BESPOKE ENGINEERING SOLUTIONS

STORMWATER MANAGEMENT PLAN

Proposed Industrial Park

AT

1 Chum Street, New Chum, QLD, 4303

FOR

Queensland Property Group

Project No. B886

April 2023

REPORT CONTROL SHEET

Date:	21.04.2023					
Report Title:	Stormwater Management Plan					
Site address:	1 Chum Street, New Chum, QLD, 4303					
Our Ref No:	B886					
Author:	Kinzang Wangdi					
Certifier:	Idris Ahamad (RPEQ 01927)					
Revision:	A	B	C	D	E	
Date:	08.08.2022	08.11.22	05.04.23	18.04.23	21.04.23	

Disclaimer:
This report is a professional opinion based on the information available at the time of writing. It is not intended as a quote, guarantee or warranty and does not cover any latent defects.

This report will comment on the civil infrastructure to the project and may outline probable costs but the extent of the commission of Bespoke Engineering Solutions does not extend to detailed cost feasibility, as such the costs should not be relied on for financing arrangements.

This report has been prepared specifically for the aforementioned client, site and project. It has been written solely for the purpose of providing engineering advice on the above issues for Council for this development site. Please note that this report has been compiled based on the information that is current at the time of report printing, and that the recommendations supplied within this report are based solely on the above.

Also, no further analysis has been conducted beyond the nominated lawful point of discharge. Any existing drainage issues downstream from the analysed area shall be considered to remain the responsibility of the Council to investigate and maintain.

Table of Contents

Table of Contents 2

1.0 INTRODUCTION 4

1.1 BASIS OF THE REPORT 4

1.2 SCOPE OF THE REPORT 4

2.0 SITE CHARACTERISTICS 5

2.1 LOCATION & DESCRIPTION 5

2.2 TOPOGRAPHY 6

2.3 SOILS 6

2.4 ACID SULPHATE SOILS 6

2.5 EROSION AND SEDIMENT CONTROL 6

2.6 FLOODING 6

3.0 STORMWATER QUANTITY 7

3.1 RUNOFF CHARACTERISTICS & LAWFUL POINT OF DISCHARGE 7

3.1.1 CATCHMENTS 7

3.1.2 FLOODING AND OVERLAND FLOW INUNDATION 7

3.1.3 EXISTING RUNOFF 8

3.1.4 PROPOSED RUNOFF 8

3.1.5 LAWFUL POINT OF DISCHARGE 8

3.2 STORMWATER DISCHARGE (CALCULATED USING THE RATIONAL METHOD) 8

3.2.1 PRE-DEVELOPMENT STORMWATER DISCHARGE 8

3.2.2 POST-DEVELOPMENT STORMWATER DISCHARGE 11

3.2.3 PRE VS POST COMPARISON 14

3.2.4 EXTERNAL CATCHMENT PRE & POST DEVELOPMENT COMPARISON 15

3.2.5 SUMMARY OF PRELIMINARY ASSESSMENT 15

3.3 HYDRAULIC MODELLING 15

3.3.1 PRE-DEVELOPMENT DRAINS CATCHMENT 17

3.3.2 POST-DEVELOPMENT DRAINS CATCHMENT 17

3.4 DRAINS MODEL 18

3.4.1 PRE VS POST DEVELOPMENT (MITIGATED) RUNOFF COMPARISON 19

3.4.2 SUMMARY OF MITIGATION 20

4.0 CONCLUSION 21

5.0 REFERENCES 22

APPENDIX A – CONCEPT DEVELOPMENT PLANS 23

Tables

TABLE 1 PRE-DEVELOPMENT INTERNAL CATCHMENT 1 (RATIONAL) 8
TABLE 2 PRE-DEVELOPMENT DISCHARGE (CALCULATED USING THE RATIONAL METHOD) 9
TABLE 3 PRE-DEVELOPMENT INTERNAL CATCHMENT 2 (RATIONAL) 9
TABLE 4 PRE-DEVELOPMENT DISCHARGE (CALCULATED USING THE RATIONAL METHOD) 9
TABLE 5 PRE-DEVELOPMENT INTERNAL CATCHMENT 3 (RATIONAL) 9
TABLE 6 PRE-DEVELOPMENT DISCHARGE (CALCULATED USING THE RATIONAL METHOD) 10
TABLE 7 PRE-DEVELOPMENT INTERNAL CATCHMENT 4 (RATIONAL) 10
TABLE 8 PRE-DEVELOPMENT (CALCULATED USING THE RATIONAL METHOD) 10
TABLE 9 PRE-DEVELOPMENT EXTERNAL CATCHMENT 1 (RATIONAL) 10
TABLE 10 PRE-DEVELOPMENT (CALCULATED USING THE RATIONAL METHOD) 11
TABLE 11 PRE-DEVELOPMENT EXTERNAL CATCHMENT 2 (RATIONAL) 11
TABLE 12 PRE-DEVELOPMENT (CALCULATED USING THE RATIONAL METHOD) 11
TABLE 13 POST-DEVELOPMENT INTERNAL CATCHMENT 1 (RATIONAL) 11
TABLE 14 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 12
TABLE 15 POST-DEVELOPMENT INTERNAL CATCHMENT 2 (RATIONAL) 12
TABLE 16 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 12
TABLE 17 POST-DEVELOPMENT INTERNAL CATCHMENT 3 (RATIONAL) 12
TABLE 18 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 13
TABLE 19 POST-DEVELOPMENT INTERNAL CATCHMENT 4 (RATIONAL) 13
TABLE 20 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 13
TABLE 21 POST-DEVELOPMENT EXTERNAL CATCHMENT 1 (RATIONAL) 13
TABLE 22 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 14
TABLE 23 POST-DEVELOPMENT EXTERNAL CATCHMENT 2 (RATIONAL) 14
TABLE 24 POST-DEVELOPMENT DISCHARGE – UNMITIGATED (CALCULATED USING THE RATIONAL METHOD) 14
TABLE 25 COMPARISON OF PRE-& POST-DEVELOPMENT DISCHARGE NODE A (CALCULATED USING THE RATIONAL METHOD) .. 15
TABLE 26 COMPARISON OF PRE-& POST-DEVELOPMENT DISCHARGE (INCLUDING EXTERNAL CATCHMENT) NODE A (CALCULATED USING THE RATIONAL METHOD) 15
TABLE 27 CRITICAL STORM EVENTS 16
TABLE 28 SOFTWARE PARAMETERS USED IN DRAINS MODEL 17
TABLE 29 PRE-DEVELOPMENT CATCHMENT SUMMARY (DRAINS) 17
TABLE 30 POST DEVELOPMENT CATCHMENT SUMMARY (DRAINS) 18
TABLE 31 PRE VS. POST DEVELOPMENT DISCHARGE (CALCULATED USING DRAINS) 20

Figures

FIGURE 1: ARIEL PHOTO OF PROPOSED SITE & SURROUNDING 5
FIGURE 2: DEVELOPMENT SITE FLOOD MAP 7
FIGURE 3: IFD DATA 16
FIGURE 4 DRAINS NETWORK MODEL 19
FIGURE 5 DRAINS MODEL RESULTS (WORST CASE MAJOR STORM 1% AEP) 20

1.0 INTRODUCTION

Bespoke Engineering Solutions have been commissioned by Queensland Property Group (referred to as the "Client" hereafter) to prepare a Site Based Stormwater Management Report for a proposed Industrial Park at 1 Chum Street, New Chum. This document will address stormwater quantity impacts of the proposed development and will be submitted to the Ipswich City Council in support of the Development Application.

1.1 BASIS OF THE REPORT

The Stormwater Management Plan has been developed to assist in identifying acceptable stormwater management measures that incorporate the design fundamentals outlined within the local authorities' engineering planning scheme policies and Queensland Urban Drainage Manual Version 3 (QUDM).

This report has been compiled based on the following information:

- Discussions between Bespoke Engineering Solutions and the project team
- Site Plan provided by Queensland Property Group
- Proposed Subdivision Plan provided by Queensland Property Group and Bespoke Engineering Solutions

1.2 SCOPE OF THE REPORT

This document will report on the following stormwater items:

- Identify the lawful point of discharge in accordance with the Local Authority requirements.
- Prepare a conceptual stormwater plan for the proposed development, which incorporates the recommendations made as part of the findings of this report.
- Identify any increases in stormwater runoff that will be generated by the development.
- Make the appropriate recommendations to ensure that stormwater discharge from the development is the same as pre-development discharge and that proposed stormwater discharge will not adversely affect surrounding properties and/or the drainage network.

2.0 SITE CHARACTERISTICS

2.1 LOCATION & DESCRIPTION

The proposed development site is located on the land described as Lot 271 SP207443 & Lot 273 RP866881. Total area of the development site is 19.395HA. Chum street is located on the south-west of Old Ipswich Road and directly adjacent to Cunningham Highway. There are local amenities within close proximity of site including (but not limited to) train station, firms for industrial purposes such as steel, waste disposal and etc. Additionally, there is an operating quarry located north-east of the proposed site.

The proposed development is to reconfigure two (2) existing lots into four (4) proposed lots for the construction of an industrial park for 1 Chum Street, New Chum, QLD in a three (3) stage program. Currently there are four (4) existing buildings on site. The proposed development will be connected by an internal collector industrial road and each will include car parking and heavy vehicle pavements. Refer to Appendix A & B for The Plan Layouts.

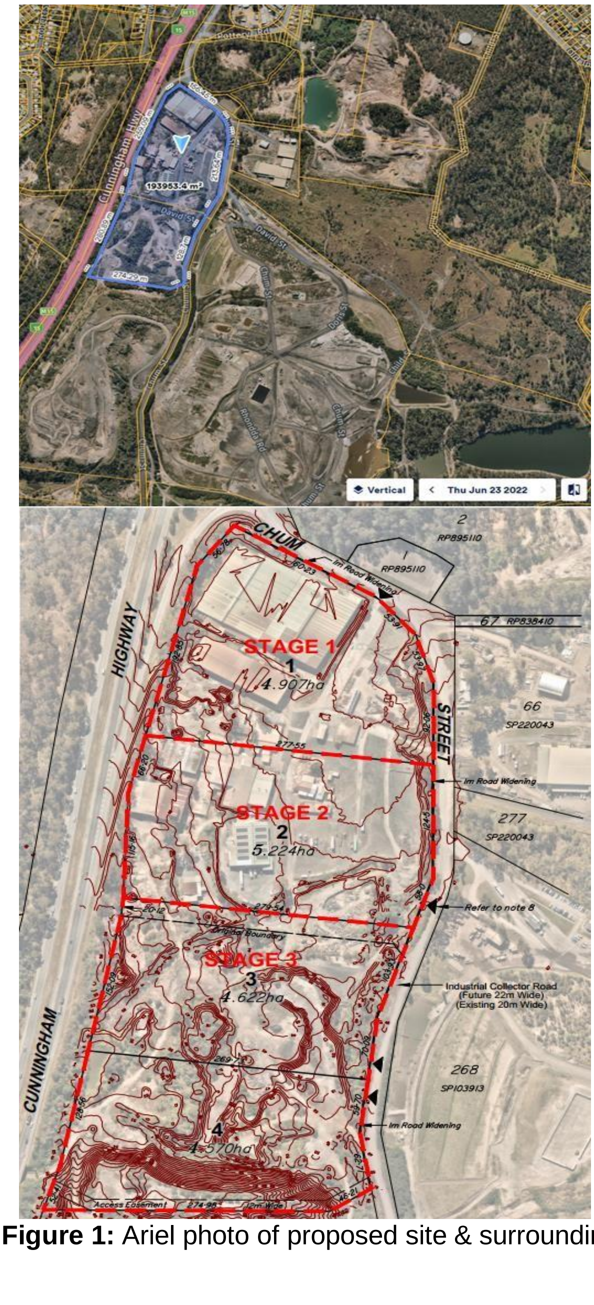


Figure 1: Ariel photo of proposed site & surrounding

2.2 TOPOGRAPHY

The site falls from RL 72.0m AHD located at the south of the site at Lot 4 to RL 35m AHD located at the north-west side of the site at Lot 1. The gradient of the site varies however the average site grades are 4.9% across the site and generally falls from south at Lot 4 to north-west at Lot 1. The site currently has five entry/exit roads via Chum Street & Rhondda Road.

2.3 SOILS

A geotechnical investigation report for the proposed site was undertaken by Douglas Partners on July 2022. The report details the soil types, current site conditions, proposed development and the constraints and mitigation that needs to be undertaken prior to construction work.

2.4 ACID SULPHATE SOILS

Acid Sulphate Soils (ASS), are normally found in Holocene sediments and are generally found at levels lower than 5.0m AHD. The minimum level of the site is approximately 35m AHD. It is not expected that ASS will be encountered, however in the event that ASSs are encountered on the site, a suitable Acid Sulphate Soils Management Plan will be developed by an appropriately qualified consultant. In addition, management of the acid sulphate soil will be required by the principal contractor in accordance with the requirements of the State Planning Policy involving ASS's.

2.5 EROSION AND SEDIMENT CONTROL

Erosion and sediment control (ESC) measures will be required to be established and maintained in accordance with Brisbane City Council's standards of best practice. Preparation of a detailed ESC plan showing how ESC will be managed during the construction phase of the project will be required. It will be the responsibility of the principal contractor to implement, and update as necessary, the requirements of the ESC plan during the construction phase.

2.6 FLOODING

The latest Ipswich City Council's Interactive Mapping (current at the time of this report) shows that the development site is not within a flood overlay zone. The proposed Site Layout has taken into consideration this flood overlay zone. Please refer to figure 2 below.

However, in accordance to the geotechnical investigation undertaken by Douglas Partners, water has accumulated in the mine workings over time, whether this is due to possible flooding or not, it should be taken into consideration. Further, due to the site conditions and levels. The development site is subjected to overland flow during heavy storm.

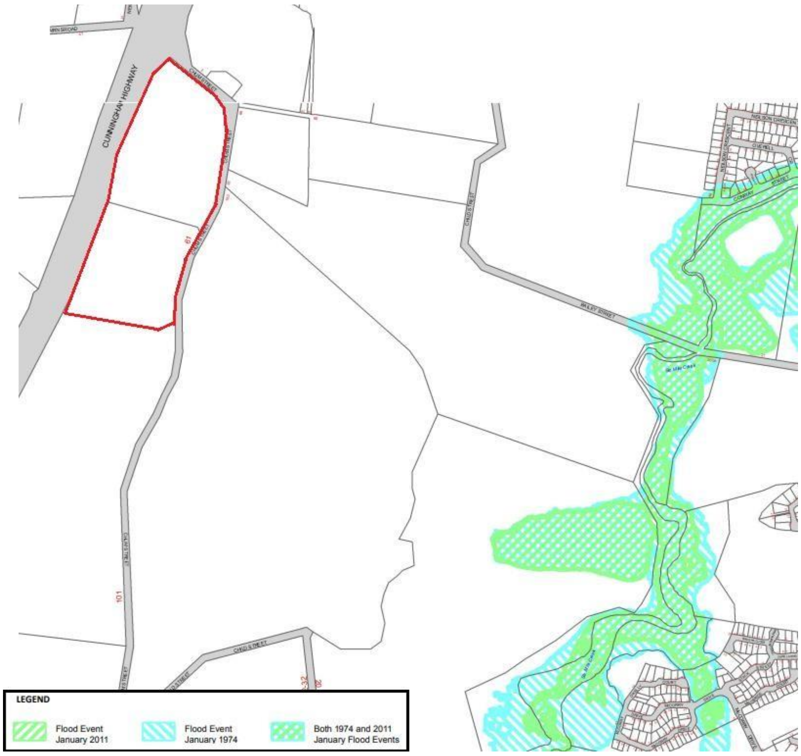


Figure 2: Development site flood map

3.0 STORMWATER QUANTITY

3.1 RUNOFF CHARACTERISTICS & LAWFUL POINT OF DISCHARGE

3.1.1 CATCHMENTS

The existing site is considered to have four (4) internal catchment areas and two (2) external catchment areas based on provided LiDAR elevation data and a preliminary site survey. Please see the list below of each catchment and its approximate size.

- Internal Catchment Area 1 = Approximately 4.910Ha
- Internal Catchment Area 2 = Approximately 5.248Ha
- Internal Catchment Area 3 = Approximately 4.635Ha
- Internal Catchment Area 4 = Approximately 4.609Ha, and
- External Catchment Area 1 = Approximately 17.750Ha
- External Catchment Area 2 = Approximately 14.020Ha

3.1.2 FLOODING AND OVERLAND FLOW INUNDATION

As mentioned in section 2.6 above, the latest Ipswich City Council's Interactive Mapping (current at the time of this report) shows that the development site is not within a flood overlay zone. The proposed Site Layout has taken into consideration this flood overlay zone. However, in accordance to the geotechnical investigation undertaken by Douglas Partners, water has accumulated in the mine workings over time this potentially may be due to possible flooding and should be taken into consideration.

3.1.3 EXISTING RUNOFF

Based on a preliminary site survey and LiDAR elevation data, stormwater that is captured on the development site is allowed to sheet overland flow towards the road on the northern part of site then onto Chum Street.

3.1.4 PROPOSED RUNOFF

For post development, stormwater drainage system will be provided within the lots. The stormwater drainage system will be designed to collect and discharge the stormwater overland sheet flow on to the new Chum Street.

3.1.5 LAWFUL POINT OF DISCHARGE

Pre-development existing internal stormwater captured on the current site are allowed to overland sheet flow towards the north of the site and into Chum Street. The external stormwater partially runs along the current Chum Street then flows into the Lot 2 of the development site due to the sag in the road. Alike the internal stormwater, the external stormwater then flows to the north of Chum street through the development site via overland sheet flow.

Post development has been designed to allow the internal stormwater to overland sheet flow from Lot 3 and 4 onto the upgraded Chum Street. The upgraded Chum street has been designed to have a series of double gully pits on both side of the road which will capture the stormwater and pipe it along Chum street to its lawful point of discharge North of the site. For stormwater in Lot 2 and 1, a custom pit has been designed to capture the stormwater and similarly, pipe it to North of the site at its natural lawful point of discharge.

External stormwater will be captured in the same manner. Another large custom pit has been proposed on Chum Street at the South of the site. It will be used to capture the external stormwater and will be directly piped to the north of the site to its natural lawful point of discharge.

Both Internal and External stormwater has been designed to be captured via drainage system.

Please refer to **Appendix A** and **B** for further detail.

3.2 STORMWATER DISCHARGE (CALCULATED USING THE RATIONAL METHOD)

A preliminary assessment of stormwater discharge has been undertaken using The Rational Method in accordance with Council's engineering planning scheme policies and QUDM. The findings are presented in the below sections.

Refer to **Appendix C** for Rational Method Calculations.

3.2.1 PRE-DEVELOPMENT STORMWATER DISCHARGE

Table 1 Pre-Development Internal Catchment 1 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
49,103.00m^2	**34,372.10m^2 (70%)**	**14,730.90m^2 (30%)**

Time of Concentration Node A = 19.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.88
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Pre-Development Discharge (m^3/s)
			Node A
1	63%	62.80	0.603
2	39%	71.60	0.730
5	18%	98.60	1.124
10	10%	117.00	1.404
20	5%	134.00	1.689
50	2%	157.00	2.141
100	1%	174.00	2.373

Table 2 Pre-Development Discharge (calculated using the Rational Method)

Table 3 Pre-Development Internal Catchment 2 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
52,476.00m^2	**36,733.20m^2 (70%)**	**15,742.80m^2 (30%)**

Time of Concentration Node A = 16.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.88
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Pre-Development Discharge (m^3/s)
			Node A
1	63%	68.40	0.702
2	39%	78.00	0.851
5	18%	107.00	1.304
10	10%	127.00	1.629
20	5%	146.00	1.967
50	2%	170.00	2.478
100	1%	189.00	2.755

Table 4 Pre-Development Discharge (calculated using the Rational Method)

Table 5 Pre-Development Internal Catchment 3 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
46,354.00m^2	**0.00m^2 (0%)**	**46,354.00m^2 (100%)**

Time of Concentration Node A = 24.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Pre-Development Discharge (m^3/s)
			Node A
1	63%	55.30	0.422
2	39%	63.00	0.510
5	18%	87.00	0.788
10	10%	103.00	0.981
20	5%	118.00	1.181
50	2%	139.00	1.523
100	1%	154.00	1.761

Table 6 Pre-Development Discharge (calculated using the Rational Method)

Table 7 Pre-Development Internal Catchment 4 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
46,088.00m^2	**0.00m^2 (0%)**	**46,088.00m^2 (100%)**

Time of Concentration Node A = 19.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Pre-Development Discharge (m^3/s)
			Node A
1	63%	62.80	0.476
2	39%	71.60	0.577
5	18%	98.60	0.887
10	10%	117.00	1.108
20	5%	134.00	1.333
50	2%	157.00	1.710
100	1%	174.00	1.978

Table 8 Pre-Development (calculated using the Rational Method)

Table 9 Pre-Development External Catchment 1 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
177,500.00m^2	**0.00m^2 (0%)**	**177,500.00m^2 (100%)**

Time of Concentration Node A = 21.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

		I (mm/hr)	Pre-Development Discharge (m^3/s)

ARI (yr)	AEP	Node A	
1	63%	59.60	1.740
2	39%	67.90	2.106
5	18%	93.60	3.244
10	10%	111.00	4.050
20	5%	127.00	4.865
50	2%	149.00	6.252
100	1%	165.00	7.224

Table 10 Pre-Development (calculated using the Rational Method)

Table 11 Pre-Development External Catchment 2 (Rational)

Development Site Area (m^2)	Pre-Development Impervious Area (m^2) (%)	Pre-Development Pervious Area (m^2) (%)
140,200.00m^2	**0.00m^2 (0%)**	**140,200.00m^2 (100%)**

Time of Concentration Node A = 19.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.70
QUDM V3, Table 4.5.3 – Table of *C_{10}* Values

ARI (yr)	AEP	I (mm/hr)	Pre-Development Discharge (m^3/s)
		Node A	
1	63%	62.80	1.370
2	39%	71.60	1.659
5	18%	98.60	2.554
10	10%	117.00	3.190
20	5%	134.00	3.836
50	2%	157.00	4.922
100	1%	174.00	5.692

Table 12 Pre-Development (calculated using the Rational Method)

3.2.2 POST-DEVELOPMENT STORMWATER DISCHARGE

Pre-development vs Post-development Aforementioned, Internal Catchments 1, 2, 3, 4, and external catchment 1 and 2 encompasses the proposed development for the site.

Table 13 Post-Development Internal Catchment 1 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
49,103.00m^2	**39,282.40m^2 (80%)**	**9,820.60m^2 (20%)**

Time of Concentration Node A = 11.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.88

QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m³/s)
		Node A	
1	63%	80.50	0.773
2	39%	91.70	0.936
5	18%	126.00	1.437
10	10%	149.00	1.788
20	5%	171.00	2.155
50	2%	200.00	2.728
100	1%	222.00	3.028

Table 14 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

Table 15 Post-Development Internal Catchment 2 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
52,476.00m²	**41,980.80m² (80%)**	**10,495.20m² (20%)**

Time of Concentration Node A = 9.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.88
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m³/s)
		Node A	
1	63%	86.60	0.889
2	39%	98.60	1.075
5	18%	136.00	1.657
10	10%	160.00	2.053
20	5%	184.00	2.478
50	2%	215.00	3.134
100	1%	239.00	3.484

Table 16 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

Table 17 Post-Development Internal Catchment 3 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
46,354.00m²	**0.00m² (0%)**	**46,354.00m² (100%)**

Time of Concentration Node A = 24.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m³/s)
		Node A	
1	63%	55.3	0.422
2	39%	63.0	0.510
5	18%	87.0	0.788
10	10%	103.0	0.981
20	5%	118.0	1.181
50	2%	139.0	1.523
100	1%	154.0	1.761

Table 18 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

Table 19 Post-Development Internal Catchment 4 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
46,088.00m^2	**0.00m^2 (0%)**	**46,088.00m^2 (100%)**

Time of Concentration Node A = 19.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m³/s)
		Node A	
1	63%	62.8	0.476
2	39%	71.6	0.577
5	18%	98.6	0.887
10	10%	117.0	1.108
20	5%	134.0	1.333
50	2%	157.0	1.710
100	1%	174.0	1.978

Table 20 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

Table 21 Post-Development External Catchment 1 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
177,500.00m^2	**0.00m^2 (0%)**	**177,500.00m^2 (100%)**

Time of Concentration Node A = 21.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.74
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m^3/s)
		Node A	
1	63%	59.60	1.740
2	39%	67.90	2.106
5	18%	93.60	3.244
10	10%	111.00	4.050
20	5%	127.00	4.865
50	2%	149.00	6.252
100	1%	165.00	7.224

Table 22 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

Table 23 Post-Development External Catchment 2 (Rational)

Development Site Area (m^2)	Post-Development Impervious Area (m^2) (%)	Post-Development Pervious Area (m^2) (%)
140,200.00m^2	**0.00m^2 (0%)**	**140,200.00m^2 (100%)**

Time of Concentration Node A = 19.00 Minutes,
Calculated using Friend's Equation; QUDM V3 Section 4.6.6 (c)

C_{10} Runoff Coefficient = 0.70
QUDM V3, Table 4.5.3 – Table of C_{10} Values

ARI (yr)	AEP	I (mm/hr)	Post-Development Discharge (m^3/s)
		Node A	
1	63%	62.8	1.370
2	39%	71.6	1.659
5	18%	98.6	2.554
10	10%	117.0	3.190
20	5%	134.0	3.836
50	2%	157.0	4.922
100	1%	174.0	5.692

Table 24 Post-Development Discharge – Unmitigated (calculated using the Rational Method)

3.2.3 PRE VS POST COMPARISON

From the calculations undertaken, a comparison of pre-development and post-development stormwater discharge is presented in table 25 below. Table 26 below will illustrate the pre & post comparison which includes external catchment influencing onto the site.

Catchment	ARI (yr)	AEP	Total Site Discharge			
			Pre-Development Discharge (m³/s)	Post-Development Discharge (m³/s)	Difference + / - (m³/s)	Difference + / - (%)
Pre vs Post Development Discharge Contributing to Node A						
XSite	1	63%	2.203	2.560	+0.357	+16.205 %
	2	39%	2.668	3.098	+0.430	+16.117 %
	5	18%	4.103	4.769	+0.666	+16.232 %
	10	10%	5.122	5.930	+0.808	+15.775 %
	20	5%	6.170	7.147	+0.977	+15.835 %
	50	2%	7.852	9.095	+1.243	+15.830 %
	100	1%	8.867	10.251	+1.384	+15.608 %

Table 25 Comparison of Pre-& Post-Development Discharge Node A (calculated using the Rational Method)

3.2.4 EXTERNAL CATCHMENT PRE & POST DEVELOPMENT COMPARISON

Catchment	ARI (yr)	AEP	Total Site (Incl. external) Discharge			
			Pre-Development Discharge (m³/s)	Post-Development Discharge (m³/s)	Difference + / - (m³/s)	Difference + / - (%)
Pre vs Post Development Discharge Contributing to Node A						
External + Site	1	63%	5.313	5.670	+0.357	+6.719 %
	2	39%	6.433	6.863	+0.430	+6.684 %
	5	18%	9.901	10.567	+0.666	+6.727 %
	10	10%	12.362	13.17	+0.808	+6.536 %
	20	5%	14.871	15.848	+0.977	+6.570 %
	50	2%	19.026	20.269	+1.243	+6.533 %
	100	1%	21.783	23.167	+1.384	+6.354 %

Table 26 Comparison of Pre-& Post-Development Discharge (including External catchment) Node A (calculated using the Rational Method)

3.2.5 SUMMARY OF PRELIMINARY ASSESSMENT

As can be identified in **Table 25 & 26**, there are increases in post-development stormwater discharges from the development site.

3.3 HYDRAULIC MODELLING

Hydrological analysis has been undertaken using DRAINS software.

DRAINS is a hydraulic modelling software package developed for the design and analysis of urban stormwater drainage systems. It utilizes either the “Extended Rational Method” or the “ILSAX method” hydrological loss model to convert Australian Rainfall and Runoff temporal patterns and rainfall data into runoff hydrographs.

Rainfall is modelled for the catchment in equal time intervals under each storm event and the subsequent runoff routed through a drainage system. In order to establish the most likely rain event that would require the greatest volume of detention. Design storms of 5, 10, 15, 20, 25, 30, 45, 60, 90, 120 and 180 minutes were modelled. A summary of critical storm events analyzed in DRAINS for each model is presented in **Table 7**.

Storm (ARI)	Duration (minutes)	Description
Q1	60	AR&R 1 year, 60 minutes storm, average 30.9 mm/h
Q2	60	AR&R 2 year, 60 minutes storm, average 39.1 mm/h
Q5	60	AR&R 5 year, 60 minutes storm, average 48.6 mm/h
Q10	60	AR&R 10 year, 60 minutes storm, average 57.8 mm/h
Q20	60	AR&R 20 year, 60 minutes storm, average 67 mm/h
Q50	60	AR&R 50 year, 60 minutes storm, average 79.2 mm/h
Q100	60	AR&R 100 year, 60 minutes storm, average 88.6 mm/h

Table 27 Critical Storm Events

The values for rainfall intensity are obtained from the Australian Bureau of Meteorology. Refer to Figure 3.

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	143	163	224	265	305	358	397
2 min	117	133	184	221	257	305	342
3 min	110	125	173	207	240	284	317
4 min	106	120	166	197	228	268	299
5 min	101	115	159	188	217	255	284
10 min	83.4	95.0	131	154	177	207	230
15 min	70.5	80.4	111	131	150	175	195
20 min	61.1	69.7	96.0	114	131	153	170
25 min	54.1	61.6	85.0	101	116	136	151
30 min	48.5	55.3	76.4	90.5	104	122	136
45 min	37.5	42.7	59.0	70.2	81.1	95.6	107
1 hour	30.9	35.1	48.6	57.8	67.0	79.2	88.6
1.5 hour	23.3	26.4	36.5	43.5	50.6	60.0	67.4
2 hour	19.0	21.5	29.7	35.4	41.2	49.1	55.2
3 hour	14.2	16.1	22.2	26.5	30.9	36.9	41.6
4.5 hour	10.7	12.1	16.7	20.0	23.3	27.8	31.4
6 hour	8.82	9.97	13.7	16.4	19.1	22.9	25.9
9 hour	6.72	7.61	10.5	12.5	14.6	17.6	19.9
12 hour	5.56	6.30	8.72	10.4	12.2	14.7	16.7
18 hour	4.26	4.85	6.76	8.12	9.50	11.5	13.1
24 hour	3.52	4.01	5.64	6.81	7.99	9.72	11.1
30 hour	3.02	3.46	4.90	5.93	6.99	8.54	9.80
36 hour	2.66	3.06	4.36	5.30	6.26	7.68	8.83
48 hour	2.17	2.50	3.60	4.40	5.23	6.46	7.47
72 hour	1.60	1.85	2.70	3.33	3.99	4.97	5.78
96 hour	1.27	1.48	2.16	2.68	3.23	4.03	4.71
120 hour	1.06	1.23	1.80	2.23	2.69	3.36	3.93
144 hour	0.908	1.05	1.53	1.90	2.29	2.85	3.33
168 hour	0.795	0.915	1.33	1.64	1.97	2.44	2.86

Figure 3: IFD Data

The adopted hydrological modelling parameters are indicated in **Table 28.** below:

Key Criteria	Adopted Value
Hydrological Model	ILSAX
Paved (Impervious) are depression storage (mm)	1
Supplementary Area Depression Storage (mm)	1
Grassed (Pervious) area depressions storage (mm)	5
Soil Type	Normal
Antecedent rainfall depth for AMC	3mm

Table 28 Software Parameters used in DRAINS Model

3.3.1 PRE-DEVELOPMENT DRAINS CATCHMENT

The breakdown of the pre-development catchment used in the DRAINS model is shown in **Table 29**. Refer to the **Catchment Plan** for the location of each of the analyzed catchments.

	Paved	Supplementary	Grassed
Discharge Contributing to Node A – Catchment 1 – 49,103m^2			
Percentage of area (%)	70	0	30
Time of concentration (minutes)	5	0	19
Discharge Contributing to Node A – Catchment 2 – 52,476m^2			
Percentage of area (%)	70	0	30
Time of concentration (minutes)	5	0	16
Discharge Contributing to Node A – Catchment 3 – 46,354m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	24
Discharge Contributing to Node A – Catchment 4 – 46,088m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	19
Discharge Contributing to Node A – Catchment External 1 – 177,500m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	21
Discharge Contributing to Node A – Catchment External 2 – 140,200m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	19

Table 29 Pre-Development Catchment Summary (DRAINS)

3.3.2 POST-DEVELOPMENT DRAINS CATCHMENT

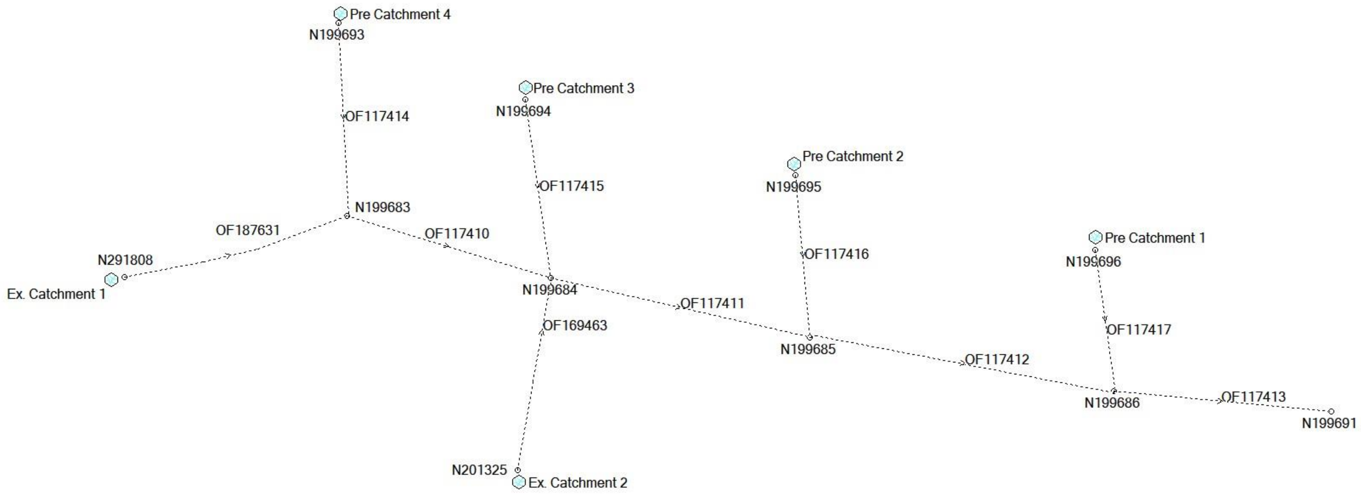
The breakdown of the post-development catchment used in the DRAINS model is shown in **Table 30**. Refer to the **Catchment Plan** for the location of each of the analysed catchments.

	Paved	Supplementary	Grassed
Discharge Contributing to Node A – Catchment 1 – 49,103m^2			
Percentage of area (%)	80	0	20
Time of concentration (minutes)	5	0	11
Discharge Contributing to Node A – Catchment 2 – 52,476m^2			
Percentage of area (%)	80	0	20
Time of concentration (minutes)	5	0	9
Discharge Contributing to Node A – Catchment 3 – 46,354m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	24
Discharge Contributing to Node A – Catchment 4 – 46,088m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	19
Discharge Contributing to Node A – Catchment External 1 – 177,500m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	21
Discharge Contributing to Node A – Catchment External 2 – 140,200m^2			
Percentage of area (%)	0	0	100
Time of concentration (minutes)	5	0	19

Table 30 Post Development Catchment Summary (DRAINS)

3.4 DRAINS MODEL

With the use of DRAINS, stormwater pits have been modelled to limit runoff to be equal or lesser than the pre-development discharge.



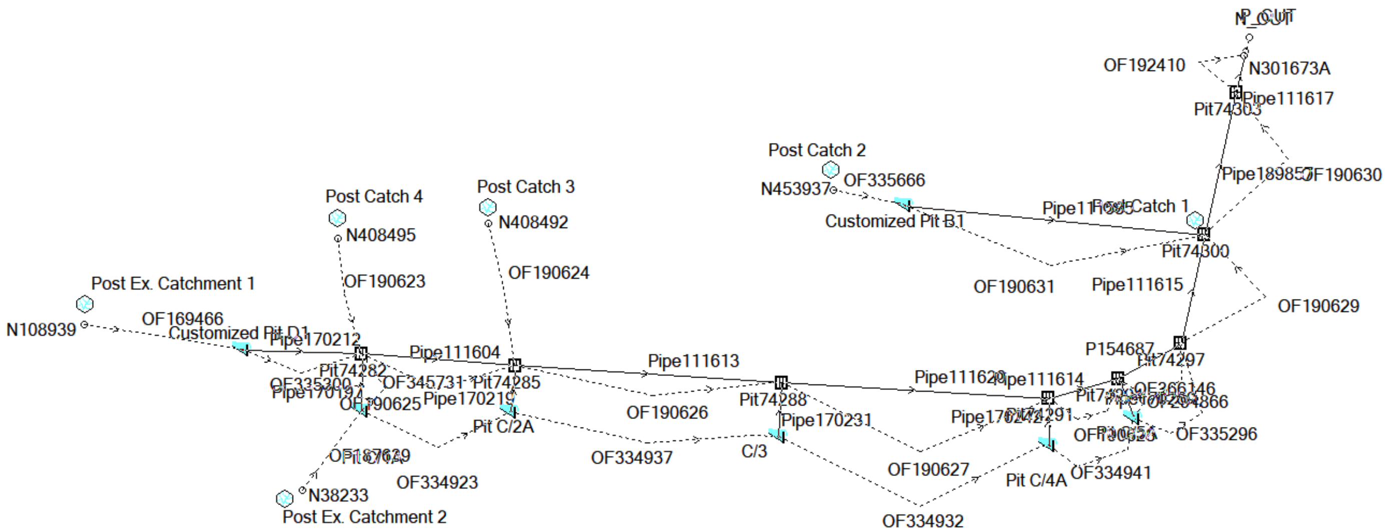
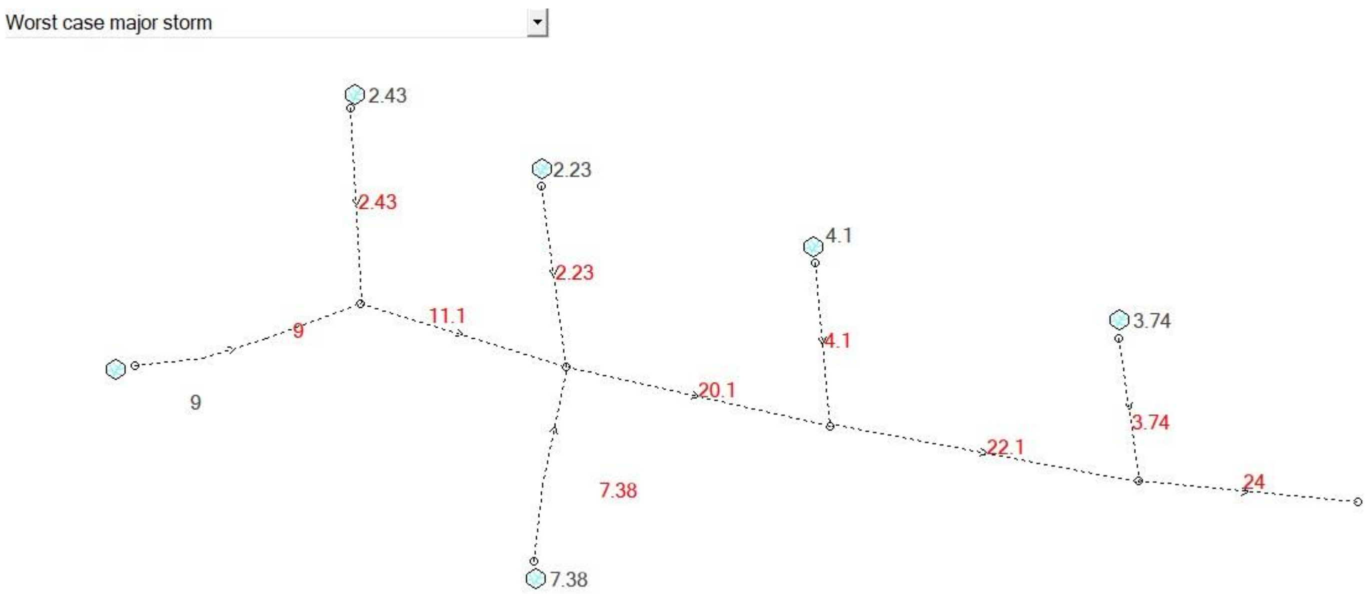


Figure 4 DRAINS Network Model

3.4.1 PRE VS POST DEVELOPMENT (MITIGATED) RUNOFF COMPARISON

Through the mitigation methods described above the post development flows have been reduced to equal or less than pre-development peak flow rates. Table 27 and Figure 5 below outline the resultant flows as calculated in the DRAINS model presented above. These results indicate peak flows for each event however detention of lesser storms have determined the detention device volume and outlet configuration.



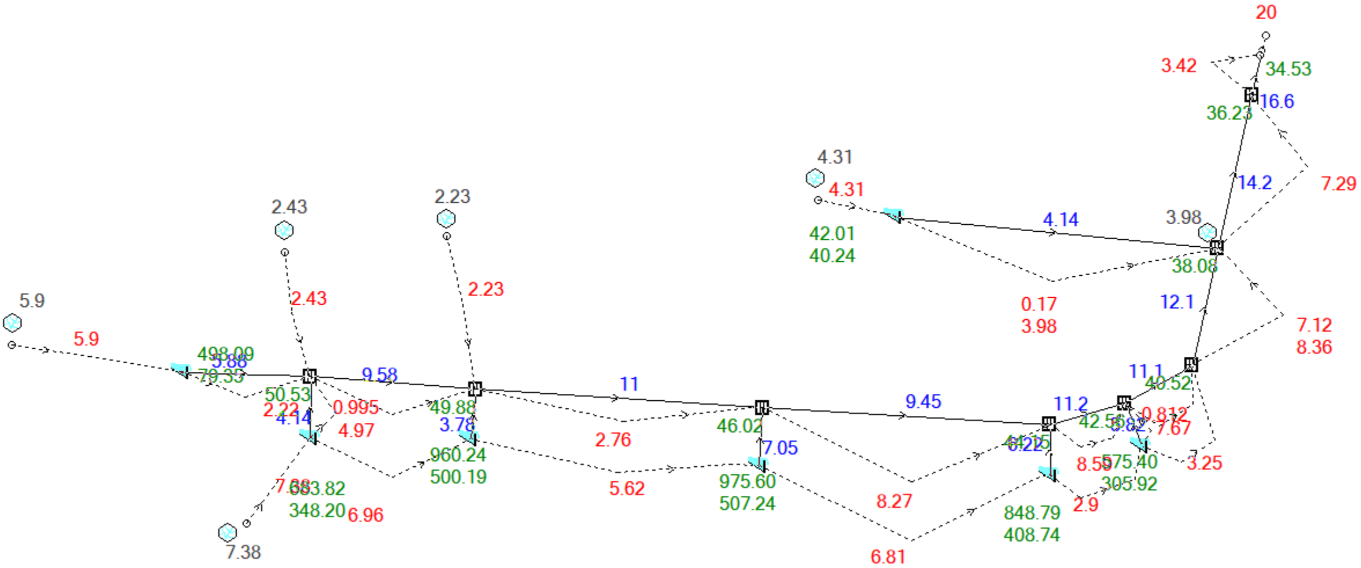


Figure 5 DRAINS Model Results (Worst Case Major Storm 1% AEP)

ARI (yr)	AEP	Pre-Development Discharge (m^3/s)	Post-Development Discharge (m^3/s)	Difference + / - (m^3/s)	Difference + / - (%)
		@ Node A	@ Node A	@ Node A	@ Node A
1	63%	2.48	2.08	-0.4	-16.13%
2	39%	5.12	5.01	-0.11	-2.15%
5	18%	8.43	6.92	-1.51	-17.91%
10	10%	11	8.99	-2.01	-18.27%
20	5%	14.5	10.8	-3.7	-25.52%
50	2%	19.3	16	-3.3	-17.10%
100	1%	24	20	-4.0	-16.67%

Table 31 Pre vs. Post Development Discharge (calculated using DRAINS)

3.4.2 SUMMARY OF MITIGATION

As can be seen in **Table 31**, there are no increases in post-development flows discharging from the development site where it discharges onto the proposed new Chum Street.

The proposed stormwater drainage system is successful in mitigating post development flows so that no adverse effects will occur to existing council stormwater infrastructure and adjacent properties in comparison to the pre-development flows.

Given the above, the mitigations of peak flows are deemed to represent an acceptable solution for this development.

4.0 CONCLUSION

This report has investigated the impacts of the proposed development on stormwater quantity in the catchment and concludes that the post development discharges from the proposed development is less than the pre development stage. Bespoke Engineering Solutions Pty Ltd have performed analysis of all site catchments and conditions, and proposed suitable recommendations whilst considering all aspects and constraints opposed on the development. Further, as the stormwater is captured by the proposed drainage system, the development will have no impact nor adverse effect to the surrounding properties.

Bespoke Engineering Solutions Pty Ltd provides the above assessment and the information contained in the attached appendices based on the information outlined on Page 1 of this report. We trust that sufficient information has been provided to allow assessment and approval of the proposal with conditions

5.0 REFERENCES

Ipswich City Council, Ipswich Planning Scheme, Implementation Guideline No.24 Stormwater Management – January 2016

Water-by-Design, MUSIC Modelling Guidelines Version 3.0 - 2018

Queensland Government, Department of Infrastructure, Local Government and Planning, State Planning Policy, July – 2017

Environmental Protection (Water and Wetland Biodiversity) Policy – 2019

Bureau of Meteorology, Meteorological Data

Water-By-Design Maintaining Vegetated Stormwater Assets - 2012

Water-By-Design Construction and Establishment Guidelines - 2019.

Water-By-Design Bioretention Technical Design Guidelines v1.1 - 2014

.

Dalrymple B, Wicks M. (2021). A review of the application of OceanGuard® in Australia. Prepared on behalf of Ocean Protect.

APPENDIX A – CONCEPT DEVELOPMENT PLANS