Metropolitan Planning Authority

Whole of Water Cycle Assessment: PSP 1082 Mt Atkinson and PSP 1085 Tarneit Plains

Summary Report

Final Issue | 17 July 2015

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Executive Summary

Arup Pty Ltd (Arup) was engaged by the MPA to prepare a Whole of Water Cycle Assessment (WoWCA) to inform the development of the two PSPs which will guide future urban development in the area. Arup's benefit focussed Design with Water partnership approach to WoWCA has been utilised in the development of this project.

The purpose of this study was to identify a high-level strategy and schematic design for integrated water management to assist in the establishment of the future urban structure for the new communities of Mt Atkinson and Tarneit Plains. The study identified issues and considerations for the future urban development of the study area and provided options and recommendations for a schematic urban structure to facilitate whole-of-water-cycle management. The assessment will enable MPA to plan the future urban structure for the Mt Atkinson and Tarneit Plains Precinct Structure Plans (PSPs) with greater consideration of the whole-of-water-cycle opportunities available.

This Summary Report brings together work undertaken to date, stakeholder feedback through the stakeholder workshop conducted in January, comments received after the workshop and consultation with key stakeholders along with other background information available regarding the Mt Atkinson and Tarneit Plains PSPs.

The development of a WoWCA for the two PSP's involved a number of key steps which include:

1. Development of a base case report to document key site characteristics and the business as usual scenario (completed in September 2014 and updated with the revised draft future urban structure for consultation (April 2015) in this report)
2. Consultation with stakeholders to explore if there are other more innovative and efficient options which meet the required criteria (completed January 2015)
3. Assessment of alternative options and comparison with the base case (the subject of this report)

Organisations consulted in the development of the WoWC Report include:

- MPA
- City West Water
- Melton City Council
- Melbourne Water
- Department of Environment, Land, Water and Planning
- Western Water

WoWCA process and Precinct Structure Planning

According to MPA in the context of Precinct Structure Planning, whole-of-water-cycle management seeks to make cost effective use of all sources of water by tailoring them to different locations and circumstances and thereby delivering multiple benefits.

MPA WoWCA Objectives:

Objectives of the whole-of-water-cycle assessment include:

- Diversification of supply thereby reducing the cost of future large scale centralised water/wastewater systems
- Waterway health improvement, consisting of less volume and higher quality
- Management of potential flooding and decreasing flood risk
- Improved liveability and urban landscapes
- Engagement of the community via key stakeholders.
- Identification of opportunities within the planning and building process that will also help to deliver on the above objectives.

To deliver on these objectives, whole-of-water management opportunities could include:

- Minimising potable water usage by use of alternative water supplies
- Roof rainwater harvesting
- Stormwater harvesting
- Stormwater quality measures
- Flood management including the minimisation of flood extents
- Sewer mining
- Groundwater including aquifer storage and recovery
- Sewage treatment and discharge
- Improving environmental, landscape and liveability outcomes through water management.

Site Details

Mt Atkinson and Tarneit Plains PSPs are located approximately 25 kilometres west of Melbourne's CBD. Both PSPs are located in the Melton City Council area. The precincts are bounded by the Western Freeway to the north; Hopkins/Derrimut Road to the east; Middle Road to the south; and the future Outer Metropolitan Ring road (just east of Troups Road South) to the west. Both areas are identified to provide local and regional employment opportunities with significant areas proposed for industrial uses as well as for business and residential uses.

The Mt Atkinson PSP will contain the following land uses: residential, industrial, commercial/retail/mixed use and active open space. The Tarneit Plains PSP will contain industrial land use. The PSP's also contain conservation areas, drainage zones and power authority easements.

Option Description and Assumptions

The first stage of the WoWCA process was to define and develop a business as usual scenario for consideration by the wider stakeholder group. The business as usual scenario was further refined in consultation with key stakeholders and was presented to the stakeholders for comment and discussion at a subsequent stakeholder workshop and was updated accordingly.

A key component of this phase of work was to also collaborate with the project stakeholders to develop two alternative whole of water cycle options for the PSP areas and document the assumptions on which analysis of these are based. This was done via face-to-face meetings, a stakeholder workshop and a formal feedback process on the alternatives developed.

There were two alternatives that were then developed: Alternative 1 is considered an '*Enhanced Liveability'* scenario and has been developed to build on the elements identified in the business as usual in order to achieve stretch water quality targets including a 60% flow reduction objective. Alternative 2, the '*Enhanced Waterway Health*' scenario, was developed to achieve more stringent water quality targets including a 90% flow reduction objective.

A summary of the options are below:

Business as Usual	**Alternative 1** ***Enhanced Liveability***	**Alternative 2** ***Enhanced Waterway Health***
Regional sewer treatment plant providing recycled water for commercial, industrial, educational and residential non-potable uses.	Regional sewer treatment plant providing recycled water for commercial, industrial, educational and residential non-potable uses	Regional sewer treatment plant providing recycled water for commercial, industrial, educational and residential non-potable uses
5% uptake in residential rainwater tanks in accordance with 6 star homes standards (toilets only).	5% uptake in residential rainwater tanks sized to maximise reuse (all non-potable uses).	5% uptake in residential rainwater tanks sized to maximise reuse (all non-potable uses).
Stormwater management to meet BPEM and 1 in 100 year ARI flood retardation through end of line stormwater systems before discharging into local water bodies.	Stormwater management to meet potential future stretch BPEM (including a 60% flow reduction target) and 1 in 100 year ARI flood retardation through a number of WSUD assets (including local stormwater harvesting schemes for active open space, infiltration trenches, and passive streetscape irrigation).	Stormwater management to meet potential future stretch BPEM (including a 90% flow reduction target) and 1 in 100 year ARI flood retardation through a number of WSUD assets (incl. local stormwater harvesting for active open space, infiltration trenches, vegetated swales, passive streetscape irrigation and drainage channels utilised as enhanced waterways).
		Catchment stormwater harvesting schemes implemented to distribute treated stormwater via the third pipe recycled water reticulation network.

Precinct Demands and Sewer Discharge

This section outlines the anticipated precinct wide demands and sewer discharges for the various land uses under each of the scenarios. A summary of all scenarios is provided below.

Scenario	Total Anticipated Water Demand (per annum)					Sewer Discharge (per annum)
	Total Water	Potable Water	Recycled Water	Residential Rainwater	Harvested Stormwater	
Business as Usual	2925 ML	1685 ML	1231 ML	9 ML	0 ML	2,251 ML
Alternative 1	2925 ML	1685 ML	1183 ML	21 ML	36 ML	2,251 ML
Alternative 2	2925 ML	1685 ML	414 ML	21 ML	805 ML	2,251 ML

Schematic Design

High level schematic designs have been prepared for each of the scenarios including the revision of the scheme design for the business as usual (revised urban structure and precinct demands) and feedback from stakeholders regarding site constraints. The schematic designs developed have been assessed based on the required runoff and water quality targets, the appropriate whole of water cycle assets for the site conditions and opportunities and the results of the constraints assessment. The schematic designs have also attempted to take into account other design considerations appropriate at the PSP scale and to fit with the proposed urban structure. It is noted that there are further requirements to re-visit these layouts as additional site information comes to hand.

Water Sensitive Urban Design

WSUD integrates urban water cycle management with urban planning and design, with the aim of mimicking natural systems to minimise negative impacts on the natural water cycle and receiving waterways and bays. It offers an alternative to the traditional conveyance approach by acting at the development scale, reducing the size of the required stormwater system.

All scenarios incorporate some form of Water Sensitive Urban Design (WSUD) to help achieve the specified stormwater quality targets; however alternatives 1 and 2 apply additional WSUD elements to increase the reuse of stormwater and rainwater and to increase flow reductions through evapo-transpiration and infiltration of stormwater.

The alternative scenarios developed require the potential use of co-located wetlands within retarding basins, infiltration trenches, passive irrigation of streetscape, vegetated swales, drainage channels utilised as enhanced waterways, residential rainwater tanks and stormwater harvesting schemes.

Land take requirements for the surface area of such wetlands, infiltration trenches and stormwater harvesting schemes range according to the figures below and detailed landtake information is provided in section 5.2

To attempt to minimise land take requirements, wetlands and infiltration beds have been co-located within or adjacent to end-of-line retarding basins. The intention is to construct the wetland/infiltration bed in base of the retarding basin and provide opportunity for public amenity around these water bodies. Where possible these assets have also been located within proposed powerline easements to reduce landtake. These areas only consider the flows from within the site boundary and will require revision as the site layout is further developed.

Land Take	**Business as Usual**	**Alternative 1**	**Alternative 2**
Extent of co-located retarding basins and wetlands (ha)	27.955	19.800	19.800
Extent of co-located retarding basins and supplementary infiltration trenches (ha)	-	26.400	37.900
Total Land Take (ha)	**27.955**	**46.2**	**57.7**
Extent of infiltration trenches in power easements or conservation areas and stormwater harvesting tanks (ha) – No additional land take requirement	-	*4.758*	*6.273*

Options Assessment – Quantitative

Based on high level capital and operational costs a high level incremental cost assessment of each alternative above the business as usual has been produced to quantitatively compare the alternatives. Further detailed costing data would be required in the next stage of work and detailed information on ground conditions would also be required. A brief overview is seen below:

High Level Incremental Cost Above Business As Usual	**Alternative 1**	**Alternative 2**
Total Additional Capex ($mil)	17.5	62.0
Total Additional Land Acquisition ($mil)	14.6	23.8
Total Additional Opex ($mil/a)	1.22	2.26
Total Additional Life Cycle (50 years and excluding renewal costs) ($mil)	**93.4**	**198.8**

Options Assessment – Qualitative

A qualitative assessment was also undertaken to determine the benefits for a variety of factors including water supply, wastewater, economy & innovation, place & community, food & agriculture, climate change, energy & carbon and health & wellbeing. Alternative 2 - *Enhanced Waterway Health*, was found to be the most beneficial, largely due to the direct co-relation with the high flow reduction target (90%). To achieve the flow reduction target the alternative requires more stormwater management measures to be implemented, therefore resulting in higher qualitative benefits.

Recommendations and Key Findings

This study assessed alternative scenarios with different flow reduction targets. These scenarios are very difficult to directly compare without incorporating the benefits of the flow reductions on the receiving waterways and the indirect benefits of the flow reductions received by the community. Determining these benefits are not a part of this study, but would need to be established before a cost-benefit analysis could be conducted in the future.

Therefore this study can only deduce the relative impact of introducing flow reductions targets on the urban form and bottom line.

In comparing the business as usual scenario with the alternatives of introducing the flow reduction targets:

- 60% flow reduction (alternative 1 – enhanced liveability) requires an additional 18 ha of land and costs an additional $93 mil over its 50 year life.
- 90% flow reduction (alternative 2 – enhanced waterway health) requires an additional 30 ha of land and costs an additional $199 mil over its 50 year life.

The installation of infiltration trenches in order to satisfy the flow reduction targets in alternatives 1 and 2 is dependent on site specific soil parameters. In the absence of site specific information, this study modelled conservative soil characteristics (medium clays typical of the region). If in fact soils favourable to infiltration are discovered on site the extent of infiltration trenches can be reduced. Conversely if the soils discovered are not-favourable to infiltration, the infiltration trenches will need to be substituted for expanded wetlands to utilise evapo-transpiration losses as the key method of flow reduction.

Under all scenarios there is an excess of wastewater generated against recycled water demands. This is most profound under the alternative 2 where 2,100 ML of treated waste water will require discharge after treatment to either local waterways or into the metropolitan sewer system.

The installation of stormwater harvesting schemes where recycled water is also available will further exacerbate the excess of treated water requiring disposal or direction to alternative uses outside of the PSP areas.

Summary

Under the current regulatory environment the ‘business as usual scenario’ is the most cost effective option. Investigated potential ‘stretch’ regulations not currently implemented and benefits cannot be fully quantified as part of this study. It is however recommended that the business as usual scenario implement additional of WSUD elements (i.e. passive irrigation of streetscape) to enhance liveability and amenity outcomes.

1 Introduction

The Metropolitan Planning Authority (MPA), in partnership with Melton City Council has commenced preparation of the Mt Atkinson and Tarneit Plains Precinct Structure Plans (PSPs) which will establish the future urban structure for a new community.

Mt Atkinson and Tarneit Plains PSPs are located in Melbourne's Western Growth Corridor (see **Figure 1**). As part of the PSP development Arup Pty Ltd (Arup) has been engaged by the MPA to prepare a Whole of Water Cycle Assessment (WoWCA) to inform the development of the two PSPs which will guide future urban development in the area. The incorporation of water management requirements at this stage in the planning process allows for the future urban developments to take into account the best available opportunities for the provision of water services along with opportunities to improve the local environment and increase amenity and liveability outcomes for residents.

A WoWCA planning approach recognises that water can enhance social infrastructure and open space making it more attractive and sustainable. It also recognised that open space and other areas can be used to treat and store water for later reuse, prevent flooding, and reduce environmental impacts from development on waterways.

Understanding the interface between water infrastructure and space requirements is the key to creating a truly multi-functional landscape that delivers multiple social, economic and environmental benefits while minimising unnecessary and costly land take. This in turn creates attractive communities, while ensuring that developer contributions for shared infrastructure are as low as possible to ensure affordability for home buyers.

Arup's benefit focussed Design with Water partnership approach to WoWCA has been utilised in the development of this project and is depicted in **Figure 2**.

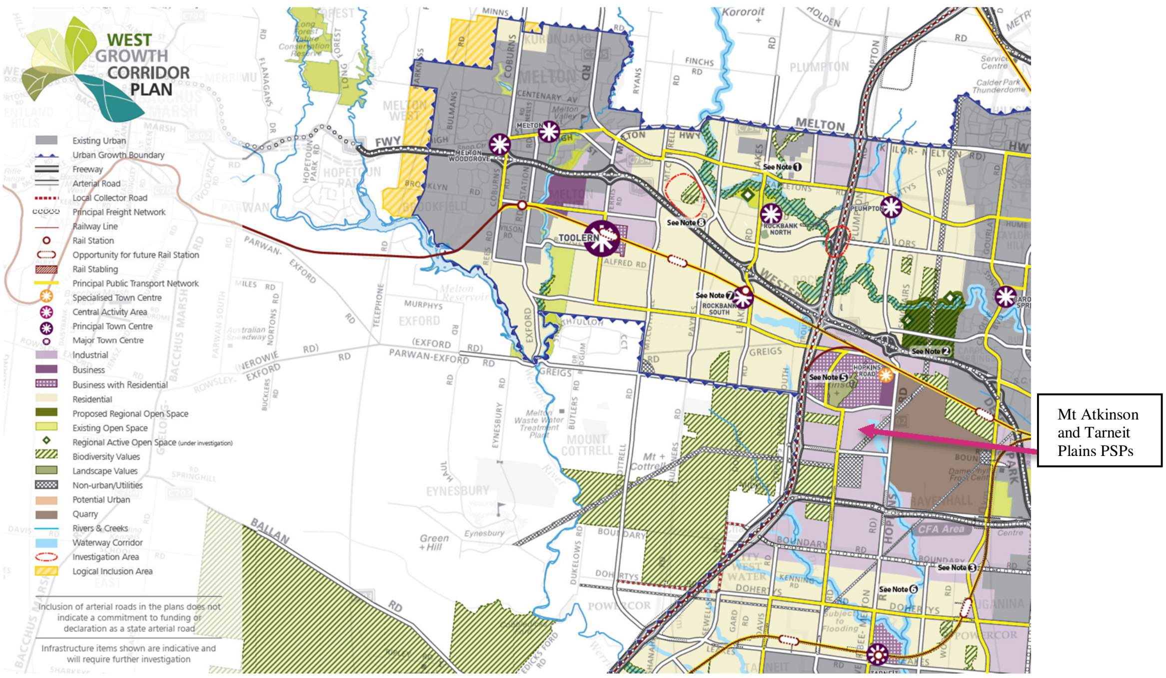


Figure 1 Extract from Western Corridor Growth Plan (source: MPA)

Placing an integrated water cycle at the centre of design can deliver multiple wider benefits.

Water Supply

Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, greywater and groundwater. Capital investment and whole-life cost savings.

Wastewater

Reduction of surface water volume to sewers, extending network asset life, improving water quality (fewer spills to rivers from combined sewer overflows), and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.

Flooding

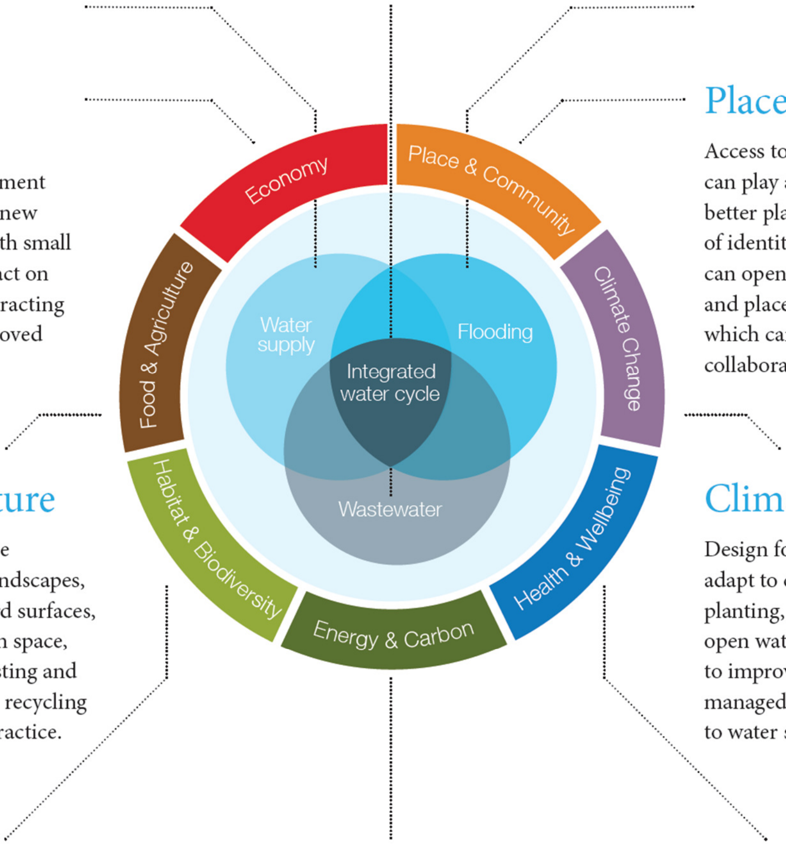
Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.

Economy

Potential direct contribution through water-related investment in infrastructure, associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.

Place & Community

Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.



Food & Agriculture

Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.

Climate Change

Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.

Habitat & Biodiversity

New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.

Energy & Carbon

Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater. Potential for renewable energy generation from hydro and waste.

Health & Wellbeing

Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.

Figure 2 The benefits of a WoWCA approach © Arup

The development of a WoWCA for the two PSP's involves a number of key steps which include:

1. Development of a base case report to document key site characteristics and the business as usual scenario (completed in September 2014 and updated with the revised draft future urban structure for consultation (April 2015) in this report)
2. Consultation with stakeholders to explore if there are other more innovative and efficient options which meet the required criteria (completed January 2015)
3. Assessment of alternative options and comparison with the base case (the subject of this report)

The purpose of this study is to identify a high-level strategy and schematic design for integrated water management within the study area, namely the two PSPs, and to identify any issues or considerations for the future urban development of the study area.

Required outputs include the provision of supporting documentation which considers options for an urban structure to facilitate whole-of-water-cycle management and which recommends a preferred option for inclusion into the PSP.

The assessment will enable MPA to plan the future urban structure for the Mt Atkinson and Tarneit Plains PSPs with greater certainty by identifying issues relating to land capability early in the planning process.

1.1 Report Contents

This Summary Report brings together work undertaken to date, stakeholder feedback through the stakeholder workshop conducted in January 2015, comments received after the workshop and consultation with key stakeholders along with other background information available regarding the Mt Atkinson and Tarneit Plains PSPs such as heritage and biodiversity constraints, roads and utilities placement, commercial and community facilities and open space.

This Summary Report is a high level strategy and schematic design responding to MPA instructions and issues arising from stakeholder workshops and makes recommendations on the draft future urban structure for the two PSPs including:

- Details of drainage, stormwater, constructed waterways, open space, waterways corridors, conservation areas that are required to support delivery of the options
- A depiction of how the draft urban structure could be amended to accommodate each of the whole-of-water-cycle options investigated
- A strategy and schematic design identifying the alignment of drainage lines/waterways and location and size of retarding basins and water quality treatment wetlands (or other water retardation or treatment facilities)
- High level opinion of cost to implement and maintain the short-listed options.
- High level comparative analysis that provides relative statements of advantages and disadvantages of each whole-of-water-cycle management option against relevant criteria (environmental impact, infrastructure requirements, etc) to assist in establishing a preferred outcome.

- Schematic plans and figures to visually demonstrate the mapping of the land take and infrastructure (required water, sewerage, alternative water, and drainage services) for each whole-of-water-cycle management option to be assessed in its relationship to the other precinct networks, including open space, community facilities and transport.

1.2 WoWCA Process and Precinct Structure Planning

According to MPA in the context of Precinct Structure Planning, whole-of-water-cycle management seeks to make effective use of all sources of water by tailoring them to different locations and circumstances and thereby delivering multiple benefits.

Sources of water could include recycled water, rainwater, stormwater, wastewater, groundwater, potable water and waterways. Whole-of-water-cycle management at the PSP scale helps:

- support liveable and sustainable communities;
- protect the environmental health of urban waterways and bays;
- provide secure water supplies efficiently;
- protect public health; and
- deliver affordable, essential water services.

The MPA Integrated Water Management PSP Note requires that each PSP include WoWCA. The PSP Note outlines the following key WoWCA concepts:

"The aim of the integrated water management plan is to identify and bring together relevant water strategies and plans to consider land use impacts and opportunities as part of an overall approach. The objective is to consider how to manage water as a strategic resource within a sustainable development framework."

"Opportunities need to be considered for combining land uses such as drainage infrastructure, recreational facilities, open space and walking and cycling trails. This approach can lead to significant cost savings while promoting efficient use of land, which ultimately assists housing affordability."

Figure 3 shows the scale and applicability of water options and at which planning scales they should be considered.

Table 1: The Water Options

	SCALE			
MANAGEMENT TECHNIQUE	Regional	Precinct (PSP)	Development /Local	Domestic / Household
Aquifer Recharge and Rural Reuse	Non-PSP			
Retarding Basins	Non-PSP	PSP	Non-PSP	
Purple pipe	Non-PSP			
Potable Water	Non-PSP			
Wetlands	Non-PSP	PSP	Non-PSP	
Sewerage Treatment & Recycled Water Plants	Non-PSP	PSP		
Dams	Non-PSP			
Rivers & Creeks	Non-PSP	PSP	Non-PSP	
Sewer Mining	Non-PSP			
Stormwater capture and reuse	Non-PSP	PSP	Non-PSP	
Pricing	Non-PSP			
Aquifer Recharge and Urban Reuse	Non-PSP	PSP		
Land Use Layout & Green space		PSP	Non-PSP	
Sediment traps		PSP	Non-PSP	
Bio-retention systems		PSP	Non-PSP	
Swales		PSP	Non-PSP	
Local run off treatments			Non-PSP	Non-PSP
Litter traps			Non-PSP	
Infiltration trenches			Non-PSP	
Porous Paving			Non-PSP	Non-PSP
Rain Gardens			Non-PSP	
Greywater Reuse			Non-PSP	Non-PSP
Rainwater Capture (roofs) and re use			Non-PSP	Non-PSP
Inspection and monitoring			Non-PSP	Non-PSP
Rooftop greening				Non-PSP
Onsite domestic sewerage treatment and reuse				Non-PSP
Education				Non-PSP

PSP
Non-PSP

Figure 3 Scale and Applicability of Water Options (source: MPA (GAA) PSP Notes Integrated Water Management)

This ultimate WoWCA developed is required to consider *Melbourne's Water Future* and the nominated whole-of-water-cycle performance outcomes and urban planning outcomes relevant to the PSP area in accordance with the IWM PSP Note. The plan should also consider available outputs of *Water Future West*, the draft proposed *Whole of Water Cycle Management Plan for Melbourne's West* and the sub-plan for Melton currently under development by various stakeholders.

The western region has the potential to benefit strongly from whole-of-water-cycle planning as it:

- has low rainfall
- is remote from drinking water sources

- will continue to experience rapid urban growth
- hosts important irrigation districts
- is connected to major sewerage treatment plants which are an important source of recycled water; and
- contains the water-stressed reaches of the Werribee River and Deep Creek, as well as a range of pristine and degraded waterways.

MPA WoWCA Objectives

Objectives of the whole-of-water-cycle assessment include:

- Diversification of supply thereby reducing the cost of future large scale centralised water/wastewater systems
- Waterway health improvement, consisting of less volume and higher quality
- Management of potential flooding and decreasing flood risk
- Improved liveability and urban landscapes
- Engagement of the community via key stakeholders.
- It is likely that there are other opportunities within the planning and building process that will also help to deliver on the above objectives.

To deliver on these objectives, whole-of-water management opportunities could include:

- Minimising potable water usage by use of alternative water supplies
- Roof rainwater harvesting
- Stormwater harvesting
- Stormwater quality measures
- Flood management including the minimisation of flood extents
- Sewer mining
- Groundwater including aquifer storage and recovery
- Sewage treatment and discharge
- Improving environmental, landscape and liveability outcomes through water management.

Water Future West Objectives

1. Support liveable and sustainable communities
    - Local agriculture and industry provides jobs and prosperity
    - Amenity in the West that creates community pride of place
    - Improved flood protection
    - Natural resources and built assets are valued, protected and used efficiently
    - Community is well informed, engaged and empowered with water cycle management
2. Enhanced environmental health of waterways and bays
    - The health of waterways and ecosystems are protected and enhanced
3. Secure water supplies are efficiently provided
    - Reliable fit-for-purpose water for optimal community outcomes is provided
    - Resilience and adaptability to shocks and trends including climate variability is provided
4. Public health and well-being is improved
    - Public health and safety for all in the community is protected and enhanced
    - Climate resilient water and green space is provided in the urban environment to enhance community health and well-being, and to promote active lifestyles
5. Affordable essential water services are delivered
    - Efficient and affordable water solutions for brownfield and greenfield sites are provided

1.3 Acknowledgments

In developing this WoWCA summary report Arup have consulted with the organisations and persons noted below. The purpose of the consultation has been to understand each organisations position with respect to a proposed water strategy for the Mt Atkinson and Tarneit Plains PSP areas, thereby ensuring that the proposed strategy developed as part of this work is congruent with the intentions of each organisation. Arup wishes to acknowledge the following people and organisations who have provided input into the preparation of the summary report.

Table 1 Organisations and persons consulted in development of summary report

Organisation	Name
MPA	Martina Johnson Stephanie Harder Chris Braddock
City West Water	Michelle Pinan Bruce Collins John Kirkbride Nigel Corby Elisa Hunter
Melton City Councl	Charles Cornish Tim Sergiacomi Lucy Slater
Melbourne Water	Stephen Miller Matthew Potter Digby Richardson Sarah Watkins Mike Brown Marion Urrutiagure
Department of Environment, Land, Water and Planning	Abby Farmer Bridget Wetherall Elliot Stuart John Chambers
Western Water	Kate Berg Julian Tully Derek Robertson Shane Cowie Anna May

2 Site Details

Mt Atkinson and Tarneit Plains are located approximately 25 kilometres west of Melbourne's CBD (see **Figure 4**). Both the Mt Atkinson and Tarneit Plains PSPs are located within the Melton City Council area. The precincts are bounded by the Western Freeway to the north; Hopkins/Derrimut Road to the east; Middle Road to the south; and the future Outer Metropolitan Ring road (just east of Troups Road South) to the west. Both areas are identified to provide local and regional employment opportunities with significant areas proposed for industrial uses as well as for business and residential uses.

The site also contains:

- biodiversity areas which are currently being investigated to establish their conservation values,
- high voltage power lines and a proposed SP Ausnet terminal station site,
- an existing chicken farm,
- a former volcano known as Mt Atkinson which provides a significant landscape feature (143m above sea level),
- the Skeleton Creek headwaters (ephemeral) and possible seasonal herbaceous wetland (subject to Melbourne Water investigation),
- gas transmission pipelines.

This draft Future Urban Structure (FUS) plan shows how the land should be developed within Mt Atkinson PSP area (1050 hectares) and Tarneit Plains PSP area (485 hectares).The current draft FUS is focussed on developing a critical population mass of 15 to 20 thousand people to create a sense of place in line with the site constraints and surrounds (see **Figure 5** and **Figure 6**). It proposes industrial areas to the south and between the Freeway and rail line; a town centre, future train station, higher density residential between commercial and more typical residential areas; commercial along the east and parts of the north (and possibly along the OMR); and typical residential densities around the mountain.

Population densities of an average 15-20 lots per hectare are currently being planned for while current estimates are that ~26 ha will be required for active open space. These active open space may present a good opportunity to co-locate with stormwater related assets to improve urban form, amenity, create place and maximise stormwater harvesting potential

The Boral Quarry to the east and some associated landfill uses (with possible future expansion) require careful consideration in planning for this PSP. The quarry, established in 1968, extracts basalt for use in the construction industry. The quarry has been described as a “very major extractive industry and landfill operation” with a “very long term life span”. The first stages of the quarry have since been filled with landfill. The ‘active’ area of the quarry is to the south of Riding Boundary Road and in the eastern half of the site. Boral has indicated that the existing landfill is now nearing its capacity under the current approved area.

Two areas of biodiversity within the PSP areas have been identified within Biodiversity Conservation Strategy for Melbourne's Growth Corridors (2013): Conservation Area 7 (32 Ha) and Conservation Area 8 (113 Ha). These are intended to protect high quality native grassland.

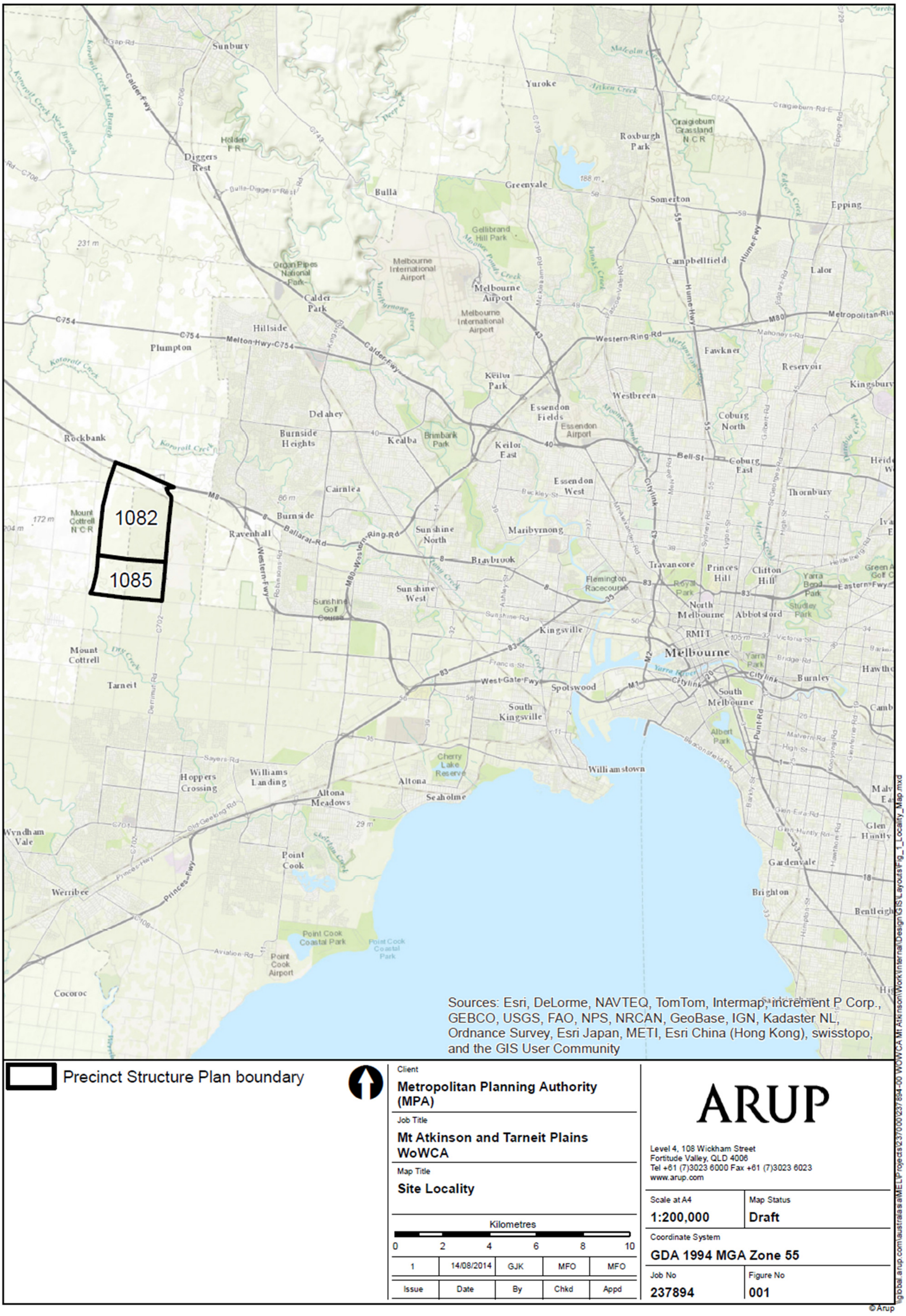


Figure 4 Locality map

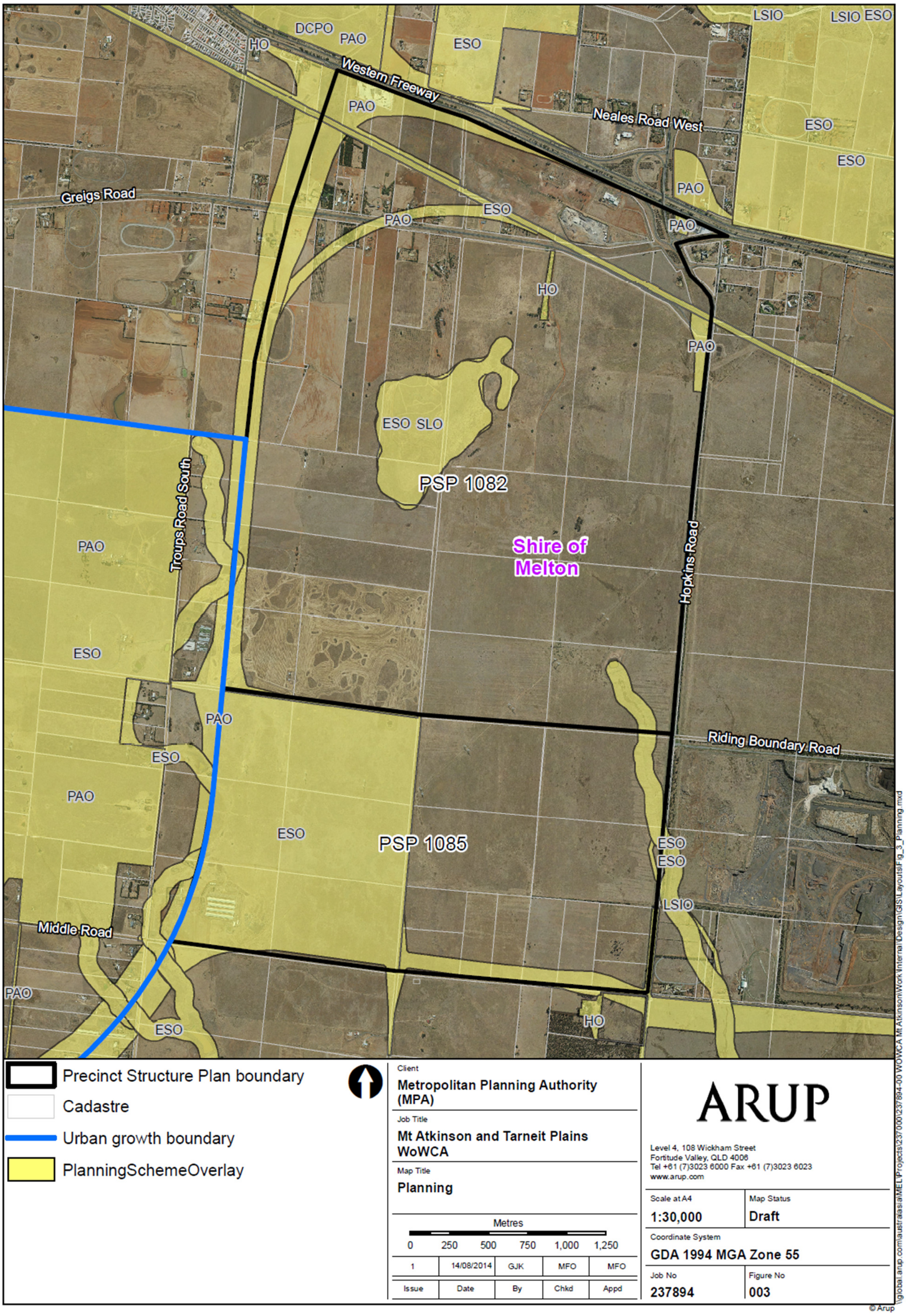


Figure 5 Victorian Planning Scheme and Urban Growth Boundary

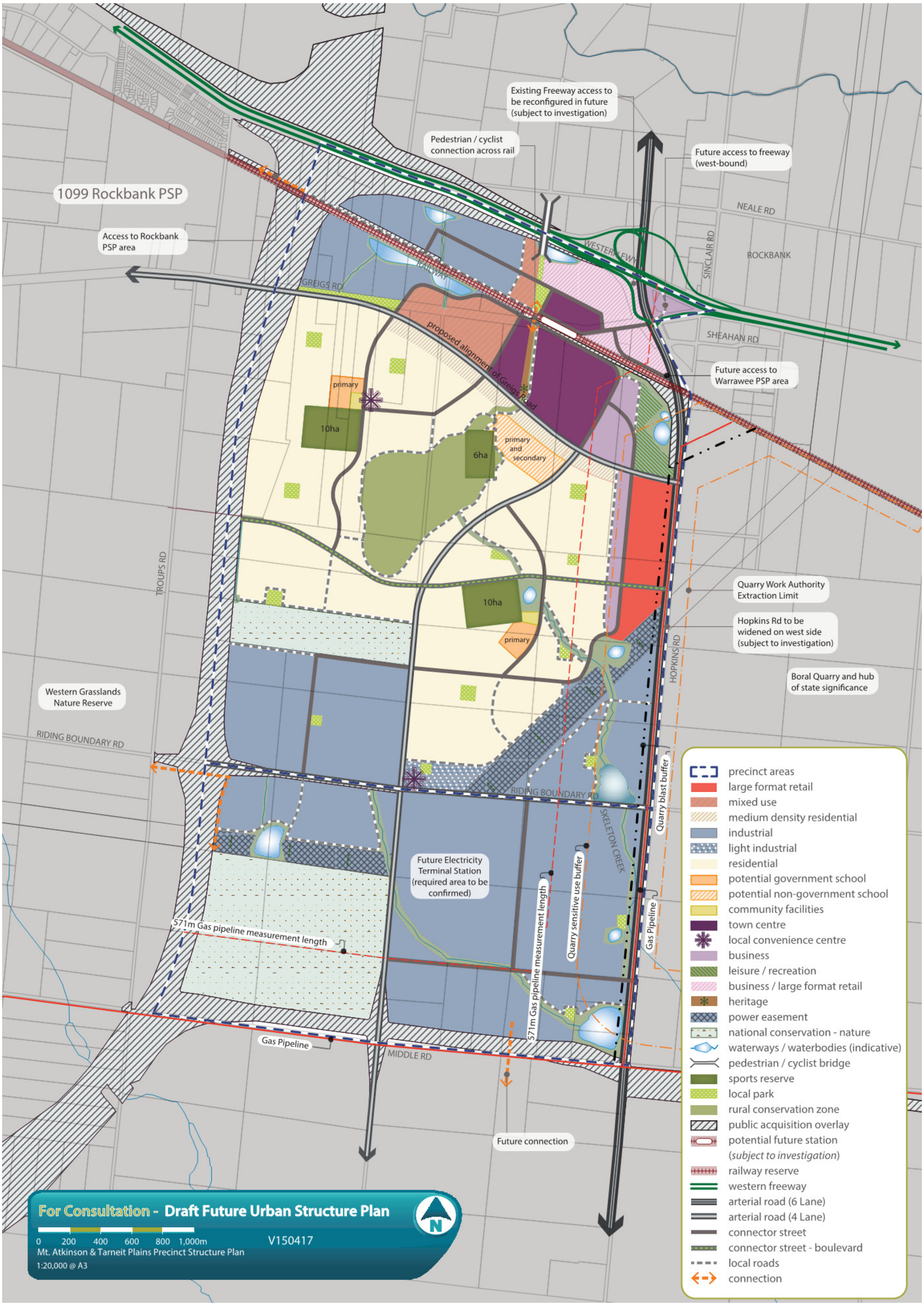


Figure 6 Draft Future Urban Structure for Consultation April 2015 (source: MPA)

2.1 Hydrology

Runoff from the precinct areas north of Mt Atkinson will generally flow towards Kororoit Creek. Runoff from the precinct areas south of Mt Atkinson will generally flow towards Skeleton Creek. Skeleton Creek originates near the Western Freeway in Truganina and passes through Hoppers Crossing and Point Cook before discharging to Port Phillip Bay near Altona Meadows via the Cheetham Wetlands. Tributaries to Skeleton Creek include Dry Creek, Forsyth Road Drain and Cheetham Creek. The creek is in moderate condition but is becoming increasingly urbanised with new development posing a major risk to its health. The creek has important Aboriginal spiritual significance and parts of the creek are popular for recreation.

Wetlands play a key role in the lower catchment, with many of the major rivers and creeks flowing through coastal wetlands listed under the international Ramsar convention. These coastal wetlands help reduce the impacts from storm damage and flooding, maintain good water quality in rivers, recharge groundwater, store carbon, help stabilise climatic conditions and control pests. They also are important sites for bio-diversity, agriculture, forestry and tourism.

Waterway health in this system faces a number of challenges such as:

- urbanisation and altering waterways for flood protection
- previous industrial activity such as quarrying and agriculture
- balancing social and environmental needs

The *Healthy Waterways Strategy* outlines Melbourne Water's role in managing rivers, estuaries and wetlands in the Port Phillip and Westernport region for the 2013/14 – 2017/18 period. It is closely linked to the Stormwater Strategy, which focuses on managing stormwater to protect and improve the health of waterways and bays.

Within the Healthy Waterways Strategy the Skeleton Creek management unit is characterised by the following key features:

- Frogs: six of the expected 11 species have been recorded in this management unit which is home to the endangered growling grass frog.
- Fish: seven of the expected 13 species have been recorded in this management unit, four of which are native.
- Birds: insufficient surveys at management unit scale.
- Priority areas: Skeleton Creek management unit contains priority areas for birds and amenity. Management objectives are to improve the diversity and abundance of streamside and wetland birds and improve amenity.
- Future management in 2030 vision: extensive water sensitive urban design features have been installed throughout the catchment which has improved water quality. Cheetham Wetlands in the lower part of the catchment continue to be a significant site for migratory birds and are managed for conservation.

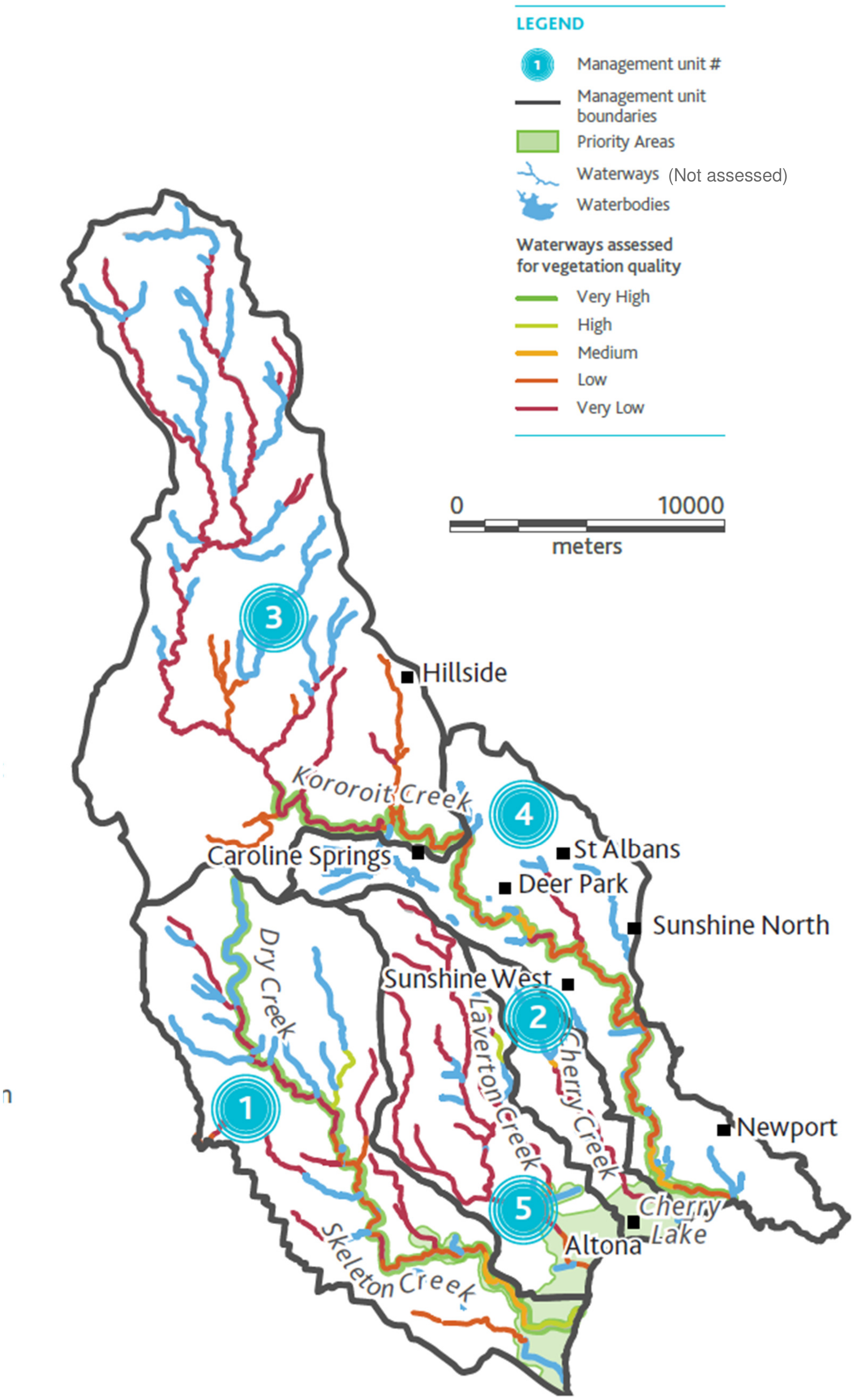


Figure 7 Map of Cherry, Kororoit, Laverton, and Skeleton system (source: Melbourne Water)

2.2 Groundwater

With reference to the DNRE Groundwater Beneficial Uses Map for South Western Victoria (1994) and the Melbourne Groundwater Directory, the groundwater beneath the site is present in two main aquifers, the upper Newer Volcanics aquifer, a fractured rock basalt aquifer (approximate depth 5 – 20m), and a deeper regional bedrock aquifer within the Silurian aged formation.

Groundwater within the upper aquifer is expected to have salinity in the range of 1,000 - 13,000 mg/L TDS, which classifies the groundwater as Segments B and C under the Groundwater SEPP (1994).

The Victorian Water Resources Map identified 22 registered boreholes within the site boundary of PSP 1082 and 1085 (see **Figure 8**).

2.3 Site Soil Characteristics

The Australian Soil Resource Information (ASRIS) map identifies the soils beneath Mt Atkinson and Tarneit Plains PSPs are predominantly Sodosols classification. Sodosol soils are generally shallow dark and reddish brown heavy clays with thin loamy topsoil. Outcrops of basalt rock are common and basalt floats occur extensively.

"Sodosols show strong texture contrast with highly sodic B horizon but they are not highly acidic (pH > 5.5). Parent materials of Sodosols range from highly siliceous, siliceous to intermediate in composition. Sodosols are only found in poorly drained sites with rainfall between 50mm and 1100mm. Generally, sodosols have very low agricultural potential with high sodicity leading to high erodibility, poor structure and low permeability. These soils have low to moderate chemical fertility and can be associated with soil salinity."
http://www.soil.org.au/soil_types.htm

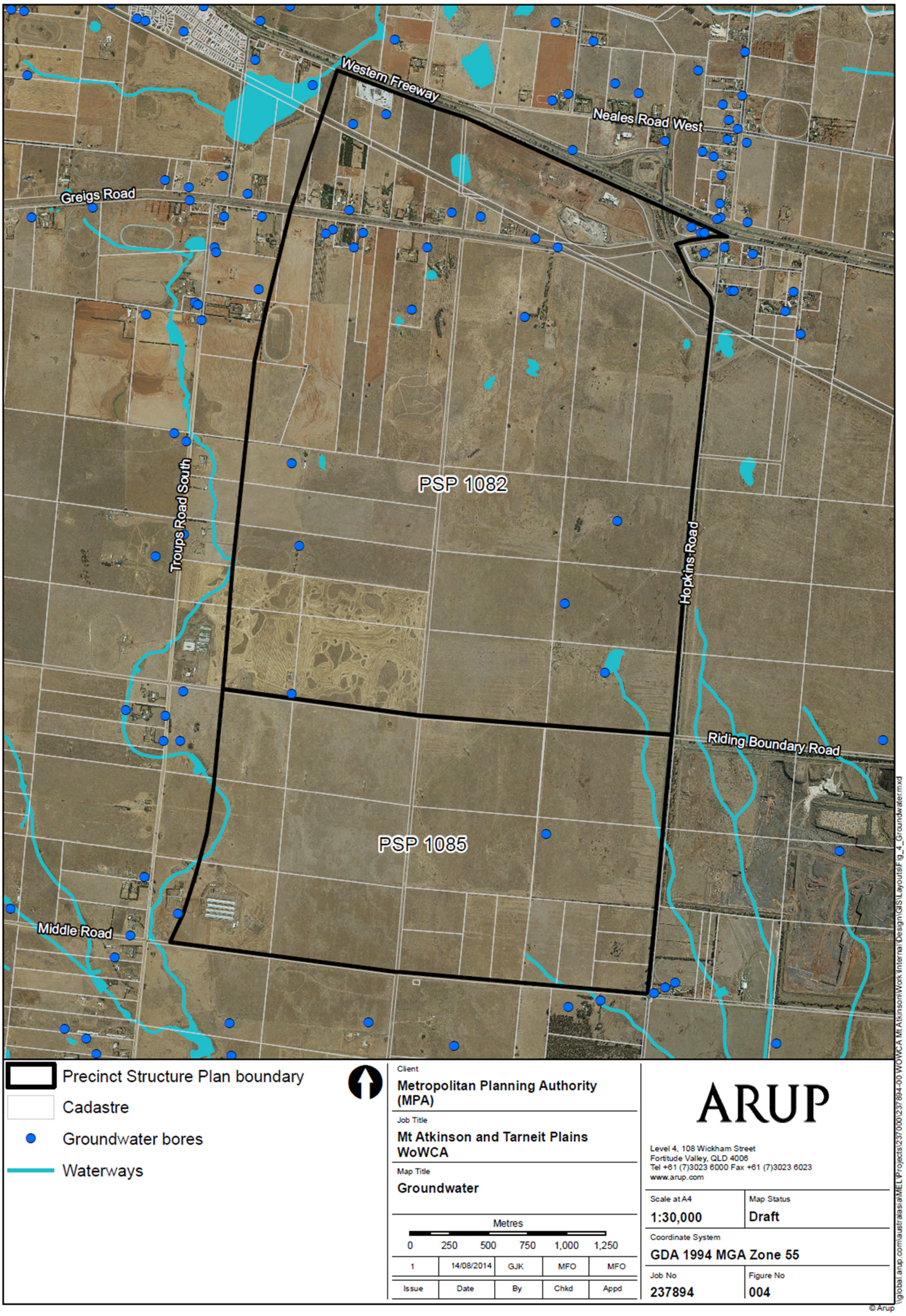


Figure 8 Registered Groundwater Bores within the PSPs (source: Victorian Water Resources Data Warehouse)

3 Option Description and Assumptions

A key component of this phase of work was to collaborate with the project stakeholders (organisations listed in

Table 1) to develop two alternative whole of water cycle options for the PSP areas and the assumptions on which analysis of these are based. This was done via face-to-face meetings, a stakeholder workshop and a formal feedback process on the alternatives developed.

3.1 Alternative Option Development

Stakeholders were asked to assist in the development of alternative WOWCA servicing options that better align with the overarching WOWCA objectives and helped leverage regional and city scale objectives as the local scale as outlined in **Figure 9**. The development of alternative WOWCA serving options were also placed in context with the Melton-wide WOWCA, which is currently under development.

CITY SCALE	
Metropolitan Integrated Water Cycle Strategy	City-wide vision Cross-boundary infrastructure (wastewater, water, drainage, waterways) – pending deferral through local scale planning City-wide objectives, standards, indicators
REGIONAL SCALE	
Regional Integrated Water Cycle Strategy	Regional vision Atlas of opportunities and constraints Regional infrastructure – pending deferral Regional objectives, standards and indicators
SUB-REGIONAL SCALE	
Integrated Water Cycle Strategy **Management – Urban Renewal** **Growth Corridor Planning**	Sub-regional vision Sub-regional infrastructure – pending deferral through local scale planning Sub-regional objectives, standards, indicators
LOCAL SCALE	
Precinct Structure Plans	Local vision Local infrastructure – pending deferral through regional scale planning Local objectives, standards, indicators

ASSET UPGRADES AND RENEWALS

Figure 9 The hierarchy of whole of water cycle management (source: Yarra Valley Water, OLV and Melbourne Water)

These alternative options were developed at a highly interactive Stakeholder Workshop held in Arup's offices on 22 January 2015. Stakeholders were asked to consider site specific objectives and the mechanisms to achieve these objectives via the alternative options developed.

The workshop was attended by representatives of:

1. Metropolitan Planning Authority
2. Department of Environment, Land, Water and Planning
3. Melton City Council
4. City West Water
5. Western Water
6. Melbourne Water

Post workshop the information was collated to develop two alternative WOWCA options. These were then circulated to stakeholders for comment.

Key comments were received by the following organisations:

1. Melbourne Water – residential rainwater tanks are to be incorporated to 6 star requirements; the future "stretch" BPEM targets with flow reduction targets are to be considered for the alternatives; and an alternative to include active open space stormwater harvesting is also sought.
2. Western Water – Alternatives and base case to include recycled water supply.
3. Department of Environment, Land, Water and Planning - the future stretch BPEM targets with flow reduction targets are to be considered for the alternatives and an alternative to include passive irrigation of streetscape.
4. City West Water – Alternatives are be cost comparable (i.e. directly comparable).

These comments were considered and the alternative options were re-drafted to account for this stakeholder feedback.

3.2 Options Description

3.2.1 Business as Usual (BaU)

The first stage of the WoWCA was to define and develop a business as usual (BaU) for consideration by the wider stakeholder group. To ensure consistency with regional planning approaches the BaU scenario has been developed based on discussion held with City West and Western Water regarding proposed water servicing strategies for the region.

It has been recognised that while recycled water provision to these PSPs is a likely possibility, it has been acknowledged that these areas have not been mandated. In the stakeholder workshop it was greed by all parties that the provision of recycled water will be considered in BaU scenario and in both of the alternatives.

The BaU scenario also recognises that in areas where recycled water is provided that uptake of residential rainwater tanks is approximately 5%.

The BaU scenario was further defined and was presented to the stakeholders for comment and discussion at a subsequent stakeholder workshop. The BaU scenario was updated following comments from stakeholders regarding the supply and use of water, new demand figures and an update to the draft future structure plan.

Business as Usual

Piped drinking water supply and sanitation services are provided through connection to Melbourne's existing or proposed centralised infrastructure. Recycled water provided to all households (toilet flushing, irrigation and washing machine) as well as commercial, industrial and educational uses for non-potable use.

With the introduction of the 6 Star Homes standards in 2011, 30 per cent of all new residential homes now install rainwater tanks for toilet flushing and outdoor uses and it is assumed this trend will continue. (In areas where recycled water is provided, this is not the case.) The 6 star requirements are prescriptive and requires a 2000 L tank connected to a minimum of 50 m^2 of roof and servicing all toilets. Household tank take-up reduced to 5% due to availability of recycled water.

Rainwater and stormwater is collected in pipes and treated through a series of settling ponds and wetlands prior to discharge into the receiving waterway in line with current BPEM requirements. 1 in 100 year ARI flood protection provided.

Figure 10 provides a graphical representation of the flow of water under the agreed BaU scenario. The BaU scenario has been modelled based on the following assumptions which have largely been drawn from data collection and information provided by MPA regarding expected densities and future urban form.

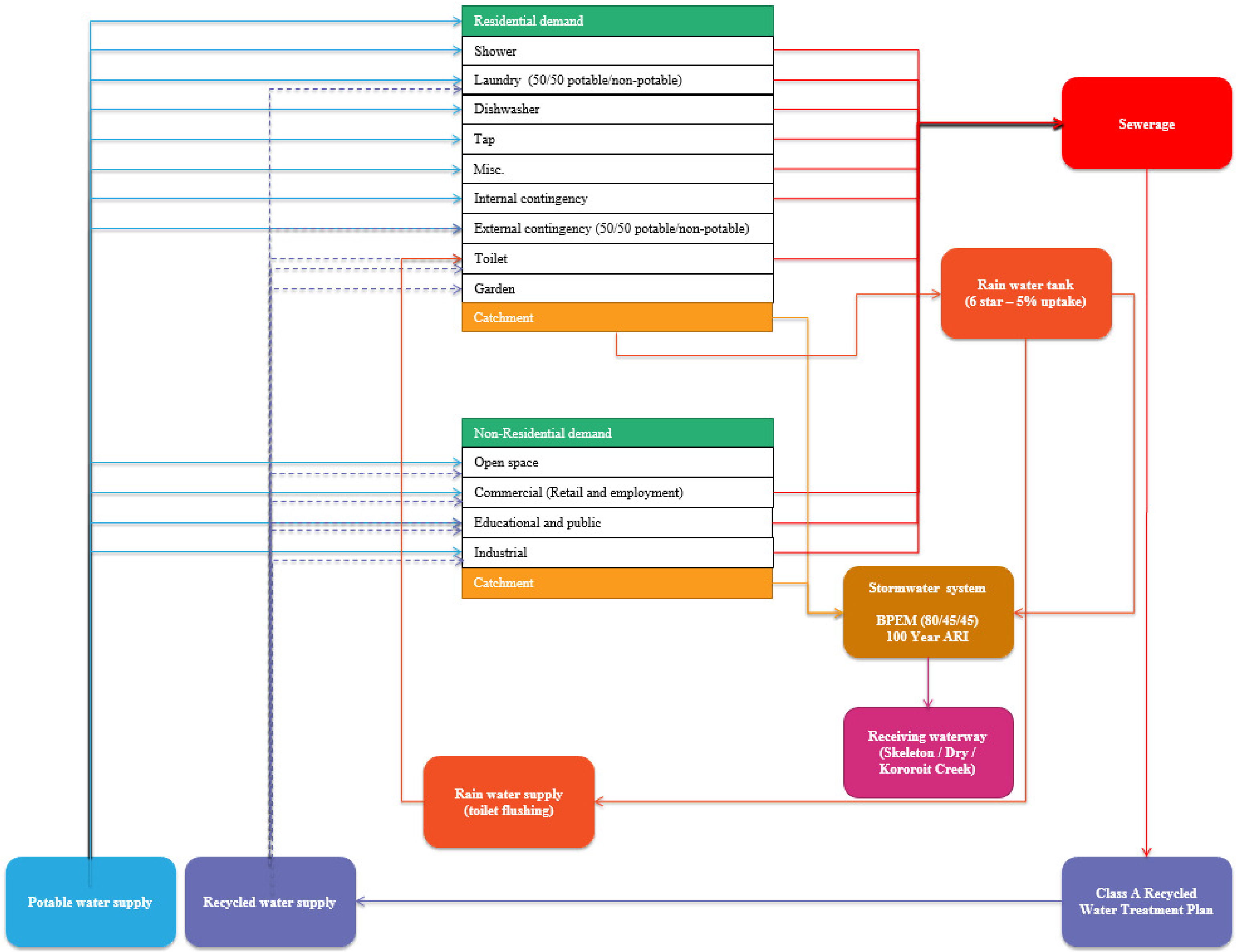


Figure 10 Business as Usual Water Flows

3.2.2 Alternative 1 – Enhanced Liveability

Alternative 1 has been developed to build on the elements identified in the BaU scenario and to reimagine/leverage these for improved WoWCA outcomes. A schematic flow diagram of water flows in this option are provided in **Figure 11**

Alternative 1 – Enhanced Liveability

Piped drinking water supply and sanitation services are provided through connection to Melbourne's existing or proposed centralised infrastructure. Recycled water provided to all households (toilet flushing, irrigation and washing machine) as well as commercial, industrial and educational uses for non-potable use.

Household tank take-up reduced to 5% due to availability of recycled water. Tanks are sized to capture 90-100% of available roof area and are directed to toilet flushing, irrigation and clothes washing.

Stormwater management as per Melbourne Water's proposed DSS with 1 in 100 year ARI detention and treatment to meet potential future BPEM requirements (as per the table below) however some assets are to be 'broken up' and distributed throughout individual catchment, in particular locating evapotranspiration beds within the perimeter of conservation areas and power easements to minimised developable land uptake. Additional evapotranspiration beds are located adjacent to proposed wetlands. The stormwater management assets implemented are to be sized to reach 60% total annual runoff volume reduction of post development volumes. This alternative has an enhanced liveability focus, so priority is given to schemes such as passive watering of street trees, promoting permeable pavements in appropriate locations and enhancing the social amenity of distributed stormwater management assets.

Potential enhanced water quality standards for all completed development targets are defined as below:

Reduction in mean annual total suspended solids load	85%
Reduction in mean annual total phosphorous load	50%
Reduction in mean annual total nitrogen load	50%

Recommended Flow standards for catchments with non-tidal and unlined waterways:

Ecological condition of catchment:	Total Annual Runoff Volume reduction
Percentage reduction in mean annual total runoff volume: Average rainfall (mean annual 500 -800mm/yr)	60%
Minimum % of mean annual rainfall volume contributing to base flow	10%
Stream Erosion Index	1.0

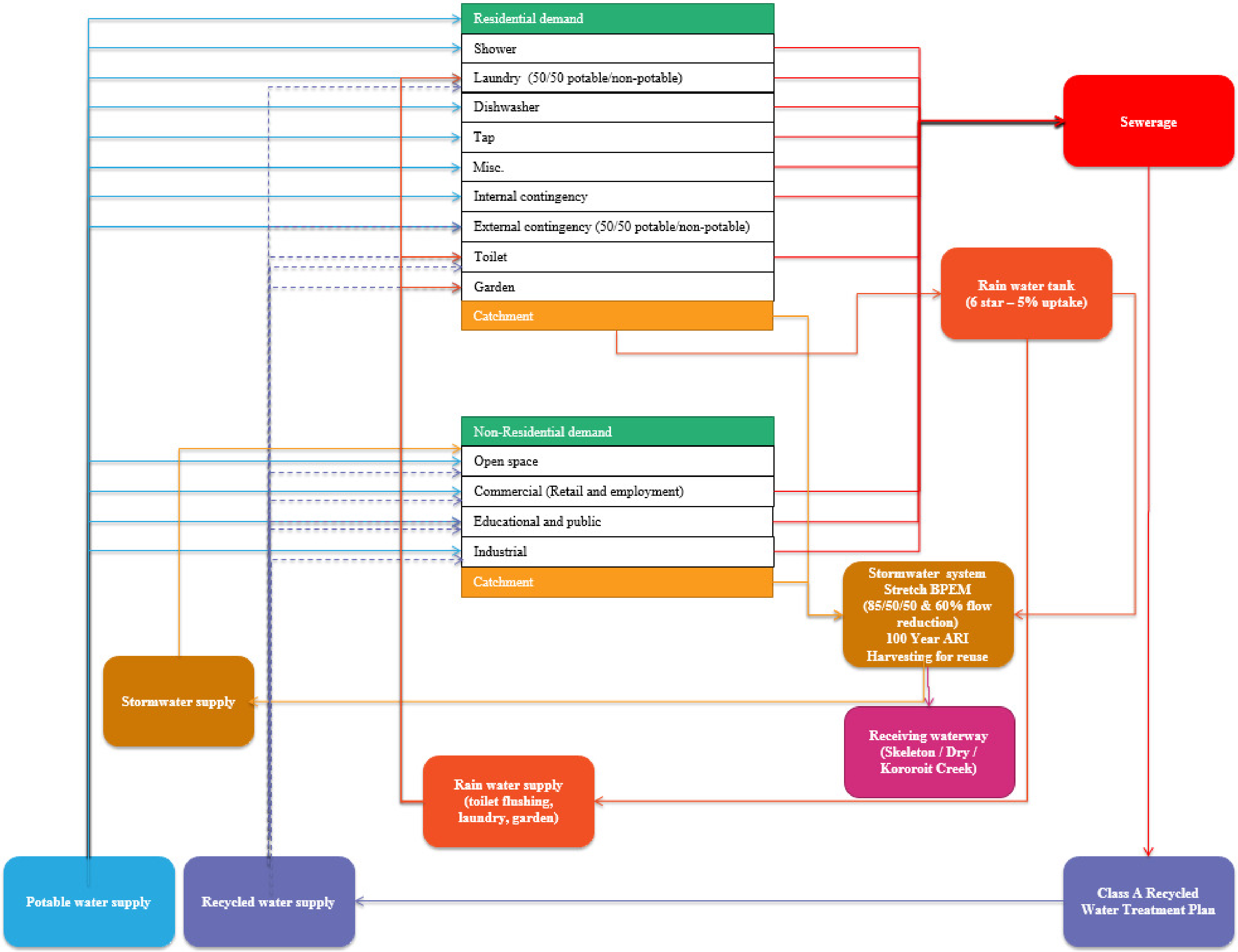


Figure 11 Alternative 1 enhanced liveability - water flows

3.2.3 Alternative 2 – Enhanced Waterway Health

Alternative 2 was developed to introduce catchment stormwater harvesting schemes to supply part of the non-potable water demand and also attempts to explore the benefits of a distributed approach to runoff water quality treatment and encourage innovation. A schematic flow diagram of water flows is provided in **Figure 12**.

Alternative 2 – Enhanced Waterway Health Focus

Piped drinking water supply and sanitation services are provided through connection to Melbourne's existing or proposed centralised infrastructure. Treated stormwater provided to all households from catchment stormwater harvesting schemes for non-potable reuse (toilet flushing, irrigation and washing machine) as well as commercial, industrial and educational uses for non-potable use. Recycled water from regional treatment facility available for backup.

Household tank take-up reduced to 5% due to availability of recycled water. Tanks are sized to capture 90-100% of available roof area and are directed to toilet flushing, irrigation and clothes washing.

In line with potential increased BPEM requirements (see table below) additional rainwater and stormwater runoff is collected and treated through a series of distributed WSUD infrastructure including median strips of higher order roads where slopes of 2% to 5% to approved Melton City Council requirements and evapotranspiration beds in conservation and power easements. Meandering drainage lines explored to increase treatment and infiltration. Any additional water to be directed evapotranspiration beds. The stormwater management assets implemented are to be sized to reach 90% total annual runoff volume reduction of post development volumes.

Potential enhanced water quality standards for all completed development targets are defined as below:

Reduction in mean annual total suspended solids load	85%
Reduction in mean annual total phosphorous load	50%
Reduction in mean annual total nitrogen load	50%

Recommended Flow standards for catchments with non-tidal and unlined waterways:

Ecological condition of catchment:	Total Annual Runoff Volume reduction
Percentage reduction in mean annual total runoff volume: Average rainfall (mean annual 500 -800mm/yr)	90%
Minimum % of mean annual rainfall volume contributing to base flow	10%
Stream Erosion Index	1.0

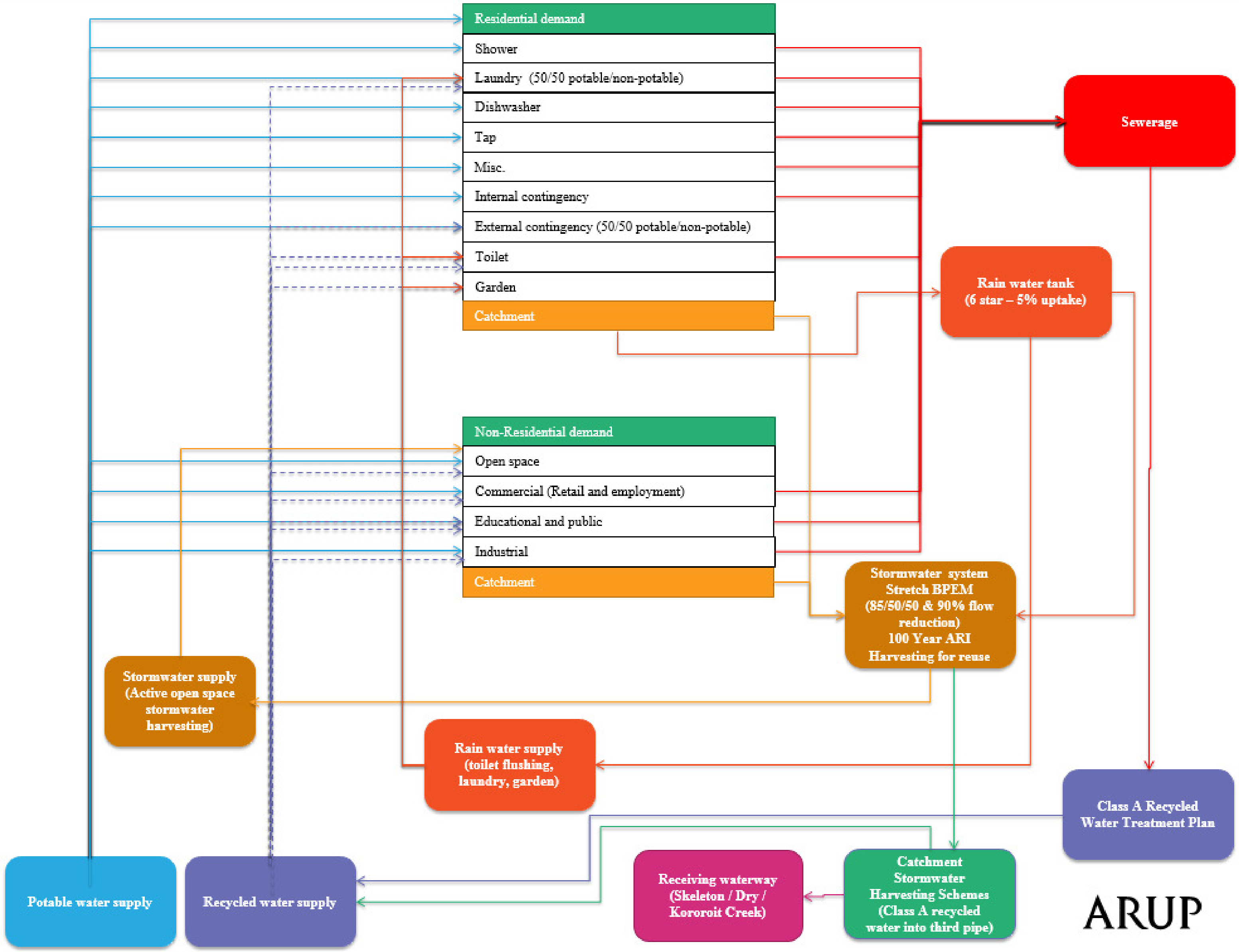


Figure 12 Alternative 2 – water flows

3.3 Key Assumptions

3.3.1 Land Use Types Requiring Water

The following land uses have been identified within the PSP areas as requiring some form of water servicing.

- Residential
  - Town Centre High Density Dwellings
  - Medium Density Dwellings
  - Conventional Low Density Dwellings
- Commercial/Retail
  - Office
  - Town Centre Retail, including DDS, two supermarkets and specialty retail
  - Town Centre Total
  - Bulky Goods Retail
  - Other Commercial/Mixed Use, including other commercial/light industrial such as car showrooms, panel beaters, service stations, trade supplies, etc
- Industrial
- Active Open Space

3.3.2 Land Use Assumptions

3.3.2.1 Mt Atkinson and Tarneit Plains

The land use split for Mt Atkinson PSP, including employment and residential assumptions have been provided by MPA.

Employment assumptions:

The table below provides square metres for office, retail and other town uses for Mt Atkinson– this is net area and not land area.

Table 2 Commercial net area and employment assumptions: Mt Atkinson & Tarneit Plains (as at March 2015)

Land Use	Net Area (Expected sqm demand (JLL))	Employment measure	Number of employees
Office	40,000	1 Job per 20 sqm	2,000
Town centre retail	23,500	1 job per 30 sqm	783
Town Centre total*	15,600	1 Job per 20 sqm	780

The table below provides the land area and employment assumptions for industrial and other commercial areas for Mt Atkinson and Tarneit Plains (as at March 2015).

Bulky goods retail[1]	100,000	40 - 50 jobs per ha	2,222

Table 3 Land area and employment assumptions: Mt Atkinson and Tarneit Plains

Land Use	Land Area (ha)	Employment measure	Number of employees
Residential Net Developable Area	471	N/A	N/A
Industrial	541	15-20 jobs per ha	9467.5
Other Commercial/ mixed use	58	40 jobs per ha	2320
Active Open Space	26	N/A	N/A

Total number of employees in Mt Atkinson Scenario and Tarneit Plains is **17,573**.

Residential assumptions:

Residential population yield breakdown for dwelling densities have been provided by MPA and are documented below for Mount Atkinson (no residential in Tarneit Plains). These values are draft (are subject to change), but have been used for the purposes of this report.

The residential Net Development Area is 471 hectares with a 70% yield, resulting in 329 hectares of Net Development Area.

Table 4 Residential estimates for Mt Atkinson (no residential in Tarneit Plains)

	Area (ha)	Number of Lots	Population
Town Centre: High Density Dwellings	12	1200	3360
Medium: Medium Density Dwellings	58	1740	4872
Conventional: Low Density Dwellings	260	4290	12012
Total	***329***	***7230***	***20244***

Land use for water supply breakdown:

The land use for water supply breakdown in **Figure 13** has been provided by MPA and is a summary of **Table 2** and **Table 3**.

[1] MPA have advised that bulky goods floorspace will range from 40,000 – 100,000 sqm, as described in the JLL report. For modelling purposes this report adopts 100,000 sqm as a baselien

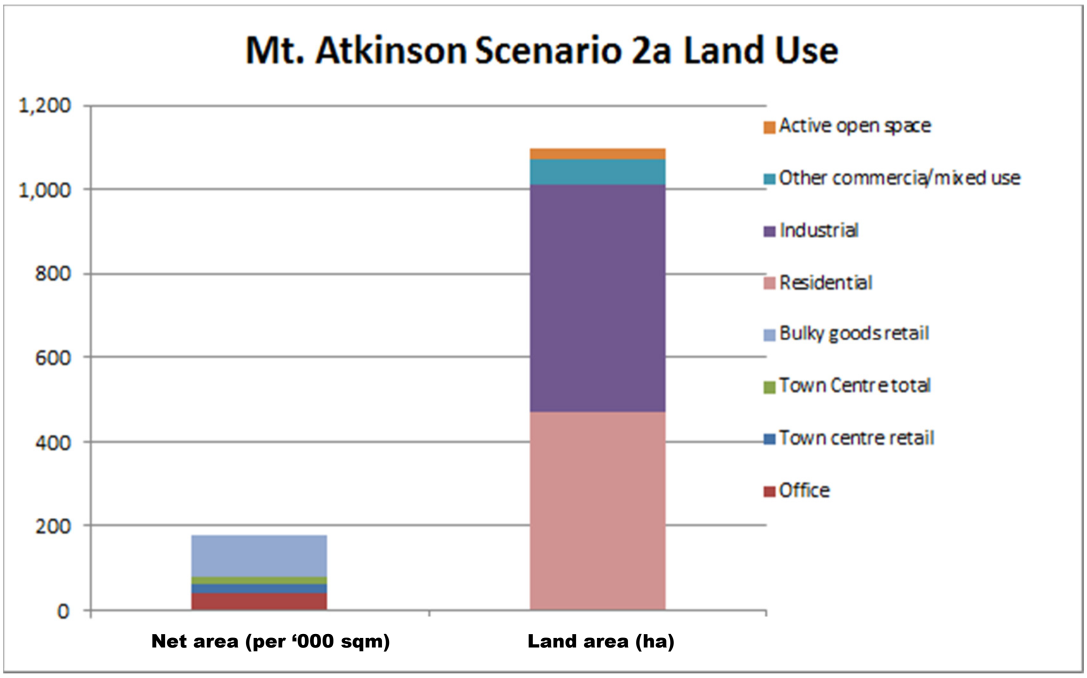


Figure 13 Mt Atkinson and Tarneit Plains land use for water supply breakdown

3.3.3 Water Supply

3.3.3.1 Potable

Western Water currently propose to provide potable water servicing to Mt Atkinson through an off-take to Melbourne Water's M483 main (under construction) passing to the south-east of the PSPs. This would require a pump station and a temporary storage in the vicinity of Mt Atkinson. The final configuration will depend on coordination, currently underway, with Melbourne Water regarding the operating ranges of M483 and Council regarding obtaining a suitable site for the tank.

3.3.3.2 Recycled

Western Water is awaiting the outcome of the Melton WoWCA study to confirm whether this area will be supplied with recycled water via a third pipe system. However as this is considered more likely than not Western Water has advised that recycled water supply should form part of the BaU option in the study, consistent with the outcomes of the earlier analysis. The Melton WoWCA is considering options for disposal of the large volumes of effluent that will be generated in the future with the growth in this region.

The BaU scenario and alternatives 1 & 2 for Mt Atkinson and Tarneit Plains WoWCA assume recycled water is provided to all households (toilet flushing, irrigation and washing machine) as well as commercial, industrial and educational uses for non-potable use.

3.3.3.3 Treated Stormwater

Under Alternative 1 and 2 passively treated stormwater from wetlands is provided for active open space irrigation where feasible to lush conditions and any shortfall is met by recycled water.

Alternative 2 also entail individual catchment scale stormwater harvesting schemes, treating to Class A equivalent which feed into the recycled water supply system. This option would require regulatory approval from various bodies.

3.3.3.4 Rainwater (Residential tanks)

Residential stormwater harvesting tanks have been assumed to have a 5% uptake due to the availability of recycled water in BaU and alternatives 1 & 2.

Under BaU scenario, the *6 Star Homes* standard requirements prescribe that a 2000 L tank is connected to a minimum of 50 m^2 of household roof and the rainwater collected is to service all toilets.

The BaU MUSIC model indicates that 2,000 L is capable of providing 94% of 56 L/day of toilet flushing demand based on a roof area of 50m^2. Taking into account seasonality, this totals 50.76L/day of tank water used per household. Multiplying this over 475 households (5% uptake) comes to 24,111 L/day or 9ML/year (rounded up from 8.8ML) of water from the mains supply saved.

In the absence of more detailed data it is assumed that recycled water usage for the PSPs is reduced by the 24,111 L/day or 9 ML per year.

Under alternatives 1 & 2, the same tank size of 2000 L is utilised with the household roof catchment maximised to 150m^3 and the rainwater collected is to service toilets, laundry and garden irrigation demand.

Alternative 1 & 2 MUSIC models indicates that 2,000 L is capable of providing 76% of 161 L/day of toilet/laundry/garden irrigation demand based on a roof area of 150m^2. Taking into account seasonality, this totals 122.36L/day of tank water used per household. Multiplying this over 475 households (5% uptake) comes to 58,121 L/day or 21ML/year (rounded down from 21.2ML) of water from the mains supply saved. The MUSIC models take into account rainfall seasonality by using the rainfall data from Melbourne Water reference year of 1996 (refer to **Appendix C** for details of the MUSIC modelling).

In the absence of more detailed data it is assumed that recycled water usage for the PSPs is reduced by 58,121L per day or 21 ML per year.

3.3.4 Sewer

Western Water currently proposes to discharge sewerage for the bulk of the site to the south-east into City West Water's (CWW) systems, subject to agreement on a suitable outlet.

The proposed permanent outlet will not be constructed for a substantial number of years. Discussions are proceeding with CWW to obtain a suitable temporary outlet, possibly utilising a temporary pump/rising main to the Derrimut System to the east.

Analysis is underway to determine if areas in the north of the PSP that naturally drain to the north, will be also temporarily serviced through the above temporary system. This depends heavily on the likely sequence of development, currently assuming early residential development on the Mt Atkinson in the north and early industrial development in the south-east corner.

3.3.5 Stormwater Management

The conversion of greenfield areas to urbanised area has the potential to greatly increase the quantity of the stormwater runoff and reduce groundwater infiltration. This is due to large scale increases to impervious areas of the site and associated decreasing travel time for stormwater moving through the catchment as it travels along impervious surfaces and through new drainage infrastructure.

Concurrently, the quality of the stormwater discharged from the urbanised catchment is reduced because of the higher pollutant loads associated with urban catchments including litter, oil and grease and phosphorous and nitrogen. If this water flows untreated and unregulated into receiving waterways there will be a marked negative impact on waterway health.

For the above reasons it is crucial that an effective stormwater management system is developed during the planning stage to provide sufficient management of both water quantity and quality.

The key requirements for the management of stormwater from residential, commercial and industrial developments included the in BaU assessment are:

- **Hydrology:** Defining the hydrograph required at the outlets from PSP 1082 and PSP 1085 in order not to adversely impact the peak flood levels in Dry Creek, Skeleton Creek and Kororoit Creek.
- **Flooding:** Ensure protection from 1 in 100 year ARI events via surface flow paths, traditional underground piped drainage and retarding basins.
- **Stormwater treatment:** Water sensitive urban design (WSUD) measures such as constructed wetlands to be implemented for stormwater discharge to meet best practice environmental management standards (BPEM).
- **Protection of the environmental:** social (including heritage) and economic values of waterways.

Additional considerations for alternative options may also include providing sufficient stormwater quality and supply for stormwater reuse on non-potable usage such as toilet flush and irrigation and additional opportunities to provide enhanced environmental and liveability outcomes (i.e. increased greening and health of street trees and playing fields through passive irrigation).

3.3.5.1 Existing Conditions & Melbourne Water DSS

The Mt Atkinson PSP 1082 and Tarneit Plains PSP 1085 contain three drainage catchments that discharge into Dry Creek, Skeleton Creek and Kororoit Creek (see **Figure 14**).

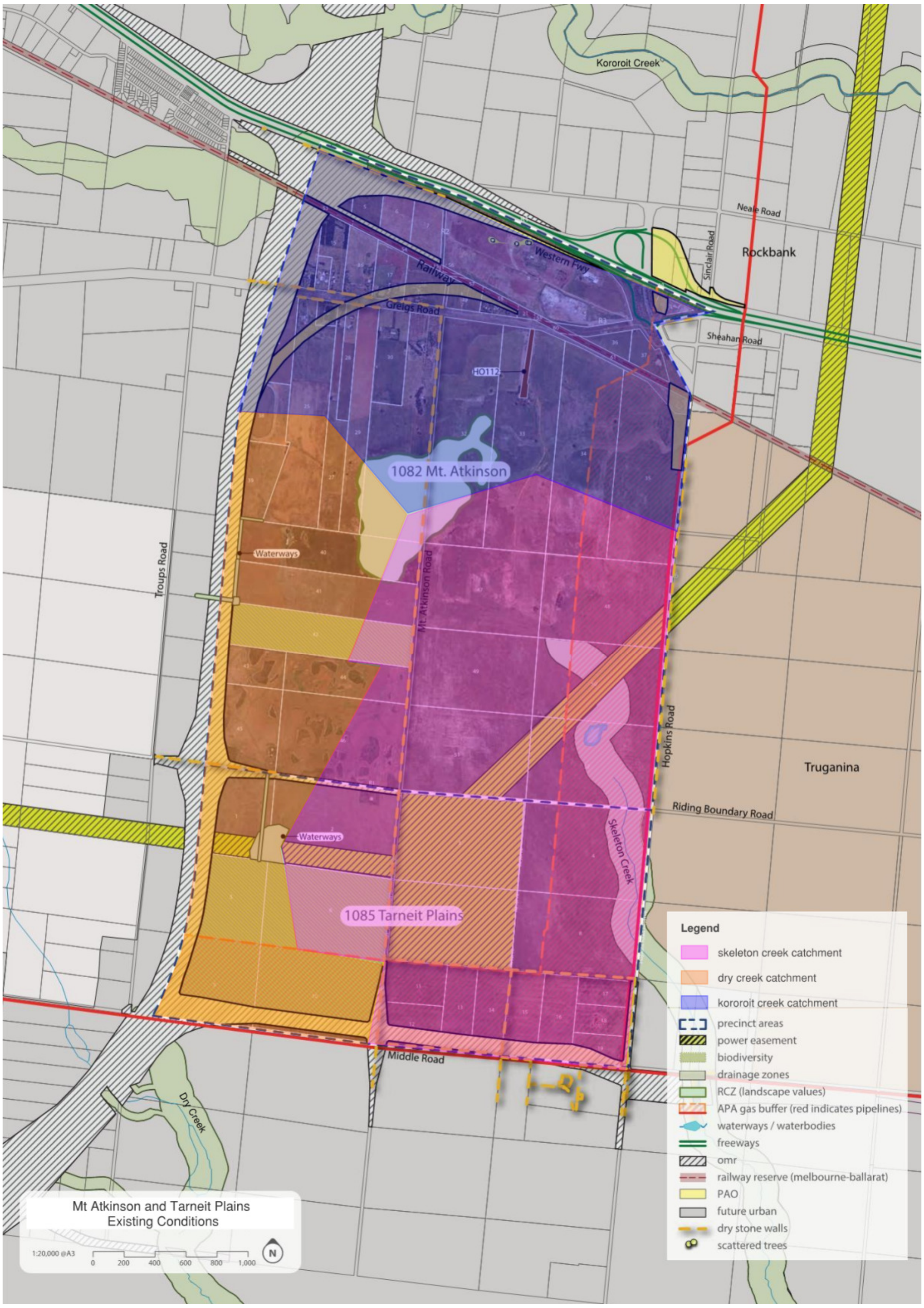


Figure 14 Existing Conditions of Mt Atkinson PSP 1082 and Tarneit Plains PSP 1085 (source: MPA)

Melbourne Water's most recent issue of their development service schemes (DSS) for Mt Atkinson and Tarneit Plains PSPs has split the three existing drainage catchments into five DSS areas (see **Figure 15**). They are the following:

- Dry Creek Upper DS
- Truganina DS
- Neale Road DS
- Gardiner Lane DS
- Deanside Drive DS

Mt Atkinson and Tarneit Plains PSPs encapsulate the upper catchments of these five DSS, which means there is no external stormwater flow from other PSP areas into the scheme study boundary.

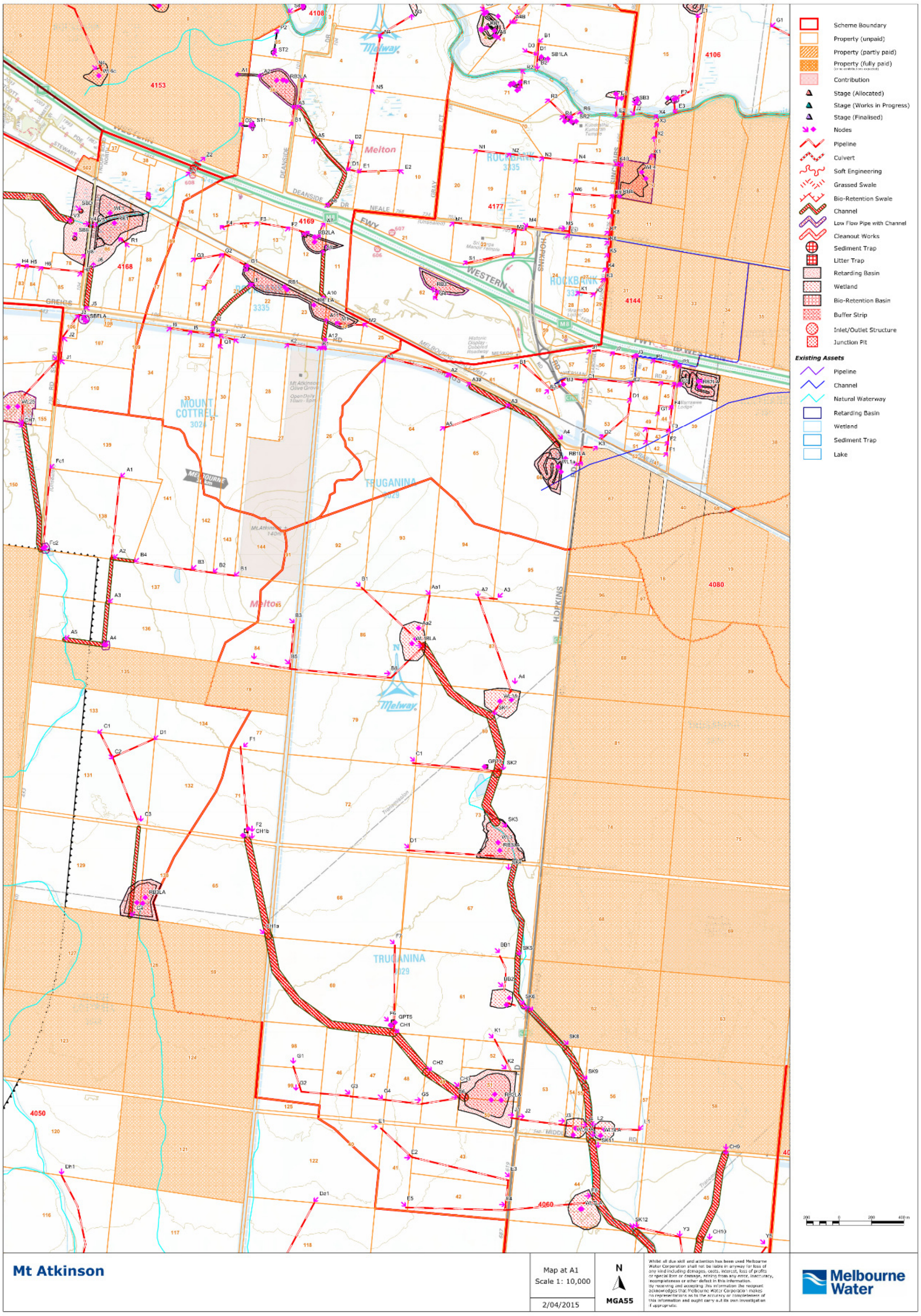


Figure 15 Preliminary Draft Melbourne Water Development Services Schemes for PSP 1082 and PSP 1085 (source: Melbourne Water)

3.3.5.2 Flood Management and Hydrology

Arup has developed RORB models for Mt Atkinson and Tarneit Plains PSPs. RORB is a general runoff and stream flow routing program used to calculate flood hydrographs from rainfall and other channel inputs. It subtracts losses from rainfall to produce rainfall-excess and routes this through catchment storage to produce runoff hydrographs at any location. It can also be used to design retarding basins and to route floods through channel networks. Refer to **Appendix B** for details of RORB modelling parameters and basin sizing assumptions.

RORB has been utilised to determine the volume and area required to retard the flows from post-development Q100 flow back to the existing predevelopment Q100 condition in order not to adversely impact the peak flood levels in Dry Creek, Skeleton Creek and Kororoit Creek in line.

The results of the RORB models in terms of the indicative location and size of retarding basins are shown in **Figure 16** and a summary of the key retarding basin features is provided in **Table 5**.

Table 5 Key retarding basin features

Retarding basin	Post-development Q100 Inflow (m3/s)	Post-development Q100 Outflow (m3/s) (equivalent to pre-development)	Volume (m3)	Land-take (ha)
DCU RB1	43.24	8.04	35,000	1.8
DCU RB2	24.35	4.95	16,700	0.9
T RB1	69.52	12.74	109,100	3.4
T RB2	12.59	4.18	5,030	0.5
T RB3	93.49	16.47	185,690	7.7
NR RB1	16.87	3.61	49,150	3.5
GL RB1	11.89	1.91	35,000	1.8
DD RB1	30.56	5.07	52,420	3.2
DD RB2	9.75	6.35	19,450	1.0

The proposed sizing and location of surface flow paths (including constructed waterways and roadways) and traditional underground piped drainage has not been explored as part of this summary report as they have been defined in Melbourne Water’s DSS for the PSPs.

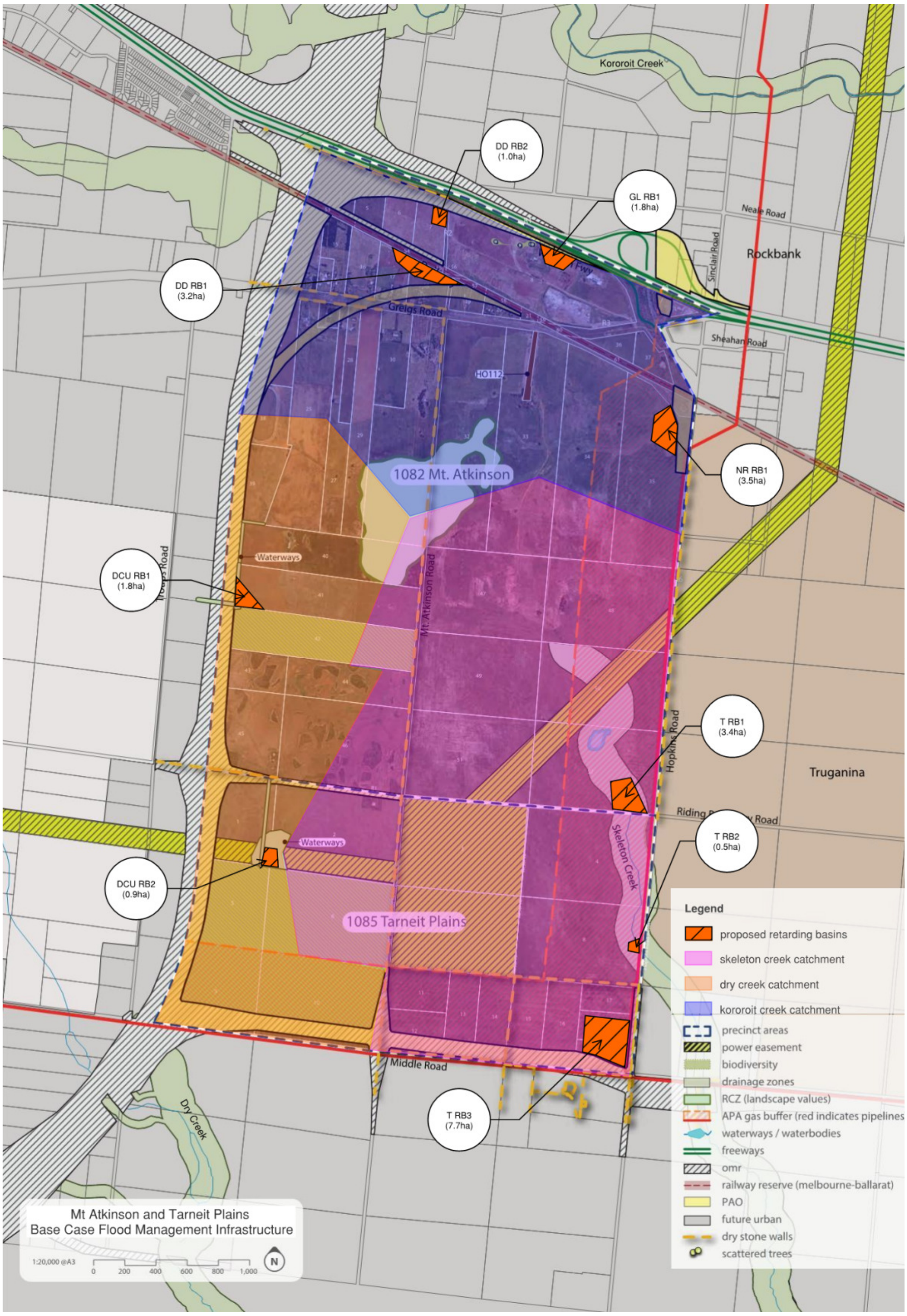


Figure 16 Base case flood management infrastructure for PSP 1082 and PSP 1085

3.3.5.3 Stormwater Quality

Maintaining water quality within the natural waterways Dry Creek, Skeleton Creek and Kororoit Creek post-development is a core priority of Melbourne Water's Healthy Waterway Strategy. During urbanisation concentrations of pollutants such as litter, nitrogen, phosphorus, oil and grease will increase and require treatment to meet current discharge guidelines.

The quality of water draining from urban developments into the receiving environment can be improved through filtration and retention via water sensitive urban design (WSUD) elements such as constructed wetlands. This approach reduces the effect that polluted water can have upon the environment and protects the natural waterways.

The general requirement for the treatment of stormwater (BaU scenario) is that annual pollutant loads achieve targets set out in the Best Practice Environmental Management Guidelines (BPEMG), these are:

- 80 % reduction in Total Suspended Solids (TSS) from typical urban loads
- 45% reduction in Total Nitrogen (TN) from typical urban loads
- 45% reduction in Total Phosphorus (TP) from typical urban loads
- 70% reduction in Litter from typical urban loads

Alternatives 1 & 2 explore the impact of the potential future "stretch" BPEMG targets, which also include a flow reduction target (60% or 90% total annual runoff volume reduction of post development volumes).

MUSIC (Model for Urban Stormwater Conceptualisation) is a decision support modelling software used to assess the effectiveness of different WSUD measures implemented in an urbanised catchment.

A MUSIC model was constructed for the Mt Atkinson and Tarneit Plains PSP post-development catchments to simulate the discharge loads and concentrations of TN, TP, TSS and Gross Pollutants (GP) generated.

Refer to **Appendix C** for details of MUSIC modelling parameters and stormwater treatment measures sizing assumptions.

To minimise land take requirements, wetlands and infiltration beds have been co-located with end-of-line retarding basins. The intention is to construct the wetland/infiltration bed in base of the retarding basin and provide opportunity for public amenity around these water bodies.

The size and treatment effectiveness of each stormwater treatment measure and the performance of each DSS catchment are detailed in **Appendix C** and are summarised the schematic design plans (**Section 5**).

3.3.6 Potable and Non-potable Water Demand Assumptions

The following section outlines the assumptions utilised in determining demand for potable and non-potable water across the various proposed land uses and employment measures related to residential, commercial, industrial and active open space. These assumptions have been provided by MPA.

3.3.6.1 Residential Assumptions

The residential data for various dwelling densities are documented below as provided by MPA and City West Water.

Table 6 Residential data assumptions (source: MPA & "20140806 Demand Assumptions – August 2014", Excel Spreadsheet by City West Water)

	Low Density (<17 dwellings per ha)	Medium Density (>17 & <30 dwellings per ha)	High Density (>30 dwellings per ha)
Occupancy per household	2.8	2.8	2.8
Dwellings per net developable hectare	16.5	30	100
Average lot size (m^2)	400	400	73
GFA	Not required for demand calculations (N/R)	N/R	73
Average roof area (m^2)	220	220	N/R
Average impervious area (m^2)	60	60	N/R
Average garden/lawn size (m^2)	120	120	N/R
Evaporative cooler uptake	50%	50%	N/R
Evaporative cooler water use (kL/hh/a)	18	18	N/R
Residential irrigation demand (kL/hh/a)	48.1	48.1	N/R
Average water use per capita/day (L)	160	160	170

The *2011 REUMS Household Water Use Breakdown* is used by City West Water in order to estimate water demand.

Table 7 2011 REUMS Household Water Use Breakdown adjusted for 160 Litres/per capita per day for medium density housing (source: "20140806 Demand Assumptions – August 2014", Excel Spreadsheet by City West Water)

End Use	Litres/Capita/Day		
	Winter	Summer	Average
Toilet	26.3	25.2	25.8
Clothes washer	28.7	24.3	26.5
Shower	46	55.6	50.8
Bathtub	1.7	1.8	1.8
Dishwasher	1.6	1.7	1.6
Tap	23.7	23.7	23.7
Irrigation	0	31.0	15.5
Evap cooler	2.5	3.3	2.9
Pool	0	0	0
Leak	9.9	13.1	11.5
Total	140.4	179.6	160.0

3.3.6.2 Commercial/Retail Assumptions

Commercial and retail areas have a usage of 60.96kL/employee/a (source: "20140806 Demand Assumptions – August 2014", Excel Spreadsheet by City West Water).

This varies seasonally and is assumed that approximately 39% (23.71 kL/employee/a) is non-potable and 61% (37.24 kL/employee/a) is potable.

3.3.6.3 Industrial Assumptions

Industrial areas have an average total water demand of 1.5 ML/ha/a.

There is an estimated alternative water demand of 1.125 ML/ha/a and an uptake of alternative water of 50%.

Therefore total potential non potable water demand of 0.5625 ML/ha/a with the remaining potable water demand of 0.9375 ML/ha/a.

3.3.6.4 Active Open Space Assumptions

There is an active open space irrigation usage of 5 ML/ha/a (monthly usage distribution defined in **Table 8**).

Table 8 Active Open Space Water Demand by Month (source: "20140806 Demand Assumptions – August 2014", Excel Spreadsheet by City West Water)

Days	Month	Distribution	Active POS (kL/ha/day)
31	Jan	15.4%	24.88
30	Feb	12.3%	20.48
31	Mar	10.9%	17.51
31	Apr	6.3%	10.14
28	May	4.3%	7.65
31	Jun	3.4%	5.53
30	Jul	3.4%	5.71
30	Aug	3.4%	5.71
31	Sep	7.1%	11.52
31	Oct	9.7%	15.67
31	Nov	9.1%	14.75
30	Dec	14.6%	24.29
Totals		100%	13.65

3.3.7 Sewer Discharge

Total wastewater discharge to sewer equates to 90% of the total water demand (discharge factor of 0.9). (source: "City West Water Pricing Handbook 1 July 2014 to 30 June 2015").

3.3.8 Climate Change Scenarios

Consistent with most recent climate data, the following three climate scenarios have been utilised in modelling of potential impacts of future climate change. This data is sourced from DSE (2008). Climate change in the Port Phillip and Westernport region. Department of Sustainability and Environment. http://www.climatechange.vic.gov.au/__data/assets/pdf_file/0008/73196/PPWP_WEB.pdf

These scenarios have been used to sensitivity test the WOWCA alternatives in MUSIC by altering climatic conditions such as rainfall, evaporation and temperature accordingly.

Table 9 Climate change criteria utilised in the modelling of scenarios

Criteria	2030	2070	
		Low emissions	High emissions
Change in average temperature (C)	0.6 to 1.1	0.9 to 1.9	1.8 to 3.7
Change in annual rainfall (%)	-8 to 0	-13 to 0	-24 to 0
Change in potential evaporation (%)	+1 to +5	+1 to +9	+2 to +17

4 Precinct Demands and Sewer Discharge

The following section depicts the anticipated precinct wide demands and sewer discharges for the various land uses under each of the options. A summary graph is provided in **Figure 17**.

4.1 Business as Usual

4.1.1 Demands

Table 10 Business as usual demands for Mt Atkinson and Tarneit Plains

Land use	Supply	Mount Atkinson and Tarneit Plains
Residential (ML/annum)	Potable	692
	Non-potable (regional recycled)	494
	Non-potable (rainwater tanks - stormwater)	9
Commercial/Retail (ML/annum)	Potable	302
	Non-potable (regional recycled)	192
Industrial (ML/annum)	Potable	507
	Non-potable (regional recycled)	304
Active open space (ML/annum)	Non-potable (regional recycled)	130
Total Water Demand (ML/annum)	**Potable**	**1501**
	Non-potable (regional recycled)	**1121**
	Non-potable (stormwater)	**9**
	Total water demand	**2631**

4.1.2 Sewer Discharge

Table 11 Calculated sewer discharge volumes for Mt Atkinson and Tarneit Plains

	Mount Atkinson & Tarneit Plains
Residential	1076 ML
Commercial/Retail	445 ML
Industrial	730 ML
Total Sewer Discharge	**2251 ML**

Business As Usual Summary

Under the *Business As Usual* scenario the total anticipated water demand for Mt Atkinson and Tarneit Plains is 2.63 GL per annum.

1.50 GL of this demand will be supplied by the potable water reticulation network.

1.12 GL of this demand will be able to be provided for by regional recycled water for non-potable uses.

9 ML of this demand will be supplied by residential rainwater tanks, which have a 5% uptake due to the presence of a third pipe recycled water supply.

Sewer discharges total 2.25 GL per annum.

4.2 Alternative 1 - Enhanced Liveability

4.2.1 Demands

Table 12 Summary of water demands for Mt Atkinson and Tarneit Plains under Alternative 1

Land use	Supply	Mount Atkinson & Tarneit Plains
Residential (ML/annum)	Potable	692
	Non-potable (regional recycled)	482
	Non-potable (rainwater tanks - stormwater)	21
Commercial/Retail (ML/annum)	Potable	302
	Non-potable (regional recycled)	192
Industrial (ML/annum)	Potable	507
	Non-potable (regional recycled)	304
Active open space (ML/annum)	Non-potable (regional recycled)	94
	Non-potable (local stormwater harvesting)	36
Total Water Demand (ML/annum)	**Potable**	**1501**
	Non-potable (regional recycled)	**1073**
	Non-potable (stormwater)	**57**
	Total water demand	**2631**

4.2.2 Sewer Discharge

Table 13 Calculated sewer discharge volumes for Mt Atkinson and Tarneit Plains under Alternative 1

	Mount Atkinson & Tarneit Plains
Residential	1076 ML
Commercial/Retail	445 ML
Industrial	730 ML
Total Sewer Discharge	**2251 ML**

Alternative 1 – Enhanced Liveability

Under *Alternative 1*, the total anticipated water demand for Mt Atkinson & Tarneit Plains is 2.63 GL per annum.

1.50 GL of this demand will be supplied by the potable water reticulation network.

1.07 GL of this demand will be able to be provided for by regional recycled water for non-potable uses.

21 ML of this demand will be supplied by residential rainwater tanks, which have a 5% uptake due to the presence of a third pipe recycled water supply.

36 ML of this demand will be supplied by a local stormwater harvesting scheme supplying the irrigation of active open spaces.

Note that although it is not represented in a reduction in water demand, the introduction of passive irrigation of the streetscape with help reduce the water demand (council watering in the warmer months) with the additional benefit of healthier and greener street trees.

Sewer discharges total 2.25 GL per annum.

4.3 Alternative 2 - Enhanced Waterway Health

4.3.1 Demands

Table 14 Summary of water demands for Mt Atkinson and Tarneit Plains under Alternative 2

Land use	Supply	Mount Atkinson & Tarneit Plains
Residential (ML/annum)	Potable	692
	Non-potable (regional recycled)	105
	Non-potable (rainwater tanks - stormwater)	21
	Non-potable (catchment stormwater harvesting)	377
Commercial/Retail (ML/annum)	Potable	302
	Non-potable (regional recycled)	38
	Non-potable (catchment stormwater harvesting)	154
Industrial (ML/annum)	Potable	507
	Non-potable (regional recycled)	66
	Non-potable (catchment stormwater harvesting)	238
Active open space (ML/annum)	Non-potable (regional recycled)	94
	Non-potable (local stormwater harvesting)	36
Total Water Demand (ML/annum)	**Potable**	**1501**
	Non-potable (regional recycled)	**303**
	Non-potable (stormwater)	**827**
	Total water demand	**2631**

4.3.2 Sewer Discharge

Table 15 Calculated sewer discharge volumes for Mt Atkinson and Tarneit Plains under Alternative 2

	Mount Atkinson & Tarneit Plains
Residential	1076 ML
Commercial/Retail	445 ML
Industrial	730 ML
Total Sewer Discharge	**2251 ML**

Alternative 2 – Enhanced Waterway Health

Under Alternative 2, the total anticipated water demand for Mt Atkinson and Tarneit Plains is 2.63 GL per annum.

1.50 GL of this demand will be supplied by the potable water reticulation network.

303 ML of this demand will be able to be provided by for regional recycled water for non-potable uses.

21 ML of this demand will be supplied by residential rainwater tanks, which have a 5% uptake due to the presence of a third pipe recycled water supply.

36 ML of this demand will be supplied by a local stormwater harvesting scheme supplying the irrigation of active open spaces.

769ML of this demand will be supplied by a catchment stormwater harvesting scheme supplying the treated stormwater into the third pipe recycled water reticulation system.

Sewer discharges total 2.25 GL per annum.

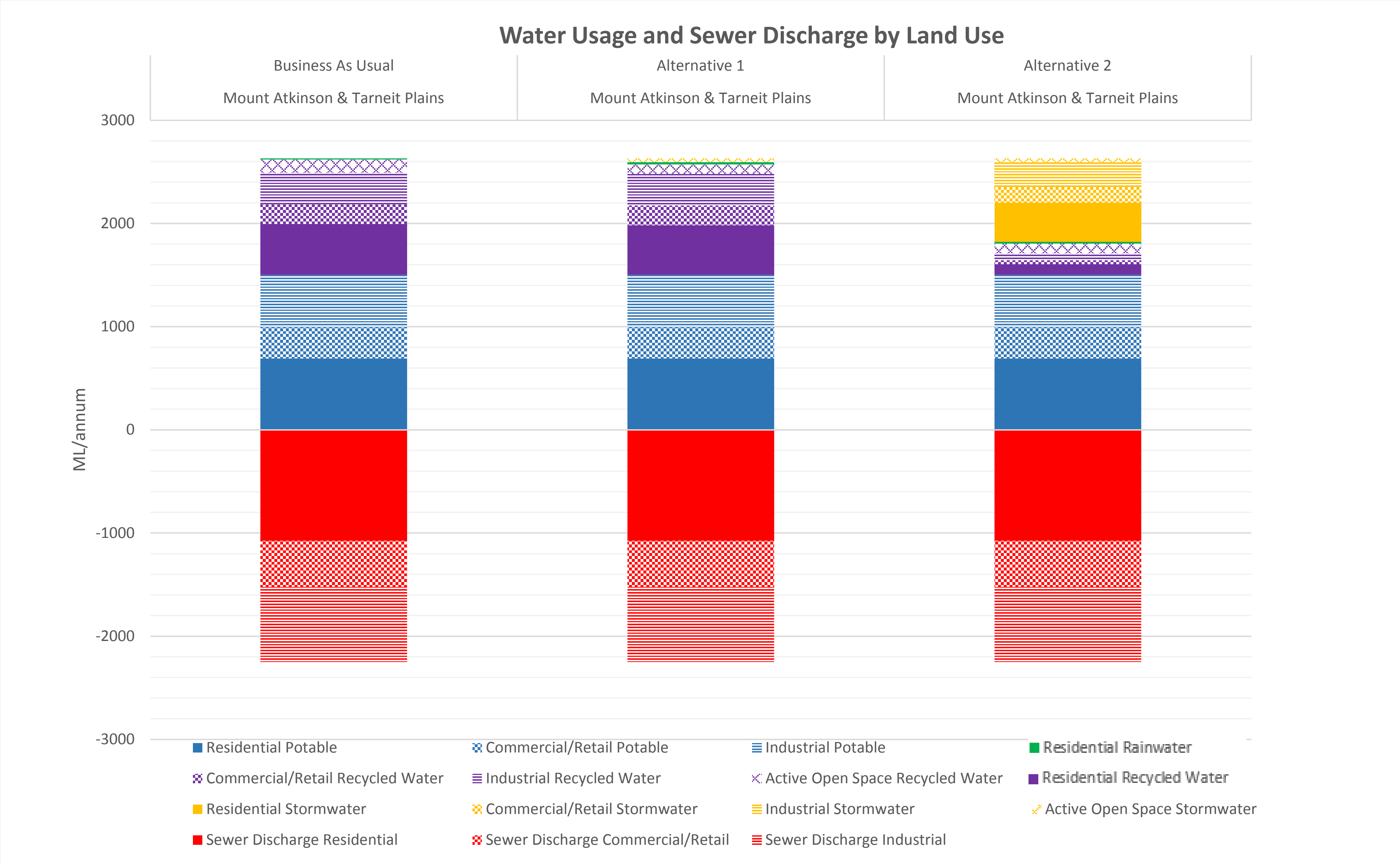


Figure 17 Water usage and sewer discharge by land use and water source

5 Schematic Design

High level schematic designs have been prepared for the business as usual scenario as well as the two alternatives. These schematic designs have been developed using the site constraints defined by MPA's draft future urban structure (**Figure 6**), Melbourne Water's DSS strategies (**Figure 15**), existing site contours and feedback from stakeholders.

The schematic designs developed have been assessed based on the required runoff and water quality targets, the appropriate whole of water cycle assets for the site conditions/opportunities and the results of the constraints assessment. The schematic designs have also attempted to take into account other design considerations appropriate at the PSP scale, such as:

- Multiple WoWCA benefits – design of surface water management systems to achieve multiple stormwater benefits, such as stormwater treatment, stormwater retention as well as water conservation and demand management.
- Consideration if other benefits can also be achieved through the stormwater design, such as high quality open space for communities along drainage lines and around wetlands and detention basins.
- Flooding – development of designs to minimise local inundation.
- Environment – consideration of surface water management measures can protect and enhance the environment.
- Climate change – consideration of the impacts that climate change may have on a system, and if these need to be accounted for in the design.
- Community – consideration of opportunities for community engagement and education, such as signage and ensuring opportunities for designing WSUD systems to be a community feature.
- Working with the current site topography to avoid major cut and fill requirements for stormwater infrastructure.
- Preliminary construction and maintenance considerations.

5.1 Water Sensitive Urban Design

All scenarios incorporate some form of Water Sensitive Urban Design (WSUD) to help achieve stormwater quality and flow targets. The business as usual scenario utilises the traditional end of line approach to stormwater water management, where wetlands and retarding basins assets are located at the end of the catchment boundaries. Alternatives 1 and 2 apply alternative configurations of these assets, incorporate other WSUD assets such as infiltration trenches and vegetated swales and utilise stormwater harvesting schemes to increase the reuse of stormwater and rainwater.

As noted by Melbourne Water innovative stormwater management, such as WSUD, can contribute greatly to sustainability and liveability, particularly when considered as part of an overall urban strategy. WSUD integrates urban water cycle management with urban planning and design, with the aim of mimicking natural systems to minimise negative impacts on the natural water cycle and receiving waterways and bays. It offers an alternative to the traditional conveyance approach to stormwater management by acting at the development scale (at the source), and thereby reducing the required size of the structural stormwater system. It seeks to minimise impervious surfaces, reuse water on site, incorporate retention basins to reduce peak flows, and incorporate treatment systems to remove pollutants. WSUD also provides the opportunity to achieve multiple benefits though sustainable urban water management.

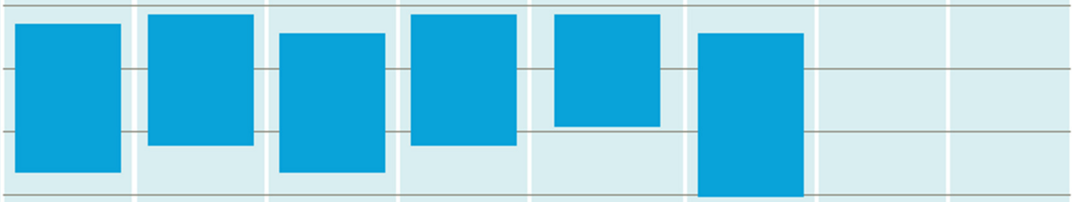
WSUD applications can include a range of applications, including:

- grassed or landscaped swales
- infiltration trenches and bio-retention systems
- gross pollutant traps, wetlands and sediment ponds
- rainwater tanks – stormwater harvesting and reuse
- grey water harvesting and reuse
- rain gardens, rooftop greening and urban forests
- aquifer recharge and reuse

A summary of WSUD features, treatment function applicability and indicative cost is provided below (**Figure 18**).

The alternative scenarios developed require the potential use of co-located wetlands within retarding basins, infiltration trenches, passive irrigation of streetscape, vegetated swales, drainage channels utilised as enhanced waterways, residential rainwater tanks and stormwater harvesting schemes. A description of these features is proved below along with maintenance considerations and cost assumptions (adapted from Melbourne Water (2014)).

Table A-1: Summary of treatment function, applicability and cost:
Adapted from: Victorian Stormwater Committee (1999); Wong (2006); EPA (2008)

✓ High applicability ✓ Medium applicability ✓ Low applicability	Bioretention swales	Bioretention basins /raingardens	Vegetated swales/ buffer strips	Sand filters	Sedimentation basins	Constructed wetlands	Ponds and shallow lakes	Rainwater tanks
FUNCTION:								
Water quality treatment	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓	✓
Flow attenuation	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓
Stormwater conveyance	✓✓✓	✓	✓✓✓	✓	✓	✓	✓	✓
Particle size removal								
Coarse-Medium particles 5000 µm-125 µm								
Fine particulates 125 µm-10 µm								
Very fine/Colloidal particulates 10 µm-0.45 µm								
Dissolved particles <0.45 µm								
Additional function		Landscape value	Aesthetic appeal Habitat values		Landscape value	Habitat, visual & recreation amenity	Habitat, visual & recreation amenity	Stormwater re-use
APPLICABILITY:	Median strip/ verge	Streets	Median strip/ verge/parks	Streets/many	Pre-treatment to wetland	Parks/vacant land	Aesthetic/ post wetland	On-property
Area requirement	Larger areas (with limited public access)	Limited space	Larger areas (with limited public access)	Limited space	Large areas	Large areas	Large areas	Limited space
Slope considerations and approach to site constraints	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Flat land. Where land is sloped terraces can be used.	Gentle slopes (< 5%). Where slopes exceed 5%, flow spreaders or check dams may be required.	Suitable for steeper slopes	Flat land	Flat land	Suitable for steep land	Suitable on most sites
Level of flow control	Conveyance	Discharge	Conveyance	Discharge	Discharge	Discharge	Discharge	Source
INDICATIVE COSTS:								
Installation costs	Moderate	Moderate	Low	Low/ Moderate	High	High	High	Low
Maintenance costs	Moderate	Moderate	Moderate/ High	Moderate	Moderate/High	Moderate	Moderate	Low

Indicative costs: Indicative costs for comparison purposes only

Installation costs: Based on the treatment's total installed cost per hectare of catchment. Broad approximations are as follows:
- High: Greater than $1500 per hectare of catchment;
- Moderate: Between $500 and $1500 per hectare of catchment; and
- Low: Less than $500 per hectare of catchment

Maintenance costs: Based on the cost per hectare per annum for each treatment type. Broad estimates are as follows:
- High: Greater than $250 per hectare of catchment per annum;
- Moderate: Between $100 and $250 per hectare of catchment per annum; and
- Low: Less than $100 per hectare of catchment per annum.

Figure 18 WSUD features, treatment function applicability (source: Melbourne Water)

5.1.1 Wetlands

Wetland systems are shallow, extensively vegetated water bodies that remove pollutants through enhanced sedimentation, fine filtration and pollutant uptake processes. Stormwater runoff is passed slowly through the vegetated areas, which filter sediments and pollutants, and biofilms establish on the plants, which absorb nutrients and other contaminants.

Wetlands are well suited to treat large volumes of stormwater runoff and have the advantage of improving local amenity and providing habitat diversity.

Key design issues to consider include:

- verifying the size and configuration for treatment;
- determining design flows;
- designing the inlet zone;
- layout of the macrophyte zone;
- hydraulic structures;
- selecting plant species; and
- planting densities and providing maintenance.

Design and maintenance considerations:

- The constructed wetland should treat at least 90% of Mean Annual Runoff (MAR) through the use of a stored event volume above the normal standing water level of the wetland.
- A high flow bypass should be capable of taking flows in excess of design flows (typically a 1 in 1 year event).
- The wetland design must meet safety requirements and implement reasonable safety measures. This includes fencing, safety batters, signage and benching.
- Health and Safety considerations for maintenance staff should also be addressed. It is recommended that an independent safety audit be conducted for each design.
- Approach batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H). All edges should have safety benches of at least 1.5m to 3.0m wide from the edge of the normal top water level.
- Safety benches should have a maximum grade of 1:8 (V:H) for the first 1.5m – 3.0m before changing to a 1:5 (V:H) grade for at least the next 0.5m. Beyond this, may be up to a maximum of 1:3 (V:H). The safety bench should be densely planted with emergent macrophytes such that casual entry will be difficult.
- Hard stand areas should be provided adjacent to the inlet zone to allow for the maintenance and cleanout of this zone.
- Measures to reduce the prevalence of mosquitoes should be taken
- Where possible, wetlands should be constructed in the base of retarding basins to reduce land requirement.

- The wetland should be divided into four macrophyte zones, an open water zone and a littoral zone and the percentage allocation of each zone in line with Melbourne Water guidance.
- Suitable vegetation should be adopted as per Melbourne Water guidelines.
- Wetlands require large areas of land for construction and are unsuited to steeply sloping land.
- A geotechnical investigation is required prior to design to determine soil profiles and infiltration rates.
- Hydrogeological investigations may also be required in areas where there is a likelihood of groundwater discharge or high seasonal water tables.

5.1.2 Infiltration Trenches

Infiltration trenches encourage stormwater to infiltrate into the surrounding soils. They are dependent on local soil characteristics and groundwater conditions, therefore they are best suited to sandy soils with deep groundwater. They have the requirement of pre-treatment of stormwater via sedimentation basins prior to infiltration to avoid clogging of surrounding soils.

Infiltration trenches may be placed in power easements under certain conditions, but typically are required to be 20m from towers and also the design is to allow maintenance vehicles to traverse them on the surface.

Design and maintenance considerations:

- Careful consideration of the location of infiltration system is required.
- The use of geotechnical reports to provide critical information for design and modelling.
- Maintenance is focused on ensuring the system does not clog with sediment and the appropriate infiltration rate is maintained.

5.1.3 Passive Irrigation of Streetscape

Passive irrigation of the streetscape from the road pavement can be achieved by allowing surface runoff to flow into with tree and vegetation zones. Overflow pits will be located at the end of these passive irrigated nature strips (either in kerb or in nature strip) to drain larger rain events.

Design and maintenance considerations:

- Careful consideration of the location of passive irrigation treatments as to not impact physically or operationally on the surrounding built environment.
- The vegetation for passive irrigation areas need to be carefully selected son its fit for purpose.

5.1.4 Vegetated Swales

Vegetated swales convey stormwater and provide removal of coarse and medium sediment. They are commonly used in conjunction with areas of vegetation through which runoff passes, known as buffer strips. Vegetated swales are similar to bio-retention swales, but are less effective in removing nitrogen from the stormwater, as they do not feature the filtering component and convey water on the surface only.

Vegetated swales can provide an aesthetically pleasing landscape feature and are relatively inexpensive to construct and maintain. They can be used median strips, verges, car park runoff areas, parks and recreation areas.

Design and maintenance considerations:

- The longitudinal slope of a swale is the most important consideration. Swales are most efficient with slopes of 2% to 5%. Lower than this, swales can become waterlogged and/or have stagnant pooling, while steeper slopes may have high flow velocities (with potential erosion and vegetation damage risks).
- Check banks (small porous rock walls) may be constructed to distribute flows evenly across the swale if they are identified as the most suitable treatment option in such areas.
- Where swales are publicly accessible, flow depths and velocities must be acceptable from a public risk perspective.
- Traffic and deliveries should be kept off swales as they may damage vegetation and create preferential flow paths that do not offer filtration. Appropriate mitigation measures should be implemented.
- Swale side slopes depend on Council regulations, traffic access and the provision of crossings. Typically 1 in 9 side slopes are suitable. For maintenance requirements, grassed swales requiring mowing must not have side slopes exceeding 1 in 4.

5.1.5 Drainage Channels Utilised as Enhanced Waterways

Drainage channels can be utilised as enhanced waterways with vegetation and meandering riffle pools to provide a stormwater treatment function.

These constructed waterways with greater ecological, social and amenity values than typical drainage channels. Melbourne Waters Constructed Waterways in Urban Developments Guidelines (2009) outlines a number of design and maintenance considerations which include:

- Waterway form to wherever practical mimic natural stream forms in the region.
- Waterway roughness – a natural formed waterway will require a larger cross-sectional area to convey the same flow of a traditional drainage channel. The manning roughness of a natural formed waterway is typically 0.05-0.07.
- Scour protection – vegetation and rockwork may be required to prevent the detrimental effects of erosion.
- Pools and riffles – provide refuge for native fish and other in stream life during dry periods.
- Batter safety for pools – batter slopes shall be no steeper than 1:5 and permanent fencing or densely vegetated buffer zones to protect access.

- Stormwater outlet – required careful design to ensure flow does not cause undermining, erosion or scouring of banks.

5.1.6 Residential Rainwater Tanks

Rainwater tanks collect roof runoff for subsequent reuse, conserving potable mains supplies and reducing stormwater runoff volumes and pollutants from reaching downstream waterways.

Rainwater tanks are applicable to areas of high roof area to occupancy ratio, while they are less applicable in regions of low roof area to occupancy ratio, such as medium and high density residential dwellings.

Design and maintenance considerations:

- Rainwater tanks should be installed in accordance with the Plumbing and Drainage Standards (AS/NZS 3500:2003).
- Rainwater tanks installed to 6 star home requirements need to be 2kl tank connected to 50m2 of roof catchment to supply water for toilet flushing.
- Rainwater tanks may not provide the optimal strategy for stormwater runoff from a effectiveness and sustainability perspective compared to a centralised stormwater harvesting scheme. This issue should be investigated thoroughly during the concept design stage of a project.
- Continual water balance assessments using MUSIC should be performed to determine how much runoff rainwater tanks are removing from the catchment in terms of runoff volumes and associated pollutant loads.
- Rainwater tanks should be sized using the appropriate reference curves for the region.

5.1.7 Stormwater Harvesting Schemes

Stormwater harvesting schemes involve the collection, treatment, storage and use of stormwater runoff from urban areas for fit-for-purpose reuse.

There are no specific laws that dictate what non-potable uses stormwater can be used for or what non-potable quality standards stormwater must meet. However, individuals and organisations responsible for stormwater schemes have a duty of care to make sure their scheme will not place people or the environment at risk.

Stormwater reuse for potable substitution as detailed in Alternative 2 is currently not supported under Victorian government policy.

Design and maintenance considerations:

- Stormwater harvesting tanks should be installed in accordance with the Plumbing and Drainage Standards (AS/NZS 3500:2003). Ideally the stormwater harvesting tanks are to be installed underground to maximise developable land.
- Continual water balance assessments using MUSIC should be performed to determine how much runoff stormwater harvesting tanks are removing from the catchment in terms of runoff volumes and associated pollutant loads.

- Stormwater harvesting tanks should be sized with the optimal volumetric reliability of 60-70%.
- The treatment train of harvested stormwater for active open space consists of extraction from treatment wetlands, followed by solids removal.
- The treatment train of the harvested stormwater for non-potable reuse (Alternative 2) will as a minimum consist of sedimentation, course filtration and UV disinfection.

The following tables (**Table 16**, **Table 17**) details the stormwater harvesting schemes tank sizing for alternative 1 & 2. **Figure 22** shows a schematic layout of the schemes.

Table 16 Stormwater harvesting tanks for irrigation of active open space sizing – Alternative 1 & 2

Stormwater Harvesting Scheme	Total Active Open Space to Irrigate (ha)	Tank Volume (kL)	Tank Surface Area (m2)	Supply Reliability (%)	Stormwater Supplied for Non-Potable Reuse (ML/yr)
T SWH - F	10.0	1500	750	72%	36

Table 17 Catchment stormwater harvesting tank sizing for non-potable water supply – Alternative 2

Stormwater Harvesting Scheme	Tank Volume (kL)	Tank Surface Area (m2)	Supply Reliability (%)	Stormwater Supplied for Non-Potable Reuse (ML/yr)
DCU SWH - A	2,000	666	73%	71.89
DCU SWH - B	2,000	666	71%	69.03
T SWH	33,000	11000	60%	352.71
NR SWH	2,500	833	72%	96.83
GL SWH	1,500	500	76%	51.48
DD SWH	4,500	1500	71%	127.50

5.1.8 Anticipated Layout

Figure 19, **Figure 20** and **Figure 21** show the anticipated schematic layouts for each of the scenarios. The schematic layouts identify potential locations and size of wetlands, retarding basins, infiltration trenches, vegetated swales in roads, alternative streetscape design for passive irrigation, drainage channels utilised as enhanced waterways and stormwater harvesting schemes. **Figure 22** provides a summary of WSUD element examples and assumptions used in the schematic design and modelling.

The schematic layouts also identifies whether the stormwater management asset will be managed by Melbourne Water (>60ha catchment) or Melton City Council (<60ha catchment).

The schematic layouts also contain summaries of the flow & water quality results, water supply & demand and high level cost estimates for each of the scenarios.

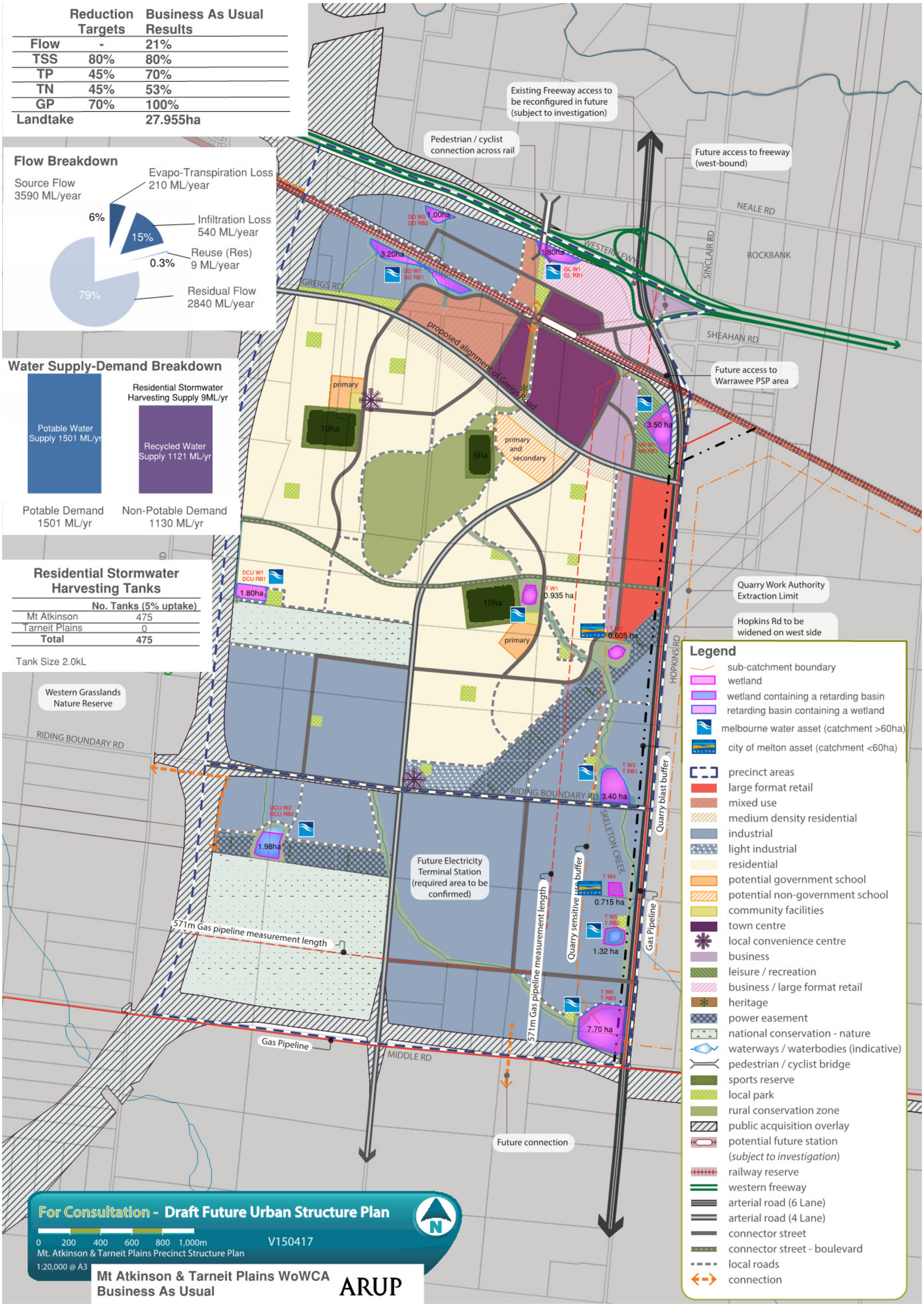


Figure 19 Schematic Design – Business as Usual

	Reduction Targets	Alternative 1 Results
Flow	60%	60%
TSS	85%	94%
TP	50%	87%
TN	50%	78%
GP	70%	100%
Landtake		50.96ha

Incremental Cost Above BaU - Alternative 1

	CAPEX ($mil)	LAND ACQ ($mil)	OPEX ($mil/yr)	LIFE CYCLE ($mil)*
Sedimentation Basins and Infiltration Trenches	+16.1	+14.6	+1.20	+91.0
Stormwater Harvesting for Active Open Spaces	+1.2	-	+0.02	+2.2
Total	+17.3	+14.6	+1.22	+93.2

* life cycle of 50yrs and excludes renewal costs

Residential Stormwater Harvesting Tanks

	No. Tanks (5% uptake)
Mt Atkinson	475
Tarneit Plains	0
Total	475

Tank Size 2.0kL

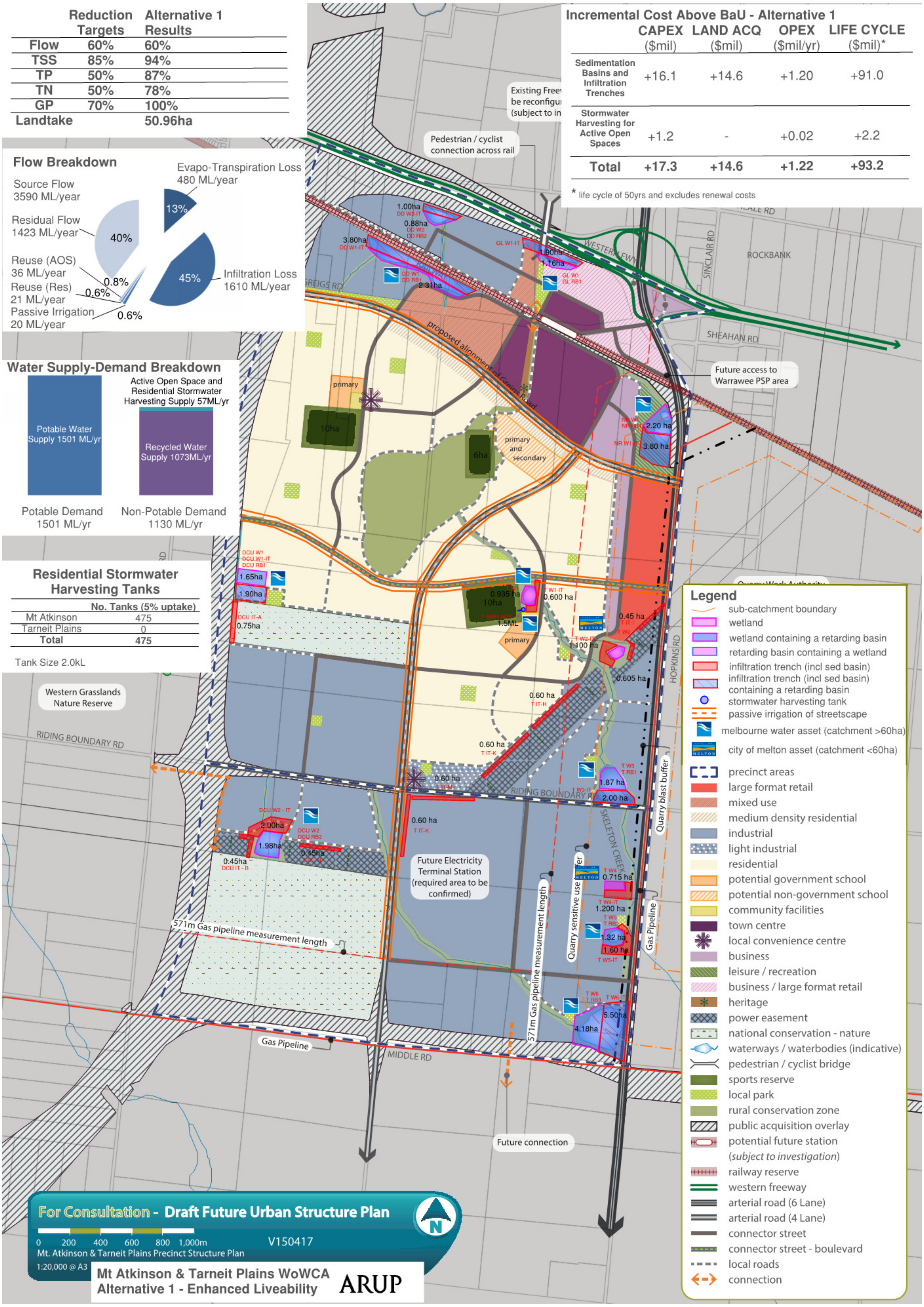


Figure 20 Schematic Design – Alternative 1 Enhanced Liveability

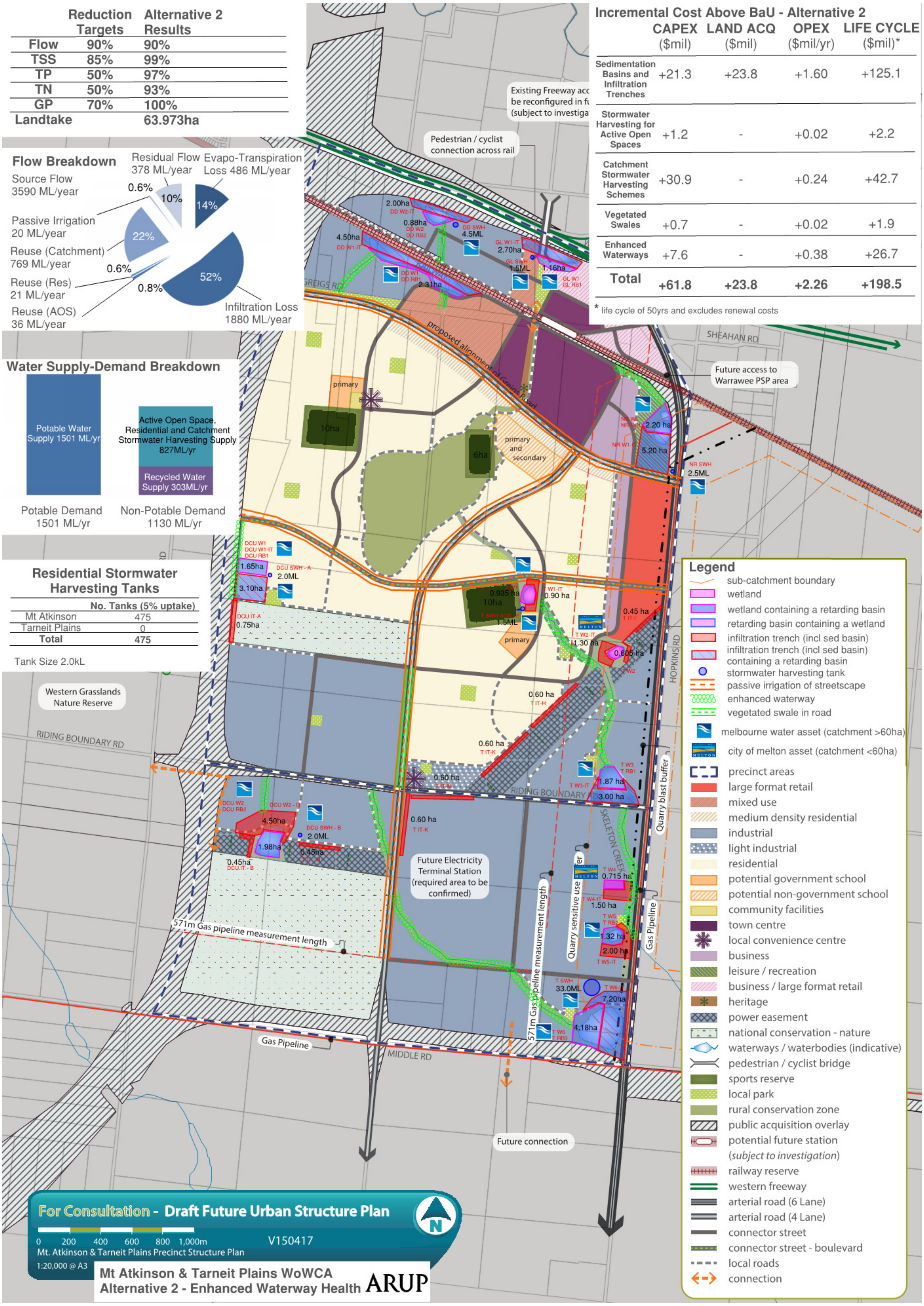


Figure 21 Schematic Design – Alternative 2 Enhanced Waterway Health

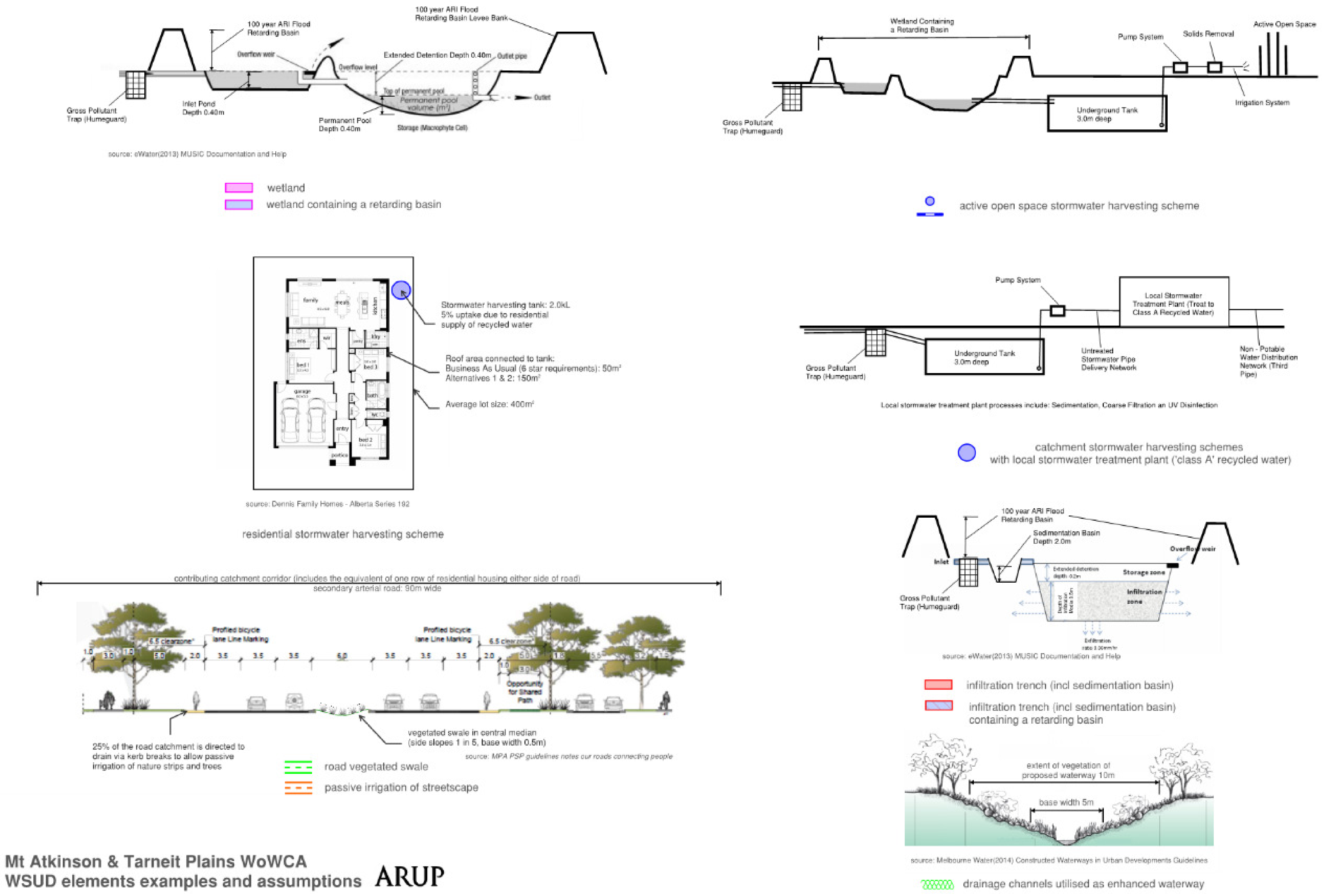


Figure 22 WSUD element examples and assumptions

5.2 Land Take Requirements

5.2.1 Business as Usual

Mt Atkinson and Tarneit Plains PSPs stormwater management assets have been split into the Melbourne Water DSS catchments. The follow table (**Table 18**) gives a breakdown summary of the proposed Melbourne Water DSS catchment assets.

Table 18 Summary of proposed Melbourne Water DSS catchment assets

Melbourne Water DSS Catchment	Name of Wetland /Retarding Basin	PSP
Dry Creek Upper DS	DCU W1 / DCU RB1	Mt Atkinson
	DCU W2 / DCU RB2	Tarneit Plains
Truganina DS	T W1	Mt Atkinson
	T W2	Mt Atkinson
	T W3 / T RB1	Mt Atkinson
	T W4	Tarneit Plains
	T W5 / T RB2	Tarneit Plains
	T W6 / T RB3	Tarneit Plains
Neale Road DS	NR W1 / NR RB1	Mt Atkinson
Gardiner Lane DS	GL W1 / GL RB1	Mt Atkinson
Deanside Drive DS	DS W1 / DS RB1	Mt Atkinson
	DS W2 / DS RB2	Mt Atkinson

The design of wetlands to treat stormwater and meet BPEM water quality requirements are discussed in the section water quality section (3.4.5.3). The wetlands for all the sub-catchments have been located inside the retarding basins to minimise land take by combining water retardation and treatment functions while still meeting 1 in 100 year flood detention and meeting best practice water quality discharge requirements. The retarding basins and wetlands have been sized in accordance with Melbourne Water and the Melton City Council requirements with assumptions and results detailed in **Appendix B and C**.

As the wetlands are located within the retarding basin, the surface area requirement of the larger retarding basin dictates the total land-take requirement.

The following land take summary table (**Table 19**) for the business as usual scenario (schematic design **Figure 19**) identifies the size of each stormwater management asset associated with each Melbourne Water DSS catchment. **Table 20** and **Table 21** summaries the land take requirements for each of the PSPs.

Table 19 Land take summary for Mt Atkinson and Tarneit Plains PSPs - business as usual

Wetland	Total Wetland Area (ha)	Co-located Retarding Basin	Retarding Basin Area (ha)	Total Land-take (ha)
DCU W1	1.65	DCU RB1	1.80	**1.80**
DCU W2	1.98	DCU RB2	0.90	**1.98**
T W1	0.935	-	-	**0.935**
T W2	0.605	-	-	**0.605**
T W3	1.87	T RB1	3.40	**3.40**
T W4	0.715	-	-	**0.715**
T W5	1.32	T RB2	0.50	**1.32**
T W6	4.18	T RB3	7.70	**7.70**
NR W1	2.20	NR RB1	3.50	**3.50**
GL W1	1.155	GL RB1	1.80	**1.80**
DD W1	2.31	DD RB1	3.20	**3.20**
DD W2	0.88	DD RB2	1.00	**1.00**
Total				**27.955**

Table 20 Land take for Mt Atkinson PSP - business as usual

Name of Wetland	Name of Co-located Retarding Basin	Total Land-take (ha)
DCU W1	DCU RB1	1.80
T W1	-	0.935
T W2	-	0.605
T W3	T RB1	3.40
NR W1	NR RB1	3.50
GL W1	GL RB1	1.80
DD W1	DD RB1	3.20
DD W2	DD RB2	1.00
Total		**16.24**

Table 21 Land take for Tarneit Plains PSP – business as usual

Name of Wetland	Name of Co-located Retarding Basin	Total Land-take (ha)
DCU W2	DCU RB2	1.98
T W4	-	0.715
T W5	T RB2	1.32
T W6	T RB3	7.70
Total		**11.715**

5.2.2 Alternative 1

Alternative 1 consists of the following stormwater management elements that have a land take requirement:

- End of line wetlands and supplementary infiltration trenches. These will have a co-located retarding basin but in all cases the retarding basin will fit within the footprint of the wetland and infiltration trenches

Note that the following stormwater management elements do not have a land take requirement as they are located in the power easement, conservation areas or underground.

- Infiltration trenches with sedimentation basins located in the power easement and the edge of conservation areas.
- Stormwater harvesting tanks for irrigation of active open spaces.

The following land take summary table (**Table 22**) for alternative 1 (schematic layout **Figure 20**) identifies the size of each stormwater management asset associated with each Melbourne Water DSS catchment. **Table 23** and **Table 24** summaries the land take requirements for each of the PSPs.

Table 22 Land take summary for Mt Atkinson and Tarneit Plains PSPs – alternative 1

Wetland	Total Wetland Area (ha)	Supplement Infiltration Trench	Supplement Infiltration Trench Area (ha)	Total Land-take (ha)
DCU W1	1.65	DCU W1 - IT	1.9	3.55
DCU W2	1.98	DCU W2 - IT	2.0	3.98
T W1	0.935	T W1 - IT	0.6	1.535
T W2	0.605	T W2 - IT	1.1	1.705
T W3	1.87	T W3 - IT	2.0	3.87
T W4	0.715	T W4 – IT	1.2	1.915
T W5	1.32	T W5 - IT	1.6	2.92
T W6	4.18	T W6 - IT	5.5	9.68
NR W1	2.20	NR W1 - IT	3.8	6.0
GL W1	1.155	GL W1 - IT	1.9	3.055
DD W1	2.31	DD W1 - IT	3.8	6.11
DD W2	0.88	DD W2 - IT	1.0	1.88
Total	**19.8**		**26.4**	**46.2**

Table 23 Land take for Mt Atkinson PSP – alternative 1

Name of Wetland	Name of Other Stormwater Assets	Total Land-take (ha)
DCU W1	DCU W1 – IT	3.55
T W1	T W1 – IT	1.535
T W2	T W2 – IT	1.705
T W3	T W3 – IT	3.87
NR W1	NR W1 - IT	6.0
GL W1	GL W1 - IT	3.055
DD W1	DD W1 - IT	6.11
DD W2	DD W2 - IT	1.88
Total		**27.705**

Table 24 Land take for Tarneit Plains PSP – alternative 1

Name of Wetland	Name of Other Stormwater Assets	Total Land-take (ha)
DCU W2	DCU W2 – IT	3.98
T W4	T W4 – IT	1.915
T W5	T W5 - IT	2.92
T W6	T W6 - IT	9.68
Total		**18.495**

5.2.3 Alternative 2

Alternative 2 consists of the following stormwater management elements that have a land take requirement:

- End of line wetlands and supplementary infiltration trenches. These will have a co-located retarding basin but in all cases the retarding basin will fit within the footprint of the wetland and infiltration trenches

Note that the following stormwater management elements are not considered to have a land take requirement as attempts have been made to locate these assets in the power easement, at the perimeter of conservation areas or underground under non-developable land such as open space.

- Infiltration trenches with sedimentation basins located in the power easement and the edge of conservation areas.
- Stormwater harvesting tanks for irrigation of active open spaces.
- Catchment stormwater harvesting tanks for non-potable supply into the third pipe system.

The following land take summary table (**Table 25)** for alternative 2 (schematic layout **Figure 21**) identifies the size of each stormwater management asset associated with each Melbourne Water DSS catchment. **Table 26** and **Table 27** summaries the land take requirements for each of the PSPs. Additional infrastructure components such as pumpstations and the treatment plant may also have land take unless there can be strategically located underground or in the basements of proposed buildings.

Table 25 Land take summary for Mt Atkinson and Tarneit Plains PSPs – alternative 2

Wetland	Total Wetland Area (ha)	Supplement Infiltration Trench	Supplement Infiltration Trench Area (ha)	Total Land-take (ha)
DCU W1	1.65	DCU W1 - IT	3.1	4.75
DCU W2	1.98	DCU W2 - IT	4.5	6.48
T W1	0.935	T W1 - IT	0.9	1.835
T W2	0.605	T W2 - IT	1.3	1.905
T W3	1.87	T W3 - IT	3.0	4.87
T W4	0.715	T W4 – IT	1.5	2.215
T W5	1.32	T W5 - IT	2.0	3.32
T W6	4.18	T W6 - IT	7.2	11.38
NR W1	2.20	NR W1 - IT	5.2	7.4
GL W1	1.155	GL W1 - IT	2.7	3.855
DD W1	2.31	DD W1 - IT	4.5	6.81
DD W2	0.88	DD W2 - IT	2.0	2.88
Total	**19.8**		**37.9**	**57.7**

Table 26 Land take for Mt Atkinson PSP – alternative 2

Name of Wetland	Name of Other Stormwater Assets	Total Land-take (ha)
DCU W1	DCU W1 – IT	4.75
T W1	T W1 – IT	1.835
T W2	T W2 – IT	1.905
T W3	T W3 – IT	4.87
NR W1	NR W1 – IT	7.4
GL W1	GL W1 – IT	3.855
DD W1	DD W1 - IT	6.81
DD W2	DD W2 – IT	2.88
Total		**34.305**

Table 27 Land take for Tarneit Plains PSP – alternative 2

Name of Wetland	Name of Other Stormwater Assets	Total Land-take (ha)
DCU W2	DCU W2 – IT	6.48
T W4	T W4 – IT	2.215
T W5	T W5 - IT	3.32
T W6	T W6 - IT	11.38
Total		**23.395**

Land Take Summary

Business as usual

- Mt Atkinson PSP land take for stormwater management is 16.3 hectares
- Tarneit Plains PSP land take for stormwater management is 11.7 hectares
- Total land take is **28.0 hectares**

Alternative 1 – Enhanced Liveability

- Mt Atkinson PSP land take for stormwater management is 27.7 hectares
- Tarneit Plains PSP land take for stormwater management is 18.5 hectares
- Total land take is **46.2 hectares**

Alternative 2 – Enhanced Waterway Health

- Mt Atkinson PSP land take for stormwater management is 34.3 hectares
- Tarneit Plains PSP land take for stormwater management is 23.4 hectares
- Total land take is **57.7 hectares**

6 Options Assessment

A high level assessment of options has been presented below based on capital and operational costs above those incurred under the base case and qualitative assessment of potential benefits based on Arup's Design with Water framework which includes a high level climate resilience assessment.

For the climate change scenarios, MUSIC models have been re-run amending the predicted evaporation increases this result in minor changes in the run-off volumes generated annually under each case with the table below depicting the % change in mean annual flows.

Table 28 Climate change criteria and mean flow reduction for each scenario

Criteria	2030	2070	
		Low emissions	High emissions
Change in average temperature (C)	0.6 to 1.1	0.9 to 1.9	1.8 to 3.7
Change in annual rainfall (%)	-8 to 0	-13 to 0	-24 to 0
Change in potential evaporation (%)	+1 to +5	+1 to +9	+2 to +17
Changes in mean annual flow (%)	0.28% reduction (+5% PET)	0.56% reduction (+9% PET)	1.11% reduction (+17% PET)

6.1 Quantitative Assessment

The following quantitative assessment summary (**Table 29**) details the water demands, sewer discharge, land take requirements, stormwater quality performance and high level cost estimates for each of the scenarios.

Table 29 Quantitative assessment summary of WoWCA for Mt Atkinson and Tarneit Plains PSP

		Business as Usual	Alternative 1	Alternative 2
Supply mix (ML/a)	Potable	1501	1501	1501
	Recycled water	1121	1073	303
	Stormwater	0	36	806
	Rainwater	9	21	21
	Total	2631	2631	2631
	Potable : Non-potable split	**57% : 43%**	**57% : 43%**	**57% : 43%**
Stormwater generation(ML/a)		**3590**	**3590**	**3590**
Sewer discharge (ML/a)		**2251**	**2251**	**2251**
Sewer excess (recycled water vs sewer discharge) (ML/a)		**1130**	**1178**	**1948**
Extent of co-located retarding basins and wetlands (ha)		27.955	19.8	19.8
Extent of co-located retarding basins and supplementary infiltration trenches (ha)		-	26.4	37.9
Total land take (ha)		**27.955**	**46.2**	**57.7**
Flow / pollutant reduction	Flow (%)	21	60	90
	TSS (%)	80	94	99
	TP (%)	70	87	97
	TN (%)	53	78	93
	GP (%)	100	100	100
Incremental CAPEX above BaU ($mil)		-	17.3	61.8
Incremental Land Acquisition above BaU ($mil)		-	14.6	23.8
Incremental OPEX above BaU ($mil/annum)		-	1.22	2.26
Incremental Life Cycle above BaU (50 years) ($mil)		**-**	**93.2**	**198.5**
Potential savings off water bill for tank water (consumption only) ($/annum)		37,300	87,000	87,000
Potential savings off water bill (council irrigation) ($/annum)		0	149,000	149,000

6.2 Qualitative Assessment

In the absence of a detail cost benefit analysis Arup has conducted a high level qualitative assessment of options using the organisation's 'Design with Water' framework. This assessment is for comparative purposes only between options.

Under the qualitative framework a 1 to 5 scale has been used based on the following in terms of the potential benefits achieved.

1 = very low

2 = low

3 = medium

4 = high

5 = very high

Option	**Key 'design with water' features**	**Assessment criteria**										
		Water supply **Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, grey water and groundwater. Capital investment and whole-life cost savings.**	**Wastewater** **Reduction of water volume to sewers, extending network asset life, improving water quality and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.**	**Flooding** **Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.**	**Economy & Innovation** **Potential direct contribution through water-related investment in infrastructure associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.**	**Place & Community** **Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.**	**Food & Agriculture** **Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.**	**Climate Change** **Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.**	**Habitat & Biodiversity** **New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.**	**Energy & Carbon** **Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater.** **Potential for renewable energy generation from hydro and waste.**	**Health & Wellbeing** **Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.**	**Total**
Business as usual	Regional STP providing recycled water for commercial, industrial, educational and residential non-potable uses. 5% uptake in residential rainwater tanks in accordance with 6 star homes standards (toilets only) Stormwater management to meet BPEM and 1 in 100 year ARI flood retardation through end of line systems before discharge to local water bodies	3 WELS standard fittings and fixtures Recycled water supply Rainwater supply for 5% of households	3 Local STP provides recycled water	3 Meets 1 in 100 ARI requirements Rainwater tanks provide minor retarding function during some events	3 Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area Installation of rainwater tanks provides opportunities for local manufacturers and tradesmen	2 Parks are supplied with potable water and subject to future water restrictions. Wetlands combined with retarding basin reduces land take and provides amenity	2 Availability of recycled water means opportunities for local food production and community gardens can be explored at later stages	3 Localised provision of recycled water provides increased resilience for water supply in times of low rainfall	2 Placement of wetlands and surface water features avoids existing high quality vegetation areas. Potential indirect creation of new habitats in wetlands	3 Localised treatment of sewage reduces pumping costs Use of rainwater reduces bulk water pumping and treatment costs and emissions	3 Bike paths walking trails can be co-located along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at later stages	27
Alternative 1	Regional STP providing recycled water for commercial, industrial, educational and residential non-potable uses 5% uptake in residential rainwater tanks sized to maximise reuse (all non-potable uses) Stormwater management to meet future stretch BPEMG (incl. 60% flow reduction) and 1 in 100 year ARI flood retardation through a number of WSUD assets (incl. local stormwater harvesting schemes for AOS, infiltration trenches, passive streetscape irrigation).	4 WELS standard fittings and fixtures Recycled water supply Rainwater supply for 5% of households Stormwater supplied for open space irrigation where possible	3 Local STP provides recycled water	4 Meets 1 in 100 ARI requirements. Infiltration trenches and passive irrigation provide minor retarding function during some events Rainwater and stormwater harvesting tanks provide minor retarding function during some events	4 Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area Installation of rainwater and stormwater harvesting tanks provides opportunities for local manufacturers and tradesmen Reuse of stormwater reduces water bills for councils maintaining open space assets	3 Parks are supplied with stormwater where feasible. Recycled water is provided as a backup meaning open space is resilient to water restrictions and low rainfall Wetlands combined with retarding basin reduces land take and provides amenity. Smart streetscape design for passive watering of trees and improved tree canopy coverage	2 Availability of recycled water means opportunities for local food production and community gardens can be explored at alter stages.	4 Localised provision of recycled water provides increased resilience for water supply in times of low rainfall. Climate independent source of water allows for maintenance of green space and tree canopy. Distribution of water bodies improves microclimate	4 Placement of wetlands and surface water features avoids existing high quality vegetation areas. Potential indirect creation of new habitats in wetlands Reuse of stormwater and diversion of rainwater reduces flows to adjacent waterways Opportunities to increase/maintain habitat connectivity along drainage lines can be explored	4 Localised treatment of sewage reduces pumping costs Local use of stormwater gathered and treated using gravity systems to the maximum extent possible reduced water travel distances and associated pumping. Use of rainwater reduces bulk water pumping and treatment costs and emissions	4 Bike paths walking trails can be co-located along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at alter stages	36

Option	Key 'design with water' features	Assessment criteria										
		Water supply **Reduction in demand for potable water supply and treatment, through use of water efficient fixtures and fittings and alternative decentralised water supplies, including rainwater, grey water and groundwater. Capital investment and whole-life cost savings.**	**Wastewater** **Reduction of water volume to sewers, extending network asset life, improving water quality and reducing treatment. Opportunity to recycle and re-use water through decentralised treatment.**	**Flooding** **Reducing risk and increasing resilience by integrated catchment management and improved management of surface water within cities. Design and planning of infrastructure, buildings and landscapes to be more adaptable to flooding.**	**Economy & Innovation** **Potential direct contribution through water-related investment in infrastructure associated new technologies, partnership with small enterprise, etc. Indirect impact on land and property values, attracting inward investment and improved labour productivity.**	**Place & Community** **Access to and engagement with water can play a significant role in creating better places with a strong sense of identity. Making space for water can open up and reconnect people and places. Water is an integrator which can facilitate partnership and collaboration.**	**Food & Agriculture** **Local food production can be a key driver to retrofitting landscapes, including breaking up of hard surfaces, flood-compatible use of open space, edible planting, water harvesting and treatment, localised nutrient recycling and improved agricultural practice.**	**Climate Change** **Design for water helps to mitigate and adapt to climate change. Large tree planting, greening of urban areas, and open water bodies directly contribute to improved microclimate. Locally managed water can increase resilience to water scarcity and drought.**	**Habitat & Biodiversity** **New and improved habitats through making space for water within green infrastructure networks, provision for natural treatment of water and wastewater, improving water quality, river/wetland and coastal restoration, woodland, green roofs and walls.**	**Energy & Carbon** **Removal and sequestration of greenhouse gases as a result of urban greening. Reduction in energy demand due to shading/insulation, reduced pumping and treatment of water and wastewater.** **Potential for renewable energy generation from hydro and waste.**	**Health & Wellbeing** **Water-related green infrastructure can absorb air pollutants and improve microclimate, provide opportunities for recreation, exercise and education. Water can help to improve overall living environments and provide opportunities for community engagement.**	**Total**
Alternative 2		4	3	4	4	4	2	4	5	4	4	38
	Regional STP providing recycled water for commercial, industrial, educational and residential non-potable uses 5% uptake in residential rainwater tanks sized to maximise reuse (all non-potable uses). Stormwater management to meet future stretch BPEMG (including a 90% flow reduction target) and 1 in 100 year ARI flood retardation through a number of WSUD assets (incl. local stormwater harvesting for active open space, infiltration trenches, vegetated swales, passive streetscape irrigation and drainage channels utilised as enhanced waterways). Catchment stormwater harvesting schemes implemented to distribute treated stormwater via the third pipe recycled water reticulation network.	WELS standard fittings and fixtures Recycled water supply Rainwater supply for 5% of households Stormwater supplied for open space irrigation where possible Treated stormwater distributed via the third pipe reticulation network	Local STP provides recycled water	Meets 1 in 100 ARI requirements. Infiltration trenches, passive irrigation and enhanced waterways provide minor retarding function during some events Rainwater and stormwater harvesting tanks provide minor retarding function during some events	Local STP provides regional employment Availability of recycled water may allow for industries requiring secure supplied of water during restrictions to locate to the area Installation of rainwater tanks and stormwater harvesting tanks provides opportunities for local manufacturers and tradesmen Reuse of stormwater reduces water bills for councils maintaining open space assets	Parks are supplied with stormwater where feasible. Recycled water is provided as a backup meaning open space is resilient to water restrictions and low rainfall Wetlands combined with retarding basin reduces land take and provides amenity. Smart streetscape design and placement of swales within planned arterial and connector roads allows for passive watering of trees and improved tree canopy coverage Drainage channels constructed as enhanced waterways provides ecological and social benefits.	Availability of recycled water means opportunities for local food production and community gardens can be explored at alter stages	Localised provision of recycled water provides increased resilience for water supply in times of low rainfall. Climate independent source of water allows for maintenance of green space and tree canopy. Distribution of water bodies improves microclimate	Placement of wetlands and surface water features avoids existing high quality vegetation areas. Potential indirect creation of new habitats in wetlands. Opportunities to increase/maintain habitat connectivity along drainage lines can be explored. Reuse of stormwater and diversion of rainwater reduces flows to adjacent waterways Vegetated swales and passive streetscape irrigation allows for creation of more resilient tree related habitats. Drainage channels constructed as enhanced waterways potential create new habitats.	Localised treatment of sewage reduces pumping costs Local use of stormwater gathered and treated using gravity systems to the maximum extent possible reduced water travel distances and associated pumping Use of rainwater reduces bulk water pumping and treatment costs and emissions	Bike paths walking trails can be collocated along major drainage lines Visual access to water bodies improves mental and physical health Further opportunities can be explored at alter stages	

7 Key Findings and Recommendations

The purpose of evaluating the two alternatives scenarios with the business as usual is to see what the impact of introducing a total post development flow reduction target has on the urban form. Given that the three scenarios evaluated have different flow reduction targets (0%, 60% and 90%) it is therefore difficult to directly compare the scenarios, as the cost-benefit of the flow reductions has not been accounted for as part of this study.

7.1 Key Findings

1. Alternative 2 *Enhance Waterway Health* scores highest in terms of qualitative assessment, and has the highest stormwater reuse ratio of approximately 68% of non-potable water demand with the remaining 32% supplied by recycled water.
2. In terms of life cycle expected costs, alternative 1 is an additional $93.4 million compared to the business as usual scenario due to costs associated with the installation of additional infiltration trenches to satisfy its 60% flow reduction target. Whereas alternative 2 is an additional $198.8 million compared the business as usual scenario due to the costs associated with the installation of additional infiltration trenches and catchment stormwater harvesting schemes to satisfy its 90% flow reduction target.
3. In terms of land-take, alternative 1 is 1.7 times the business as usual scenario and alternative 2 is 2.1 times the business as usual scenario. The additional land take for both alternatives is majority from the land required for infiltration trenches required to help achieve the flow reduction targets.
4. The installation of infiltration trenches in order to satisfy the flow reduction targets in alternatives 1 and 2 is dependent on site specific soil parameters. In the absence of site specific information, this study modelled conservative soil characteristics (medium clays typical of the region). If in fact soils favourable to infiltration is discovered on site the extent of infiltration trenches can be reduced. Conversely if the soils discovered are not-favourable to infiltration, the infiltration trenches will need to be substituted for expanded wetlands to utilise evapo-transpiration losses as the key method of flow reduction.
5. Under all scenarios there is an excess of wastewater generated against recycled water demands. This is most profound under the alternative 2 where 2,100 ML of treated waste water will require discharge to local waterways post treatment or via connection to the metropolitan wastewater network.
6. The water balance for alternatives 1 and 2 indicates that from a quantity perspective in achieving the flow reduction targets of 60% and 90%, the installation of stormwater harvesting schemes where recycled water is also available will further exacerbate the excess of treated water requiring disposal or direction to alternative uses outside of the PSP areas.
7. Under the alternatives 1 and 2 there is the potential for council to be able to offset around $149 k across both PSPs off their irrigation water bills by harvesting stormwater. This involves some additional expense in reconfiguring the placement of wetlands and applying reuse to these facilities. These costs and benefits should be explored in further detail.

7.2 Recommendations

1. Consultation with developers and Council to understand their appetite for the installation of WSUD features beyond the business as usual should be undertaken.
2. Consultation with council and Melbourne Water regarding arrangements for the ongoing management of wetlands and other WSUD features should be undertaken. This relates to large wetlands, vegetated swales and any infrastructure associated with treatment, storage or distribution for reuse.
3. Further refinement of costs, benefits, responsibilities and risk management procedures is required to better inform a preferred option at the PSP scale.
4. It is also recommended that if a beyond best practice approach to stormwater quality is sought and opportunities for the passive watering of arterial road and connector street trees is sought that land is configured within these road reserves to allow for the installation of vegetated swales where slopes allow.
5. Future PSP planning layouts need to consider the impact of water early on in the PSP development when weighing up other key planning factors. Key water impact considerations include: seeking to locate areas where stormwater could be harvested and provided to open space irrigation place in low contour points to maximise harvest volumes, reduce pumping, provide increased flood resilience, maximise opportunities to connect communities to green open space along drainage lines and enhance amenity of open space areas through the inclusion of water features.
6. The high level concepts presented for Alternative 2 require further optimisation to potentially reduce the number of stormwater harvesting treatment plants to have more centralised treatment plants e.g. one per major catchment (Skeleton, Dry and Kororoit). Low cost opportunities to transfer stormwater across natural catchment divides could also be further investigated.

Findings Summary

This study assessed alternative scenarios with different flow reduction targets. These scenarios are very difficult to directly compare without incorporating the benefits of the flow reductions on the receiving waterways and the indirect benefits of the flow reductions received by the community. Determining these benefits are not a part of this study, but would need to be established before a cost-benefit analysis can be conducted in the future.

Therefore this study can only deduce the relative impact of introducing flow reductions targets on the urban form and bottom line.

In comparing the business as usual scenario with the alternatives of introducing the flow reduction targets:

- 60% flow reduction (alternative 1 – enhanced liveability) requires an additional 18 ha of land and costs an additional $93 mil over its 50year life.
- 90% flow reduction (alternative 2 – enhanced waterway health) requires an additional 30 ha of land and cost an additional $199 mil over its 50 year life.

Alternative 2 scores the highest in terms of qualitative assessment, but that is due to the direct co-relation with the high flow reduction target (90%). To achieve the flow reduction target the alternative requires more stormwater management measures to be implemented, therefore resulting in higher qualitative benefits.

Under the current regulatory environment we can only recommend the business as usual scenario as the alternatives investigate potential ‘stretch’ regulations not currently implemented. It is also recommended that the business as usual scenario implement additional of WSUD elements (i.e. passive irrigation of streetscape) to help improve liveability.

8 References

Bureau of Metrology 2015 Melbourne Airport Station Weather Data

City West Water 2013, Integrated Water Cycle Management Summary Document

Connellan 2002 A Reference Manual for Turf and Landscape

DNRE Groundwater Beneficial Uses Map for South Western Victoria (1994)

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Appendix A

Water Services Strategies and Regional Planning

A1 Whole-of-Water-Cycle Regional Planning

Both CWW and WW have released whole of water cycle management strategic plans for their service areas which should be considered when developing alternative options in order to align with regional planning and optimise outcomes at the PSP scale. These are summarised below.

Additionally, Western Water, in partnership with City West Water, Department of Environment Land Water and Planning (DELWP), Metropolitan Planning Authority (MPA) and Melton City Council has commenced the development of the Melton City specific Whole-of-water-cycle analysis. The new Government strategy 'Melbourne's Water Future', released in December 2013, outlines a state wide whole-of-water-cycle approach to managing all available water resources. Piloting of 'out of area' competition between publicly owned Water Corporations for the provision of water cycle services in major new developments is a key part of the strategy with a fundamental principle of this approach being that the best solution for water services in new areas should be driven by the geography of the area and the availability of existing infrastructure combined with a new forward outlook to a whole-of-water-cycle management approach to be innovative and approach water solutions holistically rather than just within existing Water Corporation boundaries.

A1.1 Western Water

Western Water's Whole of Water Cycle Management Plan 2014 notes the following regional opportunities of relevance within the Melton City Council area.

A1.1.1 Recycled Water for Agriculture

In the short to long term Agricultural productivity has the opportunity to thrive from the application of recycled water in the Bacchus Marsh and Melton regions. Providing an alternative water supply for peri-urban agriculture in growth areas, green wedge areas and the Bacchus Marsh Irrigation District supports economic development and resilience through the region. These initiatives can improve water quality outcomes of the Werribee River and potentially contribute towards local urban and environmental water demands via excess supplies from Pykes Reservoir.

A1.1.2 Melton Urban Growth

Significant urban growth is forecast for the Melton area. This presents an opportunity to take a whole-of-water-cycle approach, in collaboration with key stakeholders, to service the new growth areas which will improve waterway health and increase amenity value.

Residential non-drinking water

Dual pipe in urban growth areas

In the medium term an opportunity to extend the dual pipe recycled water service into this growing area exists which could ultimately enable the interconnection of recycled water from Melton into the Metropolitan retailer's recycled water networks. This initiative has the potential to substitute 3,800 ML per year of drinking water and reduces the need to discharge recycled water into the Werribee River.

Residential drinking water

Stormwater to substitute drinking water

In the long term WW are committed to working with stakeholders and our regulators to investigate the feasibility of indirect drinking water substitution with urban stormwater excess. While not supported by current regulation this opportunity could provide 2,800 ML/year of additional water supply.

Environmental flows

Stormwater for environmental flows

In the medium terms Excess stormwater from the new growth areas of Melton could provide fit-for-purpose environmental flows in the Werribee River along with irrigation demands in the Werribee Irrigation District. This additional water could also be used to substitute urban drinking water supplies currently sourced from Merrimu and Pykes reservoirs.

A1.2 City West Water

CWW's Integrated Water Cycle Management Strategy (2013) notes the following.

The Urban Growth Area provides a unique once only opportunity to provide a dual supply system on a large scale. Primarily this is due to the potentially prohibitive cost of retrofitting a third pipe system in existing urban areas and residential dwellings/ commercial and industrial buildings rather than the comparatively cheap cost of installing during the construction of a the new urban developments and buildings.

A1.2.1 Potable Water

The preferred water servicing option for the Urban Growth Area 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.

Drinking water will be supplied from Melbourne's drinking water supply network. Recycled water will be sourced from two separate treatment plants at Western Treatment Plant and the planned Ravenhall Alternative Water Production Facility.

A1.2.2 Sewerage

Sewerage services will also be provided through established means with sewerage collected primarily through gravity based systems and transported to Western Treatment Plant and the proposed Ravenhall Alternative Water Production Facility.

A1.2.3 Stormwater Treatment and Harvesting

The preferred option includes distributed stormwater treatment systems throughout the many stormwater catchments across the Urban Growth Area. Where possible these systems should also provide flow retardation for flood management, and storage of water for use on nearby public open space for irrigation. The land area and capital cost of such systems may be kept to a minimum through designing the infrastructure to meet all three of these outcomes within a single installation.

The preferred option also includes the potential to integrate stormwater harvesting with dual reticulated recycled water and aquifer storage and recovery. Where conditions suit, stormwater may be treated further to a Class A equivalent standard and injected into the *recycled water network. Aquifer storage and recovery may also be utilised to store this water for use when needed.*

A1.2.4 Stormwater Drainage and Flood Mitigation

City West Water has no direct responsibility for managing stormwater, either through the retaining to mitigate flooding, or through its disposal through drainage. However, to ensure the Strategic Vision is realised City West Water will work with the relevant authorities to ensure the design of these systems follows the principles of Integrated Water Cycle Management and synergies with City West Water's infrastructure are explored and implemented.

City West Water has developed close relationships with municipal authorities and Melbourne Water and are collaborating to ensure the installation of any stormwater drainage or flood mitigation infrastructure aligns with the Strategy.

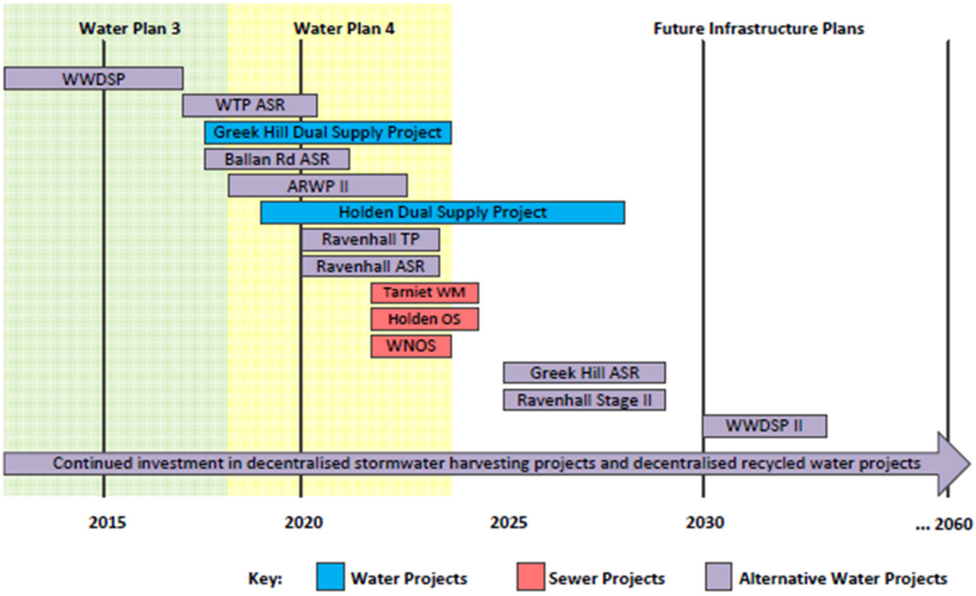
A1.2.5 Aquifer Storage and Recovery

There is typically a higher demand for alternative water during the summer months than at other times of the year due to irrigation demands, and building an alternative water treatment plant to meet the summer peak is undesirable. One means through which this over investment can be avoided, without the need to utilise potable water, is through storing excess alternative water produced during low demand winter months and utilising both production and stored water during the high demand summer months.

The challenge associated with this concept lies in the construction of suitably sized storages to store the alternative water required. Under the Strategy the preferred option involves the use of aquifer storage and recovery to achieve the storage requirements, particularly in the Urban Growth Area. City West Water is undertaking several investigations into the hydrogeology of Melbourne's west, with the initial results promising.

The Holden Dual Supply Project (Area A) will supply up to 20,000 homes with potable and alternative water in the Holden supply area. Potable water supply will be sourced from the centralised system with a storage tank at Holden. Recycled water will be sourced from the proposed Ravenhall Alternative Water Production Facility and there is also opportunity to optimise the supply sources for alternative water through the implementation of aquifer storage and recovery and/or stormwater harvesting.

The increased storage capacity offered through the operation of Ravenhall aquifer storage and recovery will 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 will 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.



Infrastructure rollout plan (source: CWW)

Appendix B

RORB Modelling

Basis of Design

B1 RORB Modelling – Basis of Design

The following basis of design describes the methodology and assumptions adopted for building the RORB models and determining retarding basin sizes for Mt Atkinson and Tarneit Plains PSP 1082 and PSP 1085.

B1.1 Catchment Assumptions

The following assumptions apply to the development of the catchment breakdown for input into the RORB models:

- The ARR IFD location for the project is Deer Park.
- The proposed developments PSP 1082 and PSP 1085 were treated as independent catchments receiving no stormwater runoff from external areas.
- The catchments of PSP 1082 and PSP 1085 were sub-divided into 6 sub-catchments with a retarding basin provided within or at the end of each catchment.
- For the undeveloped case study, catchments have been modelled using the urban source node with a 5% impervious (as specified by Melbourne Water for in other RORB models).

B1.2 RORB Modelling Assumptions

The model was developed using RORB version 6 and MiRORB plugin into MapInfo.

The following table details the RORB parameters used in modelling pre and post development catchments.

RORB Parameter	Value
m	0.8
Kc	Use Melbourne Water defined Kc from RORB models of particular DSS's issued to ARUP. If no existing RORB model has been provide the built in estimate of Vic (MAR<800mm) – EQN 3.22, ARR(BkV) has been adopted.
IL	15
RoC	0.6
Temporal Patterns	Filtered
Areal Pattern Details	Uniform
Areal Reduction Factor Method	Siriwardena and Weinmann
Loss Factor Details	Constant Losses

B1.3 Retarding Basin Assumptions

The sizing of the retarding basins firstly utilised the Melbourne Water DSS RORB models issued to ARUP. Melbourne Water defined the a height-volume relationship and spillway width and height for retarding basins T RB1, T RB3, NR RB3, GL RB1, DD RB1 and DD RB2. These characteristics were utilised in the model and the outlet arrangement adjusted to achieve the required outflow rate.

For locations were the Melbourne Water RORB models were not provided (DCU RB1, DCU RB2, TRB2) the following fixed basin sizing parameters were utilised:

- Spillway: height: 2m, length 10m
- Outlet pipes: length 20m, grade 1%

The following table is a detailed summary of the flows, Kc values, size and outlet arrangements for each retarding basin.

Retarding Basin	Pre-Development Q100 flow (m3/s)	Kc (MW – Melbourne Water Adopted Kc value)	Post-Development Q100 inflow (m3/s)	Post Development Q100 outflow (m3/s)	Volume (m3)	Outlet pipes (No. and pipe diameter mm)	Land-take (ha)
DCU RB1	8.26	0.66	43.24	8.04	35,000	4 x 825	1.8
DCU RB2	5.14	0.77	24.35	4.95	16,700	6 x 525	0.9
T RB1	13.88	1.81 (MW)	69.52	12.74	109,100	5 x 1050, 2 x 675	3.4
T RB2	4.18	1.81	12.59	4.18	5,030	4 x 900	0.5
T RB3	16.62	1.81 (MW)	93.49	16.47	185,690	10 x 1050	7.7
NR RB1	3.67	2.19 (MW)	16.87	3.61	49,150	3 x 600	3.5
GL RB1	1.99	1.45 (MW)	11.89	1.91	35,000	2 x 750	1.8
DD RB1	5.47	2.34(MW)	30.56	5.07	52,420	3 x 825	3.2
DD RB2	6.23	2.34(MW)	9.75	6.35	19,450	4 x 750	1.0

Appendix C

MUSIC Modelling

Basis of Design

C1 MUSIC Modelling – Basis of Design

MUSIC (Model for Urban Stormwater Conceptualisation) is decision support tool, developed by eWater and is used to assess different stormwater quality management measures. MUSIC modelling was undertaken to assess the changes to water quality in the receiving environments following the development of the upstream catchment.

A MUSIC model was constructed for the Mt Atkinson and Tarneit Plains precinct structure plan (PSP) catchments to simulate the discharge loads and concentrations of TN, TP, TSS and Gross Pollutants (GP) generated by the catchment. The pollutant load reductions predicted by the model were compared with the BPEMG specified targets and the effectiveness of the proposed treatment measures was determined.

The MUSIC model was varied for the base case and two alternatives, each with different stormwater management measures and performance targets to achieve.

The findings and recommendations from this assessment would need to be revisited following any significant change to the precinct structure plans.

C1.1 Modelling Parameters & Assumptions

The model was developed in accordance with Melton City Council's Water Sensitive Urban Design Guidelines (2011). This guideline provides guidance on the recommended input parameters and modelling approaches for developing MUSIC models for projects in the Shire of Melton region. The following assumptions apply to development of the conceptual MUSIC models:

- The recommended rainfall station for the project is Melbourne Airport Station which has a mean annual rainfall of 550-650mm. The reference year is 1996. A rainfall template with the rainfall data for the reference year (1996) recorded at 6 minute interval was utilised in the model. Monthly evapotranspiration values for the same period were adopted in the model.
- The proposed developments PSP 1082 and PSP 1085 were treated as independent catchments receiving no stormwater runoff from external areas.
- For the models development, the default rainfall run-off characteristics for pervious area available in MUSIC were adopted. The soil properties were adjusted to suit the Melton region as per the guidelines. The tables below summarise the rainfall run-off generation parameters.
- Similarly, the default values for expected pollutant concentrations for TSS, TN and TP were used as per the guidelines. These values are provided below.
- The catchments of PSP 1082 and PSP 1085 were each sub-divided into catchments defined by Melbourne Water's DSS boundaries. These catchments were further sub-divided in smaller sub-catchments according to the existing surface terrain.
- In assessing the post development scenario of the PSPs, each sub-catchment has been divided into the different land use types and the Melton City Council typical values for total fraction of impervious has been adopted. Not that these are not effective fraction impervious (i.e. total fraction imperious over estimates runoff as it includes not directly connected imperious areas in the fraction impervious areas whereas they should contribute to the total pervious area).

Expected Pollutant Concentrations

Catchment Land Use Type	Parameter	Total Suspended Solids (TSS) (Log 10 mg/L)		Total Phosphorus (TP) (Log 10 mg/L)		Total Nitrogen (TN) (Log 10 mg/L)	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow
Commercial	Mean	1.1	2.2	-0.82	-0.45	0.32	0.42
	Std. Deviation	0.17	0.32	0.19	0.25	0.12	0.19

MUSIC Total Fraction Impervious: Melton City Council guidelines

Land Use Type	Total Fraction Impervious (Typical Values)
Residential (normal density incl. roads)	**0.45**
Medium Density Residential (incl. roads)	**0.60**
Mixed Use Zone	**0.50**
Education / Community Facilites	**0.70**
Commercial (offices, large format retail, town centre)	**0.90**
Industrial / Light Industrial	**0.90**
Drainage Zone and Conservation Areas	**0.00**
Parks and Recreation	**0.10**
Power Easement (Power Lines)	**0.05**
Power Easement (Future Electricity Terminal Station)	**0.50 (estimate only as total area TBC)**
Railway Corridor	**0.70**
Future Major Roads/Freeways (OMR)	**0.70**
Major Roads (Western Freeway)	**0.70**

MUSIC Model Runoff Generation Parameters

MUSIC model parameter	Melton City Council Parameters (Urban)
Field Capacity (mm)	**20**
Infiltration Capacity Co-efficient (a)	**200**
Infiltration Capacity Co-efficient (b)	**1**
Rainfall Threshold (mm)	**1**
Soil Capacity (mm)	**30**
Initial Storage (%)	**30**
Daily Recharge Rate (%)	**25**
Daily Baseflow Rate (%)	**0**
Daily Deep Seepage Rate (%)	**5**
Initial Depth (mm)	**10**

C1.2 Site Soil Characteristics

The Australian Soil Resource Information (ASRIS) map identifies the soils beneath Mt Atkinson and Tarneit Plains PSPs are predominately Sodosols classification. Sodosol soils are generally shallow dark and reddish brown heavy clays with thin loamy topsoil. Outcrops of basalt rock are common and basalt floats occur extensively.

"Sodosols show strong texture contrast with highly sodic B horizon but they are not highly acidic (pH > 5.5). Parent materials of Sodosols range from highly siliceous, siliceous to intermediate in composition. Sodosols are only found in poorly drained sites with rainfall between 50mm and 1100mm. Generally, sodosols have very low agricultural potential with high sodicity leading to high erodibility, poor structure and low permeability. These soils have low to moderate chemical fertility and can be associated with soil salinity." http://www.soil.org.au/soil_types.htm

C2 Stormwater Management Measures

Stormwater management measures implemented in each of the options have been sized based on consistent design parameters, which were established in accordance with the Melton City Council WSUD guidelines, Melbourne Water MUSIC guidelines and industry standards. The stormwater management measures implemented in the base case and two alternative options are:

- Retarding basins (1 in 100 year ARI flood mitigation)
- Gross pollutant traps
- Wetlands
- Infiltration trenches (including sedimentation basins)
- Vegetated swales in arterial roads
- Drainage channels utilised as enhanced waterways
- Residential rainwater tanks
- Active open space stormwater harvesting schemes
- Catchment stormwater harvesting schemes for non-potable supply into the third pipe system

C2.1 Retarding Basins

The majority of the retarding basins have been co-located within proposed wetlands and supplementary infiltration trenches in this case the surface area requirement of the wetland and infiltration trench dictates the footprint of the retarding basin.

There are instances in the business as usual scenario where the required retarding basin size is larger than wetland. In this instance the retarding basin size dictates the total land take.

C2.2 Gross Pollutant Traps (GPT)

A gross pollutant trap has been modelled before every wetland, infiltration trench, stormwater harvesting scheme to mitigate problems associated with litter clogging up the stormwater treatment measure.

The MUSIC model has used the following gross pollutant trap for modelling purposes:

- HumeGuard (high flow bypass has been assumed to be 100 l/s

C2.3 Wetlands

Wetlands have been utilised as a treatment element that primarily removes suspended solids, nitrogen and phosphorus. To achieve the flow reduction targets they have been modelled to also provide evapo-transpiration and infiltration losses of stormwater.

- The key wetland design parameters utilised in the modelling are:
- Inlet pond surface area: 10% storage surface area with depth of 0.4m
- Extended detention depth: 0.40m
- Permanent pool depth: 0.4m
- Notional detention time: 72 hours

- Infiltration (seepage) rate: 0.36mm/hr (Sodosol soil – heavy clay)
- Assumes groundwater level is well below the base of the wetland, therefore does not affect the infiltration rate.

C2.4 Infiltration Trenches

Infiltration trenches have been utilised to assist in achieving the flow reduction targets. They have been placed in locations where they can be gravity feed. Each infiltration trench has a sedimentation basin located before it to minimise suspended solids from entering the trench, which may cause potential clogging. These trenches have firstly been located in the power easement (20m away from towers and 15m wide to allow locations for vehicles to traverse) and on the edge of conservation reserves. Trench have also be located adjacent to wetlands to provide supplementary evapotranspiration and infiltration losses to help achieve flow reduction targets.

- The key sedimentation basin parameters utilised in the modelling are:
- Extended detention depth: 0.4m
- Permanent pool depth: 2.0m
- Notional detention time: 72 hours
- Infiltration (seepage) rate: 0.36mm/hr (Sodosol soil – heavy clay)
- The key infiltration trench parameters utilised in the modelling are:
- Extended detention depth: 0.2m
- Depth of infiltration media 0.5m
- No blockage factors have been applied for modelling purposes
- Infiltration (seepage) rate: 0.36mm/hr (Sodosol soil - heavy clay)
- Assumes groundwater level is well below the base of the trench, therefore does not affect the infiltration rate.

C2.5 Passive Irrigation of Streetscape (Arterial Roads and Connector Boulevards)

Passive irrigation of the streetscape from the road pavement of arterial roads and connector boulevards can be achieved by providing kerb breaks at regular intervals that allows surface runoff to flow into depressed nature strips with trees and vegetation. Overflow pits will be located at the end of these passive irrigated nature strips (either in kerb or in nature strip) to drain larger rain events.

The key passive irrigation parameters utilised in the modelling are:

- 25% of the road pavement drains directly to a vegetated nature strip
- The implementation of passive irrigation results in a 0.15 reduction in fraction impervious for both arterial roads and connector boulevards.

C2.6 Vegetated Swales in Arterial Roads

Vegetated swales have been located in the central median of arterial roads where the grade of the road is between 2%-5%. To maximise the catchment of the swale it has been assumed that the equivalent of a row of residential lots (may be partial industrial and mixed use) on either side of the road will discharge into the swale via a pit and pipe system.

The key vegetated swale design parameters utilised in the modelling are:

- Located in central median (6m wide)
- Base width: 0.5m
- Top width: 6m
- Depth:0.55m (1in 5 batter slope)
- Vegetation height: 0.3m
- Infiltration (seepage) rate: 0.36mm/hr (Sodosol soil - heavy clay)
- Contributing catchment includes a row of residential lots on either side of road reserve (arterial catchment corridor width 90m)
- Fraction impervious for contributing catchment: 0.75

C2.7 Drainage Channels Utilised as Enhanced Waterways

Drainage channels identified in the Melbourne Water DSS are to utilised as enhanced waterways with vegetation and meandering riffle ponds to provide a stormwater treatment function.

The key enhanced waterway design parameters utilised in the modelling are:

- The model only takes into account the low flow central channel.
- Base width: 5m
- Top width: 10m
- Vegetation height 0.25m
- Infiltration (seepage) rate: 0.36mm/hr (Sodosol soil - heavy clay)

C2.8 Residential Rainwater Tanks

Residential stormwater harvesting tanks have been assumed to have 5% uptake due to the availability of recycled water.

The key residential stormwater harvesting design parameters utilised in the modelling are:

Business as usual:

- 6 star minimum requirements - sized at 2,000 L (h=1.77m, d=1.2m, SA=1.13m2).
- Typical lot size 400m2 with typical roof area captured 50m2.
- Reuse demand (just toilet flushing) 56 L/day per household.

Alternative 1 & 2:

- Sized to 76% volumetric reliability at 2,000 L (h=1.77m, d=1.2m, SA=1.13m2).
- Typical lot size 400m2 with typical roof area captured 150m2.
- Reuse demand (toilet flushing, laundry and irrigation) 161 L/day per household.

C2.9 Active Open Space Stormwater Harvesting Schemes

Stormwater harvesting schemes have been modelled where there is sufficient upstream catchment to provided sufficient recycled water to irrigate the adjacent active open space. Underground stormwater harvesting tanks have been placed after a gross pollutant trap and a wetland as to provide for pre-treatment before being stored and utilised for irrigation of active open spaces.

The key active open space stormwater harvesting scheme design parameters utilised in the modelling are:

- Optimal re-use reliability: 70%
- Nominal tank depth: 2m
- Max drawdown height: 2m
- Overflow pipe diameter: 0.225m
- Depth above overflow: 0.2m
- Monthly irrigation distribution for active open space: Jan 16%, Feb 12%, Mar 11%, Apr 6%, May 4%,Jun -Aug 3%, Sept 7%, Oct 9%, Nov 9%, Dec 15%
- Irrigation demand for active open spaces is 5ML/ha/yr

C2.10 Catchment Stormwater Harvesting Schemes

Stormwater harvesting tanks have been placed at the end of each catchment as to minimise the number of tanks and infrastructure required to collect and distribute captured stormwater treated to ‘Class A’ recycled water. The collected stormwater runoff will be treated locally with a small treatment plant consisting of the following processes sedimentation, coarse filtration and UV disinfection before being distributed into the third pipe non-potable water reticulation network.

The key catchment stormwater harvesting scheme design parameters utilised in the modelling are:

- Optimal reliability efficiency: 70%
- Nominal tank depth: 3m
- Max drawdown height: 3m
- Overflow pipe diameter: 0.3m
- Depth above overflow: 0.2m
- Monthly demand to be constant over the year.

C3 Business as Usual

The key stormwater management measures implemented for the Business as Usual scenario are as follows:

- Recycled water for residential non-potable demand.
- Residential rainwater tanks to 6 star requirements (5% uptake)
- End of line 1 in 100 year ARI flood event stormwater retardation.
- End of line wetlands.
- Treatment measures treatment to meet Best Practice Environmental Management Guideline (BPEMG) requirements (80% TSS, 45% TN, 45% TP).

C3.1 Stormwater Management Asset Sizing

The following table details the sizing of each stormwater management asset implemented in the business as usual:

Wetland Sizing – Business As Usual

Wetland	Contributing Sub-catchments	Wetland Storage Size Modelled (m2)	Wetland Inlet Pond Size Modelled (m2)	Total Wetland Area (ha)	Co-located Retarding Basin	Retarding Basin Area (ha)	Total Land-take (ha)
DCU W1	A	15,000	1,500	1.65	DCU RB1	1.80	**1.80**
DCU W2	B,D (note OMR assumed 0.0 impervious adjacent to bio diversity area i.e. runoff exported outside bio diversity area)	18,000	1,800	1.98	DCU RB2	0.90	**1.98**
T W1	F	8,500	850	0.935			**0.935**
T W2	G	5,500	550	0.605			**0.605**
T W3	H,I	17,000	1,700	1.87	T RB1	3.40	**3.40**
T W4	J	6,500	650	0.715			**0.715**
T W5	K	12,000	1,200	1.32	T RB2	0.50	**1.32**
T W6	L,M,N,O,P	38,000	3,800	4.18	T RB3	7.70	**7.70**
NR W1	S,R,Q	20,000	2,000	2.20	NR RB1	3.50	**3.50**
GL W1	T	10,500	1,050	1.155	GL RB1	1.80	**1.80**
DD W1	W,V,U	21,000	2,100	2.31	DD RB1	3.20	**3.20**
DD W2	V,U	8,000	800	0.88	DD RB2	1.00	**1.00**

Residential stormwater harvesting tanks – Business As Usual

Catchment	Residential Area (ha)	Number of Residential Lots (av size 400m2)	Number of households with rainwater tanks (2kl tanks with 5% uptake)	Total demand (toilet flushing only) (kl/day)	Volumetric Reliability
DCU - A	90.6	2265	113	6.34	**94%**
T - F	64.9	1622.5	81	4.54	**94%**
T – G	38.2	955	48	2.67	**94%**
T – H	42.6	1065	53	2.98	**94%**
T – K	16.1	402.5	20	1.13	**94%**
T – L	15	375	19	1.05	**94%**
T - M	7.1	177.5	9	0.50	**94%**
NR - Q	6.7	167.5	8	0.47	**94%**
NR - S	10.4	260	13	0.73	**94%**
DD - U	59.3	1482.5	74	4.15	**94%**
DD - V	15.4	385	19	1.08	**94%**
DD - W	13.8	345	17	0.97	

C3.2 Reduction Targets and Results

The following table identifies the stormwater flow and pollutant reduction targets and the flow and pollutant reduction rates achieved by business as usual:

Reduction targets and results – Business as Usual

MW DSS Catchment	Annual Runoff Volume Reduction %	Total Suspended Solids Reduction %	Total Phosphorus Reduction %	Total Nitrogen Reduction %	Gross Pollutants Reduction %
Targets (BPEMG)	0	80	45	45	70
Dry Creek Upper DS Total	23	80	70	55	100
Truganina DS Total	20	80	69	53	100
Neale Road DS Total	20	80	70	52	100
Gardiner Lane DS Total	21	80	70	54	100
Deanside Drive DS Total	22	80	70	56	100
PSP Total	**21**	**80**	**70**	**53**	**100**

C4 Alternative 1 – Enhanced Liveability

The key elements of the Alternative 1 – Enhanced Liveability scenario are as follows:

- Recycled water for residential non-potable demand.
- For the 5% of properties with rain water tanks and assuming 150 sq metres of roof area diverted to tank satisfies 70% of non-potable residential demand.
- End of line 1 in 100 year ARI flood event stormwater retardation.
- Infiltration trench (with sedimentation basins) located in the power easement and the edge of conservation areas.
- Passive irrigation of the streetscape from the road pavement of arterial roads and connector boulevards.
- Active open space stormwater harvesting schemes.
- End of line wetlands and supplementary infiltration trenches to help reach the flow reduction targets.
- Treatment measures to meet stretch Best Practice Environmental Management Guideline (BPEMG) requirements (85% TSS, 50% TN, 50% TP) with 60% total annual runoff volume reduction of post development volumes.

C4.1 Stormwater Management Asset Sizing

The following table details the sizing of each stormwater management asset implemented in alternative 1:

Wetland Sizing – Alternative 1

Wetland	Contributing Sub-catchments	Wetland Storage Size Modelled (m2)	Wetland Inlet Pond Size Modelled (m2)	Total wetland Area (ha)
DCU W1	A	15,000	1,500	**1.65**
DCU W2	B,D (note OMR assumed 0.0 impervious adjacent to bio diversity area i.e. runoff exported outside bio diversity area)	18,000	1,800	**1.98**
T W1	F	8,500	850	**0.935**
T W2	G	5,500	550	**0.605**
T W3	H,I	17,000	1,700	**1.87**
T W4	J	6,500	650	**0.715**
T W5	K	12,000	1,200	**1.32**
T W6	L,M,N,O,P	38,000	3,800	**4.18**
NR W1	S,R,Q	20,000	2,000	**2.20**
GL W1	T	10,500	1,050	**1.155**
DD W1	W,V,U	21,000	2,100	**2.31**
DD W2	V,U	8,000	800	**0.88**

Residential stormwater harvesting tanks – Alternative 1

Catchment	Residential Area (ha)	Number of Residential Lots (av size 400m2)	Number of households with rainwater tanks (2kl tanks with 5% uptake)	Total demand (toilet flushing, laundry and irrigation) (kl/day)	Volumetric Reliability
DCU - A	90.6	2265	113	18.23	**76%**
T - F	64.9	1622.5	81	13.06	**76%**
T – G	38.2	955	48	7.69	**76%**
T – H	42.6	1065	53	8.57	**76%**
T – K	16.1	402.5	20	3.24	**76%**
T – L	15	375	19	3.02	**76%**
T - M	7.1	177.5	9	1.43	**76%**
NR - Q	6.7	167.5	8	1.35	**76%**
NR - S	10.4	260	13	2.09	**76%**
DD - U	59.3	1482.5	74	11.93	**76%**
DD - V	15.4	385	19	3.10	**76%**
DD - W	13.8	345	17	2.78	**76%**

Sedimentation basin sizing for infiltration trenches – Alternative 1

Sedimentation Basin	Surface Area (m2)	Design Inflow (Q1 m3/s)	Capture Efficiency for 125µm sediment
T SB - H	350	2.77	80%
T SB – I	350	2.84	80%
T SB - K	130	0.98	80%
T SB - L	650	5.00	80%
T SB - M	150	1.34	80%
T SB - N	200	1.68	80%

Infiltration trench sizing (power easement and conservation areas) – Alternative 1

Infiltration Trench	Location	Surface Area (m2)	Length (m)	Width (m)	Unlined Filter Media Perimeter (m)	Load Reduction % (Total ML/yr)
DCU IT- A	Conservation Zone	7500	250	30	560	14% (34ML/yr)
DCU IT- B	Power Easement	4500	300	15	630	11% (22ML/yr)
T IT - H	Power Easement	6000	400	15	830	32% (29 ML/yr)
T IT – I	Power Easement	4500	300	15	630	25% (22ML/yr)
T IT - K	Power Easement	6000	400	15	830	83% (26ML/yr)
T IT - L	Power Easement	6000	400	15	830	19% (30ML/yr)
T IT - M	Power Easement	6000	400	15	830	66% (28ML/yr)
T IT - N	Power Easement	4500	300	15	630	41% (22 ML/yr)

Infiltration trench sizing (supplement to wetlands) – Alternative 1

Infiltration Trench	Surface Area (m2)	Length (m)	Width (m)	Unlined Filter Media Perimeter (m)	Load Reduction % (Total ML/yr)
DCU W1 - IT	19,000	380	50	860	40% (80ML/yr)
DCU W2 - IT	20,000	400	50	900	47% (84.3ML/yr)
T W1 - IT	6,000	120	50	340	28% (25ML/yr)
T W2 - IT	11,000	220	50	540	50% (48ML/yr)
T W3 - IT	20,000	400	50	900	26% (86ML/yr)
T W4 – IT	12,000	240	50	580	49% (52ML/yr)
T W5 - IT	16,000	320	50	740	41% (69ML/yr)
T W6 - IT	55,000	1,100	50	2,300	43% (239ML/yr)
NR W1 - IT	38,000	760	50	1,620	50% (164ML/yr)
GL W1 - IT	19,000	380	50	860	49% (82ML/yr)
DD W1 - IT	38,000	760	50	1620	49% (163ML/yr)
DD W2 - IT	10,000	200	50	500	17% (44ML/yr)

Stormwater harvesting tanks for irrigation of active open space sizing – Alternative 1

Stormwater Harvesting Tank	Total Active Open Space to Irrigate (ha)	Annual Irrigation Demand (kL/Annum)	Tank Volume (kL)	Tank Surface Area (m2)	Supply Reliability (%)
T SWH - F	10.0	50,000 (5Ml/ha/a)	1500	750	72%

Passive irrigation of street scape (Arterial Roads and Connector Boulevards) – Alternative 1

Catchment	Road type	Cross-section Width	Road Catchment Area (ha)	Area Impervious Reduction (ha) (0.15 fraction impervious reduction)	Flow reduction (ML/yr)
DCU-A	Collector Boulevard	25m	2.50	0.375	1.52
T-F	4 lane Arterial	34m	4.42	0.663	
T-F	Collector Boulevard	25m	2.45	0.368	4.16 (Total T-F)
T-G	Collector Boulevard	25m	1.15	0.173	0.70
T-I	Collector Boulevard	25m	0.50	0.075	0.30
T-J	4 lane Arterial	34m	1.87	0.281	1.13
T-K	4 lane Arterial	34m	1.63	0.245	0.99
T-L	4 lane Arterial	34m	7.14	1.071	4.34
T-M	4 lane Arterial	34m	1.53	0.230	0.93
NR-Q	4 lane Arterial	34m	2.92	0.438	1.78
NR-S	4 lane Arterial	34m	2.38	0.357	1.44
DD-U	4 lane Arterial	34m	2.04	0.306	1.24
DD-V	4 lane Arterial	34m	1.87	0.281	1.13

C4.2 Reduction Targets and Results

The following table identifies the stormwater flow and pollutant reduction targets and the flow and pollutant reduction rates achieved by alternative 1:

Reduction targets and results – Alternative 1

MW DSS catchment	Annual Runoff Volume Reduction %	Total Suspended Solids Reduction %	Total Phosphorus Reduction %	Total Nitrogen Reduction %	Gross Pollutants Reduction %
Targets (stretch BPEMG)	60	85	50	50	70
Dry Creek Upper DS Total	60	91	85	76	100
Truganina DS Total	60	94	88	78	100
Neale Road DS Total	60	95	88	78	100
Gardiner Lane DS Total	60	94	87	78	100
Deanside Drive DS Total	60	94	88	79	100
PSP Total	**60**	**94**	**87**	**78**	**100**

C5 Alternative 2 – Enhanced Waterway Health Focus

The key elements of the Alternative 2 – Enhanced Waterway Health scenario are as follows:

- Recycled water for residential non-potable demand.
- For the 5% of properties with rain water tanks and assuming 150 sq metres of roof area diverted to tank satisfies 70% of non-potable residential demand.
- End of line 1 in 100 year ARI flood event stormwater retardation.
- Infiltration trench (with sedimentation basins) located in the power easement and the edge of conservation areas.
- Passive irrigation of the streetscape from the road pavement of arterial roads and connector boulevards.
- Active open space stormwater harvesting schemes.
- Drainage channels utilised as enhanced waterways
- Vegetated swales in arterial roads central medians
- Catchment stormwater harvesting schemes for non-potable supply into the third pipe system
- End of line wetlands and supplementary infiltration trenches to help reach the flow reduction targets.
- Treatment measures to meet stretch Best Practice Environmental Management Guideline (BPEMG) requirements (85% TSS, 50% TN, 50% TP) with 90% total annual runoff volume reduction of post development volumes.

C5.1 Stormwater Management Asset Sizing

The following table details the sizing of each stormwater management measure implemented in the alternative 2:

Wetland sizing – Alternative 2

Wetland	Contributing Sub-catchments	Number of households with rainwater tanks (2kl tanks with 5% uptake)	Wetland Storage Size Modelled (m2)	Wetland Inlet Pond Size Modelled (m2)	Total Wetland Area (ha)
DCU W1	A	113	15,000	1,500	**1.65**
DCU W2	B,D (note OMR assumed 0.0 impervious adjacent to bio diversity area i.e. runoff exported outside bio diversity area)	0	18,000	1,800	**1.98**
T W1	F	81	8,500	850	**0.935**
T W2	G	48	5,500	550	**0.605**
T W3	H,I	53	17,000	1,700	**1.87**
T W4	J	0	6,500	650	**0.715**
T W5	K	20	12,000	1,200	**1.32**

T W6	L,M,N,O,P	28	38,000	3,800	**4.18**
NR W1	S,R,Q	16	20,000	2,000	**2.20**
GL W1	T	0	10,500	1,050	**1.155**
DD W1	W,V,U	110	21,000	2,100	**2.31**
DD W2	V,U	0	8,000	800	**0.88**

Residential stormwater harvesting tanks – Alternative 2

Catchment	Residential Area (ha)	Number of Residential Lots (av size 400m2)	Number of households with rainwater tanks (2kl tanks with 5% uptake)	Total demand (toilet flushing, laundry and irrigation) (kl/day)	Volumetric Reliability
DCU - A	90.6	2265	113	18.23	**76%**
T - F	64.9	1622.5	81	13.06	**76%**
T – G	38.2	955	48	7.69	**76%**
T – H	42.6	1065	53	8.57	**76%**
T – K	16.1	402.5	20	3.24	**76%**
T – L	15	375	19	3.02	**76%**
T - M	7.1	177.5	9	1.43	**76%**
NR - Q	6.7	167.5	8	1.35	**76%**
NR - S	10.4	260	13	2.09	**76%**
DD - U	59.3	1482.5	74	11.93	**76%**
DD - V	15.4	385	19	3.10	**76%**
DD - W	13.8	345	17	2.78	**76%**

Sedimentation basin sizing for infiltration trenches – Alternative 2

Sedimentation Basin	Surface Area (m2)	Design Inflow (Q1 m3/s)	Capture Efficiency for 125µm sediment
T SB - H	350	2.77	80%
T SB – I	350	2.84	80%
T SB - K	130	0.98	80%
T SB - L	650	5.00	80%
T SB - M	150	1.34	80%
T SB - N	200	1.68	80%

Infiltration trench sizing (power easement and conservation areas) – Alternative 2

Infiltration Trench	Location	Surface Area (m2)	Length (m)	Width (m)	Unlined Filter Media Perimeter (m)	Load Reduction % (Total ML/yr)
DCU IT- A	Conservation Zone	7500	250	30	560	14% (34ML/yr)
DCU IT- B	Power Easement	4500	300	15	630	11% (22ML/yr)
T IT - H	Power Easement	6000	400	15	830	32% (29 ML/yr)
T IT – I	Power Easement	4500	300	15	630	25% (22ML/yr)
T IT - K	Power Easement	6000	400	15	830	83% (26ML/yr)
T IT - L	Power Easement	6000	400	15	830	19% (30ML/yr)
T IT - M	Power Easement	6000	400	15	830	66% (28ML/yr)
T IT - N	Power Easement	4500	300	15	630	41% (22 ML/yr)

Infiltration trench sizing (supplement to wetlands) – Alternative 2

Infiltration Trench	Surface Area (m2)	Length (m)	Width (m)	Unlined Filter Media Perimeter (m)	Load Reduction % (Total ML/yr)
DCU W1 - IT	31,000	620	50	1340	76% (99ML/yr)
DCU W2 - IT	45,000	900	50	1900	94% (105ML/yr)
T W1 - IT	9,000	180	50	460	42% (37ML/yr)
T W2 - IT	13,000	260	50	620	59% (56ML/yr)
T W3 - IT	30,000	600	50	1300	42% (127ML/yr)
T W4 – IT	15,000	300	50	700	61% (64ML/yr)
T W5 - IT	20,000	400	50	900	51% (86ML/yr)
T W6 - IT	72,000	1440	50	2980	57% (305ML/yr)
NR W1 - IT	52,000	1040	50	2180	82% (188ML/yr)
GL W1 - IT	27,000	540	50	1180	83% (97ML/yr)
DD W1 - IT	45,000	900	50	1900	58% (192ML/yr)
DD W2 - IT	20,000	400	50	900	49% (55ML/yr)

Stormwater harvesting tanks for irrigation of active open space sizing – Alternative 2

Stormwater Harvesting Tank	Total Active Open Space to Irrigate (ha)	Annual Irrigation Demand (kL/Annum)	Tank Volume (kL)	Tank Surface Area (m2)	Supply Reliability (%)
T SWH AOS - F	10.0	50,000 (5Ml/ha/a)	1500	750	72%

Passive irrigation of street scape (Arterial Roads and Connector Boulevards) – Alternative 2

Catchment	Road type	Cross-section Width	Road Catchment Area (ha)	Area Impervious Reduction (ha) (0.15 fraction impervious reduction)	Flow reduction (ML/yr)
DCU-A	Collector Boulevard	25m	2.50	0.375	1.52
T-F	4 lane Arterial	34m	4.42	0.663	
T-F	Collector Boulevard	25m	2.45	0.368	4.16 (Total T-F)
T-G	Collector Boulevard	25m	1.15	0.173	0.70
T-I	Collector Boulevard	25m	0.50	0.075	0.30
T-J	4 lane Arterial	34m	1.87	0.281	1.13
T-K	4 lane Arterial	34m	1.63	0.245	0.99
T-L	4 lane Arterial	34m	4.49	0.673	2.73
T-M	4 lane Arterial	34m	1.53	0.230	0.93
NR-Q	4 lane Arterial	34m	2.92	0.438	1.78
NR-S	4 lane Arterial	34m	2.38	0.357	1.44
DD-U	4 lane Arterial	34m	2.04	0.306	1.24
DD-V	4 lane Arterial	34m	1.87	0.281	1.13

Vegetated swale in arterial roads sizing – Alternative 2

Swale	Contributing Catchment (ha)	Length (m)	Slope (%)
T - L	7.02	780	2.1

Drainage channels utilised as enhanced waterways sizing – Alternative 2

Enhanced Waterway	Length (m)	Slope (%)	Load Reduction % (Total ML/yr)
DCU EW - A	640	0.9%	1.3% (3.3 ML/yr)
DCU EW - B	320	0.8%	0.5% (1.4ML/yr)
T EW - F	530	1.4%	3.7% (1.9ML/yr)
T EW - HIG	670	1.0%	1.3% (5.2ML/yr)
T EW - JK	1100	0.9%	2.5% (7.6ML/yr)
T EW - PM	2200	1.0%	2.6% (18.3ML/yr)
NR EW - SR	780	0.5%	1.7% (5.0ML/yr)
DD EW - VW	340	1.2%	0.5% (1.3ML/yr)
DD EW - U	120	1.7%	0.2% (0.3ML/yr)
DD EW - UV	280	0.9%	0.7% (2.1ML/yr)

Catchment stormwater harvesting tank sizing for non-potable water supply – Alternative 2

Stormwater Harvesting Tank	% of Total Catchment Contribution to Total Runoff Flow	Annual Sub-Catchment Non-Potable Demand (kL/Annum)	Tank Volume (kL)	Tank Surface Area (m2)	Supply Reliability (%)	Stormwater Supplied for Non-Potable Reuse (ML/yr)
DCU SWH - A	0.084	98,023	2,000	666	73%	71.89
DCU SWH - B	0.084	97,374	2,000	666	71%	69.03
T SWH	0.503	584,246	33,000	11000	60%	352.71
NR SWH	0.115	133,727	2,500	833	72%	96.83
GL SWH	0.059	68,162	1,500	500	76%	51.48
DD SWH	0.155	180,467	4,500	1500	71%	127.50

C5.2 Reduction Targets and Results

The following table identifies the stormwater flow and pollutant reduction targets and the flow and pollutant reduction rates achieved by alternative 2:

Reduction targets and results – Alternative 2

MW DSS catchment	Annual Runoff Volume Reduction %	Total Suspended Solids Reduction %	Total Phosphorus Reduction %	Total Nitrogen Reduction %	Gross Pollutants Reduction %
Targets (stretch BPEMG)	90	85	50	50	70
Dry Creek Upper DS Total	90	96	94	92	100
Truganina DS Total	90	99	97	93	100
Neale Road DS Total	90	99	97	94	100
Gardiner Lane DS Total	90	98	97	93	100
Deanside Drive DS Total	90	99	97	93	100
PSP Total	**90**	**99**	**97**	**93**	**100**

Appendix D

High Level Opinion of Cost

D1 High Level Incremental Cost Estimation Assumptions

The incremental cost of implementing each alternative above the business as usual scenario has been estimated according to the following assumptions:

- Geotechnical conditions are unknown. Consequently, geotechnical conditions have not been considered in cost estimates beyond basic soils parameters and any allowance for geotechnical conditions that is inbuilt in the Melbourne Water unit cost rates.
- All unit costs are based on best cost estimates stipulated by Melbourne Water (October 2013) unless noted otherwise.[2]
- The cost of infiltration trenches (including all associated construction costs) is $50/m^2. This figure was derived from applying standard scaling techniques to the financial analysis undertaken by Taylor (2005) and Schueler (1987) (quoted in the Stormwater Management Manual for Western Australia).[3][4][5] Infiltration trenches containing a retarding basin have not been costed with a different methodology to those within retarding basins.
- Maintenance costs associated with trench component of the infiltration trenches are considered to be 7.5% of capital costs. This value is consistent with maintenance cost estimates projected by Taylor's (2005) of between 5-10% of capital costs. [6]
- All GPTs will be Hume Guard HG30 (< 300 L/s).
- Maintenance of GPTs necessitate a 'cleanout' every three months (Melbourne Water 2014). 'Inspections' are assumed to occur at the same frequency as 'cleanouts'. [7]
- The enhanced waterways in Alternative 2 will be planted with native grasses.
- The width of native grass along the enhanced waterway in Alternative 2 assumes planting across a width equal to the width at the top of the swale (10m).
- The cost associated with Passive irrigation of streetscape for Alternatives 1 and 2 is not expected to be different from the BAU case. Hence, an additional cost for this has not been included.
- The vegetated swales in arterial roads for Alterative 2 will be planted with natural grasses.
- The width of natural grasses along the vegetated swales in arterial roads for Alternative 2 assumes planting across a width equal to the width at the top of the swale (6m).
- The total cost associated with the underground piping required for the stormwater harvesting schemes is $100/m. This value is based on the unit cost used on similar previous projects undertaken by Arup.

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[2] Melbourne Water, 2013, *Water sensitive urban design – Life cycle costing data*. Access via <http://www.melbournewater.com.au/Planning-and-building/Forms-guidelines-and-standard-drawings/Documents/Life%20Cycle%20Costing%20-%20WSUD.pdf>

[3] Taylor, A.C., 2005, *Structural Stormwater Quality BMP Cost/Size Relationship Information from the Literature (Version 3),* Cooperative Research Centre for Catchment Hydrology, Melbourne, Victoria.

[4] Schuleler, T.R., 1987, *A Current Assessment of Urban Best Management Practices*, Metropolitan Washington Council of Governments.

[5] Chalmers, L. and Gray, S., 2004, *Stormwater Management Manual for Western Australia*, Department of Environment, Perth, Western Australia.

[6] See Footnote 2

[7] Melbourne Water, 2014, *City of Melbourne WSUD Guidelines*, City of Melbourne, Victoria.

- The length of pipe required for the connection of the 1.5 ML stormwater harvesting tank for Alternative 1 and 2 is assumed to be 50m.
- No additional pipework from the BAU scenario is required for the addition of the non-potable water from the non-potable water stormwater harvesting tanks into the network. Hence, this pipework has not been costed for Alternative 2.
- The maintenance costs affiliated with the underground pipe network required for the stormwater harvesting scheme is $800/km/yr. This value is consistent with cost estimated stated by the Hunter Water Corporation (2013).[8]
- The capital cost estimate of the active open space stormwater harvesting scheme treatment plant is based on previous cost data attained from the Box Hill gardens stormwater treatment plant with included dual screen filtration, UV and restricted access housing.
- The capital cost estimate of the Local Stormwater Treatment Plant for Alternative 2 is based on the cost of the previous work Arup has done on the Melbourne Olympic Park Trust Stormwater Harvesting Scheme and considers standard scaling techniques and inflation.
- The maintenance costs affiliated with the operation of the stormwater harvesting treatment plant is equal to 5% of the capital cost of the plant per year. This value is consistent with studies undertaken for similar water treatment facilities in Australia and Canada. [9]
- The total maintenance costs affiliated with the new estate water connection will the small for all options (based on $520/m). Given the inaccuracy associated with estimating the total amount of pipe required to provide water to each new lot, this cost is not included on the cost estimate tables. [10]
- In the absence of land acquisition rates for Mt Atkinson the rate is based on that for the Lockerbie East area, as advised by Michael Brown from Services Solutions, Integrated Planning, Melbourne Water. All developable land is worth $800,000/ha.

Land required for the stormwater harvesting storage tanks has been determined as follows:

> 5000 kL – 2500 m^2

5001 - 10000 kL – 5500 m^2

10000 - 15000 kL – 8100 m^2

15001 – 25000 kL – 12000 m^2

60000 kL – 30000 m^2s

[8] Hunter Water Corporation, 2013, *Operation and Maintenance Cost Estimating* Guidelines. Accessed via <http://www.hunterwater.com.au/Resources/Documents/Drawings_Plans_Specs/Guideline---Water-and-Sewer-Cost-Estimating.PDF>

[9] Government of Canada, 2013, *Operation and maintenance costs of drinking water plants*. Accessed via <http://www.statcan.gc.ca/pub/16-002-x/2011001/part-partie3-eng.htm>

[10] See Footnote 7

Alternative 1 Incremental Cost Estimate Above BaU

Asset	Asset Parameter	Construction Cost ($/m2)	Ongoing Cost ($/m2/yr)	Area (m2)	Capital Cost ($)	Maintenance Cost (per year)
INFILTRATION TRENCHES						
In-Ground GPTs (Sedimentation Basins)	< 300 L/s	$50000/asset	Inspection = $100/visit Cleanout = $1000/visit	6	$ 300,000	$ 26,400
Sedimentation Basin	< 250 m2	250	20	280	$ 70,000	$ 5,600
	250 - 1000 m2	200	10	1550	$ 310,000	$ 15,500
Infiltration Trench in Power Ease or Conservation Area (including earthworks etc)		50	5-10% of Capital Costs	45000	$ 2,250,000	$ 168,750
Supplement Infiltration Trench (including earthworks etc)		50	5-10% of Capital Costs	264000	$ 13,200,000	$ 990,000
AOS STORMWATER HARVESTING SCHEME						
In-Ground GPT	< 300 L/s	$50000/asset	Inspection = $100/visit Cleanout = $1000/visit	1	$ 50,000	$ 4,400
Pump and Diversion		$55000/asset	$650/asset	1	$ 55,000	$ 650
Underground Storage		$500000/ML	Included in Treatment Plant	1.5 ML	$ 750,000	-
Underground Piping		$100/m	$800/km	100 m	$ 10,000	$ 80
Stormwater Harvesting Treatment Plant[11]		$300,000	$15,000		$ 300,000	$ 15,000
				EST. CAPEX / OPEX	**$ 16,995,000**	**$ 1,199,980**

[11] Costs could be reduced by incorporating practices which reduce potential exposure to irrigation water

Reason for Land Acquisition	Additional Land Required over BaU (ha)	Developable Land Acquisition Cost ($/ha)		Land Acquisition Cost ($)
Infiltration trenches outside BaU land take requirements	18.245	$ 800,000		$ 14,596,000
			EST. Land Acquisition Cost	**$ 14,596,000**

Alternative 2 Incremental Cost Estimate Above BaU

Asset	Asset Parameter	Construction Cost ($/m2)	Ongoing Cost ($/m2/yr)	Area (m2)	Capital Cost ($)	Maintenance Cost (per year)
INFILTRATION TRENCHES						
In-Ground GPTs (Sedimentation Basins)	< 300 L/s	$50000/asset	Inspection = $100/visit Cleanout = $1000/visit	6	$ 300,000	$ 26,400
Sedimentation Basin	< 250 m2	250	20	280	$ 70,000	$ 5,600
	250 - 1000 m2	200	10	1550	$ 310,000	$ 15,500
Infiltration Trench in Power Ease or Conservation Area (including earthworks etc)		50	5-10% of Capital Costs	34500	$ 1,725,000	$ 129,375
Supplement Infiltration Trench (including earthworks etc)		50	5-10% of Capital Costs	379000	$ 18,950,000	$ 1,421,250
AOS STORMWATER HARVESTING SCHEME						
In-Ground GPT	< 300 L/s	$50000/asset	Inspection = $100/visit Cleanout = $1000/visit	1	$ 50,000	$ 4,400
Pump and Diversion		$55000/asset	$650/asset	1	$ 55,000	$ 650

Asset	Asset Parameter	Construction Cost ($/m2)	Ongoing Cost ($/m2/yr)	Area (m2)	Capital Cost ($)	Maintenance Cost (per year)
Underground Storage		$500000/ML	Included in Treatment Plant	1.5 ML	$ 750,000	-
Underground Piping		$100/m	$800/km	100 m	$ 10,000	$ 80
Stormwater Harvesting Treatment Plant		$ 300,000	$ 15,000		$ 300,000	$ 15,000
CATCHMENT STORMWATER HARVESTING SCHEMES						
Pump and Diversion		$55000/asset	$650/asset	6	$ 330,000	$ 3,900
In-Ground GPTs	< 300 L/s	$50000/asset	Inspection = $100/visit Cleanout = $1000/visit	6	$ 300,000	$ 26,400
Underground Storage		$500000/ML	Included in Treatment Plant	45.5 ML	$ 2,750,000	-
Stormwater Harvesting Treatment Plant - DCU SWH - A		$ 875,000	$ 25,000		$ 875,000	$ 25,000
Stormwater Harvesting Treatment Plant - DCU SWH - B		$ 850,000	$ 25,000		$ 850,000	$ 25,000
Stormwater Harvesting Treatment Plant - T SWH		$ 2,700,000	$ 70,000		$ 2,700,000	$ 70,000
Stormwater Harvesting Treatment Plant - NR SWH		$ 1,100,000	$ 30,000		$ 1,100,000	$ 30,000
Stormwater Harvesting Treatment Plant - GL SWH		$ 700,000	$ 20,000		$ 700,000	$ 20,000

Asset	Asset Parameter	Construction Cost ($/m2)	Ongoing Cost ($/m2/yr)	Area (m2)	Capital Cost ($)	Maintenance Cost (per year)
Stormwater Harvesting Treatment Plant - DD SWH		$ 1,300,000	$ 35,000		$ 1,300,000	$ 35,000
VEGETATED SWALES IN ROADS						
Vegetated Swales in Roads		150	5	4680	$ 702,000	$ 23,400
DRAINAGE LINES UTILISED AS ENHANCED WATERWAYS						
Drainage lines utilised as enhanced waterways	Native grasses established	60	3	127400	$ 7,644,000	$ 382,200
				EST. CAPEX / OPEX	**$ 61,771,000**	**$ 2,259,155**
Reason for Land Acquisition		**Additional Land Required over BaU (ha)**	**Developable Land Acquisition Cost ($/ha)**		**Land Acquisition Cost ($)**	
Infiltration trenches outside BaU land take requirements		29.75	$ 800,000		$23,796,000	
				EST. Land Acquisition Cost	**$ 23,796,000**	

Alternative 1 Incremental Cost Estimate Above BaU Summary

Cost breakdown	CAPEX	Land Acquisition	OPEX	Life Cycle (50 yr)
Sedimentation Basins and Infiltration Trenches	$ 16,130,000	$ 14,596,000	$ 1,206,250	$ 91,038,500
AOS Stormwater Harvesting Scheme	$ 1,165,000	$ -	$ 20,130	$ 2,171,500
Total Incremental Above BaU	**$ 17,295,000**	**$ 14,596,000**	**$ 1,226,380**	**$ 93,210,000**

Alternative 2 Incremental Cost Estimate Above BaU Summary

Cost breakdown	CAPEX	Land Acquisition	OPEX	Life Cycle (50 yr)
Sedimentation Basins and Infiltration Trenches	$ 21,355,000	$ 23,796,000	$ 1,598,125	$ 125,057,250
AOS Stormwater Harvesting Scheme	$ 1,165,000	$ -	$ 20,130	$ 2,171,500
Catchment Stormwater Harvesting Schemes	$ 30,905,000	$ -	$ 235,300	$ 42,670,000
Vegetated Swales	$ 702,000	$ -	$ 23,400	$ 1,872,000
Enhanced Waterways	$ 7,644,000	$ -	$ 382,200	$ 26,754,000
Total Incremental Above BaU	**$ 61,771,000**	**$ 23,796,000**	**$ 2,259,155**	**$ 198,524,750**