Capturing the potential of stormwater

Urban stormwater harvesting is a key component of whole-of-water-cycle planning and management, yet it is still under-utilised. Iouri Vaisman offers a practitioner's view of some of the issues that need to be addressed.

Management of the urban water cycle in Australia has changed significantly over the past few decades. As we lived through a series of droughts and floods, we adapted our water systems to cope with our ever-changing environment. Australia's variable climate means that droughts and floods are inevitable – we just don't know when they will next occur, or how severe they will be.

Today, we know much more about our water cycle than ever before, and we have markedly improved our knowledge of water system management.

The water cycle includes all forms of water – recycled water, rainwater, stormwater, wastewater, groundwater, potable water and water contained within our rivers and bays. The notion of the whole-of-water-cycle management and planning – also known as Integrated Water Cycle Management (IWCM) – has become an accepted fact, and common practice among water experts and within the various levels of government and the general public.

Living in a dry country, we need to value and use the rain that falls on our land, and the stormwater runoff generated by that rainfall.

Stormwater management philosophy in most developed countries has evolved over the last decades from the conventional – but still important – flood mitigation paradigm,

to the current runoff quality control approach. It is now progressing towards the harvesting and re-use concept, while retaining the previous two targets.

Urban stormwater harvesting (SWH) is one of the essential components of IWCM that offers multiple benefits to urban water systems, such as mains water demand reduction, water quality improvement and, in many cases, creek ecosystem health protection. Several SWH projects have been implemented in Australia to date, and the number of SWH schemes is expected to grow, with wider uptake of IWCM encouraged by the state and federal governments.

In this article, I present the key observations gained through my involvement in the planning, design, construction and operation of stormwater harvesting schemes and the practitioner's view on some of the key issues that need to be addressed.

Major components of urban stormwater harvesting

Urban stormwater harvesting can be defined as the collection, treatment, storage and use of stormwater runoff from urban areas. Stormwater harvesting requires a number of physical facilities. These include infrastructure for capture, storage, appropriate treatment, maintenance and supply to end users in cost-effective ways. Sufficient runoff must be available, and enough space to permit storage or retention, depending on whether the aim is water supply or to manage stormwater quantity and quality.

Typical urban stormwater harvesting schemes include all, or a combination of, the components shown in Figure 1.

Typical mode of operation for stormwater harvesting scheme (Figure 1):

a. Designated volume of run off from the catchment (1) is diverted by the diversion structure (2) installed on the existing drainage system.

b. The diverted run-off is screened to remove gross pollutants and coarse sediment (3).

c. Screened run-off gravitates into the buffer storage (4); the aim of the buffer storage is to level out the variance in the incoming flows and optimise the operational parameters of the pump that supplies water to the treatment component.

d. Water from the buffer tank is transferred/pumped (5) into the treatment component; for example, wetland/bioretention (6) where the required quality of product water is achieved.

e. Treated water is transferred to the clear water storage, typically via a pump (7).

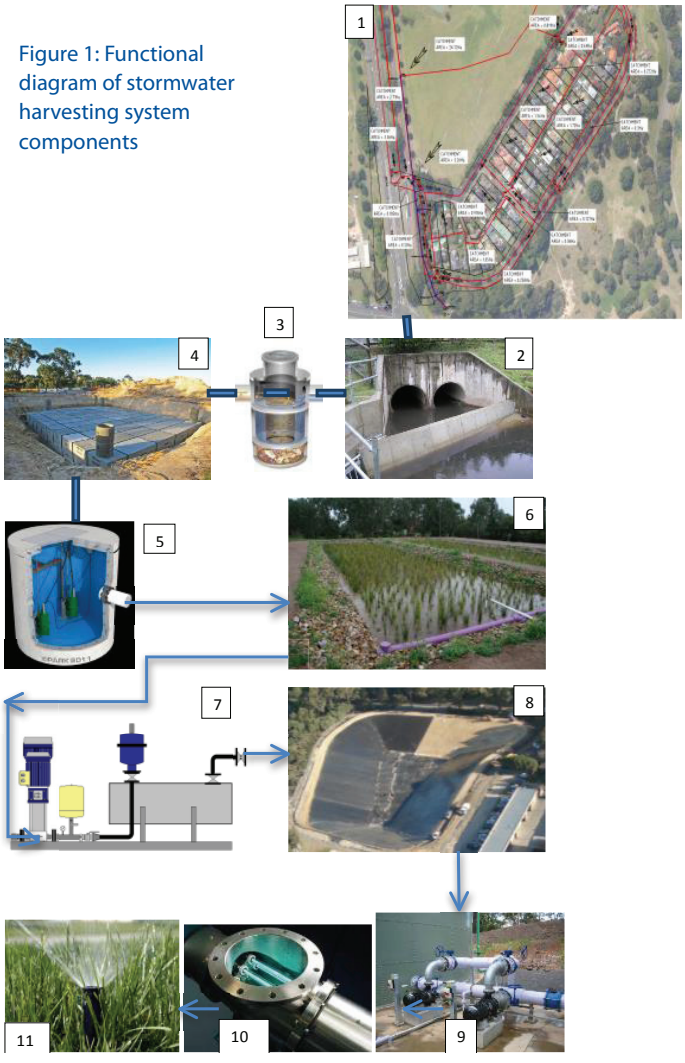
f. The treated water is stored in the clear water storage (8) for intended use; in many of the schemes involving irrigational use of product water, a relatively large storage is required due to the temporal difference between the rainfall (collection) and irrigation (usage).

g. Product water is distributed to the end users via a system of pump(s) and lilac pipes (9).

h. The distribution process typically includes the disinfection of product water (10); for example, with the online UV system.

i. Fit for purpose water is delivered to the end users (11).

Figure 1: Functional diagram of stormwater harvesting system components



Development of stormwater harvesting practice

The robust engineering basis for the planning, design, construction, operation and maintenance of urban stormwater harvesting is yet to be developed. This is because it is a relatively new engineering concept, despite having been used in some form or another in various places around the world for centuries.

In the absence of the established design basis for stormwater harvesting – designers of these schemes frequently resort to the approaches borrowed from more traditional disciplines, such as municipal drainage and water-sensitive urban design (WSUD) – a number of leading Australian stormwater professionals have commented on the issue.

For example, Hatt, Deletic and Fletcher wrote in their article 'Integrated Treatment and Recycling of Stormwater: A Review of Australian Practice' (Journal of Environmental Management):

'Existing stormwater recycling practice is far ahead of research, in that there are no technologies designed specifically for stormwater recycling. Instead, technologies designed for general stormwater pollution control are frequently utilised, which do not guarantee the necessary reliability of treatment. Performance modelling for evaluation purposes also needs further research, so that industry can objectively assess alternative approaches.'

As the practice of stormwater harvesting is continued, however, and more projects are commissioned in the years to come, the design paradigm for stormwater harvesting should be further developed and validated.

Stormwater harvesting guidelines

One of the major barriers to the wider uptake of SWH, particularly by local government, is the absence of comprehensive SWH guidelines. Such guidelines would allow the stakeholders in schemes (councils, regulators, consultants, contractors and other groups) to have a uniform reference document outlining current best practice, including legislative framework, design/functionality, construction, operation and maintenance.

Once developed, this document could offer comprehensive guidelines for implementation of stormwater harvesting schemes in Australia as part of an IWCM approach, based on current legislation, best available engineering science and practical lessons learnt during planning, design, construction and operation of existing SWH schemes.

SWH guidelines will provide a clear path for implementation of best practice stormwater management related to SWH and use in Australia, contributing to:

- better management of stormwater (balancing the harvesting to maximum aquatic and terrestrial benefits)
- improved water quantity and quality management
- reduced local flooding
- maximising the sustainable utilisation of stormwater as a resource
- greater uptake of stormwater harvesting
- improved green space in urban areas, contributing to liveability
- improved allocation and harvesting of stormwater and integration with water-sensitive urban design
- better landscapes and parkland managed with available stormwater
- informed strategic directions and policies for stormwater management and integrated water management.

By providing the knowledge and confidence to implement sustainable, well-designed SWH projects, the guidelines will set the benchmark for best practice SWH and provide the know-how to achieve it, overcoming many concerns and lack of knowledge currently associated with stormwater harvesting.

The development of SWH guidelines is a complex and multidisciplinary project, requiring good coordination, adequate resources, extensive stakeholder consultation and sufficient time. The resulting document should be based on four main components (see Figure 2):

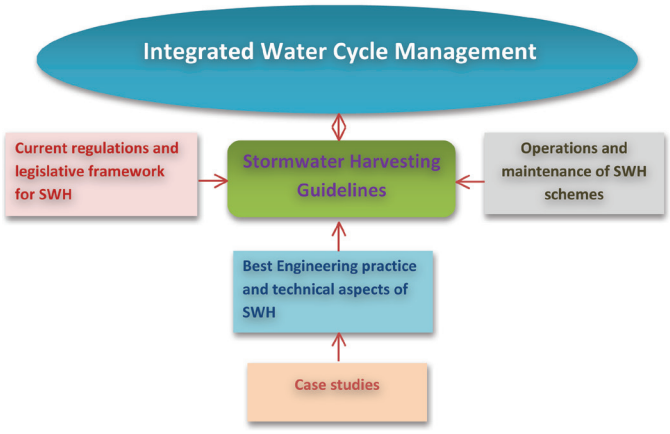
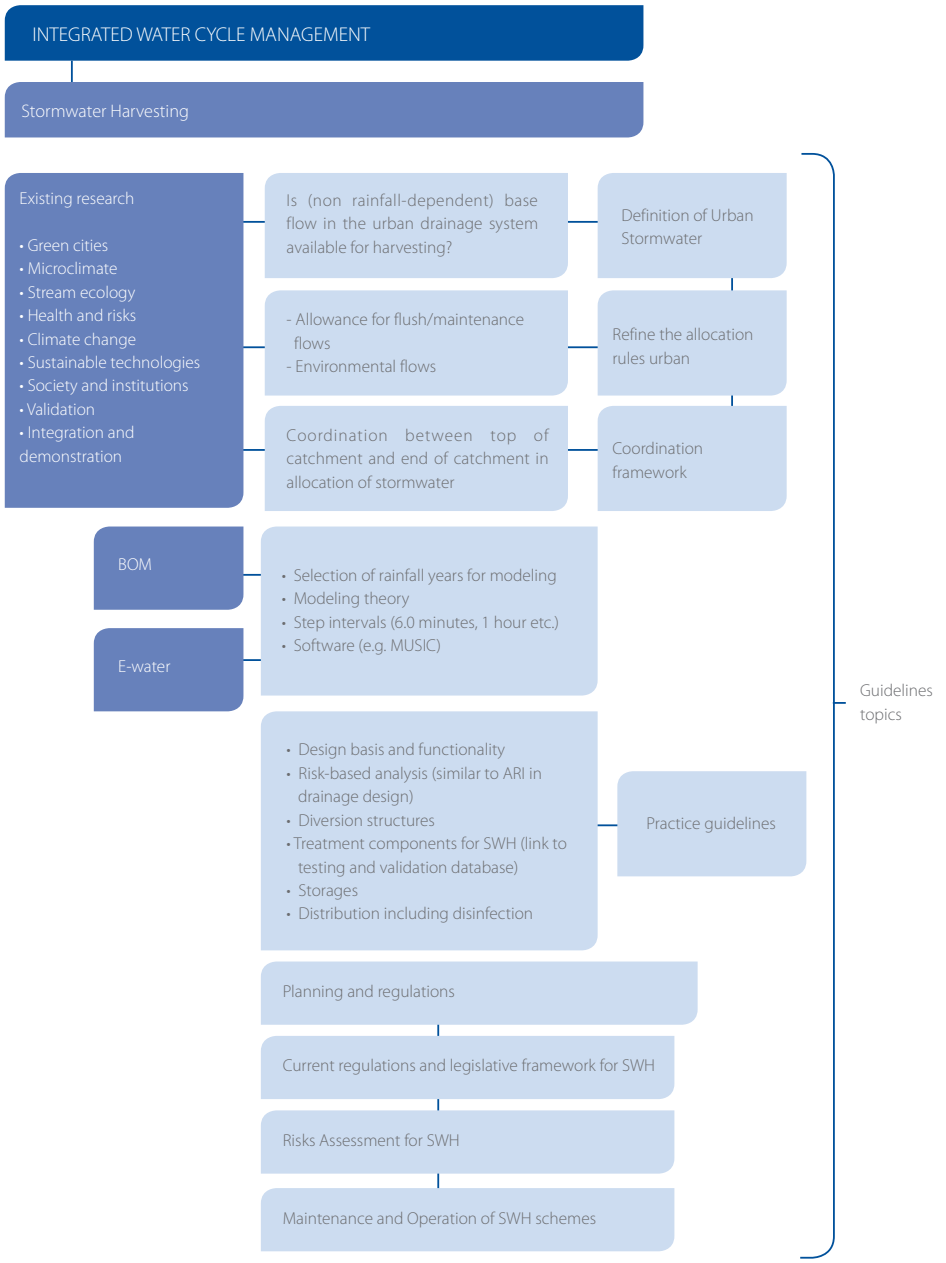


Figure 2 Major components of stormwater harvesting guidelines development

Figure 3 Stormwater harvesting guidelines – detailed topics.



- current regulation and legislation
- best engineering practice
- consideration of operation and maintenance issues
- case studies and practical examples.

A more detailed flowchart on topics and structure of the guidelines is presented in Figure 3.

Performance assessment for stormwater treatment devices

Selecting the right treatment train to meet the water quality objectives is essential for the successful and sustainable operation of SWH systems. At present, there are no standard methods or guidelines for the testing, validation and performance assessment of stormwater treatment devices in Australia. The wider uptake of IWCM and WSUD, and the growing number of stormwater treatment devices, create a need for a consistent and verifiable performance database to inform the fair and technically robust assessment and selection processes for treatment of stormwater.

As the market for stormwater treatment devices expands, the lack of published data on their performance becomes more apparent (Victorian Stormwater Committee, 1999), while detailed field monitoring is also very scarce (Wong et al., 2000). The combination of a large number of devices, a lack of reporting protocols and standard methods, and only a small number of detailed monitoring studies has resulted in a large uncertainty in stormwater treatment device selection.

Local government, which is largely responsible for the implementation and management of stormwater infrastructure in Australia, is dependent on in-house expertise and manufacturers' advice in selecting appropriate stormwater treatment strategies. Independent discussions with local government, water authorities and stormwater industry professionals have revealed interest in the documentation and development of guidelines and frameworks to assist in system design, product selection and evaluation to ensure adequate stormwater treatment and management.

> '... councils are very sensitive to the risk of grant-funded or gifted assets that become long-term financial liabilities due to their maintenance and renewal requirements.' – Municipal Association of Victoria Submission to the Office of Living Victoria's Melbourne's Water Future, September 2013.

Development of the protocols on the performance assessment for stormwater treatment devices will greatly assist in the adoption and utilisation of IWCM approaching Australian towns and cities via the:

- increased certainty in the performance of stormwater treatment devices and resultant water quality delivered by IWCM projects
- consistent and structured approach to the selection of stormwater treatment devices with direct benefit to the proponents (for example, councils/developers), designers, asset owners and other stakeholders of stormwater projects
- sharing of the legacy of knowledge in stormwater treatment with the industry.

In recognition of this industry need, a number of research projects have been commissioned by various organisations with a view to assessing the options available for independent verification of stormwater treatment devices in Australia, both at the state and federal levels.

Operation and maintenance (O&M) of SWH schemes

As the number of storm water assets maintained by Australian local government increases, so does the need to have a well-defined O&M strategy, clear understanding of expected performance, reliable estimate of all costs and a competent team to support it.

A lack of technical capacity both internally and externally to design, construct and maintain IWCM assets is a well-known issue, and a constant challenge for local government. Although many Australian councils have developed considerable in-house IWCM technical capacity in recent years, particularly in the design and construction of their WSUD projects, there is an ever-increasing need to obtain practical and reliable advice on managing O&M for its newly commissioned SWH and WSUD projects. A particular challenge has been, and will be, accurately estimating (and funding) SWH projects' asset lifecycle costs.

While there are some guidelines available on the maintenance requirements for WSUD assets designed for stormwater treatment prior to discharge (for example, 'WSUD maintenance guidelines – a guide for asset managers', MWC 2013; 'Maintaining Vegetated Stormwater Assets', Water by Design, 2012) there are generally very few, if any, publications and guidelines on operation and maintenance of SWH assets.

These current knowledge gaps and lack of established guidelines and data are recognised by the industry, and a number of industry initiatives have taken place in the recent years, such as the:

- Stormwater Harvesting and Reuse Technical Tour, Adelaide 2011, organised by the SIA and NRM Board
- Regional Stormwater Projects Tour – Geelong (as part of Stormwater 12 conference)
- development of a standardised approach to design, operation and maintenance of diversion structures as part of stormwater harvesting schemes, Melbourne Water Corporation, 2011
- Industry Testing and Validation Program – Gross Pollutant Traps (GPT), CSIRO on behalf of SIA, 2012
- Independent Verification Scheme for Stormwater Treatment Devices, Melbourne Water Corporation, 2013
- publication of 'Maintaining Vegetated Stormwater Assets', Water by Design, 2012
- publication of 'WSUD maintenance guidelines – a guide for asset managers', Melbourne Water Corporation, 2013
- development of WSUD life cycle costing, Melbourne Water Corporation, 2013
- Operation and Maintenance of WSUD Infrastructure – Interactive seminar, IPWEA VIC, 2014.

These initiatives should be continued by SIA, IPWEA and other industry bodies with support from local government, water authorities, catchment management boards and other stormwater stakeholders.

A practitioner's view

Practising in the area of integrated water cycle management, and seeing through the delivery of both wastewater and stormwater projects, I have noticed some significant differences

between those two groups affecting the choice of delivery mechanism, namely:

- stricter and more defined regulations in the wastewater market, including treatment standards, roles and responsibilities of various stakeholders, and approval processes
- wider adoption of the 'design and construct' and 'design, build and operate' contract types as a wastewater project delivery mechanism, generally with the performance guarantee provided by the contractor
- established practice of performance validation and verification in the wastewater market.

Given the current interest in the uptake of SWH and the ongoing commitment to control and treat run-off before it's discharged into the natural environment – by application of WSUD – the Australian stormwater market is likely to grow.

The pace at which the stormwater market in Australia grows will, to a large degree, depend on the certainty that it can offer to the public, clients and governments in delivering stated objectives. This requires, among other things, a clear path on how to achieve the stated objectives (for example, stormwater harvesting guidelines) and the means to verify that it actually works (validation and verification protocols).

The increased certainty in the requirements for and the performance of the stormwater treatment components delivered by these guidelines and protocols should allow the market to offer/request a guarantee of performance. This guarantee should open up more opportunities for funding, delivery, operation and maintenance of stormwater projects, leading to the greater uptake of SWH.

Acknowledgements

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'Independent Verification Scheme for Stormwater Treatment Devices – Road Map Discussion Paper': www.stormwater.asn.au/projects-a-advocacy/93-melbourne-water-roadmap-report

'Literature Review on Performance Testing Approaches of Gross Pollutant Traps': www.stormwater.asn.au/projects-a-advocacy/75-lliterature-review-on-performance-testing-approaches-of-grosspollutant- traps

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Iouri is a well-respected member of many professional bodies, such as Stormwater Industry Association (SIA), the Australian Water Association (AWA) and the Institution of Engineers Australia (IEAUS) and has been actively involved in the training and professional development of the industry on issues including stormwater harvesting, testing and validation of WSUD components, and Integrated Urban Water Management.

Iouri designed and project managed eight currently operational water re-use schemes in Australia, including stormwater harvesting, sewer mining, grey water and effluent re-use schemes.