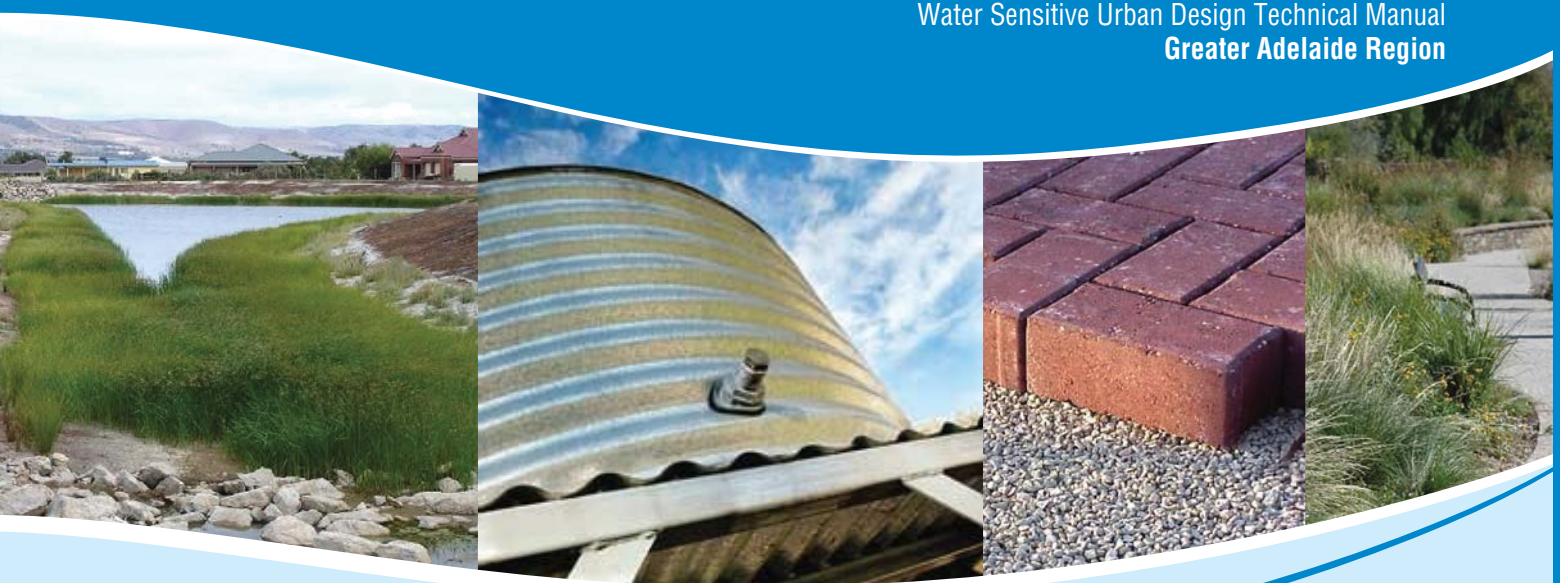


December 2010

Chapter 8

Urban Water Harvesting and Reuse

Water Sensitive Urban Design Technical Manual
Greater Adelaide Region



Department of Planning and Local Government

Roma Mitchell House, 136 North Terrace, Adelaide SA 5000

GPO Box 1815, Adelaide SA 5001

phone: (08) 8303 0600

The Water Sensitive Urban Design documents can be downloaded from the following website:

www.planning.sa.gov.au/go/wsud

© **Government of South Australia**

ISBN 978-1-876702-99-1

Preferred way to cite this publication

Department of Planning and Local Government, 2010, *Water Sensitive Urban Design Technical Manual for the Greater Adelaide Region*, Government of South Australia, Adelaide

Disclaimer

Every effort has been made by the authors and the sponsoring organisations to verify that the methods and recommendations contained in this document are appropriate for Greater Adelaide Region conditions.

Notwithstanding these efforts, no warranty or guarantee, express, implied or statutory, is made as to the accuracy, reliability, suitability or results of the methods or recommendations.

The authors and sponsoring organisations shall have no liability or responsibility to the user or any other person or entity with respect to any liability, loss or damage caused or alleged to be caused, directly or indirectly, by the adoption and use of the methods and recommendations of the document, including, but not limited to, any interruption of service, loss of business or anticipatory profits, or consequential damages resulting from the use of the document. Use of the document requires professional interpretation and judgment.

Appropriate design procedures and assessment must be applied to suit the particular circumstances under consideration.

Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that integrates the management of the total water cycle into the urban development process. It includes:

- Integrated management of groundwater, surface runoff (including stormwater), drinking water and wastewater to protect water related environmental, recreational and cultural values;
- Storage, treatment and beneficial use of runoff;
- Treatment and reuse of wastewater;
- Using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity; and
- Utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non drinking water supplies.

Therefore, WSUD incorporates all water resources, including surface water, groundwater, urban and roof runoff and wastewater.

Acknowledgments

Funding for preparation of the Water Sensitive Urban Design Technical Manual for the Greater Adelaide Region was provided by the Australian Government and the South Australian Government with support from the Local Government Association (SA).

The project partners gratefully acknowledge all persons and organisations that provided comments, suggestions and photographic material.

In particular, it is acknowledged that material was sourced and adapted from existing documents locally and interstate.

Overall Project Management

Christine Lloyd (Department of Planning and Local Government)

Steering Committee

A group of local government, industry and agency representatives provided input and feedback during preparation of the Technical Manual. This group included representatives from:

- Adelaide and Mt Lofty Ranges Natural Resources Management Board;
- Australian Water Association (AWA);
- Department for Transport, Energy and Infrastructure (DTEI);
- Department of Water, Land and Biodiversity Conservation (DWLBC);
- Environment Protection Authority (EPA);
- Housing Industry Association (HIA);
- Local Government Association (LGA);
- Department of Planning and Local Government (DPLG);
- South Australian Murray-Darling Basin Natural Resources Management Board;
- South Australian Water Corporation;
- Stormwater Industry Association (SIA); and
- Urban Development Institute of Australia (UDIA).

Technical Sub Committee

A technical sub committee, chaired by Dr David Kemp (DTEI), reviewed the technical and scientific aspects of the Technical Manual during development. This group included representatives from:

- Adelaide and Mt Lofty Ranges Natural Resources Management Board;
- City of Salisbury;
- Department for Transport, Energy and Infrastructure (DTEI);
- Department of Health;
- Department of Water, Land and Biodiversity Conservation;
- Department of Planning and Local Government; and
- Urban Development Institute of Australia.

From July 2010, DWLBC was disbanded and its responsibilities allocated to the newly created Department For Water (DFW) and the Department of Environment and Natural Resources (DENR).

Specialist consultant team

Dr Kylie Hyde (Australian Water Environments) was the project manager for a consultant team engaged for its specialist expertise and experience in water resources management, to prepare the Technical Manual.

This team comprised Australian Water Environments, the University of South Australia, Wayne Phillips and Associates and QED Pty Ltd.

Beecham and Associates prepared Chapter 16 of the Technical Manual.

Contents

Chapter 8	Urban Water Harvesting and Reuse	8-1
8.1	Overview	8-1
8.2	Legislative Requirements and Approvals.....	8-7
8.3	Design Tools.....	8-12
8.4	Design Process	8-13
8.5	Approximate Costings	8-19
8.6	Case Studies	8-20
8.7	Useful Resources and Further Information	8-26
8.8	References.....	8-28

Tables

Table 8.1	Potential Advantages and Disadvantages of Various Storage Types	8-6
-----------	--	-----

Figures

Figure 8.1	Warning Sign of Recycled Water Use at Mawson Lakes Residential Development	8-4
Figure 8.2	Schematic of Recycled Water Use at Mawson Lakes Residential Development	8-4
Figure 8.3	Unit Production Costs of Harvested Stormwater	8-19
Figure 8.4	Grange Golf Club Stormwater Harvesting and Reuse Scheme - During Construction (June 2006)	8-20
Figure 8.5	Grange Golf Club Stormwater Harvesting and Reuse Scheme - Trimmer Parade Diversion and Frederick Road Pit (August 2006)	8-22
Figure 8.6	Grange Golf Club Stormwater Harvesting and Reuse Scheme - First Fill (September 2006)	8-22
Figure 8.7	Grange Golf Club Stormwater Harvesting and Reuse Scheme - Completed Wetland (January 2007).....	8-23

Chapter 8

Urban Water Harvesting and Reuse

8.1 Overview

As detailed in [Chapter 1](#), there are many different WSUD measures which together form a 'tool kit' from which individual measures can be selected as part of a specific design response suiting the characteristics of any development (or redevelopment). Urban water harvesting and reuse is one of those measures.

Sustainable approaches to urban water management involve the use of locally generated runoff and wastewater to supplement traditional urban water sources.

The incorporation of these water sources in the urban water resource planning framework reflects the increased scarcity of water sources to meet demands; technological advancements; increased public acceptance; and improved understanding and management of risks including those concerning public health.

There is a myriad of methods to utilise runoff and wastewater as a resource.

Applications

Urban water harvesting and reuse schemes can be developed for existing urban areas or new developments and are mainly suitable for non-drinking purposes such as:

- Residential uses (including toilet flushing);
- Irrigation of public open spaces (including sporting grounds);
- Industrial uses; and
- Water features.

Harvesting of urban water is possible over a number of scales, from individual domestic allotment level to community scale or industrial precinct development.

Key factors in determining the type and scale of harvesting possible is dependent on:

- The proposed water source and quality (i.e. runoff, treated wastewater etc);
- The proposed water use (i.e. irrigation);



- The demand pattern and volume (i.e. summer for irrigation);
- The seasonality and volume of water available for harvest (depends on type and source of water);
- The storage options and site constraints (if required);
- Treatment options (if required);
- Objectives for harvesting system (i.e. reduced mains water supply or reduced runoff from site);
- Capital and operational costs including monitoring and maintenance costs.

Capture and use of water on site is an environmentally preferable source of alternative water as this method generally does away with the need for piping or pumping. Fewer resources are needed and greenhouse gas emissions are reduced.

As urban water harvesting and reuse can be applied at a range of scales and can utilise a range of water sources and storage options, this chapter only provides an overview of the range of options and the factors to be considered. The reader is referred to more detailed information as summarised in **Section 8.7**.

It should be noted that this chapter does not address potable (i.e. drinking) reuse of stormwater or wastewater. The use of rainwater for potable supply is addressed in **Chapter 5 – Rainwater Tanks**.

These documents also do not cover potential uses for water reuse in growing crops (such as reclaimed water use in McLaren Vale and Virginia), or in aquaculture.

Other chapters of the WSUD Technical Manual for the Greater Adelaide Region which may be relevant include:

- Swales and Buffer Strips (**Chapter 11**);
- Sedimentation Basins (**Chapter 12**);
- Constructed Wetlands (**Chapter 13**); and
- Wastewater Management (**Chapter 14**).

Water Sources

The Greater Adelaide Region has highly seasonal rainfall. This seasonal variation in rainfall affects the availability of stormwater and rainwater (or roof runoff). To maintain security of supply when demands are present for these water sources, storage is required.

Wastewater has less variation in supply as it is generally dependent on mains water use.

Climate in the region also impacts on the demand patterns for water, particularly outdoor uses. This is primarily evident for irrigation with high demand in summer and low demand in winter. Climatic conditions provide challenges which need to be addressed during the concept design phase.

Each available source of water available for urban water harvesting and reuse schemes is discussed briefly below.

Wastewater

Treated wastewater reuse can provide a relatively constant supply in the Greater Adelaide Region because its source is mains water. The production of wastewater is dependent on seasonal and diurnal fluctuations in water use habits. The primary technical disadvantage of wastewater reuse is the level of treatment and associated cost required to achieve the level of water quality necessary for reuse. The principal risk to human health is the inappropriate consumption of wastewater treated for non-potable uses. In addition, the public perception of treated wastewater reuse and possible health risks needs to be considered.

Further information on large scale reuse of wastewater can be found in [Chapter 14 – Wastewater Management](#).

Stormwater

South Australia is a leader in recycling stormwater. Existing stormwater harvesting schemes in Adelaide generate 6 GL/annum, with currently committed schemes expected to harvest an additional 12 GL/annum (Water For Good).

Stormwater can require a similar level of treatment to wastewater and can be a variable source of water that is dependent on rainfall patterns. Stormwater supply may not be available during long dry periods. A back up supply from another water source can be used to maintain continuity of supply.

Investigations into the public perception of water reuse show that the past use of water has an effect on how it is viewed (Po et al. 2003). From a health perspective, a study in Perth has shown that public perceptions of stormwater reuse are more positive than wastewater reuse (Mitchell et al. 2006).

Rainwater

Rainwater captured in rainwater tanks often requires little or no treatment and can be more easily used for a variety of end uses than stormwater and wastewater because of its higher raw water quality.

During long dry periods a rainwater supply may not be available but the provision of a mains water top up or bypass system can ensure continuity of supply. Further information on the use of roofwater can be found in [Chapter 5 - Rainwater Tanks](#).

It should be noted that it is possible to blend multiple water sources for recycling. The Mawson Lakes development in the City of Salisbury is an example of the utilisation of a combination of treated stormwater and wastewater.



Figure 8.1 Warning Sign of Recycled Water Use at Mawson Lakes Residential Development

Source: www.mawsonlakes.com.au

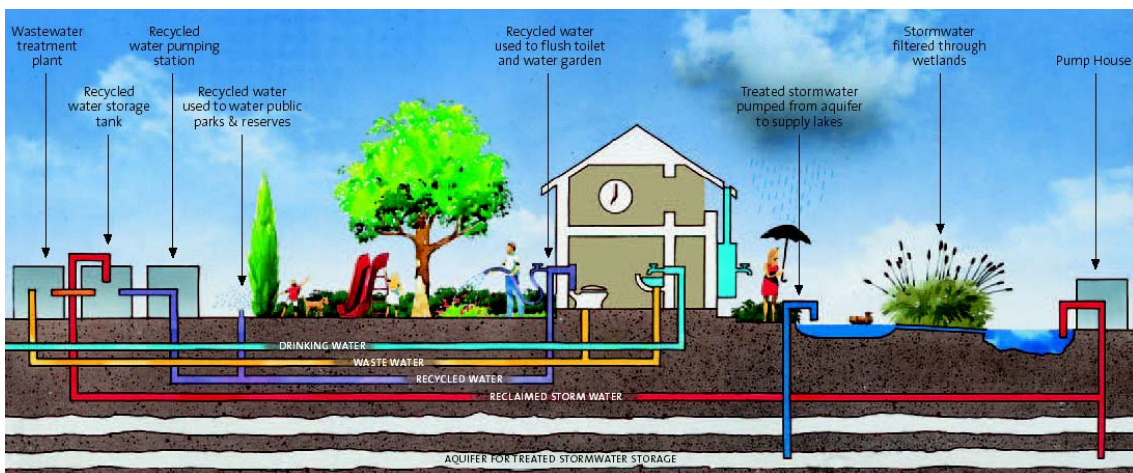


Figure 8.2 Schematic of Recycled Water Use at Mawson Lakes Residential Development

Source: www.mawsonlakes.com.au

Water Storage Options

The capacity of any harvesting and reuse scheme is significantly influenced by the size and possible type of storage system.

There are various types of storage systems including:

- Rainwater tanks;
- Underground storage tanks;
- Above ground storage tanks;
- Surface storages (e.g. dams or wetlands); and
- Groundwater (e.g. aquifer).

A summary of the advantages and disadvantages of these storage systems is contained in **Table 8.1**.

Storages used in urban water reuse schemes can provide a varying level of treatment in addition to other processes included in the treatment train. For example, storage in an aquifer can reduce the number of microorganisms present. Other water storages such as dams or tanks can reduce suspended solids and particulates through settling.

Table 8.1 Potential Advantages and Disadvantages of Various Storage Types

Storage Option	Advantages	Disadvantages
Open storages	<ul style="list-style-type: none"> ■ Low capital and maintenance cost ■ Potential water quality improvement 	<ul style="list-style-type: none"> ■ Public safety ■ High evaporation ■ Contamination ■ Mosquito breeding potential ■ Higher potential for eutrophication ■ Aesthetic issues with fluctuating water levels
Above ground tanks	<ul style="list-style-type: none"> ■ Potential water quality improvement ■ No evaporation ■ Limited public safety issues 	<ul style="list-style-type: none"> ■ Aesthetic issues ■ Space requirements
Underground tanks	<ul style="list-style-type: none"> ■ Moderate capital and maintenance cost ■ No evaporation ■ No public safety issues 	<ul style="list-style-type: none"> ■ Higher capital cost ■ Higher maintenance costs
Aquifer	<ul style="list-style-type: none"> ■ Little space required (unless wetland required for water quality treatment) ■ Cost effective ■ No evaporation ■ Prevents saltwater intrusion to aquifer 	<ul style="list-style-type: none"> ■ Required suitable geology ■ High treatment costs ■ Potential to pollute groundwater unless pre-treated ■ Recovery efficiency

Source: Adapted from Department of Environment and Conservation NSW (2006)

Public Perception

Public perception is a key issue for the design and implementation of water harvesting and reuse projects. In general, as the end use becomes more personal, support for water recycling falls (Po et al. 2003).

Investigations have also shown that there is a correlation between the scale of a water harvesting and reuse project and its degree of public acceptance. Water from a person's own home is generally more acceptable than a communal or neighbourhood scale water harvesting system. However, acceptance is high again with respect to a large scale system such as that serving a city (Mitchell et al. 2006).

8.2 Legislative Requirements and Approvals

A thorough investigation of required approvals and permits should be undertaken as part of the conceptual design of an urban water harvesting and reuse scheme. This would include consultation with:

- Local council;
- Environment Protection Authority;
- Department of Health;
- SA Water;
- Department for Water; and
- Natural Resources Management Boards.

A proposed urban water harvesting and reuse scheme needs to meet the requirements of a range of legislation including:

- *Development Act 1993*;
- *Environment Protection Act 1993*;
- *Natural Resources Management Act 2004*;
- *Local Government Act 1999*; and
- *Public and Environmental Health Act 1987*.

A brief description of the requirements of each is contained below.

Development Act 1993

An urban water harvesting and reuse scheme will generally be part of a larger development. However, whenever an urban water harvesting and reuse scheme is planned, it is advised that the local council be contacted to determine whether Development Approval is required under the *Development Act 1993*.

The likely issues that a council may want covered in a development application involving an urban water harvesting and reuse scheme include:

- Compatibility of the proposed scheme with council's objectives, plans or strategies, including any relevant strategic water management plan or strategy;
- Compatibility of the proposed plan with surrounding land uses (compliance with zoning requirements);
- Anticipated benefits and impacts associated with scheme construction and operation (including social, environmental and economic aspects);

- Consideration of environmental impacts during construction and operation phases;
- How public health and safety risks are addressed;
- Management arrangements (including monitoring and maintenance) for the scheme;
- What (if any) risks and/or financial obligations would be transferred to council if it operates the scheme (e.g. operations, maintenance, monitoring and reporting costs); and
- A management plan for the scheme (including monitoring and maintenance).

Environment Protection Act 1993

Any development, including the construction of an urban water harvesting and reuse scheme, has the potential for environmental impact which can result from vegetation removal, stormwater management and construction.

There is a general environmental duty, as required by Section 25 of the *Environment Protection Act 1993*, to take all reasonable and practical measures to ensure that the activities on a site, including during construction, do not pollute the environment in a way which causes or may cause environmental harm.

Aspects of the *Environment Protection Act 1993* which must be considered when an urban water harvesting and reuse scheme is being considered are discussed below.

Water Quality

Water quality in South Australia is protected under the *Environment Protection Act 1993* and the associated Environment Protection (Water Quality) Policy 2003. The principal aim of the Water Quality Policy is to achieve the sustainable management of waters by protecting or enhancing water quality while allowing economic and social development. In particular, the policy seeks to:

- Ensure that pollution from both diffuse and point sources does not reduce water quality; and
- Promote best practice environmental management.

Through inappropriate management practices, building sites can be major contributors of sediment, suspended solids, concrete wash, building materials and wastes to the stormwater system. Consequently, all precautions will need to be taken on a site to minimise potential for environmental impact during construction.

In addition, the discharge of water into any water body must meet the requirements of the Environment Protection (Water Quality) Policy 2003.

Noise

The issue of noise has the potential to cause nuisance during any construction works or ongoing operation (i.e. if pumps are required) of an urban water harvesting and reuse scheme. The noise level at the nearest sensitive receiver should be at least 5 dB(A) below the Environment Protection (Industrial Noise) Policy 1994 allowable noise level when measured and adjusted in accordance with that policy.

Reference should be made to the EPA Information Sheets on Construction Noise and Environmental Noise respectively to assist in complying with this policy (see **Section 8.7**).

Air Quality

Air quality may be affected during the construction phase of an urban water harvesting and reuse scheme. Dust generated by machinery and vehicular movement during site works, and any open stockpiling of soil or building materials at a site, must be managed to ensure that dust generation does not become a nuisance off site.

Waste

Any wastes arising from excavation and construction work on a site should be stored, handled and disposed of in accordance with the requirements of the *Environment Protection Act 1993*.

For example, during construction all wastes must be contained in a covered waste bin (where possible) or alternatively removed from the site on a daily basis for appropriate off-site disposal.

Guidance can be found in the EPA Handbook for Pollution Avoidance on Building Sites (see **Section 8.7**).

Licence

Certain activities – whether development or not – require a licence granted under the *Environment Protection Act 1993*.

The discharge of stormwater from stormwater infrastructure (from areas greater than 1 ha) to underground aquifers in the metropolitan Adelaide region is presently an activity specifically requiring a licence (Schedule 1, 4(2) of the *Environment Protection Act 1993*).

It should be noted that there is no provision in the licence for extraction of the water.

The Code of Practice for Aquifer Storage and Recovery (Environment Protection Authority South Australia 2004) outlines the requirements of the Environment Protection Authority for the storage of waters in aquifers.

It should be noted that the Code of Practice for Aquifer Storage and Recovery is currently under review by the EPA and a revised draft, which will cover managed aquifer recharge (MAR), is expected in late 2008.

Guidelines

The South Australian Reclaimed Water Guidelines (Treated Effluent) (Environment Protection Authority South Australia 1999) was developed by the Environment Protection Authority and the Department of Health.

The guidelines describe methods by which reclaimed water can be used in a sustainable manner without imposing undue risks to public health or the environment. It considers the use of reclaimed water for agricultural, municipal, residential (non-potable), environmental and industrial purposes. It provides information on the quality of reclaimed water required for each use, treatment processes, system design, operation and reliability, site suitability, and monitoring and reporting.

These guidelines should be consulted when considering an urban water harvesting and reuse scheme, in addition to the Australian Guidelines for Water Recycling (see below).

Natural Resources Management Act 2004

The *Natural Resources Management Act 2004* provides the statutory framework for water extraction from rivers, lakes and groundwater.

If groundwater is to be extracted from the aquifer, the proponent must obtain a licence from the Department for Water to extract water as required by the *Natural Resources Management Act 2004*.

The proponent must also obtain a well construction permit from the Department for Water for any proposed wells (i.e. groundwater bores) that will intersect the water table.

The Department for Water currently licenses the discharge of stormwater to underground aquifers wherever an EPA licence is not required under the *Environment Protection Act 1993*.

Public and Environmental Health Act 1987

The Department of Health (Environmental Health Branch) is responsible for the implementation of the *Public and Environmental Health Act 1987* in South Australia. This agency provides the required information and assistance in establishing an urban water harvesting and reuse scheme with regards to health issues.

National Guidelines

The Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council have developed Australian Guidelines for Water Recycling (Environment Protection and Heritage Council 2006). The guidelines comprise a risk management framework and specific guidance on managing the health risks and the environmental risks associated with the use of recycled water.

Phase one of the guidelines focuses on large scale treated wastewater to be used for:

- Residential garden watering, car washing, toilet flushing and clothes washing;
- Irrigation for urban recreational and open space, and agriculture and horticulture;
- Fire protection and fire fighting systems;
- Industrial uses, including cooling water; and
- Greywater treated on site (including in high rise apartments and office blocks) for use for garden watering, car washing, toilet flushing and clothes washing.

The Australian Guidelines for Water Recycling (Environment Protection and Heritage Council 2006) call for a four step process to prepare the required risk management plan for a recycled water scheme. The guidelines state that a risk management plan should be prepared for every recycled water system.

Phase two of guideline development is currently in draft and focuses on three modules:

- Stormwater harvesting and reuse;
- Managed aquifer recharge; and
- Augmentation of drinking water supplies.

The Australian Guidelines are expected to replace the existing South Australian Reclaimed Water Guidelines (Treated Effluent) (Environment Protection Authority South Australia 1999) and will be the basis for assessment of urban water harvesting and reuse schemes.

8.3 Design Tools

A range of design tools is available for the concept and detailed design of urban water harvesting and reuse schemes as detailed in [Chapter 15](#). The modelling tools which are able to assist include (but are not limited to):

- MUSIC;
- WaterCress; and
- E2.

Further information on these tools is contained in [Chapter 15](#).

The local council will be able to advise as to whether modelling is required as part of the development application process.

8.4 Design Process

Overview

There is a range of scales and types of urban water harvesting and reuse schemes that can be designed and installed. The type of scheme can vary from a greywater diversion hose in a household yard for garden irrigation to a community scale dual reticulation system using tertiary treated wastewater. The scope and degree of complexity is dependent on the individual system.

Key drivers for complexity in the systems are:

- The number of users;
- The quality of the water to be recycled; and
- The end use.

The greater the treatment requirements, the more complex the treatment component and the more involved the monitoring and management systems will need to be.

Water harvesting and reuse schemes can be implemented either in existing urban areas or as part of a new urban development. The project's context will therefore influence the nature of the planning and design process.

The key steps in the design process for an urban water harvesting and reuse scheme include:

- Assess the site, catchment and appropriate regulatory requirements;
- Identify the objectives and targets;
- Identify potential options;
- Consult with key stakeholders and relevant authorities;
- Evaluate of options;
- Prepare a detailed design of selected option;
- Undertake the approvals process; and
- Develop an operations, maintenance and monitoring plan.

The design process is likely to be iterative, requiring several rounds of review in earlier stages as new information arises and negotiations progress with stakeholders (including end users) that may alter the objectives and/or available options.

Assess the Site, Catchment and Appropriate Regulatory Requirements

WSUD responds to site conditions and land capability and cannot be applied in a standard way. Careful assessment and interpretation of the site conditions is a fundamental part of designing a development that effectively incorporates WSUD.

This step identifies and assesses the potential constraints and opportunities of the proposed project site. Potential constraints may include:

- Topography;
- Land use (including surrounding catchment land use);
- Adjacent land uses (including potential land use conflicts);
- Watercourse characteristics;
- Vegetation and other sensitive ecosystems (potential biodiversity impacts);
- Soil characteristics, such as salinity or acid sulphate;
- Existing water management infrastructure;
- Depth to groundwater, groundwater quality and existing uses of the groundwater in the vicinity; and
- Statutory or regulatory constraints.

This step should identify opportunities for reusing treated stormwater or wastewater, as well as suitable locations for storages. Other aspects of the end users' operations may also be important, such as future development plans or land use changes that may affect longer term water use patterns.

The level of the site and catchment investigation required should match the size and scale of the development and its potential impacts (i.e. larger developments having a greater impact would require greater site investigation).

A staged approach to site investigations can be adopted to minimise costs. This involves an initial screening level assessment using readily available information to identify major constraints and opportunities, and then focusing efforts on any identified constraints.

An evaluation of the pollutants that may be present within runoff needs to be carried out on a catchment basis, as the quality of runoff for a reuse project is affected by the characteristics of the scheme's catchment. Pollutants will vary according to whether the catchment drains residential, industrial, rural or a combination of any of these land use types. For example, the risk of chemical pollution in a catchment increases with the extent and nature of industrial uses and paved roads, particularly those with high traffic volumes.

The impact of such diffuse pollution sources can be gauged by investigating water quality during wet and dry weather, or by referring to existing water quality data. Similarly, the scheme should investigate the impacts on water quality from any point sources of pollution. The hazard assessment for the scheme may need to consider both diffuse and point sources of pollution.

Concentrations of pollutants typically have seasonal or within event patterns, and heavy pollutant loadings can be avoided by being selective in the timing of diversions (e.g. not diverting flow during large floods when treatment systems are often bypassed). Knowledge of the potential pollutant profile helps to define water quality sampling and analysis costs when determining the viability of a project (for example, if there are any specific industrial activities upstream that contribute particular pollutants such as hydrocarbons).

Identify Objectives and Targets

The design objectives and targets will vary from one location to another and will depend on site characteristics, development form and the requirements of the receiving ecosystems. It is essential that these objectives are established as part of the conceptual design process and approved by the relevant council prior to commencing the engineering design.

Specifying the objectives for an urban water harvesting and reuse scheme is an important step for ensuring that it operates as intended.

In developing reuse schemes for a site, broader catchment or regional objectives are important. These could involve specified reductions in:

- Mains (potable) water use;
- Runoff flow rates and/or volumes;
- Runoff pollution loads;
- The effective (connected) impervious area of the catchment; and
- Wastewater disposal volumes.

Organisational objectives, government policies and environmental planning instruments may also provide a strategic context for the project.

The most common project objectives will relate to:

- Managing public health and safety risks;
- Managing environmental risks;
- Meeting the requirements of the end user, primarily relating to water quality, quantity and reliability of supply; and
- Protecting or enhancing visual amenity or aesthetics.

Further information on setting objectives can be found in **Chapter 3** of the Technical Manual.

Identify Potential Options

This step identifies various possible layouts for a scheme to meet the project's objectives.

Various combinations of WSUD measures can be used in a water harvesting and reuse scheme, depending on the nature of the site and the end uses. The design process needs to consider the following components:

- Collection (i.e. swales);
- Storage (i.e. rainwater tanks, wetlands, underground tanks);
- Treatment (i.e. wetlands, wastewater treatment plant); and
- Distribution.

This step is likely to involve modelling the outcomes from various options and identifying the degree to which each option meets the adopted project objectives. This could be iterative, modelling the influence of a number of key aspects of the project (such as different storage volumes against predicted outcomes), and may include modelling of:

- Water balance;
- Water pollution and environmental flows; and
- Water peak flows and flood levels.

A risk assessment approach should be utilised during this stage of the process.

Identify and Consult with Key Stakeholders

The designer (or applicant) should liaise with civil designers and council officers prior to proceeding any further to ensure:

- Urban water harvesting and reuse scheme will not result in water damage to existing services or structures;
- Access for maintenance to existing services is maintained;
- No conflicts arise between the location of services and WSUD devices; and
- The objectives are consistent with the council's directions for the area.

The council will also be able to advise whether:

- Development approval is required, and if so, what information should be provided with the development application;

- Any other approving authorities should be consulted; and
- Any specific council requirements need to be taken into consideration.

Key stakeholders should also be consulted throughout the planning process (depending on the scale of the scheme), particularly during the setting of project objectives. Their engagement in the scheme from the planning stage will:

- Allow for any concerns or misconceptions to be identified and addressed early in the scheme; and
- Provide opportunities for educating the community and the proponents and build user confidence in the scheme, resulting in greater use of treated water as an alternative to mains water.

The key stakeholders will depend on the nature of the scheme.

Evaluate Options

The various options identified should be evaluated, taking into account social, economic and environmental considerations.

The evaluation of options should primarily assess how well each option meets the project's objectives. It is likely that during this process trade offs between objectives may need to be assessed as, for example, it may not be cost effective to meet all objectives.

There is no widely used evaluation technique for urban water harvesting and reuse schemes. This may be partially due to the difficulty in quantifying many of the costs and benefits of such schemes, and where some of the costs and benefits can be attributed to parties not directly involved in the proposed scheme.

Possible evaluation techniques include:

- Cost-benefit analysis;
- Triple bottom line analysis; and
- Multiple criteria decision analysis.

Detailed Design of Selected Option

During the detailed design of the selected scheme, a risk management strategy should be developed. This should identify public health and environmental hazards and an appropriate mix of controls to be implemented during the design and operational phases.

Undertake Approvals Process

As discussed in **Section 8.2**, there are several approvals that would generally be required for an urban water harvesting and reuse scheme. Therefore, ensuring that there is adequate time to obtain the approvals is an important part of the process.

Maintenance and Monitoring

Appropriate maintenance of urban water harvesting and reuse schemes is important to ensure that the scheme continues to meet its design objectives in the long-term and does not present public health or environmental risks. The actual maintenance requirements will depend on the nature of the scheme. Maintenance may include measures relating to each element of a scheme.

Protection of treatment, retention and detention systems from contamination is a necessary part of designing an urban water harvesting and reuse system. This includes constructing treatment systems away from flood prone land, taking care with or avoiding the use of herbicides and pesticides within the surrounding catchment, planting non-deciduous vegetation, and preventing mosquitoes and other pests breeding in storage ponds.

Contingency plans should be developed to cater for the possibility of contaminated water being inadvertently utilised. These plans should focus on:

- Determining the duration of recovery pumping required (to extract contaminated water);
- Sampling intervals required; and
- Managing recovered water.

Regular inspections of a scheme are needed to identify any defects or additional maintenance required. The inspections may need to include:

- Storages for the presence of cyanobacteria (i.e. algae), particularly during warmer months;
- Spillways and creeks downstream of any on line storage after a major storm for any erosion;
- Water treatment systems;
- Distributions systems for faults (e.g. broken pipes); and
- Irrigation areas for signs of erosion, under watering, waterlogging or surface runoff.

8.5 Approximate Costings

Due to the variability in the scale and type of urban water harvesting and reuse schemes, it is difficult to provide an indication of the approximate costs of construction and operation of such schemes.

However, Kellogg Brown & Root Pty Ltd (2004) undertook a review of various scale stormwater harvesting schemes and was able to develop a relationship between unit production cost against average annual production which is presented in **Figure 8.3**. For example, it is estimated that a 10 ML/a stormwater harvesting scheme would have a water supply cost of \$2/ kilolitre.

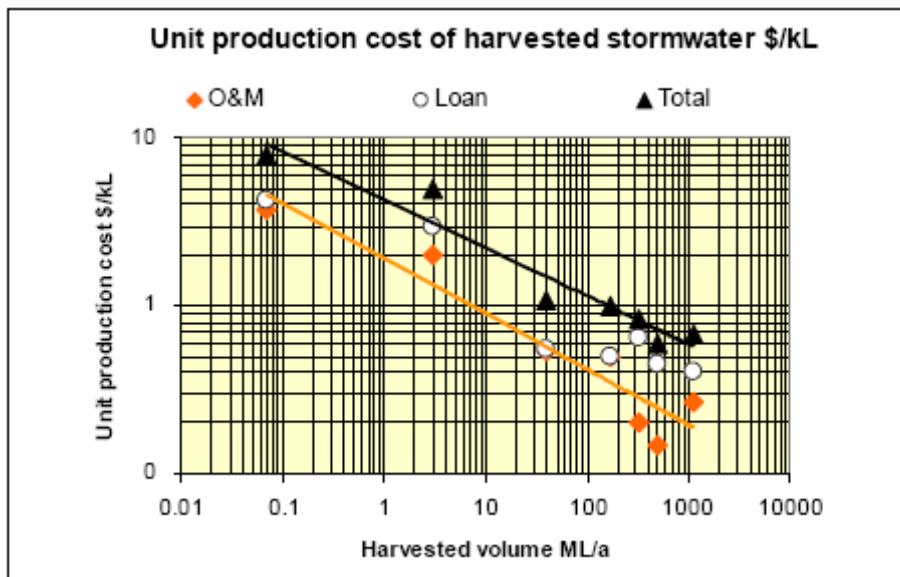


Figure 8.3 Unit Production Costs of Harvested Stormwater

Source: Kellogg Brown & Root Pty Ltd (2004)

8.6 Case Studies

Grange Golf Club Stormwater Harvesting and Reuse Scheme

Text and photos courtesy of the Adelaide and Mt Lofty Ranges Natural Resources Management Board



The Grange Golf Club Wetland and Aquifer Storage and Recover (ASR) Scheme is a major urban stormwater management project for irrigation. The club is located at the downstream end of the 4.2 km² Trimmer Parade stormwater catchment in the suburb of Seaton in the City of Charles Sturt.

The scheme is designed to harvest approximately 320 megalitres of urban stormwater by diverting water from the Trimmer Parade and adjacent West Lakes Boulevard systems into a wetland constructed on the golf course.

Using wetland processes, the water is treated to a standard suitable for injection into the locally used and stressed aquifer. The water will then be extracted from the aquifer in summer for sustainable irrigation use.



Figure 8.4 Grange Golf Club Stormwater Harvesting and Reuse Scheme - During Construction (June 2006)

The scheme was identified as a priority in the City of Charles Sturt's Trimmer Parade Catchment Initial Urban Stormwater Master Plan (USMP). The USMP identified wetlands at the Grange Golf Club as providing the major opportunity for water quality improvement for stormwater discharges into West Lakes and the Port River. The USMP also indicates that the Grange Golf Club is the only location within the catchment capable of implementing a viable wetland and ASR scheme for major water reuse. The feasibility study indicated that the scheme would intercept and reuse approximately 12% of the total urban stormwater inflow to the West Lakes system.

Irrigation of the Grange Golf Club's two 18-hole golf courses used approximately 300 ML of groundwater withdrawn from the upper Port Willunga Formation. The Grange Golf Club was the single largest groundwater user in the region and the implementation of this scheme is intended to effectively make them self sufficient on stormwater resources.

In 2003 the Torrens Catchment Water Management Board (now the Adelaide and Mt Lofty Ranges Natural Resources Management Board) and the Grange Golf Club jointly committed \$70,000 to a comprehensive feasibility study that determined the technical feasibility and the preferred option for scheme layout. Groundwater modelling and wetland functional design work was also undertaken towards detailed design.

The net present value (NPV) of the scheme (capital and ongoing operational costs) is approximately \$3.1 million which was funded jointly by the Adelaide and Mt Lofty Ranges Natural Resources Management Board, the Grange Golf Club and the Catchment Management Subsidy Scheme.

Environmental benefits of the scheme are significant and include:

- A reduction in polluted inflows of runoff to West Lakes, the Port River and ultimately the Gulf St Vincent;
- A major reduction in use of the locally stressed aquifer;
- An immediate pressure improvement and long-term salinity reduction in the local aquifer; and
- An increase in biodiversity and an opportunity to recreate native aquatic habitats.



Figure 8.5 Grange Golf Club Stormwater Harvesting and Reuse Scheme - Trimmer Parade Diversion and Frederick Road Pit (August 2006)

Social benefits include:

- Reinforcement of community awareness of water conservation issues;
- An opportunity to increase community awareness of biodiversity issues;
- Improved amenity and visual aspect to Frederick Road, a major arterial road to the West Lakes commercial and sporting precinct; and
- The opportunity to demonstrate best practice in environmental protection and water conservation to the local, state, national and international community (via the Club's high profile events calendar).



Figure 8.6 Grange Golf Club Stormwater Harvesting and Reuse Scheme – First Fill (September 2006)

Economically, the benefits of the scheme are:

- A sustainable water supply and secured long-term future for one of Adelaide's premier sporting venues;
- An aesthetic asset that increases the amenity of the Grange Golf Club adding to its value as a venue for national and international golfing events; and
- Avoidance of the need to use reticulated supply (River Murray) if the aquifer eventually reaches salinity limits for turf application.

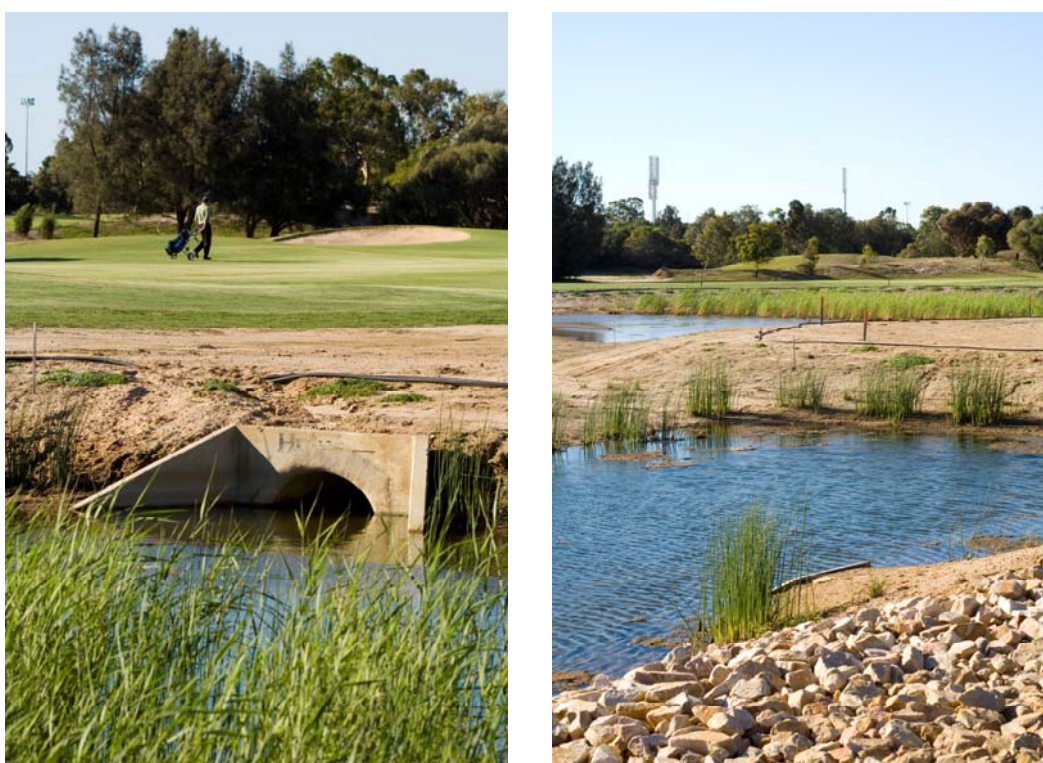


Figure 8.7 Grange Golf Club Stormwater Harvesting and Reuse Scheme - Completed Wetland (January 2007)

Parafield Partnerships Urban Stormwater Initiative



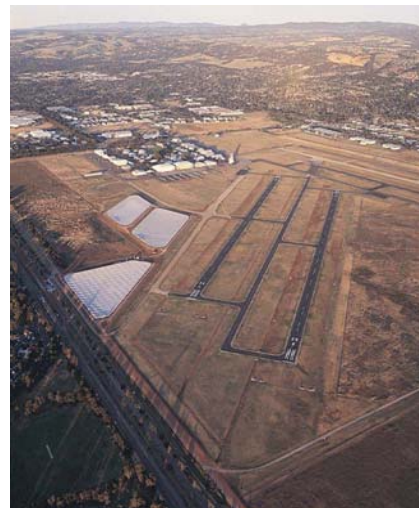
The Parafield Partnerships Urban Stormwater Initiative (PPUSI) was a landmark project commissioned in early 2003 to manage stormwater in Salisbury's last remaining catchment to receive, filter and clean stormwater.

It is a partnership between the City of Salisbury and G.H. Michell & Sons (Australia's largest wool processing company) with significant funding contributions provided by the State and Commonwealth Governments. The funding (\$1.8 million) came from the Commonwealth's Urban Stormwater Initiative and Clean Seas Program.

Michell's woolscour is one of the largest in the world. To produce its premium products it requires large volumes of good quality input water (about 1 billion litres per year). Prior to this scheme being implemented, Michell's was the biggest individual water user in Adelaide.

On the output side, the woolscour's annual waste stream provides a challenge as it contains up to 20,000 tonnes of sludge and over 4000 tonnes of salt. This wastewater was the largest single input to the Bolivar Wastewater Treatment Plant on Gulf St Vincent. After treatment, the water was either discharged into the Gulf or piped for reuse to the horticultural district of Virginia.

The City of Salisbury, Michell and Parafield Airport worked together, with the support of Environment Australia and the Northern and Barossa Catchment Water Management Board (now the Adelaide and Mt Lofty Ranges Natural Resources Management Board), to create a scheme to capture stormwater from over 2000 hectares of urban catchment that is treated in reed beds and stored in the underground aquifer for continuing industrial wool scouring use.



The scheme involves diversion of stormwater via a weir in the main Parafield drain to a 50 ML capacity 'in stream' capture basin (designed to meet 10 year ARI storm event). The water is then pumped to a similar capacity holding basin, from where it gravitates to a two hectare cleansing reed bed and then flows continuously through the densely planted reed bed to biologically cleanse the water. The reed bed ponds are located on Parafield Airport land and are appropriately bird-proofed. Surplus water is stored in an aquifer for use during summer.

Nutrient and pollutant loads are reduced by up to 90% with the treated water having salinity less than 220 mg/L (compared to average Adelaide mains supply salinity > 400 mg/L).



The residency period of the water in the treatment ponds prior to being pumped direct to users, or stored in the aquifer (approximately 650 ML is injected annually), is between seven and 10 days, depending on inflow water quality.

The scheme achieves approximately 70% capture of catchment yield.

Water quality monitoring is conducted using real time online monitoring of pH, TDS and turbidity in addition to grab sampling and composite sampling. The volume of water captured, supplied, injected and extracted is also monitored.

This scheme saves in the order of 1100 megalitres of water per year, which otherwise would have been pumped from the River Murray to meet Michell's demands. On the

output side, 2 megalitres/day of rinse water is available for irrigation in urban developments, parks and gardens following polishing in another constructed wetland.

In addition, sludge generated from Michell's is being combined with green waste collected from residential properties to produce a high quality fertiliser for the horticultural and wine industries.

8.7 Useful Resources and Further Information

Fact Sheets

www.waterforgood.sa.gov.au/wp-content/uploads/2010/07/fs0005_asr_in_sa.pdf

ASR in South Australia

www.waterforgood.sa.gov.au/

Water For Good fact sheets – Stormwater Use and Wastewater Recycling

www.decs.sa.gov.au/docs/documents/1/WaterSmartAquiferStorage.pdf

Water Smart: Aquifer Storage And Recovery for Irrigation of School Playing Fields

www.southeastwater.com.au/SiteCollectionDocuments/Recycled%20water/Recycled%20Water%20and%20

The facts about recycled water (South East Water)

www.wsud.org/downloads/Planning%20Guide%20&%20PN%27s/10-Groundwater.pdf

Practice Note No. 10 Groundwater WSUD in the Sydney Region

www.brisbane.qld.gov.au/documents/building_development/subdivision_development/Water%20sensitive%20design%20-%20practice%20notes/wsud%20practice%20note%2010%20aquifer%20storage_and_recovery.pdf

Practice Note 10 Aquifer Storage and Recovery, Brisbane City Council

www.brisbane.qld.gov.au/bccwr/lib184/treatment_train_72dpi_rgb_nobleed.pdf

Stormwater Treatment Train, Brisbane City Council

Legislation

www.epa.sa.gov.au/pdfs/cop_aquifer.pdf

Code of Practice for Aquifer Storage and Recovery, EPA

www.epa.sa.gov.au/pdfs/bccop1.pdf

Stormwater Pollution Prevention Code of Practice for the Building and Construction Industry, EPA

www.epa.sa.gov.au/pdfs/guide_waterwell.pdf

Pollutant Management for Water Well Drilling Guideline, EPA

www.epa.sa.gov.au/pdfs/guide_wws.pdf

Water and Wastewater Sampling Guideline, EPA

www.epa.sa.gov.au/pdfs/reclaimed.pdf

South Australian Reclaimed Water Guidelines

www.epa.sa.gov.au/pdfs/guide_lagoon.pdf

Wastewater and Evaporation Lagoon Construction Guideline

www.epa.sa.gov.au/pdfs/info_construction.pdf

Construction Noise information sheet, EPA

www.epa.sa.gov.au/pdfs/info_noise.pdf

Environmental Noise information sheet, EPA

<http://dataserver.planning.sa.gov.au/publications/654p.pdf>

Guide for Applicants, Planning SA

General Information

www.asrforum.com/

Aquifer storage recovery (ASR)

www.iah.org/recharge/

International Association of Hydrogeologists – Managing Aquifer Recharge (IAH-MAR)

www.ephc.gov.au/taxonomy/term/39

Australian guidelines for water recycling

www.envirotank.com.au/index.htm

Underground water tank suppliers

www.enviro-friendly.com/tankmasta-underground-water-tanks.shtml

Underground water tank suppliers

<http://waterbydesign.com.au/TechGuide/>

Aquifer Storage and Recovery – WSUD Technical Guidelines for South East Queensland

www.brisbane.qld.gov.au/documents/building_development/subdivision_development/wsud_chapt10_aquifer_storage_and_recovery.pdf

Aquifer Storage and Recovery – Brisbane City Council Draft WSUD Technical Guidelines

(Websites current at August 2010)

8.8 References

Department of Environment and Conservation NSW (2006). *Managing Urban Stormwater: Harvesting and Reuse*. Sydney, New South Wales. April.
www.environment.nsw.gov.au/resources/stormwater/managestormwatera06137.pdf.

Environment Protection and Heritage Council (2006). *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*. November.
www.ephc.gov.au/sites/default/files/WQ_AGWR_GL_Managing_Health_Environmental_Risks_Phase1_Final_200611.pdf.

Environment Protection Authority South Australia (1999). *South Australian Reclaimed Water Guidelines*. Adelaide, South Australia.
www.dh.sa.gov.au/pehs/branches/wastewater/reclaimed-water.pdf.

Environment Protection Authority South Australia (2004). *Code of Practice for Aquifer Storage and Recovery*. Adelaide. www.epa.sa.gov.au/pdfs/cop_aquifer.pdf.

Kellogg Brown & Root Pty Ltd (2004). *Metropolitan Adelaide Stormwater Management Study, Part B - Stormwater Harvesting and Use*. Local Government Association, South Australia. Adelaide, South Australia.
www.lga.sa.gov.au/webdata/resources/files/Part_B_Report_rev0.pdf.

Mitchell, V. G., Hatt, B. E., Deletic, A., Fletcher, T. D., McCarthy, D., Magyar, M. (2006). *Integrated Stormwater Treatment and Harvesting*. Institute for Sustainable Water Resources, Faculty of Engineering, Monash University. Melbourne.

Po, M., Kaercher, J. D., Nancarrow, B. (2003). *Literature Review of Factors Influencing Public Perceptions of Water Reuse*. CSIRO Land and Water. December.
www.clw.csiro.au/publications/technical2003/tr54-03.pdf.

(Websites current at August 2010)