WATER SENSITIVE URBAN DESIGN

DESIGN OBJECTIVES FOR DARWIN DISCUSSION PAPER

Prepared for the Northern Territory Department of Planning and Infrastructure
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1 Introduction

The aquatic environment of the Darwin Harbour provides many key uses and values for the community of Darwin (NRETA, 2005). It is a recreational resource, provides significant amenity to the region and underpins economic activity. Importantly the harbour represents the key aquatic ecosystem of the region providing habitat for a range of estuarine and freshwater flora and fauna. For example 27,350ha of mangrove forest is found in Darwin Harbour which constitutes approximately 5% of the total mangrove area of the Northern Territory.

The Harbour is the ultimate receiving environment for all stormwater and wastewater discharge from Darwin and Palmerston urban areas which support a population of approximately 110,000 people. Recent research has identified that although the harbour is considered to be in pristine condition with good water quality, the impacts of urban stormwater runoff and wastewater discharges are evident. Wastewater discharges are resulting in localised degradation within the estuarine tributaries of the harbour and during the wet season, stormwater runoff from urban areas is resulting in high loads of sediments, nutrients and heavy metals entering local waterways.

Current predictions for 2050 are that the Darwin Harbour region will experience strong population growth with an expectation of the need for an additional 50,000 to 100,000 new dwellings over this period. Given these large development pressures facing the Darwin Region, and the potential impact this will have on these pristine receiving systems within Darwin Harbour, the Territory has identified that a coordinated strategy is required for managing the Harbour.

In this regard, Darwin Harbour Regional Plan of Management and the Draft Stormwater Management Strategy for the Darwin Harbour Catchment establishes the initial elements of a framework for managing the water quality impacts to the Harbour. Additionally, a Water Quality Protection Plan (WQPP) is being developed for Darwin Harbour Catchment. The WQPP is a jointly funded project with the Australian Government, through the Coastal Catchments Initiative (CCI), aimed at identifying and addressing key water quality risks to the values of the Darwin Harbour and its catchment. The WQPP is being developed over a three year period and the Department of Natural Resources, Environment and the Arts (NRETA) has primary responsibility for the development of the plan.

In order to manage the impacts to Darwin Harbour, particularly from new development and re-development areas, the Territory has identified that the implementation water sensitive urban design (WSUD) on all new development zones is critical. To assist in the adoption of WSUD, the DPI (Department of Planning and Infrastructure) in conjunction with NRETA (Department of Natural Resources and Environment) have secured a grant from the commonwealth 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 4 of the Workplan. Stakeholder consultation throughout Australia has consistently identified the requirement for clear, quantitative design objectives (i.e. quantitative targets) to guide the conceptualisation and assessment of WSUD within new and infill development. The development of quantitative objectives is a key component and precursor to the WSUD policy and framework (Tasks 8, 12 and 14).

The paper provides commentary on the range of potential WSUD objectives which may apply within the Darwin Region and suggests objectives for Darwin based on the outcomes of the Workshops held on 14th and 15th June 2007. The paper is provided to initiate further discussion of WSUD design objectives for Darwin Region. Feedback on the discussion paper will be sought from stakeholders before any decisions are made with respect to adoption of the design objectives.

Table 1: WSUD Strategy for Darwin Harbour – Workplan

#	TASK	OVERARCHING ACTIVITIES							
		Project Management & Coordination	Communication & Consultation	Identifying & Overcoming Barriers to WSUD Adoption	Identifying WSUD Design Objectives	Developing a WSUD Policy & Planning Framework	Developing WSUD Guidelines & Tools	Developing Case Study Examples of WSUD	Developing a Implementation Strategy
1	Refine workplan								
2	Establish project working group.								
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)								
6	Prepare a stakeholder communication and consultation strategy (including establish website, fact sheets, presentations).								
7	Prepare and communicate a definition of WSUD within Darwin								
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).								
9	Identify potential barriers to uptake of WSUD in the NT. Develop strategy to address barriers.								
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.								
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.								
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								
18	Undertake stakeholder consultation of WSUD Policy, WSUD design manual and performance standards, and decision support Tools and seek approval.								

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		Project Management & Coordination	Communication & Consultation	Identifying & Overcoming Barriers to WSUD Adoption	Identifying WSUD Design Objectives	Developing a WSUD Policy & Planning Framework	Developing WSUD Guidelines & Tools	Developing Case Study Examples of WSUD	Developing a Implementation Strategy
19	Finalise WSUD design manual, decision support tools and performance standards								
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.\								
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								
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.								

1.1 Water Sensitive Urban Design (WSUD)

WSUD represents a new paradigm in the planning and design of urban development that aims to minimise impacts on the natural water cycle and protect the health of aquatic ecosystems. WSUD promotes the integration of the urban water streams, namely stormwater, water supply, sewerage management and groundwater, centred on delivering sustainable water cycle solutions.

Additionally, WSUD aims to integrate these urban water cycle solutions into the planning and design of the layout (buildings and landscapes) of an urban development, towards an overall goal of ecologically sustainable development (ESD), as illustrated in Figure 1. Further description of the philosophy and implementation of WSUD is provided in Australian Runoff Quality (Engineers Australia, 2005).

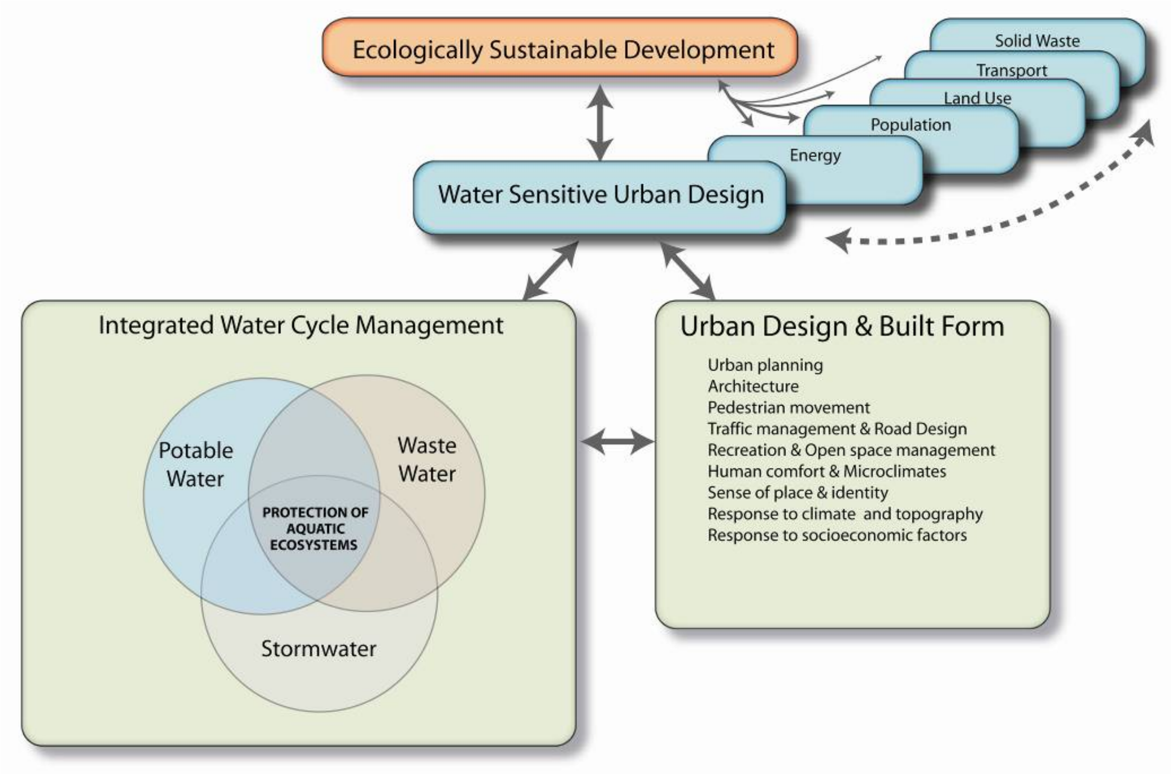

Figure 1 Relationship between water sensitive urban design, ecologically sustainable development and integrated water cycle management

1.2 WSUD Principles

The guiding principles of WSUD are to:

- Protect existing natural features and ecological processes.
- Protect water quality of surface and ground waters.
- Maintain natural hydrologic behaviour of catchments.
- Minimise demand for potable water.
- Minimise wastewater generation and discharge to the natural environment.
- Integrate water into the landscape to enhance urban design, visual, social, cultural and ecological values.

These guiding principles are adopted across Australia to reduce the impacts of urban development on receiving aquatic ecosystems. The principles are consistent with the goals of the *Darwin Harbour Regional Plan of Management* and specifically the outcomes of the stakeholder workshops associated with the Regional Plan that prioritised ecosystem protection desires for the harbour (refer *Proceedings: Darwin Harbour Technical Workshops – Current and Future Needs, 2003*).

1.3 The Need for Quantitative WSUD Objectives

In order to realise the WSUD principles listed above it is critical they are quantified. Stakeholder consultation throughout Australia has consistently identified the requirement for quantitative design objectives (i.e. measurable targets) to guide the conceptualisation and assessment of WSUD within urban development. The lack of quantitative objectives has been identified as a significant barrier to the effective implementation of WSUD (MBWCP, 2005).

The WSUD objectives must be clear, consistent and quantifiable and relate to ecosystem protection outcomes that can be readily achieved using best practice design approaches. Quantitative WSUD objectives are a key component and precursor to the development WSUD policy and framework and are an essential element of the development assessment process. It is intended the WSUD objectives will be linked with mandatory legislative and planning controls to ensure that developers seeking development approval must demonstrate to the Territory Government and Local Authorities that their proposed development incorporates WSUD to achieve these objectives.

1.4 The Process of Developing WSUD Objectives

Development of the design objectives for WSUD in the Darwin Region involves five key steps:

1. Workshop – A workshop was convened on 14th and 15th June 2007 involving industry experts and local authorities, planners, researchers and practitioners in the fields of potable water, wastewater management, stormwater, water quality, aquatic ecosystem health, and hydrology. The concept of WSUD was introduced to the group and the form and content of design objectives used elsewhere in Australia was discussed. The workshop group considered these objectives in the context of the Darwin Region, in particular the wet-dry climate, and recommended the *form* of appropriate design objectives for each of the three streams of the urban water cycle; stormwater, potable water and wastewater.

2. Discussion Paper (this document) – The outcomes of the workshop, being the preliminary WSUD objectives, along with initial feasibility testing of the stormwater objectives have been documented as a Discussion Paper (this document). The Discussion Paper is to be circulated to the participants of the workshop and a wider stakeholder group for review and comment. It is envisaged the preliminary WSUD objectives will be used by the Northern Territory Government and Local Authorities to encourage the implementation of WSUD on new developments while the final WSUD objectives are established and incorporated into legislation.

3. Feasibility Assessment – Desktop feasibility studies are to be undertaken to refine and test the practicality and achievability of the design objectives for different types of development. The scope and nature of this feasibility work is to be defined with the relevant stakeholders. It is hoped the use of 'real' developments as opposed to 'hypothetical' developments can occur which will allow the capture of 'actual' characteristics that comply with legislative and planning requirements, as well as represent housing/building product types and site/allotment layouts that reflect current market (i.e. community) expectations in the Darwin Region.

   At this point, WSUD objectives will be related to the regional catchment and receiving water quality assessment being undertaken as part of the WQPP.

4. Adoption – The outcome of the feasibility assessment will be presented to the WSUD Working Group and relevant stakeholders along with the form and content of the proposed final WSUD

Objectives for adoption. The final WSUD Objectives will be incorporated the relevant legislation and policy being developed as part of the WSUD Strategy for Darwin Harbour.

1.5 Purpose of this Discussion Paper

The paper provides commentary on the range of potential WSUD objectives which may apply within the Darwin Region and suggested preliminary objectives for Darwin based on the outcomes of the Workshop held on 14th and 15th June 2007. The paper is provided to initiate further discussion of WSUD design objectives with the WSUD Working Group and relevant stakeholders. Feedback on the discussion paper will be sought prior to resolving the scope of the feasibility assessment.

The preliminary WSUD objective recommended in the discussion paper can be used by the Northern Territory Government and Local Authorities to encourage the implementation of WSUD on new development in the Darwin Region while the final WSUD objectives are established and incorporated into legislation.

1.6 How to Provide Feedback on this Paper

Questions and feedback on the content of discussion paper should be forwarded in writing to:

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Comments are requested by 30th November after which selected direct consultation will occur (i.e. phone discussions and face to face meetings).

2 Stormwater Quality Treatment

2.1 Why Treat Urban Stormwater?

As outlined in the introduction to this discussion paper, the aquatic environment of Darwin Harbour and its associated tributaries are an invaluable natural asset. It is a recreation resource, providing significant amenity to the region and underpins economic activity. Importantly the harbour represents the key aquatic ecosystem of the region providing habitat for a range of estuarine and freshwater flora and fauna.

Darwin Harbour is the ultimate receiving environment for all stormwater and wastewater discharge from Darwin and Palmerston urban areas which support a population of approximately 110,000 people. A number of investigations within Darwin Harbour have identified that the water quality of the Harbour, particularly in the tributaries of the Harbour, has started to degrade as a result of wastewater and stormwater discharge. In the context of stormwater, runoff from urban areas is delivering proportionally high loads of sediments, nutrients and heavy metals to local waterways resulting in significant changes to the receiving ecosystems. Even though urban development covers only 3% of the Darwin Harbour catchment, stormwater runoff delivers 19% of the suspended solids, 7% of the total nitrogen load and 12% of the total phosphorus load to the harbour (Northern Territory Government, 2005).

The predicted strong population growth and associated development required to support this population will substantially increase stormwater pollution to the harbour. <u>If the health of Darwin Harbour and its tributaries are to be preserved, rather than continue to decline, the management (i.e. treatment) of urban stormwater is required to reduce the impact of stormwater pollution.</u> This principle is consistent with the goals of the *Darwin Harbour Regional Plan of Management* and specifically the outcomes of the stakeholder workshops associated with the Regional Plan that identified the management of pollution to the harbour as a top priority (refer *Proceedings: Darwin Harbour Technical Workshops - Current and Future Needs, 2003*).

2.2 Load Based Objectives versus Concentration Based Objectives

Receiving water quality objectives are typically specified in terms of desired pollutant concentration. For example, the Water Act (1992) declares *Beneficial Uses* for the water throughout Darwin and requires that the potential impact of water pollution be managed to ensure the protection of natural water resources in accordance with ANZECC (2000) which defines concentration-based criteria.

However, experience within Australia and overseas has identified difficulties with the application of concentration-based receiving water targets as discharge criteria for urban stormwater. Pollutant concentrations in receiving waterways are influenced by a wide range of factors, including the quality of stormwater from urban and other land-uses within the catchment, point source discharges and in-stream pollutant assimilation processes. For this reason, the concentration-based receiving water targets that have been derived from ambient (dry weather) flow conditions in undisturbed receiving streams do not directly apply to stormwater discharges (ANZECC 2000, p.2-17). To this end, wet weather water quality samples would need to be collected from suitable reference streams in order to extend the application of concentration based *trigger values* for use as discharge consents for urban stormwater.

Furthermore, ANZECC (2000, p.3.3-2) recommends that load based guidelines be developed for nutrients, biodegradable organic matter and suspended particulate matter (TSS). This is in recognition of the importance of the mass (or load) of these pollutants in terms of their impact on aquatic ecosystem health. In particular, loads of total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN) influence nuisance aquatic plant growth and TSS impedes light penetration and smothers benthic habitats. The adoption of a load-based objective overcomes many of the difficulties associated with the application of ambient concentration-based objectives to stormwater, and also accounts for the increase volume of stormwater, and hence load of pollutants, leaving a catchment after it is developed.

It is for these reasons that best practice load based objectives adopted for defining stormwater quality treatment requirements from urban development in the Darwin Region whereby the mean annual pollutant loads generated from an un-mitigated development are to be reduced by at least the percentage reduction rates prescribed in the design objectives (see below). This form of design objective for stormwater quality management is consistent with the current load based design objectives adopted in South East Queensland, Victoria and NSW and is consistent with the recommendations of Australian Runoff Quality (2005, p1-7) and ANZECC (2000, p.3.3-2), as discussed earlier.

2.3 Load Based Objectives from Around Australia

The current load based objectives adopted in policies and guidelines for urban stormwater quality treatment in throughout Australia are summarised in Table 2.

Table 2: Stormwater Best Practice Targets throughout Australia.

Region	Stormwater Quality Management Targets
Australian Runoff Quality	• 80% reduction in TSS • 45% reduction in TN and TP • Retention litter >50mm for flows up to 3mth ARI
NSW (Draft)	• 80% reduction in TSS • 45% reduction in TN and TP • Retention litter >50mm for flows up to 3mth ARI
Victoria	• 80% reduction in TSS • 45% reduction in TP and TN • 70% reduction in Gross Pollutants
SE Queensland (Draft)	• 80% reduction in TSS • 60% reduction in TP • 45% reduction in TN • 90% reduction in Gross Pollutants
Perth (Draft)	• 80% reduction in TSS • 65% reduction in TP • 45% reduction in TN • 70% reduction in Gross Pollutants
NSW Growth Centres Commission - Sydney South West Development Code	Targets: • 85% reduction in TSS • 65% reduction in TP • 45% reduction in TN • 90% reduction in Gross Pollutants "Ideal" targets: • 95% reduction in TSS • 95% reduction in TP • 85% reduction in TN • 100% reduction in gross pollutants

Note: - NSW guideline is in draft form and a guide for the State, Victorian guidelines are for all new developments and enforced through Clause 56 for all developments of 2 allotments or greater, SE Queensland and Perth targets at in Draft for adoption for new developments, Growth Centres Commission targets are a development code under the SEPP for South Western Sydney, and a requirement for all urban development in this region.

Of interest in the above Victorian and NSW (Draft) guidelines is that both Total Phosphorus (TP) and Total Nitrogen (TN) have been given the same guideline, being 45% reduction in mean annual load. However, TP has a strong correlation and association with TSS, being predominantly generated in a particulate form bound to both organic and inorganic forms of suspended particulate matter. Thus, the removal of TP from urban stormwater runoff occurs predominantly by sedimentation, as with TSS, with vegetation and soil based stormwater quality treatment measures such as bioretention and wetlands "locking up" the accreted particulates in an aerobic state to

prevent the desorption of phosphorus under chemically reducing conditions. It is therefore reasonable to expect the mean annual reduction of TP by contemporary stormwater quality treatment technologies would be similar to TSS with perhaps slightly lower overall removal performance for TP due to its slightly higher association with the finer fraction of the TSS particle size distribution range. Total Nitrogen on the other hand occurs in urban stormwater in particulate and dissolved forms with a much higher proportion generated in dissolved forms than TP. Removing nitrogen from urban stormwater occurs by nitrification/denitrification and to a lesser extent nitrogen fixation by plants. Generating the aerobic conditions (for nitrification) and anaerobic conditions (for denitrification) is difficult in urban stormwater treatment systems due to the episodic nature of urban stormwater. Therefore, achieving complete nitrogen cycling whereby nitrogen is removed from solution to the atmosphere as N2(gas) is rarely fully achieved within contemporary stormwater quality treatment technologies and hence the mean annual removal rates for TN can be expected to be lower than for TSS and TP (Healthy Waterways, 2006)

2.4 Derivation of Load Based Objectives for Darwin

The derivation of the load based objectives (i.e. mean annual pollutant load reduction rates) adhered to three underpinning principles, being (Healthy Waterways, 2006):

- Locally relevant - The design objectives must, to the extent possible, be derived using locally relevant information on urban stormwater pollution generation rates and stormwater quality treatment measure performance,
- Practical - The design objectives must be achievable with more than one design solution, and
- Best Practice - The design objectives must result in the adoption of the most effective and efficient forms of contemporary ‘best practice’ designed stormwater quality treatment infrastructure sized to operate at their respective limit of economic performance (i.e. beyond which any further increase in treatment size will not result in any appreciable increase in treatment performance).

The derivation of load based objectives for Darwin has used predictive modelling techniques employing continuous simulation based on a continuous period of typical Darwin climatic conditions (Healthy Waterways, 2006). The computer model MUSIC (model for Urban Stormwater improvement conceptualisation) developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH) is a conceptual stormwater model that represents our current best understanding of the transformation of rainfall to runoff (surface and baseflow) in urban environments, the generation of key stormwater pollutants (stressors) in surface flows and base flows from various land surfaces, and the removal of key pollutants (stressors) from urban stormwater runoff by contemporary best practice stormwater treatment technologies. For this reason the MUSIC model was used to derive the load based objectives for Darwin.

The MUSIC model was established for a typical urban development application in Darwin and two contemporary stormwater treatment systems (bioretention and wetland) were applied to the model. The MUSIC model was configured as follows:

- 1ha urban source node with the landuse assumed to be typical urban residential (27% roofs, 15% road reserve, 8% other impervious and 50% pervious).
- Soil parameters as recommended in the MUSIC User Guide
- Pollutant generation rates as reported in ARQ for roofs and roads and MUSIC default values for other urban areas
- Rainfall data was sourced from the Bureau of Meteorology gauging station at Darwin Airport. The average annual rainfall there is 1,711.7 mm. 6 minute rainfall data for a period of ten years, 1987-1996, was used for all model runs. Over this period the rainfall was typical of the long-term average, at 1699 mm/year.

- The bioretention and wetland systems were modelled using standard design parameters for subtropical and temperate regions. As discussed in the Stormwater Treatment Options Discussion Paper (EDAW, October 2007), treatment system designs will need to be substantially modified for the wet-dry climate of Darwin. This may reduce the treatment performance for equivalent system area. As treatment options for Darwin are further developed, the treatment performance curves will be refined and also the load based objectives.

The MUSIC models were used to produce stormwater quality treatment curves (i.e. treatment performance curves) which are shown in Figures 2 and 3. The shape of the performance curves enables the informed selection of the 'optimal' treatment size for both technologies beyond which any further increase in treatment area (and thus cost) yields only limited incremental increase in pollutant load removal. This so called "point of diminishing performance (or return)" can be considered to represent the reasonable limit of performance of each technology and has been adopted as the measure of practical 'best practice' stormwater quality treatment performance in Darwin Region (Healthy Waterway, 2006).

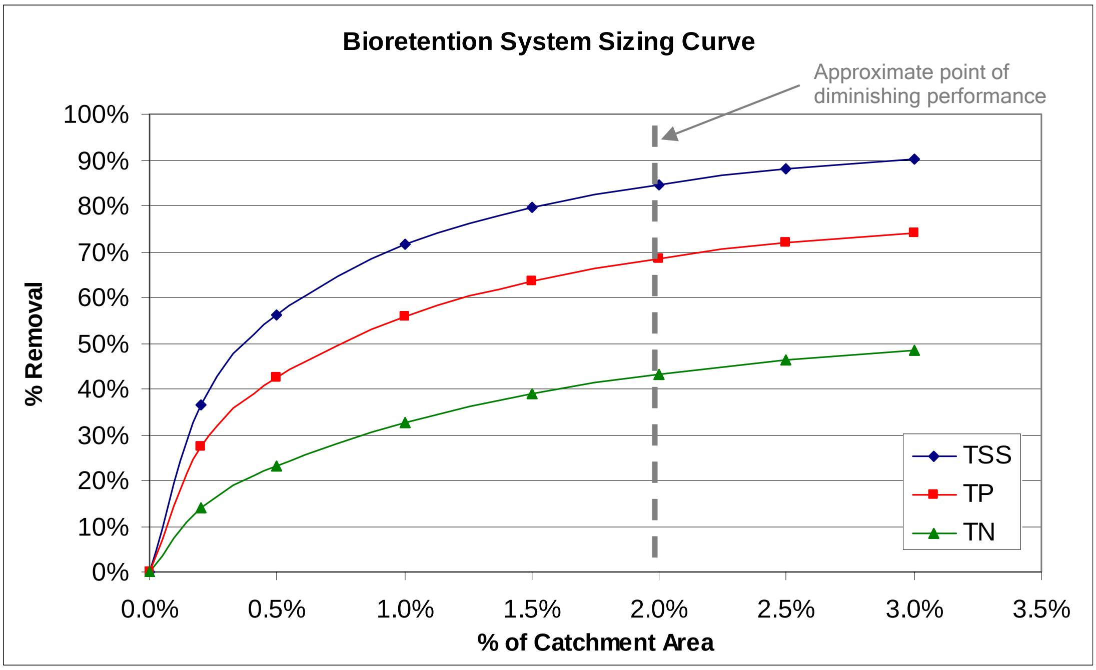


Figure 2: Bioretention system treatment performance curve

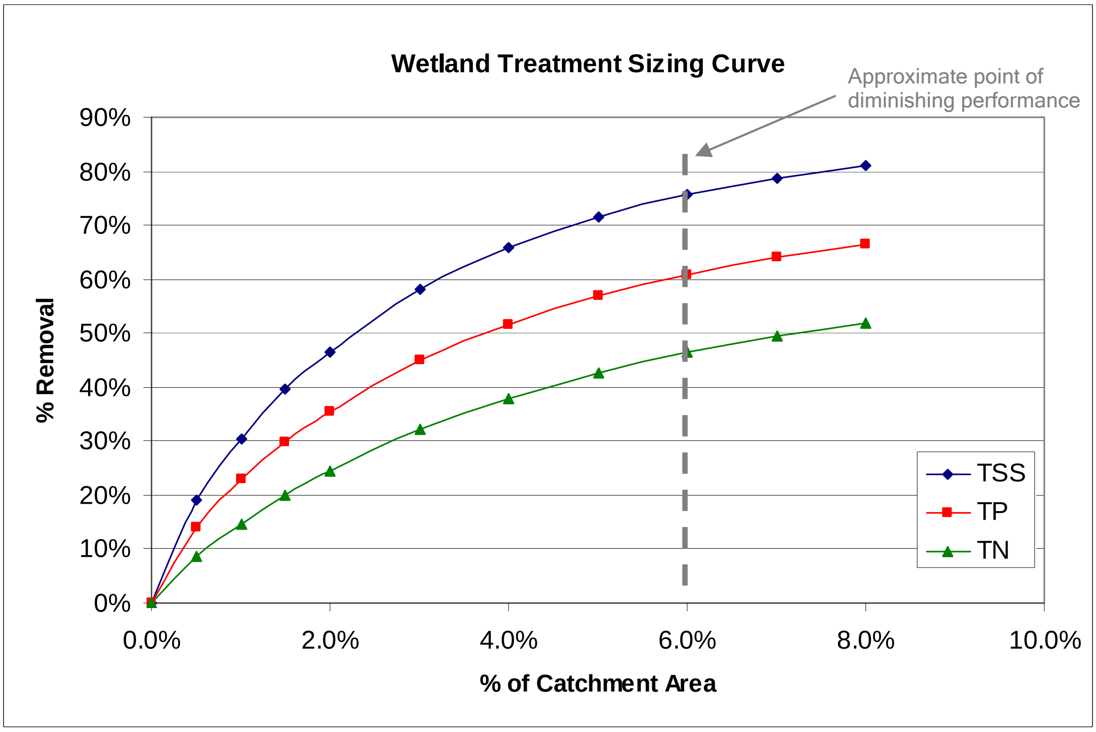


Figure 3: Wetland treatment performance curve

2.5 Recommended Objectives

The recommended preliminary load based stormwater quality objectives are outlined in Table 3. These should apply to new developments in the Darwin Region, until the performance of vegetated stormwater treatment measures in the region is better defined.

Table 3: Recommended stormwater quality objectives

Constituent	Discharge Criteria
TSS	75% reduction in post development mean annual load
TP	60% reduction in post development mean annual load
TN	45% reduction in post development mean annual load
Gross Pollutants	90% reduction in post development mean annual load

3 Waterway Stability

3.1 Why Manage Stormwater Flows?

Urban development increases the frequency, duration, peak flows and volume of stormwater runoff, due to the increase in impervious area in urban catchments. Pipe and constructed channel drainage systems deliver flows more rapidly to receiving waters. An important consequence of these effects is the potential for increased erosion of the bed and banks of natural waterways downstream of urbanising areas. Without control measures in place, this increase in erosive potential typically leads to channel enlargement and a reduction in aquatic habitat value (Healthy Waterways, 2006). These effects are now regarded by some (Roesner et al. 2001) as being of greater importance than reductions in water quality due to urbanisation.

3.2 Waterway Stability Management Requirements in Australia

A commonly applied flood management requirement in Australia is to maintain the pre-development peak flow for major flood events (up to 100 year Average Recurrence Interval event) under post-development conditions. The purpose of this requirement is to protect downstream infrastructure and residents from increased flood risk. There is no consideration of the geomorphology or ecology of the receiving stream in this approach (Healthy Waterways, 2007).

In addition to the management of extreme floods, recent stormwater management guidelines identified the retardation of the post-development 1.5 year ARI peak flow to the pre-development level (Victorian Stormwater Committee, 1999). The purpose of managing this more frequent flow was to 'protect channel form and aquatic ecosystems from flow-related impacts' (Victorian Stormwater Committee, 1999). This is consistent with other areas of Australia where the most commonly adopted type of flow management target is a peak flow management target, which calls for maintaining peak flows at pre-development levels in 1-2 year ARI events.

This objective is commonly referred to as the Waterway Stability design objectives. As highlighted in Healthy Waterways (2006), an important aspect of the Waterway Stability Management Design Objective is that the permissible peak rate of discharge for the 1-2yr ARI event from the development site is NOT the same as the pre-developed peak 1-2yr ARI discharge at the development boundary. Rather, it is the allowable peak 1-2yr ARI discharge from the development site to ensure the effect of the development on the peak 1-2yr ARI flow in the receiving waterway(s), at all locations downstream from the development site, are maintained at or below the pre-developed 1-2yr ARI flow.

Complying with the Waterway Stability Design Objective requires the provision of an on-site detention storage provided as either surface and/or sub-surface storage. This storage can be co-located with the stormwater treatment devices required to achieve the stormwater quality objectives described in Section 2.

3.3 Feasibility of Waterway Stability Objective

In order to rapidly test the initial feasibility of adopting a Waterway Stability Objective in Darwin, a very simple Rational Method calculation was undertaken to estimate peak flows before and after development in urban areas typical of the Darwin region for the 1 yr ARI storm event. The methods recommended in Australian Rainfall and Runoff (Institution of Engineers, 1987) were followed.

For typical urban catchments in the Darwin region (approximately 50% impervious), it was found that urban development increases peak flow above pre-development levels by approximately 30% in the 1 year ARI event. A simple simple storage calculation was then undertaken using triangular inflow and outflow hydrographs to establish the detention storage volumes would be required to manage peak flows to pre-development levels. <u>It was found that 340m^3/ha the following detention storage volumes would be required to manage peak1 yr ARI flows to pre-development levels</u>.

Treatment systems such as wetlands can include some storage volume dedicated to peak flow detention, however water level fluctuations in wetlands need to be limited to a range that wetland vegetation can tolerate. Typically, wetlands incorporate around 0.5 m extended detention, however this does not operate as a detention basin, as extended detention only draws down very slowly. It may be possible to incorporate an additional detention volume above the extended detention. For a wetland sized to achieve the best practice stormwater treatment objectives (1.e. 6% of the catchment area), the peak flow detention volume available would therefore be approximately 300 m^3/ha. This means it would be feasible to incorporate most of the detention storage within wetlands to manage the 1 year ARI peak flow with only a small additional storage requirement located outside or adjacent to the wetland.

Note the assessment described above represents a rudimentary review of the feasibility for adopting a waterway stability objective. To fully test the feasibility of the waterway stability objective, a detail geomorphic assessment is required to define the erosion potential of streams in Darwin under different flow regimes along with comprehensive hydrological modelling. This could be undertaken as a case study on a stream that currently has high ecological value and which may be subject to development within its catchment in the future.

3.4 Recommendations

Initial feasibility assessment indicated it “may” be practical to adopt a waterway stability objective for Darwin which aims to limit the impacts of urban development on in-stream habitat disturbance and erosion by controlling the magnitude and duration of stormwater discharges. This objective would be applied to developments that discharge to an unlined, non-tidal waterway that is considered to have significant ecological value. Where a receiving waterway is degraded, this design objective should only be applied if the Northern Territory Government or Local Authority has identified some potential for future rehabilitation.

It is recommended this 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.

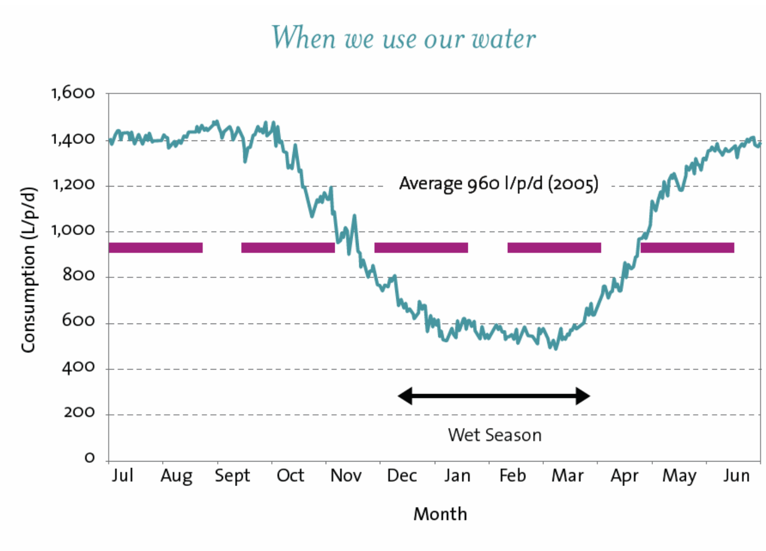
4 Potable Water Conservation

4.1 Why Conserve Potable Water?

One of the core initiatives of WSUD is potable water (drinking water) conservation. Potable water conservation ensures that urban areas are less reliant on limited high quality water resources, which is important in the context of the water supply issues which currently face Darwin.

Water consumption in the Northern Territory is significantly above the national average. Darwin residents use twice as much water per head as people in other capital cities (Darwin Water Story). While there are contributing factors, such as a warmer and drier climate in Darwin compared to other cities in Australia, there is significant potential for potable water conservation through efficiency measures and non-potable water substitutions measures.

The average consumption per person, including government and industry related water use, is 960 L/person/day. Of this demand, an estimated 65% is associated with irrigated landscapes, with all of this irrigation occurring during the dry season.



This extreme demand for water, combined with rapid population growth, has resulted in overall water demand (40 GL/yr) reaching the current supply capacity of Darwin River Dam and Howard East/McMinns borefield (46 GL/yr). Projected future population growth of between 120,000 – 260,000 people is expected to increase demand to approximately 70 GL/yr and meeting this demand will require either major expansion of the current system, or the use of alternative options to save water and provide alternative water sources. The recent "Darwin Water Story" initiative under taken by Power and Water highlights the water supply and environmental risks associated with the old water supply paradigm and suggests a range of alternative water supply alternatives to ensure current and potential water resources are protected.

A recent survey undertaken by Power and Water has shown there is widespread community support demand management and water recycling initiatives. The survey found that:

- More than half of all residents and businesses believe that water conservation in Darwin is critical
- Residents and businesses agree that it is socially responsible for them to monitor water usage
- Mandatory water efficient devices in new buildings and residences is the first preference to encourage water efficiency
- The majority of residents and businesses state that they would use recycled greywater.

4.2 Water Conservation Requirements in Australia

The management of water use is a critical issue which faces all urban centres in Australia. In response to this the eastern states have adopted the water conservation targets listed in Table 4.

Table 4: Selected water conservation targets throughout Australia

State/region	Demand type	Target	How and where the target applies
NSW	New Residential	40% reduction in mains water consumption	BASIX legislation applies to all new residential development, as well as alterations and additions > $50,000. In high-rise buildings, appliances can count towards the target, however single dwellings require an alternative water source. In western NSW, the target is reduced.
Victoria	New Residential	25% reduction in mains water consumption	Mandatory water efficient shower roses and taps and either a rainwater tank or solar hot water system for all new homes to help achieve a target of 25 per cent water savings
Queensland	New Residential	Variable targets based on location and development type. 70kL per year reduction in mains water consumption for new detached dwellings	Target applies to all new Class 1 buildings which includes attached and detached residential dwellings. Effectively mandates water efficient fixtures and the adoption of either a rainwater tank or greywater reuse system.

4.3 Water Conservation in Darwin

The merits of establishing a quantitative water conservation objective for Darwin was discussed at length as part of the Workshops held on 14th and 15th June 2007. It was resolved that rather than mandating a water conservation objective, 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 encouraging 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 (Northern Territory Government and Power & Water driven initiative). For example the Bellamack urban area currently being released by the DPI is to incorporate a third pipe which will ultimately deliver treated wastewater to the allotments and public open spaces for irrigation purposes.

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. The program will provide a centralise information resource for anyone wanting to reduce water consumption while maximising economic or commercial opportunities and also provide access to water conservation products at cheap subsidized cost.

5 Summary

The current absence of regionally clear quantitative design objectives for WSUD in the Darwin Region is an important barrier to effective implementation of WSUD. The WSUD Strategy for Darwin Harbour seeks to overcome this barrier by providing a set of appropriate design objectives.

Based on a workshop involving industry experts and local planners, researchers and practitioners, a preliminary suit of WSUD design objectives suitable for application in the Darwin Region have been developed. The proposed design objectives, summarised in Table 6, below have been tested at a preliminary level to establish the feasibility of complying with the design objectives.

It is recommended that the preliminary stormwater quality design objective be adopted at the earliest possible time as an interim design objective to ensure that stormwater pollution impacts of current urban expansion on Darwin Harbour are adequately addressed.

Table 5 – Summary of Preliminary WSUD Objectives

IWCM Objective	Performance Measure/Target
Stormwater Quality	Stormwater discharged from development areas to be treated in accordance with best practice: • 75% 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	<u>It is recommended this waterway stability objective is not adopted at this stage</u>. Further technical investigation is required to refine and test the practicality and achievability of the objective.
Potable Water Conservation	<u>No quantitative potable water conservation objective has been specified</u>. Rather than mandating a water conservation objective, 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 used gardens on private allotments. • Reducing the indoor demand for potable water through the adoption of mandatory dual flush toilets and encourage 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.

6 References

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