



CRC for
Water Sensitive Cities

Shaping Perth as a Water Sensitive City:

Outcomes and perspectives from a
participatory process to develop a vision
and strategic transition framework

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Australian Government
Department of Industry,
Innovation and Science

Business
Cooperative Research
Centres Programme

Shaping Perth as a Water Sensitive City: Outcomes and perspectives from a participatory process to develop a vision and strategic transition framework

Mapping Water Sensitive Cities (Project A4.2)

A4.2 – 1 – 2015

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Publisher

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Date of publication: November 2015

An appropriate citation for this document is:

Rogers, B.C., Hammer, K., Werbeloff, L., Chesterfield, C. (2015). Shaping Perth as a Water Sensitive City: Outcomes of a participatory process to develop a vision and strategic transition framework. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities,

Acknowledgements

The authors would like to thank the workshop participants for bringing their enthusiasm, creativity and strategic insight to the workshop series and for their input into the development of this report. The authors would also like to thank the Department of Water for their support of the project. Vision images were created by Philippa Munckton.

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1. Introduction

1.1 About this report

Australian cities and towns are grappling with the question of how to use water management as a means of delivering better liveability outcomes and broader benefits in relation to water security, flood risk, biodiversity, public open space, healthy waterways, productive and connected communities. The aspirational concept of the water sensitive city¹ represents this water management approach and many urban areas around Australia now have an explicit goal of becoming water sensitive. However, initiating and navigating the changes required to achieve this goal is difficult, particularly as existing infrastructure, regulatory and financial frameworks and citizen behaviour typically reinforce and anchor the status quo². Exacerbating these challenges is the difficulty in achieving coordinated and aligned action across multiple organisations, even when there are good intentions or policy aspirations. Targeted and context-specific insight is therefore needed to guide strategic initiatives that will support and enable shifts to more water sensitive practices³.

This report presents the outcomes and perspectives from a participatory process focused on planning Greater Perth's transition to a water sensitive city. The process was conducted with leading professionals from across water, planning, community, urban development and other related sectors in Perth. The participants took part in a series of five workshops to collaboratively develop a vision for Greater Perth as a water sensitive city in 2065, guiding principles of practice, and ideas for strategies and actions for transitioning towards the vision. The process was conducted as part of a Cooperative Research Centre for Water Sensitive Cities (CRCWSC) project, A4.2 Mapping Water Sensitive City Scenarios, which develops and applies innovative transition planning processes and frameworks in different case study contexts.

The report's primary purpose is to showcase the results of this workshop series, which provide targeted guidance for navigating Perth's water sensitive city transition. As well as a high level orienting vision and strategic transition framework, this guidance includes a range of specific ideas to inform the design and implementation of operational programs of action to accelerate the desired transitional change. The report is designed as a resource for government, industry and community stakeholders interested in steering transitions towards water sensitive cities. Although developed from the Greater Perth context, the insights are relevant for Australian cities and towns more generally.

In addition, the report demonstrates the value of engaging with a diverse array of stakeholders in envisioning and transition planning processes, and provides valuable insight into the important ingredients for such processes. These findings will inform future work in this CRCWSC

project, which focuses on developing methodological guidance and supporting CRCWSC partners to undertake similar processes with both professional and community participants to facilitate transitions towards increased water sensitivity at local and city scales.

The project outputs are summarised in Figure 1. Following this introduction, each Section of the report presents the results in more detail. The report also contains a number of Appendices that provide further detail in relation to the outcomes of the workshop discussions and analysis.

Section 2	Analysis of the local historical, social, cultural, ecological and geographical context for water in Perth
Section 3	The rationale for Greater Perth's transition towards a water sensitive city
Section 4	The vision for Greater Perth as a water sensitive city in 2065
Section 5	Principles to guide water sensitive practice in relation to planning, decision-making, engagement, design and management
Section 6	Analysis of the transition challenges facing Greater Perth in relation to its capacity to deliver on the water sensitive vision
Section 7	Strategic transition framework for delivering the vision of a water sensitive Perth, including overarching and critical strategies
Section 8	Concluding reflections and insights from the project

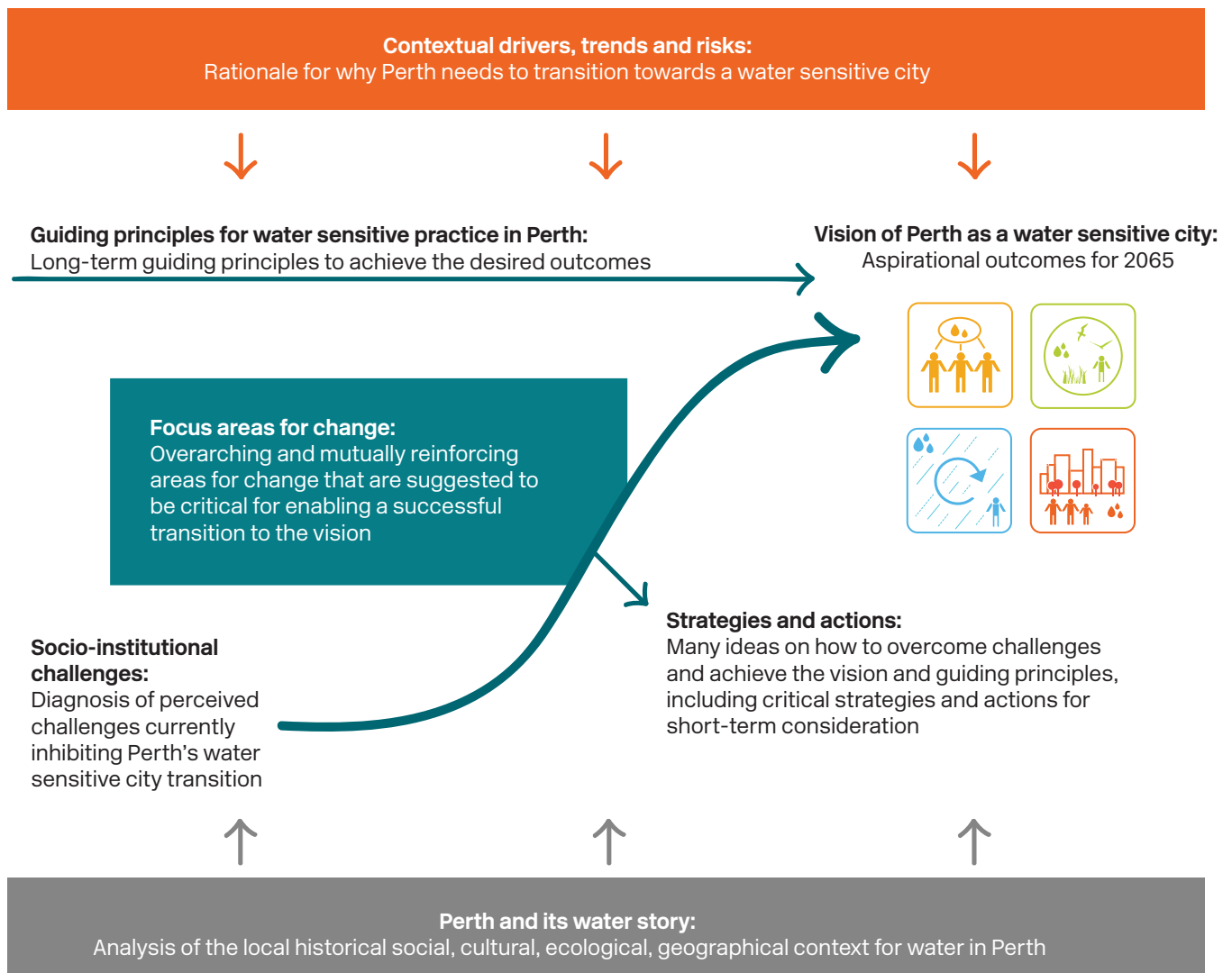


Figure 1: Individual project outputs that constitute the vision and strategic framework for Greater Perth's transition to a water sensitive city

1.2 Project overview

1.2.1 Background

There is a growing national and international interest by governments, water and planning industries, and local communities in creating liveable, sustainable, productive and resilient cities. While there is typically broad agreement about high level aspirations such as these, decision-makers face the challenge of determining how to most effectively drive the transitions needed to steer a city or town in the aspired direction. Of particular difficulty is ensuring strategic and operational alignment across the wide range of stakeholders that need to be part of the transition through their policies, strategies and programs of action³.

The CRCWSC Project A4.2 “Mapping Water Sensitive City Scenarios” develops innovative strategic planning processes and frameworks targeted at addressing these challenges, with a particular focus on accelerating the transition to water sensitive cities and towns in Australia. The research involves workshop series in multiple case study locations, designed to facilitate in-depth discussion and analysis amongst key local stakeholders of how their urban region can be transformed to provide reliable water services, ensure public health and wellbeing, enhance urban amenity and protect the environment over the long-term.

Perth stakeholders have expressed a desire to achieve a more water sensitive city, and recent policy, planning and knowledge-sharing initiatives have focused on generating momentum and alignment in this direction. Project A4.2 therefore selected Perth for one of its case studies, providing an opportunity to advance the sector-wide dialogue and develop a strategic transition framework for shaping Perth as a water sensitive city.

1.2.2 Aims and objectives

The aim of Project A4.2 is to develop tools to support the latest efforts in science, policy, and practice for understanding how envisioning and planning processes can accelerate the transition of cities and towns from their current conditions to water sensitivity, enhancing their liveability, sustainability, productivity and resilience.

The objectives for the Greater Perth case study application were to:

1. Produce a strategic transition framework for guiding government, industry, and community stakeholders to implement and support initiatives to achieve Perth’s water sensitive city aspirations. The key components of this transition framework include:
 - a. The rationale for transforming practice towards water sensitivity
 - b. A detailed vision for Greater Perth as a water sensitive city
 - c. Assessment of the city’s current transition challenges
 - d. Transition strategies and actions to realise the desired vision
2. Provide a forum in which a diversity of perspectives and rigorous discussion leads to a shared understanding, strategic alignment and long-term partnerships amongst key organisations for collaborating towards their common water sensitive city objectives.
3. Test the latest scientific thinking on transition planning processes and frameworks for application to cities and towns wanting to shift practice towards water sensitivity, and develop practical tools and innovative methods for translating water sensitive aspirations into practical outcomes for local regions.

1.3 Approach

The project involved a series of five half-day workshops held over the course of five months in Greater Perth. The workshop series was designed around a methodological approach grounded in latest insights from the science, policy and practice of strategic transition planning. The workshop process followed the basic methodological principles of envisioning, backcasting and scenario planning^{3,4,5,6,7,8}, tailored to suit the local context and adapt as the series progressed to accommodate workshop timeframes and evolving priorities of the participants. The workshops covered the themes outlined in Figure 2.

1. Visioning	<ul style="list-style-type: none"> Identify priority outcomes for water-related services
2. Visioning and horizon scanning	<ul style="list-style-type: none"> Develop guiding principles for water sensitive practice and scanning the horizon for major drivers, trends and risks
3. Unpacking the challenges	<ul style="list-style-type: none"> Explore the socio-institutional challenges and the reasons they continue to persist
4. Backcasting	<ul style="list-style-type: none"> Identify short, medium, and long-term transition strategies and actions
5. Backcasting and operationalising	<ul style="list-style-type: none"> Develop a framework for guiding the design of strategies, including focus areas for change and critical initiatives for the short-term

Figure 2: Workshop themes (July - November)



People from a diverse mix of organisations and with different disciplinary backgrounds were involved in the workshops, together representing key stakeholders that influence water management and planning across government, industry and the private sector. Participants came from the following organisations.

- Department of Water
- Department of Parks and Wildlife
- Department of Health
- Region Natural Resource Management (NRM)
- Department of Housing
- Shire of Serpentine Jarrahdale
- Department of Planning
- Australian Institute of Landscape Architects
- Department of Sport & Recreation
- State Government Architect
- City of Gosnells
- LandCorp
- City of Nedlands
- Urban Development Industry Association (UDIA)
- City of Perth
- WA Local Government Association (WALGA)
- City of Subiaco
- Essential Environmental
- Water Corporation
- Calibre Consulting
- WA Planning Commission
- Wallis Consulting & Development
- GHD
- Josh Byrne & Associates

Individual participants were identified by their peers and colleagues as being a leader and strategic thinker within their organisations and across the sector more broadly, and were invited to participate on this basis. A full list of the individual participants is contained in Appendix D. The same individuals were involved throughout the workshop series, which allowed for iterative and collective results to be developed over the course of all five workshops. Participants were asked to bring the perspectives from their professional experience and organisational contexts but to engage in workshop discussions as individuals rather than as formal representatives of their respective organisations.

Each workshop involved a combination of whole group discussions, small group discussions and facilitated activities designed to examine the workshop themes in detail. Between workshops, the research team synthesised and analysed results, which were then presented back to the participants at the following workshop for validation. This enabled an iterative process of reflection and refinement, ensuring that this final report is an accurate reflection of the workshop process and outputs. More detail on the research methodology adopted is contained in Appendix E.



2 Understanding Perth and its water story

2.1 Historic and contemporary changes

The following section narrates the social, historical, cultural, and biophysical context for water in Perth. It is based on evidence from a review of literature, participant interviews and workshop discussions. It was iteratively developed throughout the workshop series, with refinements by workshop participants and the CRCWSC research team.

Greater Perth is situated in the area now referred to as the Swan Coastal Plain, which extends inland and 30 kilometres along the coast of the Indian Ocean from Geraldton to south of Bunbury. In the vicinity of Greater Perth, four distinct landforms make up the coastal plain, the easternmost being the Pinjarra Plain, formed from wind and water-transported sediment. To the west of the Pinjarra Plain lie three distinct coastal dune systems varying in size, age, and sediment type: the Bassendean Dune System, the Spearwood Dune System, and the Quindalup Dune system. The natural drainage system of the Swan Coastal Plain reflects these geological features; lakes, wetlands, and inlets fill the natural interdunal depressions to form an interconnected drainage network. The two largest rivers in Perth, the Swan and the Canning, cut across the north-south ridge systems but still reflect the dune topography as seen by the sections of the rivers that expand north-south⁹.

Long before Europeans arrived in Australia, the Swan Coastal Plain around Perth was roamed and cherished by myriad Noongar tribes. The Aboriginal people relied on the rivers and estuaries for food and other resources, however their connection to the land was more than just physical. According to culture, the rivers, valleys, and landforms were carved out by the Waugal, a serpent-like dreamtime spirit who watches over the land and punishes transgressors¹⁰. While European settlers brought with them different values and perspectives regarding the natural landscape, resulting in significant modifications to the area's natural features. Despite these changes, the Aboriginal people's spiritual connection to the land and water is still strongly present.

Since the first European settlement was established in 1829, the people of Western Australia have had a challenging relationship with water and their surrounding environment. From their early days as what was known as the Swan River Colony, British settlers struggled to establish an agricultural colony in their new environment. They were faced with the challenges of isolation from other settlements, unfamiliar topography, unreliable climatic conditions, and disputes with Noongar tribes.

The capital city of Perth was established at the halfway point between the Port of Fremantle at the mouth of the Swan River, and the rural agricultural area that stretches along the upper Swan. The settlers brought with them the belief that cultivated land was a sign of civilisation, and that land ownership created wealth. This agrarian structure depended on a predictable climate and reliable water supplies. The Mediterranean climate patterns of the area yielded wet winters and hot, dry summers and settlers soon realised that without storage, the amount of rainfall during the winter months was insufficient to supply the city with water throughout the summer¹¹.

Settlers turned from relying on surface water to collecting and storing water from local natural springs, which was the major water source until the end of the 19th century. As Perth continued to grow, especially with the discovery of gold in the Goldfields in 1885, the city was forced to increase its water supply infrastructure to cope with the increasing population. Construction of dams began at the turn of the century to capture and store surface water supply.



After World War II, the city began to rely more heavily on the extraction of groundwater, originally from the shallow superficial aquifers and later to the deeper confined aquifers. The largest of the superficial aquifers, the Gnangara mound, lies just north of the city and is about 50 metres thick. Extraction from this aquifer proved to be relatively easy, cheap, and reliable for many decades. However, groundwater systems are complex and the consequences of cumulative impacts of extraction, recharge and a drying climate were not understood until the 1990s.

The amount of water in Perth's dams reached a record-breaking low in 2001 (Figure 3), which led to an urgent call to explore alternate water sources. The then Premier Hon Geoff Gallop MLA hosted a three day Water Symposium at Parliament House in 2003 drawing together community leaders, government representatives and community members to develop a response. The State Water Strategy¹² (2003) was born from this collaborative effort. It unleashed

an unprecedented investment in water efficiency, recycling, research and source investigation. This also supported a number of source development initiatives including new surface and ground water sources, further integration of sources, catchment management approaches and feasibility studies for technologies that were new to Australia, including seawater desalination.

The first desalination plant was constructed in 2006, and a second plant was completed in 2013. Currently, water from desalination plants can make up 49% of the public water supply, securing water resources for the people of Perth. Despite some concern about environmental impacts, the desalination plants were met with general community support as sound investments in climate resilient sources. Other alternate water sources such as wastewater recycling were also developed, and the Kwinana Water Reclamation Plant was constructed in 2004 to treat and recycle wastewater for industrial purposes.

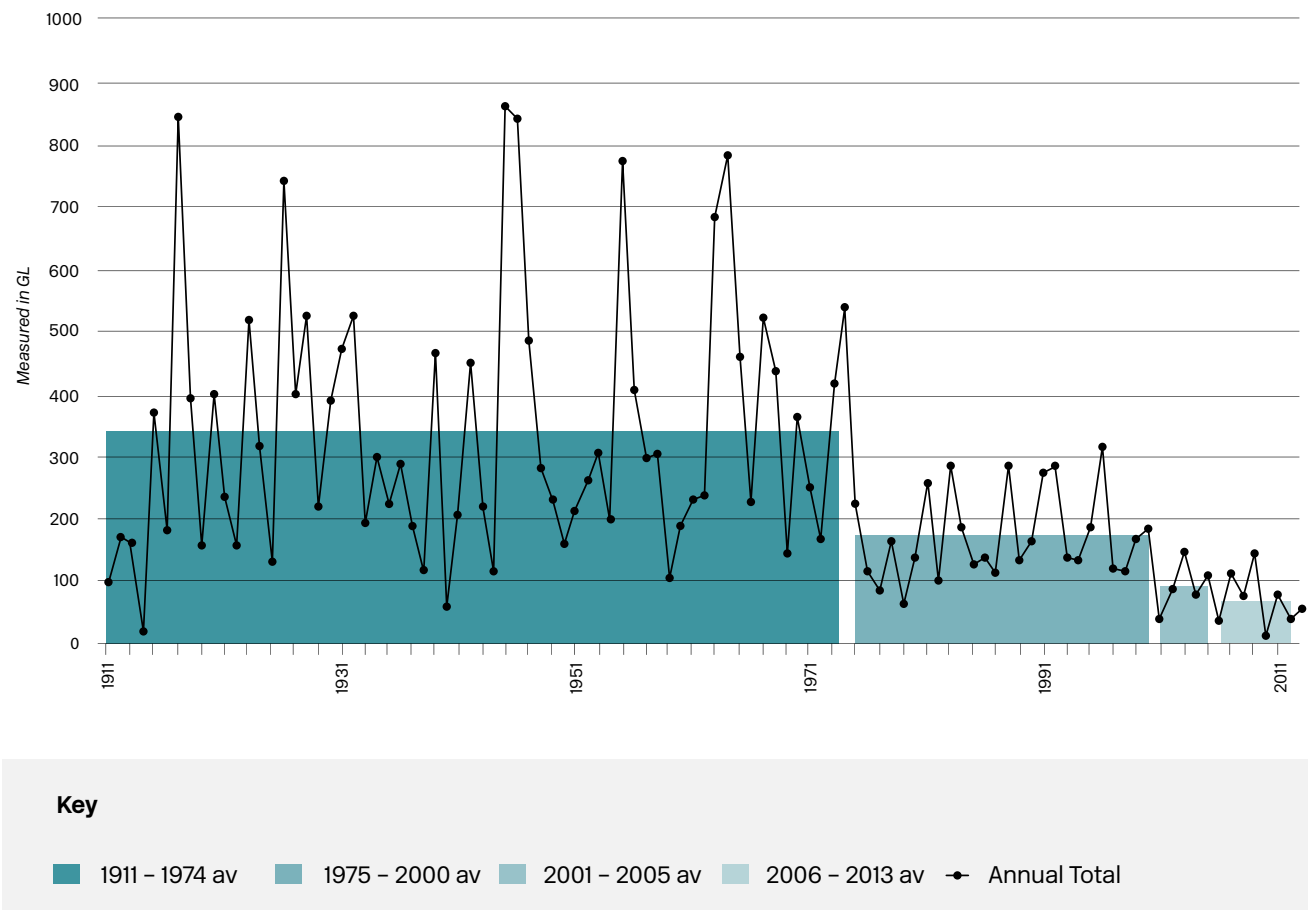


Figure 3: Historic inflow to Perth's dams (Source: Water Corporation)

Demand management strategies were also introduced in response to the drying climate – further water restrictions were added in 2001 and 2007 to incorporate seasonal sprinkler rosters, which are now a permanent feature of Perth. These restrictions are not as severe as those imposed in Australia's east, where residents were not allowed to wash their cars during the Millennium Drought years for example, but they are ongoing and no sprinkler use is permitted in winter. The people of Perth were also spared dramatic increases in the price of water. The demand management measures that were introduced have nevertheless created some awareness about water use and availability within the community.

Today, scientific opinion is that Perth is not just in a temporary period of drought – the climate is changing, becoming drier and hotter with continuing lower-than-average levels of rainfall¹³. Greater Perth is faced with the challenge of providing reliable water for a dramatically increasing population in this drying climate. While there have been some cultural shifts throughout history, the people of Perth still rely on supplied water to provide the green amenity present throughout the city.

This is particularly the case where most public and private open space is irrigated from shallow, local groundwater sources.

Further to the research program funded as part of the State Water Strategy, options for large scale water recycling were investigated. This led to a four year trial of a groundwater replenishment scheme led by the Water Corporation, which commenced in 2009. This trial sought to develop the technical feasibility, regulatory frameworks and community support to “close the loop” from wastewater treatment plants and turn this often wasted resource into a major future source for Perth.

Following the successful completion of this trial, in 2014 the State Government approved the first indirect potable recycling scheme in Australia based on groundwater replenishment from treated wastewater. Currently under construction, the scheme provides a climate independent source with a lower land, energy and environmental footprint than seawater desalination. Given the large volume of treated wastewater available in Perth, this provides a robust public water supply option for the future.



2.2 Why aspire to a water sensitive Perth?

This section narrates the rationale for why Perth needs to transition to a water sensitive city. It is based on qualitative and quantitative evidence from a review of literature, participant interviews and workshop discussions (specific details can be found in Appendix A). It was iteratively developed during the workshop series, with refinements by workshop participants and the CRCWSC research team.

Greater Perth is now at an important juncture in its development as a major Australian city. Planning is underway to accommodate a projected 3.5 million people for Perth and Peel by 2050¹⁴, requiring significant consumption of resources and urban expansion and densification. The impacts of climate change on Perth's rainfall patterns, temperatures and sea level are already being felt and will be exacerbated into the future. Against this backdrop, the community's growing aspiration for Perth to be recognised as one of the world's most liveable cities sets a clear agenda for the city's future. It is therefore critical that today's planning, design and infrastructure decisions are made with reference to the long-term liveability, sustainability, productivity and resilience of Greater Perth.

The management of water is fundamentally linked to Perth's broad goals. The city's water servicing has been traditionally based on large-scale centralised infrastructure that supplies surface and groundwater resources to urban areas and discharges treated sewage and untreated stormwater runoff into waterways and the ocean. This system has a strong legacy in meeting the city's basic needs for water supply, safe sanitation and flood protection but it has also led to instances of deteriorating waterway and wetland health and has been vulnerable to the drying climate of Western Australia. Persisting with the traditional water management approach will mean these challenges will likely become more pressing with each passing year.

Poor waterway health has long been identified as a challenge for Perth, with the majority of wetlands along the Swan Coastal Plain having been filled, drained or cleared and many inland waterways showing indications of poor ecosystem health. As Greater Perth becomes more populated and urbanised under a 'business as usual' approach, pollution from human activities would increase, causing even higher nutrient loads to enter surface, ground and coastal waters. This poorer water quality would result in more frequent algal blooms, intensified by the warmer air and water temperatures and drier climate predicted for the region. The resultant ecological impacts would be significant, reducing the biodiversity of Perth's iconic coastal and inland water systems. Algal blooms also disrupt people's access to waterways for swimming and other recreational pursuits 'and may lower the amenity and value of urban developments.'

Climate change will place additional pressure on the water quality of Greater Perth's aquatic environments in other ways too. The Swan Canning River System is expected to experience increased saltwater stratification due to sea level rise and decreased streamflow, depleting the amount of oxygen available to aquatic species in the lower layers of water. Coastline aquifers are also vulnerable to saltwater intrusion from sea level rise and intensified storm surges; this intrusion changes the ecosystem functioning and can lead to contamination of important freshwater resources. People and property are also at risk from increased storm surge and sea level rise, causing more frequent and severe coastal and inland flooding, impacts that are already being experienced in some areas (e.g. Fremantle, see Appendix A).

The extreme weather events predicted as the climate changes also include longer and more intense heatwaves, which will have severe health implications for both Perth's people and its flora and fauna. Combined with patterns of urban development that do not incorporate green space, trees or water bodies, the urban heat island effect would be expected to significantly increase the incidence of heat-related illnesses and deaths during extreme heat events. People's physical and mental wellbeing is also affected by urbanisation approaches that do not prioritise public open space, green landscapes and recreational opportunities.

Land clearing for urban development has led to the widespread depletion of endemic vegetation and natural wetlands. A relatively large number of species in the Wheatbelt and Swan Coastal Plain have become extinct and significant changes have occurred to the ecosystems and habitats of native flora and fauna, threatening Perth's rich biodiversity. Reduced availability of fresh, locally grown food is also likely, as land development encroaches on traditional agricultural areas and rainfall decreases with climate change.

Reduced rainfall also impacts on the availability of water resources for Greater Perth. The average annual streamflow into Perth's dams is now one quarter of the long-term average to 1974. Water levels in aquifers such as the Gnangara Mound have dropped, exacerbated by land use changes and over-abstraction and with major consequences for nearby ecosystems as well as water supplies. As described in the previous section, Perth has responded to these water resource challenges by constructing two seawater desalination plants and, more recently, a scheme to replenish groundwater with wastewater treatment plant discharge treated to drinking water quality. While these solutions have markedly improved Perth's water security, they are relatively costly and energy intensive. As climate change impacts worsen and urban development expands and intensifies in areas with limited or fully allocated groundwater resources, Perth's reliance on highly treated seawater and wastewater risks the affordability of water supplies being compromised, particularly for non-drinking purposes such as the irrigation of private gardens and public open space.

Greater Perth is not alone in grappling with water management complexities and uncertainties such as those described above. There is now recognition globally that significant shifts in urban water management are required for a city's long-term aspirations to be realised. In response, the concept of the water sensitive city has emerged in scientific, policy and practice domains, representing an alternative vision for urban water servicing based on principles of flexibility, diversity and integration.

The water sensitive city can be described by three pillars of practice¹, which collectively enhance urban liveability, sustainability, productivity and resilience:

1. Cities as water supply catchments, in which all the available water resources within an urban footprint are considered valuable supply sources. This includes wastewater, rainwater, stormwater and groundwater, and infrastructure systems integrate both centralised and decentralised technologies to utilise these resources at different scales in fit-for-purpose applications.
2. Cities providing ecosystem services, in which water infrastructure and the urban landscape are designed both functionally and aesthetically. These integrated systems provide multiple benefits, including stormwater treatment, flood protection, heat mitigation, ecological health and landscape amenity.
3. Cities with water-conscious citizens and communities, in which people appreciate the many values of water, feel connected to their local water environments and engage in water-conscious behaviours. Organisations and professionals that influence water management exhibit policies and practices that lead to water sensitive outcomes.

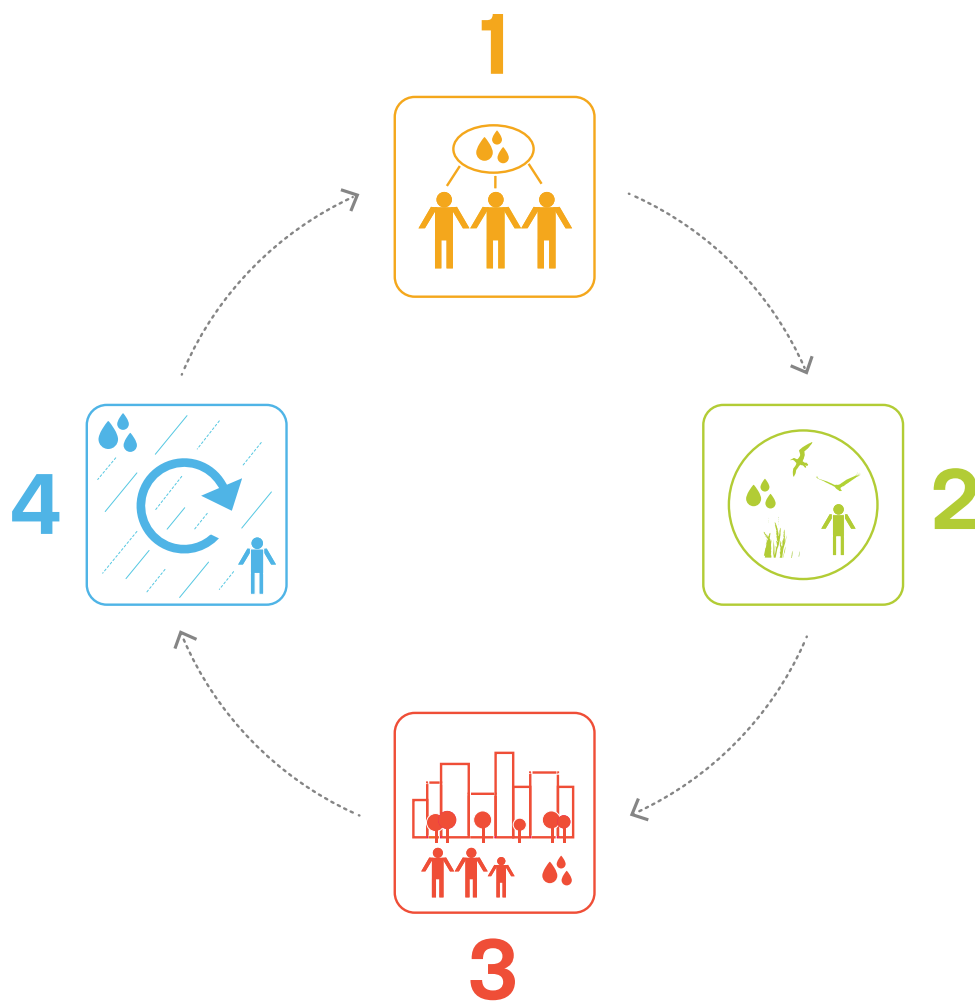
These pillars of practice represent the foundations of a water sensitive city in a general sense. However, their application is highly context-specific, depending on local characteristics, conditions and perspectives. Greater Perth's transition towards a water sensitive city therefore requires the general principles to be translated to have specific meaning and relevance for its unique ecological, geographical, cultural and institutional context. This is the focus of the next section.

3. A vision for a water sensitive Perth

This section presents the vision of Greater Perth as a water sensitive city in 2065 that was iteratively developed throughout the workshop series. Participants were given the opportunity to expand and refine the vision at each workshop. The vision is comprised of four themes and associated desired outcomes and simple visuals.

Figure 4 below describes the four themes of the vision, desired outcomes and how they are interconnected. The corresponding narratives expand on these desired outcomes, drawing from workshop discussions that explored the vision in further detail.

A WATER SENSITIVE PERTH IN 2065



1. Fostering stewardship of the system

- a. People understand the entire water cycle and recognise the need to adapt to uncertain and changing conditions
- b. People feel a sense of belonging and connection with Perth and identify with its evolving water story
- c. People are appropriately engaged in open and inclusive decision-making processes that are informed by comprehensive information and transparency in people's priorities
- d. There is continuous investment in developing necessary knowledge, skills, and capacity across water-related professions, sectors and the community

2. Protecting and enhancing the wellbeing of people and the environment

- a. Water is valued and managed with respect for the interdependent and dynamic relationship between people and the environment
- b. Perth's coastal and inland water ecosystems are protected and thriving with biodiversity
- c. Flood and inundation risks are managed in harmony with local conditions to minimise impacts on and embrace opportunities for the city

3. Integrating and engaging with the built and natural landscape

- a. Perth's urban character reflects its unique landscape and water environments
- b. The urban environment is comfortable, safe, and promotes health and wellbeing
- c. The city is filled with a network of beautiful, well-designed and high quality places that are diverse, accessible, loved and enhanced by effective water management
- d. Infrastructure planning and development are coordinated and integrated to deliver multiple benefits

4. Sustaining the long-term use of Perth's resources

- a. Water is available to equitably meet the needs of people and the environment both now and in the future
- b. Fit-for-purpose water is supplied through adaptable systems that work across multiple scales
- c. Efficient use and recovery of resources is ensured through innovative water cycle management

3.1 Fostering stewardship of the system

People understand the entire water cycle and recognise the need to adapt to uncertain and changing conditions. They feel connected to water and are committed to looking after it over the long-term. This refers to everything from the groundwater sources, to how water is supplied and managed, to wastewater treatment and resource recovery. Climate change is acknowledged and people recognise the need to proactively adapt in response.

People feel a sense of belonging and connection with Perth and identify with its evolving water story. They understand the cultural dimensions of Perth's water, which involve the historical movement of water in the environment along with Aboriginal connections to water. There is a sense of belonging and identity with this story, even amongst diverse cultural communities. The built form supports this connection by reflecting the historic and natural landscape and waterscape.

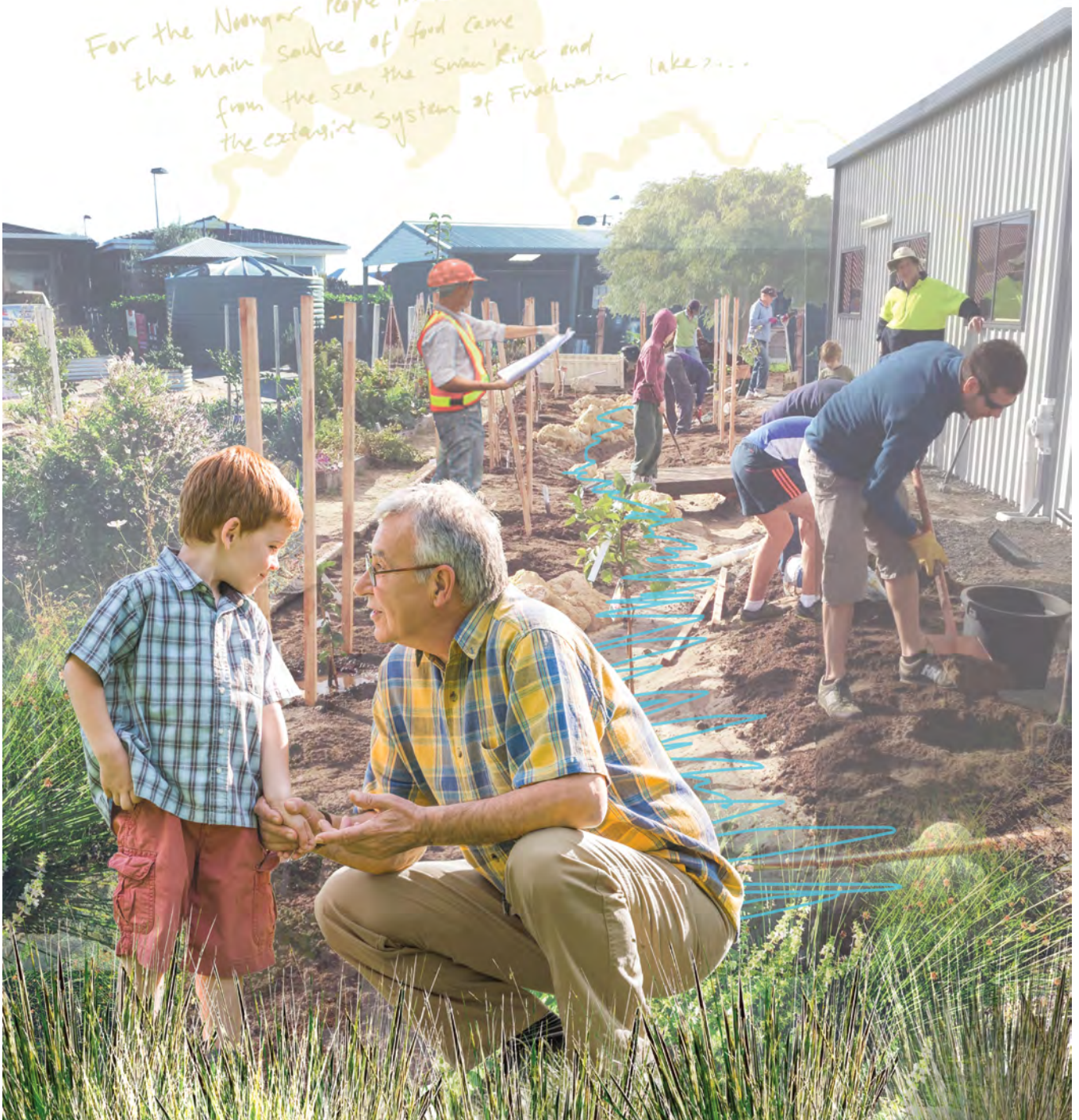
People are appropriately engaged in open and inclusive decision-making processes that are informed by comprehensive information and transparency in people's priorities. The costs, benefits and risks of different options are transparently considered and communicated to stakeholders, including the community, to inform strategic decision-making. Economic benefits are displayed through demonstrated efficiencies and local Perth projects.

There is continuous investment in developing necessary knowledge, skills and capacity across water-related professions, sectors and the community. The community is educated about demonstrations and water-related decisions through capacity-building and education programs at various levels. Innovations are encouraged in an enabling environment and driven by both collaboration and competition throughout the sector.



1. FOSTERING STEWARDSHIP OF THE SYSTEM

*For the Noongar People in Perth
the main source of food came
from the sea, the Swan River and
the extensive system of Freshwater lakes...*



3.2 Protecting and enhancing the wellbeing of people and the environment

Water is valued and managed with respect for the interdependent and dynamic relationship between people and the environment. The public is protected from potential health risks through effective water and related environmental management. Waste management handles pathogens and other hazards in a safe and reliable way.

Perth's coastal and inland water ecosystems are protected and thriving with biodiversity. The rivers, wetlands, estuaries, and coastline are alive and healthy. The air and water quality levels are exceptional and attract birds and other wildlife to the area. The Swan and Canning rivers are viewed as iconic symbols of Perth that are valued both locally and internationally. Perth also recognised for its unique extensive network of groundwater aquifers. People are conscious that these iconic natural features need to be preserved – therefore water is adequately allocated and land uses are undertaken for their protection.

Flood and inundation risks are managed in harmony with local conditions to minimise impacts on and embrace opportunities for the city. People understand these risks and also see them as opportunities for the city. There is widespread community acceptance that some inundation naturally occurs and is an important part of the natural water system, and thus the built form is responsive to shallow groundwater with scientifically-supported design features that minimise the impacts when inundation occurs.



2. PROTECTING AND ENHANCING THE WELLBEING OF PEOPLE AND THE ENVIRONMENT



3.3 Integrating and engaging with the built and natural landscape

Perth's urban character reflects its unique landscape and water environments.

The presence of water is integrated within the public realm in a way that is creative, innovative and sustainable. This creates a distinctive, beautiful city through considered urban structure, built form, landscape design and multifunctional spaces that reflect Perth's unique environmental qualities. Features such as the Swan River and the coastline, the wetlands, damplands and dune chains are celebrated and showcased through good planning and design that encourages greater awareness of water. This gives people the opportunity to connect with all aspects of the water cycle during wet and dry periods and emphasises that water exists as an ephemeral and vital element within our community, supporting Perth's comfort, amenity and resilience.

The urban environment is comfortable, safe, and promotes health and wellbeing.

The city feels cool and convenient for people to walk through. Landscape elements are well-integrated within the built environment including water-harvesting green roofs, green walls, and shaded streets. Innovations in materiality and the built form have reduced the urban heat island effect to minimise heat-related deaths and stress incidents. A network of high quality spaces is prevalent throughout the city and connected to pedestrian infrastructure to promote healthy living, not only because of the physical health benefits provided by the urban environment, but also the mental wellbeing and social amenity they offer. It is recognised that these spaces contribute to public health, so they are valued, well cared for and maintained and the importance of effective water management to support this is recognised.

The city is filled with a network of beautiful, well-designed and high quality places that are diverse, accessible, loved and enhanced by effective water management.

These places provide a sense of place and social cohesion, allowing community members to connect with their environment and one another. The city offers intact ecosystems, playground areas, sport spaces, walking paths, entertainment, alfresco eating, public art and other features that suit the needs of all people at different ages and stages of life. In addition to being diverse, the spaces are responsive to trends in sport and recreation and to the changing needs of the community. Existing natural features such as the coastline, wetlands and rivers are made accessible so people can enjoy them for their health benefits while fostering environmental responsibility.

Infrastructure planning and development are coordinated and integrated to deliver multiple benefits.

Value, performance, and community and environmental impacts are considered holistically. Functional service delivery systems are also designed to be attractive, innovative and responsive to their context. Movement networks integrate both grey and green infrastructure systems, which are demonstrated through the narrowing of some roads to allow space for green corridors. Service delivery systems are seen as opportunities to integrate multi-functional green networks. Water is also an active and considered transport mode for Perth, and Swan River ferries are accessible and used.



3. INTEGRATING AND ENGAGING WITH THE BUILT AND NATURAL LANDSCAPE



3.4 Sustaining the long-term use of Perth's resources

Water is available to equitably meet the needs of people and the environment both now and in the future. Water is not wasted and demand is well managed in order to sustain the water sources of the region. Water is available for food production in all urban and peri-urban communities so people have access to locally grown fresh produce. Larger agricultural areas are strategically located next to water sources to minimise transport and irrigation costs.

Fit-for-purpose water is supplied through adaptable systems that work across multiple scales. Users understand the concept of fit-for-purpose and there are clear water quality targets for different types of usage. Fit-for-purpose schemes integrate with the broader water system to provide reliable and adaptable configurations to suit different contexts and conditions.

Efficient use and recovery of resources is ensured through innovative water cycle management. Wastewater is recycled and utilised as a valuable source of water and other resources, such as nutrients, biosolids and energy. These resources, amongst others, are efficiently recovered through innovative water cycle management. Water supply systems are efficient in delivering services for all water purposes. Renewable energy is used where possible for energy-intensive water systems.



4. SUSTAINING THE LONG-TERM USE OF PERTH'S RESOURCES



4. Guiding principles for water sensitive practice in Perth

Accompanying the vision is a set of principles to guide water sensitive practice in Greater Perth. These principles were developed in the workshops by exploring the principles of practice that would be needed to achieve the desired water sensitive outcomes expressed in the vision. These guiding principles are organised according to planning, decision-making, engagement, design and management practice.

The guiding principles are designed as a coherent, collective set; individual statements should not be read in isolation.

Type of practice	Guiding principles for water sensitive practice in Greater Perth
<p>Urban and water systems planning</p> <p><i>Strategic and statutory planning of the greater metropolitan region, including its land use zones, development policies, water resources and water infrastructure systems.</i></p>	<ol style="list-style-type: none"> 1. Water systems planning and urban planning are integrated and consider both local and regional objectives and priorities 2. Urban and water systems planning is conducted with a long-term view that accounts for current and future water-related needs of people and the environment, resource availability and ecological limits 3. Urban and water systems planning is conducted within an overarching policy framework that reflects a locally defined vision for a water sensitive Perth 4. Urban and water systems planning is guided by outcome-focused standards that match the scale of the target area 5. Urban and water systems planning ensures public open space and the public realm is of sufficient quantity and quality to support human wellbeing in existing and developing areas
<p>Decision-making and investment</p> <p><i>System-wide governance approaches, involving formal and informal structures and processes, that inform water-related planning and investment decisions</i></p>	<ol style="list-style-type: none"> 6. Decision-makers across water-related sectors are fundamentally aligned and make decisions in the context of a shared vision and evolving narrative for a water sensitive Perth 7. Clear governance arrangements clearly define roles and responsibilities for all aspects of the water cycle 8. Governance arrangements encourage innovation while ensuring social, environmental and economic sustainability in all decisions and investments 9. Decisions about water are made pursuant to reliable evidence, transparent planning and highest community value

Type of practice	Guiding principles for water sensitive practice in Greater Perth
<p>Stakeholder engagement</p> <p><i>Engagement with community, business, industry and government stakeholders to influence water sensitive outcomes</i></p>	<ol style="list-style-type: none"> 10. All stakeholders are actively engaged and supported with targeted information and educational support to encourage shared knowledge of Perth's water narrative and to promote individual and collective responsibility and capacity as water stewards 11. The inputs of different stakeholders into water-related initiatives are facilitated with appropriate timing and with respect for their influence, capacity and needs 12. Clear and consistent messages are communicated to the community and other stakeholders 13. The community is involved in and has the opportunity to influence decision-making about water through transparent and disclosed processes
<p>Water systems and urban design</p> <p><i>Design of buildings, public and private spaces, urban landscapes, and water, transport and other urban infrastructure systems</i></p>	<ol style="list-style-type: none"> 14. Water sensitive principles, local characteristics and informed community values guide holistic site-specific designs that make water sensitivity physically and conceptually legible in the built environment and ensure multiple benefits are delivered over the long-term 15. Water system and urban design connects all elements of the water cycle and considers whole-of-life costs and benefits, including broad social and environmental impacts 16. Water sensitivity is encouraged through design practice that continually innovates, adapts and improves as conditions and objectives evolve
<p>Management and operation of water systems</p> <p><i>Management and operation of the integrated water system and its individual infrastructures, including traditional technologies, green technologies and natural environmental features</i></p>	<ol style="list-style-type: none"> 17. Overarching governance arrangements for water management ensure coordination and consistency with mutually reinforcing approaches across stakeholder organisations 18. Water management approaches are flexible and inclusive to provide opportunity and mechanisms for involvement by all interested and relevant stakeholders 19. Water systems are managed as part of the whole water cycle within their catchment and the broader urban system 20. Water infrastructure is managed according to reliable and well-resourced asset management regimes that protect the integrated system's long-term integrity

5. Perceptions of Perth's transition challenges

This section presents the range of social and institutional challenges currently perceived to inhibit Greater Perth's transition towards more water sensitive practices. The first part narrates the challenges, providing context and explanation. The second part presents a more detailed breakdown of these challenges, consolidating them into six categories.

Prior to the commencement of the workshop series, interviews were conducted with workshop participants to explore and understand these challenges, as well as the broader operating context for water in Perth. Barriers to achieving water sensitivity in Perth were further explored during workshop discussions to explore how they can be overcome. The content of this section has therefore been derived from a synthesis and analysis of both the interview and workshop discussions, supplemented by a literature review of reports from previous activities, case studies, books and journal articles related to Perth's water context.

The results in this section are a synthesis of perceptions from across various stakeholder groups and should not be interpreted as the shared view of all workshop participants. The purpose of presenting these perceptions is not to resolve which are correct or otherwise, but to understand the range of views currently held by stakeholders as a means to identifying key domains that need attention for Greater Perth's transition to its envisioned water sensitive future to be accelerated.

The factor most widely regarded as limiting advancement of water sensitive practice in Greater Perth is the lack of a singular driver or crisis to create a unifying commitment to change. There is a common perception that the community believes Perth has a healthy ecosystem and secure water supplies, which means there is limited public understanding of the need for change. While there have been concerning incidents such as dolphin deaths, which may have been a catalyst for change, such events have not yet translated into change on the ground. Impacts from existing drivers such as climate change and population growth are also diffused over long periods of time and are difficult to visualise and communicate. Taken together, the drivers for change are not seen to be evident to the community and thus there is no sense of immediate urgency. The lack of community demand for change is widely perceived to be a significant challenge in creating the mandate and momentum for moving towards increased water sensitivity.

Along with the lack of a single unifying driver, there is perceived to be an absence of strong cross-sectoral leadership to drive change and enable action towards an integrated and agreed vision. A lack of alignment between organisational incentives and collective priorities impedes the leadership that is necessary for long-term change. So far, opportunities for change have not been effectively harnessed in part because of a fragmented and uncoordinated approach amongst agencies and across the water industry. Opportunities for leadership in the political system are difficult, since long-term trends and challenges do not match the objectives of short-term political cycles. However, without strong leadership, initiatives for driving change will continue to be fragmented.

A distinct yet related barrier is the narrow and not immediately compatible mandates of organisations with responsibility for delivering water-related services. This becomes particularly problematic in times of budgetary constraints, as each organisation will necessarily prioritise their mandated licenses and responsibilities, making it difficult to implement more holistic and non-mandatory water sensitive outcomes. A further complication is that existing organisational mandates do not cover the whole spectrum of water sensitive cities, with a particular gap in relation to responsibilities for waterway quality management.

Despite a broad recognition institutional arrangements should encourage collaboration, there is currently no agreed framework for facilitating this alignment. It is challenging to coordinate the current (and sometimes competing) organisational and industry objectives across sectors because of this fragmentation. This also pertains to community engagement – there is no agreed framework or methodology for efficiently and appropriately engaging the community in decision-making processes.

There is wide agreement that transparency of costs and benefits should underpin options analysis, however it is difficult to establish these true costs and benefits due to the complex interactions and impacts across the water cycle, as well as different organisational methods and incentives. It is also difficult to understand and quantify the non-market benefits of water sensitive initiatives and, in turn, to broaden the current narrow approach to analysing options. These challenges mean evidence put forward to guide decisions and decision-making processes is sometimes perceived to be ambiguous and inadequate for supporting the consideration of water sensitive alternatives.

For the people of Perth, there is a general lack of definition in their sense of place, their physical reality and how it relates to water. Such disconnection with the surrounding landscape influences people's identity and therefore their approach to water. This is exacerbated by the community's insulation from severe impacts or the need for significant behaviour change during past water challenges, such as the Millennium Drought. This also influences the general community attitude and commitment to driving change; if there is no connection to or valuing of water in the environment, there will be no desire to sustain it.

Ultimately, the analysis reveals two distinct yet related challenges that are widely perceived to be inhibiting Perth's transition to a water sensitive city. At an organisational scale, there is a lack of strategic alignment to drive strong and coordinated action across the many government, business, industry and community stakeholders involved in water, planning, development and the urban environment. Compounding this challenge is a lack of a clearly articulated rationale and narrative for implementing increased water sensitivity. Without this compelling narrative, it is difficult for government and industry stakeholders to 'speak with one voice' to the community, undertake effective community engagement and help build a community mandate for action. Community demand for increased water sensitivity is widely regarded as essential to provide the necessary motivation for action.

Summary of perceived transition challenges

- 1. Need for a compelling vision and clearly articulated narrative**
 - a. Stakeholders do not yet share a vision for the water future of Perth
 - b. No agency has yet accepted the mandate or responsibility to develop and drive a vision
 - c. People are not yet inspired to change behaviours and practices
 - d. There is minimal conversation and hence no clarity or visibility of agreement on water-related needs and priorities
 - e. There is a general lack of overt political support and bipartisanship
- 2. Need for alignment in organisational objectives, responsibilities and capacities**
 - a. Responsibilities for managing water quality and achieving water quality outcomes are ambiguous and targets are either absent or not very aligned
 - b. There is currently no leading organisation with the clear and stated mandate to manage water quality and the whole water cycle
 - c. The process for decision-making about water allocations and investment is not always inclusive and equitable
 - d. Responsibilities are delegated to organisations without necessarily the corresponding regulatory, financial, technical, structural or knowledge capacities
 - e. There is confusion and lack of consistency in roles and interactions
- 3. Fragmented and uncoordinated structures and processes**
 - a. There is fragmentation across the many local government areas, leading to varying water-related agendas and capacities
 - b. There are minimal requirements for coordination and/or conflicting objectives between organisations for managing the drainage system
 - c. Integration of land and water planning in practice is impeded by a significant gap between policy and its implementation
 - d. Planning and approval processes between state and local governments are too often uncoordinated

4. Risk averse culture and lack of transparency in options analysis

- a. Decisions are not yet based on analysis of full costs, benefits and risks of water options
- b. Community is not well informed about the costs, benefits, and risks of all options
- c. Non-market benefits of water sensitive design are difficult to quantify to aid evaluation
- d. Innovation is impeded by an inability and/or lack of interest in managing risks associated with non-potable schemes and other alternative water systems
- e. Professional culture based on traditional water management approaches is deeply embedded
- f. There is a general lack of trust between organisations
- g. Different drivers amongst stakeholders determine their objectives

5. Need for higher and broader professional capacities

- a. Capacity-building initiatives for professionals are in place but lack secure funding and broad commitment
- b. Technological innovations are not yet fully supported with proof-of-concept in the Perth context
- c. There is a lack of research base and capacity for Perth-specific evidence and demonstration
- d. The skills required to manage an integrated water system are not yet well developed in the sector

6. Need for greater interest from the community

- a. Community knowledge and awareness of the water cycle and natural environment is generally low
- b. There is a general community apathy towards water use and conservation
- c. The community does not yet understand the benefits of water sensitive design approaches
- d. Agencies do not have the desire or resources to invest in community engagement initiatives

6. Transitioning to a water sensitive Perth

A wide range of strategies and actions were identified in workshop discussions that explored how to overcome the perceived persistent challenges and implement the guiding principles of water sensitive practice. The full list of strategies and actions is found in Appendix B. This section presents a shortlist of critical strategies and actions, which participants considered to be essential steps for enabling Perth's water sensitive city transition. This shortlist is organised into a suite of six overarching and mutually reinforcing focus areas for change.

A next step for Perth stakeholders is to develop short-term action plans and to assign responsibilities and timeframes to the strategies and actions.

6.1 Focus areas for change

Figure 5 presents the six focus areas for change, illustrating their interconnectedness and highlighting that all the strategies and actions are mutually reinforcing and stem from the need to develop a shared vision and message. While there are already activities happening in Perth to support each of these focus areas, participants generally felt that need to be further strengthened in order to enable Perth's transition to a water sensitive city.



Figure 5: Focus areas for enabling Perth's transition to a water sensitive city



6.2 Critical strategies and actions

Shared vision and message

Develop and communicate a unifying vision and message about the need for and value of Greater Perth as a future water sensitive city

1. Develop an ongoing and adaptive meta-narrative for Perth's broad identity and the role of water within it
2. Engage professionals to develop a media and communication plan and targeted materials for disseminating key messages about Perth's water narrative to the community and industry
3. Establish a multi-faceted community campaign for developing and promoting Perth's water sensitive city vision, formally endorsed by stakeholder organisations
4. Set targets for achieving the water sensitive vision for Perth, building on the outcomes of this "Shaping Perth as a water sensitive city" visioning process

Community mandate

Build community support for water sensitive outcomes that provides the mandate for driving change in water-related policy and practice

1. Initiate dialogue with the community about Perth's water narrative, building on the outcomes of this "Shaping Perth as a water sensitive city" visioning process
2. Utilise the opening of Elizabeth Quay and other suitable opportunities for initiating targeted media and community engagement about Perth as a water sensitive city
3. Implement targeted behaviour change initiatives based on social research to guide community practices towards water conservation and environmental protection
4. Develop a water sensitive cities education toolkit and dissemination strategy to inform the curriculums of primary and secondary schools, universities and professional training programs

Leadership

Foster broad political and industry support and inspire leadership at all levels to set a clear direction, drive change and model the behaviours needed to achieve water sensitive outcomes

1. Establish a non-political high level advisory committee to guide the transition towards water sensitive decisions and outcomes
2. Develop a program to recognise and profile champions of water sensitive innovation in government, industry and the community
3. Create a network of young water sensitive city leaders from peak organisations across the water, planning, development and community sectors

Governance

Strengthen governance arrangements to address gaps, remove barriers, clarify ambiguities and provide incentives for water sensitive practice

1. Establish clear organisational roles and responsibilities for managing, protecting and enhancing environmental water quality
2. Reform drainage governance arrangements to facilitate a total water cycle approach to the management of stormwater runoff, groundwater and waterways
3. Establish a sustainable financial mechanism for delivering water sensitive drainage services
4. Review outcomes of this "Shaping Perth as a water sensitive city" visioning process against current governance arrangements and existing legislative and policy frameworks to identify opportunities for influencing their implementation, development or reform (in the short term - Liveable Neighbourhoods and the Strategic Assessment of Perth and Peel Region)
5. Establish a robust review mechanism based on expert panel assessment of development applications against outcome-focused priorities and performance-based criteria related to water sensitivity
6. Provide developers with clarity about Government priorities and guidance on how to navigate approval processes

Professional culture and capacity

Develop strong capacity and enabling organisational cultures for fostering collaboration and innovation towards water sensitive practice

1. Develop an accreditation program that recognises, celebrates and incentivises innovative projects, designs and practitioners that are trusted to deliver water sensitive outcomes
2. Establish mechanisms and financial incentives to encourage risk sharing and collaboration towards innovation for water sensitivity
3. Strengthen Perth's water sensitive cities capacity building program with a sustainable funding source
4. Establish mechanisms for sharing lessons from experiences of success and failure to promote widespread learning on how future water sensitive initiatives can be improved
5. Develop a strategy for continuing to build a Perth-based water sensitive cities community of practice

Research and technology

Establish mechanisms and commit resources to ensure impact-oriented research and development, including its translation to influence water sensitive policy and practice

1. Fund research to address unresolved scientific questions and key knowledge gaps important for achieving the vision of water sensitive Perth
2. Establish reliable streams of research funding from government and industry to incentivise impact-oriented research and translation of findings to influence policy and practice
3. Continually review and update policies and guidelines with contemporary science and evidence
4. Undertake social research to understand community values and people's connection to local water narratives
5. Strengthen local research capacities related to water sensitive city objectives
6. Continually implement demonstration projects that trial innovative approaches for delivering water sensitive outcomes

7. Reflections and conclusion

This report presents the outcomes of CRCWSC Project A4.2, which centred on a series of five workshops involving 32 leaders and strategic thinkers in Greater Perth from across water, planning, community, urban development and other related sectors. Insights from the workshops were supplemented by a review of literature and pre-workshop interviews with participants and other key stakeholder representatives.

The project results comprise a set of outputs that collectively form a shared vision and strategic framework for accelerating Greater Perth's water sensitive city transition. The **vision** for Perth as a water sensitive city in 2065 is articulated through a series of desired outcomes, supported by rich narratives and simple visual images that represent shared long-term aspirations. A suite of **guiding principles** describes the planning, decision-making, engagement, design and management practices that are needed for Perth to deliver its water sensitive city goals. Acknowledgement of the **underlying challenges** that are perceived to be currently inhibiting Perth's transition towards water sensitivity provides a common base for understanding the range of issues that need strategic attention. Finally, a coherent set of mutually reinforcing **focus areas for change** with associated critical **strategies and actions** provide ideas and an overarching framework to guide initiatives across the many stakeholder organisations that need to work in a collaborative and coordinated manner to facilitate Greater Perth's transition to a water sensitive city.

Collectively, these results show that the participants, with their diverse perspectives, reached broad agreement about their future vision and the important directions that need to be followed in pursuing Greater Perth's water sensitive city transition. It is clear there are currently strong foundations to build on in taking steps towards this vision, including close linkages between the city's planning and urban water frameworks, a long history of engagement with water sensitive design approaches, and recent developments such as Elizabeth Quay that strive to connect the city more closely with its water environments.

In planning for Greater Perth's shift towards a water sensitive city, there is a range of strategies and actions that can directly build on recent momentum, including outcomes from this project. For example, developing case studies of successes and failures in the implementation of water sensitive developments to facilitate broad learning, and investing in research that addresses key social or technical knowledge gaps. There are also barriers that are more complex but need to be resolved for further progress to occur. In particular, strengthening governance arrangements to establish clear and coordinated responsibility for managing environmental water quality and for providing a total water cycle approach to drainage services. Longer-term strategies may require a build-up of widespread support over time, such as facilitating a multi-faceted community campaign, building a stronger community of practice and establishing mechanisms that encourage risk sharing and collaboration towards innovation for water sensitivity.

At the close of the workshop series, participants reflected on three process design features they considered valuable in developing the project results. First, the diversity of disciplinary and organisational perspectives represented across the participant group was vital for developing a comprehensive vision and strategic transition framework. Second, involving the same group of individuals throughout the workshop series provided opportunity for the in-depth and iterative discussions needed to develop shared understanding and alignment. It also strengthened the foundations for supporting long-term partnerships amongst the people and organisations involved. Third, asking the participants to engage in discussions as individuals rather than as formal representatives of their respective organisations enabled freedom and creativity during the workshops. While participants brought knowledge and perspectives from their professional experience and institutional contexts, they contributed their ideas largely unconstrained by current policy or organisational position, which greatly assisted the articulation of a vision and strategic framework that would be transformational for Greater Perth.

The participants showed strong commitment to the process, and throughout the workshops expressed a clear desire for this project to lead to meaningful outcomes beyond the workshop series itself. In particular, they saw significant value in ongoing collaboration as a participant group and have identified a series of tangible activities to build on recent momentum, particularly which developed through this project. Immediate next steps for participants include: (1) reviewing the project outcomes from the perspective of their own institutional or organisational context; (2) broadening the dialogue to engage with other stakeholder representatives across the range of organisations who have influence on the achievement of water sensitive outcomes; and (3) reconvening as a group in early 2016 to develop an operational transition plan, with roles and responsibilities assigned for implementing agreed key actions.

The outcomes of this project mark a potentially significant milestone for stakeholders wanting to accelerate Perth's water sensitive city transition. The vision and principles of water sensitive practice provide an orienting framework for guiding activities and initiatives over the long-term. The strategies and initiatives set an inspirational path forward for navigating the many challenges and opportunities that characterise transition processes. The learning and collaboration amongst workshop participants has strengthened and broadened a network of committed and aligned local water sensitive city champions. These ingredients provide a base for driving the innovations, partnerships and actions needed to pursue the incremental steps that, with time, will collectively support Greater Perth's transition to a water sensitive city.

Appendix A: Rationale for a water sensitive Perth

Major Driver Climate Change		
Impacts	Consequences	Why does it matter?
<p>Lower Overall Rainfall</p> <p>Since the mid-1970s a 15% decrease in rainfall has already been recorded in south-west WA¹⁵</p> <p>Modelling suggests a 20% reduction in rainfall by 2030 and then 40% by 2060, compared to the baseline year of 1990¹⁶</p> <p>An 80% increase in drought months is projected for south-west WA by 2070¹⁵</p> <p>More Random and Extreme Weather Events</p> <p>There is high confidence that the intensity of extreme rainfall events will increase in south-west WA¹⁷</p> <p>156 weather records were broken over the 2013/2014 summer, highlighting the continuing trend of more extreme weather event¹⁸</p> <p>Hotter Days and Longer Heatwaves</p> <p>By 2030 a warmer (0.5 to 1.5°C) and drier (5 to 15%+ reduction) climate is predicted for Perth, even under the best emissions scenario. This means a future climate more like the current climate of Jurien (WA) or Geraldton (WA)¹⁷</p> <p>The average number of days per year above 35°C could increase from 28 in 1995 to 67 by 2070¹⁵</p> <p>The average number of days per year above 40°C is projected to increase by 150% from 1995 to 2090¹⁹</p> <p>Since 1950 the number of heatwave days experienced in Perth has increased by 50%²⁰</p> <p>Rising Sea Level</p> <p>The WA State Coastal Planning Policy requires an allowance for a vertical sea level rise of 0.9 m over 100 years, until 2110²¹</p> <p>At Fremantle average sea level has risen at a rate of 1.54mm a year between 1897 and 2007²²</p> <p>Under sea level rise projections 40% of WA's coastline is susceptible to recession²³</p>	<p>Biodiversity Impacts: South-west WA is a known global biodiversity 'hotspot', with extreme weather events impacting important species. In 2010 an extreme heatwave left over 200 endangered Carnaby's black cockatoos dead²⁴. Cued by temperature change the arrival and departure times of migratory birds has also been significantly altered²⁵.</p> <p>Water Security: From 1911 to 1974 the average streamflow into Perth Dams was 338GL. From 2000 to 2010 inflows had quartered to 75GL, with half the decline linked to human induced climate change¹⁵. This has resulted in the reliance on groundwater and desalination²⁶.</p> <p>Food Security: Wheat production in WA could decline by 8.9% by 2030 and 13.4% by 2050 due to warming and reductions in rainfall¹⁵.</p> <p>Bushfire Risk: A harsher fire-weather climate in the future is anticipated with high confidence for south-west WA¹⁶. The Perth Hills bushfires in February 2011 saw a total of 71 homes destroyed, a further 39 structures damaged and 12 people injured²⁰.</p> <p>Health and Safety: Heat-related deaths in Perth are anticipated to more than double, to over 40, by 2050 because of climate change²⁵ and the urban heat island effect²⁷.</p> <p>Water Quality: Drought and warmer temperatures are linked to increased algae blooms²⁸. Interestingly, a toxic <i>Microcystis aeruginosa</i> bloom in the Swan Estuary prohibited recreational activities for two weeks due to an extreme summer rainfall event in 2000²⁹.</p> <p>Saltwater Stratification: The Swan Canning River System is expected to experience an increase in saltwater stratification as a result of sea level rise and decreased streamflow²². This will exacerbate the low dissolved oxygen conditions experienced in the Swan Estuary over the last 20 years which has seen the construction of five oxygenation plants²⁹.</p> <p>Saltwater Intrusion: Coastline aquifer vulnerability to seawater intrusion is likely to increase due to sea level rises and increased storm surges predicted under climate change³⁰. Perth aquifers ranked as highly vulnerable to saltwater intrusion, include: The Tamala Limestone, Yarragadee, Superficial and Leederville Aquifers³¹.</p> <p>Storm Surge and Coastal Flooding: Impacts of sea level rise will be mainly seen through increased high tides and storm surges, with increased storm surge activity already observed since 1990²². In Fremantle, a vertical increase of 0.2m since the late 1800s has been accompanied by a 300% increase in recorded flooding from high sea level events²⁵.</p> <p>Inland Flooding: Sea level rise may cause flooding some distance inland, such as along estuaries, rivers, lakes and lagoons. A 0.5m increase in sea level could see a 100 fold increase in extreme sea level events in Perth³².</p>	<p>Reduced flora and fauna biodiversity</p> <p>Increased risk to water supplies</p> <p>Increased risk for coastal communities and infrastructure</p> <p>Reduced crop yields and therefore decreased revenues</p> <p>Increased heat related illness caused by increased average temperatures</p> <p>Reduced amenity of Perth's iconic waterways</p> <p>Less readily available potable water</p>

Major Driver Population Growth		
Impacts	Consequences	Why does it matter?
<p>More Pollution and Waste in the Environment</p> <p>Based on current wastewater management practices, annual nitrogen loadings to Perth's marine environment would increase to 10,000 tonnes by 2040, predominantly as a result of domestic wastewater³³.</p> <p>Approximately 2,500kg of waste was generated per person in WA in 2006-2007. Only one third was recycled. The high reliance on landfills has negative impacts on the environment particularly in relation to methane emissions and long-term pollution of the environment through leaching of heavy metals and chemicals³⁴.</p> <p>Higher Demand for Water Supplies</p> <p>Projections suggest a 33% growth for Perth in the coming decades, with an anticipated population of 2.2 million by 2031. In the Peel region to the south of Perth, 50% growth is expected³⁵.</p> <p>The provision of scheme water in the Perth-Peel region is expected to double in the next 40 years³⁶.</p> <p>To support Perth's projected population growth, a further 110 million kilolitres per year of water is required by 2021³³.</p> <p>Larger Volume of Water Flowing Through System</p> <p>Despite goals to reduce water use by 15% per person by 2030³⁷, overall water supply and wastewater production will increase due to population growth.</p>	<p>Water Quality: In general, Perth's coastal waters are high quality. However, the marine environment is already under pressure from contamination from wastewater treatment outfalls, urban runoff, agricultural impacts and groundwater discharge³³. Modelling of the Ellen Brook Catchment, a rural catchment within the Swan River System, suggests conversion to urban lands would result in phosphorus and nitrogen loads increasing by approximately 4% and 12%, respectively, during the 10 years following urbanisation³⁸. Studies of the Peel-Harvey estuarine system suggest recent cyanobacterial blooms and macroalgae proliferations are a result of increased nutrients in the system from human activities³⁹.</p> <p>Water Security: By 2030, even with recycling targets being met, 70 to 100 GL of extra water will need to be sourced and will most likely come from desalination and groundwater sources²⁶. However, over the last 25 years the water table and amount of recharge into the Gnangara Mound aquifer, the main water supply for Perth, has reduced by around 25%⁴⁰. Wastewater recycling is already being investigated as the best opportunity to provide future water for the Kwinana Industrial Strip. Existing industry produces around \$15.5 billion annually and the Government's aim is to increase this output to \$28.3 billion. Current water use is estimated to be around 21GL annually, which is sourced from a combination of scheme water, groundwater, stormwater recovery and recycled wastewater³⁶.</p> <p>Affordability: The move away from rainfall dependent water supplies sees an increase in water supply and treatment. The energy needed to treat 1kL water to drinking standards is 0.4 to 0.6kWh for surface and groundwater sources; 0.8 to 1.0kWh for recycled water; and 3 to 5kWh for reverse osmosis desalination of seawater⁴⁶. For example, the desalination plant in Perth accounted for 82% of the energy consumption associated with treatment despite only supplying 12% of the water⁴¹. While the Kwinana Desalination Plant is powered by renewable energy (wind turbines), it does consume a relatively large amount of energy.</p>	<p>Increased pressure on urban waterways leads to reduced amenity and liveability</p> <p>Increased energy emissions and costs associated with water treatment</p> <p>Increased water treatment pushes up water prices</p> <p>Less low-cost water available for non-household or discretionary use</p> <p>Household affordability and equity considerations will become increasingly important</p>

Major Driver Urbanisation		
Impacts	Consequences	Why does it matter?
<p>Loss of Agricultural Land and Natural Areas</p> <p>Current development patterns could see an increase of 1,468km² of urban sprawl⁴².</p> <p>Urban development is still favoured over agricultural use⁴³, with more than a football oval of rural land being cleared per day around Perth⁴⁴.</p> <p>Population growth increases the demand for land and housing. In Perth at present, 880 hectares of land per year are taken up for urban development⁴⁵.</p> <p>Less Private Green Space</p> <p>Studies have revealed the amount of private green space (lawns and gardens) in Perth has reduced between 1955 and 2005 due to the increasing trend of development within home lots⁴⁶.</p> <p>Trade-offs for Public Open Space (POS)</p> <p>A study of 139 suburbs in Perth-Peel analysed the impact on POS from having multifunctional requirements (playgrounds, sports fields, bush forever sites, WSUD). While conservation areas within POS have increased from 21% to 28%, active open space has decreased from 15% to 6%. This equates to a predicted shortfall of 495ha by 2031⁴⁷.</p> <p>Depletion of Endemic Vegetation</p> <p>On the Swan Coastal Plain 80% of original vegetation has been cleared, mostly for urban development and agriculture⁴⁸. In the WA Wheatbelt 93% of the original vegetation has been cleared⁴⁸.</p> <p>Depletion of Natural Wetlands</p> <p>It is estimated that up to 80% of all wetlands have been filled, drained or cleared in the Swan Coastal Plain. The wetlands which remain are highly vulnerable to urbanisation impacts⁴⁹.</p>	<p>Food Security: With urban expansion Perth has seen movement of traditional growing areas. This displacement either results in ceasing production or moving further out of the city⁴³.</p> <p>People's Behaviours: The accessibility to POS is positively associated with its use. Park aesthetics and size are also factors influencing physical activity⁵⁰.</p> <p>Urban Heat Island Effect (UHI): Some Perth suburbs are up to 6°C hotter than surrounding suburbs. There is a strong correlation between this heat and canopy cover. The most affected are newer developed suburbs that tend to have smaller blocks with big houses and not as many trees. Some of Perth's hot spots include Piara Waters, Clarkson and Butler²⁷.</p> <p>Change in Ecosystems and Habitats: A Perth study found that native mammals are the most disadvantaged vertebrates in remnant vegetation areas, with few species surviving the effects of long-term fragmentation as a result of urbanisation⁵¹. This is also true of native bird species, however, the opposite is true of urban bird species⁵².</p> <p>Loss of Species: Due to urbanisation and clearing of land there has been a large number of species extinctions in the Wheatbelt and Swan Coastal Plain, with 43 and 26 species, respectively. In contrast, the forest ecosystems of the south-west have remained largely intact and have only one associated species loss⁵³.</p> <p>Water Security: In general it is recognised that groundwater has been degraded in areas developed for urbanisation, industry and agriculture⁴⁴. The Gnangara groundwater system, which supplies over 60% of Perth's scheme water, supports \$100 million worth of agriculture and has pivotal environmental value, has experienced a drop in water levels. This has been linked to reduced rainfall, abstraction and altered land use⁵⁴.</p> <p>Water Quality: Nutrient input rates from urban development have been shown to be greater than displaced rural lands⁵⁵. A study of 20 suburbs in the Swan Coastal Plain found medium density urban residential development was responsible for an increase in nitrogen of 5% compared to beef grazing, and 95% compared to cropping (corresponding increases in phosphorus are 79% and 171% respectively). This increase in nutrient rates is responsible for many Perth estuaries and wetlands being excessively eutrophic⁵⁶. Eutrophic wetlands in the metropolitan and Avon Catchment have been linked annually to toxic cyanobacteria detected in the Swan Canning River System. In 2003 a bloom of the <i>dinoflagellate</i> <i>Karlodinium micrum</i> killed thousands of fish in both the Swan and Canning Rivers⁵⁷.</p>	<p>Reduced availability of cheap, fresh locally grown food</p> <p>Reduced public open space for active and passive recreation</p> <p>Reduced physical and mental wellbeing of people</p> <p>Increased heat stress and related health impacts; more time spent indoors with air conditioning</p> <p>Loss of native species that shape Perth's identity</p> <p>Reduced amenity and diversity in the urban environment</p> <p>Increased frequency of algal blooms</p> <p>Reduced availability of waterways for active recreation</p>



Appendix B: Strategies and actions to be further developed and considered for supporting Perth's water sensitive city transition

The following list of strategies and actions has been drawn from workshop discussions. The critical strategies and actions in section 7.2 represent the initiatives that participants felt were most important to focus on from this broader list.

Shared vision and message

Develop and communicate a unifying vision and message about the need for and value of Greater Perth as a future water sensitive city.

Strategies	Actions
1. Develop a clear vision and rationale for Greater Perth as a water sensitive city that is relevant at multiple scales	<ul style="list-style-type: none"> a. Understand the drivers and consequences that are important in Perth and how a water sensitive city will mitigate the associated impacts <ul style="list-style-type: none"> i. Further quantify climate change projections and model consequences specifically in relation to Perth b. Illustrate both positive and negative scenarios that represent different possible futures <ul style="list-style-type: none"> i. Juxtapose photos of positive and negative future scenarios for community campaigns c. Develop an ongoing and adaptive metanarrative for Greater Perth and the role of water within it <ul style="list-style-type: none"> i. Draw from work that has previously been done eg. WALGA and the Community Newspaper Group "Discover Your Rivers" ii. Develop a series of compelling narratives representing the vision that will resonate with different stakeholders and align with their different priorities iii. Draft a concise paper outlining the benefits of a water sensitive city, quantifying (where possible) its value to the economy, community and environment, and referencing research, exemplars and benchmarks d. Run visioning processes targeted at both the broad city scale and the local community scale e. Engage communication and media professionals to develop a communication plan and targeted materials for disseminating key messages about Perth's water narrative to the community and industry <ul style="list-style-type: none"> i. Newspaper and magazine articles ii. Podcasts iii. 30 second YouTube style clip for use at outdoor venues (eg. Burswood outdoor movies, Perth Festival at Elizabeth Quay, Northbridge Piazza etc.) f. Incorporate Nyoongar stories and values into contemporary culture

Strategies	Actions
<p>2. Align organisational goals and objectives with the water sensitive Perth vision</p>	<ul style="list-style-type: none"> a. Develop and commit to a strategic framework that is formally endorsed by water-related organisations to provide a shared basis for setting goals and objectives <ul style="list-style-type: none"> i. Draw from existing strategic and policy frameworks ii. Draw from outcomes of this “Shaping Perth as a water sensitive city” project b. Set targets for achieving the water sensitive vision for Perth, building on the outcomes of this “Shaping Perth as a water sensitive city” visioning process c. Continue to facilitate cross-organisational meetings, processes and other forums to develop alignment of goals, objectives and actions d. Develop clear water policy direction for Perth as a water sensitive city
<p>3. Translate the water sensitive vision of Perth for a diversity of audiences to influence everyday practice</p>	<ul style="list-style-type: none"> a. Develop an action plan by assigning responsibilities and timeframes to the actions arising from this “Shaping Perth as a water sensitive city” visioning process b. Trial a range of strategies for translating and communicating the vision and associated messages to target a range of organisations and demographics c. Establish a multi-faceted community campaign for developing and promoting Perth’s water sensitive city vision, formally endorsed by stakeholder organisations d. Develop a communication toolkit for practitioners e. Run workshops with the broader industry on effective translation strategies f. Identify a range of champions to foster, endorse and communicate the vision, particularly to target industry, community and government members who are not yet engaged <ul style="list-style-type: none"> i. Elected members e.g. City of Perth Lord Mayor ii. Local celebrities g. Establish quality local examples that successfully demonstrate the potential of water sensitive approaches

Community mandate

Build community support for water sensitive outcomes that provides the mandate for driving change in water-related policy and practice

Strategies	Actions
1. Determine the water sensitive city outcomes and approaches that resonate most with community values	<ul style="list-style-type: none"> a. Undertake market research projects to identify community values in relation to water sensitivity <ul style="list-style-type: none"> i. e.g. “Save the Crabs, Then eat Them” campaign b. Run community visioning processes in target areas of Greater Perth c. Identify simple actions that connect people with the water cycle and test on focus groups to identify those that best resonate with target communities <ul style="list-style-type: none"> i. Draw from successful campaigns, e.g. incorporating and encouraging native vegetation that attracts birds
2. Foster strong connections and engagement between communities and their local environment	<ul style="list-style-type: none"> a. Implement good urban design that fosters connection between people and their surrounding environment b. Fund targeted behaviour change programs in priority suburbs throughout metro area <ul style="list-style-type: none"> i. e.g. Bennet Springs c. Increase community pride by bringing historic and current water stories to life <ul style="list-style-type: none"> i. Interpretive signage regarding history, culture, and economic/social values d. Organise local events around demonstration projects and iconic sites to foster community connection and engagement and to target wider audiences <ul style="list-style-type: none"> i. e.g. Opening of Elizabeth Quay ii. Organise river festivals (e.g. Autumn River Festival run by Cities of Bayswater and Belmont each year, Blessing of the River in City of Canning and Angove St. Festival in North Perth) iii. Engage with “Discover your River” program through Community Newspapers and key education venue partners showcasing mobile education displays such as Scitech and WA Museum. iv. Leverage off other media campaigns to incorporate the river e.g. City of Perth “Come get to know me” and State Government “Bigger Picture” e. Encourage and increase access to receiving environments, living streams, and treatment wetlands to foster social groups and planting days f. Broaden existing capacity-building programs to be incorporated in councils, schools, and offices <ul style="list-style-type: none"> i. Build on the foundations of “Ribbons of Blue” ii. Embed new messages and actions in existing education programs delivered by various stakeholders (e.g. Waterwise Schools, River Rangers, Great Gardens, Hot Rocks and Millennium Kids)

Strategies	Actions
<p>3. Develop the knowledge and capacity of community members to better understand the whole water cycle in relation to the entire catchment</p>	<ul style="list-style-type: none"> a. Develop a water sensitive cities education toolkit, content modules, and dissemination strategy to inform the curriculums of primary and secondary schools, universities and professional training programs <ul style="list-style-type: none"> i. Investigate opportunities to add urban greening and the water energy nexus into curriculums ii. Influence the inclusion of more locally relevant content iii. Conduct school competitions to engage interest b. Develop local pilots and demonstration sites of water sensitive approaches as educational opportunities, with good signposting and other methods to communicate the benefits of the initiative <ul style="list-style-type: none"> i. Develop effective methods for providing physical information on site and opportunities for people to further explore particular features if they are interested c. Provide opportunities for people to understand and connect with a diverse range of water sources <ul style="list-style-type: none"> i. e.g. Localised aquifer recharge projects d. Increase awareness of drainage flows so the community understands where their water goes and influences their attitudes and behaviours <ul style="list-style-type: none"> i. Increase funding and capacity for Riverwise/Waterwise behaviour change programs (e.g. Bennett Springs, South Perth) e. Adopt a range of methods to communicate the vision to target different parts of the community <ul style="list-style-type: none"> i. Engage marketing professionals ii. Explore various communication formats and methods such as blogs, social media, and local newspapers iii. Target active and vocal community advocates to help spread the message f. Learn from other Australian and international cities that have successfully raised community awareness about water-related topics <ul style="list-style-type: none"> i. e.g. "Porous community" g. Utilise mobile applications for community involvement in data tracking <ul style="list-style-type: none"> i. e.g. Dolphin watch and prawn watch applications
<p>4. Provide opportunities for the community to drive local water sensitive initiatives and to influence high level water-related decision-making</p>	<ul style="list-style-type: none"> a. Provide a range of forums and social media platforms for community members to be heard and to connect them with the network of water sensitive leaders <ul style="list-style-type: none"> i. e.g. Department of Parks and Wildlife, Rivers and Estuaries Division's engagement in the Angove Street festival ii. Engage local governments to run forums as part of their annual fairs and to better utilise their websites b. Establish mechanisms for funding and supporting water sensitive projects <ul style="list-style-type: none"> i. Crowdfunding (e.g. Installing local raingardens) ii. Professional volunteers iii. Grants from water industry iv. Grants from other industries
<p>5. Establish methods to incentivise community-led water sensitive projects</p>	<ul style="list-style-type: none"> a. Provide incentives and rewards for achieving water sensitive outcomes <ul style="list-style-type: none"> i. Community water sensitive city award under the annual AWA/Stormwater Industry awards ii. Broaden scope of existing Waterwise awards to become water sensitive awards b. Increase the capacity of sub-regional NRM groups that have established networks and community credibility

Leadership

Foster broad political and industry support and inspire leadership at all levels to set a clear direction, drive change and model the behaviours needed to achieve water sensitive outcomes

Strategies	Actions
1. Advocate to political and community leaders the need and collective aspiration for Greater Perth to become a water sensitive city	<ul style="list-style-type: none"> a. Advocate the need for transitional change towards water sensitivity, supported by sound science and reliable evidence b. Establish bipartisan support so the political will remains despite changes in government <ul style="list-style-type: none"> i. Establish a non-government independent advisory group ii. Nominate a water spokesperson – e.g. Former Chief Scientist Lyn Beazley c. Initiate parliamentary discussions and community forums on priority water-related issues d. Continuously monitor the political landscape to identify upcoming opportunities for influence
2. Educate political and community leaders on water sensitive city principles and opportunities	<ul style="list-style-type: none"> a. Develop education programs on water sensitive cities for elected members, political staffers and local officers <ul style="list-style-type: none"> i. Provide quantifiable evidence b. Present water sensitive city approaches at political and community events for strategic targeting and messaging in line with political cycles <ul style="list-style-type: none"> i. e.g. state conferences ii. Other industry peak body events involving politicians in Canberra iii. Engage with the Federal Minister for Cities and the Built Environment
3. Establish an independent and non-political high level advisory committee to guide the transition towards water sensitive decisions and outcomes	<ul style="list-style-type: none"> a. Identify group of relevant CEOs and water sensitive champions to form an industry taskforce <ul style="list-style-type: none"> i. e.g. Along the lines of CONRACE, Wentworth Group of Concerned Scientists, State Biosecurity Council ii. Participants from this “Shaping Perth as a Water Sensitive City” visioning process
4. Create a Ministerial Taskforce to drive the water sensitive city agenda in Perth	<ul style="list-style-type: none"> a. Identify industry, community and political leaders in water sensitivity to be part of the Ministerial Taskforce b. Empower the Ministerial Taskforce network with a formal role to institute a water sensitive cities agenda

Strategies	Actions
<p>5. Encourage leadership at all levels across organisations and agencies, including those for which water is not their core business</p>	<ul style="list-style-type: none">a. Develop a program to recognise and profile champions of water sensitive innovation in government, industry and the communityb. Create a network of young water sensitive city leaders from peak organisations across the water, planning, development and community sectors

Governance

Strengthen governance arrangements to address gaps, remove barriers, clarify ambiguities and provide incentives for water sensitive practice.

Strategies	Actions
1. Mandate integrated management of the built and natural water cycles	<ul style="list-style-type: none"> a. Reform drainage governance arrangements to facilitate a total water cycle approach to the management of stormwater runoff, groundwater and waterways <ul style="list-style-type: none"> i. e.g. Consider establishing a single drainage authority ii. e.g. Consider establishing a sustainable funding mechanism for delivering water sensitive drainage services b. Establish clear roles and responsibilities for managing, protecting and enhancing environmental water quality <ul style="list-style-type: none"> i. Improve the efficiency of these roles that already exist ii. Incorporate water quality into an organisation's mandate iii. Establish standards to monitor, measure and report on habitat loss, water quality, water quantity and ecosystem health c. Clearly define water management and approval roles and responsibilities across government agencies d. Clearly define roles and responsibilities for all other stakeholders involved in management of the entire water cycle e. Establish a robust review mechanism based on expert panel assessment of development applications against outcome-focused priorities and performance-based criteria related to water sensitivity
2. Measure system performance transparently in accordance with identified and agreed water sensitive outcomes and indicators	<ul style="list-style-type: none"> a. Establish clear targets and outcomes for water-related services and agency performance and measure progress through benchmarks and indicators <ul style="list-style-type: none"> i. Utilise benchmarking tools for measuring progress (e.g. "UNDO" tool to quantify nutrient runoff to determine nutrient offsets) b. Document and quantify benefits of public open space and maintenance costs to support ongoing maintenance commitments from local governments c. Review outcomes of this "Shaping Perth as a water sensitive city" visioning process against current governance arrangements and existing legislative and policy frameworks to identify opportunities for influencing their implementation, development, or reform <ul style="list-style-type: none"> i. e.g. Liveable Neighbourhoods, City of Perth Sustainable Communities Pilot in the short term d. Provide developers with clarity about Government priorities and guidance on how to navigate approval processes e. Develop an initiative to measure the value of water sensitive planning and design, including direct benefits, indirect benefits, and induced benefits f. Develop water sensitive design criteria and review mechanisms (or augment existing ones) and integrate within approval processes and project milestones

Strategies	Actions
<p>3. Ensure local government activities related to water sensitivity align with community objectives and are consistent across landscape systems, regions and catchments</p>	<ul style="list-style-type: none"> a. Reinforce Better Urban Water Management and the State Planning Policy frameworks through a major extension and communication exercise to ensure compliance b. Harmonise local policies and practices that influence the delivery of water sensitive outcomes to be consistent across local governments (e.g. tree management) c. Incorporate water sensitivity into Strategic Community Plans developed by local governments
<p>4. Ensure transparency and fair allocation of water-related revenue and expenditure</p>	<ul style="list-style-type: none"> a. Set water prices to account for broad socio-economic values in relation to water b. Ensure transparency and fairness in the collection and expenditure of funding for drainage services <ul style="list-style-type: none"> i. e.g. Allocate drainage rates to local governments for innovative water sensitive projects

Professional culture and capacity

Develop strong capacity and enabling organisational cultures for fostering collaboration and innovation towards water sensitive practice.

Strategies	Actions
1. Strengthen collaboration across all sectors and organisations that influence water-related outcomes and utilise opportunities for linkages	<ul style="list-style-type: none"> a. Foster strong connections and trust amongst stakeholder organisations <ul style="list-style-type: none"> i. Share resources and data ii. Provide transparent information iii. Disclose decision-making processes b. Establish advocacy networks with representatives from government, industry and the community for ongoing collaboration and commitment <ul style="list-style-type: none"> i. Consider the Committee for Perth model c. Connect with leaders internationally to build water-related identity and recognition d. Establish mechanisms for sharing lessons from experiences of success and failure in order to promote widespread learning on how future water sensitive initiatives can be improved e. Develop a strategy for continuing to build a Perth-based water sensitive cities community of practice
2. Encourage innovation for water sensitivity across all water-related organisations and urban sectors	<ul style="list-style-type: none"> a. Implement multi-disciplinary university curriculum and professional development training programs that foster a systems approach to water planning, design and management <ul style="list-style-type: none"> i. Engage professional bodies and industry groups e.g. PIA, AILA, AIA, ASBEC b. Encourage stakeholder organisations to be open to taking managed risks for innovating towards water sensitivity c. Document and encourage use of evidence-based and design-led (outcome-based) processes such as Strategic Design workshops and collaborative charrettes d. Quantify costs and benefits of decisions to support options analysis and encourage investment in water conservation, efficiency and other water sensitive approaches e. Strengthen Perth's water sensitive cities capacity building program, New WAter Ways with a sustainable funding source <ul style="list-style-type: none"> i. Identify funding sources beyond government ii. Encourage seed funding for innovative projects f. Work with innovative developers and local governments to implement multi-disciplinary demonstrations and pilot projects of water sensitive design at multiple scales

Strategies	Actions
	<ul style="list-style-type: none"> g. Provide easily accessible information to support developers and local governments wanting to integrate water sensitive design features h. Develop an accreditation program that recognises, celebrates and incentivises innovative projects, designs and practitioners with high enough standards to create trust that in turn inspires innovation <ul style="list-style-type: none"> i. UDIA Envirodevelopment ii. Greenstar iii. NABERS iv. Waterwise programs i. Establish mechanisms and financial incentives to encourage risk sharing and collaboration towards innovation for water sensitivity <ul style="list-style-type: none"> i. E.g. Credits and offsets in the development industry j. Ensure regulatory and approval processes are aligned to enable innovation k. Utilise and advocate the importance of using all opportunities to implement good water sensitive design practices including: <ul style="list-style-type: none"> i. Integrating grey and green infrastructure systems ii. Incorporating decentralised sources iii. Incorporating fit-for-purpose water use iv. Incorporating at-source solutions

Research and technology

Establish mechanisms and commit resources to ensure impact-oriented research and development, including its translation to influence water sensitive policy and practice.

Strategies	Actions
1. Encourage sustainable funding mechanisms for research and development	<div><div>a. Fund research to address unresolved scientific questions and key knowledge gaps important for achieving the vision of water sensitive Perth</div><div>b. Strengthen associations with CRCs and universities on research projects</div><div>c. Develop a science and research plan that is reported against</div><div>d. Establish research funding streams from government and industry to incentivise translation of findings to influence policy and practice</div></div>
2. Continuously address existing gaps in science and technology	<div><div>a. Continually review and update policies and guidelines with contemporary science and evidence</div><div>b. Undertake social research to understand community values and people's connection to local water narratives</div><div>c. Strengthen local research capacities related to water sensitive city objectives</div><div>d. Continually implement demonstration projects that trial innovative approaches for delivering water sensitive outcomes</div></div>

An important step for building on the momentum of this project and implementing initiatives for guiding Perth's water sensitive city transition is to develop a short-term action plan that assigns roles and responsibilities to specific

strategies and actions. To support this next step, Table 1 below outlines current agencies, organisations, and other groups who have influence on achieving aspired water sensitive outcomes for Perth.

Table 1. Stakeholder organisations that have influence on achieving aspired water sensitive outcomes for Perth

Organisation	Role in relation to water
Community groups	Groups of community members ranging in formality that come together to address local issues. E.g. Friends groups, river care groups
Consultants	Develop designs for water infrastructure for clients, including land developers, local government, state government
Department of Environment Regulation	Regulation of discharges to the environment (including wastewater)
Department of Health	Regulates to manage human health impacts of drinking water and wastewater transport, treatment and reuse
Department of Parks and Wildlife (now incorporating the Swan River Trust)	State government agency responsible for protecting and conserving the State's natural environment - specifically the Swan-Canning rivers and foreshores
Department of Planning	Land-use planning agency that provides technical and professional expertise for planning the state's cities and towns, transport networks, parks and recreation reserves, and social and physical infrastructure
Department of Sport and Recreation	Provides direction for managing public parkland (including active and passive recreation) provision and seeks to influence the policy of others to deliver good sport and recreation outcomes
Department of the Premier and Cabinet	Overseeing the Strategic Assessment of Perth and Peel process
Department of Water	State government agency that provides scientific expertise and advice to the water sector. Key responsibilities include licensing extraction of water, water information and monitoring, and policy for regulation and future planning
Economic Regulation Authority	Manages licensing of water service provision and provides advice on water prices

Table 1. Stakeholder organisations that have influence on achieving aspired water sensitive outcomes for Perth (Cont.)

Organisation	Role in relation to water
Environmental Protection Authority	Conducts environmental impact assessments, initiates measures to protect the environment from environmental harm and pollution, and provides advice to the Minister for Environment on environmental matters generally.
Government Architect	Aims to enhance the quality and improve the design of the built environment
Industry groups, capacity building groups and peak bodies	Independent groups of professionals and industry members with a common interest or objective. E.g. Urban Development Institute of Australia, Australian Institute of Landscape Architects, Engineers Australia, Stormwater Industry Association, New Water Ways, Committee for Perth
Land Developers	Both private and government-owned, responsible for design and coordination of urban water management systems
Local Governments	Responsible for local drainage infrastructure in conjunction with Water Corporation. Also responsible for the provision and management of public open space, recreation spaces, urban amenity and community infrastructure
Natural Resource Management groups	Plan and deliver programs that support healthy and productive environments, communities, and industries. Perth NRM, sub-regional NRMs within the Swan-Canning and Peel-Harvey catchments
Universities and research organisations	Provide research opportunities for supporting water sensitive transitions (Cooperative Research Centre for Water Sensitive Cities and other CRCs, Australian Urban Design Research Centre, Commonwealth Scientific and Industrial Research Organisation, Curtin University Sustainability Policy Institute)
Water Corporation	State government-owned corporation responsible for water supply, wastewater and drainage services
Water Service Providers	Independent water service providers, licenced by the Economic Regulation Authority
Western Australia Planning Commission	Statutory authority that operates with the support of the Department of Planning on urban, rural, and regional land-use planning and land development matters. Includes the Infrastructure Coordinating Committee

Several recent policy frameworks, outlined in Table 2 below, aim to incorporate more water sensitive behaviours into existing practice in Perth. Several of these documents aim to better incorporate urban water management into land

planning, while others focus on the protection of Perth's natural water sources and habitats. The development of short-term action plans should draw from these existing policies and expand on the content that is already present.

Table 2. Key policy and legislative documents

Title	Body	Purpose
Better Urban Water Management (2008)	Western Australia Planning Commission (WAPC)	Framework for integration of water management into the land planning system
Liveable Neighbourhoods (2009)	Western Australia Planning Commission (WAPC)	Operational policy to be followed in design and approval of urban development. Applies to greenfield sites and redevelopment of brownfield and infill sites. Liveable Neighbourhoods 2015 is currently under public review
Swan and Canning Rivers Management Act (2006)	Department of Parks and Wildlife and Swan River Trust	Legislation to develop better ways of sustaining the health and enjoyment of the rivers – requires several state and local government organisations to help the Trust to protect the Swan Canning river system
Healthy Rivers Action Plan (2008)	Swan River Trust	Five year, \$40 million plan to protect environmental health and community benefit of Swan and Canning rivers, includes eight programs
State Water Strategy (2003)	State Government	Strategic planning document for total water cycle management to improve the management of stormwater and increase the efficiency of the use of water
State Water Plan (2007)	State Government	Strategic plan outlining how to effectively manage water resources - whole of water cycle approach with a planning horizon to 2030. Includes priority actions for 2007-2011
Directions 2031 and Beyond (2010)	Western Australia Planning Commission (WAPC)	Spatial framework and strategic plan that establishes a vision for future growth of the Perth and Peel metropolitan areas
Priority Plan for Investment in the Swan Canning Catchment (2011)	Western Australia Local Government Association (WALGA)	Recommendations for state government on governance, funding, and high level program design for catchment management of the Swan Canning river system
Swan Canning River Protection Strategy (2015)	Department of Parks and Wildlife and Swan River Trust	Strategy to help conserve the Swan Canning Riverpark and its natural, cultural, and social amenity values
Swan Canning Water Quality Improvement Plan (2009)	Department of Parks and Wildlife	Plan that maps water quality conditions in the 30 sub-catchments, identifies nutrient load reduction targets and guides investment, identifying the most cost-effective management actions to address sources of land-based nutrients and improve estuarine and coastal water quality
Water Forever (2009)	Water Corporation	50 year plan for becoming more climate resilient in delivering water services across Western Australia
Better Places and Spaces (2013)	State Government	The Built Environment Policy for Western Australia. Articulates key principles of good design and actions to improve the quality of the built environment.

Appendix C: CRC for Water Sensitive Cities project team

In recognition of the challenges facing urban growth and the importance of water to the liveability of Australia's cities and towns, the Australian Government and 85 research, local and state government, industry and community partner organisations fund the \$120 million Cooperative Research Centre for Water Sensitive Cities (CRCWSC). The CRCWSC was established in 2012 to address this national priority and change the way we build our cities by valuing the contribution water makes to economic growth and development, our quality of life and to the ecosystems of which cities are a part.

The Departments of Water and Housing and The University of Western Australia are major WA funding partners of the CRCWSC. Twenty other local and state government, water utility, community, consultants and development industry organisations in WA are also partners. The CRCWSC's partners and team of over 200 researchers and PhD candidates across 20 disciplines have made great progress in addressing some of the key technical, social and institutional knowledge gaps and barriers to advancing liveable cities and towns in Australia and overseas.

Achievements of the CRCWSC projects underway in WA include increased understanding of urban hydrology on the Swan Coastal Plain, the performance of urban water systems and the value of economic, social and ecological costs and benefits of water sensitive urban design. The Batavia Coast Marina development in Geraldton and the Bentley Regeneration Project in the Perth metropolitan area are being used as research synthesis case studies, where the researchers and stakeholders jointly develop innovative water and urban design ideas to address the specific site challenges and create liveable, water sensitive developments.

The CRCWSC Project A4.2, Mapping Water Sensitive City Scenarios, develops innovative strategic planning processes and frameworks targeted at addressing these challenges, with a particular focus on accelerating the transition to water sensitive cities and towns in Australia. The research involves workshop series in multiple case study locations, designed to facilitate in-depth discussion and analysis amongst key local stakeholders of how their urban region can be transformed to provide reliable water services, ensure public health and wellbeing, enhance urban amenity and protect the environment over the long-term.

Perth stakeholders have expressed a desire to achieve a more resilient and liveable city based on water sensitive approaches, and recent policy, planning and knowledge-sharing initiatives have focused on generating momentum and alignment in this direction. Project A4.2 therefore selected Greater Perth for one of its case studies, providing an opportunity to advance the sector-wide dialogue and develop a strategic transition framework for shaping Perth as a water sensitive city.

The names and biographies of the CRCWSC Project A4.2 research team members for the Perth case study are provided below. In addition to steering and managing the project, they took on roles as facilitators and analysts.

As facilitators, the team designed the overall workshop process with clear objectives for each methodological step, and adapted the process or facilitation style when necessary in order to achieve the workshop objectives. They guided workshop discussions without contributing content, and in doing so focused on creating and ensuring a safe forum for participants to discuss their ideas throughout the entire project. At each workshop, the facilitators provided opportunities for participants to comment on results from the previous session, ensuring each iteration of workshop outputs was validated and refined as the participants' ideas and perspectives evolved.

As analysts, the team drew on the insights they gained through their facilitation role to bring a full understanding of the workshop discussions to the analytical activities conducted between workshops. They synthesised outcomes of each workshop in a way that provided true reflection of workshop discussions, while adding clarity and depth to the outputs so the participants started from an enriched point of discussion at the next workshop. In doing this, they brought the views and insights of workshop participants into the reporting and analysis rather than their personal opinions or judgements. They selected analytical methods for processing the workshop outputs that best fit the objectives of every methodological step, taking into consideration the audience for each stage of the project and presenting insights in a way that was sufficiently clear and stimulating to encourage rigorous and creative discussion at subsequent workshops. Finally, the project team consolidated and synthesised each of the validated workshop outcomes into this final report.

CRCWSC project A4.2 research team members



Dr. Briony Rogers (Project Leader, Facilitator and Analyst)

Dr. Briony Rogers is a Lecturer with Monash University's School of Social Sciences and the CRCWSC Program A (Society) Deputy Leader. Her research explores how visioning, strategic planning and institutional change processes can enable transitions in urban water systems to create more liveable, sustainable and resilient cities. Briony has an interdisciplinary background, with a PhD in Environmental Sociology, a Bachelor of Civil Engineering (Honours) and Bachelor of Science, as well as experience as an engineering consultant on water infrastructure projects in Australia and Vietnam. Briony was selected by the International Social Science Council to be one of twenty World Social Science Fellows in the area of sustainable urbanisation. She is an Associate Director of the Monash Water for Liveability Centre and co-chair of the International Working Group on Water Sensitive Urban Design.



Katie Hammer (Project Manager, Facilitator and Analyst)

Katie Hammer is a Research Assistant for the CRCWSC. Her role with the CRCWSC involves providing research support to Project A4.2, specifically focusing on shaping Perth as a water sensitive city. Katie is also the CRCWSC Program A assistant, providing operational and management support to Program A (Society). Previously, Katie has worked as a corrosion engineer designing cathodic protection systems for reinforced concrete structures across the United States. She holds a Bachelor of Science in Environmental Engineering from the University of Maryland, College Park.



Lara Werbeloff (Facilitator and Analyst)

Lara Werbeloff is currently completing a PhD with the CRCWSC, based at Monash University. Her research is focused on exploring the process of institutional change in the urban water sector with a view to understanding how institutional change processes can be harnessed to facilitate the realisation of more Water Sensitive Cities. Prior to starting her PhD, Lara worked as a lawyer, practising in the field of environmental law, among others.



Christopher Chesterfield (Facilitator and Analyst)

Chris is Director of Strategic Engagement with the CRCWSC and has a long history of championing whole-of-water cycle management and water sensitive urban design. He has rich experience in planning, project delivery, operations and stakeholder engagement through nearly 30 years in the water industry. As the General Manager of the Waterways Group at Melbourne Water, Chris grew the business to cover 38 local government areas and a directly billed customer base of 1.4 million properties and revenues of \$250 million. During this time community satisfaction with waterways increased from 64% to 86%. In 2014, Chris left Melbourne Water and has since taken on a number of roles. He is currently a Commissioner with the Victorian Environmental Water Holder and a member of the Urban Development Industry Association EnviroDevelopment Board.



Ross Allen (Facilitator)

Ross is a knowledge broker with the CRCWSC. He collaborates with researchers and practitioners to identify, plan, and implement water-management and green-infrastructure initiatives that respond to local context, enhance urban places and support the wellbeing of urban communities. He facilitates synthesis, adaptation and implementation of water-sensitive knowledge, tools, and technologies. Ross has a personal and professional interest in water and its role in sustaining and enhancing life. This interest stems from his connection with nature, which was established during his formative years in a small farming community in a remote, low-rainfall area in the south of Western Australia, and continues to develop and evolve as he expands his knowledge, networks, and experience.

Appendix D: Workshop participants

People from a diverse mix of organisations and with different disciplinary backgrounds were involved in the workshops, together representing key stakeholders that influence water management and planning across government, industry and the private sector.

Individual participants were identified by their peers and colleagues as being a leader and strategic thinker within their organisations and across the sector more broadly,

and were invited to participate on this basis. The same individuals were involved throughout the workshop series, which allowed for iterative and collective results to be developed over the course of all five workshops. Participants were asked to bring the perspectives from their professional experience and organisational contexts but to engage in workshop discussions as individuals rather than as formal representatives of their respective organisations.



The following people participated in the workshop series:

Alexandra Scott	City of Perth
Anas Ghadouani	CRC Water Sensitive Cities
Ben Harvey	Department of Planning
Brett Treby	Department of Sport & Recreation
Craig Wansbrough	Shire of Serpentine-Jarrahdale
David Horn	GHD
Debra Goostrey	Urban Development Institute of Australia
Don Crawford	Department of Water
Dumal Kannangara	City of Gosnells
Garry Middle	Western Australia Planning Commission
Giles Pickard	City of Subiaco
Greer Gilroy	Perth Region NRM
Greg Claydon	Department of Water
Greg Ryan	LandCorp
Jason Pitman	City of Perth
Jennifer Stritzke	Department of Parks and Wildlife
John Savell	Department of Housing
Josh Byrne	Josh Byrne & Associates
Julie Rutherford	Department of Sport & Recreation
Mark Batty	Western Australia Local Government Association
Max Hipkins	City of Nedlands
Meredith Blais	Water Corporation
Mike Rowe	Department of Water
Patrick Ford	Office of the Government Architect
Pip Munckton	Australian Institute of Landscape Architects
Richard Theobald	Department of Health
Rod Hughes	Department of Parks and Wildlife
Sara Padgett Kjaersgaard	Australian Institute of Landscape Architects
Shelley Shepherd	Essential Environmental
Stuart Reside	Wallis Consulting & Development
Wayne Edgeloe	Calibre Consulting

Appendix E: Project methodology

The project has approval from the Monash University Human Research Ethics Committee (Project Number: CF15/760 – 2015000341).

The project methodology was based on the latest scientific insights on transition planning processes and frameworks for application to cities and towns wanting to shift practice towards water sensitivity. It drew on the basic principles of envisioning, backcasting and scenario planning^{3,4,5,6,7,8} that underpin the development of “transition scenarios”, the latest generation of scenario approaches that has emerged in response to sustainability challenges. These approaches have integrated scholarship from socio-technical transitions (transition management⁶⁴ in particular) and social-ecological system resilience⁶⁵.

In applying these methods, the project tailored them to suit the local context, with adaptations as the series progressed to accommodate workshop timeframes and evolving priorities of the participants. It involved a series of five half-day workshops held over the course of five months (July to November 2015) in Greater Perth, designed as a “pressure cooker” participatory process. These workshops guided participants through a series of analytical and creative steps:

1. **Analysing the System:** A shared understanding of Perth’s water system was first developed through individual interviews with the workshop participants and other key stakeholder representatives, as well as a review of scientific and grey literature to analyse the local water context. Insights from this initial stage were shared in the first workshop to set the scene for early discussions and incorporated into sections of this report.
2. **Horizon Scanning:** Horizon scanning activities were iteratively conducted through the workshop series to crystallise a shared problem formulation in relation to water management. These activities started with a general discussion on future risks to Perth’s water system, which were refined with each subsequent workshop. The final workshop activity to complete the horizon scanning was a detailed mind-mapping exercise, where participants traced the linkages between major drivers, impacts and consequences for the people of Perth. This analysis was then strengthened through a targeted review of literature to substantiate the linkages identified, drawing on resources suggested by participants and others that were identified through the literature review.

3. **Envisioning:** Participants were guided through a creative envisioning process over a number of workshops, in which a shared vision for a water sensitive Perth in 2065 was developed. The envisioning process involved imagining the conditions of a desirable future and constructing a set of priority outcomes, illustrative narratives and visual images to describe the vision. Guiding principles were also developed through envisioning techniques to describe the characteristics of everyday water-related practice that would be required to achieve the vision.

4. **Diagnosing the Challenges:** Synthesised insights from the system analysis (step 1) that related to barriers for Perth’s water sensitive city transition were presented to the participants for discussion. This process involved validating, expanding and refining the set of challenges that were proposed and then diagnosing the underlying reasons why these challenges have been so persistent.

5. **Backcasting:** The backcasting phase involved taking the developed future vision and examining how that future vision could be achieved⁴, an approach that is oriented towards solving long-term problems. A number of backcasting iterations led to the identification of a wide range of strategies and actions that participants considered were important for enabling Perth to overcome its persistent challenges and achieve the developed vision.

6. **Operationalising:** The final discussion topic was prioritisation, in which the participants identified focus areas for change and critical strategies and actions for these areas. This last step aimed to position participants ready for ongoing connection and collaboration in order to mobilise the network of champions in upcoming initiatives and actions of change⁷

Each workshop involved a combination of whole group discussions, small group discussions and facilitated activities designed to examine the workshop themes in detail. Between workshops, the research team synthesised and analysed results, which were then presented back to the participants at the following workshop for validation. This enabled an iterative process of reflection and refinement, ensuring that this final report is an accurate reflection of the workshop process and outputs.

The key activities for each stage of the project are summarised below:

Pre-Workshop Analysis

- Review of academic and grey literature to synthesise important historic and current trends and contextual features that influence water management in Perth
- Semi-structured interviews with workshop participants to understand their perspectives on the current and future context for water management in Perth

Workshop 1

- Opening remarks from Mike Rowe (A/Director General of the Department of Water) and Eric Lumsden (Chair of Western Australia Planning Commission)
- Presentation of Project A4.2 and workshop methodology, followed by whole group discussion on its purpose and value for Perth and how the participants intend to engage with it
- Icebreaker activity – “Water Sensitive Taboo”
- Presentation of System Analysis to set the scene for workshop discussions (historic and current social, ecological, and economic trends in Perth), followed by whole group discussion to reflect on and refine the representations of key elements of the analysis
- Small group discussions to identify priority outcomes for water-related services in 2065

Workshop 2

- Presentation of analysed Workshop 1 outputs (themed priority outcome statements), followed by whole group discussion to refine and validate them
- Small group discussions to scan the horizon and identify future risks and vulnerabilities for Perth
- Small group discussions to identify guiding principles of practice needed to achieve the vision

Workshop 3

- Presentation of analysed Workshop 2 outputs (refined vision outcome statements, vision images, vision narratives, guiding principles of practice), followed by whole group discussion to refine and validate them
- Presentation of analysed Workshop 2 outputs (future risks and vulnerabilities), followed by whole group discussion to unpack them further

- Presentation of System Analysis (socio-institutional barriers that make transitioning a challenge), followed by small group discussions to refine and validate them, and to explore why they persist
- Whole group discussion on ideas and plans for activities once the workshop series is completed, including an event to celebrate and launch the group’s commitment to ongoing collaboration

Workshop 4

- Presentation of analysed Workshop 3 outputs (guiding principles of practice), followed by whole group discussion to refine and validate them
- Presentation of analysed Workshop 3 outputs (drivers, impacts and consequences), followed by mind-map activity to validate, refine and validate linkages and provide suggestion of resources and case examples that would support quantification of Perth’s water-related risks and vulnerabilities
- Small group discussions on initial backcasting to generate transition strategies and actions

Workshop 5

- Presentation of analysed Workshop 4 outputs (guiding principles of practice and focus areas of change), followed by whole group discussion to refine and validate them
- Small group discussions to continue backcasting (expanding on the list of strategies and actions generated in Workshop 4)
- Whole group discussion to identify critical strategies and actions for each focus area of change that should form the basis of short-term action plans
- Whole group discussion on how participants want to build on the momentum from project in the coming six months to advance water sensitive practice for Perth
- Whole group discussion to reflect on and informally evaluate the workshop process

Post-Workshop 5 Analysis and Reporting

- Presentation of analysed Workshop 5 outputs (focus areas of change, strategies and actions) in written report, circulated to participants for verbal or written validation and refinement
- Consolidation of all project findings into final draft report, followed by circulation to participants for review
- Finalisation of report

Appendix F: Glossary

Project outputs	
Vision	An imagined, desired future to be achieved over the long-term
Desired outcome	A specific aspiration for how Perth should be experienced in 2065
Guiding principle of practice	A basis of conduct to guide everyday water-related practice
Transition challenges	Social and institutional barriers that inhibit progress towards a desired future
Focus area for change	Overarching and mutually reinforcing themes that provide focus for strategies and actions to drive transitional change towards a desired vision
Strategy	A tangible method, approach or solution for achieving the guiding principle or envisioned outcome
Action	A specific step to implement a strategy that could form part of an action plan with timelines and responsibilities assigned
Critical strategy and action	Strategies and actions that are considered most important to be implemented to support the water sensitive city transition given current conditions
Transition / transitional change	Fundamental shift in cultures, structures and practices of a system
Strategic transition framework	An overarching framework that guides strategies and actions for enabling a transition towards a shared vision
Water system features	
Urban water system	Socio-technical elements that function together to deliver urban water services and benefits across the whole water cycle (including water supply, sanitation, flood protection, pollution reduction and landscape amenity). Elements include technologies and infrastructures, the built environment, organisations and professionals, and the institutional frameworks that guide servicing activities
Water sensitive city	An aspirational concept for urban water management, in which the water system is based on holistic planning and management of the integrated water cycle and emphasises adaptive, multi-functional infrastructure and urban design in its service delivery solutions
Fit-for-purpose water	Water that has been treated to a quality that is suitable for its intended use
Liveability (as it relates to the water system)	Broad benefits from the water system functioning that enhance urban liveability, including water security, flood risk, biodiversity, public green space, healthy waterways and connected communities
Sustainability (as it relates to the water system)	Water system functioning that is within a city's carrying capacity such that it can support the broad water needs of society and ecosystems over the long-term, even in the face of resource limitations
Resilience (as it relates to the water system)	Water system functioning that can cope with a wide range of future uncertainties, adapting as needed to provide reliable service outcomes over the long-term

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