Practice Note #1

WATER SMART DEVELOPMENTS

Water Smart design is the effective planning, design and building of homes, subdivisions, suburbs, towns and cities that are sensitive to the ecological needs of the waterways that are impacted by them.

Water Smart developments aim to mimic natural processes which reconnect neighbourhoods with local waterways and improve visual amenity and quality of life, make better use of all water within our urban areas, seek to protect the ecological health of urban waterways from the potential negative impacts of urban development, and to add value to our water and waterway management activities.

Each Practice Note in this series is designed to give greater detail and specific advice on different aspects of Water Smart developments and devices. The Practice Notes provide reviews of the main design features, advice on installation and maintenance issues, include diagrams and pictures to assist with implementation, and reference useful websites to assist with further research into Water Smart developments.

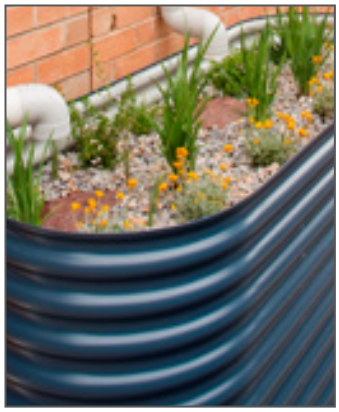
This Practice Note provides an overview of how to make your development *Water Smart.*

WHAT IS A WATER SMART DEVELOPMENT?

Developments, whether sub-divisions, road construction, new home construction, or a building renovation can all be designed using Water Smart principles by considering how water will (i) enter the site (rainwater and mains water), (ii) be used on site (water consumption), and (iii) leave the site (waste water and stormwater). The design emphasis for a Water Smart development will work to:

- capture and divert rain water into tanks for reuse or onto gardens, to treat stormwater and reduce flow speed and erosion (along with other environmental issues)
- reduce mains or potable water consumption on site through appropriate reuse of rain water and waste water (mainly grey water) and use of water saving fittings and appliances that reduce the demand on mains water
- manage the flow of water on-site by taking advantage of the natural landform and features to ensure any water leaving the site does not adversely impact the surrounding environment or local water quality in creeks and waterways; and adding design features that utilise the water as much as possible;

Water Smart developments attempt to manage and utilise water in a similar fashion to the natural environment. This is best described through a review of the urban water cycle and how developments impact on how water enters and travels through an urban area.



Examples of Water Smart designs and devices

Figure 1 illustrates the various components of the urban water cycle for both the traditional and Water Smart Approaches. The size of the arrows depicted in **Figure 1** indicates the magnitude of the various elements within the water cycle, so for instance, storm water flows are significantly larger in a traditional development as opposed to a Water Smart development.

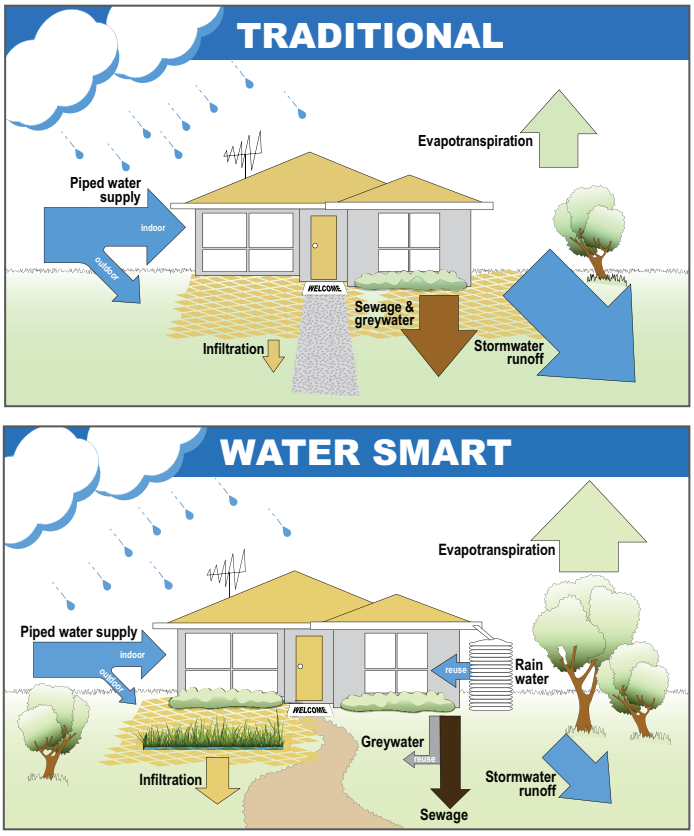


Figure 1: The urban water cycle for both Water Smart developments and traditional developments.

Traditional developments focus on collecting water and quickly moving it away through engineered systems like concrete stormwater drains, and provide for limited infiltration or re-use.

The increased water runoff and lack of vegetation in traditional developments cause increased pollution to enter waterways which has a detrimental impact on sensitive aquatic ecosystems.

Traditional style developments also disconnect surface water from groundwater, resulting in lowering of groundwater volumes and creating detrimental impacts on aquifers, waterways and wetlands.

Water Smart developments influence the water cycle differently, as they slow water flows, pre-treat stormwater (reducing sediment and pollution loads) before it reaches waterways, and make water readily available in the environment through infiltration. The Water Smart approach aims to shift the "altered" water cycle back towards the natural state, and it is through management of rainwater and stormwater that the biggest gains can be made.

WHY CREATE A WATER SMART DEVELOPMENT?

There are a number of important drivers to planning and implementing a Water Smart development, they include:

Regulation – Introduced by the NSW Government, BASIX (the Building Sustainability Index), ensures homes are designed to use less potable water and are responsible for fewer greenhouse gas emissions by setting energy and water reduction targets. A BASIX Certificate is required to be submitted with any Development Application for a single dwelling or alteration. The inclusion of Water Smart features will greatly assist in satisfying this requirement.

Cost Savings – Water Smart developments provide the opportunity for cost savings at a number of levels:

- *Household savings* - Water Smart developments generally consume less water, due to water efficiency and grey water reuse, leading to lower water bills.
- *Local Authorities and Water Utility Savings* – Less investment into maintenance is needed by local authorities and water utilities as there is less need for costly rehabilitation works, and storm water flow management

Environmental Protection – Water Smart developments provide a multitude of benefits to the local built and natural environment such as

- *Reducing Waterway Pollution* - Integration of drainage systems into landscape features such as gardens, vegetated channels and open space, filters and detains stormwater runoff, reducing sediment and pollution loads for water eventually discharged to the environment

Erosion Reduction – The effective management of the small but more frequent rainfall events, reduces overall storm water flows, thereby reducing the occurrence of erosion.

- *Water Conservation* – Reduced demand for potable water through the effective use of rainwater tanks and water efficient appliances. Use of grey water and available water in the environment will further reduce consumption. Satisfying the NSW Government's BASIX requirement will result in potable water savings of approximately 40%.

Examples of Water Smart developments and devices

WATER SMART DEVELOPMENTS VERSUS TRADITIONAL DEVELOPMENTS

Below is a summary of the key differences with the use and management of water between traditional developments and Water Smart developments. The actual measures used to create these outcomes are depicted in **Figure 2.**

Can I retrofit an existing development to become Water Smart?

Converting or retrofitting an existing home to be Water Smart, presents more challenges than designing a Water Smart new home. Water supply and drainage systems, paved areas and landscaping are already established, and may have many years of useful life left.

Any renovation work involving replacement or renewal of drainage systems or landscapes need to carefully consider the options for installing Water Smart designs (such as rainwater tanks, porous paving, rain gardens, infiltration devices and other landscape measures). All residential renovations valued at $100,000 or more, must meet the BASIX mandatory water efficiency targets, so ensure you ask your architect or designer to carefully consider all options available. More information on BASIX is provided in the following sections.

WATER SMART DEVELOPMENT	TRADITIONAL DEVELOPMENT
Decentralised potable water collection, transportation and treatment system.	Centralised potable water collection, transportation and treatment system.
Rainwater treated as a 'resource' and captured for use, or allowed to infiltrate to the groundwater.	Rainwater treated as a 'nuisance' and transported from the site as quickly as possible in concrete drains and pipes.
Slow water movement allowing detention, filtration and infiltration.	Fast water movement with limited filtration opportunities and high erosive potential.
Urban stormwater is managed through a "treatment train" approach utilising various measures that target different pollutants and flows	Urban stormwater is managed at "end-of-pipe" resulting in large and expensive systems.
Utilises natural vegetated systems to manage water volume.	Utilises built drainage systems (pits and pipes) to manage water volumes.
Low pollutant loads entering water ways which reduces impacts on the natural environment.	High pollutant loads entering water ways, potentially leading to excessive plant and algae growth and de-oxygenation of water ways.
Slow stormwater flows with limited erosion and vegetation loss.	Increased flow and force of stormwater increasing erosion and vegetation loss.

Examples of traditional design

Examples of Water Smart measures

Figure 2: Comparison between Water Smart measures and traditional design.

WATER SMART MEASURES AT A GLANCE

A number of Water Smart designs and devices are available for use in developments. Once designers have an understanding of the development needs and the site constraints, appropriate Water Smart measures can be incorporated in the development designs.

General guidance on the following Water Smart measures are included in this Practice Note series (see **Figure 3**).

- Vegetated Drainage Devices – Practice Note 5
- Water Smart Gardening – Practice Note 6
- Porous Paving – Practice Note 4
- Infiltration Devices – Practice Note 3
- Rainwater Tanks – Practice Note 2
- Waste Water Reuse – Practice Note 7
- Groundwater Management – Practice Note 8

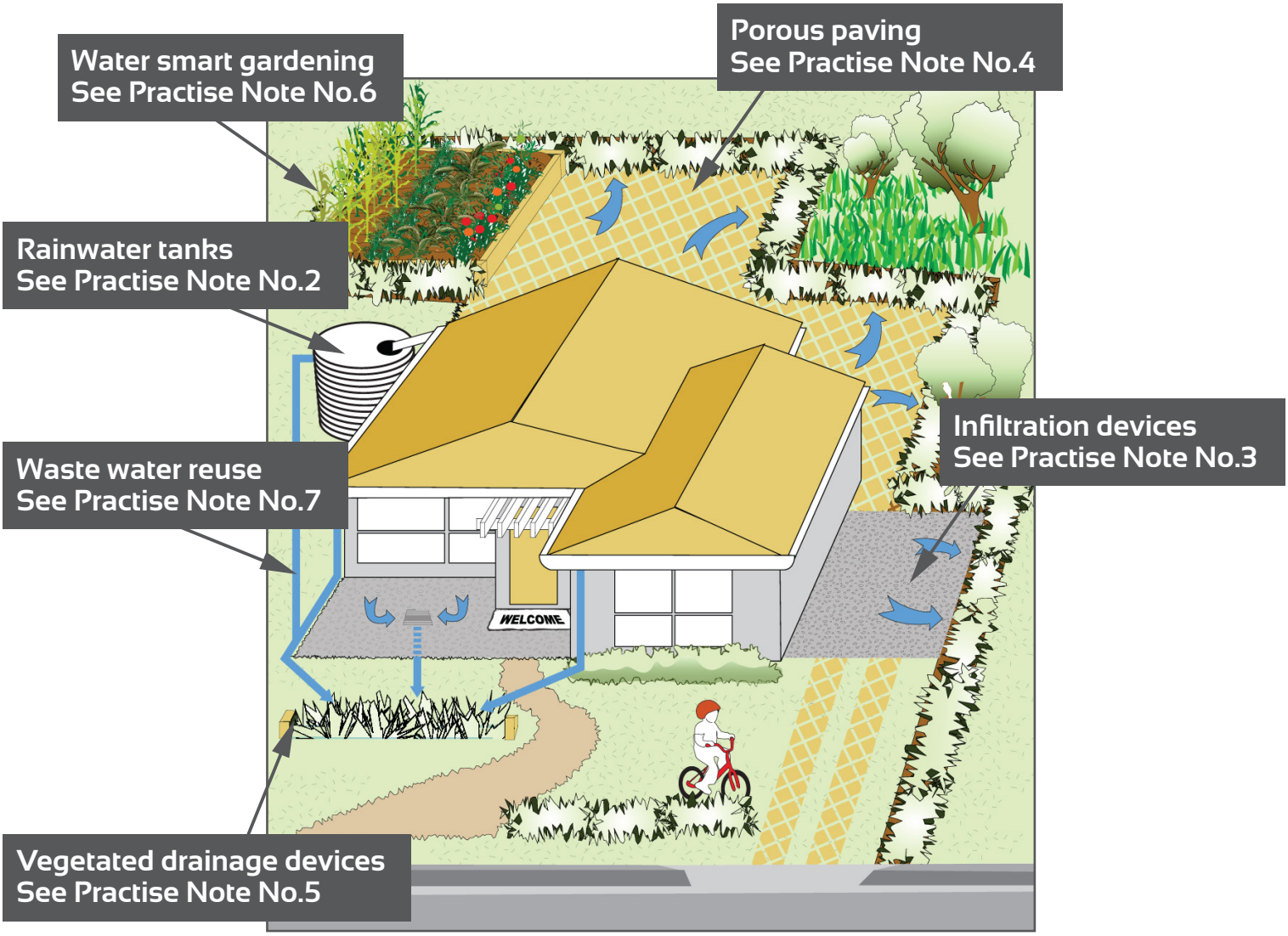


Figure 3: Depiction of the Water Smart Measures suitable for use on a lot scale and reference to their guidance Practice Notes.

PLANNING A WATER SMART DEVELOPMENT

There is enormous scope for incorporating Water Smart designs into new developments. If designed as part of an overall site strategy, a Water Smart development can be cheaper to build and maintain in the long term, than a traditional development, particularly when long-term water costs and environmental impacts are considered. Ask your architect or designer to carefully consider the options.

Since 2004 all new homes (both houses and units) need to comply with mandatory water and energy efficiency targets – requiring up to 40% reduction in water use some areas. Effective planning for Water Smart developments will require the following activities:

1. **Assess your site and development** - It is important to undertake a detailed site assessment to determine the best design approach to different features. Prior to selecting Water Smart measures, or determining where to place buildings, driveways and other structures, it is important to gain an understanding of the following issues:
   a. landform features (topography and natural features)
   b. surrounding environments (bushland, water ways)
   c. local climate (rainfall, prevalent wind directions, aspect of lot)
   d. development needs (water consumption calculations)

Conducting a site assessment will also provide the base information required to prepare a 'soil and water management plan' or 'erosion and sediment control plan' necessary with most Development Applications.

2. **Review Local and State planning requirements**
   Each local council may have specific planning requirements in relation to Water Smart designs. It is advisable to contact your council's customer service centre and ask to speak to the duty planner to receive advice appropriate to your development. The local controls are likely to be found in the relevant chapters of the council's Development Control Plan (DCP) and supporting guidelines.

   In addition to DCP requirements, developments also need to incorporate the Standards set out in BASIX (previously discussed) and the NSW Housing Code, into any development designs. The NSW Housing code is an alternative to the traditional development application (DA) process potentially saving home owner's time and money. There are certain controls on the inclusion of rain water tanks and management of stormwater if this code is used. Refer to Useful Websites for links to relevant Government Departments.

3. **Apply the principles of Water Smart design** - Water Smart design focuses on the capture, use and treatment of water onsite, through natural systems where possible. The key principles of Water Smart design are summarised below and are explained over the page:
   a. Treat stormwater to improve water quality
   b. Reduce stormwater flows into downstream environments
   c. Water conservation
   d. Minimise waster water and sewage flows

4. **Consider drainage design** - Transferring key principles into a working drainage design is the key to Water Smart Approach. Consideration of drainage issues and stormwater management in initial stages of design enables the integration of Water Smart measures without sacrificing space whilst also minimising costs.

Specific guidance and drainage design issues, including development of a treatment train, is explained in the following sections.

Example of drainage design for a large house (Source: McIntosh grounds maintenance).

WHAT TO INVESTIGATE WHEN CONDUCTING A SITE ASSESSMENT

Your site assessment, depending on the development's location and scale, may need to include information on each of the areas of consideration discussed below. Development in highly modified environments will not require as much investigation and documentation as compared to larger development sites or development in environmentally sensitive areas.

For assistance in determining the level of investigation and documentation contact your local council customer service officer and ask to speak with the duty planner. The findings of the investigation should be documented clearly on site plans and supporting documentation such as statement of environmental impacts, soil and water management plan, erosion and sediment control plan.

Landform

Topography is critical to the design and layout of buildings, stormwater controls and drainage. Plans and documents should display the following:

- Contours (1 metre intervals), survey benchmarks and areas of steep slope (>20%)
- Existing natural features (cliffs, rock outcrops, depressions, water courses)
- Orientation of site (identify North and South-facing slopes)

Water

Understanding the natural or modified water flow and drainage patterns of the site is vital. Plans and documents should display the following:

- Sources of water flowing onto the site and quality (if known)
- Drainage patterns, areas of concentrated run-off, ponding, flood prone land
- Adjoining creek or river bank "riparian" zones (the legal riparian zone is within 40 metres of a water way or creek)
- Location of groundwater table (see Practice Note 8)
- Characteristics of the downstream catchment (e.g. bushland creek or a constructed stormwater drainage channel, waterway, natural wetland, lake, channel
- Nature of flow to and from the site i.e. whether it is dispersed or concentrated
- Ephemeral drainage features such as dry gullys or soak areas
- Locate stormwater infrastructure, determine size and levels of pipes, pits, outlets, kerb, formed or unformed street drainage etc

Soils and rock

Plans and documents should display the following:

- Depth of topsoil and subsoil stratum
- Depth to bedrock
- Soil permeability and dispersability
- Soil condition, pH, fertility, whether it has been compacted, cut or filled
- Erosion problems, contamination, potential acid sulphate soils or salinity

Plants and vegetation

Undertake a tree and/or bushland survey, noting any significant species, weed species and threatened or endangered species. The survey should also note any plant species that are indigenous to the local area and would grow well on the site.

At a minimum, the following should be displayed on plans and documents:

- Existing individual trees, stands of trees and massed shrub planting - show height, spread, condition and species name (common and scientific)
- Trees listed as 'significant' on council register
- Existing ground levels around the base of trees
- Weed species present, extent of weed infestation
- Any threatened species or ecological endangered communities (EEC) present on the site or nearby land - refer to the local council for information
- Identify natural wetlands (including ephemeral) and sensitive vegetation such as salt marsh
- Identify trees and vegetation proposed to be removed

Wildlife

Documentation should include, at a minimum, details on:

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

Climate

Plans and documents should clearly note the following:

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

Existing site features
Plans and documents should note the following:

- 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 landform, (such as rock ledges)
- Any archaeological and heritage sites present, and details of each site with comment on the ability / permissions, if any, to modify or impact on the sites

Services
Plans and documents should note:

- Any easements, rights-of-way and their restrictions
- The location of existing overhead and underground utility services (electricity, gas, telephone, water, sewer and stormwater drainage lines, inlets and collection points)

Adjacent land
Development applications are assessed on the impact they have on adjacent properties, as such it is important to note the following (and include on plans and documents where appropriate).

- Identify water courses, flow paths and drainage entering and exiting the site
- Location and uses of adjacent buildings
- Rooftop ridge levels and floor levels of adjacent buildings
- Potential for shading on adjacent properties
- Street frontage features, such as street trees, poles, kerb crossovers, gutters bus stops
- Potential sources of nuisance dust or noise, such as flight paths, main roads, railway lines, quarries or mines

Planning controls
Assessment documentation should include details on the following:

- Planning objectives, zoning, design criteria, lot size, site coverage and density controls, and other provisions in local environmental plans and development control plans
- Restrictions on development due to hazards (such as flooding, landslip, land contamination)
- Controls on removing vegetation or trees or on earth-works
- Building setbacks, building envelopes, height restrictions, view corridors

THINKING WATER SMART, DESIGNING WATER SMART

Following the 'site assessment' process (described above), it is possible to gain a greater understanding of how your proposed development can be designed to work with, and take advantage of, natural landforms and features to be Water Smart. The site assessment in essence identifies the constraints and opportunities of a site to efficiently make use of any water in the environment.

By considering the findings of the site assessment, and being guided by some basic design rules, it is possible to develop a design and construction plan, which limits disturbance of the environment and neighbouring properties both during construction and the ongoing use of the site.

Below are basic design rules to assist with the development of an integrated site plan.

Design Rule #1
Minimise disruption to landforms and drainage patterns

NSW Legislation requires developers and contractors to ensure no sediment or erosion leaves a construction site, due to the significant environmental damage that can occur from excessive sedimentation of creeks and rivers.

Example of hoe to maintain existing drainage patterns

ENVIRONMENTAL ISSUE	WATER SMART DESIGN SOLUTIONS
Soil surface disturbance creates an immediate potential for: • Loss of topsoil by wind and water erosion • Sediment to be carried away and deposited down-stream • Long term changes to the pattern of runoff and in-filtration for established areas of vegetation, creeks, watercourses and wetlands thereby causing irre-versible changes to natural systems • Sedimentation in creeks and drainage lines, which can reduce flow capacity, increase localised flood-ing, cause property damage and choke downstream waterways • Erosion in areas where wide shallow stormwater flows occur.	**During construction:** • Utilise appropriate sediment and erosion control measures such as silt fences, hay bales etc. to stop sediment leaving the property After construction: • Develop a planting plan that utilises species appro-priate grasses, shrubs and trees to provide natural capture and infiltration zones, as well as act to anchor top soils to be erosion resistant. • Utilise infiltration devices to capture and slowly release stormwater to the environment.

Design Rule #2
Minimise disruption to existing vegetation

Maintaining existing vegetation avoids many soil problems (discussed above) and weed management problems. Maintaining vegetation also helps to conserve biodiversity.

Left: Example of native vegetation

ENVIRONMENTAL ISSUE	WATER SMART DESIGN SOLUTIONS
• Damage to Endangered Ecological Communities (EEC) present on the site • Increased erosion from the removal of plants and root systems • Increased light levels on bare soil which encourages weed growth • Loss of biodiversity through the removal of top soils and the variety of plant species onsite. Plants provide vital habitat for many animals, including insects and lizards, that will act as a natural pest control. Removal of habitat may increase the likelihood of needing to utilise chemical pest control, which will ultimately reduce environmental health.	• Develop a site plan that maximises the retention of existing vegetation wherever possible. • Develop a landscaping plan that clearly utilises existing vegetation wherever possible eg native gardens, vegetated drainage devices • Develop a landscaping plan that incorporates the use of appropriate Water Smart devices to maintain the health of native plants and communities.

Design Rule #3
Minimise impacts on neighbouring areas

NSW legislation requires the reduction or elimination of impacts on adjoining allotments and nearby natural areas (bushland areas, creek lines, swamps, lakes, beaches and foreshores). Remember that impacts can occur both during and after construction.

Left: Example of neighbouring boundaries

ENVIRONMENTAL ISSUE	WATER SMART DESIGN SOLUTIONS
• Disruption to existing landforms and drainage patterns • Introduction of non-native or invasive species that do not match the surrounding environment. • Inappropriate disposal of waste generated by construction activities.	• Utilise naturally occurring landforms to manage stormwater and erosion. Where appropriate install infiltration devices in natural depressions to minimise site disturbance. • Develop a planting plan with advice from local councils or arborists to ensure species planted will not become a weed or spread unintentionally onto neighbouring lands. • Manage any construction wastes appropriately and ensure they do not modify any drainage paths whilst stored onsite.

Design Rule #4
Identify services and easements

Underground and above-ground services are common, particularly in public areas like city streets and developed areas but they can also occur in private property. Such services include water mains, sewer pipes, stormwater pipes, electricity, telecommunications and gas (see Figure 4) outlets. In many instances, services are protected by 'easements' and 'rights-of-way' which are identified on property titles and plans. Investigation of services prior to designing Water Smart Measures is necessary as the outcome of the findings may have a considerable impact on the design outcome. Services and easement information can be obtained from; your local council, or the Land and Property Information Authority (www.lpi.nsw.gov.au), or surveyor. For works on public land such as footpaths, road reserve and roadways, contact 'Dial before You Dig' service.

Figure 4: Excavation pipes that can significantly impact on Water Smart designs. (Source: RA SMIth Contracting).

Design Rule #5
Design to manage steep slopes

Steep slopes are an environmental issue because they enable significant, high velocity stormwater runoff, increasing issues of erosion, sedimentation and vegetation loss (see Figure 5). The use of landscape features such as contour banks, mounds, and grassed swales can reduce slope gradients and slow stormwater intensity.

Left: Example of house on steep slope (Image source: ArchitectureNow.com)

ENVIRONMENTAL ISSUE	WATER SMART DESIGN SOLUTIONS
• increased occurrences of erosion, sedimentation and vegetation loss	• use of landscape features such as contour banks, mounds, and grassed swales can reduce slope gradients and slow stormwater intensity. • establish ground cover (through regeneration of existing plant species or the use of reusable organic matting) immediately following construction activities or land disturbance

Design Rule #6
Design to minimise flooding and stormwater

Flooding occurs in low lying areas adjacent to minor streams, major waterways, lakes lagoons and estuaries. Urban drainage systems such as concrete channels and drainage pits are also subject to localised flooding. Contact your local council for detailed information about likely occurrence of flooding, the location of overland flow paths and suitable flood protection measures (including location, floor heights, building materials and flood proofing options).

Figure 6: In some situations, floodways and overland flow paths are required around the home. (Source: Lanai beach blogspot).

ENVIRONMENTAL ISSUE	WATER SMART DESIGN SOLUTIONS
• interruption to, or increase of overland flow paths. Overland flow paths are a defined area that convey surface water during heavy rainfall events and these are commonly located between houses and/or along roadways (see Figure 6).	• installation of swales, rain gardens and infiltration devices into flood ways and drainage paths.

WATER SMART DRAINAGE DESIGN

The key consideration when assessing drainage design for residential houses and units is to determine how the property drains i.e. does water fall and drain to the street kerb or does it drain to the rear of the property? Older properties and residential areas may utilise rubble drains for disposal of stormwater which are a form of infiltration. In new housing estates the stormwater connection point is generally managed by the developer and subdivision builder. For existing residential areas and redevelopments (knock downs) it is important to ascertain the nature and extent of the existing stormwater drainage connection point(s) as this will provide important design input when selecting appropriate Water Smart Measures.

Properties draining to the rear: In this instance it is common practice for a pit and pipe drainage system to be provided for connection - this is known as Inter-Allotment Drainage or IAD (see **Figure 7**). If an IAD system is not available for connection of house drainage (common in older areas) then alternatives for managing stormwater runoff is required and in this instance incorporating Water Smart measures greatly assists.

Properties draining to the street: If the property slopes to the road then stormwater is generally discharged to the kerb and gutter or open drain (see **Figure 7**).

In both cases above it is essential to establish the height of the connection point in relation to the site and the proposed location of drainage works and Water Smart measures. This information forms the basis for design. Through the implementation of Water Smart designs, stormwater runoff leaving the site is reduced resulting in smaller connections to the street or rear drainage.

Figure 7: House drainage can be connected to either the the street and kerb (left) or the rear of the property (right).

DRAINAGE DESIGN CONSIDERATIONS

In addition to the environmental issues investigated during the site assessment, professional advice should be sought on the following issues.

Adjoining properties

Active consideration of the direction of stormwater flows is required, as the redirection and concentration of stormwater onto neighbouring properties may constitute a nuisance, allowing affected property owners to raise a legal challenge (raised in Design Rule #3).

Public safety

Stormwater run-off from intense storm events can pose serious risks to life and property. The design of overland flow paths, onsite drainage systems and stormwater management measures on your property must ensure the safety of pedestrians, vehicles and property affected by them. Buildings and access ways should be located clear of overland flow paths, or designed to be compatible with the potential flood environment. Fencing and other obstructions located in a floodway should be designed to allow passage of concentrated surface flows so as to reduce flooding and damage potential.

Floor levels and freeboard

Floor levels should be designed to be above the expected water level of overland stormwater flow paths and flood events. Allowance also needs to be made for 'freeboard' - an additional vertical separation between the expected flood water level and the floor level - the value of which varies according to local conditions and the particular type of flood risk. Floor level and freeboard requirements can be obtained from your local council.

House drainage characteristics

It must be established during the site assessment phase whether the property drains to the street or to the rear of the property. The nature of the connection and the depth of pipe work will greatly influence the design of Water Smart features around the home. Water Smart measures to be incorporated into design.

There are a number of common Water Smart measures that can be utilised in developments, and different drainage plans will be required, depending on which are going to be included in the development plans. Common measures include:

- Rainwater Tanks (specific advice included in Practice Note 4)
- Infiltration devices (specific advice included in Practice Note 5)
- Porous Paving (specific advice included in Practice Note 6)
- Vegetated Drainage Measures (specific advice included in Practice Note 7)
- Water Smart gardening (specific advice included in Practice Note 8)
- Waste Water Re-use (specific advice included in Practice Note 9)

Different site conditions and constraints may preclude the use of certain Water Smart measures. The following guide for selection of appropriate Water Smart measures (see **Table 1**) can be used.

Consideration of the overall flow path of stormwater, from when it falls on the roof as rain till it flows in drains and channels into a downstream waterway, is required. This is considered a holistic approach that will ensure the Water Smart design is robust and cost effective.

STORMWATER TREATMENT MEASURE	Steep site	Shallow bedrock	Acid sulfate soil	Low permeability soils	High permeability soils	High water table / soil salinity	High sediment input	Land availability
Swales / buffer strips*	C	D	D	G	G	D	D	C
Bio-retention swales	C	C	C	D	G	C	C	C
Sediment basins	D	G	D	D	G	D	G	C
Bio-retention basins*	C	C	D	D	G	C	C	C
Ponds	D	C	C	G	D	D	D	C
Constructed wetlands	C	D	C	G	D	D	D	C
Infiltration measures*	C	C	C	C	G	C	C	C
Sand filters*	D	G	D	G	G	D	C	G
Gross pollutant traps	G	C	G	G	G	D	G	G

Table 1: Site conditions and appropriate Water Smart measures (source adapted from Moreton Bay Waterways and Catchments Partnership (2006)

* Indicates the Water Smart measure is suitable for use around a residential dwelling.
C: indicates the constraint may preclude use of the Water Smart measure
D: Indicates the constraint may be overcome by appropriate design
G: indicates that the issue is not generally a constraint for the Water Smart measure

TREATMENT TRAIN

Water Smart drainage design involves the development of a 'treatment train' specific to the development and site conditions. Generally development of a stormwater treatment train will require the inclusion of more than one Water Smart measure, as this is necessary to cater for various pollutants that are commonly found in stormwater and for the need to reduce stormwater runoff.

Treatment Train is the term used to describe a series of Water Smart devices used to capture, slow, direct and treat stormwater run-off. Each device in the treatment train may target specific issues such as high sediment loads or gross larger gross pollutants like leaves and litter.

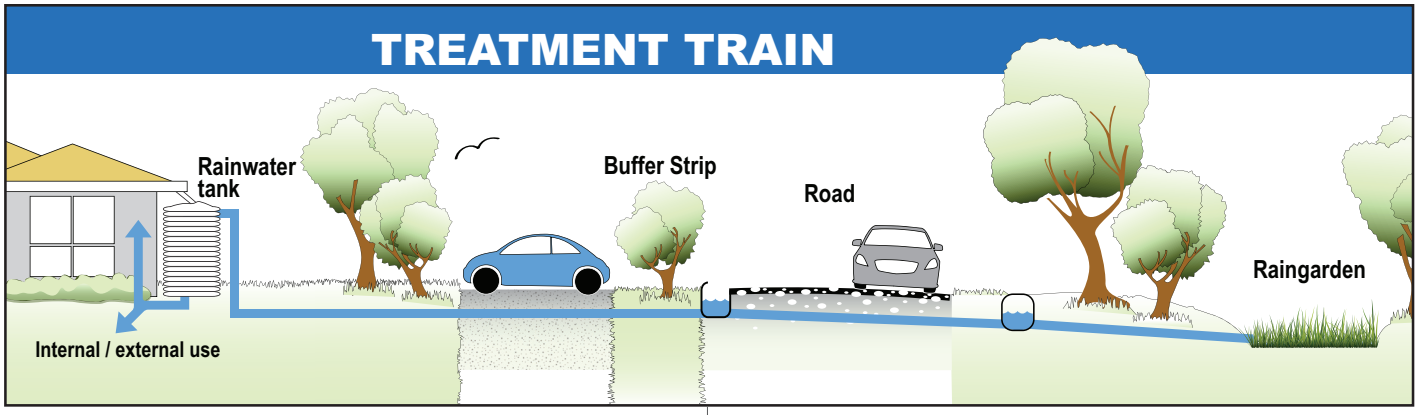


Figure 8: An example of a possible treatment train from house to creek

Figure 8 gives an example of a possible treatment train in a residential setting. Viewing from left to right; rain falls on the house roof and hard surfaces where it is captured either in rainwater tank and/or conveyed through an infiltration trench. The reduced, but treated flows then leave the site and combine with road runoff, which is treated through a roadside buffer and swale, and then final treatment and infiltration occurs in the "end of pipe" rain garden.

The treatment train concept can be equally applied at a finer scale. For instance, a rainwater tank treatment train should have the following components; a roof gutter collection system, screens to filter coarse matter like leaves and sticks, followed by a first flush diverter to remove the first portion of contaminated flow and of-course the tank which stores the water.

Analysis of a large scale treatment train is provided overleaf by examining the Murray's Beach Residential Estate project.

CASE STUDY

Large Scale drainage design Case Study Murray's Beach, Lake Macquarie.

Murray's Beach is a residential development located on the foreshore of Lake Macquarie. The development is considered a sensitive coastal area as it encompasses native forest habitat and occupies the coastal zone of Lake Macquarie. Development of the site was only permitted after careful site assessment and planning was undertaken, and the incorporation of various Water Smart measures within lots, streetscape and community land. Development of the site was only possible through careful planning and implementation of Water Smart measures.

Mature trees and native vegetation were largely retained, whilst existing drainage paths were preserved. A comprehensive Water Smart treatment train was employed with the aim to treat stormwater and minimise changes to the natural water cycle. An example from the final development plan is shown in **Figure 9.**

Figure 9: Design plans with the inclusion of Water Smart Measures (see rain garden label). (Source: Stocklands)

A brief explanation of the different components in the treatment train is provided below.

At source - A focus on source controls was necessary to satisfy the stringent water quality targets required by the approval authorities. Each house and community title lot manages stormwater via a number of measures including; rainwater capture and use, vegetated retention/infiltration basins and porous driveways. Each lot also has a defined building envelope, which ensures mature trees are retained and sufficient area is set-aside for infiltration and management of stormwater.

Lot scale Water Smart devices. (Image source: HCCREMS)

Street Scape - Buffer strips and vegetated drainage swales were installed as opposed to traditional concrete kerb and gutter systems. The use of roadside swales containing cobbles and native vegetation serves to filter coarser particles, increase infiltration and exposure to UV radiation and contact bio-films or rock surfaces. This all adds to improved water quality and reduced runoff. The swale's design is integrated with a traditional concrete pit and pipe system that conveys larger stormwater flows.

Roadside swale (Image source: HCCREMS)

End of pipe - Wetlands and bio-retention basins were installed at key locations within the development site. These Water Smart measures provide flow control and water quality treatment prior to discharge to Lake Macquarie. The rain garden basins also add to the visual amenity and overall natural character of the development.

Precinct Scale Water Smart device. (Image source: HCCREMS)

WATER SMART DRAINAGE DESIGN AROUND THE HOME

Lot-scale treatment train

Management of stormwater at a lot-scale i.e. the home can be achieved in various ways, although the most common method is through rainwater tanks and use of a Water Smart feature such as a rain garden or infiltration device.

Figure 10 provides a graphical representation of the capture of rainwater from the roof and storage in a tank where it is plumbed for indoor and outdoor re-use. Overflows from the tank are directed to an infiltration pit (rubble drain) or to the street drainage network. This example shows how a treatment train is effectively incorporated in the designs with minimal sacrifice of space or cost.

On site stormwater detention and retention

New developments can be required to specifically control stormwater run-off in order to minimise downstream flooding and overloading of the drainage network. This will require inclusion of adequate storage to detain stormwater and roof water runoff. Such devices are termed On-Site-Stormwater Detention (OSD) and they generally rely on storages to detain stormwater and then release it slowly to the drainage system once the storm has passed. Local Councils will advise if this is necessary.

Now with the emphasis on rainwater capture and use, onsite detention can be combined with retention (water re-use) resulting in an efficient and sustainable approach to the management of stormwater. **Figure 11** shows a schematic of a rainwater tank which in-effect can be used for on site detention. Studies by Coombes, Frost, Kuczera (2001) have shown that around 50% of the rainwater tank space can be used for OSD though this only applies if the tank is regularly drawn down through toilet flushing, irrigation and laundry use.

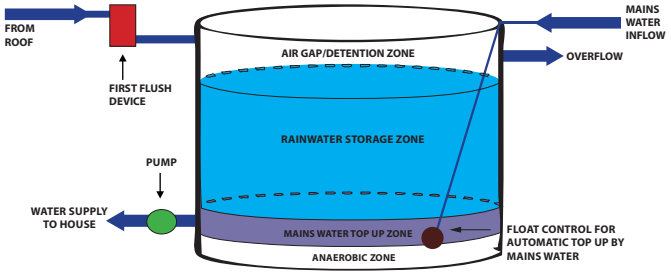


Figure 11: Configuration of OSD (source: Coombes, Frost Kuczera)

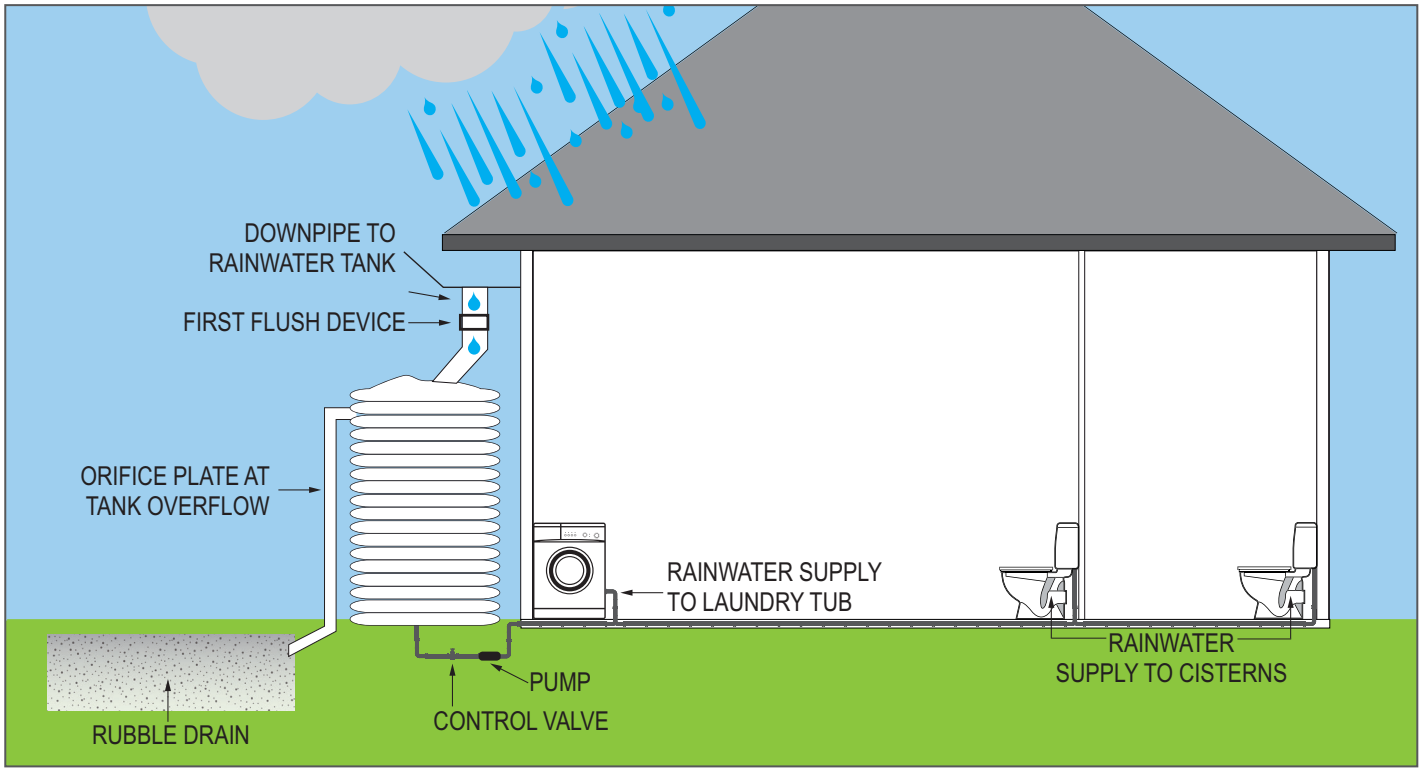


Figure 10: Management of stormwater around the home.

OSD can be included in housing developments in many ways. **Figure 12** shows stormwater storage in a proprietary system which can be located beneath a garden or courtyard area. When re-use is added to this storage, through irrigation and toilet flushing, then it becomes a cost effective and efficient way to manage stormwater at source.

Figure 12: Runoff storage units under a courtyard and garden during installation, and after (Image source: Atlantis)

Maintenance of Water Smart measures

Water Smart measures generally require maintenance to ensure the device continues to operate as intended. Maintenance requirements should be taken into account during design development as in many cases this may influence the selection of the most appropriate Water Smart measure. If maintenance work is difficult, complex or time consuming then it is unlikely to happen and this will result in failure of the design.

Maintenance should be divided into regular "minor" activities that may occur say annually and include; inspections, weeding, removal of sediment etc. Other maintenance tasks occur periodically and can be "major" in scope such as; renewal of pumps or filter media, repair of drainage pits and pipes.

Common maintenance activities that should be considered when undertaking Water Smart drainage design are mentioned below and illustrated in **Figure 13.**

- Routine inspections to ensure pipes, overflows and grates are not blocked with sediment and debris.
- Mechanical equipment such as pumps, valves and meters require inspection and occasional replacement.
- Removal of weeds and sediment build up in vegetated systems, whether by hand or machine for larger quantities.
- Replacement of filter media for vegetated drainage and infiltration measures when the lifespan is reached, which can be as short as 5-10 years depending on how regularly routine maintenance is undertaken and if the design was appropriate.

Figure 13: Maintenance activities can range from regular inspections (left) (Source: New Age Plumbing) to one-off tasks on large developments that may require specialised equipment (right). (Source: Micro machine earthworks).

USEFUL WEBSITES

BASIX: www.basix.nsw.gov.au/information/index.jsp
NSW Housing Code: www.housingcode.planning.nsw.gov.au

Educational information on WSUD, the water cycle, rivers and drainage; http://education.melbournewater.com.au/

Michael Mobbs sustainable housing, commercial and office projects: www.sustainablehouse.com.au

Michael's sustainable house at Chippendale: http://www.abc.net.au/science/planet/house/default.htm

Living Sustainably today: http://www.livingthing.net.au/index.htm http://www.environment.nsw.gov.au/sustainingourenvironment.htm

Living with Water – DVD by Landcom which can be downloaded at: http://www.landcom.com.au/content/publication-and-programs/water-sensitive-urban-design.aspx

Developing Sustainable Places by Landcom. Water Sensitive Urban Design at Victoria Park, Zetland. Download brochure from: http://www.landcom.com.au/downloads/file/factsheets/DevelopingsustainableplacesFactSheet.pdf

Water Usage Calculator: http://stratco.com.au/products/rainwater_tanks/Calculator/rainwatertanks.asp or http://www.hunterwater.com.au/Save-Water/Water-Usage-Calculator.aspx

Sustainable development and water management: www.yourhome.gov.au and http://yourdevelopment.org/

Sustaining our environment: http://www.environment.nsw.gov.au/sustainingourenvironment.htm

Water for Cities and Towns by the CSIRO: http://www.csiro.au/science/Water-for-cities-and-towns.html

Centre for water sensitive cities: http://www.watersensitivecities.org.au/

Nature Conservation in NSW—Native animals, native vegetation, landscape and soils, threatened species, protected areas. Go to Department of Environment and Conservation: http://www.environment.nsw.gov.au/natureconservation.htm

Environmental Issues in NSW— Water , air, soils, erosion, pests and weeds, contaminated land: http://www.environment.nsw.gov.au/environmentalissues.htm

Land and Property Information including Land titles and valuation, Surveying and Maps go to; www.lpi.nsw.gov.au
Dial Before You Dig to locate above and underground services: www.1100.com.au, Ph: 0418 500 155, dpuiu@bigpond.com

Building and Sustainability Index for development in NSW : www.basix.nsw.gov.au

Water Efficiency Labeling and Standards (WELS) Scheme: www.waterrating.gov.au

Murrays Beach Estate by Stockland www.stockland.com.au/home-and-land/nsw/murrays-beach.htm

Murrays Beach Water Sensitive Urban Design—project and design information and images: www.urbanwatersites.info/

Urban Water by CSIRO: http://www.csiro.au/science/Urban-Water.html

Cooperative Research Centre for Catchment Hydrology: www.catchment.crc.org.au

Hunter Water Corporation—Saving Water Fact sheets: http://www.hunterwater.com.au/About-Us/Publications/Fact-Sheets/Fact-Sheets.aspx

Michael Mobbs sustainable housing projects: www.sustainablehouse.com.au

Sustainable development in the home www.yourhome.gov.au and Water Use http://www.yourhome.gov.au/technical/fs71.html

Sustainable development http://yourdevelopment.org/ and specifically Water Management: http://yourdevelopment.org/factsheet/all/cat/articledevtopics_6

Sustainable living http://www.environment.nsw.gov.au/sustainingourenvironment.htm

Water for Life: information on water efficiency, stormwater recycling, http://waterforlife.nsw.gov.au/

National Guidelines for Evaluating Water Sensitive Urban Design—Appendices summarises information on various Water Smart measures: http://www.environment.gov.au/water/publications/urban/water-sensitive-design-national-guide.html

Sustainable road design and stormwater management: http://www.wsud.org/tools-resources/

Educational information on WSUD, the water cycle, rivers and drainage; http://education.melbournewater.com.au/
Living with Water – DVD by Landcom which can be viewed at: http://www.landcom.com.au/content/publication-and-programs/water-sensitive-urban-design.aspx

Developing Sustainable Places by Landcom. Water Sensitive Urban Design at Victoria Park, Zetland. Download brochure from: http://www.landcom.com.au/downloads/file/factsheets/DevelopingsustainableplacesFactSheet.pdf

REFERENCES

Argue, J.R. (1986). Storm Drainage Design in Small Urban Catchments: a Handbook for Australian Practice. (Special Report No. 34), Australian Road Research Board.

Argue, J.R. (2002). On-site Retention of Stormwater: Introduction and Design Procedures. Urban Water Resources Centre, University of South Australia, Adelaide.

Coombes, Frost, Kuczera (2001). Impacts on Rainwater Tanks and On Site Detention options on Stormwater Management in the Upper Parramatta River Catchment. http://www.uprct.nsw.gov.au/sustainable_water/projects/rainwater_tanks.htm

HCCREMS (2007).Water Sensitive Urban Design for Catchments Above Wetlands. http://www.hccrems.com.au/Programs/Water/Urban-Water-Resources.aspx
Engineers Australia (2006). Australian Run-off Quality – A guide to water sensitive urban design.

Sainty G.R., Jacobs S.W.L (2033). Waterplants in Australia—A Field Guide. Sainty and Associates Pty Ltd
WSUD.org (2010). WSUD Interim Reference

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