Off-site Stormwater Quality Solutions

Discussion Paper

Version 1, August 2014

water by design

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Disclaimer

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Water by Design

Water by Design is a program of Healthy Waterways Ltd. It helps individuals and organisations to sustainably manage urban water. For more information, visit www.waterbydesign.com.au

Healthy Waterways

Healthy Waterways is an independent, not-for-profit organisation working to protect and improve South East Queensland's waterways. Together with our members from government, industry and the community, we have one clear vision to achieve healthy waterways for a healthy economy. Healthy Waterways works to understand and communicate the condition of our waterways to drive and influence future targets, policy and actions. We pride ourselves in providing best practice scientific advice that informs effective and efficient waterway management. For more information, please visit www.healthywaterways.org

Reef Project and RUSMIG

"Collaboration to the Rescue: Better Reef Water Quality through smart urban water management" is a partnership project between Healthy Waterways and the Reef Urban Stormwater Management Improvement Group (RUSMIG). The project will help reduce the impact that pollutants from urban areas have on water quality in the Great Barrier Reef. The project is supported by Healthy Waterways through funding from the Australian Government Reef Programme.

RUSMIG represents the key urban stakeholders in the Reef catchment, including local governments, Regional Natural Resource Management bodies, the Department of Environment and Heritage Protection, and the Great Barrier Reef Marine Park Authority. The principal role of RUSMIG is an information exchange forum to share experiences and knowledge about urban stormwater management and associated topics. The vision of RUSMIG is healthy catchments, waters and aquatic ecosystems.

Executive Summary

Off-site stormwater quality solutions provide a mechanism whereby local governments collect payment from developers in lieu of managing stormwater quality on-site. This money is then used to implement regional stormwater solutions. There is growing interest in off-site solutions in local governments across Queensland and schemes are emerging independent of statewide guidance.

The purpose of this discussion paper is to investigate the merits and risks of off-site solutions. The approach taken included stakeholder interviews to identify key interests and concerns of a range of stakeholders; a review of legislation and how off-site schemes would fit within the current legislative structure; the development of cost abatement curves to determine the most cost effective stormwater pollution abatement measures; and a further cost analysis of several off-site arrangements.

Stakeholders identified a number of reasons for investigating off-site stormwater schemes some of which include determining whether:

- off-site stormwater schemes are a cost effective option
- off-site stormwater schemes will save time
- regional systems are cheaper to maintain than a number of distributed systems.

The lifecycle costs of an end-of-pipe bioretention system and two wetlands scenarios (delivered as off-site projects) have been compared. The life cycle cost analysis of emerging off-site schemes show similar costs between local government using the on-site stormwater management approach or by adopting an off-site stormwater scheme. A range of stormwater management actions are discussed including the multiple benefits which may be derived from each of these stormwater pollution abatement measures. Additionally, the cost effectiveness of various stormwater pollution abatement actions have been compared as cost abatement curves. Importantly, the analysis shows that there are cost effective stormwater management measures with limited maintenance requirements for local government. The analysis shows that off-site actions are only sometimes more cost effective than actions undertaken at the development site; and that the most cost effective actions are those that involve avoiding stormwater pollution in the first place.

The paper also provides a discussion on how off-site stormwater solutions may fit with future stormwater management. More specifically, the paper provides a suggested high level framework for the use of off-site stormwater schemes. Encompassed within this are:

- off-site stormwater principles
- requirements for implementing an off-site stormwater scheme including the elements of a successful off-site stormwater scheme; ensuring equivalence; achieving net benefits; pricing; establishing a market; securing the off-site solution; and achieving administrative and management efficiencies.

This discussion paper will be used to inform a guideline on the use of off-site stormwater schemes in the future. Feedback on this discussion paper is encouraged and the process for providing feedback is outlined in Section 1.3.

Through stakeholder consultation and research for this discussion paper, it is clear that there are a number of key issues and risks which need to be considered and managed before implementing an off-site stormwater scheme.

Contents

1. Introduction

There is growing interest in off-site stormwater schemes in local governments across Queensland. Off-site stormwater solutions provide a mechanism for local governments to collect payment from developers in lieu of managing stormwater on-site. This money is then used to develop stormwater solutions off-site. Off-site stormwater schemes are emerging in Queensland independent of State wide coordination or guidance. To help address this gap, Healthy Waterways hosted workshops on off-site stormwater schemes in September and December 2013 to identify stakeholder needs. At the December workshop, participants identified the need for a discussion paper on off-site stormwater solutions.

1.1. Purpose

The purpose of this discussion paper is to investigate the merit and risks of off-site stormwater schemes in Queensland, promote discussion and propose a high level framework for their use. It is envisaged that feedback obtained on this discussion paper will form the basis of a future off-site stormwater solutions guideline.

1.2. Structure

This discussion paper is comprised of six sections as shown in Figure 1.

1.3. How to Provide Feedback

Various questions are posed throughout the paper as starting points for a discussion on off-site stormwater. Readers are encouraged to provide feedback to Healthy Waterways by 10 October 2014. Feedback can be provided by filling in the feedback form or online survey at www.waterbydesign.com.au/stormwater-discussion-paper. Feedback can be emailed to info@waterbydesign.com.au.

Figure 1: Structure and Content of this Discussion Paper

Section 1 - Introduction	Introduces the *Off-site Stormwater Quality Solutions Discussion Paper.*
Section 2 - Background Information	Outlines background information and legislation relevant to managing stormwater and applying off-site solutions. Defines the term off-site stormwater quality solutions.
Section 3 - Approach	Outlines the methods used to develop this discussion paper.
Section 4 - Findings	Presents the findings of the discussion paper.
Section 5 - Discussion	Builds upon the findings of the discussion paper presented in Section 4 to further explore stakeholder questions about off-site solutions.
Section 6 - Future stormwater management: How do offsite schemes fit?	Proposes principles for future off-site stormwater schemes and outlines likely key features of successful off-site stormwater schemes.

2. Background Information

This section outlines background information and legislation relevant to managing stormwater and applying off-site solutions. The term off-site stormwater quality solutions is defined for the purposes of this discussion paper in Section 2.4.

2.1. Stormwater Impacts on Waterways

Waterways are impacted by stormwater through changes to waterway hydrology and decreasing water quality. Stormwater can carry large volumes of pollutants including nutrients, sediments, hydrocarbons, metals and litter, which can negatively impact on waterway health. Increases in impervious areas associated with urban development can change the natural hydrology and cause larger, faster rising flood events in creeks. The result is downstream erosion and negative impacts on aquatic habitat. Queensland's waterways provide significant social, economic and environmental value to society (Water by Design, 2010). This value is dependent on the good health of our waterways.

2.2. Managing Stormwater Impacts

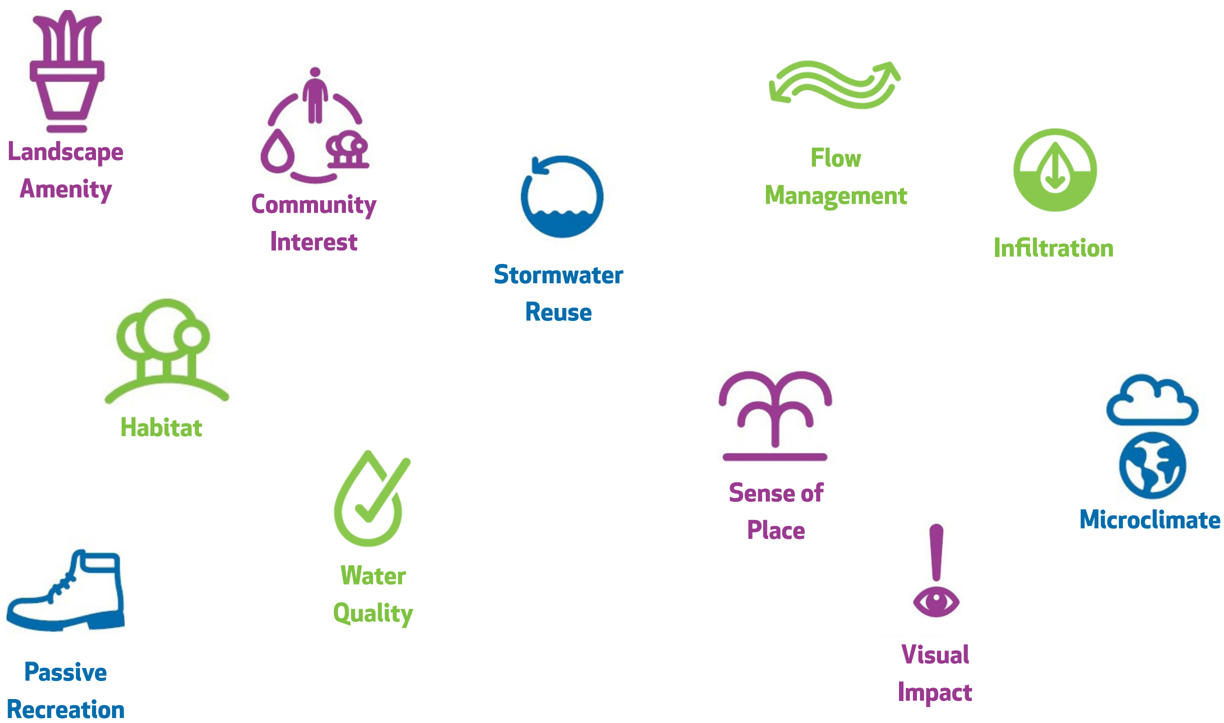
Water sensitive urban design is a holistic approach to planning and urban design that aims to minimise the impacts of development on the natural hydrology and aquatic ecosystems of waterways by integrating the water cycle into the design of urban areas. Doing so can provide multiple benefits to the community such as those shown in Figure 2. To assist in delivering these benefits, Water by Design has published Living Waterways (2014), a best practice environmental management approach to deliver enduring, engaging and affordable places.

Installing stormwater treatment assets such as bioretention systems in new development is one technique used to mitigate the impacts of development upon waterways. Water sensitive urban design however is a much broader approach, of which stormwater treatment assets are one facet.

2.3. Reasons for Considering an Off-site Stormwater Scheme

There are many examples of well built stormwater treatment assets in Queensland, however there are many sites where this is not the case. While water sensitive urban design promotes the use of a suite of tools and planning options, many developments rely on one or two types of treatment system, such as end-of-pipe bioretention systems. On ground outcomes are often not well integrated into the landscape and concerns have been raised over the lifecycle costs as well as the growing costs of maintaining stormwater assets (Scott 2012 b). Off-site solutions are seen as an alternative approach.

Figure 2: Examples of multiple benefits delivered through water sensitive urban design



2.4. What is Meant by Offsite Stormwater Quality Solutions?

Off-site stormwater quality solutions (commonly referred to as stormwater offsets) provide a mechanism for local governments to collect payment from developers in lieu of managing stormwater on-site. This money is then used to develop stormwater solutions off-site. Stakeholder consultation undertaken for this project demonstrated that, the most common understanding of the term off-site stormwater quality solutions was a 'voluntary alternative for delivering the stormwater quality management requirements of the State Planning Policy (DSDIP, 2013) (SPP) off-site'. One local government perceived off-site solutions to be a top up to meet or go beyond the SPP requirements when it was not possible to fully meet the requirements on-site.

This discussion paper focuses on off-site stormwater quality solutions. However, managing stormwater quality is intrinsically linked to providing safe drainage systems to prevent nuisance flooding, as well as mitigating changes to the hydrology of natural systems. While many local governments are interested in delivering the water quality aspect of stormwater off-site, it is unclear how water quantity (waterway stability and flood detention) aspects will be addressed within off-site stormwater schemes. If hydrologic changes associated with increased impervious areas are not adequately addressed, a risk exists that downstream channel morphology may be negatively impacted, increasing bank instability and erosion (Meyer et al. 2005). This can negatively impact downstream drainage infrastructure as well as instream habitat.

This link between stormwater quality and runoff management should be kept in mind when considering any off-site stormwater scheme. Integrated designs that reduce impervious surfaces and capture, detain and treat runoff are often able to meet multiple objectives in a coherent, attractive and cost effective manner. For example, Table A of the SPP (DSDIP, 2013) provides a generic waterway stability objective that may apply to some non-degraded waterways, and local governments may establish more fit-for-waterway flow objectives. The Queensland Urban Drainage Manual (DEWS, 2013) and local government planning schemes also set relevant drainage and flood management standards. Designers and local governments need to consider the specific needs of waterways and the objectives that apply to any site, to ensure that the relevant objectives are met and that stormwater is managed holistically.

For the purpose of this discussion paper, off-site stormwater quality solutions are defined as "a voluntary alternative for delivering the stormwater quality management requirements of the SPP (DSDIP, 2013) off-site". The more common term stormwater offsets is not used in this paper because water quality is not considered within the Environmental Offsets Act 2014 (QLD) (see Section 4.2.2).

3. Approach

A range of investigations were undertaken in order to create this discussion paper:

- Semi structured interviews with stakeholders.
- A review of legislation and literature.
- An analysis of the cost effectiveness of common stormwater management actions.
- A comparison of the cost of on-site compared to off-site stormwater management.

3.1. Stakeholder Interviews

Fourteen semi-structured interviews were held in January and February 2014 with local government officers in South East Queensland and the Great Barrier Reef catchment area, state government, and other key stakeholders to identify their interests in off-site stormwater schemes. Those discussions helped inform the direction of this discussion paper. Key issues raised by stakeholders are outlined in Section 4.1.

3.2. Literature Review

A review of the current environmental offsets legislation was undertaken to inform the discussion paper. The SPP (DSDIP 2013) was also reviewed to determine whether the development of off-site stormwater schemes is appropriate, as well as highlight the stormwater quality objectives that are currently required to be met on development sites greater than 2500m2 or greater than 6 lots. A full list of the legislation and documents reviewed for this paper are included in the reference list. Further discussion of selected legislation can be found in Section 4.2.

3.3. Assessment of Cost Effectiveness of Common Management Actions

Various management actions can be undertaken to avoid or mitigate pollutant loads and improve water quality. Each of these actions has different levels of efficacy (i.e. how much pollution they abate) and lifecycle costs. It is instructive to assess the relative cost effectiveness of different actions as part of the rationale for off-site stormwater schemes. It is the variation between the costs of each management action that may allow off-site stormwater schemes to be more efficient that on-site stormwater management, for example where the cost of abating pollution via the off-site solution is more cost effective than on-site water quality treatment.

Marginal cost abatement curves were developed to illustrate the relative cost effectiveness of a variety of common management actions. Marginal cost abatement curves were created for each of the following pollutants:

- Total Suspended Solids (TSS)
- Total Nitrogen (TN)
- Total Phosphorous (TP).

The methodology involved determining the dollar cost to remove a kilogram of pollutant (e.g. TSS) on an annual basis (e.g. $/kg TSS removed/yr). Calculations were undertaken on the basis of lifecycle costs.

For the reasons discussed in Section 5.9, TSS shows strong potential as the currency for any future off-site stormwater scheme. For this reason, the marginal cost abatement curve for TSS is shown and analysed in Section 4.3, while the related cost curves for both TP and TN are included in Appendix 3 and 4. The tabular data relating to all three cost curves is included in Appendix 2.

3.4. Comparison of the Cost of On-site and Off-site Stormwater Treatment

In addition to the marginal cost abatement curves discussed in Sections 3.3 and 4.3, further analysis was undertaken to compare the lifecycle costs of on-site bioretention systems delivered by developers with two different regional wetland scenarios delivered by local government using off-site solutions.

For the on-site bioretention scenario, the analysis assumed 10ha of development comprised of 10 individual, one hectare developments, each delivering a bioretention system sized in the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) version 6 to comply with the stormwater quality requirements of the State Planning Policy. This resulted in 10 bioretention systems, each with 100m^2 of filter media.

The first wetland scenario included a regional wetland constructed by a local government on a 10ha catchment. The wetland was sized using MUSIC to remove the same pollutant loads as the business as usual scenario. This resulted in a single wetland with a total treatment area (macrophyte zone area and inlet pond area) of 8500m^2, or 8.5% of the catchment area.

The second wetland scenario included a regional wetland constructed by a local government on a 30ha catchment. The wetland was sized using MUSIC to remove the same pollutant loads as the two previous scenarios. This resulted in a wetland with a total treatment area of 4250m^2, or 1.4% of the catchment area. The wetland requirement in the second scenario was approximately half the size of the wetland in the first scenario.

From herein, the two wetland scenarios are referred to the large regional wetland and the small regional wetland respectively.

The analysis for each of the three scenarios included costs associated with:

- planning and design
- land
- construction
- establishment
- maintenance
- renewal/ adaption
- decommissioning.

The analysis took into account costs incurred by both by local government and the developer, and considered the effects of off-site stormwater charges similar in value ($45,000/ha) to those currently being applied by some local governments in Queensland.

A full description of the parameters applied can be found in Appendix 2.

The results of the analysis can be found in Section 4.4.

4. Findings

This section outlines the findings of the investigations described in Section 3.

4.1. Key issues Raised by Stakeholders

During the stakeholder interviews, a number of key issues were raised concerning including:

- Are off-site stormwater schemes a cost effective option?
- Are regional systems cheaper to maintain than distributed systems?
- Will off-site stormwater schemes save time?
- Will off-site stormwater schemes remove the responsibility of local government associated with stormwater management?
- Does local government have sufficient capacity to deliver off-site stormwater schemes?
- Can off-site stormwater deliver equivalent environmental outcomes?
- Are catchment management actions suitable as off-site stormwater projects?
- What needs to be considered when setting off-site stormwater scheme charges?
- What currency or metrics should be used for an off-site stormwater scheme?
- Are rainwater tanks cost effective?
- Do stormwater management regulations have a significant impact on the affordability of new homes?

The analysis provided below and the discussion in Section 5 aims to respond to the key issues raised by stakeholders.

Discussion Point 1

Are there other key issues that should be considered?

4.2. Legislation

There are a range of legislative requirements relevant to managing stormwater and applying off-site solutions in Queensland.

4.2.1. STATE PLANNING POLICY 2013

In Queensland, requirements for managing stormwater are currently set out in the SPP (DSDIP, 2013) which includes design objectives for stormwater quality and waterway stability. These design objectives can be achieved using water sensitive urban design.

The SPP (DSDIP, 2013) specifies the default load-based reduction targets for managing stormwater quality in Queensland. Those targets are based on how well bioretention systems can improve the quality of urban stormwater runoff, without the treatment systems becoming excessively large (i.e. where further increases in the size of the bioretention system would lead to diminishing water quality benefits). The targets do not necessarily achieve a no-worsening of pollutant loads compared to current or natural catchment conditions.

In developing those targets, the following was not explicitly taken into account:

- The actual needs of various waterway types (lakes, streams, rivers, estuaries and coastal waters).
- The real costs to developers, especially the value of land occupied by stormwater treatment.
- Site constraints, including physical constraints and conflicting design standards for other urban infrastructure.
- How to fund the net maintenance cost.
- How to fund the necessary investment in long-term capacity building.
- Alternative strategies for improving stormwater quality outcomes.

While the performance of many common management actions in improving water quality is well established, there is a lack of evidence about its measurable benefits in improving waterway health. There is no consensus amongst ecologists about what factors are critical in achieving healthy waterways in urban environments. A range of factors are acknowledged, including instream habitat, riparian cover, water quality and hydrology.

4.2.2. ENVIRONMENTAL OFFSETS ACT 2014

The Environmental Offsets Act 2014 (QLD) came into effect on 1 July 2014. Advice from the Department of Environment and Heritage Protection (DEHP) highlights the following:

- It is possible that some urban development may need to consider offsets, depending upon the assessment requirements under existing legislation and whether or not the development will impact upon a prescribed environmental matter.
- Water quality is not a prescribed environmental matter for the purposes of the offsets framework.
- As water quality is not a prescribed environmental matter, the policy is not relevant. However, there are circumstances where prescribed environmental matters may benefit from improvements in water quality.

The DEHP has developed a framework for voluntary market-based mechanisms for nutrient management titled, Flexible Options for Managing Point Source Water Emissions (DEHP, 2014). Information on this framework is on the DEHP's website but relates specifically to pollutants coming from point sources such as sewage treatment plants.

4.2.3. SUSTAINABLE PLANNING ACT 2009

Environmental offsets are provided for under the Sustainable Planning Act 2009 (QLD) S346 (A) Environmental Offset Conditions:

(2) An environmental offset condition may be imposed only if the concurrence agency or assessment manager is satisfied that all cost-effective on-site mitigation measures for the development have been, or will be, undertaken.

However, an off-site stormwater solution condition requiring monetary payment would potentially be unlawful because it is contrary to SPA s347 (1) (b) and s626. For this reason, existing off-site stormwater schemes are voluntary. Compulsory off-site schemes are likely to be in breach of SPA s626.

4.2.4. ENVIRONMENTAL PROTECTION ACT 1994

The Environmental Protection Act 1994 (QLD) S21 (1) defines best practice environmental management as:

The best practice environmental management of an activity is the management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the measures currently used nationally and internationally for the activity.

Cost effectiveness is a key test outlined in the above documents, and this report helps shed light on the cost effectiveness of various stormwater management practices. Further, alternative approaches to stormwater management are consistent with the SPP (DSDIP, 2013), which allows for "innovative and locally appropriate solutions for urban stormwater management". In addition, Code AO1.1 of the SPP (DSDIP, 2013) allows for best practice environmental management on sites with land use constraints.

4.3. Cost Effectiveness of Common Management Actions

Various management actions can be undertaken to avoid or mitigate pollutant loads and improve water quality. A selection of these management actions are described in Table 1. When applied successfully, these actions should provide multiple benefits as described in Section 2.2

The actions outlined in Table 1 are grouped into three categories:

- Actions to avoid generating polluted stormwater runoff.
- Actions to mitigate polluted stormwater runoff.
- Catchment-based actions to improve water quality impacts.

Note that the list of actions is not exhaustive. For example, it does not include a range of point source controls such as wastewater treatment. Also note that the categorisation is subjective, as some of the mitigation options could themselves be used as off-site stormwater projects.

As described in Section 3.3, the cost effectiveness of each of the actions outlined in Table 1 was analysed. Figure 3 shows the abatement cost curve for TSS. The tabular data relating to Figure 3 can be seen in Appendix 2. Similar abatement cost curves for both TP and TN can be seen in Appendix 3 and 4.

Figure 4 compares the present value of the lifecycle costs and operating (and maintenance) costs of each abatement option.

Table 1: Summary of Common Management Actions to Improve Water Quality

MANAGEMENT ACTION	DESCRIPTION/NOTES	OFF-SITE STORM WATER SOLUTION
Actions to avoid generating polluted stormwater runoff		
Low Impact Design (two storey homes)	Taller homes with more yard. This example is based on a two-storey home with a 120 m2 footprint, instead of a single storey home with a 240 m2 footprint. The additional construction cost is $10,000 (minus savings from half as much roof, less footings etc) and the additional yard space gained is valued at $300/m2 (BMT, 2014).	
Low Impact Design	Avoids impervious surfaces by building on raised piers and using permeable pavements. Avoids the cost of stormwater pipes is avoided.	
Permeable Pavement	A permeable trafficable surface that can be used for carparks and driveways. Can be cheaper and more resilient than sealed surfaces.	
Rainwater Tanks	Domestic 3 – 5 kL rainwater tanks plumbed to toilets, laundry and outdoor uses.	
Actions to mitigate polluted stormwater runoff		
Grass swale	A roadside grass swale. Either in lieu of underground piped drainage (cheaper) or in addition/complementary to a piped drainage system.	
Street trees	A street tree which is passively irrigated by stormwater runoff from the kerb. These can be either informal (without formal bioretention underground design) or with a formal biofiltration soil filter media.	Yes
Bioretention	A system designed to filter stormwater through a vegetated, soil-based filter. In the cost effectiveness analyses, there are four options shown: • **Bioretention (Full size).** This is a typical system sized to comply with the stormwater quality targets in the SPP • **Small bioretention (Half size).** This is a bioretention system sized at half the size required to comply with the stormwater quality targets in the SPP • For each of the above two options, there are two variants, a **'land cost'** option, where the system is sited on valuable land worth $300/m2, and a **'no land cost'** option assuming the system does not take up any additional developable land (e.g. integrated into landscape requirements, creditable open space or essential flood detention systems)	Yes
Streetscape raingardens	A small bioretention system, either within an allotment or in streets. The option presented in the analysis is assumed to be integrated into the street with no real loss of developable land, and is sized at half the size needed to achieve full compliance with SPP targets.	Yes
Litter basket	A mesh insert placed in stormwater gully pits to capture leaves, litter and sediment.	Yes

MANAGEMENT ACTION	DESCRIPTION/NOTES	OFF-SITE STORM WATER SOLUTION
Cartridge Filters	A manufactured stormwater treatment device which uses fine filtration and activated media to remove particulate and soluble pollutants. There are two products being marketed in Queensland, with significant differences in their lifecycle costs. Treatment performance for these devices is highly dependent on ongoing maintenance and cartridge replacement taking place. When used as the sole measure they are unlikely to meet the SPP targets.	
Wetland	A densely vegetated shallow marsh system designed to detain and improve the quality of runoff. This refers to a constructed system rather than a natural wetland. In the cost effectiveness analyses, there are four options shown: • **Wetland (Full size).** This is a typical system sized to comply with the stormwater quality targets in the SPP. • **Wetland (Small) .** This is a wetland sized at half the size required to comply with the stormwater quality targets, and located on a larger catchment such that it still does meet the stormwater quality targets in the SPP. • For the full size wetland option above there are two variants, a **'land cost'** option, where implementing the system requires land to be purchased system , and a **'no land cost'** option assuming the system does not take up any additional developable land (e.g. integrated into open space or essential flood detention systems)	Yes
Stormwater Harvesting	The harvesting and reuse of urban runoff. A variant titled **no capital expenditure** is shown. It assumes that the capital cost of the scheme does not need to be recovered (such as when it has been funded through grants).	Yes
Catchment-based actions to improve water quality impacts		
Minimum tillage	A range of practices, including direct seeding, to retain soil structure and reduce soil loss.	Yes
Riparian protection/ revegetation	Protecting or enhancing riparian corridors adjacent to waterways. Note: there is a lack of reliable data on the efficacy of riparian works in improving in-stream water quality (see Sections 5.6 and 6.2).	Yes
Livestock Exclusion	Fencing waterways to exclude livestock from trampling banks and defecating in the water. Off-stream watering points are provided in conjunction with fencing.	Yes
Gully treatment	Measures to address the erosion of waterways, typically ephemeral gullies on soils where native vegetation has been cleared.	Yes

Figure 3: TSS abatement costs

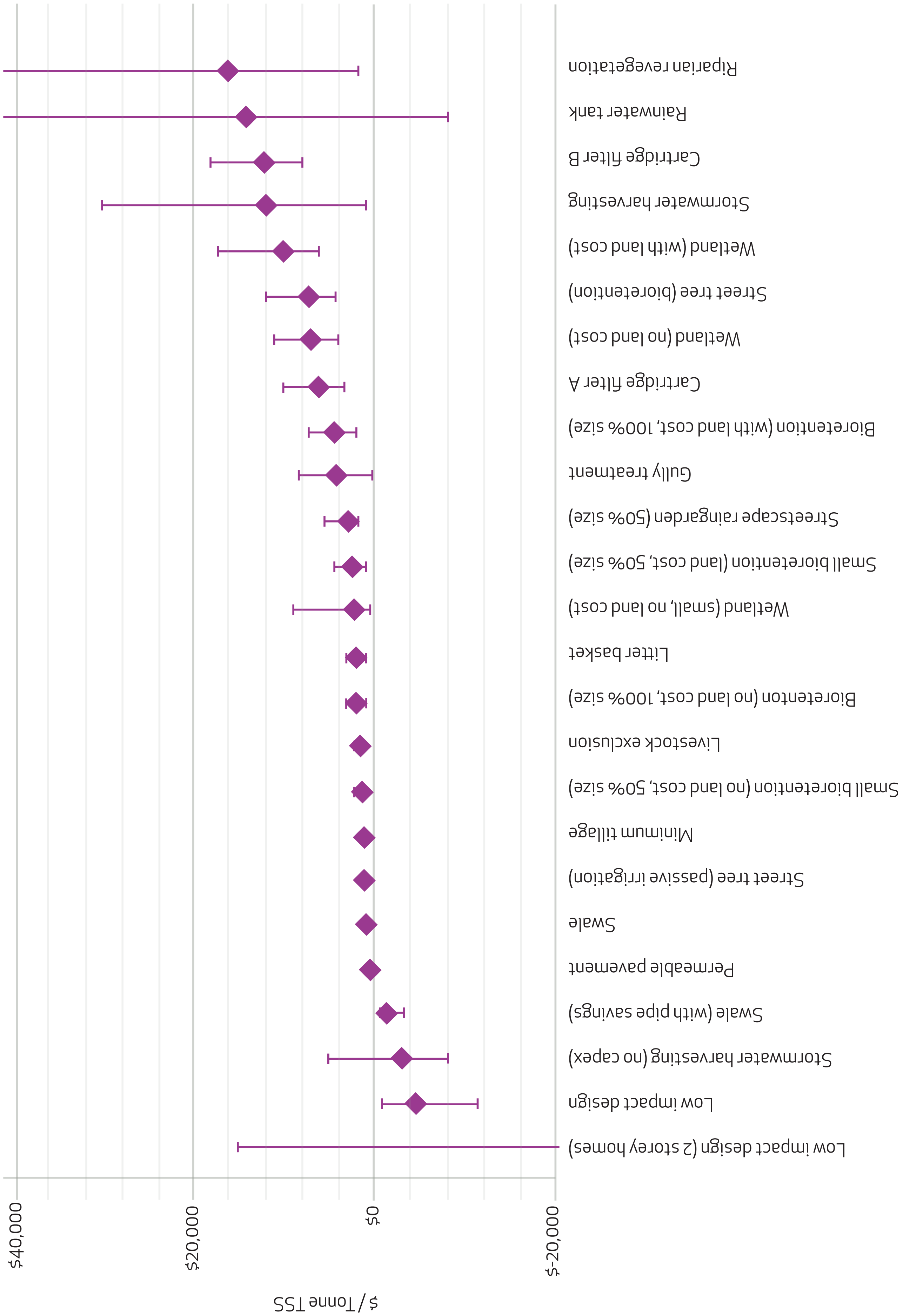
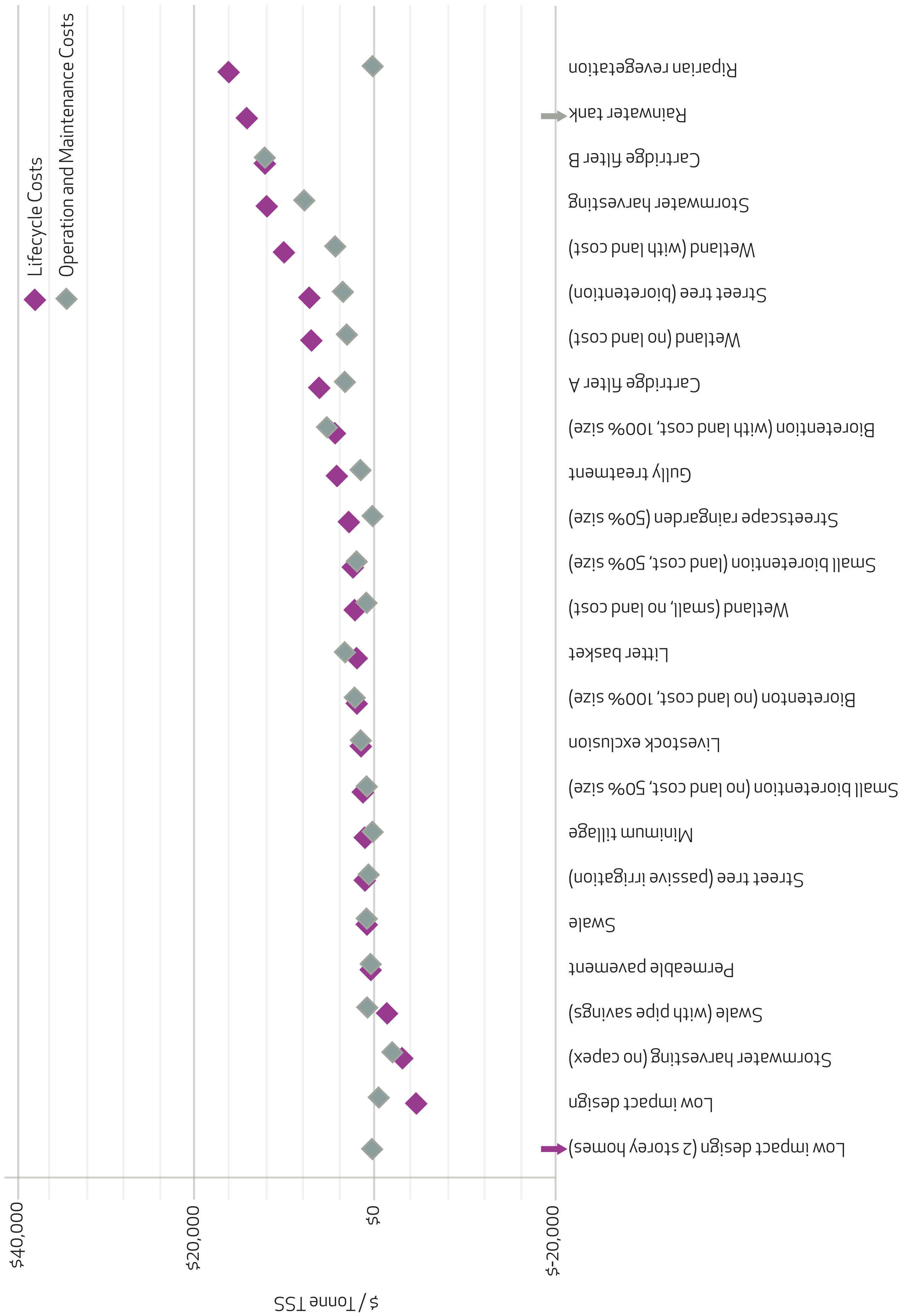


Figure 4: Comparison of the Present Value of Lifecycle and Operation and Maintenance Costs



From Figures 3 and 4 it can be seen that:

- There are cost effective ways to improve stormwater quality with limited ongoing maintenance requirements for local government. For example, on-site stormwater management actions that reduce impervious surfaces (such as building two-storey homes with a yard rather than large single storey homes) reduce stormwater pollution with no ongoing maintenance costs to the local government because the additional land is privately held and because the land can provide additional infiltration area. While the yard space requires maintenance, it is outweighed by the benefit the yard provides to the homeowners. Using rainwater tanks is another way of reducing pollution while providing a benefit to households, at no cost to the local government.
- Abatement costs vary significantly. Some actions actually provide a "win-win" situation (i.e. a negative cost). These include actions such as low impact design and low footprint design (where a positive value is placed on land made available due to building up). However, some management actions have very high costs.
- Where a mitigation action at the development site (e.g. end of pipe bioretention) could be delivered by an action further down the cost curve such as a street tree, economic efficiency can be gained from using an off-site stormwater solution.
- Off-site stormwater actions are only sometimes more cost effective than actions undertaken at the development site.
- Several off-site stormwater options (e.g. wetlands, street tree bioretention or stormwater harvesting without water sales income) have higher ongoing operation and management costs than bioretention basins.
- Some measures have very low maintenance costs, such as using permeable paving for carparks and driveways, and can even be less expensive to build than conventional pavements.
- Small bioretention systems (half of the size required to comply with load based objectives) are 3.7 times more cost effective than a 'correctly sized' bioretention system that occupies otherwise valuable land. This is because these systems can be more easily integrated into the landscaping requirements of sites without impacting on developable land.

Discussion Point 2

Are Figures 3 and 4 useful tools for examining the merits of a range of stormwater management actions?

In interpreting Figures 3 and 4, the following should be noted:

- There is limited data available on ongoing maintenance costs for riparian revegetation and gully treatment. If well structured vegetation is established, ongoing maintenance should be minimal, apart from selective weed management.
- The operation and maintenance costs of rainwater tanks is negative as the tanks provide an ongoing net benefit to homeowners, due to the value of the water supplied exceeding the cost of electricity for pump operation.
- Figure 3 shows the marginal cost of the next unit of that abatement. The figure does not necessarily reflect the cost of that abatement option in the medium or long term. For example, small wetlands constructed on land that does not need to be purchased may initially be cheaper to implement than larger wetlands (either with or without the purchase of land). However suitable wetland locations that do not require land to be purchased may quickly be exhausted. As a result, local government may be forced to purchase land for wetlands earlier than would be required if larger wetlands were constructed from the beginning. This may result in greater overall costs. How quickly suitable wetland locations are exhausted depend on a range of factors, particularly the rate of development compared to the number of available sites that don't require land to be purchased. Similar logic applies to other abatement options where local government may have a limited number of suitable locations (e.g. riparian revegetation sites).

Discussion Point 3

Are there other management actions that could be considered for either on-site stormwater management or for off-site stormwater solutions?

Discussion Point 4

Why do you think it is that low impact design and other cost effective onsite stormwater management actions are not used more regularly in Queensland?

4.4. Comparison of the Cost of On-site and Off-site Stormwater Treatment

In addition to the marginal cost abatement curves discussed in Sections 3.2 and 4.2, further cost analysis was undertaken to compare the lifecycle costs of on-site bioretention systems delivered by developers with both small and large regional wetlands delivered by local government using off-site solutions (see Section 3.4 for further details on the methodology).

Figure 5 shows the lifecycle costs per hectare of development for each of the scenarios.

Key points highlighted by Figure 5 include:

- In all scenarios, land and construction costs make up the majority of the lifecycle costs.
- Land costs makes up a relatively larger proportion, and construction a relatively smaller proportion of bioretention system lifecycle costs than wetland lifecycle costs.
- The cost of the large regional wetland scenario (including land) are significantly higher than the total (developer and local government combined) costs of the on-site bioretention scenario.
- The cost of the large regional wetland scenario (without land) are similar to the total (developer and local government combined) costs of the on-site bioretention scenario.
- The cost of the small wetland scenario (either with or without land) are lower than the total (developer and local government combined) costs of the on-site bioretention scenario.
- Maintenance costs for the small wetland scenario are similar to the on-site bioretention scenario. Maintenance costs for the large wetland scenario are approximately twice those of the on-site bioretention scenario and the small wetland scenario.

Figure 5: Comparison of the Cost of On-site Bioretention Systems and Small and Large Regional Wetlands

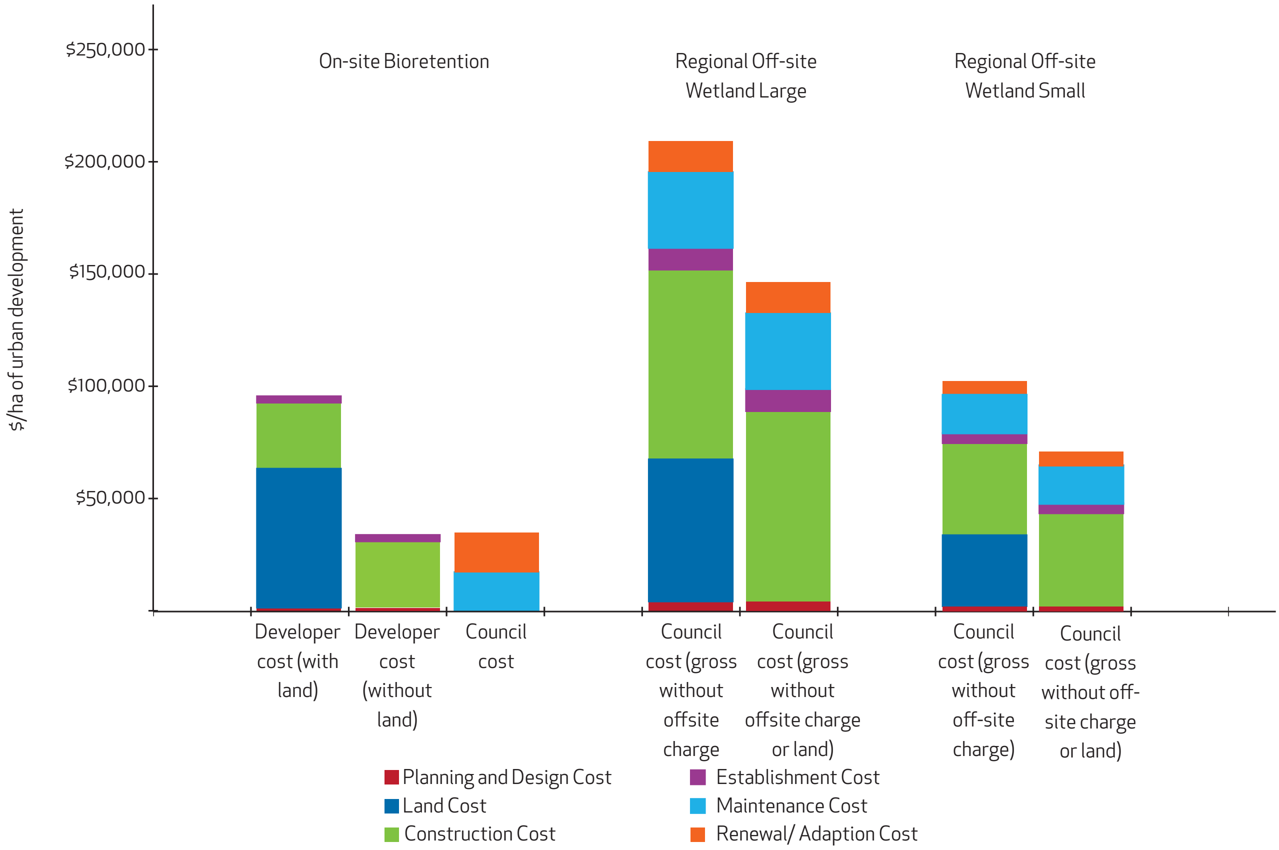
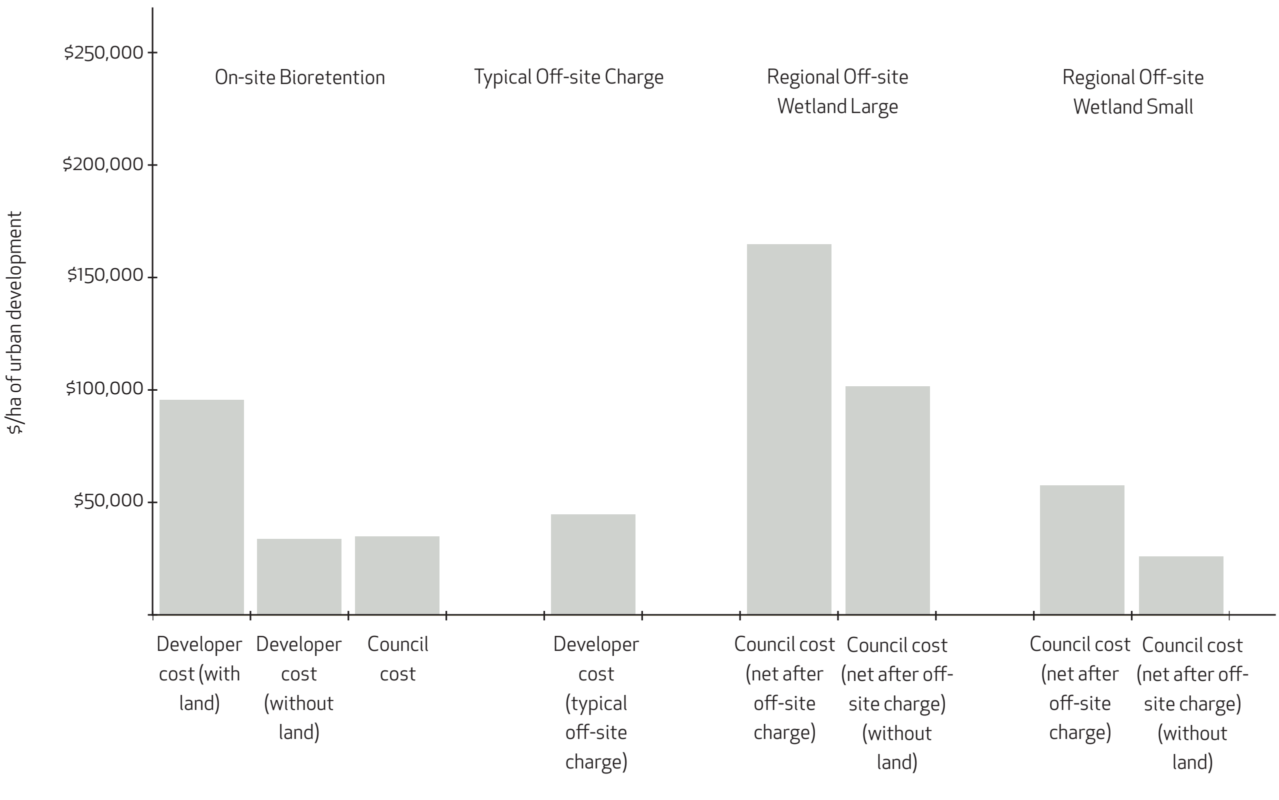


Figure 6 builds upon the data provided in Figure 5, to demonstrate the effects of an off-site stormwater solution priced similarly ($45,000/ha) to those currently being applied by some local governments in Queensland. The bioretention scenario shown is an on-site bioretention system, and hence its total lifecycle cost remains unchanged from Figure 5 to Figure 6. Both wetland scenarios are assumed to be delivered using an off-site stormwater solutions approach with charges at a rate of $45,000/ha, and hence the costs to local government are shown to have decreased by $45,000/ha.

Key points highlighted by Figure 6 include:

- An off-site stormwater solutions charge of $45,000/ha (typical of existing off-site stormwater schemes in Queensland) is slightly higher than the costs incurred by developers building on-site bioretention systems, where otherwise developable land is not required for the bioretention systems. Such situations may occur where the bioretention system can be integrated into creditable open space, flood prone land, or co-located within a flood detention basin that is otherwise required.
- A off-site stormwater solutions charge of $45,000/ha (typical of existing off-site stormwater schemes in Queensland) is roughly half of the costs incurred by developers building on-site bioretention systems, where those bioretention systems use land that is otherwise developable.
- When an off-site stormwater charge of $45,000/ha is applied, only the small wetland (without land costs) scenario results in lower net lifecycle costs to local government compared to accepting developer contributed, on-site bioretention systems. All other wetland scenarios have higher lifecycle costs.

Figure 6: An Example of the Effect of Offsite Stormwater Solution Pricing



5. Discussion

5.1. Are Off-site Stormwater Schemes a Cost Effective Option?

The analysis presented in section 4.4 of this report suggests that off-site stormwater schemes can be a cost effective option for both local governments and developers, compared with the business-as-usual approach of creating end-of-pipe bioretention systems. However, cost effectiveness is strongly influenced by the off-site options available to the local government, and the off-site stormwater solution charge set. Selecting an inappropriate off-site stormwater option, or setting an inappropriate off-site stormwater solution charge could result in an off-site stormwater scheme that increases lifecycle costs to the local government, or which is not financially attractive for the development sector. In addition, there are low lifecycle cost ways of managing water quality through on-site practices that avoid stormwater pollution in the first place that should also be considered.

Catchment management actions such as riparian revegetation tend to be less reliable in the longer term (Dosskey et al, 2010), or highly variable in terms of cost and benefit. Further, they can often be more expensive than on-site stormwater management practices. The TSS marginal cost abatement curves (Figure 3) provide the lifecycle costs of a range of stormwater management actions and can be used to determine the most cost effective option. Local governments should give careful consideration to all the costs involved in procuring an off-site stormwater solution, as well as ongoing maintenance costs, using the information provided in this report.

Discussion Point 5

Are there other management actions that could be considered for either on-site stormwater management or for off-site solutions?

5.2. Are Regional Systems Cheaper to Maintain than Distributed Systems?

One of the major reasons for local government seeking to implement off-site stormwater schemes is to minimise the cost of maintaining stormwater treatment assets. It is thought that by transitioning from having numerous small assets, to a lesser number of larger regional assets, costs will be reduced.

While there are a variety of reports on the cost of maintaining stormwater treatment systems, relatively little of this literature is based upon data collected from actual systems. Instead, most data is based on estimates from similar maintenance activities. Data collected from actual systems show that maintenance costs per square metre vary with system:

- type (i.e. streetscape bioretention systems compared to bioretention basins compared to wetlands)
- size (i.e. large versus smaller systems)
- design (i.e. is maintenance access provided?)
- construction (i.e. was the system constructed well?).

Data collected by Healthy Waterways (Mullaly 2014) and supported by Melbourne Water (2014) suggests that bioretention costs are highest per square metre of filter media for small bioretention systems (e.g. streetscape systems) reduce dramatically for moderate sized bioretention systems (e.g. 100 – 800m^2 bioretention basins) and begin to increase again for larger, regional systems.

Within each of the above scales of bioretention systems, the following elements have a significant influence on maintenance costs:

- the quality of the design including well established and structured vegetation with trees to help shade weeds,
- management of upstream risks (such as construction sites)
- good maintenance access.

Wetland maintenance data from Melbourne Water (2014) suggests that maintenance costs per square metre of treatment area decrease as wetland size increases. However, as shown in Figure 5, maintenance costs for wetlands are generally higher per hectare of development and per unit of pollutant removed than bioretention systems because wetlands are typically much larger to remove the same pollutant loads from stormwater.

Therefore, regional systems are not cheaper to maintain than a number of distributed systems, except possibly where small wetlands (relative to their catchment) are constructed, or where the distributed bioretention systems are small streetscape systems.

Regardless, local governments should ultimately be concerned about lifecycle costs as a whole rather than simply maintenance costs.

5.3. Will Off-site Stormwater Schemes Save Time?

A suggested reason for implementing an off-site stormwater scheme is that the use of such schemes will save time. A well-designed and effective off-site stormwater scheme could reduce approval and handover timelines. This would require any scheme to be efficient, preferably with a supply of off-site projects already secured that can be acquitted against development requirements as they arise. However, time commitments will be needed from local government to develop and run an effective off-site stormwater scheme. It will likely be appropriate for local government to assess the time requirements involved in:

- determining the cost effectiveness and feasibility of an off-site stormwater scheme
- evaluating expected waterway outcomes
- developing strategic and/or catchment plans to identify potential stormwater offset projects
- monitoring and evaluation of off-site stormwater scheme effectiveness.

Stormwater and Development Assessment

The Council of Mayors (Pers. Communication, 2014) estimates that stormwater quality issues may be responsible for up to 50% of the typical 340 day approval time for larger developments. However, previous analysis by MainStream Economics and Policy (2012) suggests this is probably exaggerated and cannot be statistically demonstrated, because stormwater is just one of many matters being concurrently resolved and that the bulk of the delays were actually a result of incomplete or improper applications. Furthermore, the economic value of marginal reductions in approval delays are not significant (about $350 / per month / per lot), as the holding cost of land prior to approvals does not include any costs associated with 'land improvement' (e.g. roads, landscaping etc.).

5.4. Will Stormwater Off-site Stormwater Schemes Remove the Responsibility of Local Government Associated with Stormwater Management?

To local governments, poorly designed and constructed bioretention systems present a significant ongoing environmental and financial cost to the community. Reducing the number of assets requiring maintenance and avoiding poor outcomes on small sites is one of the reasons for considering off-site solutions.

However, poorly designed off-site stormwater schemes may also present risks to local governments. Local government will need to consider issues such as:

- whether an off-site project will deliver the required pollution abatement to meet regulatory requirements
- uncertainty surrounding the time requirements to deliver a fully functioning off-site stormwater scheme
- uncertainty surrounding some of the offset project maintenance requirements such as those of regional wetlands
- achieving full cost recovery through an off-site stormwater scheme.

In addition, off-site solutions may see private developments (e.g. a multi-unit residential development with a body corporate) forgo constructing a stormwater treatment system and instead pay local government to achieve an equivalent outcome elsewhere. In this instance the on-site bioretention system would have been the responsibility of the body corporate to maintain, and as a result, by accepting an off-site solution, the local government will take on additional responsibilities they would not have otherwise incurred.

To a developer, off-site solutions do not remove a potential regulatory liability or burden. They simply change the way in which the regulatory liability is discharged. For example by purchasing an off-site solution in lieu of managing stormwater on-site. An off-site stormwater scheme should be well designed and implemented and should not result in developers avoiding liabilities, or local government wearing any additional ongoing burden.

5.5. Does Local Government Have Sufficient Capacity to Deliver Off-site Stormwater Schemes?

Poor stormwater management outcomes stem, in part, from a lack of capacity in designing and implementing stormwater treatment assets. Depending on the off-site project being considered, this lack of capacity may also apply to off-site projects. Local governments considering the use of off-site stormwater schemes will need to assess their internal capacity to deliver the off-site projects associated with such a scheme. A poorly designed and implemented off-site stormwater scheme may result in outcomes similar to poorly designed and implemented on-site projects. Particular risks that may be associated with poor implementation of off-site stormwater schemes include a decline in water quality, increased uncertainty associated with large off-site projects and the possibility of a new cost burden to local government. To reduce these risks, at a minimum, local government will need to have sufficient capacity to ensure that off-site stormwater:

- schemes are transparent and accountable
- policies are rigorous and consistent
- projects are environmentally equivalent (discussed further in section 5.6 and 6.2).

It should be noted that even where a local government does have sufficient capacity to implement off-site stormwater solutions, doing so will shift a significant responsibility and workload from that local government's development assessment team to its infrastructure design team.

> **Riparian Vegetation**
>
> Riparian vegetation influences stream water chemistry through diverse processes including direct chemical uptake and indirect influences such as supply of organic matter to soils and channels, modification of water movement and stabilisation of soil. While it is clear that riparian vegetation improves stream water quality, it is unclear how to quantify this improvement. Variables include riparian vegetation extent (width and length), type and quality. As such, it is currently difficult to determine how much riparian vegetation, or its type is equivalent to the action being offset.

> **Discussion Point 6**
>
> Do you think local government has sufficient capacity to deliver off-site stormwater schemes? If not, in what areas does capacity need to increase?

5.6. Are Catchment Management Actions Suitable as Off-site Stormwater Projects?

Catchment management actions, such as on-farm management and riparian revegetation, are often seen as desirable offset projects. There may be issues associated with land tenure and longer term reliability of the water quality benefit associated with catchment management actions which would need to be resolved to ensure the longevity of the management action and to ensure environmental equivalence. For example, what would happen if off-site stormwater charges are spent revegetating an eroding hill-slope, and then the vegetation is lost to a bushfire, or cleared by a subsequent landowner? Adequate mechanisms will need to be in place to account for the reliability of the offset and legal and financial frameworks in place to secure that offset.

> **Minimum Tillage and Livestock exclusion**
>
> Limited data exists on the efficacy and costs of rural land use practices and the benefits to water quality. While there is some evidence to suggest that rural land use change and rural actions are likely to provide significantly lower abatement costs than many on-site actions (Weber, 2008), the quality of this evidence is significantly lower than for many other abatement actions. There are a number of reasons for this including:
>
> - The significant variability in potential efficacy due to physical conditions (location, slope, soil type, grass cover etc).
> - The fact that measuring efficacy is significantly more difficult and costly than for end-of-pipe solutions.
> - Actions have tended to be achieved via non-regulatory means (e.g. grants). This has reduced the burden of proof. Furthermore, investment is modest when compared to WSUD (over $100 million per annum), so less effort on understanding efficacy has been made.

5.7. Can Off-site Stormwater Solutions Deliver Equivalent Environmental Outcomes?

A fundamental principle underpinning the successful use of off-site solutions is the concept of equivalence. An off-site stormwater project should provide outcomes (in this case pollution abatement) that are equivalent to the impacts at the development site. Equivalence is comprised of:

- **Environmental equivalence.** This is the measure of abatement efficacy of the off-site action (kg/TSS/year) at the actual site where the off-site action occurs. The tools and models used to measure this abatement are varied depending on the actions. For example, MUSIC provides estimates for grass swales, and GRASP (GRASs Production) can estimate abatement from changes in grazing practice etc.
- **Spatial equivalence.** The off-site action will be at a different site from the development requiring the offset. Therefore the issue of spatial equivalence needs to be considered. This relates to how much bigger the off-site action may need to be to produce the same water quality outcome. Models such as Source Catchments and specialised sediment transport models can be used to estimate this. Figure 7 illustrates some examples of how these spatial relationships may play out.
- **Temporal equivalence.** While the damage (and the requirement for the off-site solution) occurs at the time of the development, some off-site actions (e.g. riparian revegetation) may take several years before the annual sediment abatement of the off-site action is equivalent to the off-site requirement (i.e. there is a lag between action and abatement benefits). Where this is the case, and the lags are broadly understood, lags should be accounted for by increasing the off-site requirement until the present value of the off-site solution is equivalent to the present value of the off-site requirement. This is a relatively simple adjustment.

The cost effectiveness analysis documented in Sections 4.3 and 4.4 demonstrate that there are off-site stormwater actions available that can deliver equivalent environmental outcomes. Delivering equivalent temporal and spatial outcomes is also possible, but is dependent on the design of the off-site stormwater scheme.

Where equivalence is not considered and achieved, there is potential for inefficient investment. This may result from either of the following scenarios:

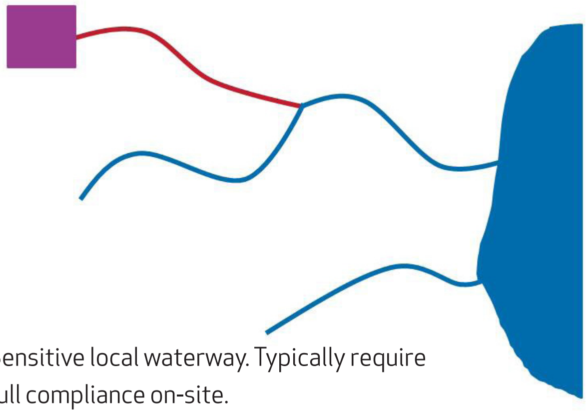
- Where the off-site stormwater solution provides lower water quality outcomes because equivalence has not been properly assessed, water quality will decline because the off-site solution will be inadequate. Furthermore, the off-site requirements have been underpriced, resulting in a windfall gain to the developer (lower development cost) at the expense of the community (water quality is worse than it would otherwise be).
- Conversely, where the offsite stormwater solution provides higher water quality outcomes because equivalence has not been properly assessed, there is an overinvestment in the offset which could be considered a tax on development.

To minimise this risk, it is critical that equivalence is embedded into stormwater offset policy design and implementation. Options for demonstrating equivalence are addressed in Section 6.2 of this discussion paper.

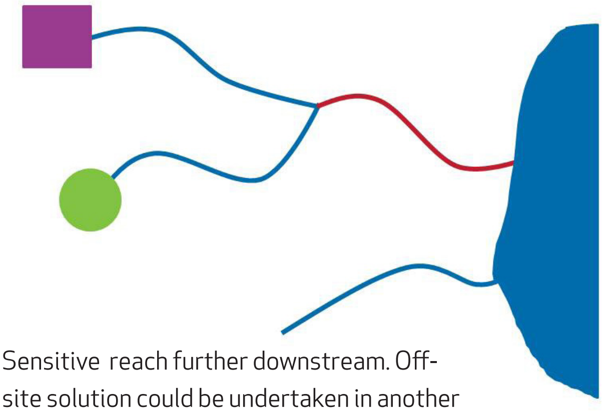
Discussion Point 7

How would you establish a off-site stormwater scheme that achieved equivalence?

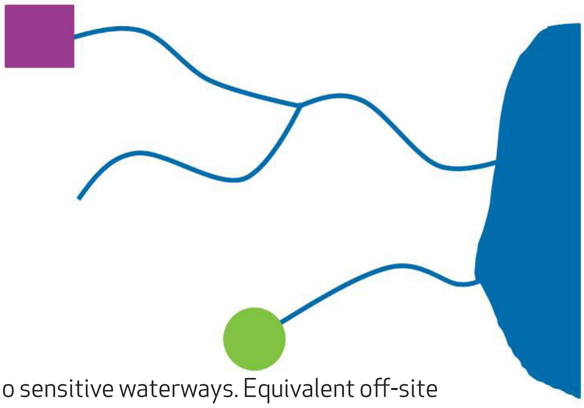
Figure 7: Spatial Relationships Between Impact Site, Sensitive Waterways, and Off-site Solution Locations.



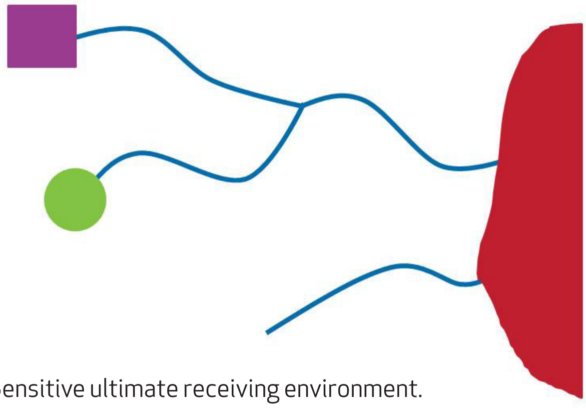
Sensitive local waterway. Typically require full compliance on-site.



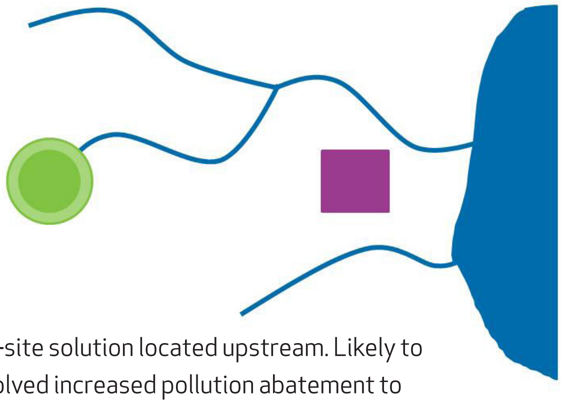
Sensitive reach further downstream. Off-site solution could be undertaken in another tributary.



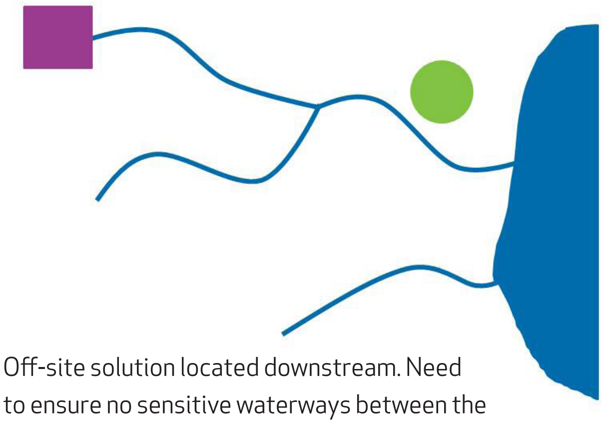
No sensitive waterways. Equivalent off-site solution could be undertaken within the same overall catchment of the receiving environment.



Sensitive ultimate receiving environment. Off-site solution could be undertaken in another tributary.



Off-site solution located upstream. Likely to involved increased pollution abatement to account for diffusion and instream processing toachieve equivalence at off-site solution site.



Off-site solution located downstream. Need to ensure no sensitive waterways between the two sites.

The purple square denotes the development site. Red denotes a sensitive receiving environment. The green circle indicates an off-site solution location.

5.8. What Needs to be Considered When Setting Off-site Stormwater Scheme Charges?

There are a large range of factors that need to be considered when setting off-site stormwater charges, including:

- the price of available offset projects
- the willingness to pay of the development sector, driven primarily by costs that could be avoided by purchasing an off-site solution, as well as other reductions in risks such as reducing the uncertainty associated with establishing and handing over stormwater treatment assets to local government
- the equivalence of available off-site projects.

If the off-site stormwater charges are set too low, there is a risk that local government will not achieve full cost recovery and costs will be passed from the developer to local government, and ultimately to the community via rates. Conversely, if local government choose to under price off-site solutions and only spend the charges they have collected, there is a risk that the level of pollution abatement will not meet the legislated requirements and waterway health will degrade.

A cost analysis of the off-site stormwater arrangements in Queensland is presented in Sections 4.3 and 4.4. A range of factors will need to be taken into account before setting off-site stormwater charges. Further discussion of costing is provided in Section 6.3.

Melbourne Water

Melbourne Water has had an off-site stormwater scheme in place for approximately 10 years. The Melbourne Water charge has nearly doubled every two years, and is yet to achieve full cost recovery. Initially the charge did not include the cost of land. Challenges have been experienced in developing quality projects at designated off-site locations (Patschke, 2013). Available land has become sparse and the cost of land has increased significantly. Melbourne Water has recently reviewed and is substantially increasing their off-site solution rate to enable full cost recovery.

Discussion Point 8

Is there anything that you would consider when setting off-site stormwater scheme charges that is not included here?

5.9. What Currency or Metrics Should be Used for an Off-site Stormwater Scheme?

There are a range of metrics or currencies available that may be suitable for use in off-site stormwater schemes such as TSS, TP and TN. TSS may be a suitable metric or currency for off-site solutions. This is because:

- There is better data on the efficacy of a range of management actions in abating TSS, and from diffuse sources compared to other options.
- There is a reasonable correlation between TSS and TP, and a fair correlation with TN as illustrated by the combined abatement cost curve shown in Appendix 5. The abatement cost curves show that only a few management practices have quite low TN or TP removal rates relative to their TSS reduction.
- Nearly all aquatic ecosystems are sensitive to TSS, while sensitivity to TN and TP tends to vary depending on whether environments are N or P limited.

As off-site stormwater schemes mature, and more data is collected on the efficacy of various management actions in abating TP and TN, the relative merits of developing a more complex multi-parametric off-site stormwater scheme will be better understood.

5.10. Are Rainwater Tanks Cost Effective?

Rainwater tanks reduce stormwater pollution. Removal of the mandatory requirement for rainwater tanks (on the premise that they are costly) leads to increased size of bioretention systems thereby placing increased pressure to introduce stormwater offset schemes. Rainwater tanks provide multiple benefits (water supply, stormwater quality and reduced erosion). Most assessments have been based on a single benefit (i.e. cost of supply), or failure to properly account for the stormwater quality benefits. Generalisations regarding the costs and benefits of rainwater tanks

Discussion Point 9

Is TSS a suitable metric for off-site stormwater schemes?

are not necessarily useful, as their relative benefits and costs will be determined by:

- The levels of service from local water supply schemes and the relative costs of all available water supply options. This differs significantly between regions.
- For a household, the marginal cost of water supply from mains supplies to households. This is largely driven by existing tariffs and their design (access charges fees and volumetric charges). However, analysis suggests the net cost to a household of a rainwater tank is less than $2 per week (MainStream Economics and Policy, 2012). The net cost to a household is the cost of financing and operating a rainwater tank, less the avoided purchase price of water from mains supplies
- The degree to which rainwater tanks contribute to achieving stormwater management objectives and act as a substitute for other stormwater management options (e.g. by reducing the size requirements for bioretention systems). Recent analysis suggests that in developments where there is a material reduction in the size and footprint of bioretention, and where land costs for that bioretention system are accounted for, capital savings of up to $2600 per lot are possible, on top of the cost of the tanks. There are also ongoing benefits, in terms of avoided maintenance of downstream stormwater treatment systems and the utility value of the tank. Over 30 years, the saving could be $5200 per lot.

The case for or against rainwater tanks should be assessed at a local scale, given all relevant inputs and information. Generalisations are misleading at best, and at worst, could lead to very poor planning decisions.

Rainwater Tanks in Toowoomba

Toowoomba Regional Council recently completed a cost benefit analysis to determine if the compulsory installation of rainwater tanks would bring a net benefit to the community. The study identified cost savings in deferring or foregoing future supply and infrastructure requirements. Non-quantifiable benefits such as drought contingency, climate change resistance, consumer preference and demand management were taken into account when making the decision to make rainwater tanks compulsory for new detached houses and large commercial buildings. The scheme will commence in September 2014 (Toowoomba Regional Council, 2014).

5.11. Do Stormwater Management Regulations Have a Significant Impact on the Affordability of New Homes?

There have been significant pressures to relax stormwater management and other related regulations (e.g. rainwater tanks) under the guise of greentape reduction and the perceived impact of stormwater regulations on the cost of new housing, and housing affordability (particularly for first home owners).

Previous analysis (Mainstream Economics and Policy, 2012) indicates that, for detached dwellings stormwater quality management (including rainwater tanks) potentially adds 1.2% to the average price of a new home (with a range of 1.0–1.6%).The tradeoff with building an additional area of the actual house within the same construction budget is around 3.0m2 (with a range of 2.5–4.1m2).

For attached dwellings stormwater quality management (including rainwater tanks) potentially adds 1.2% to the average price of a new home (with a range of 1.0–1.7%) the tradeoff with building an additional area of the actual house within the same construction budget is around 1.7m2 (range 1.4–2.4m2).

There is significant evidence to suggest that the increases in new house prices in the past two decades is more a function of:

- Increased size (average new home is 40% larger than 25 years ago). This also results in higher ongoing costs including heating and cooling.
- Additional bathrooms, better fixtures in kitchens and bathrooms, and predominantly the rising cost of land due to scarcity.

It can therefore be concluded that stormwater management regulations are not the major driver of rising house prices and lower affordability. House cost increases are primarily due to consumer choice and a scarcity of available land in many areas. Furthermore, only around 15% of new housing stock is purchased by first home owners, the segment of the market that has the greatest financial hurdle to home ownership.

6. Future Stormwater Management: How Do Off-site Stormwater Schemes Fit?

This section builds upon the investigations and discussion presented in previous sections. It begins by outlining suggested principles for applying off-site stormwater solutions, and then discusses further elements that are likely to be present in any successful future off-site stormwater scheme. Some of these elements expand upon the suggested principles.

In recent years there has been a significant convergence in the international literature on key principles for offsets. This is particularly the case for biodiversity, vegetation and carbon. Less work has been done for off-site water quality solutions.

The following off-site stormwater principles, drawn from the international literature and informed by consultation that was conducted for this discussion paper, are proposed to guide the development of off-site stormwater schemes.

> **Discussion Point 10**
>
> Do the suggested principles include the major issues that need to be considered for a successful off-site stormwater scheme?

- Off-site solutions should not replace or undermine existing environmental standards or regulatory requirements. Rather, off-site solutions should be part of a cohesive suite of measures to address water quality objectives.
- Off-site solutions should only be used once reasonable technically feasible and cost effective measures to avoid and mitigate on-site impacts of development have been exhausted.
- Any approved off-site project should demonstrate the actions are additional to business as usual.
- Off-site solutions should be environmentally, temporally and spatially equivalent to the impacts from the development.
- Time lags between the impacts of the development and benefits of the off-site solution should be minimised.
- Off-site solutions must be underpinned by secure legal agreements or an appropriate formal mechanism to ensure their ongoing provision for the period of the development's impacts.
- Off-site solutions should be independently and transparently monitored and their performance evaluated.

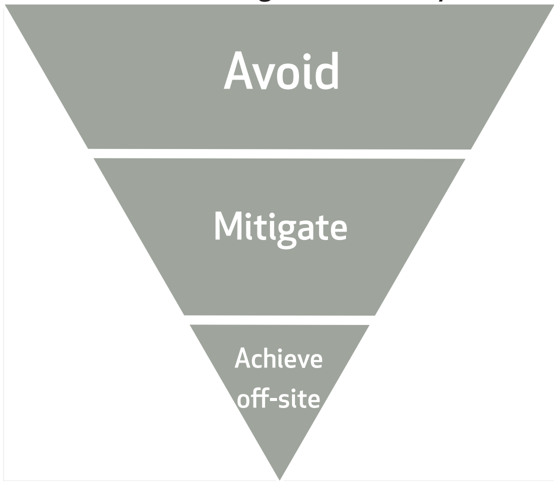
These principles are consistent with other applications of off-site solutions; provide an internally consistent suite of principles; and can be practically incorporated and implemented within the existing development regime in Queensland.

6.1. Planning Will be Undertaken

Successful off-site stormwater schemes will be underpinned by astute planning, such as total water cycle management planning. Successful planning will:

- ensure that prior to establishing an off-site stormwater scheme, local government has a clear understanding of the lifecycle costs, performance, and uncertainty associated with a range of both on-site and off-site stormwater management actions, that first avoid, mitigate and then deliver off-site stormwater solutions (Figure 8).
- ensure that off-site stormwater schemes deliver a net benefit. Net benefit can be defined as 'having an overall positive impact on relevant communities' (Standards Australia, 2014). Net benefit takes into account the costs and benefits relating to society and the community, the environment and the economy, noting that it can be very difficult to try to quantify social and environmental costs and benefits at a local (development level) scale. The WBD Business Case for best-practice urban stormwater management (WBD 2010) highlights some of the 'non-market' benefits of stormwater management including ecosystem services, recreation and community amenity. Multiple benefits associated with different stormwater management practices are included in Table 1 and could be considered to help assess net benefit. This will help to ensure that local government delivers an off-site stormwater scheme that is in the best interest of the community.
- provide all key stakeholders with the opportunity to participate in a relevant and meaningful way in developing an off-site stormwater scheme. This maximises the likelihood that the scheme will have broad organisational, industry, community and political support, and takes into account differing perspectives and values.
- be assisted if local government recognises and manages waterways as natural assets. This allows local government to understand current waterway values and desired future states. It also allows local government to know in which locations off-site solutions are permissible in lieu of on-site management. This enables local governments to explicitly and formally recognise the function of waterways within the broader economy and the fact that natural assets (and the services they provide) are often substitutes for built assets.
- give consideration for how off-site solutions will work alongside requirements for managing stormwater quantity (i.e. flood detention and waterway stability requirements).

Figure 8: Stormwater Management Hierarchy



6.2. Equivalence Will be Ensured

Successful off-site stormwater schemes will ensure that the outcomes delivered are environmentally, spatially and temporally equivalent to the practice that would otherwise be undertaken on-site. See Section 5.6 for further discussion of equivalence.

It is recognised that these tasks could be beyond the technical capacity or financial resources of individual local governments. Therefore, it would be prudent to establish a more generic framework and then use the existing suite of models to develop simple trading ratios used to calculate equivalence at a regional scale (e.g. SEQ, GBR catchments – wet tropics, GBR catchments – dry tropics). The trading ratios could then be used in a simple spreadsheet model to determine whether an off-site action is equivalent to the action that would have occured on the development site. The trading ratios would then in essence operate as a risk premium to account for the uncertainty in determining equivalence in many circumstances.

6.3. The Off-site Stormwater Solution Will be Appropriately Priced

Successful off-site stormwater schemes will establish an appropriate price for off-site solutions. The pricing regime of any off-site stormwater scheme will have a significant impact on whether developers choose to manage stormwater on-site or purchase an off-site solution. A developer will choose the option(s) that both meets their regulatory requirements and minimises costs.

A well priced off-site solution may cover:

- the capital cost of the off-site project
- the estimated present value of all future operating and maintenance costs for the off-site project
- a reasonable contribution towards the true cost of managing and administering the off-site stormwater scheme.

For an off-site solution to be appealing to local government, it should reduce the local government's lifecycle costs for managing stormwater compared to managing stormwater on-site. However, given that off-site solutions are a voluntary mechanism, the charge must also be set such that there is an incentive for developers to purchase the off-site solution. This might be achieved by establishing an off-site stormwater charge that is less than their likely cost of managing stormwater on-site. Currently the developer incurs capital costs of the project such as design, land, construction and establishment costs. These are recovered in the land price. Alternatively an incentive to purchase the off-site solution may be provided to developers by establishing a charge of similar magnitude to the on-site stormwater management costs incurred by development, and relying on reduced assessment times and increased certainty to provide an incentive for developers to adopt the off-site solution.

Finding an off-site stormwater charge that it attractive to both development and the local government will be assisted by choosing the off-site project with the lowest lifecycle costs (for example see Figure 3). This will allow greater scope for setting a charge that is low enough to appeal to developers, while still reducing the lifecycle costs incurred by the local government compared to managing stormwater on-site.

In order to be cost effective, Thurston (2012) recommends that off-site stormwater charges be based on marginal (incremental) costs rather than average costs. As land becomes scarcer, incremental costs of acquiring land and developing treatment systems could be significantly higher than historic or average costs.

It is anticipated that off-site stormwater scheme charges will vary between local governments, in part, due to differences in:

- the type of off-site projects most suitable in a given local government area
- land costs.

6.4. Off-site Stormwater Solutions Will be Procured in Advance

Procuring off-site solution in advance is common practice for other forms of off-site solution. Doing so helps to ensure equivalence by avoiding the risk of environmental harm caused by a time-lag in delivering the off-site solution, as well as ensuring off-site solutions are approved and delivered in an efficient manner. Long term cost savings may also result as economies of scale in asset delivery can be achieved.

Discussion Point 11

What issues need to be considered to ensure that procuring offsets in advance is feasible?

6.5. A Market for Off-site Stormwater Solutions Will be Established

With the exception of larger development projects, the current approach to managing stormwater, such as small scale stormwater treatment assets, provides little opportunity for strategic regional investment in stormwater management. This results in a high number of on-site action that, while meeting the performance requirements of the SPP (DSDIP, 2013), are unlikely to provide broader benefits such as recreation or biodiversity. A potential approach to enhance the effectiveness and efficiency of stormwater management could be to establish a market for off-site solutions within the suite of policies. This would require:

- an appropriate currency (TSS has been suggested)
- buyers (e.g. regulated development projects)
- sellers (e.g. landholders and entities with an interest and capacity to deliver off-site actions)
- an administrator and regulator to facilitate market transactions and ensure off-site outcomes are delivered.

At a regional (even catchment) scale, it should be relatively simple to forecast TSS abatement requirements based on existing planning information and development application forecasts. This can be used as a proxy for a regional demand forecast. Once this demand is understood, projects can be sought to meet the demand. Additional enhancements and efficiencies could include establishing larger and more efficient off-site stormwater projects (including projects that deliver multiple benefits) and then subsequently attributing these against multiple smaller projects as necessary. This would also reduce transaction costs.

Establishing larger off-site stormwater projects would enable the projects to be established and operational before the abatement they provide is required. This would reduce the uncertainty and costs of dealing with temporal equivalence in off-site solutions.

6.6. Clear, Accountable and Legal Administrative Systems Will be in Place

In order to provide confidence to regulators and the community, and allow for off-site stormwater schemes to be delivered efficiently, off-site stormwater schemes should have clear and accountable administrative systems for the collection and acquittal of off-site stormwater charges. These should be underpinned by secure legal agreements

Off-site stormwater schemes work within an existing regulatory regime. Because the off-site solution needs to provide enduring abatement, it will be necessary to establish arrangements that ensure off-site solutions are delivered and achieve the outcomes they set out to achieve. This will require either establishing:

- legally binding agreements between the off-site solution provider (e.g. a landholder) and the off-site solution scheme administrator
- some other form of agreement that ensures off-site projects are delivered. For example, where an off-site project is delivered on public land, arrangements may include ensuring public resources are set aside to ensure off-site projects are managed appropriately.

There is already a State-based register of off-site solutions administered by the State Government that could be expanded to administer all off-site stormwater solutions. The cost of this function should be included in the off-site solution charge. Irrespective of what agreements are put in place to secure the off- site solution, ongoing monitoring, evaluation and reporting of off-site solution performance should be undertaken. This is no different to managing the function and performance of other stormwater management assets.

6.7. Off-site Stormwater Projects Will be Monitored and Evaluated

Successful off-site stormwater schemes will monitor and evaluate off-site projects while and after they are implemented. This will assist to:

- demonstrate equivalency
- calibrate planning on future off-site stormwater solution to actual data on performance
- ensure off-site stormwater scheme processes are transparent and effective.

6.8. Sufficient Resources Will be Available for Maintenance

Regardless of whether off-site stormwater schemes result in stormwater treatment assets being constructed, or whether alternative actions are employed, off-site stormwater schemes will result in assets being constructed that require some level of maintenance. Successful off-site stormwater schemes will allocate sufficient resources and skills to maintain the assets that are created.

6.9. Administrative and Management Efficiencies Will be Achieved

Given the number of local governments in Queensland that effectively undertake the bulk of the development assessment, there are risks of:

- inconsistencies in the design and administration of off-site stormwater schemes
- duplication in technical assessment and administration
- low levels of effectiveness and efficiencies in establishing and maintaining off-site stormwater schemes.

The risk is that many of the efficiency gains from the use of off-site stormwater schemes would be negated through inefficient administrative management arrangements. There is the potential for inconsistencies and duplication to nullify the efficiency gains of establishing an off-site stormwater scheme. Therefore, it may be prudent for the State and local governments to pool resources and have a single body undertake many of the administrative tasks on their behalf. There is precedence for centralised offset administrative arrangements. For example, the Melbourne Water Stormwater Offsets and the NSW Biobanking Scheme, provide a clearing house for offset transactions and other related administrative functions.

Discussion Point 12

Does the list of proposed inclusions for a successful offset scheme cover all relevant issues? Are there additional issues to consider?

7. Next Steps

This discussion paper will be used to inform the development of a guideline on the use of off-site stormwater quality solutions.

Various questions are posed throughout the paper as starting points for a discussion on off-site stormwater solutions. Readers are encouraged to provide feedback to Healthy Waterways on the discussion paper or off-site stormwater solutions in general by 10 October 2014. Feedback can be provided by filling in the feedback form or online survey at www.waterbydesign.com.au/stormwater-discussion-paper. Feedback can be emailed to info@waterbydesign.com.au.

In addition, the following measures should be undertaken to improve the current implementation of on-site stormwater management:

- Further capacity building for water sensitive urban design, including clear policy, guidelines and training should be undertaken, particularly in relation to maintaining stormwater treatment assets. This ensures that on-site management meets best practice. This also helps overcome the issue of stormwater offset schemes being adopted as a reaction to poor design and delivery.
- Research as part of this discussion paper has shown low impact design approaches which seek to avoid the impacts of stormwater are the most cost effective, with little to no ongoing maintenance. The Low Impact Design policy approach should also be investigated to determine the future potential for delivering this approach for stormwater management.

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Appendix 1 –Lifecycle Costing Graph (Figures 3 and 4) Methodology

Key assumptions underpinning the lifecycle cost analysis are outlined below:

- The stormwater quality treatment measures have been sized to comply with Table B of the State Planning Policy (DSDIP, 2013).
- Stormwater offset charge: $45,000 per hectare of development (typical of the rate currently used in emerging stormwater offset schemes)
- Lifecycle: 30 yrs
- Net Present Value (NPV) discount rate: 5%

Bioretention notes:

- The bioretention systems were assumed to be undertaken at a mid-scale, serving a development of 1 ha each.
- Catchment: 55% impervious, without rainwater tanks.
- Bio-retention size: 100 m^2 per hectare (1% of catchment area).
- Construction cost: $300 per m^2, which is at the lower bound of MUSIC default costs and reflects recent cost estimates obtained by Bligh Tanner. It is possible costs could be as high as $450/$m^2$ and as low as $250/$m^2$.
- Annual maintenance cost: $5/$m^2$/yr per Healthy waterways and Melbourne Water data.
- Annual establishment cost: 3 x maintenance cost, as per MUSIC, factor based on professional experience.
- Establishment period: 2 yrs.
- Annual renewal cost: $6/ m^2/yr (2% of construction cost), as per MUSIC default
- Decommissioning cost: disregarded –Melbourne Water states there is no data.
- Footprint: twice filter media area, based on professional judgment of total footprint required for medium-scale bioretention systems.
- Land cost: $300 per m^2 based on typical sale prices of residential lots.
- Design cost: 5% of construction cost. This would be higher if the designs were particularly novel.

Large Wetland notes:

- The wetland was assumed to be undertaken at a regional level, serving a 10 ha catchment. The following assumptions were made for the wetland:
- Catchment: 40% impervious (terrain that would support a large wetland would typically have more greenspace than the catchment for the bioretention scenario), without rainwater tanks.
- Wetland treatment size: 8500 m^2 (8.5% of catchment area), made up of:
- Macrophyte zone: 7500 m^2
- Inlet zone: 820 m^2 - Inlet pond targeted at 90% of 250 micron particles (fine sand)
- Construction cost: $100 per m^2, based on MUSIC costing data, Melbourne water data and professional experience.
- Annual maintenance cost: $2/$m^2$/yr based on Melbourne water data (Healthy waterways data suggests $5/$m^2$/yr)
- Annual establishment cost: 3 x maintenance cost, as per MUSIC, factor based on professional experience.
- Establishment period: 2 yrs.
- Annual renewal cost: $0.52/$m^2$/yr (0.52% of construction cost), as per MUSIC defaults
- Decommissioning cost: disregarded. Melbourne Water states there is no data, and for a wetland this is likely to be low-cost.
- Footprint: 1.5 times the functional area (macrophyte and inlet zone), based on professional experience.
- Land cost: $50 per m^2, based on sale prices of large development lots.
- Design cost: 5% of construction cost, based on professional experience.

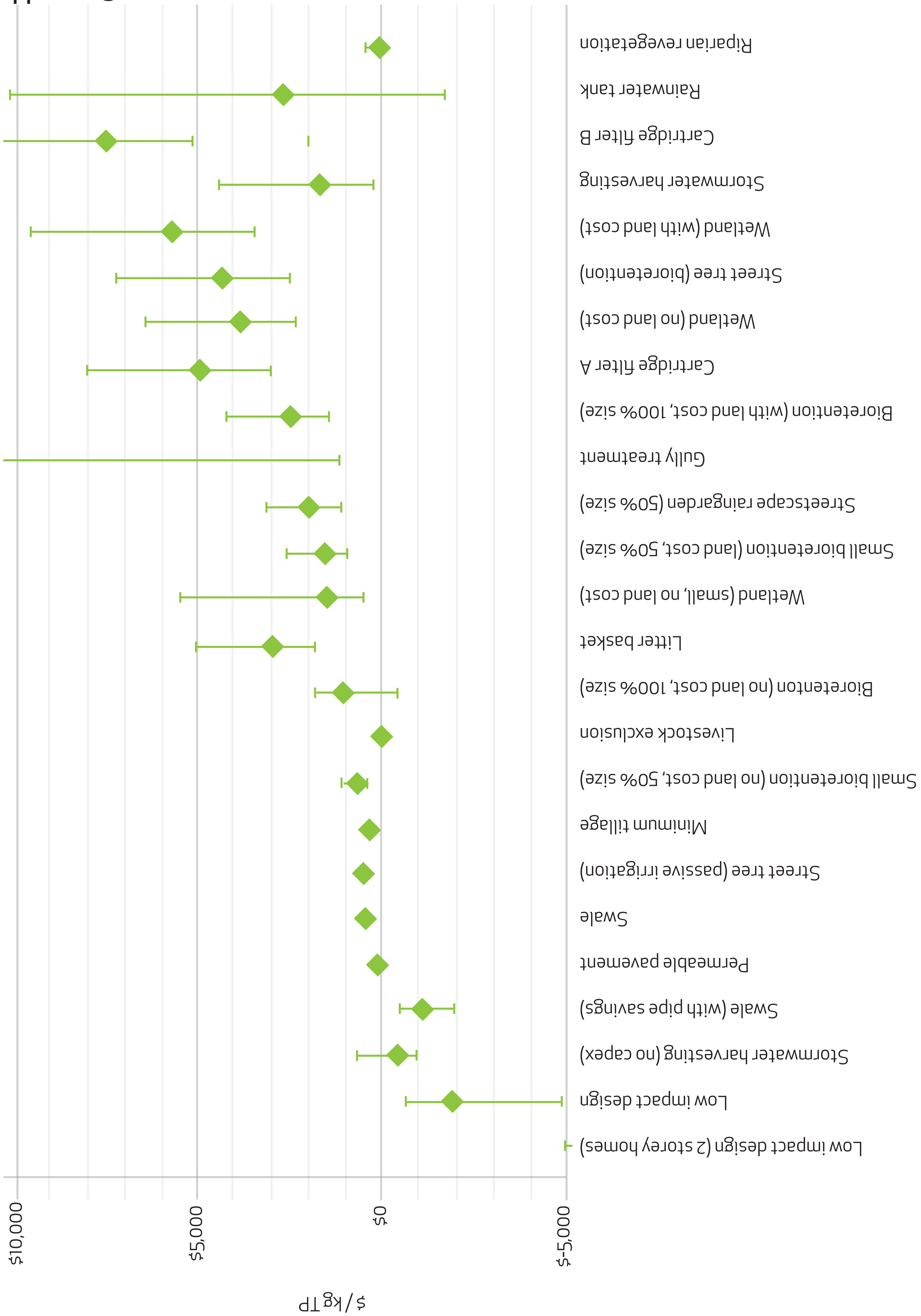
Small Wetland notes:

- The wetland was assumed to be undertaken at a regional level as an urban retrofit project, serving a 30 ha catchment. The following assumptions were made for the wetland:
- Catchment: 40% impervious (terrain that would support a large wetland would typically have more greenspace than the catchment for the bioretention scenario), without rainwater tanks.
- Wetland treatment size: 4250 m^2 (1.4% of catchment area), made up of:
- Macrophyte zone: 3700 m^2
- Inlet zone: 410 m^2
- Construction cost: $100 per m^2, based on MUSIC costing data, Melbourne water data and professional experience.
- Annual maintenance cost: $2/$m^2$/yr based on Melbourne water data (Healthy waterways data suggests $5/$m^2$/yr)
- Annual establishment cost: 3 x maintenance cost, as per MUSIC, factor based on professional experience
- Establishment period: 2 yrs.
- Annual renewal cost: $0.52/$m^2$/yr (0.52% of construction cost), as per MUSIC defaults
- Decommissioning cost: disregarded. Melbourne Water states there is no data, and for a wetland this is likely to be low-cost.
- Design cost: 5% of construction cost, based on professional experience.

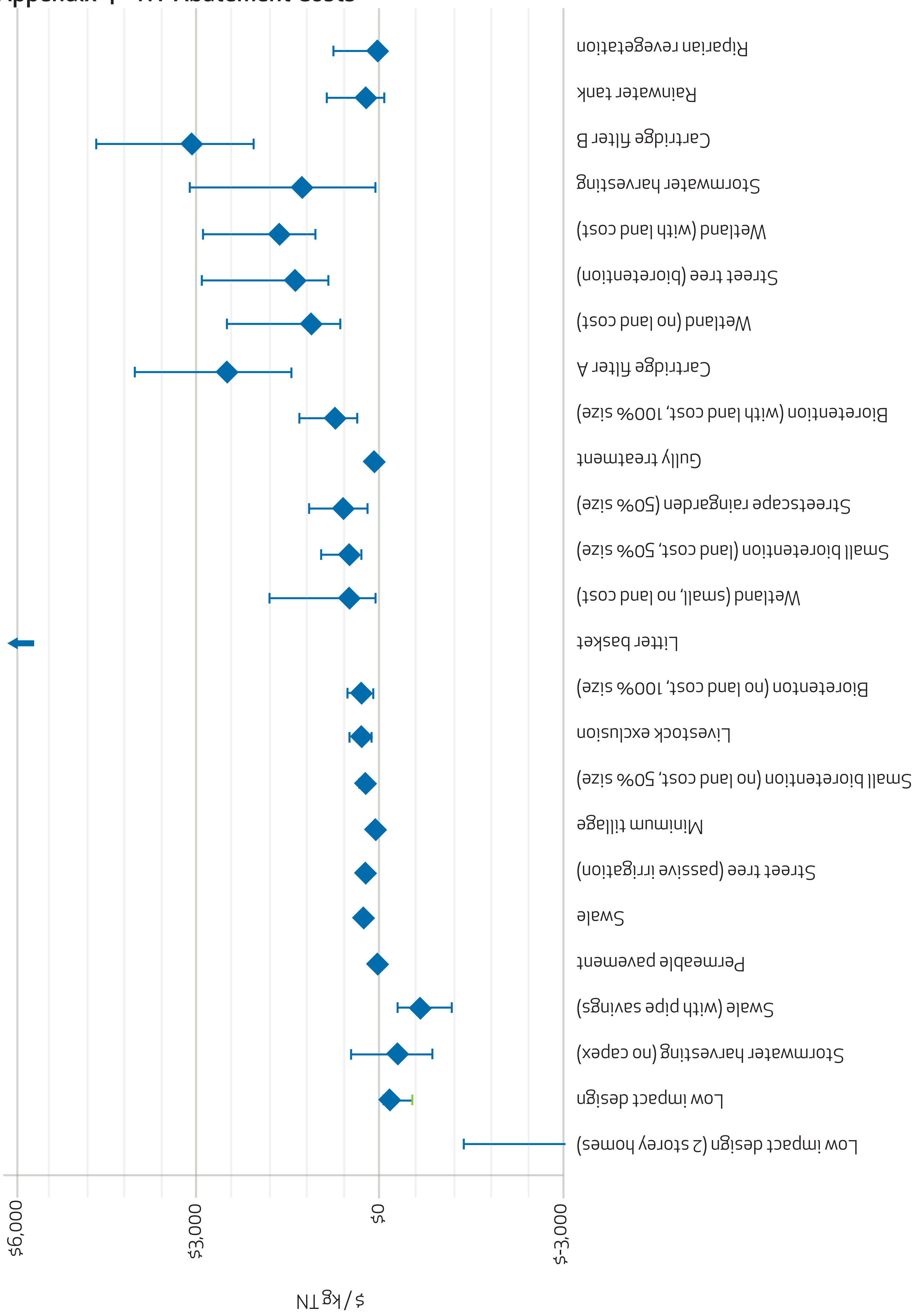
Appendix 2 – Tabular data relating to cost abatement curves

DESCRIPTION	TSS			TP			TN		
	high	med	low	high	med	low	high	med	low
	$ / tonne	$ / tonne	$ / kg	$ / kg	$ / kg	$ / kg	$ / kg	$ / kg	$ / kg
Low impact design (2 storey homes)	-$97,577	-$84,567	$15,012	-$37,894	-$32,842	$5,053	-$9,957	-$8,629	$1,328
Low impact design	-$1,677	-$4,471	-$11,179	-$709	-$1,890	-$4,725	-$86	-$228	-$571
Stormwater harvesting (no capex)	$4,988	-$3,228	-$8,158	$717	-$464	-$1,172	$543	-$352	-$888
Swale (with pipe savings)	-$2,840	-$1,704	-$1,022	-$1,907	-$1,144	-$686	-$1,154	-$693	-$416
Permeable pavement	$22	$37	$62	$14	$23	$39	$4	$7	$12
Swale	$1,053	$632	$379	$707	$424	$254	$428	$257	$154
Street tree (passive irigation)	$1,376	$825	$495	$820	$492	$295	$267	$160	$96
Minimum Tillage	$419	$833	$1,247	$291	$205	$119	$39	$31	$24
Small bioretention (no land cost, 50% size)	$2,050	$1,230	$738	$1,202	$721	$433	$408	$245	$147
Livestock exclusion	$989	$1,446	$1,903	$2	$1	$1	$499	$377	$255
Bioretention (no land cost, 100% size)	$3,455	$2,073	$1,244	$1,869	$1,122	$673	$591	$354	$213
Litter basket	$3,627	$2,176	$1,306	$5,157	$3,094	$1,856	$52,168	$31,301	$18,780
Wetland (small, no land cost)	$9,023	$2,528	$684	$5,400	$1,513	$409	$1,828	$512	$138
Small bioretention (land cost, 50% size)	$4,532	$2,719	$1,632	$2,657	$1,594	$956	$902	$541	$325
Streetscape raingarden (50% size)	$5,522	$3,313	$1,988	$3,271	$1,963	$1,178	$1,104	$663	$398
Gully Treatment	$8,568	$4,290	$11	$979,673	$490,465	$1,258	$0	$108	$215
Bioretention (with land cost, 100% size)	$7,638	$4,583	$2,750	$4,133	$2,480	$1,488	$1,306	$783	$470
Cartridge Filter A	$10,512	$6,307	$3,784	$8,209	$4,926	$2,955	$4,138	$2,483	$1,490
Wetland (no land cost)	$11,556	$6,934	$4,160	$6,400	$3,840	$2,304	$1,935	$1,161	$697
Street tree (bioretention)	$12,178	$7,307	$4,384	$7,260	$4,356	$2,614	$2,360	$1,416	$849
Wetland (with land cost)	$17,203	$10,322	$6,193	$9,528	$5,717	$3,430	$2,880	$1,728	$1,037
Stormwater Harvesting	$30,224	$11,913	$927	$4,341	$1,711	$133	$3,291	$1,297	$101
Cartridge Filter B	$18,617	$12,271	$8,464	$11,512	$7,588	$5,234	$4,786	$3,155	$2,176
Rainwater tank	$51,317	$14,052	-$8,307	$10,164	$2,783	-$1,645	$824	$226	-$133
Riparian Revegetation	$108,733	$16,754	$2,123	$228	$35	$3	$816	$36	$2

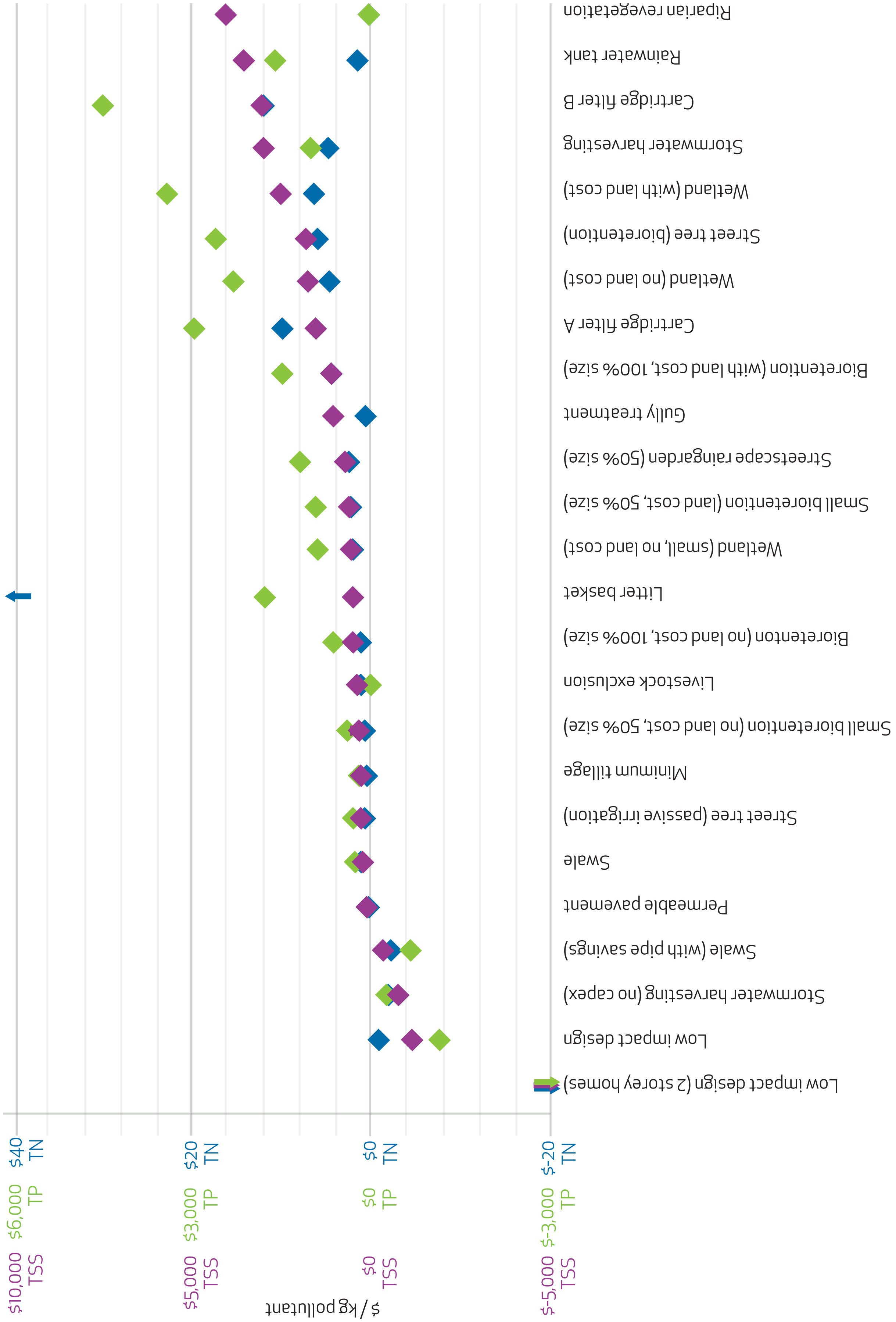
Appendix 3 – TP Abatement Costs



Appendix 4 - TN Abatement Costs



Appendix 5 – Combined Graph of TSS, TP and TN Abatement Costs



Appendix 6 – Interest in Off-site Stormwater Schemes in Queensland

A number of local governments throughout Queensland were contacted in January and February 2014 to understand their interests in off-site stormwater solutions and determine their progress towards developing an off-site stormwater scheme.

Mackay Regional Council

Mackay Regional Council (MRC) has been investigating an alternative that allows some developments to meet their on-site operational phase stormwater quality objectives through MRC's planned regional water quality improvements. The alternative is called the 'Voluntary Mechanism for Stormwater Quality Management' and depending on the receiving environment, developments may be able to transfer part or all of their operational phase stormwater quality management to regional stormwater quality improvements overseen by MRC. Developments where the voluntary mechanism has been applied will still need to achieve their construction phase stormwater quality objectives and manage their stormwater quantity in accordance with the State Planning Policy, Mackay Planning Scheme and the Queensland Urban Drainage Manual (DEWS, 2013). The development of the policy for the mechanism has involved extensive consultation; and implementation of the mechanism is to be overseen by a working group. The policy will be reviewed annually to ensure that the policy is leading to improved water quality outcomes for the region.

Moreton Bay Regional Council

There is some interest in off-site stormwater solutions in Moreton Bay Regional Council (MBRC) however it has not been explored in detail (MBRC, 2014, pers. comm., 20 January).

Sunshine Coast Regional Council

The Sunshine Coast Regional Council (SCRC) is considering off-site stormwater solutions for those developments that fall below the SPP threshold. Currently SCRC does not have a minimum lot size specified in their planning scheme and all developments require water quality management. However, their planning scheme is currently under review and SCRC may not need an off-site stormwater scheme if the SPP threshold is adopted into the updated planning scheme. SCRC has been working with developers to get good WSUD outcomes for small constrained lots (SCRC pers. comm. 20 January 2014). Further, SCRC have a good handle on asset handover and have regular maintenance of their vegetated stormwater assets (SCRC, 2014, pers. comm., 29 January).

Ipswich City Council

In December 2012, Ipswich City Council (ICC) amended its Implementation Guideline No. 24 Stormwater Management to allow voluntary water quality payments to be made in-lieu of on-site water quality treatment. The Guideline was updated in February 2014 and now refers to a 'Voluntary Water Quality Nutrient Offset Payment'. The voluntary payment is calculated based on the rate per square metre of water quality treatment area (bio-retention filter area) that would otherwise be required. The Guideline notes that the voluntary payment will "provide cost savings for development" (ICC, 2014). The charge does not include the cost of land (ICC, 2014, pers. comm., 10 January). ICC is planning to develop regional solutions on crown land, ICC owned land or work in partnership with other land owners.

The voluntary payment may be provided where development is located outside a sensitive catchment and where:

- "the catchment is mostly urbanised or is a small parcel of land within a broad land release area (in essence, infill development); or
- the waterway downstream is in poor condition; or
- the waterway downstream is not sensitive to hydrologic change resulting from development (i.e. there is no risk of increased waterway erosion)" (ICC, 2014).

Key waterway outcomes being sought by ICC include erosion and sediment control, disconnection of impervious areas and protection of base flows. Off-site stormwater are seen as one mechanism for delivering these outcomes. Primary delivery will be about protecting local waterways (ICC, 2014, pers. comm., 10 January).

ICC is continuing to undertake studies and further work to finalise the framework for delivery of the off-site stormwater scheme. For example, a waterway condition assessment is being completed to help understand catchment condition and values and an off-site stormwater implementation plan is in the process of being developed".

Implementation Guideline No. 24 is available on-line at http://www.ipswichplanning.com.au/planning-documents/planning-scheme#scheme

Logan City Council

The former State Panning Policy 4/10 Healthy Waters provided for an off-site solutions where on-site treatment is unfeasible to mitigate the adverse environmental impacts of development. Logan City Council (LCC) first applied off-site stormwater solutions in lieu of on-site treatment to satisfy the obligations of the State Planning Policy 4/10 Healthy Waters approximately three years ago for infill, constrained type development. Legal advice was obtained by LCC which confirmed Council was able to take advantage of the environmental offset condition under section 346A of the SPA. LCC has established a trust account and an internal record keeping and auditing procedure for receiving offset payments.

In April 2013, LCC endorsed the Stormwater Quality and Flow Management Guidelines. It incorporated legislative updates which had occurred at the time and provided the option of off-site stormwater solutions in lieu of on-site stormwater treatment for development to comply with the SPP 4/10. Off-site stormwater solutions have been included in Council's Draft Planning scheme (see Planning Scheme Policy 5 – Infrastructure 2.4.1 (4)) which has been through the first state interest check.

LCC "will consider an off-site stormwater solution in the form of a financial contribution in lieu of on-site treatment for proposed developments where:

- the waterway stability design objective and frequent flow design objective are not applicable (Section 5 & 6 of LCC's Guideline); and
- Council has appropriate off-site stormwater solutions designed and costed that will achieve a similar or better water quality outcome as that required by the proposed development at the time the development application is made; and
- On-site treatment is determined to be unfeasible" (LCC 2013, Section 4.3.2.1).

The current charge rates per hectare of development are (LCC, 2014, pers. comm., 30 January):

- Residential, Western region $46,800
- Residential, Greater Brisbane $54,000
- Commercial, Western Region $54,000
- Commercial, Greater Brisbane $57,600

LCC is concerned about protecting the local waterways, as well as Moreton Bay. Whilst the first priority is to achieve the required off-site stormwater solutions, LCC would not undertake a project that resulted in a poor amenity and aesthetic outcome.

LCC's Stormwater Quality and Flow Management Guidelines (July 2013) are available on-line:

www.logan.qld.gov.au/_data/assets/pdf_file/0005/9176/Stormwater-Quality-and-Flow-Management-Guidelines.pdf

LCC's Draft Planning Scheme is available on-line:

www.logan.qld.gov.au/planning-and-building/planning/draft-planning-scheme/draft-logan-planning-scheme-2014

Townsville City Council

Townsville City Council (TCC) is in the early stages of investigating an off-site stormwater scheme. They still require budget approval (2014-2015 financial year) to develop a strategy for regional stormwater quality improvement schemes. As part of the strategy, TCC plans to examine:

- Potential sites for regional stormwater quality improvement;
- Expected water quality improvement outcomes;
- Costs, business case and funding model for regional stormwater quality improvement schemes.

TCC plan to have some on-site requirements, as they don't want to lose the holistic guiding principles of WSUD. They still want good urban design. TCC plan to include the land cost in the off-site stormwater solutions charge, but this cost will be balanced against the cost of providing water sensitive urban design on-site. Currently there is a mixture of Council owned and private land where regional stormwater management could be delivered. TCC are planning to follow a catchment by catchment approach. Priorities include meeting the SPP and protecting both local waterways and the reef (TCC, 2014, pers. comm., 15 January).