Design, Construction & Maintenance of WSUD

HUME CITY COUNCIL
Macedon Ranges Shire Council
Shire of Melton
Mitchell Shire Council
City of Wyndham
The Place To Be
Melbourne Water

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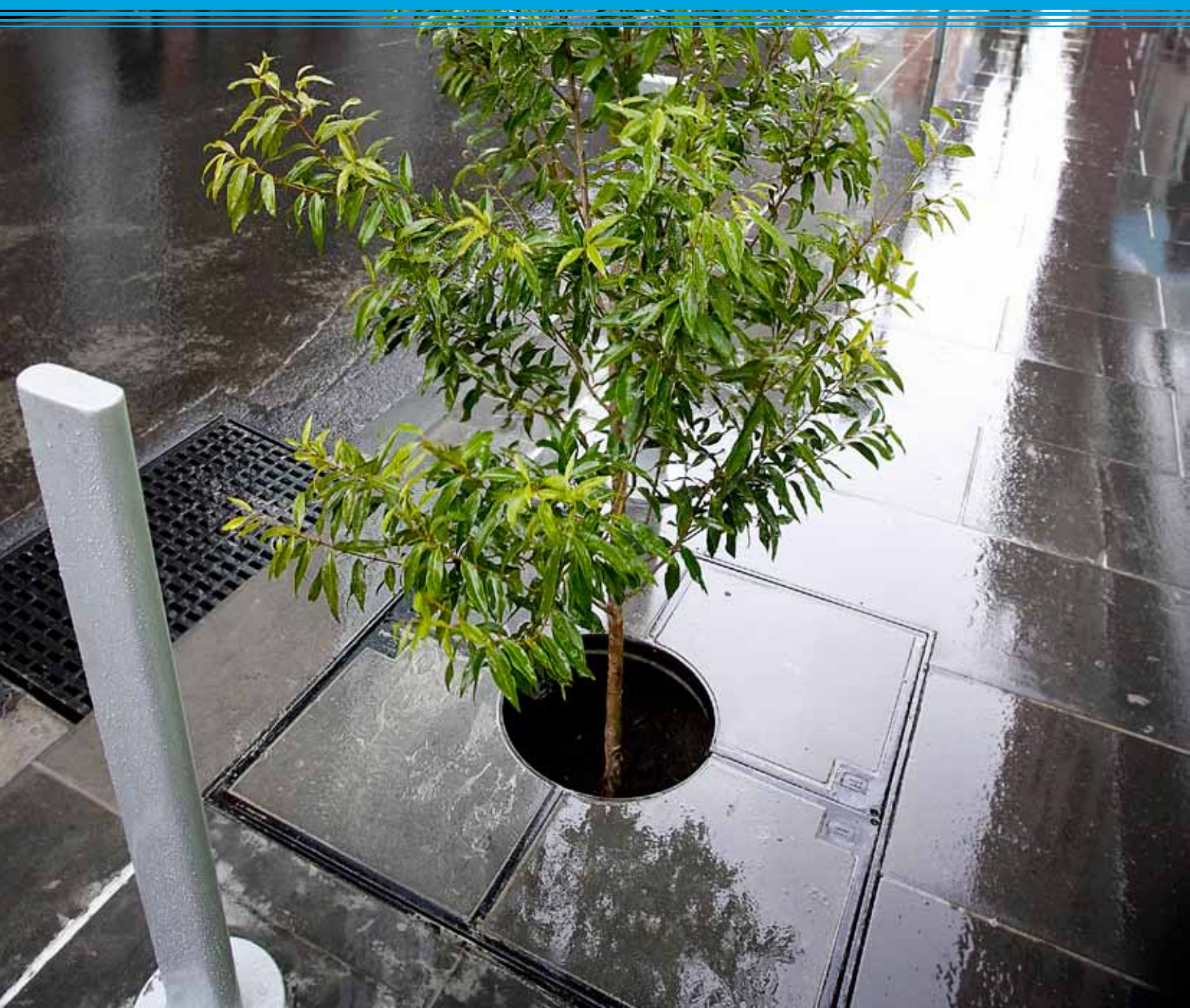

These Water Sensitive Urban Design (WSUD) Guidelines set out Council's expectations for WSUD projects within the municipality, to inform developers and consultants. The document provides information on the approvals process, design considerations, suitability of WSUD types in different conditions and considerations for construction, protection, maintenance and handover of WSUD assets.
These guidelines should be used in conjunction with the published manuals that outline the WSUD design requirements (refer to references section and the council specific addenda).

In addition to the usual requirements for planning applications, the following items should be considered for applications including WSUD:

- Approval Process (Section 2)

  1. **Pre-application consultation** between applicant, Council and other relevant stakeholders (such as Melbourne Water), to discuss proposed compliance with Council-specific WSUD requirements.
  2. **Submission of conceptual design** of WSUD treatments with planning application, including report on WSUD design intent, confirming how compliance with Council-specific requirements will be achieved.
  3. **Submission of detailed design** of WSUD treatments for construction purposes, provided after the Planning Permit is issued and prior to works commencing. Matters for attention include specific Planning Permit conditions, where applicable, and design compliance with Council-specific standard requirements such as.

     - Council-specific requirements listed in the Addendum to these Guidelines (this includes approved WSUD treatment types and information on the drainage authority, local drainage schemes and requirements for sites of less than 1 ha).
     - Construction phase requirements to ensure effectiveness of WSUD treatment systems at time of installation and protection until handover (Section 2.2.2).
     - Maintenance, handover and defects liability requirements (Section 2.2.3).
     - WSUD treatment system design and maintenance considerations (Appendices A and B).

1. Introduction

1.1 Background

In 2009, Melbourne Water's Living Rivers Stormwater Program provided funding to progress and finalise Water Sensitive Urban Design (WSUD) Guidelines for councils on the northern and western fringe of Melbourne. To assist Melbourne Water, Parsons Brinkerhoff were commissioned to develop these guidelines and relevant council specific addenda for the Hume, Whittlesea and Wyndham City Councils, and the Macedon Ranges, Melton, Mitchell and Moorabool Shire Councils.

1.2 Purpose of the Guidelines

These guidelines aim to set out Council's expectations for WSUD projects within their municipality, to inform developers and consultants. The document provides information on the approvals process, design considerations, suitability of WSUD types in different conditions and considerations for construction, protection, maintenance and handover of WSUD assets.

The WSUD Guidelines do not seek to recreate the good technical guidance provided in other published documents (see the References section), but rather to tie these documents together and act as a first reference point for WSUD projects. The guidelines also seek to provide greater consistency in WSUD requirements between Councils..

1.3 How to use the Guidelines

This document aims to provide greater consistency in Council requirements for developments incorporating WSUD techniques across Council boundaries. Hence the main document and Appendices A and B should remain consistent across the region, while the Addendum contains the Council-specific requirements. These guidelines should be used in conjunction with the existing planning framework and are applicable to various types of developments including residential, commercial and industrial developments.

1.4 What is Water Sensitive Urban Design?

Water Sensitive Urban Design integrates urban water cycle management with urban planning and design, with the aim of mimicking natural systems to minimise negative impacts on the natural water cycle and receiving waterways and bays. It offers an alternative to the traditional conveyance approach to stormwater management by acting at the development scale (at the source), and thereby reducing the required size of the structural stormwater system. It seeks to minimise impervious surfaces, reuse water on site, incorporate detention and retention basins to reduce peak flows, and incorporate biofiltration systems to remove pollutants.

The key principles of WSUD as stated in the Urban Stormwater: Best Practice Environmental Management Guidelines (BPEMG) (Victorian Stormwater Committee, 1999) are:

a. Protect and enhance natural water systems within urban environments.

b. Integrate stormwater treatment into the landscape, maximising the visual and recreational amenity of developments.

c. Improve the quality of water draining from urban developments into receiving environments.

d. Reduce runoff and peak flows from urban developments by increasing local detention times and minimising impervious areas.

e. Minimise drainage infrastructure costs of development due to reduced runoff and peak flows.

1.5 Why use Water Sensitive Urban Design?

Stormwater is the water that runs off our urban surfaces following rain events. It has been identified as a key cause of pollution and declining health of our waterways.

As urban development occurs, the proportion of impervious surfaces in our catchments increases. This increases the velocity and amount of water running into our waterways, creating problems of erosion and flooding and changing natural flow regimes, with associated ecological damage. It also washes more pollutants into our streams, further impacting upon river health.

WSUD has been identified as a means to control flows and filter stormwater to remove pollutants. It offers the potential to reduce the costs, infrastructure sizing and occupied land area associated with conventional drainage approaches whilst treating runoff closer to its source. This more effectively mimics a natural system and, as treatment can be located further upstream than for conventional approaches, is efficient by providing flow-down effects that benefit the entire catchment.

The benefits of WSUD are such that the approach is now supported – and in some cases mandated – by various regulations and policies applied across Victoria. These are briefly outlined in the following section..

1.6 Regulatory considerations for stormwater management

1.6.1 State Environment Protection Policy (Waters of Victoria)

The State Environment Protection Policy (SEPP) (Waters of Victoria) (EPA Victoria, 2003) is a state wide policy requiring that runoff from urban and rural areas must not compromise the beneficial uses of receiving waterways. This policy specifically refers to stormwater pollution and requires the implementation of measures to control its environmental impact. WSUD is a tool used to comply with this Policy.

1.6.2 Victoria Planning Provisions

The Victoria Planning Provisions (VPP) contain a number of clauses that support the sustainable management of stormwater runoff from development, including the use of WSUD. These include the State Planning Policy Framework Clauses 11, 12, 14, 15 and 18.09, which pertain to all types of development within the state. Councils are responsible for administering planning policies, and these clauses provide a solid basis in the planning scheme for Councils to apply WSUD requirements to all developments, including residential, industrial and commercial uses.

Furthermore, Clauses 56.07 and 56.08 of the VPP were introduced on 9 October 2006, and have provided a significant driver for the development of these guidelines. Clause 56.07 relates to integrated water management in residential subdivisions, and Clause 56.07-4 and Standard C25 mandate best practice targets for pollutant load reductions and flow discharges to be met in such developments. In most cases, this will necessitate the incorporation of WSUD into the subdivision design. Clause 56.08 establishes requirements for site management during residential subdivision works and includes many issues pertinent to the protection of WSUD systems, such as site sediment control.

This document is designed to guide the integration of WSUD into all types of developments, including residential, industrial and commercial. It does, in particular, also aim to set out and simplify the process and requirements involved in satisfying Clause 56.07-4.

All of the abovementioned planning policies relating to stormwater management apply state wide. Further information on these policies is provided below.

Clause 11 – Introduction, goal and principles

This Clause, and the following Clauses, establishes the link between the planning system and the state requirements for environmental protection and provides guidance for developers from a planning perspective.

Clause 12 – Metropolitan development

Clause 12 applies to development within metropolitan Melbourne. The strategy for stormwater management, under 12.07-2, is to "Reduce the impact of stormwater on bays and catchments" by:

- Incorporating water-sensitive urban design techniques into developments to:
  - Protect and enhance natural water systems.
  - Integrate stormwater treatment into the landscape.
  - Protect quality of water.
  - Reduce run-off and peak flows.
  - Minimise drainage and infrastructure costs.

Clause 14 – Settlement

Clause 14 aims to ensure a sufficient amount of land is available for residential, commercial, industrial, recreational, institutional and other public uses within urban areas. It requires that the decision making by planning and responsible authorities 'must' be consistent with relevant requirements of the State Environment Protection Policies including Waters of Victoria and any specific catchment policies.

Clause 15 – Environment

Clause 15 aims to assist the protection, and where possible, restoration of catchments, waterways, water bodies, groundwater and marine environment. It states that "Planning and responsible authorities should ensure land use and development proposals minimise nutrient contributions to waterways ... consistent with ... the Urban Stormwater: Best Practice Environmental Management Guidelines (Victorian Stormwater Committee 1999)". Refer to Section 1.7 for more information.

Clause 18 – Infrastructure

Clause 18 aims to integrate land use and transport planning around existing and planned declared highways (roads), railways, principle bus routes and tram lines.

Clause 18.09, water supply, sewerage and drainage, requires that planning and responsible authorities should ensure that:

a. Water quality in water supply catchments is protected from possible contamination by urban, industrial and agricultural land uses.

b. Best environmental management practice is used where practicable in the design and management of urban stormwater drainage systems, including measures to reduce peak flows and assist screening, filtering and treatment of stormwater, to enhance flood protection and minimise impacts on water quality in receiving waters.

Clause 56.07-4 and Standard C25

Under Clause 56.07-4 local Councils are responsible for requiring that urban runoff from new residential subdivisions of 2 lots or more meet best practice water quality and flow requirements. The objectives of Clause 56.07-4, which must be met, are:

a. To minimise damage to properties and inconvenience to residents from urban run-off.

b. To ensure that the street operates adequately during major storm events and provides for public safety.

c. To minimise increases in stormwater run-off and protect the environmental values and physical characteristics of receiving waters from degradation by urban run-off.

Standard C25 sets out the normal way of meeting the Clause 56.07-4 objectives. Among other requirements, Standard C25 requires that urban stormwater management systems 'must' be:

a. Designed to meet current best practice performance objectives for stormwater quality, as outlined in the Urban Stormwater: Best Practice Environmental Management Guidelines (Victorian Stormwater Committee 1999) as amended. Refer to Section 1.7 for more information.

b. Designed to ensure that flows downstream of the subdivision site are restricted to predevelopment levels unless increased flows are approved by the relevant drainage authority and there are no detrimental downstream impacts.

Standard C25 requires that urban stormwater management systems must be designed and managed to the requirements of the relevant drainage authority. This is typically Council, with the exception of catchments of 60ha or more within the Melbourne Water drainage boundary, in which case it is Melbourne Water.

The following link provides an additional resource for Council with the implementation of Clause 56.07-4: http://www.clearwater.asn.au/content/clause-56-victorian-toolkit

1.7 Urban Stormwater Best Practice Environmental Management Guidelines for stormwater treatments

The objectives for on-site treatment relating to urban stormwater quality, as outlined by the Urban Stormwater: Best Practice Environmental Management Guidelines (BPEMG) (Victorian Stormwater Committee 1999), are:

- 80% retention of the typical urban annual load for Total Suspended Solids (TSS)
- 45% retention of the typical urban annual load for Total Phosphorus (TP)
- 45% retention of the typical urban annual load for Total Nitrogen (TN)
- 70% retention of the typical urban annual load for gross pollutants (litter).

The guidelines prescribe that discharges for 1.5yr ARI (Average Recurrence Interval) be maintained at pre-development levels for stormwater treatments. Retarding regular low flow events reduces in-stream erosion that often results from urban development.

These stormwater quality objectives reflect the level of stormwater management necessary to meet the SEPP (Waters of Victoria) (EPA Victoria, 2003) requirements and are the target design criteria for WSUD water quality treatments (Section 2.2.1).

2. WSUD and Council Approval Process

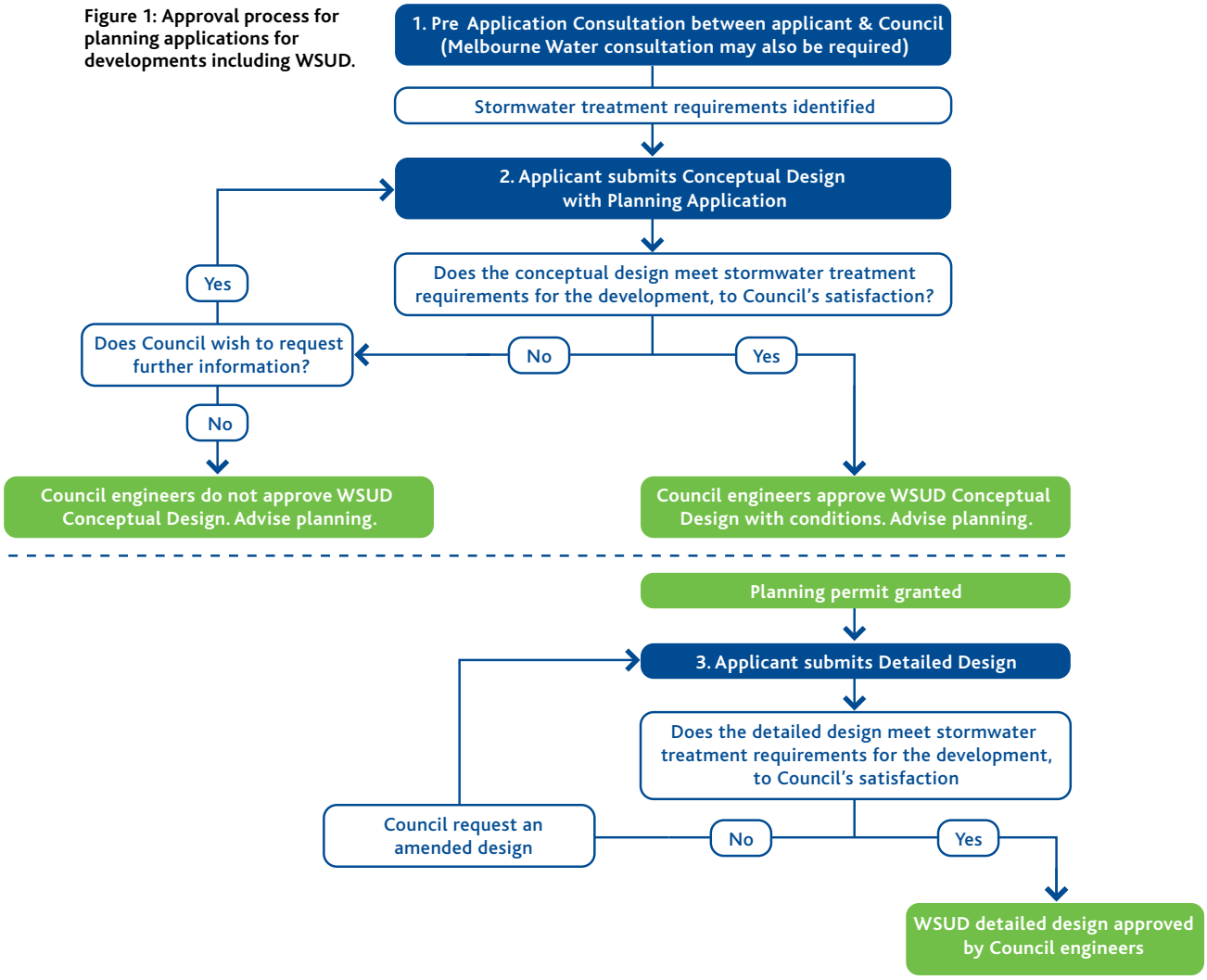

Figure 1: Approval process for planning applications for developments including WSUD.

2.1 Step 1: Pre-Application Consultation

Council encourages developers (or consultants on behalf of developers, hereafter referred to as the 'developer') to consult with Council, and where appropriate Melbourne Water in turn, early in the conceptual design stage of a subdivision to discuss suitable WSUD options. It is recommended that Council identify the need for involvement of other stakeholders, such as Melbourne Water, at the pre-application meeting. It is the responsibility of the developer to ascertain Council's requirements prior to commencing preliminary planning and design (refer to Council Addendum for specific requirements or relevant key stakeholders within Council).

At the Pre-Application Consultation the developer should provide the following information for the proposed subdivision:

a. Location
b. Type of development (e.g. residential, industrial, commercial, etc)
c. Area and number of lots
d. Development density
e. Detail of any existing water quality works
f. Proposed outfall/legal point of discharge (LPOD)
g. Proposed extent of WSUD (indicative only)
h. Possible site constraints for some WSUD treatment types and the proposed approach to overcome these (indicative only)

It is the responsibility of the developer to be familiar with these guidelines. It is recommended that the developer also refer to available Precinct Structure Plans or other relevant development planning information (refer to Council Addendum). The Pre-Application Consultation provides an opportunity to clarify requirements with Council and other relevant stakeholders. *In particular, the developer should be familiar with the following items:*

2.1.1 Approved WSUD treatment types

Council may not support the use of all WSUD treatment types, due to their unsuitability for local topography, maintenance and safety requirements. Please refer to the Council Addendum for the approved list of WSUD treatment types.

2.1.2 Construction and defect liability requirements, design and maintenance considerations

Developers should be aware of the following sections of these guidelines that outline the construction phase and defect liability requirements, and describe the design and maintenance considerations for WSUD treatments:

a. Section 2.2.2 for construction phase requirements.
b. Section 2.2.3 for maintenance, handover and defect liability requirements.
c. Council Addendum for any Council-specific design, construction, maintenance and handover requirements.
d. Appendix A for relative performance, site suitability, approaches to site constraints and ongoing maintenance considerations.
e. Appendix B for WSUD treatment descriptions, and design and maintenance considerations.

2.1.3 Subdivisions within Melbourne Water Development Services Schemes

Where Clause 56.07-4 applies and a proposed residential subdivision is located within an existing Melbourne Water Development Services Scheme (previously known as 'Drainage Scheme') that contains water quality (WQ) works, the developer will have the option of making a financial 'Development Services Scheme contribution' to Melbourne Water in lieu of using WSUD to meet some or all of the best practice stormwater quality requirements. Information on Development Services Schemes is available at http://ldm.melbournewater.com.au. Developments using WSUD to treat stormwater onsite will still require Council approval as per Figure 1.

Details of any local drainage schemes can be found in the Council Addendum.

2.1.4 Sites of less than one hectare

The Clause 56.07 Planning Practice Note (DSE, 2006) makes an exception for residential subdivisions of less than one hectare. Where the developer has proven that best practice stormwater quality requirements can not be achieved on-site and all reasonable actions within the subdivision have been taken, the relevant drainage authority may offer other options, as outlined in the Practice Notes. Refer to the Council Addendum for options.

2.2 Step 2: Submission of Conceptual Design

Conceptual Designs for developments must satisfy the following WSUD requirements:

a. Include a Report on the WSUD Design Intent meeting the requirements detailed in Section 2.2.1.
b. Consider future maintenance requirements. Where Council believes that the treatment may not be able to be adequately maintained, Council may request additional information.
c. Use Council-approved WSUD treatment types (refer to Council Addendum).
d. Meet the stormwater quality requirements for the development (see Section 1.7), and submit the relevant MUSIC models in electronic copy to Council.
e. Meet any Council-specific design, construction, maintenance and handover requirements as noted in the Council Addendum.
f. The overall development plan must also address the relevant drainage, flood management, space and public safety requirements for the development.

The conceptual design must also satisfy the drainage requirements of maintaining discharges of the 1.5 year ARI at pre-development levels for stormwater quality systems (see section 1.7) and 1 in 5 year ARI for the entire drainage system (unless otherwise specified in the Council Addendum).

The design of WSUD treatment systems should maintain design flexibility throughout the concept design phase, to allow for modifications in the development plans for issues such site constraints or other limits to the design.

WSUD conceptual designs that are approved by Council engineers should be approved with a condition along the following lines: "in accordance with the conceptual design submitted or as modified by the referral authority".

2.2.1 Report on WSUD Design Intent

Council approval will be subject to the WSUD treatments' performance meeting the stormwater quality requirements within the development, set out by the Council in the pre-application discussions. The conceptual design should include a report outlining the WSUD design intent and an electronic copy of the MUSIC model (Model for Urban Stormwater Improvement Conceptualisation). This analysis and report, submitted by or on-behalf of the developer, should be conducted by a suitably qualified and experienced engineer.

Note that the STORM modelling tool could also be used for this purpose. STORM is a simplified model for rating stormwater quality performance where the proposed WSUD systems are not linked in series (i.e. a treatment train), and is typically used on smaller catchments of generally less than 1ha.

Where STORM is used, a print-out of the input parameters and relevant performance of the system should be submitted.

Refer to Melbourne Water for guidance on using STORM:

http://wsud.melbournewater.com.au/content/storm/storm.asp

Report Contents

The report on the WSUD design intent should include a summary of the treatment performance in terms of:

a. Mean annual load (kg) from subdivision for Total Suspended Solids (TSS), Total Phosphorus (TP), Total Nitrogen (TN) and gross pollutants.

b. Percentage reduction for TSS, TP, TN and gross pollutants for the total treatment train

c. Percentage reduction for TSS, TP, TN and gross pollutants for each treatment system in the treatment train.

Where rainwater tanks or a stormwater harvesting scheme is proposed a continual water balance for one year should be provided, unless directed otherwise by Council Addenda.

The report should include a description of the function and intent of the treatment systems, including:

- Treatment types
- Treatment sizes

Topographic and spatial requirements

Development plans need to address spatial and topographic requirements for the WSUD treatment systems. Developers should provide Council with supporting design information in the form of cross sections or equivalent, particularly in confined space.

MUSIC input data

The following information about the catchment and MUSIC configuration should be included:

a. Land use zones and the fraction impervious used

b. Land use zones and the pollution concentration data used if different to the default parameters used in MUSIC (not recommended unless justified by scientifically sound, peer-reviewed studies)

c. Description of any deviation from the design process outlined below.

Council will provide rainfall data to be used with MUSIC (see the Council Addendum). The appropriate rainfall station has been selected to best represent the region. Representative years of rainfall data have been selected to best match long-term meteorological records in terms of mean annual rainfall and the 90th percentile of rainfall.

For guidance on all other input parameters, developers should refer to the Melbourne Water MUSIC Input Parameters (2010).

The MUSIC input parameters and configuration should be submitted to Council for approval, with the Conceptual Design. Any deviations from this design process should be fully explained.

Electronic data to be provided to Council

An electronic copy of the following MUSIC model information should be provided to Council with the WSUD Design Intent Report:

- Sqn or Sqz model of the catchment with treatment measures
- Map showing drainage and contour information for the catchment and sub-catchments in MapInfo or other approved format. If an electronic copy is not available then a hard copy may be acceptable.

The applicant may wish to use the free MUSIC Auditor Tool to identify and address any inappropriate input parameters prior to submission. The tool is available at: http://www.clearwater.asn.au/content/melbourne-water-music-4-guidelines

2.2.2 Construction phase requirements

Appendices A and B provide detailed information about the specific design and construction considerations for the different WSUD treatment types. Some particular requirements are listed here:

- The hydraulic conductivity of filter media should be:
  - Certified by the supplier, otherwise onsite testing must be conducted, to demonstrate if the hydraulic conductivity meets the design requirements for the treatment type (see Appendix B regarding compaction of filter media over time).
  - Tested by the developer's contractor during the handover inspection in accordance with the "Guidelines for Soil Filter Media in Bioretention Systems" (FAWB, 2009).
- Refer to the plant species list provided by Council in the Addendum for suitable vegetation options. If a specific list for the region is not provided then refer to the plant species list in the Council Addendum of the WSUD Engineering Procedures: Stormwater Guide (2005).
- Planting is best conducted during autumn months. However the timing of planting also depends on adequate water availability, adequate by-pass of high winter flows, and the schedule for the development.
- A detailed Site Environmental Management Plan (SEMP) should be submitted with the Detailed Design. Refer to the Clause 56.08 Planning Practice Note (DSE, 2006) for further guidance on the contents of an SEMP. The SEMP should at least:
  - Identify areas of stockpiling cut and fill
  - Specify how creeks, drains, pits, adjoining properties, streets and WSUD treatment systems will be protected during construction from inappropriately located stockpiled material, sediment laden runoff, tracking of soil from the site and damage from vehicles. Measures could include:
    - Silt fences
    - Straw bales
    - Wheel washes
    - Fences/bollards around WSUD treatment systems
    - Sacrificial layers in treatment systems
    - Temporary planting during construction for sediment control (e.g. with turf) can then be removed and the area planted out with long term vegetation.

2.2.3 Maintenance, handover and defect liability period

The following items should be considered during the Conceptual Design phase. Documentation indicating how these items have been addressed will be required as part of the Detailed Design documentation:

- maintenance plans: responsibilities, requirements (including cleanout frequencies and systems performance) and indicative costs
- asset handover arrangements, where appropriate, including defect liability and timeframes
- sufficient access for staff and/or machinery for maintenance requirements

Requirements between Council and the developer should be made for the following defects liability periods (to commence after practical completion of WSUD treatments):

- Bioretention systems, rain gardens, bioretention swales and sand filters – 24 months
- Sedimentation basins, wetlands, lakes and ponds
- Civil assets (e.g. pipes and concrete structures) – 24 months
- Landscape vegetation & plantings – 24 months

Any Council-specific maintenance and handover requirements are detailed in the Council Addendum.

Ongoing maintenance activities for specific treatment types are discussed in Appendices A and B.

2.3 Step 3: Submission of Detailed Design

Detailed designs of developments must satisfy the following WSUD requirements:

a. Be consistent with the Conceptual Design (Section 2.2), i.e. be consistent with the submitted MUSIC model, including parameters used therein (if these change, a new MUSIC model should be submitted to reflect the changes).
b. Include a Site and Environmental Management Plan, which meets the Construction Phase requirements detailed in Section 2.2.2.
c. Include the indicative management arrangements for maintenance and handover of WSUD treatments, and meet the Defect Liability requirements detailed in Section 2.2.3.
d. Use Council-approved WSUD treatment types (see Council Addendum).
e. Meet the stormwater quality requirements for the development (see Section 1.7).
f. Maintain discharges of 1.5 year ARI at pre-development levels for stormwater quality treatment systems (see Section 1.7) and 1 in 5 year ARI for the entire drainage system (unless otherwise specified in the Council Addendum).
g. Meet any Council-specific design or maintenance requirements in the Council Addendum.
h. The overall development plan must also address the relevant drainage, flood mitigation, space and public safety requirements for the development.

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4. Acknowledgements

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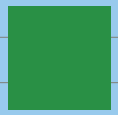
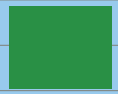
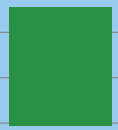
Appendix A

WSUD Treatment Function, Applicability and Maintenance Considerations

Table A-1: Summary of treatment function, applicability and cost: Adapted from: Victorian Stormwater Committee (1999); Wong (2006); EPA (2008)

✓ High applicability
✓ Medium applicability
✓ Low applicability

	Bioretention swales	Bioretention basins /raingardens	Vegetated swales/ buffer strips	Sand filters	Sedimentation basins	Constructed wetlands	Ponds and shallow lakes	Rainwater tanks	Stormwater Harvesting
FUNCTION:									
Water quality treatment	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓	
Flow attenuation	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓	
Stormwater conveyance	✓✓✓	✓	✓✓✓	✓	✓	✓	✓	✓	
Particle size removal									
Coarse-Medium particles 5000 µm-125 µm									
Fine particulates 125 µm-10 µm									
Very fine/Colloidal particulates 10 µm-0.45 µm									
Dissolved particles <0.45 µm									
Additional function		Landscape value	Aesthetic appeal Habitat values		Landscape value	Habitat, visual & recreation amenity	Habitat, visual & recreation amenity	Stormwater re-use	Habitat, visual & recreational amenity
APPLICABILITY:	Median strip/ verge	Streets	Median strip/verge/ parks	Streets/many	Pre-treatment to wetland	Parks/vacant land	Aesthetic/post wetland	On-property	Parks/vacant land
Area requirement	Larger areas (with limited public access)	Limited space	Larger areas (with limited public access)	Limited space	Large areas	Large areas	Large areas	Limited space	Large area (when using an above ground storage)
Slope considerations and approach to site constraints	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Flat land. Where land is sloped terraces can be used.	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Suitable for steeper slopes	Flat land	Flat land	Suitable for steep land	Suitable on most sites	Flat land
Level of flow control	Conveyance	Discharge	Conveyance	Discharge	Discharge	Discharge	Discharge	Source	Discharge
INDICATIVE COSTS:									
Installation costs	Moderate	Moderate	Low	Low/Moderate	High	High	High	Low	High
Maintenance costs	Moderate	Moderate	Moderate/High	Moderate	Moderate/High	Moderate	Moderate	Low	Moderate

Indicative costs: Indicative costs for comparison purposes only

Installation costs: Based on the treatment's total installed cost per hectare of catchment. Broad approximations are as follows:
- High: Greater than $1500 per hectare of catchment;
- Moderate: Between $500 and $1500 per hectare of catchment; and
- Low: Less than $500 per hectare of catchment

Maintenance costs: Based on the cost per hectare per annum for each treatment type. Broad estimates are as follows:
- High: Greater than $250 per hectare of catchment per annum;
- Moderate: Between $100 and $250 per hectare of catchment per annum; and
- Low: Less than $100 per hectare of catchment per annum.

The functionality, applicability and maintenance requirements of each WSUD treatment type should be carefully considered when preparing and approving designs. The following tables outline the functionality, applicability and maintenance considerations for various WSUD treatment systems. Indicative costs for the different treatment systems have also been included. These are intended to be a comparative guide only. These tables are intended to be used in conjunction with the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).

Table A-2: Indicative ongoing maintenance considerations: Adapted from: Melbourne Water 2005, WSUD Engineering Procedures; EPA 2008, Maintaining WSUD Elements

	Bioretention swales	Bioretention basins /raingardens	Vegetated swales/ buffer strips	Sand filters	Sedimentation basins	Constructed wetlands	Ponds and shallow lakes	Rainwater tanks	Stormwater Harvesting
Debris removal	On-going/ as required	On-going/ as required	On-going/ as required	On-going/ as required	On-going/ as required	On-going/ as required	On-going/ as required		On-going/ as required
Check inlet erosion protection	Routine inspections following significant storm events*	Routine inspections following significant storm events*	Routine inspections following significant storm events*		After significant rainfall events immediately following installation.	After significant rainfall events immediately following installation.	After significant rainfall events immediately following installation.		Routine inspections following significant storm events*
Removal of accumulated sediments	Monitor & remove accumulation near bioretention inlet particularly during construction activities.	Monitor & remove accumulation near inlet particularly during construction activities. Monitor long term for filter media effectiveness	On-going/ as required*	After significant rainfall events immediately following installation. 6 monthly after this*.	When basin is more than half full of accumulated sediment (typically every 5 years).	As required during first two years if poor site erosion management during construction, but sedimentation basin should prevent.	As required during first two years if poor site erosion management during construction, but sedimentation basin should prevent.		After significant rainfall events immediately following installation.
Vegetation maintenance – Removal of noxious plants – Replacement of dead plants – Fertilising plants	Intensive during plant establishment (2 years) then as needed. Can be coordinated with other garden maintenance carried out by Council.	Intensive during plant establishment (2 years) then as needed. Can be coordinated with other garden maintenance carried out by Council.	Intensive during plant establishment (2 years) then as needed. Can be coordinated with other garden maintenance carried out by Council.			Intensive during plant establishment (2 years) then as needed. Can be coordinated with other garden maintenance carried out by Council.	Suitable for steep land		Depending on storage type adopted Intensive during plant establishment (2 years) then as needed. Can be coordinated with other garden maintenance
Inspection of sedimentation chamber and filter/sand media	Every year check filter media composition/ infiltration rate.	Every year check filter media composition/ infiltration rate.		Every 3-6 months check sed chamber & sand surface.					Every year
Maintenance of artificial turnover system (if installed)							Specific to design		
Roof/gutter maintenance								6 months	
First flush device								3-6 months	3-6 months
Inlet/overflow screens								6 months	6 months
Sludge accumulation								2-3 years	
Pump system								As required	As required

* Note that the frequency of many of these activities will depend on the nature of the catchment, ie. more often during construction phase.

Appendix B

WSUD Treatment Measures – Design and Maintenance Considerations

WSUD Treatment Measures

This section provides information on some of the design and maintenance considerations. However, this section in no way replaces the existing WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) and other documents referred to in the respective sections, which provide detailed design and maintenance guidance for WSUD treatment measures.

This section provides a summary of key WSUD treatment measures that are currently used for best practice urban stormwater management around Melbourne and surrounding Shire Councils. A combination of measures is often used as a 'treatment train', to effectively manage stormwater and achieve desired pollutant reductions. Table A-1 (Appendix A) provides a guide to the function, applicability and cost of each of the treatment types.

It is recommended that developers refer to the Addendum for a list of Council-approved treatment types before proceeding.

Primary treatment WSUD measures such as litter and gross pollutant traps have not been included here, as there are numerous manufactured devices and technical design manuals available. Ponds and lakes are included, because they are considered to provide a stormwater management function when installed as part of a treatment train, although they are not considered as a stand-alone WSUD treatment measure.

The hydraulic conductivity of filter media is critical to the effectiveness of bioretention basins and rain gardens. Note that in the first year compaction and silting can result in reduced hydraulic conductivity of the filter media. Research suggests that it can be reduced by up to half in the first year (FAWB, 2009). It is recommended that the size or ponding depth of rain gardens and bioretention basins should be maximised to compensate for this variability by sizing the system with an ultimate hydraulic conductivity of 50% of the prescribed hydraulic conductivity. Where this is not possible, filter media should be used with a higher hydraulic conductivity (approximately twice) than that used for modelling the system in MUSIC. Refer to FAWB (2009) for more detail.

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Bioretention Swales

Bioretention swales (or bioretention trenches) are bioretention systems that are located within the base of a swale. They provide both a conveyance function for stormwater and treatment through filtration, extended detention and some biological uptake. The swale facilitates the removal of coarse to medium sized sediments, while the bioretention system is particularly efficient at removing nitrogen and other soluble or fine particulate contaminants.

Figure B-1: Bioretention Swale
Source: Melbourne Water.

Bioretention swales are often well suited to highly urbanised areas such as commercial precincts or car parks as they can be easily incorporated into landscaped areas without impacting on development opportunities. They can provide attractive landscape features in an urban development and are commonly located in the median strip of divided roads. Swales can often be used as an alternative to a conventional pipe system, resulting in construction cost reductions.

The design of bioretention swales should be in accordance with guidelines set out in Chapter 5 (Section 5.3) of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).

Design and Maintenance Considerations

- Bioretention swales are sensitive to materials that may clog the filter medium and may suffer vegetation damage through traffic and washdown wastes which should be controlled. Protection during construction phase is critical.
- Filter media should be hydraulic conductivity tested before construction and before handover. Refer to the WSUD Engineering Procedures: Stormwater Guide (2005) for the filter media specification.
- Typically bioretention swales are best suited to slopes of 1 to 4% or where velocities during major flood events do not exceed 2 m/s. Where excessive grades are identified as a constraint, check dams may be required to reduce flow velocities.
- Water ponding at entry points to the swale should not occur for longer than 1 hour after the cessation of rainfall as prescribed in Clause 56.07-4 of the VPP.
- The gradient of swale batter slopes are dependant on Council regulations and will relate to traffic access and driveway crossings. For maintenance requirements, grassed swales requiring mowing must not have side slopes exceeding 1 in 6.
- A velocity-depth check should be undertaken to ensure public safety (refer to Section 5.3.4.1 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005)).
- Consultation with landscape architects is recommended when specifying vegetation to ensure the treatment of the system compliments the landscape of the area. Refer to the plant species list in the Council Addendum of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for suitable vegetation options.

Bioretention basins/ Rain gardens

Bioretention basins and rain gardens treat stormwater by passing runoff through prescribed filter media (commonly vegetated) that provides treatment through fine filtration, extended detention and some biological uptake.

A wide range of vegetation can be used within a bioretention basin allowing them to be readily integrated into the landscape of an area.

Figure B-2: Bioretention Basin Source: Melbourne Water.

Bioretention basins are suitable at a range of scales and shapes and, hence, provide a flexible treatment measure. They can be positioned at regular intervals along streets to treat runoff prior to entry into an underground drainage system or be located at drainage system outfalls to provide treatment for larger areas. Bioretention systems are often more effective in removing Nitrogen than conventional wetlands and can therefore be a practical alternative where land for a treatment system is limited.

Design considerations for bioretention basins are detailed in Section 6.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) and should be consulted.

Design and Maintenance Considerations

- Bioretention basins are sensitive to materials that may clog the filter medium and may suffer vegetation damage through traffic and washdown wastes which should be controlled. Protection during construction phase is critical.
- Filter media should be hydraulic conductivity tested before construction and before handover. Refer to the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for the filter media specification.
- The width of water ponding at entry points to the basin should not occur for longer than 1 hour after the cessation of rainfall as prescribed in Clause 56.07-4 of the VPP.
- Soil testing to determine the expected hydraulic conductivity should be undertaken where bioretention systems are installed near to significant structures, to minimise any leakage from the system. If surrounding soils are sensitive to seepage from the bioretention basin, such as in sandy soils, or where the filter is located near a permanent structure, an impervious liner, can be used to contain all water within the basin. Lining measures should not create subsurface barriers to shallow groundwater movements.
- Consultation with landscape architects when selecting vegetation is recommended. Refer to the plant species list in the Council Addendum of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for suitable vegetation options.
- The use of biofilters should be avoided where there is a permanent base flow, which prevents the filter medium from drying out in between storm events.

Vegetated swales/ Buffer strips

Vegetated swales convey stormwater and provide removal of coarse and medium sediment.

They are commonly used in conjunction with areas of vegetation through which runoff passes, known as buffer strips. Vegetated swales are similar to bioretention swales, but are less effective in removing nitrogen from the stormwater, as they do not feature the filtering component and convey water on the surface only.

Figure B-3: Vegetated Swale Source: Melbourne Water.

Vegetated swales can provide an aesthetically pleasing landscape feature and are relatively inexpensive to construct and maintain. They can be used in median strips, verges, car park runoff areas, parks and recreation areas.

The design specifications for swales and buffer strips can be found in Chapter 8 (Section 8.3) of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005). Design techniques to ensure swales are sized appropriately should be consulted (refer to Appendix C of BPEMG (Victorian Stormwater Committee, 1999)).

Design and Maintenance Considerations

- The longitudinal slope of a swale is the most important consideration. Swales are most efficient with slopes of 1% to 4%. Lower than this, swales can become waterlogged and/or have stagnant pooling, while steeper slopes may have high flow velocities (with potential erosion and vegetation damage risks). Check banks (small porous rock walls) may be constructed to distribute flows evenly across the swale if they are identified as the most suitable treatment option in such areas.
- Where swales are publicly accessible, flow depths and velocities must be acceptable from a public risk perspective. Refer to Section 8.3.5.1 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for standards.
- Traffic and deliveries should be kept off swales as they may damage vegetation and create preferential flow paths that do not offer filtration. Appropriate mitigation measures should be implemented.
- Swale side slopes depend on Council regulations, traffic access and the provision of crossings. Typically 1 in 9 side slopes are suitable. For maintenance requirements, grassed swales requiring mowing must not have side slopes exceeding 1 in 6.

Sand Filters

Sand filters comprise a bed of sand or other media through which runoff is passed. Gross pollutants and coarse to medium sized sediment (125 µm or larger) are retained in a sedimentation chamber before stormwater percolates through the filtration media. The filtrate is then collected by an underdrain system. These systems lack surface vegetation either because they are installed underground or because the filter media does not retain sufficient moisture to support plant growth.

Figure B-4: Sand Filter Source: Melbourne Water.

Sand filters can be retrofitted and may therefore also be a suitable WSUD measure in existing developments.

The design of sand filters should follow Section 7.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005). Construction advice can be obtained from Section 7.4.2 and maintenance requirements from Section 7.5 of this document.

Design and Maintenance Considerations

Sand filters are particularly useful in areas of limited space where treatment is best achieved underground. They are suited to upstream areas where constructed wetlands are unfeasible.

- Regular maintenance is required to ensure the sand filter media does not become clogged with accumulated sediments.
- Water lost from the sand filter to the surrounding soil may be an issue if they are installed near to significant structures. The surrounding soils should be tested (particularly to determine their hydraulic conductivity). An impervious liner can be used to contain all water in the form of a flexible membrane or concrete casing.
- Large sand filters lacking vegetation may be unattractive.
- Unsuitable for highly disturbed catchments or those with high sediment yields (unless pre-treatment is proposed to protect the system).

Sedimentation Basins

Sedimentation basins serve to remove coarse to medium-sized sediments (typical target size of particles is 125 µm or larger) and are often the first element in a stormwater treatment train.
They facilitate the settling of particles through temporary detention and the reduction of flow velocities.
A sedimentation basin should always be constructed upstream of a wetland.

Determining the critical size of a sedimentation basin is crucial to:

Figure B-5: Sedimentation Basin Source: Melbourne Water.

- Prevent smothering of downstream treatment measures (if the basin is too small),
- Avoid the accumulation of smaller particles of higher contaminant concentrations (in the case of over-sized basins), and
- Prevent the need for frequent desilting.

Details on verifying the required basin size can be found in the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) sections 4.2 and 4.3.2.

Key design parameters include a consideration of design flows, sediment storage volume, target sediment size, hydraulic structures and vegetation specification. For details refer to Section 4.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).

Design and Maintenance Considerations

- The design operation discharge for the basin should be a minimum of 1 year ARI peak discharge.
- A bypass structure should provide for flow bypass of downstream macrophyte zones and wetlands for events up to 100-year ARI event. Weirs are often a suitable method of controlling surface flows so that large events can bypass a treatment, while allowing the required flow to pass through the system.
- Sedimentation basins are often large structures requiring substantial area and are important assets when constructed upstream of wetlands. When available space is constrained, the sediment basin size should not be compromised if forming part of a treatment train. If the site constrains the total size of the treatment system, the macrophyte zone in the wetland should be reduced accordingly.
- The sedimentation basin should be designed to remove 95% of the particles less than 125 µm in a 1 in 1 year storm event.
- Approach batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H). All edges should have safety benches of at least 1.5m to 3.0m wide from the edge of the normal top water level.
- Safety benches should have a maximum grade of 1:8 (V:H) for the first 1.5m – 3.0m before changing to a 1:5 (V:H) grade for at least the next 0.5m. Beyond this the grade may be to a maximum of 1:3 (V:H). It is recommended that an independent safety audit be conducted for each design.
- Refer to the Constructed Wetland Systems: Design Guidelines for Developers (Melbourne Water, 2005) for guidance on hard stand areas, which should be provided adjacent to the inlet zone to allow for the maintenance and cleanout of this zone. The hard stand should be at least 3m wide and designed to be capable of supporting a 20 tonne excavation plant. Multiple areas should be considered where the pond is greater than 7m wide. Adequate space for dewatering must be provided. Access ramps and tracks into ponds cells and to all hard stand areas are required and must be capable of supporting a 20 tonne excavation plant for maintenance.
- Where sedimentation basins double as a landscape element, a weir is recommended as an appropriate discharge control structure. Refer to Section 4.3.4.2 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).
- Accumulated sediment requires regular removal to prevent scouring during storm events. A desirable frequency of basin desilting for permanent facilities is once every five years (or when sediment accumulates to half the basin depth).
- Install a rock layer in base above clay liner to indicate limit of sediment (this reduces the risk of damage to the clay liner during future maintenance activities).
- For sediment basins less than 14m wide, access is to be provided along both edges for maintenance vehicle.
- For sediment basins greater than 14m wide, drawdown of the basin is required with vehicular access available into the base of the facility.

Constructed Wetlands

Figure B-6: Constructed wetland macrophyte zone
Source: Melbourne Water.

Constructed wetland systems are shallow, extensively vegetated water bodies that remove pollutants through enhanced sedimentation, fine filtration and pollutant uptake processes. Stormwater runoff is passed slowly through the vegetated areas, which filter sediments and pollutants, and biofilms establish on the plants, which absorb nutrients and other contaminants. Wetlands are well suited to treat large volumes of stormwater runoff and have the advantage of improving local amenity and providing habitat diversity. Key design issues to consider include: verifying the size and configuration for treatment; determining design flows; designing the inlet zone (see sedimentation basins); layout of the macrophyte zone; hydraulic structures; selecting plant species and planting densities and providing maintenance.

Refer to the following documents for detail:

- Section 9.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005);
- Section 7.9.2 and Appendix G of the Urban Stormwater: Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999); and
- Constructed Wetland Systems: Design Guidelines for Developers (Melbourne Water, 2005).

Design and Maintenance Considerations

- The constructed wetland should treat at least 90% of Mean Annual Runoff through the use of a stored event volume above the normal standing water level of the wetland.
- A high flow bypass should be capable of taking flows in excess of design flows (typically a 1 in 1 year event).
- The wetland design must meet safety requirements and implement reasonable safety measures. This includes fencing, safety batters, signage and benching. Refer to Section 5 of the Constructed Wetland Systems: Design Guidelines for Developers (Melbourne Water, 2005) for detail. Health and Safety considerations for maintenance staff should also be addressed. It is recommended that an independent safety audit be conducted for each design.
- Approach batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H). All edges should have safety benches of at least 1.5m to 3.0m wide from the edge of the normal top water level.
- Safety benches should have a maximum grade of 1:8 (V:H) for the first 1.5m – 3.0m before changing to a 1:5 (V:H) grade for at least the next 0.5m. Beyond this, may be up to a maximum of 1:3 (V:H). The safety bench should be densely planted with emergent macrophytes such that casual entry will be difficult.
- Refer to the Constructed Wetland Systems: Design Guidelines for Developers (Melbourne Water, 2005) for guidance on hard stand areas, which should be provided adjacent to the inlet zone to allow for the maintenance and cleanout of this zone.
- The following measures may be taken to reduce the prevalence of mosquitoes: Provide access for mosquito predators such as fish and predatory insects; Maintain natural water level fluctuations to disturb the breeding cycle of some mosquito species; and provide sufficient gross pollutant control at the inlet such that litter does not accumulate and provide breeding habitat.
- Ensure that the required detention time is achieved by using outlet risers to control flows.
- The riser outlet pipe should be sized to act as an emergency overflow equivalent to the one year ARI peak discharge.
- A minimum of a 0.3m freeboard for the embankment is required.
- Where possible, wetlands should be constructed in the base of retarding basins to reduce land requirement.
- When considering macrophyte zone layout, it is important to optimise hydraulic efficiency (i.e. reduce dead zones and short circuiting of water). The optimal hydraulic efficiency value for constructed wetlands should be not less than 0.5 and greater than 0.7 where possible. Refer to Section 9.3.3 and Figure 9.6 in the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).
- The wetland should be divided into four macrophyte zones, an open water zone and a littoral zone. The percentage allocation of each zone is outlined in Table 9.2, Section 9.6.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) and should be followed. Refer to the plant species list in the Council Addendum of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for suitable vegetation options.
- Wetlands require large areas of land for construction and are unsuited to steeply sloping land.
- A geotechnical investigation is required prior to design to determine soil profiles and infiltration rates. Hydrogeological investigations may also be required in areas where there is a likelihood of groundwater discharge or high seasonal water tables.

Ponds and shallow lake systems

It is not recommended that shallow lakes and ponds be used as a stand alone measure to meet BPEMG targets.

They may however function as a useful element when implemented as part of a treatment train.

Figure B-7: Pond system with edge vegetation
Source: Melbourne Water.

Ponds promote particle sedimentation, adsorption of nutrients by phytoplankton and UV disinfection. They can also double as storage facilities for reuse schemes, recreation features and wildlife habitats. Often wetlands will flow into ponds although they can exist independently in areas where wetlands are unfeasible for example in steep terrain.

Details of design procedures for ponds and lakes can be found in Section 10.3 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005). Refer also to the Constructed Shallow Lake Systems: Design Guidelines for Developers (Melbourne Water, 2005), which should be read in conjunction with the Constructed Wetland Systems: Design Guidelines for Developers (Melbourne Water, 2005) for guidance on hard stand areas. These documents should be referred to for detailed design guidance.

Design and Maintenance Considerations

- Algal blooms are the main risk with ponds and lake systems and reducing the risk of blooms is an integral component of design (refer to Section 10.3.2 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005)).
- When considering macrophyte zone layout, it is important to optimise hydraulic efficiency (i.e. reduce dead zones and short circuiting of water). The optimal hydraulic efficiency value for ponds and lakes should be not less than 0.5 and greater than 0.7 where possible. Refer to Section 10.3.2 and Figure 10.7 in the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005).
- Gentle slopes, safety benching, handrails and vegetation planting are methods that may be employed to account for public safety. It is recommended that an independent safety audit of each design be conducted.
- Fringing vegetation is important for bank stability and aesthetics but contributes little to improving stormwater quality. Refer to the plant species list in the Council Addendum of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005) for suitable vegetation options.
- Ponds are well suited to steep, confined valleys where storage volumes can be maximised.

Rainwater tanks

Rainwater tanks collect roof runoff for subsequent reuse, conserving potable mains supplies and reducing stormwater runoff volumes and pollutants from reaching downstream waterways.

Rainwater tanks are applicable to areas of high roof area to occupancy ratio, while they are less applicable in regions of low roof area to occupancy ratio, such as medium and high density residential dwellings.

Figure B-8: Rainwater tank Source: Melbourne Water.

The use of rainwater tanks should follow considerations stated in Section 12.2 and design procedures in Section 12.4 of the WSUD Engineering Procedures Stormwater Manual (Melbourne Water, 2005).

Design and Maintenance Considerations

- Rainwater tanks should be installed in accordance with the Plumbing and Drainage Standards (AS/NZS 3500 2003).
- Rainwater tanks may not provide the optimal strategy for stormwater runoff from a sustainability perspective compared to a centralised stormwater harvesting scheme. This issue should be investigated thoroughly during the concept design stage of a project.
- Continual water balance assessments using MUSIC should be performed to determine how much runoff rain tanks are removing from the catchment in terms of runoff volumes and associated pollutant loads.
- Rainwater tanks should be sized using the appropriate reference curves for the region (refer to Section 12.4.2 of the WSUD Engineering Procedures: Stormwater Manual (Melbourne Water, 2005)). (Refer to council specific addenda for use of rainwater tanks as a flow detention device).

Stormwater Harvesting

Stormwater harvesting systems collect stormwater runoff, typically from stormwater drains, for subsequent reuse. Stormwater harvesting is becoming an increasingly important component of stormwater management with the benefits of both reducing potable water use and reducing the volumes of runoff and pollutants entering the downstream waterways.

Stormwater harvesting systems generally consist of the following components: collection, storage, treatment and distribution (Department of Environment and Conservation NSW, 2006). The storage type for these schemes can vary, however they are commonly designed as storage tanks (either above or below ground) or open water ponds or dams.

Stormwater harvesting and reuse is applicable to various uses including: industrial or commercial uses, residential uses, and for irrigation of public parks or recreation reserves. They are typically a centralised system, and may require a relatively large area, particularly if using above ground storage.

Figure B-9: Royal Park Source: Melbourne Water.

Figure B-10: Stormwater harvesting Source: Melbourne Water.

The use of stormwater harvesting systems should follow considerations stated in the National Water Quality Management Strategy Document 23 – Stormwater Harvesting and Reuse (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, National Health and Medical Research Council, 2009).

Design and Maintenance Considerations

- Public health and environmental risks need to be addressed in the design. Additional treatment of the harvested stormwater runoff may be required before it is reused, depending on the quality of the stormwater captured and the required quality of water for the end-users (refer to National Water Quality Management Strategy Document 23 – Stormwater Harvesting and Reuse, 2009)
- It is necessary to address all of the public safety risks, particularly for open water storages, including side slopes, safety benching, fencing and appropriate signage. It is recommended that an independent safety audit of each design be conducted.
- All on site plumbing work to be done in accordance with the Plumbing and Drainage Standards (AS/NZS 3500 2003).
- Continual water balance assessments using MUSIC should be performed to determine how much runoff stormwater harvesting systems are removing from the catchment in terms of runoff volumes and associated pollutant loads. It is recommended that a longer period of rainfall data is used in MUSIC to more accurately model the stormwater harvesting systems.
- Maintenance for centralised stormwater harvesting systems will potentially be more consistent and reliable than that of distributed rainwater tanks, as it will typically rely on only one organisation (such as the Council) rather than individual householders (Department of Environment and Conservation NSW, 2006).
- The benefits of both stormwater harvesting schemes and rainwater tanks should be investigated during the concept design phase to determine the preferred option to best suit the development site.

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The Place To Be

Melbourne Water

These guidelines are a healthy waterways initiative in partnership between Melbourne Water and participating councils.

Design, Construction & Maintenance of WSUD

City of Whittlesea

City of Whittlesea

A healthy waterways initiative in partnership between Melbourne Water and the City of Whittlesea

The Place To Be

Melbourne Water

Council requirements

The City of Whittlesea follows a fully integrated process for the application and approval of new developments, whether they be subdivision of residential and industrial estates, or the development of multi unit residential property and commercial enterprises.

Pre-application discussions will involve planning and engineering staff in the Planning and Development Directorate, located at Municipal Offices 25 Ferres Boulevard, South Morang, to determine the suitability and extent of WSUD in any proposed development.

All planning permit applications for subdivisions are assessed by a Planning Approvals Team that is representative of all affected departments within Council (e.g. Strategic Planning, Environmental Planning, Development Engineering, Parks and Gardens, Engineering Services and Infrastructure Departments).

Pre-application meetings for commercial, industrial and multi unit residential development shall be arranged with the Manager Planning Services. Pre-application meetings for greenfield residential estate subdivision shall be arranged with the Manager Strategic Planning. Once an application has been lodged meetings on specific WSUD matters can be arranged with the Manager Development Engineering.

Council approved WSUD treatment types and Council requirements

Table A–1: Summary of Council approved treatment types

Treatment Type	Approved for Use	Not Approved for Use
Bioretention swales	☑ Open space reserves within Residential 1 Zone, central median strips and carparks (subject to adequate additional space after the provision of other infrastructure)	☒ In nature strips located adjacent to properties in a Residential 1 zone (unless provision is made for walkable slopes and level areas suitable for bin collection and pit covers) and steep topography
Bioretention basins and rain gardens	☑ Nature strips, Unit developments, Drainage Reserves and open space reserves (subject to adequate additional space after the provision of other infrastructure)	☒ In locations that restrict vehicle or pedestrian access, permanent subsurface flow conditions and where the functionality of the open space is compromised
Vegetated swales/grass swales/buffer strips	☑ Open space reserves within Residential 1 Zone, Drainage Reserves, roadside verges on rural roads and central median strips on connector and arterial roads (subject to adequate additional space after the provision of other infrastructure)	☒ In the nature strips of streets with an urban cross section
Sand filters/Treatment Plants	☑ Only for household septic effluent treatment on un-sewered lots having a minimum area of 4050m^2 (subject to a Land Capability Assessment confirming an appropriate design including consideration of soil type/ permeability, available space, vegetation retention and future reticulation)	☒ In lots smaller than 4050m^2 and Treatment Plants used for WSUD stormwater treatment on road reserves or public open space
Sedimentation basins	☑ As part of wetland system or as a temporary measure as part of the construction phase plan	☒ Permanent treatment that is not part of a maintenance regime (to ensure regular removal of silt and debris etc.) or where the functionality of the adjacent open space is compromised. Not suited to steep land
Constructed wetlands	☑ As part of an overall WSUD design strategy	☒ Shall not be relied upon to justify the avoidance of distributed WSUD treatment elsewhere within the catchment. Not suited to steep land
Ponds and shallow lake systems	☑ As part of an overall WSUD design strategy	☒ Shall not be relied upon to justify the avoidance of distributed WSUD treatment elsewhere within the catchment. Not suited to steep land
Rainwater tanks	☑ As part of an overall WSUD design strategy (subject to appropriate provision for maintenance of system performance) ☑ Particularly appropriate for unit / small lot developments in flat terrain where no underground drainage system exists or where 5 Star energy rating requires 2000 litres minimum re-use water for dwellings	☒ In small lot subdivision where the installation of the tanks can not be enforced as part of dwelling construction by Building Surveyors (including confirmation of design compliance) prior to Certificate of Occupation

Treatment Type	Approved for Use	Not Approved for Use
Gross Pollutant Traps	☑ Small commercial and industrial catchments may require specific solutions involving the use of GPT's (as part of a treatment train) if council identifies high potential pollutant loading ☑ Council requires GPT's to operate with an outlet that is not submerged and are suitable for cleaning by truck mounted suction. All weather access for this method of maintenance is required	☒ Not required in residential catchments less than five (5) hectares
Water Re-use	☑ Supplied to EPA 'fit for purpose' standard with reticulation system maintained by the water /sewerage authority, including switch to main water, if dual pipe supply is unavailable. ☑ Allowed to use in sport ovals, public open space ☑ Treatment for additional nutrient and salinity load included in design modelling including urban storm water discharges to wetlands from properties and catchments. ☑ S 173 requirement for purchasers to include and maintain on site systems for future development in accordance with Plumbing Regulations and design modelling.	☒ Non-compliant with Water / Sewerage Authority, EPA & MW requirements. ☒ Design modelling results in a potentially inappropriate increase in nutrient and/or salinity loads to water bodies or build-up in soils (via direct inputs by watering practices, pipe bursts etc).

Drainage Authority

The City of Whittlesea area sits within the Melbourne Water drainage boundary. The Port Phillip and Westernport Catchment Management Authority boundary is also the Melbourne Water boundary. Within this area, the relevant drainage authority is Melbourne Water for catchments greater than 60ha and the City of Whittlesea for catchments less than 60ha. Melbourne Water is responsible for all major drains and waterways as well as the implementation of Development Services Schemes (DSS) which are listed in Table A-4. The ownership of drainage assets created by a DSS, including WSUD elements, which have a sub-catchment less than 60 ha. Are formally transferred by Melbourne Water to Council upon the expiry of all construction requirements.

Future Drainage Strategy

The City of Whitlesea has approved a number of Development Plans for residential areas that are based upon existing Melbourne Water DSS's that have no distributed WSUD. It is an objective that development of individual subdivisions will review the opportunity to utilise current best practice to improve upon older proposals.

Sites less than 1 hectare

Conditions are included on Planning Permits for developments and subdivisions requiring compliance with best practice stormwater quality requirements. Where these are not achieved and all reasonable actions within the subdivision or development proposal have been investigated and found to be inappropriate or impossible, the appropriate drainage authority may offer other options, as outlined in the Practice Notes. At this time, no Drainage Strategies are in place in with the City of Whittlesea that will allow the acceptance of contributions towards any possible works.

Accordingly and until Drainage Strategies are in place, the Council will require designers to provide details of investigations undertaken for compliance and reasons why compliance is not achievable. Negotiations will be entered into with the applicant to ensure the best outcome is achieved from the proposal. Negotiations may result in a voluntary contribution towards future drainage treatment works in the Township or local area. These works may not necessarily be in the immediate vicinity of the subject land.

Planning for WSUD

The following considerations should be made when planning for WSUD:

- An independent safety audit to be undertaken on wetlands prior to the issue of practical completion.
- All grassed areas to have a maximum grade of 1 in 6 to meet Council's OH&S requirements.
- The supporting landscape submission shall include a comprehensive planting schedule (code, botanical name, mature height, mature spread, container size and quantity). The planting plan shall include call-outs (code and number) and all relevant soft and hard landscaping details.
- A comprehensive maintenance schedule shall be provided for each element. The maintenance schedule shall be generally consistent with the standards identified in Council's "Provision of Parks and Gardens Services (Specification of Services and Works) 2009".
- All maintenance tracks shall be designed to generally blend into the surrounding landscape (ie. featherock or grass pave construction) and shall be a minimum dimension of 3.0 metres in width. A level hardstand area 3.0 metres X 11.0 metres may be required adjacent to GPT's and sedimentation ponds.

Rainfall data to be used in MUSIC

The Melbourne Office rainfall station is the representative for most of the City of Whittlesea area, with the Melbourne Airport rainfall band covering part of the central west region and the Dandenong and Upwey Council gauges covering north east portion of the council's area. The rainfall distribution bands and representative rainfall stations are shown in Melbourne Waters MUSIC guidelines and Figure A-2).

Rainfall-runoff parameters

Rainfall-runoff parameters are outlined in the MUSIC User Manual (eWater, 2009) (see Table A-2).

Table A-2: Rainfall-runoff default parameters for Melbourne (MUSIC User Manual, 2005)

Parameter	Value
Impervious threshold	1 mm
Initial soil storage	30%
Infiltration capacity	200 mm
Infiltration exponent	1
Initial groundwater store	10 mm
Daily recharge rate	25%
Daily drainage rate	5%
Daily deep seepage rate	0%
Soil store capacity	30 mm
Field capacity	20 mm

Fraction impervious

The fraction impervious for various land types should be sought from the Melbourne Water MUSIC guidelines.

Pollution Concentration data

The default parameters for the pollution concentration data (total nitrogen, total phosphorus and total suspended solids) should be used for identified land uses (eWater, 2009).

Plant Lists

The following documents provide a general species list and recommended planting densities for the various WSUD elements:

- Appendix A, *WSUD Engineering procedures: Stormwater* (Melbourne Water, 2005).
- Appendix 6, *Constructed Wetland System: Design Guidelines for Developers* (Melbourne Water, 2005).

The following resource documents indigenous plant species that could be incorporated into the design of WSUD elements within the City of Whittlesea:

- *List of Indigenous Plants found in the City of Whittlesea* (Practical Ecology, 2000).

Plants selected must have shallow root systems that will not interfere with the underground drainage collection system and all species shall be selected on a site specific basis.

Design must be undertaken by a suitably qualified and experienced person and include consideration of Council's maintenance regime to facilitate low cost maintenance procedures (Refer to Council's *"Provision of Parks and Gardens Services (Specification of Services and Works) 2009"*).

Council-specific design requirements

It is noted that discharges from WSUD treatment systems must be maintained at 1.5 yr ARI pre-development levels under the Best Practice Environmental Management Guidelines for Urban Stormwater (See Sections 1.7 and 2.2 for concept design criteria).

Discharge from the subject land must be maintained at a minimum 5 yr ARI pre-development level for the entire drainage system where an appropriate extreme event overflow path exists for the outfall from the subject land for the acceptance of storm flows up to 100 yr ARI. However, designers must ensure that discharge from land subject to a development application is in accordance with the capacity of the existing drainage outfall system.

Compliance may require the upgrading and/or reconstruction of existing drainage systems where sufficient storage is not possible on the subject land to restrict discharge rates sufficiently. It could also require the design of main drains at a 10 yr ARI within the site for connection to the outfall system, particularly if the main drainage line extends through the subject land for the acceptance of main drainage flows from up-stream.

Designs should also include the acceptance of all up-stream flows at 5 (or 10) yr ARI with surface flows up to 100 yr ARI and transfer these flows through the subject land to the satisfaction of the Council.

Where connection to Melbourne Water controlled regional drains is required or sites are wholly within the Melbourne Water drainage area, designs must be to the satisfaction of Melbourne Water and City of Whittlesea.

Where rainwater tanks are proposed, the required storage must be generally doubled for household, garden watering purposes etc. with a minimum 2000 litres made available (in accordance with Plumbing Regulations for sustainable buildings with a 5 star rating). Any variation with respect to available tank sizes shall not vary the storage component but may slightly reduce the re-use two-thirds component with the further consent of the Council while maintaining the 2000 litre minimum.

Specific requirements for industrial/commercial developments will be required to suit the type of use proposed. Consideration must be given to the trapping of pollutants prior to discharge to Council's drainage system.

Council specific construction requirements

At the practical completion stage, an inspection of the works shall be undertaken by Council (including a representative from Parks and Gardens) in the presence of the Contractor and a representative of the developers Engineering Consultant. Outstanding matters for completion shall be identified and the 2 full summers + 3 months (ending on 31 May of the given year) maintenance period shall commence depending on the nature of the incomplete works. If the outstanding works are of a maintenance only nature (top up of subsidence, plantings vandalised or damaged through no fault of the Contractor, etc), the maintenance period shall commence immediately. Should the inspection identify defects of a structural or physical nature (filter material not compliant / insufficient hydraulic conductivity of filter media (see Section 2.2.2 of the main WSUD document), incomplete plantings or works including top soil, bunding / earthworks etc.), works shall be rejected and maintenance shall commence when works are complete.

Council-specific asset handover requirement

At the asset handover stage council has the following requirement:

- detailed "as constructed" plans to be provided in DWG format, including pipework to D-Spec Standards.
- System performance, observed cleanout frequency.
- All plant material to be established, healthy and show signs of vigour/growth. Any dead, diseased or damaged plants are to be replaced, bare areas of grass re-established, mulched surfaces reinstated, damaged or faulty infrastructure repaired or replaced.

Council-specific maintenance requirements

Where Water Sensitive Urban Design systems are to become Council assets, developers must maintain the works, including landscape plantings, for 2 full summers + 3 months prior to hand over.

For areas of grass, including grassed swale treatments and open parkland, the grass must be maintained in accordance with Council standard maintenance regimes to ensure the site is maintained in a tidy and user-friendly state, suitable for public use as intended at all times (refer *"Provision of Parks and Gardens Services (Specification of Services and Works) 2009"* Section 1.3.2.1 Mowing).

Compliance with the Fire Hazard requirements of the Municipal Fire Prevention Officer must also be considered. Grassland in and around wetlands or WSUD ponds must be slashed or mown to height not more than 150mm and thereinafter maintained in manner so as not to provide a threat to abutting property and land. The use of strategic fire breaks may be adopted after consultation with and direction by the Municipal Fire Prevention Officer. Clearance of any vegetated areas must be in compliance with Planning Scheme requirements for native vegetation when a Planning Permit may be required.

Table A-3: Summary of Council approved maintenance regimes

Asset	Maintenance
Wetland – water body (1.0m from water edge)	Collection and disposal of floating and visible submersed litter and debris as required. Siltation levels to be monitored and recorded every six months. Sediment to be cleaned out when accumulation at any point in the wetland reaches the invert level of the inlet pipe. Water bodies shall be maintained to minimise unsightly and potentially dangerous algae blooms.
Aquatic plants	Condition to be monitored and recorded every six months. Macrophyte harvesting as required. Plant replacement as required to keep a good coverage of aquatic plantings. The regenerative growth of indigenous wetland plant species although encouraged, must not be allowed to dominate such as to substantially decrease the area of open water. Although indigenous, *Typha* sp are undesirable, invasive wetland plants and shall be treated as a weed. Use of horticultural chemicals is prohibited in and around water bodies unless approved by the Supervisor. If approved, such use shall be strictly in accordance with the manufacturers' instructions and activity description.
Edge planting of wetlands	Collection and disposal of litter once every 21 days or as required. Edge treatment – erosion control and weed infestation to be monitored every 21 days and attended as requested. Plant replacement as required to keep a good coverage of marginal plantings subject to the natural growth characteristics of the plant.
Wetland – surrounds	Removal of litter once every 21 days or as requested. Sharps are to be collected and disposed of through Council's Public Health Service Provider. The service provider shall be fully aware of the associated problems of needle stick injury and therefore handle sharps accordingly. Removal of fallen tree debris and rubbish prior to mowing. Mowing in accordance with Council's cycle and intervention levels.
Pipelines, grills, concrete structures, rock weirs	Removal of litter and debris, blockages not to exceed 50% of inlet. Flush pipes of sediment prior to levels reaching 30% of pipe capacity.
Sediment ponds	Removal of litter once every 21 days around exterior of pond or as requested. Siltation levels to be monitored and recorded every six months. Sediment to be cleaned out when accumulation at any point in the wetland reaches the invert level of the inlet pipe. Any disturbance to maintenance tracks to be rectified in a timely manor.
Swale	Removal of litter every 21 days or as requested. Sediment to be cleaned out prior to the accumulation causes flooding of surrounding area.
Biorention basin and rain garden	Removal of all litter and debris every 21 days or as required. Monitor every six months and after large storm events. Sediment to be cleaned out when accumulation is within 50mm of overflow pit level.
Gross pollutant traps	Monitor every 6 months and after large storm events. Clean annually or as required. Must be removed prior to handover of assets to Council.
Netting protecting wetland area	Netting to be assessed monthly and damage repaired until end of maintenance period. Must be removed prior to handover of assets to Council.
Access tracks to sediment pond	Inspect following each desilting operation of the sediment pond and in accordance with Water Management Guidelines (currently under development). Remedy any risks to public health and maintain to Council standards.

Asset	Maintenance
Plants – trees, shrubs, garden beds and grassed areas.	Yearly tree pruning in accordance with AS4373-1996 with all debris to be disposed of off site. Weeding to occur every 21 days or as required. The use of horticultural chemicals is prohibited in and around water bodies unless approved by the Supervisor. If approved, such use shall be strictly in accordance with the manufacturers' instructions and activity description. Seasonally appropriate plant replacement once a year (autumn) or as required due to vandalism or theft. Litter and weed removal once every 21 days or as required. Mulch shall be maintained to an even depth not greater than 100mm and not less than 75mm. Adjacent lawns and hard surface areas shall be kept free of mulch.
Pedestrian paths – concrete paths and informal walking trails	Trimming of edges and monitor path condition once ever 21 days or as required. Clean and repair if required in accordance with Council standards to ensure the path is safe for public use at all times. The path shall be free of debris such as garden mulch, loose stones, weeds, grass clippings etc.
Boardwalks and timber poles	Monitor every 21 days or as required. Clean and repair if required.
Lighting	All park lighting shall be inspected at night and tested for proper operation on a quarterly basis and the results reported to the Supervisor. All repairs and globe replacement shall occur within 7 days. All park lighting must be certified by a suitably qualified electrical contractor on an annual basis.
Furniture and fixtures	All elements shall be maintained clean, hygienic and safe and be available to be used at all times for their designated purpose. Monitor every 21 days.
Information signs and displays	Warning and advisory signage is to be kept in good order at all times and inspected every 21 days.
Irrigation system	Annual inspection. Carry out repairs and replace if damaged as required. The service provider shall supply and replace necessary component parts using correct plumbing procedures to ensure irrigation systems are fully functional during dry periods. In line with Council's sustainable water plan, irrigation within reserves will not be accepted unless an alternative, reliable non potable water supply system is incorporated. Temporary systems for plant establishment may be considered subject to the system being decommissioned to the satisfaction of Council prior to handover.
Pump & pump house – for irrigation	Operate and maintain as per manufactures specifications.

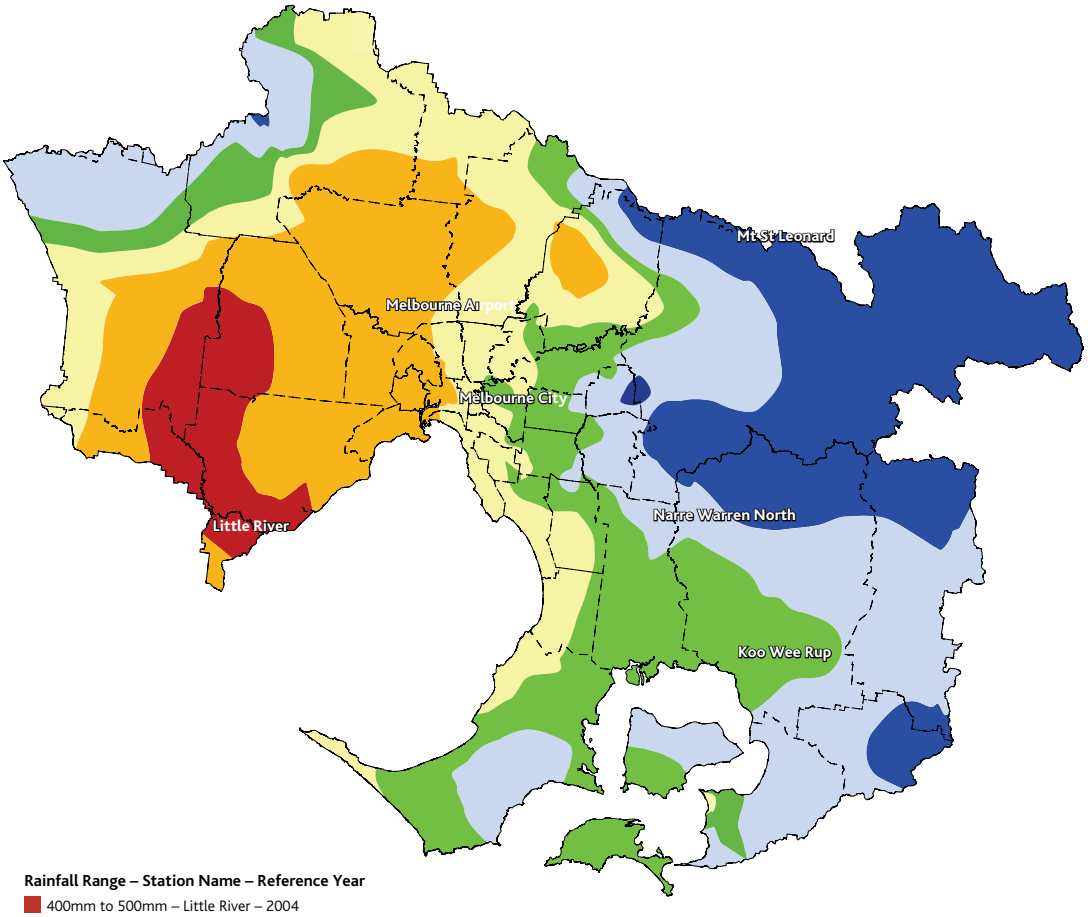
For comprehensive maintenance requirements of all "soft" WSUD elements, refer to Council's *"Provision of Parks and Gardens Services (Specification of Services and Works) 2009"*.

Table A-4 : Relevant WSUD Planning information.

Table A-4: Melbourne Water Development Services Schemes in the City of Whittlesea

Scheme Number	Development Services Scheme	Suburb
4440	Edgars Creek	Epping
4532	Upper Hendersons Creek	South Morang
4535	Findon Creek	Epping North
4615	Gorge Road	South Morang
4622	Wiltonvale	South Morang
4628	South Morang	South Morang
4634	Mernda South	Mernda
4635	Mernda Central	Mernda
4681	Doreen	Doreen
6001	Laurimar	Doreen
6004	Mernda North	Mernda

Figure A-1: Mean Annual Rainfall Distribution (Greater Melbourne)



Source: Melbourne Water MUSIC Guidelines (2010)

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