



# Draft Regional Water Strategy

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Far North Coast: Strategy

October 2020

**Published by NSW Department of Planning, Industry and Environment**

[dpie.nsw.gov.au](http://dpie.nsw.gov.au)

**Title: Draft Regional Water Strategy**

**Subtitle: Far North Coast: Strategy**

**First published: October 2020**

**Department reference number: PUB20/307**

**Cover image:** Image courtesy of Destination NSW.

**More information:** [www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy](http://www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy)

**Acknowledgements:** The input and collaboration of these NSW Government agencies is acknowledged: WaterNSW, NSW Health, Office of Local Government, and Aboriginal Affairs NSW. The feedback of the Aboriginal Water Coalition is also acknowledged, which includes the NSW Aboriginal Land Council, NTSCORP, Murray Lower Darling Rivers Indigenous Nations and Northern Basin Aboriginal Nations.

**Acknowledging Aboriginal people:** the NSW Government acknowledges Aboriginal people as Australia's first people practicing the oldest living culture on earth and as the Traditional Owners and Custodians of the lands and waters.

We acknowledge that the people of the Bundjalung and Githabul Nations hold a significant connection to the lands in which the Far North Coast Regional Water Strategy falls upon.

The Far North Coast Region holds areas of great spiritual, cultural and economic importance to Aboriginal people and the NSW Government recognises the connection of the water to the people of these nations.

We recognise the intrinsic connection of Traditional Owners to Country and acknowledge their contribution to the management of the Far North Coast Regional Water Strategy area landscape and natural resources.

NSW Department of Planning, Industry and Environment understands the need for consultation and inclusion of Traditional Owner knowledge, values and uses in water quality planning to ensure we are working towards equality in objectives and outcomes.

NSW Department of Planning, Industry and Environment is committed to continue future relationships and building strong partnerships with Aboriginal people. We thank the Elders, representatives of the Bundjalung and Githabul Nations and Aboriginal community members who provided their knowledge throughout the regional water strategy development process.

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# Minister's foreword



The NSW Government made a commitment before the last election to undertake comprehensive modelling that would enhance the management of water to improve water security and better prepare our communities for future droughts.

Water is our most precious and valuable resource—for our towns and industries and maintaining our natural and cultural assets.

Our water management and understanding has improved considerably in recent times—if you can't measure it, you can't manage it.

The knowledge we have garnered in the development of these strategies will underpin future investments through a better understanding of optimum water management.

Engaging with our Aboriginal communities is vital, given water is an essential part of their connection to Country and culture, and their cultural water holdings will be vital to creating local jobs into the future. While COVID-19 has

impacted our ability to engage with Aboriginal communities in a culturally appropriate way, we are committed to including their voices in the Far North Coast Regional Water Strategy.

I appreciate the engagement by local government in the development of the draft strategies. Their continued partnership is very important to ensure the strategies respond to the needs of catchments that may extend across many local government boundaries.

Australia is no stranger to extremes; we have always had to manage our water resources through prolonged droughts and floods.

In preparing these strategies, we've engaged leading academics at a number of universities. The paleoclimate-informed rainfall and evaporation modelling was largely undertaken by the University of Newcastle and the University of Adelaide to help understand and mitigate risk in the most extreme circumstances.

The climate modelling in this draft strategy is based on a deliberately conservative scenario which is intended to ‘pressure test’ the effectiveness of these strategies in a worst-case scenario. They do not account for changes in how we operate the system moving forward, where in reality we will respond actively to ongoing drought conditions to prolong the availability of water for critical human needs.

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 if they arise.

The recent drought has taught us a great deal about managing our water resources and we need to put these lessons to good use in preparing for possible future extreme weather events.

In short, the better evidence and information we now have means we can better plan for the future to ensure this precious shared resource is managed to sustain 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, and I encourage all stakeholders to take part in giving us your views on how to improve these draft strategies to ensure our water management policies support the future of NSW.

**Melinda Pavey**  
**Minister for Water,**  
**Property and Housing**



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## Snapshot

# The Far North Coast region



**240,000**  
population



**8,600**  
km<sup>2</sup> area



**Aboriginal Nations:**  
Bundjalung and  
Githabul Nations



**Regional centres include:**  
Tweed Heads,  
Lismore and Ballina



**Smaller towns include:**  
Casino and Byron Bay



**Main rivers:**  
Richmond, Tweed and  
Brunswick and many  
unregulated rivers



**Major water storage:**  
**Rocky Creek Dam** with a  
storage capacity of 14 GL

**Clarrie Hall Dam** with a  
storage capacity of 16 GL



**Rural water storage:**  
**Toonumbar Dam** with a  
storage capacity of 11 GL



**Groundwater sources:**  
Alstonville Basalt Plateau,  
alluvial, fractured rock,  
coastal sands and porous  
rock sources



**Key environmental assets:**

Tuckean Swamp, Stotts Island Nature Reserve, Cudgen Nature Reserve, Billinudgel Nature Reserve and the Lower Bungawalbin Catchment Wetland Complex

Gross Regional Product: **\$13 billion**





# Overview

**Across NSW, our valuable and essential water resources are under pressure. Changing industry and employment patterns and a more variable climate mean we face difficult decisions and choices about how to balance the different demands for this vital resource and manage our water efficiently and sustainably into the future.**

**The NSW Government is preparing comprehensive regional water strategies that will 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.**

**The Far North Coast Regional Water Strategy is one of 13 strategies (12 regional water strategies and a Greater Sydney Water strategy) the Department of Planning, Industry and Environment is developing in partnership with water service providers, local councils, Aboriginal peak bodies, communities and other stakeholders across NSW.**

# The Far North Coast region

The Far North Coast region (Figure 1) covers approximately 8,620 km<sup>2</sup> in the north-eastern part of NSW. The area includes the three catchments of the Richmond River (7,026 km<sup>2</sup>), the Tweed River (1,080 km<sup>2</sup>) and the Brunswick River (512 km<sup>2</sup>) and is located within the traditional lands of the Bundjalung and Githabul Nations. The region encompasses six local government areas: Ballina Shire, Byron Shire, Kyogle, Lismore City, Richmond Valley and Tweed Shire. It is nested within the NSW North Coast planning region<sup>1</sup> and bound by Queensland to the north.

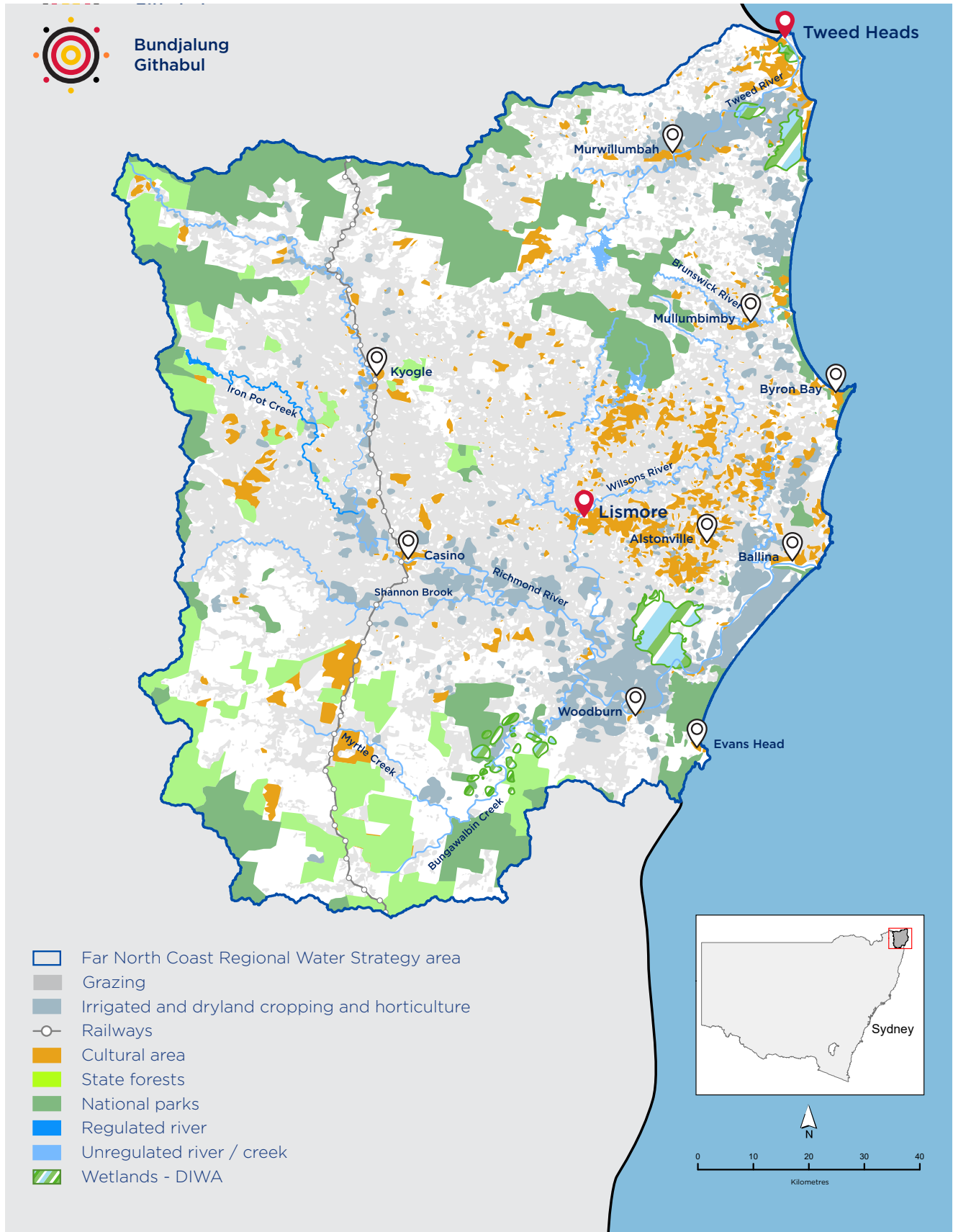
The Far North Coast region comprises most of the area commonly known as the Northern Rivers. It is bounded by the caldera escarpment of the MacPherson Range to the north, the Tweed, Burringbar, Koonyum and Richmond Ranges to the west, the Richmond Range to the south and the coast to the east. A large portion of the region's elevated areas have world heritage status and are protected as part of the Border Ranges, Mount Warning and Nightcap national parks.

The region's population is around 240,000. The main centres of Tweed Heads, Lismore, Ballina, Casino and Murwillumbah serve as important employment and services hubs for the region. There are also many smaller towns in the region with populations ranging from around 200 to 3,000 people, including Byron Bay, Mullumbimby, Nimbin and Kyogle. The region neighbours South East Queensland and is closely connected economically to the more densely populated hubs of the Gold Coast and Brisbane.

The Far North Coast region supports an exceptionally diverse economy. Its coastal, riverine and hinterland amenity, access to South East Queensland and generally excellent quality infrastructure support a multitude of industry sectors, such as tourism, agriculture, fishing, food manufacturing, health care, education, retail and a range of professional and business-enabling services.<sup>2</sup>

1. The NSW Government has divided the state into ten regions for the purpose of strategic land use planning. The Far North Coast and North Coast regional water strategy regions mostly fall within the North Coast strategic land use planning region.
2. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government

Figure 1. Map of the Far North Coast region



## Water in the Far North Coast region

The Far North Coast's common name—the Northern Rivers—highlights the centrality of water in the region. Water is a significant feature of the Far North Coast region's environment, with its many interconnected systems of rivers, creeks, groundwater aquifers and wetlands. Water supports the region's population and its liveability, protects and conserves ecological assets and Aboriginal cultural heritage, and underpins key industries and local employment.

The region has three main rivers—the Richmond River in the south, the Brunswick River and the Tweed River in the north. The Richmond River catchment has three main arms: the Richmond River, the Wilsons River and Bungawalbin Creek. The Richmond tidal pool is at the downstream end of these and forms the upstream extent of the Richmond River estuary. A unique feature of this estuary is that it is very long, with the tidal influence reaching 90 km from the ocean mouth. The Tweed River is fed by eight arms, the two major ones being the Oxley River and the Rous River. Tidal influence in the Tweed River extends up to Bray Park Weir, approximately 5 km upstream of Murwillumbah. This tidal influence dominates the river levels in this part of the catchment except during flood events. The Brunswick River begins in the Burringbar Ranges, traverses flatter coastal areas and is joined at Brunswick Heads by its two main tributaries—Marshall and Simpson's creeks—before discharging to the Pacific Ocean. The river is influenced by tides downstream of Mullumbimby. All of the rivers and creeks in the Brunswick catchment are unregulated<sup>3</sup> and have no major dams for water supply or instream structures.

The eastern part of the Richmond catchment is characterised by a very large coastal floodplain. A large portion of the Brunswick catchment drains from the mountainous terrain in the west to an area of low lying, poorly drained country. The region's floodplains support industries such as sugar cane, livestock grazing and other agricultural uses. Large parts of the region also provide habitat for a high diversity of wet flora and fauna species. These areas include nationally important wetlands such as the Tuckean Swamp and Lower Bungawalbin Catchment Wetland Complex. Large elevated nature reserves and significant parcels of environmental reserves surround both Brunswick Heads and Byron Bay. These are critical for biodiversity in the region—the Northern Rivers is the most biologically diverse area in NSW and southern Queensland, and the third most biologically diverse region in Australia.<sup>4</sup>

The Far North Coast region is recognised for its high density of rivers, streams and waterbodies. The region contains an extremely high terrestrial and aquatic biodiversity and has many species that are endemic to the region. It supports species and habitats of local and international significance, and it forms crucial links between important conservation areas. This richness in biodiversity is due to the geographic conditions of the area, which allow for the presence of both tropical and temperate species.

Unregulated rivers are the most important water resources in the region for towns, industry and water-dependent ecosystems. Groundwater from alluvial aquifers, coastal sands aquifers and from porous and fractured rock aquifers are also important water resources. Groundwater on plateau areas such as the Alstonville area provides baseflows to surface waters, and alluvial groundwater and surface water systems can have a high degree of connection in the lower reaches, in estuaries

3. An unregulated river or stream is not controlled by releases from a major state-owned dam. Water users and the environment are reliant on climatic conditions and rainfall.

4. Regional Development Australia—Northern Rivers 2013, *Northern Rivers Regional Profile*

and in coastal riverbeds. This means that the depletion of surface water sources can impact groundwater recharge and groundwater levels. Similarly, the depletion of groundwater can impact streamflows. Urbanisation in the Far North Coast region has resulted in modified surface water drainage and runoff, which can impact groundwater recharge patterns and increase surface water and groundwater pollution risks.

There is one small regulated system<sup>5</sup> in the Far North Coast region. Toonumbar Dam (11 GL)—located on Iron Pot Creek, high in the Richmond catchment near Kyogle—supplies water to a small number of agricultural producers. The dam is very underused, mostly because the region has high rainfall and supports cropping with relatively low irrigation demand. This means Toonumbar Dam is used primarily as a drought security measure. Consequently, WaterNSW operates Toonumbar Dam at a loss and water charges are high compared to other large regulated systems in NSW.

Rocky Creek Dam (14 GL) and Clarrie Hall Dam (16 GL) are the region's two major storages for town water supplies, although water is supplied to towns from multiple sources across the region. Rocky Creek Dam is located in the upper Richmond catchment, 25 km north of Lismore. Clarrie Hall Dam is located on Doon Doon Creek high in the Tweed catchment, 15 km south-west of Murwillumbah. Most urban communities in the Richmond and Brunswick catchments are connected through the Rous County Council water supply system. However, some towns are not connected to this system and councils operate several independent reservoirs and reticulation systems.

These storages are relatively small for the populations they serve but function well as the region generally receives regular and reliable

rainfall. However, strong population growth in the region, particularly along the coastal fringe, is putting pressure on town water supplies. While demand is increasing, water supply is reducing. Storage levels decreased faster during the 2018–20 period than during the Millennium Drought and water restrictions were progressively rolled out over 2019. While the risk to water security in towns varies across the region, demand for water is generally expected to exceed supply within the next 5–15 years.

Many parts of the Far North Coast region—particularly in the Richmond catchment—have been classified as being under high<sup>6</sup> or medium hydrologic stress.<sup>7</sup> While there is enough water in the region to meet demands on an annual basis, most extraction takes place in the drier seasons, when flows are low. This puts high stress on the flora and fauna that rely on the rivers, and also impacts the extraction potential and the quality of water used for agricultural purposes. Climate projections suggest that a decrease in dry season (winter) rainfall and an increase in the number of dry days is likely in the future, and that this could amplify these impacts.

Many of the water sources in the region also suffer from poor water quality, particularly those in the Richmond catchment. Water quality issues are largely a result of historic logging operations, poor agricultural practices, on-site septic management and sewage overflows, floodplain drainage—which can mobilise acid sulfate soils—urban runoff and tidal floodgate operation.

Agriculture is a key part of the regional economy. Agricultural production in the region is diverse and includes livestock and livestock products, fruit and nuts, nurseries, cut flowers and turf, and broadacre crops such as sugar cane, rice and oilseed. Due to the high amounts of reliable rainfall, production in the region

5. A regulated river is one where the flow has been modified from its natural state through structures such as a major state-owned dam, weir or off-takes. Major dams usually control the flow of water down regulated rivers.

6. High hydrologic stress: 70–100% flow extracted; Medium hydrologic stress: 40–60% flow extracted

7. Department of Land, Water and Conservation 1998, *Stressed Rivers Assessment Report: NSW State Summary*, [www.water.nsw.gov.au](http://www.water.nsw.gov.au)

has traditionally had a large focus on non-irrigated crops such as sugar cane, macadamias and bananas. Producers are now adapting to new market demands and some of these traditional crops are being converted to high-value irrigated crops such as blueberries. This is changing the demands on the water system and may impact how it functions in the future. Additionally, the reliance on rainfed crops and unregulated water extraction has made the region particularly susceptible to the impacts of drought as there is very little storage to buffer the water supply.

Aboriginal people in the region also rely on water for their health, wellbeing and connection to Country. They value maintaining

connectivity to land and water, and the region's rivers and estuaries are considered 'classrooms' for maintaining the continuity of Aboriginal culture. Aboriginal people seek more opportunities to manage water using their cultural knowledge and to create improved economic opportunities and environmental outcomes.

Engagement with Aboriginal people has been impacted by COVID-19. Department of Planning, Industry and Environment is committed to engaging with Aboriginal Elders, nation representatives and community members between now and the release of the final strategy.

## Definitions

We are using the following definitions in the regional water strategies:

**Water security** in the context of regional water strategies refers to the acceptable chance of not having town water supplies fail. This requires community and government to have a shared understanding of what is a 'fail event' (for example, no drinking water or unacceptable water quality) and the level of acceptability they will pay for.

**Water reliability** refers to how often an outcome is achieved. It is often considered to be the likelihood, in percentage of years, of receiving full water allocations by the end of a water year for a licence category.

For example, a 60% reliability means that in 60% of years a licence holder can expect to receive 100% of their licensed entitlement by the end of the water year. Other measures of volumetric reliability could also be used. For example, the percentage allocation a licence holder could expect to receive at a particular time of the year as a long-term average. Reliability may also refer to how often an acceptable water quality is available. A reliable water supply gives some clarity to water users and helps them plan to meet their water needs.

**Resilient water resources** means water users are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.

## Future climate risks

The NSW Government has invested in new climate datasets and improved modelling that provide a more sophisticated understanding of historic climate variability in the Far North Coast region, as well as likely future climate risks. This means that we have moved from making decisions that are based largely on single worst-case scenarios to a much more comprehensive understanding of natural variability and potential extreme events.<sup>8</sup>

We can now better predict and plan for plausible future climate scenarios (such as the likely frequency, duration and severity of extended droughts), better understand the climate risks faced by water users and the environment across NSW and better manage our water resources over the medium- and long-term to mitigate these risks.

This new information is the basis for preparing robust new water strategies for our regions and also offers fresh evidence for examining our existing water policies, operational rules and management plans.

The new climate data and updated hydrological modelling developed for this regional water strategy suggest that the Far North Coast region will continue to be dominated by wet and dry periods and there is a risk of:

- prolonged droughts that receive less total rainfall than those in the observed record for the region (such as the 1911 to 1916 Drought)
- more frequent short, sharp droughts, similar to the most recent drought (2018–2020)
- less frequent, but higher magnitude large flow events.

Sea levels are also predicted to rise, which will push high tides further upstream and

will increase river and groundwater salinity. Over time, this may also have impacts on land availability for agriculture and other purposes.

These events could become more severe due to likely changes in climate across north eastern NSW in both the near—and longer-term. These changes include higher temperatures, more frequent hot days and changes to the seasonality of rainfall. It also means that regular flows in rivers may reduce and some smaller creeks may stop flowing more often than they do now. Droughts that occur in closer succession and hotter, drier conditions may mean catchments require higher rainfall to generate runoff into rivers and creeks.

## Making choices for the future

Like most regions across Australia, the Far North Coast region faces choices and challenges in balancing different water uses as climatic conditions change. The region is vulnerable to these changes as both the natural and engineered water systems have developed based on high amounts of regular, reliable rainfall. However, the communities and local governments in the Far North Coast region display high levels of collaboration, which has put the region in a good position to deal with greater climate variability and tackle future challenges, which include:

- providing reliable and safe town water supplies for the growing population, with over 80% of the population of the region relying on water provided by a local government water utility
- maintaining domestic water availability during extended dry periods for the region's population who source their drinking and domestic water from unregulated rivers, groundwater aquifers, farm dams and rainwater tanks

8. More information about this modelling is provided in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

- maintaining and improving flows for the environment, aquatic habitats and fish passage
- ensuring sustainable access to water for the region's agricultural industries
- mitigating the impacts of urban and rural land management activities on water quality
- improving the region's capacity to manage the impacts of sea level rise and higher-magnitude flooding.

To meet these challenges, we may need to rethink how the region's towns, industries and rural communities access water and which water resources they rely on. We may also need to find ways to use water more efficiently, improve how we manage groundwater and water quality, and make more use of recycled wastewater and stormwater.

## A new, comprehensive water strategy for the Far North Coast region

The Far North Coast Regional Water Strategy will guide how we address future water resource challenges, make the right policy and infrastructure choices and open up new opportunities for the region.

The strategy will bring together all the tools we have—policy, planning, behavioural, regulatory, technology and infrastructure solutions—in an integrated package. This package will be based on the best evidence, respond to the region's growth and balance different water needs.

The strategy will aim to provide choices to better use, share, store and deliver water to avoid having to ride the highs and lows of water

availability. It will cover the whole Far North Coast region and all water types, and it will change how we manage water in the future.

In line with the objectives we have set for all regional water strategies, the Far North Coast Regional Water Strategy has a strong focus on working closely with communities to deliver healthy, reliable and resilient water resources that:

- deliver and manage water for local communities
- enable economic prosperity
- recognise and protect Aboriginal water rights, interests and cultural values
- protect and enhance the environment
- are affordable.

The final strategy will set out clear and accountable actions for the NSW Government, local councils and industries to tackle the challenges facing the Far North Coast region. The strategy will seek to maximise opportunities from population growth and the growing agribusiness and tourism sectors. It will also aim to expand on opportunities presented by investment in the health of the NSW marine estate<sup>9</sup> and in transport and community infrastructure, such as the Pacific Highway upgrade.

The final strategy will also help to improve the sequencing and integration of water reforms and water planning actions across the Far North Coast region to ensure they are implemented effectively.

The Department of Planning, Industry and Environment will develop an implementation plan that identifies actions and timeframes.

9. The NSW marine estate includes tidal rivers and estuaries, the shoreline, submerged lands, offshore islands, and the waters of the NSW coast from the Queensland to the Victorian border and out to three nautical miles offshore.

## Our vision for the strategy

Our vision for the Far North Coast Regional Water Strategy is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous region. To achieve this, we need to position the region so there is the right amount of water of the right quality available for people, Aboriginal communities, towns, industries and the environment.

## The options

A long list of potential options is presented as part of this draft strategy.

These options build on the NSW Government's current and planned investment in water planning and infrastructure in the region, including investments in critical water treatment plant upgrades and new environmental works to remove barriers to fish passage in the Richmond River. They also complement and build on state-wide reforms to introduce non-urban water metering, improve compliance with water sharing rules and review harvestable rights for all coastal draining catchments.

To identify and develop appropriate options for the draft strategy, we have drawn from a range of sources including previous studies, community engagement, experiences of the dry period over 2018–20 and existing government programs. We have aligned our approach with regional development and land use strategies to ensure that all options can be integrated and sequenced with state-wide and local plans.

The options cover actions, projects, reforms and investments that focus on:

- **maintaining and diversifying water supplies**, including new water storages and pipelines, refurbishing and re-purposing existing water storages, increasing on-farm storage and introducing climate-independent water sources such as desalination, wastewater reuse and stormwater projects
- **protecting and enhancing natural systems**, including better protection for native and threatened aquatic species through policy changes to ensure more sustainable water extraction, improved water quality, and river, wetland and catchment management works
- **supporting water use and delivery efficiency and conservation**, through new and upgraded infrastructure, water efficiency measures and water market reviews
- **strengthening community preparedness for climate extremes**, such as reviewing drought management responses, improving or diversifying access to water during drought and improving data collection programs
- **improving the recognition of Aboriginal people's water rights, interests and access to water**, such as reviewing cultural water access licences and ensuring greater involvement of Aboriginal people in water management.

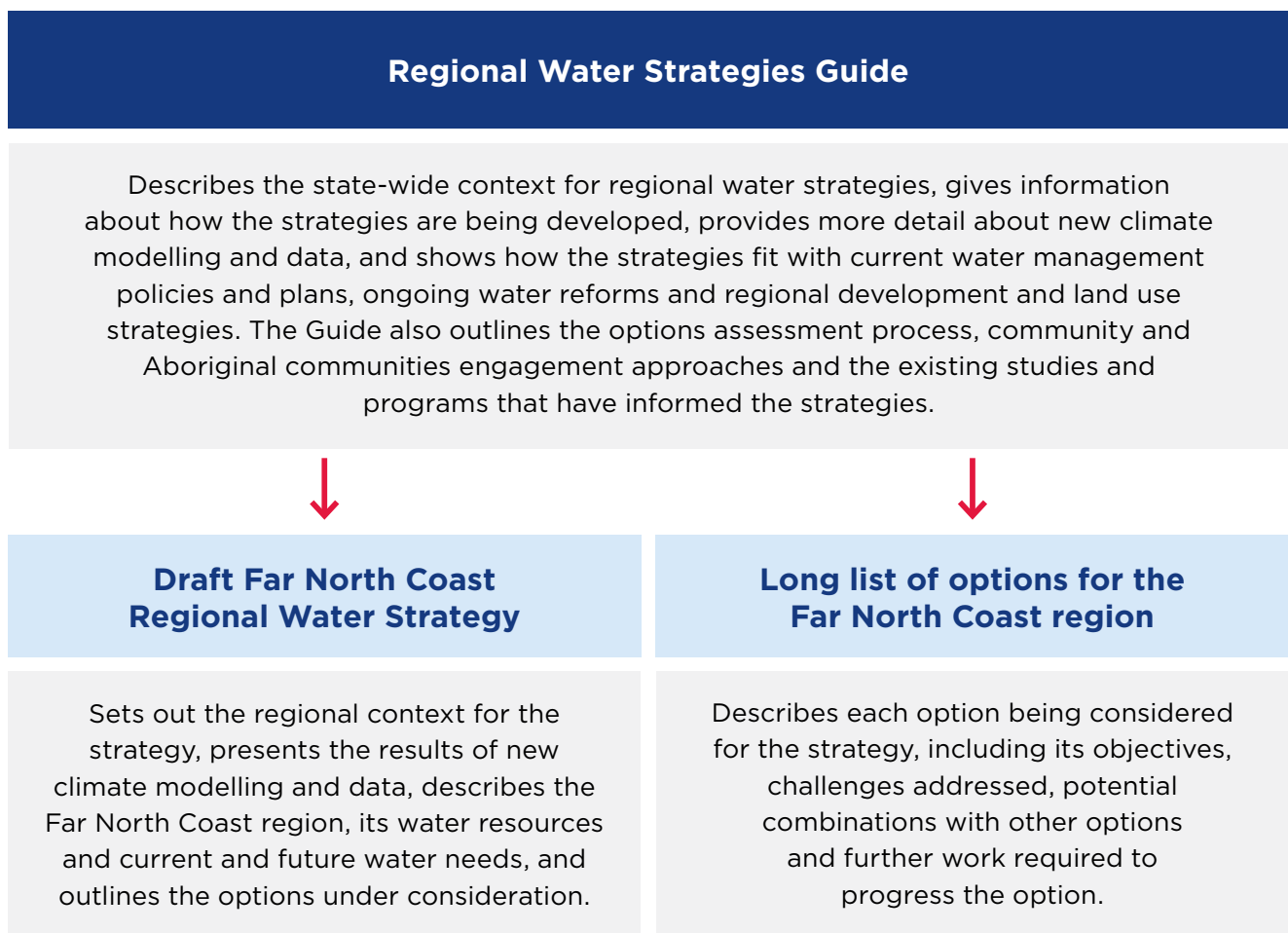
This strategy considers how government and local water utilities can adopt a more integrated approach to managing surface water, groundwater and their catchments. It also acknowledges that end of system flows are fundamental for a biologically diverse marine estate, which provides a range of social, economic and cultural opportunities for the Far North Coast’s communities, including its Aboriginal people, and visitors.

Many of the options are interrelated. This means that to get the most benefit out of these options—and make the best use of the region’s water resources—they may need to be combined into packages.

Not all options will be progressed, and many have not been costed. Following feedback on the draft strategy, we will conduct an evidence-based assessment to identify the best actions for the Far North Coast region. This will form the final, comprehensive Far North Coast Regional Water Strategy.

**The Draft Far North Coast Regional Water Strategy is accompanied by a more detailed description of the long list of options and an overarching explanatory guide that outlines the broader context for the development of regional water strategies across NSW (Figure 2).**

**Figure 2. Draft Far North Coast Regional Water Strategy**





Chapter 1

# Context

# Snapshot

**We are preparing comprehensive regional water strategies across NSW, bringing 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.**

- The strategies will aim to understand how much water a region will need to meet future demand, identify the challenges and choices involved in meeting needs and set out the actions we can take to manage risks to water security and reliability.
- Through better strategic planning the NSW Government aims to support safe and secure water for towns and communities, support regional industries, boost economic prosperity and safeguard and enhance the environment. The strategies will also recognise and protect Aboriginal rights, interests and access to water.
- The Far North Coast Regional Water Strategy is one of 13 strategies (12 regional water strategies and a Greater Sydney Water Strategy) the Department of Planning, Industry and Environment is developing in partnership with water service providers, local councils and Aboriginal peak bodies. The final strategies will also be informed by communities and other stakeholders across NSW.

**New climate data and modelling, plans, studies and investments have also influenced the direction of the Draft Far North Coast Regional Water Strategy.**

- A significant amount of work since the Millennium Drought has improved our understanding of the risks affecting water resource management in the Far North Coast region. Community engagement across NSW over the last few years has also given insights into the best way to prepare for future droughts and floods in the region.
- The NSW Government has invested in new climate datasets and improved modelling to provide a more robust and sophisticated understanding of future risks to water availability in the Far North Coast region.
- The regional water strategies will build on existing NSW Government commitments to improve water security, resilience and reliability across regional NSW, including investment in water infrastructure, a range of state-wide water reforms and a new streamlined approval process for drought-related projects.
- The strategy also aligns with existing policies and plans that are improving the management of water resources across NSW, as well as being integrated with strategic and local land use planning.

# 1.1 Purpose of regional water strategies

Regional water strategies bring together the most up-to-date information and evidence with a wide range of tools and solutions to plan and manage each region’s medium and long-term water needs.

The strategies look out over the next 20 to 40 years and identify the challenges and choices involved in meeting the region’s future water needs. They also determine the actions we can take to manage risks to water availability and to secure healthier, more reliable water sources.

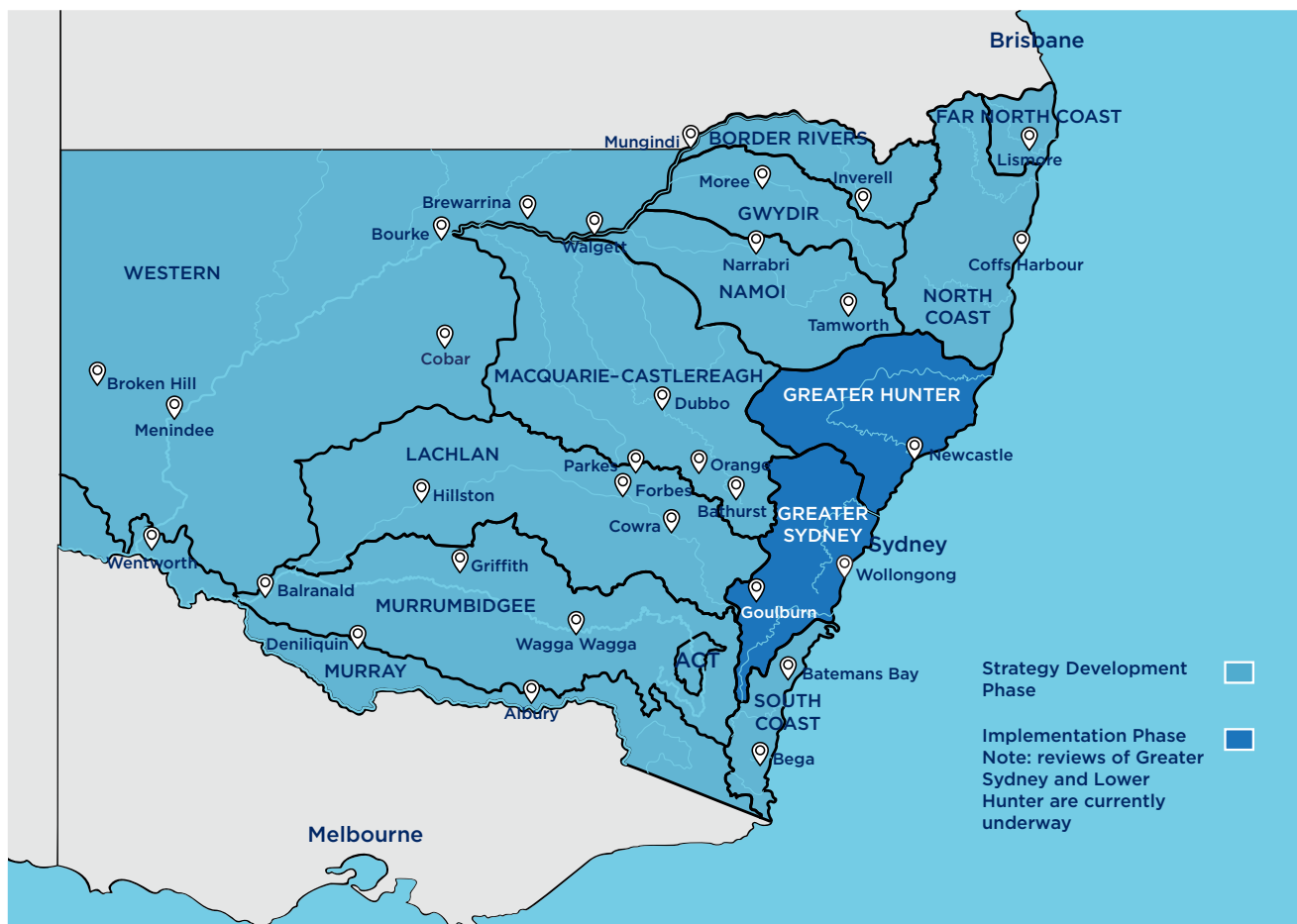
The strategies also explore new solutions to tackle these issues. These solutions have the potential to add value to the way we manage water, to generate greater community-wide

benefits and to create new economic opportunities for each region.

With improved strategic planning around water, the NSW Government aims to achieve resilient water resources for towns and communities, industry, Aboriginal people and the environment.

The Far North Coast Regional Water Strategy is one of 13 strategies (12 regional water strategies and a Greater Sydney Water Strategy) the Department of Planning, Industry and Environment is developing in partnership with water service providers, local councils, Aboriginal peak bodies, communities and other stakeholders across NSW (Figure 3).

**Figure 3. Map of NSW regional water strategy regions**





# 1.2 Objectives of regional water strategies

Regional water strategies will set out a long-term ‘roadmap’ of actions to deliver five objectives (Figure 4). Options selected for inclusion in the final strategy for each region will need to address at least one of these

objectives. Our aim is for each strategy to have a comprehensive, balanced package of options that delivers on all the objectives and the regional goals set out in the *North Coast Regional Plan 2036*.<sup>10</sup>

**Figure 4. NSW regional water strategies: objectives**



10. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

During extreme events, such as the 2018–2020 Drought, our focus is on securing basic landholder rights and essential town water supplies. Outside of these extreme events, we have greater flexibility to deliver across all of the objectives, including providing water for the environment.

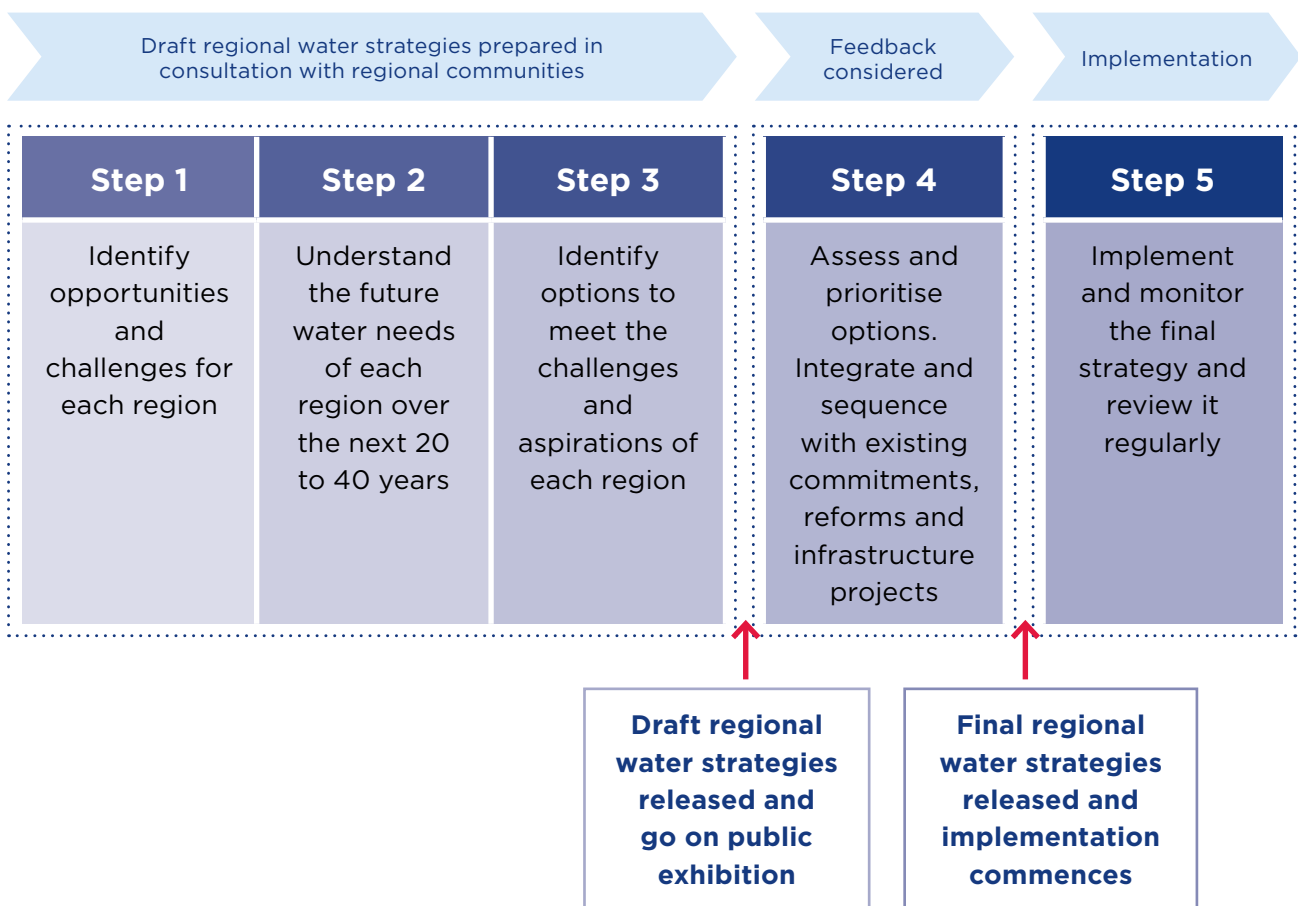
It is also important to note that when formulating water sharing plans, the NSW Government must take all reasonable steps to

prioritise the protection of the water sources and their dependent ecosystems.<sup>11</sup>

Through the regional water strategies, we aim to better manage these extreme events for all water users in the future.

The NSW Government is taking a five-step approach to preparing and implementing regional water strategies, as shown in Figure 5 below.

**Figure 5. Five step approach to NSW regional water strategies**



11. Subsections 9(1)(b), 5(3)(a) and 5(3)(b) of the *NSW Water Management Act 2000*

## 1.3 What has informed the draft regional water strategies?

To ensure we are using the best evidence and most recent data, and fully consider ideas and options from each region, we have used a wide range of sources to inform each strategy.

### 1.3.1 Improved climate modelling and data

Until now, water management in NSW has been based on historical data and observations going back to the 1890s. This has provided a limited understanding of extreme events. The NSW Government has invested in new climate datasets and modelling to develop a more sophisticated depiction of past and future climatic conditions. These improved datasets integrate recorded historical data with paleoclimate data (data reconstructed from before instrumental records began, using sources such as tree rings, cave deposits and coral growth) to give a modelling tool that generates 10,000 years of synthetic climate data. When combined with other sources of climate data—such as climate change projections—this has helped us to better understand natural climate variability, including the probability of wet and dry periods in each region, and estimate risks to future water availability.

This improved modelling means that we have moved from making decisions based heavily on single worst-case scenarios drawn from a short climatic record, to a much more accurate understanding of the length and frequency of past wet and dry periods.

We can now better understand the probability of future climate characteristics—such as the frequency and distribution of droughts and flood flows in the region—and better understand how to assess the possible benefits of medium and long-term solutions.

This new method is an important advance on previous climate datasets and models. Through this work, we can now assess the impact of changes in flows and water security over a much wider range of climatic conditions than if we had only considered the observed historical records.

This updated climate information has been used to help develop the Draft Far North Coast Regional Water Strategy and will help to assess and compare the effectiveness of the draft options. It will also support all water users in making more informed decisions and better planning and preparing for climate risks.<sup>12</sup>

Chapter 2 sets out the results from analysis of the new climate data for the Far North Coast region. We will continue to use the best and latest evidence about the future climate to develop solutions to address the challenges associated with protecting and enhancing environmental assets, regional towns and industries in a more variable climate and during extreme events.

Ongoing analysis will yield more specific and robust results, giving an updated understanding of risks to town water supply, irrigation and environmental water security in the Far North Coast region. The final Far North Coast Regional Water Strategy will use this new data to identify the best ways to share, manage and use water to manage these risks.

12. More information about this modelling is provided in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

### 1.3.2 Existing studies

A significant amount of work has been undertaken to understand the risks affecting water resource management in regional NSW. Development of the Draft Far North Coast Regional Water Strategy and the long list of options identified for the region has been informed by catchment and water security studies, water sharing and drought planning, and regional development, infrastructure and environmental strategies prepared by a range of NSW Government departments and agencies.<sup>13</sup>

The strategy has also been informed by Infrastructure NSW's *State Infrastructure Strategy* (2014<sup>14</sup> and 2018<sup>15</sup>), WaterNSW's *20 Year Infrastructure Options Study, Rural* and the NSW Government's *NSW Marine Estate Management Strategy 2018–2028*.<sup>16</sup>

The Infrastructure NSW strategies identified the Richmond River catchment as lacking in flood mitigation and flow utilisation. It also recommended that the NSW Government develop a regional water strategy for the Richmond catchment. The WaterNSW study provides a strategic assessment of management options to meet long-term targets in regulated rivers across the state, including the Richmond River regulated system.

The *Marine Estate Management Strategy* sets out actions to tackle priority threats to the NSW marine estate. Many of these also threaten the health of upstream waterways

and our objective of delivering resilient water resources for the Far North Coast region. Priority threats were identified in the *Marine Estate Community Survey Final Report*<sup>17</sup> and the *NSW Marine Estate Threat and Risk Assessment Final Report*.<sup>18</sup>

Several important studies by local and county councils have also informed the strategy:

- The *Northern Rivers Regional Bulk Water Supply Strategy*<sup>19</sup> was commissioned by the Northern Rivers Regional Organisation of Councils in 2013. It evaluated the benefits to future water supply security that could come from a regionally integrated system.
- The *Rous County Council Future Water Strategy*<sup>20</sup> and *Future Water Project 2060*<sup>21</sup> outline the proposed direction for Rous County Council to manage its water security into the future.
- Integrated water cycle management strategies have been prepared by all the region's local water utilities. Integrated water cycle management strategies are strategic plans that guide and prioritise actions for management of the urban water supply, sewerage and stormwater systems.

These and other studies will be important sources of information as we assess options for the final Far North Coast Regional Water Strategy.

13. More information about this work is provided in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

14. Infrastructure NSW 2014, *State Infrastructure Strategy Update 2014*

15. Infrastructure NSW 2018, *Building Momentum—State Infrastructure Strategy 2018–2038*

16. NSW Marine Estate Management Authority 2018, *NSW Marine Estate Management Strategy 2018–2028*, NSW Government

17. NSW Marine Estate Management Authority 2018, *Marine Estate Community Survey—Final Report*, NSW Government

18. NSW Marine Estate Management Authority 2017, *NSW Marine Estate Threat and Risk Assessment*, Sydney, NSW Government, [www.marine.nsw.gov.au](http://www.marine.nsw.gov.au)

19. Hydrosphere Consulting 2013, *Northern Rivers Regional Bulk Water Supply Strategy*, Ballina

20. Rous Water 2014, *Rous Water Future Water Strategy*, [rous.nsw.gov.au/cp\\_themes/default/page.asp?p=DOC-JNQ-72-66-37](http://rous.nsw.gov.au/cp_themes/default/page.asp?p=DOC-JNQ-72-66-37)

21. Rous County Council 2020, *Future Water Project 2060*, [rous.nsw.gov.au/cp\\_themes/default/page.asp?p=DOC-KZG-22-16-87](http://rous.nsw.gov.au/cp_themes/default/page.asp?p=DOC-KZG-22-16-87)

### 1.3.3 Community engagement

The NSW Government has been consulting widely—and is continuing to consult—on water sharing plans, metering reforms, coastal harvestable rights, environmental water management and drought. Stakeholder engagement has also recently commenced on coastal agricultural drainage management issues. Through these processes, we have heard many ideas about how to be better prepared for future droughts and floods and a more variable climate.

Due to the COVID-19 pandemic and recent bushfires, we have had to redesign our engagement program, replacing some face-to-face consultation with virtual, online and other contactless methods. We have continued to talk with local councils, other NSW Government agencies and water users about their thoughts on what the Far North Coast Regional Water Strategy could cover. Face-to-face engagement with the Aboriginal communities on the Far North Coast was slightly delayed. Engagement recommenced in July 2020 and will continue as we progress through the options assessment process and final report preparation, and as we develop the NSW State Water Strategy.

Further information about the outcomes of these initial meetings and discussions with local councils, other NSW Government agencies and water users, and our engagement approach with Aboriginal communities during the COVID-19 pandemic is in Attachment 1.



**What local councils and other groups have told us so far:**

- People are seeking meaningful engagement during the development of the strategy.
  - Opportunities exist to better align state, regional and local plans, and better coordinate catchment management activities.
  - A functioning governance framework is key to successfully implementing the regional water strategy. This includes ensuring opportunities to share data and experience with neighbouring communities and local government authorities, including in Queensland.
  - Water providers are concerned about the viability of existing water sources considering climate change and a growing population and are actively planning for new and reliable water sources.
  - Saltwater intrusion to water supplies is a key concern and is likely to become more of an issue into the future. Poor water quality is also a major issue across the region.
  - Local councils need support to deliver the proposals put forward by the regional water strategy.
  - We need to shift our approach to managing extreme events—such as drought and floods—from reactive to proactive.
- Opportunities for implementing demand management are more likely to be found with industrial and rural users than with urban residential users.
  - There is wide community support for water reuse projects, but current regulations make these expensive and difficult to implement.
  - A ‘multi-water source’ approach to water security for regional towns and communities is important. This includes expanding existing water supply networks and considering reuse and climate-independent sources such as desalination.
  - The social, cultural and environmental values are very important to Far North Coast communities. Water management options need to take these values into account.
  - Some people are concerned about increased groundwater take for water bottling in parts of the catchment and want to see groundwater supplies protected for residents, agricultural businesses and towns.
  - Farmers identified drainage as a very important issue for some crops like sugar cane and emphasised that timely irrigation is critical.
- These early insights have been considered in developing this draft strategy.

# 1.4 Building on existing commitments and reforms

The NSW Government has made significant commitments to improve the resilience and reliability of water systems across the state. Much of our current work addresses the risks facing regional NSW and sets our regions up for the future. For the Far North Coast region, this includes investing in water treatment plant upgrades and supporting studies and business case development for a range of projects aimed at securing water supplies and providing sewerage services.

We are implementing a range of state-wide water reforms, including improving water and sewerage services for Aboriginal communities, improving compliance, and transparency around water use and access. We are also introducing robust new metering laws to make sure that most water taken in NSW is accurately measured and monitored.

We are implementing the NSW Government's coastal management framework to manage the risk of coastal hazards on communities and the health of our estuaries. This is done through the preparation and implementation of coastal management programs by councils together

with their local communities. We are also implementing the *Marine Estate Management Strategy* to protect and enhance NSW's marine estate over the next ten years, including the Far North Coast region's highly valued tidal rivers and estuaries. Coastal management programs will link to—and be able to integrate actions from—the *Marine Estate Management Strategy*.

The Far North Coast Regional Water Strategy will integrate and build on *Marine Estate Management Strategy* initiatives and outcomes of coastal management plans, such as improving water quality, planning for climate change and rehabilitation of degraded coastal waterways.

We continue to work towards a state-wide Aboriginal water policy to better represent the interests of Aboriginal cultural values and rights in water management.

More information about these reforms is in the *Regional Water Strategies Guide*.

The Far North Coast Regional Water Strategy will build on these commitments and reforms. It will seek to enhance and leverage them where possible and address any outstanding gaps.

## Providing for community water supplies

The Safe and Secure Water Program is a \$1 billion regional infrastructure co-funding program established in 2017. The NSW Government has committed over \$4 million in the past three years from the Safe and Secure Water Program to co-fund eligible water and sewerage projects across the Far North Coast region. This delivers improvements to public health, water security, environmental outcomes and social benefits.

When regional town and village supplies are threatened by a major event such as an extreme dry period or extreme water quality event, the NSW Government also provides technical and financial assistance to ensure critical human water needs are met. During the recent drought the Emergency Relief for Regional Town Water Supplies program provided over \$200,000 to local water utilities in the Far North Coast.



## 1.5 Policy and planning context

Each regional water strategy sits within a broader policy and planning context. This includes policies and plans that guide the management of regional water resources in coastal NSW (Figure 6).

The NSW Government is also developing a 20-year State Water Strategy. This will establish overarching directions for managing water resources and services to ensure future water security, reliability and resilience, and address long-term challenges such as greater climate variability and population changes. The State Water Strategy will set high-level outcomes and actions to achieve these across public and environmental health, service delivery, liveability, economic development and technology, and for Aboriginal people.

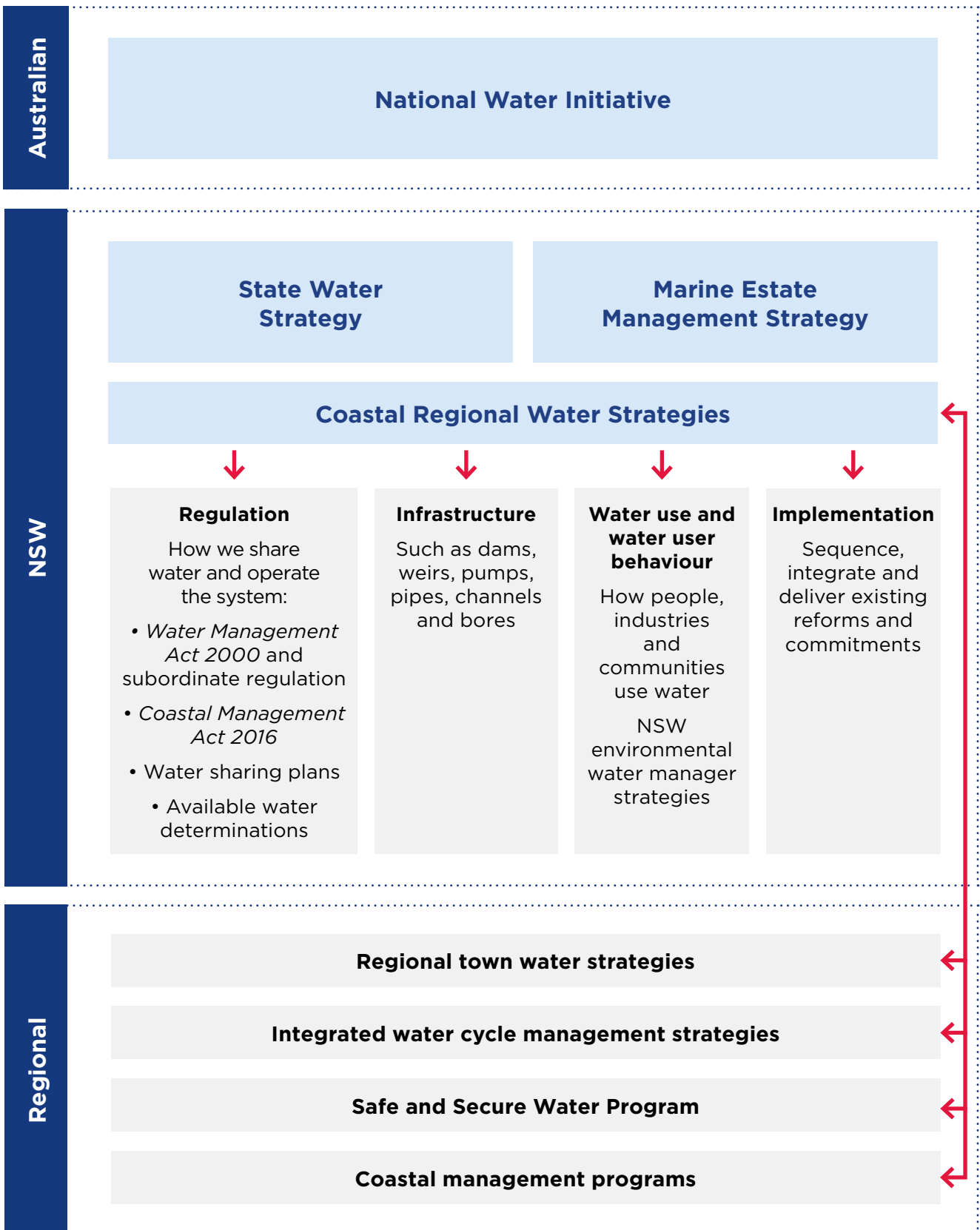
Regional water strategies provide an opportunity to explore how we can better integrate and shape these plans and policies to deliver improved water outcomes. In particular, the strategies will play a key role in the ordering, sequencing and integration of water reforms in each region.

The strategies also align with the NSW Government's strategic planning hierarchy and will be integrated with current land use and regional plans.<sup>22</sup> This includes the *North Coast Regional Plan 2036*,<sup>23</sup> which sets out the land use planning directions for the region.

22. More information about how the strategies relate to strategic, regional and water planning is in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

23. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

**Figure 6. Regional NSW water policy and planning context for coastal catchments**





Chapter 2

# The Far North Coast region, its opportunities and challenges

# Snapshot

**The Far North Coast's water resources are already under pressure. Changing climate conditions will increase this pressure and the water management challenges facing the region.**

- Securing water for towns across the region is already a challenge during extended droughts. Uncertainty around future changes in rainfall and evaporation means future flows and supply are uncertain. Demand is forecast to exceed secure yield in the Richmond and Brunswick catchments within the next two to five years unless action is taken now, while augmentation plans in the Tweed will provide only another 15-20 years of secure supply. New climate modelling will help Far North Coast communities plan to meet these challenges and ensure future investment is directed wisely.
- New climate modelling and more sophisticated climate data prepared for this strategy found that:
  - droughts may be more severe in the future. The region is also likely to see seasonal shifts in rainfall patterns, higher rates of evaporation and more hot days
  - flooding is a major issue in the Far North Coast and can adversely affect towns, businesses and communities. As the climate changes, the Far North Coast is likely to be subject to more intense storm events, although it is uncertain if the severity of associated flooding will increase
- sea levels are projected to rise in the region by between 0.31 m and 0.88 m by 2090. Saltwater may intrude further into estuaries, rivers and groundwater sources
- water extraction from waterways to meet community and industry demands is likely to increase due to decreases in rainfall and greater evaporative losses. Overall, there is sufficient water in the streams of the Richmond River catchment to meet this increase under current land use conditions. In the Tweed catchment, however, the average annual extraction for unregulated river licence holders could decrease by 4%.
- Although large impacts are not expected in the short term, and the likelihood of the worst-case scenario eventuating is small, our new projections show that just relying on observed historical records to make water management decisions is no longer the best course of action. We need to have plans in place to be prepared for plausible future climate risks.

**Towns, communities and industries in the Far North Coast are susceptible to climate variability and change.**

- The region's town water supplies, agricultural industries and other sectors rely on water from unregulated river sources. Securing water for these users will become increasingly difficult due to a combination of population growth, increased water demand and even greater climate variability.
- The Far North Coast region is not used to managing the extreme dry periods that we now know are part of the natural variability of the region's climate. Producers in the region are highly dependent on regular rainfall and therefore highly susceptible to drought. Some town water supplies in the region are not set up to manage extended dry periods. There is also relatively little regional storage available. These features mean that more frequent and severe droughts in the future may leave some towns and rural landholders vulnerable to water shortages.
- The region is particularly susceptible to the impacts of sea level rise. As rainfall declines and the sea level rises, saline water will move further up the estuaries. Many of the region's water supplies and sewage treatment plants are located in estuaries and roughly 11% of water access entitlement volume in the region is located within current tidal limits. The maximum high tide footprint is expected to increase significantly with sea level rise, potentially putting water extraction in coastal parts of the region at risk. Saline intrusion will make some supplies unfit for use and affect sewage treatment plant operations. Irrigators in tidal pool areas will be affected.

The effects of sea level rise may be magnified as freshwater inflows reduce due to climate change.

**Protecting water-dependent environmental assets and native species is becoming more challenging.**

- Clean water and healthy waterways support the region's highly valued environmental assets, which in turn support liveable communities and successful regional industries. However, providing water for a healthy environment is challenging at times. Water for the environment is not actively managed in the Far North Coast region and is largely dependent on rainfall-generated stream flows.
- Many of the region's rivers and creeks are already under stress, particularly during low flow periods. New climate modelling shows these pressures could increase, with reductions forecast for river flows and inflows into estuaries, a decrease in the magnitude of both high and low flow events and more cease-to-flow events.
- Water quality problems are present across the Far North Coast region. As the climate changes, projected lower flows, higher temperatures and sea level rise may further reduce water quality.

**We need to better manage groundwater resources.**

- Groundwater in the region is found in fractured rocks, coastal sands and smaller alluvial aquifers around rivers and creeks. This groundwater provides essential flows to ecosystems, baseflow to rivers and creeks and also provides water for irrigation, industry and town water supplies.

- Urbanisation in coastal areas is impacting groundwater recharge patterns and increasing pollution risks. Before and during any further development, there needs to be improved understanding of the region's groundwater sources and dependent ecosystems to better protect these vital resources.
- Greater knowledge and information is needed to ensure groundwater is used more efficiently, innovatively and sustainably across the region.

**There are significant opportunities to improve how we manage and use water in the Far North Coast.**

- With very strong population growth expected in the Far North Coast, we need to make decisions now about how, where and when to direct new investment to give the region adequate water security into the future.
- New climate information offers an opportunity to review and update water sharing and access rules to better reflect sustainable levels of extraction that consider the region's social, economic, ecological and cultural water needs.
- Opportunities exist to diversify town water supplies using new sources. The Far North Coast region has not maximised use of recycled water, despite the amenability of the community and the enthusiasm of local water utilities to implement water reuse projects. There is an opportunity in the region to use recycled water as a valuable water resource for towns, industry and the environment. Decentralised and regional desalination could also give the region a virtually unlimited, climate-independent source of water.

- A range of options are also available to assist the region's local water utilities to deliver safe and secure water and sewerage services and to mitigate risks to public health and the environment.
- There are opportunities to involve Aboriginal communities more directly in water decision-making and to incorporate traditional knowledge into water management in the region. There are also opportunities to support Aboriginal people to better understand and access water rights they may have under Native Title or other mechanisms.
- A range of options are also available to support the region's farmers to mitigate water security risks and accommodate shifting market trends. Options to improve water reliability will also be critical to attracting businesses and jobs to smaller towns such as Casino and Kyogle, and to helping the region's industries build resilience to climate variability and climate change.
- The Far North Coast Regional Water Strategy also provides an opportunity to investigate options to improve Toonumbar Dam's very low rate of use, reduce its financial burden and maximise the dam's value to support regional economic growth and/or provide community benefits.
- There are opportunities for the region's local water utilities to collaborate with the NSW Government and water utilities in the neighbouring North Coast and South East Queensland regions to collectively lift service standards.

# 2.1 What we know about the Far North Coast region's climate

## 2.1.1 Today's climate

The Far North Coast region has a subtropical climate with hot, humid summers and mild winters. December and January are generally the hottest months with mean summer temperatures ranging between 27°C in the inland valleys and 20°C at higher altitudes. Winter temperatures rarely fall below 7°C on the coastal strip. Frosts can occur inland on low lying flats, particularly during the coldest months of July and August. Average, maximum and minimum temperatures in the region have been increasing since records began, especially in recent decades.<sup>24</sup>

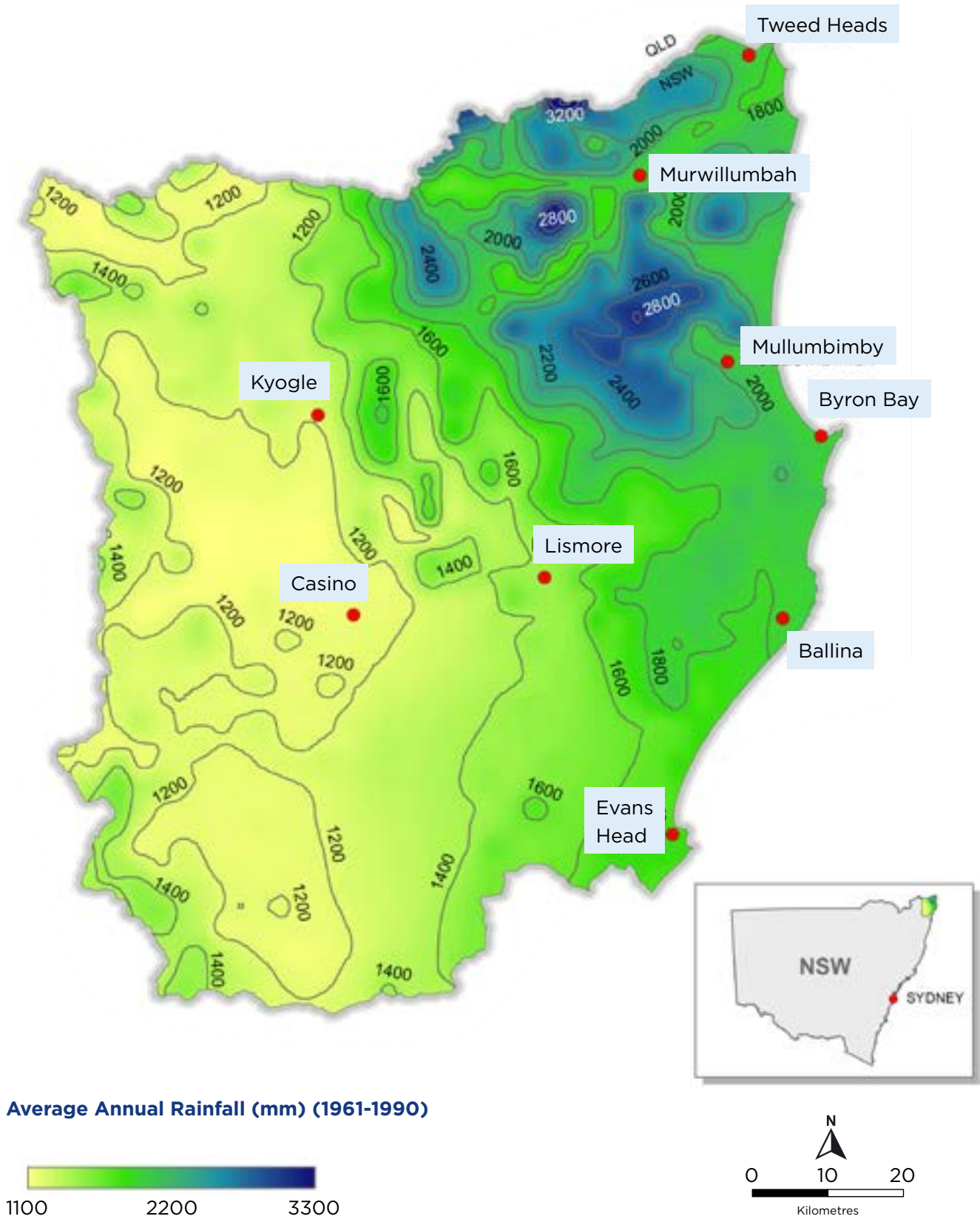
The region experiences some of the highest annual rainfall in NSW. Annual average rainfall generally decreases away from the coast from around 1,800 mm at Byron Bay to 1,200 mm near Kyogle (Figure 7). However, in the elevated national park areas towards the north, rainfall can reach 2,800 to 3,200 mm. Rainfall in the region is highly variable and very seasonal with the majority falling in summer and early autumn. Summer and autumn storms can cause flooding throughout the region.

Annual average potential evapotranspiration is in the range of 1,200 to 1,400 mm.

24. Dowdy, A., et al. 2015, *East Coast Cluster Report*. In M. Ekström, et al. (Eds.), *Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports*, CSIRO and Bureau of Meteorology, [www.climatechangeinaustralia.gov.au/](http://www.climatechangeinaustralia.gov.au/)



**Figure 7. Observed average annual rainfall in the Far North Coast region**



Source: Department of Planning, Industry and Environment—Water 2020, regional rainfall data

## 2.1.2 A better understanding of current climate variability and future climate change

As outlined in section 1.3.1, new climate datasets and improved modelling are providing a better understanding and more realistic picture of the natural variability of the Far North Coast's climate beyond the observed historical records.

Recent climate projections indicate that—due to increasing greenhouse gas concentrations in the atmosphere—the climate along the coast will change in coming years and is likely to be hotter and have more extreme events. New data and modelling suggest that the natural variability of the climate system is much greater than we have seen in recent history and that this variability will continue to be an important driver of the system as the climate changes.

This new analysis shows that the differences between wet periods and dry periods in the historical record relate mostly to rainfall (rather than evaporation).<sup>25</sup> Average annual rainfall during wet periods is roughly 135 mm higher than during dry periods. By comparison, the difference in evaporation during dry and wet periods is negligible. The analysis also found that while the cycles of wet/dry periods usually last between four and 18 years on average, it is possible for these states to last up to 60 years.

Our improved modelling also incorporates recognised climate change forecasts, which suggest that in the Far North Coast region we are likely to see:<sup>26</sup>

- **changing rainfall patterns**—spring rainfall is projected to generally increase, while late autumn and winter rainfall is predicted to decrease. Other changes in rainfall are possible but unclear. Figure 8 shows the rainfall scaling factor we used to model climate change projections
- **higher evapotranspiration**—potential evapotranspiration is expected to increase by up to 6% by 2060 compared to levels between 1990 and 2009. The cumulative effect of ongoing higher evaporation rates during extended low rainfall periods will make droughts worse than previously experienced. Figure 9 shows the evapotranspiration scaling factor we used to model climate change projections
- **higher temperatures**—average temperatures will continue to increase in all seasons. Maximum temperatures are expected to increase by 0.4–1.0°C by 2030, and by 1.5–2.4°C by 2070, while minimum temperatures are expected to increase by 0.4–1.0°C by 2030, and by 1.6–2.5°C by 2070. This will also lead to increased evaporation rates and reduced soil moisture

25. The wet period refers to the negative phase of Interdecadal Pacific Oscillation; dry period refers to the positive phase of the Interdecadal Pacific Oscillation.

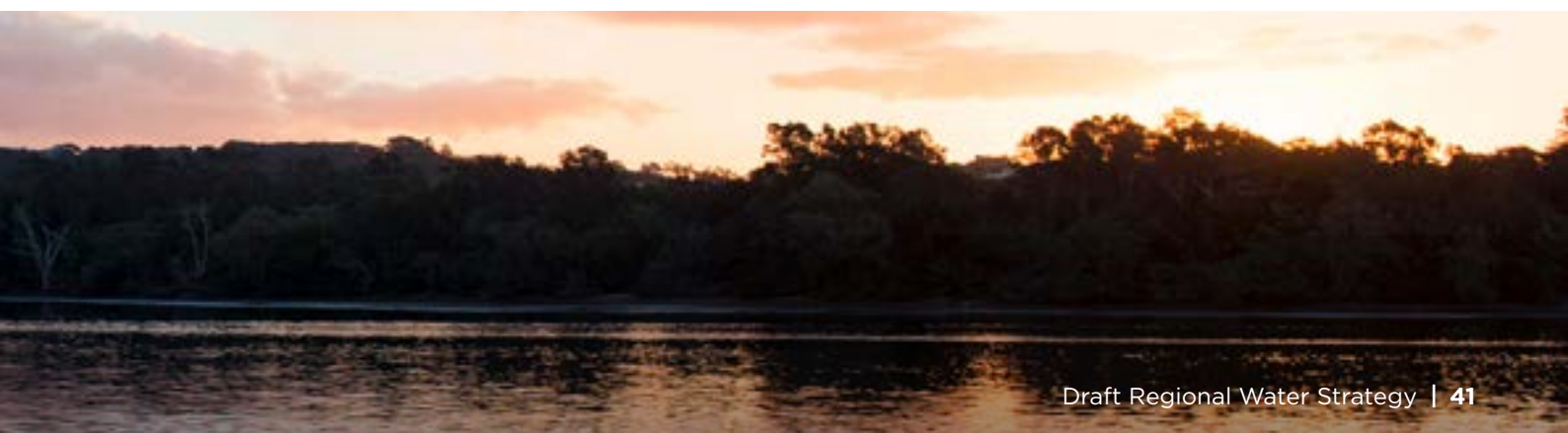
26. Office of Environment and Heritage 2014, *North Coast: Climate change snapshot*, [climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/North-Coast-Climate-Change-Downloads](http://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/North-Coast-Climate-Change-Downloads)

- **more hot days and warm spells**— towards the coast, an additional three hot days (maximum above 35°C per year) are projected by 2030 and an additional nine hot days per year by 2070 on average. However, inland around Casino and the Richmond Valley, this is projected to increase by 5–10 days by 2030 and up to 20 more hot days per year by 2070
- **decrease in the number of frosts and cold nights**—although there is likely to be little change in the number of cold nights along the coast, along the mountains there may be 10–20 fewer cold nights (defined as below 2°C) by 2030, and over 30 fewer cold nights by 2070
- **increased intensity of extreme events**—the region is likely to be subject to more intense storm events, although it is uncertain if the severity of associated flooding will increase<sup>27</sup>
- **rising mean sea level**—sea level is projected to rise in the region between 0.09 m and 0.18 m by 2030, and between 0.24 m and 0.58 m by 2070. Flooding and inundation will become more common in low-lying areas along the coast. The height of extreme sea-level events will also increase
- **harsher fire-weather** climate in the future.

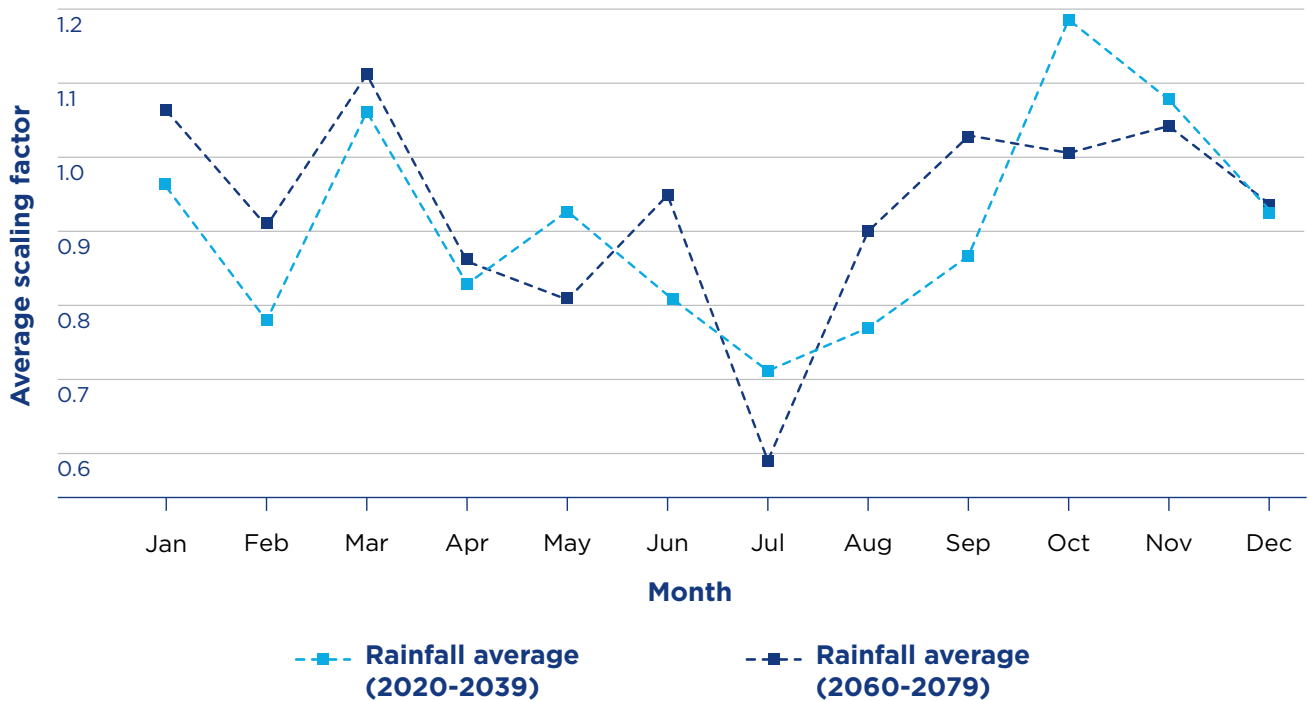
### Using climate change projections in water modelling

The NSW Government's NARClIM (climate change) datasets include a range of different future climate scenarios. We have used the most conservative result from NARClIM in our modelling—the scenario which represents the greatest reduction in average monthly rainfall. While the results of the other scenarios in the current version of NARClIM are arguably equally appropriate and probable, we intend to stress test the water system and understand the worst-case climate scenario for strategic water planning. This will test the resilience of options proposed in the regional water strategies, particularly options that go towards securing water for critical human needs.

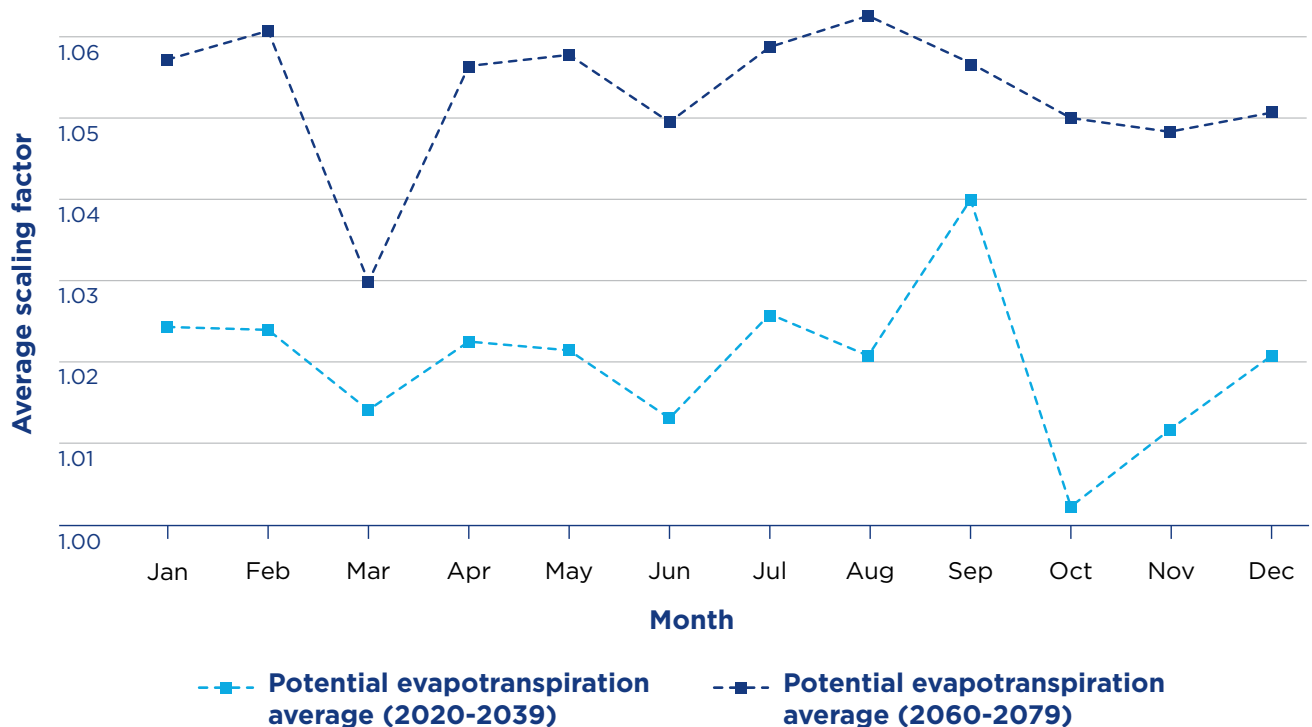
27. Wasko, C., & Sharma, A. 2017, *Global assessment of flood and storm extremes with increased temperatures*. *Scientific Reports*, 7(1), 7945-7945, doi.org/10.1038/s41598-017-08481-1



**Figure 8. Average monthly changes in rainfall for the Far North Coast region for the periods 2020 to 2039 and 2060 to 2079 compared to the period 1990 to 2009 from NARCLiM projections**



**Figure 9. Average monthly changes in potential evapotranspiration for the Far North Coast region for the periods 2020 to 2039 and 2060 to 2079 compared to the period 1990 to 2009 from NARCLiM projections**



Source: Department of Planning, Industry and Environment—Water 2020, region climate data

## Drivers of climate variability in the Far North Coast region

The Far North Coast region experiences relatively consistent long-term annual rainfall, with intermittent and occasionally intense dry and wet periods. Rainfall variability in the region is related to changes in sea surface temperatures of neighbouring oceans. A number of climatic patterns influence rainfall in the region at the annual and decadal scales. Year-to-year variability is most strongly influenced by the El Niño-Southern Oscillation (ENSO). The ENSO cycle can be in a negative phase (El Niño) or in a positive phase (La Niña). El Niño conditions refer to warming of the central and eastern Pacific Ocean and are associated with a higher probability of drier conditions.<sup>28</sup> La Niña conditions refer to cooling of the central and eastern Pacific Ocean and are associated with a higher probability of wetter conditions.<sup>29</sup>

Larger-scale, multi-decadal variability in the region is primarily influenced by the Inter-decadal Pacific Oscillation (IPO). The IPO has a cycle of 15–30 years. The IPO is caused by fluctuations in the sea surface temperature and mean sea level pressure of the north and south Pacific Ocean.<sup>30</sup> Positive phases of the IPO are characterised by a warmer than average tropical Pacific and produce drier conditions. Negative phases are characterised by cool tropics and produce wetter conditions. In the Far North Coast region, the IPO affects rainfall significantly more than evaporation.<sup>31</sup>

Rainfall variations are also linked to the Southern Annular Mode (SAM), a wind system that operates over southern Australia. The SAM is an important short-term climate driver as it can bring rain or dry periods. The timeframes for SAM events are much shorter than ENSO and IPO events, typically a few weeks to a few months. The influence of SAM is less in the Far North Coast than in Southern NSW.

Significant rainfall events may also occur over the Far North Coast due to intense low-pressure systems that form over short time scales. These may take the form of southward tracking cyclones, or east coast low systems.

## The region has experienced persistent droughts, as well as intense shorter droughts

The frequency of dry periods in the region is lower than what is experienced in other parts of the state. However, extended—even multidecadal—dry periods do occur from time to time. Reconstruction of the paleoclimate record over the past 500 years suggests that a persistent, multidecadal drought event occurred in the early 16th century, lasting for 23 years in Southeastern Australia and 28 years in Coastal Queensland.<sup>32</sup>

The Far North Coast region has experienced several droughts<sup>33</sup> over the past 130 years. The most severe have been the Federation Drought (1895–1903), the 1911–1916 Drought, the Millennium Drought (1997–2009) and the 1990s Queensland Drought (1991–1996).

28. Bureau of Meteorology 2020, *Climate glossary: El Niño*, accessed 24 August 2020 from [www.bom.gov.au/climate/glossary/elnino.shtml](http://www.bom.gov.au/climate/glossary/elnino.shtml)

29. Bureau of Meteorology 2020, *Climate glossary: La Niña*, accessed 24 August 2020 from [www.bom.gov.au/climate/glossary/lanina.shtml](http://www.bom.gov.au/climate/glossary/lanina.shtml)

30. Dowdy, A., et al. 2015, *East Coast Cluster Report*. In M. Ekström, et al. (Eds.), *Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports*, CSIRO and Bureau of Meteorology, [www.climatechangeinaustralia.gov.au/](http://www.climatechangeinaustralia.gov.au/)

31. Leonard, M., et al. 2020, *Methodology Report for Multisite Rainfall and Evaporation Data Generation of the Northern Basins—Far North Coast Region Stochastic Evaluation*, University of Adelaide.

32. Cook, B. I., et al. 2016, *The paleoclimate context and future trajectory of extreme summer hydroclimate in eastern Australia*. *Journal of Geophysical Research: Atmospheres*, 121(21), p12,820–12,838, doi.org/10.1002/2016JD024892

33. Drought is defined in terms of periods of rainfall deficit (meteorological drought), low catchment streamflow (hydrological drought) and soil moisture depletion (agricultural drought). This strategy discusses meteorological and hydrological drought.

The region’s lowest 10-year rainfall total on record occurred between 1910 and 1920. At this time, the region was affected by a series of El Niño events, which precipitated the 1911–1916 Drought. Dry conditions did not ease across coastal NSW until well after the last El Niño had ended. Our new datasets and modelling suggest that this protracted drought is not unique; nor is it the worst the region is likely to have experienced. Our new extended dataset suggests that similar events—including far more severe ones—have occurred in the longer climate record, meaning they could happen again.

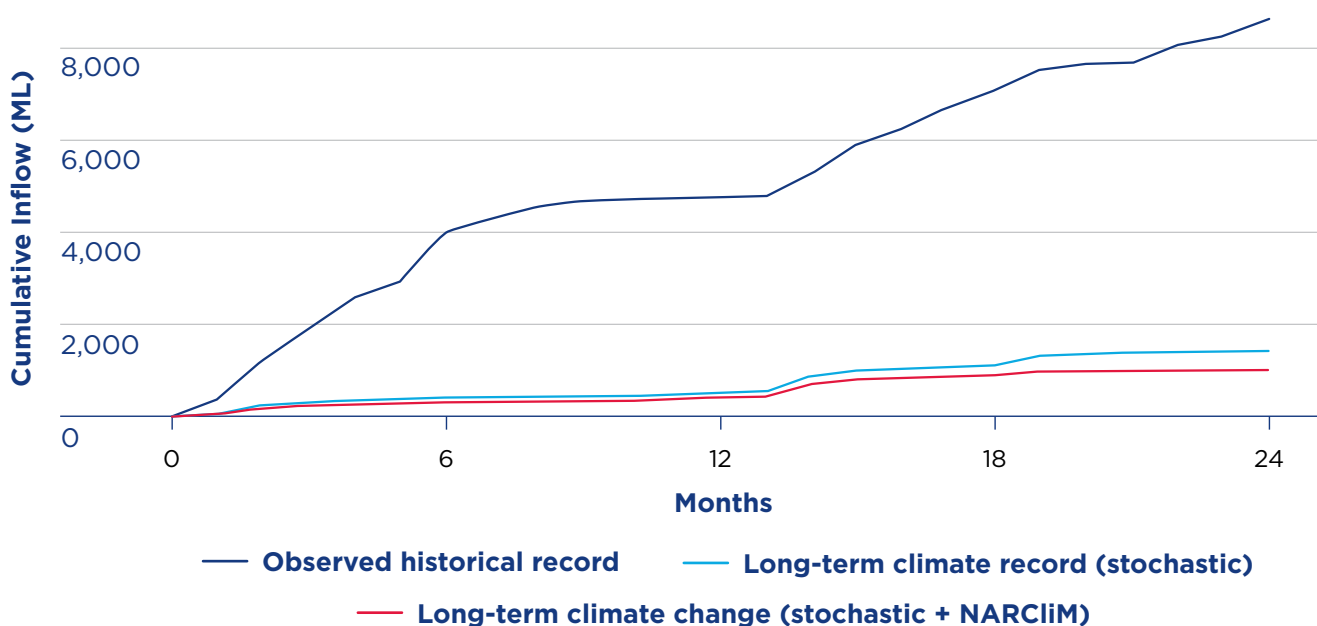
The Far North Coast has just experienced its driest two-year period on record (2018/2019). While severe, our new climate datasets suggest that the region may have experienced lower two-year rainfall totals in the past. This means that similar and even more severe droughts may occur in the future. For example, over the period 2018-20 only 13.9 GL water flowed into Toonumbar Dam.<sup>34</sup> Our modelling suggests that the probability of these low inflows (13.9 GL) occurring again over a 24-month period is about 2.5%, or a 1 in 40-year event based on the

long-term climate projection. If the worst-case climate change scenario from our modelling eventuates, the probability of these low inflows occurring again increases to about 8.5%, or a 1 in 11-year event. This is a significant increase in the probability of this extreme event occurring.

Our modelling also showed that it is possible that average two-year inflows to Toonumbar Dam may be about 10% lower than historic average two-year inflows (50,656 ML over 24 months compared to 56,389 ML over 24 months). These reduced long-term average inflow volumes would still be enough to meet the water needs of water access licence holders supplied from Toonumbar Dam.

During extreme events, our new modelling indicates that inflows significantly lower than those in the observed historic record are possible (Figure 10). The probability of worst case scenarios occurring is very low. These estimates are based on the driest, or worst-case, climate projection scenarios. Our modelling scenarios will not necessarily eventuate, but they give us an idea of the plausible future climate risks.

**Figure 10. Worst minimum inflow into Toonumbar Dam over 24 months modelled under observed historical climate records, long-term climate (stochastic) and long-term climate change scenario (stochastic + NARClIM)**



34. WaterNSW 2020, *WaterInsights portal*, accessed 10 September 2020 from [www.watarnsw.com.au/waterinsights/water-insights](http://www.watarnsw.com.au/waterinsights/water-insights)

**A note of caution:** the scenarios in these models will not necessarily eventuate. They are potential scenarios and there is always a level of uncertainty with this type of modelling, which needs to be taken into account as part of any water decision making and planning. In some instances, this may mean managing risks to our water security by being prepared and resilient, rather than relying on firm predictions and hard numbers.

As the science develops further, we will be able to reduce or quantify some of these uncertainties.

## Floods are a feature of the past, and the future

Floods are an important feature of the Far North Coast hydrologic cycle. They are a vital, natural process that support the region's diverse ecosystems. They form part of the environmental flows required to connect wetlands and floodplains with the river, including the Tuckean Swamp, Ballina Nature Reserve and Big Scrub in the lower Richmond River. They are also responsible for the highly productive soils that are found in the region's floodplains. The Richmond River has a long estuary—roughly 90 km from the ocean mouth to the tidal limit<sup>35</sup>—and large freshwater inflows are critical for its health. Flood pulses also flush rivers and floodplains of organic matter, can limit saltwater intrusion into freshwater reaches of rivers and are important reproductive cues for many fish and invertebrates.

Flooding in the Far North Coast region can occur at any time but shows a strong seasonality. Most floods in the historical record have occurred in the first half of the year, with the peak period between February and April. This seasonality is the result of two distinct

weather patterns: ex-tropical cyclones, and east coast lows that occur close to the coast. The region is occasionally affected by Queensland's tropical cyclones. Ex-tropical cyclones caused major flooding in the Tweed, Brunswick and Richmond rivers in 1990, 2013 and 2017. East coast lows resulted in record flooding in Mullumbimby and major flooding in the Tweed River in 1987, and major flooding in the Wilsons River, Tweed and Brunswick rivers in 2005. Tropical cyclones caused record flooding in 1954 in Murwillumbah and Lismore, and major flooding in 1974 in the Tweed, Richmond and Wilsons rivers.

While floods are important for ecosystems, they can also have significant detrimental impacts on people and businesses—damaging infrastructure, creating safety risks and causing financial and economic loss. In March 2017, ex-tropical cyclone Debbie generated significant flooding across the Far North Coast region. It was the largest flood to impact Lismore since 1974 and the first to overtop the Lismore levee, which was constructed in 2005 and designed to prevent flooding in 1 in 10-year events. The Lismore levee had protected the town in several earlier floods since it was commissioned. At least 68% of businesses in the CBD of Lismore suffered flood damage.<sup>36</sup> The total damage to infrastructure and agriculture in the region was estimated to be almost \$80 million.<sup>37</sup>

Climate change is expected to increase the severity and change the frequency of flood-producing rainfall events, such as east coast lows, as well as impacts due to rising sea levels. These aspects can increase the risk of flooding in the Far North Coast particularly in low lying floodplains where ocean influences can also significantly impact flood behaviour. They may also have impacts on blackwater and fish death events. As sea levels rise and flood producing rainfall events increase in severity, this will increase the exposure of communities to flooding.

35. Department of Primary Industries—Water 2016, *Water Sharing Plan for the Richmond River Unregulated, Regulated and Alluvial Water Sources—Background Document*, [www.water.nsw.gov.au/](http://www.water.nsw.gov.au/)

36. Nelson, S. 2017, *Counting the cost and facing the future: Report on the 31 March 2017 natural disaster for the Lismore Business Flood Recovery Taskforce*, Nelson Consultancy Pty Ltd

37. NSW Government 2018, Legislative Council: Portfolio Committee No. 5—*Industry and Transport, Augmentation of water supply for rural and regional New South Wales*, Report 47.

The Eastern Seaboard Climate Change Initiative examined the impacts of climate change on east coast lows. This climate modelling projected a decrease in the number of small to moderate east coast lows in the cool season, with little change in these storms during the warm season. However, extreme east coast lows in the warmer months may increase in number, while the number of extreme east coast lows in cool seasons may not change.<sup>38</sup>

The modelling methods we are using for the regional water strategies have been developed to understand long-term inflows into rivers and extraction from rivers and have not been designed for flood analysis. However, they can give some indication about the trends of flood behaviour with climate change. For example, it is plausible that there could be increases to the magnitude of floods. It is also plausible that climate variability and climate change could combine to generate maximum flows larger than what has occurred in the past 130 years of observed records.

Flood risk management developed with the technical and financial support of the Department of Planning, Industry and Environment—Environment, Energy and Science under the Floodplain Management Program uses fit-for-purpose models that are calibrated and validated against historical events to examine the full range of flood behaviour up to and including extreme events. Flood investigations under the program also consider the impacts of climate change on flood behaviour in a fit-for-purpose way for the location. Many urban areas in the Far North Coast region have a floodplain risk management plan in place. These are frequently updated with new information, particularly following significant flood events (approximately every 5-10 years). Councils work closely with the Department of Planning, Industry and Environment—Environment, Energy and Science and with the State Emergency Service to ensure that land use planning and emergency management processes are in place to protect the community from the impact of flooding, including the potential impacts of climate change on flood risk.

38. NSW Government 2020, *Eastern Seaboard Climate Change Initiative*, accessed 26 August 2020 from, [climatechange.environment.nsw.gov.au/Impacts-of-climate-change/East-Coast-Lows/Eastern-Seaboard-Climate-Change-Initiative](https://climatechange.environment.nsw.gov.au/Impacts-of-climate-change/East-Coast-Lows/Eastern-Seaboard-Climate-Change-Initiative) The Eastern Seaboard Climate Change Initiative is a major research collaboration led by the NSW Government with a number of partner organisations. The Eastern Seaboard Climate Change Initiative—East Coast Lows Program is a suite of research projects that aims to improve our understanding of past, current and future east coast lows and assess how they influence extreme rainfall, coastal processes and water security.



## Sea levels are rising

Global sea levels are rising, predominantly as a result of increasing greenhouse gas concentrations in the atmosphere and associated glacial and ice sheet melt.<sup>39</sup> As a coastal region, the Far North Coast is particularly susceptible to the impacts of rising sea levels. Low-lying areas may become inundated and sandy shorelines will recede landwards. Sea level rise is likely to exacerbate flood impacts in the region as it will increase the extent of tidal inundation and may impact flood behaviour in low-lying coastal floodplains. Rising sea levels will also cause saltwater to intrude into groundwater sources. This poses a potential threat to regional water security

because increases in salinity will restrict what these water sources can be used for and may necessitate higher levels of treatment for consumptive uses.

Local geological factors, ocean currents and local thermal expansion or contraction of oceans all affect sea level rise projections in different locations. The extent to which sea levels will rise is also highly dependent on how significantly greenhouse gas emissions are reduced in the coming years (Table 1). Sea levels in the Far North Coast region are projected to increase between 0.31 m and 0.88 m by 2090. The average projections are for 0.48 m increase for a low emissions scenario and 0.66 m for a very high emissions scenario.<sup>40</sup>

**Table 1. Sea level rise projections for the Far North Coast region (relative to an average calculated between 1986 and 2005)\***

Year	Low emissions scenario (RCP4.5) (m)	Very high emissions scenario (RCP8.5) (m)
2030	0.14 (0.09-0.18)	0.14 (0.09-0.18)
2050	0.24 (0.17-0.32)	0.27 (0.19-0.35)
2070	0.36 (0.24-0.48)	0.44 (0.31-0.58)
2090	0.48 (0.31-0.65)	0.66 (0.46-0.88)

\*Note: Values are average values with likely range provided in brackets

Source: CoastAdapt, 2017

Larger rises are possible beyond these median scenarios. The Intergovernmental Panel on Climate Change suggests that these projections could be up to several tens of centimetres higher if marine-based sectors of the Antarctic ice sheet collapse.<sup>41</sup> Other research suggests that the upper estimate of global mean sea level rise could be as high as 2 m to 2.7 m.

Roughly 11% of water access entitlement volume in the region is located within current tidal limits. The footprint of the maximum high tide is expected to increase significantly with sea level rise. This may put water extraction in coastal parts of the Far North Coast region at risk.

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

40. CoastAdapt 2017, *Sea-level rise and future climate information for coastal councils*, accessed 14 July 2020 from, [coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils](http://coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils)

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

Salinity problems due to climate have already been experienced in the region. In the Richmond River catchment, inflows during the Millennium Drought were very low, including flows into the tidal pool. The saltwater/freshwater interface migrated a significant distance upstream during this time and caused large increases in salinity within the tidal pool.<sup>42</sup> This prevented water extractors from pumping at certain times.

Alluvial groundwater sources and groundwater works where the minimum groundwater levels are below 0 m AHD are also at risk from rising sea levels and saltwater intrusion. Water from these sources may become significantly saltier over the coming years, making them harder to use without costly treatment.

In the Brunswick River catchment, the high tide could extend upstream of the Mullumbimby township by 2100 under a high-emissions climate change scenario. The current high tide extent shows limited connectivity of saltwater in the Brunswick River through Mullumbimby. The projections for low- and medium-emissions scenarios suggest more connectivity for tidal flows to Mullumbimby than present day high tides provide.

The unconsolidated alluvial sediments of the Brunswick River Coastal Floodplain Alluvial groundwater source are also vulnerable to saltwater intrusion, particularly under the medium- and high-emissions scenarios. This groundwater source is the most utilised aquifer in the Brunswick catchment. The impacts of this saline intrusion would be amplified during periods of extended drought.

In the Tweed River catchment, Tweed Shire Council already has to manage the intrusion of salty sea water into its Bray Park Weir water supply. A major inundation event took place on 21 and 22 August 2017 due to a combination of low flows in the Tweed River, high tides and a sea level anomaly.<sup>43</sup> Tweed Shire Council now needs to manage inundation events several times per year. It has carried out studies that indicate an increase in frequency and magnitude of overtopping events is likely in the future.<sup>44</sup> All the average inundation projections for the 2100 high tide extent suggest that saltwater could move even further upstream of Bray Park Weir than the current tidal limits. The high-emissions inundation scenario for 2100 suggests the high tide limit could extend along the Tweed River towards Dum Dum, almost reaching the Mount Warning Road crossing.

Sea level rise will also threaten the management, operation and maintenance of low-lying gravity agricultural drainage, stormwater infrastructure and sewerage infrastructure.

42. Department of Primary Industries—Water 2016, *Water Sharing Plan for the Richmond River Unregulated, Regulated and Alluvial Water Sources—Background Document*, [www.water.nsw.gov.au/](http://www.water.nsw.gov.au/)

43. Sea level anomalies may be caused by coastal trapped waves and can result in tides being 400–500 mm higher than predicted tide levels.

44. University of NSW Water Research Laboratory 2017, *Assessment of the Risk of Overtopping of Bray Park Weir and Contamination of Drinking Water Supply Due to Climate Change*.





## 2.2 The landscape and its water

The Far North Coast region includes three catchments—Richmond River, Tweed River and Brunswick River—and extends across six local government areas: Ballina Shire, Byron Shire, Kyogle, Lismore City, Richmond Valley and Tweed Shire. It is surrounded by Queensland to the north and the North Coast region to the west and south.

The region is bounded by a caldera escarpment comprising the MacPherson Range (NSW–Queensland border) to the north, the Tweed, Burringbar, Koonyum and Richmond ranges to the west, the Richmond Range to the south and the coast to the east. A large portion of the elevated areas are protected as national parks with world heritage status. The eastern part of the Richmond catchment is defined by a very large coastal floodplain, while a large portion of the Brunswick catchment consists of mountainous terrain or low-lying, poorly drained country (Figure 11).

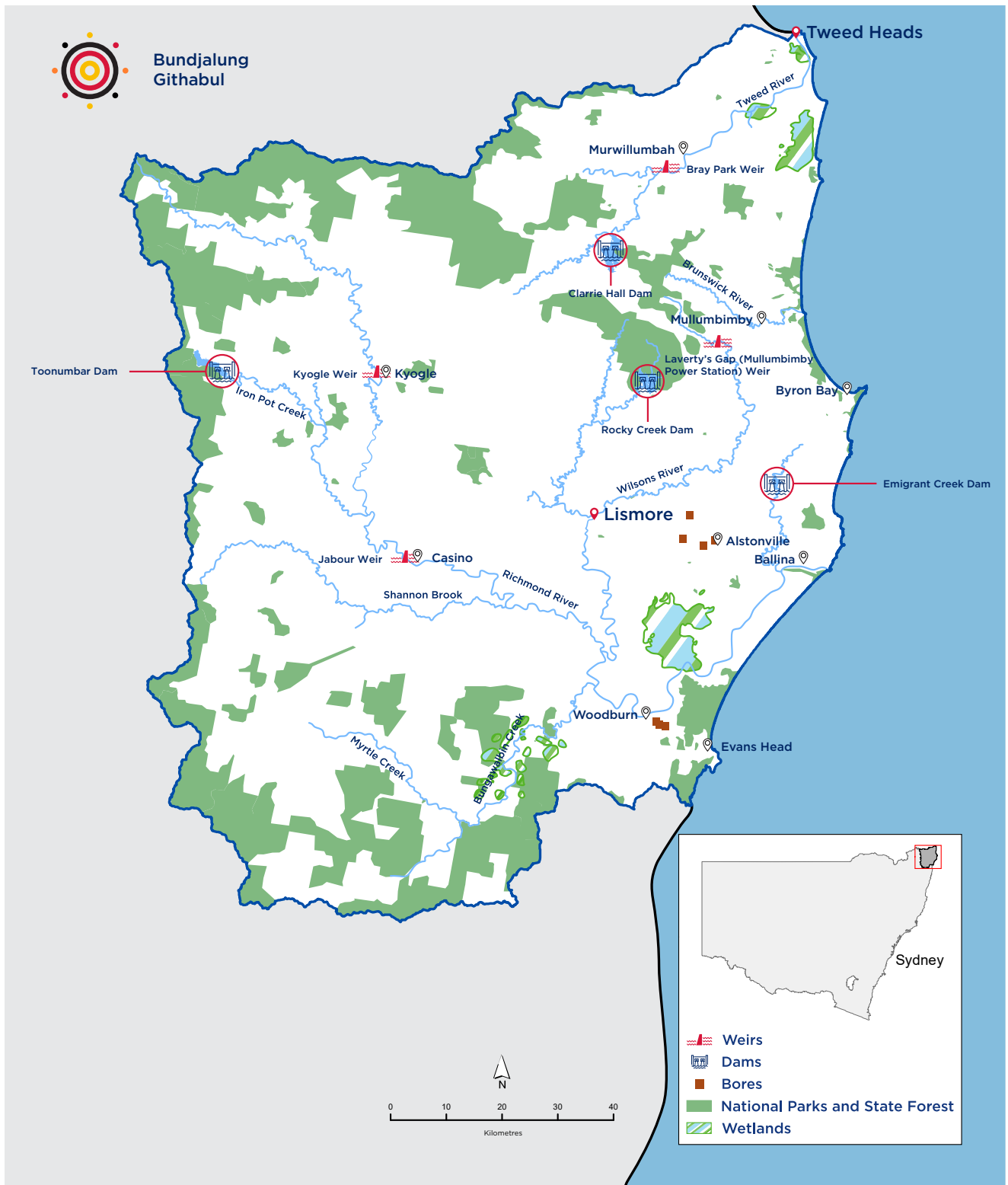
### 2.2.1 Water resources in the region

Water is critical to the health of the environment, the social fabric and liveability of the Far North Coast region, and its economic prosperity.

The region's towns, communities and industries use water from multiple sources (Figure 11 and Figure 12):

- three unregulated river systems: the Richmond River, Brunswick River and Tweed River
- a small regulated system on Iron Pot Creek, supplied from Toonumbar Dam
- a network of creeks, streams and small river systems
- groundwater sources including alluvial groundwater, the Richmond Coastal Sands and Tweed-Brunswick Coastal Sands, the North Coast Volcanics, the Alstonville Basalt Plateau, Clarence Moreton Basin and New England Fold Belt Coast
- local runoff from rainfall captured in farm dams
- recycled wastewater and stormwater harvesting.

Figure 11. Map of the Far North Coast region: key water sources and infrastructure



## Major rivers and dams

### Richmond River

The Richmond River system comprises three main arms—the Richmond River, the Wilsons River and Bungawalbin Creek. The Richmond River tidal pool is at the downstream end of these three arms. The tidal pool defines the upstream extent of the Richmond River estuary, which is unique in the region because it reaches quite far inland—around 90 km from where it meets the ocean at Ballina. The eastern part of the catchment is defined by a very large floodplain, which extends between Evans Head and Cape Byron.

On average, about 3,000,000 ML water runs through the Richmond River each year. Roughly half of this flow happens in the wet season between February and April. Some of these flows are intercepted by one of the three main storages in the catchment: Toonumbar Dam, Rocky Creek Dam and Emigrant Creek Dam.

Toonumbar Dam sits on Iron Pot Creek, a small tributary of the Richmond River. Around 26,000 ML of water flows into the dam in a typical year. Toonumbar dam can store up to 11,000 ML and defines the only—and, at 50 km length, relatively small—regulated system in the Richmond catchment. The system supports a small number of farmers and irrigators in the upper reaches of the catchment. The dam fills to capacity in most years.

Toonumbar Dam is underused. In an average year, farmers use between 1% and 10% of annual entitlement. This is mainly due to the region's high rainfall, which supports cropping with relatively low irrigation demand. But in dry years the dam provides a level of drought security and significantly more water is used. In 2019/20 farmers used roughly 2,200 ML (about 23% of entitlement).

Rocky Creek Dam (14,000 ML) and Emigrant Creek Dam (829 ML) are both owned and operated by Rous County Council. On average, roughly 19,000 ML flows into Emigrant Creek Dam and 29,000 ML to Rocky Creek Dam. The dams are used for town water supply to towns in the Richmond and Brunswick catchments.

Toonumbar Dam and Rocky Creek Dam perform reasonably well in dry periods, while Emigrant Creek Dam is less reliable. Our new modelling suggests that during extended dry periods (and assuming current climatic and operational conditions and no population growth):

- Emigrant Creek Dam could drop below 5% capacity in 29% of years (29 out of 100 years)
- Toonumbar Dam will rarely drop below 20% capacity
- Rocky Creek Dam will rarely drop below 50% capacity.

Several smaller weirs throughout the Richmond River catchment provide water supplies to some towns in the region. Jabour Weir supplies water to Casino and is operated by Richmond Valley Council. The township of Kyogle sources its water from a weir operated by Kyogle Council. Byron Shire Council operates the Laverty's Gap (Mullumbimby Power Station) weir on the upper Wilsons River to supply the township of Mullumbimby.

## **Tweed River**

Eight major tributaries feed the Tweed River, the two major ones being the Oxley River and the Rous River. Tidal influence in the Tweed River estuary reaches Bray Park Weir—approximately 35 km upstream of the Tweed River entrance. The tidal influence tends to dominate river levels except during flood events.

On average, approximately 175,000 ML flows through the Tweed River system each year. Like the Richmond River, about half of this flow happens in the wet season between February and April.

There are two major pieces of water infrastructure in the Tweed River catchment. Clarrie Hall Dam and Bray Park Weir are both part of the Tweed Shire Council water system. Clarrie Hall Dam is located on Doon Doon Creek, a tributary of the Tweed River. The dam stores up to 16,000 ML water for the Tweed Shire area. Water is released from the dam downstream to Bray Park weir, where it is extracted for the Tweed Shire town water supply. The Bray Park weir pool—which receives water from both the Tweed and Oxley rivers—stores about 520 ML.

Clarrie Hall Dam performs reasonably well during dry periods. Our new modelling suggests that during extended dry periods (and assuming current climatic and operational conditions and no population growth), Clarrie Hall Dam would rarely fall below 50% capacity.

## **Brunswick River**

The Brunswick River begins in the Burringbar Ranges, traverses flatter coastal areas and is joined at Brunswick Heads by its two main tributaries—Marshall and Simpson's creeks—before discharging to the Pacific Ocean. The river is influenced by tides downstream of Mullumbimby.

The rivers and creeks of the Brunswick catchment have no major dams for water supply or instream structures. Although there are some small dams and weirs present, most water users in the Brunswick catchment rely on natural flows for their water supply.

There is very little flow data available for the Brunswick catchment. There is, however, one river gauge in the catchment at Durrumbul. Based on this data, the average annual flow volume in the Brunswick River is just over 31,000 ML.

## **Harvestable rights farm dams**

Many landholders across the Far North Coast region source water from harvestable rights dams. Harvestable rights allow landholders to collect 10% of the average annual regional rainfall runoff from their properties and to store it in one or more farm dams up to a certain size. Due to the nature of harvestable rights—which do not require metering or an approval for dam construction or a licence for water take—there is no data available on how much water is collected or used from harvestable rights sources across the Far North Coast. The regional water strategy offers an opportunity to improve our understanding of farm dams and the storage capacity they provide across the Far North Coast.

## Groundwater

Groundwater on the NSW coast is found in fractured rocks, coastal sands and smaller alluvial aquifers around rivers and creeks. This groundwater provides essential flows to ecosystems and baseflow to rivers and creeks. It also provides water for consumptive use such as irrigation, industry and town water supplies.

Important groundwater sources in the Far North Coast region are shown in Figure 12 and include:

- the large **floodplain alluvial aquifers** in the Richmond, Brunswick and Tweed River catchments. These aquifers consist of fluvial and tidal deposited sediments and are typically comprised of fine-grained sands, silts, and clays which generally have low yields. Alluvial aquifers on the NSW coast typically have low water quality because of the acid sulfate soils and residual salts associated with the connected estuaries. Water quality in these aquifers generally makes them unsuitable for irrigation, but they are used for stock and domestic supplies
- the **Tweed-Brunswick Coastal Sands and Richmond Coastal Sands** groundwater sources. The Tweed-Brunswick Coastal Sands Source lies between the town of Tweed Heads to the north and Suffolk Park to the south and covers an area of 160 km<sup>2</sup>. The Richmond Coastal Sands Source is bounded by the towns of Lennox Head to the north and Evans Head to the south and covers an area of 360 km<sup>2</sup>. Both these aquifers are used mainly for domestic purposes, although there is some use for irrigation and commercial activities. Coastal sands aquifers often support significant vegetation communities which can be sensitive to localised extraction of groundwater<sup>45</sup>
- the **North Coast Volcanics Groundwater Source**, a fractured rock aquifer<sup>46</sup> that lies on top of the rocks of the New England Fold Belt and Clarence Moreton Basin. Groundwater in this source is typically recharged by direct rainfall infiltration, yielding excellent quality water. The aquifer is used mostly for small scale horticulture, stock and domestic supplies. Many groundwater-dependent ecosystems are sustained by this water source—streams and springs rely on groundwater for flow during dry periods because of the free-draining nature of basalt and the recharge of hard rock
- the **Alstonville Basalt Plateau Groundwater Source**, which is an area of Tertiary basalts that rise above the alluvial floodplain sediments between Lismore and Ballina. The aquifers comprise shallow (2–50 m) and deep (50–150 m) water-bearing rocks. Wetlands and remnant rainforests depend on these groundwater sources for water. The shallow groundwater sources contribute directly to the base flows of the rivers on the plateau. These groundwater sources represent an area of spiritual and cultural importance to the Bundjalung nation, especially the Jali and Ngulingah Aboriginal people. Licenced access to the Alstonville Basalt Plateau groundwater source is currently at capacity. Water from this source is used mostly for domestic purposes, town water supplies and agriculture

45. Department of Primary Industries—Water 2016, *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources—Background document*, [www.water.nsw.gov.au](http://www.water.nsw.gov.au)

46. Groundwater that is contained within, and moves through, fractures in the rock that are present due to the folding and faulting of the rock formations.

- the deeper **Clarence Moreton Basin Groundwater Source and New England Fold Belt Coast Groundwater Source**. The Clarence Moreton Basin Source is a porous rock aquifer system<sup>47</sup> that recharges by direct infiltration of rainfall but has variable water quality, with high salt content in parts. Water from this source is used mostly for stock purposes. The New England Fold Belt Coast Source is a fractured rock aquifer. It is mostly recharged by direct rainfall infiltration and generally has good quality water. The aquifer is used mostly for stock and domestic supplies.

Surface and groundwater systems in coastal areas are often highly connected. Coastal aquifers have a high degree of interaction with surface waters in the lower reaches, in estuaries and other coastal riverbeds. This interaction is bidirectional—surface water recharges groundwater at some locations (especially in alluvial sources), while at other locations, groundwater is critical to supplying baseflows to surface waterways. Groundwater provides reliability to surface water users and is important for ensuring good outcomes for the environment.

This interconnectivity means that the depletion of surface water sources—from over-extraction or from changes to rainfall during periods of drought—can also impact groundwater recharge and groundwater levels. The urbanisation common in coastal areas has resulted in modified surface water drainage, runoff and changes to areas where aquifer recharge occurs. This can impact groundwater recharge patterns and increase pollution risks.

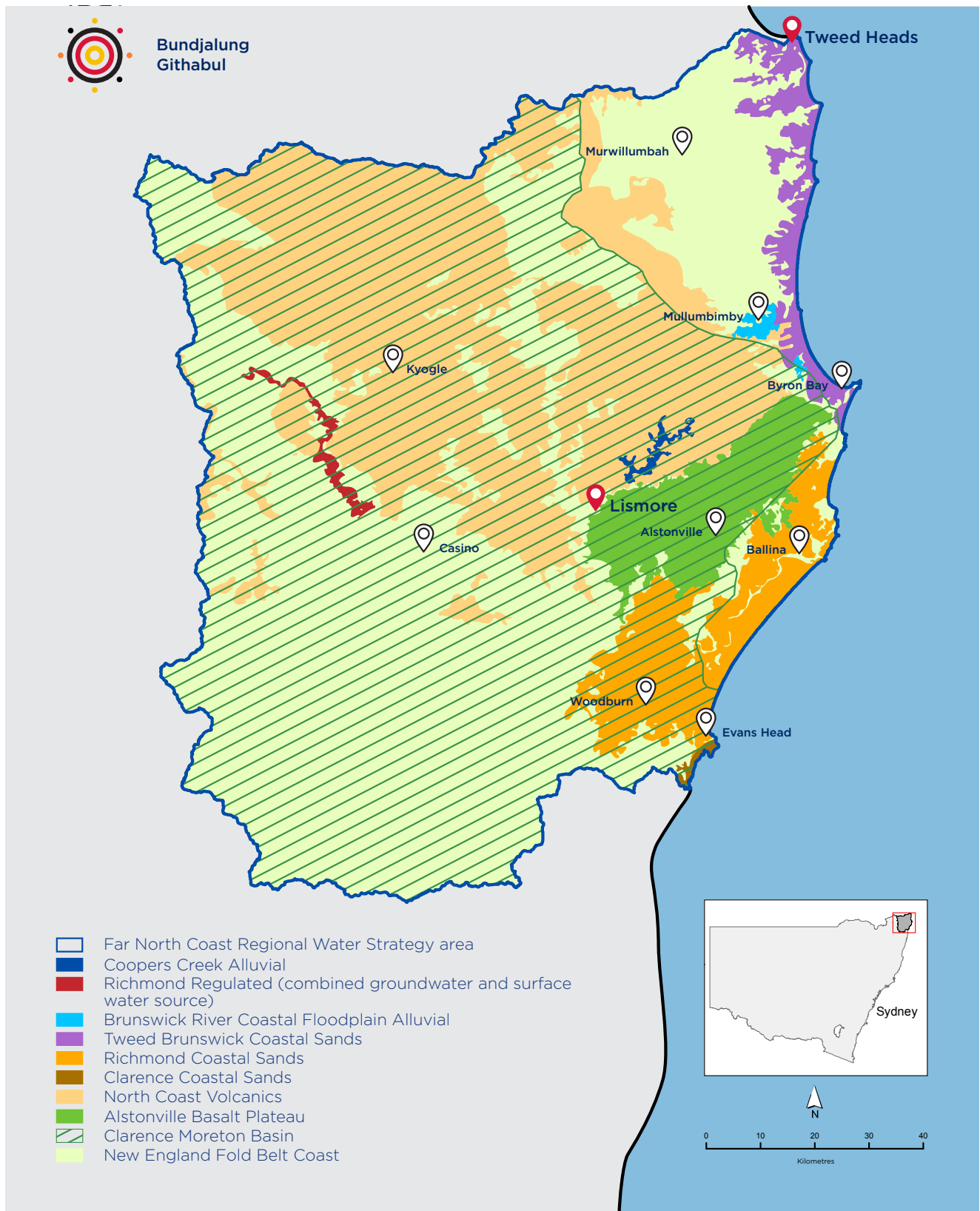
Continuing to improve our understanding of groundwater will enable better informed decisions to be made about its importance as a local water source, its management and use. Improving our understanding of aquifer recharge zone locations is important to plan for different land uses while protecting our groundwater resources. Gaining knowledge about groundwater availability across the entire Far North Coast region, not just in areas where it is usually accessible, and providing this information to towns and industries could significantly improve planning for drought.

NSW has a strong groundwater management framework that has undergone significant reform. However, opportunities still exist to continue to improve how we manage groundwater resources. Several groundwater-related options are proposed in the Draft Far North Coast Regional Water Strategy, focused on using groundwater more efficiently, innovatively and sustainably, making sure groundwater of suitable quality is available for critical needs and better managing risks to this important resource.

Further development of groundwater sources is an opportunity for the Far North Coast, in particular to improve the reliability of water supply to towns and other users in drought times when surface water is less available. However, coastal groundwater sources can be particularly vulnerable to development pressures. Before and during any further development there needs to be improved understanding of the region's groundwater resources and dependent ecosystems, as well the impacts of changes in land use and climate on groundwater volumes, movement and quality. This information is critical to ensuring the protection of these resources and their dependent ecosystems.

47. Groundwater that is contained within, and moves through, pores and fractures in the rock.

**Figure 12. Groundwater sources in the Far North Coast region**



## Recycled water

Five of the local water utilities in the Far North Coast region produce recycled water for reuse. The bulk of recycled water is used for municipal, industrial, agricultural and environmental purposes. Urban non-potable reuse has increased recently, mostly in new developments. In 2017/18 around 1,960 ML of recycled water was supplied for residential and non-residential use in the Far North Coast region.

Ballina and Byron Bay Shire Councils are expanding dual reticulation systems in new urban developments to maximise urban residential non-potable reuse and to improve town water security. Lismore City Council and Richmond Valley Council are also investigating the potential to provide dual reticulation schemes to new developments.

Recycled water is currently not used for drinking water supply. The regional water strategies provide an opportunity to explore whether purified recycled water can be used more effectively to supplement drinking water supplies or to be made more accessible to water users.

48. Ballina Shire Council 2009, *Ballina-Lennox Head Recycled Water Masterplan*, [www.ballinawater.com.au/general-information/urban-water-cycle/recycled-water-overview.html](http://www.ballinawater.com.au/general-information/urban-water-cycle/recycled-water-overview.html)

## Ballina and Byron Bay leading the way in recycled water use

In 2016, Ballina became the first regional council in NSW to deliver recycled water for indoor and outdoor non-potable residential use. Under its *Ballina-Lennox Head Recycled Water Master Plan*,<sup>48</sup> the council is aiming to achieve 80% dry weather reuse by 2026, equivalent to recycling 56% of all wastewater produced in the Ballina-Lennox Head area each year. Reuse will focus on dual reticulation, urban open space irrigation, vegetation regeneration and environmental flows.

Three recycled water schemes in Byron Bay currently use around 70% of treated wastewater for beneficial use. Most sporting fields, golf courses and nurseries are irrigated using recycled water. Public toilets in the town centre are using recycled water and a significant volume is used for constructed wetlands and biomass cropping.

The expansion of these schemes would help to conserve bulk water supplies and increase town water security.





Image courtesy of Destination NSW.

## Drainage water

In the coastal areas of NSW, drains have been actively used for over a century to remove excess water from cropping and grazing areas and to minimise the impacts of floods on agriculture. Drainage infrastructure has historically been managed through entities called drainage boards, which are governed by a board of local landholders. Drainage boards are responsible for maintaining drainage infrastructure within their designated areas, while local and county councils—as well as some landholders—manage floodgates.

The extent and exact number of drainage boards is unclear. It is likely that there are approximately 200 drainage boards in NSW with most of these presumed to be inactive.<sup>49</sup> The majority of active drainage boards are located in the Far North Coast region and include one in the Richmond catchment, one in the Brunswick catchment and a number of boards in the Tweed catchment.

While the use of fresh water in drainage channels held up by floodgates does not appear to be widespread, there probably is some use of this water. The water management regulations<sup>50</sup> allow sugar cane growers in the Far North Coast region to use water from drains for irrigation without a licence during crop establishment provided certain conditions

are met. This potential unlicensed take from drainage channels probably represents a small amount of water—in the order of 540 ML over any given five-year period.

## 2.2.2 Water and the regional environment

The Far North Coast region is recognised for its high density of rivers, streams and waterbodies. The region contains an extremely high terrestrial and aquatic biodiversity and includes many species that are endemic to the region. It supports species and habitats of local and international significance, and it forms crucial links between important conservation areas. This richness in biodiversity is due to the climatic and geographic conditions of the area, which allow for the presence of both tropical and temperate species.

A number of nationally important wetlands<sup>51</sup> are located across the Far North Coast region. These include the Tuckean Swamp, Stotts Island Nature Reserve, Cudgen Nature Reserve, Billinudgel Nature Reserve and the Lower Bungawalbin Catchment Wetland Complex. These wetlands are important coastal freshwater habitats and support large populations of migratory waterbirds.

49. Pahlow, P. Natural Resources Access Regulator 2019, pers. comm., 22 March

50. Water Management (General) Regulation 2018, [legislation.nsw.gov.au/view/html/inforce/current/si-2018-0480](https://legislation.nsw.gov.au/view/html/inforce/current/si-2018-0480)

51. Department of Environment and Energy 2005, listed in the *Directory of Important Wetlands in Australia*

Many native flora and fauna species are found in the region, including diverse native and endemic fish, spiny crayfish, freshwater mussels and freshwater snails. Many of these are essential for river health and water quality. Some of these species provide recreational fishing and have cultural value to the Bundjalung and Githabul people. A number of native fish species found in the region are listed as threatened in NSW waters, including the Oxleyan Pygmy Perch, Eastern Freshwater Cod and the Purple Spotted Gudgeon.

Some fish species require access to both freshwater and estuarine environments during their life cycles. These include a number of eel species which also have cultural and commercial fishing values.

The 2019/20 bushfires impacted a large portion of coastal fish habitats. As a result, a number of fish species—previously believed to be secure—were listed by the Australian Government on a provisional list of animals requiring urgent management intervention.

Many other threatened frogs, birds and wet flora species are also found in the region. Some of these species are highly sensitive to water extraction at times of low flow, while others—such as plants that occur in the riparian zone—are less sensitive. The Richmond River is the range limit for some species and there are several endemic aquatic invertebrates that occur nowhere else.

The Far North Coast region is home to a number of threatened ecological communities, naturally occurring groups of native plants, animals and other organisms living in a unique habitat. These include freshwater wetlands in coastal floodplains, lowland rainforest on floodplains, coastal saltmarsh and subtropical coastal floodplain forest.

Floodplains are also important assets that are critical for a healthy environment. In the Far

North Coast floodplains support industries such as sugar cane, livestock grazing and other agricultural uses. Downstream healthy floodplains support fishing, oysters and tourism.

Healthy, connected water sources are essential for protecting these environmental assets and species and achieving the NSW Government's goal for the region to have the most stunning environment in NSW. A healthy environment also improves the liveability of the region, contributes to the health and wellbeing of communities and sustains the tourism, resources and agricultural industries. For example, healthy fish species support Aboriginal cultural, recreational and environmental functions as well as stimulating the local economy.

Many factors have contributed to the deterioration of river health across the Far North Coast region. These include historic logging, degradation of instream habitat and riparian vegetation, poor land management, urbanisation and water extraction. The upper reaches of the Richmond River are under high hydrologic stress.<sup>52</sup> This means that a very large portion of low flows are extracted from the river, putting stress on the ecology of the river system. The impacts of this stress are likely to be exacerbated in the future as climate change may cause a decrease in winter rainfall and an increase in the number of dry days.

Instream and floodplain structures such as weirs and agricultural drains can affect waterway connectivity, the health of riparian and aquatic environments and the movement, spawning and feeding of native fish. Deoxygenation of flood waters and acid leaching from acid sulfate soils that drain into waterways has led to several large fish death events in the Richmond River. These are distressing for the community, Aboriginal custodians and the fishing industry, and are a loss to the environmental values of the region.

52. Department of Land and Water Conservation 1998, *Stressed Rivers Assessment Report: NSW State Summary*, [www.water.nsw.gov.au/](http://www.water.nsw.gov.au/) and Department of Primary Industries—Water 2016, *Water Sharing Plan for the Richmond River Unregulated, Regulated and Alluvial Water Sources—Background Document*, [www.water.nsw.gov.au](http://www.water.nsw.gov.au)

## Water for the environment

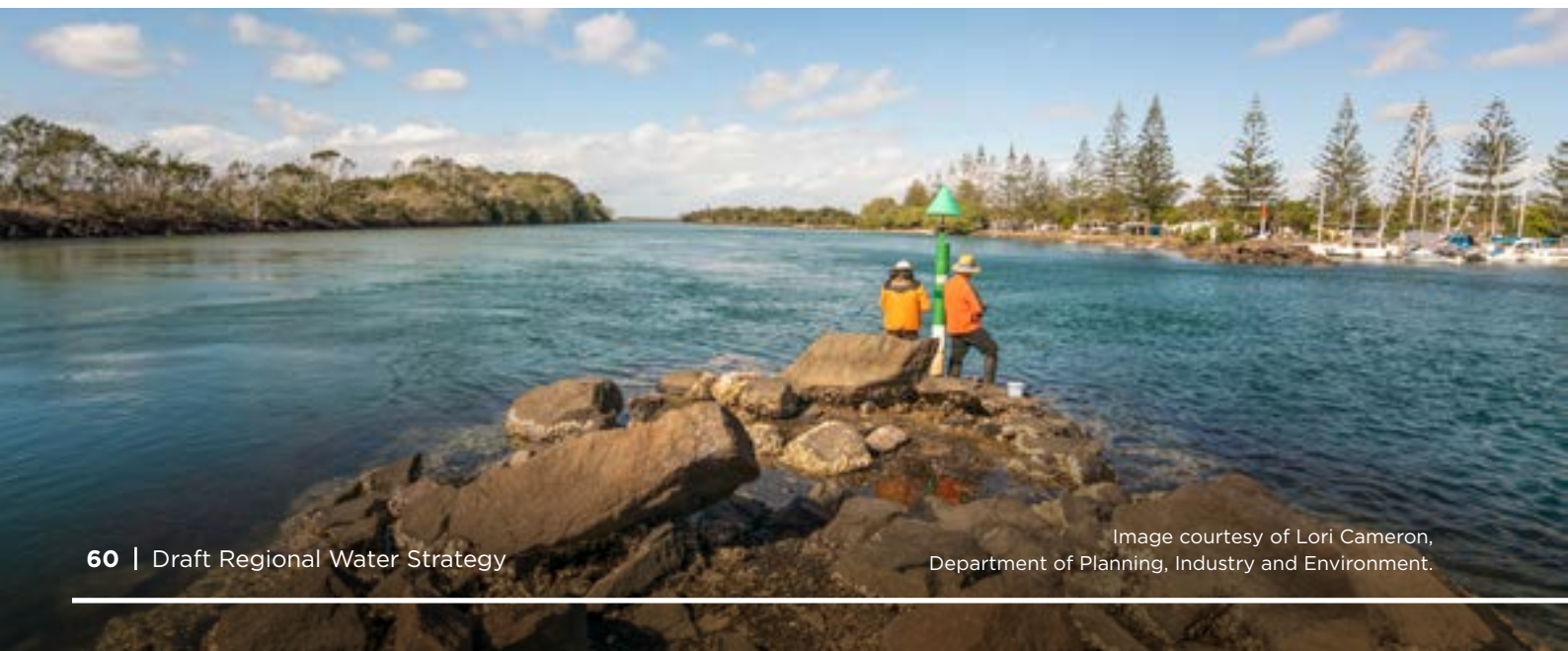
The region's water sharing plans aim to protect water for environmental outcomes. Environmental water in the plans is provided by setting limits on the volumes and timing for water extraction. Three main mechanisms aim to ensure that water is left in the rivers for environmental purposes:

- long-term average annual extraction limits set the upper limit of water that can be extracted from water sources in the region
- cease-to-pump rules protect low flows by prohibiting extraction when flow rates drop below specified levels
- environmental releases from dams and weirs in the region maintain downstream flows. Toonumbar Dam releases water to maintain a visible flow at the end of Eden Creek. In the Tweed River catchment, Clarrie Hall Dam and Bray Park weir must release a minimum of 1 ML/day and 3 ML/day respectively. These minimum releases increase in wet periods, but can be suspended for emergencies and maintenance.

Providing water for a healthy environment can be difficult at times because water for environmental assets is not actively managed in the Far North Coast. Water for the region's environment assets and ecosystem functions is very much dependent on rainfall-generated stream flows and how much water is extracted for consumption.

Currently, water extraction rules are constraining the ability to meet the region's environmental water requirements in two ways:

- annual extraction limits set out in the water sharing plans largely reflect the total licenced volumes at the time the plans were made, rather than being based on risk assessments. This means that there is some uncertainty as to whether these limits are sustainable over the long term
- although the cease-to-pump rules were informed by risk assessments and the management objective of protecting low flows, the rules in some locations are based on the presence or absence of 'visible flow' rather than an established flow rate. This means that at some locations, cease-to-pump rules only come into effect once a water source has stopped flowing. This protects pools from drawdown, providing drought refuge, but does not retain ecological function or connectivity within the system.



## Future impacts on water for the environment

Higher temperatures, increased evaporation, increased fire risk, changes to rainfall patterns and associated flows, and potentially more intense dry and wet periods have the potential to significantly impact water-dependent ecosystems that have evolved over millennia to thrive in natural cycles that are now changing.

Modelling the effects of long-term climate change on hydrology in the Far North Coast region indicates the potential for significant changes to river flows in the next 40 years, with associated impacts on riverine and estuarine ecosystems. Similar alterations to the flow regime were predicted in the regulated river<sup>53</sup> and the region's unregulated rivers<sup>54</sup> and estuary inflows.<sup>55</sup> In general, our modelling shows the total volume of water flowing each year in these sections of the catchment may reduce by 4% to 16%, and may impact all components of the flow regime (Figure 13 and Figure 14).

The magnitude of high flow events<sup>56</sup> could decrease by 6% in the unregulated rivers, but by up to 10% in Eden Creek, the regulated creek downstream of Toonumbar Dam. This may limit the number of events that trigger fish movement and spawning. It may also reduce the larger tributary flows that stimulate riverine productivity by transporting dissolved carbon and organic detritus, micro-organisms, plankton and small animals into the system.

High flow events in rivers and streams that flow directly into estuaries may also reduce in magnitude by about 6%. Reductions in the size of events flowing to estuaries will

have similar impacts to freshwater systems in terms of the availability of organic carbon and other food for organisms low in the food web. These reductions may also impact salinity and nutrient gradients and circulation patterns—detrimentally impacting the estuarine ecology, particularly in the tidal pools at the upper limits of the estuaries.

Low flows are important as they prolong the availability of the higher velocity riffle habitats that many aquatic organisms rely upon to breathe, feed and reproduce. Low flows (flows in the 95th percentile) in unregulated river systems are also projected to reduce in magnitude by 9% to 17% under the projected climate change scenario. This could be up to 12% in the regulated system and 33% at the inflow to the Richmond River estuary.

Cessation of flow in rivers and streams results in drying of flowing water habitats, increased sedimentation, water quality deterioration (elevated water temperatures and low dissolved oxygen levels) and the loss of connectivity throughout the river system. These are called 'cease-to-flow' events and they can have damaging effects on the region's aquatic ecosystems. There could be an increase in the number of years in which a cease-to-flow event occurs—across all regulated, unregulated and estuary inflow systems (Figure 15). The most pronounced increase is likely to be at the inflow to the Tweed River estuary, where cease-to-flow events could increase from about 9% (nine out of every 100 years) to about 13%. In other parts of the region, the occurrence of cease-to-flow events may increase by about 2%.

53. Measured at 203034 Eden Creek at Doubtful

54. Median of the following unregulated gauges: Richmond (203004, 203005, 203014, 203015, 203024 and 203900) Tweed (201005, 201002, 201012, 201013, 201006, 201001, 201015 and 201003).

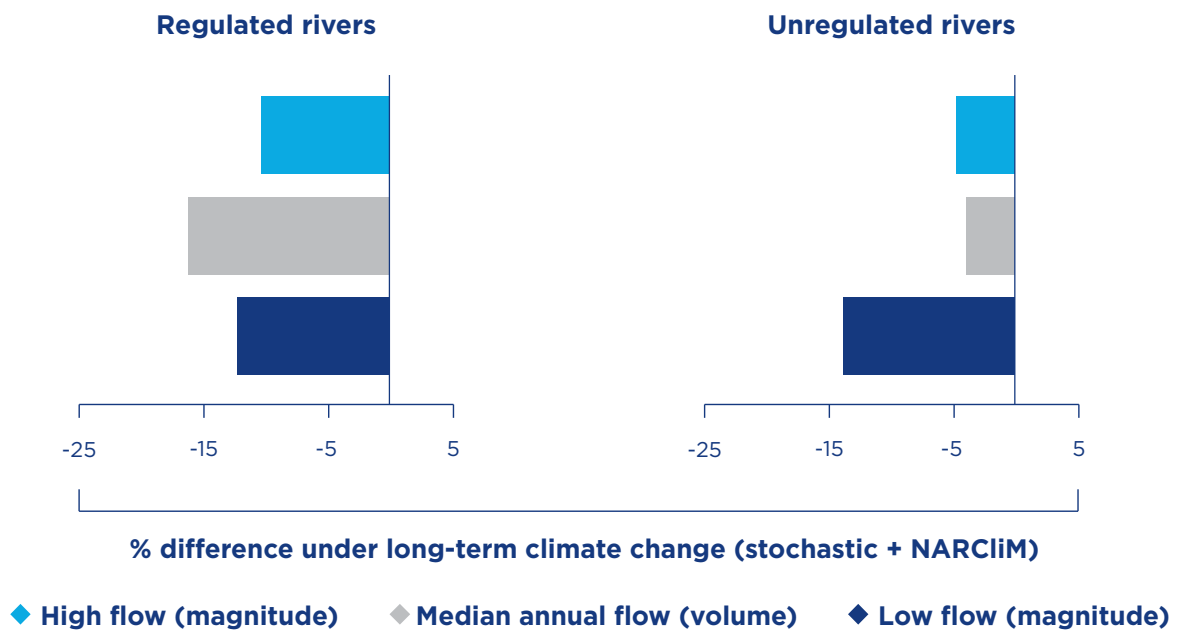
55. Measured at 203004 Richmond River at Casino for the Richmond estuary and end of system model node for the Tweed Estuary due to no appropriate gauge location.

56. Flows with an Average Recurrence Interval of 2.5 years. Average Recurrence Interval is the likelihood of occurrence, expressed in terms of the long-term average number of years, between flow events of a particular size. For example, flows with a size as large as or larger than the 2.5-year Average Recurrence Interval will occur on average once every 2.5 years.

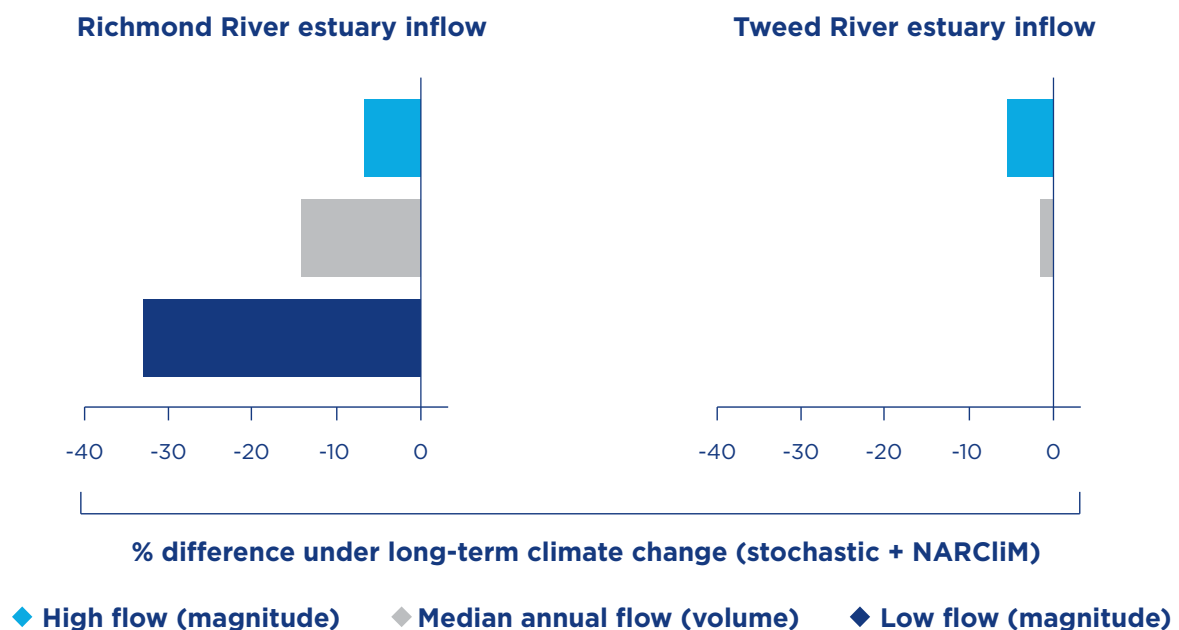
Although it is likely that cease-to-flow events will be more frequent under a changing climate, the average duration of events is unlikely to change significantly.

During cease-to-flow events and prolonged low flow events, salinity and nutrient gradients in tidal pools change as freshwater flows stop entering estuaries. This allows the salt wedge that usually sits below freshwater in tidal pools to move further upstream. The impacts of the changing salinity gradients will be amplified by salinity changes due to sea level rise.

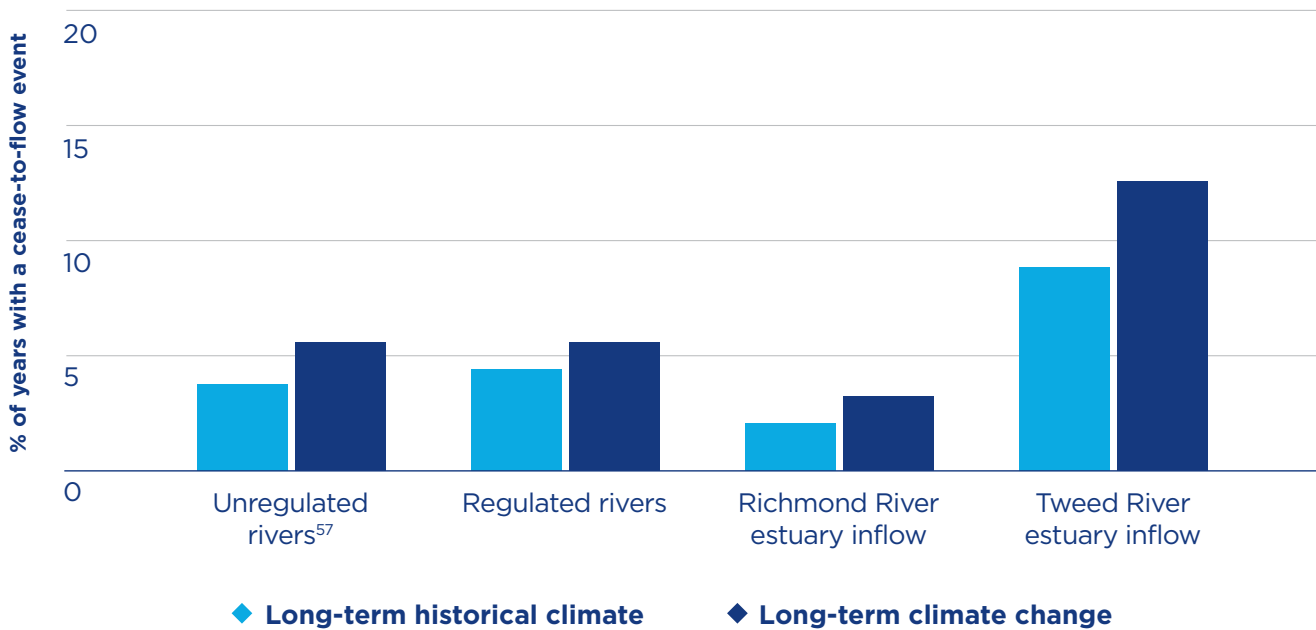
**Figure 13. Impacts of climate risks on the flow regime—regulated and unregulated rivers**



**Figure 14. Impacts of climate risks on the flow regime—estuary inflows**



**Figure 15. Impacts of climate risks on the flow regime—cease-to-flow events**



Insufficient flushing at higher flow bands can also have detrimental impacts. When floodplains and in-stream benches have not been flushed by large and overbank flows for a long period of time, organic matter such as wood, leaves and grasses builds up. When the dry period breaks, the organic matter is washed into waterways where it can lead to hypoxic blackwater events that result in fish deaths.

Importantly, these climatic changes will not occur in isolation, but will coincide with other changes such as the potential for water resources to be developed, market shifts, land use and agriculture changes, and associated changes to water management. This presents a long-term risk to river, wetland, floodplain and estuarine health. It also makes it more difficult to manage our landscapes and ecosystems and the human activities that depend on and benefit from them.

A more variable climate means that concerted and coordinated efforts will be required to protect and enhance the region’s vital environmental, economic, social and cultural assets into the future. The development of the

regional water strategy and upcoming water sharing plan reviews present opportunities to improve the effectiveness of our environmental water rules to respond to the impacts of climate change. To this end, opportunities exist to embed and build on water metering reforms to better understand the impacts of water extraction on waterway and aquifer health, to improve our monitoring and evaluation frameworks, and to facilitate water user compliance with the rules. With access to better information, there is also an opportunity to consider the long-term sustainability of existing extraction limits and cease-to-pump rules through upcoming water sharing plan reviews.

This Draft Far North Coast Regional Water Strategy also considers a range of options to protect and improve the health and resilience of the region’s natural systems and aquatic species. This includes actions to support and increase native fish populations, protect ecosystems that are dependent on coastal groundwater resources and initiatives to restore riverine habitats.

57. Calculated from the median of the following gauges: Richmond (203004, 203005, 203014, 203015, 203024 and 203900), Tweed (201005, 201002, 201012, 201013, 201006, 201001, 201015 and 201003).



## Water quality

Water quality problems are present across the Far North Coast region. High flows from rainfall and runoff result in higher levels of suspended solids and turbidity, nutrients, acidity and possibly pesticides, other toxicants and pathogens. These issues likely result from a combination of poor agricultural practices (such as cattle accessing stream banks and application of fertilisers), land clearing, sewage mismanagement, removal of riparian vegetation, acid sulfate soils and extensive historic logging operations. Clearing of riparian vegetation and a reduction in large woody debris deposits into waterways has led to an ongoing loss of riffles, channel bed erosion and a reduction of in-channel water storage.

The turbidity of surface water supplies is particularly problematic for some of the region's town water supply operators as it can cause taste and odour problems, reduce the effectiveness of disinfection and increase the cost of treatment. Along with blue-green algae,

it can also affect the cultural and social uses of water. Poor water quality also has food safety implications for industries that rely on healthy water sources for food production, including fishing and aquaculture.

The Richmond River system is the most affected by poor water quality in the region. It consistently experiences very high turbidity, very high nutrient concentrations and low dissolved oxygen at all depths in the estuary.<sup>58</sup> Low dissolved oxygen and pH levels are known to have caused many fish deaths in the Richmond River estuary.<sup>59</sup> Large flood events transport most of the sediment and nutrients out of the estuary to the ocean. However, following smaller floods—and during periods of low hydrologic flushing, such as prolonged low flow or cease-to-flow events—sediment and nutrients can remain in the estuary. This can increase biological activity in the water and lead to deoxygenation and the suffocation of aquatic fauna. Floodplain drains can also convey deoxygenated water (blackwater) to the estuary.

58. Ryder, D., et al. 2015, *Richmond Ecohealth Project 2014: Assessment of River and Estuarine Condition—Final Technical Report*, developing appropriate local responses, [www.ipart.nsw.gov.au/](http://www.ipart.nsw.gov.au/)

59. Cavanagh, D., et al. 2007, *Managing Water Quality in the Richmond River Estuary*, Australia. 10th International River Symposium.

In the past, widespread disturbance of acid sulfate soils on the Richmond River floodplain has caused large quantities of sulfuric acid to be released into the estuary. Drainage and flood mitigation infrastructure and activities such as floodgate operation continue to induce this process, which leads to acid water discharging into coastal streams and estuaries. Severe acidification of the Richmond estuary has occurred periodically around Tuckean Swamp, Sandy Creek, Bungawalbin Creek, Rocky Mouth Creek and Upper North Creek.

An example of a severe blackwater and acidification event—considered to be the worst-case scenario for the Richmond River estuary—took place in February 2001. As floodwaters were drained from the floodplains and drainage systems, large volumes of deoxygenated water were released into the estuary. This led to massive deaths of aquatic organisms in the lower reaches of the Richmond River and the closure of commercial and recreational fishing on the estuary for several months.

Drainage infrastructure can also cause blackwater events when drains hold back water after a flood. Blackwater events are a natural part of lowland systems. However, changes to floodplain hydrology and vegetation from drainage works have increased the frequency, timing and extent of these events across the region. As flood waters inundate the floodplain, microorganisms break down organic matter and consume oxygen. When the flood waters recede, oxygen-depleted (hypoxic) blackwater enters the waterways and estuary. In the Richmond River catchment, hypoxic blackwater events are fairly common and are often caused by the prolonged inundation of introduced pasture and cropping plant species.

The NSW Government is investigating measures for managing these issues through a review of coastal drainage management and other *Marine Estate Management Strategy* projects. The review will contribute to improvements in estuarine water quality over the long term.

Water quality problems are also present in the Tweed and Brunswick catchments but are generally less severe than those experienced in the Richmond. In the Tweed catchment, water quality decreases with distance upstream due to the increasing upstream influence of agricultural runoff and wastewater discharges.<sup>60</sup>

As the climate changes, projected lower flows and higher temperatures may further reduce water quality. Higher temperatures and elevated nutrient concentrations create more favourable environments for potentially harmful algal blooms, particularly in water storages. Under the right conditions these algal blooms can spread significant distances downstream. Sea level rise may also reduce the effectiveness of floodgates, and drains in estuarine areas.

The unseasonal release of cold water from dams and weirs can change the natural temperature of aquatic ecosystems and poses a serious threat to the viability and survival of fish populations. Research suggests that cold water pollution can adversely impact aquatic organisms and ecological processes and is key to river health. The major storages in the Far North Coast region vary in their likelihood of releasing cold water to the environment. However, there is a lack of monitoring sites both upstream and downstream of these storages which can make it difficult to determine the extent of cold water pollution.

60. Hydrosphere Consulting 2017, *Coastal Management Program for the Tweed River Estuary: Water Quality Assessment*, [www.yoursaytweed.com.au](http://www.yoursaytweed.com.au)

## Improving water quality through the Marine Estate Management Strategy

The *NSW Marine Estate Threat and Risk Assessment Final Report*<sup>61</sup> identified water pollution as the number one threat to both the environmental assets and the social, cultural and economic benefits derived from the marine estate. Initiative 1 of the *NSW Marine Estate Management Strategy 2018–2028*<sup>62</sup> targets improving water quality through management actions aimed at improving habitat, addressing litter, and reducing land-based runoff, including:

- clean coastal catchments
- fish friendly workshops for local government
- oyster reef restoration
- riverbank vegetation rehabilitation
- coastal wetland rehabilitation
- reducing erosion from roads and tracks
- biodiversity offsets
- marine litter campaign
- risk-based framework for waterway health
- estuarine water quality monitoring
- coastal floodplain study
- coastal drainage management
- construction sediment management
- review of the NSW Water Quality Objectives<sup>63</sup>
- Review of the NSW *Diffuse Source Water Pollution Strategy*.

Generally, water sources across the region are naturally low in dissolved salts (salinity). However, as discussed in section 2.1.1, sea level rise, combined with reduction in freshwater flows, will cause tidal limits to move further upstream and saltwater to intrude into groundwater sources. Increased salinity will combine with higher water levels to alter existing freshwater dependent habitats for numerous Far North Coast water sources. This is expected to change the condition and characteristics of the estuaries and marine wetlands of the Far North Coast region.

The impacts will vary according to local conditions, such as substrate and geomorphology, but it is broadly anticipated that marine conditions will move landwards. The NSW Government is taking action to identify estuarine and marine environments and species at threat from climate change through Initiative 3 of the *Marine Estate Management Strategy* and the preparation of coastal management programs. Saltwater intrusion will also impact water security for local water utilities and water users who currently access freshwater water sources located close to, or within, current tidal limits. Forming a clearer regional picture of this issue is critical to developing appropriate local responses.

61. NSW Marine Estate Management Authority 2017, *NSW Marine Estate Threat and Risk Assessment*, Sydney, NSW Government, [www.marine.nsw.gov.au](http://www.marine.nsw.gov.au)

62. NSW Marine Estate Management Authority 2018, *NSW Marine Estate Management Strategy 2018-2028*, NSW Government

63. Department of Planning, Industry and Environment—Environment, Climate Change and Water, *NSW Water Quality and River Flow Objectives*, accessed 24 August 2020, [www.environment.nsw.gov.au/ieo/](http://www.environment.nsw.gov.au/ieo/)



### 2.2.3 Managing water in the Far North Coast region

Water in NSW is managed and shared under the *Water Management Act 2000*, with specific water sharing rules set out in water sharing plans.

#### Managing water extraction

Water sharing plans set the limits on the amount of water that can be extracted from surface water and groundwater sources in the South Coast region. The annual sharing of water is managed through long-term average annual extraction limits (LTAAELs). Daily sharing is managed through cease-to-pump rules in unregulated river systems, which can vary for different categories of licence. In regulated systems, water extraction is managed through available water determinations. Water extraction rules aim to balance reliable access to water with protecting the environment.

LTAAELs for Far North Coast water sources are implemented through the following water sharing plans:

- *Richmond River Area Unregulated, Regulated and Alluvial Water Sources (2010)*
- *Tweed River Area Unregulated and Alluvial Water Sources (2010)*
- *Brunswick Unregulated and Alluvial Water Sources (2016)*
- *North Coast Coastal Sands Groundwater Sources (2016)*
- *North Coast Fractured and Porous Rock Groundwater Sources (2016)*.

The Richmond River and Tweed River water sharing plans are due to be replaced or amended in 2021, while the remaining plans are due in 2026.<sup>64</sup>

#### Dealing with extraction limits

The region's surface water LTAAELs reflect the sum of licenced volumes and estimated basic landholder rights at the time the water sharing plan was made. While the LTAAELs in all three major catchments are considerably less than their total annual flows (about 3% of annual flow in the Richmond River, 8% in the Brunswick River and 16% in the Tweed River), competition for water between water users and the environment is high when streamflows are low. Cease-to-pump rules in water sharing plans are in place to manage competition for water during these periods.

Our new modelling suggests that the frequency of low flow periods are likely to increase in the future. It indicates that the volume of low flows in the Richmond unregulated system may decrease by 9% to 17%. The number of cease-to-flow events will also slightly increase. For example, in the Richmond unregulated system, the occurrence of cease-to-flow events is projected to increase from 5% (five out of 100 years) to 7%. This means that competition between water users, and between water users and the environment, may increase as the climate changes.

Recent investment in new climate and environmental datasets and modelling provide an opportunity to review and update the LTAAELs and water access rules to reflect sustainable levels of extraction. Sustainable extraction limits would consider the ecological, economic, social and cultural water needs of

64. Department of Planning, Industry and Environment 2020, *Water sharing plan status—Far North Coast region*, Department of Planning, Industry and Environment, accessed 24 August 2020 from, [www.industry.nsw.gov.au/water/plansprograms/water-sharing-plans/status/far-north-coast-region](http://www.industry.nsw.gov.au/water/plansprograms/water-sharing-plans/status/far-north-coast-region)

the region. A review may result in higher or lower LTAAELs. Higher LTAAELs would support economic growth because more water access licences could be issued for productive use. Lower LTAAELs would identify where the NSW Government should prioritise reducing the impact of water extraction on the environment and between water access licence types.

The region's groundwater LTAAELs vary by aquifer and are based on the calculation of several key components, including groundwater recharge rate, risk assessments, the volume of environmental water<sup>65</sup> and current and future water requirements.<sup>66</sup>

The LTAAEL for the Alstonville Basalt Plateau groundwater source is set at 8,895 ML and is fully committed. Access to this water source can only occur through trade.

The LTAAELs have been set at 19,000 ML for both the Richmond and Tweed-Brunswick coastal sands aquifers, and 300,000 ML and 13,000 ML for the Clarence Moreton Basin and North Coast Volcanics groundwater sources respectively. Unassigned water exists in these groundwater sources because the LTAAELs still exceed the total of water access licence volumes plus the volumes estimated for 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. In 2020, a total of 15,094 shares was made available in these three groundwater sources.

Future controlled allocations will be made in accordance with the *Strategy for the controlled allocation of groundwater*.<sup>67</sup> Investment in developing a better understanding of

groundwater processes would help identify opportunities to increase LTAAELs to support economic growth or prioritise locations where current levels of water extraction are unsustainable over the long term.

Cease-to-pump rules were developed based on risk assessments that considered the instream ecological values of a water source and the level of hydrologic stress (i.e. the level of extractions). Cease-to-pump rules based on tidal pool salinity levels were developed based on risks posed by applying saline water on adjacent land. In some locations within non-tidal areas, a lack of flow information means that the cease-to-pump rules are based on the presence or absence of 'visible flow' rather than an established flow rate. This means that at some locations, cease-to-pump rules only come into effect once a water source has stopped flowing. This protects pools from drawdown, providing drought refuge, but does not retain connectivity within the system.

The current rules for allocating surface water from the Richmond regulated system are based on observed rainfall records prior to the development of the water sharing plan. The rules do not anticipate a scenario where the region's climate is likely to be more variable in the future, with more severe droughts occurring more often.

Preparation of the regional water strategies offers an opportunity to consider whether our resource assessment, allocation settings and water sharing rules are at the right levels, particularly in relation to new climate data, regional trends and other contemporary information.

65. Water allocated to support environmental outcomes and other public benefits. Environmental water provisions recognise the environmental water requirements and are based on environmental, social and economic considerations, including existing user rights.

66. Department of Primary Industries—Water 2016, *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources—Background document*, [www.water.nsw.gov.au](http://www.water.nsw.gov.au) and Department of Primary Industries—Water 2016, *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Source—Background Document*, [www.water.nsw.gov.au/](http://www.water.nsw.gov.au/)

67. Department of Primary Industries—Water 2017, *Strategy for the controlled allocation of groundwater*, NSW Government, [www.industry.nsw.gov.au/](http://www.industry.nsw.gov.au/)

## Water take in the Far North Coast

Most of the water taken from Far North Coast surface and alluvial water sources is from unregulated river sources, meaning there are no major storages to capture and control flows for water supplies. A total of 143,453 ML surface and alluvial water is licensed for use across the region. Almost 75% of this volume is licensed for extraction within the Richmond River catchment. Around 37% of licenced extraction volumes are held by local water utilities to supply towns. Just 9,654 ML is licensed from the Richmond regulated water source.

The types of licence categories vary significantly across the three surface water catchments. As shown in Figure 16, unregulated river access licences make up most of the licence types in the Brunswick River catchment. This water is mainly used for agriculture. Local water utility licences dominate in the Tweed River catchment, while licence types are more diverse in the Richmond River catchment and are spread across several categories.

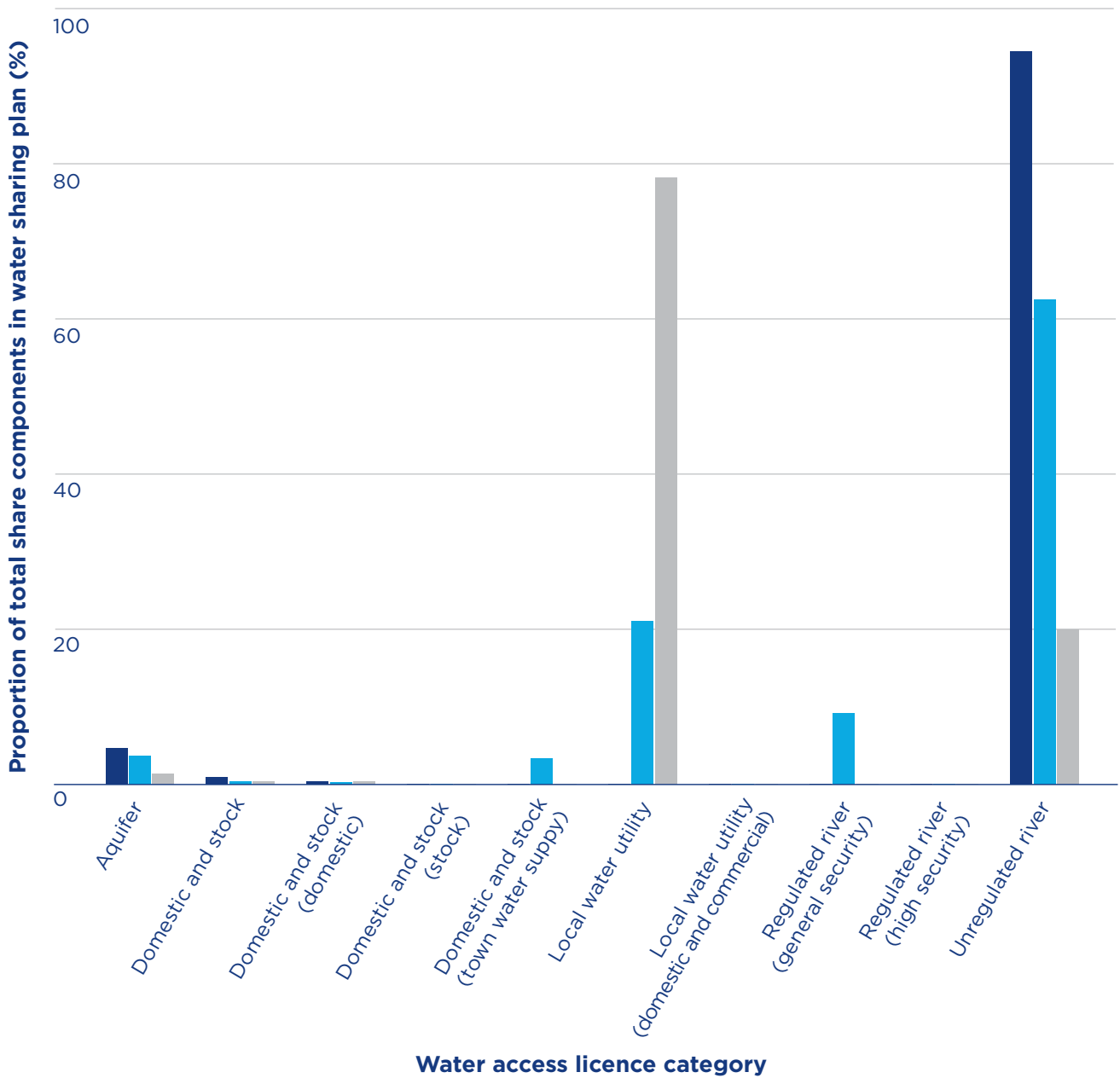
There are no entitlements held by the NSW or Commonwealth Governments to provide environmental water in the Far North Coast region. Currently, the environmental needs of these water sources can only be met from water that is not taken for other purposes, as provided for under rules set out in the water sharing plans.

An environmental contingency allowance<sup>68</sup> was provided in Toonumbar Dam for the first five years of the water sharing plan to help manage critical environmental events downstream and to maintain aquatic ecosystem health. However, this environmental contingency allowance provision was never used and expired in 2016. The regional water strategy and upcoming review of the Richmond River area water sharing plan provides an opportunity to consider the need to restore the environmental contingency allowance to manage future risks to waterway health. They also provide an opportunity to consider current and future environmental water needs across the region.

68. Water held in the dam for environmental purposes



**Figure 16. Proportion of water licence share components by licence category and catchment**



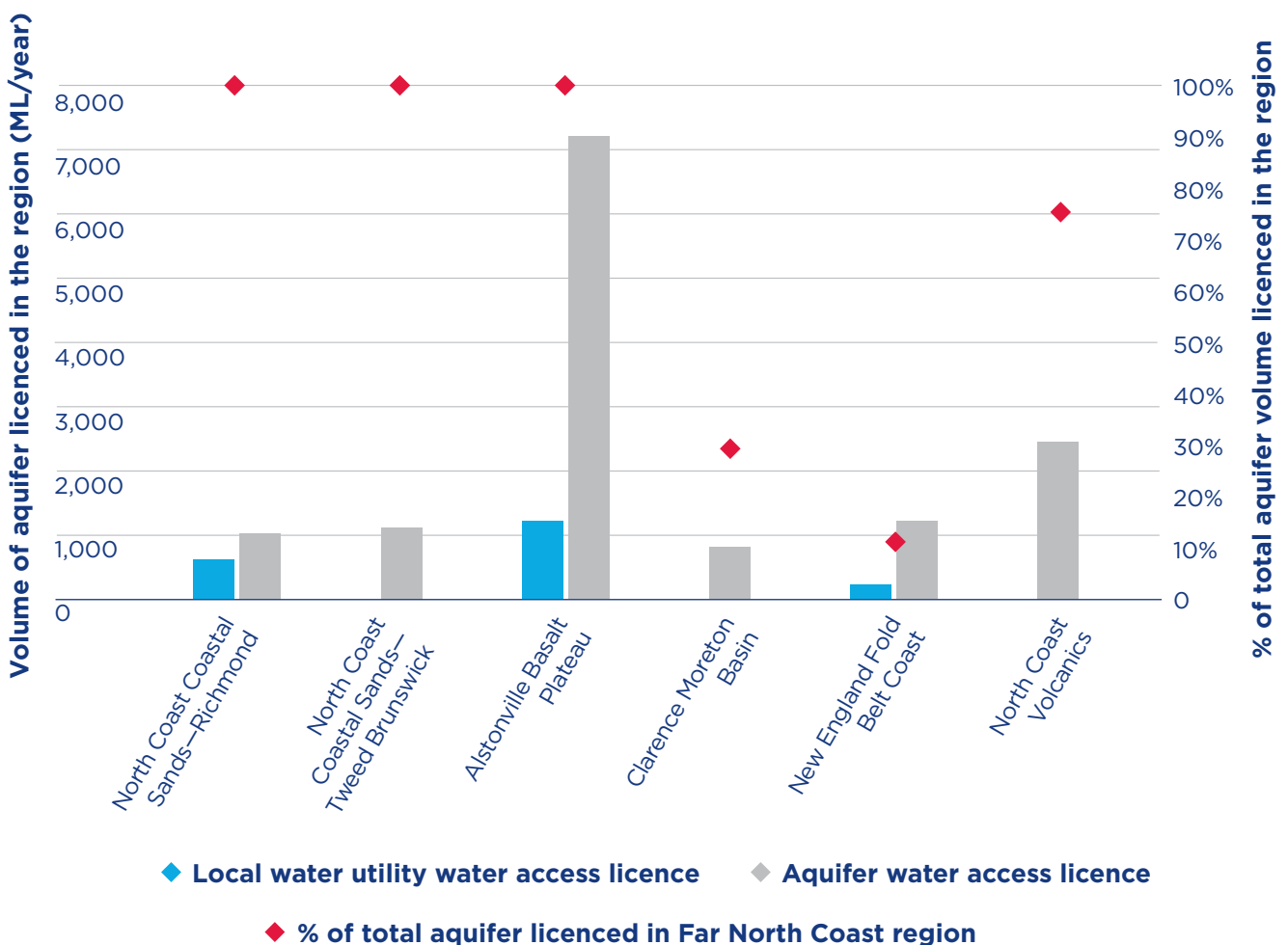
- ◆ Water Sharing Plan for the Brunswick Unregulated and Alluvial Water Sources 2016
- ◆ Water Sharing Plan for the Richmond River Area Unregulated, Regulated and Alluvial Water Sources 2010
- ◆ Water Sharing Plan for the Tweed River Area Unregulated and Alluvial Water Sources 2010

As discussed in section 2.1.1, harvestable rights allow landholders in coastal draining catchments to collect 10% of the average annual regional rainfall runoff from their properties and store it in one or more farm dams up to a certain size, without a water access licence, water supply work approval or water use approval. Harvestable rights dams can only be constructed on non-permanent mapped minor streams, or unmapped streams. 'Minor streams' are first and second order streams, as defined using the Strahler stream order.<sup>69</sup> The water captured in a harvestable rights dam can be used for any purpose, but it cannot be supplied to any other property or traded.

Groundwater entitlements are linked to the land from which the groundwater is accessed.

Due to the variable geologies of the coast, groundwater entitlements and allocations can be very diverse across small geographical scales. Approximately 16,000 ML of coastal sands and porous/fractured rock groundwater is licenced for use across the region. Figure 17 shows the volume of groundwater entitlements issued from Far North Coast aquifers, some of which extend beyond the Far North Coast region. Figure 17 also shows what proportion of the total licenced volume is issued in the region. Apart from town water supply, groundwater in the Far North Coast is typically used for irrigation (particularly large areas such as golf courses, bowling greens, school fields and public open space), sugar mills and in several quarries. New industries, such as water bottling and blueberries, are also accessing groundwater to support their growth.

**Figure 17. Groundwater licenced for extraction in the Far North Coast region**



69. Department of Industry 2018, *Determining stream order—Fact sheet*. [www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data](http://www.industry.nsw.gov.au/water/licensing-trade/hydroline-spatial-data)


## Setting priorities for water sharing

The *Water Management Act 2000* sets out how we prioritise water sharing during normal operations, with the highest priority being for the environment, followed by basic landholder rights<sup>70</sup> (Table 2).

There is currently no instrument to modify these priorities in coastal catchments in response to extreme events to safeguard available water for critical needs. Preparation of the Far North Coast Regional Water Strategy provides an opportunity to consider if such an instrument or policy is needed.

For example, in some other parts of the state, water sharing priorities change during extreme events such as prolonged droughts. Basic landholder rights and essential town water services (authorised by an access licence) become the highest priority, followed by the environment. This change in priorities is triggered when a water sharing plan (or part of a plan) is suspended. The aim is to operate within the plan rules for as long as possible, as they provide clarity for all users of these water sources.

**Table 2. Priorities for water sharing under normal circumstances and an example of extreme events rules applied elsewhere in the state<sup>71</sup>**

Priority	Extreme events	Normal circumstances
Highest	<ul style="list-style-type: none"> <li>Critical human water needs</li> </ul>	<ul style="list-style-type: none"> <li>Needs of the environment</li> </ul>
 <p>High</p> <p>Low</p>	<ul style="list-style-type: none"> <li>Needs of the environment</li> </ul>	<ul style="list-style-type: none"> <li>Basic landholder rights</li> </ul>
	<ul style="list-style-type: none"> <li>Stock</li> <li>High security licences</li> <li>Commercial and industrial activities authorised by local water utility</li> <li>Water for electricity generation on a major utility licence</li> <li>Conveyance in supplying water for any priority 3 take</li> </ul>	<ul style="list-style-type: none"> <li>Local water utility access licences</li> <li>Major utility access licences</li> <li>Stock and domestic access licences</li> </ul>
	<ul style="list-style-type: none"> <li>General security licences</li> </ul>	<ul style="list-style-type: none"> <li>Regulated river (high security) access licences</li> </ul>
	<ul style="list-style-type: none"> <li>Supplementary licences</li> </ul>	<ul style="list-style-type: none"> <li>All other forms of access licences</li> <li>Supplementary access licences</li> </ul>

70. Landholders can take water under basic landholder rights without a water licence or approval in certain circumstances. There are three types of basic landholder rights in NSW under the *Water Management Act 2000*: domestic and stock rights, harvestable rights and native title rights. More information on basic landholder rights is provided at [www.industry.nsw.gov.au/water/licensing-trade/landholder-rights](http://www.industry.nsw.gov.au/water/licensing-trade/landholder-rights)

71. This table describes priorities for water sharing under normal circumstances across the state. It also describes extreme events rules applied elsewhere in the state. There are currently no extreme event rules in place in the Far North Coast.

## Managing floods

The *NSW Flood Prone Land Policy*<sup>72</sup> outlines the government partnership for flood risk management in NSW. It identifies that local councils are primarily responsible for managing flood risk in their communities. The *Floodplain Development Manual*<sup>73</sup> outlines the roles and responsibilities of local councils, which include:

- developing and implementing floodplain risk management plans to better understand and manage flood risk to the community
- providing information to, and improving the awareness of flooding in, the community
- operating and maintaining their floodplain risk management assets (e.g. drainage, levees)
- consider flooding in land use planning, development and infrastructure decisions
- supporting NSW State Emergency Service (NSW SES) in emergency management and associated planning.

The NSW Government plays an important role in managing flood risk before, during and after floods. This is done primarily through the Environment, Energy and Science Division of the Department of Planning, Industry and Environment which leads the implementation of the *NSW Flood Prone Land Policy* and provides support to councils through the Floodplain Development Manual and associated policies, guidelines and tools. Department of Planning, Industry and Environment—Environment, Energy and Science is currently reviewing the manual and its associated guidance.

Councils also receive specialist technical support from Department of Planning, Industry and Environment—Environment, Energy and Science flood risk management experts and financial assistance through the NSW Floodplain

Management Program. This program supports the development and implementation of floodplain risk management plans consistent with the manual. Funding provided through the program to local government authorities to manage flood risk is generally at a rate of \$2 for every \$1 provided by the council.<sup>74</sup>

The SES leads flood emergency management planning and response. The Floodplain Management Program supports the NSW SES to fulfil its role as the state's flood combat agency.

### NSW Government flood risk management investment in the Far North Coast

The NSW Government, sometimes in partnership with the Australian Government, has been active in supporting flood risk management by local councils since the 1950s. This led to the establishment of the NSW Floodplain Management Program, which along with the Floodplain Development Manual, supports the implementation of the *NSW Flood Prone Land Policy* (first issued in 1984).

The NSW Government has provided substantial ongoing investment to Far North Coast regional councils to manage flooding risk. This has included financial support for the construction and upgrading of the Lismore levees, which was completed in 2005. From 2012/13 to 2019/20, the NSW Government awarded more than \$8 million of grants under the Floodplain Management Program to local councils in the region to help them better understand and manage the flood risk in their communities.

72. The NSW Flood Prone Land Policy is published in the *Floodplain Development Manual*.

73. Department of Infrastructure, Planning and Natural Resources 2005, *Floodplain Development Manual: the management of flood liable land*, NSW Government, [www.environment.nsw.gov.au/](http://www.environment.nsw.gov.au/)

74. Department of Planning, Industry and Environment 2018, *Floodplain Management Program*, accessed 26 August 2020 from, [www.environment.nsw.gov.au/topics/water/floodplains/floodplain-management-program](http://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-management-program)

## Managing the coast and estuaries

The NSW coastal management framework aims to promote thriving and resilient coastal communities living and working on a healthy coast. The framework provides technical, statutory and financial support to councils to prepare, review and implement coastal management programs to manage coastal hazards, water quality and estuary health including the impacts of climate change. The framework includes:

- *Coastal Management Act 2016*
- *State Environmental Planning Policy (Coastal Management) 2018*
- NSW Coastal Management Manual
- NSW Coastal Council
- Coastal and estuary grant program.

The framework provides the means by which councils can manage coastal hazards including coastal erosion and shoreline recession, coastal watercourse entrance instability, coastal inundation, coastal cliff stability, tidal inundation and erosion caused by tidal waters.

Councils in the Far North Coast region have been working for many years on coastal planning and are at varying stages of completing their coastal management programs for the open coast and key estuaries in close consultation with local communities and relevant agencies. Information such as tidal inundation maps developed by councils through coastal and floodplain risk management planning processes can also be used to support decision-making regarding the management of coastal waterways.

## Managing water quality

Water quality is managed through several legislative and regulatory instruments and agencies and through a number of non-regulatory initiatives.

The NSW Government has adopted the *National Water Quality Management Strategy*<sup>75</sup> as its policy to manage the quality of waterways in NSW and protect water resources. The strategy provides guidance for maintaining and improving water quality according to local community environmental values and uses.

In NSW, goals for meeting these values and uses are captured in the NSW Water Quality and River Flow Objectives.<sup>76</sup> Objectives have been developed for all major fresh and estuarine surface water catchments across the state, including the Far North Coast.

Water sharing plans are a key mechanism to meeting water quality goals. The plans use flow management measures (including extraction limits and cease-to-pump rules) to help ensure enough flow is available to meet water quality objectives and targets. Additional mechanisms are available through the approvals and licensing framework. This includes ensuring setback distances and construction standards for new water supply works are enforced to limit groundwater drawdown and minimise the likelihood of increased salinity.

Our new climate and environmental datasets and modelling will help inform our understanding of local water quality risks arising from changed flow regimes and water extraction patterns. Risk assessments are used to inform reviews of water sharing plans. These are scheduled to begin across Far North Coast catchments from 2021. Improved water quality monitoring would further strengthen these assessments.

75. Australian Government 2018, *Charter: National Water Quality Management Strategy*, Department of Agriculture and Water Resources, [www.waterquality.gov.au/](http://www.waterquality.gov.au/)

76. Department of Environment, Climate Change and Water 2006, *NSW Water Quality and River Flow Objectives*, Department of Environment, Climate Change and Water, accessed 24 August 2020 from, [www.environment.nsw.gov.au/ieo/](http://www.environment.nsw.gov.au/ieo/)

## Water quality objectives review

The Department of Planning, Industry and Environment is reviewing the NSW Water Quality and River Flow Objectives for each catchment in coastal NSW to reflect contemporary values and expectations and, where appropriate, update these objectives in consultation with the community. The department is also reviewing the *Diffuse Source Water Pollution Strategy* to improve the way land managers deal with diffuse sources of water pollution, mainly stormwater pollution. These are key actions under Initiative 1 of the *NSW Marine Estate Management Strategy 2018–2028*.<sup>77</sup>

As discussed in section 2.2.2, the quality of Far North Coast water sources is also affected by land use activities, many of which are outside the influence of flow management and therefore cannot be addressed through water planning alone. The process used to assess and manage the impacts of land use activities and water extraction on water quality is outlined in the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions*.<sup>78</sup>

This framework helps local councils to support healthy waterways through regional and local planning instruments, environmental regulation, integrated water cycle management plans, coastal management programs or other catchment management plans for restoring and protecting the health of waterways.

Managing catchment water quality also helps local water utilities meet drinking water quality standards set out in the *Australian Drinking Water Guidelines* (ADWG).<sup>79</sup> The ADWG details a preventative management approach that manages and monitors water quality from the catchment to the consumer. The ADWG is used by NSW Health, the Department of Planning, Industry and Environment and local water

utilities to assure safe, good quality drinking water for NSW communities.

Water supplies in regional NSW are monitored for microbiological and chemical quality through the NSW Health Drinking Water Monitoring Program. NSW Health also publicly reports water quality incidents. The Department of Planning, Industry and Environment's Water division monitors the performance of local water utilities in providing drinking water.

The risk of human exposure to potentially toxic blue-green algal blooms is managed through a coordinated regional approach with the Regional Algal Coordination Committees. State-wide and regional contingency plans and guidelines have been developed to manage algal blooms. The guidelines aim to minimise the impact of algal blooms by providing adequate warning to the public ensuring their health and safety in recreational situations and for stock and domestic use.

The Far North Coast Regional Water Strategy is an opportunity to consider which additional actions are needed to better manage water quality in the region.

77. NSW Marine Estate Management Authority 2018, *NSW Marine Estate Management Strategy 2018–2028*, NSW Government

78. Dela-Cruz, J., et al. 2017, *Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions*, Office of Environment and Heritage and Environment Protection Authority, [www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning](http://www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-considering-waterway-health-outcomes-in-strategic-land-use-planning)

79. National Health and Medical Research Council and Natural Resource Management Ministerial Council 2011, *Australian Drinking Water Guidelines*, [www.nhmrc.gov.au](http://www.nhmrc.gov.au)

## Gathering more and better information

Improving the information we have about water use and water needs will help us to manage the Far North Coast region's water more effectively. It will also ensure we can plan to have enough water available at the right time for water users and for the environment. Improving the collection of data will give us a better understanding of the water risks in the region for the environment and all water users. More data and knowledge will support future decisions about water sharing, investments in secure water supplies, water quality management, and ensuring compliance with water access and sharing rules.

Improved information can also help water users, future investors, and regions make more informed decisions about the industries that are most suited to each region.

The Far North Coast region largely consists of unregulated water courses that are not managed for storage and irrigation supply. Therefore extraction is generally not measured.

This means there is little data on water extraction, making it difficult to ensure water is extracted legally and shared equitably during dry conditions. There is also a paucity of water quality data across the region.

The lack of water extraction data is being addressed through the implementation of the new non-urban metering framework announced by the NSW Government as part of its 2017 *Water Reform Action Plan*.<sup>80</sup> Under the framework, all surface and groundwater works covered by the rules will need to be fitted with compliant metering equipment by 1 December 2023. Under the current rules, an estimated 247 water supply works (about 13%) in the Far North Coast region will be subject to the metering rules: 172 in the unregulated Richmond River system, 35 in the regulated Richmond River system, nine in the Brunswick River system and 31 in the Tweed River system. 1,695 licenced extraction works across these catchments will not be required to meter water take under the new framework.

### Technology can help

The NSW Government and WaterNSW are developing a new data platform<sup>81</sup> to increase the availability and accessibility of critical non-urban water information. The platform will provide information on:

- water sharing plan rules
- entitlements and works approvals
- transactions (such as water trades)
- water take from water sources
- flows in rivers and streams.

The initiative is being developed progressively and will be fully operational by

2025. Information on NSW's regulated water systems, including the regulated Richmond River, is already available.

In addition, under the new metering laws, large surface water users will need to install telemetry and remotely transmit water information to government. This will enable better decisions on the active management of water instream and for townships and will give the Natural Resources Access Regulator a reliable source of data about water take to inform its compliance and enforcement functions. It will also support WaterNSW in their billing activities.

Water users will also be able to access their information via a private online dashboard.

80. Department of Planning, Industry and Environment 2017, *NSW Government water reform action plan*, NSW Government, [www.industry.nsw.gov.au/water/what-we-do/water-reform-action-plan](http://www.industry.nsw.gov.au/water/what-we-do/water-reform-action-plan)

81. WaterNSW, *WaterInsights portal*, accessed 10 September 2020 from, [www.waternsw.com.au/waterinsights/water-insights](http://www.waternsw.com.au/waterinsights/water-insights)

Our most recent drought has highlighted the important role groundwater sources can play in providing supplementary and backup supplies for towns, domestic and stock and other commercial uses. Given the expected continuing demands on groundwater, we need to improve our understanding of the interaction between surface water and groundwater resources in the Far North Coast to enable us to make decisions to improve the resilience of our water sources. We need to understand where a change in groundwater use can influence flows to rivers and vice versa. We also need to understand how a changing climate is impacting the replenishment of groundwater resources. More broadly, we need to ensure ongoing investment in the groundwater monitoring network so we have the water quantity and quality information needed to manage the resource into the future.

The Department of Primary Industries is undertaking a three-year program to identify and map important agricultural lands.<sup>82</sup> Understanding the location, value and contribution of this land will assist in making decisions to align current and future agricultural land uses and their water needs. A comprehensive and consistent approach to collecting water statistics and information will greatly help this process.

High quality data underpins the science that drives water management decisions. Investment in our hydrometric network, water quality monitoring programs and our ecohydrological data sets (including biological and geomorphological data) is critical to fill the data gap.

The coastal regions of NSW suffer from a lack of water quality data. The current NSW surface water quality monitoring program was established in 2007. It was designed to meet the objectives and data requirements at

the time, but there are important data gaps we need to fill to help us make decisions and monitor our progress.

Good ecological science is based on high quality, long-term data collection programs. Long-term programs can be cost-effective as they are more likely to capture trends that short-term studies will miss. These programs can then inform and supplement short-term reporting, evaluation and assessment initiatives. Improvements to data management, assessment tools and data products will advance our understanding of the region's risk profile.

Data gaps are limiting our understanding of groundwater resources and the way we manage them. These gaps include information about the resources, how they are accessed and how they are used by water users. A more comprehensive groundwater monitoring network in the region that includes both level and water quality information is needed to improve our understanding of groundwater processes and the longer-term effects of climate change. It will also help us to understand the spatial variability of saltwater intrusion in coastal aquifers.

There are also opportunities to improve our groundwater modelling in areas of high groundwater use on the coast. For example, new numerical models in areas of high use or risk are needed to address town water supply needs and to assess the impacts of sea level rise and saltwater intrusion, new bore license submissions and groundwater dealings. There are also opportunities to incorporate climate change projections into our long-term planning and development of groundwater resources.

82. Department of Primary Industries 2020, *Important Agricultural Land Mapping in NSW*, accessed June 2020 from, [www.dpi.nsw.gov.au/agriculture/lup/agriculture-industry-mapping/important](http://www.dpi.nsw.gov.au/agriculture/lup/agriculture-industry-mapping/important)



## Collecting better data

Across the Far North Coast region, there are important opportunities to gather more information about:

- the water requirements (when and how much) of communities, the environment, urban-based commercial businesses and industries
- what the water is being used for, including crop types and yield values
- the interaction between groundwater and surface water in the region
- quantity of water use and patterns of water use in the unregulated system and some groundwater systems
- water quality.

Gathering and analysing this data will improve our understanding of the water risks in the region for the environment and all water users, and support future decisions about water sharing.



Image courtesy of Destination NSW.

## 2.3 People, industries and water use

### 2.3.1 Aboriginal people

The region's main traditional custodians are the Githabul and Bundjalung peoples. The lands of the Githabul Nation lie on some of the inland portions of the Far North Coast region and extend west towards the Border Rivers region. The Bundjalung Nation is a large federation of around 15 groups or clans whose lands extend across the Far North Coast and North Coast regions and into southern Queensland.

Water is the lifeblood of Aboriginal people. It allows kinship, connection, stories, songlines and healing through medicine and food. Healthy waterways and groundwater systems are critical to Aboriginal people for health, wellbeing and culture.

Aboriginal people have managed the land and water of the region for over 22,000 years.<sup>83</sup> European settlement interrupted Aboriginal peoples' connection with Country along with the accompanying responsibilities for land and water management.

The diversity and abundance of natural resources available to the Aboriginal people of the NSW north coast resulted in a high density of

Aboriginal occupation. The marine environment and the lush vegetation along the coast provided the people with much of what they needed. Fish and seafood, birds, bats and land mammals were eaten and supplemented with vegetation such as ferns, fruits and wild spinach.<sup>84</sup>

The area is home to Mt Warning (Wollumbin), which is a place of tradition and cultural significance to the Bundjalung people. Under Bundjalung law only certain people may climb to the summit of this mountain. The trail to the summit was declared an Aboriginal Place in 2015.

Many coastal sites are significant to the local people. In the Byron Bay area, Currenba (Palm Valley) is one example of a special meeting place where groups camped by the natural channels in the valley and ate pipis, fish and other sea foods. The surviving midden and campsite at Palm Valley is around 1,500 years old and is the oldest in the region. Cumbebin Swamp (connected to Belongil estuary) is another important site for hunting and gathering. Men would catch birds, eels, turtles and snakes while women would gather bush tucker, ferns for basket weaving and paperbark to build their homes.<sup>85</sup>

83. Arakwal People of Byron Bay 2011, *Welcome*, accessed 20 August 2020 from [arakwal.com.au/](http://arakwal.com.au/)

84. Hoskins 2013, cited in Department of Primary Industries—Water 2016, *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources—Background document*, [www.water.nsw.gov.au](http://www.water.nsw.gov.au)

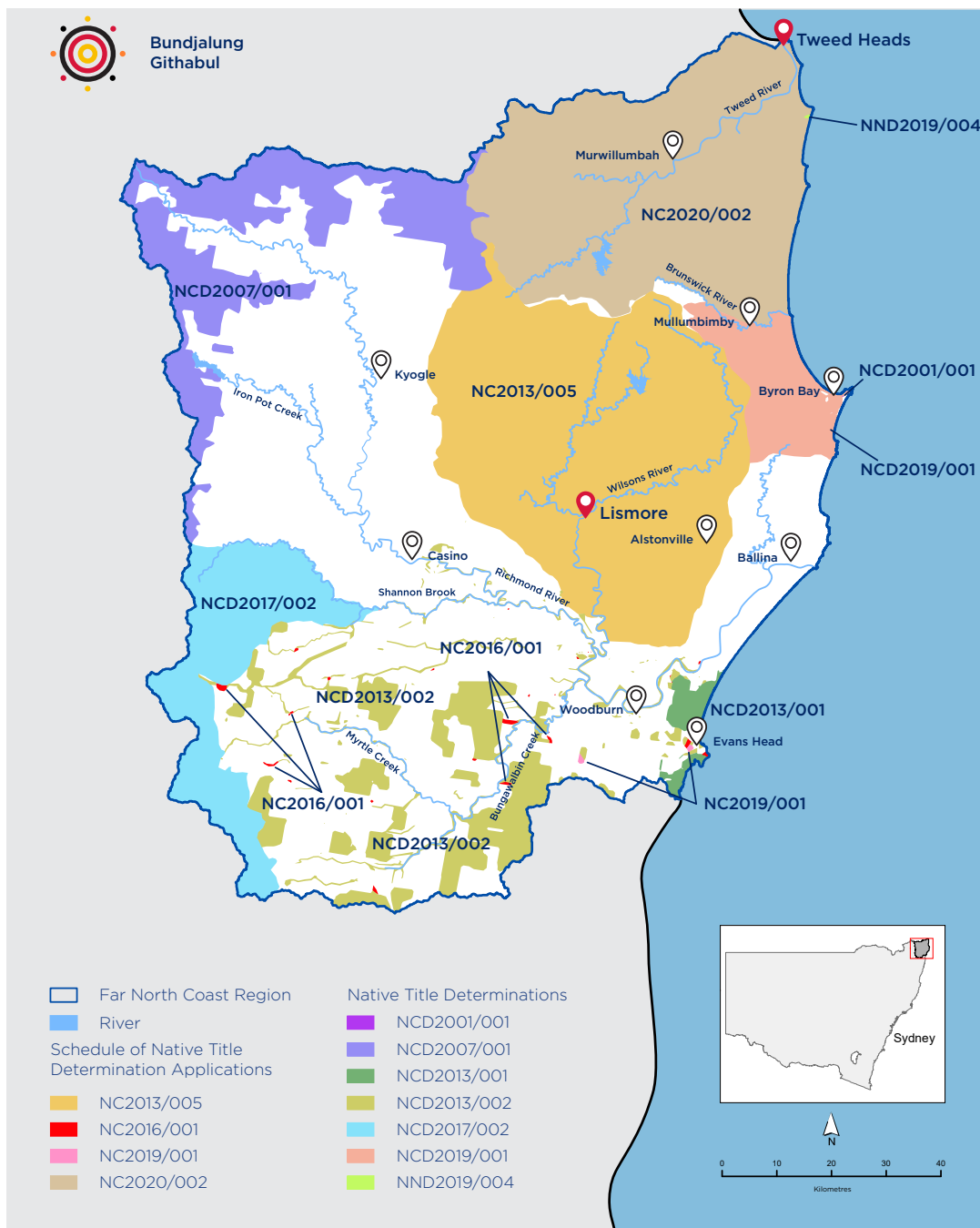
85. Arakwal People of Byron Bay 2011, *Cumbebin Swamp, Arakwal People of Byron Bay*, accessed 19 August 2020 from [arakwal.com.au/cumbebin-swamp/](http://arakwal.com.au/cumbebin-swamp/)

## Native Title claims

Native Title recognises the rights of Aboriginal people to hunt, fish, camp, protect cultural sites and gather natural resources in accordance with their traditional laws and customs. It also grants certain rights over water use and collection in these areas.

Five Native Title claims have been determined to exist in the Far North Coast region. There are currently four registered land claims being considered (Figure 18 and Table 3).

**Figure 18. Map of Native Title applications and determinations in the Far North Coast region**



**Table 3. Native Title applications and determinations in the Far North Coast region<sup>86</sup>**

Application name	Tribunal file number	Status	Native title claim overview
<b>Bandjalang People #1</b>	NCD2013/001	Determined	Native Title exists in parts of the determination area which spreads over sections of the Clarence Valley and Richmond Valley local government areas.
<b>Bandjalang People #2</b>	NCD2013/002	Determined	Native Title exists in parts of the determination area which spreads over sections of the Clarence Valley, Lismore City and Richmond Valley.
<b>Bundjalung People of Byron Bay #3</b>	NCD2019/001	Determined	Native Title exists in parts of the determination area which spread across the Ballina and Byron Bay local government areas.
<b>Githabul People</b>	NCD2007/001	Determined	Native Title exists in the entire determination area of more than 1,120 km <sup>2</sup> , spread over Kyogle, Tenterfield and Tweed Shire local government areas.
<b>Byron Bay Bundjalung People</b>	NCD2001/001	Determined	Native Title does not exist.
<b>Western Bundjalung People Part A</b>	NCD2017/002	Determined	Native Title exists in parts of the determination area.
<b>Tweed Byron Local Aboriginal Land Council</b>	NCD2019/004	Determined	Native Title does not exist.
<b>Widjabul Wia-bal People</b>	NC2013/005	Accepted for registration	The claim is located on the Far North Coast of NSW inland from the coast and commencing on the southern boundary of Border Ranges National Park, south to the western boundary of Tuckean Broadwater, east of the towns of Kyogle and Casino.
<b>Bandjalang People #3</b>	NC2016/001	Accepted for registration	Claim on select lots based application in North Eastern NSW, in the vicinity of Evans Head. These lots spread across the Clarence Valley, Lismore City, and Richmond Valley local government areas.
<b>Bandjalang People #4</b>	NC2019/001	Accepted for registration	Claim on select lots in the Richmond Valley local government area about 24 km inland from Evans Head over three separate lots.
<b>Tweed River Bundjalung People</b>	NC2020/002	Currently identified for Reg. Decision	North Eastern NSW overlapping the South Eastern Queensland Border and west to the Border Ranges National Park NSW.

### Water used by Aboriginal people

Face-to-face engagement with Aboriginal communities on the Far North Coast has been delayed due to the COVID-19 pandemic (see section 1.3.3). Engagement recommenced in July 2020 and will continue throughout the strategy's development. The department is committed to engaging with the Aboriginal

communities on the Far North Coast as appropriately as possible during the pandemic to ensure that Aboriginal rights, interests and concerns related to water are heard and included in the final strategy.

Several important themes have emerged from our consultations with Aboriginal communities in the Far North Coast to date. In particular,

86. Commonwealth of Australia 2017, *Search Register of Native Title Claims, Commonwealth of Australia*, accessed 19 December 2019 from, [www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/Search-Register-of-Native-Title-Claims.aspx](http://www.nntt.gov.au/searchRegApps/NativeTitleRegisters/Pages/Search-Register-of-Native-Title-Claims.aspx)

we heard from Aboriginal people that—as recognised traditional custodians of the lands and water sources in the region—they would like more direct input to water management decision-making. This would afford the opportunity to incorporate traditional knowledge into water management in the region. We also heard that the water rights afforded to Aboriginal communities through Native Title and cultural water access licences are not clear and that they would like more support to understand and access their water rights. The regional water strategy for the Far North Coast may also provide an opportunity to restore some important spiritual and cultural sites that have become degraded in recent history.

In our state-wide community consultations, we heard that Aboriginal communities do not have adequate access to water or access to Country to fulfil their cultural rights and to protect cultural sites. While there are some ways of accessing water for cultural purposes, we heard from Aboriginal people that the current provisions in the *Water Management Act 2000* do not meet their spiritual, cultural, social and economic needs. We also heard that healthy waterways are critical to Aboriginal communities for culture and health and wellbeing.

Aboriginal people’s legal rights as they apply to water management have been recognised in international human rights treaties and conventions, in Australian and NSW Native Title and land rights laws, and in national and state-based water plans. These instruments recognise the right to self-determination and the right to access traditionally owned lands and water. They also recognise the importance of maintaining the environmental knowledge and practices of Aboriginal people, promoting their full participation in decisions about water resources and acknowledging Aboriginal cultural values and uses in water planning.

In addition, the 2007 Echuca Declaration defines cultural flows as ‘water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, environmental, social and economic conditions of those Nations’.<sup>87</sup>

Australia’s Native Title laws recognise the traditional rights and interests to land and water of Aboriginal people. Anyone who holds Native Title with respect to water can take and use water for personal, domestic and non-commercial communal purposes. Native Title holders often have water-related aspirations, such as the protection of water, water allocations and advising on water management practices in a determinations area.

Aboriginal people can apply for Aboriginal cultural water access licences. If granted, this licence can provide up to 10 ML/year for drinking, food preparation, washing and watering domestic gardens, as well as for Aboriginal cultural uses.<sup>88</sup>

The final Far North Coast Regional Water Strategy will reflect the results of our ongoing consultation with Aboriginal people in the region and consider options on how to recognise and deliver their water rights.<sup>89</sup>

It will also consider how options will help deliver on commitments under the *National Agreement on Closing the Gap*<sup>90</sup>, including the four reform areas of:

- formal partnerships and shared decision making
- building the community controlled sector
- transforming government organisations
- shared access to data and information at a regional level.

87. Murray Lower Darling Rivers Indigenous Nations 2007, *Echuca Declaration*

88. NSW Government, *Water Sharing Plan for the Richmond River Area Unregulated, Regulated and Alluvial Water Sources 2010*, [legislation.nsw.gov.au/view/html/inforce/current/s1-2010-0702](http://legislation.nsw.gov.au/view/html/inforce/current/s1-2010-0702) NSW Government, *Water Sharing Plan for the Richmond River Area Unregulated, Regulated and Alluvial Water Sources 2010*, [legislation.nsw.gov.au/view/html/inforce/current/s1-2010-0702](http://legislation.nsw.gov.au/view/html/inforce/current/s1-2010-0702)

89. More information about our Aboriginal engagement approach is in the *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

90. *National Agreement on Closing the Gap 2020*, [www.closingthegap.gov.au](http://www.closingthegap.gov.au)



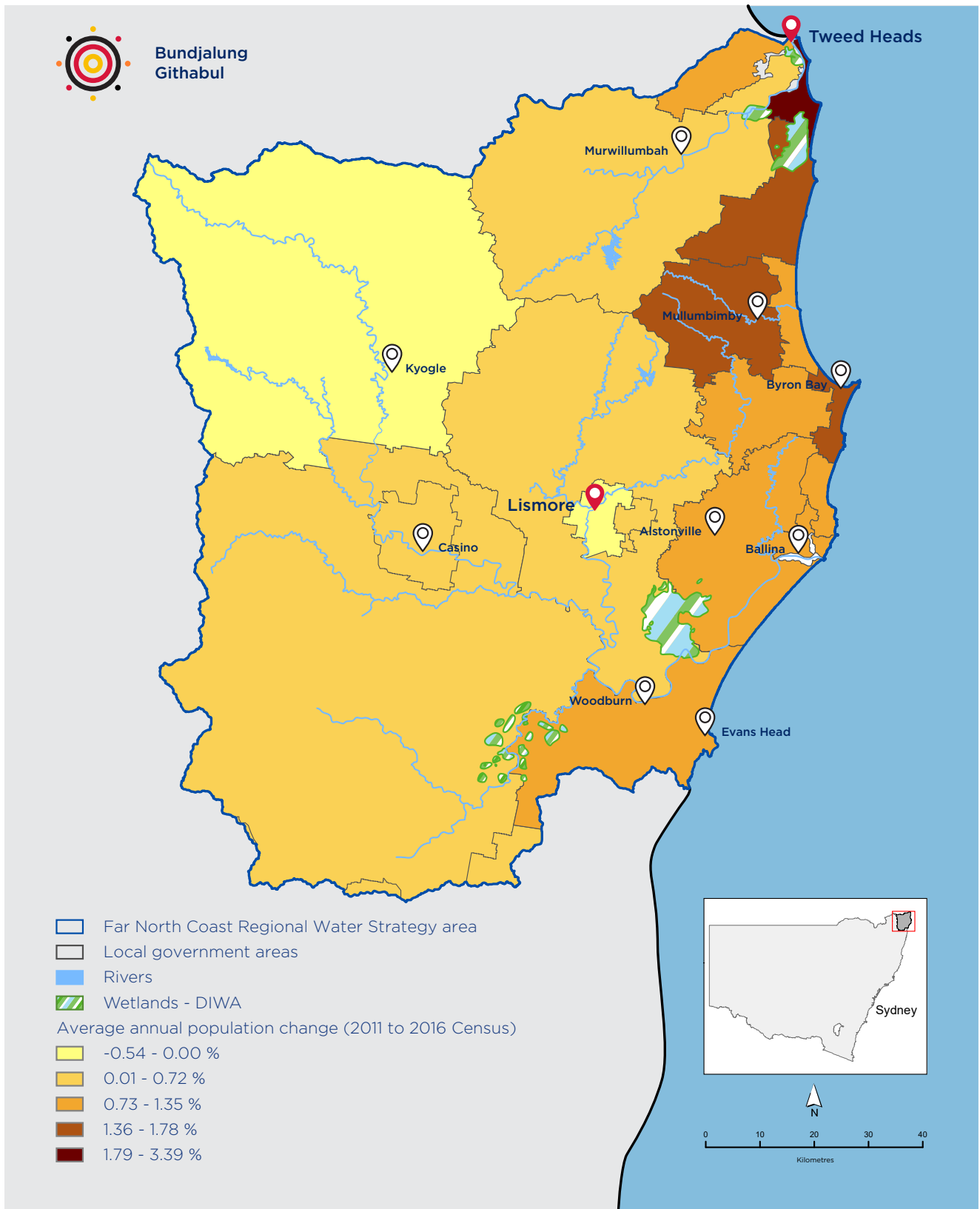
## 2.3.2 People and towns

The Far North Coast region is home to over 240,000 people and includes the large regional centres of Tweed Heads (population 61,000), Lismore (28,000), Ballina (17,000), Casino (10,000) and Murwillumbah (7,000). These centres are important employment, services and cultural hubs for the broader Far North Coast region. A large portion of the population live on productive agricultural lands in the mid and lower parts of the catchments. There are also many smaller towns and villages in the region, mostly along the coast or close to inland rivers. These towns have populations ranging from around 200 to 3,000 people and include Byron Bay, Mullumbimby, Nimbin and Kyogle. The region neighbours—and is closely connected economically—to the North Coast region and South East Queensland, including the more densely populated hubs of the Gold Coast and Brisbane.

The economy and population of the Far North Coast regional centres are expected to grow in coming years. Economic growth in the region will be driven by the growing population as well as by tourism, agriculture and industry. Over the next 20 years, the population of the region is expected to grow by about 10%. However, population growth in the region is not uniform—the majority of growth is expected to be along the coastal fringe in the Tweed, Byron and Ballina local government areas. In recent years, inland parts of the region have grown very little and some areas have seen a decrease in population (Figure 19). This could lead to disparities in employment opportunities and equity across the region.

Image courtesy of Destination NSW.

**Figure 19. Far North Coast average annual population change (2011-2016)**



Economic development in the region is guided by NSW's strategic planning framework for regional NSW. The *North Coast Regional Plan 2036*<sup>91</sup> sets out planning directions for the State Government, councils, and other organisations to realise the potential for growth across the North Coast region, including the Far North Coast. The plan provides the blueprint for harnessing the opportunities provided by the region's spectacular environment, growing cities and centres, and increasing connectivity between communities and with South East Queensland. The *Northern Rivers Regional Economic Development Strategy*<sup>92</sup> has also been designed to leverage the region's key specialisations:

- agriculture, food manufacturing and logistics chain workers in the western hinterland
- health, human services and retail in the regional hub of Lismore
- tourism, creative professionals and traditional business enabling services in coastal areas.

The NSW Government is also committed to improving employment opportunities for Aboriginal people in the Far North Coast region. The Aboriginal Participation in Construction Policy supports a minimum of 1.5% Aboriginal participation in construction projects undertaken by government agencies.

As the region grows, so will the need for services such as healthcare, construction and retail. The NSW Government is investing heavily in transport and community infrastructure to cater for the future population. This includes:

- \$4.35 billion for the upgrade of the Pacific Highway between Woolgoolga and Ballina by 2020
- \$12.9 million to upgrade airports throughout the Far North Coast

- \$6 million to support and improve regional culture
- \$20 million to help grow local economies
- \$3 million for connecting regional communities
- \$16 million to support regional sports and infrastructure.

## Water for people and towns

Providing secure and resilient water and sewerage services to regional centres, towns and outlying areas is vital for the long-term sustainability of the region, particularly in the context of a changing climate. It is also vital for supporting regional land use planning goals of a thriving, interconnected economy, vibrant and engaged communities and great housing choice and lifestyle options.<sup>93</sup>

These services support growing populations and contribute to the amenity, liveability and wellbeing of residents and visitors. Water in regional towns and communities also provides broader social benefits. Town swimming pools, healthy rivers, wetlands, lakes and other water bodies offer social and recreational opportunities. They are important spaces for family and community cohesion and provide respite from the heat and humidity of the region's summer months. High quality open spaces and parks connected to water are also important to communities across the Far North Coast region.

A number of organisations provide water and sewerage services in the region. Rous County Council is responsible for bulk water supply across most of the Richmond and Brunswick catchments. Local water utilities—Byron Shire, Ballina Shire, Lismore City and Richmond Valley councils—receive bulk water from Rous County Council but are responsible for reticulating supply within towns, as well as sewerage services and billing. Tweed Shire and

91. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

92. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government

93. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

Kyogle councils provide both bulk water and reticulated water supply and sewerage services across their local government areas. Over 80% of the population in the Far North Coast region rely on water provided by a local government water utility.

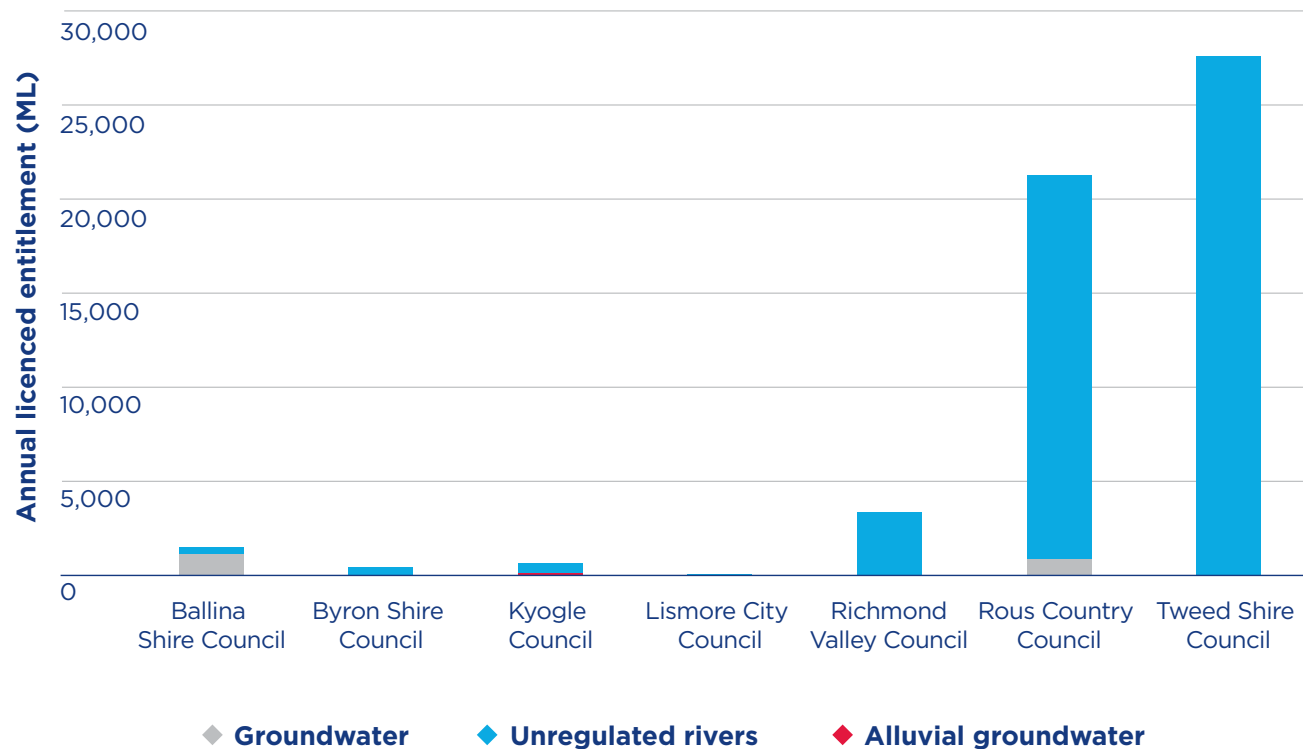
Water is supplied to towns from several sources across the region. As discussed in section 2.2.1, Rous County Council's regional water supply system sources water from multiple dams and borefields across the region but is largely reliant on surface water. Some towns—including Casino, Kyogle, Mullumbimby, Wardell and Nimbin—are not connected to the regional system and rely on smaller local systems operated by local water utilities. Some councils also rely on groundwater as an alternate or supplementary source of water.

The region's local water utilities hold 55,304 ML of surface water and groundwater water access licences to supply their connected towns and

villages (Figure 20). This equates to roughly 35% of all licensed water entitlement in the region. Annual water use by the region's towns has typically been less than this. However, the town water supplies in the region are not capable of managing the extended dry periods that our new modelling shows are possible, particularly when expected population growth is taken into account. For example, our modelling shows that under current and future climate scenarios, Rocky Creek Dam is expected to drop below 50% capacity in about 1.3% of years (just over one out of every 100 years). When future population growth is considered,<sup>94</sup> Rocky Creek Dam could drop below 50% capacity in 12% of years (12 out of every 100 years) and could drop below 5% capacity in nearly 2% of years.

Groundwater may also become less secure, as groundwater sources could receive less recharge.

**Figure 20. Water sources of town water supplies in the Far North Coast region**



Source: Department of Planning, Industry and Environment—Water 2019, water licensing

94. In addition to increased climate variability and climate change projections

In regional NSW, town water supply systems are designed on a consistent basis using the NSW Government's *Guidelines on Assuring Future Water Security*.<sup>95</sup> Systems are planned and sized in consultation with the community, giving consideration to historical and future consumptive needs and climate projections. Local water utilities are responsible for providing water and sewerage services to their respective communities in a way that balances costs and community expectations about levels of service. This responsibility extends to planning for, and delivering, secure water supplies.

All town water supplies have some level of inherent water security risk and are designed to accommodate moderate levels of restricted service. This recognises that restriction-free urban water supplies are usually not practical or cost effective. Local water

utilities undertake water security access risk analyses as part of their integrated water cycle management planning. These analyses take into account:

- headworks (water storage and treatment) arrangement and capacities
- physical water delivery system and operational rules under water sharing plans
- operating protocols and past experiences in delivering water in drought conditions.

The currently known water security risk for each water utility is shown in Table 4. It shows that the Rous County Council, Tweed and Casino systems have medium to very high water security risks. These systems supply over 95% of the serviced population in the Far North Coast region.

**Table 4. Water security risk for centres and towns in the Far North Coast region**

Water utility	Drinking water supply system	Population served in 2014 (approx)	Water security risk
Ballina Shire Council	Wardell	648	High
Byron Shire Council	Mullumbimby	3,164	Low
Kyogle Council	Bonalbo	285	Medium
	Kyogle	3,046	Low
Lismore City Council	Nimbin	1,872	Low
Richmond Valley Council	Casino	10,687	Very High
Rous County Council	Rous County Council bulk Supply	105,700	Very High
Tweed Shire Council	Tweed	78,634	Medium
	Tyaglum	255	Medium
	Uki	214	Medium

Note: These risks represent the preliminary water security risks as assessed by the Safe and Secure Water Program as of April 2020 and are subject to change over time based on further investigation, new information from councils and/or delivery of projects/solutions addressing these risks.

Source: NSW Government's Safe and Secure Water Program

95. Office of Water 2013, *Assuring future urban water security: Assessment and adaption guidelines for NSW local water utilities*

Water security risks for the Rous County Council bulk supply and Tweed water supply systems are driven by a projected reduction in yields and high population growth. This is particularly true for the Byron, Ballina and Tweed local government areas. Current local water utility projections for Rous County Council suggest that demand for water could exceed supply by 2024 unless actions are taken to improve supply security.<sup>96</sup> By 2060, the annual demand deficit in the Rous County Council system could be around 5.6 GL.<sup>97</sup> Our modelling of Rocky Creek Dam and the Clarrie Hall Dam–Bray Park Weir system supports these analyses by local water utilities that the risk of supply shortfalls will increase in the future.

To manage these risks, Rous County Council has recently released its *Future Water Project 2060*,<sup>98</sup> which is centred around the construction of a 50 GL dam on Rocky Creek near Dunoon. Tweed Shire Council has identified increasing the capacity of Clarrie Hall Dam from 16 GL to 42.3 GL as its preferred solution.

The water security risks for Casino are driven largely by a reduction in yield from the Richmond River. This analysis is supported by our new modelling, which shows that Casino could experience a doubling of the length of supply shortfall events in the future compared to the current level of shortfall. Development of the regional water strategy provides an opportunity to inform selection of the supply augmentation option adopted by Richmond Valley Council to secure Casino's supply.

More generally, the water systems in the Far North Coast region mostly rely on surface water sources that are fed by regular and predictable rainfall. Consequently, they are vulnerable to the types of extreme dry periods

we now know have occurred in the past and that our modelling suggests can occur in the future. This vulnerability is demonstrated by the fact that water restrictions have periodically been in place throughout the Byron Shire, Lismore City and Ballina Shire local government areas since 2002. Substantial water restrictions were imposed during the Millennium Drought in response to critical water shortages for many towns in the region. The worst restrictions (Level 5) occurred at the start of 2003, when dams reached the lowest storage levels in decades. More recently, storages declined faster during the 2018/19 period than during the Millennium Drought and water restrictions were progressively rolled out across the region between January and December 2019.

At the same time as streamflows are decreasing, the region's coastal areas are experiencing high and concentrated population growth. We also know from managing recent droughts that—during extended dry periods—town water supply systems experience increases in demands from private water tankers delivering water to rural users. For example, during the recent drought of 2018–20, the demand for water cartage in the region was so high that orders took two to three months to be delivered.

These challenges highlight the importance of acting now to ensure adequate water security in the future. This draft strategy considers a wide-ranging suite of options to maintain and diversify town water supply systems, including augmenting existing dams, new dams and interconnections, recycle and reuse initiatives and climate-independent sources such as desalination. Several options also aim to improve reliable and sustainable access to groundwater by towns.

96. MWH 2014, *Future Water Strategy Integrated Water Planning Process*

97. Rous County Council 2020, *Future Water Project 2060: Information for the community about the preferred options for securing the region's water supply*, Rous County Council.

98. Rous County Council 2020, *Future Water Project 2060: Information for the community about the preferred options for securing the region's water supply*, Rous County Council.

Using water more wisely will help to mitigate the impacts of lower water availability and increasing demand. It will also contribute to meeting water security objectives and may delay the need for system augmentations. The regional water strategies provide an opportunity to review and improve existing demand management initiatives. These initiatives can contribute to reducing residential water consumption,<sup>99</sup> which is generally higher across the Far North Coast than the NSW regional median of 159.6 kL/yr.<sup>100</sup> There is also an opportunity to complement these demand management initiatives with investment in water supply system efficiencies. System efficiency projects would aim to reduce the proportion of non-revenue water (water that has been produced but is 'lost' before it reaches the customer), which is higher across the Far North Coast than the NSW median.

Poor water quality in some of the region's water sources is also impacting the ability of local water utilities to provide safe drinking water in accordance with the *Australian Drinking Water Guidelines* (ADWG).<sup>101</sup> More intense storms and increased likelihood of bushfires will heighten water quality risks in the future. In response to water quality threats, local water utilities in the Far North Coast have progressively upgraded their water treatment facilities over the last decade to provide additional treatment capacity—often at great cost. This investment has led to local water utilities meeting ADWG water quality guidelines over the past ten years and receiving fewer customer complaints about water quality issues compared to the NSW median.<sup>102</sup>

Despite these high performance standards, the treatment processes of some smaller

systems are occasionally affected by high levels of turbidity following heavy rain and flooding, leading to temporary boil water alerts. Local water utilities continue to invest in water treatment upgrades to manage these impacts. Some examples include Tweed Shire Council (Uki), Lismore City Council (Nimbin) and Ballina Shire Council (Marom Creek), for which the NSW Government has provided more than \$1.5 million funding support. Additional region-scale support could be provided by coordinating catchment management improvement activities and region-wide water quality monitoring. Further support could come from ensuring that existing government water quality improvement programs—such as those committed to in the *Marine Estate Management Strategy* (refer to section 2.2.2)—consider town water supply management objectives when prioritising delivery.

Increasing the use of recycled water and improving stormwater management could help to reduce the environmental impact of the region's wastewater and stormwater systems. There are also opportunities to reduce the frequency of sewer overflows in several of the region's sewerage systems, although the number of overflows across the region is generally low compared to the NSW median. Extending local water utility sewerage systems to unsewered villages can also reduce the environmental and health impacts of on-site sewage systems in high risk areas (areas where poor water quality threatens public health or surface water or groundwater sources with high ecological values). For example, Kyogle Council is currently preparing a business case to sewer the village of Wiangaree in the upper Richmond River catchment.

99. This refers to total residential water consumption per connection (kL) for 2018/19.

100. [www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data](http://www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data)

101. National Health and Medical Research Council and Natural Resource Management Ministerial Council 2011, *Australian Drinking Water Guidelines*, [www.nhmrc.gov.au](http://www.nhmrc.gov.au)

102. [www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data](http://www.industry.nsw.gov.au/water/water-utilities/lwu-performance-monitoring-data) and [www.bom.gov.au/water/npr/index.shtml](http://www.bom.gov.au/water/npr/index.shtml)



Image courtesy of Destination NSW.

Sea level rise, coastal inundation and flooding also threaten the performance of local water utility assets. Many of the region's water supplies, sewage treatment plants and stormwater drainage networks are located in estuaries and low-lying floodplains. Improving our understanding of the risks of sea level rise across the region will help local water utilities adapt to these challenges.

Ageing water, sewerage, floodgate and drainage infrastructure requires additional and ongoing capital investment to maintain service levels. This presents a challenge to local councils in the region as the costs of refurbishing or replacing aging assets add to the costs of augmenting and operating the water and sewerage systems. Local water utility operating costs and typical residential bills across the region generally exceed the NSW regional median, reflecting the high costs of providing these services in the Far North Coast.

Smaller councils and local water utilities can often find it difficult to attract and retain skilled staff and keep pace with the advances in regulation and technology that could save money and improve services. Continued collaboration between Far North Coast councils, the Northern Rivers Joint Organisation of Councils, WaterNSW and the NSW Government will be important to meet these challenges. This could be through finding economies of scale, unlocking efficiencies through knowledge sharing and driving continued performance improvements across the region. The region's proximity to South East Queensland also provides an opportunity for local water utilities to improve relationships with their counterparts in South East Queensland, including Seqwater. Improving the overall performance of the region's local water utilities would have positive health and economic impacts for the broader region.

### 2.3.3 Jobs and industries

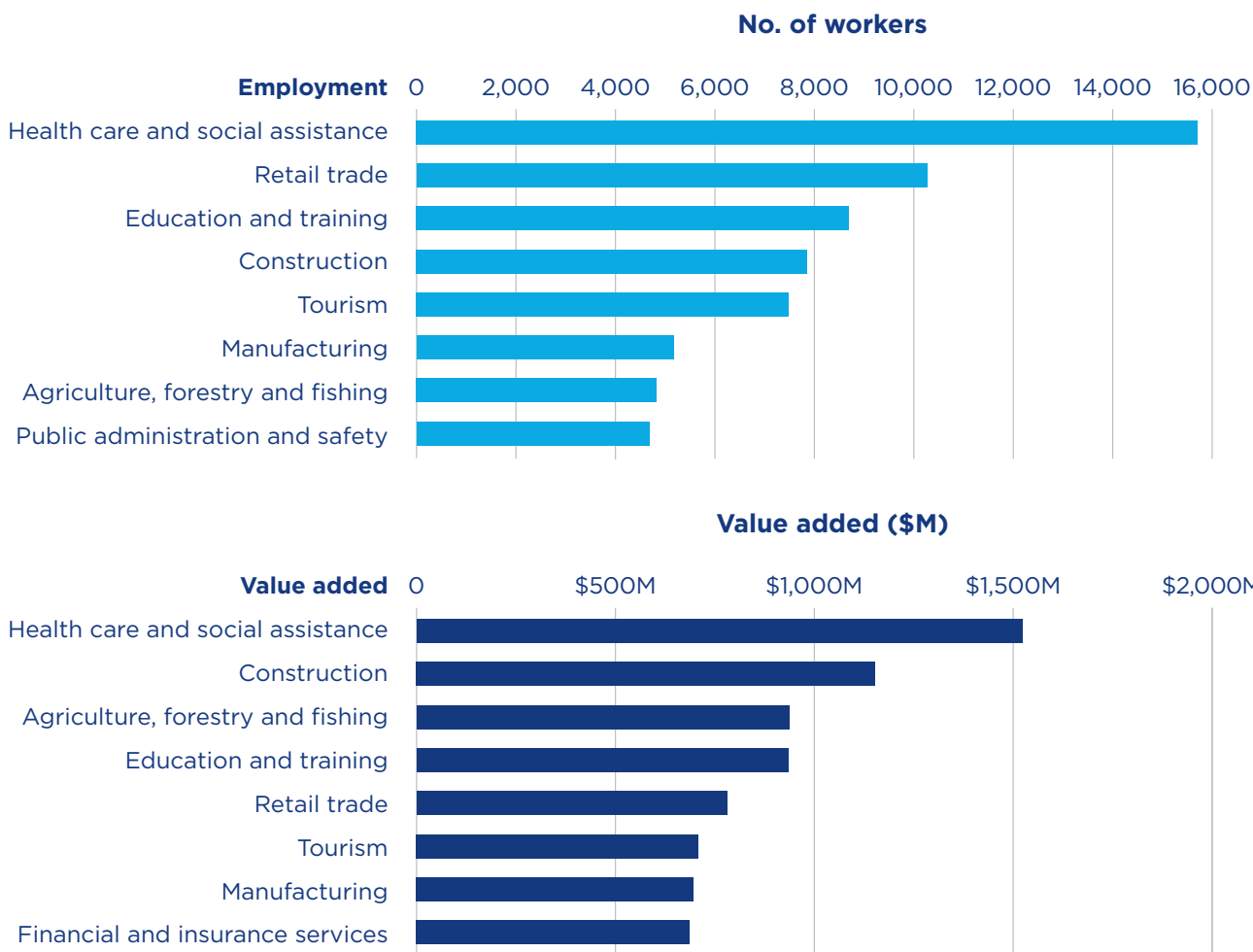
The Far North Coast region has an exceptionally diverse economy. Its coastal, riverine and hinterland amenity, access to South East Queensland, and infrastructure support a variety of industry sectors. These include tourism, agriculture, aquaculture, food manufacturing, health care, education, retail and a range of professional and business-enabling services.<sup>103</sup> Most employment is in the regional centres of Tweed Heads, Lismore, Ballina and Byron Bay.

Around 90,100 people are employed in the region, which contributes \$13 billion annually to the gross state product (about 2.3%). Water is a critical enabler of many businesses in the region. Town water use accounts for 35% of the water demand in the region and this supports important service industries and retail trade. Reliable town water supplies are also important to support growth in smaller towns. The rest of the water demand directly supports the other key industries in the region—primarily agriculture, forestry, fishing, tourism and manufacturing—and the relatively small mining and water bottling sectors.

103. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government



**Figure 21. Employment and economic outputs of key industries in the Northern Rivers region**



Note: Figures are for the Northern Rivers region excluding the Clarence Valley local government area.

Top eight industries shown only.

'Tourism' is not a defined industry category, and indirect employment and contribution to gross value added cannot be calculated. Listed value is total spend on Tourism services as defined by REMPLAN.

Source: REMPLAN 2019, REMPLAN Economy: Custom data [www.rempln.com.au/economy/](http://www.rempln.com.au/economy/)

Growing the region's industry specialisations is important for achieving the NSW Government's regional goal of a thriving, interconnected economy.<sup>104</sup> In particular, the NSW Government is focusing on growing these industries by improving the quality of connections to external markets.<sup>105</sup> NSW Government investment over the next 20 years will improve land and air transport links to the region and attract new residents and

visitors. Plans to progress the Bruxner Highway and Summerland Way corridor strategies will leverage growth in demand from national and international markets by improving the efficiency of freight activities and providing benefits from Inland Rail. Investment in hospitals and educational facilities, together with improved connectivity to the rest of NSW, will support growth in the agriculture, health care, education and tourism sectors.

104. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

105. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government



Image courtesy of Destination NSW.

**A note about the COVID-19 pandemic:** While the COVID-19 pandemic will have an impact on regional communities and economies in the short term, we expect that population will continue to grow in the longer term, although changes to the projected growth rates are uncertain. We expect that demand for water will continue to rise in line with population increases, associated service industries and tourist demands.

## Agriculture

Agriculture is a key part of the regional economy and represents the second-highest use of water. In 2017/18, agriculture contributed about \$846 million (6.5%) of the regional output. The sector employs around 5% of the regional workforce directly and 4% indirectly. While irrigated farms represent around 18% of agricultural businesses in the region, they made up about 40% of the total agricultural production in 2017/18. Livestock production, fruit and tree nut growing, dairy production and cattle farming, and other crops are four of the eight key regional specialisations identified for future growth.<sup>106</sup>

Agricultural production in the region is diverse and includes:

- livestock (including cattle, sheep, pigs and poultry)
- livestock products such as milk and eggs

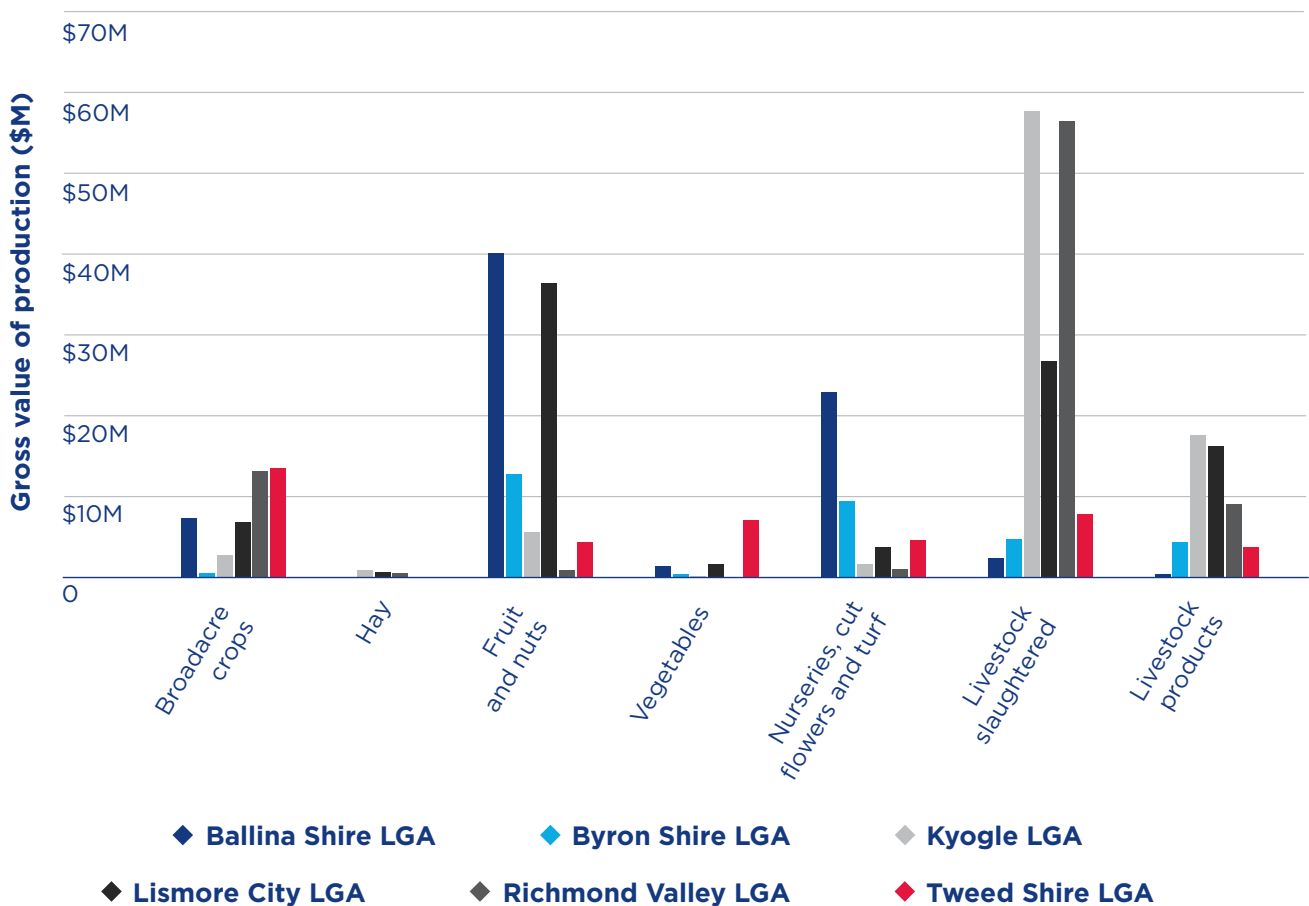
- fruit and nuts such as citrus, stone fruit, orchard fruits, blueberries, grapes, and macadamia nuts
- nurseries, cut flowers and cultivated turf
- broadacre crops including rice, sugar cane and oilseed.

Different parts of the region are better suited to producing different commodities (Figure 22). Livestock production occurs throughout the region, particularly around Kyogle and Richmond Valley, while fruit and nut orchards are mainly concentrated in the elevated areas north and west of Ballina. Sugar cane is produced primarily in the region's coastal floodplains.

106. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government



**Figure 22. Value of agricultural production in the Far North Coast region**



The agricultural profile of the region is changing. Beef and dairying have historically been an important economic driver in the region. Although they continue to be important, over the past few decades permanent horticulture land use has increased, particularly macadamia nuts. More recently,

blueberry production—which uses significantly more water than nut production—has increased while macadamia production has slowed. This growth in permanent horticulture has increased the region’s dependence on year-round water reliability.

### Agricultural water use

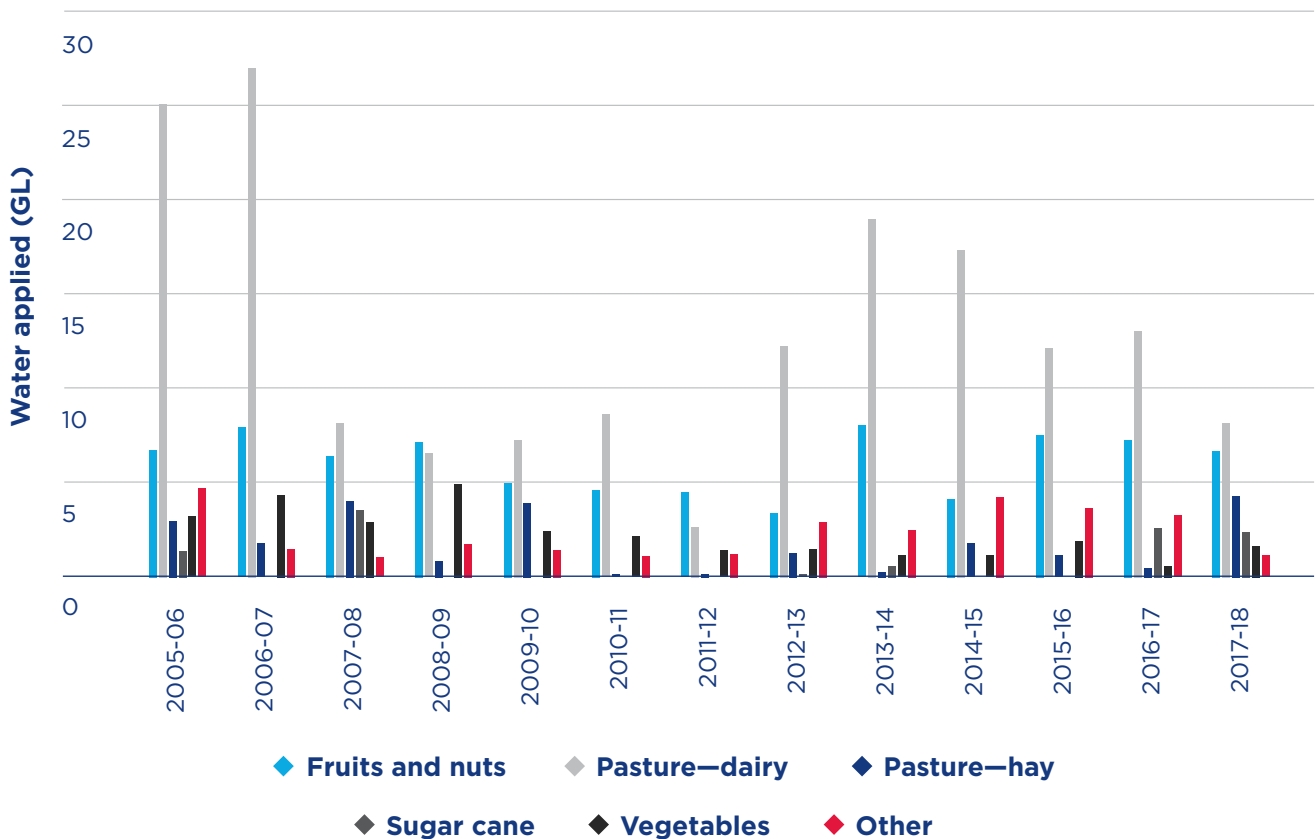
Secure water supplies are vital for supporting and growing agribusiness across the region. About 60% of water entitlements in the Far North Coast region are for agricultural purposes. Of the entitlements used for agricultural purposes, 90% are unregulated river licences, while only 10% are in the regulated system. Most of these entitlements (89%) are located in the Richmond River catchment.

In many years, rainfall provides most of the water required for crops. As a result, water extraction for agriculture in the Far North Coast can be very low in wetter years, particularly when compared to licenced entitlement

volumes. This can change in dry periods when the surface water and groundwater resources are under the most hydrological stress. For example, irrigation in 2005/06 was over four times as high as the demand in 2011/12 (Figure 23).<sup>107</sup>

Roughly half of the agricultural water used in the Far North Coast region is for pasture and cereal crops used for grazing. The average annual water use for pasture is 4,600 ML (2010 to 2018), although this can fluctuate significantly. There are now about 2,630 ha of fruit trees, nut trees and plantation or berry fruits in the Far North Coast region. On average, these permanent plantings use about 1,650 ML water per year (2010 to 2018).

**Figure 23. Agricultural water use by crop 2005-18**



107. 2005/06 was at the height of the Millennium Drought, while 2011/12 was a La Niña year with significant flooding.

In addition to water extraction from surface water and aquifers, landowners are also entitled to capture up to 10% of the rainfall runoff from their land under harvestable rights provisions. This water can be captured and stored in farm

dams on minor streams. Coastal water users have requested that the NSW Government explore options that would allow them to take more water under their harvestable rights to support agricultural production.

### Review of harvestable rights in coastal draining catchments

The Department of Planning, Industry and Environment is currently undertaking a review of harvestable rights for all coastal draining catchments. The review is exploring the potential benefits and impacts of increasing the percentage of surface water runoff that a landholder can capture and store in farm dams, as well as

allowing harvestable rights dams on third order streams and non-permanent first and second order streams without an approval or water access licence. The review is part of an ongoing discussion with coastal water users about equitable access to water. The purpose of the review is to investigate whether harvestable rights in coastal NSW could be increased while ensuring sufficient water is available for downstream water users and the environment.<sup>108</sup>

### Tourism and recreation

The Far North Coast is a key tourist hub in NSW and has experienced a steady increase in tourism over the last ten years. The region's combination of local culture and beautiful natural features—beaches, hinterlands and rainforests—and close proximity to Brisbane and South East Queensland attracts millions of visitors each year. In 2017/18, around two million people visited Byron Bay—the most iconic destination in the region—ranking it as the fourth most-visited destination in NSW. In 2018, tourist expenditure in the region amounted to about \$1.49 billion and employed over 7,600 people—almost 8% of jobs in the region.

Tourist attractions and events that rely on a healthy environment and water availability include:

- nationally significant wetlands and freshwater lakes
- World Heritage rainforests, including Border Ranges and Nightcap national parks
- one of the largest koala populations in NSW

- water sports such as kayaking and recreational fishing
- local music festivals including Bluesfest and Splendour in the Grass which draw high calibre national and international artists.

The NSW Government is supporting the growth of tourism opportunities in the Northern Rivers, focusing on coastal and inland World Heritage sites—many of which are highly dependent on water—food and creative industries.<sup>109</sup> However, the region's popularity with visitors is not without its costs and challenges, which include increasing pressure on local infrastructure—roads, water supply and wastewater services. Demands on water and wastewater services during tourist periods can be roughly 15% higher than average.<sup>110</sup>

Tourism in the region has recently been impacted by the COVID-19 pandemic, as is the case for all other parts of Australia. However, over the long-term tourism is expected to continue to be an important part of the Far North Coast region's economy.

108. For further information, see [www.industry.nsw.gov.au/water/licensing-trade/landholder-rights/harvestable-rights-dams](http://www.industry.nsw.gov.au/water/licensing-trade/landholder-rights/harvestable-rights-dams)

109. Department of Premier and Cabinet 2018, *Northern Rivers Regional Economic Development Strategy 2018-2022*, NSW Government

110. It is difficult to accurately quantify the impact of tourism on water and wastewater services due to data limitations and confounding factors. For example, irrigation demand often peaks around the same time as the peak summer tourist season.

## Mining and resources

Although mining is currently a small industry in the Far North Coast region, it is the only other industry that directly relies on extractive water use after town water supplies and agriculture. Water is used by the minerals industry mostly for operational activities including dredging, chemical processes, cooling systems, dust suppression, washing equipment and dewatering. In 2018, mining contributed around \$139 million (approximately 0.52%) of the Far North Coast region's output and employed about 250 people. The mining industry is growing, and economic output from mining in the region more than doubled between 2001 and 2016.

The Far North Coast region has high-value deposits of rare earth elements and high-tech metals such as titanium (rutile), diatomite and platinum. These are mostly found in the heavy mineral sands around Byron Bay, Ballina and Lismore, which historically have been mined. There are also several mines producing gold, copper, basalt, calcite and opals around Kyogle and Nimbin. Local quarries provided hard rock and fine aggregates for the Woolgoolga to Ballina Pacific Highway upgrade.

Opportunities exist in the region for mines to be more water efficient and to improve water quality control. Mining processes also do not need high-quality water—the regional water strategies provide an opportunity to explore options such as supplying fit-for-purpose water and supporting water reuse schemes for the mining industry.

## Other water-dependent industries

Aquaculture generates roughly \$9.6 million revenue annually in the region.<sup>111</sup> Oyster farming in particular is a developing industry on the Far North Coast. There are several commercial oyster operations in the Richmond, Brunswick and Tweed estuaries. Recreational fishing also adds to the regional economy primarily by stimulating the retail and hospitality sectors. Water bottling is a small industry in the Far North Coast and is mostly active in the Tweed Shire local government area.

Forestry in the region is a small industry. In the Richmond River catchment, forestry plantations are estimated to intercept about 1.5% of total runoff. In the Brunswick River and Tweed River catchments interception is estimated to be approximately 0.1% and 0.3% of total runoff respectively.<sup>112</sup> When large enough, forestry plantations can intercept significant quantities of surface runoff and can impact downstream water availability. The volume of water intercepted by forestry plantations in the Far North Coast is not large enough to be included within the long-term annual extraction limits of the relevant water sharing plans in the region. The plantation forestry sector in the Far North Coast region is not expected to expand or to create significant water interception issues in near the future. However, plantations are continually monitored and assessed under the *Plantations and Reafforestation Act 1999* to determine if water management changes are needed to account for any increase in water interception.

111. Barclay, K., et al. 2016, *Social and Economic Evaluation of NSW Coastal Aquaculture*, Fisheries Research and Development Corporation and University of Technology Sydney, Sydney. This estimate includes aquaculture production in the Clarence catchment.
112. Sinclair Knight Merz, CSIRO and Bureau of Rural Sciences 2010, *Surface and/or groundwater interception activities: initial estimates*, National Water Commission, Canberra.



## Industry water use and climate risks

The current climate of the region provides enough water for agricultural industries most of the time. Water users typically use much less than their licences allow. However, competition for water can become a significant issue during dry periods. Producers in the region are highly dependent on rainfall and are highly susceptible to drought—with relatively little on-farm or regional storage available, difficulties in accessing water can put farms at risk. Horticultural industries with long establishment periods, such as macadamias, are especially susceptible to drought.

Our new modelling looked at a range of plausible climate scenarios for the Far North Coast region to understand how future climate risks may impact on water users. The modelling included looking at results from a worst-case 130-year period. This showed that the need for extraction from waterways could increase, due to decreases in rainfall and increases in evaporation. This will increase the demands for water to supply towns and crops (Figure 24). Overall, in the Richmond River catchment there is sufficient water in the streams to provide for this increase in demand under current land use conditions. In the Tweed catchment, however, the average annual extraction for unregulated river licence holders could decrease by 4%.

Our new modelling also suggests there could be a small increase in the number of supply shortfall days each year. However, the length of supply shortfall events is unlikely to change. Horticultural industries with long establishment periods are most at risk from these shortfall events.

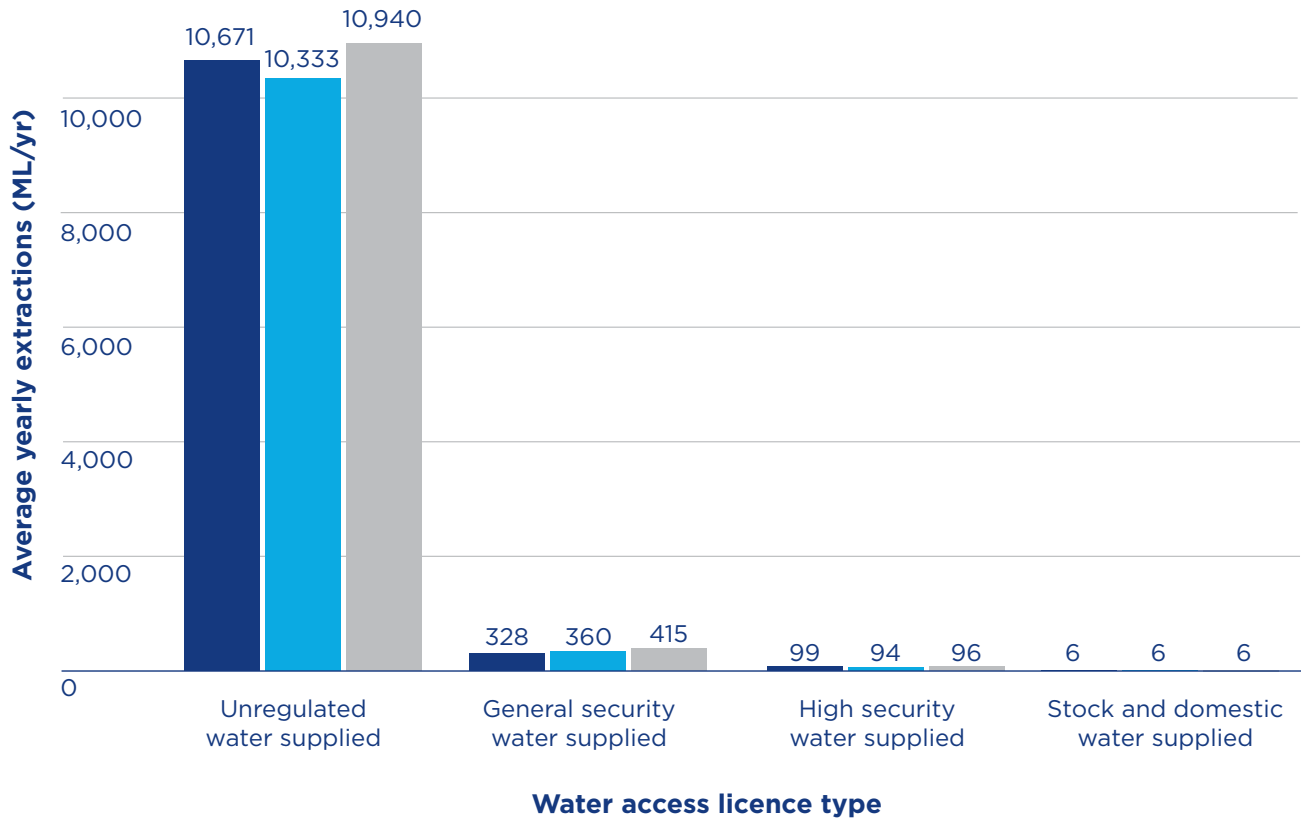
As rising sea levels increase salinity levels in the Richmond River, the ability of irrigators to use parts of the river will be impacted. Roughly 11% of water access entitlement volume in the region is located within current tidal limits. The footprint of the maximum high tide is expected to increase significantly with sea level rise. This may put water extraction in the coastal portions of the Far North Coast region at risk. This may also affect the delivery of water to urban centres and its suitability for agriculture.

A number of lower floodplain areas within the Far North Coast are serviced by drainage management infrastructure that restricts riverine flooding and allows drainage of water from the floodplain when river levels are low. Rising sea levels may reduce the opportunity for these drainage structures to operate as originally designed.

The regional water strategy provides an opportunity to support the region's industries to build resilience and mitigate the impact of these climate risks.

In addition, to better understand the effects of climate variability on agriculture, Department of Primary Industries—Agriculture is undertaking a vulnerability assessment to consider potential changes to yield and crop substitution, and identify adaptation opportunities. These findings will be available in mid-2022 and will inform future water policy and actions.

**Figure 24. Mean annual extraction in the Richmond River catchment under the ‘worst’ 130-year period of the future climate change projection period compared with the observed record**



- ◆ Observed historical record
- ◆ Worst 130-year long-term climate record (stochastic)
- ◆ Worst 130-year long-term climate change (stochastic + NARCIIM)



Chapter 3

# Options for the Far North Coast Regional Water Strategy

# Snapshot

## **We have developed a long list of options that could be included in the final Far North Coast Regional Water Strategy.**

- To identify these options, we have drawn ideas from previous studies, experiences of the 2018–20 dry period and the Millennium Drought, community consultation, government reforms and programs, and council water plans and strategies.
- Each option is expected to address at least one of the objectives set for the regional water strategies.
- The options aim to contribute to achieving our vision of having healthy and resilient water resources for a liveable and prosperous Far North Coast region. They also aim to achieve the NSW Government's focused planning goals for the region.
- The options have not been prioritised and not all options have been costed.

## **The options we are considering aim to tackle the challenges facing the Far North Coast region and maximise opportunities arising from regional growth and change.**

Options in the current long list focus on:

- **maintaining and diversifying water supplies**, including new water storages and pipelines, refurbishing and re-purposing existing water storages, increasing on-farm storage and introducing climate-independent water sources such as desalination, wastewater reuse and stormwater projects

- **protecting and enhancing natural systems**, including better protection for native and threatened aquatic species through policy changes to ensure more sustainable water extraction, improved water quality, and river, wetland and catchment management works
- **supporting water use and delivery efficiency and conservation**, through new and upgraded infrastructure, water efficiency measures and water market reviews
- **strengthening community preparedness for climate extremes**, such as reviewing drought management responses, improving or diversifying access to water during drought and improving data collection programs.

In addition to the four key focus areas identified above, the final long list of options will also include a key focus on **improving the recognition of Aboriginal people's water rights, interests and access to water**. These options will be developed following further face-to-face engagement with Aboriginal communities in the Far North Coast region (which has been delayed due to the COVID-19 pandemic).

In each of these areas, we are open to exploring fresh ideas and innovative solutions that will add value to regional industries, leverage new investments and support new economic, employment and environmental opportunities.

**Not all options will be progressed.**

- Inevitably, these options will involve trade-offs and choices. To fully understand the impacts, trade-offs and synergies, we will seek feedback on these options before undertaking a formal assessment process.
- The assessment process will look at the positive and negative effects of the option, its cost efficiency, how widely its benefits are likely to be distributed and its feasibility. Not all the regional water strategies objectives can be quantified.

When the outcome is difficult to assess in a financial context, options will be assessed on how effective they are in terms of achieving objectives, rather than on a cost basis.

- Preferred options, and packages of options delivered together, will be informed by a range of evidence including modelling, expert judgement and community input. These will form the final, comprehensive Far North Coast Regional Water Strategy.



Image courtesy of Destination NSW.

## 3.1 Our vision for the Far North Coast Regional Water Strategy

The challenges in the Far North Coast region stem from predictions for more severe extreme events, sea level rise, increasing water demands and the impacts of land use practices. We can't change today's climate, but through the regional water strategy we can deliver better outcomes for the region by changing:

- how we manage and operate our water systems, such as water sharing arrangements, allocations, dam operations and environmental flow requirements
- infrastructure in the region, such as dams, weirs, pumps, pipes and channels
- how water is used and water user behaviour, including demand management measures
- how we manage our catchments and waterways
- any combination of the above four options.

We have identified policy, planning, regulatory, educational, technology and infrastructure options that address the challenges the region may face and maximise opportunities arising from growing regional centres, emerging and expanding industries and new investments in transport and community infrastructure.

### Our vision for the strategy

Our vision for the strategy is to support the delivery of healthy, reliable and resilient water resources for a liveable and prosperous Far North Coast region. To achieve this, we need to position the region so there is the right amount of water of the right quality delivered in the right way for people, Aboriginal communities, towns, industries and the environment.

## 3.2 Identifying and developing the options

We have developed a long list of options that could be included in the final Far North Coast Regional Water Strategy. In preparing this list, we recognise that a great deal of work has been done over the last few years to identify initiatives that could improve water management and water security in the region. We have collated these initiatives and supplemented them with further actions based on feedback from local councils, joint organisations, Aboriginal communities and government agencies. The public consultation process and ongoing engagement with Aboriginal people will provide other opportunities to identify options and seek feedback on the long list of options. Bringing all of these options together will help us to align and better sequence the various water reform processes as we develop the strategy.

In developing the list of options for the Far North Coast region, we have specifically considered the following:

- Each option is expected to address at least one of the regional water strategy objectives (see Figure 4 in Chapter 1) and deliver on the regionally focused goals outlined in the *North Coast Regional Plan 2036*.<sup>113</sup> Some options will support multiple objectives. Other options may have positive benefits for one objective while having negative impacts for another objective. We do not have all of the information at the moment to understand these impacts. We will do further work to understand these impacts and seek your views on how each option may impact you and your values.
- While considering a range of options to maintain and improve the resilience of the region's water resources in the face of a variable and changing climate, we have also included options that take the next step in identifying innovative water solutions that will add value to existing industries, create opportunities for new industries and generate greater benefits that extend across the community.
- As discussed in section 1.3.1, the NSW Government has invested in new climate datasets and improved modelling to gain a more accurate understanding of future climatic conditions in the Far North Coast region. A number of options in the long list propose reviews of existing policy settings, operational rules and management plans considering this new data.
- As discussed in section 1.3.2, we have drawn on a range of sources to develop the options, including existing studies, past experience (such as water management during the Millennium Drought), community engagement and current NSW Government initiatives and programs. This process acknowledges the significant amount of thought and work already directed towards addressing the region's water-related challenges. More information about these sources is in the *Regional Water Strategies Guide*.<sup>114</sup>

113. NSW Government 2017, *North Coast Regional Plan 2036*, [www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan](http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/North-Coast/Plan)

114. *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

- We have had conversations with local councils and local water utilities to understand their views on what options could be considered in the Far North Coast Regional Water Strategy to improve water security and quality for towns and communities (see section 1.3.3).
- We have sought expert advice from government agencies.
- As discussed in section 1.3.3, face-to-face engagement with Aboriginal communities on the Far North Coast region was delayed due to the COVID-19 pandemic. Rather than including potential options in the current long list before this consultation has taken place, we are committed to ensuring that options with a primary focus on Aboriginal people's water rights, interests and access to water are developed through further face-to-face engagement with Aboriginal communities. This will also ensure that we include the extensive knowledge of Traditional Owners in water management decisions. Example options developed as a result of our state-wide consultations include reviewing cultural water access licences and ensuring greater involvement of Aboriginal people in water management.

**We have not ordered or prioritised the options identified for the Far North Coast long list of options and many options on the list have not been costed.**



Image courtesy of Destination NSW.

## 3.3 Which options will be progressed?

Not all options in the long list will be progressed. Only feasible options will be progressed following an assessment process.

Inevitably, these options—and their priority in the Far North Coast Regional Water Strategy—will involve trade-offs and choices. To understand the impacts and trade-offs we will first seek your feedback on these options and then use a formal options assessment process which will look at:

- **Effect**  
To what extent are the options expected to contribute to or otherwise impact on the NSW Government’s objectives over the planning horizon and/or during extreme events?
- **Impacts and magnitudes of impacts**  
A risk assessment of the positive or negative impact of the option on the objectives, and the magnitude and frequency of these impacts.
- **Cost efficiency**  
To what extent are the options likely to deliver cost effective outcomes?
- **Distribution of benefit**  
Is there likely to be a broader public or regional benefit from the option, or is the benefit concentrated to a small number of users?
- **Feasibility**  
To what extent is the option likely to be feasible, including regulatory/policy change, stakeholder acceptance, time to implement, cost, alignment with government policy, both national and international, and technical feasibility?

Further information on this process is in the *Regional Water Strategies Guide*.<sup>115</sup>

It is unlikely that a single option will be capable of addressing all of the identified risks across the objectives we have set for the strategy. The greatest benefits are likely to be realised by combining options so that they complement each other to improve the efficiency of the system, offset impacts or unlock greater benefits by using the different levers that are available—such as policy and infrastructure levers.

For example, infrastructure options may improve water reliability for industries and water security for towns but could have negative environmental impacts. To mitigate these impacts, and increase the benefit of the projects, infrastructure projects could be combined with:

- environmental options that could mitigate the impacts of the infrastructure on native fish species and environmental assets, such as wetlands and estuaries
- demand management measures to make sure industries are operating as efficiently as possible, and
- policy and regulatory options that review whether the water sharing arrangements under altered conditions are appropriate.

However, combining some of the options might mean that other options cannot be pursued. At present, we do not have enough information to understand the trade-offs between options or combinations of options that are described in Table 5.

115. *Regional Water Strategies Guide*, [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies/about)

As development of the strategy progresses, preferred options and combinations of options—and their trade-offs—will be informed by a range of evidence including modelling, expert judgement and community input. In particular, as discussed in section 1.3.1, the NSW Government has invested in new modelling to gain a more accurate understanding of future climatic conditions in the Far North Coast region. This new data, along with economic analysis, will be used to understand the pros and cons of each option and the impact of various combinations of options in addressing the key challenges facing the region.

It is important to remember that the way we progress options will need to take account of the *Water Management Act 2000*.

Other important considerations when we arrive at short-listed options will include who owns and maintains infrastructure options, who benefits, what the impacts are, and how to pay for them—for example, should the cost be recovered from water users and what will the Commonwealth Government pay for and what will the NSW Government pay for?



## 3.4 Far North Coast: Long list of options

Table 5 summarises the long list of options we have identified for the Draft Far North Coast Regional Water Strategy. Detailed information about each option, the challenges it will address, its potential combination with other options and further work required to progress the option is set out in the *Far North Coast: Long list of options*.

The current long list of options focuses on:

- 1. maintaining and diversifying water supplies**
- 2. protecting and enhancing natural systems**
- 3. supporting water use and delivery efficiency and conservation**
- 4. strengthening community preparedness for climate extremes**

A number of options included in the current long list will also contribute towards our fifth focus area of **recognising Aboriginal people's water rights, interests and access to water**.

Concentrating on these five objectives will enable us to address the challenges facing the Far North Coast region, while maximising opportunities for regional communities and industries, and supporting their aspirations.

We have heard from communities that the regional water strategies should not just focus on the risks and challenges of today. This is why our current long list of options not only focuses on the issues identified in Chapter 2, but also includes a number of options that may become important in future decades.

These options need to be supported by comprehensive and robust data and information and the right tools and infrastructure to implement change in the future.

However, this means that some of our draft long list options are still in a conceptual state. We need to continuously work with communities, local councils, environmental managers, Aboriginal peak bodies, Aboriginal people and industries to develop and refine these ideas further.

As noted previously, the options included in Table 5 are not ordered or prioritised and many have not been costed.

### Regional water strategy: objectives



#### Deliver and manage water for local communities

Improve water security, water quality and flood management for regional towns and communities.



#### Enable economic prosperity

Improve water access reliability for regional industries.



#### Recognise and protect Aboriginal water rights, interests and access to water

Including Aboriginal heritage assets.



#### Protect and enhance the environment

Improve the health and integrity of environmental systems and assets, including by improving water quality.



#### Affordability

Identify least cost policy and infrastructure options.

**Table 5. Long list of options: summary**







Option	Description	Objective
<p><b>Maintaining and diversifying water supplies—Opportunities to improve town water security, maintain suitable water quality and support growth and jobs in the region</b></p>		
<p><b>1. Interconnection of independent water supplies in the region to the Rous County Council network</b></p>	<p>Connect select towns in Byron Shire, Ballina Shire, Lismore City and Richmond Valley local government areas into the regional Rous County Council network to increase their water security and resilience. Towns identified as potentially suitable for connection to the Rous County Council bulk water supply network are Casino, Kyogle, Mullumbimby and Nimbin/Channon.</p>	
<p><b>2. Interconnection of Rous County Council and Tweed Shire Council bulk water supplies</b></p>	<p>Connect the region's two major water supply systems. This improves system resilience by increasing and diversifying the water supplies available in both the Tweed and Rous systems. The most likely location for the connection is between Pottsville (Tweed) and Ocean Shores (Rous).</p>	
<p><b>3. Use Toonumbar Dam to augment town water supplies</b></p>	<p>Connect Toonumbar Dam to a town water supply to provide additional town water security for the region. A number of connection opportunities exist including pipelines from the dam wall to Casino water treatment plant and Rocky Creek Dam, or pipelines from the end of Eden Creek to Casino water treatment plant and Rocky Creek Dam.</p>	
<p><b>4. Connect the regional water system to the South East Queensland water grid</b></p>	<p>Construction of infrastructure and development of governance arrangements to facilitate two-way transfer of water between the Far North Coast region and South East Queensland. This could provide mutual water security benefits for the Far North Coast and South East Queensland communities.</p>	
<p><b>5. Vulnerability of surface water supplies to sea level rise</b></p>	<p>Identify and quantify the risks to the region's surface water supplies due to sea level rise. This option would build on hydrodynamic modelling completed under the <i>Marine Estate Management Strategy</i> to assess the risks of sea level rise on tidal pool and estuarine water users and local water utility water and sewerage infrastructure.</p>	 
<p><b>6. Remove impediments to water reuse projects</b></p>	<p>The Far North Coast region has not maximised use of recycled water, despite the amenability of the community and the enthusiasm of local water utilities to implement water reuse projects. There is an opportunity in the region to use recycled water as a valuable water resource. This option would review impediments to water reuse projects in the region. It may also include the development of options for reconfiguring cost or regulatory requirements and support for on-site reuse projects by industry.</p>	   
<p><b>7. Indirect potable reuse of purified recycled water</b></p>	<p>Indirect potable reuse involves discharging purified recycled water into an aquifer or upstream of an existing dam or another major water store. It is then extracted, treated and distributed using existing water supply infrastructure to meet the requirements of the <i>Australian Drinking Water Guidelines</i>. This option would investigate potential locations for new or expanded reuse schemes from sewage treatment plants, including at East and South Lismore, Alstonville, Ballina, Lennox Head, Casino, Byron Bay and Brunswick Heads.</p>	  



Option	Description	Objective
<b>8. Direct potable reuse of purified recycled water</b>	Investigate the injection of purified recycled water directly into the drinking water supply network. This option can leverage the existing water supply network (which covers many of the sewage treatment plants in the region) to distribute purified recycled water for drinking across the region. This option could include a pilot project to consult with communities, test and promote the adoption of purified recycled water and wastewater reuse options more broadly across the Far North Coast region.	
<b>9. Managed aquifer recharge investigations and policy</b>	Investigation of possible sites for temporary storage of highly treated wastewater, stormwater and river flows in aquifers to improve storage efficiencies. This option would involve developing a regulatory framework and supporting policy to enable the storage and recovery of this water. Stored water could be reused by towns, water users or provided to groundwater-dependent ecosystems.	 
<b>10. Decentralised desalination</b>	Desalination can be an attractive option for coastal regions as it offers a virtually unlimited, climate-independent source of water. This option would investigate small-scale desalination plants sited close to a water demand in the Far North Coast region. It is possible to site several of these plants across the region to supply local demands or to feed into the Rous County Council bulk supply network. Decentralised desalination plants can be scaled up as the water demand of a town or region grows or to respond to prolonged droughts or extreme events.	
<b>11. Regional desalination</b>	Investigate a regional desalination facility that would be able to supplement supply for the entire region, connected to the bulk water supply network. A site south of Pottsville has been identified as a potential location as it could service both the Rous and Tweed systems.	 
<b>12. Raise Clarrie Hall Dam level</b>	Augment the Tweed water supply system by raising Clarrie Hall Dam by 8.5 m to achieve an increase in dam storage capacity from 16 GL to 42.3 GL. Tweed Shire Council is currently preparing an Environmental Impact Statement for this project, due for public exhibition by March 2021.	 
<b>13. New dam on Byrill Creek</b>	Construction of a dam on Byrill Creek to augment Tweed Shire Council's water supply system. The proposed dam design would provide an additional 36 GL storage. Tweed Shire Council has placed a moratorium on pursuing any new Byrill Creek Dam for 20 years, from 2012.	 
<b>14. New Dunoon Dam on Rocky Creek</b>	Construction of a new dam at Dunoon to augment Rous County Council's water supply system. The proposed site is on Rocky Creek, downstream of the existing Rocky Creek Dam. Three different full-storage capacity options have been proposed: 20 GL, 50 GL and 85 GL. Rous County Council is currently proposing the 50 GL option in its <i>Future Water Project 2060</i> .	

Option	Description	Objective
<p><b>15. Increased harvestable rights</b></p>	<p>Increase the proportion of rainfall that can be captured as a harvestable right. A review of harvestable rights is currently underway and is considering the effects of increased harvestable rights and of allowing dams to be built on larger tributaries within NSW catchments that drain to the coast. It aims to determine if greater access to water for agricultural production could be allowed while ensuring enough water is available for downstream water users and the environment.</p> <p><b>Undertaking this review is an existing NSW Government commitment.</b></p>	
<p><b>16. Provide purified recycled wastewater for industry and rural users</b></p>	<p>Highly purified recycled wastewater from sewage treatment plants has the potential to be a reliable, safe and relatively climate-independent water source. This option would investigate and support the use of treated wastewater for industry and rural users to support industry growth and reduce pressure on town water supplies. Giving rural households access to purified recycled water may also act as a drought security measure. Potential locations for new or expanded reuse schemes from sewage treatment plants include East and South Lismore, Alstonville, Ballina, Lennox Head, Casino, Byron Bay and Brunswick Heads.</p>	
<p><b>17. Increased on-farm water storage</b></p>	<p>Consider and assess several on-farm water storage options. This option would assess the current levels of farm dam implementation and use, the hurdles to constructing on-farm storages, the value of on-farm storages to industry, the regional water security consequences of low on-farm storage uptake and the benefits and disadvantages of this option compared with other water storage options. This option may be linked to the review of harvestable rights.</p>	
<p><b>18. A grid of off-stream storages in the Far North Coast region</b></p>	<p>Construct the network infrastructure to connect farm dams in the Far North Coast region to help move water between users. Watercourses or pipes could be used to distribute water, effectively increasing the storage capacity of the region without construction of large-scale instream structures. The option would also require development of a policy to support the physical movement of water between users, as well as possible modification of water sharing plans.</p>	
<p><b>19. Raise Toonumbar Dam level</b></p>	<p>Raise Toonumbar Dam to increase storage capacity and encourage additional usage uptake. By increasing the size of the dam and associated water security, dam usage becomes more attractive to business and facilitates the introduction of new users to the regulated system (e.g. town water supplies). WaterNSW investigations indicate the optimum level increase to be 6 m.</p>	

Option	Description	Objective
<b>Protecting and enhancing natural systems</b> — <i>Opportunities to protect and enhance environmental outcomes and realise broader community benefits through a healthy environment</i>		
<b>20. Establish sustainable extraction limits for Far North Coast surface water and groundwater sources</b>	Investigate methods for defining sustainable levels of extraction based on ecological, economic, social and cultural water needs. This would include quantifying the sustainable extraction volumes for water sources in the Far North Coast. The option would also need to include consideration of amendments to water sharing plans to legally establish new limits on surface water and groundwater extraction that reflect sustainable levels. Should the review indicate that the sustainable extraction limit for a water source is greater than the current limit, a strategy would be developed for the controlled allocation of new water access licences.	
<b>21. Establish and/or increase environmental water releases from major storages in the Far North Coast</b>	Establish and/or increase environmental release requirements or environmental contingency allowances at major water storages such as Clarrie Hall Dam, Rocky Creek Dam, Toonumbar Dam and Bray Park Weir. Release requirements would be informed by an assessment of risks to the riverine ecosystems located downstream of the works, impacts on secure yield for towns and the ability to mitigate these risks by changing operating rules.	
<b>22. Convert low flow water access licences to high flow water access licences</b>	Many of the region's rivers and creeks are under hydrologic stress during low flow periods. This option would review the barriers to, and opportunities for, converting low flow class water access licences to high flow class water access licences in Far North Coast surface water sources. The option would also apply the high flow conversion policy to the water sharing plans of the Far North Coast if appropriate and amend existing policy settings to provide incentives for the conversion of licences within sustainable extraction limits.	
<b>23. Improve stormwater management</b>	This option will identify and investigate potential locations for precinct-scale schemes to harvest and reuse stormwater in urban developments. This involves harvesting, storing, treating and delivering stormwater for non-potable use such as the irrigation of local parks or fields.	
<b>24. Bringing back riverine and estuarine habitat and threatened species</b>	A 'Bringing Back Threatened Species' program to restore riparian and wetland habitats by protecting and enhancing priority areas using best practice management. This program would improve the condition, connectivity and resilience of habitat and landscape that has suffered a serious decline in quality and quantity due to land use activities since European settlement. The program would also build skills and share the knowledge of local landholders, community groups and Aboriginal people.	
<b>25. Fish-friendly water extraction</b>	Install screens on pumps to reduce the amount of fish being extracted at pump sites. Native fish can be inadvertently extracted by pumps. From there the fish are unable to return to the river system. The 'Screens for Streams' program will partner extractive water users with scientists and engineers to collaboratively reduce native fish mortality. This option will target high priority reaches or installations in the Far North Coast region.	

Option	Description	Objective
<b>26. Improve fish passage in the Far North Coast region</b>	Replace or remediate five high priority fish barriers in the Far North Coast region: Jabour Weir (Casino), Eden Creek, Goolmangar, Pioneer Crossing (Coopers Creek) and Eureka Road (Coopers Creek). Remediating these structures in accordance with the NSW Fish Passage Strategy will improve recruitment, distribution, growth and survivorship for native and threatened fish species. The outcome of fish passage remediation will be enhanced by work to secure adequate environmental flows.	
<b>27. Addressing cold water pollution</b>	Evaluate the degree of cold water pollution impacts from existing storages in the Far North Coast and work with asset owners to implement appropriate capital and operational responses to mitigate those impacts. Cold water pollution is caused by cold water being released into rivers from large dams during warmer months. This option is structured as a five-year partnership with a scoping-study in the first phase to assess the issue and identify suitable works and project partners.	
<b>28. Characterising coastal groundwater resources</b>	Invest in the characterisation of coastal groundwater resources in the Far North Coast region including the coastal sands, floodplain and upriver alluvials, volcanic rock aquifers (e.g. Alstonville Plateau), Clarence Moreton Basin and underlying basement rocks. The groundwater resources for these areas would be characterised through extensive field investigations and literature reviews, expansion of existing monitoring networks, metering of all forms of groundwater take, development of conceptual and numerical groundwater flow and transport models, and publishing of annual resource updates.	
<b>29. Protecting ecosystems that depend on coastal groundwater resources</b>	A critical but often overlooked element of the water cycle is groundwater and groundwater dependent ecosystems. Groundwater dependent ecosystems support a range of species and provide important ecosystem services such as habitats. They also have inherent environmental value. Under this option, a range of projects would be initiated to advance our knowledge and management of groundwater dependent ecosystems.	
<b>30. Northern Rivers Watershed Initiative</b>	The Northern Rivers Watershed Initiative is a catchment and estuary restoration program that has been specifically devised for the 'footprint' of the Northern Rivers Joint Organisation to address ecosystem health, water security and flood risk issues across the Tweed, Brunswick, Richmond and Evans River systems in an integrated way. Preliminary scoping of the scale of work needed to address this initiative indicates that a budget in the order of \$150 million over 10 to 15 years would be required to effect the necessary changes across the landscape.	
<b>31. River Recovery Program for the Far North Coast: a region-wide program of instream works, riparian vegetation and sediment control</b>	This option will consider the costs and benefits of a region-wide program to better manage catchment hydrology and erosion by providing landholders with financial assistance and technical expertise to implement river rehabilitation works. The program could include instream works (such as log jams, rock chutes, log weirs and rock revetment), establishing/rehabilitating riparian vegetation, reducing erosion and decreasing sediment loads in streams.	

Option	Description	Objective
<p><b>Supporting water use and delivery efficiency and water conservation</b>—<i>Opportunities to improve the efficiency of existing water delivery systems, increase productivity and address water security challenges through demand management options</i></p>		
<p><b>32. Improved data collection and information sharing</b></p>	<p>Improve data collection about the environment (particularly water quality and groundwater levels), industrial water use and town water use in the Far North Coast region. The Far North Coast region suffers from a paucity of water data, particularly regarding water quality in surface and groundwater systems, and groundwater levels. There is also a lack of data on fish communities in the region. This option would improve information and knowledge to inform future water planning and management decisions in the region.</p>	
<p><b>33. Active and effective water markets</b></p>	<p>Review the efficacy of the water markets (unregulated, regulated and groundwater) in the Far North Coast region, including identifying opportunities to improve water accessibility and security outcomes across the region.</p>	
<p><b>34. Regional demand management program</b></p>	<p>Investigate the coordination of a region-wide water conservation and demand management program that would include all local water utilities in the Far North Coast. The program could also include rural water users. This could bring consistency in approach and efficiencies in monitoring and implementation across the region and may delay and downsize future water sources required for the region.</p>	
<p><b>35. Regional network efficiency audit</b></p>	<p>Region-wide audit of water supply network infrastructure leakage. The audit will identify opportunities to reduce water losses through network leaks and minimise annual volumes of non-revenue water.</p>	
<p><b>Strengthening community preparedness for climate extremes</b>—<i>Opportunities to develop fit-for-purpose policies and regulation to protect town water security, strengthen community health and wellbeing and better manage risks</i></p>		
<p><b>36. Apply the NSW Extreme Events Policy to the Far North Coast region</b></p>	<p>Extend the NSW Extreme Events Policy from the Murray-Darling Basin to coastal regions to give local water utilities and other water users clarity and direction during periods of drought. The option would also establish a Critical Water Advisory Panel and develop an incident response guide for the Far North Coast region.</p>	
<p><b>37. Protecting coastal groundwater resources for town water supplies and rural water users</b></p>	<p>Coastal sands can be a ready source of groundwater during droughts for both town water supply and rural water users. This option would take a proactive approach to protecting these resources and ensuring adequate groundwater access and sustainable use during times of low surface water availability. Activities could include collecting more information and creating up-to-date maps, installing monitoring bores near towns at high risk, addressing policy gaps and considering the viability of a groundwater supply network that feeds into local water utility infrastructure during drought.</p>	

Option	Description	Objective
<b>38. Planning for climate change impacts on coastal groundwater resources</b>	<p>The shallow nature of coastal groundwater resources provides advantages for water access. However, it also means they are vulnerable to impacts from climate change and sea level rise. Possible impacts include reduced water availability for consumptive use and the environment due to reduced groundwater recharge, salination of aquifers by seawater intrusion and inundation, waterlogging, contamination and flooding. In this option, Department of Planning, Industry and Environment—Water would collaborate with Local Land Services, councils and universities to co-design and implement local-scale projects to better understand and manage these impacts.</p>	
<b>39. Planning for land use pressures on coastal groundwater resources</b>	<p>Coastal aquifers provide reliable water sources during droughts and produce good quality, high yielding groundwater. However, these aquifers are vulnerable to contamination and are coming under increasing pressure from growing coastal populations. This option would identify the key land use pressure challenges facing coastal groundwater resources in the Far North Coast region. It would also assess whether the current legislation is fit-for-purpose in addressing these challenges, identify gaps in current policy and regulation and make recommendations for regulatory reform. A strategic framework would be developed for the long-term sustainable management of coastal aquifers.</p>	

### Cultural options developed for inland regions

A number of options have been developed for the Gwydir, Lachlan and Macquarie regional water strategies to recognise and protect Aboriginal water rights, interests and access to water. These options are:

- River Ranger Program
- Securing flows for culturally significant and water-dependent sites
- Culturally-appropriate water knowledge program
- Water-dependent cultural practices and site identification project
- Shared benefit project (environment and cultural outcomes)
- Aboriginal cultural water access licence review

- Water portfolio project for Aboriginal communities
- Regional Aboriginal Water Advisory Committee
- Co-management investigation of Travelling Stock Reserves
- Regional Cultural Water Officer Employment Program.

Full descriptions of these options can be found in the Gwydir, Lachlan and Macquarie regional water strategies.<sup>116</sup> As the development of the regional water strategy for the Far North Coast continues, these options will be discussed with Aboriginal communities to assess their appropriateness for the region. Other region-specific cultural options will also be developed in partnership with local Aboriginal communities.

116. [www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies](http://www.industry.nsw.gov.au/water/plans-programs/regional-water-strategies)

## Chapter 4

# Where to from here?

**We have developed this draft strategy based on the new evidence base we have, the latest policies and programs for the region and feedback from government agencies, local councils and peak Aboriginal groups.**

**The outcomes, challenges, opportunities and options we have identified in this strategy will be tested, evaluated and refined based on your input.**

## 4.1 Finalising the strategy

Our next steps are to use the feedback you provide to analyse, screen and assess the long list of options, put together a portfolio of options to be progressed and develop a final strategy for release by the end of 2021. We will also be prioritising further engagement with Aboriginal communities to develop additional options for the final strategy.

We recognise that in getting to the final strategy there may be hard trade-offs, but the only way we can make the best decisions possible is to deal with issues proactively and

realistically. This will give us the most likely chance of long-term success.

The final Far North Coast Regional Water Strategy will include review processes to ensure the region has an effective strategy in place that remains relevant for future water management.

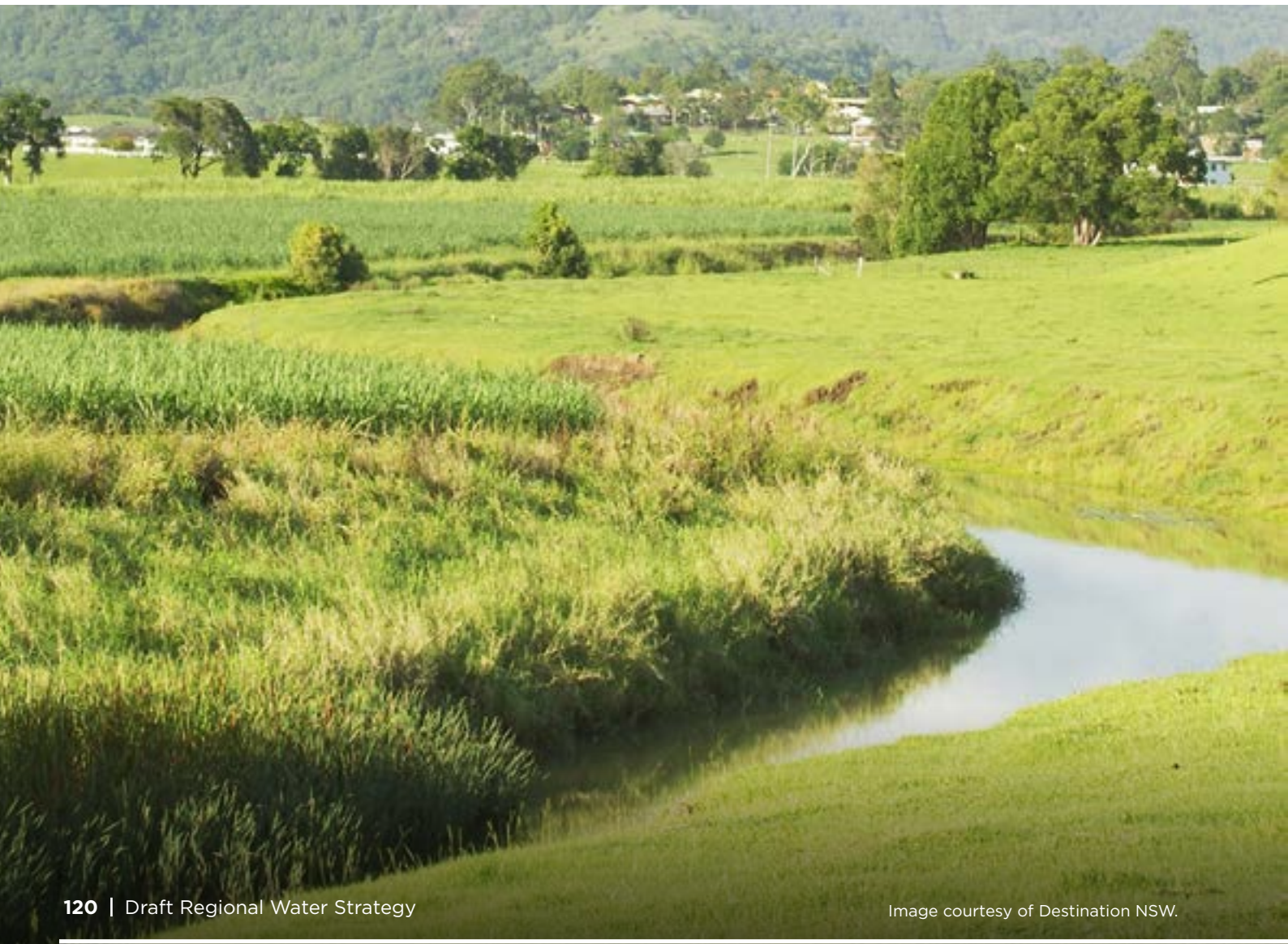
Following completion, each regional water strategy will be reviewed when the equivalent water sharing plans are reviewed.

## 4.2 Implementing the strategy

Community engagement does not end with consultation but is a vital part of implementation. The final Far North Coast Regional Water Strategy will map out our approach to implementation and include an implementation plan. This plan will set out how NSW Government agencies and other organisations with a role in NSW water management will deliver key actions and strategies for maximising water security and availability for all users and the environment. This implementation plan will be clear about timeframes and responsibilities for delivery.

We want to be clear about how we work with communities and regions to ensure:

- We are accountable for what we promise our regions.
- We have the right partnerships in place to drive forward action.
- We are transparent in how we go about those actions.
- We can check with those with on the ground and lived experience that the directions and actions we pursue continue to be the right ones for each region.



## Your voice is important

We have prepared this draft strategy to continue our discussions with you about the future management of water in your community. It has been prepared in consultation with local councils and Aboriginal communities.

We would like to hear your views on the draft strategy and whether you have any further information that could help us to assess the benefits or disadvantages of any of the options. This may include:

- how your household, business, industry or community currently manages the impacts of a highly variable climate
- the current and future challenges you see in the Far North Coast region and how you think these should be addressed
- how the management of water resources can be improved or leveraged to create and take up new opportunities in the region
- the options presented in this draft strategy
- how we can achieve our aims for accountability and transparency
- the best ways of partnering with communities and regions to implement the strategy.

Your views on the strategy's vision and objectives are also important.

This Draft Far North Coast Regional Water Strategy is on public exhibition from 30 October 2020 for a six-week period.

A range of supporting information is available at [www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy](http://www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy).

You can also have your say on the draft strategy by providing written feedback to the Department of Planning, Industry and Environment by midnight 13 December 2020 via:

**Web:** [www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy](http://www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy)

**Email:** [regionalwater.strategies@dpie.nsw.gov.au](mailto:regionalwater.strategies@dpie.nsw.gov.au)

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

We will be holding online sessions on the draft strategy during the public exhibition period to help shape the final strategy. These sessions will give participants an understanding of the context for the strategy, what the latest modelling is telling us and what the options for better managing water in the Far North Coast region could mean. Times and locations for these sessions can be found at [www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy](http://www.dpie.nsw.gov.au/far-north-coast-regional-water-strategy)

We will also continue to meet with local councils, local water utilities, Aboriginal communities and other stakeholders. Talking with these groups is critical for designing a strategy that builds on their knowledge and capacity, is feasible in terms of implementation and links to their relevant initiatives, plans and strategies.



# Attachments

## Attachment 1

# Targeted stakeholder engagement

## Overview

A thorough engagement program supports the development of the regional water strategies. The purpose of engagement is to inform, gain information and feedback, collaborate with key stakeholders on strategy development and build support for the regional water strategy.

Development of the Far North Coast Regional Water Strategy is supported by four engagement phases:

1. Targeted engagement with councils, local water utilities, joint organisations, Aboriginal people and peak bodies
2. Public exhibition of the draft regional water strategy and targeted engagement with State and regional peak bodies
3. Further targeted engagement with councils, local water utilities and joint organisations in each region, as well as Aboriginal people and peak bodies
4. Public release of final regional water strategy.

An interagency panel was formed to assist in the development of the Draft Far North Coast Regional Water Strategy. This panel, chaired by the Department of Planning, Industry and Environment—Water, included representatives from across the Department of Planning, Industry and Environment cluster including Environment, Energy and Science, Office of Local Government and Strategy and Reform.

Members of the panel also included representatives from the Department of Regional NSW, including Local Land Services, and the Fisheries and Agriculture sections of the Department of Primary Industries. WaterNSW was also represented.

The department also held a workshop with key regional stakeholders on 7 November 2018 to discuss risks and opportunities around water security for the region.

**This report documents targeted stakeholder feedback during engagement phase one of the development of the Draft Far North Coast Regional Water Strategy.**

## Engagement

Discussions were held with councils, local water utilities and Aboriginal communities on 7 November 2018 and between March 2020 and October 2020. The following organisations or communities participated in discussions.

Local council/local water utilities/ other organisations	Aboriginal community
Ballina Shire Council	NSW Aboriginal Land Council
Byron Shire Council	NSW Aboriginal Affairs
Kyogle Council	Bundjalung
Lismore City Council	Githabul/Githabal
Northern Rivers Joint Organisation	Widjabul
Richmond Valley Council	Wiradjuri
Rous County Council	Tweed/Byron Local Aboriginal Land Council
Tweed Shire Council	North Coast Local Aboriginal Land Council
Manly Hydraulics Lab	Minjungbal
Richmond Water Users	NSW Aboriginal Land Council North Coast
Toonumbar Water Users	

The purpose of discussions was to establish a collaborative relationship with local councils, local water utilities, joint organisations and Aboriginal communities, as well as to gain an understanding of key water challenges and risks in the Far North Coast region. Discussions also focused on gaining feedback on a draft long list of options for the Draft Far North Coast Regional Water Strategy.

Discussions with Aboriginal communities focused on cultural challenges, the development of cultural options and learning from Aboriginal people's knowledge of water in the region.

## Summary

### Quick stats and hot topics

A total of 25 meetings were held, with over 60 people attending and participating in discussions during the targeted engagement phase. Information about participants and a summary of recurring themes and hot topics are outlined below.

Targeted local council/local water utility/ joint organisation/ other organisation engagement	Targeted Aboriginal engagement
<b>Quick Stats</b>	<b>Quick Stats</b>
One key regional stakeholder workshop with local council and water user group representatives	8 targeted meetings
16 targeted council meetings including two meetings with the General Managers of the councils that are part of the joint organisation	20 people participated in discussions
Over 40 people participated in discussions	Over 175 ideas, opportunities, challenges and suggestions identified
Meetings held regionally face-to-face and by video conference	
Over 200 ideas, opportunities and challenges and suggestions identified	

Recurring themes	Recurring themes
Collaboration and an ongoing partnership approach between the Far North Coast Regional Water Strategy and councils	The importance of cultural heritage, including access to and protection of cultural sacred sites
Impact of predicted regional growth and climate change predictions on water security for the region in the future	The need for more information on cultural water licenses and the necessity to simplify the application process
A consistent and whole of government (local and regional) evidence-based approach to water policy, planning and regulation with good governance	Culturally appropriate engagement and partnerships are essential
Rural demand management	Water management and the importance for Aboriginal peoples' representation in decision-making processes
	Water quality concerns

Targeted local council/local water utility/ joint organisation/ other organisation engagement	Targeted Aboriginal engagement
<b>Hot topics</b>	<b>Hot topics</b>
Regional water strategies implementation plan and governance framework	Water quality issues at Tallow Creek
Impacts of reoccurring extreme events like drought and flooding on water supply and quality	Lack of awareness of cultural water access licenses and native title rights to water
Links and timeline discrepancies between the State Water Strategy, Far North Coast Regional Water Strategy, Rous <i>Future Water Project 2060</i> , integrated water cycle management strategies and other local planning processes	Importance of accessing water for cultural and recreational purposes including fishing, swimming, teaching younger generations and reconnecting as a community
Lack of funding sources for implementation of options—discrepancies between writing and delivering the strategy	Understanding why cultural water access licenses cannot be traded while commercial licenses can
Gaps in collaboration and coordination of catchment management	Cultural values around Dunoon Dam
Rural demand management and interconnection of independent water supplies	
Toonumbar Dam augmentation option and Byrill Creek Dam option	

## Detailed feedback

The following two tables summarise the feedback from round one and round two of the targeted engagement phases.

Topic	Comment
<b>Collaboration and engagement</b>	<p>Attendees value ongoing consultation. They were appreciative of ongoing engagement and are keen to be involved through the development of the Far North Coast Regional Water Strategy.</p> <p>Attendees expressed concern regarding the lack of coordination for catchment management and suggested that one of the gaps is the governance around councils' collaboration. Attendees:</p> <ul style="list-style-type: none"> <li>• suggested a better alignment between state, regional and local plans, and better collaboration to do so</li> <li>• stressed the need for ongoing engagement.</li> </ul>
<b>Regional water strategy development</b>	<p>Attendees expressed support for the Regional Water Strategy Program but raised concerns about alignment between the program and other plans and timelines.</p> <ul style="list-style-type: none"> <li>• It was indicated there are timeline and communication discrepancies between the State Water Strategy, Far North Coast Regional Water Strategy, the water sharing plan reviews, the Rous <i>Future Water Project 2060</i>, the integrated water cycle management strategies and other local planning processes.</li> <li>• A framework for governance was suggested to enhance cooperation between councils. This strategic governance is required to give Far North Coast councils the certainty to progress with proposed longer-term options as a collective, without there being delays to the short- and medium-term solutions.</li> <li>• Attendees stated that community education is required to explain the roles and responsibilities of local (councils) and State Government.</li> </ul> <p>Inconsistency in modelling approach</p> <ul style="list-style-type: none"> <li>• Councils stressed the importance of a framework for the modelling methodology. In the ideal situation, the same data could be used across the region.</li> <li>• Concerns were expressed around the costs for councils to create their own models and that support from the State Government would be appreciated.</li> </ul> <p>Water management doesn't stop at the border</p> <ul style="list-style-type: none"> <li>• Attendees raised the importance of cross-border data sharing with Queensland. It was explained that modelling has been done that shows there are benefits for both NSW and Queensland by working together—potentially resulting in substantial water security, stormwater management, environmental flow and costs benefits.</li> <li>• It was suggested that connecting to the South East Queensland water grid may be an option for drought security if the correct intergovernmental arrangements are implemented and if the interconnection of the Gold Coast and Tweed water supplies (and potentially Rous County Council water supplies) forms part of the long-term planning.</li> </ul> <p>Implementation</p> <ul style="list-style-type: none"> <li>• Attendees expressed the need for a capacity gap review as part of the regional water strategy. There was concern for a potential gap between writing and delivering regional water strategy. There could be a problem integrating across scales and regions. Concerns with implementation focused around funding and the ability to find operators for certain infrastructure.</li> </ul>

Topic	Comment
<b>Regional growth and demand management</b>	<p>Attendees stressed the importance of meeting long-term needs, especially given strong population growth predictions.</p> <ul style="list-style-type: none"> <li>• Attendees stated that new triggers for population growth need to be considered in demand planning, such as M1 highway and COVID-19 developments.</li> <li>• Around 30% of water access licences in the region are held by local water utilities for town water supply. Demand is predicted to exceed supply in the coming 10 to 15 years. This will make it harder to manage severe droughts in the future. Attendees referred to the <i>Regional Demand Management Plan</i> developed by councils to improve water conservation across the region.</li> <li>• It was stressed that councils work together as much as possible but can't necessarily do the same thing. Demand for residential uses cannot be decreased much further. It was therefore recommended to target commercial and industrial demand management.</li> <li>• Attendees mentioned that most of the residential growth is currently in the coastal fringe areas, but that residential growth isn't the only consideration. Industrial and agricultural growth need to be considered.</li> <li>• It was noted that new industries are arising with new water needs looking to secure water access licences.</li> </ul>
<b>Impact of climate change predictions on water security</b>	<p>Attendees stressed the importance of the impacts of re-occurring extreme events like drought and flooding on water supply and quality.</p> <p>Flood mitigation</p> <ul style="list-style-type: none"> <li>• It was indicated that there is a need for catchment-based floodplain management modelling where risk and disaster management are done on a state level rather than local. This would ensure coordination and the availability of funding.</li> <li>• The following were suggested by attendees regarding flood mitigation funding: <ul style="list-style-type: none"> <li>- the main challenge is the funding framework/guidelines and the lack of a consistent approach to flood management</li> <li>- this lack of funding and therefore proper flood modelling is hindering land use planning, rezoning planning and development planning</li> <li>- the department should look at the Northern Rivers Watershed Initiative as it adopts a holistic approach to water management, including water quality, flood reduction, water flow, etc.</li> <li>- there is a disparity between amounts spent by the State Government on post-flood recovery when compared with amounts spent on flood mitigation. It would be good to see recommendations in the regional water strategy to do this work—for example, natural sequencing farming that reduces soil erosion or levees</li> <li>- it was suggested there be an increase in funding towards flood management infrastructure instead of only reviewing the grant framework.</li> </ul> </li> <li>• More research should be done on the potential growth in flooding events and the impact of population growth. Understanding of future flood risks might affect land use choices.</li> <li>• It was suggested to have more focus on flood mitigation, not response. On top of that, it is also hard to meet the after-flood funding rules around betterment—'you can't put something in 'better' than it was before'. There needs to be an improved process around this.</li> <li>• Concern around existing dams and dam proposals that have been investigated and that have negligible flood mitigation. There is no capacity at all for existing dams to mitigate floods in the area.</li> </ul>

Topic	Comment
<p><b>Impact of climate change predictions on water security (continued)</b></p>	<p>Drought impact and water supply</p> <ul style="list-style-type: none"> <li>• It was raised that drought management plans haven't considered demand from rural areas up until now. There is an agreement now to revise the regional drought management plan to include learnings from the recent drought. Some of the concerns mentioned were: <ul style="list-style-type: none"> <li>- high dependence of rural area's on town water supply</li> <li>- lack of storage capacity on rural properties, with a heavy reliance on historical regular rainfall</li> <li>- poor design/location of on-property storage can make it difficult to provide support/ water-carting</li> <li>- additional releases needed from dams for rural landholders that placed substantial strain on the water supply.</li> </ul> </li> <li>• It was stressed that the focus needs to shift from reaction to pro-action—and readiness for drought. The strategy needs to include drought management options such as: <ul style="list-style-type: none"> <li>- extending rainwater tank rebates to landholders outside of towns funded by the State Government</li> <li>- extending extreme events policy to coastal areas</li> <li>- a regional drought plan</li> <li>- alternative town water supplies including groundwater options and independent rural supplies besides rainwater</li> <li>- consistent approaches to water restrictions</li> <li>- inter supply system transfers during drought should be possible.</li> </ul> </li> <li>• Attendees raised a concern around profiteering/misuse by water carters during the drought. There is a need for and benefit of an overview of services local governments can provide in these instances.</li> <li>• Compliance and enforcement of water sharing plan rules needs to be monitored during drought conditions.</li> <li>• Attendees raised a number of issues regarding water security for the towns of Nimbin and Mullumbimby during drought.</li> </ul>

Topic	Comment
<b>Comments on other draft options</b>	<p>Groundwater options</p> <ul style="list-style-type: none"> <li>Concern was raised around the impacts of the bottled water industry on groundwater sources. It was suggested the recommendations of the NSW Chief Scientist and Engineer's report should be embedded in the strategy.</li> <li>Groundwater was mentioned as an alternative water source to surface water options. However, it was stated there are issues with embargoes on issuing new water access licences to some use of groundwater sources. Attendees supported investigating options to allow local water utilities to make use of these sources during critical drought times.</li> <li>Attendees expressed concern regarding on-site septic management (septic tanks) infiltration issues into groundwater sources and suggested this be considered in the regional water strategy.</li> </ul> <p>Reuse of wastewater and storm water</p> <ul style="list-style-type: none"> <li>Attendees indicated that re-use affordability is one of the main concerns (e.g. local government stormwater charges).</li> <li>It was also stated that regulatory impediments are preventing the uptake of reuse as guidelines now require maximum treatment levels with no ability for practical trade-offs between treatment levels and intended reuse.</li> <li>A whole of government approach is needed, so the constraints can be overcome and environmental benefits can be realised. The importance of effluent/stormwater for river flows was stressed. In extreme drought, effluent water is one of the only things that keeps the river going; during wet times the effluent/stormwater is useless.</li> <li>Attendees also mentioned that community opinions are a driver, but are changing. People are starting to be more receptive to these options. However, there is a lack of industry capability to operate reuse water treatment plants.</li> </ul> <p>Desalination options</p> <ul style="list-style-type: none"> <li>It was indicated that these options need to be considered as a long-term strategy after significant steps are taken to address short-term water security needs. It was stressed, however, that operational and cost issues are associated with these options.</li> </ul> <p>Smart metering</p> <ul style="list-style-type: none"> <li>Councils are investigating implementation of smart metering as an option to influence water consumption and drive water use efficiency.</li> </ul> <p>Toonumbar Dam</p> <ul style="list-style-type: none"> <li>It was indicated that the dam needs to be raised to be of use for environmental water flows or town water supply.</li> <li>It was stressed there might be a conflict of uses between irrigation and town water supply if the dam is raised or is used to augment town water supplies.</li> <li>It was mentioned that changing industries/land use will need to be taken into account when considering this option.</li> </ul> <p>Improved data collection and information sharing</p> <ul style="list-style-type: none"> <li>Support was shown for a monitoring program for bores and standardised data loggers and formats were suggested. However, it was raised that there are issues around financial feasibility as the monitoring of bores is very expensive.</li> </ul>

Topic	Comment
<b>Comments on other draft options (continued)</b>	<p>Cold water pollution</p> <ul style="list-style-type: none"> <li>It was mentioned that cold water pollution is an insignificant issue in Emigrant Creek Dam (due to topographical features, such as Killen Falls). However, if the Dunoon Dam was constructed, cold water pollution would need to be considered.</li> </ul> <p>Byrill Creek Dam</p> <ul style="list-style-type: none"> <li>Attendees were divided about the suitability of this option. It was noted that Tweed Shire Council has placed a moratorium on not pursuing any new Byrill Creek Dam for 20 years, from 2012.</li> <li>It was stressed that this option could be highly contentious, due to the potential impacts on environmental and cultural assets.</li> </ul> <p>New Dunoon Dam on Rocky Creek</p> <ul style="list-style-type: none"> <li>The importance of the new Dunoon Dam for water supply for the region was stressed. It was noted that Lismore City Council and Rous County Council have both asked this option to be added to the State Government agenda in letters to Minister Pavey.</li> </ul> <p>Aquifer recharge</p> <ul style="list-style-type: none"> <li>It was noted that aquifer recharge can be a good alternative as a storage in times of rain to stop relying on surface water as much.</li> </ul> <p>Improve fish passage</p> <ul style="list-style-type: none"> <li>It was stressed that the main issue with upgrading the fishways is securing the funding. The impacts on town water supplies must also be considered.</li> </ul> <p>Natural sequence farming pilot study</p> <ul style="list-style-type: none"> <li>Support for this option was mentioned, with comments that it would be very beneficial in many areas and farming practices.</li> </ul> <p>Water quality issues</p> <p>Two main concerns were raised concerning water quality:</p> <ul style="list-style-type: none"> <li>blue-green algae events in storages in both dry and wet periods—for example, at Bray Park Weir. Potential risks to water supply need to be considered</li> <li>saltwater intrusion and potential contamination of the water supply.</li> </ul>

## Aboriginal engagement

Topic	Comment
<p><b>Cultural heritage and the protection of Aboriginal sacred sites</b></p>	<p>Attendees expressed the importance of being able to access and protect cultural and sacred sites through the comments below.</p> <ul style="list-style-type: none"> <li>• Water sustains life and underpins all flora and fauna.</li> <li>• Water is vital to the cultural needs of the community, which include fishing, swimming and bringing the community together. Aboriginal people need continual access to water Country for survival.</li> <li>• Water defines cultural boundaries.</li> <li>• More information is needed on infrastructure construction approvals, such as dams, particularly when they impact on a cultural site.</li> <li>• Specifically, attendees referred to a sacred site in Woodenbong, where a newly constructed farm dam has blocked flows to the site and the Fingal grave site, where sea water has washed over graves.</li> <li>• Ongoing consultation on the Dunoon Dam is needed to ensure protection of cultural heritage and sacred sites.</li> </ul>
<p><b>The need for more information on cultural water licenses and to simplify the application process</b></p>	<p>Attendees raised concerns that more information is needed around the types of water licenses available:</p> <ul style="list-style-type: none"> <li>• The application process is complicated and not culturally appropriate.</li> <li>• The application process needs to be fair and equitable. There is a social cost when the river doesn't flow—including antisocial behaviour and mental health issues.</li> <li>• Water management language is too complex and difficult to understand.</li> <li>• There is confusion over what role each government agency plays in water management, what costs are involved with cultural water access licenses and who is responsible for paying the fees. It was stated at one meeting that the community do not mind paying for water if the money is reinvested into the river.</li> <li>• It is not clear who the community needs to talk to about Native Title water rights.</li> <li>• There is frustration that commercial licenses can be traded but cultural licenses cannot.</li> </ul> <p>Attendees welcomed an opportunity for further meetings to address these knowledge gaps.</p>
<p><b>Culturally appropriate engagement and partnerships are essential</b></p>	<p>Attendees expressed the need for culturally appropriate engagement.</p> <ul style="list-style-type: none"> <li>• Some attendees expressed frustration regarding the lack of outcomes from previous engagement. Participants provided examples of existing water management plans that would help inform the regional water strategy including work undertaken with the values-interest-planning methodology.</li> <li>• It was expressed that it is important to have the right people in the community at the table who can speak on the community's behalf.</li> <li>• There was a strong desire for future engagement to be held on Country and to be driven by the local community, with anticipated dates for future engagement to be provided in advance where possible.</li> <li>• It was widely accepted that the engagement process needs to be ongoing and that appropriate consultation takes time. It was stressed that local networks should be used. The community wants to be trusted to organise themselves how they see fit.</li> <li>• Open and transparent communication is best.</li> </ul>

Topic	Comment
<b>Water management and the importance for Aboriginal people to be represented in decision-making processes</b>	<p>Attendees had concerns about how water is currently managed</p> <ul style="list-style-type: none"> <li>• It was stressed that Aboriginal people have looked after the rivers and creeks for generations and have always protected sacred sites. It is a part of their cultural responsibility to ensure that resources are available for future generations.</li> <li>• It was mentioned that the Aboriginal community needs to be represented at a decision-making level, not just a consultation level. It was suggested at several meetings that an Aboriginal decision-making committee for water be established to have a say on how cultural flows are managed for the benefit of the whole river system.</li> <li>• Concerns were raised about the continual pumping of water and depletion of aquifers particularly during drought. Attendees mentioned better management of water is needed during drought.</li> <li>• There was concern that the commercial use of water is being considered above nature and human life and that some license holders are extracting more than their allowance.</li> <li>• Attendees raised that Aboriginal people don't work in 'silos', like government departments do—rather, everything is connected. The community would like to see a holistic approach to water and land management.</li> <li>• It was raised that Aboriginal people should not have to pay for a water licence and that bag limit sizes shouldn't apply as they know how to take care of their lands.</li> <li>• It was mentioned that Aboriginal people shouldn't need to be part of an organisation like the Land Council or NSW Government committees to be able to have access to and use the waters or land.</li> </ul>
<b>Water quality concerns</b>	<p>Attendees expressed concerns regarding water quality in the region.</p> <ul style="list-style-type: none"> <li>• Dredging and salination issues at Fingal were highlighted.</li> <li>• It was also mentioned that leaching at Tallow Creek from the nearby sewage treatment plant has affected the community's ability to access quality water and fish in the creek.</li> <li>• Fish deaths at Tallow Creek and Belongil Creek were raised as a continual problem and that these events are extremely distressing for Aboriginal people to see. Aboriginal people would like their voices heard to help avoid future fish deaths.</li> <li>• Attendees said that bush tucker is being affected by the inferior quality of the water.</li> <li>• Cattle having access to creeks was also mentioned as a problem, as they can degrade the waterways.</li> <li>• It was raised that more funding is needed to restore the rivers and vegetation.</li> </ul>
<b>Opportunities</b>	<p>Attendees identified several opportunities for the region.</p> <ul style="list-style-type: none"> <li>• Use of aquaponics and to ensure sustainability.</li> <li>• More storage for flood water.</li> <li>• Business ventures such as fish farming, eco-tourism, food security and cultural tours on the water.</li> <li>• Further Aboriginal coastal body representation at a peak level.</li> <li>• Sea country and river rangers' programs to help manage and protect water ways.</li> </ul>

All feedback has been considered in developing the Far North Coast Regional Water Strategy and stakeholders will continue to be engaged

throughout the public exhibition process and the finalisation and implementation of the regional water strategies.

## Next steps

In response to the unfolding COVID-19 pandemic, the Department of Planning, Industry and Environment is redesigning its engagement program for the regional water strategies. The pandemic has changed the way we will engage with our stakeholders and communities, replacing some face-to-face consultation with virtual, online and contactless methods.

In a meeting on 25 March 2020 with Aboriginal peak bodies, the department was advised that face-to-face meetings are the only appropriate way of engaging with Aboriginal people. This meant that, due to COVID-19, face-to-face engagement with Aboriginal communities on the Far North Coast was delayed. Engagement recommenced in July 2020 and our discussions with local Aboriginal communities will continue throughout the strategy's development. The department is committed to engaging with the Aboriginal communities on the Far North Coast as appropriately as possible during COVID-19 to ensure the Aboriginal rights, interests and concerns related to water are heard and included in the final strategy.

The Draft Far North Coast Regional Water Strategy will go on public exhibition from 30 October 2020 for a six-week period. During this period, additional targeted and general public engagement will take place and written submissions will be accepted regarding the strategy. Following the review of the public exhibition period, further targeted engagement will be undertaken before the final regional water strategy documents are published.





## Attachment 2

# Glossary

Term	Definition
<b>Access licence</b>	<p>An access licence entitles its holder to take water from a water source in accordance with the licence conditions.</p> <p>Key elements of an access licence are defined in section 56(1) of the <i>NSW Water Management Act 2000</i> as:</p> <ul style="list-style-type: none"> <li>(a) <i>specified shares in the available water within a specified water management area or from a specified water source (the share component), and</i></li> <li>(b) <i>authorisation to take water:</i> <ul style="list-style-type: none"> <li>(i) <i>at specified times, at specified rates or in specified circumstances, or in any combination of these, and</i></li> <li>(ii) <i>in specified areas or from specified locations (the extraction component).</i></li> </ul> </li> </ul> <p>An access licence may also be referred to as a water access licence or a WAL.</p>
<b>Acid sulfate soils</b>	<p>Soils that are saturated with water and contain microscopic crystals of iron sulfide materials. Acid sulfate soils are harmless when undisturbed, if dug up or drained they come into contact with oxygen and the iron sulfide crystals oxidise. This turns them into sulfuric acid, which can cause damage to the environment and structures.</p>
<b>Allocation</b>	<p>The specific volume of water licence holders can access. The amount of water allocated to licence holders varies from year to year based on the type of licence, size of their individual entitlement, dam storage levels, river flows and catchment conditions.</p>
<b>Aquifer</b>	<p>Geological structure or formation, or landfill, that can hold water.</p>
<b>Basic landholder rights</b>	<p>Where landholders can take water without a water licence or approval under section 52, 53 and 55 of the <i>NSW Water Management Act 2000</i>.</p> <p>There are three types of basic landholder rights under the <i>NSW Water Management Act 2000</i>:</p> <ul style="list-style-type: none"> <li>• domestic and stock rights—where water can be taken for domestic consumption or stock watering if the landholder’s land has river frontage or is overlying an aquifer</li> <li>• harvestable rights—where landholders can store some water from rainfall runoff in dams</li> <li>• Native Title Rights—anyone with a native title right to water, determined under the <i>Commonwealth’s Native Title Act 1993</i>.</li> </ul>
<b>Blackwater event</b>	<p>An event that occurs when flooding washes organic material into waterways where it is decomposed by bacteria, releasing carbon, depleting oxygen levels and giving water a black or tea-coloured appearance. The sudden decrease in oxygen can result in the death of fish and other organisms.</p>
<b>Catchment</b>	<p>A natural drainage area, bounded by sloping ground, hills or mountains from which water flows to a low point. Flows within the catchment contribute to surface water sources as well as to groundwater sources.</p>
<b>Cease-to-pump rule</b>	<p>A requirement in water sharing plans that licence holders stop pumping when the river flow falls below a certain level.</p>

Term	Definition
<b>Climate-independent water source</b>	A source of water that does not depend on rainfall or streamflows for replenishment. Includes seawater desalination and recycled water.
<b>Climate variability</b>	Describes the way key climatic elements, such as temperature, rainfall, evaporation and humidity, depart from the average over time. Variability can be caused by natural or man-made processes.
<b>Cold water pollution</b>	An artificial decrease in the temperature of water in a river. It is usually caused by cold water being released into rivers from large dams during warmer months.
<b>Cultural flows</b>	While the NSW <i>Water Management Act 2000</i> does not define cultural flows, the Murray Lower Darling River Indigenous Nations Echuca Declaration, 2007, defines cultural flows as: 'water entitlements that are legally and beneficially owned by the Nations of a sufficient and adequate quantity and quality to improve the spiritual, cultural, natural, environmental, social and economic conditions of those Nations.'
<b>Effluent</b>	Flow leaving a place or process. Sewage effluent refers to the flow leaving a sewage treatment plant. An effluent stream is one that leaves the main river and does not return.
<b>End of system</b>	The last defined point in a catchment where water information can be measured and/or reported.
<b>Entitlement</b>	The exclusive share of the available water that a licence holder can take, subject to allocations.
<b>Environmental asset</b>	Natural features that contribute to the ecosystem of a region.
<b>Environmental water</b>	Water allocated to support environmental outcomes and other public benefits. Environmental water provisions recognise the environmental water requirements (planned environmental water) and are based on environmental, social and economic considerations, including existing user rights.
<b>Evapotranspiration</b>	The combined effect of evaporation and transpiration.
<b>Evaporation</b>	The process by which water or another liquid becomes a gas. Water from land areas, bodies of water and all other moist surfaces is absorbed into the atmosphere as a vapour.
<b>Extraction limit</b>	A limit on the long-term average volume of water that can be extracted from a source.
<b>Fish passage</b>	The free movement of fish up and down rivers and streams.
<b>Floodplain</b>	Flat land bordering a river or stream that is naturally subject to flooding and is made up of alluvium (sand, silt and clay) deposited during floods.
<b>General security licence</b>	A category of water access licence under the NSW <i>Water Management Act 2000</i> . This category of licence forms the bulk of the water access licence entitlement volume in NSW regulated rivers and is a low priority entitlement (i.e. receives water once essential and high security entitlements are met).
<b>Gross regional product</b>	A measure of the market value of all goods and services produced in a region within a period of time. Gross Regional Product is a similar measure to Gross State Product and Gross Domestic Product.

Term	Definition
<b>Gross value added</b>	A measure of the value of goods and services produced in an area, industry or sector of an economy. Gross value added is a similar measure to Gross Regional Product.
<b>Groundwater</b>	Water located beneath the ground in the spaces between sediments and in the fractures of rock formations.
<b>Groundwater-dependent ecosystem</b>	Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.
<b>Harvestable rights</b>	Harvestable rights provisions entitle landowners to build a dam or dams of a certain capacity in certain locations to capture a proportion of the rainfall runoff from their land. Landowners can do this without needing a water access licence, water supply work approval or a water use approval.
<b>High flows</b>	Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.
<b>High security licence</b>	A category of water access licenses in regulated rivers implemented under the NSW <i>Water Management Act 2000</i> . Receives a higher priority than general security licences but less priority than essential requirements in the available water determination process. Many high security licences are held by water users that have inflexible water demands, such as those growing permanent plantings and mining companies.
<b>Hydrologic stress</b>	Refers to the level of extraction in a river system. In NSW, 'high hydrologic stress' is defined as 70–100% average annual river flow extracted; and 'medium hydrologic stress' as 40–60% flow extracted.
<b>Indirect employment</b>	Jobs that are created by other businesses to support the primary employment sector.
<b>Inflows</b>	The amount of water coming into a surface water source or groundwater source.
<b>Intermittently closed and open lakes and lagoons</b>	Intermittently closed and open lakes and lagoons are coastal lakes and lagoons that alternate between being open or closed to the ocean. Intermittently closed and open lakes and lagoons are separated from the ocean by a sand beach barrier or berm that forms or breaks down depending on the movement and distribution of sand and sediment by waves, tides, floods and winds.
<b>Joint organisation</b>	An entity formed under the NSW <i>Local Government Act 1993</i> to perform three principal functions in a region: strategic planning and priority setting, intergovernmental collaboration and shared leadership and advocacy. Each joint organisation comprises at least three member councils and aligns with one of the State's strategic growth planning regions.
<b>Local water utilities</b>	Generally, these are council owned and operated utilities that provide water supply and sewerage services to local communities.
<b>Managed aquifer recharge</b>	Intentional recharge of water to aquifers for subsequent use or environmental benefit.
<b>Non-revenue water</b>	Water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).
<b>Operational rules</b>	The procedures for managing releases and extractions of water (surface and groundwater) to meet the rules of relevant legislation and policy (e.g. water sharing plans, long term water plans).

Term	Definition
<b>Paleoclimate data</b>	Refers to climate records prior to instrumental records. Various environmental indicators can be used to reconstruct paleoclimate variability extending back hundreds of thousands of years in time. These indicators include marine and terrestrial deposits, tree rings and ice cores.
<b>Permanent plantings</b>	Crops that are not replanted after a growing season. These crops generally require more than one growing season to be productive. Examples include grapes, citrus fruits and almond trees. These are different from annual (or broadacre) crops, which are harvested within 12 months of planting and require replanting to produce a new crop.
<b>Recharge</b>	Groundwater recharge is a hydrologic process where water drains downward from surface water to groundwater. Groundwater is recharged naturally by rain, floods and snow melt and to a smaller extent by drainage directly from surface water (such as rivers and lakes).
<b>Recycled water</b>	Water that has been treated to a 'fit for purpose' standard for a specific application as per the Australian Guidelines for Water Recycling.
<b>Regulated river</b>	A river system where flow is controlled via one or more major man-made structures (e.g. dams and weirs). For the purposes of the NSW <i>Water Management Act 2000</i> , a regulated river is one that is declared by the Minister to be a regulated river. Within a regulated river system, licence holders can order water which is released from the dam and then taken from the river under their water access licence.
<b>Resilience</b>	Resilient water resources as those that are able to withstand extreme events, such as drought and flood, and/or adapt and respond to changes caused by extreme events.
<b>Riffle habitats</b>	Riffles are short segments of shallow water in a river or stream created by the deposition of rocks and gravel, characterised by fast, turbulent water. The rocky bottom of riffle habitats provides shelter, food deposition and protection from predators.
<b>Riparian</b>	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
<b>Salinity</b>	The concentration of sodium chloride or other dissolved minerals in water.
<b>Stochastic climate datasets</b>	Stochastic climate datasets are extended climate sequences that are synthesised using statistical methods applied to observed data of rainfall and evapotranspiration and can include paleoclimatic data. These extended sequences include a more complete sample of climate variability, part of which describes more severe drought sequences.
<b>Storage</b>	A state-owned dam, weir or other structure which is used to regulated and manage river flows in the catchment. There are also a range of storages owned by local water utilities. Also refers to the water bodies impounded by these structures.
<b>Stormwater</b>	Flow generated from rainfall falling on hard (impervious) surfaces.
<b>Surface water</b>	All water that occurs naturally above ground including rivers, lakes, reservoirs, creeks, wetlands and estuaries.
<b>Synthetic datasets</b>	Data that is artificially created using algorithms and not obtained by direct measurement or generated by actual events.
<b>Transpiration</b>	The process where plants absorb water through their roots and then evaporate the water vapor through pores in their leaves.

Term	Definition
<b>Tributary</b>	A smaller river or stream that flows into a larger river or stream. Usually a number of smaller tributaries merge to form a river.
<b>Unregulated river</b>	<p>These are rivers or streams that are not fully controlled by releases from a dam or through the use of weirs and gated structures. However, in some catchments there are town water supply dams that control flows downstream.</p> <p>Water users on unregulated rivers are reliant on climatic conditions and rainfall.</p> <p>For the purpose of the NSW <i>Water Management Act 2000</i>, an unregulated river is one that has not been declared by the Minister to be a regulated river.</p>
<b>Wastewater</b>	<p>Water that is an output of or discharged from a particular activity; for example, from domestic, commercial, industrial or agricultural activities.</p> <p>The chemical composition of the wastewater (compared to the source) will be contaminated.</p>
<b>Water reliability</b>	Refers to how often an outcome is achieved. It is often considered to be the likelihood, in percentage of years, of receiving full water allocations by the end of a water year for a licence category. For example, a 60% reliability means that in 60% of years a licence holder can expect to receive 100% of their licensed entitlement by the end of the water year. Other measures of volumetric reliability could also be used; for example, the percentage allocation a licence holder could expect to receive at a particular time of the year as a long-term average. Reliability may also refer to how often an acceptable water quality is available. A reliable water supply gives some clarity to water users and helps them plan to meet their water needs.
<b>Water rights</b>	The legal right of a person to take water from a water source such as a river, stream or groundwater source.
<b>Water security</b>	Water security in the context of regional water strategies refers to the acceptable chance of not having town water supplies fail. This requires community and government to have a shared understanding of what is a 'fail event' (for example, no drinking water or unacceptable water quality) and the level of acceptability they will pay for.
<b>Water sharing plan</b>	A plan made under the NSW <i>Water Management Act 2000</i> which sets out the rules for sharing water between the environment and water users, and between different water users, within whole or part of a water management area or water source.
<b>Water source</b>	<p>Defined under the NSW <i>Water Management Act 2000</i> as 'The whole or any part of one or more rivers, lakes or estuaries, or one or more places where water occurs naturally on or below the surface of the ground and includes the coastal waters of the State.'</p> <p>Individual water sources are more specifically defined in water sharing plans.</p>
<b>Water trade</b>	The process of buying and selling water entitlements and water allocations.
<b>Water year</b>	The annual cycle associated with the natural progression of hydrological seasons: starting with soil moisture recharge and ending with maximum evaporation/transpiration. In NSW (as for all of the southern hemisphere), the water year runs from 1 July to 30 June.
<b>Wetland</b>	<p>Wetlands are areas of land where water covers the soil—all year or just at certain times of the year. They include swamps, marshes, billabongs, lakes, and lagoons.</p> <p>Wetlands may be natural or artificial and the water within a wetland may be static or flowing, fresh, brackish or saline.</p>





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