MM HYNDES BAILEY & Co.
REGISTERED SURVEYORS - TOWN PLANNING - CIVIL DESIGN
Surveying the Hunter since 1920

Stormwater Management Plan for DA

NORTHVIEW ESTATE STAGES 6 AND 7
212 – 216 QUEEN STREET MUSWELLBROOK
LOT 58 DP1276946

REF: 224103
REV: A
DATE: NOVEMBER 2024

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1 Introduction

MM Hyndes Bailey & Co have been engaged to prepare a Stormwater Management Plan for Development Approval for a residential subdivision development at Lot 58 (DP1276946) 212-216 Queen Street Muswellbrook, NSW.

The stormwater drainage items addressed in this report include:

- Stormwater conveyance/network;
- Stormwater detention
- Operational water quality management incorporating Water Sensitive Urban Design (WSUD) principles
- Construction water quality management incorporating soil and water management.

2 Site

2.1 LOCATION

The development site is located to the north of the previous stages 4 and 5 of the development.

Stage 6 is the extension of Sepoy Crescent to the west. There is an existing drainage reserve/stream to the south of Stage 6 and rural land to the east. Refer to Figure 1 for location of Stage 6.

Stage 7 is the extension of Queen Street to the north connecting to the extension of Sepoy Crescent from the east. The railway tracks are to the west and Sandy Creek Road to the northwest. Refer to Figure 1 for location of Stage 7.

2.2 TOPOGRAPHY

The site consists of rural land on gentle undulating rolling hills. There is an existing stream to the south of the proposed Stage 6 development. There is a crest running along the boundary between Stage 6 and 7 lots. There is an existing stream to the north of the proposed Stage 7 development.

The overall sites slope is approximately 10% across the future Stage 6 development draining to the south to the existing stream which drains to the west into the existing detention basin at Queen Street.

The overall sites slope is approximately 10% across the future Stage 7 development draining to the north and northwest to the existing stream.

Refer to Figure 1 showing the existing topography of the site.

2.3 EXISTING LAND USE AND VEGETATION

The site in its current condition is mostly cleared grassland with some trees within the southern stream and Stage 6 subdivision. Refer to Figure 1 which shows a SIX Maps image of the area.

FIGURE 1 – EXTRACT FROM SIX MAPS OF THE SITE

2.4 EXTERNAL CATCHMENTS

The Stage 6 development does not have any external catchment draining through the site that need to be considered for the stormwater drainage design.

The Stage 7 development has an upstream catchment to the east draining through the existing stream to the west. This upstream catchment does not impact on the future Stage 7 stormwater drainage infrastructure.

3 Proposed Development – Stages 6 and 7

The proposed Stage 6 development consists of 35 residential lots and associated roads. The access to Stage 6 is via existing Sepoy Crescent to the west and future extension of Sunline Street to the south across the existing stream. Refer to Figure 2 for the proposed Stage 6 layout.

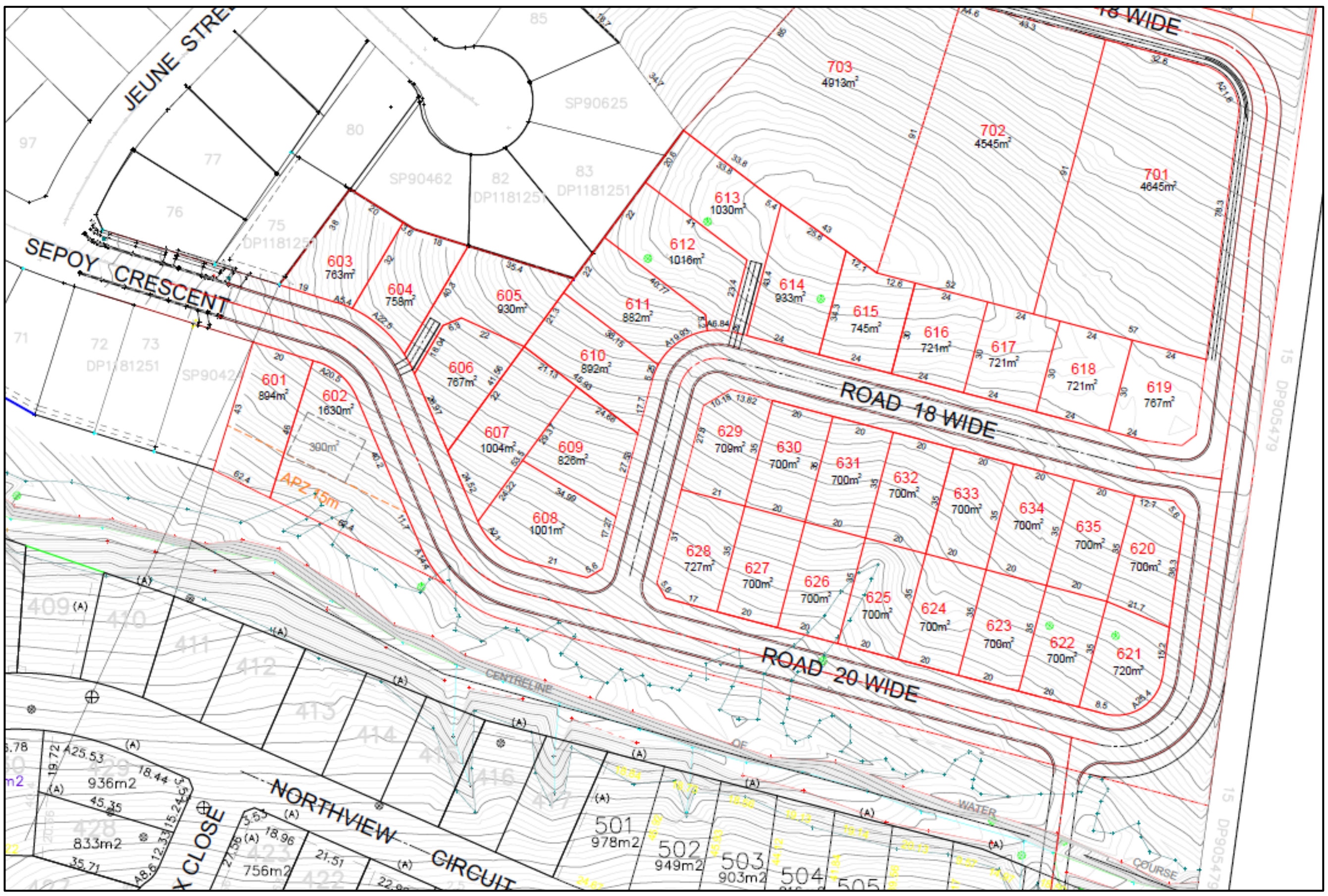


FIGURE 2 – STAGE 6 LAYOUT

The proposed Stage 7 development consists of 23 rural residential lots and associated roads. The access to Stage 7 is via extension of Queens Street and future extension of Sepoy Crescent through Stage 6. Refer to Figure 3 for the proposed Stage 7 layout.

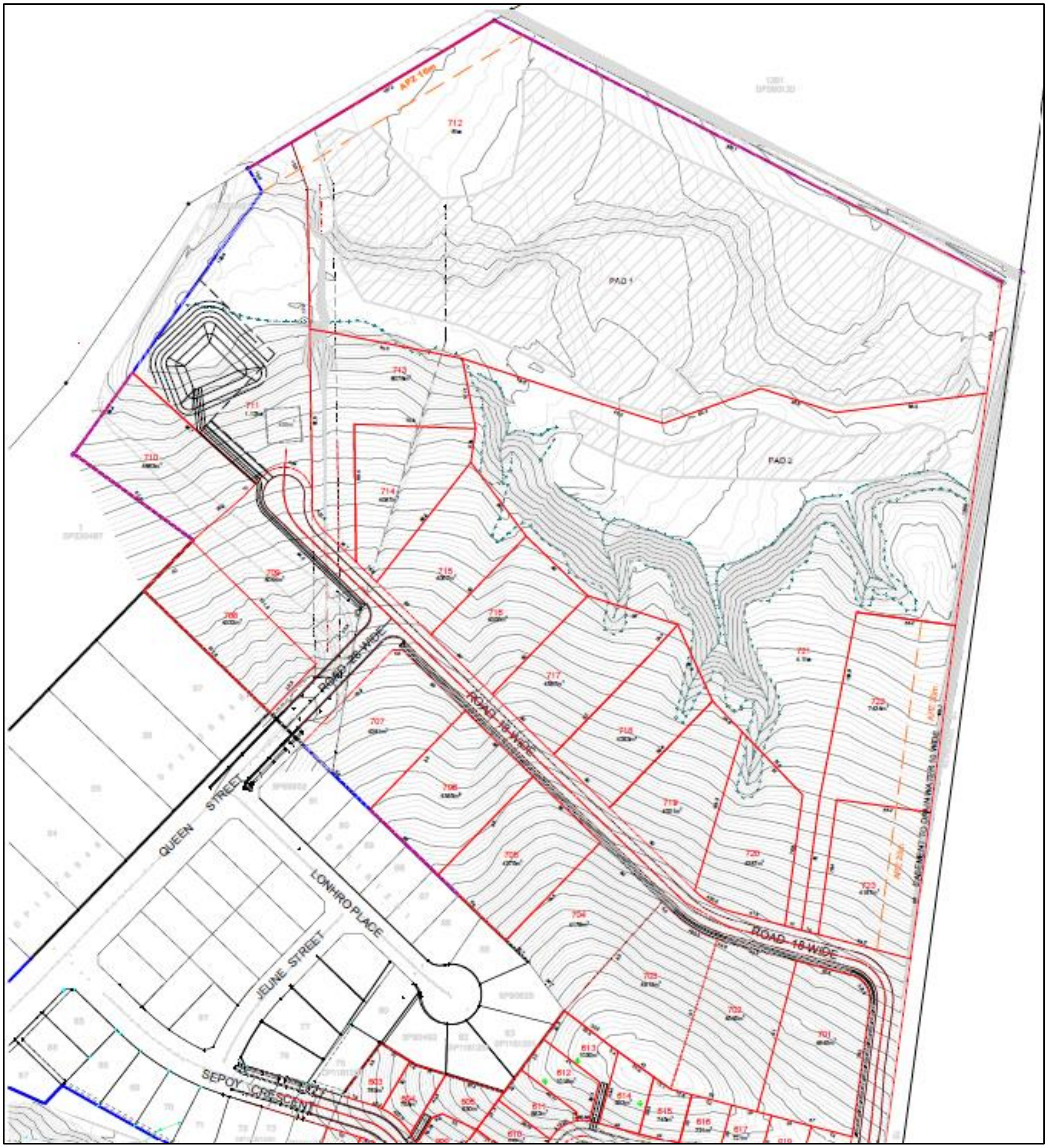


FIGURE 3 – STAGE 7 LAYOUT

4 Stormwater Quantity Management

4.1 OBJECTIVES

The objectives of the stormwater quantity management for the site are:

- Provide a stormwater conveyance system in accordance with Australian Rainfall and Runoff's minor/major system philosophy and the requirements of Muswellbrook Shire Council (MSC). The minor stormwater conveyance system will be designed to convey peak flows in the roads for the 20% Annual Exceedance Probability (AEP) storm events and for interallotment drainage systems for the 5% AEP. The major stormwater conveyance system will be designed to convey the peak flows from the 1% AEP storm events.
- Provide stormwater detention to reduce the peak flows from the site to or below the current peak runoff from the site.

4.2 STORMWATER CONVEYANCE

4.2.1 Minor Storm Event Conveyance

The minor stormwater conveyance system for the Stage 6 development will be a via a traditional pit and pipe system.

The minor stormwater conveyance system for the Stage 7 development will be a via road side drains, pits and pipes.

The minor stormwater system will have the capacity to convey the peak flows from a 20% AEP storm event in the roads and 5% AEP storm events for the interallotment drainage system.

Refer to the Figure 4 and 5 for the proposed stormwater drainage layout for Stages 6 and 7 respectively. Refer to the DA drawings for the stormwater drainage layout plans, longitudinal sections and catchment plans.

4.2.2 Major Storm Event Conveyance

Major system stormwater conveyance for the proposed development will be via overland flow. This will be via traditional trunk drainage utilising the road carriage way and footpath reserve in Stage 6, and road side drains in Stage 7.

The major stormwater system will have the capacity to convey the peak flows from a 1% AEP storm event, containing flows within the road reserve and limiting velocity depth product to or below 0.4 m^2/s.

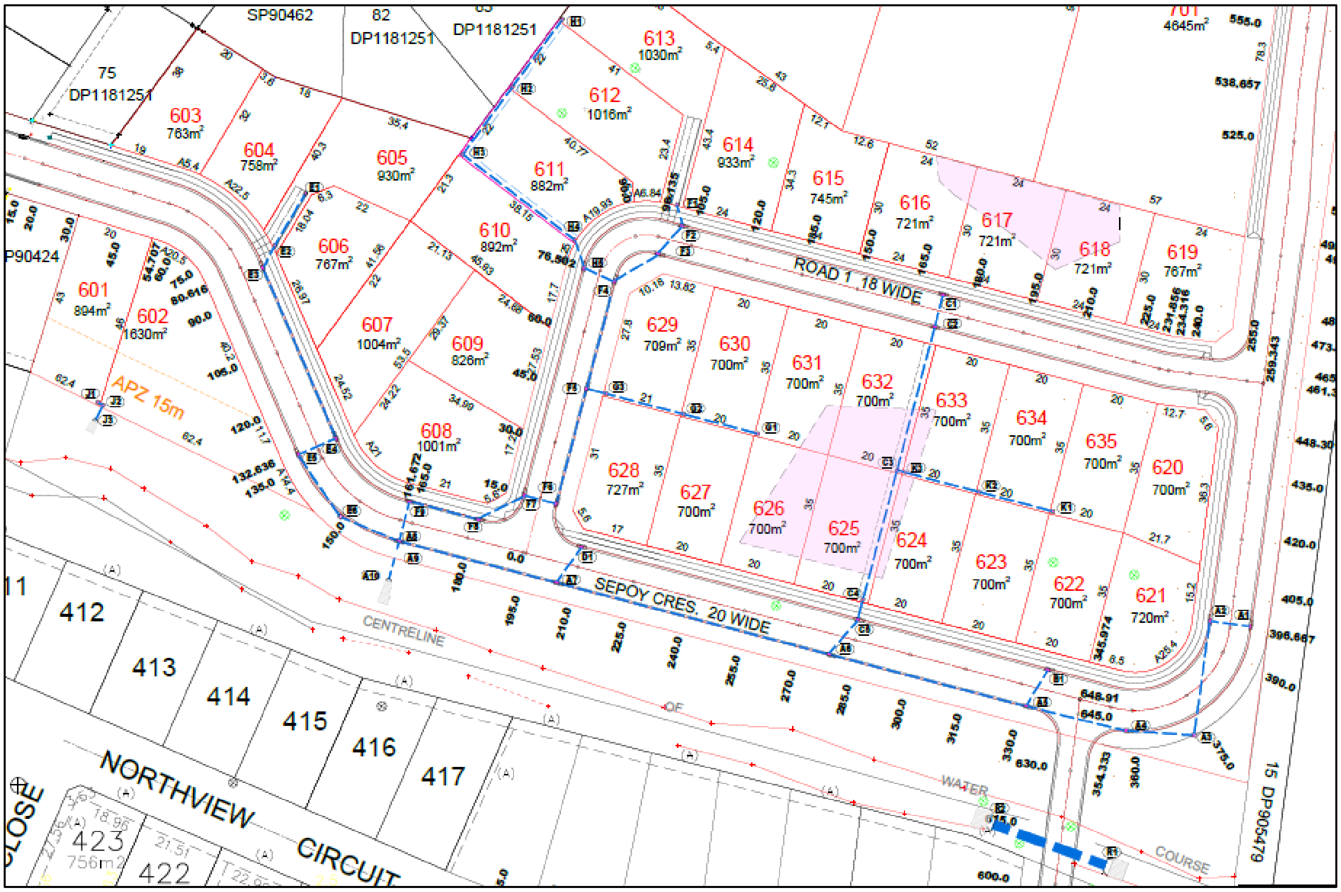


FIGURE 4 – STAGE 6 STORMWATER DRAINAGE LAYOUT

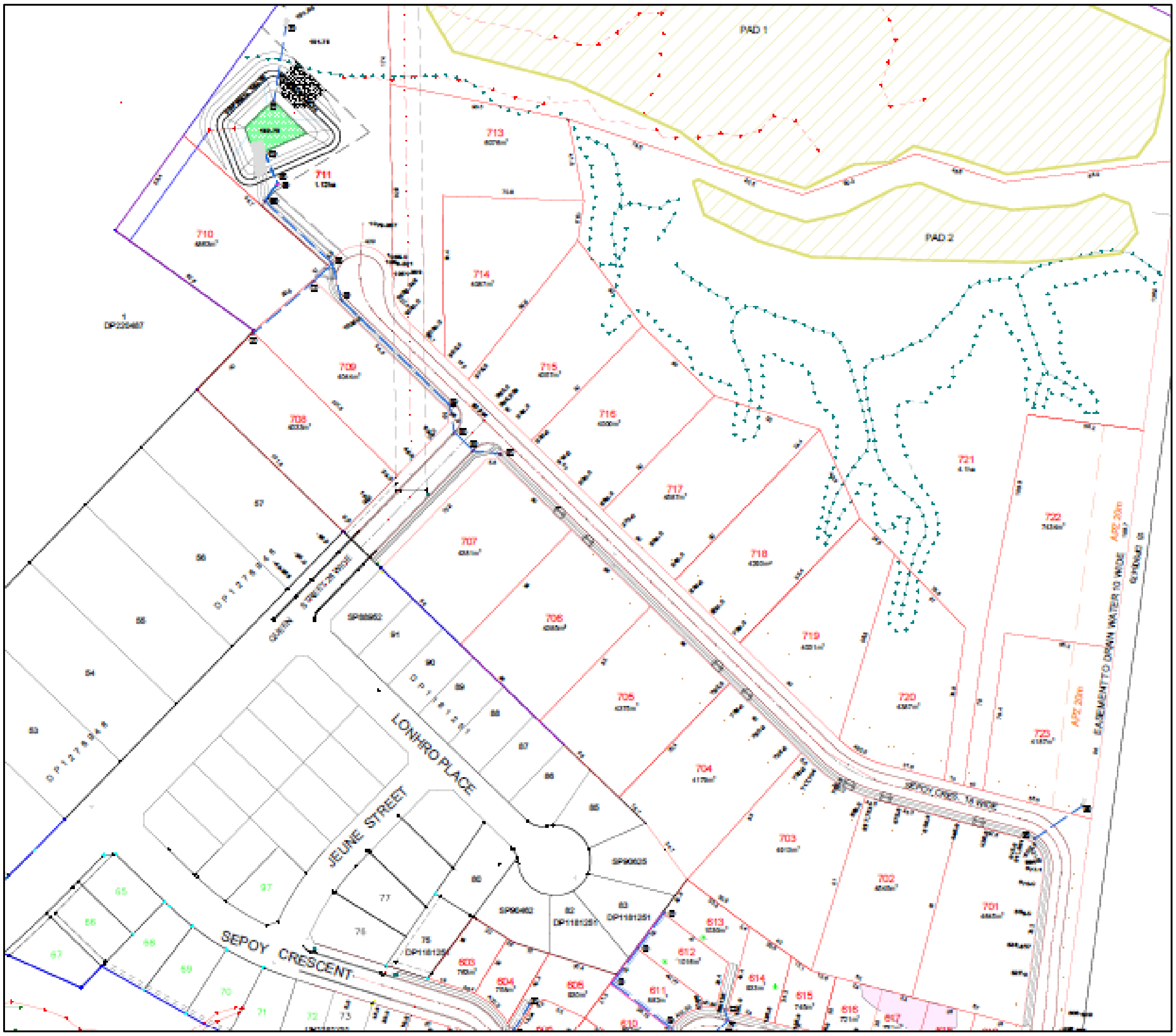


FIGURE 5 – STAGE 7 STORMWATER DRAINAGE LAYOUT

4.3 STORMWATER DETENTION

4.3.1 General

Stormwater detention needs to be provided to ensure that the post developed flows from the total site are reduced to the predeveloped flows for AEPs from 20% to 1%. Stormwater detention is generally required to be provided ensure that downstream properties are not impacted by increased flows from new developments.

4.3.2 DRAINS Detention Modelling for Stage 6

The existing detention basin at Queen Street will provide detention for the proposed Stage 6 development. Stormwater drainage flows from Stage 6 will discharge into the existing stream to the south which flows west into the existing detention basin at Queen Street.

The existing DRAINS model prepared by RHM Consulting Engineers for Stages 4 and 5 was utilized and updated to incorporated the developed Stage 6 catchments.

The following items were adjusted in the DRAINS model:

- The initial losses were changed to be 30mm and continuing losses to be 0.44mm/hr as per ARR data hub information (refer to Appendix A).
- The predeveloped catchments time of concentration was checked and adjusted to include 50m of sheet flow and 20 minutes for concentrated flow calculated in accordance with QUDM.
- The time of concentration for catchment N1 was checked and adjusted to include 50m of sheet flow and 9 minutes of concentrated flow calculated in accordance with QUDM.
- The catchment properties for catchments N2, N22 and N31 were updated for the proposed Stage 6 development and include:
    - The time of concentration was adjusted to be 5 minutes for impervious catchment and 10 minutes for pervious catchment.
    - The fraction impervious was updated to be 60%.
- The Queen Street basin outlet configuration was updated to match the details on site and include:
    - 1200x1200 surcharge pit with a 900mm diameter outlet pipe
    - Twin 1200x900 RCBC

- The Northview Street basin outlet configuration was updated to match the details on site. The outlet culvert is a 900x600 RCBC.

4.3.2.1 Peak Flows

The comparison of the predeveloped and post developed peak flows from the updated DRAINS model are shown in Table 1.

Table 1: Predeveloped Peak Flows versus Post Developed Peak Flow for Stage 6

Storm Event (AEP)	Peak Discharge m3/s (AEP)		
	Predeveloped	Post developed	Difference %
20%	1.56	1.44	-8
10%	3.43	2.77	-19
5%	5.04	4.02	-20
2%	6.84	5.13	-25
1%	8.13	6.44	-21

As can be seen from Table 1, the post developed flows with the inclusion of Stage 6 development are below the predeveloped flows downstream of the existing Queen Street detention basin.

The DRAINS model schematic and results are contained in Appendix B.

4.3.3 DRAINS Detention Modelling for Stage 7

DRAINS modelling was undertaken to determine the predeveloped and developed peak flows at the western boundary of Stage 7 for a range of AEPs from 20% to 1%. ARR 2019 procedures were utilised in the DRAINS models.

The available detention volumes from the rainwater tanks which are a requirement of BASIX for each dwelling were not accounted for in the detention modelling.

The predeveloped catchment was modelled using the RAFTS.

The proposed developed catchments were modelled using the Initial Loss – Continuing Loss (IL-CL) model.

4.3.3.1 Rainfall Data

The Australian Rainfall and Runoff (AR&R) Data Hub was used to obtain data (Storm Losses, Temporal Patterns, BOM IFD Depths, Preburst Depths and Ratios and Interim Climate Change Factors) for the development site. The AR&R Data Hub results are shown in Appendix A.

4.3.3.2 Predeveloped Catchment

The predeveloped catchment draining under the railway to the west has been estimated to be approximately 21.6 hectares. Refer to Figure 6.

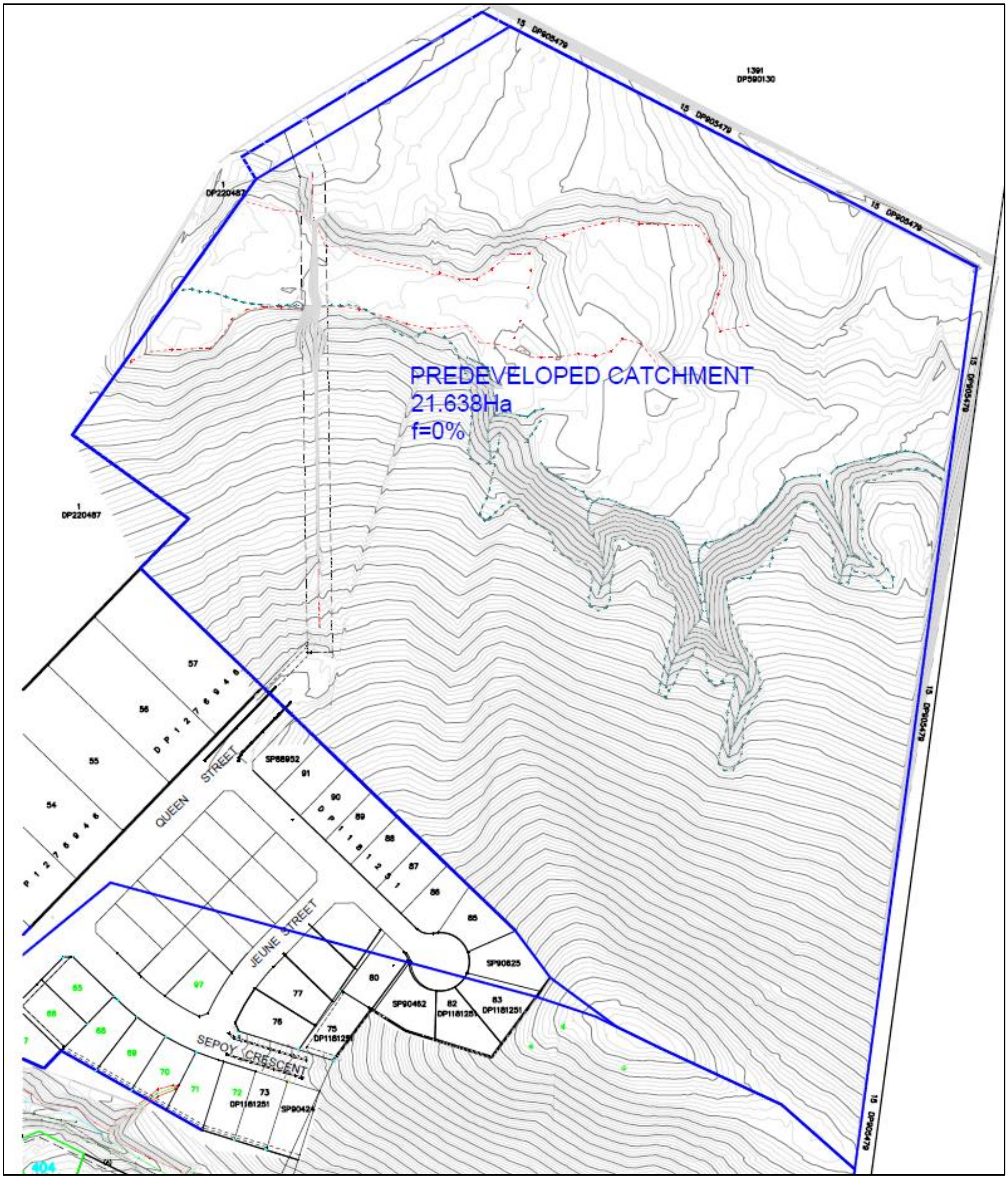


FIGURE 6 – STAGE 7 PREDEVELOPED CATCHMENT

4.3.3.3 Post Developed Catchments

The post developed catchments are shown in Figure 7. Catchments draining to the proposed detention basin and catchments bypassing the basin are shown.

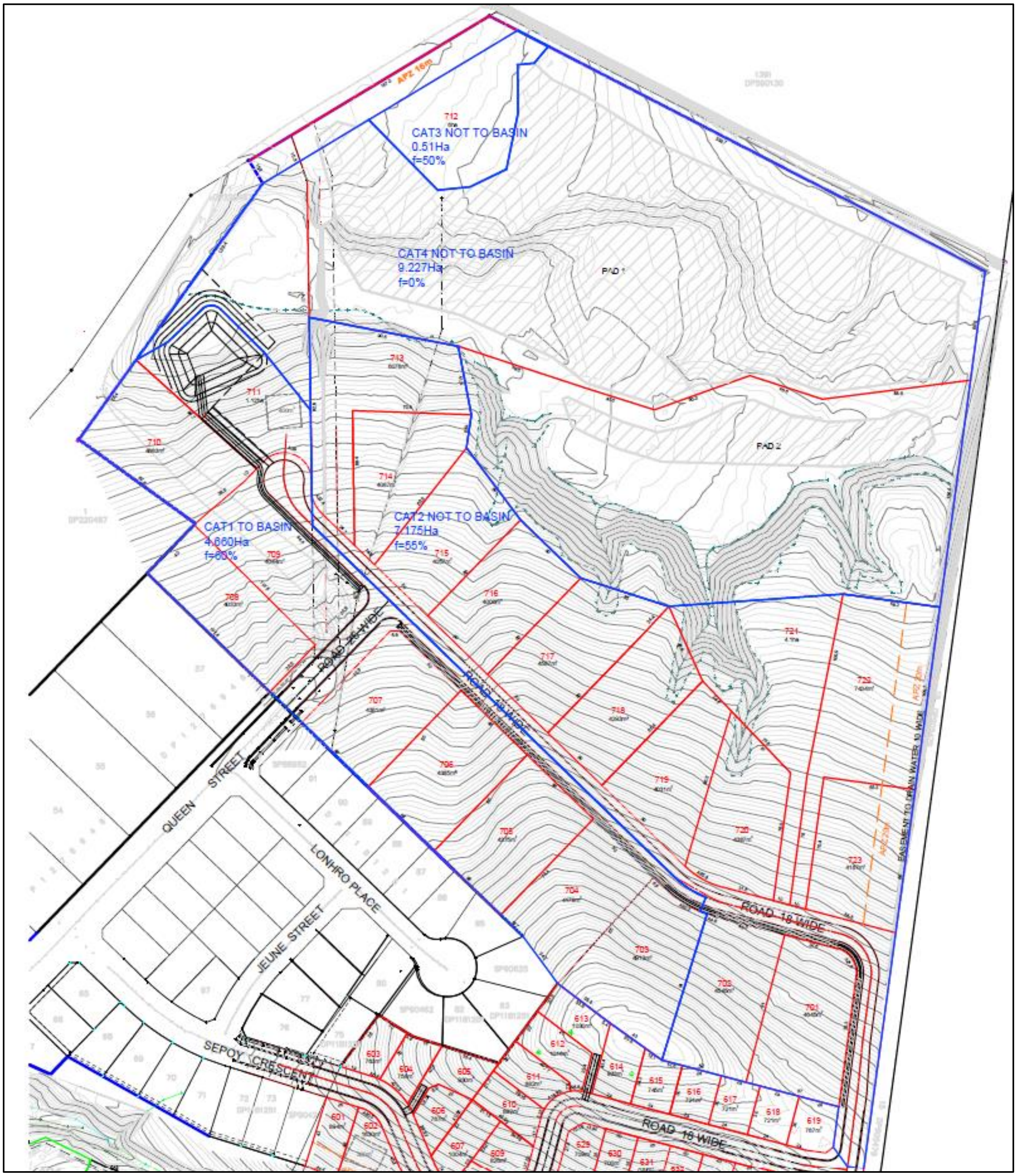


FIGURE 7 – STAGE 7 POST DEVELOPED CATCHMENTS

4.3.3.4 Fraction Impervious

The fraction impervious used in the stormwater drainage modelling is outlined in MSC Council's Handbook for Drainage Design Criteria and detailed in Table 2.

Table 2: Fraction Impervious for Various Land Use

Development Type	Fraction Impervious Road and Lot	Fraction Impervious Interallotment Drainage
Residential (2a)	0.5	0.65
Residential (2b)	0.7	0.8

4.3.3.5 Time of Concentration

The minimum time of concentration adopted for the developed catchments utilising the Initial Loss – Continuing Loss Model are 5 minutes for the impervious catchments and 10 minutes for pervious catchments. This is the time of concentration for lot runoff. Additional flow travel times along the kerbs, drains and pipes were added to the developed catchments in accordance with Queensland Urban Drainage Manual Section 4.6.7.

Time of concentration for the predeveloped catchment and existing creek catchments were determined by the program using RAFTS. Catchment information such as area, fraction impervious, catchment slope and a Manning's n value are entered into the Sub-Catchment Data. The Manning's n values adopted for the modelling are in line with recommendations from Australian Rainfall and Runoff: A Guide to Flood Estimation Table 6.2.2. A Manning's n value of 0.04 was adopted for the stream traversing through the development site (waterways with minimal vegetation and trees).

4.3.3.6 Detention Basin

The proposed detention basin has the following properties:

Table 3: Proposed Detention Basin Properties

Elevation (m)	Surface Area (m^2)
152.75 – base	443
153.75	953
154.25 – spillway	1318
154.75 – top	1697

The basin outlet configuration is:

- 900mm x 900mm surface inlet pit – top of pit RL153.05
- 375mm diameter outlet pipe from pit – pipe invert level RL151.75
- 10m wide spillway at RL154.25

4.3.3.7 Peak Flows

The comparison of the predeveloped and post developed peak flows WITHOUT a basin are shown in Table 4.

Table 4: Predeveloped Peak Flows versus Post Developed Peak Flow without detention basin

Storm Event (AEP)	Peak Discharge m3/s (AEP)		
	Predeveloped	Post developed (without basin)	Difference %
20%	1.35	1.69	25
10%	1.69	2.25	33
5%	2.19	2.73	25
2%	2.95	3.42	16
1%	3.67	4.16	13

As can be seen from Table 4, the post developed flows are higher than the predeveloped flows without a detention basin.

The comparison of the predeveloped and post developed peak flows WITH a basin are shown in Table 5.

Table 5: Predeveloped Peak Flows versus Post Developed Peak Flow with detention basin

Storm Event (AEP)	Peak Discharge m3/s (AEP)		
	Predeveloped	Post developed (with basin)	Difference %
20%	1.35	1.36	1
10%	1.69	1.77	5
5%	2.19	2.16	-1
2%	2.95	2.65	-10
1%	3.67	3.23	-12

As can be seen from Table 5, the post developed flows with the proposed detention basin have been reduced below the predeveloped flows for all AEPs except the 20% and 10% which are only higher by 5%. With the inclusion of rainwater tanks on each residence within the development, the 20% and 10% AEP post developed flows will be further reduced.

The DRAINS model schematic and results are contained in Appendix C.

5 Stormwater Quality Management

5.1 OBJECTIVES

The objectives of the Stormwater Quality for the site are:

- Meet the water quality objectives of Muswellbrook Shire Council (MSC) for the operational phase of the site by using best practice stormwater treatment measures.
- Water quality treatment measures are to be provided to ensure that stormwater generated from development does not result in pollution of water courses and receiving waters.
- Water quality management systems are to be designed to capture and remove all litter larger than 5mm in size.
- Provide pollution reduction devices e.g. Gross Pollutant Traps, to remove contaminants such as oil, sediment and other pollutants before stormwater discharges into the receiving system beyond the site of the development.
- In accordance with MSC DCP Section 25 Stormwater Management, the event mean concentration of specific pollutants is not to exceed the following:

Table 6: MSC Pollutant Mean Concentrations

Pollutant	Maximum Event Mean Concentration
Sediment	100mg/L
Hydrocarbons	500ug/L (0.5mg/L)
Total Nitrogen	1000ug/L (1mg/L)
Ammonia	15ug/L (0.015mg/L)
Phosphorus	100ug/L (0.1mg/L)

5.2 OPERATIONAL PHASE WATER QUALITY MANAGEMENT

5.2.1 General

To meet the water quality requirements of MSC, a range of water quality improvement devices will be required.

The proposed water quality improvement devices for the site will include:

- rainwater tanks
- grass swales
- Humegard GPTs
- bioretention basin

The above water quality improvement devices act as a treatment train, progressively reducing pollutants as they pass through each one.

5.2.2 Stormwater Quality Modelling

5.2.2.1 Introduction

The MUSIC model version 6.3 was used to assess the pollutant generation from the development and the performance of the stormwater quality treatment train.

5.2.2.2 Rainfall Data and Evaporation Data

The rainfall data and evapotranspiration data collected from the Liddell Power Station was used.

5.2.2.3 Soil Types

As detailed in the geotechnical report for Stages 4A/B and 5A/B prepared by DRB Consulting Engineers Project No. 210796.Rev A, dated 2 July 2021, subgrade conditions across the site are likely to consistent of either a Silty Sandy CLAY material or an Extremely Weathered SANDSTONE. The upper layers of the Extremely Weathered SANDSTONE was considered to be excavatable, and presented with clay like properties before becoming competent SANDSTONE.

5.2.2.4 Catchments

The catchment draining to the proposed bio-retention basin is CAT1 in Figure 7 which has an area of 4.66 hectares and a fraction impervious of 60%.

The other catchments (CAT2, CAT3 and CAT4) shown in Figure 7 do not drain to the proposed bio-retention basin.

5.2.2.5 Rainfall-Runoff Parameters

The rainfall-runoff parameters for the MUSIC model were adopted from the NSW MUSIC Modelling Guidelines Table 5-5 to suit Sandy clay soils and are detailed in Table 7.

Table 7: Rainfall-Runoff Parameters for Sandy Clay Soils

Soil Parameter	Value
Rainfall Threshold (mm/day)	Land uses 1.0
Soil Storage Capacity (mm)	142
Initial Storage (% of Capacity)	25
Field Capacity	94
Infiltration Capacity Coefficient – a	180
Infiltration Capacity Coefficient – b	3
Groundwater Initial Depth (mm)	10
Groundwater Daily Recharge Rate (%)	25
Groundwater Daily Base Flow (%)	25
Groundwater Daily Deep Seepage Rate (%)	0

5.2.2.6 Catchments Pollutant Mean Concentrations

The pollutant Event Mean Concentration (EMC) values were adopted from NSW MUSIC Modelling Guidelines Table 5-6 for the base flows and Table 5-7 for the storm flows. The base flow values are shown in Table 8 and the storm flow values are shown in Table 9 for residential land.

Table 8: Base Flow Pollutant Event Mean Concentration Values

Catchment Type	Base Flow Pollutant Event Mean Concentration Values					
	TSS (log 10)		TP (log 10)		TN (log 10)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Residential	1.20	0.17	-0.85	0.19	0.11	0.12

Table 9: Storm Flow Pollutant Event Mean Concentration Values

Catchment Type	Storm Flow Pollutant Event Mean Concentration Values					
	TSS (log 10)		TP (log 10)		TN (log 10)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Residential	2.15	0.32	-0.60	0.25	0.30	0.19

5.2.2.7 MUSIC Model Treatment Train

The stormwater quality treatment train consist of the rainwater tanks, vegetated swales, Humegard GPTs and a bioretention basin.

A brief description on each treatment measure is listed below.

- Rainwater Tanks receive water from the roof area of each lot. Water captured in the rainwater tanks is expected to be reused for toilet flushing, clothes washing, hot water and garden irrigation in accordance with BASIX requirements for residential dwellings.
- Vegetated swales are typically trapezoidal shaped open channels provided to convey and filter stormwater runoff through vegetation to remove coarse sediment and total suspended solids.
- Humegard GPTs are proposed to be installed at pipe outlets. The GPTs remove gross pollutants, sediment and attached nutrients. Table 10 shows the removal efficiencies of the Humegard GPT.

Table 10: Humegard GPT Removal Efficiencies

Gross Pollutant Removal (%)	TSS Removal (%)	TP Removal (%)	TN Removal (%)
90	49	40	26

- Bioretention systems remove sediments (TSS) as well as nutrients (TN and TP) from the stormwater. The bioretention basin consists of a shallow dry basin with deep rooted vegetation and grass on the surface, over an infiltration/filtration area and an underdrain area. Vegetation in the bioretention basin will be in accordance with MSC requirements. To avoid potential salinity problems, an impermeable HDPE liner is to be provided in the bioretention basins to prevent any water infiltrating.

The MUSIC inputs for the bioretention basin for Stage 7 are shown in Table 11.

Table 11: Bioretention Basin MUSIC Model Inputs

MUSIC Inputs	Basin 1
Extended Detention Depth (m)	0.3
Surface Area (m2)	443
Filter Area (m2)	443
Unlined Filter Material (m)	1
Saturated Hydraulic Conductivity (mm/hr)	100
Filter Depth (m)	0.6
TN Content of Filter Media (mg/kg)	800
Orthophosphate of Filter Media (mg/kg)	50
Exfiltration Rate (mm/hr)	0
Base Lined	Yes
Vegetation Removing Plants	Yes
Under Drain Present	Yes

For this stage of the design, the MUSIC model only includes a Humegard GPT and a bioretention basin for Stage 7. Additional water quality treatment will be provided by the rainwater tanks and road side grassed swale but these have not been included in the MUSIC model.

5.2.2.8 MUSIC Models

Two MUSIC models were prepared.

MUSIC model 1 only included the development catchment draining to the proposed bio-retention basin. Refer to Figure 8 for the MUSIC Schematic.

MUSIC model 2 included all Stage 7 catchments. Refer to Figure 9 for the MUSIC Schematic.

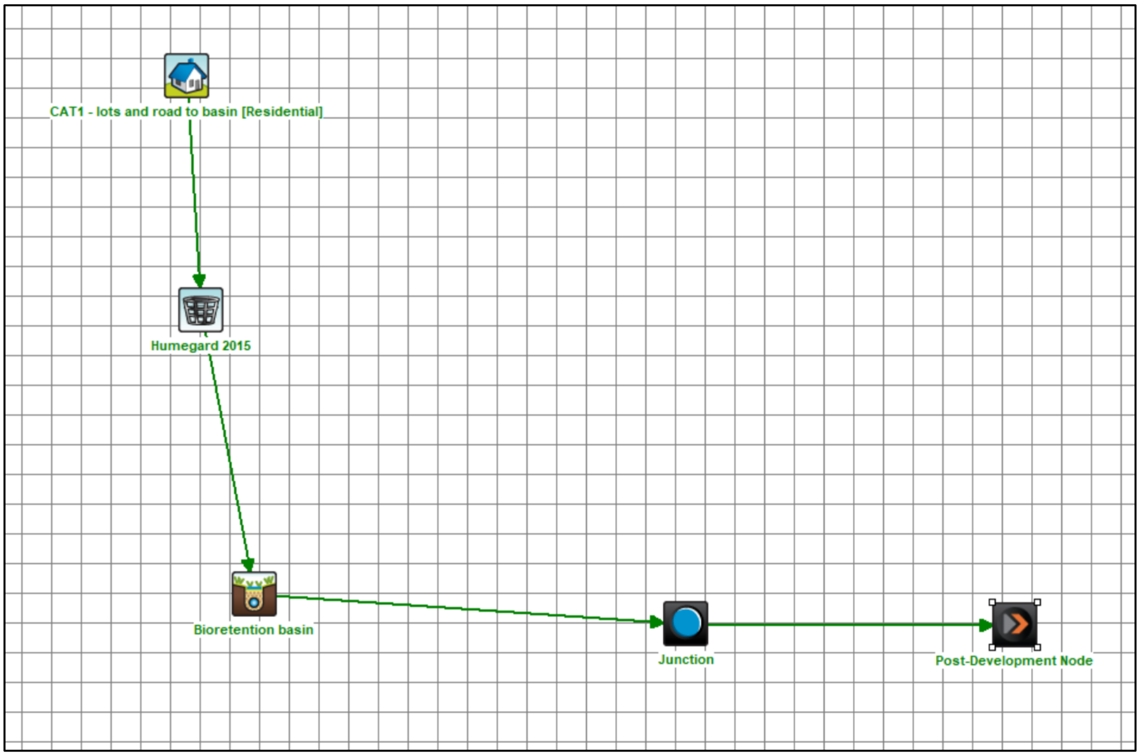


FIGURE 8 - STAGE 7 MUSIC SCHEMATIC
CATCHMENT DRAINING TO BASIN ONLY

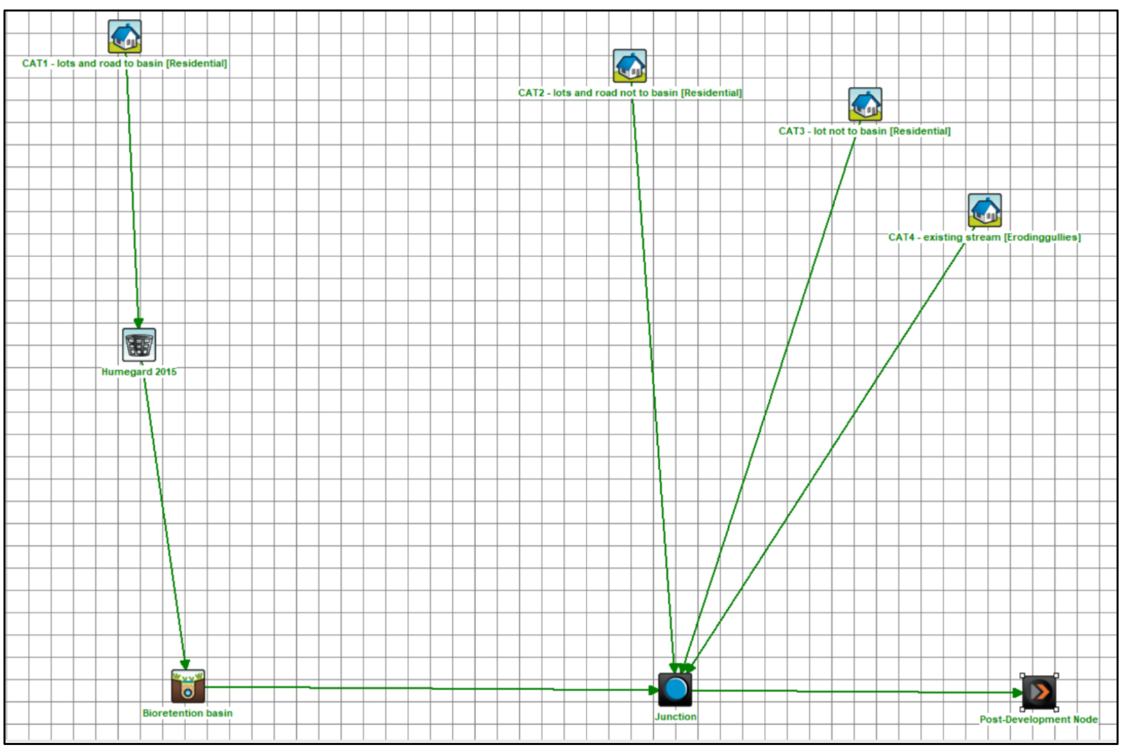


FIGURE 9 - STAGE 7 MUSIC SCHEMATIC – ALL CATCHMENTS

5.2.2.9 Stormwater Quality Modelling Results

The maximum event mean concentrations from the MUSIC model are shown in Table 12.

Table 12: Maximum Event Mean Concentrations

Pollutant	**Maximum Event Mean Concentration mg/L**		**MSC Maximum Event Mean Concentration mg/L**
	MUSIC model 1 Stage 7 Catchment draining to basin only	**MUSIC model 2 Stage 7 All Catchments**	
Sediment	2.03	58.4	100
Total Nitrogen	0.0498	0.122	0.1
Phosphorus	0.330	0.769	1

The results of the MUSIC modelling show that the proposed water quality treatments have sufficiently reduce the pollutants to an acceptable level.

5.3 CONSTRUCTION PHASE WATER QUALITY MANAGEMENT

During the construction phase of the development, an Erosion and Sediment Control Plan will be implemented to minimise the water quality impacts. The erosion and sediment controls will be in accordance with Landcom's Managing Urban Stormwater: Soils and Construction Volume 1, 4th Edition (Landcom, 2004) and the requirements of MSC. Erosion and sediment controls will be required preconstruction, during construction and post construction until the site is stabilized. The expected erosion and sediment control measures will include stabilized site access, sediment fence, gully pit sediment barriers, rock outlet scour protection and a temporary sediment basin. Erosion and sediment control plans will be provided for the development at the Construction Certificate stage.

6 Conclusion

The DRAINS modelling undertaken has shown that the existing detention basin at Queen Street has sufficient capacity to cater for the proposed Stage 6 developments. The proposed detention basin for Stage 7 has reduced the post developed peak flows below the predeveloped peak flows for most of the AEPs.

The MUSIC modelling undertaken has shown that the proposed treatment train of rainwater tanks, vegetated swales, a GPT and a bioretention basin has sufficiently reduced the mean annual pollutants loads from the proposed Stage 7 development. The bioretention basin configuration, levels and inlet/outlet details will need to be confirmed at the Construction Certificate design stage.

During the construction phase of the development, an Erosion and Sediment Control Plan will be implemented to minimise the water quality impacts. Erosion and Sediment Control Plans and details will need to be prepared at the Construction Certificate design stage.

Report prepared by
Ulrika Knight
Senior Civil Engineer

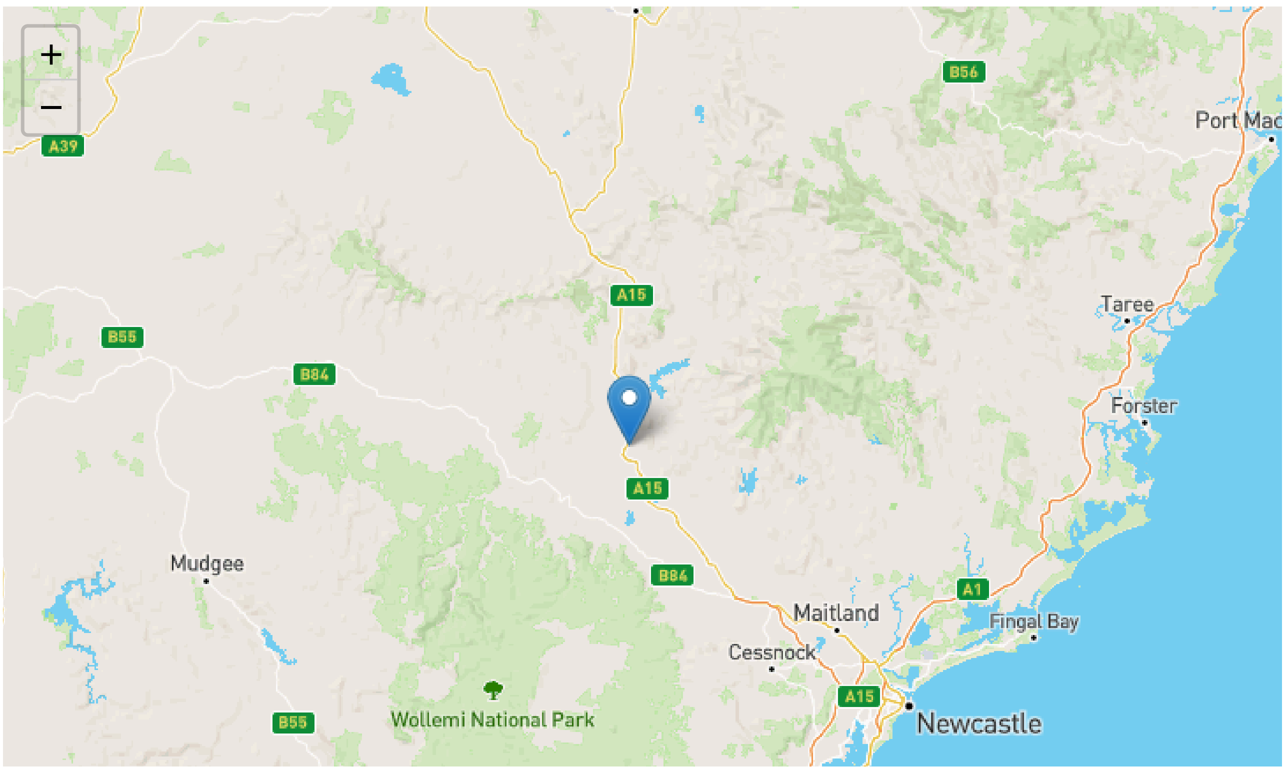
Report reviewed by
Michael Cole
Registered Land Surveyor - Director

7 Appendix A – AR&R Data Hub Information

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	150.902
Latitude	-32.247
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show
Baseflow Factors	show



Data

River Region

Division	South East Coast (NSW)
River Number	10
River Name	Hunter River

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
SE Coast	0.06	0.361	0.0	0.317	8.11e-05	0.651	0.0	0.0	0.0

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26 \text{ x } 10^{-3} \text{ x } Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141 \text{ x } Area^{0.213} \text{ x } 10^{-0.021\frac{(Duration-180)^{2}}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

Note: As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	14924.0
Storm Initial Losses (mm)	30.0
Storm Continuing Losses (mm/h)	1.1

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/ECsouth.zip)

code	ECsouth
Label	East Coast South

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_ECsouth.zip)

code	ECsouth
arealabel	East Coast South

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-32.24657&longitude=150.901652&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	29 October 2024 02:52PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.7 (0.031)	0.6 (0.020)	0.5 (0.016)	0.5 (0.012)	0.5 (0.011)	0.5 (0.010)
90 (1.5)	0.4 (0.017)	0.5 (0.014)	0.5 (0.012)	0.5 (0.011)	0.2 (0.004)	0.0 (0.000)
120 (2.0)	1.0 (0.037)	0.8 (0.021)	0.6 (0.014)	0.5 (0.009)	0.3 (0.006)	0.3 (0.004)
180 (3.0)	0.6 (0.020)	0.7 (0.018)	0.8 (0.018)	0.9 (0.017)	1.4 (0.021)	1.7 (0.023)
360 (6.0)	0.5 (0.012)	1.2 (0.024)	1.7 (0.028)	2.1 (0.032)	3.0 (0.037)	3.6 (0.040)
720 (12.0)	0.0 (0.000)	1.6 (0.026)	2.7 (0.036)	3.8 (0.044)	7.7 (0.074)	10.6 (0.091)
1080 (18.0)	0.0 (0.000)	1.1 (0.015)	1.9 (0.022)	2.6 (0.026)	6.9 (0.057)	10.2 (0.073)
1440 (24.0)	0.0 (0.000)	1.3 (0.015)	2.1 (0.022)	2.9 (0.026)	7.6 (0.055)	11.1 (0.071)
2160 (36.0)	0.0 (0.000)	0.7 (0.008)	1.2 (0.011)	1.7 (0.013)	2.5 (0.016)	3.1 (0.017)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
90 (1.5)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
120 (2.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
360 (6.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
720 (12.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
1080 (18.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.1 (0.001)
1440 (24.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2160 (36.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
2880 (48.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	11.3 (0.523)	9.4 (0.321)	8.1 (0.234)	6.9 (0.172)	7.5 (0.157)	7.9 (0.147)
90 (1.5)	15.4 (0.630)	13.0 (0.395)	11.4 (0.294)	9.9 (0.220)	7.4 (0.138)	5.4 (0.091)
120 (2.0)	13.3 (0.500)	15.2 (0.426)	16.5 (0.391)	17.7 (0.363)	15.3 (0.267)	13.6 (0.211)
180 (3.0)	12.9 (0.428)	14.2 (0.354)	15.1 (0.320)	16.0 (0.294)	24.4 (0.381)	30.7 (0.428)
360 (6.0)	9.6 (0.256)	15.8 (0.318)	19.9 (0.341)	23.9 (0.354)	40.0 (0.502)	52.1 (0.583)
720 (12.0)	8.4 (0.176)	16.1 (0.254)	21.3 (0.283)	26.2 (0.301)	37.9 (0.366)	46.6 (0.400)
1080 (18.0)	0.8 (0.014)	10.3 (0.139)	16.6 (0.189)	22.6 (0.222)	33.3 (0.273)	41.3 (0.299)
1440 (24.0)	1.9 (0.032)	9.0 (0.108)	13.6 (0.138)	18.1 (0.158)	29.4 (0.214)	37.9 (0.243)
2160 (36.0)	0.0 (0.000)	6.6 (0.069)	11.0 (0.096)	15.2 (0.113)	16.1 (0.099)	16.7 (0.091)
2880 (48.0)	0.0 (0.000)	1.9 (0.018)	3.1 (0.025)	4.3 (0.029)	5.6 (0.031)	6.5 (0.032)
4320 (72.0)	0.0 (0.000)	0.3 (0.002)	0.5 (0.003)	0.7 (0.004)	3.5 (0.017)	5.7 (0.025)

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	28.3 (1.308)	23.9 (0.816)	21.0 (0.605)	18.3 (0.453)	27.2 (0.567)	33.9 (0.627)
90 (1.5)	32.3 (1.320)	40.7 (1.235)	46.3 (1.187)	51.6 (1.146)	45.8 (0.859)	41.5 (0.693)
120 (2.0)	43.3 (1.626)	45.0 (1.260)	46.1 (1.095)	47.2 (0.971)	58.4 (1.017)	66.8 (1.037)
180 (3.0)	32.9 (1.093)	43.9 (1.095)	51.2 (1.085)	58.2 (1.071)	69.0 (1.076)	77.0 (1.072)
360 (6.0)	33.7 (0.896)	45.8 (0.919)	53.8 (0.919)	61.5 (0.913)	79.2 (0.994)	92.4 (1.033)
720 (12.0)	22.0 (0.462)	38.3 (0.602)	49.1 (0.653)	59.4 (0.684)	83.2 (0.805)	101.1 (0.866)
1080 (18.0)	15.3 (0.279)	31.6 (0.427)	42.4 (0.482)	52.7 (0.517)	73.1 (0.599)	88.4 (0.639)
1440 (24.0)	21.4 (0.352)	34.1 (0.413)	42.5 (0.432)	50.6 (0.441)	70.2 (0.510)	84.8 (0.543)
2160 (36.0)	15.3 (0.221)	28.8 (0.301)	37.7 (0.329)	46.3 (0.345)	52.2 (0.323)	56.7 (0.308)
2880 (48.0)	0.2 (0.002)	8.2 (0.078)	13.5 (0.106)	18.6 (0.125)	27.9 (0.155)	34.9 (0.170)
4320 (72.0)	7.7 (0.092)	9.1 (0.078)	10.1 (0.071)	11.1 (0.066)	27.5 (0.136)	39.9 (0.172)

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Climate Change Factors

Rainfall Factors

SSP1-2.6

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.12**	**1.12**	**1.11**	**1.1**	**1.1**
2040	1.21	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.11	1.11
2050	**1.22**	**1.2**	**1.18**	**1.17**	**1.15**	**1.15**	**1.14**	**1.13**	**1.12**	**1.11**
2060	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2070	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2080	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2090	**1.23**	**1.21**	**1.2**	**1.18**	**1.17**	**1.16**	**1.15**	**1.14**	**1.13**	**1.12**
2100	1.22	1.2	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.12

SSP2-4.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.12**	**1.12**	**1.11**	**1.1**	**1.1**
2040	1.22	1.2	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.12
2050	**1.27**	**1.24**	**1.23**	**1.21**	**1.19**	**1.18**	**1.17**	**1.16**	**1.15**	**1.14**
2060	1.3	1.27	1.25	1.23	1.21	1.2	1.19	1.18	1.16	1.16
2070	1.33	1.3	1.28	1.26	1.24	1.22	1.21	1.19	1.18	1.17
2080	1.37	1.33	1.31	1.28	1.26	1.24	1.22	1.21	1.2	1.19
2090	**1.4**	**1.36**	**1.34**	**1.31**	**1.28**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**
2100	1.41	1.37	1.35	1.32	1.29	1.27	1.25	1.24	1.22	1.21

SSP3-7.0

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.12**	**1.12**	**1.11**	**1.1**	**1.1**
2040	1.23	1.21	1.2	1.18	1.17	1.16	1.15	1.14	1.13	1.12
2050	**1.29**	**1.26**	**1.24**	**1.22**	**1.2**	**1.19**	**1.18**	**1.17**	**1.16**	**1.15**
2060	1.35	1.32	1.3	1.27	1.25	1.23	1.22	1.2	1.19	1.18
2070	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2080	1.5	1.45	1.42	1.38	1.35	1.33	1.3	1.28	1.26	1.25

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2090	**1.59**	**1.53**	**1.49**	**1.44**	**1.4**	**1.38**	**1.35**	**1.33**	**1.3**	**1.29**
2100	1.66	1.59	1.55	1.5	1.45	1.42	1.39	1.37	1.34	1.32

SSP5-8.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.2**	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.13**	**1.12**	**1.11**	**1.11**
2040	1.26	1.24	1.22	1.2	1.18	1.17	1.16	1.15	1.14	1.14
2050	**1.34**	**1.31**	**1.29**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**	**1.18**	**1.18**
2060	1.42	1.38	1.35	1.32	1.29	1.28	1.26	1.24	1.22	1.21
2070	1.52	1.47	1.43	1.4	1.36	1.34	1.31	1.29	1.27	1.26
2080	1.63	1.57	1.52	1.48	1.43	1.4	1.37	1.35	1.33	1.31
2090	**1.77**	**1.69**	**1.64**	**1.58**	**1.52**	**1.49**	**1.45**	**1.42**	**1.39**	**1.37**
2100	1.86	1.77	1.71	1.64	1.58	1.54	1.5	1.47	1.43	1.41

Loss Factors

Initial Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.02**	**1.02**	**1.02**	**1.03**
2040	1.03	1.03	1.03	1.03
2050	**1.03**	**1.03**	**1.04**	**1.04**
2060	1.03	1.04	1.04	1.05
2070	1.03	1.04	1.05	1.06
2080	1.03	1.05	1.06	1.07
2090	**1.03**	**1.05**	**1.07**	**1.08**
2100	1.03	1.05	1.07	1.09

Continuing Loss (Adjustment Factors)

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2030	**1.04**	**1.05**	**1.05**	**1.05**
2040	1.05	1.05	1.06	1.06
2050	**1.06**	**1.06**	**1.07**	**1.08**
2060	1.06	1.07	1.08	1.1

	Losses SSP1-2.6	Losses SSP2-4.5	Losses SSP3-7.0	Losses SSP5-8.5
2070	1.06	1.08	1.1	1.12
2080	1.06	1.09	1.11	1.14
2090	**1.06**	**1.09**	**1.13**	**1.16**
2100	1.06	1.1	1.14	1.18

Temperature Changes (Degrees, Relative to 1961-1990 Baseline)

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2030	**1.2**	**1.2**	**1.2**	**1.3**
2040	1.3	1.4	1.5	1.6
2050	**1.4**	**1.7**	**1.8**	**2.1**
2060	1.5	1.9	2.2	2.5
2070	1.5	2.1	2.5	3
2080	1.5	2.2	2.9	3.5
2090	**1.5**	**2.4**	**3.3**	**4.1**
2100	1.4	2.5	3.6	4.5

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2024_v1
Note	Updated climate change factors for IFD Initial loss and continuing loss based on IPCC AR6 temperature increases from the updated Climate Change Considerations (Book 1: Chapter 6) in ARR (Version 4.2). ARR recomends the use of Current and near-term (2030 midpoint). Medium-term (2050 midpoint) and Long-term (2090 midpoint)

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50.0	20.0	10.0	5.0	2.0	1.0
60 (1.0)	21.6	15.9	14.7	15.0	15.2	13.9
90 (1.5)	24.5	14.4	13.0	13.4	13.4	11.7
120 (2.0)	25.6	13.7	12.6	13.1	12.5	11.2
180 (3.0)	26.3	15.1	13.7	13.6	11.8	7.9
360 (6.0)	26.6	16.7	14.4	13.8	11.5	7.6
720 (12.0)	28.3	19.3	16.7	15.8	13.4	7.7
1080 (18.0)	31.0	22.6	20.1	19.3	16.2	8.3
1440 (24.0)	30.2	22.6	21.6	21.3	18.3	10.4
2160 (36.0)	32.0	25.2	24.4	24.1	22.1	13.4
2880 (48.0)	35.8	30.0	30.3	31.6	28.5	18.0
4320 (72.0)	34.9	30.8	31.9	35.1	29.0	19.4

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2018_v1
Note	As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

Baseflow Factors

Downstream	9687
Area (km2)	4403.33365862
Catchment Number	9596
Volume Factor	0.22062
Peak Factor	0.034561

Layer Info

Time Accessed	29 October 2024 02:52PM
Version	2016_v1

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Download JSON (downloads/c2b9ccdd-50ab-4e19-be1b-d003091cce8a.json)

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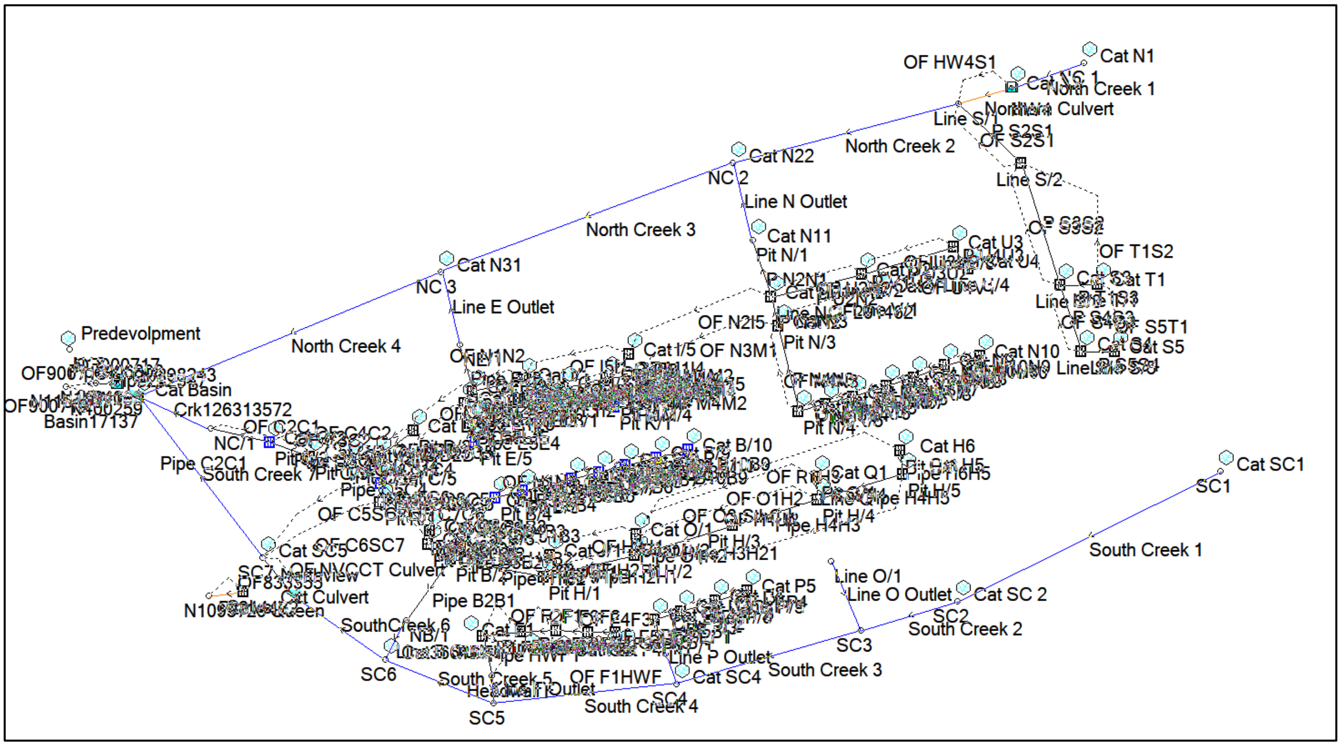
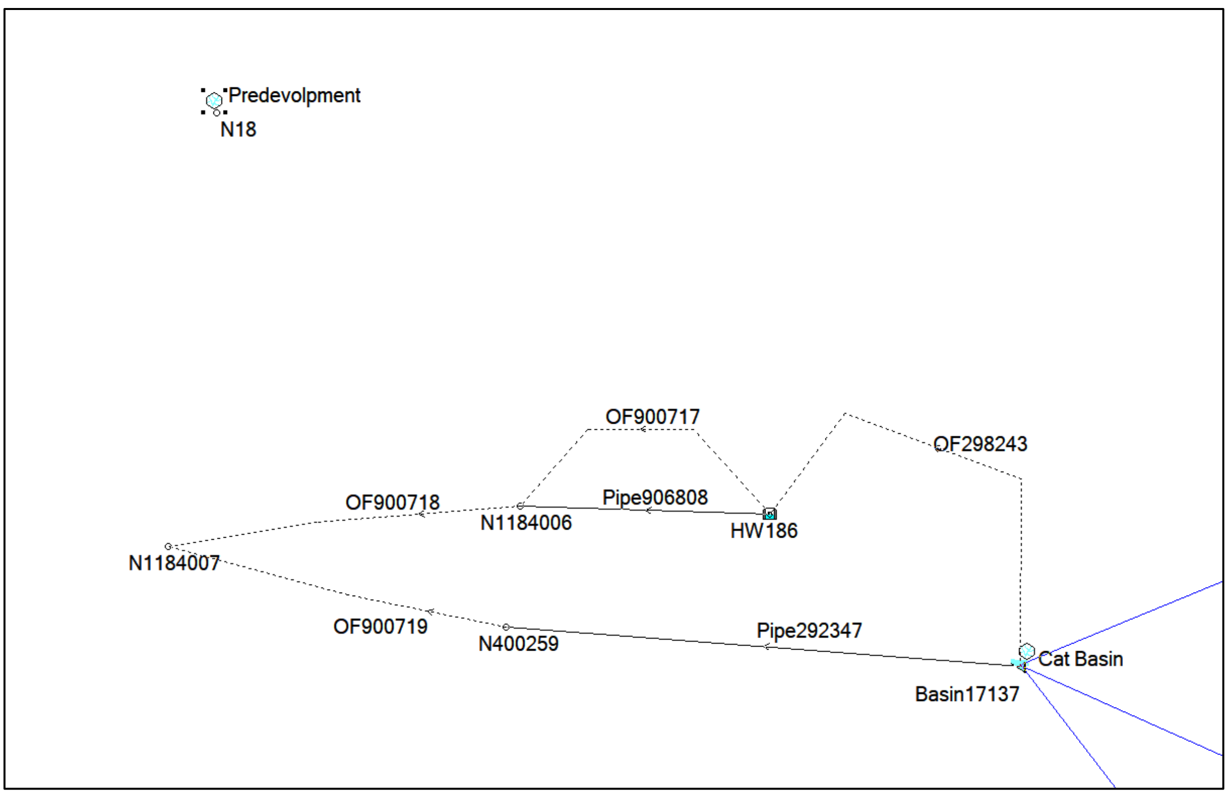
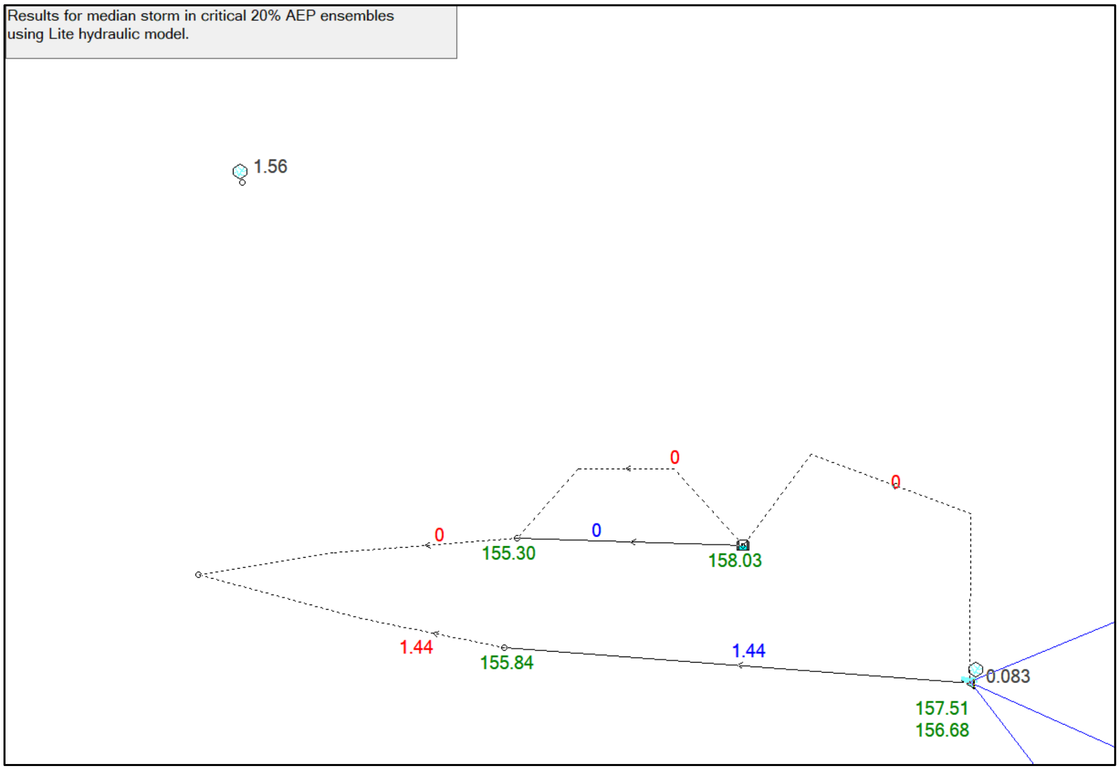
8 Appendix B – Stage 6 DRAINS Modelling Schematics



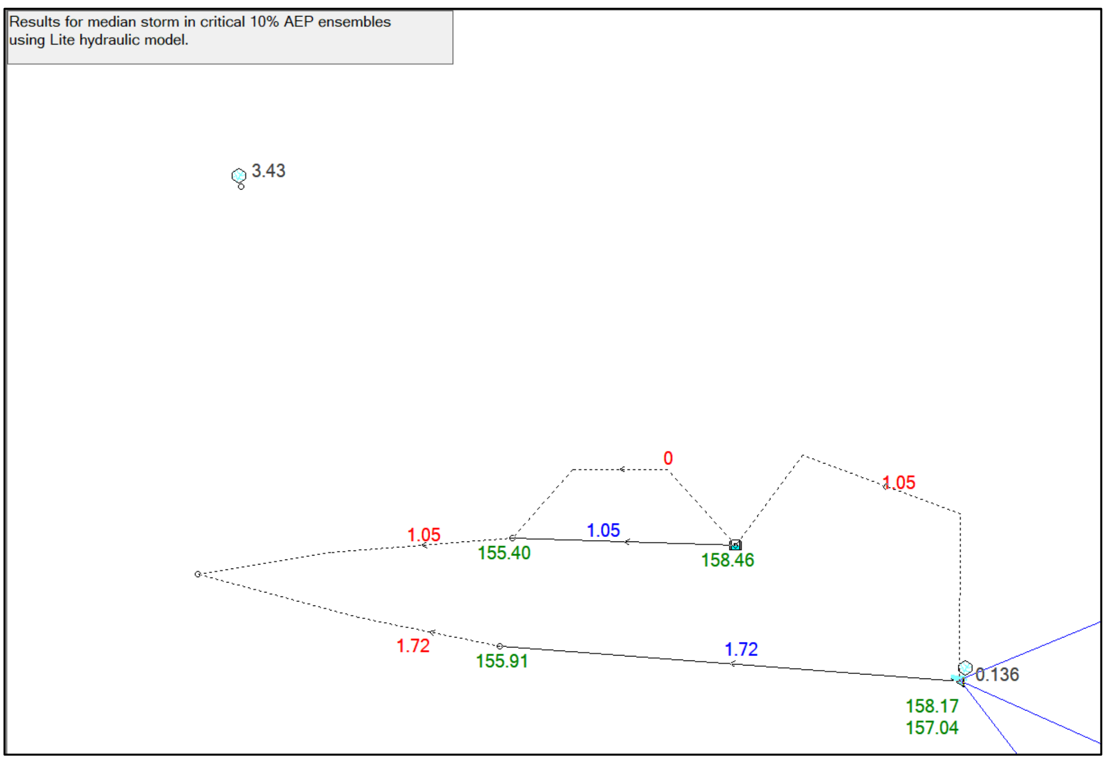
STAGE 6 DRAINS MODEL SCHEMATIC



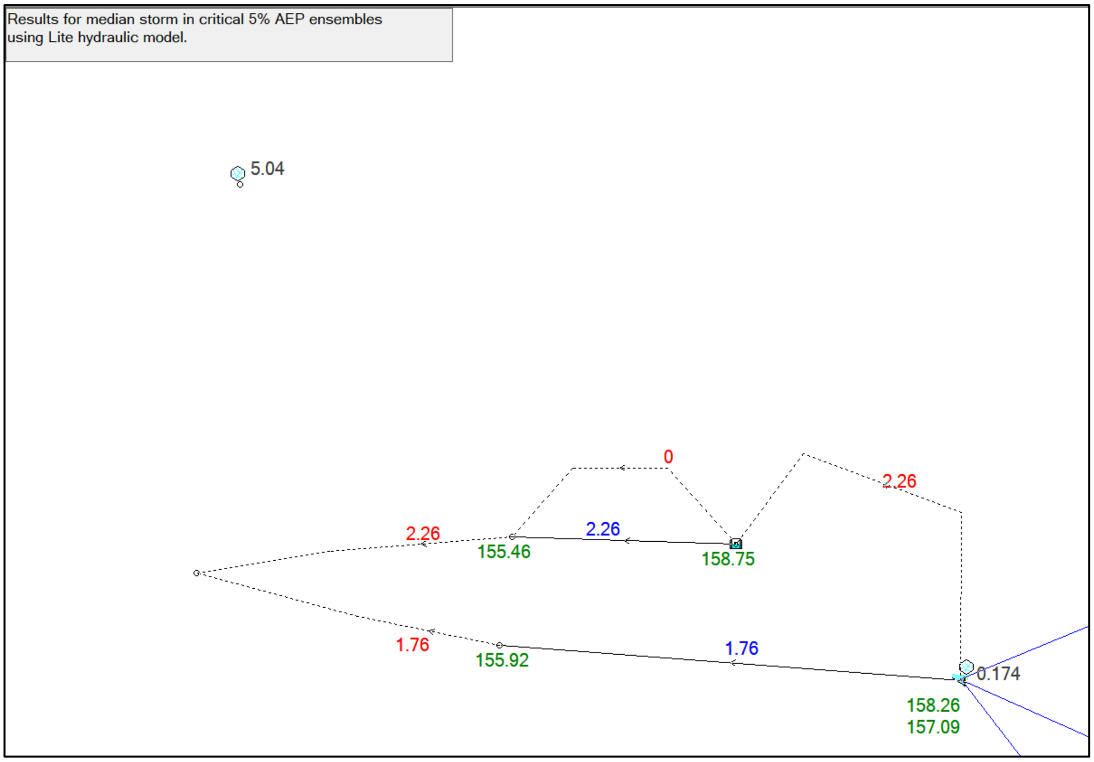
STAGE 6 DRAINS MODEL SCHEMATIC AT QUEEN STREET OUTLET



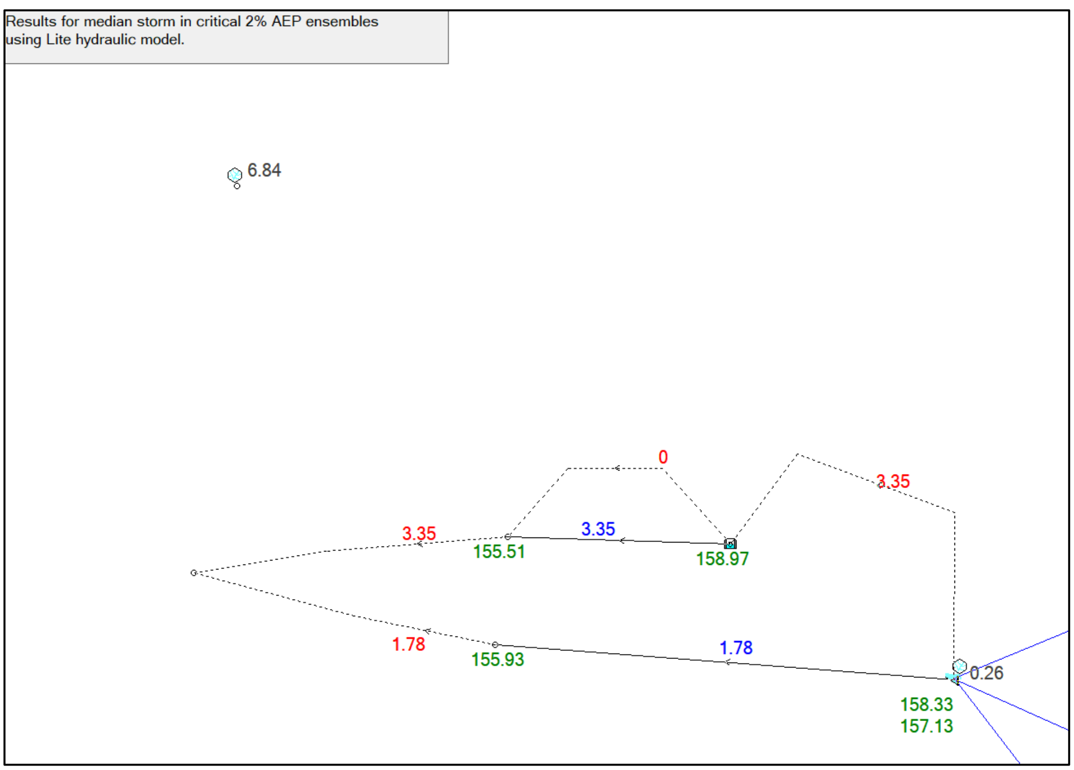
STAGE 6 DRAINS MODEL SCHEMATIC – 20% AEP RESULTS



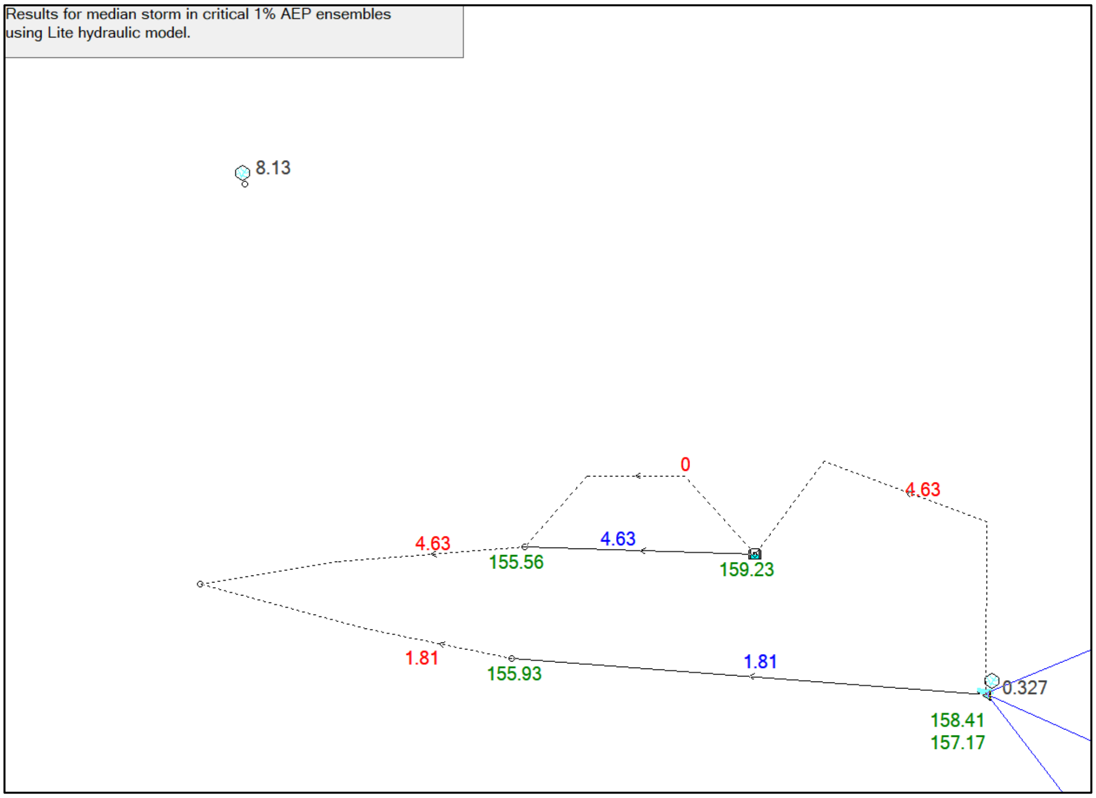
STAGE 6 DRAINS MODEL SCHEMATIC – 10% AEP RESULTS



STAGE 6 DRAINS MODEL SCHEMATIC – 5% AEP RESULTS

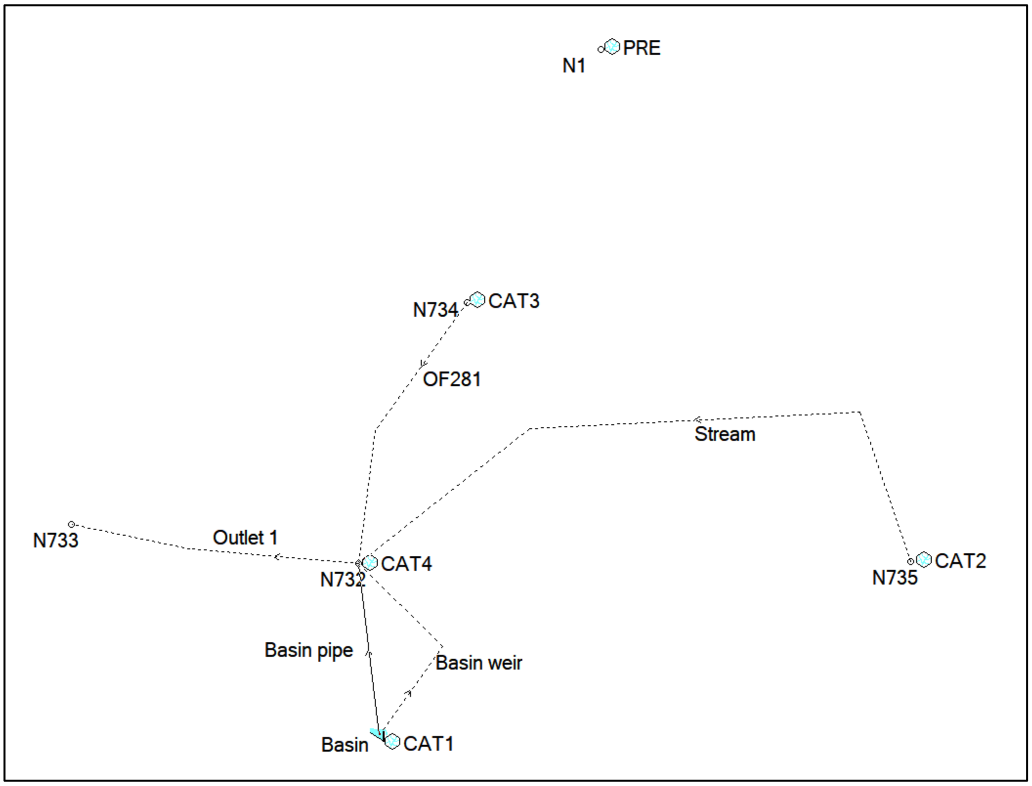


STAGE 6 DRAINS MODEL SCHEMATIC – 2% AEP RESULTS

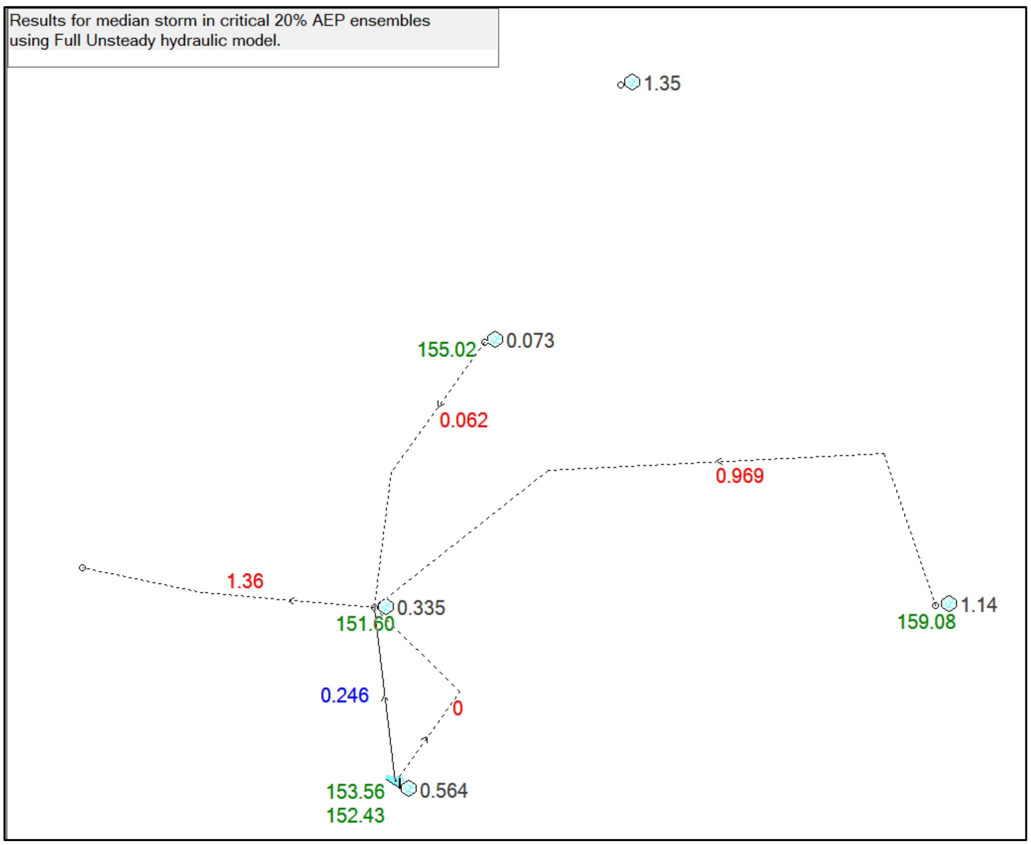


STAGE 6 DRAINS MODEL SCHEMATIC – 1% AEP RESULTS

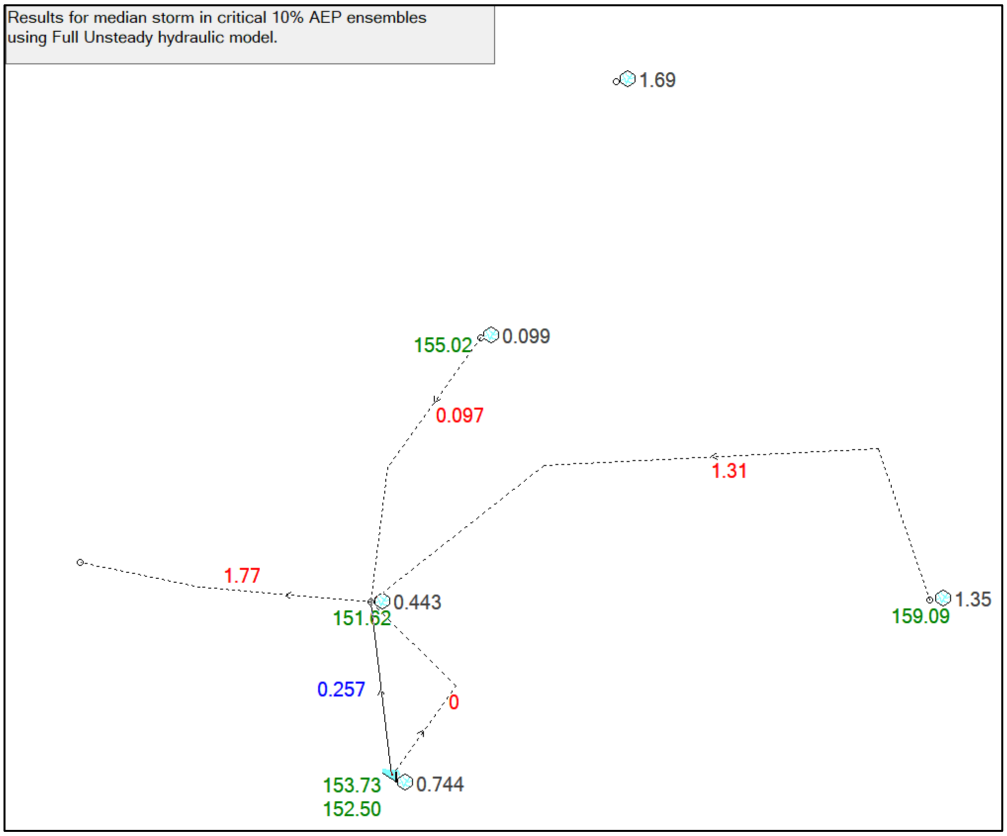
9 Appendix C – Stage 7 DRAINS Modelling Schematics



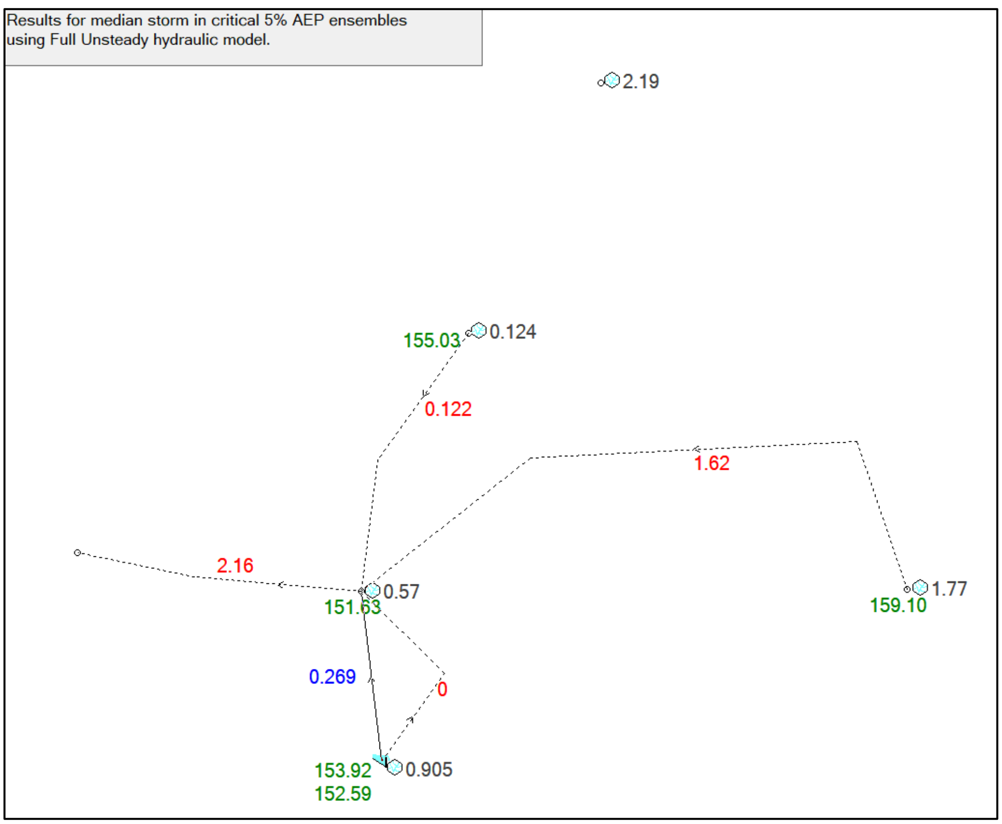
STAGE 7 DRAINS MODEL SCHEMATIC



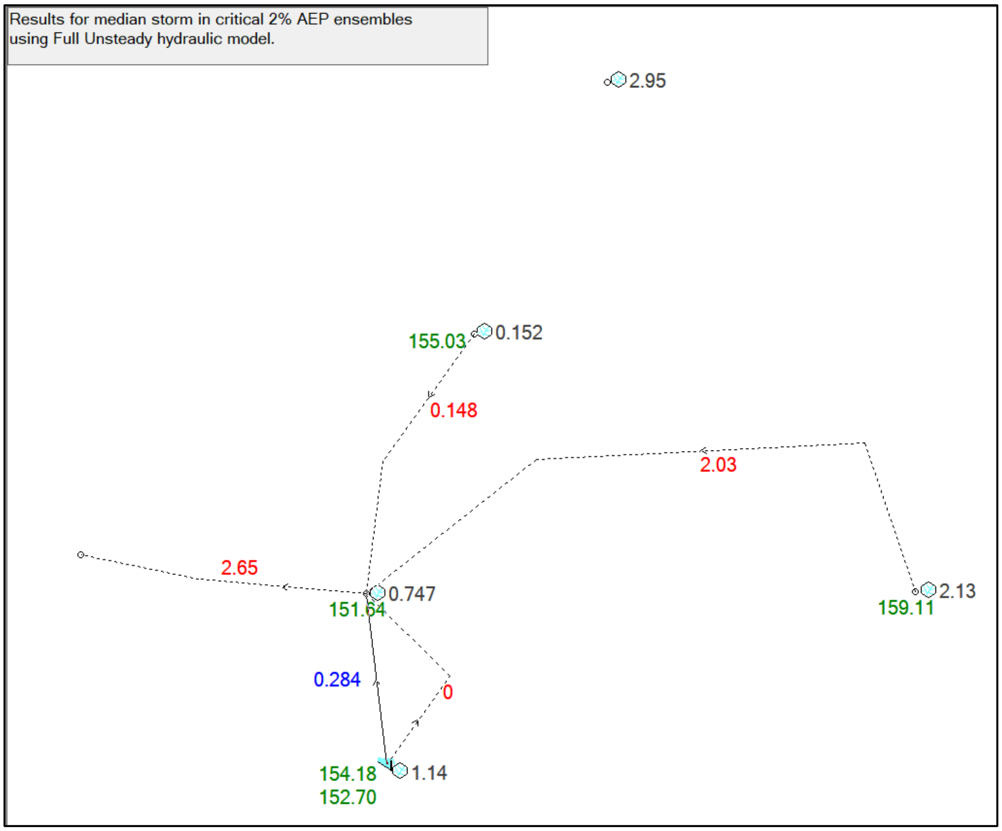
STAGE 7 DRAINS MODEL SCHEMATIC – 20% AEP RESULTS



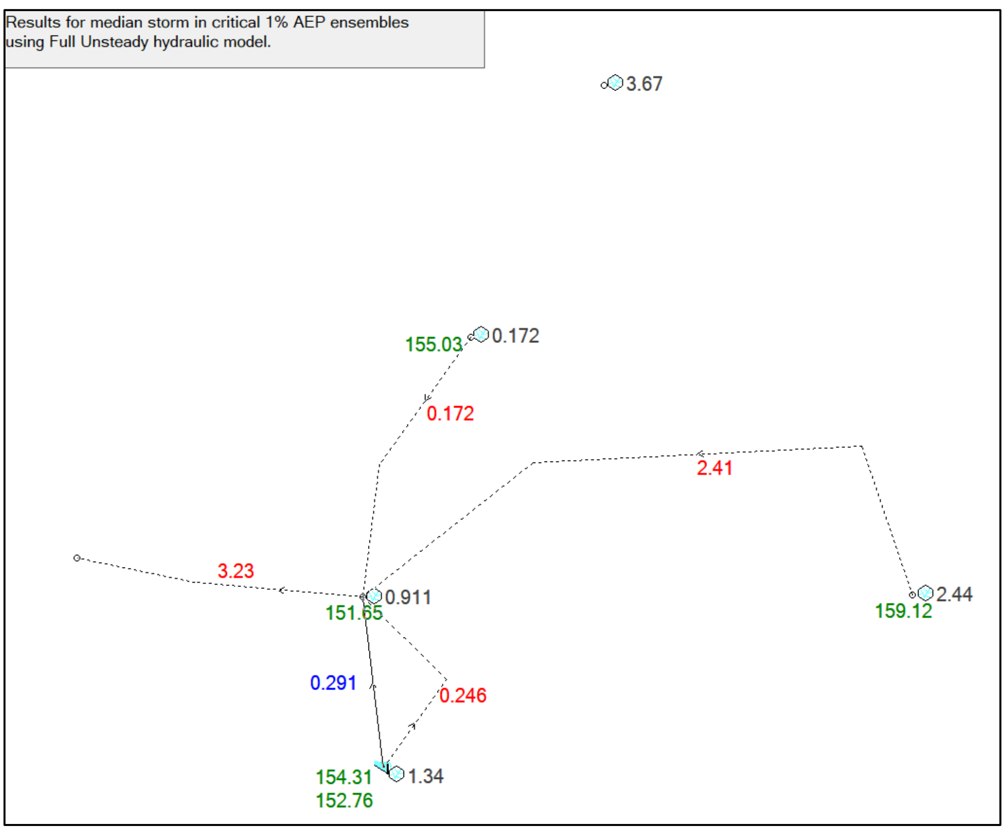
STAGE 7 DRAINS MODEL SCHEMATIC – 10% AEP RESULTS



STAGE 7 DRAINS MODEL SCHEMATIC – 5% AEP RESULTS



STAGE 7 DRAINS MODEL SCHEMATIC – 2% AEP RESULTS



STAGE 7 DRAINS MODEL SCHEMATIC – 1% AEP RESULTS