Plumpton & Kororoit PSPs
Whole of Water Cycle Analysis
Base Case and Options Assessment

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Prepared by:
Storm Consulting Pty Ltd

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EXECUTIVE SUMMARY

Preamble

The Metropolitan Planning Authority (MPA) has commissioned Storm Consulting Pty Ltd (Storm) to undertake a Whole-of-Water-Cycle (WOWC) assessment for the Plumpton and Kororoit Precinct Structure Plans (PSPs).

The Plumpton and Kororoit WoWCA was commenced and completed prior to the completion of the Melton WoWCA, which is being undertaken by OLV in partnership with Western Water and City West Water, Melton Council and Melbourne Water, for the whole of the Melton LGA. The Melton WoWCA seeks to identify preferred water servicing for the whole of the Melton LGA. It includes identification of a significant number of options (far greater than for the Plumpton/ Kororoit WoWCA) which are reduced to the preferred option/s through cost-benefit analysis.

This Plumpton/ Kororoit WoWCA has been prepared separately to the Melton WoWCA due to timing constraints, but can be used to inform the Melton WoWCA in future.

WOWC Objectives and Approach

A WOWC approach aims to manage the traditionally fragmented components of planning in an integrated manner, recognising the significance of water management at an early stage in the process to the benefit of environmental, social and economic objectives.

The WOWC assessment considers water servicing through supply, sewage infrastructure and stormwater management aiming to identify a preferred option for the PSP's based on Stakeholder and agency values.

Specifically, WOWC objectives are to:

- Identify reliable alternative water supply sources aiming to reduce conventional drinking water use and provide more resilience
- Protect and enhance the values of urban waterways, including minimising stormwater volumes and improving quality
- Improve liveability and community health
- Provide efficiencies and benefits to managing of all the elements of the water cycle mentioned above from a holistic point of view

These objectives are based on the aims of the Victorian Government's (OLV) 'Water Future West' strategy which has been developed in accordance with the Metro Framework.

The WoWC also adds value to the design of the "Future Urban Structure" plan as it develops by providing criteria around the location of open space infrastructure and road design from a water perspective. These can then be considered, among other considerations such as walkability, geographic distribution and access, in the design of the Future Urban Structure plan.

Stakeholders Values and Workshops

The options were developed through three workshops with local developers, Council and relevant agencies in attendance. Workshop 1 focussed on the developers aspirations for the subject PSP's. Presentations from each of the key agencies on their roles and perspectives with respect to the opportunities and constraints of the PSP's were first conducted. Developers were then able to have an open discussion on their aspirations.

Workshop 2 aimed to facilitate agreement between stakeholders on the priorities specific to the Kororoit and Plumpton PSP's. A presentation was conducted to promote discussion between the separate parties and begin to develop acceptable alternative options to the Base Case (also referred to as 'Business as Usual').

Workshop 3 aimed to provide comparison between potential options to be pursued to understand which options were favourable to stakeholders.

The main points expressed by the Stakeholders at the workshops were:

- Co-location of assets (eg retarding basins and wetlands) maintains a priority due to multiple benefits.
- Developers are concerned with cost, time, land take and the buy in from the community with respect to options. Commitment to affordability and liveability are key concerns.
- CWW is prepared to undertake stormwater harvesting projects with the key being 'economy of scale'.
- CWW advised they will investigate the potential to minimise sizing of the recycled water line as a low flow top up (of rainwater tanks) option.
- Council indicated they are happy with WSUD, however, emphasised swales are not preferred at the front of properties, only in medians and nature strips. Leaky tanks were also eliminated.
- Melbourne Water (MW) emphasised the health of the waterway is a high priority. However, MW also noted a risk exists in reducing centralised assets and replacing these with lot-scale and street scale measures. Nevertheless, MW was supportive of incorporating future provision of lot scale and street scale measures.
- On-lot solutions were not favoured by developers.

Options Assessed

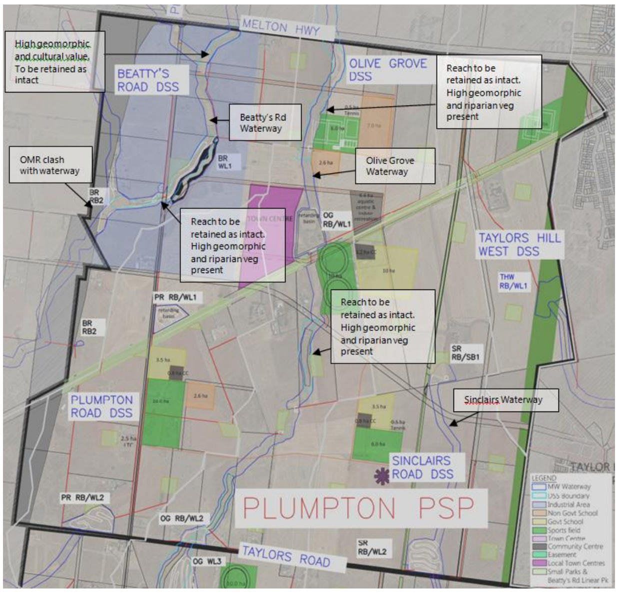
Based on the Workshops and ongoing consultation with Stakeholders objectives and WOWC options for the Plumpton and Kororoit PSP's were developed. The objectives were considered in the comparison of the alternative options for the PSP's. Two Alternative Options in addition to the Base Case has been pursued:

- *Base Case* – 'Business as usual' covering how this development would take place based on complying with the current norms of water management. Note: this scenario is based on preliminary Melbourne Water DSS work, which has been updated after undertaking this WoWCA as advised by MPA.
- *WOWC Alternative Option 1* – implementation of measures targeting water quality criteria and reducing base case Wetland footprints.
- *WOWC Alternative Option 2* – introduction of additional measures to protect and enhance the waterway and maximise reduction of traditional water supply.

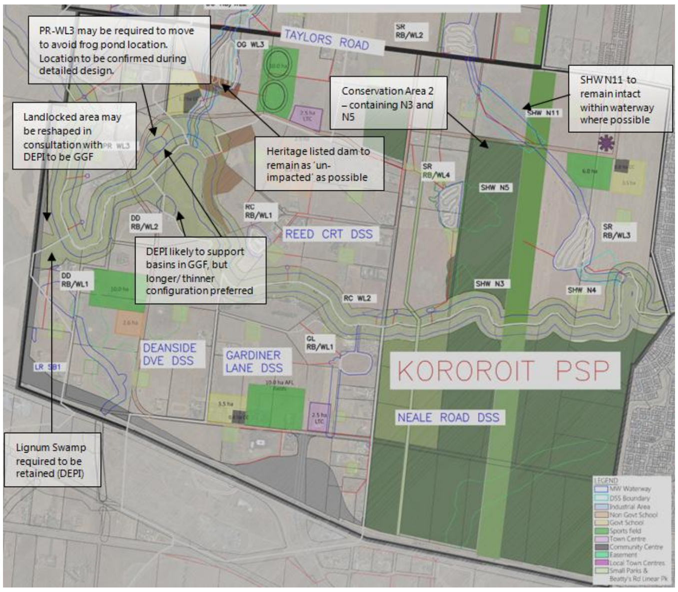
The options are represented graphically below and tabulated in subsequent tables illustrating the relevant objectives.

Base Case

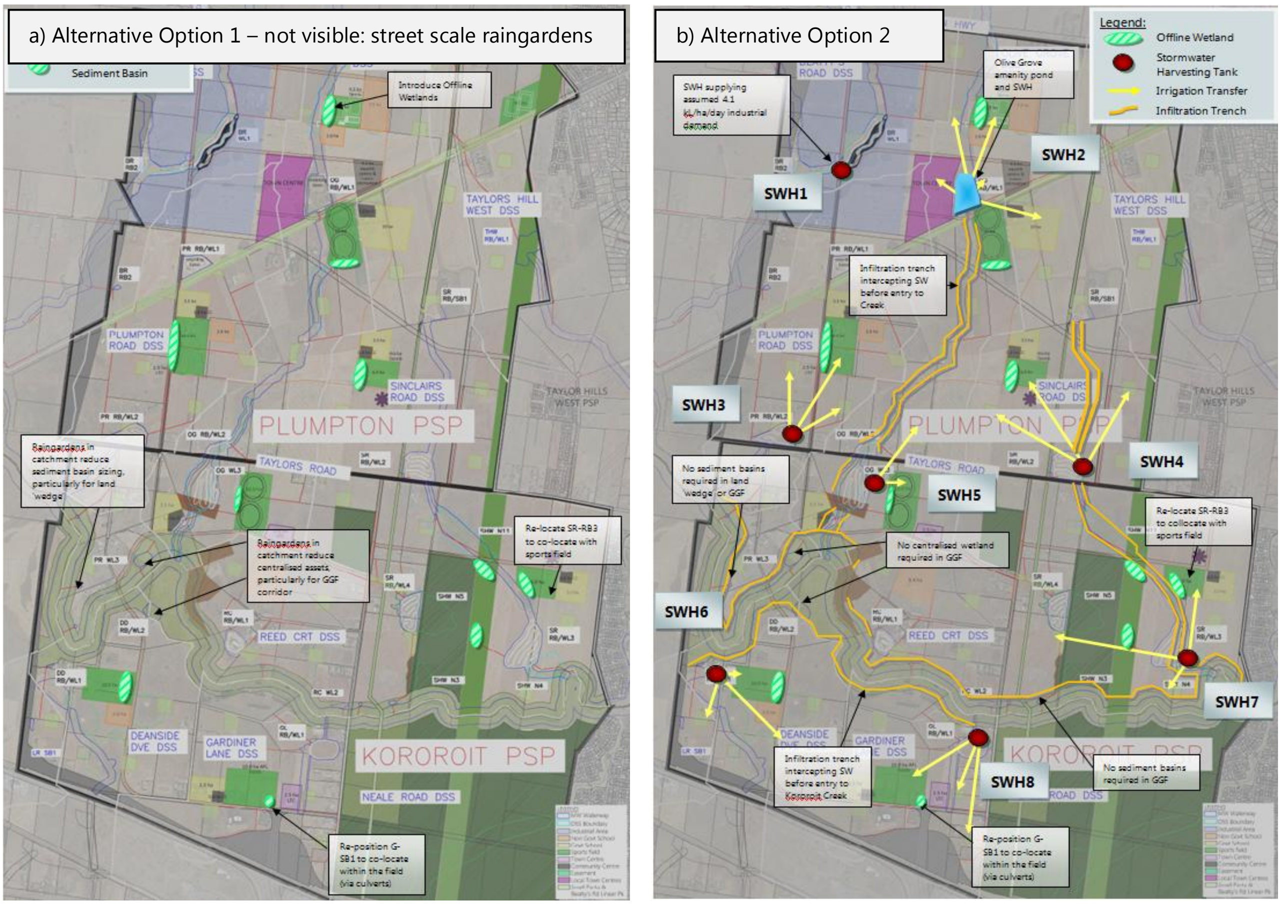
a) Base Case – Plumpton PSP



b) Base Case – Kororoit PSP



Alternative Options 1 and 2



As can be seen from the maps above, Alternative Option 1 introduces street scale measures and offline wetlands to the Base Case. Alternative Option 2 applies further measures, including stormwater harvesting and infiltration trenches, to provide alternative water sources and the best feasible option in protecting waterways. The infiltration trenches have been used in large scale at Warrick Court (as presented in workshops) and during the Little Stringybark Creek project. Melbourne Water has advised these will need further investigation.

The tables below also depict the results of the options assessment. Where the results do not achieve the objectives (represented predominantly by the BPEM targets), the result is highlighted in red. It should be noted, that while the whole of PSP result may not achieve the targets, these may generally be achieved by DSS. Additionally, this work was undertaken based on preliminary DSS work provided by Melbourne Water. MPA advises this has been updated.

In general, all options achieve the water quality and 100 Year ARI peak flow targets, however, do not meet the 1.5 Year peak flow target as shown highlighted in red in the below table. The 1.5 Year ARI peak flow target is an existing criteria under the Best Practice Environmental Management Guidelines (BPEMG) which requires the peak flow to be maintained at pre-development levels. Alternative Option 2 performs the best in this respect, being 2 times higher than pre-development conditions compared to 2.6 times higher for the Base Case and Alternative Option 1.

Costs increase with increasing benefits. While Alternative Option 2 achieves the most in terms of protecting waterway health (and the associated cultural and environmental values present within the existing waterways) and providing alternative water sources, this comes at the highest economic cost.

WOWCA Options

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
Description	Centralised Retarding basins/wetlands - MW DSS	"Practical" option - key target to reduce stormwater volume and peak flow	"Best case" option - key target is reducing volume and peak stormwater flow
	Current practice to meet BPEM	Stormwater quality improvement prior to entering waterways through street scale WSUD - above ground tree pit gardens, or below ground systems	Stormwater quality improvement prior to entering waterways through street scale WSUD - above ground tree pit gardens, or below ground systems
		Off-line wetlands to assist in minimising loads on centralised assets	Infiltration element along the creek to minimise volumes and peak flow entering the waterways[1]
POTABLE WATER			
System	Reticulated - all users	Reticulated - all users	Reticulated - all users
Supply	Centrally supplied	Centrally supplied	Centrally supplied
SEWERAGE			
System	Reticulated - all users	Reticulated - all users	Reticulated - all users
Treatment	Centrally treated	Centrally treated	Centrally treated
RECYCLED WATER			
System	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses. An opportunity exists to decrease peak demand flowrates and pressures which is expected to significantly decrease capital and operational costs.
Supply	Ravenhall RW Facility	Ravenhall RW Facility	Ravenhall RW Facility

[1]Melbourne Water has advised that infiltration trenches will require further investigation, before they would be used on broad scale applications. Storm has successfully used infiltration trenches on the Steele Creek, Warrick Court project, and the Little Stringybark Creek project at large scales, as well as many other applications in smaller scales. Melbourne Water are currently investigating this approach with Moonee City Council and will require further work before acceptance. Nonetheless, these have been included for the purposes of this assessment in order to present the best feasible option in protecting the waterways.

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
STORMWATER			
Major system - MW			
DSS Detention	BPEM - 1 in 100 year ARI detention	BPEM - 1 in 100 year ARI detention	BPEM - 1 in 100 year ARI detention
DSS Treatment	BPEM - 80, 45, 45,	BPEM - 80, 45, 45,	BPEM - 80, 45, 45,
Assets	Centralised RBs incorporating SWQT* systems; distributed precinct scale SWQT systems (to be delivered to Council for maintenance purposes once constructed if < 60 Ha catchment)	Some assets distributed throughout individual catchments and co-located adjacent to or within active open space areas to increase SWH potential and create amenity assets.	Some assets distributed throughout individual catchments and co-located adjacent to or within active open space areas to increase SWH potential and create amenity assets.
Treatment and Re-use	Not considered	Not considered	Potential to provide treated stormwater to future industrial and adjacent ag users
Local System - Council			
Detention	Assets constructed through development & delivered to local Council though the DSS process or other land development processes for catchments < 60 ha	BPEM 1.5 ARI detention	BPEM 1.5 ARI detention
Treatment	SWQT assets constructed through development and delivered to Council, as above	As per Base Case	As per Base Case
Assets	Traditional reticulated underground piped system	Traditional reticulated underground piped system	Traditional reticulated underground piped system
WSUD	Nil	Raingardens in medians (1% of catchment area). Offline wetlands in green spaces.	Opportunities to place swales (bioretention and vegetated) in medians of higher order roads explored in appropriate sub-catchments. Offline wetlands in green spaces.
			SWH to irrigate sport reserves with excess injected to recycled water system
			Infiltration trenches along sections waterways
Lot Based			
Roof tanks	Voluntary 6 star	Voluntary 6 star	Voluntary 6 star
Assumed tank uptake	5% of households	5% of households	100% of households
Assumed tank application	toilet flushing, household irrigation needs	toilet flushing, household irrigation needs	toilet flushing, household irrigation needs

*Stormwater quality treatment

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
OPTIONS COMPARISON - RESULTS			
Water Supply			
Potable supply	2,081 ML/yr	2,081 ML/yr	2,081 ML/yr
Recycled water	2,043 ML/yr	2,043 ML/yr	625 ML/ yr
Rainwater/Stormwater	74 ML/yr	74 ML/yr	1492 ML/yr
Runoff Volumes			
Volume ML	5,540	5,184	2,712
Volume Multiple (vs pre-devel)	3.1	2.9	1.5
Peak Flows			
1.5 Year (m3/s) / Multiple vs pre-develepment	22.4 / 2.64	22.4 / 2.64	16.7 / 1.96
100 Year (m3/s) / Multiple vs pre-development	110.8 / 1.18	110.8 / 1.18	102.5 / 1.09
RB Footprints	42.5 Ha	36.2	36.2
Water Quality[1]			
Targets			
TSS Reduction (%) *80*	75%	86%	91%
TP Reduction (%) *45*	64%	68%	81%
TN Reduction (%) *45*	44%	47%	70%
Quality Treatment Footprints	30	21.3	12.5
Area in developable land	43.8	37.2	35.6

[1]These results are based on preliminary Melbourne Water DSS work, which has since been updated after undertaking this WoWCA work, as advised by MPA.

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
OPTIONS COMPARISON - RESULTS			
WATERWAYS			
Waterway corridor Widths	MW modelled hydraulic width. Width defined by - *Waterway Corridor Guidelines* - MW (2013) - *Assessment of Riparian Vegetation & Geomorphology for Plumpton* - Alluvium/Practical *Ecology 2013.* - *Rockbank Area Wetland Survey* - Rakali 2013 - *Protection of intact waterways in the Olive Grove catchment*, Alluvium 2014.	As with Base Case	As with Base Case
	Some sections of natural waterway to be retained where specified by MW due to importance of geomorphological features.	As with Base Case	As with Base Case
	During design of the OMR, VicRoads and Melbourne water will need to review the alignment of the OMR and waterway where clashes occur	As with Base Case	As with Base Case
Waterway in Developable area	110	103	102
COSTS[1]			
Treatment of road runoff			
Raingardens and infiltration systems	-	$32.97 m	$25.93 m
Stormwater Harvesting	-		$28.69 m
Infiltration Systems	-		$7.17 m
Rainwater Tanks	-		$32.61 m
Total Cost		$32.97 m	$94.40 m

[1]Costs represented as excess to the Base Case

Recommendations and Findings

It is evident that Alternative Option 2 achieves the highest level of performance with respect to benefits to the environment and water supply. However, it is unclear at this stage whether the costs may be outweighed by these benefits, and who would pay for these additional costs with a more detailed assessment is required. For example, does the implementation of a rainwater tank provide sufficient savings off the water bill for the resident? No mandate on rainwater tanks exist at this stage and therefore rainwater tanks currently remain hampered more by economic drivers. Nonetheless, aspects of Alternative Option 2 may provide significant benefit to the water retailer, particularly for the larger stormwater harvesting projects, with excess water potentially recovered for storage and injection to the recycled water system.

The provision of recycled water, impacting on potable water supply, may be argued to mitigate the need to provide further alternative water sources. However, the larger schemes, such as SWH 2, are worth investigating further. CWW has advised that SWH that provides 'economy of scale' may be adopted. These have been taken as projects that supply more than 20 ML for irrigation, with added benefit being injection to the recycled water line. SWH2 also provides an amenity feature being a large pond on the edge of the commercial area, as well as being a co-located detention asset providing multiple benefits. It is recommended that this option be investigated further. A life cycle analysis including costs, would be required subject to the amenity pond proceeding to a more detailed assessment stage.

Alternative Option 1 still provides benefits to stormwater volumes and quality. Should the distributed assets for this option (raingardens or WSUD) be opted to proceed for further investigation, Melton Council will likely be responsible as they are less than 60 Ha (which would become MW's jurisdiction). Ongoing maintenance and associated costs will be of particular significance to Council and sign off prior to proceeding with these assets would therefore be required.

The Base Case performs well with respect to providing a reliable water source, mitigating flood impacts to Kororoit Creek, co-locating assets to minimise impact on developable area and protection of environmental and cultural values of the waterways. As such, this may be the best option to move forward in planning. As identified above, it should be noted that this work was based on preliminary MW work which has since been updated after this WoWCA, as advised by MPA.

Components of both Alternative Options are recommended to be further evaluated by stakeholders once the Melton WoWCA is developed in 2015. For example, MPA has located sports fields, where suitable, in proximity to the waterways, to retain future options to harvest stormwater, while meeting community needs (other criteria include distribution and access). In developed areas where drainage to a centralised asset can not be achieved (such as in the 'land wedge' within the Plumpton DSS) or where these assets may encroach on Growling Grass Frog protected areas, lot scale assets could be encouraged. This draws from Alternative Option 1 which has shown that water quality targets are readily achieved in these areas.

The key recommendations and outcomes of the WOWC investigation are:

- Proceed with the Base Case which provides benefits to water supply, co-location of water quality and detention assets, 100 Year flood mitigation, and protection of waterway values.
- Further investigate the feasibility of the SWH2 pond in consultation with Council, landowner and water authorities. This will serve to increase amenity and water supply benefits.
- Further investigate the benefits of other stormwater harvesting projects, based on liveability, amenity and water supply against economic measures and re-locate relevant sports fields to increase the likelihood of uptake of these projects.

A key note to consider is that many of the aspects proposed in the Alternative Options are subject to agreement with Stakeholders, with the WoWCA providing a foundation for discussion and decision in moving forward. Selected elements should be further investigated subject to the recommendations and findings of the Melton WoWCA in early 2015.

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1.0 INTRODUCTION

The Metropolitan Planning Authority (MPA) has commissioned Storm Consulting Pty Ltd (Storm) to undertake a Whole of Water Cycle Assessment for the Plumpton and Kororoit Precinct Structure Plans (PSPs).

The Whole of Water Cycle Assessment (WoWCA) will assist in the preparation of the Plumpton and Kororoit PSPs and help shape the urban structure of the future communities, largely residential. The Plumpton and Kororoit PSPs will form a significant community within the Western Growth Corridor of Melbourne and will contribute to a projected population increase to 241,000 residents within the City of Melton by 2031.

The MPA has adopted the WoWCA process for new PSPs to assist in delivering the objectives detailed in the Victorian Government's new urban water policy, *Melbourne's Water Future*, (Office of Living Victoria, 2013) that strives to make greater use of alternative water and adopt a more integrated approach to water management.

1.1. WoWCA Objectives and Approach

This WoWCA Report aims to identify the most effective use and management of the location specific water sources (potable and non-potable) and reflect the nature and characteristics of the catchment; the proposed urban form; environmental values; as well as other government and stakeholder objectives.

Specifically, WoWC objectives are to:

- Investigate reliable water supply sources based on identifying opportunities to diversify water supply aiming to reduce conventional use and reduce the costs of centralised systems
- Protect and enhance the values of urban waterways, including minimising stormwater volumes and improving quality
- Manage flooding and minimise risk
- Improve liveability and community health
- Provide efficiencies and benefits to managing of all the elements of the water cycle mentioned above from a holistic point of view

These objectives are based on the aims of the Victorian Governent's (OLV) 'Water Future West' strategy which has been developed based on the Metropolitan Whole-of-Water-Cycle Strategic Framework (Metro Framework).

The WoWC also adds value to the design of the "Future Urban Structure" plan as it develops by providing criteria around the location of open space infrastructure and road design from a water perspective. These can then be considered, among other considerations such as walkability, geographic distribution and access, in the design of the Future Urban Structure plan.

The overall assessment approach aims to identify whole of water cycle opportunities building on the Business as Usual (BAU) approach, referred to as the Base Case. The Base Case perspective covers how this development may take place based on complying with current best practice water management requirements. The Base Case approach establishes the infrastructure requirements to meet flooding, drainage, stormwater management and water quality objectives and adopts a relatively traditional servicing outcome.

Options to meet and improve on government objectives and the underpinning infrastructure and servicing requirements are addressed in the WoWCA to highlight the shared opportunities for water management and use.

To meaningfully address the multiple aspects of water management, water authorities and government stakeholders were engaged to identify agreed objectives in order to develop two alternative WoWCA scenarios to accompany the Base Case. The stakeholders consulted with during the preparation of this document include:

Metropolitan Planning Authority (MPA)	Office of Living Victoria (OLV)
Melbourne Water (MW)	Melton City Council (Council)
City West Water (CWW)	Department of Environment, Land, Water and Planning (DELWP)
Western Water (WW)	Major land owners/developers

It should be noted that the Melton WoWCA is being prepared by WW in conjunction with OLV, CWW and Melton Council, however, was unavailable at the time of preparing this report. This will likely impact on the Plumpton and Kororoit PSP's development and will inform further investigations.

It should also be noted that this WoWCA was based on MW DSS work which were in draft form at the time of WoWCA modelling. Since that time, some DSS boundaries have been modified and updated to ensure required standards have been met, as advised by MPA.

1.2. WoWCA Options Development

The process of establishing alternative options began by identifying values and objectives of each stakeholder and the water management options that underpinned them. Specific options to meet and enhance the values expressed were progressed based on a preliminary Base Case report and workshops.

The development of this WoWCA report involved the following key steps:

- **Base Case Report (BAU)** The information collected for the purpose of this report was used as a platform to engage with stakeholders and identify realistic and achievable aspirations for the Plumpton and Kororoit precincts. The Base Case draft report was refined based on stakeholder input and is incorporated in the report prepared herein (Section 3).
- **Workshop 1** Workshop 1 focussed on understanding the objectives of developers with respect to water management. Each agency presented their perspective on the opportunities and constraints of the subject PSP's and an open discussion with the developers ensued who collectively identified cost, time, land take and community buy in as priorities.
- **Workshop 2** Workshop 2 aimed to facilitate agreement between stakeholders on the priorities specific to the Kororoit and Plumpton PSPs. A presentation to the stakeholders was first conducted in order to promote discussion between the separate parties and begin to develop acceptable alternative water management options to the Base Case that could be further investigated.
- **Workshop 3** Workshop 3 aimed to provide comparison between potential options to be pursued. This was presented based on a 'test case' water catchment as there are ten different catchment areas relevant to the Kororoit and Plumpton PSPs and there was some uncertainty as to which options were favourable to water authorities, Melton City Council and the MPA at this time.

Following the workshops, Storm continued to accept refinement and input from stakeholders to build the WoWCA objectives, values and options. The methodology for development of options is provided in more detail in Section 4.0.

1.3. Site Overview

The Plumpton and Kororoit precincts are located centrally within the Melton City Council municipality, immediately west of the Caroline Springs and Taylors Hill West communities. The precincts are bound by the Melton Highway to the north, Western Freeway to the south and the Outer Metro Ring Road (OMR) with Taylors Road being the divide between the two precincts (refer Figure 1).

The Plumpton precinct comprises 1,015 hectares of land with 107 hectares identified as employment. A projected yield of 9,500 lots has been estimated with a population forecast of 26,500 people.

The Kororoit precinct covers approximately 1,181 hectares with a projected yield of 8,300 lots and population forecast of 23,000 people.

The subject site has been predominantly used for grazing and cropping, which has likely degraded the natural regime including the ephemeral waterways and native vegetation. There are significant native grasses and ephemeral wetlands that remain throughout both precincts, with the most significant protected as part of the BCS.

The main water feature of the site is Kororoit Creek. This is a major waterway in Western Melbourne, running in an easterly direction through the central section of the Kororoit PSP (as shown in Figure 1) and is the receiving waterway for all flows across both precincts. It is a key landscape feature for both the study area and the western growth corridor comprising significant biodiversity values with a diverse range of native flora and fauna exsiting within the creek corridor. The corridor has been identified as a key Growling Grass Frog habitat and this has been reflected in the approved Biodiversity Conservation Strategy for Melbourne's Growth Corridors (DELWP – formerly DEPI, 2013).

Several ephemeral waterbodies flow in a southerly direction through the Plumpton PSP and outfall into Kororoit Creek. These waterways are key tributaries of Kororoit Creek and retain significant heritage and hydrological value. In the southern section of the Kororoit PSP the waterways are less defined and runoff is directed to Kororoit Creek through various outlets. The land has a slight fall (approximately 1%) towards Kororoit Creek.

The geology of the area is dominated by shallow basalt bedrock overlain by clay. This subsurface has been formed by the Newer Volcanics geology with the basalt resistant to weathering, resulting in the low relief. The area is anecdotally known to comprise a rocky subsurface, supported by Alluvium observing 'scattered basalt stones and boulders, which generally become more concentrated along drainage lines' (Alluvium, 2013, *Assessment of Riparian Vegetation and Geomorphology: Plumpton Area Development Services Scheme Study Area*).

The area is situated in one of the lowest rainfall zones in greater Melbourne; this makes local waterway management all the more important. By using appropriate design in the early stages of the precinct planning, controls can be put in place to utilise water to enhance the local waterways, control the hydrology to protect local ecology and geomorphology and enhance the amenity of public spaces.

Various technical background reports have been undertaken to ensure that local values are both protected and enhanced subject to future development (detailed in Section 2). These have contributed to the opportunities and constraints governing the subject sites with respect to whole of water cycle management.

Figure 1 shows an aerial image of the site and Figure 2 shows the working draft of the future urban structure of Plumpton and Kororoit PSPs.

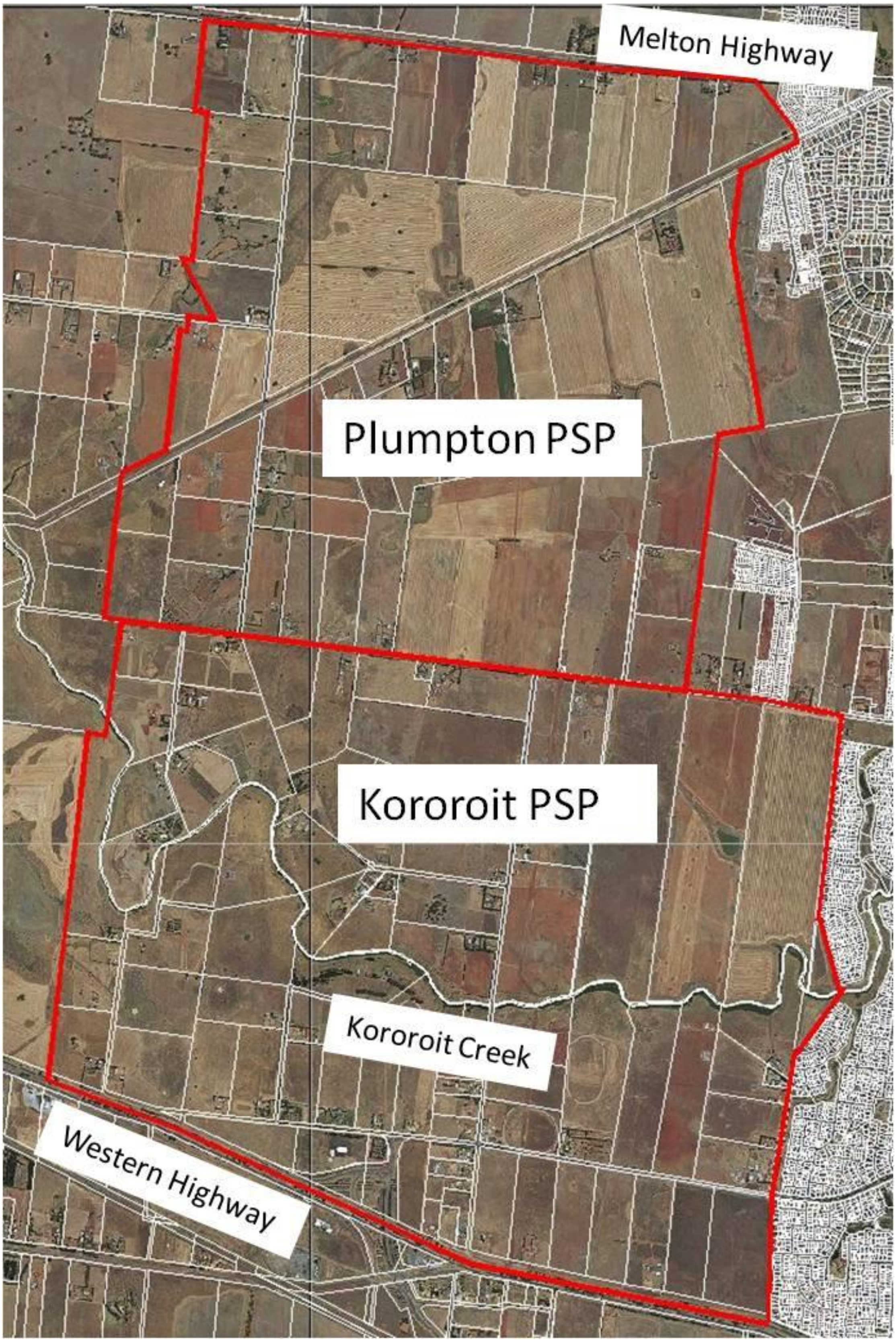

Figure 1 Existing Area

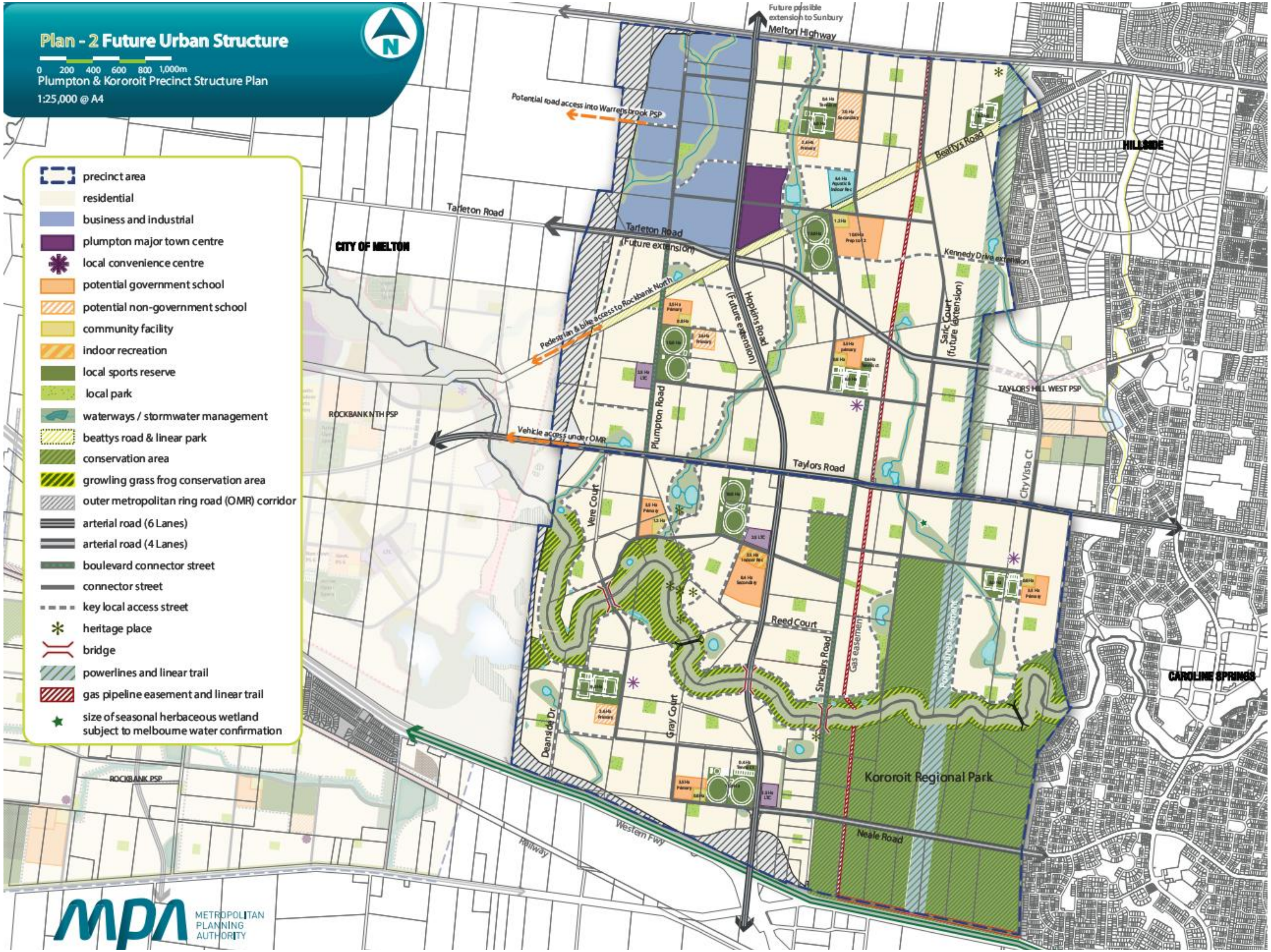

Figure 2 Proposed Future Urban Structure (Draft for Consultation November 2014)

2.0 POLICIES AND REGULATORY FRAMEWORK

The water sector in Victoria is made up of service providers, regulators and policy makers. The government arrangements are intended to establish a clear separation of policy, regulation and service delivery.

The key participants including the Office of Living Victoria (OLV), Melbourne Water (MW), City West Water (CWW) and Western Water (WW) have been involved in the development of policies and strategies which will contribute to best-practice management of water in new and existing urban environments. The roles and responsibilities of the key water authorities are provided as follows:

Office of Living Victoria – Urban Water Reform

The OLV sits within the Department of Environment, Land, Water and Planning (DELWP). Its role is to deliver urban water reform, transforming the way the state's water cycle is managed and how water cycle services are provided in Victoria. This requires aligning the strategic planning of all government agencies and other organisations responsible for both land use and water cycle planning.

Melbourne Water – Stormwater and Waterways

MW is responsible for regional drainage, flood plain and waterway management in the Port Phillip and Westernport regions. The overarching aims of MW with respect to waterways are to ensure adequate drainage and flood protection as well as protection and enhancement. MW also manages Melbourne's water supply catchments and removes and treats most of Melbourne's sewerage. On a PSP scale, MW sets out the essential requirements for stormwater-related works and infrastructure in new growth area developments. Development Services Schemes (DSSs) are the adopted policy framework used by Melbourne Water to design and plan infrastructure in an integrated manner that will ensure: flood protection; stormwater quality meets best practice; and waterways are protected, while maintaining an equitable cost basis. The DSSs are prepared to detail the location and volume requirements for centralised detention basins and water quality treatment facilities.

For new developments, MW's *Stormwater Strategy* identifies areas for integrated stormwater management solutions that may contribute to community wellbeing by providing safe and enjoyable recreational use of waterways, preventing nuisance flooding, providing an alternative water source and protecting and enhancing the health of waterways.

Kororoit Creek, the key water feature of the subject site, has been identified in MW's *Healthy Waterway Strategy* as a priority area for amenity purposes within the Werribee catchment. The strategy focuses on investing in areas that the community values and will protect and improve the environmental values and increase liveability.

Water Service Providers

City West Water (CWW) and Western Water (WW) are the retail water and sewerage service providers across the western regions of Melbourne. The provision of water supply and sewerage services to the Plumpton and Kororoit precinct is currently being negotiated.

2.1. Policy Context

Policy documents supporting and overarching the development have been identified below to understand the opportunities and constraints in developing the WoWCA.

The Victorian Government's Melbourne's Water Future Policy

The Victorian Government released a new water policy framework, *Melbourne's Water Future* (MFW), on 17 December 2013 (OLV, 2013).

MFW is characterised by a focus on a holistic approach to managing the different components of the water cycle including water services infrastructure, natural waterways and the built environment. The policy framework outlines improvements to governance, legislation, planning, innovation and project facilitation, as well as economic reform.

It is aimed at achieving a more resilient water cycle, improved security of supply and water quality, lowered costs, improved value for money in meeting the State's water needs, greater environmental and amenity benefits and increased innovation across the water sector. The plan refers to treated wastewater, stormwater and rainwater harvesting as future supply sources. Investing in these sources will substantially reduce the need for large scale additions to our drinking water supplies.

The preparation of a WoWCA for Greenfield developments is a priority initiative in MWF. MWF is clear that planning for growth areas should contribute to delivering its outcomes.

The Victorian Government's Plan Melbourne

The Victorian Government's public release of *Plan Melbourne* in October 2013 establishes an opportunity to align land use and water cycle planning.

Plan Melbourne sets the vision for the city's population growth to 6.5 million people by 2050. Much of this growth is expected to occur in the west and north, where traditional water servicing is more challenging and expensive. Plan Melbourne recognises that the urban development process is an opportunity to manage and make use of alternative water sources to protect waterways and minimise the impact of flooding.

It acknowledges the need to change the way urban development and water services are planned and managed in order to enable a more comprehensive and innovative approach to using stormwater and recycled water. Plan Melbourne commits to integrating whole-of-water-cycle management to deliver sustainable and resilient urban development (Direction 5.5).

Sub-regional Species Strategy for the Growling Grass Frog

The Sub-regional Species Strategy for the Growling Grass Frog was prepared by the Department of Environment, Land, Water and Planning (DELWP) to ensure the long term protection of the Growling Grass Frog (GGF) in the growth corridors. The GGF is threatened species are matters of national environmental significance protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The Biodiversity Conservation Strategy (BCS) is the overarching strategy for the protection of biodiversity in the growth corridors and is a significant step towards finalising the planning for biodiversity required for the Melbourne Strategic Assessment. The Sub-regional Species Strategy for the GGF helped define the areas for conservation including the GGF conservation corridor along the length of Kororoit Creek.

As part of preparing a PSP, concept plans for conservation areas are to be prepared and incorporated into the PSP. The conservation concept plan for the GGF corridor is currently under preparation. It will identify the appropriate areas to locate stormwater treatment infrastructure and passive recreation that will not negatively impact on GGF habitat.

The Kororoit PSP area has significant biodiversity values including threatened communities of Natural Temperate Grasslands in addition to threatened GGF. Threatened flora species occur throughout Kororoit, including significant populations of Spiny Rice-flower. Concept plans will also be prepared Conservation Areas 1, 2 and 3 which comprise herb-rich native grasslands that contains Spiny Rice-flower populations.

Urban Stormwater Best Practice Environmental Management Guidelines

The BPEMG guidelines (CSIRO, 1999) detail stormwater quality objectives to be achieved to assist in determining the level of stormwater management required to protect Victoria's urban waterways. The best practice objectives set performance targets for all new residential developments, now mandated under Clause 56 of the Victoria Planning Provisions.

Melbourne Water has identified these targets are required to be achieved in assessing the performance of stormwater treatment systems. These are:

- 45% reduction in Total Nitrogen (TN) from typical urban loads
- 45% reduction in Total Phosphorus (TP) from typical urban loads
- 80% reduction in Total Suspended Solids (TSS) from typical urban loads
- 70% reduction in Litter from typical urban loads
- Maintain discharges for the 1.5 year ARI event at pre-development levels

Melbourne Water have indicated these targets may be revised in the future. The targets will be used as a guide throughout this document to determine the performance between the options.

2.2. Retail Water and Sewerage Services

Water supply and sewer services within the study area are currently a shared City West Water (CWW) and Western Water (WW) responsibility. The water retailing boundaries are as shown on Figure 3, with the agencies currently exploring the benefits to customers of revising the boundary.

The servicing information has been provided for both precincts based on Aurecon's *Servicing and Utilities Report*(s) *(2013)*. It should be noted that Figure 3, reflecting this information is indicative only. Also shown on Figure 3 are the waterway corridors, as defined by MW (refer Section 2.3). All servicing will typically be located to the edge of these waterways.

Potable water

To service the future residential communities of Plumpton and Kororoit at full development a number of significant works will need to take place including:

- The construction of a 1,150mm diameter water main along the Melton Highway. The preliminary servicing plan shows that this will branch off into two main lines through Plumpton (approx 750mm and 450mm). The supply lines will continue on a slightly different alignment through the Kororoit PSP.
- The construction of a pump station to increase capacity of the transfer main from Greenvale Reservoir to the proposed storage tank at Holden Reservoir.

These features are shown on Figure 3.

Water main reticulation through the development will largely be driven by development staging and timing.

Sewer Servicing

A new gravity backbone is planned for servicing the Plumpton area. Three lines are proposed which approximately align with the waterway corridors through Plumpton (refer Figure 3). These will join a line running east along Kororoit Creek (for the entire length of the Kororoit Precinct) and be pumped from the planned permanent pump outlet south along Clarkes Road to the DIS at Robinsons Road and Riding Boundary Road, Ravenhall.

Four land parcels in the north-east of Plumpton will be serviced via an extension to the Stony Hill Creek sewer network.

The Servicing layout plan shows two main sewer lines running north through the southern area of Kororoit which will connect into the main sewer line adjacent to Kororoit Creek.

Aurecon (2013) notes the planned pumping station at Monaghans Lane and Kororoit Creek (within the Kororoit PSP) will require a site of approximately 20 m by 50 m to accommodate installation and maintenance requirements.

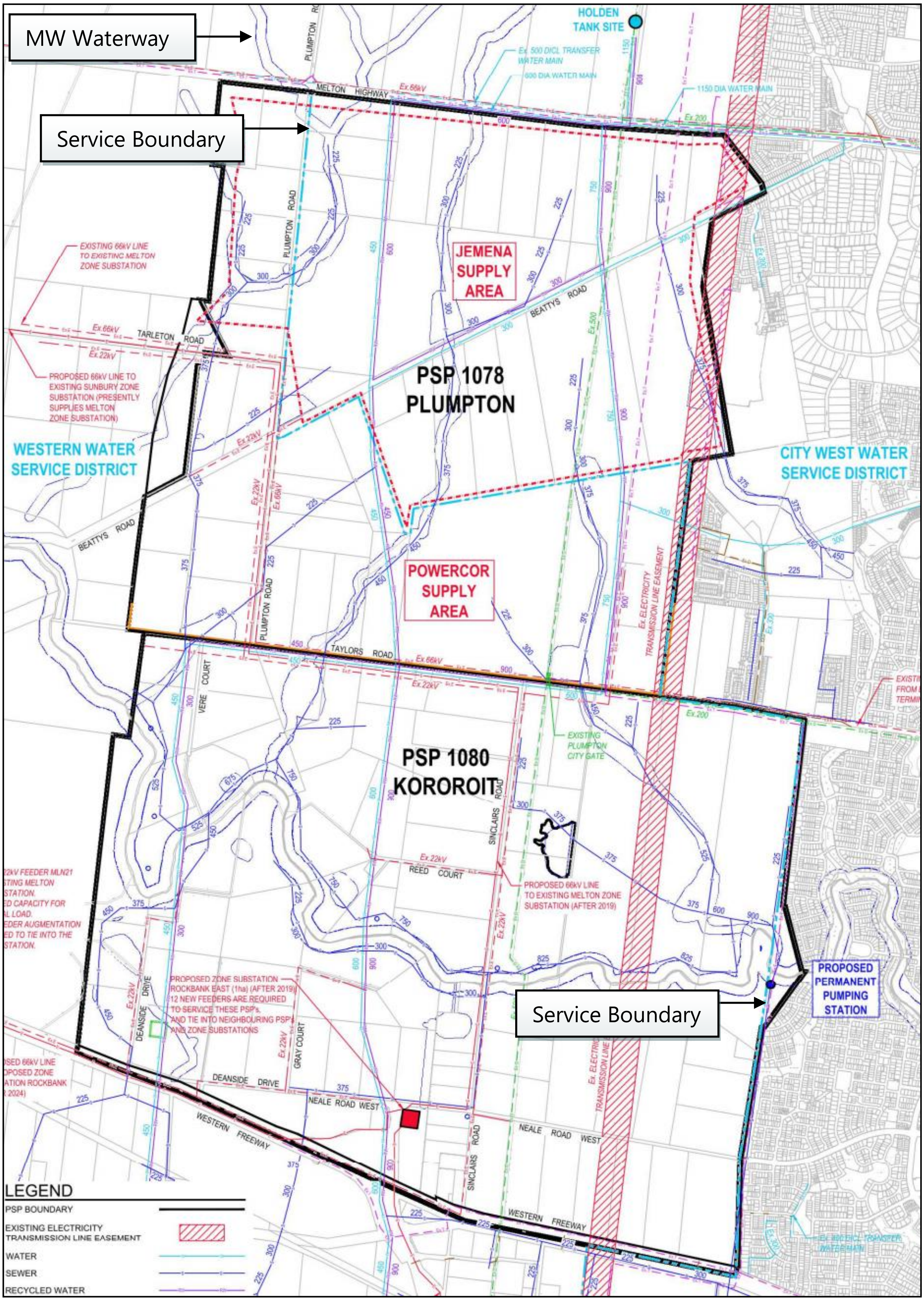

Figure 3 Plumpton and Kororoit Servicing Layout Plan (reproduced from Aurecon, 2013, Servicing and Utilities Reports)

CWW's Integrated Water Cycle Management Strategy

CWW's *Integrated Water Cycle Management Strategy* seeks to address the increasing demand for water within its service area.

CWW has addressed the demand challenges by developing and implementing sustainable, integrated water solutions to reduce dependency on potable water and eliminate the need to import potable water from external areas to meet the growth in demand.

Greenfield developments offer the opportunity to provide a dual supply system on a large scale. CWW's preferred water servicing option for Greenfield development sites is built upon large centralised potable and alternative water supply systems which are complemented by localised stormwater capture and reuse. These systems provide a resilient and sustainable infrastructure mix to ensure future water security.

Within the Plumpton and Kororoit PSPs, drinking water will be supplied from the potable supply network at the Holden tank (approximately 1.5km north of the Melton Highway). Recycled water will be sourced from the planned Ravenhall Alternative Water Production Facility (approximately 4 km SE of the south-eastern boundary of the Kororoit PSP, as shown on Figure 4).

The Plumpton and Kororoit precincts are included in CWW's Holden Dual Supply Area. CWW's IWCM states that there is the opportunity to implement aquifer storage and/or stormwater harvesting in the supply network.

The increased storage capacity offered through the operation of Ravenhall aquifer storage and recovery would allow the peak summer demands to be met while delaying the need to augment the Ravenhall Alternative Water Production Facility. The capture and reuse of stormwater could provide an additional supply of alternative water, either locally for playing fields or on a larger scale for re-injection into the third pipe system, and/or aquifer storage and recovery.

Western Water's Whole of Water Cycle Strategy (WWCS)

Western Water's WWCS recognises the need to utilise all available water resources to meet the increasing demands of the community, under population growth and potential climate change conditions. The strategy identifies rainwater, stormwater, wastewater and groundwater as potential water sources in providing an integrated and resilient water supply stream.

The WWCS aligns with the strategic direction of Melbourne's Water Future and Plan Melbourne with the key desired outcomes including optimising local water supply, maximised beneficial use of recycled water, enhanced waterway health, economic prosperity and liveability.

While the current boundary dissects the Plumpton and Kororoit Creek areas, shared with CWW, the options for water supply in the greater Melton area are being investigated under the Melton WoWCA.

This study is headed by Western Water in partnership with CWW, DELWP, MW, Council's, Southern Rural Water and the MPA. The investigation will consider the various supply options identified under the WWCS, CWW's IWCM and Plan Melbourne.

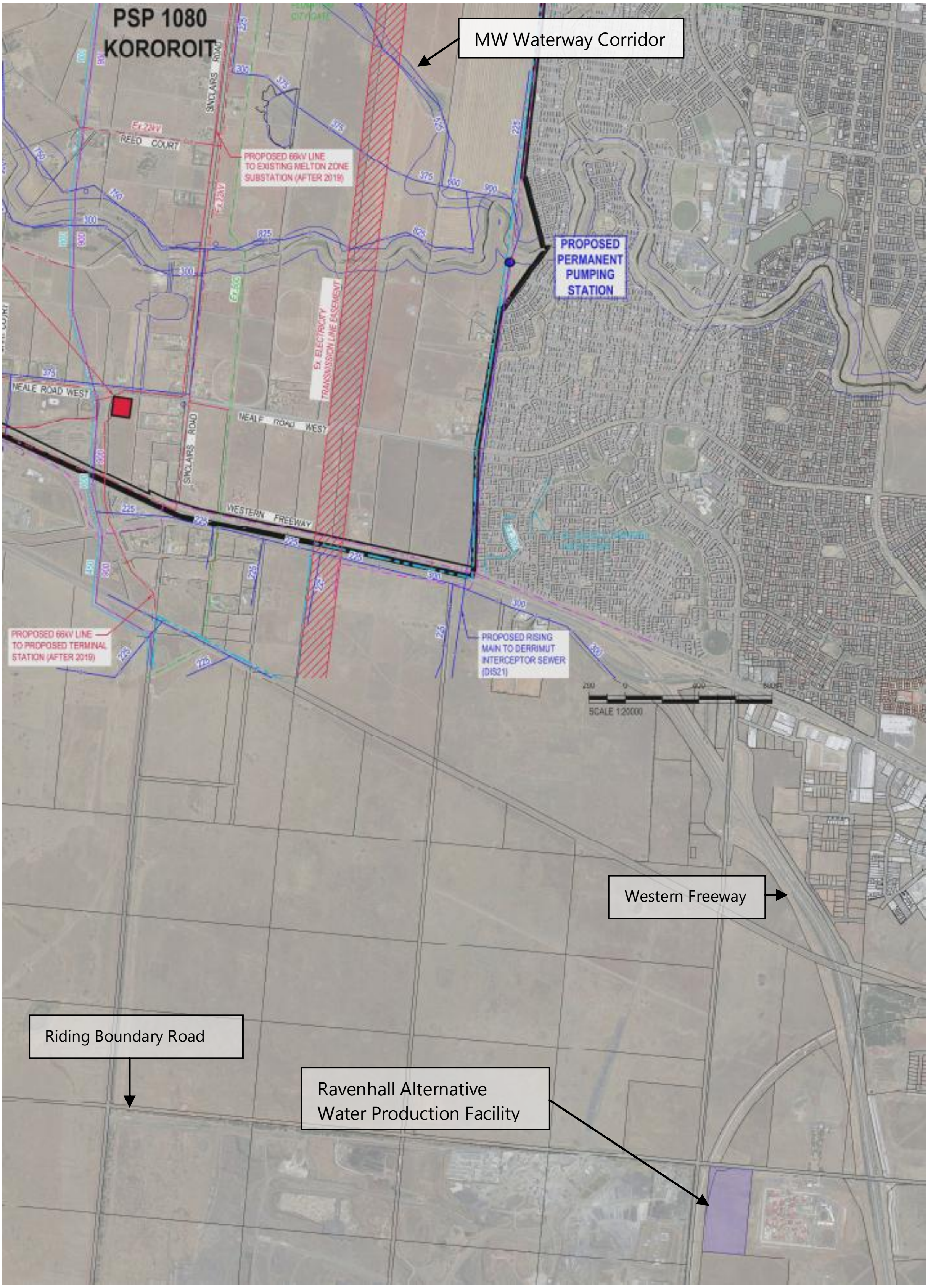

Figure 4 Kororoit Servicing Layout Plan Showing Ravenhall Facility Location (adapted from Aurecon, 2013, Servicing and Utilities Reports)

2.3. Related Local Investigations and Studies

Localised investigations have established the general character of waterways and wetlands located within the same study area. These studies define the various outcomes of the related DSS and this information together with the information gathered in Section 3.0 will be used to form the basis for alternative water management options.

Rockbank Area Wetland Study

Rakali Consulting was engaged by Melbourne Water in 2013 to report on the condition of 45 wetlands located across the Rockbank and Tarneit areas. This assessment was in response to the Environment Protection and Biodiversity Conservation Act 1999 (EPBC) recently listing the Seasonal Herbaceous Wetland (SHW) as a critically endangered) community. Six sites within Kororoit PSP qualified as 'high quality' examples of SHWs. They are therefore potentially matters of national environmental significance under the EPBC and are referred to in the report as NR1, N1, N2, N3, N5 and N11.

Sites N1 and N2 are located within the Deanside DSS catchment, NR1 lies within the Kororoit Regional Park located within the Neale Road DSS catchment and the remaining sites are within Sinclairs Road DSS catchment.

Wetlands N3 and N5 are largely within the Conservation Area 2 (as defined by the BCS). N5 extends to the west of the Conservation area boundary, marked as drainage reserve within the PSP. The area to the west of the conservation area is to be used as a retarding basin in the proposed drainage schemes.

Drainage line N11 lies directly to the north of Conservation Area 2 and has been marked as a drainage line in the Kororoit PSP. Sites N1 and N2 will not be retained.

The report also identifies site N4 as a site that is relatively intact and may support sufficient indicators if surveyed in an appropriate season. This area has been incorporated into a waterway in the PSP.

Location of the existing SHWs is provided in Figure 5, planned MW assets and waterways are also shown for context.

As shown in Figure 5, a wetland is planned within the western section of N5. N4 and N11 are shown within the future waterways and pipework has been incorporated into the DSS's to maintain a similar flow regime in the future scenario compared to the existing case.

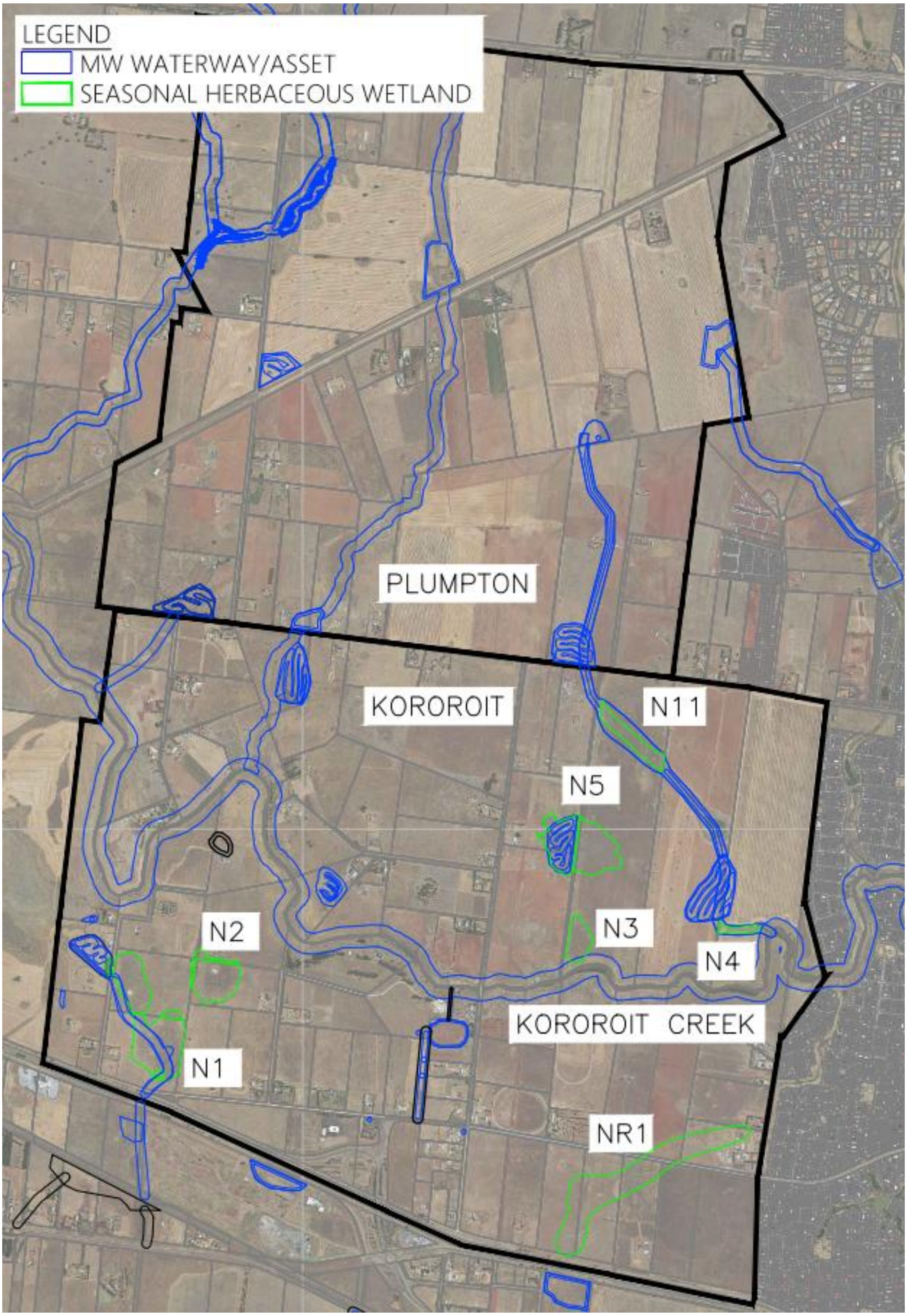

Figure 5 Existing Seasonal Herbaceous Wetlands and Proposed Waterways/Assets through Plumpton and Kororoit (Preliminary Development Services Schemes, 2014).

Assessment of Riparian Vegetation and Geomorphology: Plumpton Area Development Services Scheme Study Area

Alluvium and Practical Ecology was engaged by Melbourne Water in 2013 to assess the fluvial geomorphology, riparian vegetation and flora and fauna habitat values of the waterways within the Plumpton and Kororoit PSP areas to help inform the development of the Beattys Road, Olive Grove and Sinclairs Road catchments. The impacts of the proposed development were assessed on the defined waterways in the study area.

The geomorphic assessment defined the river condition and their ecological values in their current condition. The assessment also examined the likely impacts on geomorphic processes and forms resulting from changes in hydrology following urban development.

Geomorphic and ecological values are generally in alignment for the majority of properties.

The range of river management interventions included the following:

- maintaining the current form of resilient waterways through the construction phase,
- constructing artificial waterways; and
- catchment-scale interventions to protect high value, sensitive areas.

Each stream reach was given a management recommendation and specific actions for every property that it flows through. These are shown in Figure 6, as reproduced from the report.

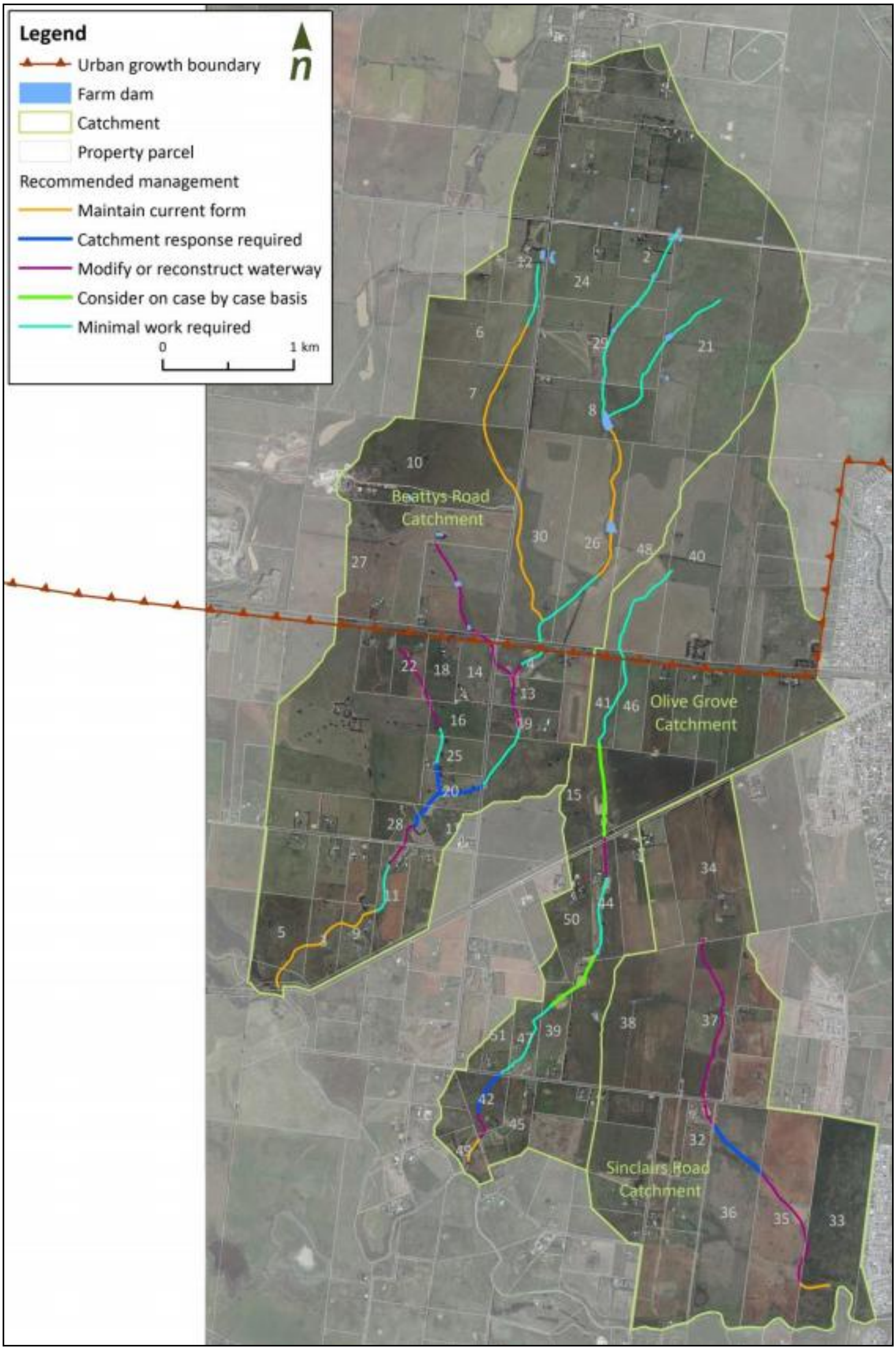

Figure 6 Recommended management interventions for waterways under development scenario (reproduced from *Alluvium, 2013*)

Feasibility Assessment: Protection of intact waterways in the Olive Grove Catchment

Melbourne Water engaged Alluvium in 2014 to provide further advice on management measures for retaining high value areas within the Olive Grove waterway and provide estimated corridor widths.

The previous study identified a number of reaches of intact waterway in the Olive Grove catchment of being high geomorphic value that should be retained where possible. These reaches represent remnant landscape features in good condition that have been largely lost from Victorian waterways since European settlement.

Future urban development will change the hydrological regime and impact on the morphology of these reaches that can lead to channel incision and destruction of the remnant form.

Recommendations were provided in regard to channel form and drainage solutions (such as flow bypasses) for development of the catchment.

Plumpton PSP 1078 – Aboriginal Cultural Heritage Assessment

The MPA engaged with AHMS in 2013 to indentify the know Aboriginal Places and Historic Sites within the study area; indentify any surfaces Places by means of pedestrian surveys and produce detailed maps of all areas of Aboriginal archaeological potential.

The report identified areas of high archaeological sensitivity, artefact scatter and high cultural values along the waterway within the Beatty's Road catchment. The report recommended retaining these areas as much as possible within open space, riparian, bio-link, set-backs and asset zones. The future urban form should minimise future development impacts on these areas where it is feasible within other planning, design and environmental constraints and considerations.

2.4. Summary of Opportunities and Constraints

As identified through the review of relevant policy documents and background studies, there is an increasing emphasis on integrated water management and its role in future developments. Integrated water management provides benefits through efficient use of water resources which will reduce our reliance on potable water (increase our resilience to drought), protect the environment (particularly waterways) and save cost of large scale infrastructure upgrades in the future.

The subject site is heavily intertwined with water management. There are currently two ephemeral waterways which flow in a southerly direction through the Plumpton and Kororoit PSPs into the Kororoit Creek. The waterways South of Kororoit Creek are less defined.

There are significant biodiversity considerations. Reserves have been identified through the BCS with their corresponding values including the GGF Corridor along the length of Kororoit Creek. There are also seasonal herbaceous wetlands that have ecological value.

Various reaches of waterway contain high geomorphic values which also require a pre-development hydrological regime to maintain their form and value. Potential ways to address the hydrological regime are through the use of stormwater harvesting systems and infiltration (in addition to flow diversions). These complementary solutions would benefit the environment and also provide water supply for local demands such as parks and ovals.

The water authorities have agreed that a third pipe network would be used to supply recycled water from Ravenhall and preliminary arrangements for servicing the area (potable supply and sewerage infrastructure) have been progressed. The retailer of these services is yet to be finalised.

The first step in progressing these solutions is presenting a Base Case, as defined in Section 3.0.

3.0 BASE CASE WATER MANAGEMENT

3.1. Overview

As previously mentioned, the Base Case covers how this development would take place based on complying with the current best practice standards of water management in land development. The Base Case is used as a benchmark for comparison of alternative options.

3.2. Assumptions

The location and size of the retarding basins and centralised water quality treatment assets in the Base Case is based on work undertaken by MW in the DSS's[1]. This section is based on the modelling and designs provided by Melbourne Water (July 2014). Modelling methodology is discussed in Appendices A and B.

Water demand is based on work undertaken for estimating future water consumption and alternative water supply by CWW.

Modelling for the Base Case is based on the following assumptions (undertaken by MW):

- Centralised retarding basins which detain the 100-year ARI storm event, as defined by MW in their DSS's
- Waterway width defined using the Waterway Corridors Guidelines by MW (2013) for natural and constructed channels. Sections of natural waterway (as opposed to constructed) to be retained where specified by MW due to importance of geomorphological features.
- Centralised water quality treatment assets within the retarding basins such as wetlands. Treatment to 80% removal of Total Suspended Solids, 45% removal of Total Phosphorus and 45% removal of Total Nitrogen, as is the current best practice standard.
- Use of recycled water as per plans for the development
- No stormwater or rainwater harvesting; and
- No infiltration measures to reduce the days of runoff into creeks.

[1] It should also be noted that this WoWCA was based on MW DSS work which were in draft form at the time of WoWCA modelling. Since that time, some DSS boundaries have been modified and updated to ensure required standards have been met, as advised by MPA.

3.3. Waterways and Stormwater Infrastructure

For the purposes of relating stormwater provisions to land take through the PSPs, the terms 'waterways and stormwater infrastructure' are used in this section to encompass the waterway corridor (i.e. creeks), wetlands, retarding basins, sediment basins and bioretention basins.

A summary of the combined land take of waterways and stormwater infrastructure for the two PSP's is provided in Table 1. The DSS's referred to in Table 1 are shown in Figure 7. Waterways and stormwater infrastructure within 'developable land' are quantified, as well as those within encumbered land such as the Growling Grass Frog Corridor.

In general, this meets the detention and water quality requirements for standard development, it also accounts for protection of seasonal herbaceous wetland and waterway corridors with significant geomorphological values for water quality but not necessarily for stormwater flow volumes.

MW has in some cases adopted a low flow bypass to reduce the impact of increased stormwater flow volumes and frequency of runoff through sensitive areas. This arrangement does work towards restoring a more natural hydrological regime however the flow volume will still re-enter the waterway at a downstream point.

Stormwater infrastructure required in each DSS is described in further detail in the following section with waterway reaches identified to be constructed or remain in their natural form throughout both PSPs, as identified by MW.

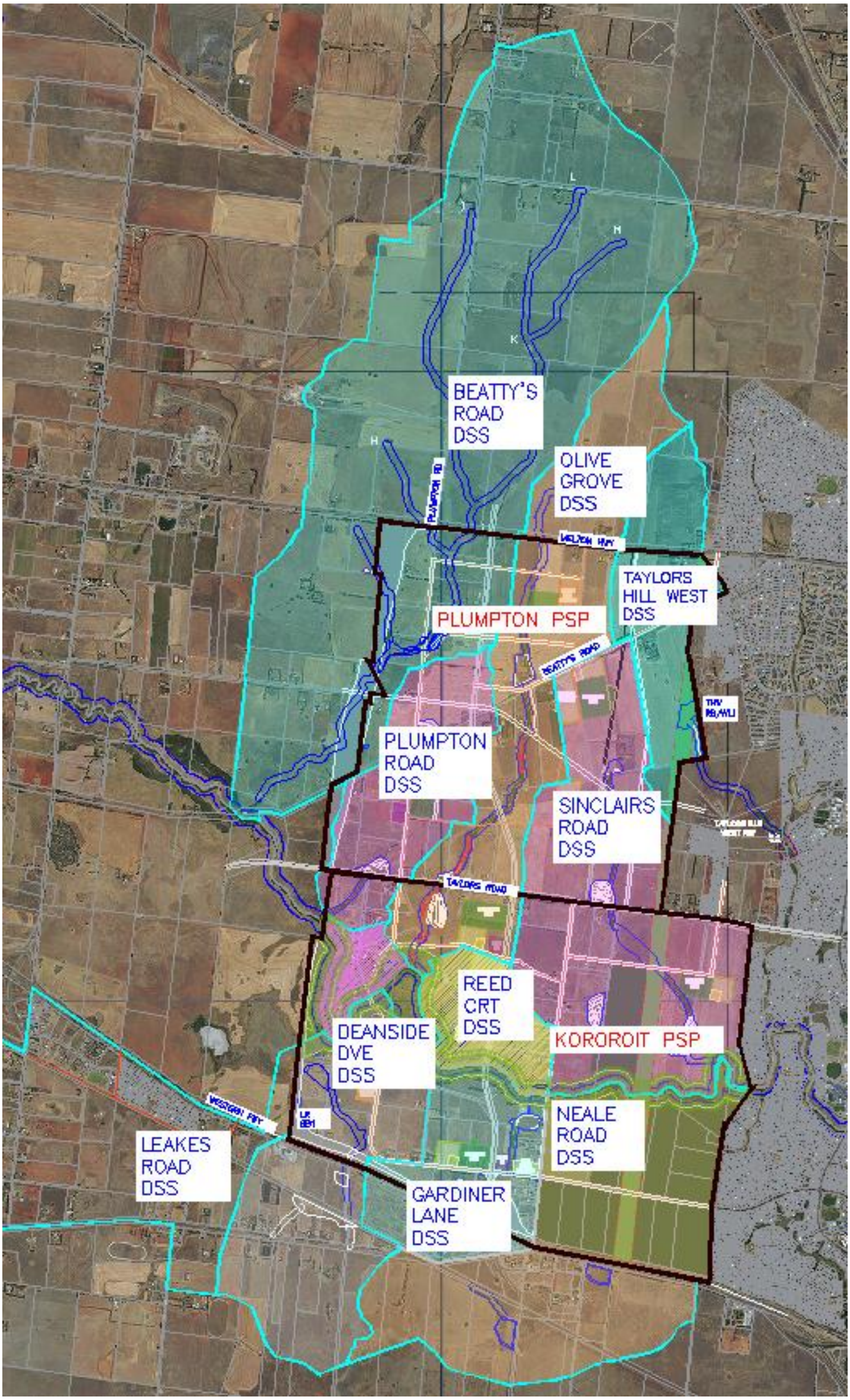

Figure 7 DSS's through Plumpton and Kororoit PSPs (Preliminary Development Services Schemes, 2014)

Table 1 Summary of DSS's and Waterways and Stormwater Infrastructure through Plumpton and Kororoit – Base Case

DSS	Area of DSS within PSP (Ha)	Encumbered Area (Ha)	Developable land	Waterway & SW Infrastructure within PSP (Ha)	Waterway & SW infrastructure in Encumbered Area (Ha)	Waterway & SW Infrastructure in Developable land (Ha)	Comment
Beatty's Road	167 (Plump)	27 (OMR)	140	21	3.5	17.5	See section 4.1. Alignment of this waterway clashes with the OMR, both within and downstream of Plumpton PSP. Review of waterway and OMR to be undertaken by MW and VicRoads in future
Plumpton Road	199 (Plump) 78 (Kor)	5 (Plump OMR) 25 (Kor GGF)	194 (Kor) 53 (Kor)	6 (Plump) 4 (Kor)	0 (Plump) 1	6 (Plump) 3 (Kor)	Lower section of DSS not detained to predevelopment rates due to topographical constraints
Olive Grove	253 (Plump) 76 (Kor)	0 (Plump) 5 (Kor GGF)	253 (Plump) 71 (Kor)	26 (Plump) 10 (Kor)	0 (Plump) 1 (Kor)	26 (Plump) 9 (Kor)	
Reed Court	108 (Kor)	21 (GGF)	87	3	0.5	2.5	
Sinclairs Road	231 (Plump) 327 (Kor)	10 (Plump, gas and elec) 100 (Kor, Conservation elec and GGF)	221 (Plump) 227 (Kor)	11 (Plump) 22 (Kor)	0 (Plump) 2 (Kor)	11 (Plump) 20 (Kor)	
Taylors Hill West	137 (Plump)	23 (gas and elec)	114	5	3	2	May be discrepancy with MW and Storm areas of Olive Grove and Taylors Hill West DSS due to difficulties with files.
Deanside Drive	153 (Kor)	39 (GGF, OMR)	114	8.5	1.6	6.9	

Gardiners Lane	155 (Kor)	40 (GGF, OMR)	115	6	0.1	5.9	Current waterway alignment is through eastern edge of LTC
Neale Road	267 (Kor)	267 (Conservation)	0				As there is no development within the Neale Road DSS area of Kororoit (i.e. there will be natural conditions through this catchment) the area has not been included for assessment in the WoWCA.
Total	2169.5	569.8	1599.7	122.7	12.7	110	Note that there is a discrepancy between the total area of Plumpton and Kororoit PSP of 2194 ha and the total area of 2169.5 shown in column 1. This is due to the area of GGF corridor to the north of Deanside Drive DSS not being included in the DSS (18ha) and also an area of OMR west of the Plumpton Rd (6.5 ha) DSS which isn't included in a DSS. Both of these areas are almost entirely encumbered by GGF/OMR, i.e. not developable.

Based on the breakdown shown in Table 1, the Base Case requires approximately 110 ha of the 1,600 ha developable land through the two PSPs to be set aside for stormwater management.

3.3.1. Beatty's Road

The Beatty's Road DSS covers the north western section of Plumpton PSP which is to be developed into an industrial area. This section of the PSP will be bound by the OMR on the west. The total length of the waterway through Beatty's road DSS is approximately 2.9 km, the alignment is shown in Figure 8.

As shown in Figure 8, an external catchment of farmland is conveyed into Plumpton via the Beatty's waterway. A second branch enters the main Beatty's waterway downstream of Plumpton Road.

Melbourne Water has planned for a retarding basin downstream of the waterway crossing below Plumpton Road, in the location of an existing dam. The footprint of the retarding basin is approximately 2.2 ha (BR RB2). A wetland (BR WL1, 1.0 ha) has also been planned on the main waterway on the upstream side of Plumpton Road.

A sediment basin and bioretention basin (total 0.15 ha) is located downstream of Plumpton Road (prior to the retarding basin). Further south, away from the main waterways there is a second sediment basin and bioretention basin (BR SB3, combined area 0.12 ha).

A key issue for this catchment is the clash of the indicative OMR alignment with the creek alignment. The current arrangement provided as part of MPA's FUS (refer Figure 2) suggests the western branch that enters the retarding basin clashes with the OMR alignment. This section has been identified by Melbourne Water as a natural waterway, comprising high geomorphic value. Nonetheless, a detailed design of the OMR has not been undertaken and no exact land take currently exists. During design of the OMR, VicRoads and Melbourne water will need to review the alignment of the OMR and waterway in this location.

The decisions will affect the amount of developable land within Plumpton. Downstream of the retarding basin there is also a waterway reach of approximately 900m which may clash with the OMR, this road and waterway alignment also requires resolution.

The width of the Beatty's Road waterway corridor is 60 m throughout the length of Plumpton (wider in locations where additional assets have been incorporated). This is the width as provided by Melbourne Water which has been adopted for this study.

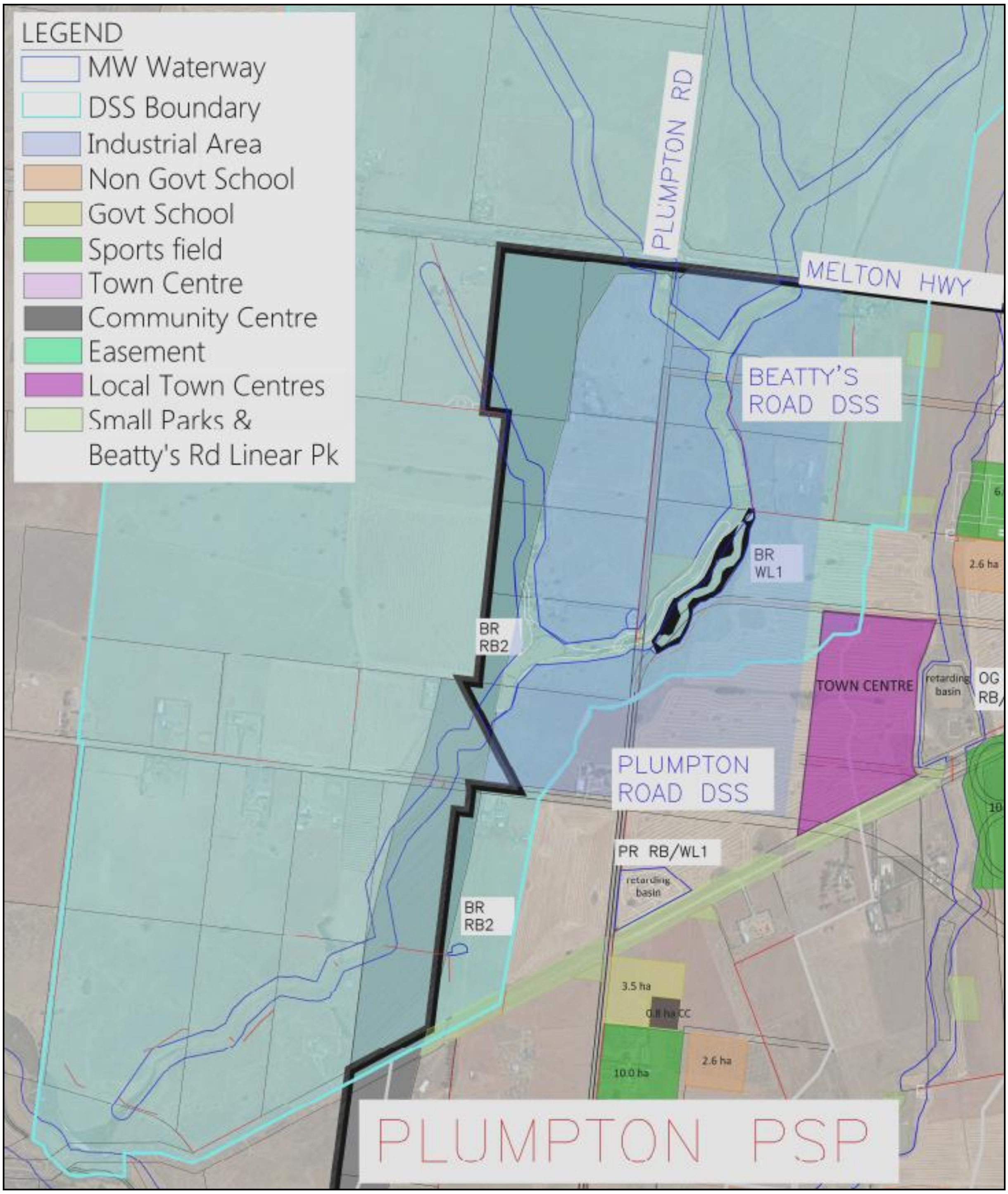

Figure 8 Beatty's Road Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

Two areas of surface artefact clusters / areas of higher cultural value have been identified in the waterway that runs through the Plumpton PSP. The extract from the CHMP showing these clusters is provided in Figure 9, clusters are shown in pink in northwest of the site.

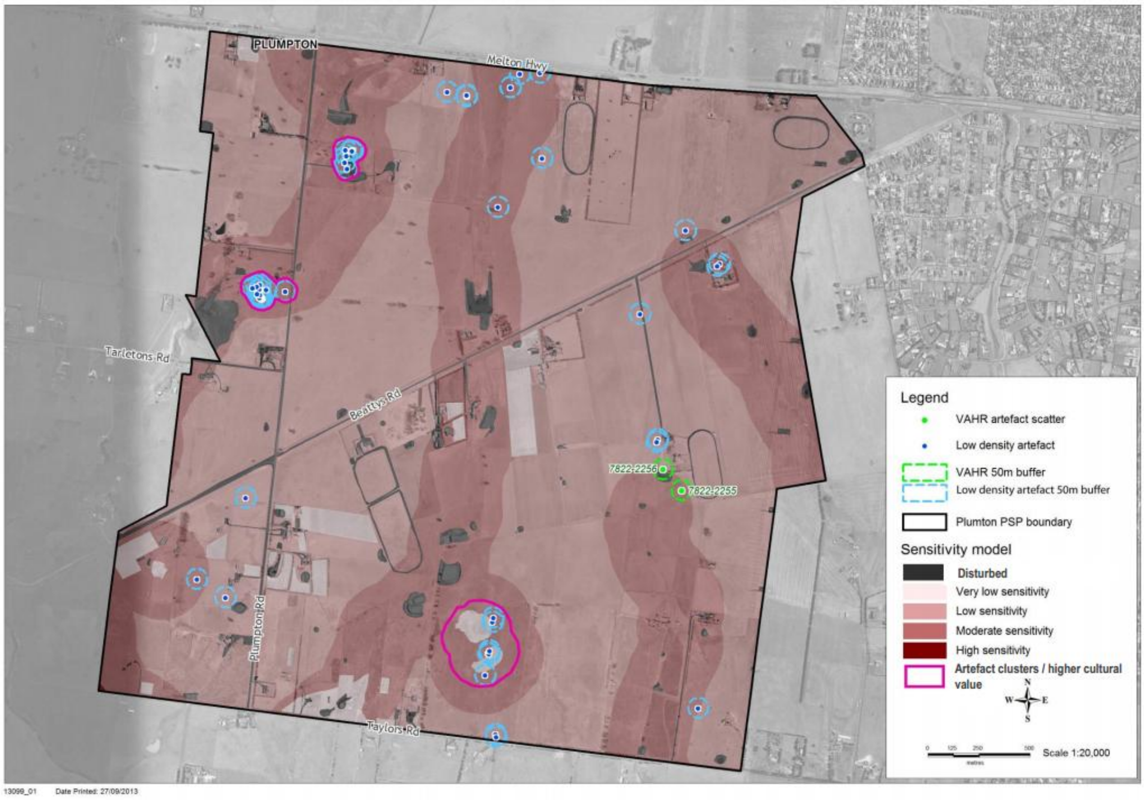

Figure 26. Predictive Archaeological Sensitivity Model incorporating results of Standard Assessment.

Figure 9 Extract from Cultural Heritage Management Plan for Plumpton PSP (p122, AHMS, 2014).

3.3.2. Plumpton Road

The Plumpton Road DSS runs through both Plumpton and Kororoit PSPs and has no external catchments. It is located to the east of Beatty's Road DSS and west of Olive Grove.

An aerial image of the catchment is provided in Figure 10.

In the developed condition, the northern section (229 ha), as defined by the light blue line, is detained to pre-development flowrates. However, the southern section (25 ha excluding the GGF corridor) receives water quality treatment but not detention, this is due to topographical constraints.

Within Plumpton, there are two wetland/retarding basin assets, 2.4 (PR RB/WL1) and 3.6 ha (PR RB/WL2). The waterway downstream of Taylors Road, in Kororoit, is a constructed waterway with a 50m width, this is approximately 500 m long. This width has been adopted based on Melbourne Water's proposed waterways. Further discussion on the adopted corridor widths is provided in the summary section (refer Section 3.3.10).

A 1.0 ha wetland is located within the GGF corridor (PR WL3). Three sediment basins have been designed through this lower section of the DSS (500 m^2 each). One has been located within the GGF corridor, one straddling the boundary and the other within the developable land. These have been positioned to intercept stormwater that can not be captured by a centralised wetland due to topography constraints. The 'land wedge' where these assets sit comprises a ridge line with the eastern portion draining east and the western catchment draining west to Kororoit Creek.

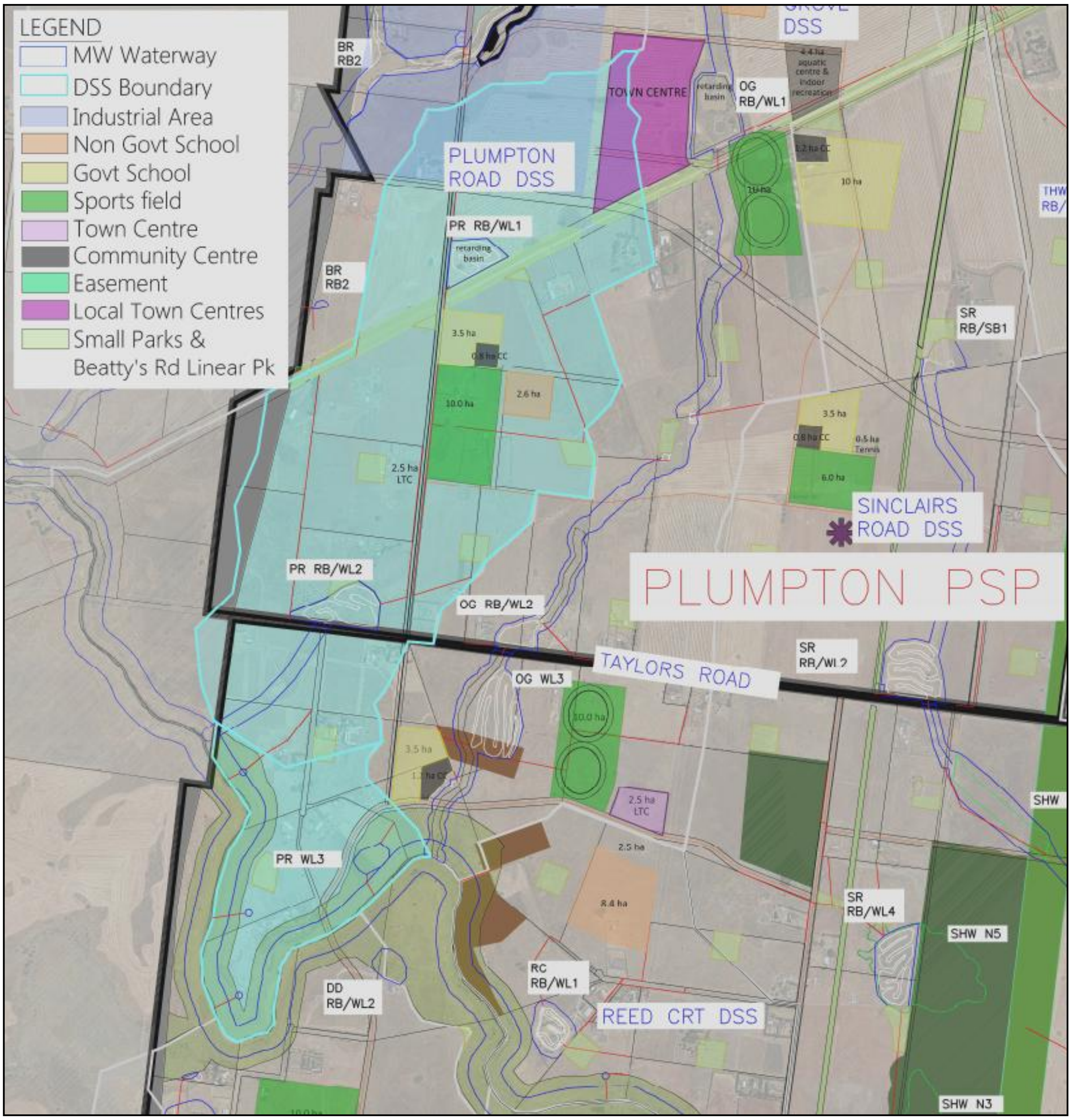

Figure 10 Plumpton Road Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.3. Olive Grove

The Olive Grove catchment extends from farming area to the north of the Melton Highway, through both Plumpton and Kororoit PSP's to Kororoit Creek. The waterway runs through the main commercial area within Plumpton and also around a heritage dam in Kororoit. The length of waterway within the PSPs is approximately 4.3 km, it is 60 m wide for the length of the alignment. The creek is a mixture of natural and constructed reaches (refer Section 3.3.13). This width has been adopted based on Melbourne Water's proposed waterways. Further discussion on the adopted corridor widths for the respective reaches along the length of the waterway is provided in the summary section (refer Section 3.3.10).

The location and extent of the catchment is shown in Figure 11.

Three wetlands perform the majority of the water quality treatment through the catchment. The northernmost wetland (OG RB/WL1) is combined with a retarding basin and located to the north of Beatty's Road in the area planned as a commercial centre for Plumpton, this has a total footprint of 4.4 ha (3.8 ha wetland).

The second wetland is also combined with a retarding basin and north of Taylors Road (OG RB/WL2). This wetland is 1.1 ha and the retarding basin has a footprint of 1.6 ha. The southernmost wetland (OG WL3) has an area of 4.6 ha.

Four sediment basins (total footprint 0.1 ha each including associated drying areas) also provide treatment along the length of the waterway.

WL1 is of particular interest as it may be used as a co-located amenity area being adjacent the main Town Centre. Further assessment of this wetland has therefore been conducted to provide an initial indication of water quality, peak flow and water balance aspects of the wetland.

Table 2 indicates this wetland achieves a high level of % reduction for total suspended solids and nutrients based on MUSIC modelling, achieving BPEMG targets of 80% and 45% respectively (refer Section 2.1 for BPEMG targets).

Table 2 WL1 MUSIC Model Results

WL1	In	Out	% Reduction
Flow (ML/yr)	417	372	10.8
Total Suspended Solids (kg/yr)	60,400	8.99E+03	85.1
Total Phosphorus (kg/yr)	148	40.2	72.8
Total Nitrogen (kg/yr)	1,140	547	52.1

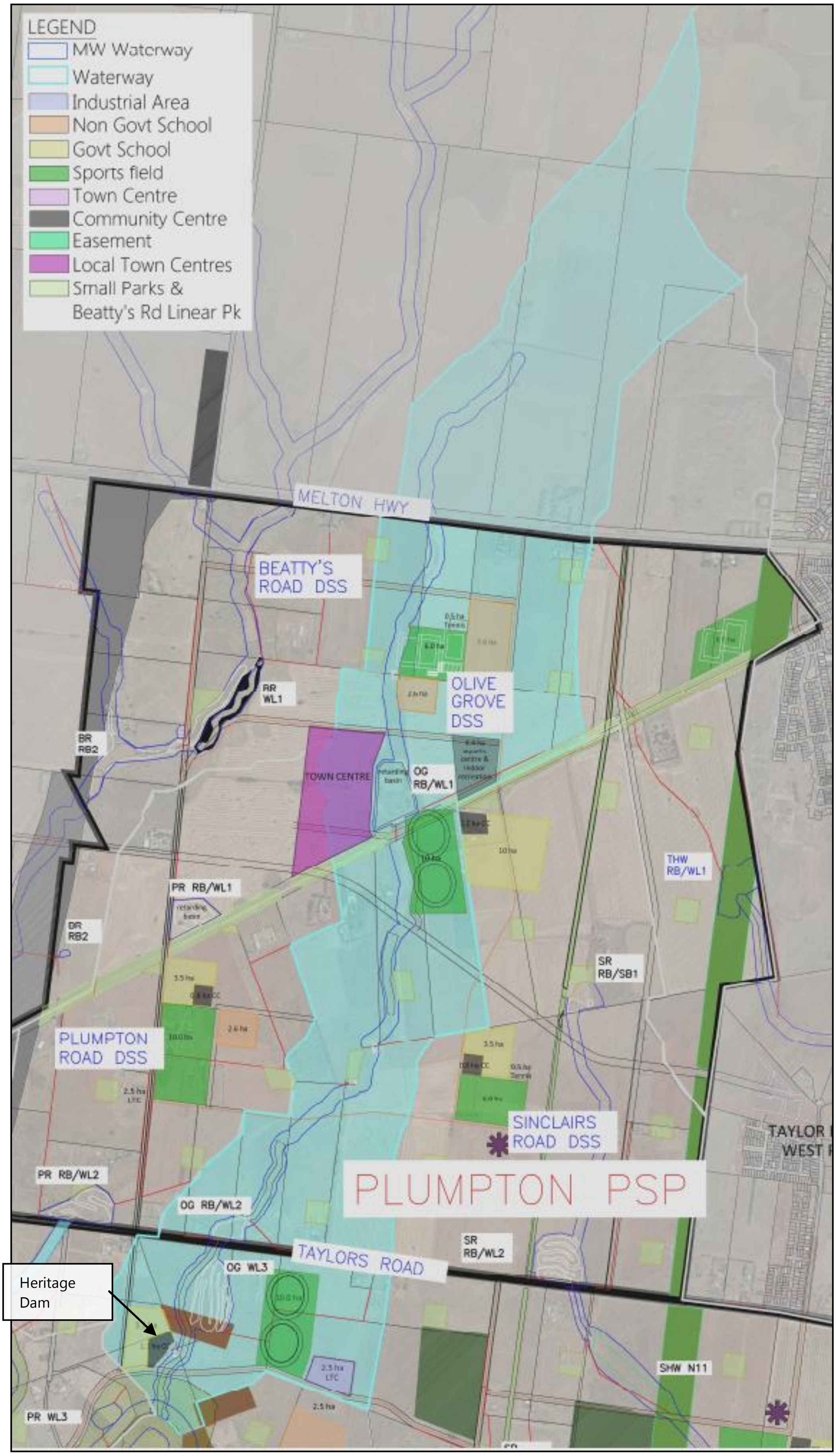

Figure 11 Olive Grove Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

Table 3 illustrates the combined pond and retarding basin does not quite achieve another aspect of the BPEMG targets – maintaining 1.5 Year flows below pre-development conditions as shown by the downstream outflow of RB1 based on output from RORB modelling. However, the 100 Year event is shown to remain below existing conditions, indicating the system contributes to minimising downstream flooding impacts in the Olive Grove waterway[2].

Table 3 RB1 RORB Model Results

WL1	Existing	Post Dev - Upstream	Post Dev – RB1 Outflow
1.5 Year	1.24	6.19	1.52
100 Year	11.9	28.4	8.94

Note: the amenity pond is assumed to be full for the purposes of hydrological modelling in RORB.

The water balance results for the amenity pond are shown on Figure 12.

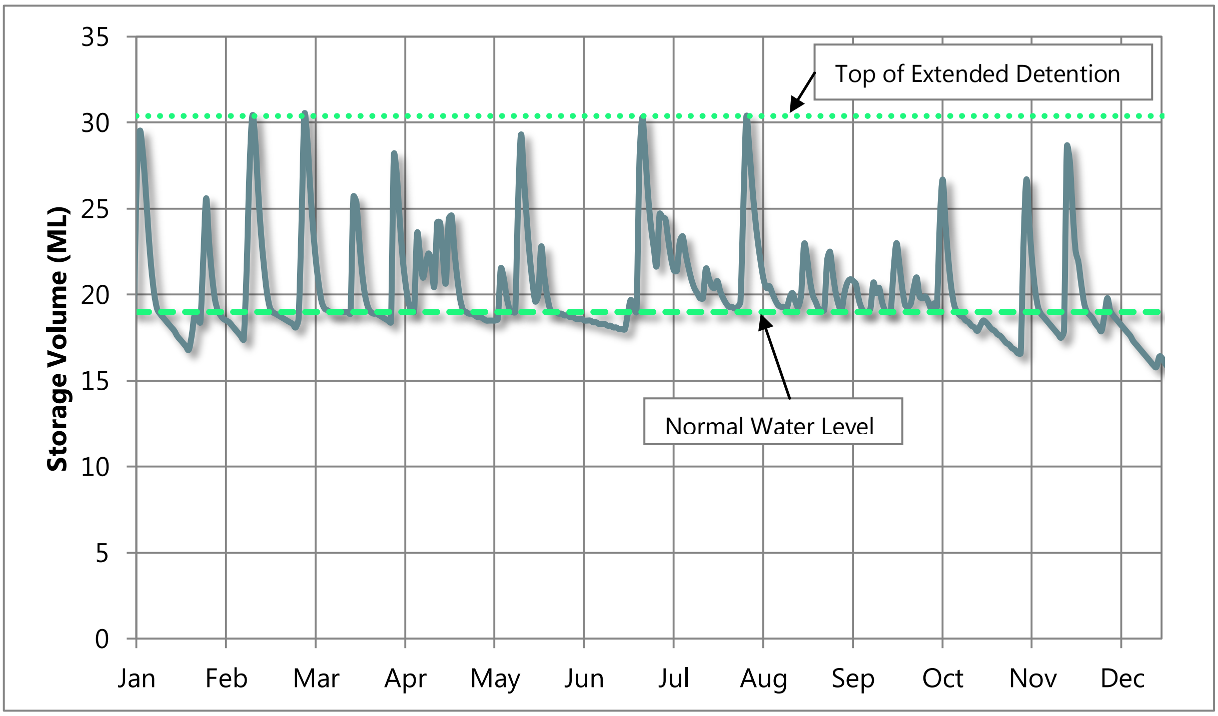

Figure 12 – WL1 Daily Water Storage Levels

The water balance, extracted from MUSIC, suggests the Wetland would not run dry for the mean year modelled as shown on Figure 12. The modelling shows the water level will drop below the normal water level (NWL) a total of 142 days in the year. The NWL is a controlled level designed to ensure effective operation of the wetland and maintaining the health of associated vegetation. Maintaining WL1 at this level may therefore require top-up from an alternative water source.

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[2] It should also be noted that this WoWCA was based on MW DSS work which was in draft form at the time of WoWCA modelling. Since that time, some DSS boundaries have been modified and updated to ensure required standards have been met, as advised by MPA.

Olive Grove's WL3 is also of specific interest with respect to position with a heritage listed dam wall. The current waterway design around the wall may require earthworks that would impact on the wall and heritage value. This dam is also highlighted in Alluvium (2014) *Protection of Intact Waterways in the Olive Grove Catchment* indicating the 100 year flooding is controlled by the outlet of the dam, and to reduce this flooding modification of the outlet would be required, impacting on the heritage structure. The potential exists to further displace the waterway around the wall such that no impact will occur, however, this will affect developable area. The current design has therefore been progressed for the Base Case.

3.3.4. Reed Court

Reed Court DSS lies to the north of Kororoit Creek, within the Kororoit PSP. The land through this area is generally flat and there is no defined waterway in the existing form. Waterway corridors have not been planned for Reed Court DSS.

The layout proposed is provided in Figure 13.

Stormwater detention is provided in RB/WL1. The wetland within this facility is 0.8 ha and the total RB is 2.4 ha. It is understood the RB has been located by Melbourne Water within a minor depression before the GGF corridor due to the steepness of topography within the corridor. The second wetland, WL2 is located within the GGF corridor in the south eastern section of the DSS, this covers an area of 0.34 ha. There is also a sediment basin within the GGF corridor (500 m^2) to provide water quality treatment.

The Reed Crt DSS comprises two heritage areas as shown on Figure 13.

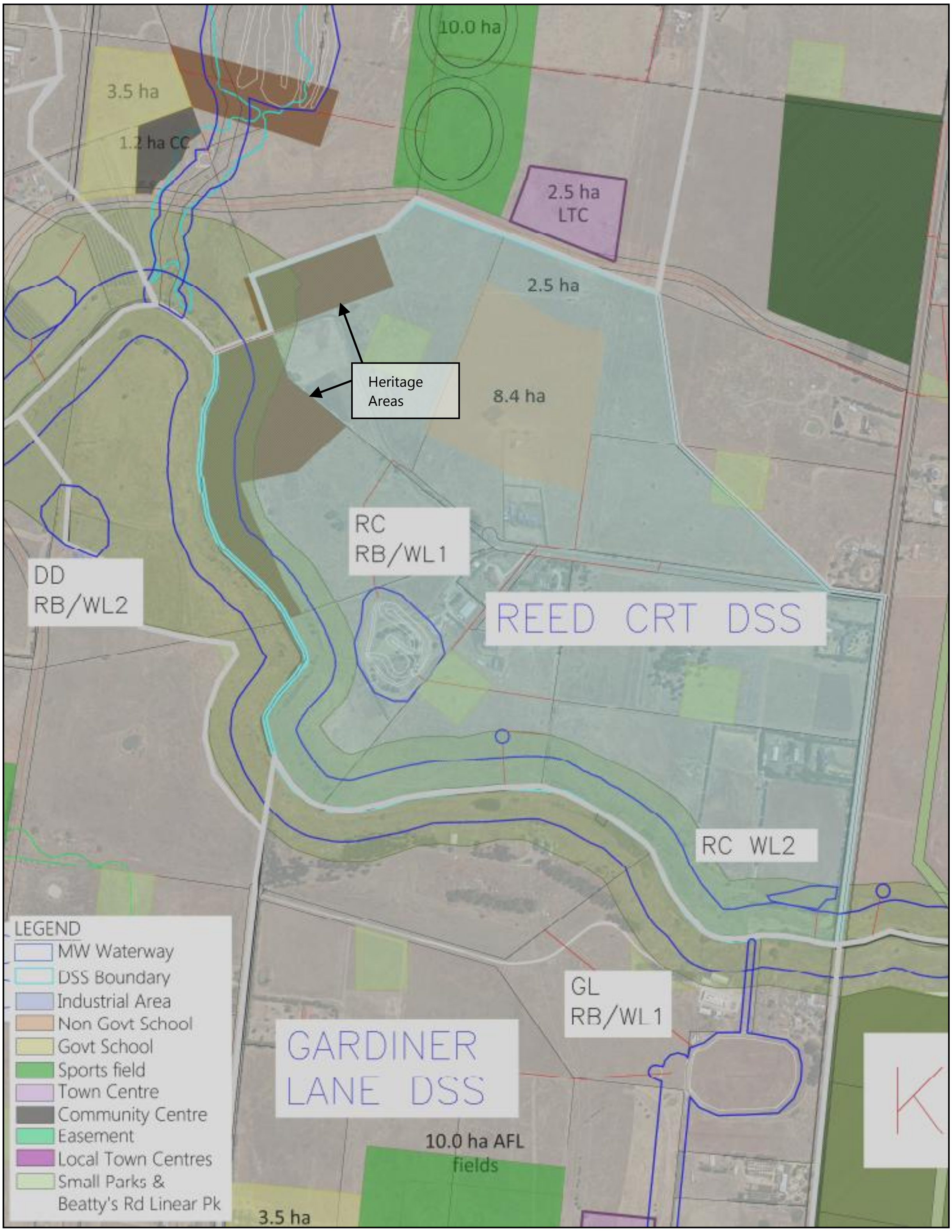


Figure 13 Reed Court Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.5. Sinclair's

Sinclair's Road DSS lies in the western section of the catchment and extends south from Plumpton, through Kororoit to Kororoit Creek.

The catchment includes a conservation reserve and several seasonal herbaceous wetlands. Two are located within the BCS Nature Conservation Areas (N5 and N3) and will be retained as required under Commonwealth legislation. Retention of these assets requires the natural flow regime to be replicated in the development of the catchment.

There is one main waterway corridor through this catchment which is 3.3 km long and is proposed to be a mixture of natural and constructed waterway reaches. The majority of the waterway has a width of 50 m. In the section surrounding the Seasonal Herbaceous Wetland N11, the waterway is proposed up to 140 m wide. These widths have been adopted based on Melbourne Water's proposed waterways. Further discussion on the adopted corridor widths for the respective reaches along the length of the waterway is provided in the summary section (refer Section 3.3.10).

The extent of the DSS is shown in Figure 14.

The majority of the catchment falls toward the main waterway. There are a total of four retarding basins and three constructed wetlands.

A sediment basin (0.2 ha) combined with retarding basin (total 1.4 ha) is located at the northern end of the waterway (RB/SB1). A second retarding basin (RB/WL2, 4.5 ha), surrounding a 3.3 ha wetland is planned upstream of Taylors Road. The Sinclair's waterway then broadens to include the Seasonal Herbaceous Wetland N11 and pipework for low flow diversion of the frequent flows.

A large RB and Wetland RB/WL3 (6.3 ha) is located upstream of SHW N4, the waterway outfalls into Kororoit Creek from SHW N4.

An additional wetland and retarding basin (RB/WL4) receives flows from the western section of Sinclair's. The constructed wetland is within the western section of SHW N5. It will control flows entering the eastern half of N5 within the conservation reserve and direct the remainder of the flows south into Kororoit Creek. Two sediment basins (500 m^2 and 1300 m^2) are located in the GGF to the south of RB/WL4.

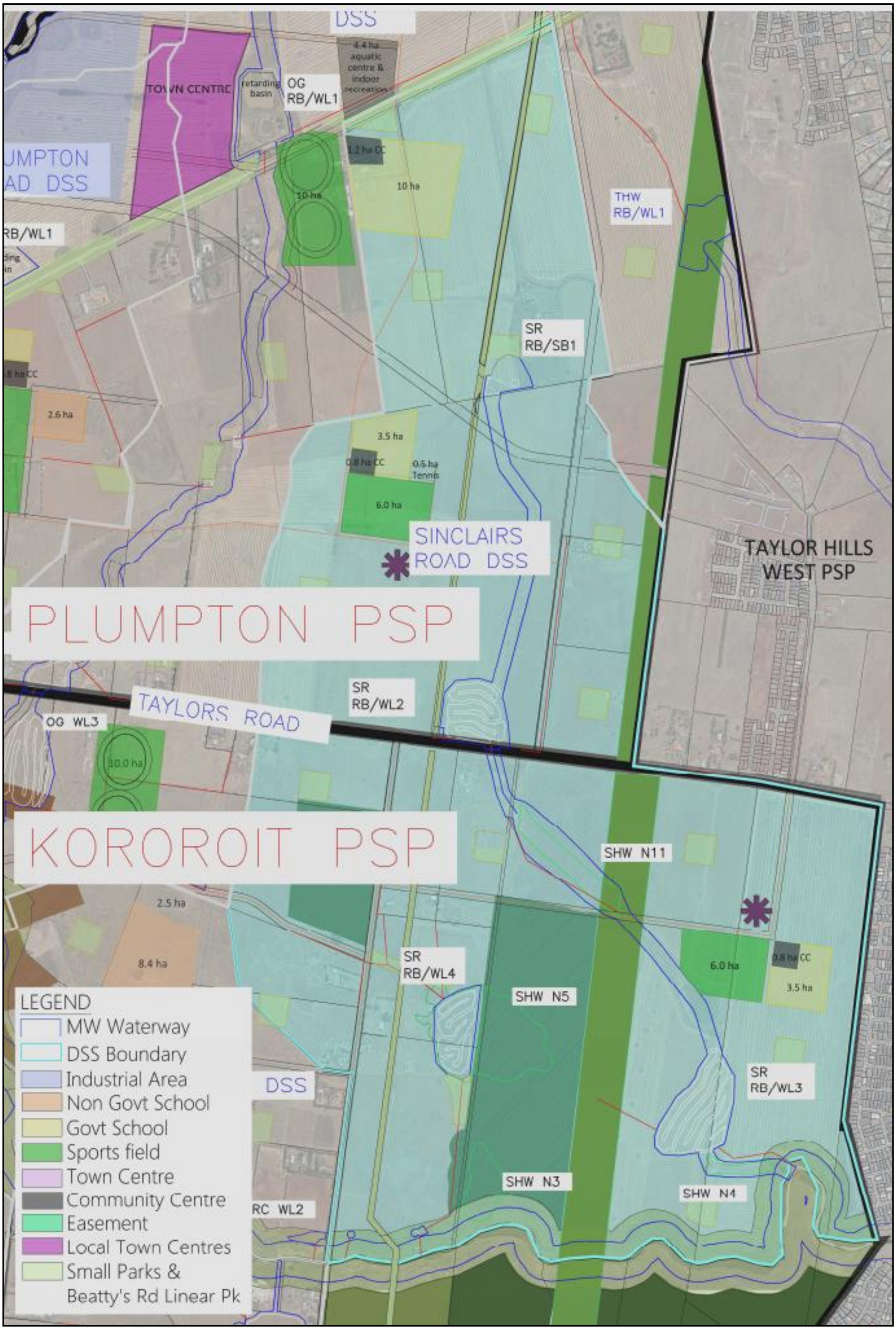


Figure 14 Sinclair's Road Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.6. Taylors Hill West

The Taylors Hill West catchment is on the eastern boundary of the Plumpton PSP. The waterway from this area runs into the Taylors Hill West PSP. Note that there may be some discrepancy between the boundary of the Olive Grove and Taylors Hill West catchments due to a scaling issue with layout files supplied by MW.

A 300 m long waterway extends from the downstream end of the powerline easement in Plumpton into the Taylors Hill West PSP. The waterway is to be constructed and have a corridor width of 50 m. The location and extent of the catchment is shown in Figure 15.

A combined wetland (2.4 ha) and retarding basin (THW RB/WL1) is located in the powerline easement, the RB has a footprint of 3.0 ha.

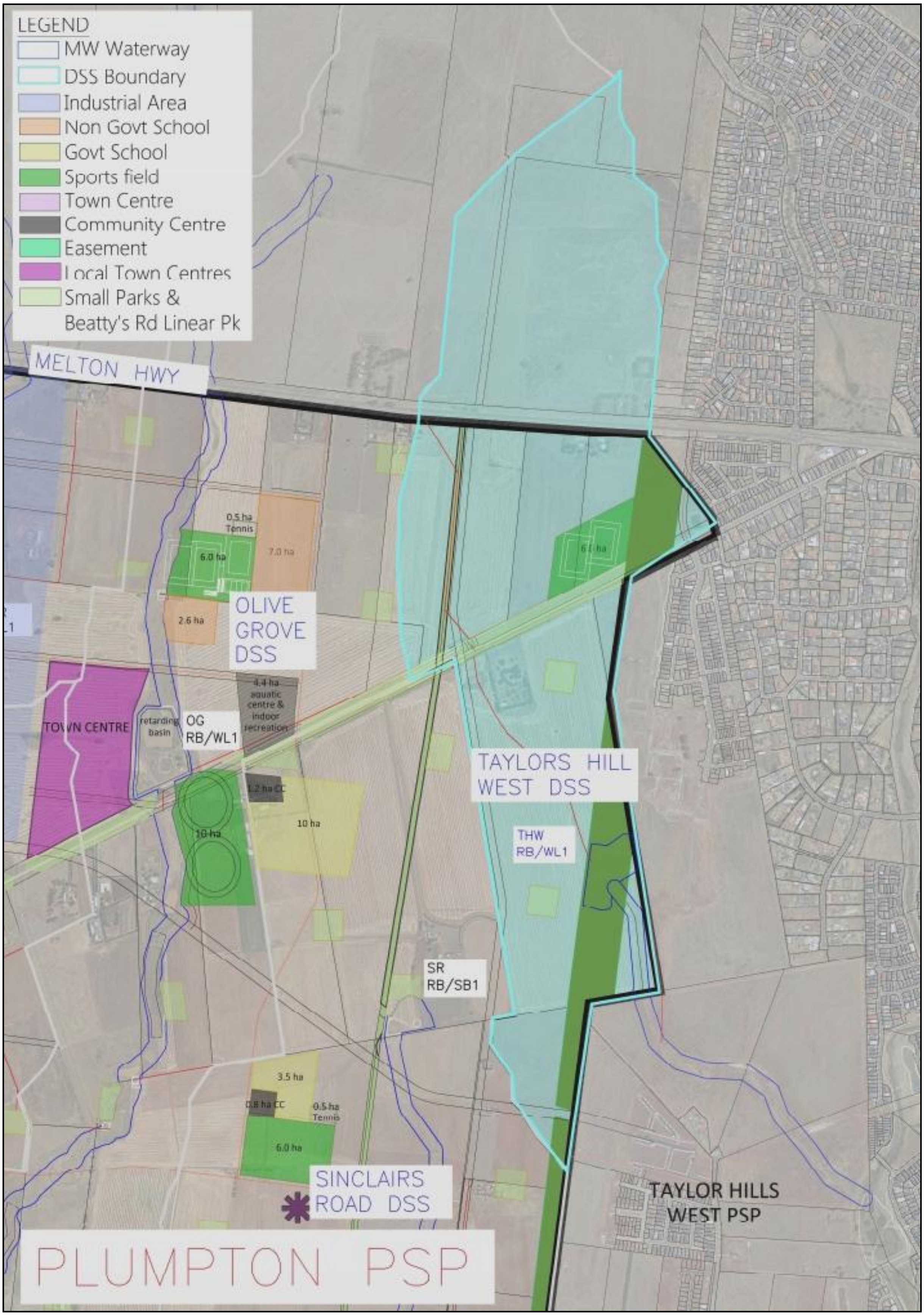


Figure 15 Taylors Hill West Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.7. Gardiner Lane

The Gardiner Lane catchment enters Kororoit Creek from the south comprising a relatively flat grade. The catchment includes land to the south of the western freeway (external to Kororoit) which is to be zoned as industrial and treated by a wetland on the southern side of the Western Freeway which is part of the Mt Atkinson PSP currently in the planning stage. A significant area within the catchment is VicRoads land.

An 800 m long waterway is to be constructed in the catchment (55m wide).

The catchment is shown in Figure 16.

A combined wetland (2.5 ha) and retarding basin (GL RB/WL1, 2.8 ha) is the main detention and treatment facility for the catchment within Kororoit. There are also three sedimentation basins through the catchment (750-900 m^2).

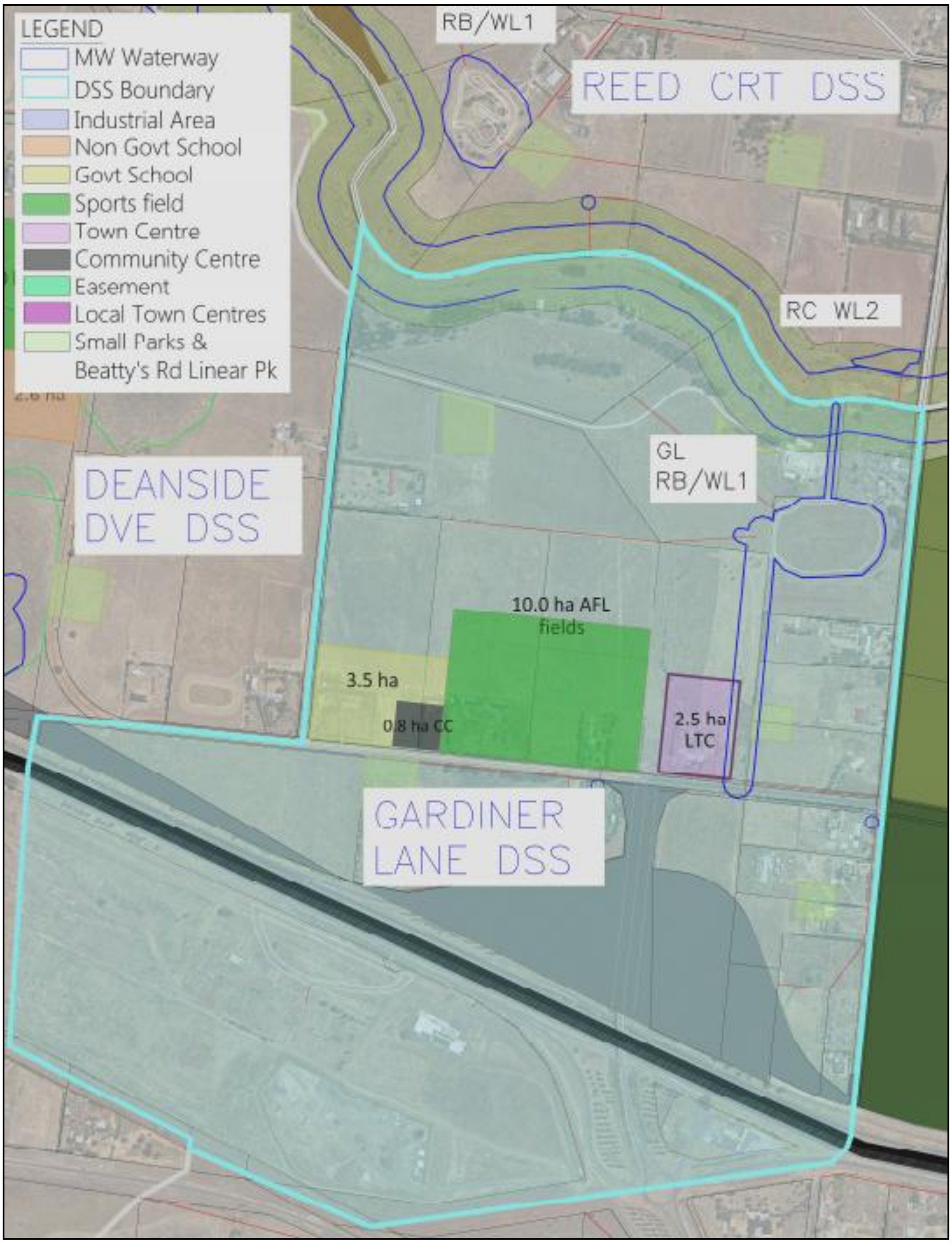


Figure 16 Gardiner Lane Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.8. Deanside Drive

The Deanside Drive catchment enters the Kororoit PSP from the south. The catchment includes an external area being part of the Mt Atkinson PSP currently in the planning stage. The area draining to the Kororoit PSP is understood to be predominantly industrial which is treated by a wetland and retarding basin system on the southern side of the Western Freeway.

The waterway through Kororoit is to be a 50 m wide constructed corridor. It is approximately 1.1 km long and conveys flows in a north-westerly direction below the OMR to the Leakes Road DSS. A layout of the Catchment is provided in Figure 17.

A 1.5 ha wetland within a 3 ha retarding basin (RB/WL1) provides treatment and flow detention prior to flows leaving Kororoit below the OMR on the western boundary of the PSP. A second RB (12 ha) and wetland system (0.5 ha), RB/WL2, is located in the GGF corridor and receives flows from the northern section of the catchment.

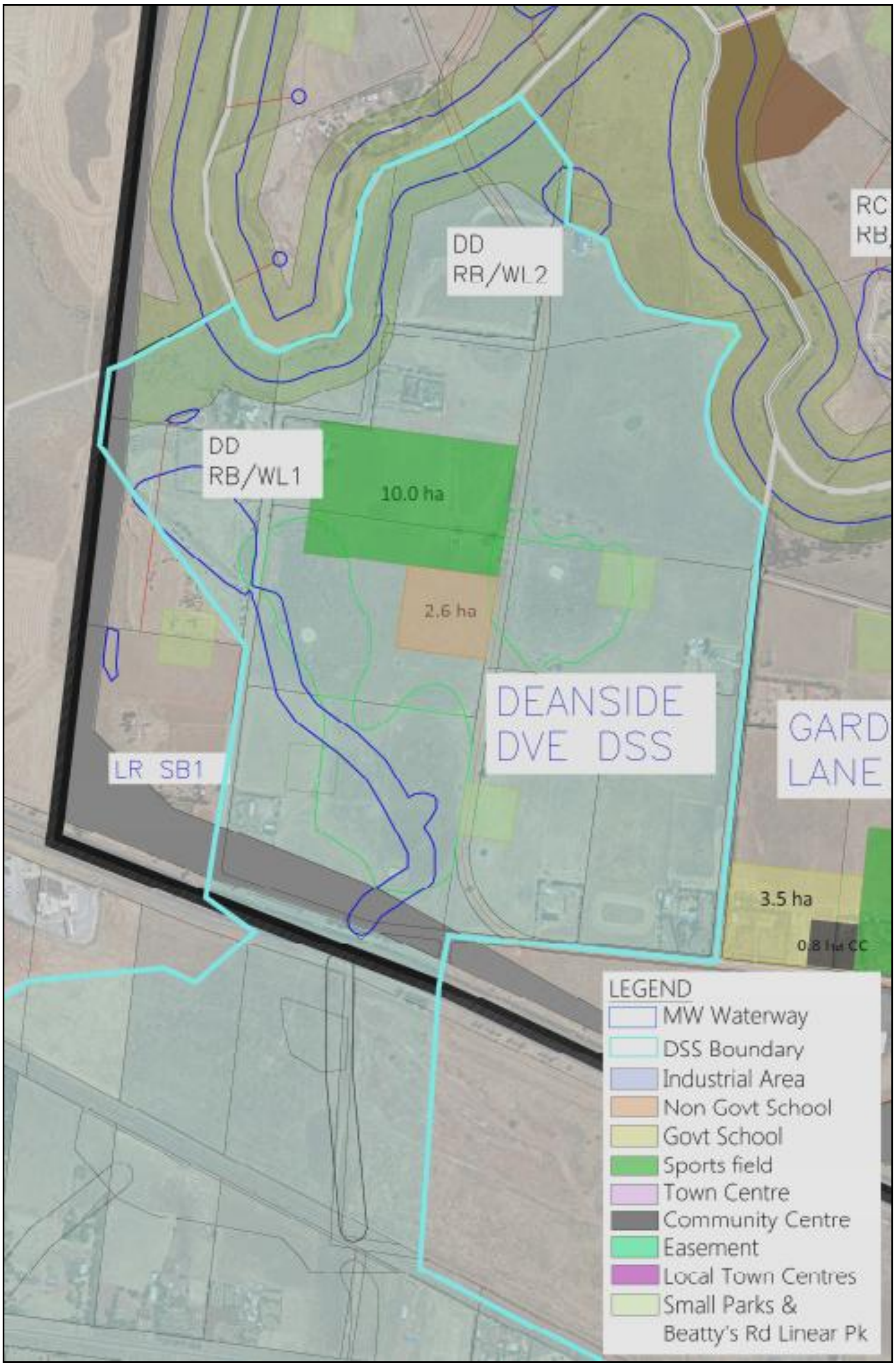


Figure 17 Deanside Drive Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

3.3.9. Neale Road

The Neale Road catchment is in the south eastern section of Kororoit. The area of Neale Road DSS within the Kororoit PSP is reserved as conservation area/open space and power easement, i.e. there will not be development within the Kororoit area of this catchment. The layout of the catchment is shown in Figure 18.

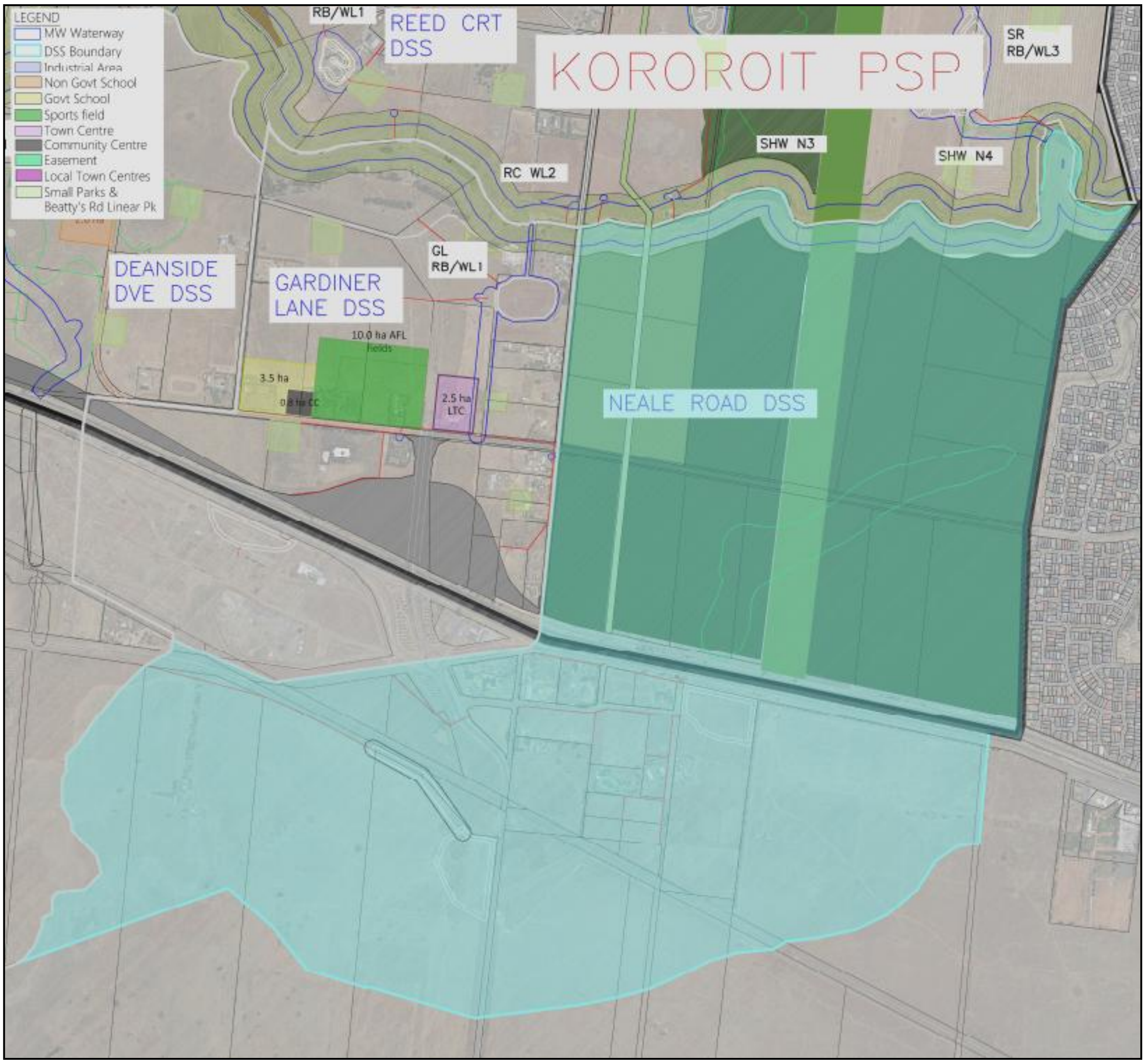


Figure 18 Neale Road Preliminary DSS (2014) (including draft FUS for Consultation – November 2014)

The external catchment that enters Kororoit and is treated and detained by infrastructure on the southern side of the Western Freeway. As waterway management for the catchment is undertaken outside of the Kororoit PSP the infrastructure for the Neale Road catchment within Kororoit has not been reviewed as a part of this WOWCA.

3.3.10. Base Case Waterways and Stormwater Infrastructure Summary

A summary of the required retarding basin configurations for the Base Case is shown on Table 4 for each PSP. These footprints impact on developable land, however, form a vital role in flood management for the precincts and are co-located with water quality treatment assets.

The footprints have been adopted based on Melbourne Water's proposed retarding basin sizings. A detailed assessment of the hydrology of each DSS catchment has been undertaken by Storm as part of this Study. Storm's modelling indicated that discharge from the Olive Grove DSS (post development) slightly exceeded the existing conditions flow. The Base Case retarding basins for this DSS (OG-RB1 and OG-RB2) are the treatment measures to retard flows. Nonetheless, Storm understands that this WoWCA assessment was based on preliminary DSS work provided by Melbourne Water. Since that time, some DSS boundaries have been modified and updated to ensure required standards have been met, as advised by MPA.

Table 4 Required Retarding Basins for Base Case by PSP

PSP	Basin ID	Storage Capacity (ML)	Footprint (ha)
Plumpton	BR-RB1	29.0	2.14
	BR-RB2	---	---
	PR-RB1	17.3	2.44
	PR-RB2	36.2	3.57
	OG-RB1	54.1	4.45
	OG-RB2	20.4	1.58
	SR-RB1	8.83	1.43
	SR-RB2	51.0	4.46
	THW-RB1	32.8	3.03
Kororoit	LR-SB1	---	---
	DD-RB1	46.3	3.05
	DD-RB2	10.5	1.17
	RC-RB1	24.4	2.43
	GL-RB1	32.5	2.66
	SR-RB3	63.0	6.25
	SR-RB4	31.6	3.79

Table 4 indicates the retarding basins occupy 23.1 Ha and 19.4 Ha in the Plumpton and Kororoit PSP's respectively.

Table 5 summarises the draft required waterway corridor widths as supplied by Melbourne Water. The proposed corridors are predominantly based on Melbourne Water's *Constructed*

Waterways in Urban Development Guidelines (using modelled hydraulic widths and allowing for buffer zones) and supported by several documents for the Plumpton and Kororoit PSP's (Alluvium/Practical Ecology 2013, *Assessment of Riparian Vegetation & Geomorphology for Plumpton*, Rakali, 2013, *Rockbank Area Wetland Survey, Protection of intact waterways in the Olive Grove catchment*, Alluvium 2014).

Table 5 – Modelled Hydraulic Widths and Proposed Waterway Corridors

Waterway	*Section	MW Proposed Corridor Width (m)
Beatty's Road	Constructed Natural Sections	60 60
Olive Grove	Constructed Natural Sections	60 60
Sinclair's Road	Constructed Natural Section 1 Natural Section 2	50 50 140
Plumpton Road	---	50
Reed Court	---	---
Taylors Hill West	---	50
Deanside Drive	---	50
Gardiner's Lane	---	55

*Natural sections of waterway identified by MW to remain intact.

The Melbourne Water model results provided to Storm show 100 Year hydraulic widths that exceed the 60m (>80m) nominated corridor width. Storm inquired on this and Melbourne Water explained that where the 100 year flooding exceeds the identified corridor width it is accepted that development may occur, however, must be protected from the flooding (for example via filling and retaining the required freeboard). For the Base Case, Melbourne Water's corridors have been adopted.

3.4. Base Case Stormwater Quality

MUSIC (Model for Urban Stormwater Improvement Conceptualisation v6.0.1) models have been developed to assess the stormwater quality of this Base Case. MUSIC is a conceptual design tool that is used to predict the performance of stormwater quality management systems and assist organisations in designing strategies to tackle urban stormwater hydrology and pollutant impacts.

As identified in Section 2.1, generally Melbourne Water requires treatment of stormwater to achieve annual pollutant load targets set out in the BEMPG as follows:

- 45% reduction in Total Nitrogen (TN) from typical urban loads
- 45% reduction in Total Phosphorus (TP) from typical urban loads
- 80% reduction in Total Suspended Solids (TSS) from typical urban loads
- 70% reduction in Litter from typical urban loads
- Maintain discharges for the 1.5 year ARI event at pre-development levels

Melbourne Water developed MUSIC models to assess the new schemes covering the Plumpton and Kororoit PSP areas for compliance with current stormwater quality objectives. This report has updated these models to reflect the latest Future Urban Structure (FUS) plan prepared by the MPA and transferred nodes across to the 1996 Melbourne Airport template as recommended by Melbourne Water's MUSIC guidelines. This template has an average rainfall of 526 mm/yr. Water quality modelling is provided in more detail in Appendix A.

A summary of the water quality assets forming part of the Base Case as a result of the MUSIC modelling is provided in Table 6. These footprints have been adopted based on Melbourne Water's proposed designs, as identified in Appendix A, although Storm notes that some DSS's are not treated to best practice requirements (Olive Grove, Beatty's and Plumpton Road – Appendix A). . It should be noted, the Base Case scenario is based on preliminary Melbourne Water DSS work, which has been updated after undertaking this WoWCA as advised by MPA.

For the case of Beatty's Road (which is the site that is least in achieving Best Practice and results in skewness of the overall PSP performance) the DSS extends beyond the Plumpton PSP site boundary, therefore best practice does not need to be achieved at the boundary as there are additional facilities downstream.

Table 6 – Wetland Configurations Summary

Catchment	Wetland ID	Footprint [ha]
Plumpton	BR-WL1	1.0
	PR-WL1	1.5
	PR-WL2	2.9
	OG-WL1	3.8
	OG-WL2	1.1
	SR-WL2	3.3
	THW-WL1	2.4
Kororoit	PR-WL3	0.25
	DD-WL1	1.5
	DD-WL2	0.5
	OG-WL3	1.4
	RC-WL1	0.8
	RC-WL2	0.1
	GL-WL1	2.5
	SR-WL3	2.0
	SR-WL4	4.1

The results of water quality modelling for each DSS is provided in Appendix A, with a summary provided in Table 7. The Base Case is shown to achieve the TP target of 45% reduction, however, fall just under the TN and TSS targets of 45% and 80% reduction respectively.

Table 7 – MUSIC Modelling Results Summary for Plumpton and Kororoit PSP's

Base Case	In	Out	% Reduction
Flow (ML/yr)	5,991	5,574	7%
Total Suspended Solids (kg/yr)	1,131,500	283,320	75%
Total Phosphorus (kg/yr)	2,333	851	64%
Total Nitrogen (kg/yr)	16,233	9,096	44%

3.5. Water Supply

City West Water (CWW) and Western Water (WW) were both consulted in the preparation of the Base Case. CWW provided a spreadsheet with demand predictions through each of the various land uses including residential, commercial, industrial and open space. They also provided advice on the proportions of each demand that could be attributed to Class A water and that which would need potable water.

As per their IWCM, CWW plan to install a recycled water plant in Ravenhall which could be used to service the Plumpton and Kororoit PSPs with alternative (non-potable) water. Although revision of the boundary for the water retailers is currently being explored, it is likely that the plant infrastructure for providing Class A will be built by CWW. Construction of the facility is expected to be completed 2020/21 as advised by CWW.

The following demand values and percentage breakdowns have been used as the basis for the annual water demand in the future PSPs. These are based on the values provided by CWW.

- Residential – 175L/person per day (42% non potable) and a population of 49,500 through the two precincts.
- Irrigation for active open space – 13.7 kL/ha.d, 96.9 ha (100% non-potable water)
- Industrial/Employment area = 4.1 kL/ha.d, 105 ha (75% non-potable water)
- Commercial –27.04 kL/ha.d, 27.3 ha of area zoned as activity centre through the future precincts. Demand of 50% non-potable water is based on supply of toilets, irrigation, and cooling towers, as provided by CWW.
- Primary/secondary schools and community centre – 6.21kL/d per ha (25% non potable). Demand is based on a supply of 0.23L/s/ha for 7.5 hours per day, 205 days per year. The following areas were used:
  - Primary school, 28.8 Ha
  - Secondary School, 25.4 Ha
  - Community Centre, 5.6 Ha

Land use through the PSPs has been broken down using the future urban structure plan provided by the MPA (V140728). MPA advises this is a draft FUS which will change as it goes to consultation and then public exhibition to finalisation. Nonetheless, approximate land areas and densities will remain the same.

The total demand for the precinct is predicted to be 4,198 ML/y, residential is largest demand sector by a large majority. The breakdown is provided in Figure 19.

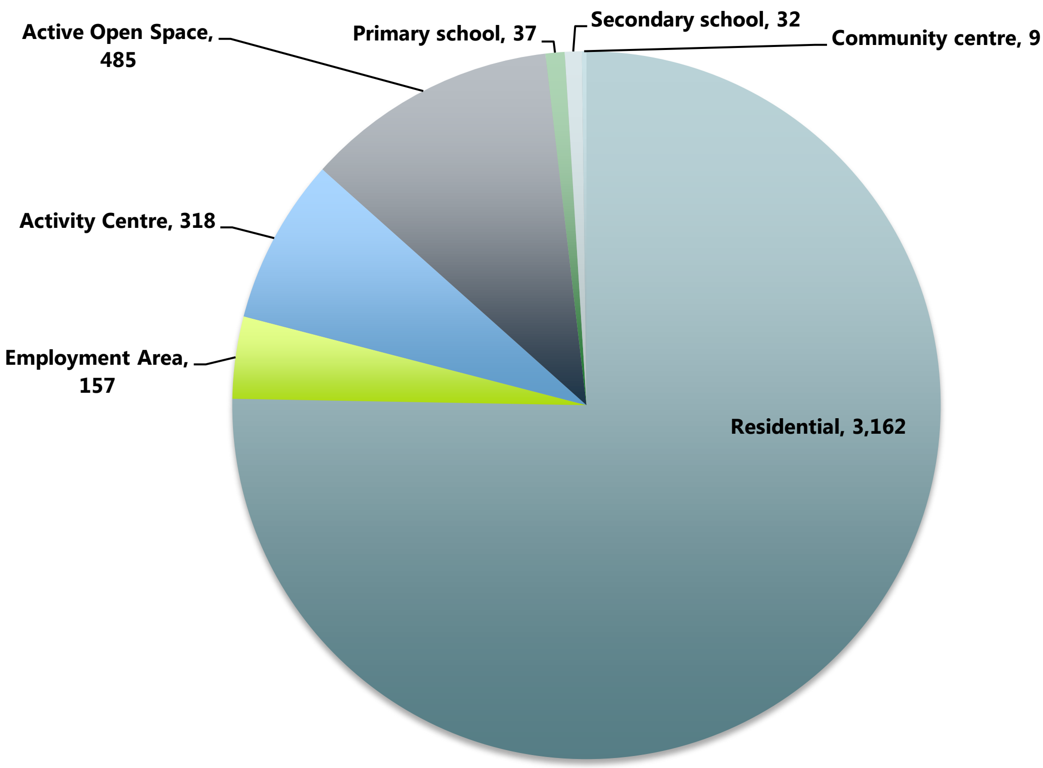


Figure 19 Total Water Demand (ML/yr) through Kororoit and Plumpton

As seen in Figure 19, approximately 75% of water consumption through the precincts will be through residential demands.

Using Class A water as a source for non-potable demands can reduce the demand on potable water by just over half, as shown in Figure 20.

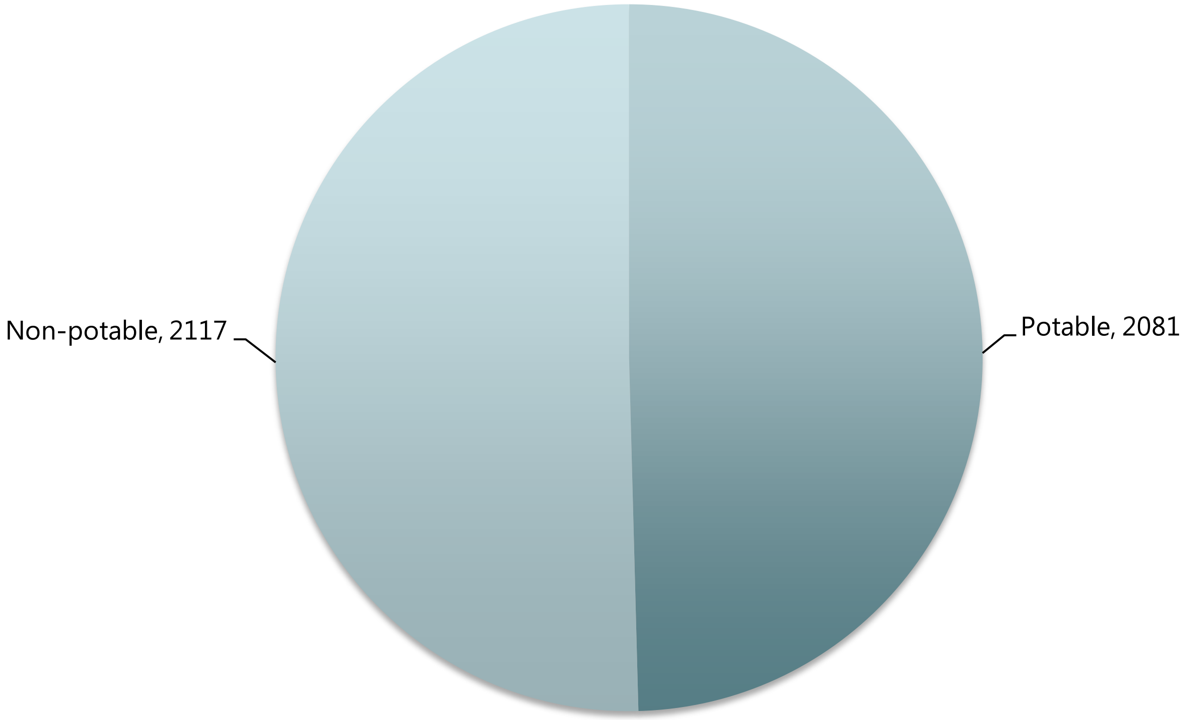


Figure 20 Water Demand with Kororoit and Plumpton PSPs

CWW has sized their future infrastructure to be able to deliver 3,500ML/y for the Holden supply zone (which extends beyond the boundaries of Plumpton and Kororoit). The facility is expected to be completed by 2020/21, as advised by CWW. They predict that there should be sufficient supply from Ravenhall to meet any alternative water demands in Plumpton Kororoit PSPs.

CWW has said that if aquifer storage and recovery (ASR) is suitable they may be able to supply an additional 500 ML/y of Class A water.

CWW also own several stormwater harvesting schemes through western Melbourne, and there may be opportunity for CWW to consider owning stormwater harvesting systems through the subject area which could offset Class A demands/make this surplus Class A available to other precincts in the Holden supply zone.

3.6. Base Case Water Budget

A water budget, connecting the stormwater, sewer and water supply aspects of the Base Case, has been undertaken as represented graphically on Figure 21.

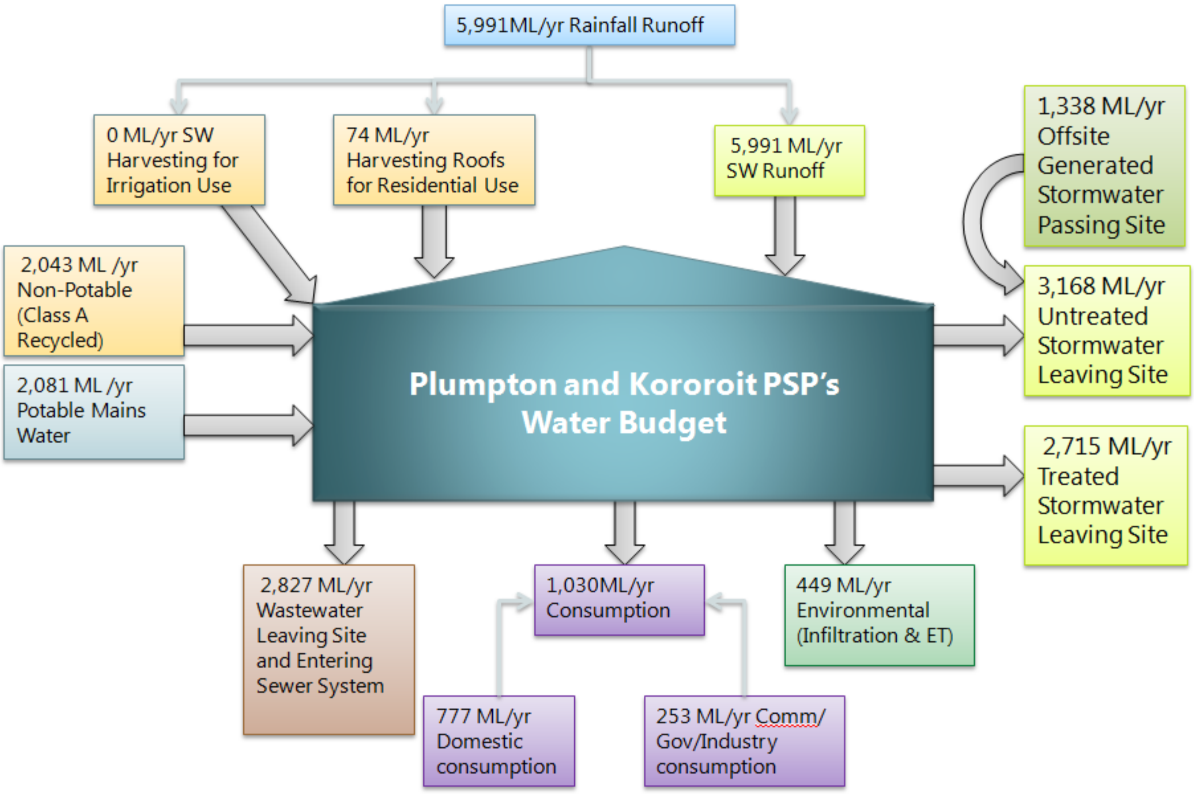
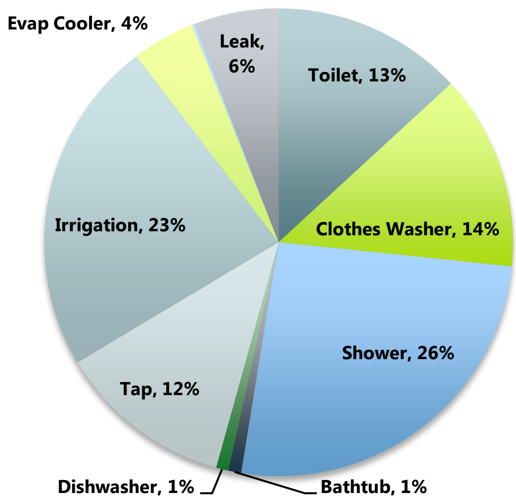


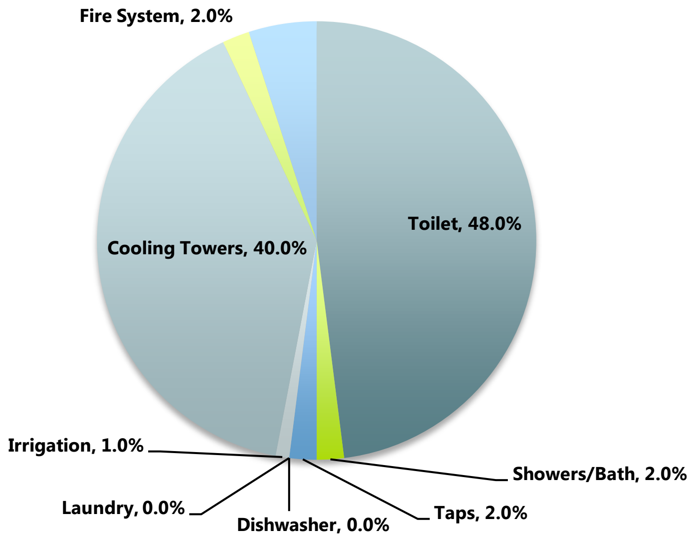
Figure 21 Base Case Water Budget for Kororoit and Plumpton PSPs

The water budget balances the potable and alternative water supply, which in the base case is recycled water only, as well as the stormwater runoff (derived from MUSIC modelling as presented in Appendix A) as input to the PSP system with the determined outputs. To determine the outputs, including the proportion of domestic, commercial and industrial wastewater, proportion of consumed water and the distribution of stormwater volumes discharging from site the following assumptions were adopted:

- CWW defines < 17 dwellings per Ha as low density. As such, the residential water use breakdown was adopted based on a low density household (given MPA's provided average density of 16.5 dwellings per Ha for Plumpton and Kororoit) as provided by CWW (Spreadsheet: *Residential Demand Assumptions – February 2014*). The breakdown is shown below.



* The distribution of residential discharge either to wastewater, stormwater or consumed were determined based on assuming all irrigation and a small proportion of tap water is consumed, leak and evap cooler discharged to stormwater and all remaining discharge as wastewater to sewer.
* The commercial water use breakdown was also provided by CWW as follows:



* All commercial toilet, shower/bath, proportion of taps and the fire system (54%) were assumed to discharge to sewer. The cooling towers report 40% of the flows to sewer and all remaining water being consumed.
* The proportion of treated and untreated stormwater leaving site was extracted from the MUSIC modelling node water balance with treated water counted as pipe flow and untreated as weir flow. Environmental losses were also extracted from MUSIC, being the difference between inflow and outflow. Lastly, the supply from rainwater tanks was extracted from MUSIC, based on a 5 % assumed uptake (considered reasonable for the development area).

3.7. Base Case Environment and Heritage Map

A summary of the environmental and heritage components of the PSP's, and how the base case approaches mitigating impacts on these, is presented below. These are represented on the Base Case Maps by PSP on Figures 22 and 23.

- Two ephemeral waterways which flow in a southerly direction through both PSP's in a path to Kororoit Creek, the Olive Grove and Sinclair's Waterways
  - Alluvium (2014) identifies a number of reaches of intact waterway in the Olive Grove catchment of being high geomorphic value that should be retained where possible. Sinclair's also comprises intact sections where SHW N11 is located and at the downstream section.
- Values falling under the BCS including the GGF corridor and the seasonal herbaceous wetlands comprise ecological value and require the existing hydrological regime to be maintained in the developed condition or as close as possible.
- SHW are matters of national environmental significance under the EPBC Act
  - Six sites within Kororoit PSP were found to qualify as 'high quality' examples of SHWs, referred to as NR1, N1, N2, N3, N5 and N11.
  - SHW's within the BCS conservation areas will be retained. Other SHW's may be retained where possible through the DSS.
- The indicative OMR alignment clashes with the Beatty's Creek alignment along a section identified by MW as a natural waterway comprising high geomorphic value and high ecological value.
  - Once the OMR design is undertaken, Vicroads and MW will be required to reach agreement on the waterway and OMR alignments.
- Several surface artefact clusters / areas of higher cultural value have been identified in the Beatty's waterway that runs through the Plumpton PSP.
  - The Cultural Heritage Management Plan for Plumpton PSP (AHMS, 2014) recommends these should be *retained as much as possible in open space, riparian, bio-link, set-backs and asset protection zones*. Two clusters have been identified along the Beatty's Road waterway and are proposed to remain as part of the intact section
- A heritage listed dam is located in the Olive Grove DSS and heritage areas have been nominated in the Reed Crt DSS

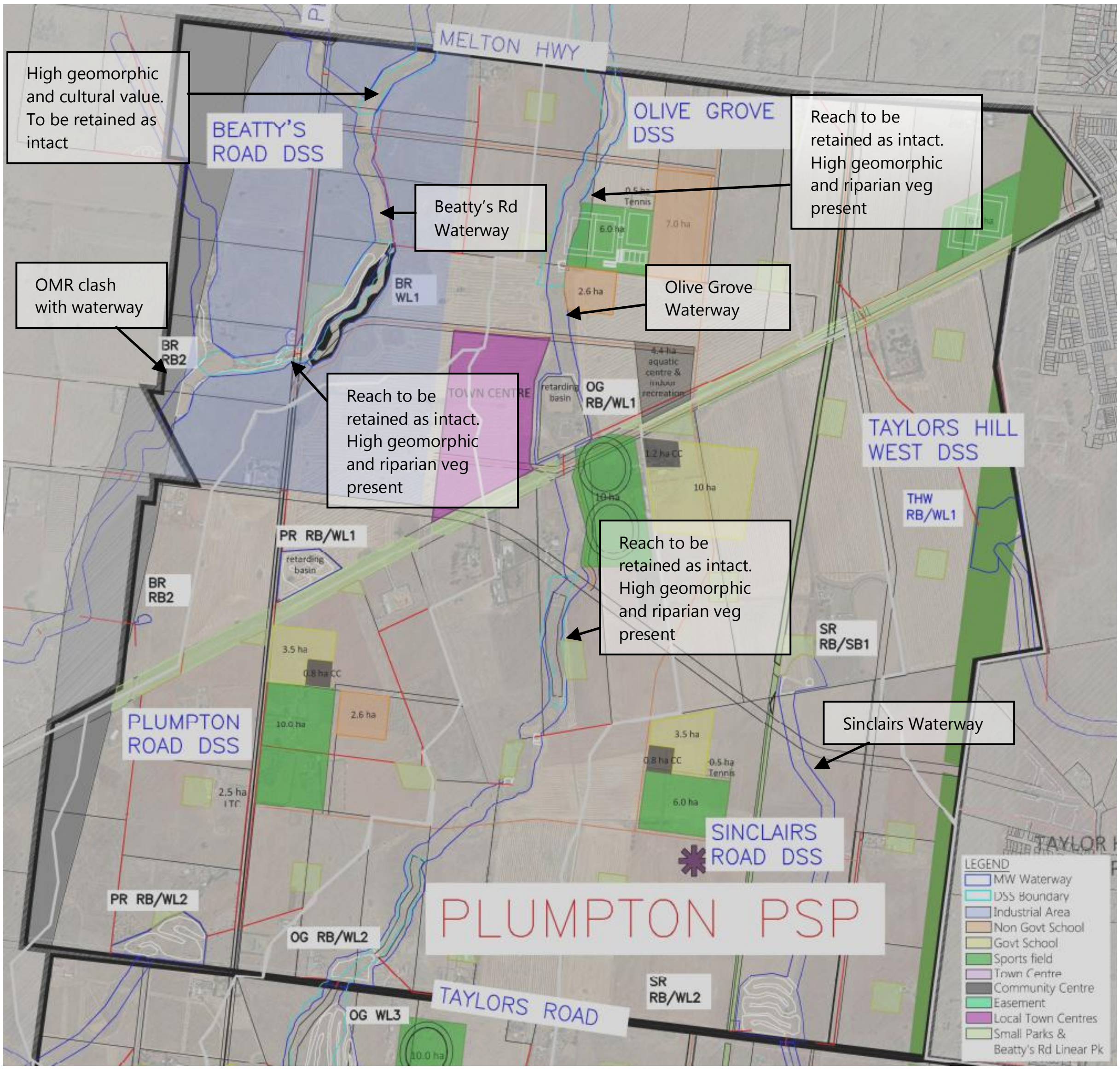


Figure 22 Plumpton PSP

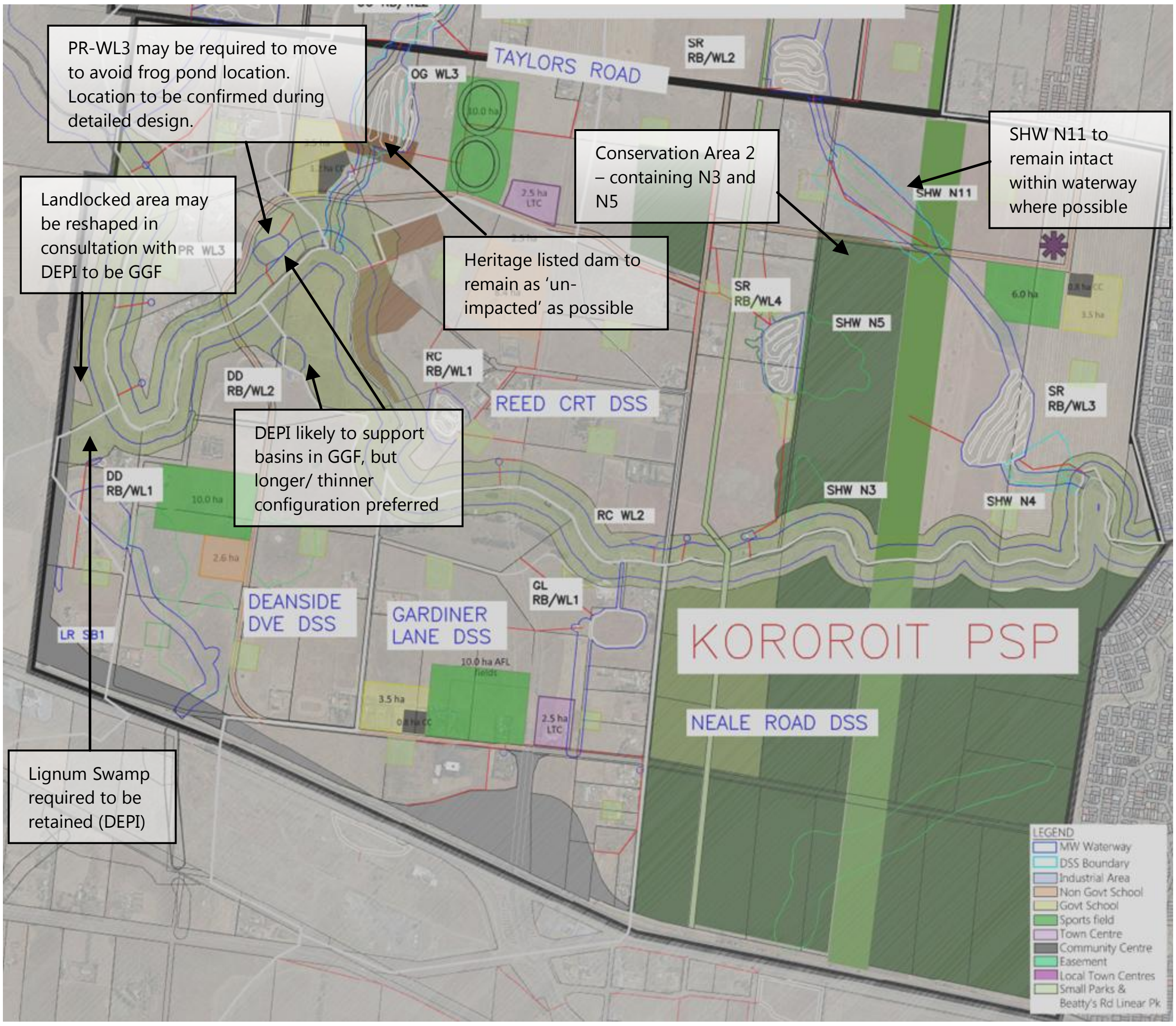


Figure 23 Kororoit PSP

4.0 ALTERNATIVE OPTIONS DEVELOPMENT METHODOLOGY

4.1. Overall Approach

The approach to development of alternative options, represented as implementation of water management measures beyond the Base Case, was undertaken primarily based on stakeholder input through workshops. The objectives of the workshops (Workshop 1, 2 and 3) were to understand stakeholder values and priorities for the Plumpton and Kororoit PSP's.

Following the workshops, Storm continued to accept refinement and input from stakeholders to build the WOWC objectives, values and options. The methodology for understanding stakeholder values and development of alternative options is outlined below.

4.2. Stakeholder Values

In order to define measurables for comparison of the Base Case to the alternative options, the first step is to agree on stakeholder definition of values and how they can be measured.

This aspect of the project is undertaken based on discussion with stakeholders on their values. Ultimately, not all of the measurables will be weighted equally for various stakeholders, for example, capital cost will be the key concern to some stakeholders, operational cost of more importance to others, waterway health and environment the driver for others and so on.

We sought feedback on values to inform the options that are progressed and also how to measure their relative likelihood of success. This was undertaken based on workshops as outlined below. The workshops involved consultation with representatives from the various agencies including the MPA, Melbourne Water, Melton City Council, City West Water, Western Water, the Office of Living Victoria and developers.

4.3. Workshop 1

Workshop 1 focussed on understanding the objectives of developers with respect to water management. The workshop was attended by representatives from the following:

- Developers - Australand, Breese Pitt Dixon, ID-Land, Lend Lease, Mesh, Modega Investments, Moremac Property Group, Pinnacle Development Group, Resi Ventures Development, Mondous
- Agencies - City of Melton, CWW, WW, OLV, MPA, MW
- Consultants – Storm, Smec, Strata PNA, Terranovis, Urban Design and Management

The approach for this workshop was for the key agencies to present their perspective and role in planning of the Plumpton and Kororoit PSP's and then begin to gauge the developer response. First, each agency presented their perspective on the opportunities and constraints for the subject PSP's. MPA presented the draft FUS, identifying the key constraints being the GGF and the gas and power line easements. Further constraints were identified by Melbourne Water with respect to geomorphic and environmental value of waterways. CWW and WW comprise a split responsibility with respect to water supply with a key plan to incorporate Class A recycled water from the Ravenhall treatment plant.

Storm then presented the three key points of focus for the WOWCA to be drainage, waterways and water supply identifying initial options may include enhancing liveability by decentralising assets (providing more green space) and reducing traditional water supply sources through harvesting.

Key aspirations and concerns expressed by developers were:

- Costs, time and land take are the main issues
- Space constraints due to higher density areas would limit the acceptance of tanks on private land
- Avoiding land take is desirable with co-locating assets and centralised systems preferred
- With respect to WWCM developers were concerned this would slow down the process of PSP finalisation
- Extra costs for options may be accommodated, however, the key concern is the additional time taken to approve 'non-standard solutions'. An incentive would be to speed up the approval process for these solutions
- Government commitment is paramount to getting buy in from developers (and the community) with respect to options.
- A mandate on WOWC options would increase housing costs and reduce affordability
- Developers believe the community values easy access to green space (including aesthetics of theses spaces) and connectivity corridors are important.

The workshop presented the opportunity for an open discussion between all the Stakeholders. The key themes and shared values were as follows:

- Liveability
- Co-location of assets is desirable
- Important to understand the economic costs and benefits of the WOWC options
- Commitment to maintaining affordability.

4.4. Workshop 2

Workshop 2 aimed to facilitate agreement between stakeholders on the priorities specific to the Kororoit and Plumpton PSP's. Representatives from MPA, Melbourne Water, Melton City Council, City West Water, Western Water, the Office of Living Victoria were present. A presentation to the stakeholders was first conducted, in order to promote discussion between the separate parties. The presentation involved introducing potential values and measurables for discussion as well as presenting alternative treatment options, or case studies, to enable stakeholders to see what has worked for other projects.

Table 8 shows the adopted outcomes used as a guide for Stakeholder collaboration being the Water Future West values. This fell in well with the values and related measurables we initially presented to the stakeholders, as shown on Table 9, which was used to drive the options that were assessed.

Table 8 Stakeholder Outcomes

Outcomes sought for Water Future West		
1		**Supported liveable and sustainable communities**
	a)	Local agriculture and industry provides jobs and prosperity
	b)	Amenity in the West that creates community and pride of place
	c)	Improved flood protection is provided
	d)	Natural resources and built assets are valued, protected and used efficiently
	e)	Community is well informed, engaged and empowered with water cycle management
2		**Enhanced environmental health of waterways and bays**
	a)	The health of waterways and ecosystems are protected and enhanced
3		**Secure water supplies are efficiently provided**
	a)	Reliable fit for purpose water for optimal community outcomes is provided
	b)	Resilience and adaptability to shocks and trends including climate variability is provided
4		**Public health and well-being is improved**
	a)	Public health and safety for all in the community outcomes is provided
	b)	Climate resilient water and green space is provided in the urban environment to enhance community health and well-being and promote active lifestyles
5		**Affordable essential water services are delivered**
	a)	Efficient and affordable water solutions for brownfield and greenfield sites are provided
	b)	Existing water infrastructure for the region is optimised without restrictions of service boundaries

Table 9 Priorities for Plumpton and Kororoit

Water Future West	Value	Related infrastructure	Measureable
1 b) 1 e) 4 b)	Social Amenity / Aesthetic Educational values Health through activity	Visual assets support education which can be lot, street or end of pipe scale. Vegetation as part of the stormwater treatment system provides education amenity and health. Irrigated vegetation water provides amenity and health but can be undertaken by any water source (Base Case?). Reducing risk of stream degradation (Environmental Value) will likely hold amenity and health value. Wetlands for stormwater treatment provide amenity and education but can be considered as Base Case. It would be the same for ponds.	This is difficult to measure and requires discussion. It is clear that community and developers would favour amenity but not at a significant cost. How much extra would a home owner pay for this and how does affordable housing impact on this? Health benefits can be massive but the research is still rather limited. Risk of degradation Resilient green space not reliant on potable water.
2 a)	Environmental – protection of natural waterways and wetlands on and downstream of the subject lands. Maintaining hydrological regime to be as close as possible to existing condition to protect natural waterway and wetlands including ecology.	Infiltration, evapotranspiration and reuse. Combination of leaky tanks, soak wells/unlined WSUD (needs to be balanced with plant stress in low rainfall environment), rainwater/stormwater harvesting	Annual volume of runoff (percentage reduction to no mitigation or ratio of post development run-off to non-developed case) Annual no of runoff days for a representative year Volume of water infiltrated/lost to evaporation Detention of minor storms such as the 1.5 year ARI (channel forming flow) to pre-development flowrates)
5 a)	Maximise developable land Either within private lots or by reducing waterway widths through public land or utilising encumbered land to free-up more space for development.	Depends on where additional development land is preferred: On-lot solutions will reduce requirements of centralised infrastructure and vice-versa. Streetscape measures benefit both.	Footprint of assets and split between private and public realm.
5 a)	Housing affordability (Government priority) Land take	All infrastructure	NPV of life cycle Capital / Operational / Maintenance
	Responsibility Installation, operation and maintenance, liability	On-lot Streetscape End of pipe (pre-waterway) Instream works Water service pipes	Lot owner / tenant Developer CWW/WW MW Council

A summary of the key points of agreement to come out of Workshop 2 were as follows:

- Co-location and minimisation of footprints of treatment assets is important for all stakeholders
- Leaky tank and swales were eliminated as potential treatment options, with Melton City Council particularly not in favour.
- Melbourne Water indicated rainwater tanks could not be relied upon to reduce the size of centralised assets.
- Stakeholders were particularly interested in stormwater harvesting as an option for recovering stormwater for irrigation, minimising potable or recycled water supply, as well as having some treatment benefits. MW indicates the design of these systems would need to demonstrate compliance with BPEMG to claim treatment benefits. Nonetheless, at the PSP level MW requires the proposed DSS assets to remain full size for 'standalone' BPEMG performance.
- The issue of responsibility or 'ownership' is unclear at this stage.

4.5. Workshop 3

Workshop 3 aimed to provide a quantitative comparison between the options that were pursued. This was presented based on a 'test case' as there was some uncertainty as to which options were favourable. The main uncertainty came from the broadness of possible options and Workshop 2 did not provide enough direction on the specific combination of options that were to be investigated. As such, Storm developed three options that covered most of the potential options and undertook a test study of one of the DSS's, providing a quantitative comparison between the options to show the relative benefits and costs that were able to be calculated. This would allow informed direction from stakeholders. The test case is outlined in detail in Appendix B and summarised below.

4.5.1. The Test Case

The test DSS selected was Olive Grove as this comprised a diversity of surfaces and sensitive areas (more detail on this catchment has been provided in Section 3.2.3).

Potential objectives and measureables were presented to the Stakeholders using the values in Table 9 (above) as a guide. The alternative options identified for quantitative comparison are as shown in Table 10. Also shown, is a summary of the results of the quantitative assessment for each option. The quantitative assessment compared peak flows (1.5 year, 5 year, 100 year ARI), runoff (runoff days, volumes) and water quality (% reduction TSS, TN, TP) of the Options, using the pre-development conditions as a benchmark. Results are shown in more detail in Appendix B.

Table 10 Summary of Test Case Results

Option	Description	Results
Alternative Option 1	Targets water quality criteria. Stormwater quality improvement is promoted prior to entering the waterway. This is achieved through street scale WSUD (predominantly raingardens) utilising the median space to treat road catchments.	Improved on runoff volumes entering the creek, compared to the Base Case, however, only seeks to achieve best practice water quality criteria. This equated to sizing the raingardens based on approximately 1 % of catchment. This also allowed for the reduction of water quality assets (mainly wetland) areas, with an estimated 47% reduced footprint.
Alternative Option 2	Expands on Option 1, with the main target volume and peak flow reduction. Lot Scale treatment is introduced to enhance waterway protection. In addition to the WSUD measures, rainwater tanks (RWT) and stormwater harvesting (SWH) are introduced to minimise volumes and peak flow entering the creek and provide an alternative water supply for irrigation of parklands.	Negates the need for the centralised wetlands, with interception of runoff shown to occur before entry to the creek. The volume of runoff discharging from the site is approximately 40% less than the Base Case. This option achieves the pre-development peak flow for the 1.5 year ARI (4.57 m^3/s) at the OG-RB2 location (4.5 m^3/s) and has an impact on 100 Year ARI flows. This option includes the implementation of rainwater tanks, with Melbourne Water previously indicating these could not be relied upon to justify reducing centralised water quality treatment assets. Nonetheless, the infiltration trenches and WSUD provided significant contribution to reducing the need for these assets under Alternative Option 2
Alternative Option 3	Further expands on the above options by also incorporating an infiltration element along the creek. Represents a 'best case' scenario with respect to protecting the creek values	Alternative Option 3 further reduces runoff days and runoff volumes entering the creek, being only twice as large as the pre-development results. This represents a best case with respect to waterway health.

Stormwater harvesting and Rainwater tanks (3kL each with demand based on servicing toilets and garden) introduced to Options 2 and 3 were found to supply 305 ML in total with a greater than 70% reliability targeted. This equates to a direct reduction in recycled water supply.

The results were also compared with respect to cost, with Alternative Option 1 representing the lowest cost at a total of ~$10.6 million and the highest cost with Option 3, being of the order of $29.5 million.

Valuing the benefits in monetary terms has not been undertaken at this stage.

4.5.2. Stakeholder Discussion

Presentation of the above test case at Workshop 3 provoked some discussion from Stakeholders present. The main points expressed were:

- Co-location of assets maintains a priority due to multiple benefits
- CWW is likely to be prepared to undertake stormwater harvesting projects with the key being 'economy of scale' and is subject to Council agreeing to repay costs over time. Nonetheless, should the projects be large enough to provide significant benefits or water savings, CWW is prepared to invest.
- CWW advised they will investigate the potential to minimise sizing of the recycled water line as a low flow top up (of rainwater tanks) option.
- Council has indicated they are happy with WSUD, however, emphasised swales are not an options. Nature strips were also flagged as constrained in residential areas, which may impact on the sizing and placement of above ground assets.
- Melbourne Water emphasised the health of the waterway is a high priority, however, indicated a risk exists in minimising centralised assets to be replaced with lot-scale and street scale measures. Melbourne Water require evidence there is minimal risk, for example a mandate for raingardens and rainwater tanks.
- The issue of responsibility or 'ownership' not specifically resolved, however, the general rules of thumb are as follows:
  - Melbourne Water services assets for catchments 60 ha and greater.
  - Local Council over assets that service less than 60 ha catchment
  - Lot scale responsibility provided by landowner

Melbourne Water has since provided further feedback with regard to the infiltration trenches as introduced under Alternative Option 2 indicating these will need further investigation before acceptance on broad scales. These have been included as they contribute to providing the best feasible option in protecting waterways and have been used successfully in large scale at Warrick Court (as presented in workshops) and during the Little Stringybark Creek project. Melbourne Water has advised investigation with Moonee City Council is underway to discuss this asset type.

4.6. Outcomes – The Final Alternative Options for WOWC

The main outcomes sought from the Workshops were agreement on the objectives, as well as development of alternative options to be investigated. Ongoing consultation with Stakeholders occurred post-workshops, with the following objectives adopted:

Table 11 Adopted Objectives for Plumpton and Kororoit PSP's

Value	Relevant Agency	Objective and Benefit Measure
Water Supply	• CWW • Western Water • OLV	• Provision of reliable water supply (ML/yr) • Provision of alternative water supply (recycled water identified – ML/yr) • Stormwater and rainwater harvesting (impact on non-potable – ML/yr). • Public safety and climate resilience a key consideration of SWH and RWT.

Waterways	• Melbourne Water
	• OLV
		• Protect and enhance health of waterway by meeting pre-development conditions
		    • Detention of Peak 1.5-yr ARI (m^3/s)
		    • Volume of runoff to stream (ML/yr)
		    • Volume of water to the environment (infiltration and ET - ML/yr)
		• Retain undisturbed (intact) portions of waterway identified as high value (protection of heritage, ecological and geomorph value)
		• Meet best practice (BPEM) stormwater quality objectives (TSS, TP and TN % reductions)

Drainage and flooding	• Melbourne Water • Council	• Protection from 100 yr peak flow (m^3/s) • Minor drainage capable of peak 5 Year ARI (m^3/s)
Liveability (including Environmental Amenity)	• Melbourne Water • OLV • MPA • Council	• Stream resilience and protection including vegetation (refer 'Waterways') • Resilience to climate change (green/open space provision, WSUD)
Community	• Developers • MPA • Council	• Affordable housing • Well being (refer 'Liveability')
Kororoit Creek Health	• DELWP	• Minimise impact on GGF (peak flow and volumes)

These objectives will be considered in the comparison of the alternative options for the PSP's. Two Alternative Options will be pursued:

- *WOWC Alternative Option 1 – implementation of measures targeting water quality criteria and reducing base case Wetland footprints.*

  This option represents a 'practical' option based on a combination of options presented in the test case. While a key target is volume and peak flow reduction, the treatment measures are selected based on likely implementation.
    - Street scale treatment is present to enhance waterway protection, which may represent above ground tree pit gardens, or below ground systems.
    - Rainwater tanks (RWT) based on a likely uptake of 5% of residence (assumption based on discussion with MPA).
    - Offline wetlands to assist in minimising loads on centralised assets

- *WOWC Alternative Option 2 – introduction of additional measures to protect and enhance the waterway and maximise reduction of traditional water supply.*

  This represents the best case scenario with regard to achieving the objectives. The main target is reducing volume and peak flow reduction. This incorporates:
    - Street scale treatment (as above),
    - 100% uptake of rainwater tanks (RWT)
    - Stormwater harvesting (on all sporting fields) with excess to be injected to the recycled water supply; and
    - An infiltration element along the creek to minimise volumes and peak flow entering the creek.

The options are represented in Table 12, illustrating the relevant objectives.

Table 12 WOWCA Options

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
Description	Centralised Retarding basins/wetlands - MW DSS	"Practical" option - key target to reduce stormwater volume and peak flow	Key target - reducing volume and peak stormwater flow
	Current practice to meet BPEM	Stormwater quality improvement prior to entering waterways through street scale WSUD - above ground tree pit gardens, or below ground systems	Stormwater quality improvement prior to entering waterways through street scale WSUD - above ground tree pit gardens, or below ground systems
		Off-line wetlands to assist in minimising loads on centralised assets	Infiltration element along the creek to minimise volumes and peak flow entering the waterways[1]
POTABLE WATER			
System	Reticulated - all users	Reticulated - all users	Reticulated - all users
Supply	Centrally supplied	Centrally supplied	Centrally supplied
SEWERAGE			
System	Reticulated - all users	Reticulated - all users	Reticulated - all users
Treatment	Centrally treated	Centrally treated	Centrally treated
RECYCLED WATER			
System	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses	Reticulated third pipe system to all households, commercial, industrial and educational users for non potable uses. An opportunity exists to decrease peak demand flowrates and pressures which is expected to significantly decrease capital and operational costs.
Supply	Ravenhall RW Facility	Ravenhall RW Facility	Ravenhall RW Facility

[1]Melbourne Water has advised that infiltration trenches will require further investigation, before they would be used on broad scale applications. Melbourne Water are currently investigating this approach with Moonee City Council (with Storm successfully implementing this asset type with the Steele Creek, Warrick Court project) and will require further work before acceptance. Nonetheless, these have been included for the purposes of this assessment in order to present the best feasible option in protecting the waterways.

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
STORMWATER			
Major system - MW			
DSS Detention	BPEM - 1 in 100 year ARI detention	BPEM - 1 in 100 year ARI detention	BPEM - 1 in 100 year ARI detention
DSS Treatment	BPEM - 80, 45, 45,	BPEM - 80, 45, 45,	BPEM - 80, 45, 45,
Assets	Centralised RBs incorporating SWQT* systems; distributed precinct scale SWQT systems (to be delivered to Council for maintenance purposes once constructed if < 60 Ha catchment)	Some assets distributed throughout individual catchments and co-located adjacent to or within active open space areas to increase SWH potential and create amenity assets.	Some assets distributed throughout individual catchments and co-located adjacent to or within active open space areas to increase SWH potential and create amenity assets.
Treatment and Re-use	Not considered	Not considered	Potential to provide treated stormwater to future industrial and adjacent ag users
Local System - Council			
Detention	Assets constructed through development & delivered to local Council though the DSS process or other land development processes for catchments < 60 ha	BPEM 1.5 ARI detention	BPEM 1.5 ARI detention
Treatment	SWQT assets constructed through development and delivered to Council, as above	As per Base Case	As per Base Case
Assets	Traditional reticulated underground piped system	Traditional reticulated underground piped system	Traditional reticulated underground piped system
WSUD	Nil	Raingardens in medians (1% of catchment area). Offline wetlands in green spaces.	Opportunities to place swales (bioretention and vegetated) in medians of higher order roads explored in appropriate sub-catchments. Offline wetlands in green spaces.
			SWH to irrigate sport reserves with excess injected to recycled water system
			Infiltration trenches along waterway sections
Lot Based			
Roof tanks	Voluntary 6 star	Voluntary 6 star	Voluntary 6 star
Assumed tank uptake	5% of households	5% of households	100% of households
Assumed tank application	toilet flushing, household irrigation	toilet flushing, household irrigation	toilet flushing, household irrigation needs

5.0 ALTERNATIVE OPTION 1

5.1. Overview

As described in Section 4.5, Alternative Option 1 would comprise a combination of treatment measures implemented in the catchment based on likely uptake. The implementation of measures in the catchment serves to intercept stormwater before entering the creek, aiming to protect waterway values. This option incorporates many of the objectives and values of the Stakeholders namely:

- Improve stormwater quality prior to entering waterway
- Co-location of assets
- Provision of alternative water supply in the form of recycled water from the water treatment plant.

A schematic of this option is presented in Figure 24.

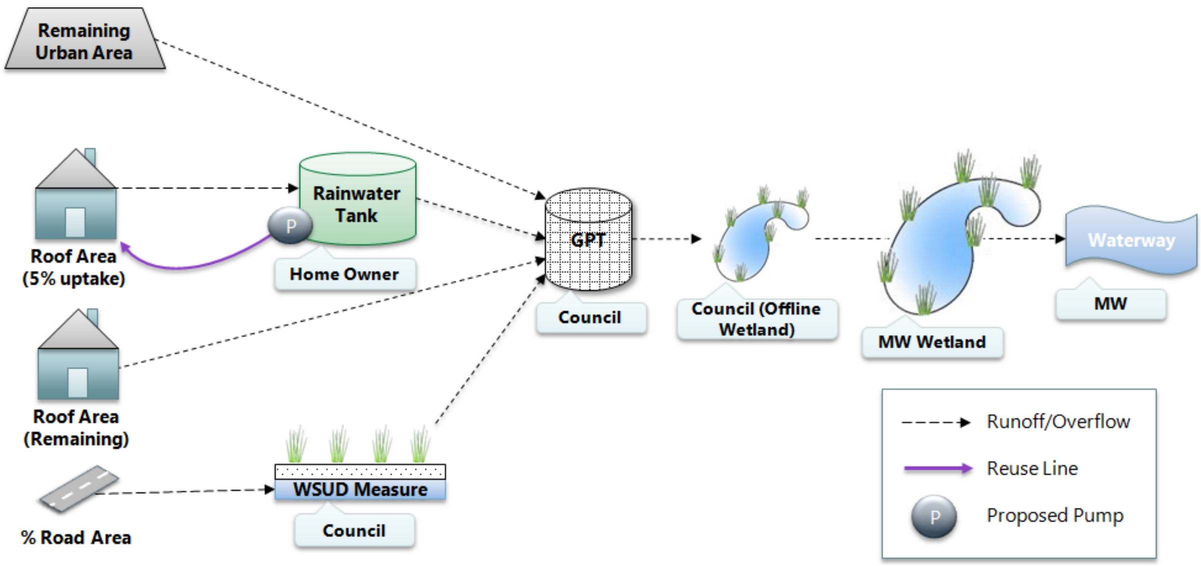


Figure 24 WOWC Alternative Option 1 Schematic

Figure 24 also illustrates the traditional responsibilities/ownership for each of the water cycle elements.

5.2. Catchment Opportunities

WSUD is incorporated in this option to treat as much of the road catchment as possible. Opportunities to implement WSUD in nature strips and green spaces exist within this catchment. These can be in the form of above ground measures, such as raingardens as shown on Figures 25a) and b), or below ground solutions as shown on Figures 25c) and d). This will depend on space constraints along the nature strips, particularly in the medium to high density areas, and Council preferences. Notably, above ground solutions can be incorporated in conjunction with tree pits, such as a tree pit raingarden (Figure 25b)).

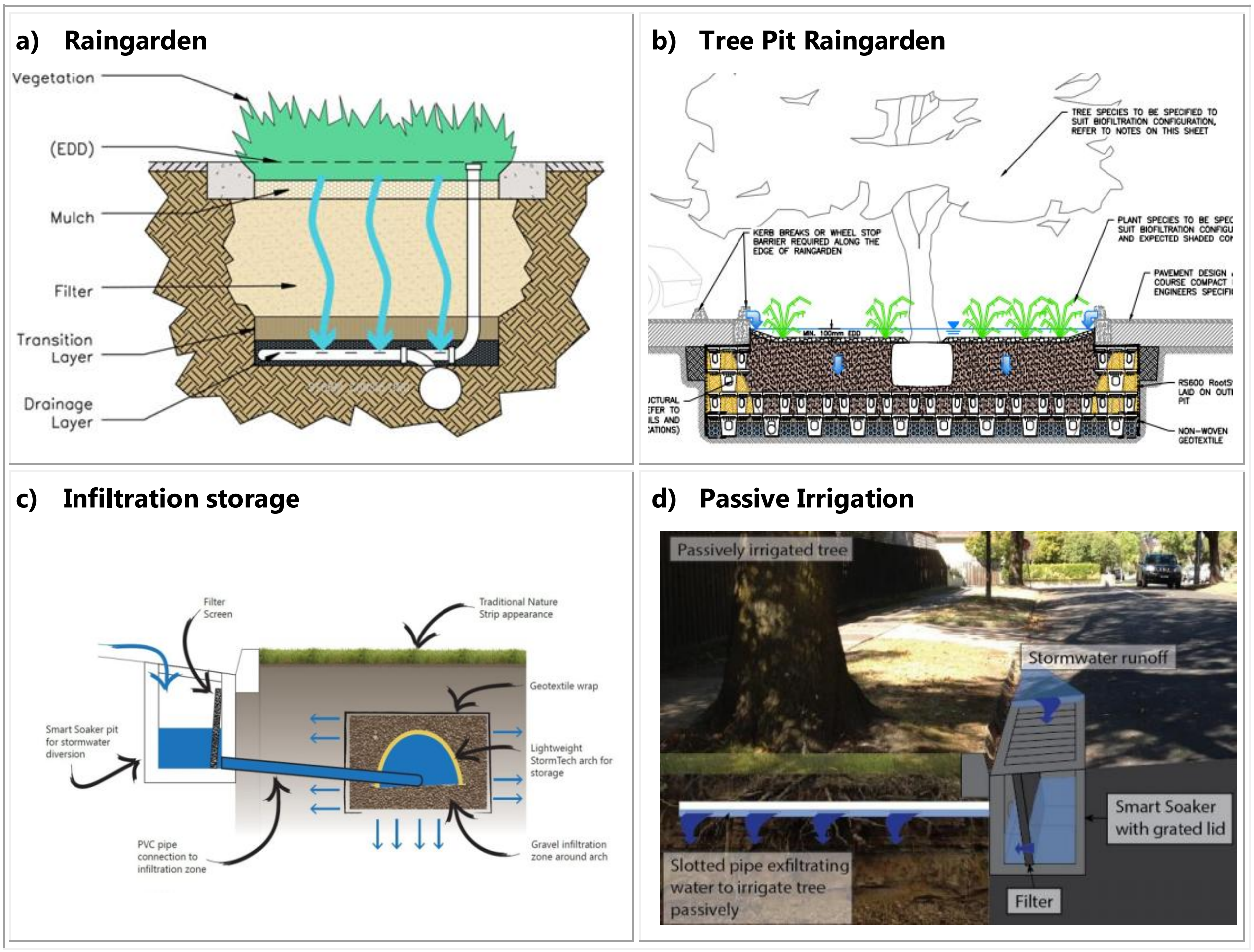


Figure 25 WSUD Opportunities

A key constraint with regard to street scale measures will be maintenance. Careful consideration to maintenance requirements should be undertaken by the designers. Council is traditionally responsible for the distributed street scale assets, and will therefore take on the burden of maintenance. As such, agreement from Council is of particular importance to this option, which would not proceed by developers without express sign off from Council. This will be the key constraint for distributed street scale measures.

Other opportunities within the catchment to detain stormwater include on lot rainwater tanks. For this alternative, these form only a minor component of the system as a conservative estimate of 5 % uptake of rainwater tanks has been adopted. The lower range of rainwater tanks is expected as many residents may prefer to be provided with recycled water supply, rather than rely on a rainwater tank.

Additionally, offline wetlands can be constructed within green areas. These would most likely be strategically positioned near waterways or 'low points' to maximise opportunity to capture and treat stormwater before entering the creeks. A typical configuration of a wetland is shown in Figure 26.

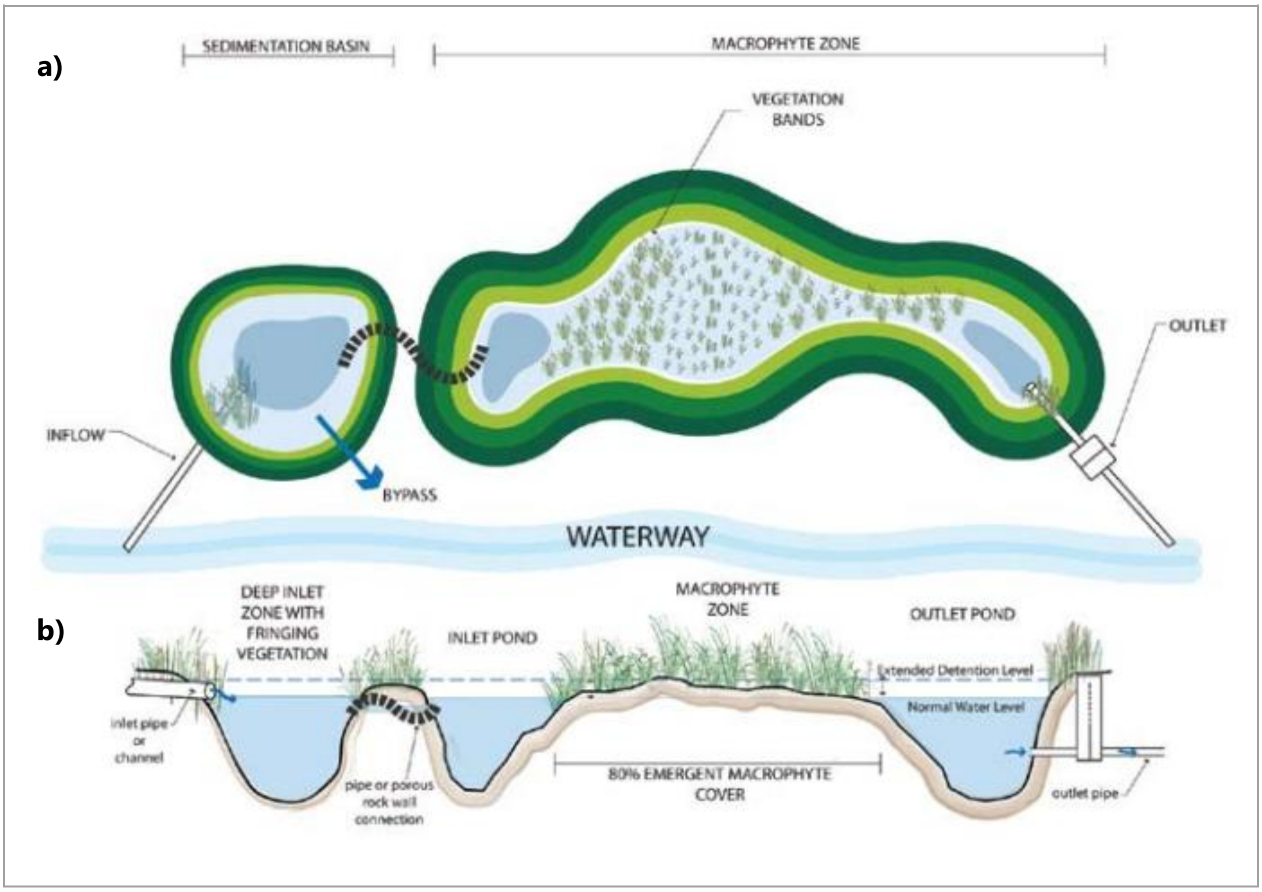


Figure 26 Typical Offline Wetland a) Plan View b) Long-Section (Source: *Melbourne Water Constructed Wetland Guidelines, 2010*)

The discussed opportunities are represented on Figure 27, showing the key raingarden and wetland locations for Alternative Option 1.

SR-RB3 is shown to be re-located to the north to maximise co-location benefits with the sports field. This provides a direct benefit to developable area. Melbourne Water has indicated that it supports this substitution and stormwater harvesting, however, is subject to approval from the local drainage authority. MW also notes that this will be determined by the asset owner (Council or private user) who would request a diversion license for irrigation purposes.

5.3. On lot Opportunities

The implementation of rainwater tanks is likely to be low if no strong incentives are in place to encourage uptake. This is particularly the case for the subject PSP's as recycled water will be an available source of water which could be viewed as negating the need for rainwater tanks. As such, under Alternative Option 1 an assumed percentage uptake of 5 % applies. The size of the tanks were selected as 3 kL tanks (1m depth) considered to represent a reasonable size for space, while not being too small to limit meeting demands. The exception for sizing of tanks is the residential areas of the Taylors Hill West DSS, where 2 kL tanks are assumed to be implemented. This is based on discussion with Villawood, the developer for this DSS, where 2 kL tanks are being incorporated in development. All the rainwater tanks would be implemented based on supplying water for toilets and garden irrigation. Data for these demands were based on values provided by CWW and experience with other precincts.

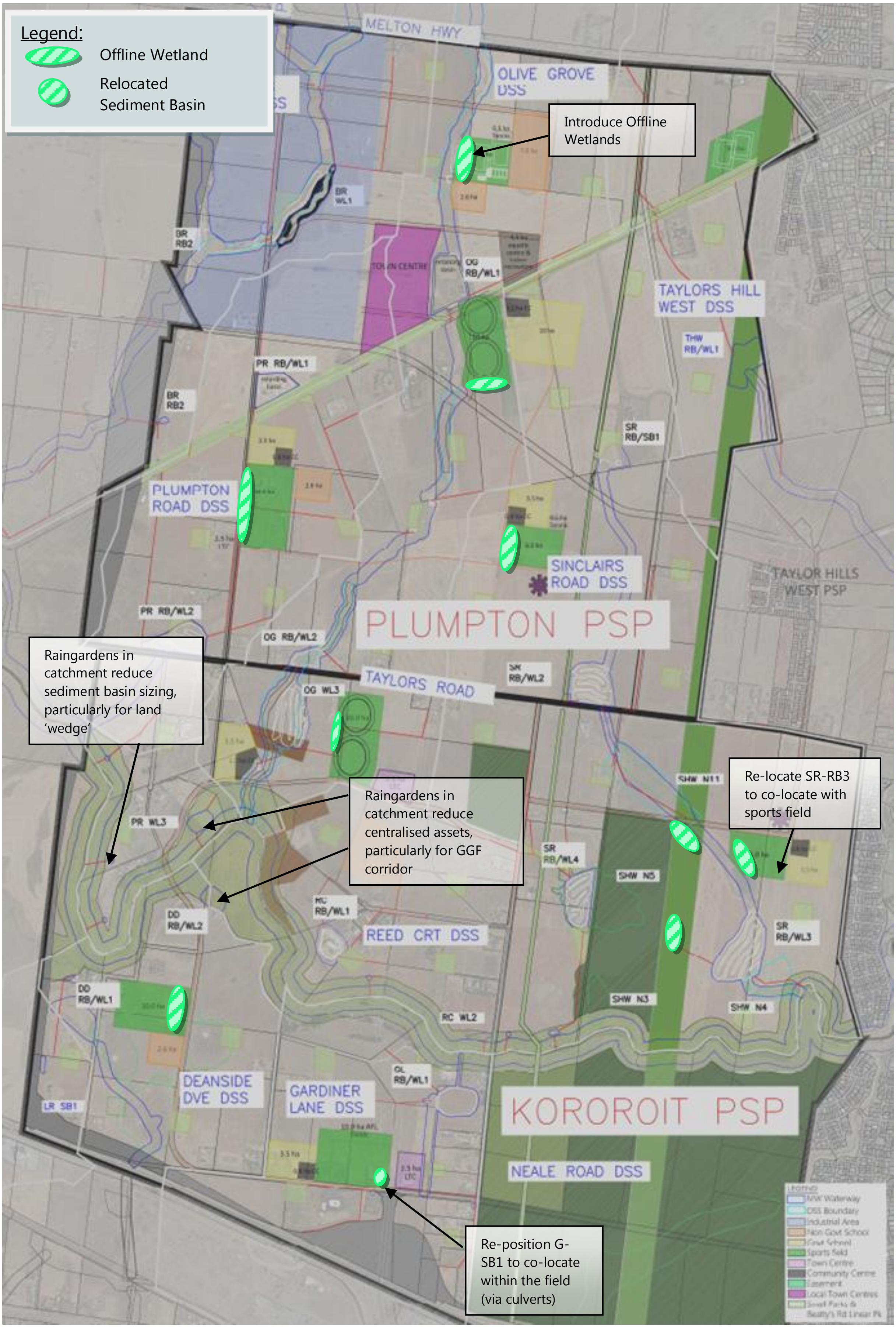


Figure 27 Alternative Option 1 Key Opportunities

5.4. Alternative Option 1 Assessment

5.4.1. Methodology

Alternative Option 1 is assessed based on a quantitative modelling approach to determine the benefits to environmental and water supply aspects of the water cycle, which is accompanied by a costs assessment.

The results are compared to existing (or pre-development) conditions as a benchmark to determine the treatment effectiveness of the proposed option which will later also be compared against the Base Case and Alternative Option 2.

Modelling with respect to quantifying runoff volumes and water quality reductions was undertaken in MUSIC using the models adapted from Melbourne Water, as described in Appendix A. The modelling is considered to be representative of average conditions, with the rainfall template adopted as 1996 (as recommended by MW MUSIC guidelines) from the Melbourne Airport record with the yearly rainfall being 526 mm.

With respect to assessing Alternative Option 1 against meeting peak flow targets (1.5 Year ARI and 100 Year ARI – refer Table 12) the street scale measures are only applied to the road catchments and lot scale treatment is minor, as such, it is considered minimal impact in reducing peak flows would occur. Retarding Basins developed under the Base Case will therefore remain as sized and peak flows are considered similar.

5.4.2. Water Quality Modelling Assumptions

The implementation of WSUD measures is largely dependent on Council preferences as they are traditionally responsible for streetscape maintenance. Council has indicated they are not willing to implement swales as a measure to treat urban runoff in residential areas, however, many of the other options have not been received negatively. Council has indicated the main constraint will be above ground space. As such, below ground measures are suggested here.

It is not practical to expect the entire road catchment to be captured, given the costs of installation and maintenance responsibility of Council. As such, a minimum criteria has been set for the overall treatment of stormwater to achieve the water quality criteria only. Nonetheless, reduction of stormwater volume entering the creeks will still be achieved to an extent.

With respect to rainwater tanks, a conservative estimate of 5% resident uptake has been assumed. Each would be assumed to install a 3 kL tank as space is likely to be a constraint. The overall assumptions are summarised in Table 13.

Table 13 MUSIC Modelling Assumptions for Alternative Option 1

Element	Catchment	Assumptions
Raingardens	Road only - 420 ha (~30% of development taken from experience with typical new areas) - 60% impervious	Exfiltration rate 4 mm/hr (clayey subsurface) Size increased/decreased based on achieving water quality targets
Wetlands	All urban areas - 60% impervious	- Exfiltration rate 0 mm/hr (wetlands are considered to seal over time and losses would be negligible)
Rainwater tanks (RWT)	Roof area only (5% residential) - 15 ha - 100% impervious	- 80 % of roof area directed to RWT - Roof area based on average of 220 m^2 - Reuse demand based on toilet and garden use at 87.5 kL/year/household (consider laundry connection as well) - 3 kL tanks were chosen as a reasonable size for space, while not being too small to ensure demands can be met.

5.4.3. Water Quality Modelling Results

The results of the MUSIC modelling based on the above assumptions are provided in Table 14 below.

Table 14 MUSIC Modelling Results for Alternative Option 1

Base Case	In	Out	% Reduction
Flow (ML/yr)	5,991	5,184	13%
Total Suspended Solids (kg/yr)	1,131,500	155,730	86%
Total Phosphorus (kg/yr)	2,333	741	68%
Total Nitrogen (kg/yr)	16,233	8,596	47%

Best practice is achieved for Alternative Option 1 for water quality. There is also a flow reduction expected of 13%.

5.5. Water Supply and Water Budget

The water supply options for Alternative 1 are not dissimilar to the Base Case, with recycled water providing the predominant portion of alternative water. A small portion of supply applies from the rainwater tanks implemented in 5% of the catchment. All assumptions presented in Section 3.6 apply with results as shown in Figure 28.

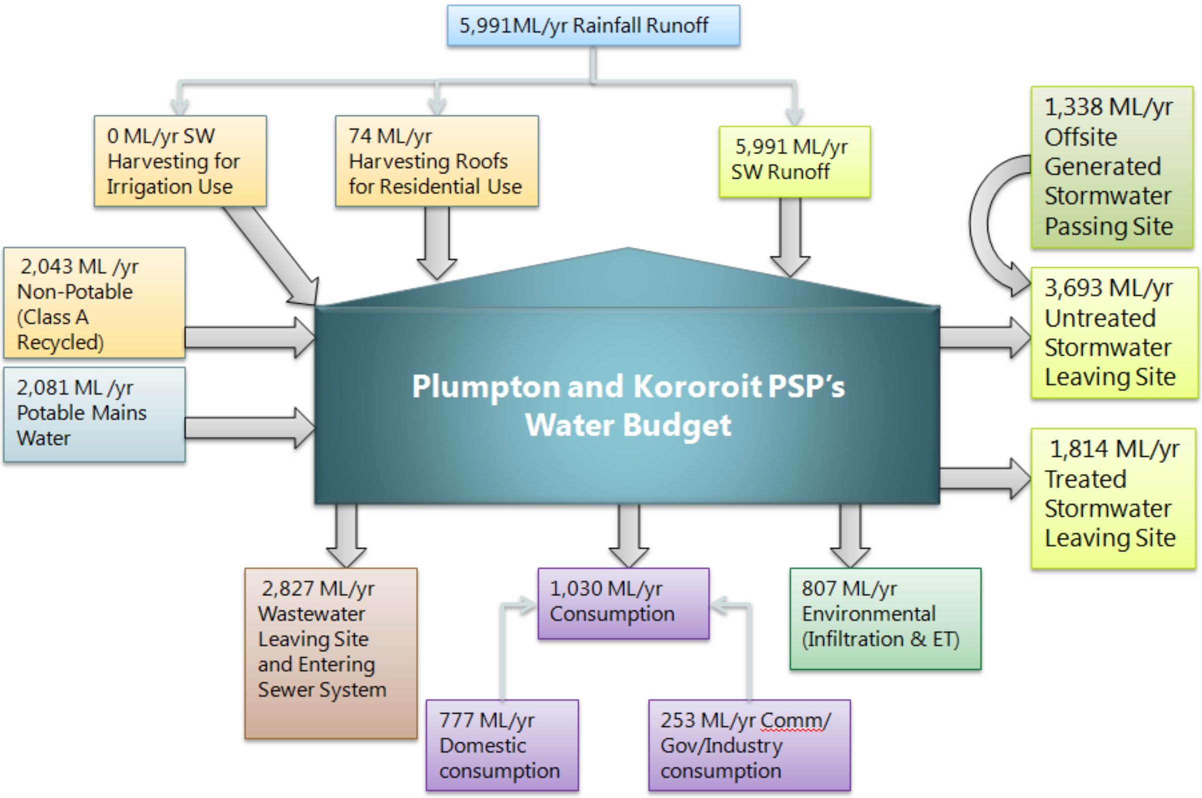


Figure 28 Alternative Option 1 Water Budget for Kororoit and Plumpton PSPs

5.6. Cost Estimate

5.6.1. Assumptions

The costs associated with Alternative Option 1 for each of the PSP's has been estimated based on the following main assumptions:

- Alternative Option 1 aims to treat roads only.
- The total road area has been estimated to be 420 Ha (~30% of residential area). Divided by PSP this becomes 189 Ha for Plumpton and 231 Ha for Kororoit.
- It is assumed that raingardens would be used in lower density areas while the arch infiltration systems will be used for the higher density areas.
- It is estimated that about 20% of the properties will be medium density with the remaining being low density. Therefore, the following treated areas apply:

- Plumpton	Raingarden	151 Ha
	Infiltration system	38 Ha
- Kororoit	Raingarden	185 Ha
	Infiltration system	46 Ha

- An average system catchment area will be between side entry pits which are spaced at about 81 m (one pit per 4.5 houses with 18 m frontages).
- A road is typically 5.5-6m wide (say 6m) and a raingarden would only capture one side of the road so therefore the typical catchment per raingarden is 81m x 3 m = 243m^2. This equates to an average raingarden size of 2.5 m^2 (to meet best practice).

It should also be noted that the costs presented in this report are indicative only.

5.6.2. WSUD Costs

Considering the raingardens would be constructed as part of the overall estate work, a reasonable cost of $2,500 per raingarden has been estimated (refer Appendix D for a break down).

With respect to the arch infiltration systems these would cost approximately $5,000 each, based on past experience (and contractor quotes).

Based on these assumptions, Table 15 summarises the costs associated with implementation of WSUD.

Table 15 Alternative Option 1 WSUD Cost Estimate

System	Total Area (Ha)	# Item	Unit Cost	Cost ($m)
Raingardens				
Plumpton	1.51	6,040	$2,500	$ 15.1
Kororoit	1.85	7,400	$2,500	$ 18.5
Total				$ 33.6
Infiltration Systems				
Plumpton	38	1,564	$5,000	$ 7.82
Kororoit	46	1,893	$5,000	$ 9.47
Total				$ 17.3
Alternative Option 1 WSUD Total				**$ 50.9**

The total WSUD costs for treating the road catchment amount to $50,900,000.

5.6.3. Wetland Costs

The wetland sizes have been reduced by nearly half based on MUSIC modelling. The construction estimates will therefore be compared to the Base Case as a reduction. This means the costs are represented as savings, with the Base Case effectively equal to zero for the purpose of this assessment. Appendix D provides a detailed breakdown of wetland costs estimated to be $ 17,941,000 for Alternative Option 1.

Compared to the Base Case, estimated to be $32,065,000, this results in savings as follows:

- Alternative Option 1 = $ 14,124,000 (refer to Appendix D for breakdown)

5.6.4. Rainwater Tanks

For Alternative Option 1, only 5% of the residential area is assumed to uptake the rainwater tanks. To connect a 3 kL tank approximately $2,500 has been estimated per connection. This equates to $2.19 m. However, the Base Case has also been assumed to uptake 5 % tanks. These are therefore nil with respect to the relative cost comparison.

5.6.5. Retarding Basins and Waterways

Retarding basins and waterways will remain essentially the same as with the Base Case to enable minimal risk against flooding under the 100 Year event. The one exception will be SR-RB3, which will be relocated to the north to be co-located with the 6 Ha sports field. The footprint of the RB is 6.25 Ha (refer Table 4) under the Base Case, with re-location providing a direct benefit to developable area. MW have provided figures relating costs and footprint. In flood prone areas land acquisition costs up to $100,000 per Ha, in developable residential areas the cost rises to 800,000 Ha. The RB comprises a flood prone area, representing the 100 Year Flood extent of the waterway, of 1.7 Ha with the remaining 4.55 Ha being developable. Therefore a cost saving of $ 3.81 m exists subject to re-location.

5.7. Alternative Option 1 Summary

The performance of Alternative Option 1 is summarised in Table 16, represented predominantly as excess to the Base Case.

Table 16 Alternative Option 1 Summary

Value	Measure	Notes
Water Supply Savings	74 ML	In excess of the Base Case - affecting non-potable recycled water supply
Runoff Volume	• Loss = 807 ML • Excess to Base Case = 390 ML	
Water Quality Reduction	• TSS - 86 % • TP – 68 % • TN – 47 %	Meets BPEM targets (refer Table 12)
Peak Flow	No difference	Assumed to be similar to Base Case, with WSUD providing limited impact
Land Take	- 7.0 Ha	Represents the reduction of developable land required including re-location SR-RB3 and sediment basins.
Cost	$ 32,970,000	Based on the cost of WSUD implementation minus the benefits of reducing Base Case assets

6.0 ALTERNATIVE OPTION 2

6.1. Overview

As described in Section 4.5, Alternative Option 2 builds on Alternative Option 1 to present a best case scenario for reduction in flows and alternative water supply. The implementation of measures in the catchment are maximised to intercept stormwater before entering the creek, aiming to protect waterway values. This option incorporates many of the objectives and values of the Stakeholders namely:

- Protection and enhancement of the waterway
- Co-location of assets
- Provision of alternative water supply in the form of recycled water from the water treatment plant.
- Provision of alternative water supply based on stormwater harvesting and reuse for irrigation and rainwater tank capacity for domestic use

It should be noted that the ability to recover costs for this option are unclear at this stage. The division of costs between responsible agencies and land holders has not been properly defined and a detailed analysis would need to be undertaken to understand this aspect more clearly.

A schematic of this option is presented in Figure 29.

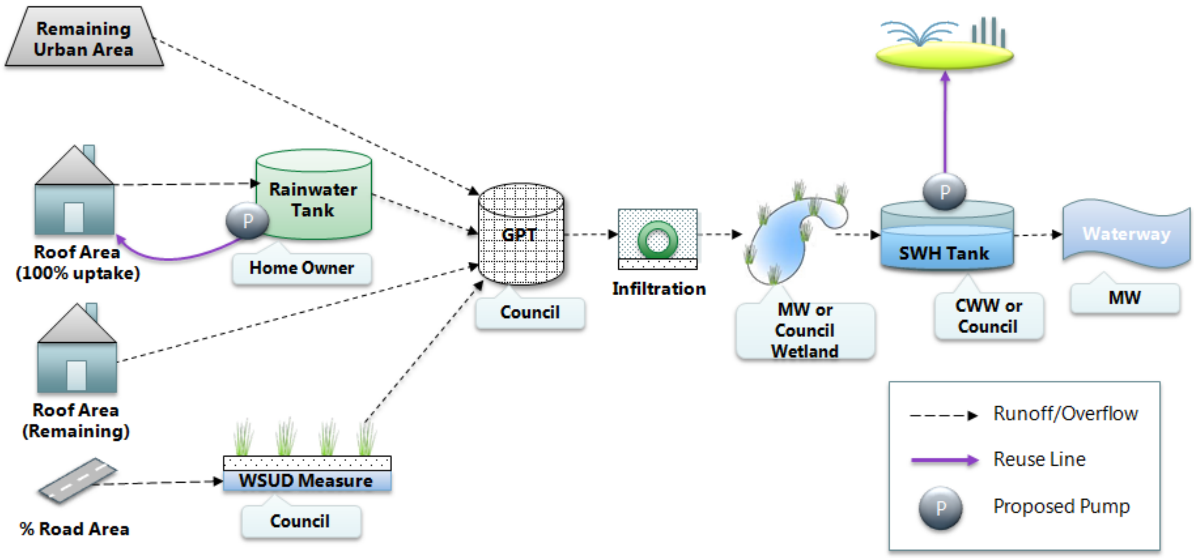


Figure 29 WOWC Alternative Option 2 Schematic

Figure 29 also illustrates the traditional responsibilities/ownership for each of the water cycle elements.

6.2. Opportunities Overview

The key opportunities for Alternative Option 2 within both precincts are represented on Figure 30, showing possible raingarden and wetland locations (building on Alternative Option 1), and the stormwater harvesting and infiltration opportunities.

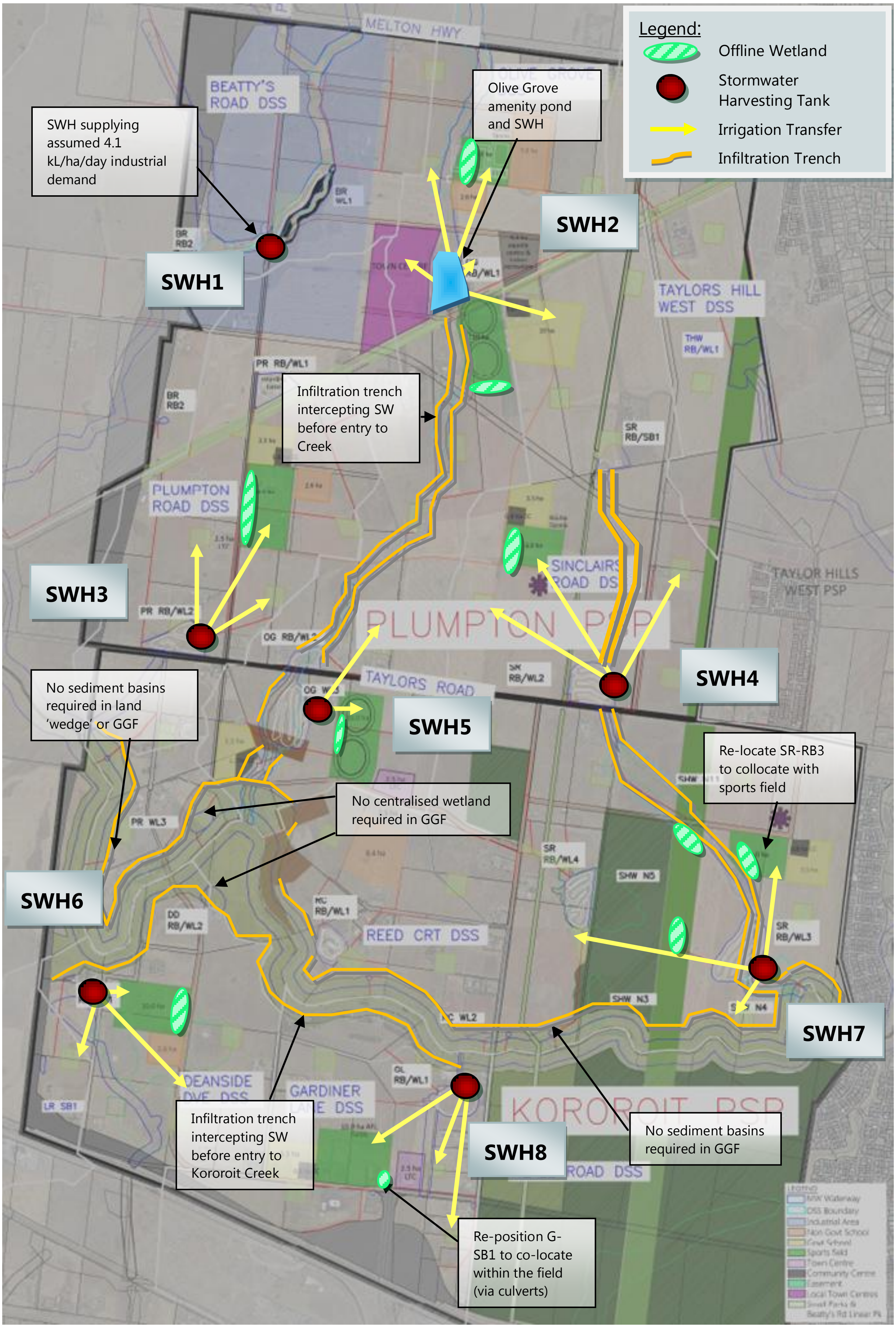


Figure 30 Alternative Option 2 opportunities

6.3. Stormwater Harvesting Opportunities

Stormwater harvesting (SWH) presents a significant planning opportunity comprising several benefits, including:

- recovering water for reuse,
- minimising demands on potable supply, providing a reliable alternative water source
- contribution to protecting the waterway by intercepting stormwater entering the creek
- assisting in a climate resilient water cycle

As shown on Figure 30, a total of 4 opportunities to recover stormwater occur in the Kororoit PSP and 4 in the Plumpton PSP. These are positioned adjacent major sports fields (with nearby minor sports fields incorporated), commercial centres and the industrial area for irrigation and other water supply purposes.

6.3.1. Stormwater Harvesting Configuration

Positioning the fields near the waterway or wetlands assists in maximising the benefit of the SWH system as capture of stormwater may occur at the lower end of the stormwater drainage grade, and also provides a co-located capture opportunity where wetlands may form part of the treatment train. The concept is represented below, showing a typical SWH project appropriate to these PSP's.

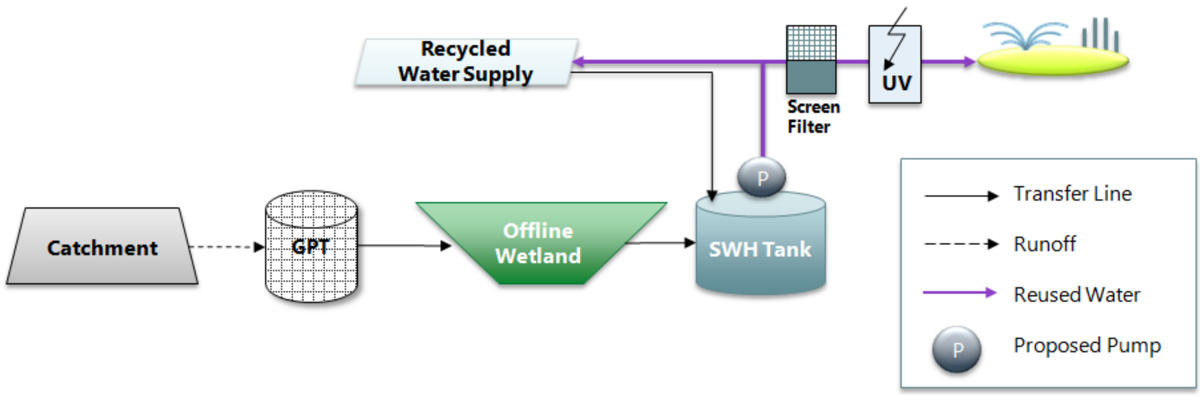


Figure 31 Stormwater Harvesting Concept

6.3.2. Water Balance Results

The MUSIC model was used to simulate the water balance based on the previously mentioned demands including seasonal irrigation demands. The storages were sized approximately to achieve an 80% reliability of supply where the balance is made up from recycled water.

During water balance modelling in MUSIC, the SWH configurations as shown in Table 17 were identified. The irrigation of the major and minor fields were based on irrigation areas as shown in Figure 30, being generally 0.8 Ha for the minor fields and between 6 – 10ha for the major fields.

Table 17 – Stormwater Harvesting Systems by PSP

PSP	SWH ID	Catchment (Ha)	Tank Size (kL)	SW Reused (ML/yr)	SW to Recycled (ML/yr)
Plumpton	SWH1 (Beatty's)	91	8,000	135[1]	139
	SWH2 (Olive Grove)	250	44,500[†]	106*	0
	SWH3 (Plumpton)	97.3	3,500	45	83
	SWH4 (Sinclairs)	229	1,700	36	79
Kororoit	SWH5 (Olive Grove)	395	3,200	45	56
	SWH6 (Deanside)	210	2,000	46	265
	SWH7 (Sinclairs)	373	2,300	33	61
	SWH8 (Gardiners)	151	1,500	31	108

[1]Industrial demand based on 4.2 kL/ha/day (refer Section 3.4)

[†]Size of Olive Grove amenity pond

[*]Includes demands for commercial area (refer Section 3.4)

Stormwater harvesting for irrigation supplies a total of 477 ML/ yr under the mean conditions modelled. An excess of 791 ML/yr exists for storage and injection into the recycled water supply.

Almost all of the proposed systems are expected to supply over 100ML each per year which is may make it viable for CWW or WW to own/operate each of them.

SHW2 is a pond which will be used to recover stormwater as well as to provide amenity. The amenity pond would be maintained at relatively full conditions throughout the year, with Figure 32 showing the water balance under average conditions (extracted from the Olive Grove MUSIC model). As can be seen, the pond water level remains quite high not falling below RL119.8m for the representative year modelled.

MPA has since received feedback from Council expressing concerns with regard to incorporating an amenity pond as part of the alternative options due to previous experience with Lake Caroline. The maintenance burden and risks associated with an amenity pond were noted as the main issues and a full life cycle analysis and cost would be required should the amenity pond proceed to a more detailed assessment stage. For the purposes of this assessment it remains part of Alternative Option 2.

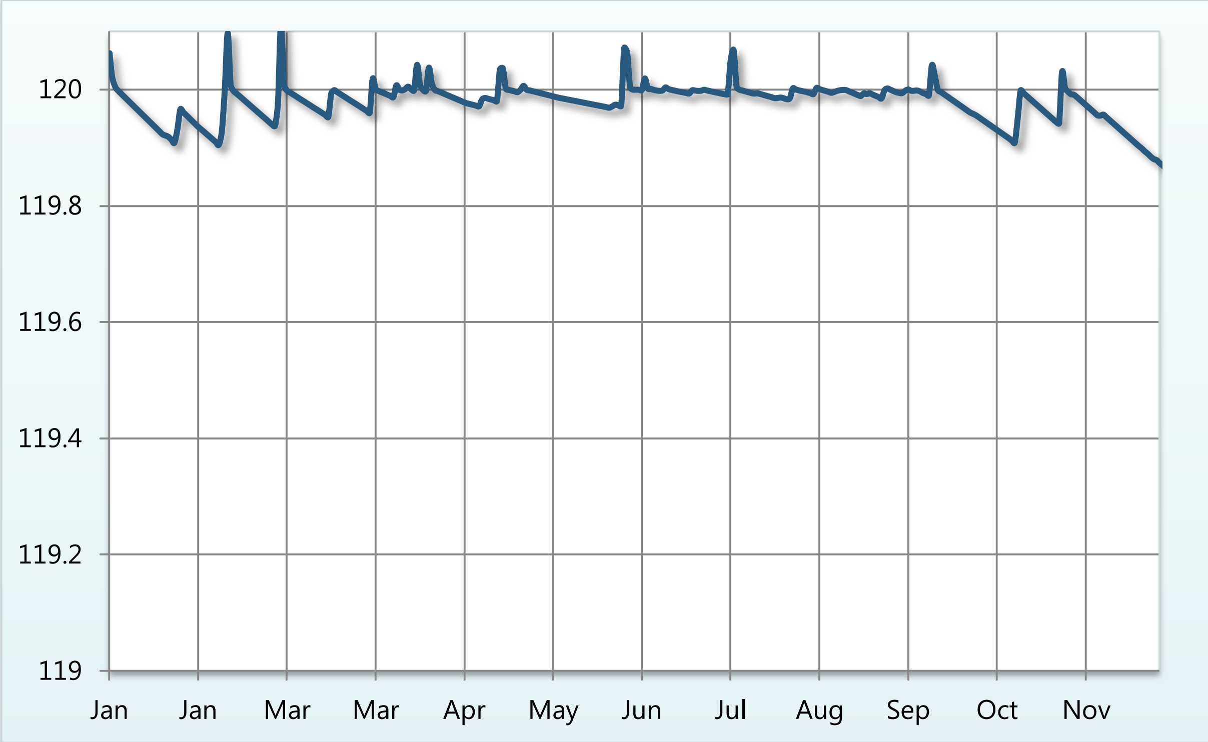


Figure 32 Olive Grove Amenity and Stormwater Harvesting Pond

6.4. Infiltration Opportunities

On top of the raingarden and WSUD opportunities presented as part of Alternative Option 1, the implementation of infiltration trenches along the buffer/vegetated zones of the waterways provides the opportunity to maximise the interception of stormwater and enhance waterway health.

Melbourne Water have provided feedback with regard to these trenches, being mostly positive, however, expressed some concern as to where the trenches would be placed in relation to the creek, and whether there would be excess water affecting amenity areas.

The infiltration trenches would be placed within the vegetated buffer zones of the proposed waterway corridors and Kororoit creek sections. It would not be desirable for these to be implemented too close to the creek as they are required to be a reasonable distance from the water table. The trenches can be designed to comprise minimum excess water build up with a cover between 300mm or 500mm (a balance of cover vs performance) to prevent 'soggy' or saturated conditions.

This has been successfully implemented by Moonee Valley City Council in their Warrick Court project. A typical cross-section of infiltration trenches previously designed by Storm is provided in Figure 33.

It should be noted that this option requires discussion with DELWP where encroachment on Kororoit Creek occurs. Benefits to providing extended passive irrigation to the vegetated zone, supporting plant growth, may be emphasised.

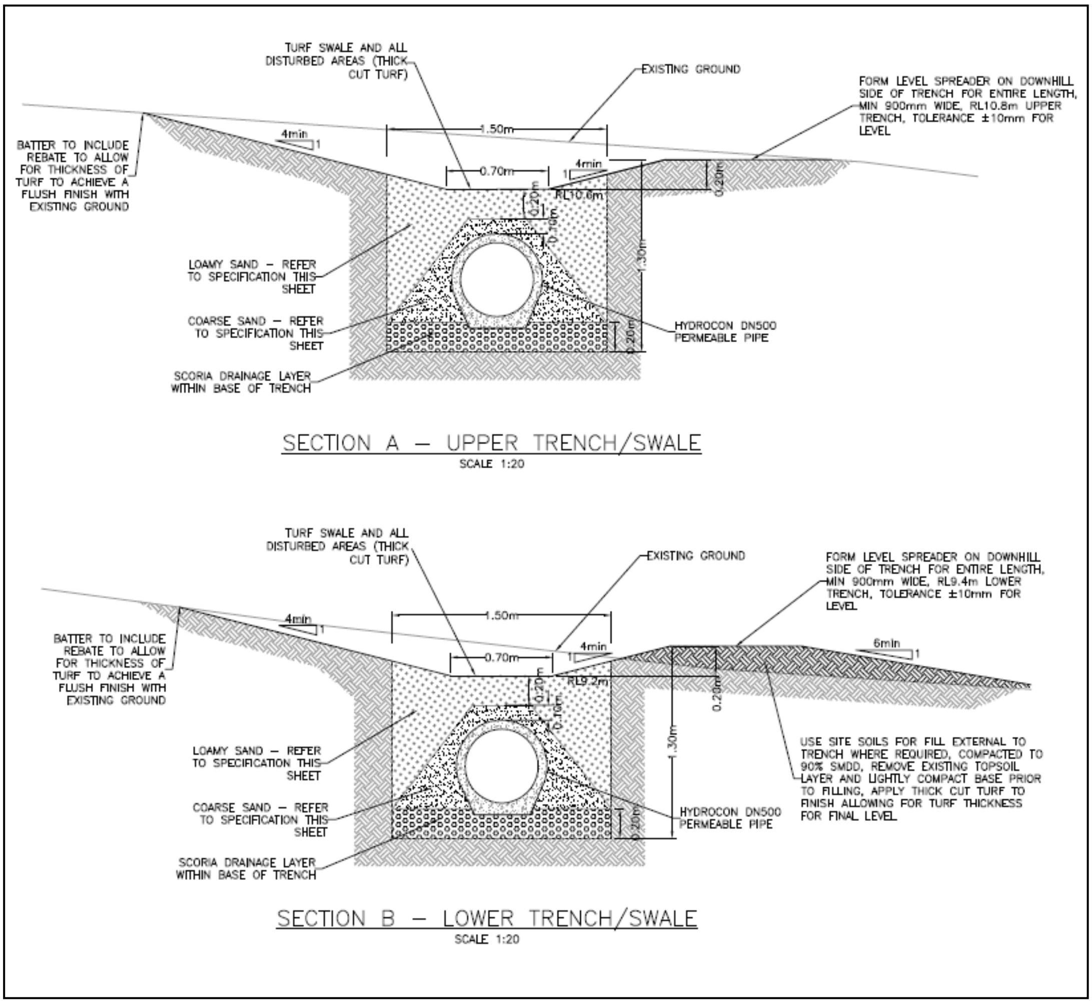


Figure 33 Infiltration Trench Cross-Section

6.5. Water Quality Modelling

6.5.1. Overall Assumptions

The overall assumptions used in water quality modelling in MUSIC are summarised in Table 18.

Table 18 MUSIC Modelling Assumptions for Alternative Option 2

Element	Catchment	Assumptions
Raingardens	Road only - 440 ha (~30% of development taken from experience with typical new areas) - 60% impervious	Exfiltration rate 4 mm/hr (clayey subsurface) Size increased/decreased based on achieving water quality targets
Wetlands	All urban areas - 60% impervious	- Exfiltration rate 0 mm/hr (wetlands are considered to seal over time and losses would be negligible)
Rainwater tanks (RWT)	Roof area only - 298 ha - 100% impervious	- 80 % of roof area directed to RWT - Roof area based on average of 220 m^2 - Reuse demand based on toilet and garden use at 87.5 kL/year/household (consider laundry connection as well) - 3 kL tanks were chosen as a reasonable size for space, while not being too small to ensure demands can be met.
Stormwater harvesting (SWH)	Overflow from road and roof. Remaining urban and residential area - ~45% impervious	- demand for irrigation derived based on crop factors for a warm season grass. 13.2 kL/ha/day - seasonally dependent (ie rainfall – ET with no irrigation under wet conditions). - a commercial SWH system has been modelled for SHW2 at the commercial area. Demands for mainly toilets were taken into account with 25 ML/yr adopted.
Infiltration (trenches)	Whole catchment	Exfiltration rate 4 mm/hr Size based on 1 m width and placement upon the whole length of the creek

6.5.2. Water Quality Modelling Results

The water quality improvement expected for Alternative Option 2 far exceeds best practice recommendations. The large reduction in flow volumes is also noted however the reader is referred to Section 6.6 Water Supply and Water Budget results for further information. The MUSIC results are presented in Table 19 below.

Table 19 MUSIC Modelling Results for Alternative Option 2

Base Case	In	Out	% Reduction
Flow (ML/yr)	5,991	2,712	55%
Total Suspended Solids (kg/yr)	1,131,500	106,710	91%
Total Phosphorus (kg/yr)	2,333	443	81%
Total Nitrogen (kg/yr)	16,233	4,795	70%

6.6. Water Supply and Water Budget

The water supply options for Alternative 2 impact heavily on recycled water supply, bringing this quite low. The largest water source comes from rainwater harvesting with stormwater harvesting for irrigation use also providing an impact. All assumptions presented in Section 3.6 apply with results as shown in Figure 34.

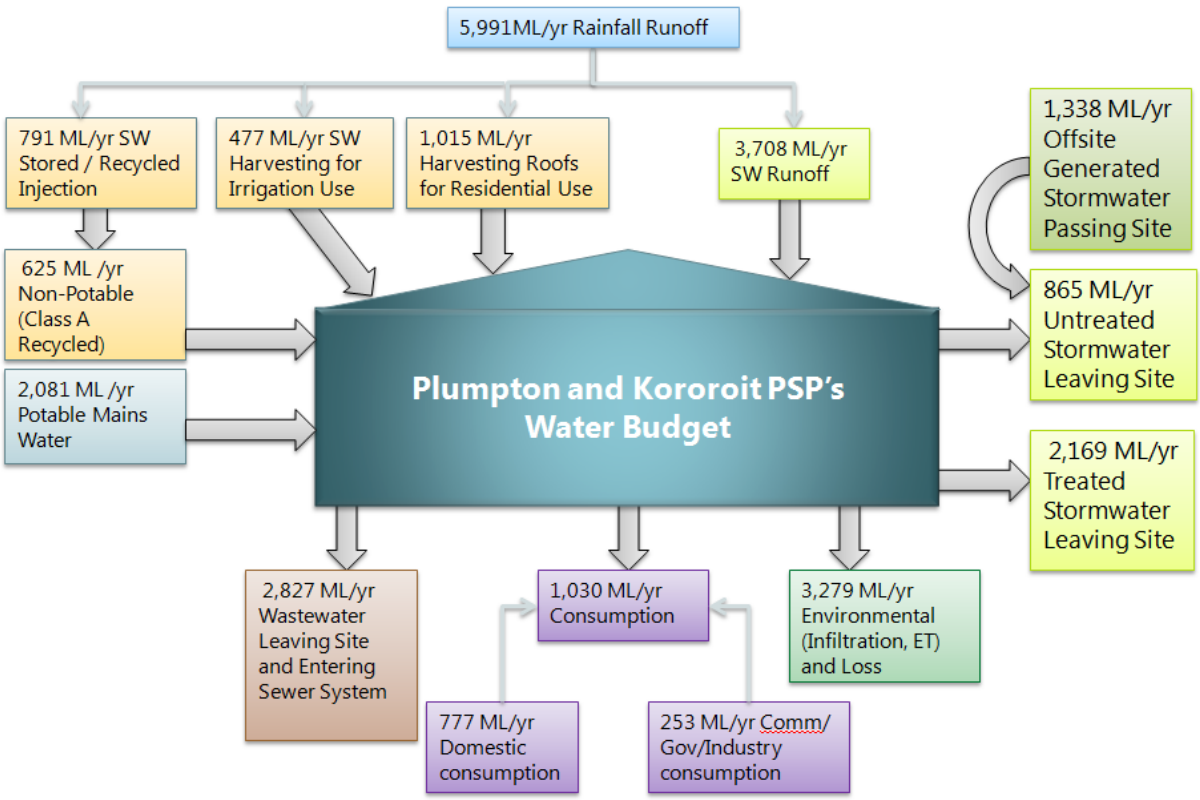


Figure 34 Alternative Option 2 Water Budget for Kororoit and Plumpton PSPs

6.7. Peak Flow

As identified in Table 12 (refer Section 4.5), objectives with respect to peak flow relate to the 1.5 Year and 100 Year ARI. These comprise targets based on achieving existing conditions, with post-development results therefore compared to pre-development to assess the performance of each option.

6.7.1. Model Development

Peak flow conditions were modelled in RORB, based on adapted Melbourne Water models. The peak flow was modelled for the following events:

- 1.5 Year ARI - representing channel forming flows which informs the geomorphological conditions of the creek. Deviation from the existing conditions peak flow are considered to result in geomorphological changes
- 100 Year ARI - design target for flood flows, with the aim of centralised infrastructure to achieve existing conditions peak flow. The options aim to reduce centralised infrastructure footprints while still achieving the target.

6.7.2. Model Assumptions

As RORB has limitations with respect to lower flows (below the 5 Year ARI) a frequency plot was developed for each of the locations in the model of interest. The annual series results provided by RORB were converted to the partial series flow to derive a factor then applied to the 1 Year ARI flow to determine the 1.5 year (and 5 Year) ARI.

To compare the options, the fraction imperviousness was modified for residential areas (or areas where stormwater harvesting was applied). This was seen as the best way for modelling the scenarios, as the volumetric runoff coefficient and initial loss values are applied globally to the model and there are varying surfaces including the agricultural land to the north. Since a global 15mm loss has been applied to the pervious fraction, this was used to match a conversion of the volume of RWT's (or volume of detention) to a depth and then relate this to an appropriate fraction imperviousness (ie the portion of roof area that is lost to the tank).

6.7.3. Peak Flow Results

A more detailed representation of the peak flow results is provided in Appendix C, with a summary for each DSS provided in Table 20, showing the results of Alternative Option 2 with existing conditions. Where exceedance of existing conditions occur for the option, the result is highlighted in red.

Table 20 Peak Flow Results for Each DSS

Option	Existing Conditions		Alternative Option 2	
	1.5 Year (m^3/s)	100 Year (m^3/s)	1.5 Year (m^3/s)	100 Year (m^3/s)
Beattys	2.6	44.9	11.1	44.7
Deanside Drive	1.3	11.9	2.3	8.9
Gardiners Lane	0.7	8.0	1.3	7.3
Olive Grove	1.5	14.6	1.9	14.2
Plumpton Road	1.0	9.1	1.3	8.9
Reed Court DSS	0.3	5.9	0.6	4.6
Sinclairs	1.3	12.7	0.8	9.2
Taylors Hill West	0.5	5.4	0.8	7.6

Generally, the 1.5 Year ARI exceeds pre-development conditions, however, the 100 Year ARI is shown to remain below.

6.8. Cost Estimate

6.8.1. WSUD and Wetland Costs

The cost of treating road runoff via WSUD has been estimated to be $ 50.9 m as calculated in Alternative Option 1.

The wetland sizes have been further reduced from Alternative Option 1 based on MUSIC modelling, translating to further costs saving. The costs are represented as savings against the Base Case (which is therefore effectively equal to zero) for the purpose of this assessment. Appendix D provides a detailed breakdown of wetland costs estimated to be $ 7,898,000 for Alternative Option 2. Compared to the Base Case, estimated to be $32,065,000, this results in savings as follows:

- Alternative Option 2 = $ 24,167,000

6.8.2. Stormwater Harvesting

A detailed breakdown of costs for each stormwater harvesting system is provided in Appendix D. This includes offtake and tank infrastructure, water transfer, pumping and treatment. A summary of the costs is provided in Table 21.

Table 21 Stormwater Harvesting Construction Cost Estimates for Alternative Option 2

SWH ID	Irrigation Area (Ha)	Irrigation Demand (ML)	Tank Size (kL)	Cost
SWH1 (Beatty's)	0	12[†]	8,000	$6,617,000
SWH2 (Olive Grove)	17.6	54	44,500	$3,665,675
SWH3 (Plumpton)	11.6	36	3,500	$3,632,850
SWH4 (Sinclairs)	7.6	23	1,700	$2,254,850
SWH5 (Olive Grove)	10.8	33	3,200	$3,099,200
SWH6 (Deanside)	11.6	36	2,000	$2,310,100
SWH7 (Sinclairs)	7.6	23	2,300	$2,633,150
SWH8 (Gardiners)	7.6	23	1,500	$1,868,750
			Total	$26,081,575
			Design Cost (10%)	$2,608,157.50
			Grand Total	**$28,689,733**

6.8.3. Infiltration System in Riparian Zone

The infiltration trenches, proposed to be installed in the riparian zone of the waterways, have been estimated to cost $550/m. This is based on a breakdown as shown in Appendix D (this assumes an average depth of 1.5m and width of 1 m for the cross section).

The total length of trench determined for Alternative Option 2 has been estimated to be 13,035 m. The total cost therefore equates to $7,170,000.

The gross pollutant trapping prior to infiltration is not included however the sediment basins proposed by MW may be removed creating a saving.

6.8.4. House Tanks vs Recycled Water

Based on preliminary land budget assumptions provided by the MPA, there will be a total of approximately 17,800 properties.

- A tank (~3kL) connected to toilet flushing will cost approximately $2,500. For the 17,800 properties this totals $44.5m (costs borne by the purchaser).
- A recycled water connection costs $2,204 per lot (as provided by CWW) plus another $1,000 for plumbing to toilets amounting to $3,204 per lot. A total of $57.03 m therefore applies (costs borne by the purchaser).
- A lower pressure recycled connection would cost $1,653 (25% saving as provided by CWW) plus another $1,000 for plumbing to toilets totals $2,653 per lot. Amounts to a total $47.22m for the PSP's (savings by CWW, passed on to the purchaser as reduced connection cost).

A saving with respect to water supply distribution exists for Alternative Option 2 should a lower pressure pipe be used of $9.67 m. However, introducing rainwater tanks incurs a total cost to the residential sector of $44.5 m. Nonetheless, since the Base Case includes 5 % rainwater tanks, this is also taken off the comparison cost. Therefore the excess cost for rainwater tanks is $32.61m (95% rainwater tanks cost minus the benefit of the low pressure pipe).

6.8.5. Retarding Basins and Waterways

Similarly to Alternative Option 1 (refer Section 5.6.5) a cost saving of $ 3.81m exists subject to the re-location of SR-RB3.

6.9. Alternative Option 2 Performance Summary

The performance of Alternative Option 2 is summarised in Table 22, represented predominantly as excess to the Base Case.

Table 22 Alternative Option 2 Summary

Value	Measure	Notes
Water Supply Savings	2,283 ML	In excess of the Base Case - affecting non-potable recycled water supply
Runoff Volume	• Loss = 3,279 ML • Excess to Base Case = 2,862 ML	
Water Quality Reduction	• TSS - 91 % • TP – 81 % • TN – 70 %	Exceeds BPEM targets (refer Table 12)
Peak Flow	• 1.5 Year - 16.7 m^3/s • 100 Year - 102.5 m^3/s	Exceeds existing conditions (refer *Section 7 Options Comparison*)
Land Take	- 8.0 Ha	Represents the reduction of developable area including re-location SR-RB3 and elimination of sediment basins.
Cost	• WSUD - $ 25,933,000 • SWH - $ 28,690,000 • Infiltration - $ 7,170,000 • RWT's - $ 32,610,000 • Total – $ 94,403,000	Based on the cost implementation minus the benefits of reducing Base Case assets (including reduction due to low flow recycled water pipe)

7.0 OPTIONS COMPARISON

7.1. Modelling

Table 23 depicts the results of quantitative modelling for each of the options. It is clear that increasing benefits occur with increasing implementation of treatment measures, affecting all the indicators: volume, peak flow and water quality.

Alternative Option 1, while an improvement on runoff volumes entering the creek, only seeks to achieve best practice water quality criteria, as such the raingardens were sized to just match the criteria for total nitrogen being 45% reduction (the limiting indicator in this case).

Alternative Option 2 mostly negates the need for the centralised wetlands, with interception of runoff shown to occur before entry to the creek. The volume of runoff discharging from the site is approximately half that of the Base Case and makes nearly 8 times the volume of water available to the environment excluding active irrigation.

With respect to peak flows Alternative Option 2 achieves a much lower 1.5 year ARI peak flow compared to the Base Case.

Table 23 Options Modelling Summary

Option	Runoff Volume		Peak Flows+		Water Quality		
	Volume (ML)	Volume Multiple	1.5 Year (m^3/s)	100 Year (m^3/s)	TSS	TN	TP
Existing	1,791	1.0	8.48	93.5	-	-	-
Base Case	5,574	3.1	22.43	110.8	75%	64%	44%
Option 1	5,184	2.9	22.43*	110.8*	86%	68%	47%
Option 2	2,712	1.5	16.7	102.5	91%	81%	70%

\+ Taken as the highest peak flow of all DSS's by summation of each with respect to each storm duration.

* Assumed the WSUD has no impact on peak flows for conservatism

It should be noted that Melbourne Water have expressed reservations with respect to incorporating rainwater tanks as a component of detention. The results show they can have some impact on the peak flow, but certainly can not control flooding, as shown by the still large flows of $102m^3/s$ for Option 2 coming through the retarding basins. As such, the detention basins have remained the same size under Alternative Option 2, minimising the risk to flood impacts to Kororoit Creek.

7.2. Footprints

Table 24 shows the overall results for both PSP's with respect to footprint. A significant difference in footprint occurs for the alternative options compared to the Base Case. This can largely be attributed to the re-location of SR-RB3 to the north, within the sports field (being 6.25 Ha). However, additional land may need to be added to the sports field area, to ensure no loss of playing fields/ovals.

Table 24 – Summary Area Requirements for Options

Options	Treatment Footprints	Area in developable land	Waterway in Developable Area
Base Case	30.0	43.8	110
Alternative Option 1	21.3	37.2	103
Alternative Option 2	12.5	35.6	102

The treatment footprints are also reduced. Appendix A shows each of the Wetlands and their respective reductions from the Base Case for both Options. The total footprints for Wetlands are 16.3 Ha and 7.1 Ha for Option 1 and 2 respectively. This is reduced from the Base Case which occupies 29 Ha. The remaining treatment assets are made up of sediment basins, which are completely eliminated under Alternative Option 2, and raingardens, however, these are not considered to be taking up developable land as they would be implemented in nature strips or as underground infiltration systems.

7.3. Overall Comparison

The alternative options are represented with respect to water supply, stormwater volumes and quality and costs in Table 25. Where the results do not achieve the objectives (represented predominantly by the BPEM targets), the result is highlighted in red. It should be noted, that while the whole of PSP result may not achieve the targets, these may generally be achieved by DSS as identified in previous sections.

In general, all options achieve the water quality and 100 Year ARI peak flow targets, however, do not meet the 1.5 Year peak flow target, with Alternative Option 2 being the better in this respect.

Costs increase with increasing benefits. While Alternative Option 2 achieves the most in terms of protecting waterway health (and the associated cultural and environmental values present within the existing waterways) and providing alternative water sources, this comes at the highest economic cost. At present, these are insufficient mechanisms to recover these costs, which will make this option difficult to deliver at this stage.

It should be noted that cost alone is not the only constraint to proceeding with any options. As discussed in a general sense in previous sections, maintenance requirements will increase with more distributed systems, which are likely to be the responsibility of Council. This is of significant concern and Council would be required to agree to take ownership and maintenance responsibility of these assets prior to construction.

Table 25 – Summary of Overall Results

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
OPTIONS COMPARISON - RESULTS			
Water Supply			
Potable supply	2,081 ML/yr	2,081 ML/yr	2,081 ML/yr
Recycled water	2,043 ML/yr	2,043 ML/yr	625 ML/ yr
Rainwater/Stormwater	74 ML/yr	74 ML/yr	1492 ML/yr
Runoff Volumes			
Volume ML	5,540	5,184	2,712
Volume Multiple (vs pre-devel)	3.1	2.9	1.5
Peak Flows			
1.5 Year (m3/s)	22.4	22.4	16.7
/ Multiple vs pre-develepment	/ 2.64	/ 2.64	/ 1.96
100 Year (m3/s)	110.8	110.8	102.5
/ Multiple vs pre-development	/ 1.18	/ 1.18	/ 1.09
RB Footprints	42.5 Ha	36.2	36.2
Water Quality[1]			
Targets			
TSS Reduction (%) *80*	75%	86%	91%
TP Reduction (%) *45*	64%	68%	81%
TN Reduction (%) *45*	44%	47%	70%
Quality Treatment Footprints	30	21.3	12.5
Area in developable land	43.8	37.2	35.6

[1]These results are based on preliminary Melbourne Water DSS work, which has since been updated after undertaking this WoWCA work, as advised by MPA.

WATER MANAGEMENT ASPECT	BASE CASE	ALTERNATIVE 1	ALTERNATIVE 2
OPTIONS COMPARISON - RESULTS			
WATERWAYS			
Waterway corridor Widths	MW modelled hydraulic width. Width defined by - *Waterway Corridor Guidelines* - MW (2013) - *Assessment of Riparian Vegetation & Geomorphology for Plumpton* - Alluvium/Practical Ecology 2013. - *Rockbank Area Wetland Survey* - Rakali 2013 - *Protection of intact waterways in the Olive Grove catchment*, Alluvium 2014.	As with Base Case	As with Base Case
	Some sections of natural waterway to be retained where specified by MW due to importance of geomorphological features.	As with Base Case	As with Base Case
	During design of the OMR, VicRoads and Melbourne water will need to review the alignment of the OMR and waterway where clashes occur.	As with Base Case	As with Base Case
Waterway in Developable area	110	103	102
COSTS			
Treatment of road runoff			
Raingardens and infiltration systems	-	$32.97 m	$25.93 m
Stormwater Harvesting	-		$28.69 m
Infiltration Systems	-		$7.17 m
Rainwater Tanks	-		$32.61 m
Total Cost		$32.97 m	$94.40 m

8.0 DISCUSSION AND RECOMMENDATIONS

The WOWC assessment has aimed to document and assess the base case, and provide alternative options that may contribute to liveability, environment and water supply benefits.

It is evident that Alternative Option 2 achieves the highest level of performance with respect to benefits to the environment and water supply. However, it is unclear at this stage whether the costs may be outweighed by these benefits and who would pay for these additional costs with a more detailed assessment required. For example, does the implementation of a rainwater tank provide sufficient savings off the water bill for the resident? Incentives are currently in place for installation of rainwater tanks, however, despite environmental benefits (such as reducing runoff volumes), limited economic benefits are apparent where recycled water is available. Nonetheless, aspects of Alternative Option 2 may provide significant benefit to the water retailer, particularly for the larger stormwater harvesting projects, with excess water potentially recovered for storage and injection to the recycled water system.

The provision of recycled water, impacting on potable water supply, may be argued to mitigate the need to provide further alternative water sources. However, the larger schemes, such as SWH 2, are worth investigating further. CWW has advised that SWH that provides 'economy of scale' may be adopted. These have been taken as projects that supply more than 20 ML for irrigation, with added benefit being injection to the recycled water line. SWH2 also provides an amenity feature being a large pond on the edge of the commercial area, as well as being a co-located detention asset providing multiple benefits. This option could be investigated further. A life cycle analysis, including costs, would be required subject to the amenity pond proceeding to a more detailed assessment stage.

Alternative Option 1 still provides benefits to stormwater volumes and quality. Should the distributed assets common for this option (raingardens or WSUD) be opted to proceed for further investigation, Melton Council will likely be responsible as they are less than 60 Ha. Sign off prior to proceeding with these assets would therefore be required from Council.

The Base Case performs well with respect to providing a reliable water source, mitigating flood impacts to Kororoit Creek, co-locating assets to minimise impact on developable area and protection of environmental and cultural values of the waterways. As such, this may be the best option to move forward in planning. It should be noted that this work was based on preliminary MW work which has since been updated after this WoWCA, as advised by MPA.

Components of both Alternative Options could be further evaluated by stakeholders once the Melton WoWCA is developed in 2015. For example, MPA have advised they have located sports fields where possible in proximity to the waterways to retain future options to harvest stormwater, while meeting community needs. The location of sports fields requires consideration to criteria other than just water supply, such as distribution of sports fields across the PSP's, accessibility and earthworks. Also, in developed areas where drainage to a centralised asset can not be achieved (such as in the 'land wedge' within the Plumpton DSS) or where these assets may encroach on Growling Grass Frog protected areas, lot scale assets could be encouraged. This draws from Alternative Option 1 which has shown that water quality targets could be readily achieved in these areas.

Additionally, Melbourne Water has indicated that it supports integrated water management projects, such as the capture and reuse of stormwater. CWW's larger initiatives are supported and may be investigated further, as well as the smaller projects that may be pursued by Council (if desired). Optimal conditions for stormwater harvesting, such as location in proximity to sports fields for irrigation and offtaking from a wetland or the waterway may also be investigated further, with MW indicating diversion licences are available subject to meeting environmental flow and other requirements.

The key recommendations and outcomes of the WOWC investigation are:

- Proceed with the Base Case which provides benefits to water supply, co-location of water quality and detention assets, 100 Year flood mitigation, and protection of waterway values.
- Further investigate the benefits of other stormwater harvesting projects, based on liveability, amenity and water supply against economic measures and locate relevant sports fields to increase the likelihood of uptake of these projects (MPA have advised sports fields are located with consideration to this already).

A key note to consider is that many of the aspects proposed in the Alternative Options are subject to agreement with Stakeholders, with the WOWCA providing a foundation for discussion and decision in moving forward. Selected elements could be further investigated subject to the recommendations and findings of the Melton WoWCA in early 2015.

APPENDIX A

Water Quality Modelling

A WATER QUALITY MODELLING

A.1 Base Case

As Melbourne Water (MW) prepared MUSIC models in the design of their DSS's, these were used as a basis for water quality modelling through Plumpton and Kororoit PSPs. Storm updated these models to reflect the latest Future Urban Structure (FUS) plan supplied by MPA.

Models supplied by MW had an average rainfall of 583 mm/y.

Each of these models were transferred across to the 1996 Melbourne Airport rainfall template, as recommended by the Melbourne Water MUSIC guidelines for the rainfall band applying to the site. This template has an average rainfall of 526 mm/yr.

MUSIC software version 6.0.4 was used for the modelling.

In some locations, wetland areas in the drawing showing DSS works provided by MW (sent to Storm by the MPA 14/7/14 *works sections.dwg*) differ slightly from the areas in the models. This has been highlighted in the comments herein.

However, it should noted, this work was undertaken based on preliminary DSS work provided by Melbourne Water. MPA advises this has been updated.

A.1.1 Beatty's Road

The Beatty's Road catchment is predominantly industrial. The industrial land use was increased from a fraction impervious of 80 to 90% and residential from 55-60%, in accordance with MUSIC Guidelines and other modelling done for different DSS's through Plumpton/Kororoit.

The Beatty's Road DSS extends beyond the Plumpton site boundary, therefore best practice does not need to be achieved at the Plumpton site boundary as there are additional facilities downstream.

The change in rainfall pattern and fraction impervious provides similar results to those afforded by the current model. When all of the flows leaving the site were taken into account, (the junction downstream of WL1, the 5.844 ha and 8.75 ha industrial catchments and also the Bioretention Basin 6 and R1Z 2.49 ha) the treatment efficiency was similar, as shown below:

Table A1 Beatty's Road Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall and frac impervious
TSS	49%	50%
TP	34%	34%
TN	36%	32%

Table A1 shows that the modifications to the model slightly reduced the % reduction of TN by the onsite treatment.

A.1.2 Plumpton Road

The Plumpton Road MUSIC model was transferred to a rainfall template for the relevant zoning (Melbourne Airport, 1996, average rainfall 526mm/y). No other changes were made to the MUSIC model.

A comparison of the Melbourne Water and Storm results are provided below.

Table A2 Plumpton Road Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall
TSS	71%	74%
TP	61%	63%
TN	42%	43%

The Storm model increases the percentage removal slightly due to the different temporal pattern.

The removal rates fall short of best practice guidelines. However, it should be noted this work was undertaken based on preliminary DSS work provided by Melbourne Water. MPA advises this has been updated.

In comparing the footprints provided in MUSIC to the works requirements provided by MW, the following areas were different:

- WL1 MUSIC 1.5 ha dwg 1.2 ha
- WL2 MUSIC 2.9 ha dwg 2.1 ha
- WL3 MUSIC 0.25 ha dwg 1.0 ha (contained within GGF corridor).

A.1.3 Olive Grove

The Olive Grove model has an external, agricultural catchment of 130 ha. The MW model was transferred onto the 1996 Melbourne Airport rainfall template, re-run and adjusted to remove the agricultural loads from both the inflow and outflow.

A comparison of MW and Storm model results is provided below.

Table A3 Olive Grove Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall
TSS	79%	81%
TP	66%	68%
TN	42%	44%

The Storm model increases the percentage removal slightly due to the different temporal pattern.

In comparing the footprints provided in MUSIC to the works requirements provided by MW, the following areas were different:

- Wetland 1 MUSIC 3.8 ha dwg 3.55 ha
- Wetland 2 MUSIC 1.1 ha dwg 0.86 ha
- Wetland 3 MUSIC 1.4 ha dwg 3.0 ha

A.1.4 Reed Court

The Reed Court model is a residential catchment. The fraction impervious used in the MW model was increased from 55% to 60% in the Storm model. The rainfall template was changed to Melbourne Airport, 1996.

A comparison of MW and Storm model results is provided below.

Table A4 Reed Court Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall and increase impervious
TSS	77%	86%
TP	66%	74%
TN	45%	53%

The Storm model increases the percentage removal due to the different temporal pattern. As the percentage reduction for TN is well in excess of the BP guidelines there is potential to reduce the footprint.

In comparing the footprints provided in MUSIC to the works requirements provided by MW, the following areas were different:

- WL1 MUSIC 0.8 ha dwg 0.53 ha
- WL2 MUSIC 0.1 ha dwg 0.34 ha

Although WL1 has a smaller footprint in the dwg than in the MUSIC model, there appears to be sufficient room within the RB footprint (shown in the dwg) to increase the wetland footprint if required.

The location of WL2 is within the GGF corridor, as such, reducing the size of this asset would not affect the land take of water management assets on developable land.

A.1.5 Sinclairs Road

The Sinclairs Road catchment is predominantly residential. Large conservation areas will remain undeveloped within the catchment, as determined through the planning process.

Similarly to the above, MW's MUSIC model was transferred onto the Melbourne Airport 1996 rainfall template. As per MW's modelling method, the conservation reserves were modelled as agricultural land use and these loads were accounted for in an adjustment to the end node load calculations.

A comparison of MW and Storm model results is provided below.

Table A5 Sinclair's Road Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall
TSS	75%	77%
TP	64%	66%
TN	44%	46%

The Storm model increases the percentage removal due to the different temporal pattern.

In comparing the footprints provided in MUSIC to the works requirements provided by MW, the following area was different:

WLRB1 MUSIC 3.3 ha, dwg 2.5 ha.

A.1.6 Taylors Hill West

Taylors Hill West is a residential area with an external farmland catchment. The MW model was moved onto the Melbourne Airport 1996 rainfall template and the agricultural catchment was accounted for in calculating the load reduction of the designed wetland.

Table A6 Taylors Hill West Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall
TSS	97%	99%
TP	90%	93%
TN	62%	67%

Although the wetland is achieving very high removal rates, ultimately the size may be reduced to make sure there is sufficient turnover of water through the waterbody. This would not affect the developable land within the site as this wetland has been located within the electricity easement.

The wetland footprints provided in MUSIC is 2.4 ha and in the works drawing from MW it is 2.1 ha. As the model shows a very high treatment efficiency from the proposed wetland, the wetland can likely be downsized without significant effect on the overall treatment for the catchment.

A.1.7 Gardiner Lane

The Gardiner Lane DSS is on the southern side of Kororoit creek and includes a future industrial area to the south of the western freeway. The industrial area is to be treated by a wetland external to Kororoit.

The MUSIC model was transferred onto a Melbourne Airport 1996 rainfall template.

Table A7 Gardiners Lane Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall
TSS	80%	81%
TP	68%	69%
TN	45%	46%

The proposed system meets best practice treatment requirements in the given arrangement.

The Gardiner Lane wetland footprint given in MUSIC is 2.5 ha, however the area marked in the dwg is 2.2 ha.

A.1.8 Deanside Drive

Similarly to the Gardiner Lane DSS, the Deanside Drive DSS extends to the south of the Western Freeway into an adjoining PSP.

In the MW model, the OMR within the Deanside Drive DSS was not connected to the receiving waterways. This was connected into the receiving waterway in the Storm model.

Note that it has also been decided that the Seasonal Herbaceous Wetland will not be retained in the future development. The fraction impervious of this node was increased from 5 to 60%.

The MUSIC model was transferred onto a Melbourne Airport 1996 rainfall template.

Table A8 Deanside Drive Comparison of % Reduction Treatment Effectiveness Generated by MUSIC Models

Indicator	MW Original	Storm - Modified Rainfall, additional catchment
TSS	80%	80%
TP	69%	69%
TN	47%	47%

Table A8 shows the results from the two models are effectively the same.

Note that the area of the southernmost wetland (within Kororoit) is 1.5 ha in the MUSIC model and in MW's scheme drawing it is approximately 1.3 ha.

A.1.9 Base Case Water Quality Assessment Summary

Collating each DSS, the following summary results for the Base Case applies. The TSS and TN indicators fall just short of the 80% and 45% targets respectively. This may be due primarily to the Beatty's Road results pulling down the overall result, as most other DSS' meet these requirements (with Sinclair's Olive Grove and Plumpton Road being slightly below for these indicators). Additionally, it should be noted this work was undertaken based on preliminary DSS work provided by Melbourne Water. MPA advises this has been updated.

Base Case	In	Out	% Reduction
Total Suspended Solids (kg/yr)	1,131,500	283,320	75%
Total Phosphorus (kg/yr)	2,333	851	64%
Total Nitrogen (kg/yr)	16,233	9,096	44%

A summary of the water quality assets forming part of the Base Case is provided in Table A9.

Table A9 – Base Case Wetland Configurations Summary

Catchment	Wetland ID	Footprint (Ha)
Plumpton	BR-WL1	1.0
	PR-WL1	1.5
	PR-WL2	2.9
	OG-WL1	3.8
	OG-WL2	1.1
	SR-WL2	3.3
	THW-WL1	2.4
Kororoit	PR-WL3	0.25
	DD-WL1	1.5
	DD-WL2	0.5
	OG-WL3	1.4
	RC-WL1	0.8
	RC-WL2	0.1
	GL-WL1	2.5
	SR-WL3	2.0
	SR-WL4	4.1

A.2 Alternative Options

Each DSS was modelled in MUSIC using the adapted Base Case (MW) MUSIC models to represent Alternative Option 1 and 2 (refer Section 5 and 6 respectively in main report). These options allow the reduction of centralised water quality treatment assets (sediment basins and wetlands).

The results of water quality modelling for each DSS is shown below.

Alternative Option 1 meets the water quality reduction occurring above the 80 % target for TSS and 45 % for nutrients. Alternative Option 2 far exceeds these targets as this option was designed as a 'best case' to achieve volume and peak flow reductions also.

Alternative Option 1

DSS	TSS	TP	TN
Olive Grove	88%	45%	67%
Plumpton	87%	45%	67%
DD	80%	45%	66%
Sinclairs	87%	46%	68%
Reed Crt	91%	56%	76%
Gardiners	90%	52%	76%
Beatty's	83%	42%	58%
THW	90%	52%	76%

Alternative Option 2

DSS	TSS	TP	TN
Olive Grove	96%	69%	85%
Plumpton	90%	68%	80%
DD	82%	68%	75%
Sinclairs	91%	69%	80%
Reed Crt	91%	69%	80%
Gardiners	95%	75%	86%
Beatty's	92%	72%	80%
THW	95%	75%	86%

Table A10 shows the new wetland footprints for both these options, increasingly becoming smaller from the Base Case (as shown in Table A9). The total footprints for Wetlands are 16.3 Ha and 7.1 Ha for Option 1 and 2 respectively. This is reduced from the Base Case which occupies 29 Ha.

Table A10 – Alternative Option 1 Wetland Configuration Summary

Catchment	Wetland ID	Alternative Option 1 Footprint (Ha)	Alternative Option 2 Footprint (Ha)
Plumpton	BR-WL1	1.0	1.0
	PR-WL1	1.0	0.0
	PR-WL2	1.0	0.0
	PR-WL2a	0.03	0.03
	OG-WL1	1.1	0.0
	OG-WL2	0.8	0.0
	SR-WL2	1.5	0.5
	THW-WL1	0.7	0.7
	THW-WL2	1.35	1.35
Kororoit	PR-WL3	0.25	0.0
	DD-WL1	0.9	0.1
	DD-WL2	0.15	0.0
	DD-WL2a	0.1	0.1
	OG-WL3	1.4	1.4
	RC-WL1	0.5	0.0
	RC-WL2	0.0	0.0
	GL-WL1	1.0	1.0
	SR-WL3	1.0	0.5
	SR-WL4	0.0	0.0
	SR-WL4a	1.0	0.25
	SR-WL4b	1.5	0.25

APPENDIX B

Test Case Study

B THE TEST CASE – WORKSHOP 2

B.1 Overview

Three options were identified for the test study in the Plumpton and Kororoit PSP's as alternatives to the Base Case. To provide a significant level of detail, such that an informed decision from stakeholders may be made, a test catchment was used to compare options. The test study enabled a higher level of detail than what would have been catered for within the entire PSP's. The Olive Grove DSS was selected as the case study from which the options would be compared as this comprised a diversity of surfaces and sensitive areas.

More detail is provided in Section 3.2.3 (main report), with a summary of the Olive Grove DSS as follows:

- Approximately 474 ha catchment predominantly in the Plumpton PSP
- Comprises residential, commercial, schools and parklands (no industrial)
- External agricultural catchment enters from the north
- Centralised assets in the Base Case include 2 retarding basins and 3 wetlands

B.2 The Objectives

The objectives for Kororoit and Plumpton PSP's were developed based on Stakeholder collaboration and agreement. Following Workshop 1 objectives were not yet confirmed and as such these were tentatively set for the purposes of Workshop 2 as shown on Table 9 (main report). These were developed to provoke discussion with the Stakeholders and were based on the Water Future West outcomes as a guide, however, further Stakeholder input would be required. Table B1 represents these tentative objectives.

Table B1 Test Case Objectives

Value	Relevant Agency	Objective and Benefit Measure
Water Supply	• CWW • Western Water • OLV	- Provision of reliable water supply (ML/yr) - Provision of alternative water supply (recycled water identified – ML/yr) - Stormwater and rainwater harvesting (impact on non-potable – ML/yr). - Public safety and climate resilience a key consideration of SWH and RWT.

Waterways	• Melbourne Water
	• OLV
		- Protect and enhance health of waterway by meeting pre-development conditions
		  - Detention of Peak 1.5-yr ARI (m^3/s)
		  - Annual no. of runoff days
		  - Volume of runoff to stream (ML/yr)
		  - Volume of water to the environment (infiltration and ET - ML/yr)
		- Retain undisturbed (intact) portions of waterway identified as high value (protection of heritage, ecological and geomorph value)

		- Meet best practice (BPEM) stormwater quality objectives (TSS, TP and TN % reductions)
Drainage and flooding	• Melbourne Water • Council	- Protection from 100 yr peak flow (m^3/s) - Minor drainage capable of peak 5 Year ARI (m^3/s)
Liveability (including Environmental Amenity)	• Melbourne Water • OLV • MPA	- Stream resilience and protection including vegetation (refer 'Waterways') - Resilience to climate change (green/open space provision, WSUD)
Community	• Developers • Council • MPA	- Affordable housing - Well being (refer 'Liveability')
Kororoit Creek Health	• DEPI	- Minimise impact on GGF (peak flow and volumes)

B.3 The Options

Three options were identified for comparison:

- WOWC Option 1 – targets water quality criteria. Stormwater quality improvement is promoted prior to entering the waterway. This is achieved through street scale WSUD (predominantly raingardens) utilising the median space to treat road catchments. Where space for a median strip is not available, alternatives to raingardens be strategically located to minimise impact on space.
- WOWC Option 2 – expands on Option 1, with the main target volume and peak flow reduction. Lot Scale treatment is introduced to enhance waterway protection. In addition to the WSUD measures, rainwater tanks (RWT) and stormwater harvesting (SWH) are introduced to minimise volumes and peak flow entering the creek.
- WOWC Option 3 – further expands on the above options by also incorporating an infiltration element along the creek.

The third option represents a 'best case' scenario with respect to protecting the creek values, aiming to intercept the volume of urban runoff before entering the waterway. All the options are shown schematically on Figure B1.

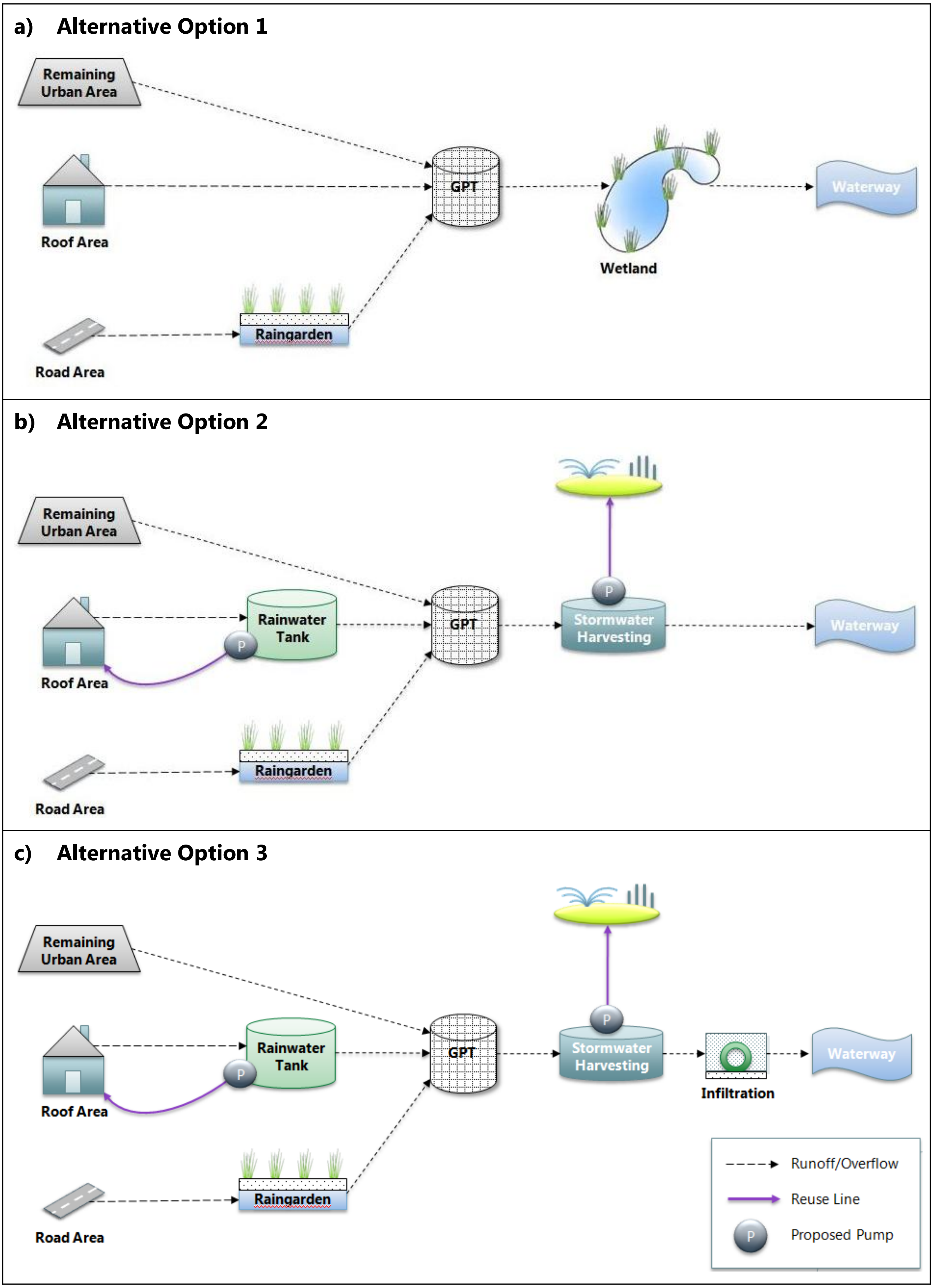


Figure B1 – WOWC Options 1, 2 and 3

B.4 Options Modelling

B.4.1 Purpose and Objectives

The purpose of modelling the options is to provide a quantitative comparison with respect to runoff volumes discharging to the creek and the peak flow conditions of the Olive Grove catchment. This provides one mechanism of relative comparison between the options, which will be accompanied by a cost comparison in later sections.

In all the modelling scenarios, the results were compared to existing (or pre-development) conditions as a benchmark to determine the treatment effectiveness of the proposed options as well as against the Base Case.

B.4.2 Model Development

Modelling with respect to quantifying runoff volumes and water quality reductions was undertaken in MUSIC using the model adapted from Melbourne Water, as described in Appendix A. The modelling is considered to be representative of average conditions, with the rainfall template adopted as 1996 (as recommended by MW MUSIC guidelines) from the Melbourne Airport record with the yearly rainfall being 526 mm.

Peak flow conditions were modelled in RORB, based on the adapted Melbourne Water model for Olive Grove. The peak flow was modelled for the following events:

- 1.5 Year ARI - representing channel forming flows which informs the geomorphological conditions of the creek. Deviation from the existing conditions peak flow are considered to result in geomorphological changes
- 100 Year ARI - design target for flood flows, with the aim of centralised infrastructure to achieve existing conditions peak flow. The options aim to reduce centralised infrastructure footprints while still achieving the target.

B.4.3 Model Assumptions

As identified above, the two models used to compare the options were MUSIC and RORB.

MUSIC Model Assumptions

Table B2 summarises the key assumptions undertaken with respect to the modelling of the elements for each of the options undertaken in MUSIC.

Table B2 MUSIC Modelling Assumptions for the options

Element	Catchment	Assumptions
Raingardens	Road only - 88.1 ha (26% of development taken from experience with typical new areas) - 60% impervious	Exfiltration rate 4 mm/hr (clayey subsurface) Size increased/decreased based on achieving water quality targets
Rainwater tanks (RWT)	Roof area only - 68 ha - 100% impervious	- 80 % of roof area directed to RWT - Roof area based on average of 220 m^2 - Reuse demand based on toilet and garden use at 87.5 kL/year/household (although connection to laundry encouraged) - 3 kL tanks were chosen as a reasonable size for space, while not being too small to ensure demands can be met.
Stormwater harvesting (SWH)	Overflow from road and roof. Remaining urban and residential area - 183 ha - ~45% impervious	- demand for irrigation derived based on crop factors for a warm season grass. 13.2 kL/ha/day - seasonally dependent (ie rainfall – ET with no irrigation under wet conditions). Figure 19 shows the monthly distribution of irrigation demand for the 1996 year. - Total demand equated to 9.6 ML/yr with the FUS showing 2 x 10 ha sporting fields*. - a commercial SWH system is also modelled at the commercial area. Demands for mainly toilets were taken into account with 25 ML/yr adopted.
Infiltration (trenches)	Whole catchment	Exfiltration rate 4 mm/hr Size based on 1 m width and placement upon the whole length of the creek

* Since then MPA has advised the FUS will be updated to incorporate further 0.5 – 0.7 ha green fields. This will be taken into account in future models.

As mentioned in Table B2, the below graph provides the monthly distribution of demand adopted for stormwater harvesting.

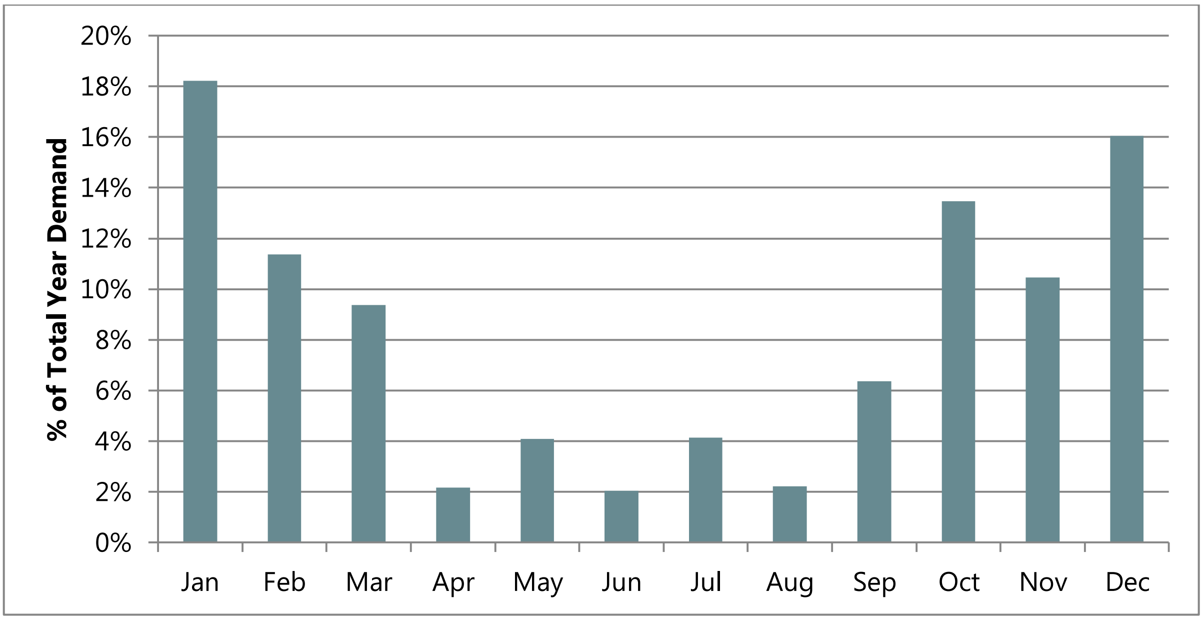


Figure B2 – Irrigation Demand Distribution for 1996

The key result for stormwater harvesting is to determine the size of stormwater infrastructure required to meet an acceptable level of demand. 'Demand met' is expressed as a % of the water that can be supplied vs how much is required. This is extracted from the MUSIC model which uses a Rain – PET distribution to determine when the irrigation area requests water (ie a moisture deficit. For example, during the wetter season or when it is raining, the field will request less or no water).

RORB Model Assumptions

To assess peak flows for each of the options, the adapted RORB models were used.

As RORB has limitations with respect to lower flows (below the 5 Year ARI) a frequency plot was developed for each of the locations in the model of interest (upstream of the RB's). The annual series results provided by RORB were converted to the partial series flow to derive a factor to be applied to the 1 Year ARI flow to determine the 1.5 year (and 5 Year) ARI.

To compare the options, the fraction imperviousness was modified for residential areas (or areas where stormwater harvesting was applied). This was seen as the best way for modelling the scenarios, as the volumetric runoff coefficient and initial loss values are applied globally to the model and there are varying surfaces including the agricultural land to the north. Since a global 15mm loss has been applied to the pervious fraction, this was used to match a conversion of the volume of RWT's (or volume of detention) to a depth and then relate this to an appropriate fraction imperviousness (ie the portion of roof area that is lost to the tank).

B.5 Options Comparison

B.5.1 Modelling Results

Table B3 depicts the results of quantitative modelling for each of the options. It is clear that increasing benefits occur with increasing implementation of treatment measures, affecting all the indicators: volume, peak flow and water quality.

Alternative Option 1, while an improvement on runoff volumes entering the creek, only seeks to achieve best practice water quality criteria, as such the raingardens were sized to just match the criteria for total nitrogen being 45% reduction (the limiting indicator in this case). This equated to sizing the raingardens based on approximately 1 % of catchment. The impact of introducing raingardens to the catchment served to not only address water quality criteria, but also allowed for the reduction of water quality assets (mainly wetland) areas, with an estimated 47% reduced footprint achieved as shown on Table B4.

Alternative Option 2 negates the need for the centralised wetlands, with interception of runoff shown to occur before entry to the creek. The volume of runoff discharging from the site is approximately 40% less than the Base Case. With respect to peak flows this option achieves the pre-development peak flow for the 1.5 year ARI (4.57 m^3/s) at the OG-RB2 location (4.5 m^3/s) and has an impact on 100 Year ARI flows resulting in reduction of the retarding basins by 14% (refer Table B4).

Alternative Option 3 further reduces runoff days and runoff volumes entering the creek, being only twice as large as the existing case. This represents a best case with respect to waterway health. Both the latter options significantly exceed water quality targets.

Table B3 Options Modelling Summary

Option	River Health (Runoff Volumes)				Peak Flows		Water Quality		
	Runoff Days	Runoff days multiple	Volume (ML)	Volume Multiple	*1.5 Year (m^3/s)	100 Year (m^3/s)	TSS	TN	TP
Existing	6.0	1.0	195	1.0	3.59 / 4.57	14.57	-	-	-
Base Case	19	3.2	862	4.4	8.85 / 5.54	17.24	81%	44%	68%
Option 1	20	3.3	783	4.0	8.85 / 5.54	17.24	88%	45%	67%
Option 2	14	2.3	528	2.7	4.64 / 4.50	17.15+	96%	69%	85%
Option 3	10	1.7	416	2.1	4.59 / 4.47	17.00+	98%	78%	90%

* prior to retarding basins + basin sizes adjusted to achieve similar peak flows

Table B4 – Comparison of Footprint Requirements

Option	WQ Treatment Footprints (ha)	Total Treatment Area (less co-location) (ha)	Waterway in Developable Land (ha)
Base Case	6.68	7.81	35.0
Option 1	3.56	7.81	35.0
Option 2	2.28	6.59	34.2
Option 3	2.47	6.59	34.2

The stormwater harvesting tank sizes in Option 2 and 3 were optimised during modelling to achieve a reasonable percentage of demand. Results for SWH and RWT's, as extracted from the Olive Grove MUSIC model, are summarised as follows:

Table B5 – Stormwater Harvesting and RWT Results

Location	Tank size	Demand Volume	Volume Supplied	Demand met
Northern Sport Field (10 ha)*	2.5 ML	48 ML	34 ML	71 %
Commercial	3.0 ML	25 ML	23 ML	93 %
Southern Sports Field (10 ha)	2.28	48 ML	36 ML	75 %
RWT's	3 kL ea	303 ML	212 ML	70 %
Total		424 ML	305 ML	

* The northern sports field has since been adjusted to 6 ha, based on an updated FUS provided by MPA. This will be taken into account in further modelling.

A total of 305 ML can be supplied through stormwater harvesting and rainwater tanks. This is a direct reduction in potable or recycled water supply.

B.5.2 Cost Comparison

A preliminary cost comparison was provided during Workshop 2 for the test case as shown below, with increasing costs incurred for increasing implemented measures (and therefore benefits).

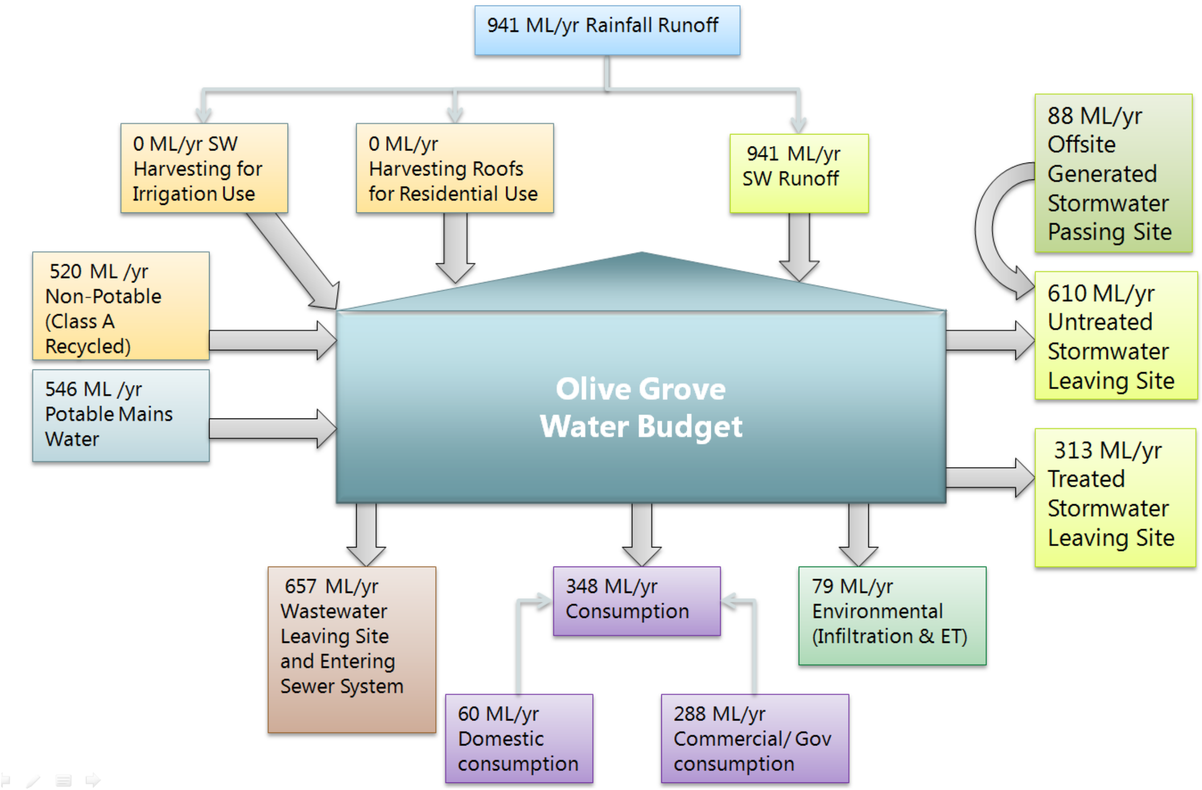
Proposed	Cost per Item/System	Total Cost
Option 1		
Raingardens	$ 6,000.00	$ 10,570,000
Total		$ 10,570,000
Option 2		
SWH	$2,000,000 + $2,500,000	$ 4,500,000
RWT	$2,500	$ 9,660,000
Total (incl Option 1)		$ 24,730,000
Option 3		
Infiltration Trench	$ 600 / m	$ 4,700,000
Total (incl Options 1 & 2)		$ 29,430,000

B.5.3 The Water Budget

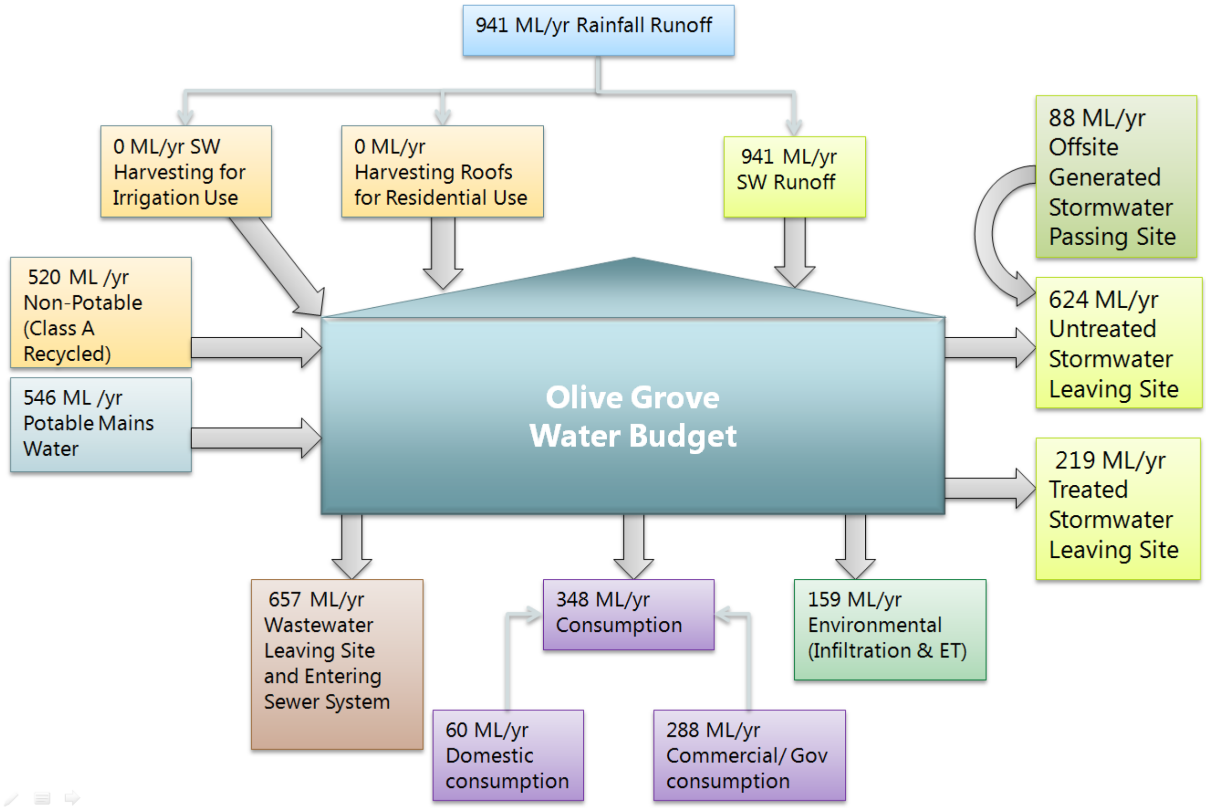
Key to the assessment is integrating the Options in terms of both environmental and water supply benefits. The following graphs show each option with respect to the water budget, with the main differences being environmental losses, treated stormwater leaving site and impact on recycled water supply (by the inclusion of stormwater harvesting).

Storm

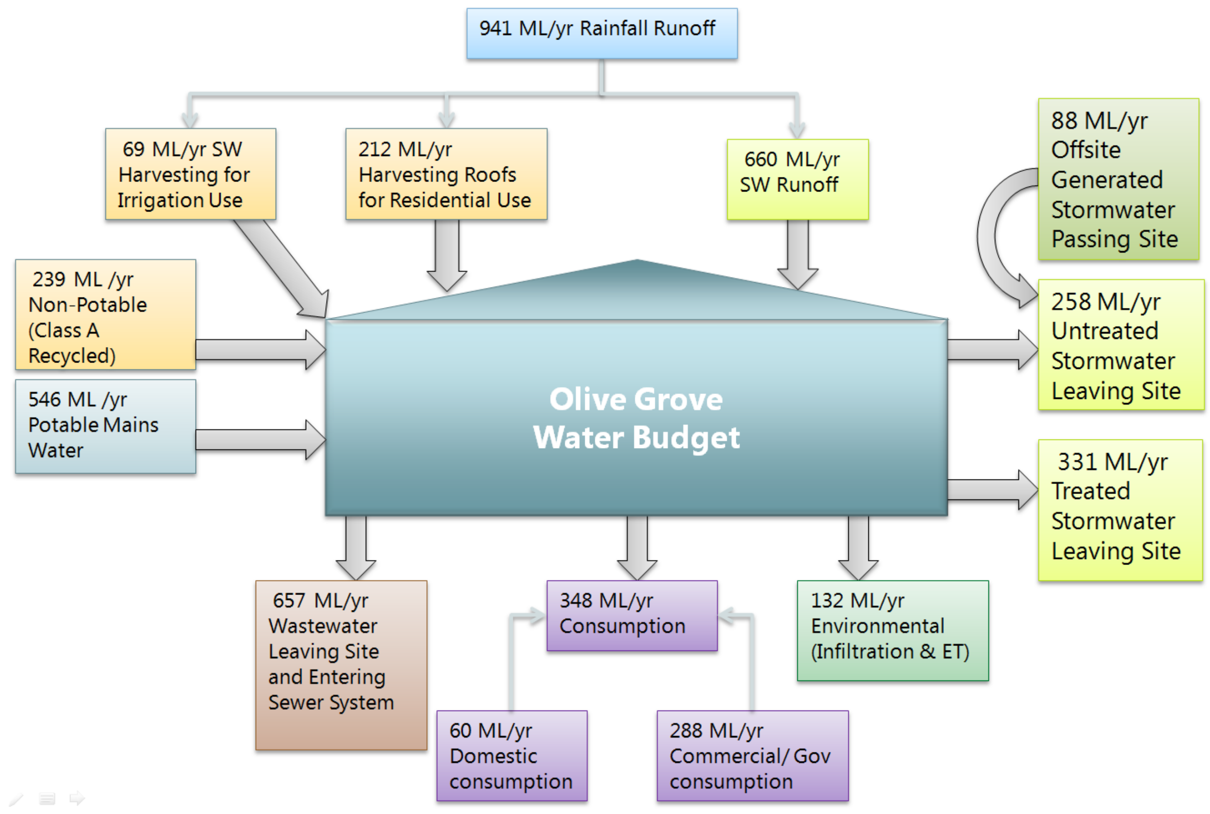
a) Base Case



b) Option 1



c) **Option 2**



d) **Option 3**

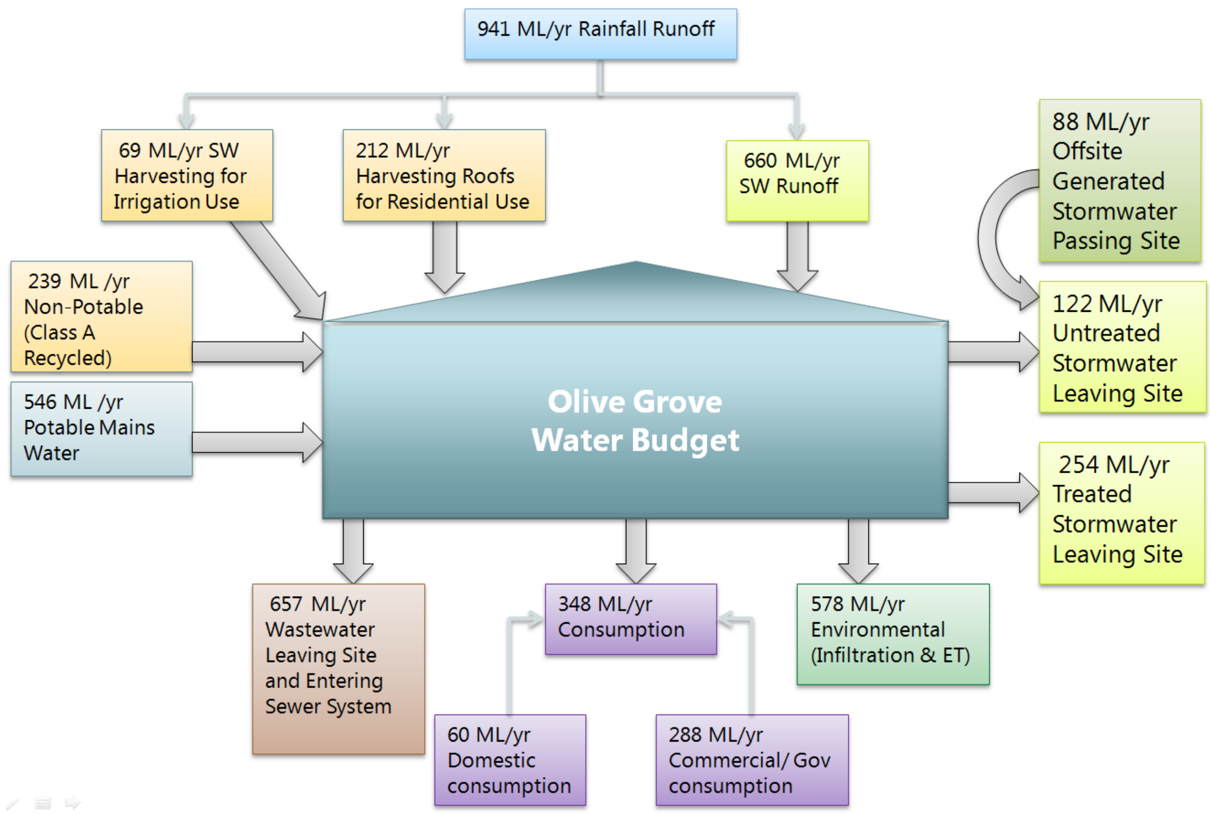


Figure B3 – Water Budgets Comparison

APPENDIX C

Peak flow results for all DSS's

C PEAK FLOW RESULTS

Peak flow results conducted in RORB modelling are presented in the Tables below.

Table C1 – Existing Conditions – 1.5 Year ARI

Existing 1.5 year	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Location	Tarletons Road culvert	Kororoit Ck 2	end	END	END	Final outlet	end	Discharge from PSP	Sum Nodes of Interest
10m Storm Duration	0.01	0.01	0.01	0.03	0.04	0.01	0.01	0.01	**0.12**
15m	0.02	0.01	0.01	0.03	0.04	0.01	0.01	0.01	**0.14**
20m	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	**0.13**
25m	0.03	0.02	0.01	0.02	0.03	0.02	0.01	0.01	**0.15**
30m	0.03	0.02	0.01	0.03	0.03	0.02	0.02	0.02	**0.16**
45m	0.04	0.03	0.01	0.03	0.03	0.02	0.02	0.02	**0.19**
1h	0.04	0.11	0.06	0.07	0.09	0.02	0.08	0.05	**0.52**
1.5h	0.05	0.29	0.14	0.22	0.23	0.02	0.22	0.11	**1.28**
2h	0.05	0.44	0.22	0.35	0.35	0.02	0.34	0.16	**1.93**
3h	0.09	0.67	0.33	0.57	0.52	0.03	0.54	0.25	**2.99**
4.5h	0.39	0.83	0.45	0.80	0.64	0.08	0.74	0.34	**4.28**
6h	0.76	0.88	0.51	0.97	0.68	0.12	0.86	0.38	**5.15**
9h	1.40	1.26	0.67	1.35	0.99	0.17	1.12	0.52	**7.48**
12h	1.96	1.12	0.70	1.46	0.83	0.23	1.26	0.54	**8.10**
18h	2.10	1.00	0.62	1.41	0.75	0.23	1.15	0.47	**7.73**
24h	2.09	1.14	0.62	1.41	0.87	0.20	1.06	0.49	**7.89**
30h	2.58	0.96	0.58	1.34	0.70	0.28	1.17	0.48	**8.10**
36h	2.43	1.03	0.62	1.43	0.77	0.24	1.20	0.48	**8.21**
48h	2.61	1.02	0.64	1.40	0.77	0.28	1.26	0.50	**8.48**
72h	1.37	0.55	0.33	0.83	0.41	0.12	0.63	0.26	**4.50**
Max (for location)	**2.61**	**1.26**	**0.70**	**1.46**	**0.99**	**0.28**	**1.26**	**0.54**	8.48

Table C2 – Existing Conditions – 100 Year ARI

Existing 100 Year	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Id	Tarletons Road culvert	Kororoit Ck 2	end	END	END	Final outlet	end	Discharge from PSP	Sum Nodes of Interested
10m	0.16	1.50	0.67	1.43	1.27	0.97	0.99	0.86	**7.85**
15m	0.21	2.63	1.31	1.87	2.13	1.83	2.01	1.56	**13.57**
20m	1.36	3.75	1.86	3.06	3.03	2.55	2.89	1.97	**20.47**
25m	2.71	4.75	2.34	3.90	3.82	3.18	3.67	2.28	**26.65**
30m	3.97	5.62	2.76	4.63	4.50	3.67	4.35	2.49	**32.00**
45m	7.30	7.78	3.78	6.44	6.15	4.85	6.05	2.97	**45.32**
1h	10.05	9.48	4.57	7.88	7.39	5.62	7.37	3.44	**55.79**
1.5h	13.86	11.27	5.50	9.72	8.61	5.82	9.01	4.33	**68.11**
2h	16.67	11.88	6.11	11.02	9.14	5.89	10.05	4.73	**75.49**
3h	20.38	11.57	6.43	12.48	8.88	5.20	10.85	4.88	**80.67**
4.5h	23.26	10.82	6.25	13.71	8.29	4.90	10.75	4.68	**82.66**
6h	24.50	10.99	6.23	14.04	8.58	4.99	10.80	4.75	**84.88**
9h	29.54	11.54	6.73	14.57	8.53	4.58	12.65	5.36	**93.50**
12h	27.57	9.90	5.55	13.78	7.18	4.01	10.41	4.62	**83.02**
18h	24.65	7.55	4.75	12.06	5.60	2.80	9.37	3.62	**70.41**
24h	25.40	8.78	5.17	11.81	6.49	3.18	10.08	4.24	**75.15**
30h	20.42	6.53	4.01	9.44	4.86	2.30	8.29	3.24	**59.11**
36h	22.30	6.80	4.22	10.34	5.05	2.28	8.54	3.43	**62.95**
48h	21.95	6.49	4.19	9.95	4.93	2.34	8.58	3.26	**61.70**
72h	15.85	4.31	2.86	7.35	3.25	1.36	6.02	2.22	**43.21**
Max	**29.54**	**11.88**	**6.73**	**14.57**	**9.14**	**5.89**	**12.65**	**5.36**	**93.50**

Table C3 – Base Case – 1.5 Year ARI

Base Case 1.5yr	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Id	Tarletons Road culvert	Kororoit Ck 2	end	END	(end)	Final outlet	End Outlet	Discharge from PSP	Sum Nodes of Interest
10m	8.75	0.28	0.15	2.72	1.70	0.35	0.02	1.64	**15.61**
15m	10.01	0.19	0.22	2.88	1.82	0.46	0.03	1.61	**17.23**
20m	9.66	0.19	0.29	2.62	1.53	0.54	0.05	1.30	**16.17**
25m	10.28	0.19	0.34	2.92	1.80	0.60	0.06	1.16	**17.36**
30m	9.83	0.21	0.39	2.62	1.63	0.63	0.07	0.87	**16.26**
45m	10.24	0.25	0.54	2.18	1.32	0.73	0.11	0.97	**16.35**
1h	10.27	0.37	0.72	2.73	1.69	0.82	0.16	0.92	**17.68**
1.5h	10.75	0.63	0.97	2.91	1.78	0.82	0.26	1.06	**19.18**
2h	11.09	0.87	1.10	3.34	2.10	0.87	0.35	1.25	**20.97**
3h	8.23	1.31	1.27	2.74	1.68	0.84	0.51	0.56	**17.12**
4.5h	9.73	1.78	1.30	2.77	1.68	0.94	0.63	0.90	**19.74**
6h	8.39	2.05	1.36	2.93	1.76	0.94	0.98	0.65	**19.06**
9h	8.32	2.54	1.90	3.72	2.45	1.14	1.48	0.88	**22.43**
12h	7.28	2.72	1.69	3.23	2.13	1.01	1.64	0.98	**20.68**
18h	5.43	2.50	1.44	2.61	1.77	0.68	1.65	0.82	**16.89**
24h	6.12	2.35	1.55	3.10	2.12	0.90	1.56	0.81	**18.51**
30h	6.20	2.36	1.40	2.63	1.60	0.69	1.75	0.83	**17.47**
36h	5.93	2.45	1.41	2.63	1.73	0.71	1.71	0.81	**17.38**
48h	6.60	2.45	1.43	2.83	1.79	0.75	1.77	0.85	**18.47**
72h	3.01	1.32	0.84	1.48	0.94	0.38	1.00	0.45	**9.42**
Max	**11.09**	**2.72**	**1.90**	**3.72**	**2.45**	**1.14**	**1.77**	**1.64**	**22.43**

Table C4 – Base Case – 100 Year ARI

Base Case 100yr	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Id	Tarletons Road culvert	Kororoit Ck 2	end	END	(end)	Final outlet	End Outlet	Discharge from PSP	Sum Nodes of Interest
10m	32.45	2.73	1.94	14.53	8.04	1.90	0.41	8.54	**70.55**
15m	35.47	2.92	3.09	15.64	8.92	2.70	1.00	10.68	**80.44**
20m	36.35	2.94	4.09	15.57	9.19	3.67	1.60	8.47	**81.89**
25m	38.50	3.06	4.76	15.11	8.94	4.38	2.15	9.11	**86.02**
30m	36.53	3.39	5.30	14.39	8.71	4.76	2.61	8.64	**84.32**
45m	39.36	4.53	6.54	15.67	10.25	5.54	3.91	8.08	**93.89**
1h	41.02	5.41	7.27	16.60	10.76	5.83	4.89	7.61	**99.38**
1.5h	42.88	6.56	7.66	16.60	10.94	5.73	6.25	8.14	**104.76**
2h	43.07	7.28	7.84	17.24	11.08	5.71	7.49	8.01	**107.74**
3h	40.42	8.14	7.42	14.98	9.99	4.65	8.80	4.55	**98.95**
4.5h	39.42	8.48	6.83	14.60	9.32	4.95	9.20	4.44	**97.25**
6h	38.36	8.57	7.28	14.10	9.57	4.76	9.30	4.39	**96.32**
9h	44.67	9.21	7.96	16.29	10.28	4.98	11.22	5.46	**110.08**
12h	40.30	8.67	6.70	13.66	8.49	4.13	10.03	4.53	**96.51**
18h	30.41	7.93	5.05	11.37	5.94	2.89	8.65	3.85	**76.09**
24h	36.97	7.92	6.02	13.01	7.38	3.49	9.05	4.25	**88.09**
30h	26.83	7.15	4.62	9.68	5.27	2.38	7.79	3.33	**67.06**
36h	28.47	7.20	4.77	10.40	5.43	2.53	7.84	3.43	**70.08**
48h	27.67	7.14	4.65	10.67	5.91	2.87	7.87	3.24	**70.02**
72h	17.55	4.77	2.94	6.60	3.76	1.66	5.04	2.21	**44.53**
Max	**44.67**	**9.21**	**7.96**	**17.24**	**11.08**	**5.83**	**11.22**	**10.68**	**110.08**

Table C5 – Alternative Option 2 – 1.5 Year ARI

Alt Option 2, 1.5yr	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Id	Tarletons Road culvert	Kororoit Ck 2	end	END	(end)	Final outlet	End Outlet	Discharge from PSP	Sum Nodes of Interest
10m	8.75	0.28	0.12	0.99	0.45	0.11	0.01	0.75	**11.45**
15m	10.01	0.19	0.10	1.09	0.45	0.14	0.01	0.76	**12.75**
20m	9.66	0.18	0.11	1.00	0.41	0.17	0.01	0.63	**12.15**
25m	10.28	0.14	0.13	1.04	0.47	0.19	0.01	0.64	**12.90**
30m	9.83	0.17	0.15	0.92	0.49	0.21	0.01	0.59	**12.37**
45m	10.24	0.18	0.19	0.85	0.47	0.25	0.01	0.52	**12.71**
1h	10.27	0.27	0.31	0.84	0.48	0.28	0.02	0.50	**12.96**
1.5h	10.75	0.52	0.47	0.81	0.46	0.28	0.05	0.45	**13.80**
2h	11.09	0.72	0.60	1.02	0.60	0.27	0.08	0.50	**14.89**
3h	8.23	1.07	0.78	1.22	0.74	0.28	0.15	0.48	**12.94**
4.5h	9.73	1.50	0.88	1.23	0.88	0.33	0.24	0.53	**15.32**
6h	8.39	1.76	0.93	1.28	0.91	0.34	0.31	0.41	**14.34**
9h	8.32	2.24	1.32	1.92	1.27	0.62	0.46	0.52	**16.67**
12h	7.28	2.39	1.29	1.85	1.31	0.58	0.60	0.57	**15.87**
18h	5.43	2.22	1.11	1.59	1.10	0.44	0.67	0.49	**13.06**
24h	6.12	2.08	1.17	1.74	1.18	0.53	0.73	0.44	**14.00**
30h	6.20	2.10	1.11	1.71	1.10	0.49	0.81	0.52	**14.05**
36h	5.93	2.21	1.09	1.62	1.12	0.49	0.78	0.51	**13.77**
48h	6.60	2.19	1.15	1.75	1.13	0.51	0.83	0.52	**14.68**
72h	3.01	1.21	0.64	0.88	0.60	0.21	0.52	0.30	**7.37**
Max	**11.09**	**2.39**	**1.32**	**1.92**	**1.31**	**0.62**	**0.83**	**0.76**	**16.67**

Table C6 – Alternative Option 2 – 100 Year ARI

Option 2, 100yr	Beattys Road	Deanside Drive	Gardiner Lane	Olive Grove	Plumpton Road	Reed Court	Sinclairs	Taylors Hill West	Total
RORB Id	Tarletons Road culvert	Kororoit Ck 2	end	END	(end)	Final outlet	End Outlet	Discharge from PSP	Sum Nodes of Interest
10m	32.45	2.72	1.20	10.01	5.29	0.77	0.16	7.56	**60.16**
15m	35.47	2.91	2.08	11.96	6.17	1.27	0.43	7.44	**67.75**
20m	36.35	2.93	2.92	10.36	5.57	2.10	0.80	6.84	**67.86**
25m	38.50	3.06	3.69	12.06	6.46	2.83	1.17	7.34	**75.10**
30m	36.53	3.11	4.21	11.32	6.04	3.31	1.53	6.90	**72.96**
45m	39.36	4.18	5.35	11.46	7.28	4.32	2.51	6.50	**80.96**
1h	41.02	5.01	6.10	12.63	8.06	4.52	3.39	7.49	**88.22**
1.5h	42.88	6.11	6.60	13.09	8.34	4.40	4.62	7.31	**93.34**
2h	43.07	6.87	6.82	13.51	8.49	4.43	5.55	7.22	**95.97**
3h	40.42	7.71	6.58	12.36	7.92	3.95	6.90	3.92	**89.78**
4.5h	39.42	8.14	6.18	11.01	7.12	4.07	7.59	3.55	**87.08**
6h	38.36	8.25	6.45	11.21	7.68	3.91	7.71	3.45	**87.01**
9h	44.67	8.85	7.32	14.19	8.93	4.56	9.17	4.77	**102.46**
12h	40.30	8.39	6.19	12.11	7.44	3.79	8.81	3.97	**91.00**
18h	30.41	7.68	4.67	10.24	5.19	2.60	7.61	3.24	**71.64**
24h	36.97	7.66	5.61	11.58	6.54	3.23	7.92	3.42	**82.93**
30h	26.83	6.90	4.34	8.77	4.64	2.20	6.94	2.83	**63.45**
36h	28.47	6.93	4.49	9.42	4.84	2.35	6.94	2.93	**66.37**
48h	27.67	6.92	4.38	9.52	5.23	2.65	7.04	2.86	**66.28**
72h	17.55	4.61	2.70	5.78	3.29	1.55	4.49	2.01	**41.97**
Max	**44.67**	**8.85**	**7.32**	**14.19**	**8.93**	**4.56**	**9.17**	**7.56**	**102.46**

Key notes with respect to this modelling are:

- 1.5yr-ARI partial series is approximately Q2-RORB output.
- Total was determined by adding relevant model flows together for the points of interest (ie. no completely new model was prepared for each PSP).

APPENDIX D

Cost Estimate Breakdown

D COST ESTIMATES

D.1 Raingardens

As detailed in 5.6.1 (main report) the raingarden configurations were based off an average catchment of 243m^2 being treated by a 2.5m^2 raingarden (this would bring it to best practice). Considering the raingardens would be constructed as part of the overall estate work a reasonable estimate of $2,500 per raingarden (or $1,000/m^2) has been estimated as shown below.

Component	$/raingarden	Assumptions
Excavation	300	A typical raingarden: 100mm ponding depth, 500mm filter depth, 100mm transition depth, 350mm drainage/submerged zone depth and ~ 150mm of freeboard (accounts for surface level difference across raingarden). Typical depth of excavation is therefore 1.2m = 3 m^3/raingarden. Use $100/m^3 to excavate and dispose (conservative estimate for new estate)
Filter Materials	475	$200/m^3 for new estate installation (varying sand and rock materials)
Plants	75	$3 per plant at a rate of 10 plants/m^2
Inlet	700	Kerb opening $500 (to be done during kerb construction) and rock armouring at inlet $200
Drainage	700	Install underdrain, flushout riser and connection to adjacent pit ~$500. A further $200 should be allowed for modifications to side entry pit to allow for overflow (to be done during pit construction)
Design & Documentation	225	10% of construction cost
Total	$2,475	Round off to $2,500 i.e. $1,000/m^2

The number of raingardens that could potentially be installed has been estimated to be 6,040 and 7,400 for Plumpton and Kororoit PSPs respectively. This works out to a total of $33,600,00.00.

D.2 Wetlands

Construction costs for the Wetlands for the Alternative Options were estimated to determine the costs savings of reducing these assets against the Base Case.

The breakdown of components and assumptions used to determine the costs were as follows:

Component	$k/ha	Assumptions
Drainage	200	
Earthworks	525	1.5m average earthwork depth & $35/m^3$ for earthwork (higher rate to take into account rock prone area in Plumpton/Kororoit PSPs)
Plants	200	$20/m^2
Design & Documentation	139	15% of construction cost
Total	1064	Round off to $1,100k i.e. $110/m^2

As shown in Table D1 the wetlands are costed at $ 17,941,000 and $7,898,000 for Alternative Option 1 and Alternative Option 2 respectively. Compared to the Base Case, estimated to be $32,065,000, this results in savings as follows:

- Alternative Option 1 = $ 14,124,000
- Alternative Option 2 = $ 24,167,000

Table D1 Wetland Sizes and Costs

Catchment	Wetland ID	Alternative Option 1			Alternative Option 2		
		Footprint (Ha)	Cost $k		Footprint (Ha)	Cost $k	
Plumpton	BR-WL1	1.00	$	1,100	1.00	$	1,100
	PR-WL1	1.00	$	1,100	0.00	$	-
	PR-WL2	1.03	$	1,133	0.00	$	-
	PR-WL2a	0.03	$	33	0.03	$	33
	OG-WL1	1.10	$	1,210	0.00	$	-
	OG-WL2	0.80	$	880	0.00	$	-
	SR-WL2	1.50	$	1,650	0.50	$	550
	THW-WL1	0.70	$	770	0.70	$	770
	THW-WL2	1.35	$	1,485	1.35	$	1,485
Kororoit	PR-WL3	0.25	$	275	0.00	$	-
	DD-WL1	0.90	$	990	0.10	$	110
	DD-WL2	0.15	$	165	0.00	$	-
	DD-WL2a	0.10	$	110	0.10	$	110
	OG-WL3	1.40	$	1,540	1.40	$	1,540
	RC-WL1	0.50	$	550	0.00	$	-
	RC-WL2	0.00	$	-	0.00	$	-
	GL-WL1	1.00	$	1,100	1.00	$	1,100
	SR-WL3	1.00	$	1,100	0.50	$	550
	SR-WL4	0.00	$	-	0.00	$	-
	SR-WL4a	1.00	$	1,100	0.25	$	275
	SR-WL4b	1.50	$	1,650	0.25	$	275
Total		16.3	**$**	**17,941**	7.18	**$**	**7,898**

D.2 Stormwater Harvesting Systems

The primary components, and assumptions involved in estimating the cost of each stormwater harvesting system is shown in Table D2.

Table D2 Stormwater Harvesting System Construction Cost Assumptions

Rates	Unit	Unit Cost	Assumptions
Offtake	30% of Storage Cost	1.3	Based on extensive experience (may include GPT or pumping from wetland)
Storage Tank	per kL	$450	Based on underground modular tanks, includes associated tank structures, excavation and
Pumping & Treatment		See Below	
Water Transfer	per meter	$200	Pressurised poly pipe, including fitting, valves and installation
Contingency	30% of total cost	1.3	

The pumping and treatment costs depend on the irrigation flow rate. These have been estimated for each stormwater harvesting system. The cost breakdown for each system is shown in Table D3.

Table D3 Stormwater Harvesting System Pumping and Treatment Costs

Pumping & Treatment	SWH1	SW2	SWH3, SWH6	SHH4, SWH7, SWH8	SWH5
Flow rate	**12L/s**	**54L/s**	**36L/s**	**23L/s**	**33L/s**
Booster Pump	$35,000	$75,000	$60,000	$45,000	$55,000
Screen Filter	$35,000	$80,000	$65,000	$45,000	$60,000
UV Disinfection	$45,000	$90,000	$75,000	$55,000	$70,000
Valves, Sensors, Controls	$50,000	$70,000	$60,000	$60,000	$60,000
Housing	$10,000	$20,000	$15,000	$10,000	$15,000
Power Supply/Electrical	$15,000	$15,000	$15,000	$15,000	$15,000
Commissioning	$15,000	$15,000	$15,000	$15,000	$15,000
Rising Mains (100m)	$5,000	$30,000	$22,000	$15,000	$22,000
	$210,000	**$395,000**	**$327,000**	**$260,000**	**$312,000**

The basis for these costs and the resulting sum totals for each stormwater harvesting system is shown in Table D4.

Table D4 Stormwater Harvesting Construction Cost Estimates

PSP	SWH ID	Irrigation Area (Ha)	Irrigation Demand (ML)	Other Use (kL/Ha)	Tank Size (kL)	Water Transfer Main (m)	Irrigation Flowrate (L/s)	Cost
Plumpton	SWH1 (Beatty's)	0	0	4.2†	8,000	1,000	12†	$6,617,000
	SWH2 (Olive Grove)	17.6	88	27.3	44,500	2,000	54	$3,665,675
	SWH3 (Plumpton)	11.6	58	0	3,500	2,100	36	$3,632,850
	SWH4 (Sinclairs)	7.6	38	0	1,700	2,400	23	$2,254,850
Kororoit	SWH5 (Olive Grove)	10.8	54	0	3,200	1,000	33	$3,099,200
	SWH6 (Deanside)	11.6	58	0	2,000	1,400	36	$2,310,100
	SWH7 (Sinclairs)	7.6	38	0	2,300	2,100	23	$2,633,150
	SWH8 (Gardiners)	7.6	38	0	1,500	1,500	23	$1,868,750
							Total	$26,081,575
							Design Cost (10%)	$2,608,157.50
							Grand Total	**$28,689,733**

†Based on demand for industrial area as a peak demand rate

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D.3 Infiltration System

The infiltration trenches, proposed to be installed in the riparian zone of the waterways, have been estimated to cost $550/m. This is based on a breakdown as shown in Table D5 (this assumes an average depth of 1.5m and width of 1 m for the cross section).

Table D5 Wetland Sizes and Costs

Component	Unit Costs	Cost / m
Earthworks	- Excavation 1.5m^3 @ $35/$m^3$ - Backfill/form swale of 0.5m^3 @ $35/$m^3$	$ 70
Hydrocon Pipe	$250/m supply + $50/m install	$ 300
Sand layer	0.7m^3 @ $120/$m^3$	$ 84
Surface works (planting, scour protection)		$ 50
Design	~10% construction cost	
Total		**$ 550**

The total length of trench determined for Alternative Option 2 has been estimated to be 13,035 m. the total cost therefore equates to $7,170,000.