CENTRAL HIGHLANDS WATER, CENTRAL GOLDFIELDS SHIRE COUNCIL, NORTH CENTRAL CATCHMENT MANAGEMENT AUTHORITY

MARYBOROUGH INTEGRATED WATER MANAGEMENT PLAN

November 2018

Developed by:

Prepared by:

TRADITIONAL OWNER ACKNOWLEDGEMENT

Central Highlands Water, Central Goldfields Shire Council and North Central Catchment Management Authority acknowledge the Traditional Owners of the region of Maryborough, the Dja Dja Wurrung. We pay our respect to the Elders of these communities past, present and emerging, acknowledging that they have been custodians of land and water for many centuries and that their continuing culture and contribution is important to the life of the region. We note in preparing and delivering on the outcomes of this plan the obligations to the Dja Dja Wurrung under the Traditional Owner Settlement Act, including Schedule 16 (NRM Participation Strategies) and Schedule 6 (Local Government Engagement).

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Attachments

Executive Summary

Introduction

The Maryborough Integrated Water Management Plan explores and sets out recommendations for future water management in the Maryborough area. The Plan examines the whole urban water cycle, including the management of stormwater, wastewater, water supplies and waterways. It also considers how water can be managed to deliver community benefits such as enhanced amenity, greener open spaces and street trees and enhanced recreational opportunities.

Water can play a key role in improving liveability and community well-being in Maryborough. The town already benefits from recycled water use for irrigation of the Golf Course and Princes Park precinct, and is harnessing stormwater runoff from part of the town to top-up Lake Victoria in the centre of the town. This Plan explores a variety of other initiatives that will further enhance the local economy, improve the environment and drive direct benefits to local communities. This Plan has been identified as a regional priority in the Central Highlands IWM Forum Strategic Directions Statement, which was endorsed by the Water Minister in October 2018.

A partnership approach to water management

This Plan has been produced by Central Highlands Water in collaboration with Central Goldfields Shire Council and North Central Catchment Management Authority. It has also benefited greatly from the input and support of key local stakeholders including local businesses, community representatives and representatives of the traditional owners of land in the Maryborough area, Dja Dja Wurrung.

It is significant and integral that this Plan is developed through a partnership process, as this recognises that the urban water cycle is interconnected. Continuation of this partnership approach will be key to deliver the vision and the actions outlined in this Plan.

Why integrated water management is important in Maryborough

There are several key drivers which mean that local and well-coordinated water management is important for Maryborough's future:

- **Future water supplies**: A combination of a changing climate and a growing population means that it is likely that additional water supplies for Maryborough will needed in the future. Uncertainty regarding the scale of impact from future climates means that new supplies could be needed as soon as 2023 or not until 2049 to maintain a good level of water supply service for Maryborough.

- **Maryborough is growing**: New development in the area places additional pressure on water resources but also provides an opportunity to introduce new infrastructure and to influence how development is delivered.

- **Securing recycled water as a long-term resource**: The town's recycled water is currently harnessed for irrigation, but algal blooms and high salinity can restrict use. Finding solutions to these issues is important so that this alternative water resource is fully harnessed.

- **Recognising stormwater as a key water asset**: Increasingly, the impacts of urban runoff on the health of waterways are being realised. Following the impacts of the drought, urban stormwater has also been recognised as a valuable water source. There is further potential to harvest and treat stormwater to support local lakes and recreation areas while also improving water quality and environmental conditions.

- **Maryborough would benefit from more street trees and green areas**: Maryborough has relatively low tree canopy cover and integration of green space, meaning that on a hot day, the dominance of exposed paved surfaces further increases local temperatures, impacting the health and comfort of communities. Water can support the health and cooling effect of trees and green spaces, supporting community well-being.

- **The community appreciates local lakes and waterways, including Lake Victoria, Tullaroop Creek and Goldfields Reservoir**: Waterbodies and waterways are important to the character of the area, and provide a focus for recreational activities, walking and tourism. Securing a sustainable source of water and maintaining water quality is a key focus for community well-being.

Vision for IWM in Maryborough

Water supports a resilient Maryborough with a thriving community, a prosperous economy, and a healthy environment.

Excellent opportunities to create a better Maryborough

This plan identified numerous opportunities for integrated water management at all scales, ranging from on-lot initiatives in homes and street-scale greening, to town-scale water infrastructure. A shortlisting process was undertaken to identify initiatives that were likely to deliver the greatest benefits to the Maryborough community. Nine opportunities were examined in detail, and a costed concept design was developed for each. An economic evaluation and an appraisal of opportunities against key objectives for the area was conducted to inform the recommendations of this Plan. As a result, a suite of physical projects as well as a set of actions to support delivery integrated water management has been set out in an implementation plan.

Six focus areas for integrated water management in Maryborough

1. Creating governance and delivery structures to support IWM
2. Harnessing stormwater for healthier street trees
3. Greening station domain as a key community asset
4. Creating a resilient and local alternative water supply network
5. Improving Lake Victoria for recreation and amenity
6. Continual improvement of waterways and flood management

1. An integrated water management approach for Maryborough

1.1 What is Integrated Water Management?

Integrated water management (IWM) recognises that interconnected nature of the water cycle, and seeks to manage water across the whole water cycle in a coordinated manner and improve its interactions with the built and natural environment in doing so. Traditionally, three 'types' of water have been managed separately; water supply, wastewater and stormwater. Roles and responsibilities have similarly focused on different types of water. An integrated water management recognises the interrelationships between different types of water, and also views water cycle management within a specific environmental, social, cultural and economic context – recognising the needs of local catchments and waterways, communities and industries.

Figure 1.1: Integrated water management diagram showing the interaction of the three 'types' of water within a context of urban form and landscapes.

In a built up environment, such as Maryborough, it is important to recognise how the water cycle is affected by urban areas. Urban development and formalised water supply and management systems have fundamentally altered the natural water cycle over time, creating an 'urban water cycle'. The urban water cycle encompasses water supplies extracted from or imported to a local catchment, wastewater and stormwater generated locally, and the catchments and receiving environments affected by those water cycle interactions. As urban settlements change and grow, additional water demands and changes in generation of wastewater and stormwater will have knock-on effects on the urban water cycle, requiring forethought and understanding of environmental, economic and social influences and sensitivities in the system.

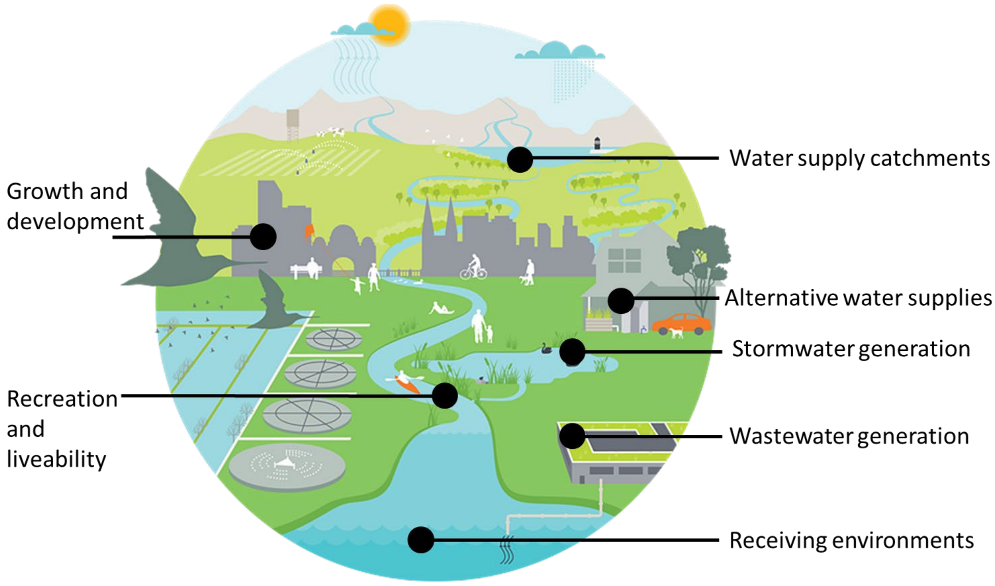

Figure 1.2: Key elements of the urban water cycle

1.2 State and Regional IWM Policy Frameworks

Water for Victoria (Victorian State Government, 2016) is "a framework to guide smarter water management, bolster the water grid and support more liveable Victorian communities". Water for Victoria identified eight themes and associated actions to implement the policy. One of those themes is 'resilient and liveable towns and cities' and Government provided a commitment to:

"Adopt integrated water planning across Victoria, with place-based planning supporting community values and local opportunities", and
"Put integrated water management into practice, working with water corporations to develop a common economic evaluation framework, promoting exemplar projects,

building the capacity of the water sector and local government to participate, and continuing research to improve urban water management".

On 8 September 2017, the Department of Environment, Land, Water and Planning (DELWP) released a document titled 'Integrated Water Management (IWM) Framework for Victoria'. The IWM Framework provides guidance aimed at helping government, the water sector and the community work together to better plan and deliver solutions for water management across Victoria's towns and cities.

The IWM framework supports the establishment of IWM Forums in each region to drive and coordinated delivery of IWM. The Central Highlands Region IWM Forum was established in March 2018, and has identified the development of the Maryborough IWM Plan as a priority project in its Strategic Directions Statement[1] (2018).

1.3 A partnership approach to IWM in Maryborough

IWM not only involves a coordinated approach to water management, but also deep collaboration between a large number of stakeholders, extending to those who are able to affect and enable urban design, natural resource management, planning and economic development.

Recognising this, the IWM Plan for the Maryborough area has been jointly developed by Central Highlands Water, Central Goldfields Shire Council and North Central Catchment Management Authority in collaboration with key stakeholders and community representatives. Stakeholders engaged in the plan development are listed in Attachment 1.

We are thankful for the attendance and participation of representatives of Dja Dja Wurrung, the traditional owners of land in the Maryborough area, in the Plan workshops. It has been highlighted that several of the projects as listed in the plan provide an excellent opportunity in both the planning and delivery phases to further engage with the DDW to incorporate opportunities to exhibit and educate the community on some of the local indigenous cultural history of the area.

This IWM Plan focusses on the urban areas of Maryborough and neighbouring Carisbrook and Flagstaff, but recognises the interconnections with key water systems outside that area, including the water supply catchments, receiving environments, and nearby agricultural water users.

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[1] Central Highlands IWM Forum (2018) Strategic Directions Statement. Published by DELWP.

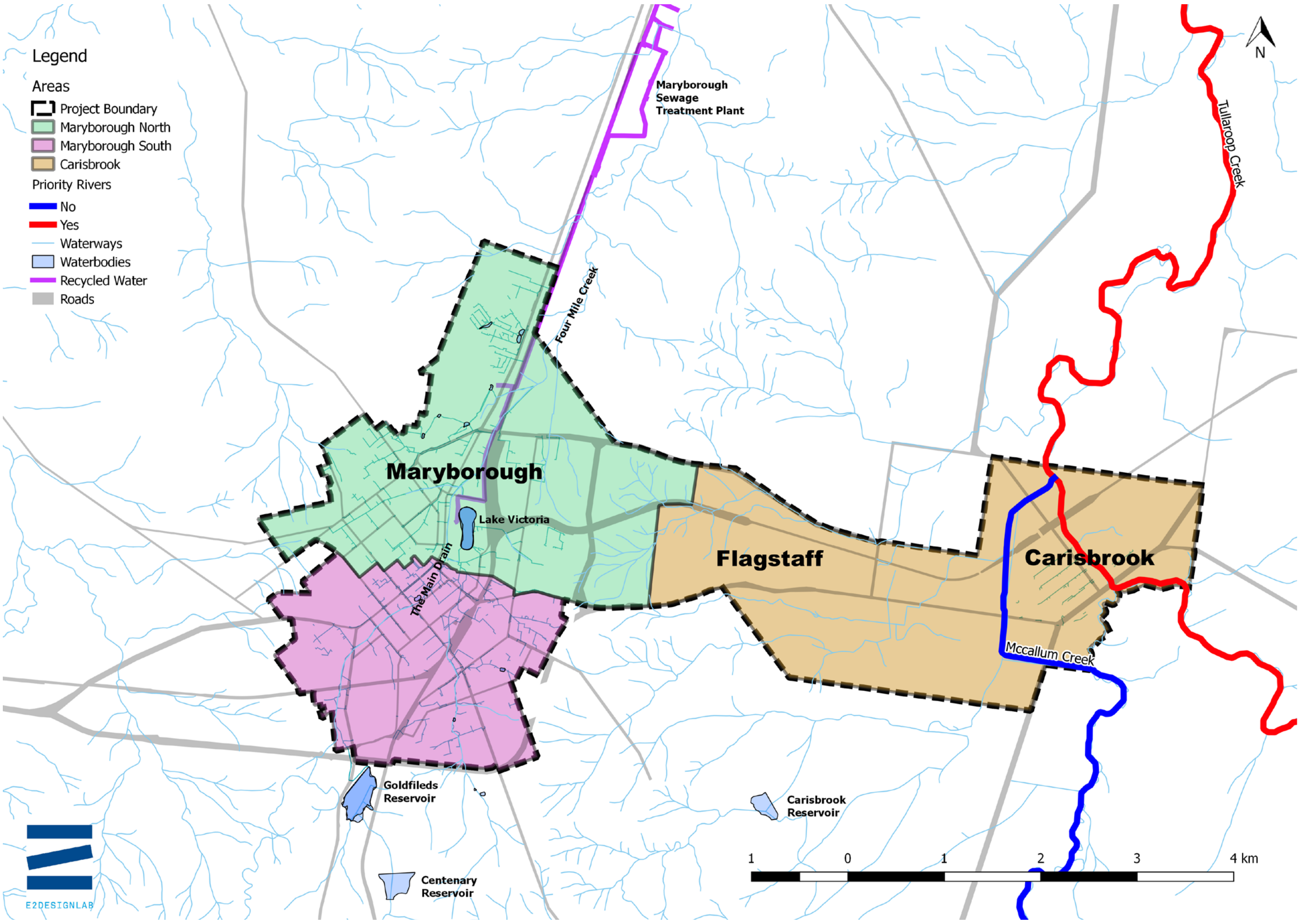


Figure 1.3: Focus area for the IWM Plan, encompassing the town of Maryborough and nearby Carisbrook

1.4 The IWM Plan structure

The Maryborough IWM plan was developed in the following four stages (Figure 1.4). The report is structured in the same manner and is supported by several appendices with further detail:

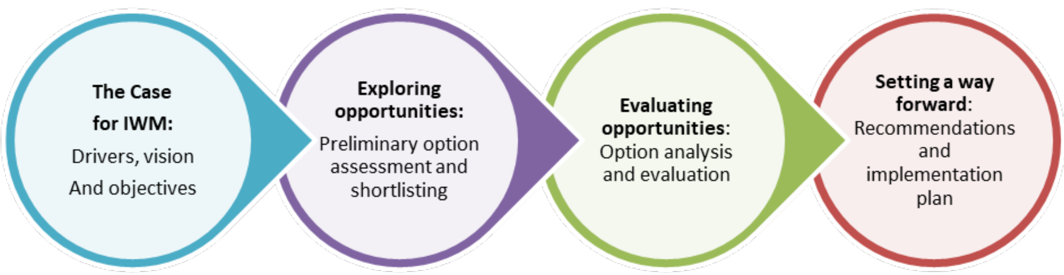


Figure 1.4: Four stages of the IWM Plan development

2. **The case for IWM:** Drivers, Vision and Objectives

2.1 Snapshot of the urban water cycle in the Maryborough Area and key drivers for change

2.1.1 Urban development and growth

Maryborough and Carisbrook have an estimated combined current population of 9,123 people, with the majority of that population (~8,000 people) in Maryborough. A relatively moderate growth rate of 0.6% per year is predicted, bringing the total population in 50 years' time to 12,304 people. New population will be housed through a combination of infill development in existing areas and planned new communities on greenfield land. A total of around 1500 new homes is expected over the plan period. Central Goldfields Shire Council expect most new development to occur in residentially zoned land on the northern edge of Maryborough. Growth brings new water demands, as well as new wastewater and stormwater volumes, but development also brings opportunities to shape the urban landscape.

Figure 2.1 Recent residential development in North Maryborough

The main industry in Maryborough is manufacturing, with a dominance of food-related industries. A cluster of industrial businesses is located in the northern area of Maryborough, with further lower density industrial land use in the Flagstaff area between Maryborough and Carisbrook.

2.1.2 Potable water supplies

The Maryborough water supply system is managed by Central Highlands Water. Providing potable water supply to Maryborough and Carisbrook as well as a few other smaller settlements in the area, the water supply is currently predominantly drawn from surface water catchments with some groundwater supply when necessary. The majority of water supply is sourced from the Tullaroop Creek catchment, with the water treatment reservoir located to the south of the town of Maryborough, adjacent to Centenary Reservoir. Central Highlands Water have recently commissioned a Salt Reduction Plant (SRP) to reduce the salinity of drinking water in the system.

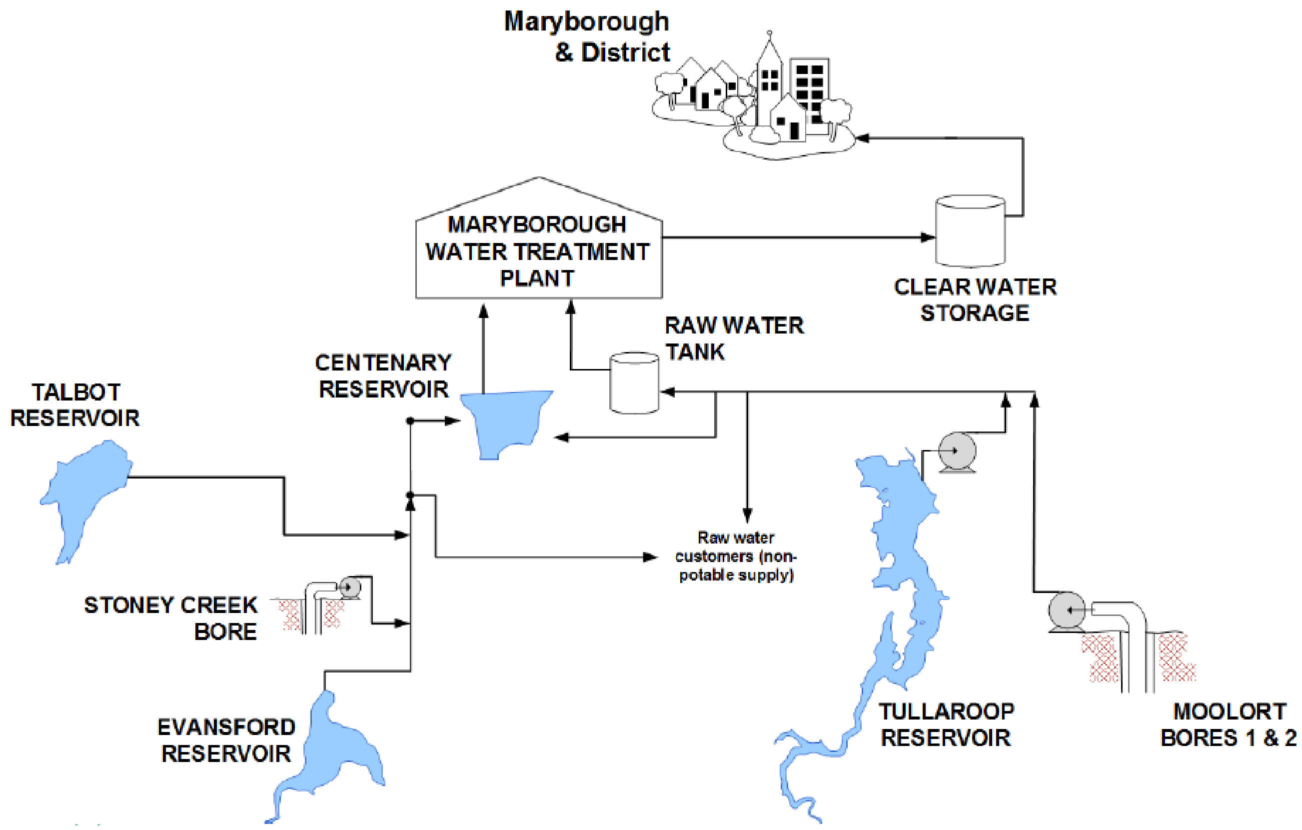


Figure 2.2: Maryborough and District Water Supply Network (Central Highlands Water Urban Water Strategy, 2017

Central Highlands Water's Urban Water Strategy predicts the impacts of population growth and climate change on water supplies and demands for the Maryborough system. To maintain the target levels of service for the area, it is expected that supplementary water supplies will be required in the next 5 to 20 years (see Figure 2.3). Central Highlands Water are currently investigating options for additional supply, including connection to the Goldfields Superpipe or additional groundwater extractions.

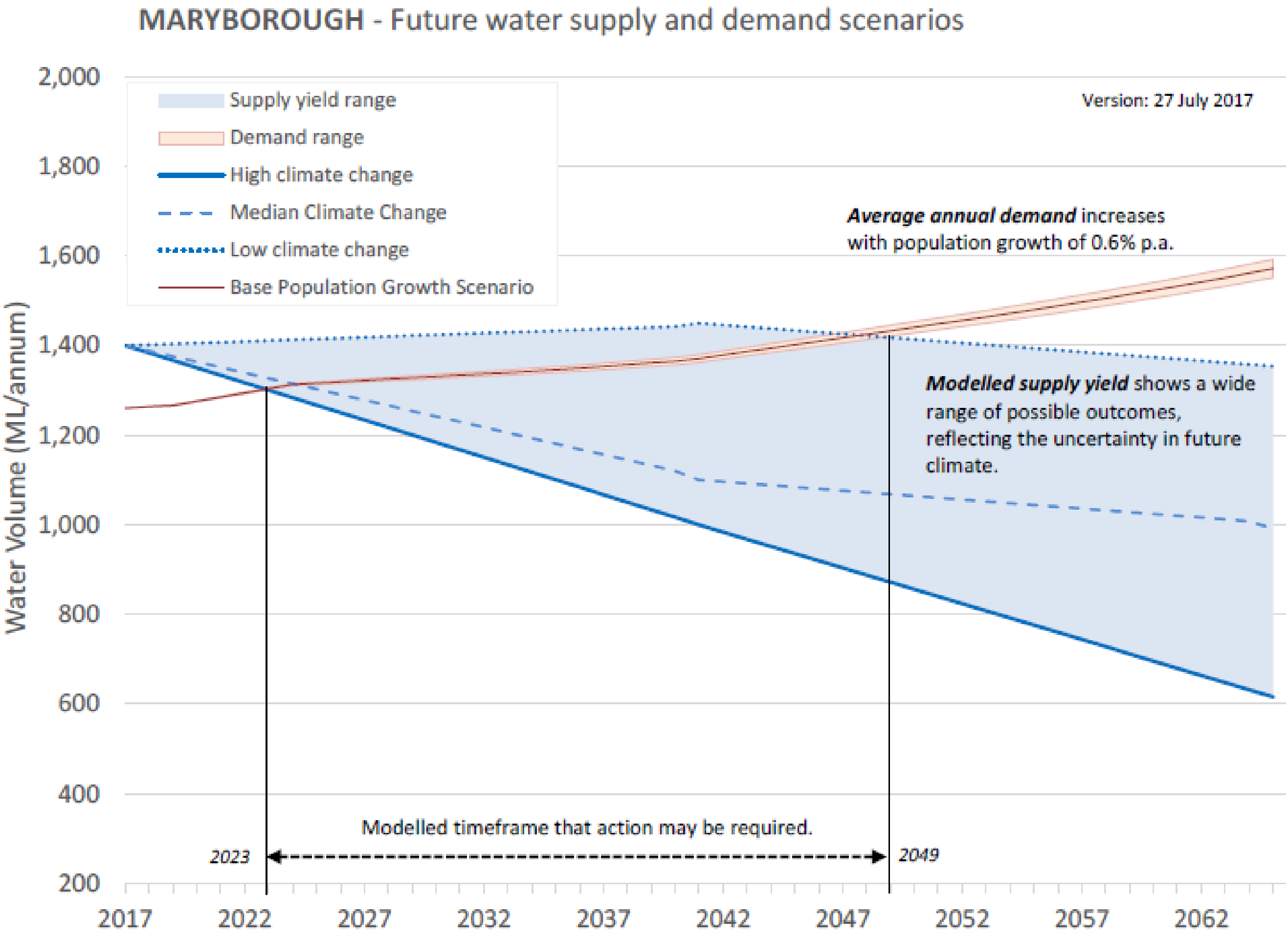


Figure 2.3: Future supply and demand scenarios for the Maryborough system (Central Highlands Water, 2017)

2.1.3 Wastewater management and recycled water

The Maryborough wastewater system is managed by Central Highlands Water. Wastewater from the Maryborough area is collected and treated at the Maryborough Wastewater Treatment Plant, located just to the north of Maryborough. Treated wastewater is reclaimed as recycled water (Class C) for local use, providing irrigation water to the Maryborough Golf Club, Princes Park and local agricultural users via a recycled water distribution network. Due to the salinity of the water catchment, wastewater in the area has high salinity, and this is likely to increase in the future when the Salt Reduction Plant is in operation (and releasing brine to the wastewater system).

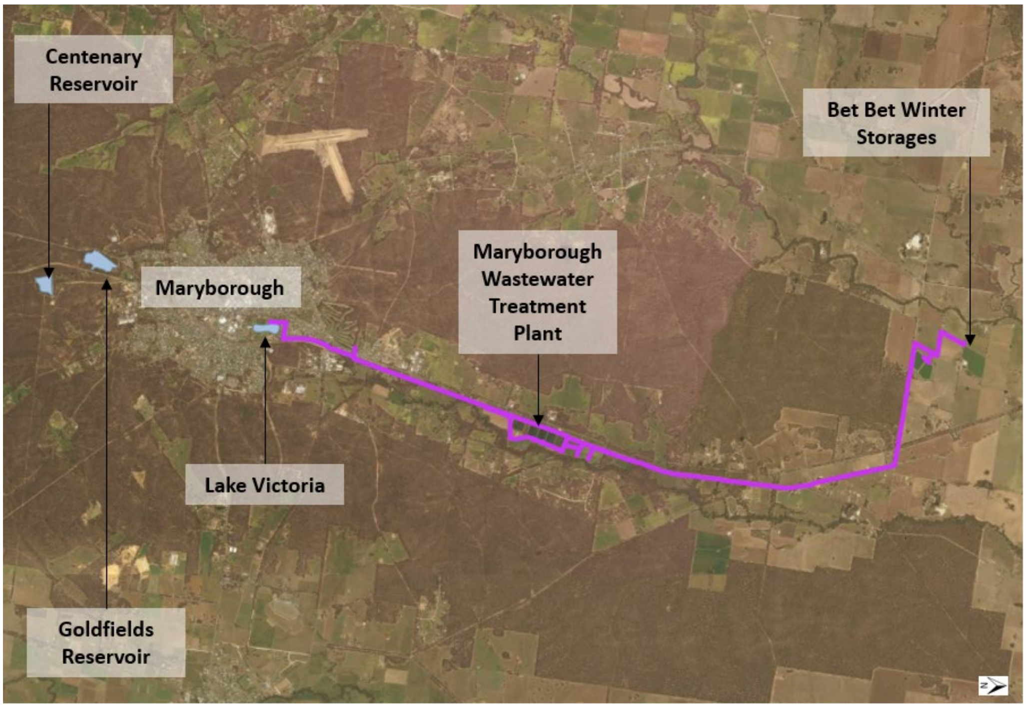


Figure 2.4: Maryborough recycled water network (purple)

2.1.4 Stormwater management and stormwater reuse

Central Goldfields Shire Council is responsible for management of urban stormwater in the Maryborough Area. The built-up areas of Maryborough and Carisbrook have underground piped drainage systems, while the outskirts of Maryborough and parts of Carisbrook do not have a formalised drainage system. Maryborough drains to Four Mile Creek (commonly known as the ‘Main Drain’) which runs through the centre of the town and is open air in many sections. Its bluestone lining has historical value and it forms a well-known landscape feature in the town.

Central Goldfields Shire Council is guided by a Stormwater Management Plan (2002), and has implemented several improvements to stormwater management in recent years, including the installation of Gross Pollutant Traps in key sections of the Main Drain and raingardens in some carparks. During the Millennium Drought, stormwater from the main drain was diverted to top up Lake Victoria in Princes Park and this system currently remains in place. Other than litter removal, there is no treatment of urban stormwater entering the lake, resulting in algal blooms frequently affecting the Lake.

Other than the diversion to Lake Victoria, stormwater is a largely unharnessed water resource in the area which could be harnessed for a range of uses. Compared with pre-development conditions, the creation of the urban areas of Maryborough and Carisbrook has led to significant increases in stormwater runoff entering local waterways, fundamentally changing their flow regime and impacting water quality.

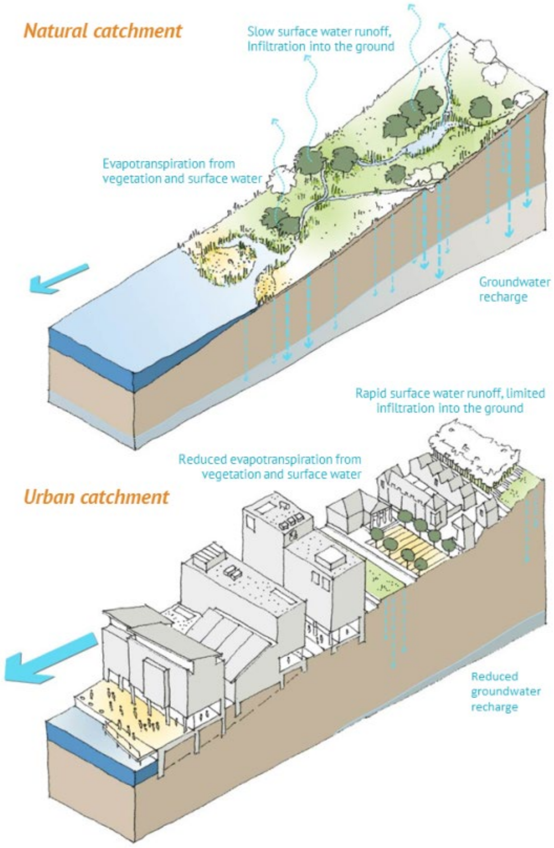


Figure 2.5: Comparison of stormwater runoff volumes from a natural catchment and an urbanised catchment

2.1.5 Local waterways and waterbodies

The urban water cycle for the Maryborough Area affects a number of waterways and waterbodies. As mentioned above, Four Mile Creek (the Main Drain) which runs south to north through Maryborough is directly impacted by stormwater from the urban area of Maryborough. The Creek is highly modified throughout the urban area, and due to its stone lining and the impact of stormwater flows, it does not have any significant ecological value. Further to the north, Four Mile Creek is unlined and in an agricultural land setting, however, the persistent stormwater flows from Maryborough are likely to have radically changed its flow regime and water quality. Four Mile Creek flows into

Bet Creek, which has been identified as a priority waterway by North Central Catchment Management Authority because of the values it provides.

To the east, the settlement of Carisbrook drains to Tullaroop Creek, which is also classified as a priority waterway. Tullaroop Creek has amenity and ecological value, and is well-loved by local residents. The urban water cycle for the Maryborough area also influences Tullaroop Creek upstream of Carisbrook, where potable water supply is sourced from Tullaroop Reservoir.

There are also significant urban water bodies in the area that offer amenity, ecological and amenity value to local community. The most significant of these are Lake Victoria in the centre of Maryborough and Goldfields Reservoir to the south of Maryborough. Both of these are well utilised by the community for walking and recreation. As mentioned above, Lake Victoria is now supplemented by urban stormwater to maintain lake levels, but it suffers from water quality issues. Goldfields Reservoir is a large water body which was historically a water supply dam. It is fed by a natural catchment, but it often suffers from low levels which restrict recreation activities including water sports.

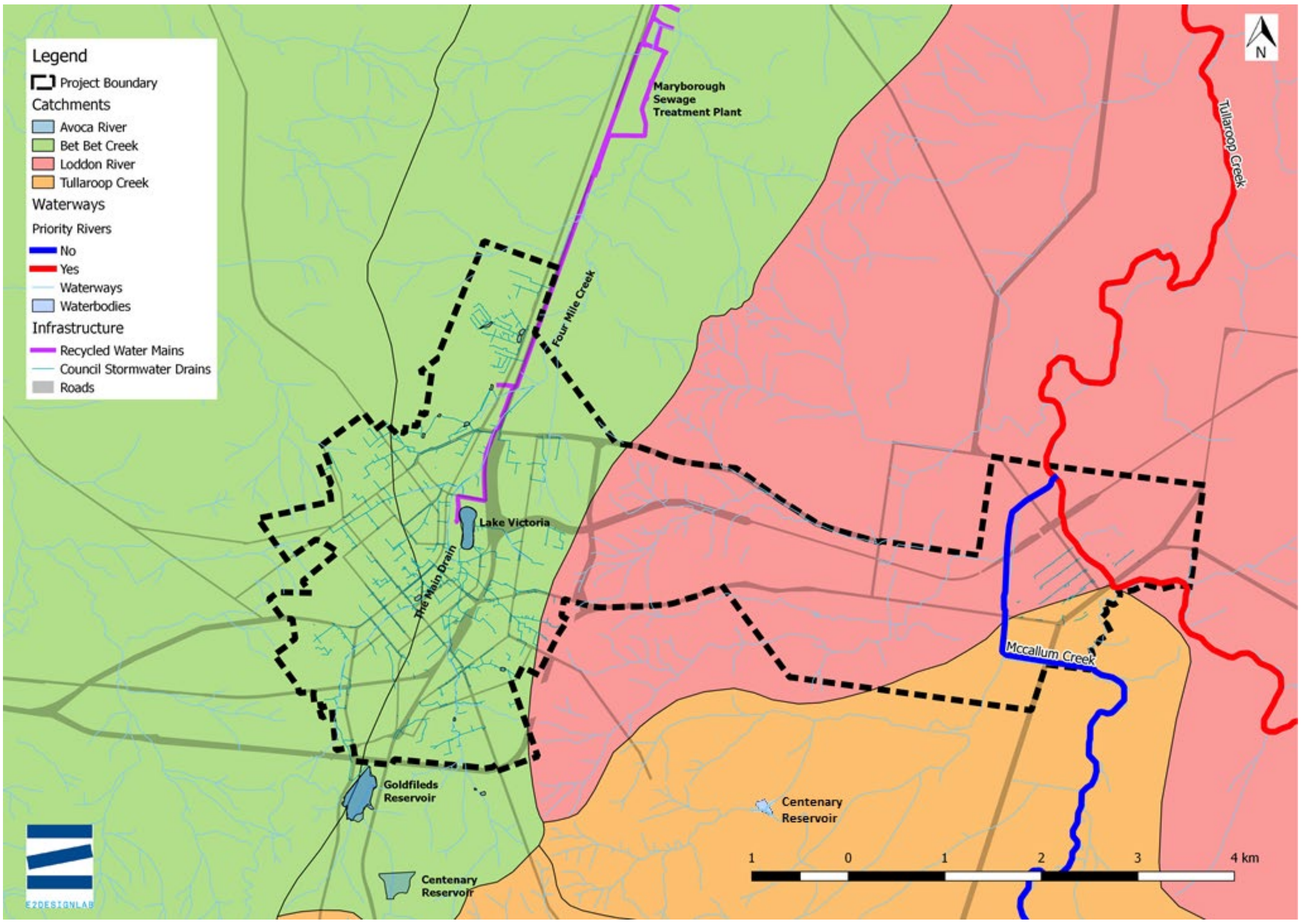


Figure 2.6: Catchments, key waterways and waterbodies

Figure 2.7: Images of local waterways and water bodies (Clockwise: Main drain, Tullaroop Creek, Goldfields Reservoir, Lake Victoria,)

2.1.6 Liveability and community well-being

Maryborough has a strong and passionate community, but the town also faces some socio-economic challenges. Identified statistically as the most disadvantaged community in Victoria in terms of average income, there is a focus on economic development and community support in the future. The Committee for Maryborough was established in 2018 with a vision "to lead Maryborough to be a centre of excellence for rural, economic and social transformation and renewal." Initiatives such as Go Goldfields have also been created to deliver community driven approaches to improve social, education and health outcomes for children, youth and families. Maryborough also has an older community with a median age of 50 (compared with 37 in Victoria), and has lower than average levels of physical activity.

Water can support and enable the liveability and well-being of communities in a number of ways. The most tangible benefits that water could deliver for Maryborough have been identified as:

- supporting physical and mental health by enhancing community assets for recreation such as sports fields, lakes and green space;
- supporting wellbeing by stimulating local economies and industries;
- supporting physical activity, climate resilience and enhanced amenity through urban greening and support of street trees; and
- supporting high quality and affordable housing with effective water infrastructure.

The enhancement of green space and urban trees is a key opportunity for Maryborough as only a select number of green areas are irrigated, and council is planning a program of street tree planting to enhance the entrances to the town and the central commercial area.

Figure 2.8: Image of Princes Park oval in central Maryborough

2.2 Objectives for Integrated Water Management in Maryborough

Through the context review and feedback from a workshop with stakeholders and community representatives, the key objectives for IWM in Maryborough have been identified (see Figure 2.9) and fall into three themes:

1. A resilient water cycle
2. Healthy landscapes and environment
3. A prosperous community and economy

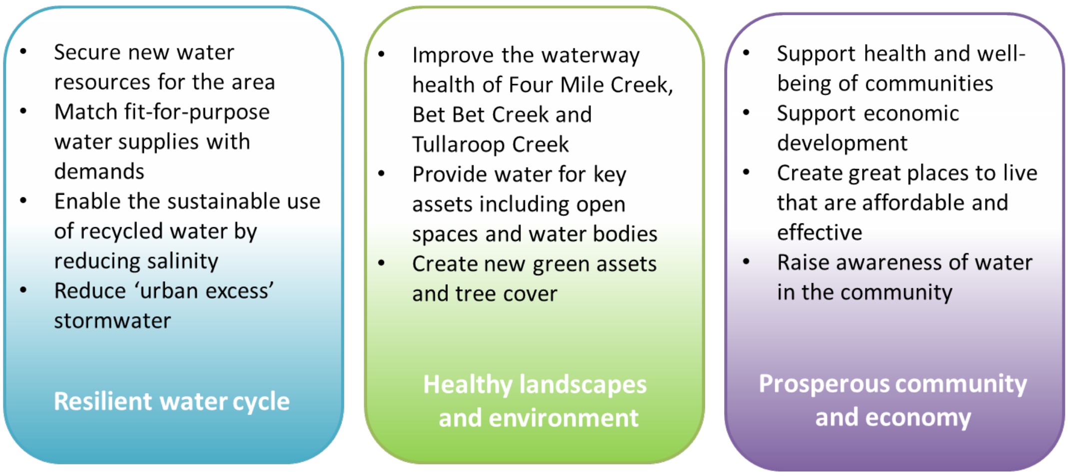


Figure 2.9: Key drivers for IWM in the Maryborough area in three themes

The drivers and the three themes identified for Maryborough map well to the seven priority IWM objectives identified by the Central Highlands Region by its IWM Forum (See Figure 2.10).

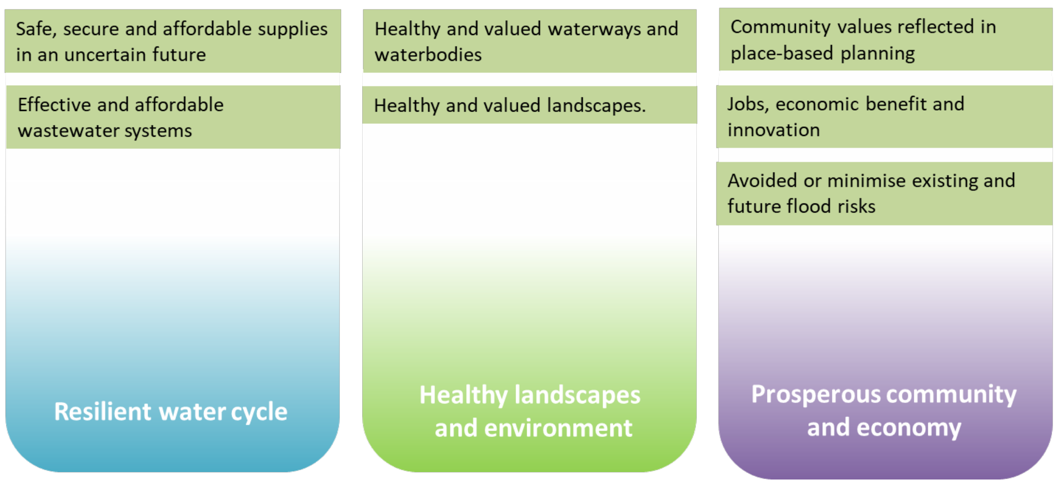


Figure 2.10: Central Highlands IWM Forum objectives in three themes

2.3 A vision for the future of IWM in Maryborough

This plan is underpinned by a long history of community and stakeholder input. A vision was originally formed for IWM in the region through the Ballarat and Region Ballarat and Region's Water Future (BRWF) (State Government of Victoria, 2014): "A greener, more liveable and prosperous water future for the city and towns of the Ballarat region".

Through examination of the local drivers and engagement with stakeholders, a vision has been developed for this IWM Plan:

> Water supports a resilient Maryborough with a thriving community, a prosperous economy, and a healthy environment.

3. **Exploring Opportunities:** Preliminary Option Assessment and Shortlisting

3.1 Maryborough's water balance

An important first step is the development of a water balance for the Maryborough area as a whole. This describes the water demands, regional potable water supplies and the stormwater and wastewater generated by the area. Stormwater runoff from the area has been modelled using MUSIC v.6 and based on a 10 year rainfall sequence, and an estimation of imperviousness across the study area. The key MUSIC parameters used are show in Table 3.1. Water demands and wastewater generation is based on scaled figures for the Maryborough network presented in the Central Highlands Water Urban Water Strategy (2017).

Table 3.1: Rainfall parameters used in catchment runoff modelling using MUSIC v.6

Mean Annual Rainfall	476mm
Rainfall Station[2]	81038 Natte Yallock
Period	1988-1997
Interval	6mins

The following figure presents this water balance for current conditions. Currently, the areas utilise around 980ML/year of potable water sourced from surface water and groundwater systems in the region. The total volume of treated wastewater from the areas is reclaimed as recycled water for irrigation of the golf club, Princes Park and other nearby agricultural areas. Aside from a top up to Lake Victoria, stormwater from the area is unharnessed as a supply, and it runs off into local waterways, carrying pollutants with it. The volume of stormwater running off the urban areas compared with pre-development conditions is approximately 800ML/year. This is referred to as the 'urban excess'.

[2] The 6 minute rainfall gauge at Natte Yallock was selected as an appropriate reference station to model rainfall in Maryborough due to the quality and quantity of data available. See Attachment 3 for details.

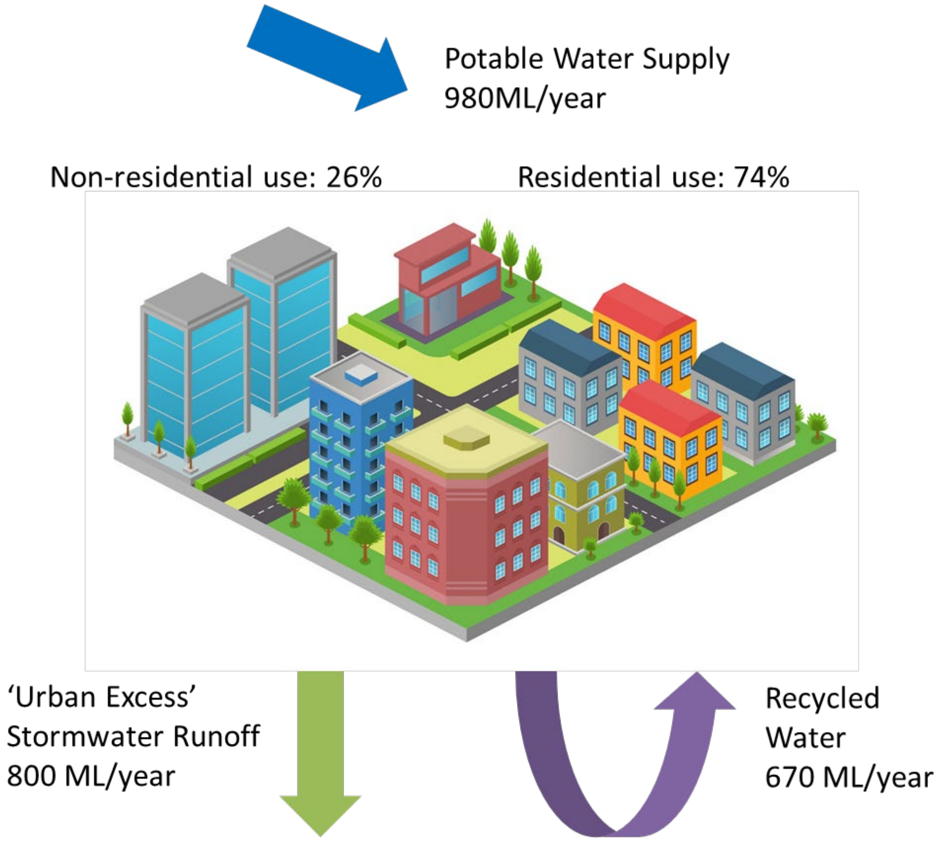


Figure 3.1: Urban water balance for the Maryborough area showing existing potable water demands, excess stormwater runoff and recycled water

Expected population growth in the Maryborough area will increase water demands. As shown by Figure 3.2, the additional demand expected by the end of the plan period (50 years) is 300ML/year. It should be noted that the total water demand for Maryborough and Carisbrook shown in Figure 3.2 is less than that shown in Figure 2.3 which shows the total demand for the Maryborough area serviced by Central Highlands Water which includes surrounding areas such as Talbot.

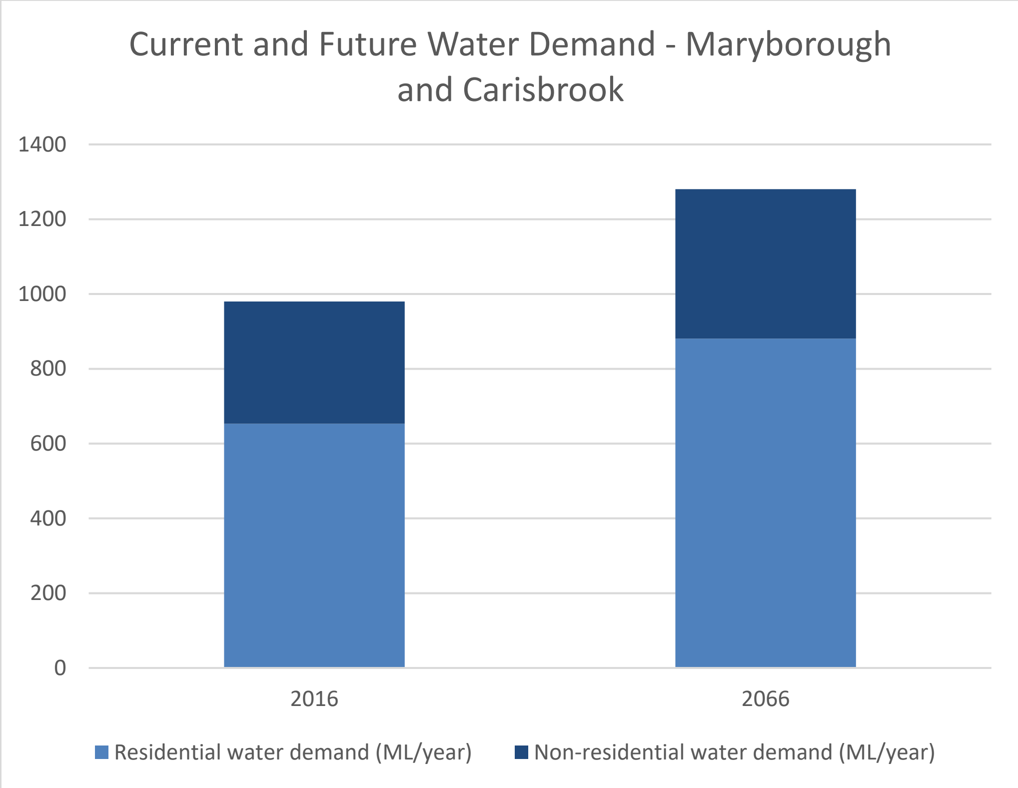


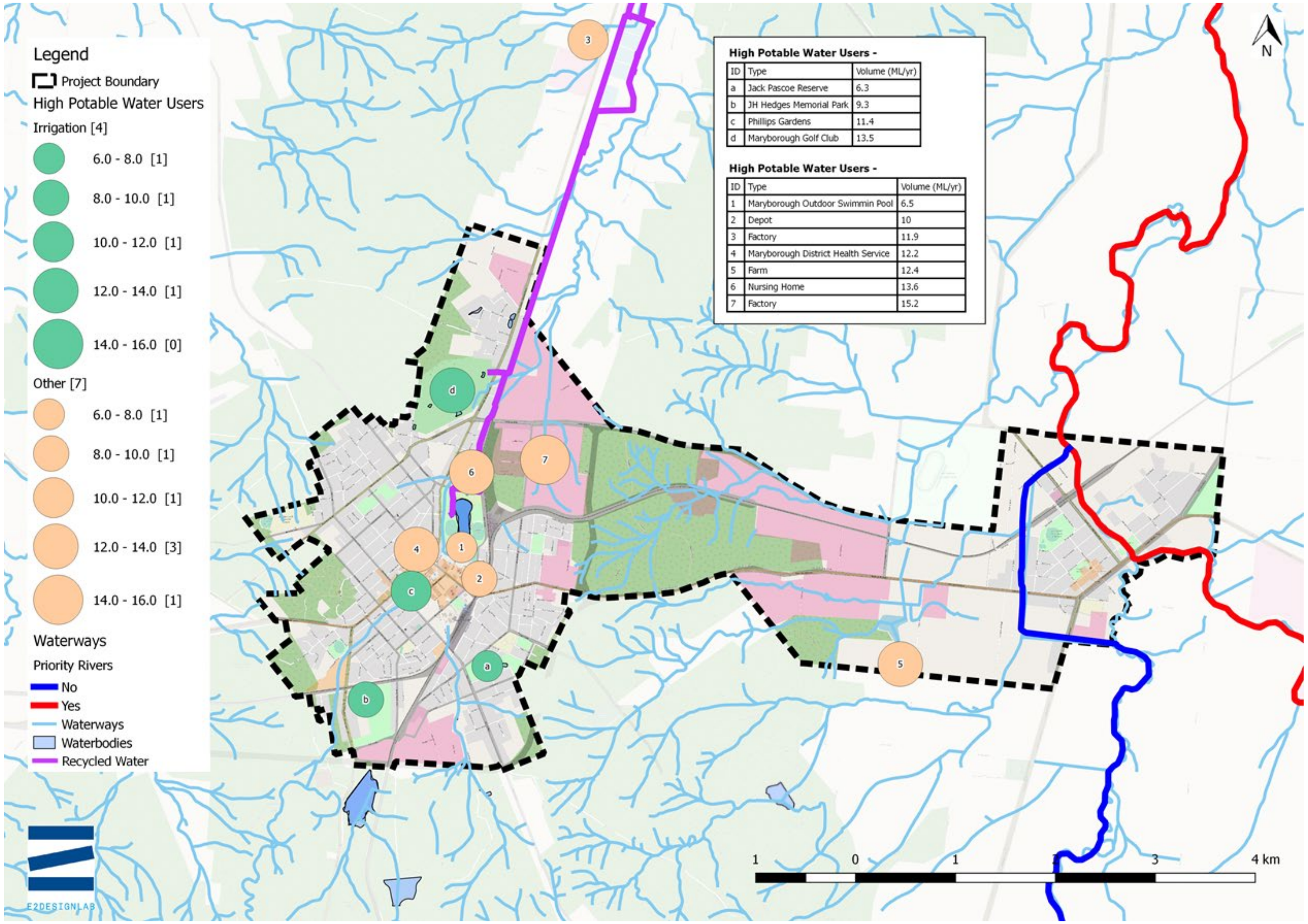
Figure 3.2: Expected increases in water demand in the Maryborough area over the plan period

As discussed in section 2.1.2, the potable water supply-demand analysis for the region has shown that additional water supply resources will be required for the Maryborough area to maintain target levels of service in the next 5-20 years. The supply-demand balance is not only affected by increasing demand, but by decreasing supply due to the predicted impacts of climate change.

In terms of local resources, stormwater is a major water resource that is currently underutilised in the area. Also, importantly, while recycled water is currently 100% utilised locally, an already high salinity profile is likely to be exacerbated by waste streams entering the wastewater system from the recently commissioned Salt Reduction Plant.

3.1.1 Spatial profile of major water users

Within the urban area, it is also useful to understand the location and spread of major water users. Figure 3.3 shows the major potable water users in the Maryborough area, shown as either irrigation demands (open space and recreational areas) or other demands (industry, processing, agricultural use, major service buildings). In some cases, these major users of potable water could use an alternative water source as the quality of water required isn't as high as potable standard. Green space and sportsground irrigation are well matched to the use of alternative sources. Other users have been assessed on a case by case basis through the preliminary assessment to determine if they are likely to have a non-potable water demand which could be met by rainwater, stormwater or recycled water supply.



High Potable Water Users -

ID	Type	Volume (ML/yr)
a	Jack Pascoe Reserve	6.3
b	JH Hedges Memorial Park	9.3
c	Phillips Gardens	11.4
d	Maryborough Golf Club	13.5

High Potable Water Users -

ID	Type	Volume (ML/yr)
1	Maryborough Outdoor Swimmin Pool	6.5
2	Depot	10
3	Factory	11.9
4	Maryborough District Health Service	12.2
5	Farm	12.4
6	Nursing Home	13.6
7	Factory	15.2

Figure 3.3: Location and scale of major irrigation and non-residential demands utilising potable water

3.2 Base case assumptions

In assessing IWM options, it is important to compare them to an expected ‘business as usual’ scenario, called a base case. This allows us to understand changes in costs and benefits compared with the status quo. A base case is different from current infrastructure, as the context will change over time. The base case is instead a best prediction of the strategies and infrastructure that will be delivered to meet future challenges.

Table 3.1: Base case assumptions

<table>
<tr><th>No.</th><th>New Development</th></tr>
<tr><td>1</td><td>There are currently no specific requirements for water management in new development areas in the Maryborough area. It is assumed this will remain the same in the base case.</td></tr>
<tr><td>2</td><td>All major developments will trigger Clause 56.07-4 of the Victoria Planning Provisions. Clause 56:07 references the Best Practice Environmental Guidelines for Urban Stormwater. The best practice environmental management objectives for stormwater quality (post-construction) are shown below.
<table>
<tr><td>Suspended solids (TSS):</td><td>80 per cent retention of the typical urban annual load</td></tr>
<tr><td>Total phosphorus (TP):</td><td>45 per cent retention of the typical urban annual load</td></tr>
<tr><td>Total nitrogen (TN):</td><td>45 per cent retention of the typical urban annual load</td></tr>
<tr><td>Litter:</td><td>70 per cent reduction of typical urban annual load</td></tr>
</table>
For the purposes of this study, it is assumed that all new greenfield developments in greenfield areas achieve this target through the use of precinct scale end-of-catchment wetlands (in the base of retarding basins).</td></tr>
<tr><td>3</td><td>All major developments in greenfield areas construct retarding basins to retard flows from the 1 in 1.5 year ARI flow (BPEMG requirement) to the 1 in 100 year ARI flow event back to pre-developed conditions. New developments in infill areas (residential and non-residential) must provide on-site detention (via on-site detention tanks or enlarged pipes)</td></tr>
<tr><td>4</td><td>No recycled water is used as an alternative water supply across the new growth areas.</td></tr>
<tr><th></th><th>Water Supply and demand</th></tr>
<tr><td>5</td><td>Community and business education around water use will continue to ensure water demands do not increase.</td></tr>
</table>

6	To meet level of service targets, it is assumed that a supplementary water supply resource will need to be linked to the Maryborough supply system in 2025, when the expected supply equals demand in a median climate change scenario. The base case assumed this supplementary water supply will come from the Goldfields Superpipe via a piped transfer. Central Highlands Water have estimated the cost of the connection and transfer.
7	The Salt Reduction Plant will be utilised when salinity in the water supply exceeds acceptable levels. Waste brine will be discharged to the wastewater system.
8	It is assumed that no major upgrades are required to treated water supply infrastructure, other than extensions to new areas.
	Wastewater and recycled water
9	The Maryborough Wastewater Treatment Plant process will be improved to prevent frequent algal blooms occurring, and thereby enabling the use of recycled water for irrigation.
10	The waste brine from the Salt Reduction Plant will elevate salinity levels in recycled water and will require shandying (diluting) with potable water to ensure sustainable irrigation use. A shandy ratio of 2:1 (potable water: recycled water) is assumed to be required.
	Stormwater
11	The main drain diversion to Lake Victoria will remain in place.
12	No WSUD assets will be built in existing areas (other than those required through new development planning policies).
	Urban greening and amenity
13	Tree planting will be undertaken by Council in Maryborough central commercial area and at the entrances to the town.
14	New development areas will include verges and street trees (with no irrigation).
15	Green spaces that are currently irrigated with potable or recycled water will remain irrigated, with no additional irrigated areas expected.
16	Goldfields reservoir will not receive flows from Centenary Reservoir and will remain reliant on water flowing from its natural catchment.

3.3 Option Identification

A workshop was held with key stakeholders and community representatives to identify IWM options for the Maryborough area. Integrated Water Management naturally covers a wide variety of initiatives. Figure 3.3 summaries some of the key types of IWM projects that were discussed with workshop participants.

Figure 3.4 Possible types of IWM projects and initiatives

The ideas and possible projects that emerged from the stakeholder workshop were diverse and met with enthusiasm. These ranged from enhancements to local waterways to large scale alternative water resources for the area.

Figure 3.5 Workshop posts showing locations of projects prioritised by stakeholders

To explore all possibilities, water sources across the following categories were considered: regional potable supply (PO), rainwater (RW), stormwater (SW), wastewater (WW), groundwater (GW), and creeks (CREEK). The results of this process are documented in Attachment 2 as a long list. A long list of 100 opportunities was identified for the Maryborough area.

3.4 Option shortlisting

The Preliminary Assessment Method for IWM options (DELWP, 2015) was utilised to assess and shortlist the longlist of IWM options. The key steps in the PAM are an assessment of the likely scale of benefits of each project, based on the water balance and a rapid modelled assessment of performance, a high-level assessment of key cost and deliverability factors. Key performance factors were selected for the analysis relating to the three primary objective themes as show in Figure 3.5.

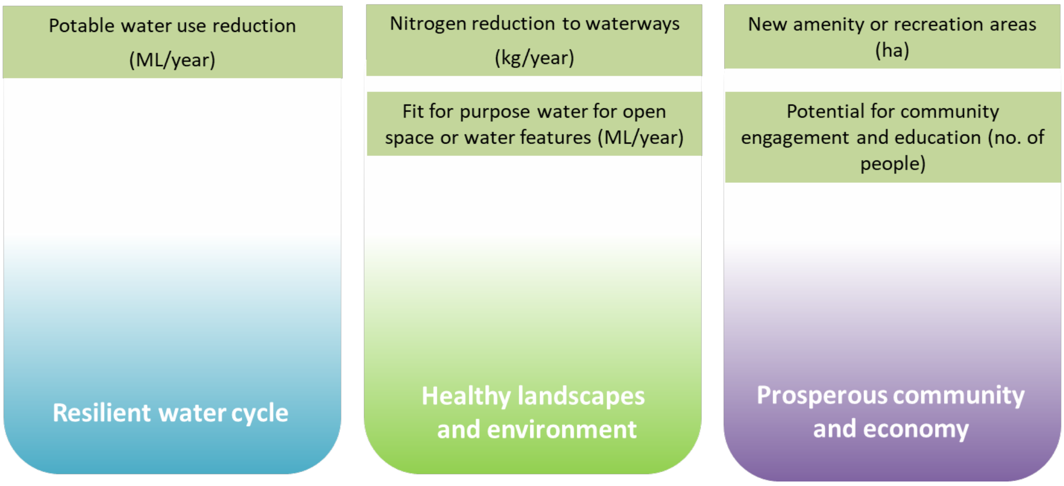


Figure 3.6: Key performance indictors from the three objective themes used in the preliminary analysis of the long list of options

The preliminary assessment is presented in Attachment 2. If a project clearly had a superior alternative which meets the same objectives in all circumstances it was considered a low-performance option. Projects which scored highly in one or more indicator were highlighted for potential selection, and those which had the greatest overall performance, or which performed very well in two or more areas were selected for further consideration.

Key insights emerging from the preliminary assessment of IWM projects for the Maryborough area

- The scale of new development is unlikely to support delivery of alternative water supply networks for non-potable water supply to buildings. Rainwater tanks could be delivered in new development areas as a policy option to deliver a local alternative water supply.
- There are currently limited irrigated open spaces in the Maryborough and Carisbrook area, and those that are irrigated are either already serviced by recycled water or are spatially wide spread, making it difficult to make alternative water supply networks cost-effective.
- There are a number of discreet stormwater harvesting schemes which may be feasible, whereby a stormwater could be harvested and treated to supply 1-2 ovals. Of those identified, Station Domain was selected as having the most potential to add community value by securing an alternative water supply for irrigation.
- The most promising options for recycled water management emerged as the creation of a shandy with recycled water to improve salinity. The desalination of recycled water was cost-prohibitive and brine disposal would be a challenge. Raw water and stormwater were highlighted as potential shandy sources.

- The scale and nature of the operations of the major non-residential water users in the area, such as local industry, food processing operations and community centres meant that non-potable water demand was likely to be a relatively small volume. The most suitable alternative water supply for these users is rainwater from an onsite collection system and tank. It was found that most major users already had rainwater tanks on site.
- Options in the settlement of Carisbrook were limited due to the low density nature of the developed area and limited water demands. The re-invigoration of the Tullaroop Creek public waterway reserve and the Carisbrook Reservoir were identified as a project that may provide recreation and amenity value.
- The key water bodies in Maryborough with community value, Lake Victoria and Goldfields Reservoir, had different water issues. Stormwater treatment could improve water quality in Lake Victoria, and this could also provide an opportunity to source water for nearby irrigation. Water supply is the main issue for Goldfields Reservoir, where raw water and stormwater were identified as possible contributors. Recycled water was not considered to be a feasible option for contribution to lakes due to salinity and water quality issues.
- Carisbrook Reservoir was identified for potential either as a flood storage or for amenity value. Investigation of the reservoir confirmed that a dam safety incident occurred in 1999, and as a result of piping failure, breaching of the dam and breaching of the race line, the dam is now considered to be decommissioned and redundant. Rehabilitation of the dam has been found not to be economically viable and it has been shown not to provide flood retardation value.
- Options that used stormwater to enhance urban greening performed well against the IWM objectives for the area.
- A north-south transfer spine was identified as being a potential option to connect key demands, storages and water sources, with;
    - major demands in the north (golf course, Princes Park) and south (Goldfields Reservoir and some ovals),
    - key sources in the north, including the bottom of the urban catchment and end of the main drain where stormwater could be harvested and the existing recycled water network, and key sources in the north with the raw water holdings at Centenary Reservoir
    - a chain of storages also run north to south: Goldfields reservoir, Phillips Gardens and Lake Victoria, and the golf course water storages.
- Flood management projects have been identified and taken forward for Carisbrook and will shortly be identified for Maryborough through the development of flood management strategies for each town. Accordingly, projects focused on flood management have not been specifically assessed by this plan.

3.5 Shortlisted options

Using the PAM assessment, nine options were shortlisted for further analysis, which are summarised in the table below.

Table 3.2: Shortlisted options for analysis

No.	Scale	Description
1	Lot	**Rainwater tanks supplying rainwater for non-potable use in new homes** – Introduction of a local policy requirement
2	Street	**Stormwater-fed street trees in new development** - Amendment of council landscape requirements for developers to require passive irrigation of street trees for increased canopy and tree health
3	Street	**Stormwater-fed street trees in central commercial area of Maryborough** - Creation of new tree pit designs to provide passive irrigation for greening of the CBD
4	Local	**Wetland treatment integrated into Lake Victoria** - Part conversion of Lake for stormwater treatment, improving water quality and amenity.
5	Local	**Stormwater harvesting from local drain for Station Domain and Council Depot** - Harvesting of stormwater from the drain beneath station domain, and natural treatment feature within the domain for amenity. Storage also can be used as a non-potable water pick up point for street tree watering and other council activities.
6	Town	**Stormwater harvesting from Lake Victoria for Phillips Gardens, Station Domain and Council Depot** - Harvesting of stormwater via wetland in Lake Victoria to provide irrigation water for Station Domain and Phillips Gardens. Also provides council depot demands for tree irrigation and other council activities.
7	Local	**Stormwater harvesting from a new Northern wetland to shandy recycled water supply** - Harvesting of stormwater from via new wetland in north of Maryborough to shandy recycled water to supply princes park and golf course.
8	Town	**Stormwater harvesting from a new Northern wetland to supplement potable supply** - Harvesting of stormwater on large scale from new northern wetland, and pumping to Goldfields via pipe along Main Drain corridor. Transfer to raw water storage in Centenary Reservoir.
9	Region	**Raw water transfer to shandy recycled water supply** - Release of raw water from Centenary Reservoir to a piped connection along the main drain to connect to the existing recycled water network to shandy recycled water for Princes Park and Golf Club. Assuming recycled water transfers can be run in reverse.

A selection of other options were also highlighted for their merit, which can be further considered through ongoing processes:

- **Revitalisation of the main drain corridor:** The main drain (or four mile creek) is a stone sealed drainage corridor through the centre of Maryborough. Many parts of the drain have been daylighted (open-air) and the stone lining provides some amenity and historical value. As its historical status means it is unlikely that it can be naturalised and enhanced for ecological value, there was found to be limited potential for the main drain to be improved to delivery integrated water management outcomes. The main potential exists in the corridor on the edges of the drain where additional greening and walking and cycling access could be created. Further consideration should be given to improving the corridor as a green link and active transport corridor. This is best achieved by Central Goldfields Shire Council as a city planning exercise.
- **Waterway management strategy for Tullaroop Creek:** The settlement of Carisbrook adjoins Tullaroop Creek, and there are opportunities to enhance the recreational and amenity value of the foreshore while also improving the flow and water quality of the creek itself. A waterway management strategy is recommended that takes a whole-of-catchment approach and considers the surrounding rural area, flood risk and the Tullaroop reservoir upstream to determine appropriate improvements. This strategy has been identified as a priority by the Central Highlands IWM Forum.

4. **Evaluating Opportunities:** Option Analysis and Evaluation

4.1 Methodology and Assumptions

Each of the shortlisted options was taken forward to conceptual design to better understand the costs and benefits which could be delivered by each option. The built components and infrastructure required for each option were estimated and sized accordingly. For those options that include rainwater and stormwater management, models were created using MUSIC v.6 to predict runoff, reuse and treatment performance. Cost rates were based on industry standards available from Central Highlands Water (pipework and storage) and Melbourne Water (stormwater treatment).

A full lifecycle costing of the options was developed for each option, including capital, operating and renewal costs to produce a net present value for each proposal. Performance indicators were also quantified wherever possible. These results were then fed into two evaluation process:

1. **An economic evaluation:** A benefit-cost analysis, where benefits have been monetised and compared with cost as possible.
2. **A scored evaluation:** An evaluation against the IWM objectives for Maryborough where scores are allocated to each project based on performance against quantifiable criteria where possible, and qualitative judgement otherwise. The methodology and results of this analysis are included in Attachment 4.

4.2 Option 1: Rainwater tanks supplying rainwater for non-potable use in new homes

Description

This option considers the application of a mandatory requirement for rainwater tanks for toilet flushing, garden irrigation and cold water laundry in new homes. Such a requirement could be applied through the planning system, with a policy requirement from Council or a water services requirement from Central Highlands Water. Maintenance would be undertaken by the householder.

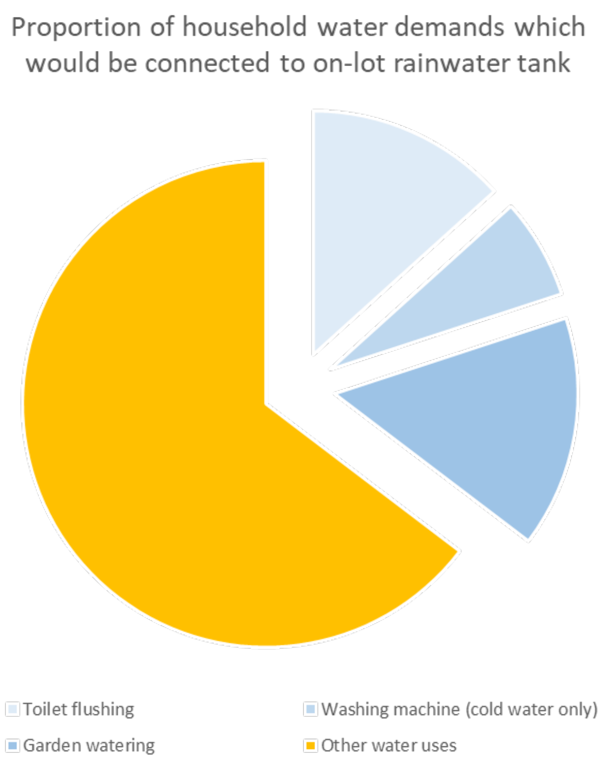


Figure 4.1: Proportion of household water demands which would be connected to an on-lot rainwater tank

The connected non-potable demands shown in Figure 4.1 make up 35% of a typical new home's water demand.

Key analysis assumptions and infrastructure requirements

Rainwater tank effectiveness in providing these non-potable demands was modelled using MUSIC v.6. It was assumed that 80% of an average 220m^2 roof could be connected to the tank. A 4.5kL tank was needed for each home to provide 70% reliability of supply (i.e. 70% of the annual non-potable demand would be met, with the remainder met by potable supply).

Cost summary		
Item	**Capital Cost ($/house)**	**Operating Cost ($/house/yr)**
Tank and pump	$2,100	$104
Installation and plumbing	$1,700	-
Total	**$3,800**	**$104**
Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Mains potable water supply substitution**: Rainwater tanks could provide 55ML/year of fit-for-purpose water for non-potable water in new homes by the end of the plan period. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 55ML/year by the end of the plan period as it is taken up by the tree, or lost to infiltration.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 137kg/year of nitrogen by the end of the plan period.	• **Dual-purpose investment**: Rainwater tanks will also satisfy the Building Regulation six star sustainability requirements for new homes (where either a solar hot water or rainwater tanks are required). • **Education**: The inclusion of community managed rainwater tanks heightens awareness around water use and places communities at the heart of water management.

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $2,537,710	19
Benefit Cost Ratio: 0.19	

4.3 Option 2: Stormwater-fed street trees in new development areas

Description

Typically, new developments in Maryborough are relatively low density and include a landscaped verge (grass or pebbled) with street trees included. Research has shown that access to water is important for the growth and health of street trees. Provision of water will be important to their establishment and to the greening and amenity of new developments, in turn enhancing health and well-being of communities. Given the typical verge width there is an opportunity to include a fairly simple mechanism for allowing stormwater that runs off the road surface to be directed into a sunken tree planting area in the verge via a gap in the kerb. This type of solution is low-cost, and it has the dual benefit of providing irrigation water to the tree, while also capturing and treating stormwater runoff.

Figure 4.2: Examples of verge conditions in the new development area Whirrakee Rise (top row) and examples of dropped kerb verges to facilitate passive irrigation (proposal in Ballarat and built example in Melbourne) (bottom row).

Key analysis assumptions and infrastructure requirements
The proposed design for the stormwater-fed trees is shown in the drawing below. The key component parts include a sunken grassed area and a dropped kerb inlet. The gradual slope of the sunken area will allow maintenance and mowing. As standard, a back of kerb perforated drainage pipe is usually included in new roads, and this inclusion will be important for the system to prevent waterlogging. It is assumed that one tree would be included outside each new home. Based on canopy growth data, a canopy diameter increase of 2.5m^2 to 5m^2 is expected due to the addition of passive irrigation. Based on one tree per home, 100 trees are estimated per km of road.

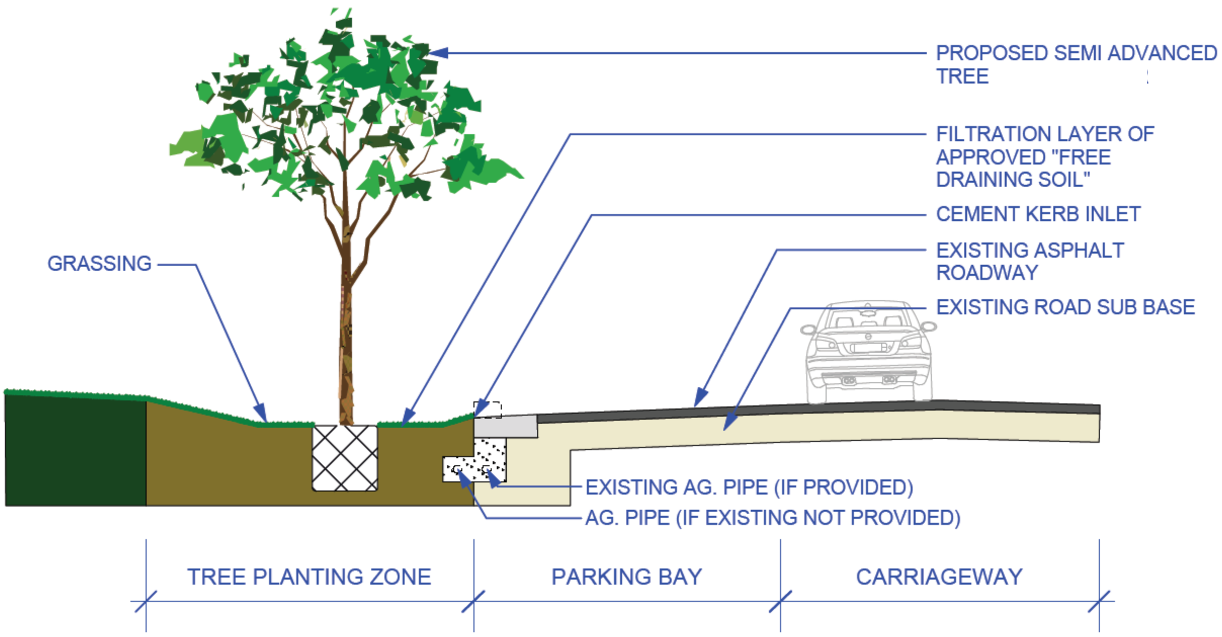


Figure 4.3: Example cross-section (not to scale) based on 'Greening Ballarat: Blue Green Infrastructure Action Plan (City of Ballarat, 2016)

Cost summary

Item	Capital Cost ($/km)	Operating Cost ($/km/yr)
Creation of sunken area with kerb inlet	$ 98,000	$ 470

Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 9ML/year by the end of the plan period as it is taken up by the tree, or lost to infiltration.	• **Street tree health:** Passive irrigation will support street tree health and enhance canopy diameter from 2.5m to 5m in each tree. Adding a total additional canopy area of nearly 21,000m^2 over the plan period. • **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 106kg/year of nitrogen by the end of the plan period.	• **Increased amenity and property prices**: The predicted increase in tree canopy cover in streets could induce a 1.8% increase in property prices. • **Improved health and wellbeing**: Trees provide shade to encourage walking, and also provide a connection to nature to improve mental health.

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $586,132	31
Benefit Cost Ratio: 2.71	

4.4 Option 3: Stormwater-fed street trees in central commercial area of Maryborough

Description
In the existing commercial centre of Maryborough there are currently very few street trees. Street trees are important for providing shade, amenity and ecological value in an urban area. Central Goldfields Shire Council have begun a program of tree planting in the commercial area and in key entrances to the town. This option proposes to include passive irrigation of street trees by modifying the standard design for tree pits. Based on yet to be completed tree planting in the CBD, it is assumed that 134 trees would be planted over a 1.14km street length.

Figure 4.4: Aerial view of the centre of Maryborough showing low canopy cover in the central commercial area

Key analysis assumptions and infrastructure requirements
To capture stormwater for street trees in a built up area where there is no grassed verge (as per option 2), the following elements are needed:

A grated inlet from in the kerb which will allow stormwater flowing along the kerb into the tree while excluding litter;
A sunken soil area for the tree, to allow water to flow in from the street level. This can be covered at footpath level by a decorative grate (with a central hole for the tree trunk);
Airspace between the soil surface and the inlet to provide 'extended detention' of stormwater, which allows a greater volume of water to be stored and gradually soak in, assisting with irrigation and stormwater treatment;
Back of kerb drainage linked to the stormwater system to prevent waterlogging. Depending on road design this may already exist, otherwise it can be introduced along the street when retrofitting a line of tree pits;
An optional component that will further enhance the health of the tree is the inclusion of an extended soil growing area, using structural soil grates or structural soil mix to extend growing media under the footpath (this has not been costed in this analysis).

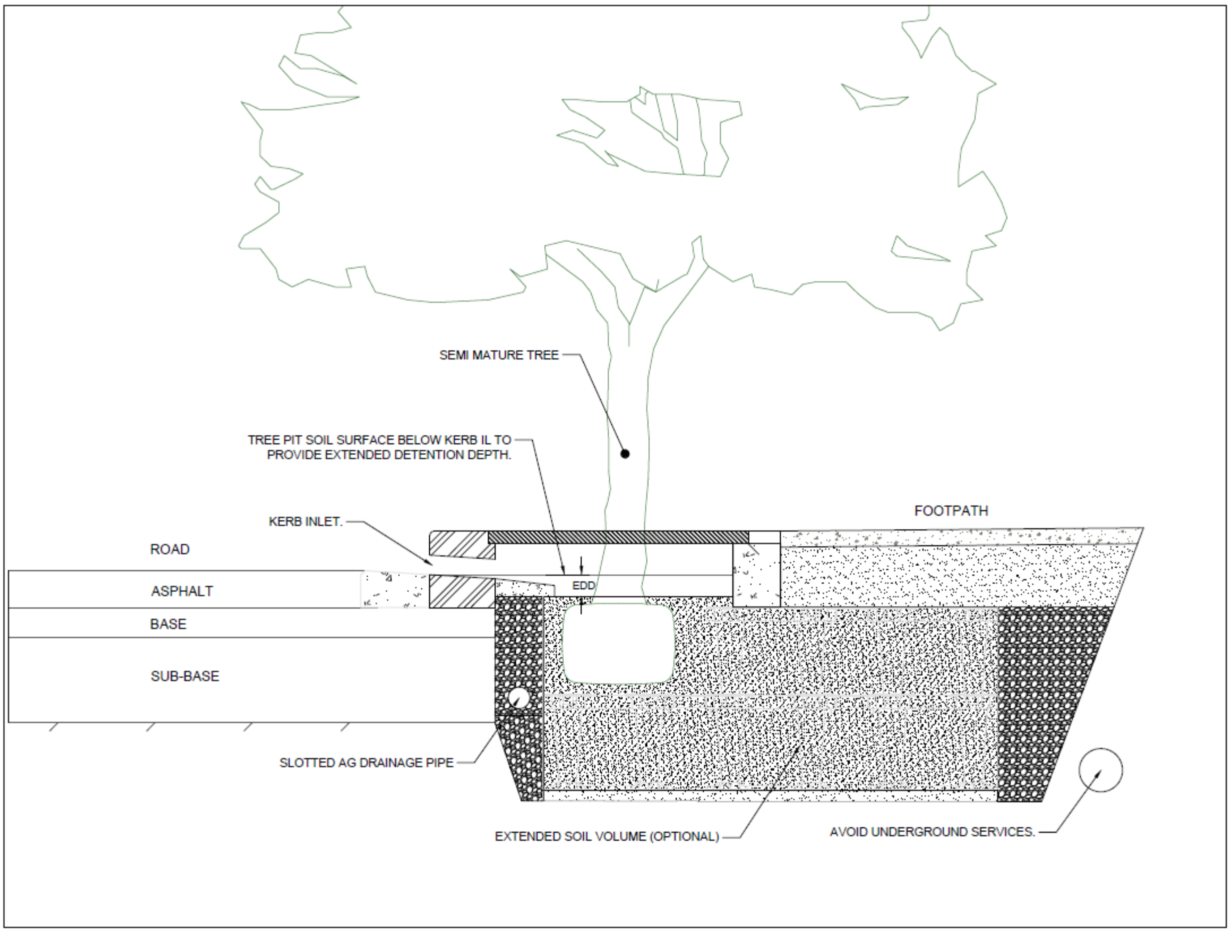


Figure 4.5: Example cross-section of a passively irrigated tree pit appropriate for integration into a commercial area (not to scale)

Cost summary		
Item	**Capital Cost ($/km)**	**Operating Cost ($/km/yr)**
Excavation, labour, filter media	$ 35,782	$500
Drainage connection	$ 117,647	-
Grate structure	$ 58,824	-
Total cost	**$ 212,252**	**$500**

Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 0.4ML/year by the end of the plan period as it is taken up by the tree, or lost to infiltration.	• **Street tree health:** Passive irrigation will support street tree health and enhance canopy diameter from 1.5m to 3m in each tree. Adding a total additional canopy area of nearly 708m^2 over the plan period. • **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 6kg/year of nitrogen by the end of the plan period.	• **Increased amenity and property prices**: The predicted increase in tree canopy cover in streets could induce a 1.8% increase in property prices. This value was sourced from a study that considered residential property but has been transferred for use for commercial areas in this context. • **Improved health and wellbeing**: Trees provide shade to encourage walking, and also provide a connection to nature to improve mental health.

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $212,208	30
Benefit Cost Ratio: 1.5	

4.5 Option 4: Wetland treatment integrated into Lake Victoria

Description
Lake Victoria is a picturesque and highly valued lake in Maryborough. It includes a shared walking and cycling track around the lake. Features of the lake and its surrounds also include: three islands within the lake, fishing, birdwatching, sporting fields and the nearby Princes Park Playground. The lake is fed by stormwater from the Main Drain. During the Millennium Drought the lake was impacted by low water levels. In response a low flow diversion was constructed to increase the volume of water in the Lake. The stormwater entering the lake is largely untreated. There are several gross pollutant traps installed, however, nutrients, sediment and other pollutants are not managed. Vegetation and habitat with the lake is very limited. Option 4 explores the opportunity of converting ~50% of the surface area of the lake into a wetland in order to address water quality issues in the lake. Wetlands are heavily vegetated water bodies. These systems can either be natural features in the landscape or can be constructed to treat stormwater. They can appear as natural systems or integrated as hard edged features in urban areas. Many constructed wetlands attract birds, frogs and mammals, and are valued by their local community for their amenity. The wetland proposed for Lake Victoria would improve water quality, increase native vegetation cover and provided habitat for birds, frogs and mammals. The new wetland/lake complex could also include upgrades to improve amenity across this site such as boardwalks, interpretive signage and seating. The improvements to the lake would need to be planned as part of a wider masterplanning exercise for the Lake and Princes Park.

Figure 4.6: Lake Victoria (left) and wetland examples in Melbourne (right)

Key analysis assumptions and infrastructure requirements

Approximately 50% of Lake Victoria is converted into a vegetated stormwater treatment asset (equivalent to 25,500m^2). This requires:

- A 150 L/s diversion from the Main Drain (i.e. the assumed existing diversion from the Main Drain is the primary source of stormwater feeding the wetland, catchment = 480 ha (25% impervious catchment))
- 2,550 m^2 sediment pond
- 22,950m^2 wetland (100mm extended detention depth, 350mm permanent pool)
- A recirculation pump to transfer water from the lake through the wetland during periods of low rainfall/inflow.

The wetland/lake complex should be also designed and managed to reduce the risk of algal blooms during extended dry periods. The additional amenity enhancements proposed in Option 4 have not been designed and would require input from the council and community. As such, the cost of any landscape or other works not required to construct the wetland have been excluded from the analysis.

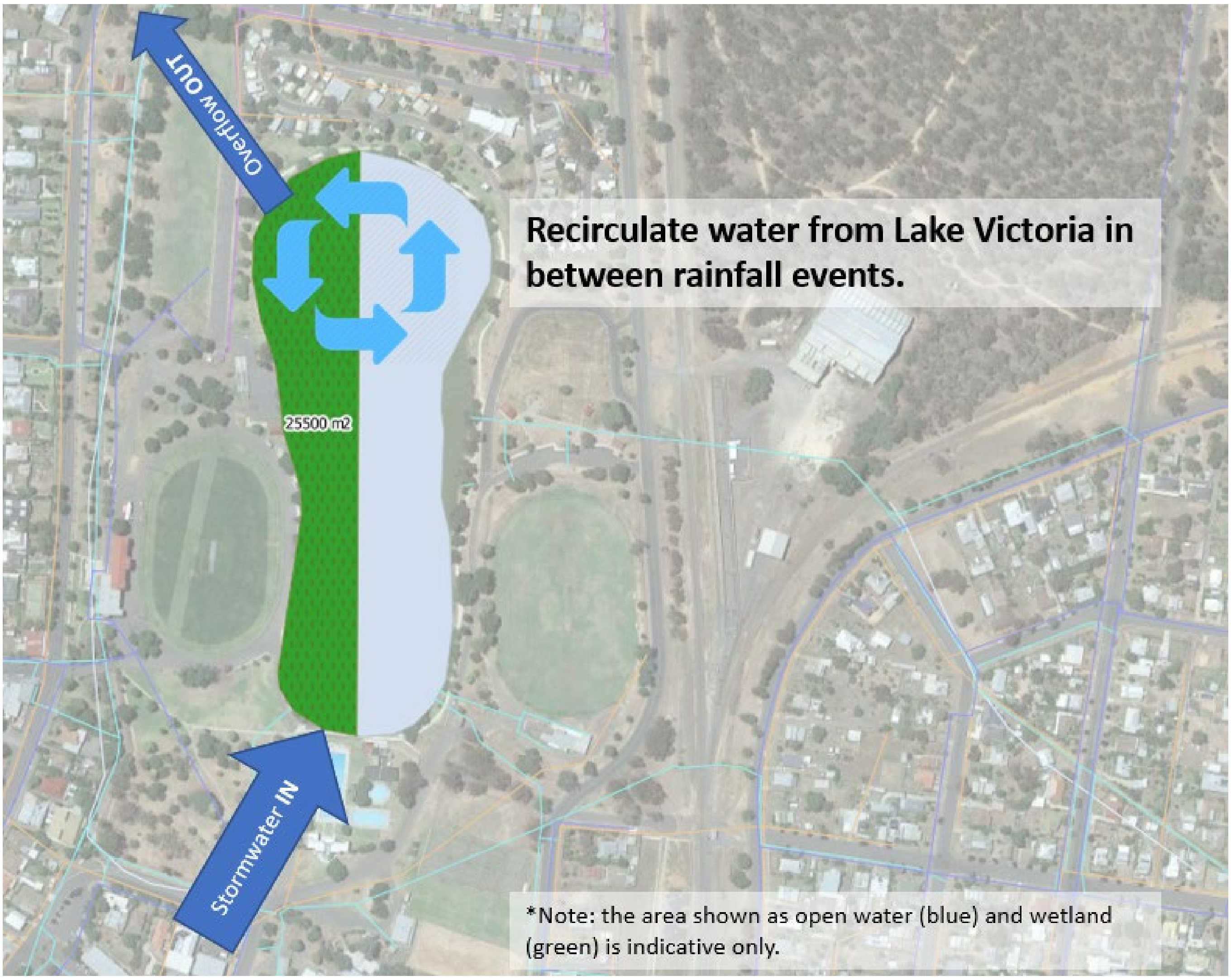


Figure 4.7: Proposed conversion of Lake Victoria

Cost summary			
Item		**Capital Cost ($)**	**Operating Cost ($/yr)**
General Infrastructure	Pumps	$99,628	$1,299
WSUD	Treatment	$3,085,521	$21,831
	Establishment	$87,871	$0
Total		**$3,273,020**	**$23,131**

Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 29ML/year.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 333kg/year of nitrogen by the end of the plan period.	• **Amenity**: The community will benefit from a 5.1 ha area of well serviced and attractive lake and wetlands area. • **Health and well-being**: The improvement to water quality and access to the lake will improve recreation opportunities for the community. • **Education**: The introduction of a wetland to the lake and wider improvements is an opportunity for community co-design and engagement.

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $4,704,447	41
Benefit Cost Ratio: 0.65	

4.6 Option 5: Stormwater harvesting from local drain for Station Domain & Council Depot

Description

There is an opportunity to harvest stormwater for non-potable reuse at the Station Domain Precinct. This area is a key location in Maryborough that has no irrigation. Harvesting stormwater for irrigation would help to increase vegetation (through the introduction as a raingarden for treatment) and increased quality of the grassed area and cooling via irrigation. The storage tank would be constructed underground to maintain the green open space area.

The Council Depot is also a short distance from Station Domain and is a high potable water user (10ML/yr). There is also potential to supply the depot with treated stormwater to (a) reduce its current potable water use and (b) service new non-potable demands (e.g. tank watering for road works or irrigation).

The proposed stormwater treatment and harvesting system would also reduce the sediment, nutrients and other pollutants that flow downstream into Lake Victoria and Four Mile Creek. Stormwater can be harvested from a drain that runs directly beneath Station Domain, which drains a relatively large area.

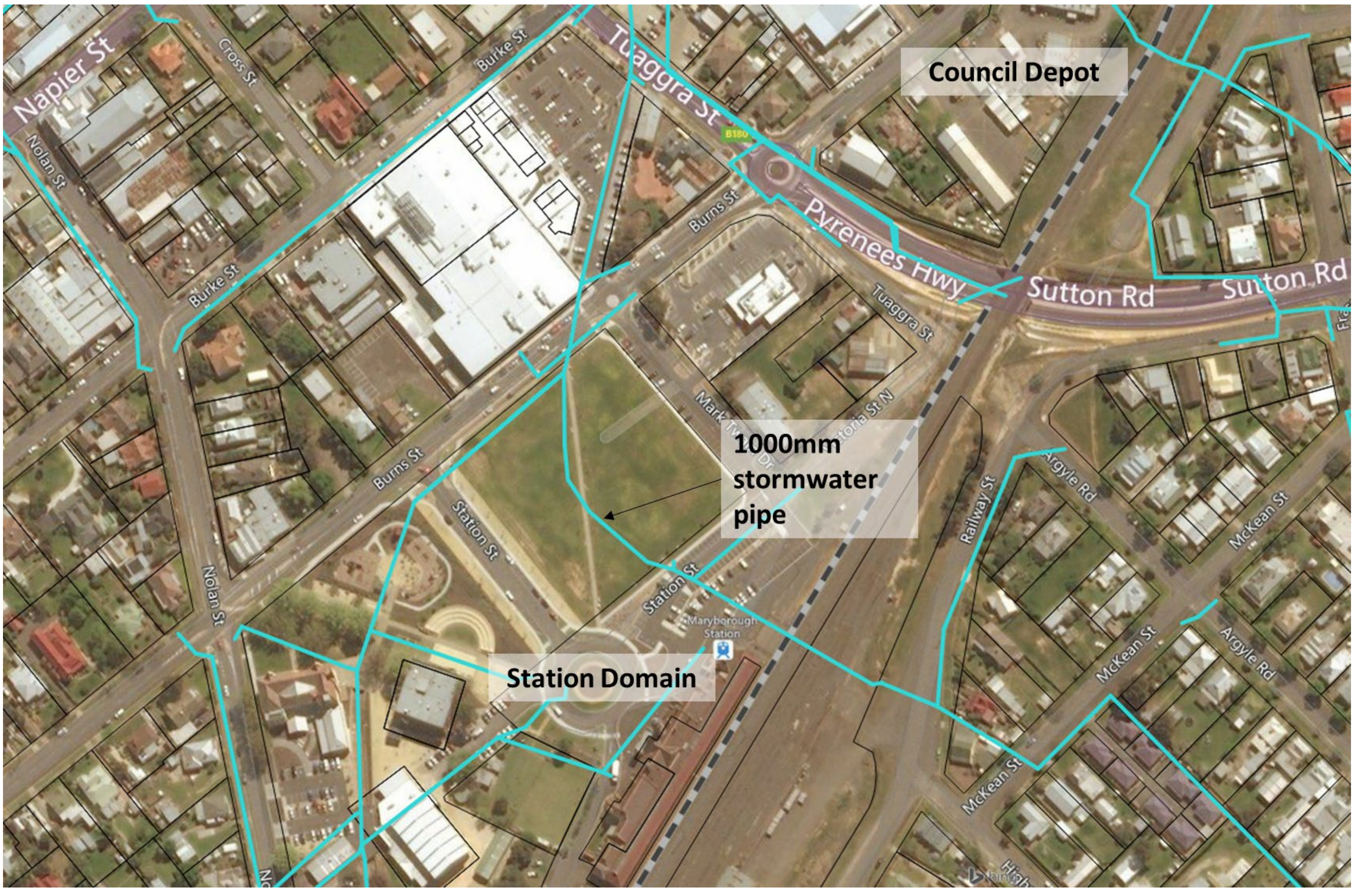


Figure 4.9: Council drainage (blue lines) running below open space in Station Domain

Key analysis assumptions and infrastructure requirements

The catchment draining to Station Domain is estimated at 377 ha (21% impervious). The design includes:

- 100 L/s pumped diversion from the Shire's drainage network (assuming a 10 L/s low flow bypass)
- 600m^2 raingarden
- UV treatment
- 1 ML underground storage tank
- 300m of pipe of 150mm pressurized pipework to transfer treated stormwater form Station Domain to the Council Depot.

The scheme is designed to supply non-potable demands at Station Domain (5ML/yr) and the Council Depot (5ML/yr). The estimated average annual yield of the harvesting scheme is 7.6 ML/yr (76% reliability).

Rainwater harvesting from the rooftops of surrounding public buildings was considered as an alternative to stormwater harvesting from the underground drainage system. However, at station domain, the area of roof that could realistically be connected to a rainwater tank from surrounding buildings is ~2,000 to 4,500 m^2. This impervious area is very small (i.e. less than 0.7%) of the impervious area (~78ha) in the catchment that is connected to the stormwater drain which runs beneath the domain. Accordingly, roof water harvesting would not provide sufficient yield to irrigate the domain.

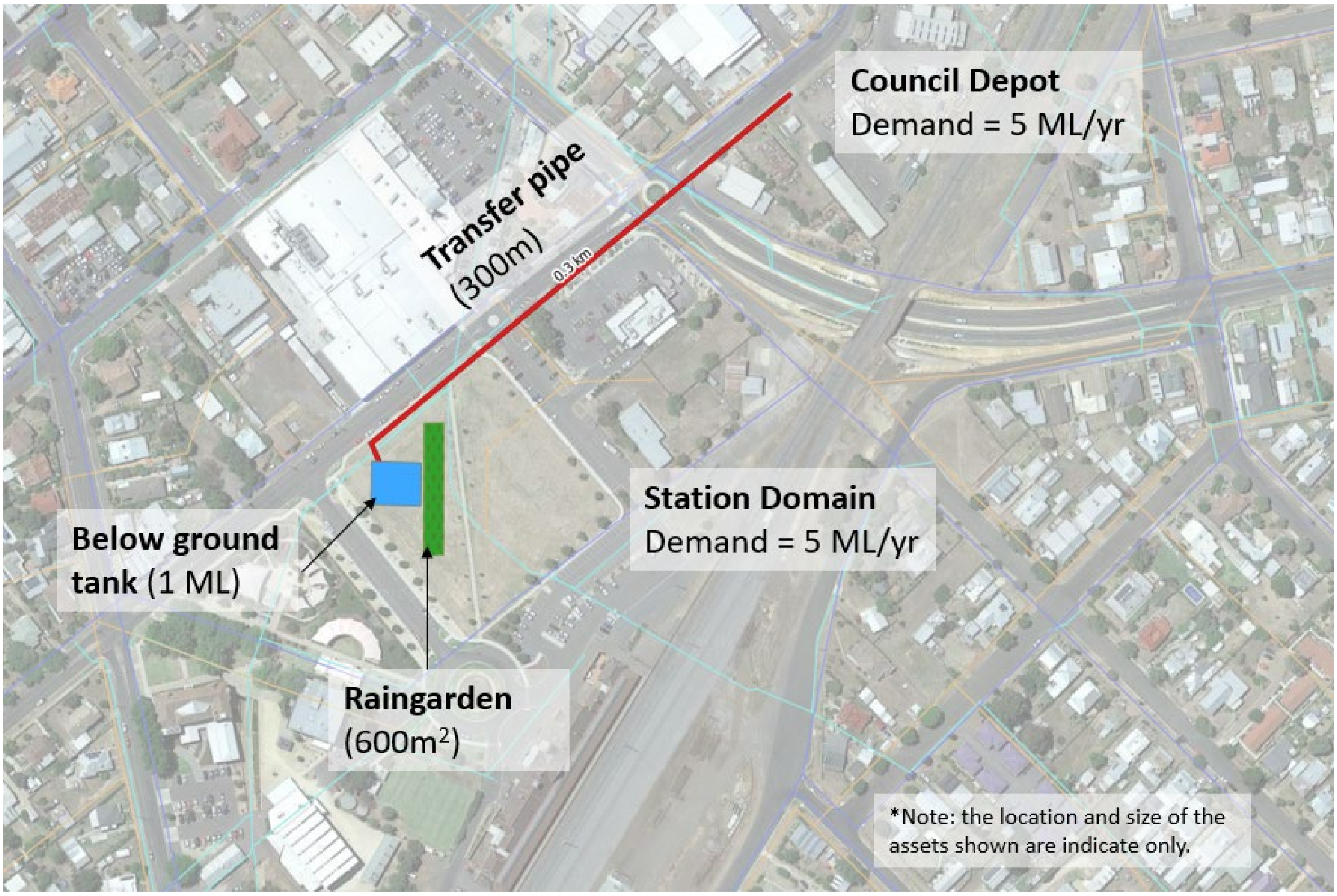


Figure 4.10: Proposed stormwater treatment and reuse network

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$123,799	$1,615
	Electrics and power	$40,250	$0
	GPT	$45,669	$1,650
WSUD	Treatment	$235,238	$3,000
	Establishment	$12,075	$0
Storage	Main storage	$853,755	$3,712
Additional treatment	UV disinfection	$17,303	$1,444
Other Items	Item 1: Transfer mains	$118,555	$635
Total		**$1,446,644**	**$12,056**

Key Benefits

A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Mains potable water supply substitution**: The supply to the depot could substitute 3.8ML/year of potable water for non-potable water. • **New water supplies**: The scheme would harness 7.2ML/year of stormwater to support local needs. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 8.8ML/year by the end of the plan period.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 225kg/year of nitrogen by the end of the plan period. • **New irrigated green space**: 2 hectares of centrally-located green space will be improved through irrigation.	• **Amenity**: The community will benefit from a greatly improved central green space, providing an attractive view of the historic railway station. • **Health and well-being**: Irrigated grass is much more effective than unirrigated grass in providing urban cooling on hot days. A greener space will also encourage outdoor recreation.

Evaluation

Economic Evaluation	Scored Evaluation (Total score, range 13-60)
Present Value of Costs: $1,783,513	40
Benefit Cost Ratio: 0.95	

4.7 Option 6: Stormwater harvesting from Lake Victoria for Phillips Gardens & Station Domain & Council Depot

Description

The potential for a new wetland within Lake Victoria is proposed in Option 4. If this wetland is constructed there is treated stormwater could be harvested for non-potable reuse. The grounds surrounding Lake Victoria itself are already connected to the recycled water network. Therefore, treated stormwater would need to be used for demands further afield. Potential demands include Phillips Gardens, Station Domain and the Council Depot.

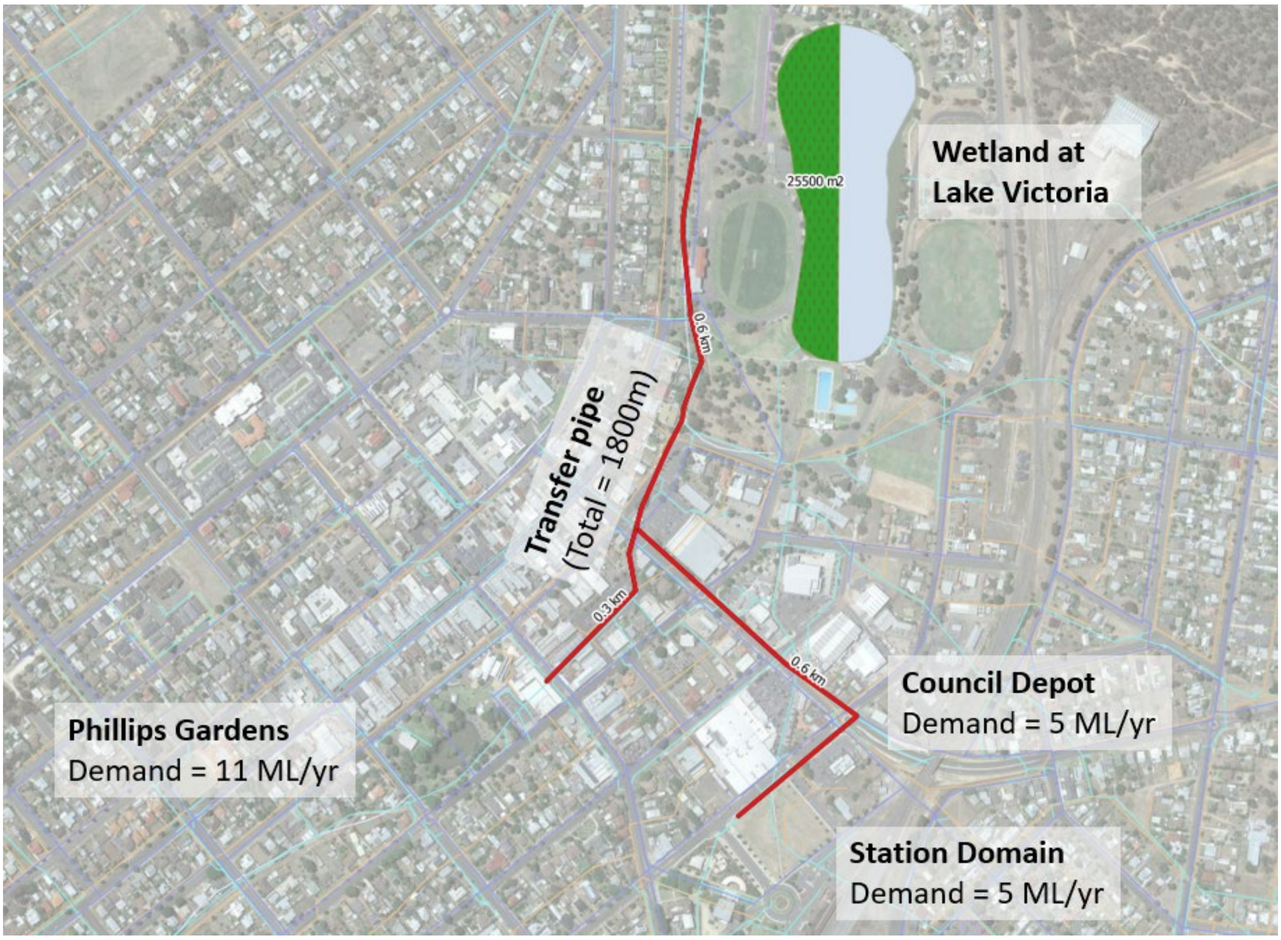


Figure 4.11: Overview of proposed reuse network

Key analysis assumptions and infrastructure requirements

Option 6 requires:

- Approximately 50% of Lake Victoria is converted into a vegetated stormwater treatment asset (equivalent to 25,500m2). See Option 4 for more details. Water is transferred 1,500m via 150mm transfer pipework.
- Stormwater will be harvested from the wetland by drawing down the permanent pool up to 100mm. This avoids the need for a costly storage. Treated stormwater will undergo UV treatment prior to reuse.

- The demands serviced include: Phillips Gardens (11 ML/yr), Station Domain (5ML/yr) and the Council Depot (5ML/yr). The annual average supply of treated stormwater = 13.1 ML/yr (63% reliability)

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$99,628	$1,299
	Electrics and power	$40,250	$0
WSUD	Treatment	$3,085,521	$21,831
	Establishment	$87,871	$0
Additional treatment	UV disinfection	$29,282	$2,444
Other Items	Item 1: Transfer mains	$473,768	$2,236
Total		**$3,816,321**	**$27,811**

Key Benefits

A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Mains potable water supply substitution**: The supply to the depot and Phillips Gardens could substitute 10ML/year of potable water for non-potable water. • **New water supplies**: The scheme would harness 13ML/year of stormwater support local needs. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 42ML/year.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 365kg/year of nitrogen by the end of the plan period. • **New irrigated green space**: 2 hectares of centrally-located green space will be improved through irrigation.	• **Amenity**: The community will benefit from a 5.1 ha area of well serviced and attractive lake and wetlands area (Lake Victoria) and a 2ha irrigated area (Station Domain). • **Health and well-being**: The improvement to water quality and access to the lake will improve recreation opportunities for the community. A greener station domain will also promote urban cooling and recreation. • **Education**: The introduction of a wetland to the lake and wider improvements is an opportunity for community co-design and engagement.

Evaluation

Economic Evaluation	Scored Evaluation (Total score, range 13-60)
Present Value of Costs: $4,863,345	59
Benefit Cost Ratio: 0.68	

4.8 Option 7: Stormwater harvesting from Northern Wetland to shandy recycled water supply

Description
There is an opportunity to construct a large regional wetland adjacent to Four Mile Creek on the northern outskirts of Maryborough. This wetland could treat a large portion of polluted urban stormwater runoff from the town. Treated stormwater could be harvested from the wetland to shandy with recycled water via a mixing tank prior to restricted reuse.

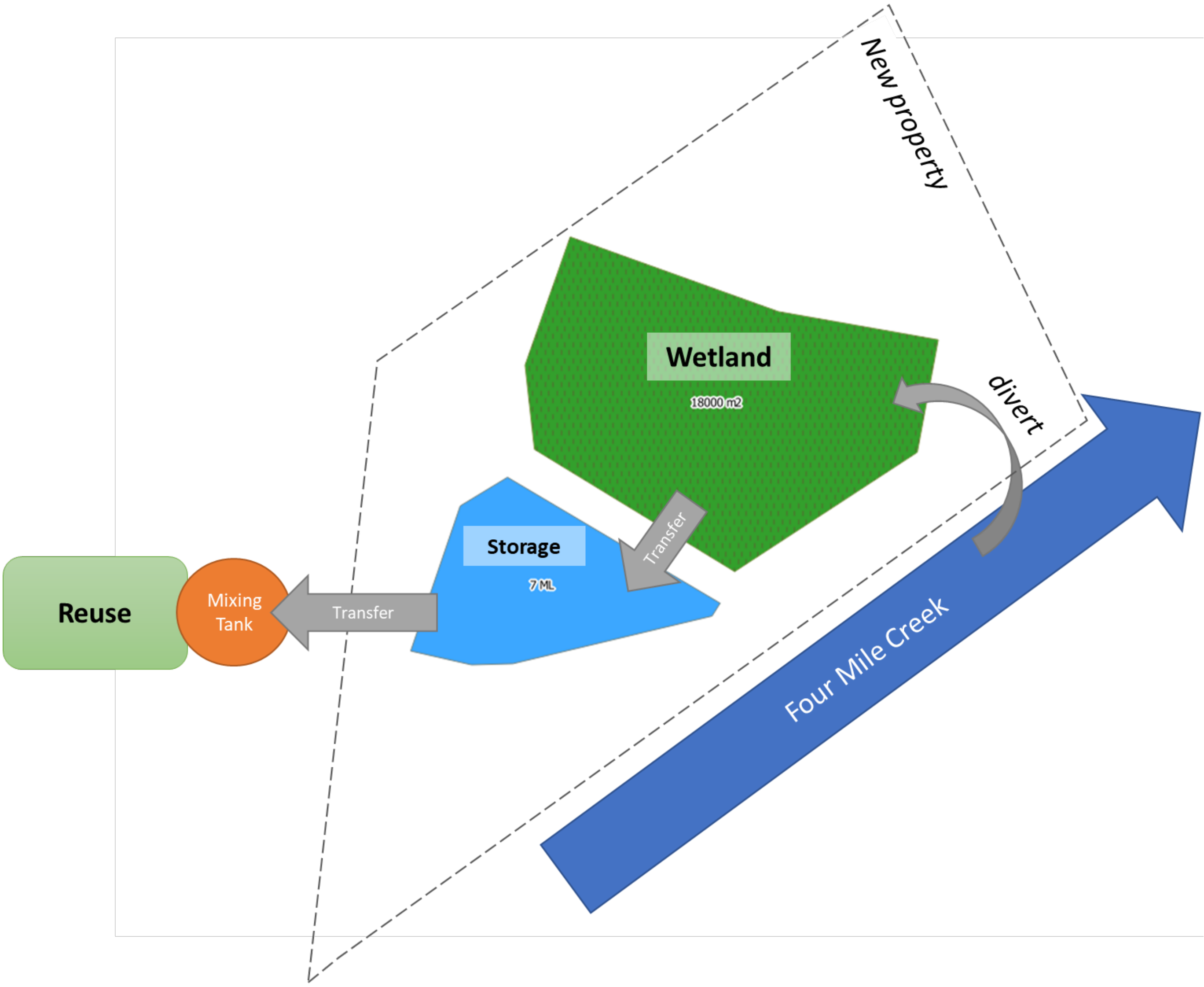


Figure 4.12: Schematic of storage and wetland adjacent to Four Mile Creek

Key analysis assumptions and infrastructure requirements
The Northern Wetland system requires: • A 1,400 ha (22% imperviousness) catchment with a 100L/s low flow bypass and gravity or pumped diversion with a capacity of 400 L/s. • A gross pollutant trap upstream of the wetland. • Purchase of private land to construct a treatment and reuse system. • Total treatment area of 18,000m^2 consisting of a 1,800m^2 sediment pond and 16,200m^2 wetland. • A wetland with a 350mm permanent pool and 350mm extended detention depth. • A storage pond with a 7,000 ML capacity • UV treatment is provided prior to shandying, peak treatment rate estimated at 1.5 ML/d. • 200m of 225mm transfer pipework (wetland to shandy location). • The demand for stormwater for shandy = 73.3 ML/yr (seasonal, assumes a 2:1 supply of Stormwater to Recycled Water, ignoring potable top up) • The supply of stormwater for shandy = 44.9 ML/yr (61% reliability) with the shortfall made up with potable water. Two alternative scenarios were considered for Option 7 which would reduce costs and deliver similar benefits. These are summarised in Attachment 5.

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$296,452	$3,867
	Electrics and power	$40,250	$0
	GPT	$86,834	$1,650
WSUD	Treatment + Storage Pond	$2,514,743	$25,675
	Establishment	$135,507	$0
Other Items	Item 1: Transfer mains	$137,880	$962
	Item 2: Land acquisition	$759,365	$0
Total		**$3,971,031**	**$32,154**

Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Supporting sustainable recycled water use**: By using stormwater as a source for shandying recycled water it will enable ongoing use of recycled water for irrigation. • **New water supplies**: The scheme would harness 45ML/year of stormwater to support local needs. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 153ML/year.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 473kg/year of nitrogen by the end of the plan period. • **New green infrastructure**: A new wetland will be created in Maryborough north which could be a valued community and ecological asset.	• **Amenity**: The community will benefit from new area of well serviced and attractive wetlands.

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $4,463,345	30
Benefit Cost Ratio: 1.13	

4.8 Option 8: Stormwater harvesting from Northern Wetland to supplement potable supply

Description

There is an opportunity to construct a large regional wetland adjacent to Four Mile Creek on the northern outskirts of Maryborough. This wetland could treat a large portion of urban stormwater runoff from the town. Treated stormwater could be harvested from the wetland and transferred to Centenary Reservoir where it could be treated further and utilized as a major new potable water resource for the town. While the yield from the natural catchments that feed the regional potable water supply are likely to substantially decrease due to climate change, runoff from urban areas is affected to a lesser degree, with decreases <3% predicted for urban stormwater harvesting schemes[3]. Accordingly, urban runoff could be a key resource for Maryborough. Extensive consultation would be required and regulatory support for this option would need to be gained to enable its delivery. Both domestically and internationally there are a small but growing number of example projects with stormwater being harvested and treated for potable reuse (see box 1).

The cross-town transfer also provides an opportunity to provide temporary storage in Goldfields Reservoir, potentially adding substantial volume to raise levels and provide additional recreation benefit.

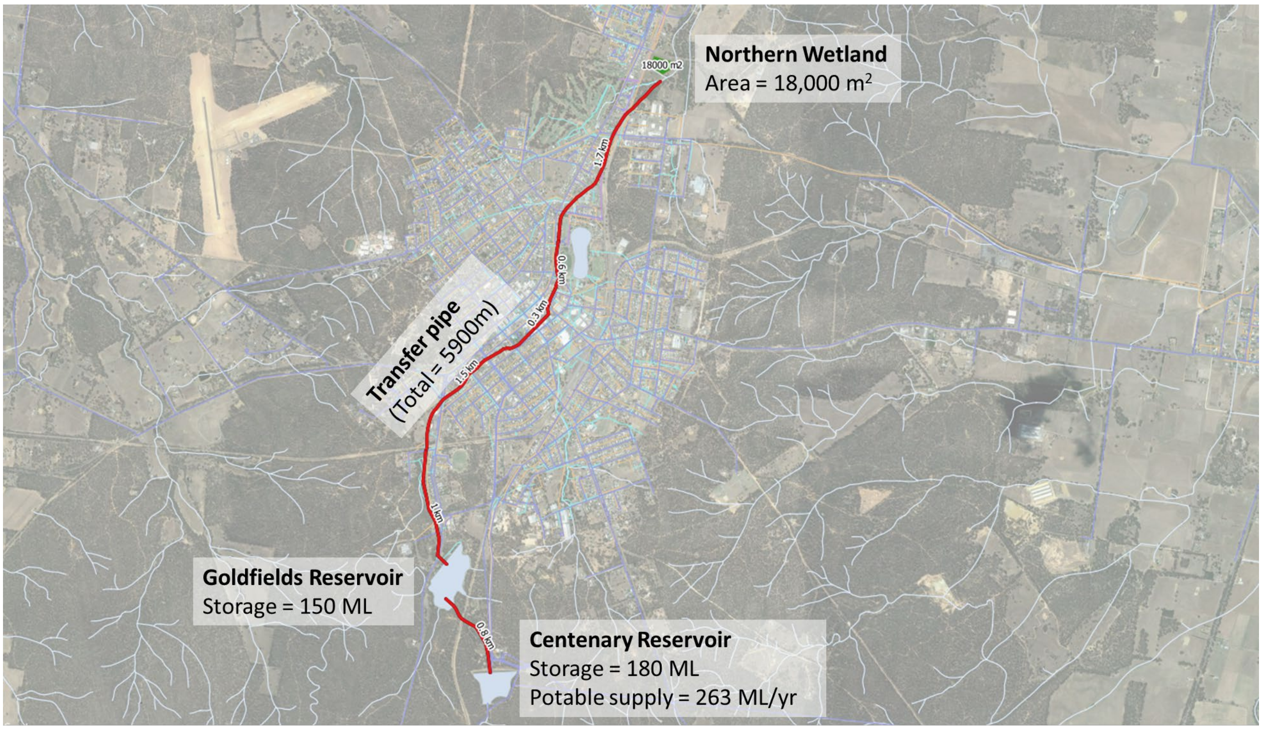


Figure 4.13: Schematic layout of the reuse scheme

[3] Kefeng Zhang, Desmond Manuelpillai, Bhupendra Raut, Ana Deletic, Peter M. Bach 2018, Evaluating the reliability of stormwater treatment systems under various future climate conditions, Journal of Hydrology, 568 (2019) 57-66

Key analysis assumptions and infrastructure requirements
The Northern Wetland potable reuse system requires: • A 1,400 ha (22% imperviousness) catchment with a 100L/s low flow bypass and gravity or pumped diversion with a capacity of 400 L/s. • A gross pollutant trap upstream of the wetland. • Purchase of private land to construct a treatment are reuse system. • Total treatment area of 18,000m^2 consisting of a 1,800m^2 sediment pond and 16,200m^2 wetland. • A wetland with a 300mm permanent pool and 600mm drawdown depth. The wetland requires specialist design and operation, a variable speed pump will control the water level in the wetland and also dictate the residence time (related to treatment). • Storage in the Goldfields and/or Centenary Reservoir. Additional treatment may be required before discharge into either of these storages. Additional risks management will be required at Centenary Reservoir as this storage is part of the existing potable water network. • Advanced treatment prior to reuse, the peak treatment rate is estimated at 3.3 ML/d. • 5900m of 300mm transfer pipework (wetland to Goldfields and/or Centenary Reservoir). • The supply of stormwater for potable reuse = 263 ML/yr.

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$296,452	$3,867
General Infrastructure	Electrics and power	$40,250	$0
General Infrastructure	GPT	$86,834	$1,650
WSUD	Treatment	$1,876,168	$17,684
WSUD	Establishment	$71,180	$0
Additional treatment	Stormwater to potable	$4,347,000	$157,830
Other Items	Item 1: Transfer mains	$3,157,725	$14,453
Other Items	Item 2: Land acquisition	$546,743	$0
Total		**$10,422,351**	**$195,484**

<table>
<tr><th colspan="3">Key Benefits</th></tr>
<tr><th>A resilient water cycle</th><th>Healthy landscapes and environment</th><th>A prosperous community and economy</th></tr>
<tr><td>New water supplies: The scheme would harness 263ML/year of stormwater to support local needs. A new supply of this scale which could be provided at potable standard would defer a potential investment in a connection to the Goldfields Superpipe by an estimated 16 years.
Reduced ‘urban excess’ stormwater flows: Stormwater flowing from urban areas will reduce by 284ML/year by the end of the plan period as it is taken up by the tree, or lost to infiltration.</td><td>Water Quality: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 720kg/year of nitrogen by the end of the plan period.
New green infrastructure: A new wetland will be created in Maryborough north which could be a valued community and ecological asset.
Support of Goldfields Reservoir: The transfer of water to Goldfields reservoir could recharge the waterbody.</td><td>Amenity: The community will benefit from new area of well serviced and attractive wetlands and top-up of Goldfields Reservoir.
Health and well-being: The option will support additional recreational value at Goldfields Reservoir.</td></tr>
</table>

<table>
<tr><th colspan="2">Evaluation</th></tr>
<tr><th>Economic Evaluation</th><th>Scored Evaluation (Total score, range 13-60)</th></tr>
<tr><td>Present Value of Costs: $15,670,883</td><td rowspan="2">60</td></tr>
<tr><td>Benefit Cost Ratio: 0.87</td></tr>
</table>

Box 1: Advances in stormwater reuse

Victoria has become a world leader in the research and development of novel stormwater treatment technologies. Through the Cooperative Research Centre for Water Sensitive Cities (CRCWSC) and other collaborative efforts, local expertise is being brought to the world through projects in the United Kingdom, Israel, Singapore and China. Because of such efforts, stormwater has emerged as a viable alterable water resource that is increasingly being utilised in major urban and rural centres across the State.

The CRC for Water Sensitive Cities is conducting ongoing research to refine existing, and develop novel, stormwater harvesting technologies and thereby build on the proven concepts of Water Sensitive Urban Design (WSUD). Constructed wetlands and bioretention systems are two of the most common WSUD technologies used in Australian stormwater harvesting schemes. There is a strong and growing body of research indicating these systems can reduce a range of stormwater pollutants to meet water quality for a variety of end uses. Real world schemes support these research findings as wetlands are used as the sole treatment technology in several non-potable harvesting schemes and as the primary and secondary treatment element in potable harvesting schemes. Given the strength of existing research and operational schemes these natural treatment systems can provide an appropriate level of primary and secondary treatment as part of the stormwater reuse option.

Table 5.2: Examples of domestic and international stormwater reuse schemes

	End use	Treatment technology	Comments
Blackmans Swamp Creek stormwater reuse Scheme (Australia, NSW)	Potable drinking water.	Runoff is treated by constructed wetlands before mixing with the potable supply prior to secondary treatment in the Council's main water filtration plant (includes ozone treatment to destroy pathogens and Biologically Activated Carbon Filtration to consume the remnants of the compounds destroyed by the ozone).	The stormwater harvesting scheme was established in 2008 and was so successful that it was expanded in 2010. The scheme is expected to supply 35 per cent of Orange Council's typical 5,700 ML annual water usage.
Kalkallo stormwater reuse (Australia, Vic)	Potable drinking water.	Stormwater will be collected on site via conventional drainage systems, treated in a series of wetlands and settling ponds, stored in a dam and then treated to potable standard to supplement the development's recycled water supply.	This scheme is not yet operational, Kalkallo is a 1,200ha industrial precinct slated for construction over the next 10 to 15 years. The project is designed to recover the upfront capital and ongoing operational costs within 25 years.
The 1st National Tap (Singapore)	Potable drinking water.	Stormwater is collected through a comprehensive network of drains, canals, rivers and stormwater collection ponds before it is collected in Marina Bay and directed to Singapore's 17 reservoirs for storage before passing through centralised waterworks for treatment to potable standards (membrane treatment is used at some of these plants).	Singapore one of the few countries in the world to harvest urban stormwater on a large scale for its water supply. Half of Singapore's land area is already part of the potable water supply catchment.
Renaissance Project (USA)	Potable drinking water.	Bar screens, alum and polymer injection, settling basin, wetland, water treatment plant.	An integrated water resource management program for urban runoff in an inner city area that utilises the 'treatment train' method to maximise the effectiveness of stormwater treatment.
Artificial Aquifer Recharge Scheme (South Africa)	Potable drinking water and industrial uses.	Multiple detention and retention basins, low salinity flows are channelled into two large spreading basins for infiltration, higher salinity baseflows are diverted to the coastal basins.	Utilises an urban stormwater collection system in the form of artificial aquifer recharge through infiltration basins.
Parafield stormwater harvesting and managed aquifer recharge (MAR)	Non potable uses including irrigation and industrial	Diversion to detention basins, treatment through wetlands that remove typically 90% of nutrients and bacteria and aquifer injection.	Long established stormwater reuse scheme (since 1999) relying primarily on wetlands for treatment
Troups Creek stormwater reuse and Household Reuse (Australia, Vic)	Toilets and outdoor taps.	Comprehensive treatment system that includes a wetland and stormwater treatment plant. It is expected that this system is somewhat overdesigned for the current end-use and its efficacy is being reduced by high sediment concentrations.	The project is now constructed and is operated by South East Water. Stormwater is supplied to 58 urban allotments via a dual reticulation network.
Royal Park stormwater reuse Project (Australia, Vic)	Irrigation (golf course, sports oval and parkland).	Sediment trap, constructed wetland and UV disinfection.	To minimise human health risks water is spray irrigated at night. The system has a back-up potable mains connection. Two water hydrants are also provided to allow trucks to fill up and use the treated water for irrigation of streetscape features.
City of Brimbank Alternative Water Project (Australia, Vic)	Irrigation (recreational reserves and a golf course)	Gross polluant traps, UV disinfection.	A contemporary and local example of a council and retail water company partnering to own and operate several stormwater harvesting systems.

4.9 Option 9: Raw water transfer to shandy recycled water supply

Description
This option considers the transfer of raw water from Centenary Reservoir to shandy recycled water in the recycled water network. Raw water provides a better source than potable water due to avoided treatment needs, however its use would reduce potable water reserves at the reservoir.

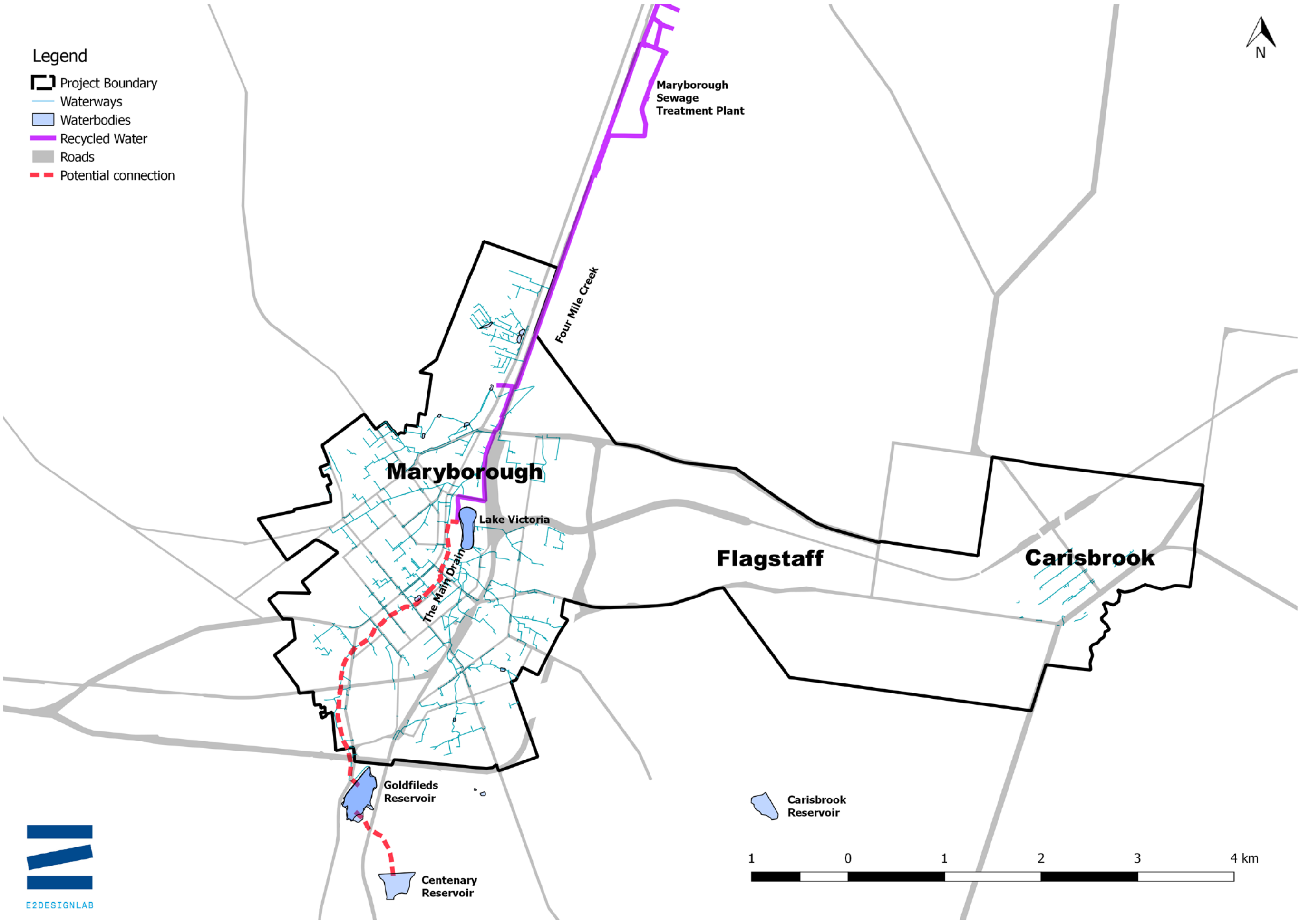


Figure 4.14: Schematic layout of existing infrastructure and potential integration of raw water supply with the recycled water network

Key analysis assumptions and infrastructure requirements
The transfer of raw water would require a new pipeline to be built. The proposal includes a transfer pipe along the alignment of the Main Drain to join the recycled water network via a mixing tank. The transfer of raw water would

enable sustainable long-term use of recycled water by reducing salinity, but it would also deplete potable water resources for the area.

Cost summary			
Item	**Capital Cost ($)**	**Operating Cost ($/yr)**	**Renewal ($)**
Transfer pipeline	$ 1,329,411	$ 6,473	None in plan period

Key Benefits		
A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Supporting sustainable recycled water use**: By using raw water as a source for shandying recycled water it will enable ongoing use of recycled water for irrigation.		

Evaluation	
Economic Evaluation	**Scored Evaluation (Total score, range 13-60)**
Present Value of Costs: $1,165,580	13
Benefit Cost Ratio: 0.41	

5. **Setting a Way Forward:** Recommendations and Implementation Plan

5.1 Overarching partnerships to support delivery of IWM projects

Integrated water management projects often deliver multiple outcomes (5.1) and accordingly require collaboration between multiple parties to establish governance models, delivery mechanisms and funding and delivery approaches.

Figure 5.1: Multiple benefits of Integrated Water Management

Through the development of this Plan, key delivery partners and stakeholders have come together. A regional IWM forum has been established for the Central Highlands Region which can support delivery of IWM projects in the Maryborough Area. To implement the recommended projects, the implementation plan sets out key tasks that need to be taken forward, timelines and key delivery partners.

In addition to project based responsibilities, research demonstrates that there are five key transition factors required to stimulate the governance and delivery conditions needed to support IWM projects. These include:

1. Champions
2. Tools and instruments
3. Platforms for connecting
4. Knowledge
5. Projects and application.

Stakeholders at the second workshop were asked to rate the collective capacity of the Maryborough community against these five transition factors, as shown in Figure 5.2.

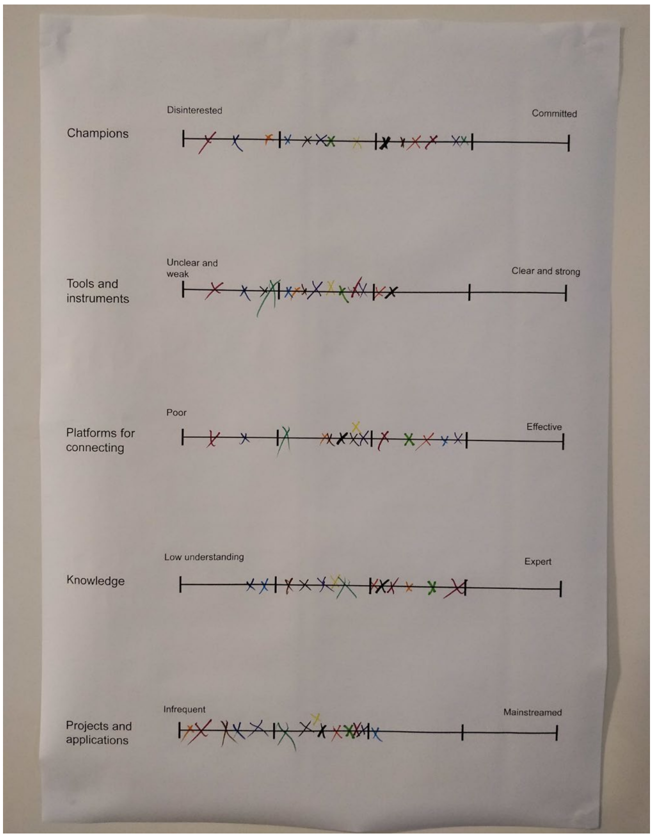


Figure 5.2: Results of the perceived performance of the Maryborough community and associated organisations against the 5 factors required to deliver IWM

The exercise shows there are mixed perspectives on Maryborough's position for all factors, but there was consensus that there is room for improvement in all areas.

Champions – The mixed rating here is probably indicative of the presence of active champions for IWM in some organisations and in parts of the community, but which aren't apparent in others. A more defined and active IWM network would help to coordinate efforts and to promote initiatives both internally in organisations and externally. An IWM practitioner group became active in 2018 as part of the IWM Forum process, and this could be established more formally to provide support and interaction between IWM champions in the region.

Tools and Instruments – This factor received a poor rating overall, indicating that more support tools and instruments such as investment, policy and delivery mechanisms are needed to support IWM in the area. While Water for Victoria provides guidance on IWM, it does not strictly require it to be undertaken. The split management responsibilities for the different streams of water may also contribute to the uncertainty. Tailored tools for regional towns and further capacity building in the area would be of benefit.

Platforms for Connecting - Communication processes were generally considered adequate but could be improved. The range in the scores again shows the wide range of stakeholders involved in IWM, and the challenges in providing effective means of collaboration. The establishment of the IWM Forum provides a platform for connecting organisations at a leadership and practitioner level, but initiatives are needed to also enhance community involvement in this area.

Knowledge - Perceptions of knowledge required for IWM were relatively more positive, suggesting a good base of understanding and skills in the area. Further development is still indicated, and could be consolidated through training programs with organisations such as Clearwater. Cross-organisational knowledge sharing networks may also be effective between local councils in the region.

Projects and Application – The delivery of on-ground IWM projects was perceived to be somewhat lacking. From discussion, there seemed to largely be a feeling that not enough was being delivered due to funding and implementation challenges. This Plan provides the basis for business cases for delivery of a range or projects and sets out an implementation plan to assist with the delivery of recommended projects.

5.2 Recommended IWM projects from option analysis

Based on the analysis and evaluation undertaken during the development of this plan a set of projects have been recommended for delivery.

The figure below presents both the results of both the economic evaluation (x-axis) and the scored evaluation (y-axis) in a comparative graph. By comparing both evaluations, we can determine which projects may have greater benefits than those recognised through a monetised economic analysis. This is particularly useful where the benefit-cost ratio of an option is less than 1, to give a clear articulation of the benefits which are perhaps not well appreciated by the economic analysis which could underpin a holistic business case for investment.

The two dashed red lines are used as comparison lines that divide the graph into four quadrants. These lines are ‘moveable’ based on the consensus of stakeholders regarding an acceptable performance. For the purposes of comparison, the scored benefit threshold is currently set at a score of 29 and the benefit-cost ratio threshold is set at 0.8. Projects in the top right-hand quadrant are justifiable in both analyses, while those in the left bottom quadrant could be justifiably dismissed from further investigation. Those in the other quadrants require further reasoning and clear reasons to be taken forward.

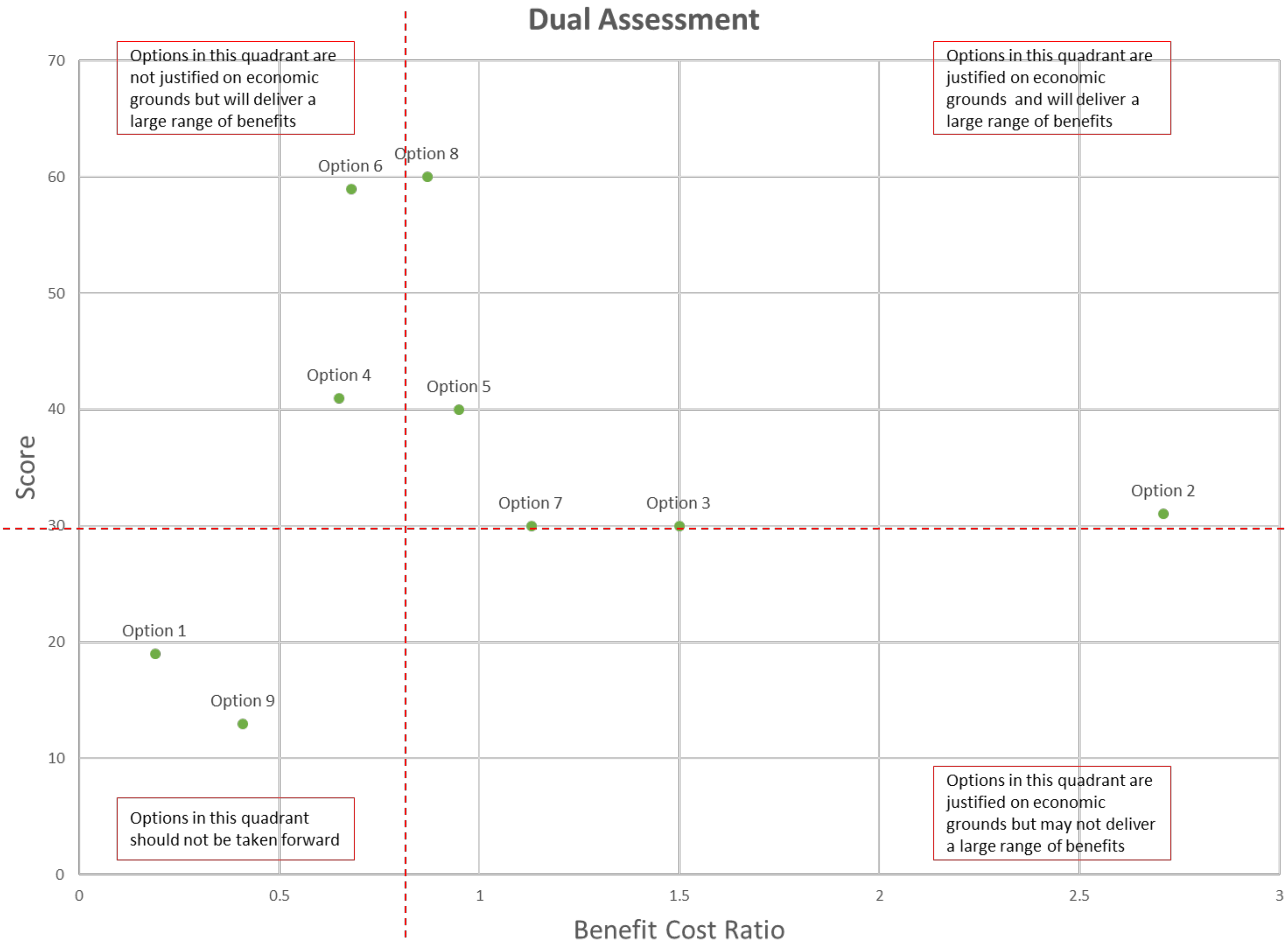


Figure 5.3: Comparison of option performance in an economic evaluation and a score evaluation

Based on this dual assessment, the following options have been taken forward into the recommendations and implementation plan:

Options 2 and 3: Stormwater-fed street trees in both new development areas and the commercial area of Maryborough demonstrated a very strong economic performance due to the multiple benefits they can return to the community.
Option 5: The stormwater harvesting scheme for station domain demonstrated a good economic business case while also showing benefit as a ‘ready-to-go’ project which could be delivered alongside other enhancements to station domain to deliver immediate community benefits.

Options 7 and 8: The creation of new wetland in the north of Maryborough to treat harvested stormwater from the main drain has been shown to be a viable project to ensure that recycled water can be used sustainably through a shandy arrangement (Option 7). Attachment 7 shows there are options to substantially reduce the cost of Option 7, which will further increase its attractiveness as an option. While this option is cost neutral with the base case, it also unlocks the opportunity to harness stormwater as a major new resource for the town, with the opportunity to deliver a cross-town transfer to Goldfields Reservoir and Centenary Reservoir in the future (Option 8).
Options 4 and 6: While the economic evaluation didn't provide justification for introduction of a wetland for Lake Victoria in monetary terms, the evaluation is unable to fully appreciate the potential social and environmental benefits of such a project. The scored evaluation recognised a much higher potential for the proposal, particularly when treated stormwater from the lake was utilised for irrigation of nearby green spaces (Option 6). The improvement of Lake Victoria was viewed by stakeholders and community representatives as a key priority for the area in workshops held for this project. Accordingly, further investigation of this option is recommended.

5.3 Recommended ongoing work to support IWM

While this Plan has identified and considered a range of IWM options in detail, there are also a number of water management initiatives which are already underway or have previously been identified as being required to support the local community and environment. It is recommended that these initiatives (summarised below) are taken forward, and key actions have been included in the Implementation Plan.

5.3.1 Flood management

The Carisbrook Flood Study (2013) recommended a range of actions to be taken to improve flood management in the Carisbrook area. Many of these actions have already been completed, and planned works to manage overland flows from the South West of Carisbrook have been partly progressed, with planned implementation by 2020.

The development of a Flood Management Plan for Maryborough is about to commence, this will identify key actions and recommendations for improvement of flood management in the area. Central Goldfields Shire Council is also investigating planning controls which can be put in place to appropriately manage development in areas with significant flood risk.

5.3.2 Waterway Management Plan for Tullaroop Creek

As identified in the Central Highlands IWM Forum Strategic Directions Statement, a waterway management plan for Tullaroop Creek is needed to understand and plan improvements to the Creek from a catchment perspective; understanding pressures and objectives for the creek relating to ecological health, flood management, water supply and recreational opportunities. The Plan can also consider flows to the creek and improvements to the public waterway reserve adjacent to Tullaroop Creek in Carisbrook.

5.3.3 Litter management

Litter has been identified as a key water quality issue of concern for the communities of Maryborough and Carisbrook. It is recommended that both physical interventions, such as gross pollutant traps, and operational programs, such as targeted consultation and education along with clean-up activities, are considered to develop a plan for litter management.

5.3.4 Improvement of the reliability of the existing Class C recycled water supply to the Maryborough Golf Club and Princess Park precinct

Central Highlands Water supplies recycled water from the Maryborough Wastewater Treatment Plant to the Central Goldfields Shire Council for irrigating grass playing surfaces at Princess Park and the Maryborough Golf Club.

While fit-for-purpose Class C recycled water provides a valuable and cost effective alternative to potable water for irrigation, from time to time the supply of recycled water is interrupted due to outbreaks of algae in the recycled water storage lagoons. Unfortunately, blooms most often occur in the warmer months, when reliance on recycled water for irrigation is at its highest.

During periods of interruption, Central Highlands Water works closely with reclaimed water customers to provide access to potable water as a short term alternative. This however comes at an additional cost and increases demand on Maryborough's drinking water resources.

To ensure fit for purpose recycled water remains available to meet the needs of the Maryborough community, CHW is pursuing several opportunities to reduce impact of algae on the reliability of the recycled water supply. These include:

- A new solar mixer has been installed in the recycled water storage lagoon at the Maryborough Wastewater Treatment Plant. The solar mixer will help to prevent the onset of algae blooms by slowly mixing the water to avoid the conditions preferred by problem algae.

- Changes to Maryborough's customer base together with the adoption of water wise behaviour has seen the volume of wastewater entering the Maryborough Wastewater Treatment Plant reducing over time. This has had the effect of increasing the residence time of recycled water within the storage lagoons. CHW is investigating the opportunity to shorten the residence time, thereby reducing the opportunity for problem algae blooms to occur.
- CHW is also reviewing a range of commercial products for their potential to assist with preventing problem algae blooms. Some examples include:
    - Additives designed to naturally increase the water's resilience to algae blooms,
    - Electronic equipment that generates ultrasound to disrupt the growth of algae; and
    - Chemical algaecides.

5.3.5 Availability of water for Goldfields Reservoir

The Goldfields Reservoir is situated downhill and approximately 600m north west of Central Highlands Water's Centenary Reservoir. Both are connected via an open stormwater channel.

The Centenary Reservoir is capable of receiving raw water supplied from Tullaroop Reservoir, Talbot Reservoir, Evansford Reservoir and the Moolort groundwater bores.

The connectivity that exists between the various reservoirs has been used previously to transfer raw water from the Tullaroop Reservoir into Goldfields Reservoir. In 2015, Central Highlands Water undertook improvement works on the open channel to increase the effectiveness of overground water transfers into Goldfields Reservoir.

Conditionally upon the availability of third party raw water entitlements and agreed commercial terms, the Central Highlands Water raw water network has the capability of transferring raw into the Goldfields Reservoir.

5.4 Implementation Plan

Six major IWM initiatives are recommended for the Maryborough area:

7. **Creating governance and delivery structures to support IWM**
8. **Harnessing stormwater for healthier street trees**
9. **Greening station domain as a key community asset**
10. **Creating a resilient and local alternative water supply network**
11. **Improving Lake Victoria for recreation and amenity**
12. **Continual improvement of waterways and flood management**

A set of actions are recommended for each initiative below, with a suggested timeframe and delivery partners attributed to each. Note that the timeline is indicative and subject to resourcing and planning by the relevant authorities.

Table 5.1: Implementation Plan

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Creating governance and delivery structures to support IWM		
Create a governance group between the partners of this plan to implement and monitor the actions in this Plan. This should be done in coordination with other regional governance groups such as the IWM Forum.	Short term (1-5 years)	Central Goldfields Shire Council, Central Highlands Water, North Central Catchment Management Authority
In addition to the project-focused actions below, the governance group should identify and implement opportunities to support the delivery of IWM in the Maryborough area by: • Identifying funding and grant options to support delivery of IWM • Fostering and supporting IWM champions • Developing tailored IWM tools and supporting capacity building to improve skills and knowledge in the area • Improving and creating platforms to connect and collaborate – within and between organisations and with the community.	Short term (1-5 years)	Central Goldfields Shire Council, Central Highlands Water, North Central Catchment Management Authority

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Harnessing stormwater for healthier street trees		
Develop detailed designs for integration of passively irrigated trees in: a. New development areas b. Central commercial / highly trafficked areas (retrofit) c. Town entrances	Short term (1-5 years)	Central Goldfields Shire Council
Secure capital funding to include passive irrigation in planned tree retrofits in Central Maryborough	Short term (1-5 years)	Central Goldfields Shire Council
Include requirements and guidance for inclusion of passively irrigated street trees in infrastructure and landscape design manuals.	Short term (1-5 years)	Central Goldfields Shire Council
Review Central Goldfield Shire Council's street tree planting guidance to ensure tree species selected provide amenity and ecological value while also being compatible with future climates, compatible with passive irrigation (wet and dry tolerance) and which offer large canopy growth.	Short term (1-5 years)	Central Goldfields Shire Council
Link designs and learnings with the Green-Blue Infrastructure Guidance for small towns (Central Highlands IWM Forum Strategic Directions Statement Priority Project)	Short term (1-5 years)	Central Goldfields Shire Council, Central Highlands Chamber of Councils
Greening Station Domain as a key community asset		
Include raingarden and stormwater harvesting system in future master planning of Station Domain.	Short term (1-5 years)	Central Goldfields Shire Council, Committee for Maryborough, Dja Dja Wurrung
Determine if water storage can be accommodated as an above ground tank at the depot site or if an underground tank is required under or near the domain.	Short term (1-5 years)	Central Goldfields Shire Council
Assemble details into business case for investment (as both a council investment and a potential application for grant funding)	Short term (1-5 years)	Central Goldfields Shire Council, Committee for Maryborough, Dja Dja Wurrung

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Complete detailed design for stormwater harvesting scheme and construct scheme	Medium term (5-10 years)	Central Goldfields Shire Council, Dja Dja Wurrung
Creating a resilient and local alternative water supply network		
Continue monitoring of salinity levels of recycled water	Short term (1-5 years)	Central Highlands Water
Conduct monitoring of salinity levels of stormwater in the main drain to determine required shandy ratio of stormwater to recycled water to achieve desired salinity	Short term (1-5 years)	Central Highlands Water, Central Goldfields Shire Council
Reduce risk of algal blooms in treated wastewater lagoons at Maryborough Wastewater Treatment Plant to improve reliability of supply of recycled water	Short term (1-5 years)	Central Highlands Water, Central Goldfields Shire Council, Maryborough Golf Club
Complete detailed design of wetland and stormwater harvesting system at either the Wastewater Treatment Plant or a selected site in Northern Maryborough	Short term (1-5 years)	Central Highlands Water, Central Goldfields Shire Council, Dja Dja Wurrung, Goulburn Murray Water, North Central Catchment Management Authority
Construct and establish connection of harvested stormwater to existing recycled water network with appropriate mixing to shandy supply	Short term (1-5 years)	Central Highlands Water, Central Goldfields Shire Council, Maryborough Golf Club
Collaborate to enable transfers of raw water from Centenary Reservoir to Goldfields Reservoir to maintain levels in priority periods (subject to availability and commercial arrangements).	Short term (1-5 years)	Central Highlands Water, Central Goldfields Shire Council, Maryborough Water Ski Club Inc

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Investigate medium-long term utilisation of large-scale stormwater harvesting to contribute to raw water supplies and supplement Goldfields Reservoir. This can be considered alongside other available medium-long term supplementary potable water supplied for the Maryborough area including groundwater and a connection to the Goldfields Superpipe. Advances in stormwater reuse and potential regulatory support for such an option should be reviewed on an ongoing basis. Box 1 provides a summary of existing examples of large scale stormwater reuse.	Medium term (5-10 years)	Central Highlands Water, Central Goldfields Shire Council, Dja Dja Wurrung, Goulburn Murray Water, North Central Catchment Management Authority, Maryborough Golf Club
Improving Lake Victoria for recreation and amenity		
Bolster and expand business case for the improvement of the Lake through community surveys, assessment of cultural value and more detailed investigations.	Short term (1-5 years)	Central Goldfields Shire Council, Dja Dja Wurrung, Committee for Maryborough
Seek funding for lake improvement including construction of a wetland.	Short term (1-5 years)	Central Goldfields Shire Council, Dja Dja Wurrung, Committee for Maryborough, North Central Catchment Management Authority
Conduct a community co-design exercise for the lake and its surroundings.	Medium term (5-10 years)	Central Goldfields Shire Council, Dja Dja Wurrung, Committee for Maryborough
Continual improvement of waterways and flood management		
Complete actions identified in the Carisbrook Flood Study to manage flood risk	Short term (1-5 years)	North Central Catchment Management Authority, Central Goldfields Shire Council

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Complete the Maryborough Flood Management Plan	Short term (1-5 years)	North Central Catchment Management Authority, Central Goldfields Shire Council
Explore opportunities to enhance the Main Drain corridor to promote walking and cycling and increase tree cover and amenity	Medium term (5-10 years)	Central Goldfields Shire Council
Develop a Waterway Management Plan for Tullaroop Creek (Central Highlands IWM Forum Strategic Direction Statement Priority Project)	Short term (1-5 years)	North Central Catchment Management Authority, Central Goldfields Shire Council, Central Highlands Water, Goulburn Murray Water, Dja Dja Wurrung
Continue delivery of stormwater management measures to improve waterways including litter management and water sensitive urban design	Ongoing	Central Goldfields Shire Council, North Central Catchment Management Authority

Attachment 1 – Stakeholder engagement

Two stakeholder workshops were held as part of the development of this plan. The first workshop considered the vision and objectives for the plan and possible IWM options. The second workshop considered the IWM options which had been analysed and key delivery opportunities and barriers. The following tables summarise the invited stakeholders and those which attended.

Table A1: Workshop 1 Invitees and Attendees

Invited	**Attended**
Highview College	Highview College
Central Goldfields Shire	Central Goldfields Shire
Maryborough Golf Club	Maryborough Golf Club
Goldfields Sustainability Group	Goldfields Sustainability Group
Maryborough Water Ski Club Inc	Maryborough Water Ski Club Inc
North Central CMA	North Central CMA
Central Highlands Water	Central Highlands Water
Bucknall & Gowers Real Estate	
Colts Phelans Cricket Club Inc	
Maryborough City Soccer Club	
Maryborough Netball Association	
Maryborough Angling Club	
Maryborough Football Netball Club	
Goulburn Murray Water	

True Foods	
Maryborough Education Centre	
St. Augustine’s	
Novo (Vic) Pty Ltd	
Sonac Australia Pty Ltd	
Havilah Hostel Inc	
Leshway Pty Ltd & M & T Smits Pty Ltd	
Carisbrook Racecourse	
McPherson's Printing Pty Ltd	
Ian & Wendy Mortlock	
Maryborough Fire Brigade	
Maryborough Midlands Historical Society	
St Lukes Anglicare	
Mitre 10 and CRT	
Maryborough Rotary Club	
Maryborough District Health Service	
First National Real Estate Maryborough	
Carramar Nurseries	
Goldfields Group of Fire Brigades	
Loraine Fitzpatrick	

Table A2: Workshop 2 Invitees and Attendees

Invited	Attended
True Foods	True Foods
Central Goldfields Shire	Central Goldfields Shire
Maryborough Golf Club	Maryborough Golf Club
Goldfields Sustainability Group	Goldfields Sustainability Group
Maryborough Water Ski Club Inc	Maryborough Water Ski Club Inc
Dja Dja Wurrung	Dja Dja Wurrung
Sonac Australia Pty Ltd	Sonac Australia Pty Ltd
Maryborough Midlands Historical Society	Maryborough Midlands Historical Society
North Central CMA	North Central CMA
Central Highlands Water	Central Highlands Water
Maryborough Netball Association	
Maryborough Angling Club	
Maryborough Football Netball Club	
Goulburn Murray Water	
Bucknall & Gowers Real Estate	
Maryborough Education Centre	
St. Augustine's	
Novo (Vic) Pty Ltd	
Colts Phelans Cricket Club Inc	
Havilah Hostel Inc	
Leshway Pty Ltd & M & T Smits Pty Ltd	
Carisbrook Racecourse	

McPherson's Printing Pty Ltd	
Ian & Wendy Mortlock	
Maryborough Fire Brigade	
Maryborough City Soccer Club	
St Lukes Anglicare	
Mitre 10 and CRT	
Maryborough Rotary Club	
Maryborough District Health Service	
First National Real Estate Maryborough	
Carramar Nurseries	
Goldfields Group of Fire Brigades	
Loraine Fitzpatrick	
Highview College	

Attachment 2 – Preliminary Assessment

Please refer to an electronic copy of this report to zoom in on text.

Source	Option	Applicability yes/no	Site	Reason/Comment	Objective theme 1 Resilient Water Cycle Quantifiable ML/Year of potable water replacement	Objective theme 2 Healthy Landscapes and Environment Quantifiable kg/year of nitrogen removed from waterway	Objective theme 2 Healthy Landscapes and Environment Quantifiable ML/year of alternative water provided for recreation, productive uses or amenity	Objective theme 3 Prosperous Community and Economy Quantifiable New amenity/productive areas created (ha)	Objective theme 3 Prosperous Community and Economy Quantifiable Potential for community engagement / education (people)	Key Cost Factors (A: Advantage, D: Disadvantage)	Risk review
PO	Water supply leakage reduction	No		Basecase							
PO	Advanced water efficient practices - outdoor	No		Basecase							
PO	Advanced water efficient practices - buildings	No		Basecase							
GW	Groundwater harvesting for open space irrigation	No	Carisbrook	Not recommended - salinity and strained resource							
GW	Groundwater harvesting for non-potable uses in buildings	No	Carisbrook	Not recommended - salinity and strained resource							
GW	Groundwater harvesting for supplementary potable supply	No		Basecase							
GW	Groundwater harvesting for agricultural irrigation	No		Not recommended - salinity and strained resource							
RW	Rainwater harvesting for garden irrigation	No	Existing development	Basecase (high uptake of rainwater tanks in existing properties)							
RW	Rainwater harvesting for garden irrigation	Yes	New developments	Possible policy position	28	76	28		3181	A. Common technology A. Implementable by policy A. Water supply augmentation	Low
RW	Rainwater harvesting for garden or open space irrigation	No	Maryborough Educational Centre	Large roof area, site dominated by synthetic open spaces, not a current top ten potabel water user (~5ML/yr), tanks already on site.							
RW	Rainwater harvesting for garden or open space irrigation	No	Marborough District Health Service	Large roof but marginal scheme: private property + uncertain NP demands + elevated health risks + limited space available							
RW	Rainwater harvesting for garden or open space irrigation	No	Havilah Hostel (Retirement Home)	Large roof but marginal scheme: private property + uncertain NP demands + elevated health risks + existign tanks on site							
RW	Rainwater harvesting for garden or open space irrigation	No	Carisbrook Primary School	Collectively large roof area but fragmented and only one oval to irrigate.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Existing developments - residential	Basecase (high uptake of rainwater tanks in existing properties)							
RW	Rainwater harvesting for non-potable uses in buildings	Yes	New developments - residential	Possible policy position	36	99	-		3181	A. Common technology A. Implementable by policy A. Water supply augmentation	Low
RW	Rainwater harvesting for non-potable uses in buildings	No	Maryborough Sports & Fitness Centre	Large roof area but not a current top ten water user.							
RW	Rainwater harvesting for non-potable uses in buildings	No	True Foods	Large roof but marginal scheme: private property + uncertain NP demands							
RW	Rainwater harvesting for non-potable uses in buildings	No	Vault Self Storage	Large roof area but not a current top ten water user.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Sutton Tools PTY Ltd	Large roof area but not a current top ten water user.							
RW	Rainwater harvesting for non-potable uses in buildings	No	McPhersons Printing Group	Large roof area but not a current top ten water user and existing tanks on site.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Marborough District Health Service	Large roof but marginal scheme: private property + uncertain NP demands + elevated health risks + limited space available							
RW	Rainwater harvesting for non-potable uses in buildings	No	Maryborough Educational Centre	Large roof area, site dominated by synthetic open spaces, not a current top ten potabel water user (~5ML/yr), tanks already on site.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Goldfields Shopping Centre	Large roof area but not a current top ten water user and very space constrained.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Havilah Hostel (Retirement Home)	Large roof but marginal scheme: private property + uncertain NP demands + elevated health risks + existign tanks on site							
RW	Rainwater harvesting for non-potable uses in buildings	No	Carisbrook Primary School	Collectively large roof area but fragmented and site not a current top ten potable water user (<1.5ML/yr).							
RW	Rainwater harvesting for non-potable uses in buildings	No	Southern Cross Feeds	Large roof area but not a current top ten water user.							
RW	Rainwater harvesting for non-potable uses in buildings	No	Bryan Perry Pty Ltd	Large roof area but not a current top ten water user and multiple downpipes/roof structures.							
RW	Rainwater harvesting for hot water use in buildings	No	Existing developments - residential	Basecase (high uptake of rainwater tanks in existing properties)							
RW	Rainwater harvesting for hot water use in buildings	Yes	New developments - residential	Possible policy position	63	171	63		3181	A. Implementable by policy A. Water supply augmentation D. Complex plumbing D. Third party monitoring	High
RW	Rainwater harvesting for potable water use in buildings	No	Existing developments - residential	Basecase (high uptake of rainwater tanks in existing properties)							
RW	Rainwater harvesting for potable water use in buildings	No	New developments - residential	Regulatory barriers							
RW	Rainwater intercepted by green roofs	No	Hospital redevelopment?	No clear opportunities for planned new large roofs in strategic locations							
SW	Stormwater managed by vegetated device on-lot	Yes	New developments	Possible policy position		112	-	0.149	3181	A. Implementable by policy D. Uncommon element to deliver at small scale D. Householder maintenance	High
SW	Stormwater managed by vegetated device on-lot	Yes	Existing developments	Retrofit program		6	-	0.009	9123	D. Uncommon element to deliver at small scale D. Householder maintenance	High
SW	Stormwater managed by vegetated device in streets/carparks	Yes	New developments	Possible policy position		420	67	12	3181	A. Implementable through policy/design standards A. Inclusion with road construction	Low
SW	Stormwater managed by vegetated device in streets/carparks	Yes	Existing streets - town centre greening focus / road renewals	Passive irrigation / WSUD introduced with tree planting		57	9	1.575	12304	A. Planned works to introduce trees D. Possible design constraints	Low
SW	Stormwater managed by vegetated device in streets/carparks	Yes	Existing streets - retrofit	Retrofit into streets		57	9	1.575	615	D. Retrofit required D. Possible design constraints	Low
SW	Stormwater managed by vegetated device in streets/carparks	Yes	Clustered carparks of Woolworths, Maryborough Tyre Service, ALDI, Mitre10, Goldfields shopping centre, McDonalds	Permeability mitigate urban island and reduce SW generation		20	1	0.0252	12304	D. Retrofit required D. Possible design constraints	Low
SW	Stormwater managed by vegetated device in open space	No	New developments	Base case							
SW	Stormwater managed by vegetated device in open space	Yes	Bottom of Green St	Treatment of stormwater before release to creek in Carisbrook		24	-	0.03	500	A. May be an opportunity for gravity diversion D. Connection of multiple drains	Medium
SW	Stormwater managed by vegetated device in open space	Yes	Carisbrook Recreation Reserve			7	-	0.02	500	D. Lengthy inflow pipe	Medium
SW	Stormwater managed by vegetated device in open space	Yes	Jack Pascoe Reserve + Frank Graham Reserve			30	-	0.04	500	D. Diversion in road way	Low
SW	Stormwater managed by vegetated device in open space	Yes	JH Hedges Oval			29	-	0.04	500	D. Not Council land? D. Difficult diversion	Medium
SW	Stormwater managed by vegetated device in open space	Yes	MKM Oval / Ron Sinclair Reserve			76	-	0.09	500	A. Adjacent to Bet Bet Creek	Medium
SW	Stormwater managed by vegetated device in open space	Yes	Peel Street Oval + Cal Gulley Reserve			65	-	0.4	500	A. Adjacent to Drain	Low
SW	Stormwater managed by vegetated device in open space	Yes	Station Domain	Large open space, potential diversion of SW drain		97	-	0.6	12304	A. Adjacent to Drain	Low
SW	Stormwater managed by vegetated device in open space	Yes	Lake Victoria	Wetland to improve quality of SW entering Lake Victoria		460	-	2.7	12304	A. Economy of scale due to large treatment + catchment D. Retrofit required	Medium
SW	Stormwater managed by vegetated device in open space	Yes	Four Mile Creek near Whirrakee Dr	Treat stormwater in Maryborough North		320	-	2.0	500	A. Economy of scale due to large treatment + catchment D. Land acquisition D. Difficult diversion	High

SW	Stormwater managed by vegetated device in open space	No	Phillips Gardens	Limited / contested space							
SW	Stormwater managed by non-vegetated device on-lot	No		Vegetated options first preference for multiple benefits							
SW	Stormwater managed by non-vegetated device in streets/carparks	No		Vegetated options first preference for multiple benefits							
SW	Stormwater managed by non-vegetated device in open space	No		Vegetated options first preference for multiple benefits							
SW	Stormwater managed by detention device on-lot	No		Not recommended - significant flooding issues not due to intensification of urban areas							
SW	Stormwater managed by detention device in streets/carparks	No		Not recommended - significant flooding issues not due to intensification of urban areas							
SW	Stormwater managed by detention device in open space	No	New developments	Base case							
SW	Stormwater managed by detention device in open space	No	Carisbrook flood management works	Base case							
SW	Stormwater managed by detention device in open space	No	Maryborough South flood management works	Base case - detention basin has been included in Golf Course							
SW	Treated stormwater distributed to evapotranspiration fields	No		Lack of flow sensitive waterways to warrant option							
SW	Treated stormwater distributed to environmental flows in waterway	Yes	Tullaroop Creek	To be defined with Camille							
SW	Stormwater harvesting for open space irrigation/water feature	No	Lake Victoria	Base case							
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Carisbrook Recreation Reserve	Catchment too small, estimated demand 12 ML/yr	-	29	6	0.02	500	D. Lengthy inflow pipe D. New irrigation infrastructure	Medium
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Jack Pascoe Reserve + Frank Graham Reserve	Potential diversion of SW drain, Jack Pascoe is currently irrigated, potable demand = 4.6 ML/yr, estimated demand = 6.3 ML/yr. Frank Graham is not irrigated, estimated demand = 8.4 ML/yr	7	36	7	0.04	500	D. Diverison in road way	Low
SW	Stormwater harvesting for open space irrigation/water feature	Yes	JH Hedges Oval	Potential diversion of SW drain. Currently irrigated, estimated demand = 9.3 ML/yr.	5	34	5	0.04	500	D. Not Council land? D. Difficult diversion	Medium
SW	Stormwater harvesting for open space irrigation/water feature	Yes	MKM Oval / Ron Sinclair Reserve	Potential diversion of SW drain. Not currently irrigated, estimated demand = 7.6 ML/yr.		83	6	0.09	500	A. Adjacent to Bet Bet Creek D. New irrigation infrastructure	Medium
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Peel Street Oval + Cal Gulley Reserve	Potential diversion of SW drain. Both not irrigated, Peel Street = 7.2 ML/yr, Cal Gulley = 6.0ML/yr.		76	9	0.4	500	A. Adjacent to Drain D. New irrigation infrastructure	Low
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Station Domain	Potential diversion of SW drain. Station Domain estimated demand = 5.0 ML/yr. Depot exisitng potable demand = 6.5 ML/yr potable demand, some rainwater tanks already installed.	4	108	8	0.6	12304	A. Adjacent to Drain	Low
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Lake Victoria	Transfer from victoria park to goldfields. Esitmated demand = 25ML/yr (5ha, 0.5m difference btw evaptran and rainfall.		470	13	2.7	12304	A. Economy of scale due to large treatment + catchment A. 50mm drawdown allows for 13ML supply => no storage costs. D. Lengthy pipe mains D. Retrofit required	Medium
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Four Mile Creek near Whirrakee Dr for Golf Club	Currenlty connected to recycled water network. Treat at Burns St.	11	340	11	2.0	500	A. Economy of scale due to large treatment + catchment D. Land acquisition D. Difficult diversion	Medium
SW	Stormwater harvesting for open space irrigation/water feature	Yes	Phillips Gardens	Potential diversion of SW drain. Currently irrigated, potable demand = 7.6 ML/yr, estimated demand = 11.4 ML/yr.	9		9		12304	A. Adjacent to Bet Bet Creek D. Retrofit required	Medium
SW	Stormwater harvesting for open space irrigation/water feature	No	Princes Park	Currenlty connected to recycled water network.							
SW	Stormwater harvesting for non-potable uses in buildings	No	Maryborough Sports & Fitness Centre	Potential diversion of SW drain, 4.2 ML/yr potable demand. Small internal demand.							
SW	Stormwater harvesting for non-potable uses in buildings	No	Marborough District Health Service	Potential diversion of SW drain, 13.1 ML/yr potable demand							
SW	Stormwater harvesting for supplementary potable supply	Yes	Harvest from Lake Victoria and distribution to goldfields then centenery		200		200	2.70	12304	A. Large buffer storages D. Lengthy pipe mains D. Complex diversion D. 900 L/s pump	Medium
SW	Stormwater harvesting for supplementary potable supply	Yes	North Maryborough harvest and transfer to Centenery via goldfields		400		400	4.00	12304	A. Large buffer storages D. Lengthy pipe mains D. Complex diversion D. 2000 L/s pump	Medium
SW	Stormwater harvesting for agricultural irrigation (greenhouses)	Yes	Assuming greenhouses within or near study area	Agricultural demands to be confirmed	48	130	48	5	100	D. Land need D. Quality may not be suitable without potable standard treatment	Medium
SW	Stormwater harvesting for agricultural irrigation (land)	Yes	Irrigation land to the north	Agricultural demands to be confirmed		542			20	A. Quality suitable for irrigation D. Potentially high cost to get it into a useable location D. Storage needed to buffer supply and demand near irrigation areas	Medium
WW	Wastewater managed by class B treatment device	No		As 100% WW not discharged to waterway, treatment upgrades considered based on reuse							
WW	Wastewater managed by class A treatment device	No		As 100% WW not discharged to waterway, treatment upgrades considered based on reuse							
WW	Treated wastewater distributed to lake or water feature	Yes	Lake Victoria	Potential connection to RW pipe as top up			15		12304	D. Class A & nutrient removal and biosolids mgt $$$	High
WW	Treated wastewater distributed to lake or water feature	Yes	Phillips Gardens	Potential connection to RW pipe. Estimated demand 11.4ML/year to fill lake	11.4		11.4		12304	D. Class A & nutrient removal and biosolids mgt $$$	High
WW	Treated wastewater distributed to lake or water feature	Yes	Goldfields Reservoir	Potential connection to RW pipe. Esitmated demand = 25ML/yr (5ha, 0.5m difference btw evaptran and rainfall.			25		12304	D. Class A & nutrient removal and biosolids mgt $$$	High
WW	Treated wastewater distributed to land	No		Base case							
WW	Treated wastewater distributed to evapotranspiration fields	No		Considered same as land							
WW	Treated wastewater distributed to environmental flows in waterway	No		Discharge of wastewater to waterways not compliant with EPA conditions							
WW	Treated wastewater harvesting for open space irrigation	No	Maryborough Golf Course	Base case							
WW	Treated wastewater harvesting for open space irrigation	No	Princes Park	Base case							
WW	Treated wastewater harvesting for open space irrigation	Yes	Extension to food cluster	Branch off exisitng. Estimated demand 4ML/year			4	1	500	D. High cost of infrastructure for small demand D. Salinity issues D. Some demand currently unirrigated	Medium
WW	Treated wastewater harvesting for open space irrigation	Yes	Extention to station domain	Branch off exisitng. Estimated demand 5ML/year			4	1	12304	D. High cost of infrastructure for small demand D. Salinity issues D. Some demand currently unirrigated	Medium
WW	Treated wastewater harvesting for open space irrigation	Yes	California Gully Recreation Reserve (6ML, currently unirrigated), Peel Street Reserve (7.3ML, currently unirrigated), Education Precinct (perhaps 15ML, currently unirrigated, may be synthetic)	Recycled water ring main - phase 1			28.3	3	1000	D. High cost of infrastructure for small demand D. Salinity issues D. Some demand currently unirrigated	Medium
WW	Treated wastewater harvesting for open space irrigation	Yes	Velodrome (6ML, currently unirrigated), MKM oval (7.6ML currently unirrigated), Hedges Oval (9.3ML irrigated)	Recycled water ring main - phase 2	9.3		22.9		1000	D. High cost of infrastructure for small demand D. Salinity issues D. Some demand currently unirrigated	Medium
WW	Treated wastewater harvesting for open space irrigation	Yes	Highview college (4ML, currently partially irrigated (1.1)), pascoe reserve (6.3, irrigated), frank graham oval (8.4, currently unirrigated)	Recycled water ring main - phase 3	6.3		15.8		1000	D. High cost of infrastructure for small demand D. Salinity issues D. Some demand currently unirrigated	Medium

WW	Treated wastewater harvesting for open space irrigation	Yes	New developments	Expanding the recycled water network - residential (recreational areas). Assume 5ML demand.			5	1	1487	D. High cost of infrastructure for small demand D. Salinty issues D. Scale of development unlikely to support Class A system	Medium
WW	Treated wastewater harvesting for open space irrigation	Yes	Non-potable collection point	For council use at depot - near station domain. Assume 5ML use.	5		5	0	500	D. High cost of infrastructure for small demand D. Salinty issues	HIgh
WW	Treated wastewater harvesting for non-potable uses in buildings	Yes	Maryborough Depot	Potential extension of RW pipe, 6.5 ML/yr potable demand	6.5		0	0	200	D. High cost of infrastructure for small demand D. Salinty issues	HIgh
WW	Treated wastewater harvesting for non-potable uses in buildings	Yes	Reduced salinty supply to golf club, princes park and station domain/depot		18		22	1	12304	D. RO plant required D. Brine disposal	Low
WW	Treated wastewater harvesting for non-potable uses in buildings	No	SONAC	Needs further investigation, but I think it is unlikely as Sonac will want potable water for blood processing, and if recycled water is going to be used for cooling, there could be issues due to salinity and pathogens on eqipment							
WW	Treated wastewater harvesting for non-potable uses in buildings	No	Marborough District Health Service	Class A - would require upgrade. Difficult to access non-potable demand							
WW	Treated wastewater harvesting for non-potable uses in buildings	No	New developments	Class A - would require upgrade							
WW	Treated wastewater harvesting for non-potable uses in buildings	No	Havilah Hostel (Retirement Home)	Class A - would require upgrade. Difficult to access non-potable demand							
WW	Treated wastewater harvesting for agricultural irrigation (greenhouses)	No		Not recommended due to class A upgrade required							
WW	Treated wastewater harvesting for agricultural irrigation (land)	No		It's a possibility, but salinity is a key problem. Best next option in addition to current irrigation of WWTP farm and Freemantle is Ipsen property, which is adjacent to Freemantle and would/could be supplied from the Bet Bet Storage. This farm is favoured due to favourable soils (i.e. good leaching potential), which can help to combat salinity issues							
SW+WW	Shandied treated wastewater and treated stormwater for local uses	Yes	Golf club and northern demands	Mixing in north Maryborough/ Lake Victoria for distribution.	25	156	55	2.0	2500.0	A. Local source in northern area D. Additional land needed for recycled water displaced	Medium
Raw water	Raw water distrbuted to lake or water feature	Yes	Goldfields reservoir + Phillips Gardens + Lake Victoria	Centenial reservoir to Goldfields reservoir. Not considered due to impact on potable supply			41		12304	A. Possible to use main drain for distibution D. Use of potable source water	Medium
Raw water	Raw water distrbuted for open space irrigation	No		Centenial reservoir to non-potable ring main. Not considered due to impact on potable supply							
Raw water + \	Shandied raw water + treated wastewater for northern uses	Yes	Golf club and northern demands				55		2500	A. Reduced salinty management A. Use existing distribution network D. use of potable source water	Low
Raw water + \	Shandied raw water + treated wastewater for agriculture	Yes	To northern agriculture (90ha)					36	50	A. Reduced salinty management A. Use existing distribution network D. use of potable source water	Low
Saline water	Saline water distrbuted to lake or water feature	No		Salt reduction plant saline water to goldfields reservoir. Considered inappropriate to introduce to a freshwater environment							
Waterways	Waterway improvement, amenity and access	Yes	Main drain - maryborough	Improved amenity and planting				4	12304	A. In keeping with council priorities for investment D. Heritage limitations to waterway improvement works	Low
Waterways	Waterway improvement, amenity and access	No	Drainage corridors - Carisbrook	Not a focus compared with other opportunities for amenity							
Waterways	Waterway improvement, amenity and access	No	Main drain - maryborough	Daylighting of north east undergrounded tributary. Not feasible due to limited catchment and flow							
Waterways	Waterway improvement, amenity and access	Yes	Tullaroop Creek (Deep Creek)	Revitalisation of Bland Reserve on Tullaroop Creek				0.25	500	A. Site established D. May be difficult to access drain / significant stormwater	Low
Waterbody	Carisbrook reservoir improvement	No	Carisbrook Reservour	Revitalisation of Carisbrook Reservoir - not feasible - decommissioned and damaged							

Attachment 3 – Rainfall Analysis

The 6 minute rainfall gauge at Natte Yallock was selected as an appropriate reference station to model rainfall in Maryborough due to the quality and quantity of data available. It is recognized that while every effort was made to choose a period that aligns with the long term mean annual average with the best quality data available, there are some gaps in the rainfall records as well as periods of accumulated data. It has been found that reuse predictions, analysis of inundation frequency and wetting and drying spells and flow frequency can be more sensitive to larger proportions of missing and accumulated data.

To address this, a patched point data set was developed for the rainfall station and period proposed. The procedure for developing the patched point rainfall data sets generally follows that described by SILO for preparation of the daily patched point data sets it makes available (Jeffrey et. al., 2001). Missing or suspect values are 'patched' with data from a nearby rainfall station. The approach recognizes that proximity is not always a good indicator of similarity. Therefore, the correlation between stations is used as the primary indicator of similarity. Under this approach, the station with the highest correlation to the target station is used to infill data first, then if data is not available the next station is adopted and so forth. For the 6 minute data, both missing data and accumulated data are infilled as follows:

- Missing data is replaced with data from the station with the highest correlation with data for that day.
- Accumulated data occurs where a daily rainfall total is available but no 6 minute distribution. The daily total is averaged across the whole day resulting in a correct total but an underestimate of rainfall intensity since rainfall typically occurs over a small portion of a day. Accumulated data is infilled by using the daily total for the target rainfall station and the 6 minute distribution from the station with highest correlation with data for that day.

The data for the reference station and period was infilled with details reported below.

Infilling of Rainfall Data

The Narre Yallock rainfall gauge was infilled with the stations listed in Table A71. It can be seen in Figure A71 that the data quality across the whole period improves with the proportion of missing data reducing from 4% to 0% and accumulated data from 2% to 1%.

Table A71 - Rainfall stations used for correlation

Rainfall Station	Correlation
88009	0.77
81026	0.76
89111	0.74
89082	0.67
89002	0.66

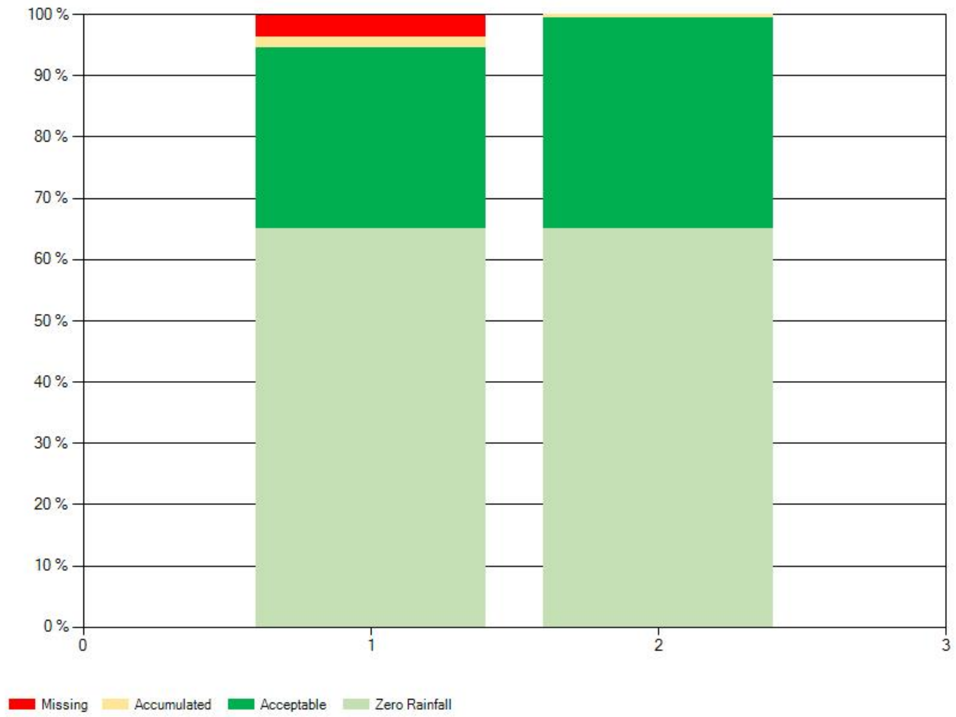


Figure A71 Natte Yallock rainfall data quality before and after infilling

Table A72 shows the impact of infilling data on the current 10 year reference period (1988-1997). In this period, the proportion of accumulated is reduced by 1% and missing data reduced by 4%.

Table A72 Effects of infilling on 1988-1997 period rainfall data quality

	1988-1997		
	Initial	Infilled	Target
Zero rain days	65%	71%	
Acceptable data days	25%	28%	

Accumulated data days	2%	1%	
Missing data days	8%	0%	
Mean annual rainfall (mm/year)	441	495	501

The target mean annual rainfall was calculated based on the weighted average of all daily rainfall stations within a 35km radius of Maryborough. Weighting was determined considering the number of years of data available at each gauge station.

The results indicate that the proportion of missing data is significantly reduced and accumulated data days are slightly reduced due to infilling of the data set. Therefore it is recommended that the Natte Yallock 1988-1997 reference period be used to model rainfall for the township of Maryborough.

Summary of outcomes

Based on the analysis, it is proposed that the infilled Natte Yallock 1988-1997 rainfall template is adopted to model rainfall in Maryborough with Ballarat Monthly Areal PET. The proposed rainfall template is summarised in Table A73.

Table A73 Rainfall template for Maryborough

Rainfall station	Period	Target mean annual rainfall	Period mean annual rainfall	% accumulated	% missing
81038 Natte Yallock	1988-1997	501	495	1%	0%

References

Jeffrey, S.J., Carter, J.O., Moodie, K.B. and Beswick, A.R. (2001). Using spatial interpolation to construct a comprehensive archive of Australian climate data, *Environmental Modelling and Software*, Vol 16/4, pp 309-330. DOI: 10.1016/S1364-8152(01)00008-1.

Attachment 4 – Scored Assessment

The economic assessment describes above provides an assessment framework to compare project costs and performance over a lifecycle. In some cases, benefits and dis-benefits are not easily evaluated in monetary terms and cannot be included in an economic assessment. To recognise the full range of objectives set for the project in the assessment, a dual assessment has been conducted, whereby key performance indicators across all objectives have been assessed using:

- A quantitative analysis, where possible, whereby performance of options is compared based on the relative performance of measured indicators out of a score of 10 (though these are not monetized); and
- Where a quantitative analysis is not possible, indicators are scored based on a qualitative judgement of relative performance.

A scoring framework of quantitative and qualitative indicators has been developed and a preliminary assessment has been made. The scored assessment is summarised against the three objective themes.

Note: The scored assessment only evaluates benefits, and does not compare these to costs of projects. The economic analysis is a much superior platform to compare economic costs and benefits. The scored benefits instead highlight overall performance against the range of key objectives, and highlights objectives which aren't evaluated by the economic analysis.

Quantified Indicators	Indicator	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
A Resilient Water Cycle	Water supplied in place of mains potable supply (ML/year)	49	0	0	0	4	10	45	263	73
	Urban excess stormwater removed (ML/year)	49	9	0.4	29	9	42	153	284	0
	Recycled water use enabled by salinity reduction (ML/year)	0	0	0	0	0	0	90	0	146
	Additional fit-for-purpose water supplies created (ML/year)	49	9	0.4	0	8	10	45	263	-73
Healthy landscapes and waterways	Pollution removed from waterways (kg Total Nitrogen/year)	137	106	6	333	225	365	473	720	0
	New irrigated green area created (m2)	0	20966	708	0	20000	20000	0	0	0
	Healthy waterbody area maintained or created (ha)	0	0	0	5	0	5	2	6.8	0
A prosperous community and economy	Number of community users (no. of people)	3181	3181	12304	12304	12304	12304	3000	0	3000
	Amenity and place-making benefit (relative judgement)	0	8	8	7	6	10	2	5	0
	Educational benefit (relative judgement)	8	3	3	5	3	6	1	3	1
	Health and well-being benefit (relative judgement)	0	6	8	6	8	10	0	4	0
Scaled Score	**Indicator**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**	**Option 9**
A Resilient Water Cycle	Water supplied in place of mains potable supply (ML/year)	2	0	0	0	0	0	2	10	3
	Urban excess stormwater removed (ML/year)	2	0	0	1	0	1	5	10	0
	Recycled water use enabled by salinity reduction (ML/year)	0	0	0	0	0	0	6	0	10
	Additional fit-for-purpose water supplies created (ML/year)	2	0	0	0	0	0	2	10	-3
Healthy landscapes and waterways	Pollution removed from waterways (kg Total Nitrogen/year)	2	1	0	5	3	5	7	10	0
	New irrigated green area created (m2)	0	10	0	0	10	10	0	0	0
	Healthy waterbody area maintained or created (ha)	0	0	0	7	0	7	3	10	0
A prosperous community and economy	Number of community users (no. of people)	3	3	10	10	10	10	2	0	2
	Amenity and place-making benefit (relative judgement)	0	8	7	7	6	10	2	5	0
	Educational benefit (relative judgement)	8	3	3	5	3	6	1	1	1
	Health and well-being benefit (relative judgement)	0	6	10	6	8	10	0	4	0
	Total Score	**19**	**31**	**30**	**41**	**40**	**59**	**30**	60	13

Attachment 5 – Option 7 Alternatives

Two variations of Option 7 were examined in order to test alternative sites, demands, technologies and opportunities for cost savings. These include:

- **Option 7b**: Stormwater harvesting from Northern Sediment Basin to shandy recycled water supply
- **Option 7c**: Stormwater harvesting from Wetland at Maryborough STP to shandy recycled water supply

Option 7b: Stormwater harvesting from Northern Sediment Basin to shandy recycled water supply

Description
Option 7 includes a large regional wetland adjacent to Four Mile Creek on the northern outskirts of Maryborough. This wetland could treat a large portion of polluted urban stormwater runoff from the town, providing stormwater for reuse, as well as pollutant load reductions and habitat. To reduce the cost of this option the wetland could be replaced with a smaller sediment pond. The sediment pond would remove coarse sediments from diverted stormwater. Treated stormwater would be transferred to existing storages at the golf storage (~1 ML) and then shandied with recycled water network via a mixing tank prior to restricted reuse.

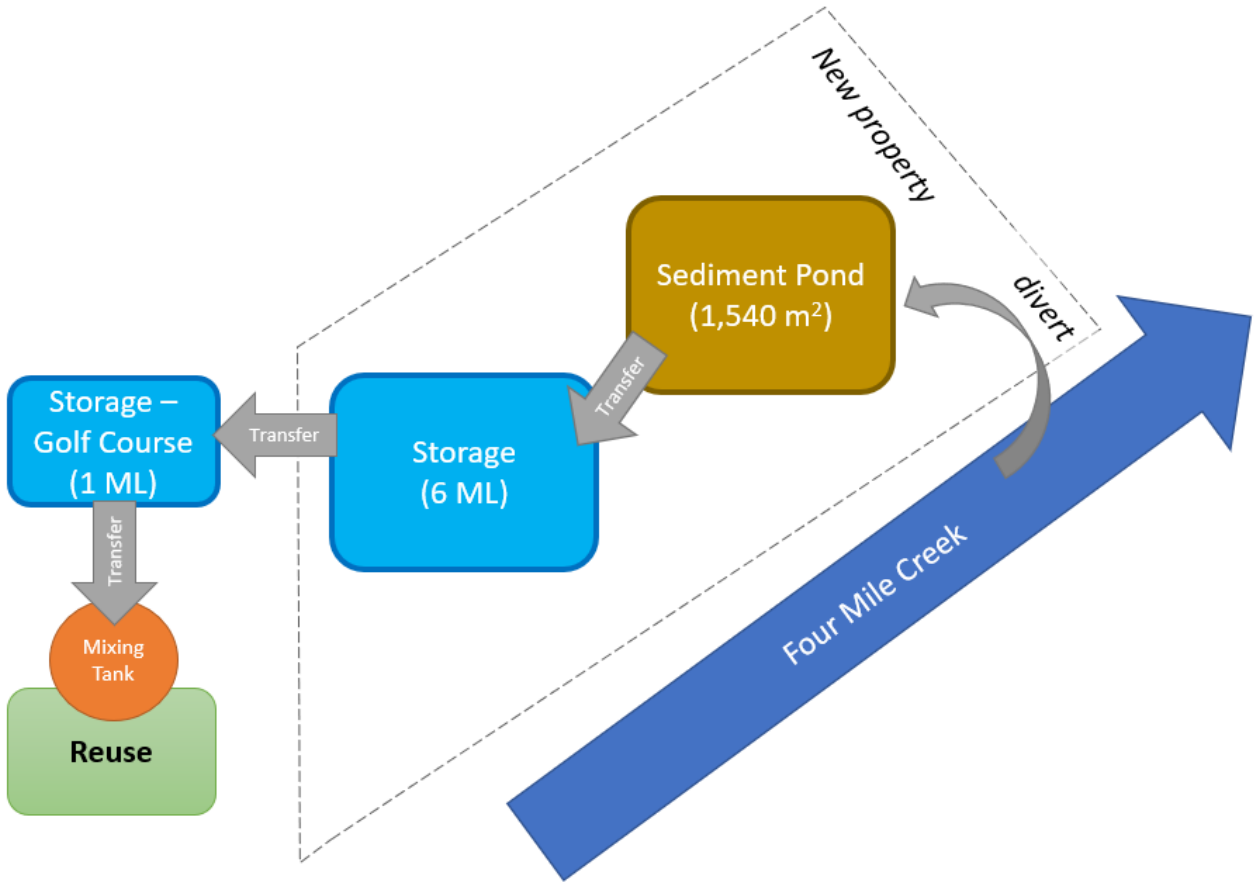


Figure A51: Schematic of storage and wetland adjacent to Four Mile Creek

Key analysis assumptions and infrastructure requirements
The Northern Wetland system requires: • A 1,400 ha (22% imperviousness) catchment with a 100L/s low flow bypass and gravity or pumped diversion with a capacity of 400 L/s. • A gross pollutant trap upstream of the wetland.

- Purchase of private land to construct a treatment are reuse system (assumed the same area as for Option 7).
- Total sediment pond treatment area of 1,540m^2 (surface area) and 2,800 m3 (volume).
- A storage pond with a 7,000 ML capacity (New = 6 ML, Existing at golf course = 1 ML)
- 200m of 225mm transfer pipework (wetland to shandy location).
- The demand for stormwater for shandy = 55 ML/yr (seasonal). This is lower than the demand in Option 7 as it assumes a 1:1 supply of Stormwater to Recycled Water. The salinity of the stormwater diverted from Four Mile Creek needs to be monitored in order to verify that it can be mixed with recycled water at a 1:1 ratio.
- The supply of stormwater for shandy = 38.3 ML/yr (70% reliability) with the shortfall made up with potable water.

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$296,452	$3,867
	Electrics and power	$40,250	$0
	GPT	$86,834	$1,650
WSUD	Treatment + Storage Pond	$918,779	$21,196
	Establishment	$112,881	$0
Other Items	Item 1: Transfer mains	$137,880	$962
	Item 2: Land acquisition	$230,847	$0
Total		**$1,823,924**	**$27,675**

Key Benefits

A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Supporting sustainable recycled water use**: By using stormwater as a source for shandying recycled water it will enable ongoing use of recycled water for irrigation. • **New water supplies**: The scheme would harness 38ML/year of stormwater to support local needs. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 40ML/year.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 470kg/year of nitrogen by the end of the plan period.	• n/a

Option 7c: Stormwater harvesting from Wetland at Maryborough WSP to shandy recycled water supply

Description
There is an opportunity to construct a large regional wetland at the Maryborough Sewage Treatment Plant (STP). This wetland could treat a large portion of polluted urban stormwater runoff from the town and would make use of existing land and storage (via retrofits of existing lagoon(s)) owned by Central Highlands Water. Treated stormwater could be harvested from the wetland to shandy with recycled water prior to reuse. Option 7b requires diversion of stormwater from a 'natural' section of Four Mile Creek, this contrasts Option 7 which diverts stormwater form an already modified / channelized section of the creek closer to the town.

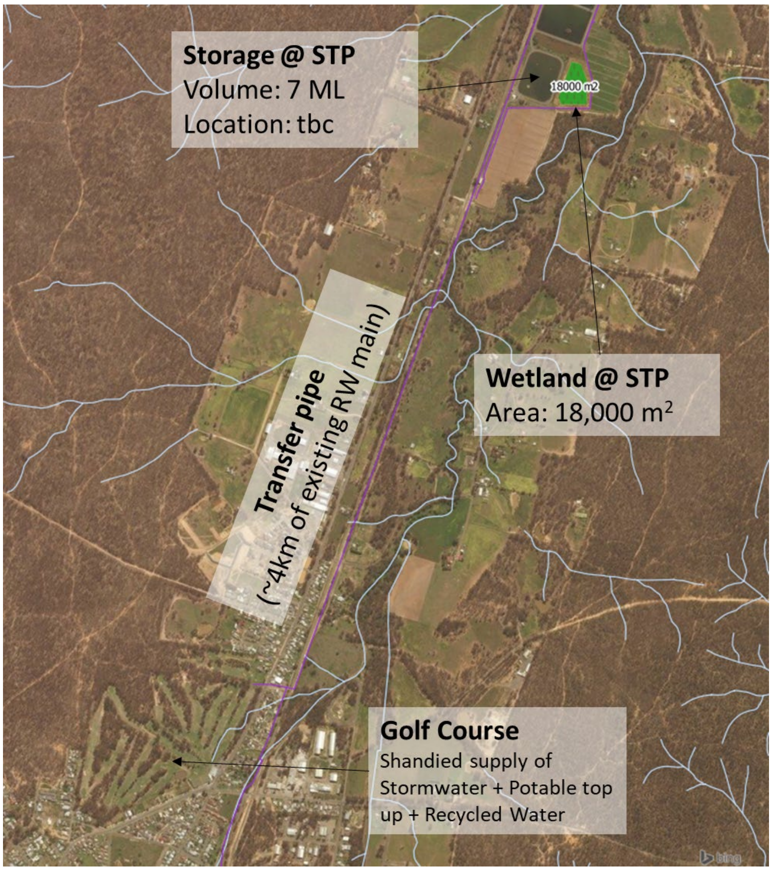


Figure A52: Schematic of storage and wetland adjacent to Four Mile Creek

Key analysis assumptions and infrastructure requirements
The Northern Wetland system requires:

- A 1,400 ha (22% imperviousness) catchment with a 100L/s low flow bypass and gravity or pumped diversion with a capacity of 400 L/s.
- A gross pollutant trap upstream of the wetland.

- Total treatment area of 18,000m^2 consisting of a 1,800m^2 sediment pond and 16,200m^2 wetland.
- A wetland with a 350mm permanent pool and 350mm extended detention depth.
- A storage pond with a 7,000 ML capacity. A nominal $110,000 has been included in the cost estimate to allow for the retrofit of existing lagoons at the Sewage Treatment Plant for use in the scheme.
- The demand for stormwater for shandy = 55 ML/yr (seasonal). This is lower than the demand in Option 7 as it assumes a 1:1 supply of Stormwater to Recycled Water, ignoring potable top up. The salinity of the stormwater diverted from Four Mile Creek needs to be monitored in order to verify that it can be mixed with recycled water at a 1:1 ratio.
- The supply of stormwater for shandy = 40 ML/yr (73% reliability) with the shortfall made up with potable water.

Cost summary

Item		Capital Cost ($)	Operating Cost ($/yr)
General Infrastructure	Pumps	$296,452	$3,867
	Electrics and power	$40,250	$0
	GPT	$86,834	$1,650
WSUD	Treatment + Storage Pond	$1,876,168	$17,684
	Establishment	$71,180	$0
Other Items	Item 1: Lagoon retrofit	$115,000	$0
Total		**$2,485,883**	**$23,201**

Key Benefits

A resilient water cycle	Healthy landscapes and environment	A prosperous community and economy
• **Supporting sustainable recycled water use**: By using stormwater as a source for shandying recycled water it will enable ongoing use of recycled water for irrigation. • **New water supplies**: The scheme would harness 40ML/year of stormwater to support local needs. • **Reduced 'urban excess' stormwater flows**: Stormwater flowing from urban areas will reduce by 148ML/year.	• **Water Quality**: Pollutants will be removed from runoff and therefore from waterways. The proposal will remove 470kg/year of nitrogen by the end of the plan period. • **New green infrastructure**: A new wetland will be created in Maryborough north which could be a valued ecological asset.	• n/a