A part of BMT in Energy and Environment

BMT WBM

Water Sensitive Development Strategy Guidelines

Port Stephens Council

R.N2107.001.02.docx
21 September 2011

Port Stephens Council
WSD Strategy Guidelines

Prepared For:	Port Stephens Council and Hunter Water Corporation
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd		
BMT WBM Pty Ltd 126 Belford Street BROADMEADOW NSW 2292 Australia PO Box 266 Broadmeadow NSW 2292 Tel: +61 2 4940 8882 Fax: +61 2 4940 8887 ABN 54 010 830 421 www.wbmpl.com.au	***Document :***	R.N2107.001.02.docx
	Project Manager :	Mark Wainwright
	Client :	Hunter Water Corporation and Port Stephens Council
	Client Contact:	Rhys Blackmore
	Client Reference	

Title :	Port Stephens WSD Strategy Guidelines
Author :	Mark Wainwright
Synopsis :	These guidelines outline an approach to assist development applicants with preparing a Water Sensitive Urban Design (WSD) strategy to demonstrate how Council's WSD objectives and targets would be achieved for a particular development.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	18 July, 2011				
1	9 September, 2011				
2	21 September, 2011	TRW		MEW	

DISTRIBUTION

DESTINATION	REVISION			
	0	1	2	3
Hunter Water Corporation	pdf	pdf	1	
Port Stephens Council			1	
BMT WBM File			1	
BMT WBM Library			1	

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

These guidelines outline an approach to assist development applicants with preparing a Water Sensitive Development (WSD) strategy that demonstrates how Council's WSD objectives and targets would be achieved for a particular development. These guidelines are relevant to all developments where a WSD strategy is required in accordance with Port Stephens Council's DCP 2007 (DCP). The DCP establishes requirements for small (<=2000m^2) and large (>2000m^2) scale developments. The WSD strategy guidelines approach is summarised in Figure 1-1.

Small scale developments have a relatively simple development assessment process to complete, reflecting the lower environmental risks from this scale of development. Small scale developments either require adoption and implementation of an acceptable solution that is specified within the DCP, or calculation of an appropriate solution applying the Small Scale Stormwater Quality Model (SSSQM). Guidance on the application of the SSSQM is provided in Section 4 of these guidelines.

Large scale developments typically have the potential to cause significant impacts to the environment. Large scale developments require a comprehensive consideration of the water management principles, objectives and targets, physical features of the site and potential WSD options when preparing an appropriate WSD strategy for a particular site. Guidance on the approach for preparing a WSD strategy is presented in Sections 5 to12.

Where a WSD strategy has previously been prepared and assessed as meeting the requirements of the DCP at the subdivision stage, no additional WSD strategies will be required for the individual dwellings/buildings within that subdivision (provided the approved subdivision stage development controls still apply). Any staging of lots may require further application to demonstrate how the approved WSD strategy is being complied with for each stage.

The following planning instruments and policies should be reviewed and considered when preparing a WSD strategy:

- Port Stephens Council Local Environment Plan;
- Port Stephens Council Development Control Plan 2007;
- Port Stephens Council Urban Stormwater and Rural Water Quality Management Plan;
- Port Stephens Estuary Management Plan;
- Port Stephens Council Infrastructure Specification; and
- Hunter Water (Special Areas) Regulation 2003.

For developments where constructed WSD measures will ultimately be handed over to Council, applicants are encouraged to discuss development proposals with Council's Development Assessment staff. Council will be able to provide examples of similar acceptable WSD strategies and development application documentation relevant to the development. The aim of this initial consultation process is to provide direction and guidance to the applicant on Council's requirements to assist with avoiding additional time and costs associated with later revisions and major modifications. The level of consultation required will depend on the size and the complexity of the development. In some instances, it may be necessary to lodge a preliminary application with Council for developments of a certain level and/or scale.

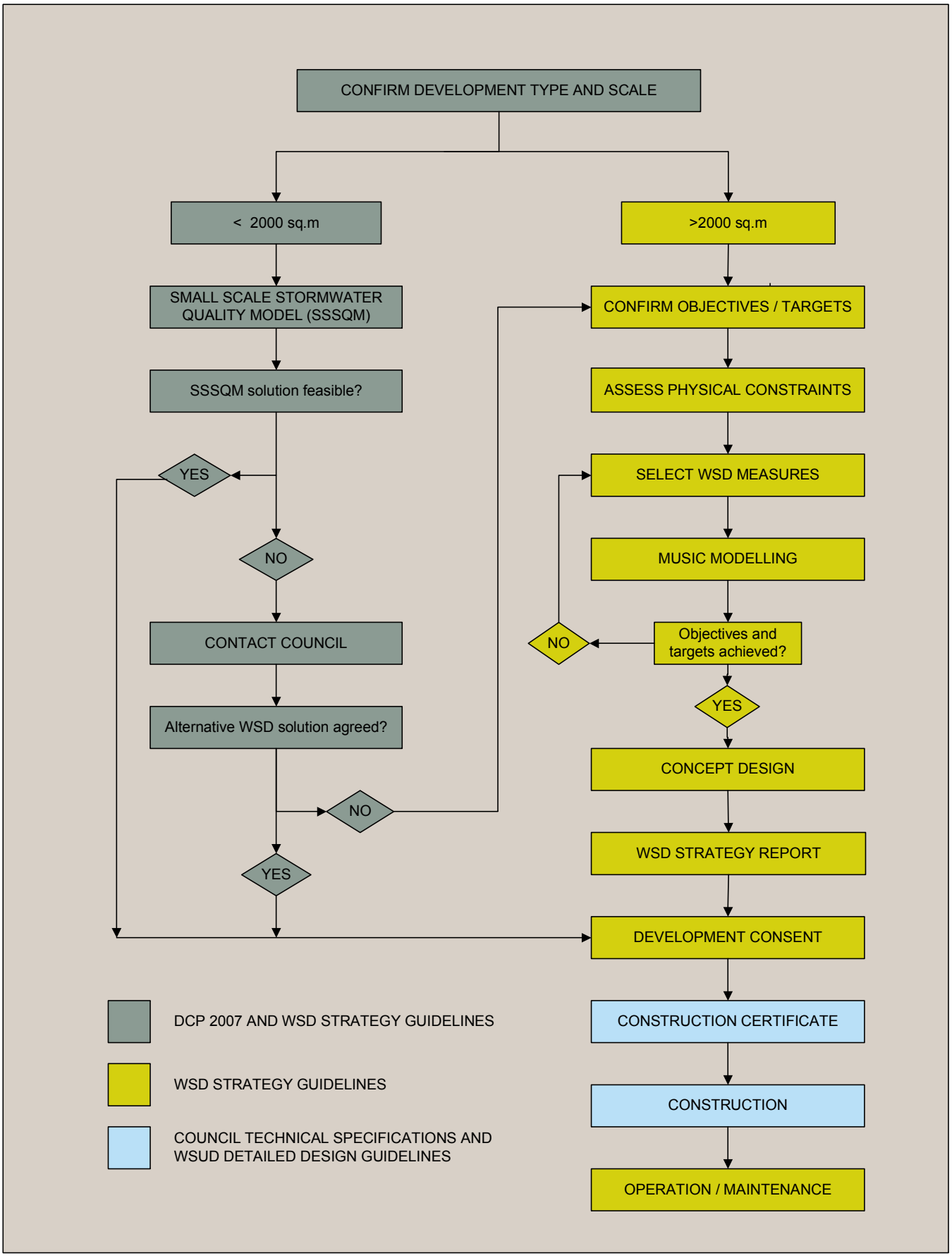

Figure 1-1 WSD Strategy Guidelines Application

2 WATER SENSITIVE URBAN DESIGN

Urban development often results in significant modification to soils, topography, catchment imperviousness and vegetation. Surface runoff volumes and pollutant concentrations from urbanised catchments are typically elevated above natural conditions and without mitigation have the potential to convey elevated pollutant loads to receiving waters. Urban development also has the potential to significantly increase surface runoff flow rates and volumes leading to impacts on stream stability, receiving water ecology and flooding.

Water Sensitive Development (WSD) is a philosophy that integrates urban water management within planning and design. WSD considers integration of urban infrastructure within the natural environment to achieve water management objectives. WSD aims to ensure protection of aquatic ecosystem health and minimise negative impacts on the natural water cycle. Achieving the full benefits of WSD requires integrated management of water supply, wastewater, stormwater, groundwater, flooding and riparian zones within developments. Stormwater quality and quantity management are particularly important for protecting aquatic ecosystems.

Water is our most precious resource and existing urban water supply systems are approaching their limits. Expanding existing water supply dams and creating new water supply sources is becoming increasingly difficult and there are growing community demands to increase environmental flows downstream of dams. As the urban population increases, more efficient use of water also becomes increasingly important. New development, redevelopment and alterations to existing buildings can contribute to environmental sustainability by incorporating a variety of water efficiency measures.

Implementation of WSD within a development to detain, retain, harvest, filter, infiltrate and biologically treat surface runoff will assist to reduce the concentrations and loads of pollutants discharged to the receiving waters. In addition, harvesting and infiltrating runoff can reduce the volume of runoff which has the potential to generate additional pollutants through erosion and sedimentation in the receiving watercourses.

A development incorporating consideration of WSD principles provides a range of community and environmental benefits when compared to conventional development including:

- Reduced litter, organic debris and other coarse matter discharging into waterways used by residents and tourists for swimming, surfing, boating, and other recreational activities;
- Reduced suspended solids, heavy metals, oils and greases , and other contaminants discharging into waterways that are used for fishing and aquaculture;
- Reduced nutrients, sediment load and exotic/weed seeds discharging to aquatic habitats resulting in lowered nuisance plant growth, lowered turbidity, less smothering of aquatic plants and animals, and improved photosynthesis;
- Reduced impacts on surface and groundwater flow regimes;
- Improved protection of watercourses, wetlands, groundwater and riparian corridors;
- Increased conservation of potable water leading to more efficient use of natural water resources;
- Reduced impacts on drinking water supply catchments;

- Reduced sewage discharges to the natural environment;
- Maintenance of stream stability through reduced erosion and sedimentation;
- Integration of stormwater, water supply, wastewater and flooding management improving efficiency and reducing long term costs to the community;
- Increased system reliability and reduced nuisance flooding through integration of stormwater quality and drainage management systems;
- Integration of water into the landscape to enhance visual, cultural and ecological values; and
- Sustainable water resources management education opportunities for the community.

3 DEVELOPMENT TYPE AND SCALE

The development type/scale shall be confirmed to enable the required level of WSD assessment to be determined for a particular development. Council has four main levels of development type/scale to consider and each of these has different assessment requirements and/or acceptable solutions. The four levels are:

- Exempt and complying development;
- Single dwellings, dual occupancies and minor (<50m^2) alterations and additions;
- Small scale developments (total lot area up to 2000m^2); and
- Large scale developments (total lot area exceeding 2000m^2).

Exempt and complying developments have no specific requirements for installation of WSD measures in accordance with the DCP 2007. Exempt and complying developments may require the installation of WSD measures to satisfy BASIX or other environmental planning instrument requirements. Council shall be contacted to confirm that WSD measures are not required for specific developments that fall into this category.

Single dwellings, dual occupancies and minor alterations and additions are required to incorporate a stormwater retention/infiltration trench sized and constructed in accordance with Plan No. S136 “On-Site Stormwater Disposal Trench for Residential Dwellings”.

Small scale developments include individual lot developments where the potential environmental risks from the development are considered to be minor by Council. The small scale development category excludes single dwellings, dual occupancies and minor alterations and additions. This category covers the majority of developments assessed by Council. Small scale developments are required to include WSD measures. The WSD requirements for small scale developments are to be determined utilising the Small Scale Stormwater Quality Model (SSSQM), BASIX tool and/or acceptable solutions. Guidance on the application of the SSSQM is provided in Section 4.

Large scale development applications require a WSD strategy to be prepared and MUSIC modelling completed to confirm that the WSD strategy achieves compliance with the stormwater quantity and quality objectives and targets. These guidelines focus on the requirements for large scale development proposals.

4 SMALL SCALE STORMWATER QUALITY MODEL

Council has chosen to use a Small Scale Stormwater Quality Model (SSSQM) to help facilitate the application of WSD and related targets to small-scale developments. This model is available for download from Port Stephens Council's website.

SSSQM users are required to enter key characteristics of the site and proposed development, such as the type of development, site area and the area of roof and other impervious surfaces (i.e. driveway, paved areas). The user is then required to identify the type, configuration and size of WSD measures that are proposed for the development. The measure options in the SSSQM include:

- Pervious pavement (not for vehicular traffic pavement areas in Port Stephens);
- Green (vegetated) roof;
- Vegetated buffer / filter strip;
- Vegetated swale;
- Bioretention basin, trench, raingarden or bioretention planter box;
- Sand filter; and
- Infiltration system.

The SSSQM Model analyses the inputs and then indicates whether the proposed WSD measures would achieve the applicable stormwater targets. If the proposed WSD measures do not comply, the user has the option to adjust the measures and iterate to a complying solution. The SSSQM also incorporates a "deemed to comply" solver that provides sizes of rainwater tanks and bioretention systems required to achieve the targets.

Once a complying solution is identified, the SSSQM allows the user to print a WSD Commitments Summary, which should be attached to the Development Application for submission to Council. The commitments made using the SSSQM then form part of the conditions of consent (if the Development Application is approved by Council).

Further information on the use of the SSSQM can be accessed in the Small Scale Stormwater Quality Model User Guide, which is available from a link on Port Stephens Council's website. The following information should be submitted as part of a development application:

- Site plan showing roofed and other impervious areas, treatment measure locations and drainage layouts;
- Drainage plan showing catchments, drainage systems and location of treatment systems;
- BASIX certificate for residential developments;
- For commercial and industrial sites a summary of water conservation measures to be applied on site, including an estimate of total water demands and expected savings associated with water conservation measures, as well as detail on how water demands will be managed and monitored; and
- A 'WSD Commitments Certificate' issued using the Small Scale Stormwater Quality Model.

5 WSD PRINCIPLES, OBJECTIVES AND TARGETS

5.1 WSD Objectives

Port Stephens Council (Council) requires that all developments are designed incorporating consideration of WSD to minimise impacts on the natural and built environment. Council's primary focus is currently on the stormwater component of WSD and specifically on mitigating the impacts of increased stormwater volumes and pollutant loads on receiving environments. Specific WSD objectives in the Port Stephens Council LGA include:

- protection and enhancement of the ecology of natural water systems (creeks, rivers, wetlands, estuaries, lakes, lagoons, groundwater systems);
- protection and enhancement of water quality, by improving the quality of stormwater runoff from urban catchments;
- maintenance of stream stability by reducing the frequency and duration of elevated stream flows from urban catchments;
- minimisation of harmful impacts of development upon water balance, surface and groundwater flow regimes, and flooding;
- integration of stormwater management systems into the landscape in a manner that provides multiple benefits, including water quality protection, stormwater retention and detention, public open space and recreational and visual amenity;
- conservation of potable water to achieve more efficient use of water resources;
- implementation of sustainable mitigation systems that can be maintained efficiently using resources available to Council; and
- creation of opportunities for community involvement and education on water management.

In addition to Port Stephens Council's local water management objectives, state-wide targets have been established by the Natural Resources Commission (NRC). The NRC has identified 13 state-wide targets for natural resource management. These targets include 5 specific targets for water management including:

- Target 5: By 2015 there is an improvement in the condition of riverine ecosystems.
- Target 6: By 2015 there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses.
- Target 7: By 2015 there is no decline in the condition of marine waters and ecosystems.
- Target 8: By 2015 there is an improvement in the condition of important wetlands, and the extent of those wetlands is maintained.
- Target 9: By 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems.

The implementation of WSD within new developments will assist with achieving the Council and NRC objectives.

5.2 WSD Principles

The following guiding principles should be considered when preparing a WSD strategy for development in the Port Stephens LGA:

- Minimising changes to environmental flows will assist with protecting stream and wetland ecology;
- Minimising changes to the runoff volume during frequent rainfall events following development will assist with reducing impacts on environmental flows, maintaining ephemeral flows and reducing impacts on wetting and drying cycles in wetlands;
- Minimising changes to the duration of flows up to the 2 yr ARI flow will assist with minimising changes to erosion and sedimentation within the receiving streams following development;
- Intercepting runoff within the development and conveying these flows within a defined drainage system with sufficient capacity to convey the 5 yr ARI flow will assist with minimising nuisance flooding for the community;
- Discharge of untreated stormwater from urban catchments into receiving waters and ground water will degrade the water quality in those environments;
- Retention of stormwater will reduce the concentrations and loads of stormwater pollutants discharging to groundwater or a surface water environment;
- Filtering of stormwater will reduce the concentration and loads of stormwater pollutants discharging to groundwater or a surface water environment;
- Reducing the quantity of sewage effluent discharged to watercourses will improve surface water quality in these receiving waters;
- Reducing the capture and consumption of water for human uses will reduce the impact of development on the natural water cycle and aquatic ecosystems that rely on the fresh water flows;
- Reducing the consumption of potable water assists with delaying augmentation of existing water supply systems;
- Replacing potable water with harvested rainwater and stormwater reduces the discharge of pollutants into urban streams; and
- Replacing potable water with harvested rainwater and stormwater assists with protecting urban streams from erosion.

5.3 WSD Targets

5.3.1 Stormwater Quality

MUSIC modelling shall be undertaken to demonstrate that the following stormwater quality targets would be achieved if the proposed WSD strategy was implemented. Guidance for MUSIC modelling is provided in Section 8.

Default Catchment Targets

The default catchment targets apply to all developments exceeding 2000m^2 located within catchments in the Port Stephens Council LGA that are not considered to be "Sensitive Catchments" by Council. MUSIC modelling shall demonstrate compliance with the following minimum treatment criteria:

- Total Nitrogen – 45% retention of post development load.
- Total Phosphorus – 60% retention of post development load.
- Total Suspended Solids – 80% retention of post development load.
- Gross Pollutants – 90% retention of post development load.

Sensitive Catchment Targets

The sensitive catchment targets apply to all developments exceeding 2000m^2 located within catchments in the Port Stephens Council LGA that are considered to be "Sensitive Catchments" by Council. MUSIC modelling shall demonstrate compliance with the following minimum treatment criteria:

- Total Nitrogen – 50% retention of post development load.
- Total Phosphorus – 65% retention of post development load.
- Total Suspended Solids – 85% retention of post development load.
- Gross Pollutants – 90% retention of post development load.

The pollutant load reduction targets are relevant to surface water discharges to receiving waters and infiltration to ground water. The proponent shall demonstrate how the load reductions would be achieved prior to discharge to watercourses or interception by the groundwater table.

5.3.2 Stormwater Quantity

Default Catchment Targets

WSD measures provided to manage stormwater quality and/or harvest stormwater shall incorporate sufficient storage volume to retain a minimum 10mm runoff depth from impervious roof, road, driveway and other paved landscaping areas within the development. Providing this retention storage between development surfaces and receiving waters provides a means to buffer the increased surface runoff volumes for a high proportion of the additional runoff events that occur following development. The required retention storage for individual WSD measures shall be proportional to the contributing impervious area draining to the measure.

The retention storage requirement may be achieved through a number of options. Some appropriate examples are summarised below:

- Storage in rainwater tanks below the tank outlet or spill level;
- Storage in stormwater harvesting basins, tanks or ponds below the lowest outlet level;
- Storage in constructed wetlands below the lowest outlet level;

- Storage within the extended detention component of biofiltration, infiltration or filtration measures (e.g. raingardens, biofiltration swales, biofiltration basins, media filters, infiltration trench) below the lowest aboveground outlet level; and
- Storage within the media voids of a biofiltration or filtration measure.

Sensitive Catchment Targets

For developments draining to receiving waters that are sensitive to wetting and drying cycles (e.g. freshwater wetlands), Council may require the applicant to demonstrate within the WSD strategy how the existing wetting and drying regime of the wetland will be maintained following development. It will be important for the WSD strategy to demonstrate how the increased runoff volumes following development will be managed to ensure that impacts on the receiving wetland ecology are minimised.

5.3.3 Water Conservation

Water is our most precious resource and existing urban water supply systems are approaching their limits. Expanding existing water supply dams and creating new water supply sources is becoming increasingly difficult and there are growing community demands to increase environmental flows downstream of dams. As the urban population increases, more efficient use of water also becomes increasingly important.

Residential developments are required to achieve BASIX water conservation targets. Water conservation potential for non-residential development will vary significantly. Whilst additional runoff from impervious areas may be high, potential for re-use of the runoff within the development may be limited. An assessment of the potential for reducing potable water use shall be completed by the development proponent. The development proponent shall estimate the future water demands and assess the potential for water to be supplied from alternative water sources (e.g. rainwater/stormwater harvesting). A written statement shall be provided for all non-residential developments confirming the methodology adopted for the assessment and outlining the outcomes.

6 PHYSICAL CONSTRAINTS AND OPPORTUNITIES

6.1 Terrain

The terrain of a site and adjacent land is typically one of the key constraints for WSD. The site terrain is typically analysed to confirm sub-catchments for a particular development for both internal and external parts of the site. The terrain analysis also assists with confirming surface drainage pathways within the site. A slope analysis may also be undertaken to interpret surface gradients across the site and confirm appropriate locations for particular WSD measures.

In addition to the terrain, the location of existing stormwater drainage systems and roads should be considered when determining sub-catchments as this infrastructure can modify catchments from that indicated by the general topography. The sub-catchments should also be defined considering land uses and the future development configuration.

The terrain of the site is commonly assessed utilising geographical information systems (GIS) and/or digital terrain models (DTM) that enable catchments to be delineated and the spatial distribution of site gradients to be interpreted. The terrain can also be interpreted from topographic maps or contour surveys where GIS data is unavailable.

To analyse the terrain, the site can be divided into gradient bands (e.g. <1%, 1-4% >4%) that relate to particular WSD constraints using GIS and the site DTM. Alternatively, hard copy plans showing contours could be reviewed to evaluate slopes within the site. By aligning infrastructure along the contours it may also be possible to modify the slopes to provide gradients more amenable for WSD measures.

In addition to assessing the gradients across the site, other terrain features should also be identified that potentially will impact on the location of WSD management elements including areas of slope instability and rock outcrops.

6.2 Soils and Groundwater

A key objective of WSD is to minimise changes in stormwater runoff volumes and flow duration following development. Typically this can be achieved through rainwater/stormwater harvesting and/or maximising infiltration/evapotranspiration within the remaining pervious areas.

In order to assess the suitability of a particular site for infiltration it is important that soil investigations are undertaken. Whilst infiltration will assist with reducing the volume of stormwater it is also important to consider the potential impacts of increased infiltration on factors including groundwater mounding/levels/flow/quality, downslope seepage, soil salinity and the function of WSD measures.

Preliminary desktop investigations may be undertaken using published soil landscape mapping/data and previous geotechnical investigations in the area and these can be used for preliminary planning and scoping geotechnical field investigations.

Geotechnical field investigations will be necessary on larger sites to confirm appropriate locations and types of WSD management elements. The geotechnical investigations typically will also assist with

defining parameters for modelling. The extent of investigations required will depend on the individual characteristics of the site and the proposed WSD measures. Investigations may include:

- Description, classification and mapping of the soil types within the site;
- Depth of individual soil layers in the profile and the depth to bedrock;
- Location of the groundwater table and assessment of the groundwater response to rainfall/seasonal influences;
- Groundwater monitoring/sampling and assessment for salinity, water quality, seasonal movement and flow direction/velocity;
- Soil pH and assessment of the presence of potential and/or actual acid sulfate soils;
- Presence or evidence of any soil contamination;
- Soil salinity classification;
- Saturated hydraulic conductivity testing and assessment of the permeability of surface and sub-surface soil layers (hydrophobic, hard setting soils); and
- Soil dispersibility and erosion potential.

6.3 Riparian Corridors

The protection of riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions. The NSW Office of Water (NOW) provides advice on appropriate riparian corridor widths.

Riparian corridors shall be defined considering the *Guidelines for Controlled Activities - Riparian Corridors* (DWE, 2008). Appropriate riparian corridor widths for a particular site shall be confirmed in writing with NOW, and this advice provided with the Development Application. The riparian corridor zones (Core Riparian Zone and Vegetated Buffer) and adjacent Asset Protection Zone are defined in Figure 6-1.

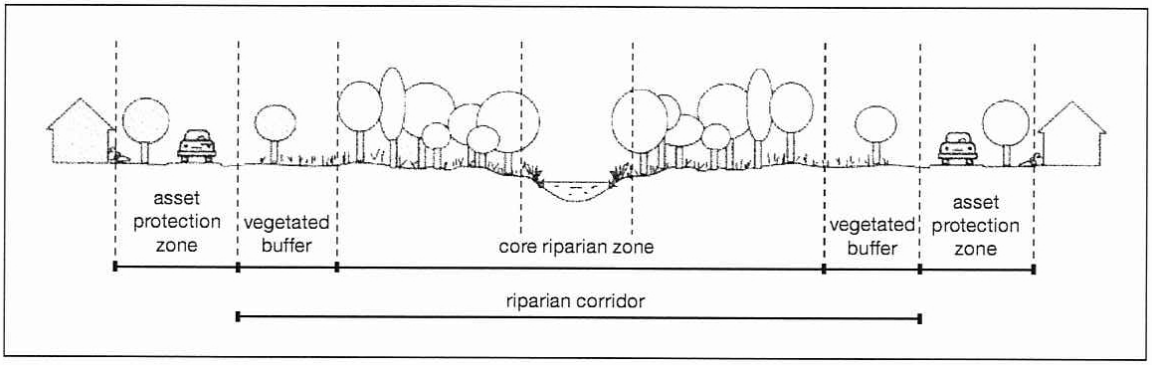

Figure 6-1 Riparian corridor zones (DWE, 2008)

The Core Riparian Zone (CRZ) is the land contained within and adjacent to the channel. NOW typically seeks to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees). WSD measures shall not be positioned within the CZR without written approval from NoW.

Typical CRZ widths for common watercourse types are provided in Table 6-1. The final CRZ width (to be measured from the top of the highest bank on both sides of the watercourse) is determined after a merit assessment of the site and consideration of any impacts of the proposed development.

Table 6-1 CRZ widths (DWE, 2008)

Watercourse description	CRZ width
Any first order[1] watercourse and where there is a defined channel where water flows intermittently	10 metres
Any permanently flowing first order watercourse or any second order[1] watercourse where there is a defined channel where water flows intermittently or permanently	20 metres
Any third order[1] or greater watercourse and where there is a defined channel where water flows intermittently or permanently. Includes estuaries, wetland and any parts of rivers influenced by tidal waters	20 – 40 metres[2]

[1] as classified under the Strahler System of ordering watercourses and based on current 1:25 000 topographic maps

[2] merit assessment based on riparian functionality of the river, lake or estuary, the site and long-term use

NOW should be contacted to confirm the requirements for riparian corridors within any particular site. Following confirmation of riparian corridor requirements for the site, these should be mapped over the site. WSD measures should be positioned outside the riparian corridor unless an alternative arrangement is approved by NOW.

The Vegetated Buffer (VB) protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution. The typical VB width is 10 metres but this depends on merit issues. NOW may require that the VB be widened on the basis of other environmental triggers such as the presence of threatened species (i.e. flora or fauna), other significant ecological communities or where the site is considered to have important ecological value. WSD measures shall not be positioned within the VB.

The Asset Protection Zone (APZ) is a requirement of the NSW Rural Fire Service and is designed to protect assets (house, buildings etc) from potential bushfire damage. The APZ is measured from the asset to the outer edge of the Vegetated Buffer (VB). The APZ should contain cleared land which means that it cannot be part of the CRZ or VB. APZ requirements are provided in the NSW Rural Fire Service document *Planning for Bushfire Protection, 2006.* WSD measures can typically be located within the APZ provided the NSW Rural Fire Service requirements are achieved.

VB and APZ widths may be negotiable and are typically confirmed on a site by site basis. NOW and the NSW Rural Fire Service should be contacted to confirm the appropriate requirements for a particular site.

6.4 Services and Infrastructure

Existing infrastructure and services can often constrain the location of WSD measures. The site analysis should also include investigations for any planned infrastructure and services that need to be accommodated in the future site design.

A services search should be undertaken through Dial-Before-You-Dig to identify the location of existing above and below ground infrastructure. Liaison with Council and the Hunter Water Corporation may be required to identify the location of stormwater drainage, sewerage and water supply infrastructure.

The location of services including water supply, sewerage, gas, electricity, telecommunications, oil pipelines and drainage should be confirmed by field survey. A plan should be prepared showing the location and typical depth (or actual depth if known) of existing infrastructure that would potentially conflict with the location of proposed WSD management elements.

7 WSD MEASURE SELECTION

7.1 Physical Constraints

Particular physical characteristics can often limit the potential for WSD measures to be incorporated into a development. A range of physical characteristics and how they broadly apply to a sample of WSD measures are summarised in Table 7-1. The physical characteristics have been assessed into three broad categories, low (L), medium (M) and high (H) for each of the WSD measures. Low constraint physical characteristics typically will not impact on the feasibility of a particular WSD measure for most sites. Medium constraints provide some restriction for a WSD measure, but can often be overcome through good design. High constraints may preclude use of a WSD measure except in exceptional circumstances where a unique design solution can be developed.

Table 7-1 Terrain, Soils and Groundwater Constraints

WSD Measure	Steep slopes	Shallow bedrock	Low permeability soil	High permeability soil	High water table	High sediment load	Land availability
Rainwater tanks	M	L	L	L	L	L	M
Vegetated filter strips	H	M	L	L	L	L	M
Pit inserts	M	L	L	L	L	M	L
Raingardens	H	H	L	M	H	M	H
Retention basins	H	H	L	L	H	M	H
Biofiltration basins	H	H	L	M	H	M	H

7.2 Stormwater Quality Considerations

The stormwater pollutants targeted for removal by WSD measures can cover a wide range of different sizes. The treatment series proposed should initially focus on capturing gross pollutants (litter, organic debris etc) and coarse particulates (sediment), followed by fine sediments, colloidal and dissolved pollutants. Configuring the treatment series in this manner will achieve pre-treatment for downstream treatment measures that could be damaged, require excessive maintenance or be impaired by excessive loads of gross pollutants and coarse sediment. For example, a biofiltration basin may become clogged with coarse sediment very quickly if no upstream retention basin is provided.

Individual WSD measures function most effectively across particular hydraulic loading rates and pollutant size ranges. As the size of the targeted pollutants reduces, the hydraulic loading rate similar reduces to ensure that effective treatment is achieved.

WSD measures that are appropriate for particular targeted pollutants and related hydraulic loading rates are shaded in Table 7-2. From Table 7-2 it can be seen that to capture certain pollutants, one treatment measure may not be sufficient. For example, whilst a rainwater tank can remove some particulate nutrients, it will be ineffective for the colloidal and dissolved nutrients for which a raingarden or biofiltration basin will provide more effective treatment.

Table 7-2 WSD Measures for Stormwater Quality Management

WSD Measure	Litter	Organic debris	Coarse sediment	Fine sediment	Metals (particulate)	Nutrients (particulate)	Nutrients (dissolved)
Rainwater tanks							
Vegetated filter strips							
Pit inserts							
Raingardens							
Retention basins							
Biofiltration basins							

7.3 Stormwater Quantity Considerations

The majority of WSD measures will typically have some influence on reducing the stormwater runoff rates and volumes from future development. The potential for a WSD measure to impact on stormwater flow rates and volumes from development sites will vary with the magnitude of stormwater retention and/or detention volume available within the measure.

WSD measures that retain and slowly release or divert stormwater volumes will typically have an influence within lower flow ranges (typically up to the 2yr ARI flow) that are important for ecology and maintaining stream stability. During medium flow range events (typically within the 2 to 10yr ARI flow range), the availability of temporary stormwater detention storage becomes important for reducing the frequency of nuisance flooding. During high flow range events (typically exceeding the 10yr ARI flow range) WSD measures are typically either located off-line or designed incorporating flood detention or bypass structures (e.g. weirs and bypass channels).

The potential for individual WSD measures to typically influence particular flow ranges is summarised in Table 7-3. This potential has been categorised into low (L), medium (M) and high (H) for each WSD measure. WSD measures with a low potential will typically have a low retention or detention storage volume relative to the contributing catchment whilst those with higher potential will have a larger retention or detention storage.

Table 7-3 WSD Measures for Stormwater Quantity Management

WSD Measure	High flows (>10yr ARI)	Medium flows (<10yr ARI)	Low flows (< 2yr ARI)
Rainwater tanks		L	M
Vegetated filter strips		L	L
Pit inserts		L	L
Raingardens		L	M
Retention basin	M	M	H
Biofiltration basins	M	H	H

8 MUSIC MODELLING

8.1 Introduction

Stormwater quantity and quality modelling shall be undertaken using the Model for Urban Stormwater Improvement and Conceptualisation (MUSIC) to estimate runoff volumes and loads of common stormwater pollutants including Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). The modelling shall be completed to inform development of a concept plan and WSD strategy for a development site.

MUSIC includes algorithms to evaluate the hydrology and concentrations / loads of common stormwater pollutants (i.e. TSS, TP and TN) from urban catchments and estimate the performance of WSD measures at capturing these pollutants.

MUSIC was designed to continuously simulate urban stormwater systems over a range of temporal and spatial scales utilising historically representative rainfall data. MUSIC is considered within the industry to be an appropriate conceptual design model for the assessment and sizing of stormwater treatment measures.

The hydrologic algorithm in MUSIC is based on the model developed by Chiew & McMahon (1997). The model simplifies the rainfall-runoff processes and requires input of the following variables to perform the hydrological assessment:

- Rainfall data (time steps varying from 6 minutes to 1 days);
- Potential evapotranspiration rates;
- Catchment parameters (area, % impervious and pervious areas);
- Impervious and pervious area parameters (rainfall threshold, soil and groundwater parameters) and
- Storm event and base flow stormwater pollutant concentrations.

MUSIC can be utilised for comparison of alternative scenarios that adopt the same base inputs. Although the magnitude of the estimates may not be equivalent to actual site conditions (due to limitations in available data for a particular site), the relative differences between scenarios is expected to be appropriate for supporting decision making. MUSIC can also be applied to evaluate the performance of stormwater treatment measures against load-based objectives.

Practical guidance to assist with the development of MUSIC models in NSW is provided in the Draft NSW MUSIC Modelling Guidelines (SMCMA, 2010). Guidance on specific modelling approaches and model inputs for the Port Stephens Council LGA is provided below.

8.2 Rainfall

MUSIC models developed in the Port Stephens LGA shall use rainfall data inputs derived from a local continuously recording (pluviograph) rainfall station. The only long-term continuous rainfall data that is publicly available in the Port Stephens LGA is recorded at the Bureau of Meteorology (BoM)

Station 061078 Williamtown RAAF. A sample of long term (>30yr) daily and continuously recording BoM rainfall stations within or adjacent to the Port Stephens LGA are summarised in Table 8-1.

Table 8-1 Rainfall Stations

Stn. ID	Type	Station Name	Record Period	Mean Annual Rainfall (mm)
061034	Daily	East Maitland Bowling Club	1902 – 1994	894
061054	Daily	Nelson Bay (Nelson Head)[1]	1881 – 2011	1348
061055	Continuous	Nobbys Signal Station	1862 – 2011	1134
061076	Daily	Raymond Terrace (Wallaroo)[1]	1936 - 2006	1146
061078	Continuous	Williamtown RAAF[1]	1942 – 2011	1124
061250	Daily	Patterson (Tocal)	1967 - 2011	925
061390	Continuous	Newcastle University	1998 – 2011	1118
061010	Daily	Clarence Town (Grey St)	1895 – 2011	1064*
061031	Daily	Raymond Terrace (Kinross)[1]	1894 - 2011	1051*
061046	Daily	Morpeth Post Office	1884 – 2011	905*
061072	Daily	Tahlee (Carrington)	1887 - 2011	1212*

1. Rainfall stations within the Port Stephens LGA, * Mean annual rainfall not listed on BoM web-site, calculated from daily rainfall data sourced from BoM.

Pluviograph data from the 061078 Williamtown RAAF have been sourced for the 1953 to 2011 period and reviewed to identify an appropriate continuous data period to use for MUSIC modelling. An appropriate 10 year period for modelling would be 1998 to 2007. This 10 year period has an average annual rainfall of 1125mm. An appropriate 5 year period for modelling would be 1999 to 2003. This 5 year period has an average annual rainfall of 1085mm which is within 4% of the long term average. Both periods have a mix of below average, average and above average rainfall years.

Digital mean annual rainfall data grids supplied by Bureau of Meteorology were utilised to evaluate the rainfall distribution across the Port Stephens LGA. The grids are based upon mean data for the 30 year period 1961-1990. Approximately 6000 rainfall stations across Australia were used to derive the grids. Review of this data indicated that the average annual rainfall varies significantly from approximately 950mm in the west of the LGA to over 1350mm in the east of the LGA. To ensure that MUSIC modelling accounts for this varying rainfall, the Williamtown RAAF rainfall data should be scaled based on the particular rainfall zones within the LGA that the development would be located within. Rainfall zones are shown in Figure 8-1. The following scaling factors should be applied to all rainfall data values in the Williamtown RAAF data record:

- Zone A – 0.9
- Zone B – 1.0
- Zone C – 1.1
- Zone D – 1.2

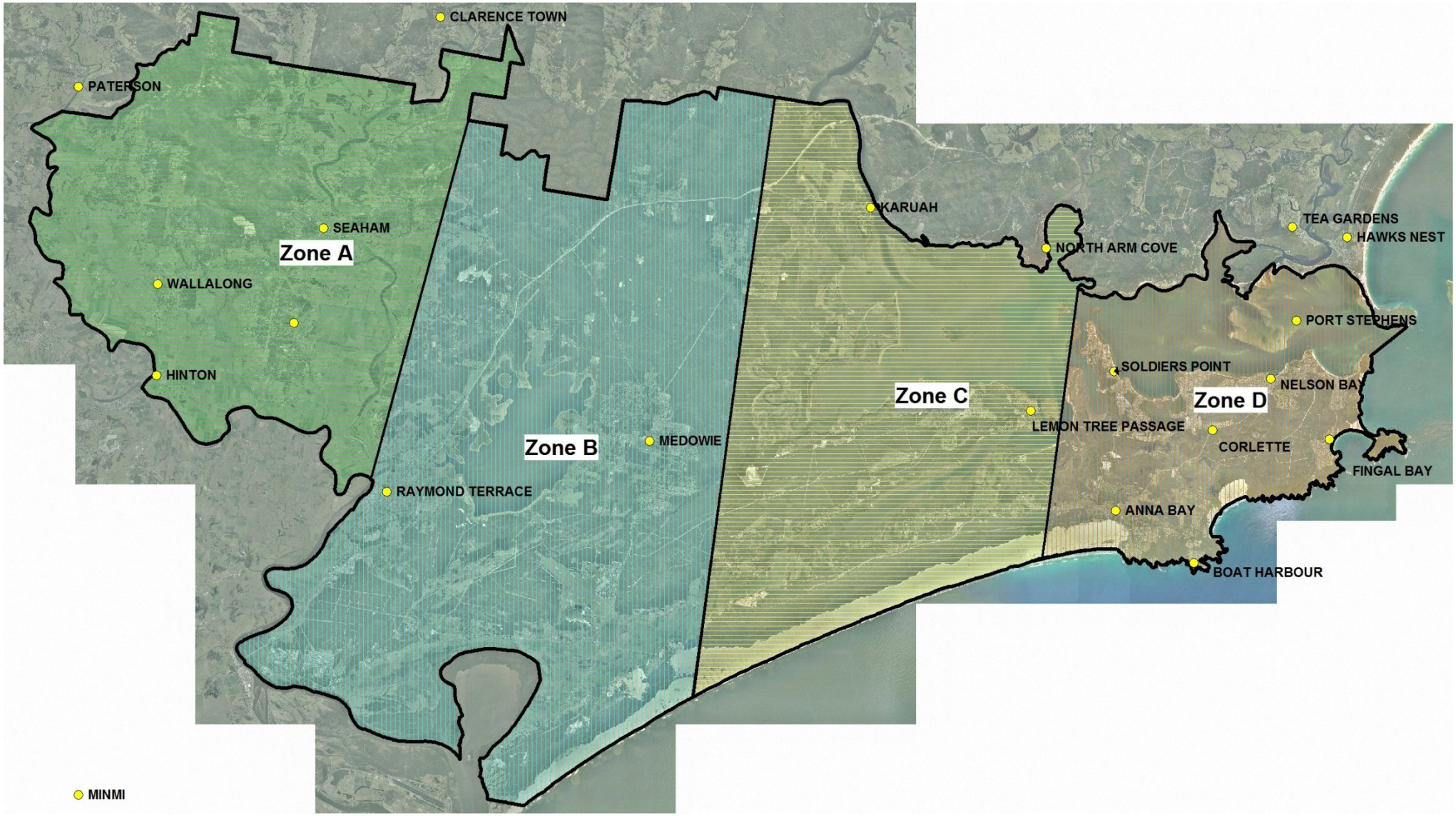

Figure 8-1 MUSIC Modelling Rainfall Zones

A 6-minute modelling time step should be adopted for all MUSIC models unless clear justification for adopting a longer time step is provided in the WSD strategy.

8.3 Potential Evapotranspiration Data

Potential evapotranspiration (PET) rates required for input to MUSIC may be determined from the Bureau of Meteorology's Climatic Atlas of Australia (BOM, 2001). Default PET rates that can be adopted for all development in the Port Stephens Council LGA are provided in Table 8-2.

Table 8-2 Adopted Average Monthly Areal PET Rates

Month	Mean monthly areal PET (mm)
January	182
February	146
March	146
April	94
May	65
June	53
July	55
August	72
September	98
October	141
November	160
December	181

8.4 Rainfall-Runoff Parameters

Modelling of the rainfall-runoff process in MUSIC requires the definition of two impervious surface parameters and eight pervious surface parameters. These parameters can be determined through a calibration and validation exercise where concurrent stream flow, rainfall and evapotranspiration data are available for the catchment being considered.

Reasonable MUSIC rainfall-runoff parameters for development sites where the dominant insitu soils are either clays or sands are presented in Table 8-3. The rainfall-runoff parameters have been derived based on the 10 year Williamtown RAAF rainfall data period indicated in Section 8.2. These parameters shall be adopted for MUSIC modelling except where development applicants can demonstrate through justifiable rainfall-runoff modelling calibration that alternative model parameters are appropriate for their particular development site.

Table 8-3 MUSIC Rainfall-Runoff Parameters

Impervious Area Parameters	Clay soils	Sandy soils
Rainfall Threshold (roofs, mm)	1.0	1.0
Rainfall Threshold (road pavement, mm)	2.0	2.0
Rainfall Threshold (mixed urban surfaces, mm)	1.4	1.4
Pervious Area Parameters		
Soil Storage Capacity (mm)	120	120
Initial Storage (% of capacity)	30	30
Field Capacity (mm)	85	40
Infiltration Capacity Coefficient – a	150	150
Infiltration Capacity Exponent - b	3.5	3.5
Groundwater Properties		
Initial Depth (mm)	10	10
Daily Recharge Rate (%)	25	90
Daily Baseflow Rate (%)	5	5
Daily Deep Seepage Rate (%)	0	0

8.5 Runoff Quality Parameters

Storm flow and base flow runoff quality parameters for all developments shall be adopted from the NSW MUSIC modelling guidelines.

9 CONCEPT DESIGN

Concept design drawings/sketches shall be prepared showing the location, size and conceptual configuration of the WSD measures. Sufficient information shall be provided to clearly demonstrate how the WSD measures function and co-ordinate within other components of the proposed development.

A sub-catchment plan shall be provided to show all site and external catchments draining to the WSD measures. Contours should be shown at an appropriate interval that clearly indicates proposed site gradients and any distinct changes in ground levels. Where the WSD measures will manage runoff from areas external to the development, contours and sub-catchments for the external areas shall be shown.

The location and total footprint of the WSD measures in relation to other infrastructure proposed within the development shall be shown. The total estimated footprint may be shown as a shaded area on a plan that shows the other elements of the development. To confirm the total footprint of the WSD measures, it will be important that consideration is given to embankments, cutting and retaining walls necessary to construct the measures. This will be particularly important within steep sites where the total footprint of a WSD measure may substantially exceed the MUSIC modelled internal treatment area of a particular measure.

A conceptual plan of the WSD measures showing the configuration of the measures shall be provided. Examples of design elements that the concept plan should show include total width/length/surface area, vehicular access, embankment and cutting extents, planting areas, maintenance access locations, proposed inlet and outlet connections to drainage systems etc.

A conceptual section/s through the WSD measures shall be provided showing the dimensions and key features of the WSD measure. Examples of the design elements that the concept sections should show extended detention depths, internal and external batter slopes, retaining wall locations, embankment crest widths, filter media layer depths, filter media characteristics, drainage pit and pipe size/location, plant species, locations and densities, inlet location/configuration etc.

Locations of existing services within or external to the development site that may require adjustment to construct the WSD measures shall be shown along with proposed connections to external drainage systems (including the existing drainage system characteristics).

There are a number of resources available to assist in the development of concept designs for WSD measures. Some examples are provided below:

Guidelines

Argue, J.R. (ed), 2004, *Water Sensitive Urban Design: Basic Procedures for Source Control of Stormwater,* Stormwater Industry Association, University of South Australia and Australian Water Association.

Brisbane City Council, (2005), *Water Sensitive Urban Design Engineering Guidelines: Stormwater, (Draft),* Brisbane City Council, Brisbane.

Engineers Australia, (2006). Australian Runoff Quality: A Guide to Water Sensitive Urban Design. Engineers Australia, ACT.

Gold Coast City Council, (2007), *Water Sensitive Urban Design Guidelines,* Gold Coast City Council.

HCCREMS, (2007) *WaterSmart Practice Notes,* Hunter & Central Coast Regional Environmental Management Strategy.

Melbourne Water (2005). *WSUD Engineering Procedures: Stormwater*. CSIRO Publishing.

Moreton Bay Waterways and Catchments Partnership 2006, *Water Sensitive Urban Design: Technical Design Guidelines for South East Queensland,* Moreton Bay Waterways and Catchments Partnership and Brisbane City Council, Brisbane.

NSW Department of Environment and Conservation, (2006) *Managing Urban Stormwater – Harvesting and Reuse*

UPRCT (2004), *Water Sensitive Urban Design – Technical Guidelines for Western Sydney* Stormwater Trust and Upper Parramatta River Catchment Trust.

Resource web sites

Water Sensitive Urban Design (WSUD) in the Sydney Region Capacity Building Program (http://www.wsud.org/index.htm).

Hunter Central Coast Regional Environmental Strategy WSUD Capacity Building Program (http://www.urbanwater.info/index.cfm).

Water by Design Capacity Building (http://www.healthywaterways.org/wbd_project_overview.html).

Clearwater Capacity Building Program (http://www.clearwater.asn.au/).

10 DRAFT OPERATION AND MAINTENANCE PLAN

To ensure that a WSD strategy will function effectively into the future it is important that operation and maintenance requirements are considered during early planning to ensure that the WSD measures can be efficiently maintained by Council.

A Draft Operation and Maintenance Plan (OMP) shall be prepared at development application stage to outline how operation and maintenance issues have been appropriately considered when preparing the WSD strategy. The Draft OMP shall be provided within the WSD strategy report and include details on the elements outlined below.

A **description of the measures** shall be provided including the locations and types of WSD measures proposed. This description shall also include a summary of the land uses / surfaces draining to the measures and the expected types and loads of pollutants that would be captured by each measure.

A **description of any staging** associated with the proposed development or WSD measure construction shall be provided. It will be important that it is demonstrated that sufficient WSD measures will be provided throughout the development and building phases to ensure that the Council's objectives and targets would be achieved from commencement to completion of all road and building construction. It is also important that measures that will subject to potential damage and/or excessive sediment loading during a building construction phase are staged to ensure that the measures will be functional during when the catchment is stabilised. It shall be clearly demonstrated how the construction of measures will be staged (e.g. temporary sacrificial vegetation or media layers during construction replaced by final layers prior to asset handover).

A **description of the maintenance methods** for the WSD measure shall be provided. A fundamental consideration for Council will be that the proposed measures can be efficiently maintained using available Council equipment and personnel. The maintenance methods described shall include a summary of the inspection and maintenance frequencies, equipment and number/qualifications of maintenance personnel required.

An **estimate of the operation and maintenance costs** for the WSD measures shall be provided to ensure that Council has a good appreciation of the future long-term operation and maintenance costs associated with the measures. Council requires the future operation and maintenance costs for WSD measures to be estimated at the DA stage to avoid construction of measures that will ultimately be ineffective due to excessive and impractical maintenance costs. Cost estimates shall be provided for the operation, maintenance and replacement/decommissioning cost elements for each measure. More detailed guidance on evaluating operation and maintenance costs is provided in a report titled 'An Introduction to Life Cycle Costing Involving Structural Stormwater Quality Management Measures' prepared by the Co-operative Research Centre for Catchment Hydrology (Taylor, 2003a).

A description of the proposed **site and measure access** shall be provided. It will be important that a legal and geometrically viable site access for the types of equipment required to maintain the measures is available. If maintenance activities will require heavy vehicles (e.g. tip trucks, excavators) then the access pavement must be planned to have sufficient strength for these traffic loads. The access alignment and gradients shall be suitable for the required maintenance vehicles

for all weather access. The site should also be checked to confirm that existing or future features/infrastructure would not impede maintenance (e.g. overhead power lines, sewerage, tree branches). The presence of other conditions that may impede future maintenance shall be confirmed (e.g. base flow, tidal flows). It will be important that safety for maintenance personnel is also considered to ensure that the measures can be safely maintained in the future (e.g. conflicts with traffic should be avoided).

The **maintenance responsibility** for the WSD measures shall be confirmed. The development proponent shall confirm if the future maintenance responsibility will lie with Council, the private property owner or a body corporate/community association. Council's preference is that WSD measures be located within public lands formed by the development wherever possible.

The OMP shall be a living document that is progressively updated through the development stages. Further revision to the Draft OMP prepared for the Development Application shall be undertaken at the following stages:

- Construction certificate – Revised Draft OMP providing further detail that will be applied during the construction period to maintain the measure.
- Asset handover – Final OMP amended at the completion of construction maintenance period to take account of any modifications or lessons learnt. Further guidance on Council's handover requirements for WSD measures are provided in Section 11.

11 HANDOVER OF DEVELOPER CONSTRUCTED WSD MEASURES

11.1 Overview

Council will typically assume responsibility for future maintenance of WSD measures on Council land following completion of construction by a developer and a subsequent developer maintenance period provided the following conditions are satisfied-:

- Work-as-executed drawings and any required engineering certifications for the WSD measure have been provided to Council;
- Council has inspected the WSD measure and confirmed that it is being well maintained in accordance with the Draft OMP;
- The Draft OMP has been reviewed and revised (if necessary) following completion of the developer maintenance period and this final plan is approved by Council;
- A final estimate of long term annual operation and maintenance costs for the WSD measure is provided to Council. The operation and maintenance cost estimates shall be based upon verifiable expenses incurred during the maintenance period and evidence provided to confirm this; and
- Details of any incidents including, OH&S incidents, public safety, and complaints received shall be provided.

If Council determines that a WSD measure is not complying with the applicable development consent conditions (e.g. WSD measure is not being maintained in accordance with the approved OMP), Council will not be obliged to accept responsibility for maintenance of the WSD measure. Until formal written approval is provided by Council accepting responsibility for maintenance, the developer would retain responsibility for maintaining the WSD measure. Where inspections identify that the WSD measure is not performing as designed, Council may require alterations prior to handover.

Large and other non-standard WSD measures that have increased maintenance requirements may require additional contributions from the developer to assist council with future maintenance. Council may require that the developer agrees to contribute a lump sum contribution for operation and maintenance costs (20 year design life, 4% discount rate, assessed by council) that are associated with the WSD measure. Maintenance bonds may be required for some developments to ensure that maintenance of WSD measures is undertaken throughout the construction and developer maintenance period. Requirements for maintenance contributions and bonds should be discussed with Council during the early development stages to confirm Council's requirements for assuming responsibility for maintenance of the WSD measures.

11.2 Developer Maintenance Period

The developer maintenance period is the interval between construction of a WSD measure and handover of maintenance responsibility for the measure to Council.

The developer shall be responsible for inspecting and maintaining WSD measures in accordance with the approved OMP during the construction and developer maintenance periods. All inspections

and maintenance of the WSD measure during the developer maintenance period shall be funded by the developer.

The developer maintenance period will typically commence at the date of practical completion, but may also be linked to a particular construction milestone. The developer maintenance period provides sufficient time for WSD measures to be fully functioning (e.g. vegetation established) and for most development surfaces disturbed during development activities to be stabilised either by covering with impervious surfaces (e.g. roads, buildings, paving) or vegetated. A maximum developer maintenance period is also specified to ensure that onerous maintenance conditions are not imposed on developers when building activities proceed slowly.

A developer maintenance period of 6 months applies to all WSD measures constructed by developers that are to be handed over to Council. Typically a developer maintenance period will apply to WSD measures constructed in public land by the developer.

Council requires that the developer operates monitors and pays for all expenses in relation to a WSD measure, in accordance with s68 of the Local Government Act in the period prior to handover.

11.3 Private Lot Installations

In situations where WSD measures are installed within private property, the developer shall arrange for the creation of appropriate restrictions on user (easements) and positive covenants, and registration of these title encumbrances with the Land Titles Office. The title encumbrances shall be registered prior to the issue of an Occupation Certificate for the development.

A Section 88B/88E instrument prepared under the Conveyancing Act 1919 by a solicitor, surveyor or other suitably qualified individual should provide appropriate restrictions and covenants to enable unhindered long term management and maintenance of the WSD measures. In particular, the instruments should-:

- Protect the WSD measure from being constructed over or modified;
- Provide a legal right-of-way for Council to inspect the WSD measure and for maintenance vehicle access;
- Require an owner/body corporate/community association to carry out maintenance of the WSD measure in accordance with the Final OMP and provide regular maintenance reports to council;
- Give authority to Council to issue a directive to the owner/body corporate/community association to clean or repair a WSD measure within 14 days of notification;
- Give authority to Council to enter the property and complete maintenance if a directive to clean or repair a WSD measure is not complied with and recover the costs to complete this maintenance from the owner/body corporate/community association; and
- Require that all current and future owners/body corporates/community associations maintain the WSD measures in perpetuity for the life of the development.

12 WSD STRATEGY REPORT

A WSD strategy report shall be submitted with the development application outlining the approach followed to prepare a WSD strategy for the development. The report shall summarise the approach adopted and provide justified reasoning for the proposed WSD strategy. The WSD strategy report shall include the following key elements (as a minimum).

A **site description** shall be provided to outline the proposed development characteristics and configuration. This description may include the site area, existing land use, proposed land use, proposed development characteristics (e.g. lots, buildings, roads, carparking, landscaping) and surrounding land uses. The development layout adopted for preparing the WSD strategy shall either be included within the WSD strategy report or reference included to a specific drawing (including drawing reference, date, issue version etc) that is included with the development application documentation.

The water management **principles, objectives and targets** applying to the development shall be summarised in the WSD strategy. The development proponent shall provide concise statements of how the individual water management principles and objectives have been addressed in the WSD strategy. Key sections of relevant policies, planning instruments and legislation that outline these principles, objectives and targets are summarised in Port Stephens Council's DCP 2007. The development proponent shall ensure that any additional planning requirements applying to the development are identified and addressed.

A **site analysis** shall be provided outlining the site terrain, soil and groundwater characteristics, riparian zones, existing services and infrastructure, and other site features that potentially would offer constraints or opportunities for WSD. Within this section sub-catchments should be defined and receiving water characteristics (including waters downstream of the site) described (e.g. aquatic/terrestrial ecology, water quality and, bed and bank conditions). Depending on the scale of the proposed development, the site analysis may also include consideration of other relevant urban design criteria that influence WSD (e.g. flooding, ecology, landscaping, visual, bushfire, heritage, archaeology, acoustics, and transport). The site analysis should provide a summary of key constraints and opportunities, and confirm potential risks to the receiving waters if mitigation measures are not provided within the development. Any review of background reports/data and additional site investigations undertaken to inform the site analysis shall be referenced and described in this section.

A summary of the **WSD measures** considered for the development shall be provided. This section of the strategy shall identify the WSD measures that are most appropriate for the site considering the principles, objectives and targets, and site analysis outcomes. This section should outline the recommended WSD treatment series and summarise the reasoning for selecting these measures. If there are any relevant issues remaining unresolved, recommendations shall be included to resolve these issues during detailed design. It will be important that any issues that impact on the feasibility of a particular measure be resolved at this stage. Only issues that potentially would require minor modifications to the selected WSD measures should be addressed during detailed design.

The WSD strategy shall include a summary of **MUSIC modelling** completed to assess the performance of the proposed series of WSD measures. This section of the report shall summarise

the model input data used, modelling assumptions, modelled arrangement of WSD measures, model results and conceptual configuration of the WSD measures. The MUSIC modelling section shall include comparisons between the modelled WSD strategy and the targets relevant to the development. A statement shall be provided confirming if the targets would be met by implementing the proposed strategy. It will be important that the MUSIC modelling results presented are based upon feasible and practical measure configurations. MUSIC models shall be submitted with the WSD strategy.

The WSD strategy shall include **concept design drawings and/or sketches** showing the location, size and conceptual configuration of the WSD measures. Conceptual plans and sections shall be provided for all key WSD measures. A conceptual WSD strategy plan shall be provided to show the location and total footprint of the recommended WSD measures, and how the individual WSD measures will be connected to form an effective treatment series. Sufficient information shall be provided to clearly demonstrate how the WSD measures function and co-ordinate within other components of the proposed development.

A section outlining the **operation and maintenance** requirements for the proposed WSD measures shall be provided in the WSD strategy. The WSD strategy shall include a summary of the access requirements, maintenance equipment, maintenance methods etc. An estimate of the annual operation and maintenance costs for each WSD measure shall be provided. The estimates shall be based on actual data for maintenance of these measures.

The WSD strategy shall be prepared by a qualified professional Civil or Environmental Engineer with qualifications suitable for admission to Engineers Australia who is actively practicing in the area of WSD.

13 GLOSSARY

A.H.D. – Australian Height Datum, a common national plane of level corresponding approximately to mean sea level.

Commercial Development – means all development permissible in the Business Zones of Council's LEP, but excludes any development separately defined in this Plan.

Consent – means development consent.

Council – means Port Stephens Council.

Development Application (DA) - means an application made to a consent authority, generally Council, to enable development to be carried out.

Development Control Plan (DCP) - means a plan prepared by Council to clearly document its policy for a type of development or a specific site or locality.

Easement – means an easement that gives a right to use or travel over a specified strip of land belonging to another. They include easements for drainage and electricity easements, or right of way.

Environment – includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.

Existing urban areas – are any lands where the percentage of impervious surface is equal to or greater than 10% of the legal property description of the land upon which the development is proposed and where the total project value is equal to or greater than that required for submission of a BASIX Certificate.

Greenfield Development – is any new development or redevelopment occurring on lands where the percentage of impervious surface is less than 10% of the legal property description of the land upon which the development is proposed.

Industrial Development – means all development permissible within the Industrial Zones outlined in Council's LEP, but excludes any development separately defined in this Part.

Locality Analysis – is an assessment completed of a site as part of preliminary studies for a Water Sensitive Design strategy.

Local Environmental Plan (LEP) - The LEP generally consists of a series of zoning maps and a written instrument.

Lot – means an area of topographical space shown on an approved plan of subdivision and on which it is intended to construct a building or buildings (also referred to as an allotment).

Multi Unit Dwelling (or Multi Dwelling Housing) – means 3 or more dwellings (whether attached or detached) on one lot of land (not being an individual lot in a strata plan or community title scheme) each with access at ground level, but does not include a residential flat building.

MUSIC – is the Model for Urban Stormwater Improvement Conceptualisation as developed by the CRC for Catchment Hydrology and eWater CRC.

Special Use Development – means development including child care centres, community facilities, education establishments, amusement centres, hospitals, places of worship, recreation areas, recreation facility and tourist facilities, as defined in Council's LEP.

Subdivision – means the division of land into two or more parts that, after the division, would be obviously adapted for separate occupation, use or disposition.

SSSQM – is the Small Scale Stormwater Quality Model developed by the BMT WBM on behalf of the Sydney Catchment Authority and Sydney Metropolitan Catchment Management Agency as a simpler model for evaluating the performance of small scale developments with respect to storm water quality rather than undertaking detailed water quality modelling.

Road – means a street, lane, highway, pathway or thoroughfare, including a bridge, culvert, causeway, road-ferry, ford, crossing and the like, on the line of a road through or over a watercourse, open to the public for the passage of vehicles, persons or animals and including community title roads.

Re-development – means any development which is undertaken on land for which a previous development application was submitted, approved and resulted in operational works being undertaken to completion.

Infill development – means any development in an existing urban area that will result in an increase in imperviousness from that which was present prior to the development

BMT WBM Brisbane
Level 11, 490 Upper Edward Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email wbm@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Denver
14 Inverness Drive East, #B132
Englewood Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email wbmdenver@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Mackay
Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email wbmmackay@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Melbourne
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email wbmmelbourne@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Newcastle
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email wbmnewcastle@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Perth
1 Brodie Hall Drive Technology Park Bentley 6102
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email wbmperth@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email wbmsydney@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Vancouver
1190 Melville Street #700 Vancouver
British Columbia V6E 3W1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email wbmvancouver@wbmpl.com.au
Web www.wbmpl.com.au