

**Former Brickworks** 78 Middleborough Road Burwood

Stormwater Strategy

## **Reeds Consulting**

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> This plan is approved pursuant to Clause 43.04 Schedule 6 of the Whitehorse Planning Scheme. This document forms part of the Development Plan for the former brickworks site at 78 Middleborough Road Burwood East.

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# 1 Introduction

Reeds Consulting Pty Ltd has engaged Incitus to undertake a Stormwater Strategy for the subdivision and development of the Former Brickworks, located at 78 Middleborough Road, Burwood.

The 20 ha parcel of land is located approximately 15 km east of Melbourne in Burwood. The site is bounded by Middleborough Road to the west, Eley Road to the north, existing development to the east and Burwood Highway to the south. The site is covered by the City of Whitehorse's Development Plan Overlay DPO6. The site is not located within Melbourne Water Development Services Scheme, however will be referred to Melbourne Water under the Planning and Environment Act (1987) and the Subdivisions Act (1988). The site is illustrated in **Figure 1.1** below.



Figure 1.1 The Former Brickworks, 78 Middleborough Road, Burwood



Urbanisation leads to an increase in stormwater runoff and a subsequent increase in pollutant wash-off. It also has detrimental effects on the receiving waterways. In determining the urban structure, it is critical that assets required for drainage purposes are determined early so that the impacts from the increase of stormwater runoff due to urbanisation can be mitigated and all new development can proceed without the risk of flooding, of flooding neighbouring properties and without impacting on the natural environment, receiving waterways and ultimately, Port Phillip Bay.

Undertaking a drainage assessment of the catchment that identifies the quantity of runoff, the conveyance of this runoff, the need to retard the runoff and the treatment and / or reuse of the runoff will assist in determining the assets and / or land-take required for the stormwater management of this catchment. It will also identify the location of all stormwater assets.

Liveability and resilience should be incorporated into all new developments. With respect to stormwater management, this involves utilising the stormwater as an asset for the community whilst ensuring fundamentals such as flood protection, safety with respect to flow management and water supply security are maintained. This can be achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Stormwater Strategy for the development of the Former Brickworks at 78 Middleborough Road Burwood outlines a management plan for the stormwater that is generated from the urbanisation of the land. It identifies the assets required to manage the increased surface water runoff from urbanisation and sets a framework to achieve the intent of the stormwater assets. The surface water management for the site has been optimised and designed to achieve multiple benefits for the community and the environment.



# 2 Catchment Characteristics

The land at 78 Middleborough Road Burwood is located on the east side of Middleborough Road, north of the Burwood Highway, and is 20 ha in size. The average annual rainfall for the region is approximately 720 mm. The land is a disused brickworks site and has had significant modification to the pre-European catchment form.

The topography is varied with some isolated depressions from former quarrying activities. The site generally drains towards an existing Melbourne Water retarding basin, the Eley Road Retarding Basin, located adjacent to the north-east corner of the development. A small catchment abutting Eley Road will drain into the Melbourne Water Eley Road Main Drain and approximately 0.17 ha of developed catchment (0.47 ha of existing land-use catchment) abutting Eley Road in the north-west corner will connect to the existing Council drainage system.

The development has an external catchment of approximately 27 ha contributing to the site from the south and the east. Of this catchment, 23 ha is contributing from south and adjacent to Burwood Highway and 4 ha is contributing from existing development located to the east. The site is not currently subject to any Special Building Overlays or Land Subject to Inundation Overlays, which indicates that it does not currently experience any flooding. However, the exclusion of flooding overlays from this site may be due to the current land use associated with the parcels.

Figure 2.1 depicts the general site characteristics.





Figure 2.1 Catchment Characteristics of 78 Middleborough Road, Burwood Figure 2.2 depicts the current drainage catchments based on existing topography.





Figure 2.2 Current Drainage Catchments of 78 Middleborough Road, Burwood



# 3 Stormwater Quantity

The drainage system for the development of the Former Brickworks at 78 Middleborough Road Burwood will be designed to prevent property flooding occurring in a 1% Annual Exceedance Probability (AEP) storm event and the stormwater runoff can be safely conveyed through the development. To achieve this, the development will adopt a minor / major drainage system philosophy.

The development will be designed to ensure that the minimum level of service achieved with respect to drainage. For the minor system, the requirements for capture and conveyance must be achieved. For the major system, minimum freeboard requirements must be achieved for allotments and safe conveyance of overland flow is provided. This is applicable for all flow paths including road reserves, through public open space areas, through retail precincts and through retirement villages and unit developments.

The development is required to provide continuity for all flow paths for rainfall events up to and including the 1% AEP design storm. The development must avoid the obstruction of the flow path caused by fences, landscaping and buildings. Should obstructions occur within the flow path, the development must demonstrate compliance with safety criteria and ensure that no adverse effects are created for neighbouring properties. The development is required to provide suitable escape routes for all design flows generated from rainfall up to and including the 1% AEP storm event.

The 1% AEP flood levels associated with the neighbouring properties shall not be increased due to the urbanisation associated with the development of this site.

#### 3.1 Minor Drainage System

The minor drainage system will consist of a subsurface pipe network designed to capture and convey all stormwater runoff generated from the catchment for rainfall events up to and including the 10% Annual Exceedance Probability (AEP) design storm for residential catchments and the 5% AEP design storm for commercial catchments.

As the localised catchments have an area less than 60 ha, the system will be designed in accordance with the City of Whitehorse design requirements and / or the Victorian Planning Authority's Engineering Design and Construction Manual. The minor drainage system must be designed so that the pit inlet adopts a 50% blockage and still captures the required flow rates.



### 3.2 Major Drainage System

The primary objective of the major drainage system is to provide flood protection for the allotments based on the 1% AEP storm event and to ensure the overland flow can be safely conveyed through the development. This will be via overland flow paths contained within road reserves. The overland flow magnitudes will be determined based on the difference between the 1% AEP design flows and the capacity of the minor drainage system, accounting for pit blockages in accordance with the Australian Rainfall and Runoff (2016).

The development is not located within a Melbourne Water Development Services Schemes (DSS) and no regional scale retardation has been provided for the development of this land. Therefore, the development must include on-site retardation to mitigate the stormwater runoff discharging from the site. Melbourne Water has specified the allowable discharge from the development as the capacity of the downstream drainage infrastructure ensuring there is no increase in the peak flood elevation or peak outflow for the 1% AEP design storm associated with the Eley Road Retarding Basin.

The development of the Former Brickworks will be designed so that all finished floor levels will be set a minimum of 300 mm above the 1% AEP flood level in Central Park drainage reserve, or 600 mm above the 1% AEP flood level in the Eley Road Retarding Basin, or 300 mm above the overland flow conveyed through the road reserves, whichever is greater.

#### 3.2.1 On-site Retardation

The City of Whitehorse and Melbourne Water require the development of 78 Middleborough Road Burwood to limit the stormwater runoff discharging from the site to the capacity of the downstream drainage system.

Melbourne Water provided Reeds Consulting with a hydrologic runoff routing model for the catchment. RORB was adopted as the design runoff routing model for generation of flows and simulation of storages catchment. RORB generates catchment runoff based on the selection of local rainfall intensity frequency duration data and appropriate loss models. This model has been revised to reflect the development of 78 Middleborough Road Burwood. The RORB model adopts the storage function S=kQ<sup>m</sup>.

The catchment plan indicating boundaries and reach lengths is included in **Appendix A**. A summary of the parameters adopted in the model is also included in **Appendix A**.

The model conveys the stormwater runoff generated from the developed catchment, including the external southern catchment, to the Central Park retarding basin. The external catchment to the east, as well as Catchment I and Catchment J have been routed directly to the Eley Road Retarding Basin.

Melbourne Water have advised that the development of the parcel must not result in any increase in peak elevation for the 1% AEP design storm in the Eley Road Retarding Basin and no increase in the peak discharge for the 1% AEP design storm in the Eley Road Retarding Basin.

The original model supplied by Melbourne Water indicates that Eley Road Retarding Basin has a current 1% AEP design storm elevation of 84.45 m AHD and a peak discharge in the 1% AEP design storm of 8.75 m<sup>3</sup>/s.

The Central Park Retarding Basin is required to mitigate the peak flows generated from the urbanisation of the site. Interactive modelling was undertaken to determine the storage



volume required to restrict the discharge from the retarding basin to 300 l/s. It has been determined that this discharge, together with the urbanised catchments downstream of the Central Park Retarding Basin connecting directly to the Eley Road Retarding Basin, will not result in any increase in flood levels or discharge from the downstream receiving asset.

The model accepted by Melbourne Water resulted in a peak storage volume of 10,000 m<sup>3</sup> in the Central Park Retarding Basin with a peak elevation of 87.63 m AHD and a peak discharge of 0.29 m<sup>3</sup>/s for the 1% AEP design storm event.

This data was then used to develop a conceptual design, from which an elevation / storage relationship was developed based on the terrain model created. The elevation / discharge relationship from the basin has been determined using the orifice equation until the spillway level is reached, and then the weir equation combined with the orifice equation. This data has been incorporated in the RORB model to refine the output. The elevation / storage / discharge relationship for the Central Park Retarding Basin are listed in **Table 3.1**.

Elevation (m AHD)	Storage (m3)	Peak Discharge (m3/s)	
84.8	0	0	
85.0	145.10	0.04	
85.2	293.65	0.09	
85.5	765.48	0.14	
86.0	2,689.0	0.19	
86.5	4,904.9	0.23	
87.0	7,340.5	0.26	
87.5	10,013	0.29	
88.0	12,957	0.32	

Table 3.1 Central Park Retarding Basin Elevation / Storage / Discharge Relationship

The outputs from the Central Park Retarding Basin for all storm events are listed in **Table 3.2**.



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Storm Event	Peak Elevation (m AHD)	Peak Storage (m³)	Peak Discharge (m³/s)	Time to Peak Elevation (hrs)	Time to Empty RB (hrs)
1 EY (1 year ARI)	85.68	1,440	0.15 (9hr)	6	10.5
39% AEP (2 year ARI)	85.81	1,900	0.17 (2hr)	1.8	5.4
18% AEP (5 year ARI)	86.09	3,100	0.20 (2hr)	1.8	7.2
10% AEP (10 year ARI)	86.33	4,110	0.22 (2hr)	2.0	8.5
5% AEP (20 year ARI)	86.68	5,770	0.24 (2hr)	2.0	10.6
2% AEP (50 year ARI)	87.12	7,980	0.27 (2hr)	2.0	13
1% AEP (100 year ARI)	87.51	10,100	0.29 (2hr)	2.08	15.1
0.5% AEP (200 year ARI)	87.95	12,700	0.32 (2hr)	2.08	17.5
0.2% AEP (500 year ARI)	88.10	13,600	1.20 (1.5hr)	1.08	17.3

Note: EY is Exceedance per year, ARI is Average Recurrence Interval, AEP is Annual Exceedance Probability. Storm duration for peak discharge is shown in parenthesis. Time to empty is from the start of the storm until flood level is contained in pond.

The results indicate 10,100 m<sup>3</sup> of storage is required to retard all events up to the 1% AEP design storm to a discharge that will not result in an increase in flood elevation or peak discharge from the downstream receiving Eley Road Retarding Basin. The results also indicate that the 0.5% AEP is still contained within the retarding basin, and that for most events the basin will empty in less than one day from the start of the storm event.

A sensitivity analysis was undertaken assuming a 50% blockage for the outlet of Central Park Retarding Basin. The analysis indicated for a 1% AEP storm event, that the blockage resulted in a marginal increase in flood level of 180 mm, an increase in volume stored of 700 m<sup>3</sup>, and a reduction in outflow of almost 50%.

The reduction in flow is due to the controlled outlet structure, and blockage of the outlet will only reduce the peak discharge from the basin, until the basin spills over the road reserve bounding it. The peak outflow will remain at the peak level for an extended duration, increasing the outflow hydrograph and subsequent time to empty the basin from the start of the storm event.

The increase in flood level within the basin will be contained within the freeboard for all events up to and including the 1% AEP design storm. The analysis indicated that the 0.5% AEP storm event will just be contained in the Central Park Retarding Basin with a 50% blockage on the outlet, and that the basin will only spill in events greater than this.



The Central Park Retarding Basin will contain flood warning signs to appropriate standards. **Figure 3.1** illustrates the proposed layout for the Central Park Retarding Basin.



Figure 3.1 The Proposed Central Park Retarding Basin Layout



#### 3.2.2 Peak Development Flows

The peak development flows are generated from the development of the site. **Figure 3.2** illustrates the major catchments and flow paths for the development.



Figure 3.2 The Former Brickworks Burwood Major Catchments

#### **External Catchment 1**

External Catchment 1 is located south of the development, encompassing a section of the Burwood Highway and development to the south. The area of External Catchment 1 is approximately 22.1 ha. The peak 1% AEP design flow for the catchment is approximately 4.4 m<sup>3</sup>/s. It is estimated that approximately 2.9 m<sup>3</sup>/s of this flow will be conveyed overland. The flow will be conveyed through the development via the road reserves towards Central Park Retarding Basin.



#### **External Catchment 2**

External catchment 2 is located south of the development, encompassing a section of the Burwood Highway and the existing RSPCA site. The area of External Catchment 2 is approximately 0.69 ha. The peak 1% AEP design flow for the catchment is approximately 0.2 m<sup>3</sup>/s. It is estimated that this flow will be conveyed via the drainage network, however an allowance has been made for an overland flow of approximately 0.1 m<sup>3</sup>/s in the event of inlet blockages. The flow will be conveyed through the development via the road reserves towards Central Park Retarding Basin.

#### **External Catchment 3**

External Catchment 3 is located east of the development, encompassing an existing residential area around Ramsey Street, Medhurst Street and Old Burwood Road. The area of External Catchment 3 is approximately 4.3 ha. The peak 1% AEP design flow for the catchment is approximately 1.1 m<sup>3</sup>/s. It is anticipated that the peak 1% AEP design flow will be conveyed via a realigned Council drain through the development, however a preliminary conservative allowance has been made for 0.2 m<sup>3</sup>/s to be conveyed overland in the event of inlet blockages. The flow will be conveyed through the development towards the existing Eley Road Retarding Basin.

#### **External Catchment RSPCA NW**

External Catchment RSPCA NW is located south of the site, adjacent to Middleborough Road and encompasses part of the existing RSPCA site. The area of External Catchment RSPCA NW is 0.2 ha. The flows generated from the catchment will be captured and conveyed through the development via the pipe drainage network.

#### **External Catchment RSPCA NE**

External Catchment RSPCA NE is located south of the site, adjacent to External Catchment RSPCA NW and encompasses part of the existing RSPCA site. The area of External Catchment RSPCA NE is 0.15 ha. The flows generated from the catchment will be captured and conveyed through the development via the pipe drainage network.

#### **Catchment A**

Catchment A is an internal catchment encompassing the Central Park Retarding Basin. The area of Catchment A is approximately 1.47 ha. The peak 1% AEP design flow entering the Central Park Retarding Basin for the total catchment is 10.5 m<sup>3</sup>/s. The peak 1% AEP design flow discharging from the Central Park Retarding Basin and Catchment A is 0.29 m<sup>3</sup>/s. This flow will be conveyed via a pipe drain to the existing Eley Road Retarding Basin.

#### **Catchment B**

Catchment B is an internal catchment located adjacent to Catchment A. The area of Catchment B is approximately 2.94 ha. The peak 1% AEP design flow for Catchment B is approximately 0.9 m<sup>3</sup>/s. It is estimated that up to 0.5 m<sup>3</sup>/s of this flow will be conveyed overland. The flow will be conveyed through the development via the road reserves towards Central Park Retarding Basin.

#### **Catchment C**

Catchment C is an internal catchment located adjacent to Catchment B. The area of Catchment C is approximately 1.82 ha. The peak 1% AEP design flow for Catchment C is approximately 0.6 m<sup>3</sup>/s. It is estimated that up to 0.3 m<sup>3</sup>/s of this flow will be conveyed



overland. The flow will be conveyed through the development via the road reserves and discharge into Central Park Retarding Basin.

#### **Catchment D**

Catchment D is an internal catchment located adjacent to Middleborough Road encompassing the proposed retail section. The area of Catchment D is approximately 2.51 ha. The peak 1% AEP design flow for Catchment B is approximately 1.2 m<sup>3</sup>/s. The retail section is to be serviced by 5% AEP internal drainage system, and prior to outfall to Catchment E, the drainage outfall and grated inlet pits will be upsized to capture and convey the 1% AEP design flows. The flow will be conveyed through the development via the drainage system towards Central Park Retarding Basin.

#### **Catchment E**

Catchment E is an internal catchment located adjacent to Catchment D and encompassing the Urban Plaza and apartments precinct. The area of Catchment E is approximately 1.61 ha. Catchment E is required to convey the flows generated from the external RSPCA catchments as well as Catchment D. The peak 1% AEP design flow for the total catchment is approximately 1.6 m<sup>3</sup>/s. Catchment D and E will be serviced by upsized 1% AEP drainage system in Urban Plaza, which will be a high amenity area. The flow will be conveyed through the development towards Central Park Retarding Basin.

#### **Catchment F**

Catchment F is an internal catchment located adjacent to Catchment A and External Catchment 3. The area of Catchment E is approximately 2.39 ha. Catchment F will convey the runoff generated from the internal Catchment G and External Catchment 1. The peak 1% AEP design flow for the total catchment is approximately 4.0 m<sup>3</sup>/s. It is estimated that a limited portion of this flow will be conveyed overland to ensure flood protection is achieved and the safe conveyance of gap flows. The flow will be conveyed through the development towards Central Park Retarding Basin.

#### **Catchment G**

Catchment G (Ryman site) is an internal catchment located adjacent to Catchment F and External Catchment 1. The area of Catchment G is approximately 2.43 ha. Catchment G will convey the runoff generated from the External Catchment 1. The peak 1% AEP design flow for the total catchment is approximately 3.4 m<sup>3</sup>/s. Prior to discharge into Catchment F, gap flows will be captured and conveyed in the subsurface drainage network. The subsurface drainage network capturing and conveying the runoff form this catchment will be sized to convey the 1% AEP design flow. The flow will be conveyed through the development towards Central Park Retarding Basin.

#### **Catchment H**

Catchment H is an internal catchment encompassing Link Road. The area of Catchment H is approximately 1.94 ha. Catchment H will convey runoff from External Catchment 2 and External RSPCA NE catchment. Flows from Catchments D and E will cross Catchment H and discharge into Catchment C, together with the runoff from Catchment H. The peak 1% AEP design flow for the total catchment is approximately 2.3 m<sup>3</sup>/s. It is estimated that up to 1.2 m<sup>3</sup>/s of this flow will be conveyed overland. The flow will be conveyed through the development via the road reserves towards Central Park Retarding Basin.



#### **Catchment I**

Catchment I is an internal catchment located adjacent to Catchment A, Catchment B and External Catchment 4. The area of Catchment I is approximately 2.23 ha. Catchment I will convey the runoff generated from the External Catchment 3 and the flows discharging from the Central Park Retarding Basin. The peak 1% AEP design flow for the total catchment is approximately 1.6 m<sup>3</sup>/s. It is estimated that up to 0.8 m<sup>3</sup>/s of this flow will be conveyed overland. The flow will be conveyed through the development via the road reserves towards Eley Road Retarding Basin.

#### **Catchment J East**

Catchment J East is an internal catchment located adjacent to Catchment B and Catchment I and abutting Eley Road. The area of Catchment J East is approximately 0.82 ha. The peak 1% AEP design flow for Catchment J East is approximately 0.4 m<sup>3</sup>/s. The flow from Catchment J East will discharge into the Eley Road Retarding Basin.

#### **Catchment J West**

Catchment J West is an internal catchment located adjacent to Catchment B and abutting Eley Road. The area of Catchment J West is approximately 0.17 ha. The peak 1% AEP design flow for the Catchment J West is approximately 0.06 m<sup>3</sup>/s. The runoff from Catchment J West will be captured and conveyed through the Council drainage system in Eley Road. The runoff generated from this catchment is equivalent to the pre-developed flow captured and conveyed by the Council drainage system in Eley Road.

#### 3.3 **Overland Flow Safety**

It is imperative that the development conveys the overland flows safely along road reserves. This requires ensuring the overland flow along major flow paths complies with Melbourne Water's floodway safety requirements. The recommended safety limits for residential streets are as follows:

For continuously grading streets:

- Vav.dav <= 0.35 m<sup>2</sup>/s
- dav <= 0.30 m</p>

For undulating streets with a saw-tooth grade:

- Crests Vav.dav <= 0.35 m<sup>2</sup>/s
- Crests dav <= 0.30 m</p>
- Dips Vav.dav <= 0.30 m<sup>2</sup>/s
- Dips dav <= 0.60 m</p>

For the minimum road grades to comply with the engineering standards, the maximum overland flow which can be conveyed along a typical 16 m road reserve is 4 m<sup>3</sup>/s. The maximum overland flow which can be fully contained within the road reserve is 3 m<sup>3</sup>/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.

Some of the access streets within the Former Brickworks site are proposed to be 14 m road reserves. The maximum overland flow which can be safely conveyed along these 14 m road reserves based on the profile depicted in **Figure 3.3** is  $4 \text{ m}^3$ /s. This is for the minimum



road grades to comply with the engineering standards, and up to a longitudinal grade of 1 in 50. The maximum overland flow which can be fully contained within the road reserve at a longitudinal grade of 1 in 200 is approximately  $1.5 \text{ m}^3$ /s. The maximum overland flow which can be fully contained within the road reserve at a longitudinal grade of 1 in 50 is approximately 3 m<sup>3</sup>/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.



Figure 3.3 Typical Cross Section for 14 m Residential Access Street

**Figure 3.4** illustrates a typical cross section from the hydraulic model for the 14 m wide access street. The section is extracted from a longitudinal grade of 1 in 50, and the water surface profile relates to a flow equivalent to  $1.5 \text{ m}^3/\text{s}$ .



Figure 3.4 Typical Cross Section for 14 m Residential Access Street from the Hydraulic Model

Link Road within the Former Brickworks site is proposed to have a 25.9 m road reserve, or greater. The maximum overland flow which can be safely conveyed Link Road based on the profile depicted in **Figure 3.5** is approximately 6.5 m<sup>3</sup>/s. This is for the minimum road grades to comply with the engineering standards, and up to a longitudinal grade of 1 in 50. The maximum overland flow which can be fully contained within the road reserve at a longitudinal grade of 1 in 200 is approximately 2 m<sup>3</sup>/s. The maximum overland flow which can be fully contained flow which can be fully contained standards are been based on 1 in 50 is approximately 4 m<sup>3</sup>/s. These figures have been based on 1 dimensional steady state hydraulic modelling using the software program HEC-RAS.



Figure 3.5 Typical Cross Section for Link Road



**Figure 3.6** illustrates a typical cross section from the hydraulic model for the Link Road. The cross sectional profile modelled was based on the profile that resulted in the smallest capacity to convey gap flows. The section is extracted from a longitudinal grade of 1 in 50, and the water surface profile relates to a flow equivalent to 4  $m^3/s$ .



Figure 3.6 Typical Cross Section for Link Road from the Hydraulic Model

The development will not exceed the safety limits for the access streets or Link Road for the overland flow conveyed along the road reserves. When safe conveyance of gap flows overland cannot be achieved, or minimum freeboard to overland flow flood levels cannot be achieved; the subsurface drainage network will be oversized to accommodate an increase flow conveyance than the minimum level of service required. The development will supply Council with hydraulic modelling of overland flow along all streets used as flow paths throughout the design phase of the development.

The development must also provide safe conveyance of flows through public open space areas. A typical shared path has been analysed at the steepest grades (longitudinal and cross sectional) compliant with the Disability Discrimination Act has been used to determine the maximum flow which can be safely conveyed overland around these paths. The maximum has been determined to be 1.3 m<sup>3</sup>/s. Overland flows in excess of this must be captured and conveyed via subsurface drainage systems.

**Figure 3.7** illustrates a typical cross section from the hydraulic model for the shared path between Link Road and the Central Park Retarding Basin. The cross sectional profile modelled was based on the profile that resulted in the smallest capacity to convey gap flows. The section is extracted from a longitudinal grade of 1 in 14, and the water surface profile relates to a flow equivalent to 1.3 m<sup>3</sup>/s.



Figure 3.7 Typical Cross Section for Shared Path from the Hydraulic Model

**Figure 3.8** depicts the location of the typical road profiles used to assess the safe conveyance of flows overland through the development.





Figure 3.8 Location of the Typical Road Cross Sections Used in Safety Check



# 4 Stormwater Quality Treatment

The State Environment Protection Policy (Waters of Victoria) defines the required water quality conditions for urban waterways. The aim of stormwater quality treatment is to reduce typical pollutant loads from urban areas to Best Management Practices as defined in the following targets:

Table 4.1 Best Practice Pollutant Reduction Targets

Pollutant	Performance Objective		
Total Suspended Solids (TSS)	80% reduction from typical urban load		
Total Phosphorous (TP)	45% reduction from typical urban load		
Total Nitrogen (TN)	45% reduction from typical urban load		
Gross Pollutants (GP)	70% reduction from typical urban load		

Source: Urban Stormwater: Best Practice Environmental Management Guidelines – Victorian Stormwater Committee, 1999.

Clause 56.07-4 of the Victorian Planning Provisions requires that all new residential subdivisions treat the stormwater runoff generated from the development to best practice pollutant reduction targets.

Typically, Melbourne Water would provide catchment scale treatment for industrial developments that are located within Development Services Schemes, however this catchment is not within a scheme.

The development can provide on-site treatment to achieve best practice pollutant reduction targets or pay Melbourne Water a stormwater quality offset contribution to help fund alternative treatment in the greater catchment. The current rate payable to Melbourne Water for offsetting stormwater quality treatment on-site in the City of Whitehorse is \$31,503 per hectare of residential development.

The provision of treatment on-site within a development where possible is preferable due to the environmental and community benefits derived from the reduction in pollutant loadings contributing to the receiving waterways. The development of the Former Brickworks at 78 Middleborough Road Burwood proposes the inclusion of on-site treatment for the development.

The development will include an ornamental pond with sediment capture capability to provide pre-treatment to the stormwater runoff from the pipe drainage network located in Central Park Retarding Basin.

The retail area will provide a 500 kL tank for reuse and rain gardens for treatment of the car park runoff. The apartment sites and the Rymans site will also include rain water tanks for reuse.

Melbourne Water have advised that the development is to pay stormwater quality offset contributions for the shortfall in the treatment performance achieved by the site (Appendix G).



Table 4.2 outlines the treatment parameters proposed.

Table 4.2 The Former Brickworks Treatment Parameters

Pollutant	Central Park RB Sediment Basin
Contributing Catchment (ha)	17.11
Area at NWL (m²)	690
Permanent Pool Volume (m <sup>3</sup> )	490
Extended Detention Depth (mm)	500
Approximate NWL (m AHD)	84.80

The treatment performance for the development has been simulated using the software package MUSIC (Model for Urban Stormwater Improvement Conceptualisation). **Figure 4.1** illustrates the MUSIC model layout for the development.



Figure 4.1 MUSIC Model Layout



 Table 4.3 outlines the pollutant reduction target and the performance of the treatment proposed.

Pollutant	Catchment Source Load (kg/yr)	Catchment Residual Load (kg/yr)	% Reduction for Site Pollutant Loads	Best Practice % Reduction Target
Total Suspended Solids (TSS)	19,500	6,520	66.6%	80%
Total Phosphorous (TP)	40.6	19.4	52.3%	45%
Total Nitrogen (TN)	290	199	31.4%	45%
Gross Pollutants (GP)	4,190	651	84.5%	70%

Table 4.3 The Former Brickworks Treatment Performance



# 5 Outfall Arrangement

The outfall for the development is the Eley Road Retarding Basin. The hydrologic modelling indicates that there is no increase in flood elevation or peak discharge from the Eley Road Retarding Basin when the site is fully urbanised and has constructed the Central Park Retarding Basin.

A small catchment of approximately 0.17 ha will discharge directly to the Council drainage system located in Eley Road. Based on feature survey undertaken for the existing site conditions, it has been determined that a catchment of 0.47 ha currently discharges to the Council system at this location. The small 0.17 ha catchment will generate the a marginally lower magnitude of stormwater runoff when urbanised to the existing 0.47 ha catchment.

As the permanent outfall works are existing, no temporary outfall works are required for this development.



## 6 Conclusion

The development of the Former Brickworks at 78 Middleborough Road Burwood is required to meet the drainage standards specified by the City of Whitehorse, Victorian Planning Authority and Melbourne Water.

The development will provide pipe drainage infrastructure to convey the 10% AEP design flows and minimise nuisance flooding occurrences in regular rainfall events. The gap flows, i.e. the difference between the 1% AEP design flows and the pipe flows, will be safely conveyed through the development along road reserve corridors.

Ultimate development of the overall catchment will include provision for conveyance of flows from the external catchment contributing to the site.

As the existing road and drainage infrastructure downstream of the Former Brickworks site does not have the capacity to safely convey the flows generated from the developed catchment; the development will provide a retardation basin within the site located at Central Park. The basin will be designed to contain all events up to and including the 1% AEP design storm with freeboard. A sensitivity analysis of the basin indicated that, even with a 50% blockage of the outlet, the basin will not spill until the design storm exceeds a 0.5% AEP storm event.

Allotments will achieve relevant freeboard from the 1% AEP flood levels associated the overland flows in road reserves or drainage reserves, whichever is greater.

The development will provide treatment on site including gross pollutant traps, sediment ponds, rainwater tanks and rain gardens. Stormwater quality offset financial contributions will be paid for the shortfall in the performance of the treatments included in the site to meet best practice pollutant reduction targets.

The outlet for development is existing and free draining.

The modelling undertaken to develop this strategy has been based on indicative and conceptual plans. Detailed modelling matching the detailed design needs to be provided throughout the course of development of the site.



# 7 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia)

CSIRO, 2006, Urban Stormwater: Best Practice Environmental Management Guidelines

Engineers Australia, 1987, Australian Rainfall and Runoff

Growth Areas Authority, April 2011, Engineering Design and Construction Manual

Laurenson EM, Mein RG and Nathan RJ, October 2007, RORB Version 6 Runoff Routing Program User Manual, Monash University Department of Civil Engineering in conjunction with Sinclair Knight Merz Pty Ltd and the support of Melbourne Water Corporation

Melbourne Water, 2017, Planning and Building website page

Melbourne Water, 2014, Constructed Wetlands Design Manual, Final Draft

Melbourne Water, 2016, Guidelines for the Use of MUSIC

Melbourne Water, 2005, WSUD Engineering Procedures: Stormwater



## Appendix A – RORB Parameters

RORB File	D Mod Eley RB INCL AUSTRALAND SITE_May 2017 05 update Central RB Rev 6 - flood duration check.catg				
kc	3.73				
m	0.8				
IL	15 mm				
RoC	0.6 (100 year ARI)				
Rainfall Location	City of Whitehorse				
Temporal Pattern	Filtered				
Aerial Pattern	Uniform				
Aerial Reduction Factor	AR&R Bk II				
Loss Factor	Variable Losses				

#### **ARI Loss Factors**

Location	1yr ARI	2yr ARI	5yr ARI	10yr ARI	20yr ARI	5yr ARI	100yr ARI	200yr ARI	500yr ARI
Initial Loss	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Prop. Loss	0.2	0.25	0.3	0.4	0.5	0.55	0.6	0.65	0.7

#### **IFD Parameters**

Location	City of Whitehorse
2  <sub>1</sub>	18.95
<sup>2</sup>   <sub>12</sub>	4.18
2  <sub>72</sub>	1.21
50  <sub>1</sub>	37.2
50  <sub>12</sub>	7.22
50 <sub>72</sub>	2.28
Skew	0.36
F2 Value	4.28
F50 Value	14.97
Zone	1







## Appendix B – Intensity Frequency Duration Data

ARI	Polynomial Coefficients												
	а	b	С	d	е	f	g						
1	2.65229273	-5.83E-01	-1.73E-02	8.90E-03	-1.29E-03	-3.79E-04	5.63E-05						
2	2.92075205	-5.92E-01	-1.86E-02	8.67E-03	-1.09E-03	-3.30E-04	4.49E-05						
5	3.18930864	-6.12E-01	-2.21E-02	7.97E-03	-3.44E-04	-1.75E-04	-1.04E-06						
10	3.33296418	-6.23E-01	-2.37E-02	7.23E-03	3.99E-05	-5.42E-05	-2.96E-05						
20	3.49902058	-6.32E-01	-2.52E-02	6.25E-03	4.83E-04	1.06E-04	-6.97E-05						
50	3.69428802	-6.44E-01	-2.68E-02	5.74E-03	8.39E-04	2.07E-04	-9.54E-05						
100	3.82933307	-6.52E-01	-2.83E-02	5.44E-03	1.13E-03	2.67E-04	-1.12E-04						

#### **Burwood Intensity Frequency Duration Polynomial Coefficients**

#### **Burwood Intensity Frequency Duration Table**

Duration	Average Storm Recurrence Interval (Years)										
			5	10	20	50	100				
5 mins	47.39	62.98	86.07	101.84	122.83	153.02	178.19				
6	44.33	58.88	80.32	94.99	114.60	142.69	166.02				
7	41.80	55.47	75.50	89.19	107.54	133.75	155.48				
8	39.64	52.56	71.38	84.22	101.45	126.02	146.36				
9	37.76	50.04	67.80	79.90	96.14	119.28	138.41				
10	36.10	47.81	64.66	76.10	91.47	113.36	131.44				
11	34.63	45.83	61.86	72.73	87.33	108.12	125.27				
12	33.30	44.05	59.36	69.72	83.63	103.44	119.77				
13	32.10	42.44	57.11	67.01	80.30	99.24	114.83				
14	31.01	40.98	55.06	64.55	77.29	95.43	110.37				
15	30.01	39.64	53.19	62.31	74.54	91.97	106.31				
16	29.09	38.41	51.48	60.25	72.03	88.81	102.61				
17	28.24	37.27	49.89	58.36	69.73	85.91	99.22				
18	27.45	36.21	48.43	56.62	67.59	83.23	96.08				



Duration	Average Storm Recurrence Interval (Years)									
			5	10	20	50	100			
19	26.72	35.23	47.07	54.99	65.62	80.75	93.19			
20	26.03	34.32	45.80	53.48	63.79	78.45	90.50			
21	25.39	33.46	44.62	52.07	62.07	76.31	87.99			
22	24.79	32.65	43.51	50.75	60.47	74.30	85.65			
23	24.22	31.90	42.47	49.52	58.97	72.42	83.46			
24	23.68	31.18	41.49	48.35	57.56	70.66	81.40			
25	23.18	30.51	40.56	47.25	56.23	68.99	79.46			
26	22.70	29.87	39.69	46.21	54.97	67.42	77.64			
27	22.25	29.27	38.86	45.23	53.78	65.94	75.91			
28	21.81	28.69	38.07	44.30	52.65	64.53	74.27			
29	21.40	28.15	37.32	43.41	51.58	63.20	72.72			
30	21.01	27.62	36.61	42.57	50.57	61.93	71.24			
35	19.30	25.35	33.50	38.89	46.14	56.42	64.83			
40	17.91	23.50	30.98	35.92	42.56	51.97	59.66			
45	16.75	21.96	28.89	33.45	39.60	48.29	55.39			
50	15.77	20.65	27.12	31.37	37.09	45.19	51.79			
55	14.92	19.53	25.60	29.58	34.95	42.53	48.71			
60	14.19	18.56	24.27	28.02	33.08	40.22	46.03			
75	12.45	16.25	21.15	24.36	28.69	34.79	39.75			
90	11.17	14.56	18.88	21.69	25.50	30.85	35.19			
2 hrs	9.41	12.24	15.75	18.03	21.13	25.46	28.96			
3	7.39	9.56	12.18	13.86	16.16	19.36	21.93			
4.5	5.80	7.47	9.42	10.66	12.36	14.72	16.61			
6	4.88	6.27	7.85	8.85	10.23	12.14	13.66			
9	3.81	4.88	6.08	6.83	7.87	9.30	10.44			
12	3.19	4.08	5.08	5.69	6.55	7.73	8.67			
18	2.47	3.15	3.93	4.41	5.08	6.00	6.73			



Duration	Average Storm Recurrence Interval (Years)											
			5	10	20	50	100					
24	2.04	2.61	3.27	3.67	4.25	5.03	5.65					
36	1.54	1.98	2.50	2.83	3.29	3.92	4.42					
48	1.25	1.61	2.05	2.33	2.72	3.25	3.69					
72	0.91	1.18	1.52	1.74	2.03	2.44	2.78					



Catchment	Tc (mins)	Area (ha)		Ae (ha)	<b>ΣAe</b> (ha)	l <sub>100</sub> (mm/hr)	Q <sub>100</sub> (m³/s)
А							10.50
В	10	2.9	0.850	2.50	2.50	131.44	0.91
С	9	1.8	0.810	1.47	1.47	138.41	0.57
D	5	2.5	0.990	2.48	2.48	178.19	1.23
E	8	1.6	0.900	1.45	4.00	143.62	1.60
F	17	2.4	0.850	2.03	3.98	99.84	4.00
G	16	2.4	0.810	1.94	1.94	102.61	3.45
Н	9	1.9	0.810	1.57	5.63	139.54	2.28
I	12	2.2	0.810	1.81	4.86	119.77	1.62
J East	6	1.0	0.810	0.80	0.80	166.02	0.37
J West	6	0.2	0.810	0.14	0.14	166.02	0.06

## Appendix C – Flow Computations



### **Appendix D – Flow Paths**







## Appendix E – Central Park Retarding Basin Hydrographs













![](_page_35_Picture_1.jpeg)

![](_page_36_Figure_0.jpeg)

![](_page_36_Picture_1.jpeg)

![](_page_37_Figure_0.jpeg)

### Appendix F – Central Park Retarding Basin Layout and Section

![](_page_37_Picture_2.jpeg)

Appendix G – Melbourne Water Requirement for Stormwater Quality Offset Contribution

![](_page_38_Picture_1.jpeg)

![](_page_39_Picture_0.jpeg)

2 August 2019

Tim Davis Frasers Property Australia C/O Sam Ravida Reeds Consulting

#### Burwood Brick Works Development: Stormwater Quality Proposal

Thank you for working with Melbourne Water to investigate the proposal to design and construct a wetland in the base of the Eley Road Retarding Basin.

Melbourne Water has reviewed the proposal and has concerns in supporting the proposal into detailed design. This decision is based on the following:

- Constraints of the site (steep batters, existing drainage and sewer infrastructure) would lead to a complicated and high risk design, construction and maintenance regime.
- Council has confirmed that they will not maintain the wetland, therefore the wetland maintenance would rest with Melbourne Water despite the catchment being significantly less than 60ha. This will result in an ongoing maintenance and reinstatement cost burden to Melbourne Water.
- Due to the small catchment and associated small treatment performance, the ongoing commitment to the required funding for maintenance and resetting of this wetland may be comprised in future.
- Potential Stormwater Quality Offset money from the development site will enable the equivalent stormwater quality treatment to be undertaken more strategically to deliver a potentially greater waterway and Port Phillip Bay benefit.

Due to the potential issues with the proposed wetland, Melbourne Water supports the option to pay into the <u>Stormwater Quality Offsets Program</u> in order to meet the development's stormwater quality requirements.

Please feel free to contact me regarding the above.

Yours sincerely

New Carrenget

Andrew Camenzuli Urban Growth Services Melbourne Water

![](_page_39_Picture_15.jpeg)

![](_page_40_Figure_0.jpeg)

## Appendix H – Pipes Exceeding 10% AEP Capacity

![](_page_40_Picture_2.jpeg)

## Appendix I – Overland Flow Safety Hydraulic Model Output

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
170.*	2	103.22	103.42	1.92	1.24	17.95	0.07	0.13	okay	okay
170.*	5	103.22	103.47	2.62	2.4	21.87	0.11	0.29	okay	okay
170.*	6	103.22	103.49	2.79	2.72	22.44	0.12	0.34	okay	okay
170.*	6.5	103.22	103.5	2.87	2.87	22.72	0.13	0.36	okay	fail
160.*	2	103.02	103.22	1.92	1.24	17.95	0.07	0.13	okay	okay
160.*	5	103.02	103.27	2.64	2.39	21.84	0.11	0.29	okay	okay
160.*	6	103.02	103.29	2.8	2.71	22.44	0.12	0.34	okay	okay
160.*	6.5	103.02	103.3	2.88	2.87	22.71	0.13	0.36	okay	fail
150.*	2	102.82	103.02	1.92	1.24	17.95	0.07	0.13	okay	okay
150.*	5	102.82	103.07	2.62	2.4	21.87	0.11	0.29	okay	okay
150.*	6	102.82	103.09	2.8	2.71	22.43	0.12	0.34	okay	okay
150.*	6.5	102.82	103.1	2.88	2.86	22.71	0.13	0.36	okay	fail
140.*	2	102.62	102.82	1.92	1.24	17.95	0.07	0.13	okay	okay
140.*	5	102.62	102.87	2.64	2.38	21.84	0.11	0.29	okay	okay

Link Road Output Based on a 1 in 50 Longitudinal Grade (NB: Only a sample has been included due to the amount of data)

![](_page_41_Picture_3.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	Vav.Dav (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
140.*	6	102.62	102.89	2.79	2.72	22.45	0.12	0.34	okay	okay
140.*	6.5	102.62	102.9	2.87	2.87	22.72	0.13	0.36	okay	fail
130.*	2	102.42	102.62	1.92	1.24	17.95	0.07	0.13	okay	okay
130.*	5	102.42	102.67	2.63	2.4	21.87	0.11	0.29	okay	okay
130.*	6	102.42	102.69	2.81	2.7	22.42	0.12	0.34	okay	okay
130.*	6.5	102.42	102.7	2.88	2.86	22.7	0.13	0.36	okay	fail
120.*	2	103.22	103.42	1.92	1.24	17.95	0.07	0.13	okay	okay
120.*	5	103.22	103.47	2.62	2.4	21.87	0.11	0.29	okay	okay
120.*	6	103.22	103.49	2.79	2.72	22.44	0.12	0.34	okay	okay
120.*	6.5	103.22	103.5	2.87	2.87	22.72	0.13	0.36	okay	fail
110.*	2	103.02	103.22	1.92	1.24	17.95	0.07	0.13	okay	okay
110.*	5	103.02	103.27	2.64	2.39	21.84	0.11	0.29	okay	okay
110.*	6	103.02	103.29	2.8	2.71	22.44	0.12	0.34	okay	okay
110.*	6.5	103.02	103.3	2.88	2.87	22.71	0.13	0.36	okay	fail
100.*	2	102.82	103.02	1.92	1.24	17.95	0.07	0.13	okay	okay
100.*	5	102.82	103.07	2.62	2.4	21.87	0.11	0.29	okay	okay
100.*	6	102.82	103.09	2.8	2.71	22.43	0.12	0.34	okay	okay

![](_page_42_Picture_1.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
100.*	6.5	102.82	103.1	2.88	2.86	22.71	0.13	0.36	okay	fail
90.*	2	102.62	102.82	1.92	1.24	17.95	0.07	0.13	okay	okay
90.*	5	102.62	102.87	2.64	2.38	21.84	0.11	0.29	okay	okay
90.*	6	102.62	102.89	2.79	2.72	22.45	0.12	0.34	okay	okay
90.*	6.5	102.62	102.9	2.87	2.87	22.72	0.13	0.36	okay	fail
79.9999*	2	101.42	101.62	1.92	1.24	17.95	0.07	0.13	okay	okay
79.9999*	5	101.42	101.67	2.64	2.38	21.84	0.11	0.29	okay	okay
79.9999*	6	101.42	101.69	2.8	2.71	22.43	0.12	0.34	okay	okay
79.9999*	6.5	101.42	101.7	2.88	2.86	22.71	0.13	0.36	okay	fail
70.0000*	2	101.22	101.42	1.92	1.24	17.95	0.07	0.13	okay	okay
70.0000*	5	101.22	101.47	2.64	2.38	21.84	0.11	0.29	okay	okay
70.0000*	6	101.22	101.49	2.8	2.71	22.43	0.12	0.34	okay	okay
70.0000*	6.5	101.22	101.5	2.88	2.86	22.71	0.13	0.36	okay	fail
60.*	2	101.02	101.22	1.92	1.24	17.96	0.07	0.13	okay	okay
60.*	5	101.02	101.27	2.64	2.39	21.85	0.11	0.29	okay	okay
60.*	6	101.02	101.29	2.8	2.71	22.44	0.12	0.34	okay	okay
60.*	6.5	101.02	101.3	2.88	2.87	22.71	0.13	0.36	okay	fail

![](_page_43_Picture_1.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
170.*	2	103.29	103.46	2.23	1.02	12.43	0.08	0.16	okay	okay
170.*	3	103.29	103.49	2.55	1.39	14	0.10	0.21	okay	okay
170.*	4	103.29	103.51	2.79	1.72	14	0.12	0.29	okay	okay
170.*	5	103.29	103.53	2.99	2.01	14	0.14	0.36	okay	fail
160.*	2	103.09	103.26	2.23	1.02	12.42	0.08	0.16	okay	okay
160.*	3	103.09	103.29	2.56	1.39	14	0.10	0.21	okay	okay
160.*	4	103.09	103.31	2.81	1.7	14	0.12	0.29	okay	okay
160.*	5	103.09	103.33	3.03	1.99	14	0.14	0.36	okay	fail
150.*	2	102.89	103.06	2.23	1.02	12.42	0.08	0.16	okay	okay
150.*	3	102.89	103.09	2.56	1.39	14	0.10	0.21	okay	okay
150.*	4	102.89	103.11	2.82	1.7	14	0.12	0.29	okay	okay
150.*	5	102.89	103.13	3.04	1.98	14	0.14	0.36	okay	fail
140.*	2	102.69	102.86	2.22	1.02	12.43	0.08	0.16	okay	okay
140.*	3	102.69	102.89	2.57	1.38	14	0.10	0.21	okay	okay
140.*	4	102.69	102.91	2.83	1.69	14	0.12	0.29	okay	okay
140.*	5	102.69	102.93	3.04	1.98	14	0.14	0.36	okay	fail

14 m Access Street Output Based on a 1 in 50 Longitudinal Grade (NB: Only a sample has been included due to the amount of data)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
130.*	2	102.49	102.66	2.23	1.02	12.42	0.08	0.16	okay	okay
130.*	3	102.49	102.69	2.57	1.38	14	0.10	0.21	okay	okay
130.*	4	102.49	102.71	2.83	1.69	14	0.12	0.29	okay	okay
130.*	5	102.49	102.73	3.05	1.97	14	0.14	0.36	okay	fail
120.*	2	102.29	102.46	2.23	1.02	12.43	0.08	0.16	okay	okay
120.*	3	102.29	102.49	2.57	1.38	14	0.10	0.21	okay	okay
120.*	4	102.29	102.51	2.83	1.69	14	0.12	0.29	okay	okay
120.*	5	102.29	102.53	3.05	1.97	14	0.14	0.36	okay	fail
110.*	2	102.09	102.26	2.23	1.02	12.43	0.08	0.16	okay	okay
110.*	3	102.09	102.29	2.57	1.38	14	0.10	0.21	okay	okay
110.*	4	102.09	102.31	2.83	1.69	14	0.12	0.29	okay	okay
110.*	5	102.09	102.33	3.05	1.97	14	0.14	0.36	okay	fail
100.*	2	101.89	102.06	2.23	1.02	12.41	0.08	0.16	okay	okay
100.*	3	101.89	102.09	2.57	1.38	14	0.10	0.21	okay	okay
100.*	4	101.89	102.11	2.83	1.69	14	0.12	0.29	okay	okay
100.*	5	101.89	102.13	3.05	1.97	14	0.14	0.36	okay	fail
90.*	2	101.69	101.86	2.23	1.02	12.41	0.08	0.16	okay	okay

![](_page_45_Picture_1.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
90.*	3	101.69	101.89	2.57	1.38	14	0.10	0.21	okay	okay
90.*	4	101.69	101.91	2.83	1.69	14	0.12	0.29	okay	okay
90.*	5	101.69	101.93	3.05	1.97	14	0.14	0.36	okay	fail
79.9999*	2	101.49	101.66	2.23	1.02	12.42	0.08	0.16	okay	okay
79.9999*	3	101.49	101.69	2.57	1.38	14	0.10	0.21	okay	okay
79.9999*	4	101.49	101.71	2.83	1.7	14	0.12	0.29	okay	okay
79.9999*	5	101.49	101.73	3.05	1.97	14	0.14	0.36	okay	fail
70.0000*	2	101.29	101.46	2.23	1.02	12.43	0.08	0.16	okay	okay
70.0000*	3	101.29	101.49	2.57	1.38	14	0.10	0.21	okay	okay
70.0000*	4	101.29	101.51	2.83	1.7	14	0.12	0.29	okay	okay
70.0000*	5	101.29	101.53	3.05	1.97	14	0.14	0.36	okay	fail
60.*	2	101.09	101.26	2.23	1.02	12.43	0.08	0.16	okay	okay
60.*	3	101.09	101.29	2.56	1.39	14	0.10	0.21	okay	okay
60.*	4	101.09	101.31	2.83	1.7	14	0.12	0.29	okay	okay
60.*	5	101.09	101.33	3.05	1.97	14	0.14	0.36	okay	fail

Shared Path Output Based on a 1 in 14 Longitudinal Grade prior to transitioning to a required 1 in 50 Longitudinal Grade section (NB: Only a sample has been included due to the amount of data)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> . D <sub>av</sub> < 0.35 (m²/s)
4.97777*	1	94.86	95.02	2.89	0.41	3.8	0.11	0.26	okay	okay
4.97777*	1.3	94.86	95.05	3.03	0.53	4.09	0.13	0.32	okay	okay
4.97777*	1.4	94.86	95.05	3.08	0.56	4.18	0.13	0.33	okay	okay
4.97777*	1.5	94.86	95.06	3.12	0.6	4.27	0.14	0.35	okay	fail
4.97777*	1.8	94.86	95.09	3.22	0.72	4.54	0.16	0.40	okay	fail
4.48*	1	94.83	94.98	2.97	0.4	3.77	0.11	0.27	okay	okay
4.48*	1.3	94.83	95.01	3.12	0.51	4.05	0.13	0.32	okay	okay
4.48*	1.4	94.83	95.01	3.16	0.55	4.14	0.13	0.34	okay	okay
4.48*	1.5	94.83	95.02	3.2	0.58	4.23	0.14	0.35	okay	fail
4.48*	1.8	94.83	95.05	3.31	0.7	4.48	0.16	0.40	okay	fail
3.98222*	1	94.79	94.94	3.04	0.39	3.74	0.10	0.27	okay	okay
3.98222*	1.3	94.79	94.97	3.19	0.5	4.01	0.12	0.32	okay	okay
3.98222*	1.4	94.79	94.97	3.24	0.53	4.1	0.13	0.34	okay	okay
3.98222*	1.5	94.79	94.98	3.28	0.57	4.19	0.14	0.36	okay	fail
3.98222*	1.8	94.79	95.01	3.4	0.68	4.44	0.15	0.41	okay	fail

![](_page_47_Picture_2.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
3.48444*	1	94.75	94.9	3.1	0.38	3.71	0.10	0.27	okay	okay
3.48444*	1.3	94.75	94.93	3.26	0.48	3.99	0.12	0.33	okay	okay
3.48444*	1.4	94.75	94.94	3.31	0.52	4.07	0.13	0.34	okay	okay
3.48444*	1.5	94.75	94.94	3.35	0.55	4.16	0.13	0.36	okay	fail
3.48444*	1.8	94.75	94.97	3.47	0.66	4.4	0.15	0.41	okay	fail
2.98666*	1	94.72	94.86	3.16	0.37	3.69	0.10	0.27	okay	okay
2.98666*	1.3	94.72	94.89	3.33	0.47	3.96	0.12	0.33	okay	okay
2.98666*	1.4	94.72	94.9	3.38	0.51	4.04	0.13	0.35	okay	okay
2.98666*	1.5	94.72	94.91	3.42	0.54	4.12	0.13	0.36	okay	fail
2.98666*	1.8	94.72	94.93	3.54	0.64	4.37	0.15	0.41	okay	fail
2.48888*	1	94.68	94.83	3.21	0.37	3.68	0.10	0.27	okay	okay
2.48888*	1.3	94.68	94.85	3.39	0.46	3.93	0.12	0.33	okay	okay
2.48888*	1.4	94.68	94.86	3.44	0.5	4.02	0.12	0.35	okay	okay
2.48888*	1.5	94.68	94.87	3.48	0.53	4.1	0.13	0.37	okay	fail
2.48888*	1.8	94.68	94.89	3.61	0.63	4.33	0.15	0.42	okay	fail
1.99111*	1	94.65	94.79	3.26	0.36	3.66	0.10	0.27	okay	okay
1.99111*	1.3	94.65	94.81	3.44	0.46	3.91	0.12	0.33	okay	okay

![](_page_48_Picture_1.jpeg)

River Station	Q (m³/s)	Min Ch Elev (m)	W.S. Elev (m)	Vel Chan (m/s)	Flow Area (m²)	Top Width (m)	D <sub>av</sub> (m)	V <sub>av</sub> .D <sub>av</sub> (m²/s)	D <sub>av</sub> < 0.3 (m)	V <sub>av</sub> .D <sub>av</sub> < 0.35 (m²/s)
1.99111*	1.4	94.65	94.82	3.5	0.49	3.99	0.12	0.35	okay	fail
1.99111*	1.5	94.65	94.83	3.54	0.52	4.07	0.13	0.37	okay	fail
1.99111*	1.8	94.65	94.85	3.67	0.62	4.3	0.14	0.42	okay	fail
1.49333*	1	94.61	94.75	3.3	0.35	3.64	0.10	0.27	okay	okay
1.49333*	1.3	94.61	94.78	3.49	0.45	3.89	0.12	0.33	okay	okay
1.49333*	1.4	94.61	94.78	3.55	0.48	3.97	0.12	0.35	okay	fail
1.49333*	1.5	94.61	94.79	3.6	0.51	4.05	0.13	0.37	okay	fail
1.49333*	1.8	94.61	94.81	3.73	0.61	4.28	0.14	0.42	okay	fail
.995554*	1	94.58	94.71	3.34	0.35	3.63	0.10	0.28	okay	okay
.995554*	1.3	94.58	94.74	3.54	0.44	3.87	0.11	0.34	okay	okay
.995554*	1.4	94.58	94.75	3.6	0.47	3.95	0.12	0.35	okay	fail
.995554*	1.5	94.58	94.75	3.65	0.5	4.03	0.12	0.37	okay	fail
.995554*	1.8	94.58	94.78	3.78	0.6	4.25	0.14	0.42	okay	fail

![](_page_49_Picture_1.jpeg)

Appendix J – A3 Plans

![](_page_50_Picture_1.jpeg)

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![](_page_51_Figure_0.jpeg)

![](_page_51_Figure_2.jpeg)

OVERLAND FLOW - INTERNAL CATCHMENT #

OVERLAND FLOW - EXTERNAL AREAS #

![](_page_51_Picture_5.jpeg)

OVERLAND FLOW - SURCHARGE OF PROPOSED RETARDING BASIN #

MINOR FLOWS - LOTS FRONTING ELEY RD  $\Rightarrow$ 

OVERLAND FLOW PATHS - ALL OVERLAND FLOW PATHS WILL BE # DESIGNED SUCH THAT ADEQUATE FREEBOARD IS PROVIDED TO ALL EXISTING AND PROPOSED DEVELOPMENT

UPDATED 25.08.2021

SITE BOUNDARY
PIPE SYSTEM PROPOSED DEVELOPMENT 🛛 🗕 🗕 🗕 🗕 🗕
PIPE SYSTEM CONTROLLED OUTLET FROM RB/WETLAND — — — — — —
PIPE SYSTEM (COUNCIL / MW EXISTING)
PIPE SYSTEM (COUNCIL EXISTING) TO BE REROUTED ====================================
INDICATIVE OPEN SPACE

PRELIMINARY INTERNAL SITE DRAINAGE SUB CATCHMENTS SHOWN

![](_page_52_Figure_0.jpeg)

![](_page_53_Figure_0.jpeg)

UPDATED 13.06.2017

![](_page_54_Figure_0.jpeg)

![](_page_55_Picture_0.jpeg)

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