MACEDON RANGES SHIRE COUNCIL, WESTERN WATER, MELBOURNE WATER

Southern Macedon Ranges Integrated Water Management Plan

Version 2

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Traditional Owner Acknowledgement

Macedon Ranges Shire Council, Western Water, Melbourne Water and E2Designlab acknowledge the traditional owners of the Southern Macedon Ranges region: the Dja Dja Wurrung, Taungurung and the Wurundjeri. We pay our respects to the Elders of these communities past, present and emerging, acknowledging that they have been custodians of land and water from many centuries and that their continuing culture and contribution is important to the life and the region.

1. An integrated water management approach

1.1 What is Integrated Water Management?

Integrated Water Management (IWM) recognises the interconnected nature of the water cycle, seeking to manage water across the whole water cycle in a coordinated manner and improve its interactions with the built and natural environment. Traditionally, three 'areas' of the water cycle have been managed separately: water supply, wastewater, and stormwater. Roles and responsibilities have similarly focused on the different areas of water management. Integrated water management recognises the interrelationships between different sources 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.

In a built-up environment, such as urban townships of Macedon Ranges Shire, 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 cycled 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 the environmental, economic and social influences and sensitivities in the system.

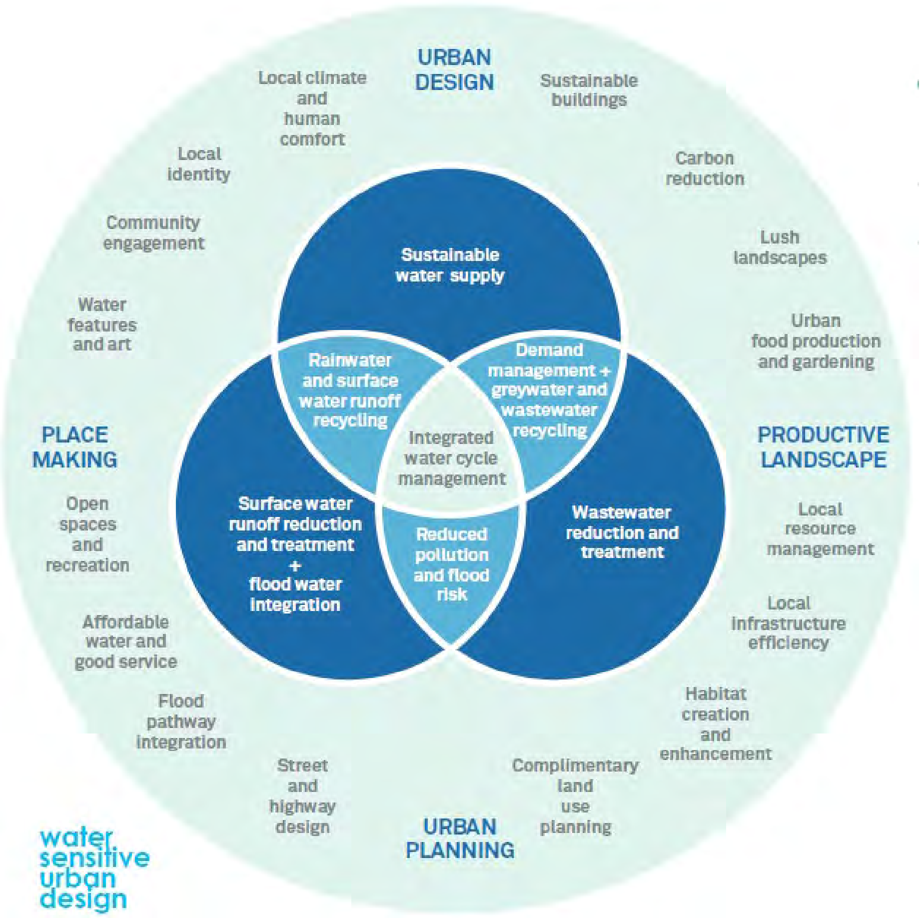

Figure 1: The elements of integrated water management

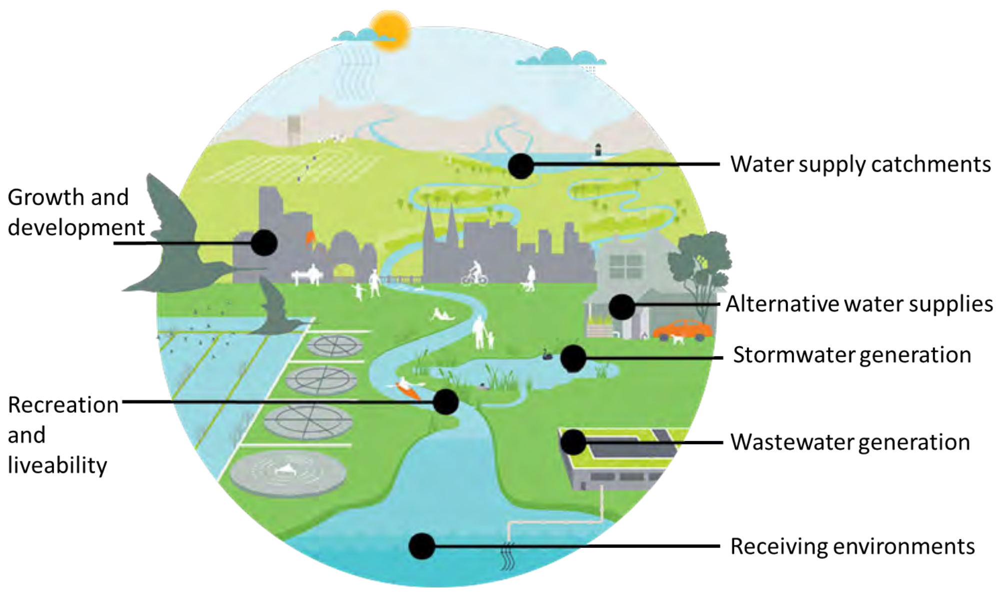

Figure 2: Key elements of the urban water cycle

1.2 State and regional IWM policy frameworks

Water for Victoria (Victorian State Government, 2016) is a "framework to guide smart 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 State Government provided a commitment to:

- "Adopted 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) release 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 to 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 coordinated delivery of IWM. Macedon Ranges Shire participates in the Maribyrnong Catchment IWM Forum.

1.2.1 Maribyrnong Strategic Directions Statement

The Southern Macedon Ranges IWM Plan is a priority project for the Maribyrnong Catchment, supported by the Strategic Directions Statement:

> *"Preserving the health of the upper Maribyrnong River tributaries is essential for the health of the entire Maribyrnong River system. These upper tributaries are home to a range of flora and fauna and hold unique Traditional Owner and recreational values. Protecting these values is critical, particularly in the context of climate change and population growth."*

1.3 A partnership approach to IWM in Macedon Ranges Shire

IWM involves a coordinated approach to water management, including 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.

This project focuses on the southern Macedon Ranges area, draining south to the Maribyrnong River catchment. The area falls within the jurisdiction of a number of organisations that have different roles in the management of water within the Shire: Macedon Ranges Shire Council, Melbourne Water, Western Water, and Southern Rural Water.

1.4 Scope of IWM plan

This IWM Plan is aimed at developing a set of objectives and list of key projects for integrated water management in four major townships:

- Gisborne (including New Gisborne)
- Riddells Creek
- Romsey
- Lancefield

An IWM plan for Woodend has already been developed. Macedon and Mt Macedon were not included in this study.

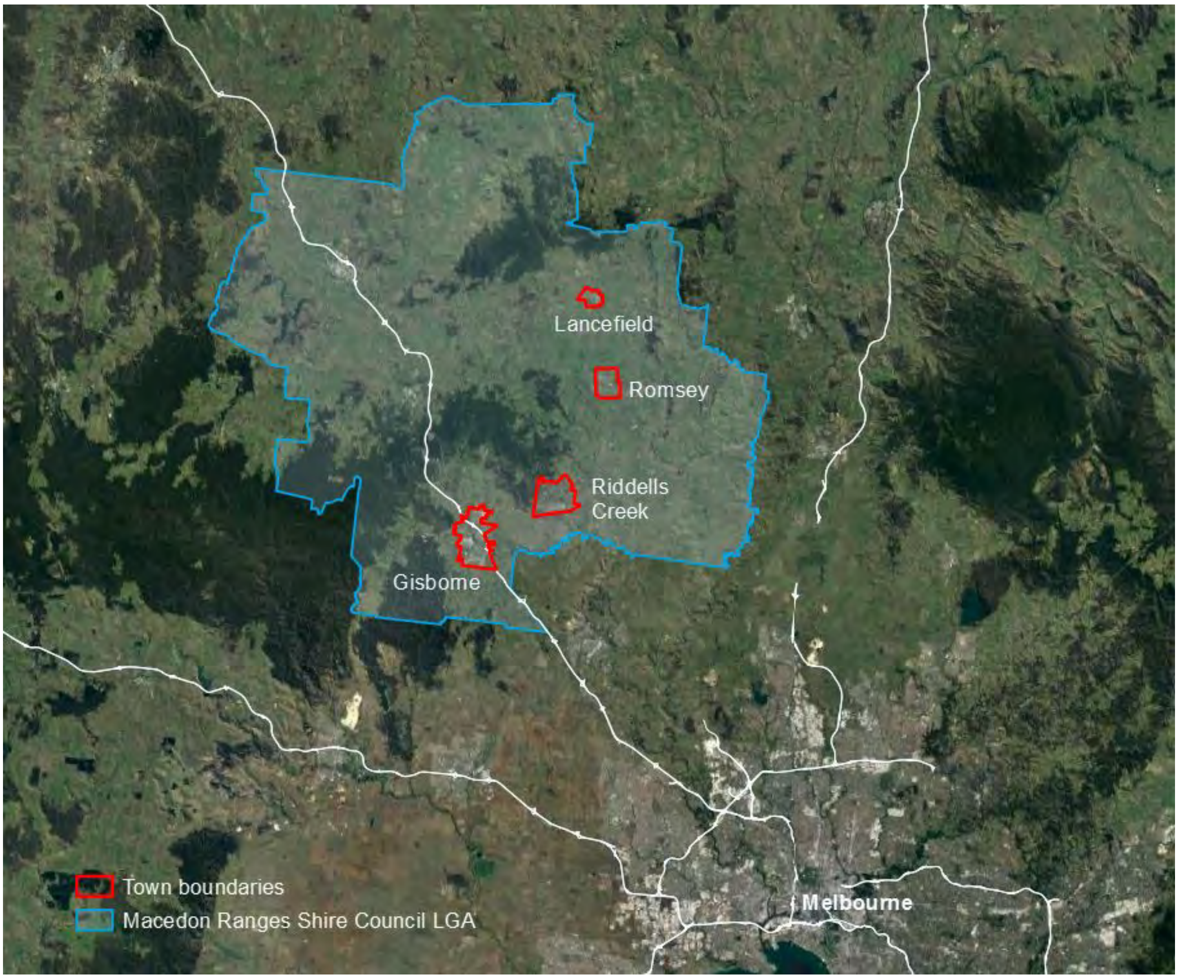

Figure 3: Macedon Ranges Shire Council, showing towns included in the IWM

For each township, project boundaries were defined using local planning zones and lot boundaries. As the project focuses on integrated water management of the urban townships, rural living zones were excluded from the scope, defining the boundary of each township[1]. Project boundaries are shown in Figure 4.

Figure 4: Project boundaries for the four towns. From top left going clockwise: Gisborne (and New Gisborne), Romsey, Lancefield, Riddells Creek. Generally, residential zones shown in yellows; conservation and parks shown in greens; commercial zones shown in light pink; urban growth zone shown in bright pink; public use zones shown in light blue; rural living zones shown in orange/pink.

[1] In Gisborne a small area of rural living zone falls within the township boundary, as it is enclosed by other urban land uses.

1.5 The IWM Plan structure

The Southern Macedon Ranges IWM plan was developed in the following four stages (Figure 5). The report is structured in the same manner and is supported by several appendices with further detail:

Figure 5: Four stages of the IWM Plan development

2. **The case for IWM:** Drivers, vision and objectives

2.1 Summary of key IWM drivers

Integrated water management is driven by a combination of factors, as summarised in Figure 6.

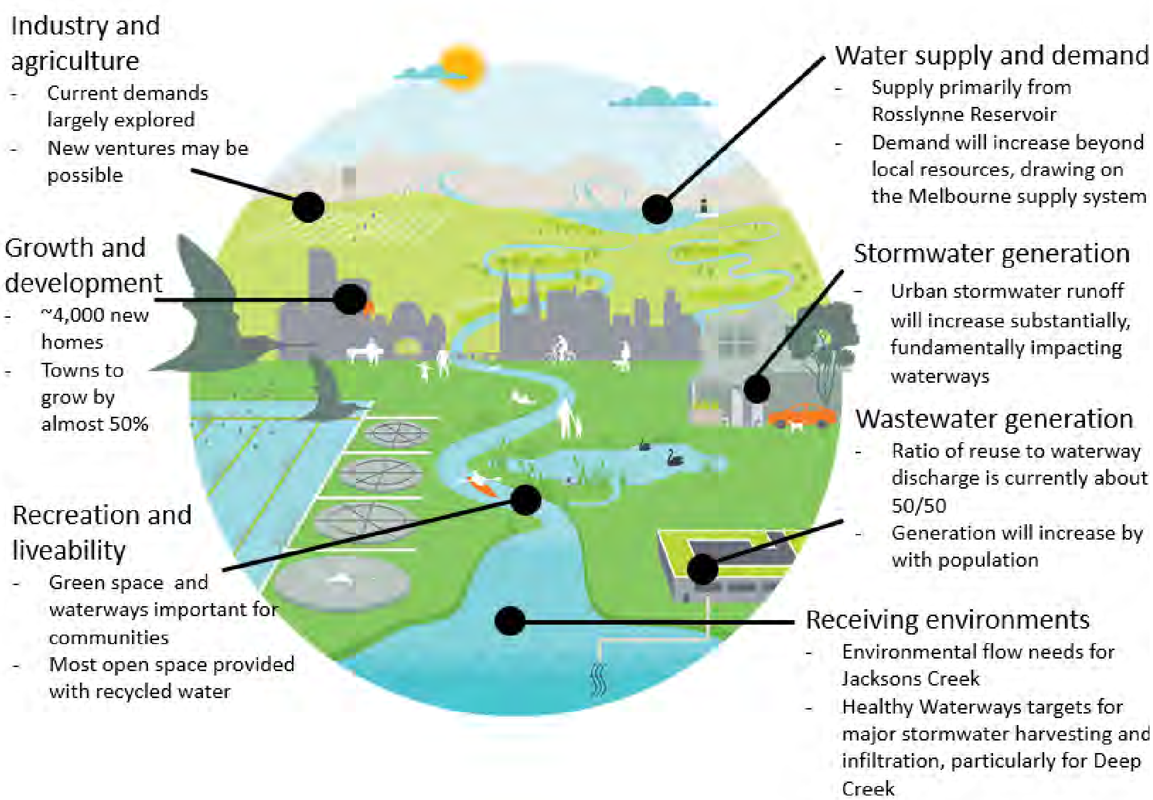

Figure 6: Summary of key IWM drivers for the Southern Macedon Ranges area

2.2 Growth and development

Substantial growth is anticipated across the Macedon Ranges Shire, with the municipality population expected to increase by 32% by 2036, from 49,626 to 65,405[2]. Much of the development across the shire will be through infill development within established towns, such as the towns at the focus of this IWM plan. Growth within Gisborne (and New Gisborne), Riddells

[2] Population projection from forecast.id

Creek, Romsey and Lancefield is highly concentrated, at a growth rate closer to 50% between 2016 and 2036. A summary of residential growth is provided in Table 1.

Growth projections for the towns have been based on the findings from the *Macedon Ranges Residential Land Demand and Supply* report (Draft, 2019). The land demand and supply analysis uses demand projections of population and dwellings from both the official State government Victoria in Future 2019 (VIF2019) projections and the Forecast ID projections prepared by *forecast.id* for Macedon Ranges Shire. Land supply estimates are based on a range of factors including: whether land is occupied; size of lot; lot size controls and other planning requirements, and existing Development Plans, Subdivision permits approved or under consideration and Subdivision Plans and stage masterplans.

Available land supply in the towns of interest is mostly within General Residential Zones, where there are a vast number of vacant blocks, broad hectare properties and opportunities for subdivisions.

Table 1: Dwelling growth adapted from *Macedon Ranges Residential Land Demand and Supply* report (2019)

Town	# of dwellings (2016) [3]	Dwelling growth rate (2016-2036) [4]	Projected # of dwellings (2036)	Planning zone with most available land supply	Other zones contributing to land supply
Gisborne	3,642	57%	5,718	General residential zone	Low density residential zone
Riddells Ck	1,334	70%[5]	2,274	Urban growth zone	Low density residential zone, Neighbourhood residential zone 8
Romsey[6]	1,450	34%	1,943	General residential zone	Low density residential zone
Lancefield	613	48%	907	General residential zone	Low density residential zone
Totals	**7,039**	**~ 3,803 new dwellings**	10,842		

[3] Based on Urban Centre Localities (UCL) for each township

[4] Based on dwelling demand projections between 2016 and 2036 except where growth is supply limited.

[5] Estimates for growth within Riddells Creek vary. The selected growth rate is based on the upper growth rate of 47 lots per annum, Scenario 3 in Table T47 of the *Macedon Ranges Residential Land Demand and Supply* draft report. The upper growth projection was selected on the basis that current policy supports substantial growth (above this rate), and this rate is still below the lot yield being proposed in early layout plan drafts for the urban growth zone.

[6] Growth is limited by supply of available land. Demand is closer to 55%, but there not enough land is available to support this demand. Dwelling growth rate is estimated based on available land capacity to accommodate new residential lots.

2.3 Water supply and demand

Water supply systems are managed by Western Water. However, the systems vary across the different townships. The potable supply comes from a mix of water from the local Rosslynne Reservoir, bore water, other local reservoirs, and imported water from the metropolitan Melbourne supply network. As the area grows, additional import of potable water from the Melbourne Supply Network is likely, as local water supplies are fully allocated. See Figure 7 for a map of infrastructure in the area.

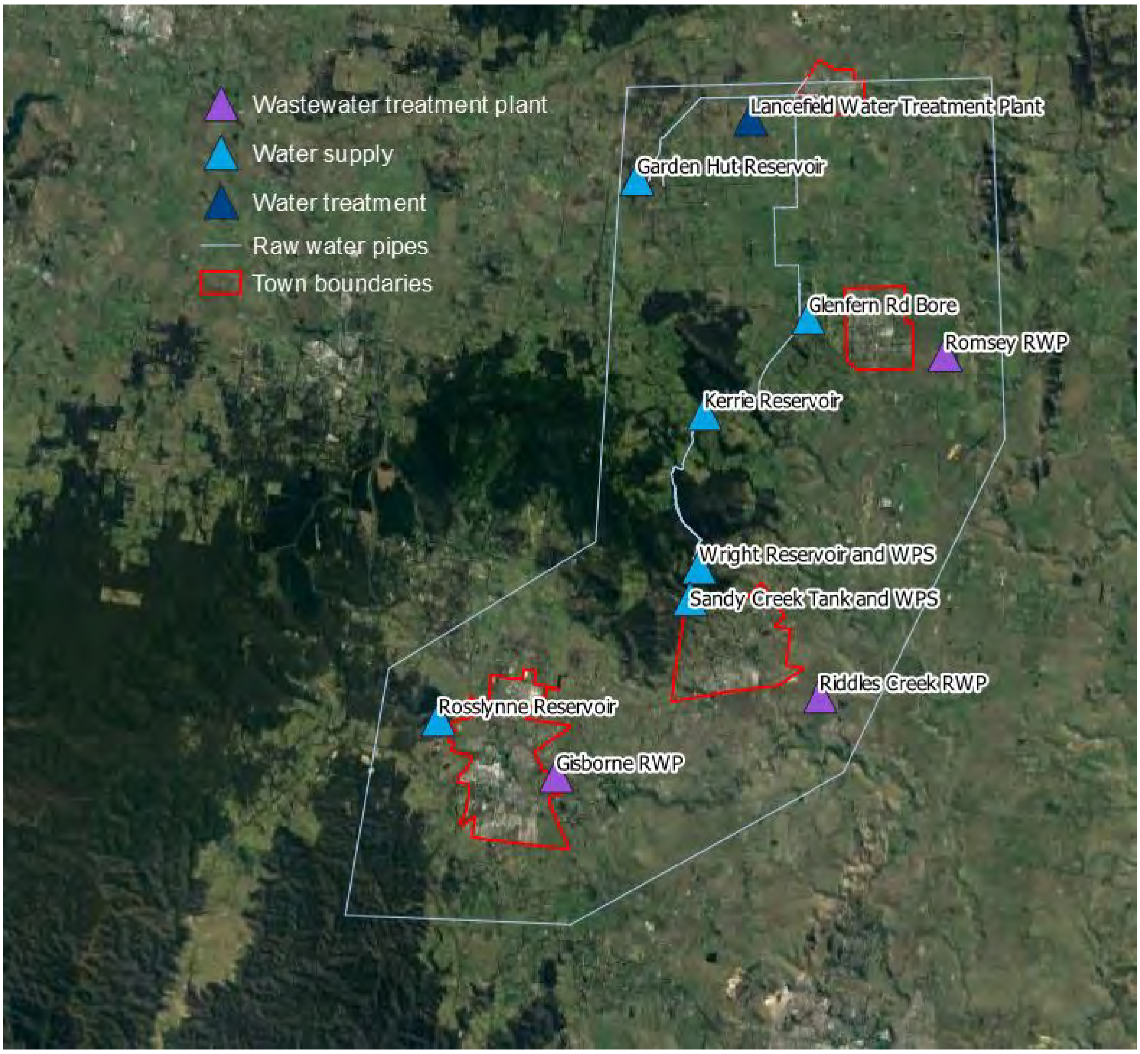

Figure 7: Map of major water and wastewater infrastructure within project area

2.4 Stormwater generation

The increase coverage in hard surfaces across the catchments increases the volume, intensity and frequency of stormwater runoff discharged to local waterways. Stormwater runoff generated by urban areas contain higher levels of pollution than runoff generated across naturalised catchments and damages receiving waterways.

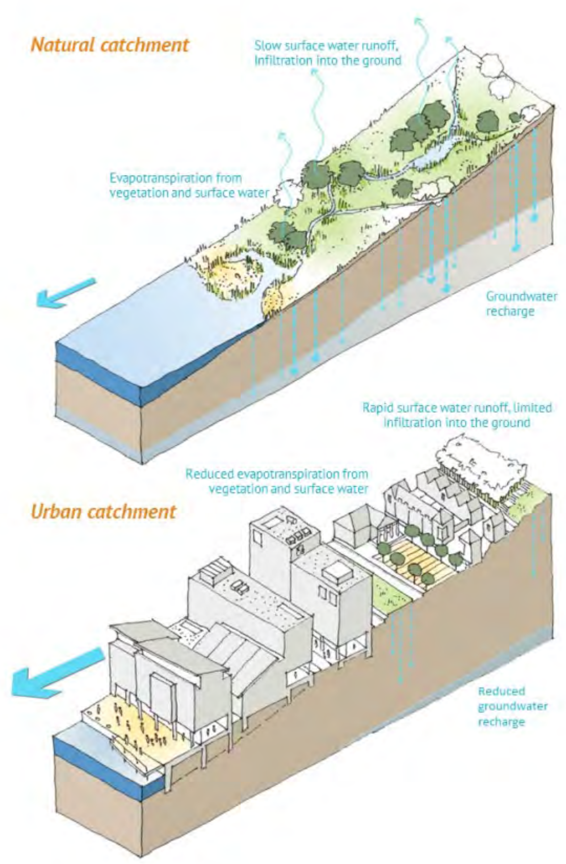

Figure 8: Comparison of stormwater runoff volumes from a natural catchment and an urbanised catchment

Macedon Ranges Shire Council is responsible for the management of most urban stormwater within the Shire. This extends to roadside drains across the large number of Council-managed roads between the urban township areas. Melbourne Water is the relevant drainage authority where a Melbourne Water Development Services Scheme exists and generally takes ownership of assets with a catchment that exceeds 60 ha. For assets with smaller catchments, Macedon Ranges Shire Council has the responsibility for drainage assets.

Water sensitive urban design and stormwater harvesting can reduce urban flow volumes and pollution reaching local creeks. However, currently, stormwater assets under Council's management are limited to sediment basins, retarding basins, a number of bioretention systems and swales. As development occurs across the towns, Council will become responsible for an increasing number of water sensitive urban design assets, such as wetlands, bioretention systems and raingardens.

The implementation of Council's *Water Sensitive Urban Design Masterplan for the Gisborne Township* (2015) will also create new assets for Council to manage and maintain, improving water quality of existing untreated urban areas across Gisborne.

2.5 Wastewater generation

Wastewater within Macedon Ranges Shire is managed on a township basis, with reticulated sewers and local wastewater treatment plants servicing each of the four townships within this strategy. Domestic wastewater treatment systems (septic systems) are also used on larger rural living lots and farmland areas within and on the fringes of the townships.

Gisborne, Riddells Creek and Romsey all have local wastewater treatment plants, with Lancefield connected to Romsey's wastewater system and treatment plant. Refer to Figure 7 for a map of the wastewater infrastructure. Table 2 summarises the wastewater treatment plants in the area, their level of treatment and the towns they service.

Table 2: Summary of wastewater treatment plants in Macedon Ranges

Wastewater treatment plant	Level of treatment	Townships serviced	Receiving waterway	Notes
Gisborne Recycled Water Plant	Class B	Gisborne	Jacksons Creek	• 10% reuse, remainder discharged to Jacksons Creek under current discharge licence.
Riddells Creek Recycled Water Plant	Class C	Riddells Creek	Riddells Creek	• Currently discharging to Riddells Creek under temporary discharge licence. • Looking for permanent licence to discharge. • Nutrient offsets project underway.
Romsey Wastewater Treatment Plant	Class C	Romsey and Lancefield	Deep Creek (Upper)	• No discharge, currently 100% reuse on land.

Recycled water

All three wastewater treatment plants produce recycled water that is used locally. However, there is still a substantial volume of recycled water that is not being used, and is discharged to the receiving waterways. Currently, this equates to approximately 50% of treated wastewater being discharged to waterways and 50% being utilised as recycled water, with the greatest discharge to waterways occurring in Gisborne. The breakdown of wastewater and recycled water generation, use and discharge for 2019 is summarised in Figure 9.

Currently, most of Council's active open space areas (sports ovals) are irrigated with recycled water, as well as a school in Riddells Creek, and some Council facilities. Other recycled water users include farms and the Botanic Gardens. In addition to customers, Western Water uses recycled water on land owned by Western Water at Romsey RWP for agricultural irrigation.

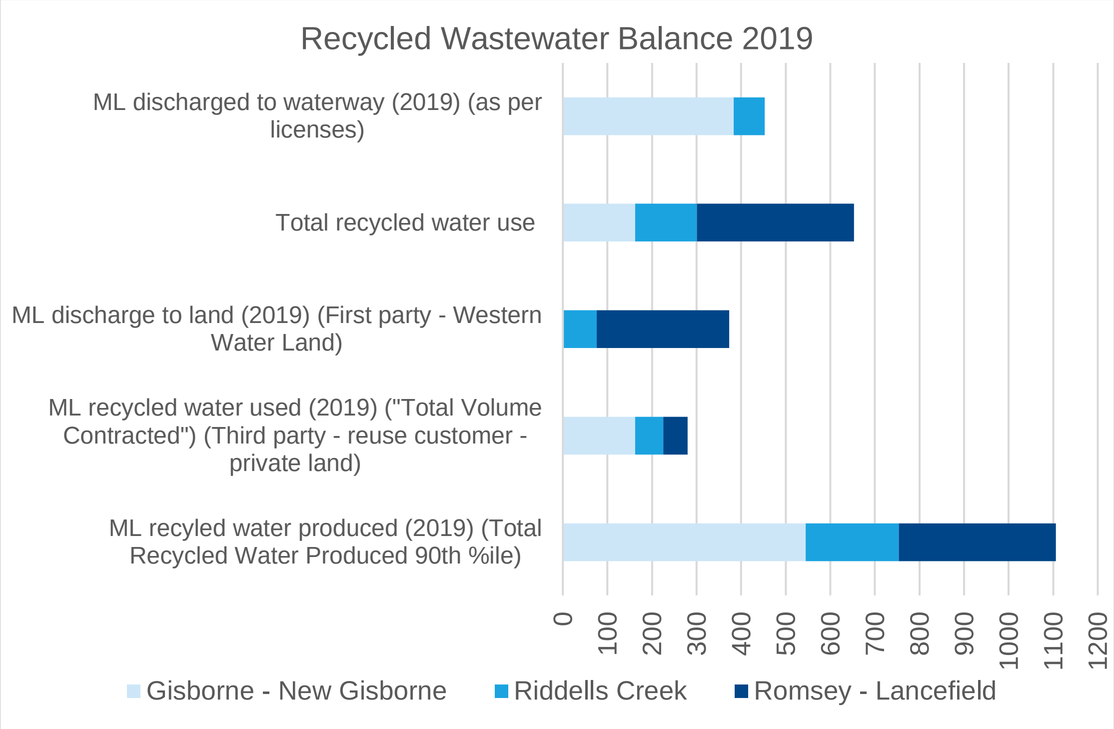

Figure 9: Breakdown of wastewater and recycled water in 2019

2.6 Receiving environmentss

Southern Macedon Ranges has three main waterway catchments – Jacksons Creek, Deep Creek (upper) and Emu Creek – all of which are part of the larger Maribyrnong River catchment that flows to Port Phillip Bay. Riddells Creek, which is a tributary of Jacksons Creek, is also a key waterway in this plan. These waterways and catchments are shown in Figure 10, sourced from the Healthy Waterways Strategy for Maribyrnong River. This strategy focuses on Jacksons Creek and Deep Creek (upper), while Emu Creek's catchment passes between the towns of interest.

Waterways play a significant role in supporting ecology, recreation, local character and amenity, cultural values and community connection. This is recognised through the condition assessments undertaken through the Healthy Waterways Strategy for the Maribyrnong Catchment.

Deep Creek (upper) and Jacksons Creek both currently have low to moderate scores across all the ecological values (e.g. aquatic birds, fish, vegetation), but high scores for amenity, community connection and recreation. Waterway condition indicators vary from very low to very high. This demonstrates that current social value of the waterways is high, and that there are elements in excellent condition. However, significant work remains to restore the waterway and protect these valued assets.

Challenges remain around private land ownership, with vast lengths of the creeks passing through private property. Council is already working with active community groups on waterway revitalisation projects, and more work is anticipated in future years to continue to protect and improve these corridors.

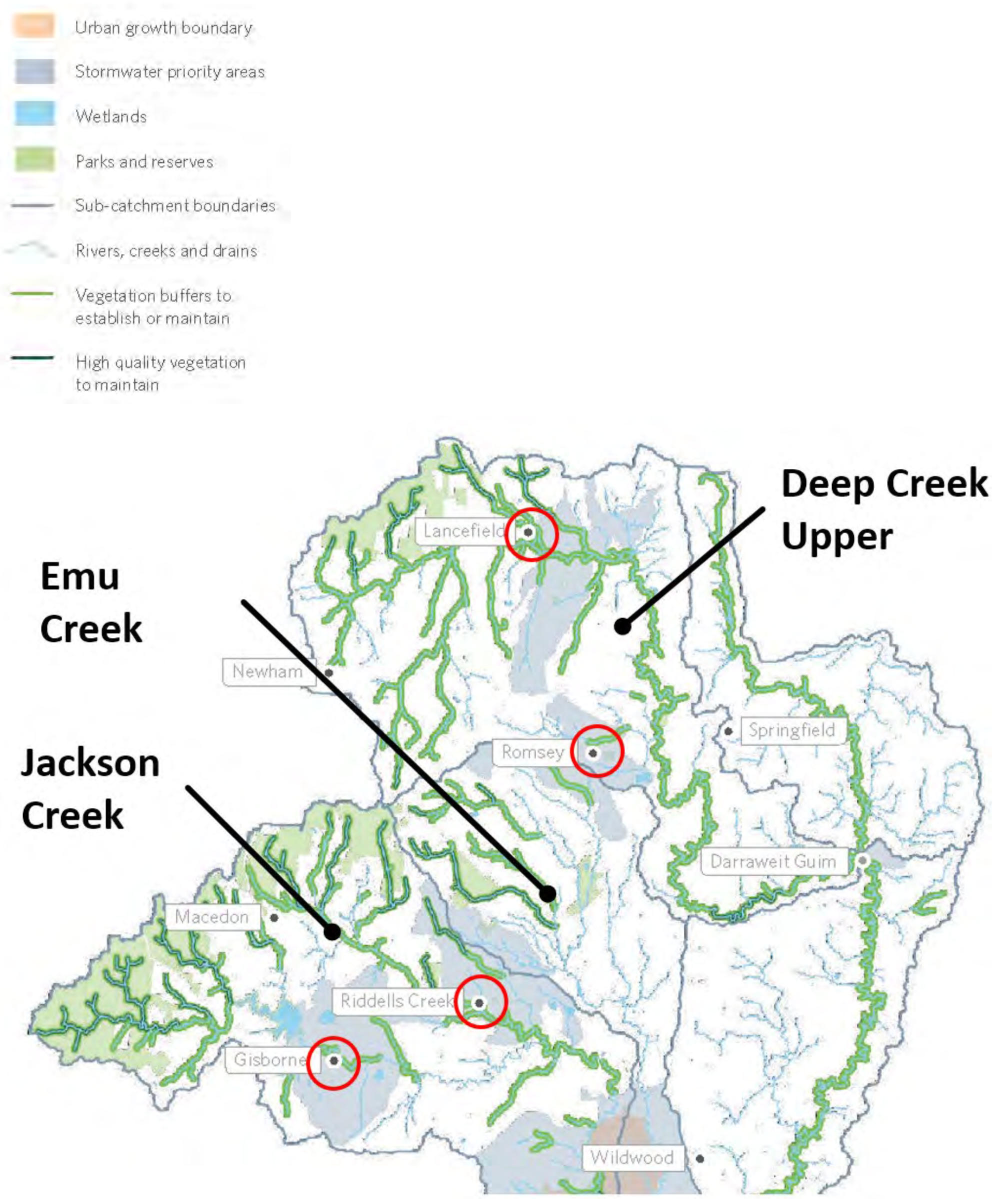

Figure 10: Waterway catchments in Southern Macedon Ranges, extract from Maribyrnong Catchment Healthy Waterways Strategy

2.6.1 Healthy Waterways Strategy

The Healthy Waterways Strategy is a collaborative strategy that has been developed closely with the community and industry stakeholders. The Healthy Waterways Strategy identifies an extensive range of objectives for each waterway. Key targets that should be considered and addressed through this IWM are summarised in Table 3. These targets are based on extensive research. However, at this stage, the targets are not enforceable. Note objectives related to physical form, vegetation extent and vegetation quality have not been included here as they will not be directly addressed by IWM approaches, and instead should be actioned in other strategies (e.g. open space strategies).

Table 3: Healthy Waterways Strategy harvesting and infiltration targets

Waterway	Objectives
Jacksons Creek	For every hectare of new impervious area, harvest 4.5 ML/y and infiltrate 1.1 ML/y, which is about 8.4 GL/y and 2.0 GL/y for full development to the urban growth boundary[7].
Deep Creek (upper)	For every hectare of impervious area, harvest 5.0 ML/y and infiltrate 1.4 ML/y. For existing urban this is 0.5 GL/y and 0.2 GL/ for Lancefield, and 0.9 GL/y and 0.3 GL/y for Romsey. For new urban, further 0.3 GL/y and 0.1GL /y is require for Lancefield and 1.0 GL/y and 0.3 GL/y for Romsey.

Interpretation of Healthy Waterways Strategy targets

The Healthy Waterways Strategy targets are new to the industry and Southern Macedon Ranges is one of the first test applications of the targets. As such, we have worked to understand the background science supporting the targets, as well as translate the existing targets as described in the Healthy Waterways Strategy to percentage flow reduction metrics to help facilitate stakeholder interpretation. These are the early interpretations, which have been discussed with Melbourne Water and key researchers at the University of Melbourne.

Key understandings and background:

- The targets are derived based on aiming to maintain pre-development (natural) annual streamflow volumes.
- Infiltration targets represent flow to be treated and returned to the creeks as filtered baseflow.
- Targets were developed based on mean annual rainfall rates for different catchments across Melbourne, and translated into per hectare annual harvesting and infiltration target rates.
- In order to ensure the harvesting and infiltration targets are aligned with project modelling, the annual harvesting and infiltration targets should be redefined based on modelled annual rainfall, in accordance with Melbourne Water recommended rainfall distribution bands for MUSIC modelling.

Given the above understanding, the targets were redefined, and initially translated to percentage reductions. The resulting targets are equivalent to harvesting 77% and infiltrating 22% of impervious surface runoff. For Gisborne and Riddells Creek, this applies to any new impervious

[7] The total figures to the urban growth boundary are for the entire Jacksons Creek catchment, including Sunbury.

areas. For Romsey and Lancefield, this targets applies to all impervious areas, both existing and new.

These percentage reductions were then applied to our water balance model estimates of impervious runoff to derive new annual harvesting and infiltration target rates. The results are summarised in Figure 11.

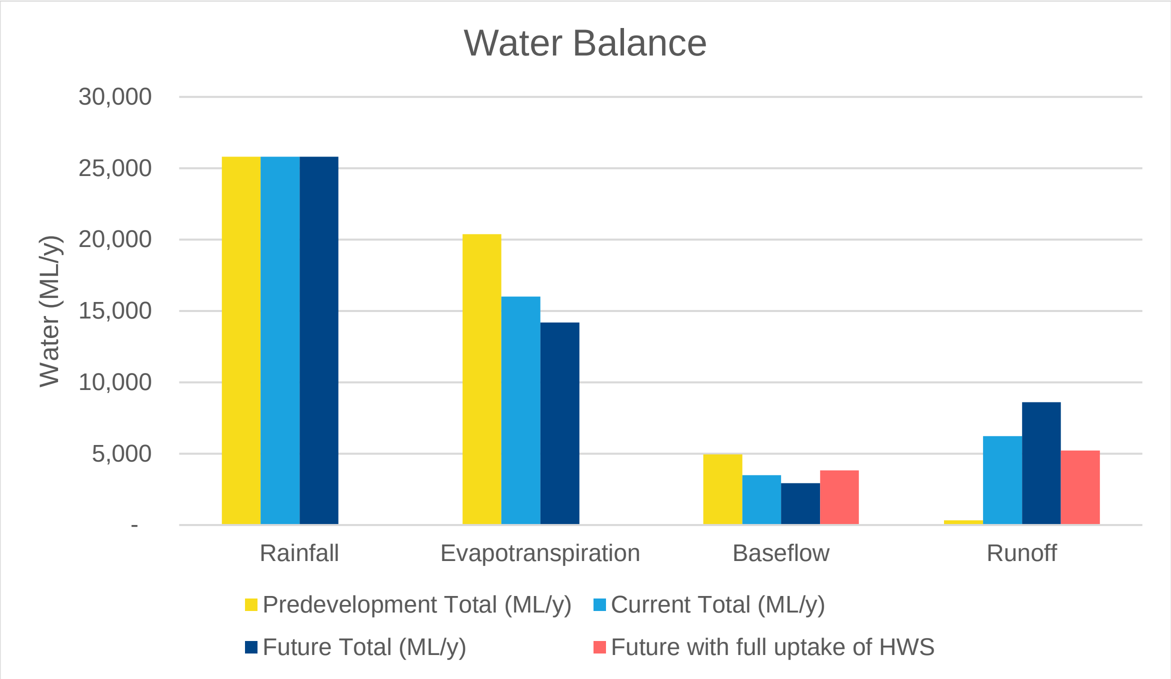

Figure 11: Natural water balance aggregated across all four townships, showing influence of Healthy Waterways Strategy targets

These figures are a preliminary interpretation of the strategy. As more interpretative guidance becomes available, these figures may be reviewed to reflect further advice from Melbourne Water. We acknowledge that growth estimates and the selection of rainfall bands may cause minor differences between the figures here and those within the Healthy Waterways Strategy.

Notwithstanding, the important takeaway from our interpretation is that the Healthy Waterways Strategy targets require harvesting and infiltrating a significant proportion of impervious runoff across all four townships. This is especially true in Romsey and Lancefield.

2.6.2 Environmental Flows[8]

Historically Jacksons Creek has been modified by the creation of Rosslynne Reservoir and experiences continual baseflow as a result. Seasonal releases for agricultural uses have inversed the natural pattern (high in summer, low in winter). To help to re-establish a natural flow pattern to

[8] Earthtech (2006) Environmental flows determination for the Maribyrnong River.

support creek ecosystems, the Healthy waterways strategy for Jacksons Creek (whole catchment) seeks to increase environmental reserves by 5GL/year by 2028.

Conversely, there is not a significant change from natural conditions to the current flow regime in the upper reach of Deep Creek. Significant chain of ponds channel morphology dominates the upper reach which is primarily threatened by riparian land use and physical channel intervention.

2.6.3 Cultural values

For Aboriginal people, Country is more than a place. Traditional Owners have cultural, spiritual and economic connections to the land, water and other resources through their associations and relationships with Country, which they have managed sustainably over a thousand and more enations. Connection to land, waters and resources on Country is important for Traditional Owners' health and wellbeing. The Wurundjeri Woi wurrung and the Wadawurrung peoples are the Traditional Owens of much of the Waterways of the West region's waterways and lands.

The following are extracts from the foreword within the *Waterways of the West Discussion Paper* (2019), written by the Wurundjeri Woi wurrung clan and the Wadawurrung clan respectively.

"Through time and continuous connection, our Ancestors developed and honed deep knowledges of these unique volcanic landscapes, local flora and fauna, seasons, and ancient waterways from their source tot eh sea. Our western waterways are some of the oldest waterways on our Country, carved into existence several thousands of years prior to the creation of the Birrarung (Yarra River). They are truly ancient places and identities. Our ancient cultural heritage, including our people's ancestral remains, are found here.

For a fleeting moment post European Settlement, our Woi wurrung clans and other members of the Kulin continued to gather as they had for countless of generations previously... They were not only places of celebration, where our Ancestors feasted, laughed and played together, they were also places of trade and learning, where ideas were shared and decisions made, both large and small."

Wurundjeri Woi wurrung

"You may have heard of connection to Country: I believe this very component is missing in our world. For Aboriginal people, this is a deep, emotional connection, which is very hard to explain.

...We need to understand the importance of the ancient significance of the area.

Imagine: close your eyes; the sound of running water; the laughter of the children playing; the crackle of the fire; the passing of an emu; the noises from a happy, living system. This is not lost. It is in a different form now but just as beautiful and important. If we could stop and hear the very things, that were here before us. They have the answers: we just need to listen."

Wadawurrung

The Waterways of the West Discussion Paper recognises the importance of Traditional Owner values and practices, which are reflected through two of the seven key directions for the Waterways of the West:

- **Key Direction 1:** Embedding Traditional Owners and their values and culture in waterway planning and management.
- **Key Direction 3:** Providing water for the environment and Country.

2.7 Industry and agriculture

These townships are situated in a semi-rural landscape, where there is existing, and further potential for, agricultural activities on surrounding land.

Good quality agricultural soils and reliable groundwater resources exist in the Lancefield / Romsey area and provide a unique opportunity to explore an alternative water option where alternative water supplies could be provided for agriculture to enable the reallocation of groundwater licenses for potable water supply. Much of the land located within the Lancefield GMA has good quality soils; Class 1 and 2 agricultural capability. A groundwater management area (Lancefield GMA) is in place over the basalt aquifer underlying the surrounding area, which provides very reliable groundwater supply.

2.7.1 Soils and land capability[9]

The Southern Macedon Ranges region has a range of soils. All of the study area is mapped within the Central Volcanic Plain landscape.

South and east of Lancefield is a relatively flat basalt plain, Unnamed trachyte (Newer Volcanics). The high land capability mapped soils for the Lancefield Romsey area is based on the presence of Ferrosols which are well structured and friable soils but are often strongly acidic and high in free iron oxide, so liming and regular phosphorus application is usually required. Ferrosols developed on Newer Volcanics occur on undulating rises and occasional low hills in the region between Ballarat, Daylesford and Lancefield. These are not as deeply weathered and are generally shallower than the ferrosols on Older Volcanics (e.g. Gippsland) and can be stony in some areas. Ferrosols should be well suited to irrigation. Soil structure is generally very well developed but there are exceptions, notably in the Romsey - Lancefield area so site specific land capability assessments are needed before committing to any particular site for recycled water irrigation.

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[9] Assessment of Agricultural Land Capability in Melbourne's Green Wedge and Peri-urban Areas, Agriculture Victoria Research Final Technical Report, Updated October 2018, Macedon Ranges Landscape Assessment Landscape Character Types & Areas, Claire Scott Planning, March 2019

The geology of Gisborne area and south of Romsey is Newer Volcanics Basalt Flow, characterised by flat to gently rolling topography, which features the two major eruption points of Mt Gisborne and Mt Aitken. Soils in this area are likely to be duplex soils with relatively well-drained sandy or loamy topsoils over heavier clay subsoils. Irrigation is possible but would require more careful management to prevent waterlogging.

2.8 Recreation and liveability

The existing community across Macedon Ranges Shire highly values waterways throughout the townships. There is already a lot of work going on to revitalise waterways, including community led programs and partnerships. Existing open spaces are also supported by alternative water sources (recycled water), and the towns are generally more green than their more urban counterparts closer to Melbourne's core.

It will be important to maintain the liveability of the towns in future years, while the towns grow substantially. This means ensuring new developments include adequate provision of open space, trees in streets, and aiming to protect existing mature vegetation that adds to the highly valued rural character of the area.

3. Exploring Opportunities
Preliminary options assessment

3.1 Southern Macedon Ranges water balance

The water balance for the urban study areas within the Southern Macedon Ranges describes the water demands, potable water supplies and the stormwater and wastewater generated by the area. Figure 12 and Figure 13 present the water balances for the Southern Macedon Ranges townships considering current and future (2036) conditions. Current and future conditions are modelled over the same spatial footprint.

A water balance has been created to understand the comparative types, qualities and quantities of water that are present today and in the future after growth and development has occurred. The water balance is an essential ingredient for use in the preliminary assessment of options, as it allows initial analysis to be undertaken to quantify the relative performance of options.

Summaries are provided in Table 4, Table 5, Figure 12 and Figure 13.

The natural water balance components were modelled using MUSIC, while the potable water, wastewater and recycled water components are based on Western Water supplied data for the towns.

Projections for the future water balance are based on the year 2036, and estimated based on the residential growth rates described in Section 2.2 – Growth and development. Western Water has its own potable water and wastewater projections, but these significantly, especially from the growth anticipated for Riddells Creek. To maintain consistency between models, water and wastewater projections were estimated based on scaling the pro-rata rates (ML/dwelling) from 2019 to the projected number of dwellings for 2036. These forecasts are similar to Western Water's projections for the year 2050, suggesting the latest information on growth in the regions assumes a faster rate of development in the medium term, but likely represents similar total growth over the long term.

While scaling the projections on a pro-rata basis from 2019 to 2036 is likely more simplified than Western Water's methods for projecting future water and wastewater balances, this approach is used to ensure consistency with the growth estimates used throughout this plan. In future, it would be valuable to work with Western Water to update these projections to account for other future trends (e.g. changes in customer behaviour, water efficiency technology).

Table 4: Summary of current water balance across towns

Town	Potable water use (ML/y)	Wastewater generation[10] (ML/y)	Recycled water use[11] (ML/y)	Wastewater discharged to waterways (ML/y)	Stormwater runoff (ML/y)
Gisborne	966	587	162	383	3,390
Riddells Creek	390	214	111	70	1,028
Romsey and Lancefield	426	375	235	0	1,812
Total	**1,782**	**1,176**	**508**	**598**	**6,230**

Table 5: Summary of 2036 future water balance across towns

Town	Potable water use (ML/y)	Wastewater generation (ML/y)	Recycled water use (ML/y)[12]	Wastewater discharged to waterways (ML/y)	Stormwater runoff (ML/y)
Gisborne	1,517	922	162	694	4,503
Riddells Creek	665	364	286	70	1,755
Romsey and Lancefield	589	518	486	0	2,350
Total	**2,771**	**1,804**	**934**	**694**	**8,609**

[10] Reporting is based on 90th%ile wastewater generation.
[11] Reporting is based on 90th%ile recycled water production.
[12] Maintaining discharge at 70ML/y and 0ML/y at Riddells Creek and Romsey respectively will require additional demands to match increases in recycled water generation (approximately 250ML/y for both towns).

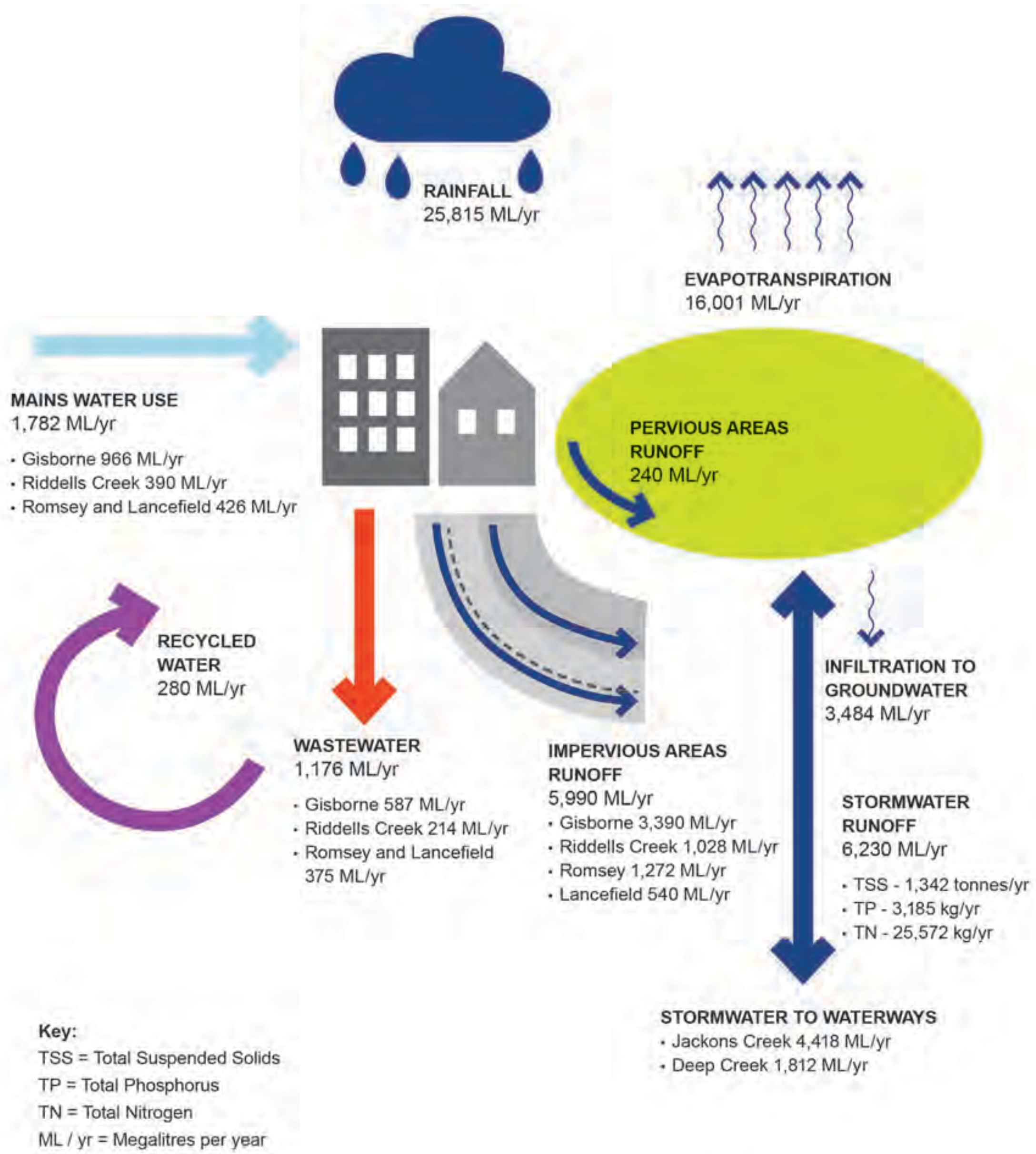


Figure 12: Water balance for current conditions across all townships

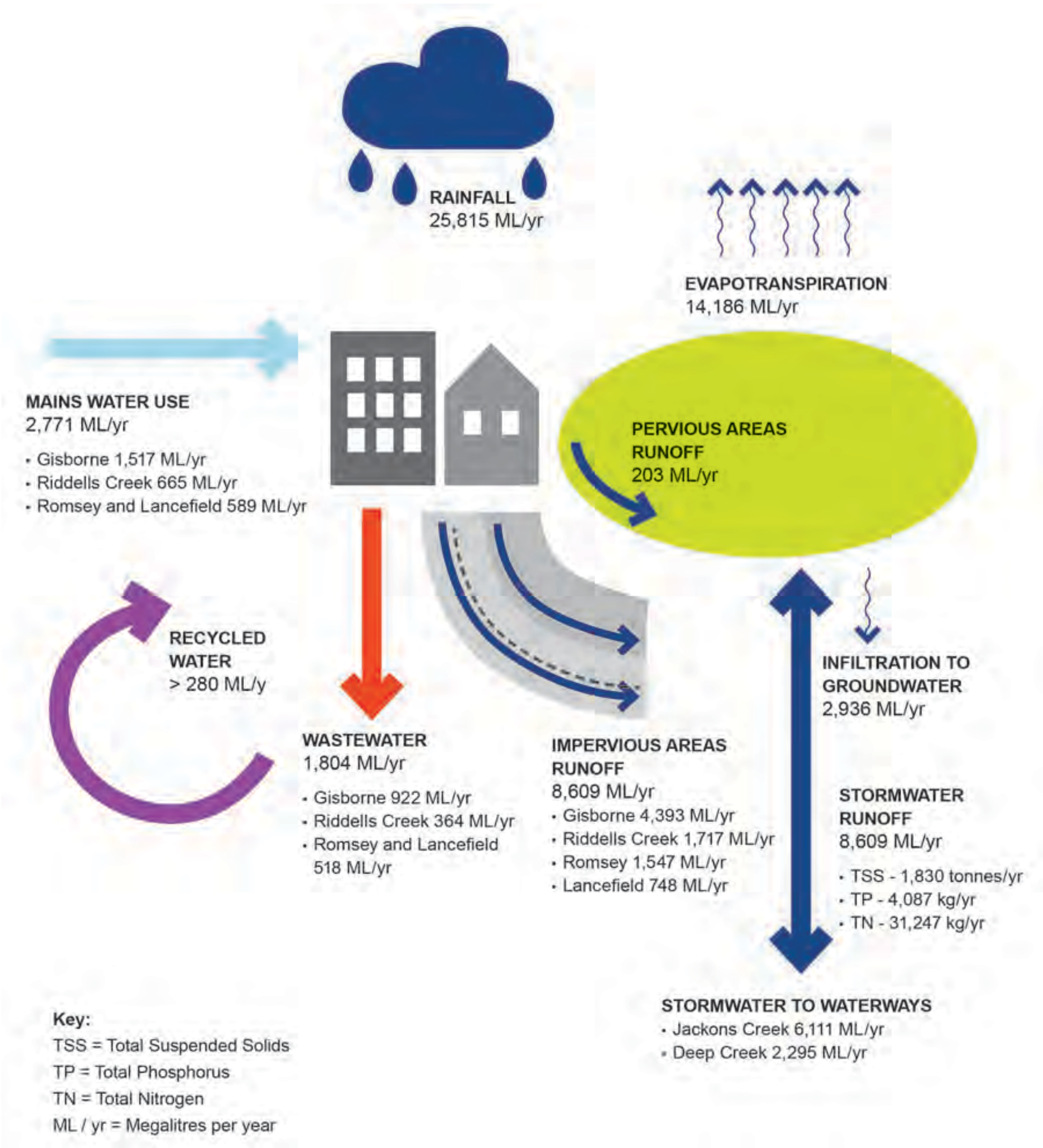


Figure 13: Water balance of future conditions across all townships (2036)

3.2 Option identification

A workshop was held with key stakeholders to identify IWM options for the 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.

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). All of these water types were then explored for a range of management options and pairing with demands, ranging from substitution of potable water use in homes or for irrigation of public spaces, to provision of environmental flows or enhanced infiltration. The results of this process are documented in Attachment 1 as a long list. A long list of 100 opportunities was identified for the Southern Macedon Ranges area.

3.3 Option prioritisation

3.3.1 Strategic IWM outcomes

Macedon Ranges Shire falls within the Maribrynong IWM forum area, which has outlined seven strategic outcomes in its *IWM Forum Strategic Directions Statement.* Figure 12 summarises the seven strategic outcomes.

These strategic IWM outcomes consist of:

- Safe, secure and affordable supplies in an uncertain future
- Effective and affordable wastewater systems
- Opportunities to manage existing and future flood risks and impacts
- Healthy and valued waterways and marine environments
- Healthy and valued landscapes
- Community and Traditional Owner values that are reflected in place-based planning
- Jobs, economic growth and innovation

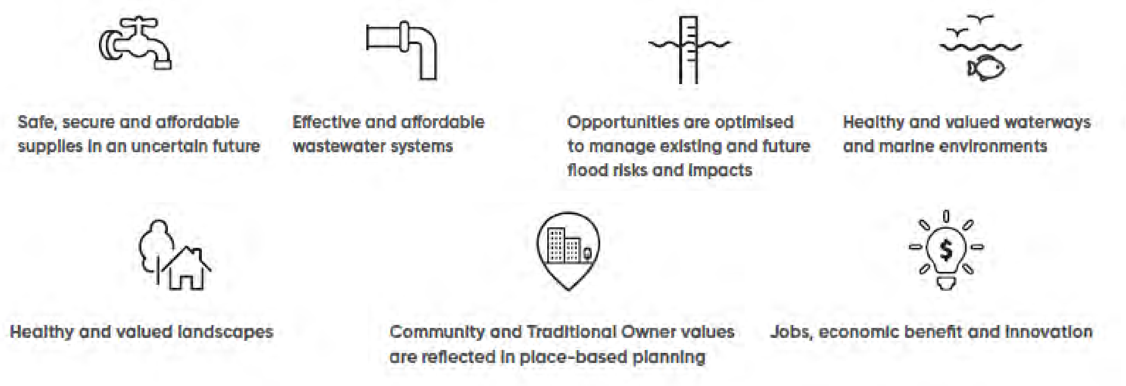


Figure 14: Strategic IWM outcomes identified in the IWM forums

3.3.2 Preliminary Assessment

The Preliminary Assessment Method (PAM) 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 seven strategic outcomes as shown in Table 6.

Table 6: Indicators selected for option assessment (blue shade indicates a quantifiable indicator, orange shade indicates a qualitative indicator)

Strategic outcome	Indicators
Safe, secure and affordable supplies in an uncertain future	Reduction in use of potable water
Effective and affordable wastewater systems	Beneficial use of treated wastewater
Healthy and valued waterways and marine environments	Reduction in total nitrogen (TN) entering local waterways
	Reduction in stormwater runoff (via infiltration or harvesting)
	Increase in environmental flow benefit for Jacksons Creek
Opportunities are optimised to manage existing and future flood risks and impacts	Reduction in local flood risk
Healthy and valued landscapes	increase in irrigation of open space with alternative water
	Increase in shade and localised cooling
Community and Traditional Owner values are reflected in place-based planning	Increase in community education and awareness
	Increased in enhancement of traditional owner values
Jobs, economic benefit and innovation	Increase in alternative water supply for agriculture

The preliminary assessment is presented in Attachment 1. 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 Southern Macedon Ranges area included:

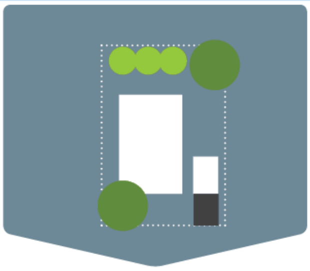
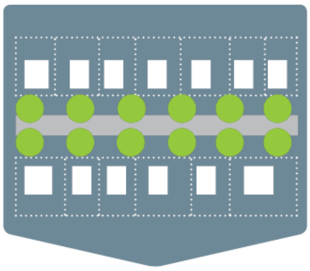
- **Nearly all existing public open space in the townships is already provided with an alternative water source (recycled water) for irrigation use.** This outcome has been driven by a desire to secure alternative sources after the impacts experienced during the Millennium Drought, and through a need to reduce treated wastewater discharges to inland waterways. This limits the scope for stormwater to be utilised as a resource to support existing open space.
- **Development areas are relatively small scale and dispersed, meaning that decentralised non-potable supply systems may be difficult to deliver.** The provision of a non-potable water supply network to new homes is unlikely to be feasible for smaller developments due to the costs of providing decentralised treatment and distribution relative to the benefits delivered. This is likely to mean that the provision of rainwater tanks, delivered at a lot scale, is a more flexible and deliverable option across dispersed developments, compared to large networks supported by recycled water or stormwater.
- **More green space in roadways and in development lots could support more opportunities for passive irrigation and infiltration.** Compared with development areas in Metropolitan Melbourne, the lot size for new homes is larger (~800m^2 is typical) and the width of roadways is more generous. This provides more opportunity for stormwater management and infiltration at a local scale. Conversely, the local drivers for enhanced greening and urban heat island mitigation are comparatively lower due to the lower ratio of 'impervious' paved areas to 'pervious' green areas.
- **The presence of local water supply storages and water treatment plants provides opportunities to supplement potable supply with alternative resources in the long-term.** Gisborne is located adjacent to Rosslynne Reservoir and the potable water treatment plant for the broader region, and Lancefield is located in a groundwater supply area, where there are existing supply bores and a treatment system and where initial feasibility of managed aquifer recharge has shown promise.
- **New agricultural enterprises and enhanced production could be supported on local land through the provision of water resources.** Land near Gisborne and Lancefield shows good potential for agricultural productivity. Agricultural uses can support large-scale utilisation of recycled water or stormwater in the area.
- **Options that will support stormwater harvesting and infiltration targets in Melbourne Water's Healthy Waterways Strategy are available at all scales, though large-scale end of line stormwater harvesting is likely to achieve the largest reductions.** Source control measures at a lot and street scale will assist in providing infiltration however, this will be limited by the infiltration rate of local soils. Local reuse of stormwater is likely to be demand-limited to non-potable uses in homes and new open space irrigation demands. Larger flow reductions will depend on large-scale regional harvesting at the end of a town's drainage system, and transfer of water to another beneficial use or large infiltration areas.

- **Water quality of local waterways will be impacted by both stormwater and wastewater, and there are drivers to reduce both of these impacts.** The water balance indicated that the nitrogen discharge to the local waterways from treated wastewater is likely to outweigh that from stormwater, highlighting the reduction of future treated wastewater discharges should not be forgotten as a priority for the area.
- **Waterway improvement options showed strong potential to enhance community values, biodiversity and stormwater retention and infiltration.** The study areas include several waterways and tributaries that run through urban areas in the study, providing great opportunities for enhancement that will improve both waterway health and liveability. Community groups, council and Melbourne Water already have active programmes which are delivering waterway improvement projects in this area.

3.4 Promising IWM Options in Southern Macedon Ranges

Based on the preliminary analysis and discussions in a stakeholder workshop, a shortlist of promising IWM options that warrant further investigation and consideration by stakeholders was created. These options vary in scale, ranging from lot-scale to town-scale initiatives. Given the major drivers for reduction of both stormwater and treated wastewater discharges to local waterways, a larger number of town-scale initiatives were identified, where economies of scale will driver greater impacts.

Table 7: Promising IWM options in the Southern Macedon Ranges area

Option scale	Promising options emerging from the preliminary assessment
 Lot-scale	• Rainwater tanks non-potable uses for new development. Possible trial of inclusion of hot water to deliver higher savings. • Increased permeability requirements for new development. •
 Neighbourhood-scale	• Roadside swales and passively irrigated street trees in new development areas to enhance liveability and stormwater management. • Bioretention and wetlands in public open space to provide enhanced stormwater treatment in existing areas. • Waterway enhancement for increased riparian value and infiltration of stormwater (particularly in Riddells Creek, Romsey and Gisborne).

 Town-scale	• Recycled water or stormwater to support agriculture on nearby land (Gisborne, Riddells Creek, Romsey and Lancefield) • Town-scale stormwater harvesting and transfer to land sponges (Romsey/Lancefield) • Town-scale stormwater harvesting and transfer to aquifer recharge (Romsey/Lancefield) • Town-scale stormwater or recycled water capture to supplement regional water supply (Gisborne) – long term option

3.5 Selected options for concept design analysis

Some of the promising options are well-understood, and are already being delivered by the stakeholders, while other options have not been examined in detail to date, and their viability is less certain. The following options were selected for concept design analysis (see next chapter), with the aim of filling gaps in knowledge and learning more about the relative cost-benefit of options. The options selected do not represent an exhaustive list of the IWM options that should be supported in the area, but rather represent promising options that were explored in more detail to better understand their deliverability.

Table 8: Promising IWM options selected for further analysis

Option	Location/s	Description
1. Lot-scale initiatives to reduce stormwater runoff in from new developments	All towns	Exploration and comparison of the performance and cost of a range of options that could be delivered on-lot to reduce stormwater runoff and promote infiltration including, including: • Rainwater harvesting (for garden, toilet flushing, laundry) • Rainwater harvesting (for garden, toilet flushing, laundry and hot water) • Leaky tanks • Raingardens • Downpipe diversion to infiltration areas • Change in permeability of ground surfaces • Passively irrigated trees (front yard or verge)
2. Large-scale end-of-line stormwater harvesting for infiltration or aquifer injection	Romsey and Lancefield	Exploration and costing of town-wide harvesting for local management of stormwater through transfer to: a) Aquifer injection b) infiltration and evaporation sponges
3. Substitution of existing groundwater extraction licenses through provision of an alternative source to agricultural uses	Romsey and Lancefield	Review of existing local allocations for groundwater which could be substituted for an alternative source. Allocations could then be utilised for potable extraction of groundwater. Two possible sources of alternative water supply could be provided to local agricultural uses: a) Recycled water b) Stormwater
4. Enhancement of recycled water use through extended provision to new open space irrigation	Gisborne	Review of possible new opportunities for irrigation with recycled water from the Gisborne (Class B) Plant and network. These may include landscapes in new development areas and currently unirrigated landscapes in established areas.
5. Large-scale end-of-line stormwater harvesting for regional supply	Gisborne	Review of favourable harvesting points in Gisborne where stormwater treatment and harvesting could be included and transferred to for regional storage and reuse (possibly linking to neighbouring scheme in Sunbury).

4. Evaluating Opportunities: Option analysis and evaluation

4.1 Evaluation approach

Each of the selected 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. Rates were based on industry standards available from Western 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 was also evaluated against the indicators identified in section 3.3 and quantified where possible. The cost assumptions and summaries for each option are included in Attachment 2.

4.2 Option 1: Lot-scale initiatives to reduce stormwater runoff from new developments

Description

This option considers the application of a range of initiatives at the private lot-scale, which could be influenced by planning controls. The initiatives are aimed at reducing stormwater runoff through increased permeability and rainwater harvesting.

Eight different design combinations were tested, and the top three performing scenarios for flow reduction were costed[14]. These all included rainwater tanks, and either infiltration trenches, passively watered street trees or pervious ground surfaces. The eight initial design combinations and their flow reduction performance is summarised in Table 9.

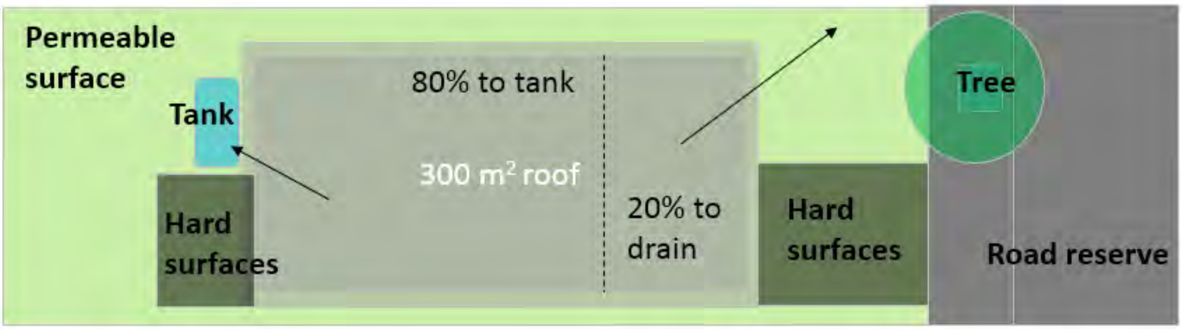
[14] While design combination 7 performed slightly better than design scenario 6, design scenario 6 was chosen to include more diversity of lot-scale initiatives for comparison purposes.

Table 9: Lot-scale design combinations, with chosen designs shown in bold

	Combination	Flow reduction (%)
	2kL tank	9
	4kL tank supplying hot water	14
	2kL tank + 10m^2 raingarden	13
Option 1a	**2kL tank + 10m^2 infiltration trench**	**31**
	2kL tank + 4m^2 street trees	10.6
Option 1b	**4kL tank (HW) + 4m^2 street trees**	**15.4**
	2kL tank + increase permeability (from 30% to 40%)	17
Option 1c	**2kL tank + 100% pervious ground**	**33**

Key analysis assumptions and infrastructure requirements

The scenarios are tested on a base case 800 m^2 lot layout. This is in alignment with Macedon Ranges Shire Council planning scheme provisions (Cl 21.13, Objective 5) and validated from inspecting aerial images of recently built suburbs across Gisborne.



Assumptions:

- Non-potable water demands: 54.2 kL/household/year for toilet, garden, outdoors and laundry (cold water); 83.1 kL/household/year for hot water (laundry and shower), toilet, garden and outdoors.
- 300 m^2 roof area
- 30% site permeability (base case)
- 20 metre road frontage, 14 metre total road reserve (equivalent to 140 m^2 per lot, based on half the road reserve)

Three combinations were costed, as described below.

1a) 2kL rainwater tanks + infiltration trenches

This scenario assumes 80% of the roof area is connected to a 2kL rainwater tank, supplying water to toilet, garden, outdoors and laundry (cold water), and that hard surfaces from the lot drain to a $10m^2$ infiltration trench. The infiltration trench assumes a subsoil infiltration rate of 0.3mm/hr, representative of heavy clays. Subsoil infiltration rates may vary significantly within Macedon Ranges depending on the underlying soil conditions. For higher permeability soils such as sandy clays or sandy loams, the infiltration rates would be much higher (20-100mm/hr).

Note it is recommended that infiltration trenches capture 'clean' stormwater that is pre-treated for sediment. This may be roof water or alternately ground-level runoff that has passed through a form of sediment treatment such as swales, grass buffers or raingardens.

1b) 2kL rainwater tank and permeable ground surfaces

This scenario assumes 80% of the roof area is connected to a 2kL rainwater tank that supplies toilet, garden, outdoors and laundry (cold water). It also assumes ground surfaces are 100% permeable. This is an ambitious scenario, which would require porous pavement for hard surfaces such as driveways and outdoor areas. The scenario is included for completeness to demonstrate the flow reduction benefits that could be delivered through complete changes to ground-level permeability at the lot-scale.

1c) 4kL rainwater tank and street trees

This scenario assumes 80% of the roof area is connected to a 4kL rainwater thank that supplies hot water (laundry and shower), toilet, garden and outdoors. It also assumes every lot has a $4m^2$ passively watered street tree on the street frontage, which is connected to excess lot runoff and runoff from the road.

Cost

The costs below are aggregated across all 3,803 new lots for all townships.

Item	Capital Cost ($)	Operating Cost ($/yr)
Option 1a	$40.5M	$509.6k
Option 1b	$29.1M	$966.0k
Option 1c	$26.4M	$414.5k

Benefits

	Safe, secure and affordable supplies in an uncertain future	Healthy and valued waterways and marine environments	Healthy and valued landscapes	Community and Traditional Owners values are reflected in place-based planning
Option 1a	• **Mains potable water supply substitution:** 175 ML/yr	• **Reduction in nitrogen entering waterways:** 1,757 kg/yr • **Reduction in stormwater discharge:** 574 ML/yr (31% flow reduction)	• **Increase in shade and localised cooling:** Alternative water is available for private gardens during dry periods, when water restrictions may limit use of potable water for irrigation.	• **Community education and awareness:** Solutions applied at the home will substantially increase understanding and literacy of water cycle and integrated water management.
Option 1b	• **Mains potable water supply substitution:** 175 ML/yr	• **Reduction in nitrogen entering waterways:** 1,966 kg/yr • **Reduction in stormwater discharge:** 620 ML/yr (33% flow reduction)	• **Increase in shade and localised cooling:** Alternative water is available for private gardens during dry periods, when water restrictions may limit use of potable water for irrigation.	• **Community education and awareness:** Solutions applied at the home will substantially increase understanding and literacy of water cycle and integrated water management.
Option 1c	• **Mains potable water supply substitution:** 269 ML/yr	• **Reduction in nitrogen entering waterways:** 2,392 kg/yr • **Reduction in stormwater discharge:** 285 ML/yr (15% flow reduction).	• **Increase in shade and localised cooling:** Alternative water is available for private gardens during dry periods, when water restrictions may limit use of potable water for irrigation.	• **Community education and awareness:** Solutions applied at the home will substantially increase understanding and literacy of water cycle and integrated water management.

Optimisation and delivery

Rainwater tanks can substantially reduce runoff volumes in suburbs where the demands are densely located, such as townhouses and small terrace housing. This is due to the relatively small roof areas per household. In Southern Macedon Ranges, roof areas are larger than average across greater Melbourne, while the internal water demands are relatively similar. As a result, rainwater tanks are highly limited by the water demands. Given this, to reduce stormwater runoff at the lot-scale, Council should encourage ground-level solutions in addition to rainwater tanks (in providing potable water substitution and resilience).

In particular, infiltration trenches have the potential to substantially reduce site runoff, beyond the 31% flow reduction estimated for Option 1a. As a sensitivity test, a higher subsoil infiltration rate of 20 mm/hr was adopted, and flow reduction for this option approximately doubled.

To get the most cost effective outcomes at the lot-scale, Macedon Ranges Shire Council should look to encourage the use of permeable paving and infiltration trenches.

4.3 Option 2: Large-scale end-of-line stormwater harvesting from Romsey and Lancefield for infiltration or aquifer injection

Romsey and Lancefield have relatively simple drainage networks, with few major drainage points leaving the townships. This makes end-of-line stormwater harvesting and infiltration systems more feasible, by reducing the number of sites required to capture and harvest stormwater before it is discharged into receiving waterways.

4.3.1 Option 2a) Stormwater harvesting for aquifer injection

Description

This option explores capturing stormwater from these major drainage points for harvesting, with a long-term option to inject this water into the aquifer, helping increase the supply of the local bore water for potable use. The sites and catchments are shown in Figure 15 and Figure 16.

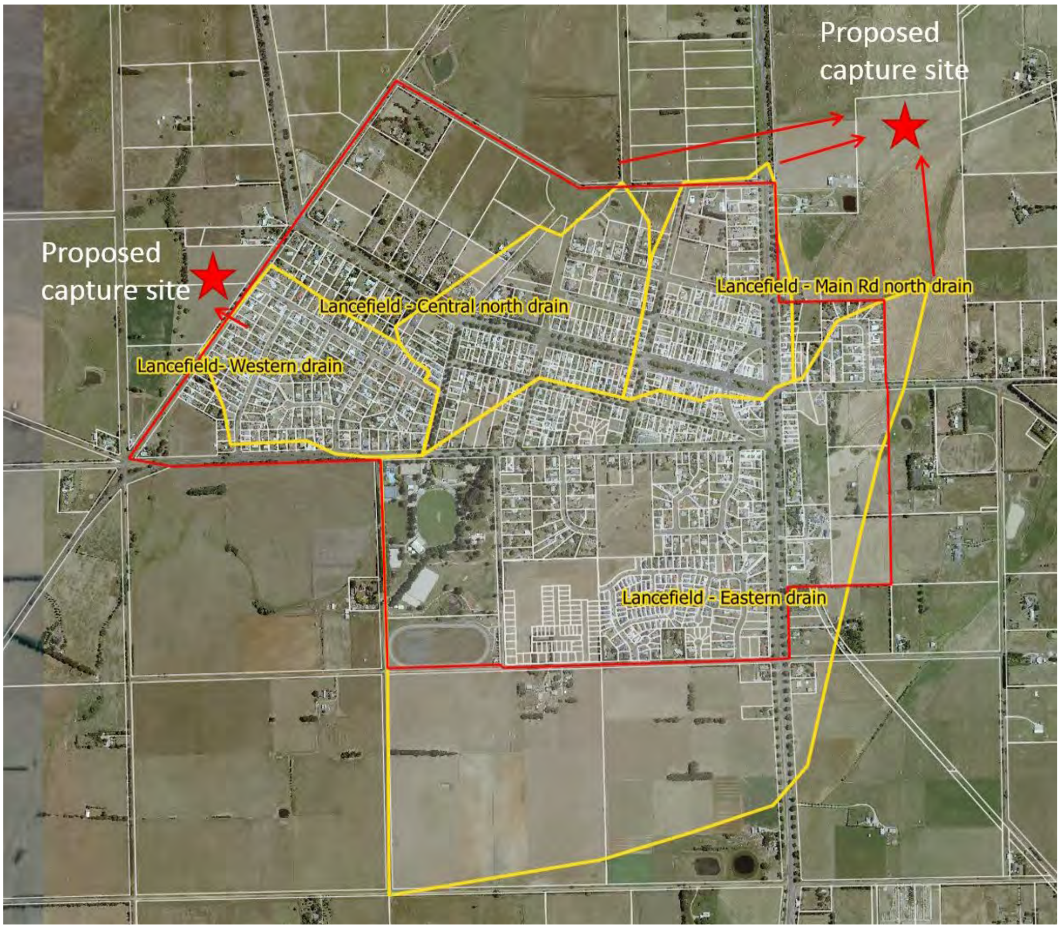


Figure 15: Stormwater catchments and proposed sites in Lancefield

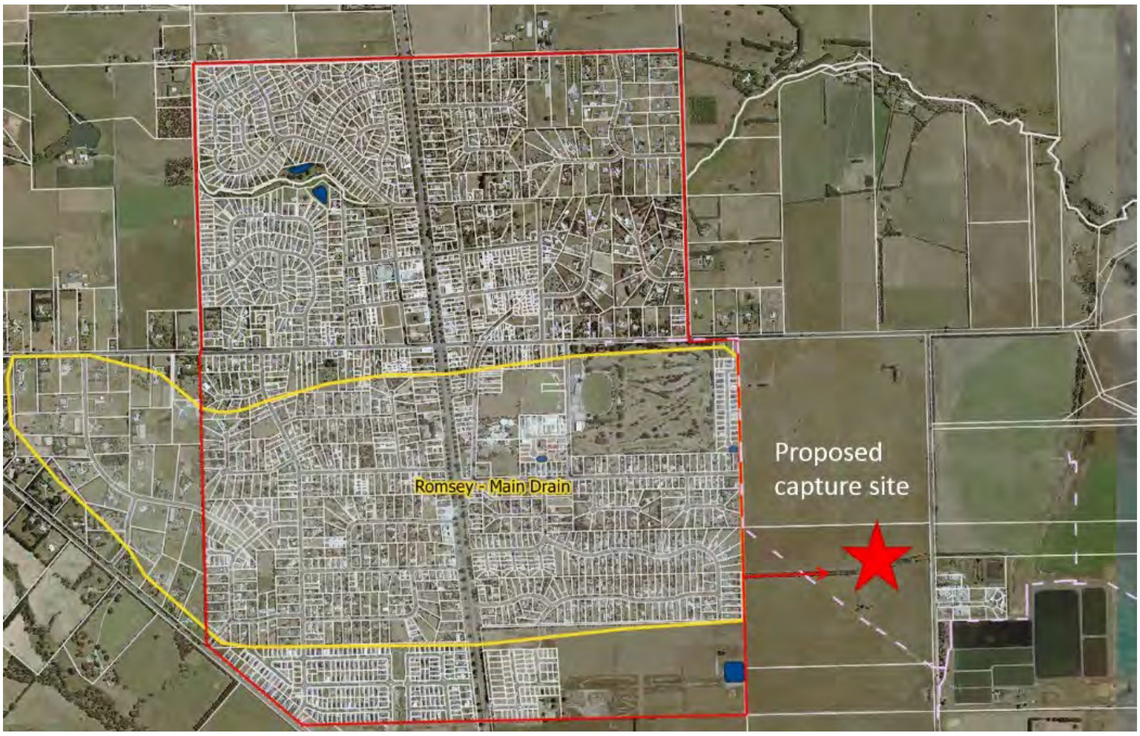


Figure 16: Stormwater catchment and proposed site in Romsey

Key analysis assumptions and infrastructure requirements

- Wetlands sized at 3% of total impervious catchment area.
- Land acquisition priced at $25/m^2 based on review of recent multi-hectare publicly listed sale prices within Macedon Ranges Shire. This is slightly above average from the prices found online (average $17/m^2 from four sale results), reflective of the higher prices found closer to town centres, and below the $39/m^2 from the Victorian Value General (2018) for rural land state-wide.
- Wetlands are configured to maximise yield, as per concept designs for Sunbury's harvesting wetland.
- Wetland design:
  - Q5 high flow bypass
  - Daily demand rate set to draw down wetland extended detention volume over three days (achieved through pumped low flow outlet)
  - 300 mm permanent pool volume
  - 500 mm extended detention depth
- Injection rate of 20 L/s for each bore.
- Lancefield harvested flows are sent to a central bore field at the treatment plant, where the new bores can be used for both injection and extraction.
- Romsey harvested flows are injected locally, recharging the regional aquifer. Additional bore included at central bore field for local extraction.

	Required infrastructure
Lancefield northern wetland	• Land acquisition – 24,060 m^2 • Treatment wetland – 20,050 m^2 • Low flow pump outlet – 2.7 kW • UV disinfection • Diversion channels between adjacent catchments – 890 m
Lancefield southern wetland	• Land acquisition – 6,012 m^2 • Treatment wetland – 5,010 m^2 • UV disinfection • Low flow pump outlet – 4.2 kW
Romsey main drain wetland	• Treatment wetland – 30,900 m^2 • UV disinfection • Low flow pump outlet – 4.2 kW
Shared infrastructure	• 100mm pipe connection from Lancefield west wetland to bore field (treatment plant) – 2,300 m • 250mm pipe connection from Lancefield north wetland to bore field (treatment plant) – 4,975 m • New bores – x7 • Water treatment plant capacity upgrade (to manage increased potable supply)

Costs

Item	Capital Cost ($)	Operating Cost ($/yr)
Lancefield northern wetland and associated bores	$3.57M	$27.7k
Lancefield western wetland and associated bores	$0.98M	$14.5k
Romsey southern drain and associated bores	$4.31M	$83.6k
Pipework from wetlands to treatment plant	$1.60M	$8k
Water treatment plant upgrade	Unknown	Unknown
Total	**$10.5M + cost of plant upgrade**	**$133.9k**

Benefits

Safe, secure and affordable supplies in an uncertain future	Healthy and valued waterways and marine environments	Jobs, economic benefit and innovation	Community and Traditional Owners values are reflected in place-based planning
• **Mains potable water supply substitution:** 904 ML/yr by injecting water into aquifer for later extraction to augment potable supply from borewells	• **Reduction in nitrogen entering waterways:** 2,791 kg/yr • **Reduction in stormwater discharge:** 1,114 ML/yr	• **Innovative water technologies:** Early adoption of ASR technology in Victoria, leading way for others in the state to follow.	• **Community education and awareness:** Large-scale infrastructure projects attract significant public attention and educate the community.

Optimisation and delivery

In order to optimise costs, this option assumes that harvested water from Romsey can be directly injected into the aquifer locally, and that the equivalent volume can be extracted for potable substitution at the treatment plant in Lancefield.

Aquifer storage and recharge is an innovative approach for integrated water management in Victoria. Western Water has begun injection trials in Lancefield showing promise. However, as a new solution, more research and trials are needed to further investigate the feasibility of this option.

In Lancefield, irrigation of the Lancefield Recreation Reserve from the proposed capture site on the west was not included in the option given the reserve is 1km uphill from the proposed site. It was assumed the cost of pumping and piping this water would be uneconomical for the demand. However, as a short-term solution, this could be considered.

4.3.2 Option 2b) End-of-line land sponges

Description

This option considers capturing stormwater in depressed vegetated zones within the landscape, referred to as ‘land sponges’. These land sponges will intercept and hold stormwater, which is then infiltrated and evaporated.

This option uses the same sites and catchments as Option 2a.

Key analysis assumptions and infrastructure requirements

- Land acquisition priced at $25/m^2 based on review of recent multi-hectare publicly listed sale prices within Macedon Ranges Shire. This is slightly above average from the prices found online (average $17/m^2 from four sale results), reflective of the higher prices found closer to town centres, and below the $39/m^2 from the Victorian Value General (2018) for rural land state-wide.
- Lancefield land sponges are sized at 10% of impervious catchment area. Sponges were tested at 5% also, with increased effective yield (i.e. cost per ML of runoff reduced) at the 10% size.
- Romsey land sponge is sized at 5%, corresponding to 25,800 m^2. Based on aerial images, there is space for this sized sponge on Western Water’s existing irrigation land, reducing costs for land acquisition.
- Land sponges are designed with 0.5m extended detention depth and 0.5 m deep infiltration media (55 mm/hr exfiltration rate).
- Bioretention nodes were used in MUSIC, without underdrainage and without nutrient effective plants. While media filtration are typically suitable for infiltration systems, media filtrations nodes cannot model extended detention, so bioretention nodes are more suitable for this application.
- Sponge construction assumes $120/m^3.

	Required infrastructure
Lancefield northern wetland	• Land acquisition – 40,092 m^2 • Land sponge – 33,410 m^2 • Diversion channels between adjacent catchments – 890 m
Lancefield southern wetland	• Land acquisition – 10,020 m^2 • Land sponge – 8,350 m^2
Romsey main drain wetland	• Treatment wetland – 51,600 m^2

Cost

Item	Capital Cost ($)	Operating Cost ($/yr)
Lancefield northern land sponge	$3.62M	$12.7k
Lancefield western land sponge	$0.9M	$2.5k
Romsey southern land sponge	$3.72M	$15.5k
Total	**$8.24M**	

Benefits

Safe, secure and affordable supplies in an uncertain future	Healthy and valued waterways and marine environments	Community and Traditional Owners values are reflected in place-based planning
• **Mains potable water supply substitution:** 1,114 ML/yr	• **Reduction in nitrogen entering waterways:** 2,791 kg/yr • **Reduction in stormwater discharge:** 901 ML/yr	• **Community education and awareness:** Large-scale infrastructure projects attract significant public attention and educate the community.

Optimisation and delivery

Infiltration rates may be higher than assumed in the modelling, but should be tested with geotechnical investigations to understand the underlying soil conditions. For this solution, the more detailed location of the site should be selected where infiltration rates are highest, to maximise stormwater runoff reduction.

4.4 Option 3: Substitution of existing groundwater extraction licenses through provision of an alternative source to agricultural uses (recycled water)

Background

Good quality agricultural soils and reliable groundwater resources exist in the Lancefield / Romsey area and provide a unique opportunity to explore an alternative water option where alternative water supplies could be provided for agriculture to enable the reallocation of groundwater licenses for potable water supply.

A groundwater management area (Lancefield GMA) is in place over the basalt aquifer underlying the surrounding area, shown in Figure 17. The GMA is about 9 km by 5 km, with a total area of 4600 ha. The area has very reliable groundwater supply.

Much of the land located within the Lancefield GMA has good quality soils; Class 1 and 2 agricultural capability. At present there are 15 licences in place with a total licenced volume of 1,380 ML. A Permissible Consumptive Volume (PCV) currently applies to the Lancefield GMA. The PCV is a cap on the amount of groundwater allocated in this management unit. The PCV for Lancefield GMA is 1,485 ML/yr. In the past five years total usage from these licences has ranged between approximately 100 and 600 ML/year, suggesting there is a significant amount of under use.

Western Water has two operational bores (one located north of the Lancefield GMA and one located south) which have contributed between 50 and 100 ML/year to the Romsey / Lancefield water supply over the past five years.

Water consumption in Romsey / Lancefield in 2018/19 was 636 ML. Water is sourced from a combination of sources with the majority from Kerrie Reservoir (Bolinda Creek) and contributions from Garden Hut Creek, Rossylnne Reservoir and groundwater (70 ML is extracted from the two bores discussed above). Unless new local sources can be found, as demand grows in future, more water will need to be drawn from the Rosslynne Reservoir, and ultimately the Melbourne water supply.

4.4.1 Option 3a) Recycled water

Description

Over the next thirty years the volume of wastewater expected to be generated from the Romsey Recycled Water Plant is projected to grow by approximately 150 ML. There is potential for some of this volume to supplement some of the current groundwater use and free up the groundwater for potable purposes.

This proposal takes advantage of the local situation by supplying farmers within the GMA with recycled water from the Romsey RWP, and in return acquiring additional groundwater entitlement for urban supplies or returning this water to the environment, noting there are identified groundwater dependent ecosystems in the upper part of Deep Creek.

Figure 17 shows the proposal on a locality map. An area of 1600 ha has been identified which is located within the Lancefield GMA, has good quality agricultural soils, and is close to the raw water main which runs between Romsey and Lancefield Water Filtration Plants. Only a small area of irrigation (approximately 50 ha) is required.

Key analysis assumptions and infrastructure requirements

- Pipeline from Romsey RWP to farm at Lancefield GMA – 12 km length, 0.5 ML/day, 6 L/s, 100 mm diameter – Capex = $200/m, Opex = 0.5% pa.
- Install distribution pipework, totalling 12km of 150mm pipe – Capex $200/m, Opex 0.5% pa.
- Winter storage provided for 10 months storage (125 ML) – Capex $15k/ML, Opex 0.5% pa.
- Distribution pump, 90 m head (= 60 m static lift + 30 m friction loss) @ 0.5 ML/day and 60% efficiency, so Power = (90 x 6)/(102 x 0.6) = 10 kW, Capital Cost = $31,580*10^0.6299 = $135,000. Opex 1.5% pa. Electricity assume $1/m head/ML = 90 x 150 = $13,500 per year
- Develop 50 ha of irrigation – no cost, assume existing irrigated area, or farmer to install.
- Transfer 150 ML of groundwater licence from farmer to Western Water – no cost.
- Set up 150 ML recycled water agreement between Western Water and farmer – no cost.
- Install new bore to facilitate increase in extraction of groundwater for potable use – (similar to existing Glenfern Road Bores) – Capex $70000/bore, Opex = 0.5%.
- Potable water treatment – assumed zero for this analysis, as these costs would need to be borne under the base case.
- Design services assumed at 20% of Capex.

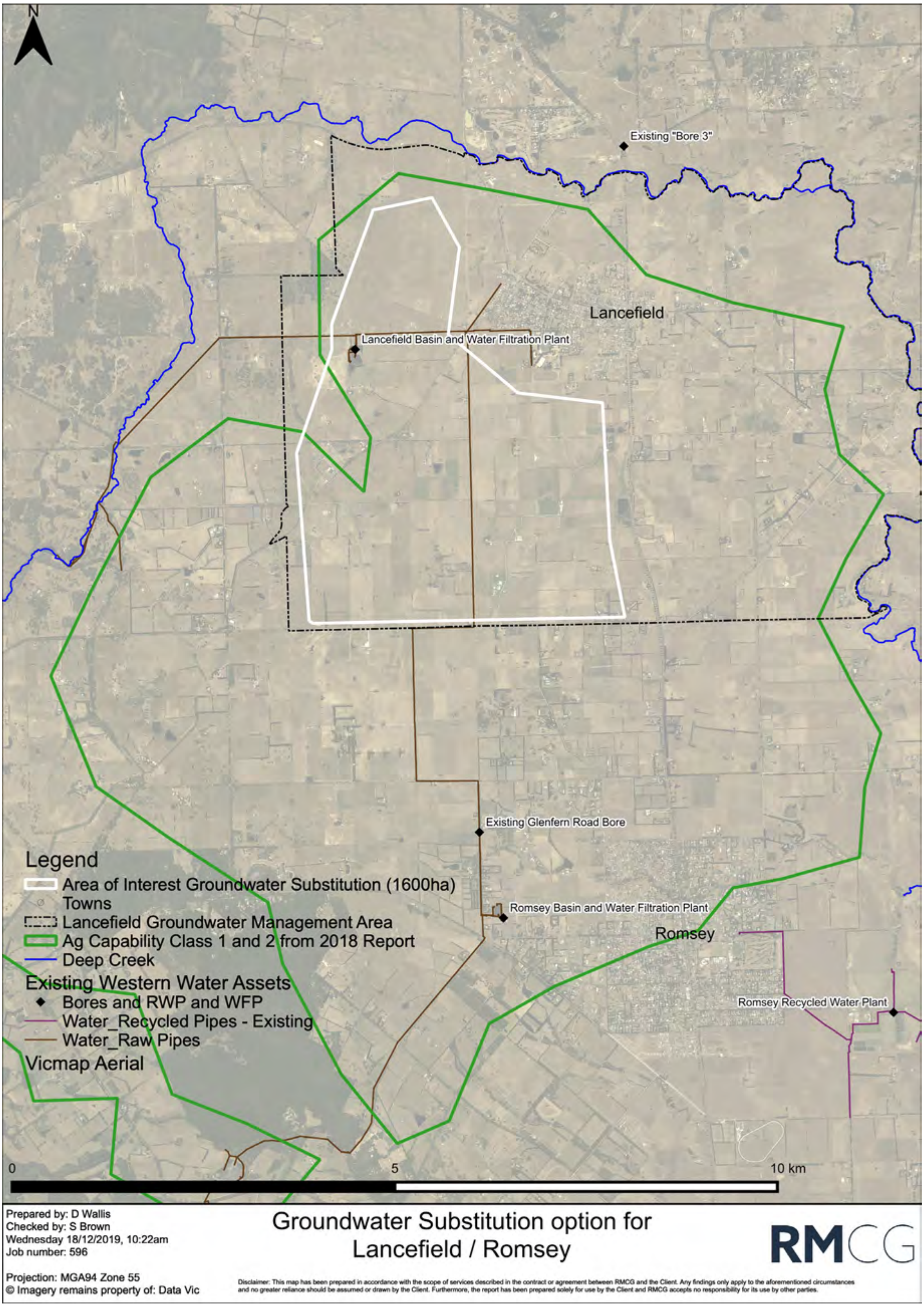


Figure 17: Lancefield and Romsey groundwater locality map

Costs

Item	Capital Cost ($)	Operating Cost ($/yr)
Pipeline	$2,400,000	$12,000
Winter storage	$1,875,000	$10,000
New bore	$70,000	$500
Distribution pump	$135,000	$2000
Power cost	-	$13,500
Design services	$900,000	0
Total	**$5,400,000**	**$38,000**

Benefits

Safe, secure and affordable supplies in an uncertain future	Effective and affordable wastewater systems	Healthy and valued waterways and marine environments	Jobs, economic benefit and innovation
• **Mains potable water supply substitution:** Through substitution, this option would achieve a 150 M/yr reduction in demand on Melbourne's potable supply. • **Resilient supply:** Western Water would have access to more local groundwater for the Romsey and Lancefield potable supplies and farmers would take advantage of reliable and unrestricted recycled water supply.	• **Beneficial use of treated wastewater:** Recycled water from Romsey RWP would be used for agriculture.	• **Reduction in nitrogen entering waterways:** Less recycled water volume and nutrients would be discharged from Romsey RWP to Deep Creek. This would result in a reduction of 1500 kg/yr of nitrogen entering Upper Deep Creek.	• **Alternative water supply for industry or agriculture:** This proposal would provide 150 ML/yr of alternative water supply to agriculture.

Optimisation and delivery

This option hinges on whether or not the farmers in the target area would be interested in such a proposal. They already have access to a very reliable and low cost source of water (groundwater licence) so might not be attracted to switching over to a recycled water supply. Nutrient contained in the recycled water could be an added advantage, but from experience we have seen that farmers are typically reluctant to relinquish any irrigation entitlement as they fear that it will reduce the value of their land. So, even if they aren't currently using the groundwater, they'll continue to pay the opportunity cost to keep access to the groundwater because they believe it will make it more valuable if/when they decide to sell.

Hidden costs borne by Western Water to treat the groundwater could also impact on the feasibility and would need to be investigated further.

Urban growth and the pressure it can put on agriculture in general and recycled water schemes in particular need to be taken into account. There is little point developing a long term plan to cater for growth if the urban growth then impinges on the scheme itself.

4.4.2 Option 3b) Stormwater harvesting

Description

This option looks at using stormwater harvesting from the western catchment in Lancefield to supplier agricultural users with an alternative use source to agricultural uses (stormwater). In return, Western Water could acquire the groundwater entitlement from farmers for urban supplies.

Key analysis assumptions and infrastructure requirements

- Seasonal water demand of 150 ML/y for agricultural use (to create direct comparison with Option 3a)
- All outflows from wetland directed to winter storage/ irrigation
- Winter storage sized at 7,500 kL
- Wetland design:
  - Q5 high flow bypass to increase harvesting yield (compared with Q1 typical high flow bypass)
  - 400 mm permanent pool depth
  - 400 mm extended detention depth
- Assume 500 m pipework from site to user
- Land acquisition priced at $\$25/m^2$ based on review of recent multi-hectare publicly listed sale prices within Macedon Ranges Shire. This is slightly above average from the prices found online (average $\$17/m^2$ from four sale results), reflective of the higher prices found closer to town centres, and below the $\$39/m^2$ from the Victorian Value General (2018) for rural land state-wide.

Costs

Item	Capital Cost ($)	Operating Cost ($/yr)
Land acquisition	$150,000	
Wetland	$427,000	$12,000
Pipework to users	$125,000	$3,600
UV disinfection	$194,000	$60
Pump and electrics	$60,000	$1,700
Winter storage	$150,000	$750
Design services	$221,000	
Total	**$1,327,000**	**$18,200**

Benefits

Safe, secure and affordable supplies in an uncertain future	Healthy and valued waterways and marine environments	Jobs, economic benefit and innovation
• **Mains potable water supply substitution:** Through substitution, this option would achieve a 93 M/yr reduction in demand on Melbourne's potable supply. • **Reliable supply:** Western Water would have access to more local groundwater for the Romsey and Lancefield potable supplies and farmers would take advantage of reliable and unrestricted recycled water supply.	• **Reduction in nitrogen entering waterways:** Less recycled water volume and nutrients would be discharged from Romsey RWP to Deep Creek. This would result in a reduction of 250 kg/yr of nitrogen entering Upper Deep Creek. • **Reduction in stormwater discharge:** 93 ML/yr	• **Alternative water supply for industry or agriculture:** This proposal would provide 93 ML/yr of alternative water supply to agriculture.

Optimisation and delivery

This option is limited by the catchment size and yield available from Lancefield's western side of town. To optimise yield for agricultural irrigation, Lancefield's northern catchments could be used instead. However, this would require higher pipe and pump costs to transfer water from the site to agricultural users (located west of town), so while the yield would increase, it is unlikely to be more cost effective than the current design. Council may also wish to investigate using the water to supply the Lancefield Recreation Reserve. However, as discussed in earlier options, the reserve is 1km from the site, uphill, so infrastructure costs may be prohibitive.

4.5 Option 4: Enhancement of recycled water use in Gisborne through extended provision to new open space irrigation

Description

Background

Gisborne (including "old" Gisborne and New Gisborne) is a fast growing locality with increasing demand for open spaces for passive and active recreation. Treated wastewater harvesting for open space irrigation presents a real opportunity in Gisborne.

All sewage from existing and new residential development in the area gravitates to the Gisborne Recycled Water Plant (RWP), which is located adjacent to Jacksons Creek downstream of the Calder Freeway. Some of the Class B recycled water generated from the Gisborne (RWP) is recycled, but most of it discharges to Jacksons Creek.

In 2019, 550 ML of recycled water was generated; 150 ML was reused, and 400 ML was discharged to the waterway. By 2050 the volume of recycled water available from the Gisborne RWP is projected to increase by 340 ML. As can been seen above, recycled water is not in short supply. This option aims to enhance recycled water use in Gisborne through extended provision to open space irrigation.

The existing recycled water infrastructure supplies a number of Council and private users. A network of small diameter pipes along Jacksons Creek supplies the bowling club and a number of Council parks along Jacksons Creek and terminates at the golf club where water is supplied into dams and then irrigated on the golf course. Additional users are supplied with a pipeline to the south, including wineries and other private landowners. The total contracted volume for the scheme is 160 ML/yr, of which 40 ML/yr is for the golf club. Figure 18 shows the extent of the existing recycled water network and a summary of the existing total contract volumes (the existing network is shown in green). Supply agreements specify peak and off peak contract volumes.

Discussions with Western Water engineers indicate the newer scheme has the capacity to allow new extensions to be made to service open space. This option looks at supplying additional and proposed open spaces with recycled water for irrigation.

Description of proposal

The following possible new opportunities for irrigation with recycled water from the Gisborne (Class B) Plant have been considered (from north to south as shown on Figure 20 – shown in purple):

1. Proposed Sports Precinct
2. Growth areas in New Gisborne
3. New Gisborne Primary School
4. Ross Watt Reserve
5. New development areas in New Gisborne
6. New development in Gisborne

Irrigation demand varies from year to year depending on the season but a volume of 5 ML//ha/year should be sufficient to water turf. Assuming 6% of development land becomes irrigated public open space, there is potential new demand of 165 ML/year across 33 ha of open space.

New winter storage lagoons will need to be built as part of this scheme. A site has been chosen for this study on Magnet Hill next to one of Western Water's existing potable water tanks. The equivalent of approximately 10 months demand is needed for a 90%ile containment scheme in this climate. A storage of 140 ML could have dual benefits in Gisborne:

1. Store more winter flows for reuse and help avoid Gisborne treatment plant exceeding discharge licence in wet years.
2. Store excess summer flows and help avoid ecologically unhelpful summer base flow discharges to Jacksons Creek.

Extending the recycled water scheme north to New Gisborne is similar in principle to extending the scheme in old Gisborne. The new network shown in Figure 18 has 11 km of water mains.

The existing pumping station at the RWP should be able to lift water to Magnet Hill (RL 510m) because the highest customers in the Gisborne South scheme are above (RL 500m). However, this and all other engineering assumptions would need to be confirmed.

Technically these schemes are relatively straightforward and a recycled water scheme to the north would be similar to the one that serves the rural area to the south.

Key analysis assumptions and infrastructure requirements

- Network designed to deliver 165 ML/year Class B recycled water from Gisborne RWP to 33 ha of new public open space.
- New recycled water mains – 11 km, average size 150 mm, Capex $300/m, Opex 0.5% pa.
- Winter storage at Magnet Hill – 140 ML, Capex $15k/ML, Opex 0.5% pa.
- Irrigation areas – cost not included, as this would be required for potable irrigation
- Water pumping - $1/m head /ML. Lift from RWP to Magnet Hill ~ 110m, Volume 165 ML/year.
- Water pump - 120 m head (= 110 m static lift + 10 m friction loss) @ 0.5 ML/day and 60% efficiency, so Power = (120 x 6)/(102 x 0.6) = 12 kW, Capital Cost = $31,580*12^0.6299 = $150,000. Opex 1.5% pa.

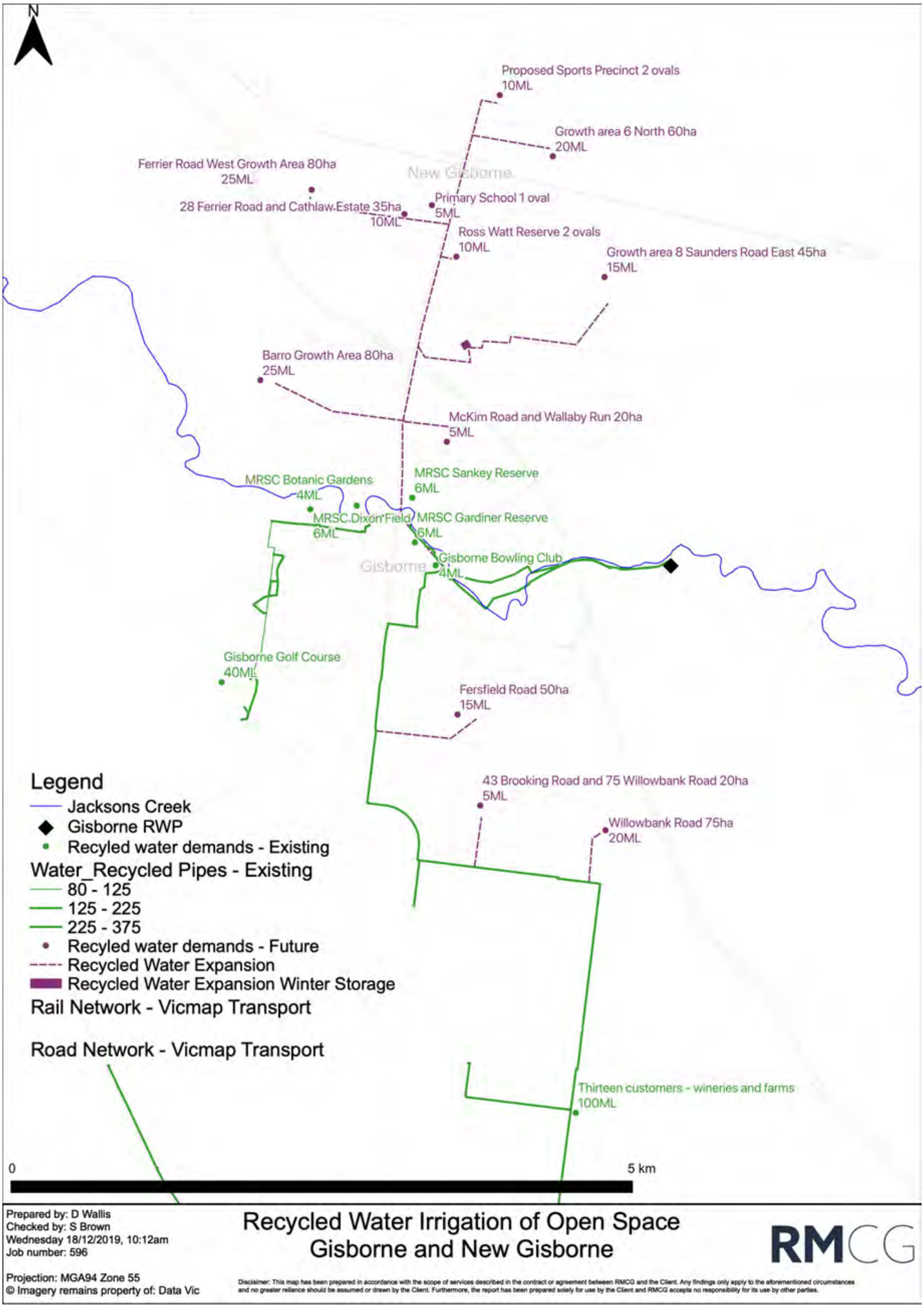


Figure 18: Gisborne and New Gisborne recycled water irrigation

Costs

Item	Capital Cost ($)	Operating Cost ($/yr)
Pipeline	$3,300,000	$16,500
Winter storage	$2,100,000	$10,500
Pump station	$150,000	$2,500
Pumping – electricity	-	$20,000
Design services	$1,290,000	-
Total	**$6,660,000**	**$49,500**

Benefits

Safe, secure and affordable supplies in an uncertain future	Effective and affordable wastewater systems	Healthy and valued waterways and marine environments	Healthy and valued landscapes
Mains potable water supply substitution: This option provides 165 ML/y of recycled water that would otherwise need to be provided through potable water.	**Beneficial use of treated wastewater**: 165 ML/year recycled water from Gisborne RWP would be used for open space irrigation.	• **Reduction in nitrogen entering waterways**: Less recycled water volume and nutrients would be discharged from Gisborne RWP to Jacksons Creek. This would result in a reduction of 1650 kg/year of nitrogen entering Upper Jacksons Creek.	• **Irrigation of open space with alternative water:** Active and passive open space up to a total area of 33 ha in established part of New Gisborne and in new developments. • **Increase in shade and localized cooling:** 33 ha

Optimisation and delivery

This option requires significant investment and there is a risk of stranded assets if the scoped irrigation demands don't come to fruition or if users decide to cease irrigation. If the rules on discharging recycled water to Jacksons Creek become stricter, then irrigating with recycled water may become a necessity.

Western Water have also acknowledged that recycled water could also be transferred from Riddells Creek to New Gisborne via the dis-used Macedon-Riddells sewer main. This may prove more cost effective for water users in New Gisborne. Long-term, this could form a hybrid supply network using both Gisborne and Riddells Creek treatment facilities to supply the townships. Further investigations should test the feasibility and cost-effectiveness of this option.

4.6 Option 5: Large-scale end-of-line stormwater harvesting to supplement regional water resources

Background

A community panel as established in 2019 to discuss how Sunbury's water will be managed while the surrounding area is developed, with the question "What water management options are best for the community and the environment?" posed. The panel provided a number of recommendations, several of which referred to harvesting stormwater and utilising this water for drinking. Stormwater harvesting involving water storage basins at Riddells Rd has been explored in previous studies, with the potential for this water to then be transferred to Rosslynne Reservoir to add to the drinking water supply. Stormwater Harvesting from Gisborne could integrate into such a scheme. These options will be explored further as planned technical work in 2020 by Western Water and Melbourne Water.

Description

This option looks at a number of sites that can be linked to form a regional-scale stormwater harvesting scheme to harvest flows from the wetlands and transfer flows to Rosslynne Reservoir. The harvesting scheme leverages from the potential future IWM Plan for Sunbury where stormwater is harvested to support regional water resources.

Using GIS, sites were investigated with consideration of topography, public land availability, known development sites, major existing stormwater drains, and Melbourne Water Drainage Schemes. Whilst there is substantial residential growth in Gisborne, sites for stormwater harvesting a limited. This is due to a combination of factors, large portion of infill development with limited space for wetlands, steep topography, and highway crossings.

Three sites were chosen as part of this scheme:

1. Willowbank Rd Development (major development area, DS 6851, Central Creek Drainage Scheme)
2. Robertson Rd Reserve (public land near town centre, major stormwater pipe draining to Jacksons Creek)
3. Jacksons Creek Reserve (public land near town centre, major stormwater pipe draining to Jacksons Creek) – this is referred to as the 'Adventure Playground' site in the Gisborne WSUD Masterplan

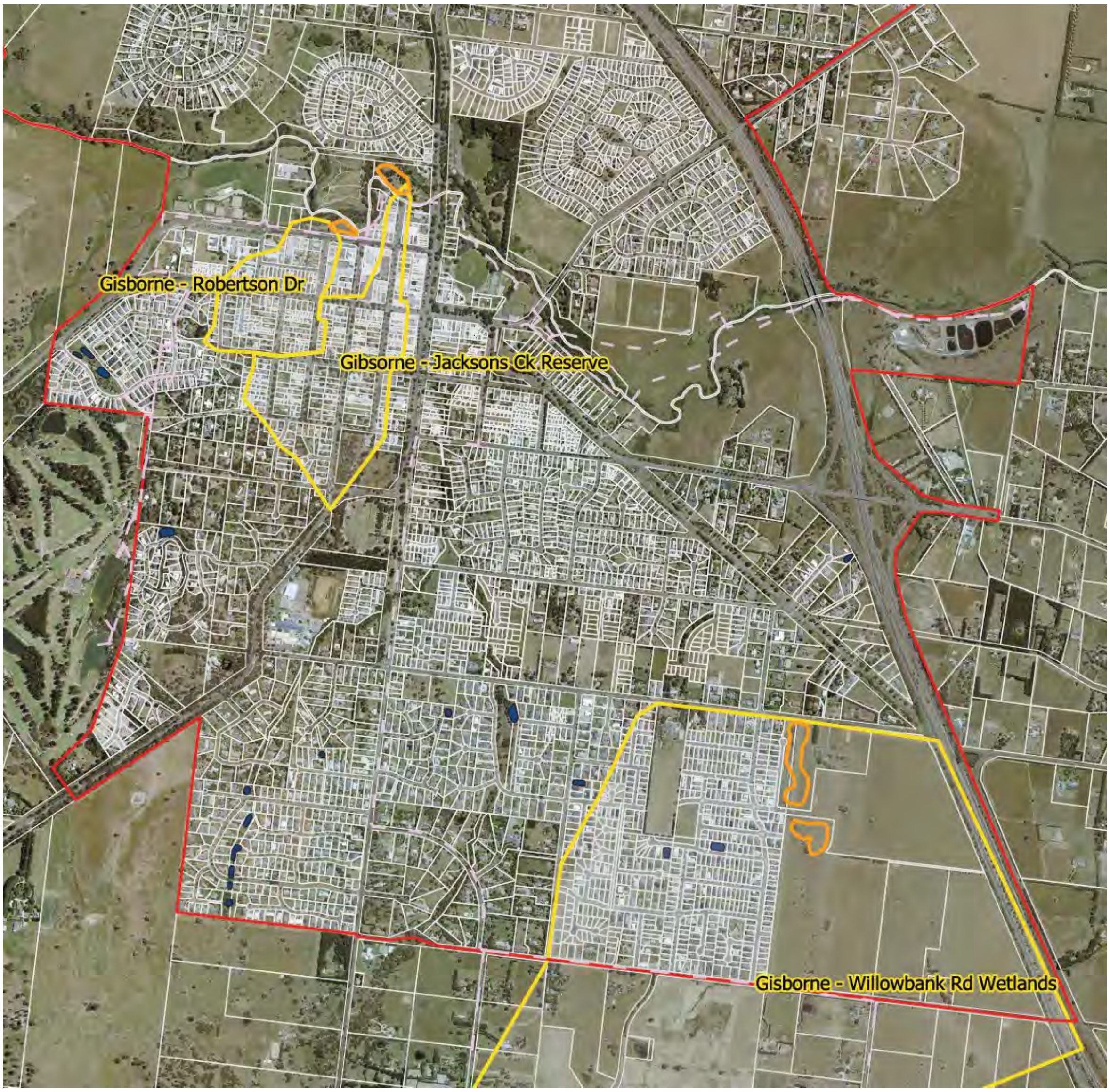


Figure 19: Locality of proposed harvesting wetlands in Gisborne (orange polygons) and their catchments (yellow polygons).

Each site is proposed to include a harvesting wetland, specifically designed to maximize volume reductions and harvesting yields, as per the design solutions for Sunbury. The sites will also include UV treatment and pumped low flow outlet to direct flows to the trunk main transfer pipes. Harvested flows from the wetlands will then be transferred to the storage and treatment facilities on Riddells Rd, in Sunbury North, before sending treated flows to Rosslynne Reservoir to supplement potable supply.

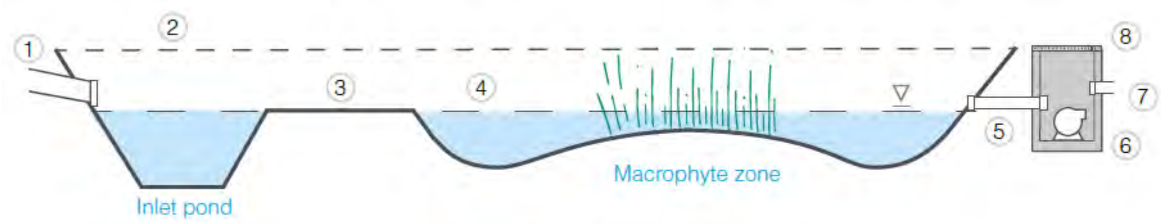


Figure 20: Wetland schematic for high yield harvesting wetlands using pumped low flow outlet

Key analysis assumptions and infrastructure requirements

The option assumes it will be integrated with the IWM Plan for Sunbury, including storage and treatment at Riddells Rd and the trunk infrastructure from Riddells Rd to Rosslynne Reservoir. The option also assumes the treatment wetlands proposed at Willowbank Rd through DS 6851 can be retrofitted into harvesting wetlands, and as such costs only include design retrofit and pump infrastructure, with the wetland construction cost covered by developers.

- Wetlands sized based on available land at each site
- Willowbank Rd wetland size based on proposed wetlands shown in DS 6851
- Wetlands are configured to maximise yield, as per concept designs for Sunbury's harvesting wetland.
- Wetland design:
  - Q5 high flow bypass
  - Daily demand rate set to draw down wetland extended detention volume over three days (achieved through pumped low flow outlet)
  - 300 mm permanent pool volume
  - 500 mm extended detention depth

	Required infrastructure
Robertson Rd wetland	• Treatment wetland – 2,780 m^2 • Low flow pump outlet – 0.4 kW
Jacksons Creek Reserve wetland	• Treatment wetland – 7,150 m^2 • Low flow pump outlet – 0.6 kW
Willowbank Rd wetland	• Low flow pump outlet – 3.8 kW
Pipework	• 100mm pipe connection from Robertson Rd to Willowbank Rd transfer main, 3.9km • 300mm pipe connection from Willowbank Rd transfer main to Riddells Rd storage and treatment, 9.6km
Pumps for transfer main	• 1x 9.7 kW • 1x 23.6 kW • 1x 33.5 kW

Costs

Item	Capital Cost ($)	Operating Cost ($/yr)
Robertson Rd wetland	$346k	$5.4k
Jacksons Reserve wetland	$134k	$7.9k
Willowbank Rd wetland	$79k	$18.8k
Pipework	$4.17M	$20.8k
Transfer pumps	$652k	$9.8k
Total	**$7.01M**	**$32.1k**

Benefits

Safe, secure and affordable supplies in an uncertain future	Healthy and valued waterways and marine environments	Jobs, economic benefit and innovation	Community and Traditional Owners values are reflected in place-based planning
Mains potable water supply substitution: By supplementing regional water supply at Rosslynne Reservoir, this solution could provide 523 ML/yr of potable water	• **Reduction in nitrogen entering waterways:** 1,751 kg/yr • **Reduction in stormwater runoff:** 533 ML/yr • **Environmental flow benefit for Jacksons Creek:** By supplying 523 ML/yr of water to Rosslynne Reservoir, this water could be discharged as passing flows for Jacksons Creek.	**Innovative water technologies:** This proposal would advance the water industry's development of innovative alternative water technologies.	**Community education and awareness:** Major infrastructure projects like stormwater harvesting schemes provide valuable education opportunities for the community

Optimisation and delivery

The majority of the cost associated with this option comes from pipework and transfer pumps required to send harvested flows from the wetlands to Riddells Road for storage and further treatment. If more sites could be connected to the scheme, this would help offset the cost of the pipe and pump infrastructure. In future design work, if other opportunities arise for harvesting sites, these should be included in the scheme. It also worth considering creating a local additional treatment step in Gisborne to reduce the cost of pipework.

Timing

Within Melbourne Water, the Urban Growth Services team have recently (Jan 2020) provided SWMS (Stormwater Management Strategy) acceptance to the property at 39 Willowbank Road. This development (owned by ID Land) will be constructing the wetland/ retarding basin asset within the Central Creek DSS.

- In UGS' dealings with ID Land, they understand that Macedon Ranges Council are keen to explore IWM opportunities in this area.
- Melbourne Water have expressed to ID land that the functionality of wetland/ retarding basin must not be compromised. Functional design has yet to be accepted.
- A development plan has been approved for this area which has locked in the land take.

To most effectively realise this opportunity, any specific provisions for the harvesting need to be pursued by Council and made clear for Melbourne Water in the immediate future to ensure appropriate layout and approvals are given.

For this option to be pursued, stakeholders would need to meet quickly to discuss necessary next steps. As a short-term option, Council could push the developers at Willowbank Road to convert the wetland to a harvesting wetland design to supply their adjacent sportsground. Long-term, this use could be redirected to a regional water supply network.

4.7 Comparative performance of options

To recognise the full range of IWM objectives for the area and the contribution the assessed options could make to those outcomes, a scored assessment has been conducted, whereby the key performance indicators identified in section 3.3 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; and
- Where a quantitative analysis is not possible, indicators are scored based on a qualitative judgement of relative performance and scored out of 10.

The breakout of the scoring assessment is summarised in Table 10. Figure 21 shows the overall score for each of the options.

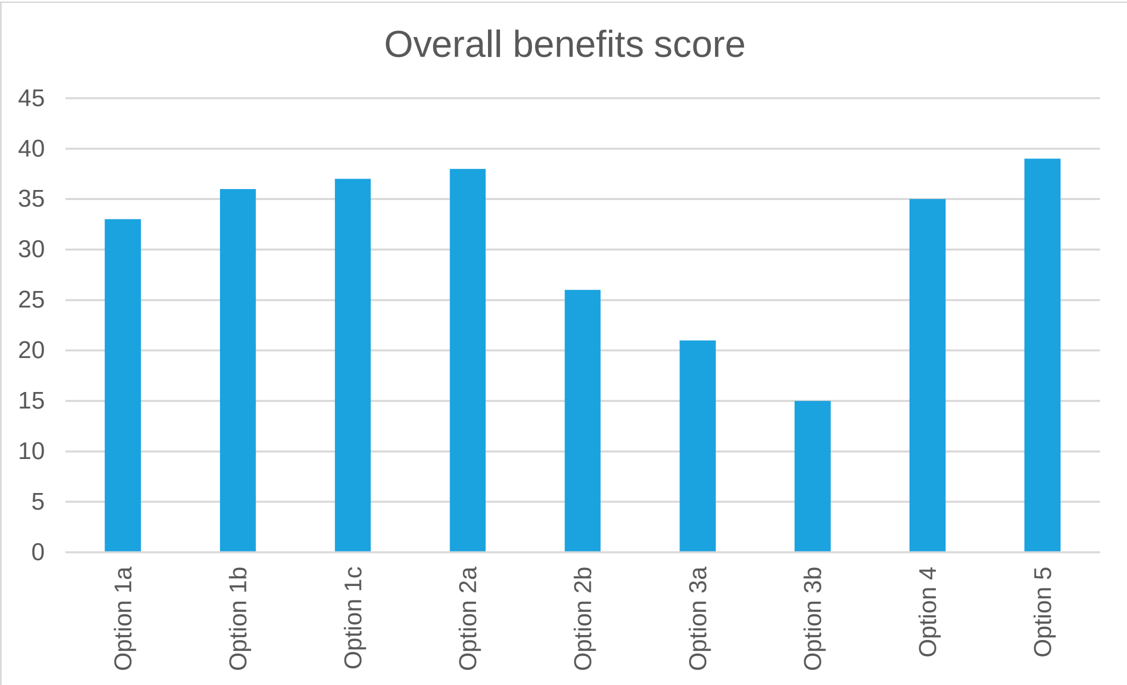


Figure 21: Comparison of options and their relative benefits assessment score

Table 10: Scored comparison of options

	Option 1a	Option 1b	Option 1c	Option 2a	Option 2b	Option 3a	Option 3b	Option 4	Option 5
Quantified indicators (0-10 where units are not given)									
Reduction in potable water import relative to BAU total (ML/year)	175	175	269	901	0	150	93	165	523
Recycled water generated which is used for a beneficial use (ML/year)	0	0	0	0	0	150	0	165	0
Reduction in nitrogen discharged to local waterways (kg/yr)	1,757	1,966	2,392	2,791	2,426	1,500	250	1,650	1,751
Stormwater reused or infiltrated locally (ML/year)	574	620	285	1,114	540	0	93	0	533
Contribution to environmental flow needs for Jacksons Creek (of appropriate quality and timing)	0	0	0	0	0	0	0	0	5
Relative contribution to reduction of local flood risk	3	4	1	0	0	0	0	0	3
Relative amount of public passive and open space irrigation proportion supported by alternative water supply (ML/year)	0	0	0	0	0	0	0	165	0
Relative contribution to increase in shade and localised cooling	3	4	8	4	4	0	1	7	2
Relative benefit of the option in terms of community engagement and awareness	7	7	7	4	4	0	0	6	4
Relative benefit of the option in terms of enhancement of traditional owner values	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Alternative water supply available to support economic activity (including agriculture, commercial/industrial uses) (ML/y)	0	0	0	0	0	150	93	0	0
Scaled score (0-10)									
Reduction in potable water import relative to BAU total	5	5	6	10	0	5	4	5	9
Recycled water generated which is used for a beneficial use	0	0	0	0	0	5	0	5	0
Reduction in nitrogen discharged to local waterways	7	8	9	10	9	6	2	7	7
Stormwater reused or infiltrated locally	8	8	6	10	9	0	4	0	9
Contribution to environmental flow needs for Jacksons Creek (of appropriate quality and timing)	0	0	0	0	0	0	0	0	5
Relative contribution to reduction of local flood risk	3	4	1	0	0	0	0	0	3
Relative amount of public passive and open space irrigation proportion supported by alternative water supply	0	0	0	0	0	0	0	5	0
Relative contribution to increase in shade and localised cooling	3	4	8	4	4	0	1	7	2
Relative benefit of the option in terms of community engagement and awareness	7	7	7	4	4	0	0	6	4
Relative benefit of the option in terms of enhancement of traditional owner values	0	0	0	0	0	0	0	0	0
Alternative water supply available to support economic activity (including agriculture, commercial/industrial uses)	0	0	0	0	0	5	4	0	0
Total score (out of 110)	**33**	**36**	**37**	**38**	**26**	**21**	**15**	**35**	**39**

4.8 Comparative costs of options

The costs of all options are summarised in Table 11: Comparison of costs and net present value of options. Net present cost has been calculated over a 50 year lifetime, between 2020 and 2069, with a 4.5% discount rate.

Table 11: Comparison of costs and net present value of options

	Capex ($)	Opex ($/yr)	Net present cost (NPC) ($)[15]	$/ML potable water	$/ML stormwater reduced	$/kg nitrogen reduced
Option 1a	$40,479,000	$510,000	$48,750,000	$6,326	$4,320	$1,412
Option 1b	$29,070,000	$966,000	$46,801,000	$6,326	$3,842	$1,211
Option 1c	$26,355,000	$415,000	$33,366,000	$4,334	$5,953	$710
Option 2a	$10,470,000	$134,000	$12,650,000	$715	$578	$231
Option 2b	$8,241,000	$31,000	$8,489,000	-	$800	$178
Option 3	$5,400,000	$38,000	$4,567,000	$1,549	-	$155
Option 3b	$1,327,000	$18,000	$1,627,000	$890	$890	$332
Option 4	$6,660,000	$49,500	$7,746,000	$2,266	-	$227
Option 5	$7,009,000	$15,000	$7,064,000	$688	$674	$205

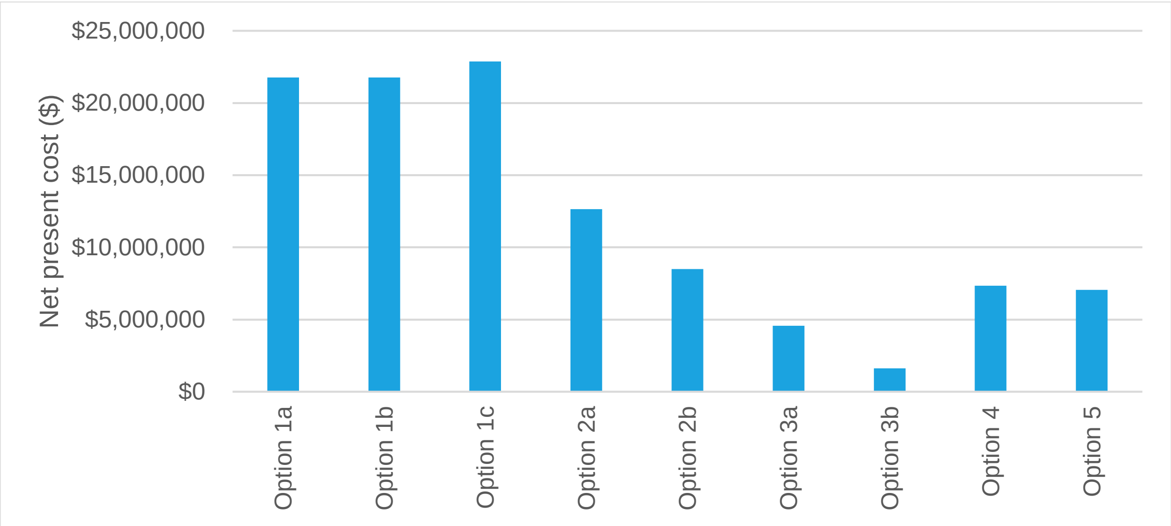


Figure 22: Net present cost ($) per option

The following figures graph the relative performance of each of the options against key quantitative criteria (potable water substitution, stormwater reduction, use of recycled water, and nitrogen reduction), as well as a comparison of the net present cost against the overall benefit score.

[15] Net present value calculated across 50 years (from 2020 to 2069) with 4.5% discount rate.

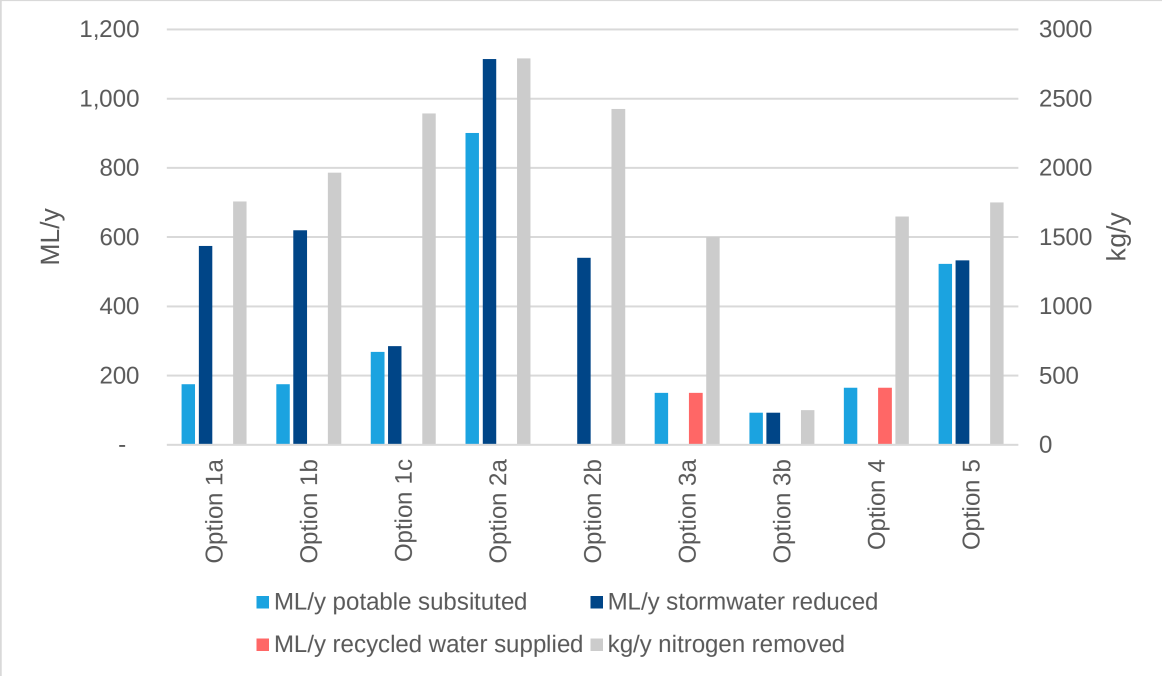


Figure 23: Comparison of performance in key quantitative categories: potable water substitution, stormwater reduction, recycled water use, and nitrogen reduction.

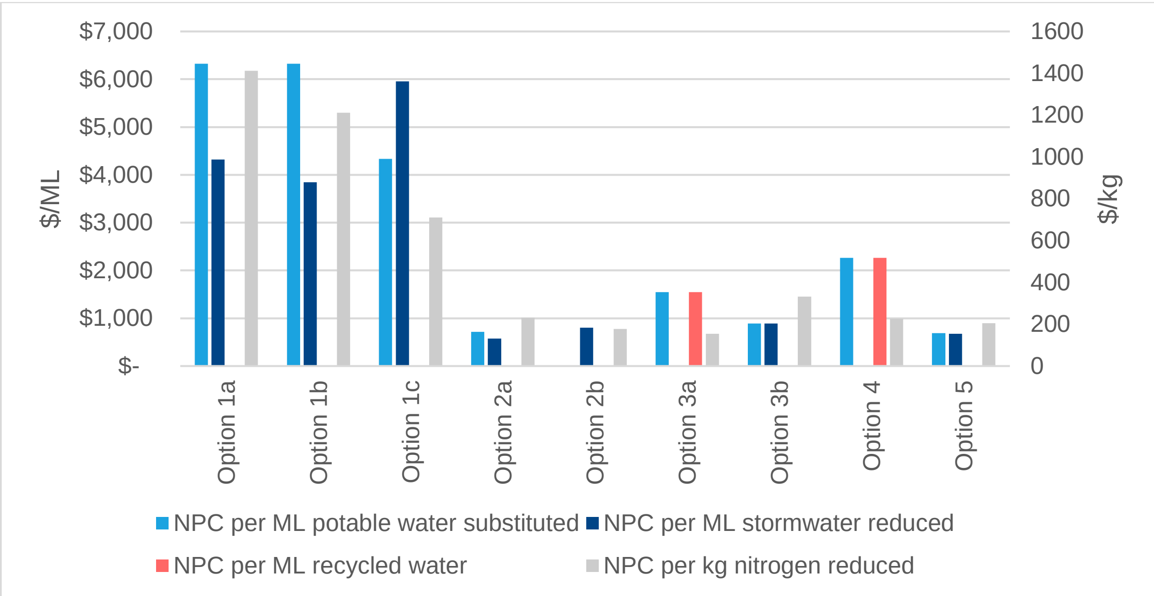


Figure 24: Comparison of the net present cost per benefit for key quantitative categories: potable water substitution[16], stormwater reduction, recycled water use, and nitrogen reduction.

[16] The net present cost of Option 1a, 1b and 1c only includes the cost of the rainwater tanks when assessing the NPC per ML of potable water substitution. This is given the cost of other elements at the lot-scale do not contribute to potable water savings.

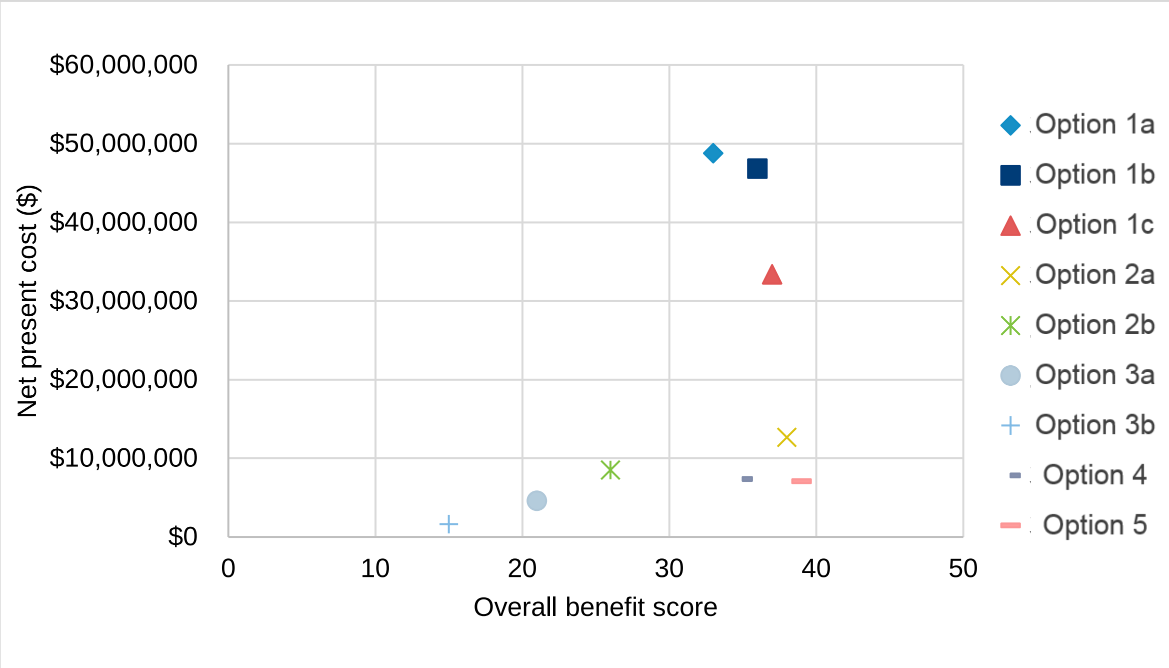


Figure 25: Comparison of net present cost against overall benefit score for each option (options in the bottom right-hand corner are most favourable from a cost-benefit perspective).

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 and accordingly require collaboration between multiple parties to establish governance models, delivery mechanisms and funding and delivery approaches.

Figure 26: Multiple benefits of Integrated Water Management

Through the development of this Plan, key delivery partners and stakeholders have come together. A catchment-wide IWM forum has been established for the Maribyrnong catchment which can support delivery of IWM projects in the Southern Macedon Ranges 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 and leadership
2. Tools and instruments
3. Platforms for connecting
4. Knowledge and skills
5. Demonstration and innovation.

Based on discussions held with stakeholders during the development of this plan, the five key transition factors have been reviewed for the Southern Macedon Ranges area and are summarised below:

Champions and leadership

- There are active IWM champions within all of the stakeholder organisations in the area, and the development of this Plan has established a working group of practitioners who could continue to collaborate to deliver the implementation plan.
- Macedon Ranges Councillor Helen Radnedge participated in the three stakeholder workshops held in the development of this plan. Her engagement and support is testament to the ongoing commitment of Council to developing sustainable water management for the region.

Tools and Instruments

- Planning instruments were highlighted as an important mechanism to implement IWM measures in new development, particularly at the lot scale.
- Incentivising developers to go beyond a 'business as usual' standard was highlighted as a need. It was noted that changes to the Best Practice Environmental Management (BPEM) standards currently being reviewed by the Environment Protection Agency (EPA) may provide new regulations in this area. Melbourne Water is also a referral authority for planning permits, and they will support and encourage stormwater management responses that will enable the Healthy Waterways Strategy targets to reduce stormwater flows. Council and Melbourne Water need to be aligned to ensure appropriate controls and in place and responses are consistent.
- Planning overlays were identified as a possible tool that could be used to implement higher requirements for permeable areas and increased infiltration, where an evidence base can be provided to demonstrate the need.

Platforms for Connecting and Communicating

- This project was conceived and funded through the Maribyrnong IWM Forum process. Continued coordination with the Forum could support the implementation of Plan recommendations.
- It was highlighted that a proactive approach was essential to encourage IWM in developments. Western Water have been working with Melton City Council to request IWM Plans from developers. This model could also be implemented with Macedon Shire Council.

Knowledge and skills

- There is a good base of understanding of IWM and skills in the area, however, the need for further upskilling and development in Water Sensitive Urban Design (WSUD) has been highlighted 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.
- Maintenance of WSUD assets is a key area where support is needed in the area. State Government is currently reviewing policy requirements for stormwater management and WSUD assets and associated maintenance standards and requirements through the Melbourne Urban Stormwater Institutional Arrangements Review (MUSIA).
- It was highlighted that resource and budget constraints for Council, can make delivery and management of IWM assets a challenge. Given the multiple benefits that IWM projects can deliver, creating shared funding and shared management arrangements between organisations could unlock various projects. For example, stormwater harvesting projects will deliver benefits to downstream catchments and regional water resources, and a co-funding model could be used whereby Melbourne Water and Western Water are delivery and funding partners. Western Water is also open to working with Council to explore delivery models where Western Water will directly manage alternative water supply assets.

Demonstration and innovation

- 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

This study has highlighted a range of potential IWM opportunities in Southern Macedon Ranges Shire that could deliver major benefits to the local community, the Maribyrnong River catchment, and the broader water resource portfolio in the region. All of the projects that were examined in detail demonstrated significant benefits that could be delivered. Most of the options are mutually exclusive, and could be delivered together, to achieve cumulative benefits.

Some options included possible variants, where conclusions can be drawn on the most promising alternative:

5.2.1 Option 1: Lot-scale initiatives to reduce stormwater runoff in from new developments

The examination of on-lot and streetscape opportunities to reduce stormwater runoff and contribute towards the Healthy Waterways Strategy, suggested that addition of various source control measures would deliver significant reductions in stormwater runoff. Three of the most promising options for runoff reduction at a local scale were analysed in this study (1a,1b,1c). All could deliver a range of benefits to the community and the environment, and all three options scored highly. The comparison of cost and benefit (Figure 24) suggests that the combination of a rainwater tank for extended uses including hot water and the inclusion of passively irrigated street trees (Option 1c) would deliver the best cost-benefit ratio. However, it should be noted that the cost of supplying hot water with rainwater could be substantially higher, depending on the consideration of water treatment requirements in relation to acceptable risk. Accordingly, all three options are fairly on-par in performance terms.

This analysis suggests that there are a range of initiatives that could be taken to deliver benefits at the lot and street scale, and that rather than recommending a specific technology or approach, a more flexible approach could beneficial, using a policy mechanism to outline a stormwater runoff reduction target for new development supported by a set of 'deemed to comply' solutions to ensure the target can be effectively assessed through the planning process without undue burden on Council. The Healthy Waterways Strategy is an important piece of evidence to supporting the delivery of stormwater runoff reduction in the area, and considering that town-scale harvesting options are not available for the all catchments in the study area, the reduction of runoff from new development areas is a priority opportunity across the board.

Given the introduction of stormwater reduction targets is being considered by the Environment Protection Authority (EPA) as a potential addition to the BPEM standards linked to the Victorian Planning Provisions (Clause 56.03), Macedon Ranges Council should consider whether a local policy provision or guidance would be fruitful, or could be introduced as an interim measure until changes are made to BPEM standards.

5.2.2 Option 2: Large-scale end-of-line stormwater harvesting for infiltration or aquifer injection

Two alternatives were considered for the end-use of this promising stormwater harvesting option at a town-scale (aquifer injection to enhance groundwater resources (2a) or distribution to evaporation and infiltration land sponges (2b)). The drivers for either option are high, considering the Healthy Waterways Strategy recognises the value of Upper Deep Creek, and has set targets to reduce stormwater runoff from both new development and the existing urban areas in Romsey and

Lancefield. It is a rare inclusion in the Strategy to highlight the importance of reducing runoff from existing towns – highlighting the special environmental conditions of this area.

Of the two variant options, the option to inject treated stormwater into a local aquifer (Option 2a) is considered more favourable from a cost-benefit perspective, as it could deliver much higher flow reductions while also enhancing groundwater resources for the towns. Accordingly, further investigation of Option 2a is recommended as the most favourable alternative.

5.2.3 Option 3: Substitution of existing groundwater extraction licenses through provision of an alternative source to agricultural uses

Two alternatives were considered here, the use of recycled water (3a) or stormwater (3b) as an alternative water supply to groundwater for agricultural use, thereby introducing the possibility of reallocating groundwater licences to local potable water supply. Of the two alternatives, Option 3a (recycled water) presented a better overall cost-benefit. This option is also likely to be more straightforward to deliver. Local farmers are likely to recognise recycled water as a more reliable water resource in dry times, and may also see the added nutrients in recycled water as a benefit to crop yield. There are many precedents of recycled water supply to agricultural use, and Western Water is highly experienced in this area. Accordingly, Option 3a is recommended as the preferred alternative.

5.2.4 Option 4: Enhancement of recycled water use through extended provision to new open space irrigation

Option 4 demonstrated a high cost-benefit in relation to the options examined. Considering that a recycled water network is already in place in Gisborne, extension of the network is not technically challenging, and the benefits are well-understood. The primary risk to the scheme is the securing sufficient demand with guaranteed longevity, however this could be addressed through collaborative planning and strategic planning. Given that out of the towns in the Region, the highest volume of treated wastewater to waterways is in Gisborne and this is set to increase with growth, the environmental and operational drivers for recycled water use in Gisborne are high. Accordingly, this option is recommended for further consideration.

5.2.5 Option 5: Large-scale end-of-line stormwater harvesting for regional supply

Out of all the options considered, this option demonstrated the best cost-benefit performance. Given the proposed large-scale harvesting of stormwater in Sunbury, additional harvesting in Gisborne could prove to be a valued addition to regional water resource initiatives, using shared infrastructure with Sunbury. In the long-term, harvested water could also be utilised to supplement drinking water (subject to community and regulatory support), but there a variety of regional uses for the harvested water in the interim that will deliver a range of benefits. Accordingly, further investigation of this option is recommended.

5.3 Recommended ongoing work to support IWM

A range of ongoing work is already underway in the area which will support the delivery of integrated water management benefits in Southern Macedon Ranges. This work should be continued and supported, including:

- **Delivery of improved stormwater management and WSUD in existing areas:** Council continues work to deliver improvements to stormwater management to increase water quality and manage local flood risk. Specifically, the Water Sensitive Urban Design masterplan for Gisborne Township (2015) identifies a range of WSUD opportunities across the existing urban area in Gisborne that will improve stormwater management. The proposal for a stormwater system at the 'Adventure Playground' site adjacent to Jacksons Creeks is also proposed in Option 5 in this report where a stormwater harvesting scheme is also proposed.
- **Delivery of waterway corridor improvements:** Riparian planting, public space improvement and naturalisation of waterways that run through and adjacent to urban areas is an ongoing activity being delivered by Council and Melbourne Water. This work has great potential to support environmental and liveability outcomes in the region.

5.4 Implementation Plan

Seven major IWM initiatives are recommended for the Southern Macedon Ranges area:

1. **Creating governance and delivery structures to support IWM**
2. **Increase rainwater use and infiltration in new development**
3. **Introduce town-scale stormwater harvesting and investigate aquifer recharge in Romsey and Lancefield**
4. **Stimulate agricultural demand for recycled water in the region**
5. **Support new open spaces with recycled water in Gisborne**
6. **Create a linked stormwater harvesting system in Gisborne to support regional water resources**
7. **Continual improvement of stormwater management and waterways**

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 12: 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 the Maribyrnong IWM Forum.	Short term (1-3 years)	Macedon Ranges Shire Council, Western Water, Melbourne Water
In addition to the project-focused actions below, the governance group should identify and implement opportunities to support the delivery of IWM in the Macedon Ranges area by: • Identifying funding and grant options to support delivery of IWM; • Setting up partnership arrangements to enable co-funding of projects that delivery multiple benefits; • Fostering and supporting IWM champions; • Developing tailored IWM tools and supporting capacity building to improve skills and knowledge in the area; and • Improving and creating platforms to connect and collaborate – within and between organisations and with the community.	Short term (1-3 years)	Macedon Ranges Shire Council, Western Water, Melbourne Water
Implement the IWM strategy request model for new development that has been trialled between Western Water and City of Melton, to work more closely with developers to identify and deliver location specific IWM opportunities.	Short term (1-3 years)	Western Water, Macedon Ranges Shire Council
Increase rainwater use and infiltration in new development (Option 1)		
Consider introducing a planning policy, a planning overlay and guidance for the four townships, which specifies an enhanced target for runoff. A range of 'deemed to comply' solutions could be specified and described in guidance to achieve the target including: • Increased permeable area in a development site • Rainwater reuse (using rainwater tanks) • Introduction of infiltration areas The development of such a policy should be done in collaboration with Melbourne Water to utilise the Healthy Waterways Strategy as a key evidence base. Discussions should also be held with the EPA to understand how this could link with possible future changes to BPEM requirements which would be implemented through the state planning system.	Short term (1-3 years)	Macedon Ranges Shire Council, Melbourne Water, Environmental Protection Authority
Include requirements and guidance for inclusion of passively irrigated street trees and roadside swales in infrastructure and landscape design manuals, to take opportunities to reduce runoff from roads at source while delivering greening and amenity benefits.	Short term (1-3 years)	Macedon Ranges Shire Council

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Introduce town-scale stormwater harvesting and investigate aquifer recharge in Romsey and Lancefield		
Further investigate the feasibility of Aquifer Storage and Recovery (ASR) to inform the feasibility of Option 2a. Consult with Southern Rural Water to understand water quality and aquifer management needs to determine the feasibility of injection of treated stormwater and future extraction for potable use.	Short term (1-3 years)	Western Water, Southern Rural Water
Develop detailed designs for stormwater treatment and harvesting schemes on a town-wide scale for both Romsey and Lancefield. Build an accompanying business-case for co-investment between partners, considering contributions to the Healthy Waterways Strategy and water resource resilience in the region.	Short term (1-3 years)	Macedon Ranges Shire Council, Western Water, Melbourne Water
Stimulate agricultural demand for recycled water in the region		
Further investigate opportunities to stimulate high-value agricultural activity in the area that could be supported by the provision of recycled water, and identify priority locations. This should include consultation with Economic Development representatives at Macedon Ranges Shire, local stakeholders and State Government.	Short term (1-3 years)	Macedon Ranges Shire Council, Western Water, DELWP
Engage with rural groundwater licence holders and Southern Rural Water in the Lancefield / Romsey area to understand opportunities and barriers relating to a potential substitution scheme whereby recycled water supply is provided in lieu of a groundwater licence exchange. Potential incentives and policy instruments could be explored.	Short term (1-3 years)	Western Water, Southern Rural Water, Macedon Ranges Shire Council
Support new open spaces with recycled water in Gisborne		
Collaboratively scope and confirm potential demands for recycled water in the New Gisborne area, to support a business case for expansion.	Short term (1-3 years)	Western Water, Macedon Ranges Shire Council
Complete detailed design for a scheme and develop a business case to support a co-funding model recognising the benefits to local communities and the avoided waterway impacts. Detailed design should include consideration of alternative distribution pipe routes to align with road upgrades and avoid disturbance of historical streets and mature trees (e.g. route via Kilmore Rd).	Medium term (3-5 years)	Western Water, Macedon Ranges Shire Council
Create a linked stormwater harvesting system in Gisborne to support regional water resources		
Complete detailed design investigations for the stormwater treatment systems which can be adapted for harvesting at the identified locations alongside Jacksons Creek. The proposed wetlands in the Willowbank Road development should also be designed and constructed to enable future harvesting.	Short term (1-3 years)	Macedon Ranges Shire Council, Melbourne Water, Western Water

Recommended Action	Suggested Timeline	Delivery Partners (lead underlined)
Complete detailed design investigations to link and transfer stormwater harvesting sites in Gisborne to the Riddells Road storages in Sunbury. In future investigations, compare the option of building a new local treatment facility in Gisborne to reduce the cost of pipework required to divert stormwater to the Riddells Rd facilities.	Short term (1-3 years)	Macedon Ranges Shire Council, Melbourne Water, Western Water
Engage with the local community regarding utilisation of stormwater on a regional scale and future drinking water supplementation opportunities.	Medium term (3-5 years)	Western Water, Melbourne Water, Macedon Ranges Shire Council
Continual improvement of stormwater management and waterways		
Continue programs to identify and deliver waterway improvements in the area to enhance waterway health and community benefits.	Ongoing	Macedon Ranges Shire Council, Melbourne Water
Continue delivery of stormwater management measures to improve waterways including litter management and delivery of water sensitive urban design assets. Allocate sufficient funding for ongoing maintenance and renewal.	Ongoing	Macedon Ranges Shire Council, Melbourne Water

Attachment 1 – Preliminary Assessment Method, Long Project List

Source	Option	Township	Location	Reason/Comment	Quantitative: Reduction in potable water import relative to BAU total (ML/year)	Quantitative: Recycled water generated which is used for a beneficial use (ML/year)	Quantitative: Reduction in nitrogen discharged to local waterways (kg/yr)	Quantitative: Stormwater reused or infiltrated locally (ML/year)	Qualitative: Contribution to environmental flow needs for Jacksons Creek (of appropriate quality and timing)	Qualitative: Relative contribution to reduction of local flood risk	Quantitative: Relative amount of public passive and open space irrigation proportion supported by alternative water supply (ML/year)	Qualitative: Relative contribution to increase in shade and localised cooling	Qualitative – Relative benefit of the option in terms of community engagement and awareness	Qualitative – Relative benefit of the option in terms of enhancement of traditional owner values	Quantitative: Alternative water supply available to support economic activity (including agriculture, commercial/industrial uses)
RW	Rainwater harvesting for non-potable residential demands	All	Existing areas	Residential rainwater tanks	26.1		70.4	26.1		L		L	H	L	
RW	Rainwater harvesting for non-potable residential demands	All	New areas	Residential rainwater tanks	156.8		423.3	156.8		M		L	H	L	
RW	Rainwater harvesting for non-potable residential demands	All	Existing developments	Rainwater tanks and soakage pits in combination (leaky tanks)	26.1		125.0	28.8		L		L	H	L	
RW	Rainwater harvesting for non-potable residential demands	All	New developments	Rainwater tanks and soakage pits in combination (leaky tanks)	156.8		751.3	173.2		M		L	H	L	
RW	Rainwater harvesting for non-potable uses in buildings	Gisborne	Aquatic Centre	Rainwater harvesting for Aquatic Centre	13.0		35.1	13.0		M		L	M	L	
RW	Rainwater harvesting for potable residential demands	All	Amess Rd development	Rainwater tanks for on-lot reuse - non-potable + hot water.	138.5		373.8	138.5		M		L	H	L	
RW	Rainwater harvesting for potable residential demands	Riddells Creek	Amess Rd development	Rainwater tanks for on-lot reuse - non-potable + hot water.	108.8		293.9	108.8		M		L	H	L	
RW	Rainwater intercepted by permeable ground surface	All	New development	Lot-scale increased permeability.			1428.6	248.0	L	M		M	M	L	
SW	Stormwater harvesting for agricultural irrigation	Romsey	Main Drain	Main Drain harvesting stormwater at key outlet of town. Divert Romsey Main Drain to new storage.			1571.8	582.1		M		L	M	L	582.1
SW	Stormwater harvesting for agricultural irrigation	Romsey	Romsey South Development	Stormwater harvesting in Romsey South Development for nearby agriculture and open space	7.2		113.8	42.1		M	7.2	H	M	L	42.1
SW	Stormwater harvesting for non-potable uses in buildings	Gisborne	39 Willowbank Road development	Regional stormwater harvesting for dual pipe.	53.9		145.5	53.9		M	20.6	L	H	L	
SW	Stormwater harvesting for non-potable uses in buildings	Riddells Creek	Amess Rd development	Stormwater water for dual pipe in Amess Rd development	117.2		316.4	117.2		M	47.3	L	H	L	
SW	Stormwater harvesting for open space irrigation	Romsey	Romsey South Development	Stormwater harvesting in Romsey South Development for open space irrigation	7.2		19.4	7.2		M	7.2	M	M	L	
SW	Stormwater harvesting for open space irrigation	Gisborne	39 Willowbank Road development	Stormwater harvesting from local retarding basin / wetland	15.0		40.5	15.0		M	15.0	L	M	L	
SW	Stormwater harvesting for open space irrigation	Gisborne	Jacksons Ck reserve, Howey Reserve, Gisborne Sports Precinct, Botanic Gardens, ovals	All available demands.	29.5		153.9	57.0	L	L	57.0	H	H	L	
SW	Stormwater harvesting for open space irrigation	Gisborne	Jacksons Ck Reserve outlet	Stormwater harvesting	9.5		25.7	9.5		M	9.5	M	H	L	
SW	Stormwater harvesting for open space irrigation	Gisborne	Sankey Reserve - two outlets	Stormwater harvesting	14.0		37.8	14.0		M	14.0	M	H	L	
SW	Stormwater harvesting for supplementary potable supply	Romsey	Main Drain (South Drain)		582.1		1571.8	582.1		M		L	M	L	582.1
SW	Stormwater harvesting for supplementary potable supply	Gisborne	39 Willowbank Road development	Regional stormwater harvesting leveraging Sunbury to Rosslynne pipeline	195.1		526.8	195.1	L	M		L	H	L	195.1
SW	Stormwater harvesting for supplementary potable supply	Gisborne	Linked schemes	39 Willowbank + Jacksons Ck Reserve + Sankey Reserve	470.4		1270.1	470.4	L	M		L	H	L	470.4
SW	Stormwater harvesting for supplementary potable supply	Lancefield	Drain outlets	Aquifer recharge and recovery for potable use. Stormwater injection into the groundwater.	459.5			459.5		M			H	L	459.5
SW	Stormwater harvesting for supplementary potable supply	Romsey	Main Drain (South Drain)	Aquifer recharge and recovery for potable use. Stormwater injection into the groundwater.	582.1		1571.8	582.1		M		H	H	L	582.1
SW	Stormwater managed by vegetated device in open space	All	Various	Retrofit detention basins into wetlands.			514.1	27.7				L	L	L	
SW	Stormwater managed by vegetated device in open space	Riddells Creek	Adjacent to oval				59.6	1.7		L		L	H		
SW	Stormwater managed by vegetated device in open space	Gisborne	Various	Deliver Gisborne WSUD strategy designs.			392.0	13.6		L		L	L		
SW	Stormwater managed by vegetated device in streets	Riddells Creek	Main Rd	Passively irrigate street trees			19.2	3.1	L	M	3.1	H	L	L	
SW	Stormwater managed by vegetated device in streets	Riddells Creek	Amess Rd development	Passively irrigate street trees			33.9	5.4	L	M	5.4	H	L	L	
SW	Stormwater managed by vegetated device in streets	Romsey	Main St	Main St Opportunities			28.3	4.5		M	4.5	H	L	L	
SW	Stormwater managed by vegetated device in streets	Gisborne	Station Rd and Hamilton St	Main St Opportunities			39.6	6.3	L	M	6.3	H	L	L	
SW	Stormwater managed by vegetated device in streets	Gisborne	39 Willowbank Rd development	Passively irrigate street trees			17.0	2.7	L	M	2.7	H	L	L	
SW	Stormwater managed by vegetated device in streets	All	Existing areas	Passively irrigate street trees			169.5	27.0	L	M	27.0	H	L	L	

Source	Option	Township	Location	Reason/Comment	Quantitative: Reduction in potable water import relative to BAU total (ML/year)	Quantitative: Recycled water generated which is used for a beneficial use (ML/year)	Quantitative: Reduction in nitrogen discharged to local waterways (kg/yr)	Quantitative: Stormwater reused or infiltrated locally (ML/year)	Qualitative: Contribution to environmental flow needs for Jacksons Creek (of appropriate quality and timing)	Qualitative: Relative contribution to reduction of local flood risk	Quantitative: Relative amount of public passive and open space irrigation proportion supported by alternative water supply (ML/year)	Qualitative: Relative contribution to increase in shade and localised cooling	Qualitative – Relative benefit of the option in terms of community engagement and awareness	Qualitative – Relative benefit of the option in terms of enhancement of traditional owner values	Quantitative: Alternative water supply available to support economic activity (including agriculture, commercial/industrial uses)
SW	Stormwater managed by vegetated device in streets	All	New developments	Passively irrigate street trees			113.0	18.0	L	M	18.0	H	L	L	
SW	Stormwater managed by vegetated device in streets	All	Existing areas	Street raingardens			23.8	1.2	L	M	1.2	M	L	L	
SW	Stormwater managed by vegetated device in streets	All	Existing areas	Carpark raingardens			40.0	2.0	L	M	2.0	M	M	L	
SW	Treated stormwater distributed to environmental flows in waterway	Gisborne	N/A	Stormwater for environmental flows into Jacksons Ck to subtitute eflows released from Rosslynne, freeing up environmental water in Rosslynne for drinking	96.6		521.8	193.2	H	M	96.6	M	L	L	
SW	Treated stormwater distributed to land	Riddells Creek	Sandy Creek	Create infiltration areas along side creeks				332.0	M	M	123.0	M	L	Unknown	
SW	Treated stormwater distributed to land	Gisborne	Jacksons Ck	Create infiltration areas along side creeks				206.0	M	M	147.0	M	L	Unknown	
SW	Treated stormwater distributed to land	Romsey	5 Mile Creek	Create infiltration areas along side creeks				155.0	M	M	112.0	M	L	Unknown	
SW	Treated stormwater distributed to land	Romsey	Main Drain (South Drain)	Evaporation fields			1571.8	582.1		M		H	M	L	
SW	Treated stormwater distributed to land	Gisborne	New agricultural lands	Stormwater to surrounding land.											
Waterways	Waterway improvement, amenity and access	Riddells Creek	10A Station St	Naturalise Riddells Creek Main Drain. Create a chain of ponds. Currently			162.0	4.0	M	M		H	H	Unknown	
WW	Treated wastewater distributed to **environmental flows in waterway**	Gisborne	Treatment at Gisborne RWP, stored and pumped to the outlet of Rosslynne Reservoir via new pipeline.	Recycled water for environmental flows into Jacksons Ck to substitute eflows released from Rosslynne, freeing up environmental water in Rosslynne for drinking. This option is part way between 1) Treated wastewater distributed to environmental flows in waterway at the WRP and 2) Recycled water to potable at Gisborne RWP into the future Sunbury-Rosslynne stormwater line. Likely to be met with cynicism from waterway managers. Also possible that historical approaches to continuous "passing flows" will be dropped in favour of releases matched to natural flow patterns (including cease to flow) in which case very large storages will be needed to store the treated recycled water					H				M	Unknown	
WW	Treated wastewater harvesting for **supplementary potable supply**	Gisborne	Treatment at Gisborne RWP, treated and pumped to Rosslynne via proposed Sunbury stormwater pipeline.	Recycled water to potable at Gisborne RWP into the future Sunbury-Rosslynne stormwater line. This indirect potable reuse option achieves full substitution of potable water use, avoids large new storages and		720.0	7200.0		H				H	Unknown	720.0
WW	Treated wastewater distributed to **environmental flows in waterway**	Gisborne	N/A	Recycled water for environmental flows into Jacksons Ck to subtitute eflows released from Rosslynne, freeing up environmental water in Rosslynne for drinking					H					Unknown	
WW	Treated wastewater harvesting for **agricultural irrigation**	Gisborne	Surrounding agricultural lands	Potential land (approximate gross area 1800 ha) in the Settlement Road West and Settlement Road areas exist. Land is zoned GWZ. Moderate class soils. Close to WRP. Depending on the scale* of the scheme all of the balance of the wastewater can be used except in 10%ile wet years when some discharge is required (and allowed under current EPA guidelines). * Broadly speaking for 90%ile containment in this climate, for each 100 ML of inflow, 30 ha of irrigation area, and 70 ML of winter storage volume is needed		720.0	7200.0						H		720.0
WW	Treated wastewater harvesting for **agricultural irrigation**	Riddells Creek	Surrounding agricultural lands	Potential sites in the Settlement Road West and Settlement Road areas exist. (In combination with Gisborne wastewater). Land is zoned GWZ. Moderate class soils. Close to WRP.		180.0	1800.0						H		180.0
WW	Treated wastewater harvesting for **agricultural irrigation**	Romsey-Lancefield	Surrounding agricultural lands	The 2018 land capability study appears to have quite good mapping of land capability for agriculture. Typically if land scores well for general agriculture then it is likely to be suited for recycled water irrigation. There is about 4500 hectares (gross area) of FZ land located between and west of Romsey Lancefield that seems to be Class 1 and Class 2 land from 2018 study - see maps. Land is on the opposite side of Romsey from the WRP, but relatively close.		260.0	2600.0						H		260.0
WW	Treated wastewater harvesting for **open space irrigation**	Gisborne	Jacksons Creek reserve Sankey Reserve Willowbank Reserve Botanic gardens 39 Willowbank Road development	A recycled water pipe network exists already in Gisborne but could be expanded to New Gisborne and to other demands in and around Gisborne. Will need large winter storage volumes otherwise Gisborne treatment plant to exceed discharge licence in wet years.	44.5	72.0	720.0		L		72.0	H	H		
WW	Treated wastewater harvesting for **open space irrigation**	Riddells Creek	Amess Rd development All new developments Vegetation establishment (tankards)	A small diameter (100mm) main exists from the WRP to the Recreation Reserve. This could be augmented or storage constructed in town if there are other current and future open space irrigation opportunities. Winter storage will be required and water sharing plans set up to equitably share water in dry years (e.g. existing agricultural uses take preference over open space uses in years when recycled water availability is low?).	47.0	47.0	470.0		L		47.0	H	H		
WW	Treated wastewater harvesting for **open space irrigation**	Romsey	Romsey south development	A 150mm diameter exists from the WRP to the Recreation Reserve / Golf Club in Romsey. There is currently no recycled water supply in Lancefield. The Romsey main could be augmented or storage constructed in town if there are other current and future open space irrigation opportunities. Winter storage will be required and water sharing plans set up to equitably share water in dry years (e.g. existing agricultural uses take preference over open space uses in years when recycled water availability is low?). Installing a new recycled water main to Lancefield (approximately 8000m) is unlikely to be economically justified just to supply open space irrigation	7.2	7.2	72.0				7.2	H	H		

Attachment 2 – Cost summaries and assumptions

General Rates and Costs			
Item	Unit Cost	Unit	Source
Capital costs:			
Dual reticulation	1100	$/lot	Economic assessment of class A and dual pipe supply to selected melton growth areas
Internal plumbing	600	$/lot	Economic assessment of class A and dual pipe supply to selected melton growth areas
One off connection fee for class A water	272.42	$/lot	Economic assessment of class A and dual pipe supply to selected melton growth areas
One off plumbing inspector commission for class A	294	$/lot	Economic assessment of class A and dual pipe supply to selected melton growth areas
Distribution pipes	refer to adjoining table		Western Water
Winter storage costs and pump infrastructure (extension to existing plant)	20000	$/ML	Western water estimate (mid-range)
Aboveground storage	refer to adjoining table	$/ML	Western Water
Underground storage	700	$/kL	E2Designlab database from Melbourne Water project costings
Open space storage and distirbution	450000	$/ML	E2Designlab database from Melbourne Water project costings
Wetland construction	100	$/m3	E2Designlab database from Melbourne Water project costings
Wetland planting	5.14	$/m2	E2Designlab database from Melbourne Water project costings
Buffer pond	60	$/m2	E2Designlab database from Melbourne Water project costings
Evapotranspiration field	120	$/m3	E2Designlab database from Melbourne Water project costings
Land purchase cost	refer to adjoining table	$/m2	Analysis of property sales for 2010 provided by Western Water
Stormwater to potable plant	2200000	$/MLD	Bespoke estimate for Sunbury by Permeate Partners
Class B/C to class A plant	variable	$/ML-year	Bespoke estimate for Sunbury by Permeate Partners
2kl Rainwater tank to hotwater	1950	$/lot	Marsden Jacobs - Cost efficiency of rainwater tanks in australia
2kl rainwater tank to toilet, laundry and irrigation (building regs)	2750	$/lot	Marsden Jacobs - Cost efficiency of rainwater tanks in australia
5kl rainwater tnka to all uses	3200	$/lot	Marsden Jacobs - Cost efficiency of rainwater tanks in australia
Porous paving	100	$/m2	Cost of WSUD (Melbourne Water)
Connection to hot water system	500	$/lot	EPA work estimate - assuming technology is mainstreamed
Self-watering street trees (4m2)	2000	$/tree	EPA work estimate - low cost assumption. Assums fairly simple installations and cost efficiencies with adoption for greenfield areas.
Pumps	Pump curve estimate		E2Designlab Database
Infiltration trench	75	$/linear m	Little stringybark project
Street raingarden	380	$/m2	Casey cost estimates (low estimate to account for marginal costs on green verge)
Lot raingarden planter box	1475	$/lot	Colourbond box raingarden southeast water (2.2 x 1.3 x 0.8)
Porous paving (lot)	30	$/m2 (marginal)	Assuming basecase $50/m2, porous $80/m2 (or $100 to $130 for fancy paving) http://www.melbournewater.com.au/getinvolved/protecttheenvironment/raingardens/Documents/Porous%20paving.pdf
Porous paving (street)	50	$/m2 (marginal)	Assuming basecase $50/m2, porous $100/m2 http://www.melbournewater.com.au/getinvolved/protecttheenvironment/raingardens/Documents/Porous%20paving.pdf
Passive irrigation	784	$/tree	
Operating costs:			
Wetland maintenance	185.4 x Macrophyte Area ^0.478		E2Designlab database from Melbourne Water project costings
Wetland renewal cost	80% capital at 25 years		E2Designlab database from Melbourne Water project costings
Tanks	1%	CAPEX	E2Designlan Estimation
Winter storage	0.5%	CAPEX	E2Designlan Estimation
Pump maintenance cost	1.5%	CAPEX	E2Designlan Estimation
Pump energy cost	Based on modelled energy at 13.6c/kwh		E2Designlan Estimation
Distribution pipes maintenance	0.5%	CAPEX	E2Designlab Estimation
Rainwater tank maintenance	60	$/tank	Marsden Jacobs - Cost efficiency of rainwater tanks in australia
Raingarden maintenance	11	$/m2	Casey cost estimates
Porous paving maintenance	500	$/half acre	http://ntl.bts.gov/lib/43000/43500/43570/TSR-2011-permeable-pavements.pdf - $400-$500 US for a half acre car park to be vacumn swept 3-4 times a yea

Western Water Pipe Rates:		Western Water Tank Rates:	
Size (mm)	Default Rates ($/m)	Size (ML)	Rate $000's
100	150	1	1074
150	200	2	1776
200	252	2.5	2183
225	252	4	3291
250	**252**	6	4400
300	400	10	6775
375	522		
450	609	/ML	414
525	696		
600	848	Crop Factors	ML/Ha
750	913	Sunbury	4.4
825	1087		
900	1217		
1050	1304		
1200	1500		
1500	1650		

Analysis of Property Sales for Hume 2010		2010	Assumed 2014 (+10%)
Mixed Farm and Grazing (low cost land)		0.8	
Res/Rural Lifestyle (high cost land within development)		42.37	4

Generic Costs	$	Per	Reasoning/Source
Bioretention	321	m2	Based on the figure from Harcrest (including excavation, media, pipework etc) and then adding for assumed cost of dense planting ($250) AND the MW First Quartile value of $392 (M 2009 adjusted for inflation to 2013).
Bioretention (street scale retrofit)	1,931	m2	MW Third Quartile value (2009 adjusted for inflation to 2013) - see Y:\142 Northland\Background\Casey\CostAnalysisAuditProjectsRevisedWaterValue and MW_WSUDcosts
Bioretention (lot scale)	720	m2	Based on (1) $1,035 Median value from MW - 2009 adjusted for inflation to 2013 - see Y:\142 Northland\Background\Casey\CostAnalysisAuditProjectsRevisedWaterValue and MW_WSUDcosts AND (2) highest self build value of $250 for residential without consideration of plumbing costs http://raingardens.melbournewater.com.au/content/what_is_a_raingarden/frequently_asked_questions.asp#5
Storage	700	kL	Taken as reasonable estimate in consideration of $400/kL for large cast in-situ tank (Stage 5 Harcrest park) and $1000kL for proprietary product with greater structural strength requir to placement below raiungarden (Stage 3 Harcrest park)
Pipework	60	m	Estimate from Gary
Purple pipe retrofit (toilet + outdoor)	500	Lot	Email correspondence, Nikko Chan, Yarra Valley Water, 17/01/2014.
Purple pipe retrofit (toilet, laundry, hot water and outdoor)	1500	Lot	Email correspondence, Nikko Chan, Yarra Valley Water, 17/01/2014.
Rainwater tank	1000	kL	Estimate from Gary
UV Treatment	6000	Block of 200 Lots	Estimate from Gary
Rainwater tank pump - block	5000	Block of 200 Lots	Estimate from Gary
Rainwater tank pump - residential	763	Lot	Average of melbourne suppliers surveyed in the National Water Commisions report 'The cost-effectiveness of rainwater tanks in urban Australia' p36 (see http://archive.nwc.gov.au/library/waterlines/1)
Downpipe connection	1000	Lot	Estimate from Gary
	3000	Apartment Block	Estimate from Gary
Operational costs - tank	**$**	**Per**	**Reasoning/Source**
Inspections	300	Year (6 inspections)	Harcrest
UV power usage	128	Year	Harcrest
Weater quality testing	375	Year (1 inspection)	Harcrest
Operational costs - tank pump	**$**	**Per**	**Reasoning/Source**
Replacement of damaged components	140	Year (twice)	Harcrest
Partial rebuild of pump	800	Year	Harcrest
Power usage	500	Year	Estimate from Gary
Operational costs - Bioretention	**$**	**Per**	**Reasoning/Source**
Bioretention	16	m2/Year	
Bioretention (street scale retrofit)	97	m2/Year	Assumed to be 5% of capital costs - as used for Casey see Y:\142 Northland\Background\Casey\CostAnalysisAuditProjectsRevisedWaterValue and MW_WSUDcosts
Bioretention (lot scale)	36	m2/Year	
Operational costs - Third Pipe	**$**	**Per**	**Reasoning/Source**
Water pipes	2.64	m/Year	
Water pipes (mild steel)	3.03	m/Year	
Water transfer main	2.73	m/Year	
Water transfer main (mild steel)	3.12	m/Year	Assumed that operational costs would be the same as the operational costs of an additional drinking water system, doesn't include estimate for metering requirements. Email correspondence, Nikko Chan, Yarra Valley Water, 20/01/2014.
Water pump station	$[243.62x + 7020.4] (where x is power rating of pumps in kW)	Year	
Water tank	$[501.75x + 12933.52] (where x is storage capacity in ML)	Year	
Replacement costs	**$**	**Per**	**Reasoning/Source**
UV lamps	300	9 years	Harcrest
Rainwater tank pump - block	5000	15 years	Harcrest
Rainwater tank pump - residential	763	10 years	National Water Commisions report 'The cost-effectiveness of rainwater tanks in urban Australia' p36 (see http://archive.nwc.gov.au/library/waterlines/1)

OPTION 1

	Option 1 a	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 1 a	2kL tank + 10m2 infiltration swale	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Rainwater tank supply (2kL)	1	-	$1,970		Designflow (2018). Assessment of costts associated with WSUD treatment of stormwater from industrial and commerical sites. DELWP
	Rainwater tank installation and plumbing	1	-	$1,400	$104	Cost effectiveness of rainwater tanks in Urban Australia (Marsden Jacobs, 2007) adjusted to 2018 dollars
	Infiltration trench	10	m2	$5,500	$30	$550/m2 Estimate, halfway between raingardens and swales. Assume same operating cost as swale
	Design services	20%	-	$1,774		
	Total			$10,644	$134	
	Total all dwellings	3803	Dw	$40,479,132	$509,602	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 1 b	2kL tank + permeable ground	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Rainwater tank supply (2kL)	1	-	$1,970		Designflow (2018). Assessment of costts associated with WSUD treatment of stormwater from industrial and commerical sites. DELWP
	Rainwater tank installation and plumbing	1	-	$1,400	$104	Cost effectiveness of rainwater tanks in Urban Australia (Marsden Jacobs, 2007) adjusted to 2018 dollars
	Porous paving (driveway)	30	m2	$3,000	$150	$100/m2 capex, $5/m2 opex, Cost of WSUD (Melbourne Water)
	Design services	20%	-	$1,274		
	Total			$7,644	$254	
	Total all dwellings	3803	Dw	$29,070,132	$965,962	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 1 c	4kL tank (HW) + street trees	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Rainwater tank supply (4kL)	1	-	$2,250		Designflow (2018). Assessment of costts associated with WSUD treatment of stormwater from industrial and commerical sites. DELWP
	Rainwater tank installation and plumbing	1	-	$1,400	$104	Cost effectiveness of rainwater tanks in Urban Australia (Marsden Jacobs, 2007) adjusted to 2018 dollars
	Connection to hot water system	1	-	$500		Estimate. Assuming technology is mainstreamed.
	Street trees (4m2)	1	-	$2,000	$5	Estimate. Capex assumes cost efficiencies in greenfield development and fairly simple installations.
	Design services	20%		$780		
	Total			$6,930	$109	
	Total all dwellings	3803	Dw	$26,354,790	$414,527	

OPTION 2 - aquifer injection

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2a	Lancefield - Northern scheme - 546 ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition (wetland size + 20%)	24,060	m2	$601,500	N/A	Estimate $25/m2. Review of recent multi-hectare sale prices across municipality (avg $17/m2 from four sales results). Compared with $39/m2 Victorian Valuer General (2018)
	Diversion channels, 1m wide	890	m	$13,350	$2,670	Based on seeded swale rates, WSUD cost calculator (Melbourne Water)
	Wetland construction	16,016	m3	$1,601,600	N/A	185.4 x Macrophyte Area ^0.478
	Wetland planting	20,050	m2	$103,057	$18,962	
	UV disinfection	1	-	$193,866	$58	From WSUD cost calculator
	Pump + electrics	2.7	kW	$94,500	$4,634	2.7 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
	Aquifer injection infrastructure	2	Bores	$140,000	$1,400	$70k per bore. Assume 1% opex
	Design services	30%		$824,362		Higher design rate asssumed for ASR given lack of local knowledge
	Total			$3,572,235	$27,724	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2b	Lancefield - western scheme 93ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	6,012	m2	$150,300	N/A	Estimate $25/m2. Review of recent multi-hectare sale prices across municipality. Compared with $39/m2 Victorian Valuer General (2018)
	Wetland construction	4,008	m3	$400,800	$12,024	
	Wetland planting	5,010	m2	$25,751	N/A	
	UV disinfection	1	-	$50,347	$58	From WSUD cost calculator
	Pump + electrics	0.7	kW	$59,760	$1,730	0.7 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
	Aquifer injection infrastructure	1	Bores	$70,000	$700	$70k per bore. Assume 1% opex
	Design services	30%		$227,088		Higher design rate asssumed for ASR given lack of local knowledge
	Total			$984,046	$14,512	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2c	Romsey - main drain scheme 729 ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	0	m2	$0	N/A	On Western Water land
	Wetland construction	24,720	m3	$2,472,000	$74,160	
	Wetland planting	30,900	m2	$158,826	N/A	
	UV disinfection	1	-	$300,347	$58	From WSUD cost calculator
	Pump + electrics	4.2	kW	$108,022	$6,624	4.2 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
	Aquifer injection infrastructure	4	Bores	$280,000	$2,800	$70k per bore, includes 1 additional bore for extraction at Lancefield treatment plant, assume 1% opex
	Design services	30%		$995,759		Higher design rate asssumed for ASR given lack of local knowledge
	Total			$4,314,954	$83,642	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Shared infrastructure	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Pipework from wetlands to plant (100mm)	2,300	m	$345,000	$1,725	$150/m, 0.5% operating cost
	Pipework from wetlands to plant (250mm)	4,975	m	$1,253,700	$6,269	$252/m, 0.5% operating cost
	Upgrade water treatment plant capacity	-	ea	Unknown	Unknown	Current treamtent plant at Lancefield likely to need upgrading to increase the yield.
	Total			$1,598,700	$7,994	
	Option 2 Aquifer Grand Total			$10,469,934	$133,872	

OPTION 2 - evapotranspiration

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2a	Lancefield - Northern scheme - 546 ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	40,092	m2	$1,002,300	N/A	Estimate $25/m2. Review of recent multi-hectare sale prices across municipality (avg $17/m2 from four sales results). Compared with $39/m2 Victorian Valuer General (2018)
	Diversion channels, 1m wide	890	m	$13,350	$2,670	Based on seeded swale rates, WSUD cost calculator (Melbourne Water)
	Sponge construction	16,705	m3	$2,004,600	$10,023	$120/m3, 0.5% operational cost
	Design services	20%		$604,050		
	Total			$3,624,300	$12,693	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2b	Lancefield - western scheme 93ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	10,020	m2	$250,500	N/A	Estimate $25/m2. Review of recent multi-hectare sale prices across municipality (avg $17/m2 from four sales results). Compared with $39/m2 Victorian Valuer General (2018)
	Sponge construction	4,175	m3	$501,000	$2,505	$120/m3, 0.5% operational cost
	Design services	20%		$150,300		
	Total			$901,800	$2,505	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 2c	Romsey - main drain scheme 729 ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	0	m2	$0	N/A	Western Water land
	Sponge construction	25,800	m3	$3,096,000	$15,480	$50/m2, 0.5% operational cost
	Design services	20%		$619,200		
	Total			$3,715,200	$15,480	
	Option 2 Evap Grand Total			$8,241,300	$30,678	

OPTION 3 - harvesting for groundwater exchange

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 3a	Recycled water to farmers	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Pipeline	12,000	m	$2,400,000	$12,000	12km length, 0.5 ML/day, 6 L/s, 100mm diameter, $200/m, opex at 0.5%
	Winter storage	125	ML	$1,875,000	$10,000	$15k/ML, opex at 0.5%
	New bore	1	ea	$70,000	$500	$70k each
	Distribution pump	10	kW	$135,000	$2,000	10kW power opex @1.5%
	Power cost		-	$0	$13,500	Assumes $1/m head/ML
	Desiign services	20%	-	$896,000.00	$0	From WSUD cost calculator
	Total			$5,376,000	$38,000	

		#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Option 3b	Lancefield - western scheme 93ML/y yield	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
	Land acquisition	6,012	m2	$150,300	N/A	Estimate $25/m2. Review of recent multi-hectare sale prices across municipality. Compared with $39/m2 Victorian Valuer General (2018)
	Wetland construction	4,008	m3	$400,800	$12,024	
	Wetland planting	5,010	m2	$25,751	N/A	
	Pipework to users, assume 500m	500	m	$125,000	$3,616	Pipeline from wetland to user, 39 L/s, assume 250mm pipe
	UV disinfection	1	-	$193,866	$58	From WSUD cost calculator
	Pump + electrics	0.7	kW	$59,760	$1,730	0.7 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
	Winter storage	7500	kL	$150,000	$750	$20k/ML, 0.5% operating cost
	Design services	20%	-	$221,095		
	Total			$1,326,573	$18,178	

OPTION 4 - Recycled water expansion in Gisborne

Option 4

Recycled water expansion in Gisborne	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Pipeline	11,000	m	$3,300,000	$16,500	11km length, 150mm diameter, $300/m, opex at 0.5%
Winter storage	140	ML	$2,100,000	$10,500	$15k/ML, opex at 0.5%
Pump station	1	ea	$150,000	$2,500	Allowance for pump station upgrade at RWP
Pumping - electricity		-	$0	$20,000	Assumes $1/m head/ML, lift from RWP to Magnet Hill ~ 110m, 165 ML/y
Desiign services	20%	-	$1,110,000.00	$0	From WSUD cost calculator
Total			$6,660,000	$49,500	

OPTION 5

Option 5a

Willowbank Rd development	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Wetland design modification	10%	-	$5,976	N/A	
Pump + electrics	3.8	kW	$59,760	$5,424	4.2 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
Design services	20%	-	$13,147.20		
Total			$78,883	$5,424	

Option 5b

Robertson Rd	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Wetland construction	2,224	m3	$222,400	$6,672	
Wetland planting	2,780	m2	$14,289		
Pump + electrics	0.4	kW	$51,312	$1,246	4.2 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
Design services	20%	-	$57,600.24		
Total			$345,601	$7,918	

Option 5c

Jacksons Reserve	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Wetland construction	5,720	m3	$572,000		
Wetland planting	7,150	m2	$36,751		
Pump + electrics	0.6	kW	$58,621	$1,594	4.2 kW pump power, cost from WSUD cost calculator (Maryborough). Maintenance at 1.5% + 13.6c/kWh
Design services	20%	-	$133,474.40		
Total			$800,846	$1,594	

Combined scheme costs	#	Units	Capital cost ($)	Operating Cost ($/yr)	Notes
Pipework (100mm main pipe from Robertson to Willowbank)	3880	m	$783,760	$3,919	100mm pipe, $202/m, 0.5% operating cost
Pipework (300mm from Willowbank to Riddells Rd)	9640	m	$3,383,640	$16,918	300mm pipe , $351/m , 0.5% operating cost
Pump 1 (bottom of Jacksons Creek)	9.7	kW	$132,305	$1,985	1.8 kWh
Pump 2 (Willowbank Rd0	23.6	kW	$231,393	$3,471	17.8 kWh
Pump 3 (Dalrymple Rd)	33.5	kW	$288,302	$4,325	17.8 kWh
Design services	20%	-	$963,880.0		
Total			$5,783,280	$30,618	
Option 2 Grand Total			$7,008,611	$14,936	