Innovation in Infrastructure

Wollert PSP
Revised Integrated Water Management Strategy

20 June 2014

This report has been prepared from the office of Spiire
Level 4 469 La Trobe Street PO Box 16084 Melbourne 8007 **T** 9993 7888

Spiire has prepared the revised IWMS in reference to the draft Urban Structure for the Wollert PSP dated 29 October 2013, in consultation with the MPA, City of Whittlesea and Melbourne Water. However, as the draft Urban Structure is subject to further changes prior to its formal release, it has been omitted from the drawings in this document and MUSIC models. A revised report updated with the draft Urban Structure will be released once the Wollert Precinct Structure Plan is formally released for public consultation.

Issue Date	Revision No	Author	Checked	Approved
18/07/2012	A	D. Davies/N. Green	L. Strauch	L. Holmes
21/11/2013	B	A. Brown	L. Holmes	L. Holmes
02/05/2014	C	A. Brown	L. Holmes	L. Holmes
20/06/2014	D	A. Brown	L. Holmes	L. Holmes

Executive Summary

Spiire has been engaged by The City of Whittlesea in consultation with the Metropolitan Planning Authority (MPA) to prepare an Integrated Water Management Strategy (IWMS) and provide recommendations for the proposed Wollert Precinct Structure Plan located within the Northern Growth Corridor. The following is a summary of Spiire's investigations for the Wollert IWMS:

Integrated Water Management Objectives

The objective of this report is identify various sustainable water management systems and practices across a range of scales and sources to produce an integrated outcome.

The Water Sensitive Cities approach has three themes of foundation upon which its ideologies are based including:

- Cities as Water Supply Catchments
- Cities providing Ecosystem Services
- Cities comprising Water Sensitive Communities

Based on these three water sensitive city themes Spiire has further defined these themes into four meaningful elements of an IWMS. The four elements are as follows:

- Conveyance and Flood Mitigation
- Waterway Health
- Alternate Water Sources
- Urban Planning and Community Values

Conveyance and Flood Mitigation

The following is a summary of the recommendations given for each of the major catchments within Wollert PSP study area.

Retardation Requirements
Adopt the retardation and drainage reserve as presented in Appendix A, drawing 137599D02-3

Catchment	Retarding Basin Name	Volume (kL)	Area (m²)
Findon East	RBG5	26,000	15,600
	RBG3	46,100	24,100
Findon West	RBF1	57,700	29,100
	RBF2 (EX DAM)	54,100	26,500
	RBF3	20,100	12,000
Edgars East	RB E1	28,800	18,000
	RB E2	18,200	12,000
Edgars West	RBD2	31,100	21,300

There is another retardation option for the Findon East catchment, whereby the existing Hanson Quarry is used as a retarding basin. This is discussed in Section 5.1.2.

Flow Conveyance
Adopt the hydraulic widths and waterway corridors as presented in Appendix A, 137599D02-4

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
FINDON EAST					
	A	22	55	X	
	B	13	45	X	
	C	16	45	X	
	D	40	60		X
	E	19	50	X	
FINDON WEST					
	A	18	50	X	
	B	23	55	X	
	C	28	55	X	
	D	20	50	X	
	E	28	55	X	
	F	21	50	X	
	G	18	50	X	
	H	22	50	X	
EDGARS WEST					
	A	13	45	X	
CURLY SEDGE					
	A	25	55	X	

Waterway Health

- Creating a growling grass frog conservation zone will seek to protect the waterway corridor health and its inhabitants. The Department of Environment and Primary Industries (DEPI) is the authority responsible for determining the requirements of this zone. Further work is still required to define how this will be integrated within the PSP to establish a sustainable community.
- The reduction of the frequency with which runoff reaches the waterway will help protect it from the negative environmental impacts associated with increased runoff instances.
- The minimisation of any increase in flow and maintaining the means by which it filters down through to the rivers and creeks will also protect the waterways health.
- This reduction of flow frequency and runoff can be achieved through the capturing of roof water at allotment level using rainwater tanks and ‘choke’ points in the flow path including retarding basins and wetlands that are strategically placed for maximum efficiency.
- The reduction in pollutants entering our waterways.

Stormwater Quantity

- There are two objectives with respect to stormwater quantity
    - Stormwater runoff frequency
    - Stormwater runoff flow rate
- It is recommended that runoff frequency be reduced to as few days as possible and runoff flow rate be limited to 1.5 times pre-development flow rate.
- This Integrated Stormwater Management Strategy outlines the use of WSUD treatment measures to address both of these objectives regarding Stormwater Quantity. The recommendations include: rainwater tanks at allotment scale, raingardens at the streetscape level, and end of line raingardens, retarding basins and wetlands at a precinct scale. , The use of streetscape level infiltration systems has also been investigated. Finally, the implementation of open space irrigation tanks will also act as reducer of both frequency and flow rate by diverting flow into storage for reuse.
- The Flow Frequency results (for details refer section 10) are as follows:

Scenario	**Flow Frequency (days/yr)**
Pre-development	9
Pre-development + 15 days	24
Post-development (no treatment)	104
Post-development (Recommended IWMS)	86

Stormwater Quality

- Whilst Clause 56 objectives will be the minimum requirements for this development. This report demonstrates that a slightly higher target could be achieved, therefore it is recommended to set the phosphorus pollutant reduction to 60%. The suggested water quality targets for the Wollert PSP are as follows:
    - 70% reduction of total Gross Pollutant loads
    - 80% reduction of total Suspended Solids
    - 45% reduction of total Nitrogen
    - 60% reduction of total Phosphorus

- This is achieved through the implementation of a 'train' of treatment measures, refer to Appendix A, drawing 137599D02-7 for the full representation of the IWMS strategy which includes the following:
    - Sedimentation basins, wetlands located within retarding basins and other strategically identified points within the catchment
    - End of line raingardens at precinct level, at strategic locations prior to stormwater drainage discharging into waterways
    - Stormwater harvesting at open space locations
    - Rainwater tanks located at lot scale, adopted by 20% of residential lots
    - No direct connections to the waterways without prior treatment (achieved with the raingardens)

Alternative Water Sources

The percentage breakdown of all water sources to be used within the Wollert development is as follows:

Alternative Water Source	% use within Wollert
Potable	29%
Rainwater/Stormwater	13%
Recycled Water	59%

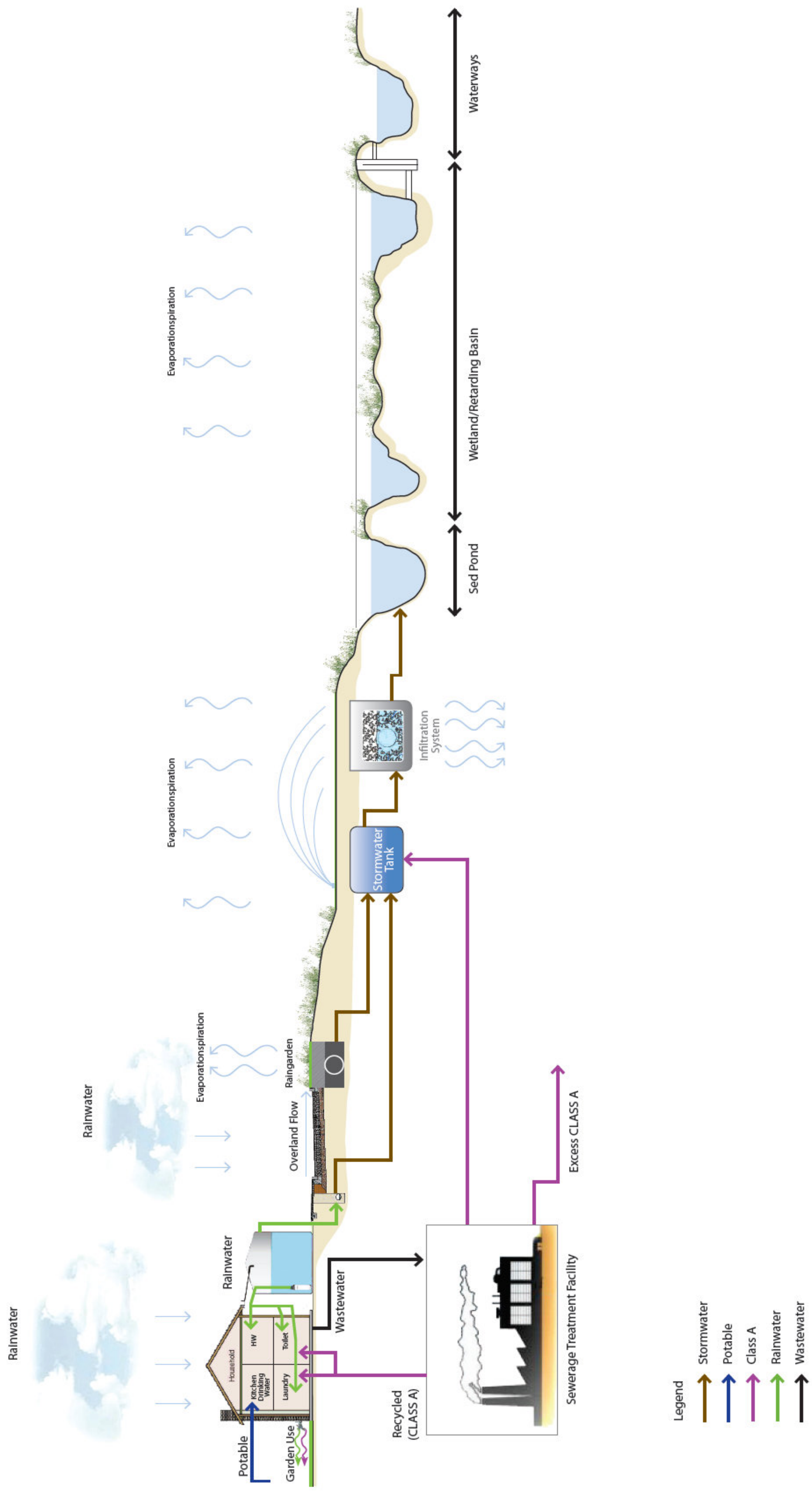
- Alternate Water Sources include recycled water (Class A), stormwater and rainwater.
- Utilising these alternate sources reduces the demand for potable within the Wollert PSP site.
- Rainwater tanks installed at an allotment level can be reused for toilet flushing, watering gardens, laundry and hot water in the shower, with a potential saving of 44% per lot per annum.
- Stormwater tanks under active open spaces can be used for irrigation providing savings of up to 7% of the total Wollert site potable water demands, before filtering through the soil into infiltration systems where pollutants are further removed prior to entering natural waterways.

- Recycled water from the Aurora Craigieburn West treatment facility will be used as an alternate source for purposes of garden watering, toilet flushing, fire fighting and laundry use as well as open space irrigation to top up supply levels in periods of low rainfall.
- Grey water, Sewer mining and Aquifer recharge systems were all regarded as not viable or suitable for the Wollert development.

<u>Urban Planning & Community Values</u>

- There is the option to place infiltration systems at an allotment level (i.e. raingardens), There are, however, a number of issues in the past with implementation, which include:
    - Regular unclogging is required to maintain them and who should bear the costs associated with this maintenance
    - Their proximity to neighbouring homes
    - Issues surrounding house foundation compromise due to soil saturation
    - The home owner removing the system
    - Amount of space they take up in the backyard
    - Infiltration rates are too low for them to function effectively without further detailed geotechnical investigations

  Due to these concerns this IWMS will not be recommending their inclusion in the overall strategy for stormwater management.
- Strategic placement of the stormwater harvesting tanks is key in the proposed IWMS to avoid excessive and costly infrastructure to divert runoff into storage tanks for irrigation. Consideration must be given to where to place open space land use within the Wollert PSP to maximise efficiency.
- There is an opportunity for conservation reserves to be infrequently inundated to aid River Red Gum health.
- Integrating WSUD within the development should also consider the community values by creating public spaces that the community is proud of and can form a sense of attachment. The development should encourage bringing people to the water rather than fencing it off and creating a disconnection to these public spaces. Utilising such techniques such as boardwalks, information boards, activity nodes around these treatments will promote community engagement with the WSUD elements within the development.



Integrated Water Management Strategy Schematic

Contents

Figures

Tables

1 Introduction

Spiire has been engaged by The City of Whittlesea in consultation with the Metropolitan Planning Authority (MPA) to prepare an Integrated Water Management Strategy and provide recommendations for the proposed Wollert Precinct Structure Plan located within the Northern Growth Corridor.

An Integrated Water Management Strategy is an important part of the planning process and its incorporation into the Precinct Structure Plan will ensure efficient and sustainable water management within a development framework.

This report will outline a number of strategies to achieve a desirable outcome as depicted in Figure 1 below.

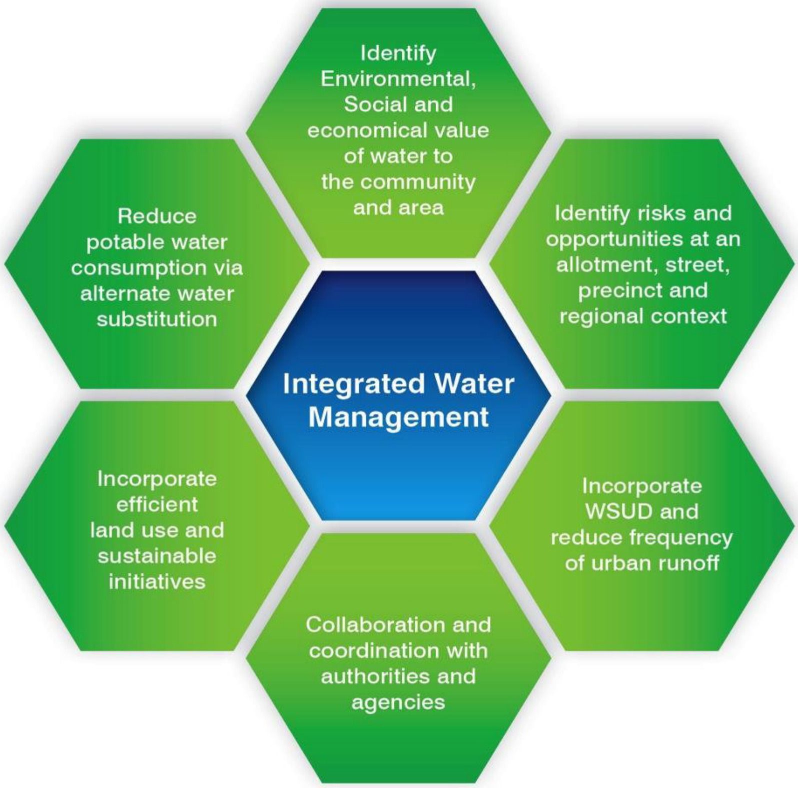


Figure 1 – IWMS Outcomes

Ultimately this report is aimed at improving Victoria's local environments and urban liveability, while providing resilient and flexible water services to its inhabitants.

1.1 Background

The Wollert site is located within the City of Whittlesea and is approximately 1433 hectares in size. It is bordered by Curly Sedge Creek to the West, Craigieburn Road East along the South, Summerhill Road to the north and Bindts Road to the East (see Figure 2).

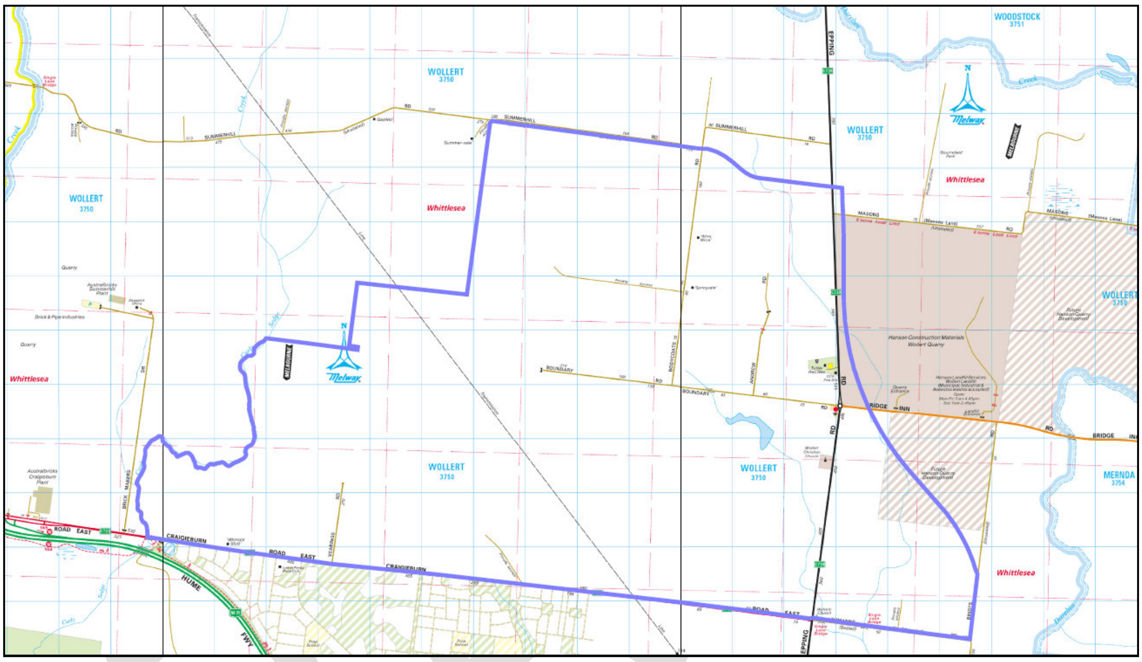


Figure 2 - Locality Plan

The Wollert PSP encompasses three major catchments namely:

- Findon Creek
- Edgars Creek
- Curly Sedge Creek

The land currently sits inside the Urban Growth Boundary and is primarily rural farm area. A large dam is located on Findon Creek just south of Boundary Road and based on observations on site is manmade. The topography of the site slightly undulates and has grades in the order of 1 – 5%.

The Department of Sustainability and Environment (now DEPI) prepared a draft report in 2011 which outlined a Sub-regional Species Strategy for the Growling Grass Frog. Negotiations are currently in place as to the land take requirements for a Growling Grass Frog habitat. The potential for a Growling Grass Frog habitat within the Wollert PSP site is being investigated by DEPI.

At this stage, investigations such as geotechnical, flora and fauna, and cultural heritage have yet to be completed.

1.2 Scope

The Integrated Water Management Strategy report will help shape and influence the future Precinct Structure Plan for the land by identifying the opportunities to utilise the existing topography arrangement, examine land use and its impacts and ways to best mitigate them. The target outcome is to manage all aspects of water (ie potable, stormwater and wastewater) and utilise this resource to achieve a sustainable development structure.

This report will look at several scenarios across a range of elements listed in the integrated water management model and make recommendations at a high level for measures that could be implemented to consolidate developmental impacts on the Wollert site. As a result it can use the outlined strategy to help shape the urban framework for future development.

2 Strategic Context

There has been a major push from both government and industry to implement strategies in line with the Water Sensitive City approach. Figure 3 below illustrates the consistent and committed effort required across the board to secure our water's future.

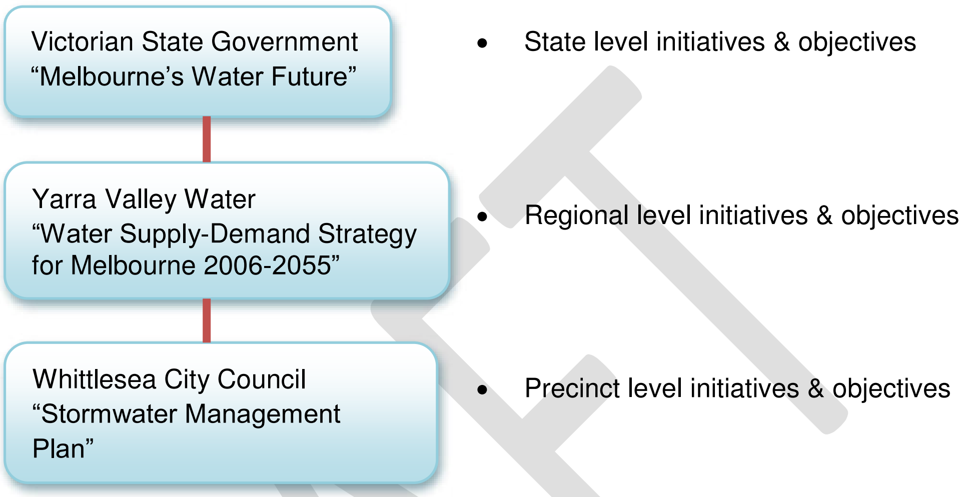


Figure 3 - Scales of Water Management Strategies

The three tiers of water management strategies in Figure 3 play an integral part in forming the Wollert PSP policy that is ultimately adopted as the Sustainable Water Management Strategy.

Federal and State government initiate large scale projects that seek to alleviate the issues of water shortage and quality on a state scale, for example the desalination plant on the Bass Coast near Wonthaggi. The water authority applies policy at a regional level and implements strategies for a balance on supply and demand within their catchment, for example the Aurora Craigieburn West recycled water project. It is then the council provides direction at a precinct scale in line with their own sustainable water management plans.

It is important that all levels of administration have a synergy between their strategies and initiatives to ensure that they are complimentary to each other. Consideration must be given to these reports from all hierarchy of government to ensure the recommendations and initiatives put forward for the Wollert PSP are aligned with the goals and objectives of the overall strategies.

3 The IWMS Approach

The two largest challenges facing Melbourne are that of an ever-increasing population and climate change; both threaten our country's standard of living and quality of life. For this Integrated Water Management Strategy we will be adopting a Water Sensitive City approach. The notion of a Water Sensitive City seeks to strategically plan and implement measures to alleviate issues such as the risk of flooding, water security and conservation, and the degradation of our urban waterways through a combined effort from government, industry and community.

To achieve these goals based on the Water Sensitive Cities approach this report will focus on the three themes of a Water Sensitive City, which are:

- Cities as Water Supply Catchments – providing access to water through a diversity of sources at several supply scales
- Cities providing Ecosystem Services – building structural frameworks to supplement and support natural environments
- Cities comprising Water Sensitive Communities – communities being water sensitive through their decision making and behaviours

Whilst the concept of Water Sensitive Cities in Australia has featured in several government policies, including the Victorian Government's Green Paper on Climate Change Adaption in June 2009, it remains largely undefined as to how to achieve this outcome.

Based on these three water sensitive city themes Spiire has further defined these themes into four meaningful elements of an IWMS. These four elements will then be separately analysed, thereby understanding how each of these elements can work together in harmony. The four elements are as follows:

- Conveyance and Flood Mitigation
- Waterway Health
- Alternate Water Sources
- Urban Planning and Community Values

By integrating the above items, this strategy will seek to leverage off the strengths, weaknesses and opportunities of each of these elements to provide a synergetic system that produces an overall efficient and effective water management system.

3.1 IWMS Assumptions

The main assumptions that underpin the strategy for Wollert PSP have been listed below as follows:

- Standard density lots:
  - Average lot size is 350m²
  - Average impervious surface area is 310m² per lot (i.e. roof, driveway, paving)
  - There are 19 lots to every hectare
- Medium density lots:
  - Average lot size is 200m²
  - Average impervious surface area is 195m² per lot (i.e. roof, driveway, paving)
  - There are 30 lots to every hectare
- Open space equates to 29% of total site area (including service easements, GGF habitat zones, conservation zones, waterways, active and passive open spaces).
- Average active open space area is 8 hectares (including two AFL ovals or thee soccer fields, a pavilion, carparking and access.
- Ovals account for 50% of total active open space
- Soil infiltration rate is negligible **
- Garden water use is lost, therefore no excess runoff
- Daily water demand for an average medium sized house (3 pax):
  - 50L/day for toilets
  - 58L/day for laundry
  - 147L/day for gardening
  - 113L/day of hot water
- Daily water demand for an average small house (2 pax):
  - 33L/day for toilets
  - 42L/day for laundry
  - 73L/day for gardening
  - 76L/day of hot water
- Rainwater tanks are adopted by 20% of residential lots

The base case scenario meets best practice objectives (wetlands, raingardens and sedimentation basins only, no tanks). The IWMS scenario provides additional water treatment with rainwater tanks for residential lots and open space irrigation, without any change to the base case WSUD assets.

Note
** YVW have indicated that infiltration rates for the area are likely to be as low as 0.01mm/hr, therefore soil permeability tests need to be carried out within the Wollert area to obtain representative infiltration rates and therefore further inform the strategy.

4 Climate Change Impacts

Before beginning the detailed investigations of the IWMS, a discussion is required regarding the effects of climate change to further underpin the rationale behind these works. If you are a believer in climate change or not, the one thing we can not deny is Australia's climate and rainfall are highly variable, with Australia having the lowest rainfall of the seven continents (besides Antarctica).

There has been an abundance of speculation as to whether we are in the midst of a climate change that threatens our way of life. While nothing is for certain, over the past decade we have certainly seen the pressures placed on our community when we are ill prepared for an extended drought.

When looking at Victoria's rainfall over the latest 10 year period as outlined in the report "Our Water Our Future (2007)" prepared by the Victorian State Government, we see an alarming observation of a decline in our average rainfall. Among the other trends specified in the report there was a:

- Reduction in rainfall
- Reduction in river inflows
- Increase in temperatures
- Reduction in soil moisture content

To dismiss the facts or refuse to action against the effects of a climate shift could prove disastrous. Looking below (see Figure 4) at one of our driest winter seasons to date in 2006, it is imperative that we plan and take action towards securing our water's future.

Melbourne's Autumn/Winter rainfall over the past 10 years has also seen a steep decline from the Capital's average since recording began over 100 years ago. It is important to safeguard our community from these negative impacts as a result of the climate shift should it become an irreversible trend. Figure 5 indicates the reduction in flow into Melbourne's storages over the past decade as a result of reduced rainfall.

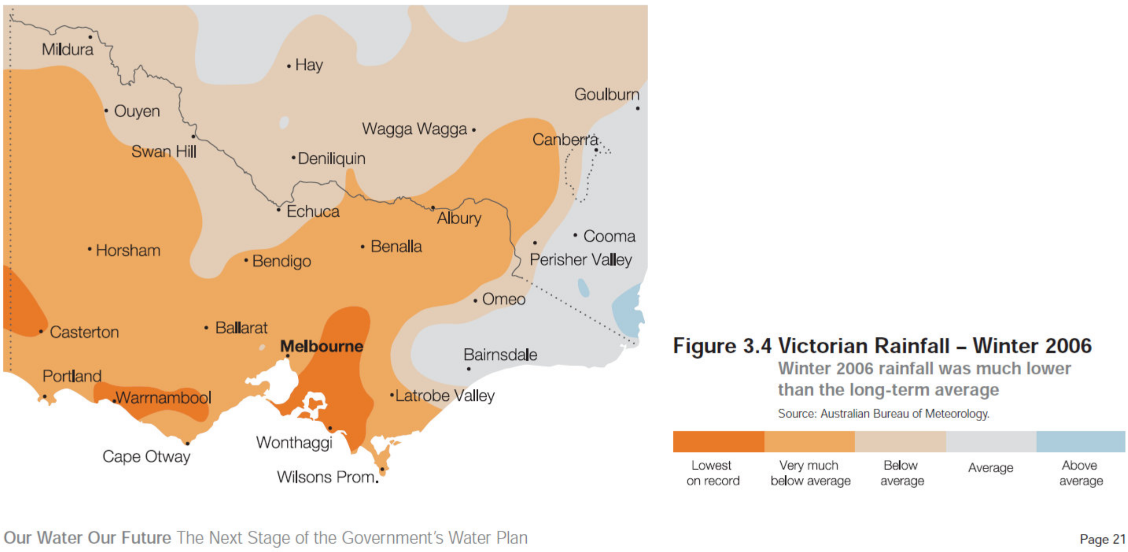


Figure 4 - Victorian Rainfall, Winter 2006

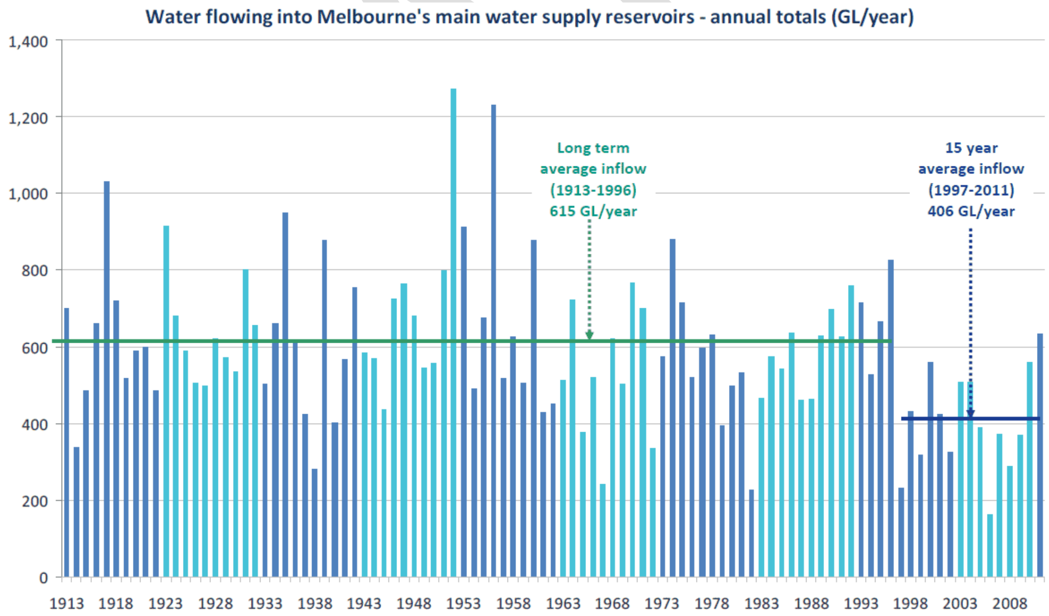


Figure 5 - Melbourne Storage Inflows, 1913-2011

As with any new development, there comes an increased demand for water and this reduction in our potable source combined with a surge in usage requires strategic water management planning and action to ensure a viable, sustainable development.

5 Flood Mitigation and Conveyance

As described earlier the Wollert precinct encompasses three major catchments as follows:

- Findon Creek
- Edgars Creek
- Curly Sedge Creek

The Conveyance and Flood Mitigation investigations of the above three catchments will be broken up into two key sections, hydrological analysis (flow predictions and flood mitigation requirements) and hydraulic analysis (conveyance requirements).

A high level schematic design for conveyance and flood mitigations requirements will be developed, including the alignment and location of drainage reserves and location and size of retarding basins.

This analysis then forms part of the holistic integrated water management strategy, which will bring the conveyance and flood mitigation requirements together with such elements as waterway health objectives.

5.1 Hydrologic Analysis

The Hydrological analysis involves the review of the existing catchment characteristics, development of RORB models (runoff-routing modelling software) and associated catchment plans for each catchment. RORB models allow for an understanding of the flows generated at key locations within the catchment and their timing at certain Annual Recurrence Intervals (ARI). For the analysis of the Wollert PSP, these include, the flows in major reaches, flows in and out of existing and proposed retarding basins, and most importantly, flows leaving the Wollert PSP region.

The Findon Creek and Edgars Creek catchments have been broken down into 4 major catchments, based on the natural topography of the site and existing water courses, for the purpose of RORB modelling. The four main catchments are Findon East, Findon West, Edgars East and Edgars West. Within both the Findon Creek and Edgars Creek catchments there are four small sub-catchments abutting the southern boundary of the PSP, along Craigieburn Road. Due to the topography and the size of these sub-catchments RORB modelling was inadequate and so rational calculations were undertaken to determine the requirements for retardation at the Craigieburn Road boundary. The four main catchments are Findon East, Findon West, Edgars East and Edgars West. Each of these catchments have an independent RORB model

5.1.1 Fraction Impervious Values

A key element in the generation of design flows is the impervious fraction of the sub-areas modelled within RORB. These fraction impervious values, when combined with the calibration for each model and reach types, set the principles for the RORB model to generate flows. The following Table 1 shows the fraction impervious values adopted for the various land use zones for each of the catchments.

Table 1- Fraction Impervious Values

Growth Corridor Plan Category	Fraction Impervious
Rural	0.00
Town Centre / Community Facility	0.70
Education Facility	0.70
Industrial / Bulky Goods	0.90
Encumbered Open Space	0.25
Active Open Space	0.25
Passive Open Space	0.25
Medium Density Residential	0.77
Standard Density Residential	0.75
Curly Sedge Creek Catchment	
Rural	0.0
Medium Density Residential	0.77
Education Facility	0.70
Active Open Space	0.25
Passive Open Space	0.25

Each of the Calibrations for the RORB models includes the rural fraction impervious values as shown above. The calibration of each model ensures that the rural flows generated correspond to either gauged pre developed flows or calculated flows.

Each of the developed catchment models has been broken up using the zones shown on the Wollert PSP 1070 Urban Structure Draft Concept Plan (Appendix D). The fraction impervious for each of these zones, as shown above in Table 1, was determined in accordance with the City of Whittlesea Land Use Fraction Impervious values, in conjunction with the “Melbourne Water Guidelines for the use of MUSIC” (refer Appendix H).

The Curly Sedge Creek Catchment has a large portion of land assigned as open space, utilities or overlaid with biodiversity values (MPA 2012). It is understood that the utilities overlay will likely manifest as buffer areas for the gas transfer station, while biodiversity values and open space will remain at or near their natural state. For this reason, and to keep the RORB models consistent, only the fraction impervious values of residential, educational and open space areas have been altered in the post-development model. The fraction impervious values chosen for the Curly Sedge Creek are those agreed upon in conjunction with City of Whittlesea, as listed in Table 1.

5.1.2 Findon Creek Catchment and Retardation Recommendations

- **Findon Creek Catchment Characteristics**
  The Findon Creek catchment is approximately 1,930ha in size, of which the proposed Wollert PSP area occupies approximately 890ha of the upper reaches.

  In order to effectively model the proposed and existing retarding basins within the Findon Creek catchment, Spiire have remodelled and re calibrated the Findon Creek RORB model to ensure a minimum 4 sub catchments upstream of proposed retarding basin sites, as well as splitting the main catchment in two – Findon East and Findon West, with two small sub-catchments ignored for the purpose of RORB modelling. Appendix B shows the RORB catchment plan and calculations adopted for the Findon Creek models.

  Within the Wollert PSP area, there is an existing dam that in all modelling of the Findon Creek catchment to date is said to act as a retarding basin. From site visits by Spiire, the actual retardation ability of the dam seems compromised as the dam looks to fill with water without any low flow outlet.

  The dam is located in an ideal location for a retarding basin. The associated open space will provide a buffer between the residential zone to the west and the office park/industrial zone to the east. In its current form the dam has very little capacity to retard flows but has potential for redevelopment. The RORB model of the dam (RB F2) includes low flow pipes, an increased capacity and spillway. Furthermore, the location will require land take from only one existing property.

- **Findon Creek RORB Models**
  RORB models have been developed for the Findon Creek catchment as follows:
  - Findon East Existing Conditions
  - Findon West Existing Conditions
  - Findon East Developed Conditions with No Retardation
  - Findon West Developed Conditions with No Retardation
  - Findon East Developed Conditions with Retardation Option A
  - Findon West Developed Conditions with Retardation Option C

- **Findon Creek Design Rainfall**
  In accordance with MWC, the adopted design rainfall parameters are that of Epping as shown below (Table 2).

Table 2 - Findon Creek Catchment Rainfall Parameters

AR&R Parameter	Value
1hr 2yr	19.50
12hr 2yr	3.9
72hr 2yr	1.1
1hr 50yr	39
12hr 50yr	7.3
72hr 50yr	2.25
Skew	0.35
F2	4.29
F50	14.90
Zone	1

- **Calibration Process**
  The pre-developed RORB model (fraction impervious = 0) has been calibrated to the rational method calculations. The parameters of these calculations have been derived from AR&R 1987, the weighted runoff coefficient has been based on a fraction impervious of zero. Velocities have been approximated from the HECRAS models of the existing channel depressions on site. The calibration has been done separately for both of the Findon East and Findon West models. The values for m, Initial Loss (IL), Runoff Coefficient (RoC) and Kc are a result of this calibration and are listed in Table 3 below.

Table 3 - Findon Creek RORB Calibration Parameters

RORB Parameter	Findon East Model	Findon West Model
Kc	2.3	3.5
m	0.8	0.8
IL (mm)	15	15
100yr Volumetric Runoff Coefficient - RoC	0.6	0.6

The calibration for the Findon East catchment was unique due to the shape of the catchment. The rational method is less accurate for a long skinny catchment. As such a ‘sample catchment’ taken from the northern third of the total catchment was used for the calibration.

- **Design Flows**
  Design flows have been generated from the various RORB models.

  The discharge limits for the Wollert PSP area for the developed model have been set by the downstream modelling that Spiire has undertaken as part of the Eucalypt Estate. These flow limits are greater than the pre-developed/existing flows, as such there is additional capacity and less retardation would be required.

  Appendix A, drawing 137599D02-3 and Table 4 below show the peak flows generated from the various development scenarios.

Table 4 - Findon Creek Peak Flow RORB Results

Location	Peak Existing Q_{100} Flows (Refer D02-1) (m^3/sec)	Peak Ultimate Un-Retarded Q_{100} Flows (Refer D02-2) (m^3/sec)	Peak Ultimate Retardation Q_{100} Flows (Refer D02-3) (m^3/sec)
FINDON EAST			
RB G5 Inflow	4.21	21.97	24.45
RB G5 Outflow	-	-	8.07
RB G3 Inflow	6.78	28.57	31.24
RB G3 Outflow	-	-	10.18
Wollert PSP Boundary / Craigieburn Road ***	6.76	28.29	10.18***
**Wollert PSP Boundary / Craigieburn Road Flow Constraint ** **	-	-	10.00**
Sub-catchment East of main catchment at Wollert PSP Boundary / Craigieburn Road	1.50**	8.90	1.50*
FINDON WEST			
RB F1 Inflow	10.98	53.57	56.13
RB F1 Outflow	-	-	19.73
RB F2 Inflow	15.47	64.07	32.92
RB F2 Outflow	-	-	24.74
RB F3 Inflow	3.15	15.09	14.67
RB F3 Outflow	-	-	3.87
Location Fa	3.25	19.13	19.13
Location Fb	5.82	39.74	39.74
Location Fd	2.67	17.99	17.99
Wollert PSP Boundary / Craigieburn Road ***	19.01	71.91	31.45***
**Wollert PSP Boundary / Craigieburn Road Flow Constraint ** **	-	-	32.00**
Sub-catchment West of main catchment at Wollert PSP Boundary / Craigieburn Road	1.30**	6.40	1.30*

*target retarded flow from indicative retarding basin on Wollert PSP Boundary
**forms discharge limit for Wollert PSP area
***flows to be no greater than discharge constraint

When comparing the ultimate un-retarded flows to the existing flows, it is evident that retardation is required to ensure that the peak flows from each catchment are below the discharge limit.

- **Retarding Basin Sizing**

  In order to establish the most suitable flood mitigation option a few different size, location and combinations of retarding basins were modelled. The preferred retardation options are presented in Appendix A, drawing 137599D02-3. All retarding basins have been modelled with an approximate depth of 2.5m and batters graded 1 in 6, integrated with the natural topography of the site.

  A summary of the retardation requirements are shown in Table 5 below.

Table 5 - Findon Creek Recommended Retardation Basin Sizes

Drawing No.	Catchment	Retarding Basin Name	Volume (kL)	Area (m^2)
137599D02-3	Findon East	RB G5	26,000	15,600
		RB G3	46,100	24,100
	Findon West	RBF1	57,700	29,100
		RBF2 (EX DAM)	54,100	26,500
		RBF3	20,100	12,000

These retarding basin sizes are strategically located to best utilise the land and have maximum effect on retarding flows downstream.

Although the recommended retardation is listed above and provided in the associated drawings, the Findon East catchment has a further option which is subject to the staging of development of the catchment. There is potential for the current Hansen Quarry site to be redeveloped into a retarding basin. If this site is available for development prior to the Findon East catchment industrial and residential development taking place then the combination of RB G5 and RB G3 can be reassessed. The Quarry site has the potential to form a 35,900m^3 retarding basin, with a land take of approximately 34,400m^2.

This Quarry site retarding option can be compared to the current recommended option by comparing the sizes of RBs in Table 6.

Table 6 – Findon East Retardation Quarry Site Option

Option	Retarding Basin Name	Volume (kL)	Area (m^2)
Recommended	RB G5	26,000	15,600
	RB G3	46,100	24,100
With Quarry RB	RB Quarry	41,200	20,600
	RB G3*	14,600	9,200

* RB G3 smaller than RB G3 in the recommended option to minimise land take but still meet the flow constraint at the PSP boundary.

Appendix A, drawing 137599D02-3 shows the Quarry retarding basin as a potential option.

There are two further retarding basins that have been sized for the Findon Creek catchment to ensure all flows leaving the PSP area are within the discharge limits. They are within the two sub-catchments, one east of Findon East and the other west of Findon West. The retarding basin requirements are only indicative as they have been calculated not modelled due to the size of the catchment. Refinement of the storage-discharge relationship is required during the design phase to determine how the water treatment can be integrated into the base of each retarding basin. The indicative retarding basin sizes for these two sub-catchments are provide on drawing 137599D02-3, Appendix A.

5.1.3 Edgars Creek Catchment and Retardation Recommendations

– **Edgars Creek Catchment Characteristics**

The Edgars Creek catchment is approximately 2400ha in size, of which the proposed Wollert PSP area occupies approximately 270ha of the upper reaches.

As with the Findon Creek modelling Spiire have remodelled and re calibrated the previous Edgars Creek RORB model to ensure a minimum four sub catchments upstream of the proposed retarding basin sites, as well as splitting the main catchment in two – Edgars East and Edgars West, with two small sub-catchments ignored for the purpose of RORB modelling. Appendix B shows the RORB catchment plan and calculations adopted for the Edgars Creek models.

– **Edgars Creek RORB Models**
RORB models have been developed for the Edgars Creek catchment as follows:
- Existing Conditions
- Developed Conditions with No Retardation
- Developed Conditions with Retardation

- **Edgars Creek Design Rainfall**
  In accordance with MWC, the adopted design rainfall parameters are that of Epping as shown below (Table 7).

Table 7 - Edgars Creek Catchment Rainfall Parameters

AR&R Parameter	Value
1hr 2yr	19.50
12hr 2yr	3.9
72hr 2yr	1.1
1hr 50yr	39
12hr 50yr	7.3
72hr 50yr	2.25
Skew	0.35
F2	4.29
F50	14.90
Zone	1

- **Calibration Process**
  The pre-developed RORB model (fraction impervious = 0) has been calibrated to the rational method calculations. The parameters of these calculations have been derived from AR&R 1987, the weighted runoff coefficient has been based on a fraction impervious of zero. Velocities have been approximated from the HECRAS models of the existing channel depressions on site. The calibration has been done separately for both of the Findon East and Findon West models. The values for m, Initial Loss (IL), Runoff Coefficient (RoC) and Kc are a result of this calibration and are listed in Table 8below.

Table 8 - Findon Creek RORB Calibration Parameters

RORB Parameter	Edgars East Model	Edgars West Model
Kc	2.7	3.6
m	0.8	0.8
IL (mm)	15	15
100yr Volumetric Runoff Coefficient - RoC	0.6	0.6

- **Design Flows**
  Design flows have been generated from the various RORB models.

  The discharge limits for the Wollert PSP area for the developed model have been set by the downstream modelling that Spiire has undertaken. These flow limits are slightly greater than the pre-developed/existing flows, as such there is additional capacity and less retardation would be required.

Appendix A, drawing 137599D02-3 and Table 9 show the peak flows generated from the various development scenarios.

Table 9 - Edgars Creek Peak Flow RORB Results

Location	Peak Existing Q_{100} Flows (Refer D02-1) (m^3/sec)	Peak Ultimate Un-Retarded Q_{100} Flows (Refer D02-2) (m^3/sec)	Peak Ultimate End of Line Retardation Q_{100} Flows (Refer D02-3) (m^3/sec)
EDGARS EAST			
RB E1 Inflow	2.56	15.39	15.39
RB E1 Outflow	-	-	2.30
RB E2 Inflow	2.76	14.99	9.88
RB E2 Outflow	-	-	3.19
Wollert PSP Boundary / Craigieburn Road ***	3.09	16.77	3.19***
Wollert PSP Boundary / Craigieburn Road Flow Constraint **	-	-	3.20**
Sub-catchment West of main catchment at Wollert PSP Boundary / Craigieburn Road	2.00**	5.90	2.00*
EDGARS WEST			
RB D2 Inflow	2.63	10.27	8.43
RB D2 Outflow	-	-	3.36
Wollert PSP Boundary / Craigieburn Road ***	2.54	8.43	3.36***
Wollert PSP Boundary / Craigieburn Road Flow Constraint **	-	-	3.40**
Sub-catchment West of main catchment at Wollert PSP Boundary / Craigieburn Road	1.20**	2.90	1.20*

*target retarded flow from indicative retarding basin on Wollert PSP Boundary
**forms discharge limit for Wollert PSP area
***flows to be no greater than discharge constraint

As for the Findon Creek catchment, retardation is required to ensure that flows leaving the Wollert PSP area do not exceed the peak discharge limits as set by the pre-developed flow rates. Each of the retardation nodes for the Edgars Creek catchment represent a typical ‘on line’ approach. That is, where the retarding basin retards the main creek / drainage network flows. The retardation option presented in Table 9 above is for an end of line, on line retarding basin.

– **Retarding Basin Sizing**
  Although the Edgars Creek catchments, East and West are both smaller than the Findon Creek catchments they still require retardation. The location of the revised Edgars Creek retardation is based on the MWC drainage scheme in conjunction with planning parameters stipulated by the City of Whittlesea and the MPA. In order to establish the most suitable flood mitigation option a few different size, location and combinations of retarding basins were modelled. All retarding basins have been modelled with an approximate depth of 2.5m and batters graded 1 in 6, integrated with the natural topography of the site. The preferred retardation options are presented in Appendix A, drawing 137599D02-3. A summary of the retardation requirements are shown in Table 10.

Table 10 - Edgars Creek Recommended Retarding Basin Sizing

Drawing No.	Catchment	Retarding Basin Name	Volume (kL)	Area (m^2)
137599D02-3	Edgars East	RB E1	28,800	18,000
		RB E2	18,200	12,000
	Edgars West	RB D2	31,100	21,300

These retarding basin sizes are strategically located to best utilise the land and have maximum effect on retarding flows downstream.

There are three further retarding basins that have been sized for the Edgars Creek catchment to ensure all flows leaving the PSP area are within the discharge limits. They are located within the sub-catchments that do not form the catchments for the main tributaries, two to the west of Edgars West and the other between Edgars West and Edgars East. The retarding basin requirements are only indicative as they have been calculated not modelled due to the size of the catchment. Refinement of the storage-discharge relationship is required during the design phase to determine how the water treatment can be integrated into the base of each retarding basin. The indicative retarding basin sizes for these sub-catchments are provide on drawing 137599D02-3, Appendix A.

5.1.4 Curly Sedge Creek Catchment

The Curly Sedge Creek catchment is approximately 2000ha in size, of which the western edge of the proposed Wollert PSP area occupies approximately 200ha of the upper reaches. This catchment is a tributary of the Merri Creek. The intended land use of this portion of the Wollert PSP area is a mix of residential development and land categorised as having biodiversity values and therefore not being developed.

Spiire has developed a RORB model of the Curly Sedge Creek catchment from its uppermost reaches to the Wollert PSP boundary, an area of approximately 1460ha. This RORB model has been calibrated against approximate peak discharge flows calculated using regional methods. The RORB catchment plan, characteristics and working calculations can be seen in Appendix B.

- **Curly Sedge Creek RORB Models**
  RORB models have been developed for the Curly Sedge Creek catchment as follows:
  - Existing Conditions
  - Developed Conditions with No Retardation

- **Design Rainfall**
  Utilising the Bureau of Meteorology IFD generator, design rainfall parameters for the Curly Sedge Creek catchment have been identified, shown below (Table 11).

Table 11 - Curly Sedge Creek Catchment Rainfall Parameters

AR&R Parameter	Value
1hr 2yr	19.66
12hr 2yr	4.0
72hr 2yr	1.08
1hr 50yr	39.93
12hr 50yr	7.24
72hr 50yr	2.29
Skew	0.33
F2	4.30
F50	14.97
Zone	1

- **Calibration Process**
  A number of approximate regional methods are utilised to generate peak discharges against which to calibrate the RORB model. The value for m remains at the RORB default, while Initial Loss (IL) and Continuing Loss (CL) are set to correspond to the values recommended in AR&R. K_c is set initially at the default RORB value and then adjusted to match peak discharge flows at the identified catchment boundary.

  This has resulted in the below parameters (Table 12) being adopted for the Spiire RORB model.

Table 12 - Curly Sedge Creek RORB Parameters

RORB Parameter	Value
Kc	7.90
m	0.8
IL (mm)	15
CL (mm/hr)	2.5

These RORB models allow for an understanding of the flows generated at key locations within the catchment. For the analysis of the Wollert PSP, these include flows in major reaches, the flows at the catchment boundary to the north, flows at the confluence at the catchment boundary to the west and flows leaving the Wollert PSP region (the specified catchment boundary).

- **Design Flows**
  Design flows have been generated from the various RORB models (Table 13).

  The flows generated from the existing conditions RORB model set the peak discharge limits for the Wollert PSP area. This is because all development that has been undertaken downstream of the Wollert PSP area has assumed that the area would only generate pre-developed flows. This is partly due to expansions of the Urban Growth Boundary (UGB) over the past years.

  Appendix A shows the locations of the peak flows generated from the pre- and post-development scenarios.

Table 13 - Curly Sedge Creek Peak Flow RORB Results

Location	Peak Existing Q_{100} Flows (Refer D02-1) (m^3/sec)	Peak Ultimate Un-Retarded Q_{100} Flows (Refer D02-2) (m^3/sec)
Major confluence to north	19.38	19.78
Scheme boundary (north)	23.19	23.61
Confluence/scheme boundary (west)	34.68	35.74
Scheme boundary (outflow)	36.07	37.19
Start of Tributary A	5.42	22.80
Inlet to southern wetland	3.33	11.39

With the current configuration of post-development land use, it appears that the impact on peak discharge flows at the scheme boundary is relatively small. Given that some of the increase occurs in reaches outside the Wollert PSP, residential development within the Wollert PSP boundary is likely to contribute approximately $1m^3/s$ increase to the peak ultimate Q_{100} flows.

5.1.5 Curly Sedge Creek Retardation Recommendation

It is considered that retardation measures are unnecessary within the Wollert PSP boundary from a flow magnitude perspective due to the relatively small increase in peak flows from pre- to post-development land use. However, from a stormwater quality and flow frequency perspective, WSUD treatments will need to be implemented in association with the residential development taking place within the Curly Sedge Creek catchment boundary. WSUD measures will be required to ensure that urban run-off treatment occurs to satisfy the water quality requirements of Clause 56, and will have the additional impact of reducing the magnitude and frequency of post-development flows reaching the Curly Sedge Creek.

5.2 Hydraulic Analysis

The purpose of Hydraulic Analysis is to understand the necessary hydraulic widths for the various drainage reserves that are required to convey the 100 year ARI flows. The land take requirements for each of the drainage reserves has been determined using Melbourne Water's Waterway Corridor Guidelines (2013). The waterway corridor width is defined as a factor of the hydraulic width.

Depending on the existing landform, the waterway corridor may take the form of an existing natural waterway or be formed as a constructed waterway. Both waterway types have setback zones either side of the main channel as defined in the Waterway Corridor Guidelines.

Natural Waterway corridors are as shown below, in which the 100year ARI flows are typically contained within the top of bank. The bank lines are a reference point to set out the riparian and buffer zones. As shown in Figure 6 the total of all these elements forms the total waterway corridor width.

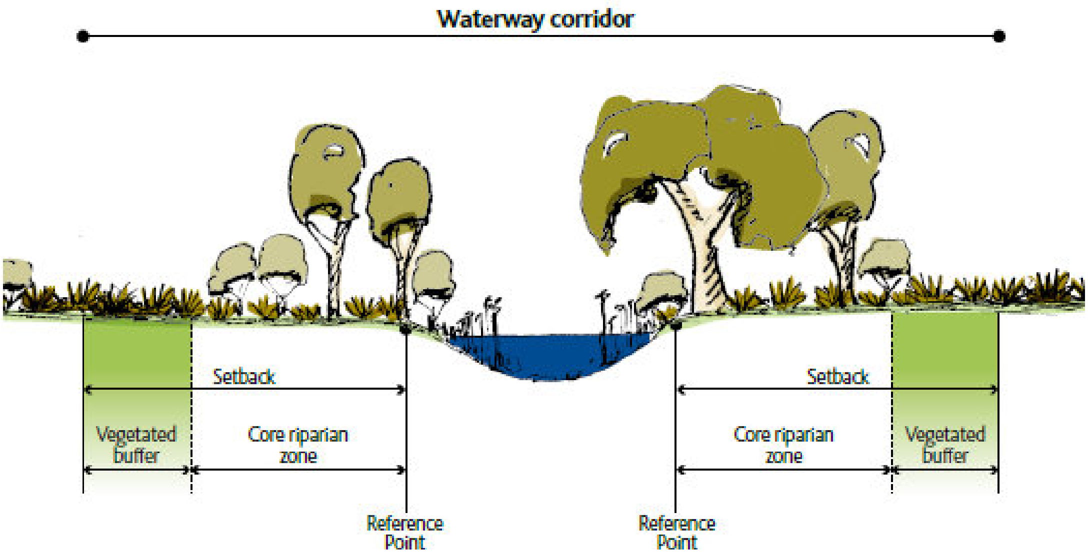


Figure 6 - Typical Natural Waterway, MWC Waterway Guidelines

All natural waterways in this study include 600mm freeboard within the reference points / top of bank.

Where the natural waterway does not have a define channel or sufficient capacity to contain the 100year ARI flows, and there is no significant overlay, a constructed waterway will be established. After detailed analysis of the site there is only one section of waterway that will remain a 'natural waterway' with all other tributaries requiring construction to form a sufficient channel.

Appendix A, drawing 137599D02-4 shows the proposed waterways within the Wollert PSP and indicates the different widths for each waterway.

As for the natural waterway, the total corridor width of a constructed waterway is made up of the hydraulic width with additional setbacks as shown in Figure 7.

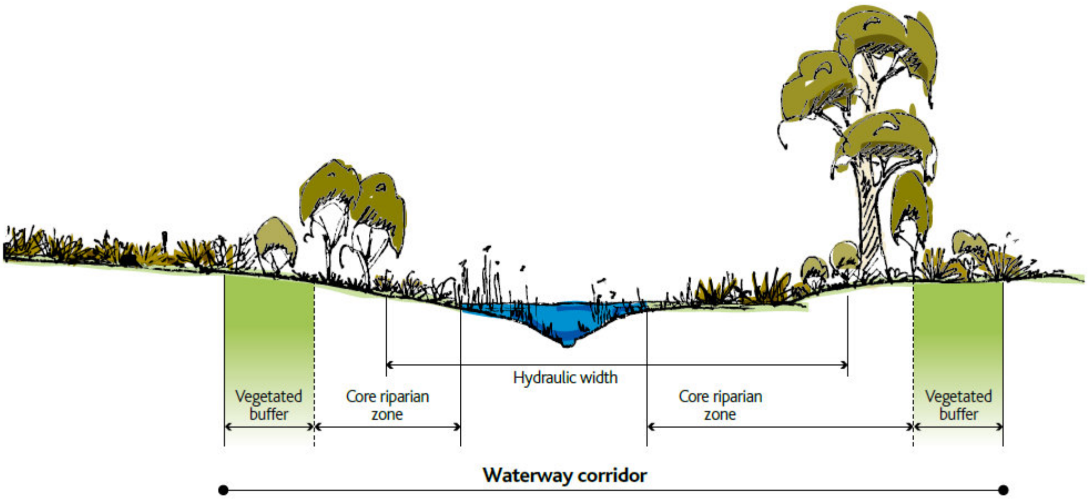


Figure 7 - Typical Constructed Waterway, MWC Waterway Guidelines

All constructed waterways in this study include 600mm freeboard within the hydraulic width.

To estimate the hydraulic width, manning's channel flow calculations have been done based on existing channel grades and a formed channel to determine a suitable flow width. This flow width with an additional 600mm freeboard forms the total hydraulic width.

The Waterway Corridor Guidelines have been used to determine the corridor widths of each of the proposed constructed waterways. The adopted widths have allowed for a shared trail / maintenance track to be accommodated either side of the channel within the vegetated buffer. A summary of the proposed hydraulic widths and waterway corridor widths can be seen in Sections 5.2 and 5.3.

5.2.1 Findon Creek Catchment

Within the Wollert PSP area, the Findon Creek catchment has a number of existing creeks and waterway depressions.

The design flows generated from the RORB models allow for hydraulic modelling of the two major existing creeks in the catchment, Findon East and Findon West. This will represent a likely inundation extent for the waterways within the catchment, and provide guidance to the total reserve widths required.

HECRAS modelling has been undertaken with Lidar survey of the site to model the inundation of the reaches using the peak design flows for various development scenarios.

It is evident, especially in the upper reaches of the catchments, that the existing channel is breached and flows extend to the floodplain. In these areas it is clear that if the natural channel form is maintained, an extremely wide reserve width or filling either side would be required to minimise the width of inundation. For this reason, as shown Appendix A, formed constructed waterways with hydraulic widths as shown will be required to convey 100 year ARI storm flows to the creeks. For the Findon East tributary, the proposed Outer Metropolitan Ring Road (OMR) will result in the natural tributary having to be realigned, as shown on the plans.

The main tributary through the Findon West catchment has a smaller tributary branching off near the PSP southern boundary. This tributary branch will be preserved, as preferred by MWC, and hence the hydraulic width has been modelled accordingly.

The Findon East tributary has a small section as shown where the natural waterway has sufficient capacity to convey the developed 100year ARI storm flows. In this area, the natural waterway will be preserved with the hydraulic width shown on the plan.

5.2.2 Findon Creek Channel Width Recommendation

The channel widths required to convey the 100 year ARI storm flows are presented below in Table 14, and Appendix A drawing 137599D02-4.

Table 14 - Findon Creek Channel Width Recommendation

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
FINDON EAST					
	A	22	55	X	
	B	13	45	X	
	C	16	45	X	
	D	40	60		X
	E	19	50	X	
FINDON WEST					
	A	18	50	X	
	B	23	55	X	
	C	28	55	X	
	D	20	50	X	
	E	28	55	X	
	F	21	50	X	
	G	18	50	X	
	H	22	50	X	

5.2.3 Edgars Creek Catchment

Within the Wollert PSP area, the Edgars Creek catchment has two existing creeks, one which will be used as a drainage reserve.

The design flows generated from the RORB models allow for hydraulic modelling of the existing creek. This will represent a likely inundation extent for the various waterways within the catchment should these depressions be adopted as natural drainage reserves, and provide guidance to the hydraulic widths required.

As the Edgars West tributary is located in the upper reaches of the catchment, only rural flows are ever conveyed via the depressions, hence there is a lack of definition and capacity. Like the Findon tributaries, if the natural channel form is maintained, an extremely wide reserve width or filling either side would be required to minimise the width of inundation. Hence the proposed drainage reserve will be a constructed waterway with hydraulic width as shown in Appendix A, drawing 137599D02-4.

The drainage network conveying flows through the Edgars East catchment is a pipe network, as per the MWC Drainage Scheme. The Edgars East main drainage network runs parallel to the electrical transmission easement, in which two retarding basins lie (RB E1 and RB E2), refer to Appendix A, drawing 137599C2-3 for details.

5.2.4 Edgars Creek Channel Width Recommendation

The channel widths required to convey the 100 year ARI storm flows are presented below in Table 15, and Appendix A, drawing 137599C2-4.

Table 15 - Edgars Creek Channel Width Recommendation

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
Edgars West	A	13	45	X	

5.2.5 Curly Sedge Creek Catchment

The Wollert PSP encompasses approximately 204ha of the Curly Sedge Creek catchment. Curly Sedge Creek forms the western boundary of the Wollert PSP boundary.

As discussed in the hydrologic modelling for Curly Sedge Creek, the increase in the peak design flows for Curly Sedge Creek are negligible for the developed conditions to that of rural conditions. As such the natural waterway (Curly Sedge Creek) will have capacity to convey the un-retarded developed flows from the Wollert PSP area and no changes to the hydraulic capacity of the creek will be required.

In addition to the existing creek waterway, a waterway will be required to convey flows from the main urban development area of the catchment (sub-catchment M) to the creek. The effect of the urban development means that the developed flow is significantly greater than the pre-developed flow (as can be seen in Table 13), hence Tributary A will be required.

5.2.6 Curly Sedge Creek Channel Width Recommendation

Tributary A will be a constructed waterway, sized in accordance with the Waterway Corridor Guidelines. The channel widths required to convey the 100 year ARI storm flows are presented below in Table 16, and Appendix A, drawing 137599C2-4.

Table 16 – Curly Sedge Creek Channel Width Recommendation

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
Curly Sedge	A	25	55	X	

5.2.7 Local Drainage

The drainage strategy for the proposed internal development should be based on the major/minor approach. The minor drainage system is the network that is capable of carrying runoff from minor storms (typically gutter and pipe systems). The major system comprises the planned and unplanned drainage flow paths that convey runoff from major storms. The word “major” does not relate to catchment size but to the size of the storm or rainfall event.

The subdivisional drainage will be constructed to standards agreed with The City of Whittlesea and Melbourne Water in accordance with the minor / major drainage system philosophy. The minor drainage system will typically be designed to accommodate a 1 in 5 year average recurrence interval event (ARI). The major drainage system will be designed for an average recurrence interval (ARI) of 100 years. Where land use is to be industrial, a minor drainage system is to cater for the 1 in 10 year ARI storm event.

The Precinct Structure Plan for Wollert can accommodate overland flows through the provision of roadways or drainage reserves. Future subdivision and urban design layouts should carefully consider the orientation and provision of local road reserves so that they can function as overland flow paths in order to minimise the need for drainage reserves.

An approximation of the expected internal overland flows was carried out to determine where drainage reserves may need to begin. The following equation was used to determine the overland flow:

$$Q_{overland} = Q_{100} - (0.8 * Q_{pipe})$$

An analysis of a typical 16m wide road reserve was carried out to determine its flow capacity based on Melbourne Water’s safety criteria and MPA’s Engineering Design and Construction Manual for Subdivision in Growth Areas, 2011. Based on a range of expected grades from 0.5-2%, the maximum road reserve overland flow capacity ranged from 1.2 – 2.5m^3/s. A wider road reserve could be used to increase the overland flow capacity of the road reserve.

Within the Wollert PSP area, based on the above guidelines, the potential exists to utilise multiple road reserves to convey overland flows across the Findon Creek and Edgars Creek floodplains to the creeks themselves.

In certain locations multiple road reserves will not be sufficient to convey the overland flows to the creeks. In this case, drainage reserves would be required within the floodplains.

The ultimate urban design layout will determine the starting location of the drainage reserves, which will begin once the capacity of the road network to convey 100 year overland gap flows is exceeded. The urban design layout should be considered during planning phases to more definitely determine the extent of the drainage reserves required. The starting location for the drainage reserves will depend the number of road reserves acting as overland flow paths, the road reserve widths and how these interact with the existing land form.

As shown in both the Findon Creek and Edgars Creek Catchments in Appendix A, the drainage reserves convey storm flows across the floodplain to the lower reaches of the creeks.

The widths, as shown on the drawings, have been derived from the calculated urban flows and average floodway longitudinal grade.

The exact form of the drainage reserves will be established giving consideration to a number of factors including:

- Existing flora and fauna
- Geomorphology
- Melbourne Water and Council maintenance requirements
- Cultural heritage elements
- Integration with WSUD and overall development plan objectives

In addition to the upgrade of drainage reserves, culvert upgrades will be required at Boundary Road, Epping Road and Craigieburn East Road. These will need to consider the redevelopment of the roads and timing thereof.

5.2.8 Development / Creek Interface

All future residential allotments adjacent to floodways, wetlands or retarding basins shall be set at the 100 year flood level plus freeboard (typically 600mm).

As per Melbourne Water guidelines for constructed waterways, footpath and shared paths adjacent to the waterways are to be constructed above the 10 year flood level.

5.3 Flood Mitigation and Conveyance Recommendations Summary

The recommendations for each of the major catchments within Wollert PSP study area are as follows:

- **Findon Creek**
  Adopt the retardation and drainage reserve plan, as presented in Appendix A, drawing 137599D02-3.
  This includes:
  - 2 retarding basins in the Findon East catchment and 3 in the Findon West catchment, refer to Section 5.1.2 for hydrologic discussion
  - Constructed waterways of various hydraulic widths refer to Section 5.2.1 for hydraulic discussion
  - Enhancement of Natural waterway, refer to Section 5.2.1 for hydraulic discussion

Drawing No.	Catchment	Retarding Basin Name	Volume (kL)	Area (m²)
137599D02-3	Findon East	RBG5	26,000	15,600
		RBG3	46,100	24,100
	Findon West	RBF1	57,700	29,100
		RBF2 (EX DAM)	54,100	26,500
		RBF3	20,100	12,000

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
FINDON EAST					
	A	22	55	X	
	B	13	45	X	
	C	16	45	X	
	D	40	60		X
	E	19	50	X	
FINDON WEST					
	A	18	50	X	
	B	23	55	X	
	C	28	55	X	
	D	20	50	X	
	E	28	55	X	
	F	21	50	X	
	G	18	50	X	
	H	22	50	X	

– **Edgars Creek**
Adopt the retardation and drainage reserve Option 1, as presented in Appendix A, drawing 137599D02-3.
This includes:
  - 2 retarding basins in the Edgars East catchment and 1 in the Edgars West catchment, refer to Section 5.1.3 for hydrologic discussion
  - A constructed waterway, refer to Section 5.2.3 for hydraulic discussion

Drawing No.	Catchment	Retarding Basin Name	Volume (kL)	Area (m^2)
137599D02-3	Edgars East	RB E1	28,800	18,000
		RB E2	18,200	12,000
	Edgars West	RBD2	31,100	21,300

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
Edgars West	A	13	45	X	

– **Curly Sedge Creek**
Adopt no retardation works and significant waterway works. Refer to Section 5.1.4 for full discussion of analysis.

Adopt one constructed waterway, refer to Section 5.2.6 for hydraulic discussion.

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
Curly Sedge	A	25	55	X	

6 Waterway Health

Melbourne is an expanding city – it is estimated that by 2030 Melbourne's population will increase by one million, and with that expansion comes urban development that encompasses formerly untouched rural landscapes.
Where previously stormwater would permeate the soil and produce a steady sub-surface flow, traditional development methods produce new impervious surfaces such as housing roofs, concrete sidewalks and asphalt roads that convey the water through a drainage scheme into the delicate ecosystem that is our creeks and rivers, increasing the frequency of surface runoff.

While there are current guidelines in place as to the quality of the stormwater that we allow into our waterways as outlined in "Urban Stormwater Best Practice Guidelines" (see Figure 8), there is still simply too much urban runoff entering our creeks and rivers from urban development.

Pollutant	Receiving water objective:	Current best practiceperformance objective:
Post construction phase:		
Suspended solids (SS)	Comply with SEPP (eg. not exceed the 90thpercentile of 80 mg/L) (1)	80% retention of the typical urban annual load
Total phosphorus (TP)	Comply with SEPP (eg. base flow concentration not to exceed 0.08 mg/L) (2)	45% retention of the typical urban annual load
Total nitrogen (TN)	Comply with SEPP (eg. base flow concentration not to exceed 0.9 mg/L) (2)	45% retention of the typical urban annual load
Litter	Comply with SEPP (eg. no litter in waterways) (1)	70% reduction of typical urban annual load (3)

Figure 8 - Urban Stormwater Best Practice Guidelines

To better manage this issue there is a requirement to mimic the natural environment by implementing measures that not only treat the water but retard the flow to counter the problem of increased impervious surfaces runoff through development. In order to achieve this in an urbanised environment we need to provide systems that separate the continuous flow of overland stormwater to enable the necessary time for it to be treated and infiltrate the surface in much the same way as the pre-developed rural scenario.

Studies have shown there is a direct link between 'catchment effective imperviousness' and the health of the surrounding waterway. Reutilising captured runoff for applications such as personal home use at an allotment level, roadside landscape irrigation at a precinct scale, and parkland irrigation on a regional scale has monetary and potable water usage savings.

6.1 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is a relatively new concept that aims to improve the quality of stormwater prior to its entering our rivers and waterways. This is done by implementing one or a number of treatment measures to remove pollutants from the stormwater discharge. Developers are now required to use WSUD practices to achieve best practice guidelines in any new development in accordance with the requirements of Clause 56.07 of the Victorian Planning Provisions. The aims of WSUD are outlined below:

- Protect natural waterways within urban development
- Protect water quality of natural waterways through removal of pollutants at proximity to the source
- Reduce stormwater quantity and frequency of flows
- Integrate stormwater treatments with the surrounding landscape
- Treat rainwater locally as it flows to reduce the requirement for large infrastructure ventures downstream
- Add value while reducing development costs and the overall cost of drainage infrastructure

WSUD seeks to integrate Best Planning Practice (i.e. design) with Best Management Practice (i.e. technology) to identify the constraints and conditions of the proposed site and recommend a multi-faceted drainage system that will achieve its set outcomes. This system will include measures across the treatment spectrum, from allotment through to streetscape and precinct.

As described above, WSUD can assist in improving the health of our waterways, as such, the objectives need to be defined for this site and further discussion of the two major attributes, stormwater quantity and stormwater quality, is required.

6.2 Stormwater Quantity

The use of WSUD for improving stormwater quantity aspects is not widely used however the Best Practice Guidelines do recognise stormwater quantity through the following target:

- Maintain discharges for the 1.5 year ARI event at pre-development levels.

This is target is not widely enforced, but current research into urban flow frequency has created a new paradigm for WSUD. This section will discuss the aspects of stormwater quantity and how WSUD can be used to assist this aspect of waterway health.

spiire

6.2.1 Flow Frequency

Flow Frequency with relation to urban development refers to the rate of reoccurrence at which runoff from impervious surfaces enters and disturbs the waterways compared to the same surfaces in their previous natural (grass and forested) state. The objective of flow frequency reduction is to restrict any increase in the number of these occurrences as much as possible. The proposed method of reducing the urban flow frequency is through the WSUD features on the site, as discussed in Section 6.3.2.

6.2.2 Flow Rate

The other concern related to increased urban development is the volumetric rate at which flow enters our natural creeks and rivers. Flow rate refers to the volume of fluid which passes through a surface per given time. It is the developer's responsibility to ensure that this flow rate does not exceed a certain level above pre-development. Flow rates within the Wollert PSP will be managed through retarding basins as detailed in Section 5.1 of this report. The modelling of the Wollert PSP site has been done by locating many of the WSUD treatment nodes, such as wetlands within retarding basins. Integrating WSUD into flood mitigation elements is an efficient use of space and thus provides multiple benefits for the one area.

6.2.3 Pre-Development Runoff Days

Prior to the urbanisation of any rural area there is a rate of reoccurrence at which rainfall from the site's catchments flows into the local waterways. The number of days at which this occurs per year is referred to as the total annual pre-development runoff days, or the flow frequency. Matching this number of pre-development runoff days in post development is the optimal outcome of the Wollert PSP IWMS. Based on Appendix B in the FAWB (Facility for Advancing Water Biofiltration) guidelines, the pre-development flow frequency was modelled using MUSIC. For new urban developments an idealist target has been set by Melbourne Water and the Department of Sustainability and Environment (DSE) as follows:

Urban Flow Frequency Target = Pre-development runoff days + 15 days.

Table 17 - Pre-development Flow Frequency Days

Scenario	Flow Frequency (days/yr)
Pre-development	9
Pre-development + 15 days	24

Based on this target, the aim of the Wollert PSP model is to reduce the flow frequency to 24 days, to be discussed later in this strategy.

6.2.4 Flow Frequency Reductions within Wollert

For developments to efficiently reduce stormwater flow frequency a combination of Evapotranspiration, infiltration and stormwater reuse are required. Reducing flow frequency to pre-development levels within the Wollert PSP site may pose some difficulties based on the heavy clay soils expected in this region. This will potentially hinder the ability of infiltration treatment measures in attaining their intended objectives.

Soil samples taken by Dalton Consulting Engineers Pty Ltd at the Kallkallo development have revealed ground conditions to be largely silty clay that is almost impermeable at extremely shallow depths and has recorded infiltration rates as little as less than 0.01mm per hour. Spiire expect that the Wollert PSP site will experience similar permeability levels. Evapotranspiration in this case will play a larger role to mitigate the urban stormwater impacts on our waterways. As described, the objective of this Integrated Water Management Strategy to achieve pre-development run-off day as best as possible.

For the purposes of this report infiltration systems have not been modelled at this stage as treatment is deemed ineffective without the known soil properties. Further investigation will be required to determine the suitability of infiltration systems.

Based on the above assumptions Spiire will address the impacts of urban flow frequency and flow rate by integrating the use of WSUD treatment measures with the natural landscape to develop this Integrated Water Management Strategy within the Wollert Precinct Structure Plan.

6.3 Stormwater Quality

WSUD is predominately known for treating water quality and therefore this section will outline the approach. As previously outlined, there is a set of best practice guidelines that outline stormwater quality performance objectives; this strategy for the Wollert Precinct Structure Plan will seek to attain these results through a number of measures. The Best Practice Guidelines are outline below:

- 70% reduction of total Gross Pollutant loads
- 80% reduction of total Suspended Solids
- 45% reduction of total Nitrogen
- 45% reduction of total Phosphorus*

* Refer to Section 6.3.2 below

6.3.1 Stormwater Quality Approach

Water quality has been modelled for each of the four major catchments within the Wollert PSP site, Edgars West, Edgars East, Findon West and Findon East.
At each of the major catchment outlet locations across the PSP boundary, flows discharging must meet best practice objective. This outcome was achieved through the computer modelling software package MUSIC (Model for Urban Stormwater Improvement Conceptualisation). The model establishes a result based on the rainfall parameters entered into the system and the characteristics of each sub-catchment. The output indicates the volume of pollutants produced, the pollutant load generated once the catchment is treated and the performance of the treatment measures.

This software enables optimisation of the size and arrangement of the selected treatment measures to produce an output that achieves the most favourable results in terms of stormwater quality, flow frequency reduction, flow rate minimisation, reliability, cost and size. These results have been achieved through utilisation of WSUD methods across a range of spatial scales from allotment level, streetscape through to neighbourhood and estate.

6.3.2 Clause 56.07 Requirements within Wollert

Clause 56.07 is the only state planning policy to enforce water quality objectives. This policy has helped define the minimum requirements for the Wollert development, to identify a base case scenario. Whilst the Clause 56 objectives state the % reductions of pollutants as above, these are minimum requirements for this development. This report demonstrates that a slightly higher target could be achieved, therefore it is recommended to set the phosphorus pollutant reduction to 60% for the Wollert PSP.

Proceeding sections of this strategy will identify further water treatment opportunities and consolidate them in one cohesive approach.

A MUSIC model was setup utilising Melbourne City rainfall data with a reference year of 1966 as per the MWC MUSIC Guidelines. The initial MUSIC model utilised large ‘end of line’ sedimentation basins and wetlands to meet best practice objectives as a first cut to gauge the size and effectiveness at a high level. This has long been the traditionally the approach for water treatment. As previously mentioned the approach of this strategy is for an integrated system and therefore treatment nodes should be dispersed at all spatial scales. This enables more efficient land use and mimics natural conveyance and treatment methods throughout the development.

Based on the traditional ‘end of line’ approach, a significant portion of each of the retarding basin sites plus extra surrounding reserve would be required for stormwater treatment, through only wetlands and sedimentation basins.

Further refinement has been carried out to implement the ‘distributed’ method of reaching water quality objectives. This has been done by adding raingardens throughout the site at a precinct level to enable a distributed model. End of line raingardens have been modelled at strategic locations, where stormwater drainage will discharge into a waterway. This concept prevents any stormwater entering a waterway without prior treatment. Where upstream catchments equate to a large area, the raingarden is modelled in conjunction with a sedimentation basin. The location of raingardens distributed throughout the Wollert PSP area can be seen in Appendix G, drawing 137599D02-5.

The distribution of raingardens has been modelled in conjunction larger wetlands and sedimentation basins. These larger treatment nodes are located within the retarding basins. This distributed approach will enable a significant land ‘saving’ benefit by reducing the total land requirements of water quality treatment measures while still achieving Clause 56 targets. The combination of raingardens, wetlands and sedimentation basins forms the base case scenario of stormwater treatment – the minimum requirement for the Wollert PSP. For each of the 5 major catchments, Curly Sedge, Edgars East and West, and Findon East and West have a combination of treatment nodes such that the catchment meets best practice objectives at the Craigieburn Road / southern PSP boundary, before discharging into downstream catchments.

There are also four sub-catchments that abut the Craigieburn Road / southern PSP boundary, each of these sub-catchments have a sedimentation basin and wetland combination to ensure that these flows also meet best practice objectives. As these sub-catchments are relative small the retardation requirements are less and hence a detail analysis of the storage-discharge will be required to determine how the water treatment assets can fit within the retarding basins.

The water quality results of modelling the base case in MUSIC are provided in Table 18. A full analysis of the MUSIC modelling can be seen in Appendix G, including drawing 137599D02-5.

Table 18 - MUSIC Results, Base Case (Clause 56)

Pollutant Reduction	Edgars West Catchment	Edgars East Catchment	Findon West Catchment	Findon East Catchment
TSS (%)	77.9	82.3	82.6	85.4
TP (%)	58.3	45.3	57.4	66.7
TN (%)	45.3	51.9	46.8	45.7
TGP (%)	98.7	100	100	100

This approach has been labelled the ‘base case’ scenario as it has been modelled with only water quality objectives in mind. Further modelling was required to address the flow frequency and potable water conservation. The following sections will identify alternative water sources and their demand followed by integration of all the IWMS elements to finalise the strategy.

7 Alternative Water Sources

Source substitution is the use of alternative sources of water treated to a level appropriate for their end use. Alternate water sources of appropriate quality will reduce reliance on potable water within the Wollert PSP. There are many possible alternative sources of water, although not all will be practical or safe for use due to the community/commercial nature of the facilities and potential public exposure. Figure 9, below, is an outline from The City of Whittlesea's "Sustainable Water Use Plan (2006)" for the recommended uses for potable and alternative water sources for the community:

	Use					
Water quality	**Kitchens/ drinking**	**Toilet High contact e.g. flushing**	**Showers**	**Restricted access irrigation**	**Clothes washing / Laundry**	**Vehicle washing**
Potable	✓	✓	✓	✓	✓	✓
Rainwater – Hot	N/R	N/R	✓	N/R	✓	N/R
Rainwater - Cold	N/R	✓	✓	✓	✓	✓
Greywater				✓		
Class A reuse water		✓		✓	✓	✓
Swimming pool backwash		✓		✓	✓	

LEGEND:

✓	Acceptable
✓	Potentially Acceptable
	Unacceptable
N/R	Not Recommended
	Not Approved by relevant Authority ie: EPA, DHS

Figure 9 – Hierarchy of Water within The City of Whittlesea

This matrix provides a useful tool in identifying areas where alternate water sources can be supplemented for potable demand in the home environment for the Wollert PSP.

7.1 Supply

Yarra Valley Water will be supplying potable, recycled water (class A) and sewer infrastructure to the Wollert PSP area. In addition to these services, other alternate water sources that could form part of this IWMS have been investigated. A separate study has been commissioned by MPA to carry out the servicing strategies, refer to the Utilities Infrastructure Servicing Assessment dated 14th May 2012 for further information. This section does not intend to inform the servicing assessment, rather discuss the opportunities, constraints and uses within the Wollert PSP.

7.1.1 Potable Water

Whilst pricing in the water industry has moved towards a "user pays" philosophy, the water pricing arrangements still do not reflect the true or total cost for water. The pricing of water is based on a financial analysis rather than an economic analysis. As result environmental and social externalities (e.g. waterway health) are not fully accounted for in the water pricing index.

In Figure 10, taken from Yarra Valley Water's "Water Plan 2009/10 – 2012/13 (2008)", it is apparent how much residential potable water tariffs have and will continue to increase. This increase means alternative water sources will only become a more feasible option.

	EXISTING 2008/09 PRICE	PROPOSED 2009/10 PRICE	PROPOSED 2012/13 PRICE
Water fixed charge (per year)	$75.54	$89.89	$128.42
Water usage charge (per kilolitre) Step 1 (0 – 440 litres per day)	$1.0192	$1.2128	$1.7326
Step 2 (441 – 880 litres per day)	$1.1957	$1.4229	$2.0327
Step 3 (881+ litres per day)	$1.7666	$2.1023	$3.0032
Sewer fixed charge (per year)	$184.54	$219.60	$313.72
Sewage disposal charge (per kilolitre)	$1.3181	$1.5685	$2.2408

Figure 10 - Tariff Structures and Prices for Residential Water and Sewerage Customers ($ January 2009 Levels)

Not only are there financial benefits to sourcing water from alternative resources, there is also the issue of water scarcity. Statistics show that there has been a significant decline in the amount of rainfall Melbourne's catchments receive each year. An Integrated Water Management Strategy can help reduce our reliance on potable water and alleviate the uncertainty of potable supply sustainability.

7.1.2 Recycled Water

The existing Aurora Craigieburn West recycled water facility is available to service the Wollert PSP area. This facility is capable of providing Class A recycled water for reuse purposes at the allotment level including toilet flushing, residential garden watering, laundry use and firefighting; as well as open space irrigation at a precinct level.

As stormwater harvesting is less reliable than recycled water, there lies an opportunity to balance recycled water with harvested stormwater to provide a 100% alternative to potable water use for certain demands within the home, while protecting our waterways. Harvesting stormwater water can produce a saving of approximately 56ML per year through open space irrigation. Capturing and reusing rainwater within households can save approximately 263ML per year. Combining these measures with Class A recycled water as a substitute for potable use for residential areas, saves approximately 430ML per year. This water balance and saving is discussed in greater details in Section 10.

7.1.3 Stormwater / Rainwater

The Wollert PSP area receives an average 665.2mm of rainfall each year. While the proposed development will increase the amount of impervious surface and stormwater runoff, it also provides the ability to treat the site as an urban water supply catchment and harness this for consumption benefits.

The estimated total annual runoff produced from the Wollert PSP catchment is approximately 95,200ML. Of this, approximately 20,889ML is captured from residential roof areas for reuse at an allotment scale. The remainder of the stormwater will runoff as overland flow and/or within the urban drainage system. The urban drainage system can be diverted to logically placed stormwater harvesting storage systems where this can be utilised for irrigation.

Yarra Valley Water has indicated that the option of alternate hot water supply in their customers' homes is acceptable. They do however take exception to rainwater being harvested for the purposes of laundry, toilet flushing and garden watering use at an allotment level as it competes with use of recycled water. Council and Melbourne Water are likely, however, to pursue a greater diversity of rainwater harvesting, as such this strategy models further scenarios including rainwater harvesting used for toilet flushing, laundry and garden watering. In order to preference one of these scenarios further discussion will be required to consider all social, economic and environmental factors.

There is however concern from the Department of Health to the quality of the rainwater being harvested. While there is the requirement that the water is treated to a certain level prior to its use, there are a number of questions raised as to how to ensure the water can meet these stringent standards at all times. Again further analysis and discussion will be required to ensure all parties are satisfied.

Capturing and storing stormwater and rainwater can often be difficult, especially if the urban development has not planned to utilise stormwater for open space irrigation. The summer months have less rain yet are the time which requires greater irrigation demands, therefore reliability of stormwater and rainwater harvesting systems decreases. Non-seasonal demands are the most beneficial demand for stormwater/rainwater systems; however this is not always available. These issues can results in larger infrastructure requirements and hence financially they become less attractive.

The Wollert IWMS has identified a non-seasonal demand and discusses the importance of appropriate urban form to assist in better water management. As the development will have the benefit of utilising recycled water, this alternate water source can be used to bolster the diminished reliability in periods of low rainfall.

The reliabilities of stormwater and rainwater harvesting have been calculated using MUSIC and rainfall data spanning 1990-2010, as opposed to a single rainfall reference year, as this is typical for stormwater quality calculations. Melbourne has seen an extended period of drought over the past decade and utilising information from this period enables the Integrated Water Management Strategy to propose a more robust and reliable stormwater / rainwater harvesting system that will better cope with any downturn in rainfall within Wollert's catchments. An analysis of the demand for rainwater reuse within the Wollert PSP is in Section 7.2, which will provide further details as to how stormwater and rainwater will be integrated into the Wollert IWMS.

7.1.4 Grey Water and Sewer Mining

There is the potential to incorporate grey water and sewer mining source substitution however due to the fact that there is recycled water available within the Wollert site it is deemed unnecessary and will not be recommended for inclusion in the Integrated Water Management Strategy.

7.1.5 Aquifer Recharge and Recovery

An Aquifer is 'an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand or silt) from which groundwater can be usefully extracted using a water well.' Aquifer Recharge is the process by which stormwater permeates the surface into an underlying Aquifer, and Aquifer Recovery is the harnessing of this water for potable use.

Southern Rural Water manages licences to take and use groundwater. It has a number of responsibilities in accordance with the *Water Act 1989* such as water allocations; including assessing applications according to policies, environmental sustainability, and impacts on Victoria's water resources.

The IWMS has identified Aquifer recharge and recovery within Wollert is not suitable. This is can be shown in Figure 11 as the Lower Tertiary Aquifer Managed Aquifer Recharge (MAR) Storage Potential is not suitable for Aquifer storage within the Wollert area.

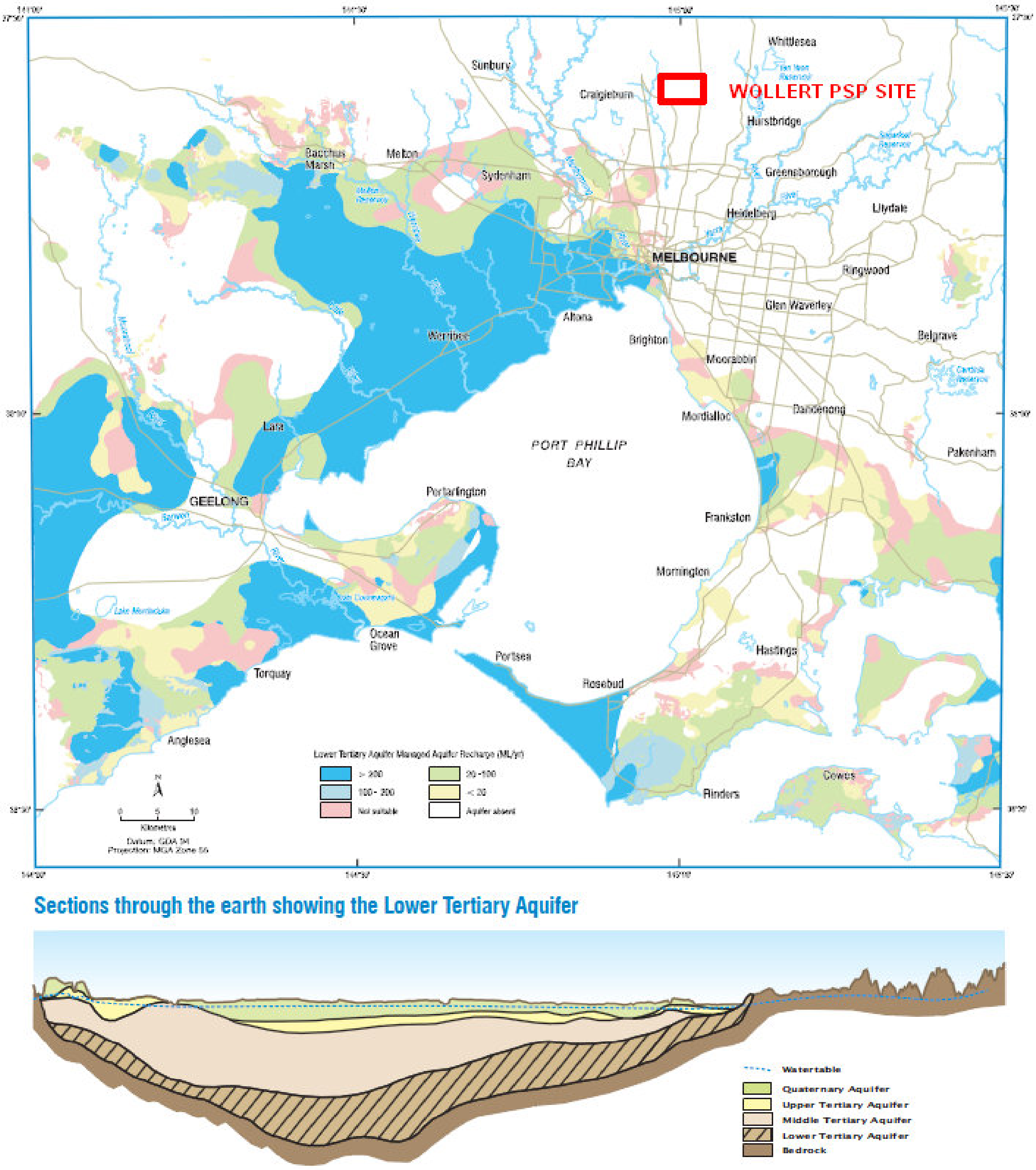


Figure 11 - Lower Tertiary Aquifer Managed Aquifer Recharge (MAR) Storage Potential

In addition to this, Figure 12 shows that any Upper Tertiary Aquifer near the Wollert PSP will yield only less than 1 litre per second.

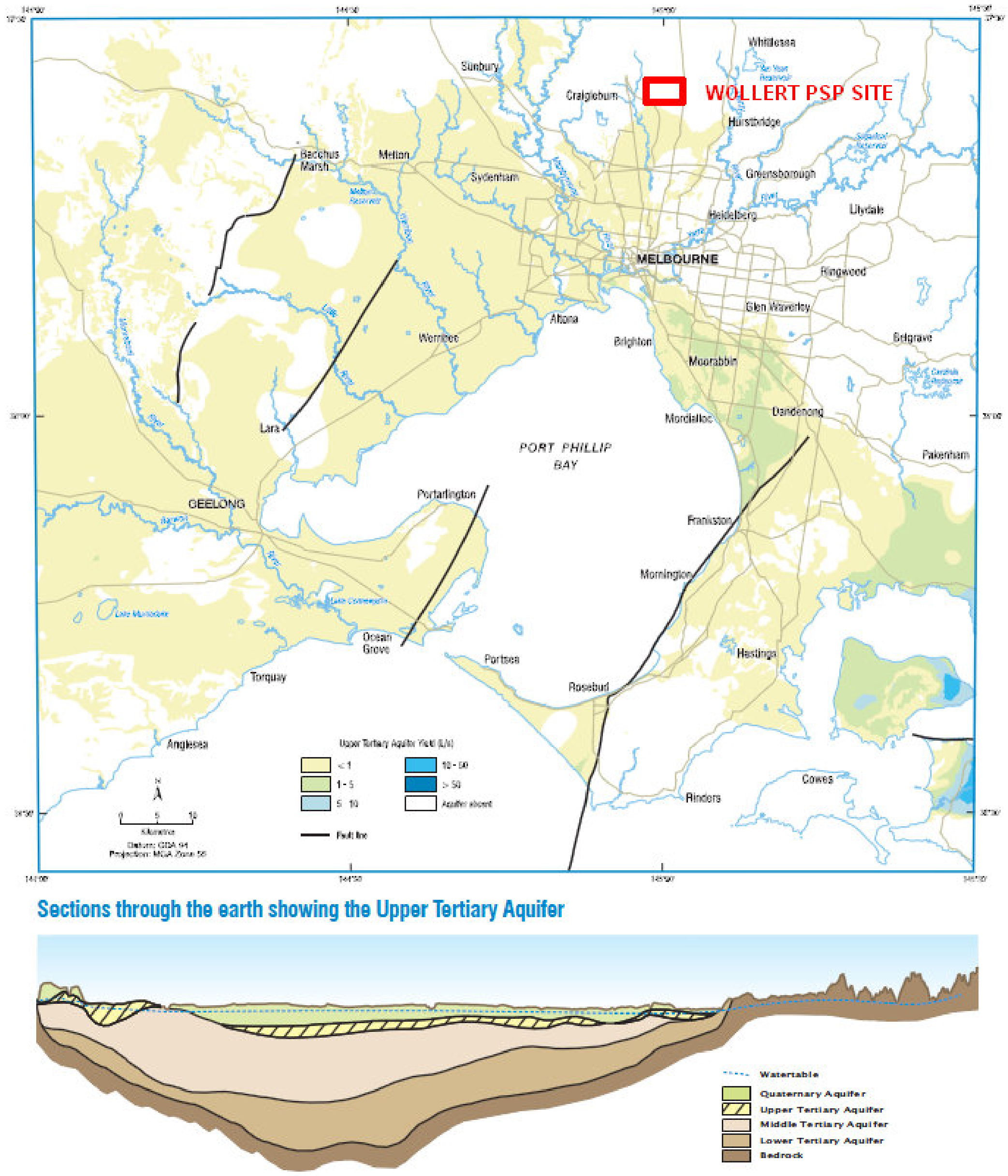


Figure 12 - Upper Tertiary Aquifer Yield

Ground water recharging is also a potential alternate water source. This option has been investigated and applied to other developments in the Whittlesea region. Until further geotechnical investigations are carried out, infiltration rates are deemed too low for groundwater recharging.

7.2 Demand

In order to utilise rainwater as an alternative water source the demand requirements for the site are required. For the purpose of this strategy the opportunities to reuse rainwater have been identified as:

- Servicing certain water demands within both standard and medium density residential households
- Irrigating ovals and fields within the active open space areas

There is also potential to harvest and reuse rainwater within the commercial and industrial sites of the PSP. Although this option has not been modelled as part of this IWMS, some commentary regarding this is provided in Appendix I.

7.2.1 Residential Demand

The following key residential water demands are from the “North Growth Area Integrated Water Cycle Management Plan” (Note: all demands listed are based on the use of water efficient appliances):

- Toilet flushing at 50L/house/day
- Hot Water at 113L/house/day
- Laundry at 58L/house/day
- Garden Watering at 147L/house/day

These figures are based on a standard sized house with 3 occupants. This is comparable to the Wollert PSP standard density households: 350m^2 lots with 310m^2 impervious area, as per the assumptions listed in Section 3.1. Using these parameters the average standard sized household total annual water requirement equates to 134kL. Of this total water use the demand for the uses listed above will be 368L/house/day.

As the Wollert PSP incorporates significant areas of medium density residential zones, the demand for a small sized house (2 occupants) must also be considered. This is comparable to the Wollert PSP medium density households: 200m^2 lots with 195m^2 impervious area, as per the assumptions listed in Section 3.1. The average small sized household water demands are as follows:

- Toilet flushing at 33L/house/day
- Hot Water at 76L/house/day
- Laundry at 42L/house/day
- Garden Watering at 73L/house/day

Using these parameters the average small sized household total annual water requirement equates to 82kL. Of this total water use the demand for the uses listed above will be 224L/house/day.

Discussion about the use about how these demands are to be met can be seen in Section 10.2, where different scenarios of supplying houses with recycled rainwater are investigated.

7.2.2 Open Space Irrigation

According to the Wollert PSP there are four local active open space areas (one within the Curly Sedge catchment) and one large district active open space within the site. The district open space has been omitted from the analysis as it is too far upstream within the catchment to efficiently reuse stormwater. As per the City of Whittlesea parameters the typical local active open space site is 8 hectares, comprising of either two AFL ovals or three soccer fields, carparking and access and a pavilion. Considering these details the total area requiring irrigation is:

- 1.75ha per AFL oval = 3.50ha
- 0.71ha per soccer field = 2.14ha
- Plus access and surround = **4ha** (50% of total active open space area)

The irrigation demand for one hectare of active open space will be approximately 3.5ML per year, derived from an irrigation demand analysis provided in Appendix E. Based on this, the overall irrigation volume requirement for the three active open space sites within the Findon Creek and Edgars Creek catchments will be approximately 42ML per year.

7.2.3 Demand Management

In order to effectively use the alternate water supply sources described management and planning for each water source is required. To achieve this efficiency within the Wollert PSP the focus should be on reducing potable and recycled water consumption and maximising the benefits of stormwater/rainwater. Utilising rainwater and stormwater to supply water to the development provides an inherent benefit to waterway health and minimises impacts of downstream developments. Demand management of potable water can be implemented in a number of others ways including:

- Water pricing,
- Influencing the community’s habits and attitudes towards water use,
- Reduction in potable water supply pressure,
- Warm season grasses used for turf areas, and
- Efficient irrigation techniques.

9 Urban Planning & Community Values

9.1 Strategic Planning

To ensure there is a synergy between the recommended water quantity and water quality measures there is a need to implement them in the correct order and position. This will require strategic placement of amenities during the planning phase to extract the maximum effectiveness of each element of the IWMS (refer to Appendix G, drawing 137599D02-4 for a summary of the proposed treatment).

Figure 13 below illustrates the importance of strategic locating of open space to be irrigated with stormwater. Doing so maximises the ability to ‘capture’ stormwater for the purpose of watering any sports fields or ‘active’ open space in the immediate area. By allocating the open space and subsequent treatment measures near the natural flow path of overland stormwater runoff, less costly infrastructure is required to divert the runoff to its desired destination.

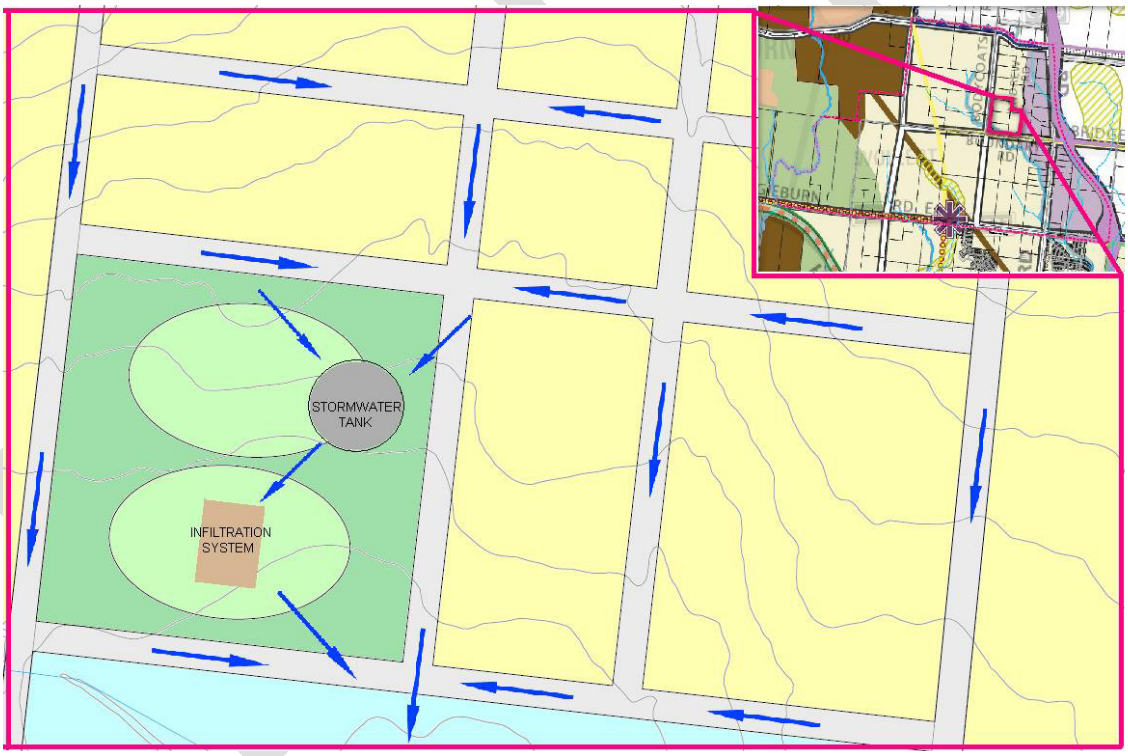


Figure 13 - Strategic Location of Open Space as Shown in MUSIC

Planning treatments at the allotment level has generated much recent discussion. The placement of raingardens and infiltration systems at the allotment level has been trialled with success in some areas of Melbourne and hence has been investigated as a possible part of the Wollert Integrated Water Management Strategy. The main objective of this is to further disconnect the impervious area from the catchment and therefore reduce the urban flow frequency. Further analysis has revealed that allotment level raingarden/infiltration systems could be impracticable due to several issues:

- Poor infiltration properties of the soil will reduce their effectiveness
- Could become an encroachment on the home owners land and potentially reducing their developable area
- Issues surrounding the location of raingardens adjacent to the building footings including neighbouring buildings
- There is no way to ensure raingardens are not removed, damaged or destroyed by the home owner
- Regulation and enforcement of maintenance issues

For the reasons listed above and as per the discussion in Section 6.2.4, infiltration systems have not been modelled in forming this strategy.

9.1.1 River Red Gum Health Opportunities

Within the PSP there are conservation reserves with an abundance of River Red Gums. River Red Gums thrive off infrequent flooding. Spiire see this as an opportunity, that urban catchments and roads adjacent to the pockets of River Red Gums could be designed to allow for large storm events to overtop into the reserve. This inundation would be on an infrequent basis and allow for supplementary irrigation, to resemble that natural state of the River Red Gums.

9.2 Community Values

Integrating WSUD within the development should also consider the community values by creating public spaces that the community is proud of and can form a sense of attachment. The development should encourage bringing people to the water rather than fencing it off and creating a disconnection to these public spaces. Utilising techniques such as boardwalks, information boards, activity nodes around these treatments will promote community engagement with the WSUD elements within the development.

10 Water Balance

The development and population of the Wollert precinct will produce an increased pressure on our water resources. The aim of this Integrated Water Management Strategy is to recommend a reliable system, above and beyond the base case scenario of meeting best practice objective, where individual treatments complement each other's strengths while minimising their weaknesses. By utilising multiple alternate water sources, the reliance on potable water can be significantly reduce, rainfall runoff can be treated, and the flow frequency and flow rate at which it enters the waterways. This integrated approach will maintain all of the features of the base case scenario (wetland, raingarden and sedimentation basin sizes will not change) while continually improving water management.

10.1 Open Space Irrigation Tanks

Stormwater supply vastly surpasses Wollert's overall demand; however reliability of stormwater and rainwater harvesting systems can be still problematic due to the vulnerability with respect to rainfall. Figure 14 below illustrates that with increased tank size comes an increased reliability that the tank can service the irrigation requirements. The relationship between tank size and tank reliability is not linear creating a point at which the levelised cost of increasing the size of the tank is not justified. For this Integrated Water Management Strategy a reliability of 60% for the open space stormwater tanks is recommended with the additional 40% of demand to be supplied by recycled water. This will avoid constructing unnecessarily large and costly infrastructure that provides only a modest return.

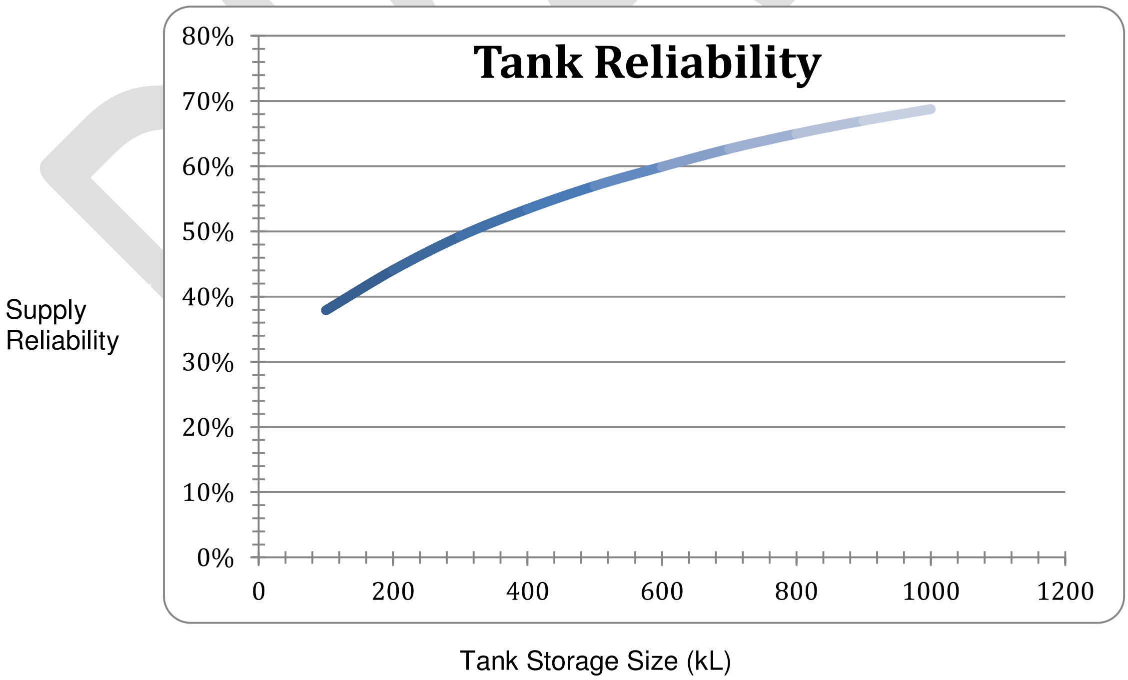


Figure 14 - Typical Stormwater Tank Size vs. Reliability Relationship

The combination of stormwater harvesting and recycled water will seek to improve the unpredictability of supply such that the entire demand can be met by alternate sources to potable water. This scenario is achieved through supplying the base demand from stormwater harvested into large underground tanks. When storage levels are close to depleted, a recycled water irrigation system is engaged as a replacement until such time that its stormwater stocks are replenished. This arrangement is illustrated below (Figure 15) and has been modelled using the MUSIC software to identify suitable tank sizes to match the requested reliability based on location and irrigation demands.

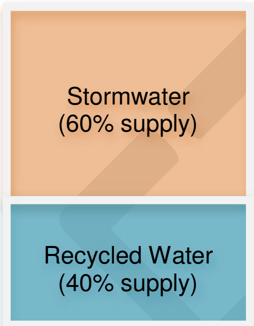


Figure 15 - Stormwater / Recycled Water Open Space Irrigation Balance

While this initiative will reduce total potable demand, there are other measures that can be implemented to play a further part in conserving water.

The water quality results that have been achieved due to the implementation of stormwater harvesting for open space irrigation are provided in Section 10.3 below, where they are incorporated as part of the whole integrated strategy.

10.2 Allotment Scale Rainwater Tanks

In addition to stormwater tanks harvesting runoff for open space irrigation, Figure 9 also highlights an opportunity to reduce potable demand at an allotment scale. Rainwater tanks have been identified as a potential alternative solution to potable water for uses within the home, as discussed in Section 7.2.1. Each standard density residential lot has been modelled with a 3kL tank, and each medium density lot has a 2kL tank. Tanks have been modelled to supply water for a number of different usage scenarios.

The aim of this strategy is to not just to meet the minimum water quality requirements. Spiire have aimed to exceed the quality objectives as well as minimise flow frequency and flow rate. As described in Section 6.3.2 the base case scenario of raingardens, sedimentation basins and wetlands is sufficient to achieve the best practice guidelines (stipulated Figure 8), but by implementing household rainwater tanks and open space irrigation tanks it is possible to further treat the water and seek to minimise any increase in flow frequency and flow rate as a result of developing the site.

The base case MUSIC model evaluated in Section 6.3.2 of this report has been modified to incorporate the use of both household rainwater tanks and stormwater harvesting for open space irrigation.

The implementation of allotment scale rainwater tanks has been done through four scenarios as follows:

- Scenario 1 – demand for toilet, laundry, and watering garden
- Scenario 2 – demand for toilet, laundry, watering garden as well as hot water
- Scenario 3 – demand for only hot water
- Scenario 4 – same demands as Scenario 1 but with only 20% of lots using tanks

The daily demand requirements for each of these scenarios has been calculated based on the data provided in the "North Growth Area Integrated Water Cycle Management Plan" discussed in Section 7.2.1.

The total daily demand for each scenario is provided in Table 19.

Table 19 – Daily Household Demand for Tank Scenarios

Scenario	Standard Density Demand (kL/ household/ day)	Medium Density Demand (kL/ household/ day)	Average % Demand Met (Tank Reliability)
1	225	148	79
2	368	224	65
3	113	76	99
4	112	74	83

Modelling each of these scenarios provides an efficiency to which a 2kL tank for each residential lot can harvest and supply water to the household. These efficiencies are expressed as a percentage of the demand of the lot met, as defined in Table 19 above.

The requirement for new houses in the Wollert PSP area is to meet a six star energy rating either through rainwater tanks or solar panels. Therefore, in reality not every residential lot will install and use a rainwater tank. Scenario 4 was developed to consider this; to model a reduced tank adoption. For the purposes of this report scenario 1 has been modelled with a 20% uptake of rainwater tanks. The demand and subsequent tank reliability of this scenario can be seen in Table 19 above.

10.3 Water Quality Results Incorporating Tanks

Going above and beyond the base case presented in Section 6.3.2 the results presented in Table 20 indicate the benefits of recycling rainwater within both open space areas and residential lots.

Table 20 - IWMS Recommended System Results

MUSIC Results – Scenario Comparison					
Scenario	**Pollutant Reduction**	**Edgars West Catchment**	**Edgars East Catchment**	**Findon West Catchment**	**Findon East Catchment**
Base Case					
	TSS (%)	77.9	82.3	82.6	85.4
	TP (%)	58.3	45.3	57.4	66.7
	TN (%)	45.3	51.9	46.8	45.7
	TGP (%)	98.7	100	100	100
IMWS Scenario (Scenario 4 – 20% tank adoption)					
	TSS (%)	80.2	83.4	83.2	85.1
	TP (%)	61.8	47.3	59.1	66.8
	TN (%)	48.3	53.9	48.4	45.7
	TGP (%)	99.3	100	100	100

The IWMS Scenario shown in Table 20 represents the results of the Integrated Water Management System. This includes the following assets:

- Raingardens, sedimentation basins and wetlands as per the base case scenario
- Open space irrigation for each of the three active open space sites
- Residential tanks used by 20% of all standard and medium density households to supply toilets, laundry, and garden watering (not hot water)

As shown by these results the integration of these additional initiatives means that discharges from the Wollert PSP site exceed minimum requirements of Clause 56 best practice objectives.

10.4 Flow Frequency

As described in Section 6.2.1 flow frequency is the number of days in which runoff enters the waterways. The objective of this strategy is to reduce the reoccurrence of this runoff. Table 21, below, highlights the increase in the number of days of runoff per annum as a result of an increase in impervious surfaces. As shown the result of implementing the recommended IWMS measures, describes above in Section 10.2, can be compared to the developed site with no water treatment measures.

Table 21 - Flow Frequency Results, MUSIC

Scenario	Flow Frequency (days/yr)
Pre-development	9
Pre-development + 15 days	24
Post-development (no treatment)	104
Post-development (Recommended IWMS)	86

Under existing conditions, there are only 9 days of runoff per year. With development as planned, there will be a further 95 days of runoff per year if no attenuation measures are put in place. These extra flow days will increase disturbance to the natural environment and its inhabitants and should to be addressed in order to protect the ecosystem.

Through the addition of rainwater tanks and stormwater harvestings tanks the number of runoff days has decreased. The reduction of runoff days is possible through the implementation of wetlands and tanks. The function of the wetland is to discharge at a slow rate over time. When the flow is less than $0.13m^3/s$ it is considered base flow and not a runoff event. The graph in Figure 16 shows the flow over time for the site with the base level $0.13m^3/s$ marked. The peaks above this line account for the flow frequency days.

If infiltration was an option for this site the flow frequency in the developed model would certainly decrease and be much closer to the pre-developed flow frequency. Infiltration is not possible at this stage as the soils are not deemed adequate, as described in Section 3.1.

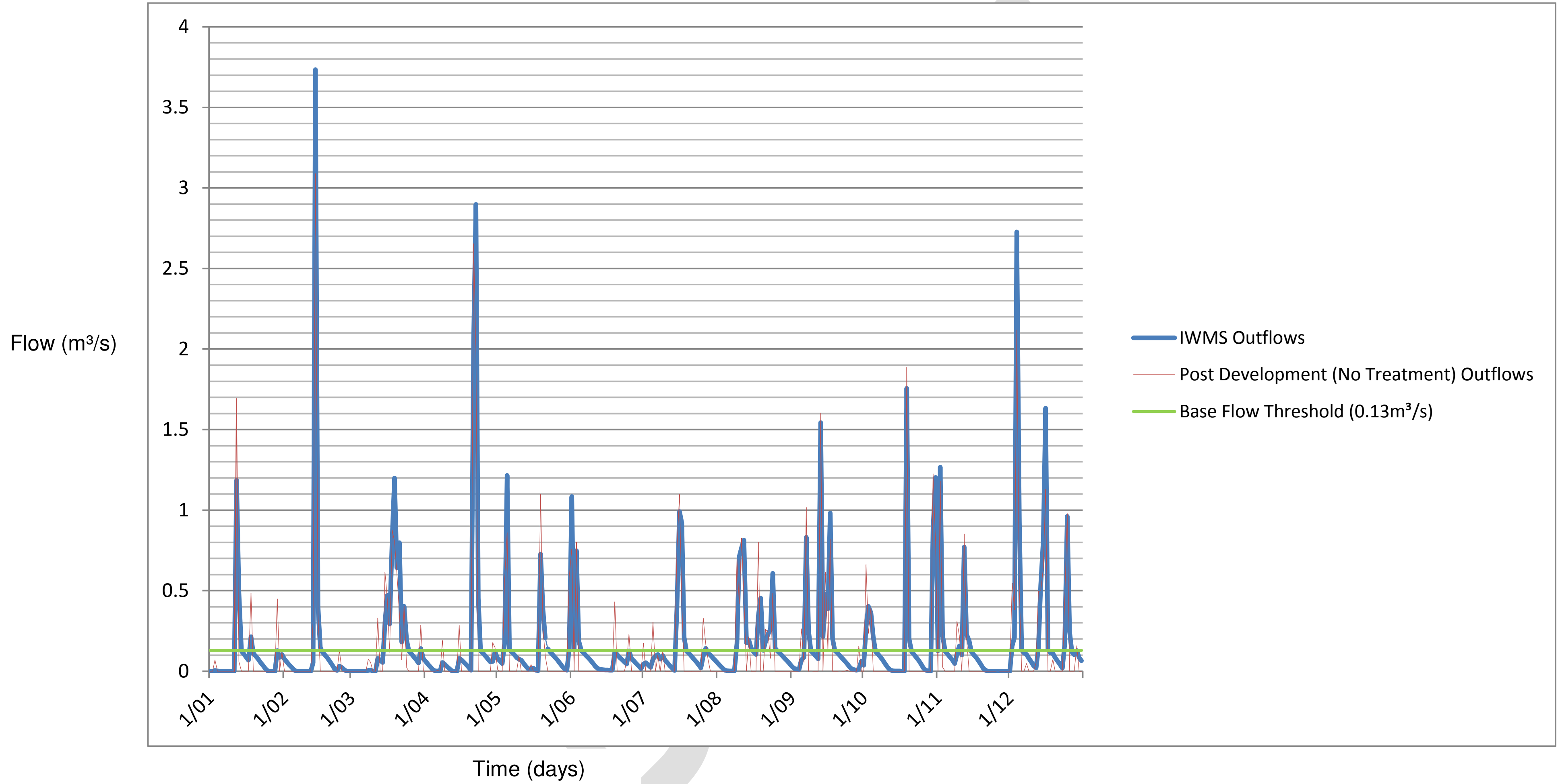


Figure 16 - Flow Frequency Graph

By reducing the peak discharge of the WSUD features the rate of discharge from the site will decrease and hence minimise the impact of receiving waterways. It should be noted that the MUSIC analysis has not included retardation basins which could further reduce peak flows when integrated with WSUD treatments.

10.5 Water Balance Summary

With all of the proposed IWMS features mentioned the total water balance for the Wollert PSP site has been developed. A plan of the site with all integrated features is supplied in Appendix A, drawing 137599D02-7. Water entering the site is supplied by rainwater, potable water and recycled water from the Aurora Craigieburn West facility. How this water is distributed, used and discharged from the site is represented in
. The supply break down for the residential lots within the development is illustrated in Table 22. This data is specific to the residential lot areas only, implementing 'scenario 4' demands – with only 20% of residential lots adopting tanks. The percentage use of rainwater as a water source would increase dramatically if tanks were adopted at a greater rate.

Table 22 - % Water Source use within Wollert Residential areas

Water Source	% Use For Residential
Potable	29%
Rainwater/Stormwater	13%
Recycled Water	59%

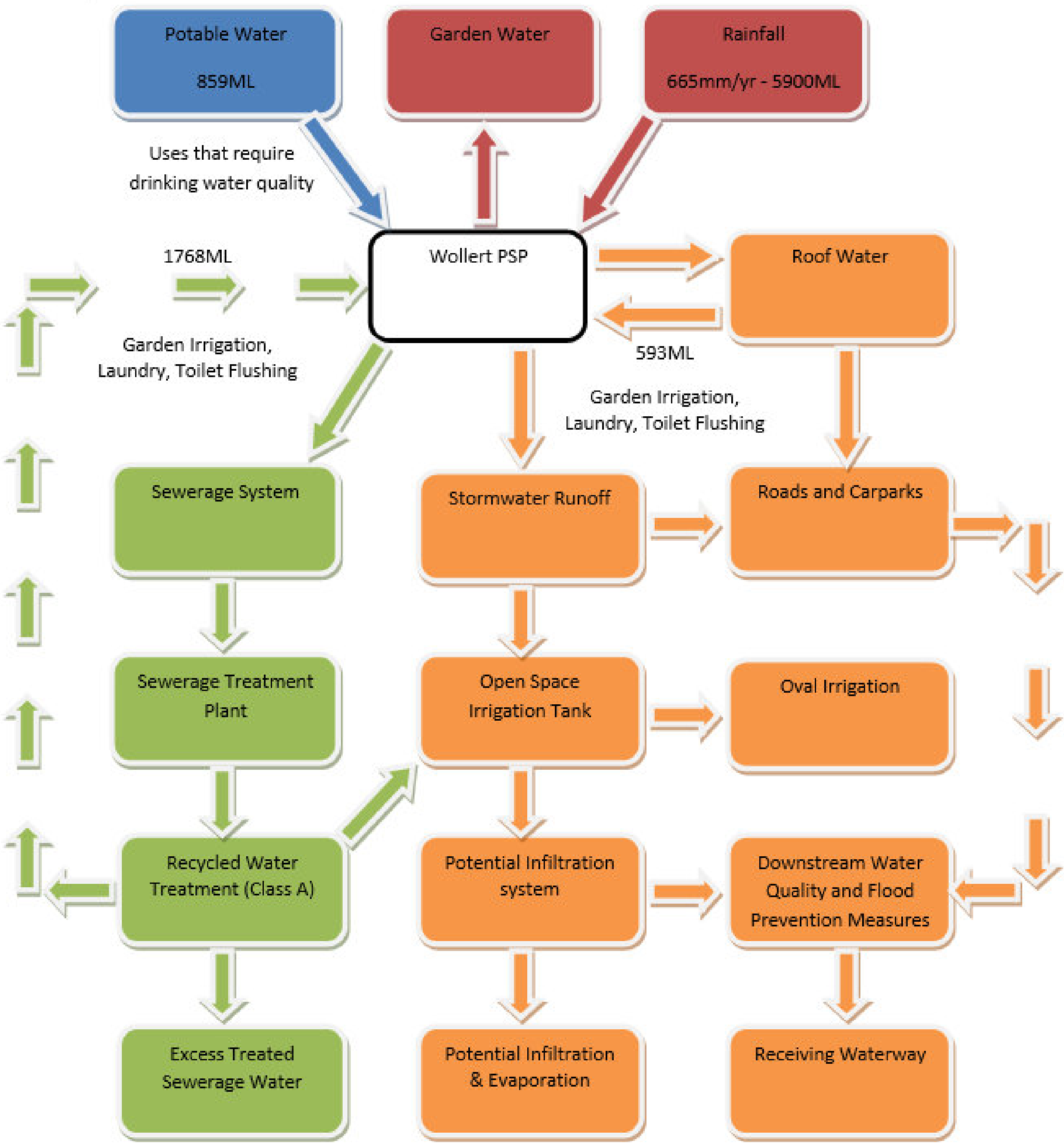


Figure 17 - Indicative Urban Water Cycle for Wollert PSP

11 IWMS Water Balance Recommendations

The successful implementation of this integrated water management strategy has been based upon identifying the synergies between individual strategies/elements (Conveyance & Flood Mitigation, Waterway Health, alternate water sources and urban planning & community values) in order to provide an integrated outcome as demonstrated in

Figure 18. Based on the findings of this report our key recommendations are as follows:

Alternative Water Source	% use within Wollert
Potable	29%
Rainwater/Stormwater	13%
Recycled Water	59%

- Recycled Water at allotment level for laundry, toilet and garden use
- Potable water at allotment level for Kitchen and basins
- 2kL and 3kL rainwater tanks at allotment level as an alternative to potable for laundry, toilet and garden use, at an assumed adoption rate of 20% of residential lots
- Stormwater harvesting tanks at precinct level for irrigation use at three active open space sites. The Aurora Craigieburn West recycled water facility to provide any additional supply required
- Target 60% stormwater and 40% recycled water for all key open space irrigation systems to enable effective and financially viable infrastructure sizes
- Sedimentation basins, wetlands and raingardens distributed throughout the precinct
- Integrate sedimentation basins and wetlands into identified retarding basins
- Ensure community values are aligned with intended WSUD treatments
- Influence the community's habits and attitudes towards water use

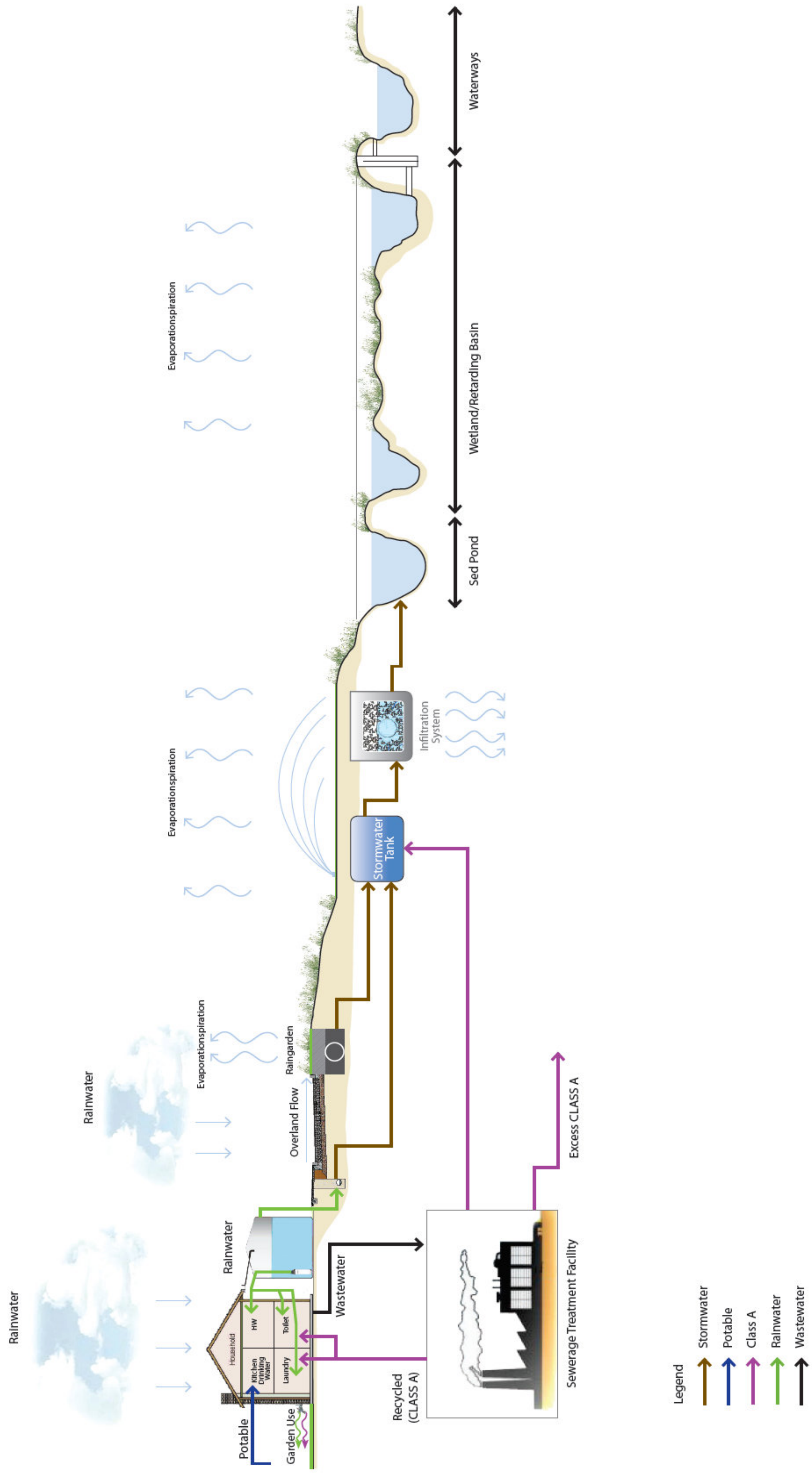


Figure 18 - Integrated Water Management Strategy Schematic Summary

11.1 Integrated Water Management Objectives

The objective of this report has been to identify various sustainable water management systems and practices across a range of scales and sources to produce an integrated outcome.

To reiterate the Water Sensitive Cities approach there are three themes of foundation upon which its ideologies are based including:

- Cities as Water Supply Catchments
- Cities providing Ecosystem Services
- Cities comprising Water Sensitive Communities

Based on these three water sensitive city themes Spiire has further defined these themes into four meaningful elements of an IWMS. The four elements are as follows:

- Conveyance and Flood Mitigation
- Waterway Health
- Alternate Water Sources
- Urban Planning and Community Values

11.2 Conveyance and Flood Mitigation

The following is a summary of the recommendations given for each of the major catchments within Wollert PSP study area.

11.2.1 Retardation Requirements

Adopt the retardation and drainage reserve as presented in Appendix A, drawing 137599D02-3

Catchment	Retarding Basin Name	Volume (kL)	Area (m^2)
Findon East	RBG5	26,000	15,600
	RBG3	46,100	24,100
Findon West	RBF1	57,700	29,100
	RBF2 (EX DAM)	54,100	26,500
	RBF3	20,100	12,000
Edgars East	RB E1	28,800	18,000
	RB E2	18,200	12,000
Edgars West	RBD2	31,100	21,300

11.2.2 Flow Conveyance

Adopt the hydraulic widths and waterway corridors as presented in Appendix A, 137599D02-4

Catchment	Tributary Name	Hydraulic Width (m)	Waterway Corridor Width (m)	Constructed	Natural
FINDON EAST					
	A	22	55	X	
	B	13	45	X	
	C	16	45	X	
	D	40	60		X
	E	19	50	X	
FINDON WEST					
	A	18	50	X	
	B	23	55	X	
	C	28	55	X	
	D	20	50	X	
	E	28	55	X	
	F	21	50	X	
	G	18	50	X	
	H	22	50	X	
EDGARS WEST					
	A	13	45	X	
CURLY SEDGE					
	A	25	5	X	

11.3 Waterway Health

- Creating a growling grass frog conservation zone will seek to protect the waterway corridor health and its inhabitants. The Department of Environment and Primary Industries (DEPI) is the authority responsible for determining the requirements of this zone. Further work is still required to define how this will be integrated within the PSP to establish a sustainable community.
- The reduction of the frequency with which runoff reaches the waterway will help protect it from the negative environmental impacts associated with increased runoff instances.
- The minimisation of any increase in flow and maintaining the means by which it filters down through to the rivers and creeks will also protect the waterways health.
- This reduction of flow frequency and runoff can be achieved through the capturing of roof water at allotment level using rainwater tanks and ‘choke’ points in the flow path including retarding basins and wetlands that are strategically placed for maximum efficiency.
- The reduction in pollutants entering our waterways.

11.4 Stormwater Quantity

- As this report has touched on their are two objectives with respect to stormwater quantity
  - Stormwater runoff frequency
  - Stormwater runoff flow rate
- It is recommended that runoff frequency be reduced to as few days as possible and runoff flow rate be limited to 1.5 times pre-development flow rate.
- This Integrated Stormwater Management Strategy outlines the use of WSUD treatment measures to address both of these objectives regarding Stormwater Quantity. The recommendations include: rainwater tanks at allotment scale, raingardens at the streetscape level, and end of line raingardens, retarding basins and wetlands at a precinct scale. , The use of streetscape level infiltration systems has also been investigated. Finally, the implementation of open space irrigation tanks will also act as reducer of both frequency and flow rate by diverting flow into storage for reuse.
- The Flow Frequency results (for details refer section 10) are as follows:

Scenario	Flow Frequency (days/yr)
Pre-development	9
Pre-development + 15 days	24
Post-development (no treatment)	104
Post-development (Recommended IWMS)	86

11.5 Stormwater Quality

- Whilst Clause 56 objectives will be the minimum requirements for this development. This report demonstrates that a slightly higher target could be achieved, therefore it is recommended to set the phosphorus pollutant reduction to 60%. The suggested water quality targets for the Wollert PSP are as follows:
  - 70% reduction of total Gross Pollutant loads
  - 80% reduction of total Suspended Solids
  - 45% reduction of total Nitrogen
  - 60% reduction of total Phosphorus
- This is achieved through the implementation of a ‘train’ of treatment measures, refer to Appendix A, drawing 137599D02-7 for the full representation of the IWMS strategy which includes the following:
  - Sedimentation basins, wetlands located within retarding basins and other strategically identified points within the catchment
  - End of line raingardens at precinct level, at strategic locations prior to stormwater drainage discharging into waterways
  - Stormwater harvesting at open space locations
  - Rainwater tanks located at lot scale, adopted by 20% of residential lots
  - No direct connections to the waterways without prior treatment (achieved with the raingardens)

11.6 Alternative Water Sources

The percentage breakdown of all water sources to be used within the Wollert development is as follows:

Alternative Water Source	% use within Wollert
Potable	29%
Rainwater/Stormwater	13%
Recycled Water	59%

- Alternate Water Sources include recycled water (Class A), stormwater and rainwater.
- Potential of a 30% increase overall in residential water use from rainwater tanks if tanks are adopted by 50% of residential lots, rather than 20%.
- Utilising these alternate sources reduces the demand for potable within the Wollert PSP site.
- Rainwater tanks installed at an allotment level can be reused for toilet flushing, watering gardens, laundry and hot water in the shower, with a potential saving of 44% per lot per annum.
- Stormwater tanks under active open spaces can be used for irrigation providing savings of up to 7% of the total Wollert site potable water demands, before filtering through the soil into infiltration systems where pollutants are further removed prior to entering natural waterways.
- Recycled water from the Aurora Craigieburn West treatment facility will be used as an alternate source for purposes of garden watering, toilet flushing, fire fighting and laundry use as well as open space irrigation to top up supply levels in periods of low rainfall.
- Grey water, Sewer mining and Aquifer recharge systems were all regarded as not viable or suitable for the Wollert development.

11.7 Urban Planning & Community Values

There is the option to place infiltration systems at an allotment level (i.e. raingardens), There are, however, a number of issues in the past with implementation, which include:

- Regular unclogging is required to maintain them and who should bear the costs associated with this maintenance
- Their proximity to neighbouring homes
- Issues surrounding house foundation compromise due to soil saturation
- The home owner removing the system
- Amount of space they take up in the backyard
- Infiltration rates are too low for them to function effectively without further detailed geotechnical investigations

Due to these concerns this IWMS will not be recommending their inclusion in the overall strategy for stormwater management.

- Strategic placement of the stormwater harvesting tanks is key in the proposed IWMS to avoid excessive and costly infrastructure to divert runoff into storage tanks for irrigation. Consideration must be given to where to place open space land use within the Wollert PSP to maximise efficiency.
- There is an opportunity for conservation reserves to be infrequently inundated to aid River Red Gum health.
- Integrating WSUD within the development should also consider the community values by creating public spaces that the community is proud of and can form a sense of attachment. The development should encourage bringing people to the water rather than fencing it off and creating a disconnection to these public spaces. Utilising such techniques such as boardwalks, information boards, activity nodes around these treatments will promote community engagement with the WSUD elements within the development.

12 References

Melbourne Water Website –
http://www.melbournewater.com.au/Default.asp?bhcp=1

Melbourne Water WSUD Website –
http://www.melbournewater.com.au/content/planning_and_building/water_sensitive_urban_design/water_sensitive_urban_design.asp

Centre for Water Sensitive Cities –
http://www.watersensitivecities.org.au/

Little Stringybark Creek Website –
http://www.urbanstreams.unimelb.edu.au/

Living Melbourne, Living Victoria Implementation Plan, Department of Sustainability and Environment, February 2012

Our Water, Our Future, Victorian Government, June 2007

Sustainable Water Use Plan, The City of Whittlesea, 2006

Water Plan 2009/10 – 2012/13, Yarra Valley Water, November 2008

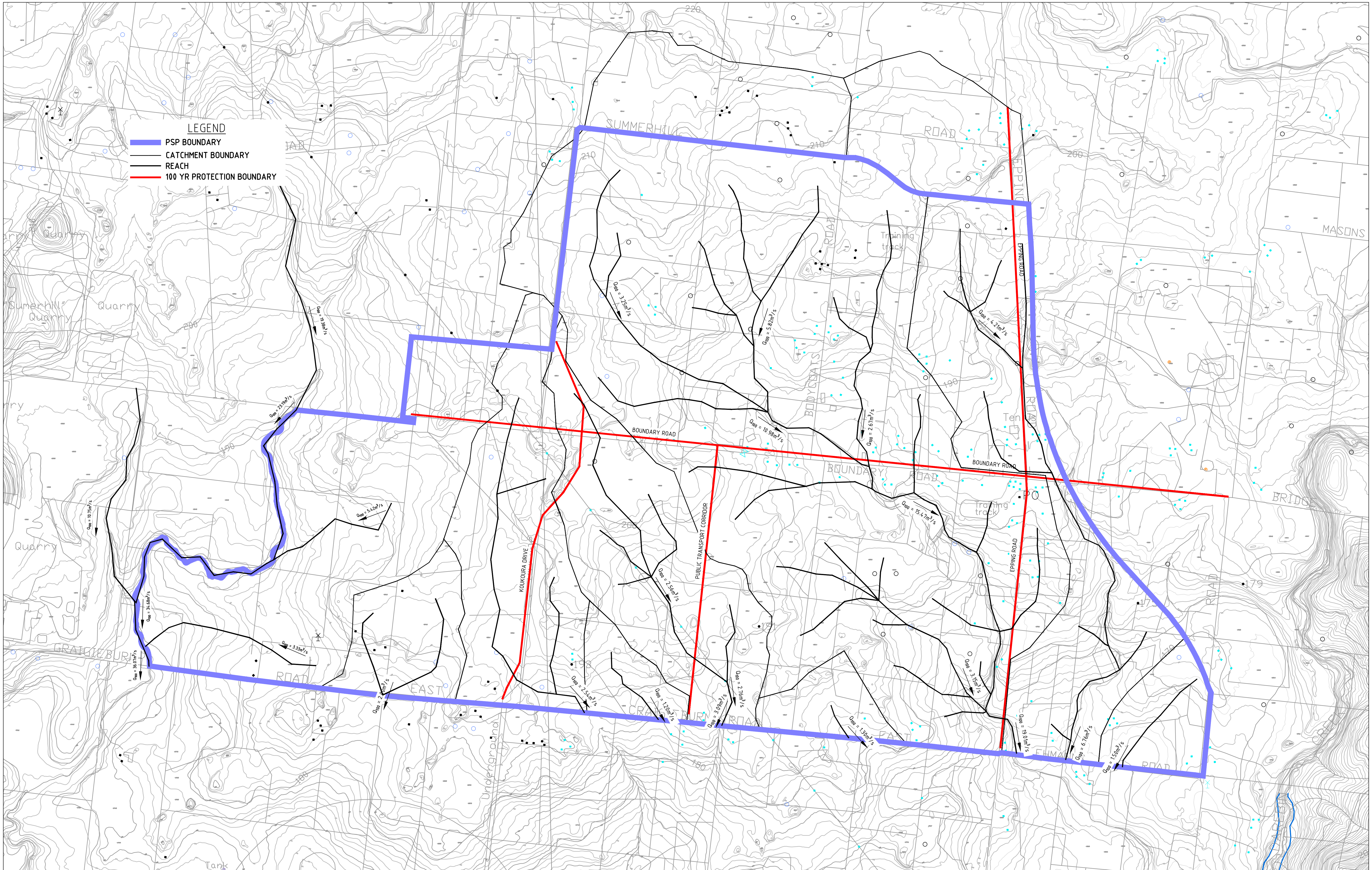
Sub-regional Species Strategy for the Growling Grass Frog, DSE, November 2011

Stormwater Management Plan 2012-17, The City of Whittlesea, 2012

Utilities Infrastructure Servicing Assessment, Spiire Australia, 14th May 2012

Spiire has prepared the revised IWMS in reference to the draft Urban Structure for the Wollert PSP dated 29 October 2013, in consultation with the MPA, City of Whittlesea and Melbourne Water. However, as the draft Urban Structure is subject to further changes prior to its formal release, it has been omitted from the drawings in this document and MUSIC models. A revised report updated with the draft Urban Structure will be released once the Wollert Precinct Structure Plan is formally released for public consultation.

Appendix A:
Wollert PSP Hydrological / Hydraulic Outputs



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-1 - RURAL
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM
© Spiire Australia Pty Ltd
Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 1
Drg Status PRELIMINARY

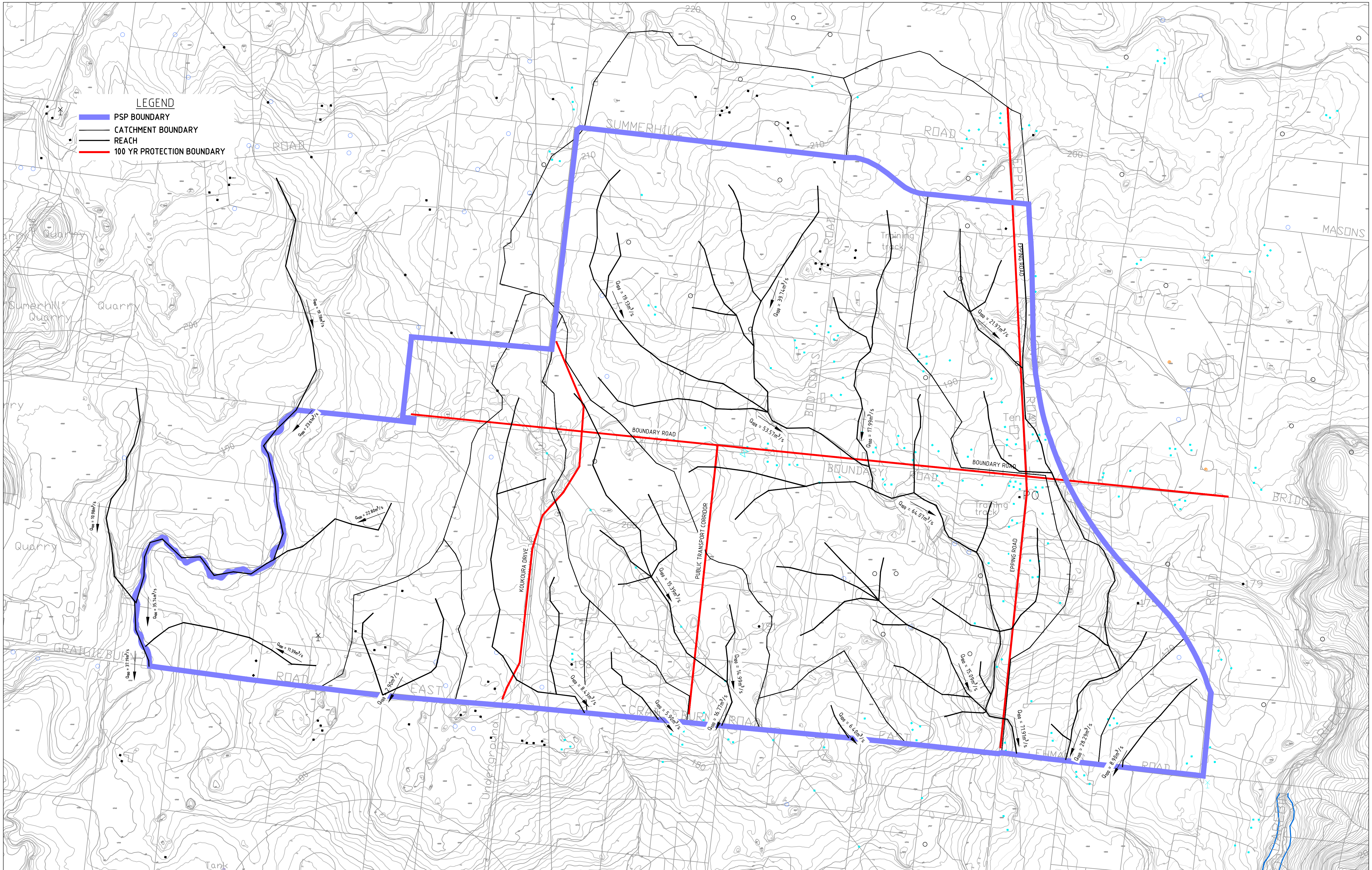
spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

spiire
Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

EXISTING CONDITIONS
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-1



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-2 - DEV NO RETARD
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM

Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 1
Drg Status PRELIMINARY

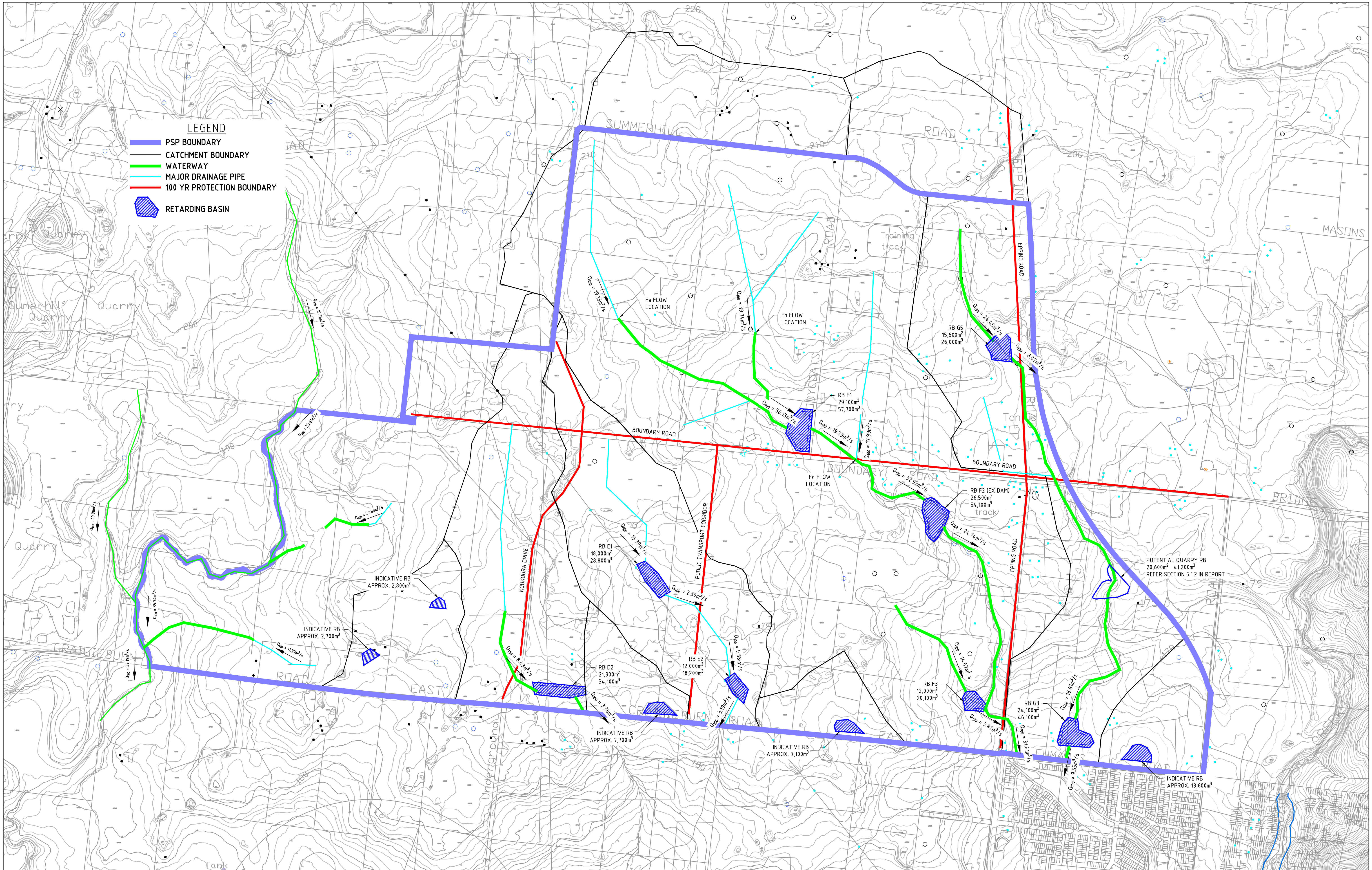
spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

DEVELOPED NO RETARDATION
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-2



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-3 - DEV RETARD
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM
© Spiire Australia Pty Ltd
Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 1
Drg Status PRELIMINARY

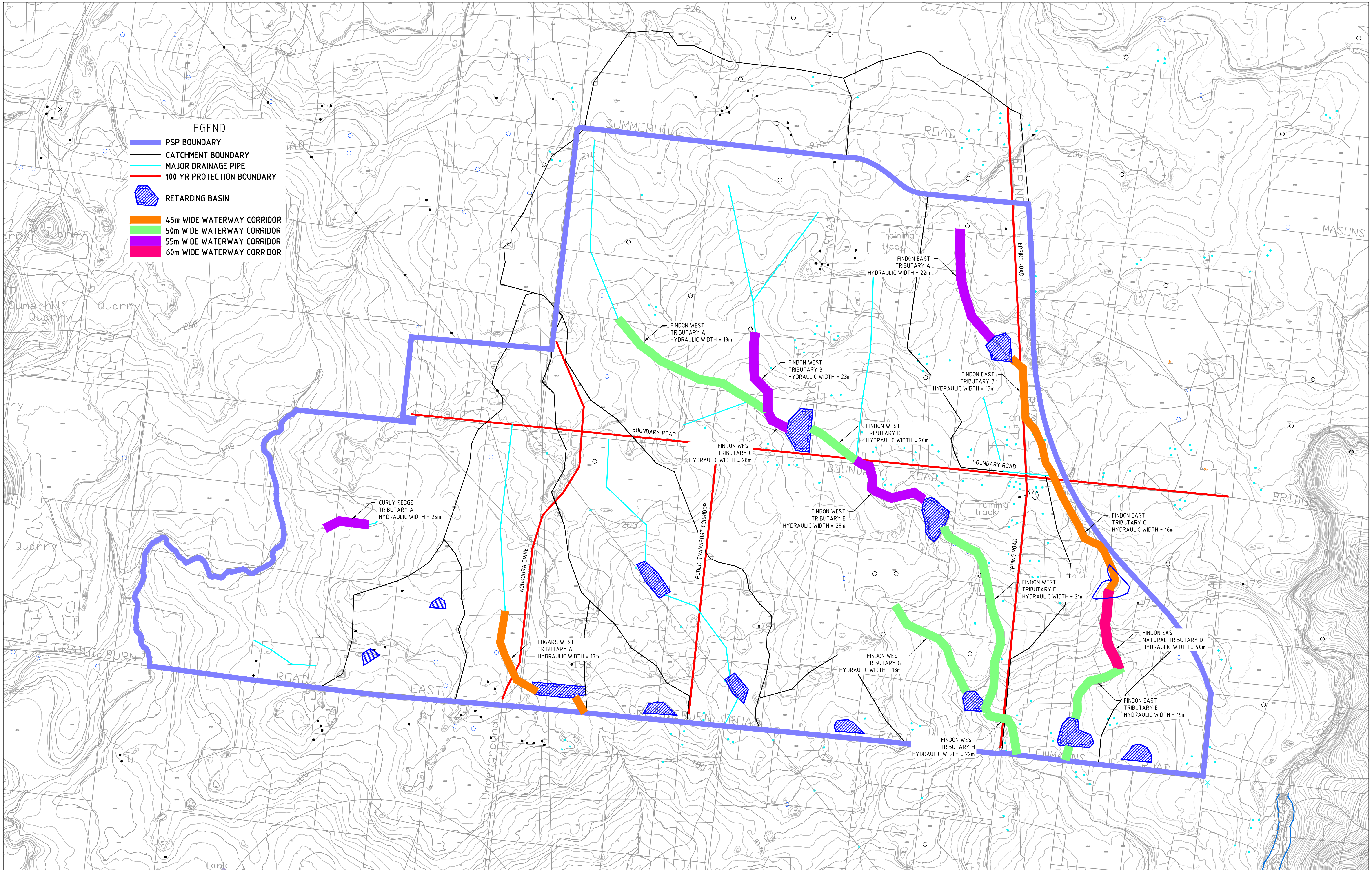
spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

spiire
Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

REVISED ULTIMATE RETARDATION
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-3



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-4 - WATERWAY WIDTHS
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM

Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 1
Drg Status PRELIMINARY

spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

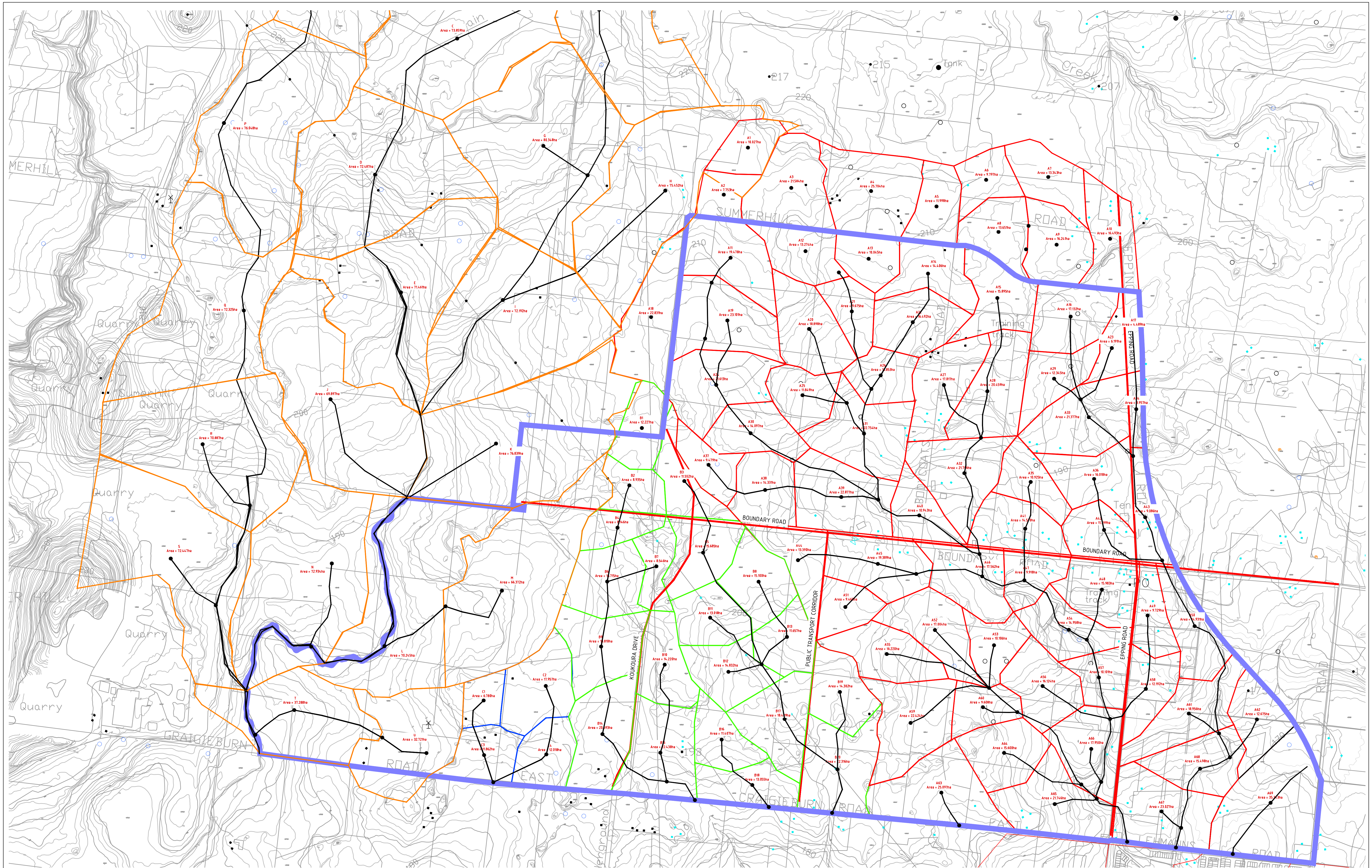
Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

WATERWAY CORRIDORS
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-4

Appendix B:
RORB Catchment Plan



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-6 - RORB CATCH PLAN
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM
© Spiire Australia Pty Ltd
Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 1
Drg Status PRELIMINARY

spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

spiire
Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

RORB CATCHMENT PLAN
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-6

Appendix C:
North Growth Corridor Plan

Appendix D:
Wollert PSP 1070 – Urban Structure Draft Concept Plan

Spiire has prepared the revised IWMS in reference to the draft Urban Structure for the Wollert PSP dated 29 October 2013, in consultation with the MPA, City of Whittlesea and Melbourne Water. However, as the draft Urban Structure is subject to further changes prior to its formal release, it has been omitted from the drawings in this document and MUSIC models. A revised report updated with the draft Urban Structure will be released once the Wollert Precinct Structure Plan is formally released for public consultation.

Appendix E:
Open Space Irrigation Demand

IRRIGATION REQUIREMENTS

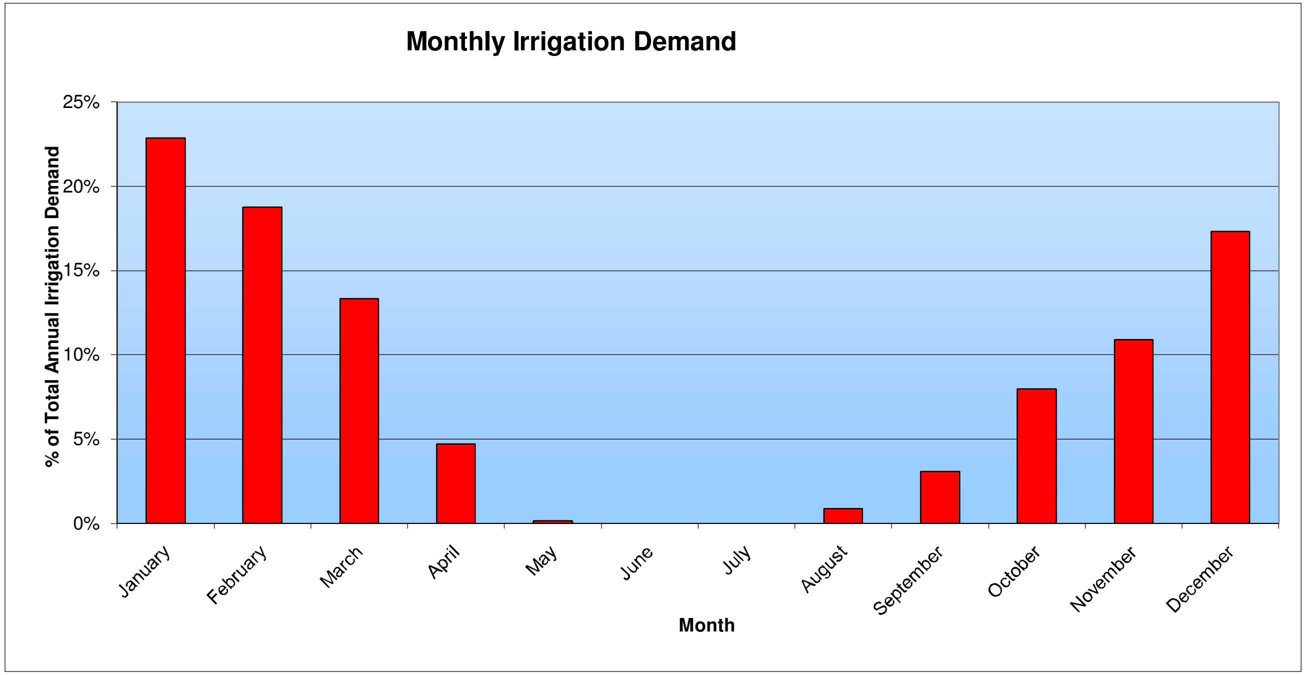
Project Name	Woolert
Project Number	137599
Date	1/11/2013
Designer	Alexandra Brown
Rainfall Data Site & Period	Bundoora - 1979 to 19/04/2012
Evaoporation Data Site & Period	Bundoora - 1979 to 19/04/2012

Turf Irrigation Area (Ha)	12
Landscape Irrigation Area (Ha)	0
Total Irrigation Area (Ha)	12
Rainfall Efficiency	0.5
Irrigation System Efficiency	0.8

	January	February	March	April	May	June	July	August	September	October	November	December
	31	28	31	30	31	30	31	31	30	31	30	31
Mean Monthly Rainfall (mm)	**47.8**	**43.9**	**45.2**	**54.4**	**51.1**	**55.2**	**48.6**	**56.6**	**59.2**	**65.6**	**71.6**	**66**
Mean Daily Epan (mm)	**6**	**5.6**	**4**	**2.6**	**1.5**	**1.1**	**1.2**	**1.8**	**2.4**	**3.5**	**4.4**	**5.4**
Mean Monthly Epan (mm)	186.0	156.8	124.0	78.0	46.5	33.0	37.2	55.8	72.0	108.5	132.0	167.4
Effective Monthly Rainfall (mm)	23.9	21.95	22.6	27.2	25.55	27.6	24.3	28.3	29.6	32.8	35.8	33
Crop Factor	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Montly Irrigation Requirement (mm)	80.7	66.3	47.2	16.7	0.6	0.0	0.0	3.1	10.9	28.2	38.5	61.2
Montly Irrigation Requirement (kL)	9687.0	7950.0	5658.0	2001.0	72.7	0.0	0.0	370.5	1308.0	3387.8	4614.0	7339.5

Total Annual Irrigation (kL)	42388.5
Annual Average Irrigation (kL/ha)	3532.375

	January	February	March	April	May	June	July	August	September	October	November	December
% of Total Annual Irrigation Demand	23%	19%	13%	5%	0%	0%	0%	1%	3%	8%	11%	17%



G:\13\137599\Water Resources\Variation\G04 001 Simplified Irrigation Demand.xls

Appendix F:
North Growth Area IWCM – Water Demands

3.5 Water Demands (Potable And Non Potable)

Residential household water demands were calculated using the YVW Demand Builder Tool[4]. This tool is underpinned by data collected from YVW's Residential End Use Measurement Study (2004)[5] and the Appliance Stock Survey (2007)[6]. The Water Efficiency Labelling Standards (WELS)[7] consumption values for new appliances were also used.

Table 7 – Residential Demand Assumptions

	Average Daily Demand (L/house/day)			
End Use	Small House	Medium House	Large House	Usage Category
Toilet	33	50	50	Non potable
Hot water	76	113	113	Potable
Laundry	42	58	58	Non potable
Dishwasher	7	9	9	Potable
Taps	57	79	79	Potable
Miscellaneous	8	9	9	Potable
Garden Watering	73	147	220	Potable
Car Washing	1	1	1	Non potable
Internal Contingency	45	64	64	Potable
External Contingency	22	44	66	Potable / Non potable
Average Winter Demand (L/house/day)	268	382	382	
Average Summer Demand (L/house/day)	364	574	669	
Average Annual Demand * (L/house/day)	324	494	549	
Persons Per House	2	3	3	
Average Annual Demand * (L/person/day)	162	165	183	

* Assumes a 7 month summer irrigation period

Table 8 - Average Daily Flows To Sewer (Dry Weather)

End Use	Small House	Medium House	Large House
Land size (m^2)	315	450	655
Household flow to sewer *	235	338	338
Non-rainfall dependant infiltration **	24	34	50
Total (L/hh/day)	259	372	387

* Assumes 50% of tap and miscellaneous use is for human consumption and does not flow to sewer

** Assumes 35% of the sewerage system is located below the groundwater table

For employment land, an average water demand of 6,450L/Ha/day and an average daily flow to sewer of 5,805L/Ha/day was assumed. This demand is roughly equivalent to 15 residential lots per Ha.

---

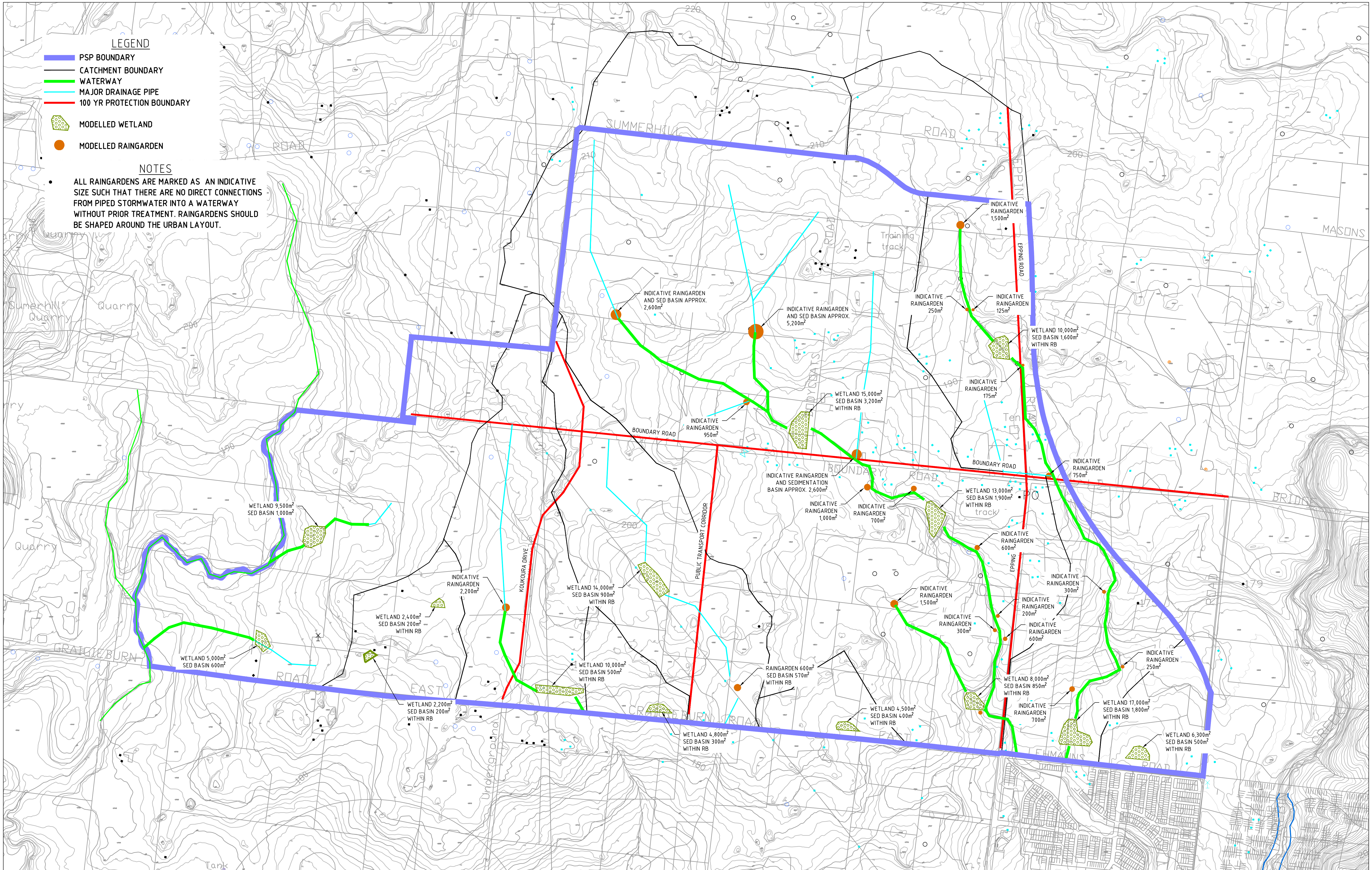
[4] Yarra Valley Water (2009) "Water And Sewer Demand Builder", Yarra Valley Water

[R] Roberts, P. (2004) "Residential End Use Measurement Study", Yarra Valley Water

[6] Athuraliya, A., Gan, K., and Roberts, P. (2007) "Appliance Stock Survey", Yarra Valley Water

[7] Standards Australia (2005) "AS6400 – Water Efficient Products – Rating And Labelling", Table D1

Appendix G:
Wollert PSP MUSIC Outputs and Treatment Summary



Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-5 - TREATMENT
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:07 PM

Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 2
Drg Status PRELIMINARY

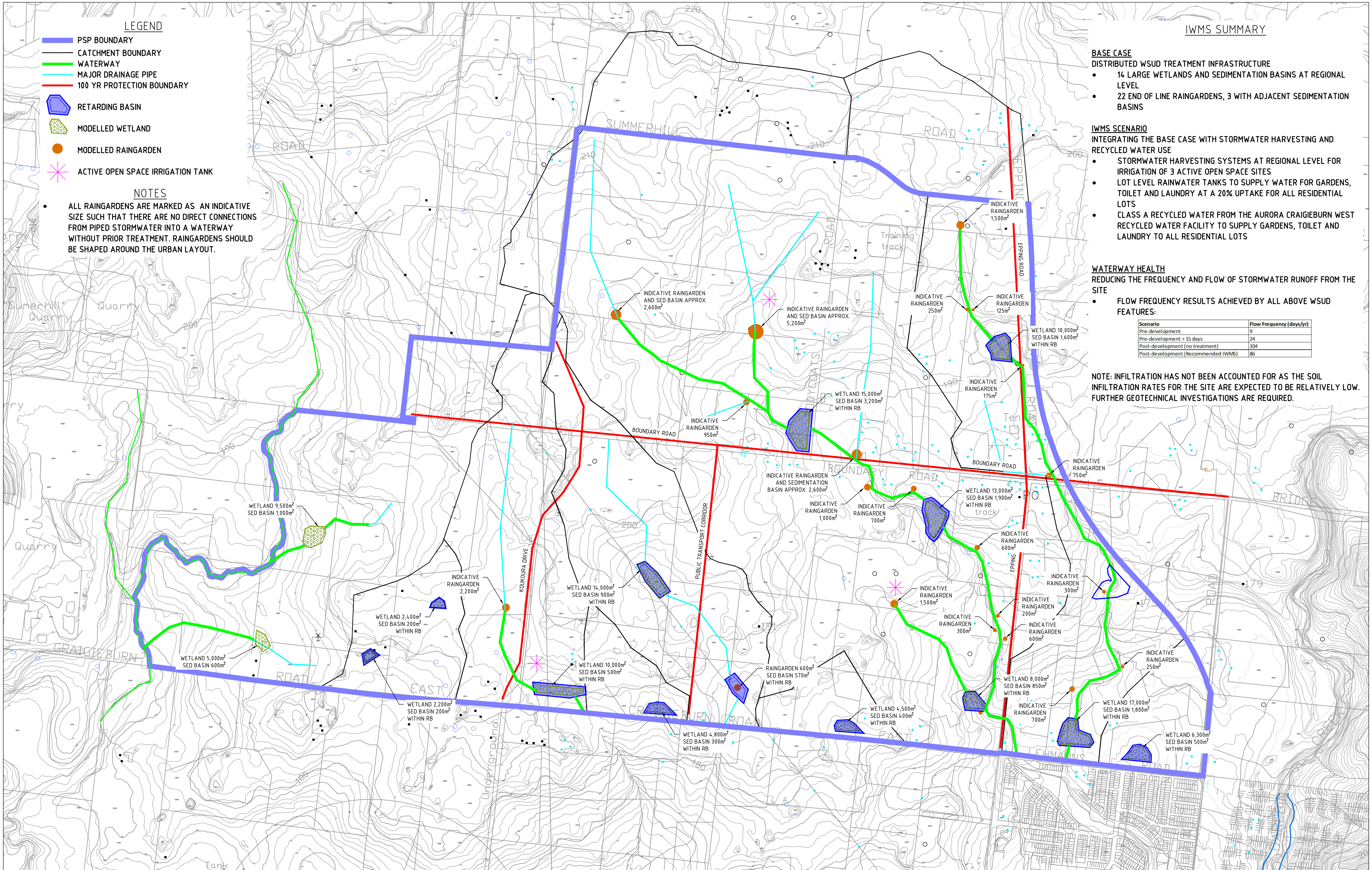
spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

spiire
Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

BASE CASE WATER QUALITY SUMMARY
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-5



IWMS SUMMARY

BASE CASE

DISTRIBUTED WSUD TREATMENT INFRASTRUCTURE

- 14 LARGE WETLANDS AND SEDIMENTATION BASINS AT REGIONAL LEVEL
- 22 END OF LINE RAINGARDENS, 3 WITH ADJACENT SEDIMENTATION BASINS

IWMS SCENARIO

INTEGRATING THE BASE CASE WITH STORMWATER HARVESTING AND RECYCLED WATER USE

- STORMWATER HARVESTING SYSTEMS AT REGIONAL LEVEL FOR IRRIGATION OF 3 ACTIVE OPEN SPACE SITES
- LOT LEVEL RAINWATER TANKS TO SUPPLY WATER FOR GARDENS, TOILET AND LAUNDRY AT A 20% UPTAKE FOR ALL RESIDENTIAL LOTS
- CLASS A RECYCLED WATER FROM THE AURORA CRAIGIEBURN WEST RECYCLED WATER FACILITY TO SUPPLY GARDENS, TOILET AND LAUNDRY TO ALL RESIDENTIAL LOTS

WATERWAY HEALTH

REDUCING THE FREQUENCY AND FLOW OF STORMWATER RUNOFF FROM THE SITE

- FLOW FREQUENCY RESULTS ACHIEVED BY ALL ABOVE WSUD FEATURES:

Scenario	Flow Frequency (days/yr)
Pre-development	9
Pre-development + 15 days	24
Post-development (no treatment)	104
Post-development (Recommended IWMS)	86

NOTE: INFILTRATION HAS NOT BEEN ACCOUNTED FOR AS THE SOIL INFILTRATION RATES FOR THE SITE ARE EXPECTED TO BE RELATIVELY LOW. FURTHER GEOTECHNICAL INVESTIGATIONS ARE REQUIRED.

Rev	Amendments	App'd	Date
3	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV D	L.H.	20/06/14
2	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV EXCLUDING PSP IMAGE	L.H.	16/05/14
1	REISSUED TO CLIENT FOR INFORMATION WITH IWMS REPORT REV C	L.H.	08/05/14
0	ISSUED TO CLIENT FOR INFORMATION	L.H.	24/10/13

file name 137599D02 ex PSP.dwg layout name 137599D02-7 - IWMS
file location G:\13\137599\ACAD\Variation
plotted by Alexandra Brown plot date 20/6/2014 4:11 PM
© Spiire Australia Pty Ltd
Standard Drawing RDA1 - Version 20120911

Designed 20-10-2013
A. BROWN
Checked 20-10-2013
L. HOLMES
Authorised PENDING
PENDING

Map Reference MELWAY 389 B10
Sheet Number 2
Drg Status PRELIMINARY

spiire ABN 55 050 029 635
469 La Trobe Street Melbourne Victoria 3000 Australia T 61 3 9993 7888 F 61 3 9993 7999
spiire.com.au

Innovation in Infrastructure

WOLLERT IWMS UPDATE
WOLLERT PSP

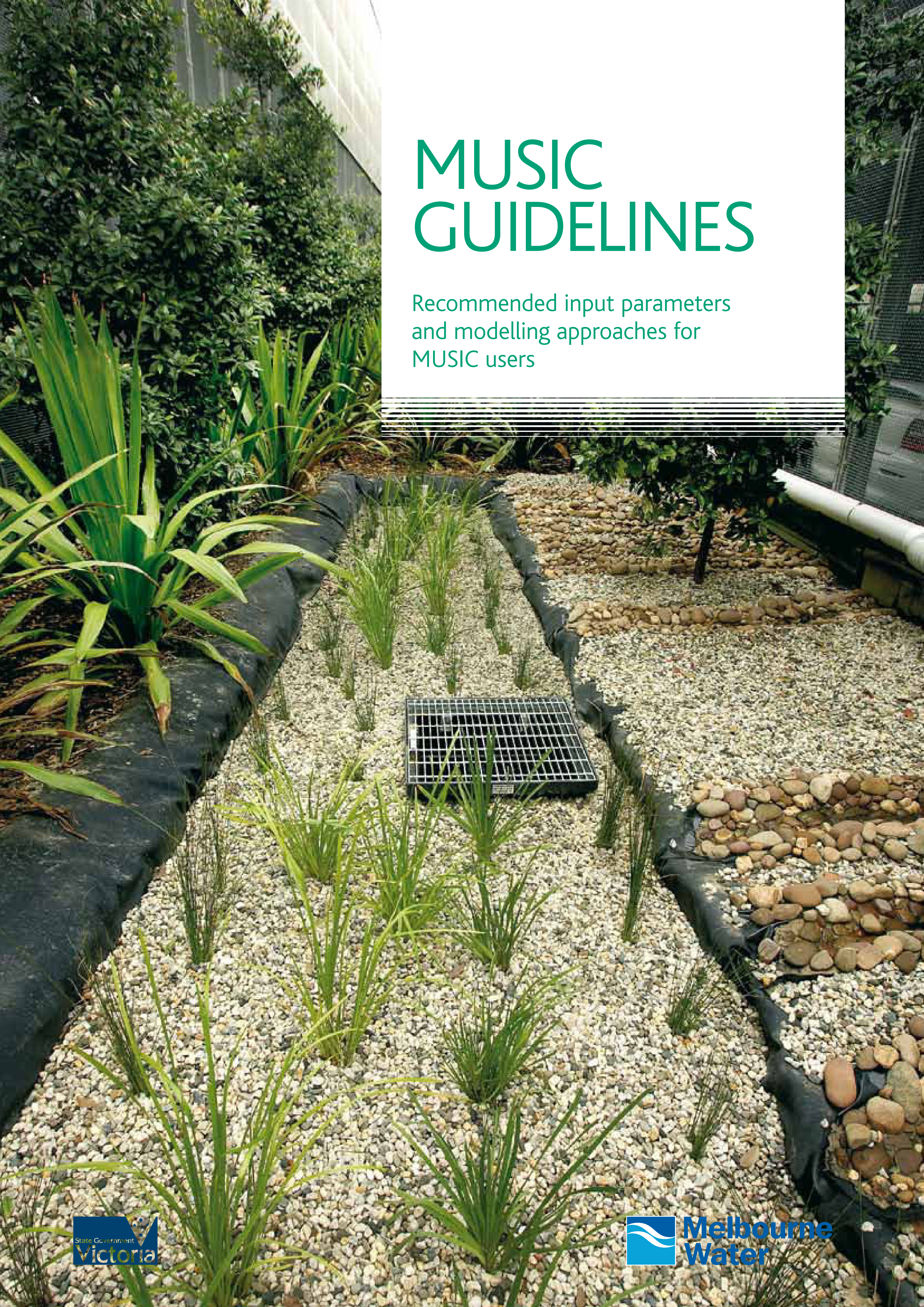
IWMS SUMMARY
WHITTLESEA CITY COUNCIL
WHITTLESEA CITY COUNCIL

Rev 3
Drg No 137599D02-7

Appendix H:
Melbourne Water Guidelines for the Use of MUSIC

MUSIC GUIDELINES

Recommended input parameters and modelling approaches for MUSIC users



State Government Victoria

Melbourne Water

INTRODUCTION

Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was developed by eWater. MUSIC is a conceptual design tool. The program can be used to estimate pollutant generation from a catchment and to demonstrate the performance of stormwater quality improvement systems.

Generally Melbourne Water requires treatment of stormwater so that annual pollutant loads achieve targets set out in the Best Practice Environmental Management Guidelines (BPEMG), these are:

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

There are however many cases where individual treatment measures will have different targets, for instance if the receiving aquatic ecosystem is identified as being of very high value, then Melbourne Water may require a higher treatment level.

The design intent for any treatment system must be clearly documented and discussed with Melbourne Water early in the conceptual design stage. Melbourne Water uses MUSIC to assess the impacts of proposed development against performance targets. If alternative methods or models are used, the developer must demonstrate to Melbourne Water's satisfaction that performance targets can be achieved.

This document provides guidance on input parameters and modelling approaches for MUSIC that are recommended by Melbourne Water.

PURPOSE OF THIS DOCUMENT

This document is aimed at supporting those submitting MUSIC models to Melbourne Water.
The objectives are to:

- Ensure a consistent scientifically based approach is applied to MUSIC models
- Provide guidance on methods specific to the Melbourne region without inhibiting innovative modelling approaches.
- Reduce the time taken by Melbourne Water in assessing models.

This document should be read in conjunction with the MUSIC Users Manual. Users of these guidelines are expected to know how to use MUSIC software and are sufficiently trained in the use of MUSIC software.

This document is not a design guideline and should be read in conjunction with appropriate design guidelines, eg. *WSUD Engineering Procedures: Stormwater* (Melbourne Water, 2005).

1. RAINFALL DATA & EVAPOTRANSPIRATION

Use of meteorological data within MUSIC is a balance between accurate representation and computing time. Testing has shown that the use of rainfall data from an appropriately selected year of rainfall data can represent the long-term metrological record. Six rainfall stations across Melbourne have been selected to reflect the rainfall gradient shown in Figure 1 below. The Representative years were selected as the best match of long-term records in terms of mean annual rainfall, distribution of rainfall and 90th percentile of rainfall. Melbourne Water recommends that results obtained by the "reference year" method be compared with long term rainfall records as a final check.

The rainfall distribution map can be used to determine the appropriate weather station, in order to better determine which station is appropriate; a large-scale version of the map is also available at the Melbourne Water website.

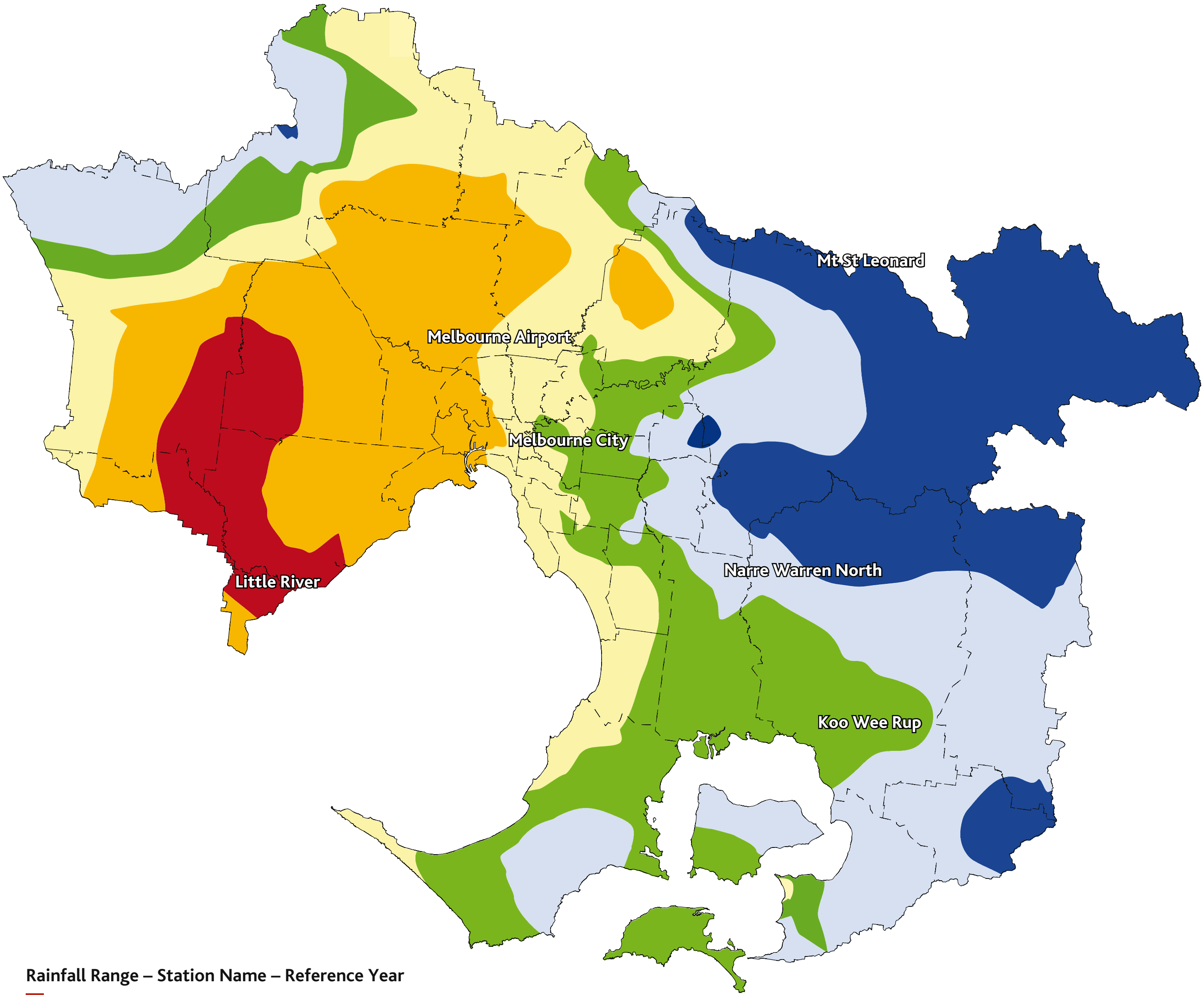
Rainfall data is available from the Bureau of Meteorology www.bom.gov.au. Templates for the six rainfall stations selected to reflect the rainfall gradient across metropolitan Melbourne are available at melbournewater.com.au.

All models created from January 2011 onwards must use either Melbourne Water's recommended rainfall templates or appropriate local rainfall. Use of alternative rainfall data is permitted if it can be demonstrated that the selected rainfall data is high quality and representative of the area to which it is being applied.

Table 1. Weather station, Mean Annual Rainfall range, reference year

Weather Station	Mean Annual Rainfall (mm) range	Reference year
Little River	400 - 500	2004
Melbourne Airport	500 - 650	1996
Melbourne City	650 - 750	1966
Koo Wee Rup	750 - 850	2004
Narre Warren North	850 - 1100	1998
Mt St Leonard	1100 - 2100	1998

RAINFALL DISTRIBUTION – GREATER MELBOURNE



Rainfall Range – Station Name – Reference Year

- 400mm to 500mm – Little River – 2004
- 500mm to 650mm – Melbourne Airport – 1996
- 650mm to 750mm – Melbourne City – 1966
- 750mm to 850mm – Koo Wee Rup – 2004
- 850mm to 1100mm – Narre Warren North – 1998
- 1100mm to 2100mm – Mount St Leonard – 1998

2. TIMESTEP

The timestep must be equal to or less than:
i. the Time of Concentration of the smallest Sub-Catchment, and
ii. the shortest detention time (under design flows) of the treatment measures being modelled.

Where either of these would be less than 6 minutes, the model should be run using a 6 minute interval.

3. HYDROLOGIC ROUTING

Hydrologic routing should be used where appropriate to reflect the Time of Concentration of the Catchment as calculated using a recognised procedure. The applicant may choose not to apply routing to reduce the complexity of the model. Generally this will result in the performance of treatment systems being underestimated.

4. SOILS

In MUSIC the pervious area properties default to Brisbane properties. These will need to be altered to reflect Melbourne properties as documented in the MUSIC User Manual. Any deviation from the Melbourne parameters listed in the MUSIC User Manual should be described in the report provided with the model. Supporting evidence should also be provided.

The MUSIC User Manual lists the following pervious area properties for Melbourne:

Soil Store Capacity = 30mm Field Capacity = 20mm

5. LOSSES FROM THE SYSTEM

The exfiltration rate specified in treatment nodes relates to the seepage rate in mm/hr of the soil surrounding the treatment systems. This does not refer to the hydraulic conductivity of any of the soils contained within the actual treatment systems. The exfiltration rate adopted in any treatment nodes that is more than 0mm/hr must be supported by a geotechnical report.

6. POLLUTION CONCENTRATION DATA

The default values for TSS, TP and TN are to be used, unless additional data is available. Any new data must be published and demonstrate that there is a significance difference between the new data and the default data. Changes to default pollutant concentrations must be confirmed by Melbourne Water in writing.

The Serial Correlation (R squared) is to be set to zero for TSS, TP and TN if using a single reference year of rainfall data. This applies to MUSIC Version 4 models only.

7. FRACTION IMPERVIOUS

Ideally models should be calibrated using local flow data. However in most cases information is not available to achieve this. Where the model cannot be calibrated using local flow data, the following table indicating the fraction impervious for different land uses can be used as a guide. Consideration should be given to the catchment modelled and where it fits within the range provided. This table may not be applicable to all catchments.

It should be noted that these figure are total fraction impervious whereas MUSIC requires the effective fraction impervious. Use of these figures may result in overestimation of more frequent flows in some cases.

Any significant deviation from these figures must be supported by relevant information (i.e. long term flow data that enables calibration of the model)

Zone	Zone Code	Brief Description/Examples	Normal Range	Typical Value
Residential Zones:				
Residential 1 & 2 Zone	R1Z	Moderate range of densities. (Allotment size 800m2 – 4000m2)	0.40 - 0.50	0.45
	R2Z	Normal densities. (Allotment size 500m2 – 800m2)	0.50 - 0.70	0.60
		Medium densities. (Allotment size 350m2 – 500m2)	0.70 - 0.80	0.75
		High densities. (Allotment size <350m2)	0.80 - 0.95	0.85
Low Density Residential Zone	LDRZ	Low densities (0.4 ha min.)	0.10 - 0.30	0.20
Mixed Use Zone	MUZ	Mix of residential, commercial, industrial and hospitals.	0.60 - 0.90	0.70
Township Zone	TZ	Small townships with no specific zoning structures.	0.40 - 0.70	0.55
Industrial Zones:				
Industrial 1 Zone	IN1Z	Main zone to be applied in most industrial areas.	0.70 - 0.95	0.90
Industrial 2 Zone	IN2Z	Large industrial zones away from residential areas.	0.70 - 0.95	0.90
Industrial 3 Zone	IN3Z	Buffer between Zone 1 and Zone 3.	0.70 - 0.95	0.90
		• for garden supplies/nurseries.	0.30 - 0.60	0.50
		• for quarries.	0.10 - 0.30	0.20
Business Zones:				
Business 1 Zone	B1Z	Main zone to be applied in most commercial areas.	0.70 - 0.95	0.90
Business 2 Zone	B2Z	Offices and associated commercial uses.	0.70 - 0.95	0.90
Business 3 Zone	B3Z	Offices, manufacturing industries and associated uses.	0.70 - 0.95	0.90
Business 4 Zone	B4Z	Mix of bulky goods retailing and manufacturing industries.	0.70 - 0.95	0.90
Business 5 Zone	B5Z	Mix of offices and multi-dwelling units.	0.70 - 0.95	0.90
Rural Zones:				
Rural Zone	RUZ	Main zone to be applied in most rural areas.	0.05 - 0.20	0.10
Environmental Rural Zone	ERZ	Rural areas with specific environmental considerations.	0.05 - 0.20	0.10
Rural Living Zone	RLZ	Predominantly residential use in rural environment.	0.10 - 0.30	0.20

Zone	Zone Code	Brief Description/Examples	Normal Range	Typical Value
Public Land Zones:				
Public Use Zone		Use of land for public purposes		
• Service and Utility	PU1Z	• power lines, pipe tracks and retarding basins.	0.00 - 0.10	0.05
		• reservoirs.	0.40 - 0.60	0.50
• Education	PU2Z	• schools and universities.	0.60 - 0.80	0.70
• Health and Community	PU3Z	• hospitals.	0.90 - 0.80	0.70
• Transport	PU4Z	• railways and tramways.	0.60 - 0.80	0.70
• Cemetery / Crematorium	PU5Z	• cemeteries and crematoriums.	0.50 - 0.70	0.60
• Local Government	PU6Z	• libraries, sports complexes and offices/depots.	0.50 - 0.90	0.70
• Other Public Use	PU7Z	• museums.	0.50 - 0.80	0.60
Public Park and Recreation Zone	PPRZ	Main zone for public open space, incl golf courses.	0.00 - 0.20	0.10
Public Conservation and Resource Zone	PCRZ	Protection of natural environment or resources.	0.00 - 0.05	0.00
Road Zone – Category 1	RDZ1	Major roads and freeways.	0.60 - 0.90	0.70
Road Zone – Category 2	RDZ1	Secondary and local roads.	0.50 - 0.80	0.60
Special Purpose Zones:				
Special Use Zone	SUZn	Development for specific purposes.	0.50 - 0.80	0.60
Comprehensive Development Zone	CDZn	Large and complex developments – residential.	0.40 - 0.80	0.50
Urban Floodway Zone	UFZ	Land identified as part of an active floodway.	0.00 - 0.05	0.00
Capital City Zone	CCZn	Special Use Zone for land in Melbourne's central city.	0.70 - 0.90	0.80
Docklands Zone	DZn	Special Use Zone for land in Docklands area.	0.70 - 0.90	0.80
Commonwealth Land:				
Commonwealth Land	CA	Army barracks, CSIRO.	0.50 - 0.80	0.60

Note: Values included in this table relate only to the average imperviousness of a land-use type. They are not runoff coefficients and should not be used as runoff coefficients. Refer to the Australian Rainfall and Runoff (Engineers Australia, 2001) for the difference between fraction impervious and runoff coefficients.

8. STOCHASTIC VERSUS MEAN GENERATED DATA

Stochastically generated data is always to be used, except where there is a requirement to examine behaviour for a particular storm event or set of operating conditions.

9. SOURCE NODES

Any Agricultural & Forest nodes must be submitted as independent subcatchments, parkland within an urban development will usually be modelled as an urban node. The uncertainties associated with the defaults used for agricultural nodes are significantly higher than those for urban nodes. In most cases the use of urban nodes, with low fraction impervious, will be preferable to the use of agricultural nodes.

10. K, C*, C**

Melbourne Water must approve any changes to these parameters in writing. Any data used to modify these parameters must be published data, and be appropriate for the circumstances being modelled.

11. INSTREAM WORKS

Any works within receiving waters (such as pool and riffle systems) shall not be included into any treatment train models. Waterways in Development Services Schemes shall not be included into any treatment models.

Online wetland treatment trains are acceptable if they comply with Melbourne Water's Constructed Wetland Guidelines.

12. GPT'S

No treatment should be attributed to a GPT unless it is supported by reliable studies. Nitrogen reductions from GPT's shall not be included in the overall performance of the treatment train.

13. WETLANDS

To access design guidelines for constructed wetland systems please refer to the Melbourne Water publication 'Constructed Wetlands Guidelines' (Melbourne Water, 2010). This document is available as a PDF download from Melbourne Water's web page.

A minimum of 80% coverage of emergent macrophytes is required within the normal water level surface area of the wetland.

The extended detention depth can vary up to a maximum of 500mm, unless otherwise approved.

The detention time in the macrophyte extended detention zone is recommended to be 72 hours, with not less than a 48 hour detention time.

Additional requirements for wetlands can be found in Melbourne Water's Constructed Wetland Guidelines, http://www.melbournewater.com.au/content/planning_and_building/information_for_developers/guidelines_for_developers.asp

14. LAKES

MUSIC is not a suitable model for in-lake processes, other than water balance assessments. Guidance on this topic can be found in the Melbourne Water publication "*Constructed Shallow Lake Systems for Developers*". This document is available as a PDF download from Melbourne Water's web page.

15. REUSE

A reuse master plan must be provided which is to be signed off by all relevant authorities (Local Government, Melbourne Water). Calculations should be provided to support reuse volumes.

Reuse used to contribute to treatment train performance must have demands that are reliable, eg. toilet flushing. Irrigation of a residential block is encouraged, however will not be accepted as demand for reuse in a model due to the high variability of this demand.

For reuse to be accepted as part of a MUSIC model there needs to be a suitable agreement between the relevant stakeholders relating to the reuse.

Use of reuse to contribute to treatment performance should be modelled in accordance with the "Rainfall Data & Evapotranspiration" and "Timestep" sections of these guidelines. Use of a different timestep and a number of consecutive rainfall years should be considered when determining the optimum size of the storage unit.

16. SWALES

Suggested vegetation heights
- **Grass swale** (mowed) height range: 10 – 100mm
- **Vegetation** (not mowed): 100 – 400mm

In the case where unmown vegetation is being used, the proponent should identify what type of vegetation is proposed, and how it will be managed within the landscape and maintenance requirements of the development. Waterways within developments cannot be deemed as swales and shall not be included in the treatment train model.

17. BIORETENTION SYSTEMS

Bioretention systems used in models must be supported by a specification of the filter media for the system included in the design. The specification should comply with the specification requirements listed in the *"Stormwater Biofiltration Systems: Adoption Guidelines"* (FAWB, 2009)

The hydraulic conductivity of the filter media used in the model should match the specification. An acceptable range of the hydraulic conductivity of a bioretention system is 100mm/hr – 400mm/hr. A geotechnical report may be required to support the selection of the exfiltration rate if the system is not lined.

If using MUSIC Version 3 or the media filtration system node in MUSIC Version 4, the median particle diameter size should match the specification. The filter media depth should not include the transition layer and the drainage layer.

If using MUSIC Version 4, the portion of organic material in the filter, the TN content of filter media and the Orthophosphate content of the filter media should also match the specification provided with the model. If the system is to be vegetated with effective nutrient removal plants, a vegetation specification is to be provided with the design. The filter media depth should not include the transition layer and the drainage layer unless there is a submerged zone. The porosity of the filter media and a submerged zone, if present, should represent the materials listed in the specification.

Consideration should be given to the extended detention depth selected for bioretention systems. The depth should be safe for construction, operation and maintenance of the system. If the system has a longitudinal slope, it will not have a uniform extended detention depth and an average should be selected.

18. PERMEABLE PAVEMENT

Permeable pavement should be modelled as per the manufacturer's guidelines. Documentation supporting the modelling must be submitted for review.

19. IMPORTED DATA NODES

Supporting documentation will be required to demonstrate the use of any imported data nodes in models.

20. GENERIC TREATMENT NODES

Generic treatment nodes should not be used unless supported by supplementary models or if modelling as per a treatment manufacturer's guidelines with supporting documentation.

Generic treatment nodes can be used to simulate the splitting of flows. Appropriate documentation must be provided to justify the split of flows if used to simulate this.

SUBMISSION REQUIREMENTS

The functional design report for the project should incorporate the following information for systems modelled with MUSIC:

Summary

- Summary of treatment performance in terms of:
  1. Mean annual load reduction for TSS, TP and TN
  2. % reduction of each treatment device
  3. % reduction of total treatment system
- Description of the function and intent of the treatment system.
- Catchment details.
- Description of how fraction impervious was calculated (what figures were used for different zonings).
- Description of and documentation for any departure from the Melbourne Water "MUSIC Inputs" document.
- A plan to an identifiable scale clearly depicting the catchment / s contributing to the treatment systems.
- Drawings depicting the design of the system.
- Specification for the treatment systems.
- Vegetation specification for bioretention systems.

Model

- Sqz model of catchment with treatment measures.
- Sqz model of catchment without treatment measures.
- Description of rainfall/ET data used (should be one of MW's reference years)
- If available an electronic copy of the catchment and subcatchment used in MapInfo or other approved format. If an electronic copy is not available a hard copy is acceptable.

Melbourne Water
100 Wellington Parade, East Melbourne
PO Box 4342 Melbourne Victoria 3001
Telephone 131 722 Facsimile 03 9235 7200
melbournewater.com.au

Designed and produced by Equest Design.

ISBN 978-1-921603-87-7 (print)
ISBN 978-1-921603-88-4 (web)

Melbourne Water

Appendix I:
CoW Commentary – Rainwater Tanks for Commercial and Industrial Precincts

Commentary - Rainwater tanks for Commercial, High Rise Residential and Council Buildings

The installation of suitably sized rainwater tanks should be considered for all roof structures. This document will specifically address rainwater tanks in industrial/commercial, mixed use high rise, residential and Council buildings.

As a general rule, tank installations have either been non-existent or capture only a small component of total rainfall landing on the roof. The reason for this is:

- The installation of a tank adds cost to the build;
- There are no regulatory requirements for the installation of a tank;
- There is little on-site use potential for the water from tanks in most commercial buildings.

However, the installation of tanks has significant benefits external to the site:

- Reducing the risk to downstream flash flooding;
- Contribution to downstream environmental flows in connecting waterways;
- Reduction in potable water use (when connected to internal/external plumbing) ;
- Reduction is size of wetlands and other WSUD features;
- Improve function of wetlands and other treatment facilities due to balanced water flow;
- Potential diversion to sewer and hence made available locally as recycled water.

The preferred approach is to capture rain in suitably sized rainwater tanks, and then release approximately 5% of the tank volume per day into the stormwater system. Melbourne Water supports and refers to this method as the “Leaky Tank” approach. Depending on individual requirements, some or the entire tank can be reserved for on-site use. The release of water can be achieved simply by using a valve operated on a timer. The emptying of tank water is an important function of the tank, because it ensures that the tank has the available capacity to capture future rain events.

Downstream the following benefits would be realised:

- Smaller peak volumes flows in waterways during high rainfall events i.e. less erosion, litter, sediment, property damage etc.;
- More days with water flowing in waterways and more constant flow;
- Improved water quality. Cleaner and less polluted water due to more efficient operation of wetlands and WSUD treatment measures i.e. wetlands/WSUD assets are unable to treat stormwater in high flow events;
- Improved health of wetlands and waterways due to more constant water flows.

<u>We need to be more prescriptive when specifying tank size</u>.

Modelling of rainfall data in the Whittlesea municipality (Epping weather station) shows that 5,000L of rainwater tank capacity is adequate to capture around 90 per cent of all rainfall for every 100m^2 of roof space per annum. This applies to all roofing structures (commercial and residential).