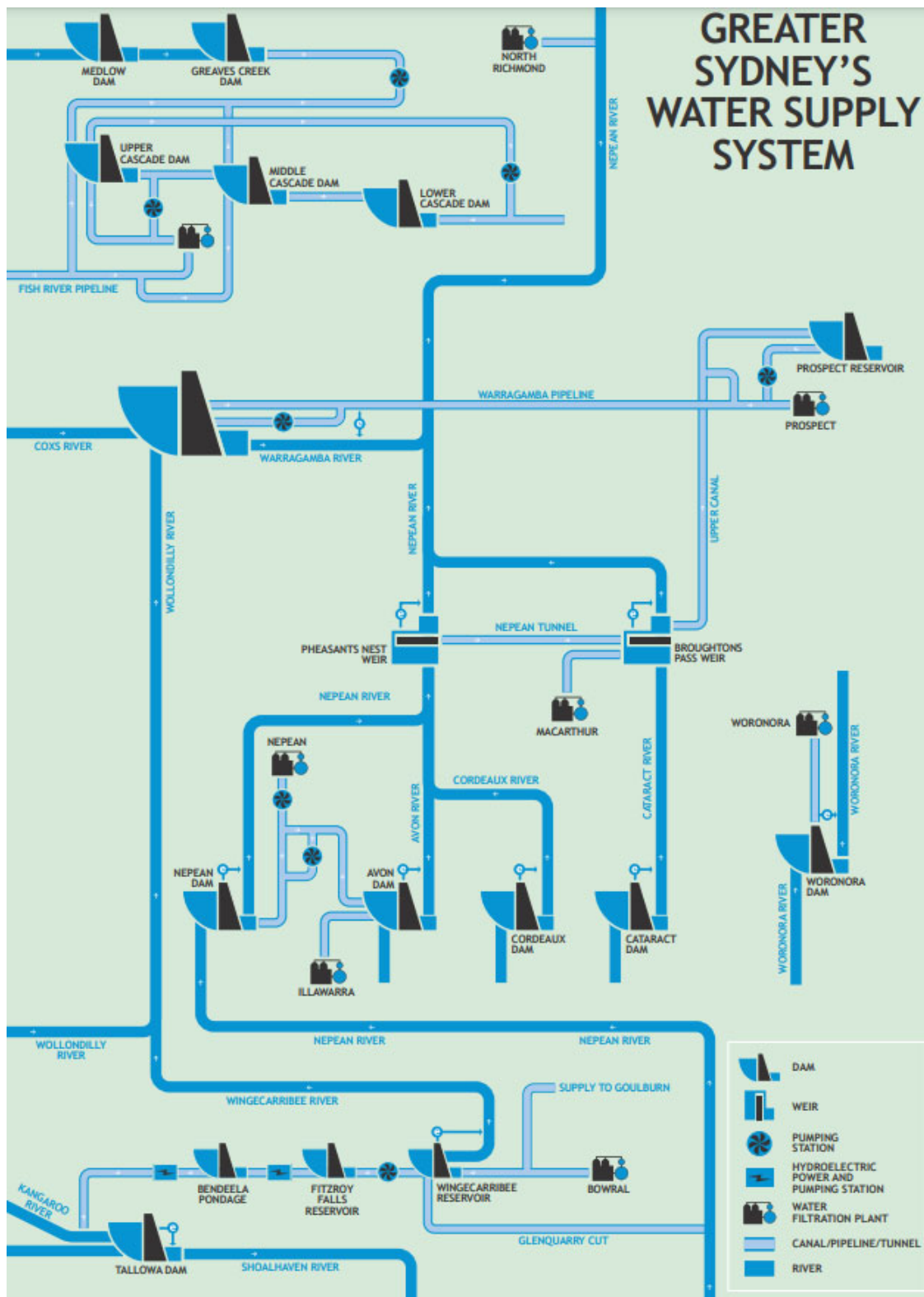


Figure 5: Schematic of Greater Sydney's water supply system, which sits within the plan area²⁹

²⁹ Figure sourced from WaterNSW (2020) *Greater Sydney's water supply network*. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0008/58319/Water-Supply-Diagram-Total-System.pdf.

2.1.2 Groundwater plan

The Groundwater Plan manages 13 groundwater sources, covering four types of aquifers: alluvial, coastal sand, porous rock and fractured rock (see **Table 2**). The Groundwater Plan's aquifers are spatially variable and mostly localised.

Table 2: Descriptions of groundwater sources according to aquifer type and their connectivity

Aquifer type	Groundwater source and description
Alluvial	The Hawkesbury Alluvium Groundwater Source : the only alluvial aquifer in the Groundwater Plan. It consists of the generally shallow, unconfined alluvial deposits, which are highly responsive to rainfall and the Hawkesbury River's streamflow events. Connectivity with surface water is significant, impacting baseflows, with travel time estimated to be days to months. ³⁰
Coastal sand	<p>Botany Sands and Metropolitan Coastal Sands: these groundwater sources are classified as having significant connectivity with surface waters. However, the impact on instream values is considered low as the aquifers occur below the tidal limit. Connectivity with surface water is significant in the tidal section, low elsewhere with travel time estimated to be days to months.³¹</p> <p>The Botany Sands Aquifer has a maximum thickness of around 45 metres³² and has been an important source of water supply for Sydney's industry and community.³³</p> <p>The Metropolitan Coastal Sands Aquifer's northern aquifer extends to the Hawkesbury River and south along the coast to the Crookhaven River (excluding the area covered by the Botany Sands Groundwater Source). The sand deposits are typically small, isolated, beach deposits.³⁴ The groundwater is generally good quality because of the relatively high rainfall and infiltration rates and relatively insoluble and clean nature of sands. Groundwater extraction is largely associated with shallow (less than 6 metres depth) domestic spear points, along with a few larger high-yielding works for recreational purposes.</p>
Inland sand	Maroota Tertiary Sands : is about 20 kilometres inland and has low to moderate connectivity with surface water. It covers less than 5 square kilometres, the smallest area of the groundwater sources. ³⁵ It is about 40 metres thick and overlies the Hawkesbury Sandstone. The groundwater quality is generally good, but of low yield, and is used for domestic, agricultural and industrial purposes. Connectivity with surface water is low to moderate with travel time estimated to be years to decades. ³⁶
Porous rock	Sydney Basin Blue Mountains, Sydney Basin Cocks River, Sydney Basin Richmond, Sydney Basin Central, Sydney Basin Nepean, Sydney Basin South and Sydney Basin North : these stretch from Port Stephens to Bateman's Bay, covering around 19,523 square kilometres, although only the area within the Plan boundary is covered by the Groundwater Plan. All consist of the Hawkesbury Sandstone Aquifer system, which occurs across the entire geological Sydney Basin. The various aquifers have

³⁰ NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/548105/wsp_metro_groundwater_background.pdf.

³¹ *Ibid.*

³² Hatley, R.K. (2004) 'Hydrogeology of the Botany Basin'. *Australian Geomechanics* 39(3), pp. 73–90.

³³ NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/548105/wsp_metro_groundwater_background.pdf.

³⁴ *Ibid.*

³⁵ *Ibid.*

³⁶ *Ibid.*

Aquifer type	Groundwater source and description
	variable transmissivities and yields as well as variable connectivity. Connectivity with surface water is low to moderate with travel time estimated to be years to decades. ³⁷
Fractured rock	Goulburn Fractured Rock Groundwater Source in the south west borders the Coxs River Fractured Rock Groundwater Source to the north west. The two fractured rock aquifers are separated by the Murrumbidgee Ranges and cover a combined area of about 9,876 square kilometres. Connectivity with surface water is low to moderate with travel time estimated to be years to decades. ³⁸

Groundwater extraction is concentrated along the alluvial watercourses. Most bores are used for domestic and stock supply, but the greatest volumes are assigned to mining leases and utilities. Most licences are aquifer access licences. Large areas of the Sydney Basin porous rock groundwater sources are covered by national parks, so there is little extraction.³⁹ Shallow bores dominate the plan area, particularly towards the coast, demonstrating reliance on alluvial aquifers. The Botany Sands groundwater source is a high yielding and low-salinity groundwater source which has been a significant source of water for commercial and industrial water use in Sydney.⁴⁰ The Botany Sands has significant historic contamination issues⁴¹ and has been fully embargoed since 2007 due to contamination and public health concerns. Due to these issues, the extraction of water is prohibited across much of the groundwater source under a Section 324 order (under the Act) until 30 June 2024.⁴²

Figure 6 shows a hydrogeological conceptual model for the interaction between aquifers and confining layers in the geological Sydney Basin where horizontal groundwater flow is significantly higher than vertical flow.⁴³ While vertical flow is typically minimal, some is expected through joints and vertical fractures.⁴⁴ Concerns have been raised regarding the connectivity across the southern water sources, but it is generally agreed that there is significant connection between the Hawkesbury River and adjacent Hawkesbury Alluvium in the north of the plan area.

³⁷ *Ibid.*

³⁸ *Ibid.*

³⁹ *Ibid.*

⁴⁰ *Ibid.*

⁴¹ See EPA (2020) *Orica Botany*. Available at: <https://www.epa.nsw.gov.au/working-together/community-engagement/community-news/orica-botany-bay-incident/orica-botany>.

⁴² DPIE-Water (2018) *Temporary Water Restrictions Order for the Botany Sands Groundwater Source 2018*. Available at: https://gazette.legislation.nsw.gov.au/so/download.w3p?id=Gazette_2018_2018-23.pdf

⁴³ Bradd, J., Cohen, T., Marx, S., Buckman, S., Burkhardt, E., Clarke, A., Cook, N., Cullen, S., Daley, J., Gavin, A., Hu, R., Kiekebosch-Fitt, E., Lemcke, M., Lowe, A., McMahon, T., McNeilage, L., O'Mara, K., Nagle, G., Robson, S., Silveri, C. and Stammers, J. (2012) *Bioregional assessment project: Sydney Metropolitan, Southern Rivers and Hawkesbury-Nepean Catchments: data collation phase to study the impact of mining activity and coal seam gas on environmental assets*. Faculty of Science, Medicine and Health – Papers. University of Wollongong. Available at: <http://ro.uow.edu.au/smhpapers/364>, based on Reynolds, R.G. (1976) *Coal mining under stored water: Report on an inquiry into coal mining under or in the vicinity of the stored waters of the Nepean, Avon, Cordeaux, Cataract and Woronora Reservoirs, New South Wales, Australia*, Department of Public Works, Sydney.

⁴⁴ Reynolds, R.G. (1976) *Coal mining under stored water: Report on an inquiry into coal mining under or in the vicinity of the stored waters of the Nepean, Avon, Cordeaux, Cataract and Woronora Reservoirs, New South Wales, Australia*, Department of Public Works, Sydney; Stammers, J. (2012) *Coal seam gas: Issues for consideration in the Illawarra region NSW, Australia*. Available at: <http://ro.uow.edu.au/thsci/45/> and references therein; Bradd, J., Cohen, T., Marx, S., Buckman, S., Burkhardt, E., Clarke, A., Cook, N., Cullen, S., Daley, J., Gavin, A., Hu, R., Kiekebosch-Fitt, E., Lemcke, M., Lowe, A., McMahon, T., McNeilage, L., O'Mara, K., Nagle, G., Robson, S., Silveri, C. and Stammers, J. (2012) *Bioregional assessment project: Sydney Metropolitan, Southern Rivers and Hawkesbury-Nepean Catchments: data collation phase to study the impact of mining activity and coal seam gas on environmental assets*. Faculty of Science, Medicine and Health – Papers. University of Wollongong. Available at: <http://ro.uow.edu.au/smhpapers/364>.

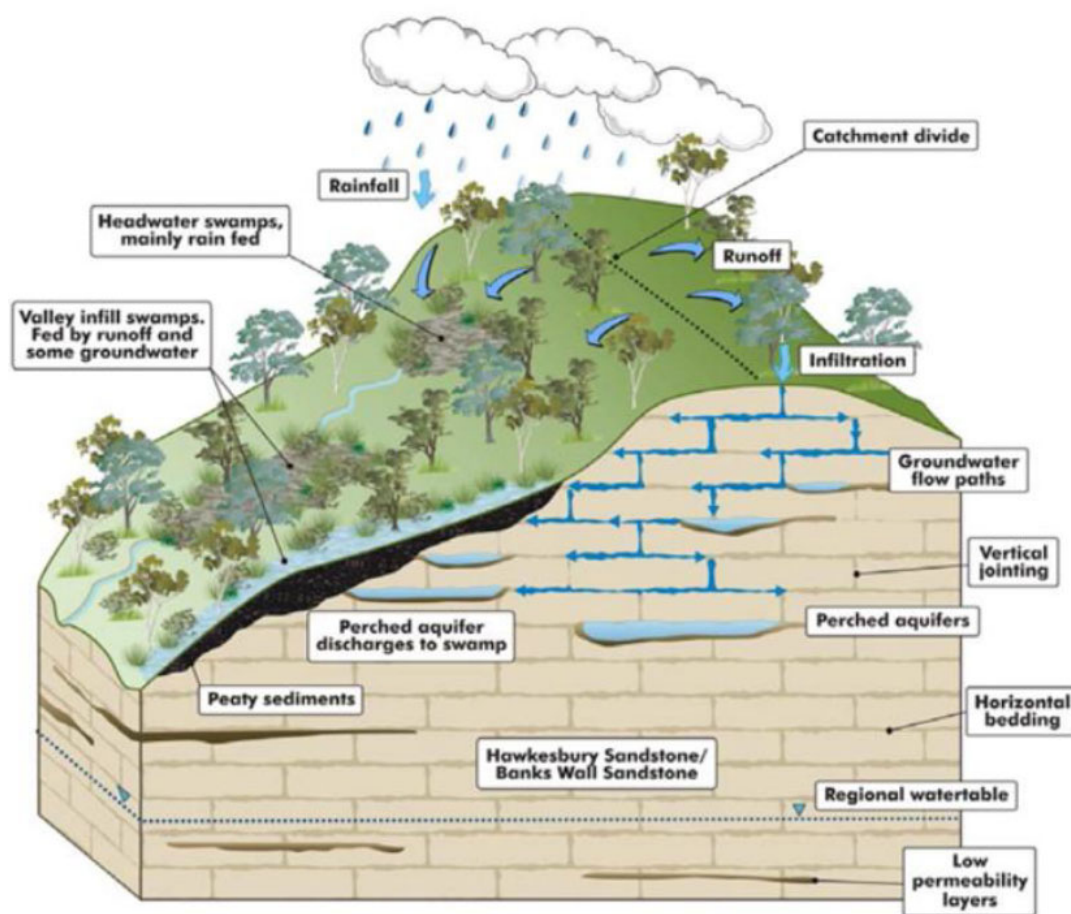


Figure 6: Hydrogeological conceptual model for the interaction between aquifers and confining layers present in the geological Sydney Basin⁴⁵

2.2 Environmental context

The plan area contains 128 national parks, reserves and conservation areas, including world and national heritage areas, particularly in the north-west (refer to **Figure 3**).

Thirty unregulated river management zones were identified during plan development as having high in-stream values, typically due to the presence of threatened species, populations, ecological communities and/or high diversity (**Appendix B**).⁴⁶ Three groundwater sources were also identified as having a high risk to environmental values from extraction due to potential

⁴⁵ Bradd, J., Cohen, T., Marx, S., Buckman, S., Burkhardt, E., Clarke, A., Cook, N., Cullen, S., Daley, J., Gavin, A., Hu, R., Kiekebosch-Fitt, E., Lemcke, M., Lowe, A., McMahon, T., McNeilage, L., O'Mara, K., Nagle, G., Robson, S., Silveri, C. and Stammers, J. (2012) *Bioregional assessment project: Sydney Metropolitan, Southern Rivers and Hawkesbury-Nepean Catchments: data collation phase to study the impact of mining activity and coal seam gas on environmental assets*. Faculty of Science, Medicine and Health – Papers. University of Wollongong. Available at: <http://ro.uow.edu.au/smhpapers/364>.

⁴⁶ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

impacts to GDEs or water quality for environmental flows (Coxs River Fractured Rock, Goulburn Fractured Rock and Botany Sands groundwater sources).⁴⁷

DPIE-EES advised that there are 158 listed threatened fauna and 167 threatened flora found in the plan area, as well as the water dependent and critically endangered Fitzroy Falls Spiny Crayfish (*Euastacus dharawalus*) and endangered Adams Emerald Dragonfly (*Archaeophya adamsi*), Australian Grayling (*Prototroctes maraena*), Macquarie Perch (*Macquaria australasica*) and Sydney Hawk Dragonfly (*Austrocordulia leonardi*).

The plan area has 58 listed high priority GDEs, including wetlands and swamps, vegetation communities and karst systems.⁴⁸ These include 19 endangered ecological communities and the Towra Point Nature Reserve a Ramsar-listed wetland on the southern shore of Botany Bay.⁴⁹ Many of the karst systems (such as the Jenolan Caves) occur in the Coxs River Fractured Rock or in the Goulburn Fracture Rock groundwater sources.⁵⁰

Rivers in the plan area have variable river condition as classified under the NSW State of the Environment reporting. The Hawkesbury-Nepean, Illawarra Coast and Shoalhaven were identified as being 'good' condition, while the Sydney Coast-Georges River was identified as being 'poor'.⁵¹ Conditions within these broad catchments are also variable over space and time. Elevated nutrient levels have been shown to impact water quality in areas with significant agricultural or urban development including in the Wollondilly, Wingecarribee, Mulwaree and (upper) Coxs Rivers.⁵²

The fractured rock groundwater sources around Goulburn have high salinity underlying some areas.⁵³ The water quality in the Metropolitan Coastal Sands and Maroota Sands groundwater sources are generally of good quality, although it has been recognised that sand mining at Maroota may impact the quality.⁵⁴

⁴⁷ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁴⁸ Schedule 4 of the Groundwater Plan.

⁴⁹ Schedule 4 of the Groundwater Plan; and Department of Environment, Climate Change and WaterNSW (2010) *Towra Point Nature Reserve Ramsar site, Ecological character description*. Available at: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Wetlands/towra-point-nature-reserve-ramsar-site-ecological-character-description-100510.pdf>.

⁵⁰ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁵¹ NSW EPA (2018) *NSW State of the Environment*. Available at: <https://www.soe.epa.nsw.gov.au/all-themes/water-and-marine/river-health#RCI>.

⁵² WaterNSW (2020) *Annual Water Quality Monitoring Report 2018-19*. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0005/155534/Annual-Water-Quality-Monitoring-Report-2018-19.pdf.

⁵³ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁵⁴ *Ibid.*

2.3 Socio-demographic context

The plan area services Sydney, a globally significant city, and the most populated region in Australia.⁵⁵ The plan area is extensive, with diverse socio-demographic characteristics. About half of the plan area is covered by what is known as the Greater Sydney region, which includes 33 LGAs (**Figure 7**).⁵⁶ Beyond Sydney, there are other major population centres and diverse socioeconomic characteristics and land uses within the plan area.

The population of Greater Sydney has grown by over 1.3 million in the last ten years, reaching an estimated resident population of 5.12 million in 2019.⁵⁷ This growth is expected to continue to 6.6 million by 2036.⁵⁸ Western Sydney (around Penrith, Badgerys Creek and Campbelltown and Macarthur) is expected to have the greatest proportional increase while eastern Sydney is projected to have the largest growth in the number of people.⁵⁹ The location and volume of water supplied and wastewater generated will increase with these future trends – this is being investigated in detail by Sydney Water and as part of the *Greater Sydney Water Strategy*.

Greater Sydney's footprint has grown not only through an increasing population, but a decline in dwelling occupancy rates (down from an average of 5.6 people per dwelling in 1909 to 2.8 in 2016) and a decline in density (down from an average of 13 people per hectare in 1909 to 4.3 people in 2016). Density is highest in Sydney's east (31 people per hectare), but this is still low compared to comparable global cities (New York City has an average density of 109 people per hectare).⁶⁰

Housing demand and prices continue to increase, as expectations have been shifting from the quarter-acre block to more compact and higher density housing. The NSW Government has identified that 725,000 additional homes will be needed by 2036 to meet demand based on current population projections. About a quarter of this growth is planned respectively for the western, central and eastern parts of the city, with lower growth to the north and south.⁶¹

⁵⁵ Australian Bureau of Statistics (2020) *Regional population*. Available at: [https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20\(113%2C500\)%20and%20Sydney%20,\(had%20the%20highest%20growth%20rates](https://www.abs.gov.au/statistics/people/population/regional-population/2018-19#:~:text=Melbourne%20(113%2C500)%20and%20Sydney%20,(had%20the%20highest%20growth%20rates).

⁵⁶ There is a total of 50 LGAs included wholly or in part within the areas of the Plans.

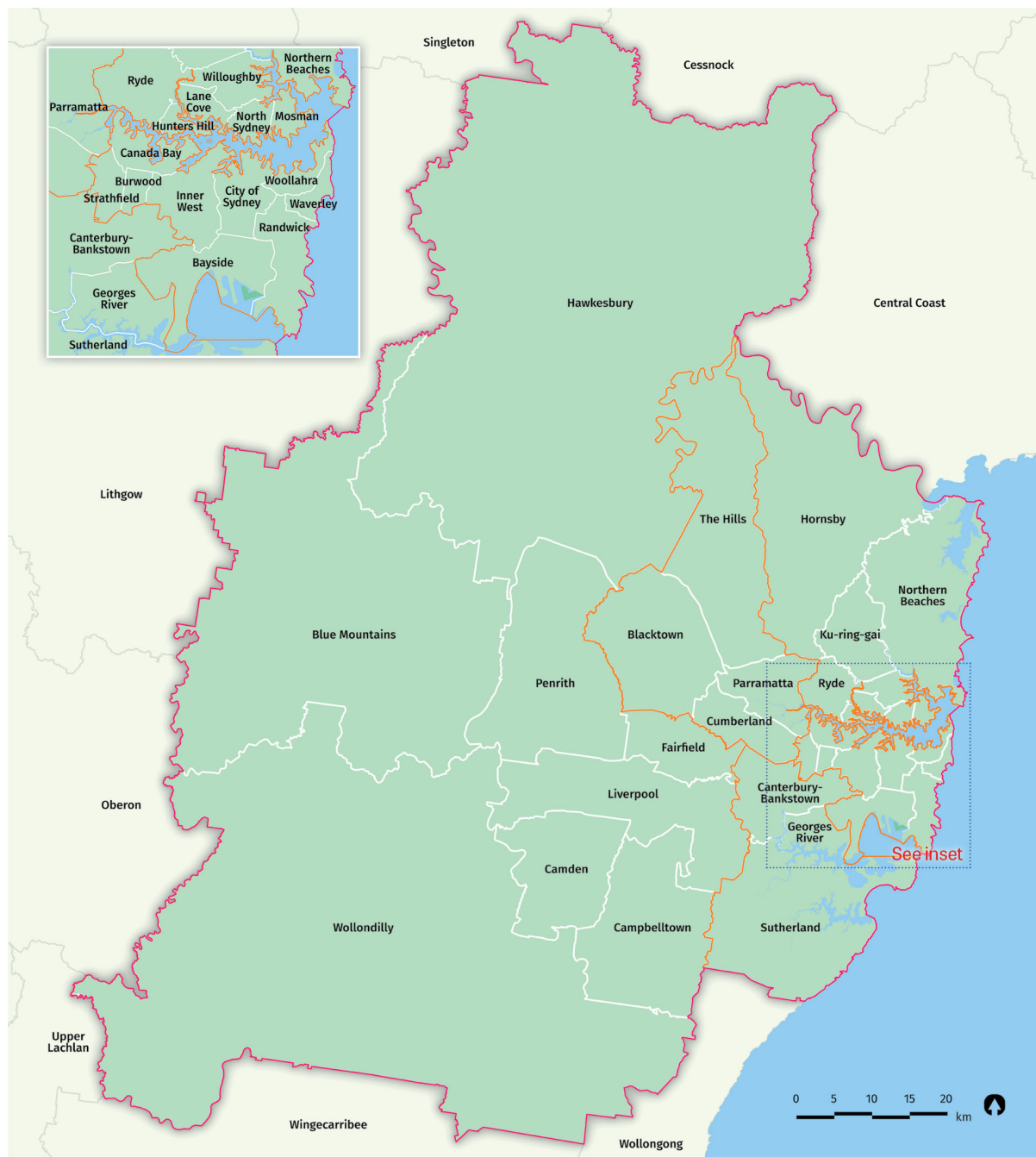
⁵⁷ Greater Sydney Commission (2019) *A Metropolis of three cities: past, present and future*. Available at: <https://www.greater.sydney/metropolis-of-three-cities/past-present-and-future>.

⁵⁸ DPIE (2020) *Population projections*. Available at: <https://www.planning.nsw.gov.au/Research-and-Demography/Population-projections>.

⁵⁹ Greater Sydney Commission (2018) *Greater Sydney Region Plan: A Metropolis of Three Cities*. Available at: <https://www.greater.sydney/metropolis-of-three-cities>.

⁶⁰ *Ibid.*

⁶¹ *Ibid.*



DISTRICTS	
Central City	Blacktown, Cumberland, Parramatta, The Hills
Eastern City	Bayside, Burwood, Canada Bay, City of Sydney, Inner West, Randwick, Strathfield, Waverley, Woollahra
North	Hornsby, Hunter's Hill, Ku-ring-gai, Lane Cove, Mosman, North Sydney, Northern Beaches, Ryde, Willoughby
South	Canterbury–Bankstown, Georges River, Sutherland
Western City	Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith, Wollondilly

Figure 7: Greater Sydney region, districts and LGAs⁶²

⁶² *Ibid.*

Other major LGAs in the plan area are located south of the Greater Sydney region and comprise Wollongong, Wingecaribee, Shoalhaven, Goulburn-Mulwaree and Queanbeyan-Palerang. Population has been steadily increasing at about 1 percent per year for each of these areas from 2006-2019, with Wollongong and the Shoalhaven having the largest populations in the area (an estimated resident population of 218,114 and 105,648 respectively in 2019).⁶³

Wollongong City is the most concentrated LGA, with the highest population density of about 3 persons per hectare.⁶⁴ Wollongong City is a combined rural and residential area, and also has substantial industrial, port and commercial areas and water catchments, which collectively constitute 60 percent of total land use. Urban development is mainly along the coast. Primary production accounts for 9 percent of land use while parkland is 25 percent of land use.⁶⁵

Shoalhaven City has a population density of 2.4 persons per hectare. It is a growing residential area, concentrated along the coastal fringe, in major centres and numerous small settlements. It is also a growing tourist area and is the most visited LGA in NSW outside of Sydney.⁶⁶ There are substantial areas of national park, state forest, bushland, beaches and lakes – with parkland representing 53 percent of land use in the area. Rural land is used mainly for dairy farming, beef cattle, nurseries, and a growing number of more intensive agricultural activities, with primary production representing 16 percent of land use.⁶⁷

In contrast, Queanbeyan-Palerang, Wingecaribee Shire and Goulburn Mulwaree LGAs have lower populations (61,100, 51,134 and 31,132 respectively) and densities (0.1, 0.2 and 0.1 persons per hectare respectively) and are mostly rural and rural-residential.

The Queanbeyan-Palerang Regional Council area is predominantly rural but with fast growing rural-residential areas of medium-high density housing, particularly in the west, closest to Canberra. Primary production represents 54 percent of land use, particularly for sheep and cattle grazing, orchards, nurseries, crop growing, honey production and vineyards. Tourism is also a growing industry in the region due to its proximity to Canberra and the snowfield areas.⁶⁸

Wingecaribee also has higher density towns and villages including Bowral, Mittagong and Moss Vale which are popular ‘tree-change’ locations.⁶⁹ However, the area remains predominantly low-density separate housing (representing 90 percent of dwelling types in the area). Primary production land represents 35 percent of all land uses, mainly for sheep and cattle grazing, with some timber production, fruit and vegetable growing, mining and viticulture.⁷⁰

The Goulburn Mulwaree Council area is 70 percent primary production land use, particularly for sheep grazing, some cattle grazing and boutique industries. Population growth has been focused in the city of Goulburn.⁷¹

⁶³ id Demographic Resources (2020) Community profiles for Wollongong City, Shoalhaven City, Wingecaribee, and Goulburn Mulwaree Local Government Areas. Available at: <https://profile.id.com.au>.

⁶⁴ id Demographic Resources (2020) *Community profile for Wollongong City*. Available at: <https://profile.id.com.au>.

⁶⁵ *Ibid.*

⁶⁶ id Demographic Resources (2020) *Community profile for Shoalhaven City*. Available at <https://profile.id.com.au>

⁶⁷ *Ibid.*

⁶⁸ id Demographic Resources (2020) *Community profile for Queanbeyan-Palerang*. Available at: <https://profile.id.com.au>.

⁶⁹ id Demographic Resources (2020) *Community profile for Wingecaribee*. Available at: <https://profile.id.com.au>.

⁷⁰ *Ibid.*

⁷¹ id Demographic Resources (2020) *Community profile for Goulburn Mulwaree*. Available at <https://profile.id.com.au>.

Given these socio-demographic trends across the plan area, there are significant challenges in addressing population growth, demographic and housing change, while ensuring liveability remains high. Key planning documents for the region consistently note this as Greater Sydney's most pressing challenge.⁷²

These trends also have obvious implications for water sharing and planning, as noted in the *2017 Metropolitan Water Plan*.⁷³ Currently, around 70 percent of all water supplied in Greater Sydney is used by residential households. Increased urban density increases drinking water demand and impacts waterway health. Planning must integrate water management to meet the community's expectations for more liveable urban communities, particularly for watering public open spaces for passive and active recreation and to improve neighbourhood amenity.⁷⁴

2.4 Aboriginal context

The Plans cover an area of cultural significance to First Nation peoples who are the original occupants and custodians of the land: including the Yuin in the Shoalhaven; Tharawal in the Shoalhaven and Illawarra up to Botany Bay; Eora to the north and west of Tharawal and to the boundary of the Hawkesbury River catchment; Dharug around the Hawkesbury catchment; and Gundungurra around the Wollondilly River. As shown in **Figure 8**, the plan area covers 17 LALC areas and there are three native title claims in the plan area, including along the South Coast and in the north-west (see **Section 9.1**). There are thousands of known registered Aboriginal sites, middens, shelters, deposits, engravings, rock art, relics, and burial sites and many more which remain unregistered.⁷⁵

Rivers in the plan area have always been significant for Aboriginal peoples for a range of cultural, spiritual, economic and practical reasons, including being a source of sustenance, economic livelihood, tradeable goods, forming clan boundaries and their role in the Dreaming. For example, one of the earliest documented evidence of Aboriginal people living along the Cooks River is a 10,500-year-old fireplace at Wolli Creek. The river was a central part of Aboriginal people's social, economic and cultural practices in the area and provided an abundance of fish and other food sources. An oral history project undertaken in the late 1990s in the area notes that many Aboriginal people still talked about walking and riding along the river, playing there as children or watching their children play. As Metropolitan LALC CEO Nathan Moran expressed it, being near the river '*you feel a beautiful power and spirit and flow to it*'.⁷⁶

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- ⁷² Greater Sydney Commission (2019) *A Metropolis of three cities: past, present and future*. Available at: <https://www.greater.sydney/metropolis-of-three-cities/past-present-and-future>; City Futures Research Centre (2013) *Implementing metropolitan planning strategies: taking into account local housing demand, Technical Report*. Available at: <https://cityfutures.be.unsw.edu.au/research/projects/implementing-metropolitan-planning-strategies/>; DPI (2017) *Sydney Housing Supply Forecast 2016 - By District*, NSW Government, Sydney.
- ⁷³ Metropolitan Water (2017) *2017 Metropolitan Water Plan Water for a Liveable, Growing and Resilient Greater Sydney*. Available at: <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/About-us/Metropolitan-Water/2017-Metropolitan-Water-Plan.pdf>.
- ⁷⁴ *Ibid.*
- ⁷⁵ Metropolitan LALC (2019) *Metro's Significant Landmarks and Footprints in the Rock*. Available at: <https://metrolalc.org.au/about-us/our-history/>.
- ⁷⁶ Australian Government and the Cooks River Alliance (2017) *Aboriginal history along the Cooks River*. Available at: <http://cooksriver.org.au/publications/aboriginal-history-along-cooks-river/>.

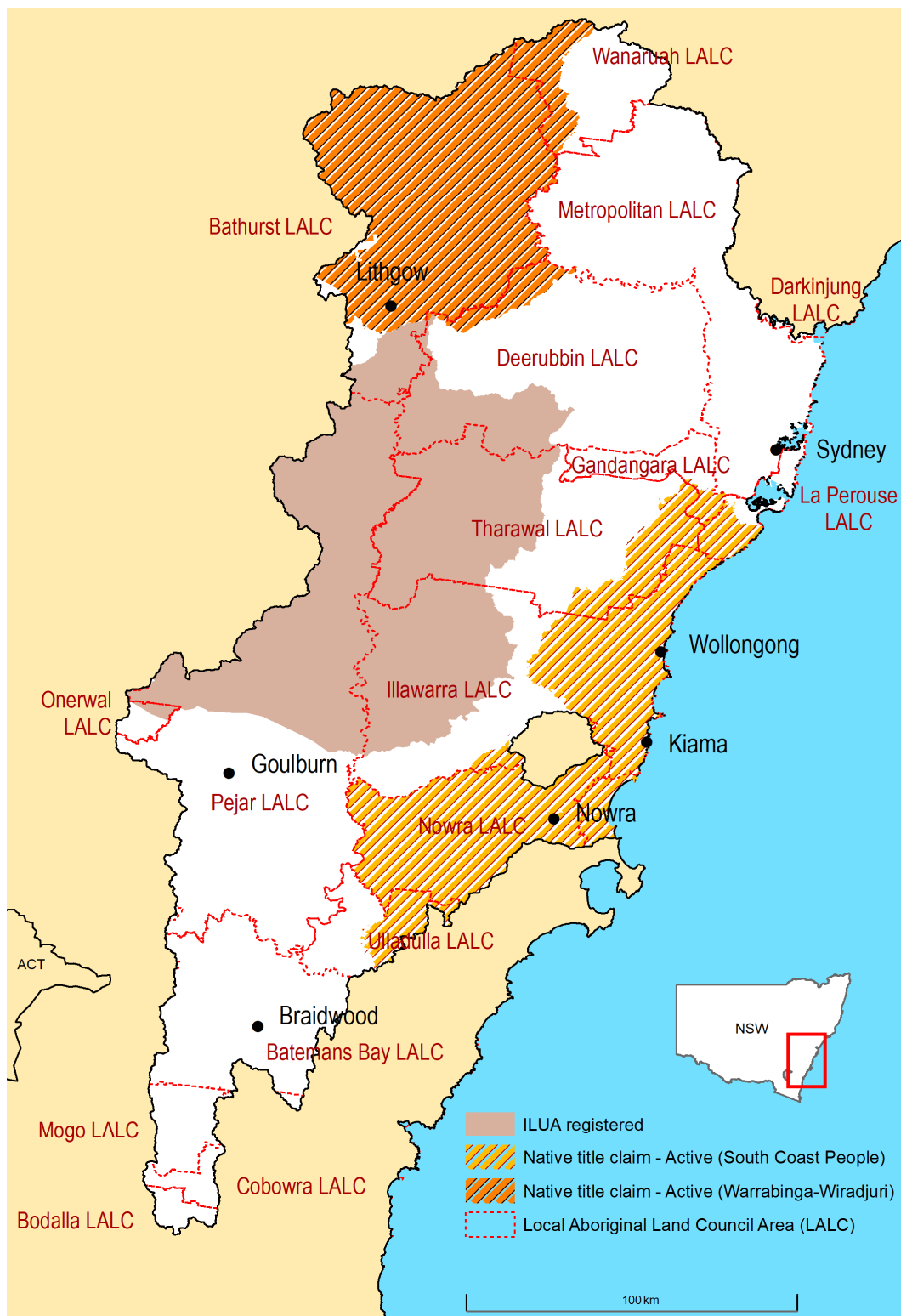


Figure 8: The plan area with native title and land council boundaries⁷⁷

⁷⁷ Map developed by the Commission using LALC data provided by DPI and native title areas from the National Native Title Tribunal website.

2.5 Economic context

Greater Sydney comprises much of the NSW economy, contributing over 70 percent of Gross State Product (GSP). Across the plan area, the high value industries are consistently health care and social assistance, construction, and manufacturing. Financial and insurance services is obviously of higher value closer to the Sydney CBD, while agricultural value tends to increase in more regional and rural parts, but overall remains quite low across the whole area. Many of the key industries have at least some degree of dependence on water supply sourced from within these plan areas, particularly manufacturing and construction. In addition, a good portion of NSW power supply is dependent on water sources in the plan areas.

The Greater Sydney's Gross Regional Product (GRP) is estimated at \$433 billion, which represents just under 73 percent of NSW's GSP.⁷⁸ This has been growing steadily at an average of 2.9 percent per year over the last ten-year period (2009-19), above the NSW average growth in GRP of 2.4 percent.⁷⁹

In Greater Sydney, financial and insurance services are the most productive industry, generating \$65 billion in 2018/19. **Table 3** lists the top ten most productive industries by value added⁸⁰ for the region (out of 19 industry categories). Agriculture and mining have been included as addendums as they are key water users in the plan area.

⁷⁸ The Gross Regional Product of an area is the equivalent of Gross Domestic Product, but for a smaller area. It is the amount of the nation's wealth which is generated by businesses, organisations and individuals working in the area. This dataset is derived from the National Economics microsimulation model and is a broad indicator of the growth or decline of the local economy over time. See: <https://economy.id.com.au/rda-sydney/gross-product>

⁷⁹ idProfile (2019) *Economic profile – Greater Sydney*. Available at: <https://economy.id.com.au/rda-sydney/gross-product>

⁸⁰ Value added by industry is an indicator of business productivity. It shows how productive each industry sector is at increasing the value of its inputs. It is a more refined measure of the productivity of an industry sector than output (total gross revenue), as some industries have high levels of output but require large amounts of input expenditure to achieve that (idProfile (2019) *Economic value – value added*. Available at: <https://economy.id.com.au/value-add-by-industry>).

Table 3: Top ten industries by value added in Greater Sydney 2018/19 (to nearest \$ billion)⁸¹

Top ten industries	\$ billion	% of total	% change 2010/11 – 2018/19
Financial & Insurance Services	65	17.7	37.1
Professional, Scientific and Technical Services	43	11.7	46.4
Construction	31	8.4	51.7
Health Care & Social Assistance	24	6.5	37.8
Transport, Postal & Warehousing	23	6.2	12.7
Manufacturing	22	5.9	-7.3
Wholesale Trade	20	5.5	32.5
Administrative and Support Services	18	5.0	26.1
Public Administration and Safety	18	5.0	21.9
Rental, Hiring and Real Estate Services	18	4.9	75.2
<i>Mining</i>	2	0.6	41.9
<i>Agriculture, forestry & fishing</i>	1	0.3	-1.6

For other major LGAs in the plan areas, the GRP and major value-added industries are summarised below:

- **Wollongong City:** estimated at **\$12.2 billion** GRP, representing 2 percent of NSW's GSP. **Health care and social assistance** is the sector with the most value added, generating \$1 billion in 2018/19.
- **Shoalhaven City:** estimated at **\$4.7 billion** GRP, representing 0.8 percent of NSW's GSP.
- **Queanbeyan-Palerang:** estimated at **\$2.5 billion** GRP, representing 0.4 percent of NSW's GSP. **Public administration and safety** is the largest industry, generating \$317 million in 2018/19.
- **Wingecarribee Shire:** estimated at **\$2.9 billion** GRP, representing 0.48 percent of NSW's GSP.
- **Goulburn Mulwaree:** estimated at **\$1.54 billion** GRP, representing 0.3 percent of NSW's GSP. **Public administration and safety** is the largest industry, generating \$180 million in 2018/19.

More detail is provided in **Table 4**, which lists the top ten industries by value added for three of these LGAs for which this data is available. Again, agriculture, mining, manufacturing, and construction have been included as addendums (in italics) where required as they are key water users.

⁸¹ Source: id Demographic Profiles (2019) *Economic profile – Greater Sydney*. Available at: <https://economy.id.com.au/rda-sydney/value-add-by-industry>.

Table 4: Value added by industry \$m (top ten) for key LGAs in 2018/19

Wollongong City (LGA)	Queanbeyan-Palerang Regional Council	Goulburn Mulwaree (LGA)
Health Care & Social Assistance \$1,077 (10.8%)	Public Administration and Safety \$317 (16.6%)	Public Administration & Safety \$180 (14.1%)
Education & Training \$979 (9.9%)	Construction \$268 (14%)	Health Care & Social Assistance \$156 (12.2%)
Construction \$966 (9.7%)	Professional, Scientific and Technical Services \$168 (8.8%)	Construction \$137 (10.7%)
Mining \$895 (9%)	Manufacturing \$162 (8.5%)	Manufacturing \$95 (7.4%)
Financial & Insurance Services \$792 (8%)	Health Care and Social Assistance \$129 (6.7%)	Transport, Postal & Warehousing \$88 (6.9%)
Transport, Postal & Warehousing \$732 (7.4%)	Education and Training \$123 (6.4%)	Education & Training \$83 (6.5%)
Professional Services \$653 (6.6%)	Retail Trade \$105 (5.5%)	Retail Trade \$82 (6.4%)
Manufacturing \$576 (5.8%)	Rental, Hiring and Real Estate Services \$92 (4.8%)	Agriculture, forestry & Fishing \$72 (5.6%)
Public Administration & Safety \$533 (5.4%)	Wholesale Trade \$88 (4.6%)	Accommodation & Food Services \$59 (4.6%)
Rental, Hiring, Real Estate \$399 (4%)	Transport, Postal and Warehousing \$86 (4.5%)	Mining \$56 (4.4%)
<i>Agriculture, forestry & fishing</i> <i>\$18 (0.2%)</i>	<i>Agriculture, forestry & Fishing</i> <i>\$58 (3%)</i>	NA
NA	<i>Mining</i> <i>\$27 (1.4%)</i>	

Note: table includes value added in \$million for the top ten industries in each area. The percentages are the proportion of total value added across all industries.

Note: bold text indicates key water-dependent industries.

2.5.1 Surface water extraction and LTAAELs

The Surface Water Plan states 1,197,554 ML per year of licenced entitlements and an additional estimated 32,252 ML per year of estimated domestic and stock basic landholder rights.⁸² Data from the *NSW Water Register* provided by WaterNSW in 2019 indicated licenced entitlements had increased by 2,390 to 1,199,944 ML per year.

Figure 9 shows the distribution of entitlement across the Surface Water Plan area. The majority of entitlement is held by WaterNSW for urban water supply. Sydney Water and power generation companies (Energy Australia) also hold major utility licences.⁸³ Potential extraction is concentrated in the Hawkesbury-Nepean, with 55 percent (676,364 ML per year)⁸⁴ of all

⁸² Basic landholder rights as per Clause 20 of the Surface Water Plan.

⁸³ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

⁸⁴ Note that some entitlement is recorded as ML and some as unit shares. Numbers throughout the report assume 1 ML per unit share.

entitlement in the Upper Nepean and Upstream Warragamba Extraction Management Unit (the two Hawkesbury-Nepean management units have a combined 65 percent of entitlement), followed by 30 percent (373,575 ML per year) in the Shoalhaven River Extraction Management Unit.

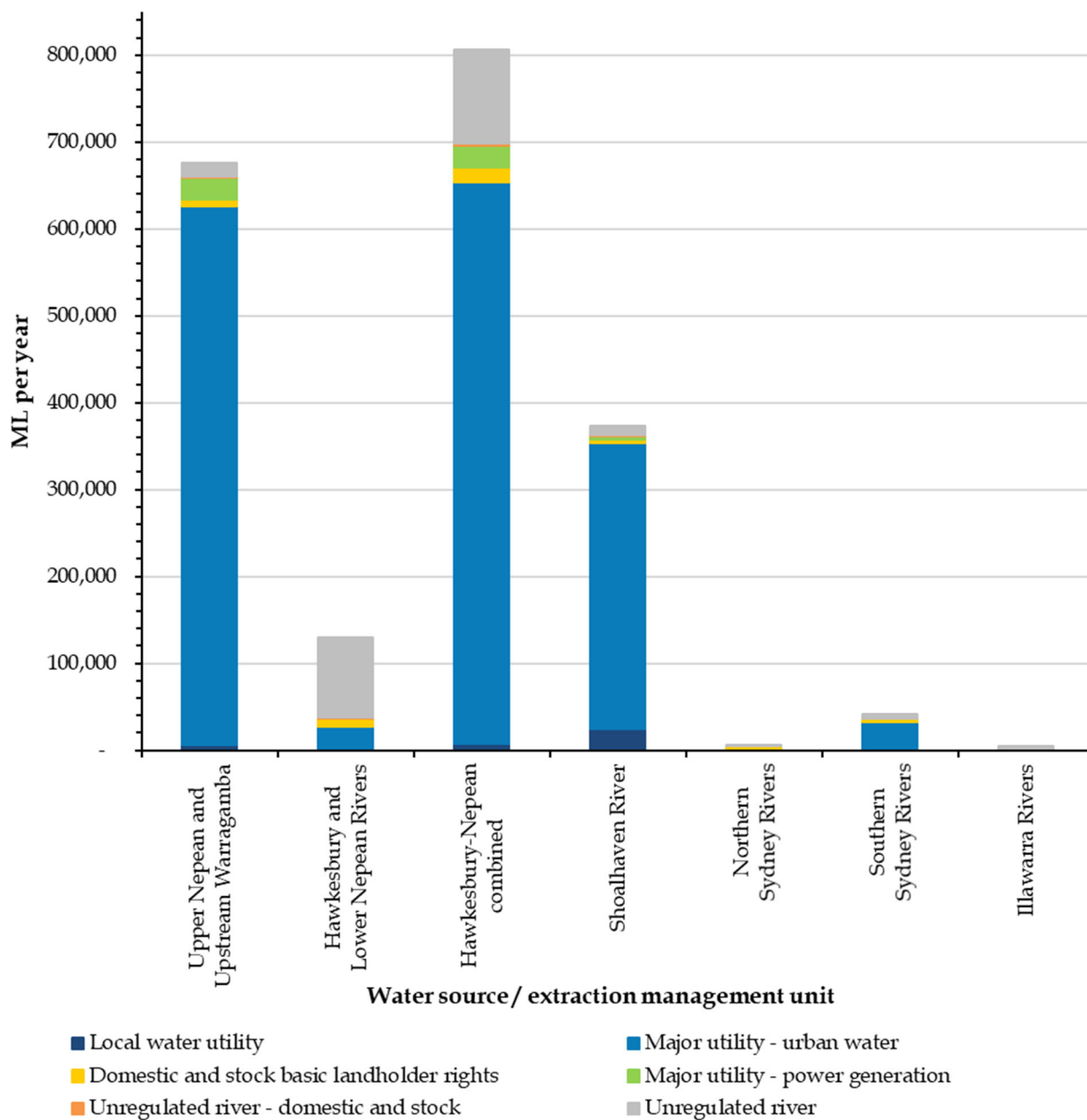


Figure 9: Licenced shares in 2019 and basic landholder rights as defined in the Surface Water Plan⁸⁵

For the two Hawkesbury-Nepean extraction management units, the LTAAELs for the non-WaterNSW licences are limited to the average annual extraction from July 1993 to June 1999 (under the *Water Act 1912*, entitlement plus native title and domestic and stock basic landholder rights, and licences for tidal pool extraction).⁸⁶ For the other extraction management units in the plan area, the LTAAEL for the non-WaterNSW licences are limited to the share components of all access licences, native title and domestic and stock basic landholder rights and licences for

⁸⁵ Basic landholder rights as per Clause 20 of the Surface Water Plan and licenced entitlement based on data provided by WaterNSW, 18 October 2019.

⁸⁶ Summarised from Clause 41 in the Surface Water Plan.

tidal pool extraction at the commencement of the Plan.⁸⁷ WaterNSW has separate LTAAELs for each extraction management unit in the plan area where they hold licences.

2.5.2 Groundwater extraction and LTAAELs

The Groundwater Plan has 62,348 ML per year of entitlements and an additional 19,663 ML per year of estimated domestic and stock basic landholder rights.⁸⁸ In 2019 licenced entitlement had increased to 86,188 ML per year.⁸⁹ This is summarised in **Figure 10**. Of this, 35 percent of potential extraction (licenced or domestic and stock rights only) is in the Sydney Basin Nepean, and 17 percent is in the Sydney Basin Richmond water sources.⁹⁰ This does not include all potential extraction (see **Section 4.4** on activities not accounted for under the Groundwater Plan). Groundwater licences for utility supply is 142 ML, although the Commission understands this is not actively used by local water utilities or Sydney Water.⁹¹

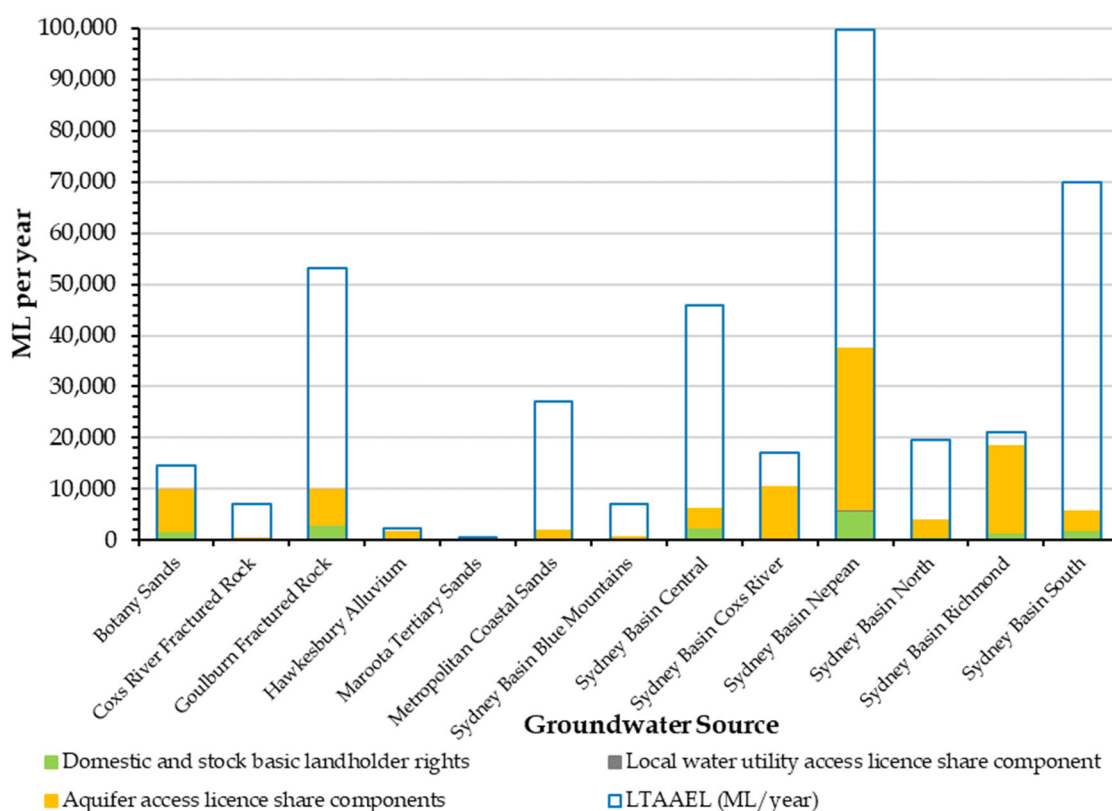


Figure 10: Licenced entitlement in 2019, and basic landholder rights and LTAAELs as defined in the Groundwater Plan⁹²

⁸⁷ Summarised from Clause 41 of the Surface Water Plan.

⁸⁸ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁸⁹ Licenced entitlement based on data provided by WaterNSW on 18 October 2019, basic landholder rights are as defined in Clause 19 of the Groundwater Plan.

⁹⁰ Based on data provided by WaterNSW on 18 October 2019.

⁹¹ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁹² Basic landholder rights as per Clause 19 and LTAAEL as per Clause 26 of the Groundwater Plan, licenced entitlement based on data provided by WaterNSW on 18 October 2019.

2.5.3 Industries dependent on water extraction

Fourteen surface water management zones⁹³ were classified as having a high level of economic dependence on commercial extraction for irrigation purposes, town water, or industrial water supply during Surface Water Plan development.⁹⁴ These were focused around the Hawkesbury-Nepean and Shoalhaven areas. Three groundwater sources were identified during Groundwater Plan development as having a high risk to financial assets due to the reliance on commercial extraction, particularly for vineyards, orchards, and permanent plantings. Maroota Tertiary Sands has high employment associated with groundwater uses for agriculture and industry (including sand and gravel mining), although it has a low level of extraction compared to other groundwater sources.⁹⁵

The plan area includes mining and extractive resources such as underground coal mining operations and coal seam gas (primarily in the south west), and extractive industries such as quarries for construction and landscaping, which are more broadly distributed. These industries contribute significant economic value to the region (see **Table 3** and **Table 4**).

Gross agricultural production in the Greater Sydney Region⁹⁶ was \$768 million in 2018-19 around five per cent of the value of NSW's agricultural output.⁹⁷ Agriculture in the plan area is focused on poultry, eggs, vegetables, nurseries, cultivated turf and cut flowers.⁹⁸ In 2018-19, agricultural commodities in the Greater Sydney region had a value of \$442 million from crops, \$241 million livestock slaughtered (and other disposals) and \$220 million from nurseries, cut flowers and cultivated turf.⁹⁹ Many of these industries also provide broader values, as described in one submission:

⁹³ Lower Kangaroo River; Broughton Creek; Broughton Mill Creek; Kangaroo River; Werriberri Creek; Upper Nepean River Tributaries Headwaters; Mid Nepean River Catchment; Lower Nepean River; Upper Hawkesbury River (Grose River to South Creek); Upper Hawkesbury River (South Creek to Cattai Creek); Upper Hawkesbury River (Cattai Creek to Colo River); Lower Hawkesbury River; Upper South Creek; Lower South Creek; and Cattai Creek management zones.

⁹⁴ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/668373/background-document-kangaroo-river-2016.pdf.

⁹⁵ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

⁹⁶ As defined by the Australian Bureau of Statistics Natural Resource Management Region.

⁹⁷ As defined by the Australian Bureau of Statistics Natural Resource Management Region.

⁹⁸ For example, the Shoalhaven River catchment supports various agricultural industries (dairying, vegetables, flowers, olives, vineyards and livestock, prawns, fish and oysters), recreational activities and production of energy, paper, sand and gravel. The Illawarra River catchment predominantly supports agriculture (dairying and beef, turf, vineyards, vegetables, fruit trees and nurseries), recreational activities and mining. The Hawkesbury-Nepean catchment supports agricultural industries (cropping, nurseries, turf, vegetables, orchards, cut flowers and livestock, fish, prawns, and oysters), recreational activities on land and on the water, mining, power generation and manufacturing (see DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf).

⁹⁹ Australian Bureau of Statistics (2020) *7503.0 - Value of Agricultural Commodities Produced, Australia, 2018-19*. Available at: <https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7503.02018-19?OpenDocument>.

'The turf production industry is a significant industry in the region with an estimated value of \$83 million a year to the NSW economy and contributes to the environmental, social and mental health and wellbeing of millions of people...green open spaces are worth an estimated \$5.3 billion dollars per year to the Greater Sydney region'.¹⁰⁰

2.5.4 Non-extractive industries dependent on water

Water in the region is also highly valued for its non-extractive uses such as for fishing, tourism and recreation. The wild-catch fishing industry generates more than \$82.6 million in revenue and 489 full-time jobs for Sydney and the Central Coast, and more than \$30 million revenue and over 284 full-time jobs in the Illawarra-Shoalhaven.¹⁰¹

In 2013, recreational fishing output in Sydney was estimated to be \$1 billion, with \$492 million value added.¹⁰² In 2016, the University of Technology Sydney's research estimated a quarter of residents in Sydney and over a third in the Illawarra-Shoalhaven identified as recreational fishers.¹⁰³

Greater Sydney receives around 3.8 million international visitors who stay 78 million nights. The tourism industry in Greater Sydney contributed \$15.4 billion to the national economy (4.7 percent of Gross Domestic Product) and directly employed 74,300 people in 2014–15.¹⁰⁴ Sydney's waterways and green spaces are a major attraction for visitors, and support recreation for the local population.

2.6 Climate

Annual average rainfall varies across each catchment, from 700-1,600 millimetres in the Hawkesbury-Nepean, 700-2400 millimetres in the Shoalhaven River, 1,200-2,300 millimetres in the Illawarra, and 900-1,500 millimetres in metropolitan Sydney.¹⁰⁵ The effects of the recent

¹⁰⁰ Submission: Turf New South Wales, received 27 April 2020.

¹⁰¹ FRDC and UTS (2016) *Valuing Coastal Fisheries, Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries - Sydney*. Available at: http://frdc.com.au/Archived-Reports/FRDC%20Projects/2014-301%20One%20page%20policy%20-%20Sydney_final.PDF; FRDC and UTS (2016) *Valuing Coastal Fisheries, Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries - Illawarra-Shoalhaven*. Available at: http://frdc.com.au/Archived-Reports/FRDC%20Projects/2014-301%20One%20page%20policy%20-%20Shoalhaven-Illawarra_final.PDF.

¹⁰² McIlgorm, A. and J. Pepperell (2013) *Developing a cost effective state-wide expenditure survey method to measure the economic contribution of the recreational fishing sector in NSW in 2012*. A report to the NSW Recreational Fishing Trust, NSW DPI. Available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/499302/UOW-statewide-economic-survey-final-report.pdf.

¹⁰³ FRDC and UTS (2016) *Valuing Coastal Fisheries, Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries - Sydney*. Available at: http://frdc.com.au/Archived-Reports/FRDC%20Projects/2014-301%20One%20page%20policy%20-%20Sydney_final.PDF; FRDC and UTS (2016) *Valuing Coastal Fisheries, Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries Fisheries - Illawarra-Shoalhaven*. Available at: http://frdc.com.au/Archived-Reports/FRDC%20Projects/2014-301%20One%20page%20policy%20-%20Shoalhaven-Illawarra_final.PDF.

¹⁰⁴ Destination NSW (2020) *Blue Mountains Visitor Profile - Year ending December 2019*. Available at: <https://www.destinationnsw.com.au/wp-content/uploads/2020/04/blue-mountain-fact-sheet-ye-dec-19.pdf>.

¹⁰⁵ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

drought can be seen in the flow monitoring data in Sydney's drinking water catchment.¹⁰⁶ Between 2016 and 2019, just over half of the flow monitoring stations had significantly reduced streamflow levels compared to the long term.¹⁰⁷ Only the Upper Coxs River and Upper Nepean River sub-catchments had substantially higher median flows in this period due to controlled releases such as those associated with the Wallerawang Power Station.¹⁰⁸

Climate change may put further pressure on resources and creates challenges for future water management in the region. NSW Government modelling¹⁰⁹ indicates a mean temperature increase of 0.7 degrees Celsius by 2030 for Metropolitan Sydney¹¹⁰ and 0.6 degrees Celsius for the Illawarra, with temperature increases in all seasons, more hot days and fewer cold nights.¹¹¹ Temperature is currently the most reliable indicator of climate change.

Rainfall projections are less certain.¹¹² Projections across models for Metropolitan Sydney range from a 13 percent decrease to 18 percent increase by 2030, and 9 percent decrease to a 24 percent increase by 2070. Illawarra models range from a 13 percent decrease to a 12 percent increase by 2030, and a 9 percent decrease to a 30 percent increase by 2070. For both regions, seasonal rainfall projections all span both drying and wetting scenarios for 2030 and 2070.¹¹³ Evapotranspiration – another key driver of water availability – is projected to increase in eastern Australia by 2090 relative to 1995.¹¹⁴

DPIE-Water advised the Commission that it is working on methods to better understand and address climatic risk to water management outcomes across NSW. This includes developing methods to incorporate climate change information based on DPIE-EES' NSW and ACT Regional Climate Modelling Project (NARClIM) climate modelling. This will be incorporated into the *Greater Sydney Water Strategy*.

¹⁰⁶ Specifically, the Boro Creek, Braidwood, Bungonia Creek, Kangaroo River, Kowmung River, Mid Coxs River, Mid Shoalhaven River, Mongarlowe River, Nattai River, Reedy Creek, Upper Nepean River, Werriberri Creek, Wingecarribee River, Wollondilly River and Woronora River catchments.

¹⁰⁷ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

¹⁰⁸ *Ibid.*

¹⁰⁹ The NSW Government has undertaken climate modelling as part of the NARClIM project, which produced a suite of 12 regional climate projections for south-east Australia across a range of likely climate scenarios.

¹¹⁰ Metropolitan Sydney is smaller than the plan area, a map of the Metropolitan Sydney Region is presented in OEH (2014) *Metropolitan Sydney Climate change snapshot*. Available at: <https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/Metro-Sydney-Climate-Change-Downloads>.

¹¹¹ *Ibid.*; and OEH (2014) *Illawarra Climate change snapshot*. Available at: <https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/Illawarra-Climate-Change-Downloads>.

¹¹² Future changes in rainfall patterns are more challenging to model due to the complexities of weather systems that generate rain. As such, there is greater uncertainty around potential changes to rainfall, including average levels, seasonality and extremes such as drought and floods (See: *Ibid.*).

¹¹³ OEH (2014) *Metropolitan Sydney Climate change snapshot*. Available at: <https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/Metro-Sydney-Climate-Change-Downloads>.

¹¹⁴ CSIRO (2016) *Australian changing climate*. Available at: https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/176/AUSTRALIAS_CHANGING_CLIMATE_1.pdf.

3 Overall advice on extension and replacement

3.1 The Plans should be replaced once further foundational work is done

The Commission's review has identified a range of issues that justify replacing the Plans. Major issues include:

- The overall water balance for the Greater Metropolitan region cannot be determined based on information available to the Commission, or adequately managed by the current Plans. There is currently no comprehensive modelling framework for the Greater Metropolitan system to develop plan rules and assess outcomes and risks (see **Chapter 4**).
- Many LTAAELs in the Plans cannot be calculated, compared across catchments, and/or are not based on sound evidence. Some limits may be increased with no assessment of sustainability. Several forms of extraction both within and outside the regulation of the Plans are not accounted for (see **Chapter 4**).
- Plans do not share water equitably between users. There are several aspects of the Plans that result in inequity across the plan area. The Plans do not define what equitable sharing would mean or explicitly outline how they support community benefits or incorporate equity into their objectives. Access to some releases and LTAAEL compliance rules are also inequitable (see **Chapter 5**).
- Not all the release and transfer rules for the major dams under the Surface Water Plan have been developed, designed appropriately or adequately implemented (see **Chapter 6**).
- Daily access rules are often inappropriate or add unnecessary complexity, which limits outcomes. AWDs cannot be used to ensure extraction limit compliance or to ration water during drought (see **Chapter 7**).
- The Surface Water Plan does not use the standard water sharing plan management hierarchy. As a result, trading rules that would normally be managed over a larger area are restricted to small river lengths, limiting trade activity (see **Chapter 8**).
- The Plans do not adequately manage connectivity, and the protection of GDEs would be improved through clarification of definitions (see **Chapter 8**).
- There is limited understanding of ecological requirements for the estuaries and the protection of their outcomes, including community value, is therefore uncertain (see **Chapter 8**).
- The Plans do not provide outcomes for Aboriginal peoples (see **Chapter 9**).

Overall, the design of the Plans focus on unnecessarily prescriptive and detailed rules, often without frameworks to support their implementation. This has resulted in provisions that are often difficult for managers or water users to understand or apply, are resource intensive and, in some cases, ineffective.

Given these issues, the Plans do not adequately manage a range of risks to environmental, social and economic outcomes. The Commission recommends replacing the Plans to strengthen rules protecting environmental outcomes in accordance with the priority they are afforded under the Act, as well as supporting social, cultural and economic outcomes. The Plans should be redesigned to focus on outcomes, and flexible rules that are simple and practical to implement. The rules should leverage new technology to achieve more efficient outcomes.

Replacing the Plans will provide an opportunity to increase the equity and appropriateness of other rules governing how much, when and where water can be extracted.

3.2 Greater Metropolitan planning processes should align

There was significant investment in improving water management in the region before the Plans were implemented in 2011 (see for example, the Hawkesbury-Nepean River Recovery Project discussed in **Section 4.4.1**). While the management of Sydney's water supply has been a key focus for policy makers, issues such as stormwater harvesting, recycled water, capture of groundwater through building construction and shepherding of environmental water released from Sydney's water supply dams have more limited policy frameworks.

The *Metropolitan Water Plan* was last updated in 2017 and provides a blueprint for securing water for a 'liveable, growing and resilient Greater Sydney'.¹¹⁵ The *Metropolitan Water Plan* was initially developed in 2004, was updated in 2006, 2010 and 2017. It is being replaced with the *Greater Sydney Water Strategy*, due to be released mid-2021 and will have implications across the Plans and vice versa.

The *Greater Sydney Water Strategy* will consider water management on a 'whole of water cycle' basis, with the aim to make Sydney's water supply security resilient to drought and climate change.¹¹⁶ It will investigate longer-term management and infrastructure investment, such as wastewater management and recycling, dam modifications, desalination, and demand management. These management approaches sit outside of the Plans but will likely have implications for overall water availability in the system and should be considered in developing replacement Plans. The Plans should clearly define environmental water requirements, consistent with the Act requirements. The *Greater Sydney Water Strategy* should accommodate these requirements.

The *Greater Sydney Water Strategy* will include new modelling to better consider natural variability¹¹⁷ and climate change projections and consider future scenarios such as: business as usual; a water sensitive management approach building resilience to future climate change; and a fully integrated water management approach with water reuse and rainfall independence. This may require a reduction in available water which would need to be reflected in the Surface Water Plan LTAAEL and entitlement. If the reduction in water availability is not reflected in the Surface Water Plan, it would impact downstream water availability and various environmental, social and economic outcomes. The modelling that calculates the Surface Water Plan LTAAEL will need to change to align with the strategy.

¹¹⁵ NSW Government (2017) *Metropolitan Water Plan*. Available at: <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/About-us/Metropolitan-Water/2017-Metropolitan-Water-Plan.pdf?la=en>.

¹¹⁶ DPIE (2020) *NSW submission to the Productivity Commission Inquiry into National Water Reform*. Available at: https://www.pc.gov.au/__data/assets/word_doc/0007/255742/sub041-water-reform-2020.docx.

¹¹⁷ Climate variability is not defined in the Act or Plans. For this review the Commission has adopted the definition from the Intergovernmental Panel on Climate Change which states climate variability is the term to describe 'variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events' (see Intergovernmental Panel on Climate Change (2013) *Annex III: Glossary in Climate Change 2013: The Physical Science Basis*. Available at: https://archive.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_AnnexIII_FINAL.pdf).

3.3 Overall recommendation

R 1	<p>The Surface and Groundwater Plans should be:</p> <ul style="list-style-type: none">a) Extended for a further two years until 30 June 2023, to allow time to complete data collection, analysis and modelling.b) Replaced by 1 July 2023 supported by the completion of the recommendations of this review. The replacement process should ensure the Plans consider the <i>Greater Sydney Water Strategy</i> to ensure water management is integrated across the region.
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4 Extraction volumes cannot be managed

The most fundamental role of a water sharing plan is to specify the amount of water available for the environment and what can be extracted by licensed users and under basic rights. To do this, the Plans establish LTAAELs for different water sources.¹¹⁸

Setting these limits is critical; a limit which is too high will reduce the amount of water remaining for the environment and downstream water users, while a limit which is too low reduces economic and social opportunities.

Similarly, the regular assessment of compliance with the LTAAEL and response to any exceedance (non-compliance) is an important part of protecting the environment, basic rights and the distribution of water shares as intended by the Act and the Plans. The Commission notes that according to the Section 44 implementation audit recently completed, the required annual assessment of LTAAEL compliance did not occur between 2011 and 2019.¹¹⁹

Defining limits to the volume of water available is particularly critical for these Plans. All surface water extraction management units (water sources) were fully allocated when the Surface Water Plan was developed. Additionally, the Sydney Basin Richmond Water Source in the Groundwater Plan was fully allocated, according to the Plan. DPIE-Water advised that there may be three additional groundwater sources that are fully allocated, based on the need to reserve water for potential increases to basic landholder rights. The Greater Metropolitan region faces increasing risks to its water supplies, as population and demand grows, water balances are altered by urbanisation and densification, and flows to major water storages are reduced by a changing climate.

The Greater Metropolitan region has a complex hydrological cycle, with multiple LTAAELs setting extraction limits for different extraction management units (for the Surface Water Plan) and water sources (for the Groundwater Plan). Adding to this complexity, several aspects of the cycle are managed through policies or regulations outside of the Plans (**Figure 11** shows the aspects of the cycle managed by the Plans and those managed outside of the Plans). As a general observation, the Plans are a collation of separate management processes and policies for different licence categories instead of a cohesive approach to holistically manage the area.

To ensure overall extraction does not deplete increasingly stretched water resources, it is essential to understand the overall water balance of the entire Greater Metropolitan region, including individual and combined extraction for the Surface and Groundwater Plans, as well as extraction outside of the Plans. From this, sustainable extraction limits can be set and impacts from extractions can be assessed and managed holistically for the region.

Currently, the overall water balance for the Greater Metropolitan region cannot be determined or adequately managed. There are several reasons for this, which are explored in this chapter:

¹¹⁸ Part 7: Limits to the availability of water, Division 1: Long-term average annual extraction limit.

¹¹⁹ Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf; Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/289478/Greater-Metropolitan-Region-Groundwater-Sources-2011.pdf.

- the Surface Water Plan does not set clear numeric LTAAELs (**Section 4.1**)
- LTAAELs are not comparable and cannot be used to manage total extraction in catchments and across the plan area (**Section 4.2**)
- LTAAELs are not based on best available evidence, especially regarding environmental requirements, climate variability, groundwater recharge, hydrogeological boundaries and connectivity between the Surface and Groundwater Plans (**Section 4.3**)
- LTAAELs and LTAAEL compliance do not consider all forms of extraction managed under the Plans (**Section 4.4**)
- high flow conversion clauses allow for increases in entitlements (**Section 4.5**)
- significant volumes are managed outside of the Plans but are material to the objects and principles of the Act and the objectives of the Plans (**Section 4.6**).

The complexity of the Greater Metropolitan system and the significant values, and risks to water security in the region, justify the development of a comprehensive modelling framework to support management (**Section 4.7**). This should:

- consider all forms of water extraction, and simulate flows and patterns of water extraction, including by utilities and basic landholder rights
- include and test a range of climate and demand scenarios
- inform development and assess the capacity of water sharing rules to deliver outcomes, including through testing the sensitivity and usefulness of rules under different extraction and demand scenarios.

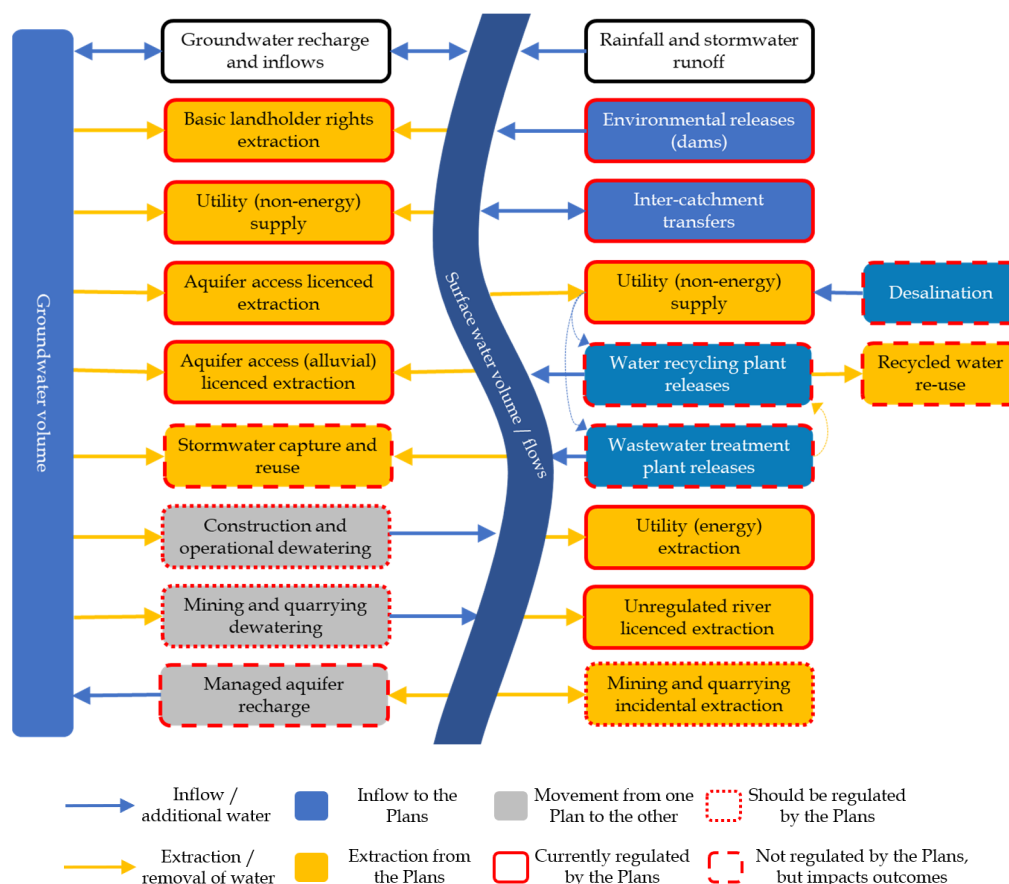


Figure 11: Schematic of the hydrological cycle in the plan area, showing those aspects regulated by the Plans and those regulated externally to the Plans

4.1 Non-numeric LTAAELs cannot be assessed

There is no overall LTAAEL for either of the Plans. The Surface Water Plan contains 10 LTAAELs, which are based on extraction management units and licence categories (**Section 2.3**). Four of these LTAAELs apply to WaterNSW and six apply to the remaining water users. Each of these LTAAELs contains up to eight components.¹²⁰

The Groundwater Plan contains 13 LTAAELs, one for each groundwater source (see **Section 2.5.2**). The Groundwater Plan LTAAELs have numeric values established. However, there are some issues with the calculation of these values, which are discussed in **Section 4.3**.

Except for WaterNSW LTAAELs, the Surface Water Plan only describes the method used for estimating the components and does not provide numeric LTAAELs. For example, the Upper Nepean and Upper Warragamba Extraction Management Unit LTAAEL is defined as the annual extraction of water averaged over the period from July 1993 to June 1999 under entitlements issued under Parts 2 and 9 of the *Water Act 1912*, plus native title and domestic and stock rights, and tidal pool entitlement.¹²¹ The primary reason for using a description rather than a numeric volume was that not all water access licences had volumes attached when the Surface Water Plan commenced. The development of numeric LTAAELs has also been impacted by limitations in the datasets and evidence available to calculate historical extraction.

The lack of numeric LTAAELs was raised in the Section 44 implementation audit of the Surface Water Plan, which recommended establishing a clear numerical statement of the LTAAELs.¹²² The Commission supports this recommendation.

The replacement Plans should include numeric LTAAELs that can be combined to establish extraction limits for each catchment and the plan area. This would:

- inform water management to manage risks associated with current entitlement levels and potential growth in use
- allow compliance with limits to be monitored – as highlighted in the Section 44 implementation audits, LTAAEL compliance was not completed for either Plan from 2011 to 2019¹²³
- ensure environmental water volumes are protected and allow determination of compliance with the protection of planned environmental water volumes
- provide transparency to stakeholders
- underpin an effective water market and ensure water is valued as a limited resource – the lack of metering and measurement also limits trading as the volume held in a licensee's account relies on them providing a statutory declaration

¹²⁰ Clause 41 of the Surface Water Plan.

¹²¹ Clause 41 (4) of the Surface Water Plan.

¹²² Alluvium and Vista Advisory (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report for DPIE. Available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf.

¹²³ *Ibid*; and Alluvium and Vista Advisory (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. Report for DPIE-Water. Available at https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/289478/Greater-Metropolitan-Region-Groundwater-Sources-2011.pdf.

- support measures to manage impacts of extraction and development on connectivity between water sources.

The lack of measurement and assessment of LTAAEL compliance is a significant barrier to the management of the complex system in the plan area. Establishing measurable LTAAELs and implementing related provisions is key to protecting the environment, basic rights and the distribution of water shares as intended by the Act and the Plans. The Commission previously recommended in its review of the *Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010*¹²⁴ that DPIE-Water should, by 1 July 2022, publish and implement a method of assessing extraction and LTAAEL compliance in unregulated water sources. Progressing this recommendation is critical for implementation of the Plans and achievement of outcomes.

4.2 LTAAELs are not comparable within and across Plans

To understand the total impact of water extraction under the Plans, the extraction under each LTAAEL should be able to be meaningfully combined to understand whole-of-system extraction. To do this, LTAAELs across the Surface Water and Groundwater Plans need to be calculated based on the same baseline model, including climate sequences and extraction assumptions.

Currently, LTAAELs in the Surface Water Plan are not able to be compared because they are based on different assessment techniques and data from different time periods. Further, within most LTAAELs there can be multiple components that are currently unable to be summed to provide a numeric LTAAEL.

For example, the LTAAELs of the two Hawkesbury-Nepean River extraction management units were developed differently to LTAAELs for the rest of the surface water units as described in **Section 2.3**. Some components of the LTAAELs in the Hawkesbury-Nepean extraction management units use average annual extraction from July 1993 to June 1999¹²⁵ as the basis of the value, while the others are based on the sum of the share components of all access licences at Plan commencement.¹²⁶

LTAAELs for the Surface Water and Groundwater Plans are calculated differently. This is reasonable, but, where possible, consistent baseline timeframes, climate sequences and assumptions should be applied. For example, the unregulated licences and rights LTAAELs for the Upper Nepean and Upstream Warragamba extraction management unit in the Surface Water Plan is based on an estimate of extraction between 1993 - 1999,¹²⁷ while the Groundwater

¹²⁴ Natural Resources Commission (2020) *Review of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010*. Available at: <https://www.nrc.nsw.gov.au/Final%20report%20-%20WSP%20review%20-%20Peel.pdf?downloadable=1>.

¹²⁵ The July 1993 to June 1999 period used across NSW for a survey for volumetric conversions process (see NSW Department of Land and Water Conservation (2000) *Volumetric Conversion – the next stage: A booklet for landholders with licences on unregulated rivers*).

¹²⁶ Clause 41 of the Surface Water Plan.

¹²⁷ The rationale for this is unclear. This method was developed for the Murray-Darling Basin system, where 1993 levels of development were the basis of all surface water sharing plans LTAAELs.

Plan LTAAELs were developed based on a percentage of estimated infiltration using average annual rainfall between 1921 and 1995.¹²⁸

For each major catchment (for example, the Hawkesbury-Nepean) there needs to be an overall numerical LTAAEL for surface water that can be used to assess if the total LTAAEL supports sustainable environmental, social, cultural and economic outcomes.

4.3 LTAAELs are not based on sound evidence

There are several limitations in the evidence base used to establish current LTAAELs. In some cases, adequate evidence is not available, while in others new evidence may be used to improve LTAAEL development. Limitations in the evidence base have impacted on the development of clear numeric LTAAEL and present a risk that LTAAELs are not able to support Plan outcomes. LTAAELs should be updated to reflect the best available evidence. Key limitations include:

- a poor understanding of ecosystem requirements on which to base sustainable extraction limits (**Section 4.3.1**)
- Groundwater Plan boundaries that do not align with hydrogeology (**Section 4.3.2**)
- use of non-representative climate data, as well as limited consideration of paleoclimate and future climate projections (**Section 4.3.3**)
- groundwater recharge estimates based on limited data (**Section 4.3.4**)
- a lack of consideration of connectivity between the Surface Water and Groundwater Plans (**Section 4.3.5**).

4.3.1 Not all LTAAELs are based on ecosystem requirements

At this point, there is not enough data on ecosystems and extraction in the region to assess if extraction levels across the major catchments are environmentally sustainable.

There are two aspects of ecosystem requirements: estuarine and freshwater. The lack of estuary data in the Hawkesbury-Nepean and Shoalhaven has limited the ability to adequately assess the estuaries' freshwater requirements using hydrodynamic models. Estuary requirements should be considered in calculating LTAAELs (see **Section 8.5**).

Freshwater ecosystem requirements should be based on assessment of flow needs for key functions and species. The Commission understands that DPIE-EES is currently assessing the ecosystem flow needs. This work should be reflected in Plan development (**Section 8.1.1**). It is also understood that significant work was undertaken by the Sydney Catchment Authority to identify ecosystem needs during Plan development. However, the Commission was not able to access these reports. These reports should be made publicly available and reflected in Plan development as appropriate.

The replacement Plans should establish clear environmental objectives and performance indicators to determine if extraction limits are appropriate. The replacement Plans should include a provision allowing for the adjustment of LTAAELs should evidence indicate that the extraction is not sustainable. Assessment of the appropriateness of extraction limits should

¹²⁸ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

reflect the most up to date information about future water inflow and demand and the plans ability to manage variations in inflows.

4.3.2 Groundwater Plan boundaries do not align with hydrogeology

The external Groundwater Plan boundary was developed based on the Surface Water Plan boundary and does not align with hydrogeological boundaries. Within the Groundwater Plan, the water source boundaries are also not fully aligned with hydrogeology. For example, the Maroota Tertiary Sands and Metropolitan Coastal Sands water sources are not bound by their sediment type (as the alluvial aquifers are).

Definition of the water source boundaries affects Groundwater Plan development (such as LTAAEL calculations, entitlement volumes, development of trade rules) and implementation (such as water access licence rules, AWDs and application of trade rules). If the water source boundaries do not align with actual hydrogeological boundaries, environmental, social and economic outcomes may be impacted as:

- cumulative impacts of licences on aquifers will not be considered if licences are categorised in different water sources but are in the same aquifer
- there may be inequity between licensees in the same aquifer but different water sources (for example, an inability to trade between licences in the same aquifer).

For example, if a potential water user wishes to gain access licences in the Hawkesbury Sandstone below the Maroota Tertiary Sands aquifer, which sits within the Sydney Basin Central Groundwater Source Area, they cannot get an access licence from the appropriate water source.¹²⁹ Any works in the Maroota Tertiary Sands Water Source, but extracting from the deeper aquifers will not be accounted for under the appropriate LTAAEL and will not have the appropriate licence conditions. DPIE-Water have advised this can be addressed in the replacement Groundwater Plan through better definition of the boundaries.

The Groundwater Plan's external boundary should be reviewed based on existing evidence and studies underway to manage all water within the hydrogeological basin. The Commission understands that the western portion of the Greater Metropolitan hydrogeology is linked to aquifers covered under the Murray-Darling Basin.¹³⁰ As part of the Groundwater Plan remake, DPIE-Water should review all water source boundaries in the plan area considering best available hydrogeological evidence and include provisions to either account for connectivity or amend boundaries as appropriate, then update LTAAELs, relevant provisions, and existing licence locations to align with hydrogeological evidence.

4.3.3 LTAAELs do not consider variability or climate change

Climate variability and climate change create challenges for future water management. NSW coastal rivers north of the Georges River have been shown to be influenced by multidecadal shifts in rainfall, moving between flood dominated and drought dominated regimes over 20-50 year periods.¹³¹ A shift to a drought dominated regime can reduce flows to a fraction of the

¹²⁹ Note that while this is unlikely to be a high proportion of users due to the relative cost and ease of extraction at shallower depths, the Commission is aware that this situation has arisen under the Plan and should be rectified.

¹³⁰ Interview: DPIE-Water, 15 June 2020.

¹³¹ Erskine, W.D. and Warner, R.F. (1988) 'Geomorphic effects of alternating flood- and drought-dominated regimes on NSW coastal rivers.' *Fluvial Geomorphology of Australia*, pp. 223-244; and Warner, R.F. (2009) 'Secular Regime Shifts, Global Warming and Sydney's Water Supply'. *Geographical Research* 47(3), pp. 227-241.

long-term average flows.¹³² Australian and NSW government modelling also indicates future risks to water resources under projected climate scenarios. The 2019 Sydney Drinking Water Catchment Audit highlighted that ‘surface and groundwater resources are not being sustainably managed, particularly in the context of climate change’.¹³³ Insufficient monitoring contributes to the uncertainty about sustainable extraction.¹³⁴

The historic data used to establish the LTAAELs for both Plans included limited climate sequences and therefore does not fully represent historical climate variability. Current knowledge around climate change and paleoclimatic records suggests that the historical record may not represent future risks appropriately. In some cases, the climate sequences used for the Plans did not include major droughts. The Groundwater Plan’s LTAAELs are based on historic average rainfall for a limited period and, like the Surface Water Plan, do not take into consideration the full range of expected natural variability in rainfall and therefore groundwater recharge.¹³⁵

Recent work regarding the paleoclimate indicates that there are risks associated with relying on the relatively brief observed climate record for water planning, which may not represent the full range of past or longer-term variability.¹³⁶

DPIE-Water should ensure the replacement Plans function under a range of climatic conditions. They should be based on all available climate data, including records that include periods of extreme variability (such as the drought since 2017) and paleoclimatic records. Given the Plans’ 10-year period, the replacement Plans should incorporate likely impacts of climate change over the medium-to long-term on water demand and stream flow.

Parts of the Surface Water Plan¹³⁷ were suspended under the 2019 severe drought conditions, under Section 49A of the Act. The ability to suspend parts of water sharing plans to enable management for critical needs under extreme events is appropriate but should only apply to specific outlying events, not expected variability, or future likelihoods under climate change. The Commission notes that for more extreme natural variability and drought, other provisions should be used in conjunction with the LTAAEL (see **Section 7.8**). Further, it is noted that, while the NSW Government has developed the *NSW Extreme Events Policy* to guide the management of water during water sharing plan suspension in the Murray-Darling Basin, there is no equivalent guidance for coastal plans.¹³⁸

¹³² Warner, R.F. (2009) ‘Secular Regime Shifts, Global Warming and Sydney’s Water Supply’. *Geographical Research*, 47(3), pp. 227–241.

¹³³ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

¹³⁴ *Ibid.*

¹³⁵ Clause 13 and associated note of the Groundwater Plan state that it recognises climate variability through provisions that ‘manage the sharing of water in these groundwater 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 reductions in the availability of water due to an increase in average annual extraction above the [LTAAEL], ... Other statutory tools are available to manage climatic variability within a groundwater source, for example, temporary water restrictions under section 324 of the Act’.

¹³⁶ Zhang, L., Kuczera, G., Kiem, A.S., and Willgoose, G. (2018) ‘Using paleoclimate reconstructions to analyse hydrological epochs associated with Pacific decadal variability’, *Hydrology and Earth System Sciences*, 22(12), pp. 6399–6414. Available at: <https://www.hydrol-earth-syst-sci.net/22/6399/2018/>.

¹³⁷ Clause 30 of the Surface Water Plan: Transfer rules from the Shoalhaven River Water Source to the Upper Nepean and Upstream Warragamba Water Source.

¹³⁸ NSW Government (2018) *NSW Extreme Events Policy*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0008/187703/Extreme-Events-policy.pdf.

The *Sydney Drinking Water Catchment Audit 2019* recommended that the Plans and LTAAELs be reviewed to be sustainable in the context of climate change, and maintain compliance with clauses 12 (assessment of performance indicators such as changes in flow regimes) and 42 to 44 (changes in annual surface water extraction relative to the LTAAEL for each extraction management unit) of the Surface Water Plan.¹³⁹

When the Surface Water Plan commenced, WaterNSW modelling indicated that its security yield would be 640,000 ML per year.¹⁴⁰ WaterNSW continually re-calculates and updates the modelling of its water supply system yield. Following the conclusion of the recent drought (2017-2019), WaterNSW extended the historical hydrological records to December 2019. Through this process, the reassessed yield is 515,000 ML per year, with only a third of this difference (35,000 ML per year) due to the inclusion of the recent drought. Other contributing factors include varying demand patterns and model improvements. WaterNSW's modelling does not consider paleoclimate, only including climate change through increased temperatures, resulting in increased demand.

The *Greater Sydney Water Strategy* will include new modelling that better considers natural variability and climate change. The modelling framework used to develop and assess the replacement Plans should use the climatic data being generated for this strategy. Development of the Plans should then assess how water will be shared to first protect the water source and its dependent ecosystems, second, protect basic landholder rights and thirdly be shared equitably among all other users, if scarcity and demand on the resource increases. This will change the sustainable level of extraction and must inform the development of LTAAELs in the replacement Plans.

4.3.4 Groundwater LTAAELs may not be sustainable

The Groundwater Plan LTAAELs are based on the estimated sustainable limit for extraction from each of the groundwater sources with the intent to '*not allow access to the storage component of the groundwater resources over the long-term [so that] over the long-term, the storage component of the groundwater resources will not be depleted as a result of extraction*'.¹⁴¹ The Groundwater Plan notes that groundwater can accumulate over thousands to tens of thousands of years, and the annual recharge is often very small comparatively. It also states that it does not allow access to the storage component of the groundwater resources over the long term, so the groundwater is not depleted.¹⁴²

The Groundwater Plan development was based on DPIE-Water's 'macro planning' approach, which used high level assumptions and limited data to develop the recharge estimates and therefore sustainable levels of extraction. The macro planning risk assessment process determines a sustainability factor for each groundwater source, which is used to determine the volume of average annual recharge to each aquifer that is reserved as environmental water and the volume available for extraction. In high conservation areas,¹⁴³ 95 or 100 percent of the

¹³⁹ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for and provided by WaterNSW.

¹⁴⁰ WaterNSW (2020) *History of Changes to Greater Sydney's Water Supply Yield*. Available at: https://www.watnsw.com.au/__data/assets/pdf_file/0014/132035/Greater-Sydneys-Water-Supply-System-yield-September-2020.pdf/.

¹⁴¹ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

¹⁴² Clause 16(2) of the Groundwater Plan.

¹⁴³ National parks, nature reserves, historic sites, Aboriginal sites, state conservation areas and karst conservation areas but not the special catchment areas under the *Sydney Water Catchment Management Act 1998*.

recharge was reserved as planned environmental water, while a sustainability factor was used over the remaining areas to determine the volume of planned environmental water and therefore the LTAAELs.

The ecological assets, water quality and aquifer integrity of three groundwater sources – the Coxs River Fractured Rock, Goulburn Fractured Rock and Botany Sands groundwater sources – were identified as being at high risk from extraction in 2011.¹⁴⁴ The Coxs River and Goulburn Fractured Rock water sources both have significant GDEs including the Jenolan Caves and high community value sites. These groundwater sources had a larger portion of recharge reserved for the environment. The Botany Sands Groundwater Source also had a greater portion of recharge reserved due to its many contaminated sites (see **Section 2.1.2**). For the Botany Sands Groundwater Source, where there was a risk to accessibility, mitigating rules were included to protect the aquifer asset while maintaining access.¹⁴⁵ DPIE-Water advised it will be reviewing the LTAAEL for this water source.

The average annual recharge calculations underpin the planned environmental water volumes and therefore the LTAAELs could be better estimated with new evidence that considers:

- Natural variability and the impacts of climate change (see **Section 4.3.3**) – the recharge calculations only use rainfall recharge (that is, not river recharge or recharge from other aquifers) based on a percentage of estimated infiltration of average annual rainfall between 1921 and 1995¹⁴⁶ and not including climate change.
- Studies completed since 2011 that demonstrate that recharge is lower than that used in Plan development, meaning the sustainable extraction limit is below that used to develop the LTAAELs (see **Table 5**).
- Spatial variation – groundwater sources are treated as homogenous within each water source. While geological complexity makes it difficult to incorporate heterogeneity into recharge calculations, attention should be given to the effects of geological variability within groundwater sources, and soils and vegetation overlying aquifer outcrops.¹⁴⁷

Aquifers may therefore be depleted under current provisions and the Groundwater Plan objectives may not be met. The value of water as a limited resource is thus undermined, impacting environmental, social and economic outcomes over the medium to long term.

¹⁴⁴ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

¹⁴⁵ *Ibid.*

¹⁴⁶ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

¹⁴⁷ NSW Chief Scientist & Engineer (2019) *Independent review of the impacts of the bottled water industry on groundwater resources in the Northern Rivers region of NSW – Final Report* Available at: https://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0019/285040/Final-Report_Northern-Rivers-Bottled-Water-Review.pdf.

Table 5: Estimated recharge infiltration rates, the calculated recharge and LTAAEL as used in Plan development, and based on current evidence¹⁴⁸

Groundwater source	Recharge infiltration rate (%)		Recharge (ML/year)		LTAAEL (ML/year)		Change
	Under the Plan	On current evidence	Under the Plan	Using current evidence	Under the Plan	Using current evidence	
Botany Sands	6	6	30,424	30,424	14,684	14,684	-
Coxs River Fractured Rock	4	1	67,087	16,574	7,005	1,702	↓
Goulburn Fractured Rock	4	1	259,784	64,946	53,074	13,269	↓
Hawkesbury Alluvium	6	6	5,043	5,043	2,456	2,456	-
Maroota Tertiary Sands	6	6	1,075	1,075	645	645	-
Metropolitan Coastal Sands	6	6	60,802	60,802	27,206	27,206	-
Sydney Basin Blue Mountains	6	5	78,474	65,395	7,039	3,245	↓
Sydney Basin Central	6	5	229,223	191,019	45,915	38,263	↓
Sydney Basin Coxs River	6	5	31,312	26,094	17,108	14,257	↓
Sydney Basin Nepean	6	5	224,843	187,069	99,568	82,973	↓
Sydney Basin North	6	5	269,187	224,322	19,682	16,402	↓
Sydney Basin Richmond	6	5	127,878	106,565	21,103	17,586	↓
Sydney Basin South	6	5	225,326	187,772	69,892	58,243	↓

Figure 12 indicates the effect the known difference in recharge has on the LTAAELs, using the same method of calculation as the Groundwater Plan. The recharge estimates for porous rock aquifers may overestimate recharge, as the 6 percent infiltration rate used in Groundwater Plan development for Triassic sandstone was updated to be 5 percent, while the 4 percent for Permian sandstone was estimated to have 1 percent infiltration.¹⁴⁹ The Commission notes that this figure does not incorporate additional evidence or other forms of extraction discussed in this review and only provides an indication of how the fundamental evidence underpinning the Plans should be as robust as possible.

¹⁴⁸ Recharge rates per EMM (2015) *Coastal Porous Rock Rainfall Recharge Study*, prepared for and provided by DPIE-Water, 11 September 2020; and Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 - Volume 2*, report prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

¹⁴⁹ *Ibid.*

This analysis suggests that the Sydney Basin Richmond Groundwater Source may not have sustainable levels of entitlement if the evidence base is updated.¹⁵⁰ It is not possible to determine if that actual level of extraction exceeds sustainable limits. DPIE-Water advised that assessment of extraction and LTAAEL compliance has not been carried out as required by clauses 27 to 29 of the Groundwater Plan. As groundwater is not metered, monitoring is not possible at this stage. The level of extraction compared to the LTAAEL is therefore unknown. However, the *Sydney Drinking Water Catchment Audit 2019* indicated that entitlements in six of the nine studied water sources have increased, with the Sydney Basin Richmond, Sydney Basin Coxs River and Goulburn Fractured Rock groundwater sources having significant increases in percentage of water allocated to entitlements in comparison to previous estimates.¹⁵¹

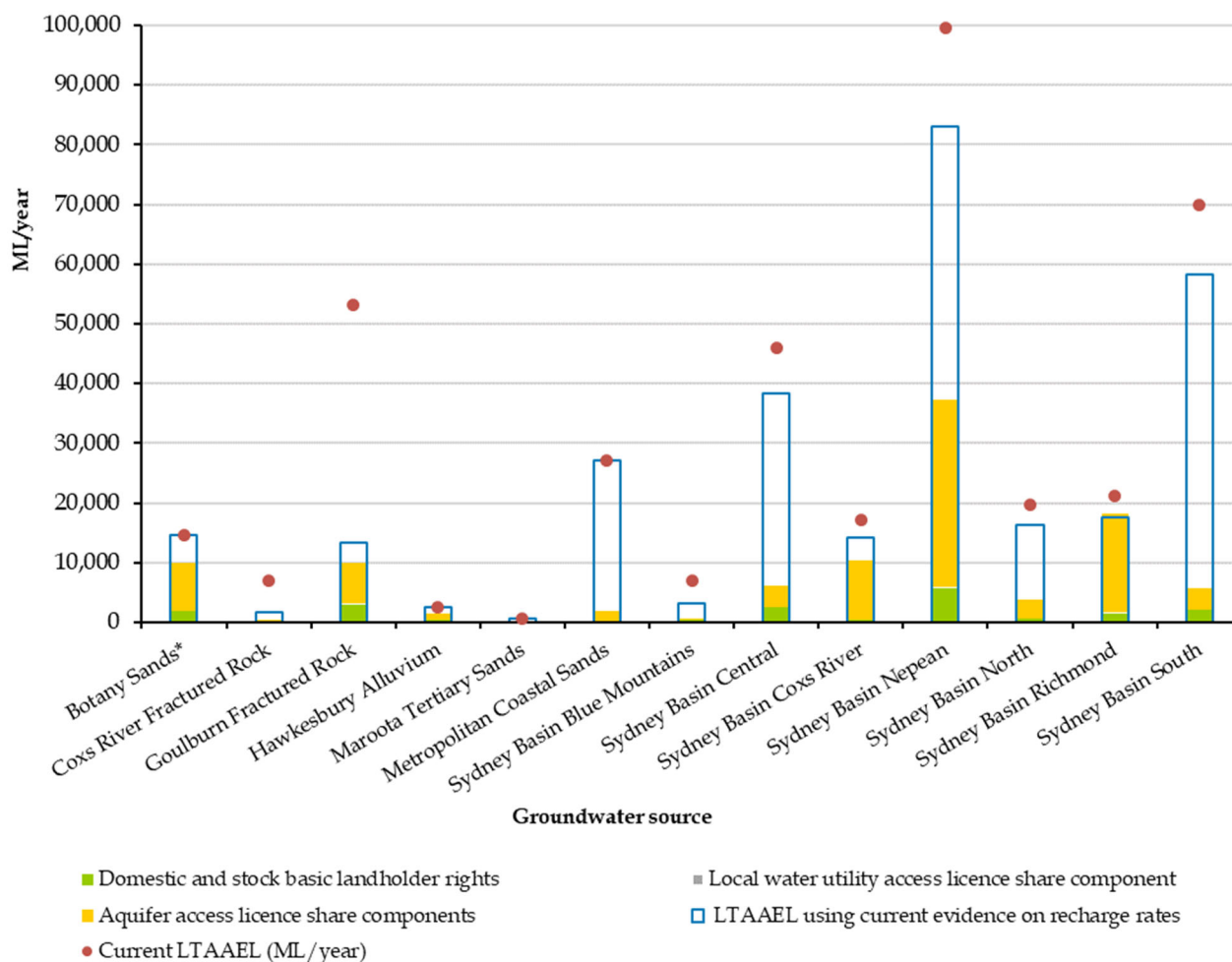


Figure 12: LTAAELs calculated using updated evidence on recharge rates, compared to the rights and share components identified in the Groundwater Plan¹⁵²

¹⁵⁰ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for and provided by WaterNSW.

¹⁵¹ *Ibid.*

¹⁵² Recharge rates per EMM (2015) *Coastal Porous Rock Rainfall Recharge Study*, prepared for and provided by DPIE-Water, 11 September 2020; and Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for and provided by WaterNSW. Available at: https://www.watnsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf. Rights as per Clause 19 in the Groundwater Plan, share components as provided by WaterNSW on 18 October 2019.

Extraction to the permitted level in the Groundwater Plan may deplete aquifers and prevent the achievement of Plan objectives because:¹⁵³

- depletion of the storage component of aquifers may impact high priority GDEs and important river flow dependent ecosystems
- aquifer integrity may be impacted by depletion of the storage component of aquifers
- the groundwater sources will not be sustainably managed
- water quality in aquifers or connected water sources may be impacted if extraction occurs beyond the actual (evidence based) sustainable limit
- connectivity between aquifers and with surface water may be impacted by unsustainable extraction limits.

The replacement Groundwater Plan should include LTAAELs based on current recharge estimates to define planned environmental water volumes and sustainability factors. LTAAEL development should also consider natural variability and climate change data to inform likely recharge potential. Monitoring of compliance with LTAAEL is critical to ensuring outcomes.

4.3.5 Surface and Groundwater LTAAELs are not linked

The Greater Metropolitan region is unique in the scale of urban populations, industry and agriculture, and the level of change set to occur in the coming decade. Broad demographic and land use changes from a growing population and urbanisation of greenfield areas in Sydney's outer rim will change the volumes of surface water runoff (affecting flows managed under the Surface Water Plan) and groundwater infiltration (affecting recharge and volumes managed under the Groundwater Plan). Individual activities such as mining, large infrastructure projects, urban construction and maintenance and stormwater harvesting each impact connectivity and lead to water movement between surface and groundwater. Connectivity must therefore be specifically covered in the Plans and the cumulative effects of these changes and activities should be considered (as discussed in **Section 4.4**).

The connectivity between surface water and groundwater in the plan area has received much attention and investigation as the drinking water supply catchments include coal mines. This has raised concerns about the influence of surface water-groundwater connectivity on reducing streamflow due to subsidence from longwall mining.¹⁵⁴ While this is not the only activity to result in altered water movement, changes such as this should be reflected in the water balance modelling and long-term flux accounted for in the LTAAELs. There are currently no provisions to adjust the LTAAELs to reflect long term, cumulative changes in water balances. This should be addressed in the remake of the Plans.

At the state scale, the Act does not explicitly identify the consideration of connectivity between water sources within its objects or water management principles. However, the National Water Initiative's *Water Planning Guidelines* state that 'surface and groundwater should be managed in an integrated manner'.¹⁵⁵ According to these guidelines:

¹⁵³ Specifically, objectives (a), (b), (d), (j) and (k) in the Groundwater Plan.

¹⁵⁴ IEPMC (2019) *Independent Expert Panel for Mining in the Catchment Report: Part 2. Review of specific mining activities at the Metropolitan and Dendrobium coal mines*, prepared for DPIE. Available at: https://chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/281732/IEPMC-Part-2-Report.pdf.

¹⁵⁵ Council of Australian Governments (2010) *National Water Initiative Policy Guidelines for Water Planning and Management*. Available at: <https://www.agriculture.gov.au/water/policy/nwi/guidelines-water>.

- connected systems should ideally be managed as a single resource under a single plan, or at least through integrated plans that refer to each other
- water should be allocated and accounted for once, considering surface and groundwater connectivity
- separate surface and groundwater entitlements are possible in connected systems, but the impact of one form of extraction on the other needs to be quantified and factored into transactions
- a conservative or precautionary approach should be used when granting access to water in shared systems where the degree of connectivity is relatively unknown or there is insufficient information to quantify the impact.¹⁵⁶

The Plans do not align with these guidelines, creating significant risk that the Plans can effectively achieve desired outcomes. The Groundwater Plan was developed separately to the Surface Water Plan. While some provisions are linked (for example, alluvial cease to pump triggers), the two plans do not adequately reference each other and the connected water sources (see **Section 8.4**).

It is important that the LTAAELs at the water source level are adaptable to reflect actual flows and recharge to protect aquifer integrity, water quality and water dependent ecosystems. The Plans should include amendment provisions to enable LTAAELs to be adjusted should monitoring or modelling demonstrate that significant, long-term changes to streamflow or recharge have occurred at the water source scale.

4.4 LTAAELs do not consider all extraction under the Plans

Currently, the LTAAEL definition does not account for several significant sources of water use, which should be included when establishing numeric LTAAELs (discussed collectively as exempt take). These are discussed in the following sections and include:

- Hawkesbury-Nepean River Recovery Project buybacks (**Section 4.4.1**)
- mining exemptions (**Section 4.4.2**)
- construction and maintenance exemptions (**Section Error! Reference source not found.**)
- stormwater harvesting (**Section 4.4.4**)
- basic landholder rights (**Section 4.4.5**).

While the scale of water capture through exempt take will be variable, the impacts of capture are likely to be significant on a local scale and have cumulative downstream effects. The volume of extraction included in DPIE-Water calculations as part of the LTAAEL should be transparent and the estimate should be updated annually for LTAAEL compliance.

4.4.1 Hawkesbury-Nepean River Recovery Project buybacks

The Surface Water Plan states that it may be amended to secure water savings associated with the Commonwealth of Australia and NSW Government Hawkesbury-Nepean River Recovery Project.¹⁵⁷ However, most of the benefits of the buybacks have not been realised.

¹⁵⁶ *Ibid.*

¹⁵⁷ Clause 82(7) of the Surface Water Plan.

The Hawkesbury-Nepean River Recovery Project received \$77 million in funding from the Australian Government.¹⁵⁸ It aimed to deliver 11,590 ML per year of water (as well as nutrient) savings across the Hawkesbury-Nepean Catchment through projects including irrigation and landscape efficiency, licence purchase and efficiency projects. Of these savings:¹⁵⁹

- 7,240 ML were to be bought by the NSW Government for additional environmental flows below the major dams and for increasing Sydney's water supply security
- 2,850 ML were to be secured for environmental flows through reduced licenced extraction through the Improving Hawkesbury-Nepean Water Balance Accounting (metering) Project
- 1,500 ML were retained by water licensees through the water smart farms water use efficiency project.¹⁶⁰

The heavy investment secured 12,433 ML of secured, unsecured and irrigator water savings per year.

The background document for the Surface Water Plan¹⁶¹ states that water users are restricted further on a daily access basis to achieve an annual savings of 11,590 ML per year to account for the Hawkesbury-Nepean River Recovery Project through amendments to daily access arrangements by:

- increased transparent¹⁶² and translucent¹⁶³ environmental releases from Warragamba Dam when these environmental releases commence. In the meantime, a fixed release may be required to pass any water savings through the dam
- through automatic adjustments to the environmental flow protection rules, which are based on environmental releases from the dam, and
- adjustments to the sharing of releases from the St Marys Advanced Water Treatment Plant via automatic adjustments to the environmental flow protection rules.

However, none of these amendments have been made to date. As **Chapter 7** will describe, the daily access arrangements were never implemented, increased transparent and translucent releases were never amended and environmental flow protection rules never applied. Further, as discussed in **Section 4.6.1**, the Surface Water Plan only accounts for releases from the St Marys Advanced Water Treatment Plant on a daily basis. Therefore, the environmental outcomes of the recovery project have been limited.

¹⁵⁸ DPI (n.d.) *Hawkesbury Nepean \$77m river recovery*. Available at: <https://www.dpi.nsw.gov.au/content/archive/agriculture-today-stories/ag-today-archives/june-2009/hawkesbury-nepean-recovery>.

¹⁵⁹ NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548058/wsp_metro_surface_water_background.pdf.

¹⁶⁰ *Ibid.*

¹⁶¹ NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/548105/wsp_metro_groundwater_background.pdf.

¹⁶² A transparent flow is when inflows are passed through a dam to enable a near-natural flow pulse into the downstream river system.

¹⁶³ A translucent flow is similar to a transparent flow but only a portion of the inflow volume is passed.

To realise the savings from the program the intended environmental releases need to be made and protected. Further, daily adjustment to access arrangements appears to be an infeasible and likely unnecessary approach.

The Commission understands that the licences that were purchased as part of the program are still 'held' by the NSW Government. As such, this entitlement is no longer available for extraction. However, there is no ability to actively protect the water available under these licences. Effectively the environmental 'licences' receive the water that isn't extracted by other license holders. This results in inequitable treatment of these licences. The Commission recommends that the Plan assigns this volume of water to the Environmental Flows Reference Group (**See Section 6.4**) and includes provisions to enable active management so this water can be used to maximise environmental outcomes.

4.4.2 Mining extraction

The Surface Water Plan LTAAELs were based on historic extraction, which did not include all extraction from mining activity, as it has not been licenced. This was because, before 2013, there was doubt about whether all of these activities would constitute the 'taking' of water under the Act and therefore trigger the need for a water access licence to account for that water.¹⁶⁴ As a result, LTAAEL compliance for the Surface Water and Groundwater Plans does not fully consider mining extraction.

In March 2013 (postdating the Plans), the NSW Government introduced the *Aquifer Interference Policy* and a new section in the Act (Section 60I) specifically requiring a water access licence for any water extracted during mining.¹⁶⁵ This includes surface flows lost to groundwater due to subsidence from underground coal mining, known as incidental extraction.¹⁶⁶

Since Section 60I was introduced, several mines in the plan area have been unable to obtain surface water entitlements to account for extraction or diversion from mining activities. NSW Minerals Council's submission suggested that this is due to '*a combination of restrictive [Surface Water Plan] rules and an illiquid water market*' (see **Section 8.1.2**).¹⁶⁷ Mining industry stakeholders advised that they have sought to resolve this issue as they wish to be '*compliant with the regulatory regime, and be licenced and pay for water like any other user*'.¹⁶⁸

The cumulative impact of past and present mining on water balances and impacts on the plan area needs to be assessed. Along with active mines, the Plans should consider surface and groundwater impacts of historic mine sites and those in care and maintenance. For example, coal mines near Lithgow (Upper Nepean and Upstream Warragamba Water Source) discharge excess mine dewatering volumes to watercourses, while there are flooded workings at mines under care and maintenance. The movement of groundwater to surface water must be tracked, accounted for, and appropriately managed. Mining extraction estimates should be informed by the significant work carried out over the last few years, and currently underway and incorporated into the modelling framework discussed in **Section 4.7**.

¹⁶⁴ Thomas, N. (2013) *Major new controls on water impacts from mining and CSG projects*. Available at: <https://www.claytonutz.com/knowledge/2013/march/major-new-controls-on-water-impacts-from-mining-and-csg-projects>.

¹⁶⁵ Section 60I of the Act, introduced by the *Water Management Amendment Act 2012* to expand the scope of the requirement to obtain a water access licence for mining and coal seam gas projects.

¹⁶⁶ Submission: NSW Minerals Council, received 24 October 2019.

¹⁶⁷ *Ibid.*

¹⁶⁸ *Ibid.*

Currently, surface water impacts are predicted using groundwater models, but these have limitations.¹⁶⁹ WaterNSW are investigating methods to model surface water impacts from mining through two methods:

- indirectly estimating total volume of water that will be diverted from the surface and inferring the distribution and rate of diversion
- analysing changes in pre- and post-mining metered streamflow and correlating losses to the area of catchments undermined to estimate the total diversion over time.¹⁷⁰

The NSW Government established the Independent Expert Panel for Mining in the Catchment (IEPMC) in 2018 to report to DPIE on the impact of mining activities in Sydney's drinking water catchment Special Areas,¹⁷¹ focusing on risks to the volume of water in the catchment. Key findings from the Panel's 2019 reports included:

- Mining in the Special Area has resulted in, and continues to result in, losses of water from the Greater Sydney water supply system. This includes baseflow losses to streams but quantifying this is currently not possible. The Dendrobium mine in the Upper Nepean River Tributaries Headwaters Management Zone was identified as a primary impactor.
- Fracturing above the longwall mines has changed surface water quality and caused surface water loss, though volumes are generally small compared to overall system losses.
- Remediation of fracturing, and hence reducing connectivity between surface and groundwaters, is unlikely to be successful and if mining is to continue GDE offsets should be considered (see **Section 7.6**).
- Cumulative impacts from the multiple mines on ground and surface water will be hard to model. More data is required to build models and develop a framework to examine predictions of cumulative impact, explain measured impacts and attribute them to the most likely causes. Acceptable loss thresholds may be developed to assign compensatory measures.¹⁷²

The Panel's final report includes about 50 recommendations, all accepted by the NSW Government.¹⁷³ DPIE is leading an interagency working group developing an action plan which includes; '*reviewing and updating current and potential future water losses from mining in line with the best available science*'; '*introducing a licensing regime to properly account for any water losses*'; and '*undertaking further research into mine closure planning to reduce potential long-term impacts*'.¹⁷⁴

¹⁶⁹ Dubikova, M., Dupen, P., Marshall, L., Tammetta, P. (2019) *Quantifying surface water losses from mining-subsided catchments*, presentation to the Australasian Groundwater Conference. Abstract available at: <http://agc2019.p.agc.currinda.com/days/2019-11-27/abstract/487>.

¹⁷⁰ Dubikova, M., Dupen, P., Marshall, L., Tammetta, P. (2019) *Quantifying surface water losses from mining-subsided catchments*, presentation for the NCGRT/IAH Australasian Groundwater Conference. Based on Tammetta, P. (2018) *Catchment Losses Assessment*. Report prepared for WaterNSW, October 2018.

¹⁷¹ The *WaterNSW Regulation 2013* defines and protects the Special Areas, located around the drinking water supply's major dams, reservoirs and canals and within which access and certain activities are restricted to protect water quality and maintain ecological integrity.

¹⁷² IEPMC (2019) *Independent Expert Panel for Mining in the Catchment Report: Part 2. Review of specific mining activities at the Metropolitan and Dendrobium coal mines*, prepared for DPIE. Available at: https://chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/281732/IEPMC-Part-2-Report.pdf.

¹⁷³ Minister for Planning and Public Spaces (2020) *Stronger Protection for Sydney's water catchment following extensive review* [Ministerial media release]. 18 March. Available at: <https://www.planning.nsw.gov.au/News/2020/Stronger-Protection-for-Sydneys-water-catchment-following-extensive-review>.

¹⁷⁴ *Ibid.*

All extraction must be accounted for under the Plans and DPIE-Water should work with mining operators to ensure activities are licenced. As discussed in **Section 4.3.1**, the Surface Water Plan LTAAELs should be based on ecosystem requirements (noting that the Groundwater Plan LTAAELs are based off estimated sustainable extraction, see **Section 4.3.4**). Reasonable entitlement volumes per water source should be assessed based off sustainable LTAAELs and measures taken to either reduce entitlement or permit additional entitlement in certain water sources. However, if extraction exceeds the LTAAEL, other management measures may be required.

4.4.3 Construction and maintenance

Certain activities for construction and maintenance that intersect or interfere with groundwater systems and where extraction is incidental to the activity's main purpose, or where there is no extraction, should be managed as aquifer interference activities. These activities are currently regulated under a mix of water supply work approvals and licences under Part 5 of the *Water Act 1912*. Further, since 2019, aquifer interference activities extracting up to and including 3 ML per year have been exempt from requiring a licence.¹⁷⁵

The current licencing under the *Water Act 1912*, as well as exemptions, are currently not accounted for as part of the LTAAEL. Further, it is unlikely that this extraction was considered in initial estimates of extraction when the Groundwater Plan was developed. In fully committed water sources, once accounted for, the legacy temporary and ongoing extraction could push extraction above the LTAAELs. This extraction should be accounted for and mechanisms used to bring overall extraction back to the LTAAELs, such as reduced AWDs, a volume set aside to allow for unaccounted take or another accounting mechanism if required.¹⁷⁶

DPIE-Water advised it is proposing a project to investigate and quantify the volumes of water historically and currently extracted under licences under Part 5 of the *Water Act 1912* for dewatering that are not accounted for in LTAAELs. This work is expected to be completed mid-2021.

DPIE-Water is also developing policies for future temporary and ongoing extraction from large works that have historically not gained licences. The use of Specific Purpose Access Licences has been raised as a potential solution for regulating and accounting for dewatering activities. The Commission suggests in any solution the implications for the water market and equality of access should be considered.

Proponents of infrastructure projects have found it challenging to obtain groundwater entitlements for extraction via incidental dewatering in some areas. For example, in the Botany Sands Groundwater Source there are development pressures, a limited trade market and water source is fully committed, so controlled allocation orders cannot be made. Defining robust state-wide policies for the long term should be a priority to enable all extraction to be managed effectively and sustainably under the Groundwater Plan. DPIE-Water should finalise its policy position and regulation on exempt take before the replacement Groundwater Plan commences.

¹⁷⁵ Note currently, extraction greater than 3 ML per year requires a licence and exempted aquifer interference activities are required to record and report their take annually. The 3 ML exemption is state-wide except for in the Botany Sands Groundwater Source, which only has a temporary exemption that is set to expire on 30 June 2021. DPIE-Water advised it intends to extend the Botany Sands exemption to align with the replacement Groundwater Plan.

¹⁷⁶ Note extraction may not exceed the LTAAEL if there are sleeper licences or if licensees do not use their full entitlement.

4.4.4 Stormwater harvesting

The Surface Water Plan states it may be amended to include rules to provide for any new category or subcategory of access licence established for the purpose of stormwater harvesting.¹⁷⁷ This did not occur. As outlined in the 2020 Auditor General report on water conservation in Greater Sydney, DPIE-Water '*has not made substantial progress to remove or coordinate a response to reported policy, regulatory and institutional barriers to water recycling and stormwater harvesting*'.¹⁷⁸ The report recommended that by July 2021, DPIE-Water should '*develop a clear policy and regulatory position on stormwater harvesting - enhancing cooperation between State and Local Government, Sydney Water and private water utilities*'.¹⁷⁹

Changes to stormwater harvesting policy will particularly affect water sources with urban growth and consolidation such as western Sydney, and downstream systems. Stormwater harvesting, combined with filtration, infiltration and irrigation, can reduce runoff volumes for the majority of storm events to close to pre-development levels, while also helping restore baseflows, return natural soil moisture levels to urban landscapes and maintain water quality.¹⁸⁰ Alternatively, it can reduce available water downstream and groundwater recharge. Stormwater harvesting should be accounted for and promoted in urban areas where it is determined to be beneficial, such as the Western Sydney Aerotropolis, to promote a green, livable city.¹⁸¹ Stakeholders observed that demand for licences and restrictive trade rules (see **Section 8.1.2**) make it difficult for developers, councils and water utilities to obtain licences for stormwater harvesting.

In developing the replacement Plans, DPIE-Water should investigate new options for 'smarter' rules that promote a more naturally variable flow regime, allow for stormwater harvesting to increase where it can assist in optimising environmental and social outcomes.

DPIE-Water advised the Commission that it is progressing work to define and develop a stormwater harvesting policy. The Commission supports the investment in resources required to complete the policy framework in a timely manner. The decisions taken in water recycling and stormwater harvesting policy and regulation will affect the function of the Plans and should be finalised in time to build assumptions and modelling into the Plans' water balances and account for this take as part of LTAAEL compliance.

In reviewing the management zones, DPIE-Water should also consider any necessary adjustments to the LTAAELs within the system. The LTAAELs, as discussed earlier in this chapter, are either based on the level of entitlement at the start of the Surface Water Plan or extraction over a specified period. The level of stress on rivers is not uniform across the plan area, with some systems receiving higher than natural level of runoff due to urbanisation. If LTAAELs were based on sustainability criteria there are likely to be areas within the system that have too much allocation and areas that could accommodate greater extraction, particularly stormwater capture.

¹⁷⁷ Clause 82(4) of the Surface Water Plan.

¹⁷⁸ NSW Auditor-General (2020) *Water conservation in Greater Sydney*. Available at: <https://www.audit.nsw.gov.au/our-work/reports/water-conservation-in-greater-sydney>.

¹⁷⁹ *Ibid.*

¹⁸⁰ Commonwealth of Australia (2015) *Stormwater management in Australia – Chapter 2 Overview of stormwater in Australia*. Available at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Stormwater/Report.

¹⁸¹ Department of Planning and Environment (2018) *Western Sydney Aerotropolis – South Creek Precinct*. Available at: <https://www.planning.nsw.gov.au/Plans-for-your-area/Priority-Growth-Areas-and-Precincts/Western-Sydney-Aerotropolis>.

This imbalance could be brought into balance over time with a well-designed trading market. For example, a stormwater harvesting project in an urban area could source entitlement from a highly stressed area. The Surface Water Plan as written would restrict trade between water sources within a 'management area'.¹⁸² These restrictions also need to be examined and replaced with rules based on an assessment of the broad range of environmental, social, and economic impacts and benefits (see **Section 8.3**).

4.4.5 Basic landholder rights

There are three types of basic landholder rights to water in NSW, which are given priority under the Act and do not require water licences:¹⁸³

- **Domestic and stock rights** – owners or occupiers of land that is overlaying an aquifer or has river, estuary or lake frontage can take water without a licence for domestic (household) purposes or to water stock
- **Harvestable rights – dams** – landholders in most rural areas can collect a proportion of the runoff on their property and store it in one or more farm dams up to a certain size
- **Native title rights** – individuals who hold native title (as determined under the Commonwealth *Native Title Act 1993*) can take and use water for a range of personal, domestic and non-commercial purposes.

Basic landholder rights are regulated outside of water sharing plans but should be considered as part of the development and implementation of the replacement Plans as they impact the LTAAEL and extraction profiles. While DPIE-Water bases estimates on a certain volume taken under basic landholder rights, there is no publicly available transparent guideline around how much water can be extracted for domestic and stock use through bores or river access.

Both greenfields development and densification can impact the volume of water extracted under basic landholder rights for both the Surface and Groundwater Plans. Subdivision as being experienced with Greater Sydney's population growth and densification, can mean additional properties have access to river frontage or install bores for domestic and stock extraction. Concerns around the growth in extraction under basic landholder rights were raised by some stakeholders.

As part of basic landholder rights, water held in farm dams is only partially regulated by the Surface Water Plan.¹⁸⁴ Water access licences are only required for extraction from surface or groundwater beyond harvestable rights. Harvestable rights are regulated by the NSW Government Gazette, not the Plan, and refer to landholders' right to capture 10 percent of average regional rainwater runoff on their land, with certain limitations.¹⁸⁵ Farm dams also require a licence if they are on a third order or greater river, a permanent spring fed first or

¹⁸² Clause 35(3) of the Surface Water Plan - trading within the same water management area are prohibited. These management areas are described by the Act as the Southern Water Management Area, the Hawkesbury-Nepean Water Management Area, the Southern Sydney Water Management Area and the Sydney Harbour Water Management Area. They were constituted by Ministerial order made under Section 11 of the Act and published in the NSW Government Gazette No 180 on 23 November 2001, page 9389.

¹⁸³ Sections 52-55 of the Act.

¹⁸⁴ Extraction from a runoff harvesting dam requires an access licence and a water supply works approval, above the landholder's harvestable right entitlement under Section 53 of the Act. See also Clause 35 of the Plan, if the share components of access licences nominating a runoff harvesting or in-river dam is reduced through a trade, surrender, amendment or cancellation then the Minister may require the dam to be modified to ensure its capacity is reduced (such as through requiring by-pass flows) in line with the reduced share components.

¹⁸⁵ NSW Government (2006) *NSW Government Gazette 40 – 31 March 2006*, pp. 1,628-1,631. Available at: https://gazette.legislation.nsw.gov.au/so/download.w3p?id=Gaz_Gazette%20Split%202006_2006-40.pdf.

second order stream or if they exceed the harvestable rights for the property.¹⁸⁶ It is important that DPIE-Water comprehensively assess and manage the environmental risk associated with farm dams and their extraction potential under the replacement Surface Water Plan.

Harvestable rights are known to have high take-up in Greater Metropolitan catchments. For example, in a study of the Wollondilly catchment (Upper Wollondilly River and Mulwaree River management zones), there was about 74 percent uptake of harvestable rights which would extract about 13 percent of mean annual stream flow.¹⁸⁷ If the landholders extracted their full harvestable rights allowance, this would increase to 20 percent extraction of mean annual stream flow.¹⁸⁸ This is a significant level of extraction, with growth unaccounted for in the implementation of the Surface Water Plan.

All forms of basic landholder rights extraction (harvestable rights, domestic and stock, and native title) must be accounted for as part of both Plans LTAAELs and extraction should be monitored. If additional water is captured, this water would be lost from downstream environments, licensees and communities and would impact the Plan outcomes unless another form of entitlement was reduced accordingly.

The Commission understands that the NSW Water Renewal Taskforce and DPIE-Water intended to introduce reasonable use guidelines for domestic and stock consumption as part of the NSW Government's Water Reform initiative.¹⁸⁹ The Water Renewal Taskforce has been disbanded and the guidelines have not been finalised. As the Commission has consistently recommended,¹⁹⁰ it is important that the guidelines are developed and implemented across NSW as soon as possible. This is particularly critical for the Greater Metropolitan region, which has a significantly higher number of properties than most plan areas.

4.5 High flow conversion clauses should be removed

To incentivise conversions, the number of shares is increased by 2.5 times when converting from unregulated river to unregulated river (high flow) shares.¹⁹¹ The Commission is not aware of any conversions occurring since 2011.

Clauses 41(7) and 41(8) of the Surface Water Plan currently allow for licensees in some management zones¹⁹² to convert low-flow access licences to high flow licences at a ratio of 1:2.5, which then allows the LTAAEL to be increased to reflect such conversions. This allowance to vary the LTAAEL does not require an assessment of sustainability.

This approach poses multiple risks to Plan outcomes:

¹⁸⁶ Clause 64(3) of the Surface Water Plan.

¹⁸⁷ HARC (2018) *Review of Harvestable Rights for Coastal Catchments, Modelling Component*. Report provided by DPIE-Water.

¹⁸⁸ *Ibid.*

¹⁸⁹ Department of Industry (2018) *NSW Non-Urban Water Metering Policy*, p. 5. Available at: https://www.industry.nsw.gov.au/_data/assets/pdf_file/0017/205442/NSW-non-urban-water-metering-policy.pdf.

¹⁹⁰ For example, see reports at Natural Resources Commission (2020) *Water sharing plan reviews*. Available at: <https://www.nrc.nsw.gov.au/wsp-reviews>.

¹⁹¹ Clause 64(3) of the Surface Water Plan.

¹⁹² The Shoalhaven River Extraction Management Unit, the Upper Nepean and Upstream Warragamba Extraction Management Unit and the Hawkesbury and Lower Nepean Rivers Extraction Management Unit.

- given uncertainties around ecosystem requirements, increasing entitlements may pose a risk to environmental outcomes
- entitlement may increase above Warragamba Dam, which poses a risk to urban water security
- other water users in those management zones and downstream could have their allocations reduced below entitlements if LTAAEL compliance is triggered, resulting in inequitable outcomes.
- it restricts the functioning of an effective water market (see **Section 8.1.3**).

These clauses should be removed to reduce the risk of overallocation. If no additional water is available through conversions, there is no net impact of trades at a catchment scale. Moving extraction to high flows would increase drought security for town water supplies pumping directly from rivers. DPIE-Water should remove the high flow conversion provisions and determine rules for high flow trades to reduce stress on low flows (see **Section 8.1.3**), benefiting environmental outcomes while improving social and economic outcomes.

4.6 Externally managed volumes should be considered alongside LTAAELs

In general, inputs and extraction not controlled by water sharing plans are assumed to be small, and in many water sharing plans, they are. However, in the plan area, inflows and extraction external to the Plans are significant and need to be considered as part of a complete water balance. Key flows that are not managed under the Plans include:

- treated wastewater discharges and water recycling
- managed aquifer recharge.

The volume of extraction outside Plan regulations poses a high risk that cumulative extraction may impact environmental, social and economic outcomes. DPIE-Water should transparently assess the specific risks of all forms of extraction to high-value ecosystems, threatened species, and social and economic values.

The NSW Government has recognised these limitations at least in part. DPIE-Water is working on a policy around stormwater harvesting, and the new *Greater Sydney Water Strategy*, which will give some direction on future treated wastewater discharge management and recycling, dam modifications, desalination and demand management. Policies around these elements should be finalised before the replacement Plans commence.

4.6.1 Wastewater discharge and water recycling

Treated discharges from Sydney Water's wastewater treatment plants contribute to the flow of rivers within the plan area. For example, the St Marys Advanced Water Treatment Plant discharges highly treated recycled water to the Hawkesbury-Nepean River near Penrith and was the main contributor to flows in the Lower Nepean and Hawkesbury Water Source in the recent drought. The background document for the Surface Water Plan states that the highly treated recycled water releases from St Marys Advanced Water Treatment Plant are shared between the environment, licensed irrigation and other water users.¹⁹³

¹⁹³ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*, p. 29. Available at:

Treated wastewater releases change from year to year and are dependent on external processes such as Environmental Protection Licences under the *Protection of the Environment Operations Act 1997*. These inflows could be included in the AWD calculations, but are not regulated by the Plans and the Plan's function could be significantly impacted by changes to these external flows (see **Chapter 9**). As Western Sydney's population grows and additional infrastructure is needed or requires upgrade, provision of recycled water directly to customers may increase in occurrence.¹⁹⁴ This may divert treated wastewater discharges from the rivers. Future growth and change in input from treated wastewater discharges and diversions to water recycling need to be considered within total water balance at a strategic level. The Surface Water Plan should include an amendment clause to update modelling and if necessary, amend provisions including the LTAAELs and AWDs if significant changes to wastewater discharges occur.

4.6.2 Managed aquifer recharge and return flows

The Surface Water Plan also allows for amendment to include rules for managed aquifer recharge. However, the Commission notes that a policy for this is yet to be developed. This involves taking water such as recycled water or urban stormwater, treating it, and then storing it in underground aquifers under controlled conditions.¹⁹⁵ This water could then be extracted later. A pre-feasibility assessment for a managed aquifer recharge project in Sydney's Botany aquifer has been undertaken by the University of NSW and the University of Technology Sydney. If implemented, this project could deliver around 5 percent of Sydney's annual water usage.¹⁹⁶

The Plans need to ensure there is no double counting of volumes of water as extraction. Licensees cannot be credited for inputting water to one plan without being debited for it in the other (for example, by adding to the groundwater balance, having extracted from surface water). If water is removed from surface water, it must be replaced in an appropriate timeline (see **Section 7.6**). This would help track and ensure that the overall surface and groundwater balances are sustainable.

4.7 A modelling framework should assess extraction limits region-wide

A comprehensive modelling framework covering the entire plan area is required to develop and assess the capacity of plan rules to deliver outcomes and assess the risks to water users and the environment from extraction and future water availability.

Hydrologic models can be joined to hydrodynamic models to assess connectivity along the rivers and the behavior of water in the estuaries, which is important to understand Plan outcomes. They can also assess the overall impact of land use change, wastewater treatment and recycled water treatment plant discharges and stormwater harvesting.

https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

¹⁹⁴ Note water recycling can refer to stormwater harvesting for beneficial use or reusing wastewater. The Commission is referring to highly treated wastewater as recycled water. See **Section 4.4.4** on stormwater harvesting.

¹⁹⁵ Clause 82 (10) of the Surface Water Plan.

¹⁹⁶ University of NSW (n.d.) *Managed aquifer recharge in the Botany aquifer*. Available at: <http://www.connectedwaters.unsw.edu.au/research/projects/managed-aquifer-recharge-botany-aquifer>.

There are currently several models in use across agencies and water corporations, but these are designed only to assesses specific elements of the Plan or specific locations and cannot be used to model water management in the Plan holistically. For example, the WATHNET model used to assess WaterNSW's supply to Sydney Water does not include irrigation extraction. Similarly, water quality models do not include irrigation. As such, the amount of water remaining for the environment on a daily time scale cannot be assessed with this model. Other models look at specific issues such as mining and wastewater discharge. There are currently no models for the Groundwater Plan.

In developing a modelling framework, DPIE-Water should draw upon currently available models and identify and address gaps in model capability and data inputs. The Hunter Valley Hydrodynamic Platform and Model(s) Project¹⁹⁷ is a multipurpose model used across state and local government, which could be used as an example.

The modelling framework should consider both surface and groundwater, all forms of water extraction (both internal and external to the Plans) and be based on a robust evidence base, including simulating water extraction patterns across a range of climate scenarios.

Most critically, the framework should be used during Plan development to establish and publish numeric values for catchment-scale LTAAELs for the Plans that protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems. The framework can also be used during the Plan period and as part of evaluations of Plan outcomes to assess the potential effectiveness of Plan provisions. The MER framework for the Plans should include actions to continuously improve the modelling framework and its data inputs and improve the Plans over time based on new model outputs.

The framework should be made publicly available to improve transparency and provide a consistent tool for other water managers in the area to manage take and assess impacts.

4.8 Recommendations

R 2	<p>To inform the replacement Plans by 1 July 2022, DPIE-Water should develop a comprehensive water balance. This should be developed using an overarching modelling framework, which includes:</p> <ul style="list-style-type: none">a) reviewing and addressing gaps in current modelling and model inputsb) all surface water and groundwater extractionc) inflows (including treated wastewater and recycled water discharges) and induced recharge (internal and external to the Plans)d) up to date evidence regarding recharge, hydrogeology, connectivity, and climate (the hydrological model should use the climatic data developed for the <i>Greater Sydney Water Strategy</i>). <p>The modelling framework should be used to inform revised provisions and assess their ability to achieve outcomes.</p>
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¹⁹⁷ UNSW Water Research Laboratory (n.d.) *Hunter scoping study*. Available at: <http://www.wrl.unsw.edu.au/research/hunter-scoping-study>.

<p>R 3</p>	<p>By 1 July 2023, DPIE-Water should ensure all extraction in the Greater Metropolitan region is managed to protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems by:</p> <ul style="list-style-type: none"> a) using the modelling framework to establish and publish numeric values for comparable, catchment-scale LTAAELs for the Surface Water and Groundwater Plans that include all forms of extraction managed under the Plans b) using the modelling framework to ensure the Surface Water and Groundwater Plans can function, protect values and achieve objectives under a representative range of climatic conditions over the medium to long term c) basing LTAAELs on sound evidence of ecosystem requirements, recharge, hydrogeological boundaries, and connectivity d) ensuring the water acquired through the Hawkesbury-Nepean River Recovery Project is adequately protected e) ensure mining activities are licenced f) removing clauses 41(7) and 41(8) allowing the LTAAEL to be increased through high flow conversions g) including an amendment provision allowing LTAAELs and Available Water Determinations (AWDs) to be adjusted should volumes managed external to the Plans change significantly.
<p>SA A</p>	<p>Finalise the reasonable use guidelines for domestic and stock use by 1 July 2022 and include the agreed standards as part of the replacement Plans.</p>
<p>SA B</p>	<p>Policies around exempt and externally managed extraction should be finalised to inform the replacement Plans' development, for example stormwater harvesting and construction and maintenance dewatering.</p>

5 The Plans do not manage extraction equitably

Once the total volume of water allowed to be extracted has been set, provisions should then distribute available water between the various uses, licence categories and water sources. This should be consistent with the priorities and principles in the Act, as well as Plan objectives, including around equity and social, cultural and economic outcomes.

There are several issues related to how the Plans allocate water within and between licence categories:

- the Plans have not sufficiently defined equitable sharing, or the social, cultural and economic objectives to support rules that are likely to achieve desired outcomes (**Section 5.1**)
- some provisions protecting releases from dams and external sources under the Surface Water Plan allow for inequitable extraction, including access to releases from the Warragamba Dam for drinking water and environmental outcomes and releases of highly treated recycled water from St Marys Advanced Water Treatment Plant (**Section 5.2**)
- reductions allowed to AWDs are not applied equitably among the same licence categories (**Section 5.3**).

Consideration of Aboriginal water values is a critical aspect of equitable water sharing. The Commission continues to identify significant issues in provisions relating to Aboriginal water values, rights and uses as part of its water sharing plan reviews. These issues, as well as plan-specific issues, are discussed in detail in **Chapter 9**.

5.1 Equitable sharing is not defined and may not be protected

The Plans include objectives to provide for critical requirements (utility needs of Greater Sydney, and basic landholder rights) and equitably share water¹⁹⁸ but do not define what equitable sharing would mean. This should be defined, consistent with the Act's requirements, so that provisions can be appropriately designed and assessed to ensure they are managed equitably.

The benefits of a healthy river system are valued by the whole community. In the Greater Metropolitan region, this includes residents and visitors to Greater Sydney, the Blue Mountains, Illawarra, Shoalhaven and beyond. The river system also has significant cultural importance to Aboriginal communities.

The Plans also do not explicitly outline how they support community benefits or incorporate those values into their objectives. The need to manage the water cycle more holistically and including community requirements in planning is recognised by various agencies in water management. For example Sydney Water is also 'reimagining' water use in Western Sydney and are '*looking at the urban water cycle as a whole, exploring the broader value of water for community benefit, and setting long term direction to positively respond to future challenges and opportunities... to consider, integrate, and understand the economic value of water for shaping, building, greening and cooling a new Western City*'.¹⁹⁹

¹⁹⁸ Objectives a, e and f of the Surface Water Plan and objective e and f of the Groundwater Plan.

¹⁹⁹ Sydney Water (2020) *Re-imagining water in Western Sydney – Western Sydney regional masterplan*. Available at: https://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mjiz/~edi sp/dd_223336.pdf

DPIE-Water has recently updated water sharing plan templates to make social, economic and environmental objectives more explicit, including how Aboriginal cultural and heritage values, uses and objectives are protected, preserved, maintained or enhanced (see **Chapter 9**). Once these objectives are made clearer, DPIE-Water should ensure that community values are appropriately and equitably protected by plan provisions.

5.2 Access to releases is poorly defined and inequitable

There are various releases from dams and external sources meant as environmental or drinking water that are regulated within the Surface Water Plan. While many provisions are designed to protect these releases, other provisions allow for inequitable extraction. Concerns include:

- Exemptions from cease to pump conditions risks downstream basic landholder rights and Sydney Water's drinking water (North Richmond Water Filtration Plant) access, circumvent the Plan's ability to achieve environmental outcomes, and are unlikely to be aligned with the Act's priorities. These exemptions also create inequitable access along river lengths (see **Section 7.1**).
- Releases from the Warragamba Dam for drinking water and environmental releases are not protected from extraction by other users (see **Section 6.2**). Despite releases from the dam, in December 2019 of the recent drought the cease to pump threshold affecting Sydney Water's North Richmond Water Filtration Plant licence was almost reached. Sydney Water advised that this should not have occurred, unless the releases were accessed by irrigators in the river between the dam and the filtration plant.²⁰⁰ This access of specific purpose releases, particularly in lower flow periods, risks drinking water supply for Sydney's residents, as well as downstream environmental outcomes and does not protect the critical priorities under the Act.
- The Surface Water Plan relies on highly treated recycled water from St Marys Advanced Water Treatment Plant to substitute environmental releases that would otherwise need to come from Warragamba Dam. However, it cannot require utilities to release treated recycled water or wastewater, rather it can only regulate how the water is accessed once it is the river (see **Section 4.6**).²⁰¹ This raises issues as utilities reconsider the balance between discharging to the river or diverting recycling water elsewhere such as to supply customers directly, and the Plans' ability to manage flows and achieve outcomes.

Discharges from Sydney Water's wastewater and recycled water treatment plants contribute significantly to the baseflow in rivers in the plan area,²⁰² affecting the annual and daily water balances. As the population of Greater Sydney grows and Western Sydney becomes more urbanised, wastewater and stormwater flows will increase and the management of these will influence how the plan operates.

The St Marys Advanced Water Treatment Plant was a main contributor to flows in the Lower Nepean and Hawkesbury Water Source in the recent drought. Although outside the Plans' management, this water is critical to the outcomes of the Surface Water Plan because:

²⁰⁰ Interview: Sydney Water, 3 November 2020.

²⁰¹ DPIE-Water advised that during the period that insufficient water was reaching North Richmond Water Filtration Plant, St Marys Advanced Water Treatment Plant was offline.

²⁰² Interview: Sydney Water, 3 November 2020.

- In 2010, under the Western Sydney Recycled Water Initiative's Replacement Flows Project²⁰³ St Marys Advanced Water Treatment Plant produced high quality recycled water that replaced flows that would have been released from Warragamba Dam for environmental flows.
- Highly treated recycled water discharges are used to determine daily cease to flow levels.

The Surface Water Plan defines the proportionate volume of the replacement flows assigned to the environment compared to licensed extraction.²⁰⁴ The basis of this distribution is unclear. The Commission could not find any documentation as to the basis for sharing prescribed by the Surface Water Plan or definitions of the terms used (such as percentile of total inflows to dams). As discussed in **Section 4.6.1**, the current Surface Water Plan's outcomes are dependent on the specified releases, any redirection would have impacts on outcomes. The Surface Water Plan needs to ensure that alterations will be made to environmental releases to maintain outcomes if replacement flows are used in manner different from the intent of the Replacement Flows Project.

Inputs from treated wastewater discharges and any reduction in inputs from diversion of water for recycling need to be considered within total water balance at a strategic level (see **Section 4.7**). The Surface Water Plan should clearly define beneficiaries of flows and how this will be reassessed if inputs external to the plan are varied.

5.3 LTAAEL compliance rules are inequitable

Figure 13 and **Figure 14** Error! Reference source not found. Error! Reference source not found. show the distribution of surface water entitlement for all licence categories across the Surface Water Plan. This distribution highlights the scale of extraction to supply urban water needs in the plan area. Most (84 percent) of the water entitlement within the Surface Water Plan is held by the major water utilities of WaterNSW and Sydney Water, or local water utilities of Shoalhaven City, Greater Lithgow, Wingecarribee Shire, Goulburn Mulwaree, Upper Lachlan and Palerang councils. Domestic and stock basic landholder rights make up only 3 percent of surface water entitlement, while 11 percent of potential extraction is from unregulated river access licences entitlement. The Surface Water Plan permits a maximum of 1,667 ML of Aboriginal community development licences, with geographic limitations on where these can be located. If these licences were all assigned, it would only make up 0.14 percent of total entitlement.

The Surface Water Plan includes rules that allow AWDs to be varied to ensure compliance with the LTAAEL. Reductions allowed to AWDs are not applied equitably among the different licence categories. Significantly, water utilities are guaranteed 100 percent AWD, with any reduction to allocation necessary to meet the LTAAEL required to come from unregulated access licences, unregulated high flow licences, and Aboriginal Community development licences. Limiting reductions in AWD to unregulated river, Aboriginal Community development licences (if issued), to account for increases in water utility growth, would have

²⁰³ Department of Planning (2007) *Major project assessment: Western Sydney Recycled Water Initiative – Replacement Flows Project*. Available at: https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=MP06_0190%2120190827T012006.003%20GMT.

²⁰⁴ Those proportions change dependent on rules that are stated to be laid out in Table D of the Surface Water Plan. However, this table is not clearly labelled. The unlabeled table on Page 99 of the Surface Water Plan is assumed to be Table D.

disproportionate impact on those licensees, particularly considering Aboriginal Community development licences are already unreasonably restricted (see **Section 8.2.3**).

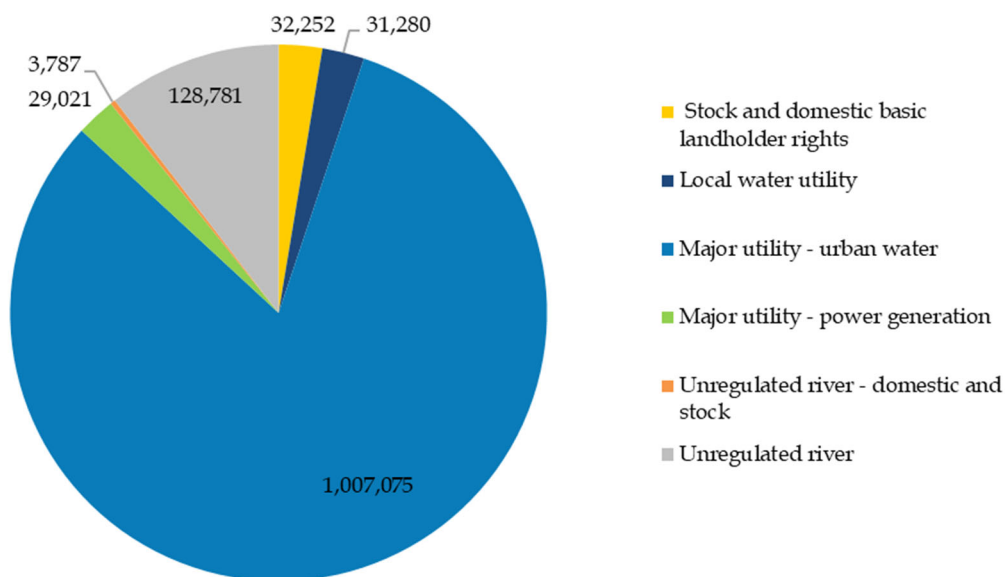


Figure 13: Distribution of surface water by entitlement²⁰⁵

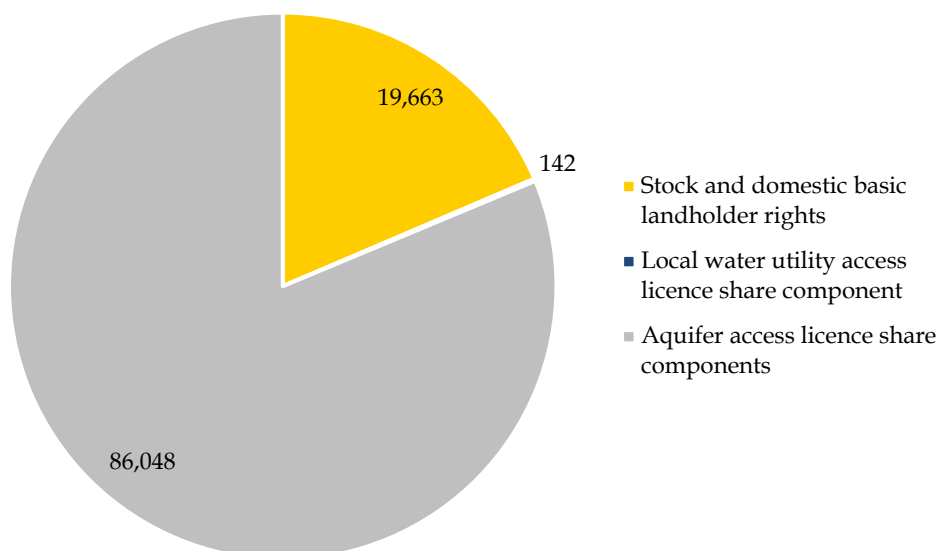


Figure 14: Distribution of groundwater by entitlement category

The LTAAEL for unregulated river access users within the Hawkesbury-Nepean catchment is based on the annual average extraction between 1993 to 1999.²⁰⁶ As no metering program existed in this period except for the utilities, extraction between those dates can only be based on estimations from user surveys with conversion rates.²⁰⁷ These estimates would be less than

²⁰⁵ Data from the *NSW Water Register*. Note these differ slightly from the figures provided in the Plan.

²⁰⁶ Clause 41(4)(a) of the Surface Water Plan.

²⁰⁷ Department of Land and Water Conservation (2000) *Volumetric Conversion – the next stage. A booklet for landholders with licences on unregulated rivers in NSW*.

the sum of entitlements, as volumetric entitlements were based on conversion from area-based licences and included both active irrigation area and inactive irrigation area. If utility water extraction, unregulated access licence and exempted activities such as harvestable rights increase, the likelihood that reductions to AWD are required to meet the LTAAEL will also increase.

The way the LTAAELs have been created greatly impacts equity within a category of licence. As extraction by categories prioritised by the Act grow, the impact of reductions in other categories is dependent on the extent of the extraction management units. A larger extraction unit allows the impact to be spread over a larger number of water users.

The Hawkesbury-Nepean has been split into two extraction management units with separate components of LTAAEL in each. The Upper Nepean and Upstream Warragamba Extraction Management Unit has a high ratio of licence categories prioritised by the Act to which the Plan allocates 100 percent of entitlement each year. This includes local and major (power generation) water utilities. The impact of growth in these categories is spread over a relatively small number of unregulated access licences and Aboriginal commercial licences. On the other hand, the Hawkesbury and Lower Nepean Rivers Extraction Management Unit is predominantly unregulated access licences, with only a small ration of licence categories allocated 100 percent of entitlement each year. The impact of growth by priority categories is significantly less.

The impact of growth in extraction is therefore inequitably impacting the same category of licence within the same catchment. There is no reason to split the catchment into two extraction management units and no assessment can be made of the extent of the inequity until numeric LTAAEL have been determined (see **Chapter 4**).

The Commission recognises that town water supply is a priority under the Act. However, other water sharing plans share the burden of any potential reductions more equitably, while still prioritising town water. Current Plan provisions provide little incentive for efficient use by water utilities, as provided they remain within their entitlement, any reduction required to meet the overall extraction limit will be carried by other users. This could have significant community impacts, given that the other licence holders already have a relatively small share of entitlement. As discussed in **Section 7.7**, in remaking the Surface Water Plan, DPIE-Water should review the AWD rules and ensure that they are consistent with the Plan's equity and social objectives.

5.4 Recommendations

R 4	<p>By 1 July 2023, DPIE-Water should ensure the Plans facilitate equitable sharing of water by:</p> <ul style="list-style-type: none">a) clearly defining equity objectives consistent with the Act's requirementsb) assessing plan provisions against (a), including access to environmental, drinking water and wastewater releases and LTAAEL compliance provisionsc) ensuring that planned Warragamba Dam environmental releases, which have been replaced by wastewater releases, continue to be met by either wastewater releases or dam releases.
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6 Dam releases and transfers need improvement

Major utilities (including WaterNSW, Energy Australia and Sydney Water) and several local water utilities store and release water from major dams and transfer water along rivers under rules set out under Part 6 (system operation rules) of the Surface Water Plan (all references to 'the Plan' in this chapter refer to the Surface Water Plan only). A map and list of the major dams is provided in **Chapter 2**.

Releases can be for either environmental or utility purposes. Environmental releases are important as they can improve downstream water quality and maintain flows for environmental values and basic rights users. They also provide for flowing rivers, which have significant social and economic benefits, including provision of recreational amenities and supporting commercial fisheries. The Plan establishes environmental releases for the larger storages and specifies that some releases must be undertaken, while others are discretionary. These are the key mechanism to achieve the Plans' objective to protect, preserve, maintain and enhance the important river flow dependent and high priority GDEs of these water sources. Currently, environmental releases are enabled through water utility licences and utility providers are responsible for managing releases. Releases are also made by the utilities to meet urban water needs and in some cases for basic rights.

Transfer rules govern the timing and volume of water that utilities can move from one location to improve social, economic or environmental outcomes in another (such as meeting utility requirements). This may also have social, economic or environmental impacts in the source location, which should be considered in the rules. The Plan establishes rules limiting when transfers may occur.

The current Plan provisions were informed by the recommendations of the Hawkesbury-Nepean River Management Forum (which considered the broader plan area).²⁰⁸ The Forum examined the need for environmental flows to address historical issues of poor water quality, pollution and low flows. The Forum submitted its final report to the NSW Government: *Water and Sydney's Future, balancing the values of our rivers and economy*. The report's recommendations included:

- Nine recommendations regarding environmental flows for the upper Nepean River system and Warragamba River; environmental flows for the Wingecarribee, Woronora and Shoalhaven Rivers; management of environmental flows and provisional environmental flows; and, management of aquatic weeds.
- Twenty recommendations regarding water supply transfers and environmental flows; modification of weirs and protection of environmental flows from extraction.
- Undertaking further scientific studies for Woronora Dam and, depending on the results of these studies, the introduction of an 80/20 transparent/translucent flow regime.

Except for environmental flow rules for Warragamba Dam, these recommendations were adopted into the Surface Water Plan.

²⁰⁸ In July 2001, the NSW Government established the Forum to examine the need to introduce environmental flows in the river system for inclusion in Sydney Catchment Authority's water licence. The forum included a broad range of stakeholders, who engaged extensively with and were supported by the Independent Expert Panel for Environmental Flows in the Hawkesbury-Nepean, Shoalhaven and Woronora River Systems. The Forum met regularly over three years and made detailed recommendations on environmental flow requirements.

While the basis for the current rules was sound at the time and some environmental outcomes have been demonstrated, there are several issues that risk the achievement of outcomes from releases and transfers:

- Tallowa Dam environmental and utility releases and transfers should be optimised to better achieve social, environmental and economic outcomes (**Section 6.1**)
- environmental release rules developed after the Plan for Warragamba Dam have not been implemented (**Section 6.2**)
- to achieve environmental outcomes, environmental releases from WaterNSW's Upper Nepean dams to Wallacia Weir could not operate in line with Plan provisions (**Section 6.3**)
- discretionary rules for environmental releases from WaterNSW dams have not been implemented – these releases include the environmental contingency allowance, high flow releases from Woronora Dam and release of water recovered from the Hawkesbury-Nepean River Recovery Project (**Section 6.4**)
- environmental flow rules for other water utilities required under Clause 39A have not been established (**Section 6.5**).

Where releases have not been made, rules not implemented or rules suspended, the planned environmental water in Part 4 of the Plan may have been undermined and, in some cases, there may also be impacts on basic landholder rights or utilities.

To help address these issues and maximise outcomes across the whole plan area, releases and transfers should be managed in an adaptive and integrated way that considers how releases across the plan area can be used to achieve outcomes in line with the priorities in the Act. The previously disbanded Environmental Flows Reference Group should be reconvened to assist in addressing these issues and drive a coordinated approach to managing releases (**Section 6.6**).

6.1 Tallowa Dam releases and transfer rules risk outcomes

Tallowa Dam in the Shoalhaven Water Source stores water from the Shoalhaven and Kangaroo rivers in Lake Yarunga for:

- transfer across the southern highlands to the Upper Nepean dams providing Greater Sydney's water supply
- utility release from the dam to supply Shoalhaven community water supply
- hydroelectric generation for Origin Energy
- environmental releases down the lower Shoalhaven River.²⁰⁹

Clause 28 in the Plan sets the environmental releases and Clause 30²¹⁰ specifies the conditions under which transfers can occur from Tallowa Dam. These two clauses are intended to work

²⁰⁹ Sydney Catchment Authority (2006) *Shoalhaven Water Supply Transfers and Environmental Flows August 2006 - Discussion Paper*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0011/548777/monitor_sholahaven_sh_discussion_paper27aug06.pdf

²¹⁰ The clause states that 'WaterNSW must not commence transferring water from the Shoalhaven River Water Source to the Upper Nepean and Upstream Warragamba Water Source unless: the total volume of water in Water NSW storages within these water sources is less than 75% of total storage capacity of those storages; and the level of water in Lake Yarunga is equal to or greater than 55.34 metres. It also states 'WaterNSW must cease transferring water from the Shoalhaven River Water Source to the Upper Nepean and Upstream Warragamba Water Source when either: the total

together to maintain environmental releases downstream. The drawdown in dam level caused by transfers reduces the volume of flows overtopping the dam, reducing the frequency and magnitude of high flows reaching the estuary. The *Sydney Drinking Water Catchment Audit 2019* summarised the Plan's environmental flow rules and exemptions and found that the releases were generally compliant with the Plan. Where releases were not met, such as at Tallowa Dam, the flow delivery was within 5-10 ML per day of the required flow.²¹¹ The audit also found that the environmental releases from the Wingecarribee Dam did not always reach past Bong Bong weir, with little or no flow over Berrima weir and dry sections of river, potentially due to losses re-wetting the river bed or extraction.²¹²

Further, stakeholders downstream of Tallowa Dam raised concerns during initial Plan development over the Plan's ability to provide enough water to the lower estuary to support estuarine industries (including the oyster industry) and ecology.²¹³ The background document for the Plan states these concerns were not addressed. This was based on the Intergovernmental Working Group and water utility CEOs Committee view that the environmental flow rules for Tallowa Dam should not be reconsidered as there were already comprehensive procedures to develop environmental flows for the Shoalhaven River below Tallowa Dam. This procedure included establishing a scientific advisory group and a community consultative group.

Stakeholders continued to raise these concerns in submissions to this review. In addition, concerns were also raised regarding the suspension of Clause 30 in August 2019 due to drought conditions, which increased the potential impact on the estuarine flows:

*'Local down-stream water users and water reliant businesses are reporting significant impacts including cuts to water allocations, rising salinity, and lack of freshwater flows which particularly impact the Oyster industry and other local commercial fishers'.*²¹⁴

The current release and transfer rules for Tallowa Dam could be improved to optimise environmental, social and economic outcomes in both the Shoalhaven and Hawkesbury-Nepean:

- The entitlement volume held by WaterNSW in the Shoalhaven under the Plan is 329,000 ML per year, which is significantly higher than their LTAAEL of 36,000 ML per year. Current entitlement levels are intended to allow for the transfer of a large volume of water in a given year to secure Greater Sydney's water supply when the Hawkesbury-Nepean is in drought and these volumes can only be transferred once WaterNSW's total storage capacity across all dams is lower than 75 percent.²¹⁵

The potential volume allowed to be transferred under entitlement is high relative to average flows and flows in drought periods and could allow extraction of up to 80 percent of transparent flow during drought.²¹⁶ Transfer rules should seek to optimise outcomes

volume of water in Water NSW's storages within these water sources is equal to or greater than 80% of total storage capacity of those storages; or the level of water in Lake Yarrunga is less than 55.34 metres'.

²¹¹ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*. Prepared for WaterNSW. Available at: https://www.watarnsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

²¹² *Ibid.*

²¹³ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548058/wsp_metro_surface_water_background.pdf.

²¹⁴ Submission: Justin Field, MLC, received 12 September 2019.

²¹⁵ Clause 30(1)(a) of the Surface Water Plan.

²¹⁶ Clause 28 (2)(b) of the Surface Water Plan.

and diffuse risk. For example, transferring and storing lower volumes over many years in preparation for drought periods may have a lower environmental impact than waiting until the systems are in drought and then transferring water.

Further, these provisions are based on modelling that indicated that the drought conditions in the Shoalhaven would occur at a different time to those in the Hawkesbury-Nepean. In other words, that when the Hawkesbury-Nepean is in drought, the Shoalhaven would be less so. Evidence from the recent drought indicates that the Hawkesbury-Nepean and the Shoalhaven regions can be in drought at the same time.

WaterNSW's assessment of Sydney's water supply yield from September 2020 states that '*any action that delays the imposition of water restrictions, or enables the lifting of water restrictions, will have a POSITIVE effect on Reliability Yield (e.g. earlier pumping from the Shoalhaven System)*'.²¹⁷ It is an undesirable practice to delay restrictions to increase yield.

- The Plan's current translucency rules for Tallowa Dam allow only 20 percent of flows to be released from the dam, with no provisions for contingent flows. However, studies undertaken during Plan development were based on a translucency rule of 30 percent plus contingent flows.²¹⁸ While the Plan's background document indicates that a decision was made by government to change these provisions, it is unclear what justification there was for reducing the translucency rules to 20 percent and removing provisions for contingent flows.

The ecological benefits of translucency and transparency rules have been clearly demonstrated in the Shoalhaven and Hawkesbury-Nepean rivers, including increased fish movement, improved water quality and better-established aquatic biodiversity.²¹⁹ Studies have also indicated specific environmental benefits at specific flow thresholds, magnitude and frequency for fish passage.²²⁰

- The Plan specifies that releases for Shoalhaven City Council's utility needs are managed by water supply protocols between WaterNSW and the council. Recent drought and bushfire events have highlighted limitations in this approach, as the protocols could not address the need of council in this situation. Shoalhaven City Council is normally supplied from Tallowa Dam. However, the Shoalhaven River stopped flowing during the recent drought²²¹ and environmental releases were no longer required under the Plan. The Plan does not specifically address utility releases in periods of no flow. In this scenario, Shoalhaven City Council draws water from Danjera Dam to replace releases from Tallowa Dam.²²² Danjera Dam was required to be shut down as it was surrounded by fire during the 2019-20 bushfires. When this occurred, WaterNSW made emergency releases from Tallowa Dam in close consultation with Shoalhaven City Council.²²³ Shoalhaven City

²¹⁷ WaterNSW (2020) *History of changes to Greater Sydney's water supply system yield*. Available at: https://www.watnsw.com.au/__data/assets/pdf_file/0014/132035/Greater-Sydneys-Water-Supply-System-yield-September-2020.pdf.

²¹⁸ Boyes, B. (2006) *Determining and managing environmental flows for the Shoalhaven River, Report 2 - Environmental Flows Investigations*. Report prepared for NSW Department of Natural Resources. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/549107/monitor_sholhaven_sh003.pdf.

²¹⁹ DoI-Water (2018) *Review of translucency rules in NSW inland rivers: effectiveness and alternative scenario review*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/169249/Translucency-rules-in-NSW-inland-rivers.pdf.

²²⁰ Reinfelds, I.V., Keenan, H., Walsh, C.T. (2019) 'Fish passage modelling for environmental flows: Hawkesbury-Nepean River, NSW, Australia', *River Research and Applications*, 2020(36): 595-606.

²²¹ Interview: Shoalhaven City Council, 29 September 2020. Streamflow for the Fossicker Flat gauging station is not available from 1 July 2019 to 1 May 2020 at <https://realtime.data.watnsw.com.au/>.

²²² Interview: Shoalhaven City Council, 29 September 2020.

²²³ *Ibid.*

Council considers that the Plan rules should accommodate a broader range of emergency scenarios, and not rely on external protocols. The Commission supports this approach.

DPIE-Water should review all transfer and release rules for the Shoalhaven River to:

- optimise the environmental outcomes across the plan area
- cover a broader range of scenarios (including drought and bushfires) and water security for each utility
- address stakeholder concerns around estuary requirements
- assess whether translucent flows combined with contingent flows provide the magnitude, frequency and duration of flow required for river and estuarine health.

This should occur by Year 5 of the replacement Plan to allow time for data to be collected to adequately monitor and model estuary requirements. The review should be informed by the overarching modelling framework (as discussed in **Section 4.7**). Clause 75 in the current Plan allows for transfers from the Shoalhaven and other transfers and environmental releases to be amended, and therefore this work can be included before the replacement Plan.

6.2 Environmental releases are not being made from Warragamba Dam

Warragamba Dam in the Hawkesbury-Nepean catchment stores 70 percent of the capacity of major dams across the plan area and is the main source of Sydney's water supply. In 2004, the Hawkesbury-Nepean River Management Forum proposed environmental flow rules for all WaterNSW's dams, but these were not placed on Warragamba Dam due to concerns around the impact of rules on Sydney's water supply.²²⁴

The Hawkesbury-Nepean river system below Warragamba Dam has historically had issues with poor water quality and environmental condition. In the 1980s and 1990s toxic algal blooms (*Mycrocystis* and *Anabaena spp.*) were prevalent,²²⁵ along with weed infestations such as salvinia (*Salvinia molesta*²²⁶), alligator weed (*Alternanthera philoxeroides*) and dense waterweed (*Egeria densa*).²²⁷ During this period, the river stopped flowing in dry periods at the weirs along the Nepean River, resulting in stratification, algal blooms and generally poor water quality.²²⁸ Gauging data indicates that the capture of high flows by the dams continues to result in ongoing low flow conditions, which together with point and diffuse sources of pollution is likely continuing to create poor environmental outcomes. Environmental releases will remain important to the ongoing management of these issues.

²²⁴ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548058/wsp_metro_surface_water_background.pdf.

²²⁵ Large algal blooms were reported in 1983, 1985, 1988, 1991, 1993 and 1994 (Western Sydney University (n.d.) *Algal data*. Available at: https://www.westernsydney.edu.au/harwest/harwest/the_health_of_the_river_system/water_quality_data/algal_data.

²²⁶ DPI (2012) *Salvinia*. Available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/81789/Salvinia.pdf.

²²⁷ Roberts, D.E., Church, A.G., Cummins, S.P. (1999) 'Invasion of Egraira into the Hawkesbury-Nepean River, Australia'. *Journal of Aquatic Plant Management* 37, pp. 31-34. Available at: <http://www.apms.org/japm/vol37/v37p31.pdf>.

²²⁸ Personal communication, A.G, Church.

In 2017, the revised *Metropolitan Water Plan* recommended the adoption of 90/10 scaled environmental flow releases for Warragamba Dam.²²⁹ The *Metropolitan Water Plan* considered this was a 'reasonable trade-off between reliability of drinking water for Sydney and the health of the Hawkesbury River'. The *Metropolitan Water Plan's* analysis examined the current condition of the river, the benefits of environmental flows, environmental flow options, economic assessment via benefit cost analysis, community consultation including choice modelling and travel cost surveys among other activities. The *Metropolitan Water Plan* indicated that the required infrastructure needed for the recommended environmental flows would be constructed to allow for these releases (note that these modifications are separate to WaterNSW's current proposed modifications to raise the dam wall).

These modifications have not yet been undertaken, and the environmental release rules have not been implemented, although the required modifications are planned by the NSW Government. To ensure the Plan can achieve environmental objectives, the infrastructure modifications required for the environmental releases should be undertaken.

6.3 Upper Nepean weir releases rules are too prescriptive and inefficient

Environmental releases from the four Nepean dams (Cataract, Cordeaux, Avon and Nepean), are required to pass through 13 weirs (the most downstream being Wallacia Weir) before the Nepean River reaches the confluence of the Warragamba River and flows from Warragamba Dam. Clauses 32(3) to (9) set out a process to account for water from each of the dams and Clause 34(1-11) set the rules for each of the 12 weirs between the dams and Wallacia Weir. This process is complex (covering five pages of the Plan) and includes specific rules for every weir based on inflow considerations.

Implementing the Plan rules requires weir mechanisms that can accurately release water from one weir to the next. The weirs initially had these mechanisms installed, but they were destroyed in the first major flood after installation in 2012 and in subsequent floods in 2013 and 2016. They have not been repaired as they require a redesign, although WaterNSW advised that this is occurring.²³⁰

Due to this flood damage, the weirs have not been operated as intended in the Plan. Instead, WaterNSW has focused on managing flows at Wallacia Weir, the most downstream weir.²³¹ Although this approach does not follow the Plan's intended process, there is evidence that it is delivering some environmental outcomes.

A 2016 study demonstrated ecological benefits of the application of this environmental flow regime in this section of the Plan and found clear environmental benefits from the environmental releases. Aquatic macroinvertebrates in three habitat types were sampled at water-supply and low-flow sites and unregulated sites in 1995 and 1996, before the environmental flows and in 2013 and 2014, about 13 years after the environmental flows. The macroinvertebrate assemblage structure was significantly different between regulated and reference sites and the number of taxa lower at water-supply sites before the implementation of

²²⁹ Transparent releases are provided by rules that define thresholds whereby 100 percent of dam inflows are released to the river downstream as if there was no dam present. Transparency rules provide a percentage of flow. The 90/10 rule refers to transparent flows up to the 90th percentile then an additional 10 percent translucency for any additional flow above the 90th percentile.

²³⁰ Interview: WaterNSW, 4 August 2020.

²³¹ *Ibid.*

the environmental flows. After the environmental flows, the assemblage structure became more similar to – although still significantly different from – the unregulated sites.²³²

Given the demonstrated outcomes and impracticalities associated with current Plan rules, the Commission considers WaterNSW's interim approach is sound. The replacement Plan provisions should be updated to be less prescriptive and more focussed on connectivity and achieving outcomes below Wallacia Weir, allowing operators the ability to manage the system efficiently while still delivering outcomes.

6.4 Discretionary release rules for WaterNSW have not been implemented

The Plan has several discretionary environmental release rules for WaterNSW that have not been implemented. While the Plan does not require that these rules be implemented, there is no agency with clear responsibilities to manage these rules. Therefore, there is no clearly documented justification as to why rules have not been implemented or whether there was a conscious decision to not implement the rules based on an assessment of environmental outcomes.

The Commission considers that the discretionary rules are likely important to achieving the Plan's environmental outcomes. The implementation of these environmental releases should not be discretionary, rather there should be choice in *how* they are implemented. DPIE-Water should establish clear responsibilities for the implementation of specific discretionary rules. To ensure accountability, the role of the Environmental Flows Reference Group should be expanded to assist in ensuring these rules are implemented and provide advice on how to implement them (similar to the role of the Commonwealth Environmental Water Holder in the Murray-Darling Basin, although they also legally hold the water, which the reference group cannot do) (see **Section 6.6**).

The key discretionary provisions that have not been implemented include:

- **The environmental contingency allowance** – the environmental contingency allowance is a volume of water held in storage from which releases are made for environmental purposes or in response to environmental events, such as fish spawning and control of aquatic weeds. In 2004, the Hawkesbury-Nepean River Management Forum recommended three annual flow releases for flushing/ scouring from Upper Nepean dams (5,600 ML), spawning/ protection from Upper Nepean dams (2,700 ML) and aquatic weed management from Warragamba Dam (3,000 ML). Clause 37 of the Plan requires an environmental contingency allowance account to be kept for Avon, Cataract, Nepean and Cordeaux dams. Clause 39 establishes an environmental flows reference group to be appointed by the Minister for the purpose of providing advice to the Minister on releases made from these accounts and the banked environmental flows accounts under Clause 38.

The 2019 Section 44 implementation audit of the Plan found that the environmental contingency allowance was set under Clause 37(2) at 0 ML per year, following environmental flow studies early in the Plan period. The Commission has not been provided with any evidence that would support the removal of contingency flows and considers that having no allowance removes the ability to deal with events such as toxic algal blooms.

²³² Gowns (2016) 'The implementation of an environmental flow regime results in ecological recovery of regulated rivers'. *Restoration Ecology* 24, pp. 406-414.

- **High flow releases from Woronora Dam** – Woronora Dam operates independently of other dams in the Upper Nepean-Warragamba schemes and supplies only the southern suburbs of the metropolitan area, including Sutherland, Cronulla and Heathcote.²³³ As the catchment is small relative to the dam size it spills less frequently than the Upper Nepean Dams. Under Clause 36(c) a high flow release from Woronora Dam shall be made before 1 February each water year in accordance with procedures, rates and duration determined in writing by the Minister. WaterNSW advised that releases were made in 2010 prior to the Surface Water Plan being implemented and a decision was made to not make subsequent releases during the plan period. WaterNSW advised that this was partly due to releases not having the desired effect on fish breeding if not aligned with a wet weather event. The Commission considers that high flow releases are important to achieve environmental outcomes and the decision to not implement them should be reviewed and advised on by the Environmental Flows Reference Group. The Commission notes that requirements for low flow releases were achieved.
- **Water recovered by the Hawkesbury-Nepean River Recovery Project** – As discussed in **Section 4.4.1** the benefits from the Hawkesbury-Nepean River Recovery project from purchases above Warragamba Dam were to be realised through increased transparent and translucent environmental releases.²³⁴ The Plan’s background document states that in the meantime, a fixed release may be required to pass the recovered water through the Dam. This has not been implemented.

In conjunction, the recovered water purchased from below Warragamba Dam was to be realised through a variable daily cease to pump applied to licenced extraction.²³⁵ As described in **Section 7.4**, this is very difficult to manage and has not been implemented.²³⁶ Further, as described in **Section 4.4.1**, the environmental licenses cannot be actively used when required for the maximum environmental benefit, making the provisions inequitable for different license holders, as extractive users can determine when to use their water. The Plan does not specify how DPIE-Water should ensure the recovered water remains in-stream and does not place a time limit on implementation.²³⁷ As none of the recovered water has been specifically used for an intended environmental outcome, the Commission recommends that the Plan assigns this volume of water to the Environmental Flows Reference Group and includes provisions to enable active management so this water can be used to maximise environmental outcomes.

6.5 Environmental flow rules for other utilities must be established

The Surface Water Plan does not include environmental release rules for all major dams in the plan area. Clause 39A was added to the Surface Water Plan in 2014 requiring local government, utilities and WaterNSW to complete studies (outlined in **Table 6**) to determine the need, feasibility and suitability of environmental release rules for the remaining major dams. The clause required the studies to be completed and determination made for most, but not all,

²³³ Heritage Council of NSW (n.d.) *Woronora Dam*. Available at:

<https://www.environment.nsw.gov.au/heritageapp/visit/ViewAttractionDetail.aspx?ID=5051466>.

²³⁴ An upgrade to Warragamba Dam’s ability to release these flows would be required and has not yet been completed.

²³⁵ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: www.water.nsw.gov.au/__data/assets/pdf_file/0003/548058/wsp_metro_surface_water_background.pdf.

²³⁶ Based on a review of licence conditions, and the lack of a mechanism (WaterNSW website) to advise licensees of cease to pump thresholds.

²³⁷ Clause 82(7) of the Surface Water Plan states that ‘*this Plan may be amended to secure water savings associated with the Commonwealth of Australia and NSW Government Hawkesbury-Nepean River Recovery Project*’.

subclauses before the end of Year 5 of the Plan (1 July 2016), which would not have been a feasible timeline. To date, only the Manly Dam study by Sydney Water has been completed.²³⁸

During consultation, some councils indicated they were not aware of these provisions. Further, local councils indicated that they do not have the expertise to complete the studies:

'[Council] tried to implement this program at the end of the drought in around 2012 seeking help from the agency at the time responsible...Councils do not have the expertise or resources to complete this work in house'.²³⁹

The Commission considers DPIE-Water should be responsible for ensuring relevant studies are completed and for setting environmental release rules for utilities and sharing arrangements with other water users. This should be done in consultation with stakeholders. It is inappropriate for licensees to set their own environmental release rules and DPIE-Water have more appropriate expertise, including broader strategic and catchment scale knowledge. In developing these rules, DPIE-Water should consider objectives for environmental releases (see **Section 4.3.1**), draw on relevant expertise in the Environmental Flows Reference Group and consider the latest climate information from the modelling framework (see **Section 4.7**).

Development of these rules should also consider implementation risks from drought and emergency situations such as fire (as discussed in **Section 6.1**). These rules should be included in the Surface Water Plan. The relevant regulator (DPIE-Water or NRAR) should then require licensees to implement these rules through more detailed licence conditions.

²³⁸ Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf.

²³⁹ Submission: Goulburn Mulwaree Council, received 16 September 2020.

Table 6: Environmental flow studies required under Clause 39A of the Surface Water Plan

Utility	Outline of study requirement	Studies completed	Plan amended
Delta Electricity / Energy Australia (current asset owners)	Energy Australia must investigate the need for environmental releases from Wallerawang Dam (Lake Wallace) and undertake infrastructure modifications as determined by the Minister during the term of this Plan	No	No
	Energy Australia must conduct an independent and peer reviewed investigation into the feasibility, suitability and adequacy of transparent and translucent flow dam releases, annual channel maintenance flow releases and drought triggers, including options and recommendations for these rules, for Lilyvale Dam	No	No
Sydney Water Corporation	Sydney Water Corporation must investigate the need for environmental releases from Manly Dam and undertake infrastructure modifications	Yes	No
Local water utilities	Goulburn Mulwaree Council, Wingecarribee Shire Council and Shoalhaven City Council each must investigate the need for environmental releases from water supply works selected by agreement between the respective council and the Minister	No	No
WaterNSW	Water NSW must investigate the need for environmental releases from Wingecarribee Reservoir and undertake infrastructure modifications as determined by the Minister	Unknown	No

6.6 A coordinated, adaptive approach to environmental releases is required

Currently, releases under the Plan are managed separately, both in terms of geographical area in the Plan and by the types of environmental release. There is currently no way of determining the overall extent to which the different releases are contributing to environmental outcomes and no accountability for managing environmental releases in a coordinated, adaptive way. For example, coordination of releases could be used to increase transparency flows to provide adequate flows for specific species requirements (such as for fish passage or breeding).

The *Greater Sydney Water Strategy* will provide guidance for optimising transfers, environmental and utility releases across the plan area. The Plan must then include provisions enabling such transfers and releases, with clear roles and responsibilities. Ongoing management of environmental releases should be undertaken in a coordinated approach to maximise environmental outcomes. The statement of intent for *2017 Metropolitan Water Plan* also recommended an adaptive management approach to environmental releases in the Greater

Metropolitan region.²⁴⁰ This would allow incorporation of new information and address stakeholder concerns.

The Environmental Flows Reference Group should be reconvened as an advisory body. Its responsibility should be broadened under Clause 39(2) of the Surface Water Plan to advise on the coordinated management of environmental releases across the plan area and actively adapt environmental releases to manage future risks. This would provide independent oversight of the implementation of key actions and improve accountability for DPIE-Water. It would also leverage the best available technical expertise within and outside government. The Environmental Flows Reference Group should also assist with advising on other recommendations in this chapter.

In addition, managing environmental flows holistically requires the flexibility to hold and release water to maximise environmental benefit. The Surface Water Plan currently contains provisions for banked environmental flows, which allow for environmental releases to be withheld during severe droughts, with water 'repaid' to the environment once the drought has broken. These rules could be reassessed to allow for banking and strategic release of water for broader, more effective environmental outcomes, such as maximising the benefits of the Hawkesbury-Nepean River Recovery Program. The Commission is of the view that DPIE-EES remains the most appropriate entity to be responsible for final decision-making on environmental releases.

In setting and managing releases, DPIE-Water and the Environmental Flows Reference Group should consider outputs from the modelling framework developed for the plan area (see **Section 4.7**), environmental requirements (including estuary requirements) and environmental and utility supply objectives for the plan area. Environmental releases and monitoring of the outcomes from release should be routinely reported on publicly to improve transparency.

²⁴⁰ NSW Government (2017) *2017 Metropolitan Water Plan: Water for a liveable, growing and resilient Greater Sydney*. Available at: <https://www.planning.nsw.gov.au/-/media/Files/DPE/Other/About-us/Metropolitan-Water/2017-Metropolitan-Water-Plan.pdf?la=en>.

6.7 Recommendations

<p>R 5</p>	<p>DPIE-Water should improve outcomes achieved from environmental and utility releases and transfers by:</p> <ul style="list-style-type: none"> a) immediately reconvening the Environmental Flows Reference Group to advise on relevant aspects of recommendations (b)-(e), and by 1 July 2023, expanding their role in the Plan to advise on a coordinated and adaptive approach to setting and managing environmental releases b) by 1 July 2023, reviewing release provisions for the Upper Nepean weirs and revising them to be less prescriptive and more outcomes-focused c) by 1 July 2023, make currently discretionary environmental releases mandatory and establish clear responsibilities for their implementation, including the environmental contingency allowance, high flow releases from Woronora Dam and water recovered under the Hawkesbury-Nepean River Recovery Program d) by 1 July 2023, set environmental release rules for other utilities in consultation with stakeholders based on the findings of required and other relevant studies, which should be overseen by DPIE-Water e) by 1 July 2027 (Year 5 of the replacement Surface Water Plan), using the modelling framework (Recommendation 2) in conjunction with the estuary model to review the transfer and release rules from the Shoalhaven River/Tallowa Dam to optimise environmental outcomes (including estuarine needs) and water security, considering a broader range of scenarios f) completing a public report outlining the environmental releases undertaken and the outcomes achieved every two years to improve transparency.
<p>SA C</p>	<p>The NSW Government should undertake planned upgrades allowing environmental releases from Warragamba Dam to ensure the Surface Water Plan can deliver environmental outcomes downstream of Warragamba Dam.</p>

7 Plans do not limit timing of extraction to protect flows and manage drought

This chapter explores how effectively the provisions of the Plans govern the timing of water extraction across the plan area. While LTAAELs (discussed in **Chapter 4**) control the maximum amount of water that can be extracted over the long term, these rules are complemented by provisions that manage extraction over the short to medium term, including:

- Daily access rules, which control when licence holders in each water source or management zone can extract water day-to-day. They are intended to protect the needs of the environment, basic landholder rights and water utilities, as well as enabling equitable access to variable flow levels. Daily access rules in the Plans include:
 - fixed cease to pump rules,²⁴¹ which require licence holders to stop pumping when the river falls below a specified level to protect that portion of the flow regime, refuge pools and to maintain connectivity along the river
 - commence to pump rules, which specify levels above which licensees in various flow classes can start pumping (limited by Total Daily Extraction limits (TDELs))
 - TDELs, which specify the total volume of water that can be extracted in each flow class by all licensees on a daily basis
 - variable cease to pump rules, which protect environmental and urban water supply releases from dams.
- AWDs, which allocate the volume of water that can be extracted under access licence within a period, usually a year. This allocation is added to licensees' accounts. Currently, AWDs are intended to be used to ensure LTAAEL compliance (noting that in 2011-2019 the LTAAEL assessment and adjustment of AWDs was not implemented). AWDs could also be an effective way of rationing water in drought periods, but the Plans do not currently include provisions to enable this.²⁴²
- Water allocation account management rules, which allow allocations not used in one year to be held in licensees' accounts to be used in the subsequent year and limits the maximum volume of water that can be taken.

There are several issues with these provisions that should be addressed in the replacement Plans:

- significant periods of extraction are exempted from cease to pump rules (**Section 7.1**)
- some management zones in the Surface Water Plan do not have effective cease or commence to pump rules allowing access to the very low flows (**Section 7.2**)

²⁴¹ The Surface Water Plan's background document notes that the term 'environmental flow protection rules' is used in place of 'cease to pump'.

²⁴² In the Surface Water Plan, after the sixth year of the plan, if average annual extractions in an extraction management unit over the preceding five water years exceeds the LTAAEL for that source by five percent or more, then the AWDs for unregulated river access licences and unregulated river (high flow) access licences in that management unit are to be reduced by an amount that is, in the Minister's opinion, necessary to return average annual extractions to the LTAAEL (clauses 44 to 51). In the Groundwater Plan, after the sixth year of the plan, if average annual extractions in a groundwater source over the preceding five water years exceeds the LTAAEL for that source by five percent or more, then the AWDs for aquifer access licences in that source are to be reduced by an amount that is, in the Minister's opinion, necessary to return average annual extractions to the LTAAEL (clauses 29 to 31).

- current TDEL provisions in the Surface Water Plan are generally unenforceable, inappropriately applied and in some cases lead to poor outcomes (**Section 7.3**)
- variable cease to pump rules to protect environmental releases in the Hawkesbury-Nepean are unnecessarily complex and cannot be effectively implemented (**Section 7.4**)
- daily access rules in the Groundwater Plan are generally sound, but require effective supporting Surface Water Plan rules and have possible drafting errors (**Section 7.5**)
- the Plans allow for cease to pump exceptions for certain users (such as mining operations), without clearly specifying mitigation requirements to account for this additional extraction (**Section 7.6**)
- while the Plan includes AWD provisions, without numeric LTAAELs and without implementing compliance these provisions cannot be applied consistently to ensure LTAAEL compliance (**Section 7.7 and Section 4.1**)
- there are opportunities to expand the use of AWDs to manage water supplies in drought periods, which will become increasingly important given climate predictions (**Section 7.8**)
- carryover provisions legally allow water users to extract more than their annual entitlement during droughts (**Section 7.9**).

7.1 Significant periods of extraction are exempted from cease to pump rules

The Surface Water Plan includes several exemptions²⁴³ to the cease to pump rules, which allow unregulated access licensees to extract in periods when daily access rules would otherwise prevent extraction, including during very low flows. Very low flows are critical to environmental outcomes and must be protected by the Surface Water Plan. While the total volume of water extracted under these exemptions cannot be determined, the Commission's analysis of the frequency at which exemptions may be triggered indicates that significant periods are exempt from cease to pump rules.

For example, in many Hawkesbury-Nepean management zones²⁴⁴ the Surface Water Plan includes temperature exemptions, which allow some users to extract above certain temperatures, even when flows are below cease to pump thresholds.²⁴⁵ Depending on the management zone, temperature exemptions are based on readings at either Campbelltown or Richmond. The Commission examined actual temperatures at Campbelltown between 1 July 2019 and 30 June 2020 to estimate the number of days the exemption would have applied in the relevant management zones (**Figure 15** shows the proportion of days analysed that were potentially exempt and the number of potentially exempted days by month). This indicates that cease to pump exemptions would be triggered around 77 percent of time. These rules and exemptions also apply to extraction in adjacent alluvial aquifers under the Groundwater Plan.

²⁴³ Clause 57(1) of the Surface Water Plan.

²⁴⁴ Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek) Management Zone and Upper Hawkesbury River (Cattai Creek to Colo River) Management Zone, Menangle Weir Management Zone, Camden Weir Management Zone, Sharpes Weir Management Zone, Cobbity Weir Management Zone, Mount Hunter Rivulet Weir Management Zone, Brownlow Hill Weir Management Zone, Theresa Park Weir Management Zone and Wallacia Weir Management Zone.

²⁴⁵ Clause 57(1) of the Surface Water Plan.

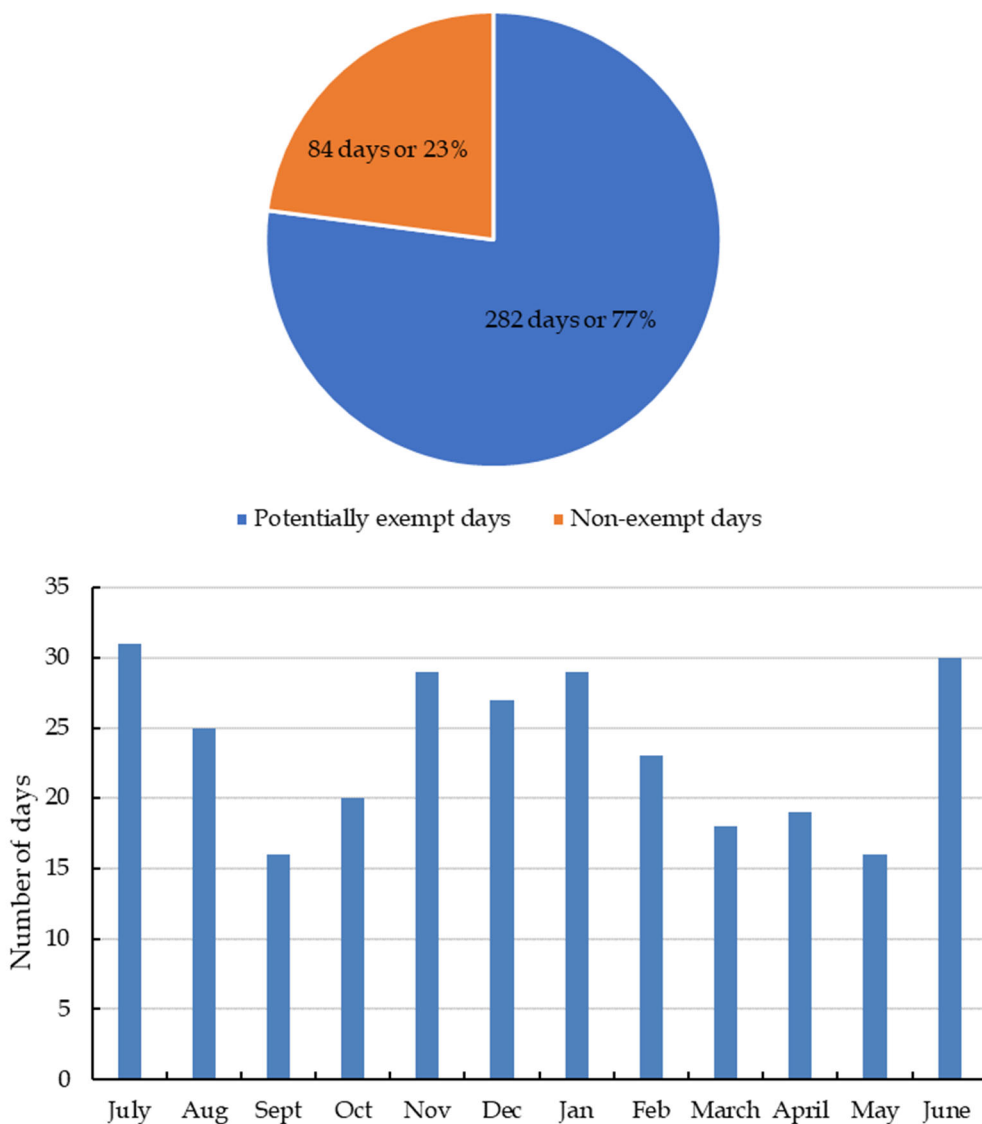


Figure 15: Proportion of days potentially exempt under temperature exemptions in the Campbelltown areas (above, noting the study period was a leap year with 366 days); number of potentially exempt days from July 2019 to June 2020 (below)

The protection of low and very low flows through cease to pumps is an important component of the Plans’ ability to achieve environmental outcomes. Protecting low flows is necessary to protect habitat and food sources for aquatic species, maintain water quality and oxygen levels and reduce algal bloom risk.²⁴⁶ It also secures water for domestic and stock basic rights users. Having significant periods where cease to pump rules are not used to protect low flows places the environment, basic land holder rights (including native title rights), and parts of Sydney Water’s water supply at risk and is unlikely to be aligned with the priorities of the Act.

Further, cease to pump exemptions are not applied uniformly across the plan area. For example, licensees in upstream water management zones may be required to comply with cease to pump rules, while downstream users may have exemptions that allow them to extract protected water from upstream.

²⁴⁶ DPIE-Water (n.d.) *River Management*. Available at: <https://www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/environmental-rules/river-management>.

The Plans contain requirements to undertake reviews and studies to support the removal of exemptions, but these have not been undertaken. Regardless of whether the studies are completed, DPIE-Water should review all exemptions in the Surface Water Plan and connected Groundwater Plan water sources to minimise the volume of exempt extraction and reduce spatial inequity.

7.2 Some water management zones do not contain cease to pump rules

In some Surface Water Plan management zones, river flows are divided into flow classes to allow for more refined management of extraction. Generally, the lower limit of each flow class is an instantaneous cease to pump limit, meaning licensees may not pump once the river hits this level.

The Surface Water Plan establishes the flow classes²⁴⁷ as the basis for the sharing of flows. All management zones of the water sharing plan have at least two flow classes – the very low flow class and A Class. However, some management zones have up to five flow classes (very low flow, A, B, C and D).

Cease to pump conditions are meant to prevent license holders from extracting water below certain critical levels. In the Surface Water Plan, rather than an instantaneous cease to pump, the lower flow band threshold specifies a “commence to pump” level – a level above which pumping can commence for the following 24 hours. This allows licensees to pump significantly below the flow band level during that 24-hour period, including accessing very low flows.

The Surface Water Plan allows for amendments to flow classes. The replacement Plan process should review current flow classes and cease to pump rules and amend them as required to ensure they protect very low flows, connectivity, environmental releases, and basic landholder rights. This process should also ensure that flow classes and cease to pump rules are practical to implement and enforceable.

7.3 Total daily extraction limits increase complexity and impact outcomes

The Surface Water Plan establishes TDELs for each flow class to specify the total volume of water that may be extracted daily (that is, the volume extracted by all licensees).

There are many examples that indicate that current TDEL provisions are often inappropriate or unnecessary, adding complexity to the Surface Water Plan that inhibits the achievement of outcomes. **Table 7** includes examples of the key issues, which are outlined in the points below:

²⁴⁷ Clause 56(1), Column 3 of Table C of the Surface Water Plan.

Table 7: Example flow class thresholds, TDELS, entitlement and estimated peak daily demand

Column reference	1	2	3	4	5
Water management zone	A-Class TDEL (ML/day)	Very low flow threshold Bottom of A Class (ML/day)	Top of A Class	Entitlement	Estimated peak daily demand ²⁴⁸ ML/day
Kangaroo River	18.04	7	30	4895	13 – 27
Dharabuladh	10.0	17	28	531	1.4 - 2.9
Minnamurra River	1.9	3	6.4	903	2.5 – 5.0
Macquarie Rivulet	5.4	8	9	973	2.5 – 5.0
Upper Wollondilly River	1.8	2	6	5280	14.4 – 28.9

- Some A Class TDELS are larger than the very low flow threshold** (see columns 1 and 2), which risks reducing flow to such an extent that the river may stop flowing. For example, in the Kangaroo River Management Zone the Surface Water Plan specifies that A Class is above 7 ML per day and below 30 ML per day. Licensees can extract up to a combined total daily limit of just over 18 ML per day within that class.

In this case, if the flow at the start of the day is 18 ML per day, the Plan rules indicate it would be announced that for the next 24 hours the river is in A Class. Therefore, the entire allowable extraction of 18 ML per day can be extracted, reducing flows in the river to zero. The extraction would then have to cease in the following days until the river recovers back to 7 ML per day. This has potential significant environmental impacts, as well as being inequitable as there are no individual daily extraction limits (IDELs) to apportion the available water between users.²⁴⁹
- Some TDELS are established in management zones with relatively low levels of entitlement** (see columns 1, 4 and 5), which don't require management at this level of detail. In many of the Surface Water Plan's management zones that specify TDELS, the volume of entitlement is small (in some cases less than 1,000 ML per year). In these circumstances there is no need for TDELS given the estimated peak daily demand is less than the TDEL. For example, in the Dharabuladh Management Zone, if licensees extracted all their entitlement within the driest six months of each year the estimated peak daily demand would be 2.9 ML per day, significantly less than the TDEL of 10 ML per day.
- Some TDELS are larger than the flow class** (see columns 1, 2 and 3). For example, in the Macquarie Rivulet, the A Class ranges between 8 ML per day and 9 ML per day, while the TDEL is 5.4 ML per day. In this case, if the maximum TDEL is extracted, there would be no water left within the A Class flow range for the environment and extraction would

²⁴⁸ Estimated by the Commission based on full use of entitlement from constant extraction in the six driest months.

²⁴⁹ Clauses 58(4) and 58(5) of the Surface Water Plan allow for the introduction of additional TDELS and IDELS if the Minister, in consultation with DPIE, determines that the amount of extraction allowed under exemptions in certain management zones in the Hawkesbury-Nepean exceed a certain threshold. However, the Commission did not identify any evidence that these calculations had been undertaken, and no IDELS were implemented.

continue well into very low flows. The TDEL should not be larger than the volume of water available in the flow class (in this case 1 ML per day).

- **Some flow classes have multiple discreet TDELs** for the purpose of sharing between different licence categories. If one category of licensees chooses not to use their TDEL, it is not reallocated to other users. This is inefficient and limits socioeconomic outcomes from water already allocated for that purpose. In some water sources in the Surface Water Plan, discreet TDELs may be inconsistent with other provisions.

For example, in the Upper Wollondilly River Water Source, Clause 57(18) states that unregulated river access licences (for example, irrigators) cannot extract when the local water utility is extracting from the river. However, the TDEL provisions allow for extraction in Class A flows of up to 1.40 ML per day for local water utility access licences²⁵⁰ and 0.38 ML per day for unregulated river access licences. This suggests that both types of licence could extract at the same time.

In addition to the limitations of the TDELs themselves, there are currently no IDELs, which proportion available water amongst eligible licensees. As such, it is not clear how the TDEL could be managed or enforced, and the Commission understands it is currently not monitored. This also creates equity issues as upstream users get first access and therefore have a significant advantage. IDELs are necessary to equitably implement TDELs.

In developing the replacement Surface Water Plan, DPIE-Water should review the flow classes and TDELs to ensure that the rules provide adequate protection of environmental water and basic landholder rights. TDELs should not allow for extraction greater than the total flow class range, and IDELs should be established to ensure equitable sharing. Given the complexity of operating under IDELs and TDELs, where it is sufficiently protective of the environment (for example, in water sources with low risk of over-extraction and low environmental value) DPIE-Water should assess if alternative rules such as a simple cease to pump would be more efficient and effective.

Cease to pump rules should apply continuously (i.e. pumping must stop when the water level reaches the cease to pump) and be actively managed so that the Surface Water Plan does not allow for pumping of very low flows. This will have beneficial flow on effects for the implementation of Groundwater Plan rules (see **Section 7.5**). Further, cease to pump levels should be set based on ecosystem requirements. The Surface Water Plan contains extensive amendment provisions allowing for adjustments to cease to pump thresholds (without triggering compensation). These should be reviewed and changes to cease to pump implemented as necessary.

7.4 Management of releases in the Hawkesbury-Nepean can be improved

The daily access rules in the Surface Water Plan were intended to protect environmental water from extraction (including environmental releases from WaterNSW's dams). The Surface Water Plan's aim is to maintain natural variability by protecting environmental releases with rules that vary daily based on a broad range of considerations including inflows from the upstream weir, tributary inflows, and inflows from wastewater treatment plants.

²⁵⁰ Excluding local water utility access licences to which Clause 2 of Schedule 2 of the Surface Water Plan applies.

In each management zone, the water available to water users is meant to be calculated daily. As they stand, the rules around whether licensees downstream of environmental releases from Hawkesbury-Nepean dams can pump or not cannot reasonably be expected to be calculated by individual licensees.²⁵¹ Due to the complexity of the Surface Water Plan rules, WaterNSW was unable to apply conditions implementing the rules on individual water access licences.²⁵² Instead, the licences have a condition that licensees must comply with the rules outlined on a website providing information on flow classes and daily extraction limits and specifying if and how much water licence holders can extract. It was intended that WaterNSW would notify licensees when the website was active.²⁵³ However, this website has not been created.

These management zones are critical to the Plan, as the combined entitlement for unregulated access licences in these management zones is 74,432 ML per year which is 78 percent of unregulated access water extraction within the Hawkesbury-Nepean Catchment and 57 percent of access irrigation across the Surface Water Plan. Although other factors such as exemptions and lack of notification have made the rules ineffective, it is still important to consider if the rules would have achieved outcomes. To assess this, the Commission compared streamflow during the peak of the recent drought (between 1 November 2019 and 31 January 2020) with estimates of streamflow if the rules had been applied.

The Commission tracked environmental releases from the Upper Nepean Dams downstream through the management zones using available information to assess outcomes. For this assessment, the Commission divided the river into three sections to reflect physical constraints and management issues (see **Figure 4 in Chapter 2**):

- Upper Nepean Dams to Wallacia Weir, where transmission through weirs is critical (**Section 7.4.1**)
- Wallacia Weir to the tidal pool, where the river is maintained by flows outside the plan (**Section 7.4.2**)
- The tidal pool, where hydrodynamic processes (tidal movements, inflow from other rivers entering the tidal pool, connectivity between river and estuary and preceding flow events) are critical to environmental outcomes (**Section 7.4.3**).

7.4.1 From the Upper Nepean Dams to Wallacia Weir the Plan need to be outcome focused

To determine if unregulated access licences can extract in this section, the Surface Water Plan requires complex daily calculations for eight management zones based on individual weirs. Potential extraction is highly variable across these management zones, with 53 unit shares in Brownlow Hill compared to 5,040 in Wallacia Weir. However, each of these management zones have equally complex rules to calculate the cease to pump thresholds.

²⁵¹ The Section 44 implementation audit of the Plans published in 2019 highlighted issues with water access licence conditions. To implement the Surface Water Plan, licensees must be able to comply with rules, but the information required to calculate the rules is not available to individual licensees.

²⁵² Agency roles have recently been revised and DPIE-Water are now responsible for drafting access licence conditions that implement plan rules. WaterNSW now manages only the notification and issue of the conditions, as well as the customer interface.

²⁵³ Condition placed on unregulated river access licences.

Effective implementation of the rules depends on:

- all weirs having an accurate water level to flow relationship
- all weirs functioning correctly, or repaired in a timely manner (as discussed in **Section 6.3**, this has not been the case since 2012)
- all weirs having a functioning gauge
- daily notifications to licensees of water availability (which requires an operational website)
- consistent travel times and losses (the Surface Water Plan specifies travel times and transmission losses).

In practice, travel times and losses vary with flow and weather conditions. Relationships between height and flow are affected by factors such as flood debris and weed growth and require periodic calibration. The number of possible errors in measurement in all the variables can be much larger than the amount of water being allowed for extraction on any day.

The Surface Water Plan's provisions should be outcomes focused, rather than specifying operational processes. Relying on complex calculations increases the cost of implementation and increases potential errors and points of failure. The Surface Water Plan should define desired outcomes and allow operators and licensed users to meet outcomes as efficiently as possible. More detailed operating procedures that support implementation but sit outside the Surface Water Plan could be developed and more easily adapted to incorporate new information. These should be transparent, publicly available and subject to consultation during development and when major amendments occur.

7.4.2 Below Warragamba Dam and Wallacia Weir the river needs holistic management

This section of river differs from the section upstream, as WaterNSW's licence does not require it to target end of system flows. There are also more inflows into this section than upstream, including urban water supply releases from Warragamba Dam for North Richmond Water Filtration Plant, highly treated recycled water from the St Marys Advanced Water Treatment Plant, other wastewater and recycled water treatment plant discharges, tributary inflows and the flows over Wallacia Weir.

The cease to pump level varies daily depending on a proportion of each of the inflows. To determine if water users extracted environmental releases, the Commission analysed the daily cease to pump at Yarramundi gauge and compared them with environmental releases at Wallacia Weir. At all times, the daily volume of releases that passed over Wallacia Weir passed the Yarramundi gauge, indicating that those environmental flows were being passed on from Wallacia Weir. The Surface Water Plan required some tributary inflow up to the 95th percentile be protected, but gauging stations were not installed, so this did not occur. If gauging stations had been installed the variable cease to pump at Yarramundi would have been lower and licensees may have been required to cease pumping. Without gauging stations, it is not possible to assess how much water came from the tributaries. Gauging stations should be installed as a matter of priority to address this problem.

Water users in this section of river continued to extract without any restriction as the river flows were maintained by the additional inflows from highly treated recycled water discharges (see

Section 4.6.1), tributary inflows, releases for urban water supply and possibly groundwater inflows.

The Plan rules in relation to the percentage of highly treated recycled water discharges that are included in calculating the variable cease to pump are unclear.²⁵⁴ However, the calculations demonstrate that treated wastewater releases are critical to maintaining base flows during the drought. This may be a significant risk to water users, as any redirection of wastewater discharges (which are not managed by the Plan – see **Section 4.6.1**) would have an impact.

Reductions in highly treated recycled water discharges also impact environmental flows, even though wastewater discharges are not within the regulatory powers of the Act and therefore cannot be required under the Surface Water Plan. Holistic management of all water is required to deliver outcomes for this and downstream management zones. The Plan should include amendment provisions, which allow for additional environmental releases should the highly treated recycled water discharges be reduced significantly.

7.4.3 Environmental releases need to consider tidal pool hydrodynamic characteristics and estuary requirements

The Lower Hawkesbury River is tidally dominated, with the tidal influence extending about 120 kilometres from Broken Bay to the tidal limit at Yarramundi, near the Grose River Junction.²⁵⁵ The freshwater section of the estuary is known as the tidal pool. During periods of high streamflow, saltwater is pushed down the estuary. During periods of low streamflow, saline water from the lower estuary can move further up the estuary as a density current (denser saltwater flowing under freshwater) or through tidal mixing.²⁵⁶ The Hawkesbury-Nepean has a significant tidal pool that sustains commercial extraction²⁵⁷ despite being affected by daily tidal movement. Water is normally suitable for irrigation (800 EC) down to the Colo River junction but has been observed to move as far upstream as Sackville.²⁵⁸

The Surface Water Plan divides the tidal pool into four management zones: the Upper Hawkesbury River (Grose River to South Creek), Upper Hawkesbury River (South Creek to Cattai Creek), Upper Hawkesbury River (Cattai Creek to Colo River) and Lower Hawkesbury River management zones. These have a combined total of 47,594 unit shares, which is 44 percent of unregulated access licences in the Hawkesbury-Nepean catchment.

The current rules in the Surface Water Plan treat the tidal pool as a continuation of the normal river and don't address the specific tidal pool behavior. This section of the river differs from upstream sections as:

²⁵⁴ Although specified in this clause there is no Table D in the Surface Water Plan. However, there is an unlabeled table on page 92, which the Commission assumed to be Table D.

²⁵⁵ Miller, B.M and Peirson, W.L. (2012) *Modelling the saline dynamics of NSW East Coast estuaries*. In Hydrology and Water Resources Symposium. Available at:
<https://search.informit.org/documentSummary;dn=953403056508523;res=IELENG;type=pdf>.

²⁵⁶ Dyer, K.R. (1997) *Estuaries: A physical introduction*, 2nd edition.

²⁵⁷ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at:
https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

²⁵⁸ Miller, B.M and Peirson, W.L. (2012) *Modelling the saline dynamics of NSW East Coast estuaries*. In Hydrology and Water Resources Symposium. Available at:
<https://search.informit.org/documentSummary;dn=953403056508523;res=IELENG;type=pdf>.

- Water level and flow are controlled by both the movement and mixing from tides in addition to inflows from rivers.
- The cumulative volume of water that passes into this tidal pool over weeks to months sets the location of the saltwater-freshwater interface. Reduction in the volume of water in the tidal pool from extraction results in a greater degree of saltwater intrusion into the downstream end of the tidal pool.
- The University of NSW advised the Commission that the size of the tidal pool has been estimated to be 34,000 ML, which is 71 percent of entitlement. The storage effect of the tidal pool would reduce the need for daily cease to pump conditions to be solely based on upstream flow conditions.
- The estuary ecology is driven by various processes that also depend on the quality of water, for example the estuary may be limited by the amount of bioavailable carbon
- Daily flows from the Nepean Dams and Warragamba are only a proportion of the tidal pools contributing catchment.

Given these confounding factors, and lack of monitoring, the Commission could not assess the outcomes from environmental releases into this section of the river. However, studies of other tidal pools such as the Hunter River suggest the tidal pool and estuary need rules specific to their location. The Surface Water Plan has provisions for amendments to protect environmental flows below the tidal limit.²⁵⁹ The Surface Water Plan's background document states it was intended that further investigations would be completed during the Plans' terms to determine alternative protection measures. They required the study and reporting on the value of adopting such rules, including consideration of:

- the homogeneity of the tidal pool indicating whether rules apply across the water source or whether specific rules may apply to management zones or areas within the water source
- the suitability of sites for measurement of flow or salinity levels
- the significance of extraction on salinity levels, if required
- ecosystem requirements
- ecological considerations.²⁶⁰

The Commission considers these studies would benefit both licenced water users and the environment. The tidal pool should be managed holistically as a single water source to reflect its unique characteristics. If smaller sections within the tidal pool require additional measures to protect outcomes, these should have additional provisions at a smaller scale (which would generally be at a management zone level).

The current rules are designed to convey environmental flows downstream and do not consider downstream estuarine requirements as a foundation to the rules. The current tidal pool rules are based on daily protection of environmental releases and minimum flows at gauges just upstream of the tidal limit.²⁶¹ These do not recognise the role of other parts of the flow regime such as high flow, the buffering and mixing effect of tidal pool or the impact of tidal pool extraction. The proposed increased releases from Warragamba Dam will provide the

²⁶⁰ Clause 78 Part 9 (b) of the Surface Water Plan.

²⁶¹ Clause 56 (13) to (14) of the Surface Water Plan.

opportunity to target specific environmental outcomes. This should be considered by the Environmental Flows Reference Group.

Sydney Water Corporation extracts water to provide for North Richmond's water supply under its access licence for the Upper Hawkesbury River (Grose River to South Creek) Management Zone within the tidal pool. The Surface Water Plan specifies that Sydney Water Corporation²⁶² cannot take when the upstream river is in the Very Low Flow Class. However, WaterNSW release water from Warragamba Dam to meet estimated summer and winter demands (25 ML per day²⁶³ and 17 ML per day, respectively). The cease to pump conditions for Sydney Water are same as unregulated access licenses and in part account for releases from Warragamba. To reflect Sydney Water's priority of access, the Commission recommends the replacement Surface Water Plan includes separate cease to pump conditions for Sydney Water and unregulated access users. In the interim, arrangements should be made to ensure security of supply for North Richmond under the extended Surface Water Plan.

The Hawkesbury-Nepean Estuary is one of many across the plan area. Discussion and recommendations for environmental flows to estuaries in general are covered in **Chapter 6**.

7.5 Groundwater daily access rules rely on effective Surface Water Plan rules

The Groundwater Plan's daily access rules are generally well conceived. The rules recognise the varying levels of connectivity between Hawkesbury Alluvium Groundwater Source and relevant rivers. Further, the daily access rules recognise connectivity between rivers and bores in areas not defined as alluvial water sources which are close to a river.²⁶⁴ However, the effectiveness of the rules in the Groundwater Plan is somewhat inhibited by the issues with the rules within the Surface Water Plan.

The Groundwater Plan includes daily access rules, which commenced in 2018. These rules recognise the connectivity of the Hawkesbury Alluvium Groundwater Source and the Hawkesbury-Nepean River. The daily access rules for aquifer access licences in the Hawkesbury Alluvium Groundwater Source require licensees to follow the rules for unregulated river access licences in the Surface Water Plan's Upper Hawkesbury (Grose River to South Creek) Management Zone.²⁶⁵ For licensees with water supply works over 40 metres from the high bank, the rules only apply 30 days after they apply for surface water and stop applying at the same time as the other licences.²⁶⁶ For extraction under an aquifer access licence in all other groundwater sources, for water supply works at or less than 40 meters from the high bank of a river, the licensee must follow the Surface Water Plan rules for unregulated river access licences in that river.²⁶⁷

²⁶² Water must not be taken under a major utility (subcategory 'Urban water') access licence held by Sydney Water Corporation with an extraction component that specifies the Upper Hawkesbury River (Grose River to South Creek) Management Zone when flows in the Lower Nepean River Management Zone are in the Very Low Flow Class.

²⁶³ Note Sydney Water advises that this volume may be increased in periods of drought.

²⁶⁴ The daily access rules do not apply to bores greater than 30 metres depth into the rock aquifers, if a study to the Ministers satisfaction demonstrated no more than minimal impact on river baseflow, for certain utility uses, and for use of less than 20 kilolitres per day for specific hygiene and animal health uses, as per Clause 36(4) of the Groundwater Plan.

²⁶⁵ Clause 36(2) of the Groundwater Plan.

²⁶⁶ Clause 36(2)(b) of the Groundwater Plan.

²⁶⁷ Clause 36(3)(a) of the Groundwater Plan

As discussed in the previous sections of this chapter, the surface water rules are complex, cannot be implemented and have numerous exemptions; hence the groundwater rules for these licensees also cannot be implemented. The effectiveness of these rules therefore cannot be assessed. This should be rectified once the issues raised in the rest of this chapter have been addressed.

The Groundwater Plan requires major utility or local water utility licensees extracting from a new water supply work at or less than 40 metres from the high bank of a river²⁶⁸ to follow the rules for unregulated river access licences in the Surface Water Plan's Upper Hawkesbury (Grose River to South Creek) Management Zone.²⁶⁹ The logic of why a utility licensee must comply with the rules in a less connected water source is not explained and the Commission believes it may be a transcription error. The rule may have been intended to only apply to any new Sydney Water offtake for the North Richmond Water Treatment Plant. DPIE-Water should revisit this clause as part of the replacement Groundwater Plan and amend it if it is a drafting error or justify its inclusion if intended.

7.6 Mitigation requirements for development are not in the Plans

The Surface Water Plan allows for aquifer interference activity, or a development approved under the *Environmental Planning and Assessment Act 1979* to be exempt from cease to pump rules for extraction if the development or activity's water management plan includes conditions requiring the return of water to mitigate extraction when access rules apply.²⁷⁰ Similarly, in the Groundwater Plan, licences with aquifer interference approvals and those for State significant developments are also exempt from daily access rules and the Plan does not specify any requirement for mitigation²⁷¹ (see **Section 7.5** on the link between groundwater and surface water cease to pump rules).

As a result, some extractive users in the plan area, such as mining operations (if licensed), can extract water from streams or alluvial aquifers in periods of very low flow. The very low flow class is intended to protect basic rights access to water and provide refuge for fish and threatened species during drought.

The Commission has considered this issue in the review of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*. As previously stated, while the exemption may be necessary from the operational perspective of the mines, by recognising these circumstances are managed by a process independent of the Plans, the exemption creates a material risk to achievement of Plan outcomes.

Further, the exemption in the Surface Water Plan states that extraction must be mitigated but does not prescribe the level required, while the Groundwater Plan does not require mitigation. This could impact outcomes under both Plans. There are also no clear requirements to fully account for extraction under this exemption. DPIE-Water advised in previous reviews that Section 60I of the Act specifies the requirement for an access licence to account for water extracted as the result of an aquifer interference activity. Therefore, regardless of the conditions of the planning approval, the mines are legally obliged to account for any extraction of water

²⁶⁸ For all groundwater sources except for the Hawkesbury Alluvium.

²⁶⁹ Clause 36(3)(b) of the Groundwater Plan.

²⁷⁰ Clause 57(3A) parts (a) and (b) of the Surface Water Plan.

²⁷¹ Clause 36(1) of the Groundwater Plan.

from a water source, unless exempted.²⁷² The IEPMC discussed options for ‘offsetting’ surface water loss in Sydney’s drinking water catchment Special Areas, including:

- purchasing lost water with the financial offset used to fund other water sources, such as desalination plants and borefields, or
- treating the water pumped from the mine to a high enough standard to supplement the drinking water catchment supply.²⁷³

The NSW Government accepted all the IEPMC’s recommendations and announced it will ensure ‘*there is a net gain for the metropolitan water supply by requiring more offsetting from mining companies*’.²⁷⁴ The connectivity and related impacts of transfer between surface and groundwater sources should be addressed as part of any offsetting or mitigation (see **Section 8.4**).

It also does not appear that mitigation for water extracted under the Surface Water Plan’s exemption is required to be returned to the river at the appropriate time to achieve environmental outcomes. The *NSW Aquifer Interference Policy* requires mines to hold licences to adequately account for ongoing extraction or alternatively, surrender the appropriate volume of licences to account for ongoing extraction. This form of mitigation would only address annual extraction (and cannot be undertaken currently as there are no existing licences). However, the exemption is related to cease to pump rules, which operate daily to protect environmental values. In the replacement Plans, this extraction should be accounted for both annually (through licencing) and daily (through mitigation).

The exemption clauses should be redrafted in the Plans to ensure all water is accounted for at all times. The Commission’s findings align with the 2018 determination of the NSW Planning Assessment Commission for the Wallarah 2 Coal Project on the Central Coast of NSW. This determination was around the impacts of mining operations on groundwater drawdown, and how this affects other water users and the environment.²⁷⁵ Under this determination, it was required that all projected loss should be accounted for at all times, rather than as part of annual accounts, and that this extraction is then fully compensated.²⁷⁶

When developing the replacement Plans, DPIE-Water should:

- ensure that provisions link accounting between the Surface Water and Groundwater Plan where appropriate
- consider including mitigation requirements and
- ensure all water is accounted for at all times.

Monitoring must then be targeted and appropriate to confirm adequacy of mitigation measures to respond to potential impacts.

²⁷² Natural Resources Commission (2020) *Final Report – Review of the Water Sharing Plan for Hunter Unregulated and Alluvial Water Sources 2009*. Available at: <https://www.nrc.nsw.gov.au/Final%20report%20-%20WSP%20review%20-%20Hunter%20v1.pdf?downloadable=1>.

²⁷³ IEPMC (2019) *Independent Expert Panel for Mining in the Catchment Report: Part 2. Review of specific mining activities at the Metropolitan and Dendrobium coal mines*, prepared for DPIE. Available at: https://chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/281732/IEPMC-Part-2-Report.pdf.

²⁷⁴ Minister for Planning and Public Spaces (2020) *Stronger Protection for Sydney's water catchment following extensive review* [Ministerial media release]. 18 March. Available at: <https://www.planning.nsw.gov.au/News/2020/Stronger-Protection-for-Sydneys-water-catchment-following-extensive-review>.

²⁷⁵ NSW Independent Planning Commission (2018) *Walarah 2 Coal Project*. Available at: <https://www.ipcn.nsw.gov.au/projects/2017/09/walarah-2-coal-project>.

²⁷⁶ *Ibid.*

7.7 AWDs should be used to ensure LTAAEL compliance

AWDs are currently intended to be used to ensure compliance with LTAAELs.²⁷⁷ If water extraction exceeds the LTAAEL, AWDs can be reduced in the subsequent years to retrospectively address this exceedance. However, LTAAEL compliance has not been assessed and AWDs are not currently used for this purpose. The drivers of this issue are different in the Surface Water Plan and Groundwater Plan.

7.7.1 Surface Water Plan

Surface Water Plan AWDs have been allocated at 100 percent per year.²⁷⁸ DPIE-Water produces allocation statements outlining the rationale for their allocations. This process appears largely administrative and is not based on clear analysis. The Commission considers this is reflective of broader issues around the lack of numerical LTAAELs to set clear limits on the total pool of water to be allocated through the AWD process. It also reflects a lack of water extraction data for unregulated users outside of major utilities (although new metering reforms are likely to address this to some extent, see **Chapter 10**). Addressing these issues will allow AWDs to be used more effectively as a compliance and water management tool and they should be implemented as such in the replacement Surface Water Plan.

7.7.2 Groundwater Plan

The Guide to the Groundwater Plan erroneously states that the '*LTAAEL is based on the level of existing entitlements plus the estimate of [basic landholder rights]*'.²⁷⁹ Based on this logic, it states that the AWD for aquifer access licences will generally be 1 ML per unit share, which is equivalent to 100 percent. As discussed in **Section 4.3.4**,²⁸⁰ the Groundwater Plan's LTAAELs are based on the estimated sustainable limit for each of the groundwater sources, not the existing entitlement. Further, current estimated limits do consider best available recharge information. Therefore, some sources may be overallocated. However, as LTAAEL assessment and compliance has not been undertaken since 2011, any potential need to reduce AWDs to meet sustainable LTAAELs is unknown.

7.8 AWDs should ration water supply in drought

Available water determinations allow water managers to adjust the amount of water available for extraction, without needing to change the level of entitlement. This makes them a good tool to manage water supply during drought, which will be increasingly important given future climate predictions. AWDs are currently used for this purpose in regulated river plans.²⁸¹

²⁷⁷ AWDs are also intended to be used to determine allocations for water users' accounts. However, the Commission understands these accounts are not established for most unregulated rivers, including in the Greater Metropolitan region.

²⁷⁸ NSW Department of Industry (2019) *Available Water Determination Order for Various NSW Unregulated and Alluvial Water Sources (No. 2) 2019*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/234427/Water-order-Variou-N-S-W-Unregulated-and-Alluvial-Water-Sources-No.-2-190701.pdf.

²⁷⁹ Office of Water (2011) *Guide to the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources*, page 3. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

²⁸⁰ *Ibid.*

²⁸¹ DPIE-Water (2020) *Available water determinations*. Available at: <https://www.industry.nsw.gov.au/water/allocations-availability/allocations/determinations>.

AWDs provisions in the Plans currently only relate to compliance with LTAAELs. AWDs can only be adjusted to below 1 ML per unit share for some access licences if the LTAAEL has been exceeded.²⁸² This limits the ability to use AWDs to proactively reduce water allocations in extreme climate events such as drought. In addition, where the Surface Water Plan LTAAELs are based on the sum of entitlements, it is unlikely that AWDs less than 100 percent would be triggered.²⁸³

Other provisions, while not designed specifically to manage climate variability, may partially fulfil this function. The effectiveness of these provisions is limited. For example, 'no visible flow' cease to pump rules restrict extraction and protect pools when flows stop. However, these rules do not encourage rationing of water and may cause equity issues between water users. These rules are important and should be used in conjunction with amended AWDs to better manage extraction in the short and medium term. Both Plans include an objective to '*manage these water sources to ensure equitable sharing between users*'.²⁸⁴ Reducing allocations through AWDs would allow proactive rationing of extraction and share the reduction in water more equitably across water users, regardless of their relative position in each water source.

Under Section 324 of the Act the Minister can implement temporary water restrictions to cope with water shortages. The Plans can also be suspended under the Act. However, these options to manage water during drought are reactive and should be reserved for extreme events. DPIE-Water should consider inclusion of more comprehensive AWD rules in the Plans to allow more proactive management of water allocation before suspension under the Act is required.

7.9 Surface Water Plan carryover encourages high extraction in drought

The Surface Water Plan allows for any entitlement that isn't extracted by an unregulated river or unregulated river (high flow) licensee to be held in their account to be extracted in subsequent years. These carryover rules allow up to a maximum of 200 percent of entitlement to be extracted in any one year.²⁸⁵ The intention of this provision is to provide an incentive to users to extract and store water in wetter years, to be stored for drier periods.

However, this is not appropriate for the Surface Water Plan, as there are limited possibilities for licensees to build infrastructure to store water in this way.²⁸⁶ Therefore, carryover allowances are not necessarily used in wet years and can lead to a higher level of water extraction in years of lower flow²⁸⁷ as there is still more water available in a licensee's account. These provisions operate counter to AWD provisions, with carryover allowing licensees to extract more in periods when allocations may have been reduced with lower AWDs. This may add additional pressure during low flow times. The combined role of the AWD and carryover needs to be examined in conjunction with the recommended review of access rules and simplified.

²⁸² Part 7 Division 2 of the Surface Water Plan.

²⁸³ An exception to this is in the Hawkesbury-Nepean, where the LTAAEL is less than the sum of entitlements (see **Chapter 4**).

²⁸⁴ Clause 10(f) of the Surface Water Plan and 10(f) of the Groundwater Plan.

²⁸⁵ And a maximum of 200 percent in one year if 100 percent is carried over from the previous year (Clause 54 of the Surface Water Plan).

²⁸⁶ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

²⁸⁷ This being periods when there is lower rainfall (and higher demand for irrigation), but not so low that the cease to pump thresholds have been met.

In the Groundwater Plan, the Botany Sands, Hawkesbury Alluvium and Maroota Tertiary Sands groundwater sources do not permit carryover of allocations²⁸⁸ as these sources are more responsive to annual changes in recharge. The other groundwater sources allow carryover of 10 percent of the share component for aquifer access licences only (0.1 ML per unit share of entitlement). The Commission considers that these rules are appropriate and should be retained.

7.10 Recommendations

R 6	By 1 July 2023, DPIE-Water should review all exemptions and simplify daily access rules in the Surface Water Plan and connected Groundwater Plan water sources to minimise the time and volume of exempt extraction.
R 7	By 1 July 2023, DPIE-Water should develop simple and transparent access rules for the Surface Water Plan and connected Groundwater Plan water sources to manage extraction consistent with the priorities of the Act. This should include: <ul style="list-style-type: none"> a) using instantaneous cease to pump rules to protect very low flows, connectivity, and basic landholder rights, ensuring rules are practical to implement, comply with and are enforceable b) develop simple, outcome-focused rules to protect environmental releases recommended by the Environmental Flows Reference Group (Recommendation 5) and town water supply c) strategic use of active management rules and developing and implementing practical total daily extraction limits (TDELs) and individual daily extraction limits (IDELs) only where required d) installing required infrastructure to implement provisions, including required gauging stations and notification system e) addressing drafting errors.
R 8	By 1 July 2023, DPIE-Water should ensure that, if licensees are unable to comply with access licences at any time, extraction is appropriately mitigated, including: <ul style="list-style-type: none"> a) amend Clause 57(3) parts (a) and (b) of the Surface Water Plan on planned environmental water, which allow for cease to pump exemptions for aquifer interference activities that are either approved by the <i>Environment, Planning and Assessment Act 1979</i> or the Minister, to require 100 percent mitigation of any exemptions b) link Groundwater Plan daily access exemption provisions to Surface Water Plan provisions where appropriate and consider including mitigation requirements c) in the Surface and Groundwater Plans, account for mitigation daily (the timescale at which cease to pump rules operate).
R 9	By 1 July 2023, DPIE-Water should: <ul style="list-style-type: none"> a) estimate extraction each year to ensure compliance with LTAAELs to determine if adjustments are necessary b) include rules following DPIE-Water’s consideration of how AWDs can be used to manage extraction during drought, including under predicted climate change c) examine and simplify the combined role of the AWDs and carryover activities.

²⁸⁸ Clause 34A of the Groundwater Plan.

8 The Plans can better account for spatial variation in values and risks

This chapter explores how effectively the Plans' provisions govern the location of water extraction across the plan area, affecting the distribution of benefits and impacts. For example, extraction from a stormwater channel has different environmental outcomes compared to extraction from a high ecological value stream downstream from a national park, or from a river high in a catchment compared to a tidal pool. The Plans aim to '*provide for healthy and enhanced water sources and water dependent ecosystems*' spatially by establishing rules to protect high value ecosystems and GDEs. The temporal aspects are discussed in **Chapter 7**. In developing the replacement Plans, DPIE-Water should:

- review the scale of surface water management for environmental and economic outcomes and account for a broader range of economically dependent industries and activities (**Sections 8.1 and 8.3**)
- ensure the Plans better support trade and investment (**Sections 8.1, 8.2 and 8.2**)
- ensure the Plans explicitly recognise all forms of connectivity between water sources and management zones, which varies over space and time (**Section 8.4**)
- improve protections of both groundwater dependent and high value (surface) ecosystems from the impacts of extraction (**Sections 8.1, 8.5 and 8.6**).

Reassessment of rules regarding the spatial distribution of extraction must protect environmental outcomes and should also improve economic and social benefits. Understanding and describing connectivity and relationships between water sources, their dependent ecosystems, and social and economic outcomes will assist with achieving plan outcomes.

8.1 The Surface Water Plan's scale of management impacts its effectiveness

From an economic perspective, less restricted trade rules are often desirable as there are more opportunities for the market. From an environmental perspective, trade rules are required to protect high value locations.

Water sharing plans usually use a hierarchy of management scales from extraction management units (generally catchments), to water sources (sub-catchments), to management zones (smaller sections or reaches of a sub-catchment warranting specific management). In most water sharing plans, trade rules are based on the water source scale, with specific exclusions for management zones. The Surface Water Plan has water sources, but these cover the same area as extraction management units and therefore the Plans do not consider an intermediate scale of management.²⁸⁹ Extraction management units/water sources are then divided into smaller management zones ranging from sub-catchments to short river sections.

The Surface Water Plan's lack of an intermediate spatial unit results in a reliance on the smaller management zones to set environmental and trade restrictions. The scale or location of management zones do not appear to be based on either environmental flow needs or economically efficient trading. The following sections discuss specific concerns with the current spatial design of trade rules including:

²⁸⁹ Note the Hawkesbury-Nepean is split into two extraction management units/water sources.

- the definition of management zones was not based on ecosystem needs and may not be at a fine enough scale to effectively target environmental protection, which may also limit economic and social outcomes (see **Section 8.1.1**)
- trade rules are based on small management zones, often with few licences, restricting the opportunities for trade, sometimes unnecessarily (see **Section 8.1.2**).

The Surface Water Plan should manage where water is extracted at the appropriate geographic scale. The current plan is not achieving this, potentially affecting outcomes. Ideally, there would be a greater protection of high environmental value areas while trade is enabled across a broader geographic range. Once the scale of management has been improved, high flow access rules should be reviewed to improve environmental, economic and social outcomes (see **Section 8.1.3**).

DPIE-Water should reconsider the scale of mapping of water sources and management zones based on a consistent hierarchy. If this is not practical, provisions should be designed at the appropriate geographic scale (for example, permitting trade between management zones, or splitting rules within management zones). Links between the intended objectives, location of high economic and environmental values, and Plan provisions should be clearly communicated.

8.1.1 Improved mapping can better target environmental protection

Water sharing plan trade rules are based on ecological value, hydrologic stress, and economic dependency. For example, when the Surface Water Plan was developed, 29 management zones were identified as having high environmental values and therefore trading into them was restricted.²⁹⁰ In addition, in high environmental value management zones, the daily access rules (cease to pump thresholds) tended to be conservative.²⁹¹

Improved understanding and mapping of ecological value and hydrologic needs will enable refinement of the Plans' daily access and trade rules. Since the Plans were developed, additional studies and research have been completed, which should be used to improve provisions and achieve outcomes. For example:

- As part of the planning for Sydney's growth, land use infrastructure and implementation plans have identified environmental values and priorities for protecting and conserving areas in the growth areas and precincts.²⁹² This data should be used in when developing the replacement Plans to maintain consistency across NSW Government planning decisions.
- DPIE-EES has been reviewing the NSW water quality objectives for catchments in the plan area (the Upper Nepean River, South Creek and Northern Beaches). These objectives are tied to water sharing plan objectives, particularly with respect to maintaining water quality appropriate for the protection of aquatic ecosystems, recreation, and livestock and irrigation supply. DPIE-Water is also working with DPIE-EES to develop community values and objectives to ensure consistency with water sharing plan objectives and state-wide regional targets being developed by DPIE-Water.

²⁹⁰ Office of Water (2011) *Water Sharing Plan – Greater Metropolitan Region Unregulated River Water Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0003/548058/wsp_metro_surface_water_background.pdf.

²⁹¹ *Ibid.*

²⁹² DPIE (n.d.) *Planning for local communities – Precincts – A new approach*. Available at: <https://www.planning.nsw.gov.au/Plans-for-your-area/Priority-Growth-Areas-and-Precincts>.

- DPIE-EES are funding projects to improve water quality (including river flows) through the *Marine Estate Management Strategy*, which recognises the links between the coast, its estuaries and contributing catchments.²⁹³ These projects and links should be considered as part of the development of the replacement Plans, as discussed in **Section 11.4**.

By 1 July 2023, DPIE-Water should use best available evidence, including fine scale HEVAE mapping, to reassess the environmental values of all management zones/water sources in the Surface Water Plan. Where necessary they should then amend both Plans' rules to address any changes to classifications and ensure that the high value environmental ecosystems are protected by the Plan rules, without unnecessarily inhibiting trade.

8.1.2 Reconsider the scale of management to better support the water market

The Plans have objectives to provide opportunities for enhanced market-based trading of access licences and water allocations within environmental and system constraints.²⁹⁴ The Plans' trading rules were developed in line with the *Access Dealing Principles Order 2004* and principles outlined in their background documents. The Order requires rules to meet environmental requirements,²⁹⁵ and prevent adverse impacts on basic landholder rights and features of major cultural, heritage or spiritual significance.²⁹⁶ To do this, the Plans set dealing rules (referred to as trade rules herein).

Multiple stakeholder submissions considered that trade and the establishment of an efficient water market has been restricted in some areas by inflexible trading rules. WaterNSW advised that management of trades is complex and difficult due to the '*many management zones ... it becomes hard to manage and ensure allocations don't get exceeded*', and that the provisions do not appear to be focused on achieving outcomes.²⁹⁷ To achieve outcomes trading units need to be at an appropriate scale. Water management zones should be combined into larger units that have discrete characteristics (such as a tidal pool).

Trade data indicate that there has been limited trade; this may mean that there has been unwarranted barriers to trade, which should be investigated. According to the publicly available *NSW Water Register*, there were 719 trades to June 2019, with most of these (537) being transfer trades²⁹⁸ from one licensee to another. The value of the 472 transfer trades of unregulated river access licences was \$1.75 million, noting that pricing data are incomplete and unreliable.²⁹⁹ The largest transfer trade (in volume) was from Sydney Catchment Authority to

²⁹³ The high-level strategy can be seen at NSW Government (2018) *Marine Estate Management Strategy*. Available at: https://www.marine.nsw.gov.au/__data/assets/pdf_file/0007/815596/Marine-Estate-Management-Strategy-2018-2028.pdf.

²⁹⁴ Clause 9(g) of the Groundwater Plan and Clause 10(i) of the Surface Water Plan.

²⁹⁵ As summarised from *Access Licence Dealing Principles Order 2004*, Clause 7, trades should: not adversely affect environmental water and water dependent ecosystems identified in the Plan; be consistent with any strategies to maintain or enhance water quality; not increase commitments to extract from water sources identified in the Plan as high conservation value; not increase commitments to extract above sustainable levels identified in the Plan.

²⁹⁶ The *Access Licence Dealing Principles Order 2004* provides guidelines for considering impacts of water dealings including new categories, subdivision, consolidation, assignments of rights or allocation, changing water sources, amending extraction components and interstate dealings. (Parliament of NSW (2004) *Access Licence Dealing Principles Order 2004*. Available at: https://www.legislation.nsw.gov.au/~/_view/regulation/2004/433/full).

²⁹⁷ Interview: WaterNSW, 30 June 2020.

²⁹⁸ Under section 71M of the Act.

²⁹⁹ Factors contributing to inconsistencies include data entry errors, confusion about reporting form requirements and the inclusion of land assets in prices. Trades are sometimes registered with a zero-dollar price due to

WaterNSW due to a governance restructure. There were 35 assignment of rights trades,³⁰⁰ all of which were for unregulated river access licences and which had a combined value of \$0.79 million. There were only three assignments of water allocation trades, totalling 86 ML.³⁰¹

The Surface Water Plan's trade rules are based on management zones. **Table 8** provides an example showing where trading is allowed within the Hawkesbury and Lower Nepean Rivers Water Source. This shows that, in most cases, trades can only occur within each management zone. Currently there is a separate management zone for each weir, but considering the longitudinal connectivity of the river, it is unclear why trades between all weirs are limited. In many cases it may be possible to trade water between current management zones without inhibiting environmental outcomes.

To improve economic and social outcomes, DPIE-Water should review trade limitations with a view to managing trade across broader areas (such as longer river lengths) provided environmental outcomes can be maintained.

transfers between related entities or family businesses, or a reluctance from licence holders to disclose trade prices. Interview: DPIE-Water, 5 November 2019.

³⁰⁰ Trade of part of a licence's share component under section 71Q of the Act

³⁰¹ Trade of part or all the water in one access licence account to another under section 71T of the Act

8.1.3 High flow access rules should be reviewed

The Surface Water Plan does not permit licensees to trade unregulated river access licences into high flow licences, or trade high flow licences between management zones.³⁰³ This includes trading from low flow in one management zone to high flow in another, even downstream on the same river. The Surface Water Plan's background document states that *'the prevalence of a town water supply licences in the Greater Metropolitan Region zone restricted the number of zones in which applications for high flow licences may be made'*.³⁰⁴

Additional access to high flow licences is limited to conversions of unregulated river access licences in nine water management zones (see **Section 4.5**).³⁰⁵ DPIE-Water developed the conversion provisions using an assessment of flow capacity, assessing the ratio of extraction to river flow at higher flow rates.³⁰⁶ This assessment only considered the 50th percentile flows, which is the flow occurring half the time, not necessarily a 'high flow'.³⁰⁷ If this ratio indicated the river had capacity for additional extraction at high flow, then conversions were permitted. However, opportunities to increase ability to trade were not considered. Increasing the flexibility of trade rules would improve outcomes compared to conversions, as no additional entitlement is created but economic opportunities are broadened.

The definition of high flow needs to be updated to reflect the attributes of the flow regime and that there is likely to be capacity to extract in higher flow events. DPIE-Water should define specific 'high flow' classes across the Surface Water Plan area, with cease to pump thresholds at levels that do not increase hydrological stress or impact environmental outcomes but allow some trade in that class in that area. This should facilitate activities such as stormwater harvesting, as well as reducing unnecessary trade restrictions. For example, runoff dams generally capture most of their volume in higher flow events. These could be constructed to pass low flows while capturing poorer quality water in high flows, increasing their environmental benefits. Liberalising these trade rules must still protect environmental and social outcomes, criteria defining restrictions would be applied, and should be at the appropriate geographic scale (as discussed in **Section 8.1.1**).

³⁰³ Clause 67(2) and 68(2)(b) of the Surface Water Plan.

³⁰⁴ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

³⁰⁵ The Upper Shoalhaven River, Broughton Creek and Broughton Mill Creek management zones in the Shoalhaven River Water Source; Maldon Weir Management Zone in the Upper Nepean and Upstream Warragamba Water Source; Lower Hawkesbury River and Macdonald River management zones in the Hawkesbury and Lower Nepean Rivers Water Source; Upper South Creek, Lower South Creek and Cattai Creek management zones in the Hawkesbury and Lower Nepean Rivers Water Source. Clause 64(2) of the Surface Water Plan.

³⁰⁶ The high flow access commences at the 50th percentile which is the flow that is exceeded 50 percent of days (DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*, p. 29. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf).

³⁰⁷ For example, the current condition for a high flow licence on the Nepean River is 500 ML per day at Yarramundi gauge (2122001), which the Surface Water Plan notes as estimated to be the 36th percentile flow – not the 50th percentile (as per Clause 57 (4) of the Surface Water Plan).

8.2 Support mechanisms for trade can be improved

There are several issues regarding the implementation of trade rules that should be addressed when implementing the replacement Plans:

- **Administrative systems limit dealings** – stakeholders raised that the lack of a transparent, easy to use licence database makes trading difficult, as does the lack of data on available allocations. The lack of market transparency is inefficient and inequitable as:
 - dealings rely on word-of-mouth and individual licence holders connecting personally to trade or transfer licences or allocations
 - remaining sleeper licences³⁰⁸ may be difficult to identify and obtain, causing frustration for those seeking licences and making it hard for licensees to understand risks around access
 - those holding remaining sleeper licences may not be aware of the value of their asset.
- **Price reporting has been inaccurate** – trading is intended to move water to the highest value use, with the cost of water therefore tracking scarcity and potential intended uses. Many trades have no costs assigned, limiting the information available to the market to support growth.³⁰⁹ WaterNSW has recently updated its trade application form to require the inclusion of costs, though cannot require costs to be accurately entered outside the Murray-Darling Basin.³¹⁰
- **Metering** – there is variable metering of licensees in both surface and groundwater. Since metering is a requirement for temporary trading, this limits trade activity.

Any actions to strengthen trade must protect environmental outcomes in line with the Act's water management principles. As discussed in previous reviews,³¹¹ the Commission suggests that DPIE-Water should continue to implement its program to improve all trade information, including coordination with relevant agencies to:

- publish a transparent overarching process for assessing trades for approval
- increase education and awareness of trading arrangements, including the use of metering to increase trade opportunities
- investigate trade drivers and barriers through stakeholder engagement processes, including with Aboriginal stakeholders.

³⁰⁸ Stakeholders advised that there may be an increasing number of sleeper licences in the Hawkesbury-Nepean River management zones due to retirement of irrigators and an increase in hobby farms. It was also noted that there may be an unwillingness to sell licences separate to the land.

³⁰⁹ In the *2016-17 Australian Water Markets Report*, ABARES reports that 74 percent of entitlement trade transactions in unregulated surface water systems outside the Murray-Darling Basin record a \$0 transaction, while 100 percent of allocation trade transactions in unregulated surface water systems outside the Murray-Darling Basin record a \$0 transaction. Most trades in the Plans had a zero-value assigned.

³¹⁰ WaterNSW (2020) *Water Allocation trade form update – fact sheet*. Available at: https://www.watarnsw.com.au/__data/assets/pdf_file/0008/158939/Water-Trade-Form-Update-Factsheet-FINAL.pdf.

³¹¹ For example, see reports at Natural Resources Commission (2020) *Water sharing plan reviews*. Available at: <https://www.nrc.nsw.gov.au/wsp-reviews>.

8.3 The Plans should consider a broader range of economic activity

Water sharing plans are meant to support the movement of water to the highest value use through trade. The Plans' trade rules were developed taking into consideration the level of hydrological stress and environmental value of each management zone or water source. The Surface Water Plan's daily access rules were developed using the risk to environmental values based on hydrological stress, and the economic dependency of each management zone. This approach assumes that trading water licences from areas of low economic value to areas of high economic value would result in improved economic outcomes. Similarly, trading from areas of high ecological value to those of low ecological value would improve environmental outcomes.³¹²

The development of the Surface Water Plan considered the economic benefits of commercial extraction by irrigators and industry such as irrigated agriculture and turf.³¹³ However, it did not consider other extractive industries reliant on water or instream commercial, recreational or environmental values. For example, the development of the Plans does not appear to have considered:

- the value of urban water supplies
- ecosystem services
- mining, quarrying or construction
- aquaculture or recreational fishing
- urban amenity and tourism
- water extractions essential for manufacturing industries.

The Commission considers that increasing understanding of the location and classification of environmental value and economic dependency can improve the Plans' ability to facilitate positive outcomes and protect vulnerable environmental values and functions. To achieve environmental, social and economic outcomes within the Plans' limited water resource, the management around optimal location of water extraction may change as the understanding of ecological and hydrological conditions improve and economic circumstances change.

Consideration of the impact of the Plans' rules on aquatic and estuarine environments should not be limited to environmental impacts. The downstream impacts on estuaries and coastal ecosystems, including on threatened fish species, should be considered under the umbrellas of environmental, social, cultural and economic outcomes. These significant environmental assets should be monitored and appropriately protected by rules in both Plans.

Commercial and recreational fisheries and tourism are among many industries that rely on the effectiveness of the Plans. In targeted consultation for the development of the current Surface Water Plan, stakeholders raised concerns regarding whether enough water was being provided

³¹² DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

³¹³ DPI-Water (2016) *Water Sharing Plan Greater Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.

to the lower estuary to support the oyster and other estuarine industries as well as estuary ecology. These concerns were raised again for this review:

*'Local down-stream water users and water reliant businesses are reporting significant impacts including cuts to water allocations, rising salinity, and lack of freshwater flows which particularly impact the Oyster industry and other local commercial fishers.'*³¹⁴

Examples of values not considered in the Plans' socioeconomic analysis include:

- **Trade-off between extractive uses** – as discussed in **Chapter 5**, the Plans should share water equitably. However, to do this the Plans must define what equitable sharing means. Trade-offs between uses should be transparent and considered when assessing extraction potential and access rules across the plan area. The movement and trade of licences can then occur within defined objectives as part of a functioning water market.
- **Shifting agricultural markets** – the economic value of agricultural production from good quality soils close to markets is different to that from poorer soils remote from markets.
- **Urban growth and social requirements** – as an increasingly important example, the social and economic value of *'cool, green and attractive urban communities'*³¹⁵ was not explicitly considered when developing the Plans. The need to retain more water in the landscape in areas such as South Creek, in Western Sydney, has been recognised as necessary to support liveability and productivity in the hot, dry areas of Sydney.³¹⁶ The retention of additional water in this area is tied not only to stream-flow but to stormwater harvesting (as discussed in **Section 4.4.4**).
- **Commercial aquaculture** – the Illawarra-Shoalhaven supports a diverse range of fisheries including an active estuary fishery.³¹⁷ Oyster farming is an important industry in the plan area, with a Shoalhaven farmer highlighting *'... the whole community can be part of this industry ... , we're a coastal community. Why can't we provide for ourselves on blue technology?'*³¹⁸ Estuarine school prawn (*Metapenaeus macleaya*) trawling is restricted to three areas in NSW, one of which is the lower estuarine reaches of the Hawkesbury-Nepean (below Lower Portland, near the confluence with the Colo River).³¹⁹ The species is popular among Sydney fish consumers.³²⁰ The prawns spawn in the estuary, migrate upstream to areas of less than 20 percent salinity, before returning to the ocean to breed.³²¹ River management should understand and consider variables affecting prawn harvest to sustain the fishing industry, for example natural rainfall events were found to yield an increased harvest compared to human-controlled flow events.³²²

³¹⁴ Submission: Justin Field, MLC, received 12 September 2019.

³¹⁵ Department of Planning and Environment (2018) *Western Sydney Aerotropolis – South Creek Precinct*. Available at: <https://www.planning.nsw.gov.au/-/media/Files/DPE/Factsheets-and-faqs/Western-Sydney-Aerotropolis-South-Creek-Precinct-FAQs.ashx>.

³¹⁶ *Ibid.*

³¹⁷ Barclay, K., McIlgorm, A., Mazur, N., Voyer, M., Schmierer, S., Payne, A.M. (2016) *Social and Economic Evaluation of NSW Coastal Aquaculture*, Fisheries Research and Development Corporation and University of Technology Sydney, Sydney.

³¹⁸ *Ibid.*, p. 34.

³¹⁹ Pinto, U. and Maheshwari, B.I. (2012) *Impacts of water quality on the harvest of school prawn (Metapenaeus macleaya) in a peri-urban river system*. *Journal of Shellfish Research*: 31(3): 847-853.

³²⁰ *Ibid.*

³²¹ *Ibid.*

³²² *Ibid.*

- **Recreational fishing** – a survey found that 36 percent of Illawarra-Shoalhaven residents were recreational fishers, as well as a quarter of residents in the Sydney area.³²³ This covers the highest number of recreational fishers in NSW due to the area's large population.³²⁴ The number of days recreational fishers spent fishing is highest in Sydney and the Mid-South Coast.³²⁵ Across NSW, 56 percent of fishing days were in estuaries, 22 percent in inshore brackish waters and 21 percent in freshwater.³²⁶ In 2013, the estimated total freshwater fishing spend in Sydney was estimated to be \$62.4 million, with saltwater spend estimated to be \$840.8 million.³²⁷ This is just over half (56 percent) of all fishing spend in NSW.³²⁸

When considering the economic dependence of management zones and water sources, DPIE-Water should assess the full range of economic benefits and impacts of both the extraction of water and presence in-stream, such as:

- benefits and impacts of secure water supply and time on water restrictions for town water supplies including residential and industrial uses
- benefits and impacts of flow and water quality on industries and water uses such as tourism, ecosystem services and recreation and community activities.

8.4 The Plans should address all forms of connectivity

Ground and surface waters are inextricably linked, and their connectivity varies significantly between systems and over time.³²⁹ Analysis of surface and groundwater availability in the *Sydney Drinking Water Catchment Audit 2019* indicated the need for improved understanding of conditions and interactions to ensure sustainable use. The Audit recommended that DPIE-Water review and revise the Plans' surface water and groundwater interactions.³³⁰

The Plans address different aspects of connectivity to variable extents, but in general, consideration of connectivity within and between them can be improved. Connectivity is three dimensional (longitudinal, latitudinal and vertical). The three aspects are intertwined but for simplicity, examples of each will be discussed separately below. The Commission's recommended improvements are discussed in the sections below.

³²³ Barclay, K., McIlgorm, A., Mazur, N., Voyer, M., Schnierer, S., Payne, A.M. (2016) *Social and Economic Evaluation of NSW Coastal Aquaculture*, Fisheries Research and Development Corporation and University of Technology Sydney, Sydney.

³²⁴ DPI – Fisheries (2015) *Survey of Recreational Fishing in New South Wales and the ACT, 2013/14*. Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/600130/West-et-al-Survey-of-rec-fishing-in-NSW-ACT-2013-14-2016_04_05.pdf.

³²⁵ *Ibid.*

³²⁶ *Ibid.*

³²⁷ McIlgorm, A. and J. Pepperell (2013) *Developing a cost effective state wide expenditure survey method to measure the economic contribution of the recreational fishing sector in NSW in 2012*. A report to the NSW Recreational Fishing Trust, NSW DPI. Available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/499302/UOW-statewide-economic-survey-final-report.pdf.

³²⁸ *Ibid.*

³²⁹ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*, p. 28. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³³⁰ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

8.4.1 Longitudinal connectivity

For surface water, longitudinal connectivity is important for connecting aquatic environments along the length of a river, supporting nutrient and sediment transport, organism dispersal and movement, and water quality.³³¹ Dams and weirs on the Hawkesbury-Nepean upstream of the Grose, Colo and MacDonald rivers alter their connectivity, as weirs can hold back or gradually release water along much of the rivers' length. Longitudinal connectivity enables fish passage along rivers and is affected by structures such as weirs, as well as water level over natural barriers such as riffles. Understanding required flow level and velocities is important to maximise fish passage and ensure environmental, social and economic benefits, while minimising social and economic costs of releasing additional water with marginal gain.

The Plans lack specific environment outcomes to focus provisions. They do not protect longitudinal connectivity as cease to pump rules were not implemented and there are no specific end of system flow requirements (see **Chapter 7**) or transparent consideration of the contribution of groundwater to stream baseflow. Longitudinal connectivity should be considered when assessing the provisions when developing replacement Plans.

For example, Australian bass are a top-level predatory fish popular among recreational anglers. These fish migrate in winter from freshwater habitats to estuaries to breed, and return in spring–summer to freshwater habitats.³³² There is a high level of community interest in flow regimes, populations, and angling catch-per-unit-effort, particularly in areas such as the Greater Metropolitan area.³³³

Bishops Bench was found to be the critical riffle barrier in the Hawkesbury-Nepean River between Penrith Weir and the tidal limit at the Grose River junction.³³⁴ If fish passage requirements for Australian bass of a target depth of 20 centimetres for environmental flows were met at Bishops Bench, then it was likely it would be met across the rest of the river length and the other 17 major riffles. This equates to flow rates over 500 ML per day, with rates 1,000 ML per day (the pre-development 50th flow duration percentile was about 1,040 ML per day)³³⁵ and above providing ideal upstream passage conditions.³³⁶ These levels also consider requirements for the migratory Pinkeye mullet (*Trachystoma petardi*), thermal de-stratification in deep pools, benthic scour, and flushing of floating aquatic weeds.³³⁷ In the Shoalhaven River below Tallowa Dam, similar conditions were required of 20 centimetres depth and maximum velocity of 1.5 to 1.8 metres per second over 10 metres, with bass migrating upstream in both regulated baseflow and flow pulse conditions.³³⁸ However, the Plan does not consider these requirements.

³³¹ MDBA (2014) *Basin-wide environmental watering strategy*. Available at: <https://www.mdba.gov.au/sites/default/files/pubs/basin-wide%20environmental%20watering%20strategy%20November%202019.pdf>.

³³² Van der Walt, B., Faragher, R. A., and Harris, J. (2005) *Comparative angler catches of Australian bass (Macquaria novemaculeata) in three major river systems in New South Wales, Australia*, *Asian Fisheries Science*, 18(1/2):175–193; and Reinfelds, I.V., Keenan, H., Walsh, C.T. (2019) *Fish passage modelling for environmental flows: Hawkesbury-Nepean River, NSW, Australia*, *River Research and Applications*, 2020(36): 595–606.

³³³ Reinfelds, I.V., Keenan, H., Walsh, C.T. (2019) *Fish passage modelling for environmental flows: Hawkesbury-Nepean River, NSW, Australia*, *River Research and Applications*, 2020(36): 595–606.

³³⁴ *Ibid.*

³³⁵ Keenan, H., Barter, S., and Kotlash, A. (2017) *Warragamba environmental flow options scenario assessment report*.

³³⁶ Reinfelds, I.V., Keenan, H., Walsh, C.T. (2019) *Fish passage modelling for environmental flows: Hawkesbury-Nepean River, NSW, Australia*, *River Research and Applications*, 2020(36): 595–606.

³³⁷ *Ibid.*

³³⁸ Reinfelds, I. V., Walsh, C. T., Meulen, D. E., Grows, I. O., and Gray, C. A. (2013) *Magnitude, frequency and duration of instream flows to stimulate and facilitate catadromous fish migrations: Australian bass (Macquaria novemaculeata Perciformes, Percichthyidae)*, *River Research and Applications*, 29(4):512–527, as in Reinfelds, I.V.,

DPIE-Water, DPIE-EES, Department of Primary Industries – Fisheries (DPI-Fisheries) and the Environmental Flows Reference Group should consider evidence of connectivity requirements such as these studies when setting cease to pump thresholds and environmental flow releases in the plan area (see **Chapters 6** and **7** for more details).

8.4.2 Lateral connectivity

Lateral surface water connectivity is critical for linking the riverine environment with its floodplain, which can then vertically increase groundwater recharge. For example, the Hawkesbury and Bulgo Sandstone aquifers (Sydney Basin South Groundwater Source) support streams and associated GDEs, providing most of the baseflow to surface water courses in the Southern Coalfield.³³⁹ Stakeholders have raised concerns that the Surface Water Plan in particular does not adequately consider connectivity of the riverine channel with floodplains, and of floodplains with shallow aquifers.³⁴⁰

For example, pre-European geomorphology included ‘chain-of-ponds’ river types in the plan area, which are now limited to areas such as Mulwaree in the Shoalhaven.³⁴¹ These alluvial, discontinuous watercourses include deep, steep-sided ponds separated by an ephemeral flow path.³⁴² These ecosystems have significant ecological functions, often contain endangered ecological communities, and their loss over time means they are important to conserve.³⁴³

Some stakeholders wish to restore chain-of-ponds river types in these catchments to reconnect ‘the floodplain, aquifer and stream’, and ‘deal with water at the catchment scale, to repair and rehydrate the whole system’.³⁴⁴ However, the Surface Water Plan includes restrictions on water supply works in certain Shoalhaven management zones,³⁴⁵ limiting licensees to works for erosion control, inhibiting these efforts. It is not clear why these limits are included for this region and not others. The Commission understands these provisions may have been included in the Surface Water Plan to protect downstream utility water supply. The replacement Plans and their supporting documents should clearly state the reason for specific exemptions and caveats. This will improve stakeholder confidence in the Plans and help identify any perverse outcomes. Justification should be supported through on ground studies and mapping to strengthen the evidence base on the extent and spatial variability of connectivity.

8.4.3 Vertical connectivity

Vertical connectivity within the plan area is variable. Within this variation, the Plans recognise a limited subset of vertical connectivity. They recognise connectivity between surface and alluvial groundwater in the Hawkesbury Alluvial Groundwater Source by linking surface water

Keenan, H., Walsh, C.T. (2019) *Fish passage modelling for environmental flows: Hawkesbury-Nepean River, NSW, Australia, River Research and Applications*, 2020(36): 595–606.

³³⁹ Madden, A. and Merrick, N.P. (2009) ‘Extent of longwall mining influence on deep groundwater overlying a Southern Coalfield mine’ in Milne-Home, W.A. (ed.) *Groundwater in the Sydney Basin Symposium. International Association of Hydrogeologists NSW*, pp. 176–186.

³⁴⁰ Submission: The Mulloon Institute, received 25 October 2020.

³⁴¹ Williams, R.T. and Fryirs, K.A. (2020) *The morphology and geomorphic evolution of a large chain-of-ponds river system*, *Earth Surface Processes and Landforms*, 45(8):1732-1748.

³⁴² Mould, S. and Fryirs, K. (2017) *The Holocene evolution and geomorphology of a chain of ponds, southeast Australia: establishing a physical template for river management*, *Catena*, 149(Part 1):349-362.

³⁴³ *Ibid* and Williams, R.T. and Fryirs, K.A. (2020) *The morphology and geomorphic evolution of a large chain-of-ponds river system*, *Earth Surface Processes and Landforms*, 45(8):1732-1748.

³⁴⁴ Interview: Mulloon Institute, 1 October 2020.

³⁴⁵ Clauses 62(2) and 62(5) of the Surface Water Plan

provisions and alluvial access rules and exemptions from year seven of the Groundwater Plan.³⁴⁶ This means that alluvial groundwater access licences are restricted 30 days after surface water unregulated access licences are restricted (see **Section 7.5**). The remaining alluvium is treated as ‘miscellaneous unmapped alluvium’, with extraction volumes accounted for under the porous or fractured rock water sources underlying the alluvial systems.³⁴⁷

The Groundwater Plan appears to relate connectivity only to the potential input of baseflow to the river. Connectivity that facilitates freshwater recharge to shallow groundwaters is also a vital source of useable water and connectivity should relate to interactions from surface to groundwaters, which are strongly influenced by recharge via the river in high flow periods. There are high levels of ground and surface water interaction throughout the plan area, but varying levels of confidence in the degree of connectivity in different areas due to varying monitoring levels.

Localised perched aquifers are sustained through localised recharge along the river and this would be compromised if groundwater extraction increased. For example, on the Newnes Plateau and in the Southern Highlands groundwater systems are associated with sensitive ecological areas of highland peat swamps (permanently or sporadically connected to the groundwater system).³⁴⁸

Fracturing of the landscape around mining areas is also known to influence connectivity. This has been investigated in detail in the plan area due to the concern around impacts from mining on Sydney’s drinking water supply. The IEPMC was formed in late 2018 to investigate this issue, and found that mining-related loss in the drinking water catchment Special Area³⁴⁹ ranged from an average of 0.09 ML per day to 8 ML per day (for context, the Kurnell desalination plant can produce about 250 ML per day).³⁵⁰ The Dendrobium mine identified as having the largest volumetric impact is in the Upper Nepean River Tributaries Headwaters Management Zone. The IEPMC recommended that WaterNSW ‘continue its program of work towards determining the significance for the Greater Sydney water supply of different thresholds of surface water loss due to mining’.³⁵¹ Further, the *Sydney Drinking Water Catchment Audit 2016*³⁵² and IEPMC recommended establishing a regulatory regime to licence surface water losses in the Special Areas to enable historic and current mines to comply with water legislation. As

³⁴⁶ Clause 36 of the Groundwater Plan.

³⁴⁷ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*, p. 29. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³⁴⁸ Commonwealth of Australia (2014) *Temperate highland peat swamps on sandstone: ecological characteristics, sensitivities to change, and monitoring and reporting techniques. Knowledge report*, prepared by Jacobs SKM for the Department of the Environment, Commonwealth of Australia. Available at: <http://www.environment.gov.au/system/files/resources/1fd762d9-7e35-4299-ba57-79297d735487/files/peat-swamp-ecological-characteristics.pdf>.

³⁴⁹ The *WaterNSW Regulation 2013* defines and protects the Special Areas, located around the drinking water supply’s major dams, reservoirs and canals and within which access and certain activities are restricted to protect water quality and maintain ecological integrity.

³⁵⁰ IEPMC (2019) *Independent Expert Panel for Mining in the Catchment Report: Part 2. Review of specific mining activities at the Metropolitan and Dendrobium coal mines*, prepared for DPIE. Available at: https://chiefscientist.nsw.gov.au/__data/assets/pdf_file/0005/281732/IEPMC-Part-2-Report.pdf.

³⁵¹ Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 1*, prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

³⁵² Alluvium Consulting Australia (2017) *2016 Audit of the Sydney Drinking Water Catchment*. Available at: <https://www.parliament.nsw.gov.au/lc/papers/DBAssets/taledpaper/WebAttachments/71475/Sydney%20Catchment%20Audit%20Vol%201.pdf>.

previously noted, the NSW Government accepted all the IEPMC's recommendations and announced it will 'introduce a licensing regime to properly account for any water losses' to address this issue.³⁵³

As another example, there has been community concern regarding a correlation with local longwall coal mining history and suspected fractures causing drying of the high value GDE of Thirlmere Lakes (near Picton in the Maldon Weir Management Zone, Upper Nepean and Upstream Warragamba Water Source). Evidence suggests that '*while the historical variability of groundwater input to the lakes remains unknown, there is no current evidence of major losses to groundwater. Thirlmere Lakes will exist only intermittently under dry climate conditions.*'³⁵⁴ This demonstrates the importance of effective, ongoing monitoring and research to enable contributors to Plan outcomes to be isolated and assessed appropriately (see **Chapter 10**).

To adequately protect both surface and groundwater sources, the Plans and their supporting documents need greater clarity regarding assumptions and known connectivity of surface water and groundwater sources. This could be achieved through:

- better defining connectivity terminology with respect to spatial and temporal variation and needs of different aquifer types
- strengthening the evidence base regarding the extent and spatial variability of connectivity through on ground studies and mapping
- specifically referring to known areas of high connectivity and lower connectivity, and distinguishing between discharging and receiving groundwater systems, gaining and losing streams to better manage the Plans as a whole.

8.5 Protections for downstream ecosystems should be improved

The estuarine area stretches from the tidal limit to the ocean. The Surface Water Plan extends to the mangrove limit in all waterways³⁵⁵ as the presence of mangroves indicates a level of salinity at which the tidal interchange is large and there is an unlimited supply of water from the ocean. The mixed fresh and saltwater section of the estuary between the tidal limit and the mangrove limit is known as the tidal pool.³⁵⁶ The tidal pool stores freshwater, which is lost to the ocean at the downstream end and replaced with freshwater inflows from upstream.³⁵⁷ The Surface Water Plan does not currently protect environmental outcomes through the estuary.

³⁵³ Minister for Planning and Public Spaces (2020) *Stronger Protection for Sydney's water catchment following extensive review* [Ministerial media release]. 18 March. Available at: <https://www.planning.nsw.gov.au/News/2020/Stronger-Protection-for-Sydneys-water-catchment-following-extensive-review>.

³⁵⁴ Peterson, M.A., Cendón, D., Hughes, C., Crawford, J., Hankin, S., Krogh, M., Cowley, K.L., Cohen, T., Andersen, M.S., Anibas, C., Glamore, W., Chen, S., Timms, W., McMillan, T. (2019) *The canary or the coalmine? Isotopic evidence of drying climate versus groundwater outflow as the cause for recent losses from Thirlmere Lakes, NSW*, presentation to the Australasian Groundwater Conference. Abstract available at: <http://agc2019.p.agc.currinda.com/days/2019-11-26/abstract/284>.

³⁵⁵ Clause 4(4) of the Surface Water Plan.

³⁵⁶ Due to its unique characteristics and management issues the tidal pool is generally considered to be a separate water source. NSW Department of Natural Resources (2006) *Survey of Tidal Limits and Mangrove Limits in NSW estuaries 1996 to 2005*. Available at: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Estuaries/survey-of-tidal-limits-and-mangrove-limits-in-nsw-estuaries-1996-2005.pdf>.

³⁵⁷ For example, the Lower Hawkesbury River is tidally dominated, with the tidal influence extending about 120 kilometres from Broken Bay to York Reach, near Wilberforce. Reduction in freshwater flows from extraction result in a greater degree of saltwater intrusion into the downstream end of the tidal pool.

The Surface Water Plan should be designed to achieve outcomes through to the downstream end of the estuary by:

- managing the volume and timing of water reaching the estuary (planned environmental water) (discussed below)
- managing the rate of extraction in the tidal pools, which determines the volume of water and therefore location of the downstream end of the tidal pool (see **Section 7.4**).

Estuaries are important for achieving environmental, social, cultural, and economic outcomes. Altering freshwater flow regimes through daily access rules (see **Chapter 7**) and environmental releases and transfers (see **Chapter 6**) has a significant impact on the physical and biological aspects of downstream estuarine and coastal environments, including sediment loads, pH, temperature, salinity, clarity, and nutrients.³⁵⁸

The modification of estuary entrances and modified freshwater flows in estuaries have been identified as priority threats for the NSW marine estate.³⁵⁹ The NSW Government has previously identified the following key principles which should be considered in the replacement Plans:

- *'Coastal catchments must be considered and managed as whole systems that extend from the upper catchment down to the offshore waters.'*³⁶⁰
- *'Water management decisions should recognise that freshwater inflows are an essential requirement for the maintenance of estuarine and coastal ecosystems.'*³⁶¹
- *'River flows should be managed so that a sufficient share of the total freshwater in a catchment is protected as inflows to estuaries to maintain and protect the biophysical processes and biodiversity of estuarine and coastal ecosystems.'*³⁶²

DPIE-Water should establish clear flow objectives for the estuaries across the Surface Water Plan area, collect data in the Hawkesbury and Shoalhaven estuaries and use this to model estuary behaviour using the models described in **Section 4.7**. This work should consider the *NSW Marine Estate Management Strategy 2018-2028* but should also extend into the freshwater-dominated sections of estuaries. Estuarine flow objectives should consider the full range of values supported in the system, including ecosystems requirements and recreational and commercial fisheries. Based on this, DPIE-Water should consult with the Environmental Flows Reference Group to develop estuarine flow requirements and include provisions to achieve these requirements in the replacement Surface Water Plan.

³⁵⁸ Gillanders, B.M. and Kingsford, M. (2002) *Impact of Changes in Flow of Freshwater on Estuarine and Open Coastal Habitats and the Associated Organisms*, *Oceanography and Marine Biology*, 40:233-309.

³⁵⁹ Marine Estate Management Authority (2017) *NSW Marine Estate – Threat and Risk Assessment Report – Final Report*. Available at: https://www.marine.nsw.gov.au/__data/assets/pdf_file/0010/736921/NSW-Marine-Estate-Threat-and-Risk-Assessment-Final-Report.pdf.

³⁶⁰ Principle 1 in NSW Government (n.d.) *No. 10 Freshwater flows to estuaries and coastal waters: Advice to Water Management Committees*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/548024/policy_advice_10-flows.pdf.

³⁶¹ Principle 2 in *Ibid*.

³⁶² Principle 4 in *Ibid*.

8.6 Protections for GDEs can be improved

8.6.1 Groundwater Plan terminology needs clarification

Water sharing plans are required to reserve water for the overall health of GDEs. There are a significant number of GDEs in the Groundwater Plan area.³⁶³ The Groundwater Plan defines GDEs as including *'ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater'*.³⁶⁴ The Groundwater Plan intends to protect identified high value GDEs through various provisions, in line with the objective to *'protect, preserve, maintain and enhance the high priority groundwater dependent ecosystems and important river flow dependent ecosystems of these groundwater sources'*.³⁶⁵ Further, a performance indicator is to measure the *'change in the ecological condition of representative groundwater dependent ecosystems, where groundwater extraction is recognised as the primary risk to their condition'*.³⁶⁶

The Groundwater Plan does not define 'high value'³⁶⁷ or 'representative GDE'. As a result, the relationship between the performance indicator and the rest of the Groundwater Plan is unclear, and it is not known if extraction risk to their condition has been assessed for all 'representative', or 'high value' ecosystems. To increase transparency, the Groundwater Plan's dictionary should clarify terminology and note that the Plan does not consider low and medium priority GDEs. This is also important as the classification of high priority or high ecological value ecosystems is inconsistent between agencies and policies.

The Groundwater Plan has broader protections compared to most water sharing plans, but still does not use generally accepted terminology, potentially causing confusion. Outside water sharing plans, GDEs are generally classified (for example by the Bureau of Meteorology and the Independent Expert Scientific Committee) according to the 'type' of ecosystems they support. The risks and impacts from changes in groundwater quantity (in terms of flow or level) or quality on the different ecosystem types varies based on their level of water dependence, hence classification by these types is important for water management. Water sharing plans do not use this 'type' terminology. Unlike most water sharing plans, which appear to focus protections on type 2 GDEs, the Groundwater Plan protects:

- **type 1** GDEs (living in an aquifer such as stygofauna) through listing 'high priority karst environment GDEs' in Table F of Schedule 4
- **type 2** GDEs (supported by discharging groundwater to the surface such as hanging swamps or wetlands in shallow water tables) through listing 'high priority GDEs' in Table D of Schedule 4
- **type 3** GDEs (supported by the subsurface presence of groundwater such as deep-rooted vegetation) through listing 'high priority endangered ecological vegetation communities' in Table E of Schedule 4.

³⁶³ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³⁶⁴ Schedule 1 – Dictionary of the Groundwater Plan.

³⁶⁵ Clause 9(a) of the Groundwater Plan. The Plan equates high priority with having high ecological value (but, not all high ecological value ecosystems automatically become high priority). Low and medium priority ecosystems are considered in other legislation such as the *Environmental Planning and Assessment Act 1979*.

³⁶⁶ Clause 11(c) of the Groundwater Plan.

³⁶⁷ Note 3 under Clause 16 of the Groundwater Plan states *'for the purposes of this Plan, "high environmental value" areas are national parks, nature reserves, historic sites, Aboriginal areas, State conservation areas and karst conservation areas'* yet this definition is broader than that used to define high value GDEs.

The Groundwater Plan should specify which types of GDE are to be considered for alignment with generally used terminology. During Groundwater Plan development, each type of ecosystem should be identified, and their groundwater requirements defined. High value ecosystems from each of these types can then be protected as required.

The definition should include culturally significant sites. The value of these sites was recognised in 2011, but they were not included in the relevant schedules for protection.³⁶⁸ The Groundwater Plan prevents approval of water supply works within 100 metres of groundwater dependent culturally significant sites for basic landholder rights, or 200 metres for any other use.³⁶⁹ However, the Groundwater Plan's background document notes that a list of high priority culturally significant groundwater dependent sites was being developed, which would be used in assessing an application for granting or amending a water supply work approval.³⁷⁰ Following this process, it was noted that the Groundwater Plan provisions may need to be amended to protect any additional groundwater dependent culturally significant sites identified in the area.³⁷¹

A 2010 study³⁷² aimed to identify these sites³⁷³ and produced a map of 48 culturally significant GDEs based on interviews with Aboriginal community members. This included nine sites which aligned with high priority GDEs, and seven sites overlapping with high priority karst GDEs.³⁷⁴ The Groundwater Plan was not amended to specifically recognise the additional 32 culturally significant GDEs.

The study contributes to a broader body of research which demonstrates the ongoing and significant value of groundwater to Aboriginal culture and knowledge.³⁷⁵ It provides a rich

³⁶⁸ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³⁶⁹ Clause 42 of the Groundwater Plan.

³⁷⁰ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*, pp. 16-17. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³⁷¹ *Ibid.*

³⁷² Moggridge, B. (2010) *Identification of Culturally Significant Groundwater Dependent Ecosystems and Identification of reaches within management zones to support Aboriginal Community Development Licenses*. Available at: <https://data.gov.au/data/dataset/4d0bc9d9-7675-4e57-b0fd-750b323fde95>.

³⁷³ The project sought to establish a list of sites to be submitted to the NSW Office of Water to coincide with the public exhibition of the Draft Plan.

³⁷⁴ Schedule 4, Tables D and F of the Groundwater Plan.

³⁷⁵ There are several Australian studies where cultural values have been considered in groundwater research. These studies highlight that the Aboriginal concept of groundwater and its movement is complex and difficult to quantify, but inherently complements non-Aboriginal modelling. Appropriate hydrogeological studies should involve substantial involvement of Aboriginal people, such that Aboriginal models concerning groundwater – particularly focused on limiting drawdown, supporting replenishment and preserving flow – can be addressed through scientific evaluation. In addition, some studies suggest that better documentation of groundwater sites is needed alongside a range of arrangements for non-volumetric provisions (language, protocols, access), non-licensed volumetric allocations (to sustain water places and associated assets of cultural and environmental value) and licensed volumetric water allocation for Aboriginal enterprises within the assessed sustainable resource for future economic use (see *ibid*; McDonald, E., B. Coldrick and L. Villiers (2005) *Study of Groundwater Related Aboriginal Cultural Values on the Ngarangara Mound, Western Australia*. Report for the Department of Environment. Estill and Associates; White, I. (2010) *Impacts of groundwater extraction on Indigenous access and use of water resources in the Central Condamine Alluvium*. Water Planning Tools Griffith University; Yu, S. (2000) *Ngapa Kunangkul: Living Water. Report of Aboriginal cultural Values of Groundwater in the La Grange Sub-basin*. Available at: https://www.water.wa.gov.au/__data/assets/pdf_file/0008/5588/11504.pdf; and Rea, N. (2008) *Provision for Cultural Values in Water Management: the Anmatyerr Story*. Available at: <https://library.dbca.wa.gov.au/static/FullTextFiles/069383.pdf>.

example of extensive Aboriginal knowledge of water-based values in the highly culturally disrupted Hawkesbury-Nepean.³⁷⁶

The study also advised that determination of high value GDEs should include an Expert Aboriginal Panel and that ground-truthing Aboriginal heritage sites and areas should be undertaken by Traditional Owners and LALCs before a new licence is granted.³⁷⁷ DPIE-Water should continue work committed to and undertaken with Aboriginal community and Traditional Owners to further expand on culturally significant groundwater sites and values and include mechanisms to support Aboriginal involvement throughout the process. The Commission notes that, while significant work has gone into identifying culturally important groundwater sites, little has gone into identifying culturally significant surface water sites. Broader issues related to the identification of Aboriginal values across the Plans are discussed in **Chapter 9**.

The definitions provided in recent inland water sharing plans should be expanded, such as the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011*, which included the following definitions:

- *'groundwater dependent ecosystems include ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater*
- *high environmental value areas are national parks, nature reserves, historic sites, Aboriginal areas, state conservation areas and karst conservation areas*
- *high priority groundwater dependent ecosystems are groundwater dependent ecosystems which are considered high priority for management actions'*³⁷⁸

The inclusion of definitions in other water sharing plans is good progress, but the definition for high priority GDEs requires further clarification. The factors considered when assessing priority (such as cultural significance, presence of endangered ecological communities, period of groundwater dependence, suitability of water quality, representativeness) should be clearly defined.

8.6.2 Identification of GDEs is inconsistent

Notwithstanding the lack of key definitions, the implementation of the Groundwater Plan's provisions relies on listing high value GDEs in Schedule 4 of the Groundwater Plan. High value GDEs are also shown in supporting maps in Appendix 2 of the Groundwater Plan and are listed in the background document. An interagency expert panel developed the list of high value GDEs in the Groundwater Plan.³⁷⁹ The list was being reviewed in 2011 and the schedule and appendix have not been updated since.

³⁷⁶ For instance, a significant Dreaming story (Gurangatch and Mirragan) provides the study with culturally significant sites important to the Gundungurra people which are dependent on groundwater. The Gurangatch and Mirragan story was recorded by anthropologist R.H. Matthews in 1908 from a small community on Aboriginal Reserve No. 26 Byrnes' Creek in the Burraborang Valley on the Wollondilly River the story is further presented in both Meredith (1989) and Stockton (1993).

³⁷⁷ Moggridge, B. (2010) *Identification of Culturally Significant Groundwater Dependent Ecosystems and Identification of reaches within management zones to support Aboriginal Community Development Licenses*. Available at: <https://data.gov.au/data/dataset/4d0bc9d9-7675-4e57-b0fd-750b323fde95>.

³⁷⁸ Schedule 1 Dictionary of the *Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources 2011*.

³⁷⁹ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document* p. 27. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

There are also discrepancies in the GDEs identified in the Groundwater Plan schedule and appendix, and background document.³⁸⁰ There are more sites listed in the schedule, reducing the likelihood that sites have been missed and potentially impacted by extraction. However, the lack of a clear criteria for defining sites or consistency between DPIE-Water documents reduces transparency and confidence that all high value ecosystems have been systematically identified. If high value sites are excluded from the schedule, provisions to protect high priority GDEs would not be implemented. This means extraction could impact on these locations with environmental, social and economic impacts (such as harm to a wetland and reduced ecosystem services).

DPIE-Water has advised that it is releasing a state-wide GDE HEVAE assessment, which prioritises GDEs. This will be rolled out on a plan-by-plan basis, although the Commission has not been advised on specific timing. Satellite imagery assessment of vegetation persistence coupled with targeted on-ground sampling and investigation should be undertaken to locate GDEs. DPIE-EES has developed a method using the surface water HEVAE framework to prioritise terrestrial vegetation GDEs for management.³⁸¹ This is a systematic, repeatable and transparent method for scheduling GDEs into water sharing plans. The method is also consistent with surface water plan mapping of high environmental value ecosystems. During Groundwater Plan development, available data should be ground-truthed and additional ecosystems included as necessary to give effect to provisions to protect GDEs.

There is also a need to improve the quality of mapping of high priority GDEs. Maps included in the Groundwater Plan are poor quality, only show spot locations rather than a real extent of GDEs and use inconsistent terminology, as shown in **Figure 16**.³⁸²

Once definitions are strengthened and high priority GDEs are identified (as discussed in **Section 8.6.1**), DPIE-Water should ensure these are consistently listed in all relevant Groundwater Plan documents, including high quality mapping showing location and extent of high value GDEs. This will improve stakeholder understanding and confidence in Groundwater Plan development and implementation.

³⁸⁰ There are sites left off both the lists in the background document and the maps in the Appendix. As Schedule 4 defines the sites protected by the Groundwater Plan's provisions, this is an issue of clarity and consistency rather than a key risk of not protecting high value ecosystems.

³⁸¹ Dabovic, J., Raine, A., Dobbs, L., Byrne, G. (2019) *A new approach to prioritising groundwater dependent vegetation communities in New South Wales, Australia*. Available at: <http://agc2019.p.agc.currinda.com/days/2019-11-25/abstract/124>.

³⁸² The Commission acknowledges that the exact location of certain site should not be fully identified, such as Aboriginal cultural sites.

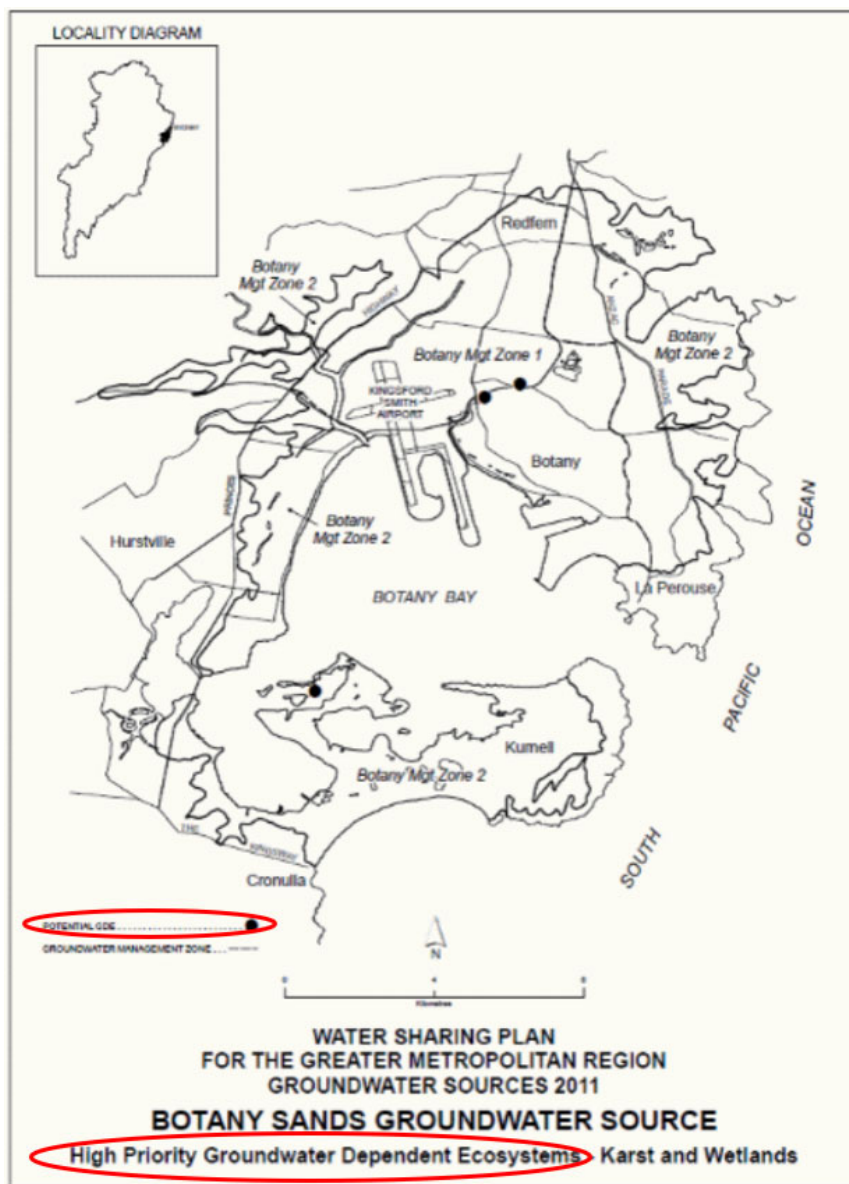


Figure 16: Example of a map with inconsistent terminology in Appendix 2 of the Groundwater Plan, showing point markers for high priority / high potential GDEs

8.6.3 Plans should consider the NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* aims to holistically protect GDEs, considering both potential water level and quality impacts.³⁸³ It outlines a comprehensive approach to GDE protection, and includes a method to assess setback distances and a reporting framework. The *NSW Aquifer Interference Policy* requires impact assessments for all proposed extraction works if an entire aquifer is a high priority GDE, including the extent of impact on the whole groundwater source.

The Groundwater Plan includes various setback distances for work near GDEs to minimise the potential impacts of groundwater extraction on environmental features, including GDEs.³⁸⁴ The Commission recommends that these distances are aligned to the *NSW Aquifer Interference Policy*

³⁸³ DPI-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.
³⁸⁴ Clause 41 of the Groundwater Plan.

for consistency between water sharing plans and NSW Government policies, except where additional measures or caveats are identified as necessary.³⁸⁵

The Groundwater Plan has additional clauses with caveats that restrict trades if *'in the Minister's opinion, the dealing would adversely affect the water levels in an aquifer, the quality of water in an aquifer, the ability to prevent land subsidence or compaction in an aquifer, groundwater dependent ecosystems, or the pressure or pressure recovery of an aquifer to the extent that a temporary water restriction order may need to be made under the Act'*.³⁸⁶ The Commission considers these caveats should be retained in future plans to align with the Groundwater Plan's objectives and priorities in the Act.

8.7 Groundwater trading rules support achievement of outcomes

The Groundwater Plan has a large variation in trading rules within and between each water source. Trading between water sources is prevented, as is appropriate for disconnected water sources to prevent degradation. The Botany Sands and Sydney Basin Nepean groundwater sources have additional trade restrictions to protect water sources and users from potential impacts of additional extraction, including due to contamination in the Botany Sands (see **Section 2.2**).³⁸⁷

Trading has likely been subdued as controlled allocation orders have been offered for several water sources³⁸⁸ where entitlement is below the LTAAEL.³⁸⁹ Those seeking new or additional allocations can therefore purchase groundwater directly from DPIE-Water rather than seeking out potential sellers. Most groundwater trades were transfer trades³⁹⁰ from one licensee to another (227 trades in total), with most of these in the Sydney Basin Nepean Groundwater Source (57 percent of trades and 74 percent of volume traded), followed by the Goulburn Fractured Rock Groundwater Source. These two water sources experienced the most trades for all types, with other trades being assignment of rights³⁹¹ and assignment of water allocations.³⁹²

The Commission generally supports the trading rules in the Groundwater Plan. As discussed in **Section 8.2**, support mechanisms for trade may encourage increased trade as potential licensees would be able to more readily find sellers rather than waiting for the controlled allocation process. This would assist with bringing currently exempt extraction into the licensing and accounting framework. **Section** Error! Reference source not found. outlined how construction and maintenance projects have been exempt from licencing. This undermines trade in groundwater sources with high levels of these activities and does not incentivise minimisation of extraction. Facilitating trades would enable construction projects to transfer licences and

³⁸⁵ DPI-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.

³⁸⁶ Clauses 47, 49, 50 and 51 of the Groundwater Plan.

³⁸⁷ Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0007/168505/metro-groundwater-background.pdf.

³⁸⁸ For example, Coxs River Fractured Rock, Goulburn Fractured Rock, Hawkesbury Alluvium Groundwater Source, Metropolitan Coastal Sands, Sydney Basin Central, Sydney Basin South and Sydney Basin North groundwater sources.

³⁸⁹ NSW Government (2020) *Government Gazette Number 107 – Friday 29 May 2020*. Available at: https://gazette.legislation.nsw.gov.au/so/download.w3p?id=Gazette_2020_2020-107.pdf.

³⁹⁰ Under section 71M of the Act.

³⁹¹ Under section 71Q of the Act.

³⁹² Under section 71T of the Act.

allocations, protecting environmental outcomes, promoting equity between users, and avoiding undermining the water market.

8.8 Recommendations

R 10	<p>By 1 July 2023, DPIE-Water should use best available evidence, to reassess the socioeconomic, cultural and environmental value of all management zones/water sources in the Plans including:</p> <ul style="list-style-type: none"> a) fine scale High Ecological Values Aquatic Ecosystems (HEVAE) mapping consistent with data used for other NSW Government planning processes b) reviewing trade limitations with a view to manage trade across broader areas provided environmental outcomes can be maintained c) the full range of economic benefits and impacts of water extraction and presence of water in-stream when considering the economic dependence of water sources, such as: <ul style="list-style-type: none"> i) benefits and impacts of secure water supply and time on water restrictions for town water supplies including residential and industrial uses ii) benefits and impacts of flow and water quality on industries and water uses such as tourism, ecosystem services and recreation and community activities. <p>Where necessary, DPIE-Water should then amend both Plans' rules to address any changes to classifications and ensure that the high value environmental ecosystems are protected by the Plan rules, without unnecessarily inhibiting trade.</p>
R 11	<p>By 1 July 2023, DPIE-Water should:</p> <ul style="list-style-type: none"> a) better define connectivity terminology with respect to spatial and temporal variation and needs of different aquifer types b) strengthen the evidence base across the plan area regarding the extent and spatial variability of connectivity through on ground studies and mapping c) specifically refer to known areas of high connectivity and lower connectivity, and distinguish between discharging and receiving groundwater systems, and gaining and losing streams to better manage the Surface and Groundwater Plans as a whole.
R 12	<p>DPIE-Water should:</p> <ul style="list-style-type: none"> a) by 1 July 2021, establish clear objectives for estuaries across the Surface Water Plan area b) by 1 July 2021, initiate detailed data collection in the Hawkesbury and Shoalhaven estuaries (including but not limited to the studies identified in 78(9) of the Surface Water Plan) and use an estuary model described in Section 4.7 to model estuary behaviour c) by 1 July 2022, use (b) to develop estuarine flow requirements in consultation with the Environmental Flows Reference Group (Recommendation 5) – as part of this, the Hawkesbury-Nepean tidal pool should be managed as a discrete area d) by 1 July 2023, include provisions to achieve the estuarine flow requirements defined in (c), including clear agency responsibilities.
R 13	<p>By 1 July 2023, to improve Groundwater Plan clarity and protection of GDEs to achieve environmental outcomes, DPIE-Water should:</p>

	<ul style="list-style-type: none"> a) Clearly define groundwater terms and their relevance to the Groundwater Plan, including GDEs, high priority (culturally significant sites), groundwater type, and connectivity – connectivity should include both discharge of groundwater to surface water and surface water recharge to groundwater systems b) Include known values relating to culturally significant groundwater dependent sites in the revised Plan and ensure these are protected by the Plan provisions c) Ground-truth updated DPIE-EES HEVAE mapping for the presence and extent of GDEs, including estuarine ecosystems. Identify and clearly refer to high priority ecosystems (considering defined factors such as cultural significance, presence of endangered ecological communities, period of groundwater dependence, suitability of water quality, representativeness) d) Review setback distances for work near identified GDEs and standardise these based on the <i>NSW Aquifer Interference Policy 2012</i>.
<p>R 14</p>	<p>By 1 July 2023, DPIE-Water should define specific ‘high’ flow thresholds where appropriate in the Surface Water Plan area, with cease to pump thresholds at levels that do not increase hydrological stress or impact environmental outcomes but will allow some trade into high flows.</p>

9 The Plans do not support outcomes for Aboriginal people

The Commission continues to identify significant issues in provisions relating to Aboriginal water values, rights and uses as part of its water sharing plan reviews – these are critical to improving statewide water sharing and are detailed at the start of each sub-section. State-wide recommendations are highlighted in **Section 9.4**.³⁹³

The review³⁹⁴ also identified several specific issues in addition to the state-wide recommendations, including:

- native title provisions are inconsistent across the Plans (**Section 9.1**)
- known values relating to culturally significant groundwater dependent sites have not been adequately considered in the Plan (discussed previously in **Section 8.6**)
- Aboriginal specific licences are highly restrictive and have not been applied for in the plan area (**Section 9.3**)
- potentially unallocated water is available across both Plans and could be reserved for Aboriginal values before being offered to the market on commercial terms (**Section 9.3**).

The Commission notes that DPIE-Water have been progressing work on an NSW Aboriginal Water Framework with key Aboriginal stakeholders. This work includes the following:

- Ongoing development of an Aboriginal Water Strategy in partnership with the NSW Aboriginal Water Coalition.³⁹⁵ The Coalition has advised the Minister for Water, Property and Housing that they would like to enter into a formal partnership with the Minister that sets out principles for co-design and commitments on Aboriginal water policy reform. The Coalition is drafting the agreement in consultation with DPIE-Water. The scope of the Aboriginal Water Strategy will be refined in partnership with the Aboriginal Water Coalition.
- Aboriginal stakeholder engagement as part of regional water strategies, including identifying challenges and aspirations around water, including options around delivering on Aboriginal water rights, interest and access to water.³⁹⁶

³⁹³ The Productivity Commission's 2017 inquiry into national water reforms found that all jurisdictions needed to undertake further work to address the needs of Indigenous Australians. Although some states and territories had progressed consultation with Indigenous communities in water planning, including in NSW, this did not extend to integrating cultural values and outcomes meaningfully in water plans. In addition, reform of legal, administrative and governance arrangements for water was identified as a priority. In the most recent Issues Paper (2020), the Productivity Commission goes further to recommend that these actions also need to better consider water to support the economic development of Indigenous communities (Productivity Commission (2020) *National Water Reform: Productivity Commission Issues Paper*. Available at: <https://www.pc.gov.au/inquiries/current/water-reform-2020/issues/water-2020-issues.pdf>).

³⁹⁴ The Commission reviewed the Plans against their relevant objectives and associated performance indicators to support Aboriginal water values, to:

- protect, preserve, maintain or enhance the Aboriginal, cultural and heritage values of these water sources
- protect basic landholder rights, including native title rights
- manage these water sources to ensure equitable sharing between users (equity relates to the appropriate prioritisation of different licence classes under the Act).

³⁹⁵ The Coalition includes representatives from peak agencies: Murray Lower Darling Rivers Indigenous Nations, Northern Basin Aboriginal Nations, Native Title Service Corporation, NSW Aboriginal Land Council, and Aboriginal Affairs NSW.

³⁹⁶ For example, see options in the Macquarie Regional Water Strategy (NSW Government (2020) *Draft Regional Water Strategy: Macquarie-Castlereagh long list of options*. Available at:

- Options to progress Aboriginal water outcomes are being considered across the DPIE-Water program of work, such as Aboriginal Country watering plans, regional Aboriginal governance, and translating values into actions.³⁹⁷ Aboriginal stakeholder engagement is also underway on the sustainable diversion limit allocation mechanism project comprising seven Aboriginal advisory bodies, a Senior Aboriginal Program Officer and project officer.
- Further funding for project officers in the Murray Lower Darling Rivers Indigenous Nations and Northern Basin Aboriginal Nations to support regional water strategies, engagement, literacy and capability-building, and additional funding for the CEOs of these bodies to undertake strategic reviews. Specific allocations have also been used to fund the Barkandji Native Title group's *Water on Country* project.

The Commission encourages DPIE-Water to continue to drive and resource this important part of its water management portfolio – to establish a NSW Aboriginal Water Framework that provides consistent and transparent guidelines and resourcing for Aboriginal water planning and management across the state. The framework must be co-designed with key Aboriginal stakeholders and set out a range of state-wide actions to ensure Aboriginal water values are planned for and managed respectfully and consistently (for example, changes to legislation and policy, review of water licensing arrangements, landscape-scale processes for identifying, assessing, monitoring Aboriginal values and outcomes, capability-building measures, ownership, management and leadership roles).

9.1 Native title provisions are unclear and inconsistent

Across all water sharing plan reviews in 2019/20, the Commission has consistently found that common native title provisions have failed to protect native title rights in a timely manner when determinations are made. The provision has also failed to consider future native title consistently and proactively, including active native title claims, Indigenous Land Use Agreements or other agreements.³⁹⁸

DPIE-Water should include a common state-wide provision to undertake preliminary amendments to a plan within six months of a native title determination or other land/water use agreement – and allow for additional time to undertake detailed engagement with Traditional Owners, make any specific water allocations and final amendments to the plan. Native title claims, Indigenous Land Use Agreements or other agreements should be considered proactively wherever possible as part of the planning, drafting and engagement process for water sharing plans. Further, DPIE-Water should ensure progress on these initiatives is transparently reported to the public at regular intervals that as part of the MER program.

https://www.industry.nsw.gov.au/__data/assets/pdf_file/0018/313281/draft-rws-macquarie-castlereagh-options.pdf.

³⁹⁷ For example, see options in the Macquarie Regional Water Strategy (NSW Government (2020) *Draft Regional Water Strategy: Macquarie-Castlereagh long list of options*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0018/313281/draft-rws-macquarie-castlereagh-options.pdf).

³⁹⁸ There are several agreements that can be made under relevant NSW and Commonwealth legislation. For example, Indigenous Land Use Agreements or a Section 31 Deed can be used successfully to resolve native title claims proactively. These are legally binding and may include rights in relation to employment, economic development, freehold land and compensation. Aboriginal Land Agreements can also be used as an alternative to the land claims process under the *Aboriginal Land Rights Act 1983* and provide a broad scope for negotiating claims. Indigenous Protected Areas are also effective, encompassing areas of land and sea country owned or managed by Indigenous groups which are voluntarily managed as a protected area for biodiversity conservation through an agreement with the Australian Government as part of the National Reserve System.

In this review, both Plans include an objective to protect basic landholder rights, including native title rights, and a performance indicator to monitor the extent to which native title requirements have been met.³⁹⁹ The Surface Water Plan also includes a provision to support amendments where native title rights may change under the *Native Title Act 1993*.⁴⁰⁰

The plan area includes three current Native Title claims (Warrabinga-Wiradjuri #2/#7, registered 2013 and 2018 and South Coast People, registered 2018) and an Indigenous Land Use Agreement (Gundungarra Area Agreement, 2007) (see **Figure 8**).

The provisions to support these claims and agreements are variable and unclear. Firstly, the Surface Water Plan includes a native title rights estimate of 26.6 ML per year⁴⁰¹ in the Kangaroo River Management Zone in the Shoalhaven River Water Source. It is not clear which native title group this relates to or how it was determined.

Secondly, the Surface Water Plan requires that '*an unregulated river (subcategory "Aboriginal cultural") access licence should not be granted under subclause (5), unless the Minister has sought the advice of the Wiradjuri native title claimants (where applicable) and the Gundungarra Tribal Council Aboriginal Corporation (or Gundungarra descendants)*'.⁴⁰² This acknowledgement does not capture the South Coast People and Warrabinga-Wiradjuri native title claims.

Finally, the Groundwater Plan states that there '*are no native title rights*'⁴⁰³ in the plan area. This is inaccurate and inconsistent with the recognition, albeit in part, of native title claimants in the Surface Water Plan. This omission also ignores the significance and values of groundwater to Aboriginal peoples (see **Section 8.6.1**).

The Commission recommends that the Plans acknowledge all current native title claimants and Indigenous Land Use Agreement holders comprehensively and reflect this consistently. The Plans should also reflect state-wide recommendations to strengthen native title provisions and proactive planning for native title rights and other agreements.

9.2 Aboriginal values are not protected by the Plans

The Commission consistently finds that Aboriginal values are generally noted in the vision statements, objectives and performance indicators of water sharing plans – yet they are not identified in detail as part of water planning and engagement processes, and are often limited to definitions of 'cultural use'. As a result, Aboriginal water values are not well understood or integrated in water planning and management, nor are they adequately protected.

DPIE-Water should identify Aboriginal water values and uses, objectives and outcomes in all plan areas across surface and groundwater sources. This process should involve extensive engagement with local Aboriginal stakeholders, in line with the NSW Aboriginal Water Framework, and consider using cultural landscape-scale principles, through extensive engagement with local Aboriginal stakeholders and in line with the NSW Aboriginal Water Framework. The Commission notes that significant work has already occurred to identify culturally significant groundwater sites, although this has not been incorporated into the Groundwater Plan (see **Section 8.6.1**).

³⁹⁹ Clause 12(f) of the Surface Water Plan and Clause 11(g) of the Groundwater Plan.

⁴⁰⁰ Clause 82(11) of the Surface Water Plan.

⁴⁰¹ Division 2, Clause 21 of the Surface Water Plan.

⁴⁰² Part 8, Clause 52(6) of the Surface Water Plan

⁴⁰³ Division 2, Clause 20 of the Groundwater Plan.

These Plans both include a vision statement regarding the protection of Aboriginal values, and access and use of water.⁴⁰⁴ However, they do not identify Aboriginal values beyond general objectives and performance indicators⁴⁰⁵ – noting that provisions may be amended when values are identified through further engagement processes,⁴⁰⁶ and that any amendments to this clause would need to take into account *‘the socioeconomic impacts of the proposed change’*.⁴⁰⁷

While these general provisions are included, the Commission has not received any information or data on this objective or performance indicator. In addition, the lack of any specified water values makes assessment of the outcomes relating to the recognition and protection of water values difficult.

The lack of consideration of Aboriginal water values was confirmed in stakeholder engagement, which identified the need for more assessment and engagement on Aboriginal values:

*‘[The Plan revisions] should do more assessment and conduct more consultation on the Aboriginal cultural and heritage values of the water sources, and determine what flows, water availability, and water quality is required to support these values.’*⁴⁰⁸

The review also highlighted limited awareness and engagement of local Aboriginal stakeholders in water planning generally. Cultural values are poorly understood in water planning and, at best, limited to individual sites, as described here:

*‘The focus in all policy and planning is on cultural sites only. This is all through the Development Assessment process for mines and other developments in the area ... These individual sites are part of an interconnected landscape which is important culturally and this is particularly the case for waterway sites. Cultural landscapes assessments need to be introduced as part of our thinking, planning and management. This is really important ... **cultural water is inherently part of the landscape and cannot just be considered through individual sites.**’*⁴⁰⁹

This type of site-based approach does not adequately capture the range of diverse and interconnected values represented in water and the broader cultural landscape, instead effectively ‘trading off’ a very narrow definition of cultural water values against other social and economic interests.⁴¹⁰

Both Plans should reflect the Commission’s state-wide recommendations to strengthen the processes for identifying and protecting Aboriginal water values, material and intangible, as

⁴⁰⁴ Both Plans include a vision statement: *‘(2) This Plan was developed with the recognition that the sharing of waters in these water sources contributes to: (a) Aboriginal peoples pursuing their economic, social and cultural development, and maintaining and strengthening their spiritual and customary relationship to the water, and (b) the involvement of Aboriginal peoples in the conservation, protection and management of these water sources.’*

⁴⁰⁵ Clause 10(12), Clause 9(11), Clause 82(12).

⁴⁰⁶ The Surface Water Plan’s background document notes there were two meetings with Aboriginal stakeholders during the public exhibition period: 1 July 2010 – Aboriginal community stakeholder groups, Goulburn; and 4 August 2010 – Local Aboriginal Land Councils, Parramatta.

⁴⁰⁷ Clause 82(13) and (14) of the Surface Water Plan.

⁴⁰⁸ Submission: Sydney Water, received 25 October 2019.

⁴⁰⁹ Interview: Illawarra Local Aboriginal Land Council, 24 October 2019.

⁴¹⁰ In the current NSW water allocation framework, cultural values are treated as sites or places where ‘cultural activities’ take place, allocations can then be used to ‘water’ those sites, in the same way that water is delivered to irrigators. Environmental, irrigation, social or cultural values are subsequently traded off in a zero-sum game which contradicts fundamentally to Aboriginal ontology in which each value is inherently connected. See: Davies, S., Wilson, J. and Ridges, M. (2020) ‘Redefining ‘cultural values’ – the economics of cultural flows’. *Journal of Water Resources*.

part of a broad cultural landscape approach.⁴¹¹ There have been significant efforts to provide guidance on how to undertake effective engagement with Aboriginal stakeholders to identify water values⁴¹², including Aboriginal waterways assessments⁴¹³ and cultural flows assessments⁴¹⁴ – these have been detailed in the Commission’s previous water sharing plan reviews.⁴¹⁵

9.3 Licence provisions limit Aboriginal outcomes

The Commission’s water sharing plan reviews continually find that Aboriginal-specific water licences available in NSW are highly restrictive, subject to significant limitations in use and awareness, and unable to be easily accessed and applied for.

DPIE-Water should co-design licences or other water custodianship and access options with Aboriginal stakeholders that meet identified needs (for a range of cultural, environmental, social and economic uses), in line with a state-wide Aboriginal Water Framework.

Both Plans include specific purpose access licences for Aboriginal uses. However, this review has not identified any instances where these licences have been issued under the Plans. As noted in other water sharing plan reviews, DPIE-Water does not have a clear process for accessing and assessing these licences, and Aboriginal stakeholders have limited awareness of their existence and use.⁴¹⁶

Both Plans provide a specific purpose access licence for ‘Aboriginal cultural’ uses.⁴¹⁷ These licences are capped at up to 10 ML per licence per year and cannot be used for commercial activities.⁴¹⁸ The Surface Water Plan restricts Aboriginal cultural access licences in specific

⁴¹¹ The document *Dhungala Baaka* provides a summary of the diversity of Aboriginal water-related values including: cultural heritage and evidence of historic occupation and use; connection to key water dependent plant and animal species; customary food, fibre and tool production; land and water management activities and expertise; creation stories and customary lore; movement and presence of spiritual and metaphysical beings; well-being and recreation economic development and opportunities. Murray Lower Darling Rivers Indigenous Nations, Northern Basin Aboriginal Nations & North Australian Indigenous Land and Sea Management Alliance (2017) *Dhungala Baaka: Rethinking the Future of water management in Australia*. Available at: <http://www.mldrin.org.au/wp-content/uploads/2018/06/Dhungala-Baaka.pdf>.

⁴¹² Including additional modules for the *National Water Initiative* and the *Basin Plan*, and as part of the *National Cultural Flows* project.

⁴¹³ The purpose of the Aboriginal Waterways Assessment Program was to develop a tool that consistently measures and prioritises river and wetland health so that Traditional Owners can more effectively participate in water planning and management in the Basin. (Murray-Darling Basin Authority (2017) *Aboriginal Waterways Assessment Program*. Available at: <https://www.mdba.gov.au/publications/mdba-reports/aboriginal-waterways-assessment-program>).

⁴¹⁴ The National Cultural Flows Research Project is a project driven by and for Aboriginal people, sought to establish a national framework for cultural flows. The framework, released in 2018, provides the first guide and method for future planning, delivery, and assessment of cultural flows (Murray-Darling Basin Authority (2019) *Cultural Flows*. Available at: <https://www.mdba.gov.au/discover-basin/water/cultural-flows>).

⁴¹⁵ See for example: *Final report: Review of the Water Sharing Plan for the Lower North Coast Unregulated and Alluvial Water Sources 2009*, April 2020 (<https://www.nrc.nsw.gov.au/2019-2020-wsp-reviews>); *Final report: Review of the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012*, September 2019 (<https://www.nrc.nsw.gov.au/2018-2019-wsp-reviews>).

⁴¹⁶ *Ibid.*

⁴¹⁷ Specific purpose category licences provide higher priority access to water than licences for most commercial purposes. These licences do not have a tradable value for purchase or sale, and the share component is expressed in ML per year. As with all specific purpose access licences, the Aboriginal Cultural Access Licence includes certain conditions need to be met to be eligible to apply.

⁴¹⁸ Water must be used only for any personal, domestic or communal purpose, including drinking, food preparation, washing, manufacturing traditional artefacts, watering domestic gardens, cultural teaching, hunting, fishing, gathering and for recreational, cultural and ceremonial purposes. See Part 8, Clause 52(7).

management zones if the granting of the licence would cause the total share components to exceed a range of specified limits.⁴¹⁹

The Surface Water Plan also includes 'Aboriginal community development' access licences, which can be used for commercial activities in some coastal catchments with higher, more reliable flows.⁴²⁰ In contrast to other licences, Aboriginal community development licences can only be provided for B Class flows and only in very limited management zones.⁴²¹ They are also not provided for as part of the Groundwater Plan.

When the Surface Water Plan was developed and put on public exhibition, concerns were raised that the number of management zones in which applications for Aboriginal community development licences would be accepted was insufficient and needed to be reviewed. A review was completed to determine if more management zones could sustain Aboriginal community development access licences than originally recommended, with a few management zones identified for further investigation. However, these were found to be not suitable due to factors including the presence of threatened species dependent on high flows, and a lack of suitable infrastructure (such as gauging station).⁴²²

The limitations on Aboriginal community development licences inhibit any meaningful commercial use. For example, accessing B Class flows requires large upfront costs and, under current rules, precludes the use of farm dams. The licences are also for relatively small volumes of water, which means that many commercial operations would be unviable.

Overall, Aboriginal-specific licences are highly restrictive with onerous conditions on their issue and operation. This is despite many water sources in the Groundwater Plan being below full allocation. Controlled allocations ('new water shares') are still being offered on commercial terms, yet this unallocated water is not reserved in whole or part to support Aboriginal values. This is inconsistent with the Act and the objectives of the Plans. If sustainable LTAAELs were determined (see **Section 4.3**) there may be opportunities outside the Hawkesbury-Nepean catchment for less restrictive surface water licences.

In addition, stakeholder consultation for this review confirmed a general lack of awareness of water access licences and a range of underlying barriers to water access and use:

- **Limited land and water ownership in coastal, metropolitan areas** – the plan area is highly developed, high value and largely freehold – meaning limited opportunities for Aboriginal ownership of land under the *Aboriginal Land Rights Act 1983* and native title claims are long-running and complex due to dispossession. As noted by one stakeholder

⁴¹⁹ See Part 8, Clause 52(6) and Part 8, Clause 57(11) of the Surface Water Plan.

⁴²⁰ In some coastal rivers, higher and more reliable flows provide an opportunity for the granting of Aboriginal community development access licences, provided this additional extraction would not negatively impact on ecological values that are dependent on these high flows. These licences allow water to be pumped from rivers during the higher flows, and stored in farm dams or tanks, to be used as needed. The total volume of water that can be extracted for Aboriginal commercial purposes from a water source is limited to a proportion of the river flow not to each individual Aboriginal community development licence. See: NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources – Background document*, July, pp. 27-28.

⁴²¹ Moggridge, B. (2010) notes that targeted consultation by the Department identified that the amount of water sources prohibiting Aboriginal Community Development Licences is very restrictive.

⁴²² NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources – Background document*, July, page 53.

group: *'We have no water licences and limited land ownership, particularly any land with water attached'*.⁴²³

- **Restricted access to waterways in Sydney's drinking water catchment Special Area** – the Surface Water Plan area includes Special Areas under the *Water NSW Act 2014*. As noted by one stakeholder group: *'these areas coincide with many key cultural sites ... this means there is literally no access for Aboriginal people. Although the reasons for this are clear – people should not be able to access our drinking water – negotiations with WaterNSW have not been productive. They want us to produce access guidelines but we do not have the resources to do this. We asked to use their existing guidelines and amend them to suit but they wouldn't agree ... at best we have been offered an escorted tour'*.⁴²⁴
- **Little awareness, engagement and proactive involvement of Aboriginal people in NSW water planning and management** – this is due to the lack of access to water, limited engagement with Aboriginal stakeholders, and poor resourcing of Aboriginal bodies to be more involved in water planning and management. As noted by one stakeholder group: *'we are often limited to responding to projects through submissions or providing input after the fact. It makes us seem like naysayers'*.⁴²⁵

There is a significant need to focus on opportunities to develop and resource proactive involvement of Aboriginal people in water planning and management across the state (see **Box 1**).

Research continues to show that Aboriginal water holdings are suffering disproportionately under NSW licencing rules, creating issues of inequity and further dispossession that need to be addressed at a state-wide scale,⁴²⁶ and in line with new Closing the Gap targets.⁴²⁷ The Plans should reflect state-wide recommendations to revise Aboriginal water access licences through a co-design process with Aboriginal stakeholders. This process needs to consider a range of volumetric, non-volumetric and non-licensed solutions, and trading flexibility under flow scenarios to better support Aboriginal water access, rights and use.

In the case of these Plans, DPIE-Water should also consider whether unallocated water could be reserved for the co-designed licences or other water custodianship options for Aboriginal peoples before being offered to the market on commercial terms.

⁴²³ Interview: Illawarra Local Aboriginal Land Council, 24 October 2019.

⁴²⁴ *Ibid.*

⁴²⁵ *Ibid.*

⁴²⁶ A recent study showed that, while Aboriginal people in the NSW Murray-Darling Basin constitute nearly 10 percent of the population, their organisations hold only 0.2 percent of the available surface water, and 17 percent of Aboriginal water holdings by volume were lost between 2009 and 2018. A range of factors rendered Aboriginal water-holders vulnerable to loss of valuable water rights and the benefits of water access, including water market participation (Hartwig, L., Jackson, S., Osborne, N. (2020) 'Trends in Aboriginal water ownership in New South Wales, Australia: The continuities between colonial and neoliberal forms of dispossession', *Land Use Policy* 99).

⁴²⁷ The new National Agreement on Closing the Gap (July 2020) includes an additional outcome area '*Aboriginal and Torres Strait Islander people maintain a distinctive cultural, spiritual, physical and economic relationship with their land and waters*' and two associated targets for land and water: a) *Target 15a*: By 2030, a 15 percent increase in Australia's landmass subject to Aboriginal and Torres Strait Islander people's legal rights or interests; b) *Target 15b*: By 2030, a 15 percent increase in areas covered by Aboriginal and Torres Strait Islander people's legal rights or interests in the sea. See further details at: <https://www.closingthegap.gov.au/sites/default/files/files/national-agreement-ctg.pdf>.

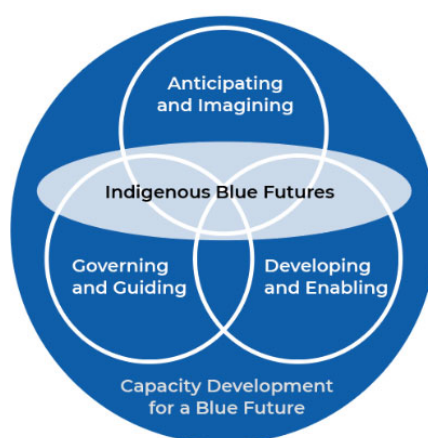
Box 1: Indigenous Blue Economy and Futures Project⁴²⁸

The Blue Futures program gained funding through the University of Wollongong 'Global Challenges' program in late 2019. After the bushfire disasters of 2019-20, the program focuses on how coastal and marine industries can contribute to the recovery of communities in the Illawarra and South Coast NSW.

The program consists of three intersecting research streams, as well as two cross cutting strategies (see image below) – one of which is the Indigenous Blue Futures strategy. This will trial a community-based model of sustainable development which places Indigenous knowledge at the heart of water planning processes.

It will look at what opportunities might exist for Indigenous communities in the blue economy, especially in fisheries and aquaculture, and explore new business models and ideas that support Indigenous communities.

The Illawarra Local Aboriginal Land Council is leading this strategy.



⁴²⁸ University of Wollongong (2020) *Blue Futures Program*, see: <https://www.uow.edu.au/global-challenges/sustaining-coastal-and-marine-zones/blue-futures/>

9.4 Recommendations

R 15	Amend the Plans to reflect all current native title claimants and Indigenous Land Use Agreement holders comprehensively and reflect this consistently across both Plans. Undertake detailed engagement with these Native Title groups to determine water allocations and access options.
R 16	Undertake subsequent work with Aboriginal stakeholders and Traditional Owners to further understand all water-related values (for surface and groundwater) and better protect them through Plan provisions.
R 17	Reserve unallocated water for Aboriginal specific licences or other Aboriginal water access options, before being offered to the market on commercial terms.
R 18*	<p>Finalise a NSW Aboriginal Water Strategy in 2021 to provide consistent, transparent guidelines and resourcing for Aboriginal water management across NSW, comprising the following at a minimum:</p> <ul style="list-style-type: none"> a) Improve recognition of native title by including a common provision to undertake preliminary amendments to a plan within six months of a native title determination or other agreement that includes water allocation. b) Allow additional time to undertake detailed engagement with Traditional Owners, make water allocations and final plan amendments; considering native title claims proactively as part of water sharing planning. c) Identify Aboriginal water values and uses, objectives and outcomes by undertaking extensive engagement with Aboriginal stakeholders in all plan areas; prioritising allocations to protect values; adopting cultural landscape-scale principles; integrating identified values into ongoing water planning and management. d) Co-design Aboriginal specific licences or other water access options with key Aboriginal stakeholders that meet identified needs for a range of cultural, environmental, social and economic uses.

10 Opportunities to improve MER

The NSW Government recognised the need for robust MER frameworks when water sharing plans were developed,⁴²⁹ consistent with requirements of the Act and the National Water Initiative.⁴³⁰ An MER framework is required to collect information to understand if plans are contributing to outcomes, inform timely decision making, improve plans and provide transparency.

However, limited MER activities have been undertaken to date for these Plans. The lack of MER is a significant and recurring issue across NSW that has been repeatedly highlighted by stakeholders, in previous Commission reviews, as well as by the National Water Commission and in 2019 Section 44 implementation audits, which found no procedure was available during the audit period for these Plans.⁴³¹ Every Sydney Drinking Water Catchment Audit since 1999 has also raised concerns about the inadequate availability and quality of data to assess catchment health indicators.⁴³² However, the most recent audit noted that *'it was encouraging to find that an increasing number of agencies are sharing datasets, which will support improved evaluation and decision-making'*.⁴³³

The Commission recognises the positive steps taken by DPIE-Water to address gaps in MER for coastal water sharing plans. DPIE-Water advised that it has recently developed a coastal MER scoping paper that identified the environmental MER needs of coastal plans and set out a roadmap for establishing an effective program to assess the ecological response to Plan provisions. This paper was superseded after DPIE-Water was successful in securing Treasury funding to support a new implementation unit, including delivery of priority water resource management, implementation and reporting activities in 2020/21. These strategic monitoring and implementation projects will be progressed to assist in the implementation of a fit-for-purpose MER program for both coastal and inland catchments.

In addition, DPIE-Water has also undertaken:

- initial irrigator surveys to monitor social and economic changes in water sharing plan areas (including the Greater Metropolitan area in 2009 and 2013)⁴³⁴
- *Guidelines for setting and evaluating plan objectives for water management (2018)*⁴³⁵

⁴²⁹ NSW Office of Water (2011) *Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation*. Available at:

http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/548153/macro_unreg_manual_web.pdf.

⁴³⁰ National Water Commission (2014) *The National Water Planning Report Card 2013 – page 65*. Available at: <https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/water/2013-national-water-planning-report-card.pdf>.

⁴³¹ National Water Commission (2014) *The National Water Planning Report Card 2013*, p. 11. Available at: <http://www.agriculture.gov.au/SiteCollectionDocuments/water/2013-national-water-planning-report-card.pdf>; DPIE-Water (2018) *Audits of water sharing plans under Section 44 of the Water Management Act 2000*. Available at: <https://www.industry.nsw.gov.au/water/plans-programs/water-sharing-plans/water-sharing-plan-audits>.

⁴³² Eco Logical Australia (2020) *Sydney Drinking Water Catchment Audit 2019 – Volume 2*, report prepared for WaterNSW. Available at: https://www.waternsw.com.au/__data/assets/pdf_file/0018/161370/12363-Catchment-Audit-Vol2-v5.pdf.

⁴³³ *Ibid.*

⁴³⁴ Department of Trade and Investment (2015) *Monitoring economic and social changes in NSW water sharing plan areas – Irrigators' surveys 2009/2010 and 2013 – A state wide comparison*. Available at: www.water.nsw.gov.au/__data/assets/pdf_file/0010/548362/irrigators_survey_report_2013.pdf.

⁴³⁵ These guidelines responded to the findings of earlier water sharing plan reviews that some objectives could not be fully evaluated as their links to Plan strategies and rules were not clear, and supporting documentation was not readily available. The guidelines provide a step-by-step process for setting and documenting

- work to improve objectives being undertaken as part of the water resource planning process in the Murray-Darling Basin, which will be expanded to improve the coastal unregulated water sharing plans in the future.

The Commission recognises that there are currently limited resources for MER activities and that DPIE Water is undertaking projects to support efficient and effective use of available resources, including water source prioritisation and transferability studies. Given limited resources, it will be critical for DPIE-Water to continue to identify efficiencies, focus on the most critical MER and continue to work collaboratively with other government agencies to coordinate monitoring activities that support the evaluation of Plan. MER and reporting systems that are publicly available should be prioritised to demonstrate accountability for this requirement under the Act.

Previous Commission reviews have discussed the state-wide limitations of water sharing plan MER in detail.⁴³⁶ These limitations make it difficult for anyone to understand the extent to which outcomes are being achieved and effectively review plans. They include:

- **No plan-specific MER framework** – the background documents for the Plans indicate that DPIE-Water was developing an MER framework for water sharing plans, which included performance indicator assessment, as well as 5-year implementation audits (under Section 44 of the Act) and the Commission’s 10-year review (this review). The MER framework was not implemented, and performance indicators were not assessed. There do not appear to be further plan-specific MER activities against the performance indicators or objectives, including on environmental water or the environmental condition of the plan area’s water sources. This should be developed and implemented for the replacement Plans.
- **No clearly defined outcome, objectives, strategies and performance indicators** – environmental, social and economic outcomes are not clearly specified or prioritised in line with the Act (as outlined in **Section 1.1**). As shown in **Appendix B**, objectives do not clearly link with the outcomes, strategies and indicators. Performance indicators are high-level, impractical to evaluate against and are not designed to be SMART. There are also significant gaps in these elements, such as around the water supply for 70 percent of NSW’s population in the Surface Water Plan. There are also gaps around sustainable and integrated management, connectivity and water quality, which have objectives but no strategies or performance indicators in the either the Surface Water or Groundwater Plan. Clearly defined outcomes and links between outcomes, objectives, strategies and performance indicators are the foundation of robust MER frameworks and should be included in the plan-specific MER framework. The replacement Plans should align with any performance indicators included in the new *Greater Sydney Water Strategy*.
- **Significant gaps in knowledge base** – the NSW Government has acknowledged that research is needed to improve understanding of the impact of freshwater extraction on estuarine and coastal ecosystems, and that adaptive management systems are required. The Surface Water Plan required several studies, most of which were not completed. Clause 39A required local government, WaterNSW and industry to complete environmental flow studies, most of which were not completed as local councils lack the

evaluable plan objectives, strategies and performance indicators and therefore present a key component of a comprehensive approach to MER (DoI (2018) *Guidelines for setting and evaluating plan objectives for water management*. Available at:

https://www.industry.nsw.gov.au/__data/assets/pdf_file/0005/172373/guidelines-for-setting-and-evaluating-plan-objectives.pdf).

⁴³⁶ For example, see reports at Natural Resources Commission (2020) *Water sharing plan reviews*. Available at: <https://www.nrc.nsw.gov.au/wsp-reviews>.

expertise or catchment-scale information required (see **Section 6.5**). Further, the relevant licence conditions were not drafted or notified to the utilities by DPIE-Water.⁴³⁷ Clauses 56(12),⁴³⁸ 78(b)⁴³⁹ and 82(13)⁴⁴⁰ allowed for amendments following socioeconomic studies. These amendments were not pursued, and socioeconomic studies have not been undertaken. DPIE-Water advised that this was because of limited resources.

In addition to required studies, there are key knowledge gaps around estuarine environmental flow requirements, connectivity, water dependent cultural values and hydrogeological variation across the plan area, with no clear processes to address these gaps. The replacement Plans should draw on available information from existing sources and identify any further studies required to improve the knowledge base. Identifying state-wide research needs and knowledge gaps across all water sharing plans may assist in streamlining this process, alongside collaborating with other organisations and research institutions.

- **Unclear roles and responsibilities** – as with water sharing plans across the state, there is no overarching program, or clearly documented procedures or responsibilities to guide MER activities and ensure enough data is collected to report on performance. MER is undertaken by many agencies (including DPIE-Water, DPIE-EES, WaterNSW, DPI-Fisheries, NRAR and councils), which can create confusion and barriers to knowledge sharing. Roles and responsibilities should be clarified and clearly documented as part of the plan-specific MER framework. The MER framework should include clear timeframes and requirements to report MER activities to ensure accountability.

WaterNSW's licences, including the *Sydney Catchment Authority Water Licences and Approvals Package*, require that 'the Approval Holder must monitor the effectiveness of environmental flow releases including monitoring water quality parameters for river health purposes to the satisfaction of the Minister'. No other utility licences in the Greater Metropolitan region have these requirements (although most are still in the process of establishing environmental releases). WaterNSW has not undertaken this monitoring and consider that, while it is able to monitor flows, evaluation should be designed and undertaken by a separate agency. The appropriateness of the monitoring requirements on WaterNSW's licences should be considered when defining roles and responsibilities and clearly outlined in the MER framework.

- **Limited implementation of available amendments** – consistent with the requirements of the Act and the National Water Initiative,⁴⁴¹ the need for adaptive management in

⁴³⁷ Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report prepared for DPIE. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf.

⁴³⁸ Clause 56(12) of the Surface Water Plan states that 'unless hydrologic modelling and analysis and a socioeconomic review conducted prior to Year 6 of this Plan demonstrate that access to very low tributary inflows between Warragamba Dam and the confluence of the Nepean River and the Grose River is not necessary for the ongoing viability of the irrigation industries in the Hawkesbury and Lower Nepean Rivers Water Source, the value of D in subclauses (7), (9) and (11) is 0'.

⁴³⁹ Clause 78(b) of the Surface Water Plan states that 'in developing new flow classes or access rules under paragraph (a) the Minister must: (ii) provide a report to [Department of Primary Industries, Office of Environment and Heritage, Local Land Services and representatives of interest groups and water users as determined by the Minister] detailing the following: ... (E) the socio-economic impacts of the proposed new flow classes or access rules...'

⁴⁴⁰ Clause 82(13) of the Surface Water Plan states that 'any amendment under subclause (12) [after Year 5 to provide rules for the protection of water-dependent Aboriginal cultural assets] will take into account the socio-economic impacts of the proposed change and the environmental water requirements of the water source'.

⁴⁴¹ Office of Water (2011) *Macro water sharing plans – the approach for unregulated rivers. A report to assist community consultation*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0008/548153/macro_unreg_manual_web.pdf.

response to new information was recognised when water sharing plans were developed. Regular assessment of plan performance and adaptive management activities are particularly important due to ongoing improvements in the Plans' knowledge base, changing water utility needs and predicted climate change, particularly increasing and intensified droughts. The Plans include provisions to make some amendments but do not have specific provisions for adaptive management. This should be addressed in the replacement Plans, including clarity on when amendments are required (such as a percentage reduction in wastewater discharges, or new evidence of impact of threatened species, streamflow or groundwater recharge) to allow the Plans to be improved over time and incorporate new information. To improve transparency, amendment requirements should be tracked with results made publicly available.

- **Risks from unmeasured extraction** – consistent metering and effective monitoring is important to facilitate compliance and trade, as well as to inform the MER framework. The Commission notes that the NSW Government has established a new metering framework for non-urban water meters in NSW, which commenced on 1 December 2018.⁴⁴² The replacement Plans should be consistent with this framework.

There is minimal groundwater metering across the plan area and surface water metering is largely limited to utilities and unregulated access licences in the Hawkesbury-Nepean. In developing the replacement Plans, residual risks associated with remaining unmetered users to implementing Plan provisions should be assessed, including compliance with LTAAELs, AWDs and cease to pump rules. The policy outlines that users not required to have meters will be subject to new mandatory conditions requiring them to keep certain records about their water take.⁴⁴³ In considering additional controls, it is important to balance the cost of implementation to government and existing users with the risk to the resource of over extraction.

Stakeholders also raised concerns around limited maintenance of meters installed in the lower Hawkesbury-Nepean as part of the Hawkesbury-Nepean River Recovery Project. NRAR conducted an audit in 2020 on meters in parts of the Hawkesbury-Nepean and made ongoing recommendations for users and WaterNSW. Landholders should refer to NRAR's guidance on the management of these meters.⁴⁴⁴

DPIE-Water advised that it is currently developing an overarching evaluation framework and monitoring plans for water sharing plans. Previous water sharing plan reviews have recommended finalising MER programs and it is evident that DPIE Water is taking steps to achieve this and build an evidence base for informing Plan reviews and replacement. As part of this process, DPIE Water should:

- identify Plan-specific outcomes linked to clear objectives, strategies and performance indicators – this should include outcomes related to environmental, social, economic and Aboriginal objectives
- clearly define roles, responsibilities and timing for MER activities and adaptive management
- identify feasible and appropriate resourcing to support MER

⁴⁴² NSW Government (2018) *NSW non-urban water metering policy*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0017/205442/NSW-non-urban-water-metering-policy.pdf.

⁴⁴³ *Ibid.*

⁴⁴⁴ NRAR (2020) *Water rake in horticulture in the Hawkesbury-Nepean basin – campaign report July 2020*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0006/315276/Water-take-in-horticulture-in-the-HawkesburyNepean-basin-report.pdf.

- specify timely reporting requirements of the results of MER activities to support transparency, public awareness and compliance, and adaptive management – this should include both government requirements (for example, annual reports to the Minister against Plan objectives and outcomes) and public reporting requirements (for example, an online water reporting platform and dashboard)
- provide clear principles, processes and governance for adaptive management
- ensure their MER is integrated with other existing MER programs where relevant and appropriate.

10.1 Recommendations

R 19	<p>By 1 July 2022, DPIE-Water should improve MER to increase transparency and support the achievement of Plan outcomes in line with the water management principles and priorities of the Act. This should include:</p> <ul style="list-style-type: none"> a) Completing relevant studies identified in the 2011 Plans b) Developing a publicly available research plan for the completion of further studies required to improve the knowledge base and for adaptive management – required studies should also be included in the Plans c) Developing Plan-specific, publicly available MER frameworks consistent with the coastal and state-wide guidelines. The framework should include linked and specific, measurable, achievable, relevant and time-bound (SMART) objectives, strategies and performance indicators, define roles and responsibilities, set timely public reporting requirements and include adaptive management processes.
SA D*	<p>Continue to develop state-wide evaluation framework and monitoring plan, considering and addressing key gaps and prioritising MER activities based on values and risk. The framework, monitoring plans and reporting should be publicly available to improve transparency.</p>
SA E*	<p>Adopt additional mechanisms to support metering and measure water extraction and movement across the plan area, such as remote sensing, to improve calculation of LTAAEL compliance and support adaptive management.</p>

11 Opportunities to improve Plan implementation

As part of this review, the Commission has identified several opportunities to improve the Plans' implementation and ensure provisions can operate effectively. The Commission recognises that implementation is assessed under the Section 44 implementation audits. However, the opportunities identified warrant noting as they are necessary to support the effective remake of the Plans, and achieve the Act's objects, apply the Act's principles, and achieve the Plans' objectives. These opportunities include:

- ensuring licence conditions clearly reflect plan provisions, can be readily complied with by licensees and are enforceable (**Section 11.1**)
- rebuilding community engagement, communication and education (**Section 11.2**)
- implementing clear, consistent and appropriate governance across multiple water agencies (**Section 11.3**)
- adopting an integrated catchment management approach (**Section 11.4**).

Many of these issues are consistent across water sharing plans and could be addressed using a state-wide approach. However, given the complexity of the Plans and the scale of reliance on water in the plan area, implementation in the Greater Metropolitan region should be given high priority.

11.1 Align licence conditions with plan provisions

To ensure licensees follow Plan rules, licences must clearly reflect Plan provisions. The Commission found examples where this had not occurred, impacting the effectiveness of those provisions. For example, an analysis of the *NSW Water Register* across a sample of management zones found inconsistencies in the way that flow class and total daily access rules (intended to protect environmental releases from major dams from extraction) were reflected on licences (see **Chapter 7** for discussion on daily access rules). This causes inequity between users, and reduces environmental, social and economic outcomes.

Specific conditions are also applied to licences that override the daily access rules in the Surface Water Plan. For example, some licences contain the following two conditions:

'Water must not be taken from the Menangle Weir Management Zone of the Hawkesbury and Lower Nepean Rivers Water Source when flows are in the Very Low Flow Class. This restriction will only apply when the system that confirms when water can be taken is available on the relevant licensor website'.

'The relevant licensor will inform the licence holder in writing of the applicable restrictions and how to access the information on its website when this system becomes operative. This restriction does not apply if water is to be taken from a runoff harvesting dam or an in-river dam pool'.⁴⁴⁵

These conditions are contradictory, as the management zone covered comprises the stretch of river behind a weir, which is considered an in-river dam pool. As such, the licence condition prevents the the implementation of the Plan's protection of the very low flow class (which

⁴⁴⁵ WaterNSW (2020) *NSW Water Register*. Available at: <https://waterregister.watarnsw.com.au/water-register-frame>.

includes environment and urban water supply releases) for the water management zones below the Hawkesbury-Nepean's major dams.

Further, as discussed in **Section 7.4**, other Surface and Groundwater Plan provisions required WaterNSW to develop and maintain a website to provide daily notifications to licensees of water availability. This website was not developed, and licensees were therefore not required to comply with the Plans' intended rules.

Licence conditions should be reviewed to be consistent with the Plans, and DPIE-Water should engage with WaterNSW to ensure provisions are practical, enforceable, and can readily be placed on access licences where relevant.

The Commission understands that DPIE-Water has recently established a function whose entire focus is enabling Plan implementation. Where Plan rules are found to be demonstrably impractical or unenforceable as licence conditions, this should be promptly addressed through adaptive management and amendment to the Plan. Divergence between Plan rules, licence conditions and lack of practical implementation, undermines the credibility of stakeholder engagement and the policy decision-making process in plan development.

11.2 Rebuild engagement, communication and education

DPIE-Water undertook significant stakeholder engagement before the Plans were implemented, which assisted in Plan development and built trust and understanding between stakeholders.⁴⁴⁶ However, stakeholder engagement has been minimal since the Plans commenced, resulting in many stakeholders not having a clear understanding of the Plans or the extent to which provisions and planned actions have been implemented.

Specific areas raised by stakeholders as having limited engagement were WaterNSW metering requirements and regulations around farm dams and harvestable rights (noting that management of this issue is outside the Surface Water Plan but that the Plan should reflect government policy in this area and account for volumes extracted):

'Irrigators, and many of our members were told it was an individual's responsibility to maintain and pay for the meters after 3 years of installation. This was poorly communicated to water users within the region. Many meters were never commissioned properly with reliability of the meters a major ongoing issue for our members'.⁴⁴⁷

The lack of stakeholder advisory panels or similar engagement mechanisms has also been raised in all the Commission's reviews of coastal water sharing plans and was seen to contribute to poor stakeholder relationships.

Regular and meaningful engagement with key stakeholders provides a foundation for communicating provisions, intended actions, adjustments and adaptive management throughout implementation.

⁴⁴⁶ NSW Office of Water (2011) *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background document*. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0005/548105/wsp_metro_groundwater_background.pdf.

⁴⁴⁷ Submission: Turf New South Wales, received 27 April 2020.

Targeted education activities should occur during development and over the life of the Plans to reaffirm water users' awareness of Plan provisions, as well as improve broader understanding of water sharing principles.

Further, while recognising that they are legal documents, the replacement Plans should be accessible and easily understood. Some stakeholders considered that the '*water sharing plan is a very complex document designed ... not for the general public to understand*'.⁴⁴⁸ Guidance documents, fact sheets and similar supporting materials must be accurate and can effectively communicate elements of the Plans.

The Commission acknowledges – as do many stakeholders – that DPIE-Water has limited resources to undertake a high level of active engagement, but the benefits of these approaches in achieving plan objectives should not be underestimated. This is particularly the case in the Greater Metropolitan region, which regulates the water supply, and environmental, social, cultural and economic outcomes for a significant proportion of NSW's population.

Strengthening the stakeholder engagement strategy developed as part of the water reform action plan would help target DPIE-Water's efforts to effectively use resources and maximise the benefits of stakeholder engagement. DPIE Water's renewed focus on Plan implementation will allow some rebuilding of the trust in the engagement and plan development process.

11.3 Implement clear, consistent and appropriate governance

This review has outlined several instances where provisions and supporting actions were not adequately or effectively implemented, partly due to unclear governance arrangements. These included:

- assessment of long-term average extractions against the LTAAEL
- discretionary environmental releases (see **Section 6.4**).
- requirements for local water utilities to investigate and establish environmental flow rules (see **Section 6.5**)
- protection of environmental flow releases from extraction
- MER, scientific investigations and adaptive management (see **Chapter 10**)
- the website required to notify water users of daily access rule status and other aspects of daily flow sharing and daily limits (see **Section 7.4**)
- policies around critical issues, such as *Reasonable Use Guidelines* for basic landholder rights.

It is important that planned actions are supported with clear governance – particularly well-defined and feasible roles, responsibilities and timeframes for actions. These are lacking in the current provisions. Section 44 implementation audits undertaken in 2019 support this finding and consistently recommend that roles and procedures are documented so that provisions are fully and consistently implemented and there is accountability.⁴⁴⁹

⁴⁴⁸ Submission: Individual, 28 April 2020.

⁴⁴⁹ Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. Report prepared for DPIE-Water. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0012/289479/Greater-Metropolitan-Region-Unregulated-River-Water-Sources-2011.pdf; Alluvium (2019) *Audit of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. Report prepared for DPIE-Water. Available at:

In addition, stakeholders considered that governance of water is confusing and that ‘multiple tiers of bureaucracy cause endless frustration for land owners and farmers’.⁴⁵⁰ While institutional arrangements can be difficult to control for, a well-defined and plan-specific MER framework can help to ensure that governance is clearly defined and that change is adequately accommodated through transferable responsibilities and risks (see **Chapter 10**). Transparent governance is important to help reduce uncertainty, and importantly, rebuild stakeholder trust in water governance in NSW. Given the updated governance and review arrangements between DPIE-Water, WaterNSW, NRAR and the Commission are still relatively new, it is important that the roles of each of these bodies is clearly stated and integrated in all revised water sharing plans and associated documentation.

11.4 Adopt an integrated catchment management approach

River flow is a key driver of river ecosystem integrity, but several other factors can influence these outcomes and the management of flow alone should not be relied on to maintain and restore river ecosystems. As such, while some environmental risks can be addressed through the Plans, factors outside of plan regulation impacting ecological condition must also be considered.

DPIE-Water should consider risks and actions to improve river and estuary health outside of the Plans during development and implementation and identify areas for collaboration or additional research or activity, including with relevant agencies across the Planning, Industry and Environment cluster.

This would have multiple benefits, including:

- Building and sustaining an effective evidence base for the Plans – this review identifies several instances where the Plans can better consider external policies, plans and risks, including the *Greater Sydney Water Strategy* (see **Section 3.2**), and data on regional climatic, social and economic trends
- Increasing overall resilience at the landscape scale, which is particularly important as climate change places additional pressures on environmental, social and economic outcomes. Key issues for water sharing that are more effectively addressed at the landscape scale include:
 - managing impacts from urbanisation and pollutant runoff (see **Section 4.4.4**)
 - improving aquatic habitat via refuge restoration, removal of barriers to fish passage and reinstatement of instream woody habitats⁴⁵¹
 - addressing water quality and coastal ecosystem impacts from bushfires – actions are being undertaken by the NSW Government as part of the Bushfire Affected Coastal Waterways Program provides \$5 million to minimise the effects of the bushfires through activities such as sediment and erosion control, water quality monitoring, wetland restoration or riparian corridor management.⁴⁵²

https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/289478/Greater-Metropolitan-Region-Groundwater-Sources-2011.pdf.

⁴⁵⁰ Submission: Individual, 28 April 2020.

⁴⁵¹ DPI-Fisheries (2019) *Improving fish habitats*. Available at: <https://www.dpi.nsw.gov.au/fishing/habitat/rehabilitating/habitats>.

⁴⁵² DPIE-EES (2019) *\$5 million for bushfire affected coastal waterways*. Available at: https://www.environment.nsw.gov.au/news/5-million-for-bushfire-affected-coastal-waterways?utm_source=miragenews&utm_medium=miragenews&utm_campaign=news.

These issues can be better accommodated in the replacement Plans by drawing on the wide range of available evidence during Plan development and applying adaptive management throughout implementation.

- Increasing opportunities for collaboration and leveraging off other investments. Agencies such as Local Land Services provide integrated approaches to regional natural resource management, among other roles in primary production, biosecurity, and emergency management.⁴⁵³ This will increase overall resilience at the landscape scale, which is particularly important as climate change places additional pressures on environmental, social and economic outcomes.

11.5 Suggested actions

SA F*	DPIE-Water should adopt state-wide processes that support the Plan remake and implementation by: <ul style="list-style-type: none"> a) enhancing communication of water sharing plans through active, simple, and consistent language and modes of communication b) improving implementation using clear and consistent governance, roles and responsibilities, and timelines.
SA G	By 1 July 2023, DPIE-Water should liaise with WaterNSW and the Natural Resource Access Regulator (NRAR) to ensure that Surface and Groundwater Plan provisions are practical, enforceable, and can readily be placed on access licences where relevant. Access licences should reflect Plan provisions.
SA H*	As part of the Plan replacement, DPIE-Water should develop well-evidenced and resourced processes for stakeholder engagement in the plan area. This should be part of a strengthened state-wide stakeholder engagement strategy.
SA I*	By 1 July 2023, DPIE-Water should adopt integrated catchment management approaches that support the Plans' replacement and implementation.

⁴⁵³ Local Land Services (2016) *State Strategic Plan 2016-2026*. Available at: <https://www.lls.nsw.gov.au>.

12 Compensation implications of recommendations

Under the Act, compensation may be payable by the State to access licence holders only in some circumstances where water allocations under a water sharing plan are reduced. Section 43A(3A) of the Act requires the Commission to consider some potential compensation requirements resulting from recommended changes to water sharing plans.

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.

There are many amendment clauses that would allow for most of the recommendations that may impact upon allocation. However, the Commission considers that compensation might be payable under Section 87AA in relation to **recommendations 3c, 3f, 6, 9a, 9b and 9c** as shown below:

- **Recommendation 3:** By 1 July 2023, DPIE-Water should ensure all extraction in the Greater Metropolitan region is managed to protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems by:
 - c) basing LTAAELs on sound evidence of ecosystem requirements, recharge, hydrogeological boundaries and connectivity
 - f) including an amendment provision allowing LTAAELs and AWDs to be adjusted should volumes managed external to the Plans change significantly.
- **Recommendation 6:** By 1 July 2023, DPIE-Water should review all exemptions and simplify daily access rules in the Surface Water Plan and connected Groundwater Plan water sources to minimise the timing and volume of exempt extraction.
- **Recommendation 9:** By 1 July 2023, DPIE-Water should:
 - b) include rules following DPIE-Water's consideration of how AWDs can be used to manage extraction during drought, including under predicted climate change
 - c) examine and simplify the combined role of the AWDs and carryover activities.

Recommendations 3c and 3f could result in a change to the LTAAELs, which may in some circumstances require compensation. The Commission notes that these recommendations are most likely to affect the LTAAELs for WaterNSW and/or utilities within the Surface Water Plan and these licence holders are not eligible for compensation. However, there are potential changes to the groundwater LTAAELs that may occur under this recommendation that could require compensation. The cause for a change in LTAAEL for groundwater may result due to a combination of an improved understanding of recharge and connectivity as well as a potential

reduction in predicted recharge due to climate change. DPIE-Water's assessment of LTAAELs should transparently identify the basis for any changes.

Recommendations 3f, 9b and 9c may result in changes to AWDs. Changing these AWD rules seeks to better manage available water, and in some cases would replace complex daily access rules which may be more onerous. The purpose of the recommendations is not to materially change allocation, but to improve timing and flexibility of water take to restore water to the environment, as well as other water users. Use of AWDs to manage water during drought (9b) and potential changes to carryover (9c) are recommended to better manage natural reductions in inflows during droughts and possible climate change scenarios. Therefore, the Commission considers these proposed changes to be consistent with Section 43A(3A)(a) of the Act.

Recommendation 6 relates to ensuring that the Surface Water plan is operating without exemptions as much as possible. The provisions providing for exemptions and the options to amend those provisions are extensive and vary between management zones. The Commission has not undertaken a comprehensive assessment of all the changes that may occur under this recommendation for each of the 88 management zones. However, the management zones with the larger volumes of extraction do have provisions to allow for amendments to the exemptions.

In developing the Surface Water Plan and assessing removal of exemptions, DPIE-Water should undertake a full assessment of exemptions and amendments provisions for each management zone to assess whether removal of specific exemptions could require compensation. The Commission considers that some current exemptions are inconsistent with the priorities under the Act as they allow extraction of environmental flows, basic landholder rights and critical water supply. Therefore, removal of these exemptions is necessary to bring the provisions in line with the Act. It should be noted that the Commission is not recommending removal of exemptions relating to animal welfare, which are standard in all plans.

In considering these requirements, the Commission has not made any determination in relation to entitlements to or amount of compensation and does not provide legal advice in this report. DPIE-Water should seek its own legal advice regarding any potential compensation implications of implementing the recommendations in this report.

Appendix A – Plan objectives, strategies and indicators

Table 9: Objectives, strategies and indicators in the Surface Water Plan

Plan objective	Plan strategy	Plan performance indicator
(1) The vision of this Plan is to provide for healthy and enhanced water sources and water dependent ecosystems and for equitable water sharing among users in these water sources.		
(2) This Plan was developed with the recognition that the sharing of waters in these water sources contributes to:		
(a) Aboriginal peoples pursuing their economic, social and cultural development, and maintaining and strengthening their spiritual and customary relationship to the water, and		
(b) the involvement of Aboriginal peoples in the conservation, protection and management of these water sources.		
(a) provide for the water supply for the people of Sydney, the Illawarra, the Shoalhaven, the Southern Highlands and the Blue Mountains, which comprise approximately 70% of the NSW population		
(b) contribute to the sustainable and integrated management of the water cycle across these water sources		
(c) protect, preserve, maintain and enhance the important river flow dependent and high priority groundwater dependent ecosystems of these water sources	(b) establish environmental water rules (f) establish rules that place limits on the availability of water for extraction	(a) change in low flow regime (b) change in moderate to high flow regime (c) change in surface water extraction relative to the long-term average annual extraction limits (e) change in the ecological condition of these water sources and their dependent ecosystems
(d) protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these water sources		(h) the change in the extent to which water has been made available in recognition of the Aboriginal, cultural and heritage values of these water sources
(e) protect basic landholder rights	(c) identify water requirements for basic landholder rights	(f) the change in the extent to which domestic and stock rights and native title rights requirements have been met
(f) manage these water sources to ensure equitable sharing between users	(d) identify water requirements for access licences	
(g) contribute to the sustainable development of those industries reliant on surface water		(g) the change in economic benefits derived from water extraction and use
(h) provide security and certainty for the life of the plan to stakeholders that utilise water resources	(e) establish rules for the granting and amending of access licences and approvals	

Plan objective	Plan strategy	Plan performance indicator
	(i) establish rules which specify the circumstances under which water may be taken	
(i) provide opportunities for enhanced market based trading of access licences and water allocations within environmental and system constraints	(j) establish access licence dealing rules	
(j) provide water allocation account management rules which allow sufficient flexibility to encourage responsible use of available water	(g) establish rules for making available water determinations (h) establish rules for the operation of water allocation accounts	
(k) contribute to the maintenance of water quality		(d) change in water quality in these water sources
(l) provide recognition of the connectivity between surface water and groundwater		
(m) adaptively manage these water sources	(a) establish performance indicators (k) identify triggers for and limits to changes to the rules in this Plan.	
(n) limit the physical transfer of water between water sources where those transfers might compromise the health of the water source and water dependent ecosystems in the water source from or to which water is transferred	(j) <i>establish access licence dealing rules (repeat)</i>	
(o) implement Government decisions on environmental flow regimes for the Upper Nepean and Upstream Warragamba Water Source, the Hawkesbury and Lower Nepean Rivers Water Source, the Southern Sydney Rivers Water Source and the Shoalhaven River Water Source		
(p) contribute to the environmental and other public benefit outcomes identified under the Water Access Entitlements and Planning Framework in the		

Plan objective	Plan strategy	Plan performance indicator
Intergovernmental Agreement on a National Water Initiative (2004). ⁴⁵⁴		

Table 10: Objectives, strategies and indicators in the Groundwater Plan

Plan objective	Plan strategy	Plan performance indicator
(1) The vision of this Plan is to provide for healthy and enhanced water sources and water dependent ecosystems and equitable water sharing among users in these groundwater sources.		
(2) The sharing of the waters in these groundwater sources contributes to:		
(a) Aboriginal people pursuing their economic, social and cultural development, and maintaining and strengthening their spiritual and customary relationship to water, and		
(b) the involvement of Aboriginal people in the conservation, protection and management of these groundwater sources.		
(a) protect, preserve, maintain and enhance the high priority groundwater dependent ecosystems and important river flow dependent ecosystems of these groundwater sources	(a) establish environmental water rules	(c) change in the ecological condition of representative groundwater dependent ecosystems, where groundwater extraction is recognised as the primary risk to their condition
(b) protect, preserve and maintain the integrity of aquifers in these groundwater sources	(e) establish rules that place limits on the availability of water for extraction	(a) change in groundwater extraction relative to the long-term average annual extraction limit (b) extent of groundwater level fluctuations
(c) protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these groundwater sources		(i) the extent of recognition of spiritual, social and customary values of water to Aboriginal people
(d) contribute to the sustainable and integrated management of the water cycle across these groundwater sources		
(e) protect basic landholder rights	(b) identify water requirements for basic landholder rights	(d) the extent to which basic landholder rights requirements have been met (g) the extent to which native title rights requirements have been met,

⁴⁵⁴ Under the National Water Initiative, water provided by NSW to meet agreed environmental and other public benefit outcomes as defined within relevant water plans is to:

- a) be given statutory recognition and have at least the same degree of security as water access entitlements for consumptive use and be fully accounted for,
- b) be defined as the water management arrangements required to meet the outcomes sought, including water provided on a rules basis or held as a water access entitlement, and
- c) if held as a water access entitlement, may be made available to be traded (where physically possible) on the temporary market, when not required to meet the environmental and other public benefit outcomes sought and provided such trading is not in conflict with these outcomes.

Plan objective	Plan strategy	Plan performance indicator
(f) manage these groundwater sources to ensure equitable sharing between users	(c) identify water requirements for access licences and requirements to satisfy urban water needs	
(g) provide opportunities for market based trading of access licences and water allocations within sustainability and system constraints	(i) establish access licence dealing rules	
(h) provide security and certainty for the life of the plan to stakeholders that utilise groundwater resources	(d) establish rules for granting of access licences and approval (h) establish rules which specify the circumstances under which water may be extracted	(h) the change in the economic benefits derived from groundwater extraction and use
(i) provide water allocation account management rules which allow sufficient flexibility to encourage responsible use of available water	(f) establish rules for making available water determinations (g) establish rules for the operation of water accounts	
(j) contribute to the maintenance of water quality		
(k) provide recognition of the connectivity between surface water and groundwater		
(l) adaptively manage these groundwater sources,	(j) establish performance indicators, and (k) identify triggers for and limits to changes to the rules in this Plan.	
(m) 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), and		
(n) where necessary, allow for the supplementation of the water supply for the people of Sydney, the Illawarra, the Shoalhaven, the Southern Highlands, and the Blue Mountains, which comprise approximately 70% of the NSW population.		(e) the change in local water utility access (f) the extent to which local water utility requirements have been met

Appendix B – Surface water sources and management zones

Plan area water sources and management zones

Shoalhaven River Extraction Management Unit	Shoalhaven River Water Source	Upper Shoalhaven River Management Zone Mid Shoalhaven River Management Zone (I) Reedy Creek Management Zone (I) Boro Creek Management Zone (I) Mongarlowe River Management Zone (I) Corang and Endrick Rivers Management Zone (I) Nerrimunga Creek Management Zone (I) Bungonia Creek Management Zone Shoalhaven River Gorge Management Zone (I) Barbers Creek Management Zone Fitzroy Falls Management Zone Yarrunga Creek Management Zone Lower Kangaroo River Management Zone (I) (E) Bundanoon Creek Management Zone Lower Shoalhaven River Management Zone Bomaderry Creek Management Zone Lower Shoalhaven River Catchment Management Zone Broughton Creek Management Zone (I) (E) Broughton Mill Creek Management Zone (E) Jaspers Brush Creek and Tributaries Management Zone Kangaroo River Management Zone (I) (E)
Illawarra Rivers Extraction Management Unit	Illawarra Rivers Water Source	Minnamurra River Management Zone (I) Minnamurra Coastal Management Zone (I) Lake Illawarra Management Zone (I) Macquarie Rivulet Management Zone (I) Wollongong Coastal Management Zone
Upper Nepean and Upstream Warragamba Extraction Management Unit	Upper Nepean and Upstream Warragamba Water Source	Mulwaree River Management Zone (I) Upper Wollondilly River Management Zone (I) Lower Wollondilly River Management Zone (I) Upper Wingecarribee River Management Zone (I) Lower Wingecarribee River Management Zone (I) Medway Rivulet Management Zone Nattai River Management Zone Little River Management Zone Lake Burragorang Management Zone Werriberri Creek Management Zone (E) Maldon Weir Management Zone ⁴⁵⁵

⁴⁵⁵ Includes the storage of Douglas Park Weir but not Pheasants Nest Weir

		Pheasants Nest Weir to Nepean Dam Management Zone ⁴⁵⁶
		Maguires Crossing Management Zone ⁴⁵⁷
		Stonequarry Creek Management Zone
		Lower Cataract River Management Zone ⁴⁵⁸
		Mid Cataract River Management Zone ⁴⁵⁹
		Avon River Management Zone ⁴⁶⁰
		Cordeaux River Management Zone ⁴⁶¹
		Upper Nepean River Tributaries Headwaters Management Zone ⁴⁶² (E)
		Wywandy Management Zone ⁴⁶³
		Dharabuladh Management Zone ⁴⁶⁴
		Jenolan River Management Zone
		Kowmung River Management Zone (I)
		Kedumba River Management Zone
Hawkesbury and Lower Nepean Rivers Extraction Management Unit	Hawkesbury and Lower Nepean Rivers Water Source	Menangle Weir Management Zone ⁴⁶⁵
		Camden Weir Management Zone ⁴⁶⁶
		Sharpes Weir Management Zone ⁴⁶⁷
		Cobbity Weir Management Zone ⁴⁶⁸
		Mount Hunter Rivulet Weir Management Zone ⁴⁶⁹
		Brownlow Hill Weir Management Zone ⁴⁷⁰
		Theresa Park Weir Management Zone ⁴⁷¹
		Wallacia Weir Management Zone ⁴⁷²
		Mid Nepean River Catchment Management Zone (I) (E)
		Warragamba River Management Zone
		Lower Nepean River Management Zone (I) (E)
		Erskine Creek and Glenbrook Creek Management Zone
		Grose River Management Zone (I)
		Capertee River Management Zone

⁴⁵⁶ Includes the storage of Pheasants Nest Weir but not Nepean Dam.

⁴⁵⁷ Includes the storage of Nepean Dam.

⁴⁵⁸ Does not include the storage of Broughtons Pass Weir.

⁴⁵⁹ Includes the storage of Broughtons Pass Weir but not Cataract Dam.

⁴⁶⁰ Does not include the storage of Avon Dam.

⁴⁶¹ Does not include the storage of Cordeaux Dam.

⁴⁶² Includes the storages of Cataract Dam, Cordeaux Dam and Avon Dam.

⁴⁶³ The Wywandy Management Zone includes the hydrological catchment of the Coxs River at and above the Lake Lyell exclusion zone 200 metres downstream of the wall of Lilyvale Dam.

⁴⁶⁴ The Dharabuladh Management Zone includes the hydrological catchment of the Coxs River between the Wywandy Management Zone and the confluence of Coxs River and Jenolan River.

⁴⁶⁵ Includes the storage of Menangle Weir but not Douglas Park Weir.

⁴⁶⁶ Includes the storages of Camden Weir, Thurns Weir and Bergins Weir but not Menangle Weir.

⁴⁶⁷ Includes the storage of Sharpes Weir but not Camden Weir.

⁴⁶⁸ Includes the storage of Cobbity Weir but not Sharpes Weir.

⁴⁶⁹ Includes the storage of Mount Hunter Rivulet Weir but not Cobbity Weir.

⁴⁷⁰ Includes the storage of Brownlow Hill Weir but not Mount Hunter Rivulet Weir.

⁴⁷¹ Includes the storage of Theresa Park Weir but not Brownlow Hill Weir.

⁴⁷² Includes the storage of Wallacia Weir but not Theresa Park Weir.

		<p>Colo River Management Zone (I)</p> <p>Upper Hawkesbury River (Grose River to South Creek) Management Zone (I) (E)</p> <p>Upper Hawkesbury River (South Creek to Cattai Creek) Management Zone (I) (E)</p> <p>Upper Hawkesbury River (Cattai Creek to Colo River) Management Zone (I) (E)</p> <p>Lower Hawkesbury River Management Zone (I) (E)</p> <p>Macdonald River Management Zone</p> <p>Upper South Creek Management Zone (E)</p> <p>Lower South Creek Management Zone (E)</p> <p>Cattai Creek Management Zone (E)</p> <p>Berowra Creek and Cowan Creek Management Zone (I)</p>
Southern Sydney Rivers Extraction Management Unit	Southern Sydney Rivers Water Source	<p>Upper Woronora River Management Zone</p> <p>Lower Woronora River Management Zone</p> <p>Hacking River Management Zone</p> <p>Lower Georges River and Bunbury Curran Creek Management Zone</p> <p>Cabramatta Creek Management Zone</p> <p>Prospect Creek Management Zone</p> <p>Georges River Catchment Management Zone</p> <p>Cooks River and Botany Bay Management Zone</p> <p>Southern Sydney Coastal Management Zone</p>
Northern Sydney Rivers Extraction Management Unit	Northern Sydney Rivers Water Source	<p>Upper Parramatta River Management Zone</p> <p>Lower Parramatta River Management Zone</p> <p>Lane Cove River Management Zone (I)</p> <p>Middle Harbour Management Zone (I)</p> <p>Northern Sydney Coastal Management Zone</p>

Note: (I) denotes high in-stream value; (E) denotes high level of economic significance⁴⁷³

⁴⁷³ DPI (2016) *Water Sharing Plan Greater Sydney Metropolitan Region Unregulated River Water Sources: Background document for amended plan 2016 incorporating the Kangaroo River Management Zone*. Available at: https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/166846/greater-metro-unmreg-background.pdf.