CRCWSC Research Synthesis

Discussion Paper | CRC for Water Sensitive Cities

IDEAS FOR THE SUBIACO STRATEGIC RESOURCE PRECINCT

CRC for Water Sensitive Cities

Australian Government
Department of Industry and Science

Business Cooperative Research Centres Programme

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Executive Summary

In recent years the Water Corporation has developed the Strategic Resource Precinct concept – also known as "buffertopia" – to transform the way it manages its wastewater treatment plants and the buffer zones that surround them. This concept transforms this critical water infrastructure by viewing its core function within a context of cities' needs to secure sustainable resources and to become more liveable. The result is a precinct, comprising the plant, its buffer zone and the land uses within it, that delivers a broader range of benefits than simply wastewater treatment and disposal.

This project considered the Subiaco wastewater treatment plant in Perth, to explore in further detail what a Strategic Resource Precinct could look like.

To do this, Water Corporation together with CRC for Water Sensitive Cities, hosted a stakeholder workshop to generate new ideas specific to the Subiaco precinct. Participants included land owners from the buffer zone, members of the Water Corporation and stakeholders from state and local government. These workshop participants were invited to share their perspectives of what success could look like, and to work together to ask: "what could the precinct be, rather than what it is now?"

Findings

The workshop discussions highlighted several insights:

- Wastewater treatment plants and their buffer zones were developed as critical community infrastructure, but community expectations for the land have changed. Asset managers can feel empowered to reconsider the way wastewater treatment plants provide value to cities and communities.
- The Subiaco precinct is rich in water and other resources. This water abundance presents a somewhat unique situation given the long term trend of declining rainfall in Perth.
- Although there is limited reliance on Scheme water within the precinct, users rely heavily on groundwater for most of their water supply, which is under pressure from a drying climate.
- The natural and green assets in the precinct can become a drawcard for businesses and visitors. It is likely that these green areas – both formal, informal and natural areas - will require additional water in the future to maintain their condition and value.
- The synergies between energy and water can provide both energy efficiency opportunities (i.e. reduce the amount of energy used) and opportunities to generate energy (i.e. from renewable sources).
- Innovation is creating economic opportunities for wastewater which can be applied at other wastewater treatment plants nationally and globally. There is an opportunity for the precinct to accelerate this innovation.

Ideas

The workshop developed a vision for the Subiaco precinct as a place to Refresh, Replenish and Recharge. To deliver this vision, participants also generated ideas under a number of headings:

Master Plan – a strategic plan for the precinct that connects water, land use planning, and other opportunities.

Water – develop a water management strategy which includes consideration of ways to recycle wastewater and local drainage and distribute this resource through the precinct and surrounding area using methods such as Managed Aquifer Recharge (MAR) and a ring-main.

Energy – harnessing water and landscape greening to reduce heat wave temperatures across the precinct and minimise the energy needed for cooling, and using the wastewater treatment process to generate additional energy and other resources.

Green infrastructure – connecting and enhancing the mosaic of natural bushland areas, schools, sports facilities and active transport corridors.

Innovation – developing an innovation hub around the water treatment plant to develop new treatment and resource opportunities. This may create new partnerships between the Water Corporation, research institutions and businesses.

Next steps

These ideas can be further developed through concept design, business cases and stakeholder engagement. Importantly these ideas make sense when presented as a package rather than individual initiatives. The Master Plan, and a memorandum of understanding to develop the innovation hub, are key initial projects.

1. Introduction

In response to droughts, the Australian water sector has recently had a focus on its water supply systems. But wastewater can no longer be the forgotten part of the urban water cycle, and Perth is demonstrating how this can be achieved.

1.1 Wastewater Treatment Plants

Wastewater treatment plants are vital community assets that ensure both community and environmental health by managing the waste that cities produce. Whilst traditionally having a singular waste treatment focus, new thinking is conceptualising wastewater treatment plants as sources of resources that can benefit the economy of cities and their regions.

These assets are often hazardous sites, can sometimes produce unpleasant odours and may be located in close proximity to urban communities. As such, they are carefully shielded from the public through their design and management. This design typically includes a buffer zone surrounding the plant, to discourage land uses deemed sensitive to odour.

1.2 Buffertopia – the Strategic Resource Precinct concept

Together, a wastewater treatment plant, its buffer and the land uses within can be re-conceptualised as a 'Strategic Resource Precinct' (Figure 1). This idea has been developed in Western Australia to reframe the function of wastewater treatment plants to centre on "resource" rather than 'waste', and to see the buffer zone as integral to this process. A Strategic Resource Precinct is primarily a land use planning initiative for the buffer zone, linked to the technology and infrastructure of treatment plant itself. It encourages land uses in the buffer zone that either use outputs from the plant (e.g. recycled water, nutrients, sludge, biogas) or provide inputs (e.g. energy, knowledge) which benefit the wastewater treatment process and urban communities (WSAA, 2017).

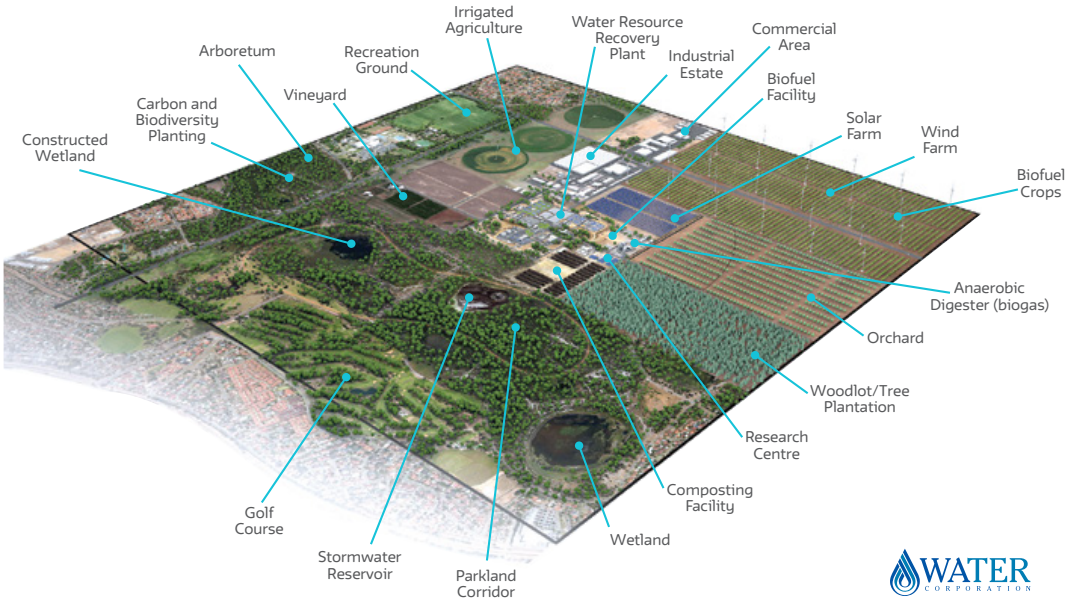


Figure 1. the Buffertopia concept (Source – Water Corporation)

1.3 The Subiaco Research Synthesis workshop

A two day research synthesis workshop was held in May 2017 to identify opportunities for the Subiaco Strategic Resource Precinct (Figure 2). This document is a representation of these ideas.

The workshop was funded by the Water Corporation and facilitated by the CRC for Water Sensitive Cities (CRCWSC). Individuals from a range of organisations participated and contributed their knowledge and experience to the discussions without implying organisational support or endorsement of the ideas generated.

The workshop generated ideas towards a central question: "If Perth is to become one of the world's leading water sensitive cities, what is the best use of the land, water, and other resources within the Subiaco Strategic Resource Precinct?" To approach this question, the workshop provided a space in which a variety of land holders, policy makers, and planners could discuss ideas together with the scientific experts of the CRCWSC.

The purpose of the workshop was to stimulate discussion to identify and refine these ideas. The next steps lie in:

- Sharing the vision and ideas
- Eliciting feedback
- Further developing the preferred ideas into more detailed designs, business cases, and an action plan for implementation.

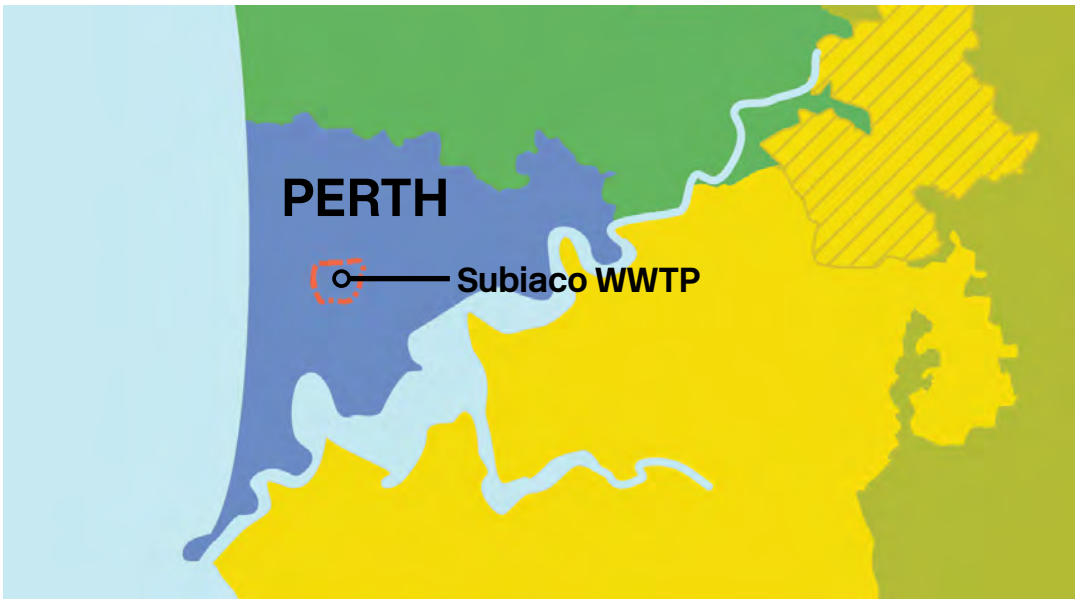


Figure 2. The Subiaco wastewater treatment plant location showing its wastewater catchment and Strategic Resource Precinct boundary (Source - Water Corporation, 2009)

2. Context

2.1 Location

The Subiaco wastewater treatment plant

The Subiaco wastewater treatment plant is located in Shenton Park, less than 6 kilometres from the Perth CBD (Figure 2). It serves a catchment including the Perth central business district that is expecting significant population growth as a result of urban infill development.

The buffer zone

The plant is surrounded by a 252 hectares (ha) odour buffer zone that separates sensitive land uses such as residential housing from the wastewater plant itself. Land within the buffer zone is still actively used as public and private open space, for nature conservation areas, and for commercial, health, education/research, horticulture, and industrial uses. As a legacy of its strategic planning status, this land has avoided fragmentation through development, and large land parcels have been retained.

The Subiaco Strategic Resource Precinct

The Subiaco Strategic Resource Precinct includes the plant, the buffer zone and the resource opportunities within.

For example, the open space across the buffer zone helps to establish an identity of a 'lush, multi-use precinct' in the heart of the city, and the significant, untapped quantities of water flowing through the precinct can be harvested to create sustainable water and energy supplies for local businesses.

The Strategic Resource Precinct provides an opportunity for these opportunities to be co-designed and strategically coordinated.

QUICK FACTS

SUBIACO WASTEWATER TREATMENT PLANT

HISTORY

The plant was built in 1927 to service central Perth, including the central business district.

It has since been upgraded to increase its capacity and level of treatment.

FUTURE

An Advanced Water Recycling Plant could be located at Subiaco in the future.

This would produce potable quality water for Perth's Groundwater Replenishment project.

TREATMENT PROCESS

Advanced secondary.

An Advanced Water Recycling Plant would utilise ultra filtration and reverse osmosis processes.

POPULATION SERVICED

2016 — 240,000

2030 — 290,000

2040 — 315,000

FROM WASTE MANAGEMENT TO RESOURCE RECOVERY...

SLUDGE = NUTRIENT VALUE

Sludge from the treatment process is reused on farms.

It provides fertiliser and corrects soil pH.

Sludge generated – 77 tonnes/day

RECYCLED WATER = WATER SECURITY

Recycled water was first provided to McGillivray Oval in 2004.

Today recycled water is used on-site as well as McGillivray Oval and Christchurch Grammar playing fields.

SEWAGE FLOWS

Inflows **60 million litres** per day

Water recycled **2.3 million litres** per day

Discharges to ocean **58 million litres** per day

Phosphorus in the water discharged **1/3 ton** per day

WHAT ABOUT STORMWATER?

Both the Perth main sewer and a major stormwater drain runs below the plant.

Both discharge to the ocean.

Approximately 1.5-3 billion litres of stormwater is discharged.

VISIT BUFFERTOPIA TO SEE THE VISION FOR THE STRATEGIC RESOURCE PRECINCTS

https://www.youtube.com/watch?v=Z35jW5QaHKg

2.2 The Water Cycle

Water supply

Perth is in a new era of water supply. The Water Forever strategy (Water Corporation, 2009) documents the transition of Perth's water supplies to a more diversified portfolio of sources. The historical reliance on rainfall-fed dams is being replaced with options to source water from groundwater, desalination, and groundwater replenishment using recycled water. Together, this mix of sources will help provide long term water security in Perth's drying climate.

Wastewater

While Perth is continuing to evolve its water network, it has also identified its wastewater system as a key opportunity. Its treatment plants have the potential to provide significant quantities of high quality, highly reliable water for a range of uses. There is also a simultaneous opportunity to harness other resources from the sewage treatment process. These opportunities are highlighted in Figure 3.

Drainage

Stormwater represents another untapped resource at Subiaco. Local and regional drainage networks, including piped and open drains, discharge to the ocean, Swan-Canning River, or to lakes. The Subiaco main drain traverses the site and is estimated to discharge between 1.5–3 billion litres each year to the ocean. If only 25 percent of this flow was captured, the volume could be enough to irrigate up to 100 hectares of public open space.

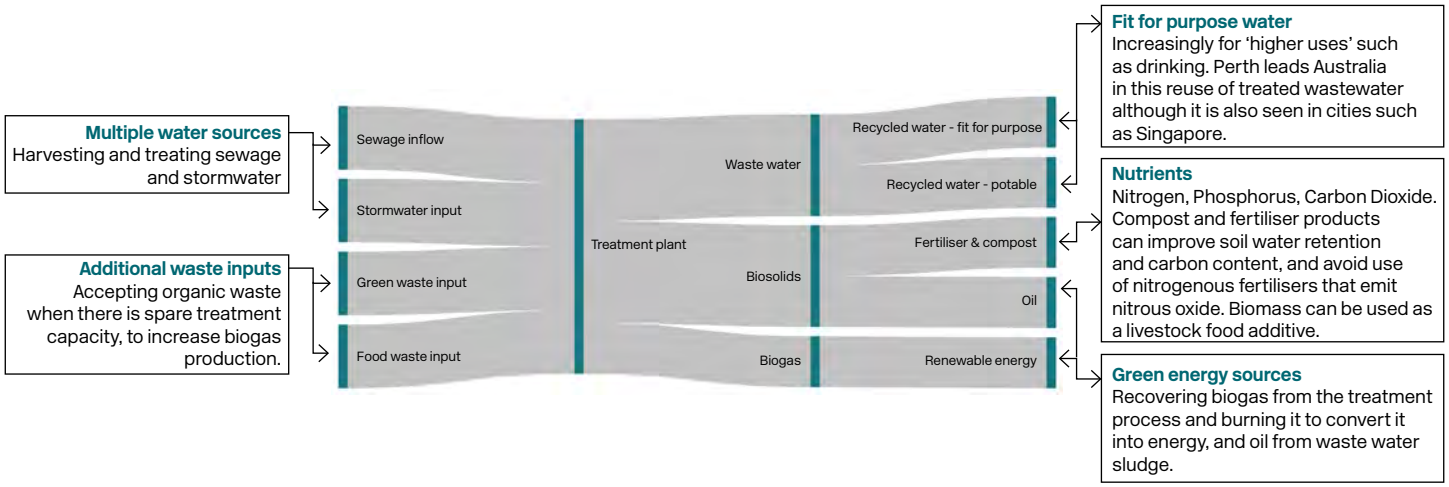


Figure 3. Five resource recovery opportunities at wastewater treatment plants.

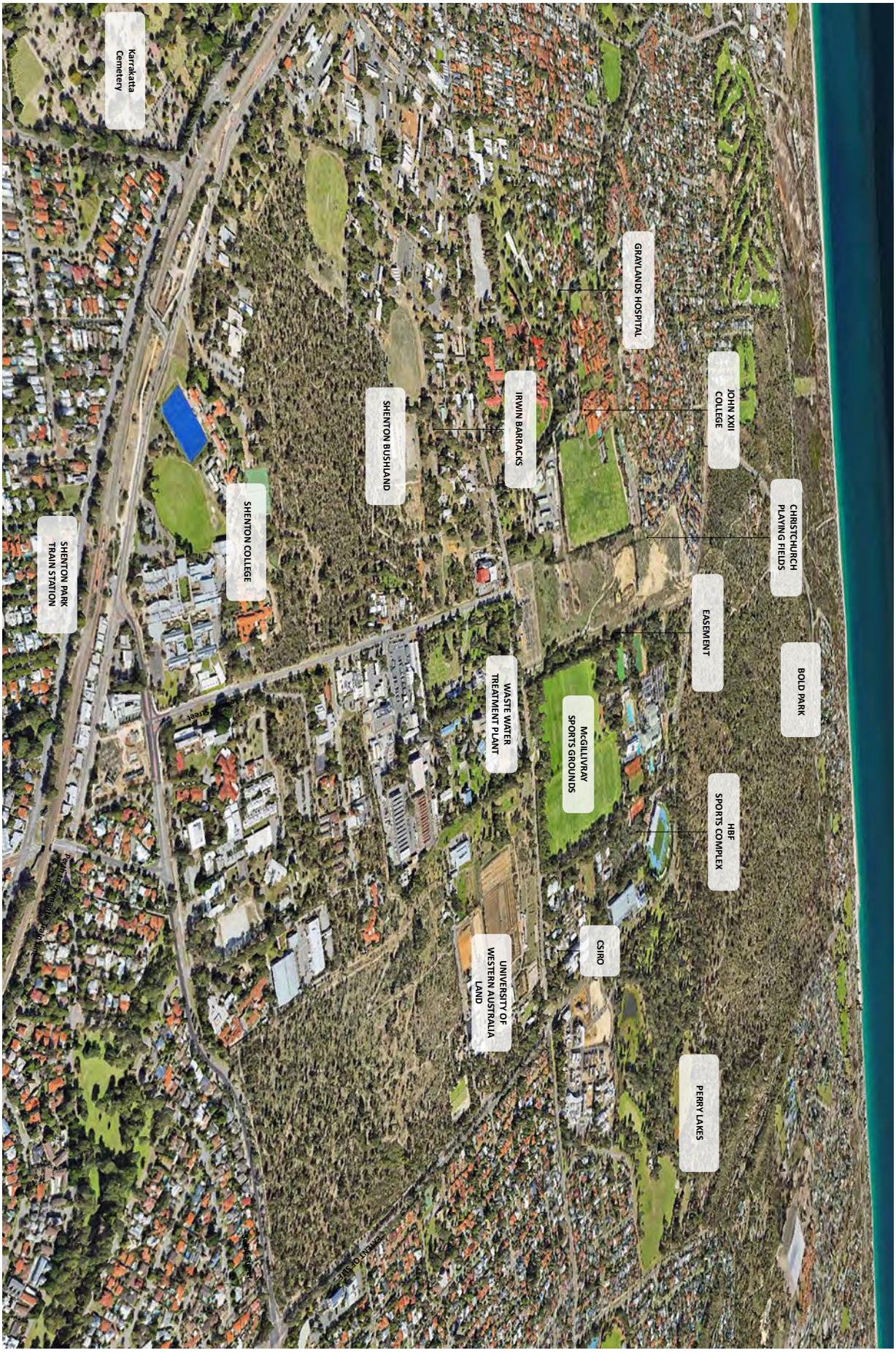


Figure 4. The major non-Water Corporation land uses in the Subiaco Strategic Resource Precinct site (source – Realm Studios)

3. A vision for the Precinct's future

The workshop participants developed a vision for the Subiaco Strategic Resource Precinct by integrating current stakeholders' and landholders' needs with an understanding of resource opportunities, and consideration of future scenarios.

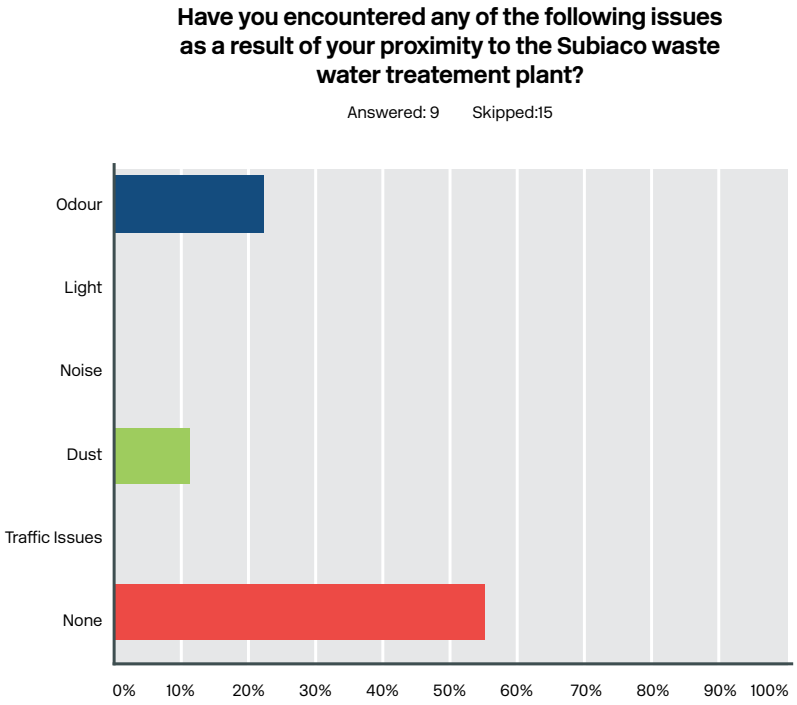
3.1 Stakeholder perspectives: what does success look like?

The buffer zone is an important community asset. Decisions about its future use will be influenced by the perspectives of different stakeholders.

Stakeholder survey

Twenty-three different local organisations were surveyed prior to the workshop (CRCWSC and Urbaqua, 2017). They were asked about their perceptions of the plant and development within the buffer zone. These organisations included a mix of businesses inside and outside of the buffer zone. The results revealed that these stakeholders have a good understanding of the plant and what it does, and that there were very few negative issues associated with being located in proximity to the plant.

Whilst odour (2 respondents) and dust (1 respondent) were noted as issues, the results debunk the perception that land use in the odour buffer is constrained. In fact, having access to a reliable and cost-effective water supply was seen as a positive. The landholders also reported synergies between land and water management options, and the community benefits of these resources. Addressing these barriers and opportunities could further unlock the potential of the buffer zone land.



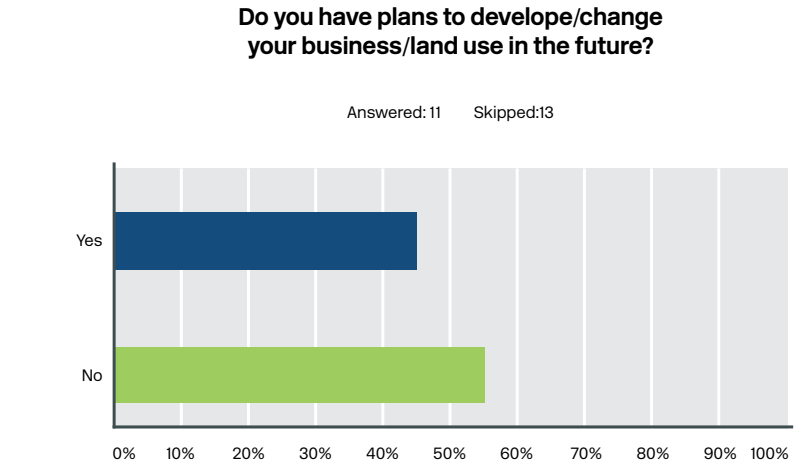
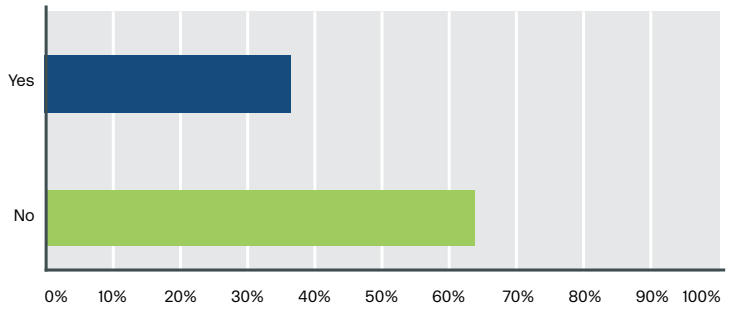


Figure 5. Survey results (CRCWSC and Urbaqua, 2017)

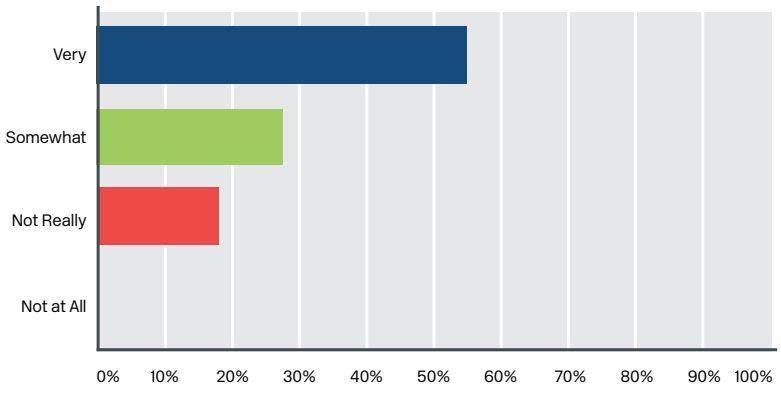
Are there any barriers that are stopping you from doing this (i.e. from developing or changing your business or land use)?

Answered: 11 Skipped:13



How important is a reliable and cost effective water supply to the operation of your business?

Answered: 11 Skipped:13



What might different stakeholders want from the Subiaco Strategic Resource Precinct?

Workshop participants described some of the key stakeholder segments in the precinct to better understand their needs.

Sports and recreational stakeholders

Have invested in ...

High class sports grounds and facilities used for rugby, basketball, hockey, swimming, soccer, netball, cricket, and the WA institute of Sport. These facilities attract in excess of 500,000 participants per year, and rely on access to secure, fit-for-purpose water supplies.

Want for the future ...

1. Security of water in the immediate term by addressing scheduling and delivery infrastructure constraints and, in the longer term, the availability of water if recycled water is reallocated to groundwater replenishment.
2. Streamlined approvals for on-site water reuse.

Schools

Have invested in ...

These stakeholders have also invested in high class sports and recreation facilities and associated water supply infrastructure. Schools in or around the precinct include John XXIII, Shenton College, Christ Church Grammar and other primary schools.

Want for the future ...

1. Security of water in the immediate term by addressing scheduling and delivery infrastructure constraints and, in the longer term, the availability of water if recycled water is reallocated to groundwater replenishment.
2. Streamlined approvals for on-site water reuse.
3. Ways to enhance local community value and relationships with neighbours.

Redevelopment and planning stakeholders

Who are they?

Councils and the development industry itself, as well as land owners, residential and commercial developers.

Outcomes they need ...

1. A clear planning framework for the buffer zone land and the precinct.
2. Improved connectivity between different land uses and removing barriers between humans and natural areas to realise the potential of the area.
3. Certainty of development opportunities.

Research Institutions

Common themes ...

There is a mix of stakeholders wanting research outcomes, and others who want to undertake research. The precinct is rich in research questions, case studies, assets/ resources to experiment with, potential research collaborations and vision.

These stakeholders are interested in ...

1. Opportunities for leverage and collaboration partnerships.

Community stakeholders

Make Up

The community is a rich mix of competing values, expectations representation, and values.

Want for the future ...

1. To play an active role in managing the inevitable changes in their suburb and transforming perceptions around the wastewater treatment plant from a negative (e.g. odour, risk of using recycled water) to a positive.
2. To recognise and include Aboriginal values.

Local Government

The challenge

The precinct straddles or abuts multiple local government areas. These councils face the daily challenge of managing preferences for competing land uses, and of maintaining community assets in a drying climate.

Want for the furture...

1. New options for water security and climate-resilient green open spaces.
2. New partnership opportunities to develop, fund, and implement local scale water sensitive initiatives.
3. Attracting new business to the area to stimulate economic prosperity.

The environment

The environment is a stakeholder in its own right.

The precinct contains a number of high value natural assets that should be retained and protected for the future. There are also opportunities to improve environmental linkages and to enhance the resilience of groundwater-dependant ecosystems such as Perry Lakes.

Want for the future ...

1. Resilience to threats from continuing development, a changing climate (water availability), and disjointed management/ governance.

3.2 Water balance: how is water currently being used?

A water balance was completed to characterise the resource opportunities across the precinct. Figure 6 maps (left to right) the sources and flows of water through the precinct in a year. The relative volumes are represented by the width of the flows in the water balance, and are derived from a number of sources including the Bureau of Meteorology, Department of Water and Environmental Regulation, and Water Corporation.

Urban metabolism: understanding water and cities as a system

This water balance can be used in an urban metabolism assessment and comparison with the water balance for Perth (see Table 1).

Urban water metabolism is a tool to quantify the water cycle performance of a city. It does this by considering the stocks and flows of all water across the water cycle, and differs from conventional water assessments that compare supply and demand budgets for individual elements of the water cycle, typically in isolation from others and at different scales (Renouf et al., 2017).

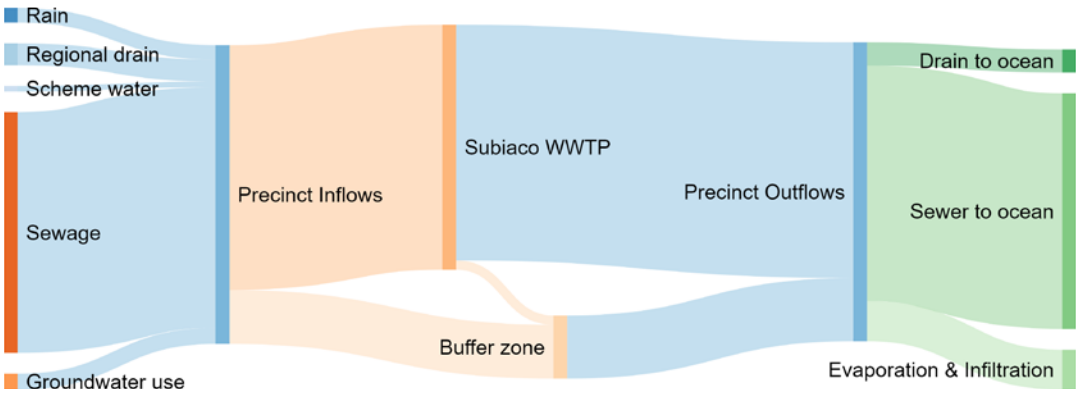


Figure 6. The current water balance for the Subiaco Strategic Resource Precinct showing inflows (left), outflows (right) and the connection between the treatment plant and the buffer zone[1].

[1] *Numerical values are not provided as the water balance is an estimate and the data confidence varies between sources.*

	Area	Water Inputs	Urban water efficiency	Water Supply internalisation
Definitions	The urban 'system' boundary being assessed.	Total annual water inputs to the system. In this case it includes sewage inputs to the Subiaco wastewater treatment plant from the Perth CBD.	This is an indicator of the 'environmental' water use (i.e. water drawn from the natural environment) for the urban system (Renouf et al 2017). The less environmental water used, the better the efficiency.	This is the proportion of total water demand met by sources harvested within the system itself, including natural sources (groundwater) and manufactured sources (recycled water) (Renouf et al. 2017). It reflects system self-sufficiency.
Subiaco Strategic Resource Precinct	252 ha	27 GL/year	7.8 ML/ha	82%
Perth (based on Renouf et al., 2017)	955 km2	268 GL/year	2.8 ML/ha	49%

Table 1. Urban metabolism assessment of the water balance and comparison to Perth

Insights

- Approximately 27 billion litres of water flows through the precinct each year.
- The water efficiency of the Subiaco precinct is 7.8 ML/ha compared with the Perth average of 2.8 ML/ha. This measures the dependency on water drawn from the natural environment and reflects the use of groundwater to maintain the high quality open spaces in the precinct.
- Perth already rates well in 'internalisation' of its water sources (49%), but the Subiaco precinct is an even better performer (82%). This assesses the degree to which water is taken from external, city-wide sources and reflects vulnerability to restrictions on these supplies. This use of local water sources is a hallmark of a water sensitive city and the precinct rates very well.
- Water users are highly dependent upon a single source (groundwater), even though other sources are potentially available.
- Whilst the precinct is water-rich, there is little connection between the wastewater treatment plant and the buffer zone.
- Increasing the production of recycled water and harvesting of stormwater would improve the 'water efficiency' rating, provide choices for water users, and reduce ocean discharges, all without affecting the 'internalisation' rating.

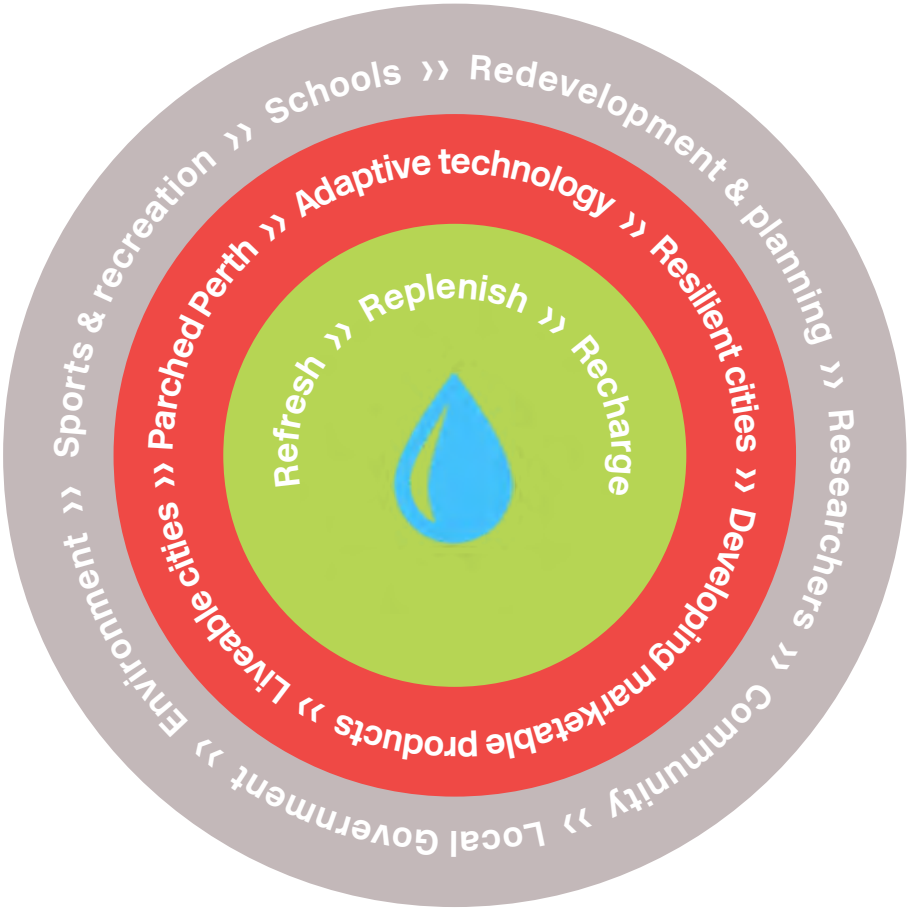
3.3 Future states: what is possible?

Workshop participants developed scenarios to characterise what the precinct might look like in 2050. These canvassed both positive and negative scenarios that could reflect the outcomes of different choices made in 2017. This exercise was intentionally provocative and hypothetical. Five scenarios emerged: scenarios 1 and 2, which suggest a rationale for a new vision; and scenarios 3-5, which collectively describe the opportunities at hand.

Scenario 1 Parched Perth	This theme suggests that the changing climate has significantly affected water resources, leaving Perth as a hot, dry and unliveable place. Further, the planning for water resources has failed to account for this scenario, leading to significant competition between users for the available water resources. This has created winners and losers. This in turn directly impacts the Water Corporation, with a break down in community and political trust.
Scenario 2 Adaptive technology	This theme refers to the potential for unintended consequences of technology. In a negative sense, new and existing technologies have failed and without a backup plan, services to the community are disrupted. An alternate outcome highlights the "opportunity cost" of a slow uptake of new approaches in the water sector, causing the industry to lag behind the rest of the economy.
Scenario 3 Resilient cities	This theme illustrates the benefits of resilience as an objective of water resource planning. As a result of decisions made in 2017, the precinct has become self-sufficient. This was achieved by recognising the resource value concentrated within the precinct, and the opportunity to co-locate activities that can harness this potential. However it also suggests that the precinct is not managed selfishly – instead, an export of finances, water, energy and other resources benefits the whole city.
Scenario 4 Marketable products & services	This theme promotes the value of Australian innovation on the global stage. This would be a new approach for Australian utilities, which have traditionally focused on the delivery of core services. Yet the market for new approaches to providing water in cities – and for designing cities to be liveable and resilient in a changing climate – is growing. In this vision, the precinct is an epicentre of innovation – the "Silicon Valley" of water innovation, research and start-ups.
Scenario 5 Liveable cities	This theme suggests that the precinct and region develops a unique character and becomes a destination of choice for Perth's community. This is enhanced by the role of the Water Corporation and the resources that it manages. It projects images of active lifestyles, green urban landscapes, and the well-resourced community-based facilities that have an international reputation.

3.4 Vision: a preferred outcome

Subiaco: a place to	**Refresh**	(Community, good lifestyle, sense of wellbeing, habitats / refresh conservation, new outlook for businesses)
	Replenish	(Biodiversity, managed aquifer recharge, connectivity and spirit for community, businesses replenish and reinvest)
	Recharge	(Protect habitats and ecosystems, different uses of water, recharge yourself through sports and recreation, bring innovation into the area)



4. Ideas

The following ideas were developed to implement the vision. The ideas relate to water, green infrastructure, energy and innovation, and will shape the way the Subiaco Wastewater Treatment Plant and its buffer is reframed as a Strategic Resource Precinct.

4.1 Master plan for the precinct

Often, buffer zones are designed to keep people away from wastewater treatment plants. The Strategic Resource Precinct concept turns this thinking around to create a precinct that people and businesses want to come to. This can be achieved by enhancing the community and economic value of the land within the precinct and sharing numerous landscape values.

A master plan can be developed to outline the specific land uses, what to protect/enhance, and how these elements fit together to create the precinct. This will include:

- Retaining and celebrating bushland linkages, connected via pathways for people, plants and animals.
- Creating "attractors" – world class recreation, research, and resource recovery opportunities within the precinct.
- Using green infrastructure technology to treat, harvest, and store water for irrigation and to enhance natural environments.
- Enhancing community experiences through sharing views and public realm activation.
- Creating commercial opportunities for businesses and food producers by offering reliable 'green' energy and water sources.
- Adding value to residential development adjacent to the buffer zone by connecting these new communities with the open space in the precinct.
- Supporting businesses and land uses that can be co-located with a wastewater treatment plant, such as horticulture or the existing data centre.

The Strategic Resource Precinct master plan should be aligned with the Sports Precinct and University of Western Australia master plans that will also be updated in the future.

Master planning for water sensitive cities – international examples

Reviewing the strategic planning of other cities seeking to become more climate resilient shows what can be achieved by transforming land use. Taking flooding as an example of a risk facing cities, the case studies of Rotterdam (Netherlands), HafenCity (Germany), and New York (United States) demonstrate city-scale approaches to transforming land use and landscapes. In these case studies, traditional flood management approaches of providing defence through infrastructure were considered unsuitable for the future (Leardini et al., 2016). As an alternative, adaptation was required to create new flood plains and temporary water storage areas (in Rotterdam), to raise a whole district's ground level above sea level (HafenCity), or encourage land uses (and thus buildings) more compatible with predicted increases in sea levels (New York). In these cases, the approach provided a catalyst for economic and social growth.

Figure 7. Subiaco Strategic Resource Precinct Master Plan

4.2 Water opportunities

More water – growing and diversifying local sources

Both the Perth main sewer and a large regional stormwater drain pass through the site. This affords an opportunity to harvest significant volumes of water for reuse, building on the current reuse in the precinct of approximately 850 million litres per year. This idea involves the continued development of the treatment process at the plant and the development of harvesting and storage capacity in the buffer zone (including managed aquifer storage and recovery possibilities).

This new water can be used for irrigation or fit-for-purpose applications in domestic or commercial situations (such as toilet flushing). This will provide much-needed water security for users within and outside the precinct, as well as reducing reliance on existing Scheme and groundwater resources, which benefits the wider city.

Ring main and precinct scale water storage

Create a local-scale water distribution network to supply fit-for-purpose water to sports facilities (such as McGillivray Ovals), schools (such as John XXIII and Shenton College) and other users.

This ring main can be developed by rehabilitating and connecting existing infrastructure in the buffer zone into a continuous main connected to the Subiaco wastewater treatment plant. It will also include irrigation booster pumps and distributed storage to enable simultaneous irrigation at sports ovals and schools across the precinct during periods of peak demand. Networked storage opportunities may include local managed aquifer recharge or constructed below-ground storage incorporated into future development works at sports grounds or open space. There is also an opportunity to use the footprint of a contaminated site within the precinct to locate a self-contained (i.e. sealed) above-ground wetland storage.

Water management plan

A key question is what to do with the significant volumes of recycled wastewater and stormwater that are potentially available. A management plan can be developed with stakeholders to address this and may include:

- A framework for short and long term resource allocation and management.
- Catchment and source management actions to maximise raw water quality and thus reduce treatment costs.
- A strategy for advancing alternative water sources to reach potable quality, and novel water use applications such as passive and active district cooling.
- Recognising local water-dependant environments as a water user, and allocating water to secure the long term health of these landscape elements.
- Opportunities to streamline approvals for use of alternative water in the precinct, based on previous scientific studies and experience of other users.

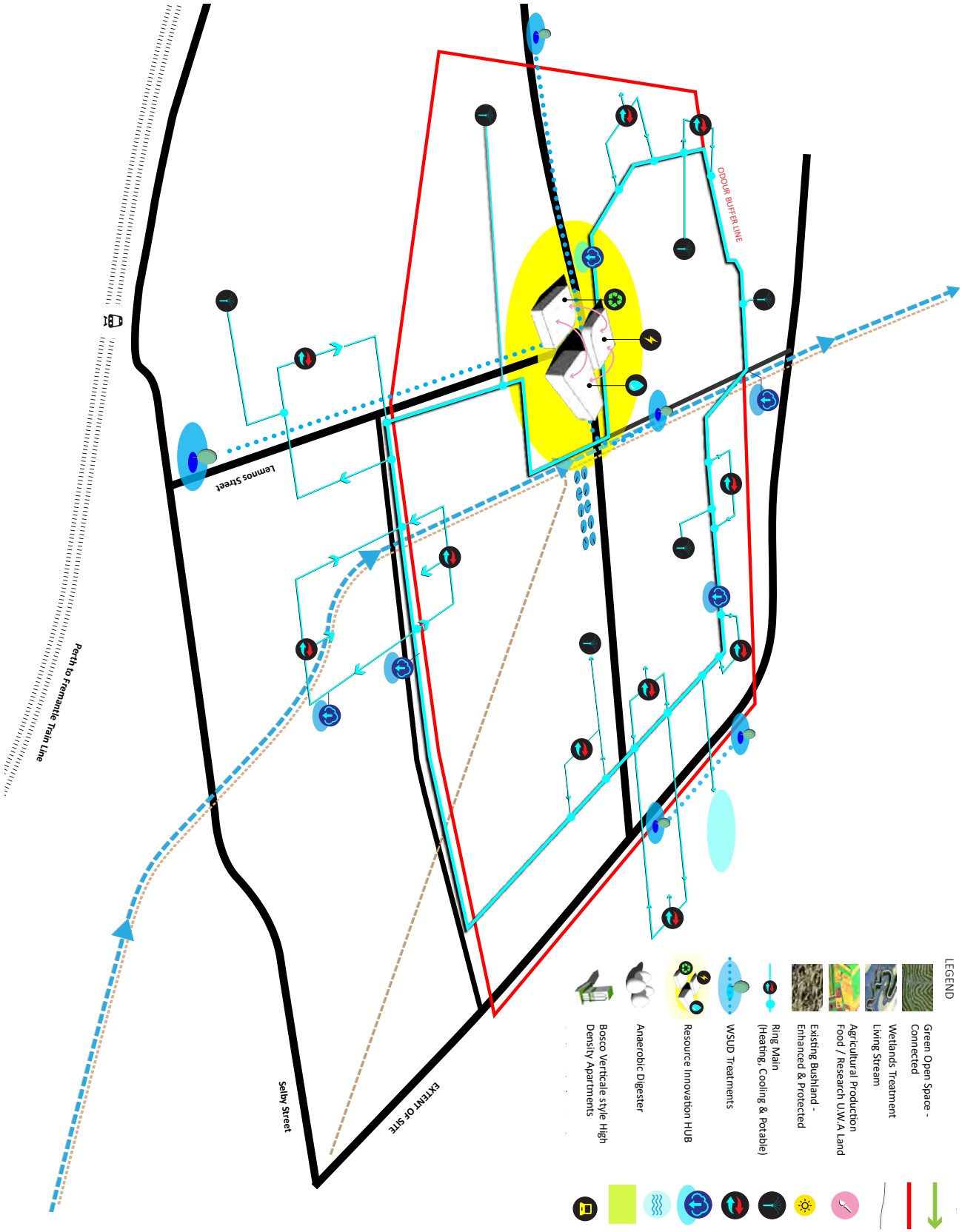


Figure 8 Water opportunities

How and why to diversify water sources

Governments, such as the Western Australian Government, are looking for ways to invest in climate resilient water sources (Water Corporation, 2009).

CRCWSC research shows that urban stormwater can provide a major new water source for cities while simultaneously helping to protect valuable waterways from excessive pollution and ecosystem degradation (Wong et al., 2013).

When looking at future water availability and the drivers of supply costs, the optimal investment decision is to diversify supplies across multiple sources. CRCWSC research shows that different sources – including dams, desalination, and stormwater – have different investment risk profiles based on exposure to climate variability and costs of water production (amongst other factors). This research shows that diversifying is a good way to "hedge" the risks of different sources, in the same way that individual investments are balanced in an investment portfolio. In an uncertain future, this is the least-cost approach (Leroux and Martin, 2015).

CRCWSC research has also characterised the quality of raw stormwater in different urban catchments across Australia. Gernjak et al. (2017) suggest that the chemical and toxicological quality of untreated Australian stormwater sits in the range of 'good quality' to effectively 'treated secondary effluent'. Thus stormwater is suitable and amenable to treatment for a broad range of reuse scenarios, with the intended end use influencing the level of treatment required. This treatment can be achieved using nature-based technologies such as biofilters or conventional processes such as those used to produce recycled water at waste water treatment plants.

4.3 Green infrastructure opportunities

The ability to harness large volumes of reliable water supplies provides an opportunity to create a well irrigated and extensively connected green landscape across the precinct.

This could comprise natural and constructed landscape features, each of which is irrigated as required with a reliable water source, or passively maintained by local stormwater runoff. Local-scale systems (e.g. street scale) may be maintained using water sensitive urban design elements; larger landscape features such as Perry Lakes may have a dedicated water allocation from the ring main (see previous Ideas), and sports ovals will be connected to formalised irrigation systems. These landscape features can be linked using well vegetated corridors and connectors that enhance the walkability, amenity, and local climate of the precinct.

Other strategies to enhance greening include:

- Retaining stormwater on the surface as a passive irrigation source.
- Catchment management to enhance the quality of stormwater runoff prior to harvesting.
- Improving public access to bushland areas to promote environmentally sustainable behaviours.
- Offset opportunities that enable investment in priority greening sites (such as the protection of high value native vegetation or creation of greenery in high traffic community areas).

The multiple benefits of green infrastructure

Heatwaves are Australia's most deadly natural phenomena, resulting in more deaths than storms, cyclones, floods, and bushfires combined (Climate Council, 2015). However the health impact of heat waves can be reduced by integrating well irrigated green infrastructure into urban landscapes.

A case study of urban green spaces in Melbourne shows the impact that even a small urban park can have in lowering air temperatures in the urban environment during heat waves. This CRCWSC study found that, on average, the park was always cooler – by up to 1.0°C – than its surrounding urban environment. At the hottest times on a summer's day, the shade and evapotranspiration within the park meant that the level of heat stress felt by pedestrians was 'comfortable' in the park compared to 'strong' in the nearby streets (Motazedian et al., undated).

Green infrastructure is also an effective tool to manage urban stormwater. Compared with undeveloped or natural catchments, stormwater runoff from urban areas tends to have larger peak flows, volumes, and pollutant loads that are highly detrimental to the health of natural waterways (streams, bays and estuaries) (Payne et al., 2015). Water biofiltration using green infrastructure is a proven technique to reduce these effects by filtering stormwater runoff through plant-based systems. Biofilters can form part of local streetscapes and public open space, as well as be used in stormwater harvesting. Biofilters can effectively remove a range of micropollutants, including hydrocarbons, oils, and phthalates, and reduce metal concentrations in stormwater to levels below those required to meet irrigation and even drinking water quality standards (Payne et al., 2015).

Figure 9 Green infrastructure opportunities

4.4 Energy opportunities

Cooling

Cooling is one of the biggest costs in Western Australia. The Strategic Resource Precinct provides an opportunity to provide cooling and to meet precinct energy loads in a cheaper and more environmentally sustainable manner. If water in the ring main (see previous Ideas) is maintained at 23°C (which can be achieved through sizing of the main, burying the main and for insulating it as required), it will be cooler than ambient air in summer but warmer in winter. This temperature differential creates an opportunity for energy load shedding by facilities connected to the ring-main.

Passive cooling can also be provided through extensive application of green infrastructure, located strategically in the areas of highest heat vulnerability. This can provide shade and cool ground temperatures that together reduce loads on air conditioning.

Renewable energy

The wastewater treatment plant itself is a point source of energy production that can be enhanced by importing organic waste, such as food waste, and digesting it to produce biogas that is in turn used to generate electricity. This suggests the possibility of a new partnership for Water Corporation in waste management, as well as opportunities to further sort waste at the source to create a green and/or food waste stream.

Domestic wastewater treatment and resource recovery with purple phototrophic bacteria

Resource recovery technology enables the recovery of water, energy, nitrogen (N), and phosphorus (P) from wastewater whilst ensuring a high-quality effluent for discharge to receiving waters. Purple phototrophic bacteria (PPB) present a new approach for resource recovery developed by Hulsen et al. (2016). Instead of reducing the biomass/sludge of the wastewater treatment process, it specifically aims to produce and concentrate biomass. The PPB biomass contains close to 100% of the wastewater chemical oxygen demand, N, and P in a small concentrated volume. The value lies in the utilisation of this biomass for the recovery of energy or heat. Another option is the direct use of the protein-rich biomass as a food additive for fish, chicken and poultry farming, or as an organic fertilizer for horticulture to improve soil quality, growth and crop yield.

Figure 10 Subiaco Strategic Resource Precinct – Energy opportunities

4.5 Innovation Hub

Facility

The Subiaco Strategic Resource Precinct can become Australia's water equivalent of Silicon Valley. It can be a precinct that invites technology companies and researchers to co-develop, trial, pilot and validate new approaches to wastewater treatment and resource recovery by experimenting on waste streams from the Subiaco wastewater treatment plant. Several factors make this appealing:

1. The need for proof-of-concept of new technology in the WA context. The Innovation Hub can develop a pipeline of innovation ideas with engagement from research and industry.

2. The availability of feed resources from the plant itself – the potential to use waste side streams from different stages of the treatment process.

3. The availability of suitable land in an existing buffer zone to house an innovation facility. The Water Corporation owns a large parcel of land in the buffer in addition to the wastewater treatment plant, and the buffer zone already excludes potentially sensitive neighbouring land uses. Part of the Water Corporation or the University of Western Australia's land could be redeveloped into a water technology park.

4. The proximity to world-class research institutions, and the potential to create a vibrant innovation ecosystem of talent, space, networks, and advice.

This idea has several components. Firstly, a physical space is required. It is possible for Water Corporation to provide the physical space and working area for technology trials, and other resources if staff could be seconded as development opportunities. Piloting in a virtual space is a further option.

Secondly, Water Corporation can provide a side stream feed from the treatment plant for research and development purposes.

Thirdly, Water Corporation together with local research organisations, can collaborate on funding opportunities as well as providing a platform for new companies to promote their findings and discoveries, or to scale up prototypes to full-scale demonstrations. This may adopt a similar 'business incubator' approach being adopted by other Australian universities. A business incubator is an organisation or program that provides mentoring and business training to start-up companies. Business incubators aim to increase the success rate of new businesses to accelerate the commercialisation of innovation.

Memorandum of Understanding

The proposed model is based on collaboration, beginning with a Memorandum of Understanding between the Water Corporation and the major research providers to deliver this initiative. Once this has been established, the second action would be to identify and attract investment and delivery partners who share the precinct vision. These start-up companies could then partner with bigger research or end user institutions in the precinct to build targeted research projects. Further collaboration can then validate, promote, and leverage the successes that emerge from the process.

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About the CRCWSC

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) was established in July 2012 to help change the way we design, build and manage our cities and towns by valuing the contribution water makes to economic development and growth, quality of life, and the ecosystems of which cities are a part.

The CRCWSC is an Australian research centre that brings together many disciplines, world-renowned subject matter experts, and industry thought leaders who want to revolutionise urban water management in Australia and overseas.

Research synthesis

Research synthesis is key to successful research application and adoption.

A facilitated design process, Research Synthesis brings together the CRCWSC's many research areas and disciplines with government and private industry partners to develop practical "ideas" for addressing specific industry-based challenges.

Research synthesis is a highly effective tool for exploring collaboration and innovation. The open-minded environment of a research synthesis design workshop is founded on science, and no individual organisation leads or owns the conversation. This supports an un-biased dialogue that enables the discovery of new and creative ideas.

CRCWSC Research Synthesis

Discussion Paper | CRC for Water Sensitive Cities

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