INITIAL ASSESSMENT REPORT:

# A Strategic Review and Analysis of ACT Urban Water Quality Management Infrastructure

December 2014

# Document history

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# Executive Summary

Alluvium has been engaged by the ACT Government to undertake a strategic review and analysis of ACT urban water quality management infrastructure. A total of 42 stormwater treatment systems were selected for review, representing a range of different types of treatment system, including ponds, wetlands, bioretention systems, swales, constructed waterways and GPTs, and including old and new systems, large and small. The focus of the project is on reviewing the stormwater treatment performance of these systems, and recommending options to improve their performance.

The project is comprised of three stages and this report presents the findings from Stage 1. Stage 1 has focused on assessing the performance of the 42 stormwater treatment systems at a “macro scale”, including their physical and organisational context, performance objectives and overall performance. This macro scale review has focused on rapid assessment methods, which provide valuable information about performance at the whole-of-system level.

The findings and recommendations at this stage of the project can be broadly categorised into the following topic areas:

- General findings, applicable across the ACT, about issues common to all types of treatment systems. These findings relate to the processes by which stormwater treatment systems are planned, designed, constructed, established and maintained.

- Findings and recommendations for specific types of assets and for individual assets included in the review.

- Recommendations for the broader Basin Priority Project, and

- Recommendations for Stage 2 of the current project.

## General findings

There are a large number of issues which are currently affecting the performance of stormwater treatment systems in the ACT. These extend from the earliest planning stages to operation and maintenance.

The ACT WSUD Code (2009) includes mandatory stormwater quality treatment targets for new development in the ACT. These are driving the construction of a significant number of new stormwater quality treatment systems in the ACT, including new types of systems designed at smaller scales for treatment closer to the source. However, the ACT Government has been unprepared for the wave of new stormwater treatment assets and has not been able to implement appropriate systems and processes, guidelines and standards, budgetary measures or management responses to keep up with the influx of new assets. In this context, stormwater treatment systems are not meeting their intended objectives.

Strategic catchment planning is a significant gap in the ACT. One key issue is a lack of catchment-scale planning and analysis – WSUD Code targets are applied uniformly regardless of specific receiving water requirements, and with the focus firmly fixed on issues at the estate scale. It is rare that anyone takes a broader view of large-scale treatment trains which span entire catchments. A second issue is that many catchments are in transition (e.g. with new development occurring upstream of old development) and older treatment systems are sometimes no longer appropriate as new development takes place upstream.

The standard of stormwater treatment system design in the ACT is relatively poor. This is partly due to outdated design standards and specifications, but also reflects a sometimes limited level of capacity in the local industry and government. There are particular issues with integrating stormwater treatment system design with other works – it appears that stormwater treatment systems fall through a gap between civil and landscape design teams, with nobody taking clear carriage of stormwater treatment system design. Key details are missed in design drawings, with neither civil nor landscape drawings showing enough detail on the treatment systems.

The principle issue at the construction stage is poor staging of stormwater treatment works. A striking recent example of this issue is at Coombs. Stormwater treatment systems designed for long-term stable catchment loads are being installed too early in the development process and are being swamped with sediment during the estate-construction and house-building phases. This is compounded by poor erosion and sediment control practices in the ACT and is a fundamental issue which requires a rethink to construction staging in the context of stormwater treatment.

Establishment is not well-recognised as a key stage in the life cycle of a vegetated stormwater treatment system and appears generally to be undertaken poorly in the ACT. Developers and contractors are under pressure to hand assets over as quickly as possible, and the government is poorly equipped to recognise establishment issues. Therefore assets are being handed over in a poor state of establishment and are never recovering from this initial setback.

Many issues could be picked up earlier in the process if there were better systems in place for asset handover. Currently, different staff undertake review at different stages, follow different processes and refer to different standards. It appears to be common that key design issues emerge too late in the process when rectification options are limited.

Limitations at the operations and maintenance stage represent a fundamental challenge for improving the performance of stormwater treatment in the ACT. The maintenance budget for stormwater treatment is significantly under-resourced. An increasing number of stormwater treatment systems have not been matched by increased maintenance funding and therefore this budget is becoming further and further stretched. Maintenance practices are therefore confined to a basic minimum level of service. Larger tasks are undertaken on a reactionary basis when significant issues occur, and there is little or no capacity for monitoring, review or planning.

## Asset-specific findings

Our review of stormwater treatment systems found wide variation in the performance of specific assets. Key high-level findings are summarised in the table overleaf and show that there is a significant range in treatment performance across each type of asset, from systems that are performing well to systems that are actually causing some negative water quality impacts. A significant number of systems are performing poorly and failing to meet their treatment potential or original objectives.

Given the wide range of performance issues observed, we have recommended that this project should explore a wide range of options for each asset. In general, we have recommended the following types of options for each asset:

- **Maintenance**: where systems are functioning effectively, they should be maintained as they are. Where systems are causing no negative water quality impacts and are meeting their other objectives, they could be maintained as they are.

- **Renewal**: this option would involve keeping the system as-is, but restoring its condition – for example by cleaning out accumulated sediment or re-establishing vegetation which has failed. This option would be suitable for some of the systems which have been affected by construction-stage sediment loads. It could also be a reasonable option for some of the older ponds which have accumulated significant sediment loads over time, and a cleanout could reduce the occurrence of in-pond water quality issues.

- **Rectification**: some systems are generally well designed, but the poor design of a key feature has an impact on treatment performance and/or ease of maintenance. Examples are diversion structures which block and bypass too easily and GPTs with specific maintenance issues.

- **Redesign**: this would involve more substantial changes to existing systems, though redesign could encompass wide-ranging measures with wide-ranging costs and benefits. There may not be an appetite for significant redesign of newer systems. However this could be an attractive option for older systems, particularly those with significant performance issues.

- **Retrofit**: in many cases, existing treatment systems would benefit from additional pre-treatment in their upstream catchments. We have referred to this as "retrofitting" additional treatment in the catchment.

- **Removal** may be an option for a limited number of systems which prove to be the wrong type of system in the wrong location, and where there are no other benefits (e.g. landscape, habitat) to retaining the system.

Stages 2 and 3 of the project will explore these options further, including the costs and benefits. Stage 2 will include a quantitative assessment of stormwater treatment system performance and the identification of specific options for physical works to improve performance of each asset.

## Recommendations for the Basin Priority Project

The general ACT-wide findings outlined above provide crucial insight into potential risks to the second phase of the Basin Priority Project, as well as potential opportunities for addressing some of these challenges.

At this stage we can see clear opportunities for the Basin Priority Project to provide the following:

- The proposed Business Case has the potential to provide useful input into investigations into alternative management and funding models, by developing an economic model for stormwater treatment in the ACT, which can be adapted for broader use.

- The Basin Priority Project is an opportunity to create demonstration projects showcasing best practice stormwater treatment systems designed to suit local conditions. This would support written WSUD guidelines being developed to accompany the WSUD Code.

- The Basin Priority Project is particularly well structured to address gaps in strategic catchment planning. Ultimately, the six priority catchments should serve as best practice examples of strategic catchment planning. The current project is reviewing assets in the context of their role in the treatment train and against multiple other objectives and will provide a strategic framework that can be applied across the ACT.

The current project has an important role in addressing challenges at the asset operation and maintenance stage. The database of life cycle cost will be a valuable input to understand, plan and manage the operation and maintenance stage of this cycle. The project is also filling a key gap in monitoring and review as methods and systems developed in this project can also be used for future monitoring and review.

The key risks for the second phase of the Basin Priority Project are concentrated in the design, construction, establishment and asset handover processes, where there are limitations in terms of industry and government capacity as well as poor systems and processes and significant gaps in guidelines and standards. More work will be required to better define these risks and develop a plan to manage them in the Basin Priority Project.

*Summary of performance of existing stormwater treatment systems*

| Treatment system type | Initial summary assessment of water quality performance | | | |
|---|---|---|---|---|
| | **Some negative impacts on water quality** | **No or minimal effect on water quality** | **Some water quality benefit** | **Performing well** |
| Large ponds and lakes | Some have in-pond water quality issues which occur intermittently (e.g. Isabella Pond, Point Hut Pond). | Online systems such as Giralang and Lyneham ponds are significantly undersized and provide minimal treatment. The diversion structure at Dickson functions poorly. | Large online ponds and lakes reduce sediment loads (e.g. Coombs Ponds are currently filling this role), but nutrient removal is limited, particularly in systems prone to re-release of pollutants. | |
| Small ponds and wetlands | | David Street has a poorly functioning diversion structure, so treats very little stormwater. Crace wetland is short-circuiting. Ponds below Point Hut are not water quality treatment systems. | Several systems lack extended detention. Other systems function as recirculating treatment in dry weather, but are ineffective for stormwater treatment (e.g. Norgrove Park, Emu Bank). | |
| Swales and waterways | Systems with bare soils and erosion (e.g. Mabo Boulevard, Plimsoll Drive). | Systems with a low flow pipe or channel (e.g. Medhurst Crescent, Knoke Ave). | Helby Street, Trephina Street, Margaret Tucker Street and Tsoulias Street are treating only very small catchments. | The Franklin waterway is an example which is well vegetated, treats significant flows, is stable, low maintenance and working effectively. |
| Bioretention systems and rain gardens | | Most streetscape rain gardens have no or minimal inflows. | Selected streetscape rai gardens and the bioretention basin at Crace are partially treating some flows. | Selected streetscape rain gardens are functioning well (e.g. some on Abena Ave at Crace and one on Turbayne Crescent at Forde). |
| GPTs | Most GPTs store decomposing organics in anaerobic conditions and release pollutants between cleanouts. | GPTs such as Wentworth Avenue which are typically over-full and operating in bypass mode. | Most GPTs are capturing reasonable quantities of gross pollutants and coarse sediments; however their performance could be improved. | |

## Recommendations for Stage 2 of this project

Stage 2 will focus on assessing the performance of the stormwater treatment systems at a "functional" level, including quantitative assessment wherever possible.

The transition from Stage 1 to Stage 2 is a key opportunity for the Project Management Group to have strategic input into the specific scope and direction of Stage 2, based on review of this report and a workshop that we have proposed at this stage.

Key considerations to be discussed include:

- Objectives and aspirations for the quantitative performance evaluation component of the project

- Objectives and aspirations for the component of the project that will look at physical works to improve existing treatment systems

- How to integrate this work with the priority catchments monitoring framework project (recently completed) and ACT-wide monitoring project (ongoing), which are also part of the initial phase of the Basin Priority Project. Outputs from these projects could be picked up and integrated into Stages 2 and 3 of this project.

- The potential to remove/add to/change any of the 42 assets included in the project, for example where other systems have been identified as in need of review (potentially in the priority catchments), or where systems included in the project have been identified as having no substantial existing or potential stormwater treatment role.

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## Abbreviations and acronyms

| | |
|---|---|
| ACT | Australian Capital Territory |
| Alluvium | Alluvium Consulting Australia Pty Ltd |
| ARI | Average recurrence interval |
| BOD | Biochemical oxygen demand |
| CDS | Continuous deflective separation |
| CMTEDD | Chief Minister, Treasury and Economic Development Directorate |
| CRC | Cooperative research centre |
| DA | Development application |
| DO | Dissolved oxygen |
| EPD | Environment and Planning Directorate |
| GIS | Geographic information system |
| GPT | Gross pollutant trap |
| LDA | Land Development Agency |
| NT | Northern Territory |
| PACS | Parks and City Services |
| TAMS | Territory and Municipal Services |
| TBC | To be confirmed |
| WSUD | Water sensitive urban design |

# 1 Introduction

Alluvium has been engaged by the ACT Government to undertake a strategic review and analysis of ACT urban water quality management infrastructure. A total of 42 stormwater treatment systems were selected for review, representing a range of different types of treatment system, including ponds, wetlands, bioretention systems, swales, constructed waterways and GPTs, and including old and new systems, large and small.

The project is comprised of three stages:

- **Stage 1**, which is now largely complete, has focused on assessing the performance of the 42 stormwater treatment systems at a “macro” scale, including their physical and organisational context, performance objectives and overall performance.

- **Stage 2** will focus on assessing the performance of the stormwater treatment systems at a “functional” level, including quantitative assessment wherever possible. Stage 2 will also include an evaluation of life cycle costs.

- **Stage 3** will focus on the opportunities for improving the 42 stormwater treatment systems, developing options for rectification, renewal and replacement, quantifying costs and benefits, and recommending a preferred set of options. Stage 3 will also refine a set of recommendations for organisational changes which would improve the performance of stormwater treatment systems.

This report presents the findings from Stage 1 of the project. The report contains the following information:

- **Section 2** presents background information about the project, including the context for it proceeding.

- **Section 3** presents information on the methods used in Stage 1.

- **Section 4** presents a summary of key Stage 1 findings with respect to each stage in the life of a stormwater treatment system; from planning and designs through to construction, establishment, operation and maintenance. This section focuses on the organisational issues which are common to all types of treatment systems.

- **Section 5** presents a summary of key Stage 1 findings in terms of different types of treatment systems (i.e. ponds, wetlands, bioretention systems, swales, waterways and GPTs). This provides more information on specific physical performance issues.

- **Section 6** presents a set of initial recommendations arising from Stage 1 of the project, including broad recommendations applicable to all stormwater treatment systems in the ACT, recommendations for the Basin Priority Project and specific recommendations for Stage 2 of this project.

# 2 Background

Water quality and catchment management are major components of the revised long-term water strategy for the ACT. Consistent with all urban development in Australia, the impact of conventional urbanisation on natural hydrology includes: increased flows, increased flooding, reduced infiltration, erosion of watercourses, destruction of riparian and fringing vegetation and pollution of receiving waters.

Within the ACT region, infrastructure has been installed in an effort to ameliorate these impacts however the actual performance of that infrastructure is largely unknown. It is therefore timely to conduct a review, audit and analysis of a representative range of existing ACT water infrastructure to determine its effectiveness and whether the assets require replacement, retrofitting or maintenance. The review will also inform the design of new infrastructure, where a substantial investment is planned over coming years.

## 2.1 The ACT Basin Priority Project

The Strategic Review and Analysis of ACT Urban Water Quality Management Infrastructure (this project) is part of a broader investment known as the ACT Basin Priority Project. The Australian Government is providing funding to help the ACT Government conduct this project to improve water quality in ACT waterways. The ACT Basin Priority Project aims to allow residents, businesses and visitors to the ACT to enjoy the benefits of healthy, functioning rivers and lakes, and to contribute significantly to improved water quality in the Murray Darling Basin. Phase 1 of the ACT Basin Priority Project involves designing and implementing a water quality monitoring program and conducting an asset performance review (focusing on six priority catchments) and Phase 2 will deliver strategic infrastructure works, an ongoing governance structure for improved management, and the implementation of long-term monitoring arrangements.

## 2.2 This Project

This strategic review and analysis is an integral part of Phase 1 of the ACT Basin Priority Project in terms of helping to fully understand and quantify stream and stormwater systems, processes and asset performance in the ACT to inform Phase 2 of the Project. It is focused on a review of existing stormwater treatment assets across the ACT. The ACT government has identified 42 assets to be included in the review, including a range of different treatment system types, constructed over different timeframes and designed to meet different objectives. The treatment systems have followed different design and construction pathways, with some being associated with greenfield development, some associated with urban infill re-development, and others being retrofit projects. The distribution of the assets and their catchments are presented in Figure 1.

Like many other jurisdictions with significant urban growth, the ACT has seen a relatively rapid increase in the number of stormwater treatment systems in its jurisdiction, and many more are proposed. They are becoming a significant class of assets as they represent substantial investment in both capital and ongoing costs, provide key services and are important features of the public domain. In this context, it is important to review and assess the performance of existing systems to i) understand if they are meeting their objectives and performing to expectations, and ii) identify opportunities to improve their planning, design, construction, establishment and long-term management. Feedback from this project will be applicable to improving the performance of both existing and new assets.

The intended function of each selected asset within each catchment is to be reviewed in this project. This includes the specific role or function of the asset against the chain of related assets that assist in management of water quality within the catchment, the appropriateness of a particular asset within the chain of assets, and its effectiveness against current ACT water sensitive urban design requirements. The review will cover the anticipated performance – as identified in the design specifications – against the current performance of the asset and the recommended maintenance against the actual maintenance carried out. Finally, the review will consider also the likely future pollutant demand on the asset and assess the ability of the asset to meet current and future demands within the catchment, conforming to relevant codes and water sensitive urban design requirements. The requirement here therefore is to establish the gap between what each asset is currently achieving, or will likely achieve, and what is actually required now and into the future.

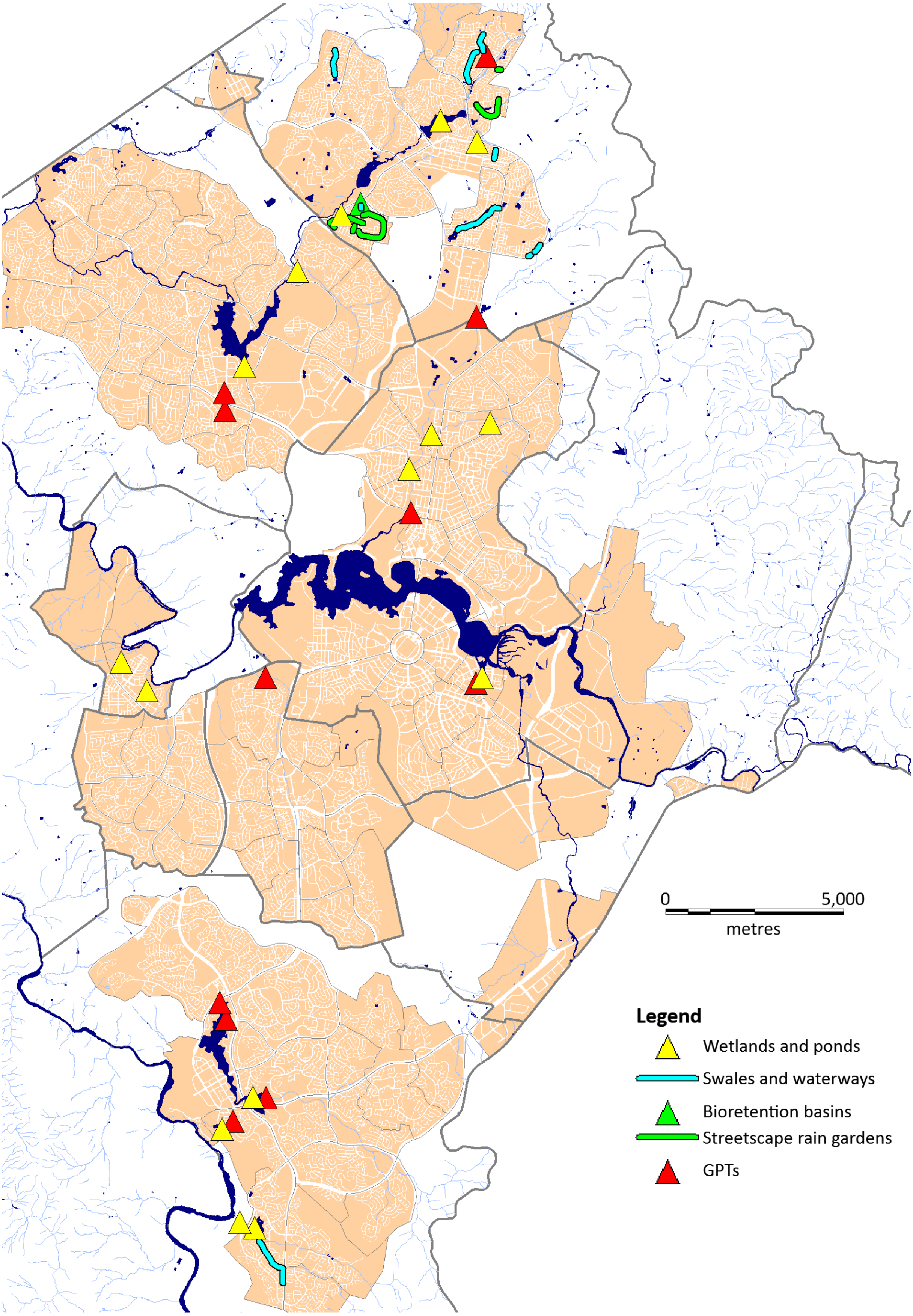


***Figure 1. Overview of asset locations***

A second key part of the project is to advise and inform the second phase of the ACT Basin Priority Project through assessment of the optimum type of strategic intervention infrastructure assets in the ACT. This involves consideration of the type and extent of any required remedial actions, including cost estimates, and advice on low cost maintenance and whole of life cycle management of the assets.

This infrastructure review will therefore deliver valuable information and tools for Phase 2 of the ACT Basin Priority Project, including:

- Information on the types of treatment system which are working most effectively in the ACT.
- Information on specific design details which are working most effectively.
- Quantification of actual pollutant load removal performance of existing treatment systems, which can be used to estimate performance of similar proposed treatment systems.
- Set of local life cycle costing parameters which can be used to estimate life cycle costs for proposed systems with improved confidence.
- Assessment of organisational factors affecting treatment system performance, and recommendations to improve organisational capacity ahead of a significant investment in new infrastructure.

## 2.3 Assets being reviewed

Table 1 summarises the treatment systems for review listed in the tender brief in terms of their type and scale.

***Table 1: Summary of treatment systems reviewed***

| Treatment types | Treatment scale | Description | Number included |
|---|---|---|---|
| **Bioretention** | Streetscape-scale rain gardens | Bioretention systems in streetscapes or at a similar scale (approx. 10-50 sqm) | 7 total (Nos. 2-8)* |
| | Precinct-scale bioretention | Larger bioretention systems in parks/regional open space (>50 sqm) | 1 (No. 1a) |
| **Wetlands, ponds and lakes** | Smaller scale, up to approx. 1 ha area | Wetland retrofit projects with a range of objectives | 5 total (Nos. 9-13) |
| | | Ponds built with residential development mainly for treatment purposes | 3 total (Nos. 22, 23, 41) |
| | Larger scale >1 ha area (up to 25 ha) | Ponds and lakes built with residential development for treatment purposes but also with broader values | 7 total (Nos. 1b, 24-27, 39-40) |
| **Swales** | Precinct scale | Located in streetscapes and parkland | 7 total (Nos. 14-20) |
| **Constructed waterways** | Large scale | Engineered/revegetated channels | 2 total (Nos. 21, 42) |
| **GPTs** | Varying scale | Underground and above-ground systems | 11 separately identified (Nos. 28-38)<br>plus approx. 10 others associated with wetlands and ponds, etc) |

* Note these numbers refer to the asset numbers used in the project brief and throughout this report

## 2.4 Relationship with water quality monitoring framework projects

We reviewed the location of all the assets in the brief and identified that there were 7 located in the 'priority catchments':

- Assets upstream of Lake Tuggeranong – nos. 35, 36, 37, 39
- Trash rack at Curtin (no. 34) is in the Yarralumla Creek catchment
- Ponds at Coombs (nos. 25, 26) are in the Lower Molonglo catchment.

There are potential connections therefore with the related ACT Government project to develop a water quality monitoring framework for these priority catchments. The water quality monitoring framework project is likely to include monitoring that would be helpful to assess treatment system performance within these catchments.

Beyond these catchments, the broader ACT-wide integrated monitoring framework project may also include monitoring that is relevant to other treatment systems in this project. However, the extent to which either of these monitoring projects will provide sufficient water quality monitoring data on individual treatment systems for a quantitative assessment of performance against pollutant load reduction objectives remains unclear. This was a consideration in developing our methodology for this project.

## 2.5 Relationship with broader implementation of WSUD in ACT

Beyond the Basin Priority Project, this review of WSUD infrastructure in the ACT comes at a time when it can help to address several broader challenges faced in the ACT in relation to WSUD implementation:

- The ACT is undergoing a significant transition towards being a water sensitive city, with increased focus on green infrastructure, sustainable urban water management and water sensitive urban design. This project will play an important role in reviewing progress made to date and providing feedback to improve future outcomes.
- There is extensive greenfield development underway and proposed in the ACT, all of which includes WSUD to meet the ACT Code. With a large number of new assets coming online, it is timely to review the effectiveness of existing assets to help ensure that new systems are the best options for the ACT and are designed to "best practice" standards.
- The health of Lake Burley Griffin is a key issue of concern in the ACT at the moment, and this project can help identify whether stormwater treatment systems installed in the Lake catchments are meeting their objectives. Some of the specific assets included in the project are within the Lake catchments, but the project will also provide general findings which can be extrapolated to other similar systems.
- Against a backdrop where WSUD is playing an increasingly important role in the ACT, there are key questions being asked about the performance of water quality management assets. A key issue (highlighted in the recent WSUD Review, ACT Government 2014) is that there has been relatively little monitoring or follow-up assessment of assets post-construction. This is a key gap, which this project will begin to address.
- Currently (as is the case in many jurisdictions) maintenance budgets are tight and the cost of maintaining water quality management infrastructure has become a significant issue. This was also highlighted in the recent WSUD Review (ACT Government 2014). This project can help provide significantly improved information on life cycle costs to help the ACT government plan for future operation, maintenance and renewal.
- There is significant community interest in water quality treatment assets in the ACT as they can provide a focal point for recreation, community involvement in environmental activities, education and engagement. This project will help to answer community questions about the performance of WSUD assets, and ensure that the things that are valued about these assets are understood.

## 2.6 Project overview

In order to most efficiently assess the performance of water quality treatment assets, we developed a nested, complementary three-stage performance assessment methodology for this project, which is outlined in Figure 2 and subsequent text. This involves increasingly detailed assessment at each stage, with increasing focus on those treatment systems where more detailed assessment is required.

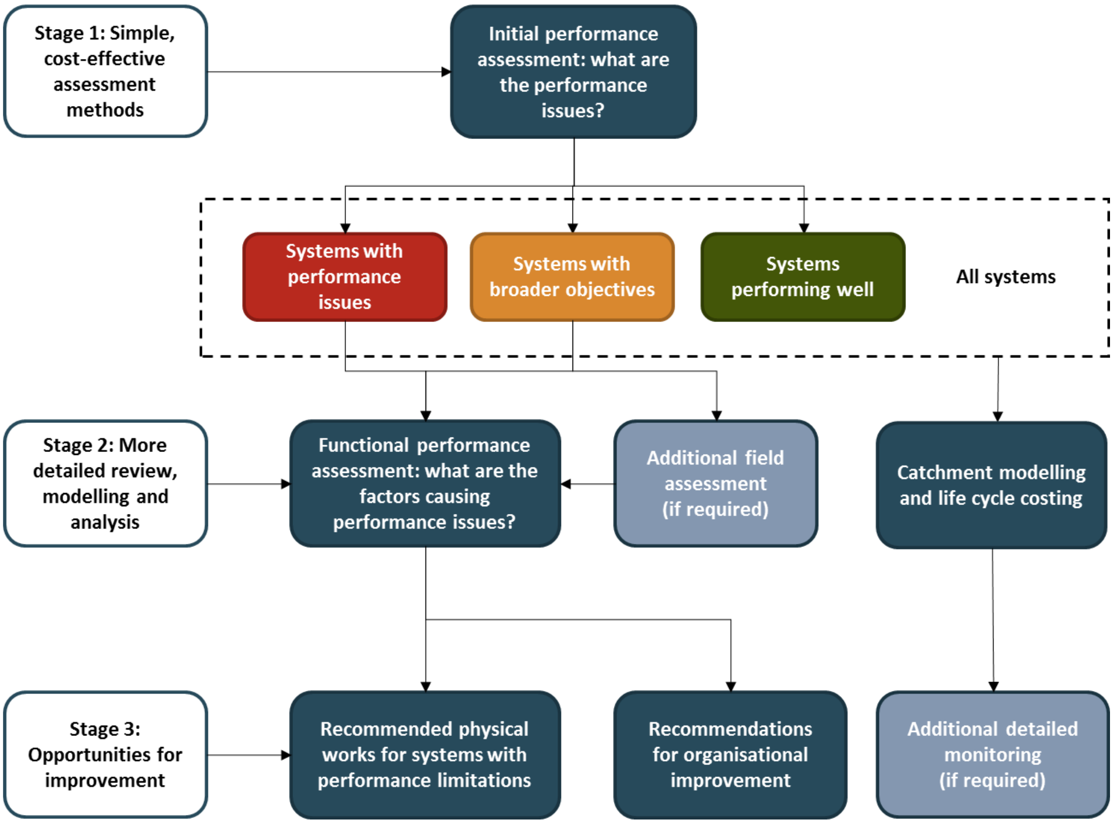


***Figure 2. Overview of the three stages of the asset performance assessment***

This report presents the findings from Stage 1 of the project. The following tasks were undertaken in Stage 1 as part of an initial "screening" level assessment:

- Desktop review of planning, design and construction information – particularly design drawings.
- Field inspections by experienced practitioners in wet weather, when it is possible to see how water is moving through stormwater treatment systems.
- Discussions with staff involved in operation and maintenance, who have spent a significant amount of time on site and have seen how systems are performing in a range of conditions. Maintenance staff tend to be aware of the common issues which occur as well as any unusual issues which have occurred in the past.
- Rapid GPT inspections which included opening and entering underground GPTs to understand the condition of these assets.

Stage 1 therefore provided the key information on the physical context of each asset and revealed many macro-scale performance issues.

# 3 Stage 1 Methods

An overview of Stage 1 is provided in Figure 3 below.

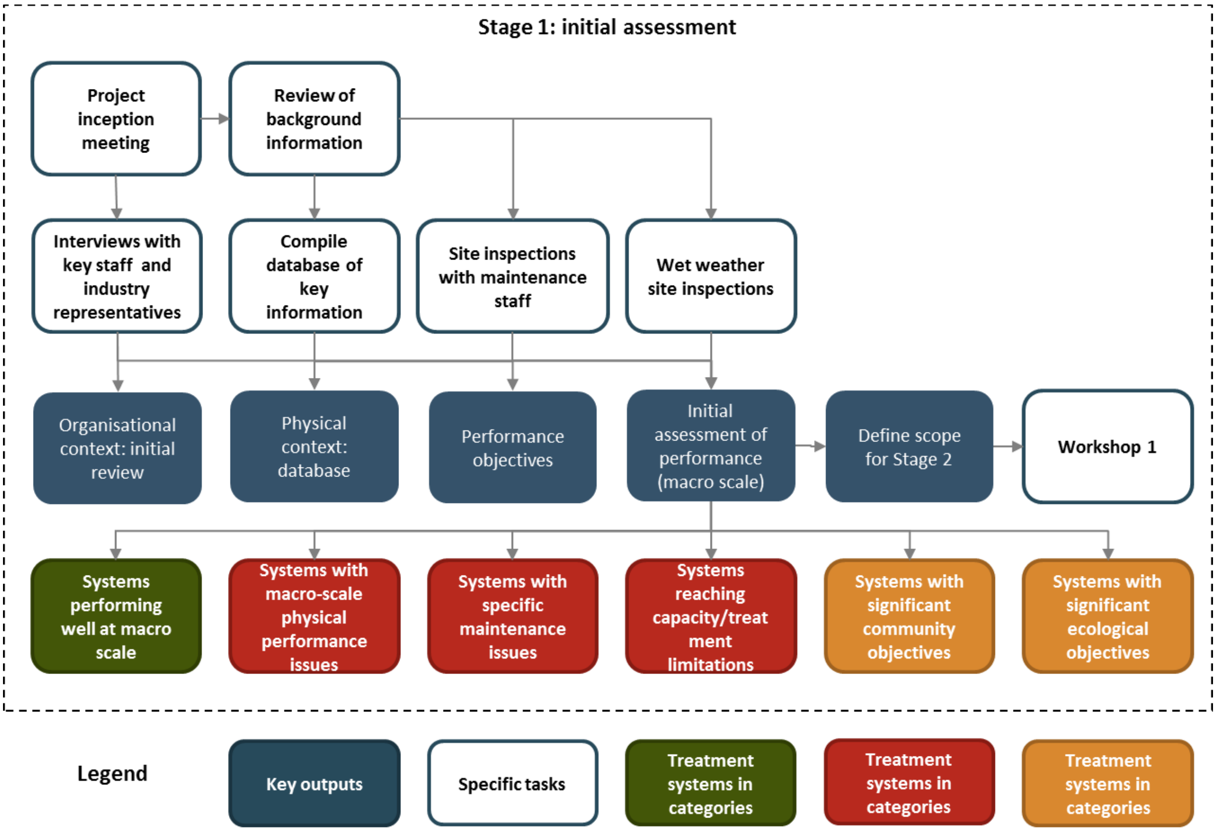


***Figure 3. Outline of Stage 1***

The purpose of Stage 1 was to understand the WSUD assets at a macro scale, including their:

- Physical context
- Organisational context
- Performance objectives, and
- Overall performance.

The tasks in Stage 1 included a review of background information, interviews with key staff and industry representatives, and site inspections in dry and wet weather. This initial performance assessment allowed us to "sort" assets into a number of categories based on their objectives and overall performance. Each task undertaken in Stage 1 is described in more detail in the following sections.

## 3.1 Inception meeting

We attended an initial inception meeting with key staff from the ACT Government to discuss the ACT Government's overall goals for the project, review the proposed approach to the project and discuss the timeline and key deliverables and how ACT Government staff will be involved throughout the project. Key attributes of the assets included in the review were also discussed along with the rationale for their selection. Alluvium prepared an agenda and took minutes at the inception meeting.

## 3.2 Gather and review background information

The review of background information was a critical task in Stage 1 in order to establish the physical context around each asset. The review of background information was used to:

- Understand the original design and intended function of each asset
- Establish the original performance objectives identified in design specifications
- Understand the context of the asset within its catchment, within a treatment train and within a land development timeline (where relevant)
- Check design against current best practice standards
- Check written maintenance records (where available)
- Gather information on costs (where available)
- Understand current and past performance issues which have been documented, and
- Understand previous studies (where available) which looked at asset condition and performance.

As we receive relevant background information, it is being reviewed, digested and summarised into a coherent dataset to support the project. Data and information received and reviewed to date is summarised in Table 2. Table 2 summarises both the information reviewed to date as well as highlighting key gaps remaining (where, based on our understanding at this stage, we expect some information to be available).

Note that a significant set of Work-as-Executed drawings were received in mid-December. Due to this timing, we have not yet been able to review all of these drawings in detail for this report. Where possible, we have undertaken a preliminary review and we will complete a more detailed review of these drawings during Stage 2 of the project.

***Table 2: Elements included in this project***

| Stages in treatment system life cycle | Elements to be included in review | Information received and reviewed to date | Key gaps remaining |
|---|---|---|---|
| Planning | Guidelines<br>Design reports<br>Spatial data for catchment | WSUD Code and WSUD Code Review (2014)<br>Basic spatial data for ACT<br>Design reports for systems in the Sullivan's Creek catchment | Design reports (e.g. DA information) for most systems |
| Design | Design standards<br>Design drawings, specifications<br>Water quality and hydraulic models | Existing design standards<br>Work-as-Executed drawings for most treatment systems (received mid-December 2014) | Any more information available on the current update to design standards<br>Water quality and hydraulic models (where available) |
| Construction | As-built drawings<br>Cost data | Work-as-Executed drawings for most treatment systems (received mid-December 2014) | Construction cost information |
| Establishment | Establishment history | Verbal information from developers and ACT Government staff (interviews and field visits) | |
| Operation and maintenance | Maintenance plans<br>Maintenance records | Verbal information from staff (interviews and field visits)<br>Basic maintenance costs estimated by TAMS | Information from asset register<br>Maintenance plans<br>Maintenance records (e.g. GPT cleanout data) |

| Stages in treatment system life cycle | Elements to be included in review | Information received and reviewed to date | Key gaps remaining |
|---|---|---|---|
| Monitoring and review | Previous studies<br>Existing performance/monitoring data | Waterwatch data<br>ACT Government annual water quality monitoring reports | ACT Government water quality monitoring data (raw data)<br>Monitoring data from other elements of the Basin Priority Project (6 catchments and ACT-wide)<br>Norgrove Park monitoring data/report<br>Data on sediment accumulation in ponds, monitored by TAMS |
| Renewal/ replacement | Details of any significant modifications already undertaken since original construction | | Any relevant reports, drawings, specifications, cost information |

## 3.3 Interviews with key staff and industry representatives

Interviews were used to check and confirm the following:

- Roles and responsibilities in relation to stormwater treatment systems
- Processes for planning, design, construction, operation and maintenance of different types of stormwater treatment systems (e.g. old systems, recent retrofits, greenfield subdivisions)
- Asset management and maintenance arrangements for stormwater treatment systems
- Procedures (e.g. written records), and
- The history and context around particular systems.

The following were also discussed at interviews:

- Perceived performance problems.
- What is going well and/or been improved?
- What is going poorly and what are the key challenges?
- What would help improve ongoing performance?
- What is needed in terms of tools, resources, etc?

We undertook interviews between Wednesday October 29 and Monday November 3. Groups with distinctly different roles were identified and separated out for interview. We allowed for a number of interviews with these separate groups to allow issues to emerge more freely. Table 3 outlines the set of interviews conducted, including attendees. Each interview lasted 1.5 - 2 hours.

***Table 3: Outline of interviews undertaken***

| Topic | Attendees (ACT Government unless otherwise noted) | Alluvium and Optimal Stormwater involvement |
|---|---|---|
| WSUD policy context | Nigel Dears; Michael Ross, John Feint; Noreen Vu | David Barratt<br>Alexa McAuley |

| Topic | Attendees (ACT Government unless otherwise noted) | Alluvium and Optimal Stormwater involvement |
|---|---|---|
| WSUD in greenfield development – ACT government perspective | Patrick Paynter, Nigel Dears, Edwina Robinson, Ivo Matesic, Jeff Bell, Michael Ross | David Barratt<br>Alexa McAuley |
| WSUD in greenfield development – industry perspective | Michael Ross, Viet Le (Indesco); Matthew Frawley (CIC), Peter Lewis (Brown Consulting), Julien Lepetit (E2DesignLab) | David Barratt<br>Alexa McAuley |
| Planning, design and construction of "retrofit" WSUD assets in existing urban areas | Michael Ross, Ian Lawrence (eWater CRC), Ross Thompson (Uni Canberra), Noreen Vu; Jennie Gillies | David Barratt<br>Alexa McAuley |
| Maintaining WSUD assets – focus on landscape maintenance | Michael Ross, Prue Buckley, Karma Sweet, Jeff Bell, Matt Kendall, Joel Kelly, Noreen Vu | David Barratt<br>Alexa McAuley |
| Maintaining WSUD assets – focus on civil maintenance including GPTs | Michael Ross, Jeff Bell, Karl Cloos, Greg Skaines, Ross Schofield | David Barratt<br>Alexa McAuley<br>Murray Powell |
| GPT maintenance – contractor perspective | Jeff Bell, Greg Skaines, Ross Schofield, Michael Ross, Scott Rob (Flexible), Tim Roff (Flexible) | David Barratt<br>Alexa McAuley<br>Murray Powell |

## 3.4 Site inspections with maintenance staff

Site visits with maintenance staff were undertaken to understand site-specific issues, performance history and preferences for certain design features. Informal discussions on site helped to understand the challenges faced in the field maintaining WSUD assets. Staff pointed to key issues (e.g. where debris tended to accumulate, where they need access) and key features (e.g. where previous rectification/renewal/ replacement works had been undertaken), what works and what doesn't, why they preferred some features over others and where they currently face particular challenges.

We undertook the following dry weather site inspections:

- 31 October 2014: visited eight GPTs with civil maintenance staff and a representative from the contractor Flexible
- 17 November 2014: visited a selection of ponds, wetlands, swales and waterways with Joel Kelly from PACS
- 20 – 21 November 2014: inspected 12 GPTs

This included all GPTs identified in the tender brief and all GPTs associated with wetlands and ponds identified in the Tender brief. The GPT inspections included the following:

- Opening and inspecting each device/solution
- Noting key dimensions relating to depth, volume, pollution storage capacity, where to monitor, etc
- Noting any problems such as debris deposition, hydraulic failings, structural issues, corrosion, vandalism, access limitations, safety concerns, and anything impacting on functionality such as backwater, etc., and
- Noting opportunities for improvement within existing solutions.

The site inspections with maintenance staff helped us to understand:

- How maintenance is carried out

- Common problems encountered with each asset
- Key issues which require frequent maintenance or cause maintenance issues
- Aspects which have been modified since design and construction
- Asset history and potential reasons behind issues such as vegetation failure

## 3.5 Wet weather site inspections

Wet weather site inspections can quickly reveal exactly how a stormwater treatment system is functioning on a macro scale – i.e. how water is moving in, out and through the system. Wet weather site visits were very useful to rapidly assess whether a system was working hydraulically. Specifically, they allowed us to:

- Check whether structures and physical features were working as expected (e.g. inlets, outlets, overflow structures)
- See whether flow diversion structures were working effectively, and
- See where there were preferential flowpaths, short-circuiting, bypassing or "dead" zones in ponds and wetlands.

This rapid assessment of the hydraulic performance could not confirm pollutant removal performance, but did provide a good indication of whether a treatment system was meeting its design intent and broad performance objectives.

We set up a wet weather inspection checklist which ensured a comprehensive assessment, was easy to complete in the field and ensured that staff were consistent in their approach. Wet weather field inspection sheets are included as Appendix C.

A summary of wet weather site inspections undertaken to date is included in Table 4.

***Table 4: Site visit register***

| Asset No | Description | Inspection dates | | | |
|---|---|---|---|---|---|
| | | PREVIOUS | DRY | WET | WET |
| 1a | Crace bioretention basin | 16/07/2014 | 15/11/2014 | 24/11/2014 | 30/11/2014 |
| 1b | Crace wetland | 16/07/2014 | 17/11/2014 | 24/11/2014 | 30/11/2014 |
| 2 | Abena Avenue raingardens, Crace | 6/04/2012 | | 15/11/2014 | 30/11/2014 |
| 3 | Ultimo Street raingardens, Crace | | 16/10/2014 | 15/11/2014 | 30/11/2014 |
| 4 | Digby Circuit raingardens, Crace | | 16/10/2014 | 15/11/2014 | 30/11/2014 |
| 5 | Langtree Crescent raingardens, Crace | | 16/10/2014 | 15/11/2014 | 30/11/2014 |
| 7 | Turbayne Crescent raingardens, Forde | | 2/11/2014 | 16/11/2014 | |
| 8 | Zakharov Avenue raingardens, Forde | | 2/11/2014 | 16/11/2014 | |
| 9 | Norgrove Park wetland, Kingston | 8/04/2012 | | 3/12/2014 | |
| 10 | Emu Bank wetland, Belconnen | | 12/07/2014 | 24/11/2014 | 3/12/2014 |
| 11 | David Street pond, O'Connor | 9/03/2013 | | 16/11/2014 | 24/11/2014 |
| 12 | Dickson wetland | 6/04/2012 | 16/07/2014 | 16/11/2014 | |
| 13 | Lyneham wetland | 28/12/2013 | 16/07/2014 | 16/11/2014 | |
| 14 | Mabo Boulevard median swale, Bonner | | 12/07/2014 | 16/11/2014 | |
| 15 | Margaret Tucker St waterway, Bonner | | 12/07/2014 | 24/11/2014 | |
| 16 | Helby Street swale, Harrison | | 12/07/2014 | 24/11/2014 | 3/12/2014 |

| Asset No | Description | Inspection dates | | | |
|---|---|---|---|---|---|
| | | PREVIOUS | DRY | WET | WET |
| 17 | Trephina Street swale, Harrison | | 12/07/2014 | 24/11/2014 | 3/12/2014 |
| 18 | Medhurst Crescent swale, Crace | | | 15/11/2014 | |
| 19 | Plimsoll Drive median swale, Casey | | 12/07/2014 | 16/11/2014 | |
| 20 | Tsoulias Street median swale, Gungahlin | | 12/07/2014 | 24/11/2014 | |
| 21 | Constructed waterway at Franklin | | 12/07/2014 | 16/11/2014 | |
| 22 | Pond at corner of Ian Potter Crescent & Tesselaar Street, Gungahlin | | 12/07/2014 | 16/11/2014 | |
| 23 | Giralang Pond | | 12/07/2014 | 24/11/2014 | |
| 24 | Point Hut Pond | | 16/10/2014 | 16/11/2014 | |
| 25 | Coombs Pond A | 17/02/2013 | | 30/11/2014 | |
| 26 | Coombs Pond B | 17/02/2013 | | 30/11/2014 | |
| 27 | Yerrabi Pond | | 12/07/2014 | 24/11/2014 | |
| 28 | GPT at Barry Drive & Watson Street, Turner | | | 3/12/2014 | |
| 29 | GPT at Flemington Road, Mitchell | | 7/12/2014 | 24/11/2014 | |
| 30 | GPT Wentworth Ave, Kingston | | 31/10/2014 | N/A | N/A |
| 31 | GPT at Catchpole Street, Macquarie | | | 24/11/2014 | |
| 32 | GPT at Ibbott Lane, Belconnen | | | 24/11/2014 | |
| 33 | GPT at Bonner Pond | | | 24/11/2014 | |
| 34 | McCulloch Street trash rack, Curtin | | 31/10/2014 | 24/11/2014 | |
| 35 | GPT at De Little Circuit Greenway (Lake Tuggeranong) | | 31/10/2014 | 24/11/2014 | |
| 36 | GPT at Athllon Drive, Greenway (Lake Tuggeranong) | | | 24/11/2014 | |
| 37 | GPT at Isabella Pond | | 31/10/2014 | 24/11/2014 | |
| 38 | GPT at Lower Stranger Pond | | | 24/11/2014 | |
| 39 | Isabella Pond | | 16/10/2014 | 24/11/2014 | |
| 40 | Lower Stranger Pond | | 16/10/2014 | 24/11/2014 | |
| 41 | Two ponds below Point Hut Pond | | 16/10/2014 | 3/12/2014 | |
| 42 | Constructed waterway at Knoke Avenue, Gordon | | 16/10/2014 | 16/11/2014 | |

Please note that our proposal allowed for two wet weather site visits to each system. In most cases we have held off on completing the second visit as we are keen to review relevant design information before returning to the field. This will mean that our second site visit is more informed and we can check any specific details that we need to confirm after reviewing documentation.

## 3.6 Compile database of key information

As we receive information on each asset, we are compiling a database which includes information on the 42 treatment systems in the brief. This database was set up such that it is easy to expand to include other treatment systems – both existing and future. Information has been included on the following (where available):

- Type of asset
- Model or description (for soft infrastructure) of the asset

- Size, dimensions of key components
- Catchment area
- Nature of the catchment (e.g. Old urban, greenfield, future growth)
- Year of installation and year of handover to TAMS
- Construction cost
- Performance parameters
- Construction/modification history
- Maintenance records.

Most of this information is summarised within the individual asset reports in Appendix A.

## 3.7 Initial assessment of treatment systems

In this report, we have brought together all of the results from Stage 1, including our findings from desktop and field assessment as well as the interviews, into an initial assessment of the treatment systems. Treatment systems have been sorted into a number of categories based on their physical attributes and their performance. This categorisation of treatment systems will inform the scope for Stage 2, as different types of treatment systems will require different evaluation pathways and options to be developed in Stage 2.

For example, where a treatment system is generally performing well, Stage 2 will be used to make a more detailed, quantitative assessment against the performance objectives. In Stage 2 we will need to identify the causes of failure and identify options for rectification where performance issues have been identified. For all treatment systems, but particularly those that are reaching the limits of their pollutant removal capacity, in Stage 2 we will need to:

- Identify remaining capacity
- Estimate future pollutant loads on the asset, and
- Recommend time frames and options for renewal.

Where we have identified that a treatment system has broader objectives beyond pollutant removal (e.g. community and ecological objectives), we will undertake further assessment in Stage 2 to assess performance against these objectives and form a more complete picture of the performance of the treatment system.

# 4 Summary of key Stage 1 findings

This section discusses the broad asset performance issues identified in our review, in terms of the process from policy and planning through design, construction, establishment, handover, operation and maintenance. The first section (4.1) provides some relevant context about the evolution of stormwater management in the ACT since the 1970s.

## 4.1 ACT's stormwater treatment history

Lake Burley Griffin was constructed as Canberra was rapidly developing in the 1960s. While it was originally conceived as a key landscape feature in Walter Burley Griffin's plans for the city, it also functions as a stormwater treatment system, receiving stormwater runoff from a large part of Canberra's urban area. This aspect of the Lake has engendered community awareness of the impacts of stormwater runoff, and leadership in urban water management has been a long-term feature of Canberra's development.

Stormwater treatment principles have evolved over the decades and stormwater treatment systems constructed over the years have reflected an evolving approach to urban water management.

### 4.1.1 1970s – early stormwater treatment systems

In the 1970s the focus of urban stormwater management was on drainage, and concrete channels were a common approach to deliver stormwater rapidly and efficiently from urban areas into receiving waters. These also delivered pollutants efficiently and directly into receiving waters and the impacts of this practice were becoming evident. Therefore, in the 1970s, the first gross pollutant traps were constructed in Canberra. These included the GPT on Sullivan's Creek at Barry Drive and the trash rack on Yarralumla Creek at McCulloch Street. These are both located on large channels with large upstream catchments.

Note that Giralang Pond is also thought to have been constructed in the 1970s and is therefore an early example of a stormwater treatment pond.

### 4.1.2 1980s and 1990s – regional ponds and lakes

Tuggeranong was developed in the 1980s at a time when the approach to urban water management was evolving. Lake Tuggeranong and Point Hut Pond were both constructed in the 1980s, however while several of Lake Tuggeranong's tributaries (e.g. Monks Creek) were constructed as concrete channels, waterways flowing into Point Hut Pond (e.g. the Knoke Avenue waterway) have grass-lined banks with only a small concrete low flow channel.

Both Lake Tuggeranong and Point Hut Pond have few upstream treatment systems in their catchments. Isabella Pond and Isabella Lake (Upper Stranger Pond) are two exceptions immediately upstream of Lake Tuggeranong. There are gross pollutant traps at lake inlets but otherwise pre-treatment is limited.

Stranger Pond was also constructed in 1989 downstream of a smaller catchment between Lake Tuggeranong and Point Hut Pond, presumably to treat flows which could drain to neither of the larger systems.

The first parts of Gungahlin were developed in the 1990s. Gungahlin Pond was built in 1989 and Yerrabi Pond in 1994 on Ginninderra Creek. These ponds are similar to Lake Tuggeranong and Point Hut Ponds, however upstream waterways include a mixture of partially concrete-lined channels (e.g. with a low-flow pipe or small low-flow channel), engineered vegetated channels and modified natural channels.

### 4.1.3 2000s – policy shift to WSUD

In the 2000s, WSUD became an important concept in the ACT's policies and its principles were adopted as part of the ACT's strategic planning. In 2002, the ACT Legislative Assembly passed a motion about water management, including an agreement that the water leaving the ACT via the Murrumbidgee River should be of no less quality than the water flowing into the ACT. The 2004 "Think Water Act Water" strategy included an objective to "facilitate the incorporation of water sensitive urban design principles into the urban, commercial and industrial development" and targets included:

- A 12 percent reduction in mains water usage per capita by 2013, and a 25 per cent reduction by 2023 (compared with 2003), achieved through water efficiency, sustainable water recycling and use of stormwater.
- An increase in the use of treated wastewater (reclaimed water) from 5% to 20% by 2013.
- The level of nutrients and sediments entering ACT waterways is no greater than from a well-managed rural landscape.
- A reduction in the intensity and volume of urban stormwater flows so that the runoff event that occurs on average once every 3 months, is no larger than it was prior to development.

Assets from this era include:

- Ian Potter Pond and Tsoulias Street swale in Gungahlin
- The constructed waterway on Gungaderra Creek in Franklin
- Norgrove Park wetland in Kingston
- David Street pond in O'Connor

#### 4.1.4 2010s – codified WSUD

The ACT WSUD Code was published in 2009 and requires new development (above a certain threshold scale) to meet mandatory stormwater pollutant load reduction targets. The code also includes "regional" targets recommended for the ACT as a whole. The targets from the WSUD Code are shown in Table 5.

***Table 5: WSUD Code pollutant load reduction targets***

| | Development or redevelopment sites | Regional or catchment-wide |
|---|---|---|
| Reduction in average annual suspended solids (SS) export load | 60% | 85% |
| Reduction in average annual total phosphorus (TP) export load | 45% | 70% |
| Reduction in average annual total nitrogen (TN) export load | 40% | 60% |

The WSUD code also encourages stormwater treatment closer to the source, with treatment systems distributed throughout an estate, as well as the inclusion of on-block stormwater treatment measures. Examples of assets constructed under the WSUD Code are those in new greenfield development including systems at Crace, Forde, Harrison, Casey, Coombs, Bonner.

The other assets constructed in recent years are retrofit projects including Dickson and Lyneham ponds and Emu Bank wetland.

This period therefore includes diverse approaches to WSUD, a wide range of different types of treatment systems and a wide range of design styles.

## 4.2 Legislative and regulatory issues

The Territory Plan defines land use zoning and defines the requirements under which each zone can be developed. Under the Territory Plan are a set of general, precinct and development codes. The WSUD Code is a general code that applies to all zones. It includes performance targets and general guidance for mains water use reduction, stormwater quality treatment, stormwater quantity management and wastewater management. As discussed above, since 2009 the WSUD Code has been a key driver for stormwater treatment in greenfield areas, as under the Code, all new estates need to include stormwater treatment systems in order to meet pollutant load reduction targets.

Our review of stormwater treatment system performance in Stage 1 revealed that a key issue associated with many treatment systems is that after systems are installed, the ACT Government is under-resourced for the operations and maintenance stage and unable to maintain treatment systems in working order. Therefore while the objectives and targets set in the WSUD Code are realistic and achievable at the development stage, the ACT Government does not currently have the capacity to meet these targets in the long-term. This indicates a potential mismatch between the Code and operation and maintenance practices, however the problem could be viewed either as the WSUD Code setting the bar too high, or operation and maintenance being under-resourced.

A second issue apparent in our review was a tension between the following points of view:

- A desire to provide for flexibility and innovation in the design process, to allow the industry to find the most cost-effective and efficient solutions to meet stormwater treatment targets and allow practices to evolve over time as new research and development occurs

- A desire for a certain level of predictability in new stormwater treatment systems (which are generally public assets), so that when they are handed over to government, their maintenance requirements are practical and well understood.

Currently, it is clear that a wide range of stormwater treatment systems are being handed over to government in varying states. However this is not solely due to flexibility in the Code, and in fact many perceive the current Code as being inflexible. In part, the issue has arisen because the ACT's design standards and other supporting documents have not kept up with the changes to stormwater treatment practices driven by the WSUD Code – this issue is discussed further in Section 4.4. Another key issue is the asset review and acceptance process within government – this is discussed in Section 4.7.

A third regulatory issue apparent in our review was the lack of enforcement of erosion and sediment control practices on development sites. Erosion and sediment control is mixed during the estate development phase (e.g. poor erosion and sediment control has been an issue at Coombs) and virtually non-existent during the house-building phase. This has had a significant impact on a number of stormwater treatment assets which have either been put in place within estate development before house-building was complete, or at some stage in their life experienced significant development somewhere in their catchment.

These three issues are summarised in Table 6.

***Table 6: Key legislative and regulatory issues***

| Issues | Implications | Potential solutions |
|---|---|---|
| Mismatch between WSUD Code objectives and targets and capacity for long-term operation and maintenance | Assets are being constructed which cannot be maintained in working order; actual outcomes in the field are falling short of relevant objectives | Review of objectives and targets and/or better resourcing of operation and maintenance |
| Tension between flexibility/innovation and predictability/practical maintenance outcomes | A wide range of stormwater treatment systems are handed over to government in varying states | Update design standards, asset review and acceptance processes and other relevant systems to improve predictability and practicality, while retaining flexibility at the Code level |
| Lack of enforcement of erosion and sediment control practices on development sites | Significant sediment loads swamping stormwater treatment systems which were not designed as construction-stage sediment controls | Regulatory reform and/or improved construction staging |

A recent review of the ACT WSUD Code (Water Sensitive Urban Design Review Report, August 2014) identified a number of issues with the legislative framework. Proposed changes to the WSUD Code include:

- WSUD requirements will be built in to precinct codes, development codes and general codes in the Territory Plan, with different types of targets applying at different levels. Different targets may also be applied to different land use types (e.g. residential/industrial) and targets are always quantitative (%, flow etc)

- Amendments to the WSUD Code will take much of the general guidance out of the statutory planning document for improved future flexibility. This means a step away from prescriptive requirements, with more focus on outcomes

- However to balance this, the WSUD Code will be supported by a new WSUD Practice Guideline, which will capture information on best practice techniques that are appropriate and suitable in the ACT. It will provide design guidance for developers on the merit path and it will also provide specific information in order for developments to go through the deemed to comply process

- Also currently underway is a review of design standards and engineering specifications to set out what government will accept.

- An asset handover guideline is also proposed and TAMS is currently working on this.

- The WSUD General Code will provide a conduit to the WSUD Practice Guideline and Design Standards by ensuring they are referenced in the code (note that the Estate Development Code is probably the first code that showcases the linkage between EPD, LDA and TAMS and provides a template).

- Consideration of lifecycle costings and maintenance programs is proposed for inclusion in the Territory Plan. This will include information on responsibilities, operational requirements, lifecycle costings, schedules and climate change adaptation.

Our review of stormwater treatment infrastructure suggests that all of these changes are moving the Code in the right direction.

## 4.3 Strategic catchment planning issues

In attempting to understand the drivers and objectives behind individual treatment systems as part of this project, it has also become evident that there are some key gaps in the strategic framework for stormwater management:

- It is difficult to find information on catchment areas and stormwater treatment trains on a catchment scale. As far as we've been able to discover, there is no urban catchment boundary GIS layer.

- There are a wide range of different treatment trains applied around the ACT and stormwater quality outcomes are likely to differ widely between different catchments. However we have not seen any analysis of stormwater quality and treatment outcomes on a catchment scale.

- The "development" and "regional" targets set in the WSUD Code have been set to manage stormwater quality from urban areas such that it meets the same standards as a well-managed rural catchment. While this seems a reasonable goal, it does not consider the different values of different receiving waters (e.g. lakes, creeks and rivers) which may be sensitive to different stormwater quality issues. The Water Use and Catchment General Code only classifies catchments as one of three types (conservation, water supply, drainage and open space) which doesn't add much detail. The ACT has a complex set of varied water management objectives to consider, with receiving waters including urban lakes such as Lake Burley Griffin, Lake Ginninderra and Lake Tuggeranong, urban creeks such as Sullivans Creek, natural creeks such as Ginninderra and Gungaderra Creek, local rivers such as the Molonglo and regional rivers such as the Murrumbidgee.

- While stormwater treatment targets are codified for new development, the objectives for retrofits are less clear. Where retrofit projects have been undertaken, each project has had its own objectives and the stormwater treatment objective is not always clear.

- In older catchments such as Sullivans Creek and Yarralumla Creek, there is a need to re-think the treatment train. The approach in the 1970s was to place large GPTs towards the downstream end of the catchment. However now that a higher standard of treatment is desired, new stormwater treatment systems targeting finer pollutants are being installed within the catchments. These need gross pollutant and coarse sediment treatment upstream. Ginninderra Creek is another example where the treatment train has evolved and a system like Giralang Pond is now out of place in the treatment train and needs a strategic re-design.

- In newer suburbs (e.g. in the upper areas of the Ginninderra Creek catchment), some people expressed a concern that there is so much stormwater treatment, some water is treated multiple times as it moves downstream through the system, and there is redundancy in the treatment train.

- Stormwater treatment assets are multi-purpose and sometimes it is unclear what their roles are and how this should inform planning decisions. For example, while large regional ponds such as Yerrabi Pond and Point Hut Pond are designed with a stormwater treatment role, they also clearly meet other objectives and have become important community assets for a range of other reasons. There is therefore an expectation that they will be protected from the impacts of future development in their catchments. It appears that in some contexts they are considered as treatment systems but in others they are considered as receiving waters.

These issues are summarised in Table 7.

***Table 7: Key issues associated with strategic catchment planning***

| Issues | Implications | Potential solutions |
|---|---|---|
| Lack of catchment and treatment train information | Difficult to understand physical context of each asset | Improved spatial information |
| Lack of catchment scale analysis | | Catchment-scale analysis should be a key outcome of the "priority catchments" element of the Basin Priority Project, which can then be translated to other (non-priority) catchments |
| Poor linkages between receiving water values and stormwater treatment objectives | Treatment system design is generic and does not take into account catchment-specific issues | Stormwater treatment targets based on downstream receiving waters |
| No clear framework for determining stormwater treatment objectives for retrofit projects | Retrofit projects have been designed for a wide range of objectives, not all of which are clear | Clear stormwater treatment targets for every catchment in the ACT |
| Older infrastructure sometimes no longer appropriate in treatment train context | Some of the older systems are performing poorly or simply failing to meet contemporary objectives | Treatment trains in evolving catchments need strategic re-design to meet new stormwater management objectives |
| Newer suburbs have overly complex treatment trains which include redundant systems | Inefficient investment in infrastructure | Catchment-scale analysis should drive infrastructure planning based on treatment train principles |
| Multi-purpose assets have competing objectives | "Performance" is difficult to define. Different stakeholders have different views on what a well-performing system should look like | Clarify the multiple roles and objectives of stormwater assets |

Note that the ACT Water Strategy 2014-44 ("Striking the Balance", August 2014) identifies amongst its key strategies to "achieve integrated catchment management across the ACT and region". Therefore addressing this issue is on the high-level agenda.

A catchment master plan would sit alongside the WSUD Code and guide its application in specific locations. It would encourage consideration of stormwater management earlier in the land use planning and estate design process. It would also guide the planning and design of retrofit projects in older suburban areas. It should be linked to:

- receiving water quality objectives,
- other objectives such as flood detention, water reuse, recreation and habitat, and
- land use planning, including precinct plans for greenfields and urban consolidation projects.

## 4.4 Design issues

In our assessment of the performance of existing stormwater treatment systems, it is apparent that many fundamental issues are arising at the design stage. Common issues across a range of treatment systems include:

- Many systems (including systems built within the last decade) lack the fundamental features which are standard practice for stormwater treatment systems, including high flow bypass, extended detention and adequate pre-treatment. Design issues specific to different treatment system types are further discussed in Section 5.
- Inlets and diversion systems are consistently designed poorly so that in many cases, very little water is able to enter stormwater treatment systems.
- Maintenance is given inadequate consideration at the design stage, so that there are access issues maintaining treatment systems, ponds and wetlands cannot be drained and bioretention systems lack flushing points.
- Poor vegetation selection appears to be one of the issues leading to vegetation failure in stormwater treatment systems.

Some of the reasons why these issues are occurring have emerged in the WSUD Code review (2014) and others were discussed at our interviews (refer to Section 3.3). We believe that the most important factors include:

- Limitations in capacity in the local industry.
- Limitations in capacity within the ACT government to review and assess designs before they proceed to construction.
- Design Standards and Specifications are outdated and limited in their scope. Design standards exist for GPTs and large ponds/lakes, but there is no local design guidance on vegetated stormwater treatment systems such as wetlands, swales and bioretention systems. A process for addressing new technology is required. We understand that the Design Standards and Specifications are currently being reviewed; however this is an initial review, which will not address all of the gaps in the stormwater treatment space.
- Within design teams for individual projects, there often appears to be poor integration between civil, landscape and ecological design, with a lack of specialist expertise on stormwater treatment. We understand that in development projects, the civil consultant tends to have continuous involvement from the planning stage to implementation, but other design consultants have piecemeal roles.

- Poor co-ordination between design teams working on separate but related projects – for example at Coombs, the regional ponds (Coombs Ponds A and B as well as Weston Pond) were designed and built ahead of the subdivision design and construction, and some of the design assumptions made for the pond design proved incorrect when the subdivision was constructed. Flowpaths and catchment areas changed, and levels around the ponds changed, making it difficult to mesh the subdivision design with the regional infrastructure.

- Where we have been able to review design drawings, the standard of these is generally poor, with insufficient detail included on key construction elements. Often it appears that important stormwater treatment system details fall into a gap between civil and landscape drawings.

Table 8 summarises the key design issues and potential solutions to avoid these issues in future designs.

***Table 8: Key issues associated with design***

| Issues | Implications | Potential solutions |
|---|---|---|
| Limitations in capacity in industry | Systems are poorly designed and fail to perform at their full potential | Local design guidance<br>Local training and other capacity building<br>Re-design, rectification and renewal of existing assets |
| Limitations in capacity in government | Design issues are not picked up at key review stages | |
| Outdated Design Standards and Specifications | Varying quality in designs; problematic issues are repeated | New design standards and specifications for new types of treatment systems |
| Poor integration within design teams | Stormwater, landscape and ecological outcomes suffer | Restructure contracts to encourage an integrated approach |
| Poor co-ordination between design teams | Stormwater treatment systems are poorly integrated into the landscape and with other systems | |
| Design outputs are of a poor standard | Construction outcomes are poor and there is limited recourse to demand higher standards of the construction contractor | Design standards and specifications should set the bar at a higher level |

The Basin Priority Project will include a substantial body of design work and is therefore an opportunity for the ACT Government to deliver a range of best-practice stormwater treatment systems, which should act as showcase projects and templates for future designs. Currently, many new stormwater treatment systems in the ACT are delivered by the development industry, which adds a layer of complexity in terms of competing priorities, tight timelines and different foci. In contrast, the Basin Priority Project will offer an opportunity for the government to take more control of the design and implementation process.

The Basin Priority Project could also potentially deliver some of the key elements of updated design guidance, local training and other capacity building, as well as the re-design, rectification and renewal of existing assets.

## 4.5 Construction issues

In our review of treatment system performance, the most significant construction issue that we witnessed on multiple sites was the staging of construction in development projects. Vegetated stormwater treatment systems such as wetlands, bioretention systems and swales are not designed to capture construction sediment and are easily over-loaded with sediment during the construction stage, causing significant damage which is not easily rectified. Many GPTs can also be damaged by construction-stage sediment loads.

Ponds are appropriate for capturing construction sediment. However there is a significant difference between a simple construction-stage sediment pond, which is designed as a short-term installation to capture a large sediment load, and a pond designed for long-term water quality management as well as broader landscape, community and ecological objectives.

Based on our interviews with key stakeholders and review of specific assets, we have observed that:

- Erosion and sediment control is normally implemented effectively at the estate development stage (however Coombs is noted as an exception), but even with best practice erosion and sediment control measures in place, vegetated stormwater treatment systems are not appropriate for the sediment loads at this stage.

- During the house-building stage, erosion and sediment controls are virtually non-existent. This is a known issue in the ACT and was discussed as a regulatory issue in Section 4.2 above. During this stage, sediment loads are high and vegetated stormwater treatment systems remain inappropriate.

- There are also other impacts at construction stage (both estate and house-building stages) that damage vegetated stormwater treatment systems, particularly where they are located in the streetscape or otherwise close to other works. For example vehicle movements, construction debris and general litter are all significant issues.

- Despite these issues, vegetated stormwater treatment systems are routinely completed too early in the development process and subsequently damaged by construction sediment loads. Examples include the ponds at Coombs, the bioretention basin and some of the streetscape rain gardens at Crace and the swale at Plimsoll Drive.

This issue has arisen in many other jurisdictions and there are several ways in which it can be dealt with. Options include:

- Establishing vegetated stormwater treatment systems offline (this works well for systems like bioretention basins and wetlands at the downstream end of a catchment, but is impossible for streetscape systems).

- Phasing the construction of vegetated stormwater systems so that civil works (e.g. bulk earthworks and major structures) are completed as part of the civil subdivision construction but then landscape works (e.g. soils, planting and mulch) are installed after the house-building phase is largely complete.

- Using more substantial temporary protection measures for sensitive systems, rather than relying on standard erosion and sediment control measures.

Some examples are shown in Figure 4 to Figure 7. Table 9 summarises the key construction issue and potential solutions.

***Figure 4. This basin (Bellamack NT) will ultimately be landscaped and will act as the sediment pond (pre-treatment) for a vegetated wetland. However during the subdivision construction stage it is acting as a construction-stage sediment basin while the wetland is establishing offline***

***Figure 5. Wetland (Bellamack NT) establishing offline (with a lowered water level while plants establish)***

***Figure 6. This basin (Johnston NT) will ultimately be a bioretention system, however until construction is complete in the upstream catchment, it has been installed as a simple sediment basin. After construction-stage sediment is removed, the drainage system and filter media will be installed and vegetation established in the system***

***Figure 7. This bioretention system (Coomera Waters Qld) has been installed with a temporary cover of geotextile and turf to protect the filter from construction stage sediment (but still provide an attractive landscape outcome during the house-building phase)***

***Table 9: Key issues associated with construction***

| Issues | Implications | Potential solutions |
|---|---|---|
| Poor staging of stormwater treatment system construction in new estates | Systems overloaded with construction-stage sediment loads | Adopt appropriate staging techniques based on experience elsewhere (e.g. Water by Design's *Construction and Establishment Guidelines* 2009) |

## 4.6 Establishment issues

Amongst the assets which we have reviewed, we saw many examples of poor establishment. Key examples include:

- In some of the wetlands and ponds (including Emu Bank wetland, Coombs Ponds A and B) there was evidence that wetland vegetation was drowned in deep water before it was sufficiently established. Wetland plants establish well in shallow water or mud, but need to be inundated slowly so that part of the plant always remains above the water level.

- Mabo Boulevard provides a striking example where good establishment in the upper sections of the swale has led to better outcomes since asset handover – vegetation remains in reasonable condition. However poor establishment in the lower sections of the swale has led to significant deterioration post-handover – the swale is now virtually devoid of vegetation.

- Plimsoll Drive has had significant establishment issues – the developer has attempted to establish the swale online while there is significant construction activity still underway in the catchment.

Establishment is a key stage in the life cycle of a vegetated stormwater treatment system, but it is a stage that appears to receive relatively little attention in the ACT. This is likely to be because:

- Establishment is a less critical issue for other public assets and therefore systems are generally not set up to deal with a long establishment phase.

- Establishment of wetland vegetation in particular is a specialist skill which is not widely understood in the industry.

- Along with maintenance, establishment is given inadequate consideration at the design stage. For example, there is often no provision to take systems offline, drain permanent water or manually control water levels during plant establishment.

- Construction contracts do not typically include a meaningful allowance for plant establishment.

- Construction timelines often encourage early handover before establishment is complete.

- The establishment phase is maintenance intensive and unless it is clearly identified as part of the implementation cost (e.g. as part of a specific contract), it may be difficult to resource.

However, despite these challenges, effective establishment does pay off in the long run due to reduced maintenance costs over the life of an asset. Table 10 summarises the key issues with establishment and potential solutions.

***Table 10: Key issues associated with establishment***

| Issues | Implications | Potential solutions |
|---|---|---|
| Poor establishment at handover | Poor treatment outcomes if vegetation fails to establish<br>Higher maintenance costs if rectification is required | Acknowledge establishment as a critical phase<br>Adopt best practice guidelines (existing guidelines such as Water by Design's *Construction and Establishment Guidelines* 2009)<br>Allocate appropriate funding to establishment<br>Include establishment in contracts |

The ACT Government should seek to ensure that the Basin Priority Project funding covers the establishment phase as well as infrastructure construction.

## 4.7 Asset handover issues

Asset handover is an important process which begins with the review of concept design information and concludes with the completion of asset acceptance.

In the interviews conducted as part of this project, asset handover processes were raised many times as a key issue for stormwater treatment systems. Our field inspections have helped confirm that asset handover issues are translating into poor outcomes on the ground. Some of the issues we have seen in our review are:

- Assets that were obviously handed over in poor condition (e.g. without vegetation being well enough established) e.g. Mabo Boulevard swale, Emu Bank wetland.

- Design issues that are preventing asset handover – for example at Lyneham pond, TAMS has not yet accepted the spillway, however this is an issue that could have been picked up at the design stage to avoid protracted negotiations at asset acceptance.

We also understand that the LDA and TAMS have not been able to agree on the handover of Norgrove Park wetland and this system is still maintained and operated by the LDA.

Our assessment is that the primary reasons for asset handover problems relate to issues of process within the ACT government. Fundamental among these are:

- Different people in different sections of government undertake review and approvals at different stages in an asset's life. Key stages are the development application, design review and asset acceptance. Different teams are involved at each of these stages and they are looking for different things. Stormwater quality treatment is an example of this – modelling results are reviewed at DA stage then subsequent design review and asset acceptance processes do not include a mechanism to check whether the anticipated stormwater treatment outcomes are actually being met.

- Input from maintenance staff is not always sought at the design review stage. When maintenance staff do provide comments at the design stage, they report that their concerns are not adequately addressed (for example the GPT at Lyneham pond).

- Until recently, we understand that Capital Works assets (e.g. Coombs Ponds) have not gone through the same design review and asset acceptance process as assets built by developers and other third parties.

Furthermore, a lack of capacity hinders the ability of staff to pick up on key issues during DA, design review or asset acceptance stages. Staff involved in the process rely on tools such as the WSUD Code, design standards and specifications, which (as discussed above) are outdated and limited in their scope. Staff report that it is difficult to assess designs for stormwater treatment systems that fall outside the scope of existing standards and specifications; however such systems are becoming commonplace.

Table 11 summarises the key issues with asset handover and potential solutions.

***Table 11: Key issues associated with asset handover***

| Issues | Implications | Potential solutions |
|---|---|---|
| Inconsistency and gaps in internal asset handover processes | Stormwater quality outcomes could change significantly between DA and asset acceptance, and this wouldn't be picked up in the process<br>Potential maintenance issues are not picked up until handover is complete | Review and improve asset handover processes from the DA stage to asset acceptance |

| Issues | Implications | Potential solutions |
|---|---|---|
| | Poor concepts, designs and constructed outcomes can be approved at each stage of the process | |
| Lack of capacity for meaningful review | Key issues can easily be missed during approval process | Improve guidelines and tools<br>Build internal capacity |

Note that one of the recommendations of the WSUD Code review (which we understand is being implemented) was that CMTEDD should lead the development of a guideline in consultation with TAMS to inform the effective transfer of government owned WSUD infrastructure from construction to management. This is a step in the right direction, however it appears that the focus is on the final step in the handover process (from construction to asset acceptance) and some of the issues noted above arise much earlier in the process.

## 4.8 Operation and maintenance issues

The operation and maintenance stage is crucial to the long-term performance of stormwater treatment systems and poor maintenance is a primary cause of poor performance in many of the systems we have reviewed. The number of stormwater treatment systems has increased rapidly in the ACT over the past decade, and the maintenance budget has not kept up with this increase.

The key issue is a lack of funding for maintenance. This is a fundamental problem that means treatment systems are not maintained regularly enough and some receive essentially no maintenance at all. The implications of a lack of maintenance are discussed in more detail in Section 5 and Appendix A, however the critical issues are:

- In ponds, lakes and wetlands there is no routine maintenance undertaken within the water body itself. These systems are only desilted occasionally, when sediment builds up to a level which demands some action. However well before sediment reaches this level, many ponds and lakes appear to have water quality issues associated with re-release of pollutants from material building up within the water body. Most wetlands have very poor macrophyte health and are therefore performing well below their potential.

- Swales and waterways have mixed results. While a system with well-established vegetation and a large grass buffer zone (e.g. Franklin waterway or Harrison swales) is relatively robust and continues to perform under a minimal maintenance regime, a swale such as Mabo Boulevard with poor vegetation cover and no grass buffer has proven to be a failure.

- In some areas, the capacity to maintain bioretention systems/rain gardens is so limited that currently they are not being maintained at all, and many of these systems are not working. Bioretention systems are low maintenance, but prone to failure if not maintained at all.

- Gross pollutant traps are generally cleaned out twice per year, which is a relatively low frequency. Where these are “major”/”minor” GPTs designed to ACT standards, the intention always was that they would be cleaned out at this frequency. However an unforseen issue is that organic matter accumulating in GPTs decomposes anaerobically between cleanouts, causing re-release of pollutants. Where GPTs are proprietary devices, many of these are prone to complete failure under such infrequent maintenance.

As discussed in previous sections, maintenance issues can stem from earlier stages in the planning, design and construction process. However, our review has revealed that when problems earlier in the process have resulted in a system that is difficult to maintain, the result has generally not been an increased maintenance effort or increased maintenance costs – the maintenance budget is so limited that these problems tend to be neglected and the result is a poorly performing asset. The bioretention systems/rain gardens are a good example in this category.

The operations and maintenance budget is so tight that staff describe their job as entirely reactionary. Asset management systems are inadequate, and maintenance plans and life cycle costing information is not being captured in current processes. There is little opportunity for operations and maintenance staff to feed useful information back to the rest of government or industry. In this context, we expect that there is also very little capacity for investment in staff training or equipment to maintain new types of stormwater treatment assets such as bioretention systems.

A connected issue is that (prior to the current projects) there has been very little effort or investment into monitoring and reviewing the performance of stormwater treatment systems. A poorly functioning asset can therefore go unnoticed for many years, unless it becomes such a nuisance that it generates public complaints.

The lack of funding at the operation and maintenance stage are a key risk to the future of WSUD in the ACT and to the Basin Priority Project, which proposes to build significant new stormwater treatment infrastructure. An overwhelming load of new assets could cause a backlash against WSUD from operations and maintenance staff. Faced with the same dilemma, other jurisdictions have moved away from treating stormwater altogether.

A lack of funding for operation and maintenance is a key consideration influencing the recommendations this project ultimately needs to make about improving the performance of stormwater treatment infrastructure. There is no point recommending substantial investment in infrastructure upgrades that cannot be matched with adequate maintenance, and there are few opportunities for works which would improve performance while reducing maintenance costs.

Table 12 summarises the key issues with operation and maintenance and potential solutions.

***Table 12: Key issues associated with operations and maintenance***

| Issues | Implications | Potential solutions |
|---|---|---|
| Inadequate funding for operations and maintenance stage | Poor performance of existing assets<br>Limited opportunity to improve asset management systems or build capacity | New funding model<br>Investment is required into systems and capacity-building as well as O&M workload itself |
| No routine monitoring or review | Poorly functioning assets go undetected<br>Investment in infrastructure is not translating into anticipated water quality outcomes | Investment is also required into monitoring and review (which the Basin Priority Project is partially addressing in the short-term) |

The WSUD Code review also identified a lack of funding for operations and maintenance as a critical issue, and proposed a priority project to investigate alternative management and funding models.

# 5 Initial assessment by asset categories

This section synthesises our initial findings in terms of broad types of assets – large ponds and lakes, small ponds and wetlands, swales and waterways, bioretention systems and rain gardens, and GPTs.

## 5.1 Large ponds and lakes

Large ponds and lakes are a feature of Canberra's stormwater management systems and a distinguishing characteristic of urban development in the ACT. The Plan of Management for Canberra's urban lakes and ponds (ACT Government 2001) identifies an "emerging vision" for the lakes and ponds:

> *"To enrich local communities through the aesthetic, recreational, sport, tourism and ecological values of lakes and ponds, and to provide opportunities for people to be involved in their use, care and management"*

Therefore while most of these systems are identified at some level as water quality treatment systems, they have multiple objectives and their stormwater treatment role is not necessarily the role most valued by the community.

We have categorised the water bodies in this review into two categories, chiefly based on their size. The large ponds and lakes:

- have a surface area in excess of 1 ha
- are predominantly open water
- are generally deeper than 1.5 m
- are typically located online
- have broader objectives beyond water quality treatment
- are regional infrastructure which serves more than a single development/estate or suburb
- have therefore been delivered by the ACT government rather than land developers.

The large ponds and lakes reviewed in this project are listed in Table 13. Even amongst these larger systems, there is a significant range of scales from 1.2-25.9 ha.

***Table 13: Large ponds and lakes reviewed in this project***

| Asset number | Name | Surface area (ha) |
|---|---|---|
| 12 | Dickson pond | 1.2 |
| 13 | Lyneham pond | 1.5 |
| 23 | Giralang pond | 1.3 |
| 24 | Point Hut Pond | 15.5 |
| 25 | Coombs Pond A | 1.8 |
| 26 | Coombs Pond B | 4.5 |
| 27 | Yerrabi Pond | 25.9 |
| 39 | Isabella Pond | 6.8 |
| 40 | Lower Stranger Pond | 4.1 |

### 5.1.1 Appropriateness

In the 1980s and 1990s, large ponds and lakes were commonly used as a stormwater treatment measure. In 1998, the CRC for Freshwater Ecology published the "Design Guidelines: Stormwater pollution control ponds and wetlands" (Lawrence and Breen 1998), which represented best practice in stormwater treatment at that time. While these guidelines provide advice about a wide range of pond and wetland design configurations, there is an emphasis in the design advice on large online ponds. The ACT's Design Standards for Urban Infrastructure, Chapter 16 – Urban Wetlands Lakes and Ponds (Urban Services, undated) also focuses on large, online ponds with minimal macrophyte zones around their edges. Extended detention and offline systems are noted as "emerging issues" in the final section of this document.

Point Hut Pond, Yerrabi Pond, Isabella and Lower Stranger Ponds were all constructed in the 1980s and 1990s. In the ACT the use of ponds has continued to the present day, with the Dickson, Lyneham and Coombs Ponds only recently constructed. Giralang Pond is thought to be older with a construction date in the 1970s.

Large ponds and lakes are effective for sedimentation of particulate matter, including fine suspended solids and adsorbed pollutants. However they are most effective when:

- they are sized appropriately for the catchment
- primary treatment is provided upstream to manage litter and debris as well as coarse suspended solids
- they provide "plug flow" conditions – steady, well-distributed flow
- they are shallow enough to be protected from temperature stratification.

### 5.1.2 Objectives

Large ponds and lakes have been designed in the ACT for stormwater treatment purposes but also have important roles to play in:

- attenuating peak flows
- recreation, including fishing, boating, passive recreation
- landscape outcomes such as microclimate and amenity
- water storage
- habitat
- community engagement.

It is not known whether the older ponds (Point Hut Pond, Yerrabi Pond, Isabella and Lower Stranger Ponds) were designed to meet any specific water quality targets. At Coombs, Ponds A and B were designed to meet the "regional" pollutant load removal targets set in the ACT WSUD Code (additional suspended solids, phosphorus and nitrogen removal over the development targets). At Dickson and Lyneham, we understand that the design of the ponds was driven more by flow attenuation and water supply objectives rather than as water quality treatment systems, however the design reports include ambitious estimates of expected suspended solids, phosphorus and nitrogen removal.

### 5.1.3 What performance issues are occurring?

There is no event-based stormwater quality monitoring data available for large ponds and lakes, so it is impossible to fully assess their performance as stormwater quality treatment systems. More information is available on the in-pond water quality issues.

Urban ponds and lakes commonly display long-term management issues including poor in-pond water quality, algal blooms and weed outbreaks. Low dissolved oxygen, high nutrient concentrations and high chlorophyll-a are common issues. As organic matter accumulates and breaks down in a pond, dissolved oxygen levels drop and decomposition is anaerobic. Under these conditions, many pollutants normally adsorbed to suspended solids, including phosphorus, are re-released into the water column. Odours are common, algal blooms can be triggered as a result and in extreme cases, the low DO levels can cause fish kills. Temperature stratification exacerbates the issue by discouraging oxygen transfer from shallow to deep water. A long-term build-up of accumulated pollutants can also exacerbate the issue.

Many jurisdictions in Australia have therefore moved away from large ponds and lakes as stormwater treatment systems. The ACT has continued to build them, however many of the ACT's ponds, particularly the older ponds, are suffering from long-term water quality issues exactly as described above.

Another prevalent issue in the ACT's ponds and lakes is an excessive build-up of sediment. In some cases (for example this is occurring at Coombs right now), this has occurred during urban development in the catchment. None of the large ponds and lakes are designed to be regularly drained (while some have dam valves, they are only intended to be drained in an emergency) and this means that sediment removal is a difficult and costly process.

Note that maintenance activities at the large ponds and lakes are minimal. Civil maintenance is largely confined to management of any GPTs at inlets and the dam and outlet structure, while landscape maintenance is confined to mowing and weed spraying around the pond edges. Neither the civil nor landscape maintenance teams have clear responsibility for maintaining the water body itself. The landscape maintenance team raised a concern that new ponds are being constructed with excessive maintenance requirements (e.g. Lyneham Pond), however it appears that they are primarily concerned with the maintenance of "shrub beds" around the terrestrial edges of the system, rather than maintenance of the pond itself. Landscaped shrub beds are not an essential feature for water quality treatment, and there are examples in the ACT (e.g. Lower Stranger Pond) where informal low-maintenance landscaping includes a variety of trees, shrubs, sedges and grasses and an attractive landscape outcome.

#### 5.1.4 Why are these performance issues occurring?

Many of the performance issues noted above are typical of urban ponds and simply a feature of this type of infrastructure. However performance issues in ponds are exacerbated by the following factors:

- High sediment loading during the construction stage. Inappropriate development staging and poor erosion and sediment controls contribute to this problem.
- High organic matter loads (including leaf litter and grass clippings). Organic matter loads tend to be high in the ACT due to the prevalence of large trees and large areas of mown grass in the public and private domain.
- Undersized ponds. Undersized ponds are easily overloaded with suspended solids and organic matter. High BOD (biochemical oxygen demand) loading exacerbates in-pond water quality issues – for example Giralang Pond is significantly undersized for its catchment and has significant water quality issues.
- Minimal pre-treatment upstream. Many of the ACT's ponds have minimal upstream pre-treatment. This is particularly true of the ponds in Tuggeranong, where flows are conveyed in concrete channels, and typically the only pre-treatment upstream of a pond is a gross pollutant trap. Gross pollutant traps are discussed further in Section 5.5.
- Pond maintenance. In the ACT, desilting of ponds is not planned for at the design stage, is not undertaken as part of routine maintenance, is not budgeted for and is generally only undertaken on a reactionary basis when necessary and when funds allow. Because large ponds and lakes are not designed with sediment removal in mind, this tends to be a difficult and costly exercise. Suspended solids and organic matter have therefore probably accumulated to a significant degree in many ponds, and are probably contributing to in-pond water quality issues associated with anaerobic decomposition.

- Pond location and design. Many of the large ponds and lakes in the ACT are relatively deep and prone to stratification, which exacerbates in-pond water quality issues.

#### 5.1.5 Opportunities to improve performance

Despite the water quality issues identified above, in general the ACT's large ponds and lakes have proved relatively robust and able to cope with low maintenance. There is the risk, however, that water quality issues increase over time as catchments become increasingly urbanised and accumulated pollutants continue to build up in these systems.

A wide range of options exists for addressing performance issues in the large ponds and lakes:

- Most of the large ponds and lakes could be **maintained** as they are. With the possible exception of Giralang Pond, most of the large ponds and lakes are not suffering from urgent problems.

- In some cases, a simple **renewal** of the existing asset to clean out accumulated sediment and decomposing organic matter could assist in improving in-pond water quality. This is particularly true of the older ponds – Giralang Pond, Point Hut Pond, Yerrabi Pond, Isabella and Lower Stranger Ponds. Before this is undertaken, we would recommend further investigation into the quality and quantity of accumulated material to understand its role in pond water quality and the potential implications of removal. TAMS advised that they monitor sediment accumulation in ponds to identify when sediment removal is required. TAMS suggested that the large ponds and lakes are generally filling with sediment at a slow rate, however we would like to review this information to better assess this issue.

- In some cases, minor **rectification** works could resolve site-specific issues (e.g. replacement of the GPT at Lyneham Pond, improvement of the diversion structure at Dickson Pond, repair of edge erosion at Lower Stranger Pond) with some bearing on the water quality performance.

- Most of the ponds could be **redesigned** to some extent to improve their function as water quality treatment systems. This could range from simple to complex measures, for example:

    - Dickson and Lyneham ponds already have extended detention and a riser outlet which is designed for a reasonable detention time within the pond. This arrangement could be retrofit to other sites and would introduce more water level variation to the system. This is potentially feasible at any of the large ponds and lakes.

    - In conjunction with the above, more macrophyte plantings could be established around the edges, in the shallow and ephemeral zones.

    - Some of the smaller systems could potentially be completely redesigned to incorporate features such as an extensive macrophyte zone, separate sediment basin and high-flow bypass. This is not likely to be practical at the sites where the pond/lake is several hectares in area, but could work at sites like Giralang Pond, Isabella Pond and Lower Stranger Pond.

- Most sites would benefit from the **retrofit** of additional stormwater treatment in their upstream catchment, in order to improve water quality arriving at the pond. Upstream of ponds, treatment systems should include measures to treat gross pollutants, organic material and coarse suspended solids.

- The Coombs Ponds are a particular case where they are still coping with significant construction sediment loads in their catchments. These ponds should be reassessed once they settle down to more typical water quality conditions.

A summary of the options recommended for further investigation is included in Table 14.

*Table 14: Large pond and lake options for further investigation*

| Asset number | Name | Potential options | | | | |
|---|---|---|---|---|---|---|
| | | Maintain | Renew | Rectify | Redesign | Retrofit |
| 12 | Dickson pond | ✓ | | ✓ | ✓ | ✓ |
| 13 | Lyneham pond | ✓ | | ✓ | | ✓ |
| 23 | Giralang pond | | ✓ | ✓ | ✓ | ✓ |
| 24 | Point Hut Pond | ✓ | ✓ | | ✓ | ✓ |
| 25 | Coombs Pond A | ✓ | | | | |
| 26 | Coombs Pond B | ✓ | | | | |
| 27 | Yerrabi Pond | ✓ | ✓ | ✓ | ✓ | |
| 39 | Isabella Pond | ✓ | ✓ | | ✓ | ✓ |
| 40 | Lower Stranger Pond | ✓ | ✓ | ✓ | ✓ | ✓ |

If any new large ponds and lakes are constructed in the ACT, they should include:

- Better staging of development, which would reduce the build-up of construction stage sediment in large ponds and lakes. While ponds are very well suited for removing sediment from stormwater, when sediment loads are high (such as during construction), temporary sediment basins are more appropriate. Staging is discussed further below.
- Better upstream pre-treatment, particularly targeting coarse suspended solids and organic matter. This could include a sediment basin immediately upstream of the main pond, with the sediment basin designed with a maintenance drain and access for sediment removal equipment.
- If they cannot be sized appropriately for their catchment (e.g. Giralang, Dickson and Lyneham are all very small for their upstream catchments), then they should be located offline with a high flow bypass.
- Water depths less than approximately 2.5-3.0 m to minimise the risk of stratification.
- Extended detention controlled by a riser outlet to achieve a 2-3 day notional detention time.
- More extensive macrophyte planting around the edges, including shallow and ephemeral zones.
- A mechanism to control water levels manually (at least within the extended detention zone) in order to facilitate maintenance.

A better approach for future regional infrastructure to be constructed in situations where significant greenfield development will take place upstream would be to design a system which can operate in different modes at different stages of its life. In the first stage, the system should be designed as a sediment basin for construction-stage runoff. This approach allows bulk earthworks and major civil infrastructure to be installed for the regional stormwater treatment system at the same time that other regional infrastructure is constructed. A regional sediment basin would help prevent sediment loads from passing downstream into receiving environments such as the Molonglo and Murrumbidgee Rivers. Normally sediment basins are smaller than regional ponds, they are easily drained and coarse sediment can be easily removed. Construction-stage sediment is generally relatively free of contaminants and can therefore be reused as fill material. The estate developer could be made responsible for cleaning out sediment at the completion of their works. The system should be converted to a stormwater polishing system only after estate development and the majority of private developments are complete. Landscaping works should be undertaken at this time.

## 5.2 Small ponds and wetlands

Small ponds and wetlands are becoming more popular as a stormwater treatment measure, particularly since the ACT WSUD Code (2009) set mandatory pollutant load reduction targets for new development.

We have categorised the water bodies in this review into two categories, loosely based on their size. The small ponds and wetlands:

- have a surface area less than 1 ha
- typically include macrophyte zones
- are typically shallower than 1.5 m
- are typically located offline or with a small upstream catchment
- have been designed mainly for water quality treatment
- are local infrastructure which serves a single development/estate, suburb or even smaller area.

The small ponds and wetland reviewed in this project are listed in Table 15. These include a diverse mix of designs, from simple online systems to more complex offline systems with extended detention and recirculating flows.

***Table 15: Small ponds and wetlands reviewed in this project***

| Asset number | Name | Type of system | Surface area ($m^2$) |
|---|---|---|---|
| 1b | Crace wetland (corner Gundaroo Drive and Abena Avenue) | Recirculating wetland connected to adjacent pond | TBC |
| 9 | Norgrove Park wetland (Kingston foreshore) | Both an online stormwater wetland as well as recirculating wetland connected to adjacent pond | TBC |
| 10 | Emu Bank wetland (Eastern Valley Way, Belconnen) | Both an offline stormwater wetland and recirculating wetland connected to Lake Ginninderra | 4,857 |
| 11 | David Street pond | Offline pond | 1,662 |
| 22 | Pond at corner of Ian Potter Crescent and Tesselaar Street, Gungahlin | Online pond | 2,379 |
| 41 | Two ponds downstream of Point Hut Pond | Online ponds – waterway stability | 4,879 |

Smaller ponds and wetlands have become more prevalent in the ACT since the introduction of the ACT WSUD Code (2009), which includes mandatory stormwater pollutant load reduction targets for new development. Ponds and wetlands can be used as part of a treatment train to meet these targets.

However, small ponds and wetlands first became popular in the early 2000s and the list above includes a few examples from this time – David Street (2001), Ian Potter Crescent/Tesselaar Street (2004) and Norgrove Park wetland (2004).

The Crace wetland and Emu Bank wetland are the newest examples of wetlands in the ACT, built within the last few years.

Note that the two ponds downstream of Point Hut Pond are a special case which do not function as water quality treatment systems and are better thought of as part of the modified waterway between Point Hut Pond and the Murrumbidgee River.

### 5.2.1 Appropriateness

The design of ponds and wetlands for stormwater quality treatment has undergone a gradual transition since the 1980s and 90s. The role of extended detention is better understood and it is used more often. In general, designs have moved away from large online systems dominated by open water, towards smaller systems, located offline with a more extensive macrophyte zone. This shift has come about due to:

- A greater focus on nutrients, trace toxicants and other fine, colloidal and dissolved pollutants in stormwater
- more research into the processes in ponds and wetlands
- more sophisticated modelling tools to help design stormwater treatment systems
- the availability of more design guidance for stormwater treatment systems
- mandatory stormwater quality targets for new developments.

The South East Queensland Healthy Waterways Partnership released design guidelines for WSUD, including constructed wetlands, in 2006, and these became (and remain) the definitive design guideline for constructed wetlands in Australia. However there are few (if any) examples of wetlands in the ACT which have been designed in line with the principles in these guidelines. Each of the small ponds and wetlands in this review has different features. A summary of key features is provided in Table 16. Each has been designed to site-specific objectives and to suit specific site constraints, as well as reflecting the design practice of the time.

It is difficult therefore to comment on the appropriateness of this asset category as a whole, but each of the features is assessed individually here. In the case of small ponds and wetlands, offline systems are generally more appropriate than online (with a possible exception where the catchment area is very small), as online systems are subject to very high hydraulic and pollutant loading. Online systems are easily damaged by high flows and it is very difficult to support healthy macrophytes in these systems. Norgrove Park is an example where this issue is evident.

Small ponds and wetlands are appropriate to treat storm flows, providing that:

- there is adequate pre-treatment of litter, debris and suspended solids
- high flows are bypassed around the system (noting that the vast majority of storm flows and pollutant loads are transported in small events with moderate flows)
- there is extended detention and a riser outlet to ensure a long residence time in the system.

Wetlands can be used successfully to treat recirculating flows. This is a common approach where they are used adjacent to an open water body (e.g. Crace, Norgrove Park). By recirculating flows through the wetland, water quality can be improved in the open water body by providing continual treatment and reducing the effective residence time. Note that a recirculating wetland does not need extended detention or a riser outlet, as the recirculation pump can be sized for an appropriate flow rate and residence time.

Shallow depths are generally preferred in order to reduce the likelihood of anaerobic conditions, support a healthy macrophyte zone and improve pollutant removal in ponds and wetlands. Deeper zones may be appropriate to target sediment removal and provide some open water for aesthetic/habitat purposes, however shallow zones (less than 0.3 m) are better able to support macrophytes and achieve significant nutrient removal.

Extended detention, controlled by a riser outlet to retain flows in the pond/wetland for a notional detention time of 2-3 days, is recommended as an integral part of a stormwater treatment wetland; however there are few examples in the ACT where effective extended detention is included in wetland systems.

Likewise there are few examples in the ACT of well-functioning macrophyte wetlands. Macrophyte wetlands which are protected from high flows are able to support biofilm systems which are highly effective for removal of dissolved pollutants including nutrients. Macrophytes do best in ephemeral to shallow (<0.3 m) zones with extended detention (up to 0.5 m) and low velocities.

***Table 16: Key features of the small ponds and wetlands included in this review***

| Asset number | Name | Online/ offline | Storm flows | Recirculation | Approx. Depth (m) | Extended detention | Macrophyte coverage |
|---|---|---|---|---|---|---|---|
| 1b | Crace wetland (corner Gundaroo Drive and Abena Avenue) | Offline | | ✓ | <0.5 | None | 60% |
| 9 | Norgrove Park wetland (Kingston foreshore) | Online | ✓ | ✓ | <0.5 | None | 50% |
| 10 | Emu Bank wetland (Eastern Valley Way, Belconnen) | Offline | ✓ | ✓ | 0.1-1.9 | 250 mm | 5% |
| 11 | David Street pond | Offline | ✓ | | 0.9 (avg) | Minimal | 10% |
| 22 | Pond at corner of Ian Potter Crescent and Tesselaar Street, Gungahlin | Online | ✓ | | <1.0 | Minimal | 50% |
| 41 | Two ponds downstream of Point Hut Pond | Online | ✓ | | >1.0 | None | 10% |

### 5.2.2 Objectives

While the small ponds and wetlands discussed above have a wide range of design features, most of them have clearly been designed with some water quality treatment purpose. Some are more focused on storm flows and some on recirculating flows, however most (with the possible exception of the ponds downstream of Point Hut Pond) are clearly intended to improve water quality.

Small ponds and wetlands also address other objectives such as flow attenuation, landscape and amenity, habitat and biodiversity, community engagement and education. David Street pond is a good example where the objectives have been articulated and include all of these aspects.

We understand that the objectives at Emu Bank were mainly focused on landscape and amenity rather than water quality improvement – the wetland is very small for the upstream catchment, therefore water quality benefits are small.

Further information on the objectives of specific projects may be available if we are able to review concept design reports (or similar).

### 5.2.3 What performance issues are occurring?

There is limited event-based stormwater quality monitoring data available for small ponds and wetlands. The possible exception is Norgrove Park wetland, where we have seen summary results from a study into pollutant load removal, however it is unclear whether pollutant removal was assessed during storm events or recirculating conditions. More information about the methodology would allow a realistic assessment of this data. At this stage it is impossible to fully assess the performance of small ponds and wetlands as stormwater quality treatment systems.

Some information is available on the in-pond water quality issues – for example from Waterwatch monitoring at David Street and Norgrove Park. Urban ponds commonly display long-term management issues including poor in-pond water quality, algal blooms and weed outbreaks. Low dissolved oxygen, high nutrient concentrations and high chlorophyll-a are common issues and all of these issues are seen to some extent at David Street and Norgrove Park. As organic matter accumulates and breaks down in a pond, dissolved oxygen levels drop and decomposition is anaerobic. Under these conditions, many pollutants which are normally adsorbed to suspended solids, including phosphorus, are re-released into the water column. Odours are common, algal blooms can be triggered as a result and, in extreme cases, the low DO levels can cause fish kills. In deeper systems, temperature stratification exacerbates the issue by discouraging oxygen transfer from shallow to deep water. A long-term build-up of accumulated pollutants can also exacerbate the issue.

Many jurisdictions in Australia have therefore moved away from ponds as stormwater treatment systems, however wetlands remain popular. Shallow macrophyte wetlands can avoid many of the issues associated with ponds, as they are not prone to anaerobic conditions and macrophytes tend to take up nutrients before algal blooms and weed outbreaks take over.

One of the common issues seen in the wetlands was poor establishment of macrophytes. This is probably due to different reasons in different locations. For example:

- At Emu Bank it appears that macrophytes were only ever planted in small areas of the wetland, and then most of the establishing seedlings were drowned before they were sufficiently established.

- At Norgrove Park the wetland is subject to high storm flows which cause physical damage and inhibit the establishment of macrophytes.

- At Crace, macrophyte establishment has been the most successful of any site, but it appears that some species have thrived while others have done poorly.

- In the other systems, it does not appear that macrophytes have been planted beyond the edges of the ponds. *Typha* and *Phragmites* seen in these systems are common sedges that could have self-propagated. Beyond the edges, David Street, Ian Pottter/Tesselaar and the ponds below Point Hut Pond are probably too deep to support macrophytes.

Other performance issues are more specific to each site – for example the diversion design at David Street and issues caused by high flows at Norgrove Park.

Note that maintenance activities at the small ponds and wetlands in the ACT are generally minimal. Civil maintenance is largely confined to management of any GPTs at inlets, while landscape maintenance is confined to mowing and weed spraying around the edges. Neither the civil nor landscape maintenance teams have clear responsibility for maintaining the water body itself. Norgrove Park is an exception, where this asset is still being maintained by LDA and has not yet been handed over to TAMS. It appears that Norgrove Park has an active maintenance regime including the water body itself, however to date we have not been able to obtain the relevant information from the LDA.

As with Canberra's large ponds and lakes, desilting is unplanned and only undertaken as a reactionary measure. Generally, designs have not included any provision for desilting (e.g. maintenance drain, access for machinery, separate sediment zone) and therefore when it has been undertaken, it has not been straightforward. TAMS reported that desilting at David Street was undertaken with a long-reach excavator without draining the pond. Trees had to be removed for this exercise.

#### 5.2.4 Why are these performance issues occurring?

Many of the issues occurring at small ponds and wetlands come back to errors at the design stage. This is probably related to the fact that the local design standards and specifications do not cover small ponds and wetlands and the knowledge of local consultants and developers may be limited.

A related issue is that ACT government review and approval processes lack consistency around small ponds and wetlands (e.g. inconsistency between Territory Plan requirements and Asset Acceptance requirements). In addition, there is limited capacity within the ACT government to assess the wide variety of pond and wetland designs which are being developed.

Key issues are given inadequate consideration at the design stage including:

- appropriate design flows and diversion/high flow bypass design

- appropriate pre-treatment upstream
- appropriate water depths
- provision of extended detention with an appropriate detention time
- maintenance access into and around ponds
- ensuring maintenance schedules and activities required by the design are reasonable and appropriate for the resources and equipment available
- vegetation species selection and placement, suitable for local conditions.

These could also be addressed in appropriate design standards.

The establishment stage is a crucial phase in the life of a vegetated stormwater quality treatment system, but it is often undertaken poorly and this appears to often be the case in the ACT. Construction contracts generally do not allow for an appropriate establishment phase and there is always pressure to finalise construction and asset handover as quickly as possible. Stormwater treatment systems are often built by civil contractors who are focused on the civil elements and lack specialist skills in vegetation establishment. Establishment of wetland vegetation is a particularly specialised skill which is lacking.

Operation and maintenance could be improved and the key issues here are identifying responsibility for maintenance of the water body itself and allocating appropriate resources.

#### 5.2.5 Opportunities to improve performance

None of the small ponds and wetlands have urgent issues which need to be addressed immediately. Therefore each of them could be **maintained** in its current state for some time.

A couple of systems may benefit from simple **renewal** to remove accumulated sediments and reduce in-pond water quality issues. However as discussed above, this has been done before at David Street pond and the same problems tend to return as sediment and organic matter continues to accumulate in the pond.

Therefore many of these systems would benefit from **redesign** works to change the way that they function. Some of the key physical design features which should be adopted in small ponds and wetlands are:

- high flow bypass (so the system operates offline)
- separate sediment basins upstream of the macrophyte zone or main open water zone
- shallow macrophyte zones
- extended detention, controlled by a riser outlet for a 2-3 day notional detention time
- manual water level control to facilitate vegetation establishment and maintenance.

Others need **rectification** works to ensure that key features function as originally intended, for example:

- bunding (to avoid short-circuiting) at Crace
- scour and erosion at Norgrove Park
- the diversion structure at David Street
- macrophyte plantings at Emu Bank.

Many of the systems would also benefit from the **retrofit** of additional treatment measures to pre-treat stormwater in the catchment upstream. The Norgrove Park wetland, Emu Bank wetland and David Street pond are particularly small for their catchment areas.

Note that the two ponds below Point Hut Pond are not in an appropriate location to provide water quality treatment, as any treatment benefit which could be achieved in a pond has already been achieved at the Point Hut Pond upstream. There is therefore little benefit in including more ponds in a series below Point Hut Pond. These ponds can be viewed as part of the waterway and the key issue which needs to be addressed is the stability of the embankment.

A summary of the options recommended for further investigation is included in Table 17.

***Table 17: Small pond and wetland options for further investigation***

| Asset number | Name | Potential options | | | | |
|---|---|---|---|---|---|---|
| | | Maintain | Renew | Rectify | Redesign | Retrofit |
| 1b | Crace wetland (corner Gundaroo Drive and Abena Avenue) | ✓ | | ✓ | | |
| 9 | Norgrove Park wetland (Kingston foreshore) | ✓ | | ✓ | ✓ | ✓ |
| 10 | Emu Bank wetland (Eastern Valley Way, Belconnen) | ✓ | | ✓ | | ✓ |
| 11 | David Street pond | ✓ | ✓ | ✓ | ✓ | ✓ |
| 22 | Pond at corner of Ian Potter Crescent and Tesselaar Street, Gungahlin | ✓ | ✓ | | ✓ | |
| 41 | Two ponds downstream of Point Hut Pond | ✓ | | ✓ | | |

## 5.3 Swales and waterways

Swales and waterways have always been used in stormwater management in the ACT, however the design approach for these systems has evolved over the years. While older systems were designed principally for conveyance and were designed to undertake this task as efficiently as possible, newer systems have gradually evolved to incorporate more of a stormwater treatment role.

The swales and waterways reviewed in this project are listed in Table 15. These range from small systems with an individual street as their catchment, to large waterways with catchments spanning several suburbs. They include systems constructed in the 1980s (Knoke Avenue Gordon), 2000s (Gungahlin, Franklin and Bonner) and 2010s (Harrison and Crace).

***Table 18: Swales and waterways reviewed in this project***

| Asset number | Name | Type of system |
|---|---|---|
| 14 | Mabo Boulevard, Bonner | Median swale |
| 15 | Margaret Tucker St, Bonner | Overland flowpath |
| 16 | Helby Street, Harrison | Small swale/overland flowpath |
| 17 | Trephina Street, Harrison | Small swale/overland flowpath |
| 18 | Medhurst Crescent, Crace | Overland flowpath |
| 19 | Plimsoll Drive, Casey | Median swale |
| 20 | Tsoulias Street, Gungahlin | Median swale |
| 21 | Franklin constructed waterway (Gungaderra Creek) | Engineered waterway with significant stormwater treatment role |
| 42 | Knoke Avenue constructed waterway, Gordon | Engineered waterway with limited stormwater treatment role |

Note that the swales and waterways include some which are clearly intended as stormwater treatment systems and others which have little or no stormwater treatment role. Many of them lie somewhere on a spectrum between conveyance systems for overland flows and stormwater treatment systems.

### 5.3.1 Appropriateness

Vegetated swales and waterways are very effective at removing sediment from stormwater, including fine sediment and sediment-bound pollutants, providing that:

- stormwater is able to drain to the swale
- swales are well-vegetated
- velocities are reasonably low
- swales are stable.

Swales are not particularly effective for nitrogen removal and therefore unlikely to be able to meet WSUD Code targets on their own. However, as part of a treatment train, they are an ideal pre-treatment step upstream of a pond or wetland. They can address fine sediment loads and sediment-bound pollutants that are missed in GPTs (refer to Section 5.5) but which are problematic in ponds and wetlands downstream (refer to Sections 5.1 and 5.2).

Swales and waterways can be low-maintenance stormwater treatment systems. For example, the Franklin waterway has been noted by TAMS as a low-maintenance system, which is providing significant water quality benefits. Designed well, swales and waterways can be robust systems which require relatively little maintenance effort.

Swales and waterways can also provide other benefits beyond water quality treatment including:

- landscape and amenity
- habitat and biodiversity
- recreational opportunities
- floodways for conveyance of high flows
- attenuation of low and medium flows.

Key risks for swales and waterways in the ACT include that:

- Local soils are highly erodible, particularly when grades are steep. Designers need to consider velocities and shear stresses and provide appropriate surface treatment.
- With tight maintenance budgets, there is limited capacity for maintenance staff to manage weeding, and therefore vegetation needs to be robust and well-established from the outset.

A key question regarding swales and waterways is what proportion of flows should be conveyed underground versus above ground. Many of the older swales and waterways in the ACT include low flow pipes and channels which convey a large proportion of the total runoff, as well as a large proportion of total pollutant loads. These flows are the highest priority for treatment, so a challenge is to turn traditional drainage design around to keep the low flows on the surface. The pipe system is still important to convey high flows which may otherwise cause scour and erosion.

#### 5.3.2 Objectives

The swales and waterways included in this review differ in their objectives and often have multiple objectives. Some have been constructed to act as stormwater treatment systems but most have primarily been designed to convey overland flows in major rainfall events. Some swales consist of vast areas of turf whilst others have extensive planting of native grasses, sedges and shrubs. Many of the swales combine multiple features such as treatment of local road runoff and conveyance of overland flows. The objectives of the studied swales and waterways are outlined in Table 19.

***Table 19: Swale and waterway objectives***

| Asset number | Name | Swale/waterway objectives ('1st' denotes primary objective; '2nd' denotes secondary objective) | | | Physical features | |
|---|---|---|---|---|---|---|
| | | Treatment of small local catchment | Treatment of large upstream catchment | Overland flow route | Low flow pipe or channel present | Significant native vegetation |
| 14 | Mabo Boulevard, Bonner | ✓ (1st) | | | ✓ | ✓ |
| 15 | Margaret Tucker St, Bonner | ✓ (2nd) | | ✓ (1st) | ✓ | ✓ |
| 16 | Helby Street, Harrison | ✓ (2nd) | | ✓ (1st) | | ✓ |
| 17 | Trephina Street, Harrison | ✓ (2nd) | | ✓ (1st) | ✓ | ✓ |
| 18 | Medhurst Crescent, Crace | | | ✓ (1st) | ✓ | |
| 19 | Plimsoll Drive, Casey | ✓ (1st) | | ✓ (2nd) | ✓ | ✓ |
| 20 | Tsoulias Street, Gungahlin | ✓ (2nd) | | ✓ (1st) | ✓ | |
| 21 | Franklin constructed waterway (Gungaderra Creek) | | ✓ (2nd) | ✓ (1st) | | ✓ |
| 42 | Knoke Avenue constructed waterway, Gordon | | | ✓(1st) | ✓ | |

#### 5.3.3 What performance issues are occurring?

There is currently no known stormwater quality monitoring data available for the swale systems. At this stage it is therefore impossible to fully assess the performance of swale systems as stormwater quality treatment systems in the ACT.

However, to date our review has allowed us to observe the performance of swale and waterway systems at a "macro" scale. We have been able to see how stormwater physically interacts with these systems and make a broad assessment of their function. The swales that have performed the worst have been Mabo Boulevard and Plimsoll Drive. Knoke Avenue waterway also has significant erosion issues. Other swales have minor issues. Key observations common to many of the swale systems have been:

- Generally the catchments draining directly to the swales are relatively small and therefore there would be little improvement in water quality in the scheme of the wider catchment. Often there is a small road catchment draining to a vast swale, such that the runoff would generally not reach the swale invert but rather be absorbed by the vegetation and soils in the space between the kerb and the swale.

- Further to the above point, the swales often appear to be a missed treatment opportunity due to the inclusion of a low flow stormwater pipe. The majority of runoff from upstream areas in frequent low intensity rainfall events passes into the low flow pipe and on to the downstream receiving waters (often a pond) with no treatment by the swale and often only coarse litter removal, allowing sediment to enter the pond.

- Castellated gutters often have issues with blockage of the kerb gaps by accumulated sediment. If left for a long time turf or weeds can grow in the accumulated sediment leading to further blockage. The blockage of the gaps leads to road runoff bypassing the gaps. Instead of the stormwater entering the swale in a distributed manner, runoff from a length of road often enters the swale in a concentrated location. The arrangement of the gaps also prevents water from passing through the gaps easily.

- Erosion is seen where velocities within swales are high and there is an inadequate surface treatment for the velocities experienced. The most notable examples of scouring are at the Plimsoll Drive swale and Knoke Avenue waterway, but there is also some at Mabo Boulevard.

- TAMS has had some difficulty with maintaining vegetation in swales (other than turf) – a key example is Mabo Boulevard. However, most of the swales and waterways have proven to be robust systems, suggesting that appropriately selected and well-established native vegetation can be easy to maintain in a swale or waterway.

#### 5.3.4 Why are these performance issues occurring?

In most cases, despite minimal maintenance, the swale and waterway systems are in reasonable condition. In some cases (e.g. Harrison) this may be due to the fact that they are not actually treating significant stormwater flows, therefore they are somewhat protected from sediment loads, weed propagules, litter, etc. The design philosophy around swales and waterways in the ACT has historically been that they are primarily conveyance systems, used to deliver water to GPTs and ponds. It is only recently that swales have been considered in terms of their potential stormwater treatment role, and this may explain why most of them have been designed conservatively, to treat only small stormwater catchments.

The performance of the swales and waterways therefore needs to be considered in the context that most of the systems are designed for conveyance of large overland flows. It is likely that they have never been tested to their design capacity (e.g. 100 year ARI overland flow). Many of the systems are effectively designed for extreme conditions which are very unlikely to have occurred to date in the life of the system.

The most common issue which was seen at many of the swales was poor performance of castellated gutters. A common design issue with the castellated gutters is that insufficient fall is provided across the kerb gap. In addition to this, there is often no dropdown provided from the back of the kerb gap to the swale surface. It is important that there is a pronounced dropdown from the back of the kerb to the top of the turf (when the turf is at its maximum height). This generally means that the topsoil should be finished no higher than 100-150mm below the back of kerb level. Based on the drawings we have reviewed to date, this detail is generally missing from design drawings and is not specified elsewhere.

Poor design documentation also appears to have been a factor at Plimsoll Drive and potentially also at Mabo Boulevard. Design drawings do not show enough detail on proposed levels, and therefore many sections have been constructed with inappropriate topography, including steep slopes and deep profiles.

Some of the issues found with swale and waterway systems are related to the local design standards and specifications, which cover only the hydraulic requirements without considering the detailed requirements that swales require for longevity. Whilst it is stated that "waterway [scour] protection must be provided to suit the local physical and scour characteristics" there may not be sufficient information to ensure that this design objective is met.

The requirement for swales and waterways is that the flow velocity must not exceed 2 m/s, but this criterion does not guarantee the stability of a swale or waterway. The standards may benefit from additional fine level details such as the acceptable flow velocity for different surface treatments (e.g. grass vs rock).

Beyond the design stage, other factors impacting on the performance of the swales are more site-specific. For example:

- the construction stage has been particularly problematic at Plimsoll Drive

- vegetation establishment (and condition at handover) was a particular issue at Mabo Boulevard

- erosion in the Knoke Avenue waterway has emerged during longer-term operation and maintenance issue. To date, the methods used to address erosion at this site have not been particularly successful in addressing the processes causing the erosion – the problem has simply shifted elsewhere.

#### 5.3.5 Opportunities to improve performance

In terms of the specific systems reviewed in this project, there are a few options available. Most of the swale systems, despite the fact that they don't treat much stormwater, are stable and reasonably well vegetated (even if only short turf), and could be **maintained** as they are without causing negative impacts.

**Renewal** is recommended for selected systems which have been impacted by scouring or erosion, or where vegetation is performing poorly. In general the swales and waterways that are performing the best from a stability perspective have the following design features:

- generous dimensions and gentle grades
- no features which concentrate flows
- well established vegetation
- turf that is robust under high velocities (and can also provide a useful buffer zone around native vegetation).

The waterway at Franklin treats significant flows and remains stable and effective, while the swales at Harrison are well protected by large grass buffers.

**Rectification** works could be undertaken to improve the function of castellated gutters. Where required the turf should be stripped and topsoil level lowered to ensure that there is a drop from the back of the kerb gap to the turf surface. Note that in some cases, this may require re-grading a significant width in order to work effectively. Alternatively, where levels are constrained, instead of dropping the entire strip behind the kerb, a small hole around 200mm deep could be excavated behind each gap to act as a sediment trap and stilling basin or soakaway for all flows that pass through the gap.

If there is a desire to improve the treatment performance of the swales, **redesign** works would be required. From a water quality treatment perspective, there are significant opportunities to increase the treatment capacity of most the systems reviewed in this project. Options include directing more stormwater to the swales – particularly low flows from frequent rain events – and maximising contact between stormwater and vegetation.

The key limitation to this approach is that most of the systems have been designed for conveyance and this function needs to be maintained in order to avoid any impacts on flooding.

A summary of the options recommended for further investigation is included in Table 20.

***Table 20: Swale and waterway options for further investigation***

| Asset number | Name | Potential options | | | |
|---|---|---|---|---|---|
| | | Maintain | Renew | Rectify | Redesign |
| 14 | Mabo Boulevard, Bonner | | ✓ | ✓ | |
| 15 | Margaret Tucker St, Bonner | ✓ | | ✓ | ✓ |
| 16 | Helby Street, Harrison | ✓ | | | ✓ |
| 17 | Trephina Street, Harrison | ✓ | | ✓ | ✓ |
| 18 | Medhurst Crescent, Crace | ✓ | | | ✓ |
| 19 | Plimsoll Drive, Casey | ✓ | ✓ | ✓ | ✓ |

| Asset number | Name | Potential options | | | |
|---|---|---|---|---|---|
| | | Maintain | Renew | Rectify | Redesign |
| 20 | Tsoulias Street, Gungahlin | ✓ | | ✓ | ✓ |
| 21 | Franklin constructed waterway (Gungaderra Creek) | ✓ | | | |
| 42 | Knoke Avenue constructed waterway, Gordon | | ✓ | ✓ | ✓ |

In general, swale and waterway systems would also benefit from updated design standards and specifications which address the water quality treatment role of swales and waterways as well as their conveyance function, and design guidance on:

- designing to maximise stormwater treatment performance
- designing systems to avoid scour and erosion (to replace prescriptive requirements)
- vegetation selection and establishment
- designing habitat features such as pools and riffles.

Melbourne Water's *Constructed Waterways in Urban Developments Guidelines* (2009) provide a good starting point – much of the advice therein is relevant to the ACT.

## 5.4 Bioretention systems and rain gardens

Bioretention systems and rain gardens have become popular as a stormwater treatment measure elsewhere in Australia over the last decade. They are sometimes preferred over wetlands because:

- they can achieve the same nutrient removal in a smaller footprint
- they are better suited to steep sites, where it can be difficult to accommodate a large water body
- they can be scaled up or down, from extensive basins to individual tree pits
- in general, when well designed and established, they are low maintenance systems.

Since the ACT WSUD Code (2009) set mandatory pollutant load reduction targets for new development, some bioretention systems have been constructed in the ACT. Some of the systems at Forde were constructed around five years ago and most of the systems at Crace have been constructed within the last 2-3 years. Bioretention systems can be used on their own or in a treatment train to meet the WSUD Code targets.

Note that the terms "bioretention system" and "rain garden" are essentially interchangeable. However, in keeping with general use in the ACT, we have referred to the streetscape systems as rain gardens and the larger basin at Crace as a bioretention system.

The bioretention systems and rain gardens reviewed in this project are listed in Table 21Table 13. These are mainly streetscape systems and all of them are located at Crace and Forde.

***Table 21: Bioretention systems and raingardens reviewed in this project***

| Asset number | Name | Type of system | Surface area (each rain garden) ($m^2$) |
|---|---|---|---|
| 1a | Bioretention basin off Medhurst Crescent, Crace | Larger basin with saturated zone | 775 |
| 2 | Abena Avenue, Crace | 16 streetscape rain gardens | 30-75 |

| Asset number | Name | Type of system | Surface area (each rain garden) ($m^2$) |
|---|---|---|---|
| 3 | Ultimo Street, Crace | 6 streetscape rain gardens | 30-55 |
| 4 | Digby Circuit, Crace | 7 streetscape rain gardens | 6 |
| 5 | Langtree Crescent, Crace | 31 streetscape rain gardens | 6 |
| 7 | Turbayne Crescent, Forde | 3 streetscape rain gardens | 9 |
| 8 | Zakharov Avenue, Forde | 61 streetscape rain gardens | 4 |

#### 5.4.1 Appropriateness

A question has been raised over whether bioretention systems are at all appropriate in the ACT, due to the fine dispersive nature of the local soils. This is a valid concern given that many bioretention systems have become clogged with fine sediment within a few years of their construction.

However, it is important to distinguish between construction-phase and long-term sediment loads. During the construction phase (both estate construction and building on private lots), sediment loads are high and a bioretention system is *not* an appropriate treatment system at this stage. This is the case all over Australia, regardless of the soil type and regardless of how effective local erosion and sediment control practices may be. Even with the best measures in place, sediment loads are still significantly higher than the long term and bioretention systems are easily smothered.

In a relatively stable catchment (e.g. once 90-95% of house construction is complete), bioretention systems can be used successfully in any soil environment. There are many examples around Australia where they are used in similar soil environments to the ACT – for example western Sydney's soils are fine dispersive clays, similar to the ACT.

A second issue with bioretention systems in the ACT is whether they are appropriate from a maintenance perspective, given the current limitations in the maintenance budget and capacity of maintenance staff. TAMS have reported that they have serious issues with bioretention systems, including that:

- They have not been provided with adequate training or information on how to maintain them.
- They do not have capacity to undertake the routine maintenance activities required (e.g. hand weeding is recommended in bioretention systems to minimise the impact of herbicides on downstream waterways, however it appears that hand weeding is generally not practiced at all by the Parks and City Services group).
- There is a belief that the whole filter and all of the vegetation within it (including street trees in many systems) will need to be replaced in approximately 10 years, at significant cost and with a significant impact on the streetscape.
- The use of streetscape rain gardens creates a very large number of small systems that require maintenance, which is potentially an inefficient solution with high maintenance costs.

We believe that at present TAMS are not maintaining any rain gardens in the ACT. This is a serious issue which needs to be resolved before any new rain gardens are constructed. This also means that many of the rain gardens we have seen in this review have not been maintained for several years.

A third key question is whether street trees are appropriate in bioretention systems. Generally in the ACT, street trees are relatively unconfined in wide verges, and are able to grow to a significant size. However a (lined) bioretention system effectively confines a street tree to a small pit with a relatively shallow depth.

As discussed below, our review has also found that the bioretention systems constructed to date have some serious design and construction issues. All of this means that there have been insufficient opportunities in the

ACT to test a well-designed and well-established bioretention system operating under an appropriate maintenance regime.

### 5.4.2 Objectives

It is reasonably clear that all of the bioretention systems in this review have been intended to provide stormwater treatment. They have probably been included in estate designs to meet the stormwater quality treatment targets in the WSUD Code (2009). However bioretention systems are also designed for landscape and amenity outcomes, and they can also provide habitat and biodiversity value. At Crace, interpretive signage at the large bioretention basin provides a simple opportunity for community engagement and education.

### 5.4.3 What performance issues are occurring?

There is currently no known stormwater quality monitoring data available for bioretention systems. At this stage it is therefore impossible to fully assess the performance of bioretention systems as stormwater quality treatment systems in the ACT.

However, our review has allowed us to observe the performance of bioretention systems at a "macro" scale. We have been able to see how stormwater physically interacts with these systems and make a broad assessment of their function. Key observations common to many of the streetscape systems have been:

- The design of stormwater drainage systems (including both lot drainage and streetscape drainage) does not appear to have been well-integrated with the design of bioretention systems. Many systems have little or no contributing catchment area.
- Typically there is a minimal (or sometimes no) drop from the gutter to the filter surface. This makes it hard for any water to enter the bioretention system and means that there is limited capacity for extended detention. Therefore, very little stormwater can be treated in most of the streetscape systems.
- Even where there is some drop from the gutter to the filter surface, many systems have poorly designed inlets, which block easily.
- While most of the trees in bioretention systems appear healthy, understorey vegetation establishment is mixed. There are probably numerous reasons for this, including:
    - poor establishment before handover
    - lack of maintenance since handover
    - lack of stormwater entering the system, which leaves vegetation in drier conditions than intended
    - species selection has probably been an important factor – it appears that some species have thrived while others have struggled.
- While most systems were relatively weed-free, some had significant weeds. This is possibly due to the limited maintenance they have received as well as poor establishment of native vegetation, which has allowed weeds to colonise the system.
- Some systems (particularly at Crace) have been severely damaged by construction-stage sediment loads, dumping of construction waste and physical construction impacts. However, it is important to note that this was not the norm and most of the systems we looked at appeared to have been well-protected from construction-stage damage.
- Some systems (particularly at Forde) had significant quantities of residential waste (e.g. grass clippings and other garden waste) dumped within them.

In most cases, despite the lack of maintenance, streetscape bioretention systems were in reasonable condition. However, this may be due in part to the fact that they are not actually treating significant stormwater flows, therefore they are somewhat protected from sediment loads, weed propagules, litter, etc.

#### 5.4.4 Why are these performance issues occurring?

There are key issues arising at many stages in the life cycle of bioretention systems in the ACT, however many issues are arising at the design stage. Most of the bioretention systems included in this review have fundamental design flaws, including the following common problems:

- No, or insufficient, allowance for extended detention
- poor inlet design (inlets which block easily)
- poor under-drainage design. Some systems lack a drainage layer. Many include filter socks on the drainage pipe, many lack flushing points or no detail was provided on how to finish flushing points appropriately.

There are good quality detailed design guidelines, typical drawings and standards available for bioretention systems elsewhere in Australia. Design guidance on these key hydraulic design details (extended detention, inlets and outlets) would be directly transferrable to the ACT, and therefore these issues should not be occurring at the design stage. There are some other potential design issues which are more locally-specific and require further review (once we've had a better chance to review design drawings and other documentation) including species selection and filter media specification.

After the design stage, other factors are compounding performance issues, such as:

- During establishment, poor staging has allowed some systems to be impacted by construction stage sediment loads and other damage.
- During asset handover, systems with significant design and construction issues appear to have been approved – the large bioretention system at Crace is a good example.
- During operation, some residents have dumped waste in bioretention systems, suggesting that they do not understand these systems.
- Maintenance has been completely lacking.

The large number of issues with bioretention systems is partially related to the fact that the local design standards and specifications do not cover bioretention systems, and specialist knowledge and experience may be limited in local developers. A related issue is that there is limited capacity within the ACT government to assess the appropriateness of bioretention system designs and constructed outcomes.

The breakdown the in maintenance of bioretention systems and rain gardens is a fundamental problem that needs to be addressed before more bioretention systems are built in the ACT. Well-designed bioretention systems are low-maintenance systems. However, a poorly designed, poorly constructed or poorly established bioretention system can quickly deteriorate into a maintenance problem. This has occurred in several cases (the Crace bioretention basin is a good example) and could be one of the key reasons why there has been a strong reaction from maintenance staff.

#### 5.4.5 Opportunities to improve performance

Before any new bioretention systems are constructed or substantial modifications are undertaken to existing systems, bioretention system maintenance needs to be given more consideration in the ACT context. Bioretention system design needs to take into account the capacity, skills and resources of local maintenance staff. This might mean locally-specific design features to make systems easy to maintain with existing equipment and using common existing maintenance practices. Appropriate guidance and training is required to equip staff with the necessary knowledge and skills to successfully maintain bioretention systems.

Due to the large number of small systems, streetscape rain gardens do have higher maintenance requirements than other stormwater treatment systems. In the context of a very limited maintenance budget, they may not be a particularly appropriate option in the ACT – at least in the short term. The question of trees in bioretention systems also needs more thought in terms of long-term maintenance requirements. While tree replacement is unlikely to be required after 10 years, it is an issue that may come up within 20-30 years, i.e. sooner than a street tree may otherwise be replaced.

Larger bioretention basins are more likely to be appropriate in the short-term, however there are still fundamental maintenance questions which need to be addressed. All bioretention systems require weeding, and this is best achieved by hand. If done regularly, this is not a large task, however if weeds go unchecked for a significant length of time, this can quickly become a very significant task. For example, in another recent rain garden review project, landscape maintenance staff at Marrickville Council reported that if they weeded bioretention systems each month, the task was small, however if they left systems much longer, it quickly grew into a significant effort. If ACT Government staff are unable to undertake hand-weeding then alternative maintenance pathways need to be considered and appropriately resourced.

Bioretention systems would benefit from:

- new locally-appropriate design standards and specifications
- training for local industry and government staff involved at all stages of the life cycle
- more careful scrutiny at DA, design review and asset acceptance stages
- in new estates, changes to construction staging and asset handover practices would be beneficial so that bioretention system can be built out later in the process, after house-building is complete
- education of local residents both to prevent issues of dumping in rain gardens and also so that residents can potentially play a role in simple maintenance tasks such as hand weeding and clearing inlets (a trial could be instituted at Forde and/or Crace).

In terms of the specific systems reviewed in this project, there are a few options available. Most of the streetscape systems, despite the fact that they don't treat much stormwater, are stable and reasonably well vegetated, and could be **maintained** as they are without causing negative impacts. **Renewal** is recommended for selected systems which have been impacted by construction-stage sediment, dumping, or similar issues, or in cases where understorey vegetation and/or street trees are absent or in poor health. Sediment and waste should be removed and vegetation should be replanted. However, this would not restore treatment performance to systems with no extended detention, poor inlet design, etc.

If there is a desire to improve the treatment performance of the streetscape rain gardens, **rectification** works would be required. The following options are recommended for further consideration:

- Minor works could be undertaken to address inlet design limitations and provide extended detention in systems where it is lacking. These works could be undertaken around existing trees, involving simply reducing surface levels and replanting understorey vegetation.
- A more substantial rebuild (essentially a full replacement of the existing rain garden) to address issues with under-drainage would require tree replacement, which is unlikely to be palatable at many sites in the short-term. This option may be more appropriate sometime in the future when street trees need replacing.

As discussed in the individual site reports, we would recommend further investigations and trialling of rectification methods before any large-scale rollout.

The large bioretention basin at Crace could be rectified in line with its current design, but could also benefit from some **redesign** to allow improved maintenance access and provide better pre-treatment. Modification to the flow regime should also be explored and this system could also benefit from the **retrofit** of additional treatment measures to pre-treat stormwater in the catchment upstream.

A summary of the options recommended for further investigation is included in Table 22.

***Table 22: Bioretention system and rain garden options for further investigation***

| Asset number | Name | Potential options | | | | |
|---|---|---|---|---|---|---|
| | | Maintain | Renew (selected systems) | Rectify | Redesign | Retrofit |
| 1a | Bioretention basin off Medhurst Crescent, Crace | | | ✓ | ✓ | ✓ |
| 2 | Abena Avenue, Crace | ✓ | | ✓ | | |
| 3 | Ultimo Street, Crace | ✓ | | ✓ | | |
| 4 | Digby Circuit, Crace | ✓ | ✓ | ✓ | | |
| 5 | Langtree Crescent, Crace | ✓ | ✓ | ✓ | | |
| 7 | Turbayne Crescent, Forde | ✓ | | ✓ | | |
| 8 | Zakharov Avenue, Forde | ✓ | ✓ | ✓ | | ✓ |

## 5.5 GPTs

Gross pollutant traps (GPTs) have been used in the ACT since the 1970s. The ACT has a well-established set of design standards for GPTs, which require GPTs to be constructed downstream of all catchments greater than 8 ha that discharge into ponds, urban lakes and receiving waterways.

The ACT design standards for GPTs define “Major” and “Minor” GPTs. Both are concrete basins with a fixed trash rack at the downstream end of the basin. Essentially the Minor GPT is a system designed for a pipe/culvert inlet, while the Major GPT is a system designed for an open channel inlet. Major and Minor GPTs are both designed to site-specific dimensions based on the catchment area, degree of urbanisation, estimated peak flows and pipe/channel dimensions.

In recent years, proprietary GPTs have also been used in the ACT, particularly in greenfield developments.

The GPTs reviewed in this project are listed in Table 23. Note that in addition to the GPTs in Table 23, we have also seen a large number of GPTs connected to other assets such as lakes, ponds and wetlands.

***Table 23: GPTs reviewed in this project***

| Asset number | Name | Type |
|---|---|---|
| 28 | GPT at Barry Drive & Watson Street, Turner | Typical Major GPT |
| 29 | GPT at Flemington Road, Mitchell | Typical Major GPT |
| 30 | GPT Wentworth Ave, Kingston | Proprietary (CDS unit) |
| 31 | GPT at Catchpole Street, Macquarie | Typical Major GPT |
| 32 | GPT at Ibbott Lane, Belconnen | Typical Minor GPT |
| 33 | GPT at Bonner Pond | Typical Major GPT |
| 35 | McCulloch Street trash rack, Curtin | Trash rack on open channel |
| 36 | GPT at De Little Circuit Greenway (Lake Tuggeranong) | Typical Minor GPT |
| 37 | GPT at Athllon Drive, Greenway (Lake Tuggeranong) | Typical Major GPT |
| 38 | GPT at Isabella Pond | Typical Major GPT |

### 5.5.1 Appropriateness

GPTs have been used in the ACT since the 1970s and have proven to be effective for removing the following types of pollutants from stormwater:

- gross pollutants, including anthropogenic litter, leaves and other organic matter transported in stormwater
- coarse suspended solids.

This is supported by GPT cleanout data, which shows that significant quantities of these materials are removed from GPTs. The ACT Major and Minor GPT designs include trash racks which are generally effective for trapping floating gross pollutants, and a concrete basin with a permanent pool, which collects coarse suspended solids and other material which settles easily.

It is often assumed that in trapping suspended solids, GPTs will also trap other particulate matter and pollutants which tend to bind to suspended solids, including phosphorus, trace metals, oil and grease and bacteria. However, we have not seen any information to indicate how effective the Major and Minor GPTs in the ACT are at trapping this material.

Note that the design standards for GPTs suggest that they are designed to trap particles down to 0.04 mm in size – i.e. a coarse silt. However, such fine particles have slow settling velocities. Under ideal conditions (i.e. plug flow with no turbulence), a 0.04 mm particle would have a settling velocity of approximately 1 mm/second (Water by Design Technical Design Guidelines – Chapter 4 Sediment Basins, 2006). Our observations of the Major/Minor GPTs in minor rain events showed that water moved through these systems quickly; the typical residence time in most systems would have been less than 1 minute. In this time, a 0.04 mm particle would settle only 60 mm under ideal conditions (and conditions were generally far from ideal). Note that a coarse sand with a particle size of 1 mm has an ideal settling velocity of 100 mm/s and therefore would settle 6 m in 1 minute (ideal conditions), allowing significant quantities to be trapped in a typical GPT, even under non-ideal conditions.

The assumption that GPTs remove pollutants, such as phosphorus, trace metals, oil, grease and bacteria, hinges on the ability of the system to remove *fine* suspended solids, as these pollutants are generally connected with fine particulate matter. Therefore, if GPTs are not able to remove fine suspended solids then they are unlikely to remove significant quantities of these other pollutants.

Information (e.g. laboratory analysis of sediment samples) on the particle size distribution and quality of sediments removed from GPTs would help to confirm exactly what existing GPTs are removing in terms of fine particulate matter and other pollutants. Established empirical relationships (e.g. the Water by Design Technical Design Guidelines 2006 recommends a modified version of the Fair and Geyer equation) can also be used to estimate the fraction of target sediments removed in sediment basins.

A key concern which has been raised numerous times regarding GPTs in the ACT is that in between cleanouts, accumulated organic matter decomposes anaerobically in the permanent pool. This is supported by common complaints of unpleasant odours from GPTs. We also observed on site at a number of GPTs that at the start of a rain event, as water began to flush through the GPT, the water emerging on the downstream side had a distinct odour of anaerobic decomposition.

When organic matter decomposes in GPTs, nutrients are released into the water column and become bio-available. The effective nutrient load to downstream systems can therefore be increased. Therefore there is a key question over whether the current GPT designs are the most appropriate for the ACT.

A second key question over the appropriateness of GPTs is their location within the catchment. Most of the older GPTs are located towards the downstream end of the catchment – for example the Sullivan's Creek GPT at Barry Drive, Turner. The GPTs were originally designed to be the only stormwater treatment measure in the catchment. However older catchments such as Sullivan's Creek are now being retrofit with stormwater quality treatment systems within the catchment, and these systems require gross pollutant and coarse sediment management further upstream. As the ACT's stormwater management objectives have changed, new urban areas have also been designed with more comprehensive stormwater treatment trains which include stormwater treatment further up in the catchment, closer to its source. In this context, large GPTs at the downstream end of the catchment may no longer be the most effective means to capture gross pollutants and coarse suspended solids.

### 5.5.2 Objectives

GPTs are generally used as a primary step in a treatment train, to reduce loads on downstream stormwater treatment systems such as ponds, wetlands and bioretention basins. As discussed above, they are appropriate for removing gross pollutants and coarse suspended solids, but in most cases they do not remove significant quantities of other pollutants. In the context of the ACT:

- Anthropogenic litter is typically a key stormwater pollutant in commercial and industrial areas, but litter loads tend to be low in residential areas. Our observations of GPTs in the ACT suggest that residential litter loads are generally very low (the key exception is during the house-building phase in greenfield areas, when there are notable litter issues). Anthropogenic litter includes floating, settleable and neutrally buoyant materials, and each of these can be targeted in GPTs.

- Organic matter (e.g. leaves, grass clippings and other organic debris) is an important stormwater pollutant in the ACT, due to the prevalence of trees and mown grass in both the public and private domain. Organic matter is also a key pollutant which impacts on water quality in lakes and ponds, due to its ability to release nutrients as it breaks down.

- Coarse suspended solids are present, however in general the soils in the ACT are fine-grained clays and therefore these are also a key stormwater pollutant.

Maintenance is a key consideration in GPT design, as there is an inherent tension in GPT design between the pollutant trapping efficiency and the required maintenance effort. Currently, a large proportion of the ACT's budget for maintaining stormwater treatment systems is spent on cleaning out GPTs. Even with this focus on GPTs, the budget is stretched and many GPTs are not cleaned as often as they should be. Therefore, any proposed changes to GPT design need to carefully consider the maintenance burden.

### 5.5.3 What performance issues are occurring?

There are a wide range of performance issues we have observed in GPTs. Key findings can be summarised in terms of the Major/Minor and proprietary GPTs.

Major/Minor GPTs are:

- Generally trapping small quantities of anthropogenic pollutants, as many are located on predominantly residential catchments with low litter loads. However, even with low litter loads, many allow floating litter to wash out easily when water overtops the trash rack. They also allow fine floating material to pass through the trash rack.

- Generally trapping significant quantities of organic matter, however due to the presence of a permanent pool, this material is decomposing anaerobically and likely to be releasing nutrients into downstream waterways. Due to the relatively low frequency of cleanouts, significant decomposition and nutrient release is likely to occur between cleanouts.

- Generally trapping significant quantities coarse suspended solids but unable to trap any significant quantity of fine suspended solids (see discussion above).

- Generally easy to maintain (with some key exceptions), as the ACT Government's stormwater maintenance contractor is well equipped for these systems, however they are becoming increasingly expensive to maintain, as tipping fees have recently increased for the material removed. TAMS reported that they used to dispose of the sediments removed from GPTs to a local recycler for $25/tonne, however the EPA has recently ruled that the material needs to be disposed to an approved landfill as general solid waste, at $189/tonne. This has substantially increased cleanout costs.

- Causing some issues in terms of local amenity – particularly where residential or other development has occurred in close proximity to GPTs or where they are located in high-use open space. These GPTs are unattractive and can be smelly. Maintenance methods also rely on using large drying areas to dewater pollutants removed from the GPT.

Proprietary GPTs are:

- Typically not being maintained frequently enough to perform as they should. In the worst cases, this means that they have completely failed. Others may work for a few storm events after a cleanout, before they are completely full and operating in bypass mode.

- Often difficult for the ACT Government's stormwater contractor to maintain, as they are not well equipped to deal with the range of systems being installed, and have not had the opportunity for adequate training. Some GPTs also have specific access or other issues.

### 5.5.4 Why are these performance issues occurring?

Again it is easiest to understand performance issues in the context of the Major/Minor and proprietary GPTs.

Major/Minor GPTs have been designed for the ACT and used successfully for many years. However, their key issues come down to the designs themselves. These GPTs are generally easy to maintain and suit the stormwater management paradigm of the 1970s and '80s but the following issues have emerged more recently:

- The strategy for location of GPTs at the downstream end of large catchments is no longer entirely appropriate in the context of current stormwater treatment objectives, which require a more substantial treatment train and generally means that stormwater treatment commences closer to the source.

- As these GPTs are located online, they are prone to larger events washing out the pollutants trapped in smaller events.

- The trash rack is simple and robust, but not particularly effective for capturing smaller floating material. Many of the trash racks also clog easily, so they overtop quickly. Once overtopped, the trash rack is ineffective for trapping floating material.

- The designs do not take into account the potential problems associated with anaerobic decomposition of organic matter in a permanent wet sump.

- The designs are not appropriate in close proximity to development or high-use open space.

Proprietary GPTs have a range of more complex issues which impact on their performance, including:

- The ACT's design standards do not provide a clear pathway to select or size an appropriate proprietary GPT, so there is a lack of guidance to developers, DA assessment or asset acceptance staff (however we understand that these standards are currently being reviewed).

- The preference of developers is generally for proprietary GPTs which suggest (on paper) a high pollutant removal performance. This could help to demonstrate compliance with the WSUD Code targets. Developers also typically prefer underground units which are out of sight. However, maintenance is not a significant consideration in their selection process, as they will only be responsible for maintenance for a short period prior to asset handover.

- GPTs are often installed before construction is complete in the upstream catchment. While the Major/Minor systems are relatively robust in this situation, some proprietary GPTs are easily damaged by construction-stage pollutant loads. An example was mentioned in interviews where cement waste washed into an underground GPT and solidified. Large debris can also damage some GPTs.

- Asset handover processes are failing to effectively identify GPTs and hand them over to maintenance staff (let alone providing appropriate documentation or training). Maintenance staff report that they normally find out about new GPTs when out in the field or when they receive an odour complaint. This means that when new GPTs are cleaned for the first time, they are often in a state of considerable disrepair.

- While the expectation in the ACT is that GPTs will be cleaned out biannually, many proprietary GPTs require much more frequent maintenance in order to function effectively. Under a biannual cleaning regime, some proprietary GPTs are prone to complete failure and irreversible damage; others may simply perform well below expectations.

#### 5.5.5 Opportunities to improve performance

A key issue with GPTs is the maintenance burden, and the balance between pollutant removal performance and maintenance. Measures to improve pollutant trapping efficiency are pointless unless there is capacity to clean out the additional material which is trapped.

Therefore our review has focused to date on the following types of opportunities:

- **"Quick fixes"** which could improve the ease of maintenance without substantially changing the pollutant removal performance (e.g. removing the basket from the Wentworth Avenue CDS unit and installing new covers at De Little Circuit, which can easily be removed by hand).

- Minor **rectification** works which could improve the pollutant removal performance without substantially changing the maintenance burden (e.g. increasing the length or area of a trash rack so that it blocks less easily and traps more pollutants).

- More substantial **redesign** options where there are opportunities to substantially improve performance or ease of maintenance (e.g. installing a high flow bypass or separating a system into multiple cells).

- At selected sites, older GPTs could be considered for **removal**, if replaced by GPTs further upstream in the catchment.

A summary of the options recommended for further investigation is included in Table 24.

***Table 24: GPT options for further investigation***

| Asset number | Name | Potential options | | |
|---|---|---|---|---|
| | | Quick fix | Rectification | Redesign |
| 28 | GPT at Barry Drive & Watson Street, Turner | | ✓ | ✓ |
| 29 | GPT at Flemington Road, Mitchell | ✓ | ✓ | |
| 30 | GPT Wentworth Ave, Kingston | ✓ | ✓ | |
| 31 | GPT at Catchpole Street, Macquarie | | ✓ | |
| 32 | GPT at Ibbott Lane, Belconnen | ✓ | ✓ | |
| 33 | GPT at Bonner Pond | ✓ | ✓ | |
| 35 | McCulloch Street trash rack, Curtin | | ✓ | ✓ |
| 36 | GPT at De Little Circuit Greenway (Lake Tuggeranong) | ✓ | ✓ | |
| 37 | GPT at Athllon Drive, Greenway (Lake Tuggeranong) | ✓ | ✓ | |
| 38 | GPT at Isabella Pond | | ✓ | ✓ |

Some broader actions could also improve the performance of new GPTs, including:

- revising the design standards to provide better guidance around proprietary GPTs (we understand that this is underway)
- in greenfield areas, most GPTs should be offline during the construction stage
- improving asset handover processes including O&M manuals and training (where required)
- considering the use of telemetry to monitor major GPTs and identify when they need cleaning
- revisiting the possibility of recycling material removed from GPTs in order to reduce disposal costs and free up budget for additional maintenance (we understand that a trial has been proposed).

# 6 Initial recommendations

During Stage 1 of this project we have looked at existing assets through a number of lenses to understand their stormwater treatment performance in the context of their stormwater treatment and other objectives, history, physical context and organisational context.

## 6.1 Organisational reforms

In Section 4 we presented our analysis of the key issues affecting the performance of stormwater treatment systems in the ACT. In this section we focused on the organisational issues which affect all stormwater treatment systems. Table 25 summarises the key findings from Section 4 and indicates:

- Issues which are currently being addressed (or where actions are planned to begin addressing the issue). Many of these actions have arisen from the recent WSUD Code Review (2014).
- Issues which the Basin Priority Project can potentially help address.
- Issues which present potential risks to the Basin Priority Project, in terms of its ability to deliver cost-effective, functional stormwater treatment infrastructure that achieves relevant stormwater treatment objectives in the long term.

Table 25 highlights that there are a large number of issues which are currently affecting the performance of stormwater treatment systems in the ACT. The actions arising from the WSUD Code Review (2014) begin to address some of these issues, with a focus on the legislative and regulatory issues, but also some actions relevant to the design, establishment, asset handover and operations and maintenance stages. The key remaining gap is the planning stage.

There are good opportunities for the Basin Priority Project to help address some of the issues identified in Table 25. This could evolve as the project takes shape, however at this stage we can see clear opportunities for the Basin Priority Project to provide the following:

- The proposed Business Case has the potential to provide useful input into investigations into alternative management and funding models, by developing an economic model for stormwater treatment in the ACT, which can be adapted for broader use.
- The ACT Basin Priority Project is an opportunity to create demonstration projects showcasing best practice stormwater treatment systems designed to suit local conditions. This would support written WSUD guidelines being developed to accompany the WSUD Code.
- The Basin Priority Project is particularly well structured to address gaps in strategic catchment planning. Ultimately, the six priority catchments should serve as best practice examples of strategic catchment planning. The current project is reviewing assets in the context of their role in the treatment train and multiple other objectives and will provide a strategic framework which can be applied across the ACT.
- The current project has an important role addressing the challenges at the operation and maintenance stage. The database of life cycle cost will be a valuable input to understand, plan and manage this stage, while the project is also filling a key gap in monitoring and review. Methods and systems developed in this project can be used for future monitoring and review.

Other issues have been identified in Table 25 that are key risks that need to be managed in the implementation of the ACT Basin Priority Project. These are concentrated in the design, construction, establishment and asset handover processes. More work will be required here to better define these risks and develop a plan to manage them in phase 2 of the ACT Basin Priority Project.

*Table 25: Summary of key findings and implications for the Basin Priority Project*

| | Issues | Implications | Potential solutions | Actions planned or underway | Implications for the Basin Priority Project |
|---|---|---|---|---|---|
| Legislative and regulatory | Mismatch between WSUD Code objectives and targets and capacity for long-term operation and maintenance | Assets are being constructed which cannot be maintained in working order; actual outcomes in the field are falling short of relevant objectives | Review of objectives and targets and/or better resourcing of operation and maintenance | WSUD Code Review Priority Project 2: Alternative management and funding models | Potential input into management and funding models through Business Case |
| | Tension between flexibility/innovation and predictability/practical maintenance outcomes | A wide range of stormwater treatment systems are handed over to government in varying states | Update design standards, asset review and acceptance processes and other relevant systems to improve predictability and practicality, while retaining flexibility at the Code level | WSUD Code Review Priority Project 1: Code restructure and revision; Project 5: Design Standards; and Project 8: WSUD asset management transfer | Opportunity to create demonstration projects to support written guidelines |
| | Lack of enforcement of erosion and sediment control practices on development sites | Significant sediment loads swamping stormwater treatment systems which were not designed as construction-stage sediment controls | Regulatory reform and/or improved construction staging | WSUD Code Review Priority Project 7: Erosion and sediment control | Key risk to be managed |
| Strategic catchment planning | Lack of catchment and treatment train information | Difficult to understand physical context of each asset | Improved spatial information | | Six priority catchments should serve as examples of strategic catchment planning |
| | Lack of catchment scale analysis | | Catchment-scale analysis should be a key outcome of the “priority catchments” element of the Basin Priority Project, which can then be translated to other (non-priority) catchments | | |
| | Poor linkages between receiving water values and stormwater treatment objectives | Treatment system design is generic and does not take into account catchment-specific issues | Stormwater treatment targets based on downstream receiving waters | | |
| | No clear framework for determining stormwater treatment objectives for retrofit projects | Retrofit projects have been designed for a wide range of objectives, not all of which are clear | Clear stormwater treatment targets for every catchment in the ACT | | |
| | Older infrastructure sometimes no longer appropriate in treatment train context | Some of the older systems are performing poorly or simply failing to meet contemporary objectives | Treatment trains in evolving catchments need strategic re-design to meet new stormwater management objectives | | Current project will review assets in the context of their role in the treatment train and multiple other |
| | Newer suburbs have overly complex treatment trains which include | Inefficient investment in infrastructure | Catchment-scale analysis should drive infrastructure planning based on treatment | | |

| | Issues | Implications | Potential solutions | Actions planned or underway | Implications for the Basin Priority Project |
|---|---|---|---|---|---|
| | redundant systems | | train principles | | objectives and provide a framework which can be applied across the ACT |
| | Multi-purpose assets have competing objectives | "Performance" is difficult to define. Different stakeholders have different views on what a well-performing system should look like | Clarify the multiple roles and objectives of stormwater assets | | |
| Design | Lack of capacity in industry | Systems are poorly designed and fail to perform at their full potential | Local design guidance<br>Local training and other capacity building<br>Re-design, rectification and renewal of existing assets | | Key risk to be managed |
| | Lack of capacity in government | Design issues are not picked up at key review stages | | | Key risk to be managed |
| | Outdated Design Standards and Specifications | Varying quality in designs; problematic issues are repeated | New design standards and specifications for new types of treatment systems | WSUD Code Review Priority Project 5: Design Standards | Key risk to be managed |
| | Poor integration within design teams | Stormwater, landscape and ecological outcomes suffer | Restructure contracts to encourage an integrated approach | | Key risk to be managed |
| | Poor co-ordination between design teams | Stormwater treatment systems are poorly integrated into the landscape and with other systems | | | Key risk to be managed |
| | Design outputs are of a poor standard | Construction outcomes are poor and there is limited recourse to demand higher standards of the construction contractor | Design standards and specifications should set the bar at a higher level | | Key risk to be managed |
| Construction | Poor staging of stormwater treatment system construction in new estates | Systems overloaded with construction-stage sediment loads | Adopt appropriate staging techniques based on experience elsewhere (e.g. Water by Design's *Construction and Establishment Guidelines* 2009) | | Key risk to be managed |
| Establishment | Poor establishment at handover | Poor treatment outcomes if vegetation fails to establish<br>Higher maintenance costs if rectification is required | Acknowledge establishment as a critical phase<br>Adopt best practice guidelines (existing guidelines such as Water by Design's *Construction and Establishment Guidelines* 2009)<br>Allocate appropriate funding to establishment<br>Include establishment in contracts | WSUD Code Review Priority Project 8: WSUD asset management transfer | Key risk to be managed |

| | Issues | Implications | Potential solutions | Actions planned or underway | Implications for the Basin Priority Project |
|---|---|---|---|---|---|
| Asset handover | Inconsistency and gaps in internal asset handover processes | Stormwater quality outcomes could change significantly between DA and asset acceptance, and this wouldn't be picked up in the process<br>Potential maintenance issues are not picked up until handover is complete<br>Poor concepts, designs and constructed outcomes can be approved at each stage of the process | Review and improve asset handover processes from the DA stage to asset acceptance | WSUD Code Review Priority Project 8: WSUD asset management transfer | Key risk to be managed |
| | Lack of capacity for meaningful review | Key issues can easily be missed during approval process | Improve guidelines and tools<br>Build internal capacity | | Key risk to be managed |
| Operation and maintenance | Inadequate funding for operations and maintenance stage | Poor performance of existing assets<br>Limited opportunity to improve asset management systems or build capacity | New funding model<br>Investment is required into systems and capacity-building as well as O&M workload itself | WSUD Code Review Priority Project 2: Alternative management and funding models | Better identification of life cycle costs (this project) |
| | No routine monitoring or review | Poorly functioning assets go undetected<br>Investment in infrastructure is not translating into anticipated water quality outcomes | Investment is also required into monitoring and review (which the Basin Priority Project is partially addressing in the short-term) | WSUD Code Review Priority Project 6: Modelling and monitoring | Focus of the current project |

## 6.2 Physical works

Table 25 focused on the organisational issues affecting stormwater treatment systems in the ACT and strategic opportunities to improve the way in which future stormwater treatment infrastructure is planned, designed, constructed and operated. However, this Stage 1 report has also drilled down to more detailed information about specific types of stormwater treatment systems. This was presented in Section 5.

Table 26 summarises our initial stormwater treatment performance assessment in general terms. When we looked at individual assets we saw wide variation in stormwater treatment outcomes, and this leads to a wide range of options for the future management of these assets.

In general, we have recommended the following types of options for each asset:

- **Maintenance**: where systems are functioning effectively, they should be maintained as they are. Where systems are causing no negative water quality impacts and are meeting their other objectives, they could be maintained as they are.

- **Renewal**: this option would involve keeping the system as-is, but restoring its condition – for example by cleaning out accumulated sediment or re-establishing vegetation which has failed. This option would be suitable for some of the systems which have been affected by construction-stage sediment loads. It could also be a reasonable option for some of the older ponds which have accumulated significant sediment loads over time, and a cleanout could reduce the occurrence of in-pond water quality issues.

- **Rectification**: some systems are generally well designed, but the poor design of a key feature has an impact on treatment performance and/or ease of maintenance. Examples are diversion structures which block and bypass too easily and GPTs with specific maintenance issues.

- **Redesign**: this would involve more substantial changes to existing systems, though redesign could encompass wide-ranging measures with wide-ranging costs and benefits. There may not be an appetite for significant redesign of newer systems. However this could be an attractive option for older systems, particularly those with significant performance issues.

- **Retrofit**: in many cases, existing treatment systems would benefit from additional pre-treatment in their upstream catchments. We have referred to this as "retrofitting" additional treatment in the catchment.

- **Removal** may be an option for a limited number of systems which prove to be the wrong type of system in the wrong location, and where there are no other benefits (e.g. landscape, habitat) to retaining the system.

During Stage 2 and 3 of the project we will develop all of these options further on a site-by-site basis. Stage 2 will include a quantitative assessment of stormwater treatment system performance and the identification of specific options for physical works to improve performance of each asset.

*Table 26: Summary of performance of existing stormwater treatment systems*

| Treatment system type | Initial summary assessment of water quality performance | | | |
|---|---|---|---|---|
| | **Some negative impacts on water quality** | **No or minimal effect on water quality** | **Some water quality benefit** | **Performing well** |
| Large ponds and lakes | Some have in-pond water quality issues which occur intermittently (e.g. Isabella Pond, Point Hut Pond). | Online systems such as Giralang and Lyneham ponds are significantly undersized and provide minimal treatment. The diversion structure at Dickson functions poorly. | Large online ponds and lakes reduce sediment loads (e.g. Coombs Ponds are currently filling this role), but nutrient removal is limited, particularly in systems prone to re-release of pollutants. | |
| Small ponds and wetlands | | David Street has a poorly functioning diversion structure, so treats very little stormwater. Crace wetland is short-circuiting. Ponds below Point Hut are not water quality treatment systems. | Several systems lack extended detention. Other systems function as recirculating treatment in dry weather, but are ineffective for stormwater treatment (e.g. Norgrove Park, Emu Bank). | |
| Swales and waterways | Systems with bare soils and erosion (e.g. Mabo Boulevard, Plimsoll Drive). | Systems with a low flow pipe or channel (e.g. Medhurst Crescent, Knoke Ave). | Helby Street, Trephina Street, Margaret Tucker Street and Tsoulias Street are treating only very small catchments. | The Franklin waterway is an example which is well vegetated, treats significant flows, is stable, low maintenance and working effectively. |
| Bioretention systems and rain gardens | | Most streetscape rain gardens have no or minimal inflows. | Selected streetscape rai gardens and the bioretention basin at Crace are partially treating some flows. | Selected streetscape rain gardens are functioning well (e.g. some on Abena Ave at Crace and one on Turbayne Crescent at Forde). |
| GPTs | Most GPTs store decomposing organics in anaerobic conditions and release pollutants between cleanouts. | GPTs such as Wentworth Avenue which are typically over-full and operating in bypass mode. | Most GPTs are capturing reasonable quantities of gross pollutants and coarse sediments; however their performance could be improved. | |

## 6.3 Specific recommendations for Stage 2 of this project

Stage 2 will focus on assessing the performance of the stormwater treatment systems at a "functional" level, including quantitative assessment wherever possible. This will include:

- A more detailed review of any quantitative performance information available for each asset (e.g. water quality information, sediment accumulation information, maintenance data, etc).
- Life cycle cost analysis to quantify costs at each stage of an asset's life, using the best available local data.
- Evaluation of benefits, including quantitative pollutant load removal. This will need to rely on modelling and analysis, but wherever possible, we will use monitoring data to validate results. We will aim to quantify for each asset:
    - expected performance (e.g. from original development application)
    - actual performance based on current condition and function
    - potential performance if the system was fully functional.

Stage 2 will also include identification of specific options for poorly performing assets, including maintenance, renewal, rectification, redesign, retrofit and (where appropriate) removal options as outlined above.

The transition from Stage 1 to Stage 2 is a key opportunity for the Project Management Group to have strategic input into the specific scope and direction of Stage 2, based on review of this report and a workshop which we have proposed at this stage.

We would like to use the workshop to discuss the following:

- Key findings of Stage 1 – the people who have been involved in meetings, interviews, field visits and other engagement undertaken to date will appreciate the feedback and involvement in the ongoing development of the project.
- Implications for Stage 2 and 3 of this project, including:
    - Objectives and aspirations for the quantitative performance evaluation component of the project.
    - Objectives and aspirations for the component of the project which will look at physical works to improve existing treatment systems.
    - How to integrate this work with the priority catchments monitoring framework project (recently completed) and ACT-wide monitoring (ongoing), which are also part of the Basin Priority Project. Outputs from these projects could be picked up and integrated into Stage 2 and 3 of this project.
    - Potential to add/remove/change any of the 42 assets included in the project, for example where other systems have been identified as in need of review (potentially in the priority catchments), or where systems included in the project have been identified as having no substantial existing or potential stormwater treatment role.
    - Implications for phase 2 of the Basin Priority Project, including how it might be shaped to address some of the systematic issues with stormwater treatment systems in the ACT (complementing actions already proposed by the WSUD Code review), and key risks for the Basin Priority Project and potential methods to address these risks.

Note that an issue in Stage 1 has been obtaining relevant information on the treatment systems to be reviewed, including concept design reports, detailed design drawings and specifications, operation and maintenance data and previous studies. We are aware of significant additional existing information, but have not yet been able to obtain this for review. This will become more critical in Stage 2 as we move into the quantitative assessment phase.

Key information gaps were summarised in Table 2 and included:

- Design reports (e.g. DA information) for most systems
- Any more information available on the current update to design standards
- Water quality and hydraulic models (where available)
- Construction cost information
- Information from asset register
- Maintenance plans
- Maintenance records (e.g. GPT cleanout data)
- ACT Government water quality monitoring data (raw data)
- Monitoring data from other elements of the Basin Priority Project (6 catchments and ACT-wide)
- Norgrove Park monitoring data/report
- Data on sediment accumulation in ponds, monitored by TAMS
- Any relevant reports, drawings, specifications, cost information on previous rectification works (where relevant)

We will discuss these information needs with the Project Management Group and we are happy to help in whatever way we can to identify, locate and review relevant information.

# 7 Referenced documents


ACT Government (2014) *Water Sensitive Urban Design: Review Report*. 82pp.

ACT Government (2014) *ACT Water Strategy 2014–44: Striking the Balance*. 49pp.

ACT Government (2009) *Waterways: Water Sensitive Urban Design General Code.*

ACT Government (2001) *Canberra's Urban Lakes and Ponds: Plan of Management. 83pp.*

Melbourne Water (2009) *Constructed Waterways in Urban Developments Guidelines. 30pp.*

Water by Design (2006) *Water Sensitive Urban Design Technical Design Guidelines*.

# Attachment A - Individual asset assessment

# Attachment B - Interview notes

# Attachment C - Site inspection notes