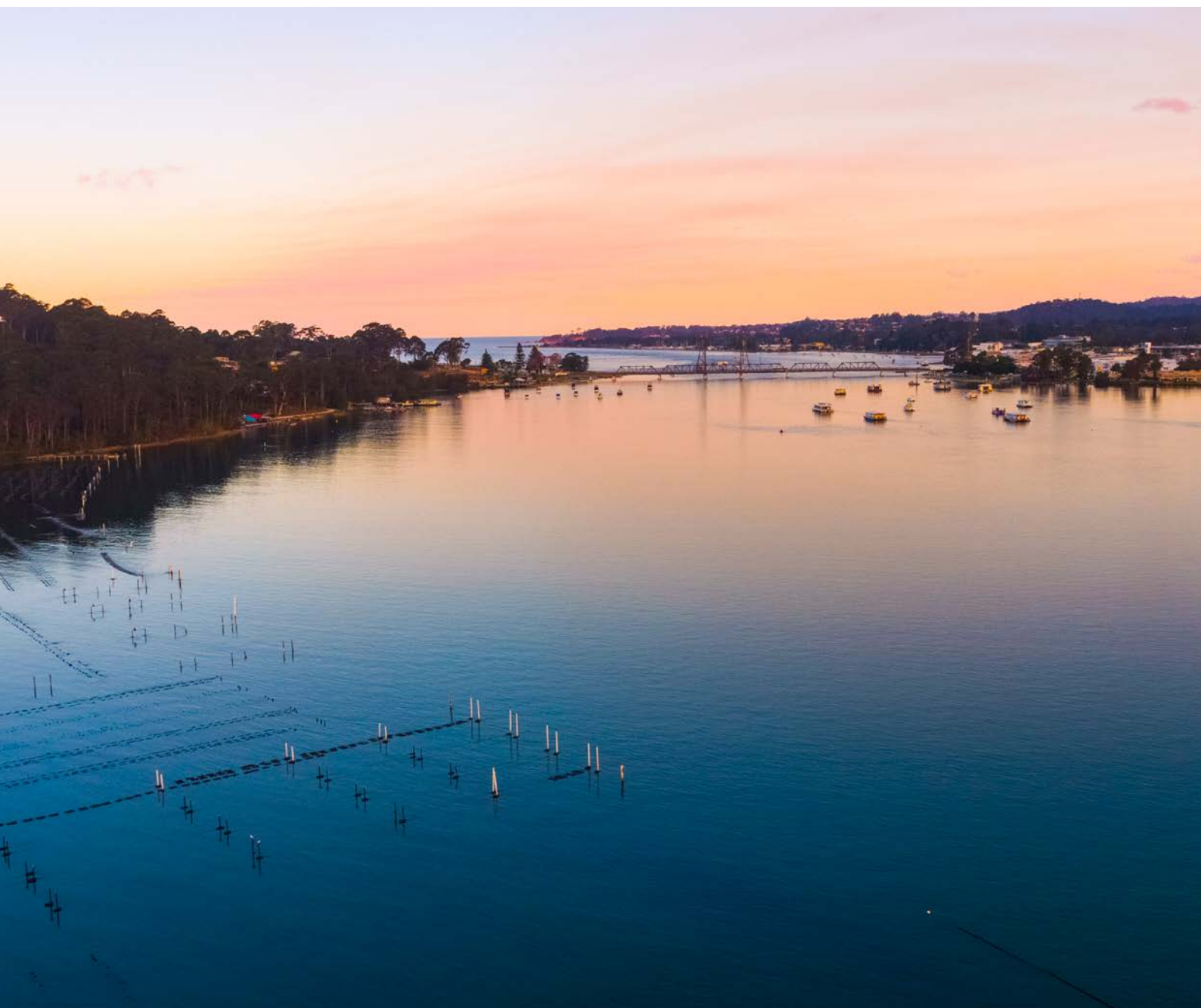


Draft Regional Water Strategy

South Coast:
Shortlisted Actions – Consultation Paper

May 2022



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Acknowledging Aboriginal people

The NSW Government acknowledges Aboriginal people as Australia's first people and the traditional owners and custodians of the country's lands and water. Aboriginal people have lived in NSW for over 60,000 years and have formed significant spiritual, cultural, and economic connections with its lands and waters. Today, they practise the oldest living cultures on earth.

The NSW Government acknowledges the Yuin people as having an intrinsic connection with the lands and waters of the South Coast Regional Water Strategy area. The landscape and its waters provide the Yuin people with essential links to their history and help them to maintain and practise their culture and lifestyle.

The NSW Government recognises that the Traditional Owners were the first managers of Country and that incorporating their culture and knowledge into management of water in the region is a significant step for closing the gap.



Artwork

Image courtesy of Nikita Ridgeway.
Aboriginal Brand Guidelines.



**The Hon. Kevin John Anderson, MP,
Minister for Lands and Water, and Minister
for Hospitality and Racing**

Minister's foreword

The NSW Government is committed to managing our state's water, improving water security and better preparing our communities for future droughts. Our towns, industries, and natural and cultural assets all rely on water, and the way we manage it deeply affects the lives and livelihoods of the people of NSW. Water is our most precious resource.

When it comes to managing water in NSW my view is healthy rivers, healthy farms and healthy communities. Not one or the other.

That is why we have invested in cutting-edge scientific modelling to bolster our knowledge and understanding of our waterways and enhance our policies and long-term planning, so we can manage water for the benefit of everyone.

The South Coast is home to 120,000 people and the thriving coastal towns of Vicentia, Milton-Ulladulla, Batemans Bay and Bega, which drive the region's \$6.1 billion average annual economy. The region is located within the traditional lands of the Yuin people.

Water drives local businesses, supports towns and ensures a healthy local environment, which on the South Coast includes the Clyde, Deua, Tuross, Murrah, Bega and Towamba rivers.

Our state is no stranger to extremes; we have always had to manage our water resources through prolonged floods and droughts. In the face of an increasingly variable climate future, we must prepare for even longer and more severe wet and dry periods.

We need to start the conversation now with the community on how to support and structure the future economic growth of the region. This strategy is the start of that conversation.

Working closely with the community, we are now making decisions around future investments that will set the region up for the future.

Engaging with our Aboriginal communities is vital, given water is an essential part of their connection to Country and culture. Ensuring that these communities have access to water and cultural water holdings will be crucial to creating local jobs into the future.

Local government has contributed greatly to the draft strategy, and I thank councils for their engagement and support. We will continue to partner with them to ensure the strategy addresses the needs of all communities across the South Coast.

This strategy, alongside 11 other regional and 2 metropolitan strategies across the state, has been developed using the best and latest scientific evidence to ensure we can understand and mitigate risk even in the most extreme climactic circumstances.

We engaged leading academics, including experts from the University of Newcastle, to undertake historical climate-informed rainfall and evaporation modelling. East coast lows are a key driver of the climate of the South Coast and work was done to better understand the impact of rainfall from these on the region. This climate modelling is based on a deliberately conservative scenario that is intended to ‘pressure test’ the effectiveness of the strategy in a worst-case scenario. These climate scenarios will not necessarily eventuate, but they give us an idea of the possible climate risks and allow us to begin planning to mitigate these risks should they arise.

The South Coast Regional Water Strategy will put forward the best mix of solutions to address these challenges and support environmental, social and economic outcomes. After widespread community consultation, we have shortlisted proposed actions to take a holistic approach to land and water management, ensure water resources are used sustainably and fairly, and prepare for a more variable climate.

To complement the regional water strategies, the NSW Government is delivering the Future Ready Regions Strategy, which aims to improve resilience and drought preparedness in regional NSW by drawing on lessons learnt from previous droughts.

In short, the evidence and information we now have means we can better plan for the future to ensure this precious shared resource is managed to sustain secure regional lifestyles, create jobs, support industry and protect our precious natural environment.

There is no ‘one size fits all’ policy to manage water in our regions. I encourage all members of the community and stakeholders on the South Coast to get involved contribute to the strategy. Water is for everyone, and we are ensuring our water management policies support the future of the South Coast and all of NSW.

We need healthy rivers, healthy farmers and healthy communities. The way we manage water deeply affects the livelihoods of people in NSW.

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Photography

Image courtesy of Destination NSW.
Cupitt's Winery, Ulladulla.

Snapshot: The South Coast region



Aboriginal people (the Yuin Nation) have lost access to land and water. Water is deeply entwined with Aboriginal cultural and Aboriginal people's connection to country.



120,000
population



Key towns include:

Vincentia, Milton-Ulladulla, Batemans Bay, Moruya, Narooma, Merimbula, Bega and Eden.



Councils include:

Shoalhaven City (southern portion), Eurobodalla and Bega Valley Shire.



Main rivers:

Clyde River, Deua River, Tuross River, Murrah River, Bega River, Towamba River.



Major water storages:

Brogo Dam (9 GL), which regulates the Brogo and lower Bega rivers.



The region **supports a vast range of native flora and fauna**, state and nationally significant estuarine wetlands and swamps, national parks and nature reserves.



Agriculture is the largest industry on the South Coast, with dairying being the major agricultural enterprise. Water entitlements for agriculture represent about 80% of available licensed water in the region.



Groundwater:

Groundwater is an important source of water for towns and industries. Main groundwater sources include: Lachlan Fold Belt Coast, Bega, Towamba and Tuross river alluviums, Araluen Creek alluvium, and South East Coastal Sands.

Figure 1. Map of the South Coast region



Purpose of this consultation paper

The NSW Government is developing 12 regional water strategies that bring together the best and latest climate evidence with a wide range of tools and solutions to plan and manage each region's water needs over the next 20 to 40 years.

Photography

Image courtesy of Destination NSW.
Kiah Wilderness Tours, Kiah.

The Draft South Coast Regional Water Strategy, including a long list of options, was released in October 2020.¹

Since public consultation on the Draft South Coast Regional Water Strategy, we have taken on-board what we heard, undertaken additional analyses to identify the key challenges in the region that need to be tackled first and have shortlisted the options into proposed actions that will help address these challenges. This consultation paper presents the outcomes of this work, summarised in Figure 2.

This consultation paper seeks your feedback on the challenges, priorities and proposed actions to help us finalise the South Coast Regional Water Strategy and implementation plan.

No decisions have been made on the shortlist of proposed actions. This consultation paper seeks your views on what the best actions are to set the

South Coast region up for the future before a final strategy and implementation plan are developed.

Additional background information can be found in:

- Draft South Coast Regional Water Strategy: What we heard
- Options assessment process: Overview²
- Economic base case report: South Coast.

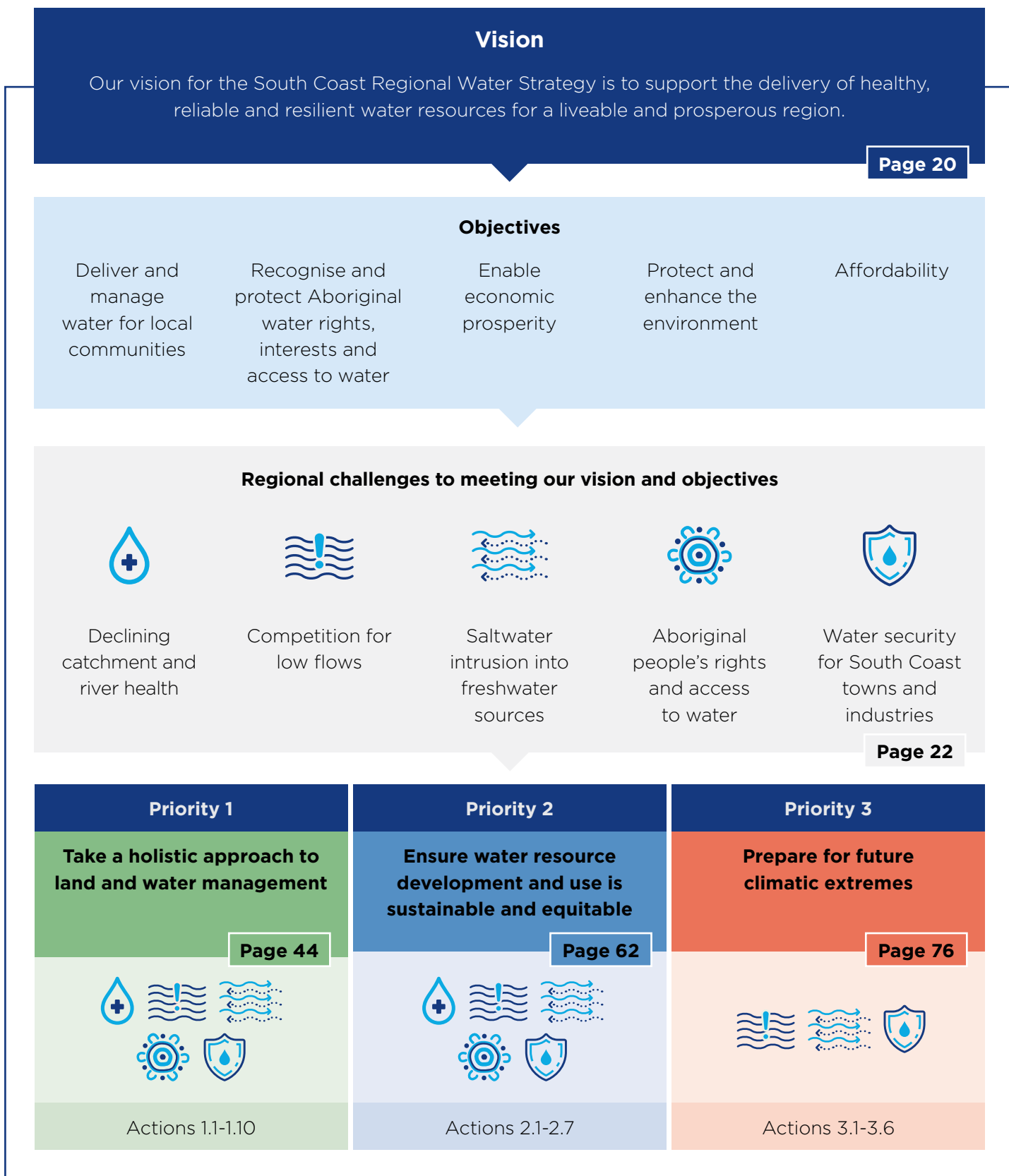
Other regional water challenges previously described in the Draft South Coast Regional Water Strategy are important and will be revisited during future ongoing reviews of the final strategy, planned to be every 3 to 4 years.

1. Full descriptions of the region, its water resources and water needs are provided in the draft strategy, which can be viewed and downloaded at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/upcoming-public-exhibition/south-coast-regional-water-strategy
2. water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/identifying-and-assessing



Photography
Image courtesy of Destination NSW.
Turoos Head, NSW.

Figure 2. Proposed water security challenges and priorities for the South Coast region





Photography

Image courtesy of Department of Planning and Environment.
Dairy cattle in pasture, Bega Valley.

Why we are developing regional water strategies

Across NSW, valuable and essential water resources are under pressure. A more variable climate, as well as changing industries and populations, mean we face difficult decisions and choices about how to balance the different demands for this vital resource and manage water efficiently and sustainably into the future.

The regional water strategy process is identifying these risks and understanding how we can manage and be best prepared for these future uncertainties and challenges, and capitalise on the region's opportunities.

The regional water strategies will include a wide range of tools and solutions to help us better use, share, store and deliver water to ride the highs and lows of water availability and change how we manage water into the future.

How do regional water strategies fit with other water strategies?

The NSW Water Strategy, together with the 12 regional water strategies, and 2 metropolitan water strategies that will underpin it, will form the strategic planning framework for water management in NSW. The NSW Water Strategy was developed in parallel with the draft regional water strategies. The NSW Water Strategy guides the strategic, state-level actions that we need

to take, while the regional water strategies will prioritise how those state-wide actions, as well as other region-specific solutions, should be staged and implemented in each region.

As part of delivering the NSW Water Strategy, the NSW Government will deliver other statewide strategies including:

- the Aboriginal Water Strategy – co-designed with Aboriginal people to identify a program of measures to deliver on First Nation's water rights and interests in water management
- the NSW Groundwater Strategy – to ensure sustainable groundwater management across NSW
- the Town Water Risk Reduction Program – in collaboration with local water utilities, this program identifies long-term solutions to challenges and risks to providing water supply and sewerage
- a new state-wide Water Efficiency Framework and Program – to reinvigorate water use efficiency programs in our cities, towns and regional centres.

The NSW Water Strategy and the South Coast Regional Water Strategy also complement other whole-of-government strategies, including the *20-Year Economic Vision for Regional NSW*, the *State Infrastructure Strategy*, the Draft South East and Tablelands Regional Plan 2041 and the Illawarra Shoalhaven Regional Plan 2041.

Figure 3. State and regional water strategies: priorities and objectives

NSW Water Strategy core objectives	NSW Water Strategy strategic priorities	Regional water strategy objectives	
Protecting public health and safety	Priority 1 Build community confidence and capacity through engagement, transparency and accountability	Aligned with all regional water strategy objectives.	Affordability – identify least cost policy and infrastructure options
Liveable and vibrant towns and cities	Priority 2 Recognise First Nations/ Aboriginal people's rights and values and increase access to and ownership of water for cultural and economic purposes	Recognise and protect Aboriginal water rights, interests and access to water – including Aboriginal heritage assets.	
Water sources, floodplains and ecosystems protected	Priority 3 Improve river, floodplain and aquifer ecosystem health, and system connectivity	Protect and enhance the environment – improve the health and integrity of environmental systems and assets, including by improving water quality.	
Cultural values respected and protected	Priority 4 Increase resilience to changes in water availability (variability and climate change)	Aligned with all regional water strategy objectives.	
Orderly fair and equitable sharing of water	Priority 5 Support economic growth and resilient industries within a capped system	Enable economic prosperity – improve water access reliability for regional industries.	
	Priority 6 Support resilient, prosperous and liveable cities and towns	Deliver and manage water for local communities – improve water security, water quality and flood management for regional towns and communities.	
Contribute to a strong economy	Priority 7 Enable a future focused, capable and innovative water sector	Aligned with all regional water strategy objectives.	

We want to hear from you

Developing an effective and lasting strategy requires input from communities, towns and industries across the South Coast region.

We are seeking your feedback on the prioritised regional water security challenges and proposed actions in this document, including the focus questions under each priority.

The feedback we receive from you will help us finalise the South Coast Regional Water Strategy and implementation plan.

The final strategy will identify a range of solutions – from policies, plans and regulation through to new technology and infrastructure changes – aimed at mitigating water-related impacts across the region and supporting thriving regional communities. The strategy will bring together these solutions in an integrated package that is:

- based on the best evidence
- designed to respond to the South Coast region's water needs
- directed towards creating new opportunities for the region
- focused on delivering the objectives of the regional water strategies and the NSW Water Strategy.

Assessing benefits and impacts of actions on Aboriginal people and communities

Aboriginal communities in South Coast region have told us that they need specific information on how the proposed actions will affect them.

We know that several of the proposed actions will have potential impacts on, or provide benefits to, Aboriginal people and Aboriginal communities. Currently, we do not have enough evidence about these potential impacts and benefits to provide a full assessment of the proposed actions. Our preliminary engagement with some Aboriginal communities in the South Coast region has identified that communities need specific information on how the proposed actions will affect them. Some of this information will not be available until we begin to do more detailed analyses of specific actions that remain in the final regional water strategy shortlist. Some of this additional analysis may be identified for early action in the strategy's implementation plan.

At this stage of the regional water strategies process, we are identifying and recording the types of questions that Aboriginal communities are likely to have about each of the proposed actions. We are also working out what information communities will need to make informed decisions about how specific actions will affect them.

Once we have undertaken the detailed analysis needed to progress proposed actions, we will share that information with Aboriginal communities and seek their feedback on how those actions may impact them. That evidence may help to refine a proposed action or identify risks in progressing with an action.

What we have heard so far



Photography

Image courtesy of Destination NSW.
Tuross River, Tuross Heads.

In 2020 we engaged with the general public and Aboriginal communities on the Draft South Coast Regional Water Strategy and the long list of options. The What We Heard report³ for the draft strategy summarises the key issues we heard during the first round of public exhibition and highlights how all feedback received during this period has informed the next steps in the development of the South Coast Regional Water Strategy.

There was general support for the regional water strategies program and the development of the South Coast Regional Water Strategy. Stakeholders asked the Department of Planning and Environment to progress the development

of the NSW Water Strategy to provide an overarching framework and objectives that would guide the 12 regional water strategies and the associated implementation plans. Since that time, the NSW Water Strategy has been released for public consultation and finalised.

The department also heard that the next phase of the South Coast Regional Water Strategy should be accompanied by an open, transparent and broad-scale consultation process to ensure all stakeholder voices are heard and a broad cross-section of the community is represented in the discussion. This consultation paper has been developed to deliver on this recommendation.

Figure 4. Stakeholder engagement



3. www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/what-we-heard/south-coast-regional-water-strategy

During consultation we also heard:

Aboriginal people's water rights, interests and access to water



- Healthy waterways and groundwater systems are essential to Aboriginal culture, community and connection to Country.
- There was broad support for improving the recognition of Aboriginal people's water rights, interests and access to water.
- Many stakeholders felt that local Aboriginal people had an important and valuable role to play in long-term water management.
- Water management (both fresh and salt water), land management and fire management must be considered together in a more holistic approach.

Water security



- Improved water reliability for agricultural industries was identified by some as being fundamental to support modern agricultural practices and encourage economic growth.
- There were concerns raised around impacts of climate change and rising sea levels on water security.
- There was support for ongoing and increased compliance monitoring to restore public confidence that water extraction is occurring equitably.
- There was support for reclaimed water use, but only if there is due consideration of environmental constraints and impacts.
- There were some concerns about the impacts of water infrastructure on both the environment and cultural and economic activities.

Environmental and ecosystem health



- Protecting and maintaining healthy rivers and ecosystems was important for many stakeholders.
- Improving water quality and increasing native vegetation cover to restore catchment hydrology was considered necessary to achieving better environmental outcomes.
- Increasing our understanding of water systems and the environment will benefit all water users.

Climate change



- There was general support for the strategy's long-term vision and its consideration of future climate risks.
- Some stakeholders raised concerns that planning for extreme events may skew water planning decisions.
- There was support for policy development and implementation that would assist the community during extended dry periods.



Photography

Image courtesy of Destination NSW.
Ben Boyd National Park, Green Cape.

Where should we focus first?

To achieve our vision for the South Coast region, we need to support the delivery of healthy, reliable and resilient water resources that will sustain a liveable and prosperous region.

Photography

Image courtesy of Lucas Boyd, Department of Planning and Environment.
Budawang National Park, NSW.

The South Coast region covers an area stretching from the Victorian border to the Clyde River catchment and Jervis Bay area. The major catchments of the South Coast region all begin in the uplands of the Great Dividing Range and flow through to the sea via a series of estuaries and intermittently closed and open lakes and lagoons. The area is located within the traditional lands of the Yuin Nation.

Like all regions across Australia, the South Coast region faces a more variable and changing climate.

We need to prepare now for the transition to a scenario where we do more with less water, make smarter decisions about our water use and management armed with better knowledge and information, and protect our most critical water needs.

We have identified 5 key challenges that are immediate priorities for the region. Addressing these will help us meet the vision and objectives we have set for the South Coast Regional Water Strategy.



Photography

Image courtesy of Destination NSW.
Wagonga Head, Narooma.



Declining catchment and river health

Poor catchment and riparian management, combined with changes in catchment and river hydrology, are affecting river health, hydrologic connectivity and raw water quality.

The decline in catchment and river health threatens aquatic and riparian ecosystems, as well as downstream estuarine health. This decline impacts Aboriginal peoples' connection to Country and cultural sites associated with waterways. Communities and towns have an increased need to treat poor quality water for consumption, and there are reduced opportunities for recreation. Industries – particularly those operating in estuaries, such as aquaculture – are directly impacted by poor water quality, while other sectors such as tourism are indirectly impacted through loss of amenity.

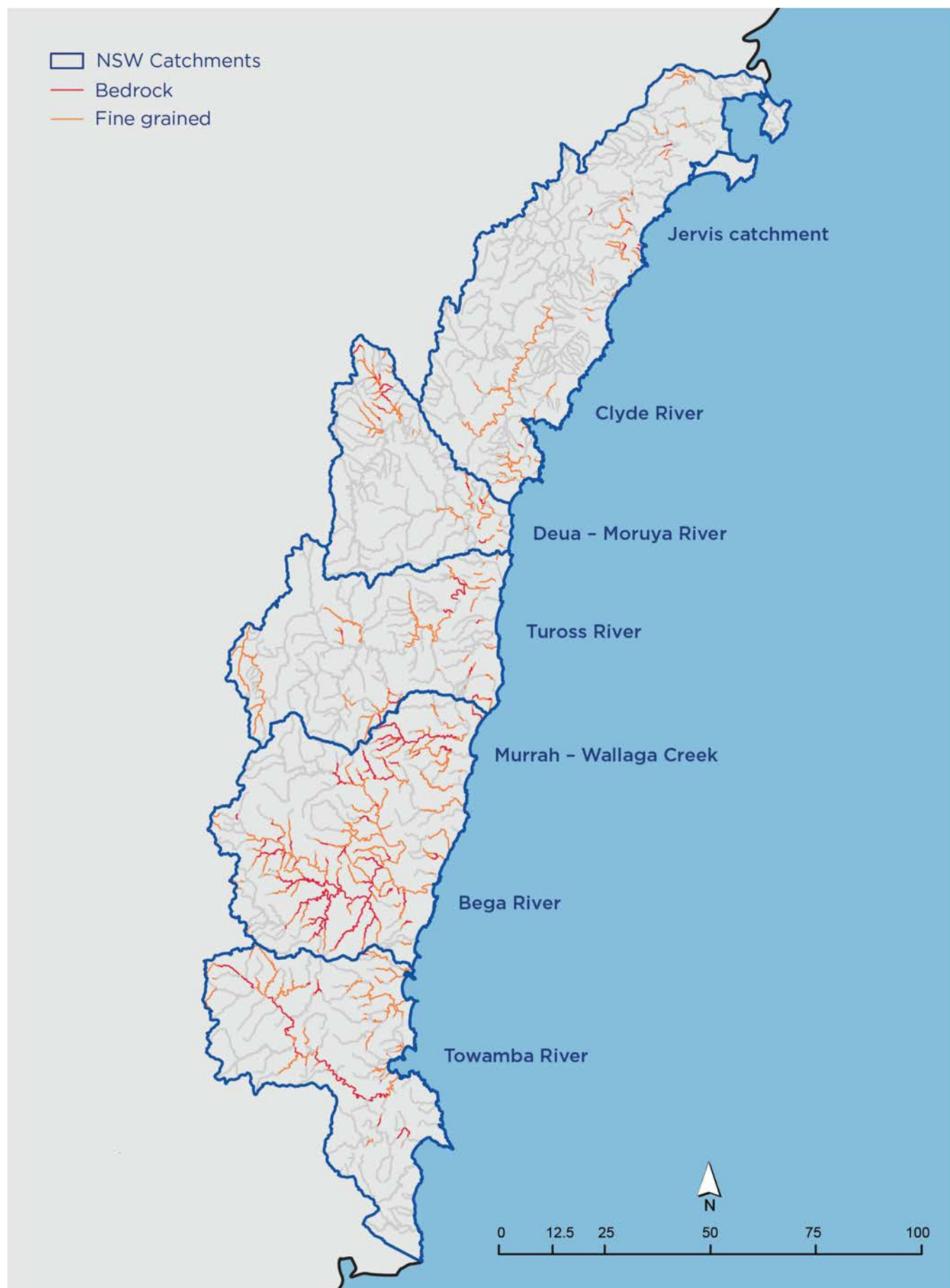
Land management practices are impacting riverine health

Land clearing, poor riparian management and uncontrolled stock access has led to riverbank and riverbed erosion, and the mobilisation of sediment, nutrients, pathogens and debris during rainfall events. These impacts are particularly acute during rainfall events following bushfire. Archival photos indicate that in the second half of the 19th century the Bega River immediately upstream of Bega widened from 40 m to 140 m

due to European settlement. River pools and the lower floodplains were then progressively smothered by 2 m of sand eroded from the upper catchment during subsequent floods.

Across the South Coast region, 4,377 km (70%) of river lengths are in good condition. River sections in moderate geomorphic condition account for approximately 22% of total river lengths. River sections in poor geomorphic condition account for approximately 8% of the total length of river across the region and are mainly located within reaches in the Bega River catchment south and west of Bega, Towamba River, Tuross River and Narira Creek between Cobargo and Wallaga Lake (Figure 5).

Figure 5. Distribution of poor and moderate condition river reaches across the South Coast region



Many of the region's rivers, creeks and estuaries are suffering from poor water quality, particularly due to increased sediment and nutrient loads.

The condition of riparian (streambank) vegetation is generally low across the region, except in protected or forested areas. This is due to weed infestations and vegetation clearing, which leads to large areas devoid of native vegetation or with poor vegetation diversity. It also leads to reduced structure – such as leaf area and canopy height – and small, isolated and poorly connected patches of native vegetation. Most estuarine areas are in poor condition and are dominated by riverbanks with little or no vegetation.

As a result of land clearing, water now moves more quickly and with more energy through the region's catchments than expected in its natural state. This fast-moving water further erodes land and waterways, as does stock access to the region's rivers and creeks. The sediment contributed by bank erosion and other sources increases water pollution and leads to less water stored in the landscape. Cattle can also be a direct source of pathogen (bacteria and virus) contamination.

The impacts of land clearing and development are heightened during the extreme rainfall events, which are characteristic of the South Coast region during east coast lows. Runoff generated during these events is typically high in nutrients and sediment, causing elevated nutrient loads and smothering vegetation, and subsequent deoxygenation and further release of nutrients. These impacts are particularly acute during rainfall events after bushfire and can lead to fish deaths.

Many of the region's local councils cannot treat water when turbidity is high. This restricts the availability of water for town water supply and becomes a critical issue when rainfall follows extended dry periods.

Feedback from the public consultation and engagement with Aboriginal communities on the Draft South Coast Regional Water Strategy noted significant concern about the continued impact of catchment land use on the quality of the region's highly valued waterways.

Current governance arrangements for catchment-scale decision-making, planning and project delivery are confusing, complicated and disconnected

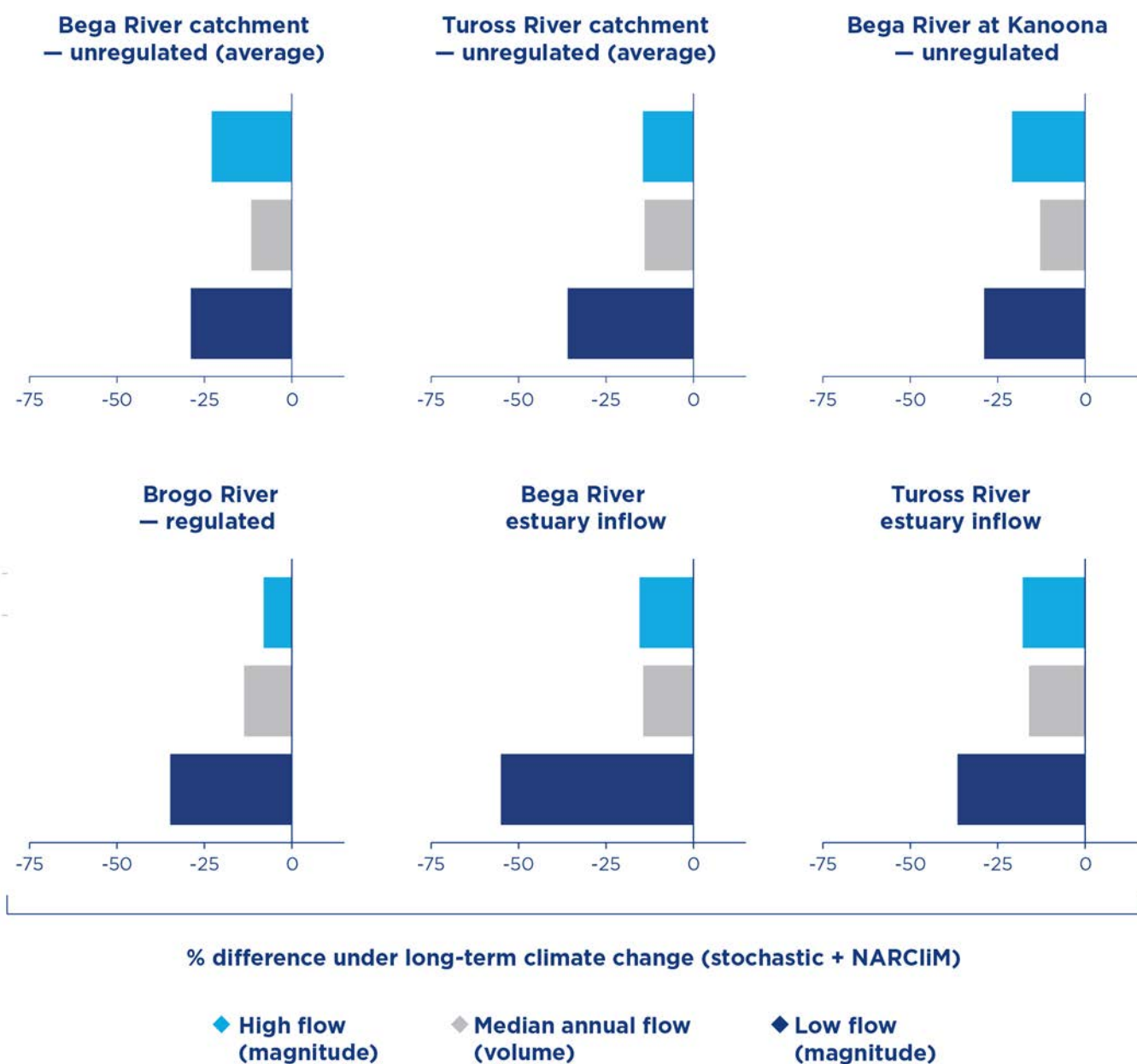
Responsibility for managing water quality impacts is shared across several state and local government agencies. We lack an overarching framework for managing water quality. This impedes planning, collaboration, coordination and reconciliation of state and local priorities. It also impacts the development and delivery of environmental catchment programs at different scales and makes it difficult to ensure that environmental water quality and quantity needs are met throughout the catchment. We have heard that a lack of social willingness amongst users and landholders, together with complicated natural resources regulation is reducing uptake of best practice.

Quality and quantity of freshwater inflows to coastal systems is affecting estuarine health

Our new climate data and hydrologic modelling show that the annual volume of flows in the Bega and Tuross catchments may decrease by up to 16%, and that all parts of the flow regime may be impacted (Figure 6). Additionally, high flow events may reduce in magnitude by up to 15% for the

Bega River estuary and up to 18% for the Tuross River estuary. Reductions in medium to high flow events would affect sediment and nutrient transport that stimulate riverine productivity, system flushing, and limit the number of events that trigger fish movement and spawning.

Figure 6. Projected impacts of climate change on the flow regime in the Bega and Tuross rivers



Freshwater inflows are critical to the health and function of the region's estuaries. These inflows help maintain low salinity levels and mobilise the nutrients, sediment and pathogens needed to support habitat diversity and productivity. Reductions in inflows may affect salinity gradients, circulation patterns, and fish movement. This would detrimentally impact estuarine ecology, particularly in the tidal pools at the upper limits of the estuaries.

Intermittently closed and open lakes and lagoons are particularly sensitive to modified freshwater flows, which can significantly impact water quality, geomorphology and entrance opening regimes. It can also impact the health and extent of mangroves, saltmarsh and seagrass, which are important fish habitats.

To help address these issues, the Marine Estate Management Strategy has flagged the extraction of freshwater flows as a priority threat.

The quality of freshwater inflows is also important to estuarine health and the communities and industries that they support. Oyster farming is a developing industry in the lakes and estuaries of the South Coast region and can be heavily impacted by poor quality freshwater inflows.

Structures that alter natural flow regimes are impacting aquatic health and fish movement

Although most South Coast rivers and streams are considered unregulated, there are still many instream structures to control and modify flows. These structures alter the natural flow of rivers and streams, and their floodplains and wetlands, and contribute to the loss of biodiversity and ecological function of waterways.

Instream structures such as dams, weirs, culverts, navigation locks and floodgates can be significant barriers to native fish migration. Instream structures can also adversely affect water quality in the South Coast region. Cold water pollution from dams and weirs can adversely impact aquatic organisms and ecological processes. Cold water pollution has been flagged as a possible issue at Brogo Dam.⁴

Species known to be directly affected by instream structures and their operation in the South Coast region include the endangered Australian grayling (*Prototroctes maraena*) and river blackfish (*Gadopsis marmoratus*). Other coastal fish species potentially impacted by barriers to fish passage include black bream (*Acanthopagrus butcheri*), diadromous species⁵ such as freshwater herring (*Potamalosa richmondia*) and short-finned eel (*Anguilla australis*), and high recreational value species such as Australian bass (*Macquaria novemaculeata*) and estuary perch (*Percalates colonorum*). Many other protected or unlisted species of invertebrates and mammals are also likely to be adversely impacted.

Aboriginal people raised concerns about the impacts of instream water infrastructure on connectivity and the movement of fish. We also heard that good connectivity contributes to the health of freshwater and saltwater ecosystems as well as cultural and economic fishing practices.

4. NSW Department of Primary Industries 2012, *NSW Cold Water Pollution Strategy – report on the implementation of stage one*, NSW Government, water.dpie.nsw.gov.au/__data/assets/pdf_file/0009/456912/NSW-Cold-water-pollution-strategy-stage-one.pdf

5. Diadromous fish migrate between fresh and salt water



Photography

Image courtesy of Destination NSW.
Tathra Oysters, Tathra.



Competition for low flows

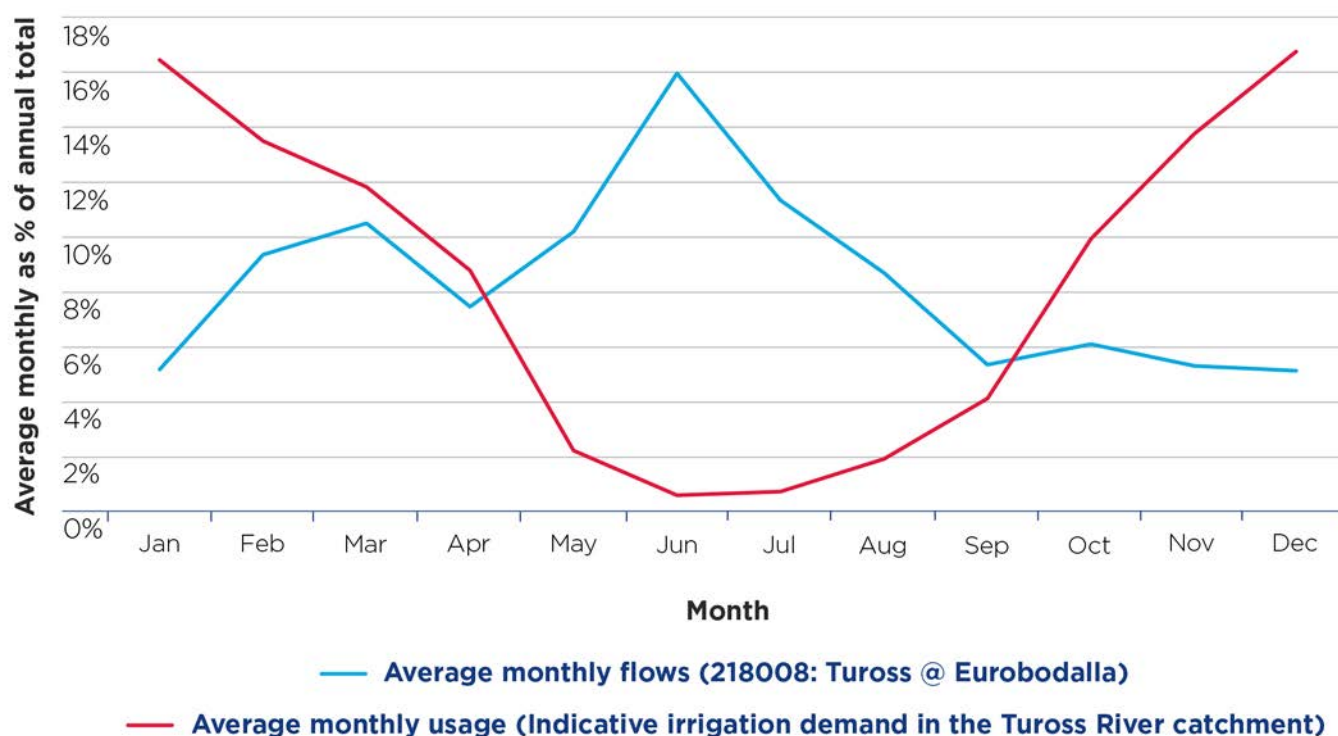
Competition for water during low-flow periods is restricting access for landholders and industries and placing many of the region's waterways under stress.

There is generally enough water across the South Coast region to meet urban and rural water demands each year on average. However, competition for low flows during the drier spring and summer months places many of the region's rivers and creeks under increased hydrologic stress.

River catchments along the South Coast are relative short and steep. Consequently, stream flows are flashy – that is, they peak dramatically

within hours of heavy rain, usually returning to low to medium flows within a few days. The periods of greatest agricultural water demand usually coincide with periods of lower stream flows (Figure 7). During periods of low flow, demand exceeds the volume of available water and water users – licensed water users, water utilities, stock and domestic users, aquaculture and the environment – compete for this limited resource.

Figure 7. Modelled water demand (irrigation) versus streamflows, Tuross River



Note: Indicative water demand derived from all modelled irrigated areas within the Tuross hydrological model.

Competition for low flows is likely to increase in the future with projected climate change. Our new modelling suggests extended droughts are not unique and it is plausible they could be more frequent and more severe in the future. Irrigators reliant on rainfall will become more dependent on surface water or groundwater sources.

Low flows are needed to maintain connectivity between river pools, to provide riffle flow and aeration, and to provide freshwater inputs to sensitive estuaries and intermittently closed and open lakes and lagoons. These river functions are critical in supporting river and ecosystem health, and water-dependent industries such as commercial fishing and the region's oyster industry.

Competition for low flows also impacts groundwater systems. Many of the region's alluvial and coastal sand groundwater systems are highly connected to surface water flows and reductions in surface flows can affect recharge rates. This impacts both the health of groundwater dependent ecosystems and consumptive users of groundwater, including the Bega-Tathra town water supply system.

Competition for water also adversely impacts the reliability of water accessed for irrigated agriculture, of which dairying is the largest industry in the South Coast region. Irrigated agriculture in the region is mostly dependent on unregulated water sources. Unreliable water supplies can seriously threaten the long-term viability of dairying especially if enterprises have to reduce stock numbers due to insufficient feed or water. Re-establishing pastures and re-stocking is expensive, and it can take several years to re-build enterprises. Water insecurity also discourages future investment in emerging industries.

Setting effective rules to manage competition for low flows is constrained by catchment conditions and limited data

Protecting low flows – to reduce the stress on the region's rivers and to protect water for downstream users – relies on cease-to-pump rules, based on either gauged flow rates or visible flow conditions, and daily extraction limits.

A lack of stream gauging has made it difficult to effectively implement cease-to-pump rules. Sand-dominated coastal streams are not suited to conventional stream gauges and identifying reliable long-term gauging sites is difficult. Gauging stations are also expensive to install and maintain, and many new gauges would be required to cover all streams where extraction occurs. Consequently, increasing the coastal gauging network would come at a considerable cost to water users, which may be difficult to justify given the low level of extraction compared to inland regions.

In many of the small unregulated coastal catchments in the region, visible flow rules were adopted primarily as a result of these challenges. However, visible flows have been criticised for being subjective and so low that they do not provide sufficient protection for environmental assets.

Daily extraction limits are another tool for addressing competition for water. They permit water users to take a proportion of the daily flow at a particular site, leaving enough water for the environment and downstream users. However, implementing daily extraction limits takes considerable resources, including stream flow gauges, water meters and coordinated rostering among users.

Very few pumps are metered, making it difficult to understand the extent of the problem and to properly manage water sharing among users

Protecting low flows requires water users to comply with the rules. However, very few pumps for surface water or groundwater are metered. This makes it difficult to ensure water is extracted legally and shared equitably during low-flow periods. In some parts of the region, water sharing arrangements are informally managed through community-operated water user associations. For example, there have been previous attempts to implement additional water monitoring on the Bemboka River. However, precise management is difficult without meters or adequate stream gauging.

Growth in harvestable rights dams and water extraction under basic landholder rights may place additional pressure on low flows

The protection of low flows can be compromised by water take that does not require licensing and approvals, particularly where there is significant take-up of harvestable rights and basic landholder rights within a catchment.

Harvestable rights allow landholders to intercept a percentage of average regional rainfall runoff from their property and store it in one or more farm dams, without a water access licence, water supply work approval or water use approval. Many landholders in coastal areas have sought the right to take and store more water during wet periods to improve their preparedness for dry periods.

However, a range of stakeholders are also concerned about the impact this may have on freshes and low flows in downstream rivers and creeks. Harvestable rights dams do not require a licence, so we have a limited understanding of their current level of water take, and their impacts on the environment and licensed water users. Additionally, many harvestable rights dams in the region have been found to be significantly larger than the permissible size. This could impact baseflows to downstream waterways. Changes to harvestable rights in coastal-draining catchments announced in October 2021 will allow an increase in the proportion of average regional rainfall runoff that may be harvested from 10% to 30%, subject to limitations and mitigation measures intended to ameliorate low flow impacts. Further detailed catchment analysis in 2022 will confirm the suitability of these changes to harvestable rights.

Anecdotally, growth in water extraction for domestic and stock purposes under basic landholder rights – particularly resulting from the sub-division of rural residential land with waterway frontage – is also increasing competition for water at low flows. Water extraction for basic landholder rights is not regulated. There is no limit on the volume of water that may be taken nor guidelines about how the right can be used, although basic landholder rights cannot be traded. Consequently, increases in these rights could compromise the effectiveness of any cease-to-pump conditions aimed at protecting the environment and downstream users. The NSW Government has committed to review and consult with communities across the state about how domestic and stock basic landholder rights are regulated in the NSW Water Strategy. This will include estimating the quantity of water extracted under these rights.



Saltwater intrusion into freshwater sources

Sea level rise, groundwater extraction and changes in catchment hydrology are projected to significantly impact coastal waterways and aquifers. We need to better understand the magnitude of this threat and how best to manage it.

Global sea levels are rising, mostly from increasing greenhouse gas concentrations in the atmosphere and associated glacial and ice sheet melt.⁶ Rising sea levels will result in saline water migrating upstream and saltwater intrusion in many of the region's groundwater and low-lying water sources. Increased water salinity may negatively impact:

- coastal wetlands, freshwater and estuarine habitats such as mangroves that are critical for fauna breeding and recruitment
- town water security and water users who currently access and rely on freshwater close to, or within, current tidal limits
- Aboriginal communities' abilities to practice culture and protect important cultural sites and assets.

The magnitude of sea level rise and its impacts will vary by location due to geological factors, ocean currents and localised thermal expansion or contraction of oceans. The extent to which it rises will also depend on how much greenhouse gas emissions are reduced in the coming years.

The average projection for sea level rise along coastal NSW is between 0.30 m and 0.45 m.⁷ For the South Coast region, the average projection is between 0.24 m and 0.59 m by 2070 (Table 1).

Larger sea level rises are possible beyond these scenarios. The Intergovernmental Panel on Climate Change states that sea level rise will continue for centuries to millennia due to continuing deep ocean warming and ice sheet melt, and the likely global mean sea level rise by 2100 is up to nearly 2 m (for a very high greenhouse gas emission scenario). Storm surges may also contribute to higher sea levels during the more frequent and intense low-pressure systems caused by climate change.

The frequency and severity of impacts from sea level rise, saltwater intrusion and altered catchment hydrology are likely to worsen as growing populations and industries increase the demand for freshwater in coastal areas.

Table 1. Sea level rise projections for the South Coast region

Year	Low emissions scenario (RCP4.5) [m]	Very high emissions scenario (RCP8.5) [m]
2030	0.14 (0.09-0.18)	0.14 (0.10-0.19)
2050	0.24 (0.16-0.32)	0.27 (0.19-0.36)
2070	0.36 (0.24-0.48)	0.45 (0.32-0.59)

Table notes: Values are averaged, with the likely range provided in brackets.

Projections are relative to an average calculated between 1986 and 2005.

RCP = representative concentration pathway

6. Oppenheimer et al. 2019, *Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities*. In Pörtner et al. (Eds.), *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*, Intergovernmental Panel on Climate Change.

7. CoastAdapt 2017, *Sea-level rise and future climate information for coastal councils*, accessed 14 July 2020 from www.coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils

Possible reductions in river flows are likely to amplify the impacts from sea level rise

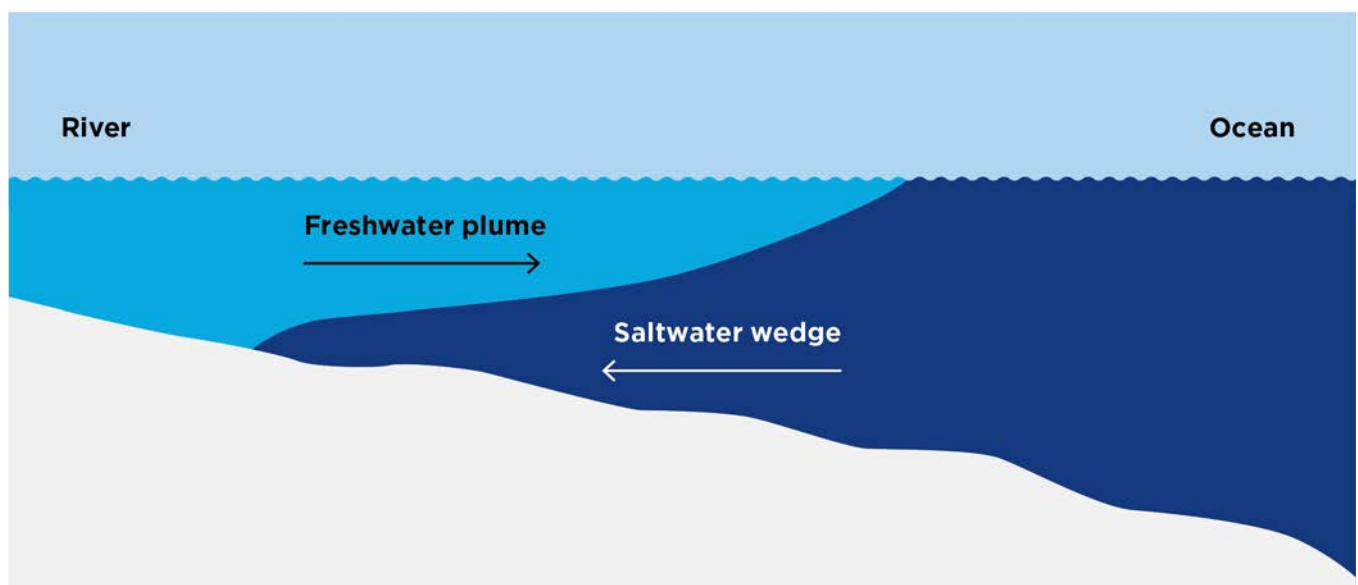
The high tide footprints of the South Coast's major rivers range between 5 km (Murrumbidgee River) and 35 km (Clyde River), with sea level rise likely to cause estuarine zones to migrate upstream. Other climate change impacts on coastal estuaries are expected, mainly due to the reduction in the magnitude of freshwater inflows and increased frequency of cease-to-flow events.

During low-flow and cease-to-flow events, salinity gradients in tidal pools change as freshwater entering estuaries is either reduced

or stops (as illustrated in Figure 8). This change allows the salt wedge that sits that usually below the freshwater in tidal pools to move further upstream.

Our modelling shows that the magnitude of low flows in the Bega River catchment may decrease in magnitude by 35% under a worst-case climate change scenario. Under the same scenario, the frequency of cease-to-flow events are projected to increase from 6% to 14% in the Brogo regulated river system, from 23% to 31% in the unregulated rivers in the Bega River catchment and from 18% to 25% in the unregulated rivers in the Tuross River catchment.

Figure 8. Concept of a tidal saltwater wedge in a permanently open estuary⁸



Note: Salt fronts form when freshwater moving downstream meets tidal water moving inland

8. Adapted from e360.yale.edu/features/as-sea-levels-rise-will-drinking-water-supplies-be-at-risk

Saltwater intrusion in freshwater and estuarine systems – and the associated increase in salinity levels in freshwater systems – is a significant future risk to water users in low-lying areas across the region. Even a small rise in sea level may reduce the suitability of water sources for irrigation, dairy-washdown, stock and domestic supplies. Historically, sand barrages have been used on the Tuross and Bega rivers to limit the impact of saltwater intrusion on freshwater sources.

Saltwater intrusion may also compromise water and wastewater treatment plants and infrastructure through corrosion and inundation of assets. Bega Valley Shire Council has identified low lying water and sewer infrastructure as a key vulnerability in its *Climate Resilience Strategy 2050*. Eurobodalla Shire Council is currently developing a Climate Resilience Plan with a draft expected to be considered by Council in early 2022, following local government elections. Councils are responsible for developing and maintaining asset management plans, including planning for water and sewer assets at risk from gradual sea level rise.

Sea level rise is likely to cause impacts on coastal environments such as low-lying coastal wetlands which could become inundated for longer, or at the most extreme, inundated permanently. The Marine Estate Management Strategy recognises this as a key threat to the NSW coastal, estuarine and marine environment and has identified several actions that prepare the region to manage this risk. These actions include on-ground activities that provide habitat protection and rehabilitation to help mitigate the impacts of climate change.

They also include tools that will help the industry and community better understand future impacts.

Plans and strategies for water resources in the region need more up-to-date information on climate change to better manage the future impacts of sea level rise.

Forming a clearer regional picture of the combined impacts from changes in catchment hydrology and sea level rise is critical to developing appropriate local management responses.

Sea level rise is likely to increase the risk of saltwater intrusion of the region's groundwater, particularly for low-lying areas with high volumes of extraction

Saltwater intrusion into groundwater is caused by sea level rise and over-extraction of groundwater and freshwater, particularly where groundwater and surface water systems are highly connected. The intrusion of saltwater into groundwater affects ecosystems and town water security by significantly degrading water quality and reducing freshwater availability over the medium-to-long term.

Groundwater sources in the South Coast region that are vulnerable to saltwater intrusion include coastal sands, floodplain alluvials and some upriver alluvials. Groundwater from these resources is important to town water supplies and for stock and domestic use across the region.

The impacts of saltwater intrusion are currently managed by ensuring coastal aquifers are not over-extracted by limiting licensed extraction and managing water levels in areas of high extraction.



Aboriginal people's rights and access to water

Historical dispossession of land, effects of colonisation and government water management processes continue to impact Aboriginal people's access to water and their ability to care for Country.

Yuin people have been the custodians of the lands and waterways in the South Coast region for tens of thousands of years. Water is deeply entwined with Aboriginal culture. Healthy waterways are essential to the culture and wellbeing of Aboriginal communities across the South Coast region, providing food, kinship, connection, recreation, stories, songlines and healing.

Aboriginal people have lost access to waterways

The historical dispossession of land and the effect of colonial era settler laws continue to impact Yuin people's access to water and ability to care for Country. Private land, fences and locked gates – often on Crown land – prevent Aboriginal people from accessing Country, carrying out cultural practices and using traditional knowledge to care for and manage land and waterways. Water infrastructure, modifications made to waterways and poor land management and land use practices impact important cultural sites and traditional water and food sources. Access to Country and waterways and the important sites they hold is critical to providing a purpose and pathway for young people to connect to culture. It also provides spaces for healing, as well as for food, medicine and teaching.

Yuin people want a 'seat at the table' when it comes to decision-making

Current water legislation and water management processes do not adequately bring Yuin people into decision-making, nor do they fully reflect Aboriginal perspectives, approaches and values. These processes also do not draw on the knowledge that Yuin people have of their traditional lands, water bodies and the flora and fauna that inhabit them. This is made worse by the limited involvement of Yuin people in water consultation processes. Most often this lack of involvement has been because:

- There is a lack of trust in governments. Historically, governments have not engaged thoroughly in water and natural resource management in the region, nor have they followed through on previous commitments.
- Consultation timeframes and processes around water policy changes do not allow the time needed for Aboriginal cultural governance processes.
- State and federal laws and systems around water and natural resource management are complex. They do not match well with Aboriginal perspectives and are often not clearly explained.
- Aboriginal groups lack resources and support to drive their engagement in water management. Often, Aboriginal people need to give up personal time and resources to have a say in water consultation processes.

Yuin people want a 'seat at the table' when it comes to decision-making, both at the state and local levels. Government needs to develop a collaborative, culturally sensitive approach that is appropriate for Aboriginal communities. This means working with Aboriginal communities to develop governance structures that are familiar to them, and setting aside adequate time to engage, consult and genuinely listen to Aboriginal people. These investments in time and resources will help build respect and trust between all parties. They will also help identify the different needs, challenges and interests of each Aboriginal community.

This model can benefit both Aboriginal communities and government by:

- offering Yuin people the opportunity to improve outcomes for Country and for their communities
- improving natural resources management with a rich and holistic approach to water and land management that Yuin people have been practicing for thousands of years.

The actions that have been proposed in the South Coast Regional Water Strategy target both state-level and local-level solutions through:

- ongoing arrangements for collaboration with local Aboriginal people in local water management
- place-based initiatives to deliver cultural outcomes for local Aboriginal people
- support Aboriginal business opportunities
- removing barriers through a statewide Aboriginal Water Strategy.



Photography

Image courtesy of Destination NSW.
Glasshouse Rocks, Narooma.



Water security for South Coast towns and industries

The viability and growth of regional industries is constrained by the uncertainty of future access to water supplies. Town water supplies are generally secure but could become less reliable under climate change scenarios.

Water-dependent industries such as agriculture, aquaculture, forestry and food product manufacturing, are facing an uncertain future in the region due to climate variability and climate change. New modelling shows that the reliability of existing water access licences is likely to be less than we originally thought and may reduce in the future. Saltwater intrusion also threatens existing supplies of high-quality surface water in low lying areas close to the coast and coastal groundwater systems.

We have also heard that gaining access to additional water to mitigate these risks or support new or expanding industries is a challenge for existing and prospective South Coast region businesses.

There is limited stored water or alternative sources of water to meet irrigation demands, particularly during drought

Historically, the need to store large volumes of water for irrigation across the South Coast region has been largely unnecessary. Traditional crops were rain-fed and only required irrigation during the drier months. For most landholders, the costs of constructing, maintaining and operating farm dams and the additional pumping infrastructure were not economically viable.

The 2018 to 2020 drought highlighted a need to shift from a reactive to a proactive management approach to weather extremes. The 2020 bushfires in the South Coast impacted farm infrastructure such as tanks and troughs, further reducing local water supplies. Water quality, as discussed in Challenge 1, was also severely impacted, especially following rain.

Our modelling shows that dry periods are likely to increase in frequency and intensity and therefore traditional surface water sources may be less reliable than we thought. Currently, there are few alternative water sources available in the region that are readily accessible and able to mitigate the water security risks of drought.

Brogo Dam and Cochrane Dam provide central storage for water users with access to the main stems of the Brogo, Bemboka and Bega rivers. However, outside of these corridors there is limited stored water available.

The resource potential of the region's hard rock aquifers is not well known. Further, the location of the region's sewage treatment plants generally do not lend themselves to developing large scale recycled water schemes for irrigation. While Eurobodalla Shire Council and Bega Valley Shire Council both own and operate several small non-potable recycled water systems, the only major scheme in the region is the reclaimed water management scheme operated by Shoalhaven Water around Nowra and Bomaderry.

Merimbula effluent options investigation

Several recycled water scheme options were considered as part of the Merimbula Effluent Options Investigation (MEOI), commissioned by Bega Valley Shire Council. Modelling undertaken as part of the MEOI showed that none of the recycled water scheme options considered could achieve 100% re-use. Key barriers included land capacities and storage sizes. Further, modelling showed limited benefits from large storages during wet weather and cooler seasons when irrigation requirements are low. It was also identified that high capital costs would be required to implement and operate such a scheme. The MEOI concluded that the option of effluent disposal via an ocean outfall instead offer the greatest relative benefit and recommended Council defer any expansion of water re-use beyond the existing schemes until after the ocean outfall project was completed. The Environmental Impacts Statement for the Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall project was in August 2021.

Water extraction limits are restricting development opportunities in unregulated catchments

Water sharing plans set limits on how much water can be extracted annually from the region's water sources through long-term average annual extraction limits (LTAAELs). LTAAELs aim to balance long-term reliable access to water with protecting the environment.

Surface water and alluvial groundwater LTAAELs in the South Coast region reflect the sum of licensed volumes and estimated basic landholder rights at the time the water sharing plan was made. As such, no new water access licences can be issued to these water sources, even if they would not cause water extractions to exceed long-term sustainable limits.

The region's groundwater LTAAELs vary by aquifer and are based on the calculation of several key components, including groundwater recharge, risk assessments, planned environmental water, and current and future water requirements. Unassigned water exists in these sources because the LTAAELs still exceed the total volume of water access licences and basic landholder rights. Acknowledging this, the NSW Government has made shares available in these groundwater

sources through a controlled allocation process each year since 2017. Future controlled allocations will be made in accordance with the *Strategy for the controlled allocation of groundwater*.⁹

We have also heard that agricultural production in the South Coast region is constrained by existing harvestable rights limits. Harvestable rights apply to coastal-draining catchments and allow landholders to collect a proportion of the average regional rainfall run-off from their property in one or more dams on non-permanent, mapped minor streams, or unmapped streams. This is allowed without a water access licence, water supply work approval or water use approval. Some water users have advocated for increases in harvestable rights to support commercial enterprises and believe that this could be done while still maintaining a sustainable level of access for downstream users. The recently announced increase in the harvestable rights limit in coastal draining catchments recognises the strong interest received from some water users for the need to improve water security for stock and domestic and basic farming use during extended dry periods and to ensure water for firefighting. It excludes the use of this water for intensive agricultural uses such as horticulture and aquaculture.

9. www.industry.nsw.gov.au/water/allocations-availability/controlled

Water users are not taking up opportunities in water sharing plans to access more water

For water sources where no additional licences can be allocated, access to additional water can occur through permanent trade of water access licences or temporary trade of water allocations in line with water sharing rules. The rules aim to maximise flexibility for water users without adversely impacting the environment or the reliability of other water access licences.

Very little trade has occurred in the region's catchments, despite trade being allowed and annual water usage in most areas generally being well below LTAAELs. There are no examples of temporary trades in South Coast unregulated rivers and only 5 water access licences, totalling about 300 ML, have been traded permanently in the South Coast region since 2011.

Only 6 temporary trades, totalling 290 ML, occurred in the Bega-Brogo regulated river system in 2018-19.

Water users have noted many barriers to trade, including limited water market information, restrictive trade rules, long processing times and lack of meters, which are required to trade water allocations.

Water sharing plan rules allow for low-flow to high-flow conversions in many South Coast region water sources. Although the main intent of this rule is to protect low flows, it also allows landholders to access a greater volume of water during high-flow periods to store for later use. In theory, this approach could also provide landholders with more water to support expanded operations. However, no licence holders in the region have taken up this opportunity.



Photography

Image courtesy of Jeremy Kinley, Department of Planning and Environment.
On-farm dams in the Bega Valley.

Water entitlements in the Bega-Brogo regulated river system are underutilised

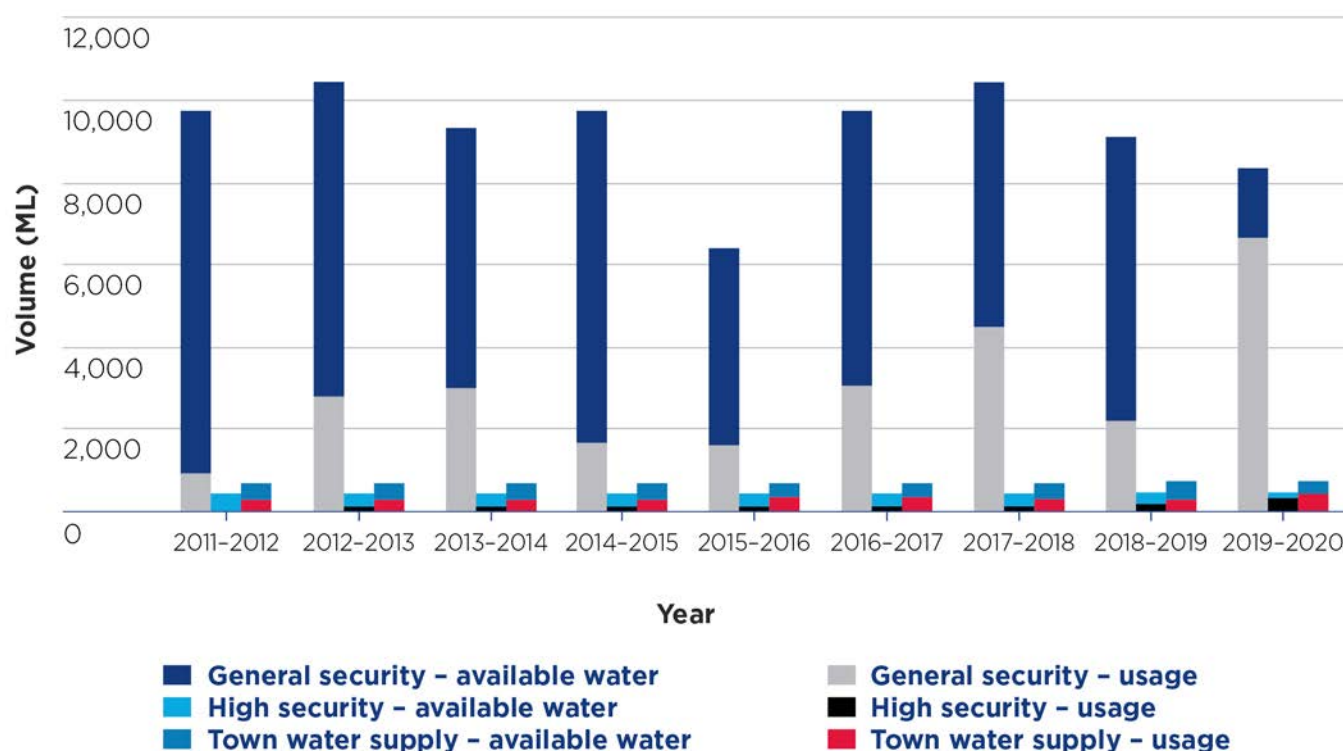
Brogo Dam is small and has historically filled and spilled regularly due to reliable rainfall. However, the Bega-Brogo regulated river system faces several challenges, including:

- Brogo Dam's capacity is far less than the volume of water entitlements
- irrigation demands occur when inflows to the dam are low

- a large proportion of irrigators are located at the end of the system, which is increasingly being impacted by saltwater intrusion
- there is a relatively large proportion of inactive water entitlement.

The combined impact of these challenges is that the Bega-Brogo regulated river system is underused during most years; rarely provides full allocations to general water security licences (Figure 9); and only provides short-term water security for water users during droughts. This is constraining economic growth and increasing the vulnerability of water users to increased climate variability.

Figure 9. Available water determinations compared with water usage in the Bega-Brogo regulated river system



Town water supplies are generally secure but could become less reliable under climate change

Residents of towns and villages in the South Coast region expect safe and reliable water services to their homes and businesses. Providing sufficient water for domestic needs and essential services is the NSW Government's highest priority during drought. Communities also value water for recreation and amenity. Extended future droughts, sea level rise and poor water quality could place greater stress on town water supplies.

Most towns in the South Coast region, with the exception of Bermagui have a relatively secure water supply because of the reliable catchments they source water from. When complete, the Southern Water Storage Project will address the existing water security risk for towns in Eurobodalla.

Extended future droughts could place Bermagui's water supply at risk

The water security risks for Bermagui were highlighted during the last drought. Brogo Dam fell to historic low levels in January 2020 and dam releases were curtailed to other water users to secure the town water supply and prevent Bermagui running out of water. These very low river levels resulted in a water pool of insufficient depth for the pumps which supply Bermagui to operate properly, requiring WaterNSW to make operational adjustments to raise the height of the river to enable town water extraction. While Brogo Dam is expected to be full or spilling for most of the time in the future, a severe climate change scenario could result in droughts longer than what we have experienced in our historical record. If nothing changes, these risks to Bermagui's town water supply increase.

Shoalhaven Water's southern system is reliant on the northern system during peak periods

The South Coast Regional Water Strategy area incorporates the southern portion of the Shoalhaven City Council local government area. For most of the year, water from Porters Creek Dam is sufficient to meet the needs of customers in Shoalhaven Water's southern system, including Milton-Ulladulla and the villages around Jervis Bay and St. Georges Basin. During periods of high demand – such as summer and Easter school holiday period – water may need to be transferred from the northern system. Water is also released from Tallowa Dam, operated by WaterNSW, into the Shoalhaven River so that Shoalhaven City Council can extract water from the river to supply Nowra township. The Tallowa Dam is being considered as part of the Greater Sydney Water Strategy area, however Shoalhaven Water's northern system was not considered under that strategy. Water issues in Shoalhaven Water's northern system will be considered strategically and may be incorporated into a future plan.

Securing town water supplies

The NSW Government and councils have been investing in infrastructure upgrades to improve water security for towns in the South Coast region.

- Towns supplied by Eurobodalla town water supply system currently do not have a secure water supply. \$25.6 million in NSW Government funding plus an additional \$51.2 million in Commonwealth funding has been provided to Eurobodalla Shire Council to assist with the construction of the Eurobodalla Southern Water Storage – a 3,000 ML off-stream storage in the Tuross River basin. This new storage will secure water supply for these Eurobodalla towns in the face of reductions in surface water yields and population growth.
- NSW Government has provided \$25 million to assist Bega Valley Shire Council upgrade the Brogo-Bermagui, Bega-Tathra and Yellow Pinch water treatment facilities. An upgrade is planned for the Yellow Pinch Dam water treatment facility. These projects when complete will ensure high quality water can reliably be provided to all main urban areas in Bega Valley Shire.

Poor quality water can impact water supply for some towns

Heavy rainfall following extended dry periods or bushfires can result in poor quality water which constrains the ability of town water treatment facilities to effectively treat and maintain adequate supply to towns and communities in the region. For example, Bega Valley Shire Council has been impacted by poor raw water quality in recent years with 'boil water' notices being issued. For Bermagui, heavy rainfall in February 2020 following an extended drought and severe bushfires resulted in a significant deterioration in water quality and prevented potable water supply to Bermagui.

More intense storms as a result of climate change and increased likelihood of bushfires will increase town water quality risks in the future. The regional water strategy will investigate what can be done to improve water quality in the region.

Councils are preparing for this by investing in upgrades to water treatment facilities.

Sea level rise could impact town alluvial groundwater sources and water supply infrastructure

Alluvial groundwater sources are highly connected to river flows. Decreased river flows from a drier climate and sea-level rise could result in saltwater ingress into alluvial sands groundwater sources. This risk is amplified for Bega as the Bega-Tathra water supply system relies on the Bega River alluvial sands groundwater source for supplying town needs. Sea level rise could significantly impact the availability of good quality groundwater for Bega Valley Shire Council. Further analysis is required to better understand this risk.

Councils in the region are planning for the vulnerabilities facing their water and wastewater treatment plants and infrastructure because of projected sea level rise. Potential increased corrosion and inundation of these assets could significantly impact delivery of water and wastewater services for their populations.

Addressing the challenges

To address the challenges in the South Coast region, we have set 3 priorities and proposed actions under each.

The regional priorities are:

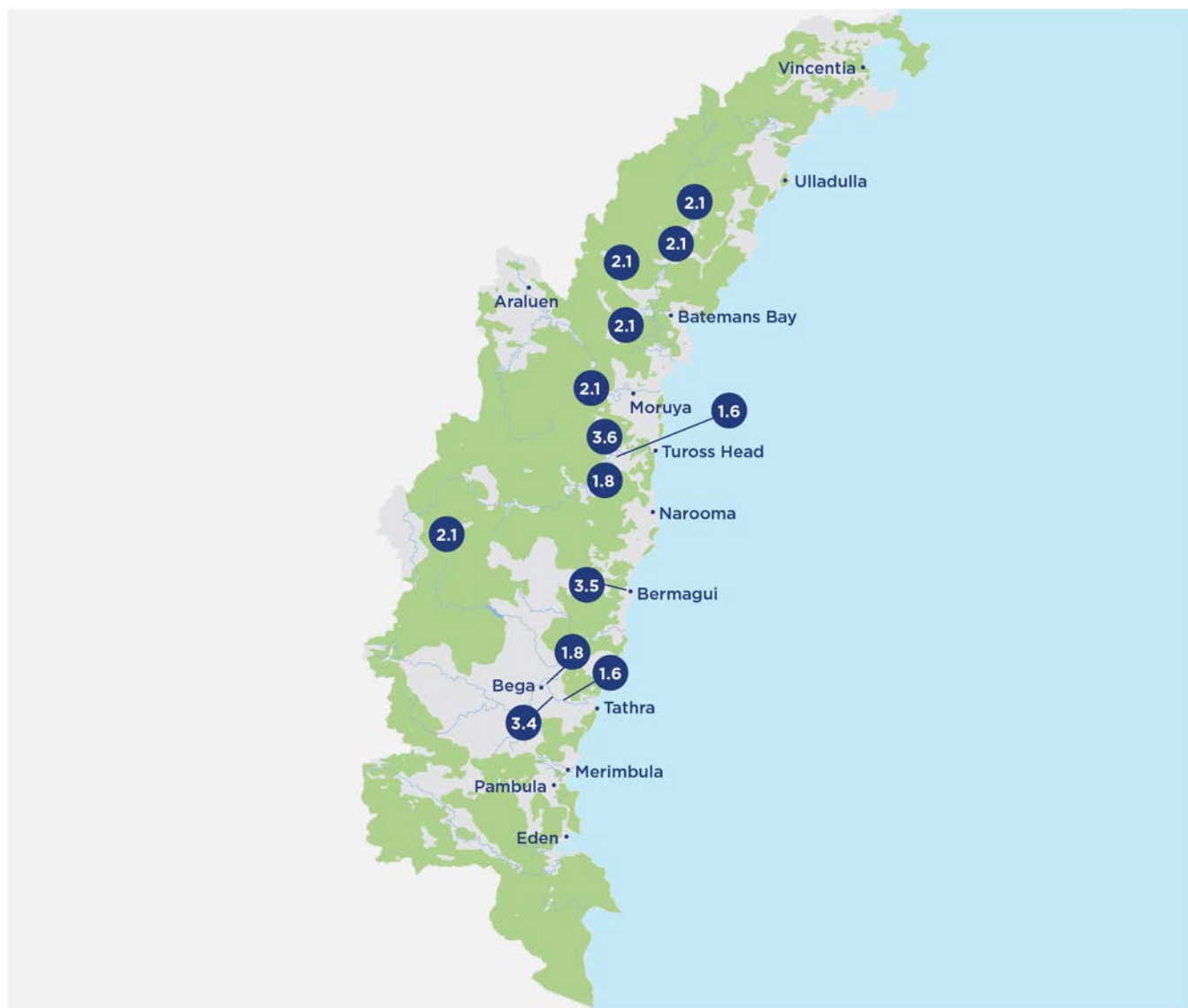
1. Take a holistic approach to land and water management
2. Ensure water resource development and use is sustainable and equitable
3. Prepare for future climatic extremes.

These priorities and proposed actions can improve the South Coast's readiness to adapt to a more variable climate and support the difficult decisions we need to make to deliver healthy, reliable and resilient water resources for the region's future.

Photography

Image courtesy of Destination NSW.
Wagonga Inlet, Narooma.

Figure 10. Summary of South Coast proposed actions



Actions not shown on the map are not location specific.

Priority 1: Take a holistic approach to land and water management

- Action 1.1: Develop ongoing arrangements for participation of local Aboriginal people in water management
- Action 1.2: Support place-based initiatives to deliver cultural outcomes for Aboriginal people
- Action 1.3: Support improved governance
- Action 1.4: Deliver a river recovery program
- Action 1.5: Support landholder adoption of best practice land management
- Action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion
- Action 1.7: Identify environmental water needs to support healthy coastal waterways
- Action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources
- Action 1.9: Protect ecosystems that depend on coastal groundwater
- Action 1.10: Improve monitoring of water extraction

Priority 2: Ensure water resource development and use is sustainable and equitable

- Action 2.1: Improve fish passage
- Action 2.2: Implement fish-friendly water extraction
- Action 2.3: Establish sustainable extraction limits for surface water and groundwater sources
- Action 2.4: Implement daily extraction limits
- Action 2.5: Reduce the take of low flows
- Action 2.6: Address catchment-based impacts of harvestable rights limits
- Action 2.7: Support Aboriginal business opportunities

Priority 3: Prepare for future climatic extremes

- Action 3.1: Provide better information about water access, availability and climate risks
- Action 3.2: Review water markets
- Action 3.3: Investigate increased on-farm water storage
- Action 3.4: Investigate delivery efficiency improvements for the Bega-Brogo regulated river system
- Action 3.5: Identify the best option to improve water security for the Bermagui town water supply system
- Action 3.6: Improve water security for lower Tuross water users

Take a holistic approach to land and water management

To continue to protect and enhance the region's waterways, groundwater systems and the ecosystems they support, we need to ensure our management systems and decision-making processes use a whole-of-catchment approach. This approach includes coordinating efforts across stakeholder groups and supporting landholders to build awareness and capacity for best practice natural resource management and sustainable agriculture. Adopting best practice land and water management that considers Aboriginal knowledge and culture, together with western science will be critical to ensuring efforts that protect waterway health are targeted and benefit users at a local, whole-of-catchment and regional scale.

What we have heard so far



- Protecting and enhancing the health of the region's catchments and waterways is a priority. This can be done by restoring natural flows, reducing the environmental impacts of water infrastructure, and increasing vegetation cover.
- We need to better manage what we do on the land and how we use water to protect what we value in rivers, creeks, and groundwater systems. Land and water (salt and freshwater) should not be managed in silos. Governments should incorporate and consider Aboriginal knowledge and culture in management decisions.
- Genuine and ongoing engagement with Aboriginal people through the regional water strategies can be an important step in providing a voice for Aboriginal people in water matters.
- Aboriginal communities want improved access to their traditional lands and waterways, as well as more clearly identified and protected cultural sites.
- More environmental monitoring is needed to improve understanding of environmental dynamism and natural variability.
- There was support for development and use of water efficient technologies for agricultural industries in the region.

What we are already doing



- The Marine Estate Management Strategy is progressing actions that address the cumulative impact of agricultural runoff, urban stormwater, sediment contamination and other threats to the water quality of NSW estuaries (Initiative 1). Actions such as on-ground activities to provide habitat protection and rehabilitation are being designed to help mitigate the impacts of climate change on estuarine and coastal habitats, particularly from sea level rise.
- Coastal Management Programs, developed by local councils with the support of the Department of Planning and Environment, provide strategic direction and funding support for local councils to address key coastal management issues, including impacts that originate from higher up in the catchment.
- The NSW Water Strategy has committed to improving river, floodplain and aquifer ecosystem health and system connectivity (Priority 3), for example by taking landscape scale action to improve river and catchment health and adopting a more intense, state-wide focus on improving water quality.
- The NSW Government is implementing the new non-urban metering framework through the 2017 Water Reform Action Plan. Under the framework, all surface water and groundwater works covered by the rules in the South Coast region will need to be fitted with compliant metering equipment by 1 December 2023.



Photography

Image courtesy of Department of Planning and Environment.
Baimanga National Park, NSW.

Legend



Declining catchment and river health



Competition for low flows



Saltwater intrusion into freshwater sources



Aboriginal people's rights and access to water



Water security for South Coast towns and industries

Proposed actions	Description	Challenges addressed
Incorporate Aboriginal knowledge and culture into land and water management		
Action 1.1 Develop ongoing arrangements for participation of local Aboriginal people in water management	Fund existing or new Aboriginal groups to participate in water management processes. These groups will help facilitate culturally appropriate: • water knowledge programs • engagement and consultation.	 
Action 1.2 Support place-based initiatives to deliver cultural outcomes for Aboriginal people	Fund and support Aboriginal organisations and communities to develop tailored projects for their communities. This action would aim to move away from central decision-making and develop a flexible program that can be adapted and is driven by the principle of self-determination and collaboration.	 
Undertake whole-of-catchment planning, decision-making and project delivery		
Action 1.3 Support improved governance	Develop a new governance approach that recognises stakeholder roles and responsibilities and supports whole-of-catchment planning, coordination, decision-making, and project delivery.	 
Action 1.4 Deliver a river recovery program	A whole-of-catchment program that prioritises and guides works to improve the health of the region's rivers and the ecosystems they support (including native and threatened aquatic species).	  
Support local landholders to adopt best practice land use and water management		
Action 1.5 Support landholder adoption of best practice land management	Build on existing programs to support private landholders to adopt best practice farm management. This will help improve the health of priority waterways by reducing the discharge of sediment and nutrients from agricultural land.	 

Proposed actions	Description	Challenges addressed
Improve our understanding and management of the region's water resources		
Action 1.6 Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion	Improve our understanding of the risks of saltwater intrusion from sea level rise, changes in catchment hydrology, and extraction to local council water supplies and industries, by developing an integrated catchment model for high priority sites.	
Action 1.7 Identify environmental water needs to support healthy coastal waterways	Define objectives and the amount and quality of water necessary to sustain key, priority surface water and groundwater aquatic ecosystems across the region.	
Action 1.8 Characterise and plan for climate change and land use impacts on coastal groundwater sources	Increase investment in accurately determining the availability and vulnerability of groundwater sources from climate change. Ensure the NSW Government and the community have the necessary information to inform management frameworks, including considering protecting water resources in land use planning decisions.	
Action 1.9 Protect ecosystems that depend on coastal groundwater	Better understand groundwater dependent ecosystems and incorporate knowledge and monitoring programs into current and future water quality and water sharing plans.	
Action 1.10 Improve monitoring of water extraction	Expand on recent NSW Government metering reforms by investigating opportunities to improve how we monitor water extraction – particularly in managing competition during low-flow periods and assessing the impact of extraction limits on water sharing plan objectives.	



Photography

Image courtesy of Scott Nichols, Department of Primary Industries—Fisheries, Bega, NSW.

Incorporate Aboriginal knowledge and culture into land and water management

As custodians of Australia's land and water for thousands of years, Aboriginal people have developed a rich spiritual connection to Country and have a large body of culture and knowledge. Land and water are not considered as separate to Aboriginal people, and healthy waterways are critical for their health, wellbeing and culture.

A more holistic approach to land and water management involves working collaboratively with Aboriginal people, drawing on their

knowledge and experience, and integrating their perspectives, approaches and values into water legislation and management frameworks. We need to develop whole-of-system governance structures that are supported and understood by Aboriginal people and give Aboriginal people direct input to water management decision-making. We also need to provide Aboriginal people with opportunities to manage water using their culture and knowledge and to create improved economic opportunities and environmental outcomes. Restoring degraded spiritual and cultural sites are also important acts of reconciliation.

Proposed action 1.1: Develop ongoing arrangements for participation of local Aboriginal people in water management

Aboriginal people have told us that consultation with their communities on water issues has been infrequent and poorly executed. Community sentiment is that government agencies often come out to 'tick a box' and after they have got what they want they are never seen again. During consultation in the South Coast region, Aboriginal groups told us that government has to earn the trust of the community as the first step in building a strong, lasting relationship with them.

To address this issue now and over the next 20 years, we need an approach that allows Aboriginal people in each local area and region to get the right people involved or appointed to seats where decisions about water are being made. Aboriginal people need to have a direct line of contact with regional water managers, compliance officers and decision makers. Aboriginal knowledge and science should be actively sought, respected and incorporated into decision-making.

An effective governance, engagement and knowledge-sharing arrangement is the first step in improving Aboriginal people's involvement in water management. The makeup and function of groups need to be led by local communities to be successful. Experience has shown that governance models for Aboriginal communities do not work when they are set by government.

This action would include supporting new or existing Aboriginal groups to develop a model for involvement in water management processes. The success of this action will be driven by the extent to which it enables self-determination and provides an adequate level of support for the groups.

This action supports Priority Reform 1 in the Closing the Gap National Agreement to enter formal partnerships and decision-making arrangements and develop place-based partnerships to respond to local priorities.

Local Aboriginal groups in the South Coast region could be involved in:

- developing culturally appropriate water knowledge programs
- identifying culturally appropriate methods for how and when communities should be consulted and how their feedback should be considered in decision-making processes
- outlining a process that the NSW Government can follow to ensure water decisions have been appropriately considered by the community.

Have your say



- What level of government support do you think is needed to successfully implement this action?

Proposed action 1.2: Support place-based initiatives to deliver cultural outcomes for Aboriginal people

The Australian Government's Closing the Gap report and Local and Indigenous Voice program have highlighted that Aboriginal people want strong and inclusive partnerships in which local communities set their own priorities and tailor services and projects to their unique situations. Successful programs are often those that are tailored to local circumstances, are place based, well resourced, and locally driven.

This action would fund and support Aboriginal organisations and communities to develop tailored projects for their communities. It would aim to move away from central decision-making and develop a flexible program that can be adapted and is driven by the principle of self-determination – local communities 'speaking with their voice' to make decisions about which programs are needed for their community and their region.

There are already some examples of local Aboriginal groups leading the way in delivering education programs. For example, Djiriba Waagura aims to revitalise and strengthen Aboriginal culture on the South Coast by developing and delivering multifaceted Aboriginal Cultural Programs. From commercial tours and camps to on Country cultural experiences and education-based programs and services, its core vision is to empower our local community with a strong focus on our youth.¹⁰

There are also examples of NSW Government investment in supporting partnerships that empower Aboriginal communities to protect, conserve and restore cultural landscapes and waterways that are important to the local Aboriginal people. The Protecting Our Places Grants Program is a contestable grants program for Aboriginal community organisations and groups, seeking to achieve long-term beneficial outcomes for the environment. Under the grants program, several projects in the South Coast region were successful in being awarded funding, including:

- Batemans Bay Local Aboriginal Land Council working to protect threatened and vulnerable species and target feral animals under the development of a cultural Land Management Plan Cultural.
- Firestick Alliance Indigenous Corporation (Southern Yuin Firesticks) enabling Cultural Burning Crews and Traditional Owners to work together alongside NSW National Parks and Wildlife Service and Rural Fire Service staff within the Murrah Flora Reserve in the Southern Yuin Nation.
- A joint venture between Mogo Local Aboriginal Land Council and Batemans Bay Aboriginal Land Council and their respective Environmental Rangers Teams to rehabilitate the cultural and historical resource area called 'Grandfathers Gully', which is a significant site to the local Aboriginal community.

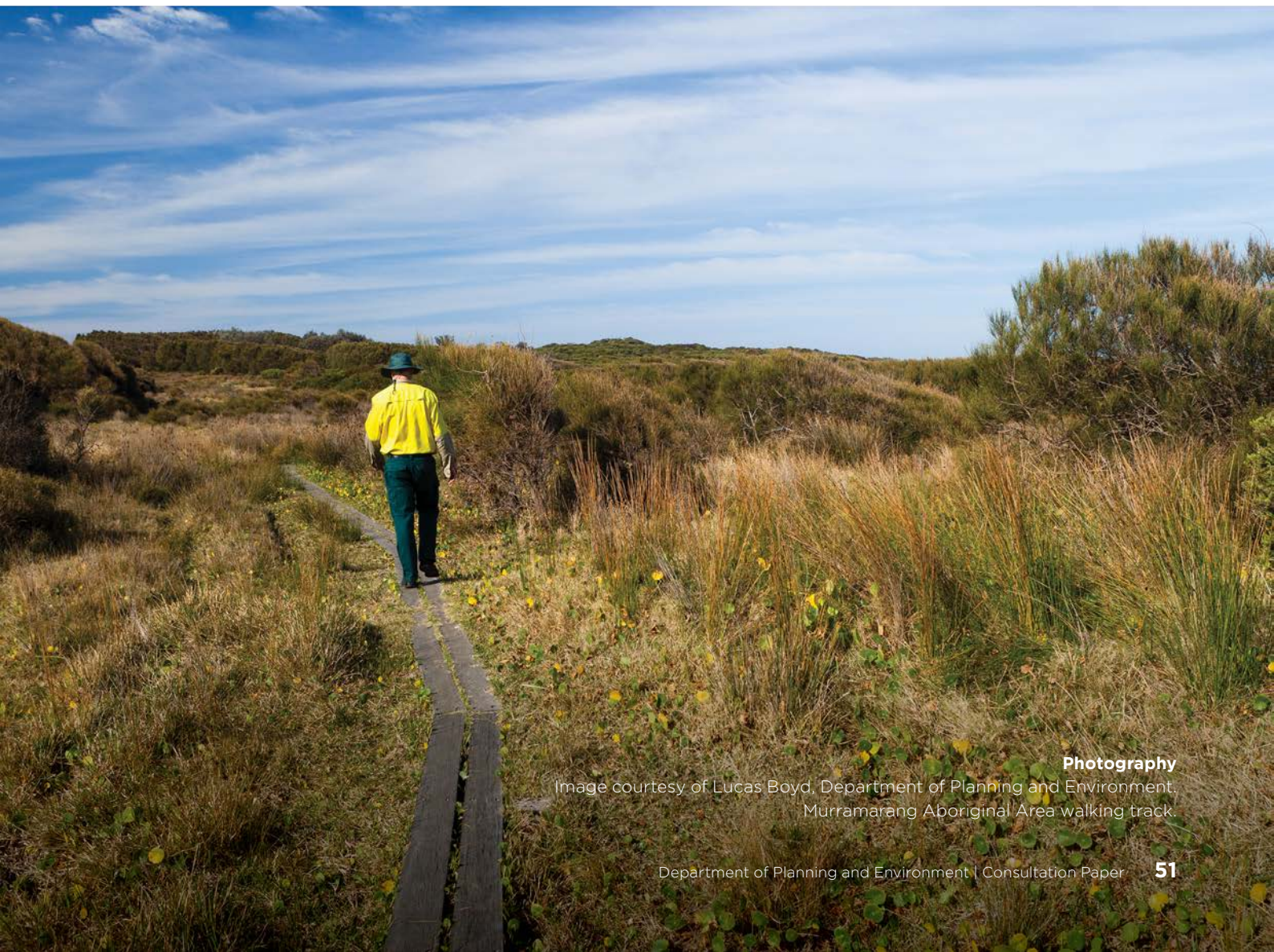
10. Further information on Djiriba Waagura can be viewed at: www.djiribawaagura.com/

In the South Coast region, this action would build on the work already started by local aboriginal groups by:

- identifying **cultural water needs** for specific sites or locations where water may support cultural practices. This could involve working with the Department of Planning and Environment – Water, Department of Planning and Environment – Environment, Energy and Science and WaterNSW to identify whether cultural water access licences or water for the environment could help deliver water to these locations
- improving access to Country, including locations of significance, **by opening up local parcels of land** that have access to waterways but are otherwise gated or locked. These include travelling stock reserves or Crown roads that provide access to waterways

- developing a **demonstration reach** within the River Recovery Program (proposed action 1.4), where cultural knowledge and science is used to rehabilitate riparian land, plant native species and care for Country
- supporting other local Aboriginal communities develop ‘Caring for Country’ programs that **engage young Aboriginal people** in water and landscape management, with the objectives of building cultural awareness and giving a sense of ownership and cultural connectivity.

To receive government funding or support, these initiatives would need to have local champions, effective local governance arrangements and a strong capacity building component, such as activities that focus on water legislation, licensing structures, landscape management or knowledge activities for schools and youth programs.



Photography

Image courtesy of Lucas Boyd, Department of Planning and Environment, Murramarang Aboriginal Area walking track.

Undertake whole-of-catchment planning, decision-making and project delivery

Various strategies, programs and on-ground projects have been implemented to improve the health of the region's aquatic environment. These have mainly focused on managing the impact of diffuse pollutants from urban and rural land on the coastal, estuarine and marine environments. These initiatives include the NSW Government's Marine Estate Management Strategy, the NSW Coastal Management Framework and delivery of coastal management programs, and on-ground works administered by the Department of Planning and Environment – Water, Local Land Services, Department of Regional NSW (Department of Primary Industries—Fisheries and Agriculture), local councils, community groups, private landholders and local Aboriginal groups.

The following actions aim to build on these programs by applying a whole-of-catchment approach to planning, decision-making and project delivery. Catchment planning will help target and coordinate these programs under one framework. It will also help highlight and address gaps in the current range of programs being delivered, particularly those related to river and geomorphic health.

Proposed action 1.3: Support improved governance

Current governance arrangements have been criticised as fragmented, which affects decision-making, investment prioritisation, monitoring and reporting. Delivering effective governance is a key initiative of the Marine Estate Management Strategy to help address threats and improve health outcomes to the NSW coastal, estuarine,

and marine environments. The Marine Estate Management Strategy recognises the need to improve collaboration and integration across government agencies and has proposed to try a new governance framework, starting with a pilot program for the Richmond River catchment in the Far North Coast region.

These issues are not unique to the Far North Coast region or the coastal environment; they impact the delivery of good environmental management outcomes across all coastal as well as riverine environments.

This action proposes to use the Richmond River pilot program to guide the development and implementation of a new governance approach to support whole-of-catchment planning, coordination, decision-making and project delivery for South Coast catchments. The action will adapt the Richmond River governance model to the South Coast region based on existing programs, key stakeholders, current funding sources, and capacity needs. The action will also map out how this process of adaption will occur, including identifying anything that can be done before the Richmond River governance model is finalised.

The new framework will help to improve river and estuarine health by clarifying roles and responsibilities, synchronising projects, building collaborative networks, avoiding duplication, coordinating funding and highlighting gaps in knowledge. This action would underpin planning and delivery of the River Recovery Program (proposed action 1.4). The framework will also benefit the region's commercial, social, and cultural values, which all place a high priority on the local natural environment.

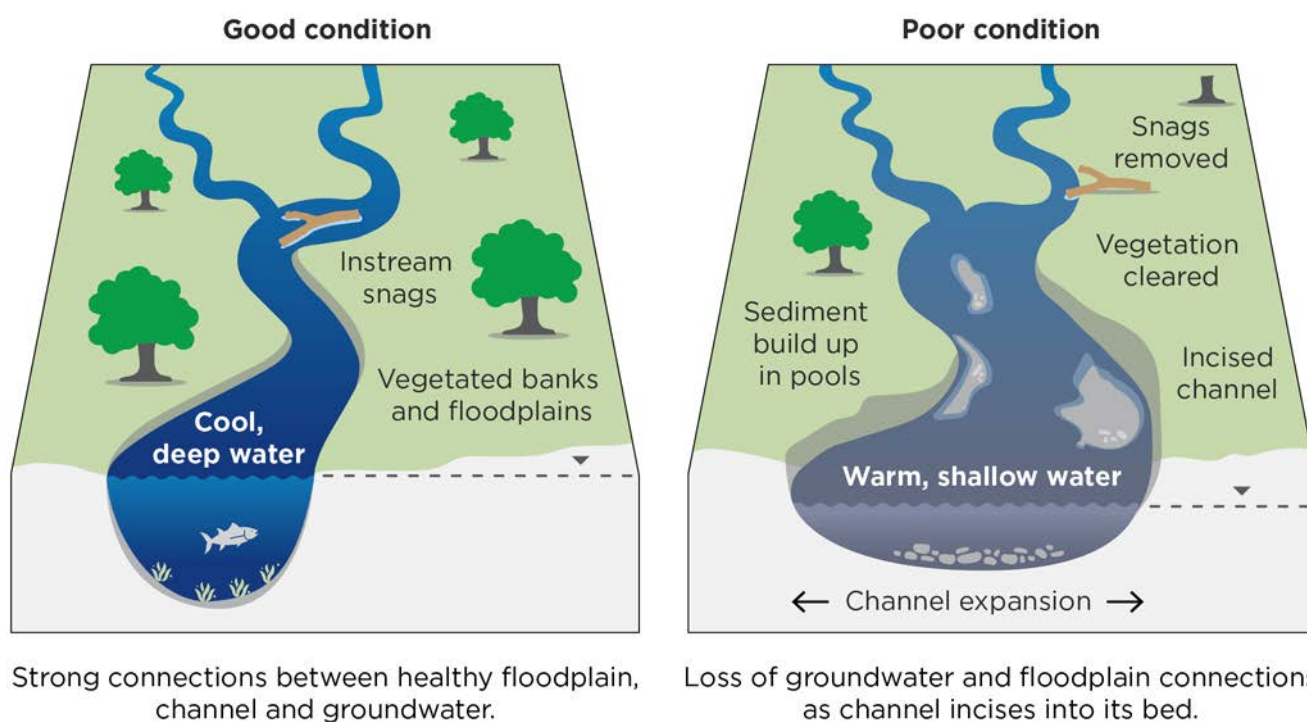
Proposed action 1.4: Deliver a river recovery program

The health and resilience of rivers and the ecosystems they support is directly linked to their geomorphic condition and that of the surrounding floodplain. This is illustrated in Figure 11.

This action will develop a whole-of-catchment program for improving the health and water quality of the region's rivers and the ecosystems they support, including native and threatened aquatic species.

A key component of the program will be the development of a framework to prioritise the works required and where they should be implemented. The framework will be based on metrics, such as condition and recovery potential classes in the NSW River Styles classification system (mainly focusing on reaches classified as conservation, strategic or rapid recovery), severity of land degradation, mapped high ecological value aquatic ecosystems, as well as local Aboriginal knowledge and cultural water needs.

Figure 11. Conceptual models underpinning river health and resilience¹¹



11. Adapted from water.dpie.nsw.gov.au/science-data-and-modelling/surface-water/monitoring-changes/nsw-river-condition-index

Other key steps for implementing this action are:

- addressing any overlaps with similar programs – particularly coastal management programs – to ensure efforts are complementary and not duplicated
- establishing a program of potential recovery and management measures such as increased riparian vegetation, spawning boxes for the recovery of threatened species, and measures that address bed erosion and improve river system function (for example, rock chutes and log jams, and creating pool and riffle systems)
- identifying funding models, including landholder incentives
- developing a clear decision-making and program delivery framework that brings together relevant government agencies with responsibilities in these areas. It would also consider how to involve local community and Aboriginal groups
- developing a monitoring and evaluation framework.

This action is important to ensuring future river recovery efforts are coordinated and effective at a catchment scale and support broader ecological, as well as social, cultural and economic outcomes.

For example, measures that slow and filter water – such as increasing channel roughness and re-introducing large wood in pool and riffle systems, and instream native vegetation – improve water quality by removing sediment and nutrients and can provide flood mitigation benefits downstream. This provides benefits to local towns both in terms of water security, asset protection and amenity, Aboriginal people, and local industries – particularly aquaculture. Riparian revegetation improves bank stability and helps retain water within the landscape, improving soil health and potentially making crops more resilient to extended dry periods.

The impact of this action is tightly linked to the effectiveness of the governance framework established under proposed action 1.3 and to the capacity of landholders to implement best practice land and water management practices (proposed action 1.5).

Proposed actions that seek to reduce the impact of extraction on flows, such as establishing sustainable extraction limits for surface water and groundwater sources (proposed action 2.3) and reducing the take of low flows (proposed action 2.5) will complement the efforts sought through this action. Future reviews of water sharing plans will also consider and manage future changes in flow.

Photography

Image courtesy of Destination NSW.
Deua National Park, Deua.



Support local landholders to adopt best practice land use and water management

The Department of Planning and Environment, South East Local Land Services, and Regional NSW (Department of Primary Industries—Fisheries and Agriculture) already deliver programs that support the adoption of best practice land management by local landholders to improve productivity and reduce land and water degradation. These programs include irrigation audits, guidelines for fertiliser application, improved management of farm runoff and water quality and improved capacity to prepare and recover from droughts and bushfires. Complementary extension services are also provided by the Natural Resource Access Regulator.

While many landholders have adopted best practice land and water management, there is still a lack of willingness among some landholders to change land management practices that negatively impact water quality and river health. We have also heard that some landholders need support in recognising potential improvements in managing their land and water requirements, even relatively simple ones. Furthermore, feedback received through recent water engagements with local landholders indicates some are frustrated with the lack of extension services available to help them understand the rules, obligations and opportunities for accessing and managing farm water needs.

Proposed action 1.5: Support landholder adoption of best practice land management

This action will build on existing programs to support private landholders to adopt best practice land management to improve water quality of priority waterways by reducing the discharge of sediment and nutrients from agricultural land across the region.

Support will largely be provided through natural resource management and sustainable agriculture advisory services and on-ground projects, with a focus on:

- stock grazing management
- carbon farming
- soil disturbance and erosion management
- soil condition and ground cover management
- native vegetation and biodiversity management
- streambank and riparian vegetation protection and restoration
- structural instream habitat restoration works
- drainage and fertiliser use management.

A suite of fit-for-purpose tools would be used to build landholder capacity in knowledge, skills, access to networks and resources; including one-on-one consultation, advice and referrals, webinars and podcasts, YouTube videos, regular social media, field days, demonstration sites, farm planning training and incentives to deliver on-ground projects.

The delivery of this program will align with the framework developed in proposed action 1.4: Deliver a river recovery program, and the environmental water requirements established under proposed action 1.7. This will ensure that improvements in private landholder land and water management practice are directed to

catchments where either river reaches have a high recovery potential or improvements are critical to achieving key environmental objectives.

Implementation of this action will be delivered in partnership with other government agencies, as well as local Aboriginal and community groups.

Have your say



- What are the constraints to landholders adopting measures that reduce farm run off and fertiliser use?
- What support is needed to encourage widespread improvements?

Photography

Image courtesy of Department of Planning and Environment. Cleared Land, South East Forests National Park.

Improve our understanding and management of the region's water resources

The NSW Government has a key role to play in helping coastal regions prepare and adapt to future climate-related challenges.

Filling critical gaps in our understanding of the impacts of climate change is key to us fulfilling this role. Our investment in new climate datasets, the development of new hydrological models and the roll-out of the NSW Government's non-urban metering framework are all good first steps. However, further targeted investigations are required to properly understand the cumulative impacts of climate change, water extraction, and sea level rise on the region's water resources and to allow more flexibility in how we share and manage them.

The following proposed actions have been identified as important first steps to improving our understanding and future management of the region's water resources. These actions will build on the initiatives of other strategies, particularly the NSW Water Strategy, the Marine Estate Management Strategy and the draft NSW Groundwater Strategy (to be released in 2022).

Proposed action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion

This action would improve our understanding of the risks of saltwater intrusion from sea level rise. It will consider the impacts of changes to future hydrology and water extraction on salinity dynamics, and estuary closure in the case of intermittently closed and open lakes and lagoons, in key tidal pools and estuaries of the South Coast region. High priority sites include the Bega River and Tuross River tidal pools.

This action will require the development of integrated models that will identify possible changes to salinity by considering several important variables: surface water flows, local-scale runoff, water extraction and estuary hydrodynamics. These models will use the new hydrologic modelling completed for the Draft South Coast Regional Water Strategy and the hydrodynamic models developed for the Marine Estate Management Strategy. Similar work that assesses the impacts of water extraction on salinity dynamics is underway in the Richmond River and Shoalhaven tidal pools, providing important insights for progressing this action.

As part of this action, we would develop a framework to assess the economic and social impacts of sea level rise and saltwater intrusion to water users, local council water management infrastructure, and Aboriginal cultural assets identified as being at risk. The outputs of the modelling may also inform our understanding of future environmental water requirements.

This action provides 3 key benefits:

- **Reduced cost to government and water users in the long term:** Formulating policy for sea level rise challenges is complex due to the uncertainty involved. While this uncertainty cannot be removed entirely, taking early action can significantly reduce the possible future costs of damages.
- **Tidal pool water users supported in managing their business risks into the future:** Previous studies have considered the impacts of projected sea level increases on coastal properties, infrastructure and future development. However, little has been done in NSW to assess risks to water users and water resources, particularly regarding increasing tidal pool salinity.
- **Aboriginal communities supported in managing cultural assets that may be impacted by sea level rise:** Includes identifying cultural assets that may be impacted by future sea level rise.

Proposed action 1.7: Identify environmental water needs to support healthy coastal waterways

This action will establish objectives and water requirements for priority environmental assets – species, communities and aquatic ecosystem functions – across the region.

Coastal water sharing plans have ecological objectives however they are difficult to evaluate. This is for 2 reasons: the links between objectives and water management activities that are used in water sharing plans are unclear and the data required to undertake effective evaluation is insufficient or missing.

As well as measurable ecological objectives, we also need to know more about the environmental water requirements – both in terms of flow and quality – for species and aquatic ecosystems in the South Coast region. Environmental water requirements define a suite of flow strategies to maintain and improve aquatic health. This includes information related to the volume, frequency, timing, and duration of flows for various flow classes, the impacts from changes in baseline water quality, as well as the risks, constraints, and complementary non-water measures. Environmental water requirements are a key tool for linking environmental objectives to management strategies and water sharing plan rules. Despite this, many species and aquatic ecosystems in the South Coast region have not been studied sufficiently to reliably describe these requirements and target them through management actions.

The key steps for this action are:

- developing a method to prioritise key environmental assets (for example, based on high ecological value aquatic ecosystems) and the subsequent data and monitoring needs for defining their environmental water requirements

- establishing objectives for the recommended environmental flow and water quality requirements, including upper and lower threshold limits that are adaptive to predicted climate variability
- testing the proposed environmental water requirements (for example, through hydrological modelling) to ensure they are achievable
- agreeing to an initial set of environmental water requirements
- investing in required research to assist in developing and monitoring environmental water requirements.

This action will also provide a framework to identify and prioritise data and monitoring gaps, as well as develop methods to address these gaps. These methods could include using data from information-rich areas to represent the water needs of a broader river reach or valley, as appropriate. The framework will also consider existing initiatives to address monitoring gaps, such as WaterNSW's review of the existing hydrometric gauging network. This information will be integrated with existing data platforms, where possible, in a readily accessible format.

The delivery of ecological objectives and environmental water requirements would be coordinated with the review of water sharing plans across the region. The proposed objectives will be tested against rules in current water sharing plans – such as long-term average annual extraction limits and cease to take conditions – to ensure they are feasible and can be met within the required timeframe.

Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources

There is currently a lack of data and information about groundwater sources across the coastal regions. Data is essential to ensure future management decisions effectively mitigate the potential impacts of climate change, particularly saltwater intrusion, and associated changes to catchment hydrology, sea level rise, and over-extraction.

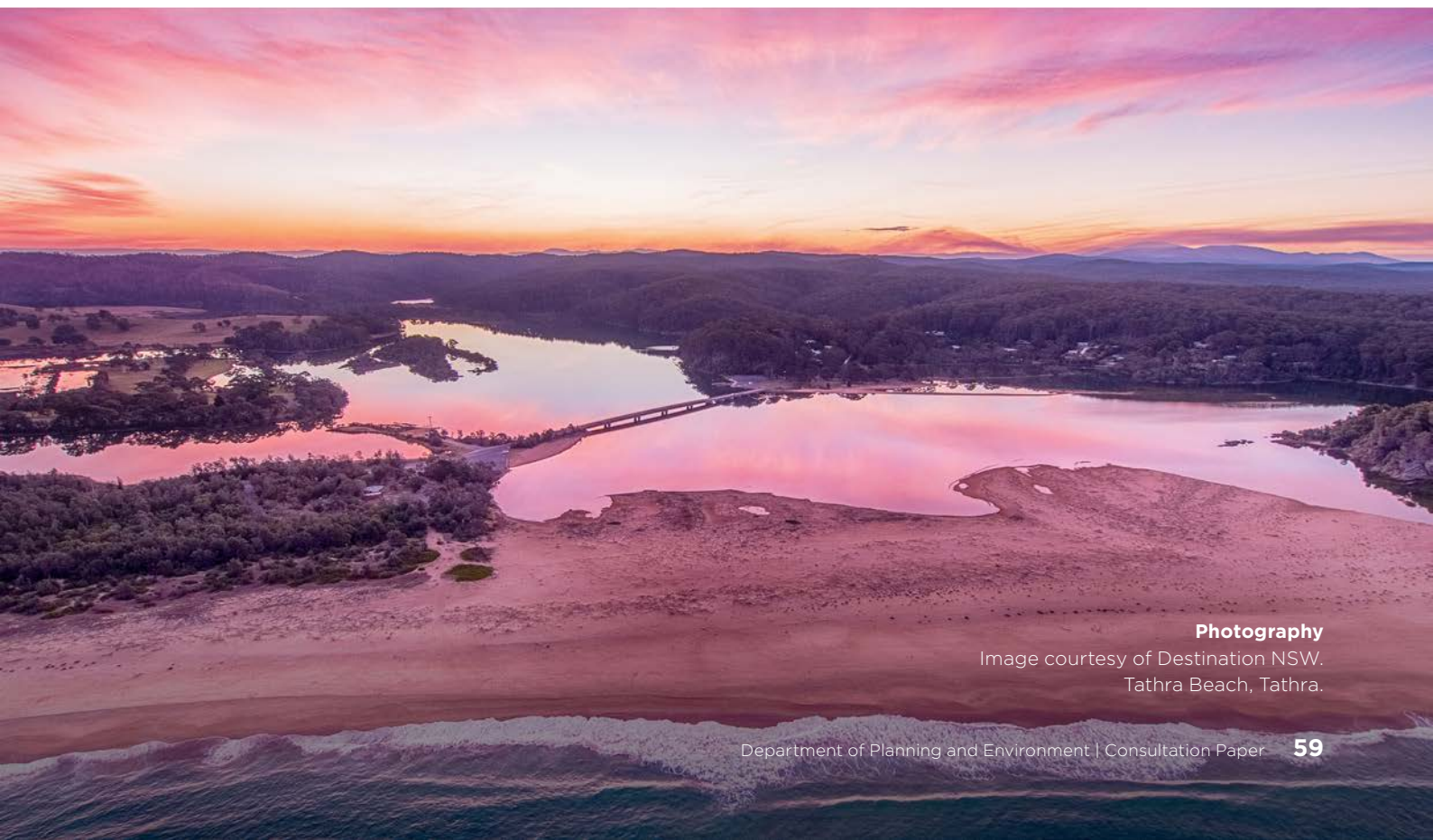
This action would develop a climate change risk profile for key groundwater resources across the region, focusing on the Bega Sands alluvium and the South East Coastal Sands. These 2 groundwater resources have been chosen because there is a high level of dependency on groundwater by industry, towns and rural landholders, and evidence of saltwater intrusion has already been observed.

The development of this risk profile would require initial satellite imagery, field investigations (such as geological, geophysical, geochemical,

ecological and hydrogeological studies) to help characterise the groundwater resource based on factors known to be affected by climate change and land use pressures. These investigations would be supported by a review and potential expansion of the bore monitoring and metering network.

The outcome of this work would be the development of a conceptual model of key groundwater resources across the South Coast region that would provide decision makers with a better idea of how much groundwater is available, how it recharges, where it discharges, and how extraction impacts on the resource. Depending on what this conceptual model tells us about the risk of climate change and land use to these resources, further, more detailed modelling may be conducted.

This action will also consider how this information is made available to water users to inform individual decision-making, and co-design potential projects with local stakeholders and universities to mitigate the key impacts of climate change and land use identified.



Photography

Image courtesy of Destination NSW.
Tathra Beach, Tathra.

Proposed action 1.9: Protect ecosystems that depend on coastal groundwater

This action would advance our knowledge and management of groundwater dependent ecosystems in the South Coast region to guide sustainable water sharing arrangements that protect the inherent environmental values of these ecosystems.

Groundwater dependent ecosystems are classified broadly as terrestrial (vegetation communities), aquatic (wetlands and springs) or subterranean (aquifers).

Our knowledge of these communities is still developing. To support knowledge-based management and protection of these communities, this action will develop a method for identifying groundwater dependent ecosystems across the South Coast region that are reliant on surface water flows (i.e. baseflows) and monitoring the condition and extent of the associated vegetation community.

The ability to implement this action will be conditioned on the adequacy of the monitoring bore network and metering coverage across the South Coast, both of which are being considered as part of other actions (see proposed action 1.10: Improve monitoring of water extraction and proposed action 2.3: Establish sustainable extraction limits for surface water and groundwater sources).

Outputs from this action will be critical to informing environmental water requirements for the region's catchments (see proposed action 1.7: Identify environmental water needs to support healthy coastal waterways) and reviewing the effectiveness of associated water sharing plan rules in protecting these groundwater dependent communities.

Proposed action 1.10: Improve monitoring of water extraction

A lack of monitoring and data is impacting our understanding of the effects of extraction, on-farm storage and growth in basic landholders rights on water sources across the South Coast. This scarcity of data has been noted in several reports and reviews, including the recent audit reports by the Natural Resources Commission of the South Coast groundwater sources water sharing plan. Obtaining this data is important for effective natural resource planning, as well as irrigation management and planning.

Implementing the NSW Government's non-urban metering framework will ensure around 31% of water (surface and groundwater) supply works will be metered along the coast by 2023. This metering will provide a good starting point to better understand the impact of water extraction in the South Coast region.

While the current metering reforms target larger water users, smaller water users taking water under licences and basic landholder rights, can also have a large impact on water resources during low-flow events. Additionally, increases in water extraction under basic landholder rights, particularly from the recently announced increase in the harvestable rights limits in coastal-draining catchments, may increase unmetered water take across the South Coast region.

This action aims to give us a better understanding of the impact of extraction limits on water sharing plan objectives and may allow us to better manage competition during low flows. It will expand on the current metering reforms by investigating opportunities to further improve how we monitor water extraction across the region. These investigations would consider alternative, innovative methods for collecting data (such as satellite imagery or GIS databases) to estimate water use, or calibrating electricity meters to track pump rates and use. This action may also include incentives for voluntary uptake of metering and telemetry, or a review of thresholds for pump sizes requiring metering.

These types of initiatives have already been flagged through the recent announcement of recent changes to the coastal harvestable rights limit in coastal areas. The NSW Government has purchased high-resolution satellite imagery to better understand the current levels of uptake of harvestable rights dams. Further, landholders who build new or enlarged dams – above their existing maximum harvestable right dam capacity – will also need to notify the change with the

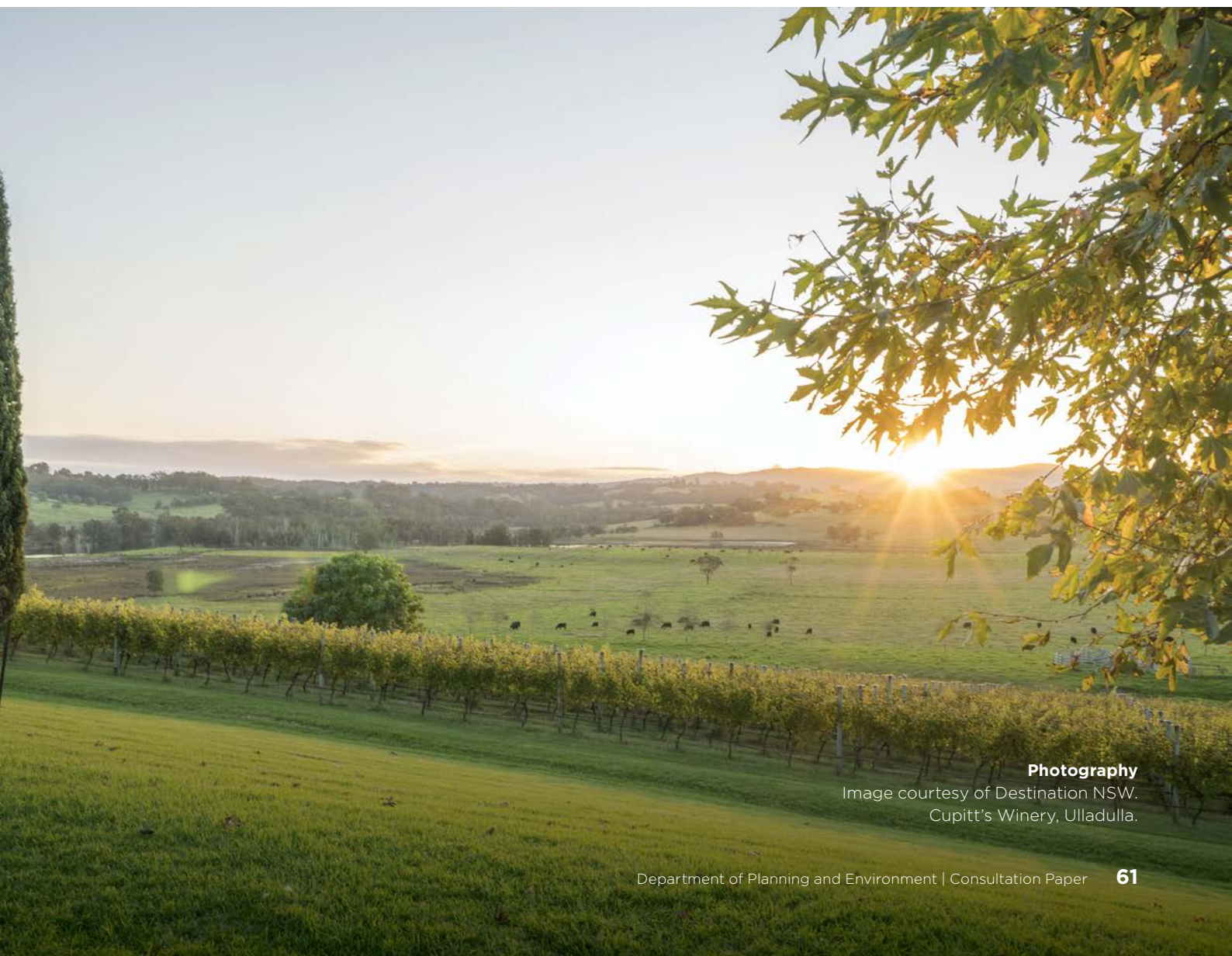
relevant water agency. These initiatives will provide important information to both planners and regulators.

Improving how we monitor water take is critical to guiding future water sharing decisions. It also provides a useful tool for landholders to identify where water use can be reduced to help build resilience against extended dry periods.

Have your say



- What other options are available to improve how water extraction is monitored in the region?



Photography

Image courtesy of Destination NSW.
Cupitt's Winery, Ulladulla.

Ensure water resource development and use is sustainable and equitable

Sustainable water management means that we meet the water needs of the present without compromising the ability of future generations to do the same. Ensuring this for the South Coast region will require improved management of water use between various users, as well as reducing the impact of infrastructure on waterway health.

What we have heard so far



- The strategy should focus on sustainable water use and options that improve demand management, increase water use efficiency, protect ecosystems and water sources, and enable river connectivity.
- Water infrastructure should be upgraded or designed to reduce impacts on river connectivity, the movement of native fish, waterway health and cultural and economic fishing practices.
- Flow objectives need to be based on a good understanding of natural flows.
- Water needs to be more accessible for Aboriginal communities. The water licensing framework need to be easier to understand and more flexible for Aboriginal people to exercise their rights.
- Supporting employment opportunities for local Aboriginal people is a priority.

What we are already doing



- The NSW Water Strategy has committed to the sustainable management of surface water and groundwater systems. These initiatives include better integrating land use planning and water management, reviewing water allocation and water sharing in response to new climate information, and the development of the NSW Groundwater Strategy.
- The Department of Planning and Environment is applying a new risk-based assessment process to help understand the relative impact of various water sharing plan rules on key environmental functions (such as impacts on low flows, freshes and water quality due to reduced inflows). This new approach is being considered as part of the review or remake of coastal water sharing plans.
- The NSW Fish Passage Strategy provides a coordinated 20-year plan to proactively restore unimpeded fish passage and improve native fish access to main-stem rivers and key off-channel habitats across NSW. The strategy, led by the Department of Regional NSW (Department of Primary Industries—Fisheries), provides a framework for prioritising restoration work across the state and South Coast region.
- The NSW Government is currently updating the Illawarra Shoalhaven and South East and Tablelands regional plans. The objectives of these plans recognise the need to think holistically about water management and to encourage innovation in water efficiency and whole-of-water-cycle management.



Photography

Image courtesy of the Destination NSW,
Deua National Park, Deua.

Review of Harvestable Rights

From early 2022, landholders in the South Coast region will be able to capture a maximum of 30% of the average regional rainfall runoff from their property in harvestable right dams built on non-permanent minor streams, hillsides and gullies. The remaining run-off will continue to flow into licensed dams and the local river systems, where it is shared the environment and other downstream water users.

This increase from a 10% to 30% limit follows a review and community consultation of harvestable right limits in coastal-draining areas of NSW.¹² It will provide landholders in these regions better access to water storage for domestic and stock and extensive agriculture, such as stock grazing and pasture irrigation. It excludes intensive livestock and plant agriculture, such as horticulture and feedlots. Water taken under the existing 10% harvestable right can continue to be used for any purpose.

A number of critical steps have been completed to support these new arrangements. These include:

- further consultation with native title holders
- determining a method for setting a landholder's revised maximum harvestable right dam capacity
- adjusting the harvestable right calculator on the WaterNSW website
- working with other agencies, including the Natural Resources Access Regulator (NRAR), on monitoring and enforcement issues

- replacing the harvestable rights Order applying to the Central and Eastern Division with 2 separate new Orders
- supporting landholders and the public to understand the changes.

The South Coast Regional Water Strategy will provide a path for supporting the implementation of these changes, while effectively managing future impacts from an increased uptake in the higher limit on downstream water needs, including those of the environment. During 2022/23 the department will assess whether the increase to a 30% harvestable rights limit is appropriate for each catchment and sub-catchment water source, or whether an alternative limit should apply.

The department will include an amendment provision in upcoming water sharing plans to review the uptake of harvestable rights by either year 3 or year 5 of the plan. The provision will require a review of access, trade and water supply work approval rules if the uptake of harvestable rights has increased above the 10% limit in the original Harvestable Rights Order. Updated plans will include an estimate of the current uptake in harvestable rights within the long-term average annual extraction limit.

Through such action, the South Coast Regional Water Strategy can help ensure these changes not only improve water security for rural landholders but also consider the impacts on downstream environments and licenced users.

12. www.industry.nsw.gov.au/water/licensing-trade/landholder-rights/harvestable-rights-dams/review

Photography

Image courtesy of Department of Planning and Environment, Biamanga National Park, NSW.



Photography

Image courtesy of iStock.
Malabar Creek, Moruya River, NSW.

Legend



Declining catchment and river health



Competition for low flows



Saltwater intrusion into freshwater sources



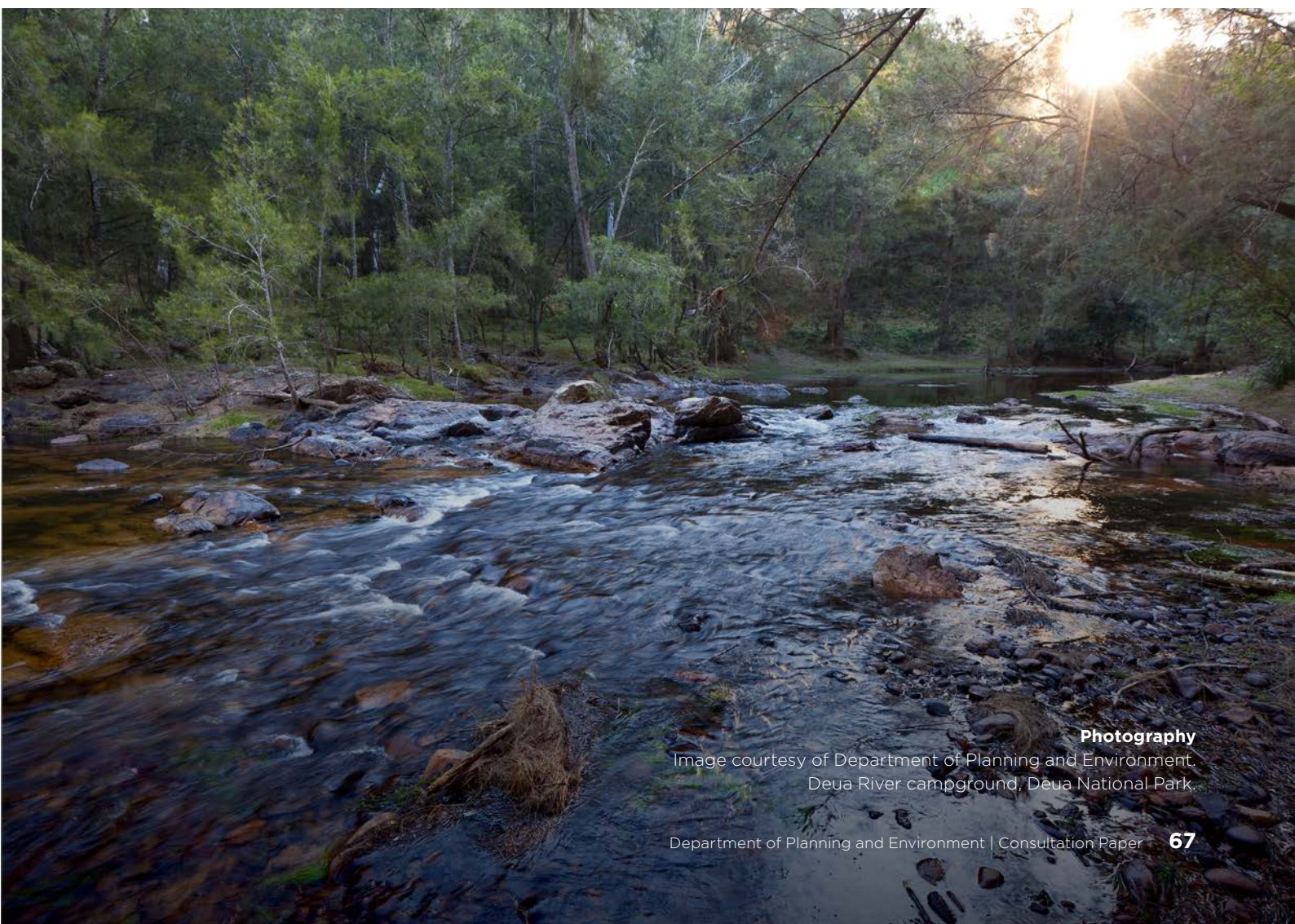
Aboriginal people's rights and access to water



Water security for South Coast towns and industries

Proposed actions	Description	Challenges addressed
Reduce the impact of water infrastructure on native fish populations		
Action 2.1 Improve fish passage	Implement the NSW Fish Passage Strategy to replace or remediate 6 high priority fish barriers in the South Coast region: Buckenbowra Dam, Currowan Creek–Western Distributor, Shallow Crossing, Clyde Ridge Road, Burra Creek Weir and Wadbilliga Road.	 
Action 2.2 Implement fish-friendly water extraction	Promote and implement the strategic installation of diversion screens on irrigation pumps and diversion offtakes, across priority waterways and irrigation channels.	 
Better manage competing demands for water		
Action 2.3 Establish sustainable extraction limits for surface water and groundwater sources	Review the existing long-term average annual extraction limits for surface water and groundwater sources to ensure they are sustainable; are based on best available science; and protect ecological, economic, social and cultural water needs.	    
Action 2.4 Implement daily extraction limits	Investigate and assess options for implementing daily extraction limits and determine an approach that would cost-effectively ensure the protection of low and medium flows in streams where there is high competition for water.	    

Proposed actions	Description	Challenges addressed
Action 2.5 Reduce the take of low flows	Investigate and assess options for reducing water extraction during low flows focusing on the effectiveness of high-flow conversions, adopting low-flow bypasses for farm dams, and options for landholders to store water extracted from the region's streams under basic landholder rights.	   
Action 2.6 Address catchment-based impacts of increased harvestable rights limits	Ensure that any impacts on downstream licence holders and the environment resulting from the uptake of increased harvestable rights are understood at the local scale and potential impacts from any increase are considered (and managed where necessary) in future water sharing plan arrangements.	  
Action 2.7 Support Aboriginal business opportunities	Support Aboriginal people to develop business opportunities in the South Coast region, some of which may require access to water.	 



Photography

Image courtesy of Department of Planning and Environment.
Deua River campground, Deua National Park.

Reduce the impact of water infrastructure on native fish populations

Many native fish species in the South Coast region require free passage up and down the region's rivers: to access food, avoid predators and find shelter; and seasonally to spawn, migrate and reproduce. Removing high-risk barriers to fish movement will help the resilience of fish species, particularly those that are threatened or endangered.

Proposed action 2.1: Improve fish passage

Physical barriers to fish passage such as weirs, floodgates, causeways and bridges can limit fish movement, leading to a decline in the health and viability of native fish populations. Removing barriers to fish movement and allowing fish to breed, find food and locate ideal habitat is critical to supporting native fish populations in the South Coast region.

The NSW Fish Passage Strategy aims to address the highest priority fish barriers remaining in NSW. This action would remediate fish passage at 6 priority barriers in the South Coast region: Buckenbowra Dam, Currowan Creek–Western Distributor, Shallow Crossing, Clyde Ridge Road, Burra Creek Weir and Wadbilliga Road.

Proposed action 2.2: Implement fish-friendly water extraction

Every year, large numbers of native fish are removed from rivers. Adult fish as well as juveniles, larvae and eggs are extracted by pumps, along with debris such as sticks and leaves. This impacts the sustainability of native fish populations and can also cause damage to irrigation infrastructure.

Installation of screens at pump sites can reduce fish losses at these sites by over 90%, helping more fish survive to maturity and boosting fish numbers. The protection also extends to other aquatic species such as crayfish and turtles.

As well as benefiting fish, the screens will help prevent blockages caused by debris. This will avoid damage to irrigation infrastructure and improve pump operation, water delivery and extraction efficiency for asset owners.

This action proposes to support the installation of screens on pumps at key sites across the South Coast region. The action will confirm the location of diversion pumps and prioritise where the installation of screens will have the largest impact – for example, in protecting threatened or susceptible species. The project will include high-level costing and an implementation plan to support landholders install screens in priority locations.

Have your say



- What support do irrigators require to implement screens on pumps?

Better manage competing demands for water

Governments have a legal responsibility to ensure that water is allocated and used to achieve beneficial environmental, social and economic outcomes. We need to review how we regulate extraction across the region to ensure that we appropriately meet this responsibility, particularly in managing competing demands for water during dry and low-flow periods. We also need to provide greater opportunities for Yuin people to gain access to water.

The following proposed actions would help provide confidence that the rules that determine water sharing arrangements are equitable and sustainable, while also providing opportunities to shift water demand and extraction out of critical low-flow periods.

Proposed action 2.3: Establish sustainable extraction limits for surface water and groundwater sources

Setting long-term average annual extraction limits (LTAAELs) in water sharing plans across the South Coast region would maximise water resource development within ecological boundaries and ensure water is shared equitably among users. Moving to a regime that is based on science and the capacity of the region's surface water and groundwater systems would better protect the region's environmental assets. It would also provide water users with a greater level of certainty in their share of the resource, from which they can confidently make business investment decisions. In some areas, calculating LTAAELs may help identify where additional entitlements or extractions may occur.

There are different steps for establishing sustainable surface water and groundwater LTAAELs:

Surface water long-term average annual extraction limits (LTAAELs)

1. Review how other jurisdictions define and calculate sustainable extraction limits.
2. Develop methods for determining sustainable surface water LTAAELs, considering legislative requirements and available data and resources, potential changes to catchment hydrology from climate change, ecological needs (including marine park values), and potential future increases in water extraction under basic landholder rights, including water taken in harvestable rights dams.
3. Apply, consult and assess methods in trial catchments to understand environmental, social, economic and cultural impacts.
4. Adopt preferred method and develop supporting implementation policy.
5. Prioritise implementation of sustainable surface water LTAAELs for water sharing plans.
6. Quantify sustainable surface water extraction limits and amend water sharing plans.
7. Where the revised sustainable surface water LTAAEL is larger than the existing limit, develop and implement a controlled allocation strategy to issue new water access licences.
8. Monitor, evaluate and review.

Groundwater long-term average annual extraction limits (LTAAELs)

1. Based on new data and information, review and update the current method to calculate sustainable extraction.
2. Prioritise implementation of sustainable groundwater LTAAELs for water sharing plans.
3. Quantify sustainable groundwater extraction limits and amend water sharing plans.
4. Where the sustainable extraction limit is calculated to be larger than the current limit, update and implement the controlled allocation strategy to issue new water access licences.
5. Monitor, evaluate and review.

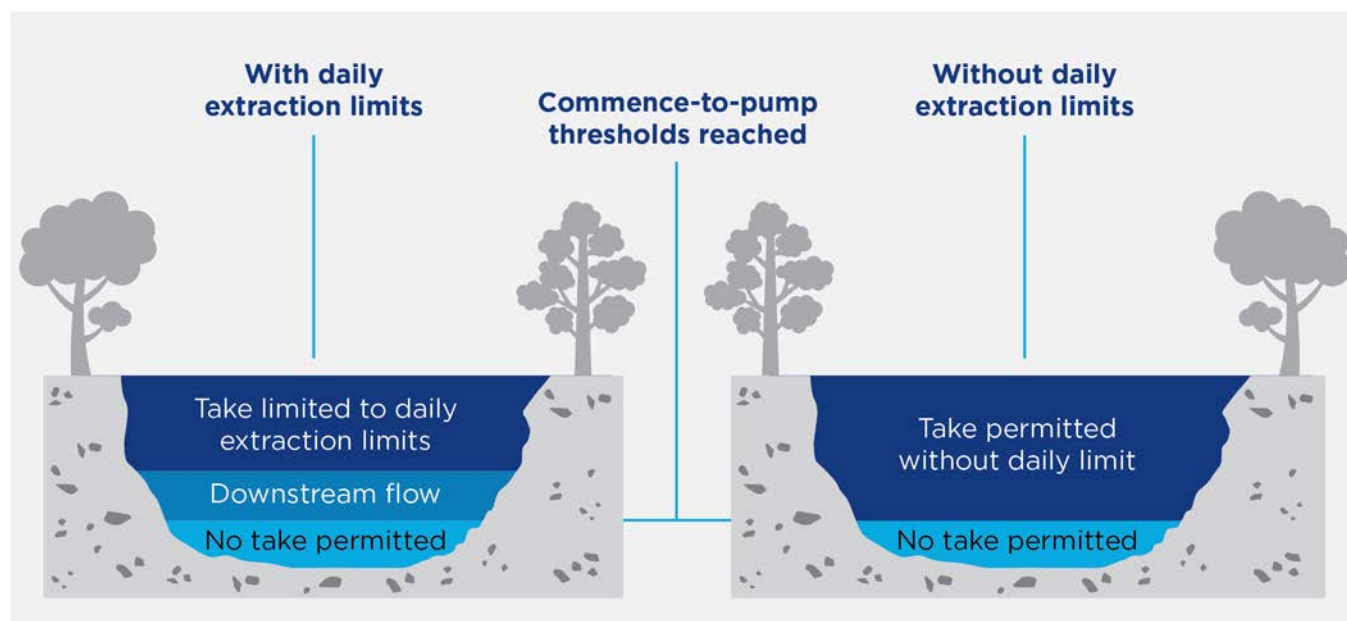
Proposed action 2.4: Implement daily extraction limits

This action would investigate and assess options for implementing daily extraction limits and determine a cost-effective approach that would ensure the protection of low and medium flows in streams where there is high competition for water.

Daily extraction limits restrict the impact of rapid removal of water during peak irrigation periods

(Figure 12). They have been written into water sharing plans to protect low and medium flows so that there is enough water in a system at any one time for the environment, non-extractive users (aquaculture, cultural, recreation) and downstream water users. Implementing daily extraction limits requires stream gauging and monitoring, daily measurements (or estimates) of water extraction, and someone to coordinate extractions amongst water users.

Figure 12. Daily extraction limit concept



The NSW Government previously supported the implementation of daily extraction limits in some catchments by providing field officers to coordinate extractions among water users. However, the government ceased carrying out this role about a decade ago, with the expectation that water user groups would implement daily extraction limits in line with

water sharing plan rules. In most cases, this has not eventuated because water user groups lack established infrastructure, systems and incentives. Consequently, daily extraction limits are not being implemented and the environment, downstream water users and non-extractive water users risk not receiving their designated share of low and medium flows.

Proposed action 2.5: Reduce the take of low flows

This action would investigate and assess options for reducing water extraction during low flows. The assessments would focus on:

- the effectiveness of high-flow conversions
- adopting low-flow bypasses across catchments
- options for landholders to store water extracted from the region's streams under basic landholder rights.

Reducing the take of low flows would improve river connectivity and natural flow variability in the region's rivers and complement other actions proposed in the South Coast Regional Water Strategy aimed at improving river health.

High-flow conversions

In some water sources in the South Coast region, water users can apply to have their existing water access licence converted to allow extraction of a greater volume of water under high flow conditions. The high-flow conversion rule applies in catchments that are gauged and experiencing hydrologic stress.

As described above in 'Which challenges should we focus on first?', no licence holders in the South Coast region have taken up the opportunity to convert their entitlement – mainly because the proposed conversion rates do not provide enough water security benefits to offset the additional costs of irrigating from on-farm storages. Widespread adoption across a catchment would increase the protection of low flows and improve river connectivity during dry times, while increasing the water available for extraction during wetter times. Any modification to the current conversion rate would also need to consider the impact on all parts of the flow regime, particularly high flows, and subsequent changes to river health, the reliability of downstream licences, and social or cultural values.

Overcoming constraints in constructing and operating on-farm storages (proposed action 3.3) and an improved understanding of climate risks to surface water availability in the region, may make high-flow conversions more viable in the future.

Have your say



- What barriers do we need to overcome for irrigators to convert to high-flow licences?



Image courtesy of Jeremy Kinley, Department of Planning and Environment.
On-farm dams in the Bega Valley.

Photography

Low-flow bypasses

Farm dams offer increased water security for landholders but reduce the volume of runoff that makes its way into downstream waterways. The impacts are greater during extended dry periods, when the volumes of water stored in farm dams is typically low, and the dams are configured in a way that prevents all runoff from passing downstream. Farm dams fitted with devices that allow some runoff to bypass or flow through the dam reduce their impact on low flows, while still offering water security benefits for landholders.

A targeted, catchment-wide program investing in low-flow bypasses on existing dams has the potential to restore more natural streamflows in the region's stressed waterways. The Department of Planning and Environment will commission a

desktop review of the use of low-flow bypasses in other jurisdictions to inform further potential measures for mitigating downstream impacts from an increase in extraction from coastal harvestable rights dams. Subject to the findings of this review, field trials will be conducted to test their design efficacy under a range of NSW coastal conditions and their cost effectiveness. The outputs of these investigations will be a key input to understanding the benefits and constraints of low-flow bypasses more broadly.

Low-flow bypasses may also be necessary to mitigate the environmental impacts of infrastructure options being proposed through the South Coast Regional Water Strategy, such as investigating increased on-farm water storage (proposed action 3.3).

Figure 13. Low-flow bypass technology¹³



Source: Diagram copied from *Flows For the Future – Factsheet #1*, South Australian Government Department of Environment and Water

13. Adapted from *Flows For the Future – Factsheet #1*, South Australian Department of Environment and Water.

Storage of water extracted under basic landholder rights

Landholders with river frontage are allowed to extract water under very low flow conditions under their basic landholder rights, regardless of water sharing plan cease-to-pump rules. Extracting water under these rights during higher-flow periods and storing in tanks or turkey nest dams¹⁴ can reduce the volume of water extracted from stressed rivers and delay the need to cart water from town water supply networks.

State and local government rebates on rainwater tanks have assisted in addressing this problem. We need to better understand the extent to which current and future growth of water extraction under basic landholder rights threaten environmental assets.

Proposed action 2.6: Address catchment-based impacts of increased harvestable rights limits

The recent decision to increase the current harvestable rights limit from 10% to 30% in coastal-draining areas includes a range of mitigation measures to manage the impact of these changes on downstream users.

This action supports the implementation of these mitigation measures through the following two measures:

- *Further analysis to confirm the appropriateness of the 30% limit at a local level:* An assessment will be conducted at the

water-source scale to determine whether a higher or lower limit – including reverting to the previous 10% limit – is more appropriate in the longer term. The action would prioritise catchments (or water sources) across the South Coast region based on the sensitivity of the downstream environment or the likely uptake of the new limit. Landholders will be required to adjust any works at their own cost to ensure they comply with the new limit.

- *Introduce levers to manage future impacts from an increase in the uptake of harvestable rights on existing water sharing plan arrangements:* An amendment provision will be included in upcoming water sharing plans to review the uptake of harvestable rights by either year 3 or year 5 of the plan. The provisions will require a review of access, trade and water supply work approval rules if the harvestable rights uptake has increased above the 10% limit in the original Harvestable Rights Order. The review will occur within the first 3 years for all areas where there is a high possibility of uptake of increased harvestable rights.

Revised coastal water sharing plans will also include an estimate of annual extractions under harvestable rights in establishing the long-term average annual extraction limits. This is an important first step in ensuring harvestable rights take is included when establishing sustainable long-term average annual extraction limits into the future (see proposed action 2.3).

14. A dam with a completely enclosed earth embankment that is filled by pumping water from alternative water sources.

Proposed action 2.7: Support Aboriginal business opportunities

During our consultation on the Draft South Coast Regional Water Strategy we heard of a need for, and support of, business opportunities in the region that are led by Aboriginal communities.

Investing in local Aboriginal businesses can help diversify incomes, create employment for local Aboriginal youth, and help deliver positive social and economic outcomes for Aboriginal people. Realising some of these opportunities may require access to surface water or groundwater resources.

This action will focus on supporting Aboriginal business development opportunities in the South Coast region and will be led by the Department of Regional NSW. Through the Aboriginal Partnership Program, a dedicated Aboriginal Senior Regional Coordination Officer will work with Aboriginal organisations, businesses, and individuals to identify and develop new business opportunities (or better manage existing ones) and access support or grant funding.

Other support is also available through NSW Department of Aboriginal Affairs, NSW Aboriginal Lands Council and National Indigenous Australians Agency. The Aboriginal Partnerships program within the Department of Regional NSW works in collaboration with local Aboriginal community representatives to co-design solutions and use NSW Government programs to increase economic participation, grow employment, improve skills and employability, and enhance services for Aboriginal people in regional NSW. There are 9 Senior Regional Coordination Officers who work in communities across NSW to deliver the program.

A dedicated Senior Regional Coordination Officer – Aboriginal Partnerships will be available to work with the Local Aboriginal Land Councils to progress their project ideas.

Photography

Image courtesy of the Department of Environment and Planning.
Lilly pilly/riberry, Aboriginal bush tucker food.





Photography

Image courtesy of Destination NSW.
Wallaga Lake Bridge, Bermagui.

Prepare for future climatic extremes

We need to prepare for future climate variability, particularly extended dry periods, to help build a stronger and more resilient region. Providing more and better information on the impacts of climate change on water resources will allow the community to plan better for the future, particularly local councils and businesses that are highly dependent on water. The resilience of local industries will be strengthened by having the tools and infrastructure at hand to make the most of existing water supplies and manage risks of increased climate variability and change.

What we have heard so far



- The need for greater water security, particularly in times of drought, was an important priority for town water and industrial water users. Improved water reliability through increased harvestable rights and the ability to trade an increased volume for on-farm storage and irrigation would help the agricultural industry to reduce costs, forward plan and expand with confidence.
- It was also noted that any change to harvestable rights needs to be well regulated and not impact downstream environments, in particular sensitive estuaries that are already under stress.
- Increasing the amount of water stored across the landscape would help facilitate the response to future bushfires. Maintaining greener pasture lands for longer into the summer drying period would also provide some bushfire protection.
- There was support for recycled water schemes, such as Shoalhaven Water's Reclaimed Water Management Scheme, but only if there is due consideration of environmental constraints and impacts.
- There was support for policies that would assist the community during dry periods such as applying the NSW Extreme Events Policy to coastal regions.
- Some participants were concerned that climate data modelling takes an overly conservative view of the possible extreme events and that basing decisions off the worst-case scenarios may skew planning outcomes.

What we are already doing



- The \$1 billion Safe and Secure Water Program supports councils to implement infrastructure and non-infrastructure solutions to address key risks to regional water safety and security.
- The Town Water Risk Reduction Program is currently underway. Its aim is to work with councils to develop a new framework to better support local councils manage safe, secure and sustainable water supply and sewerage services to regional communities across NSW.
- The Government will support water utilities to diversify sources of water including groundwater, stormwater harvesting and recycling. This will include progressing relevant regulatory reform and community acceptance campaigns to help increase the uptake of diverse water sources with the potential to increase water security and resilience for towns and communities.
- The NSW Water Strategy has also committed to increasing the resilience of the region's water users to changes in water availability. This includes supporting more efficient water use by industry and improving drought planning, preparation and resilience.



Photography

Image courtesy of Destination NSW.
Pigeon House Mountain (Didthul), Moreton National Park.

Legend



Declining
catchment and
river health



Competition for
low flows



Saltwater
intrusion into
freshwater
sources



Aboriginal
people's rights
and access
to water



Water security
for South Coast
towns and
industries

Proposed actions	Description	Challenges addressed
Support water users to manage risks		
Action 3.1 Provide better information about water access, availability and climate risks	Improve existing platforms and products to provide information about water availability and climate change in forms that are suitable to stakeholders to allow better business planning.	 
Optimise use of existing water supplies		
Action 3.2 Review water markets	Review water markets to ensure water security, encourage trade efficiencies and allow transparency of information.	 
Action 3.3 Investigate increased on-farm water storage	Assess the barriers to constructing on-farm storages, and the value of on-farm storages to landholders, industry and local fire-fighting.	 
Action 3.4 Investigate delivery efficiency improvements for the Bega-Brogo regulated river system	Investigate improvements in efficiency of water deliveries to the tidal pool in the Bega-Brogo regulated river system.	  
Action 3.5 Identify the best option to improve water security for the Bermagui town water supply system	Undertake a study to assess the benefits, impacts and costs of a range of options to identify the best solution to improve security of water supply for Bermagui.	 
Action 3.6 Improve water security for lower Tuross water users	Develop and assess options to provide greater water security for lower Tuross water users.	  

Support water users to manage risks

Proposed action 3.1: Provide better information about water access, availability and climate risks

The NSW Government's Future Ready Regions Strategy recognises that providing clear and accessible information on surface and groundwater availability allows industries to plan with certainty. This data is often not accessible or available to water users in a format that is useful to their needs or preferences. Recent consultation on the coastal regional water strategies and the review of the coastal harvestable rights limit echoed this concern, with stakeholders stating they did not know who to contact for advice on their options for accessing water. This ultimately affects landholders' ability to make optimal business decisions particularly when considering the impacts of extended dry periods.

The NSW Government is committed to supporting better planning and decision making for normal and dry times by providing more information and data to enable businesses to make the right decisions for their circumstances. For example, access to good climate information ahead of time, and sound risk management and business planning are significant determining factors in the ability of farming businesses to weather prolonged droughts.

The new climate data that has been published as part of the regional water strategies is a key step in providing more information to water users and managers on the risks of different climate scenarios on the reliability of their licences over the long term.

The NSW Government can design and deliver suitable training and information products in relation to:

- medium-term climate outlooks over the next 12 months. This will look at how climate outlooks will influence water availability, to help water users make informed decisions on managing their allocations, irrigation patterns or trading water on the market
- implications of the long-term climate data on surface water availability, the likelihood of consecutive years of low or no water availability, and on periods where access to water allocations may be restricted by delivery problems in the Bega-Brogo regulated river system
- implications of the long-term climate data on groundwater availability from different aquifers
- understanding water access options in coastal areas, including the implications of the recent changes in the coastal harvestable rights limit.

The NSW Government will consult with stakeholders and review the ways water information is made available to users to improve usability and accessibility. Where appropriate, this work would build on existing information platforms and products to provide data in forms that are suitable to stakeholders.

Have your say



- What water information would you like made available?

Optimise use of existing water supplies

Water resources are finite, and by using water wisely today, we can support thriving and resilient communities in a drier future. Current rules and regulation aim for flexibility in how and when water is extracted while protecting the environment and other water users. The following actions propose to review these rules to ensure they provide the flexibility needed for local businesses to prepare for and manage drought.

Proposed action 3.2: Review water markets

Climate modelling indicates that the South Coast region is likely to experience more frequent droughts and drier conditions in the future. Active and effective water markets are important for maintaining a thriving regional economy by enabling industries, especially those reliant on unregulated water, to prepare for drier conditions. Trade could also be used as a key tool in shifting water demands from low flows to high flows in the region's unregulated rivers, consistent with the regional priority to better manage competing demands for water.

Active and effective water markets could play an important role in increasing water usage in the Bega-Brogo regulated river system and improving the financial operations of Brogo dam. Hydrologic and economic modelling carried out as part of the South Coast Regional Water Strategy explored the benefits of increasing usage of the Bega-Brogo regulated river system by activating sleeper entitlements, which are up to 50% of entitlements in some reaches. This modelling showed that, based on instrumental data, there could be an 8% increase in the median annual general security usage, based

on an increase in the median area planted in the regulated river areas of 10%. Net economic benefits were also modelled when trade-activated use in the regulated system was combined with increasing on-farm storages in the unregulated systems, consistent with proposed action 3.3: Investigate increased on-farm water storage. The benefits of these combined options are concentrated largely in the growth of perennial pasture on average over the 40-year period with minimal impact on town water supplies.

This action would investigate why so little trade has occurred in region's unregulated, regulated and groundwater sources, and identify what improvements can be made to its water markets.

The Australian Consumer and Competition Commission identified common elements of effective water markets in its *Murray-Darling Basin Water Markets Inquiry*. This action would assess how well South Coast region water markets are set up to deliver these key elements, by identifying and exploring barriers for participation in the markets. This action would also consider the extent to which the issues and barriers identified in the *Murray-Darling Basin Water Markets Inquiry* would apply to a more developed water market in the South Coast region.

Recommended actions arising from this investigation would be informed by forecast behaviour change and more detailed hydrologic and economic analysis of benefits and costs. They would also be informed by recommendations from the department's review of trade rules in unregulated catchments, proposed action 2.3: Establish sustainable extraction limits for surface water and groundwater sources and the Australian Consumer and Competition Commission's water markets inquiry.

Have your say



- What are the barriers to buying or selling water through the water market on the South Coast?

Proposed action 3.3: Investigate increased on-farm water storage

This action considers water harvested and stored in farm dams under a water access licence, and would investigate:

- current levels of on-farm storage and usage as well as barriers to constructing them
- options to mitigate downstream environmental and water security impacts of on-farm storages, such as the provision of low-flow bypasses
- the value of on-farm storages to various South Coast industries and as a local water supply to fight bushfires
- options for incentivising the uptake of on-farm storage.

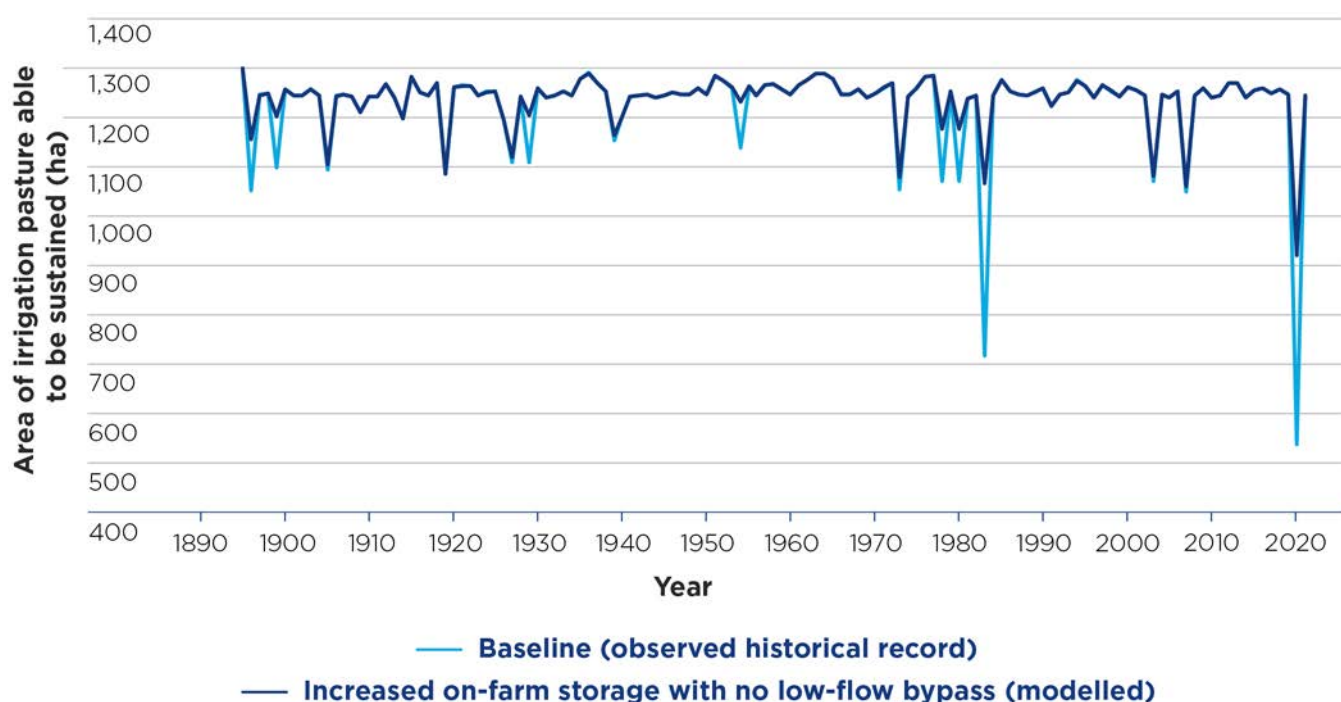
On-farm dams can be either *catchment dams* constructed in a drainage line or gully, or *turkey-nest dams* which do not harvest surface flows and must be filled by pumping. Landholders usually prefer catchment dams because they are cheaper to construct and operate. They can be sited in less productive gully country and naturally fill following rainfall. Conversely, turkey-

nest dams need to be sited on flat land, which are often productive alluvial flats, and require pumping to be filled. Turkey-nest dams have less environmental impact.

Increasing the volume of water stored on farms will help landholders in unregulated catchments manage the impacts of climate change on water security. Furthermore, capturing runoff high in the catchment and applying it for irrigation in drier times will assist in retaining water in the catchment for longer periods. Water in farm dams also provides vital supplies to help fight bushfires.

Preliminary modelling of this option across the Bega River catchment, based on 21 on-farm storages ranging from 100 to 600 ML with a total storage volume of 6,300 ML, illustrated the potential water security benefits of increased on-farm storage (Figure 14). The modelling showed the greatest benefits of on-farm storages are realised in the drier years. Our modelling indicates that increasing on-farm storage could support more irrigation for pasture (e.g. almost 50% more in 1983 and more than 70% in 2020). In the 15 driest years over the historic record, the same level of on-farm storage without low-flow bypasses could have increased water provided to pasture, on average.

Figure 14. Area (ha) of irrigated pasture able to be sustained with and without additional storage¹⁵



15. Department of Planning and Environment—Water 2021, South Coast Regional Water Strategy climate data and hydrologic modelling.

Any proposal to construct new dams must consider the impact on catchment hydrology, and in particular, the potential impact on low flows. Dams can be constructed so that low flows are not captured but are allowed to pass through or around the dam. Low-flow bypasses are discussed in proposed action 2.5: Reduce the take of low flows.

As on-farm dams can increase how much licensed water is taken, this action may risk placing further pressure on rivers and streams already under hydrologic stress. This action will have the greatest benefits to extractive users and the least impact

on river ecology if considered in conjunction with actions that shift water extraction away from low flows, which is where the greatest pressure on extraction occurs (proposed action 2.5: Reduce the take of low flows), or through increased trade (proposed action 3.2: Review water markets).

Further, any proposal to increase on-farm storage will need to be considered and implemented alongside the investigations to address catchment-based impacts of increased harvestable rights limits (proposed action 2.6) and establish sustainable extraction limits for surface water and groundwater sources (proposed action 2.3).

Have your say



- Do on-farm dams (including dams with low-flow bypasses as discussed in action 2.5) offer a realistic, environmentally acceptable option for improving water security for landholders and industry?

Photography

Image courtesy of Department of Planning and Environment.
Biamanga National Park, NSW.

Proposed action 3.4: Investigate delivery efficiency improvements for the Bega-Brogo regulated river system

This action proposes to improve the efficiency of water deliveries to the tidal pool in the Bega-Brogo regulated river system.

For much of the time, releases from Brogo Dam are made on top of unregulated flows in the Bega River to supply water to regulated water users downstream of the confluence of the Bega and Brogo rivers. However, larger releases of 50 ML/day from Brogo Dam are required to deliver the same volume of water to the end of system during periods of very low flow in the Bega River.

Our modelling shows that very low flows in the unregulated Bega River are expected to occur more often in the future and will lead to an increased reliance of releases from Brogo Dam. For example, flows below 33 ML/day in the Bega River at Kanoona were modelled to occur 5 percent of the time under historic conditions. Under climate change, this is expected to occur 10 percent of the time. During periods of very low flow in the Bega River, larger releases of 50 ML/day from Brogo Dam are required to deliver the same volume of water to the end of system. Our new modelling also shows that, as a consequence of climate change, demand for irrigation water is likely to increase. Future tidal pool demands for releases from Brogo Dam are also expected to increase as sea levels rise and greater volumes of freshwater are needed to maintain low salinity levels.

A temporary sand barrage located on the Bega River near Jellat Creek currently helps minimise the volume of water WaterNSW needs to release from Brogo Dam to manage salinity levels in the tidal pool. This barrage is subject to a Department of Primary Industries—Fisheries requirement to be breached every 6 weeks to allow fish passage. Being of a temporary nature the sand barrage washes out following moderate rainfall.

WaterNSW and water users have discussed potential options to improve the operation of the Bega-Brogo regulated river system including:

- the continued use of the temporary sand barrage
- a more permanent barrage with fish way
- piping of water from the Bega-Brogo confluence to on-farm storages.

Several outcomes from the regional water strategy will help WaterNSW assess these options with water users and the department. Our new climate data and hydrological model of the Bega-Brogo regulated river system will provide improved data about the performance of the system under increased climate variability. Hydrodynamic modelling carried out in action 1.6 to understand the vulnerability of the Bega tidal pool to sea level rise, will improve our understanding of the freshwater flows needed to mitigate rising salinity levels in the future.

Further, identify the best option to improve water security for the Bermagui town water supply system (proposed action 3.5) and reviewing water markets (proposed action 3.2) will complement efforts to improve the efficiency and utilisation of the Bega-Brogo regulated river system.

Proposed action 3.5: Identify the best option to improve water security for the Bermagui town water supply system

Bermagui town water supply system has been identified as having the greatest unaddressed water security risk in the South Coast region. Bermagui draws its town water supply directly from the Brogo River, with releases supplied by the regulated Brogo Dam.

At the start of each water year a set amount of water is set aside in Brogo Dam for essential needs, which includes water for towns, before water is allocated to other water licences. Currently the reserve is fixed.

During extended dry periods when the capacity of Brogo Dam is low, water releases are reduced to help maintain the supply in the dam and prolong water for towns and other essential needs. Brogo Dam is operated by Water NSW whilst Bega Valley Shire council is responsible for the water supply system to Bermagui. A combination of how the dam is managed and town water infrastructure meant that Bermagui's town water supply faced additional stress during the last drought.

In January 2020, Brogo Dam dropped rapidly to 14% capacity (holding just 1.2 GL). During this period, water releases from Brogo Dam were reduced to approximately 5 ML/day while trying to satisfy Bega Valley Shire Council's 1 ML/day requirement for its Bermagui town water supply system. These very low river levels resulted in a water pool of insufficient depth for the pumps which supply Bermagui to operate properly. WaterNSW was required to make further operational adjustments to raise the height of the river and support town water supplies.

A drier future climate could result in times when the river and dam fall to levels lower than what we

have seen in the past. This may mean that there may not be enough water in the dam to support town water supplies under the current operating regime. We need to understand the best option available to set Bermagui up for this scenario, recognising that some options will have system wide impacts given the town sources water from a regulated dam which supplies water to a range of users.

This proposed action involves investigating a range of options, including changes to policy or Brogo Dam operational regimes, as well as possible infrastructure options to identify the best solution to improve water security for Bermagui. This could include:

- investigate if changing the reserve set aside in Brogo Dam could improve the ability of Brogo Dam to deliver water to the Brogo-Bermagui town water supply during extreme events. The reserve is used to provide water for high priority users such as those holding local water utility, stock and domestic, and high security access licences. Changing the reserve may impact on the reliability of licences for other water users. The system wide benefits and costs of this option would need to be compared with local solutions.
- constructing a weir at the off-take site that will enable a sufficient depth of water to be maintained during periods of low-flows for council pumps to operate. This would allow water to be delivered more efficiently during periods of low-flow, increasing water availability to all Bega-Brogo regulated river system water users.

Any change in policy or new infrastructure being proposed as a result of the investigation would require detailed environmental assessment, including impacts on fish passage, native fish populations (including threatened species), ecological communities and ecosystems.

Photography

Image courtesy of Destination NSW.
Bermagui Point, Bermagui.



Proposed action 3.6: Improve water security for lower Tuross water users

The floodplain of the lower Tuross River supports about 600 ha of irrigated pasture for dairying, generating an estimated average annual income of around \$10 million and directly employing 40 to 50 people. In addition to irrigation, local dairy farms rely upon the Tuross River for stock drinking water and dairy wash-down water. Every few years, during periods of low flow and when the estuary mouth closes, saltwater moves upstream from the Tuross River Estuary into the lower reaches of the Tuross River, threatening essential water supplies for local landholders. With projected sea level rise, the severity and frequency of saltwater intrusion into the lower Tuross is expected to increase.

Historically, a temporary sand barrage has been used to restrict the upstream movement of saltwater to prolong landholders' access to fresh stream flows. The NSW Department of Primary Industries—Fisheries has expressed concerns that the barrage creates a barrier to the passage of native fish.

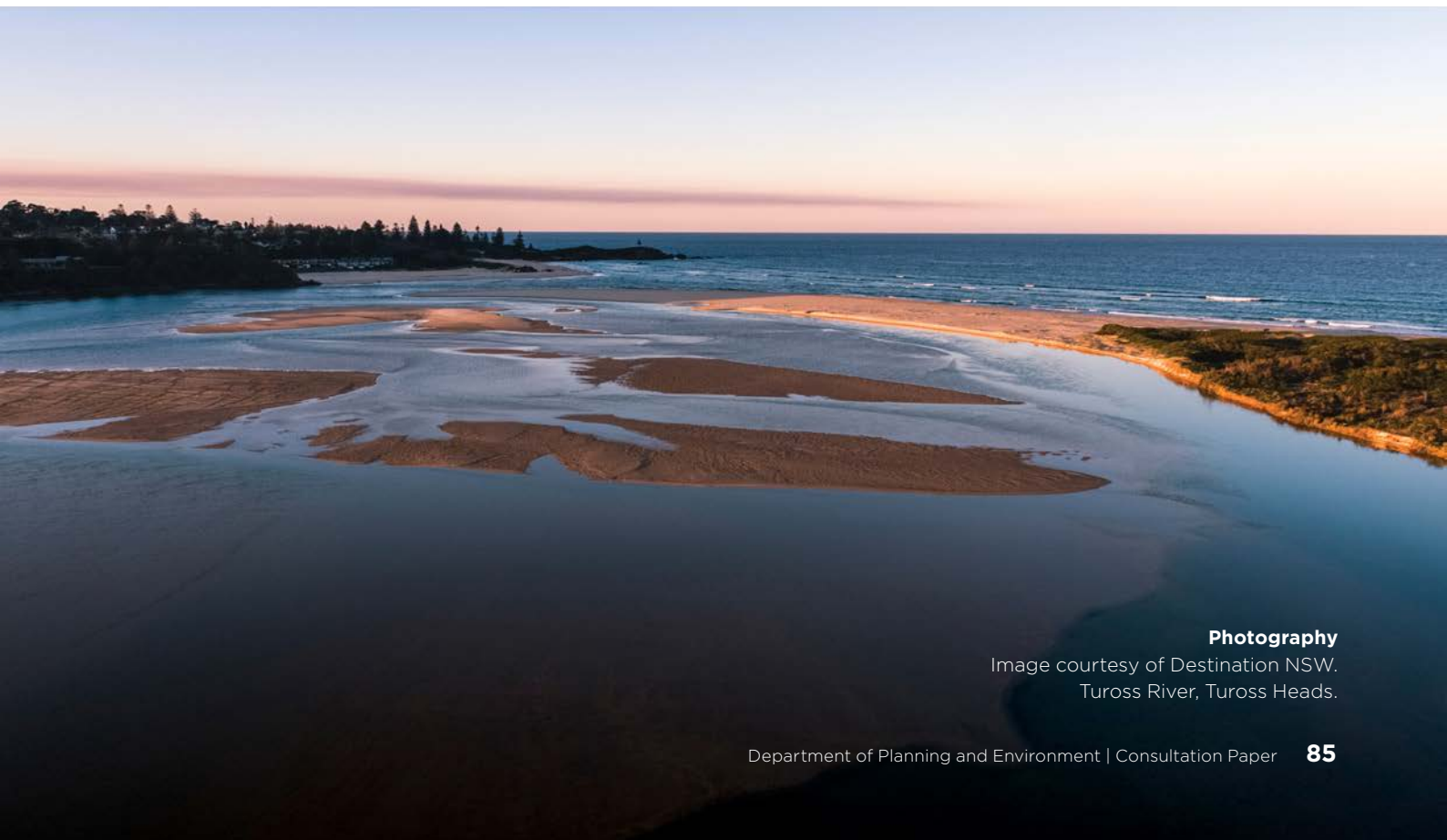
In recognition of the water security challenge for lower Tuross River water users, Eurobodalla Shire

Council revised its design and operation of the proposed Eurobodalla Southern Water Supply Storage to reduce town water supply demands on low flows.

Several options have previously been identified to provide greater water security for lower Tuross water users. This action will build on previous work and further develop and assess options with affected landholders, water users and NSW Government agencies. Options may include:

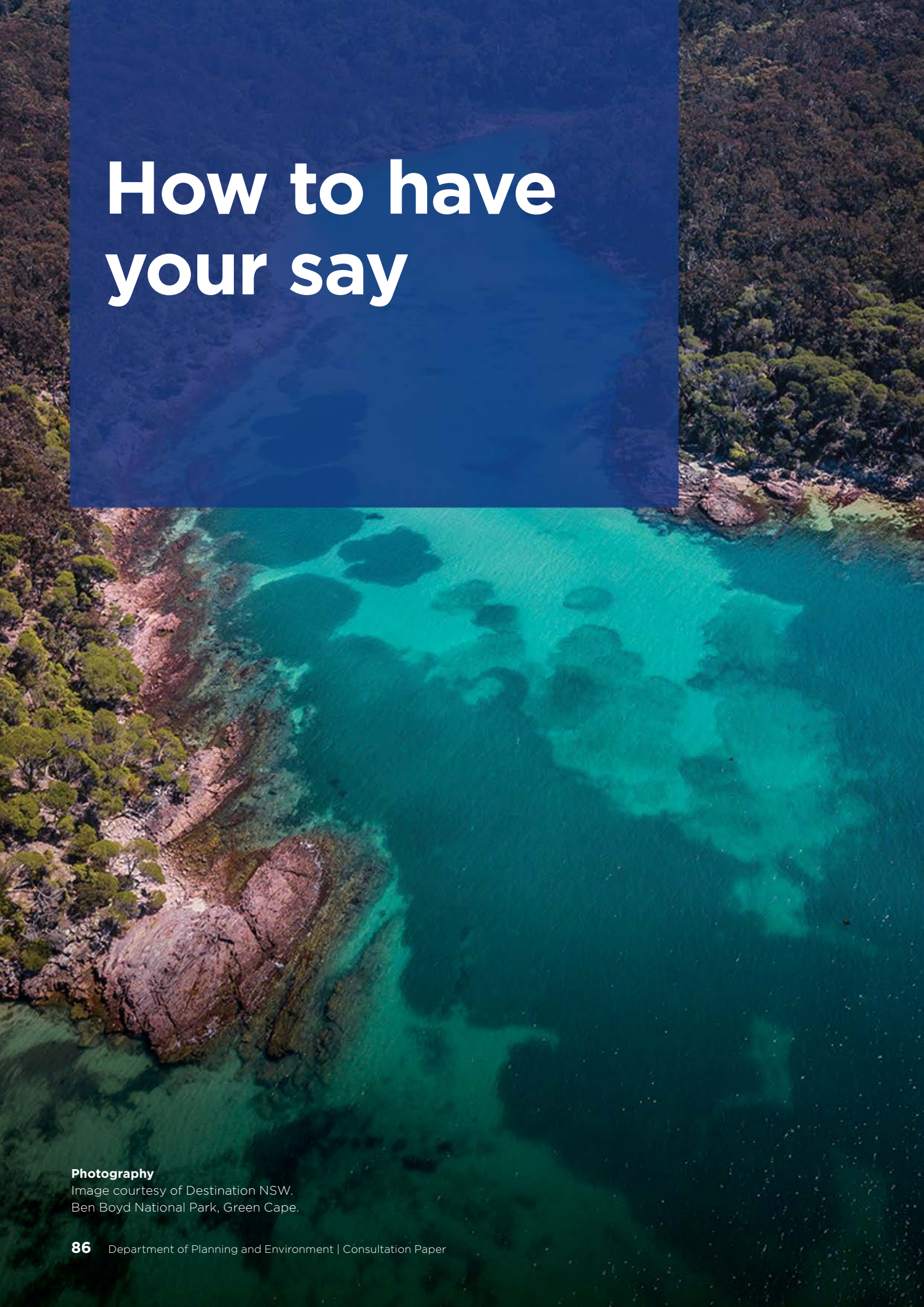
1. Continued use of the sand barrage with temporary fish ladder.
2. Installation of a permanent barrage or weir with fish ladder.
3. Development of groundwater sources to provide stock and dairy washdown water.
4. Increased on-farm storage.

Our new climate data and hydrological model of the Tuross River will provide improved data about the river flows and water availability under increased climate variability. Hydrodynamic modelling carried out in proposed action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion, will help us to better understand the vulnerability of the Tuross tidal pool to sea level rise and will improve our understanding of the future risks to water quality in the area.



Photography

Image courtesy of Destination NSW.
Tuross River, Tuross Heads.

An aerial photograph of a coastline. The top portion of the image is covered by a dark blue rectangular overlay. Below this, the water is a vibrant turquoise color, revealing the rocky seabed. The shoreline is rugged, with large, reddish-brown rock formations and dense green vegetation. The overall scene is a beautiful natural landscape.

How to have your say

Photography

Image courtesy of Destination NSW.
Ben Boyd National Park, Green Cape.

When will the actions be implemented?

A critical feature of the final South Coast Regional Water Strategy is making sure we identify clearly what actions and investments are needed now and those that will or may be needed further into the future. The strategy considers a 20-year timeframe aiming to chart a progressive journey that enables us to meet existing challenges, identify and prepare for foreseeable coming challenges and lay the groundwork for adapting to future uncertainties and changed circumstances.

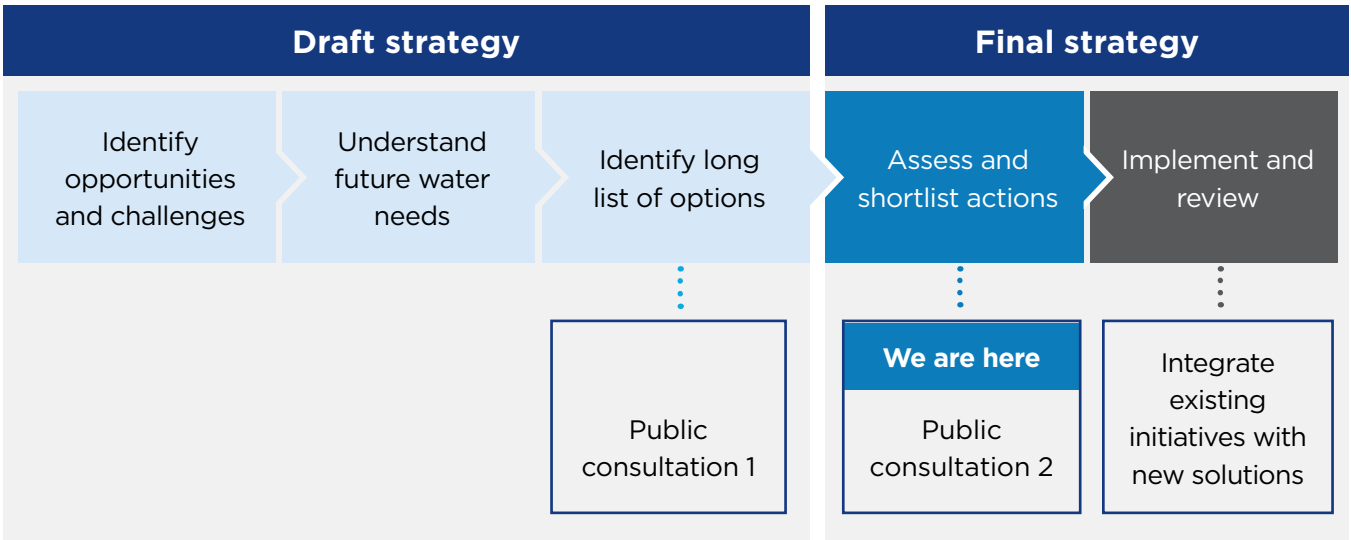
Following public consultation, we will develop an implementation plan that will set out when

we plan to commence each action and what we plan to achieve by when. The implementation plan will also identify key partners in effectively delivering these actions, including local councils, government agencies, local community groups and local aboriginal communities.

Not all actions will be commenced at once, and funding will be a key consideration in planning when and how the actions will be implemented. The regional water strategies will be a key tool in securing funding as future opportunities arise.

We want your feedback on which actions should be prioritised for implementation over the next 3 to 5 years, and which ones should be implemented in the medium or longer term.

Figure 15. Regional water strategy delivery timeline



Your voice is important. This consultation paper is on public exhibition from 4 May to 1 June. Supporting information is available at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/upcoming-public-exhibition/south-coast-regional-water-strategy

You can also have your say by providing written feedback to the Department of Planning and Environment by midnight on 1 June 2022 via:

Web: water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/upcoming-public-exhibition/south-coast-regional-water-strategy

Email: regionalwater.strategies@dpie.nsw.gov.au

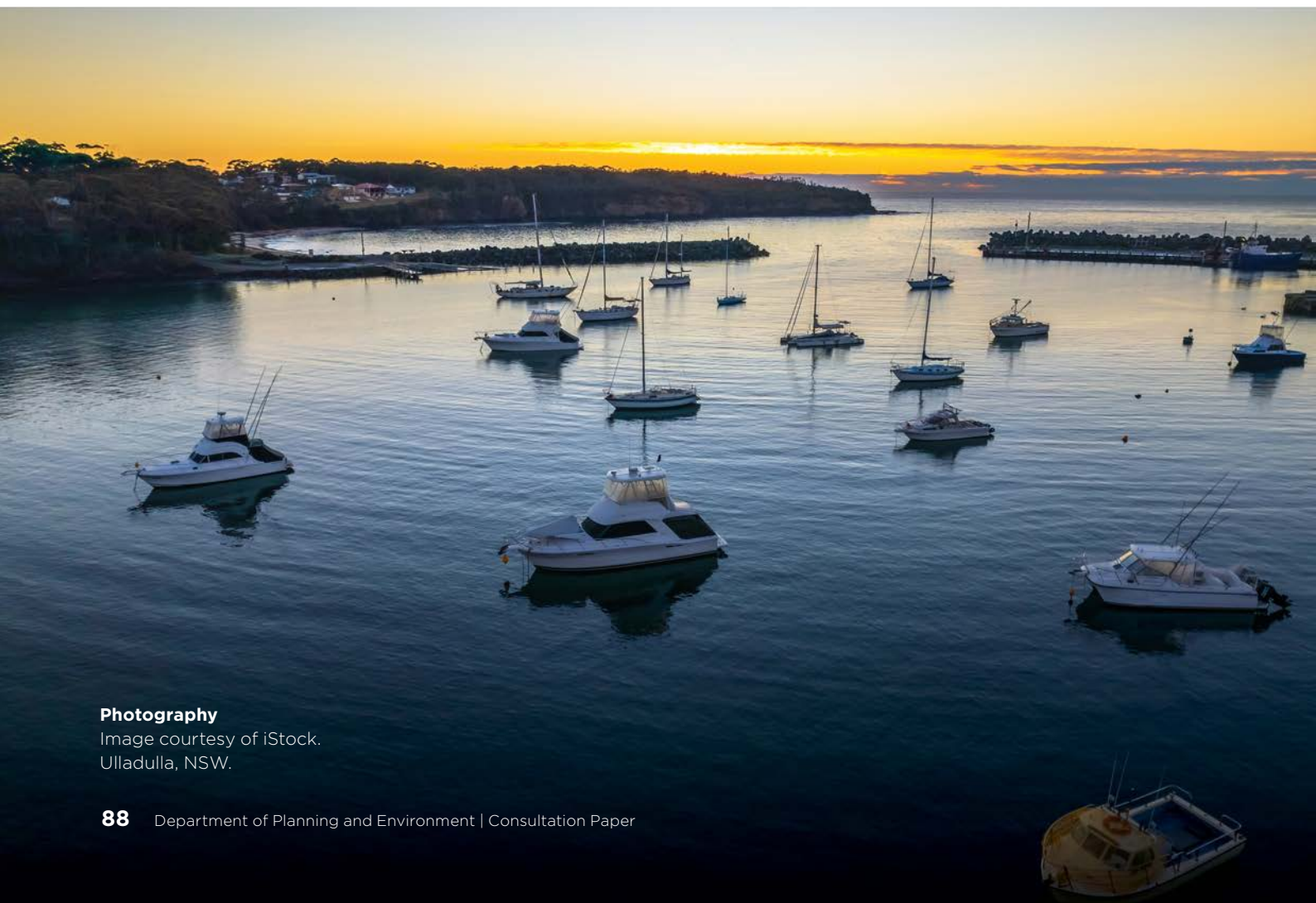
We have included focus questions throughout this consultation paper that we'd like to hear your thoughts on. We would also be interested in your thoughts on:

- whether any of the actions in this consultation paper should not be proposed and why?

- how actions should be staged and which actions should be implemented first?

Please note that all submissions will be published on the Department of Planning and Environment's website, unless you let us know in your submission that you do not wish the content to be released.

We will be holding community engagement sessions to give participants an understanding of the context for the regional water strategy and an overview of the key proposed priorities and actions. Face-to-face sessions will be held subject to COVID-19 restrictions and risks; otherwise, they will be held online. Details of these sessions can be found at the website listed above.



Photography

Image courtesy of iStock.
Ulladulla, NSW.



Photography

Image courtesy of Destination NSW.
Ben Boyd National Park, Green Cape.

Attachments



Photography

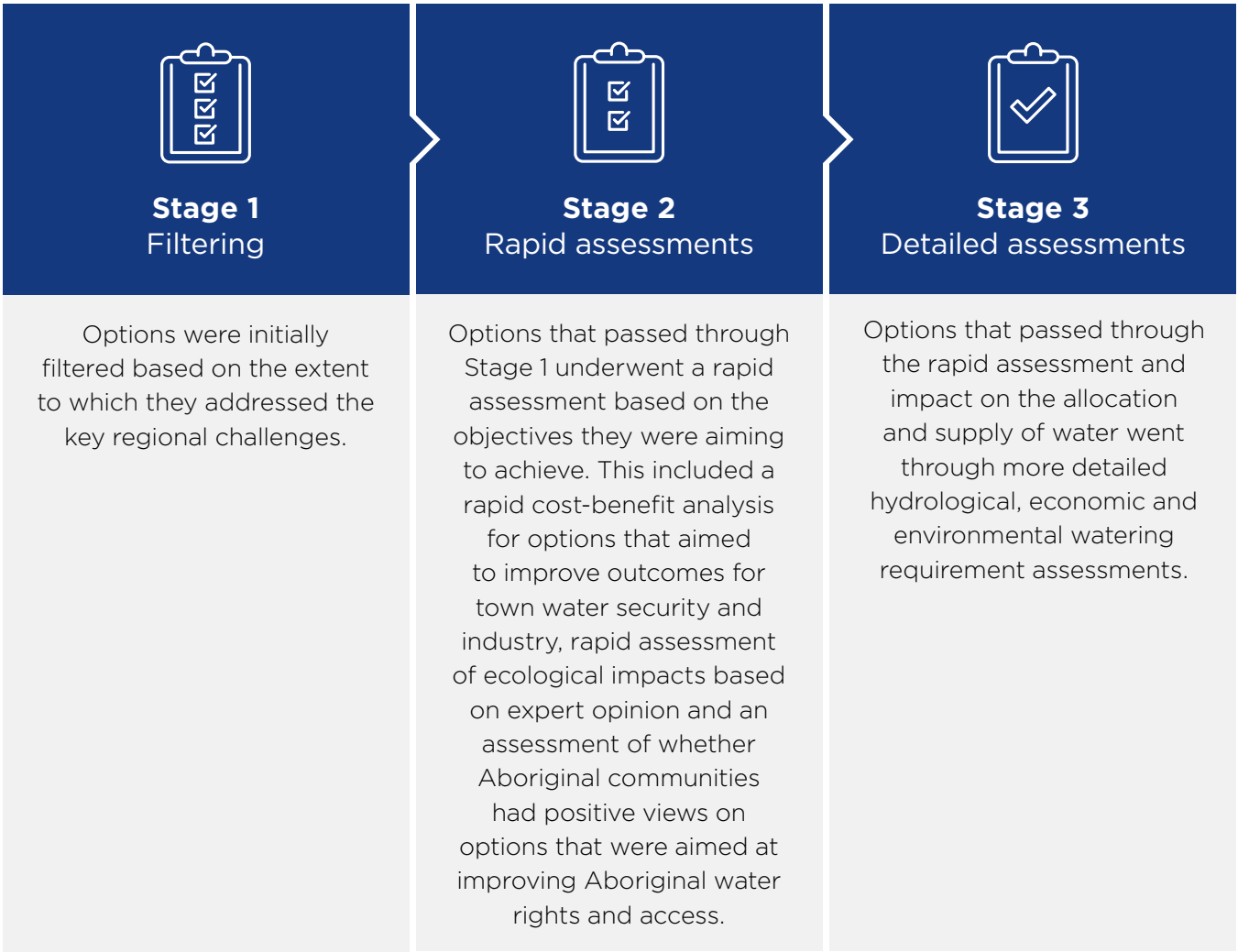
Image courtesy of WaterNSW.
Brogo Dam, NSW.

Summary of the options assessment

The Draft South Coast Regional Water Strategy identified 44 draft options. An additional 13 were identified during the public consultation process.

The process we followed to move from the long list to the short list is summarised in Figure 16 and described in the *Options assessment process: Overview*.¹⁶

Figure 16. Going from a long list to a final strategy of actions



16. www.dpie.nsw.gov.au/water/plans-and-programs/regional-water-strategies/identifying-and-assessing

At each step of the assessment, we narrowed down and filtered out the long list of options from the Draft South Coast Regional Water Strategy, based on the evidence we gathered and the analysis we undertook. Based on our analysis, several options were consolidated, refined, or not progressed and converted into proposed actions.

This attachment summarises the outcomes of our options assessment. Results from the cost benefit and ecological analyses is presented in Attachment 2.

The analysis we have undertaken is a high-level assessment process, appropriate for a strategic document, and is not designed to consider all

possible impacts on the environment, water users or Aboriginal people in detail. However, it does provide enough detail to understand if an option is likely to make a net positive contribution to the regional water strategy's objectives. More detailed environmental, economic and cultural assessments are required and will be undertaken in any subsequent business case development or planning processes for options that proceed to implementation stage.

After community consultation, the recommended options for the regional water strategy will be sequenced, meaning, they will not all be progressed or implemented at the same time.



Photography

Image courtesy of Department of Planning and Environment.
Biamanga National Park, NSW.

Assessment results – Long list of options to proposed shortlist of options

This section summarises how each of the options in the Draft South Coast Regional Water Strategy, and new options identified during public consultation, were shortlisted or filtered out at different assessment stages.



Options progressed to next step



To be considered in other NSW processes



Option not progressed

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
1. Pipeline from Brogo Dam to Bega-Tathra town water supply system			Minor/ Moderate impact		Option does not address a key regional challenge.
2. A reserve volume for the Brogo Bermagui town water supply system		Not assessed	Minor/ Moderate impact		This will be considered as part of proposed action 3.5: Identify the best option to improve water security for the Bermagui town water supply system.
3. Water treatment plant for Brogo Bermagui town water supply system		Not assessed	No/little change		Bega Valley Shire Council is implementing this option with NSW Government support through the Safe and Secure program. To be considered in other NSW processes.
4. Water treatment plant for Yellow Pinch Dam		Not assessed	Major/ Extreme impact		Bega Valley Shire Council is progressing this option with NSW Government support through the Safe and Secure program.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
5. Upgrade water main between Bewong and Milton	⊗	Not assessed	Minor/ Moderate impact	⊗	Shoalhaven Water is progressing this option.
6. Pipeline connecting Bega Valley Shire Council and Eurobodalla Shire Council town water supply systems	⊗	Not assessed	Major/ Extreme impact	⊗	Option does not address a key regional challenge.
7. Vulnerability of surface water and groundwater supplies to sea level rise	✓	Not assessed	Minor/ Moderate improvement	✓	Incorporated into: - Proposed action 1.6: Assess the vulnerability of surface water supplies to sea level rise and saltwater intrusion. - Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
8. Reuse of reclaimed water	✓	Not assessed	Minor/ Moderate improvement	⊗	This option will be supported through Action 6.7 of the NSW Water Strategy – Proactive support for water utilities to diversify sources of water.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
9. Managed aquifer recharge investigations and policy	⊗	Not assessed	Minor/ Moderate impact	⊗	Option does not effectively address a key challenge. The aquifers in the South Coast region are generally not suitable for managed aquifer recharge as they are highly connected to surface water sources.
10. Decentralised desalination	⊗	Not assessed	Minor/ Moderate impact	⊗	Option does not address a key challenge. Local water utilities have existing plans in place to address town water security risks.
11. Instream dam at Reedy Creek	⊗	Not assessed	Major/ Extreme impact	⊗	Option does not effectively address a key challenge. Previous economic analyses have shown that the costs outweighed benefits.
12. Eurobodalla Southern Storage	✓	⊗	Major/ Extreme impact	➤	Eurobodalla Shire Council is implementing this project with NSW Government support through the Safe and Secure program and with Australian Government support.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
13. Increased harvestable rights	✓	Not assessed	Department of Planning and Environment - Water has requested a review of the rapid environmental assessment based on the recent changes to the coastal harvestable rights policy, including mitigation measures. Major/ Extreme impact	✓	See Proposed action 2.6: Address catchment-based impacts of harvestable rights limits. The environmental assessment of this option recognises the risk of new dams being constructed to the 30% limit prior to a) local scale assessments having been undertaken and b) the setting of sustainable extraction limits (see Proposed action 2.3). The intent of this option has been changed to address these issues. Stakeholders have requested that the recent changes to harvestable rights be supported by further detailed assessments at the local scale to understand the impact of the change and that provision is made to adjust the limit depending on the outcome of the assessments. The revised action also describes management levers to ensure current and future uptake in harvestable rights is considered in updated coastal water sharing arrangements and plans, including long term average annual extraction rates, trade and water supply approval works. Provided these measures are put in place, it is expected risk ratings for the original option would be reduced to an acceptable level.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
14. Improve releases from Cochrane Dam to better match the water demands of irrigators	✓	Not assessed	Minor/ Moderate impact	✗	Not progressed. Option was considered as part of the assessment process of Option 21 – see below.
15. Increased industry access to high flows	✓	Not assessed	Major/ Extreme impact	✓	Incorporated into Proposed action 2.5: Reduce the take of low flows and 3.3: Investigate increased on-farm water storage.
16. Increased on-farm water storage	✓	✗	Major/ Extreme impact	✓	See Proposed action 3.3: Investigate increased on-farm water storage.
17. A grid of off-stream storages in the Bega Valley	✗	Not assessed	Minor/ Moderate impact	✗	Does not effectively address a regional challenge. Feedback during public exhibition was that Option 16 Increased on-farm water storage provided a more realistic alternative.
18. Tuross River barrage	✓	Not assessed	Major/ Extreme impact	✓	Incorporated into Proposed action 3.6: Improve water security for lower Tuross water users.
19. Increase capacity of Brogo Dam	✓	✗	Major/ Extreme impact	✗	Not progressed. Rapid cost-benefit analysis showed that costs outweighed benefits.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
20. Increase capacity of Cochrane Dam	✓	Not assessed	Major/ Extreme impact	✗	Not progressed on the basis that: - Augmentation of Cochrane Dam would inundate national park land, and - Any increase in centralised water storage in the Bega catchment would likely be part of a pumped hydro system – refer to draft options 21 and 22 below.
21. Brown Mountain Water Project (pumped hydro scheme)	✓	✗	Major/ Extreme impact	✗	When assessed solely based on increased water security, the Brown Mountain Water Project did not pass the rapid cost-benefit analysis. A comprehensive cost benefit analysis that includes the benefits of power generation is the responsibility of the proponent and beyond the scope of the South Coast Regional Water Strategy.
22. Instream dam at Crystalbrook	✓	Not assessed	Major/ Extreme impact	✗	Not progressed. Previous economic analyses have shown that the costs outweighed benefits.
23. Establish sustainable extraction limits for South Coast surface water and groundwater sources	✓	Not assessed	Major/ Extreme improvement	✓	See Proposed action 2.3: Establish sustainable extraction limits for surface water and groundwater sources.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
24. Convert low-flow water access licences to high-flow water access licences	✓	Not assessed	Minor/ Moderate improvement	✓	See Proposed action 2.5: Reduce the take of low flows.
25. Extend water and sewer services to southern villages (Shoalhaven Water)	✗	Not assessed	Minor/ Moderate improvement	✗	Option does not address a key regional challenge.
26. Southern Reclaimed Water Management Scheme	✗	Not assessed	Minor/ Moderate improvement	✗	Not progressed. Previous investigations identified high capital and operating costs, and uncertainties around demand for reclaimed water. Further, there appears to be no strong environmental or water security driver for this project.
27. Merimbula STP Upgrade and Ocean Outfall Project	✓	Not assessed	Minor/ Moderate improvement	➤	Bega Valley Shire Council is implementing this project with NSW Government support through the Safe and Secure program and with Australian Government support.
28. Fish-friendly water extraction	✓	Not assessed	Minor/ Moderate improvement	✓	See Proposed action 2.2: Implement fish-friendly water extraction.
29. Improve fish passage in the South Coast region	✓	Not assessed	Minor/ Moderate improvement	✓	See Proposed action 2.1: Improve fish passage.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
30. Improve stormwater management	✓	Not assessed	Major/ Extreme improvement	➤	This option will be considered as part of the NSW Marine Estate Management Strategy.
31. Bringing back riverine and estuarine habitats and threatened species	✓	Not assessed	Minor/ Moderate improvement	✓	Incorporated into Proposed action 1.4: Deliver a river recovery program.
32. Characterising coastal groundwater resources	✓	Not assessed	Minor/ Moderate improvement	✓	See Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
33. Protecting ecosystems that depend on coastal groundwater resources	✓	Not assessed	Major/ Extreme improvement	✓	See Proposed action 1.9: Protect ecosystems that depend on coastal groundwater.
34. Active and effective water markets	✓	✓	Minor/ Moderate impact	✓	See Proposed action 3.2: Review water markets.
35. Improved data collection and information sharing	✓	Not assessed	Minor/ Moderate improvement	✓	See Proposed actions 1.10: Improve monitoring of water extraction and 3.1: Provide better information about water access availability and climate risks.
36. Weir at Brogo-Bermagui town water supply off-take	✓	Not assessed	Major/ Extreme impact	✓	See Proposed action 3.5: Identify the best option to improve water security for the Bermagui town water supply system.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
37. Shorten the Bega-Brogo regulated river system	✓	Not assessed	Major/ Extreme impact	✗	This option was not short-listed because of the impacts on end-of-system water users.
38. Increase general security allocations in the Bega-Brogo regulated river system	✓	Not assessed	Major/ Extreme impact	✓	Option has been re-developed to focus on increasing delivery efficiency to the lower end of the regulated system. Refer to Proposed action 3.4: Investigate delivery efficiency improvements for the Bega-Brogo regulated river system.
39. Regional network efficiency audit	✓	Not assessed	Minor/ Moderate improvement	➤	This option will be considered through Action 6.6 of the NSW Water Strategy – A new state-wide Water Efficiency Framework and Program.
40. River Recovery Program for the South Coast: a region-wide program of instream works, riparian vegetation and sediment control	✓	Not assessed	Major/ Extreme improvement	✓	See Proposed action 1.4: Deliver a river recovery program.
41. Apply the NSW Extreme Events Policy to the South Coast region	✓	Not assessed	No/little change	➤	This option is being considered through Action 4.3 of the NSW Water Strategy – Improve drought planning, preparation and resilience.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
42. Quantify the resource potential of South Coast hard rock aquifers	✓	Not assessed	Insufficient information to assess	✓	Incorporated into Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
43. Planning for climate change impacts on coastal groundwater resources	✓	Not assessed	Insufficient information to assess	✓	Incorporated into Proposed action 1.8: Characterise and plan for climate change and land use impacts on coastal groundwater sources.
44. Planning for land use pressures on coastal groundwater resources	✗	Not assessed	Major/Extreme improvement	✗	Option does not address a key regional challenge.
New option: Identify environmental water needs to support healthy coastal waterways	✓	Not assessed	Major/Extreme improvement	✓	Option proposed for North Coast Regional Water Strategy and supported for all coastal strategies. See Proposed action 1.7: Identify environmental water needs to support healthy coastal waterways.
New option: Advisory services and projects that support landholder adoption of best practice land management	✓	Not assessed	Not assessed	✓	See Proposed action 1.5: Support landholder adoption of best practice land management.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
New option: Establish a research centre for agricultural water productivity, efficiency and management	✓	Not assessed	Not assessed	✗	Not progressed, however similar outcomes will be supported through Proposed action 1.5: Support landholder adoption of best practice land management.
New option: Identify water efficiency options that maximise agricultural water productivity, without reducing agriculture's share of water	✓	Not assessed	Not assessed	✗	This will be supported through Proposed action 1.5: Support landholder adoption of best practice land management.
New option: Upgrading council owned sewage treatment plants to recycle water for allowable land use	✓	Not assessed	Not assessed	➤	This option will be considered through Action 6.7 of the NSW Water Strategy – Proactive support for water utilities to diversify sources of water.
New option: Construction of storage facilities such as dams and wetlands for water to be used by agricultural enterprises, for firefighting and recreation	✓	Not assessed	Not assessed	✓	This will be supported in part through Proposed action 3.3: Investigate increased on-farm water storage.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
New option: Locate storages as high as practicable in the landscape; fill these storages by the interception of stormflow runoff with feeder drains; manage the flow in feeder drains using smart culverts and utilise the water stored as soon as economically opportune using gravity-fed irrigation	✓	Not assessed	Not assessed	✗	This will be supported in part, through Proposed action 3.3: Investigate increased on-farm water storage.
New option: Construction of a barrage at Bottleneck Reach as an economical option	✓	Not assessed	Not assessed	✗	Option not progressed. Proposed action 3.4: Investigate delivery efficiency improvements for the Bega–Brogo regulated river system, will consider the on-going use of a sand barrage on the Bega River near Jellat Jellat Creek.
New option: Construct a much larger storage at the Crystalbrook site and use excess variable renewable energy to pump from this dam to the Cochrane dam, then generate power at the optimal price using existing infrastructure	✓	Not assessed	Not assessed	✗	Not progressed. The NSW Government is encouraging investment in new infrastructure through private sector proposals for new energy investments. Previous economic analyses of an instream dam at Crystalbrook have shown that the costs outweighed the water security benefits.

Draft strategy option	Stage 1: Filtering	Stage 2: Rapid assessments		Shortlisted	Comment
	Meets key regional challenge	Passes rapid cost-benefit analysis	Rapid ecological assessment		
New option: Increase the education and motivation of the public on water conservation	✗	Not assessed	Not assessed	✗	Option does not address a key regional challenge. Ongoing water conservation will be considered by local councils and through Action 6.6 of the NSW Water Strategy – A new state-wide Water Efficiency Framework and Program.
New option: Adaptive management if an extreme event equivalent to a drought of record occurred, without carrying significant opportunity cost every single year	✓	Not assessed	Not assessed	➤	This option will be considered through Action 4.3 of the NSW Water Strategy – Improve drought planning, preparation and resilience.
New option: Conduct a review of water management practices and policies preceding and during the 2018 to 2020 drought to identify learnings	✓	Not assessed	Not assessed	➤	This option will be considered through Action 4.3 of the NSW Water Strategy – Improve drought planning, preparation and resilience.

Attachment 2

Assessment of options that impact supply, demand or allocation of water

This attachment summarises the results of assessment of options in the Draft South Coast Regional Water Strategy that were able to be assessed for hydrologic and economic impact and benefit. It outlines the rapid cost-benefit analysis of the long-list of options. It also outlines the results of the detailed cost-benefit analysis that was conducted using the stochastic, climate change adjusted (NARClIM) and east coast low data sets.¹⁷

A rapid cost benefit and hydrologic analysis (using historic instrumental data) was undertaken on the options that could be modelled. Based on the results of this analysis, more detailed hydrologic and environmental analysis using long-term historic and climate change data was undertaken on three combinations of options.

High level results of the cost-benefit assessments are presented below. More comprehensive and detailed assessment outcomes are presented in the Detailed economic and ecological analysis report for the South Coast.

Rapid cost benefit analysis results

The following options from the Draft South Coast Regional Water Strategy were given a rapid assessment for hydrologic and economic impact and benefit:

- Option 1: Pipeline from Brogo Dam to Bega-Tathra town water supply system
- Option 16: Increased on-farm water storage
- Option 19: Increase capacity of Brogo Dam

- Option 21: Brown Mountain Water Project
- Option 34: Active and effective water markets.

The key limitations in the rapid cost-benefit analysis that are common to all options were:

- Hydrologic assessment was done by introducing the option into the department's South Coast Bega River and Tuross River system models and observing the changes that occurred to extraction of water and flows compared to the base case of current situation.
- Economic assessment used results from the hydrologically modelled options and estimated the value of those changes in terms of town water supply shortfalls and agricultural production. All general security, supplementary, and unregulated water was assumed to be used for perennial pasture and all high security water was assumed to be used for cattle. The change in value was compared to the cost of installing and operating the option.
- Ecological assessment used hydrological modelled results to assess whether changes to a set of flow parameters at several points were positive or negative relative to environmental water targets.

Due to these limitations, we have not used the rapid cost-benefit analysis for options selection or when developing combined options.

The results of the rapid assessment for hydrologic and economic impact and benefit of options identified above is presented below.

17. Details of the new climate datasets can be viewed and downloaded at water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies

Pipeline from Brogo Dam to Bega-Tathra town water supply system

Purpose	To provide an alternative water source for the Bega-Tathra town water supply should saltwater intrusion compromise water extraction from the Bega Sands aquifer. This was Option 1 in the Draft South Coast Regional Water Strategy.
Description	With forecasted rises in sea level, more extreme droughts, and increased demands on water resources, saltwater ingress into the Bega Sands aquifer presents a potential risk to the security of the Bega town water supply. A pipeline from Brogo Dam into the Bega-Tathra town water supply would provide an alternative supply of water if needed. To model this option, the Bega-Tathra town water supply node was shifted from the unregulated system to the regulated system, and the existing unregulated licence for the Bega-Tathra town water supply system was converted from 2,640 ML of unregulated entitlement to 1,120 ML of regulated town water supply entitlement. Note that the hydrologic model fully moves the Bega-Tathra town water supply demand from reliance on groundwater which experienced low levels of predicted shortfalls. This in turn leads to a low level of economic cost due because current supplies are adequate to meet demand. For these reasons the results shown here should be considered a sensitivity analysis of Brogo Dam's ability to supply some level of town water and of the potential impact of that supply to other extractive users. In reality this option would likely be used in conjunction with the current ground water source.
Hydrologic results	The hydrologic modelling showed that: • Brogo Dam had lower modelled storage volumes – for example, the percentage of time that the dam storage is below 50% was modelled to increase from 5.9% to 7.6%. • The mean end-of-year available water determinations for general security water licences reduced from 64% to 60%.
Economic assessment	This option delivered a low benefit cost ratio (<0.01) which can be explained by the modelled high level of water security of the Bega-Tathra town water supply over the instrumental record. Consequently, the existing costs of economic shortfalls are substantially less than the cost of the option. In terms of distributional impact there is a clear benefit to the Bega-Tathra town water supply (35.4%) and a marginal negative impact to agricultural economic outcomes (-0.1%). This indicates that the option may be able to provide additional water security for towns without a proportional drop in agricultural economic outcomes, despite reductions to mean end-of-year available water determinations for general security water licences.

Key assumptions & limitations	The hydrologic model moves the Bega-Tathra town water supply completely from the groundwater source to a surface water source. In the base case losses to the groundwater system from the unregulated and regulated system fill the aquifer stores drawn on by the town water supply system. Additionally, the model does not include Yellow Pinch storage nor the pipelines connecting the various systems operated by Bega Valley Shire Council. Consequently, the modelled impacts on storage volume and annual flows may be overestimated.
Outcome	This option was not progressed to the detailed assessment stage because of the low benefit cost ratio. Despite this, the analysis provides insight into the performance of Brogo Dam if it is required as an alternative water source for the Bega-Tathra town water supply system. This might occur if the Bega Sands are shown to be significantly threatened by saltwater intrusion.

Summary of modelled results. Changes are compared to base case (i.e. no change)

Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Perennial Pasture	Total			
+0.2 (35.4%)	-0.2 (-0.1%)	0.0	74.3	-74.3	<0.01



Photography

Image courtesy of Department of Primary Industries.
Dairy cattle, Bega Valley.

Increased on-farm water storage

Purpose	To improve water security for landholders and industry. This was Option 16 in the Draft South Coast Regional Water Strategy.
Description	Lack of water storage is a major constraint to balancing water supply and demands in the South Coast region, particularly in the Bega and Tuross river catchments where higher volumes of entitlement have been issued for industry. Increasing the volume of water stored on farms will help landholders in unregulated catchments manage the impacts of climate change on water reliability. This option was modelled based on information presented in a business case developed by Bega Cheese, <i>Critical Water Infrastructure for the Agriculture and Food Manufacturing Sectors on the Far South Coast</i>. The business case includes detail about the location and volume of on-farm storages as part of a region-wide proposal to increase water security for the dairy industry in the Bega and Tuross valleys. Note that only those catchments in the Bega Valley were modelled. Storages were assumed to harvest surface runoff rather than store water extracted from streams. It was also assumed that landholders would extract water from streams under current water access licence conditions in preference to utilising stored water. Two sub options were considered given the potential for on-farm storages to reduce downstream flows: • 16a: Increased on-farm storage with low-flow bypasses • 16b: Increased on-farm storage with no low-flow bypasses.
Hydrologic results	Water security Hydrologic modelling showed that additional on-farm storage increased the water usage by agricultural users in unregulated catchments. Over the period of record, on-farm storage increased annual average water use of unregulated users by 3.8% with low-flow bypass, and 4.4% without low-flow bypass. The water use benefits of on-farm storages are realised in the driest years, when there is a shortfall in water available in streams. For example, in the 10% of driest years, water use of unregulated users is estimated to increase by around 13% compared to current conditions.

Economic assessment	On-farm storage provides minor benefits to agricultural users who may see an increase of on-farm water usage for storages with and without the low-flow bypasses. This increase in water usage results in economic improvements to growers of perennial pasture of around \$2.2 million (with low-flow bypasses) and \$2.5 million (without low-flow bypasses) over 40 years on average. The impact of on-farm storages improves economic performance in dryer periods (over 40 years) by approximately 3.4% with low-flow bypasses and 7.3% without low-flow bypasses when compared with wetter periods. Despite the benefits, the costs of the option produce a benefit to cost ratio of less than one.
Key assumptions & limitations	- It was assumed that water in additional on-farm storages would only be used when existing demands could not be met by existing water sources. It did not assume growth in demand. - The total volume of the combined additional on-farm storage is 6,300 ML across the Bega River catchment. - Increases to harvestable rights limits were not considered because the NSW Government had yet to announce the changes when this option was modelled.
Outcome	This option progressed to the detailed cost benefit analysis despite recording a benefit to cost ratio of less than one because of the additional benefits on-farm storages may provide for the region, such as helping reduce the take of low flows and to facilitate increased trade.

Summary of modelled results. Changes are compared to base case (i.e. no change)

Option	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
16a	0 (1.4%)	2.2 (0.7%)	2.2	14.0	-11.8	< 1

Option	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
16b	0 (1.4%)	2.5 (0.8%)	2.5	14.0	-11.6	< 1

Increase capacity of Brogo Dam

Purpose	To increase water security for town water supplies and holders of general security water licences. This was Option 19 in the Draft South Coast Regional Water Strategy.
Description	During public exhibition of the Draft South Coast Regional Water Strategy, Bega Valley Shire Council put forward the option of augmenting Brogo Dam to supply water to Eurobodalla Shire Council as an alternative to the proposed Southern Storage project. An augmented Brogo Dam could provide an alternative to the Bega-Tathra town water supply option should the Bega Sands aquifer be compromised by saltwater intrusion. Additionally, an increase in capacity may provide increased reliability for general security water licences. The hydrologic impacts of raising the Brogo Dam wall by 6.5 m were modelled. This level of augmentation was chosen based on previous investigations by Water NSW (then State Water, 2004), which suggested that this would be the maximum level of augmentation that could be achieved without significant additional infrastructure. Such an augmentation would increase the capacity of Brogo Dam by about 8,640 ML. Given only about 30% of available water allocated to general security water licences on the Bega-Brogo system is used each year on average, the option of augmenting Brogo Dam solely for the purpose of increasing water reliability for general security water users was not considered. Only those options which include improvements to town water supply security were modelled. Three sub-options were considered, where an augmented Brogo dam was combined with: • Option 19a: Brogo Dam augmentation and pipeline to the Eurobodalla Shire Council town water supply system. • Option 19b: Brogo Dam augmentation and pipeline to the Bega-Tathra town water supply system. • Option 19c: Brogo Dam augmentation and pipelines to the Eurobodalla Shire Council and Bega-Tathra town water supply systems.

Hydrologic results	Town water supply water security (TWS): As per Option 1, the modelling for this option provides only indicative insights into potential benefits for the Bega-Tathra town water supply, as the supply of ground water is removed in the option model. However, the modelling does provide some insights into the benefits that this option offers Eurobodalla Shire Council's town water supply compared to the Eurobodalla Southern Storage. In all 3 combinations of options, the town water supply demands of the target towns are largely met. Water usage (General Security): • There was a significant increase in the end of water year available water determinations. Currently, allocations never exceed 80%, and would not occur every year. Modelling showed that augmenting Brogo Dam and introducing some town water supply demand would result in 100% allocations in a greater number of years. • However, this did not result in significant increases in mean annual water usage. Use of general security licences only increased by 6.8, 5.2, and 5.1% for Options 19a, 19b and 19c respectively.
Economic assessment	The 3 sub-options all returned benefit cost ratios below 0.01. All options (19a, 19b, and 19c) reduced town water supply shortfalls. Augmenting Brogo Dam and connecting Eurobodalla Shire Council town water supply achieves an approximately 40% reduction in the cost of regional shortfalls. Augmenting the dam and connecting the Bega-Tathra system achieves an approximate 50% reduction in the economic cost of shortfalls. Augmenting the dam and connecting both town water supply systems achieves an 85% reduction in cost of town water supply shortfalls. Despite the positive outcomes, the reduction in economic cost incurred due to shortfalls does not cover the considerable cost of dam augmentation. The modelled benefits of increased water security for perennial pastures were minimal; less than \$100,000 over 40 years.
Key assumptions & limitations	• Only the costs of dam augmentation were included in the economic assessment. The costs of the pipelines were not included. • The existing operational rules of Brogo Dam (transparency releases when flows above the new 50% dam level) were included in this modelling. • The modelling does not allow for the existing connection between the northern and southern Eurobodalla Shire Council town water supply systems. • The Eurobodalla Shire Council only makes extractions to supplement the shortfalls in the Tuross baseline modelling.
Outcome	Due to the unfavourable benefit cost ratio, these options were not progressed to the detailed assessment stage.

Summary of modelled results. Changes are compared to base case (i.e. no change)

Option	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
19a	0.2 (38.5%)	0.0 (0%)	0.2	105.6	-105.4	<0.01
19b	0.3 (49.9%)	0.1 (0%)	0.3	105.6	-105.3	<0.01
19c	0.4 (84.9%)	0.1 (0%)	0.5	105.6	-105.1	<0.01

- Option 19a: Brogo Dam augmentation and pipeline to the Eurobodalla Shire Council town water supply system.
- Option 19b: Brogo Dam augmentation and pipeline to the Bega-Tathra town water supply system.
- Option 19c: Brogo Dam augmentation and pipelines to the Eurobodalla Shire Council and Bega-Tathra town water supply systems.

Note: Option 19a and 19b include the cost of the Brogo Dam augmentation component only, and not the pipeline component. A cost estimate for the pipeline to Bega-Tathra was available to consider for assessment. Conversely, a cost estimate was unable to be completed for the pipeline to Eurobodalla Shire Council town water supply system due to limited information available at the time.



Photography

Image courtesy of Department of Planning and Environment.
Brogo Dam, NSW.

Brown Mountain Water Project

Purpose	To improve water security for irrigators, Bemboka township, and stock and domestic water users. This was Option 21 in the Draft South Coast Regional Water Strategy.
Description	Cochrane Dam is in the Bemboka catchment and is principally used to generate hydro-electricity. Water users downstream of the dam have historically derived benefits from controlled flows from the dam. The owner and operator of the dam, Cochrane Dam Pty Ltd is currently investigating options to transform the existing system into a pumped hydro scheme, the 'Brown Mountain Water Project'. Such options would require capture and storage of water higher in the catchment. Two scenarios that are currently being investigated by Cochrane Dam Pty Ltd are a 5.3 GL storage or a 20 GL storage to be located at Steeple Flat. The proposal was developed on the assumption that the NSW Government would fund and construct the upper storage at Steeple Flat and Cochrane Dam Pty Ltd would fund and construct the pumped hydro facility. Although the objective of the Brown Mountain Water Project is to generate electricity, the additional water storage would benefit irrigators, Bemboka's town water supply and stock and domestic water users. Four variations of dam size and assumed demand were modelled: • Option 21a: 5.3 GL dam with existing agricultural demand. • Option 21b: 5.3 GL with 10% increase in maximum planted area of irrigators in the unregulated system downstream of Cochrane Dam. • Option 21c: 20 GL dam with existing agricultural demand (regulated releases for downstream users). • Option 21d: 20 GL with 10% increase in maximum planted area of irrigators in the unregulated system downstream of Cochrane Dam (regulated releases for downstream users). The hydrologic modelling and economic assessment undertaken for the regional water strategy only considered the impacts on water security. The economic benefits from power generation are not within the scope of the regional water strategy.

Hydrologic results	Within the instrumental record considered, Bemboka did not experience any shortfalls in the base case scenario, meaning an assessment of the ability of these options to support Bemboka town water is not possible under this record. Other town water supply within the Bega catchment are able to gain from the downstream impacts of the dam, which is reflected in reductions of shortfalls for Bega-Tathra. Option 21b shows an increase in agricultural usage of unregulated water by an average of 8% over each 40-year period, consistent with an assumed increase in agricultural cropping area. The effect was least noticeable in 21a with an increase of approximately 0.3%. Once regulation of the system is introduced in Options 21c and 21d, the unregulated use is partially substituted by use of the introduced general security water licences from the 20 GL variant of the proposed dam. These new general security water licences have similar reliabilities, achieving average end of year allocation rates of 91% and 89% for Options 21c and 21d respectively. Total 40-year water extractions for agriculture across the Bega River catchment increases under all 4 sub-options. However, the magnitude of the increase varies. Extractions increase by 0.2% for Option 21a. This increases to 4.4% in Option 21b once an increase in downstream agricultural area is introduced. The inclusion of the larger dam and creation of new general security water licences leads to increases in total extractions for agriculture of 1.5% in Option 21c and 6.2% in Option 21d.
Economic assessment	Despite the varying degrees of hydrologic benefits that each of the options affords to the catchment, in all cases the cost of constructing and operating both variants of dams outweigh the economic benefits. This is illustrated by the very low average benefit cost ratio, being less than 0.01. The largest economic benefit of the option is achieved through an uptick in agricultural production in Option 21b and Option 21d. In these cases there are benefits of \$13.6 million and \$15.4 million respectively arising from increases in agricultural usage.
Key assumptions & limitations	• The economic benefits from power generation were not included in the economic assessment, as this is beyond the scope of the regional water strategy. • The hydrological modelling assumes that the only releases made from the combined Brown Mountain storages to the Upper Bemboka would be due to spills or to maintain expected environmental targets. Other operational changes of the storages required for the pumped hydro scheme were not considered. • When an increase in downstream demand (due to an increase in planted area) is introduced, the planted area becomes fixed and is not subject to scheduled planting decisions. It is also assumed that there is no capital cost associated with additional infrastructure that may be required due to the expansion of the downstream agricultural area.

Outcome	This option delivered a low benefit to cost ratio when assessed solely as a water security project. With the inclusion of the economic benefits from power generation, the Brown Mountain Pumped Hydro Project may deliver a positive economic outcome, however such an assessment is beyond the scope of the regional water strategy. If this project were to go ahead, it would considerably change the hydrology of the Bemboka catchment. For this reason, this option was progressed to the combined options assessment so that these implications could be understood.
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Summary of modelled results. Changes are compared to base case (i.e. no change)

Option	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
21a	0 (0.3%)	0.3 (0.1%)	0.3	166.2	-166.0	<0.01
21b	0 (0.4%)	13.6 (4.4%)	13.6	166.2	-152.6	<0.01
21c	0 (7.1%)	1.3 (0.4%)	1.3	188.6	-187.3	<0.01
21d	0.1 (9.9%)	15.4 (5%)	15.4	188.6	-173.2	<0.01

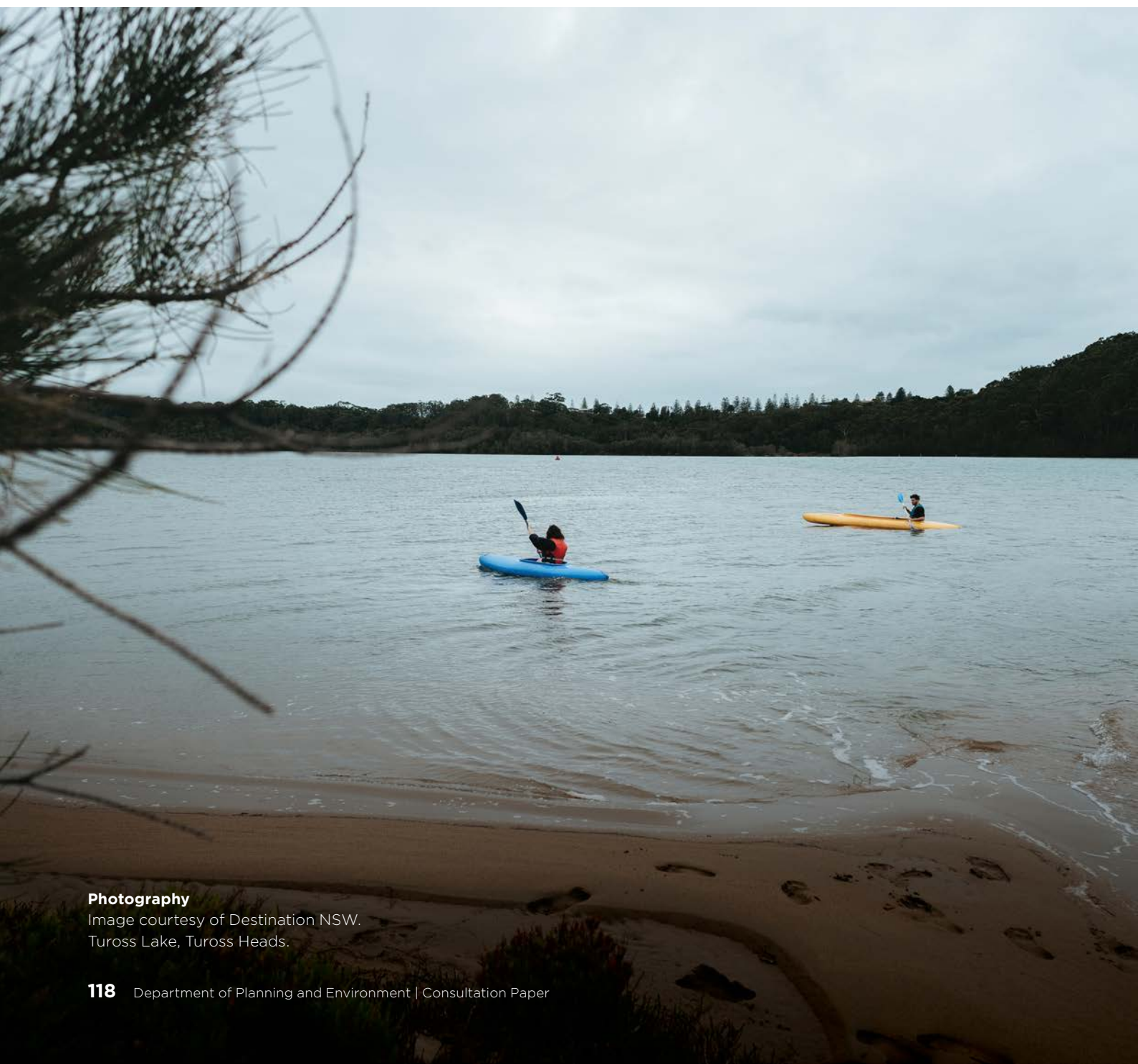
- Option 21a: 5.3 GL dam with existing agricultural demand.
- Option 21b: 5.3 GL with 10% increase in maximum planted area of irrigators in the unregulated system downstream of Cochrane Dam.
- Option 21c: 20 GL dam with existing agricultural demand (regulated releases for downstream users).
- Option 21d: 20 GL with 10% increase in maximum planted area of irrigators in the unregulated system downstream of Cochrane Dam (regulated releases for downstream users).

Active and effective water markets

Purpose	To improve water access for active water users. This was Option 34 in the Draft South Coast Regional Water Strategy.
Description	We modelled the benefits of increasing usage of the Bega-Brogo regulated system by activating sleeper licences through trade. A significant proportion of water licences (estimated 1,783 ML, about 14% of total licensed volume) in the Bega-Brogo regulated river system is currently inactive, which is limiting production and negatively impacting annual water determinations for general security water access licence users. Under this option, the impact of activating sleeper entitlement to increase total water usage and irrigation area was modelled.
Hydrologic results	Results show an increased usage under existing general security licenses. There is more use from Brogo Dam. The following key results identified in the instrumental model run were: • increase in mean annual general security licence usage of 9% • increase in mean 1 Jan regulated planting area of 9.6%.
Economic assessment	The results indicate an increase of water usage assumed for perennial pasture of 4% on average for the unregulated and the regulated system, which translates to an economic gain of \$9.1 million over 40 years on average for this user group. Findings suggest negative economic impacts are experienced by towns. Despite these negative impacts, this option produces a positive benefit cost ratio.
Key assumptions & limitations	• All activated licenses are assumed to be used by new users with their planting area and usage characteristics based off existing users within the region. • Sleeper licences were identified as those general security licences for which no orders were received (or extractions made) over the past 10 years. This approach did not identify underuse associated with otherwise active licences, or licences that are used sporadically. • Any capital expenditure required by new users of the activated sleeper licenses has not been considered within this analysis. • A nominal cost of \$1 million was assigned to this option.
Outcome	Considering the potential benefits and assuming relatively low costs – with no additional public infrastructure – this option progressed to the design of combined options investigated within the detailed assessment.

Summary of modelled results. Changes are compared to base case (i.e. no change)

Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
Towns	Perennial Pasture	Total			
0 (-1.4%)	9.1 (3%)	9.1	1.0	8.1	>1



Photography

Image courtesy of Destination NSW.
Tuross Lake, Tuross Heads.

Detailed economic and ecological analysis results

In the past, water infrastructure and policy changes have been assessed against the historic set of instrumental data. However, using the long-term historic climate projections developed for the regional water strategies, together with projections of future climate change gives us a much better understanding of the water risks that the region could face.

For the purpose of the regional water strategies, we have looked at 4 different plausible futures. These futures include:

1. Historical data: the future based on what would happen if our future climate is similar to the last 130 years of observed data.
2. Long-term climate projections (stochastic data) based on historic data: applied stochastic modelling to our 130-year picture of past climate (step 1) to develop 13,000 years of possible climate sequences. This approach provided more information on climate variability and shows it's possible the region could experience more severe drought and wet sequences.
3. Applying climate change projections to our new climate dataset: 2 climate change scenarios were developed based on work carried out through NARClIM, Electricity Sector Climate Information project and research undertaken by University of Newcastle. The scenarios were applied to the 13,000-year dataset, including:
 - i. A NARClIM-informed future climate scenario (based on a dry scenario for 2060 to 2079): this assumes that there is a dry, worst case climate change scenario in the future.
 - ii. Reduced number of east coast low (ECL): modelled one less ECL event per year. A potential reduction in ECL as well as intensity of rainfall associated with ECL are associated with concerns for water security.

Detailed assessment of options portfolios

Some of the individual options evaluated under the rapid CBA analysis (see the Rapid cost-benefit analysis section above) have been merged to make a series of combined options. These combined options have been modelled using the long-term stochastic, NARClIM and ECL climate scenario data sets. The combined options have undergone a more detailed level of economic and ecological analysis process. The environmental assessment was based primarily on modelled changes to flows across the Bega and Tuross river catchments. It considered whether these flow changes impacted the achievement of environmental flow targets in a positive or negative way.

Selection of combined options

The following options portfolios have been tested using the detailed hydrologic assessment process:

- Combined option 1: Increase on-farm water storage and active water markets.
- Combined option 2: Increase on-farm water storage, Brown Mountain Water Project, and active water markets – variant 1 (5.3 GL storage at Steeple Flat).
- Combined option 3: Increase on-farm water storage, Brown Mountain Water Project, and active water markets – variant 2 (20 GL storage at Steeple Flat).

The selection of portfolios was informed by the rapid cost-benefit analysis (see Rapid cost-benefit analysis above). The rapid cost-benefit analysis considered the short-term average outcomes of current climatic conditions. However, the detailed assessment was able to consider the more extreme outcomes as it is likely that they will drive investment decisions in the South Coast.

The sections below describe the results of the detailed cost-benefit analysis of the 3 combined options. They draw together the hydrologic, ecological and economic assessments of the modelled options.

Ecological assessment methodology

The ecological effects of the options portfolios were modelled and assessed at 20 sites in the Bega River catchment, as all 3 combined options were located in that catchment. The sites were selected based on their relationship to the likely or potential ecological requirements of aquatic flora and fauna.

Flow metrics used for the assessment included the frequency and duration of cease-to-flow events and base flows; the frequency of freshes, large and infrequent bankful and overbank flows, and low flows (90th and 95th percentile flows); and the annual volume of flows.

These metrics were assessed for the stochastic, NARClIM and east coast low climate scenarios. As with the rapid ecological assessment, the results were then categorised as having an impact from extreme improvement to extreme impact (stage 1). It uses a categorisation system to rate the potential impacts or benefits to the environment. The rapid ecological assessment uses a 5-category ranking (stage 1) and the detailed assessment used an expanded 11-category ranking (stage 2). Table 2 describes the impact categories used in the ecological assessments and their associated changes in hydrology.

Table 2. Explanation of categories used in ecological assessment

Stage 1 category	Stage 2 category	Estimated percentage change in hydrology/ecology
Major/Extreme impact	Extreme impact	More than 30% change in a negative direction (< -30%).
	Major impact	More than 20% change in a negative direction (< -20%).
Minor/Moderate impact	Moderate impact	More than 10% change in a negative direction (< -10%).
	Minor impact	More than 3% change in negative direction (< -3%).
No/Little change	Little impact	Less than 3 % change in a negative direction (< 0%).
	No change	0%, rounded to the nearest whole percentage point.
	Little improvement	Less than 3% change in a positive direction (>0% and <3%).
Minor/Moderate improvement	Minor improvement	More than 3% change in a positive direction (> 3%).
	Moderate improvement	More than 10% change in a positive direction (> 10%).
Major/Extreme improvement	Major improvement	More than 20% change in a positive direction (> 20%).
	Extreme improvement	More than 30% change in a positive direction (> 30%).

It is important to note that the ecological assessments presented below are based on generic flow metrics that describe typical components of the flow regimes upon which flow-dependent species and communities rely. However, flow-dependent species and communities often have different and more complex environmental water requirements that cannot be represented with simple or generic metrics. There are also many external factors and long-term hydrological and ecological effects associated with river management that the models used for these assessments cannot capture which could affect

the viability of aquatic species and populations. The metrics used for these assessments are designed to help eliminate unviable management options and to support identification of a shorter list of options that can undergo more detailed analysis at future stages of development if required. While brief summaries of the analyses are presented below, more comprehensive and technical analyses are presented in the Detailed economic and ecological analysis report for the South Coast.



Photography

Image courtesy of Destination NSW.
Pambula River, Pambula.

Combined option 1: Increase on-farm water storage and active water markets

Economic assessment

Purpose	Increase agricultural production by increasing on-farm water storage and increasing opportunities for irrigators to access water that is not being used through trade.
Description	This combined option integrates: • Increased on-farm water storage with low-flow bypasses (Draft South Coast Regional Water Strategy Option 16a). • Active and effective water markets (Draft South Coast Regional Water Strategy Option 34).
Hydrologic results	Combining on-farm water storages and active and effective water markets results in an aggregated increase of surface water usage (from both regulated and unregulated sources) by perennial agriculture of 4.9% on average over a 40-year period in the stochastic and NARClIM climate scenarios. Under the east coast low climate change scenario this is marginally lower at 4.6%. In all climate scenarios considered, the average potential impact to water availability for towns is less than 1%.
Economic assessments	The benefits are concentrated largely in the growth of perennial pasture, with an average increase in economic output of nearly 5% on average over each 40-year period. This result is consistent across climate sets. Increases in the output of perennial pasture is achieved with minimal impact on town water supplies.
Key assumptions & limitations	All assumptions and limitations for the individual options relevant to this combined option discussed in the rapid cost benefit analysis hold for the detailed analysis.

Summary economic modelling results are shown below

Climate Data	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
Stochastic	0 (-0.4%)	10.5 (4.7%)	10.5	14.0	-3.5	<1
NARClIM	0 (-0.8%)	10.5 (4.8%)	10.5	14.0	-3.6	<1
East coast low (ECL)	-0.1 (-1.5%)	10.1 (4.6%)	10	14.0	-4	<1

Ecological assessment

The main ecological impacts identified with this option was on the number of days at or below low flows (defined as at about the 80th percentile). In particular, the annual median of days below flow flows was doubled for Bega River at Warraguburra (from 2 to 4, 7 to 13, or 6 to 12 days under the stochastic, east coast low (ECL) and NARClIM scenarios respectively). At the same site, the annual median of days at flow flows was often higher by about 50% (from 2 to 3, 7 to 9, or 6 to 9 days under the stochastic, ECL and NARClIM scenarios respectively). Bega River at Warraguburra (gauge 219026), although now a decommissioned river gauge, can be considered a proxy for the end-of-system flows as it is downstream of the confluence of the Brogo and the Bega rivers.

An increase in the number of low flow days can have many ecological implications. It can reduce the amount of available river habitat for aquatic plants and animals, reduce long-term sediment control and can increase the likelihood of poor water quality. It can also inhibit fish movement and increase predation because of fewer slack waters.

In this instance, these are still not long periods of low flow, and the greatest risk is probably that the river is more prone to the risk of short no-flow periods. This site is about a third of the way along the Bega River from the Bega township to where the river discharges into the sea. It is also located in the floodplain area where there is more obvious floodplain agricultural development, which explains the impacts on low flows. This emphasises the need to ensure that local extraction does not overly draw down the river overall, over time and along the river in general, but also specifically at this location if this option is pursued.

Predicted ecological effects of combined option 1 under stochastic and NARClIM scenarios (Planning assumption). The ecological effect is calculated as the percentage change against the base case for stochastic, NARClIM and east coast low scenarios

Metric	Stochastic		NARClIM		ECL	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Number of years with greater or equal to one zero flow spell per 130 years	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Average duration of zero flow spells (number of days)	No effect	Moderate improvement – no effect	No effect	Moderate improvement – no effect	No effect	Moderate improvement – no effect
Number of zero events per 130 years	No effect	Major improvement – moderate impact	No effect	Moderate improvement – moderate impact	No effect	Moderate improvement – moderate impact
Very low flow rate (ML/d), measured as the 95th percentile discharge of daily flows	No effect	Major impact – minor improvement	No effect	Major impact – moderate improvement	No effect	Major impact – moderate improvement
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	No effect	Minor impact – no effect	No effect	Moderate impact – no effect	No effect	Moderate impact – no effect
Median annual low flow days	Minor impact	No effect – extreme impact	Minor impact	No effect – extreme impact	Minor impact	No effect – extreme impact
Median days below low flow	Minor impact	No effect – extreme impact	Minor impact	No effect – extreme impact	Minor impact	No effect – extreme impact
Low flow standard deviation	No effect	No effect – minor improvement	No effect	No effect – minor improvement	No effect	No effect – minor improvement
Low flow days below the 75 percentile	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect

Metric	Stochastic		NARCIIM		ECL	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Mean annual discharge (ML/y)	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Fresh flow rate (ML/d), measured as the 20th percentile discharge of daily flows	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Average number of freshes per year	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Average duration of freshes (number of days)	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
High flows – 2.5-year Annual Return Interval (ARI) flow rate (ML/d)	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
High flows – 5-year ARI flow rate (ML/d)	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Very high flows – 10-year ARI flow rate (ML/d)	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Monthly flow coefficient of variation	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Daily flow coefficient of variation	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Weekly flow coefficient of variation	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect

Combined option 2: Increase on-farm water storage, Brown Mountain Water Project, and active water markets – variant 1 (5.3 GL storage at Steeple Flat)

Economic assessment

Purpose	Increase agricultural production by increasing on-farm storage, centralised water storage, and increasing opportunities for irrigators to access water that is not being used through trade.
Description	This combined option integrates: - Increased on-farm water storage, with low-flow bypasses (Draft South Coast Regional Water Strategy Option 16a). - Brown Mountain Water Project, with 5.3 GL storage at Steeple Flat (Draft South Coast Regional Water Strategy Option 21a). - Active and effective water markets (Draft South Coast Regional Water Strategy Option 34). It assumes the Bemboka River remains an unregulated river and the storage supports existing irrigation demands.
Hydrologic results	The unregulated system sees an increase in agricultural water usage by 3.7% in both the stochastic and east coast low (ECL) climate scenarios on average over a 40-year period. This increases to 4.1% in the NARClIM climate scenario. Within the regulated system general security usage increases by approximately 10% to 11% on average over 40 years under all climate scenarios, with significant increases in supplementary water usage due to the inclusion of the storage. This is accompanied by reductions in orders of high security licenses and in uncontrolled flow. Regionally, the changes in water assumed for agricultural usage is increased by approximately 5.1% under the stochastic and NARClIM climate scenarios and 4.8% under the ECL climate change scenario. In all cases there are benefits to towns. Bega-Tathra experiences a 4% to 6% increase in town water security, with other towns experiencing smaller, positive improvements. In aggregate across the region average improvements to town water supply over the analysis period are the least under the NARClIM scenario (2.3%) and the greatest under the ECL climate change scenario (3.1%). The stochastic climate scenario showed a 2.8% improvement to town water security. These are minor changes between climate sets, and the improvements are modest considering the relative town water security of the region.
Economic assessments	The benefit-cost ratio was never greater than 1.0 for the standard climate scenarios, or for the sensitivity analysis, which would suggest the project is not economically efficient from a water security perspective. Any potential economic gain from electricity generation of the hydropower scheme were not considered. The largest absolute gains due to the combined option are seen in the agricultural sector which experiences approximately \$11 million benefit on average over the 40-year analysis periods in all climate sets.

Key assumptions & limitations	All assumptions and limitations for the individual options relevant to this combined option discussed in the rapid cost benefit analysis hold for the detailed analysis.
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Summary of modelled results. Changes are compared to base case (i.e. no change)

Climate Data	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
Stochastic	0.1 (4.7%)	10.7 (4.8%)	10.7	180.3	-169.6	<0.1
NARClIM	0.2 (2.6%)	10.7 (4.9%)	10.9	180.3	-169.4	<0.1
East coast low (ECL)	0.1 (2.7%)	10.3 (4.7%)	10.4	180.3	-169.8	<0.1

Ecological assessment

Combined option 2 showed similar but more extreme impacts than with combined option 1. Again, the impact was on the number of days at or below low flows (defined as at about the 80th percentile). Both these measures increased to an extreme level with the number of low flow days generally doubling across stochastic, NARClIM and east coast low (ECL) scenarios. In particular, the annual median of days below low flows was doubled for Bega River at Warraguburra (from 2 to 5, 7 to 15, and 6 to 13 days under the stochastic, ECL and NARClIM scenarios respectively). At the same site, the annual median of days at low flows was also higher by about 50% (from 2 to 6, 7 to 12 and 6 to 13 days under the stochastic and NARClIM scenarios respectively). Again, these are proportionally large increases but from relatively small numbers, and so how they relate to real world river operations and field ecology would require further verification if this option was to progress.

The duration and frequency of freshes was also reduced. This is especially the case at a site about 5 km west of Bemboka on the Bemboka River, which receives about a quarter less freshes per year, and about a quarter shorter fresh duration across all 3 climate scenarios when compared to that scenario's base case. The frequency, timing, shape and duration are all important components of freshes, which are generally important for key ecological processes such as the transfer of river nutrients and stimulating movement and growth in native fish species. Gauge 219021 on the Bemboka River at Bemboka is the gauge closest to downstream Cochrane Dam, so impacts to flows here make sense and are worth further investigation to assess how natural freshes are affected.

Predicted ecological effects of combined option 2 under stochastic and NARClIM scenarios (Planning assumption). The ecological effect is calculated as the percentage change against the base case for stochastic, NARClIM and east coast low scenarios

Metric	Stochastic		NARClIM		East coast low (ECL)	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Number of years with greater or equal to one zero flow spell per 130 years	Moderate improvement	Extreme improvement - no effect	Moderate improvement	Extreme improvement - no effect	Moderate improvement	Extreme improvement - no effect
Average duration of zero flow spells (number of days)	Extreme impact	Moderate improvement - extreme impact	Extreme impact	Moderate improvement - extreme impact	Extreme impact	Moderate improvement - extreme impact
Number of zero events per 130 years	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact
Very low flow rate (ML/d), measured as the 95th percentile discharge of daily flows	Major improvement	Minor impact - extreme improvement	Major improvement	Minor impact - extreme improvement	Major improvement	Minor impact - extreme improvement
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	Moderate improvement	Minor impact - extreme improvement	Moderate improvement	Minor impact - extreme improvement	Moderate improvement	Minor impact - extreme improvement
Median annual low flow days	Extreme impact	No effect - extreme impact	Extreme impact	Extreme improvement - extreme impact	Extreme impact	Extreme improvement - extreme impact
Median days below low flow	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact
Low flow standard deviation	Minor impact	Extreme impact - minor improvement	Minor impact	Extreme impact - minor improvement	Minor impact	Extreme impact - minor improvement

Metric	Stochastic		NARCIIM		East coast low (ECL)	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Low flow days below the 75th percentile	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	Minor improvement	Minor impact – extreme improvement	Minor improvement	Minor impact – extreme improvement	Minor improvement	Minor impact – extreme improvement
Mean annual discharge (ML/y)	No effect	Minor impact – no effect	No effect	Minor impact – no effect	No effect	Minor impact – no effect
Fresh flow rate (ML/d), measured as the 20th percentile discharge of daily flows	No effect	No effect – no effect	No effect	No effect – no effect	No effect	No effect – no effect
Average number of freshes per year	Minor impact	Extreme impact – no effect	Minor impact	Extreme impact – no effect	Minor impact	Extreme impact – no effect
Average duration of freshes (number of days)	Minor impact	Extreme impact – no effect	Minor impact	Extreme impact – no effect	Minor impact	Extreme impact – no effect
High flows – 2.5-year Annual Return Interval (ARI) flow rate (ML/d)	No effect	Minor impact – no effect	No effect	Minor impact – no effect	No effect	Minor impact – no effect
High flows – 5-year ARI flow rate (ML/d)	No effect	Moderate impact – no effect	No effect	Moderate impact – no effect	No effect	Moderate impact – no effect
Very high flows – 10-year ARI flow rate (ML/d)	No effect	Moderate impact – no effect	No effect	Moderate impact – no effect	No effect	Moderate impact – no effect
Monthly flow coefficient of variation	Minor impact	Moderate impact – no effect	Minor impact	Major impact – no effect	Minor impact	Major impact – no effect
Daily flow coefficient of variation	Minor impact	Major impact – no effect	Minor impact	Major impact – no effect	Minor impact	Major impact – no effect
Weekly flow coefficient of variation	Minor impact	Moderate impact – no effect	Minor impact	Moderate impact – no effect	Minor impact	Moderate impact – no effect

Combined option 3: Increase on-farm water storage, Brown Mountain Water Project, and active water markets – variant 2 (20 GL storage at Steeple Flat)

Economic assessment

Purpose	Increase agricultural production by increasing on-farm storage, centralised water storage, and increasing opportunities for irrigators to access water that is not being used through trade.
Description	This combined option integrates: - Increased on-farm water storage with low-flow bypasses (Draft South Coast Regional Water Strategy Option 16a). - Brown Mountain Water Project 20 GL dam with 10% increase in maximum planted area of irrigators in the unregulated system downstream of Cochrane Dam (regulated releases for downstream users). (Draft South Coast Regional Water Strategy Option 21d). - Active and effective water markets (Draft South Coast Regional Water Strategy Option 34). It also assumes the Bemboka River downstream of Cochrane Dam is proclaimed as a regulated river and that the storage supports increased irrigation demands.
Hydrologic results	Water assumed for agricultural usage across the region is increased by approximately 10% on average over 40 years over the 3 climate scenarios considered. This represents an uplift of nearly 5% when compared with Combined option 2, which can be attributed to the increase in size of the dam and the assumed 10% increase in agricultural demand.
Economic assessments	Compared with the first variant this combined option has the potential to produce greater economic output for perennial pasture under all climate scenarios due to the increased size of the dam at Steeple Flat (to 20 GL) and assumed increase in downstream demand. Additionally, in all cases the benefits to towns are improved compared to the results of the first variant. The combined option performs similarly under all climate scenarios, with an average net benefit to the region across all users of between \$25 to \$26 million over 40 years.
Key assumptions & limitations	All assumptions and limitations for the individual options relevant to this combined option discussed in the rapid cost benefit analysis hold for the detailed analysis.

Summary of modelled results. Changes are compared to base case (i.e. no change)

Climate Data	Average Change in Economic Outcomes (\$ million, over 40 years)			Option Cost (\$ million, over 40 years)	Net Present Value (\$ million, over 40 years)	Benefit to cost ratio
	Towns	Perennial Pasture	Total			
Stochastic	0.2 (17.7%)	24.9 (11.1%)	25.1	202.7	-177.6	<1
NARClIM	0.8 (12.4%)	24.9 (11.4%)	25.7	202.7	-177.0	<1
East coast low (ECL)	0.6 (10.9%)	24.1 (11%)	24.7	202.7	-178	<1

Environmental assessment

Combined option 3 showed similar but more extreme impacts than with combined options 1 and 2. Several changes also indicate a minor flow regime change in the river, especially at the low flow end. There is generally about a 30% increase in the number of days below low flow across the climate models, and an 60-80% increase in the average duration of no flow spells. However, the frequency of no flow spells decreases by about 16%, and the 90th and 95th percentile flow rates both increase by about one fifth. On average, there are small percentage decreases in flow variation across daily, weekly and monthly flows, as well as about a 10% loss in variation around low flows.

This manifested in more extreme changes at some sites. At the Bemboka River site west of Bemboka, low flow days increased from 1 to 22 days per year under the stochastic scenario, but this was associated also a 61% increase in very low flows, and 100% decrease in the annual median number of days below low flows.

Predicted ecological effects of combined option 3 under stochastic and NARClIM scenarios (Planning assumption). The ecological effect is calculated as the percentage change against the base case for stochastic, NARClIM and east coast low scenarios

Metric	Stochastic		NARClIM		East coast low (ECL)	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Number of years with greater or equal to one zero flow spell per 130 years	Moderate improvement	Extreme improvement - no effect	Moderate improvement	Extreme improvement - no effect	Moderate improvement	Extreme improvement - no effect
Average duration of zero flow spells (number of days)	Extreme impact	Moderate improvement - extreme impact	Extreme impact	Moderate improvement - extreme impact	Extreme impact	Moderate improvement - extreme impact
Number of zero events per 130 years	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact
Very low flow rate (ML/d), measured as the 95th percentile discharge of daily flows	Major improvement	Minor impact - extreme improvement	Major improvement	Minor impact - extreme improvement	Major improvement	Minor impact - extreme improvement
Low flow rate (ML/d), measured as the 90th percentile discharge of daily flows	Moderate improvement	Minor impact - extreme improvement	Moderate improvement	Minor impact - extreme improvement	Moderate improvement	Minor impact - extreme improvement
Median annual low flow days	Extreme impact	No effect - extreme impact	Extreme impact	Extreme improvement - extreme impact	Extreme impact	Extreme improvement - extreme impact
Median days below low flow	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact	Moderate improvement	Extreme improvement - moderate impact
Low flow standard deviation	Minor impact	Extreme impact - minor improvement	Minor impact	Extreme impact - minor improvement	Minor impact	Extreme impact - minor improvement

Metric	Stochastic		NARCIIM		East coast low (ECL)	
	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges	Average effect	Range of effects across gauges
Low flow days below the 75 percentile	No effect	No effect - no effect	No effect	No effect - no effect	No effect	No effect - no effect
Base flow rate (ML/d), measured as the 80th percentile discharge of daily flows	Minor improvement	Minor impact - extreme improvement	Minor improvement	Minor impact - extreme improvement	Minor improvement	Minor impact - extreme improvement
Mean annual discharge (ML/y)	No effect	Minor impact - no effect	No effect	Minor impact - no effect	No effect	Minor impact - no effect
Fresh flow rate (ML/d), measured as the 20th percentile discharge of daily flows	No effect	No effect - no effect	No effect	No effect - no effect	No effect	No effect - no effect
Average number of freshes per year	Minor impact	Extreme impact - no effect	Minor impact	Extreme impact - no effect	Minor impact	Extreme impact - no effect
Average duration of freshes (number of days)	Minor impact	Extreme impact - no effect	Minor impact	Extreme impact - no effect	Minor impact	Extreme impact - no effect
High flows - 2.5-year Annual ReturnInterval (ARI) flow rate (ML/d)	No effect	Minor impact - no effect	No effect	Minor impact - no effect	No effect	Minor impact - no effect
High flows - 5-year ARI flow rate (ML/d)	No effect	Moderate impact - no effect	No effect	Minor impact - no effect	No effect	Moderate impact - no effect
Very high flows - 10-year ARI flow rate (ML/d)	No effect	Moderate impact - no effect	No effect	Moderate impact - no effect	No effect	Moderate impact - no effect
Monthly flow coefficient of variation	Minor impact	Moderate impact - no effect	Minor impact	Moderate impact - no effect	Minor impact	Major impact - no effect
Daily flow coefficient of variation	Minor impact	Major impact - no effect	Minor impact	Major impact - no effect	Minor impact	Major impact - no effect
Weekly flow coefficient of variation	Minor impact	Moderate impact - no effect	Minor impact	Major impact - no effect	Minor impact	Moderate impact - no effect



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