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Engineering

Working Beyond Expectations

Stormwater Management Report

Proposed Residential Subdivision
Precinct 1B

Property:
464 Cessnock Road, Gillieston Heights

Applicant:
Loxford Project Management Pty Ltd

Date:
August 2022

Document Control Sheet

Issue No.	Amendment	Date	Prepared By	Checked By
A	DRAFT	22 July 2022	H Jeung	R Brown
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Executive Summary

ADW Johnson has been engaged by Loxford Project Management Pty Ltd to complete a Stormwater Management Report to accompany the Development Application for a proposed residential subdivision along 464 Cessnock Road, Gillieston Heights. The development will contain 263 residential lots.

The strategy requires the assessment of the potential impacts on water quality, water quantity, effects to downstream wetlands and assessment of flooding for local overland flows and accessibility during flood events.

The objective of this report is to take a holistic approach to the treatment of stormwater runoff from the development for both quality and quantity purposes.

The methodology employed was to treat all stormwater within the limits of the development in order to maintain receiving waters in their current state. All water quality and quantity modelling has been completed based on the information provided by the client prior to lodgement of the Development Application.

Modelling indicated that stormwater detention basins will be required to attenuate storm flows to pre-development conditions. The detention basins were sized to determine the volumes of stormwater to be detained. The proposed location and footprint for these basins has also been identified based on these requirements.

An analysis of the Maitland City Council flood map showed no potential risk of flooding to the development given the RL's of the existing and potential future site.

The stormwater quality model utilised a treatment train approach which included rainwater tanks, gross pollutant traps and bioretention basins. The results of the modelling indicated the reduction in pollutant loads and peak discharge entering receiving waters meet their target objectives.

The study has concluded that with appropriate controls stormwater can be adequately managed for the site. Hence, stormwater management does not prevent the development of the site.

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1.0 Introduction

ADW Johnson has been engaged by Loxford Project Management Pty Ltd to complete a Stormwater Management Report to accompany the Development Application for a proposed residential subdivision along 464 Cessnock Road, Gillieston Heights. The development will contain 263 residential lots.

The site location is shown below in Figure 1: Site Location. The site fronts Cessnock Road and is situated to the south of Gillieston Heights Town Centre.

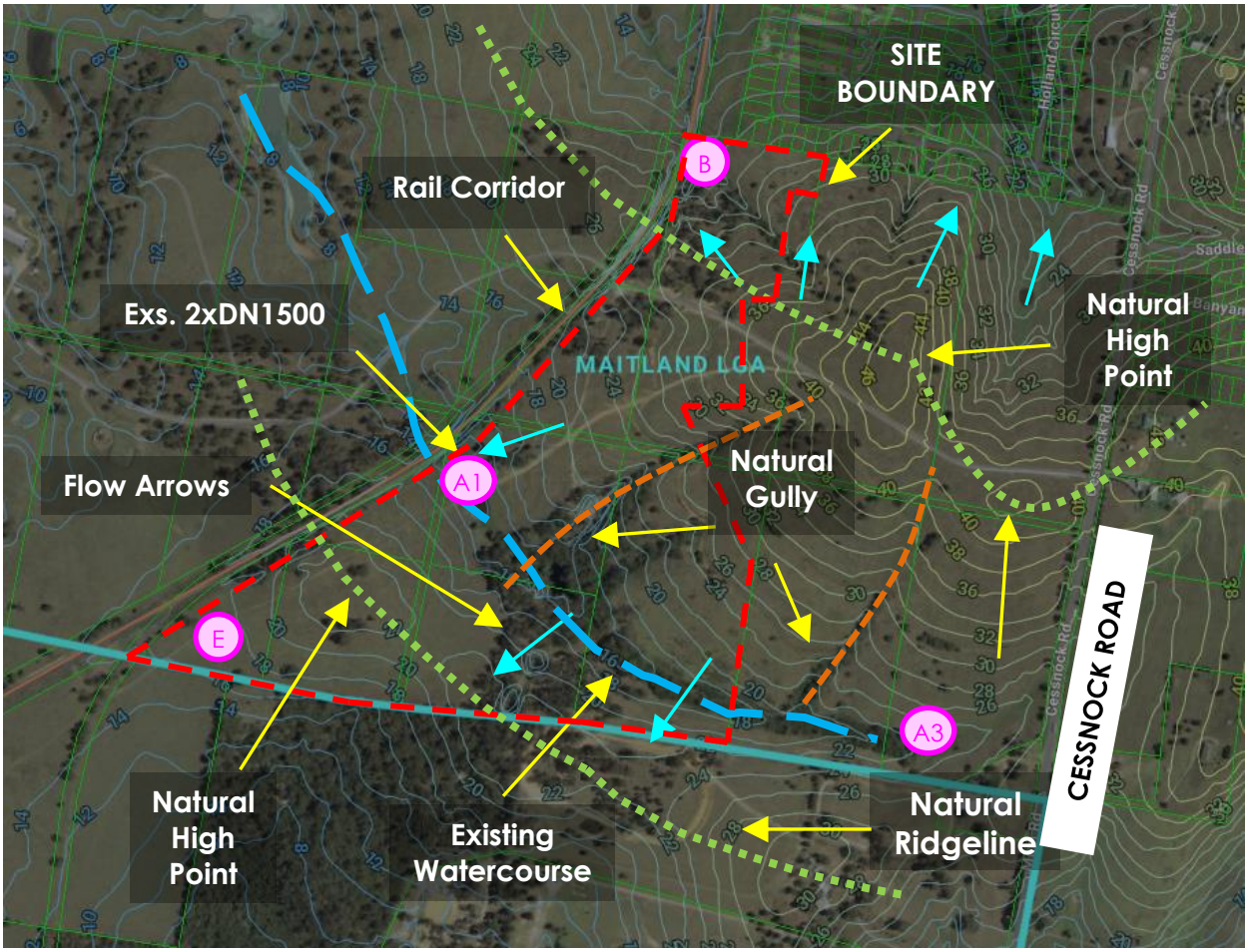

Figure 1: Site Location
(Source: Mecone MOSAIC)

This report will cover localised flooding, water quality, stormwater detention and total water management of the site based on the requirements of Maitland City Council's Guidelines.

1.1 EXISTING SITE

The site is bounded by existing rural properties to the south, an existing subdivision to the North and Cessnock Road to the East. An existing rail corridor separates the development site from Wentworth Wetlands to the West.

The majority of the preliminary development area can be classified as fully pervious.

Site slopes within the development area are in the range of 2-15%. The existing site is primarily cleared open pasture with the exception of some scattered trees and more

dense vegetation along the existing watercourse in the south of the site.

Review of Maitland City Council's Local Environmental Planning (LEP) mapping, the site is mapped as Class 5 and therefore there is low probability for the occurrence of acid sulphate soils through the site.

There are three (3) mapped first order watercourses and a single second order watercourse within the site. The first order watercourses are minor topographical depressions and have of little to no existing vegetated riparian zones. As such, these mapped watercourses are expected to be declassified, regraded and developed.

The development site is within the Wentworth Wetlands catchment with all stormwater runoff ultimately being conveyed there via four (4) different site discharge locations. These are labelled 'A' to 'E' in Figure 1.1.

The existing catchments as shown in Exhibit 001 are described as:

- Catchment A1 – Western Catchment (shown by orange hatching)

  Stormwater runoff from the existing site is split in half by a natural ridgeline that runs East-West. Some of the runoff south of this ridgeline drains to two existing natural depressions in the south-western section of the development site via a natural gully. The gully conveys runoff from catchments upstream of the site to the existing depressions which are located directly east of the rail corridor. The catchments runoff exits the site through an existing headwall and dual 1450 mm diameter pipe. The existing dual pipes run under and across the railway corridor. The general location of the gully and natural depressions can be seen in Figure 1.1: Site Location.

- Catchment A2 - Southern Catchment (shown by orange hatching)

  Stormwater runoff from the existing site is split in half by a natural ridgeline that runs East-West where all runoff South of this ridgeline drains to the existing second order watercourse in the southern section of the development site. This watercourse conveys runoff from catchments upstream of the site to the existing dual culverts under the rail corridor and towards Wentworth wetlands.

- Catchment B1 – North-Western Catchment (shown by purple hatching)

  All site runoff north of the main ridgeline concentrates in natural gullies which drain to three discrete discharge locations. Catchment B concentrates in a natural gully prior to leaving site in an existing channel.

- Catchment E - South-Western Catchment (shown by blue hatching)

  This Catchment is split off with a natural highpoint, and the runoff south of the highpoint is directed south into Lake Testers Hollow.

1.2 PROPOSED DEVELOPMENT

The proposed residential subdivision as depicted in Figure 2 will contain 263 residential lots.

The stormwater management system designed for the development consists of a

combination of pit and pipe networks and WSUD elements to convey runoff from the site and the upstream catchments to the four discharge locations as described in section 1.1.

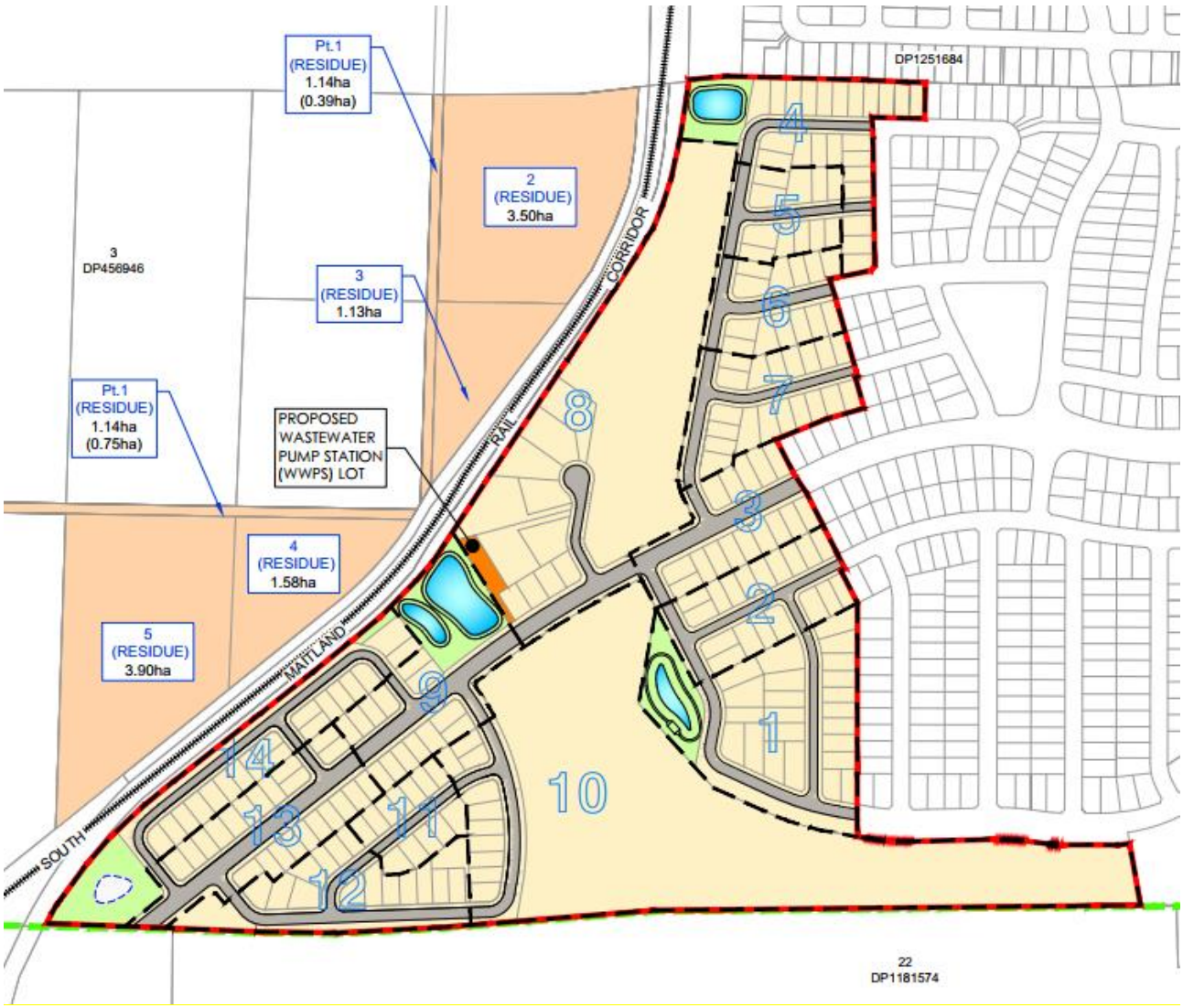

Figure 2: Proposed Development

2.0 Requirements

Stormwater management within the proposed development is designed to comply with Maitland City Council (MCC) documents including:

- MCC Manual of Engineering Standards – Stormwater (MOES);
- MCC Development Control Plan (DCP) 2011 – Part B.3 – Hunter River Floodplain Management;
- MCC Development Control Plan (DCP) 2011 – Part B.7 – Riparian Land and Waterways.

2.1 HYDROLOGY

Impervious fractions have been adopted from MOES and have been determined based on the proposed land usage. These impervious percentages can be found in Table 2.1 below.

Table 2.1: Fraction Impervious Rates for Land Uses

LAND USE	PERCENTAGE IMPERVIOUS (%)
Residential Lot	60
Road Reserve	70
Public Recreation Areas	50

2.2 CONCEPT STORMWATER DESIGN

A concept stormwater design is required to demonstrate that stormwater runoff can be effectively conveyed from the proposed development to the existing discharge locations. The stormwater design is required to consider upstream catchments, drainage of both the lots and roads, and dispersal of flows via stabilized outlets to prevent scour of existing creek beds.

In accordance with MOES Section 3.2 "Recurrence Interval" - the pit and pipe network will need to be designed to cater for the minor storm event (10% AEP) without any surcharging within the system and minimising flow widths and ponding. Overland flow paths are to be designed to cater for the 1% AEP storm event.

The concept stormwater layout can be found in the concept engineering plans.

2.3 STORMWATER DETENTION

Where post-development peak runoff exceeds pre-development peaks, on-site stormwater detention systems may be required to reduce flooding of downstream. These detention devices attenuate peak post-development flow rates to pre-development peak flow rates for the critical duration for design storms with annual exceedance probabilities (AEPs) ranging from 63.2% to 1%.

2.4 STORMWATER QUALITY / WATER SENSITIVE URBAN DESIGN

The stormwater drainage system must effectively remove the nutrients and gross pollutants from the site prior to the runoff entering the existing downstream waterways.

The stormwater design for the proposed subdivision is to adopt Water Sensitive Urban

Design (WSUD) principles throughout the development to promote sustainable and integrated land and water resource management.

The guidelines for stormwater quality treatment objectives are expressed as mean annual reductions of pollutant loads. The target objectives were obtained from the MCC Manual of Engineering Standards – Stormwater and can be found in Table 2.2.

Table 2.2: Stormwater Treatment Objectives

Pollutant	Stormwater Treatment Objectives
Gross Pollutants > 5mm	70% retention of the average annual load
Suspended Solids	80% retention of the average annual load
Total Phosphorus	45% retention of the average annual load
Total Nitrogen	45% retention of the average annual load
Litter > 50mm	Retention up to the 3 mth peak flow
Oil and Grease	90% retention of the average annual load

2.5 EROSION AND SEDIMENTATION CONTROL

Erosion and sedimentation control measures need to be implemented during any construction activities on the proposed subdivision to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to downstream drainage. A sediment and erosion control plan has been prepared and can be found within the concept engineering plans.

3.0 Regional Mapping

3.1 REGIONAL FLOOD MODELLING

NSW Government Planning Portal (ePlanning) online flood mapping has been assessed for the site. The flood mapping shows the site is not flood affected. A screenshot of the flood map for the area is shown in Figure 3 below.

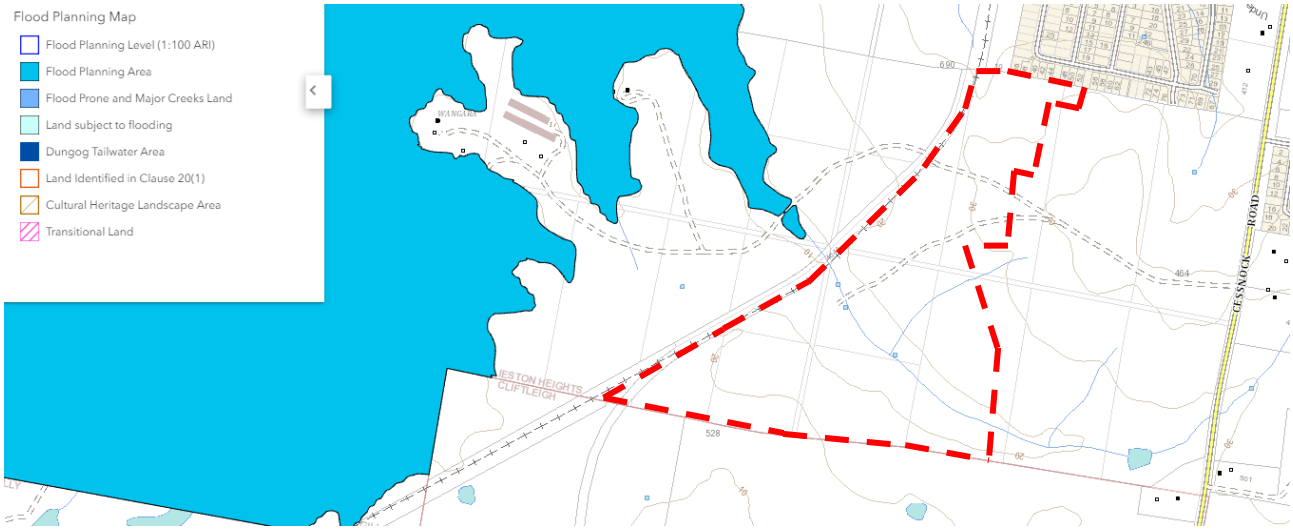

Figure 3: Screenshot of the Online Flood Map
(Source: NSW Government Planning Portal)

3.2 WETLAND MANAGEMENT

NSW Government Planning Portal (ePlanning) online SEPP (Coastal Management) 2018 mapping has been assessed for the site.

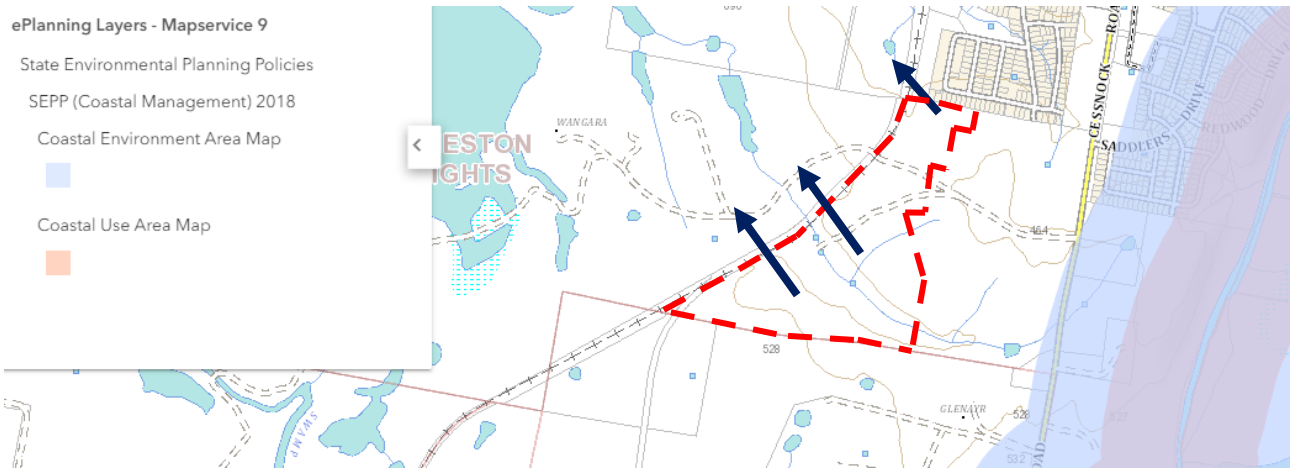

Figure 4: Screenshot of the Coastal Wetlands Extents
(Source: NSW Government Planning Portal)

Stormwater discharge from the proposed development will be directed towards the Wentworth Wetlands which is not included within the SEPP (Coastal Management) 2018 mapped area. The proposed stormwater management strategy incorporates WSUD elements to limit pollutant runoff from the site to meet the target objectives mentioned in Section 2.0 Table 2.2.

4.0 Stormwater Management Strategy

As described in Section 1.0, the site comprises of site grades that generally range from 2-15%. This allows for a limited selection of water quality treatment devices within the overall treatment train.

The proposed stormwater system contains a combination of conventional pit and pipe networks and WSUD elements to effectively convey stormwater runoff to the downstream waterways.

The following water quality/quantity treatment devices have been proposed:

- Rainwater Tanks

  Rainwater tanks will be utilised for each lot, meeting the general requirements of Maitland City Council and BASIX. Rainwater tanks will reduce potable water demand as well as having additional benefits in terms of reducing the volume of flow as well as pollutant loads being directed towards the downstream stormwater system.

- Gross Pollutant Traps (GPTs)

  The use of GPTs will be utilised in the development to treat stormwater runoff and reduce pollutant loads being directed towards the downstream stormwater system.

- Ponds/Sediment Basins

  Ponds will be utilised in the development as the downstream water quality treatment device. The ponds will also act as detention basins to allow post-development flows to be reduced to pre-development flows as stormwater runoff is discharged from the site towards the existing downstream stormwater system.

- Bioretention Basins

  Bioretention basins will be utilised in the development as the downstream water quality treatment device. The bioretention basins will also act as detention basins to allow post-development flows to be reduced to pre-development flows as stormwater runoff is discharged from the site towards the existing downstream stormwater system

A schematic diagram of the proposed stormwater strategy is shown in Figure 5.

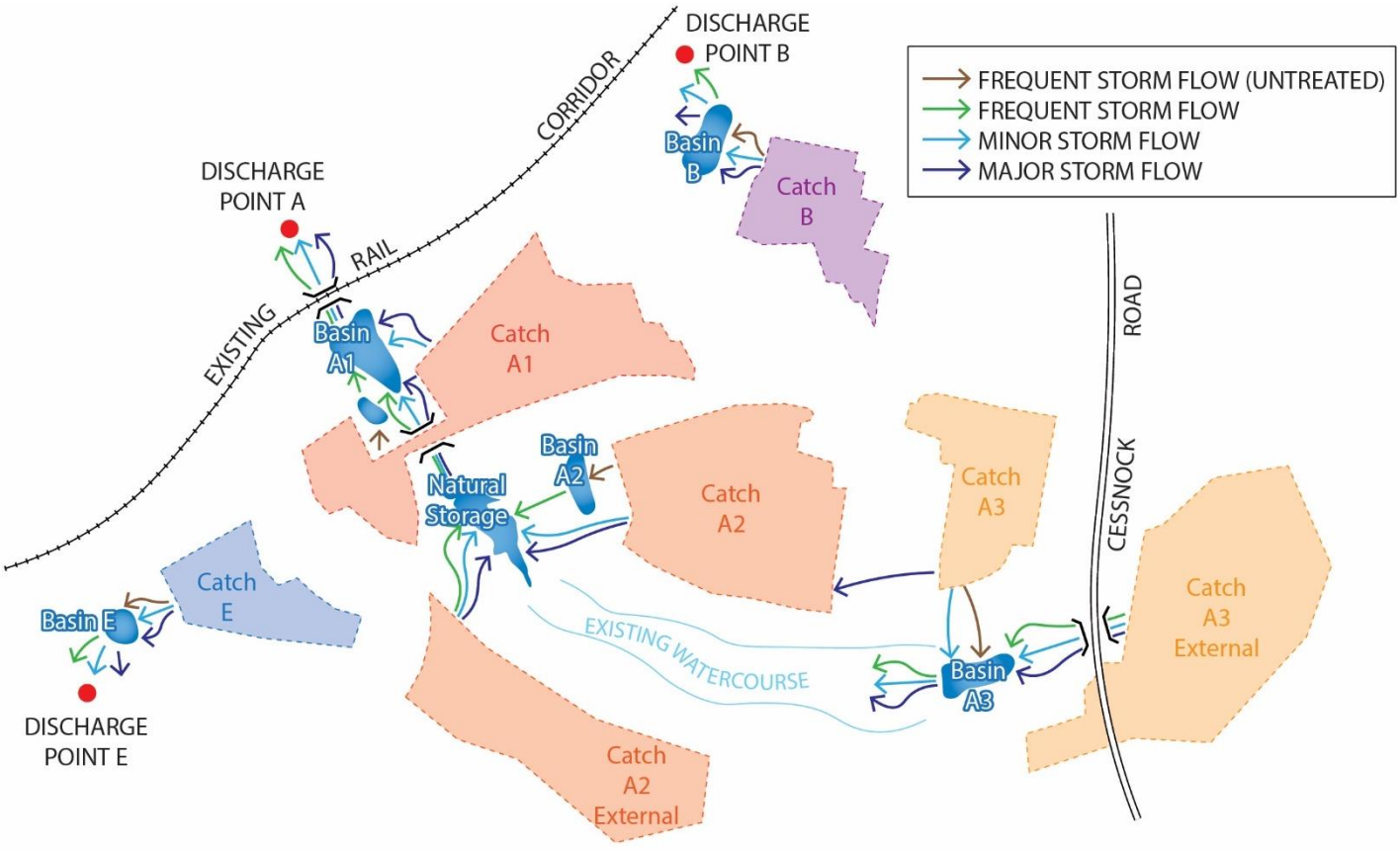

Figure 5: Proposed Stormwater Strategy Schematic

5.0 Stormwater Detention

The proposed stormwater system has been designed to protect downstream properties and infrastructure from increased stormwater flows as a result of the development. To ensure there are no adverse impacts on the downstream properties and infrastructure, the stormwater system has to be designed to ensure that the peak flow rate of stormwater runoff post-development flows leaving the site are less than the pre-development peak flows for all and storm durations for the 63.2%, 10%, and 1% AEP storm events.

As the development of the site will result in an increased impervious area, on-site detention will be required to reduce the peak median flows back to existing conditions.

The proposed stormwater system, as detailed in Section 4.0, uses a combination of pit and pipe networks and WSUD elements to capture and convey stormwater runoff from the site.

The subject site is subdivided into a series of sub-catchments for the post development scenarios. Parameters of sub-catchment areas, imperviousness, and times of concentration are used to simulate the catchment response to storm events to generate hydrographs and estimate the peak median discharge flows.

5.1 MODELLING PARAMETERS

The stormwater management reports for the existing adjacent developments were sourced and the same hydrological model and parameters were adopted to improve standardization.

Catchment runoff hydrology was simulated using the ILSAX Hydrological model with the following modelling parameters.

5.1.1 Rainfall Data

Rainfall data was retrieved from the Maitland City Council MOES Appendix C.

5.1.2 Surface Roughness Coefficient 'n*'

There are two flow components considered when calculating the time of concentration for each sub-catchment - A constant component and a kinematic wave calculation component. The surface roughness coefficient 'n*' is required for the kinematic wave component.

This value is adjusted to represent the different response of rural and urbanised catchments, impervious and pervious surfaces. Values of Surface Roughness Coefficient 'n*' have been adopted from MOES Section 3.7.2 "Coefficient of Roughness".

5.1.3 Loss Model

The ILSAX loss model with utilises Horton infiltration curves was used to determine the rainfall excess hydrograph. The parameters for this loss model are shown in Table 5.1.

Table 5.1: ILSAX Loss Model Parameters

Parameter	Value
Soil Type	3.5
Antecedent Moisture Content	4
Grassed Depression storage	5mm
Paved Depression storage	1mm

5.1.4 Catchments

The pre-development catchment areas were determined via detailed survey, Lidar contours, and site inspections.

The post-development catchment areas for the site were determined based on the topography of the site, proposed subdivision layout and discharge locations.

The pre- and post-development catchments and the respective parameters can be seen in Table 5.2 and Table 5.3 respectively.

Table 5.2: Pre-Development Catchment Details

Catchment Name	Area (Ha)	Impervious Area (Ha)	Pervious Area (Ha)	Percentage Impervious (%)	Slope (%)	Roughness Coefficient n*	
						Perv.	Imperv.
Pre A1 Cat	15.17	0	15.17	0	4.5	0.4	-
Pre A2 Cat	27.85	0	27.85	0	6	0.4	-
Pre A3 Cat	21.67	1.3	20.37	6	4.5	0.4	0.02
Pre B1 Cat	6.29	0	6.29	0	7	0.4	-
Pre E Cat	5.59	0	5.59	0	6	0.4	-
Total Pre-developed	**54.9**	**0**	**54.9**				

Table 5.3: Post-Development Catchment Details

Catchment	Area (Ha)	Impervious Area (Ha)	Pervious Area (Ha)	Percentage Impervious (%)	Slope (%)	Roughness Coefficient n*	
						Perv.	Imperv.
Post Basin A1 Cat	19.16	10.73	8.43	56	4	0.35	0.02
Post Basin A2 Cat	22.58	11.29	11.29	50	5	0.35	0.02
Post Basin A3 Cat	17.651	0.706	16.945	4	4	0.35	0.02
Post Ext A2 Cat	9.65	0	9.65	100	6	0.35	0.02
Post B1 Cat	6.35	3.175	3.175	50	5	0.35	0.02
Post E Cat	5.58	4.58	1	82	5	0.35	0.02
Total Developed	**80.97**	**30.48**	**50.49**				

5.1.5 Basin Data

The volumes and outlet configuration of the detention basins have been modelled using DRAINS to ensure that the peak discharge flows leaving the site are less than or equal to the pre-development flows at each of the discharge locations.

The details for the detention basins and storages can be seen in Table 5.4 to Table 5.8

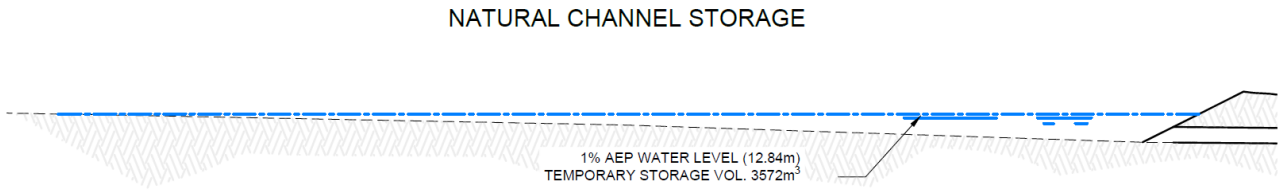

Figure 7: Channel Storage Section

Table 5.6. Typical sections are shown in Figure 6 to Figure 8.

Table 5.4: Basin A1 Data

Basin Parameter	Detail
Base RL	RL 11.00m
Emergency Spillway	RL 12.63m
Crest of Embankment RL	RL 13.23m
Outlet Controls	Twin DN1500mm pipes – IL 11.00m
	10m Weir RL 12.63m
Total Storage at 1% AEP Stage	2370m³
1% AEP Storage Stage R.L. (m)	RL 12.63m

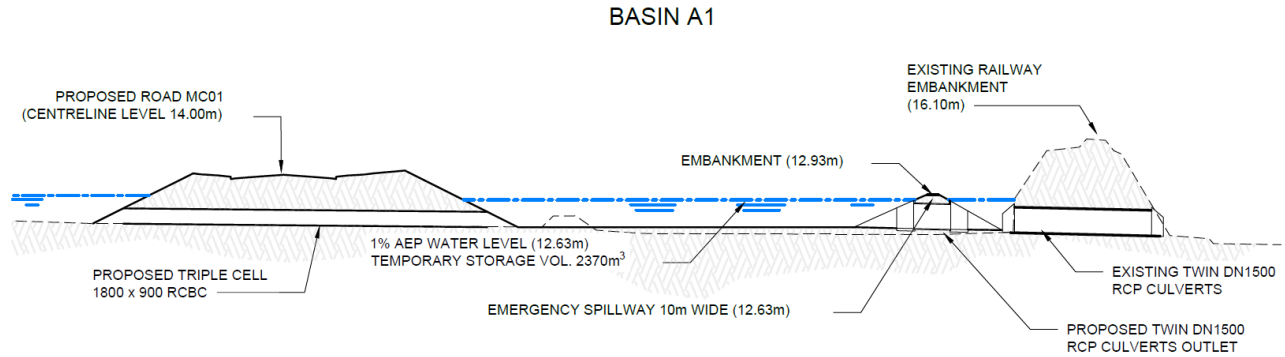

Figure 6: Basin A1 Section

Table 5.5 : Channel Storage Data

Basin Parameter	Detail
Base RL	RL 11.2m
Road Verge Level	RL 14.14m
Outlet Controls	3 x 1.8 x 0.9m RCBC
Total Storage at 1% AEP Stage	3572m³
1% AEP Storage Stage R.L. (m)	RL 12.84m

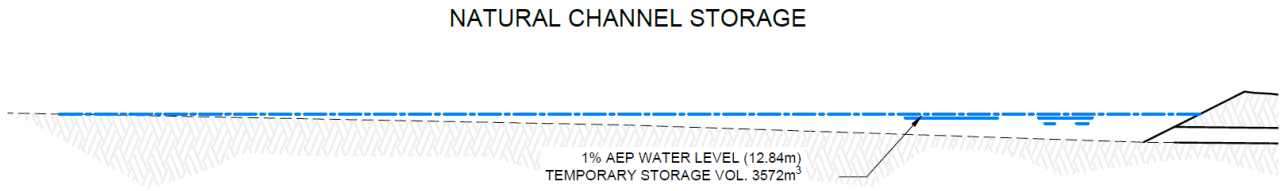

Figure 7: Channel Storage Section

Table 5.6: Basin A3 Data

Basin Parameter	Detail
Base RL	RL 21.70m
Emergency Spillway	RL 23.20m
Crest of Embankment RL	RL 23.50m
Outlet Controls	Twin DN525 pipes – IL 21.70m
	10m Weir RL 22.93m (1% AEP VxD = 0.233)
Total Storage at 1% AEP Stage	3839m³
1% AEP Storage Stage R.L. (m)	RL 23.20m

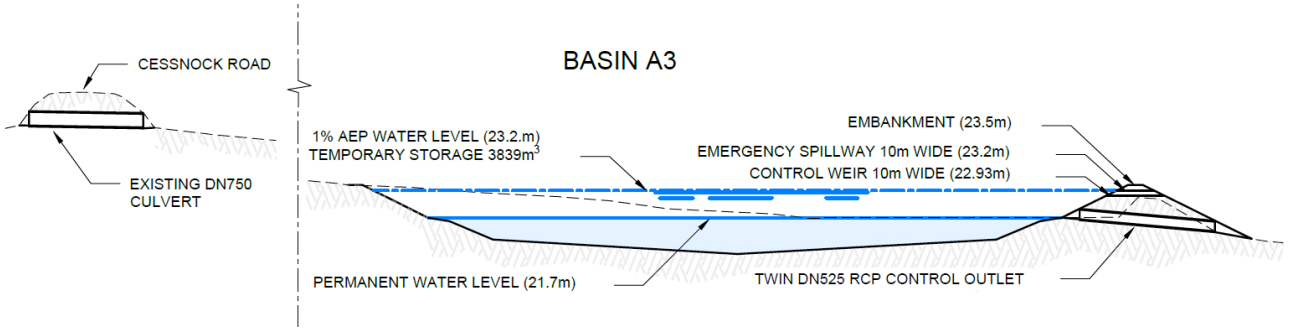

Figure 8: Basin A3 Section

Table 5.7: Basin B1 Data

Basin Parameter	Detail
Base RL	RL 21.3m
Emergency Spillway	RL 22.00m
Crest of Embankment RL	RL 22.70m
Outlet Controls	Dual DN375mm pipes – IL 21.00m
	Pit Cutout – IL 21.50m – Width 1500mm – Height 800mm
	2m Weir RL 22.00m
Total Storage at 1% AEP Stage	1367m³
1% AEP Storage Stage R.L. (m)	RL 22.40m

Figure 9 below represents the outlet configuration for Basin B1.

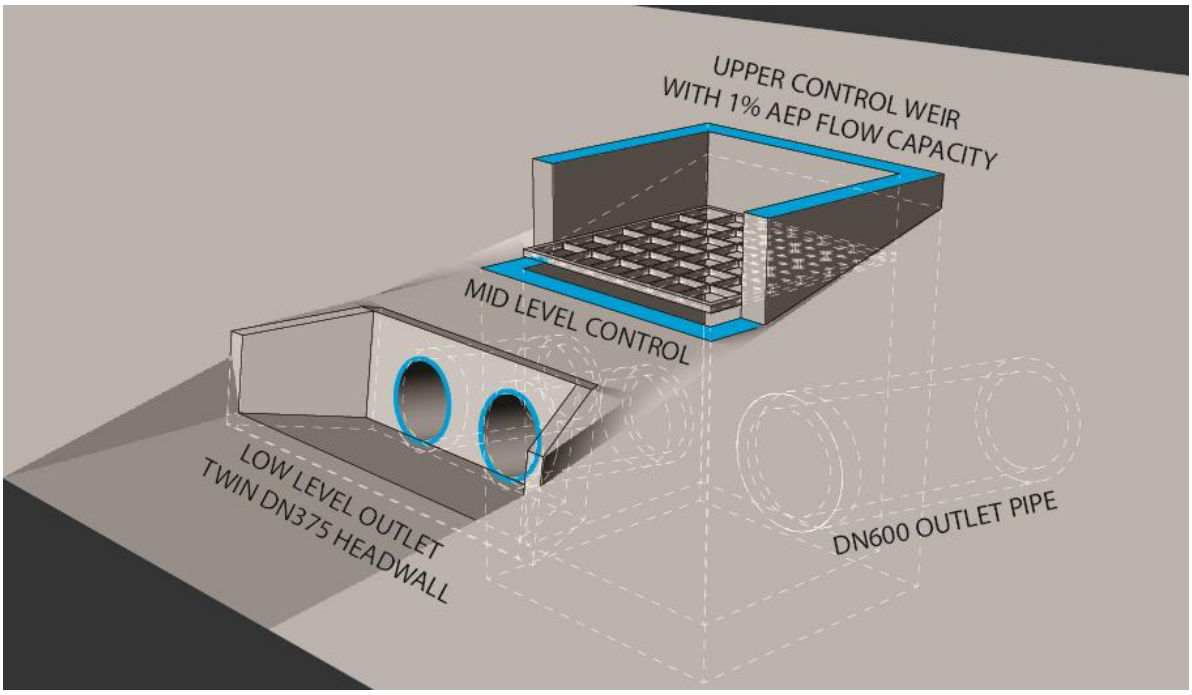

Figure 9: Basin B1 Outlet Control Structure

Table 5.8: Basin E Data

Basin Parameter	Detail
Base RL	RL 14.60m
Crest of Embankment RL	RL 15.80m
Outlet Controls	Dual DN450 pipes – IL 14.60m
	4m Weir RL 15.20m
Total Storage at 1% AEP Stage	1489m³
1% AEP Storage Stage R.L. (m)	RL 15.52m

5.2 RESULTS

A summary of the results for the pre and post-development DRAINS analysis for each catchment can be seen in the following tables.

Table 5.9: DRAINS Peak Flow Pre and Post-Development for Discharge Point A

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm Duration	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm Duration
63.2%	2.714	120min	2.567	60min
10%	8.332	60min	5.737	60min
1%	9.882	60min	9.690	60min

Table 5.10: DRAINS Peak Flow Pre and Post-Development for Discharge Point B

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm Duration	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm Duration
63.2%	0.371	60min	0.363	60min
10%	1.079	60min	1.076	90min
1%	1.943	25min	1.872	90min

Table 5.11: DRAINS Peak Flow Pre and Post-Development for Discharge Point E

AEP	Peak Discharge Pre-Development (m^3/s)	Critical Storm Duration	Peak Discharge Post-Development Detained (m^3/s)	Critical Storm Duration
63.2%	0.341	60min	0.321	120min
10%	0.978	60min	0.847	120min
1%	1.740	25min	1.722	90min

From the results, it is evident that the post-development flows for all storm events are less than the existing flows leaving the site.

For the complete results for both the pre and post-development analysis refer to Appendix C.

6.1.2 Channel Storage Inundation

Figure 10 represents the Natural Basin's inundation during the 63.2%, 10% and 1% storm events. The proposed design strings and lot pads are overlaid on an aerial image of the natural watercourse.

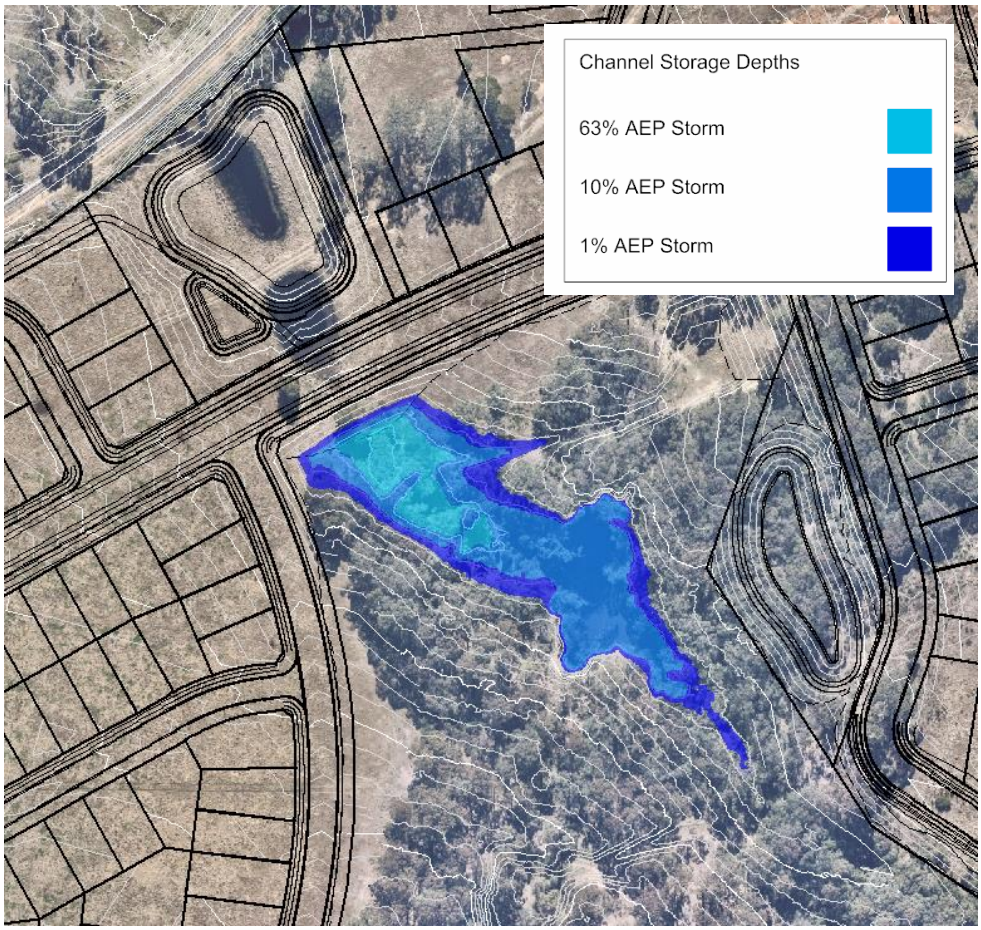

Figure 10: Channel Storage Depths during Storm Events

6.0 Water Quality / Water Sensitive Urban Design

The proposed stormwater system, as detailed in Section 4.0, uses a combination of pit and pipe networks and water sensitive urban design elements to convey stormwater runoff from the site. It is intended to use a combination of treatment devices within the drainage system to remove nutrients and sediments from the stormwater prior to the runoff leaving the site.

6.1 TREATMENT DEVICES

The stormwater design for the proposed subdivision will consist of a combination of at source, conveyance, and end of line controls to treat the stormwater runoff from the site. The treatment train of at source, conveyance, and end of line controls will be modelled for demonstration of compliance with MCC's key performance objectives and can be summarized as follows:

- At Source

  The roof runoff for each of the future dwellings will be captured by rainwater tanks where the stormwater will receive at source treatment via a first flush system and a portion of the stormwater will be used for reuse.

- Conveyance

  Flows from Catchment A and D will be conveyed through a GPT which will be the conveyance control used to treat the stormwater. Flows from Catchment B will be conveyed through a headwall trash rack.

  As these Gross Pollutant Removal devices are the primary pollution control device in the treatment train after the stormwater is conveyed via the pit and pipe network, the devices will primarily remove litter, large debris and the nutrients attached to particles.

- End of Line

  Flows from Catchment A1, A2, and B1 will be discharged to end-of-line Bioretention Basins.

6.2 MUSIC MODELLING PARAMETERS

The software used for the water quality modelling is MUSIC. MUSIC (Model for Urban Stormwater Improvement Conceptualisation) is the industry standard model for prediction of stormwater quality outcomes from proposed development. The modelling approach is based on continuous simulation, operating at time steps to match the scale of the catchment.

The parameters used for the WSUD devices can be found in Appendix C.

6.2.1 Time Step

A time step of five (5) minutes was specified prior to any modelling. This is recommended by the software to increase reliability and output sensitivity.

6.2.2 Rainfall and Evapotranspiration

The rainfall data from Tocal Paterson weather station was input into the MUSIC model. Five (5) minute rainfall information for the year 1989 was analysed and deemed to be a reasonable representation of the average yearly rainfall and rainfall event distribution.

The rainfall data file was reviewed and it was noted that the rainfall for 1989 (904.6mm) was comparable to the annual average for the 47-year period from 1967 to 2015 being 930.4mm. During 1989, there were 89 days of rainfall which is equivalent to the long-term average of 89.9.

The average monthly area Potential Evapotranspiration (PET) rates for the site were sourced from the Bureau of Meteorology. The PET values for the model are summarised in Table 6.1.

Table 6.1: Monthly Average Area Potential Evapotranspiration (Bureau of Meteorology, 2015)

Month	Average PET (mm/month)
January	180
February	155
March	150
April	115
May	75
June	70
July	65
August	95
September	125
October	150
November	175
December	200

The annual rainfall and evapotranspiration time series graph for 1989 is shown in Figure 11.

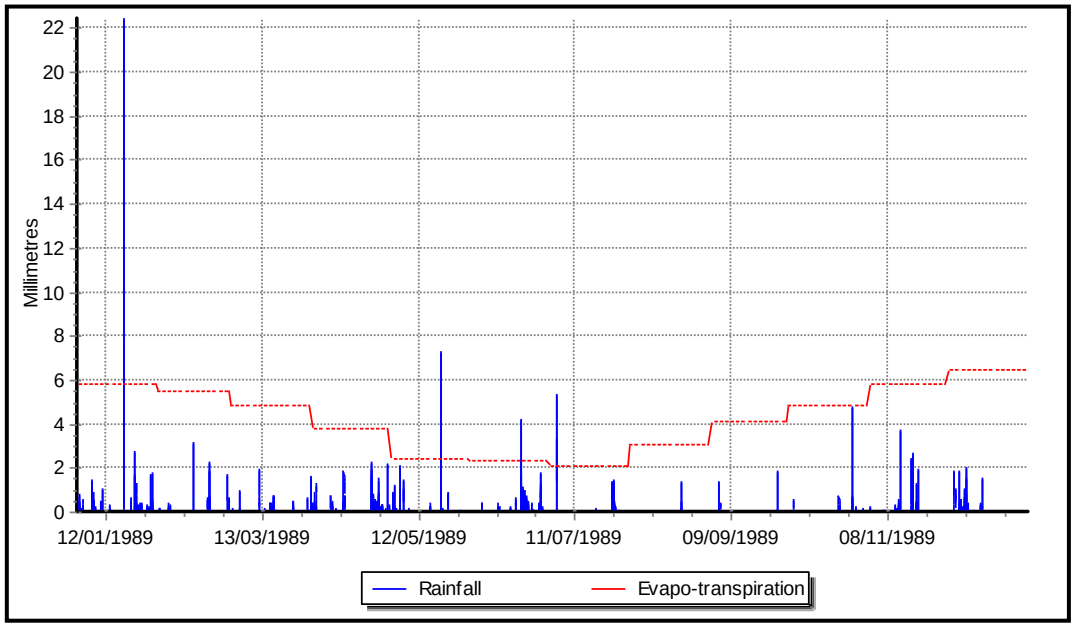

Figure 11: Rainfall and Evapotranspiration Graph

6.2.3 Source Nodes

The MUSIC model defined the following land uses:

- Roof (Urban) – This land use defines the impervious roof area of each lot, estimated at 250m^2 per lot and has been assumed to be 100% impervious;
- Lots (Urban) – This land use defines the lot area after the removal of the roof area. The impervious percentage of this node has been calculated so that the sum of the roof and lot equivalates to a total lot impervious percentage of 60% (as dictated in MOES);
- Road (Urban) – This land use defines the road reserve area. It has been assumed to be 70% impervious accounting for pervious road verge (as dictated in MOES).

6.2.4 Rainfall-Runoff Parameters

Pollutant source inputs were obtained from the *'Using MUSIC in the Sydney Drinking Water Catchment'* (Water NSW, 2012). The parameters adopted for the varying land uses were implemented in accordance with Table 3-2 and 3-7 of the above stated document assuming a 'clay' soil description. The parameters used within the MUSIC model are presented in Table 6.2 and Table 6.3.

Table 6.2: MUSIC Rainfall-Runoff Parameters

Parameter	Value
Impervious Area Properties	
Rainfall Threshold (mm/day)	1
Pervious Area Properties	
Soil Storage Capacity (mm)	120
Initial Storage (% of Capacity)	30
Field Capacity (mm)	80
Infiltration - a	200
Infiltration - b	1
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Daily Deep Seepage Rate (%)	0

Table 6.3: MUSIC Model Baseflow and Stormflow Pollutant Concentrations

Land Use		Mean Concentration		
		TSS	TP	TN
		mg/L	mg/L	mg/L
Roof	Baseflow	12.59	0.15	2.09
	Stormflow	19.95	0.13	2.00
Lot	Baseflow	12.85	0.15	2.03
	Stormflow	137.40	0.39	2.58

Road	Baseflow	12.85	0.15	2.03
	Stormflow	254.68	0.26	2.13
Basin	Baseflow	12.59	0.15	2.09
	Stormflow	158.49	0.35	2.63
Open Space	Baseflow	12.59	0.15	2.09
	Stormflow	158.49	0.35	2.63

6.2.5 Catchment Data

The catchments and associated parameters used for the model were based on the node parameters as detailed in Table 6.4. Water quality modelling was limited to the catchments that drain through the proposed treatment devices.

Table 6.4: MUSIC Node Sub-catchment Details

Catchment	Sub Catchment	Area (Ha)	Impervious Area (Ha)	Pervious Area (Ha)	Percentage Impervious (%)	Development Flows (m^3/s)	
						63% AEP	3 mth
Catchment A1	Roof	4.575	4.575	0.00	100		
	Lots Area	3.05	0.84	2.21	27		
	Roads	4.256	2.98	1.276	70		
	Grassland	3.70	0.19	3.51	5		
Total		**15.581**	**8.585**	**7**	**55**	**2.03**	**1.015**
Catchment A2	Roof	5.20	5.20	0.00	100		
	Lots Area	5.33	1.44	3.89	27		
	Roads	4.77	3.34	1.43	70		
	Grassland	9.06	0.906	8.154	10		
Total		**24.36**	**10.886**	**13.474**	**45**	**1.809**	**0.905**
Catchment A3	Roof	1.95	1.95	0.00	100		
	Lots area	2.69	0.84	1.86	31		
	Roads	1.64	1.15	0.49	70		
	Grassland	16.60	0.83	15.77	5		
Total		**22.89**	**4.76**	**18.12**	**21**	**0.948**	**0.474**
Catchment B1	Roof	1.836	1.836	0.00	100		
	Lots Area	1.224	0.33	0.894	27		
	Roads	1.829	1.28	0.549	70		
	Grassland	1.461	0.07	1.391	5		
Total		**6.35**	**3.516**	**2.834**	**55**	**0.846**	**0.423**
Catchment E	Roof	1.53	1.53	0.00	100		
	Lots Area	1.03	0.28	0.75	27		
	Roads	1.96	1.37	0.59	70		
Total		**4.52**	**3.18**	**1.34**	**70**	**1.012**	**0.506**

The Lot areas were split to 'Roofs' and 'Lots' subareas to represent an overall impervious area of 60%.

6.2.6 Rainwater Tank Details

The proposed subdivision is to incorporate water retention or reuse measures to reduce the demand on potable water.

As part of the stormwater management for the future development, there will be a requirement to install a rainwater tank to capture roof runoff. This tank will be connected to toilet cisterns and be used for laundry and landscaping to minimise the demand on potable water supply. In addition, future dwellings are to have AAA+ fixtures and appliances, dual flush toilets, water efficient gardens and rainwater tanks. These are BASIX requirements, imposed upon the proponent of the new dwellings on the lots.

To ensure the future development does adequately reduce the demand on potable water, the building consent should be conditioned with water saving requirements.

The input parameters of the MUSIC model are shown below in Table 6.5.

Table 6.5: MUSIC Model Rainwater Tank Parameters

Rainwater Tank Properties	
Volume below overflow pipe (kL)	3,000
High Flow Bypass (m^3/s/dwelling)	0.005
Annual Demand (kL/yr/dwelling)	143

Note: Annual demand based on 3 bedroom residential dwelling using water for toilet + laundry (50%) + gardens

6.2.7 Gross Pollutant Removal Details

Gross pollutant traps (GPTs) will be incorporated at the end of the street networks within catchments A1, A2, and B1, before runoff is discharged into the basins for further quality treatment. GPTs are designed to capture and retain gross pollutants, litter, grit and sediments from stormwater. The GPTs have been modelled as a Humegard HG18 for Catchment A3 and as Humegard HG24s for Catchment A2 and D within the MUSIC model. MUSIC nodes created by the manufacturer were used in the MUSIC model to ensure correct pollutant reduction efficiencies were modelled and high flow bypasses were adjusted to model specific treatable flow rates of the selected GPTs.

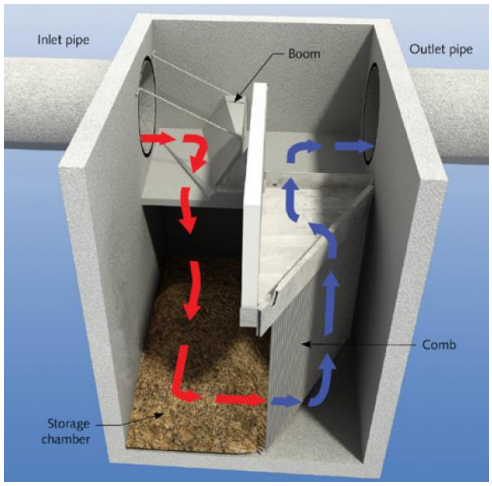

Figure 12: Humegard GPT

(Source: Humes HumeGard GPT Technical Manual)

For catchment E, where the basin is proposed is a temporary sediment basin to be utilised until development of future stages. The gross pollutant removal system proposed is the use of trash racks fixed to the headwall outlet on Road MC01.

6.2.8 Sediment Basin Details

Basin E has been modelled as 'Sediment Basins' respectively in the MUSIC model. The basin nodes are utilised as the end of line control to treats the stormwater water prior to discharging offsite.

Pollutant removal is achieved through the process of providing extended detention time to allow for sedimentation and some biological and chemical uptake within the macrophyte zone of the pond nodes. The characteristics of both basins can be seen in Table 6.6.

Table 6.6: MUSIC Model Basin Parameters

Inlet Storage Properties	Basin E
Surface Area (m^2)	1120
Extended Detention Depth (m)	1.2
Permanent Pool Volume (m^3)	100
Initial Volume (m^3)	50
Exfiltration Rate (mm/hr)	0.2
Evaporative Loss as a % of PET	75

The inlet structures are overflow weirs as detailed in the previous section.

6.2.9 Bioretention Basin Details

Basin A1, A2, and B1 have been designed as both a bioretention and detention basin. Refer to Exhibit 003. Basin A2 has been previously designed and modelled in '240289(1)-SWMP-A' report which submitted in a separate DA. Refer to Exhibit 003 in '240289(1)-SWMP-A' current design of Basin A2 in Precinct 1A.

Bioretention basins allow infiltration of stormwater through suitable vegetation and a filter media to remove nitrogen, phosphorous and gross pollutants before discharging the stormwater from site.

The inlet structures are a series of pipes and headwalls at the discharge locations. The inlet pipes convey flows through the GPT, located upstream of the outlets, before discharging to the basin through a headwall outlet.

The bioretention basins have been sized based upon the pollutant removal efficiency for their respective catchments modelled in the MUSIC software.

The characteristics of both bioretention basins can be seen in Table 6.7.

Table 6.7: MUSIC Model Bioretention Parameters

	Retention Properties	Basin A1	Basin A2	Basin B1
Storage	Surface Area (m^2)	240	750	300

Properties	Extended Detention Depth (m)	0.3	0.3	0.3
Filter and Media Properties	Filter Area (m^2)	240	75	20
	Unlined Filter Media Perimeter (m)	50	60	20
	Saturated Hydraulic Conductivity (mm/hr)	100	100	100
	Filter Depth (m)	0.45	0.45	0.45
	TN Content of Filter Media (mg/kg)	800	800	800
	Orthophosphate Content of Filter Media (mg/kg)	55	55	55

The lowest outlet structure in each basin has been set 300mm above the invert of the basin to enable retention of flows during a three (3) month storm event.

The inlet structures, outlet structures and overflow structures will be designed with scour protection to avoid scouring of the bioretention basin.

7.3 RESULTS

In accordance with MCC requirements, modelling has been undertaken to demonstrate compliance with water quality objectives for stormwater runoff from the proposed development prior to discharge of stormwater into the downstream waterways. The results of the modelling are shown in **Error! Reference source not found.**8 to Table 6.11.

Table 6.8: Pollutant loads and Reductions Catchment A1

Pollutant	Sources	Residual Load	% Reduction	% Reduction Required
Total Suspended Solids (kg/year)	14400	2650	81.6	80
Total Phosphorus (kg/year)	29.4	11.7	60.1	45
Total Nitrogen (kg/year)	213	112	47.3	45
Gross Pollutants > 5mm (kg/year)	2500	0	100	70

Table 6.9: Pollutant loads and Reductions Catchment A2

Pollutant	Sources	Residual Load	% Reduction	% Reduction Required
Total Suspended Solids (kg/year)	17600	2630	85	80
Total Phosphorus (kg/year)	36.2	13.6	62.3	45
Total Nitrogen (kg/year)	262	139	47	45
Gross Pollutants > 5mm (kg/year)	3190	0.00	100.0	70

Table 6.10: Pollutant loads and Reductions Catchment B1

Pollutant	Sources	Residual Load	% Reduction	% Reduction Required
Total Suspended Solids (kg/year)	6000	969	83.8	80
Total Phosphorus (kg/year)	11.9	4.27	64.2	45
Total Nitrogen (kg/year)	84.4	44.3	47.5	45
Gross Pollutants > 5mm (kg/year)	1010	0.00	100.0	70

Table 6.11: Pollutant loads and Reductions Catchment E

Pollutant	Sources	Residual Load	% Reduction	% Reduction Required
Total Suspended Solids (kg/year)	6010	738	87.7	80
Total Phosphorus (kg/year)	12.2	3.91	68	45
Total Nitrogen (kg/year)	86.6	47.7	45	45
Gross Pollutants > 5mm (kg/year)	1080	0	100	70

From the results it can be seen that the designed stormwater management infrastructure has achieved the required target reductions. It is noted that MUSIC does not have the capacity to route litter + oil/grease pollutants, however they are qualitatively addressed by the proposed treatment train.

7.0 Erosion and Sedimentation Control

Erosion and sedimentation control measures need to be implemented during any construction on the proposed subdivision to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to downstream waterways.

During the construction period, it is recommended that the detention basins are constructed early and used as temporary sediment basins. It is also recommended that an appropriate Erosion and Sedimentation Control Plan is implemented throughout the entire construction period to minimise the quantity of sediments being conveyed to the temporary sediment basin. A concept Erosion and Sediment Control Plan can be found within the concept engineering plans.

8.0 Conclusion

The Stormwater Management Strategy has been prepared to accompany the Development Application for a proposed residential subdivision along Cessnock Road, Gillieston Heights.

The preparation of this management plan has been undertaken to document the stormwater management facilities designed for the site and how they achieve the requirements of Maitland City Council's Guidelines.

Hydraulic modelling indicated that post-development peak median flows are attenuated within the site to pre-development peak median flow levels after provision is made for detention storage for stormwater up to the 1% AEP storm event.

Water quality treatment has been modelled and utilising the adopted treatment meets Council target pollutant removal objectives prior to discharge of stormwater from the site. This was achieved by a treatment train approach utilising rainwater tank, gross pollutant traps, ponds, sediment basins and a bioretention basins.

An erosion and sedimentation control plan will be implemented to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the development site to the receiving waters during construction.

Appendix A

240289(1B)-ESK-008 PRE-DEVELOPMENT CATCHMENT PLAN
240289(1B)-ESK-009 POST-DEVELOPMENT CATCHMENT PLAN
240289(1B)-ESK-010 PROPOSED BASIN DETAILS

LEGEND

- PRE A1 CATCHMENT (15.17 ha)
- PRE A2 CATCHMENT (27.85 ha)
- PRE A3 CATCHMENT (21.67 ha)
- PRE B CATCHMENT (6.29 ha)
- PRE E CATCHMENT (5.59 ha)
- EXISTING EXTERNAL CATCHMENT
- SITE DISCHARGE ANALYSIS POINT

DISCHARGE POINT 'A'

DISCHARGE POINT 'B'

DISCHARGE POINT 'C'

DISCHARGE POINT 'D'

DISCHARGE POINT 'E'

Pre 'A1' Cat

Pre 'A2' Cat

Pre 'A3' Cat

Pre 'B' Cat

Pre 'E' Cat

REFER ADW JOHNSON REPORT "STORMWATER MANAGEMENT REPORT - PROPOSED RESIDENTIAL SUBDIVISION - PRECINCT A1" FOR DETAILS

CESSNOCK ROAD

DIAL 1100 BEFORE YOU DIG

NOT FOR CONSTRUCTION

ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
A	04.08.22	INITIAL ISSUE	LS	RB	DATUM: AHD CONTOUR INTERVAL: 1m	A1 1:2500 — 0 50 100 125m — A3 1:5000	

drawing title:

PRE-DEVELOPMENT CATCHMENTS

location: 464 CESSNOCK ROAD, GILLIESTON HEIGHTS

council: MAITLAND CITY COUNCIL

dwg ref: 240289(1B)-ESK-008

client: McCLOY GROUP

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central coast office ph: (02) 4305 4300
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240289(1B)-ESK-008 TO 010(A).DWG

LEGEND

- POST A1 CATCHMENT (19.16 ha)
- POST A2 CATCHMENT (22.58 ha)
- POST A3 CATCHMENT (23.91 ha)
- POST B CATCHMENT (6.35 ha)
- POST E CATCHMENT (5.58 ha)
- EXISTING EXTERNAL CATCHMENT
- SITE DISCHARGE ANALYSIS POINT

DISCHARGE POINT 'B'
BASIN B
DISCHARGE POINT 'C'
DISCHARGE POINT 'D'
Post 'B' Cat
REFER ADW JOHNSON REPORT "STORMWATER MANAGEMENT REPORT - PROPOSED RESIDENTIAL SUBDIVISION - PRECINCT A1" FOR DETAILS
CESSNOCK ROAD
DISCHARGE POINT 'A'
BASIN A1
Post 'A1' Cat
BASIN A2
Post 'A2' Cat
Post 'A3' Cat
Ext 'A3' Cat
BASIN E
Post 'E' Cat
DISCHARGE POINT 'E'
BASIN A3 REFER DA 2022/193
Ext 'A2' Cat

DIAL1100 BEFORE YOU DIG

NOT FOR CONSTRUCTION

Plotted By: Rexx Plot Date: 04/08/22 2:34:22PM Cad File: N:\240289\240289(1B)\DWG\ENGINEERING\ESK\240289(1B)-ESK-008 TO 010(A).DWG

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ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
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drawing title:

POST-DEVELOPMENT CATCHMENTS

location: 464 CESSNOCK ROAD, GILLIESTON HEIGHTS

council: MAITLAND CITY COUNCIL

dwg ref: 240289(1B)-ESK-009

client: McCLOYGROUP

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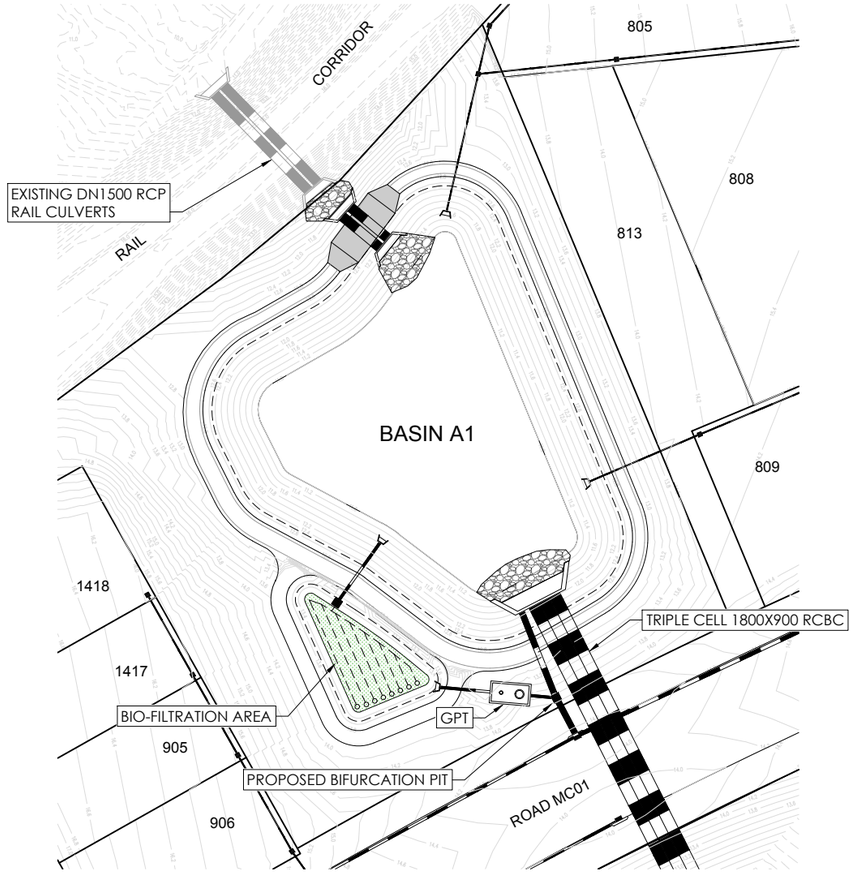
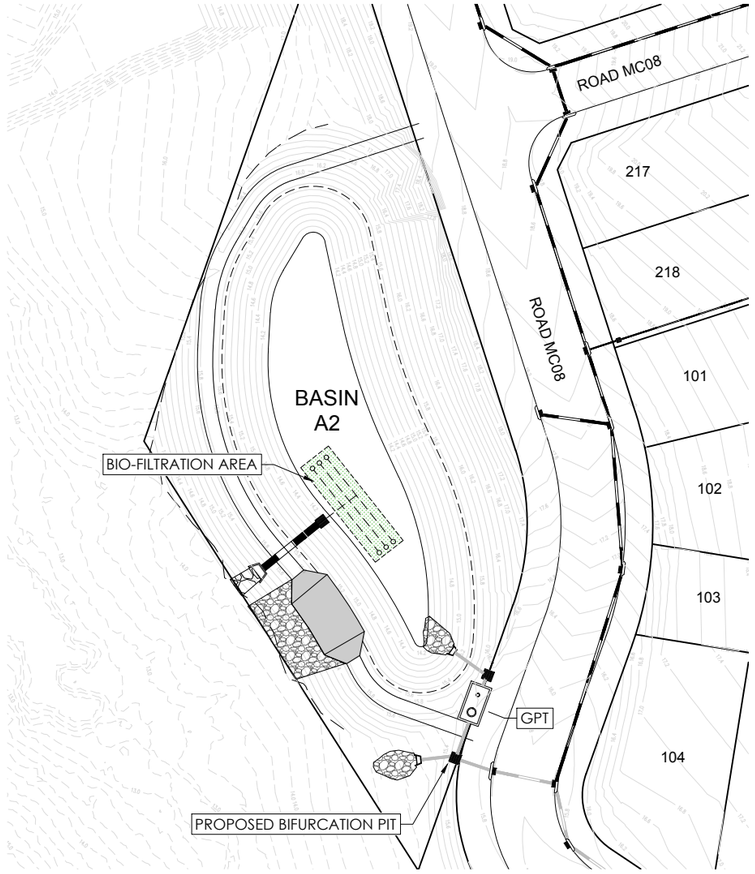


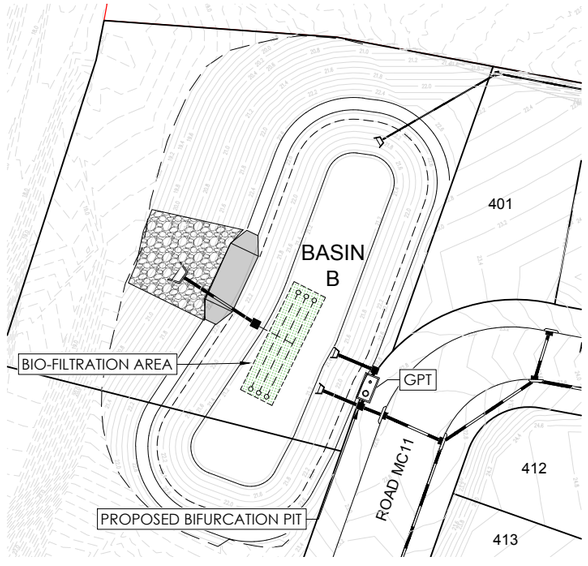
SEDIMENT BASIN BASIN A1

SCALE 1:500



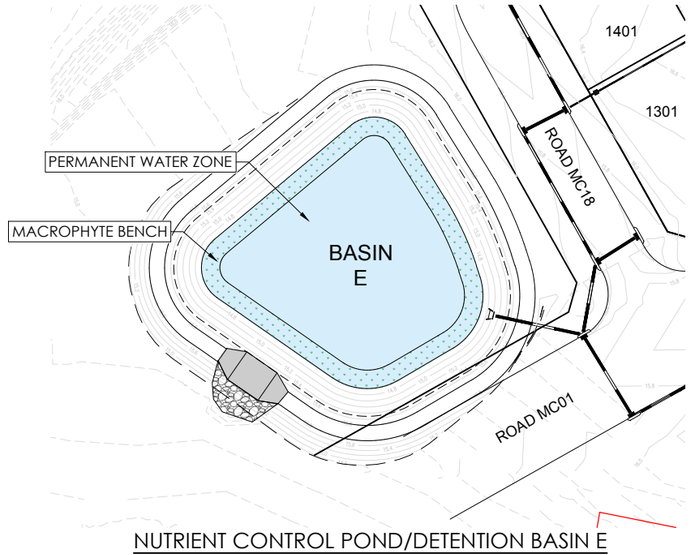
BIO-RETENTION BASIN A2

SCALE 1:500



BIO-RETENTION/DETENTION BASIN B

SCALE 1:500



NUTRIENT CONTROL POND/DETENTION BASIN E

SCALE 1:500

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ver.	date	comment	drawn	pm	level information	scale (A1 original size)	notes
A	04.08.22	INITIAL ISSUE	LS	RB	DATUM: AHD CONTOUR INTERVAL: 0.2m	A1 1:500 · 0 12.5 25.0m · A3 1:1000	

drawing title:

BASIN DETAILS

location: 464 CESSNOCK ROAD, GILLIESTON HEIGHTS

council: MAITLAND CITY COUNCIL

dwg ref: 240289(1B)-ESK-010

client: McCLOYGROUP

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Appendix B

RAINFALL DATA

STORMWATER DRAINAGE

1. RAINFALL INTENSITY FREQUENCY DURATION CHART – rainfall intensities

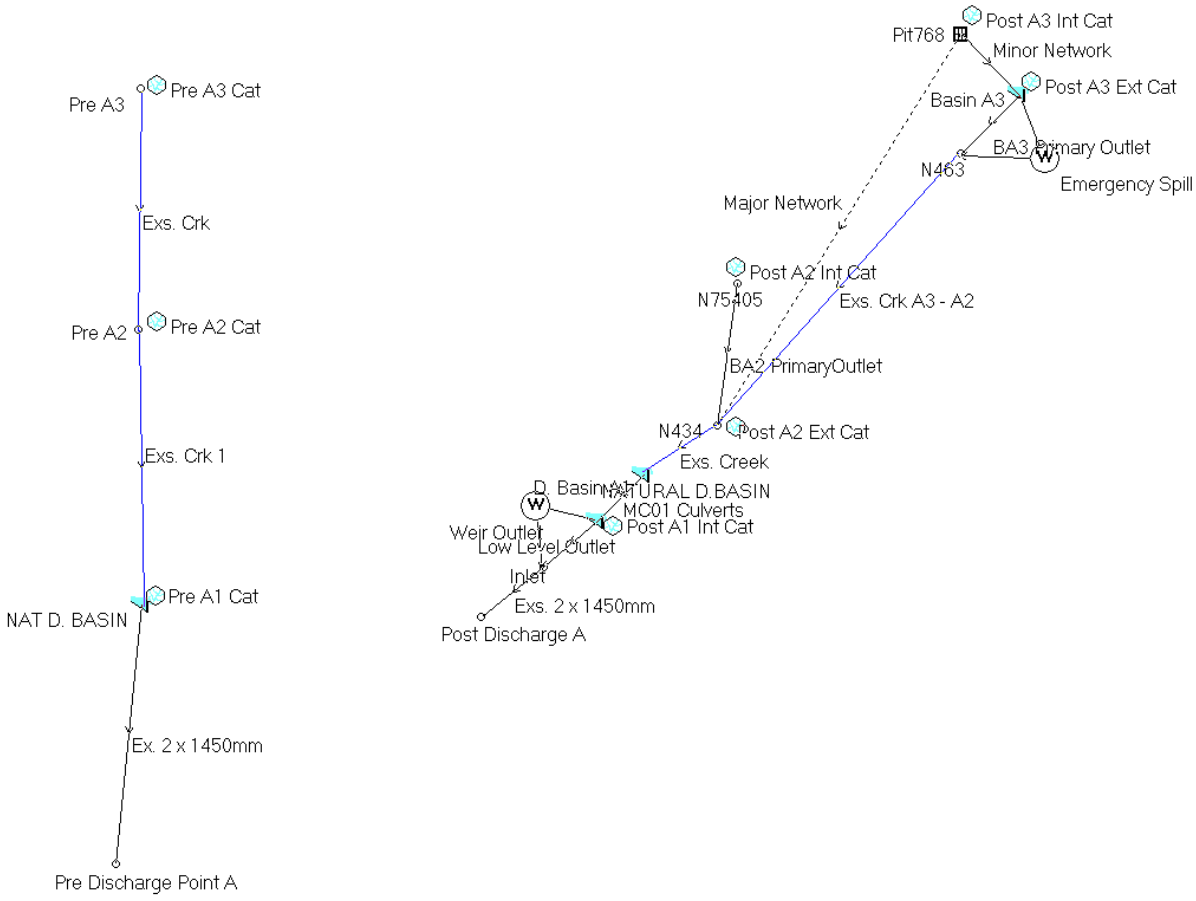
DURATION	1 YR	2 YR	5 YR	10 YR	20 YR	50 YR	100 YR	200 YR	500 YR
5 min	76.07	98.03	128.09	146.13	169.82	201.35	225.75	250.79	285.09
6 min	71.24	91.79	119.92	136.79	158.94	188.44	211.26	234.68	266.75
10 min	58.16	74.92	97.81	111.53	129.56	153.55	172.10	191.14	217.21
12 min	53.73	69.20	90.32	102.98	119.61	141.74	158.84	176.40	200.44
15 min	48.52	62.49	81.53	92.30	107.92	127.87	143.29	159.11	180.76
18 min	44.47	57.26	74.69	85.12	98.84	117.09	131.20	145.67	165.48
20 min	42.22	54.36	70.89	80.79	93.80	111.11	124.49	138.21	157.00
24 min	38.49	49.56	64.61	73.62	85.46	101.22	113.39	125.88	142.97
30 min	34.24	44.07	57.43	65.43	75.94	89.92	100.73	111.80	126.97
45 min	27.39	35.25	45.90	52.27	60.65	71.78	80.38	89.21	101.27
1.0 hr	23.22	29.88	38.89	44.27	51.35	60.77	68.03	75.49	85.68
1.5 hr	18.21	23.43	30.50	34.72	40.27	47.65	53.35	59.20	67.19
2.0 hr	15.27	19.65	25.57	29.11	33.77	39.96	44.74	49.65	56.35
3.0 hr	11.88	15.29	19.90	22.65	26.28	31.10	34.82	38.63	43.85
4.5 hr	9.24	11.88	15.47	17.61	20.42	24.17	27.06	30.02	34.08
6.0 hr	7.73	9.94	12.94	14.73	17.08	20.21	22.63	25.11	28.50
9.0 hr	6.01	7.73	10.06	11.46	13.29	15.73	17.61	19.54	22.18
12.0 hr	5.03	6.47	8.43	9.59	11.13	13.17	14.74	16.36	18.56
18.0 hr	4.01	5.14	6.64	7.52	8.69	10.24	11.44	12.66	14.32
24.0 hr	3.41	4.36	5.59	6.32	7.28	8.55	9.53	10.53	11.89
30.0 hr	2.99	3.82	4.88	5.50	6.33	7.42	8.25	9.10	10.26
36.0 hr	2.69	3.43	4.36	4.90	5.63	6.59	7.32	8.06	9.07
48.0 hr	2.25	2.87	3.63	4.06	4.65	5.42	6.01	6.61	7.42
72.0 hr	1.73	2.19	2.74	3.06	3.49	4.05	4.47	4.90	5.48

Source: Maitland City Council Manual of Engineering Standards, Appendix C

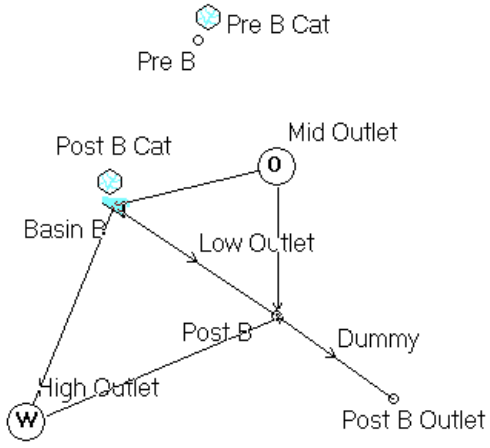
Appendix C

DRAINS MODEL DATA

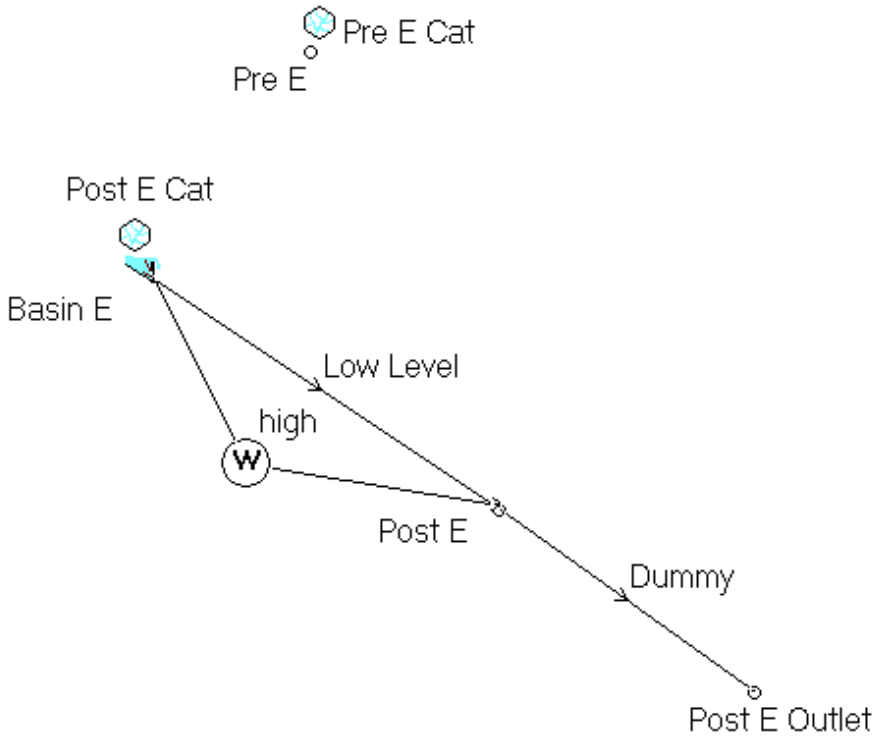
CATCHMENT A:



CATCHMENT B1:



CATCHMENT E:


Pre E Cat
Pre E
Post E Cat
Basin E
Low Level
high
Post E
Dummy
Post E Outlet

CATCHMENT A - 63.2% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Pre A3	19.83		0.997				
Pre A2	12.82		2.321				
Pre Discharge Point A	10.95		0				
Pit768	24.05		0.948		0	0.215	Outlet System
N463	19.81		0				
N434	12.96		1.209				
Inlet	11.14		0				
Post Discharge A	10.97		0				
N75405	13.19		1.809				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre A3 Cat	0.997	0.238	0.954	3.85	57.31	0	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Pre A2 Cat	1.36	0	1.36	0	51.24	0	AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1
Pre A1 Cat	0.9	0	0.9	0	53.84	0	AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1
Post A3 Int Cat	0.948	0.726	0.258	8.7	12.72	0	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1
Post A3 Ext Cat	0.816	0.129	0.793	3.85	57.31	0	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Post A2 Ext Cat	0.472	0	0.472	0	51.24	0	AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1
Post A1 Int Cat	2.029	1.785	0.303	11.68	42.28	0	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1
Post A2 Int Cat	1.809	1.278	0.662	8.7	22.05	0	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.7 impervious + 114 pervious = 138 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 1 year, 5 minutes storm, average 76.07 mm/h, Zone 1	8746.99	1509.66 (17.3%)	1263.16 (84.2%)	246.50 (3.4%)
AR&R 1 year, 5 minutes storm, average 22.0 mm/h, Zone 1	2529.69	197.15 (7.8%)	197.15 (45.5%)	0.00 (0.0%)
AR&R 1 year, 5 minutes storm, average 76.1 mm/h, Zone 1	8746.99	1509.66 (17.3%)	1263.16 (84.2%)	246.50 (3.4%)
AR&R 1 year, 10 minutes storm, average 58.2 mm/h, Zone 1	13375.18	5197.90 (38.9%)	2056.71 (89.7%)	3141.19 (28.3%)
AR&R 1 year, 15 minutes storm, average 48.5 mm/h, Zone 1	16737.38	8163.83 (48.8%)	2633.19 (91.8%)	5530.65 (39.9%)
AR&R 1 year, 20 minutes storm, average 42.2 mm/h, Zone 1	19418.85	10463.63 (53.9%)	3092.95 (92.9%)	7370.68 (45.8%)
AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1	22130.22	12621.60 (57.0%)	3557.84 (93.8%)	9063.77 (49.4%)
AR&R 1 year, 30 minutes storm, average 34.2 mm/h, Zone 1	23623.89	13197.03 (55.9%)	3813.94 (94.2%)	9383.09 (47.9%)
AR&R 1 year, 45 minutes storm, average 27.4 mm/h, Zone 1	28345.22	17300.90 (61.0%)	4623.45 (95.1%)	12677.45 (54.0%)
AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1	32037.43	20035.24 (62.5%)	5256.53 (95.7%)	14778.72 (55.7%)
AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1	37689	23507.03 (62.4%)	6225.55 (96.3%)	17281.48 (55.3%)
AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1	42137.8	25586.63 (60.7%)	6988.32 (96.7%)	18598.31 (53.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Ex. 2 x 1450mm	2.714	3.12	11.118	10.948	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Minor Network	0.47	6.65	23.624	22.41	AR&R 1 year, 20 minutes storm, average 42.2 mm/h, Zone 1
BA3 Primary Outlet	0.782	4.81	21.911	19.811	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
MC01 Culverts	1.717	0.41	11.874	11.868	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Low Level Outlet	2.567	2.67	11.472	11.142	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Exs. 2 x 1450mm	2.567	2.75	11.142	10.972	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
BA2 PrimaryOutlet	1.813	6.19	13.187	12.956	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm
Exs. Crk	0.974	0.55			AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Exs. Crk 1	2.261	4.89			AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Exs. Crk A3 - A2	0.78	0.51			AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Exs. Creek	1.876	0.55			AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Major Network	0.215	0.219	0.33	0.137	0.11	5.32	0.9	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1
Emergency Spill								
Weir Outlet								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
NAT D. BASIN	11.58	2390.3	2.714	2.714	0
Basin A3	22.41	1562.1	0.782	0.782	0
NATURAL D.BASIN	11.88	365.8	1.717	1.717	0
D. Basin A1	11.87	1002.8	2.567	2.567	0

CONTINUITY CHECK for AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre A3	3411.89	3453.91	0	-1.2
Pre A2	7657.6	7726.61	0	-0.9
NAT D. BASIN	10613.37	10175.91	376.24	0.6
Pre Discharge Point A	10175.91	10175.91	0	0
Pit768	1402.01	1266.85	0	9.6
Basin A3	3944.4	3578.36	366.04	0
N463	3578.36	3432.54	0	4.1
N434	8328.37	7964.32	0	4.4
NATURAL D.BASIN	7964.32	7841.9	14.86	1.4
D. Basin A1	11934.89	11582.68	352.24	0
Inlet	11582.68	11561.79	0	0.2
Post Discharge A	11561.79	11561.79	0	0
N75405	3313.24	3315.08	0	-0.1

Run Log for Catchment A 2.8m 220802.drn run at 10:24:10 on 4/8/2022 using version 2021.01
No water upwelling from any pit.
Freeboard was less than 0.15m at Pit768
Flows were safe in all overflow routes.

CATCHMENT A - 10% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Pre A3	19.96		2.847				
Pre A2	13.12		6.858				
Pre Discharge Point A	11.34		0				
Pit768	24.99		2.184		0	1.056	Outlet System
N463	19.92		0				
N434	13.28		3.069				
Inlet	11.41		0				
Post Discharge A	11.24		0				
N75405	13.48		4.331				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre A3 Cat	2.847	0.445	2.794	2.52	40.91	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Pre A2 Cat	4.092	0	4.092	0	37.41	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Pre A1 Cat	2.718	0	2.718	0	39.23	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Post A3 Int Cat	2.184	1.417	0.768	7.86	9.82	0	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1
Post A3 Ext Cat	2.352	0.242	2.323	2.52	40.91	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Post A2 Ext Cat	1.42	0	1.42	0	37.41	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Post A1 Int Cat	4.408	3.609	0.968	10.38	34.45	0	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1
Post A2 Int Cat	4.331	2.492	2.135	7.86	17.01	0	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.7 impervious + 114 pervious = 138 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 year, 5 minutes storm, average 146 mm/h, Zone 1	16802.92	9329.72 (55.5%)	2644.42 (91.8%)	6685.30 (48.0%)
AR&R 10 year, 10 minutes storm, average 112 mm/h, Zone 1	25648.8	17669.39 (68.9%)	4161.12 (94.6%)	13508.27 (63.6%)
AR&R 10 year, 15 minutes storm, average 92.3 mm/h, Zone 1	31839.65	23411.64 (73.5%)	5222.60 (95.7%)	18189.04 (68.9%)
AR&R 10 year, 20 minutes storm, average 80.8 mm/h, Zone 1	37158.9	28358.60 (76.3%)	6134.64 (96.3%)	22223.97 (72.2%)
AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1	42327.52	33050.52 (78.1%)	7020.83 (96.7%)	26029.70 (74.2%)
AR&R 10 year, 30 minutes storm, average 65.4 mm/h, Zone 1	45140.09	34993.43 (77.5%)	7503.08 (96.9%)	27490.35 (73.5%)
AR&R 10 year, 45 minutes storm, average 52.3 mm/h, Zone 1	54092.91	43089.55 (79.7%)	9038.08 (97.4%)	34051.47 (76.0%)
AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1	61086.37	48934.43 (80.1%)	10237.22 (97.7%)	38697.21 (76.5%)
AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1	71859.41	57263.62 (79.7%)	12084.29 (98.1%)	45179.32 (75.9%)
AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1	80333.88	63121.46 (78.6%)	13537.35 (98.3%)	49584.11 (74.5%)
AR&R 10 year, 3 hours storm, average 22.6 mm/h, Zone 1	93766.55	72058.05 (76.8%)	15840.57 (98.5%)	56217.48 (72.4%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Ex. 2 x 1450mm	8.332	4.19	11.511	11.341	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Minor Network	0.534	7.55	24.498	23.063	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1
BA3 Primary Outlet	1.18	4.31	22.018	19.918	AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1
MC01 Culverts	4.173	0.86	12.381	12.349	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Low Level Outlet	5.737	3.29	11.736	11.406	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Exs. 2 x 1450mm	5.737	3.41	11.406	11.236	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
BA2 PrimaryOutlet	4.343	7.21	13.48	13.279	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm
Exs. Crk	2.827	0.79			AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Exs. Crk 1	6.642	0.73			AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Exs. Crk A3 - A2	2.091	0.72			AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1
Exs. Creek	5.432	0.72			AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Major Network	1.056	1.113	2.911	0.218	0.29	8.44	1.41	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1
Emergency Spill	0.915	0.915						AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1
Weir Outlet								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
NAT D. BASIN	12.16	6409.4	8.332	8.332	0
Basin A3	23.06	3668.3	2.096	1.18	0.915
NATURAL D.BASIN	12.41	1849.1	4.173	4.173	0
D. Basin A1	12.35	1797.4	5.737	5.737	0

CONTINUITY CHECK for AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre A3	7441.18	7568.57	0	-1.7
Pre A2	16984.06	17083.45	0	-0.6
NAT D. BASIN	23559.08	20817.9	2625.88	0.5
Pre Discharge Point A	20817.9	20817.9	0	0
Pit768	2514.04	1707.06	0	32.1
Basin A3	7196.22	5252.73	1943.48	0
N463	5252.74	4780.38	0	9
N434	15019.78	14331.85	0	4.6
NATURAL D.BASIN	14331.85	14004.76	234.46	0.6
D. Basin A1	21494.22	20658.93	835.26	0
Inlet	20658.93	20614.66	0	0.2
Post Discharge A	20614.66	20614.66	0	0
N75405	6307.68	6308.08	0	0

Run Log for Catchment A 2.8m 220802.drn run at 10:00:47 on 4/8/2022 using version 2021.01
No water upwelling from any pit.
Freeboard was less than 0.15m at Pit768
Flows were safe in all overflow routes.

CATCHMENT A - 1% AEP

DRAINS results prepared from Version 2021.01

Version 8

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Pre A3	20.08		5.125				
Pre A2	13.33		12.022				
Pre Discharge Point A	11.44		0				
Pit768	25.57		3.162		0	2.044	Outlet System
N463	20.04		0				
N434	13.48		6.346				
Inlet	11.71		0				
Post Discharge A	11.54		0				
N75405	13.81		6.988				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre A3 Cat	5.125	0.64	4.972	2.12	36.03	0	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Pre A2 Cat	7.241	0	7.241	0	32.29	0	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Pre A1 Cat	4.86	0	4.86	0	31.97	0	AR&R 100 year, 45 minutes storm, average 80.4 mm/h, Zone 1
Post A3 Int Cat	3.162	2.02	1.142	7.19	7.52	0	AR&R 100 year, 15 minutes storm, average 143 mm/h, Zone 1
Post A3 Ext Cat	4.217	0.347	4.134	2.12	36.03	0	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Post A2 Ext Cat	2.512	0	2.512	0	32.29	0	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Post A1 Int Cat	6.662	5.222	1.665	9.55	29.43	0	AR&R 100 year, 20 minutes storm, average 124 mm/h, Zone 1
Post A2 Int Cat	6.988	3.518	3.734	7.4	14.31	0	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

Outflow Volumes for Total Catchment (23.7 impervious + 114 pervious = 138 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 226 mm/h, Zone 1	25958.11	18603.85 (71.7%)	4214.16 (94.7%)	14389.69 (66.9%)
AR&R 100 year, 10 minutes storm, average 172 mm/h, Zone 1	39578.22	31718.50 (80.1%)	6549.45 (96.5%)	25169.05 (76.8%)
AR&R 100 year, 15 minutes storm, average 143 mm/h, Zone 1	49429.06	41103.95 (83.2%)	8238.46 (97.2%)	32865.48 (80.2%)
AR&R 100 year, 20 minutes storm, average 124 mm/h, Zone 1	57258.46	48498.77 (84.7%)	9580.90 (97.6%)	38917.87 (82.0%)
AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1	65191.36	55944.09 (85.8%)	10941.05 (97.9%)	45003.04 (83.3%)
AR&R 100 year, 30 minutes storm, average 101 mm/h, Zone 1	69495.3	59365.86 (85.4%)	11678.98 (98.0%)	47686.88 (82.8%)
AR&R 100 year, 45 minutes storm, average 80.4 mm/h, Zone 1	83184.4	72204.44 (86.8%)	14026.19 (98.3%)	58178.25 (84.4%)
AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1	93868.9	81638.42 (87.0%)	15858.09 (98.5%)	65780.33 (84.6%)
AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1	110419.98	95646.64 (86.6%)	18695.92 (98.8%)	76950.72 (84.1%)
AR&R 100 year, 2 hours storm, average 44.7 mm/h, Zone 1	123468.62	106050.53 (85.9%)	20933.27 (98.9%)	85117.27 (83.2%)
AR&R 100 year, 3 hours storm, average 34.8 mm/h, Zone 1	144140.83	121885.56 (84.6%)	24477.75 (99.0%)	97407.82 (81.6%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Ex. 2 x 1450mm	9.882	4.35	11.612	11.442	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Minor Network	0.536	7.58	25.114	23.199	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1
BA3 Primary Outlet	1.253	3.25	22.138	20.038	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
MC01 Culverts	7.707	1.59	12.729	12.629	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Low Level Outlet	9.689	3.64	12.044	11.714	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Exs. 2 x 1450mm	9.69	3.77	11.724	11.554	AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
BA2 PrimaryOutlet	7.004	7.95	13.814	13.481	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm
Exs. Crk	5.087	0.96			AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Exs. Crk 1	11.619	0.87			AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Exs. Crk A3 - A2	4.182	0.9			AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Exs. Creek	9.78	0.88			AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Major Network	2.044	2.223	2.911	0.275	0.46	9.86	1.74	AR&R 100 year, 20 minutes storm, average 124 mm/h, Zone 1
Emergency Spill	2.959	2.959						AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1
Weir Outlet								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
NAT D. BASIN	12.62	11903.1	9.882	9.882	0
Basin A3	23.2	4178.1	4.213	1.253	2.959
NATURAL D.BASIN	12.84	4081.8	7.707	7.707	0
D. Basin A1	12.63	2347.4	9.689	9.689	0

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre A3	12574.53	12660.19	0	-0.7
Pre A2	28667.99	28743.23	0	-0.3
NAT D. BASIN	39758.88	34884.8	4556.35	0.8
Pre Discharge Point A	34884.8	34884.8	0	0
Pit768	4005.93	2608.55	0	34.9
Basin A3	11427.66	9297.56	2130.1	0
N463	9297.56	8898.45	0	4.3
N434	26327.69	25831.67	0	1.9
NATURAL D.BASIN	25831.67	24574.74	889.48	1.4
D. Basin A1	36610.06	35205.2	1404.86	0
Inlet	35205.2	34846.41	0	1
Post Discharge A	34846.41	34846.41	0	0
N75405	10242.19	10242.55	0	0

Run Log for Catchment A 2.8m 220802.drn run at 09:18:19 on 4/8/2022 using version 2021.01
No water upwelling from any pit.
Freeboard was less than 0.15m at Pit768
Flows were safe in all overflow routes.

CATCHMENT B - 63.2% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving	Max Pond Volume	Min Freeboard	Overflow (cu.m/s)	Constraint
			(cu.m/s)	(cu.m)	(m)		
Post B	0.1		0				
Post B Outlet	-0.3		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre B Cat	0.371	0	0.371	0	38.04	0	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Post B Cat	0.846	0.662	0.23	4.44	20.91	0	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1

Outflow Volumes for Total Catchment (3.17 impervious + 9.47 pervious = 12.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 1 year, 5 minutes storm, average 76.07 mm/h, Zone 1	801.27	197.72 (24.7%)	169.52 (84.2%)	28.20 (4.7%)
AR&R 1 year, 5 minutes storm, average 76.1 mm/h, Zone 1	801.27	197.72 (24.7%)	169.52 (84.2%)	28.20 (4.7%)
AR&R 1 year, 10 minutes storm, average 58.2 mm/h, Zone 1	1225.24	568.11 (46.4%)	276.01 (89.7%)	292.09 (31.8%)
AR&R 1 year, 15 minutes storm, average 48.5 mm/h, Zone 1	1533.23	842.58 (55.0%)	353.38 (91.8%)	489.20 (42.6%)
AR&R 1 year, 20 minutes storm, average 42.2 mm/h, Zone 1	1778.87	1059.01 (59.5%)	415.08 (92.9%)	643.93 (48.3%)
AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1	2027.25	1272.73 (62.8%)	477.47 (93.8%)	795.26 (52.4%)
AR&R 1 year, 30 minutes storm, average 34.2 mm/h, Zone 1	2164.07	1369.83 (63.3%)	511.84 (94.2%)	857.99 (52.9%)
AR&R 1 year, 45 minutes storm, average 27.4 mm/h, Zone 1	2596.57	1701.55 (65.5%)	620.47 (95.1%)	1081.08 (55.6%)
AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1	2934.8	1955.20 (66.6%)	705.43 (95.7%)	1249.77 (56.9%)
AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1	3452.51	2284.68 (66.2%)	835.48 (96.3%)	1449.20 (56.1%)
AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1	3860.05	2488.98 (64.5%)	937.84 (96.7%)	1551.14 (53.7%)
AR&R 1 year, 3 hours storm, average 11.9 mm/h, Zone 1	4504.58	2782.13 (61.8%)	1099.74 (97.2%)	1682.39 (49.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Outlet	0.348	2.16	0.256	0.156	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Dummy	0.363	4.35	0.102	-0.298	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Mid Outlet	0.016	0.016						AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
High Outlet								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin B	0.53	460.9	0.363	0.348	0.016

CONTINUITY CHECK for AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre B	825.14	825.14	0	0
Basin B	1130.07	1021.94	108.13	0
Post B	1021.94	1021.51	0	0
Post B Outlet	1021.51	1021.51	0	0

Run Log for Catchment B.drn run at 15:22:37 on 25/7/2022 using version 2020.05

CATCHMENT B - 10% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Post B	0.28		0				
Post B Outlet	-0.12		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre B Cat	1.079	0	1.079	0	30.07	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Post B Cat	1.891	1.266	0.72	3.88	16.59	0	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1

Outflow Volumes for Total Catchment (3.17 impervious + 9.47 pervious = 12.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 year, 5 minutes storm, average 146 mm/h, Zone 1	1539.24	936.21 (60.8%)	354.89 (91.8%)	581.32 (50.4%)
AR&R 10 year, 10 minutes storm, average 112 mm/h, Zone 1	2349.57	1705.40 (72.6%)	558.43 (94.6%)	1146.97 (65.2%)
AR&R 10 year, 15 minutes storm, average 92.3 mm/h, Zone 1	2916.68	2235.42 (76.6%)	700.88 (95.7%)	1534.54 (70.3%)
AR&R 10 year, 20 minutes storm, average 80.8 mm/h, Zone 1	3403.95	2690.16 (79.0%)	823.28 (96.3%)	1866.88 (73.2%)
AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1	3877.43	3125.72 (80.6%)	942.21 (96.7%)	2183.51 (75.2%)
AR&R 10 year, 30 minutes storm, average 65.4 mm/h, Zone 1	4135.07	3346.07 (80.9%)	1006.93 (96.9%)	2339.15 (75.5%)
AR&R 10 year, 45 minutes storm, average 52.3 mm/h, Zone 1	4955.2	4060.82 (82.0%)	1212.93 (97.4%)	2847.89 (76.8%)
AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1	5595.83	4603.03 (82.3%)	1373.85 (97.7%)	3229.18 (77.1%)
AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1	6582.7	5383.71 (81.8%)	1621.74 (98.1%)	3761.97 (76.3%)
AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1	7359.01	5941.25 (80.7%)	1816.73 (98.3%)	4124.52 (74.8%)
AR&R 10 year, 3 hours storm, average 22.6 mm/h, Zone 1	8589.51	6794.52 (79.1%)	2125.82 (98.5%)	4668.70 (72.6%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Outlet	0.473	2.14	0.868	0.278	AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1
Dummy	1.076	5.74	0.278	-0.123	AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Mid Outlet	0.602	0.602						AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1
High Outlet								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin B	0.87	862	1.075	0.473	0.602

CONTINUITY CHECK for AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre B	2140.7	2140.7	0	0
Basin B	2462.33	2329.58	132.75	0
Post B	2329.58	2329.14	0	0
Post B Outlet	2329.14	2329.14	0	0

Run Log for Catchment B.drn run at 15:22:37 on 25/7/2022 using version 2020.05

CATCHMENT B - 1% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Post B	0.65		0				
Post B Outlet	0.08		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre B Cat	1.943	0	1.943	0	21.58	0	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1
Post B Cat	2.904	1.75	1.238	3.59	14.28	0	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

Outflow Volumes for Total Catchment (3.17 impervious + 9.47 pervious = 12.6 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 226 mm/h, Zone 1	2377.9	1782.32 (75.0%)	565.55 (94.7%)	1216.77 (68.3%)
AR&R 100 year, 10 minutes storm, average 172 mm/h, Zone 1	3625.57	2989.43 (82.5%)	878.95 (96.5%)	2110.48 (77.7%)
AR&R 100 year, 15 minutes storm, average 143 mm/h, Zone 1	4527.96	3853.60 (85.1%)	1105.61 (97.2%)	2747.99 (81.0%)
AR&R 100 year, 20 minutes storm, average 124 mm/h, Zone 1	5245.18	4534.38 (86.4%)	1285.77 (97.6%)	3248.61 (82.7%)
AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1	5971.87	5222.70 (87.5%)	1468.31 (97.9%)	3754.40 (84.0%)
AR&R 100 year, 30 minutes storm, average 101 mm/h, Zone 1	6366.14	5579.50 (87.6%)	1567.34 (98.0%)	4012.16 (84.2%)
AR&R 100 year, 45 minutes storm, average 80.4 mm/h, Zone 1	7620.13	6726.08 (88.3%)	1882.33 (98.3%)	4843.75 (84.9%)
AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1	8598.89	7600.54 (88.4%)	2128.18 (98.5%)	5472.37 (85.0%)
AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1	10115.05	8904.24 (88.0%)	2509.02 (98.8%)	6395.22 (84.4%)
AR&R 100 year, 2 hours storm, average 44.7 mm/h, Zone 1	11310.38	9881.52 (87.4%)	2809.26 (98.9%)	7072.26 (83.5%)
AR&R 100 year, 3 hours storm, average 34.8 mm/h, Zone 1	13204.06	11369.48 (86.1%)	3284.93 (99.0%)	8084.55 (81.8%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Outlet	0.525	2.38	1.108	0.646	AR&R 100 year, 45 minutes storm, average 80.4 mm/h, Zone 1
Dummy	1.777	6.29	0.646	0.1	AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
Mid Outlet	1.223	1.223						AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1
High Outlet	0.084	0.084						AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin B	1.11	1207.4	1.831	0.525	1.307

CONTINUITY CHECK for AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre B	2489.64	2489.64	0	0
Basin B	2733.06	2443.25	289.81	0
Post B	2443.25	2442.34	0	0
Post B Outlet	2442.34	2442.34	0	0

Run Log for Catchment B.drn run at 15:22:37 on 25/7/2022 using version 2020.05

CATCHMENT E - 63.2% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving	Max Pond Volume	Min Freeboard	Overflow (cu.m/s)	Constraint
			(cu.m/s)	(cu.m)	(m)		
Post E	0.03		0				
Post E Outlet	-0.37		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre E Cat	0.341	0	0.341	0	36.62	0	AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1
Post E Cat	1.012	0.954	0.073	4.28	20.91	0	AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1

Outflow Volumes for Total Catchment (4.58 impervious + 6.59 pervious = 11.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 1 year, 5 minutes storm, average 76.07 mm/h, Zone 1	708.08	262.69 (37.1%)	244.30 (84.2%)	18.39 (4.4%)
AR&R 1 year, 5 minutes storm, average 76.1 mm/h, Zone 1	708.08	262.69 (37.1%)	244.30 (84.2%)	18.39 (4.4%)
AR&R 1 year, 10 minutes storm, average 58.2 mm/h, Zone 1	1082.75	598.79 (55.3%)	397.77 (89.7%)	201.02 (31.4%)
AR&R 1 year, 15 minutes storm, average 48.5 mm/h, Zone 1	1354.92	847.79 (62.6%)	509.26 (91.8%)	338.53 (42.3%)
AR&R 1 year, 20 minutes storm, average 42.2 mm/h, Zone 1	1571.99	1044.57 (66.4%)	598.18 (92.9%)	446.38 (48.1%)
AR&R 1 year, 25 minutes storm, average 38.5 mm/h, Zone 1	1791.48	1240.20 (69.2%)	688.09 (93.8%)	552.11 (52.2%)
AR&R 1 year, 30 minutes storm, average 34.2 mm/h, Zone 1	1912.4	1333.63 (69.7%)	737.63 (94.2%)	596.00 (52.8%)
AR&R 1 year, 45 minutes storm, average 27.4 mm/h, Zone 1	2294.6	1645.51 (71.7%)	894.19 (95.1%)	751.32 (55.5%)
AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1	2593.49	1885.94 (72.7%)	1016.62 (95.7%)	869.32 (56.8%)
AR&R 1 year, 1.5 hours storm, average 18.2 mm/h, Zone 1	3050.99	2212.91 (72.5%)	1204.03 (96.3%)	1008.88 (56.0%)
AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1	3411.13	2431.82 (71.3%)	1351.56 (96.7%)	1080.27 (53.6%)
AR&R 1 year, 3 hours storm, average 11.9 mm/h, Zone 1	3980.71	2756.68 (69.3%)	1584.87 (97.2%)	1171.81 (49.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Level	0.321	2.15	0.214	0.114	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1
Dummy	0.321	3.28	0.027	-0.372	AR&R 1 year, 2 hours storm, average 15.3 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
high								

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin E	0.45	645.3	0.321	0.321	0

CONTINUITY CHECK for AR&R 1 year, 1 hour storm, average 23.2 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre E	734.99	734.99	0	0
Basin E	1150.95	910.08	240.87	0
Post E	910.08	908.56	0	0.2
Post E Outlet	908.56	908.56	0	0

Run Log for Catchment E.drn run at 15:55:01 on 25/7/2022 using version 2020.05

CATCHMENT E - 10% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
Post E	0.1		0				
Post E Outlet	-0.3		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre E Cat	0.978	0	0.978	0	29.2	0	AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1
Post E Cat	2.022	1.825	0.228	3.76	16.59	0	AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1

Outflow Volumes for Total Catchment (4.58 impervious + 6.59 pervious = 11.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 year, 5 minutes storm, average 146 mm/h, Zone 1	1360.23	913.67 (67.2%)	511.44 (91.8%)	402.23 (50.1%)
AR&R 10 year, 10 minutes storm, average 112 mm/h, Zone 1	2076.32	1601.25 (77.1%)	804.77 (94.6%)	796.48 (65.0%)
AR&R 10 year, 15 minutes storm, average 92.3 mm/h, Zone 1	2577.48	2076.72 (80.6%)	1010.06 (95.7%)	1066.66 (70.1%)
AR&R 10 year, 20 minutes storm, average 80.8 mm/h, Zone 1	3008.08	2484.74 (82.6%)	1186.45 (96.3%)	1298.29 (73.1%)
AR&R 10 year, 25 minutes storm, average 73.6 mm/h, Zone 1	3426.49	2876.80 (84.0%)	1357.85 (96.7%)	1518.96 (75.1%)
AR&R 10 year, 30 minutes storm, average 65.4 mm/h, Zone 1	3654.17	3078.58 (84.2%)	1451.11 (96.9%)	1627.46 (75.4%)
AR&R 10 year, 45 minutes storm, average 52.3 mm/h, Zone 1	4378.92	3730.14 (85.2%)	1747.99 (97.4%)	1982.15 (76.7%)
AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1	4945.05	4227.97 (85.5%)	1979.90 (97.7%)	2248.07 (77.0%)
AR&R 10 year, 1.5 hours storm, average 34.7 mm/h, Zone 1	5817.15	4956.90 (85.2%)	2337.14 (98.1%)	2619.76 (76.3%)
AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1	6503.17	5490.44 (84.4%)	2618.16 (98.3%)	2872.28 (74.8%)
AR&R 10 year, 3 hours storm, average 22.6 mm/h, Zone 1	7590.57	6315.67 (83.2%)	3063.59 (98.5%)	3252.08 (72.6%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Level	0.6	2.44	0.325	0.225	AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1
Dummy	0.847	4.38	0.101	-0.298	AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
high	0.246	0.246						AR&R 10 year, 2 hours storm, average 29.1 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin E	0.74	1149.2	0.847	0.6	0.246

CONTINUITY CHECK for AR&R 10 year, 1 hour storm, average 44.3 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre E	1903.73	1903.73	0	0
Basin E	2324.24	2021.86	302.38	0
Post E	2021.86	2020.08	0	0.1
Post E Outlet	2020.08	2020.08	0	0

Run Log for Catchment E.drn run at 15:55:01 on 25/7/2022 using version 2020.05

CATCHMENT E - 1% AEP

DRAINS results prepared from Version 2021.01

PIT / NODE DETAILS **Version 8**

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving	Max Pond Volume	Min Freeboard	Overflow (cu.m/s)	Constraint
			(cu.m/s)	(cu.m)	(m)		
Post E	0.18		0				
Post E Outlet	-0.21		0				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Pre E Cat	1.74	0	1.74	0	21.3	0	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1
Post E Cat	3.066	2.869	0.197	3.13	11.32	0	AR&R 100 year, 5 minutes storm, average 226 mm/h, Zone 1

Outflow Volumes for Total Catchment (4.58 impervious + 6.59 pervious = 11.2 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 226 mm/h, Zone 1	2101.36	1660.15 (79.0%)	815.03 (94.7%)	845.12 (68.1%)
AR&R 100 year, 10 minutes storm, average 172 mm/h, Zone 1	3203.93	2734.43 (85.3%)	1266.68 (96.5%)	1467.75 (77.6%)
AR&R 100 year, 15 minutes storm, average 143 mm/h, Zone 1	4001.37	3505.35 (87.6%)	1593.34 (97.2%)	1912.01 (80.9%)
AR&R 100 year, 20 minutes storm, average 124 mm/h, Zone 1	4635.18	4113.94 (88.8%)	1852.97 (97.6%)	2260.98 (82.6%)
AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1	5277.36	4729.28 (89.6%)	2116.02 (97.9%)	2613.25 (83.9%)
AR&R 100 year, 30 minutes storm, average 101 mm/h, Zone 1	5625.77	5051.51 (89.8%)	2258.74 (98.0%)	2792.76 (84.1%)
AR&R 100 year, 45 minutes storm, average 80.4 mm/h, Zone 1	6733.93	6085.11 (90.4%)	2712.68 (98.3%)	3372.42 (84.8%)
AR&R 100 year, 1 hour storm, average 68.0 mm/h, Zone 1	7598.86	6877.46 (90.5%)	3066.99 (98.5%)	3810.47 (84.9%)
AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1	8938.7	8069.66 (90.3%)	3615.85 (98.8%)	4453.81 (84.4%)
AR&R 100 year, 2 hours storm, average 44.7 mm/h, Zone 1	9995.01	8974.01 (89.8%)	4048.52 (98.9%)	4925.50 (83.5%)
AR&R 100 year, 3 hours storm, average 34.8 mm/h, Zone 1	11668.46	10365.61 (88.8%)	4734.02 (99.0%)	5631.59 (81.8%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Low Level	0.692	2.5	0.922	0.266	AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1
Dummy	1.722	5.13	0.193	-0.206	AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
high	1.03	1.03						AR&R 100 year, 1.5 hours storm, average 53.3 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin E	0.92	1507	1.722	0.692	1.03

CONTINUITY CHECK for AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1

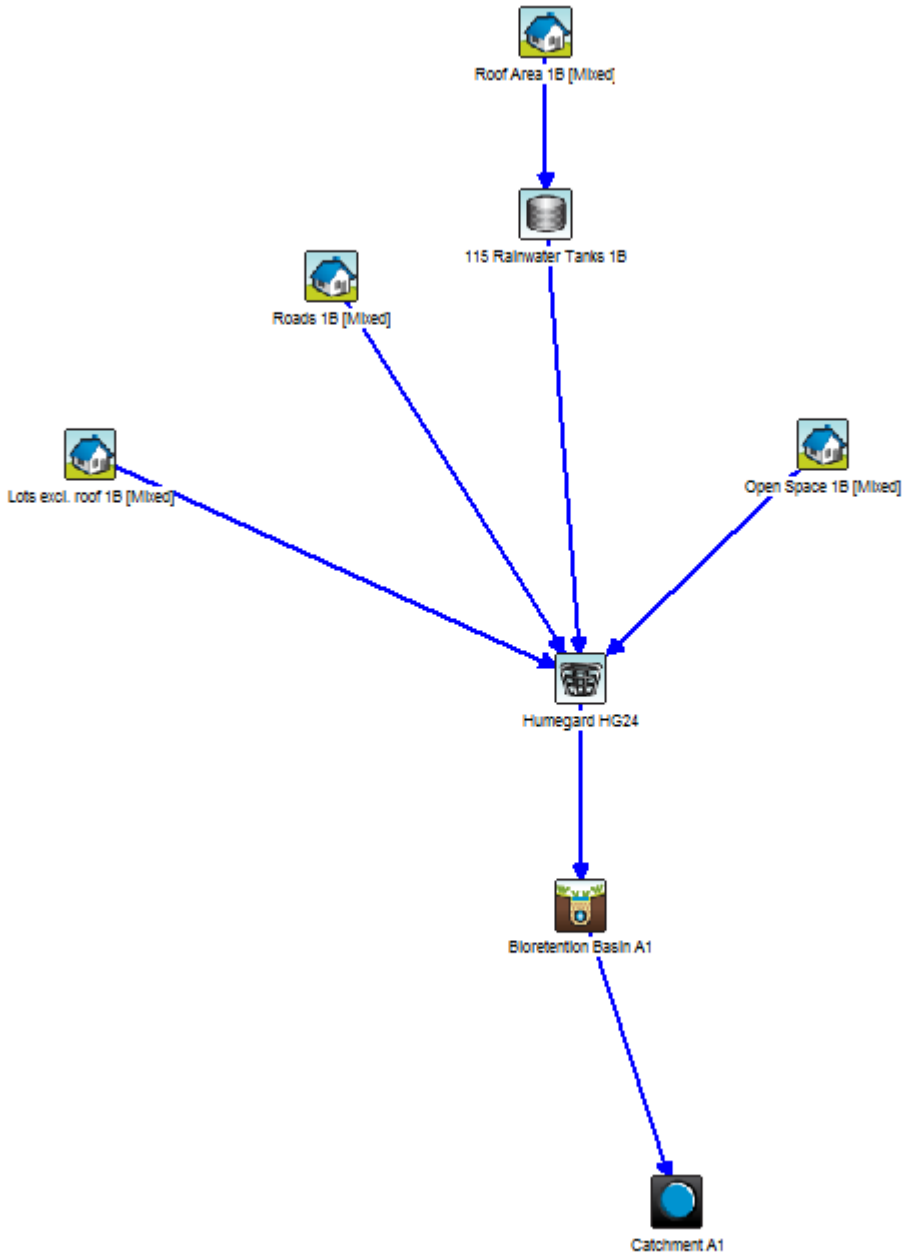
Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Pre E	2213.15	2213.15	0	0
Basin E	2516.13	1982.18	533.95	0
Post E	1982.18	1979.27	0	0.1
Post E Outlet	1979.27	1979.27	0	0

Run Log for Catchment E.drn run at 15:55:01 on 25/7/2022 using version 2020.05

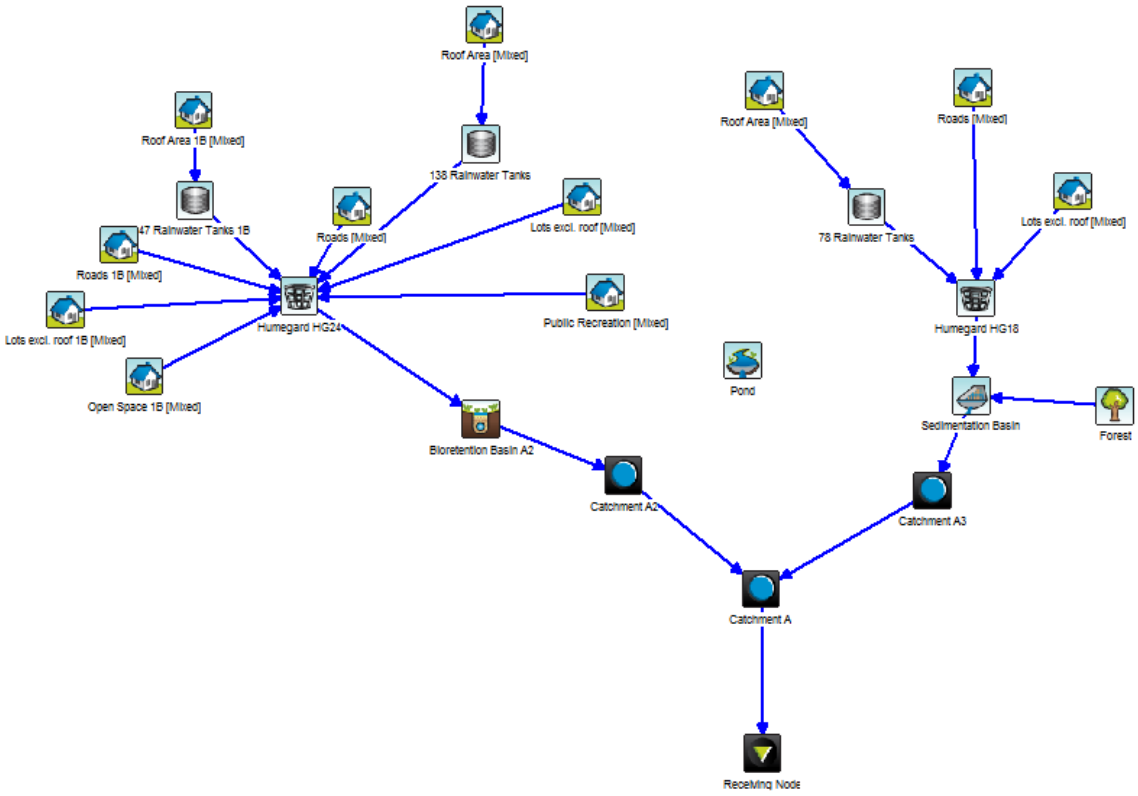
Appendix D

MUSIC TREATMENT TRAIN DIAGRAMS

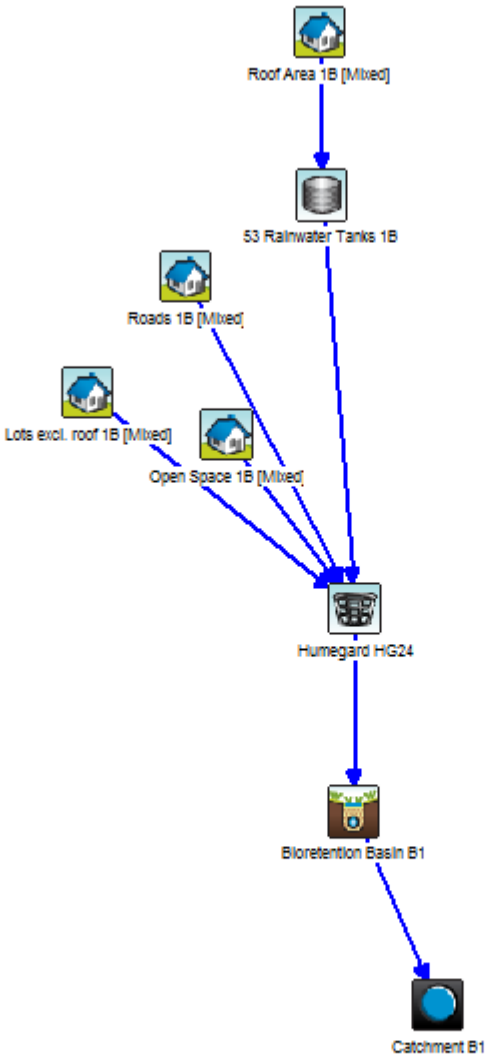
Catchment A1:



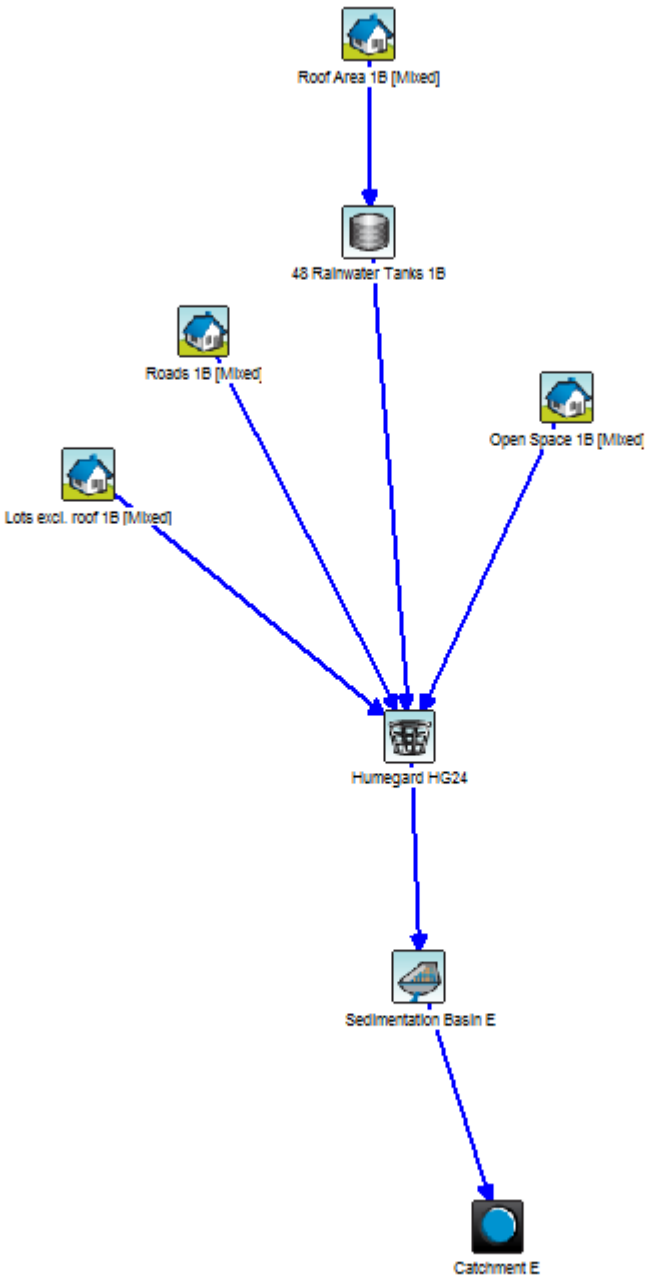
Catchment A2:



Catchment B1:



Catchment E:


Roof Area 1B [Mixed]
48 Rainwater Tanks 1B
Roads 1B [Mixed]
Open Space 1B [Mixed]
Lots excl. roof 1B [Mixed]
Humegard HG24
Sedimentation Basin E
Catchment E