Water Sensitive Urban Design

BEST MANAGEMENT PRACTICES

Purpose of this fact sheet:

This fact sheet provides advice to the development industry on applying Water Sensitive Urban Design to meet Best Management Practices in the Coastal Dry Tropics Region.

Introduction to WSUD

Water Sensitive Urban Design (WSUD) is an internationally recognised concept that offers an alternative to traditional development practices. WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at the development scale.

- WSUD represents a fundamental change in the way urban development is conceived, planned, designed and built. Rather than using traditional approaches to impose a single form of urban development across all locations, WSUD considers ways in which urban infrastructure and the built form can be integrated with a site's natural features. In addition, WSUD seeks to optimise the use of water as a resource.
- The key principles of WSUD are to:

  - Protect existing natural features and ecological processes.
  - Maintain the natural hydrologic behaviour of catchments.
  - Protect water quality of surface and ground waters.
  - Minimise demand on the reticulated water supply system.
  - Minimise sewage discharges to the natural environment.
  - Integrate water into the landscape to enhance visual, social, cultural and ecological values.

Design Objectives

Design objectives are specific and measurable water management targets, selected to meet desired outcomes, such as a reduction in water usage or protection of downstream environmental values.

The adopted design objectives for the Coastal Dry Tropics in mean annual pollutant load leaving a development site, compared to traditional urban design where stormwater is not treated:

- >80% reduction in total suspended solids load
- >65% reduction in total phosphorus load
- >40% reduction on total nitrogen load
- >90% reduction in gross pollutant load.

KEY POINTS OF THIS FACT SHEET

This fact sheet provides advice to professionals in the development industry with

- An introduction to WSUD and meeting best management practices
- An overview of WSUD treatment measures
- A guide to the application and effectiveness of different treatment measures and understanding the possible site constraints

City of Townsville

WSUD Treatment Measures

There are a range of WSUD treatment measures available. The selection of the device will vary from site to site, so it is important that the most appropriate treatment measures are chosen based on assessments of site characteristics. Different treatment measures also provide different levels of treatment. In most cases a combination of devices acting as a treatment train provides the best overall stormwater treatment.

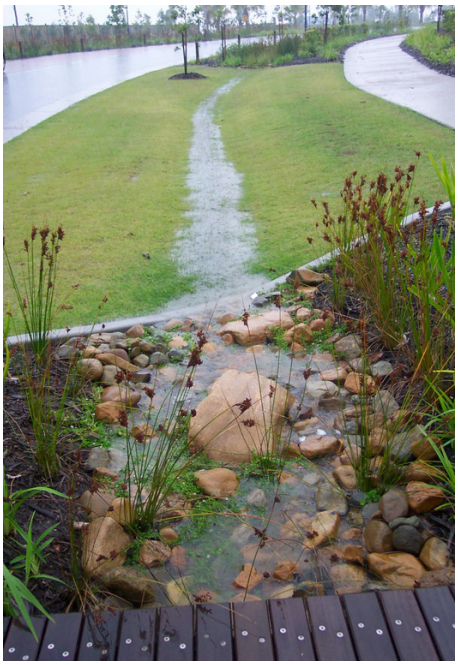
Primary Treatment Measures

These treatment devices usually target litter and other gross pollutants and course sediment.

Litter (trash) rack and Gross pollutant traps:These litter collection devices are intended to retain gross organic and anthropogenic litter that is washed from urban surfaces. They rely predominantly on physical screening rather than flow retardation to remove litter

Oil collector/trap: There are currently a number of oil and grease separators being used in the stormwater industry, with varying success. The separation of oil and grease in such systems rely on near-quiescent flow conditions and are most appropriate when used in treating runoff from clearly isolated oil and grease source areas (i.e. limited stormwater peak flows).

Sediment trap: Sedimentation basins are stormwater detention systems that promote settling of sediments through the reduction of flow velocities and temporary detention. They can take various forms and can be used as permanent systems integrated into an urban design, or temporary measures to control sediment discharge during construction.



Secondary Treatment Measures

These devices usually target sediments, with partial removal of heavy metals and bacteria.

Buffer strips: Buffer strips (or buffers) are areas of vegetation through which runoff passes while travelling to a discharge point. They reduce sediment loads by passing a shallow depth of flow through vegetation and rely upon well distributed sheet flow. With their requirement for uniformly distributed flow, buffer strips are suited to treatment of road runoff in situations where road runoff is discharged via flush kerbs or through regular kerb ‘cut-outs’.

Swales: Vegetated swales provide a means of disconnecting impervious areas from downstream waterways, assisting in protecting waterways from damage by frequent storm events, by reducing flow velocity compared with piped systems. They provide removal of coarse and medium sediments and are commonly combined with buffer strips and bioretention systems to provide further treatment.

Sand filters: Sand filters operate in a similar manner to bioretention systems, with the exception that stormwater passes through a filter media (typically sand) that has no vegetation growing on the surface, reducing their treatment performance comparatively. The absence of vegetation is due to low moisture content in the sandy soils and low light due to systems often being installed underground. Sand filters should only be considered where site conditions, such as space or drainage grades, limit the use of bioretention systems.

Infiltration systems: These systems do not treat stormwater, but capture runoff and encourage infiltration into surrounding in-situ soils and underlying groundwater. This has the benefit of reducing stormwater runoff peak flows and volumes, reducing downstream flooding, managing the hydrologic regime entering downstream aquatic ecosystems and improving groundwater recharge.

Tertiary Treatment Measures

These aim to remove nutrients, bacteria, fine sediments and heavy metals.

Bioretention systems: Bioretention systems operate by filtering stormwater runoff through densely planted surface vegetation and then percolating runoff through a prescribed filter media. During percolation, pollutants are retained through fine filtration, adsorption and some biological uptake.

Constructed Wetlands: Constructed wetland systems are densely vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater.

Source controls

These devices aim to minimise the quantity of stormwater runoff generated, therefore minimising the size requirements of additional WSUD treatment measures in a treatment train.

- Rainwater tanks
- Porous pavement

Selection of Appropriate WSUD Treatment Devices

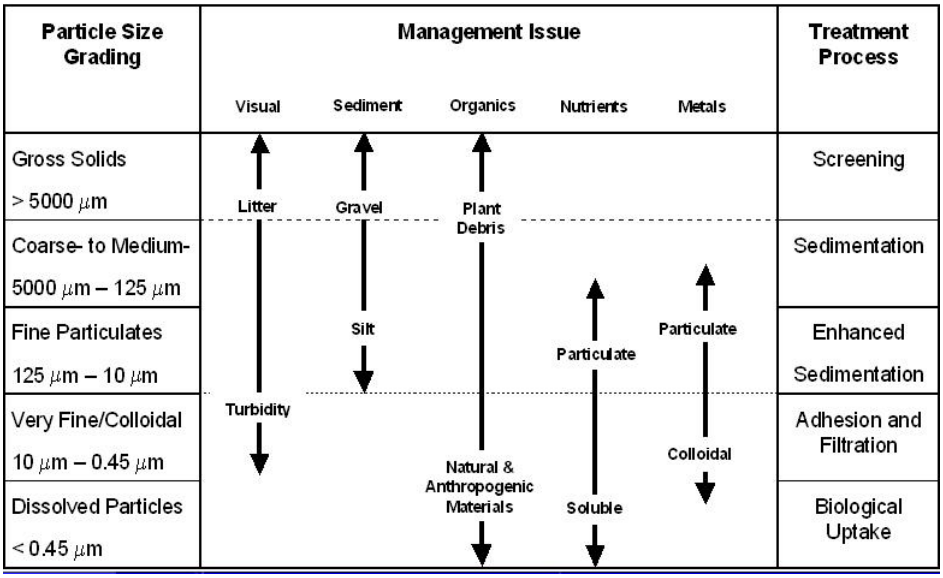
Not all of the stormwater management measures presented in this factsheet are suitable for any given site. Appropriate measures should be selected by matching device characteristics to target pollutants and the physical constraints of the site.

Table 1: Site Conditions and Benefits of WSUD Treatments (adapted from the City of Melbourne's *Water Sensitive Urban Design Guidelines)*

TREATMENT MEASURE	POTENTIAL BENEFITS	SUITABLE SITE CONDITIONS	UNSUITABLE CONDITIONS
Gross Pollutant Trap	Reduces litter and debris. Can reduce sediment. Pretreatment for other measures.	Conventional drainage systems	Sites larger than 100 ha. Natural channels
Oil Collector/Trap	Separate oil and grease	Areas with clearly isolated oil and grease source areas (limited stormwater peak flows)	Areas with high stormwarter peak flows
Sediment Trap	Course sediment capture. Temporary installation. Pretreatment for other measures.	Need available land area.	Proximity to airports
Buffer Strips	Pretreatment of run-off for sediment removal. Streetscape amenity.	Flat terrain	Steep terrain
Swales	Medium and fine particulate removal. Streetscape amenity. Passive irrigation.	Mild slopes (< four per cent)	Steep slopes
Sand Filters	Particulate removal	Consider if site conditions limit bioretention systems	Where other technology more appropriate
Infiltration Systems	Reduce peak flows and volumes and encourage infiltration	Soils with high hydraulic conductivity	Soils with very low hydraulic conductivity
Bioretention Systems	Fine and soluble pollutants removal. Streetscape amenity. Frequent flood retardation.	Flat terrain	Steep terrain. High groundwater table.
Constructed Wetlands	Community asset. Medium to fine particulate and some soluble pollutant removal. Flood retardation. Storage for reuse. Wildlife habitat.	Flat terrain	Steep terrain. High groundwater table. Acid sulphate soils
Rainwater Tanks	Storage for reuse. Sediment removal in tank. Frequent flood retardation.	Proximity to roof Suitable site for gravity feed. Incorporate to urban design	Non-roof run-off treatment
Porous Pavement	Provide flow attentuation and remove sediments and attached pollutants	Best suited to catchments with flat terrain, low sediment loads and light vehicle weight	High traffic volumes or weights, steep terrain, high sediments loads, high water table.

Selection of Appropriate WSUD Treatment Devices

The following screening tools are available to assist in the selection of appropriate WSUD treatment devices based on the site and pollutant characteristics (from WSUD Technical Design Guidelines for the Coastal Dry Tropics, Townsville City Council).



From the City of Melbourne's *Water Sensitive Urban Design Guidelines*

Table 1.2 Scale of WSUD Application in Urban Catchments

WSUD Measure	Allotment Scale	Street Scale	Precinct or Regional Scale
Swales and buffer strips		✓	
Bioretention Swales		✓	✓
Sedimentation basins			✓
Bioretention basins	✓	✓	✓
Constructed wetlands		✓	✓
Infiltration measures	✓	✓	
Sand filters	✓	✓	
Aquifer storage and recovery			✓

Selection of Appropriate WSUD Treatment Devices

Device Screening Tools (continued)

Table 1. 3 Effectiveness of WSUD Measures for Runoff Quality and Quantity Management

WSUD Measure Water	Quality Treatment	Peak Flow Attenuation *	Reduction in Runoff Volume *
Swales and buffer strips	M	L	L
Bioretention Swales	H	M	L
Sedimentation basins	M	M	L
Bioretention basins	H	M	L
Constructed wetlands	H	H	L
Infiltration measures	H	H	H
Sand filters	M	L	L
Aquifer storage and recovery	H	H	H

H – High; M – Medium; L – Low * Frequent events only

Table 1. 4 Site Constraints for WSUD Measures

WSUD Measure	Steep site	Shallow bedrock	Acid Sulfate Soils	Low permeability soil (eg. Clay)	High permeability soil (eg. sand)	High water table	High sediment input	Land availability
Swales and buffer strips	C	D	D	✓	✓	D	D	D
Bioretention Swales	C	C	C	✓	✓	C	D	D
Sedimentation basins	C	✓	✓	✓	✓	D	✓	D
Bioretention basins	D	D	D	✓	✓	C	C	D
Constructed wetlands	C	D	C	✓	D	D	D	D
Infiltration measures	C	C	C	C	✓	C	C	D
Sand filters	D	✓	✓	✓	✓	D	C	✓
Aquifer storage and recovery	C	C	C	C	✓	C	C	D

C – Constraint may preclude use; D – Constraint may be overcome through appropriate design;

✓ - Generally not a constraint

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