WATER SENSITIVE URBAN DESIGN

PLANNING GUIDE

FINAL

Prepared for the Northern Territory Department of Planning and Infrastructure
GPO Box 2520
Darwin NT 0801

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1 INTRODUCTION

Urban development in the Darwin Region is occurring without appropriate consideration of its impact on the health of the region's waterways. In order to manage the impacts of new development and redevelopment on Darwin Harbour, the Territory Government is seeking to implement Water Sensitive Urban Design (WSUD) within all new development

To facilitate the adoption of WSUD, the DPI (Department of Planning and Infrastructure) in conjunction with NRETA (Department of Natural Resources, Environment and the Arts) have secured a grant from the Australian Government's Coastal Catchments Initiative (CCI) program to develop a WSUD Strategy for Darwin Harbour. The WSUD Strategy will create an enabling environment to ensure commitment to urban water cycle and stormwater management through a WSUD framework for Darwin. The WSUD framework will link policy to locally relevant technical design guidelines, manuals and industry tools. Development of the Strategy represents a substantial project as defined by the Workplan provided in Table 1 below.

1.1 Purpose of this Document

This document has been developed as part of Task 16 (Stage 6) of the Workplan. It is intended as a guide for developers, consultants, local councils, the Development Consent Authority (DCA) and the Department of Planning and Infrastructure (DPI) on how to implement WSUD as part of the development process. This document builds on previous work undertaken as part of the WSUD Strategy project:

- WSUD objectives for new development have been put forward in the "WSUD Design Objectives for Darwin" Discussion Paper (EDAW, October 2007).
- The "Recommendation for the Incorporation of WSUD within existing Legislation and Policy Framework" Discussion Paper (Draft, EDAW, April 2008) recommends how to include WSUD objectives in the planning and legislative framework .
- A framework for implementing WSUD as part of new and existing development has been constructed in the "WSUD Implementation Framework for Darwin" Discussion Paper (Final Draft, EDAW, March 2008).
- Applying WSUD principles to different development types was discussed in the "WSUD Objectives and Options for Various Development Types" Draft Discussion Paper (EDAW, April 2008).

This document brings together this information into a succinct guide on implementing WSUD in the development process, from the initial feasibility investigations to Development Application submission.

At this stage in the development of the WSUD Strategy for Darwin Harbour, the main focus is to implement WSUD in new greenfield subdivisions. This document explains how to prepare a WSUD Strategy for a new subdivision, including:

- The WSUD objectives that apply to new greenfield development.
- The options available to meet the objectives, including water conservation and stormwater treatment measures.
- Where to find more information on implementing WSUD options.
- Assessment of WSUD Strategies as part of the development assessment process.

Table 1: WSUD Strategy for Darwin Harbour - Workplan

STAGE	TASK #	Activity
1	1	Refine workplan
	2	Establish project working group.
2	3	Develop WSUD Strategies for case studies in suitable format for communication and identify case studies for sub-catchment scale application of WSUD treatment train. • *WSUD Showcase - Bellamack residential sub-division conceptual WSUD Strategy is complete* • *Design development of Bellamack WSUD Strategy is about to commence (see Task below)*
	4	Identify potential WSUD objectives for Darwin • *Stakeholder workshop held on 14th and 15th June 2007* • *WSUD Objectives for Darwin - Discussion Paper (EDAW, Oct 2007)*
	5	Critical Analysis of WSUD/Stormwater Treatment Options for Darwin • *Stakeholder workshop held on 14th and 15th June 2007* • *Water Sensitive Urban Design Stormwater Treatment Options For Darwin - Discussion Paper (EDAW, Oct 2007)*
3	6	Prepare a stakeholder communication and consultation strategy (including establish website, fact sheets, presentations). *About to commence in collaboration with WQPP*
	7	Prepare and communicate a definition of WSUD within Darwin *About to commence in collaboration with WQPP*
	8	Review and report on policy, programme, technical and decision-support systems for WSUD in Australia (including any barriers to uptake of WSUD and respective jurisdictional responses). About to commence in collaboration with WQPP
	9	Identify potential barriers to uptake of WSUD in the NT. Develop strategy to address barriers. *Much of this work is complete as part of the Darwin Harbour Regional Plan of Management and WSUD projects elsewhere in Australia. This is to be summarised in a discussion paper. If the Working Group identify the need to further define the barriers a stakeholder workshop and interview process will be undertaken.*

STAGE	TASK #	Activity
4	10	Develop WSUD Strategies for case studies in suitable format for communication and identify case studies for sub-catchment scale application of WSUD treatment train. *WSUD Showcase - Complete design development of the Bellamack WSUD Strategy* *Identify and scope work associated with "retrofit" WSUD case study*
	11	Prepare detailed workplan for development of NT WSUD policy, objectives, design manual, performance standards and decision-support tools.
5	12	Prepare draft NT WSUD policy and objectives for Darwin including understanding existing legislation, workshops etc.
	13	Assess application of WSUD objectives and management practice options across a range of development situations and/or catchment-scale treatment-train & confirm set of objectives.
	14	Undertake consultation of draft WSUD policy and WSUD objectives to stakeholders and barriers to WSUD.
6	15	Define requirements of WSUD Guidelines and Tools (workshop to define design needs in detail and assess whether exiting guidelines satisfy this need)
	16	**Document Draft WSUD Guidelines and Tools in including High Level and Conceptual Design Guideline, Technical Design Guideline and Design Tools (MUSIC Guidelines, Deemed to Comply Solutions, Standard Drawings etc.)**
	17	Prepare Draft WSUD decision support tools for Darwin Harbour, consistent with WQPP, linking policy, objectives and guidelines
7	18	Undertake stakeholder consultation of WSUD Policy, WSUD design manual and performance standards, and decision support Tools and seek approval.
	19	Finalise WSUD design manual, decision support tools and performance standards
8	20	Seek NT Government approval for WSUD Policy, WSUD design manual and performance standards and decision support tools.
	21	Develop and publish stormwater management plans for key subcatchment in Darwin to illustrate application of WSUD Policy/Framework, design manual and decision support tools.
9	22	Develop an implementation strategy for incorporating policies and provisions for WSUD within NT planning policies, strategic plans and development approval processes as well as local government instruments
	23	Ongoing communication and website management
	24	Capacity Building and Training including government, local authorities, developers and industry practitioners
10	25	Incorporate policies and provisions for WSD into NT government planning policies, strategic plans and development approval processes, as well as relevant local government instruments. Implement agreed strategy to address barriers to uptake of WSD.

1.2 Outline of this Document

This document is organised into the following sections:

- Section 2 summarises the different types of development to which WSUD may apply, and explains why greenfield subdivisions are the initial focus of the Darwin Harbour WSUD Strategy
- Section 3 includes the WSUD objectives for new development, and explains the purpose and intent of each objective
- Section 4 explains what WSUD implementation will mean in greenfield subdivisions, in terms of the water conservation and stormwater management measures required
- Section 5 is a guide to preparing a WSUD Strategy for a new residential subdivision
- Section 6 is a guide to assessing a WSUD Strategy as part of the development assessment process

2 WHEN IS WSUD REQUIRED?

The long-term goal of the WSUD Strategy for Darwin Harbour is the broad-scale adoption of WSUD in all new development and redevelopment in the region. The "WSUD Implementation Framework for Darwin" Discussion Paper put forward a framework for WSUD implementation, including two major development types – new and existing development.

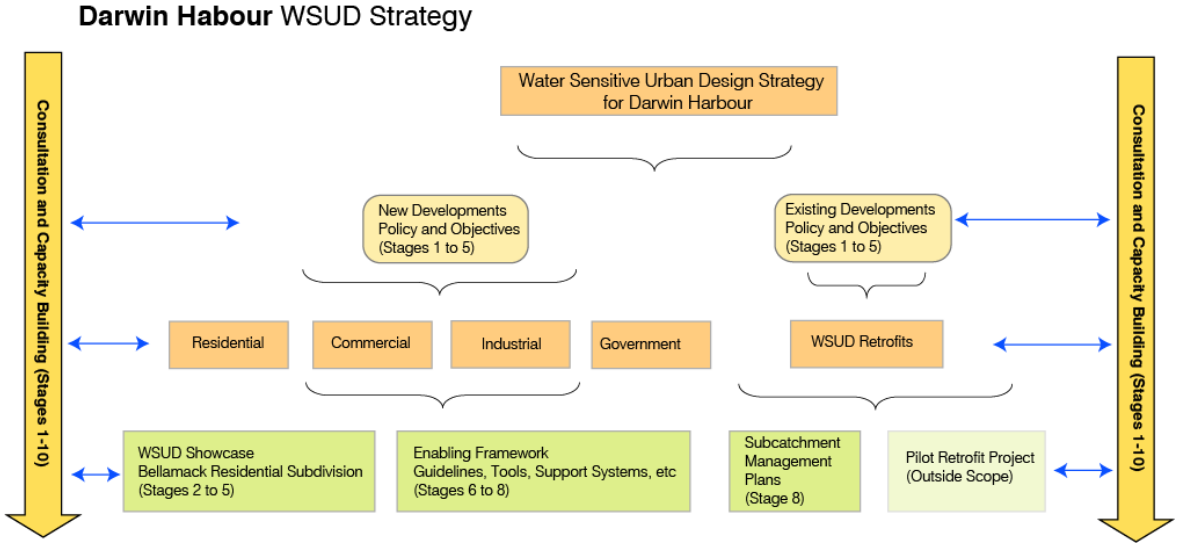

Figure 1: Broad framework for application of WSUD to various development types

The "Water Sensitive Urban Design Objectives and Options for Various Development Types" Discussion Paper identified the following development types:

- Single detached dwellings and low density attached dwellings (e.g. dual occupancy dwellings, townhouse development, etc.)
- Medium and high density residential development (e.g. unit blocks, high rise apartment buildings)
- Commercial and industrial development (e.g. warehouses, factories, retail development)
- Public sector development, including buildings and public open space
- Transport infrastructure (e.g. roads, car parks)

Recommendations on the adoption of WSUD targets for these differing development types is shown in Table 2. At this stage in the development of the WSUD Strategy for Darwin Harbour, the focus is on implementing WSUD in large greenfield subdivisions. This type of development typically includes single dwellings, areas of public open space including parkland and sporting fields and typically includes small proportions of mixed and multi-purpose uses as well as transport infrastructure. Some subdivisions are also predominantly commercial and industrial development. The size of greenfield subdivisions is usually greater than 2 hectares.

Some of the key reasons for the initial focus on greenfield subdivisions are:

- The lack of WSUD examples and practice in the Darwin region warrants a narrow focus on large developments whereby WSUD can be trialled and controlled to ensure its success.

- Experience elsewhere in Australia has shown that greenfield subdivisions have been one of the most successful arenas in which to implement WSUD
- The large scale of greenfield subdivisions allows the use of specialists, including specialist WSUD consultants, in the planning and design process
- Greenfield sites often have the potential for significant impact on aquatic environments, as greenfield development often represents a significant change in land use, and the receiving environment may not yet have experienced any impact from urban development
- In comparison with existing urban areas, greenfield subdivisions often include more space for WSUD measures such as stormwater treatment systems. If WSUD is incorporated early in the planning process, suitable areas can be allocated to WSUD measures
- Often the government has a greater potential to influence the nature of development in large greenfield subdivisions than in small scale redevelopment

For these reasons it is recommended that greenfield subdivision development should be the initial focus of WSUD implementation in the Darwin region. As the Darwin Harbour WSUD Strategy progresses, WSUD can be encouraged in smaller developments and retrofit situations.

Table 2: Recommendations on WSUD Objectives for different development types.

Development Type	WSUD Objective	
	Stormwater Quality	**Potable Water Conservation**
Single Allotment	× - not recommended in the short to medium term	✓- recommended
Medium and High Density Residential	✓- recommended in the medium term	✓- recommended
Large Residential Subdivisions	✓- recommended	✓- recommended
Commercial and Industrial	✓- recommended	✓- recommended
Government Buildings	✓- recommended in the short to medium term	✓- recommended
Infrastructure	✓- recommended in the short to medium term	NA

3 WSUD OBJECTIVES

The principles of WSUD are to:

- protect and enhancement of natural water systems (creeks and rivers etc.);
- treat urban stormwater to meet water quality objectives for reuse and/or discharge to receiving waters;
- match the natural water runoff regime as closely as possible (where appropriate)
- reduce potable water demand through water efficient fittings and appliances, rainwater harvesting and wastewater reuse;
- minimise wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and;
- integrate stormwater management into the landscape, creating multiple use corridors that maximise the visual and recreational amenity of urban development.

To facilitate the implementation of the WSUD principles a series of performance targets define the specific outcomes that a development is to meet. For Darwin these objectives were identified at by a workshop involving industry experts and local planners, researchers and practitioners. The interim design objectives are summarised in Table 3.

Table 3: Summary of Interim WSUD Objectives

WSUD Objective	Performance Measure/Target
Potable Water Conservation	No quantitative potable water conservation objective has been specified, however a 20% water conservation target is considered technically feasible and is suggested as an interim target.
Stormwater Quality	Stormwater discharged from development areas to be treated in accordance with best practice: • 80% reduction in the mean annual load of Total Suspended Solids (TSS) • 60% reduction in the mean annual load of Total Phosphorus (TP) • 45% reduction in the mean annual load of Total Nitrogen (TN) • 90% reduction in the mean annual load of Gross Pollutants
Waterway Stability	It is recommended that a waterway stability objective is not adopted at this stage. Further technical investigation is required to refine and test the practicality and achievability of the objective.

These objectives will evolve in the future, as WSUD practice develops in the Darwin region. The "WSUD Implementation Framework for Darwin" Discussion Paper has recommended that these objectives be developed in the future as follows:

- Further development of an appropriate water conservation target, including an analysis of the technical and economic feasibility of a range of targets. This task involves an analysis of current water consumption data, the potential for demand management measures to reduce water consumption and the feasibility of non-potable water supplies such as rainwater tanks, aquifer storage and reuse and wastewater reuse.
- Further development of the stormwater quality targets and their application to various developments including industrial developments, high density urban residential developments and various government developments.
- Further development of technical and economic feasibility of a waterway stability objective.

For greenfield subdivisions being developed now, the interim objectives should apply.

4 WHAT DOES WSUD INVOLVE?

The WSUD objectives currently include potable water conservation and stormwater quality objectives. The following sections describe the type of activities that should be undertaken by subdivision developers as part of a WSUD Strategy that meets the potable water conservation and stormwater quality objectives. Specific WSUD measures are discussed in more detail in the "WSUD Practice Guide".

4.1 Potable Water Conservation

Potable water conservation can involve some relatively straightforward measures that are readily undertaken by individual households and businesses. For example, Power and Water have released some useful fact sheets for householders on:

- "How to create a water wise garden in the Top End"
- Choosing water efficient fixtures and appliances and using simple water saving practices around the home ("Green Guide")

A rainwater tank fact sheet could also be prepared on the basis of the "Rainwater Tank Discussion Paper" (Draft, EDAW, March 2008) and it would also be useful to provide information to businesses on key water saving measures they can undertake in their operations.

In addition, Territory Government and Power and Water are currently working with the SaveWater Alliance to establish a water conservation program. The program will provide a centralised information resource for anyone wanting to reduce water consumption while maximising economic or commercial opportunities and also provide access to water conservation products at reduced cost.

Subdivision developers can support these initiatives on the lot scale by:

- Providing fact sheets and other education materials to people who purchase lots
- Providing meaningful incentives to new landowners, such as:
    - Free water efficient shower heads and flow-reducing tap aerators
    - A voucher for low water use plants at a local nursery
    - Discounts on water efficient appliances, particularly washing machines and dishwashers
    - A discount on water efficient toilets

  The developer of a large subdivision may be able to negotiate such incentives with local suppliers or through the SaveWater Alliance water conservation program
- Encouraging the adoption of low water use gardens, water efficient fittings and appliances and rainwater tanks by incorporating these features into display homes

It has been estimated for typical residential development in Darwin that if gardens include some low water use vegetation, water-efficient fixtures are used inside the home and a 1-2 kL rainwater tank is installed and plumbed in to toilets and at least one of the laundry and/or hot water system, then the 20% potable water conservation target can be met. More details are available in the "WSUD Practice Guide" and the "Rainwater Tank Discussion Paper".

At the subdivision scale, there are additional opportunities for water conservation:

- Reducing the irrigation demand for potable water by adopting low water use landscapes in public parks and road reserves.

- Maximising the use of recycled wastewater and groundwater for non-potable end uses, in particular garden irrigation which constitutes 65% of residential water demand.

In a new subdivision when water supply infrastructure is installed, a dual water supply system can be installed to distribute both potable and non-potable water throughout the development. This is recommended whenever a suitable non-potable supply (such as groundwater or recycled wastewater) can be identified. Non-potable water may be used for landscape/garden irrigation and other outdoor uses, toilet flushing and laundry demands. Specialist advice should be sought to help identify an appropriate water source and design the infrastructure for treatment, storage and reticulation.

In preparing a WSUD Strategy for a new development, water conservation opportunities should be identified and documented. The development application should detail the measures to be undertaken and where possible, estimate the expected potable water savings.

4.2 Stormwater Quality

Meeting the stormwater quality targets will involve directing stormwater runoff to treatment systems. The "WSUD Practice Guide" includes information on:

- Vegetated swales and buffer strips
- Bioretention systems (vegetated soil media filters)
- Wetlands
- Gross pollutant traps
- Infiltration

WSUD emphasises the use of vegetated stormwater treatment systems integrated into the urban landscape. Treatment systems can be integrated into streetscapes, parks and other public open spaces. While some stormwater treatment systems can be implemented in private open space, the preference is normally to integrate stormwater treatment systems into public open space, along with other stormwater drainage infrastructure.

Specialist advice will be required to design stormwater treatment systems. At the planning stage, consideration should be given to suitable locations for stormwater treatment systems within the subdivision.

In streetscapes, treatment systems can be integrated into traffic calming bays, nature strips, landscaped verges and other vegetated areas. Some examples of streetscape bioretention systems are shown in Figure 2. Streetscape stormwater treatment systems are often defined by hard edges to protect them from traffic, but otherwise their design is flexible. They can be constructed in discrete cells or continuous systems (as in a median strip or linear verge). Stormwater treatment systems can capture and treat stormwater runoff before it enters the piped drainage system, and can be integrated into the landscape without the need to set aside an area dedicated to stormwater treatment.

Stormwater treatment elements can be incorporated into parks, at any scale from a small pocket park to a major regional park. Figure 3 shows some examples of bioretention systems and wetlands in urban parks. Stormwater treatment systems in parks can form landscape features as well as habitat and passive recreation opportunities. In major parks there is the opportunity to create large wetlands which can treat stormwater runoff at the downstream end of a significant urban catchment.

Figure 2: Streetscape stormwater treatment systems

Figure 4 shows some examples of stormwater treatment systems including wetlands and bioretention systems in plazas, walkways and building forecourts.

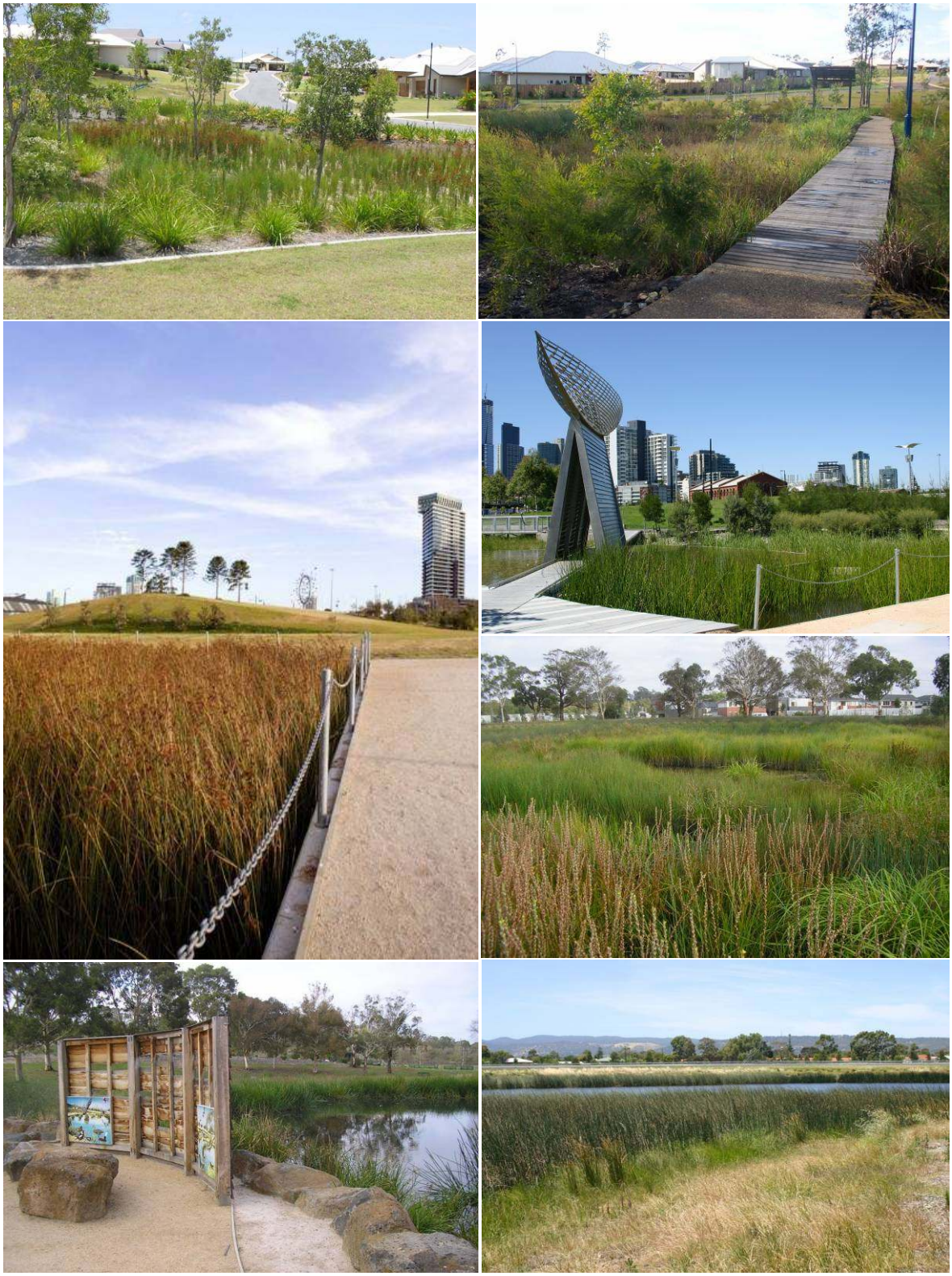

Figure 3: Stormwater treatment systems in parks

Figure 4: Stormwater treatment systems in plazas, walkways and building forecourts

5 INCLUDING WSUD IN THE DEVELOPMENT PROCESS

While potable water conservation and stormwater quality treatment have been presented as separate activities in Section 4, WSUD emphasises an integrated approach to urban water management, whereby potable water, wastewater, stormwater and groundwater are considered together so as to protect aquatic ecosystems. An integrated approach will help ensure that the water cycle is considered as a whole, in keeping with the fundamental principles of WSUD. Figure 5 shows how WSUD aims for an integrated approach at a number of levels:

- Integrated Water Cycle Management (IWCM), a key component of WSUD, emphasises the holistic management of potable water, wastewater, stormwater and aquatic ecosystems
- WSUD emphasises integration between IWCM and the urban/built form, emphasising that water cycle management is a key urban design consideration rather than simply a matter of provision of infrastructure
- WSUD should be integrated with other Ecologically Sustainable Development (ESD) considerations such as energy, land use and waste management

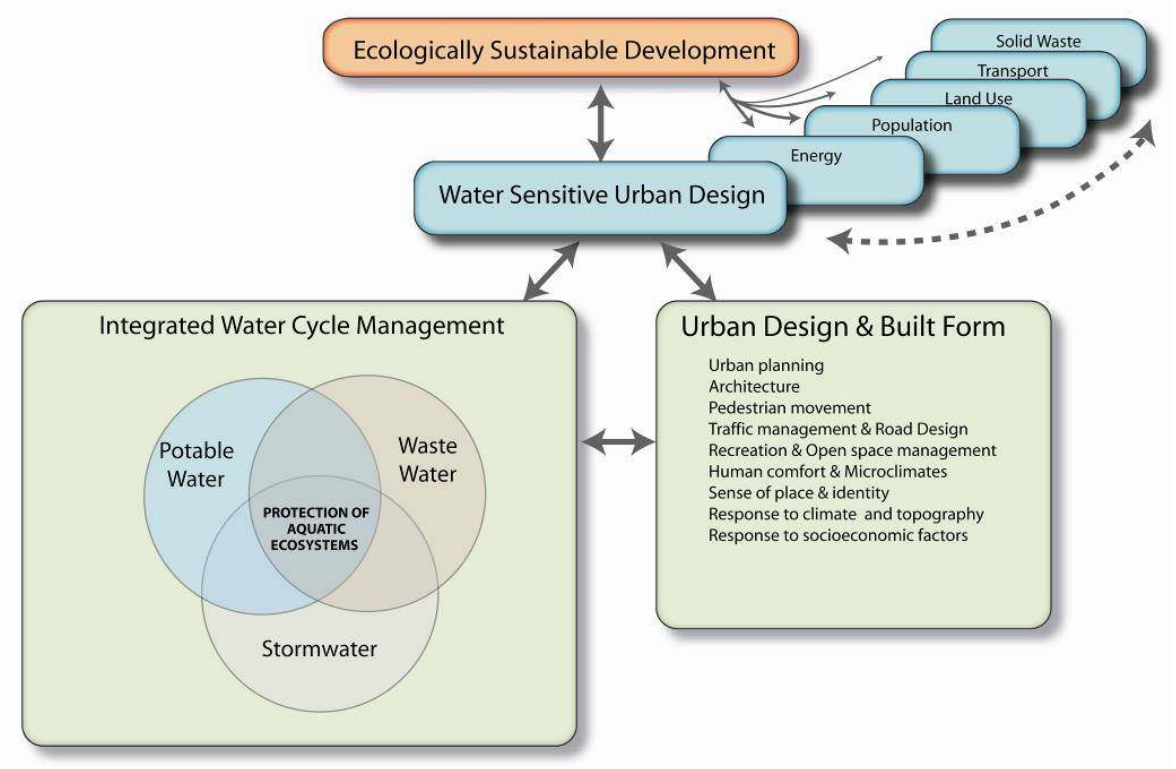

Figure 5: WSUD conceptual framework

In addition, WSUD aims for an integrated approach across a range of scales, from individual allotments to large subdivisions and major catchments. Table 4 shows how typical WSUD measures apply at different scales of development.

Table 4: WSUD implementation in different development types

WSUD measures		Single detached dwellings and low density attached dwellings	Medium and high density residential development	Commercial and industrial development	Public sector development		Transport infrastructure	Major subdivisions
					Buildings	Open space		
Potable water conservation	Water efficient fittings and appliances	■	■	□	■			
	Water efficient landscaping	■	□	□		■	■	□
	Rainwater tanks	■		■	□			
	Water recycling			□				■
	Stormwater harvesting and reuse					■		■
Stormwater quality	Gross pollutant traps			□				■
	Swales					□	■	■
	Bioretention systems					■	■	■
	Wetlands					■		■
	Infiltration	□				□		■

■ ideal WSUD measure for this type of development
□ recommended WSUD measure for this type of development
□ not a practical WSUD measure for this type of development

Table 4 highlights that individual lots can undertake several steps towards meeting the potable water conservation objective, including water efficient fittings and appliances, water efficient landscaping and rainwater tanks. However it is recommended that stormwater quality measures, including gross pollutant traps, swales, bioretention systems, wetlands and infiltration systems, are more effectively implemented at the subdivision scale, in public open space and/or road reserves. At the subdivision scale there is also the opportunity to undertake large scale potable water substitution, for example utilising wastewater recycling or stormwater harvesting and reuse.

Because of the emphasis on an integrated approach, WSUD is implemented most effectively when it is supported by an interdisciplinary team working together throughout the design process. This is illustrated in Figure 6.

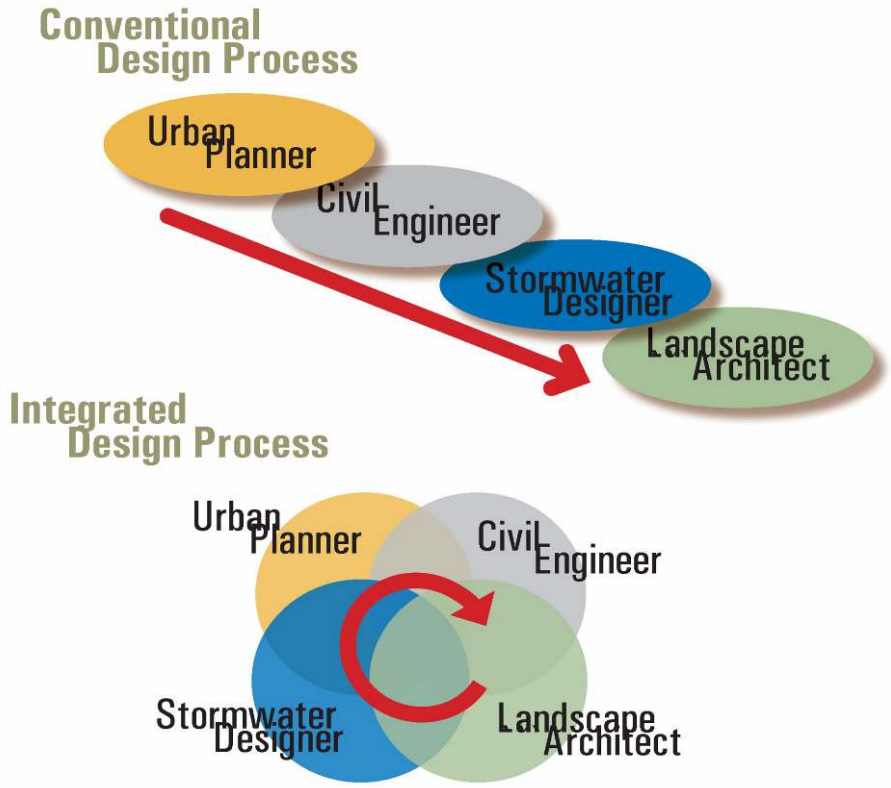

Figure 6: Conventional and integrated design processes

5.1 Supporting WSUD through the Development Process

As the WSUD Strategy for Darwin Harbour is focusing on the adoption of WSUD in subdivisions, there is a need to ensure the inclusion of WSUD requirements within the existing Territory planning framework. The discussion paper "Recommendation for Implementation of WSUD Strategy within Existing Legislation and Policy Framework" reviewed the relevant planning and water management policy and framework recommending, a number of options which are summarised below.

Adoption of Strategy within a Territory planning policy

- Option 1 - amendment of Section 51 of the Planning Act to include WSUD as an element that is to be considered as part of the development assessment and determination process by the consent authority (DCA).

Adoption of Principles and Objectives within a the Territory Planning Framework

- Option 1 - amend Section 4.1 and Section 4.2 of the Planning Scheme to include WSUD planning principles for both the Northern Territory as a whole, as well as principles relating to the Darwin Region and amend Section 11.1 to include specific WSUD Principles and Objectives that should be considered within subdivision design.

- Option 2 - amend Section 4.1 and Section 4.2 of the Planning Scheme to include WSUD planning principles for both the Northern Territory as a whole, as well as principles relating to the Darwin Region and amend Schedule 3 of the Planning Scheme to attached a linked but standalone WSUD Principles and Objectives document, pursuant to Section 2.8 of the Scheme.

Incorporation of Guidelines within the existing planning framework

- Option 1 – amend Section 3.9 of the Darwin City Council Development and Subdivision Guideline and Section 4 of the City of Palmerston Subdivision Guideline to include specific WSUD requirements (including numerical performance controls).

- Option 2 – attached a WSUD Guideline document that includes specific WSUD requirements (including numerical performance controls) as an additional appendix to both the Darwin City Council Development and Subdivision Guideline and City of Palmerston Subdivision Guideline.

WSUD should therefore be incorporated within the Planning Act, the Planning Scheme and local government guidelines.

5.2 Preparing a WSUD Strategy

The implementation of WSUD occurs at every stage of the development process. A WSUD Road Map has been developed for the Darwin Region, outlining the process of development from project initiation to completion. The Road Map highlights the supporting information available to government and the development industry to assist in meeting the required WSUD Objectives. The road map is shown in Figure 7.

The road map shows the WSUD guidelines and tools being developed as part of the Darwin Harbour WSUD Strategy to assist with the implementation of WSUD. Documents currently available are highlighted in blue.

One of the key steps in the development process is the Development Application. At the Development Application stage, the following WSUD guidelines are available:

- This “WSUD Planning Guide”
- A “Site Assessment Guide”
- A “WSUD Practice Guide”
- A “Stormwater Quality Modelling Guide”

In addition, the WSUD Strategy for Bellamack is available as an example of a WSUD Strategy for a greenfield subdivision.

The amendment to the Planning Act will define when there is a need to address WSUD objectives as part of a Development Application. In effect, this requirement will be triggered for large greenfield subdivisions. The suggested threshold is 2 ha area.

WSUD requirements at the Development Application stage should be addressed by developing a **WSUD Strategy**. Developing a WSUD Strategy broadly involves the following steps:

1. Establish the site context:
    - Climate
    - Natural capital
    - Local ecology
    - Landscape attributes (view lines, key site features)
    - Physical infrastructure (within the site and the broader region)
    - Development imperatives (e.g. demographic, density, land uses)
2. Interpret the physical setting, including the topography and drainage, geology, soils and groundwater, existing development
3. Establish key desirable outcomes / performance objectives, including objectives for the built and natural environment
4. Collaborate amongst an interdisciplinary team including urban planners, engineers, WSUD specialists and landscape architects to develop urban design and infrastructure solutions responsive to the above.
5. Critique and review solutions against key desirable outcomes (often competing uses of public open space)

Table 5 includes further detail on the contents of a WSUD Strategy. Table 5 also indicates where to find further information to assist in each stage of WSUD Strategy preparation.

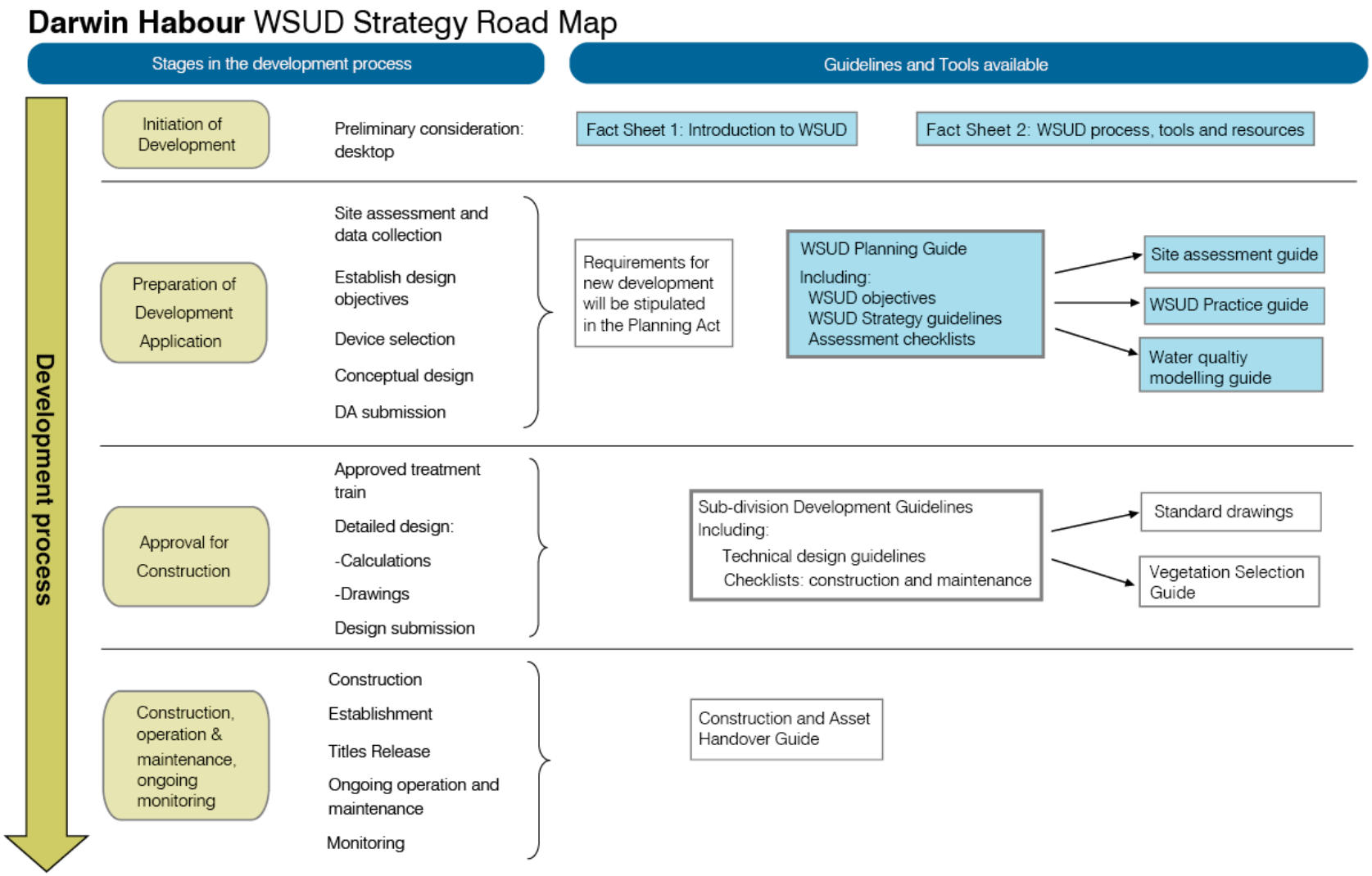

Figure 7: Road Map

Table 5: Contents of a WSUD Strategy, and tools and resources available

Outline contents	Details	Key tools and resources
Background information Summarise any background information available, including previous studies, concurrent studies, mapping data.	Some of the key themes to investigate are: ▪ Groundwater, geology and soils ▪ Drainage and flooding ▪ Ecology of receiving environments ▪ Regional planning ▪ Regional infrastructure (e.g. wastewater treatment)	*www.nt.gov.au/**nretamaps***
Proposed development Describe the proposed development at the site, including site boundaries, proposed land uses, densities, population, infrastructure, development staging.	This information will be needed to understand: ▪ Future water demands at the site ▪ Future stormwater runoff from each subcatchment at the site ▪ Potential areas available for stormwater treatment	
Constraints and opportunities Identify the key constraints and opportunities for water management on the site.	Analyse the site context: ▪ Review available climate data (rainfall and evapotranspiration) ▪ Identify natural capital which should be protected and enhanced on site ▪ Characterise the local ecology, including receiving environments ▪ Identify landscape attributes of the site ▪ Identify existing physical infrastructure in the region ▪ Summarise development imperatives Analyse the physical setting: ▪ Gather information on the topography, drainage, geology, soils and groundwater ▪ Map general drainage patterns, natural water courses and flow paths on site, as well as the location of all points/areas of discharge from the site.	*Site Assessment Guide*
WSUD objectives Identify the WSUD objectives which apply to the proposed development.	The Planning Act/Planning Scheme/Local Government guidelines should be consulted for a statement of the WSUD objectives that apply. Initially, these will include water conservation and stormwater quality objectives. In the future, a waterway stability objective may also apply.	*WSUD Planning Guide*

Outline contents	Details	Key tools and resources
Water conservation This section should demonstrate how the water conservation targets will be met.	Plan for integrated water cycle management through the site by conducting a water balance. The water balance for the development should determine baseline potable mains water consumption and stormwater flows and seek to optimise the three urban water streams. Investigate potable water conservation, wastewater reuse and stormwater harvesting opportunities and formulate a water conservation strategy.	*WSUD Practice Guide*
Stormwater quality This section should demonstrate how the stormwater quality targets will be met. It should include stormwater quality modelling results and identify the location, size and configuration of stormwater treatment measures proposed for the development.	It will be necessary to establish a stormwater quality model for the development to predict expected stormwater quality pollutant loads generated from development and to develop a strategy to achieve the Stormwater Quality targets. This section of the WSUD Strategy should include: ▪ Location, size and configuration of stormwater treatment elements to meet the appropriate targets. ▪ Summary of stormwater quality model results demonstrating compliance with the targets ▪ Details of key assumptions and parameters used in the stormwater quality model. Parameters are required for rainfall (rain station, time step and years of rainfall), source nodes (catchment areas, impervious fractions, soil parameters and pollutant mean and standard deviation values), and treatment nodes (including k-C* values for all pollutants and rationale for non standard pollutants). Where possible, modelling parameters should be correlated with monitoring data. ▪ For specific treatment nodes the following parameters also need to be supplied: gross pollutant traps — assumed sediment and nutrient removal rates bioretention systems — hydraulic conductivity, extended detention depth and filter depth ponds and wetlands — inlet pond size, permanent pool depth, extended detention depth and notional detention time swales — slope and vegetation heights	*WSUD Practice Guide* *Stormwater Quality Modelling Guide*
Integration with the urban design The WSUD Strategy should outline how WSUD elements will integrate with other elements of the urban design.	Co-ordinate the activities of WSUD specialists, urban designers, engineers and landscape architects to integrate WSUD elements into the development masterplan. This section of the WSUD Strategy may include: ▪ Site plans (and cross-sections, where relevant) including WSUD elements ▪ Drawings to illustrate conceptual layout of WSUD elements within the context of other site features ▪ Landscape plan	*WSUD Planning Guide*

Outline contents	Details	Key tools and resources
Monitoring and Maintenance Plan A monitoring and maintenance plan should outline how the WSUD elements will be monitored and maintained		
Costs The WSUD Strategy should include cost estimates for construction and ongoing maintenance	Prepare capital and operation and maintenance cost estimates of proposed water cycle management measures. Both typical annual maintenance costs and corrective maintenance or renewal/adaptation costs should be included.	

6 ASSESSMENT OF WSUD STRATEGIES

When a WSUD Strategy is submitted as part of a Development Application, the Development Assessment Authority and the local council will need to assess the WSUD Strategy to ensure that it will obtain the requisite WSUD objectives.

Just as the process of preparing a WSUD Strategy involves an integrated approach by planners, engineers, WSUD specialists and landscape architects, WSUD Strategy assessment should be undertaken with an interdisciplinary approach. An integrated assessment approach is illustrated in Figure 8.

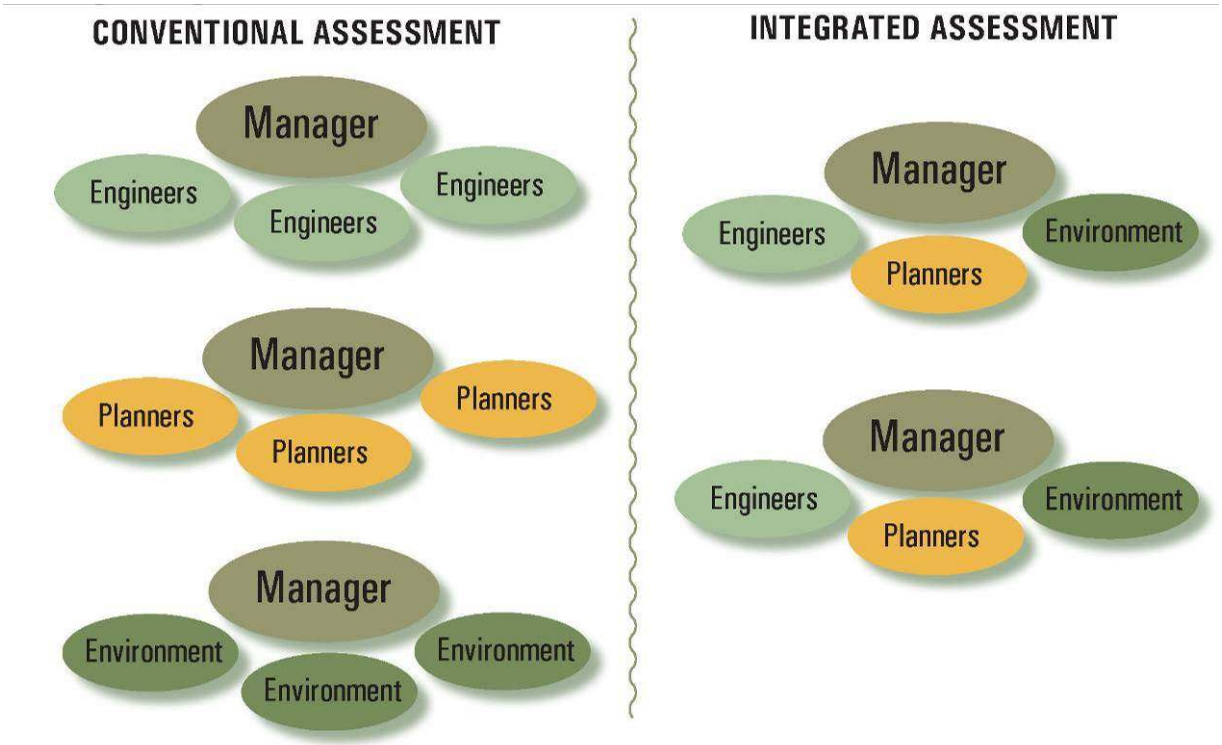

Figure 8: Conventional and integrated assessment

Assessment of a WSUD Strategy should aim to determine whether:

- the Strategy will meet the requisite potable water conservation and stormwater quality objectives.
- the Strategy is an appropriate solution for the site. The WSUD Strategy should respond to the physical setting and site context; address site constraints and build on opportunities.
- the WSUD Strategy is adequately integrated with the urban design, landscape strategy and civil infrastructure plans for the site.
- the proposed WSUD measures are technically feasible and appropriate.
- the WSUD Strategy will lead to an appropriate overall urban design outcome for the site.

Assessment is a task that will broadly involve two stages of assessment:

1. High level assessment by the Development Consent Authority
2. Detailed assessment by the local council, with input where necessary from NRETA, Power and Water, and other government bodies.

The assessment tasks involved in each of these stages is outlined in Table 6.

Table 6: WSUD Strategy assessment tasks

Element of the WSUD Strategy	High level assessment	Detailed assessment
Site assessment: – Background information – Proposed development – Constraints and opportunities	Does the site assessment consider climate, topography, geology, soils, groundwater and ecology? Does the site assessment address natural capital, landscape attributes, physical infrastructure and development imperatives? Have receiving environments been identified? Has a catchment analysis been done for the site?	Have the key site constraints been identified? Are sensitive receiving environments adequately protected? (NRETA) Do the proposed WSUD measures respond to the site constraints? Check the catchment analysis, including estimated impervious fractions Is the proposed strategy the best solution, given the site constraints and opportunities?
WSUD objectives	Are the appropriate WSUD objectives identified for the site?	
Water conservation	Does the WSUD Strategy include provisions for water conservation? Has a water balance been done for the site? Has the strategy investigated the feasibility of providing at least two or more of the following measures: – Incentives for potable water conservation – Dual reticulation – Recycled wastewater supply – Stormwater harvesting and reuse – Groundwater extraction Does the water conservation strategy show how a 20% reduction in baseline water demand can be achieved?	Check the water balance estimates for accuracy Are water conservation incentives appropriate? When the WSUD Strategy includes provisions for non-potable water supply: – Has a suitable water source been identified? – Is the water quality appropriate for the proposed end uses? – Are sufficient quantities available from the non-potable source? – Can any treatment, storage and distribution requirements be met? – Power and Water may need to review the proposal Check the estimated water savings

Element of the WSUD Strategy	High level assessment	Detailed assessment
Stormwater quality	Does the WSUD Strategy include provisions for stormwater treatment? Have suitable locations been identified for stormwater treatment measures? Has water quality modelling been undertaken to size stormwater treatment measures? Have key modelling assumptions been documented? Does the WSUD strategy show how the stormwater quality targets will be achieved?	Will the stormwater treatment train provide appropriate water quality outcomes? Have stormwater treatment measures been located and sized appropriately? Check water quality modelling assumptions Check concept design details for each stormwater treatment measure
Integration with the urban design	Is the WSUD Strategy consistent with the masterplan, infrastructure plans and landscape strategy? Are stormwater treatment elements located in public open space?	Will the WSUD elements contribute to a good urban design outcome for the site? Could the urban design outcome be improved with respect to the WUSD elements?
Maintenance Plan	Has a maintenance plan been included for stormwater treatment measures?	Are maintenance requirements adequate and realistic? Could the design be improved to facilitate maintenance?
Costs	Have capital, operation and maintenance costs been identified?	Are ongoing costs reasonable?

The assessment process can be facilitated by tools such as assessment checklists and auditing tools. These tools are outside the scope of the current WSUD Strategy for Darwin Harbour, however they could be developed in the future once the WSUD process is more common in the region and there may be a need to streamline assessment to some extent.