Setting our future urban water directions

Support Paper 3:
Water for life – Water to support healthy and enjoyable urban living

SOUTH AUSTRALIA

Government of South Australia
Department for Environment and Water

Introduction

To set South Australia on the path to integrated urban water management we are developing urban water directions to guide all stakeholders in the delivery of integrated water, sewerage and stormwater services. This will contribute to the full suite of water security, public health, environmental and urban amenity outcomes that the community seeks.

The paper, *Setting our future urban water directions: Delivering integrated urban water management for the benefit of South Australia*, is the principal paper that contains background information and summarised the key issues relating to the provision of water supply; drainage, flood mitigation and other stormwater management objectives, and opportunities for water to contribute to healthy, green and cool cities and towns.

Three support papers include:

- *Support Paper 1: Water supply for the future – All options on the table*
- *Support Paper 2: Drainage and flood management – Managing our rain for the next century*
- *Support Paper 3: Water for life – Water to support healthy and enjoyable urban living* (this paper)

This paper (Support Paper 3: Water for life – Water to support healthy and enjoyable urban living) invites your feedback on opportunities for ensuring our water management can effectively support strategic urban greening and cooling outcomes in South Australia's towns and cities so that they will remain resilient places to live in and prosper over the next 50 to 100 years.

Life in our towns and cities

South Australia is renowned for a high quality of life and is recognised for its liveability. The lifestyle in the state's towns and cities, where almost 90% of the state's population live, is changing in response to the changing climate, growing populations and changing community expectations, such as preference for a greener urban landscape, more affordable housing and less urban sprawl, resulting in increased housing density. Water must be managed so that our towns and cities can continue to evolve in line with these challenges and desires of the community.

Liveability and sustainability are essential to attracting and retaining people. People want to live in places with easy access to parks, schools, community facilities and reasonable travel times to work, shops and services. In the 2021 Heart Foundation Survey "What Australia Wants" living close to open spaces was more important to South Australians than to people from other states and was the second most important neighbourhood element. Creating liveable urban places is intrinsically linked to economic growth and will play a key role in realising the State's growth agenda.

For communities to continue to support urban changes such as population growth and densification into the future, these changes must be supported by community services and infrastructure that underpins the liveability communities seek.

In this paper the contribution that water management makes to urban liveability is focussed on four areas:

- water as the foundations for greening, and water features known as 'blue spaces'
- applying water to manage urban heat
- protecting and managing natural areas
- supplying water for urban living.

South Australia's climate

The future prosperity and liveability of South Australia will depend on how effectively we build our towns and cities to address and respond to the hot and dry climate that is projected to become more extreme in the future. Appropriate planning of the urban form can create climate resilient urban environments that mitigate heat effects and support vegetation that make towns and cities more liveable. Water management is critical to climate resilient urban developments.

The state's hot, dry climate impacts water supplies, demands, drainage and natural areas in towns and cities, so it is important to understand the climatic influences as we set future urban water directions. Projected climate change impacts in the state include hotter summer temperatures with more extreme heat days; more frequent, more severe and longer heatwaves; reduced annual rainfall; more intense high rainfall and storm events; and increased likelihood of bushfires and droughts. Water management is critical for minimising the impact of these changes on life in urban centres.

Climate change is already being felt by South Australia's people, environment and economy. Some aspects of the climate are changing faster than previously projected including annual rainfall decline and increased number of extreme heat days. More information on climate projections for South Australia can be found in *Guide to climate projections for risk assessment and planning in South Australia*.

Summer 2020-21 an example of SA climate extremes

Suring the summer of 2020-21, southern parts of South Australia experienced very low rainfall between mid-October and mid-January, with only 39.6 mm of rainfall recorded at West Terrace, Adelaide during these three months. This is less than 40% of the long term average for this period.

Temperatures during this period fluctuated. November was a particularly hot month; more than 5 degrees above average, and other months were closer to average temperatures. December was the windiest on record, which would have accelerated evaporation and increased drying of soils and plants.

The dry period ended on January 25 with heavy rain fall across the city - 29.8mm was recorded at West Terrace, including 10 mm in 30 minutes. This caused minor flooding of roadways. This was the highest January daily rainfall since 1977, but it is not unusual for Adelaide to experience occasional high rainfall days in summer.

Health, recreation and amenity

The increased heat and drier conditions projected for the future are also predicted to impact human health, wellbeing and quality of life. Water can be used to cool towns and cities for liveable outcomes. Hotter temperatures have direct impact on mortality rates, but also reduce the uptake of many outdoor activities including active transport such as walking and cycling. SA Health advises that people (especially older and more vulnerable persons) may not be able to remain cool enough to stay healthy on days that exceed 35°C. Beyond this temperature, many people avoid non-critical outdoor activities and events.

South Australia's vibrant sporting, recreational and creative sectors are a defining part of life in our state and how it is seen by visitors. Major sporting events and festivals support local businesses and the state's economy. To remain nationally and internationally competitive in hosting major sporting events and other events, we need high quality cultural and recreational infrastructure as well as an attractive and inviting urban environment for visitors.

Urban form

The way we live and the design of our urban areas in Adelaide and across South Australia is changing, particularly in Greater Adelaide. This has been led by the *30 Year Plan for Greater Adelaide* which prioritises infill development over expansion of the urban footprint.

South Australia is one of the most affordable places in Australia based on actual housing costs and the associated costs of transport and access to services. Historically housing growth has been dominated by construction of detached dwellings on large allotments, which has led to sprawling low density urban centres. South Australia has committed to delivering more compact and higher quality towns and cities with small footprint housing.

There are many benefits to compact forms of urban development, but the success of this form of development is reliant on good design. The change to a more compact urban form will lead to less private green space, increasing the role and importance of high quality urban public open spaces. Increased infill development leads to higher rates of hard or impervious surfaces, which generates more rainfall runoff that, without effective management, will increase the likelihood and consequences of flooding and increase environmental impacts. Unless addressed, these risks would be compounded by projected increased intensity of extreme rainfall events.

For information about some of the unintentional effects of urban development for urban stormwater management, see **Support Paper 2: Drainage and Flood Management**

Nature in urban areas

The natural, and often visually stunning, aquatic and coastal environments found in or close to many of the state's towns and cities are vital habitats for flora and fauna. Publicly accessible natural spaces include beaches and coastal areas, rivers and freshwater water bodies. Watercourses and water bodies often provide 'habitat oases' within highly modified urban areas and these areas and the ecology that they sustain are culturally significant to Aboriginal nations.

Natural areas in our towns and cities also provide opportunities for communities to incorporate nature in their lives close to their homes. Many of the natural aquatic environments in South Australia's urban areas are iconic destinations that provide opportunities for the public to get active, connect with nature or to relax. With many of South Australia's towns and cities located beside the coast, beaches and coastlines offer natural environments with significant opportunity for lifestyle activities such as swimming, recreational fishing, walking coastal pathways, or visiting beachside cafés and restaurants. The *Healthy Parks Healthy People SA* initiative recognises there is a fundamental connection between human health and environmental health, promoting a nature-based approach for simultaneously improving population health and environmental outcomes based on these valuable interactions.

Some formerly natural waterways in our urban areas have been extensively modified to provide convenient and hydraulically efficient drainage for floodwaters. It is only in recent decades that prominence has been given to re-imagining urban watercourses and urban drains to deliver more nature-based and other outcomes valued by South Australians. For more information see **Support Paper 2: Drainage and Flood Management**

Adelaide has a long history of enhancing urban life with blue spaces

Water features have been installed to enhance urban life since the earliest days of the city. These have become popular again in the past decade since the end of the millennium drought.

The ornamental lakes in the Adelaide Botanic Gardens were constructed in the mid-1800s, within 20 years of the development of the city. Today the River Torrens (Karrawirra Parri) Lake is the city's most recognisable water feature, providing a backdrop for concerts and other events in the adjacent parklands.

The Three Rivers Fountain in Victoria Square and the Rundle Mall Fountain are historical icons of Adelaide life. The Rundle Mall fountain even had a central role in the mall opening celebrations when it was filled with Champagne.

Water to some fountains was stopped and ornamental ponds were drained in response to water security concerns during the millennium drought. Improvements to water security following the drought has coincided with the development of many new water features across the city. This includes ponds central to urban renewal developments such as Lightsview and Live West; splash pads at the redeveloped Henley and Mosely Squares; and the Bowden Main Park and Square water feature that provides for water play as well as artistic displays.

Figure 1 - Bowden green space and water feature

Urban green and blue spaces

There are many community benefits of access to areas of grass, trees and other vegetation in urban environments, known as 'green spaces' and coasts, rivers, lakes, and other waterbodies, known as 'blue spaces'. Smaller features are also important including green walls and roofs, ponds, fountains and water play areas such as spray parks (Figure 1) or splash pads. As well as providing a pleasant environment, these landscapes contribute to improved community health and wellbeing, air quality, stormwater management and biodiversity.

Well-designed 'green infrastructure' (street trees, parks, and gardens) and 'blue infrastructure' (drainage and flood management, rivers and water bodies) can contribute to mitigating urban heat impacts, reducing flood management risks and improving drainage, water quality and urban biodiversity habitat. Historically, planning occurred separately for green and blue infrastructure. Integrating the planning for green and blue infrastructure can deliver better outcomes.

Water for healthy and enjoyable green and blue spaces

Green and blue spaces are an important component of urban life - providing a place for social interaction, recreation and relaxation. Such spaces may take many forms including (green) parks, gardens, sports fields, conservation areas, school grounds, rooftop gardens, green walls and vegetated streetscapes; and, (blue) reservoirs, ponds, fountains and splash pads.

In our hot and dry climate water management is critical for sustaining such spaces. Future challenges will include supplying enough water to where and when it is needed to ensure urban vegetation is healthy and resilient, and to water bodies in order for them to provide benefits valued by communities.

State and Local governments have recognised the need to increase the amount and accessibility of green and blue spaces to those living in our towns and cities. For example, *30 year plan for Greater Adelaide* recognises the importance of green spaces and includes a target to increase urban tree canopy cover by 20% in metropolitan Adelaide by 2045 from a baseline 27.28%. In support of this target Green Adelaide offers a new approach to urban management that will transform the city into a world-leading, sustainable, green, climate resilient city. For blue spaces, the broadly favourable reaction shown by South Australians and businesses to to the decision to make reservoirs, including some providing urban water supplies, more accessible to the public, and the popularity of many other quality blue spaces such as our coastal waters and engineered lakes and wetlands, signify that they offer itrinsic social and economic value.

South Australia's low rainfall and long, hot, dry summers mean that water availability is potentially a limiting factor for successful urban greening. Additional water will be needed to increase urban green spaces and sustain vegetation as our climate heats and dries. Unless

Ensuring that adequate water will be available for all of our green spaces, and our blue spaces (except coastal waters) will become a more significant challenge in a warming and drying climate. In addition to ensuring there is adequate water supplies to support greening, there are also other important challenges with creating more extensive urban green space, including:

- Available under-utilised space for new plantings in many established urban areas is already quite limited. Existing built infrastructure such as buildings and roads, and services such as water, sewage, drainage, power, and communications, can restrict the space available for additional greening.
- Increased land conversion for buildings on privately owned land and some other purposes can significantly limit the ability for increased urban greening where there is significant competition for space.
- Soil degradation and compaction is prevalent in urban environments, particularly in highly trafficked areas. Such soil conditions can significantly limit opportunities to establish and maintain healthy trees and other plants irrespective of the capacity to provide adequate water supply. Fortunately, some new approaches such as high load bearing planting media offer promise to support healthy vegetation even in compacted soils.
- Concerns over potential impacts of trees and shrubs on building footings and roads, particularly in areas with highly reactive clay soils. In some cases, fear over potential liability is a constraint for enabling trees to be located close to building footings and roads.
- Concerns about how the delivery and ongoing maintenance of green and blue spaces might be funded.
- Variable community attitudes to trees and shrubs in the urban environment, with some seeing trees as a potential maintenance issue or a liability, whereas others appreciate the holistic value of plants. Understanding community attitudes and the reasons individuals hold a particular view is important to overcome some existing notions about the dis-benefits of vegetation in urban areas.

carefully planned for, many trees planted in today's climate may not thrive, or perhaps even survive, without significant irrigation water. Likewise, without sufficient supplementary water, plants will be unable to transpire at levels that meaningfully assist in mitigating high temperatures.

Many of our urban landscapes are already watered well above natural levels. This can be seen in summer when artificially-watered parks and playing fields are easily distinguished from unirrigated areas (Figure 2).

Figure 2. Irrigated and unirrigated areas are clearly identifiable in summer (Adelaide, Jan. 2021)

Estimating the irrigation requirements for a large town or city is difficult due to the complexity of the urban environment, which comprises a wide variety of urban forms, soil types, vegetation types and planting densities that in combination create many different microclimates. Proximity to hard surfaces such as buildings and roads may increase ambient temperatures with resulting increases in vegetative water demand. While the total required annual or seasonal volume of irrigation water is important for water managers to know, an appreciation of the maximum short term water requirement of green spaces is particularly important to appreciate in order to plan for adequate water being available during extreme droughts and heat events.

Water demands will also depend on the type of greening and the urban form. Low water use vegetation such as the native vegetation adapted to the state's semi-arid climate can grow without additional irrigation, but additional water will be required for other vegetation types, especially to survive the extreme heat events of summer, more so when these follow extended dry periods. Landscapes in the city of Phoenix in the USA have been classified according to urban landscape characteristics and vegetation type. This has been adapted to South Australian conditions in Figure 3, with landscapes ranging from the natural South Australian 'Arid' to an irrigated landscape known as 'mesic'. An urban landscape classification might assist water planning in South Australia by identifying which landscapes are likely to require significant irrigation. Irrigated mesic landscapes are coolest during hot weather, while built up areas and unirrigated 'drought tolerant' (xeric) vegetation, which can better conserve water by minimising plant transpiration, will not mitigate heat as effectively.

Figure 3. Urban landscapes categorised by water demands and urban heat characteristics (Arizona)

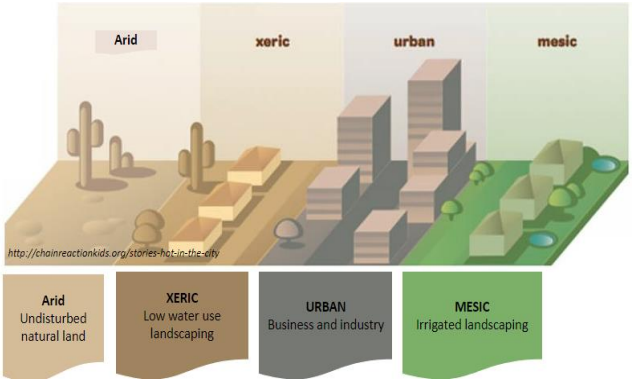
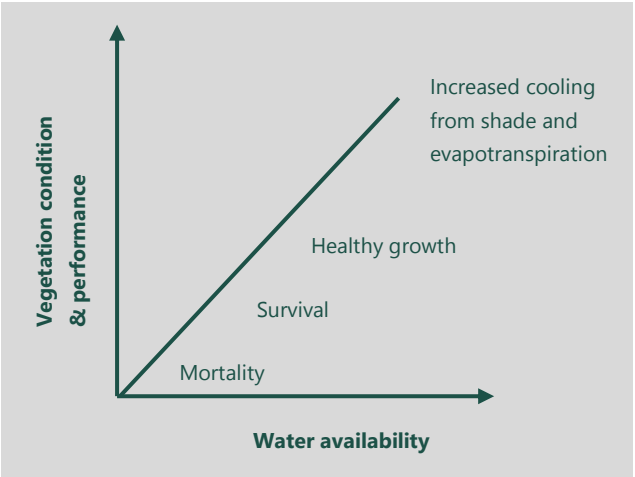


Figure 4. Relationship between water availability and vegetation condition / performance



Irrigation water demands can be reduced by capturing and retaining rainwater runoff in the landscape and directing this to increase soil moisture levels for the vegetation through passive irrigation. Other heat mitigation options, such as evaporative cooling and increased roadway and building surface reflectivity, can also reduce the ambient air temperatures in built up areas, lowering vegetation water demands. In some cases the reduction in urban temperatures from heat mitigation by planting trees or using heat-reflective materials, will be cancelled out by the temperature increases anticipated from the changing climate; in these locations, plant selection will become critical for the survivability of vegetation.

Providing more water to vegetation in hot conditions improves vegetation condition and the cooling performance through denser tree canopies that provide darker shade and increased evapotranspiration. Figure 4 shows the relationship between water availability and vegetation condition and performance. Despite the clear importance of water for plant health and survival, an accurate understanding of the water requirements of urban vegetation to maximise cooling remains a knowledge gap.

In South Australia's dry climate, bodies of freshwater (blue spaces) are often constructed features, rather than natural. These include reservoirs, ponds, fountains, swimming pools and splash pads that offer urban communities a variety of benefits. Major blue spaces include:

- rural rivers as they pass through townships, for example the River Murray and North and South Para Rivers
- reservoirs such as Happy and Hope Valley
- urban rivers such as the River Torrens (Karrawirra Parri), Sturt River (Warriparri), Brownhill Creek (Willawilla/Wirraparinga), Field River and Minnow Creek
- natural estuaries such as the Port River and the Onkaparinga River, or the Port Pirie River
- urban coastlines
- seawater canal estates and marinas such as West Lakes, North Have, Patawalonga Lake, Lincoln Cove Marina (Port Lincoln), Encounter Lake (Victor Harbor)
- constructed stormwater wetlands such as the Paddocks and Barker Inlet in the northern suburbs, St Clair in the West and Oaklands Park in the southern suburbs.

In recent decades, stormwater management wetlands and rehabilitated watercourses have become important blue spaces in some South Australia towns and cities, with many of them also providing harvested stormwater for irrigating parks and other green spaces (Figure 5).

Figure 5 - Oaklands Park wetlands – a multifunctional success

Constructed wetlands are common in many towns and cities and these are popular sites for the community to engage with nature as well as managing urban stormwater. Many wetlands have been constructed in Adelaide over the past 40 years for stormwater treatment and harvesting, most notably in the large wetland complexes in the cities of Playford and Salisbury. The existing wetlands at St Clair and Oaklands Park and the Victoria Park (Pakapanthi) wetland that is currently in construction are the three largest open water bodies created in Adelaide in the last several decades.

Linear paths that follow watercourses provide popular locations exercise and recreation. The linear park that follows the River Torrens (Karrawirra Parri) from the Hills to the coast was the first riverine linear park developed in Australia. Stretching for 30 kilometres and incorporating the iconic lake Torrens, this linear reserve provides essential drainage and flood management as well as a public open space and natural habitat. A lake edge walking path at West Lakes adds to the use of this international standard aquatic sporting facility that is renowned for rowing, kayaking and sailing. Laratinga wetlands with its pathways at Mount Barker is an example of the value accessible blue spaces provide for communities.

The **Oaklands Park wetland, Marion**, exemplifies many qualities of a well-integrated urban wetland and green space setting. The wetland is a central feature of the reserve – a biologically diverse freshwater and open space with a network of paths and recreational facilities providing visitors with a range of experiences.

The wetland cleans and stores stormwater from the Sturt River, making it available to irrigate up to 30 council reserves. The created landscape provides valuable aquatic habitat, and people are encouraged to interact with the water in the wetland by a mix of formal and natural edges, low bridges, weirs and stepping stone pathways.

Water planning for green and blue spaces

Where irrigation is determined to be appropriate, its availability and options for its supply should be considered at the commencement of green space planning. In particular, consideration should be given to planning for the water requirements likely to be needed for extended periods of high temperatures and low rainfall (including droughts) that are typical of South Australian summers and likely to become more extreme in the future.

Adequate water availability for urban greening and cooling will become increasingly vital to ensure South Australia's urban green spaces successfully adjust to the challenges of a hotter and drier future climate. For more information about ensuring our urban water supplies are resilient see **Support Paper 1: Water for the future**

Over the past few decades urban irrigation practices have changed as green space managers seek more efficient methods and alternative water sources to mains water supplies. Innovations include irrigation system performance, system audits, scheduling, moisture sensors, rain sensors, subsurface irrigation, improved maintenance, and an analysis of soils and site conditions as part of site planning.

The development and introduction of the Irrigated Public Open Space (IPOS) Code of Practice was an initiative of the SA Government's Waterproofing Adelaide Strategy early in the 21st century. The IPOS code encourages irrigation efficiency by addressing turf and irrigation management through careful planning, programming and monitoring. The 2018 IPOS code reported a 30% increase in water requirement for irrigating turf to the same quality over a 10 year period due to increase urban temperatures and declining rainfall.

Sustainable irrigation management necessitates better understanding of water requirements in order to decrease environmental risks and increase water use efficiency. Maintaining soil moisture in the root zone for the plants is a key factor for plant survival, health and performance. The monitoring of soil moisture to inform efficient watering is becoming a common part of best practice irrigation. Soil moisture monitoring could be delivered regionally to guide water application rates across a town or city. A monitoring program could be similar to the regional program in the Murraylands and Riverland Landscape region, which monitors soil moisture in different locations and soil types to provide land managers with an accurate picture of the amount of stored moisture within the soil profile. More information regarding this program including visual outputs of the real time monitoring can be accessed at https://www.landscape.sa.gov.au/mr/land-and-farming/tools-for-land-managers/soil-moisture-monitoring-network

The addition of water to the landscape for urban greening through sprinklers and other irrigation systems is known as active irrigation. The volume of water required for active irrigation can be reduced by passive irrigation that involves directing natural rainfall runoff (when it occurs) directly to gardens and landscaped areas where it can soak into the soil. Many local governments are increasingly incorporating passive irrigation into streetscapes to provide additional water to street trees, while also providing a stormwater management benefit (Figure 6). Homeowners are also being encouraged to retain rain water on their properties with passive irrigation techniques like maintaining open spaces such as gardens to facilitate infiltration, by using rainwater tanks, and by installing raingardens - which are specially constructed gardens where water is diverted from

Figure 6. Tree inlet pits connected to associated underground soakage provides for passive use of urban runoff for urban greening

Recent research of 'TREENET' inlets (see photo above) connected to soakage pits demonstrated, for the studied tree species:

- a 25% growth increase in young trees and 50% increase in saplings, compared to traditional council watering methods
- a two-fold increase in photosynthesis rates and stomatal conductance suggesting enhanced outcomes for tree health and enhanced evapo-transpirational cooling

Source: Space Down Under research

downpipes to a garden area. Passive irrigation can also achieve multiple benefits reducing stormwater flows, particularly as a result of smaller rainfall events.

Urban water features and wetlands also have a significant water demand to maintain them through high-evaporation summer conditions. Options for supplying water for water features and wetlands is discussed further in the final section of this paper. Integrated urban water planning and decision making can drive investments to make water available for the additional water demands created by water features and wetlands while also providing stormwater management benefits such as water quality improvement and flood mitigation.

Adequate water availability will be needed to maintain quality blue spaces in our urban environment. For more information about ensuring our urban water supplies see **Support Paper 1: Water for the future**

Examples of irrigation practices in other cities with extensive green and blue spaces

The water for urban irrigation can be supplied in different ways. Increasingly in South Australia non-potable water from urban stormwater runoff and treated wastewater is being delivered through separate supply networks to irrigate urban green spaces. In addition natural groundwater and surface water sources are used where available. Some other approaches that have been taken elsewhere are outlined below.

Mendoza, Argentina – runoff diversion and gravity fed irrigation water

The city of Mendoza is an urban oasis in the rain shadow of the Andes, which is famous for its cool shaded streets, plazas, pathways and fountains despite having hot summers and low annual rainfall (220mm), (Figure 7).

Figure 7. Street trees in low rainfall Mendoza, Argentina, are irrigated with water supplied by ancient gravity fed channel systems

Mendoza proudly promotes itself as a 'forest city' and this is made possible by water that is gravity-fed throughout the city landscape by an ancient series of channels, known as acequias. The watering system was first established hundreds of years ago, before the arrival of the Spanish, and has since been expanded so that it is now able to supply water to trees throughout the shady city.

Montecito, USA – private water security investment

Montecito is a small community adjacent to the city of Santa Barbara in the USA with high rates of urban greening and associated liveability. The Montecito community contributed half of the funding for the construction and operation of the Santa Barbara seawater desalination plant. With this investment the Montecito community, which can afford a higher water supply costs than its larger neighbour, secured the water rights to sustain high rates of greening. On a smaller scale, during the millennium drought some private landholders in Adelaide who could afford to purchased non-potable water (including carted reclaimed water) and installed rainwater tanks when water restrictions were imposed on irrigation.

Melbourne – citywide planning

Melbourne has an ambitious plan to create urban forests across the city. Melbourne, which has a notably higher average summer rainfall and lower evapotranspiration than most of South Australia, is undertaking water planning with strong water sensitive urban design focus that capitalises on these summer conditions to maximise the retention in the landscape of water available from urban runoff, stormwater and others sources.

Singapore – extensive urban greening with high rainfall and reclaimed water use

Singapore has an ambitious greening program, which it is successfully achieving in a climate characterised by high humidity and a high rainfall (Singapore's rainfall is more than four times the rainfall of Adelaide). The city has also a substantial water reclamation program to increase water security for the future.

Managing urban heat

Urban heat will have a significant impact on the future liveability of South Australia's towns and cities as climate change brings longer and more extreme hot and dry periods. Extreme heat creates major challenges for urban living and increases the water needs, especially for establishing and sustaining green and blue spaces that are so important.

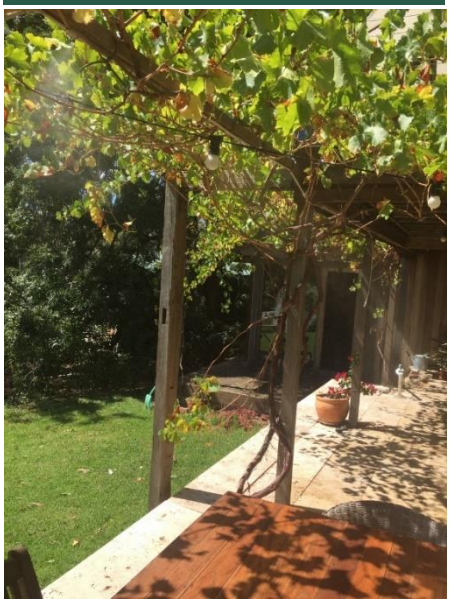
A combination of urban development and other factors leads to additional heat generation in towns and cities, known as the Urban Heat Island Effect (UHI). Contributors to the UHI include heat that is stored in roads, buildings and bare soils with dark, non-reflective surfaces that are exposed to the sun as well as emissions from activities such as vehicle exhausts and air-conditioning. Heat that is stored is radiated into the city during the day and continues to radiate during the night. In line with large cities all over the world, an Urban Heat Island effect is observed in Adelaide.

Extreme high temperature weather events and the UHI combine to create even hotter temperatures, particularly overnight when the retained heat in the urban landscape is radiated into the surrounding cityscape. While the impact of the urban heat island effect can be reduced with actions within the city, the broader meteorological conditions are not influenced at this scale and water and other management consideration should anticipate some future increases in urban temperatures even if features of the urban environment that contribute to the heat island effect are managed. In the many of the smaller towns and cities in South Australia the UHI does not have as great an effect as the high ambient temperatures of the surrounding landscape. This is demonstrated in towns and cities that regularly experience higher daytime maximum temperatures than Adelaide, but cooler nights.

Applying water for urban heat mitigation

Responses to high urban temperatures need to include adaptation and mitigation. Adaptation aims to reduce the impact of high temperatures on residents through applications such as building insulation and air-conditioning, while mitigation reduces the air temperature through actions such as planting trees, retaining water in the landscape and using heat-reflective materials. Heat mitigation will enhance human comfort and the need for adaptation leading to lower costs of living as cooling energy demands are reduced.

Figure 8. Misting and vegetation for heat mitigation in the home



There are many urban cooling methods that can be applied to mitigating heat in urban environments. The Guide to Urban Cooling Strategies summarises many of these approaches and provides practical guidance for moderating urban microclimates and mitigating urban heat island effects in major urban centres across Australia. Water is a key component of many of these approaches.

Examples of water use in urban cooling strategies include:

Shading with vegetation including tree canopies and climbers. Irrigation enhances vegetation condition and performance for optimum cooling by increasing transpiration and dense canopy cover. Passive irrigation can reduce water demand.

Evaporative cooling is a highly effective cooling strategy in drier climates like Adelaide's. Water is evaporated from the soil and air. Water can be added to the soil through irrigation and to the air with sprinklers, misters (Figure 8), fountains and other spray systems.

Evapotranspiration by vegetation is a natural cooling system if adequate water is available either from irrigation or natural groundwater. This can be used to cool many settings including parks, gardens, pathways and carparks.

Water cooled pavements such as permeable concrete, asphalt and block pavements both prevents the surface from heating and drives evaporative cooling when moisture is available within the pavement material. In South Australia this will require water to be added as there is not adequate summer rainfall. This would be effective for cooling high traffic areas such as hard stand festival areas, high traffic pedestrian streets, malls and arcades.

Surface water on exposed surfaces, water features or contained water bodies can cool the surrounding environment. This includes water play features such as spray parks, or splash pads that are becoming common in Adelaide and regional centres such as the redeveloped Renmark waterfront.

Water for nature in towns and cities

As the driest state in the driest inhabited continent in the world, freshwater resources are a valued feature of the landscape in South Australia. Most of the rivers and creeks in the state are ephemeral and have highly variable flow patterns. There are many significant water dependent environments in or near to the state's towns and cities. The waterways and coast and marine environments in or near the state's towns and cities are vital for urban drainage, provide recreational opportunities, sustain ecological communities, and are culturally important to Aboriginal nations.

Adelaide is rare in world terms because it is a large city in the middle of a biologically diverse area and the towns and many of the other cities of the state are located near to high value natural areas. Adelaide is located within one of the nation's 15 biodiversity hotspots, featuring disproportionately high numbers of species including many of conservation concern due to a range of pressures that include urban development that fragments the natural systems.

In many areas ecosystem condition and biodiversity has declined following landscape changes since European settlement including land degradation, increased watercourse erosion from higher rates of runoff, and pest plant infestation in terrestrial and aquatic environments. Adelaide's coastal seagrasses have been affected by substantially altered stormwater outflows with increased nutrients and suspended sediment discharge from the developed area. While the long term impacts of urban development on freshwater and marine environments were not fully understood by our early European settlers, South Australians today recognise that protecting and improving natural water assets and biodiversity within our urban environments is important not only for restoring and maintaining the state's functioning ecosystems, but also for increasing environmental resilience to climate change impacts. The community health and wellbeing benefits of access to natural environments is also recognised, and these environments are key attractions which support the tourism sector of the economy.

In the management of water in our towns and cities, it is important to consider enhancing and protecting the natural environments in urban areas and the adjacent natural and primary production areas that can be impacted. Key water related approaches include enhancement and protection of watercourse and coastal biodiversity, runoff and pollution controls and legislation aimed at reducing litter and plastics entering our environment where it can impact on marine and other life. Most recently nation-leading legislation banning single-use plastic in South Australia complements the long standing container deposit legislation. The incorporation of water sensitive urban design approaches into urban developments through planning controls can also protect natural systems as well as providing many other benefits.

In towns and cities watercourses have been highly modified to accommodate adjacent urban activities and reduce the risk of flooding. This has resulted in artificially straightened channels that are able withstand the higher flows that occur in urban areas, but with reduced natural values. River Torrens (Karrawirra Parri) in metropolitan Adelaide is a riverine area of national and international quality. Environmental management actions in the river includes the management of pests, debris and litter, revegetation, pollution control and environmental flow releases. See also the River Torrens Recovery Project https://www.environment.sa.gov.au/topics/green-adelaide/our-priorities/River-Torrens-Recovery-Project. Natural freshwater bodies in urban areas such as the Lower Murray Lakes at Goolwa and the Blue Lake in Mount Gambier are significant landscape features in the local urban context and regionally. These form important parts of their local economy as tourist attractions and water supply that these have become synonymous with many towns. Adjacent urban management needs to include minimising pollutant inflows and other impacts on ecosystem health. Constructed freshwater environments have reintroduced aquatic habitats across the urban landscapes that have otherwise been removed as the urban areas were drained to allow for development.

Watercourse management is part of the programs of Landscape Boards including Green Adelaide, addressing significant erosion issues and ecological improvements. Stormwater drainage is managed to minimise high flows, floods and associated erosion and pollution by a number of different organisations. Local Governments manage the stormwater networks in their areas and in recent decades have been including water sensitive design features. The Stormwater Management Authority sets high level strategic directions for stormwater management planning both within and across

local council areas and co-invests in stormwater improvements. The planning system under the *Planning, Development and Infrastructure Act 2016* includes requirements for stormwater discharge management from developments.

Urban coastlines and marine environments adjacent to towns and cities are significant tourism attractions and contributors to regional economies through fishing and aquaculture. These environments are particularly susceptible to being impacted by urban impacts such as pollution and sedimentation from watercourse erosion. The Environmental Protection Authority is responsible for the control of stormwater pollution through the *Environment Protection Act 1993* (EP Act) including regulation of pollution and other discharges to the environment and the rehabilitation of contaminated soil and groundwater. The Authority delivers stormwater and coastal improvement programs, particularly in metropolitan Adelaide, including the Adelaide Coastal Waters Quality Improvement Plan that was based on the Adelaide Coastal Waters Study undertaken by the CSIRO and the Australian Government funded Catchment to Coast Program that included Rain Garden 500.

Urban stormwater runoff can carry significant amounts of suspended solids and organic matter that can impact waterways and is implicated in the loss of around 50 square kilometres of seagrass meadows in Adelaide's coastal waters. Other pollutants including litter and contaminants from roads and vehicles also make their way into waterways. For further information about coastal impacts see **Support Paper 2: Drainage and flood management**

Supplying and funding water for life

Urban water management in the future will need to ensure there is an adequate supply of water to create and maintain green and blue spaces and for heat mitigation. The water requirements of these actions will be significant and will need to be considered early in planning processes. A lack of adequate water is a significant limitation to the performance of green space, the application of urban heat mitigation actions and, as occurred in the millennium drought, a lack of water can see blue spaces abandoned.

For water to be available for liveability other water uses will need to continue to be efficient and new supplies will be needed. This will lead to more complex water supply systems and demand management in our towns and cities, with water efficient practices maintained for some activities (e.g. in-home use, vehicle washing), while water use for greening and cooling increases. This additional water use for greening and cooling could appear wasteful in light of the accepted water conservation measures maintained since the millennium drought. Communication of the value of water use to support liveability will be required as part of creating a water literate and water wise community.

Water security management will need to meet the increasing urban liveability water demands in addition to the increased water requirements from a growing population and economy. Water extraction for urban water uses can impact the natural environment and water allocation plans limit extraction to sustainable limits.

Water supply options for South Australia's urban areas are discussed in **Support Paper 1: Water for the future**

How do we pay for the additional water demands for greening and cooling?

There is currently an increasing desire to invest in urban greening for the range of benefits that it provides; the additional water needs of this increased green cover are not always being fully considered as part of the planning for green spaces, or factored into the long term maintenance costs. Water is an essential part of successfully creating liveable urban environments: viable urban green and blue spaces and other heat mitigation techniques. The full development of green and blue spaces across urban areas will require additional water use, which will come at an additional cost. Economic regulation guides the price of water which is set based on National Water Initiative pricing principles. These principles are fundamentally about fully recovering the cost in infrastructure investments, while meeting all regulatory obligations.

The use of a diverse range of water sources to support greening and cooling as well as the broad range of benefits that can be attributed to that water use warrant further consideration of how water used for cooling and greening should be

priced, and who should pay for that water use. This is particularly important in consideration of the fact that the greatest benefits of additional greening and cooling may be attributed to the lower socio-economic parts of our urban areas, who are least able to afford to pay for the additional water use.

It is therefore timely for water supply funding approaches to be reviewed in consideration of the full suite of economic benefits that increased water supply for urban greening and cooling can make to community health and well-being, as well as potential benefits that may be achieved through the use of treated stormwater and wastewater through decreased discharges. Such a review should also consider the cost to society of not adequately providing water for cooling and greening in South Australian cities and towns as the climate heats and dries.