Community Acceptance of Water Sensitive Urban Design: Six Case Studies

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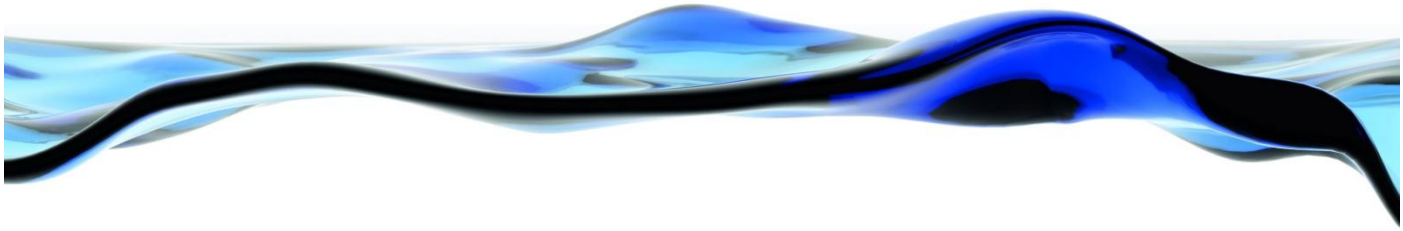

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Contents

Figures

Tables

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Executive summary

The Socio-Technical Analysis and Community Engagement Research is Task 2 of the Goyder Institute funded project, *Water Sensitive Urban Design Impediments and Potential Contributions to the SA Urban Water Blueprint*. The broader project aims to gain insight into the impediments to mainstream adoption of Water Sensitive Urban Design (WSUD) systems in the Greater Adelaide region. The need for WSUD is becoming paramount as the population of Adelaide continues to grow, placing pressure on existing infrastructure, receiving water bodies and water resources. This project aimed to determine the factors that facilitate or inhibit community acceptance of WSUD. More specifically, it provides an understanding of:

- **Perceived benefits** of WSUD by community members.
- **Perceived barriers** affecting the uptake of WSUD by the community.
- **Community responses** to WSUD.
- **Ways to improve** community acceptance of WSUD over the long term.

The research design adopted a case study approach because of its ability to integrate multiple sources of information within a single site and also to contact community directly living in developments designed with WSUD approaches. The six case studies were Christie Walk, Lochiel Park, Mawson Lakes, Springbank Waters, Mile End streetscape and Harbrow Grove Reserve. They provided opportunity for comparison of findings across a diverse range of WSUD installations and represented WSUD operating at different scales and in both new developments and retrofitting existing suburban areas.

Consistent with a case study approach, for each site there were three main components to the data collection: 1) analysis of the **technical aspects** of the WSUD sites, 2) **interview material** from key informants, focus groups and short interviews, 3) **questionnaires** to assess attitudes to the environment and water.

Findings

Overall there was **strong support** for WSUD innovations. There were two categories of WSUD features:

- WSUD features that had instant appeal included features that improved *aesthetics, greenscape, recreational amenity, and increased resident control over their own water supply*
- WSUD features that were less obvious but gained community support once the features were explained and understood. They included features that improved the quality of water runoff or flood mitigation.

There were no specific WSUD features that were disliked by respondents rather there were problems that could arise with any feature and, if left unaddressed, could jeopardise acceptance of WSUD both long-term and to the wider community. The **barriers**, which could be cumulative, included:

1. **Poor functioning of the WSUD systems**, often occurring soon after installation: Poorly functioning WSUD features make developers, residents, and councils reluctant to invest in them. Increased availability of technical knowledge, and training of contractors and those who oversee the work seems to be required if WSUD is not to get a reputation of being “too difficult”.
2. **Inadequate maintenance and ongoing management**: Respondents wanted a long-term maintenance plan including a plan for the hand-over to council so councils and residents are aware of the long-term maintenance requirements and costs.
3. **Lack of community consultation**: Most obviously communities cannot support WSUD facilities if they do not know that they exist. Understanding a WSUD facility is likely to need two-way communication such as discussion groups and tours of the facility rather than one way communication such as the distribution of flyers. Two-way dialogue also has the added benefit of directly hearing back from the

community aspects about the WSUD feature that they particularly like or dislike. This type of feedback can assist future innovation and development of WSUD.

4. **Uncertainties about costs**: All residents in the new sites had paid extra for their home with WSUD and other features; however poor design, functioning and maintenance, changes in water pricing, and attempts to retrofit had all led to unexpected costs. Up-front information on costs of WSUD features should be relatively easy to provide e.g. a cost–benefit analysis of water tanks would be useful. Further, they were concerned about the lack of incentive for reducing the use of mains water. Cheaper prices for recycled water, subsidies for water saving devices and water bills that emphasised water usage rather than service connection were seen as desirable.
5. **Lack of knowledge and understanding**: Lack of community information about WSUD features and how to use water sustainably, and a lack of industry and government knowledge contributed to a lack of appreciation of the value of WSUD, and at times unnecessary problems. In particular there needs to be recognition that new residents come to an area so information dissemination needs to be on-going.

Community Response: Social capital, the strength of relationships among residents, and **place attachment**, how strongly people felt about their place of residence, were closely linked to community acceptance of WSUD principally by supporting the formation of community groups. The groups greatly mediated the relationship between the WSUD installations and the community which enhanced benefits and overcame barriers through:

- Community education
- Providing communication channels connecting residents with developers, councils and government authorities
- Supporting the ongoing management of WSUD installations with monitoring and maintenance activities

The improved amenity and community activity prompted by WSUD-related activities could, in turn, enhance social capital and place attachment

The way forward

An understanding of barriers and benefits provides a platform for ways to address acceptance, and can be summarised into four main areas.

1. Ensuring the **effective functioning** of the WSUD systems:
    - Functioning of the initial development, hand-over and ongoing maintenance all needed to be addressed.
    - Management responsibility needed to be clarified at each stage.
    - WSUD systems were not expected to work perfectly but residents did expect to find authorities responsive and remedying any problems that arose in a timely way.
    - Some people were willing to be part of experiments in WSUD but they needed to be consulted and kept informed of progress.
2. A **water pricing structure** that encourages the use of alternative water sources and water savings.
3. **Education** and information for all parties:
    - Education and knowledge pooling for developers and their sub-contractors, councils, water providers, government, and community, were seen as crucial especially in times of rapidly changing technology.
    - More knowledge made community members more supportive of WSUD. They were generally more positive after having the systems explained.
    - In particular there was a lack of knowledge about potential improvements in the quality of storm water run-off.
    - There is untapped support for the dissemination of WSUD and some groups were keen to be part of the educative process.

4. **Supporting the development of social capital** within the community.
    - For example, some developers supported the formation of community groups that have had an ongoing interest in monitoring the WSUD installations.
    - Councils could contact local community organisations to invite involvement.
    - The aim is to start a positive cycle in which groups assist in the monitoring and maintenance WSUD installations and the improved amenity and interaction increases place attachment and enhances social capital.

1 Introduction

This study, *Socio-technical analysis and community engagement*, is Task 2 of the Goyder funded project, *Water Sensitive Urban Design Impediments and Potential: Contributions to the SA Urban Water Blueprint*. The broader project aims to gain insight into the impediments to mainstream adoption of Water Sensitive Urban Design (WSUD) systems in the Greater Adelaide region. The need for WSUD is becoming paramount as the population of Adelaide continues to grow, placing pressure on existing infrastructure and increasing the demand for new developments. Hence the broader project will investigate social and technical impediments to WSUD implementation; and potential for WSUD in South Australia to achieve water conservation through alternative resources application, water quality, water quantity, and flood management.

1.1 What is WSUD?

Water Sensitive Urban Design is broadly defined as

> *"the integrated design of the urban water cycle where water supply, wastewater, storm water, groundwater, urban design and environmental protection are all incorporated"* (Joint Steering Committee for Water Sensitive Cities, 2009).

The Intergovernmental Agreement on a National Water Initiative incorporated the concepts of WSUD into its urban water reform agenda, and defined WSUD as (NWC, 2004):

> *"The integration of urban planning with the management, protection and conservation of the urban water cycle that ensures urban water management is sensitive to natural hydrological and ecological processes."*

As such, the main objectives of WSUD are to reduce potable water demand and to minimise the generation and impact of wastewater on the local environment. Additional objectives are to restore and preserve natural catchments (i.e. reducing erosion, improving waterway health), reduce flood risk, improve aesthetics and community connections with water, to promote water-related self sufficiency, to reduce the cost of providing and maintaining water infrastructure, and reduce greenhouse gas emissions. (Department of Planning and Local Government, 2010b; Joint Steering Committee for Water Sensitive Cities, 2009)

Given the context of the study, a more localised definition of WSUD is also appropriate to include here. The South Australian government's WSUD policy '*Water sensitive urban design – creating more liveable and water sensitive cities in South Australia* (Government of South Australia, 2013) defines WSUD as *an approach to urban planning and design that integrates the management of the total water cycle into the land use and development process*. In addition to the broad WSUD objectives mentioned above, the Department of Planning and Local Government (2010b) highlight the management components of WSUD including: the storage, treatment and beneficial use of runoff; the treatment and reuse of wastewater; and the use of vegetation and landscaping for treating and enhancing biodiversity.

The sustainability of the water environment is therefore seen to play an integral role in the process of urban development and redevelopment and a major challenge is for WSUD to be pursued more seriously in residential land divisions (Barton and Argue, 2007). Therefore decentralised systems that incorporate WSUD principles are becoming more commonplace in urban developments, given the increase in urbanisation and subsequent pressure on freshwater resources (Cook et al., 2009). Sharma et al. (2013) suggest the following definition of decentralised systems:

> *"Decentralised systems can be defined as systems provided for water, wastewater and storm water services at the allotment, cluster and development scale that utilise alternative water resources including rainwater, wastewater and storm water; based on a 'fit for purpose'*

concept. These systems can be managed as standalone systems, or integrated with centralised systems. Wastewater streams are partially or completely utilised at or close to the point of generation. At cluster and development scale, storm water is also managed as part of an integrated approach that aims to control the quality and quantity of runoff at or near the source to minimise the impact of the development on the natural ecosystem."

Further, Cook et al. (2009) include rainwater tanks, storm water systems, greywater recycling systems, wastewater recycling schemes, demand management strategies as features of decentralised systems.

Wong and Brown (2009) suggest three pillars that characterise water sensitive cities:

1. *Cities as Water Supply Catchments*: access to a diversity of water sources (storm water, groundwater, recycled water) underpinned by a diversity of centralised and decentralised infrastructure.
2. *Cities Providing Ecosystem Services*: provision of ecosystem services for the built and natural environment.
3. *Cities Comprising Water Sensitive Communities*: socio-political capital for sustainability and water sensitive decision making and behaviours.

In practice, the application of WSUD may employ any of the following strategies:

- installation of water efficient appliances and systems (including landscaping)
- use of alternative waters sources
- detention, reuse, storage and infiltration of storm water
- protection of water related environmental, recreational and cultural values
- localised wastewater and storm water treatment and reuse systems
- use of recycled urban water to provide environmental water requirements
- flexible institutional arrangements
- focus on long term planning and ongoing monitoring, evaluation and review
- a diverse portfolio of water sources.

WSUD elements normally have multi-functional objectives, which often include flood mitigation, mains water conservation and landscape amenity. The tools and approaches applied to achieve WSUD objectives need to be adaptable to site-specific conditions and development objectives. In South Australia, the Department of Planning and Local Government (2010b) developed the *Water Sensitive Urban Design Technical Manual*, which provided guidance for the implementation of the following twelve WSUD tools in the greater Adelaide region, as shown in Table 1.

Table 1 WSUD tools for adoption

WSUD APPROACH/TOOLS	WSUD APPROACH/TOOLS
1. Demand reduction	7. Bioretention systems for streetscapes
2. Rain gardens, green roofs and infiltration systems	8. Swales and buffer strips
3. Rainwater tanks	9. Sedimentation basins
4. Pervious pavement	10. Constructed wetlands
5. Urban water harvesting/reuse	11. Wastewater management
6. Gross pollutant traps	12. Siphonic roofwater systems

Table 1 gives an indication of the breadth of approaches that can be applied, according to local conditions, in achieving WSUD objectives. These tools can be categorised: mains water conservation, minimising wastewater flow, management of storm water quantity and quality, and flood mitigation.

1.2 The Australian context

The rapid urbanisation in Australia over the last century has resulted in a number of water related pressures, including water extraction, pollution, discharge and disturbance to natural hydrological regimes (Sharma et al. 2012). They argue that a paradigm shift in the provision of water services is needed for sustainable development and long term reliability of water services.

The Australian Water Sensitive Urban Design Research Group were among the first to investigate storm water management and water sensitive planning in 1989 (Carmon and Shamir, 2010). Wong (2007) notes that this 'radical' approach did not gain widespread favour until early 1990s and was not further developed in the eastern states of Australia until the mid 1990s. Since then, WSUD has become a topic of national importance, particularly as a result of the severe droughts affecting eastern Australia in the 2000s. Of particular importance has been a shift in the way storm water is perceived from once being considered as a nuisance and a liability to being recognised as a valuable water resource (Roy et al., 2008).

The first guidelines on WSUD were published in Western Australia in 1994; soon to be followed by the Victorian Storm water Initiative and guidelines by the NSW government (Fletcher, Deletic and Hatt, 2004; Roy et al 2008). It has been noted that guidelines at the state level often take two forms, either those developed by the relevant state agencies or information related to design practices developed by industry groups and local governments (Fletcher et al. 2004).

In 2004, a national strategy known as the intergovernmental National Water Initiative (NWI) was devised by federal, state and territory governments. Among the key objectives of the NWI are to address water shortages and improve economic, social and environmental outcomes through effective management of urban water. More recently, national guidelines for the implementation of WSUD have been provided by the Joint Steering Committee for Water Sensitive Cities (2009, see Chapter 3) and cover a range of issues including objective setting, site analysis, land capability assessment, and evaluation objectives.

In practice, the Australian application of WSUD has so far mostly been to address local storm water management for environmental protection and flood prevention. However, Wong (2007) argues that WSUD in Australia has evolved from its early association with storm water management to become a broad framework for integrating holistic and integrated management of potable water, wastewater and storm water. Thus, the concept of Integrated Water Cycle Planning (IWCP) has become prevalent within the Australian water industry (Brodie, 2009), although this approach is still largely idealistic and has not had wide-scale implementation (Roy et al, 2008). Whilst growing in number, few sites around the country currently exhibit on site management of storm water and wastewater in conjunction with integrated conservation and reuse.

Some of the constraints that have limited the widespread uptake of WSUD include governance and regulation issues; a paucity of knowledge and skill for design, construction, operation and management of sites; community resistance; uncertainty over potential public health risks; non-equitable distribution of costs among various stakeholder; and uncertainty surrounding the effectiveness of WSUD approaches or its broader system impacts (Tjandraatnadja et al, 2008, Sharma et al, 2012).

According to Roy et al. (2008) it is necessary to push the boundaries of WSUD further in Australia in order to create sustainable urban storm water management systems that not only protect human health and property but also preserve natural and functioning ecosystems. Further they add three premises that are fundamental to achieving sustainable urban storm water management: firstly they must maintain the natural ecological structure and function of receiving water bodies; secondly they should make use of existing technologies that are capable of mimicking the natural water cycle and reducing downstream transport of storm water pollutants; and thirdly that sustainable urban storm water management must be planned and implemented at the watershed scale.

1.3 Project setting and background: Adelaide

Adelaide currently has a population of approximately one million people and experiences a Mediterranean-like climate with dry summers and moderate rainfall over the winter months. Until a desalination plant was commissioned in 2010, Adelaide relied solely on the River Murray and local catchments in the Mount Lofty Ranges for the provision of drinking water. Institutionally, mains water supply including the desalination plant and wastewater are managed by the water utility SA Water. Some storm water is captured and managed by local government. Thus, in order to use storm water processed by local government, SA Water would need to purchase it. In 2012, the legislation was changed to allow private providers to enter the water market and some private providers have now been licensed. The new Water Industry Act appoints the Essential Services Commission of South Australia (ESCOSA) as the independent regulator for urban and regional water and sewerage services. This legislation also allows for an independent Water Industry Ombudsman, along with a Consumer Advisory Committee, to ensure customers' complaints are investigated (Water for Good, 2012).

Given the dry climate, water has always been an important issue and it is not surprising that it is prominent in the South Australian Government's 30 year plan for greater Adelaide. The Vision for Greater Adelaide *Principle 11, Climate Change resilience* includes dramatically improving the water efficiency of new buildings and new neighbourhoods. *Principle 12, Environmental protection* includes the protection of environmentally significant waterways and marine areas. Water is also important for *Principle 8, Healthy safe and connected communities,* which emphasises open space and sports fields and *Principle 113 Natural resource management* (Department of Planning and Local Government 2010a).

The South Australian Government's *Water for Good* plan was launched in 2009 and outlined 94 actions to ensure security and safety of the Adelaide water supply until 2050. In recent times, two main drivers have arisen which are forcing change in the management of the city's water resources, these being population growth and changes in climactic conditions which are predicted to lead to decreased annual rainfall along with an increase in the frequency of severe rain storms (Dillon, 2011). In particular, population growth will drive increases in water demand, sewage flows and storm water runoff due to a greater number of dwellings and related infrastructure with impervious surfaces. At the same time, it is anticipated that urban flooding events may become more frequent with the predicted increase in severe rain storm events unless changes in land use or storm water infrastructure are implemented especially in areas with high infill developments.

In South Australia water has always been an important issue and to address drought various measures were planned and implemented. For example, the desalination plant at Port Stanvac is a major infrastructure investment to mitigate drought. In addition, as part of the Basin Plan 2012, the Federal government aims to restore the health of the river systems within the Basin, including the River Murray, by achieving the recovery target of 2750 GL of environmental water. South Australia is dependent on the River Murray for water supply, and the Federal government has committed additional funding for infrastructure improvements, removing impediments to flow and improving water efficiencies on farms, actions aimed at recovering an additional 450 GL of water to the Basin (Australian Government, 2012).

Water for Good commits the state government to introduce WSUD 'targets'. This is seen as a means to ensure compatibility between the intended performance of WSUD systems with WSUD principles and objectives established by state government (Goyder, 2011). To date, a range of WSUD systems have been implemented in Adelaide including storm water harvesting, recycled sewage use, and collection of roof runoff in rainwater tanks at the household level. A brief summary of these systems is provided below.

Adelaide's storm water harvesting capacity is understood to exceed 20 billion litres (pers. comm. Martin Allen, DEWNR) which is consistent with the State's Water for Good plan to be capable of harvesting 20 billion litres of storm water per year by 2013. Water for Good also targets 60 billion litres of storm water recycling capacity per year in Greater Adelaide, and up to 15 billion litres in regional areas, by 2050. Commonwealth funding secured in 2009 from the *Water for the Future* funding pool has injected specific funds into recovering storm water in the Adelaide region. Adelaide has been a leader in the use of storm water, particularly for greening the city (Argue & Pezzaniti, 1999), for example, storm water harvesting has

been occurring in Adelaide since 1992 at Andrew's Farm, a wetland aquifer storage and recovery (ASR) system situated in the city's north. The water captured in this system is stored in a confined aquifer and is recovered for distribution via an alternative supply system for industrial and irrigation uses (Dillon and Pavelic, 1996). The City of Salisbury (in Northern Adelaide) has also undertaken research to investigate the potential for storm water to be harvested and treated for drinking water purposes (Dillon et al., 2008).

Recycled sewage from the Bolivar, Glenelg and Christies Beach sewage treatment plants is distributed for use in horticulture and viticulture industries, irrigation of parkland, and more recently, for distribution to households in new development sites for toilet flushing and garden irrigation.

Rainwater tanks are more common in Adelaide households than other Australian cities with 38% of households accessing water from this source, compared with 11% national average (ABS, 2007). Since 2006, there has been a requirement for new homes and home extensions in South Australia to have a rainwater tank connected to a toilet, a cold water laundry outlet, or a hot water service (SA Government, 2009).

Water conservation measures have also been effectively implemented in the Adelaide region, particularly since the drought, which affected the Eastern states of Australia in the mid 2000s. This period saw a reduction in the total amount of water used by Adelaide from 200 gigalitres a year (Water for Good, 2012) to approximately 120-135 gigalitres per year at the current time (D. Bursill, Chief Scientist, personal communication, October 9th 2012).

As is often the experience with WSUD developments, the approach to their implementation in Adelaide has often been ad hoc. However, the South Australian Department of Planning and Local Government (2010) has produced a WSUD Technical Manual with objectives and principles specific to the Greater Adelaide region so there may be more uniformity in recent WSUD sites. Hence, there is a need to explore how early and recent developments have been experienced by the community in order to inform policy decisions to ensure the success of future WSUD developments.

2 Existing knowledge about public perceptions and community acceptance of WSUD

There is growing evidence for the importance of public engagement and acceptance of WSUD projects.

For example, Sharma et al.'s (2012) review of the literature found that the majority of barriers to WSUD developments are social and institutional rather than technical. The technical knowledge exists but there is a lack of practical experience within institutions to aid uptake. From their review of nine WSUD sites, Sharma et al. (2012) concluded that community engagement and consultation is essential for successful implementation. Further supporting the importance of community engagement, Wong and Brown (2009) note that community values and aspirations govern urban design and, therefore, water management practices.

Reflecting the importance of community engagement, the term 'hydro-social contract' has been adopted to describe the pervading values and often implicit agreements between communities, governments, and businesses on how water should be managed (Turton and Meissner, 2000). Brown, Keath, and Wong (2008) propose that the hydro-social contract in the Water Sensitive City is adaptive and underpinned by flexible institutional regimes and co-existing and diverse infrastructure. To establish the Water Sensitive City, Brown et al. (2008) suggest that there will need to be a socio-technical overhaul of conventional approaches to water management, which will increase the salience of community engagement.

Despite the increased recognition of the importance of public and community perceptions, relatively little research has been conducted on the topic. For example, Wong (2007) noted that the socio-institutional dimensions of WSUD are an underdeveloped area of research. Also Mankad and Tapsuwan's (2011) literature review found that the majority of research on community acceptance has been conducted in regard to centralised alternative water sources such as recycled wastewater and desalination, and there is a need to understand acceptance of household scale sources such as rainwater harvesting and greywater recycling. Mankad and Tapsuwan (2011) highlighted that much of the social research in the water domain has focussed on planned or intended behaviour, rather than focussing on actual behaviour; community acceptance is the planned focus in this project.

Finally, some research that has been conducted suggests that levels of community engagement may be low. Tjandraatmadja et al. (2008) in their review of iconic WSUD developments suggest that overall there is a need to further educate and engage the community based on previous surveys, which indicated that residents living in established WSUD developments, such as Mawson Lakes and New Haven Village in South Australia, have a low level of awareness. Ongoing education is also required as residents have reported lack of awareness about recycled water schemes, such as when they are on and offline and the inappropriate use of recycled water (e.g. for filling swimming pools).

2.1 Risks and barriers to acceptance

The barriers to the uptake of WSUD that are emerging from the literature were summarised by Sharma et al. (2012) into eight themes: 1) governance, regulations and guidelines, 2) community acceptance and social impacts, 3) skills and knowledge, 4) public health, 5) system evaluation, performance and monitoring, 6) financial incentives for WSUD, 7) system operation and maintenance, and 8) sustainability and broader system impacts. From the point of view of the community, a number of these themes are inter-related. Perceptions of the effectiveness of governance and system maintenance will affect concerns about public health. Similarly, earlier work by the Healthy Waterways Partnership in SEQ (Moreton Bay Waterways and Catchments Partnership, 2005) identified four main barriers including lack of policy direction; lack of stakeholder awareness about benefits; lack of consumer demand; and costs for building, maintenance and replacement.

Financial incentives for WSUD are another important actor underpinning acceptance and uptake. Unless there are specific funding schemes, when the cost of drinking water is low there are few financial incentives for the uptake of all alternative water sources (Dimitriadis, 2005). The another aspect is that the cost of implementing and maintaining the WSUD features which would provide an alternative to or supplement mains water are generally high and can lead be a financial challenge particularly if other benefits of such systems (e.g. potentially environmental, amenity, enhanced water security) are not considered in the overall assessment. Also, the Healthy Waterways Partnership, have found that the demand may not be widespread because the associated costs can be high, and therefore, WSUD projects are only likely to appeal to higher socio-economic groups (Moreton Bay Waterways and Catchments Partnership, 2005).

Public perceptions of a high risk will always be a barrier to acceptance; however, it is important to separate the actual degree of risk from the risk perception (see Howes, 2005; cited in Centre for Water Sensitive Cities, 2011a, Appendix 6). Risk perceptions can be linked with the degree of unknown consequences, the temporal and spatial proximity to certain risks, fairness and trust. Similarly, Roy et al. (2008) argue that there are multiple layers of risk and risk aversion that may cause resistance to WSUD by both practitioners and the general public. These can include risks at the institutional level, such as loss of revenue, loss of functionality, risk of failure, and risk of disease; or at the community level where it may be perceived as unattractive or ineffective (Roy et al. 2008).

Focussing on the actual degree of risk, the Joint Steering Committee for Water Sensitive Cities (2009) detail four areas of risk that can be associated with the implementation of WSUD. The four areas are:

- Rainwater capture and reuse, typically seen as low risk yet concerns relate to the quality of the water stored in tanks and the use of the water.
- Wastewater, storm water and greywater reuse, typically seen as moderate to high risk depending on degree of management measures and adherence to Australian Guidelines for Water Recycling.
- Storm water treatment, typically seen as low risk provided the appropriate design, operation and maintenance measures are in place. Best management practices are required for services, construction and establishment, erosion, public safety, and maintenance to minimise risk and issues.
- Institutional risks which are complex, dependent on human factors, and require understanding of and commitment to WSUD principles.

In relation to alternative supplies for potable use, Po et al. (2003) found a variety of factors that may influence acceptability: disgust; perceptions of risk; specific uses; source of recycled water; issue of choice; trust and knowledge; attitude towards the environment; environmental justice issues; cost; and socio-demographic issues. However, it is the actual health risks and perceptions that are likely to be the strongest barriers and that is related to the degree of personal contact (Mankad and Tapsuwan, 2011). Thus, Mankad and Tapsuwan (2011) argue that the public might be more accepting of decentralised options that do not involve 'dirty' water (e.g. recycled wastewater).

2.2 Drivers of acceptance

Community acceptance and broad scale political support for WSUD is fundamental, not only, for enhanced rate of implementation, but also, for aiding the growth of the industry's technical capacity and ingenuity in complex urban environments (Wong 2007). Fortunately, there are a range of intrinsic benefits associated with many WSUD projects, which make them attractive to the community such as; improved aesthetics; increased liveability and improved health of communities; adding a distinct character and identity to the area; sustainability; expression of heritage values; and more opportunities for the community to engage in public life (Centre for Water Sensitive Cities, 2011b). Also, Lloyd (2004; cited in Tjandraatmadja et al., 2008) reports that people positively associate with WSUD features such as improved aesthetics, greener surroundings, and improved local habitat.

Positive community attitude to WSUD is supported in survey research. For example, Marks et al's (2003) survey of behavioural intention in the South Australian communities of New Haven and Mawson Lakes indicated high acceptance for non-potable uses for treated reclaimed water. McKay and Hurlimann (2003; Hurlimann and McKay, 2004), also examined residents' attitudes to reclaimed water at Mawson Lakes and

found a high level of support, overall, for water recycling among residents. Similarly, Leonard and Alexander (2012) found good support for the use of treated storm water for non-potable purposes in the Adelaide region, however, participants who had received information from experts in a focus group preferred to use the treated storm water in the mains system, hence for potable purposes. The reasons for their judgement were two-fold: they were reassured that the storm water could be properly treated, and they perceived the mains water system as cheaper and fairer than third pipe distribution. Participants believed only new developments would have access to a third pipe system. These results suggest that public participation and education could significantly change support for WSUD schemes, even those involving potable water.

Local government has an important role in the development of many WSUD projects and their support for WSUD may either lead the community or be a response to community interest. Local governments in positions of greater economic advantage are most able to commit to treating urban storm water using best practices with WSUD, as was the case in Melbourne (Morison and Brown, 2011). As municipalities grow in population and wealth, their level of organisational commitment to WSUD increases. Those with obvious environmental assets are also more likely to commit to WSUD. This high commitment may be influenced by those areas with active local environmental groups and a long history of civic environmentalism. Those that form what the authors refer to as the 'limited commitment' group demonstrate problems with disassociation between the waterways and residents. Further, environmental issues appear to be fragmented, ignored and sometimes concealed by other issues of higher priority. The social learning to build public support for WSUD was insufficient, which hindered municipal commitment to WSUD (Morrison and Brown, 2011).

Some good examples of local government initiatives come from Melbourne, Brisbane and Kogarah. The City of Melbourne has been acknowledged as a WSUD leader in Australia and internationally (Wong and Brown, 2009). Brown and Clarke (2007) investigated the development of WSUD across Melbourne and suggest that the success has been the result of a complex and sophisticated interplay between key champions and local contextual variables such as the rise of environmentalism, strategic external funding and the development of industry focused co-operative research centres. Brisbane city is in a unique position for consistent waterway management as a single local authority responsible for the majority of the capital city (Rahman and Weber, 2003). In Brisbane, WSUD elements are frequently used to meet the requirements of the Storm water Management Code and the performance of particular WSUD elements such as grassed swales, constructed wetlands and bioretention devices are constantly evaluated (Rahman and Weber, 2003). This raises the importance of appropriate institutional arrangements as drivers of WSUD implementation. Local councils within New South Wales have also demonstrated to be drivers of WSUD. Singh and Kandasamy (2009) investigate two WSUD case studies from Kogarah Local Government (14km south of Sydney CBD): Connells point reserve and Shipwrights Bay. Singh and Kandasamy (2009) conclude that these sites reached their objectives through good design development, community and stakeholder consultation, project management and innovative construction of storm water treatment system. Local governments, therefore, are in a prime position to involve local communities, which is important for understanding WSUD and a necessary driver of acceptance.

Economic drivers must also be considered. They can operate at the household scale where people are keen to have cheaper water for toilet and garden but also at the neighbourhood and city scales. There is now market demand for a new green aesthetic development (Centre for Water Sensitive Cities 2011b) and Tjandraatmadja et al. (2008) reported that some developers identified that an increase in landscape amenity as a result of WSUD was attractive to the community for sustainability purposes and increased property prices. Healthy cities rely on healthy waterways (Water Sensitive Cities, 2009a), for example, the Mersey Basin Campaign to improve river water quality also helped the economic recovery of Liverpool and Manchester in the UK as businesses decided to return to the banks of the river as it improved (Water Sensitive Cities, 2009a).

2.2.1 THE IMPORTANCE OF COMMUNICATION

Gaps between actual risk and perceptions of risk suggest the need for community education. It is thought that public understanding of WSUD systems may be limited or inaccurate (Eadie, 2002 and Mongard, 2002 cited in Roy et al. 2008) and Morison and Brown (2011) suggest that WSUD jargon may prevent necessary connections with the public. Indeed, Tjandraatmadja et al. (2008) showed that poor stakeholder engagement and management of community expectations were barriers to the successful implementation of WSUD developments. Issues included a lack of familiarity with WSUD development systems and the requirement for a greater involvement of community in the management of decentralised systems. Also Marks and Zadoroznyj (2005) investigated four case studies which included Mawson Lakes and New Haven Village in Adelaide. They found low awareness of operations and risks associated with non-potable re-use in these sites. The authors conclude that having transparency in governance and regulatory systems as well as two-way communication between stakeholders is vital in ensuring a smooth transition to decentralised water systems.

Although there may be many limitations to public understanding of WSUD, there has been a significant increase in the focus on the role of communities in both refining the WSUD problem and participating in developing WSUD strategies, Wong (2007) gives examples of the incorporation of public art and the implementation of community participatory action models. Demonstration sites and utilising the media effectively have been noted by Roy et al. (2008) as ways to increase public awareness and reduce any scepticism or resistance to WSUD. Even simple techniques like putting blue dye into recycled greywater can increase residents' awareness that the blue water is for non-potable use (Sant Cugat regional council in Spain: Water Sensitive Cities, 2009b).

Three examples of effective public communication come from Perth in Western Australia, Zaragoza in Spain and Singapore. Perth has been using water from aquifers as an important water source but, due to overuse, water levels are declining with negative consequences for ecosystems dependent on groundwater and variations in the water table have led to contamination of the aquifer (Government of Western Australia 2009). The water supplier, the Water Corporation of Western Australia, has piloted a Managed Aquifer Recharge scheme to replenish the aquifer with treated sewerage and storm water. The treatment process is thorough, involving microfiltration, ultraviolet and microwave treatments and reverse osmosis. Community engagement has been a key part of the pilot and an interactive website a major component of the community engagement process. The key features of the website are transparency and two-way communication. All deviations from ideal operating levels are reported online and available to the public, as is the action taken by the Water Corportation to address the problem, additionally, the public can make comments or ask questions about the process.

Zaragoza in north-eastern Spain also showcases examples of good communication. It has a focus on water literacy amongst its citizens with a centrally located public water library as part of its water saving program. The program focuses on reducing water use in the family home by enlisting water 'champions', using an interactive website where water saving ideas can be uploaded and has approximately 140,000 active participants. It also hosted the international Expo Zaragoza 2008 – Water and Sustainable Development exhibition which attracted high profile leaders, celebrities and sports people (Water Sensitive Cities, 2009a).

The success of the NEWater recycling facility in Singapore has been credited to the Public Utility Board (PUB) for creating a focus on water literacy amongst citizens. Despite processing wastewater and storm water for potable uses, the NEWater scheme seems to have wide public acceptance (Water Sensitive Cities, 2009b). Numerous techniques were used in the successful awareness raising campaign of Singapore's Water Reclamation Scheme, such as documentaries, media releases, internet websites, school visits and a visitor's centre (Po et al. 2003). Singapore's Water Authority, PUB, states that part of the reason the Singaporean public have been accepting of the NEWater scheme is because the water authority decided to change the pre-existing communication paradigm to one where creative communication methods, such as street style magazines and creative ideas for people to engage with water recreationally, were used to encourage Singaporeans to take ownership over their water supply (PUB, 2008). Visitors to NEWater in Singapore are invited to watch videos of Californian residents speaking about the benefits of the California

Water 21 reuse scheme (Khan and Gerrard, 2006). Elements of the paradigm shift in PUB's water communication included: a Water Wally mascot, a magazine style annual report, a street style magazine revolving around water aimed at youth, use of glamorous celebrities in promotion, attractive packaging for NEWater bottles and an open, honest and timely approach in all media releases (PUB, 2008).

2.2.2 THE ROLE OF AESTHETICS

Suburban development has often been attacked for its aesthetics, commonly seen as monotonous, bland and tasteless (Forsyth and Crewe, 2011). In response, many planners, architects and theorists have attempted creating more attractive and aesthetically pleasing urban design options, including water sensitive urban design, throughout various suburban developments over recent years (Forsyth and Crewe, 2011). Dzidic and Green (2012) investigated the acceptance of alternative non-potable water supply schemes and the role of aesthetics. Results from a photo-elicitation survey depicting aesthetically degraded water (staining, discolouration and turbidity) in different use scenarios (toilet, laundry, garden) demonstrated that overall participants were accepting of some degree of aesthetic degradation for all non-potable uses. Participants were accepting of using non potable groundwater for the watering of public open space and household gardens, regardless of the aesthetic attribute. However, acceptability decreased as use became more personal, e.g. clothes washing less acceptable than use in the toilet, which aligns with other research demonstrating that acceptability decreases as uses become more 'personal' (Lazarova et al., 2003). In addition, issues relating to fairness and 'keeping up appearances' were identified as influences on acceptance. The importance of the neighbourhood context is so great that people are more inclined to accept a non-potable groundwater scheme, or other sustainable urban design features, if they are operating at the neighbourhood scale (Nassauer et al., 2009).

2.3 Institutional and industry issues

Despite rapid development of technology and infrastructure, change to water sensitive urban environments remains slow and cities continue to invest in conventional approaches to water management (Wong and Brown, 2009). There are a number of reasons for the inertia.

First, barriers arise from institutional arrangements. Water authorities, local governments, government departments and private industries have evolved to deliver conventional water services, therefore, a re-evaluation of roles and responsibilities within organisations is needed to deliver water services with integrated water management concepts (Mitchell, 2004). Current organisational structures for urban water management treat water supply, storm water management and wastewater services separately which is inefficient for sustainable urban water management (Shipton and Mitchell, 2002; cited in Sharma et al. 2012). For Melbourne from mid 1960s to 2006, Brown and Clarke (2007) concluded there was a lack of co-ordination of policies, fragmented administrative frameworks, lack of trust, and inappropriate risk transfers between stakeholder organisations, which impedes change. Further, they note that conflict between design and authoritarian processes can hinder innovation and change and reinforce existing historical administrative, political and economic values.

Second, there is a general lack of information on the performance of WSUD projects over their life cycle, which inhibits change to non-conventional approaches to water management systems. This includes a lack of data on maintenance and operating costs (Brown, Farrelly and Keath, 2007; Urrutiaguer, Lloyd, and Lamshed, 2010) and lack of knowledge about construction and maintenance practices (Wong 2007). To help overcome this barrier Sharma et al. (2012) suggest that knowledge about water quality monitoring, operation and maintenance requirements need to be published in the public domain.

The third barrier to change is economic. Although sustainable and water sensitive urban design is becoming more prominent in residential developments, developers may still hold reservations due to perceived barriers such as increased cost, and the lack of desire for changes in the housing market as properties sell regardless of their design during real estate 'booms' (Brown and Liebman, 2004). Further, Wong (2007) highlights the conflicting roles that land development companies may have, needing to be profitable whilst

ensuring suburbs are built that enhance the social and community wellbeing needs of its residents. The institutional problems noted above have economic consequences as lack of local government consistency and lack of clear guidelines leads to approval delays and increased costs (Brown and Liebman, 2004).

3 Social and design theories underpinning community acceptance of WSUD

Two social theories that are able to provide an understanding for community acceptance of change to water management systems are place attachment theory and social capital theory. These theories are described in the sections below. Both frameworks are not independent or competing, rather they are interconnected and can potentially be applied in unison as drivers of change. They provide the fullest explanation of acceptance in this context when applied in collaboration with relevant theories of urban design, such as green urbanism, so that the social and physical components are integrated into the overall shaping of a community.

3.1 Place attachment theory

Attachment to place refers to a dependence on or an emotional bond with biophysical aspects of the landscape; such as the natural resources or the recreational and open spaces that support social activities. There are a number of related terms used in the literature such as sense of place, place identity and place satisfaction (see Deutsch and Goulias, 2009). The strongest connection to place is reflected in the term place identity which refers to a state whereby behaviours and self identity (their sense of themselves), or their collective group belonging, become equated with a particular locale through process, project and performance. Devine Wright and Howes (2010) argue that interpreting attachment to a place is as much a social as a psychological process. In a context of change, individuals adopt specific beliefs and attitudes contingent upon levels of trust which position them among influential groups or institutions (such as energy companies, government agencies or local opposition groups) which are actively seeking to influence ways of thinking (Devine Wright, 2010). Given that many WSUD systems service defined locations such as a neighbourhood, place identity and attachment could be important drivers for the support for WSUD systems especially where the WSUD system improves the ambiance of the area through greenery or water features. However there are likely to be variations in the degree of attachment from just enjoying the pleasant ambiance to a strong personal identification. Such variations in attachment are likely to influence people's engagement and general support for WSUD schemes.

3.2 Social capital

WSUD initiative can be recognised as 'common pool resources' either in the narrow sense that a neighbourhood may share the maintenance and benefits of an installation or in the broader sense that the water supply is a finite resource that needs to be shared across the city. In the broadest sense the environment is a common pool resource for everyone on the planet.

Ostrom (1990) argued that management of common pool resources is widespread and only becomes a problem when "participants may simply have no capacity to communicate with each other, no way to develop trust or no sense that they must share a common future" (1990 p21). Since Ostrom formed her argument, Putnam [Putnam (2000); Putnam, Leonardi, and Nanetti (1993)] has popularised the concept of social capital and the literature has grown exponentially (Halpern, 2005). The definitions of social capital are now many and varied but the common thread is social networks and the resources that can accrue from them (Rostila, 2010). The concepts of trust and a sense of shared resources are also common themes. (eg Putnam 2000; Leonard and Onyx, 2004). Thus the issue of the management of common pool resources can be understood as only problematic in the absence of social capital.

There have been a number of studies that have identified a positive relationship between social capital and environmental action primarily in rural communities in developing countries (Adger, 2003; Anderson,

Locker, & Nugent, 2002; Pretty & Ward, 2001). In Australia, Onyx, Osburn, and Bullen (2004), found a strong relationship between social capital and concern for the environment in a remote mining town. Also Morrison, Oczkowski, and Greig (2011) found social capital was a better predictor of landholders' participation in environmental programs than psychological theories which focused on attitudes. Some of the most powerful evidence however comes from Portney and Berry (2010) who examined 27 US cities using the Social Capital Benchmark Survey. They found that those cities most committed to pursuing sustainability policies did tend to be more participatory places with respect to signing petitions, participating in demonstrations, belonging to local reform groups, and joining neighbourhood associations, even controlling for personal income and other factors related to social capital.

In the current project, participants' social capital will be examined at several levels. Mostly directly participants will be asked about their sense of joint shared ownership, communication with neighbours, and participation in the maintenance of their local WSUD installation (eg helping to maintain clean storm water runoff). More generally they will be asked about their attitudes and activities in relation to water and the environment as shared resources and the particular importance of WSUD schemes in the Adelaide region.

3.3 Green urbanism

Many water projects are deemed most successful when they are incorporated into the overall design of the city or precinct. Therefore water is a strong component of urban design and is incorporated into many theories and visions shaping the design of urban areas, particularly in the Green Urbanism movement (Beatley, 2000). Lehmann (2010) outlines three main pillars of Green Urbanism, including energy and materials; water and biodiversity; and urban planning and transport. Within the water and biodiversity pillar the emphasis is on urban water management; water recycling and irrigation; grey water recycling; and storage of urban storm water. Lehman also describes 15 guiding principles of Green Urbanism of which water is one, suggesting that urban design components need to work interactively to achieve sustainable urban development. This focus on the importance of interaction between urban components suggests that in the current project it will be important to gain insight into participants perceptions of not just the WSUD attributes of their suburb but also their knowledge and experience of other elements which may have been influenced by WSUD, for example recreation areas.

4 Project aims and rationale

This project explores the factors that influence community acceptance of existing WSUD approaches within the Greater Adelaide region, and considers ways to create community support for WSUD approaches. It is anticipated that uncovering perceptions about past and current WSUD developments will lead to the identification of socio-technical drivers that will influence greater uptake of WSUD by governments and industry. This information will inform policies for the uptake of preferred WSUD systems in the Adelaide region.

4.1 Aims

The project aims to determine the drivers that encourage or inhibit community acceptance of WSUD. More specifically, answers will be sought for the following questions:

What are the perceived benefits of WSUD by community members?

This aim addresses whether or not there is community support for WSUD and why, by examining what people like about WSUD, whether there are particular types of WSUD features that they view favourably, and how they view WSUD as a benefit to their community or everyday lives.

What are the perceived barriers affecting the uptake of WSUD by the community?

This aim addresses what and why people don't like WSUD by identifying sources of dissatisfaction with WSUD, and whether there are particular WSUD features that they do not support. In particular, the cost of WSUD and any knowledge deficits are considered. These factors, if left unaddressed, may evolve into a lack of acceptance of the WSUD concept and act as potential barriers to the wider uptake of WSUD within the community.

How is the community responding to WSUD?

This aim examines how the community integrates the WSUD features into their day to day living and the resultant impact on the social fabric of their community.

What are ways to improve community acceptance of WSUD over the long term?

This aim investigates different approaches that communities recommend to improve the wider uptake of WSUD, including the role of education and key stakeholders. This aim is addressed by drawing on the community's previous experiences with WSUD, such as during the design, implementation, and ongoing management phases.

4.2 Rationale: the need for community involvement in WSUD

The implementation and delivery of WSUD systems is generally driven or initiated by local government or developers. Although the end users are likely to have daily interaction with the WSUD system they are not usually invited to provide input into the type of WSUD systems in their environs. Community engagement prior to implementation is not generally possible with new developments, so it is important to understand the social-technical drivers that have the potential to influence the uptake of WSUD systems in South Australia, and to identify solutions for dealing with issues such as ownership and maintenance.

In particular, there is a need to better understand issues such as perceived additional costs, safety issues, operation, management, and technical understanding of WSUD developments. It is expected that this will

deliver a detailed characterisation of community acceptance of WSUD and the types of WSUD measures that are most effective with consideration given to a range of community based issues.

5 Methods

The research was conducted in Adelaide, South Australia and focussed on six urban sites with WSUD features (see

). Data collection occurred between January and June 2013. Ethical approval for the study was granted by the CSIRO Human Research Ethics Committee.

5.1 Study design

The research design used a case study approach and included six in-depth case studies of WSUD sites across Adelaide. Yin defines the case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between the phenomenon and context are not clearly evident" (Yin 1991: 23). As Sarantakos (1998) notes, the case study is appropriate when the object of study is complex and the researcher is interested in the structure process and outcomes of a particular unit. Key features of case study research are the focus on a unit in its entirety, use of a variety of method applied to a single unit, respondents are viewed as key informants, and the units chosen for study are exemplars of a particular type of case. For each site in the present research there were three main components to the data collection: 1) analysis of the technical aspects of the WSUD sites, 2) key informant interviews, focus groups and short interviews, and 3) questionnaires to assess attitudes to the environment and water.

5.1.1 WSUD SITE ANALYSIS AND SITE SELECTION

The initial phase of the study involved the collation of data on the Adelaide context and a range of potential sites with WSUD features. This phase involved seeking information from a number of key informants including water providers, researchers and government personnel, as well as preliminary visits to potential sites. A desktop review was undertaken to further understand the technical and demographic aspects of potential sites before selection, for example, plans, management systems, extent of site, site analysis (e.g. ABS information on population, type of dwellings, land use mix etc; geographical attributes; local government). WSUD sites that were under construction and not yet being utilised were excluded from consideration. From over 200 sites in Adelaide, twelve were selected as potential case study sites. Eight selection criteria were used to determine the final six sites for the project, and these criteria are summarised in Table 2.

Table 2 Broad project criteria for selecting sites for in depth socio/technical and post implementation investigation

CRITERION	JUSTIFICATION
1. Select a case study for each of the rainfall zones in Greater Adelaide, as defined for the Goyder targets project	A selection of a case study site in each of the zones will capture the diversity in rainfall patterns that impact on storm water management issues, and also influences the demand and supply of local water sources.
2. Select a case study for each alternative water source used (recycled water, rainwater, storm water (aboveground and ASR)	The community perceptions of risks and acceptance are likely to vary depending on the alternative water source being used. Also, the issues associated with maintenance and operation is also likely to be different for these water sources.
3. Select a case study for each major WSUD approach for storm water management (permeable paving, bioretention swales, wetlands etc.)	The community acceptance are likely to vary depending on the WSUD approach, and how noticeable the feature is in the urban environment or if the functioning of the system is integrated with the landscape and out of sight.
4. Select a case study representing different development types (infill, retrofit and greenfield)	The drivers for implementing WSUD may vary depending on the development type, and it will also influence the community perceptions if the WSUD approach is either imposed as change in an existing context (retrofit), or is implemented at the time of development prior to being occupied. (Greenfield)
5. Density of development – medium density and low density housing)	Same as for 4.
6. Scale of development (lot, street, cluster, development)	The scale of development will influence both the resources that were available for the planning and implementation, and also the appropriate models for ongoing operation and maintenance.
7. Availability of monitoring studies and supporting information	To enable in-depth case studies supporting information in the form of reports, monitoring studies will be useful to allow the case study developments to be described. In some cases there may have been previous community consultation processes, while this may mean the issues have already been explored it could provide some good validation to findings and background to issues.
8. A range in the Socio-economic status of the residents	It is possible that those with higher incomes and higher levels of education might better understand and appreciate the WSUD installations,

The six sites selected for in-depth case study were Mawson Lakes, Lochiel Park, Springbank Waters, Harbrow Grove Reserve, Mile End, and Christie Walk. The sites demonstrate significant diversity in technical, social and institutional aspects and were considered appropriate for detailed socio-technical analysis. A brief overview of each site detailing the WSUD features and neighbourhood characteristics is presented in

. In addition, demographic information (sourced from the 2011 ABS Census) for each of the suburbs in which the six WSUD sites indicated a range of ages, education levels and median household incomes across the six sites. Detailed tables of demographic data for each site can be found in Appendix A.

Table 3 Six WSUD sites selected for detailed socio-technical analysis

WSUD SITE	COUNCIL	ALTERNATIVE WATER SOURCE USED	WSUD ELEMENTS	DEVELOPMENT TYPE	SCALE OF DEVELOPMENT
Mawson Lakes	Salisbury	Storm water Wastewater	Wetlands ASR Wastewater reuse	Greenfield (mixed use)	Large
Lochiel Park	Campbell-town	Rain water Storm water	Bioretention Wetlands ASR	Infill	Medium
Springbank Waters	Salisbury	Storm water	Wetlands ASR	Greenfield	Medium
Harbrow Grove Reserve	Marion	Storm water	Swales Bioretention	Retrofit	Neighbourhood
Mile End streetscape	West Torrens	Storm water	Bioretention	Retrofit	Street scale
Christie Walk	Adelaide	Rain water Storm water	Raintank and greenroof	Retrofit	Small

5.1.2 KEY INFORMANT INTERVIEWS AND FOCUS GROUPS

At each chosen site, interviews and focus groups were held with members of the community who used the WSUD facility either through living or working in the area, or through some other association (e.g. representatives from local government). The interviews were conducted prior to the focus groups in order for the project team to gain some perspective into each site from key informants before inviting members of the community to a broader discussion. There were two types of interviews conducted: a) with residents of the area selected from referrals, or because of the positions of voluntary leadership that they held, and b) with non-residents who were associated with the site either through working in the neighbourhood or visiting on a regular basis for some other reason. These included real estate agents, school officials, business owners, and an elected representative.

There were eight focus groups across the six sites. At Mawson Lakes, the participants split into two separate groups for the main discussion. There were also two focus group sessions held at Springbank Waters in order to reach residents associated with the school, and Community Centre users during separately scheduled events (day and evening). The number of participants attending the focus groups ranged from 5 to 12. Overall there were 17 resident key informant interviews, 6 non-resident key informant interviews, 30 doorknocking short interviews, and 77 focus group participants.

5.1.3 BRIEF QUESTIONNAIRE WITH ATTITUDE SCALES

Prior to the commencement of interviews and focus groups, participants were asked to complete a brief questionnaire that assessed attitudes towards water and the environment, as well as obtaining background demographic information.

5.2 Data collection

5.2.1 INSTRUMENTS

Examples of the instruments used in the study are all supplied in the Appendices for this report. A brief description of each is provided below.

Participant information and consent forms (Appendix B and Appendix C)

Information and consent forms were prepared in accordance with requirements of the CSIRO Human Ethics Committee. The information sheet explained the purpose of the study to participants and outlined potential risks of involvement. The consent form was required to be signed in order for participation in either the interview or focus group to proceed. Slightly different information and consent forms were prepared for interviews versus focus groups reflecting the different types of participation.

WSUD site fact sheets (APPENDIX D)

A technical fact sheet was prepared for each of the six WSUD sites to provide participants with a brief explanation of the systems in their area. These fact sheets were given to participants during both interviews and focus groups after they had been asked to describe (in interviews) or draw (in focus groups) their existing knowledge.

Interview schedules for each site

Interview schedules were prepared for each of the WSUD sites. The introduction of the interview differed slightly depending on whether or not the participant was a local resident, however the remainder of the interview was identical for both residents and non-residents. The schedules covered a range of topics including affiliation/ relationship with the site, awareness and knowledge about the local system, general opinions about the site (from peers / colleagues), personal opinions of the site including benefits and problems, whether or not they would recommend similar features to be developed in other areas and comparisons with other types of water systems across Adelaide. (Example in Appendix E).

Focus group schedules for each site

A schedule was developed for the focus groups at each of the sites. The discussion topics were similar to those covered in the interview schedule. More detail about the focus group process is provided below. (Example in Appendix F).

Focus group PowerPoint presentations for each site

A PowerPoint presentation was developed for each of the focus group sites. The presentation included a welcome slide and one or two slides to provide a brief explanation of the WSUD features associated with the site (identical to the information provided in the WSUD site fact sheets). The final slide outlined the topics to be covered in the group discussion. (Example in Appendix G).

Questionnaire (Appendix H)

A brief questionnaire seeking attitude and demographic information was prepared for participants in interviews and focus groups. The attitude questions consisted of 16 items with five-point Likert scale responses (ranging from Strongly Disagree to Strongly Agree). The items measured pro-environmental beliefs, attitudes towards waste, water value beliefs, and water security beliefs. All items were based on previously reported measures or past research in the water domain and demonstrated high levels of reliability. Table 4 outlines the description of each scale used, and Appendix H details the questions for each of the sixteen scale items. The demographic questions sought information about the age, gender and education level of the participant, as well as, information about whether or not they were a local resident and the length of time they have been associated with the area.

Table 4 Description of the scales

NAME OF ATTITUDE SCALE	RELIABILITY*	REFERENCE
Pro-environmental beliefs (4 items)	Coef H = .86	Adapted Dunlap et al., (2000)
Attitude towards waste (4 items)	Coef H =.84	Adapted Fujii (2006)
Water value beliefs (4 items)	Coef H =.83	Developed from past water research (Mankad &Tucker, 2013; Mankad et al., 2011)
Water security beliefs (4 items)	Coef H =.87	Based on problem awareness measures (Eriksson et al., 2006)

*Coef H is a measure of reliability, a Coef H over .7 is considered reliable

Knowledge Diagrams

To gain an understanding of people's level of knowledge of WSUD, focus group participants were asked to draw a representation of the WSUD features at their location. A blank piece of paper and coloured pens were used for this activity.

5.2.2 DATA COLLECTION PROCESS

Participant recruitment

A combination of methods was employed to recruit participants for key informant interviews and focus groups. These included contacting local businesses, community groups and other relevant organisations (e.g. schools, local government, sporting groups) to invite representative spokespeople to take part. In addition, residents were targeted through leafleting, advertisements in local newspapers, door-knocking and through resident contact channels that existed in some areas (e.g. resident email lists). In some instances, members of the research team attended regular meetings of existing community groups (e.g. the Burton Primary School Governing Council meeting) to speak to community members in that setting. All interview participants were also asked for advice on how to contact additional individuals for interviews and focus groups. In this way, existing community networks were used to reach as many people as possible.

Interview protocol

The interviews commenced with a brief introduction and the signing of consent forms. Participants were then asked to complete the questionnaire before the interview questions began. After the first set of questions, which asked participants about their existing knowledge of the WSUD systems in the area, the participants were shown the WSUD site fact sheets to explain how the system worked. Interviews were mainly conducted with just one participant at a time, however, in some cases there were two or more present. Interviews were generally about 30 minutes in length. All interviews were recorded and later transcribed. At the two neighbourhood scale WSUD developments where those most impacted lived immediately adjacent, supplemental interviews were also completed. In Mile End, doorknocking provided a rich data source with interviews lasting about 10 minutes.

At Harbrow Grove, given a lack of informant referrals and the absence of a targeted community organisation, a series of short interviews (lasting approximately 5 minutes) were also conducted with members of the community who were approached by a member of the research team. Participants of these latter interviews were not asked to complete questionnaires. Detailed notes were taken of the responses.

Focus group schedule

The focus groups were facilitated by a member of the research team, following a standard script. The session commenced with introductions and the completion of consent forms and questionnaires. A knowledge diagram activity then took place in which participants were asked to draw a representation of their understanding of the water systems in their local area. They were provided with a blank sheet of paper and a variety of coloured pens for the exercise. After collection of the diagrams, a technical explanation of the local WSUD features was then presented by one of the hydrologists involved in the WSUD project, who also attended the focus group session. Participants were given the opportunity to ask questions about the water system features to clarify their understanding. The group discussion then commenced with the participants encouraged to share their opinions on seven topics including:

1. Benefits of having the WSUD system in the local area.
2. Functioning of the system and any related problems.
3. Costs of the system.
4. Access to information and management of the system.
5. Future improvements that would be desirable or potential problems.
6. Comparison with other systems.
7. Overall assessment.

Focus groups were audio-recorded after permission had been sought from participants.

5.3 Data management and analysis

5.3.1 DATA MANAGEMENT

All recordings of interviews and focus groups were professionally transcribed by a commercial transcription service. All data was stored on a secured server and hard copies were stored in a locked access area, to preserve confidentiality.

Qualitative analysis

The transcripts, along with notes taken by the project team during interviews and focus groups formed the basis of the qualitative social analysis. Verbal content was analysed by grouping similar responses and identifying them broadly as drivers, inhibitors or future recommendations. Following this first order grouping, more detailed sub-themes were identified.

Quantitative analysis

The questionnaire data was entered into an excel spreadsheet and imported into STATA software for analysis. Each of the six sites was compared to an Adelaide-wide sample collected in the Goyder Managed Aquifer Recharge Storm water Use Options (MARSUO) survey (Mankad et al., 2013). For each scale, the *t* statistic, allowing for unequal variances, was calculated and used to compare the mean for the site with the mean for the Adelaide-wide sample (Appendix I).

Assessment of knowledge diagrams

Each element (either drawn or written) within the knowledge diagrams was classified into one of six categories (water source/capture, water storage, treatment, distribution and removal, end uses, other). A total count was then made of the number (and %) of people who either drew or mentioned: a) at least one element in each category, and b) each individual element (see Appendix J).

6 Results

6.1 Christie Walk

Christie Walk is a medium density residential development of about 50 people located within the Adelaide CBD, which has a population of nearly 13,000. In the CBD there is predominantly high density housing and an average of 1.8 people per household. The median age of residents within the CBD is 29 years and 56% have had Tertiary education. The median weekly household income $949 and approximately 33% of CBD residents are homeowners (National census, ABS 2011). The development aims to provide an eco-friendly and sustainable neighbourhood amidst the densely populated CBD.

Figure 1 Christie Walk roof garden

The Christie Walk development consists of 27 separate dwellings, which are a mix of townhouses and apartments with communal indoor and outdoor spaces to promote social mixing among the residents. The site is situated on a T-shaped block of land of approximately 2000 square meters (the size of two to three urban blocks). The development was initiated in 1999 by Urban Ecology Australia and was intended to be a demonstration project to promote the viability of a liveable, affordable and environmentally sensitive urban community (Urban Ecology Australia, 2013).

The Christie Walk project is a community initiative with a vision for more sustainable living. At the initial stage the price of the homes ranged from $200,000 to nearly $400,000 per house.

The development claims to be the first of its kind in Australia; an inner city high density model with sustainable living. It has a number of pro-environmental features including:

- Positioning of the openings to capture maximum sunlight.
- Double glazed windows and 125mm thick self supporting walls to provide extra insulation, future proofing and energy saving.

- Utilisation of diversified ecofriendly construction methods like the 'Straw bar construction' to exclude toxic materials from being used for Enhancing visual amenity within the building by providing curving off the edges.
- Adoption of integrated building design incorporating seismic design and weather, fire and vermin proofing with an estimated building life span of 100 years.
- Wide spread use of bicycles, car pooling facilities, and public transport for individual commuting purposes.
- Use of solar energy for supplementing the electricity supply and shared laundry facilities.
- Sealed paving has been avoided, with permeable pavers having been installed by the residents themselves to allow storm water infiltration.
- Excellent solid waste management strategy with the focus on achieving zero contaminant transport out of the site (organic waste generated in the development converted to compost and reused in gardens and usage of only three bins for the whole development suggesting lower waste generation rate), which received appreciation from Adelaide City Council.

6.1.1 WSUD FEATURES

The architect and the Convenor of Urban Ecology Australia were key sources of information about the WSUD features at Christie Walk. Roof runoff (except the green roof runoff, which is directed to the sub-surface soakage) and surface water runoff at the site are captured and stored in two large underground tanks to meet demand for community garden irrigation and for toilet flushing in some of the residences. There are two small rainwater tanks (circa 1 kL) that harvest water off rooves not connected to the main storm water system (e.g. verandas), which is used for garden watering. Roof water is also collected and stored in a smaller rainwater tank located in the front apartment building for public irrigation purposes. There were plans for onsite treatment and reuse of wastewater, however, the costs associated with building and operating the proposed scheme was considered prohibitive. Two water meters on-site record the mains water consumption for the site and SA Water provides the development with an aggregate water bill, which is equally divided between 27 residences irrespective of the quantity used by each. Residents closely monitor the water consumption within the complex. Some of the apartment buildings use ultra-flush toilets which have lower water requirements compared to the normal ones due to their siphon action principle, which further reduces the development's dependence on mains water for non-potable purposes. Irrigation at the development has been minimised through planting of drought tolerant species, and in the case of the produce garden and ornamental plants irrigation is adjusted to the seasonal demands and recent rainfall. The WSUD features at the site are summarised in Table 5, and an overview of the storm water management system is illustrated in Figure 2.

Table 5 Summary of WSUD features at Christie Walk

FEATURE	TECHNICAL ASPECTS	OUTCOME
Storm water reuse	Roof and surface runoff captured and stored in two large underground tanks with 20,000 litre capacity each. Runoff to the street is limited by the slope of the entrances. To avoid site flooding when there is excess water, a high volume low pressure pump is used to discharge water into street drainage.	Community garden irrigation reduces heat island effects and allows vegetable production. Reduced use of mains water for toilet flushing and garden. Storm water runoff is reduced and filtered.
Rainwater	Most roof capture is stored in the underground tanks where it mixes with surface run-off. There is also a small tank for collecting roof run-off at the front of the complex.	Garden irrigation of delicate plants.
Green roof	Roof garden has a slight grade towards drains along the perimeter; this water is discharged to sub-surface soakage.	Supports local biodiversity; Effectively stops first flush getting into the drains; and provides for roof insulation and the mitigation of local urban heat island effect.
Wastewater recycling scheme	Planned system for onsite wastewater treatment and reuse.	Abandoned due to high costs relative to benefits for scale of development.

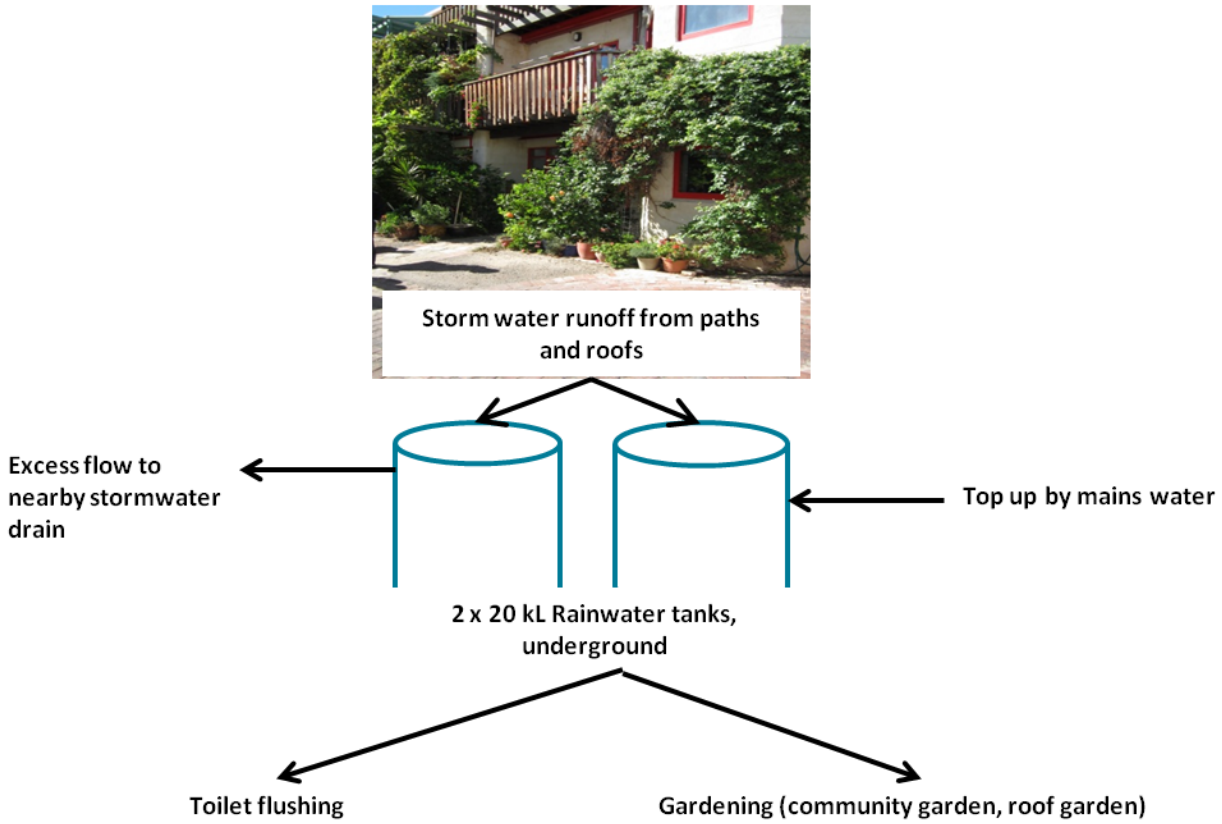

Figure 2 Storm water management at Christie Walk

6.1.2 COMMUNITY PARTICIPANTS

A key informant interview was conducted with the convener of Urban Ecology Australia which is the community education group in Christie Walk, with input from two other residents. Ten people attended the focus groups, in total 25% of adult residents gave input into to the research.

The residents who represented the development in the focus group and interview mainly consisted of older people with a median age of 60-75 with only two participants below 60 years of age. Nine participants reported having a university degree(s) and 80% were home owners. The group represented a mix of people including long-term residents (who have lived there for more than 10 years since the completion of Phase 1 of the development) and some who had lived there for only a few months.

As described in the Method section, four scales were used to measure the respondents' pro-environmental attitudes and attitudes to water so see if the respondents were significantly different from the general population of Adelaide. The residents from the Christie Walk development differed from the general population on two scales. They had higher scores for pro-environmental attitudes and a more negative attitude to wasting water compared to the general population of Adelaide. The scores regarding the concept of valuing water and water security scale were high, and were comparable to the general Adelaide population (details in Appendix I). These differences are not surprising given that the development was designed to attract people who were interested in living sustainably. However, eco-developments such as Christie Walk require a very strong environmental ethos, which might not have a broad appeal across the population.

6.1.3 KNOWLEDGE AND UNDERSTANDING OF THE WSUD SYSTEM AT CHRISTIE WALK

Based on the focus group discussions and their diagrammatic representations of the WSUD features in Christie Walk, participants seemed very knowledgeable of the main features of their site. In response to high community and international interest in low footprint urban in-fill and sustainable lifestyles, Christie Walk has a formal system to host resident-led paid tours by school groups, professionals and homeowners. Residents leading such tours need to be very well informed. In their diagrams, they included both rainwater and storm water run-off in their depictions of water collection and the underground water tank for storage. All the respondents illustrated the collected water as being used in the garden and all except for one mentioned the toilet as a component of reuse but it is not certain if they are aware of the ultra low flush properties. Each mentioned at least one aspect of distribution (e.g. reticulated storm water) and they were keen enough to mention minor WSUD components such as the additional tank, low-flow shower heads, and more community driven measures like shower timers and bucketing greywater (see Appendix J). However, there was a lack of understanding among participants of the benefits to rivers and coastal waters in limiting the storm water runoff from the site.

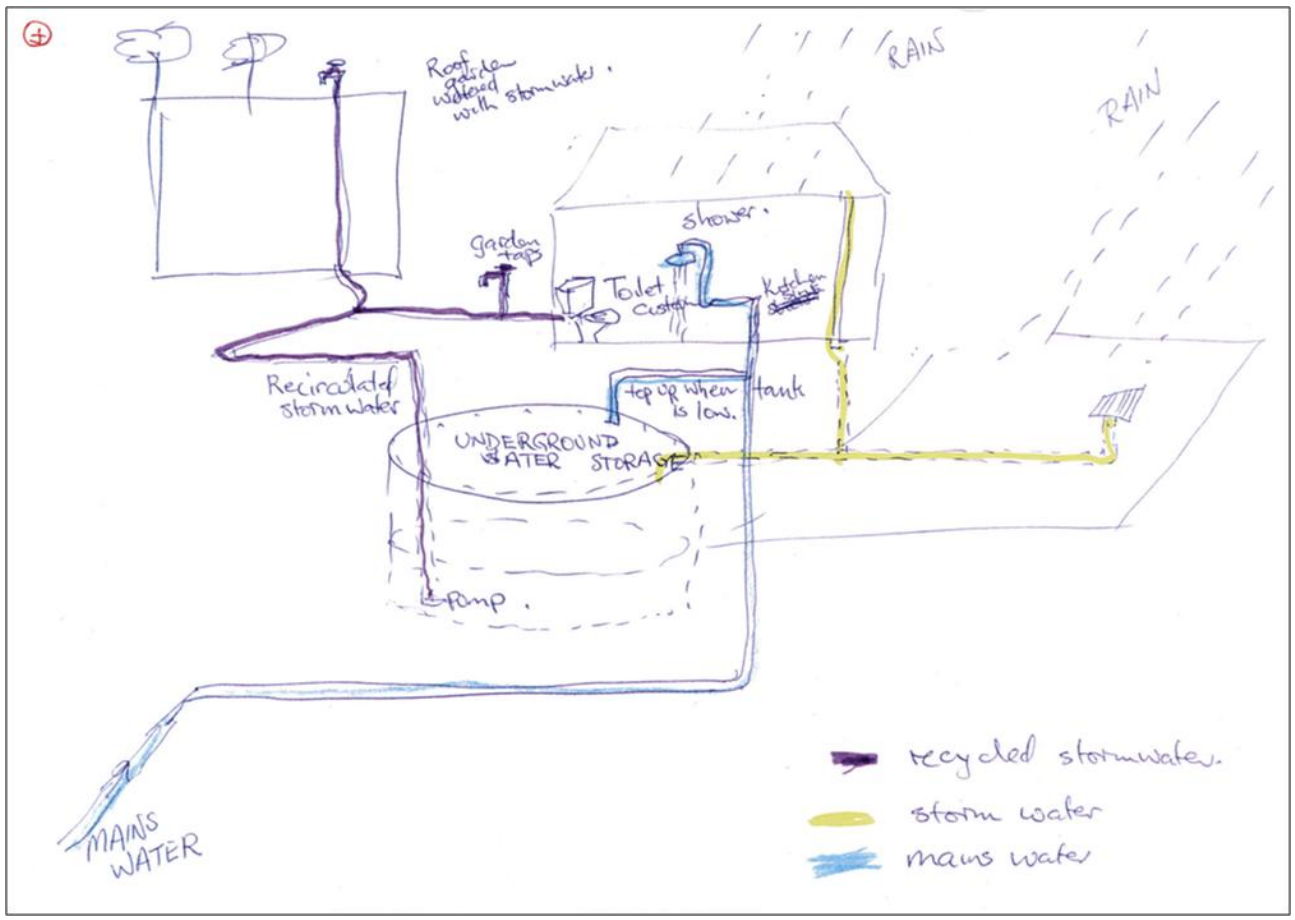

Figure 3 Best depiction of the WSUD system at Christie Walk

6.1.4 WHAT PEOPLE LIKE ABOUT CHRISTIE WALK

Residents viewed Christie Walk very favourably, reporting that they loved living in the complex and enjoyed the benefits of an inner city location, the strong sense of community, and sustainable living approaches. Resident groups were very active within the complex and worked collaboratively on pro-environmental activities and the ongoing management of their water features by forming groups and committees for managing and recycling green waste as well as monitoring the water consumption, and held regular working bees for garden maintenance and maintenance of their WSUD installations. There was a clear sense of ownership in the way participants discussed their housing community and the language used suggested that taking part in the various committees was almost expected, to demonstrate one's commitment to the sustainability ethos of the development.

Collecting, storing and reusing storm water was very satisfying to residents and appealed to their notion of preserving precious resources and limiting waste. Storm water reuse enabled the residents to maintain a community vegetable patch, fruit garden and extensive greenscape without the concern for high water costs. The WSUD features of Christie Walk also supported other water saving initiatives that were undertaken by the residents within the complex, such as bucketing shower water for the garden, and plants are spatially arranged by their water requirements (native, hand-watered, fruit and vegetables).

Overall, residents were very proud of their water conservation strategies and this contributed to a wider sense of pride in the complex, including their areas of greenery, solar energy supply, and the unique construction of their houses, which were made from natural and renewable materials. The WSUD features at Christie Walk were experienced and enjoyed as part of a 'bundle of benefits', which included inner city living, a small ecological footprint, and a strong sense of community. Further details of key aspects that residents liked about Christie Walk are included in Table 6.

Table 6 Key aspects that residents liked about Christie Walk

ASPECT	DESCRIPTION	EXAMPLE
Strong sense of community	Residents enjoyed a strong sense of community depicted as a supportive community and a 'great bunch of people.'	*"The pulling together to make things happen is probably the most enjoyable part of this place for me and facilitating some of the group activities, including the governance of the whole community."*
	They formed active groups and worked collaboratively on initiatives that supported pro-environmental and sustainable lifestyles; and the ongoing maintenance of the WSUD features within the complex.	*"I belong to the maintenance group. So you're always looking for how to improve the place and do things with others."*
	Even though many of the residents were initially attracted to the eco-village notion of CW, the collaborative approach to activities and ongoing management had added a very positive dimension to the CW experience.	*"I initially moved here because of the environmental credentials but I've thoroughly enjoyed the collaborative activities that we get up to."*
	Owner-occupiers as well as tenants embraced the 'eco' way of living; both developing a strong sense of ownership of the WSUD features.	*"There's a lot of social capital invested in this place. People have a really strong sense of ownership."*
Sustainability dimension	Residents viewed the 'sustainable way of living' favourably, and saw this aspect as a benefit of living at CW; including water conservation and the WSUD features. There is an induction when moving into the complex, with manuals and training available.	*"I love living here. I [am] attracted by the whole environmental ethos."* *"We use all the water that we feel we need to and yet use a whole lot less on average than even households without gardens. So that's very satisfying to know that."*
The notion of 'not wasting' water	Residents not only embraced their WSUD features for saving and storing water, but also actively tried to use water efficiently by collecting greywater, and planting water efficient plants.	*"I like that we get feedback on our water consumption when the bill comes in so that we get a sense of how we're doing and, yeah, I find it very satisfying that we use - without any great effort, but a little bit of pre-planning - we use way less than the average."*
Greenscape (30% of the footprint)	The greenscape created is dominant within the complex which appealed to residents and visitors. Features included extensive gardens, a roof top garden, and a communal fruit and vegetable patch. The storm water system enabled maintenance of the garden during all weather conditions, which was valued highly by residents. The aesthetics of the greenscape and the cooling effects of the flora were also considered benefits.	*"I guess one of the things that I love is the garden, the fact that you've got so much garden in the middle of the city."* *"We've got 32 per cent green space. We've achieved it by cutting down in terms of the motor car, its impact on the property and by developing gardens along the walk and on the rooftop."* *"If we didn't have the storm water collection for up to, you know, 60,000 litre capacity, then you wouldn't be able to maintain gardens in quite the same way either."*
Style of housing	Residents also felt very proud of the style of housing within the complex, which used straw and recycled materials.	*"I think aesthetically this place is fantastic…the gardens…the look of the houses is unusual, unique and something good to come home to."*
WSUD part of a 'bundle' of benefits	The water savings features were enjoyed as a package of benefits of living in the complex; inner city living, a small ecological footprint and less dependence on mains water for non- potable uses combined with a strong sense of community.	
Public recognition	A strong sense of pride in the complex was demonstrated by the residents of Christie Walk. They were particularly proud of the educational tours of the complex, which they conducted to teach school children and the general public about the WSUD features at Christie's Walk. Local government officials and water industry professionals also often visited the complex.	*"Everybody here is really proud to showcase what we do."* *"We have monthly site tours for the public…"* *"Apart from schools we also get local government people coming through, you know people from governments, federal government, state [people interested in sustainability]."* *"SA Water shows us off. Talk to us when they have a pilot or an idea."*

6.1.5 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT CHRISTIE WALK

In general, the Christie Walk community expressed minimal negative attitudes towards the WSUD features. Any dissatisfaction of their existing water systems were related to four main areas: poor design or installation of onsite 'Biolytic' treatment system for Wastewater, cost pressures, difficulties associated with upgrading or extending their existing system, and the ongoing management of the water system. All areas were potentially negative influences on acceptance. Poor initial design of a planned Wastewater biolytic system combined with cost concerns to replace it resulted in residents abandoning the system. Residents also reported that retrofitting additional features, such as increased water storage, was not only very difficult in an established complex with such a small footprint, but also very costly. These impediments deterred residents from extending their water sensitive infrastructure, despite their desire to do so. Another potential difficulty in living with WSUD was the perception that ongoing management of the WSUD features required a high level of personal involvement, motivation and commitment from residents. Residents described the day to day management of maintenance and dealing with problems as they arose as a time consuming endeavour requiring a high level of motivation to undertake this shared responsibility. Fortunately, within Christie Walk residents reported all others as being like-minded, thus the preservation and utilisation of the WSUD was of primary importance within the community. However, for larger housing estates with less motivated residents, ongoing maintenance of WSUD features might prove a barrier to total acceptance.

Table 7 Potential areas of dissatisfaction

ISSUE	DESCRIPTION AND OUTCOME	EXAMPLE AND QUOTES
Poor design or installation	Poor choice of 'Biolytic' treatment system for Wastewater treatment resulted in eventual abandonment of the system, regardless of the interest among the residents to pursue it.	*"the [biolytic system], was installed … but it turned out that it was quite unsuitable. It was a system that had been used effectively in car washes. But the sort of Wastewater you get on a site like this is very different from what you get in car washes….[we had to decommission it] which was sad, but couldn't do anything else about it."*
Costs	Unable to replace failed 'Biolytic' treatment system due cost pressures. Also installation of larger tank to effectively capture the storm water runoff was given up due to cost and space issues.	*"[The Biolytic system] was proving extraordinarily expensive to keep it going, and so we just had to discontinue it."*
Upgrading of existing system	Retrofitting additional features are difficult, sub-optimal, and costly	*"I think what we have learnt from all of this is that it's very much more difficult to retrofit"* *"We'd probably be very lucky if we found something that was really cost effective to retrofit. Because of the problems with putting in piping, digging holes in the ground, water switches in..."*

6.1.6 WAYS THAT CHRISTIE WALK MITIGATED POTENTIAL PROBLEMS WITH ONGOING MANAGEMENT OF WSUD FEATURES

Enduring satisfaction and acceptance of WSUD features seemed to relate largely to how the features were managed long-term by the Christie Walk community. Problems related to ongoing management had been substantially mitigated over a ten year period, and were attributed to five main factors. These included: management of knowledge in terms of transferring and maintaining knowledge about the WSUD features, a strong sense of community and level of involvement, a sense of ownership, an effective relationship with industry experts, and an interest in continual improvement. All five factors helped to ensure that the ongoing operation of the WSUD features was as reliable, safe (in terms of water quality), and efficient as possible. This, in turn, underpinned resident satisfaction and acceptance of the WSUD features long term.

Table 8 Key factors for mitigating problems associated with ongoing management of WSUD features

FACTOR	DESCRIPTION AND OUTCOME
1. Knowledge management issues	Knowledge transfer supported by: • Multiple people with a technical back ground involved in maintaining the water reticulation system. • Written guidelines in place eg. how to check the flushing and filtering systems, which were developed by the residents from their past experience and current knowledge in maintaining the system. • Specific training of residents undertaken eg. induction program. • Conducting their own in-depth research into technological options and cutting edge advances.
2. Strong sense of community and a high level of involvement	Increases the appeal of living at Christie Walk. Supports ongoing management of the WSUD features. Many residents actively involved in committees that manage the development. All maintenance undertaken by residents in monthly 'Working Bees.' Supports a strong sense of ownership of the WSUD feature. Developed through direct involvement e.g. establishing gardens, creating paved areas.
3. Sense of ownership	Not necessarily dependent on home ownership. Renters can have a sense of ownership developed through being involved in ongoing management (30% of residents are renters).
4. Effective relationship with local council and water authority	Although at times the relationship with the water authority had been tense and residents had experienced obstructions in sorting out certain problems, e.g. decommissioning the sewer mine, the overall relationship has been very cordial contributing to productive outcomes. These experiences suggested that an effective and ongoing relationship with water authorities was essential in water resources management.
5. Concern for continual improvement	Ongoing interest for improving things. Interest in new technologies that could deliver better outcomes.

6.1.7 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

Experience of the WSUD features in the development provided the residents with insights into ways of improvement that could result in increased benefits or encourage others to adopt WSUD technology. Four main ideas emerged from the experiences of Christie Walk as suggestions to others: adequate forward planning, openness to innovation, maximisation of water storage capacity, feedback to improve water use and partnerships in education. Adequate forward planning and embracing of new and innovative technologies were considered cornerstone for best outcomes, in the long term. Residents found that they had to discount alternative water saving devices because of the cost and level of difficulty of retrofitting additional features. Receiving some sort of metric feedback on the amount of mains water used to top up rainwater tanks was seen as a way of increasing the residents' level of understanding of how best to use the conserved water, and also to motivate greater mains water savings.

Table 9 Ideas for improvement and advice to others

IDEA	DESCRIPTION
Forward planning	Plan at the outset for maximum utilisation and capture of storm water; very difficult and expensive to retrofit storage
Be as innovative as possible	Be open to new technologies that could provide best possible outcomes. An impression exists within this sample that the government and authorities are afraid to try new approaches because of the difficulty in changing and explaining things to people.
Maximise water storage capacity	The idea of 'not wasting water' drives motivation to increase water storage to enable all storm water to be captured Increasing the existing storage capacity impeded by cost and lack of space
Feedback on performance	Feedback information on water usage and water mix would be valued by people who live at Christie Walk. Water mix feedback would help to inform residents on how best to use their conserved water Water usage feedback, such as level indicators and meter tor top-up water, would motivate and support residents to further save water "Some way of measuring when [tank]...automatically switches to piped water [would be good] - when the tanks get down to a certain amount - the only way you can tell is taking the lids off the tanks and that's one hell of a big drop".
Government emphasis on importance of education	They believed they had a solid information transfer and education programme, which would be complemented by a government emphasis on the importance of education for water use, house re-design and sustainable living.

6.2 Lochiel Park

Lochiel Park Village is a medium sized residential development of 109 dwellings located in the City of Campbelltown and situated next to the River Torrens, approximately 8 km from the Adelaide CBD. The site covers 15 hectares of land of which 4.25 hectares are designated for housing while the remaining 10 hectares have been developed as wetlands and parkland adjacent to the River Torrens. The development promotes a green lifestyle; its' branding is the 'Living with Nature' slogan. Until 2013 when the last building sites were sold, state government ran Sustainability House in one of the homes, to educate about sustainable living and showcase building innovations and the smart screens that track, program and benchmark energy and water use in each household. A carbon neutral house, whose design was selected in a Zero Carbon Challenge competition, is currently being constructed in the subdivision. A fence along the O-bahn high speed busway forms the eastern boundary. Although, Lochiel Park is located near the busway, the transit stops are located over 0.5 km away. The village is part of the suburb of Lochiel Park that has 7, 500 people. It has an older population (median age 40). Only 17% have university degrees and the median weekly household income is $859. It is an area for retirees and for families and the average household has 2.3 people. About 58% own their own home (National Census ABS 2011).

Figure 4 Lochiel Park southern wetland

The site was officially launched in October 2009 by the Land Management Corporation (LMC, now Renewal SA) and was intended to be a demonstration project for sustainable living in medium density urban developments. The major areas of sustainable development included water, energy, waste, built form, transport and community. It aimed to reduce energy use by 66% and potable water use by 80% compared to current housing stock. This is to be achieved through an integrated urban development management approach. The total cost of the project excluding land acquisitions, preliminary expenses and housing was approximately $18 million. The development has been acknowledged by the housing and development industries with a number of national awards including awards from the Australian Institute of Landscape Architects, the Planning Institute of Australia and the HIA Greensmart Award.

There is a mix of demographics living in Lochiel Park including retirees and families with young children. Previous social research conducted in Lochiel Park revealed that most of the residents were attracted by the environmental appeal of the development, and most have strongly appreciated the close-knit community that was fostered during the building phase of the site (Edwards & Pocock, 2011).

6.2.1 WSUD FEATURES

Key informants for the WSUD features were the City of Campbelltown engineering services personnel, engineers from the consultant company that designed the storm water system (but not the ASR) and water specialists at SA Water. Lochiel Park site has two wetlands incorporated into the design. Storm water harvesting is intended to occur from the southern wetland, which collects water from an upstream catchment (190 hectares). This water is stored and treated in the wetland after passing through a gross pollutant trap. After wetland treatment, an aquifer storage and recovery scheme has been initiated with the intention that storm water will be used for non-potable supply in the development via a ‘third pipe’. The water supply aspect of the scheme is not yet fully operational however the third pipe has been plumbed in to all homes.

A second wetland harvests water from another upstream area known as the Charlesworth catchment (169 Ha). It provides amenity, detention and treatment of this water prior to disposal to the River Torrens.

Runoff from the Lochiel Park development does not get treated by these two wetlands. Site runoff is treated by bioretention systems and swales at the street level prior to discharge to the River Torrens. All homes are equipped with energy saving and monitoring equipment, water saving devices and rain water tanks connected to the hot water supply. Table 10 presents a summary of the WSUD features in place at Lochiel Park.

Table 10 Summary of WSUD features at Lochiel Park

FEATURE	TECHNICAL ASPECTS	OUTCOME
Storm water reuse (not yet operational)	Storm water is captured from an upstream catchment, treated using gross pollutant trap and wetland and stored in the T2 aquifer. Managed by SA Water.	Proposed for garden and open space irrigation and toilet flushing.
Rainwater	Domestic roof capture Storage in household rainwater tanks min 1500 L, some homes have large underground tanks	Tanks are connected to the hot water supply tank, washing machines and shower heads.
Storm water quality improvement	Bioretention basins and swales treat excess runoff from properties and roads prior to discharge into the Torrens River.	Detention and water quality treatment of onsite storm water runoff Some issues with plant management during the construction phase There is a mixture of intended vegetation (selected for water quality treatment purposes) and re-vegetation of systems (selected by residents) evident in street systems
	Northern and Southern Wetland harvest storm water from two upstream catchments and provide treatment of this runoff prior to reuse (Southern Wetland) or disposal to River Torrens	Provides effective detention of flows downstream and reduced pollutant load from upstream catchments heading into Torrens River and Gulf St Vincent
Flood mitigation	Roof runoff is retained by rainwater tanks. Surface runoff from on-site is detained by street side Bioretention pits and street swales.	Reduced volume and flow rate proceeding downstream into River Torrens
	Runoff from surrounding catchments collected and retained and/or detained by treatment wetlands.	Reduced volume and flow rate from surrounding catchments proceeding downstream via River Torrens.
Monitoring system	Smart screens for monitoring daily treated storm water, rain water and mains usage	Effective monitoring of daily water use available to residents

6.2.2 POST IMPLEMENTATION EXPERIENCES

Lochiel Park is an ambitious project and there have been a number of problems with its delivery. Currently, the City of Campbelltown is delaying the takeover of the site from developer until outstanding issues with the water system, trees and the board walk lights are resolved. Discussions with consultant engineers revealed there were problems with the installation of the gross pollutant trap, which meant it was not effectively removing gross pollutants prior to storm water reaching the southern wetland. This problem resulted in delays in commissioning the recycled water scheme while the problem was rectified. Further, a Council member reported that Council is reluctant to sign an agreement with the water utility which covers the supply of storm water from the Charlesworth Park catchment and the maintenance of the system. Council indicated that it should be entitled discounts from the water utility as it was supplying water to the development and maintaining the water recycling system. Certain issues have been reported in the media regarding the non-availability of treated storm water water for residents, even after two years of commissioning of the scheme.

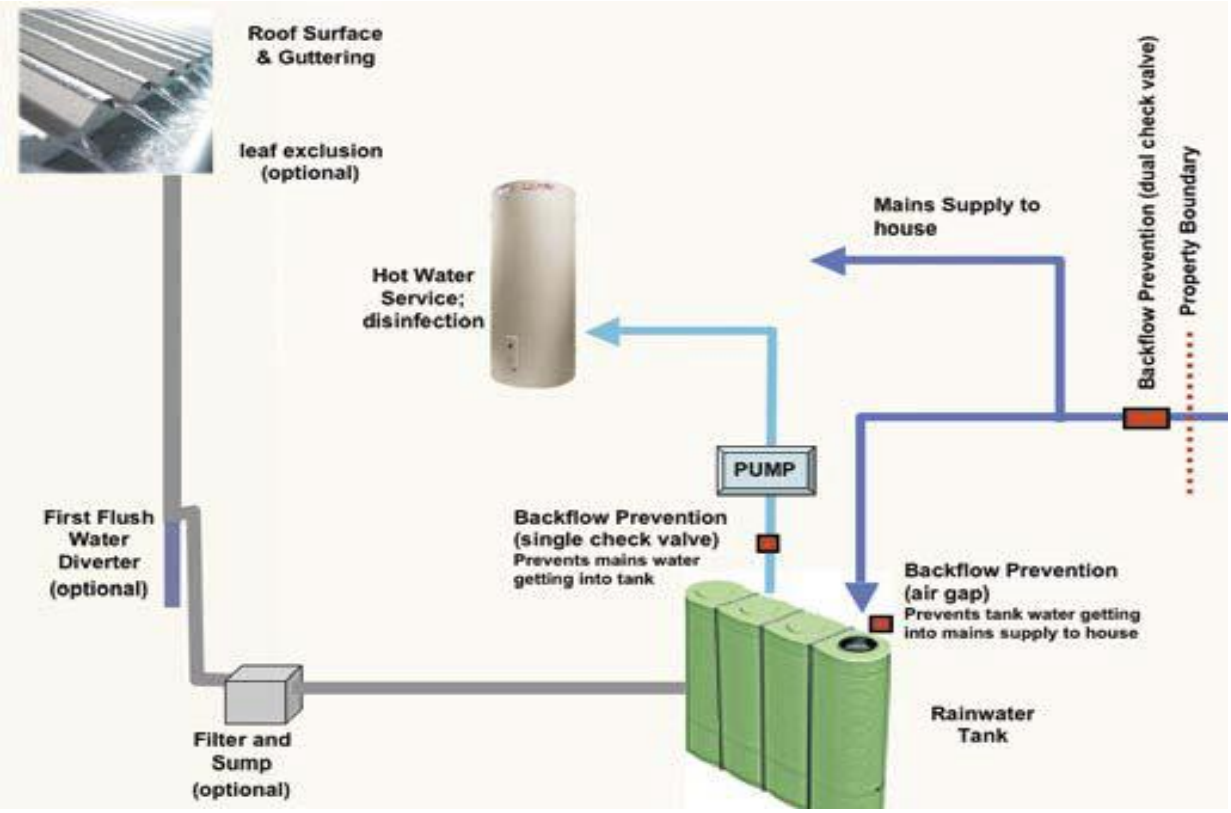

Figure 5 Rainwater tank connected to hot water service

Source: Lochiel Park, 2011

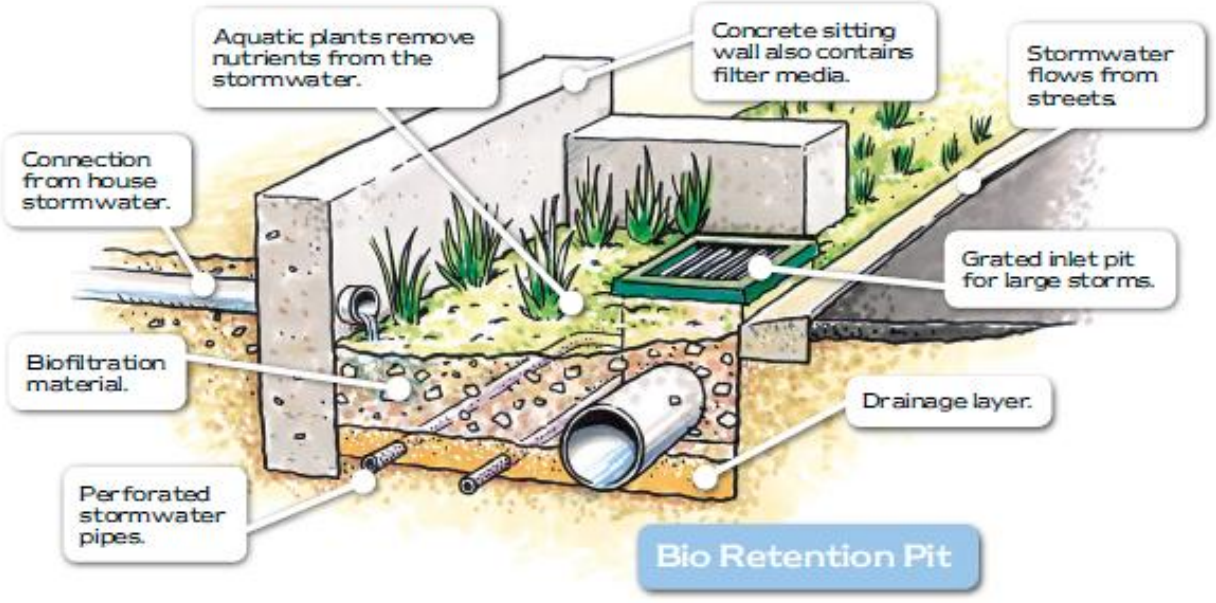

Figure 6 Bioretention System

Source: Lochiel Park, 2013

6.2.3 COMMUNITY PARTICIPANTS

There were seven key informant interviews: a local school teacher, a local Councillor, President of the Lochiel Park Friends Association, the informal secretary of various local community groups, two community gardeners, and the chair of the local historical society. Sixteen people attended the focus group.

The 23 respondents from Lochiel Park village were older with a median age 60-74 years and none had children at home. In contrast to the wider suburb of Lochiel Park, they were mostly well-educated and over 90% had tertiary qualifications. All but one was a home owner. Since the development is new, most had been there less than 2 years but six had come in the early stages of the development and had been there 2 to 5 years.

Although Lochiel Park was designed as a model eco-village development, it did not appear to attract people with exceptionally pro-environmental attitudes or any particular awareness or strong attitudes towards saving water. The respondents from Lochiel Park had average scores on the pro-environmental and the three attitudes to water scales that were almost identical to the Adelaide population as represented by the MARSUO survey (Details in Appendix I). Given their pro-environmental motivations for moving to Lochiel Park (discussed below) it was surprising that their scores on the attitude scales were not higher than the Adelaide average.

6.2.4 KNOWLEDGE AND UNDERSTANDING OF THE WSUD SYSTEM AT LOCHIEL PARK

The Lochiel Park system is one of the more complex systems and therefore there was a wide range of WSUD features people might discuss or depict. Key informants, who were long-term residents who held volunteer leadership positions, were accurate and thorough in their depiction of the WSUD system; such information transfer was included in sales seminars and literature as part of the marketing package to promote building in Lochiel Park and showcased innovations in water management. Participants believed that WSUD knowledge was weaker in later residents as such information packages were not available or circulated when later lots were developed or homes were resold. Early Lochiel Park residents also signed encumbrances (“we had to read a thick booklet”) that detailed requirements on household use of water. In focus group diagrams, everyone mentioned some aspect of storm water, however, only six depicted rainwater and eight depicted tanks, despite all residents owning a rainwater tank on their property. All but one depicted the wetlands or lakes as storage but only four were aware of the treatment function of the wetlands. Seven depicted the aquifer. The large treatment tank at the back of the southern wetland was only identified by one person as a treatment facility but another seven just identified it as a tank or storage tank. All but two depicted the purple pipe system. The Bioretention gardens outside each house were not mentioned as a significant feature in the diagrams and only three key informants mentioned them briefly in the interviews. (Appendix J).

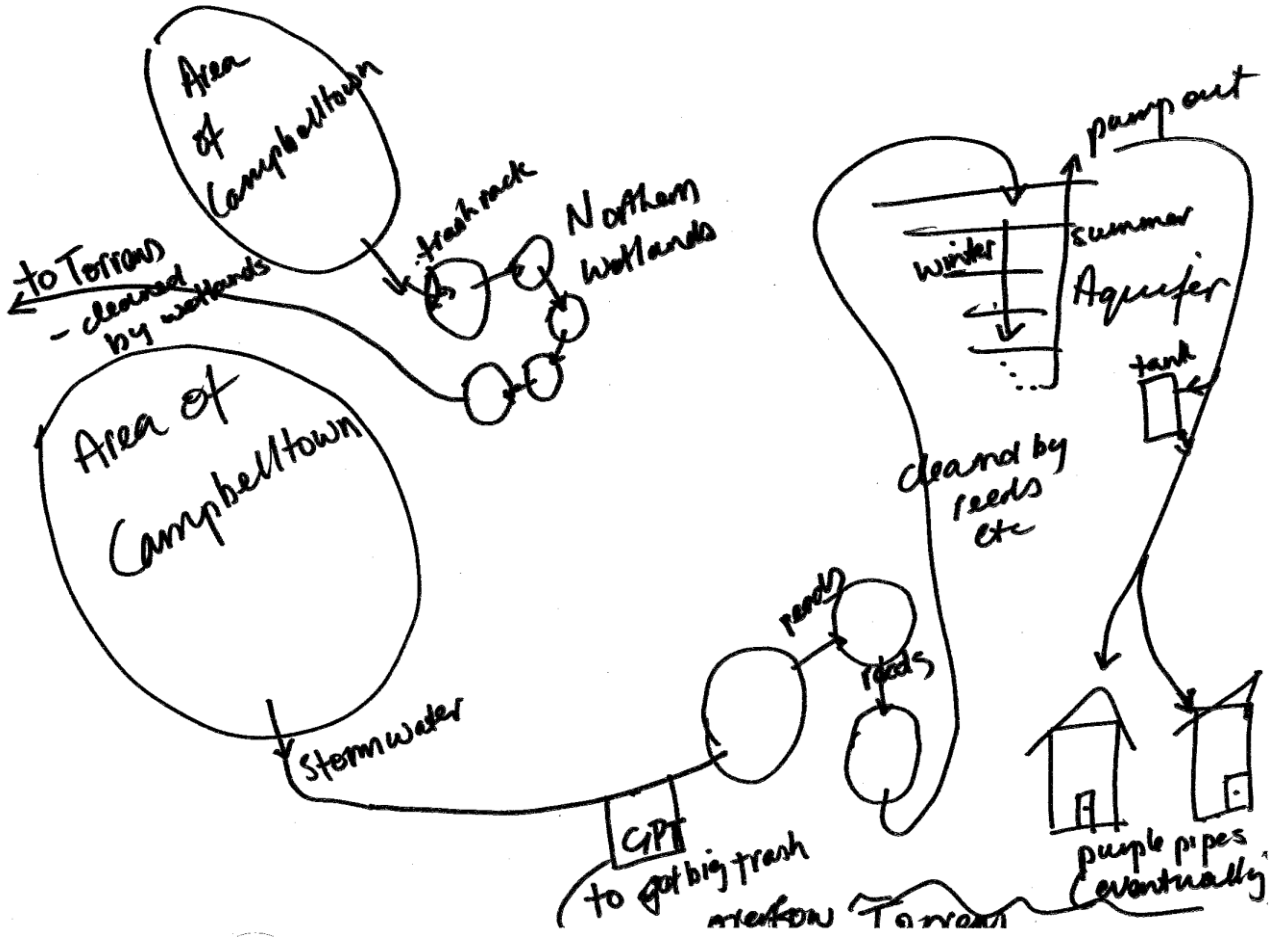

Figure 7 Depiction of Lochiel Park water system with the most features by a respondent

6.2.5 WHAT PEOPLE LIKE ABOUT LOCHIEL PARK

Residents reported very favourable attitudes towards living at Lochiel Park, despite ongoing problems relating to the quality of the housing and the implementation of the WSUD features. In keeping with other studies of Lochiel Park (Edwards and Pocock, 2011) we found that many residents were drawn to Lochiel Park because of the environmental and sustainability aspects of the development, and planned to stay long term. Residents enjoyed the open spaces, trees and bird life, and were proud of the sustainability concept that underpinned the Lochiel Park development. Both new residents and long term residents loved the strong sense of community, which was depicted as having active community groups, caring neighbours, extensive opportunities for social engagement and gatherings, and feelings of personal safety. Residents viewed the community life as a key attraction for living at Lochiel Park for the long term. One LMC staff member was instrumental in establishing the *Friends of Lochiel Park* group, with approximately 20 active members. It is the main representative community group with a mandate to tend gardens in common areas, manage weeds, mulch gardens with support from Council, and educate residents. They have also added lobbying to their role and are actively pursuing the necessary corrections to the recycled water system and a reduction of the price for purple-pipe water. A current campaign is underway to decorate the WSUD street infrastructure with mosaic art. Table 11 details these positive attributes of Lochiel Park. However, residents felt very disgruntled about the development in terms of the quality of the buildings and the failed WSUD features. These issues are addressed in more detail in the next section.

Table 11 Key aspects that residents liked about Lochiel Park

ASPECT	DESCRIPTION	EXAMPLE
Strong sense of community	A number of community groups were active within Lochiel Park and these contributed towards a sense of social cohesion. e.g. community garden group, book group, arts groups, dog walking group. *Friends of Lochiel Park* is an active community group.	*"it's a beautiful community and the community's getting stronger and stronger because there's so many groups...plus all the informal gatherings and things that just happen in the street, it's quite unique…"*
	Neighbours help each other, share ideas, and demonstrate a strong sense of reciprocity.	*".. it's just the sort of place where people do like to share their ideas and neighbours help each other out...a neighbour is helping us build a fence now."* *"...we've all been helped out, or have helped out our neighbours in return."*
	Residents feel a sense of personal safety.	*"This is a beautiful place to live. I feel very safe here. I feel very safe for my grandchildren..."*
Greenscape and natural environment	Aesthetics of gardens and natural environment are very appealing to residents and create opportunities to strengthen ties within the community.	*"I think the big thing is obviously the environment and it's close to the river, it's good for walking and the sense of community."*
	Ambience - the peace and the quiet, a rural feel.	*"For me I don't feel like I'm living in the city, [feels like I] haven't left the rural I'm used to."*
Open spaces	Open spaces are widely enjoyed and create the benefit of a garden without the burden of looking after it.	*"One of the reasons I didn't mind coming to live here is I was going to have this huge garden that I didn't have to do anything about. I was very conscious of that the whole time."*
Sustainability focus	Residents were attracted to the sustainable living dimension of Lochiel Park.	*"I've been here nearly four years ...and one of the good things is I've never, ever had an electricity bill. Never had to pay a cent."* *"I mean I like the [sustainability] concept of the place."*
A sense of pride	A sense of pride in Lochiel Park as a role model of sustainability.	*"Although...we're only achieving maybe 70 per cent of the design targets or potential of this place...it's getting people thinking about the issues like sustainability, like ecological issues...hopefully it will be a role model for better stuff to be achieved in the rest of the community."* *"We're happy to be an experiment."*

6.2.6 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT LOCHIEL PARK

In general, the residents of Lochiel Park consistently complained about the ongoing issues with failed WSUD features. These failures included the various elements of the storm water reuse system (the gross pollutant trap of the wetlands, the aquifer storage and recovery system, the weaknesses in the aquifer, and the pricing of the non-potable water). The residents talked negatively about having no access to harvested storm water, despite the development being almost four years old, their homes fitted out for pending connection, and the promise of non-potable water use. A range of issues and problems emerged that contributed to their feelings of dissatisfaction with the various WSUD features. These included perceptions of poor initial design and installation, ineffective ongoing functioning of the feature, problems with the developer especially at the time of handover, and an inadequate ongoing system of management. Residents felt there had been a general lack of information regarding their recycled water system and were frustrated by the ongoing delay in getting the system functioning. The three builders that were initially approved were also perceived to be learning as the projects proceeded, and they did not always participate

in the developer's workshops. Adding to resident dissatisfaction was confusion regarding the proposed pricing of the non-potable water. The community expected the price of non-potable water to be 75% of mains, but when the tiered pricing system was introduced they faced prices greater than the Tier 1 mains water cost. However, following a combined effort by community and Council appealing to SA Water the price was lowered to 90% of Tier 1 mains water. Several residents were able to quote daily water usage by source from their smart screen data but others thought they were a waste of money. Many believed they would not get cost recovery on their rainwater tank installation.

Overall, cost pressures and a lack of knowledge and information aggravated these issues and fostered feelings of unmet expectations. A final dissatisfaction to emerge was that people felt locked into their existing technology and unable to become truly independent of mains water for their non-potable water supply. Table 12 outlines each of these points in more detail. A failing of the WSUD systems which was only mentioned by one participant was the failure of the bioretention gardens outside each house because the specialised plants had not been watered. The Friends of Lochiel Park committee was demanding that the developer replant the gardens but this seemed to be a minor concern amongst other problems in the estate.

Table 12 Potential barriers to acceptance of WSUD features at Lochiel Park

CONSIDERATION	OUTCOME	EXAMPLE
Poor initial design and installation	Poor initial design and or installation has resulted in major problems and ongoing dissatisfaction. e.g. the community understood that the gross pollutant trap was a major problem.	*"We had a plumber who installed mum and dad's hot water back to front so it was never going to work."* *"[There is] absolute frustration and fury re: Gross Pollutant Trap."*
Ineffective functioning of the WSUD feature	The WSUD feature needs to work efficiently and effectively to maintain trust in the technology and long term community acceptance. e.g. perception that the lake liner of the Northern Lake has failed resulting in a half-filled lake and dying gum trees.*	*"If the system had worked, probably ...we wouldn't particularly care about how it works, just as long as it delivered the goods. It's only because it hasn't that we suddenly want to question the technology."* *"I'm finding out that there's more and more, more and more problems, and that water still isn't working. It's ridiculous."*
Ongoing problems with the developer	Ongoing problems with developer create ongoing negativity and can influence the community view towards the WSUD feature, the water authority, and may even result in litigation. The problems are inflamed by a perceived lack of information to the community regarding responsibility and solutions.	*"Because if it's not going to work no end of these meetings is ever going to fix it. I think the next step along then is a class action against the government for misleading us."* *"But in point of fact it wasn't SA Water's problem to begin with, it was [the developer] and its civil contractors. They designed the system. SA Water only took it over what 12 months ago."*
Ongoing management	Problems with ongoing management lead to dissatisfaction with the WSUD feature.	*"The gutters are still full with leaves. They've got nobody that goes around on a regular basis and clears the gutters."*
	Lack of a 'management body' frustrates residents, particularly renters, when dealing with problems related to their water systems.	*"I think it's a pity... it's sad that there isn't an organisation or a body that oversees the whole lot and then you can go there and all complaints are dealt with, rather than that you've got to sort them out for yourselves."*
	Ongoing management compromised during time of transition from developer to council. e.g. problems with irrigation of open spaces, lawns and grass in parks died.	*"I also had a sewerage issue. I've had sewerage up in my unit...I had to live in it -that unit- while there was sewerage in it and nobody took responsibility for that and nobody could."*
Cost factors	Cost factors were important considerations. The long duration in repaying back assets because of the small cost benefit margin in owning an alternative water asset (e.g. a domestic rain water tank) and the cost associated with managing ongoing maintenance may act as a disincentive.	*"I mean you spend $1,000 a kilolitre putting your tank in to probably store $20 worth of water if you're lucky and okay yes that gets re-filled and re-filled but it takes an awfully long time [to pay back the tank]."* *"Why would the government spend $100,000 of taxpayer money [to fix pollutant trap] if in fact at the end of the day they know that when they run the water into the aquifer they're not going to get it back."*
Lack of knowledge	Lack of knowledge impedes problem solving and an inadequate understanding of the technology creates inaccurate expectations.	e.g. Poor understanding as to the purpose of rainwater gardens. Residents refer to rainwater gardens as 'the drains.' *"The other thing is that nobody knew how anything worked..."*
	Rely heavily on a local community group to pass on information.	e.g. *Friends of LP* is major source of information regarding WSUD management.
Expectations not met	Perception that the developer overpromised and under delivered, resulting in dissatisfaction with the outcome.	e.g. homes still not connected to storm water, even though they're fitted out to connect the storm water to their toilets and laundry. Also issues with pricing of non-potable water.
'Locked in' to the mains water supply	A perceived conflict of interest for water utility is viewed as maintaining the high cost pricing for non-potable sources of water, keeping residents 'locked in' to the mains water supply, and reducing ability to function independently from mains water. Some residents have installed larger rainwater tanks but unable to connect them to the laundry or toilet.	*"[The water utility] has an internal conflict of interest essentially. They sell us the potable water and the mains."* *"As someone said before the whole model is wrong because what's the incentive for the supplier who's selling water to reduce your consumption [by supplying non-potable water]?"* *"When you've got rainwater why have we got to use main water?"*

*It is unclear if problems with the northern wetland are due to faulty installation or maintenance

6.2.7 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

Ideas for improvement for future WSUD developments reflected the frustrations and dissatisfaction that residents at Lochiel Park had experienced with their WSUD features. Residents felt they had all the responsibility of compliance, but that the mutual responsibilities of government and project partners were not detailed and implemented. As a result, ensuring correct installation and effective ongoing management were key suggestions for improvement and advice to other WSUD sites. The Lochiel Park experience also pointed to mitigating problems that arise from the transition from developer to the final recipient of the WSUD features. Based on the present experience, participants suggested that the final caretaker of the housing estate be involved early on in the development project, with, in this case, utilisation of Council planning and design expertise, and that this should help to alleviate problems at the time of handover to the Council. Further suggestions included pricing non-potable water so that it would be acceptable to new owners and not a surprise, and ensuring the developer delivers on expectations. Finally, participants agreed that incorporating a strong educational focus within the development would help to create and maintain ongoing awareness for water-based sustainability initiatives.

Table 13 Ideas for improvement and advice to others

IDEA	COMMENT
Correct design and installation	Correct design and installation was important for reducing potential problems in the future, and to mitigate dissatisfaction and ultimate rejection of the WSUD feature by the community.
Good ongoing maintenance	Ongoing maintenance was important to endure the WSUD features functioned optimally and reliably. A one-stop maintenance/complaint entity that could act on behalf of the community became especially important to deal with serious problems.
Involve the final recipient early	The final recipient of the eventual handover e.g. council should be involved up front in the planning and design of the development.
Plan non-potable water prices at the outset	Plan at the outset for a price for non-potable water that is acceptable to residents.
Deliver on promises and foster realistic expectations	The Lochiel Park community agreed the intention of the water initiatives at LP were great, but the execution was poor. The poor implementation dented the satisfaction with the WSUD features because expectations were unmet.
Educate sustainable living and water initiatives	Residents felt there is an important role for examples of local initiatives to create increased awareness to the wider community, and teach people about water sustainability. 'Sustainability House' no longer exists and residents feel there is now a gap in educating the public and would like to see this addressed.

6.3 Mawson Lakes

Mawson Lakes is a large-scale mixed use development situated 12km north of the Adelaide CBD. The site covers 620 hectares and consists of approximately 4000 households, as well as a commercial centre, a technology park, two schools and a university campus. Census data (ABS 2011) shows that it comprises 23,000 people, with many choosing to both live and work in Mawson Lakes. The median age is 31 years and approximately 24.2% of this population have a completed university degree, but it is important to note that the university attracts students in the process of obtaining their degrees. The median weekly household income is $1,670, which is highest among the case study populations and higher than the Adelaide average. The average number of people per household is 2.6 people and 63.4% own their own home.

The development features include ornamental lakes and large, open, green spaces throughout the development. The Mawson Lakes project was intended to demonstrate how sustainable development, incorporating new urban principles and WSUD, could be achieved. While walk-ability is enhanced by co-located work and residential functions and certain design features reduce energy consumption (e.g. solar water heaters) some cutting edge design standards (e.g. verandas, passive solar) were not mandated, and

not all of the WSUD elements included in the initial design were implemented (Barton and Argue, 2007). The original design included the construction of an onsite wastewater treatment plant to allow localised treatment to occur. However, this construction did not go ahead due to concerns about noise, cost, salinity problems, and odour pollution and the subsequent effects of these on local housing amenity.

There is a diverse and vibrant community living and working within Mawson Lakes. The suburb includes home businesses, a technology park with over 100 different companies and an onsite university with a significant proportion of international students. Some of the residents are transient because of their attendance at the university, or involvement at nearby Australian Defence Force sites.

Figure 8 Mawson Lakes, main lake

6.3.1 WSUD FEATURES

Information about the WSUD features was obtained from a consultant engineer involved in the construction of Mawson Lakes and City of Salisbury engineering services personnel. The main WSUD features incorporated into the site include the use of water from a nearby ASR system and reuse of Wastewater for non-potable uses throughout the site (Sharma et al., 2012). These two water sources are combined into a single onsite alternate water supply for toilet flushing, garden irrigation and other non-potable outdoor uses. The storm water is harvested from the Parafield Wetlands Harvesting Scheme and mixed with treated wastewater from the Bolivar Treatment Plant before being distributed throughout the site using a third (purple) pipe scheme (Myers et al., 2013). The pipeline (purple pipe) ring system is nearly 60km long and runs around the Local Government Area for the supply of recycled water to some residential developments and private industries. The operational and maintenance costs for the entire system are approximately $600K per year (City of Salisbury engineering services personnel).

In addition to water reuse, runoff from Mawson Lakes is managed by a mixture of conventional (pit and pipe) and water sensitive means. Drainage was a key design consideration during the development phase of Mawson Lakes. The land was originally known as ‘The Levels’, and consisted of low lying land subject to inundation. The main drainage line through Mawson Lakes was and still is Dry Creek, which has been preserved as a vegetated open channel through the development. In addition to decorative lakes in the commercial centres, the site also incorporates small and larger scale wetlands in residential areas and along the north-western border; all are popular for recreational walking and wildlife habitat. In addition to the natural, passive treatment in wetlands and open channels, gross pollutant traps were also installed in Mawson Lakes to prevent larger pollutant materials from progressing downstream into the adjacent Greenfields Wetlands.

6.3.2 POST IMPLEMENTATION EXPERIENCES

The Mawson Lakes development requires ongoing maintenance. It has 32 in-ground gross pollutants traps (GPTs) which cost the Council $200K to $300K per year to maintain. The culvert near to the development,

which was designed for a 1 in 100 year storm event, flooded in a relatively minor 15 mm rain event, due to severe sedimentation in the basin (nearly 1 m deep), reducing its effective capacity. However maintenance requires the drying out of the wetlands which receives wide public opposition. However during summer the Council receives complaints from the residents about the wetlands being dry causing fish deaths and occasionally serving as habitat for snakes. (City of Salisbury engineering services personnel).

Table 14 Summary of WSUD features of Mawson Lakes

FEATURE	TECHNICAL ASPECTS	OUTCOME
Storm water and wastewater reuse	Water from the Parafield Wetlands Harvesting (ASR) Scheme consisting of an upstream storage basin, downstream sedimentation tank, treatment wetland and aquifer storage (managed by City of Salisbury). Storm water is mixed with treated wastewater from Bolivar and undergoes disinfection treatment (chlorination) then distributed via third pipe to residences (managed by SA Water Corporation).	Garden and open space irrigation. General outdoor use (e.g. car washing). Toilet flushing.
Wetland/creeks	Preservation of Dry Creek as an open channel for flood management. Incorporation of open channel drainage and wetlands in residential area. Vegetated channels provide some detention and treatment of flow.	Area is frequented by wildlife including several bird species. Heavy recreation use by local community. Improved water quality discharge into the Greenfields Wetlands and Barker Inlet.
Gross pollutant traps	Prevent larger pollutant materials from progressing downstream (managed by City of Salisbury).	Improved water quality discharge into the Greenfields Wetlands.

6.3.3 COMMUNITY PARTICIPANTS

Key informant interviews were conducted with the President of the local environmental watch, the Editor of the local, privately run, magazine for the community, primary and high school teachers, the owner of a fitness centre and a real estate agent. Twenty-two people attended the two focus groups.

The 28 respondents had a median age range of 40-59 years, but all age groups from young adults, families and the elderly were represented. Participants were mostly well educated, with 59% having university degrees. In terms of length of residence, there was a spread from older (5 > 10 years) to more recent residents (5 < 2 years), and three participants who were not home owners.

Although Mawson Lakes was designed as a prototype for the use of storm water, groundwater and recycled wastewater, the respondents from Mawson Lakes had attitudes to water and pro-environment attitudes that were almost identical to the Adelaide population as represented by the MARSUO survey (details in Appendix I). This is promising for the acceptance of WSUD features throughout Adelaide as it suggests the positive attitudes expressed in Mawson Lakes would be replicated elsewhere.

6.3.4 KNOWLEDGE AND UNDERSTANDING OF THE WSUD SYSTEM AT MAWSON LAKES

Mawson Lakes is a complex WSUD system and participants differed widely in their levels of knowledge about the system. In the focus group diagrams, all but two depicted the purple pipes and most (77%) depicted the lakes or wetlands. Twelve mentioned treated Wastewater as a source. Some people had very little knowledge, for example, just depicting a bridge over a lake. (Appendix H). Additionally, during focus group discussions numerous questions were posed seeking expert advice regarding the safety of recycled water contact with skin or swallowing (e.g. children playing under sprinklers, drinking from outdoor hose), and growing food for consumption. There was even confusion that the lakes near adjacent to the retail centre were filled with recycled sewage (even among university researchers residing in Mawson Lakes). Some of the key informants, including the real estate agent, those residents active in the environmental

group, and the community magazine editor, were all very knowledgeable about WSUD operations and could readily describe the components. In the latter case, there was a belief that two of the functions of the community magazine and associated website were to educate residents about water use, plants, appropriate behaviour around the lakes, and low impact living, and to promote an environmental orientation in the community. The non-resident informants with the schools and business were curious but had many questions about appropriate lakes use and water quality, and one was completely uninformed about the water features beyond the aesthetic appeal.

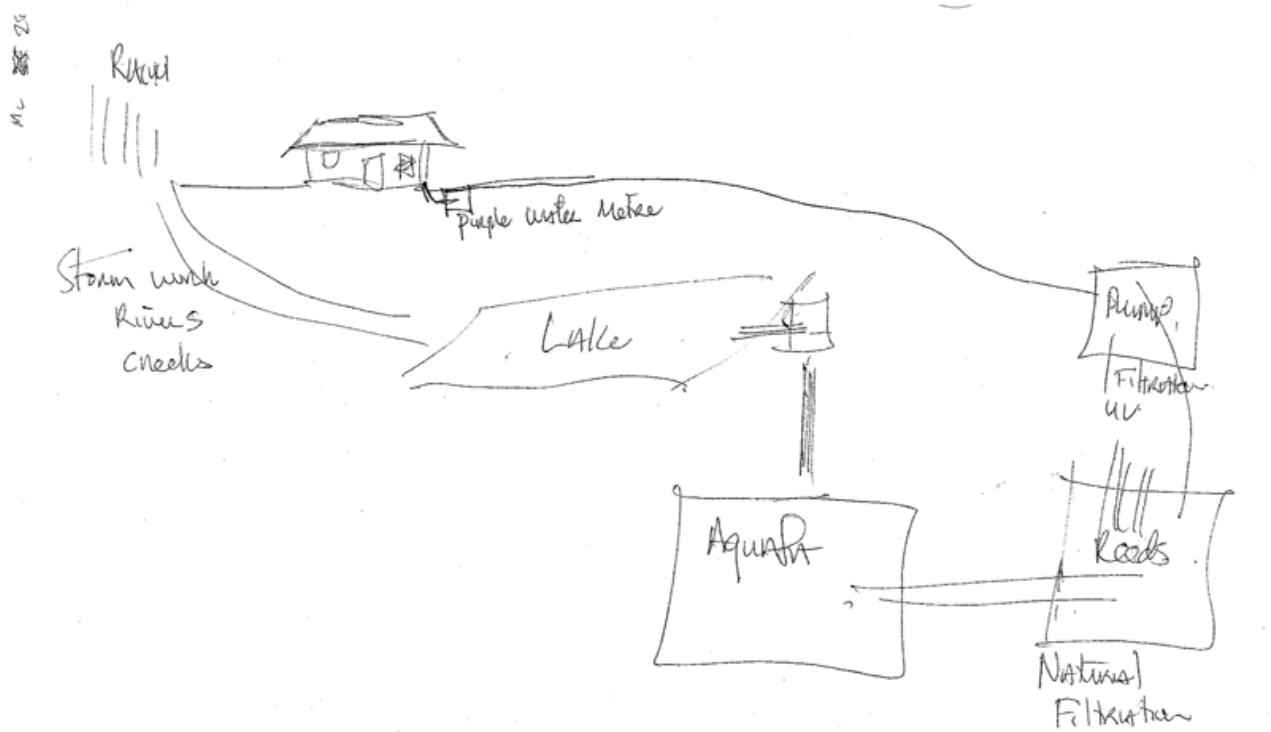

Figure 9 Depiction by a participant of Mawson Lakes with the most WSUD features

6.3.5 WHAT PEOPLE LIKE ABOUT MAWSON LAKES

Overall, participants' feedback about living at Mawson Lakes was positive. Most people considered Mawson Lakes as a great place, even a 'premium suburb,' to live with good value homes and a variety of choice options for housing. Residents regarded Mawson Lakes as a community with very good amenities, on-site recreational activities, and an attractive landscape, well served by transport infrastructure. Based on the language used, residents seemed to enjoy the status associated with living in such an exclusive complex that was well known around the Adelaide area.

The gardens, parks, lakes and creeks were key features that were admired and enjoyed by the local community. The water recycling system was seen as a drawcard to the overall development and residents enjoyed the access to non-potable water. The recycled water system offered a secure source of water, which residents saw as important, along with the sustainability dimension that a recycled system embodied. However, the WSUD features were not the most important reasons why people chose to live in Mawson Lakes, but rather, an added advantage. Mawson Lakes was described as an 'oasis' during the drought, and some saw 'guilt-free water' as advantageous. Despite the associated concerns of living in Mawson Lakes (described in the next section), there was an overall sense of pride within the community for their recycled water status, in many cases, showcasing 'world firsts' where overseas visitors came to inspect cutting edge water use. Although WSUD may not have been a dominant factor in one's decision to live at Mawson Lakes, residents seemed to embrace the WSUD features of the complex and spoke favourably of living with the design as it seemed to be beneficial in terms of amenities, as well as aesthetics. People working in Mawson Lakes did not seem to notice the WSUD of the development however, they too viewed working in the area positively.

Table 15 Key aspects that residents liked about Mawson Lakes

ASPECT	DESCRIPTION	EXAMPLE
Greenscape	The extent of the gardens, parks and open spaces.	*"Our gardens and waterways and open spaces…are so green…we are a really unique suburb…it's like an oasis."* *"during the drought, it was just strikingly positive that when you come to Mawson Lakes, it was green"* *"With selection of the right salt -and nitrogen- loving plants, things grow quite well at home."*
Waterways	The lakes and creeks are enjoyed by the local community and visitors. For the school, access to the creek is a benefit and helps to promote environmental awareness.	*"The reason I came to Mawson Lakes is because of the wetlands and the environment, and the nature."* *"an alternative to living on the beach by living on the lake and still being surrounded by water."*
Diverse choice of housing	A range of housing options available within the development including apartment blocks, combined residential-commercial dwellings and homes.	*"There's an opportunity to 'step up' within the estate i.e. start off with one property and then move 'up' within Mawson Lakes to another property."*
On-site recreational activities and social events	There are a variety of recreational activities available for residents e.g. Fishing, model yacht races, library, cycling, carols by candle light etc.	*"Usually, more than 50% of residents are involved in the Mawson Lakes infrastructure and recreational activities"* *"I like the walks. I can wheel the pram and walk to school."*
On-site amenities	All amenities such as schools, sporting facilities, university, retirement homes are on site; close proximity to the city.	*"It is a beautiful place; it's one of the best places in the world… We've got good infrastructure, good house to [plot] size ratios, we have shops and everything here."*
A secure water source	The third-pipe system of non-potable water was an attraction for some residents to chose living at Mawson Lakes, and for some it was a feature that they were prepared to pay extra for.	*We moved here from Golden Grove … and the water issue was one thing that really attracted us here, the fact that we've got unlimited water... so we could have a nice garden."* *"I do love Mawson Lakes. I think it's the best place on earth. I never really minded paying a little extra for the water because to have that benefit of that recycled water I was quite happy to pay a little bit extra for it."*
Sustainability dimension: Uses less mains water	Some residents valued the notion of being less reliant on mains water and the environmental benefits of recycling water. Some residents were drawn to the area because of the pro- environmental aspect of the water management and solar energy supply.	*"There is another benefit, though, not to us but to society. If we're using recycled water we're using less mains water and that's the most important…"* *"I think like quite a few of the residents who come here - if they're not coming here because of work or study, they're coming here because they actually have an empathy for the principles of ecosystems …not only with water, but also with energy saving devices."*
A sense of pride in the facility	Residents were very proud to be seen as a hub of water recycling initiatives .	*"We're very proud of water saving, ... wherever I go, people say to me, 'Oh, you're the suburb where they recycle all the water. You're the suburb where you can wash your car in a drought, or you can stand outside watering your gardens, when everybody else has restrictions.' And that makes us really quite gifted in the whole of Adelaide"*

6.3.6 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT MAWSON LAKES

The residents of Mawson Lakes seemed very supportive of their community; however, several themes emerged as areas of dissatisfaction with their WSUD features and possible sources of ongoing concern. Cost concerns were perceived as a major negative aspect of the recycled water system. Residents thought the purple pipe water was expensive (at 75% of Tier 2 pricing), relative to treated mains water, and that the

third pipe infrastructure added a layer of cost onto the housing price. Recent council changes in nearby suburbs (Golden Grove) promulgated another concern among residents that their greenscape could be reduced as a cost saving measure in Mawson Lakes. According to some of the residents, the aesthetics of the development was much appreciable and if the council failed to maintain it, they would even consider moving out of the development.

A perceived lack of information and lack of understanding among residents regarding aspects of the recycled water management system and other WSUD features created opportunity for misunderstandings to develop. In particular, some residents reported a limited understanding of how the recycled water should be safely used (drinking, showering, garden sprinkler, eating vegetables watered with recycled water), how the purple pipe system should be repaired and checked, and mosquito related risks of the wetlands. Some residents thought the lake clarity was poor given its source as treated sewage water. The secondary school across from the lake discontinued water-based recreation activities in part due to uncertainty about water quality. Several participants did not use the purple pipe water for washing their cars because they believed the water was damaging to rubber and plastic. Finally, effective ongoing management of the WSUD infrastructure was important to residents. Issues related to maintenance of the development in terms of rubbish removal and repairs of infrastructure were concerns for the Mawson Lakes community. A local community group was active in helping to maintain gardens and keeping the precinct clean and tidy of rubbish. There was a perception among residents that some of the WSUD features were already damaged and needed repairing, and then there was little attention given to day-to-day maintenance issues.

Table 16 Potential barriers to acceptance of WSUD features at Mawson Lakes

ISSUE	DESCRIPTION	EXAMPLE
Cost	The cost of the recycled water was perceived as expensive by many and detracted from the perceived benefit of having the purple pipe water. It was viewed as adding another cost layer onto the housing and locking people into a water system over which they have limited choice. Some residents felt the water price at Mawson Lakes was higher than other areas, and were concerned that the council might be inclined to 'fill in the green spaces' in an attempt to reduce costs.	*"I think we've been discriminated against because we're eco-friendly."* *"I just don't believe that purple water is a way to go. …it does add another $3000, $4000 to the house by the time you run another line, plus you have the second service charge …. I just think there's a better way of doing it."* *"The one thing is the guilty factor. I don't feel guilty when I use the recycled water but now probably I feel guilty because it costs more."*
Lack of information and understanding	A general lack of information and understanding about the wetlands, and practical aspects of the purple pipe systems created potential for misunderstandings. e.g. unsure of risk of attracting mosquitoes, the potential and safe use of recycled water, evaporation losses from ornamental ponds, rationale for the 'no swimming' signs, the operation of the aquifers, technical aspects of the purple pipes including special tap fittings, self-assessments of the recycling system, and plumbing inspections.	*"I think there's a bit of a misunderstanding about this recycled water, whether you can drink it, whether you can shower in it or the kids under the sprinklers [compared to] the potable water."* *"The thing we weren't told about the purple pipes is that the ordinary fittings don't go on them. You can't get a fitting from the shop and put it on."*
	There was concern for renters, especially international students who were new to the region.	*"The concern I have is for the…international students …I would suggest the rental agent…give some information about what's in your home, and what is the system."*
Ongoing management: Keeping the lake, wetlands, and surrounds well maintained	The lake gets dirty looking and rubbish accumulates around the shore. Poor functioning of the sprinkler system resulted in only small patches of open spaces getting watered. Pedestrian walkway in disrepair and slipping into the lake. Maintenance of the waterways became problematic when the developer left; it took time to reinstate the upkeep of the lakes and wetlands to an alternate service provider (council). A local environmental group comprising 25 active members voluntarily help to keep the lake and wetlands clean of rubbish.	*"My real concern is that the maintenance of the lake is just going bad"* *"I go for walks every night and I come home with a handful of rubbish and I put it into my recycle bin because I don't want the area to go down.* *"That's one of the…biggest problems. Maintaining what we've got there to what we've paid for."* *"There are quite often broken pipes. I live on the main lake, and on my morning walk with the dog, there's quite often broken pipes. They can take quite a while to fix, which wastes water."*
Water use categories perceived as restrictive	Homeowners create more variable water use demands than policy permits.	*"I want to use recycled water in swimming pool but legally can't."*
Variability among lakes	Unlike the wetlands, the ornamental lakes have no reeds to keep them clean.	*"Shearwater Lake has reeds and appears clean. Shoalhaven Lake seems dirty, with insects. Why the difference?"*

6.3.7 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

Several main ideas emerged for ways to improve resident satisfaction with the WSUD features at Mawson Lakes. One suggestion was to incorporate a range of water saving approaches into the design of the complex, rather than the community relying on one main system, such as the purple pipe system. Residents felt recycled water could become expensive and suggested the installation of tanks be encouraged for those who wanted to reduce their use of the recycled system. Additionally, rainwater was perceived by participants to be of a higher quality than recycled storm water. A second dominant issue was planning for the handover from developer to the next caretaking entity. Participants felt that in the case of Mawson

Lakes, little was done to plan for this eventuality, which left residents feeling as though the development was not being managed adequately. In this case, the Council was perceived as less accessible, when compared to the developer, who had an office in the Mawson Lakes neighbourhood, where drop-in visits were used to report any problems. Some participants suggested that a handover plan would help mitigate problems associated with this transition.

Ensuring adequate ongoing management of the WSUD features, so that they remained well maintained and in a good state of repair, was seen as crucial to ongoing support. Participants felt that certain areas were losing their appeal because of poor maintenance and pollution spoiling the facade (e.g. rubbish lying around). Further, participants felt it was important to ensure the initial design of the WSUD features was as aesthetically pleasing as possible, to maximise the potential enjoyment of the feature long term. Finally, participants were very conscious of the financial costs associated with using alternative water options as part of living in a WSUD development. They encouraged developers to aim for a recycled system that could be as cost effective and efficient as possible, so that residents could enjoy the lowest possible prices for their non-potable water, to encourage more widespread use of alternative water.

Table 17 Ideas for improvement and advice to others

IDEA	DESCRIPTION.
Don't rely on one water saving approach	Recycled purple pipe water can become very costly as a sole source of non-potable supply Consider installing rainwater tanks as well as the purple pipe. *"Purple pipes discourage rainwater tanks – they tell you we're using recycled [water] you think it doesn't matter…but the boss told me our bills are phenomenal, because we have recycled water we don't think about putting in water tanks. So there's a false sense of confidence in water because of the purple pipes."*
Plan for the transition from developer to permanent owner	Plan for the transition from developer to the alternative recipient; who is going to take on the ongoing maintenance of the WSUD features when the developer leaves.
Ensure adequate ongoing management	Ongoing management needs to be of a stand that ensures WSUD features are well maintained and kept in good repair.
Ensure the design as aesthetically pleasing as possible	The lake always looks muddy and dirty – could this appearance have been improved with alternate design.
Aim for decreased cost and improved efficiency	A cheaper and more efficient version of the recycled water system would be beneficial to residents in the long term.

6.4 Springbank Waters

Springbank Waters is a medium size residential development of 407 allotments located in the suburb of Burton in the City of Salisbury approximately 21 km north of the CBD. Burton is located in close proximity to the Edinborough RAAF base and 3.5 kilometres from Adelaide's Bolivar Wastewater Treatment Plant. Burton has a population of over six thousand people with median age 29 years; households comprise an average of 3 people per household and 72% own their home. The area has are a diverse socio-economic and multicultural population. The median weekly household income is $1237; however there are relatively low levels of education with only 6.9% having tertiary qualifications (ABS 2011). As a low socio-economic area, the urban region is characterised by higher incidence of unemployment/joblessness and single-parent families, and lower high school attendance rates than metropolitan Adelaide. Northern Adelaide's Index of Relative Socio-Economic Disadvantage score (918) is below the Adelaide (1006) and South Australia (1000) averages. Council personnel reported that site was chosen, in part, to demonstrate how effectively a development similar to Mawson Lakes could be implemented in a lower socio-economic suburb like Burton. However, Springbank Waters appears to be more affluent than other areas of Burton, possibly due to the number of defence force personnel and the aesthetic appeal of the new development.

Figure 10 Parkland irrigated with purple pipe water and some of the more costly homes opposite the wetlands

The development was a joint venture between AV Jennings and Opthummell as well as a number of other investors including Defence Housing Australia. Springbank Waters is located in close proximity to the Edinburgh RAAF base. The development is administered by the Salisbury Council, which also manages Mawson Lakes. The sites contain similar WSUD features, however, in contrast to Mawson Lakes, there is no third pipe distribution system to residences in Springbank Waters.

Springbank Waters WSUD system was designed to:

- Reduce dependence on mains water whilst maintaining a 'green' landscape
- Effectively manage storm water from the development area and upstream
- Produce runoff of suitable quality for harvesting downstream
- Reduce the quantity and improve the quality of runoff to the coast.

Figure 11 Springbank Waters development master plan

Source: AV Jennings

6.4.1 WSUD FEATURES

Information about the WSUD features at Springbank Waters was obtained from City of Salisbury engineering services personnel. Springbank Waters receives water from the City of Salisbury recycled storm water system. An offsite ASR scheme (Kaurna Park) operates immediately north-east of the development, with water being pumped into the aquifers during the wet season and drawn out again during the dry, summer months. The Springbank Waters wetland and drainage system receives overflow from this system and the local surrounds. The water is then discharged to an open channel which leads to more wetlands downstream. In the future, these downstream wetlands may also be used for harvesting.

The Springbank Waters wetland has a storage capacity of 52 ML and forms the main part of the local catchment. This wetland detains storm water during the rainy season and controls its progress to improve its quality and reduce flooding. Public open spaces in the development, including local parkland, the grounds of the local school and a sports field adjacent to the community centre, receive recycled storm water from the recycled storm water system and purple pipes are visible in the area. Runoff throughout the area is managed through a mixture of conventional pits and pipes and vegetated open channels.

6.4.2 POST-IMPLEMENTATION MAINTENANCE

City of Salisbury personnel reported that there are problems with the design of the development which make it expensive to maintain. Silting up of the entrance waterway is the main problem. Also the storm water runoff from the development is directly discharged into the wetland without any treatment, eventually letting the nutrients into it. The system needs to be regularly supplemented with ASR water, as

the residents have complained when the wetlands dry out. Also the development had gross pollutant traps (GPT) with bags near the storm water outlets and once the developers moved out, the City of Salisbury was not able to maintain them. So the screening bags have been removed from the GPTs which now directly discharge into the waterways.

There is also a practical difficulty in liaising with upstream councils on storm water management, whereby the filling up of upstream storages in Playford Council, caused flooding in Springbank Waters during a heavy rainfall event.

Figure 12 Springbank Waters wetland drying out in late summer

Table 18 Summary of WSUD features at Springbank Waters

FEATURE	TECHNICAL ASPECTS	OUTCOME
Storm water reuse	Harvested storm water from the Salisbury recycled water grid is used for irrigating public open spaces in the development including the local school. Unlike Mawson Lakes, there is no third pipe supply into residences.	Reduced demand for potable water for irrigation
Water quality improvement	Overflows from the Kaurna Park wetland, upstream of Springbank Waters, and from parts of the development, are drained via open vegetated channels allowing some water quality treatment to occur. All water drains to a wetland constructed as part of Springbank Waters which provides detention and water quality improvement prior to discharge to downstream wetlands (which may in future be used for harvesting)	Water quality discharge from Springbank Waters has been drained over land allowing infiltration to occur, and treated by the main wetland; this may reduce pollutant loads exported to the gulf. Treatment is also important to ensure that water quality does not impede the potential for proposed water harvesting downstream.
Flood management	Storm water is drained from the development via vegetated open channels which impede flow and allow for some infiltration to occur. The 52 ML wetland provides detention and retention of storm water runoff. The system is also intended to cope with overflows from the Kaurna Park wetlands immediately upstream.	Detention of flow reduces overall peak flows heading downstream, and minimises the risk of pollutant 'washout' risks when high flows enter and leave wetlands too quickly.
Wastewater management	There are no wastewater management features included in the Springbank Waters development	
Other	Wetland areas and open drainage channels provide for amenity and habitat	A variety of water birds are attracted to the area

6.4.3 COMMUNITY PARTICIPANTS

Participants for Springbank Waters were recruited from the local primary school, the Burton Community Centre and door-knocking as there was no community group identified specifically for Springbank Waters residents. There were 5 individual interviews (a community liaison officer and 4 residents) and 2 focus groups (10 participants from the primary school staff and parents and 5 from the Community Centre)

The 18 respondents from Springbank Waters who completed the questionnaire had a median age of 40-59 years but there were representatives of all age groups. Five had children at home. About 40% had tertiary qualifications, significantly above the area average of 6% (ABS 2011). Although it is a relatively new development almost all had been residents for over 2 years with a median of 2-5 years. The majority (69.2 %) were home owners and the respondents reflected some of the cultural diversity of the area, including a Sudanese refuge with his extended family and a Vietnamese couple.

The respondents from Springbank Waters were more concerned about wasting water and felt more strongly about the Value of Water than the Adelaide population. However, they had similar scores on the Pro-environmental attitudes and the Water Security scales as the Adelaide population (Details in Appendix I). These positive attitudes to the value of water and avoiding waste suggest that they would be appreciative of the water systems installed in Springbank Waters and perhaps more appreciative than people in other areas of Adelaide might be.

6.4.4 KNOWLEDGE AND UNDERSTANDING OF THE WSUD FEATURES AT SPRINGBANK WATERS

Although there were a few respondents who had a working knowledge of the WSUD system, this was certainly not the norm. Only one focus group attempted the diagram of the WSUD system at Springbank waters as the other group had limited time. Of the six people in that group, two had no idea and left the page blank. Two had very simple diagrams and two put in a fair amount of detail, including the one

illustrated and one which showed the ASR system (Appendix J). Of the people at the local school focus group, where there was no time to complete the mapping exercise, in self-assessment six reported very little knowledge, eight claimed medium awareness and three were reasonably expert in the system, for example:

> *"Rainwater is collected in Kaurna wetlands put together by Salisbury Council. Burton had issues with flooding in the early days, canal down the back of the school which was always flooding: large muddy puddle at the bottom end. The Council decided to set up a situation to catch water, run it though wetlands, make it a more eco-friendly setup. Purple pipe runs through the development; reduces water flow into Barker Inlet."*

Of the five individual interviewees, three did not have any knowledge and did not know about the purple pipe system for public open space. One, who had been working there for many years, had seen the development and knew that the system dealt with the problems with flooding. The young woman had a good general knowledge of the role of wetlands in filtering water and knew the water came from the Kaurna wetlands from exploring the area. She had seen the purple pipes around and knew they indicated recycled water but could not remember being given any specific information.

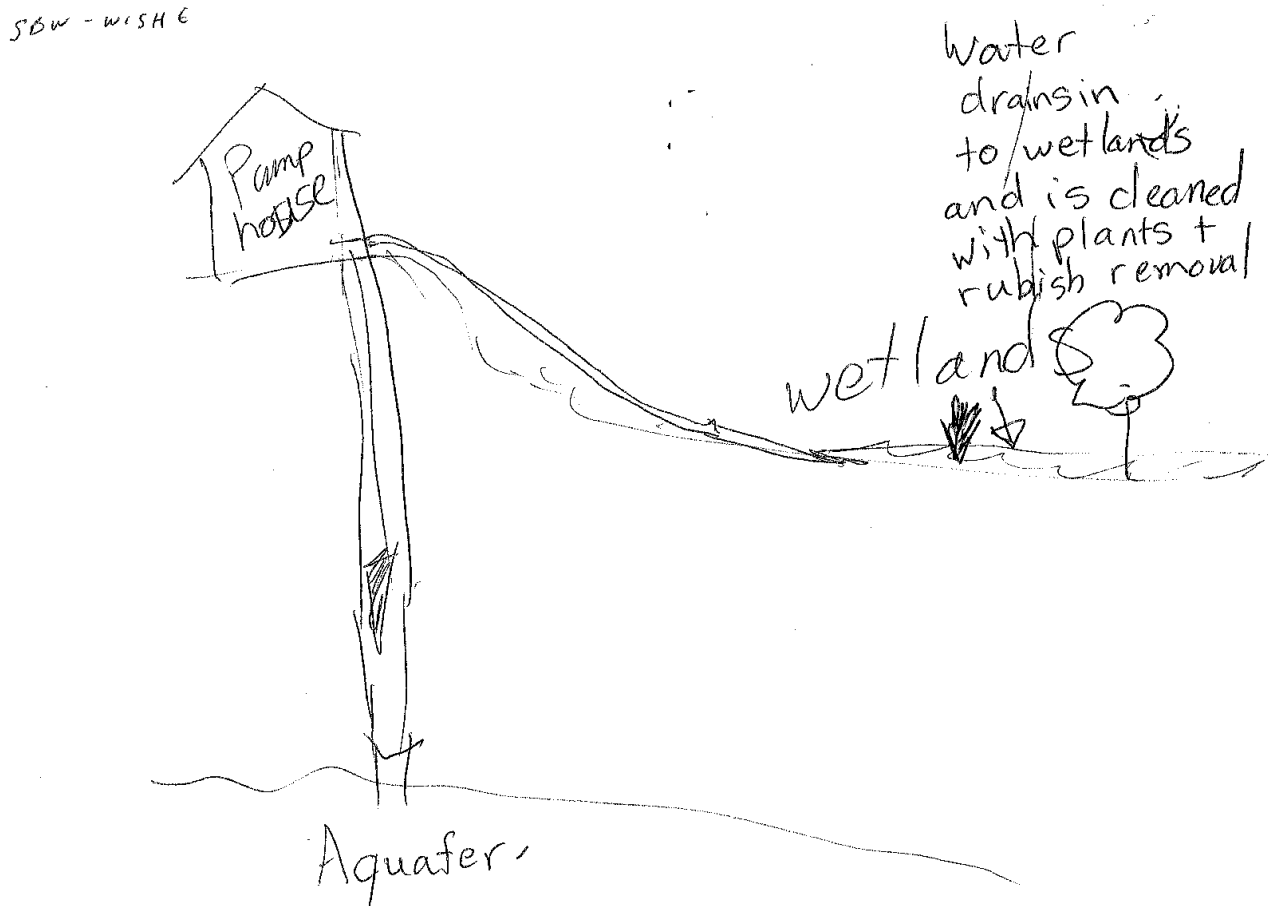

Figure 13 Best depiction of the WSUD system at Springbank Waters

6.4.5 WHAT PEOPLE LIKE ABOUT SPRINGBANK WATERS

Residents of Springbank Waters describe it as a quiet, family-friendly community with a 'country' feel. Residents enjoy the amenity and aesthetics of the wetlands, parklands, and ponds. There are walking trails, barbeque areas and local places for fishing. The residents and school community enjoy the extensive bird life, sounds of frogs at night and the green ovals and open areas. The wetland has provided opportunity for the school to engage with environmental management activities and students have planted reeds, trees

and other plants in the wetland area. Those affiliated with the school pride themselves on a range of on-site sustainability initiatives, including rainwater tanks and solar panels funded by the Commonwealth government and a school garden. The school community described a strong sense of involvement over the years with the wetlands and this link was fostered by the developer and local council (City of Salisbury). The developer and the City of Salisbury actively involved the school community in early planning proposals of the water features, planting vegetation, water testing and naming of local landmarks, which contributed to the school feeling a sense of ownership regarding the wetlands. However, participants say this involvement has not continued since the development was complete.

Many in the community liked the idea that the WSUD features supported water conservation and a reduction in the use of mains water for non-potable purposes. In addition, the ability of the wetlands to mitigate local flooding and to improve water quality was viewed as beneficial. However, most respondents were unaware of all the environmental benefits of the system before the information was provided in the interview or focus group. With no local organisation to promote the site, residents must rely on word of mouth or *Salisbury Aware*, the Council's publication, and it seems that these sources are not adequate in informing residents or the general public about the WSUD features in Springbank Waters. In general, there was a sense of pride regarding the water features and a high regard for the Salisbury Council for their management of the area.

Table 19 Key aspects that residents liked about Springbank waters

ASPECT	DESCRIPTION	EXAMPLE
Aesthetics	Residents enjoy the open spaces, water features, and greenscapes and view these areas as assets to the community and the suburb, creating a 'country' feel. There were no issues regarding noise from the WSUD system.	*"People like water…I think it's a real attraction."* *"It's nice to see some greenery around the place."* *"…because I am from the country it is a bit of the country almost."*
Lifestyle amenity	The common areas provide opportunity for residents to engage in outdoor activities such as walking, fishing, and outdoor play for children.	*"There's barbecues - it's all set up beautifully, and there are some lovely walking trails."* *"Great place to go walking and to walk with the dog."* *"We use lakes for leisure time...Children play around the lakes – kids like water."*
Birdlife	There are a variety of birds which the community seems to enjoy.	*"The birds and the water fowl…beautiful, out on the oval every day, got ducks and crows. You've got pelicans strutting in there."*
School engaged with wetlands	The school community has been engaged with the development of the wetlands over many years. The developer and local council worked collaboratively with the school to include their ideas in planning various water features and involve them in water testing and planting vegetation. The school community valued the educational opportunities and felt a sense of ownership of the WSUD features, even naming some of the local landmarks.	*"Our school was very heavily involved in the development of Springbank Waters and we had occasions when classes...went across and started some of the plant species...the involvement of the [school] community in that development has been a real plus."* *"It was certainly useful for us as a school to have that wonderful opportunity right on our doorstep...[The developer] purchased all the rubber boots and hard hats and safety vests…[The developer] would come and talk to us...about what they were doing, how they were putting pipelines in, how roads were being made...We were involved - Salisbury Council sent people along, and we were involved in water testing and looking at pollution."* *"They've got a plaque over there saying that the schoolchildren named the park."*
The notion of conserving water	The WSUD features provided an opportunity to reduce mains water use. The recycled storm water was combined with other water saving initiatives being undertaken in the community. e.g. rainwater tanks on school buildings to supply toilet blocks.	*"I think environmentally -for a school system- to know you're using purple pipe rather than the normal [mains water] pipe...it feels good."*
Potential flood mitigation	The potential for local flood mitigation was viewed positively.	*"Well it's protecting us from flooding which is always a good thing."*
Improved water quality as an envtl benefit	Improving the water quality in the suburb was seen as an eventual benefit to the sea and coastal water.	*"It [urban runoff after heavy rain]…was actually causing major problems out in the Gulf - we've lost about 14,000 hectares of seagrasses in that area because of the freshwater outflow."*
Sense of pride	A sense of pride regarding the WSUD features was evident within the community, especially for those connected to the school.	*"They're very proud of it. Very proud of it...the lakes, the fountains, with that grand entrance. [They] are an extremely proud community- they love it... and the children always want to [walk] that way and make sure the fountains are on, and...Salisbury Council is known worldwide for its wetlands."* *"Well the mayor often makes reference to it..in public forums."*
High regard for council management	The community seemed to regard the Salisbury Council in high regard. The Council were an effective source of information providing the community with updates on the wetlands with their Salisbury Aware publication. There also appeared to be an effective ongoing relationship with other activities planned. e.g. a community garden.	*"I would go so far as to say that Salisbury Council needs to be congratulated on their... water management."* *"They've taken the initiative to actually have good water management and it's fantastic to know that we live in a city where it's given such a high priority...I commend them for it."*

6.4.6 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT SPRINGBANK WATERS

Five main areas of concern created potential for future dissatisfaction among the community (Table 20). Poor aesthetics during the dry summer months was viewed as a negative and related to the parts of the system that relied on seasonal rain, which were dry for extended periods. Residents did not expect that part of their wetlands water system would go dry each summer. Related to this was the noise and land disturbance caused by an influx of motorbikes that used the dried out water bed for recreation, as well as other incompatible use conflicts. For many residents the mosquitoes and midges were problematic, but not everyone agreed. In addition, the pond developed an unpleasant odour of 'stagnant and musty' water that was particularly bad in the summer; participants said the odour was worse on some days than others and worse in some areas of the park than other areas. However, some residents believed that the odour didn't relate to the pond, but rather to a nearby farm, Bolivar or ongoing work on sewage pipes. At times the water seemed quite polluted from the ducks and contained rubbish, which detracted from the aesthetics for some residents. The final concern was regarding safety and small children. Those connected with the school community saw the waterways as a potential safety issue. Even though they viewed the risk as small, because of the shallow depth of the water, water safety was still a concern when responsible for the wellbeing of children. This sentiment was echoed by parents of infants who were mindful of needing to supervise their children at all times when near the water's edge.

Table 20 Potential barriers to acceptance of WSUD features at Springbank Waters

CONSIDERATION	OUTCOME	EXAMPLE AND QUOTES
Poor aesthetics during summer	During the summer months the pond becomes a dry bed, which residents find unattractive and contrary to expectations. Exacerbated by seasonal dieback of vegetation as well.	*"Pretty much every year by early March the whole lot of it is dry. Springbank Waters and Garnet Park are all dry."* *"I actually thought it would have at least some water in it because it was advertised as Springbank Waters and a wetland."*
Noise/land disturbance from motorbikes	When the pond is dry people use the dry bed for speeding around on their bikes (motor bikes, quad bikes and trail bikes), creating a noise disturbance and significant problem to the local residents.	*"When it's summer...it's dry and they go out there and speed around on their bikes and whatever."* *"We're talking about motorbikes honking, not bicycles."* *"[It's] a massive problem."*
Mosquitoes and midges	Some residents find the influx of mosquitoes and midges as a significant problem. For others, they avoid being outdoors at dusk.	*"The only downside, as most people in this area would say, is we've had a huge influx of bloody mosquitoes and they're big enough - ... they'll take off and take you with them."* *"The little midges. You open your mouth some days and you [can't talk] and walk..."*
Unpleasant odour	The water develops an unpleasant 'musty' stagnant water odour during the summer. The smell varies from day to day with some days and areas of the waterways worse than others. However, some residents felt the odour was coming from a neighbouring suburb - some felt it was a mushroom farm, another fertiliser.	*"It's worse in the summer - It's worse, it's whiffy."* *"Especially this end down here, some afternoons you can smell it's stagnant water ."* *"It does change. ... sometimes it's very strong, other times you don't smell it at all."*
Polluted water	The water gets dark and polluted.	*"The water colour sometimes is bad - looks 'murky.'"* *"The other problem you've got down there too is there's a lot of ducks that are there that are not wild ducks, they're not indigenous ducks. So you've got white ducks and other ducks that have been let go and they go in and pollute the water a fair bit...it spoils it a lot ... "*
Rubbish in the water	At times there is rubbish in the water, although residents report the council cleaning the lake every couple of weeks.	*"[The rubbish in the water] is a shame,"* *" They clean the lakes every 2 weeks or so – sometimes if they don't come the water does smell and there are flies,"*
Concern for water safety	Some residents felt the water was a concern for safety of small children, because even though the water was shallow it was murky and would be hard to see an infant. Also, a child could fall from the bridge into the water and at times the water could be quite deep in that part of the pond. Parents of small infants report the need for extra vigilance around the water's edge. The school community is also wary of the water and child safety.	*"Safety is serious, ... I understand the wetlands are growing ... What I do have trouble with is that it seems that you've got to have a ... backyard fence or swimming pool [fence] and yet you can have those massive areas of canals."* *"There are some safety concerns with the bridges ... should there be railings along those bridges"* *"Have been worried that children can fall in, so need to have care from adults, cannot let kids go on their own."*

6.4.7 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

In general there was support for the WSUD features of Springbank Waters and residents suggested four ways in which things could be improved (Table 21). First, the opportunity to retrofit recycled water from the purple pipe system to homes in the area. Residents recognised that this would involve cost and inconvenience, and for some this would outweigh the potential benefit, but for others they would value

access to a non-potable water source. Similarly, some residents suggested that access to non-potable water could be enabled by government, through support to install domestic rainwater tanks. They suggested government subsidies in this area be continued. Likewise, school parents and teachers wanted to maintain targeted government grants programs that allow continual infrastructure improvements in environmental management, including funding for water capture and storage. Residents also believed that ongoing maintenance of their WSUD features could be improved to ensure things were 'kept looking good'. Some felt the area looked 'tired' and needed 'freshening up'. A final suggestion was a fence to keep the area safe from small children. However, not all residents concerned with child safety suggested this option, and it was unclear the extent to which the idea of a fence was supported.

Overall, it seems that better community awareness of the benefits of the WSUD system may increase support for WSUD features. When informed of WSUD benefits by the researchers, participants responded very positively. Lengthy resident discussions that emerged about the potential for the aquifer to dry up indicate a need for provision of more baseline information on WSUD systems.

Table 21 Ideas for improvement and advice to others

IDEA	COMMENT
Retrofit recycled water to houses in the area	Residents suggested extending the recycled water scheme to include houses in the area by retrofitting purple pipes to existing residences. Although there are recognised costs and inconvenience associated with retrofitting, some residents would like the opportunity to be able to access a source of non-potable water.
Government support and subsidy for installation of rain water tanks	Ongoing government support for the installation of a domestic rainwater tank was viewed as important to those who would like to be able to access non-potable water at the household level. Likewise the school wanted to continue their onsite sustainability initiatives.
Ongoing management	Residents felt that maintaining the WSUD features was important and that this could be improved in their suburb. They felt the WSUD areas looked tired and needed 'freshening up.'
Fence for safety	Fencing around some areas of the waterways was suggested as a way to improve child safety. However, not all participants who were concerned with child safety supported this suggestion.
Education about water management options for property owners	Homeowners mentioned underground rainwater tanks in new suburban developments (Munno Para, Blakeview Crossing) and expressed an interest in knowing more about retrofitting options.

6.5 Mile End

Mile End is an inner city suburb of western Adelaide where street scale bioretention basins are currently being incorporated into residential streets throughout the suburb and surrounding suburbs in the City of West Torrens. It is one of Adelaide's older suburbs with a mix of residential with commercial properties on the main roads. Mile End has a population of over four thousand and the median age is 34 years. The population mainly consists of families but there are also groups of students and other young adults. The average household has 2.3 people. Perhaps due to the groups of students, the median weekly household income is not high ($1,132) and about half the people own their own home (51.7%) (ABS, 2011).

Figure 14 Typical Bioretention garden soon after planting

6.5.1 WSUD FEATURES

An engineering services coordinator for the City of West Torrens was the major source of information about the site. There are approximately 90 bioretention basins in place in the City of West Torrens, with significant and increasing numbers installed in Mile End. The bioretention basins collect storm water runoff from residences and streets and provide detention and filtration of the water prior to discharge into the conventional pit and pipe storm water system. The installation of the basins is occurring during routine upgrades and redevelopment of the streets, and is intended to help reduce localised flooding and improve storm water runoff quality. In addition, the basins provide street vegetation, enhance the streetscape and act as passive traffic management infrastructure. Sustainability was the key driver for the installation of the street basins, along with the opportunity to retrofit WSUD infrastructure into existing streets. It is projected that Mile End might become the first suburb completely retrofitted with rain gardens, in Australia. The bioretention systems are all situated on the road edge between the footpath and passing vehicular traffic and vary in their dimensions according to site conditions. In Mile End, there are typically six gardens per block with the basins are often positioned symmetrically on either side of the road however the number of basins per stretch can vary based on available spaces to incorporate the bioretention basins.

Economic efficiencies for the project have been achieved by conducting the civil works in conjunction with routine street upgrades. In addition, the systems are designed with a 'standard' design that is adjusted to suit local need, making the bioretention basins easier to design and implement. The goal throughout the process has been to develop streetscape pods that can be adapted to any situation. The design of the system consists of 'Lego block' like components that may be stuck together to create streetscape pods suitable for a host of applications to prevent interrupting services and maintain traffic. Over time, there has been a noted improvement in design and construction techniques as local government and road redevelopment contractors refine their methods with increasing installation experience. Table 22 provides a summary of the WSUD features at Mile End.

The installation of the bioretention pods created a number of challenges:

- Setting up the system in a manner that does not interfere with existing services
- Acquiring appropriate sand and soil media
- Selection of appropriate plants: The Facility for Advancing Water Bio-filtration (FAWB http://www.monash.edu.au/fawb) have recommendations for appropriate plants, however those recommendations were developed in the eastern states and are not necessarily the best for the

Adelaide climate. Also the Council prefers to use indigenous species. As such, plant selection is proceeding in a trial and error fashion until the best plants are discovered.

- Planting: The works are typically completed towards the beginning of the hot dry summer. As planting cannot reasonably take place then, it is delayed until the beginning of winter when rains can be expected. The bare garden beds have led to complaints from residents however it has given the Council the chance to kill off any weeds in the soil media prior to planting
- Certain features at the inlet of bio retention systems which prevent a build-up of gross pollutants and clogging at the inlet have not been applied in some basins either because of its exclusion in design or exclusion during construction.

Table 22 Summary of WSUD features at Mile End

FEATURE	TECHNICAL ASPECTS	OUTCOME
Water quality treatment	Bioretention basins collect runoff from surrounding houses and roads and water is detained at the surface of gardens prior to infiltration through engineered soil media.	Improved runoff quality proceeding down drains and into Patawalonga River. Improved aesthetic amenity (potential). Detention of storm water prior to discharge into the drainage system (potential to reduce peak flow). Reduced local flooding.
Flood management	Bioretention basins are being installed in conjunction with conventional pit and pipe drainage works in streets. The gardens provide some flow retention (via a permanent underdrain and provision of soil moisture) and detention via the temporary storage above the filter media. A bypass system is present to manage high flows.	Flow volumes and flow rates reduced, especially in small runoff events.
Water reuse	Bioretention basins provide amenity through the integration of vegetation into the streetscape. Vegetation has been selected based on local conditions, and these receive water from only a permanent water storage at the base of the bioretention basin, and intermittently by water collected for filtration.	Gardens do not need to receive irrigation even during hot, dry summer months.
Wastewater management	There are no components for managing wastewater in Mile End.	

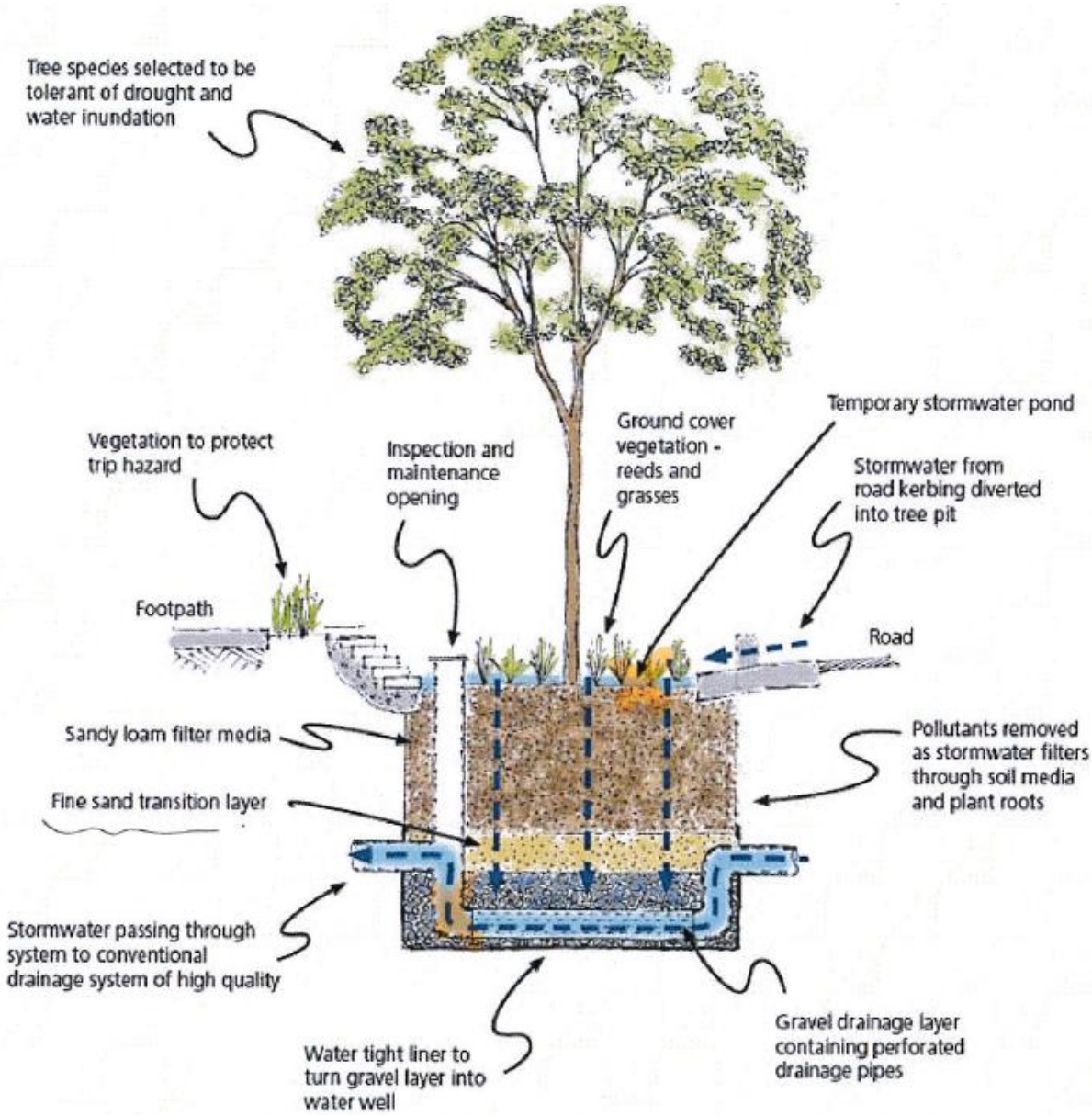

Figure 15 Cross-section of the bioretention basins

6.5.2 COMMUNITY PARTICIPANTS

Key informants at Mile End were a local business man who was active in Rotary and two real estate agents, all of whom lived in the area. The focus group attendees were members of the local historical society. In addition, 23 short interviews with people recruited through door-knocking near the sites of the bioretention basins obtained input from those most directly affected. Of these 23 interviews, 14 were conducted at the end of summer and nine after the winter rains had commenced.

Only nine people (4 men, 5 women) completed the quantitative data sheets at Mile End so we were not able to get a good representation. The median age was 60-74 with three people older and three younger. Partly reflecting the older age of our respondents, most had only high school level education and only one had a tertiary degree. All had lived in the area for over 6 years and two-thirds owned their own homes. Of the respondents to the short interviews, seven of the 23 were male and the median age was approximately 50. Three were renters, two were new owners and the others were long term residents.

Only nine people completed the four scales measuring attitudes to the environment and water (See Method section) but those respondents had almost identical scores on all four scales as the Adelaide population (Appendix I). This sample is too small to represent the people of Mile End but it does suggest

that the attitudes expressed in the qualitative analysis are those of people with typical positions on the environment and water management.

6.5.3 KNOWLEDGE AND UNDERSTANDING OF THE WSUD FEATURES AT MILE END

The majority of participants had no declarative understanding of bioretention systems. One focus group participant, who is actively involved in residents' groups engaging with SA Water, was familiar with the system. However, he did not have any specific knowledge of the Mile End system and was unable to find information on the web. He was the only respondent aware that there was some filtering of storm water and flood reduction but was unaware of the bioretention basin functions under the gardens. He also mentioned that the drains in the gardens were for flood mitigation. Individuals interviewed after the winter rains had begun also commented on the control of flooding. Otherwise respondents focused on the plants, beautification, and the effect on traffic and parking.

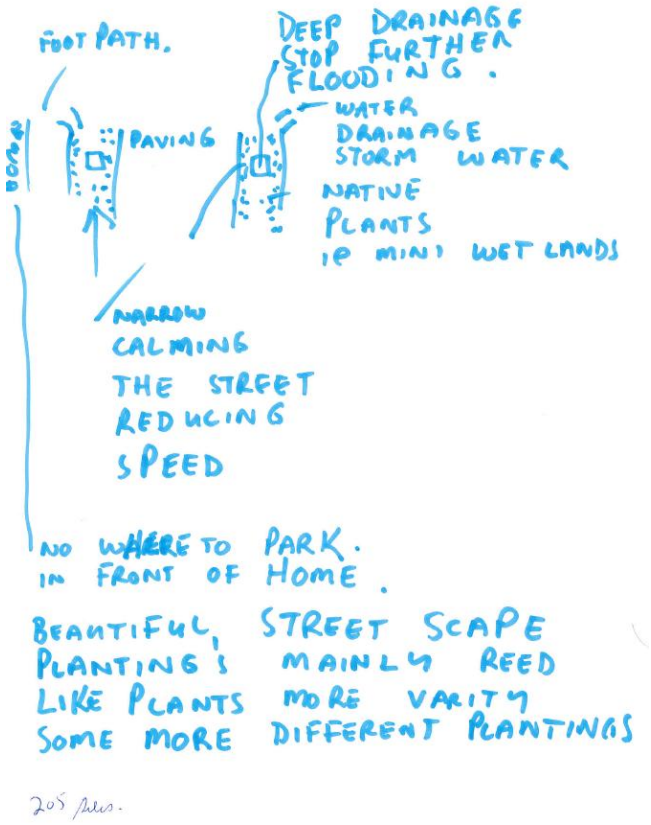

Figure 16 Depiction of Mile End system by a community participant with the most WSUD features

6.5.4 WHAT PEOPLE LIKE ABOUT MILE END

Residents of Mile End describe their community as multicultural with strong links to history and heritage. Residents enjoy the cultural diversity, coffee shops and restaurants and the convenience of being located close to the city. They see their housing options as good value for an inner city suburb. There are a range of different housing styles in the area with higher density housing options becoming popular, particularly to young home buyers. Housing blocks are being subdivided and different types of residencies established such as community lot apartments blocks. There was no strong sense of community, with most community activity described as associated with church groups and a coffee culture. Residents within the suburb enjoy the style of the homes and are proud of the heritage character. Table 23 summarises these points.

Table 23 Key aspects that residents liked about Mile End

ASPECT	DESCRIPTION	EXAMPLE
Location	Located close to the city and beaches. Convenience of nearby shops, coffee shops and restaurants. Mile End viewed as good value housing for inner city living.	*"Well, it's a good spot to live. It's close to everything, the city, the beaches."* *"..plenty of nice cafes and stuff like that."* *"the convenience of living in a location like Mile End and local shops are within walking distance."* *"There's no way we could have lived this close to town in Melbourne for the money and still had the lifestyle..."*
Style and choice of housing	Heritage and character homes are appealing to residents.	*"I love the character. Love the character homes."* *"the heritage of housing in the area is important to me."*

6.5.5 WHAT PEOPLE LIKE ABOUT THE RAIN GARDENS

In relation to the rain gardens, residents appreciated the aesthetic value of the garden and the impact of the garden on calming traffic in busy streets. Residents also felt that the rain gardens had helped to mitigate flooding in some areas and that this was beneficial. The potential for the rain gardens to appeal to the environmentally conscious young home buyers was also seen as a positive. The perceived benefits of the rain gardens are detailed in Table 24.

Table 24 Perceived benefits of the rain gardens

ASPECT	DESCRIPTION	EXAMPLE
Aesthetically pleasing	When fully planted and well maintained the rain gardens were considered to be aesthetically pleasing.	*"The ones that are on my street are a different plant and they've just installed all the plants. It looks really good."*
Mitigates local flooding	The rain gardens appeared to be helping to mitigate local flooding when working effectively.	*"Yeah I'd say it's noticeably better for the dispersion of water."* *"It seems to be working."* *"With rain like last week the water would be a meter and a half into the road – now it's all gone."*
Traffic calming	Residents felt the traffic had slowed in busy streets. However in some cases it was not clear if they were referring to the rain gardens or other traffic calming measures.	*"So that's probably been a good thing I think, slowed [the traffic] down, because normally they come off South Road and quite often they just plant it."*
Increases appeal of the area to the environmentally conscious	The rain gardens are potentially appealing to young home buyers moving into the area who are reportedly more environmentally conscious and concerned.	*"I think the younger people that are coming into the area and buying into the area, I think they could see the value...[in the rain gardens]... they are always, predominantly more environmentally conscious."*

6.5.6 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT MILE END

Seven main areas emerged as potential sources of dissatisfaction and problems for acceptance of the rain gardens long term (see Table 25). These included the installation and construction phases of the rain garden, which were described as being overly long (up to 12 months in some instances), noisy, dusty and inconvenient. Aligned to this phase was a perceived lack of consultation and notification about the installation. Not only were residents ill-informed about pending construction, but also seemed to lack an understanding about the purpose of the roadside "gardens" and the possible benefits. This lack of information about the potential benefits seemed to increase dissatisfaction among residents. In some instances, residents were concerned about the appearance of the gardens and described them as bare, unfinished looking, and an eyesore. In doorknocking, several residents expressed concern about tree loss

from road reconstruction and rain garden placement. Some of this related to the type of plants (or lack of), and some to the accumulation of rubbish within the garden. Ongoing maintenance of the garden was therefore seen as important. Some residents had experienced a build up of leaves blocking the drain in the rain garden, which had resulted in local flooding. Residents' primary concern seemed to be the negative impact that the installation of rain gardens had on street parking for residents, especially those that lived in high density housing.

Table 25 Potential barriers to acceptance of WSUD features at Mile End

CONSIDERATION	OUTCOME	EXAMPLE
Installation and construction phase	The installation and construction phase disrupted the road, interfered with parking and nearby vegetation, and created noise, dust, and inconvenience for local residents.	*"It was mainly the upset of the roadworks rather than the actual [rain garden] that they were [installing]."*
	For some the disruption lasted 12 months.	*"[We had construction] out the front of our house...and that was nearly 12 months we had road issues. So that was full on."*
	Issues made worse by a lack of consultation and lack of understanding as to the purposes of the rain garden.	*"The installation process was a bit of a bug bear for local residents...[There wasn't consultation] about when it was happening and what the process was for installing them."* *"A lot of residents don't know their purpose particularly well."*
Lack of consultation	Minimal consultation regarding forthcoming installation and construction of the rain garden; nor was there communication of the overall plan for the suburb in relation to the number of rain gardens and where they would be placed.	*"I think that information's at council, but I think a lot of the older generation...wouldn't even bother to go to council to find out."* *"I would like to have known what they were actually going to do, where they're going to do it and probably why they're doing it."* *"Three days before they started construction there was a letter in the mail box, no talking."*
Lack of information	A lack of information has contributed to a lack of understanding within the community as to the purpose of the rain garden and their potential benefit. This type of information would potentially help mitigate the dissatisfaction experienced during installation and construction, and also encourage the community to take care of them.	*"I don't think we've actually ever had anything saying exactly what they're [rain gardens] for or how they're going to work or even what they're going to look like."* *"Most Mile End residents wouldn't see the benefit of them because...it hasn't been explained to them and....they don't see the difference."* *"I suppose if people are more informed about the difference that they make then people will take more care [of the rain garden]."*
Aesthetics	The rain gardens can look untidy and unfinished, especially if there are plants missing or if rubbish has accumulated.	*"[People] stealing the plants."* *"Still looks unfinished."* *"Residents have to deal with rubbish, even though it's a council project."*
	Loss of trees.	*"We lost an acacia tree."*
Ongoing maintenance	Ongoing maintenance is important otherwise they could look shabby and unkempt, and be a negative for the suburb.	*"If it started to turn a bit grotty then the whole area would just be completely...brought down with it"* *"I'd like to see them [maintained]...so they actually enhance the streetscape, if you like, rather than actually make it just somewhere to dump your rubbish as you walk."*
Ineffective functioning	If the rain garden not maintained properly it can cause local flooding and affect other nearby infrastructure, such as internet cable, which causes inconvenience and possibly expense.	*"I know last year we had lots of rain for a period and there was trouble in one [rain garden]...where it was flooded for a period of time and it affected some of the...underground wiring."* *"The copper wiring that runs underground is sometimes affected by the water that pools in these beds."*
Impact on local street parking	The impact on parking was a significant issue for some community members, especially for those that had multiple members of the family with cars, or in shared accommodation, and especially in situations where the rain gardens are placed in pairs on either side of the street.	*"It does reduce the amount of on street parking there is...There's a house two doors down from me. They've got a driveway with enough room for one car but there are actually three cars that reside at that residence."* *"I mean when you've got students living, or two or three or four or five people...living in a house, then you need the car spaces."* *"It's trouble: harder to get car in and out of driveway."*
Safety	Animals or pets could get trapped in space under grate.	*"The open grate on sides could trap small animals including pets."*
	Tripping hazard.	*"It's a tripping hazard for older people – we told the council."*

6.5.7 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

Ideas for improvement revolved around community consultation processes, improved information, and ongoing maintenance. Residents felt that improving consultation about proposed new gardens, such as when they are likely to be installed and the overall plan for the area would be beneficial. Improving information available to the community about the purpose and benefit of the rain gardens would create increased awareness and understanding, and ultimately wider approval of the feature. Residents reacted very positively to the information provided to them as part of the research process and indicated that this type of information would be of value. Reliable ongoing maintenance in terms of maintaining the garden, weed prevention and rubbish removal was fundamental for some residents' long term approval.

Table 26 Ideas for improvement and advice to others

IDEA	COMMENT
Community consultation	Particularly in relation to pending construction and plans for future rain gardens in the suburb.
Information sharing	Information about the purpose of the rain garden, how it functions and the benefit to the street and local environment would improve awareness and satisfaction among residents.
Ongoing management	Ensure the gardens are maintained in terms of plants, and weeds. Ensure rubbish is removed. Ensure optimal functioning of the rain garden.

6.6 Harbrow Grove Reserve

The Harbrow Grove Reserve was identified for redevelopment in the City of Marion Council's open space and recreation strategy**.** The existing reserve was a long narrow undeveloped stretch of land without formal plantings located between Harbrow Grove and Eurunderee Avenue in the suburb of Seacombe Gardens, 15 km south-east of the Adelaide CBD.

The southern suburb of Seacombe Gardens has a population of two and a half thousand. The population is generally older with a median age of 39 years. Less than a quarter of the residents have tertiary degrees (22.6%). The median weekly household income is the lowest among study sites at $826, and significantly lower ($200) than the City of Marion average. There are 2.2 people per household reflecting a mixture of families (1.6 children) and retirees. About half the people own their own homes (53.3%). Seacombe Gardens is also culturally diverse; 18% of residents come from countries where English is not the first language (ABS, 2011). The proximity of Seacombe Gardens to the Marion Shopping Centre, a well-resourced public library and cultural centre (located less than a kilometre from these facilities) makes it a more attractive hub for families.

The Harbrow Grove redevelopment project accessed funding from the Federal government's $800 million Community Infrastructure Program for the redevelopment of the reserve, to support jobs and boost local economies by building and renewing community infrastructure. Harbrow Grove Reserve underwent an extensive redevelopment between 2009 and 2011 at a cost of approximately $1.1 million. Four local schools have supported the project based on the value the reserve would offer in terms of environmental and science studies, particularly water management. Marion Council conducted community consultations prior to undertaking the project to identify appropriate recreational facilities and amenities for the community**.**

The reserve redevelopment included a number of WSUD features which were mainly intended to reduce localised flooding and to reduce the use of mains water for irrigation along with providing additional benefits of sustainable native landscaping and the promotion of community health and well-being (along with natural landscape features other recreational amenities including a playground, walking and cycling paths, bike/skate stations for youth and barbeque areas were provided).

Figure 17 Harbrow Grove Reserve: Site of the underground storage tank

6.6.1 WSUD FEATURES

Information about Harbrow Grove Reserve was obtained from City of Marion engineering personnel, and consultant engineers who worked on the design, but not implementation, of the water balance system. The reserve is among the first in the City of Marion to incorporate WSUD. Features include the collection and reuse of storm water for irrigation and operation of a water feature, and the installation of a detention basins and swales to manage peak runoff events during heavy downpours. The WSUD features form a 'treatment train' from east to west. First, storm water runoff from the local street network upstream is diverted through a series of kerb inlets into an open grass channel ("swale") at the eastern end. Water that does not infiltrate through the swale surface proceeds through a grate and underground pipes to a bioretention basin where it is detained and treated by infiltration through soil media. Treated water then proceeds via subsurface collection pipes to a subsurface tank at the western end of the reserve. To improve amenity, water from this tank is used to irrigate the open space of the reserve. Water is also regularly pumped into a centrally located decorative pond to ensure the pond water is not 'stagnant'. Overflows from the pond are recollected and retreated by the bioretention system, and subsequently recollected by the subsurface tank. The surface above the storage tank is also designed to act as a detention basin in high flow conditions. Picnic, barbeque, playground, and restroom facilities are located at the 'uphill' (east) end of the corridor, and cycle/skate facilities are at the western end.

Local council indicated that it has been difficult to maintain the WSUD features due to lack of funding. Lack of monitoring has prevented the council from assessing the performance of the system. Once the system became fully functional, it was noted that the pond was unable to retain water which was probably linked to the improper laying of the impermeable lining below the pond. The empty pond has thus reduced the ambiance of the site.

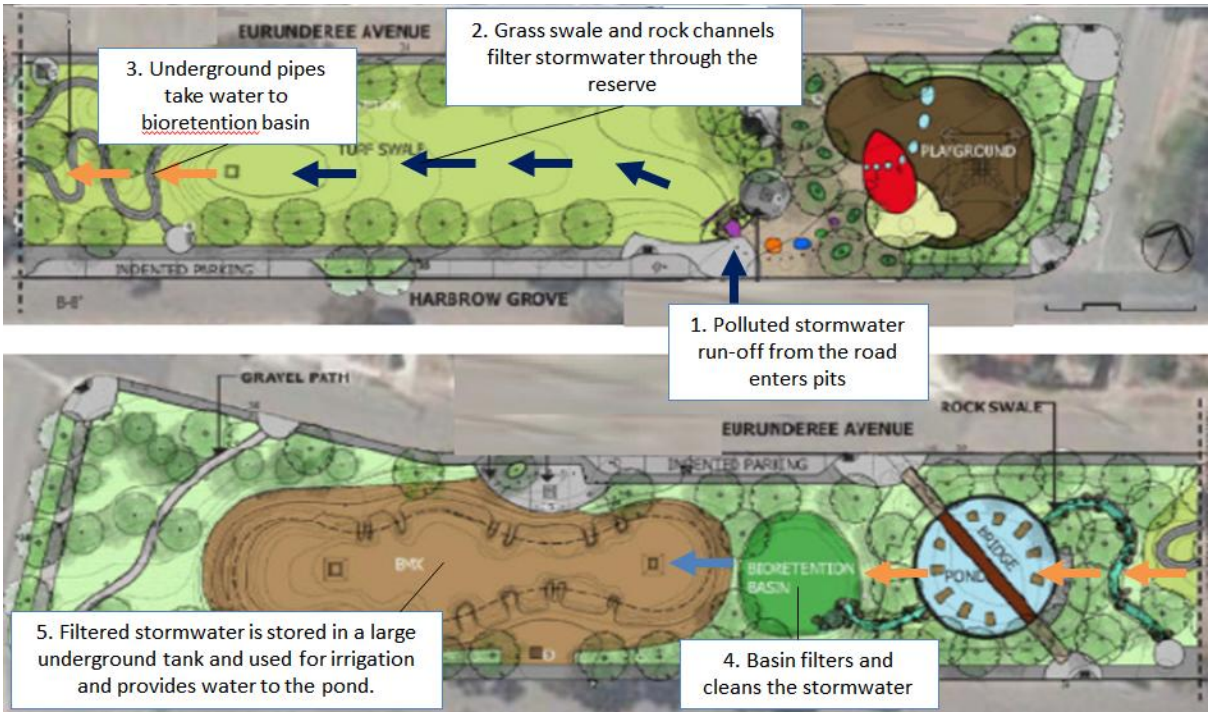

Figure 18 Diagram of Harbrow Grove Reserve WSUD features

Table 27 Summary of WSUD features at Harbrow Grove Reserve

FEATURE	TECHNICAL ASPECTS	OUTCOME
Water reuse	Water is conveyed via swale, pipe and bioretention treatment system to subsurface tank; water is reused for irrigation and circulated through decorative pond.	Reserve remains green and usable during dry summer months and water keeps circulating through the pond system discouraging algal growth.
Water quality treatment	*Swale:* Slows flow and allows sedimentation of solids to occur. *Bioretention basin:* the water from the swale, and pond overflows, are collected by the bioretention system and allowed to pond at the surface allowing sedimentation to occur. Water infiltrates through the engineered soil media and subject to filtration. *Pond:* acts as a sedimentation basin as well as an ornamental water feature in the reserve, regular circulation promotes dissolved oxygen in the pond and underground water tank *Detention Basin:* In high flow conditions, water passes over the swale and may be collected by the detention basin at the western end of the park. It allows for infiltration, evaporation and sedimentation.	Quality of water in the tank and decorative pond is treated to provide a reasonable standard for irrigation and amenity. Overflows from the system are treated by the swale and detention basins, reducing the load of pollutants downstream.
Flood mitigation	*Swale:* Flow passes slowly over the swale compared to conventional pit/pipe systems and allows for some infiltration to occur, reducing flow volumes. *Underground storage tank:* Collects storm water that would otherwise proceed downstream. *Detention Basin:* under high flow conditions, bypass of the storm water collection system proceeds to a detention basin above the underground tank. This slows the rate of flow downstream from via a controlled outlet, and reduced the volume of runoff via infiltration.	Reduced flow volume and flow rate proceeding downstream through harvesting and promotion of on-site infiltration.

Figure 19 Empty ornamental pond in the reserve

6.6.2 COMMUNITY PARTICIPANTS

The respondents for Harbrow Grove were five focus group participants, a young man and woman who completed the full interview, and three residents who completed brief interviews.

The median age for the five people in the focus group was 60-75 years. Three had only high school education, 1 technical and 1 tertiary. They all owned their own homes and had lived in the area over six years; four had lived there over 10 years. In keeping with the cultural diversity of the area, two of the participants were from non-English speaking backgrounds. Young people were also represented by two 18 year olds.

Due to the small number of participants, results for the attitude scales cannot be considered representative of residents of Harbrow Grove. The five who attended the focus group had higher scores for Pro-environmental attitudes and a more negative attitude to Wasting Water than the general population of Adelaide (Appendix I). These results suggest that the attitudes expressed in the qualitative analysis are those of people with particularly positive positions on the environment and water management.

6.6.3 KNOWLEDGE AND UNDERSTANDING OF THE WSUD SYSTEM AT HARBROW GROVE

People from Harbrow Grove focused on the visible features of the site rather than understanding the system. None of the interviewees or focus group attendees were aware of the important WSUD features such as the underground tank or the importance of the swales for filtering the water. In their diagrams they all depicted the (empty) ponds and other aspects of the park. Two drawings had more functional features such as the pump box, water coming in from the street, and the dry stone water course and long grassy depression which were depicted as being for water collection rather than for water treatment. (Appendix J).

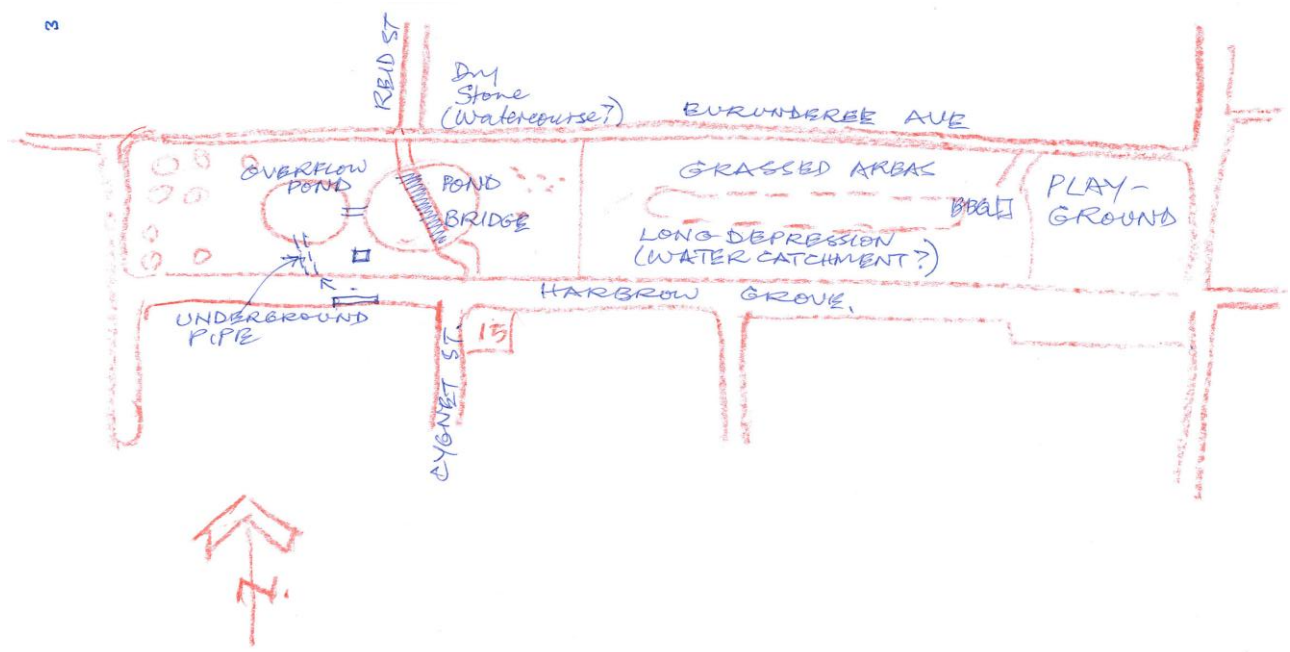

Figure 20 Depiction of Harbrow Grove by a resident with the most WSUD features

6.6.4 WHAT PEOPLE LIKE ABOUT HARBROW GROVE RESERVE

Residents of Harbrow Grove and surrounds felt very favourably towards the reserve area. Users are perceived to be children (on a daily basis), older dog walkers, fitness and exercise enthusiasts, and in addition to social events (picnics, birthday parties), sometime people play baseball. They enjoyed the open spaces, the ornamental bridge, and the recreational facilities and felt that the park was particularly popular with families. Residents regarded the upgrade of the reserve as a positive improvement on what had been there previously.

The only dissenting voice was an 18 year old who had enjoyed the previous informal BMX track built by volunteers, as the new small track with jump stations is just for children. However, he too was positive about a having a clean, updated, child-friendly gathering place for the community. Although there were issues with the pond (unable to store water) they particularly liked the notion of the storm water system as a way to help mitigate local flooding. However, at this stage residents were unable to determine if the system had actually helped in flood management, because there had been no significant rain event since installation and because any flood mitigation benefit would be revealed downstream. People in the focus group also liked the harvesting features, indicating the 'waste' of seeing water go downstream to the gulf.

Table 28 Key aspects that residents liked about Harbrow Grove Reserve

ASPECT	DESCRIPTION	EXAMPLE
Aesthetics	Residents saw the area as a vast improvement, and that the green open spaces were magnificent.	*"It was a dump for years and we used to walk across it and ignore it because it was just a mud path - it's a magnificent park now."*
	The ornamental bridge was a feature that everyone seemed to like.	*"It's green and pleasant...because it was an eyesore before. Terrible it was."*
	There were no issues regarding smell or noise from pumps.	*"I like the walkway, the bridge over. It's a nice feature...It's wonderful."*
Recreational amenity	The playgrounds, and barbeque areas are well used and were considered a key attraction for families.	*"Well, it's a great family area."* *"You've got a first class playground at the eastern end and an [adventure playground] at the other end .... so, for the grandchildren, it's fantastic. There's a barbecue area there. So, for a family get-together, it would be great."* *"Whenever there's fine weather on the weekend, it's always busy. So, from that aspect, it's a real success."*
Potential flood mitigation	Residents were very positive towards the storm water system being able to mitigate local flooding, although they had not yet had an opportunity to see this in action because no major rain events to date.	*"So we've seen that [flooding] for many, many years and at least now if the [storm water system] retains some of the water, fantastic."*

6.6.5 POTENTIAL BARRIERS TO ACCEPTANCE OF WSUD FEATURES AT HARBROW GROVE RESERVE

The most prominent area of dissatisfaction with the reserve was the mal-functioning pond, which residents described as a failure. The pond was unable to hold water for more than a couple of days and so for the majority of the time it was empty. Apart from the unattractiveness of the empty pond, residents also found this a frustrating situation because they saw it as a 'wasted' opportunity to be capturing storm water runoff. Many residents suspected the leaking pond was due to poor installation or design. There was a general lack of understanding about how the system was designed to function, even though residents had been provided with some information from council initially. This information had been mainly in connection to pending construction rather than the functioning and purpose of the storm water system. Residents felt that because the system had never functioned effectively that this would also be contributing to their lack of understanding of how it was meant to work. The residents also complained about graffiti (especially on the picnic tables), noise disturbance, and their concerns for their own personal safety, which were all related to 'gangs' that now hang out in the park area more frequently. No issues regarding child safety around the water features, pump noise, mosquitoes from the reserve, or odour were raised as a concern by residents. There was some concern for mosquitoes breeding in the area, but this was in relation to back yard habitats, rather than the reserve. Although not a barrier to overall acceptance, two interviewees expressed surprise about vegetation. They had expectations the setting would be more attractive and lush with flowers adding colour. The teenager thought the park did not offer any activities or appeal for young adults; he proposed a skating facility for the neighbourhood.

Table 29 Potential barriers to acceptance of WSUD features at Harbrow Grove Reserve

CONSIDERATION	OUTCOME	EXAMPLE AND QUOTES
Ineffective functioning of the pond	The pond doesn't hold water and is empty within a couple of days of filling.	*"We've had [rains] in the last week .... At the moment, there's a pond about as big as this table, but it's gradually soaking away."* *"[The council] came along with his truck full of bore water and filled the pond...It was actually full of water. But that's literally the only time we've seen the pond full of water. it just gradually trickled away [within a few days]"* *"If it worked, it would be fabulous."*
Poor aesthetics	Pond always looks dry and empty. Plantings not attractive.	*"I quite often go down Harbrow Grove and have a look while I'm driving by... usually see a blank canvas ... with no water in it, shopping trolleys in there sometimes."* *" last Friday, when it was raining beautifully for the first time - in a year I think and we both went across there in the evening ... hoping that it was going to be full, and I found that the ... pond was just mud"* *"Thought it would be more green and more dense plantings."*
Poor installation and or design	Perceptions that the lining of the pond was not right.	*"There's obviously something not quite right with the sealing of the pond and it's a real frustration because, as I say, we would love to have a pond and it just hasn't really worked.* *"I think someone stuffed up the design quite frankly."* *"I was involved in design all my life and when I see good design I love it, but when I see a mistake in design, I think, [whistles], boy oh boy."*
Lack of understanding	Despite being provided with Council information on pending construction of the park, residents had not received information that explained the purpose or water saving and environmental benefits of the storm water system. Residents felt it would be beneficial to have a greater understanding of how the system works.	*"Well, I don't think there was a lot about the system [how it works]. It was all about what was going to be where, how it was going to be laid out and the water system just went over my head, I think."* *"We vaguely knew there was a system, didn't we, but we'd forgotten about it ... as we never saw water."* *"I don't know how it works; it just seems to be dry most of the time."*
Wasting precious water	Residents believed strongly in the idea of not wasting water and that a dysfunctional system was a wasted opportunity to capture the water.	*"it is quite frustrating...when it rains you get this beautiful rain and then water comes down the street and ... then all the water goes down the drain. It would be lovely to be able to savour it and keep it."* *"It's beautiful and better. But sometimes when the Council waters, it goes in the street not on the plants." (shows researcher uncovered irrigation pipe)*
Graffiti and concerns for personal safety	Some residents described graffiti in the park area, noise from disturbances in the park, and a general concern for their safety as a negative aspect of the reserve.	*" What I don't like about it is ... it's the graffiti."* *"[there are] creeps and gang members lurking."*

6.6.6 IDEAS FOR IMPROVEMENT AND ADVICE TO OTHERS REGARDING WSUD FEATURES

Most residents believed that the development was well worth the financial investment, and that the concept should be replicated in other areas of the city. They felt it was important to ensure the correct implementation of the system and that all elements were fully operational. Providing the surrounding community with adequate information, so that residents developed a deeper understanding of the system's purpose and benefits, was also viewed as important The residents felt that initiatives that captured and harvested storm water were very beneficial because of the opportunity to 'not waste good water'.

Table 30 Ideas for improvement and advice to others

IDEA	COMMENT
Replicate the idea to the wider community	Residents believed that extending the storm water scheme to other suburbs of Adelaide would be very worthwhile, and particularly nominated the Sturt River area as a place for improvement.
Ensure the system is fully operational	Residents felt correct implementation of the system was important and that all elements of the system needed to be operating effectively; otherwise the final outcome was sub-optimal and detracted from the overall initiative.
Improve community understanding of the storm water system	Council information could be improved by highlighting the purpose of the storm water system, how it is designed to operate and the benefits that the system will provide.

7 Discussion and implications

The six case studies incorporated a variety of WSUD principles at varying scales of operation and with different management structures. Mawson Lakes was the largest specialised WSUD housing development included in the sample. Medium-sized developments, Lochiel Park and Springbank Waters, were also included, and the smallest specialised WSUD housing complex analysed was Christie Walk. However, WSUD in Adelaide is not limited to new housing developments. The inclusion of participants from suburbs, Mile End and Harbrow Grove, represented areas where WSUD was retrofitted into established urban areas as part of the streetscape as in Mile End, or created in a designated communal area as in Harbrow Grove.

The breadth and depth of data sources ensured that the research captured a variety of opinions on WSUD and at varying scales of operation. Table 31 shows the variety of WSUD features installed across the sites.

Table 31 Main WSUD features installed in the six sites

ASPECTS	CHRISTIE WALK	LOCHIEL PARK	MAWSON LAKES	SPRINGBANK WATERS	MILE END	HARBROW GROVE
Water source	Storm water	Storm water	Storm water	Storm water	Storm water	Storm water
	Rainwater	Rainwater	Wastewater			
	Wastewater re-use attempted					
Storage	Shared under-ground tank	Wetlands	Wetlands	Wetlands	Bioretention gardens	Large under-ground tank
	Rainwater tank	Domestic rainwater tank	MAR	MAR		
		(MAR not yet functioning)				
Water quality treatment	Roof garden	Bioretention gardens	Vegetated channels/ponds	Vegetated channels/ponds	Bioretention gardens	Swales
	Site gradients restrict runoff	Wetlands	GPT			
		Swales				
		GPT				
Flood mgmt	Pump	Catchment run off collected	Vegetation impedes flow	Vegetation impedes flow	Road runoff collected	Road runoff collected
End use	Gardens	Envtl flow	Envtl flow	Envtl flow	Envtl flow	Envtl flow
	Most toilets	Hot water system	Public open space	Public open space	Roadside garden (traffic taming)	Public open space
		Public open space	Gardens			(Pond not yet functioning)
		(MAR water to homes not yet functioning)	Toilets			

There were generally high levels of community support for all these WSUD installations and no indications that any particular type of installation, per se, would be rejected. However there were a range of issues that could increase or reduce acceptance which are discussed in this section. The section provides a synthesis of the case study findings and discusses WSUD in relation to: perceived benefits of WSUD,

barriers to WSUD acceptance, community response and ways to improve community acceptance over the long term.

7.1 Perceived benefits of WSUD: What people like

In keeping with previous research there was a positive community attitude to WSUD and high acceptance for non-potable uses for treated reclaimed water (Marks et al., 2003; Hurlimann & McKay, 2004; Leonard & Alexander, 2012) including an appreciation of improved aesthetics, greener surroundings, and improved local habitat (Centre for Water Sensitive Cities, 2011b). As described below, there was an appreciation of both the direct benefits and the indirect benefits.

7.1.1 DIRECT BENEFITS OF IMPROVED WATER MANAGEMENT

The case study findings revealed participants' perceptions of four benefits that are attributed to improved water management:

- water saving and reuse,
- alternative water sourcing,
- flood mitigation, and
- improved quality of water run-off.

Water savings and reuse

WSUD systems conserve water by increasing capture and reuse and this water-saving approach appealed to residents and the wider community as a significant benefit. From a philosophical point of view, residents at the case study sites were troubled by unnecessary or excessive water usage and the potential wastage of a scarce resource. Within a general context of responsible stewardship of water, stories emerged about watering plants with storm water overflow because 'we're crazy about using every drop' (Christie Walk), feelings of regret when seeing water going out to the Gulf during heavy rainfall events, (Mile End), and concern when broken pipes were watering the street rather than vegetation (Harbrow Grove). A similar point of view supporting this philosophy was expressed in Mawson Lakes, where with a sense of relief recycled water could be used to water gardens and wash cars 'without guilt.' At two localities, the water utility was criticised for sending mixed messages to the wider community, first teaching South Australians how not to Wastewater during the drought, and then backing off the educational campaign when rains increased. Consistent with the ethic of water saving, there was not only frustration where large-scale WSUD systems were not fully operational, but also support for expanded use of recycled water and rainwater (e.g. to toilet and laundry), or retrofitting older suburbs for household applications (Springbank Waters). The purple pipe infrastructure, carrying recycled water, was widely known and perceived as providing security against water shortages. Study participants may not always have been able to articulate how water saving approaches such as ASR works, specify the exact source of lake water, detail the underground technology of WSUD systems, or analyse the trade-offs of various water policy alternatives, but support in principle for water saving and reuse was never questioned during the research.

Alternative water sourcing

This research documents the high-regard with which participants viewed an alternative water source that is independent of the centralised mains water grid. All participants with access to alternative water, such as recycled water, felt positively about it because of the increased supply and the improved water security this offered. Participants acknowledged that although the cost of alternative water was high, the security of a guaranteed water supply, regardless of fluctuating rainfall, was a strong incentive for most people. Residents did not seem overly knowledgeable about the precise nature of the water source, but were happy to use it and did not cite any risks or concerns that would prevent them using it, other than the cost. Past attitudinal research on acceptance of alternative water sources (e.g. Dolnicar and Hurlimann, 2010; Marks et al., 2005) has consistently shown that while personal contact with recycled water stays low or

limited, acceptance for use will be high. In this current study, for the majority of cases, personal contact with recycled water remained low, as the water was specifically designated for non-potable uses in the medium-large housing developments or neighbourhood park spaces. Therefore, use of the alternative water seemed highly acceptable to residents. In Christie Walk, the smallest of the WSUD developments, recycled water was more widely used; however, acceptance for use remained high within this group. This is arguably because of residents' high level of knowledge of the WSUD features and their "hands-on" involvement with the day-to-day running of the WSUD systems and related features (e.g. community garden).

Flood mitigation

The role of WSUD systems in flood control was also recognised as a benefit by participants. The newly constructed neighbourhood scale WSUD systems were perceived to be effective in flood mitigation. This was demonstrated in Mile End where interviewees observed after heavy rains, 'it (rainwater gardens) seems to be working,' except where organic litter blocked the drains. A significant rainfall event had also occurred in Harbrow Grove post installation, with no reports of damage. Mawson Lakes and Springbank Waters, both locations where swampy ground had been re-engineered as housing sites, had over the long-term functioned well without significant flood events which was cited as an achievement by residents given historic patterns of serious flooding.

Improved water quality

WSUD's ability to improve quality of water runoff was recognised as a benefit by some participants, but was less well understood and appreciated. A few respondents from Springbank Waters community discussed the importance of clean water discharge in maintaining the seagrass ecosystem in Barker Inlet, with consequent benefits for fish stock, and one Mile End resident talked about the filtering function of the rainwater gardens in delivering cleaner water to purify the river. In terms of understanding ecological processes, residents near WSUD wetlands seemed generally aware of the cleansing function of reed beds, but the design intent of landscaped swales was not clear for Harbrow Grove residents and the benefits of the rain gardens at Lochiel Park were largely overlooked. Overall, awareness of offsite effects of water quality was generally not given significant attention by participants, perhaps reflective of general knowledge levels regarding environmental linkages among the Adelaide public. Even the environmentally conscious population at Christie Walk was unaware of the water quality benefits of keeping water onsite.

7.1.2 INDIRECT BENEFITS OF WSUD

A commonly cited benefit of WSUD was the *increase in urban greenspace* that the designs afforded, as well as the presence of aesthetically pleasing waterways in some developments. Participants were particularly happy in developments where green areas remained lush even during periods of low rainfall and drought, because of the availability and utilisation of recycled water. Participants felt that the open green spaces were an asset to the community and created a "country" atmosphere in the city. In Mile End and Harbrow Grove, where the WSUD did not incorporate large greenspaces, but rather, purpose-built greenspace for water filtration, participants believed the greenery to be aesthetically pleasing and, in Harbrow Grove, a good recreational amenity. The main factor that might contribute to a lack of acceptance cited by participants related to a water feature at Harbrow Grove which would not retain water and plants dying in summer due to lack of water in Mile End.

The *high social and recreational value* attributed to greenspace and waterways in these housing developments suggests an important area for future WSUD research. The psychological and physical benefits of WSUD features have the potential to increase acceptance for such novel projects, while also having the dual benefit of increasing well-being and quality of life among its residents. Maller et al's meta-analysis (2008) showed improvements in mental health, longevity, and life satisfaction, and enhanced social integration, derived from time in outdoor green spaces. Our research also highlighted that those residents who were highly involved in the day-to-day management of the water sensitive features, or those who felt well-informed and consulted, experienced a sense of pride in the green credentials of their housing

development. It was as though participants felt reflected praise for their eco-living through other members of society and were proud to be representatives of living with the benefits of WSUD.

Biodiversity benefits were articulated in three case study sites, and the wildlife habitat, the rich birdlife, and the sounds of frogs at night were reported as positives. Springbank Waters and Lochiel Park offer the most natural landscape, with variability among the water features at Mawson Lakes in terms of density of shoreline plantings and reed beds. However, Springbank Waters and Mawson Lakes were also locales where mosquitoes emerged as an issue for some. Perceptions of an insect problem were extremely variable within the subdivision and location-specific. In both settings, resident complaints about mosquitoes were offset by other study participants who viewed the mosquitoes as part of a balanced and healthy ecosystem. Findings suggest more expansive WSUD features with native vegetation will provide more positive nature interaction benefits, with probable need for education about or control of mosquitoes. Plant communities at the other case studies were too small and isolated to serve as biodiversity reservoirs or too urbanised in a CBD location. Although lack of water clarity was mentioned in Springbank Waters and Mawson Lakes, some residents interpreted this in the context of natural influences (e.g. carp, ducks) or infrastructure design (e.g. lack of a liner or lack of reeds). Biodiversity benefits were not named in urbanised Christie Walk, or on the small neighbourhood-scale WSUD sites.

7.2 Barriers to WSUD acceptance: What people don't like

Barriers to WSUD acceptance centred on functioning of the WSUD features, maintenance responsibilities, consultation, cost factors, and lack of knowledge and understanding, and covered a very similar set of factors as those identified in SE Queensland research (Sharma et al., 2012). Due in large part to the focus on non-potable water uses at the six sites, there was an absence of concern about risks associated with water quality, even for Mawson Lakes which uses a mixture of treated wastewater in the purple pipe system (Mankad & Tapsuwan, 2011). In terms of Roy et al.'s (2008) listing of risks, loss of functionality and ineffectiveness were the concerns rather than the risk of disease.

7.2.1 POOR FUNCTIONING

Stakeholder perceptions of the effectiveness of the WSUD feature in achieving its dedicated function were linked to acceptance. The more effective the functioning of the feature, for example, in providing greenscape, water capture, treatment and storage; or distribution of the recycled water, the more appreciative they were of the feature. Conversely, when ongoing operations of the WSUD feature were sub-optimal, acceptance appeared lower. Effective ongoing functioning seemed to be dependent on correct initial design and installation, as well as adequate ongoing maintenance. Poor design and installation caused significant cost issues, frustration, and ill feeling towards the developer or final caretaker. In small specialised housing developments such as Christie Walk, the cost of rectifying faults effects residents more directly than in larger developments where costs can be absorbed by a greater number of residents. In situations where problems were ongoing and cause for community concern and frustration, many of these problems were reportedly evident from the beginning. Resulting tension jeopardises not only community acceptance, but also, council enthusiasm for future expansion of WSUD features to other sites.

7.2.2 INADEQUATE MAINTENANCE

Good ongoing management and maintenance also underpin perceived effectiveness. In larger developments, where alternative water systems were on a wider scale and were servicing many homes directly, upkeep was considered very important. There was discontent among participants when WSUD installations around the home and in communal areas were not maintained adequately, or in a timely manner. In particular, participants from the large and medium sized developments were unhappy when management of the housing development shifted from the developer (initial caretaker) to the local council (final caretaker). During this transition period, some participants felt that aspects of the maintenance and

upkeep for the development went unattended because the new caretaker was unaware of certain issues and the old caretaker had not adequately informed the new caretaker about certain arrangements and priorities. Participants recommended that for future large-medium scaled WSUD developments, the developers and subsequent caretakers must create a comprehensive “handover” plan to prevent overlooking important maintenance issues. It was also important to residents that once the developer had vacated from the site, the new caretaker set up a discernible presence in the area so that residents had somewhere to report future problems as and when they were identified.

7.2.3 LACK OF CONSULTATION

Residents consistently reported being unhappy about the lack of consultation with a subsequent mismatch of expectations and information related to the WSUD features. Residents often felt a lack of control in decision making related to the WSUD features and their involvement with the everyday functioning of the WSUD was limited to those on their individual properties. The smaller street-scale initiatives in Mile End were received negatively after weak public input, meaning that the reduction in availability of on-street parking came as a surprise to residents. In contrast, only residents of Christie Walk did not mention lack of consultation as a barrier to acceptance because of their integrated involvement in the activation and maintenance of the systems. Although they did face difficulties with accessing information, they were able to overcome this problem and, due to their strong commitment, such obstacles were not going to diminish their level of acceptance of WSUD. This barrier to acceptance is an important factor to consider when designing WSUD buildings at different scales.

7.2.4 LACK OF KNOWLEDGE AND UNDERSTANDING

Every focus group except Christie Walk was attended by individuals who had a very weak, or no, understanding of the WSUD system. In particular, the retrofit examples of Mile End and Harbrow Grove people were unaware of the WSUD features until they were explained by the researchers. In Mile End those interviewed at the end of a dry summer only referred to the traffic taming function of the bioretention gardens however those interviewed after some heavy rain noticed the flood mitigation function. Among people in Mawson Lakes, knowledge levels were variable, with some being highly knowledgeable and others only aware of basic elements, such as a storm water lake. Mawson Lakes respondents seemed unaware of the problem of evaporation from the open lakes. Residents in Springbank Waters were limited in their ability to illustrate the WSUD features being used in their area. Although almost everyone we spoke to at Mawson Lakes was aware of function of the purple pipes, at Springbank Waters some new residents were unaware that they did not carry mains water. Given that Mawson Lakes is a highly publicised site we would expect knowledge about it to be greater. The eco-community at Christie Walk was the only case study where all participants demonstrated a sound understanding of their system. Lochiel Park residents also seemed to be knowledgeable of the many forms of WSUD in their development with participants able to list at least two or three features.

Knowledge of less conspicuous WSUD features such as swales and bioretention gardens was weaker than that for obvious features such as wetlands. Even in Lochiel Park where people were attracted by the range of green credentials, the bioretention gardens tended to be overlooked and people did not maintain the plants that were selected for their ability to filter contaminants. Similarly in Christie Walk, people were aware of the value of restricting run-off for on-site water collection but were not conscious of its value for improving the quality of storm water runoff for the environment and they were pleased to hear about another environmental benefit from their site.

Clearly people cannot be appreciative of WSUD systems if they do not have a basic understanding of the role of the system even if they do not understand the details of how it functions. The survey findings of Mankad et al. (2013) suggest that some basic knowledge is a significant predictor of acceptance but more complex knowledge has no further effect. Further, there is a health requirement that people understand when recycled water is in use and also more knowledgeable residents are more likely to help maintain the systems (e.g. removing or reporting blockages). Clearly knowledge is more accessible for owners of new

developments as part of the process of buying in a new area. At retrofit sites and for people who rent or move into new developments later, there need to be clear strategies to ensure all residents are informed.

7.2.5 COST CONSIDERATIONS AND VALUE PERCEPTIONS

After assessing individual levels of WSUD knowledge, each focus group session and key informant interview provided site-specific WSUD information to participants. Almost all participants expressed positive attitudes to the WSUD features after the purpose and operation of the WSUD were explained and discussed. Therefore, it was not surprising that, when told the cost, participants agreed that the system was worth the expense. The exception was Lochiel Park where many WSUD features did not work and thus residents perceived WSUD as not worth the expense unless, it could be properly repaired without cost to the residents.

There were also some doubts and differences of opinion expressed about particular WSUD aspects. Purple pipe water was seen as expensive, especially when it was more expensive than Tier 1 mains water. The dominant perception was that recycled water should be cheaper, and had even been free at one development in the early phases. Staff at two schools, Mawson Lakes and Springbank Waters, were shocked at their water bills, struggled to interpret their usage patterns, and suspected errors. At Mawson Lakes some argued that purple pipe systems discourage the installation of rainwater tanks, which were perceived to be a cheaper alternative in the long run. However, at Lochiel Park where tanks were mandatory, some believed that they were not getting a good return on their investment in a tank.

The price of purple pipe water reduced to 90% of Tier 1 in July 2013 but there were other pricing issues that were believed to discourage water saving. As pointed out by Dimitriadis (2005) WSUD development is discouraged when there is a relatively small cost charged for the amount of water used compared to a much larger fixed cost charged for pipes and sewerage on each water bill. Another salient issue for participants regarding water billing was the belief that water providers were mainly concerned with making a profit from selling more water. One respondent summarised participants' cynicism as "The whole model is wrong because what's the incentive for the supplier who's selling water to reduce your consumption."

There were different reports as to whether the WSUD developments made an appreciable difference to the value of the properties. In Christie Walk in the inner city they thought that valuers were unimpressed by their underground water tanks and gardens, whereas the announcement of the development at Springbank Waters immediately increased the land values by one hundred thousand dollars. Obviously these are very different developments in terms of their location and nature of the WSUD elements and it cannot be assumed that WSUD installations always create increased property value.

There was general agreement that it was far more cost effective to integrate WSUD features into the initial development of a site and that the cost of retrofitting was prohibitive. The operational problems in the installations mentioned previously highlighted the need to install WSUD elements correctly in the first place to avoid costly repairs. Many of these faults were attributed to poor work by contractors suggesting the need for more training for contractors in WSUD installations and better supervision. However, there was also recognition that much of the WSUD development was still experimental and that everything was not always going to work first time.

As with other factors, there was a fairly consistent call for more information about costs so people can make sensible decisions and avoid expensive maintenance costs, like the $1,000 per quarter cost of inspections for the Christie Walk wastewater treatment system. In places like Mile End and Harbrow Grove where many residents are unaware that they have a WSUD system, clearly they need this information to understand the value of the installations. There were questions raised about whether such small scale developments return a significant enough water quantity/quality return as compared with larger scale storm water reuse. Ultimately the judgements about whether WSUD systems were worth the cost were not about return on investment but about amenity and environmental values.

7.3 Community response to WSUD systems: Strengthening social capital and place attachment

Social capital and place attachment provide a conceptual framework for understanding acceptance of WSUD systems by case study residents. The amenity benefits of WSUD features, such as greenscape, recreational areas, parks, and waterways, support the building of social capital within the community by providing a common open space for informal interaction, community connectedness, and opportunities for participating in community activities. The social capital that is created, in turn, supports the ongoing maintenance of the WSUD features with formal and informal community groups contributing to maintenance programs and management activities as volunteers. (Strong social connectedness also assists promulgation of word-of-mouth communication about WSUD, which if positive creates an increased understanding and awareness of the WSUD features, and supports the acceptance of WSUD within the wider community. In three sites, Christie Walk, Lochiel Park and Mawson Lakes, social capital was very evident in the formal organisations that supported education about and maintenance of the WSUD system and the general environment. These groups could also access resources from Council and, when necessary, lobby and negotiate with Council, developers and SA Water for repairs and improvements. They claimed credit for reducing the price of purple pipe water. Thus there is a positive feedback loop whereby WSUD supports social capital and social capital supports WSUD. The practice of encouraging connections among future residents and locals during the construction (e.g. Lochiel Park and Springbank Waters) is to be encouraged.

Place attachment likewise is strengthened by the aesthetics that can be created by WSUD features. When this combines with strong social capital a sense of meaning around place that encompasses both the physical and the social relationships is created. Place attachment associates with community wellbeing and an increased sense of life satisfaction and happiness (Maller et al 2008). The sense of pride associated with WSUD features provides a positive feedback loop further strengthening place attachment. WSUD features can also create a unique sense of identity for the surrounding community, which a person living within the community may align to their own identity, which in turn may influence their attitudes and behaviours. In the case of WSUD, it creates an identity of a community that conserves water, and potentially at the individual level, as a person who conserves water. This influence may have positive spillover into people's wider use of water in their everyday practices.

Social capital and place attachment were experienced differently across the sites and seemed dependent on the size and scale of the development. For example, the small housing development of Christie Walk comprised 27 dwellings. Participants perceived the resident group to be like-minded individuals. Together, residents were involved in various committees designed to maintain the housing complex and its “green” initiatives. People who lived in Christie Walk moved into the development because of the WSUD features and worked together to ensure its longevity. Their communal efforts fostered a high level of social capital within the development, which was essential to accepting and maintaining the WSUD features of their property. These shared norms between residents, and the high quality relationships between residents at Christie Walk, were unique to that location and were arguably present because of the nature of the Christie Walk development and the WSUD ethos of the architecture and installations there. Lochiel Park, although considerably larger than Christie Walk had many of these same qualities in their shared groups and activities but without the more intimate features such as the shared laundry and community room. In contrast, Mawson Lakes, which comprises 4,000 dwellings, was home to a variety of residents and businesses who chose Mawson Lakes because of its status or opportunity, rather than its WSUD credentials. Given the high number of residents within the development, and the varying reasons for why people chose to live at Mawson Lakes, the social connections among residents were not as strong as in Christie Walk. However, residents did give the impression that they had a shared interest in seeing Mawson Lakes properly maintained and prospering and displayed some level of shared capital and social cohesion.

Smaller communities nested within the larger communities created their own social capital and strengthened social capital and place attachment within the larger communities. In Springbank Waters, social capital appeared to centre on the pre-school and primary school community which had a community liaison officer and actively engaged the community. The school had been invited by the developer to be

involved with the development of the estate but was no longer involved since its completion. There appeared to be no other group in Springbank Waters for those without school aged children.

Different again were the relationships between people living in the suburbs with retrofitted WSUD features, such as Mile End and Harbrow Grove. In Mile End, many residents were unaware of the WSUD installations and felt themselves to be ill-informed and separate from the decision-making process. This sentiment meant that many residents were unhappy with the changes to their streetscape and perceived the newly installed bioretention basins as an obstruction to street parking space, rather than as a novel and potentially beneficial storm water harvesting system. Residents in these areas had no sense of shared obligation or norms with their neighbours and viewed their property independently of others in the street. In Harbrow Grove, another area with retrofitted WSUD, residents were happy with the greenspace created and spoke about the space being popular for families living in the area and being a social activity hub. However, beyond these observations, there was little or no evidence of shared values between residents and their neighbours, or evidence of any social capital that may have been developed through shared maintenance efforts in the area.

A further influence of social capital was on community understanding of the WSUD features. The findings suggested that increased social capital within the community is associated with an increased understanding of the WSUD features. This was demonstrated in the case studies with Springbank Waters, Mile End and Harbrow Grove having low levels of knowledge about their sites and lacking formal organisations to keep residents informed. In contrast in Christie Walk and Lochiel Park which had multiple organisations with groups that distributed information and were involved in education activities thus the residents were generally well-informed. Mawson Lakes was the largest site and respondents had a wide range of knowledge levels but the community magazine and the environment group's ongoing contact with council provided avenues for community education.

7.4 Ways to improve community acceptance of WSUD

7.4.1 INCREASING BENEFITS AND REMOVING BARRIERS

The results suggest that any type of WSUD development can be appreciated by the community but it will be immediately appealing to the community when it allows more watering of gardens, both personal and communal especially in dry periods, increases the extent of greenspace and improves the ambience of the area. For those connected to purple pipe systems and rainwater tanks, having autonomy over their own water supply was also immediately appealing. Participants also appreciated flood mitigation benefits, particularly after they have experienced them. The attitudes to lakes versus wetlands also showed the importance of lived experience. From a WSUD perspective, wetlands are preferable as they filter the water, reduce evaporation and do not need extra aeration, but formal lakes may be more visually impressive. However, those living with lakes noticed that the water is always muddy and unattractive whereas the water is clear in the areas with reeds. When this is added to the wide concern about wasting water, information about the muddiness and wastefulness of lakes could easily move preferences to wetlands. Similarly, WSUD features that are not so obvious such as swales and bioretention gardens are not immediately well appreciated. As Sofoulis points out *'who normally entertains an attitude about a tap, a drain, or a sewage pipe?'* (Sofoulis 2005, p448). However, raising community awareness of the value of swales in terms of water saving and the environment is likely to lead to higher levels of approval. It is not so much about changing community attitudes as focussing on aspects of WSUD that tap into existing positive attitudes.

The barriers to acceptance also did not reveal objections to any particular type of WSUD installation per se. Rather, the main focus was on the need for any WSUD system to be installed properly and to be maintained in good working order. Although, residents of the four new housing development sites paid more to be in a site that had WSUD features, installation and maintenance problems could create hidden costs which were resented. They would also like a water pricing system that is more supportive of the use of alternative water sources. Further, the need was noted for easily accessible information on costs of

various WSUD systems, in particular, the return on rainwater tanks was debated. If people are going to be asked to pay more for WSUD then they need to know how much more they need to pay.
The installation and maintenance problems suggest that councils and developers should only work with simple systems and well-established methods. However, WSUD systems are constantly being developed and there is some community appreciation of innovation and experimentation. More experimental methods will need an appropriate consultation strategy probably focussing on community pride in being part of innovative technology and engaging their assistance.

7.4.2 THE NEED FOR EDUCATION

The need for education on WSUD systems and water use was a common point of agreement for further action across the sites. Lack of understanding about WSUD system operations, lack of community information about WSUD features and how to use water sustainability, and lack of industry and government knowledge about WSUD technology emerged as three separate but related dimensions that participants identified as requiring intervention. First, participants were aware of the deficits in their knowledge and called for more community education programs.

Second, with respect to retrofitting WSUD into an existing community the need for education is also important for community acceptance. When WSUD features are retrofitted, the incumbent community is less likely to care about the presence of WSUD features because they chose to live in the area for other reasons. This is in contrast to the new developments where the WSUD features may be part of the reason why someone chooses to live there. In the retrofitting case, the water authorities or council will have to be very active in creating awareness and involvement within the community, so that the community perceives the added benefit of the features, and ultimately accepts the features as an improvement to their area. Councils could consider mobilising the existing social capital of the community by contacting existing groups, or if there are no appropriate groups, inviting residents to form one to have an active role, for example, in monitoring the system.

Finally, the poor quality of the installation work suggested the need for more training for plumbers and other contractors in WSUD installation. A further knowledge barrier identified by the Christie Walk and Lochiel Park communities was rapidly changing technology, suggesting that government, industry, developers and residents need to come together more openly to pool knowledge about options and identify knowledge gaps.

More positively, Christie Walk is a place where formal resident outreach activities played a role in wider community education about innovative and best water practices, and they were looking for more government support for that function to occur at the wider level. In Christie Walk and Lochiel Park, residents expressed a belief that they could serve as exemplars for wider Adelaide to build community awareness and expertise about sustainable water management if information outlets and information transfer mechanisms were strengthened.

7.4.3 PROMOTING SOCIAL CAPITAL AND PLACE ATTACHMENT

There were marked differences between the levels of knowledge and engagement in those sites that had residents groups and those that did not. These groups provide a channel for two way communication and consultation among residents, developers, councils, and other regulatory bodies. Such channels of communication can be used to give residents realistic expectations about WSUD features. For example, letting them know about those aspects that are truly experimental and therefore have a higher level of risk versus those that have been widely implemented. Such groups are also key players in the generation of social capital for an area so they can foster a sense of ownership, responsibility for WSUD installations and pride in their local area.

Developers often promote community by inviting existing local residents and home purchasers to local events. From such events, a residents' group might emerge but the developers could take this a step further and support the formation of such a group pointing out the value for a formal channel of

communication between residents, council, and the developers, particularly to address ongoing maintenance at the time of the handover from the developer to the council. Councils could require such initiatives as part of the approval process. In places where WSUD installations are being retrofitted, Councils could contact local existing community organisations to invite involvement or invite local residents to form a group, such as a monitoring group. In both situations, the aim is to start a positive cycle in which groups assist in the monitoring and maintenance WSUD installations and the improved amenity and interaction increases at place attachment and enhancing social capital.

8 Conclusion

The findings from the six case studies, examining community acceptance and WSUD, have highlighted the perceived benefits and barriers of WSUD systems of various scales, on green-field sites, on in-fill, and retrofits. The findings provide insights for ways to improve community acceptance at the local level and to the wider public, and how acceptance can be maintained over the long term.

Benefits

The research produced insights for two main areas of benefits:

1. Direct benefits associated with improved water management including *water conservation*, improved water security through utilisation of *alternative water sources*, *flood mitigation*, and *improved water quality*.
2. Indirect benefits associated with enriched community life including improved *aesthetics* and *greenscape*, improved *recreational amenity*, and increased *biodiversity.* These improvements helped to build the physical and environmental assets of the community, and provided opportunity for increased quality of life and wellbeing for many of the residents and wider public.

There were two categories of WSUD features, those that had instant appeal and those that were less obvious but gained community support once the features were explained and understood. WSUD features that improved *aesthetics, greenscape*, *recreational amenity, and increased resident control over their own water supply* had instant appeal. Installations that had less visible outcomes, such as improving water quality or flood mitigation, were often overlooked by the community. However, there was strong support for these measures when the function of the WSUD feature was explained, resulting in a new level of appreciation of the benefits that they provide.

Barriers

The study identified five main barriers to acceptance, which if left unaddressed may jeopardise acceptance of WSUD both long-term and to the wider community. The barriers included:

1. **Poor functioning of the WSUD systems**, often occurring soon after installation: Poorly functioning WSUD features make developers, residents, and councils reluctant to invest in them. Increased availability of technical knowledge, and training of contractors and those who oversee the work seems to be required if WSUD is not to get a reputation of being “too difficult”.
2. **Inadequate maintenance and ongoing management**: There needs to be a council approved long-term maintenance plan including a plan for the hand-over to council so councils and residents are aware of the long-term maintenance requirements and costs.
3. **Lack of community consultation**: Most obviously communities cannot support WSUD facilities if they do not know that they exist. Understanding a WSUD facility is likely to need two-way communication such as discussion groups and tours of the facility rather than one way communication such as the distribution of flyers. Two-way dialogue also has the added benefit of directly hearing back from the community aspects about the WSUD feature that they particularly like or dislike. This type of feedback can assist future innovation and development of WSUD.
4. **Uncertainties about costs**: All residents in the new sites had paid extra for their home with WSUD and other features; however poor design, functioning and maintenance, changes in water pricing, and attempts to retrofit had all led to unexpected costs. Up-front information on costs of WSUD features should be relatively easy to provide e.g. a cost–benefit analysis of water tanks would be useful.
5. **Lack of knowledge and understanding**: Lack of community information about WSUD features and how to use water sustainably, and a lack of industry and government knowledge contributed to a lack of

appreciation of the value of WSUD, and at times unnecessary problems. In particular there needs to be recognition that new residents come to an area so information dissemination needs to be on-going.

These barriers could apply to any WSUD installation so the focus needs to be not on what is done but how it is done. Some of the barriers overlap and underpin other barriers, and often cascade into ongoing problems. For example, inadequate maintenance contributed to poor functioning of the WSUD system and increased costs; and lack of technical expertise contributed to poor initial design and installation, and ultimately to poor functioning; and a lack of community consultation contributed to poor levels of awareness and knowledge of WSUD systems.

The role of social capital and place attachment are closely linked to community acceptance and can be used to overcome barriers and to enhance benefits, and ultimately to foster acceptance. Not only is social capital created from the benefits of WSUD, especially the indirect benefits, but also social capital supports the ongoing management of WSUD. Interventions that initiate and support development of community groups strengthen social capital within a community, and support WSUD over the long term. The six case studies highlighted that the presence of organised community groups greatly mediated the relationship between the WSUD installations and the community with their influence being stronger in smaller developments connecting through shared involvement in running and maintaining features.

The way forward

An understanding of barriers and benefits provides a platform for ways to address acceptance, and can be summarised into four main areas.

1. Ensuring the effective functioning of the WSUD systems, including improved initial design and installation, improved ongoing management, and improved handover arrangements was seen as important for future acceptance. Adequate maintenance and ongoing management of WSUD was particularly viewed as fundamental to long term acceptance. Participants were concerned that without adequate maintenance there was a risk that the WSUD features would fail or fall into disrepair, which they would find unacceptable. Participants were very clear that for future developments, both residents and caretakers would benefit from greater consultation and planning when it came to "handing over" the development to its ultimate caretaker. Participants believed this would minimise site/facility disruptions to residents and optimise resident-caretaker relationships. This issue was seen as important for current and future residents.
2. Participants wanted a water pricing structure that better encouraged the use of alternative water sources and water savings
3. Education and information for all parties, developers and their sub-contractors, councils, water providers, government, and community, were seen as crucial especially in times of rapidly changing technology. Some people were willing to be part of experiments in WSUD but they needed to be consulted and kept informed of progress. Others were keen to be part of the educative process.
4. Supporting the development of social capital within the community and utilising this asset to help manage the WSUD features long term emerged as an important indirect influence on ongoing acceptance. The indirect benefits created from WSUD, such as improved aesthetics, green-space, recreational amenity and biodiversity provided opportunity for improving social connectedness and attachment to the location. The social capital that is created, in turn, supports the ongoing maintenance of the WSUD features with formal and informal community groups contributing to maintenance programs and management activities as volunteers. Increased social capital within the community also facilitates an increased awareness and understanding of the WSUD features. Developers and councils can be proactive in supporting existing groups or developing new groups to act as two-way channels for consultation, dissemination of information and site monitoring.

Future research could explore innovative ways to promote wider understanding of WSUD amongst professionals and the community including ways to connect those with high levels of understanding and technical expertise and pool knowledge and experience.

Appendix A **Demographic information for WSUD site suburbs**

Appendix Table 1 Demographic information for WSUD site suburbs

	SUBURB (WSUD SITE)					
	Mawson Lakes	**Lochiel Park**	**Burton** *Springbank Waters*	**Seacombe Gardens** *Harbrow Grove*	**Mile End**	**Adelaide** *Christie Walk*
Number of People	10872	7573	6153	2551	4413	12962
% Male	51	47.5	49	45.7	48.5	53.3
Median Age	31	40	29	39	34	29
Number of Families	2935	1994	1662	720	1064	2050
Average Children/Family	1.8	1.8	1.9	1.6	1.8	1.4
Number of Private Dwellings	4575	3512	2143	1249	2055	7318
Average People/Household	2.6	2.3	3	2.2	2.3	1.8
Median Weekly Household Income	$1670	$859	$1237	$826	$1132	$949
% with University Degree	24.2	16.9	6.9	22.6	32.7	56
% Work Full Time	67.2	55.6	62	54	57.1	55.6
% Owned (outright + mortgage)	63.4	57.7	72.3	53.3	51.7	31.3
% Rented	34.3	34.8	25.1	42.6	45.2	65

Source: Australian Bureau of Statistics, *2011 Census of Population and Housing*

Appendix B **Participant information sheet**

B.1 Individual

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PARTICIPANT INFORMATION SHEET

Water Sensitive Urban Design: Social Analysis

This project aims to find out about the main barriers to installing systems to save water across all of Adelaide. This information will be used to guide the planning and implementation of water saving systems in the future. This study is part of a project funded by the Goyder Institute for Water Research (a partnership between the South Australian Government through the Department of Environment, Water and Natural Resources, CSIRO, Flinders University, The University of Adelaide and the University of South Australia) and conducted by CSIRO and University of South Australia. The findings of the project will be used to guide planning and implementation of water saving systems in the future.

Why is this research important?
The need to save water is becoming increasingly important as the population of Adelaide continues to grow, placing pressure on existing infrastructure and increasing the demand for new developments. Hence the project will investigate social and technical difficulties in implementing water saving systems by interviewing residents and other key informants of suburbs with existing water saving systems. This will help to understand the main advantages and disadvantages of these systems as experienced by key stakeholders.

What is involved?
Your involvement in this research will be through participation in a 30 minute interview in which you will be asked a range of questions regarding your experiences and knowledge of water system features in the local area. You will also be asked to provide some basic demographic information about yourself. The interview will be recorded to allow for analysis.

Participation and withdrawal
Participation in this study is completely voluntary and you are free to withdraw at any time without prejudice or penalty by informing the interviewer. If you do withdraw from the study, the information that you have provided up to that point can be removed and destroyed if requested and will not be included in the study unless you give us permission to use that information.

Risks
Participation in this study should involve no physical or mental discomfort, and no risks beyond those of everyday living. If, however, you should find any question or procedure to be invasive or offensive, you are free to omit answering that question. If you have any concerns about any aspects of the study, please contact Anneliese Spinks (see overleaf for contact details).

Confidentiality
All information collected in this study will be confidential. The information you provide to us will only be seen by members of our research team, and will be stored in a secure area that is not accessible to anyone other than the research team. Your information will only be used for research purposes.

How will my information be used?
The information you provide to us will be used to help the researchers understand problems for the uptake of water saving systems in the Greater Adelaide region. A short report will be written to provide feedback to participants on these outcomes. The information will also be used to prepare technical reports and manuscripts for academic publication. Your personal information will not be identifiable at any stage of the writing process.

How can I find out more about the study?
Please feel free to contact Anneliese Spinks or other members of the team listed below. If you would like to receive a summary of the findings from this study, please tick the box on the attached consent form. In addition, please feel free to contact us at any time during the study.

Ethical clearance and Contacts
This study has been cleared in accordance with the ethical review processes of CSIRO, within the guidelines of the National Statement on Ethical Conduct in Human Research. If you have any questions concerning your participation in the study feel free to contact the researchers involved. Alternatively any concerns or complaints about the study can be raised with CSIRO's Social Science Human Research Ethics Committee by email at csshrec@csiro.au or by contacting the Manager of Social Responsibility and Ethics on (07) 3833 5693.

Thank you for your help with this very important research.

Yours sincerely,

Rosemary Leonard (PHD)
Project Leader

For further information about the project please contact

Anneliese Spinks Project Scientist CSIRO Ecosystem Sciences 41 Boggo Rd Dutton Park, QLD 4102 Ph: (07) 3833 5743 Email: anneliese.spinks@csiro.au	Dr Rosemary Leonard Senior Research Scientist CSIRO Ecosystem Sciences Underwood Ave Floreat, WA 6014 Ph: (08) 9333 6663 Email: rosemary.leonard@csiro.au

B.2 Focus Group

cnr Underwood Ave and Brockway Rd, FLOREAT WA 6014
Private Bag 5, WEMBLEY WA 6913, Australia
T (08) 9333 6663 **ABN** 41 687 119 230

PARTICIPANT INFORMATION SHEET

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What is involved?
Your involvement in this research will be through participation in a 90 minute focus group in which you will be asked to take part in a group discussion to relate your experiences and knowledge of water system features in the local area. You will also be asked to provide some basic demographic information about yourself and complete a short questionnaire concerning water and the environment. The focus group will be recorded to allow for analysis.

Participation and withdrawal
Participation in this study is completely voluntary and you are free to withdraw at any time without prejudice or penalty by informing the interviewer. If you do withdraw from the study, the information that you have provided up to that point can be removed and destroyed if requested and will not be included in the study unless you give us permission to use that information.

Risks
Participation in this study should involve no physical or mental discomfort, and no risks beyond those of everyday living. If, however, you should find any question or procedure to be invasive or offensive, you are free to omit answering that question. If you have any concerns about any aspects of the study, please contact Anneliese Spinks (see overleaf for contact details).

Confidentiality
All information collected in this study will be confidential. The information you provide to us will only be seen by members of our research team, and will be stored in a secure area that is not accessible to anyone other than the research team. Your information will only be used for research purposes.

How will my information be used?
The information you provide to us will be used to help the researchers understand problems for the uptake of water saving systems in the Greater Adelaide region. A short report will be written to provide feedback to participants on these outcomes. The information will also be used to prepare technical reports and manuscripts for academic publication. Your personal information will not be identifiable at any stage of the writing process.

How can I find out more about the study?
Please feel free to contact Anneliese Spinks or other members of the team listed below. If you would like to receive a summary of the findings from this study, please tick the box on the attached consent form. In addition, please feel free to contact us at any time during the study.

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Thank you for your help with this very important research.

Yours sincerely,

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Project Leader

For further information about the project please contact

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Appendix C **Consent form**

Centre for Environment & Life Sciences
Cnr Underwood Ave & Brockway Rd, Floreat, WA 6014
Private Bag 5, Wembley WA 6913 Australia
T (08) 9333 6000 **ABN** 41 687 119 230

CSIRO

RESEARCH PARTICIPANT CONSENT FORM

Water Sensitive Urban Design

Dear Participant

Please review the information below and sign where required if you agree to participate in this research project

I _____acknowledge that:

- I have agreed to participate in the above project being conducted by CSIRO.
- I have been provided with information about the project and had any questions regarding my participation and any associated risks and benefits answered to my satisfaction. I understand my participation in the research will consist of participation in an interview to discuss features of water systems in the local area and that this interview will be recorded.
- I have been provided with contact details of the investigating officers and understand that I can contact them at any point during the study. I have also been provided with the contact details of an independent ethics officer at CSIRO should I wish to raise any concerns or complaints about the conduct of the research.
- I understand that my participation in the project is entirely voluntary and that I am free to withdraw from the study at any time and without having to provide a reason for my withdrawal.
- I understand that I may ask for part of all of the information provided by me to be removed from the study without penalty or explanation.
- I understand that the information I provide for this research will be treated confidentially and will be used for the following purposes: understanding the experience of key stakeholders of urban water systems and the subsequent preparation of reports and journal publications. I will not be identified in any publications resulting from the study.
- Information provided by me will only be accessed by members of the research team and used for the purposes outlined above. It will be stored securely by CSIRO and retained for a period of 7 years after which is will be destroyed.

Name:_____

Signature: _____

Date: _____

I would like a copy of final project report when available? ❑ **YES** ❑ **NO**

If yes, please provide contact details on the space provided overleaf

We thank you for your agreement to participant in this research.

Please provide your contact details here if you would like to receive a copy of the final project report

Name_____

Address_____

_____

_____

Email_____

Appendix D **WSUD fact sheets for the six sites**

Fact Sheet: Mile End Streetscape

The Mile End streetscape in City of West Torrens incorporates street-scale bio-retention basins designed to reduce stormwater flows to the drainage system, improve stormwater quality, and improve street amenity

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

The street scale bioretention basins were designed to:

- Reduce stormwater runoff from the streetscape to our coast.
- Improve the quality of stormwater runoff to our coast.
- Enhance visual amenity of the streetscape with vegetation.
- Manage traffic

How it works

Stormwater runoff from the street and adjacent housing is directed to the streetscape bioretention basins. Intercepted runoff water is temporarily stored on the surface of the basin and filtered by the soil.

A portion of the collected water is stored at the bottom of the basin for 'passive' irrigation of the vegetation. Excess treated water is directed back to the existing stormwater drainage system (underground pipes).

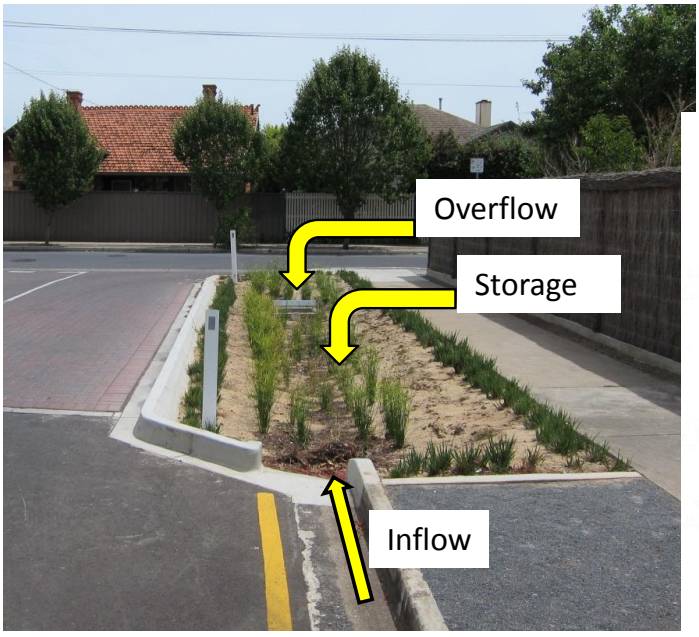

Figure 1: Bioretention Basin in Mile End

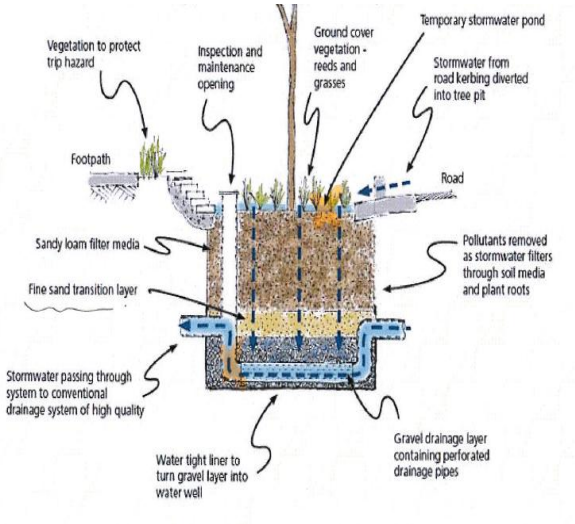

Figure 2: Tree pits (Source: City of West Torrens)

FOR FURTHER INFORMATION
Goyder Institute for Water Research
e enquiries@goyderinstitute.org
w +61 8 8303 8952
www.goyderinstitute.org

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Fact Sheet: Springbank Waters

Springbank Waters, located in the City of Salisbury, was designed as a sustainable urban development which included WSUD for stormwater treatment and open space irrigation.

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

Springbank Waters was designed to:

- Reduce dependence on mains water whilst maintaining a 'green' landscape.
- Effectively manage stormwater from the development area and upstream.
- Produce runoff of suitable quality for harvesting downstream.
- Reduce the quantity and improve the quality of runoff to our coast.

Figure 1: Springbank Waters wetlands

How it works

Springbank Waters is designed to manage stormwater runoff from the development site and from upstream in a sustainable way. Runoff from or entering the site is directed to vegetated drains ('swales') and finally to a wetland where water is detained and treated by natural processes.

Open space in the development is irrigated using recycled stormwater from the local council (City of Salisbury). Runoff may be harvested downstream of Springbank Waters in future.

Figure 2: Park lands irrigated with recycled water

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Fact Sheet: Mawson Lakes

Mawson Lakes, located in the City of Salisbury, was designed as sustainable urban development with a non-potable 'third pipe' water source supplying a mixture of stormwater and treated wastewater.

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

Mawson Lakes was designed to:

- Reduce dependence of residents on mains water for irrigation and toilet flushing.
- Reduce dependence on mains water for maintaining 'green' open space.
- Reduce the discharge of treated wastewater to our coast.
- Reduce the quantity and improve the quality of runoff to our coast.
- Showcase sustainable development in a commercial development site.

How it works

Treated wastewater from Bolivar treatment plant is mixed with treated stormwater water from the City of Salisbury. This non-potable 'third pipe' water source is connected to almost all homes and used for irrigating home gardens and toilet flushing. Open space in the development is also irrigated with recycled water.

Mawson Lakes also incorporates Dry Creek which flows seasonally through an open channel to the Barker Inlet. These flows are carried through open vegetated channels.

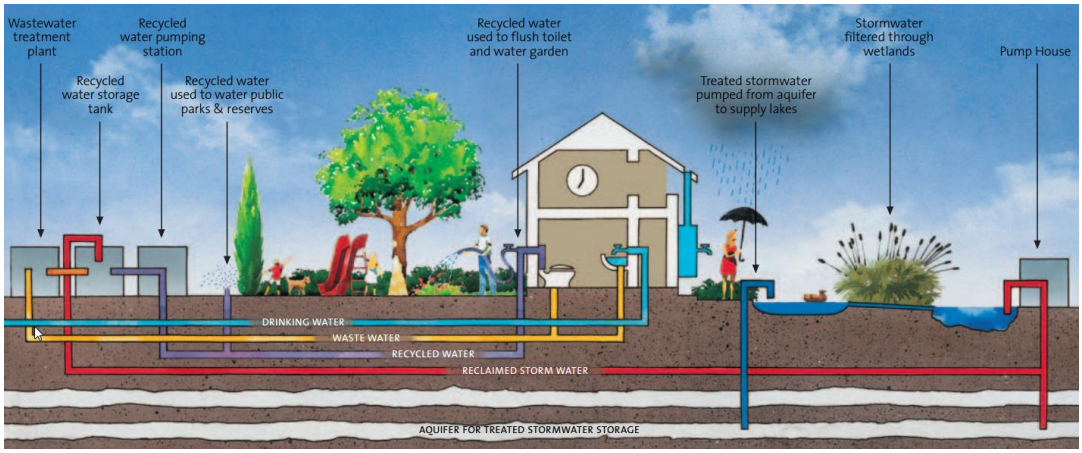

Figure 1: Water management at Mawson Lakes (source: Lend Lease)

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Fact Sheet: Lochiel Park

Lochiel Park, located in the City of Campbelltown, was developed as an example of sustainable urban development. The development includes WSUD approaches for mains water conservation and stormwater management.

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

Lochiel Park was designed to:

- Set a benchmark for ecologically sustainable development.
- Reduce dependence on mains water.
- Reduce the quantity of runoff heading to our coast.
- Promote community health and wellbeing.
- Improve water quality from upstream development.

Figure 1: Bioretention basin in Lochiel Park

How it works

Water from Lochiel Park is treated by vegetated channels ('swales') and bioretention basins prior to being discharged to the Torrens River. Stormwater runoff from upstream of Lochiel Park is harvested by wetlands, stored underground and reused by residents for toilet flushing and irrigation. Each house also harvests rainwater for hot-water. A second wetland on the site harvest more water from upstream for treatment prior to discharge to the Torrens River.

Figure 2: Part of the wetlands in Lochiel Park

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Fact sheet: Harbrow Grove Reserve

Harbrow Grove reserve, located in the City of Marion has WSUD features integrated with public open space as part of a park redevelopment. The site provides improved stormwater management, reduced mains water use and improved amenity.

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

Harbrow Grove was designed to:

- Reduce local flooding
- Reduce dependence on mains water for irrigation
- Reduce the quantity of runoff heading to our coast
- Promote community health and wellbeing

How it works

Water from the surrounding catchment flows onto the site, over a grass channel ('swale'), and then via subsurface pipe to a bioretention basin. This water infiltrates through a soil filter where it is collected and stored in a subsurface tank. The stored water is used for irrigation of the park and to maintain the level of a pond water feature.

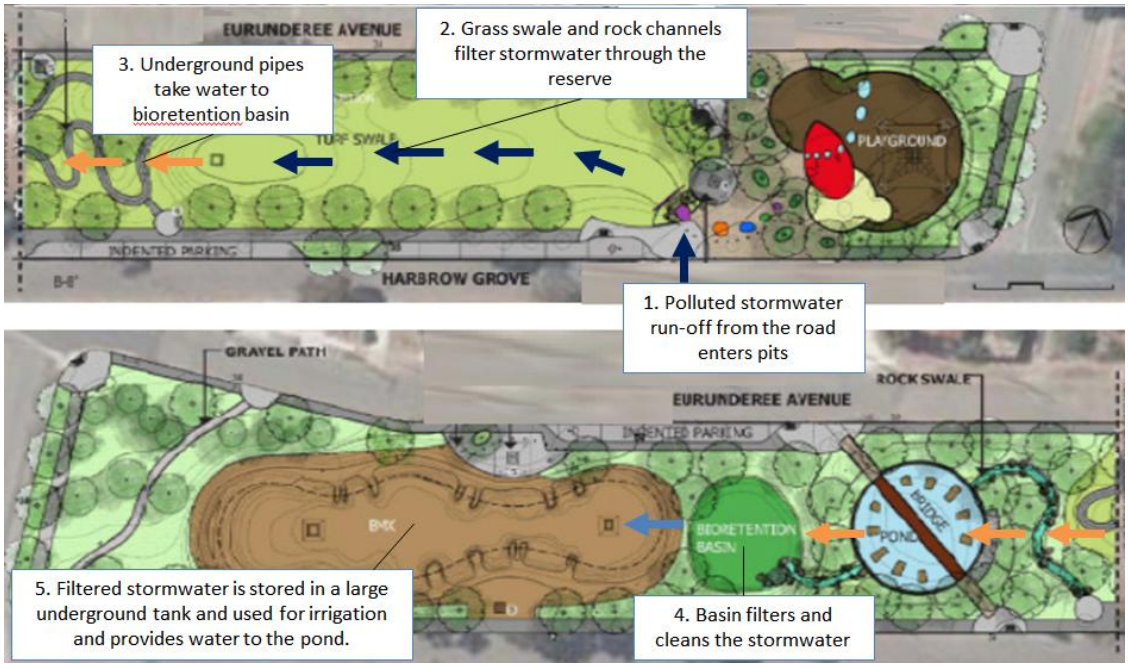

Figure 1: Water sensitive features at Harbour Grove (adapted from City of Marion 2009)

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Fact sheet: Christie Walk

Christie Walk Housing Development, located in the central business district of Adelaide, is a leading example of sustainable urban development on an existing urban development site.

Goyder Institute Project Fact Sheet Pro No./20U1.

Purpose

Lochiel Park was designed to:

- Provide an example of ecologically sustainable development in the developed environment
- Reduce dependence on mains water for irrigation
- Reduce the quantity of runoff heading to our coast
- Promote community health and wellbeing

How it works

Stormwater runoff from roofs and paths is harvested by two 20 kL underground rain water tanks. Harvested water is reused for toilet flushing and irrigation of the site. There were two attempts made at on-site wastewater treatment which did not proceed.

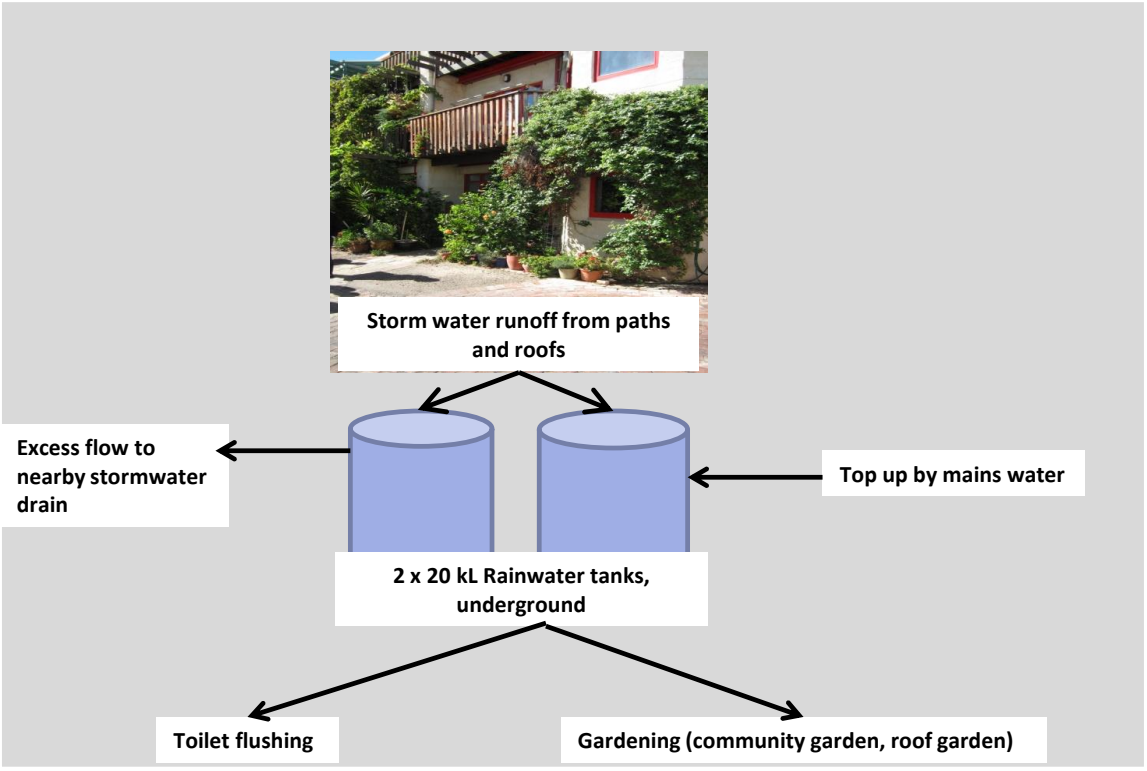

Figure 1: Stormwater management at Christie Walk

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Appendix E Interview schedule example (Lochiel Park)

Thank-you for agreeing to this interview.

Confirm basic information on demographic sheet for the tape *[eg 'So Jane you have been renting here for a year now']*

As you know from the information sheet we are interested in places where special water systems have been put in place around Adelaide. So we are interested in Lochiel Park.

SECTION A

for people who are associated with the area as workers or in some other role

- Can you tell us about how you are associated with Lochiel Park?

Prompt for:

- *More details about their role*
- *Length of association*
- *Frequency of visits*
- *How are you finding it as a place to work? (or other role)*
- *Do you plan to continue coming here for long?*
- *Favourite things about…/least favourite thing about...*

for residents

- We wanted to start by asking you about coming to this area.

  - *Was there a reason why you chose this particular area/ estate/ suburb?*
  - *Ok so ... was the main reason –were there other attractions?*
  - *Do you think this place is more attractive to certain groups of people? (social identity)*
  - *How are you finding it generally – is it a good place to live - if not mentioned, ask if there is a sense of community, people getting to know each other, helping each other out maybe a community activity or event (social capital)*
  - *Favourite things about…/least favourite thing about...*
  - *Do you plan to stay for long? - Is that because of something about this place or some other reason – only probe if it is about the place (place attachment)*

As you know our research is about water systems so we were wondering how familiar people are with the water system that is installed here.

- Can you tell us anything about it?

- Do you know why they have they ditches with plants in the centre of the road?

- Do you know where the water for this lake goes to?
- Can you tell me any of the advantages of having all they reeds in the lake?

- These gardens on the street – they used to all be planted with plants like these and the grates used to be smaller and higher off the ground – did you know that is part of the water saving system here?
- And I noticed you all have purple pipes going into your houses – how does that system work? Where does the water come from?
- Do you make much use of your tank water?
    - *Who looks after the system?*
    - *How did you find out about it? (skip if they have no knowledge)*
    - *Do the local residents talk about it much / is there a group who are interested?*
    - *Would be interested in knowing more about it? What sort of things would you like to know? Where would you start to find out?*

I HAVE A SHEET HERE THAT SHOWS HOW THE SYSTEM IS SUPPOSED TO WORK. *(POINT & READ OFF SHEET)*

Now we would like to know more about your opinions

- Can you give us a few words that best describe what you think of this system?
- So what are the positive benefits of having this system in place?
- Has the system been working 'well'? Are you happy with the landscape? *(etc as applicable)*
- Have there been any problems? – *(if so, ask about them).*
  Prompt where appropriate
    - *Water quality (appearance, smell)*
    - *Seasonality/changes in system over a year*
    - *Aesthetics*
    - *Safety (security from crime, tripping/falling, child safety)*
    - *Noise (e.g. pumps)*
- Looking to the future do you see any problems that are likely to arise? *(if so, ask about them)*
- What about future benefits or opportunities? *(if so, ask about them)*
    - *Given that it cost a lot to build this system, do you think there has been good value for money?*

- *Has it been worth it in terms of the benefits of the system outweighing the negatives?*
- *What improvements do you think could be made to this system or are you aware of systems in other places that work better?*

- *(Wrapping up for this section)* Do you think it would be a good idea to build more water systems like this in other places? *(ask to rank on a scale of 1 to 5, where 1 means a very poor idea and 5 means a very good idea)*

COMPARING IT TO OTHER SYSTEMS *(NOT ALWAYS ASKED - DEPENDING ON INTEREST)*

- Do you think it is a problem that people in older suburbs are not getting access to more water from treated storm water for their laundry and garden like you do - or you will when the system is working properly?
- Did you know that in some places that have these storm water systems, they mix in water from the sewerage treatment plant with the storm water – would that be OK you?
- It is possible to just harvest all the storm water from the main drainage system and treat it and then put it back in the reservoir so everyone gets it – would that be a better system?
- An alternative to water saving systems is just to run the desalination plant so there is plenty of water to keep the parks green – what do you think?

Further recruitment:

- Who else should we talk to get important information about community response or reaction to this water system? *(Snowball referrals)*

Appendix F Focus group schedule example (Christie Walk)

Focus Group Outline – Christie Walk

1. **Welcome and consent form / scale completion**
2. **Introduction**
3. **Knowledge activity – drawing of water systems**
4. **Brief presentation of water systems**
5. **Group discussion**
6. **Wrap-up and goodbye**

1. Welcome and consent form/scale completion

- each participant should be given:
  - information sheet
  - consent form
  - scale sheet numbered to match drawing
  - blank piece of paper (for drawing activity) numbered to match scale sheet
  - pen
  - $20 gift voucher
- ask participants to complete consent forms and scale questions and collect them
- tell participants the information sheets are for them to keep
- ask for permission to record the focus group and turn on the recorder
- box of coloured pens on the table.

2. Introduction

Thank you all for coming along here tonight. As you know we are interested in finding out about people's experiences with places where special water systems have been put in place around Adelaide. So we are interested in Christie Walk.

To get started, we will go around the group and you can each introduce yourselves by telling us

- your name
- how long you have been living in Christie walk for
- any local groups you are involved with
- tell us your favourite and ....if there is one....your least favourite thing about the complex.

GROUP INTRODUCTIONS

Baden will introduce the Goyder Project in a few sentences. This will include the project title and a broad definition of water sensitive urban design so participants know what the term refers to.

i.e. The Goyder Institute is conducting research on existing and potential applications of water sensitive urban design in South Australia to inform government policy on water management. Water sensitive urban design is a term used to describe a more 'holistic' management of the water cycle. WSUD includes measures for conserving mains water, treatment and reuse of storm water and wastewater, and measures which try to restore the natural water balance in an urban development.

3. Knowledge activity – drawing of water systems

As you know our research is about water systems. Before we start talking about them, we have a little activity for you all to do just to get your heads into gear and that is to draw the water systems in Christie Walk

DRAWING ACTIVITY

- Ask participants if anyone wants to explain their drawings to the rest of the group.....don't force people do this though – discussion with clarification by Baden
- Collect all the drawings *(use to get a score on how familiar they are with the system - just 1 no idea to 3 very detailed)*

4. Brief presentation of water systems

We have some information sheets here for you to keep which explain how the water systems work in Christie Walk. *[pass around Christie Walk fact sheets or put up on the overhead projector]*.

Note that there are detailed manuals of the rainwater systems here at Christie Walk which the maintenance committee has which have more details on how the components go together.

Note - we are fairly sure everyone in Christie walk knows the system so this will be covered in the discussion of the drawings

However if it does not emerge from the drawings we will ask about the attempts to have a Wastewater system (maintenance and inspection issues) and the roof garden. Baden will lead this section.

Have residents considered the beneficial effect that systems like the rooftop gardens and large rainwater tanks can have on storm water flows?

5. Group discussion

Now, we would like to hear from you about your experiences and opinions of the water systems here in Christie Walk. Here is the range of topics we would like to cover: *(put up on PP or show A3 card)*

1. Benefits of having the water system here at Christie Walk.
2. Its functioning - what's going well and any problems.
3. Costs – both to build the system or for the resident to buy and ongoing costs.
4. Access to information and management.
5. Future – improvements you would like to see, opportunities or problems.
6. Comparison with other systems.
7. How significant were the water management aspects of Christie Walk to you when you decided to live in the development?
8. Overall assessment - should we build more water systems like Christie Walk elsewhere *(score out of 10).*

We would like you all to provide your thoughts and ideas. Remember that no one is going to be individually identified in any of the reporting from this study so please don't be afraid to talk about any negatives or problems you may be having.

Proceed with group discussion – asking questions as conversation begins to lag. Interrupt if conversation gets too off topic or if needed to move along for time to ensure all topics are covered

1. **Benefits** - So what are the positive benefits of having your systems in place?
2. **Functioning** - Has the system been working 'well'? (ie, how it was planned to work)

   Have there been any problems?

   Prompt where appropriate…

a. *water quality (appearance, smell)*
b. *seasonality/changes in system over a year*
c. *aesthetics*
d. *safety (security from crime, tripping/falling, child safety)*
e. *noise (e.g. pumps)*

3. **Costs** - Given that it cost more to build this system, do you think there has been good value for money?

   - Do you think the using rain water is good value for money for you personally? Ie, is it worth putting in the tanks using due to being cheaper than mains water?
   - Prompts on Wastewater system – willingness to pay to have it working

4. **Access to information and management** - Do you think people in the complex are generally aware of the water systems in place – how much information is provided? Is this level of information appropriate?

   - Do you think people in the complex care much about where the water comes from?
   - Who looks after the system?
   - Do you trust them to manage the system appropriately?
   - How about access to information from SAWater or other regulators

5. **Future** - What improvements do you think could be made to this system or are you aware of systems in other places that work better?

   - Looking to the future do you see any problems that are likely to arise?
   - What about future benefits or opportunities?
   - Do you think it is a problem that people in older suburbs are not getting access to cheaper treated storm water for their laundry and garden
   - Do you think that people in Christie Walk use water differently to people in other suburbs (because of different water restrictions during the drought)
   - It is possible to just harvest all the storm water from the main drainage system and treat it and then put it back in the reservoir so everyone gets it – would that be a better system?
   - An alternative to water saving systems is just to run the desalination plant so there is plenty of water to keep the parks green – what do you think?
   - Are there any concerns with the outflow from Christie Walk going to Considine Place? Should this water be treated on site?
   - Would residents be concerned with the reuse of rainwater at Christie Walk for a greater number of uses? For example:

     a. *Clothes washing?*
     b. *Drinking?*

6. **Overall assessment** - Can you give us a few words that best describe what you think of this system?

   - Has it been worth it in terms of the benefits of the system outweighing the negatives?
   - Would you recommend that this system be replicated in other parts of Adelaide? On a scale of 1-10 what score would you give Christie Walk?

6. Wrap-up and goodbye

Well we are out of time so we will have to finish up now. Thank you all very much for coming here tonight and sharing your thoughts with us. Please feel free to contact any of the researchers at any time if you have any queries or concerns about the project. If you nominated that you would like a copy of the final report we will be sending this to you when it is ready.

Appendix G **Focus group presentation example**

Christie Walk

A community discussion about Water Sensitive Urban Design

Researchers:
Dr Rosemary Leonard
Dr Barbara Koth
Dr Baden Myers
Dr Aditi Mankad

Funded by the Goyder Institute for Water Research

CSIRO University of South Australia

WSUD

Water Sensitive Urban Design is broadly defined as “the integrated design of the urban water cycle where

water supply,

waste water,

stormwater,

groundwater,

urban design and

environmental protection

are all incorporated” (Joint Steering Committee for Water Sensitive Cities, 2009)

Group Introductions

To get started, we will go around the group and you can each introduce yourselves by telling us

- Your name,
- How long you have been living in Christie walk for
- Any local groups you are involved with and
- Tell us your favourite and ....if there is one....your least favourite thing about the complex.

Drawing Christie Walk water system

- An exercise to get our heads into gear:
- Use the plain paper to draw a diagram of the water system here at Christie Walk (Please help yourself to coloured pens if you like)

- Would anyone like to talk about their diagram?

Fact sheet: Christie Walk Development

Purpose

Christie Walk Development was designed to:

- implement sustainable and affordable living within the city
- reduce dependence on mains water
- incorporate sustainable measures in water, waste water and energy management
- promote a strong sense of community and social interaction

How it works

- Usage of environmentally friendly building materials for the construction of houses in the development
- Use of solar panels, double glazed windows and innovative construction materials and passive thermal management design features to minimise energy use for heating and cooling
- Storm water from roofs and paved areas is harvested into two 20,000 Litre underground rain water tanks which. Water is reused from these tanks for toilet flushing and gardening throughout the development.

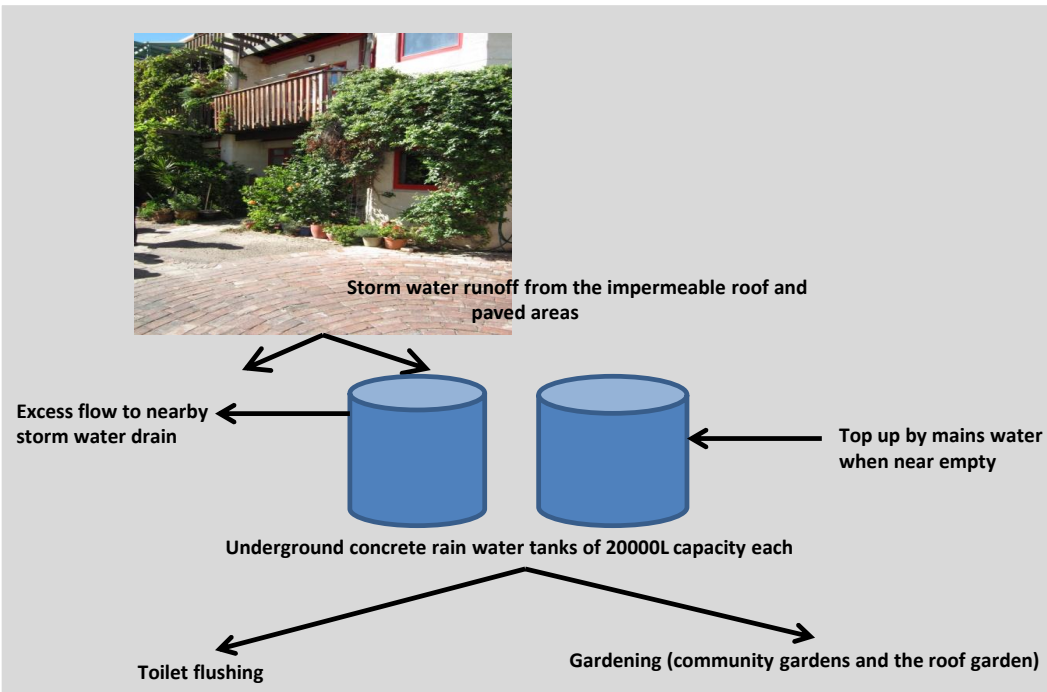

Figure 1: Stormwater management in Christie Walk

Rainwater tanks – How is the water used? How else might it be used? Risks? costs?
Roof garden
Waste water system abandoned?
Is outflow to the street a concern?
Benefits for managing downpours

Group Discussion

1) Benefits of the water system
2) Functioning: what's going well and any problems
3) Costs: both to build the system and to individual residents
4) Access to information and management
5) Future: improvements you would like to see, opportunities and problems
6) Comparison with other systems
7) Overall assessment and a score from 1 to 10

Appendix H Questionnaire with attitude and demographic questions

The following statements represent views towards water and the environment in general. They are designed to be answered quickly, therefore, your first answer is most appropriate. Please indicate your level of agreement to each statement by circling the appropriate number.

		STRONGLY DISAGREE		NEITHER		STRONGLY AGREE
1.	Water is a precious resource	1	2	3	4	5
2.	The balance of nature is very delicate and easily upset	1	2	3	4	5
3.	I think that it is not good to waste any water	1	2	3	4	5
4.	When humans interfere with nature, it often produces disastrous consequences	1	2	3	4	5
5.	Water is an unlimited resource	1	2	3	4	5
6.	I think that wasting water is bad	1	2	3	4	5
7.	Humans are severely abusing the environment	1	2	3	4	5
8.	We, as a community, should cherish water	1	2	3	4	5
9.	If things continue on their present course, we will soon experience a major ecological catastrophe	1	2	3	4	5
10.	I feel regretful if I Wastewater	1	2	3	4	5
11.	Water is important to my way of life	1	2	3	4	5
12.	Conserving water is part of the Australian lifestyle	1	2	3	4	5
13.	Without water we cannot survive	1	2	3	4	5

Please indicate your level of agreement with each of the following statements concerning water supply in Adelaide.

		STRONGLY DISAGREE		NEITHER		STRONGLY AGREE
1.	Having a secure water supply is important	1	2	3	4	5
2.	Droughts put pressure on water resources	1	2	3	4	5
3.	Water supply problems are very important	1	2	3	4	5
4.	Ensuring the water supply for future generations is important	1	2	3	4	5
5.	Now that Adelaide has a seawater desalination plant, we don't need to use other sources	1	2	3	4	5
6.	Adelaide can afford to buy River Murray water from the water market, so we don't need to use treated storm water	1	2	3	4	5

How much knowledge do you think you have about Adelaide's water supply? (Please circle the appropriate number)

None at all		A moderate amount		A lot
1	2	3	4	5

Background information about you: (please circle the relevant answer)

1. **Are you Female or Male?**
2. **Which age group are you in?** 18-24, 25-39, 40-59, 60-74, 75 and over
3. **What is your highest level of education?** Primary school, High school, Technical / trade University/ tertiary

4. **Are you a resident of this suburb? Yes No**

If you are a resident:

Do you rent or own your home here? Rent Own/ paying a mortgage

How long have you lived here?

Less than 3 months, 4 months to 1 years, 1-2 years, 2-5 years, 6- 10 years, over 10 years

How many people in your household? 1 2 3 4 5 more then 5

If you have children living with you, what is the age of the youngest child?

< 1 year, 1-3 years, 3-5 years, primary school age, high school age,

If you are not a resident:

What is your reason for coming here? work, regular visits, some other reason

How long have you been coming here?

< 3 months, 3 months to 1 year, 1-2 years, 2-5 years, 6- 10 years, > 10 years

Appendix I Attitude scales analysed by location and compared to Greater Adelaide

Scale items

Pro-environmental beliefs

1. When humans interfere with nature, it often produces disastrous consequences
2. Humans are severely abusing the environment
3. If things continue on their present course, we will soon experience a major ecological catastrophe
4. The balance of nature is very delicate and easily upset

Attitude towards waste

5. I think that wasting water is bad
6. I feel regretful if I Wastewater
7. We, as a community, should cherish water
8. Conserving water is part of the Australian lifestyle

Value of water

9. Water is a precious resource
10. Without water we cannot survive
11. Water is important to my way of life
12. Water is an unlimited resource *(reverse coded)*

Water security beliefs[b]

1. Having a secure water supply is important in Adelaide
2. Ensuring the water supply for future generations is important in Adelaide
3. Now that Adelaide has a desalination plant we don't need other sources *(reverse coded)*
4. Adelaide can afford to buy water from the Murray river so we don't need to use treated storm water *(reverse coded)*

Analysis

The aim of the analyses was to assess whether the respondents at each site differed significantly from the Adelaide population on any of the four scales. In these analyses, for each scale, the mean for each site was compared to the mean for the greater Adelaide population as represented in the MARSUO survey (Mankad et al 2013). Because each site had a small sample size but the sample for the Adelaide population was 1218, the statistic t was calculated for the mean comparison allowing for unequal variances.

Because the variable Value of Water was highly skewed, Wilcoxon Mann Whitney tests were also conducted but they were also non-significant.

Appendix Table 2 Comparison of Christie Walk and Greater Adelaide sample for the four attitude scales

	CHRISTIE WALK N=10		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	4.60	.46	3.93	.81	4.54	.001
Attitude to Wasting Water	4.90	.13	4.48	.63	9.34	<.00005
Value of Water scale	4.48	.28	4.52	.54	0.49	ns
Water Security scale	3.70	.19	3.79	.45	1.6	ns

Appendix Table 2 shows that residents from the Christie Walk development differed significantly from the general population on two scales. They had higher scores for pro-environmental attitudes and a more negative attitude to wasting water compared to the general population of Adelaide. The scores regarding the concept of valuing water and water security scale were high, and were comparable to the general Adelaide population.

Appendix Table 3 Comparison of Lochiel Park and Greater Adelaide sample for the four attitude scales

	LOCHIEL PARK N=22		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	3.97	.99	3.93	.81	.18	ns
Attitude to Wasting Water	4.49	.69	4.48	.63	.04	ns
Value of Water scale	4.50	.60	4.52	.54	0.14	ns
Water Security scale	4.18	.99	3.79	.45	1.80	ns

Appendix Table 3 shows that there were no significant differences between the mean scores for the respondents from Lochiel Park and those for the Adelaide population on any of the scales.

Appendix Table 4 Comparison of Mawson Lakes and Greater Adelaide sample for the four attitude scales

	MAWSON LAKES N= 28		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	4.21	.73	3.93	.81	1.90	ns
Attitude to Wasting Water	4.56	.51	4.48	.63	0.81	ns
Value of Water scale	4.54	.37	4.52	.54	0.37	ns
Water Security scale	4.00	.58	3.79	.45	1.80	ns

Appendix Table 4 shows that there were no significant differences between the mean scores for the respondents from Mawson Lakes and those for the Adelaide population on any of the scales.

Appendix Table 5 Comparison of Springbank Waters and Greater Adelaide sample for the four attitude scales

	SPRINGBANK WATERS N= 18		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	4.13	.61	3.93	.81	1.30	ns
Attitude to Wasting Water	4.79	.33	4.48	.63	3.80	.001
Value of Water scale	4.74	.25	4.52	.54	3.58	.002
Water Security scale	3.89	.44	3.79	.45	0.80	ns

Appendix Table 5 shows that the respondents for Springbank Waters differed significantly from the general population on two scales. They had higher scores for the Value of Water and a more negative attitude to wasting water compared to the general population of Adelaide. The scores regarding the concept of pro-environmental behaviours and water security scale were high, but were comparable to the general Adelaide population.

Appendix Table 6 Comparison of Mile End and Greater Adelaide sample for the four attitude scales

	MILE END N= 9		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	4.39	.66	3.93	.81	2.10	ns
Attitude to Wasting Water	4.58	.63	4.48	.63	0.48	ns
Value of Water scale	4.75	.35	4.52	.54	1.95	ns
Water Security scale	4.07	.46	3.79	.45	1.80	ns

Appendix Table 6 shows that there were no significant differences between the mean scores for the respondents from Mile End and those for the Adelaide population on any of the scales, however the sample size was only 9.

Appendix Table 7 Comparison of Harbrow Grove and Greater Adelaide sample for the four attitude scales

	HARBROW GROVE N= 5		GREATER ADELAIDE N= 1218			
Scales	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*t*	*p*
Pro-environmental Attitudes	4.75	.35	3.93	.81	5.10	.006
Attitude to Wasting Water	4.95	.11	4.48	.63	8.79	.0003
Value of Water scale	4.32	.41	4.52	.54	1.09	ns
Water Security scale	3.87	.18	3.79	.45	0.80	ns

Appendix Table 7 shows that residents from the Harbrow Grove site differed significantly from the general population on two scales however the sample size was only 5. They had higher scores for pro-environmental attitudes and a more negative attitude to wasting water compared to the general population of Adelaide. The scores regarding the concept of valuing water and water security scale were comparable to the general Adelaide population.

Appendix J Analysis of knowledge diagrams of WSUD features for each site

Participants were asked to draw a representation of the WSUD features at their location, to get an understanding of people's depth of knowledge of WSUD. Each element (either drawn or written/labelled) within the knowledge diagrams was classified into one of six categories *(Water source / capture, Water storage, Treatment, Distribution and removal, End uses, Other)*. A total count was then made of the number (and %) of people who either drew or mentioned: A) at least one element in each category; and B) each individual element

Diagram categories:

Water source / capture

This category was used to classify elements in the diagrams that depicted either the source of water coming into the local area (e.g. Mains water, storm water, treated recycled water), or infrastructure within the local area used to capture the water (e.g. drains, downpipes).

Water storage

The Water Storage category was used to classify elements that related to the storage of water in the local area (e.g. wetlands, lakes, rainwater tanks, aquifers).

Treatment

The treatment category was used to classify elements relating to the process of cleansing or filtration of the water, whether locally (e.g. in wetlands) or off-site (e.g.in the Wastewater treatment plants). Note, however, that for drawings from Mawson Lakes, the Bolivar Wastewater treatment plant has been classified as a 'Water Source' and not as 'Treatment' as it was mainly referred to as the source of recycled water coming into the site.

Distribution and removal

This category was used to classify elements in the diagrams depicting infrastructure in the local area used for distributing and removing water to homes and other buildings. This included the mains and recycled (purple) water pipes, sewerage pipes and pumps or related machinery used in the distribution process.

End uses

This category included all uses of water within the local area (e.g. toilet flushing, garden irrigation) as well as the final destination of water pipes shown in the diagrams (e.g. houses / buildings). The category includes end uses for both Mains water and for alternative water systems at the site (e.g. recycled storm water).

Other

This category was used to classify elements included in the diagrams that were not directly relevant to the local WSUD features. This included non-local features related to the broader Adelaide water supply (e.g. the River Murray, desalination plant, mains water reservoirs) and features of the local area that were not directly related to the water systems (e.g. the local café, bridge, playground facilities).

Appendix Table 8 WSUD Elements depicted in drawings for Christie Walk (N = 11)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	(%)
Water Source / Capture	***Category total***	***11***	***(100%)***
	Rain / precipitation	9	(82%)
	Roof water catchment / downpipe	5	(45%)
	Storm water	5	(45%)
	Drains to capture surface water	3	(27%)
	Runoff from paved areas	2	(18%)
	Direct to soil / garden	2	(18%)
	Roof garden	1	(9%)
Water Storage	***Category total***	***11***	***(100%)***
	Underground tanks	11	(100%)
	Small tank on front veranda	2	(18%)
Treatment	***Category total***	***0***	***(0%)***
Distribution and Removal	***Category total***	***11***	***(100%)***
	(Recycled) rainwater pipes	6	(55%)
	Storm water pipes (to tanks)	3	(27%)
	Pump	3	(27%)
	Storm water drain (for overflow)	2	(18%)
	Grey water collection in buckets	2	(18%)
	Shower timers	1	(9%)
	Low flow shower heads	1	(9%)
End Uses	***Category total***	***11***	***(100%)***
	Toilet	10	(91%)
	Garden taps / watering	11	(100%)
	House / buildings	6	(55%)
	Laundry	3	(27%)
	Sprinkler system	2	(18%)
	Special plants in atrium	1	(9%)
	Sea or estuaries	1	(9%)
	Drinking (by homeless people)	1	(9%)
Other	***Category total***	***5***	***(45%)***
	Education	1	(9%)
	Drought	1	(9%)
	Shower	1	(9%)
	Kitchen	4	(36%)
	Mains water pipes	4	(36%)
	Mains SA Water	9	(82%)
	Sewage system	7	(64%)
	Dam	1	(9%)

Appendix Table 9 WSUD Elements depicted in drawings for Lochiel Park (N = 15)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	(%)
Water Source / Capture	***Category total***	***15***	***(100%)***
	Storm water	10	(67%)
	Rainwater	6	(40%)
	Collection from roads	5	(33%)
	Storm water collection pipes	3	(20%)
	Collection from Campbelltown	3	(20%)
Water Storage	***Category total***	***15***	***(100%)***
	Wetlands (Northern and Southern)	9	(60%)
	Household rainwater tanks	8	(53%)
	Big storage / holding tank	7	(47%)
	Aquifer	6	(40%)
	Lakes / ponds (manmade)	5	(33%)
	Fractured rocks (to aquifer)	1	(7%)
Treatment	***Category total***	***7***	***(47%)***
	Gross Pollutant trap / trash rack	3	(20%)
	Cleaned by wetlands / reeds	3	(20%)
	Nature	1	(7%)
	Water treatment	1	(7%)
	Filtration	1	(7%)
	Purification system	1	(7%)
Distribution and Removal	***Category total***	***14***	***(93%)***
	Purple pipes / recycled supply	13	(87%)
	Overflow to Torrens River	4	(27%)
	Pump to aquifer	3	(20%)
	Pump to homes	2	(13%)
	Triple plumbing system	1	(7%)
	Meter boxes	1	(7%)
	Monitoring (Rainbank) system	1	(7%)
	Summer / winter pumping	1	(7%)
End Uses	***Category total***	***14***	***(93%)***
	Houses / residences	11	(73%)
	Toilets	7	(47%)
	Washing machines / laundry	6	(40%)
	Hot water system	6	(40%)
	Torrens River	5	(33%)
	Household gardens	4	(27%)
	Community garden	2	(13%)
	Bathroom / showers	2	(13%)
	Public areas / lawns	2	(13%)
	Sea	1	(7%)

Other	***Category total***	***11***	***(73%)***
	Mains SA Water	8	(53%)
	Mains water pipes	3	(20%)
	Main reservoirs	2	(13%)
	Murray River	2	(13%)
	Kitchen	2	(13%)
	Desalination plant	1	(7%)
	Solar hot water system	1	(7%)
	Drinking	1	(7%)
	Lochend House	1	(7%)

Appendix Table 10 WSUD Elements depicted in drawings for Mawson Lakes (N = 22)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	(%)
Water Source / Capture	***Category total***	***21***	***(95%)***
	Bolivar / wastewater treatment plant	12	(55%)
	Rain	7	(32%)
	Storm water / Road runoff	7	(32%)
	Industrial recycled water	2	(9%)
	Recycled Water	3	(14%)
	Groundwater	1	(5%)
	Drains	1	(5%)
	Dry creek / river bed	4	(18%)
Water Storage	***Category total***	***17***	***(77%)***
	Aquifers	10	(45%)
	Lakes	10	(45%)
	Wetlands	9	(41%)
	'Storage'	1	(5%)
	Underground	1	(5%)
	Pit storage at Parafield	1	(5%)
Treatment	***Category total***	***12***	***(55%)***
	Filtration	6	(27%)
	Treatment / disinfection	4	(18%)
	Mixer Tank	2	(9%)
	Reeds / natural filtration	1	(5%)
	'Becomes recycled'	1	(5%)
	Water purification plant	1	(5%)
Distribution and Removal	***Category total***	***19***	***(86%)***
	Purple / recycled pipes	19	(86%)
	Purple taps	4	(18%)
	Pump station	3	(14%)
	Purple water metre	1	(5%)
	Drippers	1	(5%)
End Uses	***Category total***	***20***	***(91%)***
	Houses / buildings	20	(91%)
	Parks / recreational areas	4	(18%)
	Kitchen / bathrooms	3	(14%)
	Garden / lawn	3	(14%)
	Toilets	2	(9%)
	Virginia market garden	1	(5%)
	Wildlife	1	(5%)
	Ocean	1	(5%)

Other	***Category total***	***13***	***(59%)***
	SAWater/ Mains pipes to homes	Check 13	(59%)
	Sewer / wastewater from homes	7	(32%)
	Bridge	2	(9%)
	Watershed café	1	(5%)
	Dollar sign (cost)	1	(5%)
	Dirty water	1	(5%)
	Clean water	2	(9%)
	River Murray	3	(14%)
	Desalination	3	(14%)
	Potable water	2	(9%)
	Main reservoirs	3	(14%)

Appendix Table 11 WSUD Elements depicted in drawings for Springbank Waters (N = 6)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	(%)
Water Source / Capture	***Category total***	***2***	***(33%)***
	rain	1	(17%)
	Storm water	1	(17%)
Water Storage	***Category total***	***4***	***(57%)***
	Wetlands	2	(33%)
	Aquifer	3	(50%)
Treatment	***Category total***	***3***	***(50%)***
	Aquifer storage & recovery (ASR)	1	(17%)
	Wetlands/plants	1	(17%)
	Plant (as in treatment plant)	1	(17%)
Distribution	***Category total***	***3***	***(50%)***
	Pump	3	(50%)
End Uses	***Category total***	***1***	***(17%)***
	Irrigation	0	(0%)
	End users (generic)	1	(17%)

Appendix Table 12 WSUD Elements depicted in drawings for Mile End (N = 6)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	FIX (%)
Water Source / Capture	***Category total***	***3***	***(60%)***
	Rainwater	3	(60%)
	Storm water/road runoff	1	(20%)
Water Storage	***Category total***	***0***	***(0%)***
	Bioretention basin		
Treatment	***Category total***	***1***	***(20%)***
	Reeds/natural filtration	1	
End Uses	***Category total***	***4***	***(80%)***
	Plants	4	(80%)
	Prevent street flooding	2	(40%)
	Keep plants green	1	(20%)
	Water saving	1	(20%)
Other	***Category total***	***5***	***(100%)***
	Reduced parking space	5	(100%)
	Beautification	3	(60%)
	Low maintenance	1	(20%)
	Street character	1	(20%)
	High cost to install	1	(20%)
	Water wasting	1	(20%)
	Safer streets through reduced traffic speed	1	(20%)

Appendix Table 13 WSUD Elements depicted in drawings for Harbrow Grove (N = 5)

CATEGORY	ELEMENT DESCRIBED / DRAWN	N	(%)
Water Source / Capture	***Category total***	***2***	***(40%)***
	Water in streets / gutters	2	(40%)
	Dry stone watercourse	1	(20%)
	Long depression water catchment	1	(20%)
Water Storage	***Category total***	***5***	***(100%)***
	Pond	5	(100%)
	Bioretention basin / overflow pond	4	(80%)
	Underground tank	0	0
Treatment	***Category total***	***0***	***(0%)***
Distribution and Removal	***Category total***	***2***	***(40%)***
	Pump box	2	(40%)
	Sprinkler system	1	(20%)
	Underground pipe	1	(20%)
End Uses	***Category total***	***3***	***(60%)***
	Trees	3	(60%)
	Grassed areas	3	(60%)
Other	***Category total***	***5***	***(100%)***
	Bike track	1	(20%)
	Bridge	5	(100%)
	Playground	3	(60%)
	Barbeque	2	(40%)
	Toilet	2	(40%)
	Underground sewer system	2	(40%)
	Tables	1	(20%)

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