

Sustainable and Climate Resilient Solution for Water Services – from Policy to Implementation – a Case Study

Dr Marlene Kanga AO, FTSE, FISC, Hon. FIEAust, Hon. FIChemE, Past President (2017-2019) World Federation of Engineering Organisations, Australia
E: marlene.kanga@wfeo.org

Abstract

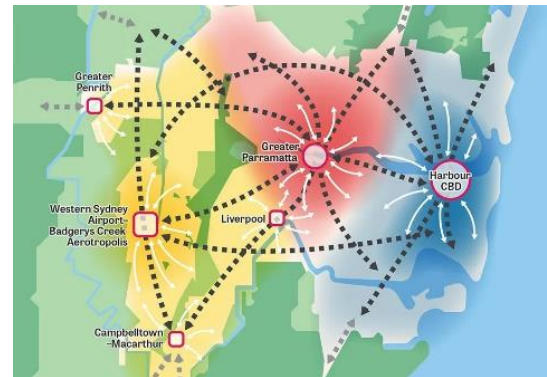
This Policy Brief presents a rare example of how a utility has implemented a government policy for sustainable development through long-term planning for sustainable water infrastructure for the expansion of the city of Sydney. It presents a roadmap for sustainable infrastructure development from government policy to long-term planning, the role of innovation and frontier technologies, the cost and benefits analysis that enables investment optimization, the use of innovative financing for major projects using SDG targets and reporting on progress against specific SDGs. These essential stages can be used as a blueprint for other cities to advance SDG Goal #6, as well as other related goals of SDG #13 (Climate Change), SDG #12 (Responsible of resources), SDG #11 (Cities and Communities) and SDG #8 (Economic Growth), SDG #3 (Health and Well-being), for the city of Sydney.

As with many cities around the world, Sydney Australia is growing rapidly. The proposed Aerotropolis and Western Sydney International Airport and associated industrial, commercial and residential development is expected to increase the population of Sydney, especially in the west, making it one of the top 10 fastest-growing regions in the Western world. By 2036 Sydney is projected to be home to another 1.7 million people and 3.2 million more people by 2056. The area of western Sydney is approximately 300 square kilometres, equivalent to the size of Adelaide, Australia, one of Australia's major capital cities. It is currently mainly rural and comprises chicken farms and vegetable gardens and, as a greenfield site, presents significant opportunities for sustainable and innovative development.

The historical and geographical context for Greater Sydney

Sydney can be considered as having three sub-cities, each with its unique urban characteristics. Since the Eastern harbour side city is the oldest, most of the jobs are concentrated in this area (blue area). The transport networks, especially rail, business head offices, universities and research precincts are all clustered in this area. The central part, is located around the Parramatta river (pink area) and the western part extends to the blue mountains (yellow area).

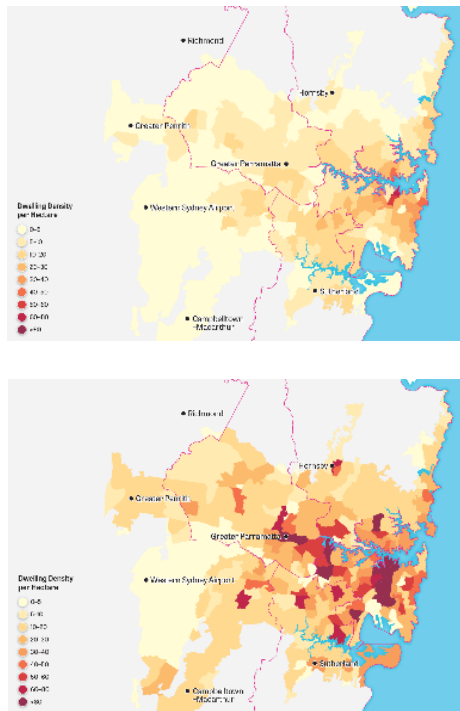
Figure 1. The “Three Cities” in Greater Sydney



Source: [Past, present and future | Greater Cities Commission](#)

Sydney is surrounded by waterways and mountainous ridges of the Blue Mountains which result in an approximately semi-circular area and which limits the extent that the city can grow. The ridges and ravines of the Blue Mountains national park and the Hawkesbury and Nepean rivers to the North West and South West in particular, hamper the development of roads and rail and in some areas and significantly constrain accessibility.

Figure 2: Sydney in 1996 (left): Detached housing dominated and in 2036 (right) increased housing density.



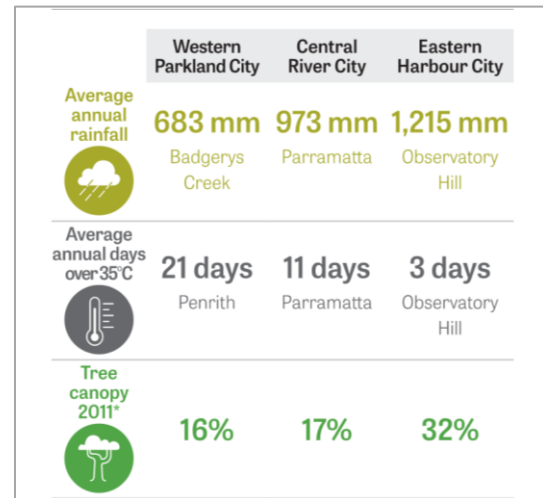
Source: [Past, present and future | Greater Cities Commission](#)

Western Sydney has had limited public transport development and there has been a heavy reliance on cars. Major roads have been a recent development although the toll road costs are a heavy impost on families. A historic car-based suburban form has significantly influenced the pattern of growth in much of the western parts of Greater Sydney. There has also been a shift in demographics due to the rising cost of housing, increasing demand for health and education facilities in western Sydney.

Climate change is impacting western Sydney which is expected to be at least 4 degrees warmer than the eastern city in summer, due to low rainfall and less tree canopy cover. The area is prone to flooding from the rivers with increasing frequency and severity.

The expected growth in the city mainly in the west, therefore required a re-think of the strategies for the city, especially with the location of the second Sydney International Airport, to open in 2025, and associated residential and industrial development.

Figure 3. Climate Variations across Greater Sydney



Source: [Past, present and future | Greater Cities Commission](#)

Government Policy for Sustainable Development

[The Greater Sydney Commission Vision](#) is a statement of government policy that takes account of the existing physical attributes of western Sydney and the prospective growth in population in the region, along with the need for transport and housing while keeping the area liveable, cool and green.

The Commission has recommended a plan for sustainable development which includes new health and educational facilities to meet the increasing demand arising from changing demographics. New knowledge-intensive jobs are to be created in western Sydney with the location of institutions for tertiary education and research, particularly in the fields of science, technology, engineering and mathematics (referred to as STEM).

Figure 4. Greater Sydney dashboard for monitoring the implementation of sustainable development plans



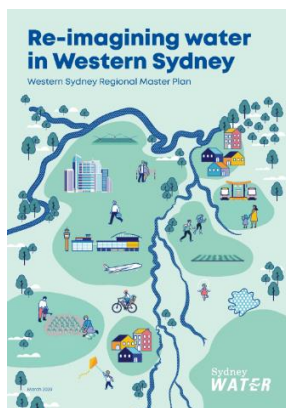
Source: [Past, present and future | Greater Cities Commission](#)

Sydney Water: Long-Term Planning to implement Government Policy for Sustainable Development

Water is of course essential to life and [Sydney Water Corporation](#), as Australia’s largest water services utility, and currently serving more than 5 million people in Greater Sydney has the important role of providing essential water services to the growing city.

Sydney Water Corporation is a rare example of how government policy for sustainable development. the [Greater Sydney Commission’s three-cities vision](#) for a smart and sustainable city, has been used as a basis for long term planning for investment decisions for future development of water infrastructure over the next 30 years.

Figure 5: Western Sydney Master Plan for Water



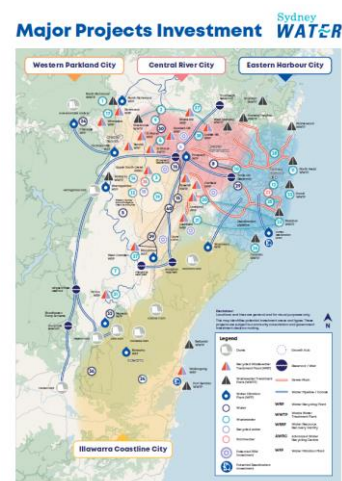
Source: [Western Sydney regional master plan \(sydneywater.com.au\)](#)

Long-term planning incorporates the government’s assumptions of the location and extent of future population growth, expected demand for water services, economic factors including inflation and

community appetite for improved recreational facilities incorporating inland waterways and the use of recycled water and the re-use of waste, including food and organic waste.

This is recognized as a once-in-lifetime opportunity to develop a sustainable city in a greenfield location and to implement new approaches to integrated water management for sustainable development. Sydney Water is developing major capital projects for water supply, and wastewater treatment. [More than \\$1.5 billion](#) is to be invested each year in these projects over the next ten years.

Figure 6: Sydney Water: Major Project Investments to 2030



Source: [Major Project Investment \(amazonaws.com\)](#)

A key Sustainability goal is to get to net zero carbon emissions by 2040. Sydney Water is one of 14 Australian and New Zealand water utilities to become [signatories to the United Nations-led Race to Zero carbon emissions campaign](#).

Another key component is [facilitating a circular economy](#). Infrastructure project ensure the sustainable use of water, including recycling, the re-use of valuable resources in wastewater, and the reuse of wastewater sludge and organic waste by converting to bio-methane, to generate renewable energy, with excess biomethane gas being injected into the gas grid. Sydney Water Corporation has a goal to achieve net zero emissions by 2030, thus addressing SDG # 13 (Climate Change).

For example, the [Sydney Water Malabar Wastewater Resource Recovery Facility \(WRRF\)](#) (formerly known as Wastewater Treatment Plants, showing the emphasis now on resource recovery) in south Sydney, is being expanded and will generate 95,000 gigajoules

of biomethane each year – enough to meet the gas demand of over 6,000 homes and reduce greenhouse gas emissions.

The [Advanced Water Recycling Centre \(AWRC\)](#) located in Western Sydney is a \$1.1 billion investment that will treat 100 million litres of wastewater daily by 2036 with resource recovery for Western Sydney from domestic and agricultural organic waste, to produce biomethane, and enable water recycling. The project is expected to generate up to \$10 billion in social and economic benefits, thus advancing SDG #12, Responsible Use of Resources, SDG #11 Sustainable Cities and SDG # 9 Innovation. A 10-minute drive from the new Western Sydney International Airport (opening 2025), it will activate a broader circular economy, making Western Sydney a truly smart and circular city.

Innovation for Sustainable Integrated Water Management Solutions at no additional cost

Sydney Water has developed [sustainable approaches to catchment and waterway management](#), including new urban typologies for this major new growth area. The typologies represent innovative thinking, capturing rainwater runoff for greening and cooling and winning national awards. They demonstrate sustainable catchment management, resolving the combined challenges of urban density, housing affordability, urban greening and floodplain management through the sustainable management of stormwater. There is no additional cost involved and with significant environmental and social benefits, including city greening and cooling and improved waterway health to enable [a better living and recreational environment](#) and quality of life for the people of Sydney.

These approaches are now mandated through planning controls for small and large, private and residential and industrial developments.

Figure 7: Sydney Water: Greenprint for Western Sydney



Source: [Sydney Water's 'greenprint' for Western Sydney - Government News](#)

Figure 8: Managing waterways through stormwater rehabilitation



Source: [Managing stormwater \(sydneywater.com.au\)](#)

Frontier Technologies for Sustainable Solutions

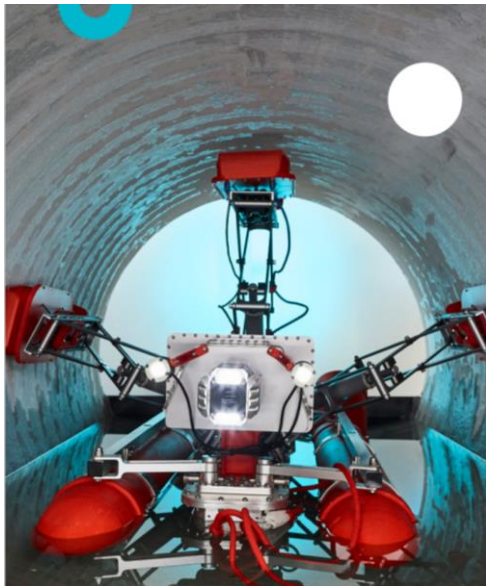
The organisation is implementing frontier technologies and has a [strategic approach to innovation](#).

For example, electronic devices have been installed in manholes to track water levels and transmit alarms to the central water network control room if there is a sudden increase in level, as this indicates a blockage that could overflow to the environment. Hundreds of sewer overflows have been anticipated and prevented with data obtained from this Internet-of-Things (IoT) technology. Digital technologies, including artificial intelligence, are used for failure prediction modelling, using data on historical breaks of mains and related age, soil type and materials of construction to develop a predictive model that enables targeted inspection and maintenance, thereby optimising costs and

reducing unplanned breakages and unwanted discharges to the environment, and service interruptions.

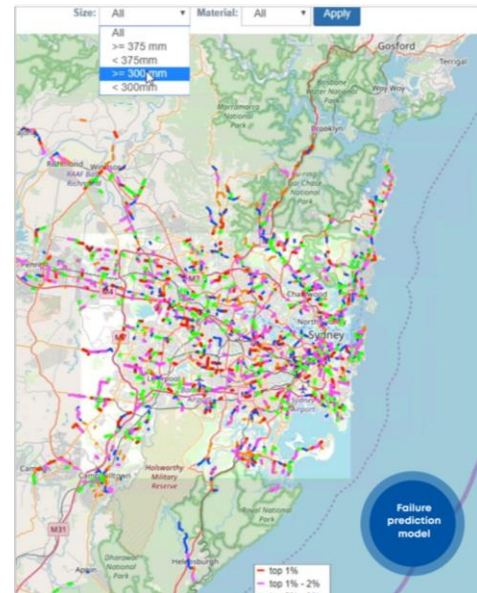
Robotics technology is used for the inspection of critical mains, especially in areas that are difficult to access, providing data on the internal condition of mains, the level of various chemical present, that can accelerate corrosion and assist in rehabilitation where needed, increasing safety for inspection and maintenance crews. Research partnerships have been well established with the major universities in Sydney.

Figure 9: Sydney Water: Robots for mains inspections



Source: [Research and innovation highlights 2021 \(sydneywater.com.au\)](https://www.sydneywater.com.au/research-and-innovation-highlights-2021)

Figure 10: Sydney Water: AI for predicting Mains Failure



Source: [Research and innovation highlights 2021 \(sydneywater.com.au\)](https://www.sydneywater.com.au/research-and-innovation-highlights-2021)










Cost Benefit Analysis of Sustainable Development Projects

The modelling of costs and benefits shows significant environmental, social and economic benefits for approximately the same net present value of investments as those that use conventional infrastructure planning without a focus on sustainable targets. The modelling optimises the timing of investment to maximise the benefits and estimates that the projects will deliver an additional dollar of benefits for every dollar of investment by advancing the sustainable development of water services and advancing SDG Goal #6, and other related goals of SDG #13 (Climate Change), SDG #12 (Responsible of resources), SDG #11 (Cities and Communities) and SDG #8 (economic growth), SDG #3 (health and well-being), for the city of Sydney.

Funding for Sustainable Projects

The projects are recognized for their sustainability credentials and are funded through the [NSW Government Sustainability bond program](https://www.nsw.gov.au/government-sustainability-bond-program). This provides a source of financing and a reduction in interest rates if sustainability targets are met, and an increase if not met, thereby providing an incentive for to deliver on these targets.

Figure 11: Sydney Water: Sample Projects financed through the sustainability bond program.

Project name	Project description	SDG	Indicator
Lower South Creek Treatment Programme: Quakers Hill and St Marys Water Recycling Plants Process and Reliability Renewal 	<p>Sydney Water is delivering the largest anaerobic granulated sludge bioreactor in Australia (as at construction) and infrastructure upgrades to meet the demands of a growing Western Sydney. Working towards a circular economy, the Lower South Creek Treatment Program includes the upgrade of St Marys and Quakers Hill water recycling plants which will deliver improved sustainability and significant energy and carbon savings. When fully operational, the improved treatment processes will produce a higher grade of stabilised biosolid and also generate more biogas captured through co-generation to increase energy efficiency and allow a large proportion of self-supply of electricity at the plants.</p> <p>Status: Most construction works completed and staged process commissioning began March 2022. Upgraded facilities expected to be fully operational from mid-2023.</p> <p>Target population: General population.</p>	  	<p>Operations (current): 100% (~7748 tonnes) of biosolids recovered from wastewater beneficially reused.</p> <p>Operations (post-upgrades): 42% estimated reduction in GHG emissions during construction and across its 50 year operation.</p>
Waterway naturalisation and stormwater improvement – Tranche 1 	<p>Replacement of deteriorating concrete sections with sandstone and stabilisation of banks with native plants, trees and rocks.</p> <p>Naturalising the stormwater channels increases the asset life from approximately 80 to 150+ years.</p> <p>Naturalisation and restoration works improve water quality, mitigate flooding, increase amenity and livability, as well as provide greater park access for the community.</p> <p>Status: Completed in stages up to March 2019 with vegetation establishment periods of 24 months and ongoing maintenance.</p> <p>Target population: General population.</p>	   	<p>Operations Removal of 436 cubic metres of silt and 179 tonnes of combined sediment and litter.</p>

Source: [NSW Sustainability Bond Programme Annual Report 2022.pdf](https://www.nsw.gov.au/infrastructure/infrastructure-funding/sustainability-bond-programme)

Reporting on Progressing the UN Sustainable Development Goals

Sydney Water is a signatory to the United Nations Global Compact and has pledged to embody its principles in the areas of human rights, labour, the environment and anti-corruption within its strategies, policies and operations. The Ten Principles of the UN Global Compact provide a common ethical and practical framework for reporting on progress in achieving the UN SDGs, based on the Global Reporting Initiative, a universal standard of sustainability reporting.

Progress is reported through the UN Global Compact's Early Adopter Programme, by mapping projects against specific UN SDGs and demonstrating their impact each year.

Policy recommendations / conclusions

This Policy brief provides an example of how government policy for a sustainable city has been implemented into specific development plans, especially for water infrastructure. It is recommended that sustainable development for city infrastructure be considered in the following essential elements:

- (a) explicit government policies for sustainable development of infrastructure,
- (b) long term planning of required investment of both the timing and location of investments
- (c) innovation and frontier technologies to maximise the benefits

(d) analysis of social, economic and environmental benefits

(e) financial support for required capital investment, linked to achievement of specific sustainable development targets

(f) reporting on progress through the UN Global Reporting Initiative.

This approach will enable city authorities to advance sustainable development plans in alignment with government policy, advancing SDG #11 (Cities and Communities), SDG #6 (Water), SDG #7 (Energy), SDG #13 (Climate Change), SDG #12 (Responsible use of resources), SDG #8 (Economic Growth) and SDG #3 (Health and Well-being).

References

- Greater Sydney Commission, Three Cities Vision, 2016, , [Three Cities | Greater Cities Commission](https://www.threecities.com.au/)
- Sydney Water Annual Report ,2022, <https://www.sydneywater.com.au/content/dam/sydneywater/documents/sydney-water-annual-report-2021-22.pdf>