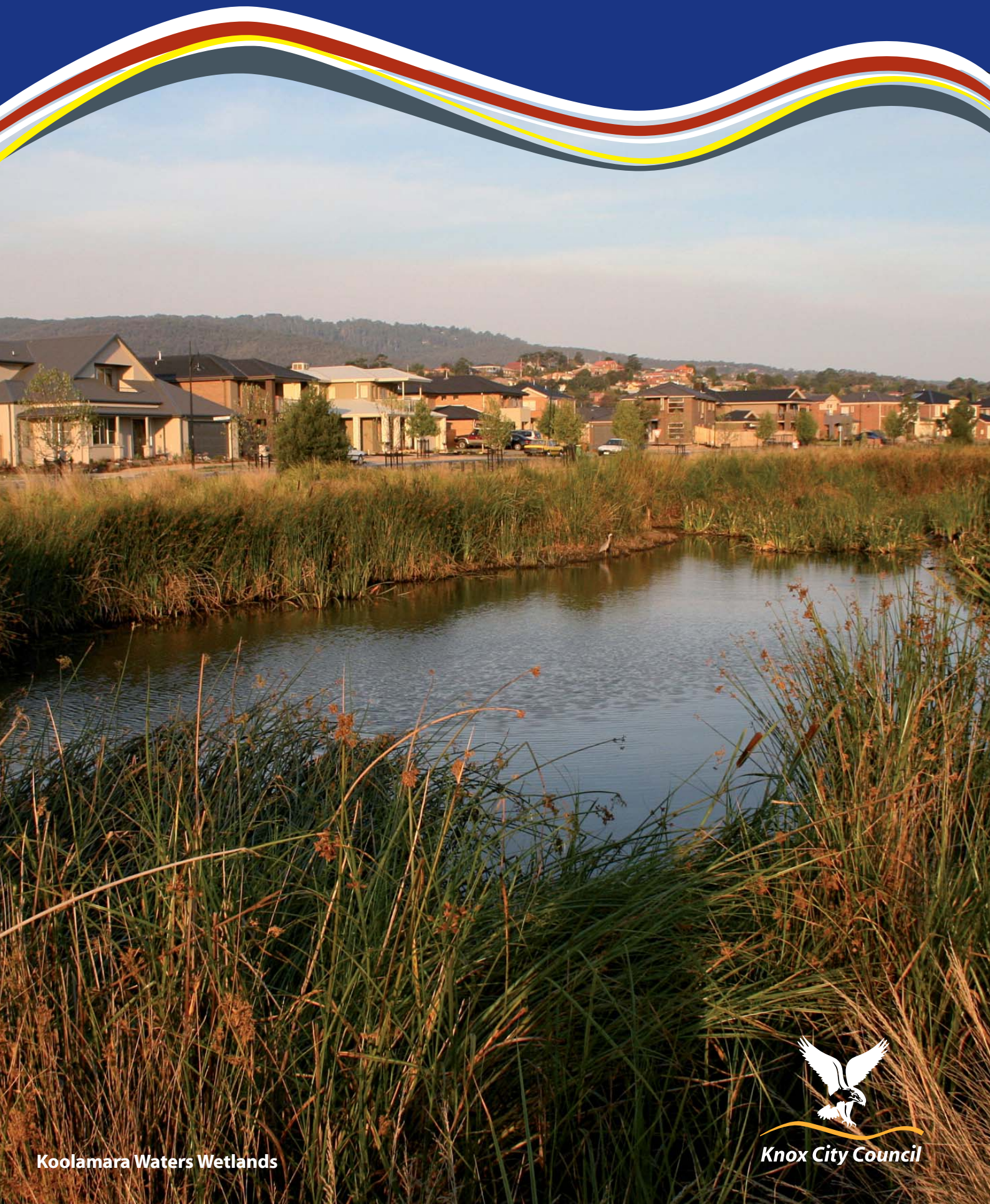
Knox City Council

water sensitive urban design & stormwater management strategy 2010



Koolamara Waters Wetlands

Knox City Council

Executive Summary –

The Water Sensitive Urban Design (WSUD) and Stormwater Management Strategy aims to protect and improve the health of Knox's streams and creeks for our future generations, whilst improving the amenity value and sustainability of today's urban stormwater infrastructure.

Streams, creeks and waterways are an important asset to the City of Knox. They provide the community with recreational opportunities and contain areas of high biodiversity and conservation value critical to the environmental sustainability of Knox and to its community as shown in Knox's 2008/2018 Sustainable Environment Strategy.

Furthermore, water as a resource is an important issue for Australia. Melbourne statistics show:

- A 20% reduction in rainfall since mid 1990's;
- A predicted 4% decline in average rainfall by 2030;
- Melbourne water storages are at a low 35%
- Extreme weather events

Studies carried out in 2007 have shown that the amount of stormwater generated is close to the quantity of reticulated water supply in Melbourne. Managing stormwater appropriately through WSUD systems is becoming an increasingly important issue in Australia, with respect to its ability to provide both an alternative water resource and to reduce the amount and frequency of hydrologic and water quality disturbance to receiving waterways.

Figure 1: Water Balance in Australian Cities, showing relative volume of stormwater to potable water supplied in each city (Source: PMSEIC Working Group, 2007)

Victorian, national and international research has shown that disconnecting the number of impervious areas i.e. carparks, roads, roofs etc, that discharge stormwater directly to a waterway via a pipe of paved channel, through the use of WSUD systems can improve waterway health.

WSUD systems imitate the natural water cycle processes and are able to retain, filter, infiltrate and even use stormwater before it flows into a waterway.

This doesn't mean the removal of all pipes or changing flood management standards. It simply means that small, frequent storm events are captured and retained and not allowed to discharge quickly into the waterway, whilst the large events are conveyed as before, using the network of pipes and channels, to protect against local flooding.

A major aim of this strategy is to ensure that virtually all impervious surfaces are treated with WSUD over the long-term.

The WSUD & Stormwater Management Strategy presents a vision and a plan for implementing WSUD within the municipality, outlining goals and actions to improve Council's existing stormwater management and planning processes and activities.

WSUD systems may include rainwater and stormwater harvesting, as well as infiltration and filtration systems such as swales and rain-gardens, throughout the municipality.

Whilst working towards the long-term, the WSUD Strategy will focus on six (6) priority areas:

1. **High-value waterways program:** *this program will focus on the highest value waterways within the municipality – Dobsons Creek, Blind Creek (East of Knox), Ferny Creek (East of Knox) and Monbulk Creek (East of Knox). WSUD systems, including rain-gardens, infiltration systems and stormwater harvesting will be constructed in these catchments.*
2. **Hotspots program:** *aimed at addressing areas with very high pollution loads such as industrial zones and commercial areas (particularly for litter reduction). A combination of education and enforcement will be required, using a partnership between Council, EPA and Melbourne Water.*
3. **Opportunistic program:** *integrating WSUD into council retrofit and upgrade projects. This approach has the benefits of having a very low marginal cost (because construction works are occurring anyway).*
4. **Planning program:** *It is important that Council has appropriate stormwater management planning requirements that ensure that new developments do not continue to degrade Knox's waterways. This program will investigate the possibility of new planning instruments. Council will seek opportunities to work in collaboration with other councils in the region.*
5. **Maintenance program:** *To ensure that WSUD systems are effective and functional they require maintenance. Within Knox, WSUD assets are relatively new and will need to be maintained. This program will develop and implement a maintenance program to ensure WSUD systems are maintain their functionality and effectiveness.*

6. **Evaluation and reporting**: *Each year the effectiveness of implemented WSUD works will be reported, including pollutant load reductions, area of catchment treated. We will also work in collaboration with others to report on changes in the health of the municipality's creeks.*

The WSUD & Stormwater Management Strategy focuses on reviewing and improving Council's Management and Planning Processes to ensure that WSUD systems are designed, constructed and maintained to best practice standards and in locations that will maximise their environmental, social and economical benefits to the community. The aim is to deliver the greatest benefit to the community at the least cost.

Acknowledgements:
This strategy wishes to acknowledge the commitment and advice of Toby Prosser (Melbourne Water) and Professor Tim Fletcher (Monash University).

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1. Introduction

1.1 Purpose of the Strategy

The Water Sensitive Urban Design (WSUD) and Stormwater Management strategy aims to protect and improve the health of Knox's streams and creeks for current and future generations, at the same time as ensuring that flooding impacts are minimised. This strategy presents a vision and a carefully prioritised plan for the planning, implementation and maintenance of WSUD systems, outlining goals and actions to improve Council's existing WSUD management and planning processes and activities. The aim is to maximise the benefits to the community.

The strategy's prioritisation approach is based on the rationale *that high-value waterways should be protected wherever possible from degradation; protecting these high value waterways is more cost effective than allowing them to degrade and then undertaking rehabilitation works.* ***The highest priority for construction of WSUD systems should be where the biggest environmental gains can be made for the least cost.***

The highest value waterways in the municipality include Dobsons Creek, Blind Creek (East of Knox), Ferny Creek (East of Knox) and Monbulk Creek (East of Knox).

Victorian, national and international research shows that stream and creek health is negatively impacted significantly by the percent of impervious surfaces (e.g.: roofs, roads, car park areas) *that are connected directly to a waterway*[1] *through stormwater drains*. WSUD can help to *disconnect* these impervious surfaces. WSUD systems imitate the natural water cycle processes and are able to retain, filter, infiltrate and even use stormwater before it flows into a waterway.

As well as protecting our waterways, WSUD systems can provide us with a 'new' source of water for urban needs (e.g. open space irrigation).

In addition, WSUD system can help mitigate the "Urban Heat Island" effect (increases in local temperatures due to more development of hard surfaces in urban areas) leading to a cooler Knox.

Given the benefits to both the community and our environment, it is critical that we ensure that WSUD systems are built within Knox and ensure that they appropriately located, designed, constructed and maintained, so that it is possible to continue development of the municipality, without impacting on the ability of our receiving waters to provide healthy environments for us and our children to enjoy.

This strategy focuses specifically on WSUD. Implementation will require integration with the existing strategies that deal with other aspects of stream and creek restoration and stormwater management.

[1] (Catford et al., 2007; Hatt et al., 2004; Taylor et al., 2004)

The two main aims of the Strategy are to:

1. Present a rigorous, informed framework for implementing WSUD actions in a way that maximises the benefits to the community and the environment, whilst minimising costs.
2. Develop an effective and efficient maintenance framework for Council's WSUD assets, so that its investment in WSUD are protected and worthwhile in the long-term.

1.2 Vision

A municipality with healthy, beautiful and lush green corridors along streams, creeks and lakes, full of biodiversity, which can be enjoyed by us, by our children and their children.

A community that values stormwater as a resource and understands the need to protect waterways from stormwater inputs.

A municipality where all homes, industrial business districts and commercial precincts have WSUD systems such as raingardens and rainwater tanks, that retain water within the catchment, allowing it to be infiltrated, filtered and purified through natural process, so that our creeks and streams have natural flows unaffected by urbanisation**.**

A municipality that can sustain the majority of its watering and drainage needs through the use of stormwater captured via stormwater tanks and WSUD systems. Stormwater will be used to keep the landscape green and cool, even during summer.

A community that values waterways, and therefore works with the Council in achieving healthy streams and creeks and maintaining them.

A community and Council who work in partnership with upstream and downstream neighbouring Councils and agencies to manage the region's waterways in a sustainable and cost-effective manner.

The WSUD will contribute to a more liveable, sustainable and productive municipality.

2. Background

2.1 What is WSUD?

'*WSUD' – Water Sensitive Urban Design* is an evolution of the traditional 'single-focus' conveyance approach to stormwater management. It seeks to minimise the direct connection of impervious areas (by pipes and channel) to waterways, and thus mitigate changes to the natural water balance, through techniques such as stormwater harvesting, rain-gardens, swales and infiltration systems. It aims to mimic the natural hydrologic cycle, whilst at the same time minimising flooding risks. WSUD systems are very flexible in their form and design, and can be readily integrated into most urban landscapes.

The key principles of Water Sensitive Urban Design are (Victorian Stormwater Committee, 1999) are:

1. **Protect waterways such as creeks**
   Protect and enhance natural water systems within urban developments
2. **Integrate stormwater treatment into the landscape**
   Use stormwater in the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity
3. **Protect water quality**
   Protect the quality of water draining from urban developments
4. **Reduce run-off frequency and peak flow rates**
   Reduce peak flows from urban development and by local retention and detention measures and minimising impervious areas
5. **Add value while minimising development costs**
   Minimise the drainage infrastructure cost of development
   Maximise the benefits to the community

2.2 Why have a WSUD and Stormwater Management strategy?

The development of the WSUD and Stormwater Management Strategy was recommended by Council at its meeting of 24 November 2009 following the presentation of preliminary investigation on WSUD systems and their potential to protect and enhance the value of waterways in the municipality.

Stormwater runoff from most of the municipality (94%) discharges to Dandenong Creek which drains to Port Phillip via Mordialloc Creek. A small area in the southeast corner of the municipality drains to Eumemmerring Creek which drains to Port Phillip via Patterson River.

Detailed research undertaken for Knox (in partnership with Melbourne Water) shows that our waterways are degraded by the amount of impervious surfaces that are directly connected to the waterway through stormwater drains.

However, this does not mean that in order to protect waterways all impervious areas should be removed. Instead, WSUD can help to effectively *disconnect* these impervious surfaces. WSUD systems should imitate the natural environment and be able to retain and filter stormwater within the catchment, allowing it to naturally infiltrate and be filter through the soil. As well as improving water quality, WSUD aims to maintain the flow rates in the

waterway near their natural (pre-developed) level, in order to avoid erosion and degradation, and minimise future rehabilitation costs for Council.

It is an important fact that urban streams suffer from too much water, in contrast to rural streams. In urban streams, any small rainfall event can result in a large deluge of water which erodes and degrades the stream. As soon as the rain stops, the stream then dries out. The aim of WSUD is to reduce those 'peak flows', and instead allow water to naturally infiltrate through the catchment soils into the stream. Techniques such as swales, infiltration systems and stormwater harvesting can all be used to achieve this aim. In this way, the stream will have water gently flowing in it all year round, rather being dry most of the time, and then suffering powerful polluted flows whenever it rains.

The WSUD strategy aims to protect and improve the health of Knox's streams and creeks for our future generation through the use of WSUD systems. Most importantly, the strategy aims to do this in a carefully prioritised way – ensuring that money is spent where it will make the greatest difference. This strategy therefore presents a vision and a plan for building of WSUD systems outlining goals and actions to improve Council's existing WSUD protocols.

2.3 What is Council's responsibility in relation to stormwater and waterways health?

Local government has the responsibility for local land-use planning, land and stormwater management and educating the community, which has a significant ability to affect waterway health. They have a range of responsibilities for land and water planning and management, including statutory provisions of the Planning and Environment Act 1987. Knox City Council is required to do all things necessary to encourage and promote the orderly and proper use, development and protection of land in the area for which it is a planning authority.

Stormwater management is a local government responsibility and traditionally has been undertaken from a drainage perspective, to protect public safety and property from flooding, and increasingly to protect receiving environments. In particular, the Council is responsible for the management of various parts of the urban environment that discharge directly into the stormwater system and adopting a best practice environmental management approach in regard to the operation and maintenance.

Additional consistent information on Council's responsibility as per the *Protecting Our Bays and Waterways Agreement (1999)* can be found in Appendix A.

Roles and responsibilities of other agencies in relation to stormwater management and a summarised Legislation and Policy review can be found in Appendix B.

2.4 Relevant policies, strategies, plans & guidelines

Council has a number of relevant policies which must be taken into account in implementing this strategy (Table 1). The important advance that this current strategy makes is to propose a rigorous and scientifically based means of prioritising WSUD works so as to maximise environmental outcomes for a given investment.

Table 1. Objectives for environmental Management of Stormwater

Document	Comment
Knox City Council's Stormwater Quality Management Plan, 2001	Previous stormwater management plan, developed in 2001. Now superseded by additional information on prioritisation of WSUD works to achieve best outcomes at reduced costs.
Knox City Council's 2008/2018 Sustainable Environment Strategy (Aug 08)	Broad sustainability policy. This WSUD strategy is consistent with the directions set in the Sustainable Environment Strategy.
Knox City Council's WSUD interim policy 2008	Interim policy. This Strategy builds on this interim policy. To be updated 2010.
Knox City Council's review of sporting facilities – Feasibility Study 2008	Review identifying opportunities to provide water for sports grounds through stormwater harvesting.
Knox City Council WSUD Guidelines 2002	Detailed guidelines for implementing WSUD works. Useful detailed document; to be updated 2010.
Knox City Council WSUD Engineering Standards, 2007	Detailed design guidance; currently in process of review.
Knox City Council Drainage Guidelines – Updated Draft, 2009	Detailed guidelines for implementing WSUD works.

2.5 How is stormwater and WSUD currently managed in Knox?

In its Community and Council Plan 2009-2013, one of the Strategic Objectives under the Sustainable and Natural Environment initiative is "to protect and enhance the natural environment and reduce our environmental footprint through various strategies including improving water quality in local waterways with sustainable drainage management & Water Sensitive Urban Design (WSUD)."

In fact, significant implementation of WSUD, in partnership with Melbourne Water, has already commenced. This has initially been championed by a number of keen staff and then formalised through the use of the Knox WSUD interim policy (the WSUD interim policy requires all Capital Works to incorporate, where practicable, the implementation of WSUD). Implementation of the Review of Sporting Facilities Feasibility Study also uses WSUD to provide an ongoing program of retrofitting sports grounds with a stormwater supply managed by the Facilities and Sustainability Departments. As well as helping to keep the sports grounds in good condition the retention of stormwater for watering will help to protect downstream waterways from scour, erosion and pollution. So far stormwater tanks have been installed in twenty-six (26) Council sites in 2008/09 and in (six) 6 sites in 2009/10, with the capacity to store a total of 3,161 ML of stormwater for re-use.

Appendix C presents a list of the WSUD systems constructed within the municipality that are considered a Council asset.

3. Prioritisation of WSUD activities in the municipality

3.1 Overview

The first aim of this Strategy is to develop a prioritisation framework – *to ensure that priority is given to implementation of WSUD works in places where the environmental and community benefit will be maximised*. This section outlines the prioritisation framework, and its rationale.

The WSUD working group within Council has identified the need to conduct six (6) types of WSUD-related activities (Table 2). These are described in more detail in Appendix D, but are outlined briefly here to provide a basis for the proposed prioritisation procedure. As can be seen in Table 2, the greatest allocation of proposed resources is to the *High Value Catchments Program*, which aims to protect existing waterways of high-value. This is an important advance in the prioritisation of WSUD for the Municipality, because it recognises that, given limited resources, the greatest community and environmental outcome can be achieved by targeted investment. The rationale for this approach is explained in more detail in Section 3.2.

Table 2. Proposed WSUD activities

Program (proposed % of investment)	**Description and Rationale**
High-Value Catchments Program **(50%)**	Implement WSUD in identified 'high-value' catchments, where waterways have significant environmental value, and can be protected at relatively little expense. **Large environmental outcome.**
Opportunistic Retrofit Program (**15%)**	Implement WSUD opportunistically as part of infrastructure upgrades. Primary purpose is demonstration and cost-saving (marginal cost is small). **Large capacity-building outcome.**
Hotspots Program **(10%)**	Implement WSUD in identified 'pollution hotspots' (i.e. industrial areas) to reduce threat to waterways. **Large water quality outcome.**
Planning Program **(10%)**	Investigate the possibility of developing new planning controls to require/or encourage WSUD as part of new developments, focusing on cost-effective approaches. **Large environmental outcome at low cost.**
Maintenance Program **(10%)**	Develop rigorous process for identifying and implementing regular maintenance. **Large outcome at very low cost.**
Monitoring & reporting **(5%)**	Monitor outcomes in terms of (i) actions implemented, (ii) reductions in stormwater inputs and (iii) changes in waterway health. Important **feedback.**

The **Opportunistic Retrofit**, **Planning**, **Maintenance** and **Monitoring & Reporting** Programs will all be applied at a municipality-wide scale. In contrast the **Hotspots Program** requires that potentially high pollutant load-generating areas (industrial areas) are identified.

Implementation of the **High-Value Catchments Program** also requires identifying the 'priority catchments', based on an assessment of their current environmental condition. The process for identifying these *high value catchments* is described in Section 3.2

3.2 Identifying high-value catchments in Knox

Studies have shown that there is a very clear link between directly connected impervious areas (i.e. impervious areas which drain via a pipe or constructed channel to a waterway) and stream health.

Figure 2 shows the relationship between waterway health and Effective Imperviousness. Figure 2 shows that when the effective impervious area in a catchment exceed around 2-5% (of catchment area), the waterway is likely to be degraded. *Conversely, catchments with low Effective Imperviousness* (i.e. less than 0.5%) are likely to be in very good condition, and thus be of ***high value***.

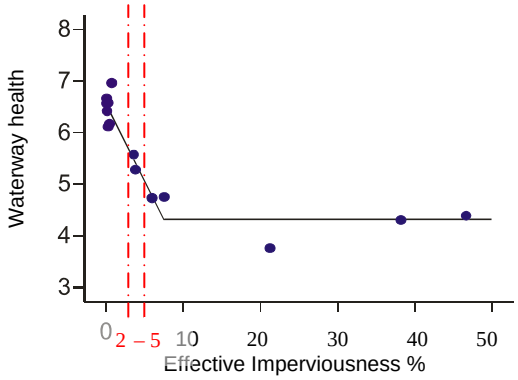


Figure 2. Effective imperviousness vs. waterway health. The waterways in good condition all have catchment with less than 2% effective imperviousness. Source: Walsh et al. (2005).

Associate Professor Chris Walsh (University of Melbourne) has conducted extensive research on the impact of directly connected impervious (DCI)[2] surfaces to waterways and the effect this had on the Dandenong catchment which includes the municipality of Knox, as shown in Figure 3 below (this data is available on Council's GIS system).

[2] NOTE: *directly connected imperviousness* and *effective imperviousness* are used interchangeably; they both describe the proportion of a catchment made up of impervious surfaces draining directly via a pipe or constructed channel into a waterway.

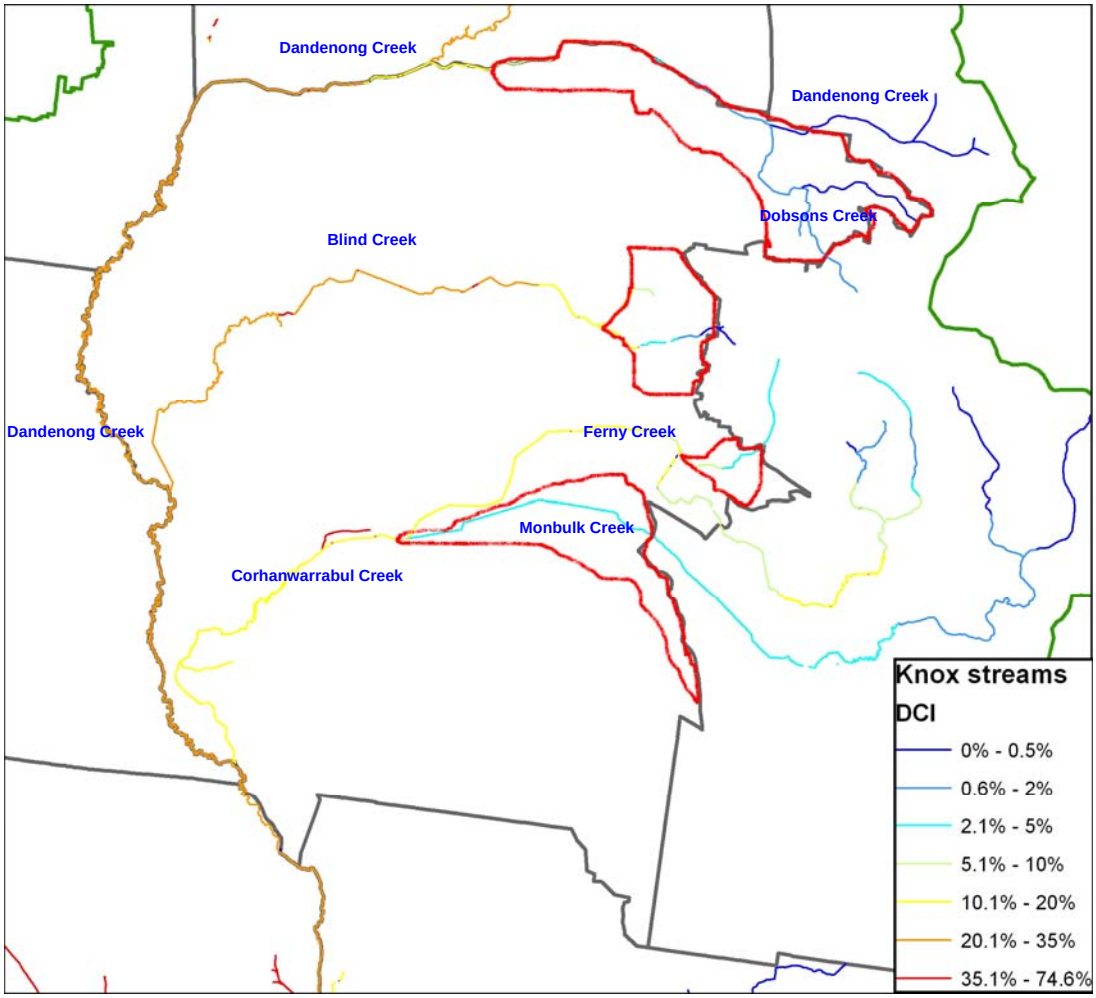


Figure 3. Map of % directly connected imperviousness (DCI) vs. waterway health, 2007. The red areas are the high value catchment areas with 0-0.5% DCI.

Based on extensive research in the Dandenong Ranges, and in Knox in particular, it can be concluded that streams with:

- **<0.5% DCI** will have minimal stormwater degradation, and be of "**high value";**
- **0.5-2% DCI** will have some stormwater degradation but are likely to be relatively inexpensive to restore; these streams are also considered "**high value**"
- **2 -5% DCI** are likely to be at least partially degraded by stormwater impacts
- **>5% DCI** are certain to be severely degraded by stormwater impacts

It can be seen from Figure 3 that the highest value waterway in Knox is Dobsons Creek (it is the only catchment with <0.5% directly connected imperviousness). Blind Creek (east), Ferny Creek and Monbulk Creek are also waterways considered to be of high value, with levels of DCI which are low enough to make their protection and restoration feasible and cost-effective.

3.3 A targeted approach to WSUD to achieve the maximum outcome

This Strategy proposes, based on scientific and financial grounds, that priority should be given to implementation of council WSUD works in identified high-value catchments, in order to maximise environmental and community benefit. Catchment-wide implementation of the **Planning** and **Opportunistic Retrofit** Programs will be used to ensure that other catchments are (i) protected from further degradation and (ii) steadily restored back towards 'high-value' status. At the same time, pollution **hotspots** will be targeted, to ensure that highly polluting areas are dealt with. This approach, integrating various targeted programs, aims to deliver the maximum outcome for Knox's investment. Each Program will be implemented where it have the greatest outcome (Figure 4).

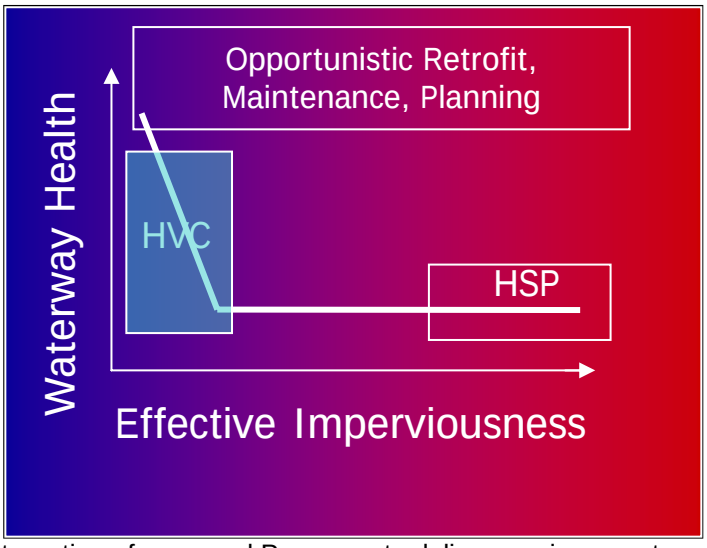


Figure 4. Integration of proposed Programs to deliver maximum outcome. *High Value Catchments (HVC)* program will target waterways in good condition (catchments with relatively low levels of imperviousness), whilst hotspots program (HSP) will target highly polluted areas (usually industrial areas with high levels of imperviousness). The Opportunistic Retrofit, Maintenance and Planning programs apply at a catchment-wide scale.

The important of this approach to prioritising works is that it will allow Council to achieve more tangible improvements in waterway health and amenity, more quickly, at less cost, than simply spreading its WSUD expenditure randomly through the municipality.

There is an opportunity to protect high value catchments within the next few years that will come at a relatively low cost to Council if treated now, but if these catchments are left to degrade through the creation of further connected impervious area, the cost of treatment will become much greater. In many cases this protection will often be simple and rely on using old technologies that are well understood by council and that have been utilised for many years. Roadside swales, simple infiltration systems and rainwater harvesting can all be used to reduce stormwater impacts and protect these *high value waterways* from stormwater impacts.

4. Maintenance of WSUD systems

Effective maintenance is critical to ensuring that Council's investment in WSUD is effective. The consultation and investigation conducted as part of the development of this strategy identified that a better process is needed for specification of maintenance procedures and frequency.

Knox City Council had difficulty maintaining its WSUD assets due to a general lack of understanding of the maintenance requirements and consequently appropriate funding levels. This poses a threat to the effectiveness of Knox's investment in WSUD implementation.

There is no current asset management database or centralised area with information on WSUD systems within the municipality. However, a database and a life cycle process to capture the information about the location, construction and maintenance of WSUDs, as each project is undertaken, is programmed to be developed.

APPENDIX F presents estimated financial maintenance and renewal requirements for WSUD systems within Knox. For 2010/11 a $30,000 budget is proposed to initiate the maintenance of Council's current functioning WSUD assets.

It is recommended that a maintenance program including an asset management database on WSUD systems be developed. Table 3 shows the maintenance program outline.

The program should include a database and a life cycle process to capture the information about the location, construction and maintenance of each WSUD system within the municipality of Knox. As such a process outlined in Table 3 is recommended.

Table 3. Possible approach to development of WSUD maintenance program.

Task	Description
1	Work out where WSUD assets are located – mark up on a GIS plan
2	Quantify WSUD assets – take an inventory
3	Classify WSUD assets into categories – e.g. rain gardens or wetlands
4	Determine appropriate maintenance activities of WSUD categories, using standard 'maintenance templates' for each type of system. Template to be modified for individual system, based on (i) value of waterway being protected, (ii) type (and robustness of system) and (ii) community significance of system.
5	Ascertain which activities are routine or reactive
6	Establish frequency of routine maintenance activities
7	Determine estimated cost for each maintenance activity and establish a unit rate. Develop a database of costs, and required maintenance cost data to be collected for at least three of each WSUD device type over the next 2-3 years, so that accurate maintenance cost forecasting can be undertaken into the future.
8	Apply unit rate to WSUD quantities by categories and frequency
9	Document maintenance cost applicable to WSUD assets
10	Present documentation to Manager – Operations to consider for inclusion into operational practices.

The development of this program is expected to be completed by 2010/2011.

5. Continue building a WSUD 'culture' within Council

There is currently a lack of connectivity between departments in relation to the implementation of WSUD. Achieving effective WSUD systems involves the disciplines of planning & urban design, engineering, landscape protection & design, and infrastructure and service provision to work in an integrated manner. It is vital that integration of the activities occur early in the process to ensure an optimal water quality management solution is delivered.

Although Knox has a number of documents that relate to WSUD (see section 2.4), many of these require updating or are no longer practical. Many are 'high level' and need a document capable of directing on-ground actions into the right locations, so that the projects which deliver the biggest benefit at the least cost are foremost.

Furthermore, there needs to be a "whole-of-Council" support for the concept and a corporate culture developed which supports WSUD.

Achievement of WSUD outcomes is currently resource intensive. This is largely due to the requirements for information, substantiation and assessment and to some degree a function of the "newness" of these projects and approach. There is a significant gap in the information available and needed to support WSUD. This is also clear with developers, builders and other relevant stakeholders, who often do not have the understanding of WSUD concepts and clear information for building WSUD systems.

To continue to build a 'WSUD culture' within council, it is recommended that:

1. Appropriate WSUD resources are provided such as, engineering standards and maintenance regimes to support 'WSUD culture'
2. A WSUD working group be implemented, involving representatives from all relevant sections of council.
3. Staff continue to undertake training and professional development in WSUD-related activities.
4. Knox City Council continue to collaborate closely with Melbourne Water, accessing resources in terms of capacity building wherever possible.

6. WSUD Implementation Framework

6.1 Proposed Framework and Actions

Based on the integrated suite of Programs outlined in Section 3, the proposed Implementation Framework is outlined in Table 4. Activities are proposed under each of the proposed Programs:

1. High Value Catchments
2. Hotspots
3. Opportunistic Retrofit
4. Planning
5. Maintenance
6. Monitoring, Evaluation and Reporting

Following the specification of proposed actions, timeframes, costs and responsibility, a set of targets are outlined, which will be used to monitor both the *implementation of actions* and the *resulting outcomes* in terms of water quality and waterway condition and health.

Table 4. Management Framework Strategy Plan, including actions, timeframes, resources, costs and responsibilities.

No	Objectives	Actions	Timeframe	Resources & Year of implementation	Estimated Cost	Responsible Dept/Officer
1. HIGH VALUE CATCHMENT PROGRAM						
1.1	**Waterways in 'High Value Catchment' Areas are protected and rehabilitated towards pre-development waterway characteristics (original ecosystem). To be done through the disconnection of directly connected impervious surfaces.**					
1.1.1		Define DCI % for 'High Value' Catchment Areas.		Project Manager - Engineering	Completed	Project Manager – Engineering
1.1.2		Locate all 'High Value Catchment' Areas.		Project Manager - Engineering	Completed	Project Manager - Engineering
1.1.3		Create a 'High Value Catchment' Area layer on Council's GIS system.		Engineering, IT	Completed	Project Manager - Engineering
1.1.4		Investigate the possibility of developing and implementing a 'High Value Catchment' area overlay in the Knox Planning Scheme.	Subject to prioritisation of actions resulting from Planning Scheme review project (December 2010)	Project Manager, Engineering, Strategic & Economic Development	Unknown at this stage	Project Manager – Engineering, Economic & Strategic Development
1.1.5		Prepare a Handout for planners and applicants that provide design advice for development in High Value Catchment areas.	Year 1 (25% funded)	Project Manager, Engineering, Planning.	30 hours	Engineering, Planning
1.2	**Directly connected impervious (DCI) surfaces to waterways are disconnected via appropriate WSUD treatments.**					
1.2.1		Locate all DCI surfaces to waterways	Year 1 (25% funded)	Project Manager - Engineering	100 hours	Project Manager – Engineering
1.2.2		Create a 'DCI' Area layer on Council's GIS system.	Year 1 (25% funded)	IT	20 hours	Project Manager - Engineering
1.2.3		Investigate the possibility of developing and implementing DCI planning controls (e.g. overlay, local planning policy) in the Knox Planning Scheme.	Subject to prioritisation of actions resulting from Planning Scheme review project (December 2010)	Project Manager, Strategic & Economic Development Dept, Sustainability	Unknown at this stage.	Project Manager – Engineering, Economic & Strategic Development

1.3	**WSUD systems are built in locations that maximise their environmental, social and economic benefits to the community**					
1.3.1		Locate 'high social' value areas along waterways. Link task with Open Space Strategy.	Year 1 (25% funded)	Project Manager – Engineering, Sustainability	100 hours	Project Manager - Engineering
1.3.2		Create a holistic process to be explained in the interim policy ensuring solutions to improve water quality & hydrological flows are done in a collaborative and transparent approach between all departments.	Year 1 (25% funded)	Project Manager, Sustainability, Engineering, Operations, Economic Dev.	150 hours	Project Manager – Engineering
1.3.3		Prioritise projects to be done, based on the high-value catchments identified in Actions 1.1 to 1.5	Year 2 (not funded)	Project Manager	150 hours	Project Manager – Engineering
1.3.4		Commence minor catchment strategy for high value catchment & social areas	Year 2 (not funded)	Project Manager, Engineering, Sustainability	150 hours	Project Manager – Engineering
1.3.5		Create business cases to obtain funding for constructing WSUD systems within located high value catchment and social areas	Year 2 (Not funded)	Project Manager	20 hours	Project Manager – Engineering
1.3.6		Communicate set targets per major catchment and minor catchment for Knox's catchments and waterways through GIS and through reporting mechanisms.	Year 3 (Not funded)	Project Manager, IT, Engineering, Sustainability	20 hours	Project Manager – Engineering
2. HOTSPOT POLLUTION PROGRAM						
2.1	**Direct illegal discharge of pollutants into waterways is minimised through education, enforcement & interception systems.**					
2.1.1		Define Council's responsibility is in relation to Hotspot Pollution areas including industrial sites and construction sites (link to Draft Waste Water Management Plan).	Year 3 (Not funded)	Management	50 hours	Project Manager - Engineering
2.1.2		Undertake a desktop analysis for Hotspot pollution areas - risk-based prioritisation (using land maps; target areas where pollutant loads are likely -especially industrial zones and commercial areas for litter)	Timeframe dependant on Council's responsibilities	Project Manager	100 hours	Project Manager - Engineering
2.1.3		Based on Council's defined responsibilities - Use a combination of enforcement and education to	Timeframe dependant on	Project Manager, Consultant.	$100,000	Project Manager - Engineering

		target Hotspot Pollution areas. Construct targeted interception systems where appropriate.	Council's responsibilities			
3. OPPORTUNISTIC & MAINTENANCE PROGRAMS						
3.1	**WSUD systems are functional by ensuring that they are designed, constructed and maintained correctly and to 'best practice' standards within Knox.**					
3.1.1		Update Knox's WSUD guidelines- tailored for civil engineers, planners, drafters and home owners to use when developing Council, industrial, commercial, residential developments and projects. Guidelines to include maintenance information. Design should allow water to become part of the landscape and for the community to interact with it.	Year 1 (25% funded)	Project Manager, Engineering, Landscaping, Planning, Melbourne Water, South East Melbourne Drainage Interest Group (SEMDIG)	100 hours	Project Manager - Engineering
3.1.2		Update Knox's WSUD interim policy for Council's New and Renewal Capital Works projects and Operational Maintenance Requirements with required processes for designing (with well documented assumptions), construction, and maintenance, registering and storing information about WSUD systems.	Year 1 (25% funded)	Project Manager, Engineering, Landscaping, Planning.	100 hours	Project Manager - Engineering
3.1.3		Update Knox's WSUD engineering design standard. Ensure that information is practical and adopted by all Council departments, developers, planners, builders etc. Ensure that the WSUD policy and the guidelines refer to these standards.	Year 1 (25% funded)	Project Manager, Engineering, Landscaping, Planning.	100 hours	Project Manager - Engineering
3.1.4		Action the maintenance management plan in Appendix A. Prepare standard maintenance requirements forms/lists for new WSUD systems.	Year 1 (25% funded)	Project Manager, Engineering, Operations Department.	150 hours	Project Manager – Engineering
3.1.5		Create an education and enforcement plan to communicate changes to WSUD processes and documents to internal Council Departments and an education plan for External Stakeholders –	Year 2 (not funded)	Project Manager – Engineering	100 hours	Project Manager – Engineering

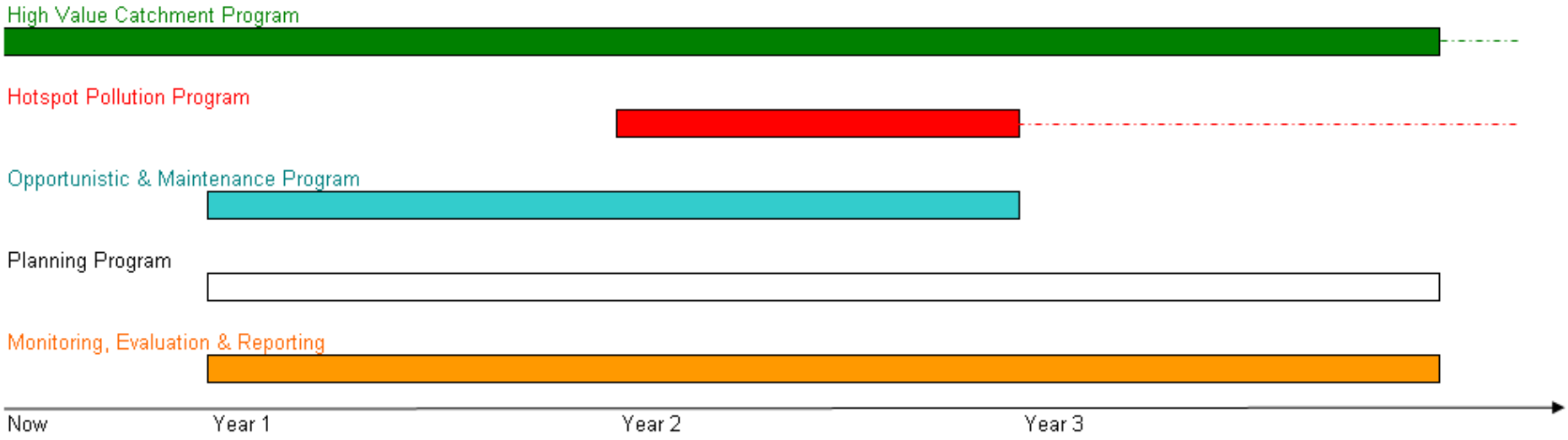
		developers, builders, businesses, residents.				
4. PLANNING PROGRAM						
4.1	**Ensure that there is appropriate regulatory power and structure to enforce on and educate the community to construct WSUDs and to understand their effect on waterways**					
4.1.1		Investigate if there are any gaps in the planning process that would enhance the incorporation of WSUDs into Council's planning requirements. Develop a flow chart of planning process – external and internal.	Year 1 (25% funded)	Project Manager, Planning	150 hours	Project Manager – Engineering
4.1.2		Agreed principles (or rules) and direction for planning, design and development, translated into a shared vision for WSUD outcomes.	Year 1 (25% funded)	Project Manager, Planning	150 hours	Project Manager – Engineering
4.1.3		Define planning requirements for building within 'High Value' catchment areas, DCI areas to waterways and all other areas. Ensure this is captured in the WSUD interim policy & WSUD guidelines.	Year 1 (25% funded)	Project Manager, Planning, Engineering, Sustainability	150 hours	Project Manager – Engineering
4.1.4		Prepare a handout for planners and applicants that provide design advice for developments in High Value Catchment areas, DCI areas to waterways and all other areas.	Year 1 (25% funded)	Engineering, Planning	30 hours	
4.1.5		Inclusion of WSUD requirements within existing EMPs and SDAs.	Year 2 (Not funded)	Project Manager, Engineering, Planning, Sustainability	150 hours	Project Manager – Engineering
4.1.6		Investigate the possibility of incorporating policy statements regarding 'High Value Catchment" and DCI areas into the Municipal Strategic Statement via the Planning Scheme Review Project.	Year 1 (25% funded)	Strategic & Economic Development Department	10 hours	Strategic & Economic Development Department
4.1.7		Ensure place-based projects include WSUD principles, particularly where new development is encouraged to front waterways.	Ongoing	Strategic & Economic Development Department	Ongoing	Strategic & Economic Development Department
4.1.8		Investigate the possibility of incorporating policy	Year 1 (25%	Engineering,	10 hours	Engineering,

		statements regarding opportunities that new development fronting waterways presents and the need for WSUD into the Municipal Strategic Statement via the Planning Scheme Review project.	funded)	Strategic & Economic Development		Economic & Strategic Development
4.1.10		Ensure processes are in place to have and maintain effective communication between departments.	Year 2 (25% funded)	Project Manager	150 hours	Project Manager – Engineering
4.1.11		Develop incentives to promote WSUD systems to the community and to developers and builders.	Year 3 (Not funded)	Project Manager, Planning	100 hours	Project Manager – Engineering
4.1.12		Continue to advocate the State Government to have stronger regulations and policy for enforcement of WSUD systems.	Year 2 (Not funded)	Project Manager	20 hours	Project Manager – Engineering
4.1.13		Investigate Price Charges for harvesting Water from Council and MW drains	Year 3 (Not funded)	Project Manager	40 hours	Project Manager – Engineering
5. MONITORING, EVALUATION AND REPORTING PROGRAM						
5.1	**Ensure that there is reporting and monitoring on the effect of WSUD systems on stormwater quality in Knox's waterways**					
5.1.1		Investigate the long term impacts and benefits of implementing WSUD and managing stormwater as community asset (source of water, amenity, biodiversity, etc) and a water management levy (similar to the infrastructure levy) which may assist in implementation.	Year 1 (25% funded)	Project Manager - Engineering	30 hours	Project Manager – Engineering
5.1.2		Provide annual reports to management of WSUD projects constructed (with capital & maintenance costs) within Knox and reduction in flow and pollutants to waterways.	Year 2 (25% funded)	All relevant departments	20 hours	Project Manager – Engineering
5.1.3		Annually report changes to waterways - through ISC and updated DCI information to management, councillors and EAC, linked to Knox Sustainable Environment Strategy 2008-2018.	Year 2 (Not funded)	Project Manager - Engineering	20 hours	Project Manager – Engineering
5.1.4		Report on education and enforcement plan outcomes.	Year 3 (Not funded)	Project Manager - Engineering	150 hours	Project Manager – Engineering
5.1.5		Monitoring of performance to validate WSUD	Year 3 (Not	Project Manager -	150 hours	Project Manager -

		approaches and feed back into the calibration of assessment tools.	funded)	Engineering		Engineering
5.2	**Transparent and structured direction in Management & in Processes for the implementation, education and enforcement of WSUDs within the municipality of Knox.**					
5.2.1		WSUD projects to be registered in GIS - link to dataworks, lifecycle or pop up info on maintenance requirements.	Year 2 (25% funded)	All relevant departments	150 hours	Project Manager - Engineering
5.2.2		Provide training for the use of MUSIC models & using local parameters - to record flow reductions and pollutant reduction and pre-development flow targets and EBI	Year 2 (Not funded)	All relevant departments	External training $2,000 per person	Relevant department
5.2.3		Provide training on how to locate high value catchment areas, imperviousness layer etc	Year 2 (25% funded)	Project Manager – Engineering – IT	20 hours	Project Manager - Engineering
5.2.4		Communication and training on how to maintain WSUD systems as required	Year 2 (Not funded)	Project Manager - Engineering	All relevant departments	Project Manager - Engineering
5.3	**Create partnerships – state government, neighbouring Councils, the community - to implement solutions**					
5.3.1		Liaise and participate with relevant agencies including Melbourne Water, EPA, VicRoads, MAV, CAM and other Councils to develop uniform requirements, guidelines, policies and laws that support the Strategy.	Year 2 (not funded)	Project Manager – Engineering, Planning, Economic Development	10 hours	Project Manager - Engineering
5.3.2		Partner with neighbouring Councils to implement solutions in High Value Catchment areas where waterways are shared.	Year 2 (not funded)	Project Manager – Engineering, Planning, Economic Development	Ongoing	Project Manager - Engineering
5.3.3		Agreed responsibilities and improve collaboration between boundary owners of waterways.	Year 2 (not funded)	Project Manager - Engineering	Ongoing	Project Manager - Engineering
5.3.4		Partner with affected and interested community groups as each minor catchment strategy is commenced	As per minor catchment strategy	Project Manager – Engineering, Sustainability	Ongoing	Project Manager - Engineering
5.4	**Obtain funding for strategy actions**					
5.4.1		Apply for funding through Council's business case process	As required	Project Manager - Engineering	Ongoing	Project Manager - Engineering
5.4.2		Apply for funding to MW for 'High Value'	As required	Project Manager	Ongoing	Project Manager -

		Catchment projects.				Engineering
5.4.3		Explore opportunities for joint funding applications with adjoining municipal councils or agencies.	As opportunities arise.	Project Manager	Ongoing	Project Manager - Engineering
5.4.4		Explore options for project sponsorship – for community involved projects	As opportunities arise and as per minor catchment strategy	Project Manager	Ongoing	Project Manager – Engineering
6. MANAGEMENT & IMPLEMENTATION OF STRATEGY						
6.1	**Strategy is implemented**					
6.1.1		Continue the funding of 0.6 EFT position for a project manager to implement the strategy actions.	Ongoing	Project Manager - Engineering	$60,000/year – (incl. super etc.)	Manager Engineering
TOTALS						
	Totals					
		Total Hours + additional costs			2,860 +hours (Ongoing timeframe – approx 500 hours) (Project Manager ($70,000/yr) $100,000 (based on Council's decision) $2,000/person trained for MUSIC V4	

Table 4.1 WSUD and Stormwater Management Strategy 2010 timeframe of implementation program


High Value Catchment Program
Hotspot Pollution Program
Opportunistic & Maintenance Program
Planning Program
Monitoring, Evaluation & Reporting
Now
Year 1
Year 2
Year 3

Timeframe

6.2 Targets for evaluating implementation and outcomes

If Knox is going to invest money into the implementation of a WSUD strategy within the municipality, it is critical that the implementation of the strategy is measured, both in terms of actions completed, but also in terms of waterway health outcomes. This section thus proposes a suite of targets by which the strategy's implementation will be measured. It starts with targets for each of the identified Programs, and then outlines simple measures for assessing the performance of a single WSUD project. Longer-term 'outcome' targets – in terms of waterway health improvement – are also discussed.

6.2.1 Targets for Program Objectives

Table 5 proposes a set of actions, targets and timeframes for each of the proposed WSUD Programs, outlining appropriate monitoring and reporting mechanisms.

Table 5. Proposed WSUD Program targets, actions, timeframes, monitoring and reporting

Program	Target	Actions	Timeframes	Monitoring & reporting
High value catchments	Reduce DCI in Dobsons Ck catchment to less than 1%	Construct WSUD systems focussed on (i) infiltration, (ii) stormwater harvesting	2020	1. Measure number of ha reduced each year 2. Measure performance against best practice objectives set out in Table 6.
	Reduce DCI in Blind Ck (East) catchment to less than 1%	Construct WSUD systems focussed on (i) infiltration, (ii) stormwater harvesting	2020	
	Reduce DCI in Ferny Ck (East) catchment to <2 %	Construct WSUD systems focussed on (i) infiltration, (ii) stormwater harvesting	2025	
	Reduce DCI in Monbulk Ck catchment to <2 %	Construct WSUD systems focussed on (i) infiltration, (ii) stormwater harvesting	2025	
Hotspots	Reduce number of hotspot pollution areas to < 5 sites	Educate and Enforce to target hotspot pollution areas. Construct targeted interception systems where necessary	2025	1. Report on education and enforcement programs implemented.
Opportunistic	Include WSUD systems into all Capital Works Programs where practicable	Policies, Standards and Processes are in place to ensure that WSUD systems are included into Capital Works Programs	2012	1. Annual report on Capital projects that included WSUD systems and reasons why the rest of the projects did not include WSUD systems. 2. Amount spent on WSUD systems annually.
Planning	There is appropriate regulatory power and structure to enforce on and educate the community to construct WSUD systems and to understand their effect on waterways	Investigate opportunities to develop and implement new WSUD planning controls in the Knox Planning Scheme. These could include additional policy statements in the Municipal Strategic Statement, a new local planning policy and/or overlays that specifically target High Value Catchment and DCI areas. Advocate the State Government to have stronger regulations and policy for enforcement of WSUD systems.	2012	1. Monitor and report on progress as part of the four-yearly review of the Planning Scheme required by legislation. 2. Report on the impact of changes to Council's processes.
Maintenance	All WSUD sites constructed by Knox City Council are maintained to best practice standards	All projects that include WSUD system to include a maintenance routine and lifecycle costing	2012	1. All WSUD systems in lifecycle program 2. All WSUD systems maintained

Monitoring & reporting	Council aware of impact actions strategy on municipality.	Annual report on outcomes of strategy. Monitoring of performance to validate WSUD approaches and feed back to the calibration of assessment tools.	2012	1. Report on all implemented actions from the strategy. 2. Report on any changes to creek and stream health 3. Report on reduction of loads of TSS, TP, TN and potable water savings

6.2.2 Implementation targets

In addition to the proposed targets for measuring overall Program implementation, two discrete implementation targets are proposed: one which allows the performance of individual WSUD projects to be reported, and another which records the long term reduction in directly connected impervious areas across the municipality.

Implementation Target 1: Modelled performance of individual WSUD projects

Council can readily assess the performance of an individual WSUD project, by modelling (using the Model for Urban Stormwater Improvement Conceptualisation, MUSIC), the performance of constructed systems in terms of water quality and flows (Table 6). Given that these are very strongly related to waterway health, they will give a very good indication of likely changes to the health of our waterways resulting from the WSUD works being undertaken.

Table 6. Targets for the performance of individual WSUD works.

Parameter	**Current Best Practise Performance Objective**
Suspended Solids (SS) load	80% retention of the typical urban annual load
Total Phosphorus (TP) load	45% retention of the typical urban annual load
Total Nitrogen (TN) load	45% retention of the typical urban annual load
Litter	70% reduction of the typical urban annual load
Flows • Frequency of runoff above natural level (days/year) • Volume of runoff per year • Volume infiltrated per year	 No increase in frequency from pre-developed No increase in pre-developed volume Volume equivalent to pre-developed
Potable water savings (kL/year)	Site- or project-specific targets to be used.
Construction Phase:	
Suspended Solids (SS)	Effective treatment of 90% of daily run-off events
Litter	Prevent litter from entering the stormwater system
Other Pollutants	Limit the application, generation and migration of toxic substance to the maximum extent possible

Implementation Target 2: Reduction in Directly Connected Imperviousness (DCI)

Given the well-established linked between the area of directly connected imperviousness in a catchment and the health of its waterway, it is appropriate to adopt long-term targets for reductions in the amount of directly-connected impervious areas in the municipality. Melbourne Water has produced a discussion paper that recommends 5 & 50 year DCI targets for urban streams. The proposed targets (Table 7) are adapted from these, and recognise that Knox, in the Dandenong foothills, has an opportunity to exceed these generic Melbourne targets.

Table 7. Waterway health DCI targets for waterway types

Type of waterway	Melbourne Water 5 years target DCI	Melbourne Water 50 years target DCI	Knox City Council's 5 Year Target DCI	Knox City Council's 50 Year Target DCI
Natural grassland woodlands	<1%	<1%	<1%	<0.5%
Rural waterways	<1%	<1%	<1%	<0.5%
Urban growth	<2%	<1%	<2%	<0.5%
Existing Urban (with DCI <10%)	<2%	<1%	<2%	<0.5%
Existing Urban (with DCI 10-20%)	<3%	<1%	<3%	<0.5%
Existing Urban (with DCI 20-30%)	<5%	<1%	<5%	<0.5%
Existing Urban (with DCI >30%)	<7%	<1%		<0.5%

Note: Council will also advocate Melbourne Water to continue to fund research that assesses the impact of directly connected impervious surfaces to waterways and the effect this has on the Dandenong catchment including the Knox area, to monitor the impact of the implementation of the WSUD programs on water quality and waterway health.

6.2.3 Waterway Health targets

Waterway Health Target 1: Water quality & aquatic life

Ultimately, with the continued implementation of WSUD, particularly in high-value catchments, we expect that the condition and health of waterways in the Knox region will improve. Monitoring of such waterway health indicators is beyond the scope and resources of Council. However, Melbourne Water has waterway health monitoring programs in place throughout the region, and Council could use these region-wide programs, perhaps supplemented by additional local monitoring.

For example, the Index of Stream Condition (ISC) combines the scores for five factors of stream health: Aquatic Life; Water quality; Stream side zone; Physical form; Hydrology. The ISC is a numerical score that translates into a rating of excellent, good, poor or very poor. The Index is relatively coarse, and applied at only a few sites within the region. Other biological monitoring programs may also be used, which are better suited to the scale and needs of the Council.

It is proposed that Council enter into an arrangement with Melbourne to conduct long-term locally-relevant ecosystem health monitoring of Knox's waterways, and to provide this data to council as a GIS layer, to allow Council to track long-term trends.

Council could also enter into an agreement with Melbourne Water to fund water quality monitoring at designated points on a regular basis, to help assess the impact of the implementation of WSUD actions on water quality within the municipality's waterways.

APPENDICES

APPENDIX A – Council's responsibility as per Protecting Our Bays and Waterways Agreement (1999)

Protecting Our Bays and Waterways Agreement (*1999*) between EPA, Melbourne Water and Municipal Association of Victoria (MAV) sets out specific roles and responsibilities with respect to particular aspects of stormwater management within the Port Phillip and Westernport catchment areas. Of particular relevance to Knox City Council, it states that local government:-

- has a shared responsibility with Melbourne Water (within its drainage jurisdiction) and sole responsibility outside this jurisdiction (generally drains and waterways with catchments of less than 60 Ha within MWC drainage jurisdiction) for stormwater management within municipalities.
- participates in urban stormwater policy development and practice with Melbourne Water and EPA
- leads the development and implementation of local stormwater management plans within the regional context established in cooperation with Melbourne Water and EPA
- undertakes local urban drainage works in accordance with agreed best practice standards and guidelines developed by EPA, Melbourne Water and local government
- incorporates best practice guidelines in local planning policies
- undertakes community awareness and participation activities to encourage adoption of best practice by individuals and businesses.

Councils are responsible for the local drainage network, generally in catchments of less than 60 hectares. It is understood and it is important to note that there is no formal legislation in place with regards to the 60 hectares rule and though MAV on behalf of all Council has signed an agreement with Melbourne Water, each Council can approach Melbourne Water to form their own agreement. Indeed, Knox City Council is currently working very closely with Melbourne Water, through Melbourne Water's "Living Rivers" stormwater program and 'Flood Management' Planning Program.

It must be also noted that a lack of support at the State Planning level renders Council's position weak when it comes to enforcing the implementation of WSUD by others in the municipality.

APPENDIX B – Roles and responsibilities of other agencies in relation to stormwater management and waterway health

The responsibility for planning and management of water resources encompasses a range of government departments, water authorities and regulators. However, it is primarily Melbourne Water and Local Councils who are responsible for stormwater and with the EPA having the responsibility for point sources contamination management.

Melbourne Water (MW)

The Victorian Government in its white paper "*Securing Our Water Our Future 2004*" designated Melbourne Water as caretaker of river health with responsibility for waterways, drainage and floodplain management, the management of the Environmental Water Reserve, and water quality monitoring throughout Port Phillip.

Environment Protection Authority (EPA)

EPA regulates the protection of water quality and preventing pollution and licensing waste discharges. However, up to date EPA has not had resources to provided support in inspection and enforcement of point source contamination management.

Legislation and Policy Review

A review of relevant legislation, policies and plans identifies the Water Act 1989, Catchment and Land Protection (CALP) Act 1994 and the Water Industry Act 1994 as the principal Acts affecting water quality.

The Environmental Protection Act, 1970, provides for the development and promulgation of State Environmental Protection Policies including State Environmental Protection Policy (Waters of Victoria) Thereafter SEPP (WoV)]. SEPP (WoV) and the schedule, SEPP (F8) Waters of Western Port and Catchment, are of specific relevance since it establishes beneficial uses and water quality objectives for the protection of these uses.
In addition, a range of Government Policies and Strategies are of importance to water quality including:

- Victorian River Health Strategy, 2002
- White Paper: Securing Our Water Our Future, 2004
- Regional Catchment Strategy, 2004-2009
- Regional River Health Strategy, 2006
- Waterways Water Quality Strategy, 2008/09

APPENDIX C – WSUD systems within the municipality of Knox owned by Council

No.	Location	Type	Functioning?
1	Jenola Reserve, Rowville - Jenola Parade & Timmothy Drive	1 x Raingarden & vegetated swale	Yes
2	Fairway Drive Reserve, Rowville	3 x Vegetated Infiltration Basins	Yes
3	Boronia Place Management, Dorset Square, Boronia	45 Bio-retention tree pits & Permeable Paving along the south walkway	Yes
4	Clayden Rise - subdivision of 47-53 Palmerston Rd, Lysterfield	Bioretention swale	No
5	Lords Crt, Lot 7 Rathgar Rd, Lysterfield	Bioretention swale	No
6	Arboretum car park	1 x Filtration trench	Yes
7	Heany Park wetlands, Rowville (Bergins Rd/Churchill Dve)	Wetland	Yes
8	Railway Avenue, Boronia PEREGRINE ESTATE	2 x Raingardens	No
9	Coleman Rd/Lewis Rd shops	11 x Bio-retention tree pits	Yes
10	Boronia Park - behind basketball centre (Park Cres, Boronia)	2 x raingardens, 2 x rock infiltration beds	No
11	Knox Civic Centre	Raingardens & Rainwater tank	Yes
12	Rowville Community Centre	Filtration trench (top of car park, Porous pavement (surrounding building), swale drain (top of garden bed).	No
13	Amanda Crt, Rowville	Infiltration trench garden bed	Yes
14	Wantirna Road carpark, Wantirna	Disconnection of impervious carpark to waterway	Yes
15	Koolamara Waters, FTG	3 x wetlands	Yes
16	Whitehall Terrace, FTG	Vegetated Bioretention swale	Yes
17	Carrington Park, Knoxfield	GPT, Secondary Infiltration system, Sedimentation tank, Stormwater tank	Yes

APPENDIX D – WSUD related activities

Program	Approx. % of budget
High value catchments program Prioritisation based on % Connected Imperviousness (GIS) & stream condition (matrix to be developed); *Dobsons Creek is highest value waterway in municipality*. Focus close as possible to source where possible, but work at all scales as necessary, to achieve necessary retention capacity (Walsh et al, 2009) Four stages of implementation: 1. Identify High Value Catchments in GIS 2. Opportunity search (look for places to construct systems in priority areas) 3. Design & construction phase (rainwater harvesting, infiltration, raingardens, etc): e.g. rainwater harvesting from roofs and infiltration of other impervious areas. 4. PLUS include a "trial and demonstration" component Form a partnership with Little Stringybark Creek project, to provide guidance.	50%
Opportunistic retrofit program In catchments as opportunities arise (road renewals, construction projects, etc) to reduce marginal cost of implementing WSUD. Prioritisation within program based on feasibility of program (i.e. cost / catchment area treated)	15%
Hotspots program – aimed at addressing 'high-pollution' areas such as industrial zones, etc. Three components 1. Risk-based prioritisation (using land use maps; target areas where high pollutant loads are likely – esp. industrial zones) 2. Use a combination of education and enforcement 3. Construction of targeted interception systems (filtration, etc)	10%
Planning program Investigate opportunities to develop and implement new WSUD planning controls in the Knox Planning Scheme. These could include additional policy statements in the Municipal Strategic Statement, a new local planning policy and/or overlays that specifically target High Value Catchment and DCI areas. Continue advocating for more pro-active planning controls (through regional group and Stormwater Victoria)	10%
Maintenance Program Develop a program to include an asset management database on WSUD systems and a life cycle process to capture information about the location, construction and maintenance of each WSUD system within the municipality of Knox to ensure systems are effective and maintained to best practice standards.	10%
Monitoring & Reporting MUSIC model for every system constructed – to calculate load reductions (should be available from design-phase modelling). Compile annual report: loads of TSS, TP, TN reduced and potable water savings For any sub-catchments in which actions are anticipated to improve stream ecological condition (or protect high value streams from new development), then an ecological monitoring program should also be developed.	5%

APPENDIX E - What are other Victorian Councils doing to manage stormwater through WSUD systems?

During the preliminary research and consultation for development of this strategy, 15 Victorian Municipal Councils were interviewed. This represents 19% of Councils in Victoria.

The amount of involvement in managing stormwater quality and flow within Victorian Councils ranged depending on the specific Councils' available resources and their location within the regional catchment. Councils bordering the bay had more awareness of stormwater management than Councils located further inland. A summary of the findings from the consultation with Victorian Councils is as follows:

- A number of Councils monitored water quality through Waterwatch groups.
- Melbourne City Council used data from Waterwatch to monitor the effect their two (2) larger WSUD projects on water quality.
- Interestingly, some Councils such as; Manningham City Council had consultants look at pollutant loads for the whole municipality and set targets to improve the quality of their catchments.
- Various Councils use a WSUD conception software tool - Model for Urban Stormwater Improvement Conceptualisation (MUSIC) - to observe the reduction of pollutants loads resulting from the construction of a WSUD system and use this information to set and meet stormwater pollutant reduction targets.
- In the adjacent Shire of Yarra Ranges, a large pilot project – the Little Stringybark Creek Project – is underway, which is demonstrating the retrofit of a wide range of WSUD works (streetscape rain-gardens, stormwater harvesting and infiltration systems in private allotments, regional stormwater harvesting, etc) at a whole-of-catchment scale. This project is a partnership between Melbourne and Monash Universities, Melbourne Water, The Shire of Yarra Ranges and Yarra Valley Water.

However, apart from the Little Stringybark Creek pilot project, none of the Councils interviewed looked at the direct impact that WSUD systems have on water quality and waterways health within their overall catchment. That is, where the construction of WSUD would result in the greatest improvement in water quality and waterways health per dollar spent. For bayside municipalities, this is understandable, because they are simply trying to reduce the load of pollutants into the bay. However, for inland councils like Knox, there is a need to identify and protect the values of the waterways themselves. Knox's primary responsibility should be to protect the values of the waterways in its municipality – in turn this will help to protect and restore downstream waterways anyway.

APPENDIX F – Estimated financial maintenance and renewal requirements for WSUD systems within Knox

Table F.1: Operational WSUD systems within Knox

	Operational WSUD systems within Knox	Operational Cost
1	Whitehall Terrace, FTG	$ 1,800
2	Heany Park wetlands, Rowville (Bergins Rd/Churchill Dve)-Maintained by Bushland Crew	(Currently managed by Bushland Crew)
3	Koolamara Waters, FTG - Maintained by Bushland Crew	(Currently managed by Bushland Crew)
4	Knox Civic Centre	$ 900
5	Arboretum car park	$ 1,800
6	Coleman Rd/Lewis Rd shops	$ 1,800
7	Jenola Reserve, Rowville	$ 2,800
8	Fairway Drive Reserve, Rowville	$ 1,800
9	Boronia Place Management, Dorset Square, Boronia	$ 10,400
10	Carrington Park, Knoxfield	$ 2,000
11	Wantirna Road Carpark	$ 2,200
	TOTAL	**$ 25,500**

There are a number of WSUD systems that are currently not functional/operational and need to be renewed. The table below shows the estimated renewal costs and maintenance costs that will be required for future years.

Table F.2: Non–0perational WSUD systems within Knox

	WSUD system	Capital Cost (Renewal)	Year Maintenance is required	Maintenance Costs once renewed
1	Boronia Park - behind basketball centre (Park Cres, Boronia)	$ 30,200	2010/11	$ 1,800
2	Lords Crt, Lot 7 Rathgar Rd, Lysterfield	$ 33,300	2010/11	$ 1,800
3	Rowville Community Centre	$ 30,400	2011/12	$ 900
4	Clayden Rise - subdivision of 47-53 Palmerston Rd, Lysterfield	$ 34,900	2011/12	$ 5,300
5	Railway Avenue, Boronia PEREGRINE ESTATE	$ 30,000	2012/13	$ 900
	TOTAL	**$ 158,800**		**$ 10,700**

A number of WSUD projects are in their design stage and should as per Council's new requirements include lifecycle costing to cover maintenance costs.

Table F.3: WSUD in design stage –once finalised to be maintained

	WSUD system
1	Cardiff St Reserve, Boronia
2	Wicks Reserve
3	Talaskia Reserve
4	Wantirna Mall
5	Knox Gardens
6	Eastern Recreation precinct (bio-retention systems - raingardens and swales)
7	Stamford Park