WATER SENSITIVE URBAN DESIGN

OBJECTIVES AND OPTIONS FOR VARIOUS DEVELOPMENT TYPES - DISCUSSION PAPER

FINAL

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

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Author(s):	David Knights, Courtney Henderson and Richard McManus
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1 INTRODUCTION

Urban development in the Darwin Region is occurring without appropriate management of the urban water cycle and its impact on the health of the region's waterways.

In order to manage the impacts to Darwin Harbour, particularly from new development and re-development areas, the Territory has identified that the implementation of Water Sensitive Urban Design (WSUD) on all new development zones is a key component. To assist in 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 Coastal Catchments Initiative (CCI) program to develop a WSUD Strategy for Darwin Harbour. The Strategy is to create an enabling environment to ensure commitment to urban water cycle and stormwater management through the development of a WSUD framework linking 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.

This discussion paper has been developed as part of Task 13 (Stage 5) of the Workplan. It is intended to identify to which development type WSUD objectives for Darwin Harbour are appropriate.

1.1 Outline of this Discussion Paper

The paper presents interim WSUD objectives which have been established for Darwin Harbour, and reviews a series of development types to determine which WSUD elements may be appropriate for each development type. Recommendations as to which objectives should be proposed for each development type are made. The development types assessed include:

- Single allotments up to six lots
- Multi-unit residential and subdivision
- Residential subdivision greater than six lots
- Commercial and Industrial
- Government Buildings
- Infrastructure

A consistent WSUD framework is applied to each development type, but opportunities and constraints are specific for each development type, requiring slightly different approaches for each category of development.

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.

2 WSUD OBJECTIVES APPROPRIATE FOR DEVELOPMENTS

A series of interim WSUD objectives have been proposed for the urban areas within the Darwin Harbour Catchment. These objectives define the specific outcomes that a development is to meet for stormwater quality, waterway stability and potable water conservation. The interim objectives are presented in Table 1.

Table 2: Summary of Interim WSUD Objectives

WSUD Objective	Performance Measure/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	A waterway stability objective is currently being assessed. Further technical investigation is required to set and test the practicality and achievability of any waterway stability objective.
Potable Water Conservation	A voluntary water conservation target of 20% is recommended. It is proposed to move to a mandatory water conservation target after further analysis of water conservation measures in the Darwin region. Education and incentives schemes will be adopted which focus on: • Reducing the garden irrigation demand for potable water by adopting low water use landscapes in public parks and encouraging low water use gardens on private allotments. • Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of treated wastewater and groundwater for non-potable end uses, in particular landscape irrigation which constitutes 65% of residential water demand. In support of the above initiatives, Territory Government and Power and Water are currently working with the SaveWater Alliance to establish a water conservation program.

NRETA is currently undertaking a project to revise these interim objectives to determine final water quality objectives based on the beneficial uses of Darwin Harbour. The water quality objectives will inform the analysis of sustainable loads for Darwin Harbour and it is likely that they will be similar to those identified in Table 1.

As can be seen in Table 1 a waterway stability management targets is still being assessed and so the assessment of each of the application of WSUD into each of the development types in the following sections focuses on and makes recommendations for stormwater quality and potable water conservation.

2.1 Development and Sub-catchment Management Plans

The Stormwater Management Strategy for Darwin Harbour recommends as one of the key actions the development of sub-catchment management plans (SMPs) for the Darwin Harbour. The SMPs will

- prioritise those sub-catchments which are the highest risk to the degradation of the water quality and Darwin Harbour
- identify management actions including structural and non-structural management measures
- estimate the timeframes and cost of actions

The relationship between SMP and development is shown in Figure 1. SMPs will be developed for priority catchments. These catchments are likely to catchments with sensitive receiving environments, rapid development occurring and catchments with existing high impacts.

New development, infill and greenfield, will occur in areas which have SMPs developed. Any WSUD options should be consistent with the SMPs developed for these areas. If strategies have been developed which identify regional structural actions for these catchments that meet the water quality objectives for the development then a WSUD strategy is not required for these catchments. In some cases a developer contribution may be levied on developments for contribution to any stormwater management actions undertaken in the sub-catchment.

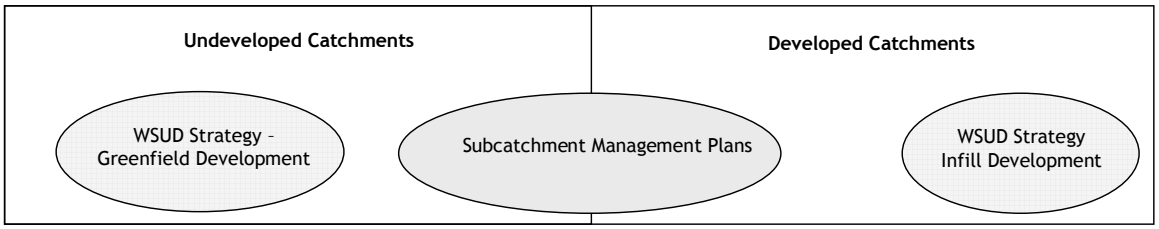

Figure 1 Development and SMPs

In new developments where the SMP is unable to meet the water quality objective then a WSUD strategy specific to the development will be required. The following sections address for these type developments which require a WSUD strategy what objectives are required for the site and broadly discusses appropriate solutions.

2.2 Development in Darwin

Development Applications in the Darwin Region were 1,220 in 2006-07 including development and subdivision applications and planning scheme amendments (DPI Annual Report 2006-07). As can be seen in Tables 3 and 4, this included 1104 residential developments.

Table 3 shows the number of detached dwellings approved in Darwin and Palmertson from 1995-96 through to 2006-07. While a detached dwelling is a stand along house the "other" residential buildings include semi-detached, row or terrace house or townhouse with one storey; semi-detached, row or terrace house or townhouse with two or more storeys; flat, unit or apartment in a building of one or two storeys; flat, unit or apartment in a building of three storeys; flat, unit or apartment in a building of four or more storeys; flat, unit or apartment attached to a house; other/number of storeys unknown.

Table 3: Residential Building Approvals in Darwin and Palmerston 1995-96 through 2006-07

Building approvals	DARWIN			PALMERSTON			Total		
	Separate	Other	Total	Separate	Other	Total	Separate	Other	Total
1995-96	75	193	268	336	101	437	411	294	705
1996-97	112	444	556	479	231	710	591	675	1266
1997-98	105	445	550	658	335	993	763	780	1543
1998-99	102	468	570	690	124	814	792	592	1384
1999-00	101	486	587	350	112	462	451	598	1049
2000-01	55	288	343	235	86	321	290	374	664
2001-02	61	181	242	227	45	272	288	226	514
2002-03	127	337	464	105	21	126	232	358	590
2003-04	82	563	645	158	11	169	240	574	814
2004-05	63	555	618	267	75	342	330	630	960
2005-06	48	403	451	347	40	387	395	443	838
2006-07	84	493	577	356	171	527	440	664	1104

Table 3 highlights an ongoing trend in the Darwin Region whereby the predominant residential type in Darwin is townhouse / high rise buildings where as in Palmertson there are a higher number of detached dwellings.

Table 4 shows the building approvals for all types of buildings in Darwin and Palmerston, with a further comparison to the total number of approvals in the Northern Territory. The value of new non-residential buildings in the Darwin Palmerston region is approximately 23% of the total building value. Alterations and additions comprise a small percentage of both the housing approvals (13%) and the other residential approvals (0.3%), or 5% of the total residential development.

Table 4: Building Approvals in Darwin and Palmerston 2006-2007 (ABS 2008)

		Darwin	Palmerston-East Arm	TOTAL	Northern Territory
HOUSES					
New	no.	84	356	440	761
New	$'000	29,306	98,672	127,978	212,079
Alterations/additions	$'000	16,830	2,996	19,826	58,745
Total	$'000	46,136	101,667	147,803	270,824
OTHER RESIDENTIAL BUILDINGS					
New	no.	493	171	664	693
New	$'000	168,608	24,862	193,470	198,875
Alterations/additions	$'000	667	32	699	1,357
Total	$'000	169,275	24,894	194,169	200,232
TOTAL RESIDENTIAL BUILDINGS					
New	no.	577	527	1,104	1,454
New	$'000	197,914	123,533	321,447	410,954
Alterations/additions	$'000	17,498	3,028	20,526	60,101
Total	$'000	215,412	126,561	341,973	471,056
NON RESIDENTIAL BUILDINGS					
New	$'000	61,317	35,772	97,089	170,192
Alterations/additions	$'000	61,144	8,674	69,818	94,661
Total	$'000	122,460	44,446	166,906	264,853
TOTAL BUILDINGS					
New	$'000	259,230	159,305	418,535	581,146
Alterations/additions	$'000	78,641	11,702	90,343	154,763
Total	$'000	337,872	171,007	508,879	735,909

As suggested in Table 3, Table 4 shows that there is a greater value of new detached houses in Palmerston as compared to Darwin while for other residential building types the situation is reversed.

3 WSUD IN A SINGLE ALLOTMENT AND SMALL RESIDENTIAL SUB-DIVISIONS

This category describes the bulk of residential suburban houses, dual occupancy and small scale sub-divisions such as townhouses and attached dwellings. These developments typically comprise a single detached dwelling and associated buildings such as garages and sheds. These allotments will often include such features as driveways and front and rear yards. The size of the allotments may be typically between 500 to 1000 m^2 but can be larger in rural residential areas.

The impervious surfaces associated with single allotments include the roofs, driveways, paths, and other hard surfaces such as patios. Pervious areas of the site include any garden or lawn areas. A medium-sized lot may have a site imperviousness of 40 to 60%.

The water used on single allotments comprises:

- potable water requirements such as drinking and food preparation
- non-potable water requirements such as toilet flushing, clothes washing, hot water systems, pools, and garden irrigation.

3.1 Opportunities and constraints for WSUD

Single allotments present the following opportunities for water conservation:

- Demand for non-potable water exceeds supply
- Many non-potable water demands can be met using alternative water supplies such as treated wastewater, rainwater and/or groundwater
- Water appliances and fittings can reduce potable water consumption
- Types of garden plants used can substantially influence irrigation demands and garden irrigation is approximately 50% of total demand
- Roof runoff may be collected in rainwater tanks and reused for internal uses such as toilets and washing machines
- Space is available for rainwater tanks

Single allotments present the following opportunities for water quality improvement:

- Space is typically available for small scale treatment systems such as raingardens, sand filters and buffer strips
- Soil types are suitable for infiltration of runoff in some areas
- Space is available for infiltration measures and infiltration of runoff is currently practised in some parts of Darwin
- Rainwater tanks provide some water quality treatment

The following constraints to WSUD apply in single allotments:

- In general rainwater tanks are not appropriate for irrigation in Darwin
- The installation of most stormwater treatment devices in individual suburban yards is not currently pragmatic or appropriate
- The maintenance of stormwater treatment devices on single allotments may not be sufficient to ensure satisfactory performance
- Not all treatment systems are suitable for use in single dwellings

3.2 Appropriate WSUD Options

WSUD measures suitable for use on single allotments include:

- Demand management – through low water use appliances and fittings
- Supplementing water supplies – with alternative non-potable sources such as wastewater, groundwater for external uses and/or rainwater tanks
- Some stormwater treatment measures, such as raingardens, sand filters and buffer zones are suitable to address water quality and waterway stability objectives. These objectives may be partially met with the use of rainwater tanks.
- Infiltration systems can be suitable in some areas

3.3 Recommended WSUD Objectives for Single Allotments

The following table outlines the recommended WSUD objectives for application in single allotments:

WSUD Objective	Single Allotment	Comment
Stormwater Quality	× - not recommended in the short to medium term	Currently not recommended at this stage. Further investigation of appropriate WSUD options for stormwater treatment at the allotment scale is required
Potable Water Conservation	✓- recommended	• Reducing the garden irrigation demand for potable water by encouraging low water use gardens on private allotments • Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of rainwater for non-potable end uses, in particular for internal indoor demands

4 WSUD IN MEDIUM and HIGH DENSITY RESIDENTIAL DEVELOPMENT

This category includes medium and high rise development such as large blocks of units, and high-rise apartment residential buildings. The size of the development may range from relatively small footprints of 2000 m^2 to more than a hectare.

The impervious surfaces associated with multi-dwelling residential developments include the roofs, driveways, car parks, access ways, paths and other hard surfaces. Pervious areas of the site include any garden or lawn areas. Multi-unit residential developments are expected to have a much higher imperviousness than single allotments due to the high density dwellings and intensive use of space. Site imperviousness is expected to be between 60% and 80%.

The water used in multi-unit residential developments comprises:

- potable water requirements such as drinking,, and kitchen uses
- non-potable water requirements such as toilet flushing, clothes washing, gas hot water, pool filling and garden irrigation.
- Irrigation requirements of public open spaces

4.1 Opportunities and constraints for WSUD

Multi-unit residential dwellings have the following opportunities for water conservation:

- Demand for non-potable water exceeds supply
- Water appliances and fittings can reduce potable water consumption
- Types of garden plants used can substantially influence irrigation demands
- Private open space can utilise the latest in irrigation technology including drip irrigation, irrigation schedulers and irrigation timers
- Many non-potable water demands can be met using alternative water supplies such as groundwater, treated wastewater and/or rainwater
- Centralised hot water systems and cooling towers can be supplied with roofwater in cases where sufficient roof area exists
- Large single water users such as cooling towers in high rise buildings can be metered to detect leakage

Multi-unit residential dwellings have the following opportunities for water quality improvement:

- There is the potential to incorporate stormwater treatment measures in the common spaces of formally maintained gardens within medium to high-rise developments
- Soil types in some areas are suitable for infiltration of runoff
- The regular maintenance of stormwater treatment devices is more likely to be sufficient to ensure satisfactory performance.

Multi-unit residential dwellings present the following constraints to WSUD:

- Large areas of impervious associated with these developments generate more runoff and pollutant loads than less impervious sites
- Space for treatment systems and infiltration measures can be limited
- Space for rainwater tanks can be limited
- Individual dwellings in medium to high rise developments may not be metered
- In general rainwater tanks are not appropriate for irrigation in Darwin

4.2 Appropriate WSUD Options

WSUD measures suitable for use in multi-unit residential developments include:

- Demand management through low water use appliances and fittings
- Supplementing water supplies with alternative non-potable sources such as rainwater tanks, groundwater or treated wastewater (the use of treated wastewater requires regional infrastructure and treatment)

- A range of stormwater treatment measures, such as hard edges wetlands, raingardens, sand filters, and buffer strips are suitable to address water quality objectives.

4.3 Recommendations for WSUD

The following table outlines the recommended WSUD objectives for application in single allotments:

WSUD Objective	Multi-unit residential and small subdivisions	Comment
Stormwater Quality	✓ - recommended in the medium term	Appropriate with a recommended implementation of an example high density development.
Potable Water Conservation	✓- recommended	• Reducing the garden irrigation demand for potable water by adopting low water use landscapes. • Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of wastewater, rainwater and groundwater for non-potable end uses.

5 WSUD IN LARGE GREENFIELD SUBDISIVIONS

This category includes large greenfield development with predominantly single dwellings, areas of public open space including parkland and sporting fields and typically includes small proportions of mixed and multi-purpose uses. The size of such developments is usually greater than 2 hectares.

The impervious surfaces associated with large subdivisions include the roofs, driveways, car parks, paths and other hard surfaces of the individual allotments in addition to the roads, paths, and commercial spaces. Pervious areas of the site include any garden or lawn areas and public open space. Large subdivisions are expected to have a site imperviousness in the order of 40% to 60%.

The water used in large subdivisions comprises:

- potable water requirements such as drinking, and kitchen uses
- non-potable water requirements such as toilet flushing, clothes washing, hot water systems, pools and garden irrigation.
- irrigation requirements of public open spaces

5.1 Opportunities and constraints for WSUD

The opportunities for WSUD in large subdivisions include those opportunities identified for single allotments in addition to the following:

- Intensive site analysis by specialists and urban designers during the master planning process allows for greater consideration for the incorporation of WSUD into large subdivisions.
- Construction of services throughout the subdivision offers greater potential to install dual reticulation plumbing that can facilitate the use of treated wastewater or groundwater to meet non-potable water demands
- There is the potential to incorporate stormwater treatment measures in the formally maintained public open spaces and road reserves. The regular maintenance of stormwater treatment devices is more likely to be sufficient to ensure satisfactory performance.

Large subdivisions present the following constraints to WSUD

- Large subdivisions must also deal with runoff from roads and paths
- There is greater complexity in the planning and design process in order to incorporate the requirements for WSUD with those of the authorities responsible for the services such as transport, electricity, water and sewerage
- A range of site constraints may be encountered including steep sites, acid sulphate soils, and groundwater levels.

5.2 Appropriate WSUD Options

WSUD measures suitable for use in large Greenfield developments include:

- Demand management – through low water use appliances and fittings
- Supplementing water supplies – with alternative non-potable sources such as wastewater, groundwater for external uses and/or rainwater tanks
- A wide range of stormwater treatment measures, such as wetlands, bioretention systems, raingardens, sand filters, swales, sediment basins and buffer zones are suitable to address water quality objectives. These objectives may be partially met with the use of rainwater tanks.
- Infiltration systems may be suitable in some areas
- Regional aquifer recharge is possible at larger scales through the use of aquifer injection of treated stormwater flows. Larger volumes of stormwater can be recharged as road runoff can be captured, treated and infiltrated.

5.3 Recommendations for WSUD

The following table outlines the recommended WSUD objectives for application in single allotments:

WSUD Objective	Large Subdivisions	Comment
Stormwater Quality	✓- recommended	Appropriate and future designs of treatment systems will be guided by the implementation and experience from case studies such as Bellamack.
Potable Water Conservation	✓- recommended	• Reducing the garden irrigation demand for potable water by adopting low water use landscapes in public parks and encouraging low water use gardens on private allotments. • Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of treated wastewater and groundwater for non-potable end uses, in particular landscape irrigation which constitutes more than 50% of residential water demand. • Maximising the use of rainwater for internal non-potable uses

6 WSUD IN COMMERICAL AND INDUSTRIAL

This category includes a wide range of development designed to meet commercial and industrial needs. The buildings associated with this category may include warehouses, factories and retail outlets.

The impervious surfaces associated with commercial and industrial developments typically include large roof areas, driveways and extensive car parking or paved and hard ground surfaces used as work areas. Many sites have limited landscaping. Site imperviousness may be as high as 80% to 100%. The water used in commercial and industrial areas is highly industry specific and may range from very small quantities to very high quantities. Typically there are:

- Low potable water demands such as drinking, and kitchen uses
- Higher non-potable water demands associated with the nature of the industry or use on site
- Limited requirements for garden irrigation.

6.1 Opportunities and constraints for WSUD

The opportunities for WSUD in industrial and commercial developments include:

- Large roof areas or extensive impervious ground areas generate large volumes of runoff that can be reused on site
- Where an industry has high internal water demands there may be a financial incentive to harvest rainwater or stormwater
- Rooftop runoff management can be very effective in industrial areas due to the large roof areas

The constraints to WSUD in industrial and commercial developments include:

- Industrial areas are associated with a wide range of chemicals and other potential pollutants and can discharge a more toxic and wider range of industrial chemicals.
- The large amounts of impervious area generate large volumes of runoff which require larger treatment system areas to achieve the pollutant load reduction targets
- In general it is likely that space for stormwater management will be limited
- Many industrial areas are located in low-lying topography. Consequently the groundwater tables may be shallow or subject to tidal inundation, precluding the use of a large range of stormwater treatment measures as a means to treat runoff.
- Many large retail areas contain minimal landscaping areas and are highly impervious reducing the options available for effective treatment of stormwater runoff

6.2 Appropriate WSUD Options

WSUD measures suitable for use large subdivisions include:

- Structural separation in industrial areas. Structural separation is a form of source control which isolates industrial pollutants from the stormwater drainage system. This is achieved by activities such as covering work areas, directing wash down to sewer discharge and control of activities discharging to stormwater drains.
- Demand management – especially through the adoption of latest water efficient production, cleaning, washing etc devices in high water using industries
- Demand management – adoption of low water using fixtures and appliances in commercial and retail areas.
- Supplementing water supplies – with alternative non-potable sources such as rainwater tanks, groundwater or treated wastewater.
- A wide range of stormwater treatment measures, such as wetlands, bioretention systems, raingardens, sand filters, swales, sediment basins and buffer zones may be suitable to address water quality objectives.

6.3 Recommendations for WSUD

The following table outlines the recommended WSUD objectives for application in single allotments:

WSUD Objective	Commercial and Industrial	Comment
Stormwater Quality	✓- recommended	• Stormwater quality treatment should be phased in for large industrial and commercial lots due to the significant impacts that these developments can have on receiving water. • Stormwater treatment for industrial areas should include structural separation which will have a significant positive stormwater quality impact.
Potable Water Conservation	✓- recommended	• Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of wastewater rainwater and groundwater for non-potable end uses.

7 WSUD IN GOVERNMENT BUILDINGS

This category may include a diversity of building types specific to the intended purpose of the site. Consequently, the size of allotments may range from small single allotments to large developments, and may include site uses such as domestic housing, commercial office space, community buildings such as schools and public open space such as sports fields and parks.

The imperviousness of sites containing government buildings depends on the use of the site and may range from as little as 40% to as much as 100%. The water used in government buildings is highly specific to the building purpose and is likely to comprise of the following:

- Potable water demands such as drinking and food preparation uses
- Non-potable water demands including indoor internal demands
- Requirements for garden and turf irrigation.

7.1 Opportunities and constraints for WSUD

The opportunities and constraints of government building sites that influence the application of WSUD will be specific to the nature of the land use of the site. Many Government building sites will be similar or identical to the previous four categories of development types, namely:

- Single allotments
- Multi-unit residential
- Large developments
- Commercial and industrial developments.

In these cases the category that is similar to the nature of the government site land use should be used to guide the application of WSUD.

There are particular opportunities for some community uses and public open space including:

- Large areas of open space which may be suitable for the integration of stormwater treatment options into the landscape
- High non-potable water demands including irrigation use and toilet flushing
- Opportunities to provide treatment for external catchments

Specific constraints for some community uses and public open space include:

- Nature of the use includes high public usage and therefore
- Children in particular are a higher risk community especially in term of healthy and safety and access systems in these areas needs to be assessed.
- Health and safety risk assessments may be required.
- Litter loads generated from these sites can be high and requires appropriate management
- Parks and open space can be key sources for nutrients and source control and appropriate fertiliser regimes should be adopted

7.2 Appropriate WSUD Options

WSUD measures suitable for government buildings will vary and should be influenced by the nature of the site activities. When the nature of the government site is similar to one of the four previous categories discussed, the WSUD options for this category should be applied to the government building site. Consideration may need to be given to site-specific potable water demands and internal and external non-potable water demands. If the nature of the government site is considered dissimilar to each of these categories, then specialist advice should be sought.

WSUD measures suitable for use in community and public open space developments include:

- Demand management – through low water use appliances and fittings and application of latest irrigation technologies including irrigation control systems incorporating irrigation schedulers and irrigation timers and best practice irrigation systems

- Supplementing water supplies – with alternative non-potable sources such as wastewater, groundwater for external uses and/or rainwater tanks
- A wide range of stormwater treatment measures are appropriate at the large scales including wetlands, raingardens, sand filters, swales, sediment basins and buffer zones are suitable to address water quality objectives. These objectives may be partially met with the use of rainwater tanks.
- Infiltration systems may be suitable in some areas
- Regional aquifer recharge is possible at larger scales through the use of aquifer injection of treated stormwater flows. Larger volumes of stormwater can be recharged as road runoff can be captured, treated and infiltrated.

7.3 Recommendations for WSUD

The following table outlines the recommended WSUD objectives for application in single allotments:

WSUD Objective	Government Buildings	Comment
Stormwater Quality	✓- recommended in the short to medium term	• WSUD objectives should be phased in at the appropriate time scale • Government buildings that fall into the previous 4 categories should adopt the recommendation from the corresponding category • Community and Public Open space are appropriate for stormwater quality and offer a number of opportunites for the adoption of WSUD for external existing catchments
Potable Water Conservation	✓- recommended	• Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and the adoption of water efficient fixtures and appliances • Maximising the use of rainwater, treated wastewater and groundwater for non-potable end uses, in particular landscape irrigation which constitutes 65% of residential water demand. • Application of best management practice irrigation systems

8 WSUD IN INFRASTRUCUTURE

Transport infrastructure, particularly roads, are the principal type of infrastructure that requires consideration in WSUD. Transport infrastructure includes parking areas for vehicles in this category.

In many urban areas, runoff from roads and other transport infrastructure contains a high proportion of the pollutants in urban stormwater run-off. Roads form extensive parts of the landscape and thus influence the quality of stormwater in many areas. Where roads are used frequently this can lead to a build-up of many pollutant particles on the road surfaces i.e. brake dust, fuels and oils, rubber, dust soil, debris and litter (Wong *et al.* 2000). The imperviousness associated with the transport corridors and road reserves depends on the proportion of area dedicated to bitumen or concrete. Site imperviousness typically range from 50% to 100% of the road reserve.

8.1 Opportunities and constraints for WSUD

The opportunities for WSUD in transport corridors and road reserves include:

- A variety of stormwater treatment devices are available and can be configured to accommodate the road runoff drainage network
- Passive irrigation for landscaping
- Space available for stormwater treatment
- Some soil types in Darwin are suitable for infiltration
- Gross pollutant and coarse sediment removal
- Treatment of road runoff removes a significant source of oil and grease, heavy metals and other toxic pollutants from urban stormwater runoff

The constraints to WSUD in road reserves include:

- Many services are associated with transport corridors and road reserves (i.e. electricity, gas, sewer, water) and these can restrict the space available for stormwater treatment
- Road networks are extensive and it is not be pragmatic to treat all road runoff, therefore specific locations should be targeted
- Road surfaces generate large volumes of runoff
- Strict controls regarding flooding, safety, facilities and access requirements may override WSUD objectives

8.2 Appropriate WSUD Options

WSUD measures suitable for infrastructure include:

- Stormwater treatment measures appropriate for transport infrastructure treatment include swales, bioretention systems and buffer strips to address water quality and objectives. These objectives may be partially met with the use of rainwater tanks.
- Pre-treatment of road runoff using gross pollutant and coarse sediment removal techniques such as gross pollutant traps, pit inlets and road side swales
- Infiltration systems may be used in some areas with appropriate pre-treatment of stormwater and a suitable buffer from infrastructure to protect road pavement.

8.3 Recommendations for WSUD

The following recommendations are made for WSUD application in infrastructure developments:

- Stormwater run-off from key pollutant generating areas should be subjected to stormwater treatment
- Future opportunities for the detention, treatment and infiltration of road runoff should be investigated for key pollutant generating areas.

WSUD Objective	Infrastructure	Comment
Stormwater Quality	✓- recommended in the short to medium term	Stormwater runoff from roads is a major source of sediment and heavy metal pollutants, and stormwater treatment should be considered for significant road and other transport infrastructure projects.
Potable Water Conservation	NA	There is limited water use in infrastructure and it is therefore not appropriate.

9 CONCLUSIONS AND RECOMMENDATIONS

Interim WSUD objectives have been identified for the Darwin Region to minimise the impact of urban development on the beneficial uses of Darwin Harbour. WSUD options available for various development types have been assessed and recommendations are made on what WSUD objectives should apply to these development types. This is summarised in Table 5.

Table 5: 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

As shown in Table 5 potable water conservation targets are recommended for all development types. These targets are a voluntary 20% reduction in potable water conservation compared to the benchmark for residential dwellings. The potable water conservation objectives are based on education and incentives schemes which focuses on:

- Reducing the irrigation demand for potable water by adopting low water use landscapes in public parks and encouraging low water use gardens on private allotments.
- Reducing the indoor demand for potable water through the adoption of water efficient fixtures and appliances including adoption of industrial best management practices in water conservation.
- Maximising the use of treated wastewater and groundwater for non-potable end uses, in particular irrigation which constitutes a substantial proportion of potable demand in Darwin.

The potable water conservation objective should be undertaken in partnership with the Territory Government and Power and Water.

Stormwater quality objectives which are a reduction in the mean annual load of total suspended solids, total phosphorus and total nitrogen are proposed at this stage for large residential and industrial subdivisions.

In the short to medium term it is suggested that these objectives be applied more broadly to other development types. WSUD elements for stormwater treatment within the Darwin region need to be further trialled and tested within the specific climatic conditions and organisational capacity of Darwin. Within these larger subdivisions guidance can be sort from research institutions to determine appropriate sizing and configuration of these elements to ensure their success prior to being more widely adopted.

Showcase developments are still being developed which will provide key technical and organisational capacity to deliver WSUD to other development types. WSUD can not be adopted in a comprehensive program to all development types without first overcoming significant technical, industry and organisational and social barriers. This requires a phased implementation.

Based on experience of the development of WSUD around Australia and its application to various development types a timeframe has been developed and is shown in Figure 2. This diagram shows the implementation timeframe for different development types, different potable water conservation options as well as water quality treatment solutions. Specifically it shows that:

- In the short term greenfield and large industrial subdivisions are the most suitable development types for WSUD strategies
- In the short term centralised treatment systems which treat regional catchments are most suitable as well as pilot scale tests of treatment systems
- In the medium term WSUD strategies are will be appropriate for a broad range of development types and treatment solutions
- In the long term WSUD should apply to all development, with single allotments also having to meet WSUD objectives

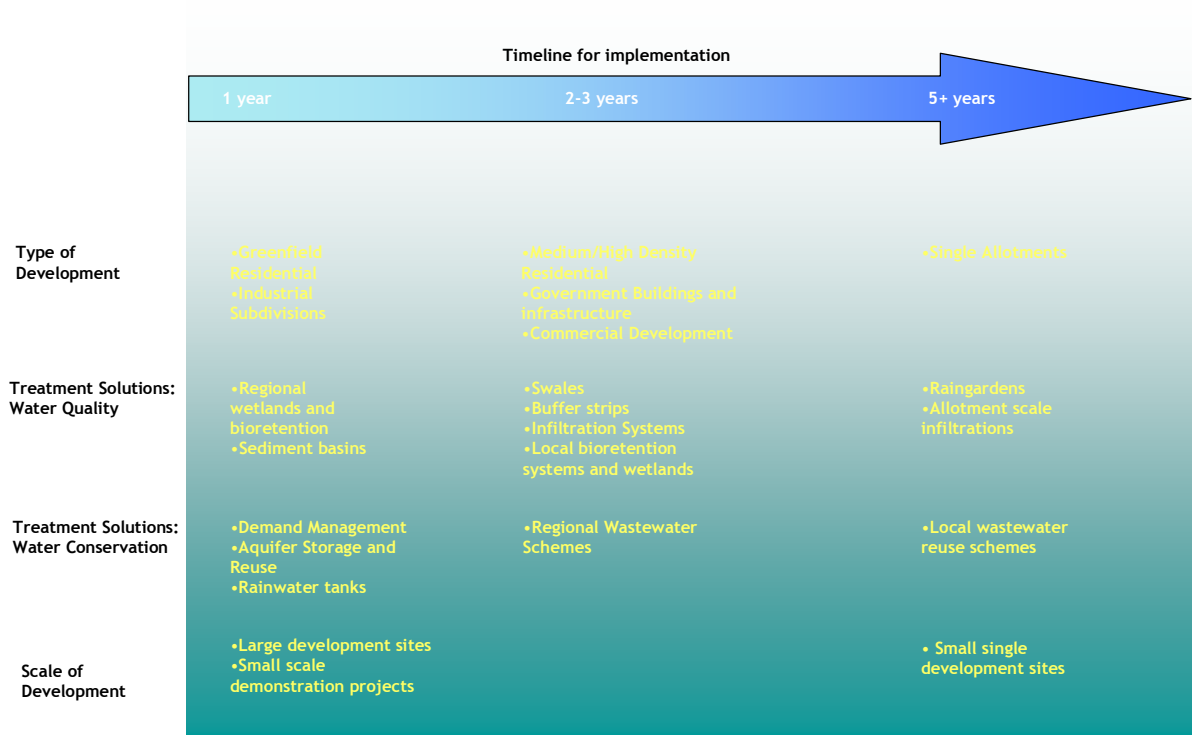

Figure 2 Implementation Timeframes

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