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REAL TIME WATER SENSITIVE URBAN DESIGN

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Abstract

Numerous research papers have been written on the ways and processes to implement water sensitive urban design. The barriers, the drivers, the frameworks and pathways have all been documented. But does this research reflect what happens in reality?

Seven councils within the Parramatta River catchment started a journey 3 years ago to proactively try and integrate WSUD into their organisations. Two million dollars from the NSW Environmental Trust Urban Sustainability Program was provided to assist them in this process. The project involved a number of integrated tasks trying to encompass a broad spectrum of institutional capacity drivers. These included construction of demonstration projects, MUSIC modelling, operation and maintenance plans, WSUD planning framework reviews, monitoring and evaluation, research into champions, bus tours, case studies and staff training.

Initially, each council was on a separate progressive path with their own perceived barriers and drivers. The conference paper will discuss the barriers that were broken down, those that remain and whether councils were successful in improving their institutional capacity. Questions that will be answered include what were the key triggers for their progression and what role did the project have in this institutional reform and more importantly, where are they at, now the project has ended?

Introduction

The project *Working Together to Sustain the Parramatta River* aimed to promote sustainability through the implementation of Water Sensitive Urban Design (WSUD) initiatives across the Parramatta River catchment in Sydney, Australia. The Parramatta River catchment is highly urbanised and covers 257 square kilometres extending from the confluence of the Lane Cove River in the east and Blacktown in the west. The Parramatta River is the largest river entering Sydney Harbour with the tidal extent alone covering some 19 kilometres.

Seven councils within the catchment participated in the project:

- Ashfield Council;
- Auburn Council;
- City of Canada Bay;
- Hunters Hill Council;
- City of Ryde;
- Parramatta City Council; and
- Strathfield Council.

The project consisted of a variety of measures that provided councils with the tools and knowledge to facilitate the uptake of WSUD. The project focused on sharing ideas and findings across the councils whilst allowing for the fact that the pathway to implementation varied across each council, reflecting their own operational priorities and available resources.

Background

In 2007 the Parramatta River Catchment Group (PRCG) identified that there was little or no uptake of WSUD across most of the councils within the catchment and the opportunity for sharing outcomes from councils who were implementing WSUD principles was being lost. The PRCG was successful in obtaining $1.9M in grant funding through the NSW Environmental Trust Urban Sustainability Program for the *Working Together to Sustain the Parramatta River* project to address the specific capacity building needs that councils would require to implement WSUD.

Prior to the project, it was widely acknowledged that implementation of WSUD was slow and that there were many diverse and persistent barriers to councils transitioning towards a "water sensitive city" (i.e. Marsalek *et al*, 2001; Vlachos and Braga, 2001; Brown, 2005; Wong, 2006, Brown, 2007, Brown *et al*, 2008).

To improve the capacity of local government to implement WSUD, research has indicated that the following areas need to be addressed (Brown et al, 2006):

- Human resource development (e.g. recruitment and training);
- Intra and inter organisational strengthening (e.g. networking within and between organisations); and
- Institutional reform (e.g. policy and legal change).

Brown et al (2006) also identified that capacity building interventions typically fail when only one of these areas is focused upon. Therefore to enable wide spread change to more sustainable water management practices, a holistic approach was undertaken for this project and capacity building across all three areas was implemented through a number of tasks.

The key objectives of the project were:

1. To reduce urban runoff and improve the receiving water quality of the River by using WSUD principles i.e. runoff that would normally be discharged to Parramatta River will be collected, treated and reused for irrigation and other purposes.
2. To raise community awareness of the urban impacts on natural resources and the links between the project facilities and the ecology of the River and the biodiversity of the Region.
3. To build capacity within and between Council's and the Parramatta River Catchment Group (PRCG) to meet the above objectives for the long term.
4. To demonstrate that WSUD can be successfully implemented in existing, constrained urban areas.
5. To improve public amenity.
6. To reduce water consumption i.e. reducing the use of potable water and maximising fit-for-purpose water uses.
7. To monitor, assess and evaluate the capital, capacity building, and planning and policy initiatives across all councils in terms of WSUD.

The range of the objectives was reflected in the wide variety of activities that were supported by the project.

Methodology

Each council designed and constructed one or more WSUD demonstration projects, undertaken as a learn-by-doing exercise. To ensure these projects had the appropriate resources to be maintained into the future, their life cycle and annual maintenance costs were calculated and Operation and Maintenance Plans were developed.

Demonstration projects were seen as an important step to allow each council to pilot a combination of WSUD practices and technologies. Table 1 provides a summary of each project. The number of capital works projects undertaken by each council varied due to Council's own operational priorities.

Table 1 Summary of WSUD Demonstration Projects

Council	WSUD Demonstration Project
Ashfield Pratten Park Stormwater Harvesting System	Stormwater harvesting system diverting water from a stormwater drain, storing and treating it and then using it to irrigate Pratten Park oval.
Ashfield Rawson St / Denman Ave Stormwater Treatment System	Construction of 2 leaf inlet retention basins around street trees to divert and capture leaf litter and reduce flooding issues of the adjacent residents.
Auburn Wyatt Park Stormwater Harvesting System	Stormwater diverted from a Sydney Water GPT, stored and treated, then utilised to irrigate Wyatt Park.
Canada Bay Powells Creek Reserve Stormwater Harvesting System	Stormwater runoff from carpark was captured and treated then utilised to irrigate Powells Creek Reserve oval.
Hunters Hill Clarkes Point Reserve Stormwater Harvesting System	Stormwater runoff from carpark was captured and treated then utilised in the adjacent Hunters Hill Sailing Club for boat wash down as well as toilet flushing at the Club and the nearby public toilets. Excess water directed through treatment train prior to discharge into Parramatta River
Parramatta Guildford Road Stormwater Treatment System	WSUD incorporated into upgrade of laneway between supermarket and its adjacent carpark. Stormwater runoff from Guildford Rd directed through the mall via a series of rain gardens incorporating existing trees, and grated drains set in pervious paving.
Parramatta Church St South Stormwater Treatment System	WSUD incorporated into streetscape upgrade program, including a series of interconnected rain gardens and car parking bays lined with pervious pavers.
Ryde Meadowbank Park Stormwater Treatment System	Bioretention system constructed within Meadowbank Park to retain stormwater from 1.53ha residential catchment draining directly to Parramatta River.
Ryde Meadowbank Station Stormwater Treatment System	Construction of 4 biofiltration tree pits and 2 rain gardens into the upgrade of Meadowbank Station Plaza and surrounding streets.
Ryde Looking Glass Bay Park Stormwater Treatment System	Stormwater from Amiens St Catchment (residential with a high percentage of roads) captured and retained within bioretention basin prior to discharging to creek and Parramatta River.
Strathfield Mason Park Stormwater treatment System	Bioretention swale constructed to take stormwater from the carpark and oval providing water quality improvements and reduced volumes discharging into Saleyard Creek.

After completion of all the demonstration projects a guided tour involving all project participants was undertaken to share the lessons learnt and insights gained from each council. To accompany these tours, case studies for each project were developed both in brochure and more detailed formats and included within a Monitoring and Evaluation Report. This report also included comparative results on water quality modelling and event monitoring to identify actual water quality improvements; potable water savings for stormwater harvesting projects; as well as providing a triple bottom line assessment of the effectiveness of each demonstration project against environment, social and economic criteria.

Another focus of the project was to support the growth of champions within the participating councils as research had recognised that WSUD champions play a critical role in the transition to more sustainable water management practices (Taylor, 2008). The project therefore incorporated a Monash University PhD research project focusing on leadership competencies in people that aim to deliver sustainable urban water management. Learnings from this research were then incorporated into a leadership training course for member councils aimed at identifying and developing young professionals within the WSUD arena, as well as building support networks between councils within the catchment.

To provide further support to these other capacity building initiatives a review of the existing use of WSUD in council's policy and planning frameworks was undertaken to provide an impetus for improvement and to build consensus across councils as to how a consistent planning approach to WSUD could be developed across the catchment. Some councils further utilised the grant funding to get external assistance in reviewing their specific Development Control Plans (DCP's) to incorporate consistent water quality objectives for new development and relative WSUD planning requirements.

The project also had a large evaluation component, assessing the level of success of the individual tasks as well as assessing the broader outcomes of whether the project improved council's capacity to implement WSUD.

Project Outcomes

The effectiveness of the WSUD demonstration projects were assessed against water quality improvements, potable water savings as well as a triple bottom line assessment incorporating life cycle cost and social amenity improvements.

Each WSUD system achieved single or multiple objectives, depending on the constraints and limitation of the site and budget. A Monitoring and Evaluation Report evaluated water quality modelling and monitoring results to identify water quality improvements and potable water savings for stormwater harvesting projects.

Water Quality Improvements

MUSIC modelling was undertaken for ten of the WSUD pilot projects (with the exception of the Rawson & Denman Streets leaf/litter racks). MUSIC modelling predicted the performance of the systems with regards to average annual pollutant loads and the percentage reduction. The comparison of the modelling results is provided below in Table 2.

Table 2 indicates that according to MUSIC modelling the systems achieving the greatest percentage reduction in pollutants are the Guildford Road, Clarkes Point Reserve, Powells Creek Reserve and Looking Glass Bay Park systems. In regards to the actual loads of pollutants removed from the system, the Pratten Park, Mason Park and Meadowbank Park systems showed the best results.

Table 2: Predicted Water Quality Performance Comparison

WSUD Pilot Project	Average Annual Pollutant Reduction (kg)			Average Annual % Reduction		
	TSS	TP	TN	TSS	TP	TN
Mason Park	1,688	1.9	3.4	87%	57%	17%
Guildford Road	103	0.1	0.5	98%	96%	85%
Church Street South	344	0.3	1.2	90%	71%	47%
Meadowbank Park	1,466	2.5	11.4	78%	63%	39%
Looking Glass Bay Park	1,088	1.6	9.4	85%	74%	57%
Meadowbank Station	828	1.2	3.0	71%	59%	31%
Wyatt Park*[1]	190	2.9	28.0	2%	5%	5%
Powells Creek Reserve[1]	599	0.5	3.8	99%	95%	91%
Clarkes Point Reserve[1]	1,284	1.4	9.8	98%	90%	90%
Pratten Park[1]	2,600	5.3	35.0	68%	45%	20%

** The percentage reduction results of Wyatt Park are lower than for all other systems because the Wyatt Park system already had an existing GPT in place, which treats the stormwater prior to the water entering the harvesting system.*
[1] Stormwater Harvesting Projects

Two of the four Stormwater Harvesting Systems are predicted to provide significant pollutant load removals due to the sheer volume of runoff collected, treated and stored. The results also predict a significant improvement in stormwater quality as a result of implementing bioretention systems and swales, such as those constructed at Mason Park and Meadowbank Park.

Table 3 compares the modelled performance of the WSUD systems with draft DECCW *Managing Urban Stormwater: Environmental Targets* to provide an appreciation of the systems effectiveness.

Table 3 DECCW Water Quality Treatment Targets

Pollutant	Average Annual Pollutant Load Reduction Target
Total Nitrogen	45%
Total Phosphorous	65%
Total Suspended Solids	85%

It is noted that five of the systems are predicted to meet the targets for all the pollutants, including the Guildford Road, Church Street South, Looking Glass Bay Park, Powells Creek Reserve and Clarkes Point Reserve systems.

As part of the project, consultants were engaged to monitor water quality improvements at the established WSUD systems and compare the actual results to the modelled predictions. At the time of writing, three

representative sites (of the ten pilots) were undergoing monitoring. The following sites were included in the monitoring program:

- Guildford Road Stormwater Treatment System;
- Clarkes Point Reserve Stormwater Harvesting System; and
- Pratten Park Stormwater Harvesting System.

Preliminary results show pollutant removal rates of greater than 50% for nutrients and greater than 90% for suspended solids. Findings will be presented as they become available in future.

Potable Water Savings

Four of the demonstration projects involve stormwater harvesting, three of which utilise the water to irrigate sports ovals. The fourth provides water for the Hunters Hill Sailing Club for boat washdown and toilet flushing. Together these projects have been designed to save a total of 26.45ML potable water annually. Table 4 details these predicted savings for each project as well as the percentage of mains water demand that maybe met through their installation.

Table 4 Predicted Potable Water Savings from Stormwater Harvesting Projects

Stormwater Harvesting Project	Annual Potable Water Savings (ML)	Water Savings as a % of Mains Water Demand
Ashfield Pratten Park	8.0	80%
Canada Bay Powells Creek Reserve	2.0	50%
Hunters Hill Clarkes Point Reserve	0.15	67%
Auburn Wyatt Park	16.3	95%

Triple Bottom Line Assessment

This assessment has incorporated life cycle costing and the public amenity improvements obtained through each project to gain an appreciation of triple bottom line factors.

Initially the projects were scored against the following environmental and social criteria:

- Potable water reduction;
- Pollutant load removal, (the pollutant load was selected as the performance indicator rather than the percentage reduction as it is a consistent indicator across the sites to allow comparison of sites). For example, a site with a high percentage reduction may only have a small total load removed as the total volume of flow captured may also be small;
- Improvement to public amenity; and
- Replication of natural flow regimes by reducing flooding and 'time concentration' of runoff.

The results as shown in Table 5 show that the WSUD projects in Pratten Park, Wyatt Park and Meadowbank Park provided the most benefits, when integrating social and environmental assessment criteria. Pratten Park and Wyatt Park's higher rankings are due to the additional benefits of the reduction in potable water demand that stormwater harvesting projects provide. Powells Creek Reserve and Church St South systems were ranked as the lowest performing projects when combining social and environmental benefits, largely due to their small catchment areas and therefore small total load volumes being captured.

Economic criteria were then added to this evaluation. A lifecycle cost estimate was determined for each demonstration project. This lifecycle cost included all expenses associated with the project, including acquisition, installation, operation and maintenance. A full account of the triple bottom line assessment is shown in Table 6.

Table 5: Environmental and Social Assessment

Assessment Criteria	Environmental Factors								Social Factors		Total Score	Ranking
	Annual Reduction in Potable Water (kL)	Score	Annual Reduction in TN (kg)	Score	Annual Reduction in TP (kg)	Score	Annual Reduction in TSS (kg)	Score	Improvement in Public Amenity	Improvement in Natural Flow Regime		
WSUD Project												
Pratten Park	7216	2	35	5	5.3	5	2600	5	1	1	18.0	High
Wyatt Park	16297	4	28	5	2.9	3	190	1	1	1	14.0	High
Meadowbank Park	NA	0	11.3577	3	2.50904	3	1466.4	3	2	4	12.0	High
Mason Park	NA	0	3.4	1	1.89	2	1688	4	3	4	10.5	Medium
Looking Glass Bay Park	NA	0	9.3644	2	1.62877	2	1088	3	2	5	10.5	Medium
Clarkes Point Reserve	263	1	9.8	2	1.44	2	1283.65	3	2	1	9.5	Medium
Meadowbank Station	NA	0	3	1	1.19	2	828	2	3	2	7.5	Medium
Guildford Road	NA	0	0.45	1	0.117	1	103.3	1	5	4	7.5	Medium
Powells Creek Reserve	412	1	3.802	1	0.539	1	598.55	2	2	1	6.5	Medium
Church Street South	NA	0	1.24	1	0.258	1	343.9	1	4	2	6.0	Low

Note: No MUSIC or water quality modelling was undertaken for the Rawson Street / Denman Avenue project and as such it has not been included in this assessment.

Table 6: Triple Bottom Line Assessment

WSUD Project	Environmental/ Social Performance Score	Economic Performance Score	Total Score (benefit/cost)	Ranking
Looking Glass Bay Park	10.5	2.7	3.9	High
Meadowbank Park	12.0	3.2	3.8	High
Mason Park	10.5	2.9	3.6	High
Meadowbank Station	7.5	2.5	3.0	High
Pratten Park	18.0	7.3	2.5	High
Wyatt Park	14.0	8	1.8	Medium
Guildford Road	7.5	4.8	1.6	Medium
Church Street South	6.0	4.1	1.5	Medium
Clarkes Point Reserve	9.5	6.9	1.4	Medium
Powells Creek Reserve	6.5	7.7	0.8	Low

Integration and consideration of all criteria resulted in Looking Glass Bay Park and Meadowbank Park delivering the highest scores and overall benefit cost ranking. Mason Park, Meadowbank Station and Pratten Park also scored high rankings.

Construction and Operational Lessons Learnt

One of the other key outcomes of the construction and operation of the WSUD demonstration projects has been the lessons learnt by each council and how these can provide improvements to future WSUD implementation across the catchment. This is a key factor to embedding sustainability and building capacity.

The lessons learnt were documented in the Project Case studies and the Monitoring and Evaluation Report and discussed during the guided educational tours of the completed projects. Table 7 provides a summary of the findings.

Table 7 Summary of Construction and Operational Lessons Learnt

Issue	Lessons Learnt
Base Flows	Need to understand base flows to proposed systems in terms of storage sizing and environmental flows
Inlet design and maintenance	Side entry pit traps should not be placed at low points or sags. Inspection and maintenance of these systems should be after 10mm of rainfall within 24hrs and more frequently if Council has wind storms or deciduous street trees. Regular maintenance of system inlets are critical to prevent blockage and bypass. Offline designed systems need to consider the appropriate angle and grade of runoff off take to maximise water diversion, treatment and storage.

Design Insights	Design briefs need to be very specific in regards to project objectives and system requirements prior to issue and estimating. The use of in-house design and construction increases the council's capabilities with regards to WSUD projects and encourage a sense of ownership of the project. Utilise professional assistance if required to build capacity and expertise. Be open and flexible to design modifications and variations during consultation and consider maintenance requirements prior to construction. This can result in efficiencies and cost savings.
Communication between design and construction staff	Poor or misinterpreted understanding of design and WSUD technology / function can result in errors, time delays and under performance of systems. The civil contractors and in-house staff often lack experience in the construction of WSUD designs particularly biofiltration systems (including substrate elements). A formalised asset handover process with Operation and Maintenance Plans is required to understand roles, responsibilities and maintenance frequencies particularly where vegetated systems are involved.
Organic litter loads	The degree of tree canopy (natural and deciduous) within the catchment or directly over the site can impact on organic litter loads and blocking of systems, diversion of flows or water discolouration due to tannins leaching from matter
Site constraints and unknowns	Projects need to consider site constraints such as steep slopes, flat grades, excavation to rock, ground water or tidal intrusions, sensitive areas, physical obstacles and services. These factors can affect the system size, depth and performance and often determine if the project is feasible based on cost benefit assessment. Consideration of factors such as contaminated land or acid sulphate soils also should be determined prior to final design.
Traffic management during construction	Planning and allowance for both vehicular and pedestrian traffic during construction is important in areas of high commuter and retail use in terms of safety, public relations and liability. The impact of vehicles and pedestrians also needs consideration during the operation and maintenance phase due to damage/trampling of vegetation and compaction of soil.

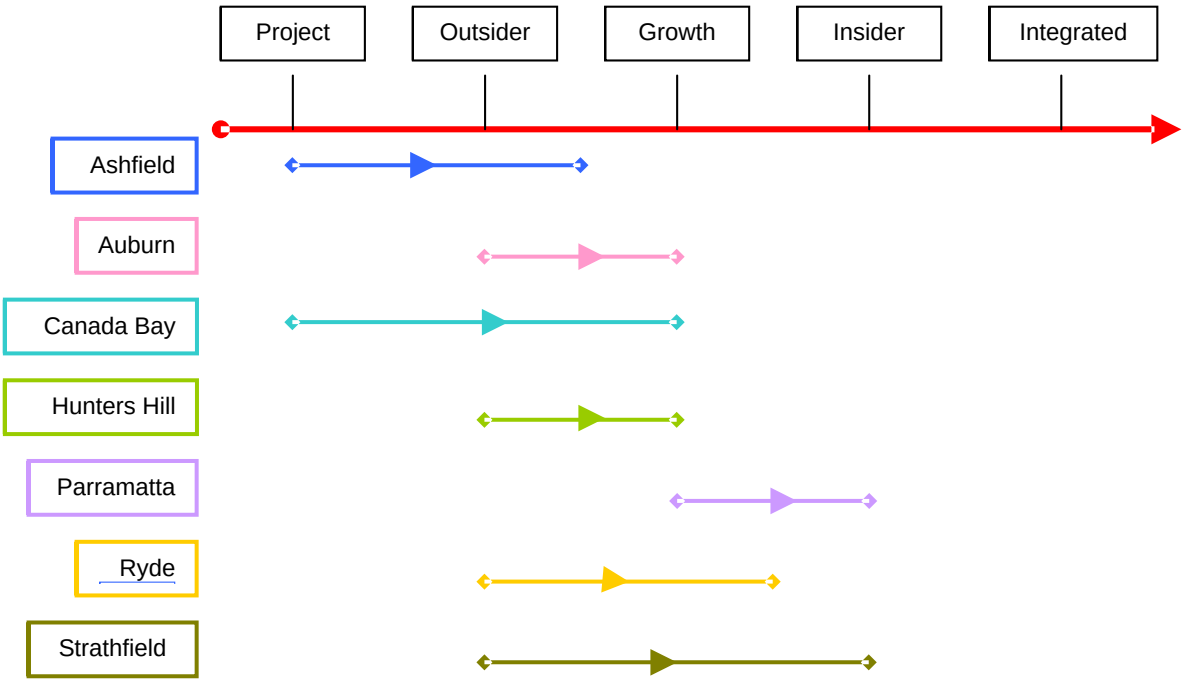
In order to evaluate how effectively each council has embedded WSUD into their core business, two areas of research were drawn upon. The first enabled a rapid assessment of how far councils had increased their capacity to implement WSUD during the course of the project. The second body of research provided a more detailed approach to identify the elements that are required to embed WSUD successfully into an organisation. Conversely, it also identified gaps that can be proactively addressed to move further towards best practice.

The rapid assessment tool was based on research that Brown (2008) undertook over a five year research project investigating the capacity of local government to implement WSUD across Sydney.

The evaluation identified gaps in the tasks required to progress each council's journey towards best practice. This triggered another set of training workshops for council staff to increase their knowledge and skills in WSUD construction techniques and the use of the MUSIC water quality modelling program. These training sessions were focused on staff who are involved in design of WSUD projects as well as planning staff who would have to assess development applications against any revised or updated planning instruments containing WSUD controls. Reflecting their own operational priorities and implementation barriers some councils also utilised their funding for supporting other aspects of WSUD. This included part funding of the employment of a Stormwater Engineer, development of an Integrated Water Management Plan, WSUD Vegetation Selection Guidelines and development of WSUD Standard Drawings, all of which were shared across the member councils.

Figure 1 shows the rapid assessment tool developed by Brown (2008) used to determine where each council is positioned on their pathway to best practice in WSUD implementation.

Figure 1. Assessment of Council's Progress in Increasing their Institutional Capacity



The snapshot shows that all councils through the course of this project have increased their institutional capacity to implement WSUD. It shows the varying degrees of implementation to begin with as well as the rate of increasing capacity. There was an overall improvement in all council progress, but this was not uniform and once again reflects the different barriers that each council faced.

A summary of each council's past and potential future progress towards increasing their capacity is provided below.

Ashfield

As a result of the grant and the introduction of the stormwater levy, Ashfield was able to implement WSUD actions for the first time. The grant monies also assisted in the employment of a stormwater engineer which has been seen as a key step in allocating resources and providing support for the implementation of WSUD projects. As the council is small, external expertise is still relied upon and further training across all disciplines is required. However, staff now participate in many regional grant programs and projects furthering sustainable water management. An integrated water management plan providing future strategic direction for WSUD actions has been drafted and integrating WSUD into council's LEP and DCP is seen as a future step.

Canada Bay

Canada Bay had resources for implementing WSUD prior to this project and had already implemented a stormwater harvesting project. However they do not have a recognised WSUD champion and there are no clear roles and responsibilities defined for WSUD across the organisation. Nevertheless, staff are designing and constructing WSUD in-house and have implemented further WSUD actions that build on the demonstration projects that have already been built. Actions focusing on the internal implementation of WSUD; covering training, planning frameworks and defining responsibilities are seen as a priority for the future.

Auburn

Resources are now available to fund WSUD actions, however these are limited and further senior executive support may be required to establish WSUD into management and business plans. WSUD is now driven by identified champions and supported by the internal Sustainability Team. Due to interest in the initial WSUD project and internal sharing of information, WSUD is being taken up by landscape architecture and urban design groups and integrated into projects currently in planning phases. These are intended to be designed internally with external peer review. A WSUD policy is planned to be developed this year and incorporation of WSUD into the LEP and DCP is to be progressed. Further training across all departments is required as is more information on cost-effectiveness and life cycle costs[1] and formal mechanisms to ensure lessons learnt are incorporated into future works.

Hunters Hill

Hunters Hill entered this project with executive support but minimal resources. Resourcing has now been incorporated through their stormwater levy. Whilst undertaking this project they have integrated WSUD into their DCP objectives and have included it into their strategic management plan. They have undertaken a further WSUD project in addition to the one supported through grant funding. The small size of the council has meant that it is not practical to have a cross discipline WSUD team and the identified champions have implemented the projects through a combination of in-house and external expertise. Further training and incorporating WSUD into LEP principles and drafting a WSUD policy have been identified as potential future activities.

Strathfield Council

Strathfield have obtained funding since the project inception however this budget is also utilised for projects to minimise flooding. A cross departmental working group has been set up to construct their first in-house

[1] Note: the uncertainties around Life Cycle costing have been recognised by the WSUD in Sydney Program and they are developing a national project on setting parameters, collating, housing and promoting life cycle costing data sets and tools.

project. Limited training has been undertaken to date and further progress in this area across most disciplines is required. The incorporation of WSUD into the DCP has been drafted. An overall WSUD policy and vision statement could be developed in the future for council projects. No WSUD projects were implemented prior to this project however four others have been constructed during the course of this project (through other funding sources). Strathfield identified their future needs to include a broader strategic plan that will incorporate WSUD; better understanding of life cycle costs and maintenance requirements; as well as understanding what mechanisms work best to strive for continual improvement.

Parramatta

Parramatta commenced this project at a fairly well developed phase of implementation, with funding, executive support and an identified champion in place. Nine WSUD projects have now been completed using in-house expertise with further projects proposed within the 2009-2013 Waterways Improvement Program. They now have a draft DCP and LEP incorporating WSUD (expected to be adopted by October 2010) and a WSUD policy drafted for council review. Ongoing professional development and training across all disciplines is still required through external service providers and incentives. A WSUD cross discipline team has been formed but the process for progressing WSUD planning and consideration across all future Council civil works (not just environmental) needs to be established.

Ryde City Council

During this project's timeframe Ryde has incorporated WSUD into its capital works annual budget and is waiting on the formalisation of a WSUD policy to define roles and responsibilities further. Training that has been provided has enabled engineers to design and construct WSUD projects in-house. Four WSUD projects will be completed by the end of 2010 (three of which are grant assisted). This cross departmental training has been seen as successful and more workshops are required to build more capacity. Draft WSUD DCP and LEP conditions have been completed, as has a WSUD manual to assist internal and external WSUD works. Externally focused provisions in the form of workshops, incentive programs and approval conditions have been identified as areas for future progress.

Conclusion

From this evaluation it can be concluded that the project did provide Councils with the momentum and support to progress further down the path to best practice WSUD implementation. This can be seen through the following:

- construction of further WSUD capital works projects after the demonstration projects were completed;
- implementation of lessons learnt from the design and construction of demonstration project into future projects;
- training in MUSIC modelling led to what were once externally designed projects to being internally designed by council staff;
- sharing of resources such as standard drawings and model Development Control Plans that would otherwise have to be sourced externally and been potentially inconsistent;
- ensuring that WSUD is part of core council business for both its own future works and new development.

Outside the project influences, the greatest driver for progress came through the realisation of funding sources with the introduction in NSW of the Stormwater Management Service Charge (stormwater levy).

The barriers to sustainable water practices identified by Brown (2008) applied in varying degrees to councils participating in this project. Each barrier presented a different degree of difficulty for respective councils depending on their organisational structure, culture and operational priorities.

The project did not break down all of these barriers, especially those related to internal council operations and management. For example:

- Resourcing issues of small councils with limited staff taking on WSUD application and responsibility;
- Lack of operational procedures and systems within councils such as project management, asset handover and quality assurance to ensure checks and balances and continual improvement processes are in place; and
- The need for a WSUD leader or champion to drive the positive attitude and behavioural changes with key staff and a succession plan if they leave.

A more important outcome of the project was the focus and value put on identifying the lessons learnt and sharing of these between councils. The evaluation exercises provided the councils with a bigger picture and a context for their actions.

From the evaluation process each participating council now has an understanding of the activities that they need to work on to progress their own journey forward. These tasks need to be incorporated into management plans, process and service improvements and progress needs to be continually reviewed. To ensure councils are supported in these challenges the Parramatta River Catchment Group and its Stormwater sub-committee will provide the mechanism for continuity in order to maintain the drive for ongoing sustainable water management practices.

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