

2017 METROPOLITAN WATER PLAN

WATER FOR A LIVEABLE, GROWING AND RESILIENT
GREATER SYDNEY



2017 Metropolitan Water Plan
Water for a Liveable, Growing and Resilient Greater Sydney

First published March 2017

ISBN 978-1-76058-020-9 (print version)

ISBN 978-1-76058-021-6 (web version)

ISBN 978-1-76058-022-3 (USB version)

Author

Metropolitan Water

More Information

www.metrowater.nsw.gov.au

Acknowledgements

All photography by Adam Hollingworth © NSW Department of Primary Industries except

36: Gary Hamer © NSW DPI

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Foreword from the Premier



Sydney, the Blue Mountains and Illawarra (Greater Sydney) is home to about five million people. The region is continuing to grow as more and more people embrace the opportunities and diversity of lifestyles it offers. A secure and affordable water supply is essential for the continued success of our growing metropolis.

The 2017 Metropolitan Water Plan builds on previous versions of the plan and looks to a future where we increasingly value water in all aspects of urban life.

Higher average temperatures and more extreme weather events are telling us that our water supply system and our communities must be even more resilient to a changeable environment. The plan includes a mix of measures that are capable of meeting our water supply needs.

The 2017 plan also embraces broader objectives that contribute to the NSW Government's vision for an even more sustainable, liveable and productive Greater Sydney.

The 2017 plan uses an adaptive approach to meet projected growth for the next 10 or more years, and provides a pathway towards the community's vision for water in the region over the next 50 years. It will achieve this by:

- providing a secure and affordable water supply – varying how the system is managed and making best use of existing supplies
- investing in value-for-money water conservation projects
- responding flexibly to drought with a strategy that can cope with droughts more extreme than we have previously experienced
- integrating the delivery of water, wastewater and stormwater services under a new WaterSmart Cities program that will contribute to more liveable communities and healthy waterways
- releasing environmental flows from Warragamba Dam to help protect and improve the downstream health of the Hawkesbury-Nepean River.

We are all aware that water is a precious resource that needs to be managed responsibly. Current and future residents can be confident that the 2017 Metropolitan Water Plan is a robust, sound and flexible plan to manage the region's water supplies and support a more resilient and liveable Greater Sydney.



Gladys Berejiklian, MP
Premier of NSW

Message from the Minister



Water is a precious and finite resource, and ensuring that our communities have safe, secure and affordable water supplies is one of the most important responsibilities of government. I am pleased to present the 2017 Metropolitan Water Plan to explain how we are carrying out this responsibility.

The Metropolitan Water Plan is comprehensive, and shows careful and proper planning to balance water supply and demand in Greater Sydney. It brings together community members, experts, and government to plan for a future with secure drinking water supplies and more liveable neighbourhoods, green open space, and healthy waterways.

The Plan is a win on the cost of living, a win for communities in our growing city, and a win for our precious local environment.

Securing our water supply into the future is central to the Metropolitan Water Plan, and the news here is good. The plan includes strategies to secure water supplies for Greater Sydney for 10 or more years, even if we experience a drought more severe than the Millennium Drought of the

early 2000s. We also have the capacity to adjust our strategies so the current supply system can provide more water in the future, without the need for major new infrastructure.

The security of our current water supply system is due largely to more efficient water use by Greater Sydney's residents and businesses. During the Millennium Drought, water use decreased significantly, and has not returned to pre-drought levels in the years since the drought has broken. This is a glowing endorsement of the civic character of our community.

Thanks to the community, we can optimise the mix of supply and demand measures to save \$20 million per year on average compared to business as usual. We can also defer major capital investment in new infrastructure. All of this places downward pressure on water bills.

In addition to supplying water to our homes and businesses, our water supply system interacts with the environmental infrastructure which supports our economy and quality of life. We have precious natural areas around us, with intrinsic value beyond their utility. But we also know that a healthy environment inevitably benefits the health of our community. The Plan will deliver landmark river health initiatives to restore environmental flows to the Hawkesbury-Nepean, which will improve habitat, recreational opportunities in Western Sydney, and the sustainability of Sydney as a whole.

The 2017 Metropolitan Water Plan is an ambitious document that sets us on a path to a water future that addresses both the needs and aspirations of the communities that make up Greater Sydney.

Hon. Don Harwin, MLC
Minister for Resources
Minister for Energy and Utilities
Minister for Arts
Vice President of the Executive Council

Message from the Independent Water Advisory Panel

The Independent Water Advisory Panel commends the 2017 Metropolitan Water Plan to the community and all stakeholders.

The plan aims to ensure Greater Sydney's water supply system serves the community at least cost while also accommodating the longer term stresses of population growth and climate change; responding to shocks like drought; and promoting river health and urban liveability. This inevitably involves trade-offs.

Developing a plan that delivers these outcomes has relied on a combination of hydrological and economic modelling via the design and skilled operation of the MetroNet model referred to in the plan. Careful and sustained engagement by the planning team with relevant agencies and water utilities, and peer review by experts outside government where appropriate were also critical to the successful completion of the plan.

Importantly, through a range of social research and engagement activities, the plan was formulated in consultation with community members and industry stakeholders. Community expectation is strong that the Hawkesbury-Nepean will be a healthy and productive river downstream of the water supply dams – through improving fish communities, water quality, boating conditions and amenity. Under the 2017 plan, this is to be achieved by managing environmental flows (variable discharges from the dams, to mimic natural flow patterns), along with highly developed adaptive management and meaningful monitoring and interpretation.

The panel is pleased to see that this plan is opening the door to a broader range of recycling options, provided they are cost effective. A welcome initiative is the WaterSmart Cities program, a holistic approach to water planning in our new and expanding communities and the metropolitan landscape generally. Planning for water, sanitation, land use and flood management needs to be closely coupled. Sydney has the potential to be a world leader in embracing an innovative approach, in keeping with its position as a modern metropolis.

We are confident that the 2017 Metropolitan Water Plan will provide Greater Sydney with the blueprint for an affordable water system, having the security and resilience that it needs, as well as achieving associated societal goals. Congratulations on a job well done.

The members of the Independent Water Advisory Panel are Chris Davis (Chair); Ross Chapman; Dr Tony Church; Professor George Kuczera; Professor Cynthia Mitchell FTSE FIEAust and Dr William (Wej) Paradise.



Chris Davis
Chair of the Independent Water Advisory Panel

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The 2017 Metropolitan Water Plan

Our goal – securing water for a liveable, growing and resilient Greater Sydney

A secure and sustainable supply of water is essential for Sydney, the Illawarra and Blue Mountains (the Greater Sydney region) to grow and prosper. Reliable and affordable water is vital for our households, businesses and industries to thrive and remain economically competitive, nationally and internationally. Water supports our environment and the healthy, vibrant quality of life for which Greater Sydney is famous.

Water is a limited natural resource, and managing this for the benefit of our community presents challenges. The region's rapidly growing population and expectations for more liveable cities create new and increased demands for water.

Urbanisation has impacts on our local communities' water needs and waterways. A variable and changing climate means that we cannot know with certainty how much rainfall will support our water supply system in the future. All of this means additional pressure on our water supplies.

The 2017 Metropolitan Water Plan is the NSW Government's response to these challenges and pressures.

The plan's overarching goal is to secure water for a liveable, growing and resilient Greater Sydney. It establishes key strategies to be implemented over the life of the plan, and beyond that will set us on a pathway towards a water supply system to meet Greater Sydney's needs for the next 50 years.

Highlights of the plan include:

- **Optimising the way we manage the water supply system.** We have made changes to the mix of water supply and demand measures (such as dams, desalination, water restrictions) so our system can provide the water security we need at the least cost.
- **Investing in water conservation.** An innovative approach to determining the optimal level of investment, led by Sydney Water, means value-for-money initiatives will help save water.
- **Preparing for drought.** The plan includes a Drought Response Strategy that is flexible and can respond to droughts more extreme than any in the historical record.
- **Delivering WaterSmart Cities.** A new program to facilitate a more integrated approach to providing water, wastewater and stormwater services will contribute to making our communities more liveable and resilient.
- **Improving river health.** Variable environmental flows will be released from Warragamba Dam to help protect and improve the health of the Hawkesbury-Nepean River.

Implementing the plan means that:

- **Our water supply system can meet both current and medium-term demands.** Our projections show that with current programs and the settings in this plan, the system is capable of meeting our water supply needs over the next 10 or more years.
- **Greater Sydney does not need a major new source of supply at this time.** There is sufficient water to meet demand in the medium term, however we will continue to monitor water use and review options to meet the future water needs of Sydney's growing population.
- **We will maintain affordable water bills for households and businesses.** Optimising the mix of supply and demand measures will save \$20 million per year on average compared to business as usual.
- **We will move towards a more liveable and resilient region.** We will plan and develop innovative water solutions that address, in a holistic way, the water needs of our new and expanding communities.

The Metropolitan Water Plan secures water for the Greater Sydney region

The Metropolitan Water Plan is the NSW Government's plan to ensure sufficient water to meet the needs of the people and environment of the Greater Sydney region now and for the future.

The first Metropolitan Water Plan was developed in 2004. This plan included initiatives to reduce demand through recycling and water efficiency, increase supply from existing dams, and investigate desalination and groundwater for use as drought supplies. It also included a range of measures to improve river health downstream of Greater Sydney's water supply dams. In particular, it introduced variable environmental flows from major dams on the Hawkesbury-Nepean, Shoalhaven and Woronora rivers (with the exception of Warragamba Dam).

In response to deepening drought, an updated plan was released in 2006. It put in place a series of drought measures, including increased water recycling and water efficiency programs. With dam storage levels approaching 30 per cent in early 2007, the government triggered the construction of the Sydney Desalination Plant.

The 2010 plan was developed as part of this regular cycle of review and updating of the plan, taking into account new data, emerging trends

and developing technologies. This plan provided for a secure supply of water to 2025 from a combination of sources, including dams, recycling, desalination and water efficiency. The plan also included initiatives to help protect the health of rivers, and ensure there would be adequate water supplies during drought.

The 2017 plan presents the outcomes of the latest review of the plan. It is based on the findings from technical studies, modelling and economic analyses, independent reviews and social surveys. An extensive community and stakeholder engagement program helped inform the development of the strategies in the plan.

The 2017 plan is supported by a monitoring, evaluation, reporting and improvement strategy, which will guide implementation and ensure we can adapt to changing circumstances. An implementation guide summarising the strategies described in the plan, associated actions and timing for implementation can be found in Section 8.

The plan will continue to be reviewed on a regular basis so that it remains up to date and responsive to the challenges ahead.

A collaborative approach ensures the best possible outcomes for water management

A number of government agencies as well as public and private water utilities are responsible for different aspects of delivering water services to Greater Sydney. They also ensure that those services meet health and environmental standards, and water management is coordinated with other public planning and infrastructure programs. This means that extensive collaboration is required to deliver water services, both in day-to-day operations and through the strategic approach represented in this plan. The plan is the product of close partnerships among those agencies and utilities and extensive collaboration with community members and water planning experts outside government.

Metropolitan Water (Metro Water) within NSW Department of Primary Industries - Water led and coordinated metropolitan water planning for Greater Sydney. Metro Water convened the teams of technical experts and decision makers who developed the strategies of the plan, and led engagement with the community and stakeholders who helped inform key decisions in the planning process.

Numerous other government agencies contributed their environmental, public health, planning and public policy expertise, including:

NSW Office of Environment and Heritage, NSW Environment Protection Authority, NSW Health, Infrastructure NSW, Department of Planning and Environment, NSW Department of Premier and Cabinet, Public Works Advisory and NSW Treasury.

The plan rests on a foundation of detailed, technical operational and management knowledge provided by the major public water utilities that supply customers in Greater Sydney. WaterNSW manages the water supply dams and catchments, and Sydney Water provides drinking water, wastewater and some stormwater services throughout the Greater Sydney region.

The Sydney Desalination Plant Pty Ltd, which is responsible for the desalination plant at Kurnell, also provided information and advice to inform the development of the plan.

The Metropolitan Water Chief Executive Officers (CEOs) Committee, comprising representatives of government agencies and the major public water utilities, met regularly to provide guidance throughout the planning process. The CEOs developed a statement of intent that shaped the development of the plan and will guide its implementation.



A number of stakeholder workshops were held during the review of the Metropolitan Water Plan

Statement of intent for metropolitan water planning

- Water for the people of the Greater Sydney region will be secured by a portfolio of water supply and demand measures that is least cost to the community, meets agreed levels of service and takes into account community values and preferences.
- Risks to water security will be adaptively managed and Sydney's water supply will be secured in drought by making the most of our existing supplies and triggering measures and/or readiness strategies to respond to severe drought.
- Investment in water conservation will be undertaken where and when it is economically efficient, and government will ensure there is the capacity to manage demand during drought, rising water use and other water security risks.
- Future water supplies will be assured through a government review of augmentation options, taking into account the needs of the region's growing population, climate variability and climate change.
- The health of waterways impacted by water supply dams will be maintained and improved by implementing and adaptively managing environmental flow releases from dams, as well as coordinated action to ensure river health benefits are not eroded over time.
- The liveability and resilience of communities in the Greater Sydney region will be improved by managing water on a whole-of-water-cycle basis.
- Plans will be reviewed on a regular basis (typically every five years) and ongoing monitoring, evaluation and improvement processes will guide adaptive management.
- Community and stakeholder values, preferences and perspectives will be integrated into decision making throughout the plan implementation and review cycle.

The Independent Water Advisory Panel (IWAP), whose members have significant knowledge and experience in urban water planning, provided independent advice throughout the planning process. The panel is appointed by the Minister. It also advises on the review and implementation of the Lower Hunter Water Plan.

An extensive program of community engagement and social research underpins this plan. Metro Water engaged with a broad cross-section of the Greater Sydney community as well as stakeholders from local government, private water utilities, peak industry groups and non-government organisations. Engagement activities included community workshops, surveys and a 'futures forum' where the community developed a vision for Sydney's water future.





Excerpt from 'educated, informed, aware' artwork by Aleta Lederwasch. Community futures forum, December 2015

Community visions for the future

A one-day futures forum was held as part of developing the plan. We wanted to hear community members' views on what water use and management in Greater Sydney might look like in 50 years' time. Some of the visions put forward (using participants' own words) were:

1. A healthy, green, balanced environment: *'Sydney has attractive leafy green environments for recreation, relaxation, health and living that support a sense of community. All people in Sydney, no matter where they live, have access to, and enjoy, these environments. This is achieved through smart choices for urban planning with effective use of space that 'designs in' vegetation. Throughout Sydney, natural landscapes, healthy rivers, built environments, infrastructure, and good public transport are integrated. There is different development in different parts of the city, from skyscrapers to low-density residential. With growing population higher density living is needed in some areas. But with smart use of space and water systems, everyone is able to enjoy these areas'.*
2. The use of innovation, technology and data: *'The path to innovation and technology is driven by ground-level education. This education helps us to define our needs, and allows us to harness the technology to address these needs. Governments lead the way in the process, by providing incentives to develop and implement innovative water saving and other technologies. All in the community are involved in participating in implementation and are accountable for our sustainable future. Individuals, corporations and governments are harnessed to report data transparently in order to increase efficiency through technology. Intelligent computing is an example of future-driven technology, along with the decentralisation of water movement and storage'.*
3. To be educated, informed and aware: *'To use education, information and awareness to build connected communities that are committed to a shared vision for water in Greater Sydney'.*

Our plan is structured around four key outcomes

Our goal for the 2017 Metropolitan Water Plan – securing water for a liveable, growing and resilient Greater Sydney – is based on the statement of intent set out earlier in this section (page 4), and on input from the community and our stakeholders.

Figure 1, the Metropolitan Water Plan framework, shows the relationship between our goal, our desired outcomes and the strategies to achieve those outcomes, supported by a program of ongoing monitoring and adaptive management. The chapters of this plan are organised around the framework.

The outcomes that this plan will achieve are explained in more detail below. Collectively they will help us reach our goal; and, by using the strategies outlined in this plan, we will ensure that our Greater Sydney region has:

- a water supply that is secure and affordable
- a water supply system that is resilient to stresses and shocks
- more liveable and resilient urban communities
- rivers downstream from dams that are healthy.



2017 Metropolitan Water Plan framework

Goal	Outcome	Strategies
A liveable, growing and resilient Greater Sydney	Our water supply is secure and affordable	Making the best use of our existing supplies
		Investing in water conservation
		Investigating new water sources for long-term needs
	Our water supply system is resilient to stresses and shocks	A Drought Response Strategy with a broad suite of measures
		Identifying and mitigating risks to water security
		Planning for our variable climate and climate change
	Our urban communities are more liveable and resilient	Establishing the WaterSmart Cities program
		Investigating barriers and enablers to cost-effective water recycling
		Establishing partnerships and collaborative arrangements
	Rivers downstream from dams are healthy	Implementing variable environmental flows from Warragamba Dam
		Modifying Warragamba Dam to release the flows
		Protecting the benefits of environmental flows
		Monitoring and adaptive management of flows
Adaptive planning		

FIGURE 1: 2017 Metropolitan Water Plan framework showing the goal, outcomes and strategies of the plan

Outcome 1: Our water supply is secure and affordable

A secure water supply is essential for Greater Sydney's continued prosperity, and an affordable water supply is equally important to many households and businesses. To achieve a secure and affordable water supply, we will use our existing supplies more efficiently, invest in water conservation initiatives, and make sure there is sufficient water to meet Greater Sydney's long-term water needs.

The trigger levels for the supply and drought response measures (set as a percentage of total dam storages) have been revised to secure our water supply and enable it to be operated at least cost to the community. These supply and drought response measures are implemented in a planned sequence and deployed as dam water storage levels drop.

Currently, we use about 530 billion litres of water each year in Greater Sydney. This plan sets out a cost-effective mix of water supply and drought response measures and can also respond to severe drought conditions to meet demand for the next 10 years or more, taking account of projected population growth. If necessary, the existing system can be adjusted to supply up to 625 billion litres annually.

Water conservation also has a critical role to play in balancing supply and demand. Sydney Water will take the lead on water conservation through development of a Water Conservation Program, which will target investment in value-for-money leakage reduction, water efficiency and water recycling initiatives.

Options to meet future growth in demand have been identified in the plan, and will be further investigated in the next review period. All available options need to be considered so we can minimise costs and maximise the benefits of any new investment in water supplies. Depending on the rate of increase in water use in the region, it may be decades before a decision on new supply is required.

Outcome 2: Our water supply system is resilient to stresses and shocks

Resilience is the capacity of individuals, communities, institutions, businesses and systems within a region to survive, adapt, and grow – no matter what chronic stresses and severe shocks they experience. For our water supply system in Greater Sydney, resilience is particularly important because our highly variable climate means the system can be subject to severe drought stress that can last for years.

Greater Sydney's water supply system has been designed for resilience. In comparison to cities with more predictable rainfall, Sydney has large water storages that can cope (within limits) with extended drought periods. The system's resilience is enhanced by maintaining an adequate buffer between demand and supply, having access to a diversity of non-rain dependent water sources, including water from the Sydney Desalination Plant and over 70 recycled water schemes, as well as a robust strategy to respond to droughts.

The review identified a range of response options to help slow demand and supplement the region's water supplies during drought. Water restrictions remain an important element in our Drought Response Strategy and the introduction of water conservation measures as dam storage levels deplete will further help reduce demand for water.

A number of options could be implemented if severe drought conditions return to the region. These include the second stage of the existing Sydney Desalination Plant, using groundwater, using temporary desalination plants, building a new regional desalination plant, and using recycled water for drinking. At this stage recycled water is used for non-drinking purposes only, and its future uses will depend on community attitudes and acceptance.

As the timing of the next drought is unknown, more detailed studies on the available options will be undertaken when required. This approach will enable us to consider community preferences and improvements in technology when making decisions about the best way to respond to the next drought.

Outcome 3:

Our urban communities are more liveable and resilient

A liveable region not only meets the basic social, environmental and financial needs of its people, it also addresses community values and preferences for amenity, wellbeing and a sense of place. Water is a key factor in making a place liveable and communities resilient by meeting people's need for clean drinking water, underpinning economic growth, helping cool and green our cities and contributing to healthy waterways.

The plan presents a series of strategies that will support the move towards more liveable and resilient urban communities.

The new WaterSmart Cities program will explore opportunities to deliver drinking water, wastewater and stormwater services to new communities in a more integrated, cost-effective and sustainable way. By building integrated water solutions and cost-effective water recycling into new development areas, we can reduce future demand on drinking water supplies, help mitigate flooding risks, reduce pollutants entering our waterways, and defer or avoid the need for major new water infrastructure.

We will support the WaterSmart Cities program with an investigation into the barriers and enablers of investment in economically efficient recycling initiatives, and work to establish partnerships and collaborative arrangements between government and industry.

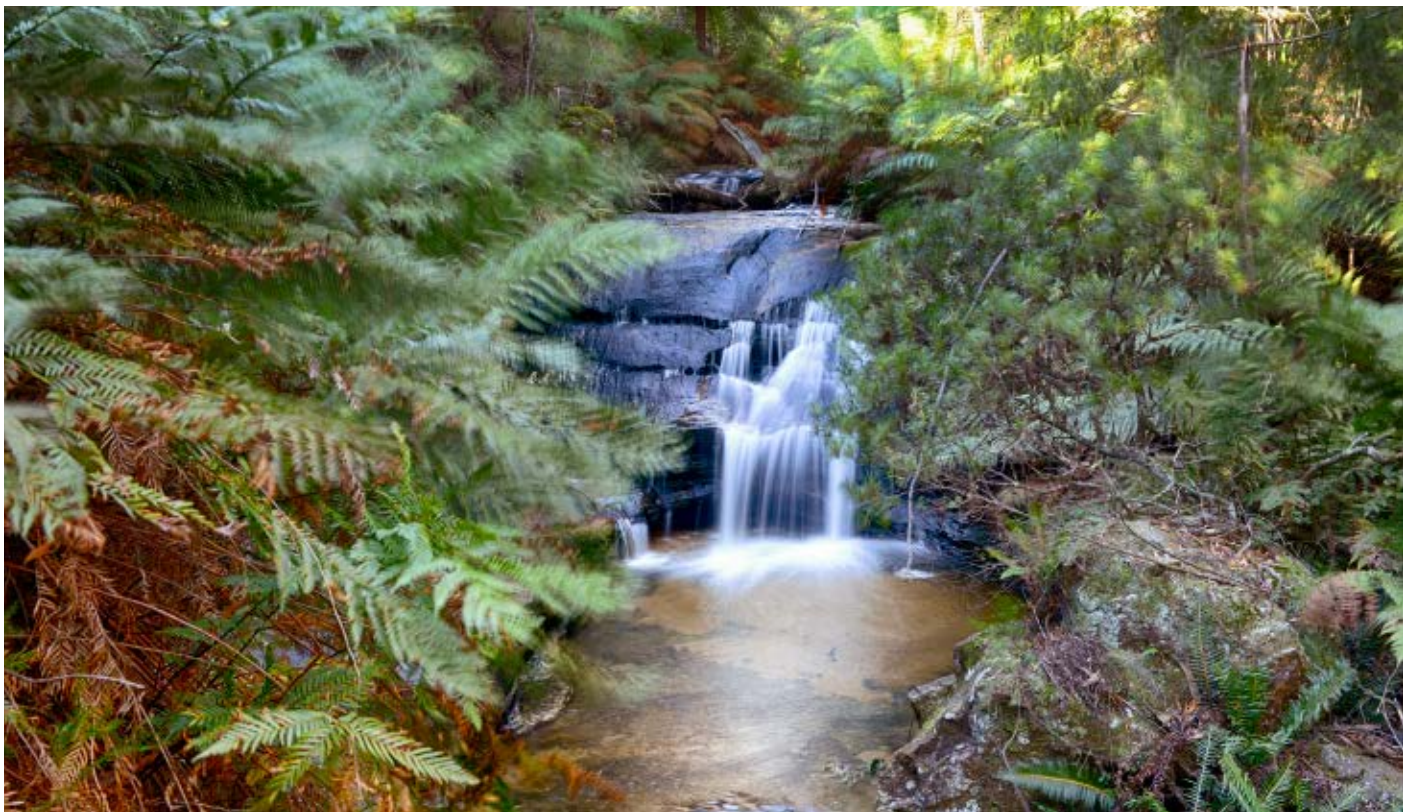
Outcome 4:

Rivers downstream from dams are healthy

The plan provides for the introduction of new variable environmental flows from Warragamba Dam to help protect and improve the health of the Hawkesbury-Nepean River. Implementing flows from Warragamba Dam is part of a program of work over more than a decade to improve the health of rivers impacted by dams in the Greater Sydney region.

The release of variable flows from Warragamba Dam will enhance the community's use of the river for boating, fishing, swimming, recreation, tourism and agriculture. Environmental flow releases will achieve this by reintroducing more natural flow conditions, improving water quality, reducing problems caused by excessive growth of floating aquatic weeds, and enhancing fish populations.

Warragamba Dam wall will need to be modified to release variable environmental flows. We are assessing the most appropriate option for the infrastructure to allow for the release of these flows. This is being coordinated with investigations into the raising of Warragamba Dam for flood mitigation purposes. It is expected that the new environmental flows will commence by 2024.





Greater Sydney's water supply system

Where does our water come from?

Most of the region's water is supplied from dams, which capture and store rainwater run-off from the catchment areas located above the storages. Greater Sydney's water storage capacity per person is one of the largest in the world among metropolitan areas of comparable size, and provides a buffer against the long periods of drought that are characteristic of Australia's climate.

The resilience of our water supply system is increased by having an interconnected network of dams so water can be drawn from where it is available and transferred to where it is needed most. When dam storage levels drop, supplies are supplemented by water from the Sydney Desalination Plant, which is a non-rainfall dependent water source. In addition, the use of recycled water and stormwater helps preserve our drinking water supplies.

This complex system is highly flexible and can be reconfigured during times of drought, high rainfall or during maintenance to enable the best quality water to be supplied to the community.

Water from dams and the Sydney Desalination Plant is treated to the high standards set by the Australian Drinking Water Guidelines, which means it is safe to drink straight from the tap¹. Water sourced from recycling projects is treated according to the Australian Guidelines for Water Recycling². This means that recycled water is safe for its intended use, for example watering gardens or flushing toilets.

Taken together, Greater Sydney's sources of water supply constitute a system that can meet current demand with water treated to high standards of safety, is resilient enough to cope with drought, and capable of being adapted to meet future needs.

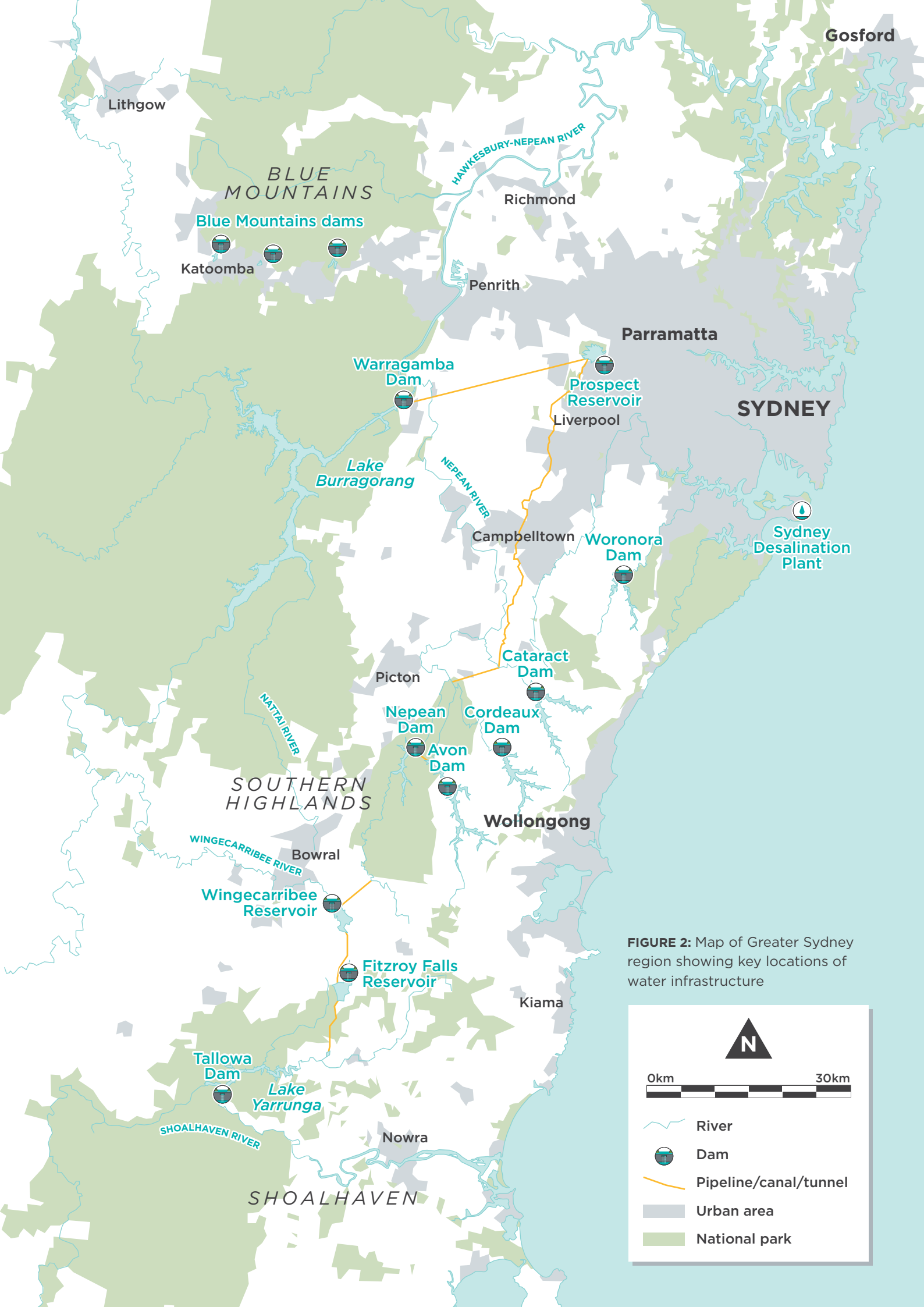


FIGURE 2: Map of Greater Sydney region showing key locations of water infrastructure

Dams are our major source of water

Greater Sydney's water supply catchment area covers 16,000 square kilometres to the west and south of Sydney, extending from Lithgow to Goulburn. It encompasses two major river systems, the Hawkesbury-Nepean and the Shoalhaven, as well as the Woronora River, and 11 major dams³.

- **Warragamba Dam** is by far our largest dam, supplying around 80 per cent of Greater Sydney's water. The dam receives flows from the Coxs and Wollondilly rivers, forming Lake Burragorang.
- **Nepean, Avon, Cordeaux and Cataract Dams** capture and store water from the Upper Nepean catchment. Water from these dams is transferred into the Sydney water supply system via the Upper Canal, a 64-kilometre long combination of open canals, tunnels and aqueducts.
- **Tallowa Dam** stores inflows from the Shoalhaven River, which can be transferred to Warragamba Dam via the Wingecarribee River or to Nepean Dam when needed to boost supplies to both Sydney and the Illawarra. The Shoalhaven system has operated since the 1970s and can provide a significant portion of supply when storage levels in the Warragamba and Upper Nepean dams are declining.
- **Woronora Dam** supplies water to communities in Sutherland Shire (in Sydney's south) and the northern suburbs of Wollongong.
- **The Blue Mountains system** sources water from within and outside the Blue Mountains catchments, a small group of bushland valleys that feed water to Lake Medlow, Greaves Creek and the three Cascade dams. When water levels are low, some water can also be transferred from the Fish River water supply scheme to top up supply for the Upper Blue Mountains community.

Megavolumes and gigavolumes

A water supply system that provides drinking water to nearly five million people deals in very large volumes. In the water industry, water storage capacity is usually measured in megalitres (ML) or gigalitres (GL).

- One megalitre is equivalent to one million litres.
- One gigalitre equals one billion litres or 1,000 million litres.

Within this plan, we use millions and billions of litres, as these terms are easier to understand and more commonly used.

Putting it in perspective

Even using everyday language, it can be hard to get an understanding of the vast quantities of water stored and delivered through Greater Sydney's water supply system. To address this, it is useful to relate large volumes to well-known bodies of water. For example:

- a standard olympic-sized swimming pool contains 2.5 million litres of water (2.5 ML)
- Sydney Harbour holds about 500 billion litres of water (500 GL).

The capacity of our largest water storages is sometimes expressed in numbers of Sydney Harbours. For example, Warragamba Dam is equivalent in storage capacity to approximately four Sydney Harbours.

Catchment management, water treatment and distribution systems are vital elements in our water supply system. They ensure the water captured and stored in dams is transported efficiently to households and businesses and is safe to drink. Management for water quality starts in the catchments, where WaterNSW employs a Healthy Catchment Strategy that provides the framework for reducing the risks to water quality, and is an important element in ensuring reliable, quality drinking water for the region. The areas around the region's water supply dams are also managed to protect the ecological integrity and natural and cultural values of these areas.

Water from the dams is treated at Sydney Water's nine water filtration plants and then supplied to almost five million people in Greater Sydney through a network of over 21,635 kilometres of water pipes, 242 reservoirs and 150 pumping stations.

Water is also released from the dams to help improve the health of the downstream river environments and support recreational, tourist and community activities. In 2009-10, variable environmental flows were introduced from major dams in the Greater Sydney region, except for Warragamba Dam (see Section 7).

Sydney Desalination Plant supports our water supply

The Sydney Desalination Plant is a key component of Sydney's water supply and helps guarantee water supply even in years of drought. It was constructed in response to the worst drought in 100 years, which saw Sydney's dam levels approach 30 per cent in early 2007.

Using reverse osmosis membrane technology, the plant turns seawater into fresh water. Once treated, the water is pumped from Kurnell into Sydney Water's drinking water network at Erskineville.

The plant can produce an average of 250 million litres per day of drinking water. This is equivalent to 17 per cent of Sydney's current water demand. It was designed so that its capacity could be doubled if required to meet future needs⁴.

The plant began supplying drinking water for Sydney in January 2010. Following a return to high dam levels, however, it went offline on

1 July 2012. Currently in Water Security Mode, the plant is not producing drinking water but it will be ready to return to full production when needed.

Demand management plays a critical role in securing our water supply

Demand management includes water conservation and water restrictions in drought. Water conservation refers to water recycling, leakage management and programs to enhance water efficiency. Water recycling refers to both harvesting stormwater for beneficial use and reusing wastewater.

Water conservation

Water conservation, including recycling water, makes the drinking water supply go further. Increasing water conservation efforts may be cheaper than building new large scale supply options and can delay the timing of investment in new supply infrastructure. It allows us to reduce total demand so we can respond to drought conditions or rising demand.

Water recycling

Water recycling involves treating and reusing wastewater, greywater and stormwater for use in and outside the home, in industry, for irrigation and agriculture. Recycled water is used in Greater Sydney to water gardens, golf courses and parks, flush toilets, wash cars and fight fires. It is also used for some industrial purposes and to supplement river flow in the Hawkesbury-Nepean River. Use of recycled water helps preserve water stored in dams for drinking, reduces the impact of stormwater run-off on our waterways, and helps cool and green our urban environments.

In 2010, the use of recycled water saved about 33 billion litres of water a year that might otherwise have come from our drinking water supplies. Stormwater and wastewater reuse schemes completed over the past five years have increased our recycled water capacity to 63 billion litres per year.

Recycled water projects across Sydney

Recycled water projects can help protect river health and provide water for industrial and commercial use, for non-drinking uses in houses and to green parks, gardens and buildings. Across Greater Sydney these include:

- St Marys Advanced Water Treatment Plant, which provides highly treated recycled water to the Hawkesbury-Nepean River at Penrith to help protect the health of the river
- Wollongong Recycled Water Plant, supplying water for industrial use and to water sporting fields
- Australia's largest dual-pipe residential recycling scheme at Rouse Hill, which supplies recycled water to homes for toilet flushing and watering gardens
- the Rosehill-Camellia Recycling Scheme, supplying recycled water to major industrial and commercial users
- around 70 local scale stormwater reuse projects in the Greater Sydney area, helping reduce demand on our water supplies by providing water for parks, gardens, golf courses and sporting fields.

Details of recycled water projects in Greater Sydney can be found at:

<https://www.metrowater.nsw.gov.au/recycling/map>⁵



Sydney Park stormwater harvesting, providing unrestricted irrigation of playing fields, passive recreation areas and forested areas in a high-density inner city area.

Who provides our water services?

Storing, treating and distributing water from the catchments to your tap, as well as managing disposal of stormwater and wastewater, requires specialised skills and technical knowledge including strategic water planning, catchment management, infrastructure planning and management, and customer services. In Greater Sydney, these functions are managed in a coordinated approach by NSW Government agencies and public and private water utilities and service providers.

- **Metro Water** leads and coordinates metropolitan water planning for Greater Sydney.
- **WaterNSW** manages the dams that collect rainwater run-off from river catchments to the south and west of Sydney. The water is stored and transported via a network of rivers, pipes and canals to Sydney Water. WaterNSW is also responsible for protecting the health of Greater Sydney's drinking water catchments, and developing infrastructure options for water supply security and reliability.
- **Sydney Water** operates nine water filtration plants that treat the raw water provided by WaterNSW. Sydney Water takes the treated drinking water and distributes it to customers. Its area of operation covers 12,700 square kilometres and stretches from Palm Beach in the north, to Kiama in the south and to the Blue Mountains in the west. Sydney Water also collects and treats wastewater, provides recycled water services to some areas and manages some major stormwater infrastructure.
- **The Sydney Desalination Plant** supplements water supplies from the dams when needed and enhances water security for all water customers in Greater Sydney.
- **Local councils** manage most stormwater infrastructure across Greater Sydney. Some councils harvest and treat stormwater for use on their parks and ovals.
- **Private water utilities** licensed under the *Water Industry Competition Act 2006* (the WIC Act) provide water services to a number of communities in Greater Sydney, often using alternative servicing solutions that include recycled water. The NSW Government introduced the WIC Act to foster diversity, growth and innovation in the water industry.
- **The Independent Pricing and Regulatory Tribunal (IPART)** reviews and determines the maximum prices that can be charged for bulk and retail water by the major water utilities including WaterNSW, Sydney Water and the Sydney Desalination Plant Pty Ltd. IPART administers the licensing of private water utilities in NSW. It also reviews public utilities' operating licences and monitors the utilities' compliance with their licences⁶.



Warragamba Dam is Sydney's major water supply dam, providing around 80 per cent of the region's supply.

How much water do we use?

Water use in Greater Sydney has declined from relatively high levels in the 1990s. As can be seen in Figure 3, per capita demand has been declining since 2002 and our current total demand is approximately 100 billion litres per year lower than it was 25 years ago, despite a significant increase in population. Water use in 2015-16 was 530 billion litres.

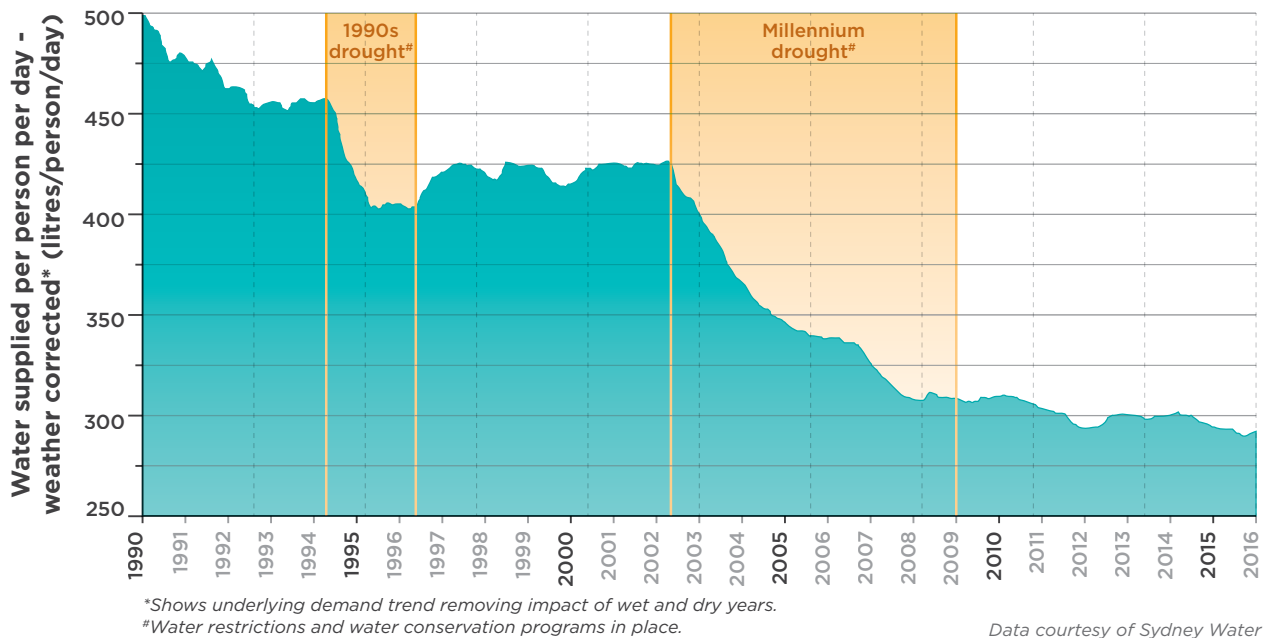


FIGURE 3: Historical water use in Greater Sydney

During the Millennium drought of the early 2000s, water use decreased significantly due to restrictions on water use and successful water conservation and efficiency campaigns. Water use has not returned to pre-drought levels due to a combination of factors including:

- ongoing water saving behaviours by the community
- increasingly efficient water using appliances supported by the Water Efficiency Labelling and Standards (WELS) Scheme
- ongoing programs that save water such as mandatory minimum water saving standards for housing (BASIX), and Water Wise Rules, which are simple, common sense actions about the way we use water outside our homes
- less water being used by industry with a transition to a more technological and service driven economy.

Trigger nozzles for outdoor watering is a Water Wise Rule and plays an important role in saving water around the home.



Water Efficiency Labelling and Standards Scheme⁷

The Water Efficiency Labelling and Standards Scheme (WELS) requires certain products to be registered and labelled with their water efficiency and given a star rating in accordance with the national *Water Efficiency Labelling and Standards Act 2005*.

The scheme also introduces minimum water efficiency standards for various water-using products including toilets.

The WELS Scheme is a joint initiative of the Australian, state and territory governments. In Greater Sydney, by 2021, it is estimated that using water efficient products will:

- save more than 20,100 million litres each year
- reduce total greenhouse gas output by 84,000 tonnes each year from less hot water use – equivalent to taking 19,000 cars off the road each year.

Over one-third of the water savings will come from more efficient showers, one-third from washing machines and 23 per cent from toilets. By choosing to use more water-efficient products in the home, customers will save water and reduce their water and energy bills.

Building Sustainability Index⁸

The Building Sustainability Index (BASIX) aims to deliver equitable, effective water and greenhouse gas reductions across the state by improving new homes when they are built. BASIX is one of the strongest sustainable planning measures undertaken in Australia.

An integrated part of the planning system, BASIX applies to all residential dwelling types and is part of the development application process in NSW.

Environmental outcomes under BASIX provide long-term financial savings for the homeowner – and are a valuable contribution to the sustainable future of our communities.

Water Wise Rules⁹

Water Wise Rules are simple, common sense actions about the way we use water outside. This includes watering your garden, looking after your pool and cleaning.

Water Wise Rules apply all the time and to everyone in Sydney, the Blue Mountains and the Illawarra. This includes both residents and businesses.

Water Wise Rules include actions such as:

- watering your garden with hoses fitted with a trigger nozzle, sprinklers or irrigation systems any day before 10 am and after 4 pm
- using a bucket or watering can to water lawns and gardens at any time
- using a bucket, watering can or a hose fitted with a trigger nozzle to wash vehicles
- using water from your rainwater tank, as long as it is not connected to, or topped up with, drinking water.

Challenges in securing water for Greater Sydney

The population of Greater Sydney is growing at a rapid rate. We are becoming an increasingly urbanised and densely settled region. We have a highly variable climate, with prolonged and severe droughts followed by periods of high rainfall. Despite significant analysis there is a high degree of uncertainty about the impacts of climate change on our water supplies and future demand for water. The plan responds to these uncertainties and challenges by adopting a leading practice, adaptive approach to securing water for the people and environment of Greater Sydney. Table 1 outlines the challenges we face and how the plan will address them.

TABLE 1: Challenges to water security

What are the challenges?		Putting it in context	Going forward
Increasing demand for water will place pressure on our water supplies	The population of Greater Sydney is expected to grow by more than two million people over the next 20 years, placing significant pressure on our water supply system.	<p>The key drivers of demand for drinking water are household water use, dwelling type, appliance efficiency and population.</p> <p>Forecasting water demand is a challenge because one of the key uncertainties is whether households will continue with water-saving habits that were formed during the last drought.</p>	<p>With a prediction of rapid population growth in Greater Sydney and significant uncertainty around forecasts of per capita water use, we need ongoing monitoring of demand and flexible strategies so we can respond quickly if needed.</p> <p>Strategies to address this challenge are found in Section 4, Our water supply is secure and affordable, and include investing in water conservation and investigating new water sources for long-term needs.</p>

What are the challenges?		Putting it in context	Going forward
Increasing urbanisation is impacting the liveability of our communities	<p>Increasing density of urban living across many areas of the region can increase demand for water and impact waterway health</p>	<p>Water is needed to meet the community's expectations for more liveable urban communities, particularly for watering public open spaces for passive and active recreation and to improve neighbourhood amenity.</p> <p>Increasing urbanisation puts pressure on our waterways with more pollution run-off from urban centres.</p>	<p>Making the best use of local water resources through recycling wastewater and harvesting stormwater reduces pressure on our drinking water supplies and enhances local environments. Harvesting stormwater can also reduce the impact of flooding and urban run-off on local waterways.</p> <p>Strategies to address these challenges are found in Section 6 – Our urban communities are more liveable and resilient and includes establishing the WaterSmart Cities program.</p>
Managing our variable climate and the impacts of climate change	<p>A key challenge is to manage the uncertainty associated with our highly variable climate and the impacts of future climate change.</p> <p>Our climate is characterised by periods dominated by hot and dry weather that may last for years, followed by wetter periods.</p> <p>The climate of NSW is changing. Future temperature increases and changes in patterns of rainfall are likely to place additional pressure on the region's water resources.</p>	<p>Historical rainfall and run-off data has been recorded for over a century but this period is unlikely to give us a good indication of the future variability in climate.</p> <p>The NSW Government has worked with the ACT Government and the Climate Change Research Centre at the University of NSW to provide local-scale projections of future changes in temperature, rainfall and other climate variables for NSW and the ACT.</p> <p>These local-scale projections will help build resilience in the face of future extreme events and hazards by helping to understand the impacts of climate change in the Greater Sydney region.</p>	<p>We need to ensure there is capacity in our supply system to manage extreme droughts and continue to build our knowledge on climate variability and climate change.</p> <p>The plan provides strategies so our water supply system is resilient to stresses and shocks (see Section 5), in particular the Drought Response Strategy and planning for our variable climate and climate change. This aligns with the NSW Climate Change Policy Framework's¹⁰ aim of helping NSW become more resilient to a changing climate.</p>

What are the challenges?		Putting it in context	Going forward
Protecting the health of rivers impacted by dams	<p>Warragamba Dam on a tributary of the Hawkesbury-Nepean River supplies about 80 per cent of Sydney's water. The presence of the dam has had an impact on the health of the river by greatly reducing the amount of water that flows to the downstream environment.</p> <p>Due to its important role in Sydney's water supply, studies were needed to assess the value of environmental flows from Warragamba Dam and to ensure a balance was achieved between the drinking water needs of Greater Sydney and the health of the Hawkesbury-Nepean River.</p>	<p>Environmental flows – water released from dams to improve downstream river health – were introduced in 2009-10 from all of Sydney's major supply dams, except Warragamba Dam.</p> <p>Elevated nutrient levels and reduced river flows are the two major factors that contribute to excessive aquatic weed growth and toxic algal blooms, which in turn reduce recreational and commercial uses of the river and affect aquatic life. Increased urbanisation is putting further pressure on the water quality of a river that is already under stress.</p>	<p>Introducing variable environmental flows from Warragamba Dam will complement a range of initiatives undertaken over the past decade to improve the health of the Hawkesbury-Nepean River.</p> <p>See Section 7, Rivers downstream from dams are healthy, which includes the strategies on implementing variable environmental flows, protecting the benefits of environmental flows and monitoring and adaptive management.</p>
Providing cost-effective and sustainable water infrastructure to support growth	<p>The water sector has had only a limited influence on decisions that affect the shape and density of cities.</p> <p>Most commonly, these decisions have considered the delivery of water infrastructure and services late in the planning process, or services have been provided on an incremental basis as cities expand¹¹.</p>	<p>Split responsibilities between state and local government for water, wastewater and stormwater servicing in Greater Sydney, and the misalignment of land use and water planning, hinder an integrated and whole-of-government approach to water infrastructure servicing decisions.</p> <p>Building integrated water solutions and cost-effective water recycling into new developments can reduce future demand on drinking water supplies and defer or avoid the need for major new water and wastewater infrastructure.</p>	<p>The projected housing growth in Greater Sydney provides a significant opportunity to make efficient and effective infrastructure investment decisions for the long term.</p> <p>Strategies to address this challenge are found in Section 6, Our urban communities are more liveable and resilient, including establishing the WaterSmart Cities program, and establishing partnerships and collaborative arrangements particularly with the Greater Sydney Commission as it moves forward with reviewing and finalising the regional strategy and district plans for Greater Sydney.</p>

What are the challenges?		Putting it in context	Going forward
Keeping the costs of water services affordable	<p>Maintaining ageing infrastructure and servicing growth areas will require considerable investment in the future.</p> <p>Risks to water security can be viewed narrowly, with only expensive new supplies considered as solutions.</p>	<p>Without all water supply and conservation options being considered in water planning, and the supply system optimised for least cost to the community, the most effective and affordable water security solutions can be missed.</p>	<p>We must manage our water supplies to use water wisely and minimise costs while maintaining secure supply over the long term to meet population growth.</p> <p>Strategies to address this challenge are found in Section 4, Our water supply is secure and affordable, in particular the strategies that deal with making the best use of our existing supplies and investing in water conservation.</p>



Outcome 1: Our water supply is secure and affordable

Goal	Outcome	Strategies
A liveable, growing and resilient Greater Sydney	Our water supply is secure and affordable	Making the best use of our existing supplies
		Investing in water conservation
		Investigating new water sources for long-term needs

A secure supply of water is essential for the Greater Sydney region to continue to grow and prosper. It underpins the city's quality of life, and is an important element in making the region a great place to live and work. A secure water supply safeguards the region's competitiveness both internationally and domestically, and supports the economic growth needed to maintain it as the largest contributor to Australia's gross domestic product.

By using a cost-effective mix of water supply and demand management measures, we will ensure that water remains affordable and there is sufficient water to meet our needs, both now and over the long term.

While the majority of the region's water comes from capturing rainwater and storing it in dams, we also access other water sources as the water levels in our dams reduce. These include transfers from Tallowa Dam on the Shoalhaven River (Shoalhaven Transfers), and water from the Sydney Desalination Plant at Kurnell. The operation of these measures is activated by trigger levels, which are set as percentages of the total dam storage capacity.

In times of drought we impose water restrictions, limiting how and when water can be used. If drought conditions persist, worse than any in the historical record, our water security will be maintained by building new sources of water supply. These drought-response measures are also activated by trigger levels set as a percentage of dam storage levels.

Together, this mix of measures and triggers form our water supply and drought response portfolio.



Our review showed the water supply system can be run more cost effectively

We have reviewed and updated the settings and assumptions underpinning the 2010 plan, and identified and assessed potential new measures.

Using a sophisticated hydro-economic model, MetroNet, we identified the most cost-effective portfolios to meet our water supply and drought response needs, both now and in the future. The final selection took into account the identified risks to the supply system, as well as community values and preferences around water supply and drought response.

Our review showed the water supply system can be run more cost effectively by adjusting the trigger levels and measures within the water supply and drought response portfolio.

The review found that continuing strategies to improve the water efficiency of installed appliances and plumbing products and new residential developments remained effective. These are the Australian Government's Water Efficiency Labelling and Standards (WELS) and the NSW Government's Building Sustainability Index (BASIX) schemes.

However, a new approach to investing in water conservation was warranted for Greater Sydney

that linked investment in water conservation to when it was needed to manage droughts or rising demand.

At this time, a decision about the next major supply augmentation for Greater Sydney is not required. There is sufficient supply to meet demand over the next 10 years or more based on current demand forecasts, providing a buffer between available supply and forecast demand. Depending on the rate of increase in water use by households and businesses in the Greater Sydney region, it may be decades before a decision on new supply is required.

Given the level of uncertainty about future demand for water, a decision to build additional supply capacity at this time would not be prudent. As the plan is regularly reviewed, we will assess new supply options and make decisions based on the most robust up-to-date information when we need to make that choice.

However, it is important to put strategies in place that enable our water supply to remain secure, including ongoing monitoring of water usage as well as cost-effective and timely investment in water conservation and new sources of supply when needed.

The community supports water efficiency and recycling

The community's views and preferences were sought as an input to decision-making in relation to: potential savings from water restrictions; water conservation including recycling; the sequencing of supply and drought response measures in the portfolio; as well as acceptable trigger levels for particular measures.

Engagement findings consistently highlighted the importance of water efficiency and recycling to the community. This was particularly evident in the high ranking of values relating to efficient use of water; the apparent capacity to be more water efficient in and around the home; and the willingness to pay higher household bills to facilitate greater investment in value-for-money water conservation initiatives including recycling.

Community members were asked their preferences around the introduction of restrictions, with the majority indicating they would be satisfied with the implementation of Level 1 water restrictions at total storage levels of greater than 60 per cent, and Level 3 restrictions up to and including 45 per cent. These are higher than current restriction triggers under the 2010 plan.

Findings from the workshops also provided some insights around the introduction of a potential new supply option, with the majority of participants indicating that a trigger level of 40 to 50 per cent of dam storage levels 'sounded about right' when it came to starting construction for a new supply measure.

Our strategies were informed by review findings and community views

Strategies have been developed in light of the technical findings from the review and were informed by the community's views and preferences. The portfolio of supply and drought response measures meets the agreed levels of service for the water supply system.

Levels of service

Metropolitan water planning for Greater Sydney is undertaken in line with the National Urban Water Planning Principles adopted by the Council of Australian Governments (COAG) in 2008¹². These principles refer to the delivery of urban water supplies in accordance with agreed levels of service.

In Sydney's water supply planning context, the levels of service have remained the same since the first Metropolitan Water Plan. They are based on three criteria:

- **Security:** water storages do not approach emptiness more than 0.001 per cent of the time or once in 100,000 years. This level is designed to ensure that the system does not run out of water.
- **Robustness:** water restrictions occur no more often than one year in 10. This ensures that restrictions are not too frequent.
- **Reliability:** restrictions last no longer than 3 per cent of the time, meaning restrictions do not last for too long (even if restriction periods are infrequent)¹³.



Making the best use of our existing supplies

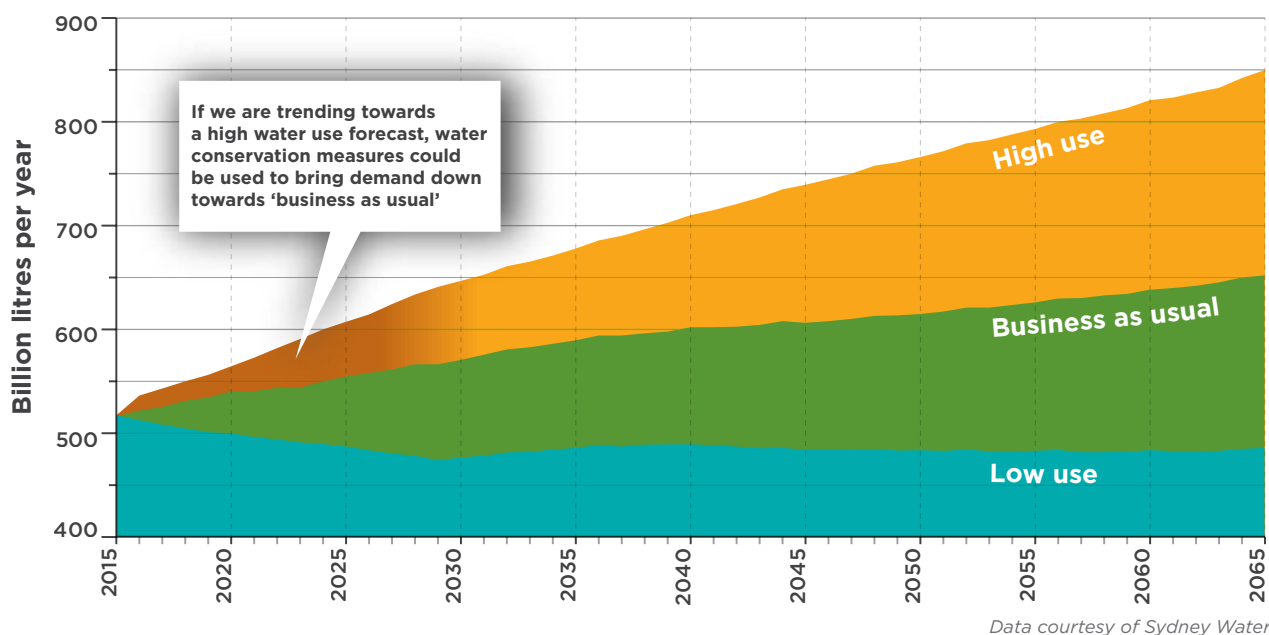


FIGURE 4: Forecast water demand (based on mid-population growth projection)

To keep costs down we have adjusted the mix of water supply and drought response measures used to secure water supply for the region, and changed the trigger levels for deploying these measures as dam levels drop.

The measures and triggers included in the plan will provide a secure water supply over the next 10 or more years while keeping the costs of supplying water to the Greater Sydney region to a minimum.

Actual water usage will be monitored against the forecast demand to see if we are on track, and the trigger levels will be reviewed and adjusted as necessary to maintain sufficient supply to meet future demand.

Demand forecasts for the next 50 years were prepared for developing the plan. These water use demand projections, as shown in Figure 4, define a potential range of water demand for Greater Sydney based on the Department of Planning and Environment's 2014 mid-population growth

projections, and considering three possible water use futures for Sydney – high, business as usual and low water use per person. The projections are based on current water use and possible future trends in the community's water using behaviours, appliance efficiency and demand for water by the non-residential sector.

Currently, around 70 per cent of all water supplied in Greater Sydney is used by residential households. The amount of water used by households is determined by:

- the water efficiency of household appliances such as toilets, showers and washing machines
- the amount of water from alternative sources used in the home e.g. from rainwater tanks, using grey water for gardens or water from established recycled water schemes
- type of dwelling (detached houses, townhouses or flats)
- people's water saving behaviour in their everyday lives.

Other drivers of demand are the number and type of non-residential customers, the amount of leakage from the water supply system, and the amount of water that is recycled for industrial, irrigation or agricultural purposes.

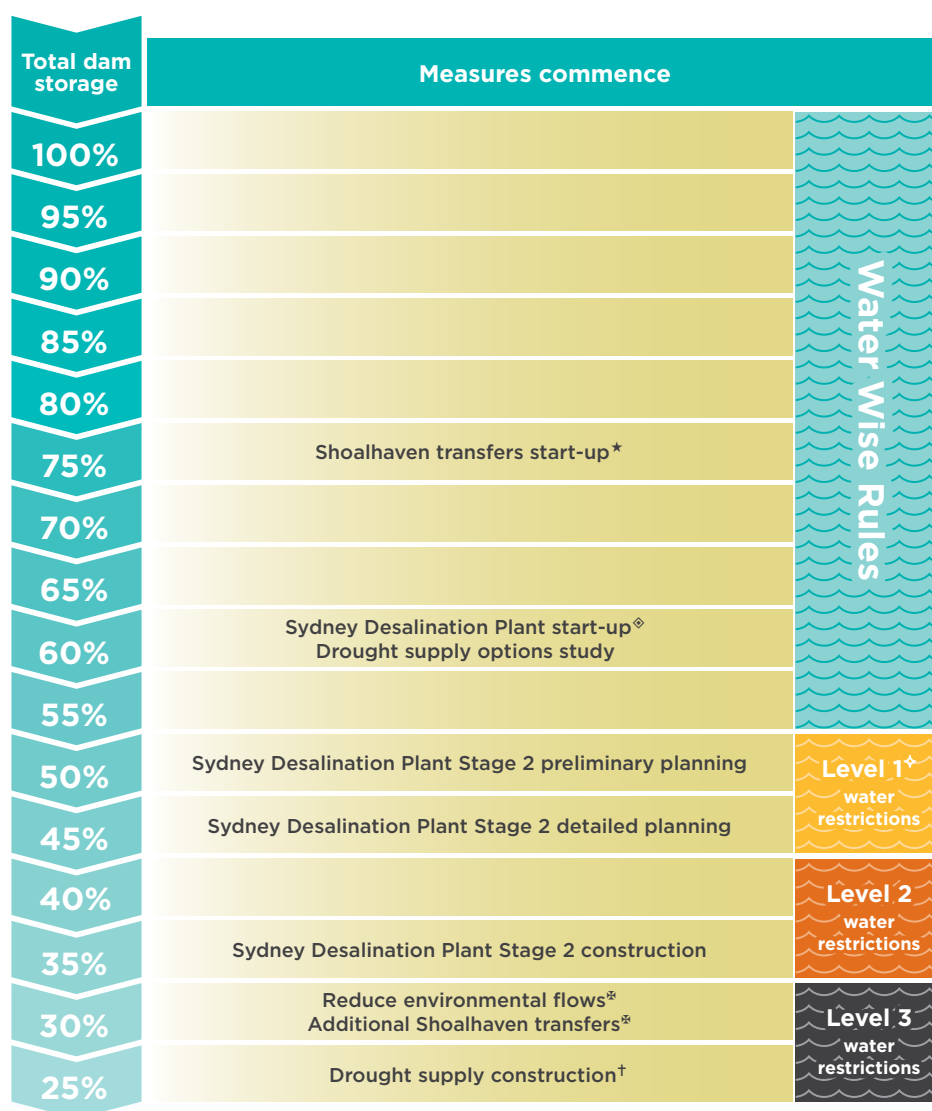
Making the most efficient use of our existing water supplies will allow us to meet demand for water in a way that maintains water security and is affordable.

The new mix of water supply and drought response measures (portfolio) shown in Figure 5 was selected following extensive modelling of our

water supply system, and takes into account the identified risks to the supply system, as well as community values and preferences. The portfolio can provide water to meet a demand in the range of 565 billion to 585 billion litres per year, which is enough water to meet the region's demand for 10 years or more. To make the system more robust, this target supply has been set well above current water use of 530 billion litres (in 2015–16).



2017 Metropolitan Water Plan portfolio of measures



★ Shoalhaven transfers turned off when dam storage levels reach 80%.

◆ Sydney Desalination Plant operates in a certain way in its drought response role: when total dam storage levels fall below 60% ('on' trigger) Sydney Desalination Plant Pty Ltd must operate to maximise its supply of drinking water to Sydney Water's area of operations. Outside the 'minimum run time', these arrangements will continue to apply until total dam storages reach 70% ('off' trigger).

✧ Water restrictions eased as dam levels rise, based on circumstances at the time.

* Off trigger linked to the easing of Level 3 water restrictions.

† Dependent on the outcomes of the drought supply options study, some drought supply options may need to be introduced earlier.

FIGURE 5: Sequencing of measures and triggers for the 2017 Metropolitan Water Plan portfolio

The portfolio of water supply and drought response measures in the plan:

- uses existing measures, including water supply from dams, Shoalhaven transfers (transfers from Tallowa Dam on the Shoalhaven River), the use of water from the Sydney Desalination Plant, and the introduction of water restrictions
- includes a broad range of drought supply measures, to ensure the region has sufficient water to withstand a severe drought
- includes new triggers for planning and construction of drought measures
- changes the operational storage triggers for some measures, including lowering the 'on' and 'off' triggers for the Sydney Desalination Plant.

The changes, including the lowering of the Sydney Desalination Plant triggers, will make the best use of our existing water supplies and will save around \$20 million per year on average, compared to the current settings for the water supply system. The savings will help maintain affordable water bills for households and businesses into the future.

As shown in Figure 6, if demand rises, the measures in our 2017 portfolio can provide more water if we adjust trigger levels upwards. This would make operating the system more expensive, but would maintain water security at the higher demand. Our investigations show demand can get considerably higher before raising triggers becomes more expensive than building new supplies.

Looking to the future, we have estimated the potential capacity of the supply system using the current measures we have in our portfolio. By moving the trigger levels upwards, while remaining within the bounds considered acceptable by the community, we could provide a maximum supply of around 625 billion litres per year (+/-20 billion), which is approximately 95 billion litres more than our current demand (see Figure 6). The maximum supply (see note below) provides an indication of the timing of the next supply augmentation to meet growth in demand.

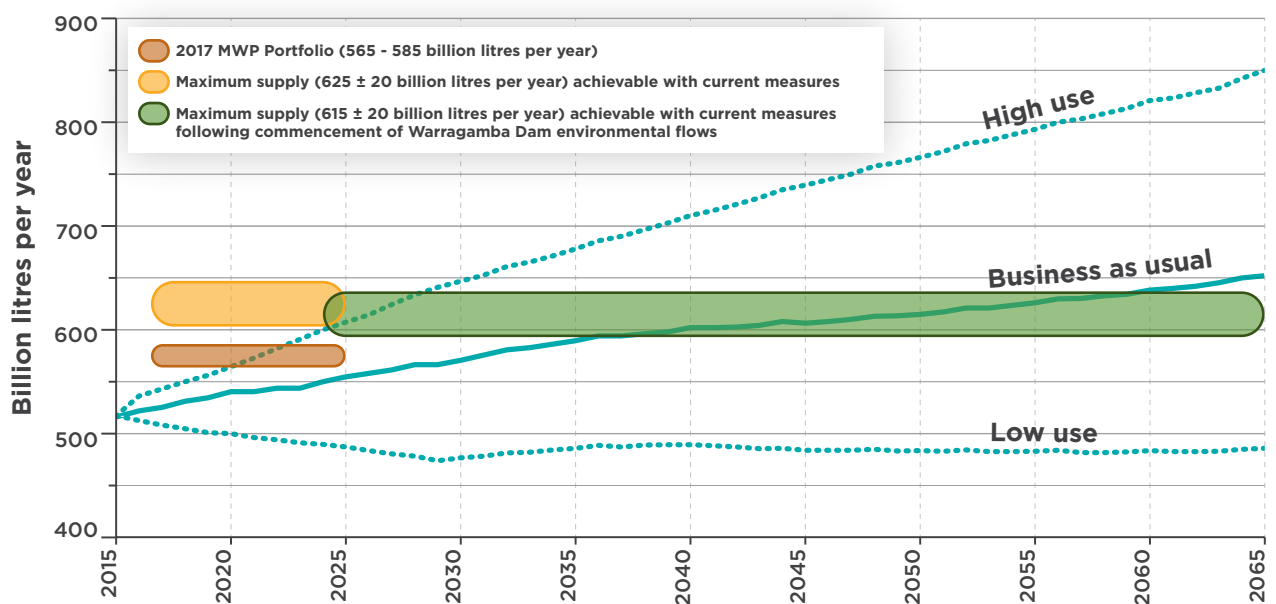


FIGURE 6: Demand forecasts with 2017 portfolio and maximum supply estimates

NOTE: Maximum supply estimates use current measures with higher trigger levels than the 2017 MWP Portfolio, but limited to within bounds considered acceptable by the community and practicable by stakeholders. These upper bounds include: Sydney Desalination Plant start-up at 80 per cent, Level 1 water restrictions on at 60 per cent and Level 3 on at 35 per cent, new drought supply construction at 50 per cent and Sydney Desalination Plant Stage 2 construction at 45 per cent. Within these upper bounds a range of solutions exist that would maximise our available supplies.



Investing in water conservation

Water conservation has a critical role to play in balancing supply and demand. It allows us to reduce total demand so we can respond to drought conditions or rising demand. Demand for drinking water will rise with population growth and may also increase if people's water use behaviour or choices about the appliances and plumbing products they buy shift to less water efficient models.

Increasing water conservation efforts may be cheaper than building new large scale supply options or could delay the timing of investment in a large new supply. The plan provides for an appropriate level of investment in water conservation to help achieve a secure and affordable water supply. It ensures that risks to water security from drought or rapidly rising demand are managed. We will:

- invest in economically efficient leakage management, water efficiency and recycling measures and increase investment in water conservation measures as dam levels drop and drought conditions return

- invest in water conservation measures, where economically efficient, and increase investment if demand grows rapidly and water use is significantly above the business as usual water use demand forecast in this plan
- maintain knowledge and expertise on the latest information, trends and technological advances.

Sydney Water will take the lead on water conservation initiatives through development of a Water Conservation Program based on the economic level of water conservation. Metro Water will undertake an annual assessment of Sydney Water's level of investment in water conservation against water security risks and our capacity to respond when drought conditions return or demand rises, and make recommendations to government in relation to any required actions.

Sydney Water – Water Conservation Program and the economic level of water conservation (ELWC)

In the past, Sydney Water has had fixed water conservation targets. While the targets have been successful in reducing water use, they provide little additional benefit once the target has been achieved. Fixed targets may also lead to over-investment when water is more plentiful, therefore increasing costs for the community.

Following a change to its Operating Licence, Sydney Water has developed a new, flexible approach that allows the level of water conservation to vary with dam storage levels and water demand, based on an analysis of costs and benefits. This means investment in water conservation can be expected to increase should Greater Sydney go into a drought, or if water use rises significantly above the business as usual water demand forecast used in this plan.

The new ELWC method applies to leakage reduction, water efficiency, and water recycling projects. The method will set investment priorities for each type of project, and details of which projects have been selected for delivery will be explained in a Water Conservation Program report. Sydney Water will maintain its knowledge, skills and experience in water conservation as part of the program. The first new five-year Water Conservation Program will be released in September 2017 and updated annually.



Fixing leaks in the system is an important part of ongoing water conservation.

Investigating new water sources for long-term needs

As well as optimising our existing measures to decrease overall costs, an affordable water supply comes from considering a wide range of potential options for new supply.

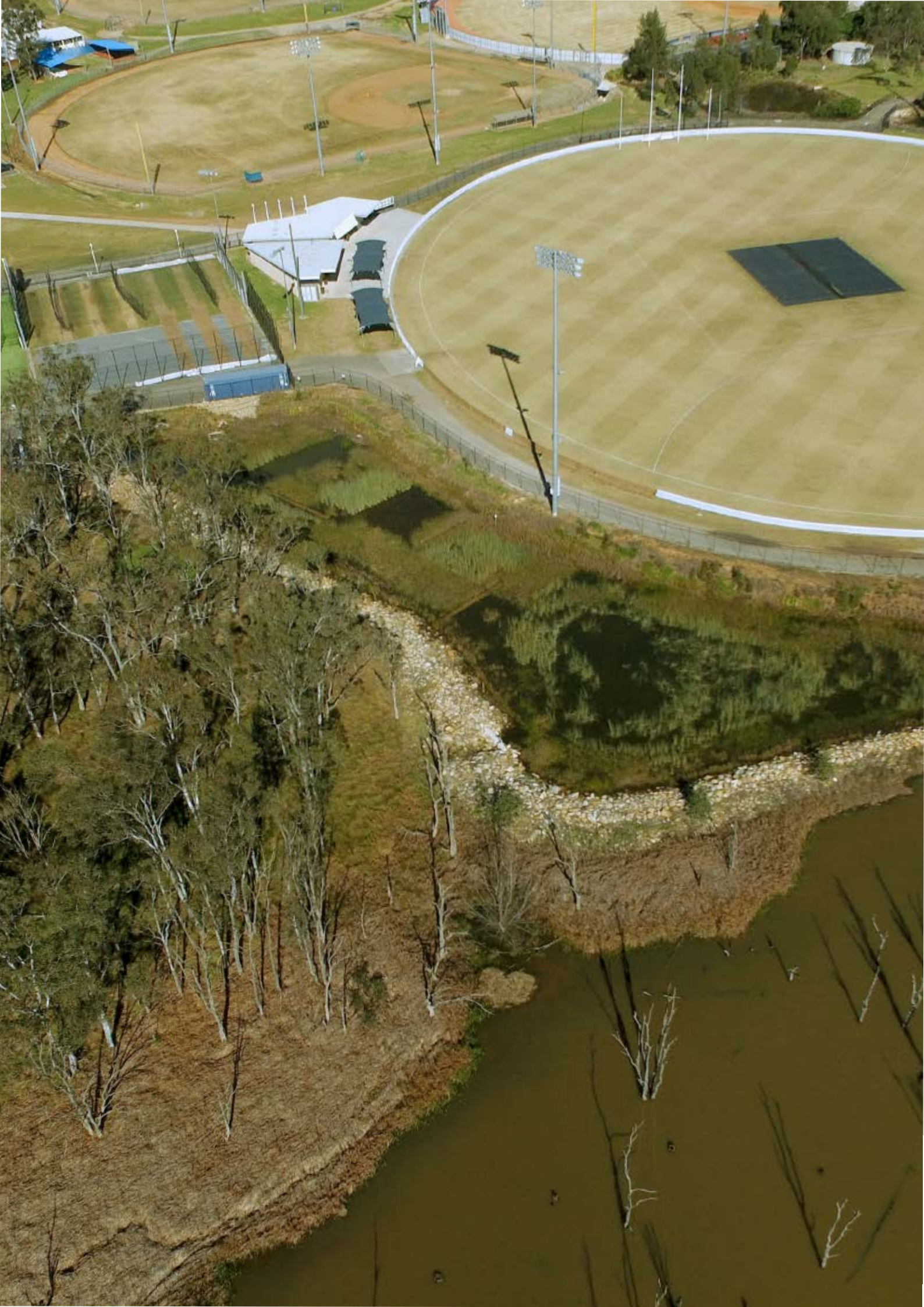
A short list of supply options to meet growth in demand was identified in the review, including opportunities to expand the capacity of existing dams and desalination plants, building temporary supplies to respond to drought and new schemes for drinking highly treated recycled water (subject to community views).

In the future, all available options need to be considered so we can minimise costs and maximise the benefits of any new investment in water supplies. The timing of a decision to invest in new water supply will depend on the rate of growth in demand, technological changes and costs. WaterNSW will be developing infrastructure options for water supply security and reliability as an input to investigations in the next plan review by Metro Water of new supply options to meet long-term growth in demand.

Additional studies will also be undertaken in the next plan review period to better understand the impacts of climate variability and climate change on the existing water supply system.

Two new initiatives will be explored to increase the available options for regional water supply in the future:

- engagement with the community to understand whether highly treated recycled water can be considered as an option for drinking water supply in the future. Recycled water for drinking is wastewater or stormwater that receives an advanced level of treatment to achieve high-quality drinking water. At this stage recycled water is used for non-drinking purposes only. Its future use for drinking water will depend on community attitudes and acceptance, and systems would be put in place to ensure its safety, including oversight by health regulators.
- enabling new proposals that might help meet the region's water supply and water security needs to be submitted to government for assessment and testing against those measures included in the Metropolitan Water Plan. This would allow options to be considered outside the plan's regular review cycle. The details of this initiative will be developed as part of the implementation of the plan.



Outcome 2: Our water supply system is resilient to stresses and shocks

Goal	Outcome	Strategies
A liveable, growing and resilient Greater Sydney	Our water supply system is resilient to stresses and shocks	A Drought Response Strategy with a broad suite of measures
		Identifying and mitigating risks to water security
		Planning for our variable climate and climate change

Resilience is the capacity of individuals, communities, institutions, businesses and systems within a region to survive, adapt and grow – no matter what kinds of stresses and shocks they experience.

To have a resilient water supply system, we must be able to respond and adapt to stresses and shocks that pose a risk to the security of our water supply. These stresses and shocks include rapid growth in demand, drought, floods, fire, extreme climate variability and climate change, and exceptional circumstances that interrupt supply or impact water quality.

Our review of system resilience focused on assessing the risks to the water supply system, and engaging with the community to understand their preferences around drought response measures, and the role the community can play in making our supply system more resilient.

What makes our water supply resilient?

The resilience of the existing water supply system for Greater Sydney is enhanced by:

Large storages: the water storages that supply the Greater Sydney region are large with over 2600 billion litres of water available when the dams are full (equivalent to five years of unrestricted demand). These large storages make the supply system robust enough to withstand extended periods of drought.

Ensuring an adequate buffer between demand and supply: the portfolio of supply and drought response measures meets a demand in the range of 565 billion to 585 billion litres per year, which is safely above current water use of 530 billion litres. We can also increase system capacity to meet increased demand with these current measures (by raising some trigger levels), and invest in water conservation to manage rapidly rising demand.

Diversity of sources: having access to alternative and diverse water sources such as water transfers from the Shoalhaven River, a range of dams, recycled water schemes in some areas, and the production capacity of the Sydney Desalination plant means the system is better able to withstand shocks. For example, a water quality problem at one or more of the dams can be overcome by drawing water from other sources.

A robust strategy to respond to droughts: our supply and drought response measures are triggered in sequence as dam storage levels drop, allowing the full storage capacity of all the dams to be used. This enables us to 'buy time' until it rains and dam levels are restored. We also have a strategy to manage droughts much more extreme than any in the historical record.

Our review found we need to manage risks to our water supply

Despite its high level of in-built resilience, our water supply system remains vulnerable to shocks (sudden changes) or trends (gradual changes) that pose a risk to the delivery of high-quality drinking water to Greater Sydney. To manage these vulnerabilities, high-priority risks were identified by government stakeholders as part of the review. These risks included:

- rapid onset of drought conditions or an extended drought (possibly driven by climate change)
- sudden bounce back in demand towards the high demand forecast
- damage to a major piece of supply infrastructure, which interrupts water supplies
- major planned maintenance or construction that reduces the capacity of our water supply system and/or increases our vulnerability to drought
- water quality problems due to bush fires, storms or other natural hazards that impact water supplies
- delays or issues with the start-up of the existing desalination plant
- failure of monitoring and adaptive management or poor decision-making that endangers water security.

The plan focuses on ways of mitigating and managing these identified risks.

The community supports water restrictions and investment in water conservation

The community's views were sought about their preferences around how they might respond to stresses or shocks to our water supply, in particular water restrictions in future droughts. The community told us that:

- water restrictions should remain the key tool for responding to future droughts. While drought restrictions do impose some costs on the community (for example, inconvenience and adverse impacts on gardens and playing fields) and on some industries, there was a high level of support for using water restrictions as the primary way to manage demand during a drought
- water restrictions should be combined with other measures including increased investment in water conservation and, if a drought continues, new supplies
- they could 'do more' to reduce their water use in and outside the home in a drought. Despite continuing with water-saving behaviours and choosing water-efficient appliances, the community felt they could further reduce water use in their laundries, kitchens and gardens or by installing more water-efficient appliances and infrastructure, for example, rainwater tanks
- voluntary per person water use targets were supported as part of a water restrictions program, and the community felt that a comprehensive education and communication campaign to support such targets would be needed
- reducing environmental flows during drought should be a 'last resort', although it was acknowledged that this may be needed to protect water supplies.

Our strategies will improve the resilience of our water supply system

The plan includes a series of strategies to improve the resilience of the water supply system now and into the future. These are:

- a flexible Drought Response Strategy
- mitigation strategies for identified risks to water security
- planning for climate variability and long-term changes in our climate.

A Drought Response Strategy with a broad suite of measures

The Drought Response Strategy has been developed to withstand a drought more extreme than any experienced over the past century. It includes a broad suite of supply and demand management measures that can be deployed at pre-determined trigger levels as dam storages fall. The measures include a drought supply options study, implementing water restrictions, building new water supplies, and contingency plans for responding to an extreme drought.



Figure 7 shows the sequence for deploying the measures in the Drought Response Strategy in the worst drought on record.

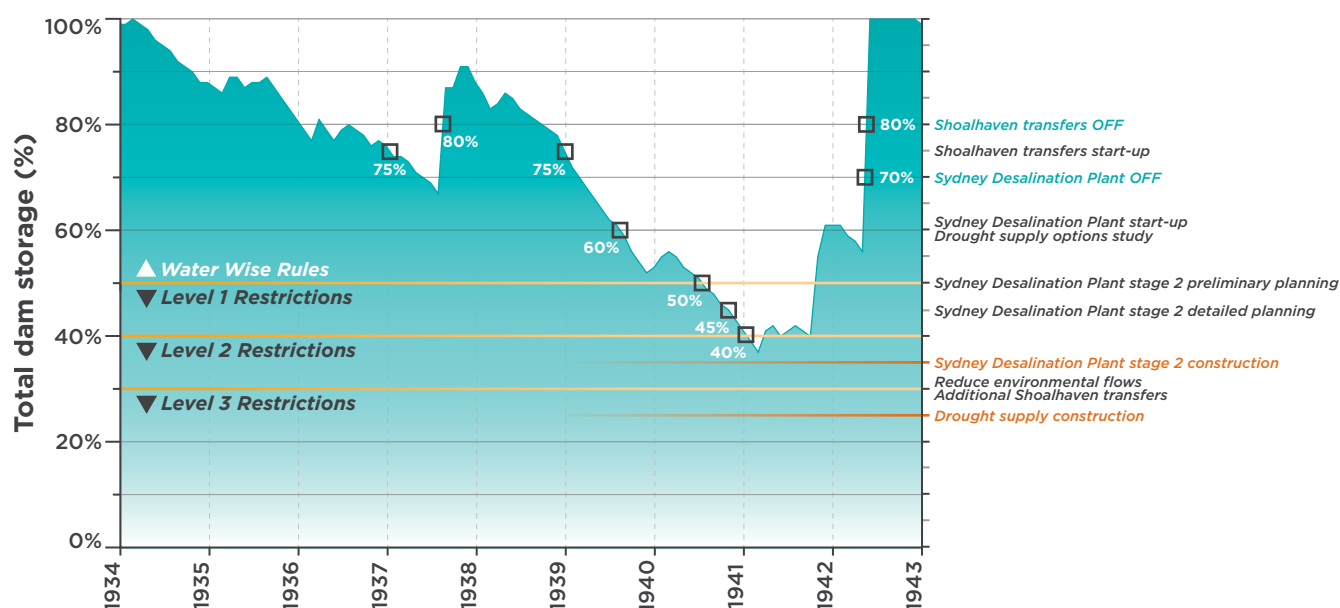


FIGURE 7: Modelled performance of 2017 portfolio against worst drought on record

Alongside the Drought Response Strategy, investment in water conservation will also increase as dam storage levels fall. This includes increased efforts to reduce leaks from the water distribution system as well as programs to reduce water use. The increased water conservation activity will slow the rate at which the storages drop and can avoid or defer the need to build new water supplies.

A drought supply options study will investigate the most effective drought measures

As part of the adaptive approach to securing supply, the plan provides for a drought supply options study to be triggered at 60 per cent of total dam storage. This study will investigate the most suitable drought response measures for use in the event of an extreme drought. The best option(s) for supplying up to 100 million litres per day will be selected from the list of measures identified as part of this plan. These include:

- the development of new groundwater bore fields
- the use of small-scale temporary desalination units (shipping-container-sized plants located close to the ocean and able to be readily connected to the supply network)

- building a new desalination plant in a different location to the current Sydney Desalination Plant
- the introduction of highly treated recycled water for drinking. At this stage recycled water is used for non-drinking purposes only, and its future uses will depend on community attitudes and acceptance.

As the timing and severity of the next drought cannot be known, this approach enables the most suitable options to be investigated and decisions made based on the latest information. It also means we can take into account future advances in water supply technology, improvements in our understanding of future climate, and community views and preferences.



An example of reverse osmosis membrane technology used for the desalination of seawater.

TABLE 2: Water restrictions

Restriction level	Total dam storage level	Description
1	50%	Enforcement of existing Water Wise Rules, with potential for further minor mandated measures limiting outdoor water use.
2	40%	Mandated measures will constrain water use, for example the number of days per week you can water gardens. May involve per person water use targets supported by extensive education and communication campaigns.
3	30%	Emergency restrictions involve very limited or no outdoor water use. This could include no washing of outdoor surfaces or cars, only using greywater for garden watering, and lower per person water use targets to save water in and around the home.

Water restrictions are a key tool for responding to droughts

The use of water restrictions defers the need to invest in expensive supply or other drought measures by reducing water consumption and slowing the rate of decline of dam storage levels.

The community is generally highly supportive of water restrictions with reasonable limits on how often and for how long they are in place. Water restrictions will remain a key tool for responding to future droughts.

Water restrictions and per person water use targets are critical elements of the Drought Response Strategy. They can be implemented quickly and can significantly reduce water use. The implementation of water restrictions will be triggered as dam storage levels drop, with the most restrictive level introduced only in extreme drought (see Table 2).

Restrictions will apply to using water outdoors, such as watering gardens, washing cars and filling swimming pools. The likelihood of restrictions being triggered is relatively low, with Level 1 restrictions likely to be imposed for less than 1 year in every 20 years on average.

Daily per person water use targets were successfully implemented in other Australian cities during the Millennium drought and resulted in water savings beyond those achieved through mandatory water restrictions. The targets are voluntary. They give people a choice in how they save water – indoors or outdoors – and are supported by extensive education and communication campaigns.

During the last drought in Greater Sydney, the community saved water by limiting their water use in the garden, using greywater, installing and using water efficient devices and by taking a more water wise approach to using water indoors, for example turning off the tap while brushing teeth and taking shorter showers.

The NSW Government will work with the community to manage water use when drought conditions return.

Augmenting the Sydney Desalination Plant will provide additional water supplies if needed

Sydney's desalination plant can be increased in size if water supplies need a significant boost in the future. In the unlikely event that the region experiences an extreme drought, the capacity of the desalination plant can be doubled. This will increase water production from 90 billion to 180 billion litres a year.

There are a series of trigger levels for augmenting the Sydney Desalination Plant: pre-planning would begin at 50 per cent of total dam storages; detailed planning at 45 per cent; and construction at 35 per cent. This staged approach means that the final decision to construct the augmented plant can be delayed until absolutely necessary, allowing time for it to rain and the dam levels to recover.

In case of extreme drought further emergency measures will be put in place

Emergency drought measures will be implemented if we experience prolonged drought conditions beyond those experienced to date in the Greater Sydney region. They will be put in place only after other measures designed to reduce demand and boost water supplies have been implemented.

The following suite of emergency drought responses will be implemented if dam storage levels reach 30 per cent.

INTRODUCTION OF LEVEL 3 WATER RESTRICTIONS

Level 3 restrictions involve very limited or no use of water for outdoor uses, other mandated measures to constrain water use and a voluntary per person water use target (see Table 2).

REDUCING ENVIRONMENTAL FLOWS FROM ALL MAJOR DAMS

Environmental flows are released from the region's dams and weirs to maintain river health. Should the region experience an extreme drought, environmental flows will be reduced to keep as much water as possible in the dams for drinking water purposes (refer Section 7 for more information on environmental flows).

SUPPLEMENTING DRINKING WATER SUPPLIES WITH ADDITIONAL TRANSFERS FROM THE TALLOWA DAM ON THE SHOALHAVEN RIVER

Sourcing water from Tallowa Dam on the Shoalhaven River is critical to maintaining water supplies to Greater Sydney. Shoalhaven pumping begins when dam storages drop to 75 per cent of total dam storages but the drawdown level of Tallowa Dam is limited to one metre below the full supply level to avoid negative impacts on recreational use of the river, storage and the local economy. During an extreme drought, and in line with existing agreements, we are able to lower the level in Tallowa Dam to three metres below the full storage, which provides additional water to top up the region's water supplies.

BUILDING DROUGHT SUPPLIES IN EXTREME DROUGHT

In a drought significantly more extreme than any in the historical record, new drought supplies will be needed. The supply measures identified in the drought supply options study will then be built.

Identifying and mitigating risks to water security

As well as drought, other identified high-priority risks to water security include rapidly rising demand, supply interruptions, reduced system capacity and water quality problems.

Rapidly rising demand will trigger increased investment in water conservation (as described in Section 4). To manage the other identified risks to water security, we will change the way the current system is operated.

The trigger levels for supply and drought response measures can be altered on a short-term basis for a range of exceptional circumstances to mitigate risks to water security. The responses may include:

- drawing water from different storages in the water supply system
- operating the desalination plant in response to an event that poses a threat to our water supply (allowing for the fact that when in care and maintenance mode the plant takes an extended period to restart)
- introducing water restrictions to reduce water use and manage demand.

As a separate initiative to mitigate some of the risk associated with the restart of the Sydney Desalination Plant, and to provide certainty for the operator in staff recruitment, the plan provides Sydney Desalination Plant Pty Ltd with the option of running the plant for a minimum period of 14 months. This comprises six months of running at up to full capacity in addition to a maximum eight-month start-up period. The plan provides for this minimum run time option even if storage levels return to above the designated 'off' point for the plant. Outside the new minimum run time, the 70 per cent (of storage levels) 'off' trigger then applies.

Planning for our variable climate and climate change

Greater Sydney's climate varies naturally over years and decades and has distinct wet and dry periods. Understanding how rainfall varies over the long term is difficult because records of river flow and rainfall have been taken over a relatively short timeframe of around 100 years. However, research is now providing a better understanding of natural variability over the last thousand years and how this could impact water planning.

During the review period we studied and modelled the expected impacts of climate change across the Greater Sydney region and its catchments as part of a larger study across NSW. This modelling shows that temperatures and evaporation will increase in many regions in NSW.

However, the modelling shows far less certainty on changes in rainfall and run-off for the Greater Sydney region. There is potential for the region to get wetter as well as the potential for a drier future. There are indications that extremes in both rain intensity and rain events and periods of drought will increase.

Our studies showed that natural variability in rainfall is likely to have a greater impact on water security for our 50-year planning horizon than long-term climate change.

Due to significant uncertainties around climate variability and long-term changes in our climate, the plan takes an adaptive approach. The plan has strategies that can be deployed in response to changing circumstances, including additional investment in water conservation and additional or earlier implementation of drought supply measures. This adaptive approach to planning allows us to manage climate uncertainty in a way that acknowledges both potentially wetter and drier futures.

In the next review of the plan, studies will be undertaken to further our understanding of the impacts of climate change on future rainfall, run-off and water demand. As our understanding of climate change and variability improves, the plan will be reviewed and updated and actions developed to further improve the resilience of our water supply system. This aligns with the NSW Climate Change Policy Framework's aim of helping NSW become more resilient to a changing climate.





Outcome 3: Our urban communities are more liveable and resilient

Goal	Outcome	Strategies
A liveable, growing and resilient Greater Sydney	Our urban communities are more liveable and resilient	Establishing the WaterSmart Cities program
		Investigating barriers and enablers to cost-effective water recycling
		Establishing partnerships and collaborative arrangements

While water is a key factor in making a place liveable, it is also a limited natural resource. The region's growing population and expectations for more liveable cities will place additional pressures on our water supplies.

This plan aims to secure drinking water for people as well as establish the foundations for enhancing the liveability of our urban communities. Research into the contribution of water to urban liveability, community values and preferences, and the findings from our review work have helped identify the next steps we need to take to enhance the liveability and resilience of our urban communities.

A liveable city or region helps meet the social, environmental and economic needs of its people. It also addresses community values and preferences for amenity, wellbeing and a sense of place. To be long-lasting and resilient, a liveable city or region must consider the needs of future generations and think 'holistically' to understand and respond to shocks and long-term change¹⁴.

Water provides many benefits to the community, at a household, local and regional level. It is an essential service and helps safeguard the health of individuals and the community. Water also contributes to the cooling and greening of our cities, healthy waterways and the long-term economic security of the region.

For many decades the urban water industry has supplied safe and reliable drinking water, wastewater services and flood management. This focus has now broadened to consider waterway health, maintenance of recreational areas and the amenity of our waterways. More recently, the water industry has recognised the strong connection between providing access to safe, green open space and the physical health of our communities. Water in the landscape, as a deliberate element in the design of our cities, can provide an effective and potentially efficient means of providing urban cooling and reducing the impacts of heat stress¹⁵.



Street tree canopy cover has been shown to significantly cool urban areas, reducing heat stress impacts and enhancing the resilience of local communities. Without integrated solutions, establishing and maintaining tree canopy cover is likely to place significant new demands on our water supplies.

Our review found that we need a new approach to water service provision

The Metropolitan Water Plan review found that we need a new approach to planning and managing water services. This will enable our cities to become more resilient to drought and heat, improve the amenity of local communities, enhance human health and protect our precious waterways.

Currently there is a lack of alignment between land use planning and water servicing strategies. In addition, responsibility for the delivery of water, wastewater and stormwater services is split between water utilities, state agencies and local governments. This makes it difficult to achieve integrated water solutions.

There are also significant institutional, policy and regulatory barriers to the uptake of economically efficient water recycling, for example:

- there is different treatment of recycled water scheme costs compared to traditional wastewater servicing costs for Sydney Water
- developer charges are levied for recycled water schemes but are not levied for traditional water and wastewater servicing
- there is limited access to planning and land release processes for private sector service providers (who often include recycled water in their developments).



Carefully thought out urban design can protect, maintain or restore waterway health at the same time as enhancing social wellbeing and the aesthetics of neighbourhoods.

The community emphasised the importance of green spaces and water quality

During the course of the review, the community consistently highlighted the importance of water conservation and recycling in helping create a more liveable and resilient region. This was particularly evident in the high ranking of values relating to efficient use of water; being more water efficient in and around the home; and a willingness to pay higher household bills for cost effective investment in water conservation and recycling.

In the context of increased population growth and development in Greater Sydney over the next 10 years, participants at community workshops

emphasised the importance of having equitable access to public green spaces. This included a desire for secure, reliable and diverse water services that contribute to maintaining green spaces and tree canopy, and improving river health, water quality and biodiversity.

The community's desire for liveable and sustainable communities is challenged by rising urban temperatures; increasing wastewater and stormwater discharges, which impact our waterways; and rising energy consumption and costs of living.



Irrigation is often required to maintain quality green spaces so that they provide the essential passive and active recreation opportunities as well as health benefits communities have come to expect from them.

Our strategies will contribute to making our communities more liveable and resilient

The plan contains a suite of strategies designed to improve the contribution that water makes to the liveability and resilience of our urban communities in Greater Sydney. The key strategies (discussed in more detail below) are:

- establishing the WaterSmart Cities program
- investigating barriers and enablers to cost-effective water recycling
- establishing partnerships and collaborative arrangements between state agencies, local government and industry.

These strategies will build on and be coordinated with a range of government initiatives already underway or planned that will contribute to achieving the government's goal of a liveable, growing and resilient Greater Sydney.

Government initiatives to improve the liveability and resilience of communities in Greater Sydney

- The Greater Sydney Commission is leading metropolitan planning to make the region more productive, sustainable and liveable. The Commission has released draft district plans with the goal of having well-coordinated, integrated and effective planning for land use, transport and infrastructure. In addition, the Commission's Green Grid and Metropolitan Greenspace Programs will link existing green spaces with new or enhanced natural corridors to provide better recreational and amenity options for local residents. Integrated water cycle solutions can enhance the viability and quality of these natural and irrigated corridors of green.
- The NSW Government's Draft Climate Change Fund Strategic Plan¹⁶ is helping people prepare for a changing climate by investing in actions to reduce costs to public and private assets arising from climate change, reducing the impacts of climate change on health and wellbeing, and managing the impacts of climate change on natural resources, natural ecosystems and communities.
- The Office of Environment and Heritage has a lead role in developing environmental objectives for water quality and river flows for government and providing a framework for councils to develop stormwater management objectives.
- Sydney Water is investigating the benefits of investing in recycled water, stormwater management, local integrated water solutions and water conservation programs.
- Parramatta City Council's Our Living River¹⁷ aims to revitalise the Parramatta River and make it a safe and enjoyable place to swim by 2025.
- The Australian and NSW Governments will work together with local governments in a collaborative partnership to realise the potential of Sydney's west as part of the Western Sydney City Deal.

Establishing the WaterSmart Cities program

The International Water Association has recently released its Principles for Water-Wise Cities¹⁸. These principles help water managers move beyond equal access to safe water and sanitation, and towards collaborative planning and design that is resilient. Underpinning the principles are three important ideas:

- resources are limited and we need to do more with less
- city densification is both an opportunity for economic growth and a threat to liveability
- an uncertain future underlies the planning of our cities.

In Greater Sydney we need to plan our water, wastewater and stormwater services in an integrated way to fully realise the benefits from the multi-billion dollar investment in water infrastructure.

Integrated water cycle planning manages and uses water in a localised and coordinated way. It treats all water products – drinking water, wastewater and stormwater – as interconnected services. This means that servicing solutions are planned and managed in a holistic way, taking into account the needs of the local community and the environment.

The benefits of integrated water cycle solutions include (illustrated in Figure 8):

- increased flexibility in releasing land for development
- reduced demand on drinking water supplies
- reduced wastewater and stormwater volumes disposed of to waterways and oceans for improved environmental outcomes
- the ability to deliver higher-quality residential development.

The WaterSmart Cities program will explore opportunities for adopting integrated water cycle solutions and a more cohesive approach to planning and managing water services in new developments. The program aims to improve the coordination of water and land use planning, contributing to a more liveable and resilient Greater Sydney region into the future.

The program will be delivered as a partnership between the Department of Planning and

Environment, Sydney Water, the Greater Sydney Commission and Metro Water. It will develop integrated water plans and strategies for two pilot growth areas as well as the tools needed to plan and provide infrastructure to other growth areas across Greater Sydney. The program will be underpinned by a comprehensive community and stakeholder engagement strategy.



Integrated water cycle planning can cost effectively utilise locally available water sources such as harvesting stormwater to ensure active use of sport fields even deep in a drought.

In parallel with the pilot projects, we will undertake a range of activities to enhance collaboration and identify economic, planning, and regulatory barriers and enablers to implementing integrated water solutions. These include:

- identifying opportunities to better align water infrastructure plans and city plans
- undertaking social research and stakeholder and community engagement, including assessing customer willingness to pay for liveability and resilience benefits
- reviewing funding arrangements and options for improved allocation of costs and benefits

- evaluating the program and developing business cases to identify the value of extending the WaterSmart Cities program to other growth areas in Greater Sydney and regional NSW.

The WaterSmart Cities program will help the NSW Government and its partners shape a long-term strategy to improve water security, enhance liveability, ensure a cost-effective urban water system and support innovation. It will allow us to meet the community's expectations that water conservation and recycling should play a major role in the city's transition to a more liveable and resilient place to live and work.

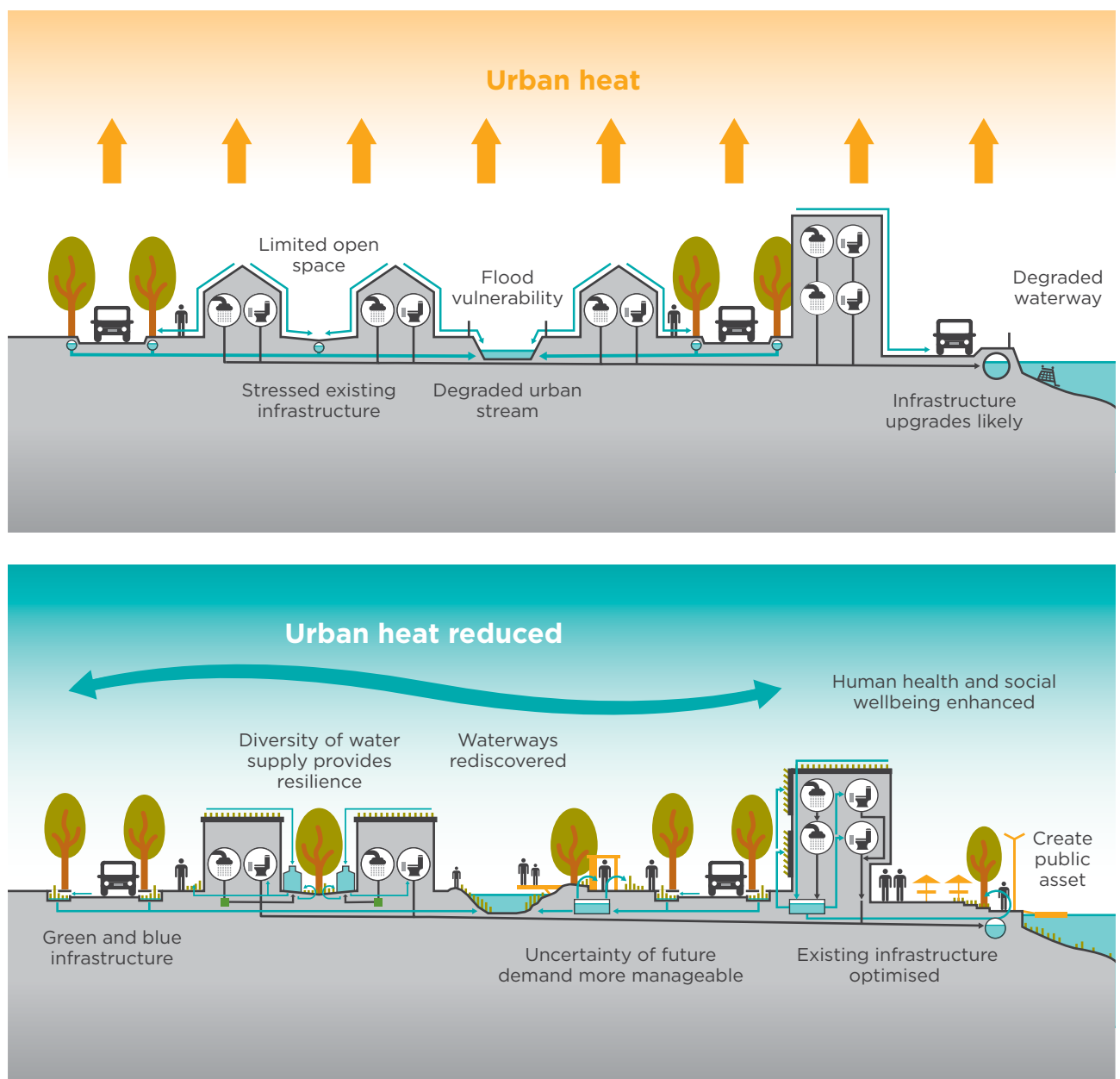


FIGURE 8: Benefits of integrated water cycle solutions

Original image concepts © Water Sensitive Greater Sydney



Central Park high-density living, provides quality urban recreational spaces (town square) and aesthetics (green walls) irrigated by stormwater and wastewater recycling.

Investigating barriers and enablers to cost-effective water recycling

Our review identified a range of pricing and regulatory issues that make it difficult to implement cost-effective recycled water initiatives. It also found that many of the current pricing and regulatory settings can bias investment toward traditional servicing models, such as centralised water and wastewater networks. This occurs even where integrated solutions (including recycling) are shown to be as cost effective.

The plan recommends establishing an independent inquiry into barriers and enablers to the uptake of cost-effective water recycling, including consideration of potential regulatory and pricing reforms.

Establishing partnerships and collaborative arrangements

Opportunities for improved social, environmental and economic outcomes from water, wastewater and stormwater investment can be realised with state agencies, local government and industry working together.

We will address current coordination gaps across government and between state and local government – which has been identified as a key barrier to a more efficient and integrated approach to water servicing in our region.

To improve coordination, the plan allows for a working group to be formed. This group will comprise representatives of relevant agencies from state government, local government, industry and non-government organisations to properly integrate programs and avoid duplication of effort.

The water industry invests billions in water, wastewater and stormwater services globally,

yet the sector has had only a limited influence on decisions that affect the shape and density of cities. Most commonly, these decisions have considered the delivery of water infrastructure and services late in the planning process or services have been provided on an incremental basis as cities expand.

Research¹⁹ by the International Water Association's Cities of the Future Program has concluded that leading Cities of the Future should employ a new strategy where the delivery of all urban infrastructure and services are planned through a partnership approach. This would include urban planners, the water sector and other sectors working together to meet sustainability and liveability objectives set by the community.

Towards a more integrated future: Blacktown City Council

Blacktown City Council has developed an innovative way to manage stormwater in new medium density developments. The new approach lowers costs, protects waterway health and captures water to irrigate parks and sports fields. Ratepayers, developers and local waterway users are all benefiting from this new approach.

Council traditionally required developers to construct and maintain treatment devices within the development footprint. On some developments these devices have not always been designed and maintained optimally, reducing the waterway health benefits.

Council are now applying an innovative approach to some smaller medium and high density residential and business/industrial developments. This allows developers to voluntarily choose to pool their stormwater contributions to lower the construction and maintenance costs and thus achieve better waterway outcomes.

This approach means council can use the pooled funds to construct precinct-scale devices to treat, detain and slow stormwater with ongoing maintenance undertaken by council. The benefits include faster development times, lower lifecycle costs, better waterway health and improved local spaces for residents to relax, recreate and play.



Ponds and other devices that capture, treat and slow stormwater run-off from urban environments can significantly enhance the aesthetics of local areas and improve waterway health.



Outcome 4: Rivers downstream from dams are healthy

Goal	Outcome	Strategies
A liveable, growing and resilient Greater Sydney	Rivers downstream from dams are healthy	Implementing variable environmental flows from Warragamba Dam
		Modifying Warragamba Dam to release the flows
		Protecting the benefits of environmental flows
		Monitoring and adaptive management of flows

Dams have an enormous impact on the health of rivers by reducing the amount of water that flows to the downstream environment. It is long recognised that maintaining sufficient flow in the river is important to reduce floating weed growth, help native fish and other river-dependent species thrive, and enable our rivers to be used for fishing, swimming, boating and other recreational and commercial activities.

Following recommendations by the Hawkesbury-Nepean River Management Forum in 2004, water releases from the dams to help the downstream river environment (environmental flows) were introduced from all of Sydney's major supply dams in 2009-10, except Warragamba Dam. Due to its vital role in providing over 80 per cent of Sydney's water supply, and to ensure a balance between drinking water needs and the health of the Hawkesbury-Nepean River, the forum recommended detailed studies on the benefits and impacts of environmental flows from Warragamba Dam be undertaken.



Environmental flows mimic natural flows

Environmental flows are designed to mimic the patterns of a natural flow regime and support a river's ecology. They are released to help improve water quality, fish passage and reduce floating weeds.

Variability in flow is a natural part of Australian rivers, with ecosystems evolved to cope with our variable climate. In dry weather or during drought there would be little water in a river. In wet weather, river flows are much higher. Plants and animals in and around the river have evolved with this pattern of dry and wet. No flows or steady, low flows below dams contribute to poor water quality, invasive floating weed outbreaks, toxic algal blooms and impact adversely on the native fish population.



FIGURE 9A: High dam storage levels, high rainfall - high environmental flow release



FIGURE 9B: High dam storage levels, low rainfall - moderate environmental flow release

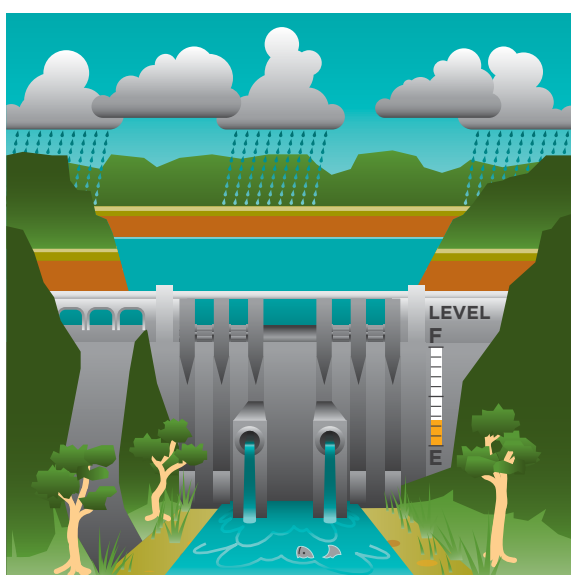


FIGURE 9C: Low dam storage levels, high rainfall - moderate environmental flow release



FIGURE 9D: Low dam storage levels, low rainfall - low environmental flow release

Our review found that introducing environmental flows from Warragamba Dam will improve river health

Detailed research and analysis was undertaken into the impact that environmental flows could have on the health of the Hawkesbury-Nepean River downstream of Warragamba Dam. Different flow options were evaluated using a combination of environmental data, model outputs, scientific literature and expert opinion to estimate the likely response of the current river condition to additional flows. The process considered the likely change to river flows and water quality, predicted ecological responses to these changes and assessed the benefits of these changes on the community's use of the river.

Our investigations showed that releasing additional water from Warragamba Dam will directly improve flow, water quality and the ecology in the Hawkesbury-Nepean River below the dam as far downstream as Sackville Gorge, with the most benefit expected upstream of Windsor (see Figure 10). This will help provide the community and businesses with a river that will continue to support a wide range of commercial and recreational activities.

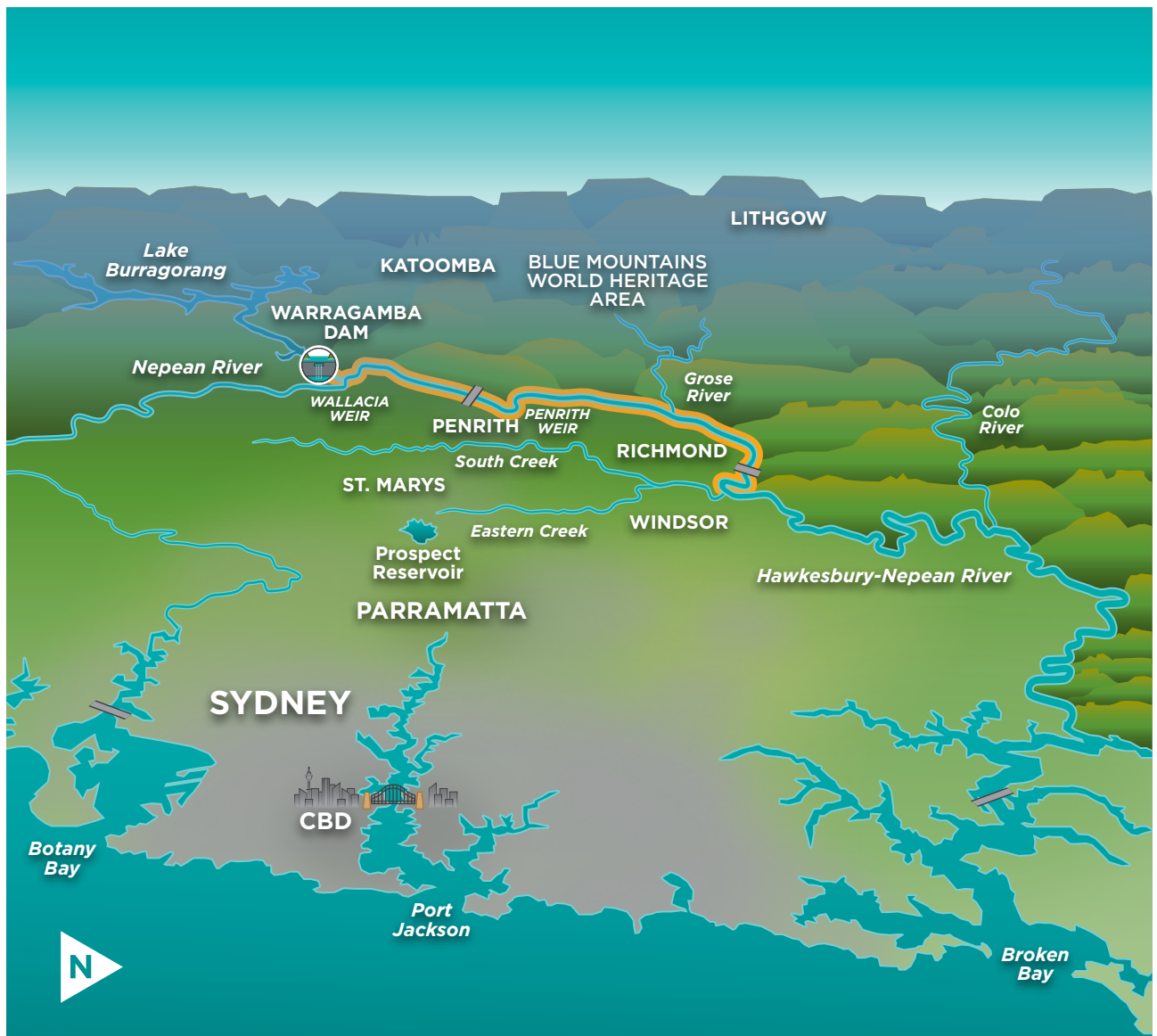


FIGURE 10: Main area of the Hawkesbury-Nepean River that will benefit most from Warragamba environmental flows

The community strongly supports introducing environmental flows to protect river health

Our community places a high value on the health of the iconic Hawkesbury-Nepean River. The review found that there is strong community support for improving the condition of the Hawkesbury-Nepean River downstream of Warragamba Dam and for the introduction of environmental flows. The community told us that the health of the river, protecting the environment and the species that depend upon it, and the ability of people to use and enjoy the river for generations to come is important to them.

We also found that the river held intrinsic value for Sydneysiders, in that they value the river even though they may not experience it first-hand.

Our strategies will ensure a balance between river health and water supply

To protect and improve the health of the Hawkesbury-Nepean River, we will:

- implement variable environmental flows from Warragamba Dam
- modify Warragamba Dam to enable flows to be released
- protect the benefits of environmental flows
- monitor the river and adaptively manage flows for the best possible outcome.

Implementing variable environmental flows from Warragamba Dam

While a specific environmental flow regime is recommended in the plan (a 90/10 scaled flow rule, as outlined below), the final rule for releasing the flows will be refined and reviewed before releases start. This will ensure that there is an optimal balance between river health benefits and water supply impacts. The rule can be varied at a later stage to meet changing requirements if necessary.

This adaptive management approach means that environmental flow releases will deliver ongoing community, economic and environmental benefits while we continue to manage the impact of the releases on Sydney's water supply.

Environmental flow rules for Warragamba Dam

Following the implementation of environmental flows from Warragamba Dam, the amount released will change from day to day, reflecting the natural pattern of water flowing into the dam.

While the majority of inflows will be held in the dam for water supply, a portion will be released as an environmental flow to support the river's ecology downstream. The variable nature of the release, and the additional water, will improve water quality, reduce floating weed outbreaks and help fish such as Australian bass move over barriers and use more of the river.

A 90/10 rule would mean that all low flows into the dam up to 110 million litres per day (the 90th percentile inflow) are released from the dam as an environmental flow. If inflows are greater than the 90th percentile, an additional 10 per cent of inflows is also released.

An important innovation for the Warragamba Dam environmental flows is that the releases will be scaled. This means that the volumes released will be linked to the total amount of water available for the region. As this reduces during drought, the daily release from the dam will be reduced accordingly.

Environmental flows will help the Australian bass

Environmental flows are predicted to improve the migration opportunities for Australian bass (*Macquaria novemaculeata*) by up to 35 per cent.

Many Australian native fish spend part of their lives in fresh water and part in salt water. Some species that live in the Hawkesbury-Nepean River, like the Australian bass, migrate to the estuary to breed. Once spawning is complete, the adults migrate back upstream and the juveniles follow once they reach a certain size. Both upstream and downstream migrations are triggered by river flows and water temperature. Natural flow pulses at the right time of year are needed to encourage fish to move. That flow has to be large enough and long enough to allow the fish to pass all the natural barriers – such as rock bars – in the river.

Most weirs on the Nepean River have had fishways installed to allow fish to migrate up and downstream. However, the 19 natural barriers between Penrith and Yarramundi (near Windsor) have to be ‘drowned out’ by flows to allow fish to move past them. The biggest barrier, at Emu Plains, requires a minimum of 500 million litres per day to allow adult bass to pass upstream. The environmental flows will increase the time by around 35 per cent that this barrier (and all the other barriers) are inundated, allowing migrating fish access to more of the river for longer periods. This is expected to improve fish populations.



Australian bass populations are expected to improve downstream of Warragamba Dam with the introduction of environmental flows.

Modifying Warragamba Dam to release the environmental flows

Modifications will be needed to Warragamba Dam to enable the release of variable environmental flows. Preliminary investigations indicate that a variable level offtake will need to be installed on the upstream side of the dam wall, to allow water of the appropriate quality to be released downstream. Infrastructure will be installed that allows the releases to be changed on a daily basis to match the variable nature of inflows from the catchments.

We are currently investigating the most appropriate option for the infrastructure to allow for water releases ranging from 20 million litres per day to a maximum of 6,700 million litres per day at full supply level. An assessment of the benefits of installing a new hydroelectric plant to generate power from the environmental flow releases is also being undertaken. These studies are being coordinated with investigations into the raising of Warragamba Dam for flood mitigation purposes. It is expected that the flows will begin by 2024.



Protecting the benefits of environmental flows

It is important that the benefits of environmental flows are not eroded over time because of the impacts on the river from wastewater discharges as our population grows, as well as the increased sediment and nutrient loads entering our river systems from urban development. To protect the benefits of the flows a number of associated activities will occur.

There will be improved coordination of government efforts to help reduce the impact of nutrients and pollutants on the Hawkesbury-Nepean River associated with wastewater treatment plant discharges and run-off from farmland, urban areas and other activities. As well as the ongoing licensing and monitoring of wastewater treatment plants, the introduction of integrated water cycle planning in new developments will help to minimise these effects (see WaterSmart Cities program, Section 6). By treating and reusing stormwater and wastewater, nutrient and pollution loads can be reduced.

Water sharing plans set out the specific rules for how water drawn directly from rivers is shared between different users, including the environment. The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources will be amended to reflect the

decision to introduce environmental flows from Warragamba Dam. In Greater Sydney, the Water Sharing Plan will detail the rules for releasing environmental flows from Warragamba Dam and will protect those flows by preventing the water being extracted from the river downstream of the dam.

Monitoring and adaptive management of environmental flows

Water quality, fish abundance and the extent and persistence of floating weed outbreaks in the Hawkesbury-Nepean River will be among the environmental measures that will be monitored over the longer term. The flow rules will be regularly reviewed to assess how well they meet environmental and/or water security needs. They will be adaptively managed in response to the findings from the monitoring regime. Before releases begin, monitoring of the river's current condition will establish a baseline against which improvements can be measured.

To meet the community's values, and our water quality and river flow objectives, continued management of the river environment will be needed.





An adaptive plan is better able to support a liveable, growing and resilient Greater Sydney

The Metropolitan Water Plan was first developed in 2004, and reviewed in 2006 in response to a severe drought. It was revised again in 2010 as part of a regular schedule of review.

The 2017 plan was developed by Metro Water in collaboration with water utilities and state agencies, key industry stakeholders and the community following an extensive review period.

The review was undertaken in line with the National Urban Water Planning Principles adopted by all Australian governments in 2008.

National Urban Water Planning Principles²⁰

Council of Australian Governments (COAG) 2008

National principles for urban water planning should be universally applicable when developing plans to manage the supply/demand balance of a reticulated supply for an urban population.

The key principles to achieve optimal urban water planning outcomes are:

- deliver urban water supplies in accordance with agreed levels of service
- base urban water planning on the best information available at the time and invest in acquiring information on an ongoing basis to continually improve the knowledge base
- adopt a partnership approach so that stakeholders are able to make an informed contribution to urban water planning, including consideration of the appropriate supply/demand balance
- manage water in the urban context on a whole-of-water-cycle basis
- consider the full portfolio of water supply and demand options
- develop and manage urban water supplies within sustainable limits
- use pricing and markets, where efficient and feasible, to help achieve planned urban water supply/demand balance
- periodically review urban water plans.

Developing the 2017 Metropolitan Water Plan

The 2017 Metropolitan Water Plan was developed in light of findings from a robust review of the 2010 Metropolitan Water Plan and extensive engagement with stakeholders and the community. The review comprised technical studies, independent reviews, hydrological modelling and economic analyses, community and stakeholder engagement activities and social surveys. An iterative approach to the review was adopted, which allowed changes in the planning context over the course of the review to be considered in the development of the plan.

Changes to planning and policy settings

The current review of the Metropolitan Water Plan has considered changes in the planning context and policy settings since the 2010 plan and has incorporated new data, updated information and emerging technologies. The key changes in the planning context that were considered during the review included:

- Population projections released by the Department of Planning and Environment in 2014 were the basis for the demand forecasts prepared by Sydney Water for the plan.
- The Hawkesbury-Nepean Valley Flood Management Review was established by the NSW Government in 2012 to consider a range of infrastructure and non-infrastructure options to help manage flood risk in the valley. Links were established between the review of the plan and the Hawkesbury-Nepean Valley Flood Management Review as a number of the flood management options had implications for water supply for Greater Sydney, in particular the potential raising of Warragamba Dam wall to provide flood mitigation.
- A new requirement was included in Sydney Water's Operating Licence 2015–2020²¹ to develop a Water Conservation Program, based on an economic level of investment in water conservation, and this has been recognised in the plan.
- The assumptions and costs underpinning the 2010 supply and drought response measures were revised based on updated data, new supply measures were identified and data on costs and volumes was collated and confirmed.
- The plan recognises new technologies in the urban water sector over the last decade

including permanent or temporary desalination plants which produce high quality water without relying on rainfall. Membrane-based wastewater treatment and small bore sewers allow for local and more integrated water solutions to be considered instead of the traditional approach of connecting new developments to existing centralised sewer networks.

The planning context for metropolitan water planning continues to change. In late 2016 the Department of Planning and Environment released new NSW population projections and revised dwelling forecasts²². Preliminary forecasts show that demand for water under the revised population projections would be 3 per cent higher in 2027 than was modelled for the plan. This projected demand remains within the plan's target supply range of 565–585 billion litres. Higher demand can be accommodated within the maximum supply from the measures in the plan of 625 billion litres, but would require trigger levels to be adjusted upwards.

In November 2016, the Government released the NSW Climate Change Policy Framework, which commits NSW to the aspirational objectives of achieving net-zero emissions by 2050 and helping NSW to become more resilient to a changing climate. Due to the connection between water use and energy use, efficiency in water usage and supply are important to help achieve the objective of net-zero emissions by 2050.

Links to regional and strategic plans

The strategies within the 2017 Metropolitan Water Plan will help inform government decisions in relation to future water infrastructure investment and will guide strategic planning to deliver the regional plan for Greater Sydney and the district plans.

The Metropolitan Water Plan is a key input to the regional strategic plans for Greater Sydney and the Illawarra-Shoalhaven. A Plan for Growing Sydney²³ is the NSW Government's regional plan for the Sydney Metropolitan Area over the next 20 years. Securing Sydney's water supplies is a key action in this plan, and supports the goal of ensuring Sydney is a competitive economy with world-class services and infrastructure.

The Greater Sydney Commission is reviewing A Plan for Growing Sydney, with the aim of revising and aligning it to the recently released draft district plans. The new strategy – Towards our Greater Sydney 2056²⁴ – will provide a framework that can better underpin strategic planning to achieve the vision for the region of a more productive, liveable and sustainable city.

The Metropolitan Water Plan also supports the Illawarra-Shoalhaven Regional Plan²⁵. Drinking water for the Greater Sydney region is sourced from the Illawarra-Shoalhaven, with approximately 20 per cent of the Illawarra-Shoalhaven Regional Plan region located within the Sydney Drinking Water Catchment Area. Protecting water quality and quantity in this catchment is essential for the health and security of local communities as well as the people of Greater Sydney.

The review process used the latest tools and techniques

As described above, an adaptive approach has been taken in reviewing and developing the Metropolitan Water Plan. The mix of demand and supply measures has been adjusted over time to manage risks and changes in the planning context while minimising costs and maximising benefits. Up-to-date information is sought and analysed to support decision-making.

A decision-making framework was developed to guide the analyses for the review and to make sure all relevant planning and policy issues were taken into account. The framework aimed to recognise and manage uncertainty, particularly by embedding ‘real options’ thinking. In decision-making, this means that options or pathways for future action are not cut off unnecessarily, and irreversible decisions are deferred where there is uncertainty and their deferral does not compromise the plan’s objectives.

This adaptive real options approach to water planning will help to manage both significant uncertainties in future demand, climate variability and the potential impacts of climate change.

Modelling to evaluate options

Modelling for the mix of supply and drought response measures (the portfolio) was undertaken in the hydro-economic model MetroNet, which identifies optimal solutions (maximum supply at least cost) for securing water for Greater Sydney.

All inputs to the model and the modelling results were reviewed by technical experts from across government. An independent review of the economic analysis in MetroNet was undertaken to verify its appropriateness for use in the review.

Demand forecasts, informed by the Department of Planning and Environment’s population projections, were developed by Sydney Water to underpin the plan and its outcomes. The demand forecasts were endorsed by the governing groups as the basis for metropolitan water planning.

A long list of new supply options for growth was screened using multi-criteria analysis. A short list of options was then developed and endorsed by the government for modelling purposes. An external consultant independently reviewed volumes and cost data for each of the potential new supply options.

Environmental flow options were evaluated using a combination of environmental data, model outputs, scientific literature and expert opinion to estimate the likely response of the current river condition to additional flows. A preliminary business case was prepared and examined the contribution that variable environmental flows from Warragamba Dam could make to improve the health of the Hawkesbury-Nepean River. Based on an analysis of estimated project benefits and costs, the business case identified the most cost-effective environmental flow regime.

Targets for water conservation and recycled water capacity that were included in the 2006 plan, and confirmed in the 2010 plan, have now expired. The 2017 plan provides for a new approach to water conservation and recycling, which was informed by studies undertaken as part of the plan’s review, work undertaken by Sydney Water, and discussions with agencies, stakeholders and the community.



Engagement and social research informed the review

Our review process was supported by a comprehensive engagement and social research program. The key objectives of our community engagement were to:

- understand community preferences around specific drought response measures, water efficiency strategies, environmental flows and alternative portfolios
- increase awareness and facilitate dialogue around the plan and the review process
- gain an understanding of the differences across the region in community values relating to water planning and management
- provide opportunities for representation of a broad cross-section of the community and stakeholders affected by water planning decisions
- develop clear tools for explaining complex concepts to the community.

Engagement activities were selected to complement each other and broaden participation across the different audiences, including the following:

- Deliberative-style community workshops were held between mid-2013 and late 2015 in three rounds (designed to reflect the phased review process) across the Sydney Water customer area. A demographically-representative group of around 200 community members attended the workshops.
- A one-day futures visioning workshop was held for community participants to contribute their views and aspirations for the future of water use and management in Greater Sydney. Three visions of what this might look like in 50 years' time were developed – healthy, green, and balanced; innovative, technological, and data driven; and educated, informed and aware.
- Annual community sentiment monitor surveys were conducted, forming an integral part of the review process. These involved online and phone surveys with representative samples of residents. The surveys were conducted during each planning phase, and tested the community's perception of their water use, level of support for water restrictions, recycling and stormwater reuse, and their views on implementing environmental flows from Warragamba Dam.

- Online focus groups and surveys validated and updated the community planning principles used in the 2010 plan, checking the existing principles, refining them and then ranking a revised set of values. The five top-ranked community values were further explored in the third round of workshops, with participants individually ranking the five values in order of importance to them. The final community value rankings were:

1. Clean and safe water for drinking and swimming.
2. Efficient use of water to avoid waste.
3. Water that is affordable to all.
4. Planning for the future.
5. Protecting the natural environment.

Stakeholder views and preferences informed the plan

A range of state and local government, private sector and non-government stakeholders participated directly in the review through a series of facilitated events, workshops and briefings. This allowed stakeholders to provide input across a variety of issues, including water efficiency and recycling, liveable cities, and water scarcity and security. Stakeholders also received updates on various aspects of the water planning process, including the latest climate modelling and population projections.

Workshops for stakeholders, attended by peak industry bodies and state and local government representatives, were run parallel to community workshops in the first two phases of the review.

A series of meetings and briefings were held between Metro Water and the Sydney Desalination Plant Pty Ltd during the review. Representatives of the Sydney Desalination Plant Pty Ltd provided technical, financial and operational data and information relevant to the review of the supply portfolio for the plan, as well as advice on perceived risks and potential alternative operating rules.

Socio-economic research helped us understand the community's preferences

Economic, survey-based 'choice modelling' was used for quantifying the non-market values associated with drought response measures and river health options. Choice modelling is a 'stated preference' technique that can be used to estimate non-market environmental benefits and costs. It involves a sample of people who are expected to experience the benefits/costs being asked a series of questions about their

preferences for alternative future resource management strategies.

The choice modelling survey findings were used to gain an understanding of the community's preferences for individual drought response measures and package of measures and their willingness to pay/willingness to avoid measures, in particular water restrictions. A separate survey was undertaken to assess the community's willingness to pay for Hawkesbury-Nepean River health benefits to inform the Warragamba Dam environmental flows options assessment project²⁶.

Monitoring and evaluation support continuous improvement

Monitoring and evaluation are essential tools for the implementation and ongoing improvement of the plan. In a process of continuous improvement, the latest and most robust information will be used to assess if the plan is meeting its objectives and to make timely decisions on how best to

adapt it to incorporate the latest knowledge, experience and technology. This adaptive management approach is illustrated in Figure 11 below, showing how the evaluation process can trigger adjustments to the plan ahead of a major review.

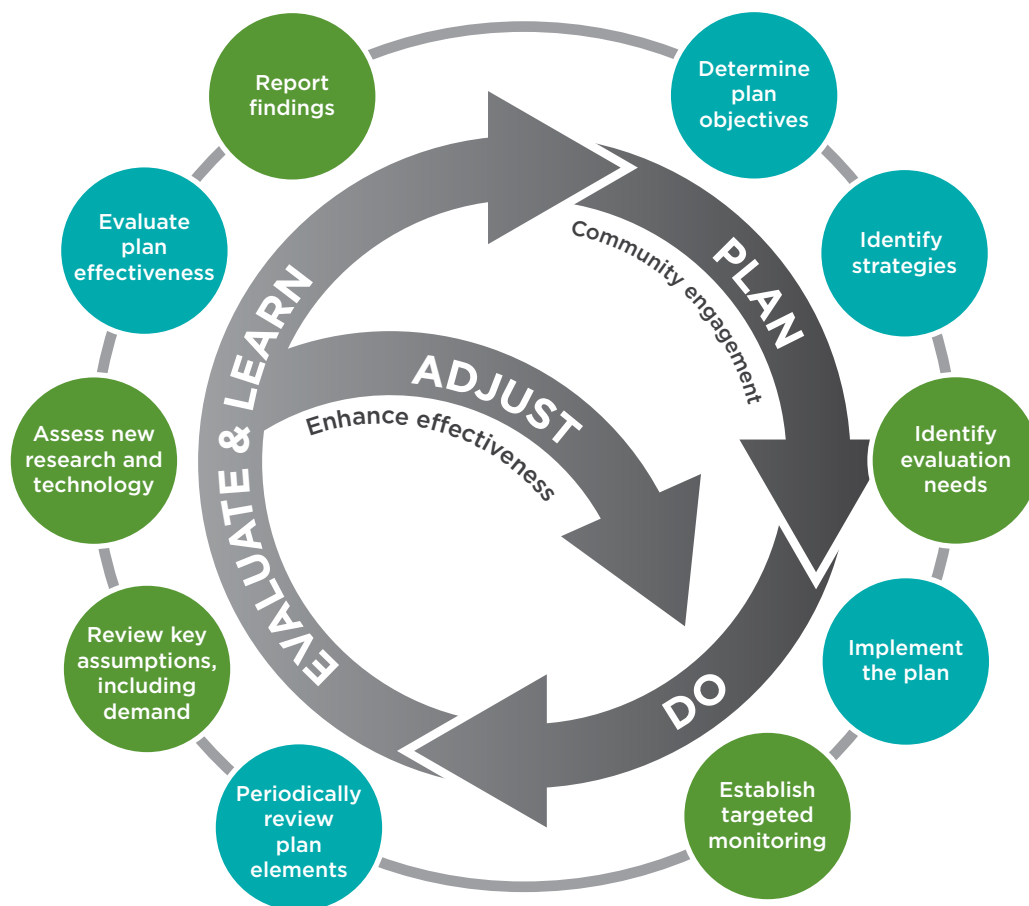


FIGURE 11: Adaptive management approach

A detailed Monitoring, Evaluation, Reporting and Improvement Plan is being developed to guide and support the plan's implementation.

Monitoring and evaluation of the plan will involve assessing:

- effectiveness and efficiency in delivering on the goal and outcomes
- whether strategies have been implemented in a timely way
- key assumptions in the demand forecasts and supply modelling
- the actual supply and demand balance compared with our forecasts
- the effectiveness of the Drought Response Strategy (if we experience a drought)
- whether the measures continue to be appropriate and relevant with changes in the supply-demand balance, regulatory regimes, advances in technology and other developments
- any adjustments to the plan that may be required due to new proposals being brought forward for consideration by government.

How the plan will be implemented

The Metropolitan Water Plan comprises a suite of strategies that build on work undertaken as part of previous plans, new programs and initiatives that will be rolled out over the next several years, and actions that will be taken should drought conditions return. The implementation guide below (Table 3) provides a summary of these strategies in the plan, associated actions and the timeline (where relevant) for implementation.

The plan will be subject to ongoing review by the governing framework, led by the Metropolitan Water Chief Executive Officers Committee and overseen by the Independent Water Advisory Panel.

Effective community and stakeholder engagement will remain an ongoing feature of the plan's implementation and the development of future water plans.

This engagement will be 'fit-for-purpose', addressing the needs of the plan and the expectations of our community and stakeholders. Engagement activities will be complementary, delivered across a range of platforms (workshops, surveys, online) and involve a broad cross-section of the Greater Sydney community.

The plan's outcomes will be monitored regularly and the plan will be subject to a full review no later than 2022.



TABLE 3: Implementation guide for the 2017 Metropolitan Water Plan

Outcome	Strategies	Actions	Timeframe
Our water supply is secure and affordable	Making the best use of our existing supplies	Water supply system is managed according to triggers and sequencing of measures in the plan	2017 onwards
		Changes to regulatory instruments to reflect revised operating rules for Sydney Desalination Plant	2017
	Investing in water conservation	Finalisation of Sydney Water's Water Conservation Report	September 2017 and measures implemented as required
		Sydney Water's Water Conservation Report	Annually
		Metro Water's annual assessment of level of investment in water conservation against water security risks and capacity to respond to drought	Annually
	Investigating new water sources for long-term needs	Develop mechanism for investigating new proposals for meeting the region's water supply and water security needs	2017-18
		Assessment of shortlisted and new options to meet long term water supply needs	2017-20
		Engagement with the community on future uses of recycled water	2018-21

Outcome	Strategies	Actions	Timeframe
Our water supply system is resilient to stresses and shocks	Drought Response Strategy	Commission study to recommend most suitable drought supply options to respond to extreme drought	Triggered at 60% of total dam storage
	Identifying and mitigating risks to water security	If required, alter trigger levels for supply and drought response options in response to rapidly rising demand, supply interruptions and water quality problems	As required
	Planning for our variable climate and climate change	Undertake studies to understand the impacts of climate change on rainfall, run-off and water demand	2017-21
Our urban communities are more liveable and resilient	Establishing the WaterSmart Cities program	Implement program elements including developing integrated water plans in two growth areas, capacity building and community engagement	2017-20
		Funding for the WaterSmart Cities program from contributions by Sydney Water to the Climate Change Fund. An amount of \$7.12 million to be allocated to the program	2017-20
	Investigating barriers and enablers to cost-effective water recycling	Scope and undertake review	2017-18
	Establishing partnerships and collaborative arrangements	Develop collaborative arrangements between state agencies, local government and industry	2017-20

Outcome	Strategies	Actions	Timeframe
Rivers downstream from dams are healthy	Implementing variable environmental flows from Warragamba Dam	Finalise flow rules following investigation of other options to 90/10 scaled	2017–20
		Implement flows once release infrastructure is constructed	~2024
	Modifying Warragamba Dam to release the flows	Investigate the most appropriate infrastructure design for release of flows Coordinate studies with investigations into the raising of Warragamba Dam for flood mitigation purposes	2017–19
	Protecting the benefits of environmental flows	Improve coordination of government efforts to help reduce the impact of nutrients and pollutants on the Hawkesbury-Nepean River	Ongoing
		Amend the Water Sharing Plan to protect flows	By 2023
	Monitoring and adaptive management of flows	Develop and implement pre-release monitoring regime	2017–24
		Monitor and evaluate flows	From 2024 onwards

References

- ¹ Sydney Water 2017, 'Safe drinking water', <http://www.sydneywater.com.au/SW/water-the-environment/how-we-manage-sydney-s-water/safe-drinking-water/index.htm>, viewed 15 Jan 2017.
- ² Department of the Environment and Energy 2006, 'Australian guidelines for water recycling: managing health and environmental risks (phase 1) 2006', <http://www.environment.gov.au/water/publications/quality/water-recycling-guidelines-health-environmental-21.html>, viewed 15 Jan 2017.
- ³ WaterNSW 2017, 'Water network', <http://www.watnsw.com.au/supply/Greater-Sydney/dams>, viewed 15 Jan 2017.
- ⁴ Sydney Desalination Plant 2017, <http://www.sydneydesal.com.au>
- ⁵ Metropolitan Water Directorate 2017, 'Water recycling projects', <https://www.metrowater.nsw.gov.au/recycling/map>, viewed 15 Jan 2017.
- ⁶ Independent Pricing and Regulatory Tribunal New South Wales (IPART) 2017, <https://www.ipart.nsw.gov.au/Home/Industries/Water>, viewed 15 Jan 2017.
- ⁷ Australian Government 2005, 'Water Efficiency Labelling and Standards' scheme (WELS), <http://www.waterrating.gov.au/>, viewed 15 Jan 2017.
- ⁸ Department of Planning and Environment 2004, 'BASIX', <https://www.planningportal.nsw.gov.au/planning-tools/basix>, viewed 15 Jan 2017.
- ⁹ Sydney Water 2009, 'Water Wise Rules', <http://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/water-restrictions/>, viewed 6 Feb 2017.
- ¹⁰ Office of Environment and Heritage 2017, NSW Climate Change Policy Framework, <http://www.environment.nsw.gov.au/topics/climate-change/policy-framework>, viewed 15 January 2017.
- ¹¹ Binney P, Donald A, Elmer V, Ewert J, Phillis O, Skinner R and Young R, 2010. *IWA Cities of the Future Program: spatial planning and institutional reform conclusions from the World Water Congress, September 2010*: IWA Cities of the Future Program. International Water Association, Melbourne.
- ¹² Australian Government, Department of Agriculture and Water Resources 2008, 'National Urban Water Planning Principles', <http://www.agriculture.gov.au/water/urban/policy-reform-urban-water/planning-principles>, viewed 15 Jan 2017.
- ¹³ Sydney Catchment Authority 2011. *Water Supply System Model and Yield Review 2009/2010* (Vol 1: Main Report, p.27). Sinclair Knight Merz.
- ¹⁴ Water Services Association of Australia 2014. The role of the urban water industry in contributing to liveability: Occasional Paper 30, <https://www.wsaa.asn.au/publication/occasional-paper-30-role-urban-water-industry-contributing-liveability>
- ¹⁵ Water Services Association of Australia 2014. The role of the urban water industry in contributing to liveability: Occasional Paper 30, <https://www.wsaa.asn.au/publication/occasional-paper-30-role-urban-water-industry-contributing-liveability>.
- ¹⁶ Office of Environment and Heritage 2016, 'Climate Change Fund Draft Strategic Plan 2017 to 2022', <http://www.environment.nsw.gov.au/resources/climatechange/Environmentalfuturefundingpackage/draft-climate-change-fund-strategic-plan-20160438.pdf>, viewed 15 Jan 2017.
- ¹⁷ Parramatta River Catchment Group (PRCG) 2017, <http://www.ourlivingriver.com.au>, viewed 15 Jan 2017.

- ¹⁸ International Water Association 2016, 'The IWA Principles for Water Wise Cities', <http://www.iwa-network.org/publications/the-iwa-principles-for-water-wise-cities/>, viewed 15 Jan 2017.
- ¹⁹ Binney P, Donald A, Elmer V, Ewert J, Phillis O, Skinner R and Young R, 2010. *IWA Cities of the Future Program: spatial planning and institutional reform conclusions from the World Water Congress, September 2010*. IWA Cities of the Future Program. International Water Association, Melbourne.
- ²⁰ Australian Government, Department of Agriculture and Water Resources 2008, 'National Urban Water Planning Principles', <http://www.agriculture.gov.au/water/urban/policy-reform-urban-water/planning-principles>, viewed 15 Jan 2017.
- ²¹ Sydney Water, 'Operating Licence' 2017, <https://www.sydneywater.com.au/SW/about-us/our-organisation/what-we-do/operating-licence/index.htm>, viewed 15 Jan 2017.
- ²² Department of Planning and Environment 2016, 'Population projections', <http://www.planning.nsw.gov.au/Research-and-Demography/Demography/Population-projections>, viewed 15 Jan 2017.
- ²³ Department of Planning and Environment 2014, 'A plan for growing Sydney', <http://www.planning.nsw.gov.au/Plans-for-your-area/Sydney/A-Plan-for-Growing-Sydney>, viewed 15 Jan 2017.
- ²⁴ Greater Sydney Commission 2014, 'Towards Our Greater Sydney 2056', <http://www.greater.sydney/towards-our-greater-sydney-2056>, viewed 15 Jan 2017.
- ²⁵ Department of Planning and Environment 2015, 'A plan for the future of the Illawarra-Shoalhaven', <http://www.planning.nsw.gov.au/Plans-for-your-area/Regional-Plans/Illawarra-Shoalhaven/Plan>, viewed 15 Jan 2017.
- ²⁶ Bennett, J, Cheesman, J, Blamey, R, Kragt, M, 2015, 'Estimating the non-market benefits of environmental flows in the Hawkesbury-Nepean River', *Journal of Environmental Economics and Policy*, vol. 5, no. 2, pp. 236-248.



