City of Sydney

Recycled Water Plan

5 June 2012

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Glossary

Term	Definition
BOOS	Bondi Ocean Outfall System
CBD	Central Business District
CoS	City of Sydney
Demand intensity	Volume of demand per unit geographical area (i.e. ML per hectare)
End use	Refers to the specific use of water within sectors, for example 'toilets' or 'cooling towers'
FES	City of Sydney's Floor Space and Employment Survey
GIS	Geographical information system
GL	Gigalitre – 1 billion litres
IPART	Independent Pricing and Regulatory Tribunal
IPCC	Intergovernmental Panel on Climate Change
ISF	Institute for Sustainable Futures
kL	Kilolitre – 1 thousand litres
LGA	Local government area
Lot	A single parcel of land. A lot may represent a property and may be empty or have one or more buildings within it. In the context of water servicing, lot scale refers to the smallest administrative scale.
Major development	State Significant Developments as defined by the State Environmental Planning Policy (State and Regional Development) 2011. Previously defined under Part 3A of the State Environmental Planning Policy (Major Development) 2005, now repealed.
MAR	Managed aquifer recharge and recovery
MBR	Membrane Bioreactor Filtration Systems
MCA	Multi-criteria analysis
ML	Megalitre – 1 million litres
MUSCO	Mutli-utility servicing company (i.e. water and electricity)
NABERS	National Australian Built Environment Rating System
NWC	National Water Commission
OEH	NSW Office of Environment & Heritage
Potable	Drinking water or water of sufficient quality to be consumed or used with low risk of immediate or long term harm.

Term	Definition
Precinct	An area or part of the City containing a number of lots with similar attributes or local characteristics that may be beneficial to a particular water servicing strategy.
Rain garden	A planted depression designed to receive and treat surface runoff. The soil bed retains and slows the flow of water while microorganisms in the soil and vegetation remove pollutants.
Recycled water	Water that has been captured and treated to a high quality for use as an alternative water supply, including treated stormwater, sewage, grey water, groundwater and seawater.
SBLP	Smart Business Live Green Program
Sector	Broad categories defining the major land use associated with the water bill, such as ‘industrial’ or ‘residential’.
SWC	Sydney Water Corporation
SWSOOS	South Western Suburbs Ocean Outfall System
Thermal desalination	The use of heat to remove salt and other minerals from saline water to produce fresh water.
Trigeneration	The simultaneous generation of electricity, useful heating and useful cooling from the same energy source such as gas.
WASCO	Water Servicing Company
WICA	Water Industry Competition Act
WSUD	Water Sensitive Urban Design

Summary and Introduction

The Recycled Water Plan has used an evidence-based approach to provide a detailed understanding of Sydney's water context and uses an Integrated Water Catchment Management framework to understand opportunities that can transform the vision into reality.

The Plan is accompanied by a Water Sensitive Urban Design and Stormwater Infrastructure plan and a Water Efficiency plan which together form the Decentralised Water Master Plan.

GHD, Institute of Sustainable Futures and P3IC have prepared this Recycled Water Plan to validate the City of Sydney's Sustainable Sydney 2030 Vision.

This recycled water plan is summarised in the following chapters

Chapter 1 Context and Drivers

This chapter briefly explores the evolution of water supply in Sydney and introduces the values and drivers that are considered in the development of this recycled water plan. It discusses pull factors that value a different future and push factors that drive change such as policy and regulations.

Chapter 2 Approach and Methodology

This chapter outlines how an Integrated Water Catchment Management approach is used to identify decentralised water solutions by harnessing and mapping the data and knowledge that exists across the agencies responsible for managing the elements of the urban water cycle.

Chapter 3 Mapping Recycled Water Opportunities

This chapter investigates in detail the varied opportunities that exist throughout the City of Sydney's Local Government Area and identifies potentially viable recycled water opportunities.

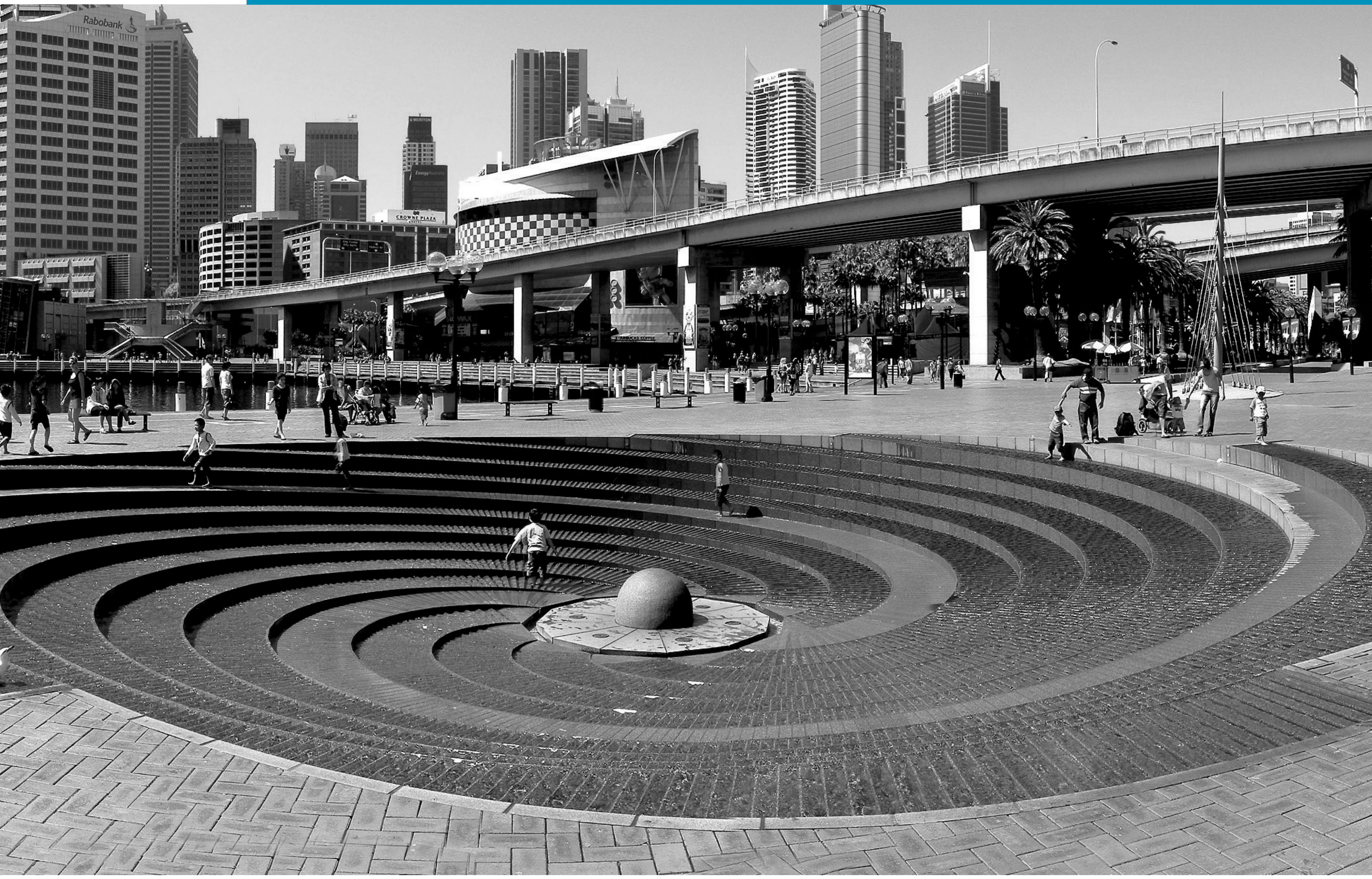
Chapter 4 Assessment of Conceptual Recycled Water Initiatives

This chapter assess a select number of opportunities that varied in scale of supply and demand and water sources for comparison across social, financial and environmental benefits.

Chapter 5 Recommendations

This chapter makes recommendations on a broad level to progress the initiative identified.

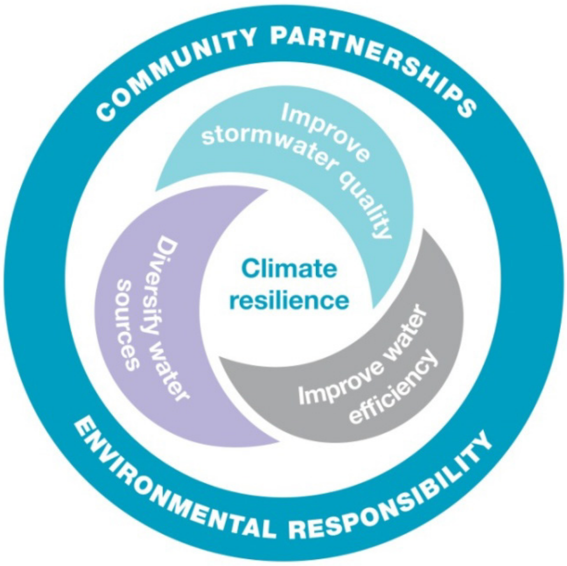
1. Context and Drivers



The City of Sydney's *Sustainable Sydney 2030* has set a target to generate 10% of water supply through local water capture, improve environmental performance of existing buildings and to reduce pollution to waterways by 50%.

Realising such a transformative vision cannot be achieved using the old ways of thinking about cities and city planning, it requires a new approach to how we understand the city and use our water sources.

Our framework uses an Integrated Water Catchment Management approach to consider water opportunities. Water efficiency, stormwater quality and diversified water sources are examined on their own merit in the Recycled Water Plan but inevitably are interlinked. This is not a Plan for the City of Sydney – it is a Plan for the people of Sydney and will need to be delivered in partnership with the community, businesses and government agencies.



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1.1 Context and Drivers

1.1.1 Evolution of Water Supply in the Sydney Context

The evolution of Sydney's water supply has come full circle, with each century heralding a new era as summarised in Figure 1 and below[1].

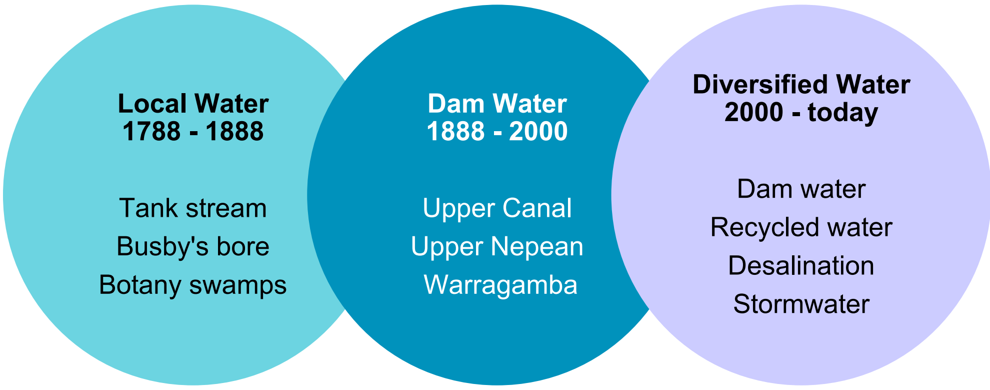

Figure 1 History of Sydney's water supply

Local water 1788- 1888

Sydney's first water supply was named the Tank Stream after the tanks that were cut into the side of a natural stream that ran into Circular Quay, where Pitt Street is today. Our first attempts at catchment management failed to prevent early settlers polluting the stream, which subsequently became an open sewer in 1826; and is now a stormwater drain that still operates today.

Sydney's second water supply was known as Busby's bore which transferred water from the Lachlan Swamp in Centennial Park through a four-kilometre tunnel to the south-eastern corner of Hyde Park. The tunnel was difficult and expensive to construct and was allowed to flow continuously, which eventually drained the Lachlan Swamp.

The Botany Swamps Scheme commenced in 1859 at the location known as Botany Wetlands today. It was a plentiful supply for 20 years but was again depleted as the population and demand grew. The Botany Wetlands are connected to the Centennial Park wetlands and the Botany Sands groundwater aquifer.

Dam Water 1888 – 2000

The end of the first century of English settlement brought water from further afield, originally from the Upper Nepean, which diverted water from four rivers to the Prospect Reservoir via 64 kilometres of tunnels, canals and aqueducts known as the Upper Canal. Drought in 1901-1902 brought Sydney perilously close to running out of water and resulted in two Royal Commissions and the construction of four dams on the source rivers for the Upper Nepean Scheme – Cataract, Cordeaux, Avon and Nepean.

Sydney's largest dam, Warragamba which is over 70 km away, was completed in 1960 following another record drought between 1934 and 1942. Warragamba is

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[1] Sydney Catchment Authority, available at: http://www.sca.nsw.gov.au/dams-and-water/water-supply-history [accessed on 6 February 2012]

still the major source of drinking water supplied to Sydney, which is treated at the Prospect Water Treatment Plant.

Diversified Water 2000 – today

Sydney has been a leader in water efficiency since the mid 1990's with a target to reduce demand by 35 per cent from the 1991 baseline by 2010, which deferred the need for any major augmentation since Warragamba Dam. Sydney Water's internationally recognised Every Drop Counts program has successfully targeted both residential and non-residential demand with over $370 million invested.

Sydney Water was also the first Australian water utility to introduce recycled water, delivered through a third pipe system, to a residential development at Rouse Hill in 2001 . Whilst these schemes do not directly benefit properties in the City of Sydney, they reduce demand from Sydney's existing drinking water supplies.

Our recent drought saw Warragamba Dam's level drop to 33% in 2007, which triggered stage three restrictions and community and political debate about how to manage the risk of running out of water and augmenting the water supply in the context of climate change.

Non-rainfall dependent water supply solutions, including recycled water and desalination, were alternatives introduced to improve the resilience and the capacity of the integrated supply system. Expansion of the Shoalhaven scheme and completion of the desalination plant at Kurnell in 2010 and introduction of recycled water schemes in growth areas have addressed the short to medium term demand for water.

At the same time, water restrictions resulted in a proliferation of rainwater tanks and small-scale stormwater harvesting and recycled water schemes.

The combination of drought response measures, including desalination and water efficiency improvements, has bought Sydney some more time (beyond 2025 according to the Metropolitan Water Plan) before we need to consider the next major source augmentation. However this is subject to climate conditions continuing to supply the dams.

Every option has an environmental and financial cost. This could be avoided or deferred if we start thinking smarter about how we use the water we do have and maximise opportunities for reuse in a planned, efficient and cost effective way.

1.2 Drivers for Setting Recycled Water Targets

The Sustainable Sydney 2030 Vision was developed with broad community involvement and support during 2007 and 2008 to create a green, global and connected City and recognised that liveability and sustainability are fundamental to the City's future and competitive advantage.

The targets in Sustainable Sydney 2030 were originally framed with 2006 as the baseline year, which was when Sydney was experiencing water shortages and was at the peak of the drought. The aspirational targets were formed in the absence of the detailed analysis that has been undertaken as part of the Decentralised Water Master Plan. There have been significant changes in the water landscape in Sydney since these targets were established.

1.2.1 Diversify water sources

The trend towards more water sensitive cities is gaining a lot of traction in Australia and internationally. Melbourne and Perth [2] have both produced long term plans to achieve a water sensitive city, which is described by the Centre for Water Sensitive Cities as a city where:

"water's journey through the urban landscape is managed with regard for its rural origins, coastal destinations and spiritual significance. A philosophy of flexibility in supply and use to meet all users' needs underpins the collection and movement of water, and the technologies to facilitate the physical movement of water are designs that manifest these ideals visually for all to acknowledge and appreciate."[3]

Without a broader vision Sydney is at risk of locking in a pattern of city design and development that will commit us to costly ongoing augmentation of our water supply and further environmental damage.

The *Sustainability 2030* vision set a target to capture 10% of water locally by 2030 as a step towards a more water sensitive City of Sydney.

For the purposes of this Master Plan we have defined 'local water' as non-potable water substituted for potable water from diversified sources including, groundwater, stormwater, roof water, sea water and recycled wastewater (including grey water, black water and sewer mining). It is also assumed that water efficiency savings are additional to the local water capture target.

Target setting involves both push factors (i.e. the things that we simply must respond to where the question is how and not if) and pull factors (our aspirations for a preferred future). There have been a number of changes in Sydney's water supply since the City of Sydney first established its vision in 2006 to capture 10% of water locally. This section summarises the key Pull and Push factors that influence the review of this target:

1.2.2 Pull Factors

The City of Sydney's vision aims to merge water management objectives with objectives to improve liveability within the city such as healthier waterways, reduced urban heat and green public spaces. This approach requires a broader assessment framework than pure quantities and costs.

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[2] Water Corporation, Water Forever: Towards Climate Resilience, October 2009

[3] Centre for Water Sensitive Cities, available at http://www.watersensitivecities.org.au/about-us/water-sensitive-cities/what-is-a-water-sensitive-city/ [accessed at 6 February 2012]

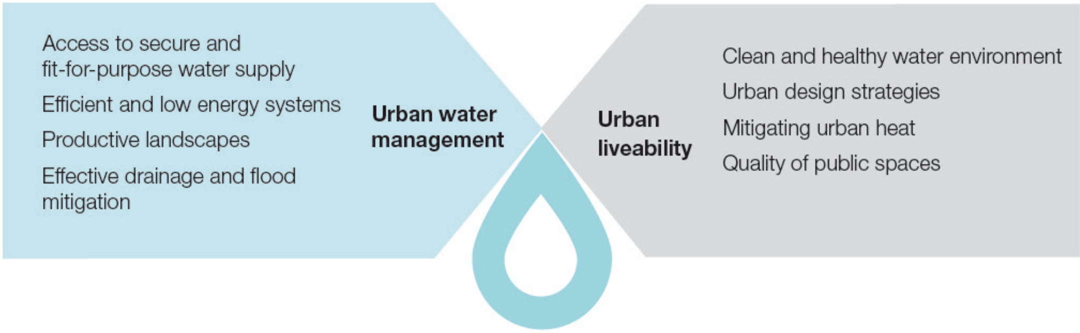

Figure 2 Merging water and liveability objectives

Sydney's Decentralised Water Master Plan has the potential to improve water management and liveability at the same time through:

- **Access to secure and fit-for purpose water supply;** The centralised water supply is treated to drinking water standards offering a 'one size fits all' product at a uniform price. Decentralised water systems can match treatment to the purpose and can provide additional resilience in the water supply system during times of drought.
- **Efficient and low energy systems**; Water is heavy and requires energy to treat, pump and transfer water over long distances. Capture of local water potentially requires less energy than the centralised water supply system, although small recycling plants can be energy intensive, depending on the level of treatment required. To minimise energy consumption there is potential to utilise waste heat from trigeneration plants, using thermal desalination in the treatment process.
- **Productive landscapes**; Whilst community water saving efforts and, at times, water restrictions have helped us through drier periods, they have constrained the community's use and enjoyment of public open space, private gardens and many sporting fields. Diversified water sources offer the potential to improve the community's sense of well-being and quality of life.
- **Effective drainage and flood mitigation**; Water Sensitive Urban Design and stormwater harvesting will reduce pollution levels and may also ease nuisance flooding through additional detention and storage
- **Cleaner and healthier waterways**; through reduced volumes of stormwater and sewage disposed to the rivers, harbour and ocean. Healthy waterways provide not only environmental benefits, but also improved opportunities for both passive and active recreation.
- **Urban design**; water sensitive design integrates water into the landscape, improving aesthetics and social amenity as well as environmental outcomes
- **Mitigating urban heat;** through a greener Sydney, decentralised water systems can help to lower the average temperature and thereby reduce potential death and discomfort; reduce energy demand on peak days; and improve local climate change outcomes
- **Quality of public spaces**; public open space, roads and footpaths incorporating Water Sensitive Urban Design and stormwater harvesting to irrigate green landscapes and filter pollutants

An investment in a water sensitive future is also an investment in a green economy by partnering with the private sector to build, operate and maintain decentralised water systems. This could help Sydney to become a leader in innovative design and technology.

Better Building Partnerships and NABERS accreditation

A unique position exists within the City as approximately 80% of properties within the CBD are owned by a small number of owners. This creates a unique opportunity to discuss and engage with building owners for better outcomes for both the City , its residents and the building owners. The City has recognised this significant opportunity and have established a forum with these owners called the Better Building Partnership.

The City's economic activity represents 8% of the National Australian economy with over 20,000 business establishments that provide jobs for over 385,000 people. The City is an international tourist destination with over 4 million visitors per year. As a result the City attracts major national and international companies that seek environmental and positive corporate image credentials. This translates to NABERS green star credentials which are of major interest. The recycled water plan supports the ease in which these objectives could be realised.

1.2.3 Push Factors

Water supply security, climate change, government targets, population growth and avoided system costs are amongst the push factors that will influence the demand for and timing of diversified water opportunities:

Population Growth and Redevelopment

Water resources, the capacity of the water supply and wastewater transfer systems and subsequent environmental impacts are key considerations for the targets in the Recycled Water Plan.

The government's population forecast for Greater Sydney is expected to reach six million, an increase of 1.5 million by 2036. In the context of the City;

There are over 180,000 people that live in the City of Sydney which is expected to grow by 63,000 to 243,000 by 2030. The City attracts over 4 million visitors per year. Additionally the City's economic activity represents 8% of the national Australian economy with over 20,000 business establishments that provide jobs for over 385,000 people.

Population growth will not only impact upon water supplies but also on wastewater discharges to the ocean.

Accordingly, the Recycled Water Plan has identified an estimated 30% increase in potable water supplies to the City, and a 30% increase in wastewater discharges to the ocean from the City by 2030.

Figure 3 shows the major infill development sites identified in the City of Sydney area in the next five years, which have also been captured in the Decentralised Water Master Plan growth forecasts. Growth is characterised by a number of major redevelopments in the short to medium term, including Barangaroo, Green Square, Fraser's Central Park and the Darling Harbour convention centre. Additional growth is expected south of the City in the Cooks River catchment in areas surrounding Alexandra Canal, although timing and planning for this development is less clear.

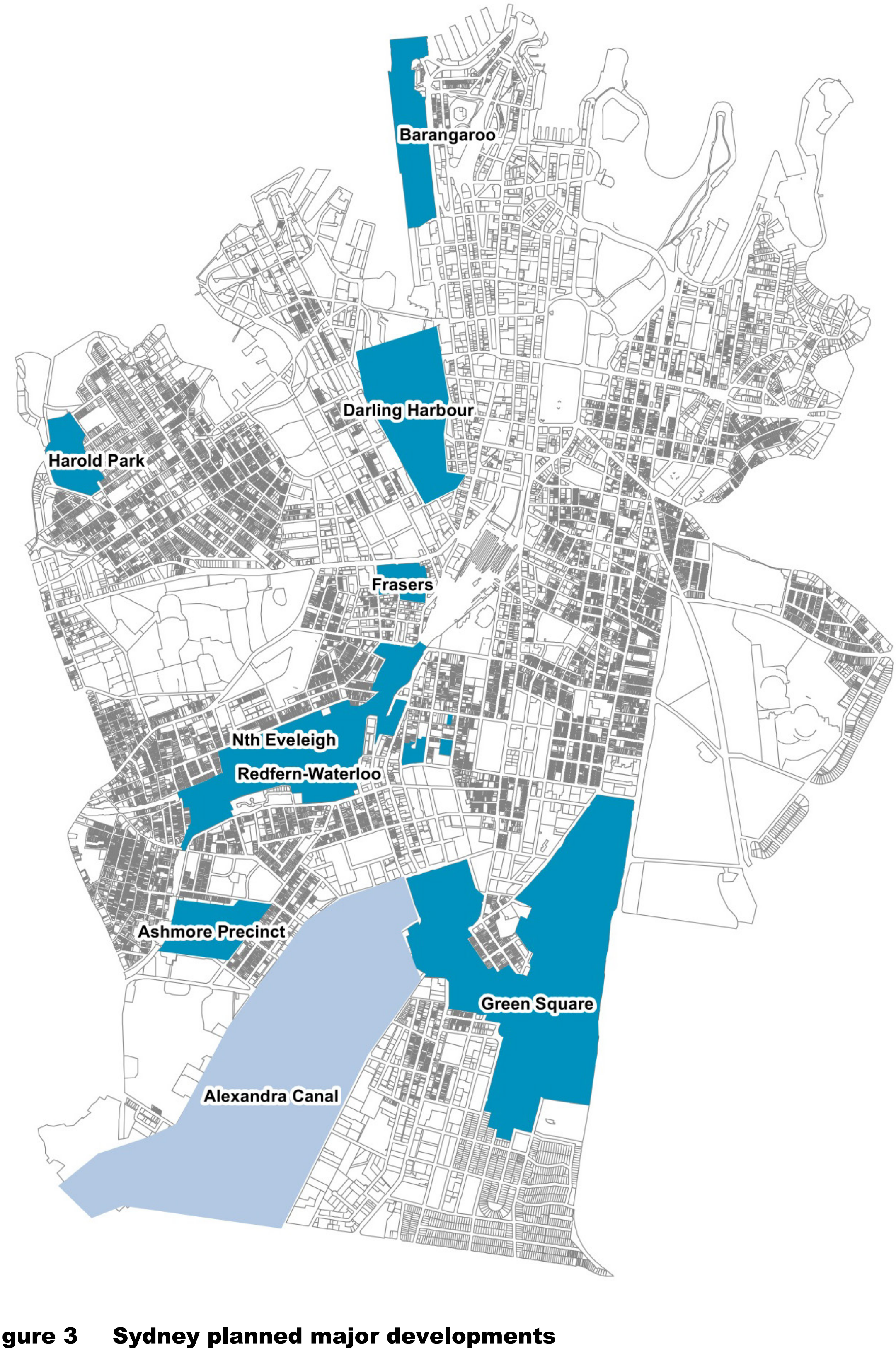

Figure 3 Sydney planned major developments

Water Supply Security

The City of Sydney's *Sustainability 2030* targets were originally set with 2006 as a baseline, at a time when drought and water security were front page issues. The front page has more recently been replaced with stories of record rainfall and floods, reflecting Australia's variable climate.

Figure 4 shows' low storage levels in 98 and 2006 and increases in dam storage capacity since 2006 as well as the increase in storage levels since the drought ended. Dam storage levels at the time of writing this report (February, 2012) were 80 per cent.

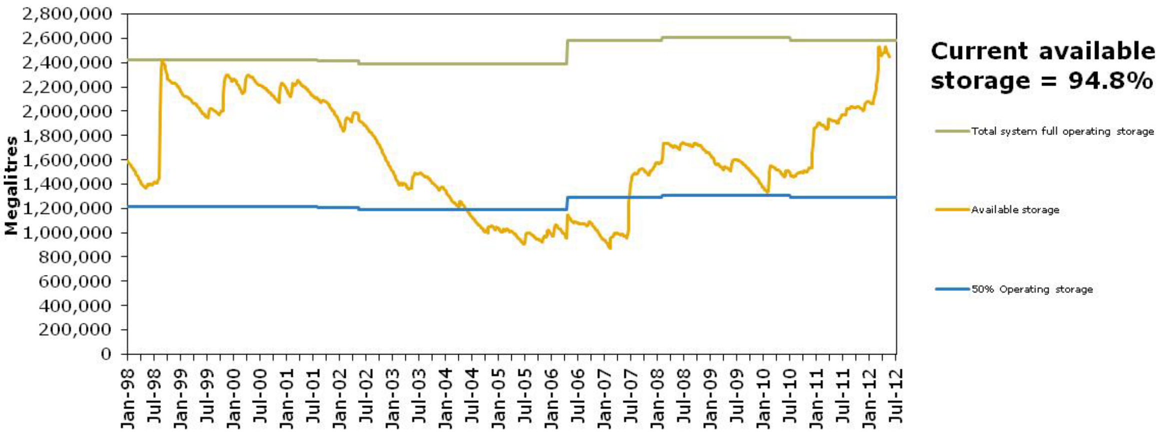

Figure 4 Available water storage[4]

Drought has long been a part of the Australian landscape, which is why we have one of the highest per capita storage levels in the world. Approximately 20% of Sydney's storage equates to more than one year's water supply.

Figure 4 highlights how sensitive and vulnerable the Sydney metropolitan water supply catchment is to climate variability. Following low storage levels in early 1998, significant rainfall rapidly filled Warragamba Dam and then storage levels steadily declined in the decade following, with well below average rainfall between 2003 and 2007. This resulted in diversifying and augmenting the supply system and triggered the construction of the desalination plant (capacity of 90 GL/y at full production, with potential to expand to 180 GL/y) when storage levels reached 33% in 2007. Again in 2012 Sydney experienced significant rainfall events which caused Warragamba dam to fill and overflow.

Climate Variability

The Sydney Metropolitan Catchment Management Authority projects an 8% decrease in yield from Sydney's dams over the next 20 years under the most likely climate change scenario.

[4] Sydney Catchment Authority 18 May 2012, http://www.sca.nsw.gov.au/dams-and-water/weekly-storage-and-supply-reports/2012/19-january-2012

The NSW Office of Water, in partnership with Sydney Water, conducted a study on climate change at its impact on water supply and demand in Sydney, which concluded an adaptive management approach to water planning. Through this adaptive approach it was recommended to:

- Manage risk by having the appropriate buffer between supply and demand
- Understand the likely pressure points on the supply and demand balance in the future
- Respond to changing conditions due to both climate change and climate variability

Whilst Sydney had experienced periods of climate variability before, the awareness of climate change risk has led to a more diversified approach to water supply planning that includes non-rainfall dependent supply options, including desalination recycled water and water efficiency.

This plan seeks to further extend this strategy with more local and synergistic considerations that are present within the City of Sydney.

Government Recycled Water Targets

In 2007 the Federal Government set a national recycled water target of 30%. In contrast Sydney in 2009/10 was only achieving 7% of this target with the 2010 Metropolitan Plan setting a target of 21% by 2030 falling short of the Federal targets.

The Federal Government set a recycled water target of 30% in 2007, which is now subject to review. There has been a significant investment in recycled water across Australia and lessons learned from these initiatives. The National Water Commission produced a Position Statement in 2010 stating it support for recycled water, subject to four conditions[5]:

- Prior cost /benefit and risk analyses are conducted which take full account of social and environmental externalities and avoided costs
- The best available science is utilised
- The project is subject to best practice regulatory arrangements
- Community participation in decisions to introduce recycling and that subsequent management arrangements are transparent and accountable

The National Water Commission also produces a National Performance Report, which compares water statistics, including recycled water, across Australia and for major cities as summarised in Figure 5 below:

[5] National Water Commission Urban Water Recycling Position Statement, November 2010

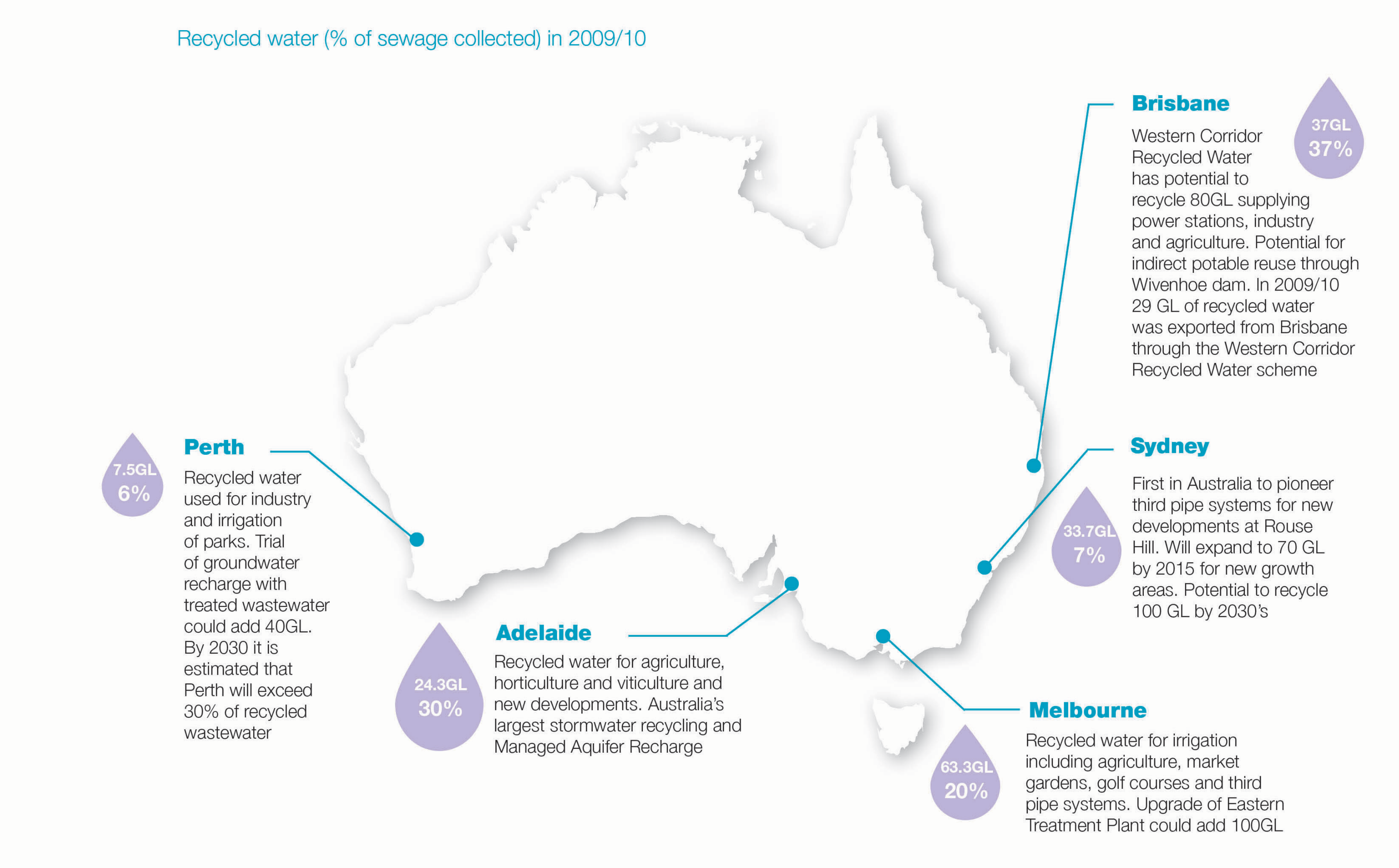

Figure 5 Recycled Water 2009/10 in Major Capital Cities[6]

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[6] Adapted from National Water Commission, National Performance Report 2009-10

Figure 5 summarises the current levels of recycled water (expressed as a % of wastewater collected in 2009/10) in Australia's major cities. The drought threatened the water supply security in each of the major cities depicted, which have since introduced desalination and invested in recycled water to provide additional capacity and strengthen the resilience of the water supply systems. The figure also includes a brief summary of planned recycled water initiatives, based on a review of available plans. It shows that Sydney produces the second highest volume of recycled water (33.7 Gigalitres) but is well behind other states as a percentage of wastewater collected (7%). The NSW Metropolitan Water Plan forecasts that this will increase to 12% by 2015 and up to 100 GL (21%) by the 2030's.

The NSW government released the Metropolitan Water Plan in 2010[7]. The Plan expects Sydney's population to grow to six million by 2036 and sets out how water agencies will work in partnership with the community to provide a secure water supply for the future. The Plan expects to provide water security until at least 2025 using a portfolio approach including:

- **Dams** – continuing to provide most of Sydney's drinking water (up to 570 GL per annum)
- **Recycled water** – reducing the demand for drinking water (70 GL per annum by 2015)
- **Desalination** – having capacity to supply up to 15 per cent of Sydney's current needs (up to 90 GL per annum at full production)
- **Water efficiency** – reducing demand for water by households and business (145 GL per annum saved by 2015 through BASIX and WELS program)

Figure 6 demonstrates how the NSW government plans to meet the 70 GL recycled water target through a combination of environmental releases, residential use, industrial and commercial use, irrigation and Sewerage Treatment Plant reuse.

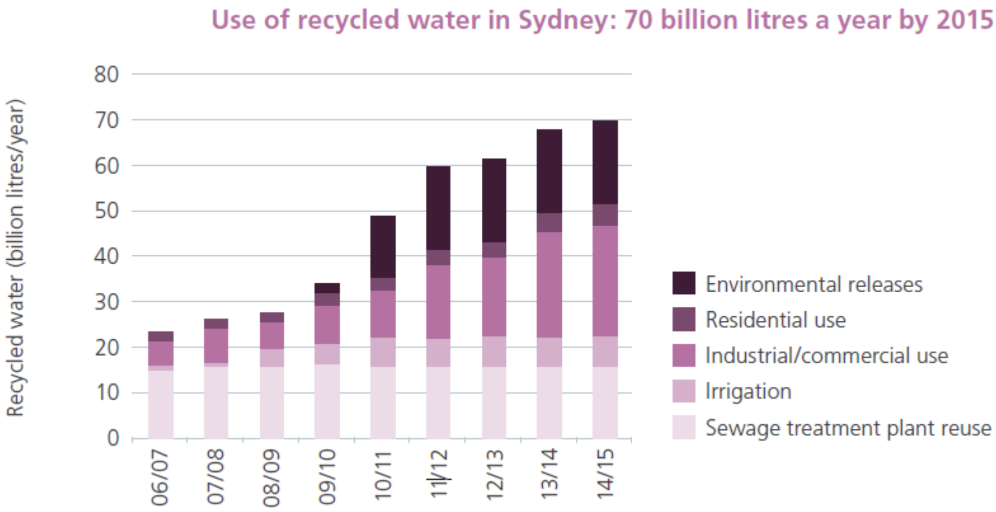

Figure 6 Use of recycled water in Sydney by 2015[8]

[7] 2010 Metropolitan Water Plan, NSW Office of Water, August 2010

[8] 2010 Metropolitan Water Plan, NSW Office of Water, August 2010

Beyond 2015, the Metropolitan Water Plan forecasts potential to recycle up to 100 GL of water by the 2030's. This includes a commitment to continue to support cost-effective smaller local-scale recycling, stormwater and sewer mining projects across Sydney and provide financial assistance through the NSW Climate Change Fund.

The Decentralised Water Master Plan has the potential to contribute to the achievement of the NSW water efficiency and long term recycled water targets.

City of Sydney, as a local council, has a unique level of control and influence to take the lead in exploring through this study the opportunities that exist for precinct scale decentralised solutions regardless of which agency will take responsibility for delivering them. Through the DWMP, the City of Sydney sees its role as a facilitator of integrated water cycle management at a local government scale, to initiate a conversation with the community and stakeholders about the possibilities

The government is supportive of private sector investment and has established Australia's first third-party access and licensing system under the *Water Industry Competition Act 2006*. Licences have been granted to private companies in the CBD and Darling Harbour to supply recycled water.

Sydney Water

A review was undertaken of Sydney Water's key planning documents, relating to the City of Sydney area, to understand existing objectives and plans for investment.

Sydney Water's updated Growth Servicing Plan for 2011- 2016 sets out Sydney Water's plans for water, wastewater and recycled water infrastructure to service urban growth over the next five years. This Plan is consistent with the government's 2010 /2011 Metropolitan Development Program and is updated annually.

The Plan indicates that Sydney Water has sufficient potable water trunk main capacity in the City area in the short term. There is a plan to amplify the Botany wastewater system in the Cooks River catchment and Bondi Ocean Outfall Sewer (BOOS), which services the CBD and Sydney Harbour catchment. Medium to long-term growth will require amplification of the Malabar trunk wastewater system to cater for the cumulative impact of growth upstream.

Additionally on inspection of indicative age of infrastructure within the LGA , GHD believe the potable water system may require significant replacement within the next 20 to 30 years. A significant number of potable water mains within the LGA are greater than 70 years old.

Sydney Water are supportive of decentralised non-potable solutions for new developments. The planning recommendation from their own studies are that a non-potable (non-drinking water) supply be managed on a site-by-site basis and Sydney Water would also support precinct schemes under the following conditions[9]:

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[9] Precinct based stormwater systems, conditions for making a precinct decentralised system viable in Sydney CBD, Sydney Water

- Consistent demand for the alternate water source, located close to supply both in space and time
- Ability to access existing pipes of the network or the ability to schedule laying with other planned work to minimise disruption and cost
- Willingness to pay for the alternate supply, both capital and operating costs. This may require some upfront funding to reduce costs to customers or developers
- Willingness to operate the scheme and obtain a licence under the *Water Industry Competition Act*

Sydney Water has indicated, through discussions, that reduced demand has relieved capacity in both the water and sewerage systems. Accordingly this has delayed investment into capacity building in the short term.

Water efficiency and decentralised water options would have benefits for Sydney Water's existing systems in the long term, however there are no planned projects that would clearly be avoided or deferred as a result of the Decentralised Water Master Plan in the short to medium term, according to Sydney Water.

Sydney Water participated in the development of the City of Sydney's Decentralised Water Master Plan through attendance at stakeholder workshops and by supplying relevant consumption, planning and asset data when requested.

1.2.4 Regulatory Context

The key legislative instrument guiding private sector access and licensing arrangements for water and sewerage services in Sydney is the Water Industry Competition Act 2006 (NSW) (the WICA). The WICA and associated regulations aim to encourage competition in water supply and sewerage services in NSW and to facilitate the development of infrastructure supporting production and reticulation of recycled water (WICA, 2006). The WICA was passed by parliament in 2006 and came into force in 2008. The WICA is supported by the Water Industry Competition (General) Regulation 2008.

Commencement of the WICA represents a significant shift in the landscape for water and sewerage services in NSW, with the WICA introducing:

- A licensing regime for private sector providers of reticulated drinking water, recycled water and sewerage services.
- A third-party access regime for water and sewerage infrastructure.
- Authorisation of the Independent Pricing and Regulatory Tribunal (IPART) to arbitrate certain sewer mining disputes.

Under the WICA, a corporation can apply for a licence to be a network operator and/or a retail supplier. As a licensed network operator, a corporation is authorised to construct, maintain and operate water industry infrastructure for the purpose identified in the licence. A retail supplier's licence authorises the licensee to supply water or provide sewerage services by means of water industry infrastructure (that may or may not have been constructed by the licensee). Corporations can apply for either a network operator or retail supplier licence, or for both if they are seeking to construct and operate infrastructure and then use that infrastructure to supply water or provide sewerage services.

Within the current set up, local councils are exempt from licensing under WICA. However, following the current review of the regulation, this is likely to change. The review of WICA is also looking to remove the duplication of technical review of the recycled water scheme by local council as well as IPART.

Table 1 below provides a brief overview of the roles of various agencies in the regulation and oversight of recycled water schemes in NSW:

Table 1 Agencies and roles in the regulation of recycled water schemes

Agency	Role
IPART	IPART processes applications for licences and arbitrates disputes under WICA. They also regulate Sydney Water and periodically review Sydney Water prices, including for recycled water.
NSW Health	Advisory role based on Commonwealth water quality guidelines and risk based management approach. NSW Health also provides accreditation for very small schemes (serving < 10 equivalent persons).
Local councils	Councils are the approval authority for schemes exempt from WICA and subject to Section 68 approval under the Local Government Act. Councils can also be the proponents, owners and managers of recycled water systems. As public utilities they are xempt from requiring a WICA licence, but require Section 60 approval from the Office of Water for any water treatment or sewage schemes. In the case of sewage discharge schemes, depending on the size and nature of the system proposed they may also require an environmental protection licence under the Protection of the Environment Operations (POEO) Act 1997. With reference to stormwater reuse schemes, the legislation is less clear. It appears that if the proposal is to treat and supply stormwater, Section 60 approval may be required. In other cases, the local council may be both proponent and approver, with no statutory obligations to seek Ministerial Consent. While there is often no statutory obligation, councils are likely to seek advice and approval from NSW Health, the Office of Water and the Environmental Protection Authority to ensure technical proficiency of proposed schemes and to manage risk.
NSW Office of Water (Department of Primary Industries	The Office of Water provides advice and input to IPART deliberations regarding licence applications under WICA. They are also the approval authority for councils seeking to undertake water treatment or sewage works under Section 60 of the Local Government Act. The Metropolitan Water Directorate may also have a role here.

Agency	Role
Directorate of Metropolitan Water	The Directorate of Metropolitan Water is responsible for coordinating the current review of WICA.
(Department of Finance and Services)	Previously part of the Office of Water, the Directorate is now situated within a separate department. Some overlaps between the two remain with reference to Section 60 and Section 68 approvals under the Local Government Act.
Environmental Protection Authority (Office of Environment and Heritage)	Responsible for administering the Protection of Environment Operations Act (POEO Act). Environment protection licences under the POEO Act may be required for some recycling schemes.
Sydney Water Corporation	Sewer mining applications go to Sydney Water for approval, and Sydney Water then manages agreements with sewer miners to construct, operate and maintain sewer mining connections and return waste to sewerage systems.

1.2.5 Review of 'local water capture' target

As outlined above there has been considerable changes in the water landscape in Sydney including the introduction of diversified water through desalination and recycled water in the growth suburbs of greater Sydney. There has also been a steady recovery in the dam storage levels since July 2007, which are now at 80 per cent. Sydney Water reports a sustained reduction in demand from the water efficiency measures introduced during the drought.

These combined developments have improved Sydney's water security for at least the next 10 to 15 years and have also helped to relieve the capacity in major trunk mains servicing the City of Sydney area in the short term.

Although these options have bought more time, planned growth will ultimately put pressure on the existing water and wastewater trunk system capacity, which will benefit from improved water efficiency and diversified water sources to meet non-potable demand.

The 2030 timeframe for this Master Plan needs to envisage the next horizon, as many of the decentralised options will require considerable planning, industry engagement and community consultation to deliver.

City of Sydney Initiatives

Since publishing Sustainability 2030 in 2007/08 the City of Sydney has made some progress towards the water targets through efficiency, stormwater and roof water harvesting initiatives, which in aggregate have reduced the City of Sydney's demand for drinking water by 17% since 2006 (approximately 100 million litres per annum).

The most significant initiative is the Sydney Park Stormwater Harvesting and Reuse Scheme. Phase one has been completed and phase two has received federal funding and is about to commence construction. When complete this initiative will treat and supply 5GL/yr, which will be reused to top up the wetlands and irrigate the park, and potentially be made available to other users throughout the City as part of this Master Plan.

Figure 7 Sydney Park, Stormwater Harvesting and Reuse

Developer Initiatives

There are a number of major developments that have or plan to incorporate alternative water supply options to meet non-potable demand including Barangaroo, Fraser's Central Park, One Bligh Street, Darling Harbor, the Google Building in Pyrmont and Westfield's Sydney Shopping Centre. These initiatives have been developed to seek NABERS accreditation. Frasers Central Park comes the closest to be connected and available to other recycled water initiatives however most progress in isolation. However isolated systems are by their nature vulnerable and often lack genuine economies of scale. Therefore a connected system allows improved economies of scale and improved flexibility and reliability.

2. Approach and Methodology

This Master Plan has used an Integrated Water Catchment Management approach that recognises all aspects of the water cycle and its interrelationship with the community and environment.

This chapter outlines how the Integrated Water Catchment Management approach is used to identify decentralised water solutions by harnessing and mapping the data and knowledge that exists across the agencies responsible for managing the elements of the urban water cycle.

The Integrated Water Catchment Management cycle is presented in a Sydney context, showing how the traditional water system fits within a broader integrated water management framework.

The concept of decentralised water systems is introduced as an alternative to the traditional centralised water system. This represents a change in paradigm, with the City relying less on imported drinking water by maximising opportunities for water efficiency and use of local water resources including recycled wastewater, stormwater, roof water, groundwater and seawater.

2.1 The Approach

Traditionally, water, sewage and stormwater – key elements of the urban water cycle are managed in silos – treating each element independent of the other and by different agencies. Traditional urban water management is characterised by large scale, centralised solutions, single use of water and managing stormwater pollution through end-of-the-pipe solutions. Transforming City of Sydney's water cycle requires us to re-think how it is managed to secure our water future and to gear us better for climate change adaptation.

Water in the City of Sydney is supplied by Sydney Water Corporation through a centralised network that imports and distributes drinking quality water from central water sources such as Warragamba Dam. Sewage in the City of Sydney is managed by Sydney Water Corporation through a centralised network of sewer pipes and treated at wastewater treatment plants located in Malabar and Bondi. Following treatment, effluent is then discharged to the ocean. Stormwater management is responsibility of City of Sydney. Stormwater in the City is collected through an intricate network of stormwater drainage assets such as pipes and pits – about half of them owned by Sydney Water Corporation and the remaining half are owned by City of Sydney.

The Decentralised Water Master Plan re-thinks urban water management by proposing solutions that are integrated, tailored to local issues and makes use of sewage and stormwater in the mix of local water resources that can be harnessed for producing recycled water for non-drinking purposes.

Figure 8 shows the interrelationships between each element in the water cycle including existing primary sources, diversified water sources and the environment. All water is ultimately recycled in the natural water system including stormwater and sewage disposed to waterways and the ocean, which are returned to the system through evaporation and rainfall. Figure 8 is followed by a description of the elements in the water cycle.

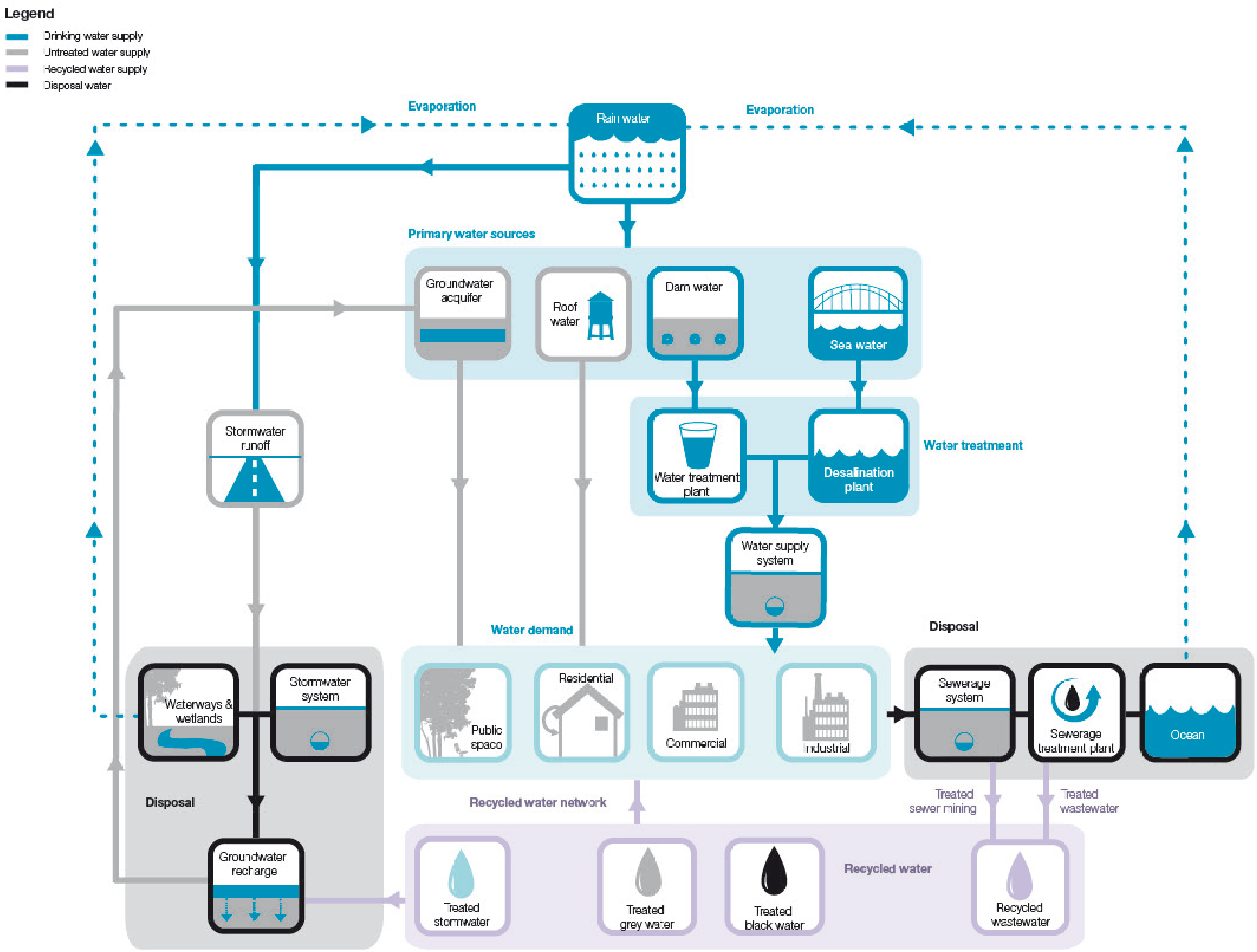


Figure 8 Integrated Water Catchment Management Cycle, Sydney

Drinking water supply

The blue icons show how the traditional drinking water supply is collected, treated and delivered. The majority of today's water demand is met through the drinking water supply operated by Sydney Water. Properties in the City of Sydney area would primarily receive water from Warragamba dam, treated at Prospect Treatment Plant, and water from the desalination plant at Kurnell.

Untreated water supply

The grey icons represent existing untreated water sources including groundwater, roof water and stormwater runoff. These sources are typically used to meet irrigation demand for private and public property. Groundwater can also be used by some industries as process water and roof water can be used for non-drinking purposes including toilet flushing, laundry use and cooling towers.

There is also some direct use of raw and treated seawater from commercial properties located on the Sydney Harbour foreshore. With further treatment there is potential to increase this supply using local thermal desalination plants.

Wastewater and stormwater disposal

The black icons represent the transfer and treatment process for water disposed to the environment. Bondi and Malabar Sewerage Treatment Plants treat and dispose of wastewater via ocean outfalls. The sewer system is nearing capacity in the City of Sydney area and can experience sewer overflows during wet weather events due to stormwater and groundwater infiltration. Relieving the volume of sewer flows through sewer mining is an option considered in the Decentralised Water Master Plan.

Stormwater runoff entering the stormwater system is ultimately discharged to Sydney Harbour and Botany Bay via the Cooks River and Centennial Park wetlands. Stormwater may have some basic treatment removing gross pollutants and sediment and in some cases nutrients are removed through WSUD, including rain gardens and wetlands. The Decentralised Water Master Plan evaluates how stormwater can be harvested and improved before it is discharged to waterways. Opportunities to mitigate local flooding, where there are synergies, are also examined.

Infiltrated stormwater naturally recharges the groundwater aquifer. Recent examples in Adelaide and Perth demonstrate how groundwater can also be actively recharged with treated stormwater and treated sewerage, acting as an underground storage reservoir for potential groundwater supply. This process is known as Managed Aquifer Recharge (MAR) and is a possibility in the south of Sydney, in the vicinity of the Botany aquifer.

Water demand

The light blue icons represent various types of residential and non-residential water demand. The Master Plan considers how water can be used more efficiently within the property by targeting high water using properties and sectors. The Plan also considers analysis of non-potable water alternatives that are fit for purpose and cost effective. This requires an understanding of water uses and the water quality required as well as the volume of demand, which will vary between and within properties.

Recycled water supply

The Lilac icons represent the alternative recycled water sources, which are a key focus of this Decentralised Water Master Plan. Grey water and black water are typically lot scale recycled water alternatives, treating and reusing water on an individual property or cluster of properties.

Harvested and treated stormwater is generally reused to irrigate public open space but could also be included in a precinct recycled water scheme. Recycled wastewater is treated sewage, which can be undertaken on a local scale, via a process known as sewer mining, or as an additional treatment process connected to the Sewerage Treatment Plant. Recycled water from the sewerage treatment plant is outside the scope of this study.

An integrated water management approach seeks to optimise water efficiency, pollution management and alternative water supply opportunities either separately or in combination, where there are synergies. It is possible to implement water efficiency and stormwater opportunities independently of a decentralised water system, however there is also an interrelationship as:

- water efficiency opportunities may reduce the potential demand for non-potable water
- there is overlap between WSUD and stormwater opportunities incorporating stormwater harvesting, which has stormwater pollution and water supply benefits

2.2 Decentralised Water Systems

A decentralised water system refers to a cluster of opportunities for providing water from diversified sources including groundwater, seawater, roof water and recycled water (treated stormwater, treated wastewater, grey water and black water). These opportunities can be provided independently at a lot or precinct scale or in combination through a decentralised water network.

The Decentralised Water Master Plan highlights opportunities to introduce local decentralised water systems. The concept of a city-scale decentralised water system includes:

- Maximising use of locally available alternative water sources, reducing dependence on the imported drinking water supply
- Moving away from ad-hoc building scale systems to a city wide decentralised water system
- Utilising a network that enables buildings and developments to import alternative water to meet demands and export surplus water to meet the demands of others.

The key benefits of this approach include:

- Increasing water availability provides water for greening the city and improving liveability
- Decentralised water systems that source water locally reduce the amount of energy and infrastructure required to transport water
- Decentralised water systems can harness local synergies using existing infrastructure and integrating the water systems with other infrastructure such as the trigeneration network

The key challenges include:

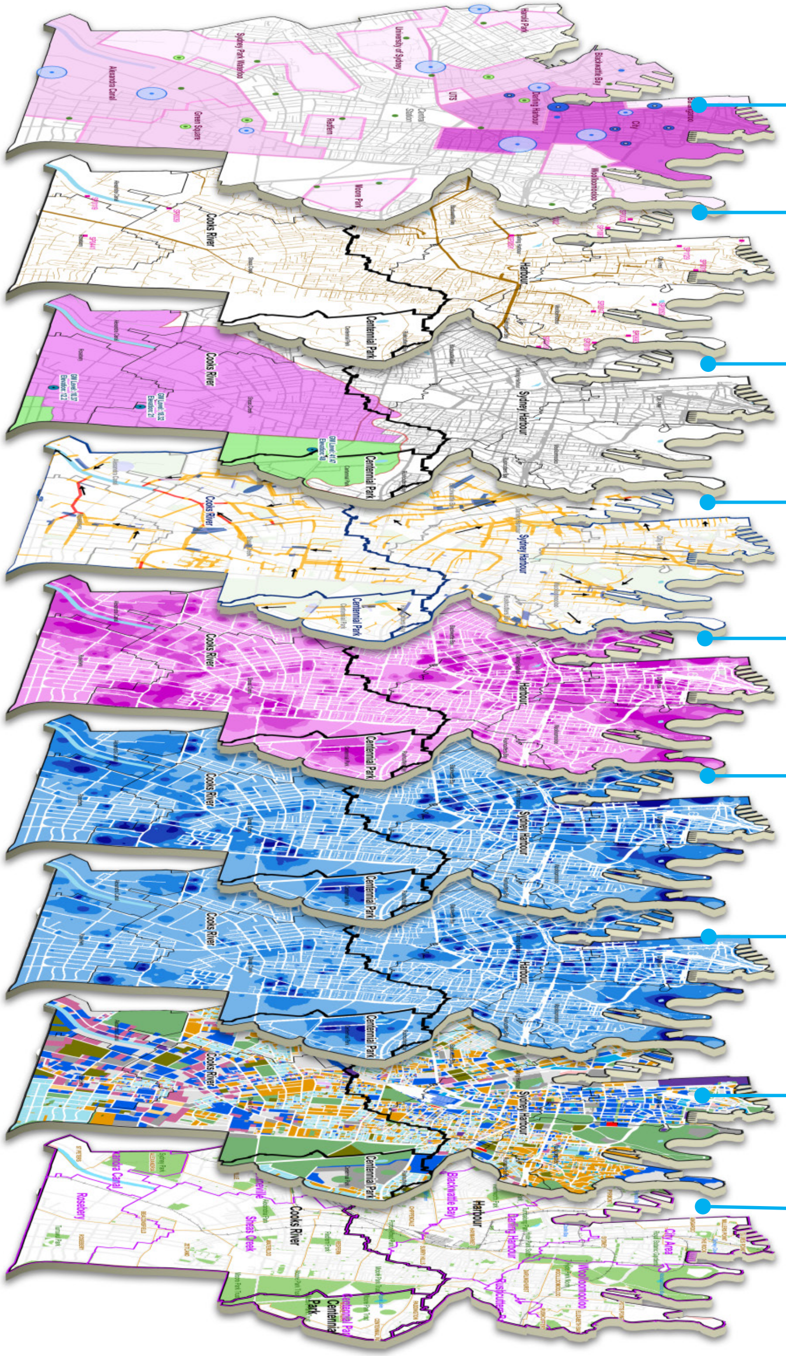
- Regulatory uncertainty and governance barriers
- Uncertainty of demand as solutions rely on the behaviour of individual property owners to connect
- Alternative water sources, and recycled water in particular, typically exceed the cost of the drinking water supply and may require subsidies
- Funding and incentives to attract public and private sector investment over the short, medium and long term.

These benefits and challenges will be discussed further in Chapter 3 and 4 of this report.

2.3 The Evidence Base

The City of Sydney's rich land use and floor space data reconciled against metered water consumption data, provided by Sydney Water Corporation, has enabled mapping of the city's water demands for determining the scope and potential for recycled water solutions. Spatial mapping of key infrastructure, such as water, sewerage and stormwater networks, not only allowed system capacity constraints to be identified, but was also useful in identifying the scale of potential recycled water opportunities, such as wastewater recycling and stormwater harvesting, that can be accessed for producing recycled water for non-drinking purposes.

Figure 9 shows the relationship between the layers of data that formed the basis of the analysis undertaken for the recycled water network plan.



SUMMARY = OVERVIEW OF SUPPLY AND DEMAND

Following detail analysis of demand, supply and networks summary opportunities are described based upon areas of concentrated non-potable demand in areas where there is a feasible supply source.

LAYER G = WASTEWATER

The location and characteristics of Sydney Water Corporation's sewerage network along with the location and frequency of sewage overflows was mapped. This data was used to identify the location and scale of opportunities to recycle wastewater as an alternative water source.

LAYER F = GROUNDWATER AND SEEPAGE WATER

Groundwater and seepage water are potential water sources and the Botany Aquifer may also provide an opportunity for storage and reuse of recycled water. The location of the Botany Aquifer and the location of tunnel dewatering activities were mapped to identify the potential location of these opportunities.

LAYER E = STORMWATER AND ROOF WATER

Stormwater and roof water are potential recycled water sources. To help identify the location and scale of these opportunities, stormwater drainage networks owned by the City of Sydney and Sydney Water Corporation were mapped, along with roof areas and flooding hotspots obtained from the City's flood studies.

LAYER D = NON POTABLE WATER DEMAND

Non potable demand refers to any water use that be substituted with water that is non-drinking quality without posing any risk to health and safety. Non potable water demands across the City were mapped based on projected 2030 water demands and an analysis of the potable and non-potable water end use data.

LAYER C = GROWTH IN WATER DEMAND BY 2030

Growth in water demand by 2030 was estimated and mapped based on projected increase in water demand arising from growth in population and urban development in 2030. This included anticipated water use by the tri-generation plants that are planned to be built by 2030. Mapping of projected urban development to accommodate the forecasted growth in population to 2030 was based on the City's Capacity Study (2010).

LAYER B = WATER CONSUMPTION DATA

With the assistance of Sydney Water Corporation, metered water consumption data was provided for the properties across the local government area, allowing the City's FES data to be matched to real metered water consumption data. This allowed water use for specific end uses such as such as cooling tower water use, toilet flushing and irrigation to be estimated and mapped.

LAYER A = LAND USE & FLOOR SPACE

The City of Sydney's Floor Space and Employment Survey (FES) measures and captures the entire built form of the city providing an understanding of every space and use across every building in the local government area.

BASE LAYER = BOUNDARIES & CONTEXT

Topographically, the City of Sydney is made up of 11 sub-catchments that drain to three receiving waters – Sydney Harbour, Cooks River and Centennial Park Ponds.

Figure 9 Spatial Analysis of Relevant Information

BASE LAYER - BOUNDARIES & CONTEXT

Figure 10 shows the City of Sydney's LGA boundary, catchment and sub-catchment boundaries as well as the location of suburbs and parks and public open spaces.

The City of Sydney is made up of 11 sub-catchments that drain to three receiving waters - Sydney Harbour, the Cooks River and Centennial Park Ponds. The three receiving water catchments are defined by natural topography.

The 11 sub-catchments are defined by the drainage network that collects stormwater run-off and diverts it to the receiving water bodies. This Master Plan has used the stormwater sub-catchments and receiving water catchments as a basis for identifying water recycling opportunities at a local scale.

A stormwater catchment based approach helps to contextualise and marry the constraints and opportunities and thereby develop decentralised water solutions that can achieve multiple objectives.

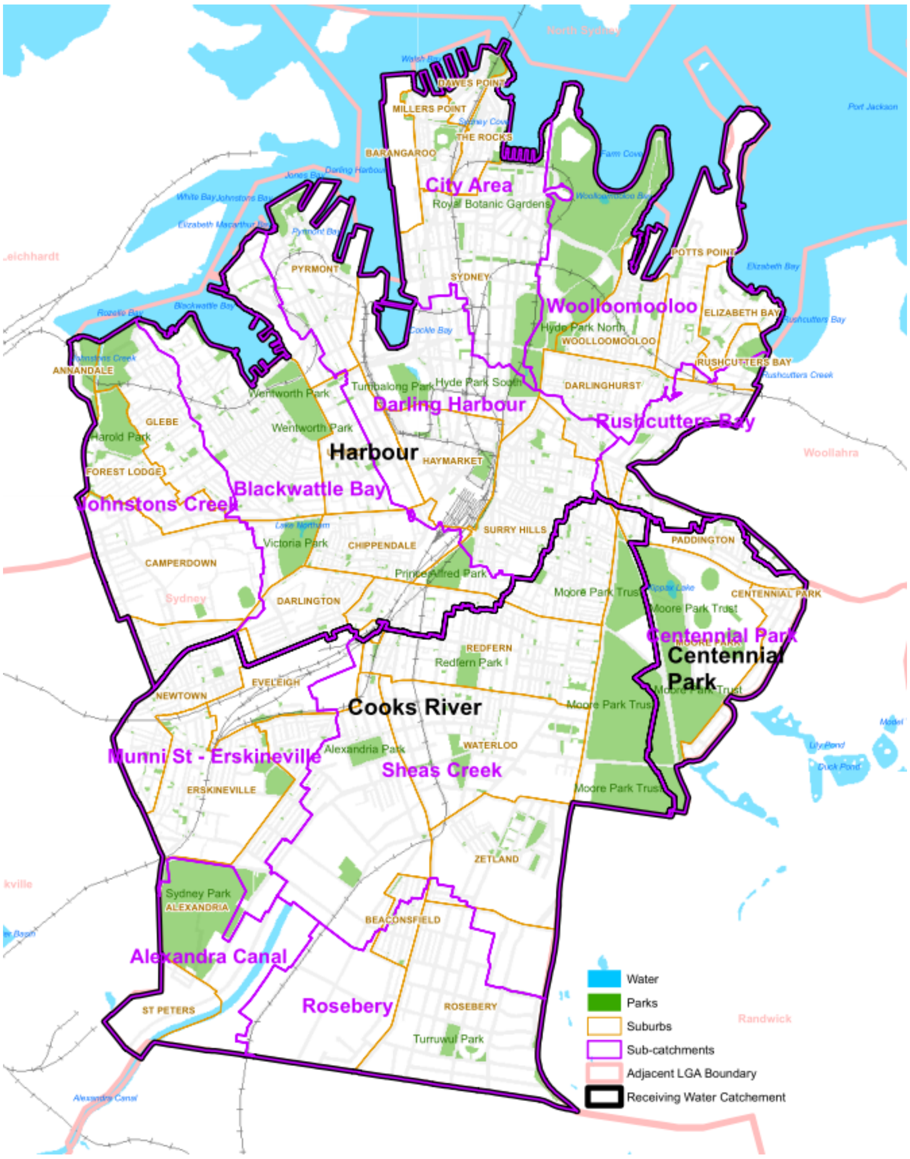


Figure 10 LGA and catchment boundaries

LAYER A - FLOOR SPACE & EMPLOYMENT SURVEY

The City of Sydney Floor Space and Employment Survey (FES) provides an unprecedented detailed understanding of the city's buildings and land use. The FES measures and captures the entire built form of the city, providing an understanding of the breakdown of floor space and its use across every building in the LGA.

This layer of information identifies the scale of different floor space use across the City and provides the foundation for analysing the city's current water consumption and potential recycled water demand at both building and precinct scales.

Each building use is characterised by a different water demand profile. While commercial office buildings require water for cooling towers to provide air conditioning during weekday working hours, water demands in residential buildings peak in the mornings and evenings. The Land Use Zoning map (Figure 11) highlights the commercial, residential and industrial zones in the city and represents where the water demands are distributed across the city.

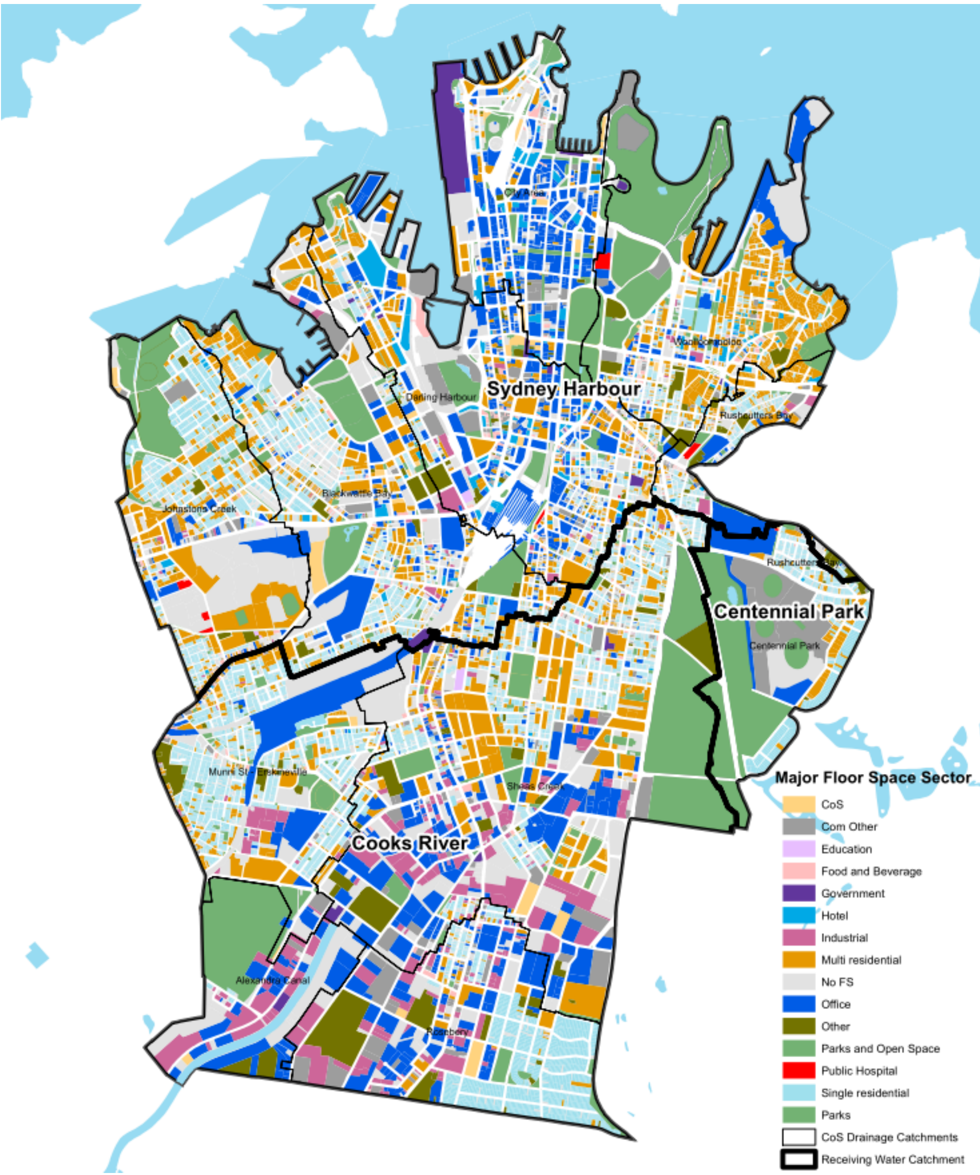


Figure 11 Land use

LAYER B - WATER CONSUMPTION DATA

Most macro scale analysis of cities relies on assumptions and data generated through models. Sydney Water provided 10 years of historical metered water consumption data. This was combined with the city's FES data to map water consumption across the City (Figure 12), break down water demand by sector (Figure 13) and develop water use profiles for properties within each sector (Figure 14).

In 2010, properties in the City of Sydney used 33.7 billion litres of drinking water, which is 7% of water demand in greater Sydney. The breakdown of water demand by sector (Figure 13) shows that multi-residential and office buildings consume the greatest amount of water in the city.

As shown in Figure 14, almost 50% of water demand in the city has the potential for using non drinking quality water compared to the remaining half that needs to be supplied with drinking quality water.

Cooling towers consumed 4.4 GL or 13% of total water demand in 2010. Figure 15 reveals the concentration of cooling tower water demand in the Harbour catchment, which highlights an opportunity to target this demand through water efficiency and recycled water initiatives.

Other non potable water demands that are currently supplied with drinking quality water include toilet flushing (20% of demand), laundry (7% of demand), irrigation (3% of demand) and other uses such as washing of parking bays and other common areas of buildings.

This analysis has helped in identifying the scope for water efficiency and water recycling solutions.

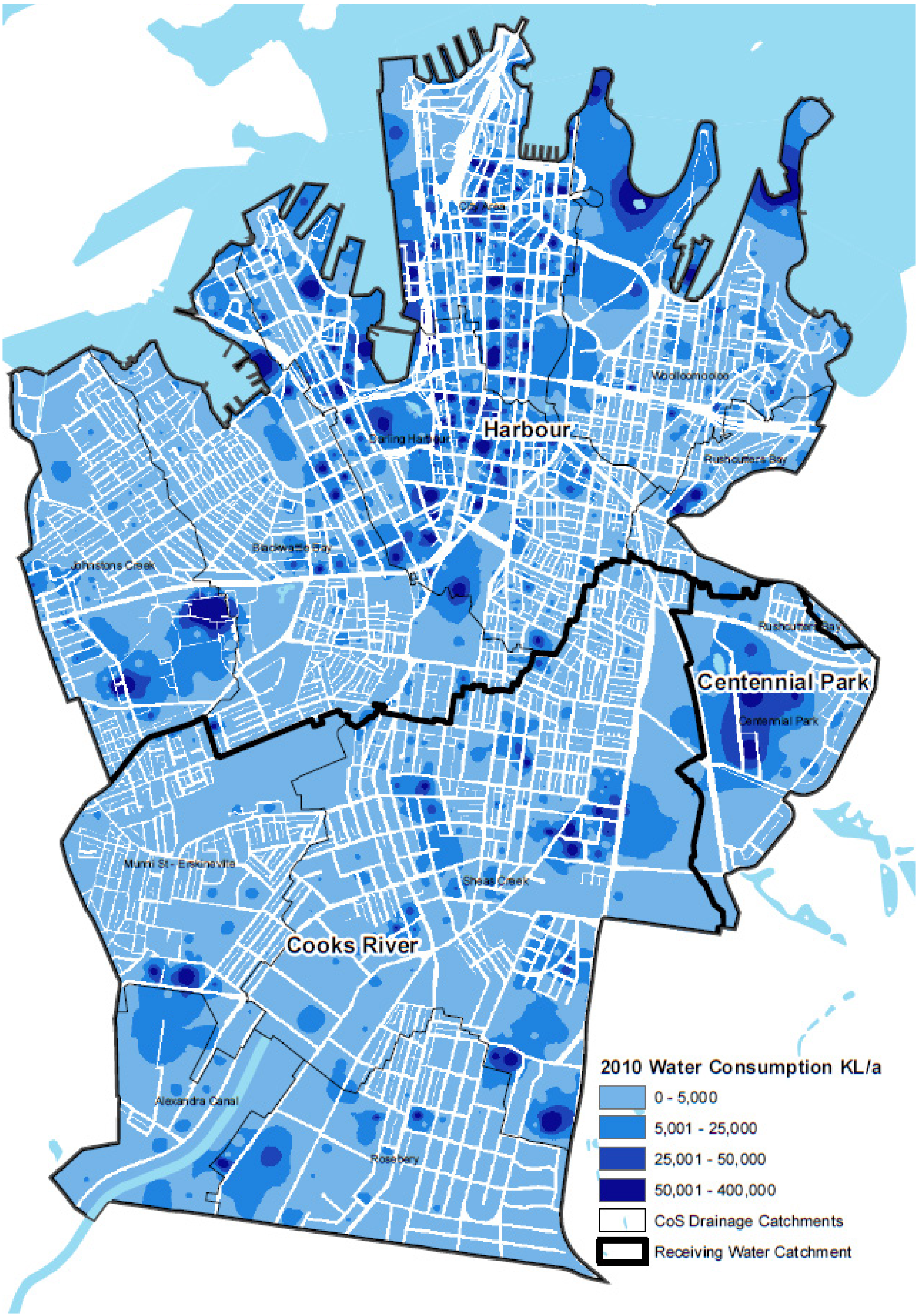


Figure 12 2010 total water demand

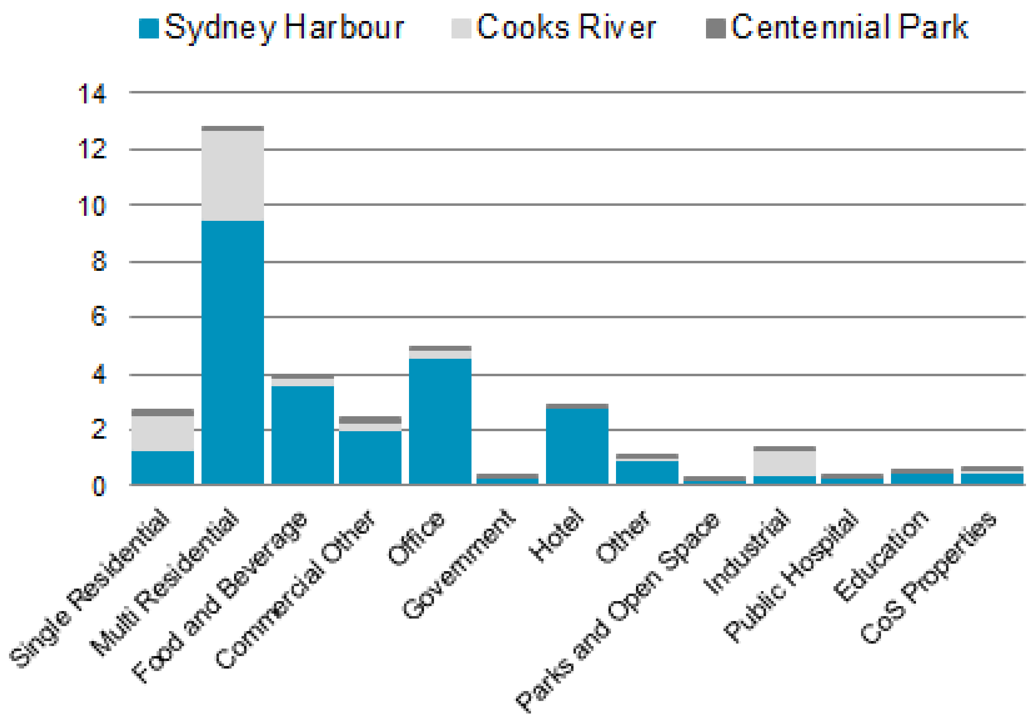


Figure 13 2010 total water consumption by sector and receiving water catchment (GL/y)

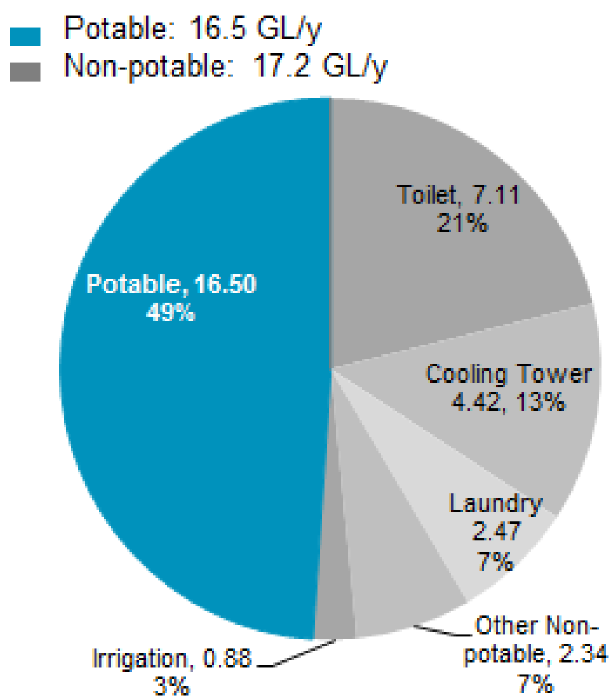


Figure 14 2010 End use – potable and potential non-potable demand

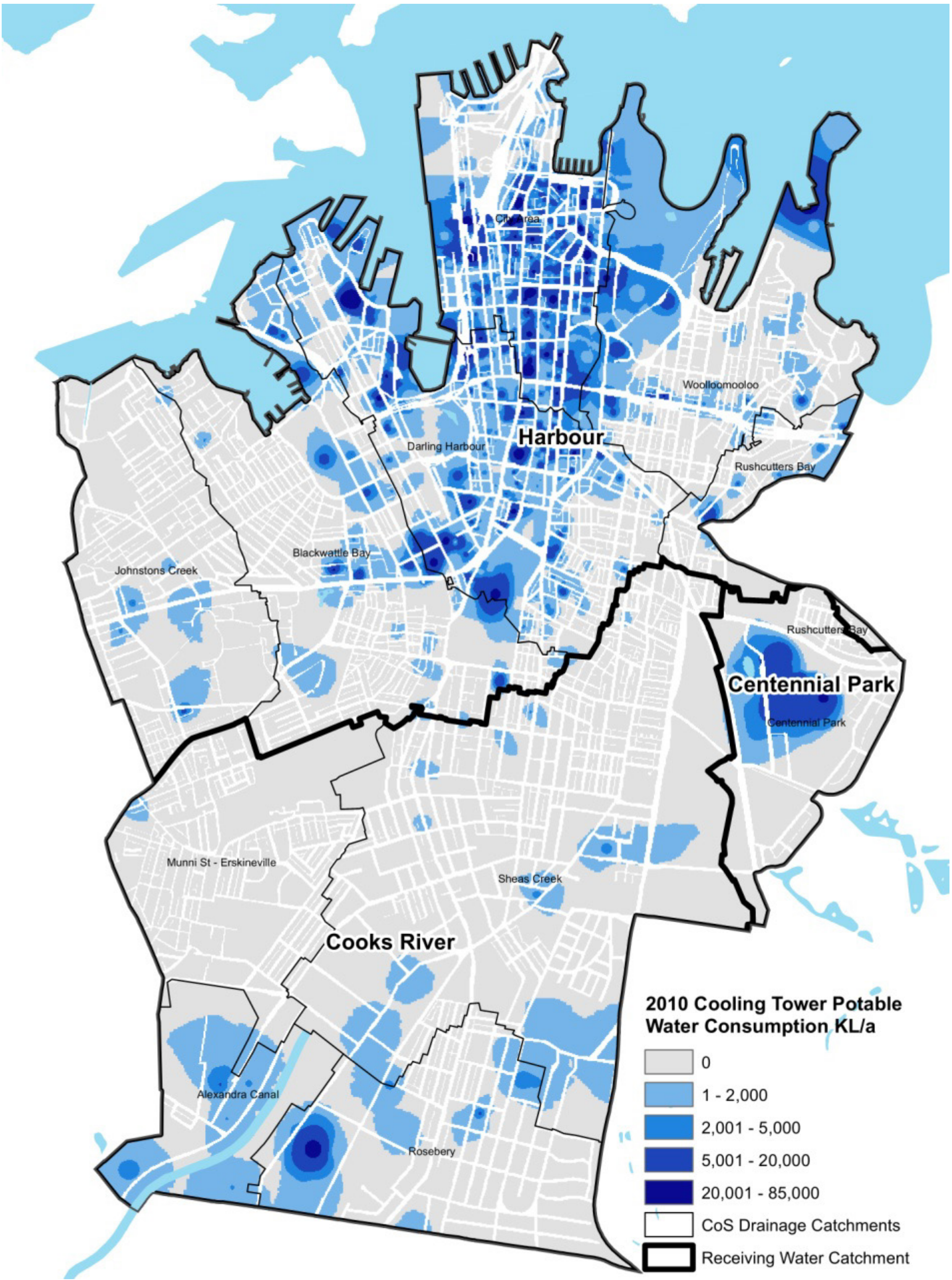


Figure 15 2010 Cooling tower water consumption

LAYER C - GROWTH IN DEMAND BY 2030

Growth in water demand across the City was forecasted based on projected urban development to accommodate the forecasted growth in population to 2030 in the City's Capacity Study (2010).

Figure 16 & Figure 17 show the change in the water use by each sector from current (2010) to the future (2030). Water demand in re-development areas present the most attractive opportunities for incorporating decentralised water solutions during their planning and design stage. That is because, unlike retrofitting new solutions to old and existing properties, re-developments provide an almost blank landscape to work from.

However, existing development can also provide economically viable opportunities as they provide a known water demand against which projects can be financed whereas new development can be built in phases over many years making financing of projects for the initial phases difficult.

Figure 18 maps the growth in water demand, with areas forecasted to experience the greatest growth in demand shown in darker blue. This also includes those currently under development such as Barangaroo, Central Park and Harold Park in the Sydney Harbour catchment. Significant development and changes in land use are planned in the Cooks River catchment with major developments anticipated in the greater Green Square area and Waterloo. Significant growth is also projected in the area surrounding Alexandra Canal, where the nature of land use is expected to change from industrial to multi-residential.

City wide, approximately 40% of total growth in built form is expected to be infill development. The remaining 60% is expected to be in major brown field redevelopment. This is forecasted to result in an increase in water demand of 30% between 2010 and 2030, which the largest increases in demand likely to be in the multi residential and office sectors.

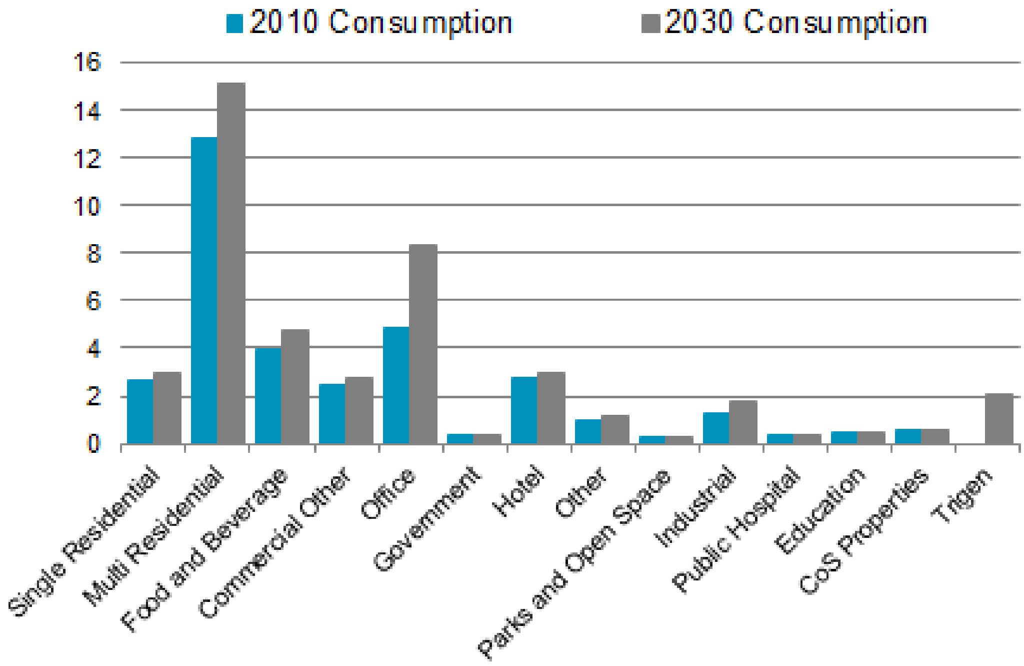


Figure 16 Comparison of water consumption by sector in 2010 with 2030 (GL/y)

Note: Trigeneration air conditioning cooling tower demand is new demand.

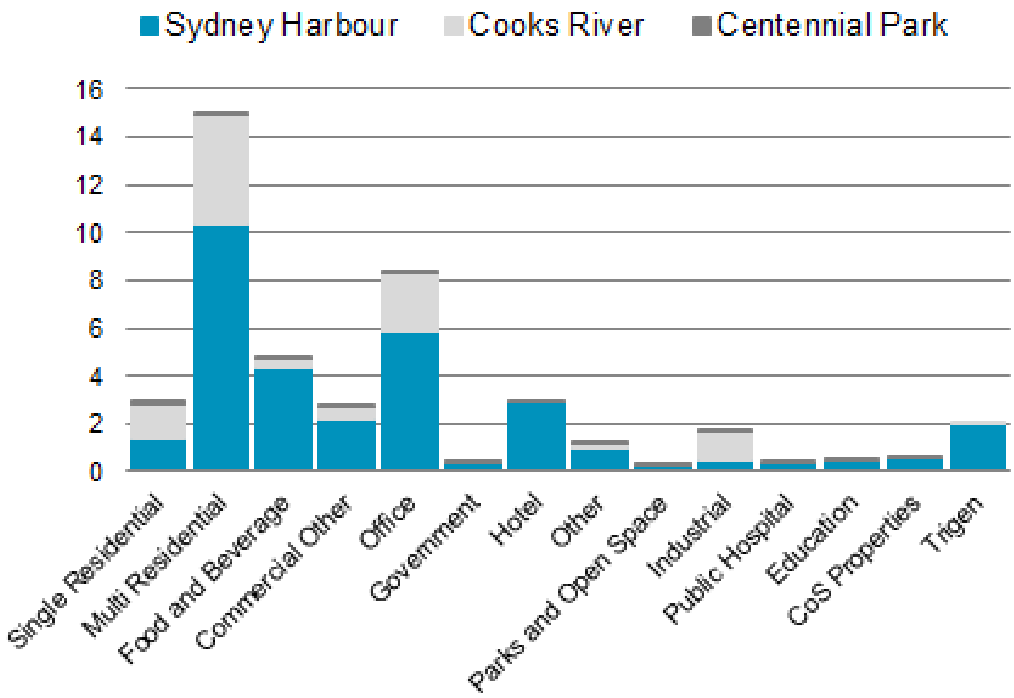


Figure 17 Projected water demand by sector and receiving water catchment in 2030 (GL/y)

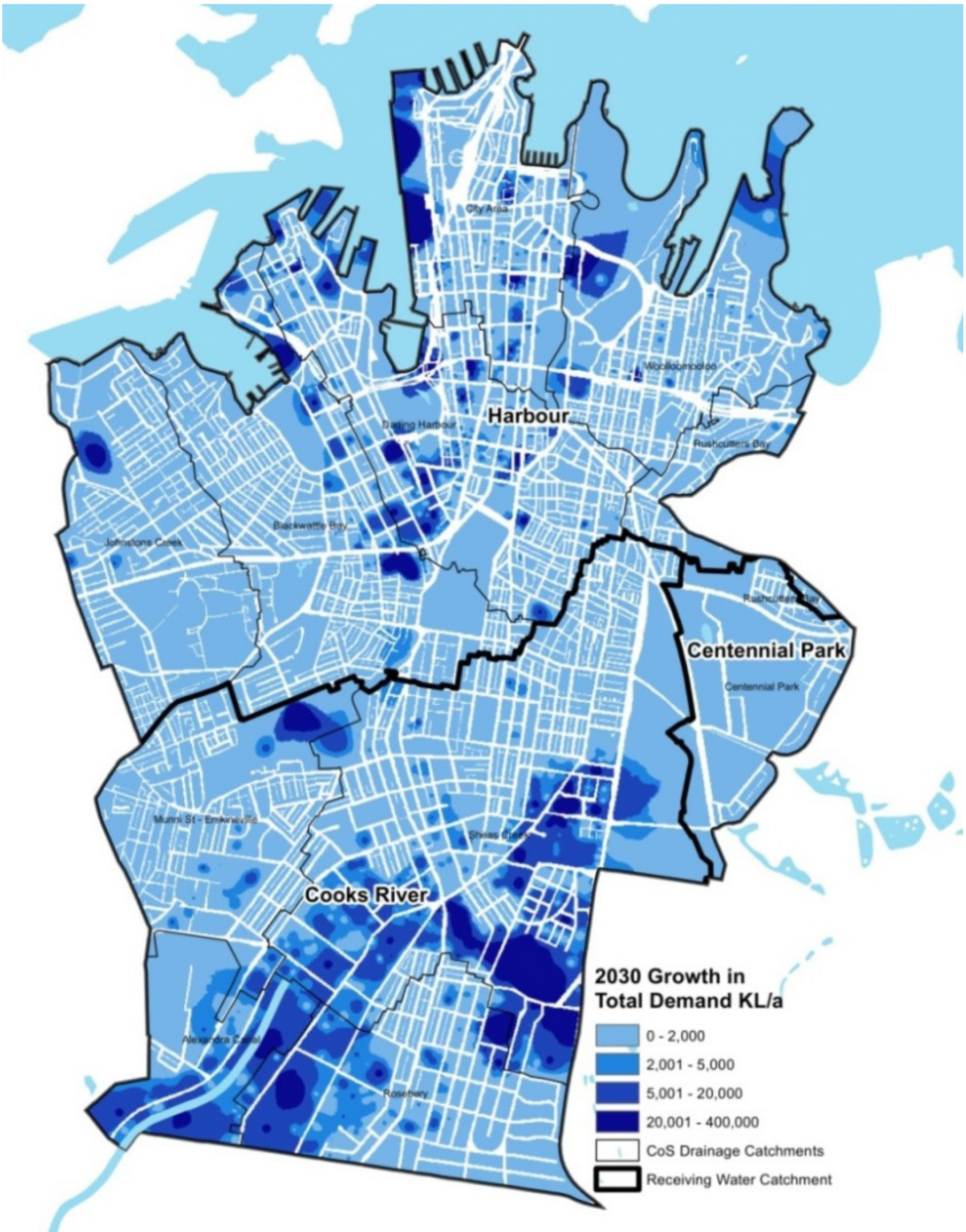


Figure 18 Growth in total water demand from 2010 to 2030

Note: Trigeneration air conditioning cooling tower demand is considered new demand

LAYER D – NON POTABLE WATER DEMAND

Non potable demand refers to any water use that may be substituted with water that is non-drinking quality without posing any risk to health and safety.

The scale of non potable water demand was estimated by deducting the potable demand, water demand by those end uses that must be supplied with drinking quality water for public health reasons, from total water demand. The analysis in this Master Plan assumes that taps in kitchens and bathrooms, shower and bath areas would be supplied with drinking quality water.

Figure 19 shows the distribution of non-potable demand in 2030, which accounts for 54% (23.7 GL) of total demand. The analysis demonstrates that there are areas of concentrated non potable water demand in:

- Central Business District (CBD)
- Darling Harbour and Pyrmont
- Greater Green Square area
- Area around Sydney Park and Alexandra Canal in the south west of the city

Other smaller pockets of high projected non-potable water demand are the major developments of Redfern-Waterloo and Harold Park, the Sydney Cricket Ground and surrounds and Garden Island.

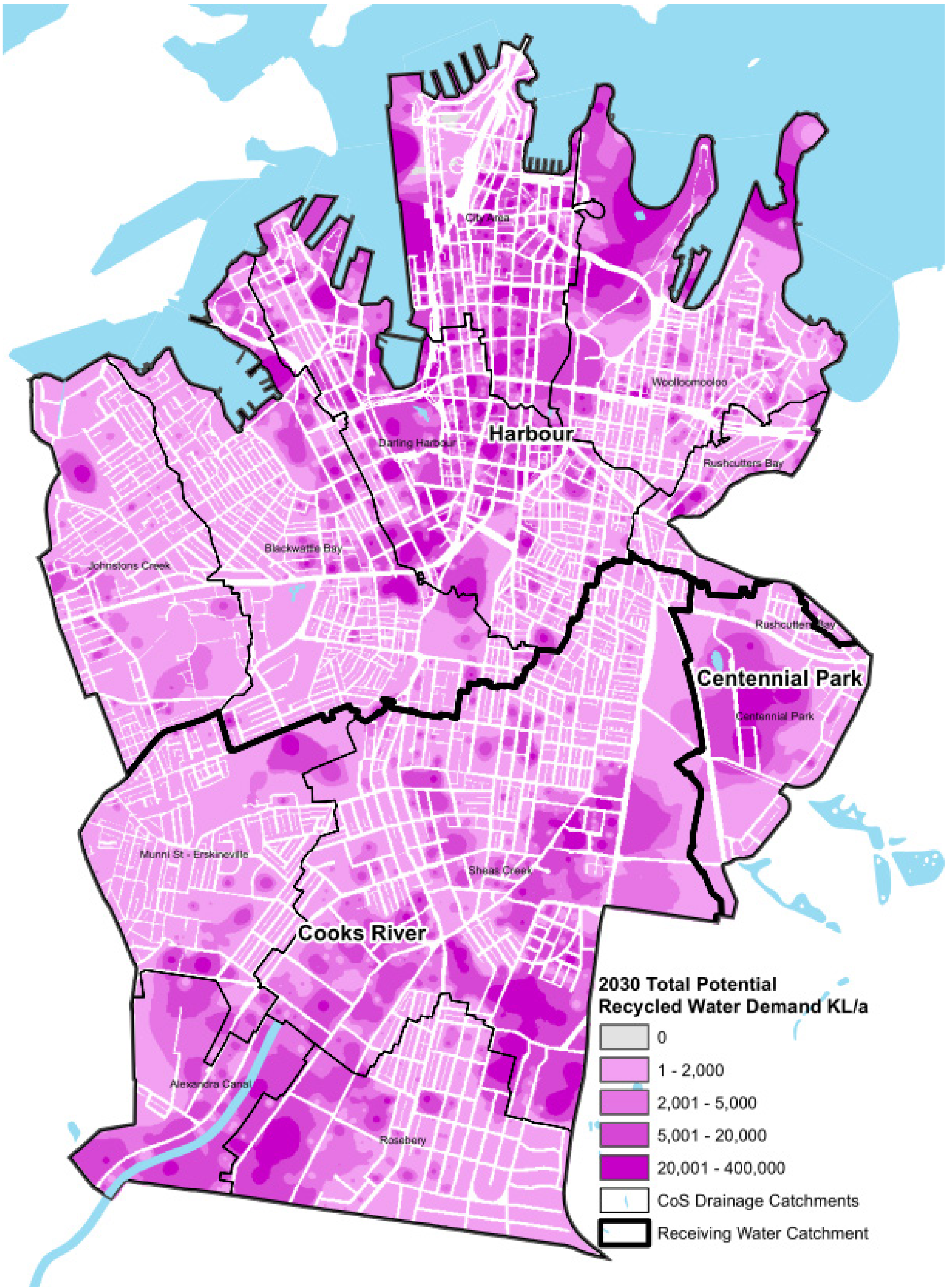


Figure 19 Total potential recycled water demand in 2030

LAYER E – STORMWATER AND ROOF WATER

Stormwater and roof water are potential recycled water sources. Figure 20 shows a map of the stormwater drainage network, showing the indicative capacity of the stormwater pipes, overlaid with the flooding hotspots. Nearly half of the stormwater drainage network (downstream - bigger pipes or trunk drains) is owned and managed by Sydney Water. The remaining half of the network (upstream – smaller pipes and pits) is owned and managed by the City of Sydney. This divided ownership of the stormwater assets adds complexity to the provision of stormwater management services.

Urban development results in the replacement of natural pervious soil surfaces with hard and paved surfaces. This results in more stormwater runoff generated and more pollutants picked up by fast flowing stormwater and discharged into local waterways.

Nearly 20 billion litres of stormwater is discharged annually from the City into the waterways. This is nearly the same volume of water we would need by 2030 for non drinking purposes.

Figure 21 provides further detail on the surface characteristics within the LGA. The proportion of roads, roofs, hard surfaces and parks has been used to calculate stormwater run-off volumes and pollution concentrations for each sub-catchment. The roof area has also been used to model potential to harvest roof water.

The analysis of catchment surface has enabled the calculation of catchment and roof area used to model the potential yield from roof water and stormwater harvesting.

Reliability of supply refers to the proportion of potential non-potable demand that can be supplied by a rainwater or stormwater harvesting scheme. The amount of rainwater or stormwater that can be harvested is dependent on:

- volume of rainfall falling on the catchment,
- characteristics of the catchment
- size of the water storage
- size and frequency of the demands that are to be supplied

The relationship between rainfall, which varies from day to day, seasonally and annually, storage size and demand is complex and climate change may also have a significant impact on the reliability of roof water and stormwater harvesting schemes. This was analysed using the integrated water balance model developed by GHD.

Figure 31 presents an indication of the likely reliability of roof water harvesting initiatives. It indicates the size of storage required to offer a reliable source of supply for a given demand. 100% reliability, that is the ability to meet 100% of the potential non-potable demand within a precinct with harvested rainwater, is only possible with very large storage (more the 1.3 ML per hectare roof catchment area) and relatively low demand (less than 0.5 ML demand per hectare roof catchment).

Demand intensity in the City and Darling Harbour is very high, which means that roof harvesting will be less reliable in these areas. In contrast, demand intensity in the southern areas of the City, such as Alexandra canal and Roseberry, is relatively low making roof harvesting initiatives more reliable.

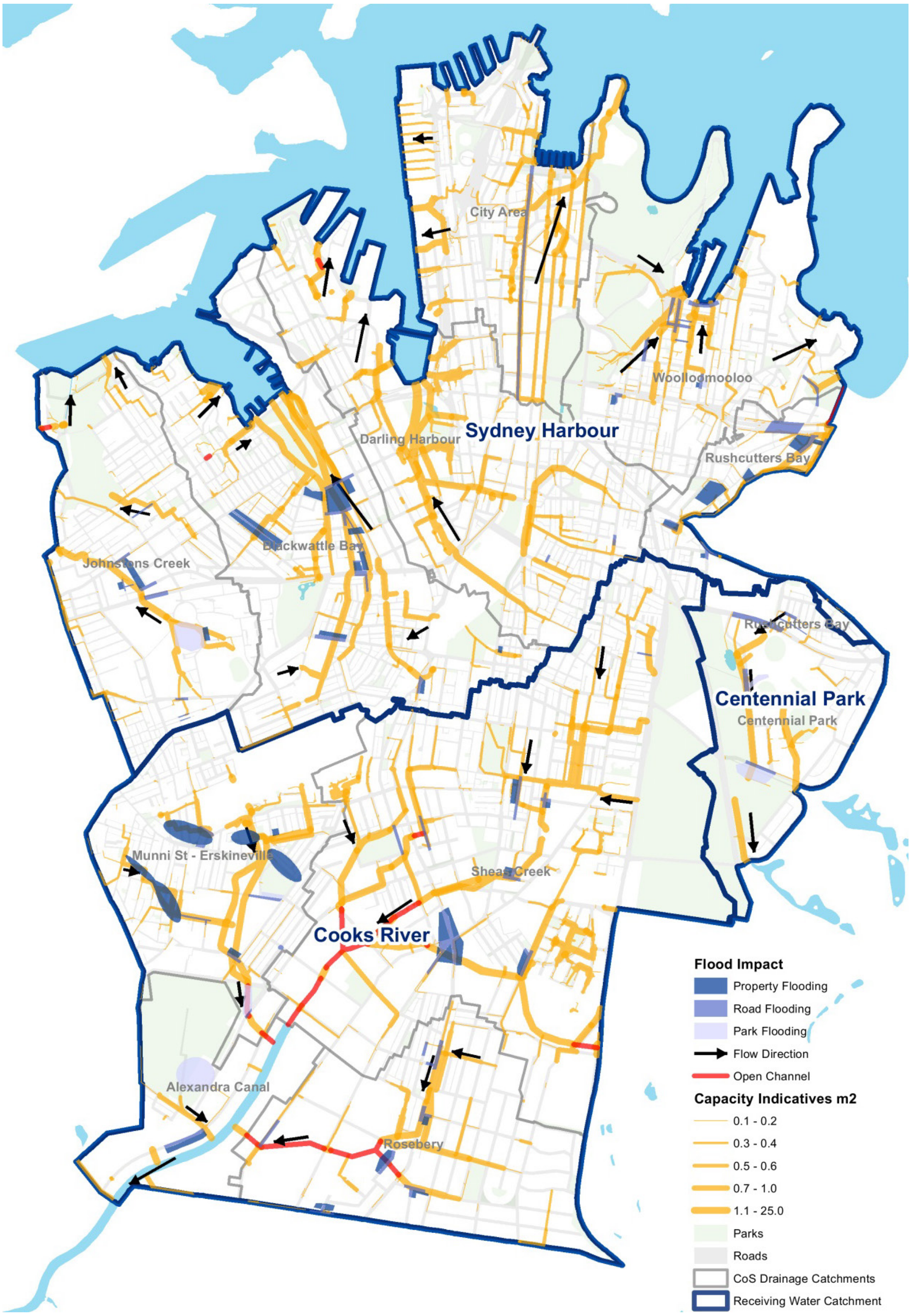


Figure 20 Map of stormwater network showing flooding hot spots

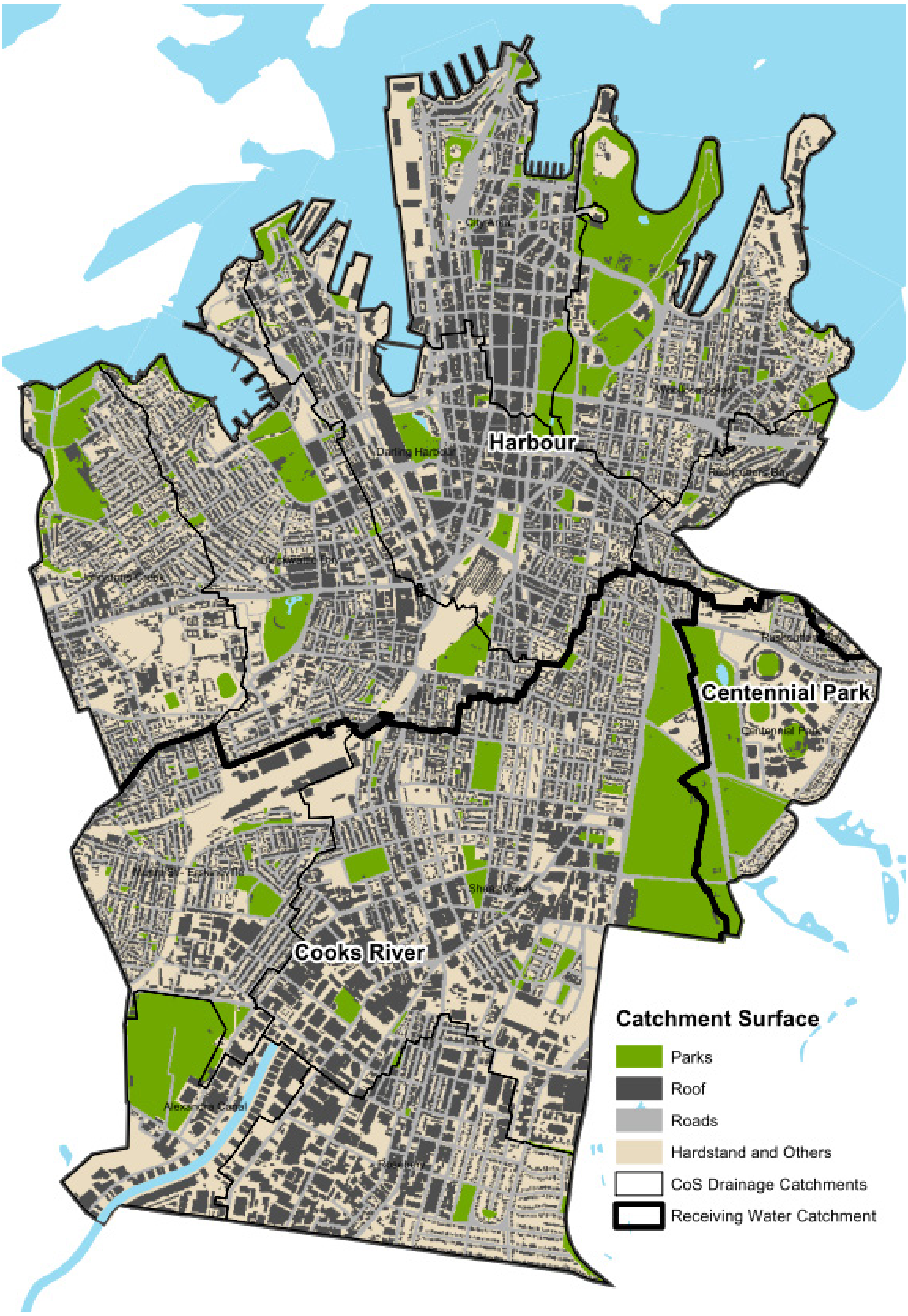


Figure 21 Map of surface types within the City of Sydney

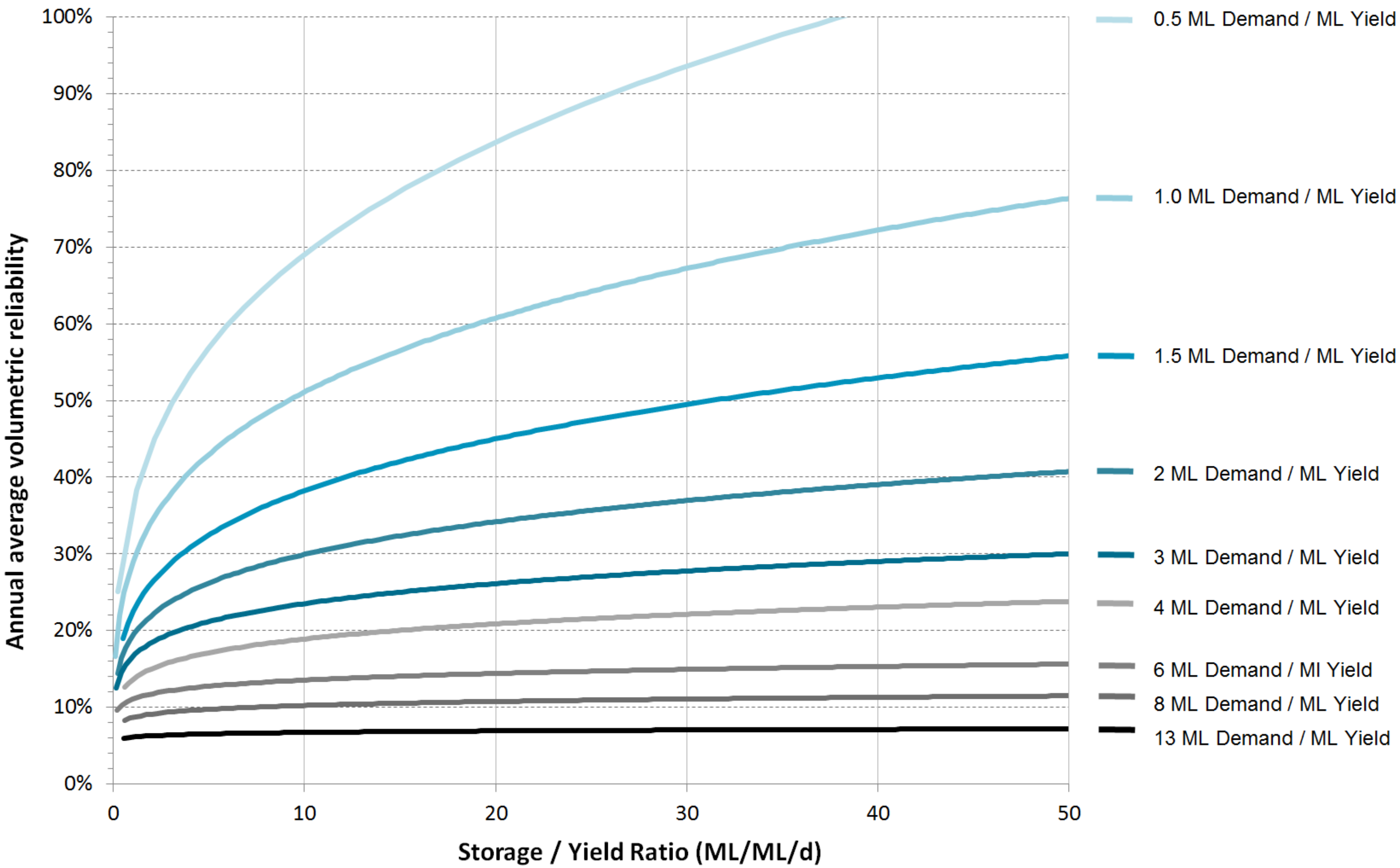


Figure 22 Generic rainwater and stormwater harvesting reliability curves

LAYER F – GROUNDWATER AND SEEPAGE WATER

Groundwater stored in the Botany Sands aquifer is a potential source of alternative water. Numerous groundwater bores already exist and groundwater is used for irrigation e.g. golf courses and by industry as process water.

Figure 23 shows the extent of the Botany Sands aquifer underlying the Cooks River and Centennial Park catchments as well as the current groundwater management zones. The general zone (green) near Centennial Park is available for domestic use and zone 2 (pink) is currently banned for domestic use. The aquifer in the Cooks River catchment of the city is a potential source of alternative water.

Groundwater is also relevant to this study as a potential source and storage area for treated stormwater and recycled wastewater. Additional hydro-geological investigations may be required to fully understand the potential of the aquifer for this purpose.

Figure 24 shows the location and volume of water dewatered from railway tunnels, which is estimated at 30 million litres per year. The total volume of dewatering activities across the city is estimated to be 287 million litres per annum, with the major sources including the Cross City Tunnel (131 ML/year) and Energy Australia's Campbell St tunnel (96 ML/year). This represents approximately 1.3% of the total non-potable water demand opportunity.

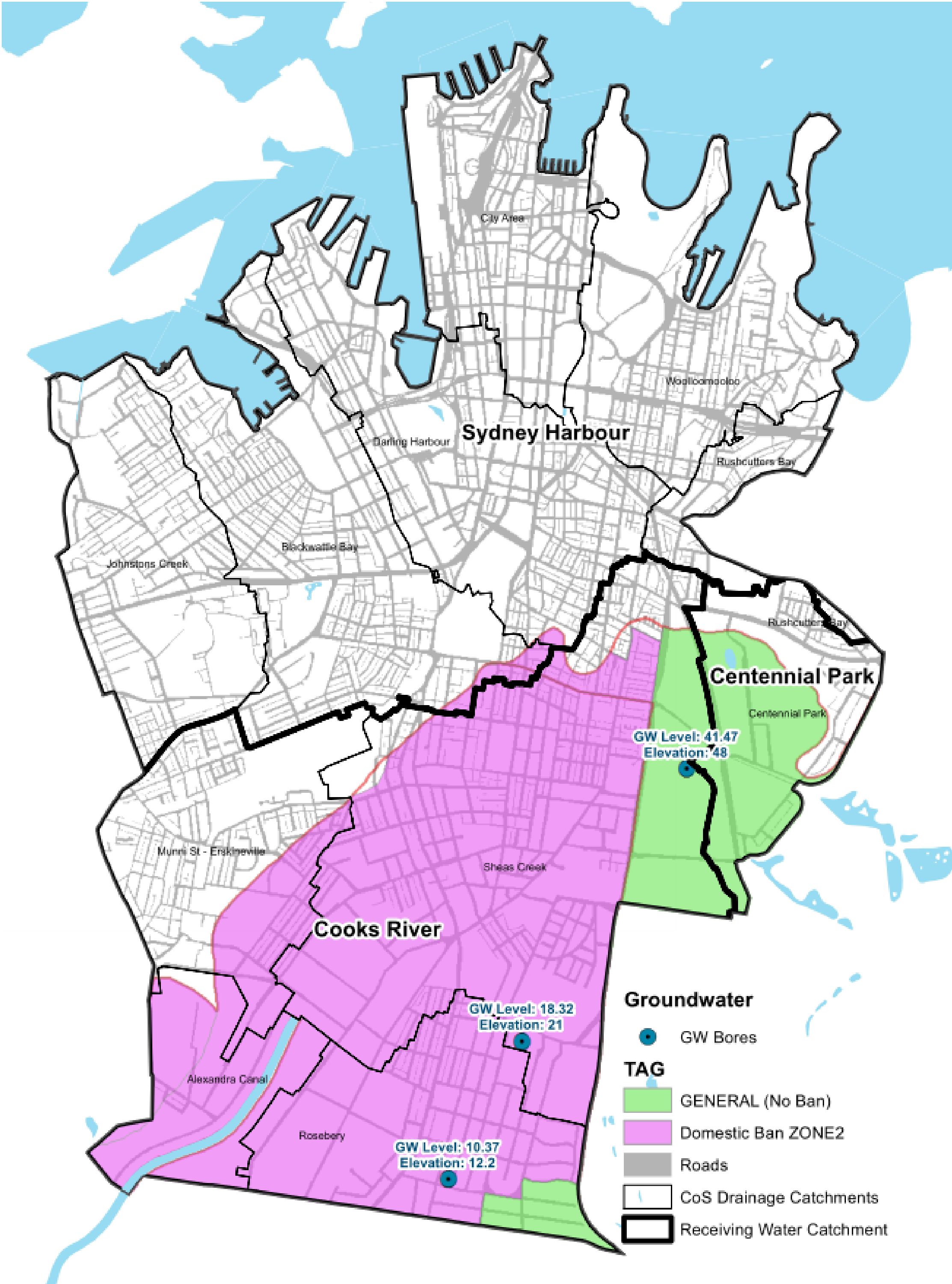


Figure 23 Groundwater management zones in the Botany Aquifer

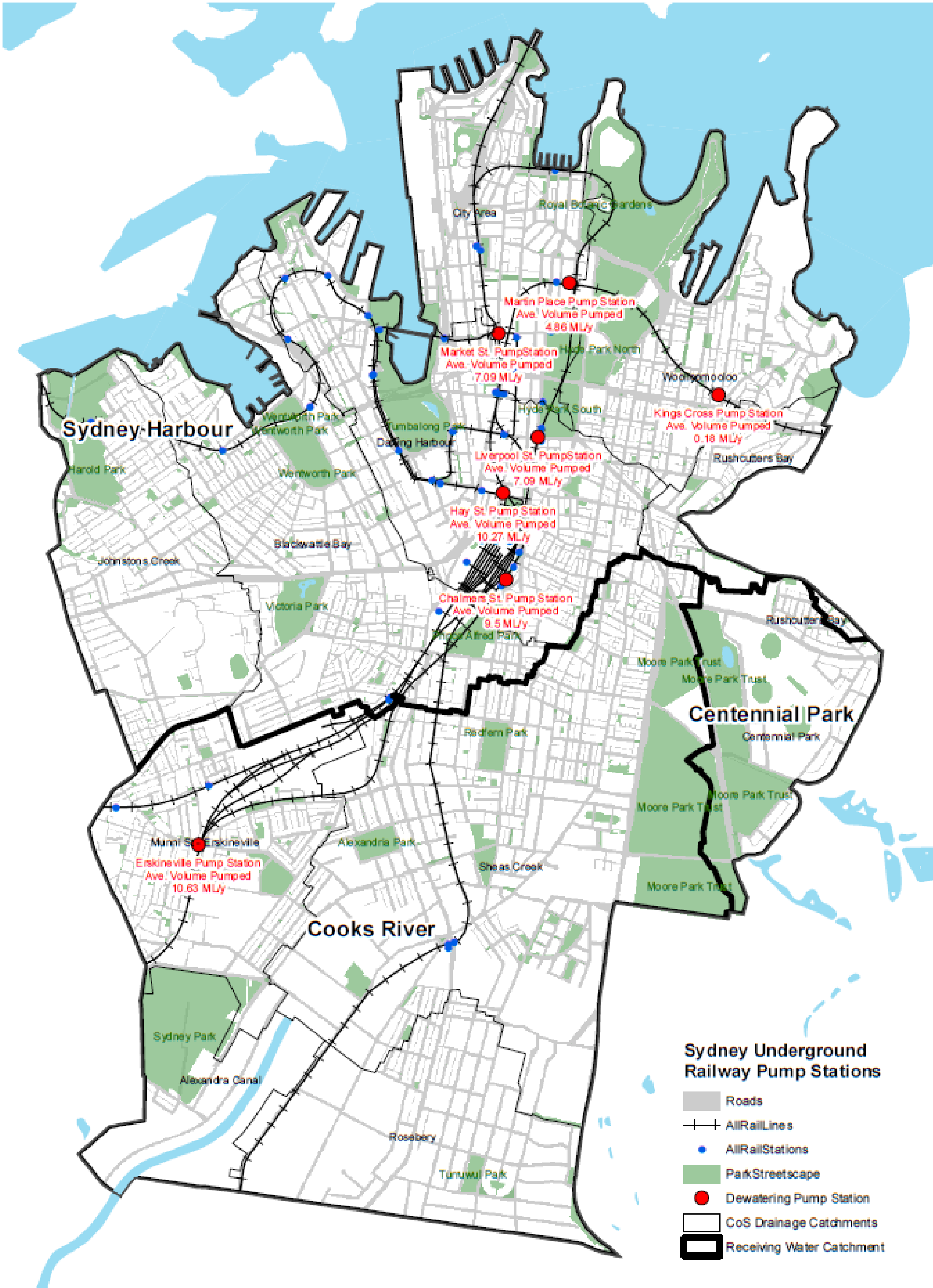


Figure 24 Location and volume of railway tunnel dewatering activities

LAYER G - WASTEWATER

There are two wastewater catchments relevant to the city – the Bondi Ocean Outfall Sewer (BOOS) which collects wastewater from the north of the city and transfers it to the Bondi wastewater treatment plant and the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS) which transfers the wastewater from the south-west of the city to the wastewater treatment plant in Malabar.

The volume of wastewater collected relates to the volumes discharged from individual properties in the city area as well as volumes from neighbouring areas. There can also be considerable ingress of stormwater and groundwater into the sewer system through cracks developed in the ageing sewer pipes.

Figure 25 shows a map of the existing wastewater collection system, including pipes and pumping stations within the city. This enabled the location and yields of wastewater to be estimated as a local water resource for producing recycled water suitable for non drinking purposes.

Wastewater overflows occur during wet weather events and result in discharge of wastewater to the stormwater system and local waterways. Harvesting and recycling of wastewater through sewer pipes may offer the potential benefit of relieving the sewer capacity during dry weather and potentially reducing the frequency or volume of sewer overflows.

Pumping stations are often the preferred location for harvesting wastewater from the network to make use of existing wastewater pumping stations and avoid additional pumping costs.

Nearly 28 billion litres of wastewater is collected annually from the city and discharged into the ocean after primary treatment. This is more than the volume of water that we would need in 2030 to supply non drinking water demand.

Figure 26 shows the projected growth in wastewater volumes generated from individual properties in the city by 2030. This estimate was based on the growth in water demand. Understanding how much wastewater is generated was necessary to map and analyse the precinct and catchment scale opportunities for using wastewater as an alternative source for producing recycled water to meet non potable water demand.

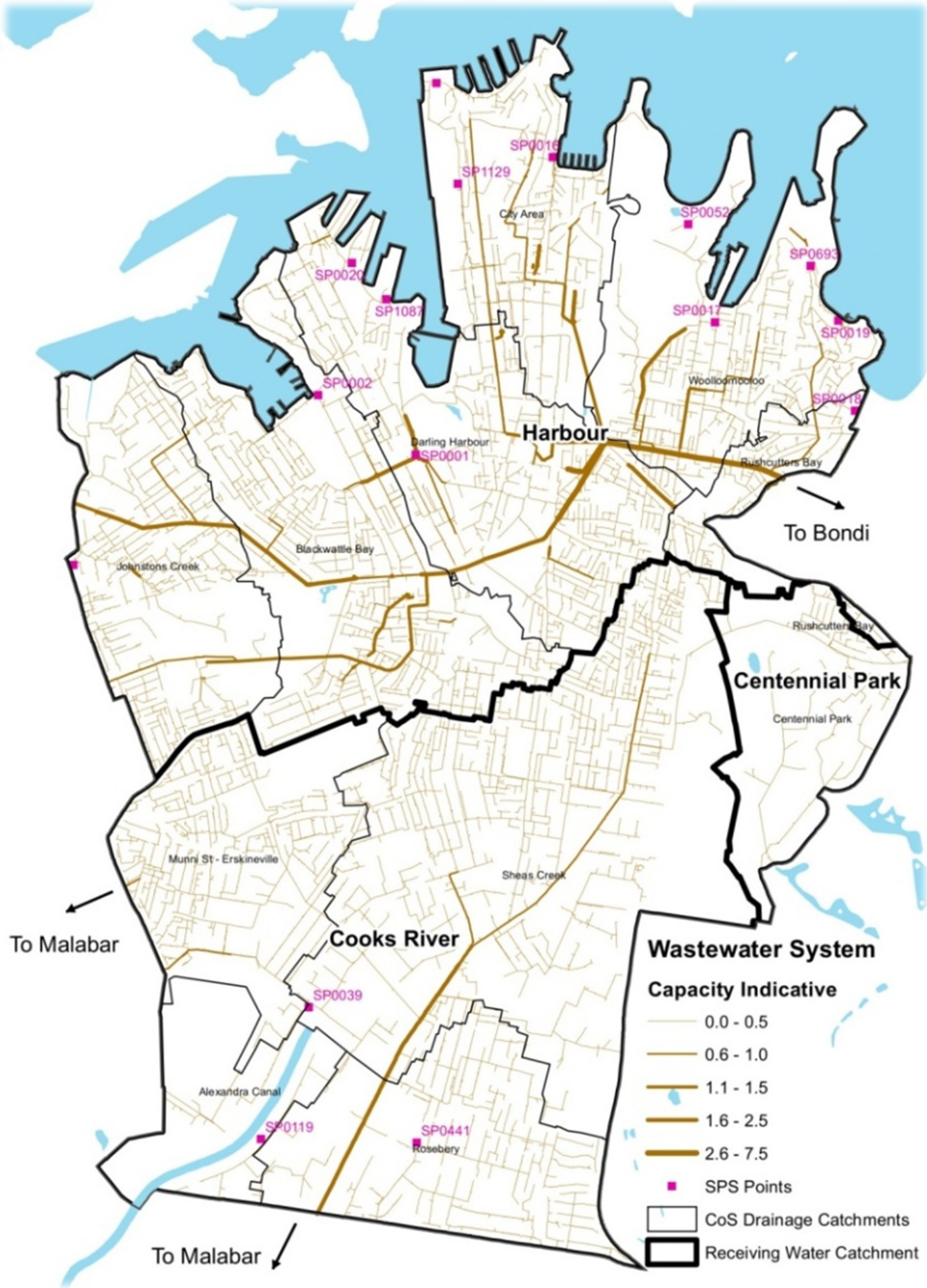


Figure 25 Overview of existing wastewater system

Figure 26 Projected growth in flows to sewer to 2030

3. Mapping Recycled Water Opportunities

3.1 Comprehensive Water Balance Analysis

A water balance analysis was undertaken for the 11 sub-catchments, which then aggregated to provide a water balance analysis for the 3 receiving water catchments, which in turn were aggregated to provide a City-wide water balance.

Integrated water modelling was used to assess the consequences of population and employment growth, water use efficiency and climate change on the long-term water balance for the City of Sydney. It takes account of all source waters, where they are used and where they are transferred, including the volume of drinking water imported, the volume of sewage generated within the City and the volume of stormwater runoff from the surfaces within the City.

Figure 27 shows the outputs from the model for four water balance scenarios.

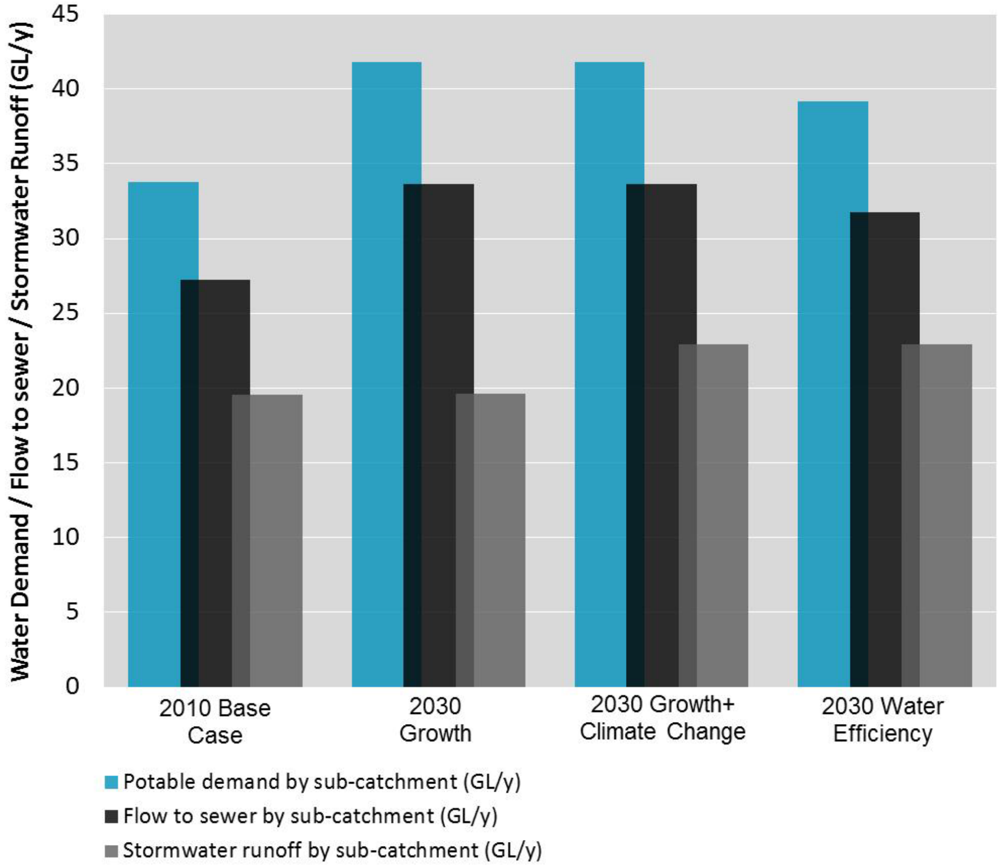


Figure 27 Analysis of the City's water balance under four scenarios

The Baseline Model simulates the historic water balance of the City and is based on 20 years of historic climate data from 1991 to 2010. It incorporates the catchment characteristics from layer A, the existing water demand data from Layer B and the existing sewage generation calculated based on the data in Layer B. The baseline model provides a picture of the historic water use and discharges from the City.

2030 Growth

The Growth Model is based on the Baseline Model. It incorporates the projected growth in demand from Layer C and growth in sewage generation from Layer G, however it is still based on historic climate data from 1991 to 2010. The Growth Model provides a picture of the water demands and discharges from the City based on future population and assuming that Sydney's climate will be similar to what it has been historically.

Climate Variability and Climate Change

The Climate Change Model output was produced by simulating the City water balance in 2030 incorporating the 'most likely' climate change predictions for the City for the 20 years from 2021 to 2040. It is based on the Growth Model. The climate change data was developed by the University of New South Wales and uses the IPCC Global Climate models to forecast the likely impact of climate change locally. This data was incorporated into the IWM Toolkit to model the impacts of climate change on water demand, sewage generation and stormwater runoff from the City in 2030.

Water Efficiency

The Water Efficiency Model simulates the City water balance in 2030 assuming the proposed water efficiency program has been fully realised and builds on the Climate Change Model. Accordingly itt incorporates the water efficiency estimates from Layer C. The Water efficiency Model provides a picture of the impact of the proposed efficiency program on the dynamic water balance both in terms of reductions in water demand as well as the associated reductions in sewage generation in the City.

The key insights from the modelling outputs summarised in Figure 28 are:

- the majority of the projected increase in water demand to 2030 is likely to be due to population and employment growth;
- the impact of climate change on water demand is likely to be minimal due to the relatively small amount of water used for irrigation within the City. (Analysis was undertaken on seasonal variability of cooling tower demand. However the analysis was clouded by tourist base demand from hotels and therefore was not conclusive);
- water efficiency will result in a significant reduction in demand based on implementation of the 10% efficiency portfolio (as per the Water Efficiency Plan), however overall demand is still expected to grow significantly between 2010 and 2030;
- trends in flows to sewer under the four scenarios are similar to the trends in potable water demand described above; and
- stormwater runoff based on future climate change data is greater (by 8.5% increase) than the historic scenarios, consistent with climate change projections that runoff will increase in coastal areas.

A summary of the LGA water balance (pre recycled water opportunities) is presented within Figure 28. A full suite of summary balances for 2010 and 2030 by sub-catchments are available within Appendix A.

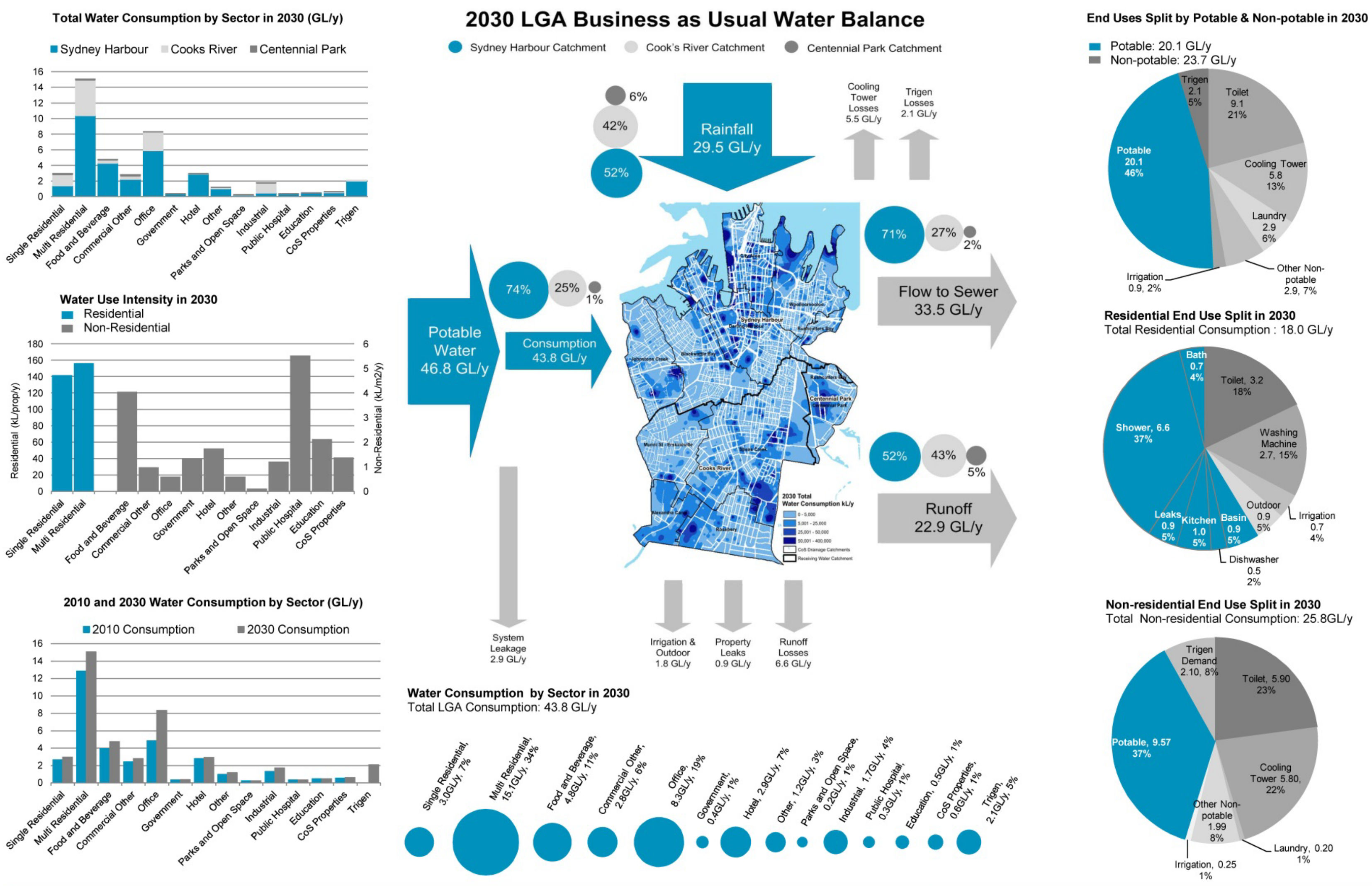


Figure 28 2030 Summary water Balance by LGA

3.2 Opportunity Analysis

The opportunities analysis used an open approach to assess all potential opportunities without prejudice to potential barriers or costs. This established an extensive range of preliminary opportunities, which was subsequently refined using multi-criteria and levelised cost analysis.

The way water is used within the City of Sydney differs from the greater Sydney averages. The large number of apartments, offices, hotels and food outlets dominate water use compared with greater Sydney, which has a large proportion of single residential homes and a larger industrial sector. Figure 29 identifies the largest water consuming sectors by potable water consumption between 2010 and 2030.

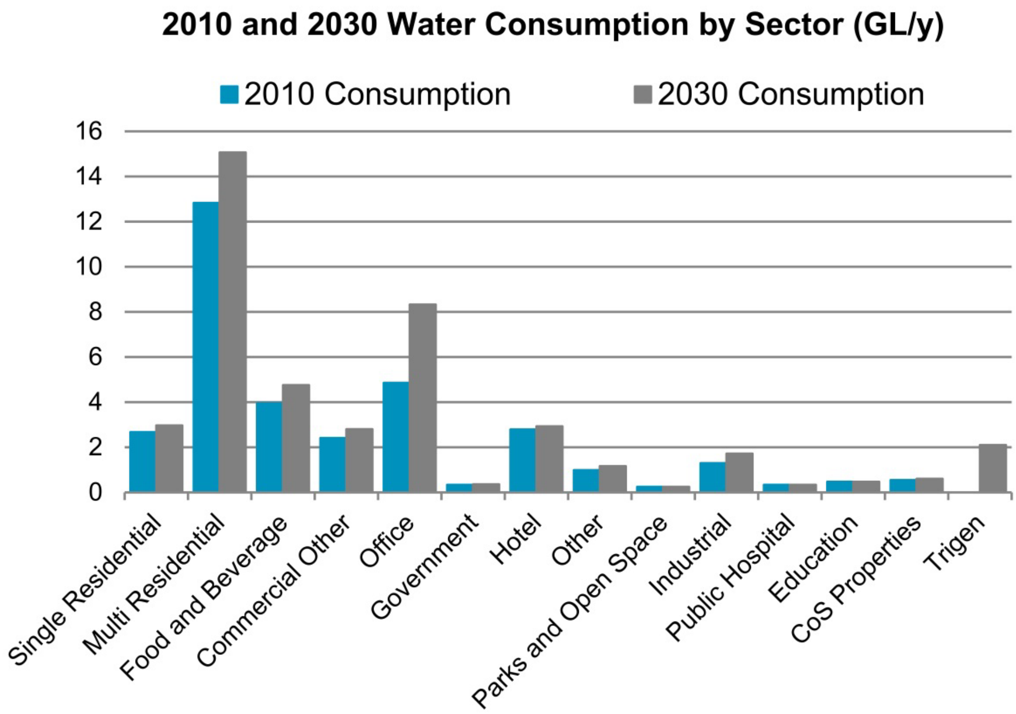


Figure 29 End use split by Potable and Non potable in 2030

Water recycling solutions aim to substitute potable mains water with recycled water from locally available water resources for non-drinking water demand. The analytical process for determining water recycling solutions was aimed at finding a match between supply (available yield) of local water resource and water demand (non-drinking use) in the proximity of the water source.

3.3 Recycled Water Demand

The non-drinking water demands that were considered for supply with recycled water include suitable demands from both existing and future developments:

- Toilet flushing
- Cooling towers
- Irrigation
- Washing bays etc.
- Industrial processes
- New demand by tri-generation plants

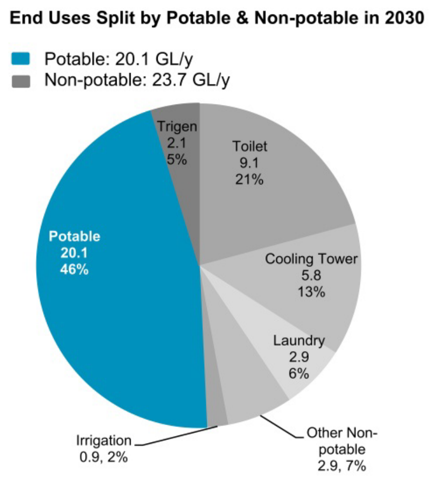


Figure 30 Suitable end use targets for recycled water

An estimate of the total non-drinking demand in 2030 that may be suitable for recycled water was derived based on current metered consumption data and projected 2030 future water demands. It was found that there is 24 billion litres of recycled water demand across the City. This represents 54 per cent of the water demand in 2030.

Layer D maps the recycled water demand and reveals that this demand is concentrated in areas such as:

- Barangaroo
- Central Business District (CBD)
- Darling Harbour & Pyrmont
- Greater Green Square area
- Area around Sydney Park
- Areas around Alexandra Canal.

Other pockets of high projected recycled water demand exist in planned major developments in:

- Redfern-Waterloo
- Harold Park
- Sydney Cricket Ground and surrounds
- Garden Island

3.4 Local Water Resources for Recycled Water Supply

The local water resources that were analysed for their yield and how it matched with the recycled water demand included:

- Roof water
- Stormwater
- Sewage and Blackwater
- Grey water
- Groundwater
- Sea water

A brief description of each of these water supply opportunities follows:

Roof water

Roof water is rain water that runs off from the roof area of buildings and is diverted into a large storage tank before it reaches the stormwater system. The treatment level is dependent on the end use and can include filtering and disinfection to meet internal and external non-potable demand.

Roof water harvesting opportunity is primarily limited by the volume and frequency of rainfall, the roof area that is available to capture rainfall and may also be limited by the size of the storage and the relative non-potable demands. There are economies of scale for large roofs, providing there is sufficient storage capacity, and where less treatment is required. The volume of roof water runoff is much less than stormwater runoff, due to the relative small collection area.

Stormwater

Stormwater is rain water that runs off of all surfaces within the City including roofs, roads, pathways, parks and other open areas, which is diverted to the stormwater system. Stormwater harvesting captures stormwater runoff from the stormwater system, treating the stormwater to a level suitable for the end use and storing this water in a tank, wetland / pond or underground aquifer.

Stormwater uses a relatively low level of treatment through WSUD in public open spaces but can be treated to a higher level for other non-drinking water purposes. Stormwater harvesting is primarily limited by the size of storage available to store the stormwater, the availability of suitable stormwater harvesting sites as well as the volume and frequency of rainfall.

Harvesting stormwater has the dual benefit of reducing demand for drinking water and reducing the volume of polluted stormwater discharged to waterways. Combining a stormwater harvesting scheme with WSUD treatments, such as rain gardens and constructed wetlands, can reduce operating costs and further reduce the pollutant load discharged to waterways.

Stormwater harvesting schemes can also incorporate stormwater detention basins that capture stormwater runoff during storms and reduce the risk of flooding.

Sydney Park is an excellent example of a stormwater harvesting initiative where there is a large supply of stormwater close to significant non-potable demand and storage capacity in an existing constructed wetland that has been designed to naturally treat stormwater. There is potential to divert more stormwater to this storage, which could potentially be combined with Managed Aquifer Recharge and Recovery, as it is close to the Botany Sands aquifer.

The major downside of stormwater harvesting initiatives is that very large storages are required and it is unlikely that 100% reliability of supply could be achieved. Therefore a backup supply of potable water would always be required.

Wastewater and Blackwater

Wastewater flows within the City are greater than the estimated potential recycled water demand. In addition to this, a significant volume of wastewater is transported through or near to the City from adjacent LGAs. Wastewater can be treated to a high standard and reused for non-drinking purposes such as toilet flushing, clothes washing, process water, garden watering and other outdoor uses. Recycled wastewater reduces the demand for imported drinking water, can relieve sewer capacity and may reduce the volume of wastewater discharged to the environment.

Sewer mining involves extraction of wastewater directly from the wastewater system. The wastewater is treated, using a small-scale local treatment plants, to a high quality level and distributed to properties through a third pipe to a single property, cluster of properties or to a precinct. Collecting and reusing wastewater locally may also reduce the cost of maintaining and amplifying the wastewater systems.

Sewer mining is limited by the maximum potential non-potable demand within the City, cost of implementing a third pipe network in a built up area and retrofitting existing plumbing within existing buildings.

Blackwater is similar to sewer mining except that it captures wastewater generated from the buildings that will be supplied with recycled water using an isolated, lot scale or small precinct scale, network and does not utilise wastewater generated in neighbouring areas. It is most relevant to new growth areas that will require new wastewater collection systems and is therefore only feasible and cost effective for new growth areas.

Wastewater is collected in a dedicated collection network and treated and disinfected to produce high quality recycled water. Recycled water would be delivered to properties to meet internal and external non-potable potable demand. The black water opportunity is limited by the amount of sewage generated within an area and the potential non-potable demand within that area.

Grey water

Grey water is wastewater that excludes toilet waste and is therefore a higher quality than sewage. It includes waste from uses such as hand washing, showering and clothes washing. Separating grey water from sewage requires special plumbing within buildings and is only cost effective and feasible for new buildings.

Grey water is separated from the sewage generated by buildings, collected in a dedicated grey water collection network and treated and disinfected to produce high quality recycled water. Grey water represents only a portion of the total sewage generated by buildings and is limited by the amount of grey water generated and projected growth within the City.

Groundwater

Groundwater is naturally infiltrated and stored in shallow and deep water aquifers. The major aquifer in the City of Sydney area is the Botany Sands aquifer, which is relatively shallow. Groundwater is accessed through bores for domestic and industrial purposes, which are licensed through a Water Sharing Plan managed by NSW Office of Water. The groundwater in the Water Sharing Plan has been fully allocated, although there is uncertainty about the volume of inactive licences.

Groundwater can also seep into underground structures such as tunnels and is dewatered by a number of infrastructure operators and discharged to the stormwater system. This is potentially a source of recycled water.

The groundwater aquifer can also be used as an underground storage aquifer, where treated stormwater for wastewater is actively reinjected into the aquifer to replenish groundwater supplies. Groundwater availability is determined through the Water Sharing Plan and volume of dewatering activities. Groundwater treatment relates to the intended reuse and can be treated to a high standard to meet potable and non-potable demand.

The City has commissioned an information gap analysis to understand what further information is required to examine this opportunity more thoroughly. This summary document is contained within Appendix E.

Seawater

Raw seawater refers to untreated seawater extracted from Sydney Harbour. There are some office buildings close to the harbour that use raw seawater for cooling towers. Raw seawater has the potential to meet cooling tower demand in the CBD and Darling Harbour and is limited by proximity to the harbour, water quality requirements of existing cooling towers and disposal options for brine and high temperature effluent.

There are various ways to remove salt from seawater to produce potable and non-potable water. All are energy intensive. The higher the quality of product water, the higher the energy input. The most common involve some kind of filtration using membranes, such as the Sydney Water Desalination plant at Kurnell. Thermal desalination is another mechanism, which relies on heat, rather than pressure for membrane filtration. The benefit of thermal desalination is that waste heat from other processes such as the proposed trigeneration units could be utilised to reduce the quantity of energy required for the desalination process.

This opportunity relates to areas close to Sydney Harbour, where raw seawater could be extracted and treated using a thermal desalination process to remove salt and other minerals, with the produced water suitable for a wide range of internal and external non-potable potable demand.

The opportunity is primarily limited by the amount of heat available to vaporise water and thereby remove the salt from the raw seawater. Normally the amount of heat required means that the process is energy intensive and produces large amounts of greenhouse gases. However, there are benefits in combining thermal desalination with the ‘green transformer’ trigeneration plants as these require water to produce energy and have the potential to provide waste heat for the thermal desalination process.

Thermal desalination is different to the desalinated water provided by Sydney Water, which uses a reverse osmosis (RO) process reliant on high pressure

3.5 Matching Supply & Demand

As shown in the Figure 31 bubble chart, the supply and demand comparison reveals that there is sufficient volume of locally available water sources to meet all of the recycled water demand within the City if an appropriate storage and distribution network were available. The potential recycled water demand is greatest in Darling Harbour and the City Area, followed by Sheas Creek and Blackwattle Bay, with relatively small non-potable water demand in the other sub-catchments.

As previously stated, a decentralised water system refers to a cluster of opportunities for providing alternative water including groundwater, seawater, roof water and recycled water (treated stormwater, treated wastewater, grey water and black water). These opportunities can be provided independently at a lot or precinct scale or in combination through a decentralised water network.

The Recycled Water Plan has focused on precinct scale and greater opportunities, recognising that lot scales solutions are still available, with or without a Decentralised Water System. Lot scale opportunities however can still tap into a Decentralised Water System.

The stormwater harvesting opportunities included in the decentralised water supply analysis are above and beyond the local stormwater harvesting opportunities identified in the WSUD and Stormwater Infrastructure report, which focuses on public open space opportunities.

Using the baseline data (described within Section 2) and the water balance data, a rigorous process of matching supply with demand taking into account, topography, network and pumping required, and indicative volumetric water balances and water quality improvement benefits identified over 300 small scale opportunities. These opportunities are listed within Appendix B. While conceptual schemes were progressed in detail for further analysis, this list identifies opportunities that may be equally valid to progress.

Ground water supplies were uncertain and require further evaluation. Therefore they were not considered beyond this phase of the analysis. The City of Sydney however have commenced investigations into the feasibility of groundwater. A summary of this is presented within Appendix E.

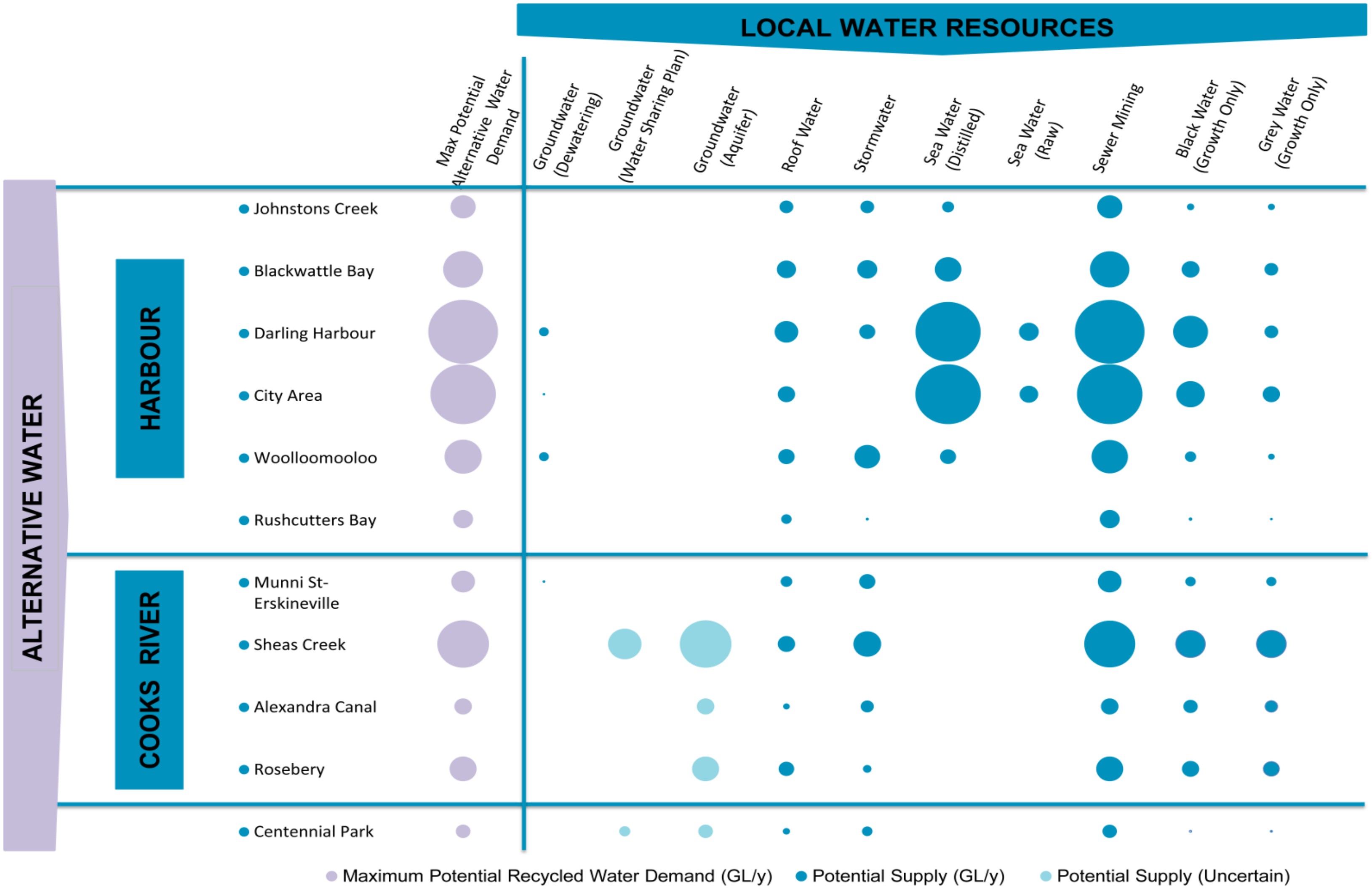


Figure 31 Summary of potential local water supplies and potential recycled water demands by sub-catchment

3.5.1 Refining Opportunities

The 300 preliminary opportunities list was further refined to a list of 34 opportunities using a set of technical, environmental, social and economic criteria known as Multi Criteria Analysis (MCA) as shown in Figure 32.

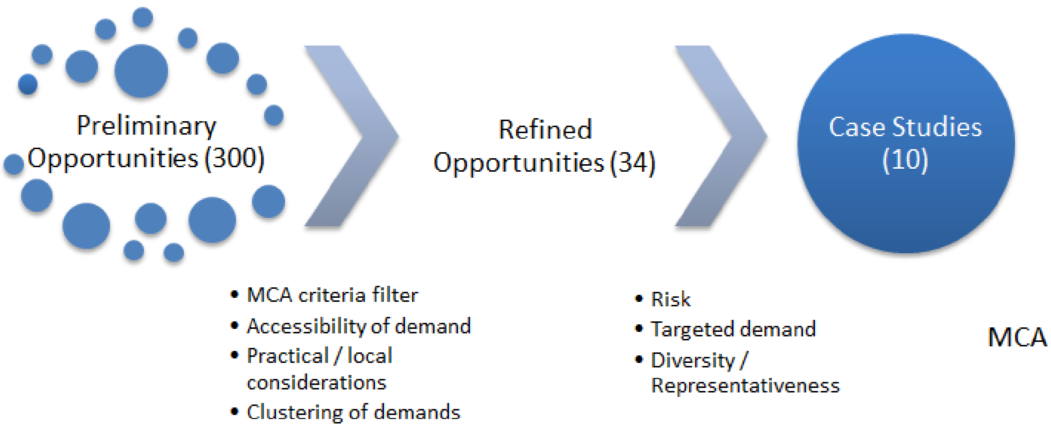


Figure 32 Process for refining the preliminary opportunities

Considerations during the filtering process included local characteristics, potential synergies and reliability and effectiveness such as those outlined in Table 2.

Table 2 Considerations used to filter preliminary opportunities

Local Characteristics	Synergies	Reliability & Effectiveness
Target larger residential and commercial buildings with fewer connections and higher demand	Synergies with existing and proposed infrastructure and initiatives	Reliability of supply e.g. stormwater and roof water reliability is driven by demand, yield and storage.
Avoid older areas and terraced properties requiring multiple connections with low demand	Utilise existing infrastructure including sewerage pumping stations and collection networks	Sewer mining is more cost effective with increased volumes. Small opportunities were clustered to improve economies of scale
Target new developments to include third pipe and plumbing during construction	Co-location of infrastructure to minimise disruption and avoid costs e.g. trigeneration network	Small opportunities targeting only a few properties suit lot-scale solutions
Consider topography to avoid pumping and energy costs	Minimise energy use and carbon emissions and reduce waste e.g. utilise waste heat from trigeneration to thermally desalinate seawater	Network effectiveness targets clusters of high recycled water demand and minimises length of supply network

In summary these refined opportunities are presented within Figure 33. The figure highlights the scale of recycled water opportunity by source type. As previously discussed the source types have been determined by local demand. Thermal desalination and sewer mining (predominantly within the CBD area) present the major opportunities of supply/demand balance followed by stormwater harvesting.

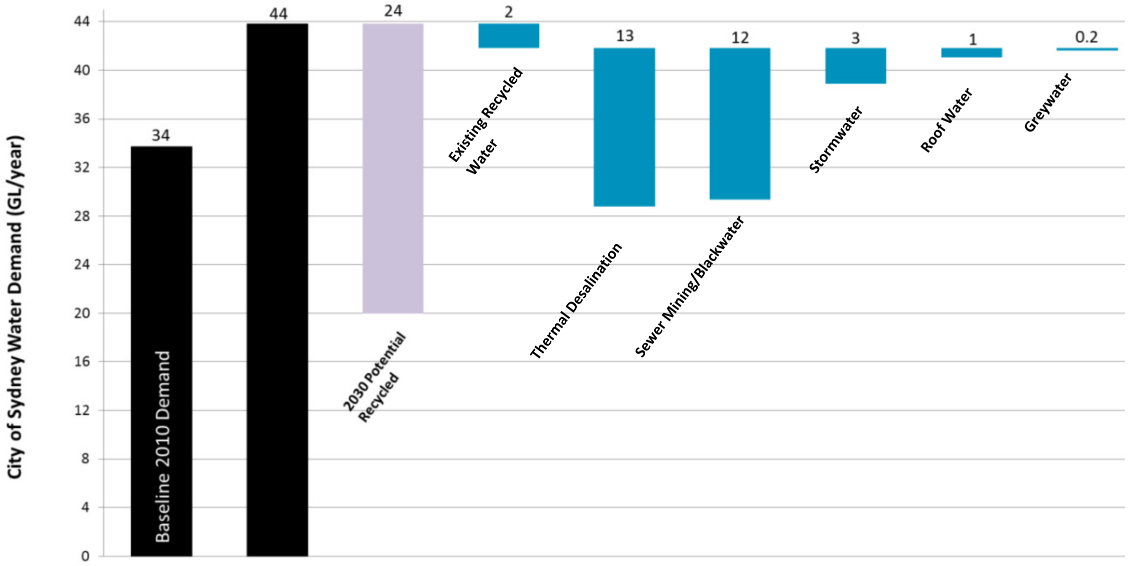


Figure 33 Total recycled water demand opportunity by supply type for 34 refined opportunities

3.5.2 Locating Opportunities

34 opportunities were distilled from the preliminary opportunities and are represented in a map of the LGA in Figure 34. The map shows the areas of concentrated non-potable demand in areas where there is a feasible supply source.

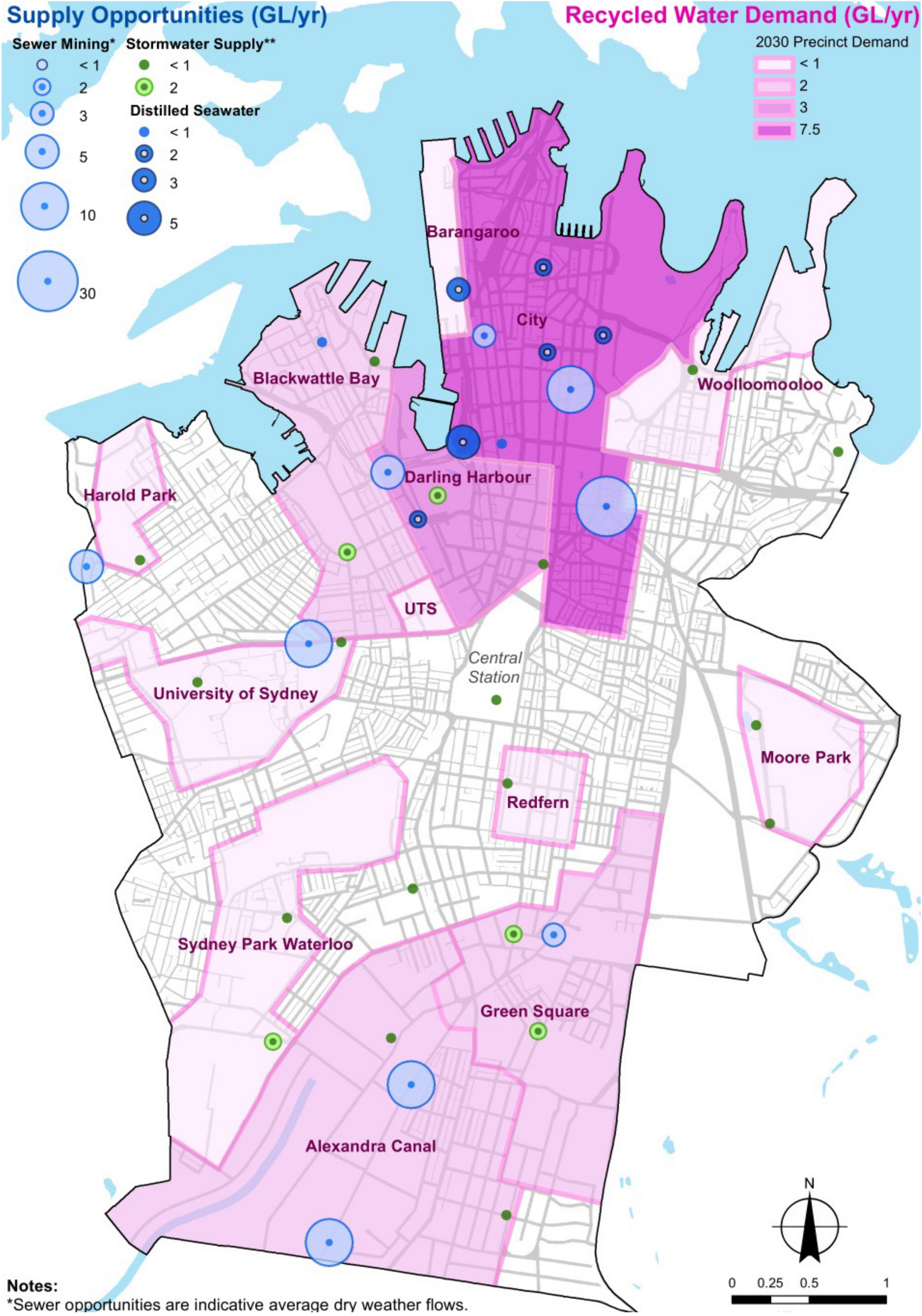


Figure 34 Map showing identified recycled water demand precincts and supply opportunities

In some cases more than one supply source could feasibly supply the non-potable demand in each catchment. Table 3 summarises the water supply opportunities in each of the precincts presented in Figure 34.

Table 3 Recycled water demand and potential water supply opportunities in each precinct

Precinct	Recycled Water Demand (GL/y)	Supply Opportunities (GL/y)		
		Sewer Mining	Stormwater Supply	Distilled Seawater
Harold Park	0.1	3.3	0.4	0.0
University of Sydney	0.3	5.1	0.4	0.0
Blackwattle Bay	1.9	0.0	1.9	1.0
Darling Harbour	3.0	3.1	2.3	1.7
Barangaroo	0.7	2.6	0.0	2.0
City Area	7.1	25.5	0.0	8.3
Woolloomooloo	0.6	0.0	0.7	0.0
Sydney Park Waterloo	0.4	0.0	2.7	0.0
Redfern	0.1	0.0	0.1	0.0
Green Square	1.8	2.2	3.0	0.0
Alexandra Canal	1.4	13.1	0.3	0.0
Moore Park	0.2	0.0	0.8	0.0
Totals	**17.4**	**54.9**	**12.6**	**13.0**

Sewer Mining

Figure 34 shows the key sewer mains of interest for sewer mining opportunities. These include sewer mains with high dry weather flows with the ML per day indicated on the map. Areas with sewer mining potential include the CBD, Darling Harbour, Sydney University surrounds, Harold Park surrounds, Sheas Creek and Roseberry.

Grey Water Reuse

The area surrounding Alexandra Canal has also been identified for potential grey water reuse where there is high non-potable demand and growth forecast. The trade waste from industrial properties in the area may mean that sewer mining is unsuitable. A dedicated grey water collection system may avoid this issue. Grey water is not cost effective compared to sewer mining in other areas.

Thermal Desalination

Thermal desalination opportunities have been identified in areas close to Sydney Harbour and proposed trigeneration plants. It assumes that there is sufficient waste heat from the trigeneration plant to supply distilled seawater to surrounding properties.

Roof Water Harvesting

Layer E shows the areas where there are clusters of large roofs. This includes Darling Harbour, Moore Park and the area surrounding Alexandra Canal.

Stormwater Harvesting

20 stormwater supply opportunities have been identified in Figure 34 including indicative average annual stormwater yields (presented as daily flows for comparison purposes). Ideal stormwater harvesting opportunities include a confluence of large stormwater mains near a suitable storage, typically in a park or large open space. Table 4 below includes further detail on the supply, demand and storage characteristics for a range of stormwater harvesting opportunities. Storage sizes were based on a land-take of up to 10% of the identified park area or a sub-surface storage of equivalent volume.

Table 4 Preliminary assessment of stormwater supply opportunities

Source ID	Opportunity	Potential Yield (ML/d)	Example Storage Capacity (ML)	Example Potential Demand (ML/d)	Volumetric Reliability	Demand Opportunity (ML/d)
1	Federal Park / Bicentennial Park	1.1	12	0.2	98%	0.2
2	Sydney University	0.6	16	0.5	75%	0.4
3	Victoria Park	0.5	5	0.3	74%	0.2
4	Wentworth Park	5.1	12	2.7	55%	1.5
5	Prince Alfred Park	0.4	7	0.3	77%	0.2
6	Pyrmont Bay Park	0.2	3	0.1	79%	0.1
7	Tumbalong Park / Chinese Garden	4.4	6	1.4	60%	0.8
8	Belmore Park	1.9	10	0.8	79%	0.6
9	Woolloomooloo	2.0	30	1.3	78%	1.0

Source ID	Opportunity	Potential Yield (ML/d)	Example Storage Capacity (ML)	Example Potential Demand (ML/d)	Volumetric Reliability	Demand Opportunity (ML/d)
	Oil Bunker					
10	Reg Bartley Oval	1.7	22	1.2	76%	0.9
11	Moore Park	0.9	7	0.4	82%	0.3
12	Extension of Lake Network	1.3	22	1.0	93%	0.9
13	Redfern Park	0.3	12	0.2	81%	0.2
14	Waterloo Oval	5.4	8	2.7	50%	1.4
15	Joynton Park	2.8	6	1.4	57%	0.8
16	Alexandria Park	0.8	20	0.7	79%	0.5
17	Perry Park	0.4	6	0.3	78%	0.2
18	Turruwul Park	0.3	11	0.3	80%	0.2
19	Erskineville Oval	2.5	17	1.0	84%	0.8
20	Sydney Park (Stage 2)	4.8	20	1.6	89%	1.5
	TOTALS	38	253	18	70%	**13**

Table 4 shows how volumetric reliability is determined by the potential yield and storage capacity relative to demand. The integrated water model was used to develop reliability curves, which provide an approximate estimate of reliability (Refer Figure 22).

These results suggest that, for most of the stormwater supply opportunities shown in Figure 34, a reliability of 70 to 80% could be achieved. The demand opportunity for stormwater harvesting ranges from 0.1 ML/d to 1.5 ML/d.

Options 9 (Woolloomooloo Oil Bunker) and 20 (Sydney Park Stage 2) stand out as opportunities that can reliably supply a relatively high demand (> 1ML per day). This compares with Wentworth Park and Waterloo Oval, which also have high demand but lower reliability. The nature of the water demand will determine how critical reliability is to the schemes.

3.5.3 Summary of Key Decentralised Water Findings

The investigation into decentralised water opportunities has demonstrated that there is an abundance of water available from local sources including the sewer, stormwater system and the sea. It has also shown that there is significant potential demand (24 GL per year in 2030) for non-potable water. Historical focus on recycled water opportunities for irrigation is only a small fraction of the potential recycled water demand.

Water source opportunities have been assessed for each receiving water catchment based on size of opportunity, suitability or availability of water source to meet demand and location characteristics.

The Sydney Harbour Catchment

The combination of high demand and low growth means that the Sydney Harbour catchment is most suited to opportunities that target existing demand. Suitable sources include sewer mining, stormwater harvesting and thermally desalinated seawater.

The key challenge is in retrofitting existing buildings (cooling towers and / or fixtures) with plumbing that can connect to a third pipe. Locating a third pipe will also be a challenge in a densely populated area.

The major opportunities include synergies with the Decentralised Energy Master Plan (trigeneration plants), major developments and ongoing building refurbishments in the city.

The Cooks River Catchment

Major redevelopments in the Cooks River catchment should be a target for recycled water opportunities, including Green Square, Redfern and Waterloo developments.

Sewer mining and stormwater harvesting opportunities are the most suitable sources with the potential. Sydney Park offers the ideal confluence of a large storage, combined with a large supply source and high non-potable demand. Phase 2 is underway to meet the non-potable demand within the Park however this opportunity has further potential to be scaled up through a decentralised network and potentially MAR.

Stormwater harvesting opportunities have lower reliability, compared with sewer mining, but include synergies with stormwater quality objectives.

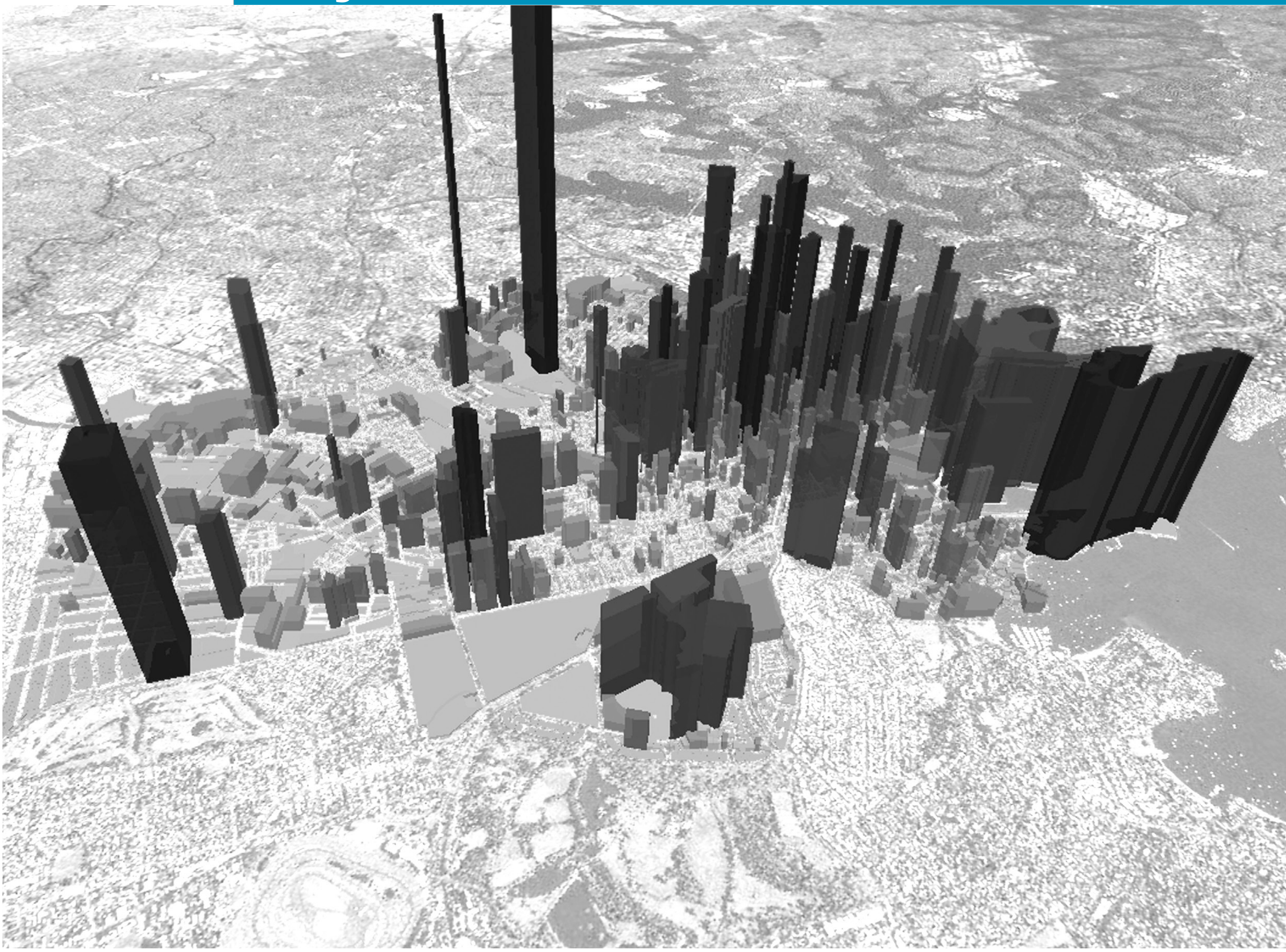
The Centennial Park Catchment

Whilst Centennial Park is a relatively small catchment, it has potential to use local water potentially from roof water harvesting or stormwater harvesting. There are large commercial demands in the sports stadiums and Entertainment Quarter as well as irrigation opportunities in the vast parkland surrounds.

Cost is the common challenge for all decentralised water opportunities evaluated. However there are other benefits including reduced discharge to the environment, improved liveability and potentially avoided costs for future system upgrades need to be considered.

The Multi-Criteria Analysis, described in Chapter 4, provides further insight into the relative merits of the alternative supply options using representative Case Studies.

4. Assessment of Conceptual Recycled Water Initiatives



The Decentralised Water Master Plan has avoided 'picking winners' as there are a number of factors that could influence the priority and cost-effectiveness of opportunities during the life of the Master Plan.

However, ten Case Studies have been developed with Concept Plans to further demonstrate the relative cost –benefit using Multi-Criteria analysis and levelised cost analysis. The selection of these case studies were chosen to represent scale, region and types of recycled water opportunities. The selection does not undermine the list of 34 strategic options discussed previously and listed within Appendix B.

The City of Sydney intends to invite the private sector to bid for project opportunities, which may introduce a different perspective on opportunities, benefits and costs identified in this Master Plan. New technologies, changes to regulations, consumer expectation and alternative procurement methods can change the relative performance of different supply opportunities.

4.1 Description of the Case Studies

The Recycled Water Plan includes 10 major precinct scale recycled water concepts, as case studies for undertaking financial and multi criteria analysis. These case studies were selected to represent a range of locations and source water used to produce recycled water.

The 10 conceptual case studies include five sewer-mining options, three stormwater harvesting options, one roof harvesting option and a thermal desalination option. These case studies are indicative of the range of opportunities available across the City in terms of source and sensible scale of opportunity.

Table 5 Conceptual case studies

Sewer Mining	Stormwater Harvesting	Roof Water Harvesting	Thermal Desalination
Johnstons Creek	Wentworth Park	Moore Park	Barangaroo
City Wide	Waterloo oval		
Darling Harbour	Sydney Park		
Barangaroo			
Greater Green Square			

Figure 35 shows the location of the ten conceptual case studies, which are further described below.

Appendix C includes concept plans for each of these 10 conceptual case studies.

1. **Johnstons Creek Sewer Mining:** Sewer mining of the large sewer mains adjacent to Sydney University and transfer to a 1.2 ML/day advanced wastewater treatment facility within the Sydney University. Recycled water of a high quality would be delivered to properties within Sydney University, as well as the major developments at Waterloo and Harold Park, and used to meet internal and external non-potable demands.

2. **City Wide Sewer Mining:** Sewer mining at two large sewer mains running through the CBD as well as the large sewage pumping station SP0001 in Darling Harbour. Wastewater would be delivered to three advanced wastewater treatment plants with a combined capacity of 22 ML/day. Recycled water of a high quality would be delivered to properties throughout the CBD, Darling Harbour and Pyrmont via a city wide recycled water network and used to meet internal and external non-potable demands.
3. **Darling Harbour Sewer Mining:** Sewer mining at the large existing sewage pumping station SP0001 in Darling Harbour. Wastewater would be delivered to an 8.5 ML/day advanced wastewater treatment plant, which may be co-located with the proposed trigeneration plant. Recycled water of a high quality would be delivered to properties within precincts with high recycled water demand via a local recycled water network and used to meet internal and external non-potable demands.
4. **Barangaroo Sewer Mining:** Sewer mining at the existing sewage pumping station SP1129 adjacent to Barangaroo. Wastewater would be delivered to a 2.2 ML/day advanced wastewater treatment plant which may be co-located with the proposed trigeneration plant. Recycled water of a high quality would be delivered to properties within the major development of Barangaroo and adjacent properties to the south of Barangaroo via a local recycled water network and used to meet internal and external non-potable demands.
5. **Greater Green Square Sewer Mining:** Sewer mining from the large sewer main running through the Green Square development. Wastewater would be delivered to a 5.7 ML/day advanced wastewater treatment plant which would be co-located within the Green Square development. Recycled water of a high quality would be delivered to properties within the major developments of Green Square and Redfern via a local recycled water network and used to meet internal and external non-potable demands.
5. **Wentworth Park Stormwater Harvesting:** Stormwater harvested from the large stormwater mains running under Wentworth Park. Stormwater would be diverted to a large 12 ML surface storage pond located within Wentworth Park. Stormwater would be treated to a high quality and delivered to properties within Blackwattle Bay via a local recycled water network and used to meet internal and external non-potable demands.
6. **Waterloo Oval Stormwater Harvesting:** Stormwater harvested from the large stormwater mains running under Waterloo Oval. Stormwater would be diverted to a large 8 ML sub-surface storage located within Waterloo Oval. Stormwater would be treated to a high quality and delivered to properties adjacent to the oval in the north of the Green square development and to Moore Park via a local recycled water network and used to meet internal and external non-potable demands.
7. **Sydney Park Stormwater Harvesting:** Stormwater harvested from Stage 1 and Stage 2 of the Sydney Park wetlands. Stormwater would be treated to a high quality and delivered to properties in Alexandra Canal, the Waterloo major development and the areas of high growth to the north of Sydney Park via a local recycled water network and used to meet internal and external non-potable demands.
8. **Moore Park Roof Water Harvesting:** Roof water harvesting from the roofs within the Sydney Cricket Ground, Fox Studios, the Entertainment Quarter and

surrounding buildings. Harvested roof water would be delivered to a long 8.5 ML sub-surface storage main running the length of the facility providing both storage and pre-treatment and distribution of the harvested roof water. Recycled roof water would be extracted from the storage, disinfected and used to meet internal and external non-potable demands.

9. **Barangaroo Thermal Desalination:** Extraction of raw seawater from Sydney Harbour and delivery to a 5.6 ML/day thermal desalination plant within the Barangaroo development. The desalination plant would be co-located with the proposed trigeneration plant CBDN2 and use waste heat from the trigeneration plant to distil seawater. Desalinated water would be delivered to properties in the Barangaroo major development and properties in the west of the CBD via a local recycled water network and used to meet internal and external non-potable demands.

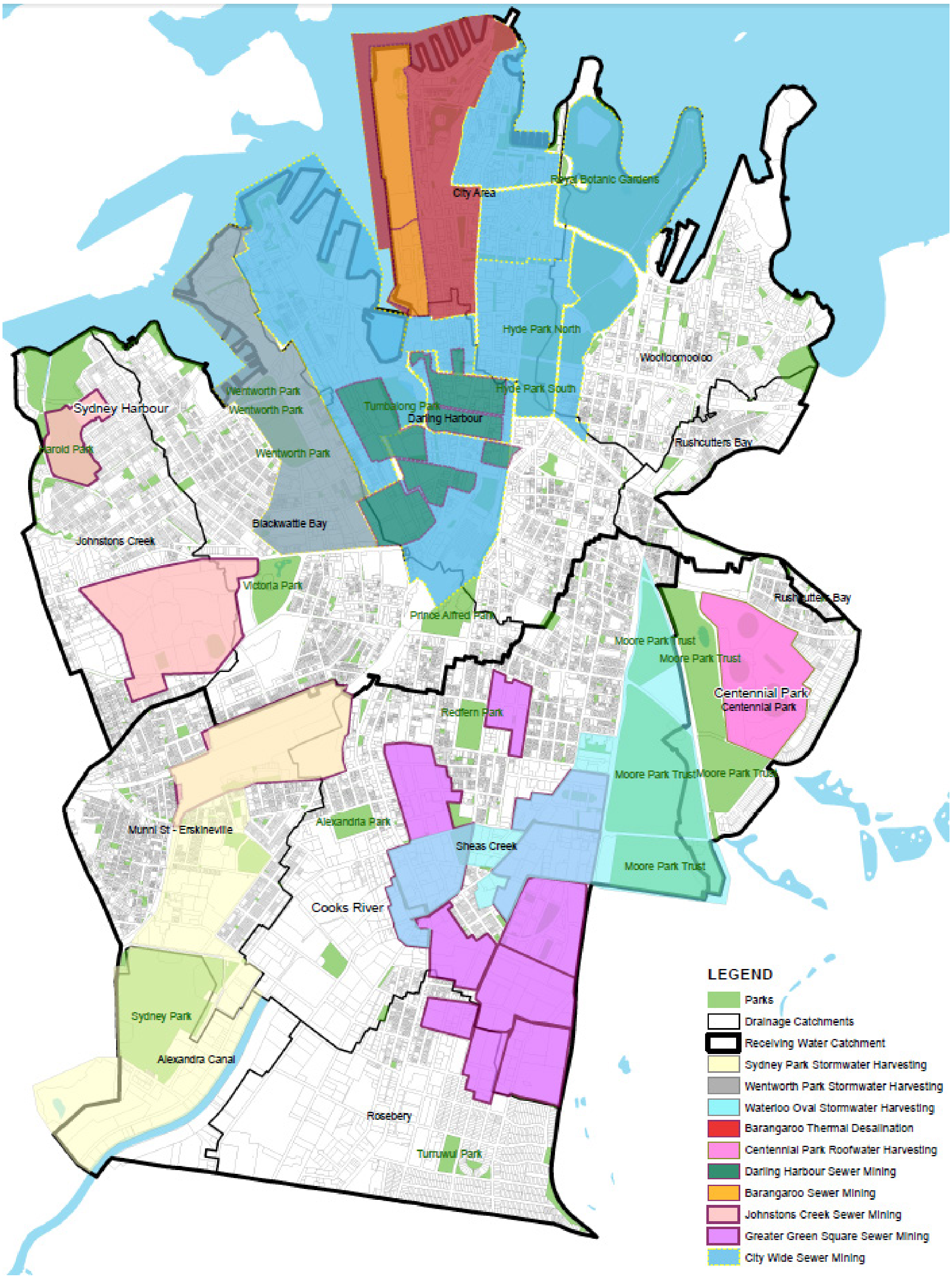


Figure 35 Location of 10 conceptual options

4.2 Assessing the Case Studies

Multi-criteria analysis was undertaken which aimed at assessing the recycled water schemes for a number of criteria in addition to financial. These criteria involved some that were easy to quantify and others that were qualitative in nature and therefore required professional judgement to make the assessment. This analysis was therefore completed with input from the key stakeholders.

Financial Analysis

The financial analysis involved making assumptions on capital costs and operation and maintenance cost of establishing a recycled water scheme and operating it for 20 years, from the perspective of a water service provider and from the broader whole of society perspective.

Figure 36 presents a comparison of the estimated capital costs, operating costs and business costs associated with each case study. A comparison of these costs with the potential recycled water supply capacity of each of the case studies is also presented. Figure 37 compares the estimated levelised costs (cost per billion litres of recycled water capacity in present value) for each of the 10 case studies that were used as a basis of assessing the comparative costs of the case studies in the MCA. It is important to note levelised costs for the purpose of comparing the case studies in the MCA are whole of society costs, but exclude business costs and revenue, as these are difficult to estimate at this stage and may skew the results of the multi criteria analysis.

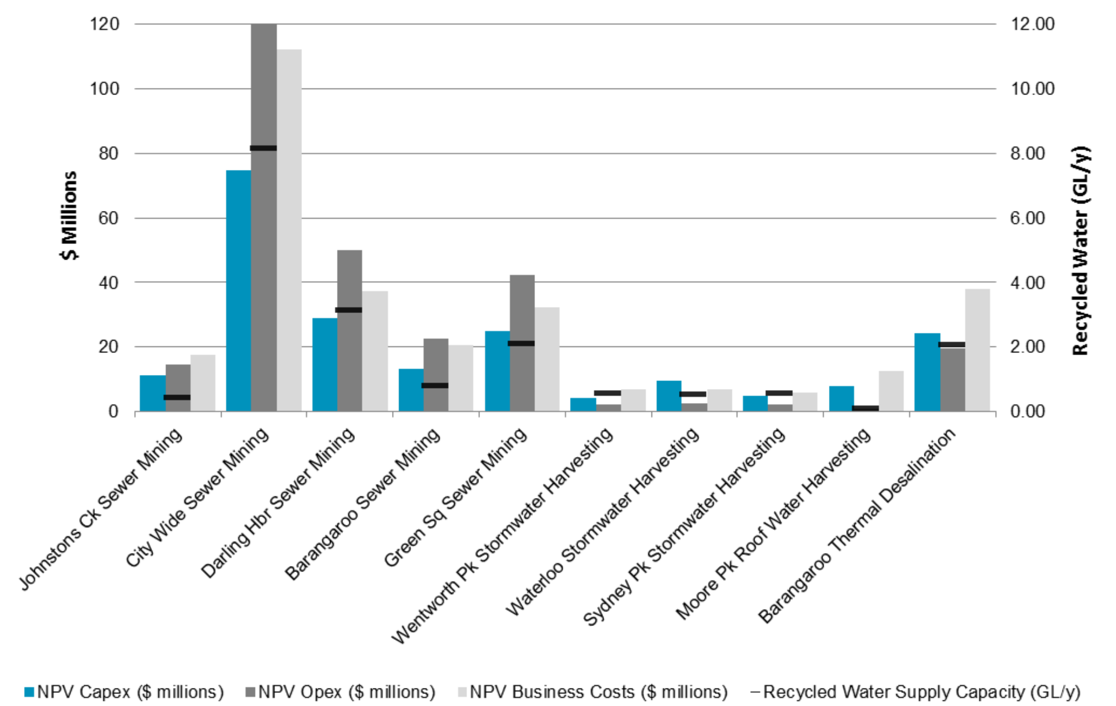


Figure 36 Comparing of the capital, operating and business costs with recycled water supply capacity for the 10 case studies

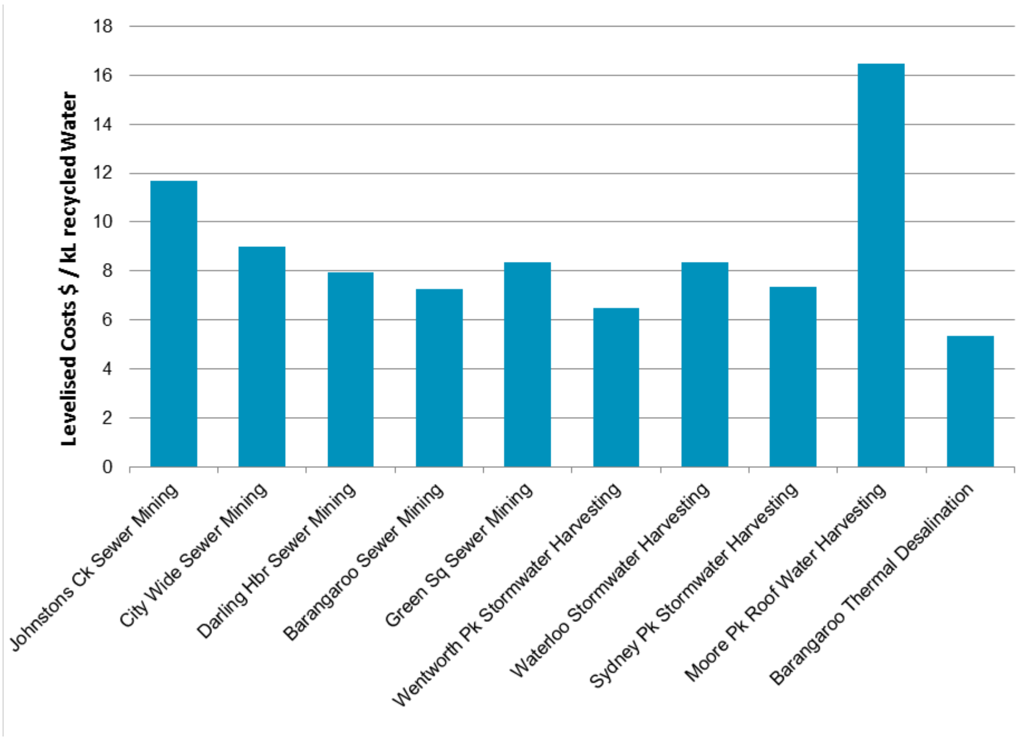


Figure 37 Estimated levelised cost of recycled water supply for the 10 case studies

Note: Levelised costs for the purpose of comparing the case studies in the MCA are whole of society costs, but exclude business costs and revenue as these are difficult to estimate at this stage and may skew the results of the multi criteria analysis.

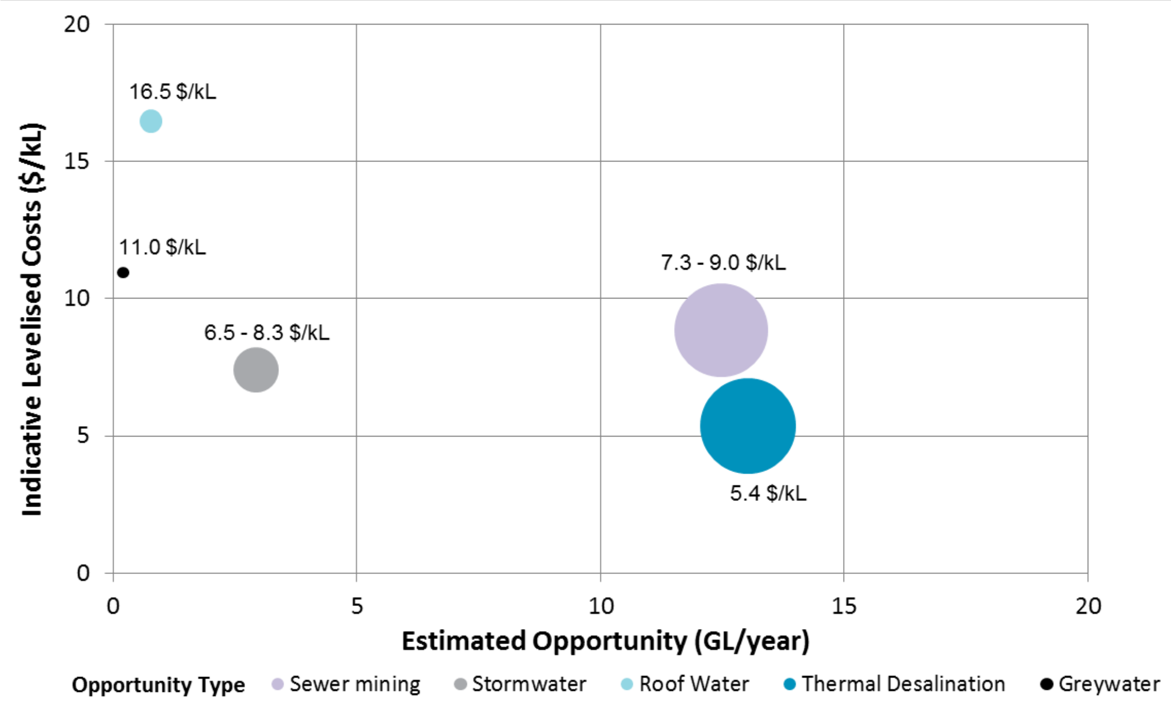


Figure 38 Estimated range of levelised cost of recycled water supply by supply type

Greenhouse Gas Analysis

The greenhouse gas (GHG) emissions intensities associated with each of the 10 case studies were estimated. Three scenarios were investigated based on alternative energy sources:

- Energy from the grid: this scenario assumes that electricity will be sourced from the existing power grid and supplied from traditional centralised sources (i.e. coal and gas).
- Natural gas powered trigeneration: this scenario assumes that electricity will be sourced from the City's trigeneration plants powered by natural gas.
- Biogas gas powered trigeneration: this scenario assumes that electricity will be sourced from the City's trigeneration plants, however these plants would be powered by carbon neutral biogas sourced from the digestion of locally sourced waste.

Figure 39 shows the estimated GHG emissions (expressed as carbon dioxide equivalent) for each of the 10 case studies under the three power source scenarios described above. This figure shows sourcing electricity from the City's proposed biogas powered trigeneration network will reduce GHG emissions from recycled water supply by around 70 to 80%.

This City aims to power their trigeneration plants with 100% biogas by 2030 and plans to source energy for recycled water supply from the trigeneration network. Therefore the biogas powered trigeneration GHG emissions intensities were adopted for the MCA.

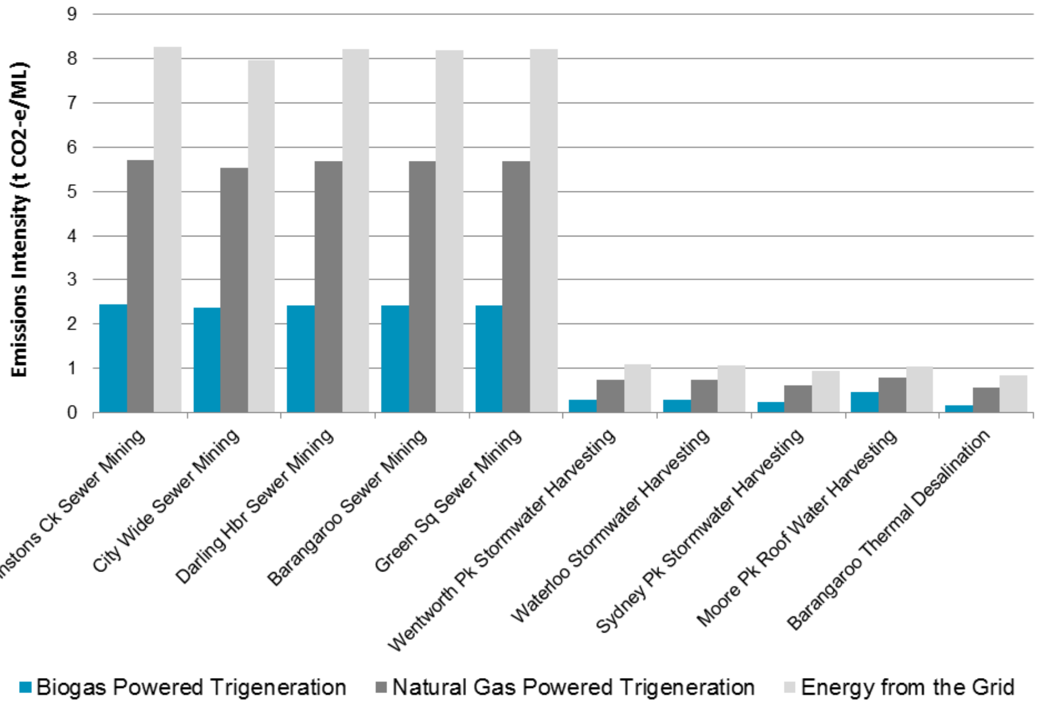


Figure 39 Comparison of greenhouse gas emissions for the case studies assuming three energy sources

Notes:

1. GHG emission intensities include both construction emissions and operating emissions

2. GHG emissions intensities for biogas do not account for avoided GHG emissions at the source (i.e. methane emissions from landfill). On a whole of life basis, the use of biogas for power generation may be carbon neutral or even carbon positive.

Multi Criteria Analysis

The City of Sydney invited a number of stakeholders, including Sydney Water, neighbouring councils and relevant government departments, to participate in the development of assessment criteria and weightings for the Multi- Criteria Analysis (MCA), which was used to identify and compare conceptual options. The criteria and relative weightings are shown in Figure 40 below.

A Multi-Criteria Assessment was used to assess the conceptual case studies against the weighted criteria. Both Table 6 and Figure 41 present the results of this analysis. Although many of the case studies have a similar weighted score, Figure 41 demonstrates that the scores against individual criteria differ between opportunities. For example, stormwater harvesting options have better carbon intensity and environmental impact scores but lower reliability and network effectiveness compared with sewer mining options. The scale of the weighted score reflects the overall benefit of that criterion e.g the higher the cost the lower the score. The highest scores rank the most preferred.

Summary of the MCA analysis

The MCA results clearly show the need to consider multiple supply sources and local considerations. Sewer Mining and stormwater suggested preferences are comparable however for very different drivers. For example carbon intensity values support stormwater and thermal desalination and network intensity supports sewer mining and thermal desalination (due to the volumes of demand that can be satisfied).

The following high level observations regarding the relative performance of the options can be concluded from the outcomes of the MCA:

- Barangaroo thermal desalination is suggested to be preferred, performing well against all criteria, particularly levelised cost, carbon intensity and network effectiveness;
- Overall, the sewer mining and stormwater harvesting options perform similarly;
- Of the sewer mining options, Darling Harbour sewer mining and Barangaroo sewer mining are preferenced and represent the ‘low hanging fruit’ compared to the City Wide option that takes in these options but also includes less effective network areas ;
- The sewer mining options perform particularly well against the reliability and network effectiveness criteria;
- Of the stormwater harvesting options, all perform well with the Sydney Park and Waterloo Stormwater Harvesting options preferenced over Wentworth park which has been penalised due to land take within the park;
- The Moore Park roof water harvesting option performs the worst of all the options assessed but roof water harvesting performs well in terms of carbon intensity.
- The stormwater harvesting options perform particularly well in terms of carbon intensity and perform better in terms of environmental impact in comparison to the other options.

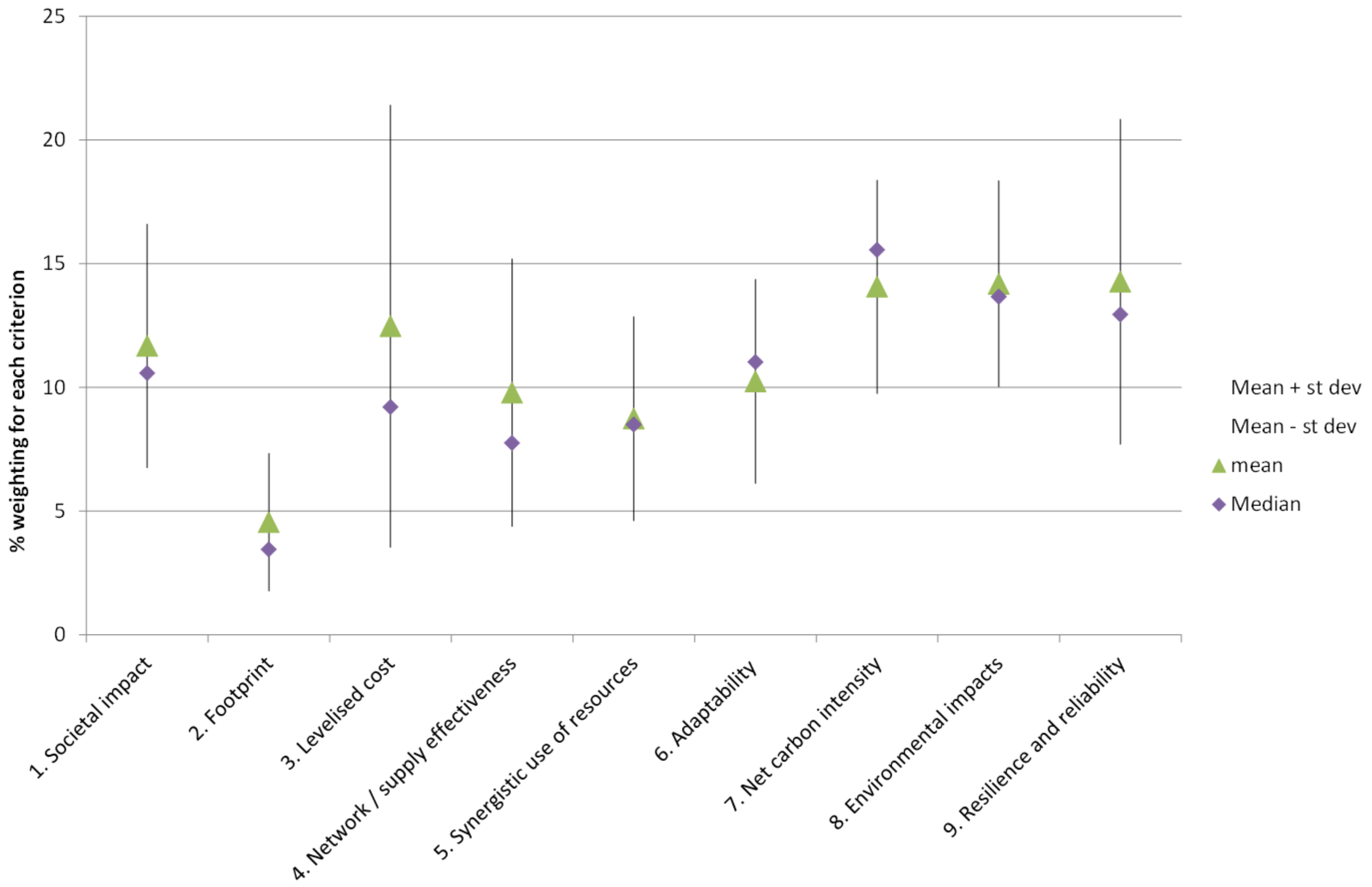


Figure 40 Stakeholder weightings of agreed assessment criteria

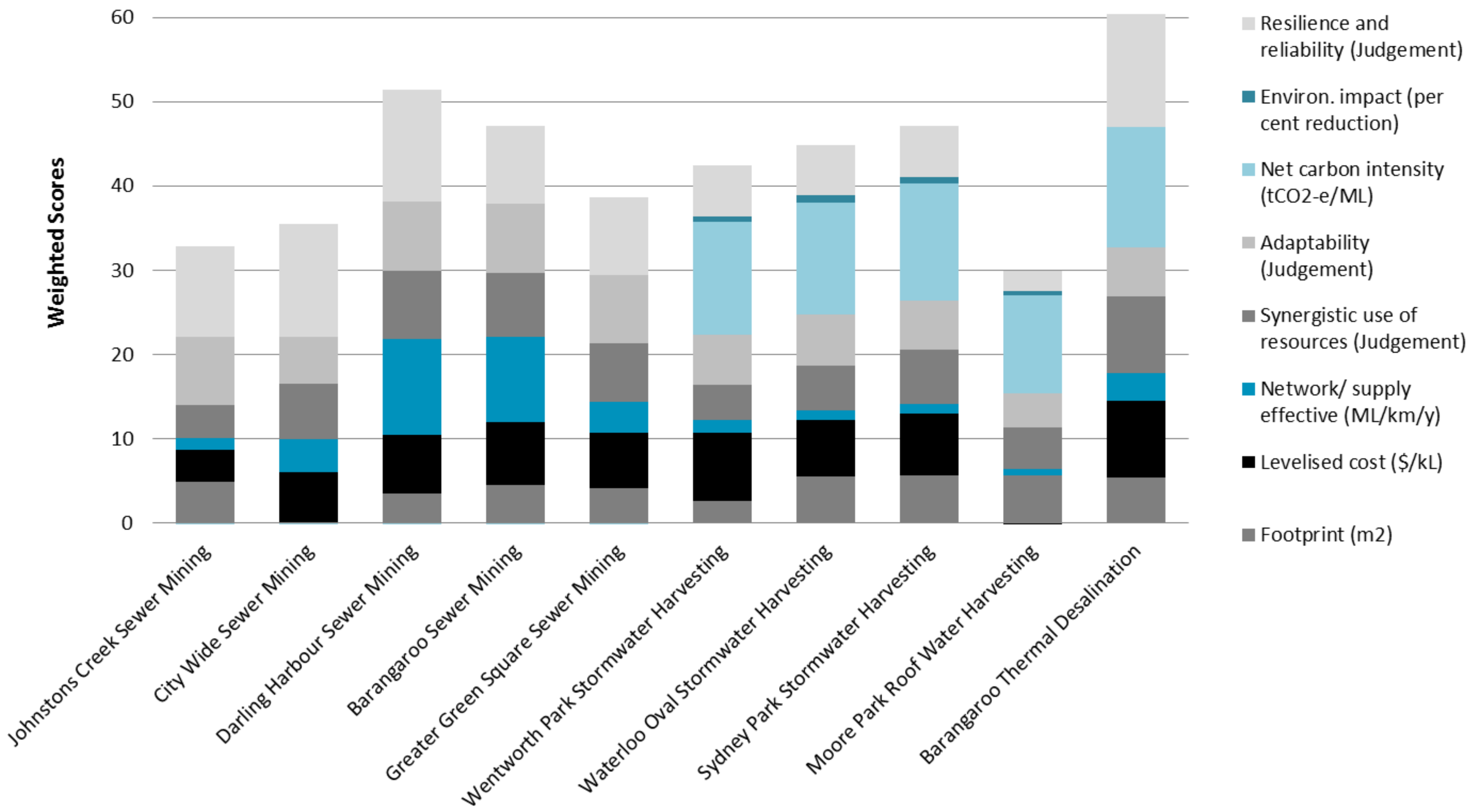


Figure 41 Multi-Criteria Assessment of 10 conceptual options

Decentralised Water Recycling Case Study	Demand opportunity (GL/y)	Footprint (m2)	Levelised cost ($/kL)	Network/ supply effective (ML/km/y)	Synergistic use of resources (Judgement)	Adaptability (Judgement)	Net carbon intensity (tCO2-e/ML)	Environ. impact (per cent reduction)	Resilience and reliability (Judgement)
1. Johnstons Creek Sewer Mining	0.4	3,200	11.7	60	0.38	0.72	2.4	0.0%	0.67
2. City Wide Sewer Mining	8.1	22,800	9.0	180	0.64	0.49	2.4	0.0%	0.84
3. Darling Harbour Sewer Mining	3.1	8,600	7.9	500	0.79	0.72	2.4	0.0%	0.84
4. Barangaroo Sewer Mining	0.8	4,900	7.3	450	0.75	0.72	2.4	0.0%	0.58
5. Greater Green Square Sewer Mining	2.1	6,100	8.4	160	0.68	0.72	2.4	0.0%	0.58
6. Wentworth Park Stormwater Harvesting	0.5	12,500	6.5	60	0.41	0.53	0.3	4.5%	0.38
7. Waterloo Oval Stormwater Harvesting	0.5	500	8.3	50	0.52	0.53	0.3	5.1%	0.38
8. Sydney Park Stormwater Harvesting	0.5	400	7.3	50	0.64	0.51	0.2	5.3%	0.38
9. Moore Park Roof Water Harvesting	0.1	100	16.5	40	0.48	0.36	0.5	3.2%	0.15
10. Barangaroo Thermal Desalination	2.0	1,100	5.4	140	0.89	0.52	0.2	0.0%	0.84

Table 6 Summary of results of the quantitative and qualitative assessment of 10 representative case studies

Note: Levelised costs estimated whole of society costs that exclude business costs and revenue and significant avoided costs.

4.3 Preliminary Cost Assessment and Indicative Subsidies

A preliminary business case (Appendix D) has been prepared for a select number of conceptual options previously discussed. The City of Sydney are considering supporting in part the progression of the identified initiatives but require assistance to do so. Assistance is being sought in both subsidies to support the initiatives and from interested organisations to further progress the initiatives in some form of commercial arrangements. The commercial arrangements for the purpose of this report have been referred to as a Water Servicing Company (WASCO).

The purpose of the preliminary business case is to identify indicative and preliminary costs and risks associated with key options. It is a first pass and subject to further detailed analysis on procurement, subsidies, business costs and risks.

Assumptions and details of all of the costs estimates are contained within Appendix F and Appendix D.

Potential Avoided Costs

The preliminary business case has been made in isolation of a detailed understanding of potential avoided costs. Potential avoided costs are those costs that would have occurred without these initiatives progressing. They could extend to;

- reduced wastewater system operating and capital investment as a result of reduced loads into the wastewater system,
- reduced water system operating and capital investments as a result of reduced water demand from the potable water system,
- avoided upstream investments (such as alternative supply sources) as a result of reduced water demand,
- avoided expensive private water investment on a lot scale (such as the building by building blackwater schemes developing to achieve desired NABERS[10] accreditation).
- synergistic cost reduction activities in incorporating infrastructure into;
    - potential significant investment programs to reduce wet weather overflows and improve system reliability within the wastewater system,
    - incorporate assets within major infrastructure strategies such as light rail, thermal network and major road renewals,
    - major developments and renewals such as Barangaroo, The entertainments Centre and Convention Centre, Sydney Cricket Ground etc..

Potential avoided costs can be significant and requires a total Government and community approach to fully identify, understand and realise these opportunities.

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[10] NABERS - the National Australian Built Environment Rating System - measures an existing building's environmental performance during operation. NABERS rates a building on the basis of its measured operational impacts in categories such as energy, water, waste and indoor environment

WASCO Business Costs

The costs include broad estimates on business costs. Business costs include startup and ongoing fixed and variable costs incurred by any business. To the extent that these costs are realised are subject to clear signals by regulatory bodies to facilitate these initiatives, the business model, the risks and difficulties in securing customers and the maturity, understanding and existing business structures of proponents to progress these initiatives. They can be therefore extremely variable.

Cross Subsidies

Additionally the preliminary cost analysis has been made on a case by case basis without the inclusion of cross-subsidies. For example the costs and revenue associated with the recent construction of the desalination plant at Kurnel was made considering the total impact upon the water system and customers of Sydney Water. Accordingly the costs of this initiative have been born by all potable water customers of Sydney Water and not just those receiving water from this plant. Additionally the potable water system has had a legacy of significant investment over a long time that is not available to alternative new supplies where the costs have to be wholly carried by the new initiative.

Levelised Costs and Net Present Value (NPV) WASCO costs

The NPV costs differ from the levelised costs discussed previously. Table 7 presents a summary of these differences and Figure 42 and Figure 43 present the indicative values.

Business costs were excluded from the levelised costs assessment due to the highly variable and uncertain nature. Business costs are highly variable and subject to the proponents ability to minimise risk and maximise opportunity which cannot be quantified across different scales and types of opportunities.

Revenue was excluded from the levelised costs assessments. To include revenue in a cost to society assessment when the costs of implementation have already been included would have led to double counting., distorting the benefit.

The significant costs to building owners in retrofitting buildings[11] has been excluded from the WASCO NPV assessment as it does not directly affect the financial arrangement of that business.

[11] Retrofitted building costs are incurred when a building is re-plumbed to receive recycled water. These cost are born by customers choosing to connect and may be significant. However the scale of costs may be substantially reduced if incorporated within other refurbishments. Additionally the cost of retrofitting a recycled water delivery system is a small component of costs when compared to single lot scale recycled water initiatives. These lot scale initiatives are occurring on a adhoc basis across the City by developers and tenants seeking NABERS accreditation.

Table 7 Differences between levelised costs and WASCO NPV analysis

Description of costs		Levelised Costs	WASCO NPV analysis
CAPEX	Collection	✓	✓
	Treatment	✓	✓
	Storage	✓	✓
	Distribution	✓	✓
OPEX	Electricity costs	✓	✓
	Maintenance costs	✓	✓
	Trade waste discharge fees	✓	✓
Business Costs	Start up and fixed business		✓
	Variable business costs		✓
Revenue	Residential volumetric recycled		✓
	Residential recycled water		✓
	Residential sewer discharge		✓
	Non res volumetric recycled		✓
	Non res recycled water access		✓
External	Cost to building owners	✓	
	Limited avoided costs to society	✓	

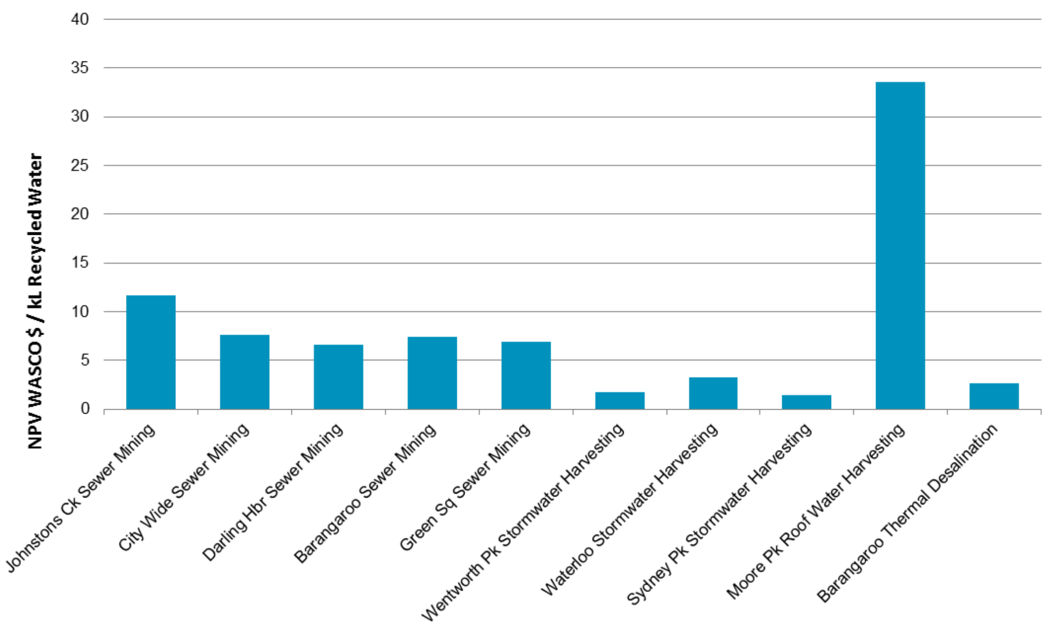

Figure 42 Indicative NPV WASCO costs of recycled water supply for the 10 case studies

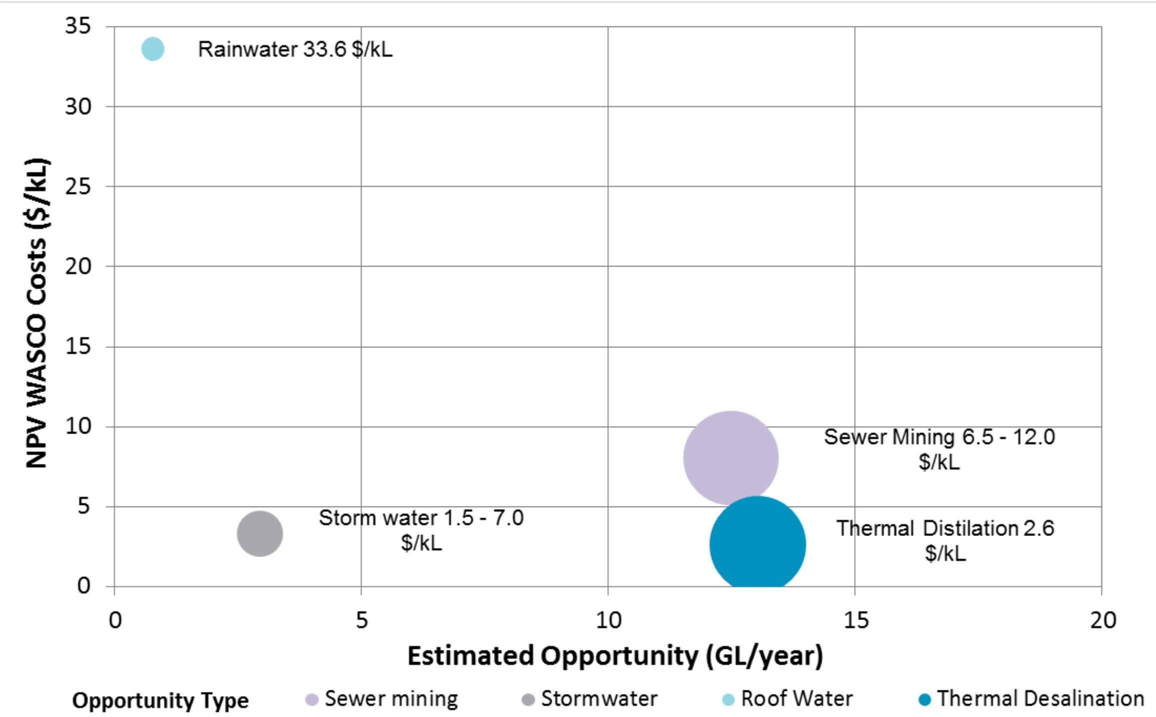

Figure 43 Indicative range of NPV (WASCO) costs of producing recycled water by source water

Case Study differences and subsidies

The detailed preliminary business case analysed a select number of concepts. This analysis was further extrapolated across the 10 conceptual options to derive an indication of subsidy requirements across all 10 conceptual options. Figure 44 provides the indication of the scale of subsidy required for each concept compared to the scale of recycled water opportunity.

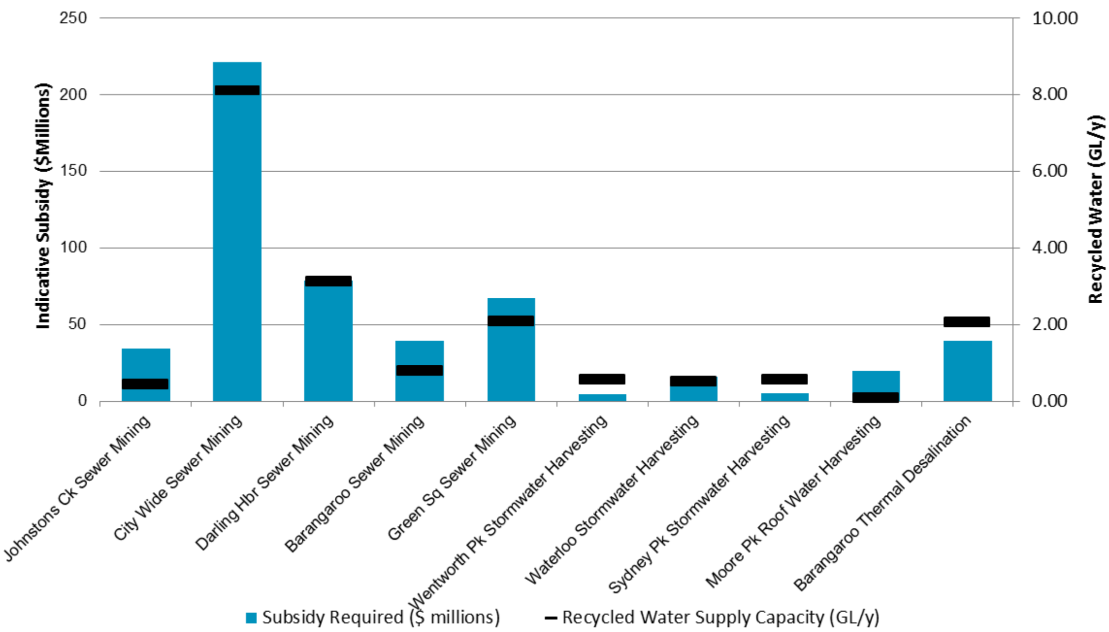

Figure 44 Indicative subsidies required for each of the schemes described in the 10 case studies

Sewer Mining

Sewer Mining involves the collection of wastewater and energy intensive filtration systems to purify the water to acceptable standards. Membrane Bioreactors (MBR) have a relatively small footprint and are typically the technology of choice in urban environments. They are however subject to economies of scale and currently inefficient for lower recycled water volumes (less than 1.0 ML/d) as outlined in Figure 45.

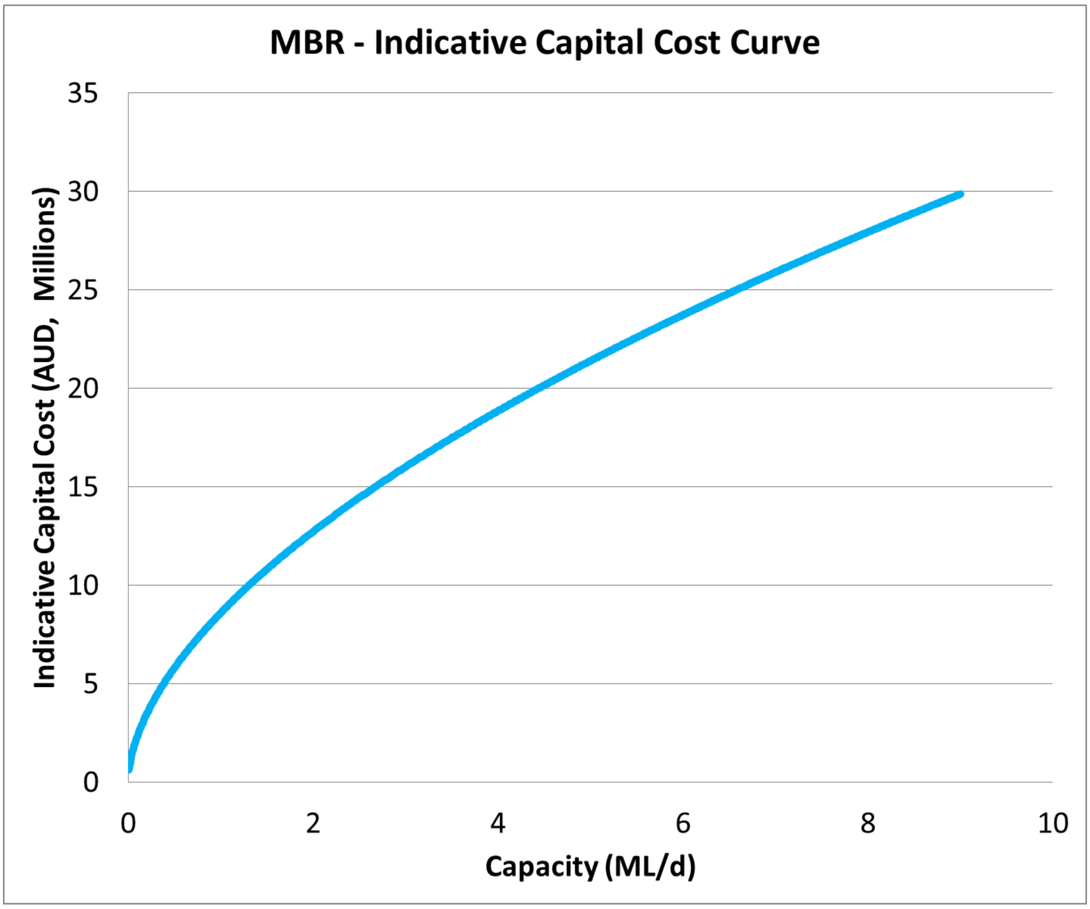

Figure 45 Indicative Capital Costs curve for MBR

The sewer mining concept around Johnstone Creek and surrounding areas is characterised by the relatively lower volumes of recycled water (0.4 GL/yr) when compared to other concepts. Therefore this scheme sits on the lower portion of the curve within Figure 45 and is subject to higher proportional capital costs. Additionally the customer base is mainly non residential and therefore subject to relatively higher volumes of water but lower service charges. Accordingly the estimated WASCO NPV analysis is the highest of all sewer mining costs of around 12.0 $/kL. Table 22 within the Stormwater and WSUD report has identified stormwater benefits within this locality that maybe better placed to capture the best opportunities within this area.

The sewer mining concepts around Darling Harbour, Barangaroo and Green Square, are characterised by the synergistic opportunity of major redevelopment within those areas and therefore avoids significant retrofits (although some will occur when servicing existing properties). The City wide concept involves significant retrofits but is also of a significant scale (around 8 GL/yr). The WASCO NPV analysis is similar for all four of these concepts at around $7 to $8/kL .

The scale of subsidies however vary. The City Wide Sewer Mining case study is estimated to deliver 8 GL/yr and requires an indicative subsidy of $200 to $300M, whereas the Darling Harbour sewer mining scheme delivers 3.1 GL/yr of recycled water for a subsidy of $60 to $100M.

Stormwater

The stormwater options are influenced by the constraints of storage and reliability. However all three options are of a similar scale of recycled water supply around 0.5 GL/yr. The concepts for Waterloo included subsurface storage[12] to limit land take, which has significantly increased costs compared to surface ponds for Green Square and Wentworth Park.

Accordingly, the capital costs for Waterloo have significantly affected the WASCO NPV analysis suggesting $3.3 /kL and a subsidy estimate of $8M compared to Green Square and Wentworth Park of $1.5 - $2/kL and a subsidy of $4M to$5M.

The analysis for Sydney Park has not considered historical investment for comparison purposes. Sydney Park however has already had a level of investment within the WSUD ponds stage 1 and therefore may not require additional subsidy.

The stormwater options have a limited impact upon the current water demand to the City. In total these 3 options provide 1.5 GL/yr of recycled water or 3 % of the potable water delivered to the City by 2030. Subject to the funding available they contribute to the overall target for the City and provide additional water quality and potentially amenity benefits.

Thermal Desalination

The thermal desalination opportunity benefits from its synergistic qualities with the trigeneration initiative in utilising the heat available from electricity generation. They are anticipated to be co-located. Other than the two stormwater schemes at Wentworth Park and Sydney Park, this opportunity looks financially the most attractive requiring a subsidy of an estimated $20M to $60M with an indicative WASCO NPV analysis of $2.6/kL. Additionally the quality of water available from thermal desalination may be more acceptable for the provision of potable water into the existing reticulation network, which would significantly reduce the WASCO NPV estimates. Potable water provision would also avoid building owner costs that have been included in this levelised costs assessment.

Rainwater

The rainwater scheme within Centennial Park at Moore Park was identified in recognition of the large roof and green areas. However the costed network system is significant compared to the benefit and revenue stream identified. Similarly to the sewer mining scheme within Johnstone Creek, the main customers are commercial , requiring relatively large volumes of recycled water, but a small number of connections . This appears to be affecting revenue projections. There may still be

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[12] Subsurface storage was selected in consultation with the community stakeholder group that expressed a view that the impact upon park amenities would be tolerated providing that the facilities were shared and enhanced. And land take was not excessive. Surface ponds in additional to water quality benefits may also be seen to add additional amenities and to area introducing more interesting land and water scapes.

opportunity to progress with a lot scale or hybrid scheme however to take advantage of the proposed refurbishment to the SCG.

4.4 Summary

There is clearly no single supply type nor scaled initiative which presents itself as the ideal strategy. In contrast the analysis shows that diversity of supply in sympathy to the local situations support preferences for the initiatives identified.

The recycled water analysis has focused on 10 concepts for the purpose of detailed analysis however Appendix B shows a more comprehensive list of opportunities that could be also progressed.

In summary, the Recycled Water Plan has identified;

- An abundance of local and variable supply sources exist suitable for recycled water supply.
- The Master Plan supports diversity, adaptability and environmental influences in supplying recycled water demand opportunities.
- The analysis is detailed and diverse to support urban planners, architects and developers in achieving sustainability values.

With subsidies the schemes are viable and effective.

Table 8 Indicative summary of conceptual options is presented not as an action plan but a suggestion on the range in scale , cost and diversity of initiatives that may make up the Decentralised Water Master Plan (DWMP). The realisation of these initiatives will be dependant upon subsidies, WASCO developments, developers and the timing of synergistic developments, in conjunction with political and community will and access to the necessary funds to enable action.

Table 8 Indicative summary of conceptual options

Conceptual Option	Recycled water GL/yr	Indicative subsidies $M	WASCO NPV analysis $/kl	Cumulative recycled water GL/yr	Cumulative subsidy $M
2.8a Sydney pk stormwater harvesting	0.5	5	-1.46	0.5	5*
2.3a Wentworth Pk stormwater harvesting	0.5	4	- 1.74	3.1	49
5.1d Barrangaroo Thermal desalination	2.0	39	- 2.64	2.6	45
1.2e Darling Hbr sewer mining	3.1	79	- 6.56	6.2	128
1.5c Green Sq sewer mining	2.1	67	- 6.92	8.3	195
1.2b City Wide sewer mining	8.1	221	- 7.62	16.4	416
2.7a Waterloo stormwater harvesting	0.5	8	- 3.28	16.9	424
1.2h Barrangaroo sewer mining	0.8	39	- 7.42	17.7	463
1.1b Johnson Creek sewer mining	0.4	34	- 1.68	18.1	498
3.2a Centennial Park Roof Water Harvesting	0.1	20	- 33.60	18.2	518

- Subsidy may not be required (May be already funded)

5. Recommendations

The Recycled Water Plan provides a long range view of the opportunities that could be implemented by the City of Sydney in partnership with the community, business, developers and other agencies.

The opportunities range in impact and cost-benefit and do not point to a silver bullet solution. The Recycled Water Plan provides the City of Sydney with rich data to make considered and evidence based decisions on how to proceed.

Implementation of the following ten steps will further progress the outcomes of the Plan.

1 Quick Wins

The Decentralised Water Master Plan has assessed over 300 opportunities to improve water efficiency, reduce pollution discharged to waterways and diversify water supply through decentralised water systems. The intention is not to pick winners, however there were a number of opportunities identified that had a clear cost-benefit that could readily be implemented by the City including:

- Complete Phase 2 of Sydney Park stormwater harvesting opportunity, which has received Federal funding. Maximise opportunities to supply recycled water demand in surrounding area
- Secure commitment from Better Building Partnerships to connect to a Decentralised Water System if made available.
- Engage major developers in areas of high recycled water demand e.g. Barangaroo, Green Square, Central Park, Harold Park, Darling Harbour and Sydney Cricket Ground in further assessment of decentralised water system and water sensitive urban design opportunities. In particular Darling Harbour Entertainment and Convention centre re-development.

2 Link

Link opportunities identified within the Decentralised Water Master Plan to NSW government and the City of Sydney's Master Planning including

- Metropolitan Water Plan – feed into actions and funding for recycled water and efficiency targets
- Sustainable Sydney 2030 Vision - update water targets
- Decentralised Energy Master Plan - approach seawater thermal desalination opportunity from a combined energy and water perspective
- Other major infrastructure- such as light rail to minimise social disruption and maximise infrastructure efficiency

3 Inform

There were a number of opportunities where further information is required to fully understand potential

- Complete investigation of Botany groundwater aquifer to understand potential to extract groundwater or recharge the aquifer through MAR
- Develop cost studies that identify the issues with retrofitting existing buildings (cooling towers and internal fixtures) to inform and continuously improve innovation and efficiency
- Evaluate the potential and available technology for using waste heat from trigeneration to treat alternative supplies through seawater desalination and its impact on the Harbour
- Further evaluate the possibility of desalination as a potential potable water source.

4 Review

Areas where policy and regulatory drivers could be strengthened include:

- Introduce Development Control Plan clause to enforce minimum water efficiency standards in all new buildings and major refurbishments (e.g. beyond BASIX)
- Almost all of the alternative water supplies identified require a significant upfront investment in treatment and distribution. Without a pre commitment to connect, it makes the investment risk high and unattractive. And without enough connections, many schemes may not be considered viable. Explore opportunity to include a pre-commitment clause in Development Control Plan requiring provision for connection to an alternative water supply in areas of high non-potable demand intensity
- The City of Sydney could work with relevant agencies and partners to streamline or facilitate the WICA application process to increase the level of interest in appropriate decentralised water opportunities.

5 Engage

The City of Sydney has involved a Stakeholder Reference Group and Community Reference Group throughout the development of the Plan.

- The City should market and promote the Decentralised Water Master Plan. Engage with relevant government agencies, industry, development, community and other stakeholders to highlight opportunities to participate.
- Share data analysis and concept plans to assist with evaluations of market opportunity, risk, cost and feasibility. The data is spatial, relevant and provides the foundation to link other decentralised water opportunities together as they unfold over time.
- Provide transparent reporting on progress against implementation objectives.

6 Partner

The responsibility for progressing the Plan requires a whole of industry approach. The City of Sydney cannot achieve the opportunities without significant assistance from the key partners, including:

- Community – can contribute to a water sensitive city through on site water efficiency, rain gardens and rainwater tanks and through support for key initiatives
- Industry – identify and trial innovative technologies that could improve performance or reduce costs of opportunities identified in the Plan
- Government – through policy alignment and the provision of enabling funds better outcomes can be achieved.

7 Plan

Synergies with other infrastructure renewals and programs have the potential to reduce the capital cost of opportunities including:

- Working with Sydney Water to review the Servicing Strategies for the CBD and Botany areas to maximise decentralised water system opportunities. In particular identify potential avoided costs associated with renewals, overflow abatement and capacity augmentation for the water, sewerage and stormwater systems
- Identify priority areas for pre-commitment zoning, requiring provision of connections to a decentralised water system
- Identify and secure easements for treatment, storage and distribution in priority zones with consideration of geotechnical, environmental and heritage issues

8 Fund

The City of Sydney has allocated capital and operating budget ($50M to achieve the 10% target set by the Sustainability 2030 strategy) to implement priority opportunities identified through the Plan in partnership with government and industry.

- The levelised cost of decentralised water supply opportunities is greater than the current price of drinking water and will requires significant subsidies to make most opportunities viable to the private sector and consumers. This could come from a combination of council funds, state and federal grants headworks charges, supplemented with private investment
- Work with government regulators and IPART to understand potential pricing tariffs, incentives and offsets for avoided costs elsewhere in the system
- Consider funding arrangements and incentives for building owners to retrofit and connect
- Identify potential land that could be used to progress the Green Infrastructure Plan

9 Procure

The Preliminary Business Case (Appendix D) identifies potential business models and procurement options for progressing the Decentralised Water Systems.

- Conduct market sounding and industry briefings to outline risks, costs and benefits and to encourage participation
- Bundling of opportunities may improve the attractiveness and cost effectiveness of implementing like initiatives
- Identify financial schemes to support diverse players

10 Evaluate

The Decentralised Water Master Plan has been developed using the best available data and ideas to present a future to 2030 in a dynamic environment.

Decentralised water opportunities are still an emerging field where trends in technology and innovation can improve cost effectiveness and ease of implementation of opportunities.

A comprehensive data toolkit has been presented to the City of Sydney with detailed spatial maps, assumptions, baselines and methodologies that will allow the City to monitor and update the Plan over time.