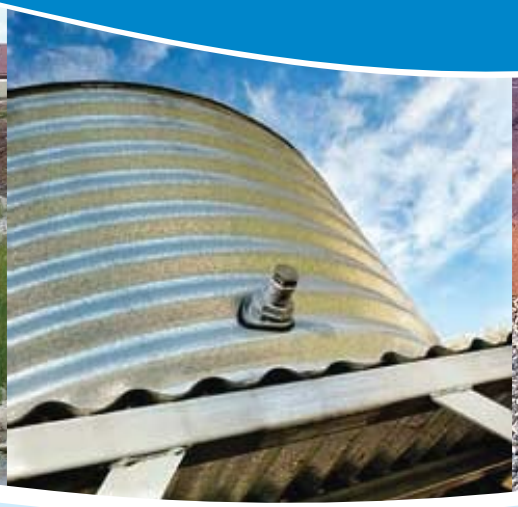
December 2010

Chapter 3

Designing a WSUD Strategy for Your Development

Water Sensitive Urban Design Technical Manual
Greater Adelaide Region

Government of South Australia

Australian Government
Department of the Environment, Water, Heritage and the Arts

Securing tomorrow's water today.

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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.

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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.

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Chapter 3
Designing a WSUD Strategy for Your Development

3.1 Overview

The main focus of the WSUD Technical Manual for the Greater Adelaide Region is to ensure the consideration of water management in the **initial** layout and design of a development, rather than it being left until all other elements (such as lot layouts and street design) have been completed, or later added as an ad-hoc development requirement.

This chapter of the Technical Manual provides guidance on the matters that should be considered from the outset when formulating or assessing an overall WSUD strategy for a site.

It presents a 12 step process and, where necessary, refers the user to documents that contain greater detail or other processes which may need to be followed to successfully implement WSUD.

It should be noted that the process is consistent with suggested processes used in other states. It is also consistent with the National Guidelines for Evaluating Water Sensitive Urban Design (BMT WBM 2008).

3.2 12 Step Decision Process

The process set out in this chapter highlights 12 key steps in the overall conceptual design process to incorporate WSUD in a development and identifies which professionals are required for input (where appropriate).

In general, a broad scale assessment may initially be appropriate to ensure that a proposal complies with the overall intent of WSUD. Further detailed, local scale assessments may be required to ensure that specific water quality, hydrologic, drinking water use and wastewater generation or reuse objectives are satisfied. Finally, examination of the specific design elements for each measure may be needed to ensure that they are adequate to treat the required runoff rates and volumes being discharged to them and achieve the required targets.

A checklist summarising the steps is provided in **Appendix A** and a flowchart illustrating the steps in the process is provided in Figure 3.1.

It should be noted that for a small scale development, not all of the steps in the outlined design process may be required.

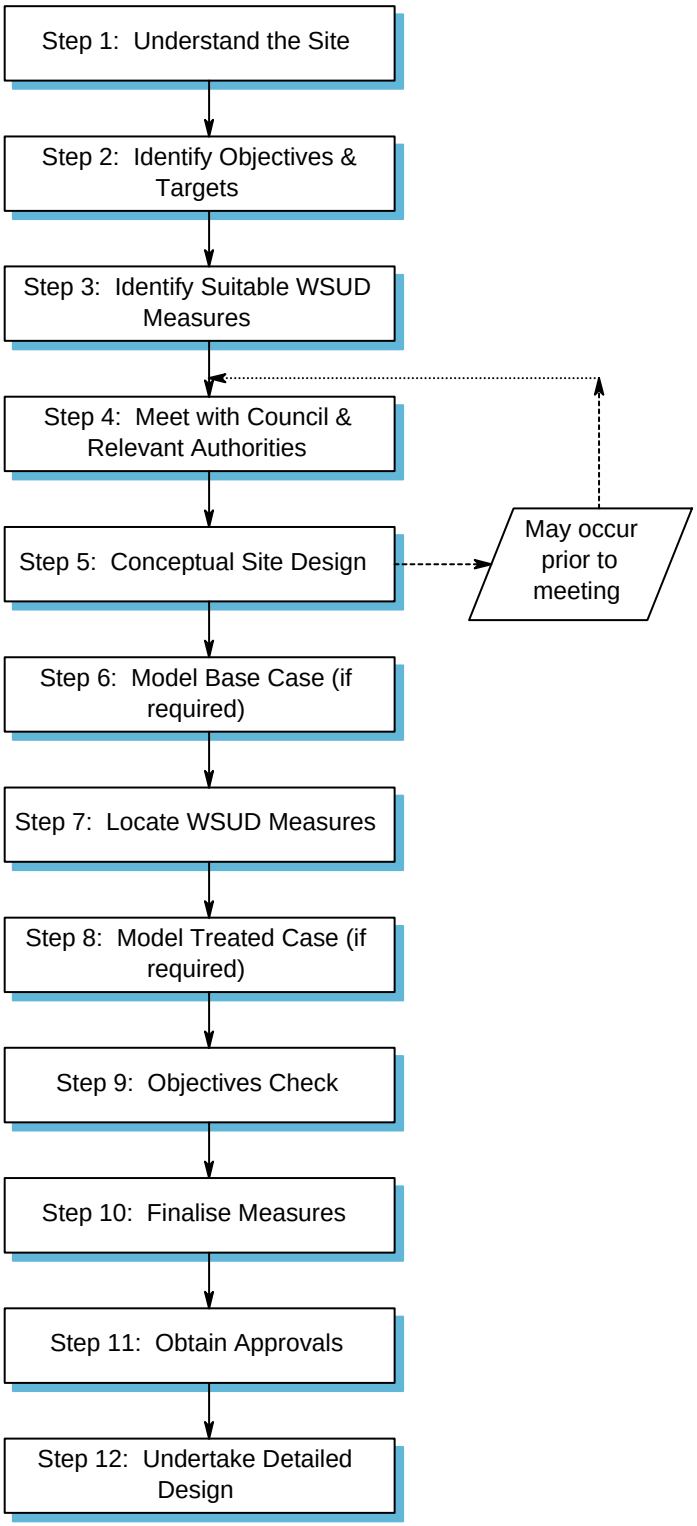

Figure 3.1 WSUD Decision Process Flowchart

The successful application of WSUD requires input from a range of professions, including engineering, ecological, landscape architecture and several other interdisciplinary considerations. A multi-disciplinary team approach is generally required to promote urban design that integrates best practice water planning and management measures with attractive streetscapes and open spaces.

This integration creates attractive and sustainable urban landscapes that can provide developers with a marketing advantage.

For the majority of large scale developments, a person proficient in WSUD will lead a team through the required tasks, or at least seek to facilitate the process. This cannot be conducted separately to other processes such as the overall urban, engineering or landscape design and may require several iterations through the overall urban development project.

Step 1: Understand the Site

Step 1 in the design process is about developing a broad overview of the subject site and identifying those issues that may assist or hamper the overall delivery of WSUD practices.

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 therefore a fundamental part of designing a development that effectively incorporates WSUD.

Appendix B (Site Analysis Information) gives a general guide to the wide range of factors that influence the design, layout, construction and subsequent use and maintenance of a development site. Not all these matters may be relevant to each individual site.

Appendix B outlines issues including: landform; water; soils and geology; plants; wildlife; climate; views; existing site features; services; use of adjacent land; and planning controls.

The breadth of technical expertise required to assess a given site will be dictated by the site itself and particularly its scale. In many cases this will require additional professional expertise.

There are several key characteristics of a site that can influence the overall delivery of WSUD. These characteristics influence the level of detail necessary to give confidence that WSUD can be successfully delivered.

To assist in determining the level of information necessary, **Table 3.1** provides a scoring system to determine the potential risk to the effective implementation of WSUD on a subject site. If the risk is identified as being high, the level of detail necessary to demonstrate that the WSUD strategy can be successfully implemented will also need to be high.

A suggested set of information requirements related to the risk profile is then provided in **Table 3.2**.

Such a site analysis can be submitted to support a development application.

From the site assessment, a list of opportunities and constraints as they apply to WSUD at the subject site should be prepared to assist with the remaining steps in the decision process.

Table 3.1 Site Suitability Review

Characteristic	Potential Implementation Constraint			Score
	Low	Moderate	High	
% Imperviousness (post implementation)	1 = 0-10%	2 = 10-50%	3 = 50-100%	
Soils	1 = Sand	2 = Loam	3 = Clay	
Average slope	1 = 0-1%	2 = 2-5 %	3 = > 5%	
Developed area	1 = < 1ha	2 = 1-10 ha	3 = > 10 ha	
Depth to groundwater	1 = > 3m	2 = 1.5-3 m	3 = < 1.5 m	
Mean annual rainfall	1 = < 400 mm/yr	2 = 400-600 mm/yr	3 = > 600 mm/yr	
			Total score	

Source: Adapted from BMT WBM (2008)

Table 3.2 Indicative Information Requirements

Total Score	Implementation Risk	Local Scale Assessment Level	Suggested Information Requirements
6 – 8	Low	Demonstrate implementation of best practice techniques	Site plan showing location, size and dimensions of WSUD measures Detailed design calculations
9 – 12	Medium	Demonstrate how relevant WSUD objectives are achieved (e.g. load based reduction targets achieved, peak flows compliant with hydraulic objectives)	Overall water management plan provided including: Site plan showing location, size and dimensions of WSUD measures Detailed design calculations Estimates to show how WSUD targets achieved
13 - 18	High	Demonstrate how relevant WSUD objectives are achieved (e.g. load based reduction targets achieved, peak flows compliant with hydraulic objectives) Demonstrate how high risk factors addressed	Overall water management plan provided including: Site plan showing location, size and dimensions of WSUD measures Detailed design calculations Estimates to show how WSUD targets achieved Detailed assessment of proposed mitigation to address risk factors

Source: Adapted from BMT WBM (2008)

Step 2: Identify Objectives

The implementation of WSUD in a development seeks to achieve a range of outcomes relating to water quality, hydrology, conservation, biodiversity and amenity. Each of these outcomes can be met by ensuring development complies with the appropriate objectives and targets identified for the site. Therefore, before any other activities are undertaken with respect to site planning, the objectives should be clearly established so that they can be referred to during remaining steps in the concept design process.

The objectives should focus on:

- Water quality;
- Water quantity;
- Integrated water cycle management;
- Landscape and amenity;
- Biodiversity enhancement; and
- Social outcomes.

These objectives should reflect the overall objectives of WSUD in the Greater Adelaide Region to ensure delivery and integration consistency and facilitate achievement of the desired overall water and environmental protection outcomes of WSUD.

In considering and applying WSUD objectives, site specific constraints may in some cases not allow compliance with the complete suite of objectives. In most cases the objectives will not be equal in terms of importance and due consideration is therefore required.

Hence, in developing objectives, care must be taken to ensure that the end result is something that can be practically achieved using existing techniques.

Information to assist with setting objectives is contained in **Appendix C** and in **Appendix D**, which outlines key principles of WSUD.

Step 3: Identify Suitable WSUD Measures

To assess whether a WSUD measure is appropriate requires an understanding of the requirements of the WSUD outcomes and the suitability of the particular measure to assist in achieving those outcomes. In developing a proposed WSUD strategy, it is often necessary to review this on an iterative basis, so that the characteristics of different WSUD measures can be appropriately integrated.

The list of possible WSUD measures (see **Chapters 1 and 2**) should be used to develop a series of potential retention systems and treatment trains for the proposed development, based on the interpreted site conditions, and site opportunities and constraints.

Other factors that should also be taken into consideration in selecting appropriate treatment measures include:

- Cost – benefit ratio of the devices (capital and maintenance costs) against the water quality, water quantity and biodiversity results achieved;
- Workplace health and safety issues (for maintenance crews);
- General public amenity and safety;

- Greenhouse gas emissions and savings;
- Whether a distributed or 'bottom of catchment' approach will be utilised;
- Integration with urban design including road and lot layouts; and
- Life cycle costs and ongoing maintenance requirements and resources.

These factors should be considered alongside the opportunities and constraints identified at the site and the opportunities to layout the development to respond to WSUD requirements.

The information provided in **Appendix E** is intended to assist in the strategy development and review process, which is based upon the information contained in the National Guidelines for Evaluating Water Sensitive Urban Design (BMT WBM 2008).

Step 4: Meet with Council and Relevant Authorities

In the majority of situations, it will be beneficial to the overall development process to meet with council officers to:

- Discuss the site of the proposed development, including opportunities and constraints of the site;
- Discuss the concept design of the proposed development;
- Establish objectives and targets for the proposed development;
- Discuss any likely council requirements, including any modelling expectations;
- Discuss land and asset ownership issues including future maintenance and operation; and
- Determine the necessary approvals including any State Government approvals.

Typically, this would form part of a 'pre-lodgement' meeting which allows informal discussions between the developer (and/or their consultants) and council.

In relation to delivery of WSUD on the site, the primary purpose of this meeting will be to establish that the objectives and targets identified in **Step 2** are the most appropriate and current for the area in question.

A draft concept design of the proposed development (including potential WSUD locations) could be prepared to form the basis of discussion at the pre-lodgment meeting. Further guidance on this is provided in **Step 5**.

This meeting will also allow proponents to discuss the opportunities and constraints identified in **Step 1** to determine whether any compromise may be necessary in the objectives to address the issues noted.

This meeting should also be used to discuss the implications, if any, of council Catchment and Stormwater Management Plans, particularly in relation to the opportunity or requirement for larger catchment scale detention or water quality treatment measures.

Guidance should also be sought from council as to whether it expects modelling of the WSUD measures to be undertaken. If so, the results should be submitted with the development application.

At this meeting it will also be necessary to determine what approvals might be necessary for the proposed development. Other approving authorities (such as the Environment Protection Authority, the Department of Health, the Department for Water, the Natural Resources Management Boards[1], SA Water) may subsequently need to be consulted to ensure that their requirements are taken into consideration at the conceptual and detailed design stages.

Land and asset ownership issues are key considerations prior to construction of any WSUD measures. A proposed design should clearly identify the asset owner and who is responsible for maintenance. This aspect should also be discussed during the initial meeting with the local council.

Step 5: Conceptual Site Design

WSUD principles are most effective and economical when integrated into development design at the concept design stage. Each development type may vary significantly and present different WSUD opportunities. There are many ways to incorporate WSUD in development projects to meet the objectives and targets. The design strategies used in a project will depend upon:

- The location and geography of the site;
- Land use and activity (residential, commercial, industrial);
- Development or redevelopment scale;
- Water use and demand (garden irrigation, industrial needs, etc.);
- Water sources available, including rainfall, stormwater and wastewater;
- On-site catchment area (roof and surface);
- Groundwater and soil type;
- Infrastructure (building and roads);
- Surrounding environment opportunities and constraints;
- Operation and maintenance (council or site owner);

[1] The Adelaide Mount Lofty Ranges Natural Resources Management (NRM) Board and the SA Murray Darling Basin NRM Board are the relevant organizations for the Greater Adelaide Region.

- Urban landscape design (architectural and landscape); and
- Catchment water quantity and quality objectives and targets.

Based on the outcomes of **Steps 1** and **2**, an initial conceptual site design based on broad development outcomes should be undertaken. This may simply be a sketch using intended land uses (e.g. residential areas, local open space, regional open space, protected zones) and should identify areas for possible implementation of lot, local and regional scale WSUD measures.

The objectives identified previously should provide guidance. However, the key to this conceptual design will be the opportunities and constraints identified in **Step 1** and addressing these in a 'whole of development' context. This conceptual site design becomes the overall vision for more detailed design in later steps.

The emphasis of the concept design is on minimising the impacts of development, managing construction activities and considering the ongoing use and dynamics of the proposed development and the landscape in which it sits. Each aspect is interrelated with the others. Adherence to the principles outlined in **Appendix D** will make a considerable contribution to reducing impacts on the total water cycle.

Step 6: Model Base Case (if required by approving authority)

At this stage, sufficient information would have been collected to allow modelling of both the existing site (i.e. pre-development) and the 'untreated' developed site that would form the 'base case' with which to compare future modelling of the WSUD systems proposed for the development (if required by the approving authority).

In the majority of developments, water quality modelling should focus on total suspended solids, total nitrogen, total phosphorus and gross pollutants as the key pollutants of interest, in addition to the hydraulic outcomes. Faecal coliforms and organics should also be considered, depending on the measure being assessed.

Further guidance on modelling is provided in **Chapter 15** of the WSUD Technical Manual.

Step 7: Locate WSUD Measures

When determining the optimal WSUD measures for a site, some consideration should be given to the site analysis and the opportunities available, and the 'natural' or obvious areas for WSUD measures (e.g. overland flow paths). The site analysis may provide information on whether a 'bottom of catchment' approach or a distributed approach to WSUD is optimal for the site.

Step 8: Model Treated Case (if required by approving authority)

Evaluation and assessment of alternative water management strategies are based on predictions made using forecasting tools.

The emergence of new models and design methods to evaluate the use of roofwater and stormwater, and reuse of treated wastewater allow more reliable assessment of the multiple benefits of utilising these alternative sources.

Modelling tools such as MUSIC and WaterCress should, depending on the scale and type of the development, be used to demonstrate that the proposed strategy:

- Achieves the load reduction targets adopted by council; and
- Results in adequate hydrological control of the site as per council's water quantity targets.

Other tools may include water balance modelling (which may include greywater recycling) and flooding or hydraulic modelling where this is appropriate to the site. **Chapter 15** of this Technical Manual should be referred to for further guidance.

Step 9: Objectives Check

At this stage, several iterations may be required to ensure that the majority of objectives set out in **Step 2** are achieved. Note that it may not be possible for all objectives to be met and it may be that a degree of compromise is required in some areas to achieve an optimal outcome.

Where necessary, if particular objectives are essential, then it may be appropriate to revisit the conceptual site design and/or the type of WSUD measures used.

Step 10: Finalise Measures

Once the final WSUD conceptual design has been developed, it will be necessary to confirm sizing and locations of measures prior to entering the detailed design process. Of key importance at this stage will be the identification of services and completed design elements (e.g. roads, open space areas, final lot layouts, hydraulic design) within which WSUD measures may need to be integrated.

A conceptual design should be developed that shows:

- The location of the WSUD measure(s) within the development;
- The proposed layout of the measure in its specific location (also showing key features such as roads and other services). The proposed layout should also provide detail of proposed access to the WSUD measure for maintenance and monitoring and, where relevant, any surrounding recreational infrastructure. This is to ensure that adequate consideration has been given to ongoing maintenance and that the functionality of open and other recreational spaces is not impeded.

The 'design considerations' in each chapter of the Technical Documents should also feed into the conceptual design. Designers may also use the Design Assessment Checklist in each chapter during the concept design to check that no key issues will arise later in the detailed design.

At this stage, it will also be appropriate to document operation and maintenance plans, including all ongoing requirements of each of the measures.

An implementation plan should also be developed for the WSUD measures, particularly where they will be used as interim erosion and sediment control measures, and when the final setting of the system will take place some time after initial functional installation of the device.

The plan should identify:

- When structural elements of the device are to be constructed;
- If devices are to be used as temporary sediment control measures, and for what period; and
- How the final setting of the WSUD measure is to be undertaken.

For soil and water management during the construction phase, it is recommended that procedures outlined in the following references are followed:

- The South Australian EPA's *Stormwater Pollution Prevention Code of Practice for the Building and Construction Industry* (see www.epa.sa.gov.au);
- The NSW Department of Housing 'Blue Book', *Managing Urban Stormwater – Soil and Conservation* (see www.environment.nsw.gov.au/stormwater/usp/docs.htm).

These references outline the general requirements for the preparation of a soil and water management plan.

All erosion and sediment control measures must be maintained in a functional condition throughout the duration of the works.

Where it is envisaged that the final setting of the WSUD measure will take place some time after the functional installation of the device (e.g. after the building phase of the contributing catchment area has been completed), discussions should be held with council to determine the process by which the WSUD device will be completed. Options are to either provide a contribution to council to complete the WSUD asset/s or for the developer to return and complete the asset as designed at a later time. These options should be discussed at the pre-lodgment meeting with council outlined in **Step 4**.

Further guidance can be found in the 'construction and establishment' sections of the Technical Documents.

Step 11: Obtain Approvals

The required relevant approvals, as determined during **Step 4**, should be sought prior to continuation with the detailed design phase.

Step 12: Undertake Detailed Design

Following approval of the development and the conceptual water management plan, the detailed design should be undertaken.

3.3 References

BMT WBM (2008). *National Guidelines for Evaluating Water Sensitive Urban Design (WSUD)*. March. www.nwc.gov.au/publications/index.cfm

Gold Coast City Council (2007). *Water Sensitive Urban Design Guidelines*. June. www.goldcoast.qld.gov.au/gcplanningscheme_policies/policy_11.html#guidelines

Upper Parramatta River Catchment Trust (2004). *Water Sensitive Urban Design, Technical Guidelines for Western Sydney*. Prepared by URS Australia Pty Ltd. www.wsud.org/tools-resources/

(Websites current at August 2010)

Appendix A
Design Implementation Process Checklist

The *Design Implementation Process* was modified for South Australian designs and conditions from checklists and forms provided in Gold Coast City Council (2007).

All parts of all checklists should be completed. Even if design checks or field inspections were not performed, it is important to record the reasons for this in the relevant checklists.

Water Sensitive Urban Design

Design Implementation Process Checklist

Item	Checked Y/N	Comments
Step 1: Understand the Site		
1. Land use planning information obtained		
2. Slope and terrain information obtained		
3. Groundwater conditions		
4. Soil properties (reactivity)		
5. Information on natural features obtained (waterways, wetlands, vegetation, etc)		
6. Information on planning constraints obtained (waterway buffers, open space, flood lines, general land use planning information)		
7. Receiving waters identified		
Step 2: Identify Objectives and Targets		
8. Water quality objectives identified		
9. Water quantity objectives identified		
10. Flood management objectives identified		
11. Integrated water cycle objectives identified		
12. Landscape objectives identified		
13. Vegetation and natural features objectives identified		
14. Social objectives identified		
Step 3: Identify Suitable WSUD Measures		
15. Range of suitable WSUD measures identified		
16. Optimal range of WSUD measures identified based on site-specific constraints and opportunities, maintenance requirements and costs		

Item	Checked Y/N	Comments
Step 4: Meet with Council and Relevant Authorities		
17. Pre-lodgement meeting held with council		
18. Objectives, targets and site constraints discussed		
19. Relevant legislative requirements identified		
20. Land and asset ownership issues discussed		
Step 5: Conceptual Site Design		
21. Sketch of conceptual site design undertaken		
Step 6: Detailed Site Analysis		
22. Hydrologic patterns and features identified		
23. Site characterised		
24. Ecological assessment undertaken and significant vegetation / habitat / trees identified		
25. Soil / geology description and analysis undertaken		
26. Existing and planned infrastructure identified		
27. Opportunities and constraints summarised		
Step 7: Model Base Case		
28. Water quality of base case modelled		
29. Hydrology / hydraulics of base case modelled		
Step 8: Locate WSUD Measures		
30. WSUD locations identified		
31. WSUD incorporated into development design giving consideration to space and infrastructure requirements		
32. Open space, lot layout and street configuration considered and appropriately managed		

Item	Checked Y/N	Comments
Step 9: Model Treated Case		
33. Water quality of treated case modelled		
34. Hydrology / hydraulics of treated case modelled		
35. Life cycle costs presented		
Step 10: Objectives Check		
36. Water quality objectives achieved		
37. Water quantity objectives achieved		
38. Flood management objectives achieved		
39. Integrated water cycle objectives achieved		
40. Landscape objectives achieved		
41. Vegetation and natural features objectives achieved		
42. Social objectives achieved		
Step 11: Finalise Measures		
43. Size and location of WSUD measures confirmed		
44. WSUD measures shown to fit within development layout without impacting on open space, road function or service functioning		

Source: Adapted from Gold Coast City Council (2007)

Appendix B
Site Analysis Information

Site Analysis Information

Landform

- Topography is critical to the design and layout of buildings, stormwater controls and drainage. Show contours (1 metre intervals), survey benchmarks and areas of steep slopes (at or greater than 10 degrees or 18%).
- Existing natural features (e.g. cliffs, rock outcrops, vegetated areas, potential groundwater recharge areas, creek lines, permanent water bodies).
- Orientation of the site (e.g. north point).
- Terrain – areas of high and low gradients, flatter areas which may allow larger WSUD measures such as wetlands, level areas which may present difficulties in terms of hydraulic head and high groundwater table.

Water

- Catchment boundaries – internal to the site and catchment areas external to the site.
- Sources of water flowing onto the site and general quality of that water.
- Drainage patterns, areas of concentrated run-off, ponding, flood prone land.
- Adjoining riparian zone, if within 40 metres of waterway.
- Characteristics of the site's downstream catchment (e.g. bushland creek, sensitive potential groundwater recharge area, constructed stormwater drainage channel).
- Receiving environment – identify those waterways or drainage lines where discharge off site is likely to occur.
- Groundwater – depth to, quality, any surrounding usage of the groundwater.

Soils and Geology

- Depth of soil/regolith.
- Soil reactivity.
- Soil pH to indicate affects of soil microorganisms and nutrient availability for plants.
- Soil condition, fertility, whether it has been compacted, cut or filled.
- Erosion problems.
- Contamination potential.

Plants

- Undertake a vegetation survey.
- Existing individual trees, stands of trees and shrubs – show height, spread, condition and species name (common and scientific, if known).
- Trees listed as 'significant' in the council's Planning Schemes.
- Existing ground levels around the base of trees.
- Weed species present and extent of weed infestation.
- Plants that grow well on the site or that are characteristic of the local area.
- Any threatened species or ecological communities present on the site or nearby land (consult council's GIS).
- Trees and vegetation proposed to be removed.

Wildlife

- Habitats present on the site or nearby land.
- Potential to provide fauna habitat, such as niches in rockeries, ponds for frogs, habitat plants (nectar-bearing shrubs for small birds).

Climate

- Direction of summer and winter winds.
- Windbreaks and their likely permanence.
- Frost pockets.
- Areas of full or partial shade in summer and winter at 9am, midday and 3pm.
- Direction and extremity of bushfire threat.

Views

- Views from the site – good views to be retained where possible, unpleasant views to be screened if possible.
- Views into the site, privacy and security problems.
- Qualities of the site that are important in the view to and from the site (e.g. major trees).

Existing Site Features

- Location and uses of any existing buildings and structures on the site showing those to be removed and retained.
- Location and height of walls and fences built to the boundary.

- Heavily shaded areas from existing structures, mature trees or dominant landforms.
- Archaeological and heritage (Aboriginal and European) sites.
- Any easements, rights-of-way and their restrictions.

Services

- Location of existing overhead and underground utility services (electricity, gas, telephone, water, sewer and stormwater drainage lines, inlets and collection points).

Use of Adjacent Land

- Location and use of adjacent buildings.
- Rooftop ridge levels and floor levels of adjacent buildings.
- Potential for overlooking into and from window openings in walls adjacent to the development site.
- Potential for shading adjacent properties.
- The form and character of adjacent and nearby development, including characteristic styles of buildings and landscaping, and bulk and scale of buildings.
- Street frontage features, such as street trees, poles, kerb crossovers and bus stops.
- Potential sources of nuisance, dust and noise, such as main roads.

Planning Controls

- Planning objectives, zoning, design criteria, lot size, site coverage, density controls and other provisions in local area Development Plans or other state legislation.
- Restrictions on development due to hazards (such as flooding, landslip, land contamination).
- Controls on removing vegetation or trees or on earthworks.
- Building setbacks, envelopes, height restrictions, view corridors.
- Planning constraints – environmental corridors, waterway corridors, flood lines, open space or recreational nodes.
- Strategic catchment planning – identify catchment or subcatchment plans (this will include natural resource management plans, stormwater management plans and infrastructure plans) to identify any regional or catchment-scale strategies applicable to the site.

Appendix C
Setting Objectives

Setting Objectives

The overarching objective (or vision) of WSUD in the Greater Adelaide Region is to stabilise and improve the health of the Region's coastal waters, watercourses and groundwater systems while maintaining and enhancing human health and reducing the ecological footprint of the Region.

WSUD Frameworks and Guidelines interstate and overseas have wide-ranging and varied objectives which relate to the context in which they were written. A key outcome of consultation undertaken during the WSUD project was the identification of a number of objectives which were considered to be appropriate for the Greater Adelaide Region.

The key objectives of implementing WSUD are:

- To move towards a natural flow regime (for example lower flows to reduce erosion of creeks and improve/maintain ecological value);
- To manage risk in relation to drought, flood, climate change and public health;
- To protect, enhance, value and conserve water resources;
- To encourage leading practice in the use and management of water resources to increase water efficiency, reduce reliance on imported water and apply at-source reduction of impacts on water quality, flooding, erosion and sedimentation;
- To raise awareness and catalyse change in the design, construction and management of urban development and urban infrastructure; and
- To recognise and foster the significant environmental, social and economic benefits that result from sustainable and efficient use of water resources.

Water Quality Objectives

One of the primary roles of WSUD is to reduce the impacts of urban development on receiving water quality. As part of the design process, relevant environmental values and water quality objectives of receiving waters or other water quality targets relevant to the site must be identified and documented. These may include:

- Concentration-based water quality objectives for receiving waters;
- Concentration-based discharge standard from a site;
- Load-based criteria (mass per unit of time) or reduction in load.

The relevant water quality objectives should be used as primary performance criteria on which a development is assessed for its ability to ensure protection of receiving water quality.

Different types of land use typically generate specific stormwater pollutants in significant quantities. Consequently, the 'key' pollutants to be addressed from new development, and the control techniques employed, are a function of the type of development. **Table C1** identifies the significance of pollutants likely to be generated by different land uses.

Table C1 Range of Pollutants Likely to be Generated by Different Land Uses

Development Style	Litter	Coarse Sediment	Fine Particles	Total Phosphorus	Total Nitrogen	Heavy Metals	Hydrocarbons, Motor Fuels, Oils & Grease
Low Density Residential	M	L	L	M	M	L	L
High Density Residential	M	M	M	M	M	M	M
Commercial, Shopping and Retail Outlets	H	M	M	M	M	M	M
Industrial	M	M	M	L	L	H	H
Fast Food Outlets and Restaurants	H	L	M	M	M	L	M
Carparks, Service Stations and Wash Bays	H	M	M	L	L	H	H

Source: Adapted from Upper Parramatta River Catchment Trust (2004), Gold Coast City Council (2007)

Note: H = High, M = Medium, L = Low

Note: for industrial and commercial developments, site-specific assessment should be undertaken to identify key pollutants that need to be targeted for the proposed development

It should be noted that gross pollutant and sediment load is not necessarily a product of allotment-specific development types; it can also be as a result of the street network associated with them and the street cleaning regime adopted. Street trees are often a major contributor.

Water Quantity Objectives

Another key principle of WSUD is to reduce the impact of urban development on the natural hydrologic conditions of a site. Inundation times should be considered as part of the setting of water quantity objectives. This will be particularly relevant where inundation times may be increased for downstream properties.

Further discussions should be held with council development assessment officers during **Step 4** to ensure appropriate quantity targets have been identified.

It should be recognised that WSUD elements in isolation will not be sufficient to address all flooding/hydraulic requirements but may be integrated within the overall hydraulic design of the development.

Integrated Water Cycle Management Objectives

One of the major benefits of WSUD is the ability to incorporate measures that can benefit all parts of the water cycle. Specific objectives may be defined for the subject site. WSUD elements such as rainwater tanks, water efficient devices, aquifer storage and recovery, and wetlands can all be useful elements in an overall integrated water management plan.

Landscape and Amenity Objectives

While deterministic objectives may not be available, broad objectives for the integration of landscape elements into WSUD may include the following:

- Ensure the integration of landscapes, recreational amenity and WSUD functionality facilitates creative expression and solutions, meets standards of service for recreation and landscape amenity, can be comprehended by the community and is sensitive to the environment and the local setting;
- Provide appropriate buffers to open space areas or environmental corridors;
- Ensure the functionality of open space areas is not compromised by the WSUD elements in most circumstances;
- Provide a desirable community amenity and integrate WSUD into the overall design of the urban framework;
- Ensure the sustainability of landscape amenity through design which accounts for longevity of the system considering maintenance and community use aspects (e.g. vandalism, litter protection);
- Provide 'green' elements and visual breaks in the urban landscape.

Landscape objectives for WSUD should identify specific features within and surrounding the site to ensure:

- Consistency with the current character of the area;
- The qualities of the existing or built environment landscape are retained;

- Retention of existing landscape and heritage features;
- Provision of social and recreational opportunities; and
- Retention of important view and vistas.

Vegetation and Natural Features

The objectives of WSUD relating to vegetation and natural features include:

- Protection and enhancement of waterways, wetlands and their buffers;
- Ensuring appropriate development setback from waterways and wetlands;
- Protection of remnant vegetation communities;
- Retention and reinstatement of native vegetation;
- Natural channel design responses for natural gullies and waterways.

Each of these objectives should be developed in conjunction with **Step 7** to ensure natural features of the site are identified and their protection/enhancement, specific to the identified feature, is listed as an objective for that development.

Social Outcomes

Increasingly, developers are recognising the benefits of incorporating social design into the delivery of new urban areas. Objectives relating to public safety, community enhancement and recreational opportunities may be identified through other processes. However, it is important that they are considered as a specific outcome.

Appendix D
WSUD Principles

WSUD Principles

There are numerous guiding principles that underpin the objectives for water management and the implementation of WSUD in the Greater Adelaide Region. These principles should be addressed when undertaking the planning and implementation of water management.

The guiding principles include:

- Incorporate water resources as early as possible in the land use planning process;
- Address water resource issues and conservation of biodiversity at the catchment and subcatchment level;
- Ensure water management planning is precautionary and recognises inter-generational equity, conservation of biodiversity and ecological integrity;
- Recognise water as a valuable resource and ensure its protection, conservation and reuse;
- Recognise the need for site-specific solutions and implement appropriate non-structural and structural solutions;
- Protect ecological and hydrological integrity;
- Integrate good science and community values in decision making; and
- Ensure equitable cost sharing.

The emphasis is on minimising the impacts of development, managing construction activities and considering the ongoing use and dynamics of the proposed development and the landscape it sits within. Each aspect is interrelated with the others. Adherence to the following principles will make a considerable contribution to reducing impacts on the natural water cycle.

Minimise Disruption to Landforms and Drainage Patterns

By minimising disruption to landforms and drainage patterns you can avoid related impacts on vegetation, weed growth and loss of habitat, both on and off the site. According to Hobart City Council (2006), soil surface disturbance creates an immediate potential for:

- Loss of topsoil by wind and water erosion;
- Sediment to be carried away and deposited downstream;
- Changes to nutrient and moisture conditions in deposition zones which may make existing plants unsuitable for the conditions, cause native plants to die or not regenerate and create conditions for weeds to establish and dominate; and

- Long-term effects on the pattern of runoff and infiltration for established areas of vegetation, damp spots, creeks and watercourses, thereby causing irreversible changes to natural systems.

Therefore, the minimisation of cut and fill is recommended by:

- Using natural ground levels where possible for siting houses and other structures;
- Using house construction techniques to accommodate slope (e.g. pole construction, split level or stepped design);
- Using pier and beam foundations rather than slab on ground construction to minimise ground and tree root disturbance; and
- Designing driveways to contour around slopes. Use grassed swales to direct flow towards vegetated areas at regular intervals (every 3 metres) to reduce water volume and to permit smaller depressions in the driveway profiles.

It is also recommended that stormwater flow be managed by:

- Slowing down flow rates where possible to prevent erosion, promote infiltration and reduce reliance on supplementary watering and irrigation;
- Using pervious paving, pebble paths, infiltration trenches, swales, terraced garden walls, mulched garden beds or other landscaping elements to slow down and infiltrate runoff (where soil conditions are appropriate e.g. sandy soils).

Minimise Disruption to Existing Vegetation

Maintaining existing vegetation avoids many soil and weed management problems, and helps conserve biodiversity. In doing so, consideration should be given to:

- Minimising removal of plants and root systems as this makes the site prone to erosion and can alter water table levels, causing potential flooding problems or vegetation decline;
- Avoiding increased light levels on bare soils as this encourages weed growth;
- Maintaining the area's full ecological spectrum of plants as this helps to conserve habitats for all sizes of fauna, including insects, lizards, fogs and insectivorous birds. Their disappearance from gardens and their natural ability to help control pests can lead to the reliance on chemical control and detrimental impacts on other natural elements such as soil ecology.

Assess the health, vigour and longevity of existing mature trees at the site planning stage. Existing trees may not tolerate construction activity in the root zone, resulting in a decline in tree health, accelerated limb loss, pest and disease attack or complete demise, which can lead to injury or property damage.

If removing trees, consider planting replacement trees that are deep rooted species to:

- Maintain or lower the water table to mitigate potential for flooding;
- Bind the soil and reduce soil erosion;
- Decrease runoff velocities;
- Filter nutrients and capture sediments.

Minimise Impacts on Neighbouring Areas

The minimisation of impacts on neighbouring areas includes adjoining lots as well as nearby natural areas (e.g. bushland areas, waterways, swamps, groundwater recharge areas, foreshores):

- Consider your site as one part of the whole landscape. For instance, planting large trees to provide shade in summer may be unpleasant for neighbours by providing unwanted shade in winter;
- Avoid impacts on adjoining sensitive environments due to construction works, gradual accumulation of sediment or exotic plants that become weeds and displace other plants;
- Manage construction works so as to minimise environmental impacts on soil, water, vegetation and air. Limit nuisances such as noise and waste. Make detailed plans to:
  - Protect the site and adjoining properties prior to commencement of work. This will provide long-term benefits for ongoing site use and management;
  - Prevent sedimentation in waterways and drainage lines, as this can reduce flow capacity, increase localised flooding and cause property damage.

Prevent or Repair Ongoing Problems

Some sites are already disturbed or experience problems caused by external activities. These may include soil loss, sediment deposits, weed invasion or risk from bushfire, landslip or other hazards. These must be factored into decisions regarding layout, construction materials and ongoing management:

- Carry out measures to reverse existing damage and control/prevent further damage (e.g. soil conditions or weed invasion);
- Choose building materials and planting species to suit conditions (e.g. bushfire hazard);
- Place pavement areas so as to redirect or reduce impact of large stormwater flows;
- Reduce reliance on supplementary garden watering by species selection and placement, grouping species with similar water needs, creating and utilising microclimates to advantage, changing maintenance and watering regimes, or other horticultural practices.

Consider Siting Requirements

Buildings, utilities and stormwater measures have particular siting requirements:

- Position and orientate buildings to take best advantage of solar access, views, microclimate and natural site features;
- Position driveways so as to minimise gradient to reduce the velocity of runoff;
- If possible, site water tanks so that water can be fed by gravity;
- Filtration/infiltration devices need to observe minimum separations from buildings. These vary according to soil conditions;
- Place pervious paving in locations that will not receive significant amounts of sediment, debris or other material likely to hinder performance;
- Place landscaped areas in positions that will receive runoff from upstream areas to promote infiltration and filtering of runoff;
- Place structures on sites that are already cleared to minimise ground disturbance;
- Set structures below the topmost point of a property to reduce the intensity of wind exposure. Take advantage of established wind breaks or other natural features to create a pleasant microclimate;
- Reduce driveway, paths and other pavement areas to a minimum by re-dimensioning, choosing alternative materials or rationalising the layout so that some areas become multi-purpose (and more economic to construct);
- Consider the safety of the general public adjacent to the WSUD device. Consideration should be given to the risks associated with open water bodies, ponded water etc and should be appropriately managed through selection of devices and subsequent detailed design;
- The device must be able to integrate with the local character and built environment and be suitably located to treat the maximum amount of runoff from the site.

Maintenance and Operation

A poorly maintained treatment measure may not only perform badly; it may become a hazard or a source of pollution itself. Treatment measure operation and maintenance requirements vary widely. When assessing the treatment measure's maintainability and operability, the following issues should be considered:

- Ease of maintenance and operation: the selected treatment should be easy and safe to maintain and operate;
- Extent of maintenance: ensure the maintenance requirements are within the operator's capability;

- Access to the treatment site: consider the ease of site access when reviewing the treatment's maintenance requirements;
- Frequency of maintenance: ensure that resources are available to carry out maintenance at the required frequency;
- Debris and pollutant clearing: during clearing, the treatment should not require direct human contact with debris and trapped pollutants (automated clearing facilities are preferred); and
- Disposal: consider the disposal of any waste (e.g. gross pollutants, vegetation etc) from the treatment process.

The devices selected should represent a reasonable maintenance burden, particularly where the asset will be handed over to council at some time in the future.

The maintenance requirements must be within council's capacity in terms of skills, resources and equipment. The treatment devices should be safe to maintain and should not require direct contact by maintenance staff with pollutants and other trapped materials. Furthermore, maintenance procedures should be simple without the need for specialised equipment.

The devices and their locations must be accessible for ongoing maintenance, including for all equipment (such as any heavy machinery).

Appendix E
WSUD Treatment Train Suitability Assessment

Table F1 below can be utilised to assist in the development and review process. If a particular goal is determined as being an essential component, a score of 1 for that objective suggests that the measure needs to be re-examined.

This is simply a guide to assist the practitioner where other, more detailed, guidelines are not available, but can also provide an overview of how measures can be optimised to achieve objectives.

Particular measures may not achieve all objectives and some may be completely unsuitable. As such, guidance is also required on which types of measures or practices are most appropriate to specific objectives.

Table F1 WSUD Treatment Train Suitability Assessment

Objective	Suitability			Score
Water Quality				
Treatment Train Elements				
Primary Treatment (screening / sedimentation)	1 = None (no specific measure)	2 = Incidental (measure may treat though not designed to)	3 = Dedicated (e.g. GPT, sedimentation basin)	
Secondary Treatment (enhanced sedimentation / vegetative filtering)	1 = None (no specific measure)	2 = < 50% vegetation coverage	3 = > 50% vegetation coverage (e.g. wetland, swale)	
Tertiary Treatment (biological uptake)	1 = None (no specific measure)	2 = Filtration only (e.g. infiltration trench, pervious pavement)	3 = Filtration + vegetation (e.g. biofilter, raingarden)	
Water Quality Outcomes achieved	1 = No compliance for any parameter	2 = Partial compliance	3 = Full compliance (or not applicable)	
Load based reductions achieved	1 = No compliance for any parameter	2 = Partial compliance	3 = Full compliance (or not applicable)	
Water Quantity				
Disconnection of impervious areas	1 = No disconnection	2 = Conveyance provides disconnection, but >10% directly connected impervious area	3 = Disconnection achieves < 10% directly connected impervious area	
Detention	1 = No detention capacity	2 = Detention component provided for minor flows	3 = Detention for major flows integrated into measure	
Water harvesting	1 = None	2 = < 10% of storage volume available for harvesting	3 = > 10% of storage volume used for harvesting	

Objective	Suitability			Score
Water Supply				
Measure can provide alternative sources of water	1 = none possible	2 = one potable water source can be substituted	3 = two or more water sources can be substituted	
Reduces potable water demand	1 = no demand reduction possible	2 = 0-20% reduction expected	3 = >20% reduction expected	
Amenity				
Multiple uses provided by the measure	1 = only has one function	2 = has an amenity function in addition to primary function	3 = has multiple functions	
Form is integrated into landscape	1 = discontinuous from other landscape elements	2 = has one or more consistent features with overall landscape character	3 = completely integrated within landscape	
Existing natural features retained	1 = < 25% natural features retained	2 = 25-75% features retained or enhanced	3 = > 75% of natural features retained	
Public safety elements addressed	1 = likely to pose public safety hazard	2 = public safety elements incorporated into design	3 = no public safety issue	
Linkages (pedestrian, bicycle, vehicular) maintained or enhanced	1 = links severed by measure	2 = existing links retained through measure	3 = existing links maintained and additional linkages provided	
Functionality				
Maintenance elements incorporated within measure	1 = no dedicated maintenance elements incorporated	2 = maintenance access provided	3 = maintenance access provided, working areas highlighted and provision for waste handling included	
Maintenance plans provided	1 = no maintenance plans given	2 = generic maintenance plan provided	3 = maintenance plan specific to measure provided, including costings	
Service corridors allowed for	1 = no service areas allowed for	2 = services can be included, but constrained	3 = service corridors dedicated and sufficient	

Source: BMT WBM (2008)

Total score:

18 – 27 = strategy, measure or treatment train may need considerable refinement
28 – 40 = strategy, measure or treatment train may achieve WSUD objectives, however further refinement would be beneficial
41 – 54 = strategy, measure or treatment train has a high likelihood of successful implementation.