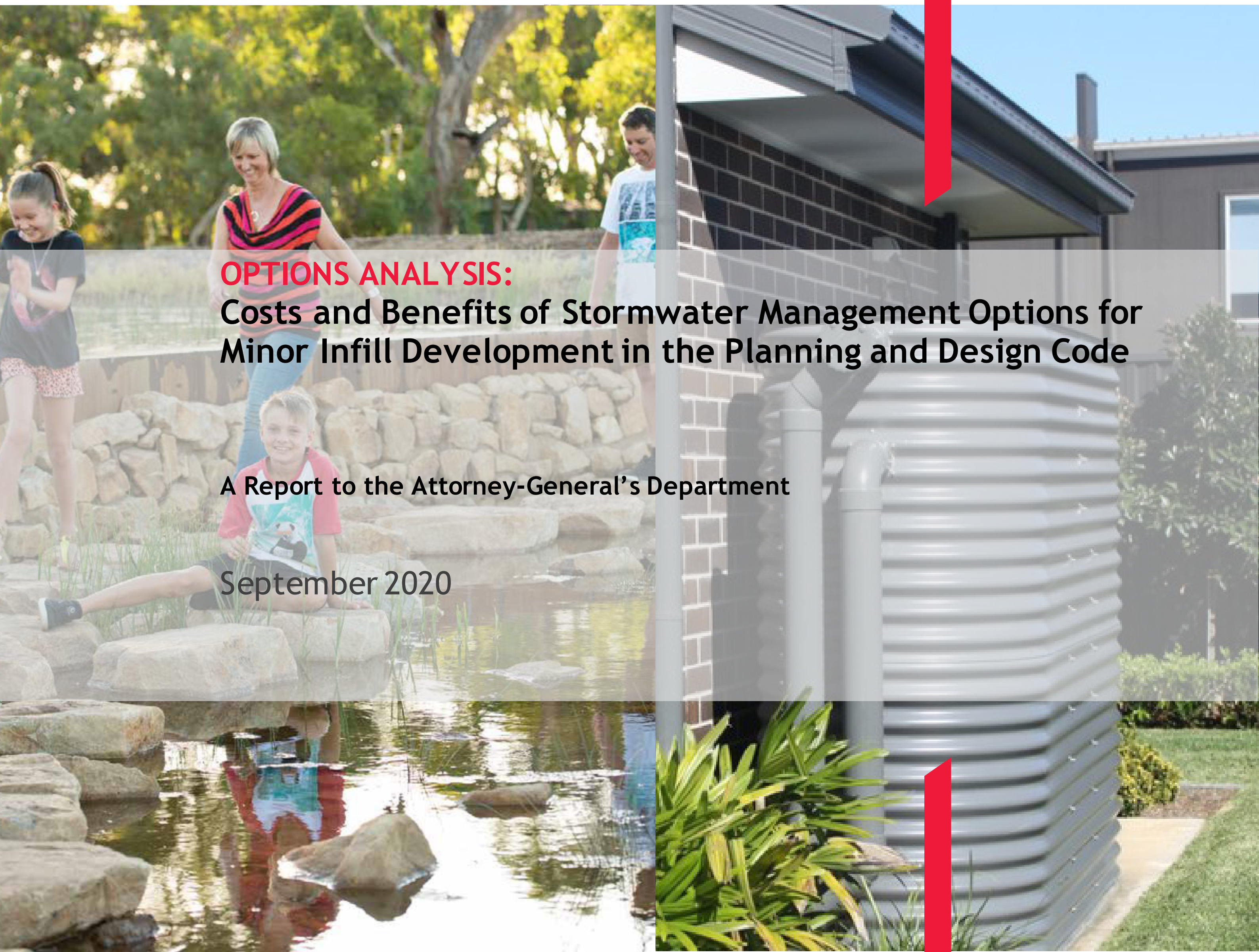

OPTIONS ANALYSIS:
Costs and Benefits of Stormwater Management Options for Minor Infill Development in the Planning and Design Code

A Report to the Attorney-General's Department

September 2020

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ACKNOWLEDGMENTS

This study was commissioned and project managed by the Attorney-General's Department's (AGD) Planning Reform area. The development of this study was guided by an Across Agency Working and Steering Group which included representatives from:

- AGD (Planning Reform and Sustainability and Environment areas)
- Department of Environment and Water (Green Adelaide and Urban Water areas)
- Wellbeing SA.

A Stakeholder Reference Group provided feedback on the draft project scope and included representatives from the following organisations:

- Department of Treasury and Finance
- Housing Industry Association (HIA)
- Master Builders Association (MBA)
- Urban Development Institute of Australia (UDIA)
- Local Government Association of South Australia (LGA)
- Stormwater Management Authority
- Premier's Climate Change Council
- Water Sensitive SA
- Stormwater SA
- Australian Institute of Landscape Architects (AILA)
- Australian Institute of Architects (AIA)
- Conservation SA
- South Australian Council of Social Services (SACOSS)
- Property Council of Australia
- Community Alliance.

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Name of Client: Attorney-General's Department

Name of Project: OPTIONS ANALYSIS: Costs and Benefits of Stormwater Management Options for Minor Infill Development in the Planning and Design Code

Document Version: 7

Job Number: ES2001

#15766943

EXECUTIVE SUMMARY

Major Findings

To determine the most cost-effective way to balance stormwater management and urban infill outcomes, this study tested three policy options for the new Planning and Design Code (the Code):

- Option 1a: Draft Code policy for onsite retention tanks
- Option 1b: Addition of onsite detention capacity to Draft Code policy
- Option 2: Offsite management in wetlands or biofilters, via an offset scheme.

Additional tank costs will generally be offset by water bill savings for individual households that increase their retention tank capacity and plumb the tank into all non-potable water sources.

One of the aims of stormwater management is to reduce peak flows. Lower peak flows would flatten the flood curve, reducing the risk of property damage and the upgrades required to Council drainage systems. For individual households, detention capacity is the most crucial factor in managing peak flows. Onsite detention capacity should therefore be included in new Code policy. This would improve the Code’s contribution to meeting peak flow policy targets, and would be more cost-effective for the community than requiring retention tanks alone (i.e. Option 1b is more cost-effective than Option 1a).

In areas where there are currently no requirements for onsite detention tanks, adding a requirement for detention tanks would significantly improve community outcomes. This is because adding onsite detention capacity would enable some stormwater system upgrades to be delayed or avoided entirely.

Managing stormwater offsite through wetlands and biofilters (Option 2) would deliver a better community outcome than onsite management (Options 1a or 1b). This is due to avoided tank costs, improved water quality, and improved neighbourhood amenity. However, this option will not be practical in every scenario. Feasibility is dependent on a range of variable factors. This option would require further investigation as part of a future Code generation.

Purpose of this Report

BDO EconSearch and Tonkin Engineering have been commissioned by the Attorney-General’s Department, Department for Environment and Water, Department of Treasury and Finance, and SA Health to analyse the cost-effectiveness of the proposed Planning and Design Code policies for minor infill, in relation to:

- Stormwater management and rainwater tanks (*this report*)
- Tree canopy cover and the ‘One Tree Policy’ (*refer to separate report*).

The State Planning Policies give direction to improving water sensitive urban design outcomes, in recognition of the multiple benefits they provide. Draft Planning and Design Code (Code) policies have been prepared and consulted on in response to this direction.

Feedback received during the Code’s consultation indicates there is a dichotomy of views in community and industry about whether the proposed stormwater management policies for minor infill developments go too far, or not far enough. Concerns included, on one side, the potential impacts on upfront housing affordability from higher rainwater tank supply and installation costs, and on the other side, the potential costs of enlarging underground drainage networks, and the potential of inadequate onsite stormwater management to increase nuisance flooding of streets, flood damage to property, watercourse erosion, pollution of receiving waters like Gulf St Vincent, and damage to metropolitan Adelaide beaches. It is important to respond to these concerns with an independent and sound evidence base.

This report is intended to inform decision-making on the cost-effectiveness of proposed Code policy, alongside other feedback. It aims to improve understanding of all the up-front and long-term costs and benefits of the proposed policies to the individual household and the Greater Adelaide community, and ensure they can be weighed up objectively.

Balancing stormwater management and urban infill outcomes

Minor infill is now the single largest provider of new housing in Greater Adelaide, with a net annual increase of about 2,500 residential dwellings. The *30-Year Plan for Greater Adelaide (2017 Update)* (the 30-Year Plan) has a target for 85 per cent of all new housing to be built within the existing urban footprint, because infill development helps to create walkable neighbourhoods, protect valuable farming and environmental land, and meet consumer demand for living close to jobs, shops, and services.

South Australia also has a Water Sensitive Urban Design Policy, with objectives to support the sustainable and climate resilient use of water resources; to protect the health of water dependent ecosystems; to manage flood risks; and to encourage integrated planning and design. The policy has a number of performance targets, including for runoff quality (achieving minimum reductions in exported pollutant load) and for runoff quantity (ensuring the runoff rate does not exceed pre-development levels or the capacity of the drainage system). Apart from the critical stormwater management outcomes that are the aim of this policy, water sensitive urban design can have other benefits, such as capturing water for reuse by households, improving the amenity of our streetscapes, and contributing to cooler, greener and more liveable suburbs.

There is evidence minor infill has contributed to a significant increase in peak flows, the frequency and volume of runoff, and exported pollutant load. This is because infill development increases density and can create up to 90 per cent impervious surfaces, which is considered 2.5 times higher than most existing drainage systems were designed for.

In order to meet both desired policy outcomes – more infill and effective stormwater management – while ensuring consistency across Greater Adelaide, it is important to establish Planning and Design Code policies that find the best balance between up-front and long-term costs and benefits, for both individuals and the community.

Testing the effectiveness of rainwater tank policies

Current policies

For infill development, individual households are currently required to help manage stormwater onsite by using rainwater tanks.

The Residential Code requires a 1kL retention tank plumbed to one water source (e.g. a toilet or laundry tap), in line with the Building Code of Australia.

Many of the Development Plans in metropolitan Adelaide require a retention tank (ranging from 1kL to 5kL). Others require a combination retention and detention tank system. Almost all rely on broader stormwater detention policies that require development to restrict flows to those expected in a pre-development state[1].

Proposed Code policy

The draft Planning and Design Code contains the following deemed-to-satisfy[2] provisions for minor infill:

- Allotments <200m², minimum site perviousness 15%, minimum retention tank 2kL
- Allotments 200 - 400m², minimum site perviousness 20%, minimum retention tank 3kL
- Allotments 401 - 500m², minimum site perviousness 25%, minimum retention tank 5kL.

> **Retention vs. Detention**
>
> **Retention tanks** (standard rainwater tanks) are designed to harvest water for future use. They are frequently already full when it rains. However, plumbing tanks into more non-potable uses inside the home may increase their 'detention effect', because the tanks are less likely to be full when it rains.
>
> **Detention tanks** are designed to flatten the flood curve during storm events, by capturing and then slowly releasing water over time. They are generally empty when it starts raining.
>
> In existing Development Plans, councils often encourage households to **combine retention and detention capacity in one tank**. This can be done simply and inexpensively by adding an outlet in the side of the tank. The tank volume above the outlet is the detention capacity.

The policy also stipulates the proportion of the roof area the tank must be connected to, and that the tank be plumbed into all toilets, and either the laundry cold water outlets or the hot water service. Discounts on tank sizes are available if the pervious area of the site is increased.

Are they effective?

When considering the effectiveness of rainwater tank policies, there are three factors to consider: peak flows, the frequency and volume of runoff, and exported pollutant load.

There is a direct correlation between increases in impervious surfaces and increases in both the frequency and volume of runoff, and the exported pollutant load. Therefore these factors are more readily managed through consistent state-wide policies. Recent South Australian modelling has shown that the **draft Code**

[1] Generally based on either a 5-year Average Recurrence Interval (ARI) or 10-year ARI.

[2] A deemed to satisfy policy is a measurable criteria that is one way of meeting a performance outcome in the Planning and Design Code. Applicants can instead choose alternative solutions that meet the relevant performance outcome.

provisions will achieve satisfactory reductions in runoff frequency and volume, and in exported pollutant load[3].

Managing peak flows is more challenging however. Peak flows are impacted by variable factors like the timing and duration of rainfall, distance from the end of the system, and the characteristics of the catchment. These effects are one reason the policies in existing Development Plans are so diverse, and they make it challenging to apply state-wide policies that will effectively manage peak flows. In fact, modelling shows that the **draft deemed-to-satisfy provisions in the Code will not fully meet the requirement**[4] **for reducing peak flow discharges to pre-development levels.**

Key conclusions from the research are that retention systems alone will not reduce peak flow to match pre-development levels[5]; but onsite retention combined with onsite detention can produce substantial reductions in peak flow. Based on these findings, **it is recommended that the draft Code policy be modified to include a provision for onsite tanks that combine retention and detention capacity**.

Another way to help reduce peak flows is to increase the 'detention effect' of retention tanks, by plumbing them into more non-potable household uses. The rainwater being stored is more likely to be used by the household, making it more likely there will be some room in the tank when it starts raining. This strategy can contribute to overall storage capacity during a rainfall event, but it is not as reliable as a detention tank because it is dependent on household behaviour, and the amount of time between rainfall events.

[3] To within 10 per cent of the pre-development flow.

[4] As outlined in the associated Planning and Design Code performance outcome, which is based on South Australia's Water Sensitive Urban Design Policy.

[5] Unless all infill households use the retained water at very high rates, typically considerably higher than all internal household uses. This scenario is highly unlikely.

Methodology

Which options have been analysed?

The cost benefit analysis tested three policy options against the base case. The purpose of this approach is to test whether the Draft Code policies stack up against the current South Australian policy requirements[6]. Note that the tested policies are being considered for minor infill sites only, not for greenfield developments where responsibility and costs for constructing the stormwater network are borne by the developer.

The base case scenarios and policy options analysed were:

- **Base Case Scenarios - Two 'business as usual' catchment-scale scenarios:**
  - City of Marion Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)
  - More Typical Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention).
- **Base Case Scenarios - Three 'business as usual' dwelling-scale scenarios:**
  - City of Marion Development Plan – 5kL retention tank
  - More Typical Development Plan – 1kL retention plus 2kL detention tank
  - Residential Code – 1kL retention tank.
- **Option 1a - Retention tank required (draft Code policy).**
  The proposed deemed-to-satisfy provision for minor infill to provide a 3kL retention tank[7].
- **Option 1b - Retention and detention tank required.**
  As per Option 1a, with the addition of 1kL detention capacity to contribute to peak flow management.
- **Option 2 - Offset scheme.**
  No provision for onsite rainwater tanks. Stormwater impacts of infill development are addressed offsite in wetlands or street scale biofilters[8], funded by an offset scheme.

Reflecting diverse requirements

Current rainwater tank requirements vary greatly across Greater Adelaide, so it is challenging to define a single 'average' requirement. Instead, our two base cases represent the scenario for our case study catchment in the City of Marion (without detention), and a more typical catchment (with detention).

Under these two scenarios, the weighted average requirements are:

City of Marion Catchment – 2.4kL retention

More Typical Catchment – 1kL retention + 1.8kL detention

[6] Under the Building Code of Australia, all new houses are required to have a 1kL retention tank installed and plumbed into one non-potable outlet (a toilet, laundry tap or hot water system). In South Australia, additional requirements for onsite detention, retention and reuse of stormwater are commonly applied through Council Development Plans. These requirements vary, and do not apply to complying developments approved though the State's Residential Code.

[7] The Draft Code policy provides for a 2kL, 3kL or 5kL retention tank, depending on allotment size. Our analysis indicated that most potential minor infill developments would occur on allotments between 200m² and 400m², resulting in a 3kL rainwater tank provision for most minor infill dwellings.

[8] Other offsite strategies were found to be of greater cost and lower performance, so were not considered further.

To check if proposed policy options will add or subtract value, we needed to clearly define an accurate base case – that is, what happens with stormwater management in minor infill developments now. This was a key part of this project. We use two catchment-scale scenarios, representing a catchment *without* a detention tank requirement (our case study catchment in the City of Marion), and a catchment *with* a detention tank requirement (a more typical scenario)[9]. We also used three dwelling-scale scenarios, representing the three assessment pathways considered in our case study catchment. Each policy option was compared against each base case scenario.

The variable factors applying to peak flows and flood management make it extremely difficult to extrapolate a cost benefit analysis over every catchment in Greater Adelaide. A case study catchment[10] has therefore been selected to enable examination of each of the policy options **on a per catchment basis** instead. This case study catchment is not intended to be a proxy for the wider Greater Adelaide area. However, it is intended to illustrate the **relative costs and benefits** of each of the policy options.

What is a cost benefit analysis, and why have we taken this approach?

A cost benefit analysis is undertaken to enable all quantifiable costs and benefits of various policy options to be considered on an even playing field. This includes testing the likelihood and significance of any net costs or benefits. The aim of using this approach is to ensure the Planning and Design Code uses the most cost-effective and beneficial solutions to meet the desired policy outcomes.

In determining the costs and benefits of the two policy options, it is important to distinguish between who is accruing the costs and the benefits. The analysis was therefore undertaken at two levels:

- **At the community level** – expected costs and benefits (both monetary and non-monetary) accruing to people (households, businesses and government) and the environment in a catchment, as a result of the proposed options.
- **At the individual household level** – expected cost and benefits (monetary only) accruing to the household undertaking the development, as a result of the proposed options.

A cost benefit analysis has limitations. It can only include costs and benefits that are quantifiable in dollar terms, backed by the best available, relevant and defensible information. It provides an indication of the likelihood and significance of costs and benefits, but due to the many variables at play, it is not possible to identify the exact net cost or benefit applicable to every individual household in every possible scenario.

The analysis was conducted over a 25-year period. Results were expressed in terms of net costs or benefits – that is, how each option compared against the base case, in real terms (i.e. 2020 dollars). The criteria measured is Net Present Value (NPV). Where NPV is a positive, this shows a net benefit, and where negative, a net cost.

[9] For a realistic representation of the base case, Councils with high numbers of infill developments were asked how many applications are typically approved under the Residential Code, and how many under the Development Plan. The 'Marion Catchment' base case represents the requirements of the case study area in the City of Marion, with 64% of developments meeting Residential Code requirements (1kL retention tank) and 36% meeting City of Marion Development Plan requirements (5kL retention). The 'Typical Catchment' base case represents a more typical requirement, with 10% of developments meeting Residential Code requirements (1kL retention tank) and 90% meeting typical Development Plan requirements (2kL detention + 1kL retention).

[10] The case study is the Frederick Street catchment in Glengowrie within the City of Marion, one of only two catchments in Adelaide with a long-term flow record. A number of previous investigations have modelled the effects of infill development on flow peaks and volumes in the catchment, with some studies comparing stormwater management approaches (onsite vs offsite and detention vs retention). This is why the Frederick Street catchment was selected over The Paddocks (the other catchment with a long-term flow record).

Which costs and benefits have been considered?

Monetary costs and benefits considered include those that are direct (e.g. buying a rainwater tank or upgrading council drainage systems) and those that are indirect (e.g. reduced demand for potable water). Non-monetary costs and benefits were also considered (e.g. amenity value of wetlands).

The analysis captures a conservative estimate of the benefits, due to the rigorous and transparent approach taken to quantify benefits in financial terms. We have preferenced South Australian and then best practice Australian data sources.

What is measured?	Individual Household Level	Community Level
COSTS	Tank supply, installation and plumbing (Options 1a, 1b) Tank and connection maintenance (Option 1a, 1b) Offset scheme payments (Option Option 2)	Drainage system upgrades (Options 1a, 1b, 2) Wetland or biofilters construction (Option 2) Wetland or biofilters maintenance (Option 2) Offset scheme management (Options 2)
BENEFITS	Reduced potable water demand (Options 1a, 1b) Residual value of project capital (tanks) (Option 1a, 1b)	Delayed or avoided drainage system upgrades (Options 1a, 1b, 2) Improved water quality (Options 1a, 1b, 2) Residual value of project capital (drainage system) (Options 1a, 1b) Residual value of project capital (wetland or biofilters) (Option 2) Amenity value of wetland or biofilters (Option 2) Biodiversity value of wetland or biofilters (Option 2)

Who bears the costs?

As Local Government is largely responsible for constructing and maintaining stormwater management systems, funding for street-scale stormwater infrastructure works (including underground drainage systems) is generally borne by the wider community via council rates.

For minor infill development, individual households are required to manage the excess stormwater generated by the development onsite, and bear any costs of doing so.

In the case of greenfield developments, the developer bears the costs of establishing the site's stormwater management scheme.

If stormwater is not managed onsite, the costs may be passed on to downstream catchments and communities.

Offset schemes are possible[11], but they are problematic at a broad scale. This is because the variability of applicable factors across and between catchments would cause significant difficulty in identifying an appropriate payment rate per allotment, and because infill development generally occurs in built-up areas where there is no room to manage stormwater offsite unless land is acquired (which would add substantially to the cost and associated offset payment rate).

[11] The City of Onkaparinga, and other interstate councils, operate an offset scheme to fund offsite works in lieu of stormwater management occurring onsite.

Key Findings of the Cost Benefit Analysis

Additional tank costs will generally be offset by water bill savings (over 25 years) for individual households that increase their retention tank capacity and plumb their tank into all non-potable water sources[12].

For onsite stormwater management, Option 1b (retention and detention tank) is more cost-effective for the community than Option 1a (retention tank only – Draft Code policy). This is because Option 1a has no requirement for detention tanks, so it will cause higher peak flow rates, requiring a **higher investment in council drainage systems**[13]. Therefore, adding a detention tank requirement to the draft Code policy should be considered.

For onsite stormwater management, the range of expected outcomes for the community depend on the policy option and the base case:

- Compared to a typical base case, the draft Code policies (Option 1a) would deliver a net cost to the wider community (NPV -$137,659 for the catchment). This is because existing requirements for detention tanks would be removed, requiring more upgrades to council drainage systems.
- The draft Code policies (Option 1a) would deliver a net benefit to the wider community, compared to the City of Marion case study catchment (NPV $223,999 for the catchment). This is because the draft Code policy requires more household connection points, which adds to the 'detention effect'. This would avoid or delay needed upgrades to Council drainage systems.
- Adding a detention tank to the draft Code policy (Option 1b) would deliver a net benefit to the wider community, compared to both the City of Marion case study catchment (NPV $487,764 for the catchment) and the typical base case catchment (NPV $126,106 for the catchment).

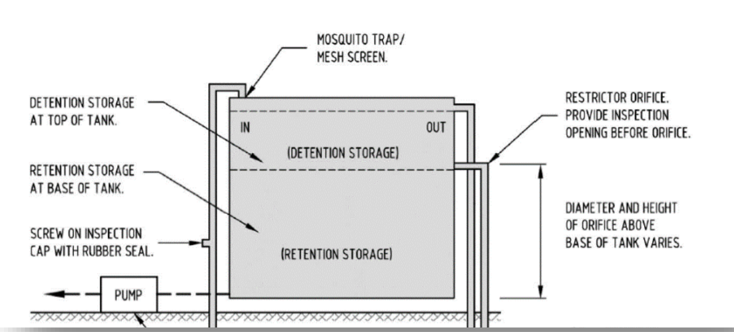
Offsite stormwater management in wetlands and biofilters, via an offset scheme, would deliver a net benefit to the wider community compared to both base cases (NPVs between $298,552 and $790,534 for the catchment). This is due to avoided tank costs for individual households, as well as improvements to water quality and neighbourhood amenity. However, offsite management is not practically feasible in every scenario, and would require further investigation.

[12] Compared to the Residential Code requirements, Option 1b would return a net cost of $410 over 25 years. All other scenarios tested returned a net benefit.

[13] This would shift the cost of managing peak flows from the infill household to the community, via increased Council rates.

Key Policy Considerations

1. A combination of retention and detention is needed to manage peaks flows



- Reducing peak flows to pre-development levels is a key desired policy outcome for stormwater management. This is because lower peak flows reduce flood risks and the potential for property damage. Also, higher peak flows require upgrades to council drainage systems, placing an additional cost burden on the community via increased council rates.
- Recent South Australian modelling shows that retention systems alone will not reduce peak flow to match pre-development levels. However, onsite detention tanks can flatten the flood curve, producing substantial reductions in peak flow.
- Draft code policy only has a retention tank requirement, so it will not meet this key performance outcome. It will also be more costly for the wider community, because of the additional upgrades to Council drainage systems that will be required.
- It is therefore recommended that the draft Code policy (Option 1a) be modified to include a provision for onsite detention capacity (refer to the breakout box to the right and Appendix 5 for an additional detail about the economic analysis results for a 3kL rainwater tank (which includes 2kL retention and 1kL detention).

Testing of a 3kL rainwater tank (including 1kl detention)

An economic and financial analysis was run for a draft Code policy scenario proposing a 3kL tank (with 2kL retention and 1kL detention).

Overall the results were positive. At the **community level**, the results ranged from **$22,064 to 169,488** of net benefit over 25 years. On the individual household level, there was also a net benefit against all base case scenarios:

- $980 (Typical base case)
- $729 (Marion base case)
- $276 (ResCode base case).

2. Other ways to manage peak flows

- Another way to help reduce peak flows is to increase the 'detention effect' of retention tanks, by plumbing them into more non-potable household uses. The rainwater being stored is more likely to be used by the household, making it more likely there will be some room in the tank when it starts raining.
- This strategy can contribute to overall storage capacity during a rainfall event, which may assist in reducing street-scale nuisance flooding, and reducing exported pollutant load.
- However, it is not as reliable as a detention tank for peak flow management because it is dependent on household behaviour, and the amount of time between rainfall events.
- **The proposed Code requirement to plumb tanks into more non-potable household uses than is currently required under the Residential Code should therefore be supported.**

3. Providing an offset scheme for stormwater to be managed offsite

- Managing stormwater offsite in wetlands and biofilters (Option 2) would deliver a better community outcome than the base case and onsite options. This is due to avoided tank costs, improved water quality, and improved neighbourhood amenity and biodiversity. These benefits would not otherwise be available.
- There is however a lost opportunity for infill households to reuse stormwater for non-potable purposes.
- Feasibility of offsite management is dependent on a range of variable factors, which would need to be assessed on an individual stormwater catchment basis, via development of catchment-scale water sensitive urban design plans.
- Delivery is constrained by the lack of available land in an urban infill setting. It is important to note that land acquisition costs have not been factored into the catchment-scale analysis[14], and would need to be considered when establishing appropriate offset payments.
- Importantly, an offset scheme is only likely to be attractive to infill households if there is already underutilised land available to council in a suitable location for the wetland or biofilter (i.e. if no land acquisition is necessary)[15]. This not likely to be a common situation in catchments where significant infill is occurring.
- However whilst land acquisition may be difficult to justify purely for stormwater management, it may be able to be justified as a strategy to achieve the duel objectives of stormwater management and urban greening.
- Equitable funding mechanisms would also need to be resolved. The costs of delivering offsite stormwater management would need to be borne either by infill households via an offset scheme, or by the wider community via increased council rates.
- Any offset scheme should be administered on a voluntary basis, with applicants being offered the choice of an onsite or offsite solution, if feasible.
- **Offset schemes are not practical in every scenario, are subject to a number of catchment-by-catchment variables, and are therefore not suitable for broad application in deemed-to-satisfy provisions without further investigation**.

4. Other factors

- Apart from stormwater management outcomes, other factors may be important considerations when formulating rainwater tank requirements.
- For example, larger retention tanks may be a priority because they improve opportunities for stormwater capture and reuse by households and are preferred by consumers compared to detention.
- Although some of these benefits have been captured in this analysis, there may be others that were not considered.

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[14] Land acquisition costs are considered a 'transfer payment' in a community-scale cost benefit analysis, because the payment made by local government (the buyer) is transferred to the private landholder (the seller), with the total value remaining within the community. However, these are costs that would need to be incurred by Councils in delivering this option, and passed on to the wider community via increased Council rates.

[15] A sensitivity analysis was undertaken to demonstrate the effect of including land acquisition costs on an offset scheme payment for an infill household (see Section 4.2.2). If land acquisition is needed, net costs will be incurred by infill households participating in the offset scheme.

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ABBREVIATIONS

AEP	annual exceedance probability
ARI	average recurrence interval
CBA	Cost Benefit Analysis
CPI	Consumer Price Index
DEW	Department of Environment and Water
AGD	Attorney-General's Department
DTS	Deemed-to-satisfy
LGA	Local Government Area
NPV	Net Present Value
SPC	State Planning Commission
WSUD	water sensitive urban design

1. INTRODUCTION

1.1. Background to this study

The progressive implementation of the *Planning, Development and Infrastructure Act 2016* (the Act) will reach a major milestone in 2020, as the Planning and Design Code (the Code) is brought into formal operation across South Australia.

Introduction of the Code provides a valuable opportunity to refine and improve policies to meet the State's strategic directions, including those related to water sensitive urban design (WSUD) and urban greening in the context of increasing minor residential infill.

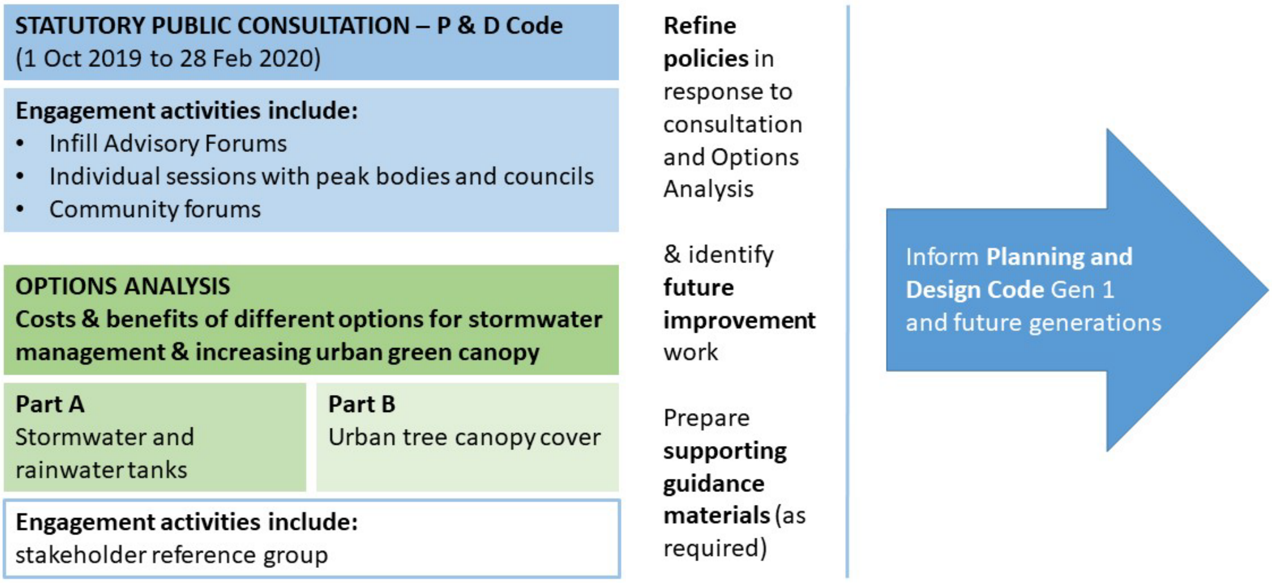
The State Planning Policies give direction to improving WSUD and urban greening outcomes, in recognition of the multiple benefits they provide. Draft Planning and Design Code (Code) policies have been prepared and consulted on (until 28 February 2020) in response to this direction.

BDO EconSearch and Tonkin Engineering have been commissioned by the Attorney-General's Department (AGD), Department for Environment and Water (DEW), Department of Treasury and Finance (DTF), and SA Health to analyse the cost-effectiveness of the proposed Planning and Design Code policies for minor infill, in relation to:

- Stormwater management and rainwater tanks (*this report*)
- Tree canopy cover and the 'One Tree Policy' (*refer to separate report*).

This work sits within the context of the public consultation process for Phase 3 (Urban Areas) of the Planning and Design Code as illustrated in Figure 1-1.

Figure 1-1 Relationship of this Options Analysis to development of the Planning and Design Code



Stakeholder engagement

A stakeholder reference group with representatives from the following organisations provided input and advice into the scope of this work:

- Department of Treasury and Finance
- Department for Environment and Water
- SA Health
- Housing Industry Association (HIA)
- Master Builders Association (MBA)
- Urban Development Institute of Australia (UDIA)
- Local Government Association of South Australia (LGA)
- Stormwater Management Authority
- Premier's Climate Change Council
- Water Sensitive SA
- Stormwater SA
- Australian Institute of Landscape Architects (AILA)
- Australian Institute of Architects (AIA)
- Conservation SA
- South Australian Council of Social Services (SACOSS)
- Property Council
- Community Alliance
- Engineers Australia.

Background evidence gathering

As a first stage to this work, AGD sought to identify and review some of the likely costs and benefits associated with proposed Code policies. These efforts were informed by a number of stakeholder workshops held as part of the State Planning Commission's Residential Improvements Infill Forum series. These forums included members of the Stakeholder Reference Group as well as representatives from key government agencies, local councils and developers with experience in infill development. This options analysis used and built on this work. The outputs relevant to this report are provided in **Appendix 1.**

1.2. Study objectives and scope

This report is intended to inform decision-making on the cost-effectiveness of proposed Planning and Design Code policy for minor infill in relation to stormwater management and rainwater tanks, alongside other feedback. It aims to improve understanding of all the upfront and long-term costs and benefits of the proposed policies, to both the individual household and the Greater Adelaide community, and ensure they can be weighed up objectively. Note that the tested policies are being considered for minor infill[16] sites only, not for greenfield developments where responsibility and costs for constructing the stormwater network are borne by the developer.

The analysis was undertaken at two levels:

- **At the community level** – expected costs and benefits (both monetary and non-monetary) accruing to people (households, businesses and government) and the environment in a catchment, as a result of the proposed options.
- **At the individual household level** – expected cost and benefits (monetary only) accruing to the household undertaking the development, as a result of the proposed options.

The cost benefit analysis tested three policy options against the base case. In this study, the community level analysis was undertaken against two catchment-scale base cases, and the individual household level analysis was undertaken against three dwelling-scale scenarios. The purpose of this approach is to test whether the Draft Code policies stack up against the current South Australian policy requirements[17].

The options analysed were:

- **Base Case Scenarios - Two 'business as usual' catchment-scale scenarios:**
  - City of Marion Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)
  - More Typical Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention).
- **Base Case Scenarios - Three 'business as usual' dwelling-scale scenarios:**
  - City of Marion Development Plan – 5kL retention tank
  - More Typical Development Plan – 1kL retention plus 2kL detention tank
  - Residential Code – 1kL retention tank.
- **Option 1a - Retention tank required (draft Code policy).**
  The proposed deemed-to-satisfy provision for minor infill to provide a 3kL retention tank[18].
- **Option 1b - Retention and detention tank required.**
  As per Option 1b, with the addition of a 1kL detention tank to contribute to peak flow management.

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[16] Minor infill is defined as 'Development and adaptation of the existing housing stock, including demolition and resubdivision, on sites less than 4,000m² and involving 10 dwellings or less. Minor infill is an important component of the overall land supply equation and makes a significant contribution (around 40 per cent) to the annual metropolitan housing supply growth within Greater Adelaide' (DPTI 2019).

[17] Under the Building Code of Australia, all new houses are required to have a 1kL retention tank installed and plumbed into one non-potable outlet (a toilet, laundry tap or hot water system). In South Australia, additional requirements for onsite detention, retention and reuse of stormwater are commonly applied through Council Development Plans. These requirements vary, and do not apply to complying developments approved though the State's Residential Code.

[18] The Draft Code policy provides for a 2kL, 3kL or 5kL retention tank, depending on allotment size. Our analysis indicated that most potential minor infill developments would occur on allotments between 200m2 and 400m2, resulting in a 3kL rainwater tank provision for most minor infill dwellings.

- **Option 2 - Offset scheme.**
  No provision for onsite rainwater tanks. Stormwater impacts of infill development are addressed offsite in wetlands or street scale biofilters[19], funded by an offset scheme.

The variable factors applying to peak flows and flood management make it extremely difficult to extrapolate a cost benefit analysis over every catchment in Greater Adelaide[20]. A case study catchment[21] has therefore been selected to enable examination of each of the policy options **on a per catchment basis** instead. This case study catchment is not intended to be a proxy for the wider Greater Adelaide area. However, it is intended to illustrate the **relative costs and benefits** of each of the policy options.

[19] Other offsite strategies were found to be of greater cost and lower performance, so were not considered further.

[20] The study was initially intended to cover Greater Adelaide, however as outlined in Section 3.1.1, adequate information to assess costs and benefits of offsite stormwater management was only available for one catchment, which could not be reasonably extrapolated to other catchments in Greater Adelaide. The study area was therefore limited to that single case study catchment.

[21] The case study is the Frederick Street catchment in Glengowrie within the City of Marion, one of only two catchments in Adelaide with a long-term flow record. A number of previous investigations have modelled the effects of infill development on flow peaks and volumes in the catchment, with some studies comparing stormwater management approaches (onsite vs offsite and detention vs retention). This is why the Frederick Street catchment was selected over The Paddocks (the other catchment with a long-term flow record).

2. STUDY CONTEXT

This section provides a more in-depth discussion of the study context and describes urban infill trends in Greater Adelaide, the impacts of infill on stormwater runoff, and stormwater planning in South Australia. It also discusses the planning reforms and how they will affect urban stormwater management.

2.1. Urban infill trends in Greater Adelaide

The 30-Year Plan for Greater Adelaide (2017 Update)

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Containing our urban footprint and protecting our resources

85% of all new housing built in established urban areas by **2045**

Target 1 of the *30-Year Plan for Greater Adelaide (2017 Update)* (the 30-Year Plan) has a target for 85 per cent of all new housing to be built within the existing urban footprint, because infill development helps to create walkable neighbourhoods, protect valuable farming and environmental land, and meet consumer demand for living close to jobs, shops, and services. This target has facilitated a significant increase in the ratio of infill development compared to greenfield development in Greater Adelaide. See Figure 2-1 for a map of Greater Adelaide.

In recent decades, a large amount of development has occurred at major infill broadacre sites such as Mawson Lakes and Northgate. Now the focus is shifting to identifying new opportunities within established suburbs. Currently, about 80 per cent of Greater Adelaide's new housing growth is in these established suburbs (AGD 2020).

Minor infill development[22] (see Figure 2-2) for an illustrative example) is now playing a significant role in delivering the 30-Year Plan target, contributing about 40 per cent of the overall housing supply each year (DPTI 2019). From 2012 to 2018, minor infill produced an average annual net increase of about 2,500 residential dwellings (DPTI 2019). Figure 2-3 gives context to the role played by minor infill in recent housing supply.

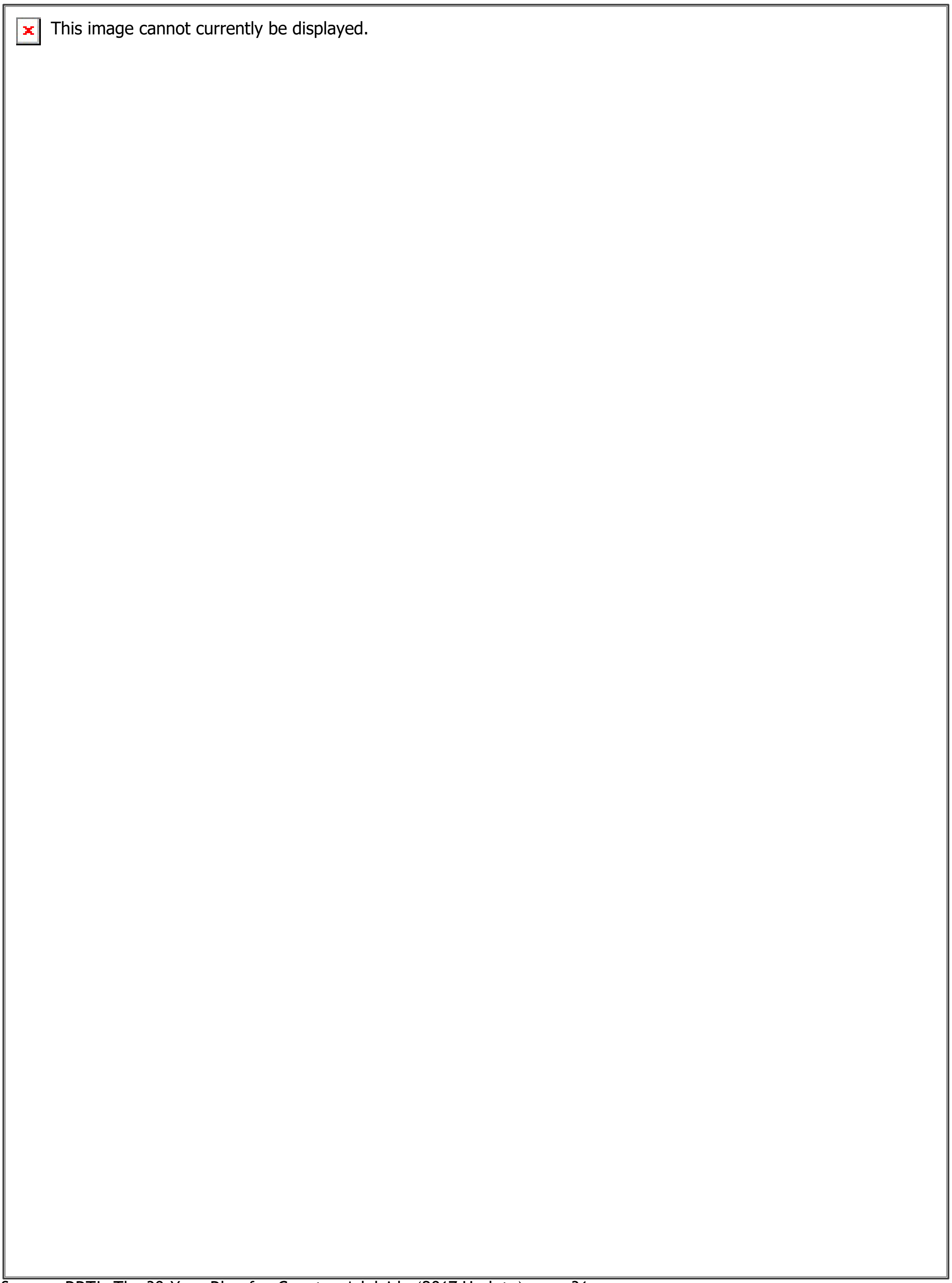
The median allotment size of new development across Greater Adelaide has reduced significantly in recent years. In 2018/19, the median size of new allotments (detached and semi-detached) was 361m^2, down from 518m^2 in 1999/2000.

It has been observed that minor infill development is generally not occurring in a way that addresses water sensitive urban design objectives. For example, minor infill often results in up to 90 per cent hard, impervious surfaces (roof space surrounded by concrete and paved driveways and footpaths). The implications of these trends for stormwater management are discussed in Section 2.2.

Refer to the extract from DPTI's People and Neighbourhoods Discussion Paper overleaf for further information about recent minor infill trends in Greater Adelaide (Figure 2-4).

[22] Minor infill involves the demolition of dwellings and/ or the subdivision of land to generate new housing at the same or greater densities (up to 10 dwellings) on sites less than 4,000m^2 (DPTI 2019).

Figure 2-1 Map of Greater Adelaide



Source: DPTI, The 30-Year Plan for Greater Adelaide (2017 Update) page 31

Figure 2-2 Examples of minor infill development

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Source: DPTI 2019

Figure 2-3 Demand driven residential trends, Greater Adelaide

Source: DPTI 2019

Figure 2-4 Recent trends in minor infill development

Department of Planning, Transport and Infrastructure summary of minor infill activity in Greater Adelaide 2012-2018

Between 2012 and 2018, minor infill was the single greatest provider of new housing in Greater Adelaide, contributing 39% of the region's net dwelling increase compared with major / other infill (32%) and broadhectare (29%) sites.

Occurring within existing built up areas on sites of less than 4,000m², minor infill involves the demolition of dwellings and/ or the subdivision of land to generate new housing at the same or greater densities (up to 10 dwellings).

Example of minor infill created by a demolition and resubdivision

In the Greater Adelaide region between 2012 and 2018:

- The net dwelling increase from minor infill was 2,501 dwellings per annum (total 15,005).
- Demolition and resubdivision generated an average of 1,374 dwellings per annum.
- Vacant land parcels that were created through broadhectare land division, demolitions and resubdivsions prior to 2012, generated an additional 1,128 dwellings per annum.
- Marion LGA generated an additional 2,008 dwellings through minor infill, followed by Charles Sturt (1,988) and Onkaparinga (1,788).
- The rate of demolition increased steadily from around 1,765 dwellings per annum from 2008 - 2014, to the current 2,018 dwellings per annum. Charles Sturt LGA experienced the greatest number of demolitions, with a total of 1,909, followed by Port Adelaide Enfield LGA with 1,892.
- Resubdivision occurred on an average of 395 sites per annum (total 2,371). Onkaparinga LGA experienced the largest share of resubdivisions with 354 sites, which generated an additional 276 dwellings and 119 vacant lots. This was followed by Charles Sturt LGA, with 301 sites, generating an additional 289 dwellings and 53 vacant lots.
- The average replacement rate for demolition sites was 1:1.85. Onkaparinga LGA recorded the highest replacement rate of 2.4, followed by Marion and Gawler LGAs with 2.2. This is largely influenced by allotment size, planning policy and market demand.

Buoyed by a supportive policy framework provided within the 2017 update of The 30 Year Plan for Greater Adelaide, which both encourages the reduction of our urban footprint and the provision of more housing diversity close to public transport options, this steady increase in the importance of minor infill to the overall settlement pattern of metropolitan Adelaide is set to continue for the foreseeable future.

The full version of DPTI's Summary of Minor Infill within Greater Adelaide 2012-2018 can be downloaded from saplanningportal.sa.gov.au

Figure 3: Minor Infill Activity in Greater Adelaide 2012-2013

Source: State Planning Commission 2019a

2.2. Impacts of infill on stormwater runoff

Infill development increases density and can create up to 90 per cent impervious surfaces, which can increase stormwater runoff by 2.5 times more than what most existing drainage systems were designed for (Jensen 2011).

The effects of this increasing development density on stormwater runoff from urban areas are reasonably well understood and are generally described in the literature as producing:

- An increase in peak flows
- An increase in the frequency and volume of runoff
- An increase in the exported load of pollutants.

Where these effects are not mitigated, the observable impacts can include:

- More frequent overloading of underground drainage systems, leading to wider and deeper surface flooding. In minor events, where flows are contained to the street, these impacts can be considered as increased nuisance flooding. In major events, the greater depths can increase risks of flood damage to property
- A further heightened risk of flood damage to properties that are: upstream of the first inlet to a drainage system; adjacent to low points (in flatter areas); and adjacent to creeks, channels and surface flow paths (in steeper areas)
- An increased potential of watercourse erosion and scouring from increased peak flows and volumes
- An increase in runoff volume and exported pollutant load, which can have adverse impacts on receiving waters such as the urban waterways, Barker Inlet, Gulf St Vincent, and metropolitan Adelaide beaches.

While there is a general agreement on these potential impacts, there are a range of views on how they can be best addressed, whether this be at the source (on individual allotments), on a sub-neighbourhood scale, or a catchment scale.

2.3. Stormwater planning in South Australia

Within South Australia generally, and the Greater Adelaide region specifically, local government is responsible for the construction, maintenance and upgrade of stormwater management systems within their council boundaries.

As catchment boundaries do not generally align with council boundaries, some coordination of stormwater management activities between local governments is required. Planning of stormwater management systems for broader catchments is achieved via Stormwater Management Plans, which are overseen by the Stormwater Management Authority.

To date, eight catchments within Greater Adelaide have had Stormwater Management Plans approved, with a further eight plans either being prepared or awaiting approval. A key factor considered by many of these plans has been the impact of infill development on runoff, and how these impacts should be best addressed.

Floodplain maps have been prepared for many of the Stormwater Management Plans, which show likely flooding extents under existing and future development scenarios (including infill without any onsite management). This mapping has shown evident increases in flood extent for both more (5-year ARI) and less (20+ year ARI) frequent events, with larger and more obvious increases for the more frequent floods.

Broadly speaking, strategies developed in Stormwater Management Plans to mitigate property flood risks have been sized to address the larger, less frequent flood events, including allowances for increased flow from infill development.

A number of Stormwater Management Plans have also recognised the need to address the more obvious increases in frequent (nuisance) flooding brought about by infill development. These plans, including those for the Torrens Road Catchment and the Holdfast Marion Coastal Catchments, propose that management of peak flows be undertaken onsite. The drivers for adopting onsite measures include that:

- The distributed nature of infill development creates impacts across large areas
- There are significant potential costs of extending and enlarging underground drainage systems across large areas
- There are practical constraints to expanding underground drainage systems, including space limitations within roadways for duplicate pipe systems.

2.4. Funding stormwater management

As local government is largely responsible for constructing and maintaining stormwater management systems, funding for street-scale stormwater infrastructure works is generally borne by the wider community via council rates. Where relevant, some funding has been provided by Natural Resources Management Boards, through the State Government's Stormwater Management Fund (for catchments over 40 hectares in size), and from the Federal Government (in certain cases, for regional flood mitigation works).

In the case of greenfield developments, the developer bears the costs of establishing the site's stormwater management scheme. The system must be designed so that downstream drainage systems have capacity to carry any flow leaving the site.

For infill development, the approach in existing Development Plans has been to require individual sites to manage stormwater onsite, ensuring that any flows leaving the site do not exceed pre-development levels. This approach is also envisaged in the draft Planning and Design Code.

Alternative funding mechanisms may also be possible. Offset schemes, in which developers contribute to offsite works in lieu of delivering onsite works, are used in the City of Onkaparinga and in some local government areas in other states. However, the development of a broad scale offset scheme for Greater Adelaide is problematic at this point because:

- There is insufficient information on which to base an appropriate payment rate, particularly for management of peak flows
- Appropriate offsets payments for peak flow management are likely to be highly catchment dependent, and would be influenced by variable factors such as topography, distance to the coast, and availability of land for offsite works
- Privately owned land would most likely need to be acquired (at high and variable prices) for offsite stormwater management works, because infill development generally occurs in built-up areas with space limitations in drainage corridors and streets. However whilst land acquisition may be difficult to justify purely for stormwater management, it may be able to be justified as a strategy to achieve the duel objectives of stormwater management and urban greening.
- The catchments covered by Stormwater Management Plans may be too large to allow for the detailed scoping, feasibility and costing of a successful offset scheme. The complexity of offsite management may demand an additional layer of more fine-grained catchment planning.

2.5. Current policy framework

2.5.1. South Australia's Water Sensitive Urban Design Policy

The South Australian Government's WSUD Policy has the following objectives:

- To support the sustainable use of natural water resources that provide our water supplies and to help ensure that our water supplies are resilient to climate variation through water conservation

- To help protect the health of water bodies and associated ecosystems in or downstream of urban areas, by managing and maintaining or improving runoff
- To assist the management of flood-related risk associated with urbanisation, by controlling runoff quantity
- To promote the potential for WSUD to support other relevant State, regional, and local objectives to achieve multiple outcomes, by encouraging integrated planning and integrated design (DEWNR 2013).

The policy sets out the following performance principles and targets which are relevant to residential development (Table 2-1). The performance targets are not mandated, but they define when the State Government recognises a development as being 'water sensitive'.

Table 2-1 Performance principles of South Australia's WSUD Policy

Performance Principle	Performance Principle Intent	State-wide Performance Target
Water conservation - Water systems are efficient and, where safe and appropriate, sustainable local water resources are given preference over non-local water sources.	Water systems are efficient and water resources are sustainably used.	Demonstrated compliance with South Australian residential building provisions for water efficiency.
Runoff quality - Positively manage the quality of urban runoff through implementing water-sensitive urban design.	To help protect and, where required, enhance, the quality of runoff entering receiving water environments, in order to support environmental and other water management objectives.	Achieve the following minimum reductions in total pollutant load, compared with that in untreated stormwater runoff, from the developed part of the site: - Total suspended solids by 80% - Total phosphorus by 60%; - Total nitrogen by 45% - Litter/gross pollutants by 90%.
Runoff quantity - Post-development hydrology should, as far as practical and appropriate, minimise the hydrological impacts of urban built environments on watercourses and their ecosystems	- Help protect waterways and, where relevant, promote their restoration by seeking to limit flow from development to predevelopment levels. - Help to manage flood risk, by limiting the rate of runoff to downstream areas to appropriate levels.	For waterway protection: Manage the rate of runoff discharged from the site so that it does not exceed the pre-urban development 1-year average recurrence interval (ARI) peak flow. For flood management: For development and other relevant infrastructure that will drain runoff to an existing publicly managed drainage system or to a drainage system such as a creek or watercourse on privately-owned land: - the capacity of the existing drainage system is not exceeded; and - there is no increase in the 5-year ARI peak flow and no increase in flood risk for the 100-year ARI peak flow, compared to existing conditions
Integrated design - That the planning, design, and management of WSUD measures seeks to support other relevant State, regional and local objectives.	Implement WSUD in a way that promotes establishment of 'green infrastructure' and achievement of multiple outcomes, for example: public amenity, habitat protection and improvement, reduced energy use and greenhouse emissions, and other outcomes that contribute to the wellbeing of South Australians.	Evidence that relevant stakeholders are engaged at appropriate stages of planning, designing, constructing, and managing WSUD measures so as to maximise the potential for WSUD to contribute to 'green infrastructure' and other relevant State, regional, and local objectives.

Source: DEWNR (2013).

2.5.2. Current policy for managing stormwater in minor infill development

All new dwellings are required to have a 1kL retention tank plumbed to one water source (a toilet, laundry tap or hot water system), under the Building Code of Australia.

In South Australia, where a proposed development meets certain criteria, it is assessed under the Residential Code. The Residential Code requirement is in line with the Building Code of Australia.

Otherwise, the development is assessed under the relevant Development Plan. Many of the Development Plans in Greater Adelaide require a retention tank (ranging from 1kL to 5kL). Others require a combination retention and detention tank system. Almost all rely on broader stormwater detention policies that require development to restrict flows to those expected in a pre-development state, generally based on either a 5-year Average Recurrence Interval (ARI) or 10-year ARI.

These policies are based on engineering studies, and consider the capacity and condition of infrastructure in specific catchments. Higher requirements may reflect that existing stormwater management systems are nearing or already at capacity.

A summary of Development Plan requirements is set out in Appendix 1, which is taken from work carried out by Organica Engineering (2017)[23].

> **Retention vs. Detention**
>
> **Retention tanks** (standard rainwater tanks) are designed to harvest water for future use. They are frequently already full when it rains. However, plumbing tanks into more non-potable uses inside the home may increase their 'detention effect', because the tanks are less likely to be full when it rains.
>
> **Detention tanks** are designed to flatten the flood curve during storm events, by capturing and then slowly releasing water over time. They are generally empty when it starts raining.
>
> In existing Development Plans, councils often encourage households to **combine retention and detention capacity in one tank**. This can be done simply and inexpensively by adding an outlet in the side of the tank. The tank volume above the outlet is the detention capacity.

2.6. Future policy framework

2.6.1. Overview of the South Australian planning reforms

The *Planning, Development and Infrastructure Act 2016* is being progressively introduced to enable a more efficient, responsive and effective planning system.

Concerns about climate change, liveability, stormwater management, increasing health costs and declining biodiversity are driving an increased interest in water sensitive urban design (WSUD) and the many co-benefits it provides. WSUD has been a significant area of interest for the State Planning Commission, and the State Planning Policies on Climate Change and Design Quality reflect this.

State Planning Policies provide the high-level goals and requirements for the new planning system, which Regional Plans and the Planning and Design Code must respond to.

The 30-Year Plan for Greater Adelaide (2017 Update) has transitioned over as a Regional Plan.

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[23] Organica has modelled various infill development scenarios, which show that for a typical residential development of a single allotment divided into two, a 2kL detention tank would typically be needed for each dwelling to meet Development Plan performance outcomes (with a range of requirements between 0kL and 7.5kL).

The Code will replace the complex and at times inconsistent planning rules found within the 72 Development Plans currently in use. Establishing the Code presents an opportunity to refine and improve WSUD policies to meet the State Planning Policies and Regional Plan targets.

Draft policy directions were included in the Commission's *Natural Resources and Environment* and *People and Neighbourhood* Discussion Papers (released for consultation in August 2018 and September 2019 respectively). Draft Code policies were prepared in response, and were out for formal public consultation until 28 February 2020. These include both 'performance outcomes' and 'deemed-to-satisfy' provisions (see breakout box) for minor infill developments to manage stormwater onsite.

Planning and Design Code
A performance-based planning system

Performance Outcomes (PO) are used in the Code to clearly describe the outcome being sought by the policy.

Deemed-to-Satisfy (DTS) provisions are clear and measurable criteria that have been assessed as one way to achieve a performance outcome. These criteria are designed to make policies easier to interpret and implement, but applicants can always choose to meet the performance outcome another way.

Source: DPTI 2019b

2.6.2. Draft Code policy for managing stormwater in minor infill development

The draft Planning and Design Code includes a number of stated Performance Outcomes (PO) and Deemed to Satisfy (DTS) provisions for stormwater management in infill developments (Table 2-2).

Table 2-2 Draft Code policy for managing stormwater in infill development in Greater Adelaide

	Performance Outcome	Deemed-to-Satisfy
22.1	Residential development will be designed to capture and re-use stormwater to maximise conservation of water resources; manage peak stormwater runoff flows and volume to ensure the carrying capacities of downstream systems are not overloaded; and to manage stormwater runoff quality.	Detached, semi-detached or row dwelling and hammerhead allotments with an allotment size of up to 500m^2 provide a retention tank of 2kL, 3kL or 5kL depending on allotment size. Further details are provided in Table 2-3 and below.
22.2	Development creating 5-19 dwellings includes stormwater management systems that minimise the discharge of sediment, suspended solids, organic matter, nutrients, bacteria, litter and other contaminants to the stormwater system, watercourses or other water bodies.	Development creating 5-19 dwellings is accompanied by an approved Stormwater Management Plan that achieves the following stormwater runoff outcomes: (a) 80 per cent reduction in average annual total suspended solids; (b) 60 per cent reduction in average annual total phosphorus; and (c) 45 per cent reduction in average annual total nitrogen.
22.3	Development creating 5-19 dwellings includes a stormwater management system designed to mitigate peak flows and manage the rate and duration of stormwater discharges from the site to ensure the carrying capacities of downstream systems are not overloaded.	Development creating 5-19 dwellings (a) maintains: i. a pre-development peak flow rate from the site based upon a 0.35 runoff coefficient for the 5-year ARI (18.1 per cent AEP) 30-minute storm; and ii. the stormwater runoff time to peak to match that of the pre-development condition; or (b) capture and retain the difference in pre-development runoff volume (based upon a 0.35 runoff coefficient) vs post development runoff volume from the site for a 5-year ARI (18.1 per cent AEP) 30-minute storm; and (c) manage site generated stormwater to ensure development is protected from a 100-year ARI (1 per cent AEP) event.

Source: Draft Planning and Design Code, SPC 2019c.

Minor infill is defined by AGD as occurring on sites less than 4,000m^2 and involving 10 dwellings or less. Larger developments (creating over 5 dwellings) often have a road and/or communal space as part of the development and therefore have more options to manage stormwater compared to smaller development (creating 1-4 dwellings). This is why onsite rainwater tanks have been considered for smaller developments as a DTS provision. This analysis assesses the costs and benefits of DTS provision 22.1. Further detail on this provision is provided in Table 2-3 and below.

Table 2-3 Draft Deemed-to-Satisfy Provision 22.1 for Minor Infill

Allotment size (m²)	Minimum site perviousness (%)	Minimum rainwater tank volume (L)	Additional site permeability discount opportunity	
			Site perviousness (%)	Minimum rainwater tank volume (L)
<200	15%	2,000		
201-400	20%	3,000	30%	2,000
400-500	25%	5,000	35%	3,000

Source: Draft Planning and Design Code, SPC 2019c.

Besides the provisions in Table 2-3, DTS 22.1 stipulates that:

- The tank be connected to at least 80 per cent of the roof area of the dwelling (row dwelling), or at least 60 per cent of the roof area of the dwelling (detached and semi-detached dwellings)
- The tank be connected to all toilets and either the laundry cold water outlets or the hot water service
- The roof be at least 80 per cent of the impervious area.

2.7. Testing of the effectiveness of policy options

When considering the effectiveness of rainwater tank policies, there are three factors to consider: peak flows, the frequency and volume of runoff, and exported pollutant load.

There is a direct correlation between increases in impervious surfaces and increases in both the frequency and volume of runoff, and the exported pollutant load. Therefore these factors are more readily managed through consistent state-wide policies. Recent South Australian modelling has shown that **the Draft Code provisions will achieve satisfactory reductions in runoff frequency and volume, and in exported pollutant load**[24]. See Section 2.7.2 for more details on research into managing runoff volume and exported pollutant load.

Managing peak flows is more challenging however. Peak flows are impacted by variable factors like the timing and duration of rainfall, distance from the end of the system, and the characteristics of the catchment. These effects are one reason the policies in existing Development Plans are so diverse, and they make it challenging to apply state-wide policies that will effectively manage peak flows. In fact, modelling shows that the **draft DTS provisions in the Code will not fully meet the requirement[25] for reducing peak flow discharges to pre-development levels.**

Key conclusions from the research are that retention systems alone will not reduce peak flow to match pre-development levels[26]; but onsite retention combined with onsite detention can produce substantial reductions in peak flow. Based on these findings, **it is recommended that the draft Code policy be modified to include a provision for onsite tanks that combine retention and detention capacity**.

[24] To within 10 per cent of the pre-development flow.

[25] As outlined in the associated Planning and Design Code performance outcome, which is based on South Australia's Water Sensitive Urban Design Policy.

[26] Unless all infill households use the retained water at very high rates, typically considerably higher than all internal household uses. This scenario is highly unlikely.

Another way to help reduce peak flows is to increase the 'detention effect' of retention tanks, by plumbing them into more non-potable household uses. The rainwater being stored is more likely to be used by the household, making it more likely there will be some room in the tank when it starts raining. This strategy can contribute to overall storage capacity during a rainfall event, but it is not as reliable as a detention tank because it is dependent on household behaviour, and the amount of time between rainfall events. See Section 2.7.3 for more details on research into managing peak flows.

2.7.1. Performance outcomes of base case and options

The likely performance of each base case and option in achieving catchment-scale stormwater management objectives have been assessed using the outputs of the investigations described in this section. The determined performance outcomes are described in Table 2-4.

Table 2-4 Stormwater management performance outcomes of Base Case and Options

Stormwater management performance outcomes	Achievement towards performance outcomes
City of Marion Base Case Catchment - weighted average 2.4kL retention	
▶ Peak flows not exceeding pre-development levels	63% above pre-development levels
▶ Meeting water quality targets	71% of target
▶ Increasing stormwater reuse	14,660kL per year across catchment
More Typical Base Case Catchment - weighted average 1kL retention and 1.8kL detention	
▶ Peak flows not exceeding pre-development levels	20% above pre-development levels
▶ Meeting water quality targets	43% of target
▶ Increasing stormwater reuse	8,925kL per year across catchment
Option 1a - 3kL retention tank required (Draft Code policy)	
▶ Peak flows not exceeding pre-development levels	55% above pre-development levels
▶ Meeting water quality targets	100% of target
▶ Increasing stormwater reuse	21,840kL per year across catchment
Option 1b - 3kL retention and 1kL detention tank required	
▶ Peak flows not exceeding pre-development levels	20% above pre-development levels [b]
▶ Meeting water quality targets	100% of target
▶ Increasing stormwater reuse	21,840kL per year across catchment
Option 2a - Wetlands	
▶ Peak flows not exceeding pre-development levels	No effect
▶ Meeting water quality targets	100% of target
▶ Increasing stormwater reuse	No effect
Option 2b - Biofilters	
▶ Peak flows not exceeding pre-development levels	No effect
▶ Meeting water quality targets	100% of target
▶ Increasing stormwater reuse	No effect

a Insite Tool modelling indicates that Options 1a and 1b will largely meet the water quality targets - see Section 2.7.2.

b Very similar peak flow levels will be generated by the More Typical Base Case Catchment and Option 1b. This is due in part to the increased 'detention effect' of having a larger retention tank plumbed more water outlets in Option 1b.

2.7.2. Recent research into runoff volume and water quality management

Organica Engineering was engaged by Water Sensitive SA to undertake modelling of the proposed DTS Requirements of the draft Code, using the Insite Integrated Water Management Tool (Water Sensitive SA, 2019). This tool assesses the performance of water sensitive urban design assets in meeting a specified set of performance requirements at an allotment scale. The results of the modelling are attached in Appendix 2.

The draft DTS provisions were modelled under a range of allotment sizes and impervious area fractions. The analysis has shown that draft Code policy will achieve reductions in runoff volume to within 10 per cent of pre-development levels.

The Insite tool was also used to examine impacts on water quality. The analysis indicates that draft DTS provisions will meet the performance targets set out in South Australia's WSUD Policy in most cases. Development scenarios that fail to meet the targets only do so by 10 to 15 per cent. Where water quality improvements are reported, these are most likely produced by a reduction in flow volume (due to water being captured in tanks) rather than by 'treatment'.

Given uncertainties in water quality modelling and the fact that modelled water quality improvements are likely to be related to volume reduction, which itself is within 10 per cent of predevelopment values, we do not see any need to modify the DTS provisions in light of the modelling results.

2.7.3. Recent research into peak flow management

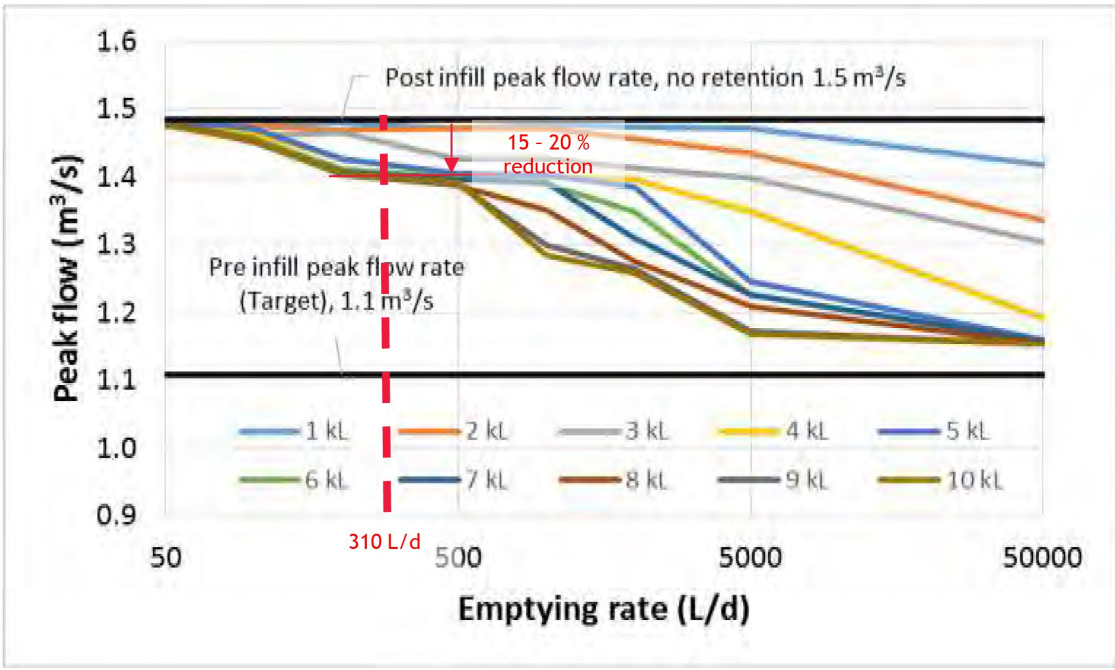
Water Sensitive SA also commissioned Organica Engineering to test the effectiveness of DTS provisions in managing peak flows, using the Insite tool as mentioned above. **The modelling showed that the proposed DTS provisions will not meet the requirement for reducing peak flow discharges to pre-development levels**. The Insite study indicates that additional detention capacity would be needed to meet this requirement, with values ranging from 0.2kL to 1.5kL.

The University of South Australia (UniSA) has recently undertaken a number of studies aiming to provide some guidance on relative changes in peak flows that can be brought about by various allotment scale and street scale strategies. The most recent is an investigation of the likely effectiveness of retention and detention measures applied within the Frederick Street catchment in Glengowrie (Meyers et al, 2018), which this cost benefit analysis has used as its case study (see Section 3.3).

The Frederick Street catchment investigation undertaken by UniSA did not directly model the draft DTS provisions. However, it did include an investigation of the likely impact on peak flows associated with retention systems with various outflows, and contrasted this with the performance of detention systems. The analysis considered single allotments being divided to produce two dwellings.

Figure 2-5 shows the modelled impact on peak flows of a retention-only system. Results are provided for various retention tank sizes and emptying rates. The tank volumes and emptying rates are combined values for the two dwellings, created as a result of division of a single allotment. Two households with average occupancies of 2.5 persons will use 310L of the retained water per day for toilet flushing and hot water (with the tank plumbed to these outlets as envisaged in the draft Code). Plotting this usage rate onto Figure 2-5, it can be seen that only small reductions in peak flow will be achieved (up to 15 to 20 per cent reductions for retention capacities of 3kL and above per dwelling).

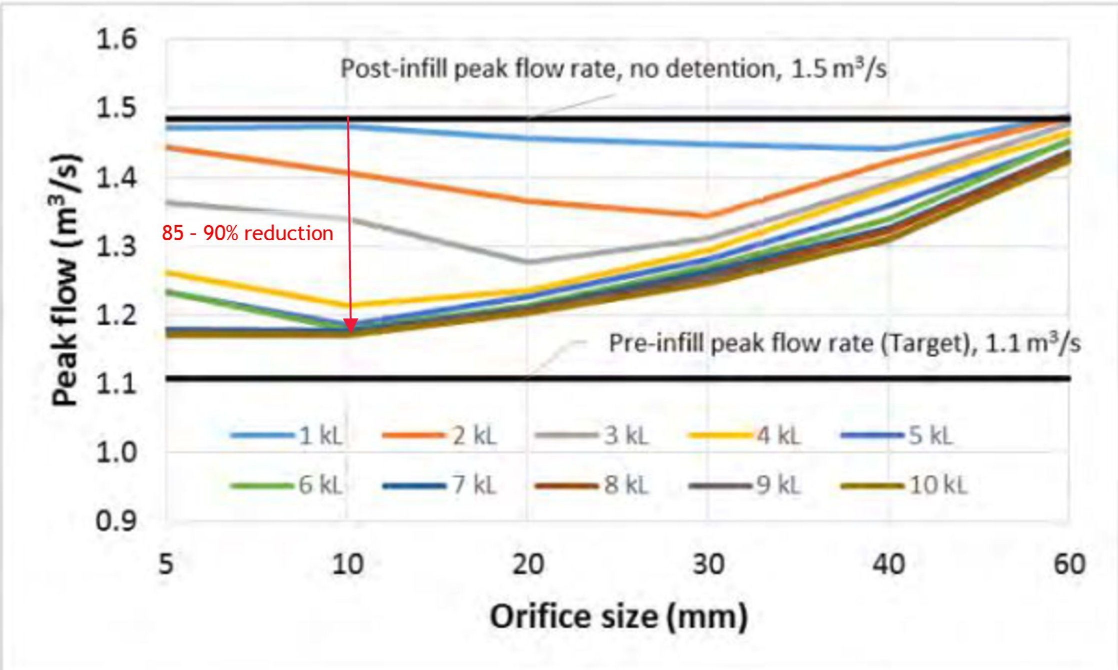
Figure 2-5 Impact of allotment scale retention on Frederick Street peak flows



Note: Tank volumes and emptying rates are combined values for two dwellings following subdivision of a single allotment.
Source: Meyers et al., 2018.

Figure 2-6 shows the impact on peak flows produced by detention tanks of various sizes. The reduction in peak flow is highly dependent on outlet (orifice) size. However for the small outlet sizes likely to be used on onsite tanks, reductions of up to 85 to 90 per cent of the flow increase due to redevelopment are achievable for detention tanks of 2.5kL and above per dwelling.

Figure 2-6 Impact of allotment scale detention on Frederick Street peak flows



Note: Tank volumes and emptying rates are combined values for two dwellings following subdivision of a single allotment.
Source: Meyers et al., 2018.

While the absolute values are likely to vary depending on connected roof area and configuration, the key conclusions that can be drawn from both the Insite and UniSA modelling are that:

- The effectiveness of retention systems in reducing peak flow is dependent on emptying rate (how quickly the household uses the water captured in the tank), with higher rates leading to greater reductions in peak flow
- Retention systems alone are unlikely to produce sufficient reductions in peak flow to match pre-development rates unless very high rates of usage, typically considerably greater than all internal household uses, can be applied
- Provision of onsite detention, combined with onsite retention, can produce substantial reductions in peak flows.

Based on the above, we would suggest that:

- **Proposals to plumb retention tanks into more household uses should be supported, to increase household reuse and contribute to peak flow management**
- **The draft Code policy should be modified to include a provision for some detention storage, to provide more reliable contributions to peak flow management.**

3. STUDY APPROACH

As described in Section 1.1, this work sits within the context of the public consultation process for Phase 3 (Urban Areas) of the Planning and Design Code. The Stakeholder Reference Group provided input and advice into the scope of this work. The consultation, review and evidence gathering process is described in Section 1.

Other key information sources include:

- Analysis of infill housing statistics for this study provided by AGD's Planning Research Analysis Unit
- Insite Integrated Water Management Tool, kindly made available for use by this study by Water Sensitive SA
- The INFFEWS Value Tool, kindly made available for use by this study by the CRC for Water Sensitive Cities
- Myers, B., Pezzaniti, D. and Kemp, D. 2018, *The impact of infill development and WSUD solutions on minor drainage system performance*, Australian Flow Management Group, University of South Australia.

A full list of references is provided in this report.

3.1. Method of analysis

This cost benefit analysis (CBA) was undertaken according to the principles and method outlined in South Australian and Australian Government guidelines for conducting evaluations of public sector initiatives (Department of Treasury and Finance (2008) and Department of Finance and Administration (2006)).

The key characteristics of the CBA method employed in this study include the following:

- The CBA includes a base case or counterfactual scenario, that is, the benchmark against which the policy options were compared. Two bases cases were defined for the catchment-scale analysis, and three for the dwelling-scale analysis. The base cases are derived from the stormwater management provisions that currently apply in the case study catchment and a more typical Greater Adelaide catchment (see Section 3.4).
- The CBA was conducted over a 25-year time period and results were expressed in terms of net benefits, that is, the incremental benefits and costs of the options relative to those generated by the base case scenario[27]
- Costs and benefits were specified in real terms (i.e. constant 2020 dollars). Past and future values were converted to present values by applying a discount rate of 6 per cent
- In order to account for uncertainty, a sensitivity analysis was undertaken using a range of values for key variables
- The evaluation criterion employed in the analysis is net present value (NPV)[28]
- Costs and benefits for the option and base case scenarios have been listed in tabular form and include those that can be readily identified and valued in monetary terms as well as those which cannot be easily valued in monetary terms because of the absence of market signals[29]. The tables also provide an indication of the likely distribution of costs and benefits between stakeholder groups and the source of the information.

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27 Where incremental benefits = (option benefits – base case benefits) and incremental costs = (option costs – base case costs).

28 NPV is defined as discounted net benefits, where net benefits = (incremental benefits – incremental costs).

29 The analysis only includes costs and benefits that are quantifiable in dollar terms, backed by the best available, relevant and defensible information. It likely captures a conservative estimate of the benefits, due to the rigorous and transparent approach taken to quantify benefits in financial terms. We have preferenced South Australian, then best practice Australian data sources.

The cost benefit analysis was undertaken at two levels:

- **At the community level** – expected costs and benefits (both monetary and non-monetary) accruing to people (households, businesses and government) and the environment in a catchment, as a result of the proposed options. This analysis was undertaken at a catchment-scale.
- **At the individual household level** – expected cost and benefits (monetary only) accruing to the household undertaking the development, as a result of the proposed options. This analysis was undertaken at a dwelling-scale.

3.2. Scope of the cost benefit analysis

3.2.1. Policy options analysed

The cost benefit analysis tested three policy options against the base case. In this study, the community level analysis was undertaken against two catchment-scale base cases, and the individual household level analysis was undertaken against three dwelling-scale scenarios. The purpose of this approach is to test whether the draft Code proposals stack up against the current South Australian policy requirements.

The options analysed were:

- **Base Case Scenarios - Two 'business as usual' catchment-scale scenarios:**
    - City of Marion Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)
    - More Typical Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention).
- **Base Case Scenarios - Three 'business as usual' dwelling-scale scenarios:**
    - City of Marion Development Plan – 5kL retention tank
    - More typical Development Plan – 1kL retention plus 2kL detention tank
    - Residential Code – 1kL retention tank.
- **Option 1a - Retention tank required (Draft Code policy).**
  The proposed deemed-to-satisfy provision for minor infill to provide a 3kL retention tank[30].
- **Option 1b - Retention and detention tank required.**
  As per Option 1b, with the addition of a 1kL detention tank to contribute to peak flow management[31].
- **Option 2 - Offset scheme.**
  No provision for onsite rainwater tanks. Stormwater impacts of infill development are addressed offsite in wetlands or street scale biofilters[32], funded by an offset scheme.

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[30] The Draft Code policy provides for a 2kL, 3kL or 5kL retention tank, depending on allotment size. Our analysis indicated that most potential minor infill developments would occur on allotments between 200m2 and 400m2, resulting in a 3kL rainwater tank provision for most minor infill dwellings.

[31] This option was added during the course of the study, when it was identified that detention capacity would be needed to meet peak flow performance management outcomes onsite (see Section 2.7).

[32] Other offsite strategies were found to be of greater cost and lower performance, so were not considered further.

3.2.2. Costs and benefits considered

Monetary costs and benefits considered include those that are direct (e.g. buying a rainwater tank or upgrading council drainage systems) and those that are indirect (e.g. reduced demand for potable water). Non-monetary costs and benefits were also considered (e.g. amenity value of wetlands). The analysis only includes costs and benefits that are quantifiable in dollar terms, backed by the best available, relevant and defensible information. It likely captures a conservative estimate of the benefits, due to the rigorous and transparent approach taken to quantify benefits in financial terms. We have preferenced South Australian and then best practice Australian data sources.

The costs and benefits of options were measured using a 'with' and 'without' framework, that is, quantification of the incremental changes associated with the option compared to the base case scenario. A zero value indicates there is no change to accrued costs or benefits compared to the base case. A negative cost indicates an avoided cost (i.e. a benefit) compared to the base case, and a negative benefit indicates a lost benefit (i.e. a cost) compared to the base case.

The major economic costs and benefits of the options are listed in Table 3-1 and Table 3-2, respectively. The method, data sources and assumptions used to quantify these values are described in Section 3.5. Consideration was given to those benefits and costs likely to occur over a 25-year period.

Table 3-1 Costs considered in the analysis

Option	Description of Costs	Bearer of Cost	Valued in $ Terms	Source of Information
Base Case, Option 1a&b	Tank supply, installation and plumbing	Infill household	Yes	AGD
Base Case, Option 1a&b	Tank and connection maintenance	Infill household	Yes	BDO EconSearch analysis
Base Case, all Options	Drainage system upgrades	Local Government	Yes	Tonkin analysis
Option 2	Wetland or biofilters construction	Local Government	Yes	Tonkin analysis
Option 2	Wetland or biofilters maintenance	Local Government	Yes	Tonkin analysis
Option 2	Offset scheme payments	Infill household	Yes	BDO EconSearch analysis
Option 2	Offset scheme management	Local Government	Yes	BDO EconSearch analysis

Table 3-2 Benefits considered in the analysis

Option	Description of Benefits	Recipient of Benefit	Valued in $ Terms	Source of Information
Base Case, Option 1a&b	Reduced potable water demand	Infill household	Yes	Tonkin analysis
Base Case, all Options	Improved water quality	Community	Yes	BDO EconSearch analysis
Base Case, Option 1a&b	Residual value of project capital (tanks)	Infill household	Yes	BDO EconSearch analysis
Base Case, Option 1a&b	Residual value of project capital (drainage system)	Local Government	Yes	BDO EconSearch analysis
Option 2	Residual value of project capital (wetland or biofilters)	Local Government	Yes	BDO EconSearch analysis
Option 2	Amenity value of wetland or biofilters	Households adjacent to wetland or biofilters	Yes	BDO EconSearch analysis
Option 2	Biodiversity value of wetland or biofilters	Community	Yes	BDO EconSearch analysis

3.3. Case study catchment

Examination of the likely costs and benefits of policy options is highly complex when it is applied across the Greater Adelaide region.

Costs and benefits related to stormwater volume and water quality are likely to be linearly proportional to the amount of impervious area generated by infill development, so they can be more readily extrapolated. However, impacts associated with peak flows are affected by a much greater range of factors, such as catchment size, distance to the end of the system, age and condition of existing underground infrastructure, and practicalities of stormwater system upgrades (e.g. availability of land for surface treatment and of space within roadways for duplicate pipe systems). These variables make extrapolation of costs and benefits related to peak flow management much more difficult.

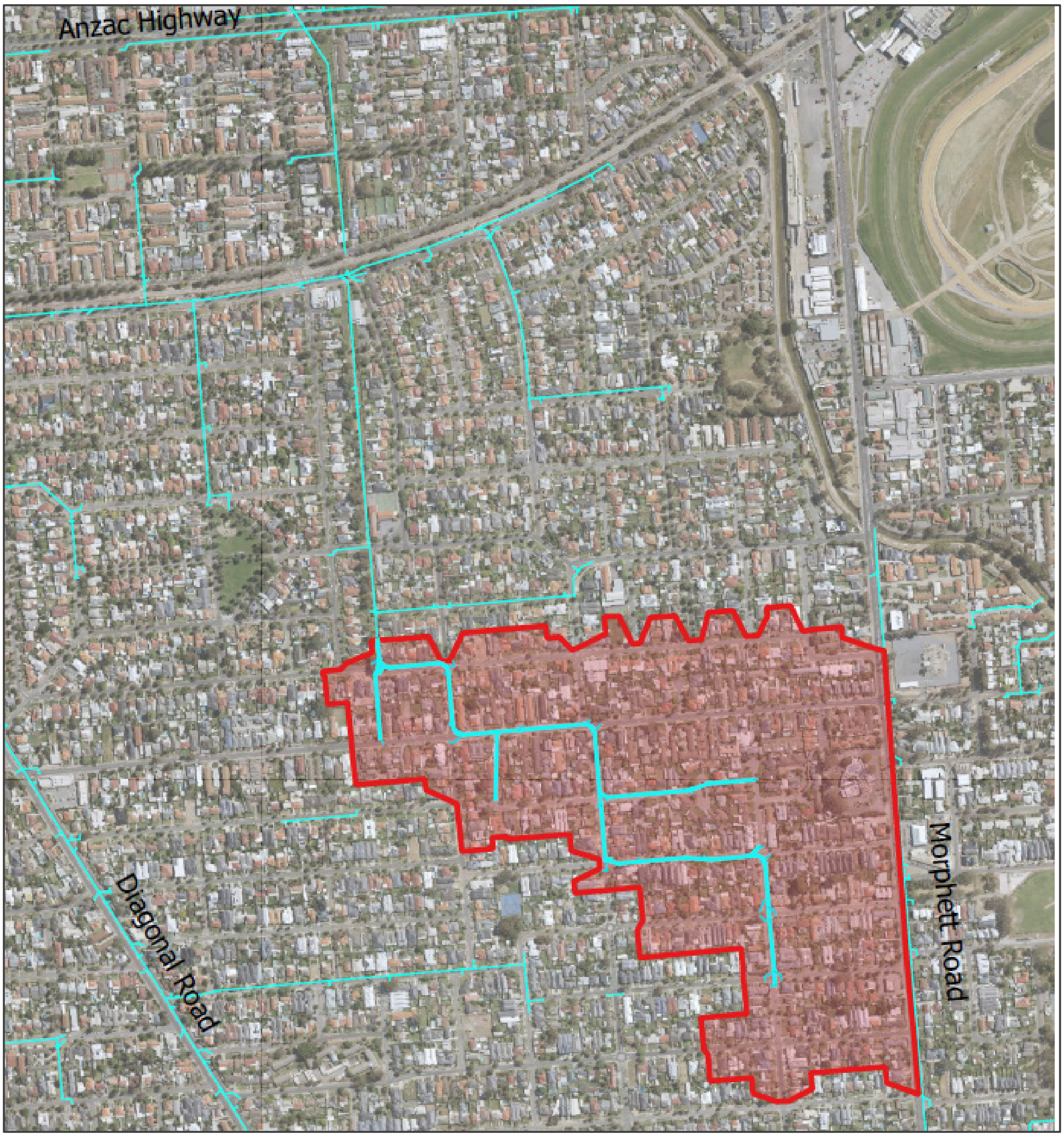
A case study catchment has therefore been selected to enable examination of each of the policy options **on a per catchment basis**, instead of the entire region. The case study catchment is not intended to be a proxy for the wider Greater Adelaide region. However, it is intended to illustrate the **relative costs and benefits** of each of the policy options. Where appropriate, commentary is provided with the results to assist in understanding how these results might vary across different catchments.

The selected case study site is the Frederick Street catchment in Glengowrie, within the City of Marion. Figure 3- shows the location of this catchment.

The topography of the catchment is typical of much of the western and south western suburbs of Adelaide. The general topography is relatively flat, with no well-defined watercourses. Stormwater drainage is provided by an underground system designed for low density residential development. The catchment is largely residential and has experienced infill development, with further development likely over the coming years.

The Frederick Street catchment is one of only two in Adelaide that have a long-term flow record (the other being The Paddocks in the City of Salisbury). This has enabled a number of previous investigations to model the effects of infill development on flow peaks and volumes in the catchment, with some studies comparing stormwater management approaches (onsite vs offsite and detention vs retention). The effects of different approaches have been modelled in more detail for the Frederick Street catchment than for The Paddocks, providing more useful data on which to base the assessment of costs and benefits. The Frederick Street catchment was therefore the best available case study for this analysis.

Figure 3-1 Case study catchment, Frederick Street in the City of Marion



Source: Tonkin.

3.3.1. Potential for development in the case study catchment

To assess the catchment-scale costs and benefits of each of the policy options to the community, it is necessary to understand the potential increase in dwelling numbers within the catchment. The analysis outlined below drew on a number of sources to determine that 339 new dwellings are expected to be built between 2020 and 2045, at a rate of 13 or 14 dwellings per year. These 339 new dwellings are the subject of the catchment-scale analysis.

A previous UniSA investigation of the Frederick Street catchment (Myers et al, 2018) assessed the impact of redevelopment on the performance of the drainage system. As a part of this investigation, progression of development within the catchment was assessed using aerial photography. It was found that prior to 1993, development could be largely classified as low density residential with limited infill. Pre-1993 was therefore classified as the catchment's 'pre infill' state. From 1993 to 2013, the number of dwellings increased by 77, from 555 to 632.

AGD analysis shows that from 2012 to 2019, the number of dwellings increased by 53. Data on the number and type of residential developments in the catchment is summarised in Table 3-3. This increase in dwelling numbers was assumed to apply to 2013 to 2020, to align with the period assessed in the UniSA study and the 2020 baseline.

Table 3-3 Actual development in case study area (2012 to 2019)

Type	No of Dwellings	
	Pre Development	Post Development
1 into 1 dwellings	9	9
1 into 2 dwellings	27	54
1 into 3 dwellings	13	39
Totals	**49**	**102**

Source: AGD analysis.

AGD has also provided data on the number of allotments available for development within the catchment, and the maximum number of dwellings that could be constructed on these allotments. The data from Table 3-3 was used to determine a likely rate and number of infill developments over the next 25 years (from 2020 to 2045). This analysis showed a significant prospect that the 160 available allotments would all be developed within this timeframe, adding 179 new dwellings. This data is summarised in Table 3-4.

Table 3-4 Projected development in the case study area (2020 – 2045)

Type	No of Dwellings	
	Pre Development	Post Development
1 into 1 dwellings	28	28
1 into 2 dwellings	90	180
1 into 3 dwellings	38	114
1 into 4 dwellings	3	12
1 into 5 dwellings	1	5
Totals	**160**	**339**

Source: Tonkin analysis.

Table 3-5 combines the development statistics from the three sources, showing that between 1993 and 2045, a total of 286 allotments are expected to be developed in the catchment, producing 595 new dwellings, or 309 additional dwellings. Importantly, 339 new dwellings are expected to be built following the 2020 baseline. This cost benefit analysis tests the impact of the policy options on those dwellings.

Table 3-5 Combined development statistics for the case study area (1993 – 2045)

Period	No of Allotments Divided	No of New Dwellings	No of Additional Dwellings
1993 - 2013	77	154	77
2013 - 2020	49	102	53
2020 - 2045	160	339	179
Totals	**286**	**595**	**309**

Source: Tonkin analysis.

Because the analysis is over a 25-year period, it is also important to understand the rate at which the new dwellings will be built (for the purpose of discounting costs and benefits over the study period). Projections for the rate of minor infill developments in Greater Adelaide between 2016 and 2035 were provided by AGD, and the rate of infill development in the case study area was assumed to be consistent with the rate across Greater Adelaide. The rates used in this analysis are provided in Table 3-6.

Table 3-6 Expected rate of minor infill development in the case study area

	2021-2025	2026-2030	2031-2035	2036-2045
No. dwellings built/year	13	14	13	14

3.3.2. Change in effective impervious area in the case study catchment

The UniSA investigation referred to above (Myers et al, 2018) assumed the 1993 catchment condition to represent the 'pre-infill' state, with any changes assessed relative to this baseline. We have adopted the same base point for the purposes of this analysis, across all scenarios.

This analysis measures the difference in outcomes going forward (i.e. from 2020 to 2045), as different stormwater management approaches are applied. By determining the change in impervious area between 1993 and 2045, we can assume a change between 2020 and 2045, because all scenarios (base case and options) have the same stormwater management history between 1993 and 2020, so there is no difference between the scenarios during this period.

According to the UniSA investigation, the effective impervious area of the catchment in 1993 (assessed by the gauged volumetric runoff coefficient) was 0.28 (28 per cent).

The 160 allotments identified as being potentially developed within the study period have an average site area of 780m^2. Assuming that all 286 allotments developed since 1993 are in accordance with draft Code provisions and have a minimum pervious area of 25 per cent, an effective impervious area of the order of 65 per cent could be assumed, with the remaining 10 per cent being impervious areas draining to gardens and so on.

The increase in effective impervious area for the period 1993 to 2045 therefore becomes:

286 allotments x 780m^2 x (0.65 – 0.28) = 8.2 ha

The catchment has an area of 43.5 ha. With the addition of the impervious area resulting from 286 developed allotments, the effective impervious area is expected to be 68 per cent greater in 2045 than in 1993.

By selecting a single catchment for the case study, impervious area becomes the only variable affecting peak flow that will change between 2020 and 2045. The change in peak flow as a result of infill development during the study period has therefore been taken to be directly proportional to the increase in impervious area.

3.4. Defining the base case and options

3.4.1. Base case scenarios – dwelling-scale

The three proposed options were compared against the 'base case' – that is, what happens with stormwater management in minor infill developments now. To check if proposed policy options will add or subtract value, we needed to clearly define an accurate base case. This was a key part of this project.

While the case study catchment is located in the City of Marion, the base case assessment considered costs and benefits associated with a range of current policy requirements. As described in Section 2.5.2, the range of requirements for stormwater management vary widely across Greater Adelaide. The current requirements of the City of Marion follow a retention only approach, broadly requiring a 3kL tank plumbed into the household for development with roof areas less than 150m², and a 5kL tank for roof areas greater than 150m². For the purpose of this study, the upper-end requirement of a 5kL retention tank was used. More typically, a 1kL retention tank with 2kL of detention capacity is required by a number of councils in Greater Adelaide (refer Appendix 1).

To ensure an accurate understanding of policy outcomes for **individual infill households**, the cost benefit analysis was undertaken at the dwelling scale. This analysis compared each policy option against three current requirements applying to individual dwellings:

- City of Marion Development Plan – 5kL retention tank
- More typical Development Plan – 1kL retention plus 2kL detention tank
- Residential Code – 1kL retention tank.

3.4.2. Base case scenarios – catchment-scale

To understand policy outcomes for the broader community, we needed a more a realistic representation of the base case at a **catchment-scale**. This required consideration of a typical blend of assessment pathways across a catchment.

To achieve this, we considered the proportion of developments typically approved under the Residential Code, compared to those approved under the Development Plan. Councils with high numbers of infill developments were asked to report these proportions. The City of Marion has reported that as many as 64 per cent of applications are approved under the Residential Code. Other Councils such as the City of West Torrens and City of Charles Sturt report a much lower percentage of around 10 per cent of applications approved under the Residential Code. See Section 2.5.2 for details on current Residential Code and Development Plan requirements.

For the purposes of the base case assessment at the catchment-scale, we use two scenarios, representing a catchment *without* a detention tank requirement (our case study catchment in the City of Marion), and a catchment *with* a detention tank requirement (a more typical scenario). These two base case scenarios were used to analyse the policy options at the **community level**.

City of Marion case study catchment

This scenario assumes that 64 per cent of new minor infill developments are approved under the Residential Code, requiring a 1kL retention tank, with the remaining 36 per cent being approved under the City of Marion Development Plan, requiring a 5kL retention tank.

The weighted average requirement is for a 2.4kL retention tank, plumbed to one non-potable water outlet (a toilet, laundry tap or hot water system).

More typical catchment

This scenario assumes that 10 per cent of new minor infill developments are approved under the Residential Code, requiring a 1kL retention tank, with the remaining 90 per cent being approved under a more typical Development Plan, requiring a 1kL retention and 2kL detention tank (3kL total). This scenario is likely to represent a more typical approach adopted by councils across Greater Adelaide.

The weighted average requirement is for a 1kL retention and 1.8kL retention tank, plumbed to one non-potable water outlet (a toilet, laundry tap or hot water system).

3.4.3. Option 1a – onsite retention tank required

This option examines the costs and benefits associated with the retention tank provisions outlined in the draft Code.

For this option, the proposed DTS provisions in the draft Code were applied to the allotments with subdivision potential within the case study catchment, as identified by AGD. This analysis indicated that most of the potential minor infill developments would occur on allotments that are greater than 200m^2 and less than 400m^2 in size (see Table 2-3). For the purposes of this study, we considered the requirements of that allotment size only, which include a requirement for a 3kL retention tank be plumbed into all toilets, and either the laundry cold water outlets or the hot water service.

3.4.4. Option 1b – onsite retention and detention tank required

This option examines the costs and benefits associated with the retention tank provisions applying to Option 1a, but with the addition of 1kL of detention storage provided to improve peak flow management (see Section 2.7.3).

This option would bring the performance of Code provisions more into line with requirements in many of the existing Development Plans. The size of the proposed detention capacity is based on the outputs of the Insite tool contained in Appendix 2.

3.4.5. Option 2 – offsite infrastructure funded by an offset scheme

This option examines the costs and benefits of having no provisions for onsite stormwater management, with impacts of infill development addressed offsite using water sensitive urban design infrastructure, funded by infill households via an offset scheme.

A new feature of the *Planning, Development and Infrastructure Act* 2016 is the capacity to establish other schemes, beyond existing carpark funds, for 'off-setting contributions'. An offset scheme would allow councils to accept financial contributions from infill households, in-lieu of them complying with stormwater management provisions under the Code. The financial contribution would contribute to delivery of offsite infrastructure (like wetlands or biofilters) to achieve equivalent stormwater management benefits. For the purpose of this analysis, an offset scheme to fund a local wetland or street-scale biofilter was designed and costed (see Section 3.5.9).

Implementation of offsite strategies to deal with the impacts of increased flows from infill development is highly specific to catchments and sub-catchments. Detailed feasibility and planning of offsite WSUD infrastructure is normally undertaken to cater for specific opportunities and constraints associated with topography, existing services and development, and availability of suitable land. Two potential options, local wetlands and street-scale biofilters, have been considered in this analysis as two separately costed scenarios. Other options were assessed, but were not considered further. See below for more details.

Option 2a - Wetlands

Wetlands have been used and are recommended in many of the current Stormwater Management Plans, but their applicability can be constrained by the availability of underutilised land.

Construction of wetlands in the Frederick Street catchment (and more broadly in the wider Greater Adelaide area) would most likely require the purchase of private land to provide space. Upgrade of the drainage system upstream of the wetland would also still be required to cater for increased flows from infill development.

Wetlands can provide water quality treatment outcomes as envisaged in the SA WSUD Policy[33]. They can also deliver amenity and biodiversity benefits to neighbouring households.

As a rule of thumb, the required wetland area can be calculated as being 2 per cent of the impervious area of the catchment. If a wetland was to be constructed to treat runoff from the additional impervious area generated by infill development in the case study catchment (8.2 ha, from Section 3.4.5), a wetland of 1,600m^2 would be required. Allowing for batters and surrounding landscaping, the land provision for such a system could be double this area (up to 4 allotments at an average area of 780m^2 per allotment).

[33] The runoff volume treated by the wetland that is attributable to minor infill developments was estimated at 42,070kL per year.

Option 2b - Biofilters

Many councils are now installing biofilters within streetscapes to improve runoff quality from existing roads and development, while improving biodiversity and amenity outcomes.

However, the experience of many councils in planning and installing these systems has been that after allowing for on-street parking, driveways, space for bin pick up and so on, the available locations are limited. Such constraints are expected to increase with infill development, which leads to more closely spaced driveways and a greater demand for on-street parking. Implementation of additional systems to cater for infill development should therefore allow for land acquisition costs.

Biofilters do not provide sufficient storage to affect peak flows, nor do they provide for a reduction in stormwater volume (apart from watering of plants within the filter), as in most cases they are lined with an impermeable membrane. Their main function is to improve runoff water quality[34].

As a rule of thumb, the required surface area of a biofilter is between 0.5 and 1 per cent of the impervious area of the catchment. If biofilters were constructed to treat runoff from the additional impervious area generated by infill development in the case study catchment (8.2 ha, from Section 3.4.5), a filter area of between 400m^2 and 800m^2 would be required. Allowing for batter, the land requirement for such a system could be double this area (up to 2 allotments at an average area of 780m^2 per allotment).

Other strategies not considered further

The study considered the option of integrating wetlands with aquifer recharge schemes and distribution systems with wetlands. Such schemes can supply water for irrigation or purple pipe supply back to allotments. However, the economic viability of harvesting water from aquifer recharge systems is related to the availability of a nearby beneficial use or distribution system for more remote uses. For the purposes of this study, it was assumed that, due to scale, aquifer recharge schemes and distribution systems would not be economic and were therefore not considered further.

The possibility of installing street-scale underground detention tanks to mitigate flows was also investigated by UniSA (Myers et al, 2018). The investigation found that for the case study catchment, underground detention tank systems that manage peak flows to pre-development level were of a similar or greater cost than upgrading the drainage system. Detention tanks do not provide the water quality or water use benefits envisaged under the SA WSUD Policy and were therefore not considered further.

3.5. Quantifying the costs and benefits

3.5.1. Infrastructure costs – onsite rainwater tanks

Tank purchase, installation and plumbing costs per dwelling

The costs of onsite rainwater tanks and plumbing for individual households were calculated using data provided by AGD (2020). The unit costs are outlined in Table 3-7.

In existing Development Plans, Councils often encourage households to combine retention and detention capacity in one tank. This can be done simply and inexpensively by adding an outlet in the side of the tank. The tank volume above the outlet is the detention capacity. The total tank capacity has therefore been used to calculate unit costs, regardless of the split between retention and detention capacity.

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[34] The runoff volume treated by biofilters that is attributable to minor infill developments was estimated at 42,070kL per year.

Table 3-7 Cost of tanks and plumbing for individual households

Tank size	Required under	Cost per dwelling			Additional cost over Residential Code
		Cost of tank	Cost of plumbing	Total cost	
1kL tank	Residential Code	$600	$1,258	**$1,858**	-
3kL tank	More Typical Development Plan	$1,054	$1,508	**$2,562**	$704
3kL tank	Option 1a (3kL retention)	$1,054	$1,508 - $1,757 [a]	**$2,562 - $2,812** [a]	$704 - $954
4kL tank	Option 1b (3kL retention + 1kL detention)	$1,654	$1,589 - $1,839 [a]	**$3,243 - $3,493** [a]	$1,385 - $1,635
5kL tank	City of Marion Development Plan	$1,890	$1,670	**$3,560**	$1,702

[a] Plumbing for double storey dwellings will cost an additional $250 for plumbing to the upstairs toilet.

Source: AGD, 2020

As described in Section 2.6.2, the draft Code policy requires plumbing the retention tank to all toilets and either the laundry cold water outlets or the hot water service. Options 1a and 1b will therefore require additional plumbing to an upstairs toilet for double storey dwellings. This cost was estimated at $250 per dwelling.

Tank purchase, installation and plumbing costs per catchment

The net present cost of tanks per catchment for a projected 339 infill development dwellings, built over a period of 25 years at a rate of 13 or 14 dwellings per year (see Section 3.3.1), have been calculated as:

- **City of Marion Base Case Catchment** – 64 per cent of approvals under Residential Code (1kL retention tank) and 36 per cent under the City of Marion Development Plan (5kL retention tank) – $837,586
- **More Typical Base Case Catchment** – 10 per cent of approvals under Residential Code (1kL retention tank) and 90 per cent under a more typical Development Plan (2kL detention & 1kL retention) - $844,652
- **Option 1a -** 3kL retention tank required (draft Code policy) - $878,297
- **Option 1b -** 3kL retention and 1kL detention tank required - $1,109,156.

Based on analysis of the case study catchment, it was assumed that under Option 1a and 1b, the proportion of single storey and double storey dwellings would be 88 per cent and 22 per cent respectively.

Operation and maintenance costs

A number of references provided by AGD (2020) provide estimates of ongoing rainwater tank and connection system maintenance. Hall (2013) provided the most comprehensive analysis of likely costs, and these were estimated at approximately $104 per system per year. This cost applied as a separate line item to both base cases and Options 1a and 1b.

3.5.2. Infrastructure costs – drainage system upgrades

Costs associated with upgrading the council drainage system to achieve the same standard that existed prior to infill development have been estimated. These costs were determined using two methods described below, then averaged for use in the cost benefit analysis. Valuation rates are based on stormwater asset replacement costs derived from local government projects undertaken by Tonkin.

For the case study catchment, the as-is replacement cost of the existing underground drainage system (pipes, inlets and junction boxes) was calculated as $1,860,000. The below methods assign upgrade costs over and above this amount, which are attributable to the expected infill development.

Method 1

This method was based on the 'drainage impairment' cost attributable to redevelopment. This study assumes that the required upgrade will be achieved via complete replacement of the drainage system in Year 1.

First, we determined the current value of the existing drainage system in the case study catchment. A modified post-development network configuration was then determined by taking the existing network capacity (based on pipe grade), calculating the expected flow increase arising from development, and determining the modified pipe grade that would be required to carry the increased flow. The need for gutter upgrades to cater for larger flow widths was also considered. The resulting network was costed, with the cost attributable to the redevelopment determined by subtracting the modified network value from the original network value.

The network in the case study area is currently between 50 and 60 years old. Taking an asset life of 80 to 100 years for concrete pipe, if a council were to follow this approach, the cost of this option should also include any loss of useful life of the current asset at the time the full replacement occurs. The loss of useful life in the case study catchment has been considered in this analysis.

Method 2

The second method was based on the cost of providing a parallel system to cater for the increased flows, with the existing system left in place. Such a strategy is more costly upfront, but avoids the need to 'waste' any useful life of existing assets. It has the limitation that space is required within the street to construct the parallel system. For the case study catchment, it was assumed this space was available.

Average cost

The costs associated with upgrading the network have been determined using both methods for each of the base case scenarios and options. These results are set out below (Table 3-8).

For both scenarios under Option 2, the required upgrades were assumed to take a full 68 per cent increase in peak flow attributable to redevelopment, as described in Section 3.4.5.

Table 3-8 Cost of drainage system upgrades

Scenario	Method 1	Method 2	Average (used in analysis)
Base Case - City of Marion Catchment	$845,000	$1,540,000	**$1,192,500**
Base Case - More Typical Catchment	$345,000	$895,000	**$620,000**
Option 1a - Retention	$690,000	$1,430,000	**$1,060,000**
Option 1b - Retention & Detention	$345,000	$895,000	**$620,000** [a]
Option 2a - Wetlands	$870,000	$1,590,000	**$1,230,000**
Option 2b - Biofilters	$870,000	$1,590,000	**$1,230,000**

[a] Very similar peak flow levels will be generated by the More Typical Base Case Catchment and Option 1b, so the required pipe grade required to upgrade the drainage system is the same.

Source: Tonkin analysis

3.5.3. Infrastructure costs – wetlands and biofilters

Construction costs

Costs associated with building wetlands and biofilters across the catchment over a 25-year period are estimated at:

- Wetland construction: $250,000
- Biofilter construction: $160,000

Construction costs of wetlands and biofilters were based on rates contained in the *Water Sensitive Urban Design Technical Manual for Greater Adelaide* (DPLG 2010). This resource was the best information available for the purposes of this study. Actual construction figures are expected to be highly variable, and costs may be higher or lower, which would affect the cost benefit analysis results.

Costs are also likely to be incurred in acquiring land suitable for the construction of offsite wetlands and biofilters. Land acquisition is considered a 'transfer cost' when analysing community level costs and benefits, because the value is transferred from the buyer (i.e. local government) to the seller (i.e. individual households), with the total value remaining within the community. Due to this, and the fact that land acquisition costs are highly variable, land acquisition costs have not been considered in this analysis[35].

Maintenance costs

There will be also be ongoing costs to maintain the function of the wetlands or biofilters.

Coombes (2018) estimated that the typical cost of maintenance of a constructed wetland would be 2 per cent of the construction cost. On this basis, an annual cost of $5,000 was assumed.

The *Water Sensitive Urban Design Technical Manual for Greater Adelaide* (DPLG 2010) provides estimated annual costs for maintaining biofilters, which (converted to current prices) ranged between $2.00 to $3.50 per m^2 of bio filter. An average cost of $2.75 was applied, giving a total annual cost of $1,650.

3.5.4. Residual value of project capital

This is the value of capital investment at the end of the project period. These project capitals were:

- Rainwater tanks and associated connection systems, assumed useful life of 25 years (base cases and Options 1a & 1b)
- Council drainage system, assumed useful life of 90 years (all base cases and options)
- Wetland and biofilter infrastructure, assumed useful life of 40 years (Option 2).

The residual value benefit was calculated based on the depreciated value of the investment. Straight-line depreciation was applied.

The residual value of project capital for each base case and policy option is provided in Table 3-9.

[35] A sensitivity analysis was undertaken to demonstrate the effect of including land acquisition costs on an offset scheme payment for an individual household (see Section 4.2.2). This analysis shows that if land acquisition is required to enable construction of wetland or biofilter infrastructure, net costs will be incurred by infill households participating in the offset scheme. This is likely to make an offset scheme an unattractive option for infill households.

Table 3-9 Residual value of project capital

Scenario	Tanks and connections	Council drainage system	Wetland and biofilters
Base Cases – Dwelling-scale	$0	NA	NA
Base Case – City of Marion Catchment	$402,030	$1,532,917	NA
Base Case – More Typical Catchment	$405,422	$1,119,444	NA
Option 1a – Retention	421,571	$1,437,222	NA
Option 1b – Retention & Detention	$532,380	$1,119,444	NA
Option 2a – Wetlands	NA	$1,560,000	$93,750
Option 2b - Biofilters	NA	$1,560,000	$60,000

Source: BDO EconSearch analysis

3.5.5. Reduced potable water demand

Yield from tanks

In a 2004 paper, the South Australian Government described the drivers for requiring rainwater tanks to be provided and plumbed into new residential development, which include a more sustainable and secure water supply.

The paper included daily water balance modelling on the average annual volumes of water able to be supplied by tanks under a range of conditions including:

- Various tank sizes
- Various connected roof areas
- Demands for various household use scenarios (based on 2.5 persons per dwelling)
- Different rainfall regimes including metropolitan Adelaide and Mt Barker (among others).

The various combinations of household use, tank size and roof area cover the range of scenarios currently required by the Residential Code and Council Development Plans, as well as those proposed under the draft Code.

This data was used to determine of annual yields across the catchment from retention tanks under the base cases and Options 1a and 1b. The yield is the amount of non-potable water likely to be used within the infill households as a result of the relevant tank size and plumbing requirements.

By the end of the analysis period, when all available infill development has occurred, the mature catchment yield would be:

- City of Marion Base Case Catchment (weighted average 2.4kL retention): 14,660kL per year
- More Typical Base Case Catchment (weighted average 1kL retention): 8,925kL per year
- Option 1a (3kL retention): 21,840kL per year
- Option 1b (3kL retention): 21,840kL per year.

Reduced potable water demand

By installing and plumbing retention tanks into non-potable water outlets in the house, infill households can reduce their potable water use for non-potable purposes. This is an efficiency gain to the water supply network, with indirect monetary benefits accruing to infill households. We can estimate the value of stormwater capture and use by its next best alternative use, i.e. reticulated potable water.

We assumed a value of $3.41 per kL, equivalent to the current SA Water Tier 2 residential potable water charges. For individual households, the full benefit is applied from Year 1. For the community, this benefit builds up over time, as more infill households are built and tanks installed and plumbed in accordingly. The benefit applied to the base cases and Options 1a and 1b.

Option 2 applies a lost benefit, as there is no household use of stormwater.

3.5.6. Improved water quality

Suspended solids and nitrogen are known (McDowell & Pfennig 2013) to be the key pollutants of concern for the Gulf St Vincent, limiting seagrass growth. Phosphorous is a pollutant of concern in inland waters, causing excessive algal growth. It is of particular concern to the Barker Inlet due to algal growth caused by relatively high levels of nutrients (in particular nitrogen and phosphorus) stifling mangrove shoot growth (EPA 2005). The Barker Inlet is the discharge point for stormwater from much of Port Adelaide Enfield, Salisbury and some of Charles Sturt.

By removing water from the catchment via household capture and use (base cases and Options 1a and 1b) or by treating stormwater to capture pollutants (Option 2) it is expected that the water quality of urban waterways, the Barker Inlet and Gulf St Vincent will be incrementally improved.

This environmental benefit was estimated by assuming a typical level of nutrients in stormwater (total phosphorous and total nitrogen) sourced from Coombes et al. (2016) and applying a unit value of avoided removal cost for each of these nutrients (Iftekhar & Polyakov 2019). The benefit was estimated to be $2.02 per kL for phosphorous and $0.49 per kL for nitrogen.

Suspended solids are also another key pollutant, however, an appropriate monetary value for this pollutant was not readily available, so this benefit was not considered.

3.5.7. Amenity value of wetlands and biofilters

Amenity values are the characteristics that influence and enhance people's appreciation of a particular area. These values are derived from the pleasantness, aesthetic coherence and cultural and recreational attributes of an area.

Pandit et al. (2014)[36] found a significant positive relationship between managed wetlands in an urban setting and house prices. The CRC for Water Sensitive Cities INFFEWS Value tool has derived a wetlands value function based on that study, and the tool has been used to determine the amenity value of wetlands in this study.

A 1,600m^2 wetland (see Section 3.4.5) is likely to increase the median house price of houses immediately adjacent to the wetland by 3.06 per cent. Our analysis estimated there would be 16 homes bordering a wetland of this size. The current median house price in the Adelaide metropolitan region is $485,000[37]. On this basis, an amenity value of $237,456 was estimated. This value was applied to Year 2 of the analysis. It was also assumed to apply to the biofilters.

3.5.8. Biodiversity value of wetlands and biofilters

It is likely that the wetland and biofilters constructed will increase the habitat available for local biodiversity (birds, frogs, insects, small mammals, plants and fungi). In a meta-analysis of some 89

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[36] Pandit et al. (2014) undertook a hedonic pricing study of a number of environmental assets in the public realm. This study estimated the effect of vegetation cover on sales price of urban residential properties in Perth, Western Australia.

[37] Source: https://www.sa.gov.au/topics/planning-and-property/buying-and-selling/researching-a-property/median-house-sales-by-quarter.

studies, Schuyt and Brander (2004) identified a number of social, economic and environmental values of wetlands, including biodiversity support services. They estimated a median value of US$415 per ha per year globally. Converted to current Australian dollars [38], this equates to $1,083 per ha per year. For the 1.6ha (1,600m^2) wetland, this gave a value of $1,733 per year. In Year 1, when the wetland was constructed, a nil value was assumed, increasing by 20 per cent each year between Year 1 and Year 6, when the full value was assumed to be reached, then applied in full every year onwards. This value was also assumed to apply to the biofilters.

3.5.9. Offset scheme payments and management

Offset scheme payments

It should be noted that this offset scheme has been developed for the purposes of this analysis and its formulation is intended to be illustrative only. It is based on the approach devised by Marsden Jacobs and Associates for Moonee Valley City Council's WSUD Developer Voluntary Contribution Scheme. Actual costs are likely to vary, and would need to be further investigated to ensure the feasibility of any scheme.

Offset scheme payments represent a cost to infill households and a benefit to offset scheme providers, and are, for the community level analysis, a transfer payment. These costs and benefits apply to Option 2.

The payment is based on the midpoint price between the cost to infill households to meet the Draft Code provisions (i.e. Option 1a) and the cost to councils to provide the equivalent outcomes offsite via a wetland or biofilters. Table 3-10 describes how this payment was estimated.

Delivery of offsite solutions is likely to be constrained by the lack of available land in an urban infill setting, and it is likely that land would need to be purchased to install wetlands or biofilters. Land acquisition costs have not been factored into this analysis[39], but would need to be considered when establishing appropriate offset payments, to enable the offsite management solutions to actually be delivered. To demonstrate the effect of including land acquisition costs in offset scheme payments, a sensitivity analysis was undertaken for the dwelling-scale analysis (see Section 4.2.2). This analysis shows that if land acquisition is required to enable construction of wetland or biofilter infrastructure, net costs will be incurred by infill households participating in the offset scheme. This is likely to make an offset scheme an unattractive option for infill households.

38 Using a US CPI adjustment of 1.5, to convert from 2000 values to 2020 values, and a current exchange rate of A41.60 to the US dollar, to convert US dollars to Australian dollars.

39 Land acquisition costs are considered a 'transfer payment' in a community-scale cost benefit analysis, because the payment made by local government (the buyer) is transferred to the private landholder (the seller), with the total value remaining within the community.

Table 3-10 Offset scheme payment calculation

	Wetland	Biofilters
Offsite provision ($, PV)		
Drainage system upgrade	170,000	170,000
WSUD construction	250,000	160,000
WSUD maintenance	67,752	22,358
Total PV ($)	487,752	352,358
PV ($/dwelling) - A	**1,439**	**1,039**
Onsite provision ($, PV)		
Rainwater tank ($/dwelling, PV) - B	2,591	2,591
Offset payment ($/household)		
Average (A,B)	2,015	1,815

Offset scheme development and management

In accordance with the approach devised for the Moonee Valley City Council (see Table 3-10), an administration fee charged to payees of 8.9 per cent of the offset scheme payment was applied to cover the costs of scheme development and management. These costs apply to Option 2.

Again, the scheme developed for this analysis is intended to be illustrative only. Actual costs are likely to vary, and would need to be further investigated to ensure the feasibility of any scheme.

4. COST BENEFIT ANALYSIS RESULTS

The analysis was undertaken at two levels:

- **At the community level** – expected costs and benefits (both monetary and non-monetary) accruing to people (households, businesses and government) and the environment in a catchment, as a result of the proposed options. For results, see Section 4.1.
- **At the individual household level** – expected cost and benefits (monetary only) accruing to the household undertaking the development, as a result of the proposed options. For results, see Section 4.2.

4.1. Community

4.1.1. Cost benefit analysis results

Options 1a and 1b

For onsite stormwater management, Option 1b (retention and detention tank) is more cost-effective for the community than Option 1a (retention tank only – draft Code policy). This is because Option 1a has no requirement for detention tanks, so it will cause higher peak flow rates, requiring a **higher investment in council stormwater management systems**[40]. Therefore, adding a detention tank requirement to the Draft Code policy should be considered.

For onsite stormwater management, the range of expected outcomes for the community depend on the policy option and the base case, as outlined in Table 4-1:

- Compared to a typical base case, the draft Code policies (Option 1a) would deliver a net cost to the wider community (NPV -$137,659 for the catchment). This is because existing requirements for detention tanks would be removed, requiring more upgrades to Council stormwater systems.
- The draft Code policies (Option 1a) would deliver a net benefit to the wider community, compared to the City of Marion case study catchment (NPV $223,999 for the catchment). This is because the draft Code policy requires more household connection points, which adds to the 'detention effect'. This would avoid or delay needed upgrades to council stormwater systems.
- Adding a detention tank to the draft Code policy (Option 1b) would deliver a net benefit to the wider community, compared to both the City of Marion case study catchment (NPV $487,764 for the catchment) and the more typical base case catchment (NPV $126,106 for the catchment).

Detailed results are provided in Appendix 4.

[40] This would shift the cost of managing peak flows from the infill household to the community, via increased Council rates.

Table 4-1 Results of the community cost benefit analysis for Options 1a and 1b, catchment-scale

Description	Option 1a[a] (Marion Catchment)[c]	Option 1a[a] (Typical Catchment)[d]	Option 1b[b] (Marion Catchment)[c]	Option 1b[b] (Typical Catchment)[d]
Incremental Benefits ($[e])				
Reduced potable water demand	76,211	137,084	76,211	137,084
Improved water quality	56,161	101,019	56,161	101,019
Residual value of capital (tanks)	4,826	3,988	32,194	31,356
Residual value of capital (drainage system)	-23,634 [f]	78,484	-102,119 [f]	0 [h]
Total Incremental Benefits ($[e])	**113,563**	**320,576**	**62,446**	**269,459**
Incremental Costs ($[e])				
Tank supply, installation and plumbing	22,064	18,234	147,183	143,353
Tank and connection maintenance	0 [h]	0 [h]	0 [h]	0 [h]
Drainage system upgrades	-132,500 [g]	440,000	-572,500 [g]	0 [h]
Total Incremental Costs ($[e])	**-110,436**	**458,234**	**-425,317**	**143,353**
Net Present Value ($[e])	**223,999**	**-137,659**	**487,764**	**126,106**

[a] Option 1a: Retention only (3kL retention tank plumbed into all toilets, and either the laundry cold water outlets or the hot water service as per draft Code provisions)

[b] Option 1b: Retention and detention (3kL retention plumbed into all toilets, and either the laundry cold water outlets or the hot water service as per draft Code provisions, *plus* 1kL detention)

[c] City of Marion Base Case Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)

[d] More Typical Base Case Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention)

[e] Current dollars, present value (PV)

[f] Negative benefits indicate a lost benefit compared to the base case

[g] Negative costs indicate an avoided cost compared to the base case

[h] Zero values indicate no change in cost or benefit between the base case and the option

Source: BDO EconSearch analysis

Option 2

Offsite stormwater management in wetlands and biofilters, via an offset scheme, would deliver a net benefit to the wider community compared to both base cases (NPVs between $298,552 and $790,534 for the catchment). This is due to avoided tank costs for individual households, as well as improvements to water quality, neighbourhood amenity and biodiversity that would not otherwise be available. However, there is a lost opportunity for infill households to use stormwater for non-potable purposes.

Relative to the base case it is apparent that this potential option could provide an overall benefit to the community, and is a worthwhile option for the State Government to consider. However, offsite management is not practically feasible in every scenario, and would require further investigation. It should also be noted that some delivery costs (eg. land acquisition) are not factored into this analysis because they are highly variable and are considered a transfer cost at the community level.

Detailed results are provided in Appendix 4.

Table 4-2 Results of the community cost benefit analysis for Option 2, catchment-scale

Description	Option 2a[a] (Marion Catchment)[c]	Option 2a[a] (Typical Catchment)[d]	Option 2b[b] (Marion Catchment)[c]	Option 2b[b] (Typical Catchment)[d]
Incremental Benefits ($[e])				
Reduced potable water demand	-155,606 [f]	-94,733 [f]	-155,606 [f]	-94,733 [f]
Improved water quality	214,396	259,254	214,396	259,254
Residual value of capital (tanks)	-99,293 [f]	-100,131 [f]	-99,293 [f]	-100,131 [f]
Residual value of capital (drainage system)	6,689	108,808	6,689	108,808
Residual value of capital (wetland/biofilter)	23,154	23,154	14,819	14,819
Offset scheme receipts	403,125	403,125	363,170	363,170
Amenity value	224,015	224,015	224,015	224,015
Biodiversity value	18,660	18,660	18,660	18,660
Total Incremental Benefits ($[e])	**635,141**	**842,153**	**586,850**	**793,863**
Incremental Costs ($[e])				
Tank supply, installation and plumbing	-453,947 [g]	-457,777 [g]	-453,947 [g]	-457,777 [g]
Tank and connection maintenance	-192,445 [g]	-192,445 [g]	-192,445 [g]	-192,445 [g]
Drainage system upgrades	-132,500 [g]	440,000	-132,500 [g]	440,000
Wetland/biofilter construction	250,000	250,000	160,000	160,000
Wetland/biofilter maintenance	67,752	67,752	22,358	22,358
Offset scheme payments	403,125	403,125	363,170	363,170
Offset scheme management	32,946	32,946	29,681	29,681
Total Incremental Costs ($[e])	**-25,069**	**543,601**	**-203,684**	**364,987**
Net Present Value ($[e])	**660,210**	**298,552**	**790,534**	**428,876**

[a] Option 2a – Stormwater outcomes met offsite via constructed wetlands
[b] Option 2b – Stormwater outcomes met offsite via constructed biofilters
[c] City of Marion Base Case Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)
[d] More Typical Base Case Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention)
[e] Current dollars, present value (PV)
[f] Negative benefits indicate a lost benefit compared to the base case
[g] Negative costs indicate an avoided cost compared to the base case

Source: BDO EconSearch analysis

4.1.2. Sensitivity analysis

The results of the analysis were sensitivity tested to reflect any uncertainties present in key variables. Sensitivity analyses were undertaken for the following variables:

- Discount rate
- Period of analysis
- Drainage system upgrade costs
- Value of nutrient removal
- Amenity value of wetlands.

The range of values used for each uncertain variable and results of the sensitivity analysis are set out below with some interpretation of the results. Note that each sensitivity analysis for each variable was undertaken by holding all other variables constant at their 'expected' values.

Discount rate

Costs and benefits are specified in real terms (i.e. current dollars) and future values are converted to present values by applying a discount rate of 6 per cent. A sensitivity analysis was conducted using discount rates of 4 and 8 per cent (Table 4-3).

Table 4-3 Results of the sensitivity analysis – discount rate, NPV ($[a])

Discount rate	1a (Marion)	1a (Typical)	1b (Marion)	1b (Typical)	2a (Marion)	2a (Typical)	2b (Marion)	2b (Typical)
4%	233,426	-20,197	442,657	189,034	760,169	506,546	895,607	641,984
6%[b]	171,195	-137,844	434,960	125,921	607,406	298,367	737,730	428,691
8%	125,486	-217,493	426,404	83,426	490,394	147,416	616,332	273,354

[a] In current dollars

[b] Expected value

Source: BDO EconSearch analysis

As expected, the NPV improves with the lower (4 per cent) discount rate and decrease under the higher discount rate (8 per cent). This occurs because, although the bulk of the project costs are up-front and are not significantly affected by the discount rate, the benefits accrue over many years and are greater, in present value terms, when the discount rate is lower.

The results are shown to be sensitive to changes in discount rate. This means that a 4 or 8 per cent discount rate will have a significant effect on the magnitude of the NPV results, however the results remain positive across the range in this variable (with the exception of Option 1a (Typical), which remains negative).

Period of analysis

Stormwater assets have lives varying from less than 20 years (e.g. rainwater tank pumps) to over 80 years (e.g. drainage systems) and major planning policies are likely to have a life of two to three decades. A sensitivity analysis was undertaken with a period of analysis of 15 years and 40 years (Table 4-4).

Table 4-4 Results of the sensitivity analysis - period of analysis, NPV ($[a])

Period of analysis	1a (Marion)	1a (Typical)	1b (Marion)	1b (Typical)	2a (Marion)	2a (Typical)	2b (Marion)	2b (Typical)
15 years	76,260	-161,304	300,618	63,054	384,084	146,520	486,172	248,609
25 years[b]	171,195	-137,844	434,960	125,921	607,406	298,367	737,730	428,691
40 years	239,069	-88,297	543,978	216,612	722,152	394,786	868,847	541,481

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

The results are shown to be moderately sensitive to changes in period of analysis, however the results remain positive across the range in this variable (with the exception of Option 1a (Typical), which remains negative).

Drainage system upgrade costs

In the analysis, an average of two common approaches used by councils for upgrading council drainage systems was used. A sensitivity analysis of using the first method and the second method was undertaken (Table 4-5).

Table 4-5 Results of the sensitivity analysis - drainage system upgrade costs, NPV ($[a])

Drainage system upgrade costs	1a (Marion)	1a (Typical)	1b (Marion)	1b (Typical)	2a (Marion)	2a (Typical)	2b (Marion)	2b (Typical)
Method 1	211,695	99,756	237,860	125,921	650,120	538,181	780,444	668,505
Average[b]	171,195	-137,844	434,960	125,921	607,406	298,367	737,730	428,691
Method 2	142,695	-305,044	573,660	125,921	577,348	129,609	707,672	259,933

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

For both Option 1 and Option 2, the results are shown to be sensitive to changes in the drainage system upgrade costs. In particular, Option 1a (Typical) returns a positive NPV if Method 1 is assumed (rather than negative NPVs using Method 2 or the average).

Value of nutrient removal

The unit values used for nutrient removal (nitrogen and phosphorous) were based on Iftekhar and Polyakov (2019). These are conservative values, and other estimates in the literature were up to 3 times as high. A sensitivity analysis was undertaken with the values used in the analysis and values three times as high (Table 4-6).

Table 4-6 Results of the sensitivity analysis – value of nutrient removal, NPV ($[a])

Value of nutrient removal	1a (Marion)	1a (Typical)	1b (Marion)	1b (Typical)	2a (Marion)	2a (Typical)	2b (Marion)	2b (Typical)
100%[b]	171,195	-137,844	434,960	125,921	607,406	298,367	737,730	428,691
300%	300,490	64,194	564,254	327,959	1,053,172	816,876	1,183,496	947,200

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

The results are shown to be sensitive to these changes in the unit values used for nutrient removal. In particular, Option 1a (Typical Catchment) returns a positive NPV if nutrient removal unit values are tripled.

Amenity value of wetlands

Pandit et al. (2014) found a significant, positive relationship between managed wetlands in an urban setting and house prices. Using the CRC for Water Sensitive Cities INFFEWS Value tool, which has derived a wetlands value function based on this study, it was estimated that a wetland is likely to increase the median house price of houses immediately adjacent to the wetland by 3.06 per cent. A sensitivity analysis was undertaken using the other values suggested by the INFFEWS Value tool of 1.52 per cent and 4.61 per cent (Table 4-7).

Table 4-7 Results of the sensitivity analysis – amenity value, NPV ($[a])

Change in median house price	2a (Marion)	2a (Typical)	2b (Marion)	2b (Typical)
1.52%	494,667	185,628	624,990	315,951
3.06%[b]	607,406	298,367	737,730	428,691
4.61%	720,878	411,839	851,201	542,163

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

The results are moderately sensitive to change. If a zero value is assumed for amenity benefits, the results remain positive, with the lowest NPV value being approximately $74,000 for Option 2a (Typical).

4.2. Individual infill households

4.2.1. Cost benefit analysis results

This analysis shows that additional tank costs will generally be offset by water bill savings (over 25 years) for individual households that increase their retention tank capacity and plumb their tank into all non-potable water sources.

Individual households could also benefit from introduction of a voluntary offset scheme, however delivery of offsite stormwater solutions will not be practical in every scenario. Importantly, an offset scheme is only likely to be attractive to infill households if there is already underutilised land available to Council in a suitable location for the wetland or biofilter (i.e. if no land acquisition is necessary)[41]. This not likely to be a common situation in catchments where significant infill is occurring.

Individual households will return a net benefit under all of the policy options considered (ranging from $43 to $1,301 in present value terms), except one:

- Option 1a returns net benefits between $270 and $970.
- Option 1b returns net benefits between $43 and $294 compared to current Development Plan requirements, but compared to the Residential Code requirements, it returns a net cost of $410.
- Option 2 returns net benefits between $379 and $1,301.

Detailed results are provided in Appendix 4.

Table 4-8 Results of the individual household cost benefit analysis for Options 1a and 1b, dwelling-scale

Description	Option 1a[a]			Option 1b[b]		
	Marion DP[c]	Typical DP[d]	ResCode[e]	Marion DP"[c]	Typical DP[d]	ResCode[e]
Incremental Benefits						
Reduced potable water demand	-245[f]	1,004	1,004	-245[f]	1,004	1,004
Residual value of capital (tank)	0[h]	0[h]	0[h]	0[h]	0[h]	0[h]
Total Incremental Benefits ($[i])	**-245**	**1,004**	**1,004**	**-245**	**1,004**	**1,004**
Incremental Costs						
Tank supply, installation and plumbing	-969[g]	29	733	-288[g]	710	1,414
Tank and connection maintenance	0[h]	0[h]	0[h]	0[h]	0[h]	0[h]
Total Incremental Costs ($[i])	**-969**	**29**	**733**	**-288**	**710**	**1,414**
Net Present Value ($[i])	**724**	**975**	**271**	**43**	**294**	**-410**

[a] Option 1a – Stormwater outcomes met offsite via constructed wetlands
[b] Option 1b – Stormwater outcomes met offsite via constructed biofilters
[c] Marion DP: Base Case City of Marion Development Plan requirements (5kL retention tank)
[d] Typical DP: Base Case more typical Development Plan requirements (2kL detention & 1kL retention tank)
[e] ResCode: Base Case Residential Code requirements (1kL retention tank)
[f] Negative benefits indicate a lost benefit compared to the base case
[g] Negative costs indicate an avoided cost compared to the base case
[h] Zero values indicate no change in cost or benefit between the base case and the option
[i] Current dollars, present value (PV)

Source: BDO EconSearch analysis

[41] A sensitivity analysis was undertaken to demonstrate the effect of including land acquisition costs on an offset scheme payment for an individual household (see Section 4.2.2).

Table 4-9 Results of the individual household cost benefit analysis for Option 2, dwelling-scale

Description	Option 2a[a]			Option 2b[b]		
	Marion DP[c]	Typical DP[d]	ResCode[e]	Marion DP[c]	Typical DP[d]	ResCode[e]
Incremental Benefits						
Reduced potable water demand	-1,942 [f]	-694 [f]	-694 [f]	-1,942 [f]	-694 [f]	-694 [f]
Residual value of capital (tank)	0 [h]	0 [h]	0 [h]	0 [h]	0 [h]	0 [h]
Total Incremental Benefits ($[i])	**-1,942**	**-694**	**-694**	**-1,942**	**-694**	**-694**
Incremental Costs						
Tank supply, installation and plumbing	-3,560 [g]	-2,562 [g]	-1,858 [g]	-3,560 [g]	-2,562 [g]	-1,858 [g]
Tank and connection maintenance	-1,409 [g]	-1,409 [g]	-1,409 [g]	-1,409 [g]	-1,409 [g]	-1,409 [g]
Offset scheme payment	2,194	2,194	2,194	1,977	1,977	1,977
Total Incremental Costs ($[i])	**-2,775**	**-1,777**	**-1,073**	**-2,993**	**-1,995**	**-1,291**
Net Present Value ($[i])	**833**	**1,083**	**379**	**1,050**	**1,301**	**597**

[a] Option 2a – Stormwater outcomes met offsite via constructed wetlands
[b] Option 2b – Stormwater outcomes met offsite via constructed biofilters
[c] Marion DP: Base Case City of Marion Development Plan requirements (5kL retention tank)
[d] Typical DP: Base Case more typical Development Plan requirements (2kL detention & 1kL retention tank)
[e] ResCode: Base Case Residential Code requirements (1kL retention tank)
[f] Negative benefits indicate a lost benefit compared to the base case
[g] Negative costs indicate an avoided cost compared to the base case
[h] Zero values indicate no change in cost or benefit between the base case and the option
[i] Current dollars, present value (PV)

Source: BDO EconSearch analysis

4.2.2. Sensitivity analysis

The results of the analysis were sensitivity tested to reflect any uncertainties present in key variables. Sensitivity analyses were undertaken for the following variables:

- Discount rate
- Period of analysis
- Offset payments including land acquisition.

The range of values used for each uncertain variable and detailed results of the sensitivity analysis are set out below with some interpretation of the results. Note that each sensitivity analysis for each variable was undertaken by holding all other variables constant at their 'expected' values.

Discount rate

Costs and benefits are specified in real terms (i.e. current dollars) and future values are converted to present values by applying a discount rate of 6 per cent. A sensitivity analysis was conducted using discount rates of 4 and 8 per cent (Table 4-10).

Table 4-10 Results of the sensitivity analysis – discount rate, NPV ($[a])

	Option 1a			Option 1b			Option 2a			Option 2b		
Discount rate	Marion	Typical	Res Code	Marion	Typical	Res Code	Marion	Typical	Res Code	Marion	Typical	Res Code
4%	676	1,175	471	-5	494	-210	705	1,204	500	937	1,436	732
6%[b]	724	975	271	43	294	-410	833	1,083	379	1,050	1,301	597
8%	761	825	121	80	144	-560	929	993	289	1,135	1,199	495

a In current dollars

b Expected value

Source: BDO EconSearch analysis

Under all options, the NPV improves for all Options against the Typical Development Plan or Residential Code base cases with the lower (4 per cent) discount rate and decreases under the higher discount rate (8 per cent). This occurs because, although the bulk of the project **costs** are up-front and are not significantly affected by the discount rate, the benefits accrue over many years and are greater, in present value terms, when the discount rate is lower. The converse is true for all the Options when comparing against the Marion Development Plan base case. This occurs because the bulk of the project cost Fsavings (i.e. **benefits**) are up-front and are not significantly affected by the discount rate, the costs accrue over many years and are greater, in present value terms, when the discount rate is lower.

The results are shown to be sensitive to changes in discount rate. This means that a 4 or 8 per cent discount rate will have a significant effect on the magnitude of the NPV results, however the results remain positive across the range in this variable (with the exception of Option 1b (Marion DP), which becomes negative under the lower discount rate).

Period of analysis

Stormwater assets have lives varying from less than 20 years (e.g. rainwater tank pumps) to over 80 years (e.g. council drainage systems) and major planning policies are likely to have a life of two to three decades. A sensitivity analysis was undertaken with a period of analysis of 15 years and 40 years (Table 4-11).

Table 4-11 Results of the sensitivity analysis – period of analysis, NPV ($[a])

	Option 1a			Option 1b			Option 2a			Option 2b		
Period of analysis	Marion	Typical	Res Code	Marion	Typical	Res Code	Marion	Typical	Res Code	Marion	Typical	Res Code
15 years	612	739	159	51	178	-401	331	458	-121	549	676	96
25 years[b]	724	975	271	43	294	-410	833	1,083	379	1,050	1,301	597
40 years	867	1,147	472	55	336	-339	1,421	1,701	1,026	1,639	1,919	1,244

a In current dollars

b Expected value

Source: BDO EconSearch analysis

For both Option 1 and Option 2, the results are shown to be sensitive to changes in the period of analysis. Generally the results remain positive across the range. There are two exceptions. The first is Option 1b (ResCode) which remains negative across the range. The second is Option 2a (ResCode) which changes from a positive result for the 25 year period to a negative result for the 15 year period.

Offset payments including land acquisition

The construction of wetland or biofilter infrastructure may require land to be purchased in an infill setting. This analysis did not include the cost of land acquisition in the offset scheme payment calculations (see Section 3.5.9).

To demonstrate the effect of including land acquisition costs in an offset scheme, a sensitivity analysis was undertaken to include those costs in the offset scheme payments for individual households (Table 4-12). This was not undertaken for the community analysis because land acquisition is considered a transfer cost at the community scale.

Based on an assumed average cost per allotment of $485,000 (see Section 3.5.7), and the estimated number of allotments required to construct a wetland or biofilters (four and two, respectively – see Section 3.4.5), the following land acquisition costs were assumed:

- Option 2a – Wetland: $1,940,000 per catchment, $4,876 per household
- Option 2b – Biofilters: $970,000 per catchment, $3,246 per household.

Table 4-12 Results of the sensitivity analysis – offset payments, NPV ($[a])

Offset payments	Option 2a - Wetland			Option 2b - Biofilters		
	Marion	Typical	Res Code	Marion	Typical	Res Code
Include land acquisition	-2,283	-2,033	-2,737	-508	-257	-961
Exclude land acquisition[b]	833	1,083	379	1,050	1,301	597

a In current dollars
b Expected value
Source: BDO EconSearch analysis

Based on the results of the sensitivity analysis, it is apparent that whether or not land needs to be acquired is likely to have a significant effect on the attractiveness of an offset scheme for infill households. An offset scheme is likely to be attractive to both councils and infill households when underutilised council land is already available in an appropriate location in the catchment. This not likely to be a common situation in catchments where significant infill is occurring.

5. KEY POLICY CONSIDERATIONS

1. A combination of retention and detention is needed to manage peaks flows

- Reducing peak flows to pre-development levels is a key desired policy outcome for stormwater management. This is because lower peak flows reduce flood risks and the potential for property damage. Also, higher peak flows require upgrades to council stormwater management systems, placing an additional cost burden on the community via increased council rates.
- Recent South Australian modelling shows that retention systems alone will not reduce peak flow to match pre-development levels. However, onsite detention tanks can flatten the flood curve, producing substantial reductions in peak flow.
- Draft Code policy only has a retention tank requirement, so it will not meet this key performance outcome. It will also be more costly for the wider community, because of the additional upgrades to Council stormwater systems that will be required.
- **It is therefore recommended that the draft Code policy (Option 1a) be modified to include a provision for onsite detention capacity.**

Testing of a 3kL rainwater tank (including 1kl detention)

An economic and financial analysis was run for a draft Code policy scenario proposing a 3kL tank (with 2kL retention and 1kL detention).

Overall the results were positive. At the **community level**, the results ranged from **$22,064 to 169,488** of net benefit over 25 years. On the individual household level, there was also a net benefit against all base case scenarios:

- $980 (Typical base case)
- $729 (Marion base case)
- $276 (ResCode base case).

2. Other ways to manage peak flows

- Another way to help reduce peak flows is to increase the 'detention effect' of retention tanks, by plumbing them into more non-potable household uses. The rainwater being stored is more likely to be used by the household, making it more likely there will be some room in the tank when it starts raining.
- This strategy can contribute to overall storage capacity during a rainfall event, which may assist in reducing street-scale nuisance flooding, and reducing exported pollutant load.
- However, it is not as reliable as a detention tank for peak flow management because it is dependent on household behaviour, and the amount of time between rainfall events.
- **The proposed Code requirement to plumb tanks into more non-potable household uses than is currently required under the Residential Code should therefore be supported.**

3. Providing an offset scheme for stormwater to be managed offsite

- Managing stormwater offsite in wetlands and biofilters (Option 2) would deliver a better community outcome than the base case and onsite options. This is due to avoided tank costs, improved water quality, and improved neighbourhood amenity and biodiversity. These benefits would not otherwise be available.
- There is however a lost opportunity for infill households to reuse stormwater for non-potable purposes.
- Feasibility of offsite management is dependent on a range of variable factors, which would need to be assessed on an individual stormwater catchment basis, via development of catchment-scale water sensitive urban design plans.

- Delivery is constrained by the lack of available land in an urban infill setting. It is important to note that land acquisition costs have not been factored into the catchment-scale analysis[42], and would need to be considered when establishing appropriate offset payments.
- Importantly, an offset scheme is only likely to be attractive to infill households if there is already underutilised land available to council in a suitable location for the wetland or biofilter (i.e. if no land acquisition is necessary)[43]. This is not likely to be a common situation in catchments where significant infill is occurring. However the acquisition of land for community-scale WSUD could be attractive as a strategy if it also achieves urban greening objectives.
- Equitable funding mechanisms would also need to be resolved. The costs of delivering offsite stormwater management would need to be borne either by infill households via an offset scheme, or by the wider community via increased council rates.
- Any offset scheme should be administered on a voluntary basis, with applicants being offered the choice of an onsite or offsite solution, if feasible.
- **Offset schemes are not practical in every scenario, are subject to a number of catchment-by-catchment variables, and are therefore not suitable for broad application in deemed-to-satisfy provisions without further investigation.**

4. Other factors

- Apart from stormwater management outcomes, other factors may be important considerations when formulating rainwater tank requirements.
- For example, larger retention tanks may be a priority because they improve opportunities for stormwater capture and reuse by households and are preferred by consumers compared to detention.
- Although some of these benefits have been captured in this analysis, there may be others that were not considered.

[42] Land acquisition costs are considered a 'transfer payment' in a community-scale cost benefit analysis, because the payment made by local government (the buyer) is transferred to the private landholder (the seller), with the total value remaining within the community. However, these are costs that would need to be incurred by Councils in delivering this option, and passed on to the wider community via increased Council rates.

[43] A sensitivity analysis was undertaken to demonstrate the effect of including land acquisition costs on an offset scheme payment for an infill household (see Section 4.2.2). If land acquisition is needed, net costs will be incurred by infill households participating in the offset scheme.

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Disclaimer

The assignment is a consulting engagement as outlined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 17. Consulting engagements employ an assurance practitioner's technical skills, education, observations, experiences and knowledge of the consulting process. The consulting process is an analytical process that typically involves some combination of activities relating to: objective-setting, fact-finding, definition of problems or opportunities, evaluation of alternatives, development of recommendations including actions, communication of results, and sometimes implementation and follow-up.

The nature and scope of work has been determined by agreement between BDO and the Client. This consulting engagement does not meet the definition of an assurance engagement as defined in the 'Framework for Assurance Engagements', issued by the Auditing and Assurances Standards Board, Section 10.

Except as otherwise noted in this report, we have not performed any testing on the information provided to confirm its completeness and accuracy. Accordingly, we do not express such an audit opinion and readers of the report should draw their own conclusions from the results of the review, based on the scope, agreed-upon procedures carried out and findings.

APPENDIX 1 Summary of Current Council Rainwater Tank Requirements

The data provided in this Appendix has been extracted from the report *Online Stormwater Assessment Tool for Small Scale Infill Development – Milestone 1 Report* prepared by Organica Engineering (2017).

It contains a summary of current Council requirements in relation to the use of rainwater tanks and management of runoff from development as embodied in the various current development plans. Appendix Table 1-1 provides the results of modelling of a development scenario and presents the required detention volume and retention volume of rainwater tank(s) necessary to meet these requirements. Note that the scenario presented for a single allotment divided into two and volumes quoted are a combined volume for the total development (i.e. for two allotments). So, for example, an infill allotment in Alexandrina Council would require 2.85kL of detention tank volume and 1kL of retention tank volume.

Appendix Table 1-1 Summary of current council rainwater tank requirements

Council	Region	Residential detention requirements	Detention volume required (kL)	Retention volume required (kL)
Adelaide City Council	Metro	1 in 20-year ARI (post to pre-development).	5.7	2.0
Adelaide Hills Council	Greater Adelaide	Nil	0.0	2.0
Alexandrina Council	Greater Adelaide	Default – detain 10%AEP (Q10) storm with duration of 30 min.	5.7	2.0
The Barossa Council	Greater Adelaide	Residential development up to 2 dwellings: ▸ Detention shall be provided to limit the 5-year ARI post-development peak discharge to the 5-year ARI pre-development peak discharge from the site or as required by Section 1, (Site discharge), whichever is the lesser ▸ Residential, more than 2 dwellings & land division: ▸ Detention shall be provided to limit the 20-year ARI post-development peak discharge to the 20-year ARI pre-development peak discharge from the site or as required by Section 1 (Site discharge), whichever is the lesser. The maximum point discharge to kerb and gutter up to a 10-year ARI event shall be 12 ls-1; 100-year ARI event shall be 20 ls-1. High risk zones may be subject to additional controls.	4.0	2.0
City of Burnside	Metro	Default – detain 10% AEP (Q10) storm with duration of 30 min.	5.7	2.0
Campbelltown City Council	Metro	1 in 20-year ARI (post development) to 1 in 5-year pre-development.	8.0	2.0
City of Charles Sturt	Metro	For residential development of less than 3 dwellings and more than 50 m^2, the design storm is 5-year ARI. For all other development, the design storm is 100-year ARI.	4.0	2.0
Town of Gawler	Greater Adelaide	Detain 1 in 100-year ARI event for post development to 1 in 5-year ARI event predevelopment	15.2	2.0
City of Holdfast Bay	Metro	Generally, for average residential developments, discharge to the street should not exceed 10 L/second, any excess above this flow to be detained onsite.	4.0	2.0

Council	Region	Residential detention requirements	Detention volume required (kL)	Retention volume required (kL)
City of Marion	Metro	In the urban area north of Seacombe Road, all discharges from residential sites are to be limited by CoR of 0.45 for 1 in 100-year events and a CoR of 0.25 for 1 in 5-year ARI, south of Seacombe Road. However, Council is currently reviewing development plan to be consistent with new State stormwater policy and replace detention tanks with plumbed into home retention tanks. For simplification, 3 kL tanks for units and 5 kL tanks for houses*. CSIRO research supports the reliance of a 1/3 tank emptiness on average over the catchment to be consistent in effect with current CoR detention requirements. * Usually the site areas attributed to each allotment would be less than $350m^2$ requiring $1.667m^3$ detention or 5kL retention providing the required detention based on 1/3 emptiness of retention tank (City of Marion, pers. comm. 2020).	3.4 or nil	nil or 10.0
City of Mitcham	Metro	Combination of retention and detention required. Refer to *City of Mitcham Development Information Rainwater Tanks* fact sheet.	6.1	4.0
District Council of Mount Barker	Greater Adelaide	Dependent on location in catchment.	4.0	2.0
The Rural City of Murray Bridge NOTE: Ensure it accounts for presence of Blanchetown clay.	Greater Adelaide	River Murray Flood Zone - 1 in 100-year detention. Regional Town Centre Zone & Residential Zone - 1 in 5-year ARI post development to 1 in 5-year ARI pre-development. Rural Living Zone - 1 in 10-year ARI post-development to 1 in 10-year pre-development.	4.0	2.0
City of Norwood Payneham & St Peters	Metro	1 in 5-year ARI (post to pre-development).	4.0	2.0
City of Onkaparinga	Metro	Post development flow must not exceed the pre-development flow. 1 in 5-year ARI (post to pre-development).	4.0	2.0
City of Playford	Metro	Detain 1 in 5-year ARI - eater quality to be protected by following the Australian Runoff Quality procedures and guidelines.	4.0	2.0
City of Port Adelaide Enfield	Metro	Residential development up to 3 dwellings (minor development): ▶ Detention shall be provided to limit the 5-year ARI post development peak discharge to the 5-year ARI pre-development peak discharge from the site.	4.0	2.0

Council	Region	Residential detention requirements	Detention volume required (kL)	Retention volume required (kL)
		Residential development with 4 or more dwellings or any commercial or industrial development (major development): ▸ Detention shall be provided to limit the 100-year ARI post-development peak discharge to the 5yr ARI pre-development peak discharge from the site In minor and major developments, the pre-development runoff coefficient that should be used for calculations is 0.35 unless otherwise approved by Council		
City of Prospect	Metro	1 in 10-year ARI (post to pre-development). Maximum discharge 20 ls^{-1}	5.7	2.0
City of Salisbury	Metro	1 in 5-year ARI pre-development equivalent.	4.0	2.0
City of Tea Tree Gully	Metro	See City of Tea Tree Gully Detention Policy.	1.7	2.0
City of Unley	Metro	Refer to City of Unley Stormwater Policy DRAFT.	2.0	2.5
Corporation of the Town of Walkerville	Metro	No detention policy.	1.7	2.0
City of West Torrens	Metro	1 in 20-year ARI Coeff runoff (02-0.25).	8.0	2.0

Source: based on Table 12 in Organica (2017), City of Marion, pers. comm. 2020.

APPENDIX 2 Insite Tool Modelling Results

Appendix Table 2-1 Performance of DTS provision relative to InSite Water performance objectives

1	2	3	4	5	6		
		Critical allotment size (m²)	Retention only tank volume and connected roof area	% roof area connected to tank	Performance of DTS solution (Table 3, WSUD 02) relative to InSite Water performance objectives		
					Quality Target Score = or > 100%	Volume (< 10% increase)	Flow Additional detention storage to ensure no increase in peak relative to pre-development
Site percentage imperviousness	65%	< or = 200	2000L	80%	PASS	PASS	PASS
			2000L	60%	PASS	PASS	PASS
		201-300	3000 L	80%	PASS	PASS	FAIL 200 L detention
			3000 L	60%	PASS	PASS	FAIL 200 L detention
		301-400	3000 L	80%	PASS	PASS	FAIL 600 L detention
			3,000 L	60%	FAIL Score 96%	PASS	FAIL 600 L detention
		301-400	2,000 L plus permeable driveway	80%	PASS	PASS	FAIL 600 L detention
			2,000 L plus permeable driveway	60%	FAIL Score 96%	PASS	FAIL 600 L detention
		401-500	3000 L	80%	PASS	PASS	FAIL 900 L detention
			3000 L	60%	FAIL Score 92%	PASS 3.4% increase (< 10%)	FAIL 900 L detention
	70%	< or = 200	2000L	80%	PASS	PASS	FAIL 200 L detention
			2000L	60%	PASS	PASS	FAIL 200 L detention
		201-300	3000 L	80%	PASS	PASS	FAIL 400 L detention

1	2	3	4	5	6		
		Critical allotment size (m^2)	Retention only tank volume and connected roof area	% roof area connected to tank	Performance of DTS solution (Table 3, WSUD 02) relative to InSite Water performance objectives		
					Quality Target Score = or > 100%	Volume (< 10% increase)	Flow Additional detention storage to ensure no increase in peak relative to pre-development
			3000 L	60%	PASS	PASS	FAIL 400 L detention
		301-400	3000 L	80%	PASS	PASS	FAIL 900 L detention
			3,000 L	60%	FAIL score 95%	PASS 9.3% increase	FAIL 900 L detention
			2,000 L plus permeable driveway	80%	PASS	PASS	FAIL 1200 L detention
			2,000 L plus permeable driveway	60%	FAIL score 86%	PASS 9.3% increase	FAIL 1200 L detention
		401-500	5000 L	80%	PASS	PASS	FAIL 700 L detention
			5000 L	60%	PASS	PASS	FAIL 700 L detention
	75%	< or = 200	2000L	80%	PASS	PASS	FAIL 300 L detention
			2000L	60%	FAIL Score 99%	PASS	FAIL 300 L detention
		201-300	3000 L	80%	PASS	PASS	FAIL 700 L detention
			3000 L	60%	FAIL Score 99%	PASS	FAIL 700 L detention
		301-400	3000 L	80%	PASS	PASS	FAIL 1200 L detention
			3,000 L	60%	FAIL Score 94%	PASS	FAIL 1200 L detention
		401-500	5000 L	80%	PASS	PASS	FAIL 1100 L detention

1	2	3	4	5	6		
		Critical allotment size (m^2)	Retention only tank volume and connected roof area	% roof area connected to tank	Performance of DTS solution (Table 3, WSUD 02) relative to InSite Water performance objectives		
					Quality Target Score = or > 100%	Volume (< 10% increase)	Flow Additional detention storage to ensure no increase in peak relative to pre-development
			5000 L	60%	FAIL Score 99%	PASS 4.8% increase	FAIL 1100 L detention
		< or = 200	2000L	80%	PASS	PASS	FAIL 500 L detention
			2000L	60%	FAIL Score 98%	FAIL 12.6% increase	FAIL 500 L detention
	80%	201-300	3000 L	80%	PASS	PASS	FAIL 900 L detention
			3000 L	60%	FAIL Score 98%	FAIL 13% increase	FAIL 900 L detention
		301-400	3000 L	80%	PASS Score 110%	PASS 4.1% increase	FAIL 1500 L detention
			3000 L	60%	FAIL score 92%	FAIL 18.4% increase	FAIL 1500 L detention
	85%	< or =200	2000 L	80%	PASS	PASS	FAIL 700 L detention
			2000 L	60%	FAIL Score 97%	FAIL 20.6% increase	FAIL 700 L detention

Source: Organica 2017

APPENDIX 3 Background evidence gathering

As a first stage to this work, AGD sought to identify and review some of the likely costs and benefits associated with proposed Code policies. These efforts were informed by a number of stakeholder workshops and forums, which included members of the Stakeholder Reference Group as well as representatives from key government agencies, local councils and developers with experience in infill development. This Appendix contains the relevant outputs of that earlier work.

Summary of engagement activities

Engagement activity	Participants	Purpose	Summary of key outcomes and further info
Industry Infill Advisory Forum 13 August 2019	Local developers, builders and four inner metropolitan councils (West Torrens, Salisbury, Campbelltown and Charles Sturt)	The purpose of this workshop was to seek input and evidence sources on the costs and benefits of WSUD and urban greening.	There was strong interest in identifying what role rainwater tanks might have in local stormwater management. John Eckert (from River Gum Homes) also volunteered to organise for three of the structural engineers that commonly do work for small scale infill development for Rivergum Homes to participate in the below workshop.
Footings and the Effects of Trees Workshop 29 August 2019	Local developer (Rivergum Homes), structural engineers and landscape architects	The purpose of the workshop was to identify: • opportunities and challenges with the proposed tree planting policy, including any factors specific to Adelaide • ways to improve the policy • any further information or support that industry would need to implement the policy.	There was a diversity of viewpoints raised. Trees were seen by most at the workshop as common existing 'infrastructure' in neighbourhoods that needed to be designed for and were therefore not a 'new cost'. It was recommended that further supporting guidance was provided about this policy such as trees not to plant.
Infill Advisory Forum 24 September 2019	Representatives from the SPC, Ministerial Liaison Group, 3 x Planning Reform Advisory Groups (Development and Industry, Local Government and Community and Sustainability), local councils, government agencies and research groups	Workshop - Understanding and balancing the different costs and benefits of WSUD / greening: • What are the benefits and challenges? • What are the opportunities to address the challenges? • What further information/support is needed to assist implementation	There was a diversity of viewpoints raised. Some groups thought that the Code policies proposed weren't strong enough, while other industry groups preferred that they were removed. There was discussion about potential implementation issues e.g. compliance with rainwater tank installation. There was also discussion about whether guidance material was needed about what type of tree and where to plant.
Stakeholder Reference Group meetings	As listed in the Options Analysis	Three meetings to discuss the scope and findings of the Options Analysis	

Methodology to determine rainwater tank costings

Rainwater tank quotes were obtained from three leading South Australian rainwater tank manufacturers i.e. Maxiplas, Team Poly and Southern Tanks. An average of the three quotes was used to determine the average cost of a rainwater tank of 2000L, 3000L and 5000L. A slim line tank design was chosen as space is often at a premium on small allotments.

Quotes were also obtained from two leading rainwater tank installers to determine the cost for plumbing of tanks that were installed for both builders and private property owners i.e. Complete Tanks and Pumps & Eco Building Supplies.

Summary of results on rainwater tank costings

Size of rainwater tank	**Where applied**	**Cost of tank ($)**	**Total cost** (including tank, plumbing, filter and pump)	**Additional cost ($)**
1,000L retention	**Building Code** All residential dwellings unless larger development plan rainwater tank requirement	$600	**$1,858**	
2,000L retention	Proposed **Planning and Design Code** - allotments: **<200m^2**	$961	**$2,469**	+ $611
3,000L retention	Proposed **Planning and Design Code** - allotments: **201-400m^2**	$1,054	**$2,562**	+ $704
5,000L retention	Proposed **Planning and Design Code** - allotments: **>401m^2**	$1,890	**$3,560**	$1,702

**This cost includes the plumbing connection cost of one plumbing connection to a toilet or another source of water.*

Notes:

- Due to the rise in small allotments (and market preference) the proportion of two story houses in South Australia has more than doubled in the ten years to the 2016 Census. Therefore the additional cost to plumb to a toilet upstairs was identified. This is approximately $250 in additional plumbing cost.
- For a 'super slimline tank', the cost is an additional of $250.

This investigation found that the majority of the upfront cost is the tank and pump. The additional plumbing connections are generally a fraction of the overall cost i.e. an additional $250-750 to connect to all toilets, laundry cold taps or hot water service. These additional plumbing connections allow a household to double the volume of rainwater that can harvested and re-used in the home. This would lead to better value from the tank, as well as provide a better ability to reduce stormwater runoff to the stormwater system.

APPENDIX 4 Detailed CBA Models

Appendix Table 4-1 Detailed community level CBA, Option 1a (Marion Catchment)[a,b]

Base Case - Marion Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	155,606	1,131	5,654	6,818	11,474	12,597	17,090	18,232	27,365	28,507
Improved water quality	114,668	833	4,166	5,024	8,455	9,283	12,594	13,435	20,166	21,007
Residual value of capital (tanks)	99,293	0	0	0	0	0	0	0	0	402,030
Residual value of capital (drainage system)	378,598	0	0	0	0	0	0	0	0	1,532,917
Total Benefits ($)	**748,165**	**1,964**	**9,820**	**11,842**	**19,929**	**21,880**	**29,684**	**31,667**	**47,531**	**1,984,461**
Costs ($)										
Tank supply, installation and plumbing	453,947	33,225	33,225	34,198	34,198	33,004	33,004	33,545	33,545	33,545
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,192,500	1,192,500	0	0	0	0	0	0	0	0
Total Costs ($)	**1,838,892**	**1,227,123**	**40,217**	**42,630**	**48,388**	**48,583**	**54,140**	**56,093**	**67,389**	**68,801**
Option 1a (Retention)										
Benefits ($)										
Reduced potable water demand	231,817	1,685	8,423	10,157	17,093	18,766	25,460	27,161	40,768	42,469
Improved stormwater quality	170,829	1,241	6,207	7,485	12,596	13,829	18,762	20,015	30,042	31,296
Residual value of capital (tank)	104,119	0	0	0	0	0	0	0	0	421,571
Residual value of capital (Drainage system)	354,963	0	0	0	0	0	0	0	0	1,437,222
Total Benefits ($)	**861,728**	**2,926**	**14,630**	**17,642**	**29,689**	**32,596**	**44,222**	**47,176**	**70,811**	**1,932,558**
Costs ($)										
tanks & plumbing installation	476,011	34,840	34,840	35,860	35,860	34,608	34,608	35,176	35,176	35,176
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,728,456**	**1,096,238**	**41,832**	**44,292**	**50,050**	**50,187**	**55,744**	**57,724**	**69,020**	**70,432**
Incremental Benefits ($)	**113,563**	**962**	**4,810**	**5,800**	**9,760**	**10,716**	**14,538**	**15,509**	**23,279**	**-51,903**
Incremental Costs ($)	**-110,436**	**-130,885**	**1,615**	**1,662**	**1,662**	**1,604**	**1,604**	**1,630**	**1,630**	**1,630**
Net Benefits (NPV) ($)	**223,999**	**131,847**	**3,195**	**4,138**	**8,098**	**9,112**	**12,934**	**13,879**	**21,649**	**-53,534**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-2 Detailed community level CBA, Option 1a (Typical Catchment)[a,b]

Base Case - Typical Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	94,733	688	3,442	4,151	6,985	7,669	10,404	11,099	16,660	17,355
Improved stormwater quality	69,810	507	2,537	3,059	5,147	5,651	7,667	8,179	12,277	12,789
Residual value of capital (tank)	100,131	0	0	0	0	0	0	0	0	405,422
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**541,152**	**1,196**	**5,979**	**7,209**	**12,133**	**13,320**	**18,071**	**19,279**	**28,937**	**1,555,011**
Costs ($)										
Tank supply, installation and plumbing	457,777	33,505	33,505	34,486	34,486	33,282	33,282	33,828	33,828	33,828
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,270,222**	**654,904**	**40,498**	**42,918**	**48,676**	**48,861**	**54,418**	**56,376**	**67,672**	**69,084**
Option 1a (Retention)										
Benefits ($)										
Reduced potable water demand	231,817	1,685	8,423	10,157	17,093	18,766	25,460	27,161	40,768	42,469
Improved stormwater quality	170,829	1,241	6,207	7,485	12,596	13,829	18,762	20,015	30,042	31,296
Residual value of capital (tank)	104,119	0	0	0	0	0	0	0	0	421,571
Residual value of capital (drainage system)	354,963	0	0	0	0	0	0	0	0	1,437,222
Total Benefits ($)	**861,728**	**2,926**	**14,630**	**17,642**	**29,689**	**32,596**	**44,222**	**47,176**	**70,811**	**1,932,558**
Costs ($)										
tanks & plumbing installation	476,011	34,840	34,840	35,860	35,860	34,608	34,608	35,176	35,176	35,176
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,728,456**	**1,096,238**	**41,832**	**44,292**	**50,050**	**50,187**	**55,744**	**57,724**	**69,020**	**70,432**
Incremental Benefits ($)	**320,576**	**1,730**	**8,652**	**10,433**	**17,556**	**19,275**	**26,150**	**27,897**	**41,874**	**377,547**
Incremental Costs ($)	**458,234**	**441,335**	**1,335**	**1,374**	**1,374**	**1,326**	**1,326**	**1,347**	**1,347**	**1,347**
Net Benefits (NPV) ($)	**-137,659**	**-439,604**	**7,317**	**9,059**	**16,183**	**17,950**	**24,825**	**26,550**	**40,526**	**376,200**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-3 Detailed community level CBA, Option 1b (Marion Catchment) [a,b]

Base Case - Marion Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	155,606	1,131	5,654	6,818	11,474	12,597	17,090	18,232	27,365	28,507
Improved stormwater quality	114,668	833	4,166	5,024	8,455	9,283	12,594	13,435	20,166	21,007
Residual value of capital (tank)	99,293	0	0	0	0	0	0	0	0	402,030
Residual value of capital (drainage system)	378,598	0	0	0	0	0	0	0	0	1,532,917
Total Benefits ($)	**748,165**	**1,964**	**9,820**	**11,842**	**19,929**	**21,880**	**29,684**	**31,667**	**47,531**	**1,984,461**
Costs ($)										
Tank supply, installation and plumbing	453,947	33,225	33,225	34,198	34,198	33,004	33,004	33,545	33,545	33,545
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,192,500	1,192,500	0	0	0	0	0	0	0	0
Total Costs ($)	**1,838,892**	**1,227,123**	**40,217**	**42,630**	**48,388**	**48,583**	**54,140**	**56,093**	**67,389**	**68,801**
Option 1b (Retention & Detention)										
Benefits ($)										
Reduced potable water demand	231,817	1,685	8,423	10,157	17,093	18,766	25,460	27,161	40,768	42,469
Improved stormwater quality	170,829	1,241	6,207	7,485	12,596	13,829	18,762	20,015	30,042	31,296
Residual value of capital (tank)	131,486	0	0	0	0	0	0	0	0	532,380
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**810,611**	**2,926**	**14,630**	**17,642**	**29,689**	**32,596**	**44,222**	**47,176**	**70,811**	**1,725,589**
Costs ($)										
tanks & plumbing installation	601,130	43,997	43,997	45,286	45,286	43,704	43,704	44,422	44,422	44,422
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,413,575**	**665,396**	**50,990**	**53,718**	**59,476**	**59,283**	**64,840**	**66,970**	**78,266**	**79,678**
Incremental Benefits ($)	**62,446**	**962**	**4,810**	**5,800**	**9,760**	**10,716**	**14,538**	**15,509**	**23,279**	**-258,872**
Incremental Costs ($)	**-425,317**	**-561,728**	**10,772**	**11,088**	**11,088**	**10,701**	**10,701**	**10,876**	**10,876**	**10,876**
Net Benefits (NPV) ($)	**487,764**	**562,690**	**-5,963**	**-5,288**	**-1,328**	**15**	**3,837**	**4,633**	**12,403**	**-269,748**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-4 Detailed community level CBA, Option 1b (Typical Catchment) [a,b]

Base Case - Typical Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	94,733	688	3,442	4,151	6,985	7,669	10,404	11,099	16,660	17,355
Improved stormwater quality	69,810	507	2,537	3,059	5,147	5,651	7,667	8,179	12,277	12,789
Residual value of capital (tank)	100,131	0	0	0	0	0	0	0	0	405,422
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**541,152**	**1,196**	**5,979**	**7,209**	**12,133**	**13,320**	**18,071**	**19,279**	**28,937**	**1,555,011**
Costs ($)										
Tank supply, installation and plumbing	457,777	33,505	33,505	34,486	34,486	33,282	33,282	33,828	33,828	33,828
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,270,222**	**654,904**	**40,498**	**42,918**	**48,676**	**48,861**	**54,418**	**56,376**	**67,672**	**69,084**
Option 1b (Retention & Detention)										
Benefits ($)										
Reduced potable water demand	231,817	1,685	8,423	10,157	17,093	18,766	25,460	27,161	40,768	42,469
Improved stormwater quality	170,829	1,241	6,207	7,485	12,596	13,829	18,762	20,015	30,042	31,296
Residual value of capital (tank)	131,486	0	0	0	0	0	0	0	0	532,380
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**810,611**	**2,926**	**14,630**	**17,642**	**29,689**	**32,596**	**44,222**	**47,176**	**70,811**	**1,725,589**
Costs ($)										
tanks & plumbing installation	601,130	43,997	43,997	45,286	45,286	43,704	43,704	44,422	44,422	44,422
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,413,575**	**665,396**	**50,990**	**53,718**	**59,476**	**59,283**	**64,840**	**66,970**	**78,266**	**79,678**
Incremental Benefits ($)	**269,459**	**1,730**	**8,652**	**10,433**	**17,556**	**19,275**	**26,150**	**27,897**	**41,874**	**170,579**
Incremental Costs ($)	**143,353**	**10,492**	**10,492**	**10,799**	**10,799**	**10,422**	**10,422**	**10,593**	**10,593**	**10,593**
Net Benefits (NPV) ($)	**126,106**	**-8,762**	**-1,841**	**-367**	**6,757**	**8,853**	**15,728**	**17,304**	**31,280**	**159,985**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-5 Detailed community level CBA, Option 2a (Marion Catchment)[a,b]

Base Case - Marion Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	155,606	1,131	5,654	6,818	11,474	12,597	17,090	18,232	27,365	28,507
Improved stormwater quality	114,668	833	4,166	5,024	8,455	9,283	12,594	13,435	20,166	21,007
Residual value of capital (tank)	99,293	0	0	0	0	0	0	0	0	402,030
Residual value of capital (drainage system)	378,598	0	0	0	0	0	0	0	0	1,532,917
Total Benefits ($)	**748,165**	**1,964**	**9,820**	**11,842**	**19,929**	**21,880**	**29,684**	**31,667**	**47,531**	**1,984,461**
Costs ($)										
Tank supply, installation and plumbing	453,947	33,225	33,225	34,198	34,198	33,004	33,004	33,545	33,545	33,545
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,192,500	1,192,500	0	0	0	0	0	0	0	0
Total Costs ($)	**1,838,892**	**1,227,123**	**40,217**	**42,630**	**48,388**	**48,583**	**54,140**	**56,093**	**67,389**	**68,801**
Option 2 (Wetland)										
Benefits ($)										
Improved water quality	329,064	2,391	11,957	14,418	24,263	26,639	36,141	38,555	57,870	60,285
Residual value of capital (drainage system)	385,287	0	0	0	0	0	0	0	0	1,560,000
Residual value of capital (wetland)	23,154	0	0	0	0	0	0	0	0	93,750
Offset scheme receipts	403,125	29,505	29,505	30,369	30,369	29,309	29,309	29,790	29,790	29,790
Amenity value of wetlands	224,015	0	0	0	0	0	0	0	0	0
Biodiversity value of wetlands	18,660	0	1,386	1,733	1,733	1,733	1,733	1,733	1,733	1,733
Total Benefits ($)	**1,383,305**	**31,896**	**42,848**	**46,520**	**56,366**	**57,681**	**67,182**	**70,078**	**89,393**	**1,745,558**
Costs ($)										
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Wetland construction	250,000	250,000	0	0	0	0	0	0	0	0
Wetland maintenance	67,752	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Offset scheme payments	403,125	29,505	29,505	30,369	30,369	29,309	29,309	29,790	29,790	29,790
Offset scheme management	32,946	2,411	2,411	2,482	2,482	2,395	2,395	2,435	2,435	2,435
Total Costs ($)	**1,813,823**	**1,346,916**	**36,916**	**37,851**	**37,851**	**36,704**	**36,704**	**37,224**	**37,224**	**37,224**
Incremental Benefits ($)	**635,141**	**29,932**	**33,028**	**34,678**	**36,437**	**35,801**	**37,499**	**38,411**	**41,862**	**-238,904**
Incremental Costs ($)	**-25,069**	**119,793**	**-3,301**	**-4,779**	**-10,537**	**-11,879**	**-17,436**	**-18,869**	**-30,165**	**-31,577**
Net Benefits (NPV) ($)	**660,210**	**-89,861**	**36,329**	**39,457**	**46,974**	**47,680**	**54,934**	**57,280**	**72,027**	**-207,327**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-6 Detailed community level CBA, Option 2a (Typical Catchment)[a,b]

Base Case - Typical Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	94,733	688	3,442	4,151	6,985	7,669	10,404	11,099	16,660	17,355
Improved stormwater quality	69,810	507	2,537	3,059	5,147	5,651	7,667	8,179	12,277	12,789
Residual value of capital (tank)	100,131	0	0	0	0	0	0	0	0	405,422
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**541,152**	**1,196**	**5,979**	**7,209**	**12,133**	**13,320**	**18,071**	**19,279**	**28,937**	**1,555,011**
Costs ($)										
Tank supply, installation and plumbing	457,777	33,505	33,505	34,486	34,486	33,282	33,282	33,828	33,828	33,828
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,270,222**	**654,904**	**40,498**	**42,918**	**48,676**	**48,861**	**54,418**	**56,376**	**67,672**	**69,084**
Option 2 (Wetland)										
Benefits ($)										
Improved water quality	329,064	2,391	11,957	14,418	24,263	26,639	36,141	38,555	57,870	60,285
Residual value of capital (drainage system)	385,287	0	0	0	0	0	0	0	0	1,560,000
Residual value of capital (wetland)	23,154	0	0	0	0	0	0	0	0	93,750
Offset scheme receipts	403,125	29,505	29,505	30,369	30,369	29,309	29,309	29,790	29,790	29,790
Amenity value of wetlands	224,015	0	0	0	0	0	0	0	0	0
Biodiversity value of wetlands	18,660	0	1,386	1,733	1,733	1,733	1,733	1,733	1,733	1,733
Total Benefits ($)	**1,383,305**	**31,896**	**42,848**	**46,520**	**56,366**	**57,681**	**67,182**	**70,078**	**89,393**	**1,745,558**
Costs ($)										
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Wetland construction	250,000	250,000	0	0	0	0	0	0	0	0
Wetland maintenance	67,752	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Offset scheme payments	403,125	29,505	29,505	30,369	30,369	29,309	29,309	29,790	29,790	29,790
Offset scheme management	32,946	2,411	2,411	2,482	2,482	2,395	2,395	2,435	2,435	2,435
Total Costs ($)	**1,813,823**	**1,346,916**	**36,916**	**37,851**	**37,851**	**36,704**	**36,704**	**37,224**	**37,224**	**37,224**
Incremental Benefits ($)	**842,153**	**30,701**	**36,869**	**39,311**	**44,233**	**44,360**	**49,111**	**50,799**	**60,456**	**190,547**
Incremental Costs ($)	**543,601**	**692,013**	**-3,581**	**-5,067**	**-10,825**	**-12,157**	**-17,714**	**-19,152**	**-30,448**	**-31,860**
Net Benefits (NPV) ($)	**298,552**	**-661,312**	**40,451**	**44,378**	**55,058**	**56,518**	**66,825**	**69,951**	**90,904**	**222,407**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-7 Detailed community level CBA, Option 2b (Marion Catchment) [a,b]

Base Case - Marion Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	155,606	1,131	5,654	6,818	11,474	12,597	17,090	18,232	27,365	28,507
Improved stormwater quality	114,668	833	4,166	5,024	8,455	9,283	12,594	13,435	20,166	21,007
Residual value of capital (tank)	99,293	0	0	0	0	0	0	0	0	402,030
Residual value of capital (drainage system)	378,598	0	0	0	0	0	0	0	0	1,532,917
Total Benefits ($)	**748,165**	**1,964**	**9,820**	**11,842**	**19,929**	**21,880**	**29,684**	**31,667**	**47,531**	**1,984,461**
Costs ($)										
Tank supply, installation and plumbing	453,947	33,225	33,225	34,198	34,198	33,004	33,004	33,545	33,545	33,545
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	1,192,500	1,192,500	0	0	0	0	0	0	0	0
Total Costs ($)	**1,838,892**	**1,227,123**	**40,217**	**42,630**	**48,388**	**48,583**	**54,140**	**56,093**	**67,389**	**68,801**
Option 2 (Biofilters)										
Benefits ($)										
Improved water quality - urban waterways & GSV	329,064	2,391	11,957	14,418	24,263	26,639	36,141	38,555	57,870	60,285
Residual value of capital (drainage system)	385,287	0	0	0	0	0	0	0	0	1,560,000
Residual value of capital (biofilters)	14,819	0	0	0	0	0	0	0	0	60,000
Offset scheme receipts	363,170	26,581	26,581	27,359	27,359	26,404	26,404	26,837	26,837	26,837
Amenity value of wetlands	224,015	0	0	0	0	0	0	0	0	0
Biodiversity value of biofilters	18,660	0	1,386	1,733	1,733	1,733	1,733	1,733	1,733	1,733
Total Benefits ($)	**1,335,015**	**28,972**	**39,924**	**43,510**	**53,356**	**54,776**	**64,277**	**67,125**	**86,441**	**1,708,855**
Costs ($)										
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Biofilters construction	160,000	160,000	0	0	0	0	0	0	0	0
Biofilters maintenance	22,358	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
Offset scheme payments	363,170	26,581	26,581	27,359	27,359	26,404	26,404	26,837	26,837	26,837
Offset scheme management	29,681	2,172	2,172	2,236	2,236	2,158	2,158	2,193	2,193	2,193
Total Costs ($)	**1,635,209**	**1,250,403**	**30,403**	**31,245**	**31,245**	**30,212**	**30,212**	**30,681**	**30,681**	**30,681**
Incremental Benefits ($)	**586,850**	**27,008**	**30,103**	**31,668**	**33,427**	**32,896**	**34,594**	**35,458**	**38,909**	**-275,606**
Incremental Costs ($)	**-203,684**	**23,280**	**-9,814**	**-11,385**	**-17,143**	**-18,371**	**-23,928**	**-25,413**	**-36,709**	**-38,121**
Net Benefits (NPV) ($)	**790,534**	**3,728**	**39,918**	**43,053**	**50,570**	**51,267**	**58,522**	**60,871**	**75,618**	**-237,486**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-8 Detailed community level CBA, Option 2b (Typical Catchment) [a,b]

Base Case - Marion Catchment	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	94,733	688	3,442	4,151	6,985	7,669	10,404	11,099	16,660	17,355
Improved stormwater quality	69,810	507	2,537	3,059	5,147	5,651	7,667	8,179	12,277	12,789
Residual value of capital (tank)	100,131	0	0	0	0	0	0	0	0	405,422
Residual value of capital (drainage system)	276,479	0	0	0	0	0	0	0	0	1,119,444
Total Benefits ($)	**541,152**	**1,196**	**5,979**	**7,209**	**12,133**	**13,320**	**18,071**	**19,279**	**28,937**	**1,555,011**
Costs ($)										
Tank supply, installation and plumbing	457,777	33,505	33,505	34,486	34,486	33,282	33,282	33,828	33,828	33,828
Tank and connection maintenance	192,445	1,399	6,993	8,432	14,190	15,579	21,136	22,548	33,844	35,256
Drainage system upgrades	620,000	620,000	0	0	0	0	0	0	0	0
Total Costs ($)	**1,270,222**	**654,904**	**40,498**	**42,918**	**48,676**	**48,861**	**54,418**	**56,376**	**67,672**	**69,084**
Option 2 (Biofilters)										
Benefits ($)										
Improved water quality - urban waterways & GSV	329,064	2,391	11,957	14,418	24,263	26,639	36,141	38,555	57,870	60,285
Residual value of capital (drainage system)	385,287	0	0	0	0	0	0	0	0	1,560,000
Residual value of capital (biofilters)	14,819	0	0	0	0	0	0	0	0	60,000
Offset scheme receipts	363,170	26,581	26,581	27,359	27,359	26,404	26,404	26,837	26,837	26,837
Amenity value of wetlands	224,015	0	0	0	0	0	0	0	0	0
Biodiversity value of biofilters	18,660	0	1,386	1,733	1,733	1,733	1,733	1,733	1,733	1,733
Total Benefits ($)	**1,335,015**	**28,972**	**39,924**	**43,510**	**53,356**	**54,776**	**64,277**	**67,125**	**86,441**	**1,708,855**
Costs ($)										
Drainage system upgrades	1,060,000	1,060,000	0	0	0	0	0	0	0	0
Biofilters construction	160,000	160,000	0	0	0	0	0	0	0	0
Biofilters maintenance	22,358	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
Offset scheme payments	363,170	26,581	26,581	27,359	27,359	26,404	26,404	26,837	26,837	26,837
Offset scheme management	29,681	2,172	2,172	2,236	2,236	2,158	2,158	2,193	2,193	2,193
Total Costs ($)	**1,635,209**	**1,250,403**	**30,403**	**31,245**	**31,245**	**30,212**	**30,212**	**30,681**	**30,681**	**30,681**
Incremental Benefits ($)	**793,863**	**27,776**	**33,945**	**36,301**	**41,223**	**41,455**	**46,206**	**47,847**	**57,504**	**153,844**
Incremental Costs ($)	**364,987**	**595,499**	**-10,095**	**-11,673**	**-17,431**	**-18,649**	**-24,206**	**-25,696**	**-36,992**	**-38,404**
Net Benefits (NPV) ($)	**428,876**	**-567,723**	**44,040**	**47,974**	**58,654**	**60,105**	**70,412**	**73,542**	**94,495**	**192,248**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-9 Detailed individual household level CBA, Option 1a (Marion DP) [a,b]

Base Case - Marion DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	1,942	143	143	143	143	143	143	143	143	143
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,942**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**
Costs ($)										
tank & connection system installation	3,560	3,560	0	0	0	0	0	0	0	0
tank & connection system maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,969**	**3,664**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1a (Retention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	2,591	2,591	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,000**	**2,695**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**-245**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**
Incremental Costs ($)	**-969**	**-969**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**724**	**951**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-10 Detailed individual household level CBA, Option 1a (Typical DP) [a,b]

Base Case - Typical DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	2,562	2,562	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,971**	**2,666**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1a (Retention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	2,591	2,591	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,000**	**2,695**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**1,004**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**
Incremental Costs ($)	**29**	**29**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**975**	**45**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-11 Detailed individual household level CBA, Option 1a (Residential Code) [a,b]

Base Case - Residential Code	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	1,858	1,858	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,267**	**1,962**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1a (Retention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	2,591	2,591	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,000**	**2,695**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**1,004**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**
Incremental Costs ($)	**733**	**733**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**271**	**-659**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-12 Detailed individual household level CBA, Option 1b (Marion DP) [a,b]

Base Case - Marion DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	1,942	143	143	143	143	143	143	143	143	143
Residual value of capital (tank)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,942**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**
Costs ($)										
Tank supply, installation and plumbing	3,560	3,560	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,969**	**3,664**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1b (Retention & Detention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	3,272	3,272	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,681**	**3,376**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**-245**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**
Incremental Costs ($)	**-288**	**-288**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**43**	**270**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**	**-18**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-13 Detailed individual household level CBA, Option 1b (Typical DP) [a,b]

Base Case - Typical DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	2,562	2,562	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,971**	**2,666**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1b (Retention & Detention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	3,272	3,272	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,681**	**3,376**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**1,004**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**
Incremental Costs ($)	**710**	**710**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**294**	**-636**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-14 Detailed individual household level CBA, Option 1b (Residential Code) [a,b]

Base Case -Residential Code	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	1,858	1,858	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,267**	**1,962**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 1b (Retention & Detention)										
Benefits ($)										
Reduced potable water demand	1,698	125	125	125	125	125	125	125	125	125
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,698**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**	**125**
Costs ($)										
Tank supply, installation and plumbing	3,272	3,272	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,681**	**3,376**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Incremental Benefits ($)	**1,004**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**
Incremental Costs ($)	**1,414**	**1,414**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Benefits (NPV) ($)	**-410**	**-1,340**	**74**	**74**	**74**	**74**	**74**	**74**	**74**	**74**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-15 Detailed individual household level CBA, Option 2a (Marion DP) [a,b]

Base Case - Marion DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	1,942	143	143	143	143	143	143	143	143	143
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,942**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**
Costs ($)										
Tank supply, installation and plumbing	3,560	3,560	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,969**	**3,664**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Wetland)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	2,194	2,194	0	0	0	0	0	0	0	0
Total Costs ($)	**2,194**	**2,194**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-1,942**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**
Incremental Costs ($)	**-2,775**	**-1,470**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**833**	**1,327**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-16 Detailed individual household level CBA, Option 2a (Typical DP) [a,b]

Base Case - Typical DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	2,562	2,562	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,971**	**2,666**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Wetland)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	2,194	2,194	0	0	0	0	0	0	0	0
Total Costs ($)	**2,194**	**2,194**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-694**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**
Incremental Costs ($)	**-1,777**	**-472**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**1,083**	**421**	**53**	**53**	**53**	**53**	**53**	**53**	**53**	**53**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-17 Detailed individual household level CBA, Option 2a (ResCode) [a,b]

Base Case - ResCode	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	1,858	1,858	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,267**	**1,962**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Wetland)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	2,194	2,194	0	0	0	0	0	0	0	0
Total Costs ($)	**2,194**	**2,194**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-694**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**
Incremental Costs ($)	**-1,073**	**232**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**379**	**-283**	**53**	**53**	**53**	**53**	**53**	**53**	**53**	**53**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-18 Detailed individual household level CBA, Option 2b (Marion DP) [a,b]

Base Case - Marion DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	1,942	143	143	143	143	143	143	143	143	143
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**1,942**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**	**143**
Costs ($)										
Tank supply, installation and plumbing	3,560	3,560	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**4,969**	**3,664**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Biofilters)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	1,977	1,977	0	0	0	0	0	0	0	0
Total Costs ($)	**1,977**	**1,977**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-1,942**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**	**-143**
Incremental Costs ($)	**-2,993**	**-1,687**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**1,050**	**1,544**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**	**-39**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-19 Detailed individual household level CBA, Option 2b (Typical DP) [a,b]

Base Case - Typical DP	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	2,562	2,562	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,971**	**2,666**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Biofilters)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	1,977	1,977	0	0	0	0	0	0	0	0
Total Costs ($)	**1,977**	**1,977**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-694**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**
Incremental Costs ($)	**-1,995**	**-689**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**1,301**	**638**	**53**	**53**	**53**	**53**	**53**	**53**	**53**	**53**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

Appendix Table 4-20 Detailed individual household level CBA, Option 2b (ResCode) [a,b]

Base Case - ResCode	PV 25	2021	2025	2026	2030	2031	2035	2036	2044	2045
Benefits ($)										
Reduced potable water demand	694	51	51	51	51	51	51	51	51	51
Residual value of capital (tanks)	0	0	0	0	0	0	0	0	0	0
Total Benefits ($)	**694**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**	**51**
Costs ($)										
Tank supply, installation and plumbing	1,858	1,858	0	0	0	0	0	0	0	0
Tank and connection maintenance	1,409	104	104	104	104	104	104	104	104	104
Total Costs ($)	**3,267**	**1,962**	**104**	**104**	**104**	**104**	**104**	**104**	**104**	**104**
Option 2 (Biofilters)										
Benefits ($)										
Total Benefits ($)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Costs ($)										
Offset scheme payment	1,977	1,977	0	0	0	0	0	0	0	0
Total Costs ($)	**1,977**	**1,977**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Incremental Benefits ($)	**-694**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**	**-51**
Incremental Costs ($)	**-1,291**	**15**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**	**-104**
Net Benefits (NPV) ($)	**597**	**-66**	**53**	**53**	**53**	**53**	**53**	**53**	**53**	**53**

[a] Years 2-4, 7-9, 12-14 and 17-23 hidden for presentational purposes.

[b] In current dollars.

BDO EconSearch analysis.

APPENDIX 5 Additional 3,000L rainwater tank policy (2,000L retention and 1,000L detention) -

Yield, water quality and street stormwater system upgrade costs

The economic and financial analyses were run for a draft Code policy scenario proposing a 2kL retention and 1kL detention tank requirement.

Average annual yield

Average annual yield of 12,477 kL/annum. This is slightly higher than for draft DTS requirements, despite tank size being reduced. The reason is that the requirement for the semi-detached dwellings has changed from 60% of roof area being connected to requiring 80%.

Cost of upgrades to stormwater system

Method 1: $365,000

Method 2: $1,010,000

Water quality improvement

Water quality improvement will be close to the previous DTS requirement, which we assessed as achieving '100%' of the required improvement.

CBA results – community level

Table 4-1 Results of the community cost benefit analysis for Options 1b, catchment-scale

Description	Option 1b[a] (Marion Catchment)[b]	Option 1b[a] (Typical Catchment)[c]
Incremental Benefits ($[d])		
Reduced potable water demand	76,839	137,712
Improved water quality	56,623	101,482
Residual value of capital (tanks)	4,826	3,988
Residual value of capital (drainage system)	-90,079[e]	12,040
Total Incremental Benefits ($[e])	**48,210**	**255,222**
Incremental Costs ($[d])		
Tank supply, installation and plumbing	22,064	18,234
Tank and connection maintenance	0[f]	0[f]
Drainage system upgrades	-505,000[g]	67,500
Total Incremental Costs ($d[e])	**-482,936[g]**	**85,734**
Net Present Value ($[d])	**22,064**	**169,488**

[a] Option 1b: Retention and detention (2kL retention plumbed into all toilets, and either the laundry cold water outlets or the hot water service as per draft Code provisions, *plus* 1kL detention)

[b] City of Marion Base Case Catchment – 64% of approvals under Residential Code (1kL retention tank) and 36% under the City of Marion Development Plan (5kL retention tank)

[c] More Typical Base Case Catchment – 10% of approvals under Residential Code (1kL retention tank) and 90% under a more typical Development Plan (2kL detention & 1kL retention)

[d] Current dollars, present value (PV)

[e] Negative benefits indicate a lost benefit compared to the base case

[f] Zero values indicate no change in cost or benefit between the base case and the option

[g] Negative costs indicate an avoided cost compared to the base case

Source: BDO EconSearch analysis

Sensitivity analysis – community Level

Discount rate

Table 4-2 Results of the sensitivity analysis – discount rate, NPV ($[a])

Discount rate	1b (Marion)	1b (Typical)
4%	518,539	248,979
6%[b]	531,146	169,488
8%	535,787	113,600

[a] In current dollars

[b] Expected value

Source: BDO EconSearch analysis

The results are shown to be moderately sensitive to changes in discount rate.

Period of analysis

Table 4-3 Results of the sensitivity analysis – period of analysis, NPV ($[a])

Period of analysis	1b (Marion)	1b (Typical)
15 years	379,173	74,570
25 years[b]	531,146	169,488
40 years	648,819	264,655

[a] In current dollars

[b] Expected value

Source: BDO EconSearch analysis

The results are shown to be sensitive to changes in period of analysis, however the results remain positive across the range in this variable.

Drainage system upgrade costs

Table 4-4 Results of the sensitivity analysis – drainage system upgrade costs, NPV ($[a])

Drainage system upgrade costs	1b (Marion)	1b (Typical)
Method 1	293,796	201,213
Average[b]	531,146	169,488
Method 2	712,946	145,188

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

The results are shown to be sensitive to changes in drainage system upgrade cost method used, however the results remain positive across the range in this variable.

Value of nutrient removal

Table 4-5 Results of the sensitivity analysis – value of nutrient removal, NPV ($[a])

Value of nutrient removal	1b (Marion)	1b (Typical)
100%[b]	531,146	169,488
300%	644,393	372,451

[a] In current dollars
[b] Expected value
Source: BDO EconSearch analysis

The results are shown to be moderately sensitive to these changes in the unit values used for nutrient removal, however the results remain positive across the range in this variable.

Cost benefit analysis results - Individual infill households

Table 4-6 Results of the individual household cost benefit analysis for Option 1b, dwelling-scale

Description	Option 1b[a]		
	Marion DP[b]	Typical DP[c]	ResCode[d]
Incremental Benefits			
Reduced potable water demand	-240[e]	1,008	1,008
Residual value of capital (tank)	0	0	0
Total Incremental Benefits ($[f])	**-240[e]**	**1,008**	**1,008**
Incremental Costs			
Tank supply, installation and plumbing	-969[g]	29	733
Tank and connection maintenance	0[h]	0[h]	0[h]
Total Incremental Costs ($[f])	-969[g]	29	733
Net Present Value ($[f])	729	980	276

[a] Option 1b: Retention and detention (2kL retention plumbed into all toilets, and either the laundry cold water outlets or the hot water service as per draft Code provisions, *plus* 1kL detention)

[b] Marion DP: Base Case City of Marion Development Plan requirements (5kL retention tank)

[c] Typical DP: Base Case more typical Development Plan requirements (2kL detention & 1kL retention tank)

[d] ResCode: Base Case Residential Code requirements (1kL retention tank)

[e] Negative benefits indicate a lower benefit compared to the base case

[f] Current dollars, present value (PV)

[g] Negative costs indicate an avoided cost compared to the base case

[h] Zero values indicate no change in cost or benefit between the base case and the option

Source: BDO EconSearch analysis.

5.1.1. Sensitivity analysis

Discount rate

Table 4-7 Results of the sensitivity analysis – discount rate, NPV ($[a])

	Option 1b		
Discount rate	Marion	Typical	Res Code
4%	681	1,180	476
6%[b]	729	980	276
8%	765	829	125

[a] In current dollars

[b] Expected value

Source: BDO EconSearch analysis

The results are shown to be moderately sensitive to changes in discount rate.

Period of analysis

Table 4-8 Results of the sensitivity analysis – period of analysis, NPV ($[a])

Period of analysis	Marion	Typical	Res Code
15 years	615	742	163
25 years[b]	729	980	276
40 years	872	1,153	478

[a] In current dollars

[b] Expected value

Source: BDO EconSearch analysis

The results are shown to be moderately sensitive to changes in the period of analysis.