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2 Karingal Drive, Pimpama

Conceptual Stormwater Management Plan

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Executive Summary

This Conceptual Stormwater Management Plan (CSMP) has been prepared for BJS Gets Richer Pty Ltd, the proponent of this Development Application. The proponent is seeking Development Approval for a proposed 71 lot multi-unit townhouse development over 2 Karingal Drive, Pimpama properly described as Lot 19 on RP 152380 (the subject site).

The subject site is situated within the City of Gold Coast Local Government Area (LGA) and is zoned by the City of Gold Coast City Plan Version 6 as '*Medium Density Residential*'.

Stormwater Quantity

- The Lawful Point of Dishcharge for the site has been defined as the existing waterway on the site's eastern property boundary.
- Stormwater runoff from Catchment A1 & A2 will be conveyed to detention basins within their respective catchments, where it will be released at the LPD in a controlled manner to ensure that there is non-worsening peak flow in the post-developed scenario. The detention Basin A1 will have a 1% AEP volume of 104m^3, and Basin A2 will have a 1% AEP volume of 41.4m^3.
- Stormwater runoff entering the site from Catchment Ext A and A3 will be detained via the On-Line detention system. This detention device will have a 1% AEP volume of 1,360m^3.
- Minor flows from all catchments have been minimised to ensure that peak discharge from the developed catchment will be that of or less than the pre-developed scenario.

Stormwater Quality

- To achieve the City of Gold Coast's Water Quality Objectives, it is proposed to use bioretention systems to treat stormwater runoff. These bioretention systems will be private infrastructure, owned and maintained by the body corporate.
- The bioretention device positioned within Catchment A1 will have a total filter media footprint of 130m^2.
- The bioretention device positioned within Catchment A2 will have a total filter media footprint of 60m^2.

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1. Introduction

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1.1 Background

1.1.1 Regulatory Requirements and Technical Guidelines

The strategies proposed in this CSMP have been developed to address the requirements of the City of Gold Coast City Plan Version 6, and have also been prepared in accordance with the following guidelines:

- SC6.9 City Plan Policy – Land Development Guidelines (CoGC, 2019);
- *State Planning Policy July 2014* (DSPIP, 2014)*;*
- Queensland Urban Drainage Manual (QUDM) Fourth Edition (IPWEAQ, 2017);
- Australian Rainfall & Runoff: A Guide to Flood Estimation (Ball J, 2016);
- Australian Government – Bureau of Meteorology (Bureau of Meteorology, n.d.);
- MUSIC Modelling Guidelines (Water By Design, 2019);
- WSUD Technical Guidelines for South East Queensland – Version 1 (Healthy Waterways, BCC, MBWCP, 2006);
- Concept Design Guidelines for Water Sensitive Urban Design - Version 1 (Water By Design, 2009);
- Urban Stormwater Quality Planning Guidelines 2010 (DERM, 2010); and
- Best Practice Erosion and Sediment Control (IECA, 2008).
- Best Practice Erosion and Sediment Control Appendix B - Draft Document Revision December 2016 (IECA, 2016)

1.2 Purpose

The main objectives of this CSMP have been established from the criteria set out in the City of Gold Coast City Plan Version 6 and are summarised as follows:

- Avoid the creation of nuisance flow or hazard problems;
- Protect the quality of surface and ground waters during construction and operation of new development;
- Maintain the natural hydraulic behaviour of catchments;
- Protect existing natural features and ecological processes; and
- Integrate stormwater management infrastructure carefully in the urban and natural landscape.

1.3 Scope

To achieve the above-mentioned objectives, this CSMP details the following:

- Site description including:
  - Topography;
  - Existing Land Use; and
  - Vegetation.
- Stormwater Quantity:
  - Assessment of the peak flow rates discharging the site to ensure no adverse external impacts (up to the 1% Average Exceedance Probability (AEP)).
- Stormwater Quality:
  - Methods to ensure quality objectives of the receiving waters are achieved.

1.4 Site Details

Important information about the subject site has been included in Table 1.1, and a site locality map is presented in Figure 1.1. Further detail regarding the proposed development layout, please refer to the complete and latest development plans attached within Appendix A.

Table 1.1 Site Details

Subject	Description
Address	2 Karingal Drive, Pimpama
Lot / Plan	Lot 19 on RP 152380
Local Government Area	City of Gold Coast
Zoning	Medium Density Residential
Existing Land Use	The site is currently vacant and is vegetated with grass and tree cover.
Topography	There is an existing waterway traversing diagonally through the site, entering the site in the southern corner, and exiting the site in the northern corner. All portions of the site generally fall towards this central waterway that splits the site into two (2) catchments. The highest points in the site are at RL 10.0m AHD in the north-west corner, and RL 8.0m AHD in the south-east corner of the site.

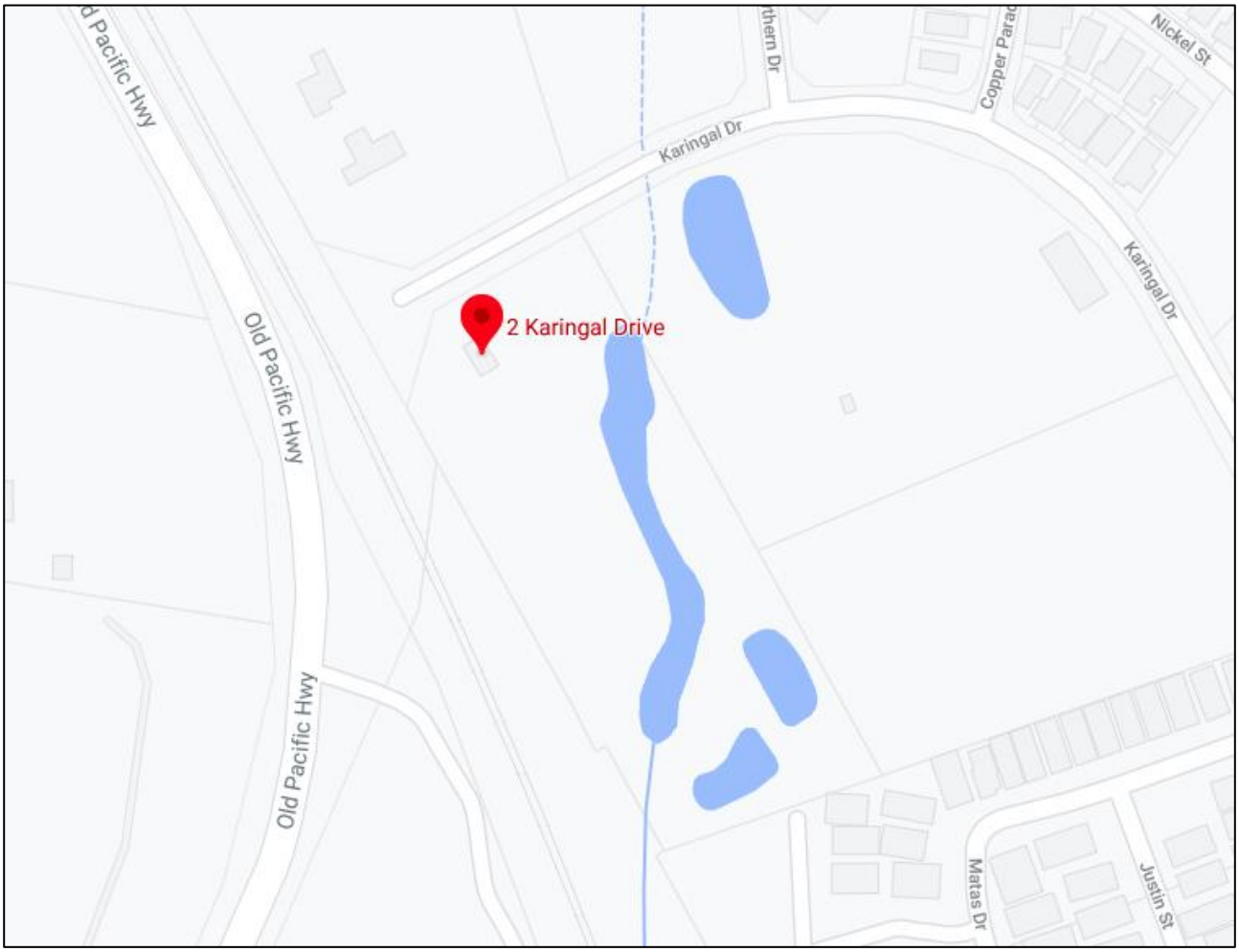


Figure 1.1 Site Locality Map (CoGC, 2020)

1.5 Proposed Development

The proposed development consists of 71 multi-residential townhouses to be established under a Community Title Scheme. The development proposes a series of internal private roadways and associated car parking; where the development is generally positioned around the central waterway.

The proposed stormwater management systems, including the waterway that traverses the site will remain under the ownership of the body corporate of the proposed development. The body corporate will be responsible for the ongoing maintenance of all stormwater infrastructure proposed.

For further details, please refer design drawings prepared by Brian Johnston Plan Design attached in Appendix A of this report. Figure 1.3 below provides an excerpt taken from the development's site plan.

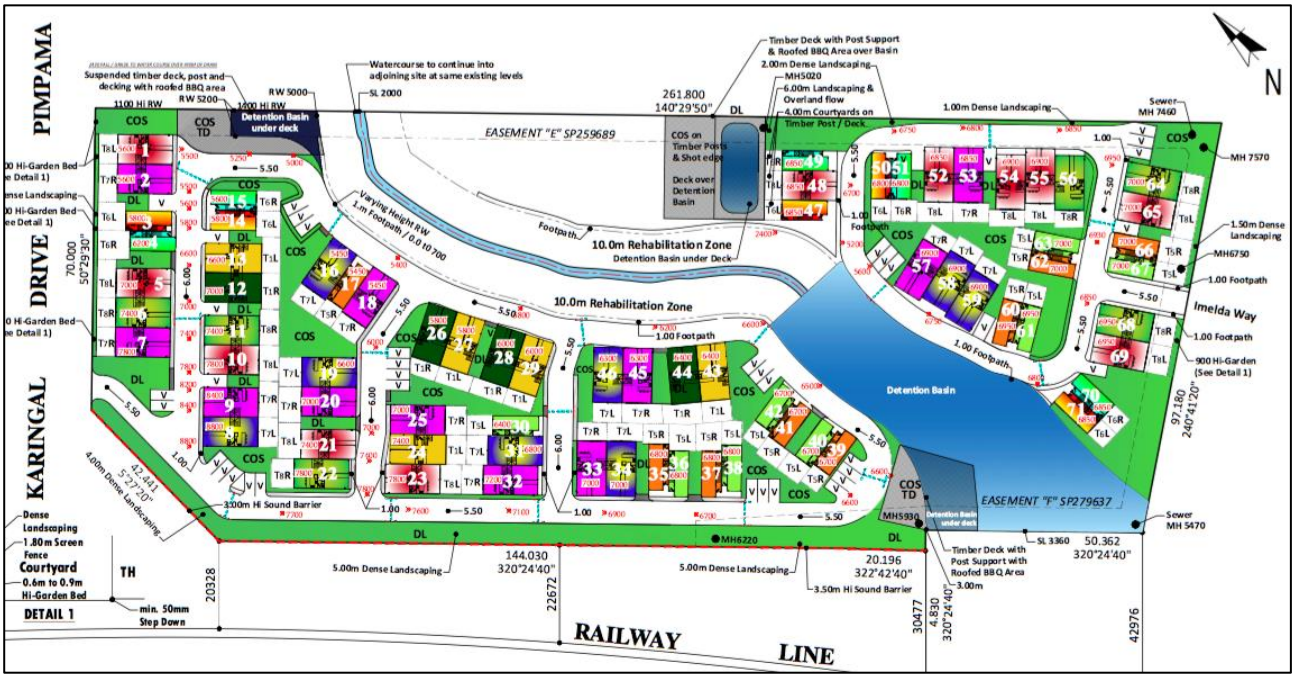


Figure 1.2 Proposed Site Layout

2. Stormwater Quantity Management Plan

2.1 Overview

The following section of this report outlines the measures required to meet the above-mentioned objective in regard to stormwater quantity. In order to meet these objectives, it is necessary to ensure that post development discharge from the site will not create a worse situation for downstream property owners than that which existed prior to the development (i.e. non-worsening) (IPWEAQ, 2017).

Due to the increase in impervious areas within the proposed development, peak stormwater flow rates will increase. In order to mitigate these flow rates from the developed site it is proposed to implement an On-Site Detention (OSD) system. OSD systems temporarily store stormwater runoff and release flows at a controlled rate that is no greater than the pre-developed peak flow rate.

2.2 Drainage Catchment Parameters

Drainage catchments have been delineated using site survey, aerial imagery and development plans in the post developed scenario. Pre and post development catchment parameters are summarised in Table 2.1. Catchment plans are provided in Appendix D.

Table 2.1 Catchment Parameters

Scenario	Catchment ID	Total Area (ha)	Impervious %	Catchment Slope (%)
External	Ext A	141.69	20	4.0
Pre-developed	A	2.455	1	4.8
Post-developed	A1	1.227	70	4.8
	A2	0.611	70	4.8
	A3	0.245	100	0.5
	A4	0.372	100	0.5

2.2.1 Conveyance of Flows

Important information about the conveyance of flows for the pre-development and post-development scenarios are included in Table 2.2 below.

Table 2.2 Conveyance of Flows

Subject	Description
Lawful Points of Discharge (LPD)	• One (1) Lawful Point of Discharge (LPD), defined as the discharge point of the waterway that discharges to the neighboring allotment immediately east of the subject site.
Pre-development	• The Site Catchment (A) is conveyed via overland flow to the existing waterway which forms the site's LPD. • Pre-development catchment plans are included in Appendix D (Drawing No. N200).
Post-development	• The Site Catchment (A) is conveyed from the development's roof water and from any ground areas through the proposed drainage system to 1 of 2 detention basins

	(Detention Basin B & C) depending on development sub-catchment, which then discharge to the adjacent waterway (the LPD). • Low flows from the roof and roadway areas are conveyed and detained by the proposed detention basins via orifice plates in the outlet pit (sized for Q3month flows) and ultimately discharge to the LPD. • High flows captured by the roof and driveway are conveyed to the proposed detention basins and will overflow the bounds of the basin via an overflow weir, and ultimately discharge to the LPD.
External Catchments	• The External Catchment (Ext A) enters the site on its western boundary via the adjacent railway culverts where it is then detained via a proposed on-line detention basin (Detention Basin A) positioned within the bounds of the waterway.

2.2.1 Lawful Points of Discharge

The site's Lawful Points of Discharge (LPD) has been identified at the site in LPD A, where the existing waterway exits the site.

In accordance with the City of Gold Coast Land Development Guidelines, stormwater discharging the site will not cause any actionable nuisance, environmental or property damage. This will be achieved by the inclusion of onsite stormwater detention devices and through post-developed catchment minimisation.

2.3 XP-SWMM Analysis

XP-SWMM (version 2018.1) software was utilised to model the performance of the proposed stormwater quantity control measures. This modelling software is a link-node model capable of performing hydrology and hydraulics of stormwater drainage systems simultaneously.

Laurenson's Hydrology has been adopted as the runoff routing method within XP-SWMM. Sub-catchment routing in this method is carried out using the Muskingum procedure, which is a storage routing method based on the storage equation.

Details of the assumptions and input parameters used within the XP-SWMM model inputs are included in Appendix C.

2.3.1 Rational Method Comparison

The Rational Method has been used to gain an initial understanding of the relative impact of the proposed development on peak flow rates at the site's LPD. The Rational Method is a basic method for assessing peak flow rates and is considered suitable given the catchment area is less than 500 ha and the time of concentration within the contributing catchments is less than 30 minutes (IPWEAQ, 2017).

It should be noted that although the Rational Method has been used as an initial estimate of site peak flows, it has not been used for the design of any mitigation measures nor has been used for calibration of the runoff XP-SWMM model. A comparison between the peak discharge values obtained using the Rational Method and the XP-SWMM model for the 1% AEP event at the Lawful Point of Discharge is contained in Table 2.3 below.

Table 2.3 Rational Method vs XP-SWMM Generated Peak Discharges

Scenario	Catchment ID	Rational (m^3/s)	XP-SWMM (m^3/s)	Difference (%)
Pre-developed	PD-A	37.737	44.488	15.2
Post-developed	PD-A	40.596	45.116	10.1

The peak discharges generated by XP-SWMM and the Rational Method compare well and are considered acceptable for this assessment.

2.4 XP-SWMM Results

2.4.1 Performance of OSD

To confirm the performance of the proposed OSD system, a pre and post-development model was constructed. These models compare the discharge hydrographs for a range of storm durations at the existing Lawful Points of Discharge. A full range of events have been simulated for critical events.

A summary of the modelling results for different ARI events is contained in Table 2.4. Results of the modelling indicate the proposed system is capable of maintaining the pre-development peak discharges for the all storm events up to the 1% AEP event at LPD A.

Table 2.4 Pre-Development vs Post-Development (Mitigated) Peak Discharges at LPD A

AEP Event (%)	Pre-Development		Post-Development	
	Peak Discharge (m3/sec)	Critical Duration	Peak Discharge (m3/sec)	Critical Duration
1	44.488	ECN_1pct_1hr_1	44.040	ECN_1pct_1hr_1
2	37.798	ECN_2pct_1hr_1	37.453	ECN_2pct_1hr_1
5	36.338	ECN_5pct_3hr_1	35.979	ECN_5pct_3hr_1
10	28.460	ECN_10pct_3hr_1	28.128	ECN_10pct_3hr_1
18.13	23.490	ECN_0.2EY_3hr_3	23.250	ECN_0.2EY_3hr_3
39.95	14.460	ECN_0.5EY_2hr_7	14.447	ECN_0.5EY_2hr_7

A plot of the pre-development vs post-development (mitigated) hydrographs for the 1% AEP event is included as Figure 2.1.

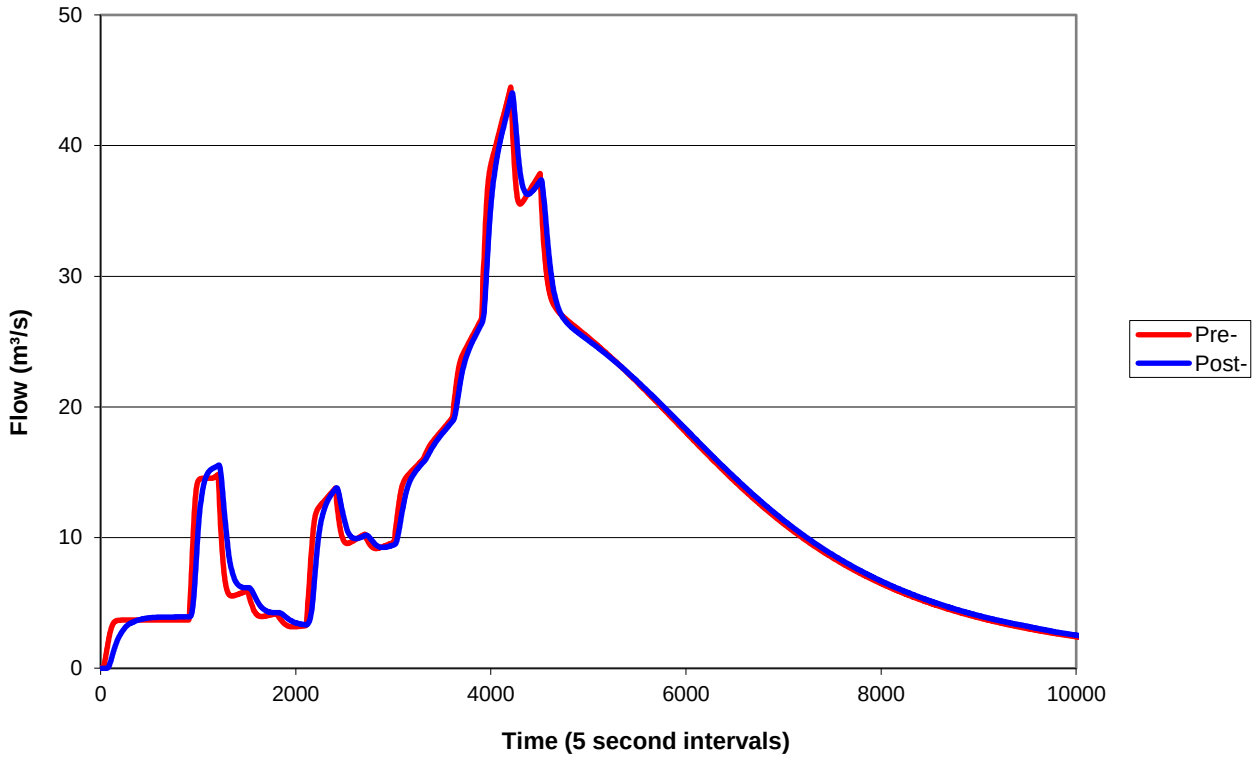


Figure 2.1 Plot of Pre-Development vs Post-Development 1% AEP Hydrographs at LPD

2.5 On Site Detention (OSD) Details

The proposed OSD systems are to be implemented to ensure a non-worsening of peak discharges at the LPD.

Table 2.5 below contains the details of the proposed OSD systems within the subject site.

Table 2.5 OSD Details

Detention ID	Outlet Structures		100yr ARI Detention Volume (m3)
	Outlet Pipe (s)	High Flow Weir	
Basin A1	600mm @ RL 2.4m AHD	5m Wide @ RL 3.4m AHD	104
Basin A2	450mm @ RL 5.0m AHD	5m Wide @ RL 5.6m AHD	41.4
Basin A3	3x1.2mx1.2m RCBC @ RL 2.5m AHD	18m Wide @ RL 3.1m AHD	1,360

2.5.1 Basin Depths

QUDM specifies the maximum depth of water in the detention basin shall not exceed 1.2 m during the 5% AEP storm event. Table 2.6 results demonstrates that the depth of water within the proposed basin does not exceed 1.2 m during the Q20 storm event.

Table 2.6 Detention Basin Depths 5% AEP Event

Detention ID	Detention Base Level (m AHD)	Peak Water Surface (m AHD)	Peak Depth of Water (m)
Basin A1	2.4	3.03	0.63
Basin A2	5.0	5.48	0.48
Basin A3 (On-Line Basin in Waterway)	2.5	3.97	1.47

QUDM requires that during a 1% AEP storm event, that a basin is designed to achieve:

- a freeboard of 0.3 m; and
- a depth flow of no greater than 0.3 m over the highflow weir.

The 1% AEP storm event was simulated for the post development scenario to confirm these requirements and the results are presented in Table 2.7.

Table 2.7 Detention Basin Depths 1% AEP Event

OSD ID	Peak Water Surface (m AHD)	Freeboard Achieved (m)	Peak Water Depth over Weir (m)
Basin A1	3.43	0.37	0.03
Basin A2	5.66	1.04	0.06
Basin A3 (On-Line Basin in Waterway)	4.11	2.39	1.01

It is noted that Basin A3 does not meet the above criteria. This is due to this detention device being positioned within the waterway and acting as an on-line detention device.

2.5.2 Weir Flow

During larger events the weirs included in the basin configuration has been designed to act as a high-flow control. The peak flow experienced over the weirs for the range of events at which the weirs are active are presented in Table 2.8 below. Any stormwater discharging the basin over the weir has been taken into consideration to calculate total peak flows discharging the site.

Table 2.8 Peak Flow Over Weir

Basin	AEP Event (%)	Flow (m^3/s)	Flow Depth (mm)
Basin A1	1	0.054	30
	2	-	-
	5	-	-
Basin A2	1	0.118	60
	2	0.072	40
	5	-	-
Basin A3 (On-Line Basin in Waterway)	1	30.613	427
	2	25.115	353
	5	24.334	341

2.5.3 Sensitivity Analysis

In accordance with the requirements of QUDM Section 5.8, consideration has been given to the consequences of a fully blocked low-level outlet. In this case, the low flow components of the outlet structure were turned off, leaving only the high outlet. A summary of the results observed during the 1% AEP event is contained in Table 2.9.

Table 2.9 Sensitivity Analysis Results for 1% AEP Event

OSD ID	Peak Water Surface (m AHD)	Top of Bank (m AHD)
Basin A1	3.611	3.8
Basin A2	5.734	6.7
Basin A3 (On-Line Basin in Waterway)	4.357	6.5

Based on the conceptual OSD design, the peak water level does not exceed the top of bank during a 1% AEP event in the unlikely scenario that the low flow outlets become 100% blocked. The requirements of QUDM Section 5.8 are therefore satisfied.

3. Stormwater Quality Management

3.1 Water Quality Objective (WQO)

In accordance with the City of Gold Coast City Plan Version 6, the total effect of permanent water quality control measures are to achieve reductions in the mean annual load generated by the development site at a minimum of:

- 90% for Gross Pollutants (>5mm);
- 80% for Total Suspended solids (TSS);
- 60% for Total Phosphorus (TP); and
- 45% for Total Nitrogen (TN).

This will ensure the environmental values of the downstream receiving waters are maintained and have been chosen as the WQO for the development.

3.2 MUSIC Model

To ensure the above WQOs can be met at the site's LPD, a treatment train was proposed for the developed site and modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software. The model was constructed to demonstrate that the load-based reduction targets can be achieved. Details of the MUSIC model input parameters used are included in Appendix D.

3.3 Treatment Train Details

The proposed treatment train consists of two (2) proposed bio-retention basin devices to treat the split sub-catchments. These devices are to consist of filter depth of 500mm. Bio-retention basin A1 has a total filter area of 130m^2, and bio-retention basin A2 has a total filter area of 60m^2.

The conceptual parameters of the proposed treatment trains are presented in Table 3.1, and further detail of the input parameters used within MUSIC are included in Appendix D.

3.4 MUSIC Results

Results of the MUSIC modelling for the treatment train effectiveness are summarised in Table 4.1. The results indicate the 80%, 60%, 45% & 90% reduction target for TSS, TP, TN and gross pollutants respectively are achieved for the rainfall data set simulated.

Table 3.1 Treatment Train Effectiveness

Pollutant	Inflows (kg/yr)	Outflows (kg/yr)	Reduction Achieved (%)	Water Quality Objective (%)
TSS	2930	545	81.4	80
TP	5.6	1.53	72.7	60
TN	29.2	15.3	47.5	45
GP	344	0	100	90

NOTE: All simulations have been run with pollutant export estimation set to "stochastic generation".

A screen capture of the MUSIC model and treatment train effectiveness results is presented in Figure 4.1.

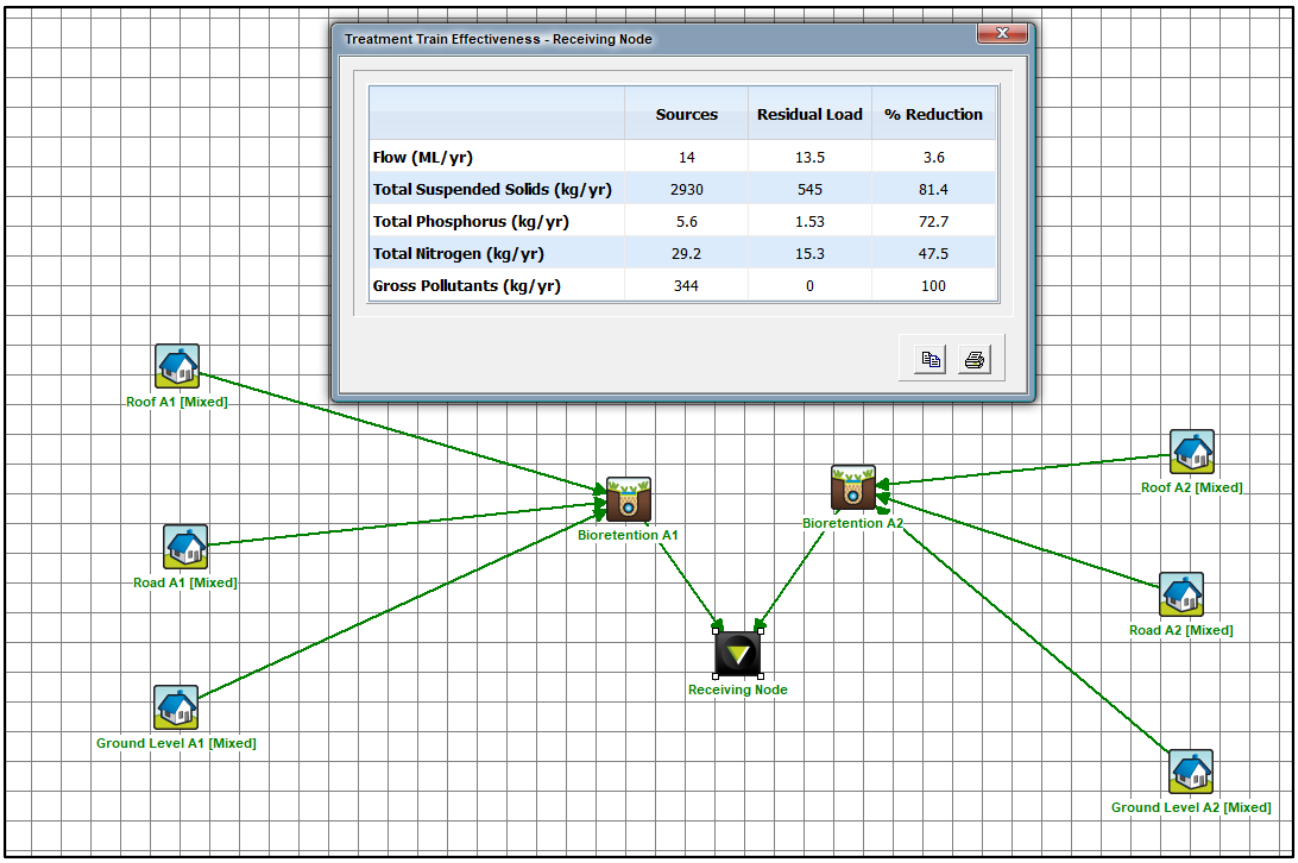


Figure 3.1 Treatment Train Layout & MUSIC Results

4. Conclusion

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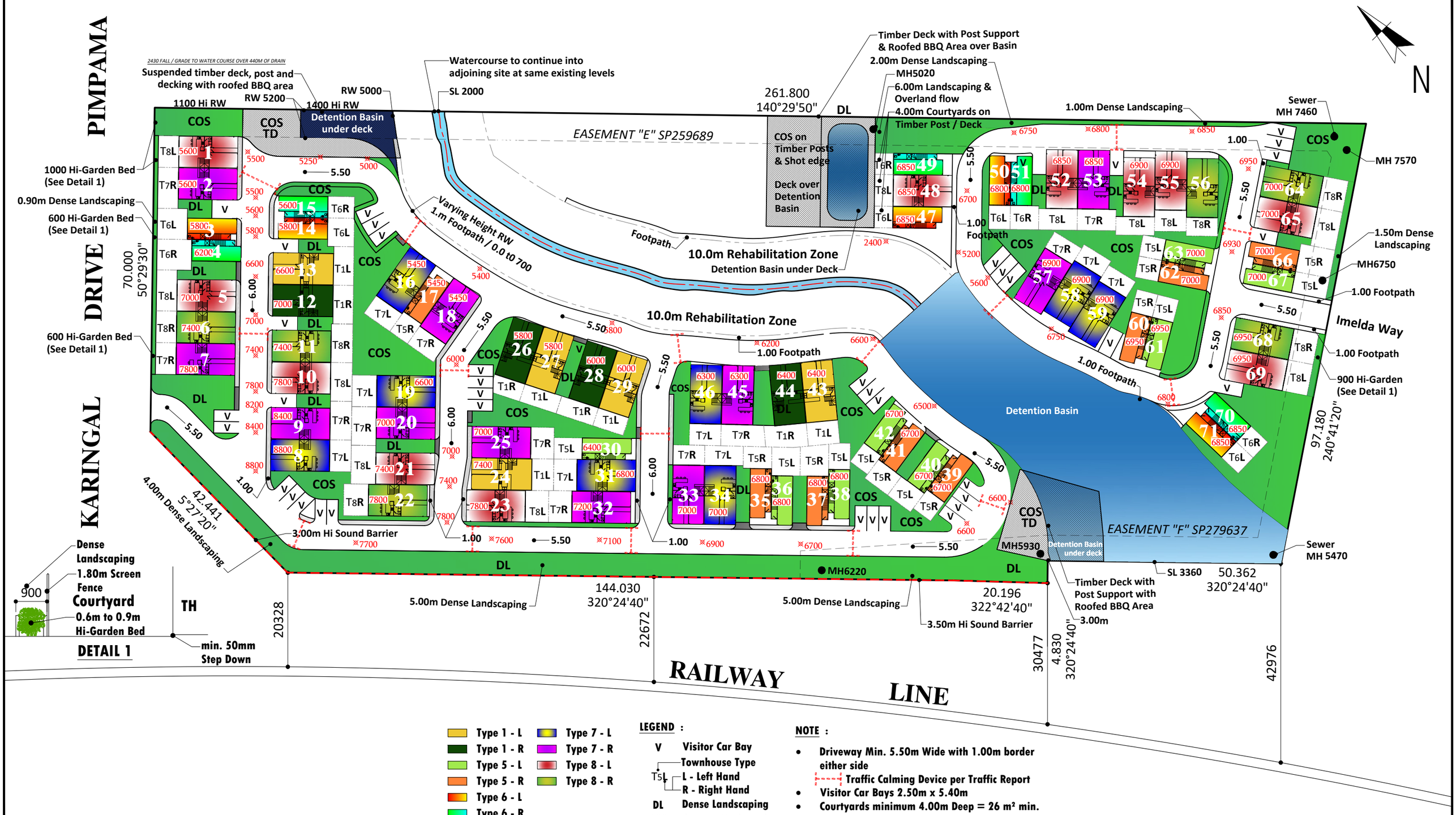
- The LPD for the site have been defined as the existing waterway on the site's eastern property boundary.
- Stormwater runoff from Catchment A1 & A2 will be conveyed to detention basins within their respective catchments, where it will be released at the LPD in a controlled manner to ensure that there is non-worsening peak flow in the post-developed scenario. The detention Basin A1 will have a 1% AEP volume of 104m^3, and Basin A2 will have a 1% AEP volume of 41.4m^3.
- Stormwater runoff entering the site from Catchment Ext A and A3 will be detained via the On-Line detention system. This detention device will have a 1% AEP volume of 1,360m^3.
- Minor flows from all catchments have been minimised to ensure that peak discharge from the developed catchment will be that of or less than the pre-developed scenario.

Stormwater Quality

- To achieve the City of Gold Coast's Water Quality Objectives, it is proposed to use a bioretention systems to treat stormwater runoff.
- The bioretention device positioned within Catchment A1 will have a total filter media footprint of 130m^2.
- The bioretention device positioned within Catchment A2 will have a total filter media footprint of 60m^2.

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Appendix A Proposed Plans of Development



Type 1 - L
Type 1 - R
Type 5 - L
Type 5 - R
Type 6 - L
Type 6 - R
Type 7 - L
Type 7 - R
Type 8 - L
Type 8 - R

LEGEND :

- V — Visitor Car Bay
- T5L — Townhouse Type; L - Left Hand; R - Right Hand
- DL — Dense Landscaping
- COS — Community Open Space
- TD — Timber Deck

NOTE :

- Driveway Min. 5.50m Wide with 1.00m border either side
  - Traffic Calming Device per Traffic Report
- Visitor Car Bays 2.50m x 5.40m
- Courtyards minimum 4.00m Deep = 26 m² min.

Total Area (sqm) : 24,592

Dence Landscaping = 1,566 sqm
Community Open Space = 3,174 sqm
20.0m Rehabilitation Zone = 4,118.19 sqm
Timber Deck = 1414 sqm

NOTE :
HRV / GARBAGE TRUCK MANOEUVRING MIN. 10.5m KERB TO KERB PER J.J. RICHARDS DESIGN

1:750
15m 0 15m 30m 45m 60m 75m

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Verify all dimensions on site and from the dimension on the plans. Do not scale from drawings

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Drawn by
John C.

Checked by
JPD, Brian Johnston plan design P/L

Client

SITE LAYOUT

RAY SUGARS
2 Karingal Drive Pimpama
Lot 19 on RP 152380

Drawing Scale
1:750

Layout ID
JPD-P24-KDP-01

Status

Paper Size
@A3

Appendix B MUSIC Input Parameters

Rainfall and Evapotranspiration Parameters

MUSIC modelling was based on 6-minute interval data obtained from the Bureau of Meteorology (BOM) for rainfall station 40406 Beenleigh, as summarised in Table B.1.

Table B.1 Meteorological and Rainfall Runoff Data Reporting Table

Input	Data Used in Modelling
Rainfall station	40406 BEENLEIGH
Time step	6 minute
Modelling period	1-01-1990 to 31-12-1999 (10 years)
Mean annual rainfall (mm)	1105
Evapotranspiration	1492
Rainfall runoff parameters	Residential
Pollutant export parameters	Residential

Catchment Parameters

Based on the proposed land uses within the development, the subject site has been modelled as commercial land use as detailed in Table B.2. The site has been divided into roof, road and ground level source nodes as per the architectural drawings included in Appendix A.

Table B.2 Land Use Parameters

Catchment ID	Area (ha)	Land use	Total Impervious (%)
A1 - Roof	0.353	Mixed	100
A1 - Ground	0.520	Mixed	30
A1 - Road & Carpark	0.354	Mixed	100
A2 - Roof	0.171	Mixed	100
A2 - Ground	0.301	Mixed	30
A2 - Road & Carpark	0.139	Mixed	100

The pollutant loads and runoff parameters for each source node have been based on the data from the Water by Design MUSIC Modelling Guidelines (Water By Design, 2019), as summarised in Table B.3 and Table B.4.

Table B.3 Rainfall Runoff Parameters

Parameter	All Nodes
Landuse	Residential
Rainfall threshold (mm)	1
Soil storage capacity (mm)	500
Initial storage (% capacity)	10
Field capacity (mm)	200
Infiltration capacity coefficient a	211
Infiltration capacity exponent b	5
Initial depth (mm)	50
Daily recharge rate (%)	28
Daily baseflow rate (%)	27
Daily deep seepage rate (%)	0

Table B.4 Pollutant Load Parameters

Urban Residential	Total Suspended Solids (log mg/L)		Total Phosphorous (log mg/L)		Total Nitrogen (log mg/L)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Storm Flow Concentration	1.30(1) 2.43(2) 2.18(3)	0.39	-0.89(1) -0.30(2) -0.47(3)	0.31	0.26	0.23
Base Flow Concentration	0(1) 1.0(2,3)	0(1) 0.34(2,3)	0(1) -0.97(2,3)	0(1) 0.31	0(1) 0.20(2,3)	0(1) 0.20(2,3)

NOTE: (1) Values applied to “Roof” areas
(2) Values applied to “Road” areas
(3) Values applied to “Ground” areas

Treatment Node Parameters

The following sections describe the modelling parameters applied to MUSIC for each of the treatment nodes included as part of the water quality assessment.

Table B.5 Bioretention Parameters Bio A1

Parameter	Bio A1
High Flow Bypass (m³/s)	100
Surface area (m²)	130
Extended detention depth (m)	0.15
Filter area (m²)	130
Unlined filter media perimeter (m)	0.01
Filter Depth (m)	0.50
Exfiltration Rate (mm/hr)	0.00
Is the base Lined?	Yes
Overflow Weir Width (m)	13
Underdrain present?	Yes
Submerged zone with carbon present?	No
Confirmation that K and C* remain default?	Yes

Table B.6 Bioretention Parameters Bio A2

Parameter	Bio A2
High Flow Bypass (m³/s)	100
Surface area (m²)	60
Extended detention depth (m)	0.15
Filter area (m²)	60
Unlined filter media perimeter (m)	0.01
Filter Depth (m)	0.50
Exfiltration Rate (mm/hr)	0.00
Is the base Lined?	Yes
Overflow Weir Width (m)	6
Underdrain present?	Yes
Submerged zone with carbon present?	No
Confirmation that K and C* remain default?	Yes

Appendix C Time of Concentration and Rational Method Calculations

Pre-Development Hydrology

The natural hydrology of the site has been assessed in accordance with QUDM (IPWEAQ, 2017) Section 4.1. The time of concentration for all catchments has been determined using Friend's Equation as per QUDM Section 4.6.6, combined with a channel time flow calculation.

$$Friend's\ Equation\ tc = (107nL^{0.333})/S^{0.2}$$

Table C.1 presents a summary of the catchment parameters used within Friend's Equation and the calculated time of concentration for the pre-development scenario.

Table C.1 Time of Concentration for Pre-Development Scenario

Catchment ID	Ext_A	Pre_A
Standard Inlet Time	-	-
Overland Flow		
Estimated Sheet flow Length (Table 4.06.3)	50	100
Horton's Roughness Value	0.06	0.06
Slope (%)	10	5
tc (minutes)	14.90	21.56
Channel/Creek Flow		
Length of Channel Flow (m)	1350	75
Velocity (m/s) - assumes 1.5	0.7	0.9
tc (minutes)	32.14	1.39
TOTAL tc (minutes)	**47**	**23**

Post-Development Hydrology – Unmitigated

Table C.2 presents a summary of the catchment parameters used for the calculated time of concentration for the post-development scenario. The time of concentration for the external catchment is presented in Table C.1 above.

Table C.2 Time of Concentration for Post-Development Scenario

Catchment ID	Post A1	Post A2	Post A3	Post A4
Standard Inlet Time	5	5		
Channel/Creek Flow				
Length of Channel Flow (m)	240	120	90	115
Velocity (m/s) - assumes 1.5	1	1	1.5	1.5
tc (minutes)	4.00	2.00	1.00	1.28
TOTAL tc (minutes)	**9**	**7**	**5**	**5**

Design storm event flows across the site were derived using the Rational Method as per the above-mentioned manuals. This involved:

- Determination of a C10 value (derived in accordance with QUDM Table 4.05.3(b) and Council guidelines). A value of 0.66 was applied to the pre-development catchment and 0.83 was applied to the post-development catchment;
- Adoption of design rainfall using BoM IFD data; and
- Calculation of design flows through the site for Q100, Q50, Q20, Q10, Q5, Q2, and $Q3_{month}$, where $Q3_{month}$ is deemed to be 50% of Q1.

Summaries of the hydrologic calculations are contained in Table C.3 and Table C.4 for pre and post-development (un-mitigated) scenarios respectively.

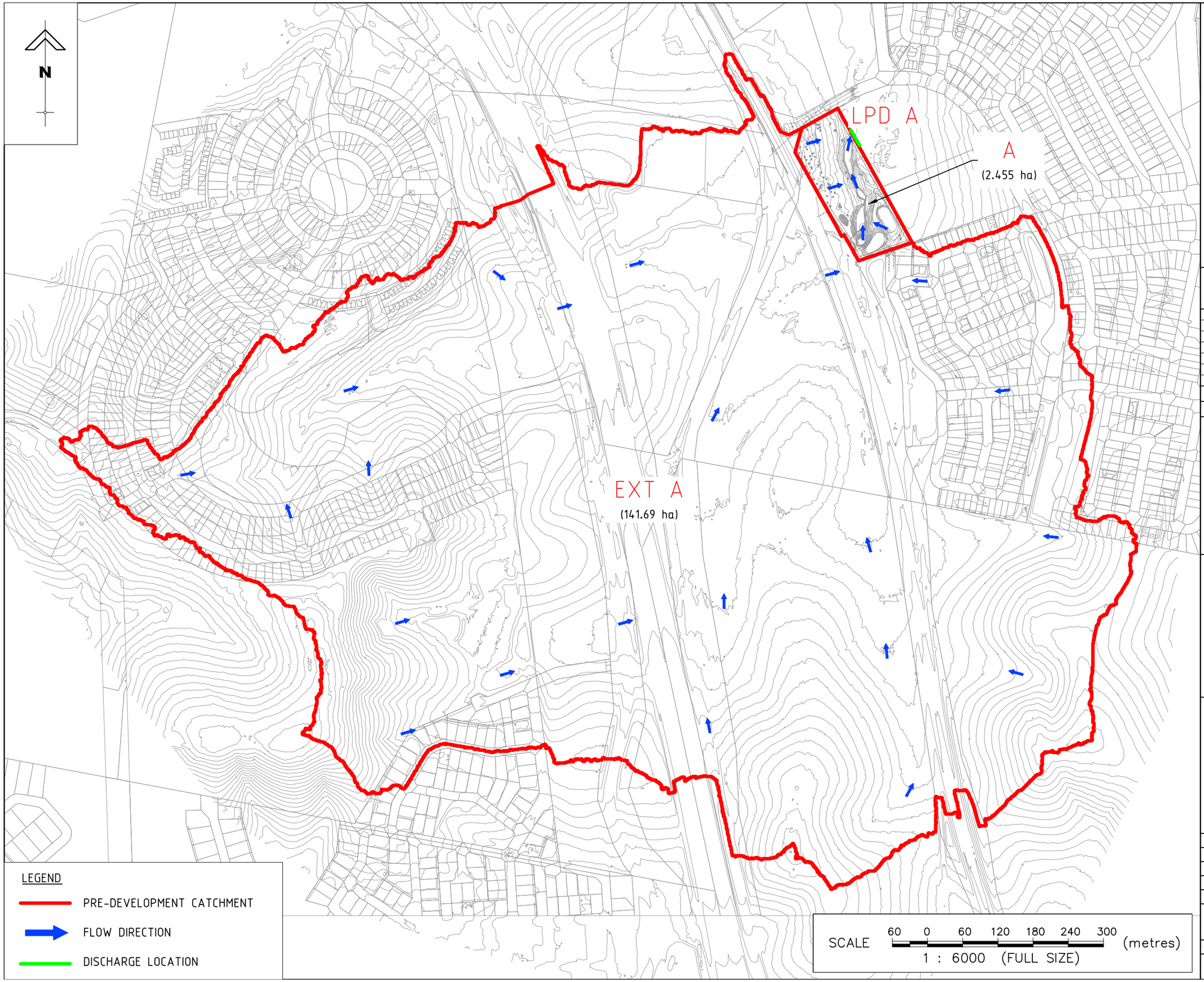
Table C.3 Pre-Development Hydrology

Catch.	Area (ha)	tc (min)	I_{100} (mm/hr)	C	Q_{100} (m^3/s)	I_{50} (mm/hr)	C	Q_{50} (m^3/s)	I_{20} (mm/hr)	C	Q_{20} (m^3/s)	I_{10} (mm/hr)	C	Q_{10} (m^3/s)	I_5 (mm/hr)	C	Q_5 (m^3/s)	I_2 (mm/hr)	C	Q_2 (m^3/s)	I_1 (mm/hr)	C	Q_{3month} (m^3/s)
Ext A	141.69	47.00	118.00	0.79	**36.783**	105.00	0.76	**31.367**	88.90	0.69	**24.248**	77.00	0.66	**20.002**	66.30	0.63	**16.361**	52.80	0.56	**11.658**	42.10	0.53	**4.374**
Pre A	2.46	23.00	169.00	0.79	**0.913**	153.00	0.76	**0.792**	131.00	0.69	**0.619**	115.00	0.66	**0.518**	99.70	0.63	**0.426**	80.10	0.56	**0.306**	63.90	0.53	**0.115**

Table C.4 Un-Mitigated Post-Development Hydrology

Catch.	Area (ha)	tc (min)	I_{100} (mm/hr)	C	Q_{100} (m^3/s)	I_{50} (mm/hr)	C	Q_{50} (m^3/s)	I_{20} (mm/hr)	C	Q_{20} (m^3/s)	I_{10} (mm/hr)	C	Q_{10} (m^3/s)	I_5 (mm/hr)	C	Q_5 (m^3/s)	I_2 (mm/hr)	C	Q_2 (m^3/s)	I_1 (mm/hr)	C	Q_{3month} (m^3/s)
Post A1	1.23	9.00	256.00	1.00	**0.869**	232.00	0.95	**0.755**	199.00	0.8715	**0.591**	174.00	0.83	**0.492**	151.00	0.79	**0.406**	121.00	0.71	**0.291**	96.60	0.66	**0.109**
Post A2	0.61	7.00	282.00	1.00	**0.477**	254.00	0.95	**0.411**	217.00	0.8715	**0.321**	190.00	0.83	**0.268**	164.00	0.79	**0.219**	131.00	0.71	**0.157**	105.00	0.66	**0.059**
Post A3	0.25	5.00	316.00	1.00	**0.214**	283.00	0.95	**0.184**	240.00	0.8715	**0.142**	208.00	0.83	**0.117**	180.00	0.79	**0.097**	143.00	0.71	**0.069**	114.00	0.66	**0.026**
Post A4	0.37	5.00	316.00	1.00	**0.325**	283.00	0.95	**0.279**	240.00	0.8715	**0.216**	208.00	0.83	**0.178**	180.00	0.79	**0.147**	143.00	0.71	**0.104**	114.00	0.66	**0.039**

Appendix D Burchills Engineering Solutions Conceptual Stormwater Management Drawings



PROJECT NAME

2 KARINGAL DRIVE, PIMPAMA

FOR

CLIENT

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		14.12.20

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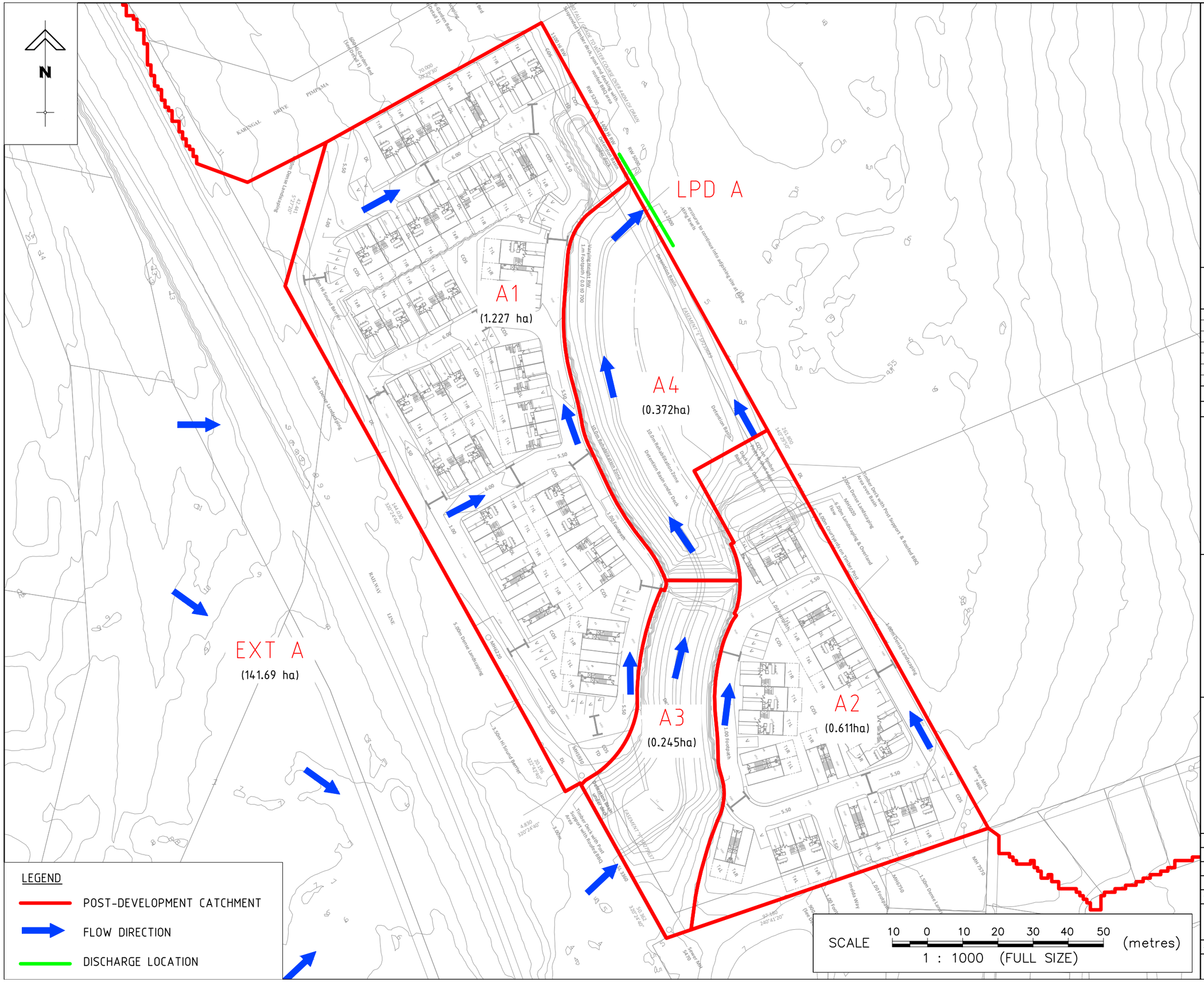
DRAWING TITLE :

PRE-DEVELOPMENT CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 14.12.20
PROJECT LEADER : JH	
DESIGNER : JH	
DRAFTSPERSON : TP / LD	
CHECKED :	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365	
RPEQ No. :	

SCALE : 1:6000	DATUM :	FULL SIZE : A3

PROJECT No.:	DRAWING No. :	VERSION:
BE200223	N200	A



PROJECT NAME

2 KARINGAL DRIVE, PIMPAMA

FOR

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ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		14.12.20

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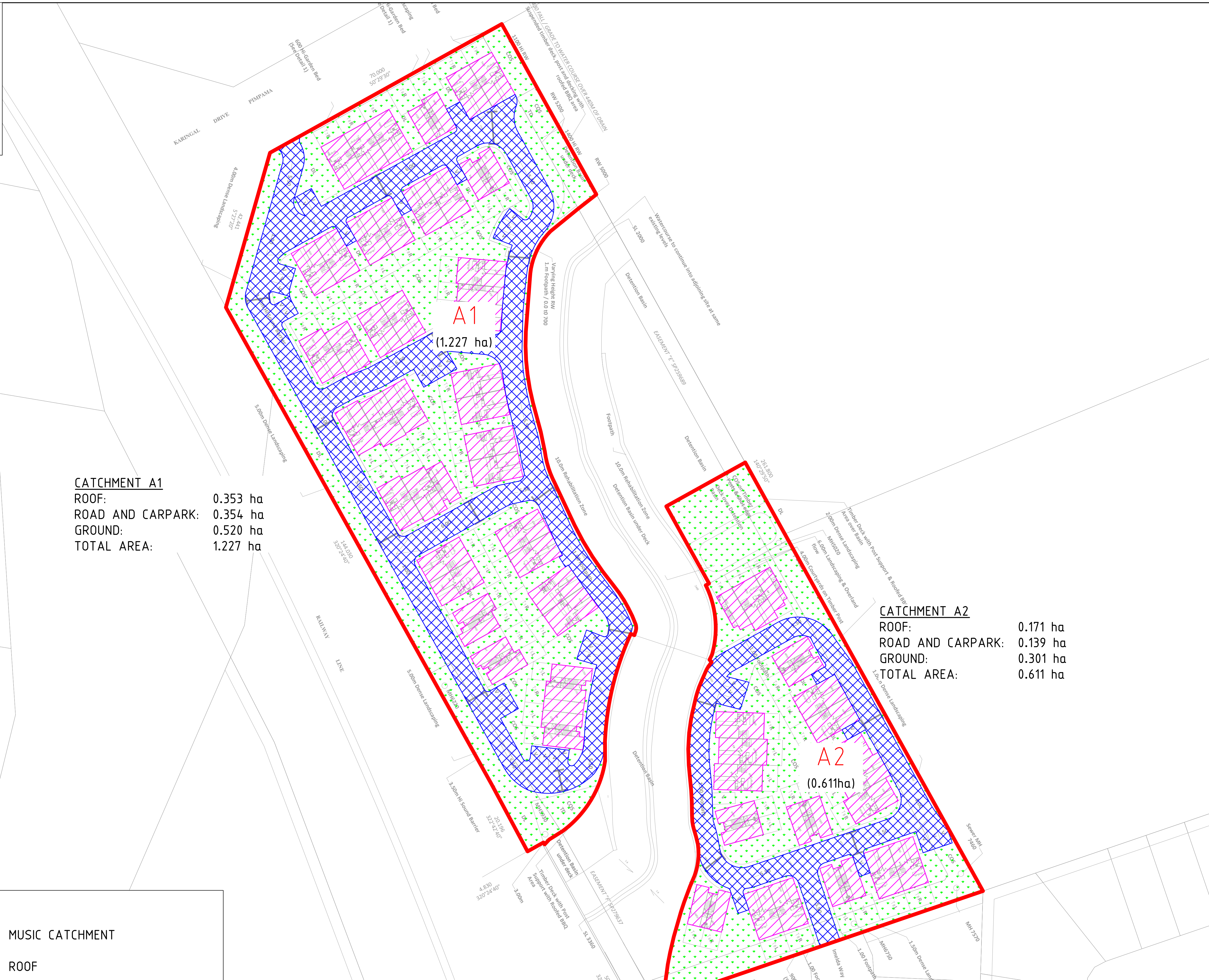
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DRAWING TITLE :

POST-DEVELOPMENT CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 14.12.20
PROJECT LEADER : JH	
DESIGNER : JH	
DRAFTSPERSON : TP / LD	
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APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365 RPEQ No. :	
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PROJECT No.: BE200223	DRAWING No. : N201 / VERSION: A



CATCHMENT A1

ROOF:	0.353 ha
ROAD AND CARPARK:	0.354 ha
GROUND:	0.520 ha
TOTAL AREA:	1.227 ha

CATCHMENT A2

ROOF:	0.171 ha
ROAD AND CARPARK:	0.139 ha
GROUND:	0.301 ha
TOTAL AREA:	0.611 ha

LEGEND

- MUSIC CATCHMENT
- ROOF
- ROAD AND CARPARK
- GROUND

SCALE 10 0 10 20 30 40 50 (metres)
1 : 1000 (FULL SIZE)

PROJECT NAME

2 KARINGAL DRIVE, PIMPAMA

FOR

CLIENT

ORIGINAL SCALE BEFORE REDUCTION
A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		14.12.20

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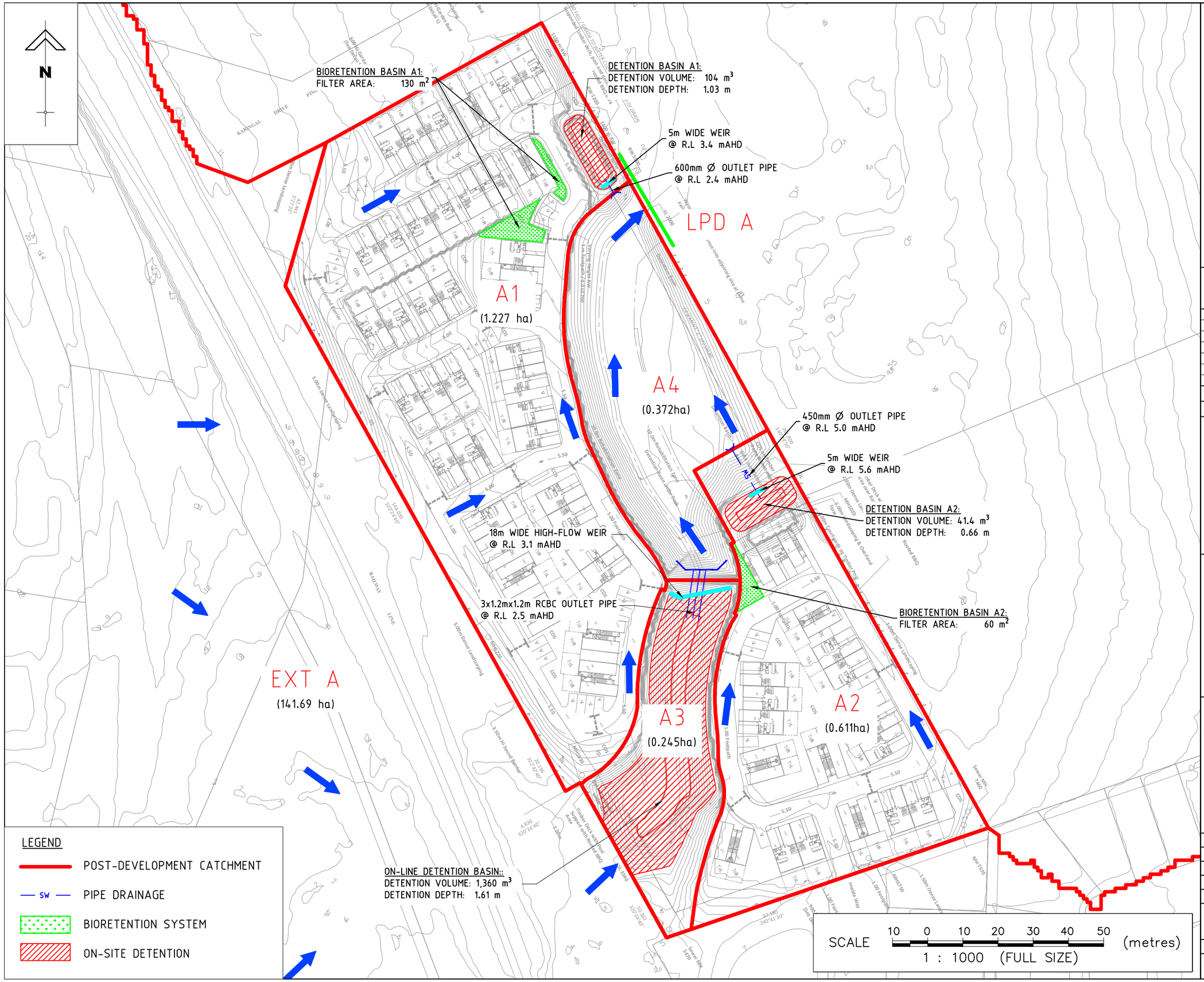
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ABN 76 166 942 365

DRAWING TITLE :

MUSIC CATCHMENT PLAN

DEVEL. APPLIC. No. :	DATE : 14.12.20
PROJECT LEADER : JH	
DESIGNER : JH	
DRAFTSPERSON : TP / LD	
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APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365 RPEQ No. :	

SCALE : 1:1000	DATUM :	FULL SIZE : A3
PROJECT No.: BE200223	DRAWING No. : N202	VERSION: A



PROJECT NAME

2 KARINGAL DRIVE, PIMPAMA

FOR

CLIENT

ORIGINAL SCALE BEFORE REDUCTION

A3 0 10 20 30 40mm.

VER.	DESCRIPTION	APPR.	DATE
A	ORIGINAL ISSUE		15.12.20

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DRAWING TITLE :

OPERATIONAL CONTROL PLAN

DEVEL. APPLIC. No. :	DATE : 15.12.20
PROJECT LEADER : JH	
DESIGNER : JH	
DRAFTSPERSON : TP / LD	
CHECKED :	
APPROVED FOR AND ON BEHALF OF BURCHILLS ENGINEERING SOLUTIONS ABN 76 166 942 365	
RPEQ No. :	
SCALE : 1:1000	DATUM : / FULL SIZE : A3
PROJECT No.: BE200223	DRAWING No. : N400 / VERSION: A