APPENDIX G

Site Based Stormwater Management Report

Prepared by:

Pinnacle Engineering

PINNACLE
ENGINEERING GROUP

SITE BASED STORMWATER MANAGEMENT PLAN

PROPOSED CENTRE DEVELOPMENT
Homestead Drive, Flagstone QLD

BLUEPOINT FLAGSTONE PTY LTD

JUNE 2025
REVISION 05

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In accordance with the requirements of the *Queensland Professional Engineers Act 2002*, this document was prepared under the supervision of, reviewed and approved by the following experienced Registered Professional Engineer of Queensland (RPEQ).

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Document Control

Rev	Date issued	Review	Approved	Approved on	Revision type
01	30-November-2021	A. Cresswell	B. Popa	30-November-2021	Issued for comment
02	17-April-2025	J. Hardman	B. Popa	17-April-2025	Issued for comment
03	26-May-2025	J. Hardman	B. Popa	26-May-2025	Issued for comment
04	16-June-2025	J. Hardman	B. Popa	16-June-2025	Issued for use
05	18-June-2025	J. Hardman	B. Popa	18-June-2025	Issued for use

Distribution of Copies

Revision	Quantity	Distribution
01	1.pdf	Bluepoint Property Pty Ltd
02	1.pdf	Bluepoint Flagstone Pty Ltd
03	1.pdf	Bluepoint Flagstone Pty Ltd
04	1.pdf	Bluepoint Flagstone Pty Ltd
05	1.pdf	Bluepoint Flagstone Pty Ltd

Printed:	17/06/2025
Last saved:	17/06/2025 21:15
File name:	P:\Projects\PEG0810_Flagstone Commercial Precinct\03 Reports\02 SBSMP\250618_PEG0810_Flagstone Commercial Precinct_SBSMP_R005.docx
Author:	Jai Waters
Project manager:	Bogdan Popa
Name of organisation:	Pinnacle Engineering Group
Name of project:	Flagstone Commercial Precinct
Name of document:	250618_PEG0810_Flagstone Commercial Precinct_SBSMP_R005.docx
Document version:	REV 05
Project number:	PEG0810

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1 Introduction

Pinnacle Engineering Group (Pinnacle) was engaged by Bluepoint Flagstone Pty Ltd to prepare a site-based stormwater management plan (SBSMP) and undertake the associated investigations as supporting documentation for the proposed development application for a commercial, retail and future residential development located at Homestead Drive, Flagstone QLD located in Logan City Council (LCC) under the authority of Economic Development Queensland (EDQ).

The stormwater management strategy described in the following sections of this report has been developed with reference to, and is generally consistent with, previous design documentation prepared by Peak Urban in 2020 and 2021. Section 2 outlines how these earlier reports have influenced the current strategy, with the original Peak Urban documentation included in Appendix H.

1.1 Scope of Investigation

This report addresses the proposed stormwater management strategy for the aforementioned development, including but not limited to the following elements:

- Nomination of the Lawful Point of Discharge;
- Details of stormwater quantity management strategy for the site;
- Details of the stormwater quality treatment train to be implemented for the site;
- Nomination of maintenance schedules and techniques for each of the proposed stormwater quality improvement devices; and
- Sediment and erosion control plan.

1.2 Site Description

1.2.1 Location

Street Address	-	Homestead Drive, Flagstone QLD
RP Description	-	Lot 25007 and 25009 on SP303120
Total Site Area	-	6.5236 Hectares
Current Zoning	-	Priority Development Area
Proposed Use	-	Commercial, Retail, and Residential (Future) Development Precinct
Local Authority	-	Logan City Council (LCC)
Assessment Authority	-	Economic Development Queensland (EDQ)

Refer to Figure 1.1 for the site location.

1.2.2 Existing Site Conditions and Topography

The subject site is generally clear of significant structures and vegetation. As a result of previous earthworks operations, the site generally grades north, into an existing dam within the northeast corner of the site, and subsequently into the existing dam within the adjacent property to the northeast being Lot 905 on SP216472. The highest elevation of the site of RL50.50m AHD is reached at the southwest corner of the site while the lowest elevation of approximately RL36.25m AHD is reached along the northern property boundary adjacent to the future New Beith Road reserve. The site is currently burdened by an existing easement (EMT M on SP303120) which is aligned along the northern boundary of Lot 25007 on SP303120.

Refer to Figure 1.2 for the existing aerial view of the site with the latest site survey included in Appendix B.

1.2.3 Proposed Development

The proposed development will deliver commercial and retail tenancies across the two existing allotments, along with associated carparking and road infrastructure, and will be delivered in four stages. A residential development is planned for the site's northeastern corner, and is to be delivered as part of a future stage. Access to these developments will be facilitated via the proposed extensions to Hollows Road and New Beith Road.

A 'Reconfiguration of a Lot' (ROL) application is anticipated for Lot 25009 on SP303120 to subdivide the current parcel into eight lots. This subdivision will allocate individual lots to the commercial and retail tenancies T1-T5 and T10, the future residential development, and a road reserve lot for the proposed extension of Hollows Road which will be dedicated to Council. The remaining commercial and retail tenancies T6-9 will occupy a shared lot.

Stage 1 of the proposed development involves delivery of tenancies T4–T9, which includes three fast-food outlets, a car wash, a showroom, a workshop, and the Hollows Road extension. Stage 2 will deliver the remaining fast-food tenancy (T3). Stage 3 will encompass the construction of T1 and T2 showrooms and their associated carparking facilities, while Stage 4 will deliver tenancy T10 and the extension of New Beith Road. The residential development will be delivered separately as part of future works.

Plans detailing the proposed development are included within Appendix A.

1.2.4 Existing Drainage System

Currently, stormwater generated within the subject site, and the external catchments to the south and east are conveyed north, into an existing dam within the site that is adjacent to the intersection of New Beith Road and Parkside Drive.

Adjacent to the site, a pit and pipe stormwater network beneath the Hollows Road and Allis Street Road reserves captures flows from surrounding developments, conveying them into an existing drainage channel within the site via a 750mm diameter pipe and culvert headwall. Similarly, flows generated within the adjacent Flagstone Early Learning Centre are discharged into the site's existing drainage channel via a 450mm diameter pipe and culvert headwall.

Additional stormwater pit and pipe systems are located beneath the Homestead Drive and the Wild Mint Drive road reserves to the south and east of the subject site, respectively.

1.3 Flood Assessment

A review of the LCC interactive online mapping system has identified that the subject site is partially located within the mapped flood affected zone as a result of adjacent tributaries. The defined 1% AEP flood level is 36.7m AHD which encroaches into the northern corner of the site.

However, we refer EDQ to the approved Masterplan flooding solution report, *Flagstone City – Masterplan, Flooding Assessment*, by Cardno Limited (now Stantec) for Peet Flagstone City Pty Ltd (report reference: 721743/032/V6, 2014). This report concludes that the implementation of catchment-wide culverts and detention basins results in negligible flood impact both upstream and downstream of the Flagstone City Masterplan development.

Analysis of TUFLOW peak water surface levels in Figure B1 confirms that the northern corner of the site is subject to flooding from adjacent tributaries during the 1% AEP storm event. Conversely, Figures C1 and D1 indicate that post-development, the site remains flood-free under the 1% AEP storm condition, attributed to enhanced routing and storage provided by the proposed culvert and basin system networks within the wider catchment.

The relevant LCC Planning Scheme maps are included within Appendix G.

1.4 External Catchments

Multiple upstream external catchments have been identified, including the existing commercial and retail development southeast of the site and the Flagstone Early Learning Centre to the east, at the corner of Allis Street and Wild Mint Drive. Flows generated within these catchments are discharged into the subject site via piped and overland flow. The existing stormwater reticulation network beneath Allis Street and Hollows Road discharges into a drainage channel within the site via a 750mm diameter pipe and culvert. Similarly, flows generated by the childcare facility are discharged into the same drainage channel via a 450mm diameter pipe and culvert. These external catchments are incorporated into the stormwater analysis of the proposed development. It is noted that the quantity and quality of flows generated from these catchments will be mitigated by the regional bio-retention and detention basin proposed by Peak Urban. Refer to Section 2 of this report for details as well as the catchment plans and stormwater management layouts within Appendix C and E respectively.

Figure 1.1: Map View (Source: Google Maps)

Figure 1.2: Aerial View (Source: Queensland Globe)

2 Project History

2.1 Flagstone City Masterplan for Peet Limited

Ongoing consultation with Economic Development Queensland (EDQ) has confirmed that the subject site is part of a previously approved Masterplan Development by Peet Limited. A review of the relevant planning and engineering documentation indicates that EDQ has endorsed a Masterplan solution for managing stormwater quantity and flood mitigation across the broader Flagstone East area.

This review also identified a more local stormwater management strategy prepared for the subject site by Peak Urban in 2020 and 2021. The original has been preserved, forming the basis of this report, which remains generally consistent with the previously endorsed documentation. A summary of the previous reports and their key outcomes is provided below, with full copies available from Pinnacle upon request.

2.1.1 Key Reference Reports

- *Flagstone City – Masterplan, Flooding Assessment*, by Cardno Pty Ltd (now Stantec) for Peet Flagstone City Pty Ltd (report reference: 721743/032/V6, 2014).
- *Flagstone City – Stage 7, Stormwater Management Report*, by Cardno Pty Ltd (now Stantec) for Peet Flagstone City Pty Ltd (report reference: 7217/43/R11/V1, 2015).
- *Stormwater Management Plan at Flagstone Stage 7 North*, by Bradlees Civil Consulting (now Meinhardt Australia) for Peet Flagstone City Pty Ltd (report reference: 15-891, Revision A, 2017).
- *Stormwater Infrastructure Master Plan,* by Meinhardt Australia (report reference: Stormwater IMP, version 1.4, 2018).
- *Flagstone Stage 7A-G – Stormwater Management Strategy* Technical Memorandum by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178.TM02.DC.DOCX, 2020)
- *Stormwater Management Plan, Flagstone – Stages 7C/D/G* by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

2.1.2 Critical Discussion of the Reference Reports

Flagstone City – Masterplan, Flooding Assessment, by Cardno (now Stantec) – 2014

The *Flagstone City – Stage 7, Stormwater Management Report*, prepared by Cardno Pty Ltd in 2014 provides discussion on the proposed regional stormwater management strategy for the Flagstone City Master Development Plan. The report advocates for a Masterplan approach to stormwater quantity management, aiming to enhance infrastructure efficiency across the broader development area while minimising initial and ongoing maintenance costs. Additionally, it recommends the integration of bio-retention systems across Flagstone East (which includes the subject site) to treat post-development runoff. This report was approved by Economic Development Queensland (EDQ) in July 2015, and has informed subsequent detailed studies by Bradlees, Meinhardt, and later Peak Urban, contributing to the ongoing refinement of stormwater management strategies in the area.

Flagstone City – Masterplan, Flooding Assessment, by Cardno (now Stantec) – 2015

The *Flagstone City – Masterplan, Flooding Assessment*, prepared by Cardno Pty Ltd in 2015 provides the most current recommendations for catchment wide stormwater infrastructure within the Flagstone City Master Development Plan. The report recommends that stormwater quantity and flooding be addressed as a Masterplan solution to maximise the efficiency of the infrastructure within the wider development area and to reduce initial and on-going maintenance costs. Importantly, this report concludes that the implementation of catchment-wide culverts and detention basins will resolve flood impacts within the subject site, whilst maintaining negligible impacts both upstream and downstream of the wider development area.

Stormwater Infrastructure Master Plan by Meinhardt Australia – 2018

Meinhardt Australia delivered a consolidated Stormwater Infrastructure Master Plan (IMP) for the wider Flagstone City development area in 2018. In this report, the subject site is clearly identified in Context Area 1 on the Context Area Plan drawing PFP-001 and is noted on the Local Infrastructure Proposed Stormwater Network Plan drawing PFP-003. Importantly, Section 5.2 of this report confirms that the management of stormwater quantity and site flooding will be addressed as a masterplan solution. However, the stormwater quantity infrastructure proposed in this report is specific to major storm events (i.e. the 1% AEP) which facilitated additional reporting by Peak Urban in 2020 and 2021 to assess the minor storms.

This report was approved under DEV2012/209/6/8 in July of 2019 and forms the consolidated groundwork for the most current stormwater quality and quantity management reporting.

Stormwater Management Strategy Technical Memo, Flagstone Stage 7A-G, by Peak Urban – 2020

The *Flagstone Stage 7A-G – Stormwater Management Strategy Technical Memorandum* by Peak Urban in 2020 builds upon previous reporting by Bradlees / Meinhardt, proposing a stormwater strategy incorporating both on-site and off-site bio-retention and detention basins to manage flows from the site and contributing external catchments. The intent of the bio-retention basins is to treat flows within the site and to mitigate the increase in discharge for the lower storm events, with flows generated by major storm events being mitigated by regional infrastructure under the above IMP. This memorandum also establishes delivery timeframes for the off-site basin, with its implementation contingent on the development of adjacent key lots within the subject site, specifically, Lots 25009 and 25021 (as identified in the memorandum). In the context of this report, the construction of the off-site basin depends on the delivery of tenancies T3–T5, which serve as an acceptable substitute for Lot 25021, as Lot 25009 is designated for future residential development.

Stormwater Management Plan, Flagstone – Stages 7C/D/G by Peak Urban – 2021

The *Stormwater Management Plan: Flagstone – Stages 7C/D/G*, prepared by Peak Urban (now Colliers) in 2021, provides the latest framework for stormwater management at the subject site. The report refines historical design documentation by optimising both on-site and off-site basins to effectively manage flows from the site and contributing external catchments. The off-site bio-retention and detention basin was designed to mitigate post-development flows from the entire Flagstone City Stage 7 footprint, which comprises Catchments 7B, 7C, 7Di, 7Dii, 7Gi, 7Gii, 7Giii, and 7Giv. Specifically, the basin was designed to attenuate minor storm flows (from the 63.21% AEP up to and including the 10% AEP threshold); with major flows (such as those from a 1% AEP storm) to be managed by the regional infrastructure described in the Meinhardt IMP.

Due to topographical limitations and construction constraints imposed by an existing adjacent dam, an additional on-lot bio-retention basin was incorporated within the strategy to treat flows from the 7Giii catchment before discharging northward into the regional dual-use facility. Key design assumptions associated with the above basin designs include commercial land zoning with an average fraction impervious of 0.8. Sections 2.1.3 and 2.2 further discuss the currency of these models relative to the current architectural layout and their influence on design rationale.

2.1.3 Impacts on Current Stormwater Strategy

This report seeks to maintain the original design intent for an off-site dual-use bio-retention and detention basin, as proposed by Peak Urban in their 2020 and 2021 reports, ensuring it continues to treat and attenuate an equivalent contributing area within the proposed development. As per the above discussion, construction of the off-site basin is contingent on the delivery of tenancies T3-T5.

Section 2.2 of this report presents an objective assessment of the applicability of this design intent in the context of the current architectural layout.

2.2 Offsite Bio-Retention and Detention Basin

Tables 2.1 and 2.2 present the historical and proposed catchment parameters contributing to the off-site bio-retention and detention basin initially designed by Peak Urban. It is noted that catchment descriptions have been simplified in this document relative to previous reports to reflect the current, reduced architectural scope resulting from development in Catchments 7B and 7C. For further details, please refer to the current catchment plan which is included within Appendix C. Furthermore, it is noted that a fraction impervious of 90% has been assumed for the future residential development area (Catchment A2) for the purposes of hydrologic analysis and assessment. This is deemed consistent with Council's zoning and future use as well as QUDM fraction impervious guidelines.

2.2.1 Historical versus Proposed Catchment Parameters

Table 2.1: Historical Catchment Parameters (Peak Urban Design)

Peak Urban Design Parameters				
Catchment Label	**Land Use**	**Area (ha)**	**Impervious Area (ha)**	**Fraction Impervious**
7B and 7Giv	Commercial Lumped	1.800	1.440	0.80
7C	Commercial Lumped	0.800	0.640	0.80
7Di	Commercial Lumped	0.997	0.798	0.80
7Dii	Road Reserve	0.319	0.262	0.82
7Gi	Commercial Lumped	1.200	0.960	0.80
7Gii	Road Reserve	0.160	0.131	0.82
7Giii	Commercial Lumped	3.481	2.785	0.80
Total	**–**	**8.757**	**7.016**	**0.80**

Table 2.2: Proposed Revised Catchment Parameters (Consistent with Current Layout)

Revised Catchment Parameters				
Catchment Label	**Land Use**	**Area (ha)**	**Impervious Area (ha)**	**Fraction Impervious**
A1	Commercial Lumped	1.9384	1.6366	0.85
A2	Future Residential	0.7768	0.6991	0.90
A Total	**Mixed Use**	**2.7152**	**2.3357**	**0.86**
B1	Commercial Lumped	3.2448	2.8328	0.87
B2	Commercial Lumped	0.5636	0.4772	0.85
B Total	**Commercial Lumped**	**3.8084**	**3.3100**	**0.87**
Ext 1	Commercial Lumped	1.8086	1.5460	0.86
Ext 2	Commercial Lumped	0.4208	0.2435	0.58
Ext Total	**Commercial Lumped**	**2.2294**	**1.7895**	**0.80**
Total	**–**	**8.7530**	**7.4352**	**0.85**
Total (Excl B2)	**–**	**8.1894**	**6.958**	**0.85**

2.2.2 Analysis and Conclusion

Stormwater Quantity:

As shown in Table 2.2, the current architectural layout exhibits an overall impervious fraction of 0.85, which exceeds the design threshold of 0.80 established in the Peak Urban report. To preserve the integrity of the detention design for this off-site basin, Pinnacle recommends that Catchment B2 be subjected to separate detention measures prior to discharge into the environment. This measure aims to reduce the overall impervious area contributing to the regional basin to acceptable levels.

Although the overall impervious fraction for the catchment contributing to the offsite basin remains at 0.85 after removing Catchment B2, the total contributing catchment area and its associated impervious surface are reduced to align with the original design parameters. Consequently, Pinnacle acknowledge that the revised contributing catchments (Catchments A1, A2, B1, Ext 1, and Ext 2) meet the established design criteria, eliminating the need for revised quantity modelling for these areas.

Section 3 of this report will therefore focus on the stormwater quantity modelling for Catchment B2 as the remaining catchments will be managed by the previously documented regional bio-retention and detention basin by Peak Urban and also the regional infrastructure provided by Peet as per the 2018 IMP by Meinhardt Australia.

Stormwater Quality:

In the original Peak Urban documentation, the off-site dual-use basin was designed to treat stormwater from all sub-catchments, excluding Catchment 7Giii (now Catchments B1 and B2). This area represented 5.276ha of commercial land, with an impervious area of 4.231ha and a fraction impervious of 0.80. In comparison, the catchments proposed to be treated by the basin in this report, being Catchments A1, A2, Ext 1, and Ext 2, represent 4.945ha of commercial land, with 4.125ha impervious and a slightly higher impervious fraction of 0.82.

Despite exceeding the original fraction impervious threshold, the reduced overall contributing area and associated impervious area aligns with the original design parameters outlined by Peak Urban. Accordingly, the existing design for the off-site dual-use basin is considered adequate for stormwater treatment under the proposed development layout. Therefore, no further stormwater quality modelling has been undertaken for these catchments, as the strategy remains generally in accordance with the original Peak Urban design.

Conversely, the treatment strategy for the balance lot (formerly Lot Giii, now Catchments B1 and B2) diverges from the original bioretention basin approach. In line with the development team's preference for an underground solution, supplementary modelling has been undertaken using proprietary tank and cartridge systems, as detailed in Sections 3 and 4.

3 Stormwater Quantity Assessment

3.1 General Discussion

As outlined in Sections 1 and 2 of this report, stormwater quantity assessment is only triggered for Catchment B2 as defined in the stormwater catchment plans included within Appendix C. Minor storm (63.21% AEP to the 10% AEP) outflows from Catchment A, B1, Ext 1 and Ext 2 will be mitigated by an off-site dual-use bio-retention and detention basin located within adjacent Lot 905 on SP216472, in accordance with previous design documentation by Peak Urban. Major storm outflows (i.e. from the 1% AEP storm) from Catchments A, B1, Ext1, and Ext2 will be managed via regional infrastructure under Meinhardt Australia's IMP. For additional details, refer to the *Stormwater Management Plan, Flagstone – Stages 7C/D/G* by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021), and the *Stormwater Infrastructure Master Plan*, by Meinhardt Australia (report reference: Stormwater IMP, version 1.4, 2018).

3.2 Hydrologic Objectives

The hydrologic objectives for the subject site were set in accordance with the requirements of the Queensland Urban Drainage Manual (QUDM, 2016) and the LCC Planning Scheme Policies. These objectives include but are not limited to the following:

- The proposed development shall ensure that all stormwater drainage is directed to the Lawful Point of Discharge in accordance with QUDM Section 3.9;
- Minor System Design for 39.35% AEP (Q_2) storm event;
- Major System Design for 1% AEP (Q_{100}) storm event;
- No adverse impact on adjoining or downstream properties; and
- No increase in post-development stormwater discharge, up to and including the 1% AEP storm event.

3.3 Lawful Point of Discharge

The Lawful Point of Discharge for the subject site is taken as Lot 905 on SP216472, and subsequently the existing adjacent Sandy Creek as documented in previous approved reporting.

3.4 Stormwater Quantity Assessment

The analysis of the stormwater runoff from the subject site was undertaken using the non-linear software package XP-Rafts.

3.4.1 Site Specific Rainfall Data

The design rainfall Intensity Frequency Duration (IFD) data for the storm events up to and including the 1% AEP storm event was derived based on the LCC Planning Scheme Policies and the AR&R.

The design IFD data for the catchment is summarised in Figure 3.1 below.

The rainfall temporal patterns utilised by the XP-Rafts analysis were derived in accordance with Australian Rainfall and Runoff (AR&R), 2016 edition.

	Annual Exceedance Probability (AEP)						
Duration	63.2%	39.35%	18%	10%	5%	2%	1%
1 min	139	176	224	261	301	354	394
2 min	112	141	180	211	247	294	331
3 min	105	133	170	199	231	275	309
4 min	101	128	163	191	221	262	293
5 min	97.6	123	157	183	212	250	280
10 min	81.2	103	131	153	176	206	228
15 min	68.8	87.4	111	130	149	175	194
20 min	59.6	75.7	96.6	112	130	152	169
25 min	52.7	66.8	85.3	99.4	115	135	150
30 min	47.2	59.9	76.5	89.2	103	121	135
45 min	36.2	45.9	58.7	68.6	79.6	94.1	105
1 hour	29.7	37.5	48.0	56.2	65.4	77.7	87.3
1.5 hour	22.1	27.9	35.7	42.0	49.0	58.6	66.1
2 hour	17.9	22.6	28.9	34.0	39.8	47.8	54.1
3 hour	13.3	16.8	21.5	25.4	29.8	35.9	40.8
4.5 hour	10.0	12.6	16.2	19.1	22.4	27.2	31.0
6 hour	8.24	10.4	13.3	15.7	18.5	22.5	25.7
9 hour	6.32	7.98	10.3	12.2	14.3	17.4	19.9
12 hour	5.28	6.67	8.62	10.2	12.1	14.7	16.8
18 hour	4.12	5.23	6.81	8.11	9.58	11.7	13.4
24 hour	3.46	4.41	5.78	6.90	8.17	9.96	11.4
30 hour	3.02	3.86	5.09	6.09	7.22	8.82	10.1
36 hour	2.69	3.45	4.58	5.49	6.52	7.97	9.14
48 hour	2.24	2.88	3.85	4.63	5.52	6.76	7.77
72 hour	1.69	2.18	2.94	3.56	4.27	5.25	6.05
96 hour	1.35	1.75	2.37	2.88	3.46	4.27	4.94
120 hour	1.12	1.45	1.96	2.39	2.89	3.57	4.13
144 hour	0.953	1.23	1.66	2.03	2.44	3.02	3.51
168 hour	0.823	1.06	1.42	1.74	2.10	2.59	3.01

Figure 3.1: IFD Data for Flagstone, QLD (mm/hr) (-27.8061, 152.9494) (Source: BOM)

3.4.2 XP-Rafts Modelling Inputs

The rainfall loss parameters for each sub-catchment were applied using an initial and continuing rainfall loss model. The design rainfall loss parameters input into the XP-Rafts model are based on the guideline values recommended by the AR&R and other reputable industry standards.

The rainfall loss parameters adopted for this XP-Rafts model are as tabulated below.

Table 3.1: Adopted XP-Rafts Rainfall Loss Parameters

Storm Event	Pervious Areas		Impervious Areas	
AEP (%)	Initial Loss (mm)	Continuing Loss (mm)	Initial Loss (mm)	Continuing Loss (mm)
39.35-18	15	2.5	1	0
10-5	10	2.5	1	0
2-1	2.5	2.5	0	0

3.4.3 XP-Rafts Model Validation

The validation of the XP-Rafts model was undertaken through the comparison of the XP-Rafts generated stormwater discharge rates to the pre-development Rational Method calculations included within Appendix D.

The Rational Method adopted a C_{10} coefficient of runoff of 0.70 for the pre-development Catchment B2, in accordance with Tables 4.5.3 and 4.5.4 of QUDM. As detailed in Table 2.2 below, the stormwater discharge rates calculated using the Rational Method are generally comparable to the stormwater discharge rates calculated using the XP-Rafts model. We can therefore reasonably adopt the stormwater discharge rates generated from the XP-Rafts model.

3.4.4 Critical Duration Analysis

Design storm durations ranging from 10-minutes to 720-minutes were simulated by the XP-Rafts model analysis in order to determine the design stormwater discharge for the subject site.

3.4.5 Existing Discharge Locations

As outlined in the previous sections of this report the subject site generally discharges towards the northern property boundary prior to entering the adjacent Sandy Creek.

3.5 Hydrologic Analysis

3.5.1 Pre-development Scenario

The results obtained from the XP-Rafts model generally show that the critical storm duration throughout the local catchment analysed for all AEP storm events is generally the 15-minute to 30-minute storms.

A fraction impervious area of 0.0 was calculated for the pre-development Catchment B from the topographic survey included within Appendix B.

The pre-development catchment discharges for the 39.35%, 18%, 10%, 5%, 2% and 1% AEP storm events are detailed in Table 3.2 below.

Table 3.2: Pre-development Catchment Details and Peak Discharges

Catchment	Area (ha)	Imp. Area (ha)	Ave. Slope (%)	XP-Rafts Results						Rational Method
				39.35% AEP (m^3/s)	18% AEP (m^3/s)	10% AEP (m^3/s)	5% AEP (m^3/s)	2% AEP (m^3/s)	1% AEP (m^3/s)	1% AEP (m^3/s)
B	0.5636	0.0	5.0	0.092	0.142	0.188	0.228	0.281	0.318	0.300
Critical Storm				**90mins**	**30mins**	**25mins**	**25mins**	**15mins**	**15min**	

3.5.2 **Post-development Scenario – Unmitigated**

Based on the provided architectural drawings, a fraction impervious of 0.85 was calculated for Catchment B2 in the post-development scenario. A copy of the architectural drawings is included in Appendix A. The post-development catchment plan is included in Appendix C.

For the purposes of this analysis, the impervious areas were modelled using the second sub-catchment option within XP-Rafts. The total impervious area for each sub-catchment is tabulated below. The results of the XP-Rafts post-development analysis show that the critical storm duration throughout the catchment for all AEP storm events varies between the 15-minute to 90-minute storm events. Table 3.3 summarises the unmitigated peak flow rates for the post-development catchment.

Table 3.3: Catchment Details and Peak Discharges (Unmitigated)

Catchment	Area (ha)	Ave. Slope (%)	Imp. Area (ha)	XP-Rafts Results					
				39.35% AEP (m^3/s)	18% AEP (m^3/s)	10% AEP (m^3/s)	5% AEP (m^3/s)	2% AEP (m^3/s)	1% AEP (m^3/s)
B2	**0.5636**	**1.5**	**0.4772**	**0.182**	**0.230**	**0.274**	**0.316**	**0.379**	**0.421**
Critical Storm				**15mins**	**15mins**	**10mins**	**10mins**	**15mins**	**15mins**

A comparison of the XP-Rafts results in Tables 3.2 and 3.3 generally indicates increases in stormwater discharge of $0.090m^3/s$, $0.088m^3/s$, $0.086m^3/s$, $0.088m^3/s$, $0.098m^3/s$ and $0.103m^3/s$ for the 39%, 18%, 10%, 5%, 2% and 1% AEP storm events. This is due to the increased impervious areas observed across the site during the post-development scenario.

It is proposed to mitigate the increase in discharge observed across Catchment B2 through the use of an underground detention and treatment tank.

3.6 Post Development Mitigation Strategy

Based on the above investigation, the following stormwater management strategy is proposed to mitigate the post-development stormwater discharge to the site's pre-development discharge rates. The strategy is designed to remain consistent with the previously approved stormwater management frameworks established by Peak Urban and Meinhardt Australia. Specific reference is made to the following documents:

- Stormwater Infrastructure Master Plan, by Meinhardt Australia (report reference: Stormwater IMP, version 1.4, 2018).
- Flagstone Stage 7A-G – Stormwater Management Strategy Technical Memorandum by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178.TM02.DC.DOCX, 2020)
- Stormwater Management Plan, Flagstone – Stages 7C/D/G by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

Catchment A, Catchment B1 and External Catchments Ext 1 and Ext 2:

Main consistency with the previously approved *Stormwater Management Plan, Flagstone – Stages 7C/D/G* by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

- Attenuation of post-development stormwater discharge via an off-site dual-use detention/bio-retention basin designed and documented by Peak Urban;
    - This basin will attenuate minor storm flows (from the 63.21% AEP up to and including the 10% AEP threshold), with major flows (such as those from a 1% AEP storm) to be managed by the regional infrastructure described in the Meinhardt IMP.
- Direct all stormwater runoff to the off-site basin via an internal stormwater reticulation network and overland sheet flow prior to discharge to the Lawful Point of Discharge;
- Discharge the minor (up to the 10% AEP storm event) stormwater runoff to the Lawful Point of Discharge via a piped network;
- Discharge the major (up to the 1% AEP storm event) stormwater runoff to the Lawful Point of Discharge via piped and overland flow;
- Generally, maintain the existing drainage regimes and drainage discharge locations.

Catchment B2:

- Attenuation of post-development stormwater discharge via a private on-site underground detention tank;
- Direct all stormwater runoff to the dual-use detention/treatment system via an internal stormwater reticulation network and overland sheet flow prior to discharge to the Lawful Point of Discharge;
- Discharge the minor (up to the 10% AEP storm event) stormwater runoff to the Lawful Point of Discharge via a piped network;
- Discharge the major (up to the 1% AEP storm event) stormwater runoff to the Lawful Point of Discharge via piped and overland flow;
- Generally, maintain the existing drainage regimes and drainage discharge locations.

3.6.1 Detention System Design

Table 3.4 details the proposed detention basin characteristics with Table 3.5 detailing the basin storage/height relationship adopted. The basin was used to mitigate the flow discharging from the post-development site.

Table 3.4: Catchment B2 Detention Tank Design Details and Outflow Characteristics

Design Parameter	Details					
Tank Outlets	Low-flow Outlet = 0.25m wide x 0.2m high rectangular penetration Low-flow Level = base of tank High-flow Outlet = 4m wide internal weir (with Ø375mm pipe beyond) High-flow Outlet Level = 1.0m above base of tank					
Tank Geometry	Base Area = 150m^2 (min.) Storage Height = 1.2 m (min.) Storage Volume = 180m^3 (min.)					
Tank Modelling Summary	AEP (%)	Peak Outflow (m^3/s)	Stage (m)	AEP (%)	Peak Outflow (m^3/s)	Stage (m)
	39.35	0.092	+0.481	5	0.145	+0.852
	18	0.116	+0.616	2	0.201	+1.031
	10	0.130	+0.723	1	0.317	+1.081

Table 3.5: Catchment B2 Detention Tank Height-Storage Relationship

Tank Height (m)	Tank Storage (m^3)	Tank Height (m)	Tank Storage (m^3)
0.0	0	0.7	105
0.1	15	0.8	120
0.2	30	0.9	135
0.3	45	1.0	150
0.4	60	1.1	165
0.5	75	1.2	180
0.6	90	-	-

3.6.1 Pre-development and Post-development Scenario Comparison

Table 2.6 details the comparison between the pre-development and post-development site total discharge.

Table 2.6: Pre-development and Post-development Scenario Peak Discharge Comparison

Storm Event	Total (To Sandy Creek)		Difference (%)
	Pre (m^3/s)	Post (m^3/s)	
39% AEP	0.092	0.092	0%
18% AEP	0.142	0.116	-18%
10% AEP	0.188	0.130	-31%
5% AEP	0.228	0.145	-36%
2% AEP	0.281	0.201	-28%
1% AEP	0.318	0.317	0%

The results presented above demonstrate that the post-development site discharge is less than or equal to the pre-developed rates.

4 Stormwater Quality Assessment

4.1 General Discussion

As outlined in Section 2 of this report, stormwater quality assessment is triggered for the Catchment B area as defined in the stormwater catchment plans included within Appendix C. Water quality objects for outflows from Catchment A will be managed by an off-site bio-retention and detention basin located within adjacent Lot 905 on SP216472, in accordance with previous design documentation by Peak Urban. For additional details, refer to the *Stormwater Management Plan, Flagstone – Stages 7C/D/G* by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

4.2 Water Quality Objectives

This water quality analysis was undertaken in accordance with Healthy Waterways WSUD Technical Design Guidelines for South East Queensland – Version 1 and the Queensland State Planning Policy.

The pollutant types and the associated Water Quality Objectives that will be evaluated are as follows:

Table 4.1: Water Quality Objective Summary

Pollutant Types	Site Water Quality Objective
Total Suspended Solids (TSS)	80% reduction
Total Phosphorous (TP)	60% reduction
Total Nitrogen (TN)	45% reduction
Gross Pollutants (GP)	90% reduction

4.3 Proposed Treatment Strategy

In order to meet the above Water Quality Objectives, the following strategies are proposed to treat stormwater runoff from the site prior to discharge to the Lawful Point of Discharge.

4.4 Proposed Treatment Measures

The following water quality treatment measures are proposed for this development which include only 'Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) verified products, as required by the local governing authority (Council). Note that if an approved equivalent product is proposed by the Developer, appropriate modelling and testing data shall be provided by the supplier and approved by Council prior to installation to ensure that the water quality objectives for the site can be achieved.

4.4.1 Off-site Bio-retention Basin

The off-site bio-retention basin will accept the 3-month ARI discharge from Catchment A, and External Catchments Ext 1 and Ext 2. For additional details, refer to the *Stormwater Management Plan, Flagstone – Stages 7C/D/G* by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

The basins will retain this runoff within an extended detention depth of 0.3m and infiltrate this water through the filter media (sandy loam topsoil). Filtered stormwater is then recovered at the base of the filter media via a drainage layer containing perforated pipes. The surface of the bio-retention device is to be heavily planted with locally occurring native ground cover species and shrubs. It is recommended that the vegetation be selected

in consultation with a landscape architect and the approved landscaping plans for the site. A typical section of a bio-retention basin is presented in Figure 4.1.

The treatment of the stormwater takes place both on the surface of the bio basin and within the filter media. When large storm inflows cause short-term ponding on the surface of the basin, pollutants are removed from the stormwater through sedimentation and particulate adhesion onto the stems and leaves of the vegetation. The agitation of the surface layer of the soil caused by movement of the vegetation and the growth of root systems prevents the accreted sediments clogging the filter media. As stormwater infiltrates through the filter media, fine particulates and some soluble pollutants are removed through processes such as adhesion to the surface of the filter media particles, biological transformation of pollutants by bio-films growing on the surface of the filter media particles, and biomass uptake of nutrients and metals through the root systems of the vegetation growing in the basin.

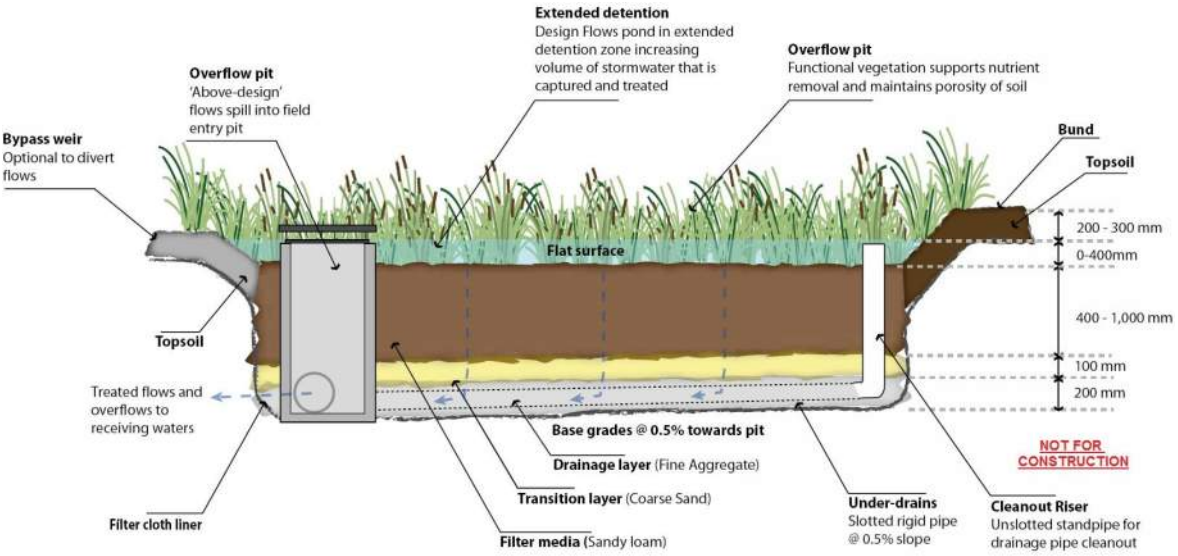


Figure 4.1: Bio-retention Basin – Typical Section (Source: Healthy Waterways WSUD Technical Design Guidelines)

4.4.1 ATLAN Stormwater Water Quality Treatment Products

The treatment option involves utilisation of stormwater pit inserts in each stormwater gully-pit or field inlet which act as primary Gross Pollutant Traps (GPT) before conveying captured stormwater run-off to an underground treatment tank for secondary filtering via a cartridge system.

The Atlan Stormwater 'AtlanFilter' cartridge filter system incorporates an upflow treatment process that maximises surface treatment area. Flow through the filter cartridges utilises a self-regulating siphon which results in a low maintenance and high performance stormwater treatment. The automatic backwash at the end of each storm event further lengthens the lifespan of the filter.

Hydraulic pressure forces water through the filter media — causing a constant velocity throughout the filter area realising a consistent media contact time and therefore treatment. Upon completion of a treatment cycle, the filter backwashes and effectively dislodges particulates from the filtration layers.

Figure 4.2 below illustrates a typical Atlan Stormwater treatment train configuration. Additional information on Atlan Stormwater treatment devices is included in Appendix H.

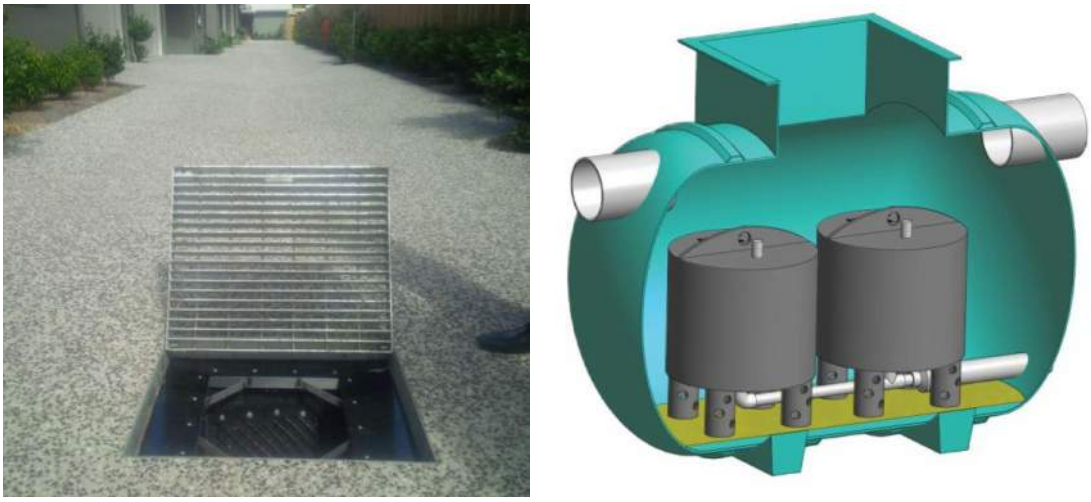


Figure 4.2: Typical Atlan Stormwater Treatment Train Configuration (Source: Atlan Stormwater)

4.5 MUSIC Modelling

The proposed treatment train is detailed in Appendix F with additional details of the modelling procedure described in the following sections.

4.5.1 Meteorological Data

The meteorological data inputs utilised by MUSIC to simulate catchment hydrology processes includes rainfall data (at intervals relevant to the time step being modelled) and average areal potential evapotranspiration (measured in millimetres per day).

The meteorological data adopted for this model was the Greenbank Thompson Road station 40659 (1/1/1980 to 31/12/1999) as outlined in the MUSIC Modelling Guidelines for South-East Queensland.

4.5.2 MUSIC Source Nodes

Source node properties were obtained from the Healthy Waterway MUSIC Modelling Guidelines for South East Queensland and are as follows.

Table 4.2: Pollutant Export Parameter for Lumped Catchment (Log[10] Values)

Mean EMC (mg/L)							
Land Use		TSS		TP		TN	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Commercial	Mean	2.16	0.78	-0.39	-0.60	0.37	0.32
	Std. Deviation	0.38	0.39	0.34	0.50	0.34	0.30

Table 4.3: Pollutant Export Parameter for Split Catchment (Log[10] Values)

Mean EMC (mg/L)							
Land Use		TSS		TP		TN	
Commercial Development		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Roof	Mean	1.30	0.00	-0.89	0.00	0.37	0.00
	Std. Deviation	0.38	0.00	0.34	0.00	0.34	0.00
Roads	Mean	2.43	0.78	-0.30	-0.60	0.37	0.32
	Std. Deviation	0.38	0.39	0.34	0.50	0.34	0.30
Ground	Mean	2.16	0.78	-0.39	-0.60	0.37	0.32
	Std. Deviation	0.38	0.39	0.34	0.50	0.34	0.30

4.6 Performance Assessment

The site has been modelled as a number of commercial source nodes. The MUSIC model parameters were adopted according to the Healthy Waterway MUSIC Modelling Guidelines for South East Queensland and are outlined in Table 4.4 and Table 4.5.

Table 4.4: Adopted MUSIC Model Source Node Parameters

Parameter	Value
Source Data	
Rainfall data setup	Greenbank Thompson Road station 40659
Rainfall data period	1/1/1980 to 31/12/1989
Model time step	6 Minute
Soil properties (Runoff generation parameter)	Commercial and Residential (MUSIC Modelling Guidelines for South East Queensland)
Site Data	
Catchment B1 – Commercial (Split)	1.2203 Ha – Roof (100% Impervious) 1.4599 Ha – Road (100% Impervious) 0.5646 Ha – Ground (27% Impervious)
Catchment B2– Commercial (Split)	0.2647 Ha – Roof (100% Impervious) 0.2125 Ha – Road (100% Impervious) 0.0864 Ha – Ground (0% Impervious)

Table 4.5: Adopted MUSIC Model Treatment Node Parameters

Parameter	Value
Treatment Devices	
Catchment B1 – ATLAN Stormsack and ATLAN Vault	ATLAN Stormsack Required number = 20 min. High flow bypass = 0.025m^3/s per Stormsack (0.50m^3/s Total) ATLAN Vault (27.0m^2 min) High flow bypass = 100m^3/s Storage surface area = 27.0m^2 min Extended detention depth = 0.85m Low flow pipe diameter = 205mm ATLAN Filter Cartridge Type = Full Height SF.30-EMC Required number = 27 High flow bypass = 0.0810m^3/s (3.0 L/s per cartridge)
Catchment B2 – ATLAN Stormsack and ATLAN Vault	ATLAN Stormsack Required number = 4 min. High flow bypass = 0.025m^3/s per Stormsack (0.10m^3/s Total) ATLAN Vault (6.0m^2 min) High flow bypass = 100m^3/s Storage surface area = 6.0m^2 min Extended detention depth = 0.85m Low flow pipe diameter = 97mm ATLAN Filter Cartridge Type = Full Height SF.30-EMC Required number = 6 High flow bypass = 0.018m^3/s (3.0 L/s per cartridge)

Tables 4.6-4.8 below summarise the load reduction by MUSIC using the WSUD strategy outlined above.

Table 4.6: MUSIC Pollutant Load Assessment – Catchment B1

System	Parameter	Sources	Residual Load	Reduction (%)
Receiving node	Total Suspended Solids (kg/yr)	2,840	556	80.4
	Total Phosphorous (kg/yr)	8.32	2.16	74.1
	Total Nitrogen (kg/yr)	65.5	30.1	54
	Gross Pollutants (kg/yr)	520	0	100

Table 4.7: MUSIC Pollutant Load Assessment – Catchment B2

System	Parameter	Sources	Residual Load	Reduction (%)
Receiving node	Total Suspended Solids (kg/yr)	419	73.8	82.4
	Total Phosphorous (kg/yr)	1.26	0.314	75.2
	Total Nitrogen (kg/yr)	11.3	5.06	55.1
	Gross Pollutants (kg/yr)	88.5	0	100

Table 4.8: MUSIC Pollutant Load Assessment – Catchment B Total

System	Parameter	Sources	Residual Load	Reduction (%)
Receiving node	Total Suspended Solids (kg/yr)	3,260	647	80.2
	Total Phosphorous (kg/yr)	9.49	2.43	74.4
	Total Nitrogen (kg/yr)	76.7	35.1	54.2
	Gross Pollutants (kg/yr)	608	0	100

As illustrated in Tables 4.6-4.11 above, the load reduction objectives of 80% for TSS, 60% for TP, 45% for TN and 90% for GP have been achieved for the post development site through the use of proprietary cartridge systems and gross pollutant traps.

5 Monitoring and Maintenance

5.1 Bio-Retention Basins

5.1.1 Monitoring of Devices

In accordance with the Water by Design Construction and Establishment Guidelines: Swales Bio-retention Systems and Wetlands (C&E Guidelines), a monitoring program will be established for the stormwater treatment devices as outlined below in Table 5.1. All monitoring activities associated with the operation of the vegetated treatment areas, including weed inundation, erosion, vegetation density, determination and inappropriate access shall be included in the general monitoring of the landscaped areas. The below schedules are for guidance only. Routine clean out and maintenance should be scheduled based on the outcome of routine inspection.

Table 5.1: Monitoring Program for Vegetated Bio-retention Basin

Time Frame (Post Construction)	Monitoring Activity	Frequency
0-6 months	Erosion/scour of basin base & batters	Following major storm events> 25mm
	Weed inundation/litter accumulation within basin	3 monthly
	Excessive wear & damage of basin base & batters	3 monthly
	Build up of sediments within basin	3 monthly
	Check vegetation within swale drain	Monthly
>6 months	Erosion/scour of basin base & batters	6 monthly
	Weed inundation/litter accumulation within base	6 monthly
	Excessive wear & damage of basin base & batters	6 monthly
	Build up of sediments within basin	6 monthly
	Check vegetation within swale drain	6 monthly

The tenancy operators/body corporate will be responsible for all monitoring activities associated with the operation of the vegetated bio-retention basin during the operational phase of the development.

5.1.2 Maintenance

The successful long term functionality of bio-retention system will be dependent on the maintenance conducted. A maintenance program as outlined below within Table 5.2 is to be implemented for the stormwater treatment devices.

Table 5.2: Maintenance Program for Vegetated Bio-retention Basin

Time Frame (Post Construction)	Maintenance Activity	Frequency
0-6 months	Repairs to basin profile	As required by monitoring
	Watering, revegetating	As required by monitoring
	Removal of litter, debris, weeds & excessive sediment build up	Monthly or as required
>6 months	Repairs to basin profile	As required by monitoring
	Removal of litter, debris, weeds and excessive sediment build up	As required by monitoring

The tenancy operators/body corporate will be responsible for all maintenance activities associated with the operation of the vegetated bio-retention basin during the operational phase of the development.

5.2 Proprietary Filter Cartridges

5.2.1 Monitoring of Devices

A monitoring program will be established for the stormwater treatment devices as required by the SQIDEP approved proprietary product supplier.

The supplier will be responsible for all monitoring activities associated with the operation of the treatment train which will be undertaken under a maintenance agreement between the supplier and the Developer.

5.2.2 Maintenance of Devices

The ongoing performance of the SQIDEP approved proprietary treatment devices will be dependent on the regular maintenance conducted.

The maintenance program will be as required by the supplier and will be undertaken as part of maintenance agreement between the supplier and the Developer.

6 Erosion and Sediment Control Strategy

The objective of erosion and sediment management on construction sites is to minimise soil erosion and control silt and/or sediment discharge from the sites through the use of suitable control devices during the four primary phases of the project lifecycle being:

1. Pre-construction/Establishment Phase;
2. Bulk Earthworks/Change to Ground Level Phase;
3. Construction Phase; and
4. Post-development/Operational Phase.

Sections 6.2 and 6.3 below outline the typical and industry best practice erosion and sediment control measures that will be implemented throughout the life cycle of this project.

6.1 Development Lifecycle Erosion and Sediment Management

6.1.1 Pre-construction/Establishment Phase

Prior to the commencement of construction, during the site establishment phase of the works, the following sediment and erosion control measures will be implemented in order to minimise site disturbance and ensure that water quality is maintained.

- Silt/Sediment fences will be installed around the proposed bulk earthworks site (along the toe of the batter alignment) and any environmentally sensitive areas; and
- A construction vehicle entry/exit shakedown area will be installed and will comprise of a vibratory cattle grid or gravel/rock pad in accordance with the IEAust Guidelines.

6.1.2 Bulk Earthworks Phase/Change to Ground Level

Excavation during the bulk earthworks/change to ground level phase of the project will be staged in a manner that runoff will generally be directed towards sediment and erosion controls established during the pre-construction phase.

As applicable, sediment basins will be constructed within proposed park/open space areas generally in the location of the proposed bio-retention basins to ensure that all sediment runoff is intercepted and treated prior to discharging from site.

6.1.3 Construction Phase

During the construction phase of the project, the following erosion and sediment controls will be implemented to ensure water quality is maintained.

- Sediment fences will be erected at the base of all batters and stockpiles to prevent sediment transportation offsite;
- All sediment and erosion control structures will be maintained and inspected regularly as well as after each storm event to ensure the ongoing integrity is maintained. No structure is to accumulate sediment above 40% of its capacity; and
- Regular monitoring of water quality will be undertaken to determine the effectiveness of the sediment and erosion control measures. Testing may be required and shall be provided to the Local Authority on request.

6.1.4 Post-development/Operational Phase

Following the completion of the construction phase of the project and the development reaching 'Practical Completion' and/or 'On-maintenance', a monitoring program will be established for the stormwater treatment devices outlined previously within this report, where applicable. The monitoring program will ensure the ongoing integrity and effectiveness of these stormwater treatment devices following the completion of the construction phase of the project.

6.2 Dust Suppression and Erosion Control Measures

The time of disturbance onsite will be kept to a minimum by ensuring that the civil works are undertaken directly following the earthworks phase. Consideration to staging of the works shall be given in order to minimise the area of exposed earthworks at any given time.

Erosion control and dust suppression measures shall be applied to the exposed areas of the site as deemed necessary by the site supervisor in order to prevent the emission of dust from the site.

A number of erosion control measures are available inclusive of but not limited to the following:

- Water spraying (by water truck);
- Dust suppressants;
- Surface stabilisation; and
- Covering of exposed areas.

6.3 Sediment Control Measures

With reference to the IEAust Guidelines and Current Industry Best Practice, there are three (3) fundamental sediment control principles that have been identified for use during construction:

- Construction Vehicle Shakedown and/or Entry/Exit;
- Sediment Fences; and
- Sediment Barriers.

6.3.1 Construction Vehicle Shakedown and/or Entry/Exit

A dedicated construction vehicle shakedown will be installed at the site's entry/exit point for road and construction vehicles. This construction vehicle shakedown area will be established to facilitate the removal of soil, mud, dust and debris from the tyres of vehicles prior to leaving the construction site. The construction shakedown will comprise of a gravel/rock pad designed or a vibratory grid system constructed and maintained in accordance with the IEAust Guidelines. The advantages of the vibratory grid system include ease of movement and ability to reuse for several years at different construction sites.

6.3.2 Sediment Fences

Sediment fencing will be established at the bottom of slopes on any exposed earthworks batters where there is an established risk of contaminated water discharging from the site prior to clearing and earthworks commencing. Sediment fencing may be required at regular spacing down the disturbed slope to limit scour and rutting caused by channelising of stormwater discharge. Sediment fences will be used to protect any temporary stockpile sites as required. Sediment collected from sediment barriers will be regularly removed and either taken offsite as part of the earthworks phase or stockpiled for use during revegetation works.

6.3.3 Sediment Barriers

Sediment barriers will be constructed around all stormwater drainage gully pits and field inlets where contaminated water may enter the existing and proposed stormwater network. The provision of these sediment barriers will facilitate the settlement of sediments prior to entering the downstream stormwater drainage network. Sediment barriers will generally comprise of gravel wrapped in geotextile 'sausage', sediment fences around field inlets or similar approved products.

6.4 Monitoring and Maintenance

The site supervisor will be responsible for the following regular monitoring and maintenance activities during the various phases of the development:

1. Inspection of downstream stormwater network as well as sediment and erosion controls will be conducted at the end of each construction day and after each rainfall event greater than 25mm.
2. If any established complaints by neighbouring property owners and/or local authority or evidence of water quality deterioration is reported downstream of the works site the following actions are to be taken immediately:
   a. locate source of stormwater quality deterioration.
   b. construct temporary erosion and sediment controls to prevent the continuing short term stormwater quality deterioration.
   c. repair existing erosion and sediment controls, modify construction procedures or construct additional controls to prevent further deterioration.

7 Conclusions and Recommendations

This report outlines the stormwater drainage management strategy developed to manage potential impacts due to the proposed commercial, retail and future residential development located at Homestead Drive, Flagstone.

Following the investigation, the following stormwater quality management strategy has been adopted for the subject site. The strategy is designed to remain consistent with the previously approved stormwater management frameworks established by Peak Urban and Meinhardt Australia. Specific reference is made to the following documents:

- Stormwater Infrastructure Master Plan, by Meinhardt Australia (report reference: Stormwater IMP, version 1.4, 2018).
- Flagstone Stage 7A-G – Stormwater Management Strategy Technical Memorandum by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178.TM02.DC.DOCX, 2020)
- Stormwater Management Plan, Flagstone – Stages 7C/D/G by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

Catchment A, and External Catchments Ext 1 and Ext 2:

- **Treatment and Attenuation:**
  - Utilise an off-site dual-use detention/bio-retention basin, designed and documented by Peak Urban, to treat and attenuate minor storm flows (from the 63.21% AEP up to and including the 10% AEP threshold).
  - Major flows (e.g., those from a 1% AEP storm) will be managed by the regional infrastructure described in the Meinhardt IMP.
- **Runoff Routing:**
  - Direct all stormwater runoff to the off-site basin via an internal stormwater reticulation network and overland sheet flow prior to discharge to the Lawful Point of Discharge;
  - Discharge the minor (up to the 10% AEP storm event) stormwater runoff to the Lawful Point of Discharge via a piped network;
  - Discharge the major (up to the 1% AEP storm event) stormwater runoff to the Lawful Point of Discharge via piped and overland flow;
- **General Measures:**
  - Maintain consistency with the previously approved reports discussed in Section 2 above, unless otherwise discussed in this report.
  - Generally, maintain the existing drainage regimes and drainage discharge locations.

Catchment B1:

- **Attenuation:**
  - Utilise an off-site dual-use detention/bio-retention basin, designed and documented by Peak Urban, to attenuate minor storm flows (from the 63.21% AEP up to and including the 10% AEP threshold).
  - Major flows (e.g., those from a 1% AEP storm) will be managed by the regional infrastructure described in the Meinhardt IMP.
- **Treatment:**
  - Treatment of post-development stormwater discharge via an on-site (local) treatment train consisting of gross pollutant traps and proprietary filter cartridges within an underground tank;

- **Runoff Routing:**
    - Direct all stormwater runoff initially to treatment tank prior to the off-site basin via an internal stormwater reticulation network and overland sheet flow prior to discharge to the Lawful Point of Discharge;
    - Discharge the minor (up to the 10% AEP storm event) stormwater runoff to the Lawful Point of Discharge via a piped network;
    - Discharge the major (up to the 1% AEP storm event) stormwater runoff to the Lawful Point of Discharge via piped and overland flow;
- **General Measures:**
    - Generally, maintain the existing drainage regimes and drainage discharge locations.

Catchment B2:

- **Treatment and Attenuation:**
    - Utilisation of a private on-site dual-use detention/treatment tank system, supported by upstream gross pollutant traps, to manage post-development stormwater discharge.
- **Runoff Routing:**
    - Direct all stormwater runoff to the dual-use detention/treatment system via an internal stormwater reticulation network and overland sheet flow prior to discharge to the Lawful Point of Discharge;
    - Discharge the minor (up to the 10% AEP storm event) stormwater runoff to the Lawful Point of Discharge via a piped network;
    - Discharge the major (up to the 1% AEP storm event) stormwater runoff to the Lawful Point of Discharge via piped and overland flow;
- **General Measures:**
    - Generally, maintain the existing drainage regimes and drainage discharge locations.

Following the completion of this investigation we can conclude that the development site, with the implementation of the stormwater quality management strategy outlined in this report, will result in a 'no worsening' effect of the current stormwater quality upstream or downstream of the site.

8 Reference Documentation

LCC Planning Scheme Policies (LCC, 2015)

Institution of Engineers, Australia (2001) "Australian Rainfall and Runoff – A Guide to Flood Estimation"

Institute of Public Works Engineers Australia (Queensland Division) (2016) “Queensland Urban Drainage Design Manual (QUDM)”, Fourth Edition

The State of Queensland: Department of State Development, Infrastructure and Planning, July 2017. State Planning Policy

Water by Design (2018) “MUSIC Modelling Guidelines” – Consultation Draft, November 2018

Flagstone City – Masterplan, Flooding Assessment, by Cardno Pty Ltd (now Stantec) for Peet Flagstone City Pty Ltd (report reference: 721743/032/V6, 2014).

Flagstone City – Stage 7, Stormwater Management Report, by Cardno Pty Ltd (now Stantec) for Peet Flagstone City Pty Ltd (report reference: 7217/43/R11/V1, 2015).

Stormwater Management Plan at Flagstone Stage 7 North, by Bradlees Civil Consulting (now Meinhardt Australia) for Peet Flagstone City Pty Ltd (report reference: 15-891, Revision A, 2017).

Stormwater Infrastructure Master Plan, by Meinhardt Australia (report reference: Stormwater IMP, version 1.4, 2018).

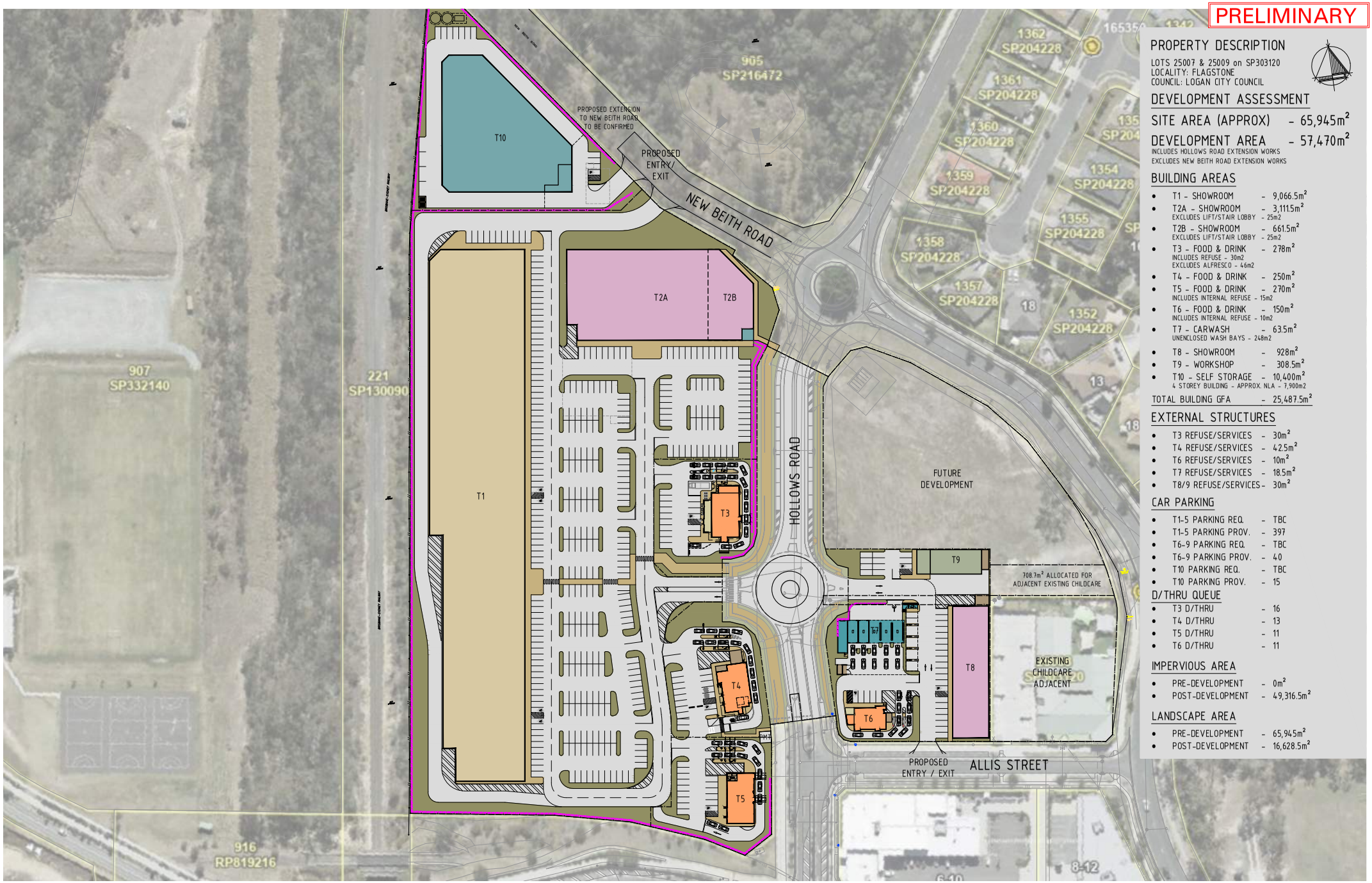
Flagstone Stage 7A-G – Stormwater Management Strategy Technical Memorandum by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178.TM02.DC.DOCX, 2020)

Stormwater Management Plan, Flagstone – Stages 7C/D/G by Peak Urban (now Colliers) for Peet Flagstone City Pty Ltd (report reference: 20-0178SMP01-V1, 2021).

Appendix A

Proposed Development Plans

PRELIMINARY



PROPERTY DESCRIPTION

LOTS 25007 & 25009 on SP303120
LOCALITY: FLAGSTONE
COUNCIL: LOGAN CITY COUNCIL

DEVELOPMENT ASSESSMENT

SITE AREA (APPROX) - 65,945m²

DEVELOPMENT AREA - 57,470m²
INCLUDES HOLLOWS ROAD EXTENSION WORKS
EXCLUDES NEW BEITH ROAD EXTENSION WORKS

BUILDING AREAS

- T1 - SHOWROOM - 9,066.5m²
- T2A - SHOWROOM - 3,111.5m²
  EXCLUDES LIFT/STAIR LOBBY - 25m2
- T2B - SHOWROOM - 661.5m²
  EXCLUDES LIFT/STAIR LOBBY - 25m2
- T3 - FOOD & DRINK - 278m²
  INCLUDES REFUSE - 30m2
  EXCLUDES ALFRESCO - 46m2
- T4 - FOOD & DRINK - 250m²
- T5 - FOOD & DRINK - 270m²
  INCLUDES INTERNAL REFUSE - 15m2
- T6 - FOOD & DRINK - 150m²
  INCLUDES INTERNAL REFUSE - 10m2
- T7 - CARWASH - 63.5m²
  UNENCLOSED WASH BAYS - 248m2
- T8 - SHOWROOM - 928m²
- T9 - WORKSHOP - 308.5m²
- T10 - SELF STORAGE - 10,400m²
  4 STOREY BUILDING - APPROX NLA - 7,900m2

TOTAL BUILDING GFA - 25,487.5m²

EXTERNAL STRUCTURES

- T3 REFUSE/SERVICES - 30m²
- T4 REFUSE/SERVICES - 42.5m²
- T6 REFUSE/SERVICES - 10m²
- T7 REFUSE/SERVICES - 18.5m²
- T8/9 REFUSE/SERVICES - 30m²

CAR PARKING

- T1-5 PARKING REQ. - TBC
- T1-5 PARKING PROV. - 397
- T6-9 PARKING REQ. - TBC
- T6-9 PARKING PROV. - 40
- T10 PARKING REQ. - TBC
- T10 PARKING PROV. - 15

D/THRU QUEUE

- T3 D/THRU - 16
- T4 D/THRU - 13
- T5 D/THRU - 11
- T6 D/THRU - 11

IMPERVIOUS AREA

- PRE-DEVELOPMENT - 0m²
- POST-DEVELOPMENT - 49,316.5m²

LANDSCAPE AREA

- PRE-DEVELOPMENT - 65,945m²
- POST-DEVELOPMENT - 16,628.5m²

Consulting Engineer

VERVE DESIGN GROUP
BUILDING DESIGNERS LICENCE No. 1002212 PH. 07 3857 0942
OFFICE 2, LEVEL 1, 488 LUTWYCHE ROAD, LUTWYCHE QLD 4030 E: info@vervedesigngroup.com.au
imagine ▫ create ▫ deliver

▫ commercial / industrial / retail
▫ fast food restaurant design
▫ travel centre / service stations
▫ project concept to completion

Revision and approvals				
Code	Date	Drn	Description	Dwn
P3	7.04.2025	SS	PRELIMINARY ISSUE FOR COMMENT	
P5	12.06.2025	SS	PRELIMINARY ISSUE FOR COMMENT	
P4	30.05.2025	SS	PRELIMINARY ISSUE FOR COMMENT	

Project Description
PROPOSED MIXED USE DEVELOPMENT
HOLLOWS ROAD, FLAGSTONE

Drawing Title
PROPOSED SITE PLAN

Scale 1:750 @ A1 / 1:1500 @A3
Drawn SS
Approved
Issued

Drawing Number 24072-DA01

Revision P5

PINNACLE ENGINEERING GROUP

Appendix B

Topographic Survey

LEGEND

SEWER LINE		LINEMARKING – BROKEN 3X9	GV	GAS VALVE		
STORMWATER LINE		LINEMARKING – CHEVRON		COMMUNICATIONS PIT		
WIRE FENCE UNLESS STATED		LINEMARKING – CONTINUITY LINE	E	ELECTRICAL BOX		
BANK		LINEMARKING – DOUBLE LINE	EP	ELECTRICAL PIT		
V	WATER VALVE	LINEMARKING– HOLD LINE GIVE WAY		ELECTRICAL LIGHT		
M	WATER METER	LINEMARKING – PEDESTRAIN CROSSING		TRAFFIC LIGHTS		
H	FIRE HYDRANT	LINEMARKING – STOP BAR		TREE		
SW	STORMWATER MANHOLE	LINEMARKING – UNBROKEN	D0.100	DIAMETER		
S	SEWERAGE MANHOLE	SL10·0	SURFACE LEVEL	H10	HEIGHT	
	BENCHMARK	IL10·0	INVERT LEVEL	S10	SPREAD	

NOTES:

Contour interval is 0·25m. Contours have been generated and plotted by computer program.

Note that spot levels shown do not necessarily represent Natural "Ground Level" as defined by the relevant Local Authority.
Only visible features of underground services located.

Position of underground Gas, Water, Telecommunications and Electricity mains have not been plotted. For alignment refer to Services Search supplied by the relevant Authority.

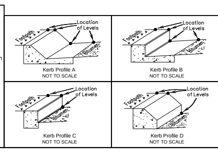
Position of Sewer & Stormwater mains have been plotted from a combination of survey and records supplied by Logan City Council and Pinnacle Engineering Group and may not be accurate.

Unmapped services may also exist.

Accurate location of all services to be obtained prior to any detailed design, demolition, excavation or construction on or around the site.

Only trees on site with a trunk diameter greater than 0·2m and council street trees have been located.

Property boundaries shown have been compiled from plans in the Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development. To accurately define the property boundaries, an Identification Survey will need to be undertaken.



Scale 1:500 – Lengths are in Metres.

10 0 10 20 30 40 50 60 70

SITE ADDRESS 14-22 Wild Mint Drive, Flagstone		
CLIENT BluePoint Property		
LOCAL AUTHORITY Logan C.C	SURVEYED AK	FIELD BK ———
HORIZONTAL DATUM SP290276	DWG FILE 21031-1C DATE 29/11/2024	DRAFTED AK
VERTICAL DATUM - AHD VIDE PM No 132691 RL 48.677m		CHECKED AK

DETAIL AND LEVEL SURVEY

Over Lot 25009 and 25007 on SP303120

SIMPSON RAYNER SURVEYS
SIMPSON RAYNER SURVEYS PTY LTD A.C.N. 078 818 167
CADASTRAL LAND SURVEYORS, PLANNERS AND LAND DEVELOPMENT CONSULTANTS
5/M53 Metroplex Avenue, MURARRIE QLD 4172
Telephone (07) 3899 8105 Fax. (07) 3899 8107
Email: info@srsurveys.com.au

SCALE	PLAN REFERENCE
1:500	21031A0/1C

PINNACLE ENGINEERING GROUP

Appendix C

Catchment Layouts

LEGEND

— — T — —	EXISTING TELSTRA CABLE
— — S — —	EXISTING SEWERAGE RETICULATION
— — W — —	EXISTING WATER RETICULATION
— — SWD — —	EXISTING STORMWATER PIPE
— — OE — —	EXISTING OVERHEAD ELECTRICAL
— — UE — —	EXISTING UNDER GROUND ELECTRICAL
red arrow	SEWER RETICULATION FLOW DIRECTION
	EXISTING BOUNDARY
	EXISTING NOMINAL KERB LINE
	INDICATIVE WORKS AREA
— — 30.0 — —	EXISTING SURFACE CONTOURS (0.5m)
	EXISTING FEATURE TO BE DEMOLISHED
	ROOF / BUILDING HARDSTAND AREA
	CONCRETE DRIVEWAY / PAVED AREA
	PERVIOUS AREA
	ONSITE TREATMENT
	OFFSITE TREATMENT
	OVERLAND FLOW DIRECTION
	CATCHMENT BOUNDARY
A	CATCHMENT LABEL
	EXTERNAL CATCHMENT BOUNDARY
EXT 1	EXTERNAL CATCHMENT LABEL

CATCHMENT TABLE (PRE)

CATCHMENT AREA - A	2.7152 ha
CATCHMENT AREA - B	3.8084 ha
CATCHMENT AREA - EXT1	1.8086 ha
CATCHMENT AREA - EXT2	0.4208 ha

NOTES

1. THE LOCATION OF THE EXISTING SERVICES HAS BEEN PLOTTED FROM SURVEY AND RECORDS AND IS TO BE CONFIRMED PRIOR TO CONSTRUCTION.
2. HISTORICAL AERIAL PHOTOGRAPHY HAS BEEN USED TO VALIDATE SURVEY DATA AND ESTABLISH PRE-DEVELOPMENT CATCHMENTS.

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CATCHMENT DATA	A	B	EXT1	EXT2
BUILDING / ROOF AREA	N/A	N/A	0.4902 ha	0.1453 ha
HARDSTAND / DRIVEWAY	N/A	N/A	1.0558 ha	0.0982 ha
GARDEN / PERVIOUS AREA	2.7152 ha	3.8084 ha	0.2626 ha	0.1773 ha
TOTAL IMPERVIOUS AREA	N/A	N/A	1.5460 ha	0.2435 ha
TOTAL PERVIOUS AREA	2.7152 ha	3.8084 ha	0.2626 ha	0.1773 ha

PINNACLE ENGINEERING GROUP
LEVEL 1 19 SHORT STREET, SOUTHPORT QLD 4215
(PO BOX 517, PARADISE POINT QLD 4216)
WWW.PINNACLEENG.COM.AU

REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.H.	26.11.2021
B	REVISED LAYOUT	J.W.	15.04.2025
C	REVISED LAYOUT	J.W.	26.05.2025
D	REVISED LAYOUT AND STORMWATER STRATEGY	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		26.11.2021
DESIGN	H. WEBBER		26.11.2021
DRAWN	J. HARDMAN		26.11.2021

SCALE 10 0 10 20 30 40 50 1:1000
(SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT: BLUEPOINT FLAGSTONE PTY LTD

PROJECT: PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE: PRE-DEVELOPMENT CATCHMENT LAYOUT

STATUS: PRELIMINARY (NOT TO BE USED FOR CONSTRUCTION)

APPROVED | RPEQ No

DRAWING NUMBER: PEG0810-DA-SK07 | REVISION: D

LEGEND

— T —	EXISTING TELSTRA CABLE
— S —	EXISTING SEWERAGE RETICULATION
— W —	EXISTING WATER RETICULATION
— SWD —	EXISTING STORMWATER PIPE
— OE —	EXISTING OVERHEAD ELECTRICAL
— UE —	EXISTING UNDER GROUND ELECTRICAL
— — —	EXISTING BOUNDARY
— — —	EXISTING NOMINAL KERB LINE
red dashed line	INDICATIVE WORKS AREA
orange fill	ONSITE TREATMENT
cyan fill	OFFSITE TREATMENT
blue hatched	FUTURE RESIDENTIAL AREA (LUMPED)
green fill	PROPOSED DUAL-USE BASIN
blue hatched fill	PROPOSED DUAL-USE TANK
arrow	OVERLAND FLOW DIRECTION
blue dashed line	CATCHMENT BOUNDARY
A1	CATCHMENT LABEL
red dashed line	EXTERNAL CATCHMENT BOUNDARY
EXT 1	EXTERNAL CATCHMENT LABEL

NOTES

1. THE LOCATION OF THE EXISTING SERVICES HAS BEEN PLOTTED FROM SURVEY AND RECORDS AND IS TO BE CONFIRMED PRIOR TO CONSTRUCTION.
2. THE DETAILED DESIGN OF THE DISCHARGE PIPE WORK IS THE SUBJECT OF THE SEPARATE PLUMBING AND DRAINAGE APPLICATION.
3. FUTURE DEVELOPMENT CATCHMENT B AREA BREAKDOWN ASSUMED BASED UPON STANDARD FRACTION IMPERVIOUS FOR DEVELOPMENT ZONING of 90%.
4. CATCHMENT 'A4-S1' WAS EXCLUDED FROM DETENTION AND TREATMENT MODELING AS IT WILL BE DEDICATED TO COUNCIL AND WILL NOT FORM PART OF OUR SITE.

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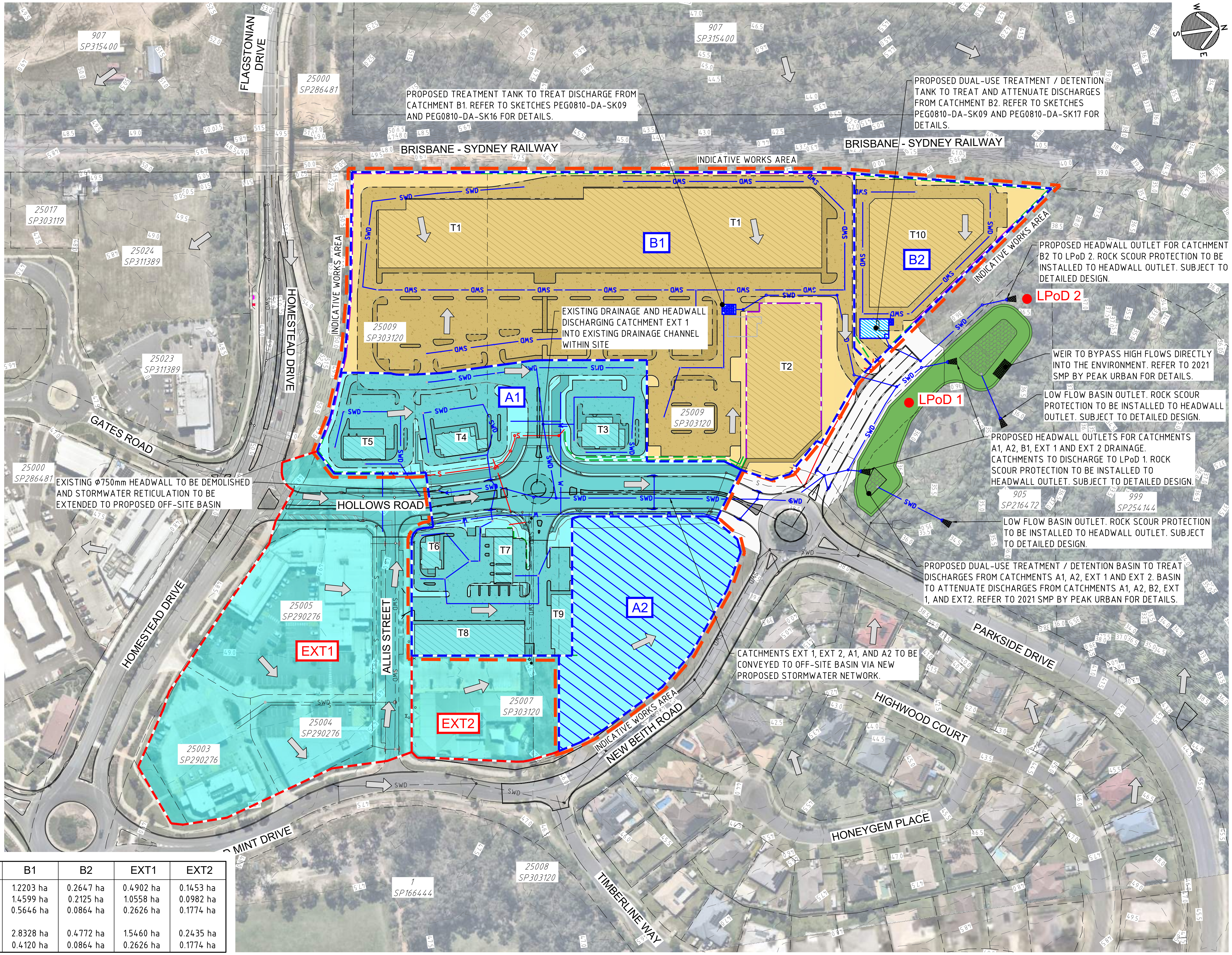
CATCHMENT TABLE (POST)

CATCHMENT AREA - A1 (COMMERCIAL / ROAD)	1.9384 ha
CATCHMENT AREA - A2 (FUTURE RESIDENTIAL)	0.7768 ha
CATCHMENT AREA - B1 (COMMERCIAL)	3.2448 ha
CATCHMENT AREA - B2 (COMMERCIAL)	0.5636 ha
CATCHMENT AREA - EXT1 (COMMERCIAL)	1.8086 ha
CATCHMENT AREA - EXT2 (COMMERCIAL)	0.4208 ha



CATCHMENT DATA

CATCHMENT DATA	A1	A2	B1	B2	EXT1	EXT2
BUILDING / ROOF AREA	0.2704 ha	0.3884 ha	1.2203 ha	0.2647 ha	0.4902 ha	0.1453 ha
DRIVEWAY	1.1334 ha	0.3107 ha	1.4599 ha	0.2125 ha	1.0558 ha	0.0982 ha
HARDSTAND / PERVIOUS AREA	0.5346 ha	0.0777 ha	0.5646 ha	0.0864 ha	0.2626 ha	0.1774 ha
TOTAL IMPERVIOUS AREA	1.6366 ha	0.6991 ha	2.8328 ha	0.4772 ha	1.5460 ha	0.2435 ha
TOTAL PERVIOUS AREA	0.3018 ha	0.0777 ha	0.4120 ha	0.0864 ha	0.2626 ha	0.1774 ha

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REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		13.06.2025
DESIGN	J. WATERS		13.06.2025
DRAWN	J. WATERS		13.06.2025

SCALE 1:1000
(SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT
BLUEPOINT FLAGSTONE PTY LTD

PROJECT
PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE
POST DEVELOPMENT TREATMENT CATCHMENTS

STATUS
PRELIMINARY
(NOT TO BE USED FOR CONSTRUCTION)

APPROVED | RPEQ No

DRAWING NUMBER: PEG0810-DA-SK08
REVISION: A

LEGEND

— T —	EXISTING TELSTRA CABLE
— S —	EXISTING SEWERAGE RETICULATION
— W —	EXISTING WATER RETICULATION
— SWD —	EXISTING STORMWATER PIPE
— OE —	EXISTING OVERHEAD ELECTRICAL
— UE —	EXISTING UNDER GROUND ELECTRICAL
	EXISTING BOUNDARY
	EXISTING NOMINAL KERB LINE
	INDICATIVE WORKS AREA
	ROOF AREA
	ROAD / DRIVEWAY AREA
	PERVIOUS GROUND AREA
	IMPERVIOUS GROUND AREA
	FUTURE RESIDENTIAL AREA (LUMPED)
	PROPOSED DUAL-USE BASIN
	PROPOSED DUAL-USE TANK
	OVERLAND FLOW DIRECTION
	CATCHMENT BOUNDARY
A1	CATCHMENT LABEL
	EXTERNAL CATCHMENT BOUNDARY
EXT 1	EXTERNAL CATCHMENT LABEL

NOTES

1. THE LOCATION OF THE EXISTING SERVICES HAS BEEN PLOTTED FROM SURVEY AND RECORDS AND IS TO BE CONFIRMED PRIOR TO CONSTRUCTION.
2. THE DETAILED DESIGN OF THE DISCHARGE PIPE WORK IS THE SUBJECT OF THE SEPARATE PLUMBING AND DRAINAGE APPLICATION.
3. FUTURE DEVELOPMENT CATCHMENT B AREA BREAKDOWN ASSUMED BASED UPON STANDARD FRACTION IMPERVIOUS FOR DEVELOPMENT ZONING of 90%.
4. CATCHMENT 'A4-S1' WAS EXCLUDED FROM DETENTION AND TREATMENT MODELING AS IT WILL BE DEDICATED TO COUNCIL AND WILL NOT FORM PART OF OUR SITE.

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CATCHMENT TABLE (POST)

CATCHMENT AREA - A1 (COMMERCIAL / ROAD)	1.9384 ha
CATCHMENT AREA - A2 (FUTURE RESIDENTIAL)	0.7768 ha
CATCHMENT AREA - B1 (COMMERCIAL)	3.2448 ha
CATCHMENT AREA - B2 (COMMERCIAL)	0.5636 ha
CATCHMENT AREA - EXT1 (COMMERCIAL)	1.8086 ha
CATCHMENT AREA - EXT2 (COMMERCIAL)	0.4208 ha

CATCHMENT DATA	A1	A2	B1	B2	EXT1	EXT2
BUILDING / ROOF AREA	0.2704 ha	0.3884 ha	1.2203 ha	0.2647 ha	0.4902 ha	0.1453 ha
DRIVEWAY	1.1334 ha	0.3107 ha	1.4599 ha	0.2125 ha	1.0558 ha	0.0982 ha
HARDSTAND / PERVIOUS AREA	0.5346 ha	0.0777 ha	0.5646 ha	0.0864 ha	0.2626 ha	0.1774 ha
TOTAL IMPERVIOUS AREA	1.6366 ha	0.6991 ha	2.8328 ha	0.4772 ha	1.5460 ha	0.2435 ha
TOTAL PERVIOUS AREA	0.3018 ha	0.0777 ha	0.4120 ha	0.0864 ha	0.2626 ha	0.1774 ha

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REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.H.	26.11.2021
B	REVISED LAYOUT FOR COMMENT	J.W.	27.02.2025
C	REVISED LAYOUT FOR COMMENT	J.W.	16.04.2025
D	REVISED LAYOUT FOR COMMENT	J.W.	26.05.2025
E	REVISED LAYOUT AND STORMWATER STRATEGY	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		22.11.2021
DESIGN	H. WEBBER		22.11.2021
DRAWN	H. WEBBER		22.11.2021

SCALE 1:1000 (SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT: BLUEPOINT FLAGSTONE PTY LTD

PROJECT: PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE: POST DEVELOPMENT CATCHMENT LAYOUT

STATUS: PRELIMINARY (NOT TO BE USED FOR CONSTRUCTION)

APPROVED | RPEQ No

DRAWING NUMBER: PEG0810-DA-SK08 | REVISION: E

PINNACLE ENGINEERING GROUP

Appendix D

Rational Method Calculations

RATIONAL METHOD CALCULATIONS

Project:	PEG0810_Flagstone Community Precinct
Date:	11-Jun-25
Designed:	J. Waters
Comments:	Catchment B - Pre-development

PARAMETERS	VALUE		
Catchment Name	B2		
Catchment Size	0.5636	ha	
C10 Coefficient of Runoff	0.70		(QUDM Tables 4.5.3 & 4.5.4) (fi = 0.0, I110 = 56.2))
Total Time of Concentration			QUDM Figure 4.07
Total time of Conentration **(tc)**	**10.0**	**mins**	75m flow path, 5% average slope over grassed surface
Rational Method for Peak Catchment flow			Q = 0.00278 x C x I x A

AEP	Rainfall Intensity (mm/h)	Rainfall Depth (mm)	Fy	Coefficient of Runoff	Discharge (m^3/s)
3 month					0.036
63	81.20	13.53	0.80	0.56	0.071
39	103.00	17.17	0.85	0.60	0.096
18	131.00	21.83	0.95	0.67	0.136
10	153.00	25.50	1.00	0.70	0.168
5	176.00	29.33	1.05	0.74	0.203
2	206.00	34.33	1.15	0.81	0.260
1	228.00	38.00	1.20	0.84	0.300

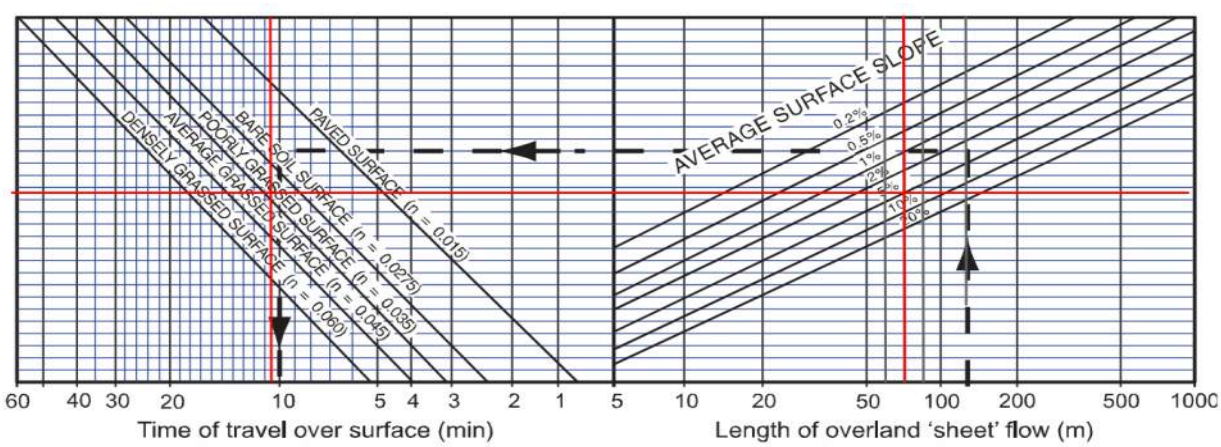

Figure 4.4 – Overland sheet flow times (shallow sheet flow only) (source: ARR, 1977)

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Appendix E

Stormwater Management Layout

LEGEND

- EXISTING TELSTRA CABLE
- EXISTING SEWERAGE RETICULATION
- EXISTING WATER RETICULATION
- EXISTING STORMWATER PIPE
- EXISTING OVERHEAD ELECTRICAL
- EXISTING UNDER GROUND ELECTRICAL
- EXISTING BOUNDARY
- EXISTING NOMINAL KERB LINE
- INDICATIVE WORKS AREA
- ROOF / BUILDING HARDSTAND AREA
- CONCRETE DRIVEWAY / PAVED AREA
- PERVIOUS AREA
- PROPOSED DUAL-USE BASIN
- PROPOSED FILTER MEDIA
- PROPOSED RESIDENTIAL AREA (LUMPED)
- PROPOSED DUAL-USE TANK
- OVERLAND FLOW DIRECTION
- CATCHMENT BOUNDARY
- A1 — CATCHMENT LABEL
- EXTERNAL CATCHMENT BOUNDARY
- EXT 1 — EXTERNAL CATCHMENT LABEL

NOTES

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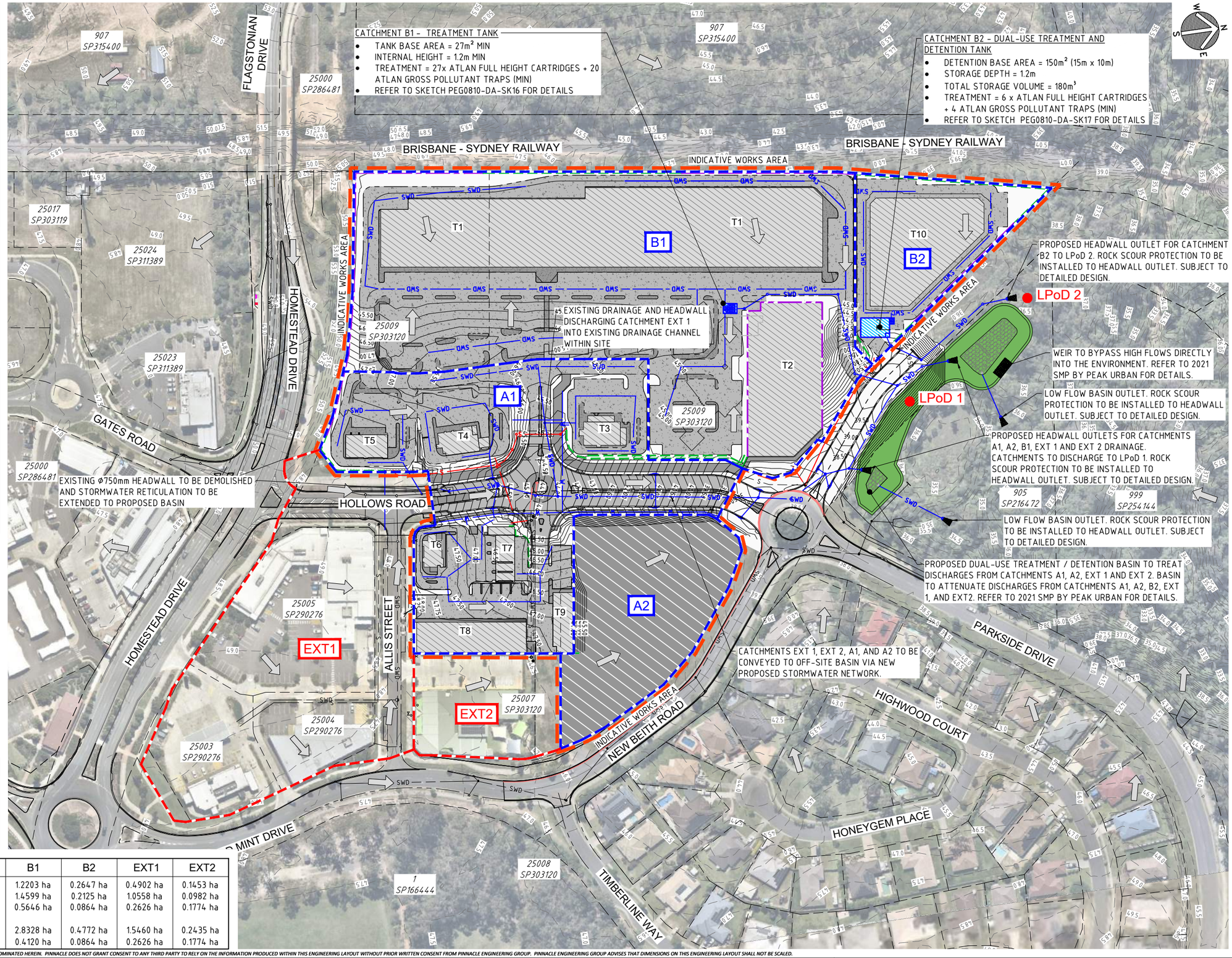

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REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.H.	26.11.2021
B	REVISED LAYOUT FOR COMMENT	J.W.	16.04.2025
C	REVISED LAYOUT FOR COMMENT	J.W.	26.05.2025
D	REVISED LAYOUT AND STORMWATER STRATEGY	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		22.11.2021
DESIGN	H. WEBBER		22.11.2021
DRAWN	H. WEBBER		22.11.2021

SCALE 10 0 10 20 30 40 50 1:1000

(SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT: BLUEPOINT FLAGSTONE PTY LTD

PROJECT: PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE: STORMWATER MANAGEMENT LAYOUT

STATUS: PRELIMINARY (NOT TO BE USED FOR CONSTRUCTION)

APPROVED

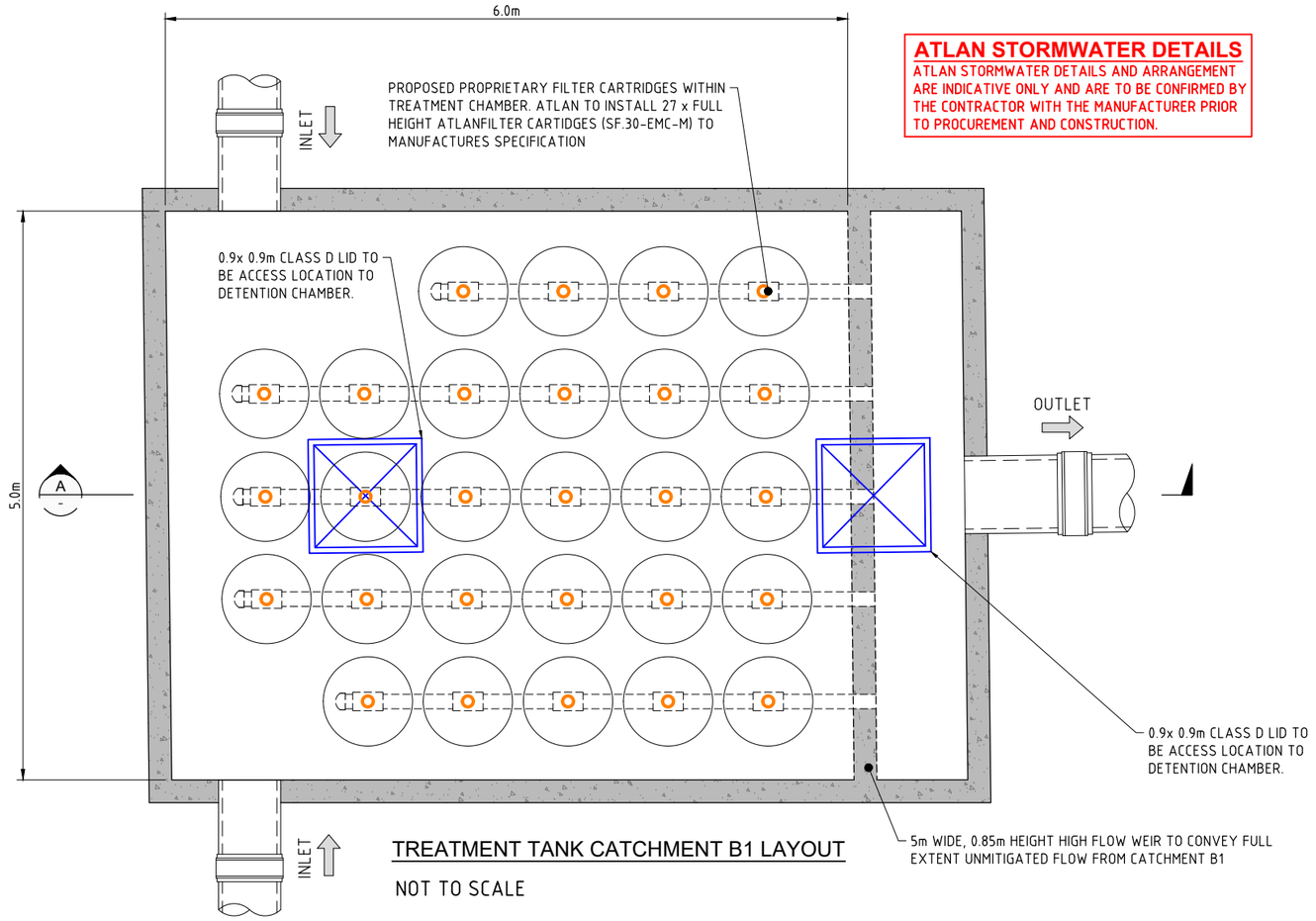
RPEQ No

DRAWING NUMBER: PEG0810-DA-SK09

REVISION: D

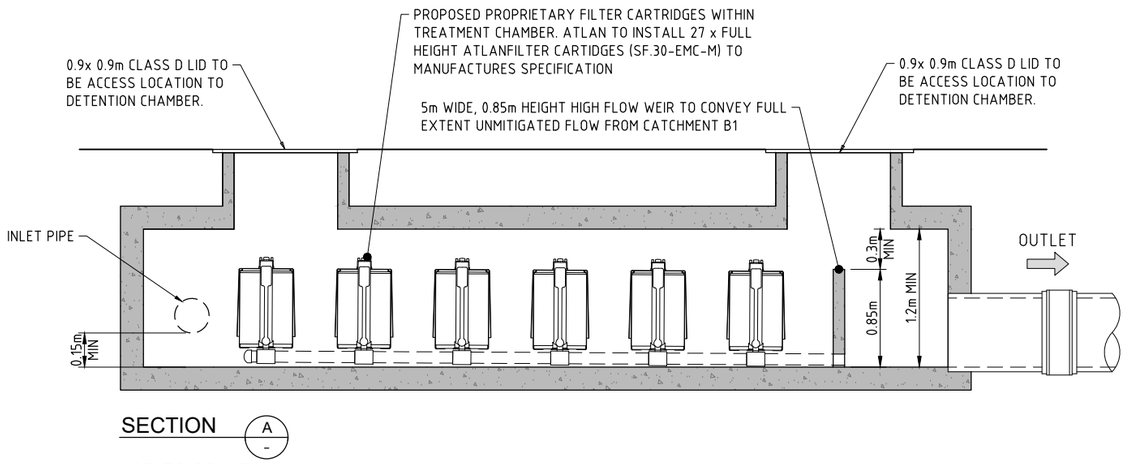
ATLAN STORMWATER DETAILS

ATLAN STORMWATER DETAILS AND ARRANGEMENT ARE INDICATIVE ONLY AND ARE TO BE CONFIRMED BY THE CONTRACTOR WITH THE MANUFACTURER PRIOR TO PROCUREMENT AND CONSTRUCTION.



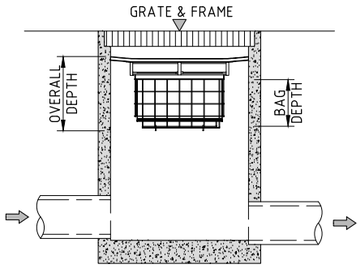
TREATMENT TANK CATCHMENT B1 LAYOUT

NOT TO SCALE



SECTION A-

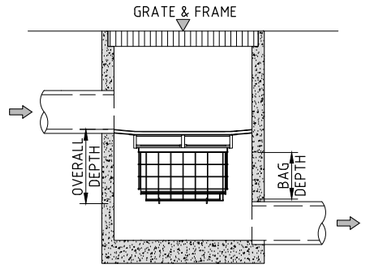
NOT TO SCALE



TYPICAL DETAIL

ATLAN STORMSACKS SURFACE FLOW CONFIGURATION

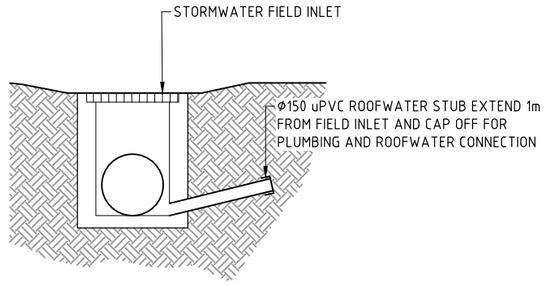
SCALE N.T.S.



TYPICAL DETAIL

ATLAN STORMSACKS PIPE FLOW CONFIGURATION

SCALE N.T.S.



TYPICAL DETAIL

ROOFWATER DRAINAGE CONNECTION

SCALE 0.5 0 0.5 1.0 1:25

TANK B1 QUALITY TREATMENT DETAILS

CATCHMENT B1 - ATLAN VAULT	
STORAGE SURFACE AREA	= 27.0m^2 (MIN)
EXTENDED DETENTION DEPTH	= 0.85m
LOW FLOW PIPE DIA.	= 205mm
CATCHMENT B1 - ATLAN FILTER	
ATLANFILTER CARTRIDGE TYPE	= 850mm SF.30-EMC-M
REQUIRED NUMBER	= 27
HIGH FLOW BYPASS	= 0.0810m^3/s
CATCHMENT B1 - ATLAN STORMSACK (GPT)	
TYPE	= STORMSACKS
REQUIRED NUMBER	= 20 (MIN)

PINNACLE ENGINEERING GROUP
LEVEL 1 19 SHORT STREET, SOUTHPORT QLD 4215
(PO BOX 517, PARADISE POINT QLD 4216)
WWW.PINNACLEENG.COM.AU

REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.W.	16.04.2025
B	REVISED LAYOUT AND STORMWATER STRATEGY	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		16.04.2025
DESIGN	J. WATERS		16.04.2025
DRAWN	J. WATERS		16.04.2025

SCALE: AS SHOWN

(SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT: BLUEPOINT FLAGSTONE PTY LTD

PROJECT: PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE: STORMWATER MANAGEMENT DETAILS SHEET 1 OF 2

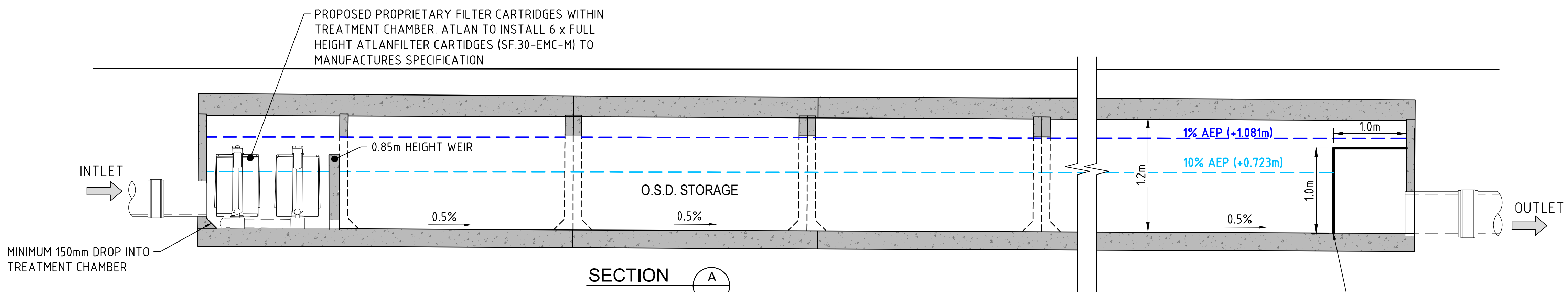
STATUS: PRELIMINARY (NOT TO BE USED FOR CONSTRUCTION)

APPROVED

RPEQ No

DRAWING NUMBER: PEG0810-DA-SK16

REVISION: B

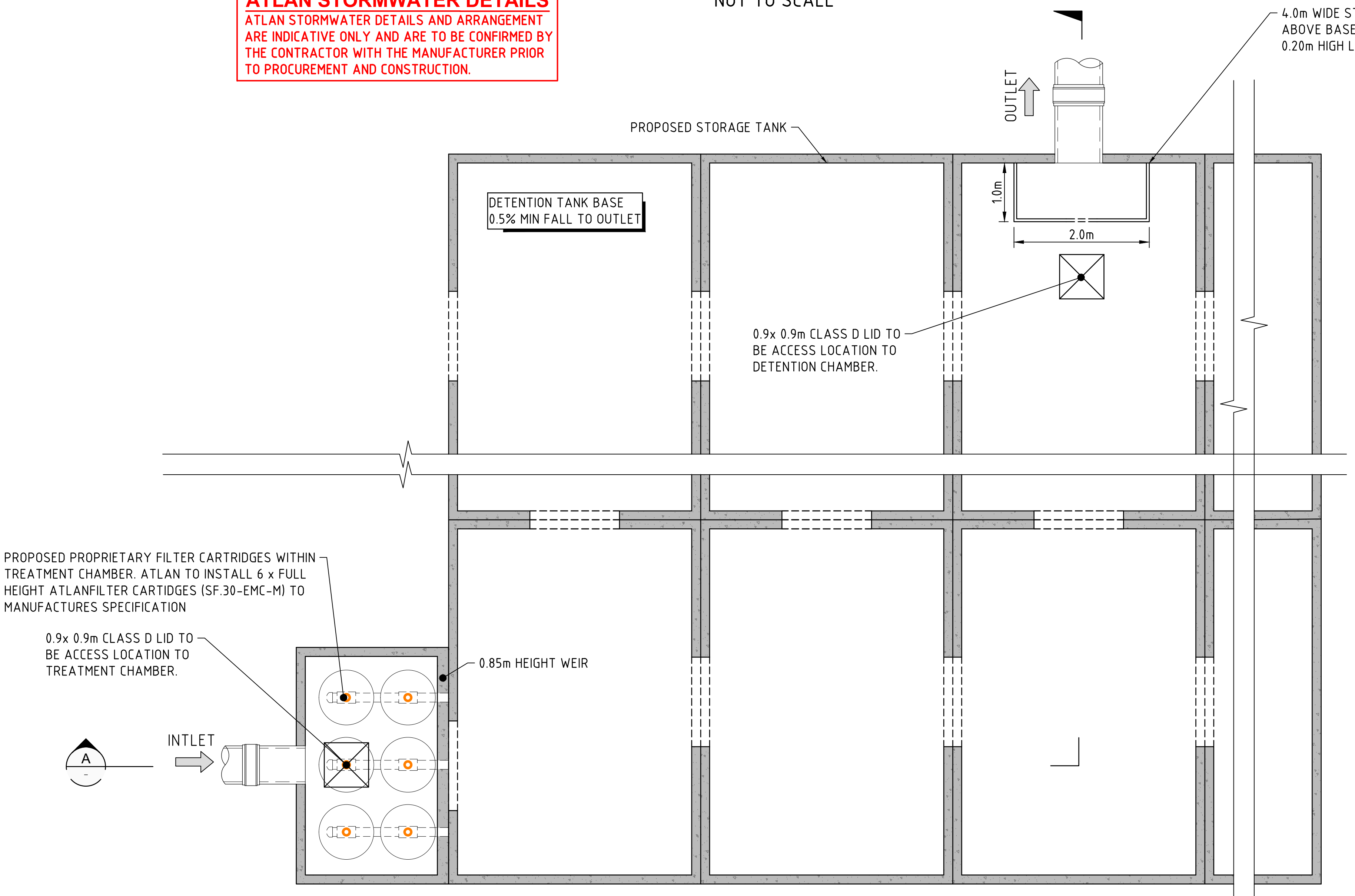


SECTION A

NOT TO SCALE

ATLAN STORMWATER DETAILS

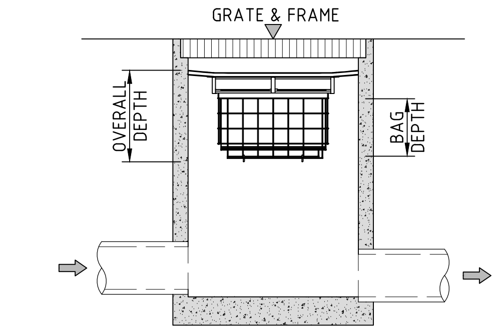
ATLAN STORMWATER DETAILS AND ARRANGEMENT ARE INDICATIVE ONLY AND ARE TO BE CONFIRMED BY THE CONTRACTOR WITH THE MANUFACTURER PRIOR TO PROCUREMENT AND CONSTRUCTION.



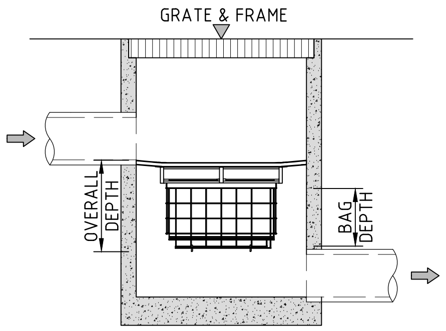
TANK DETAILS ARE INDICATIVE ONLY AND SUBJECT TO DESIGN AND DOCUMENTATION BY MANUFACTURER

DETENTION TANK A7 LAYOUT

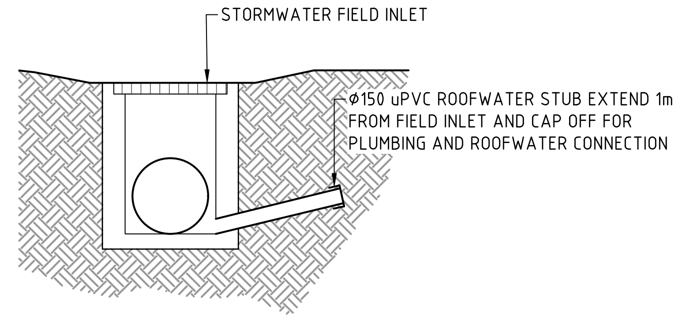
NOT TO SCALE



TYPICAL DETAIL
ATLAN STORMSACKS
SURFACE FLOW CONFIGURATION
SCALE N.T.S.



TYPICAL DETAIL
ATLAN STORMSACKS
PIPE FLOW CONFIGURATION
SCALE N.T.S.



TYPICAL DETAIL
ROOFWATER DRAINAGE CONNECTION
SCALE 0.5 0 0.5 1.0 1:25

TANK B2 QUALITY TREATMENT DETAILS

CATCHMENT B2 - ATLAN VAULT	
STORAGE SURFACE AREA	= 6.0m^2 (MIN)
EXTENDED DETENTION DEPTH	= 0.85m
LOW FLOW PIPE DIA.	= 97mm
CATCHMENT B2 - ATLAN FILTER	
ATLANFILTER CARTRIDGE TYPE	= 850mm SF.30-EMC-M
REQUIRED NUMBER	= 6
HIGH FLOW BYPASS	= 0.0180m^3/s
CATCHMENT B2 - ATLAN STORMSACK (GPT)	
TYPE	= STORMSACKS
REQUIRED NUMBER	= 4 (MIN)

TANK B2 DETENTION DETAILS

PARAMETERS	TANK (CATCHMENT B2)
TANK OUTLETS	
LOW FLOW OUTLET	= 0.25m WIDE x 0.2m HIGH ORIFICE
LOW FLOW OUTLET LEVEL	= AT BASE OF TANK
HIGH FLOW OUTLET	= 4.0m WIDE WEIR
HIGH FLOW OUTLET LEVEL	= +1.0m ABOVE BASE OF TANK
TANK GEOMETRY	
STORAGE AREA	= 150m^2 MIN.
STORAGE HEIGHT	= 1.2m
STORAGE VOLUME	= 180m^3
TANK MODELLING SUMMARY	
39%AEP PEAK OUTFLOW	= 0.092m^3/s
39%AEP PEAK STAGE	= +0.481m
10%AEP PEAK OUTFLOW	= 0.130m^3/s
10%AEP PEAK STAGE	= +0.723m
1%AEP PEAK OUTFLOW	= 0.317m^3/s
1%AEP PEAK STAGE	= +1.081m

PINNACLE ENGINEERING GROUP
LEVEL 1 19 SHORT STREET, SOUTHPORT QLD 4215
(PO BOX 517, PARADISE POINT QLD 4216)
WWW.PINNACLEENG.COM.AU

REV	DESCRIPTION	DRAWN	DATE
A	ORIGINAL ISSUE FOR COMMENT	J.W.	16.04.2025
B	REVISED LAYOUT AND STORMWATER STRATEGY	J.W.	13.06.2025

TASK	BY	INITIAL	DATE
REVIEW	B. POPA		16.04.2025
DESIGN	J. WATERS		16.04.2025
DRAWN	J. WATERS		16.04.2025

SCALE: AS SHOWN
(SCALE ABOVE DENOTES ORIGINAL SHEET SIZE - A1)

CLIENT: BLUEPOINT FLAGSTONE PTY LTD

PROJECT: PROPOSED COMMERCIAL DEVELOPMENT 'FLAGSTONE' - PRECINCT 1 (LOT 25007 & 25009 ON SP303120)

DRAWING TITLE: STORMWATER MANAGEMENT DETAILS SHEET 2 OF 2

STATUS: PRELIMINARY
(NOT TO BE USED FOR CONSTRUCTION)

APPROVED

RPEQ No

DRAWING NUMBER: PEG0810-DA-SK17

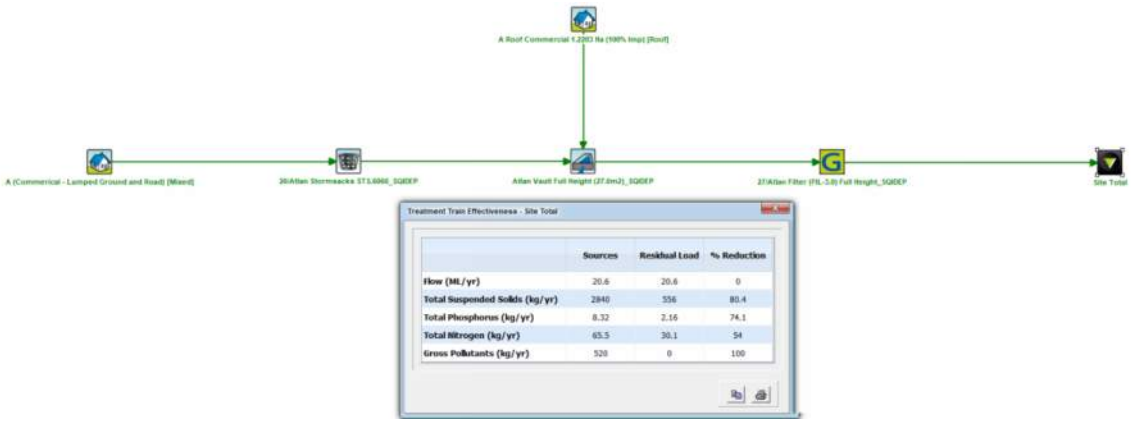
REVISION: B

PEG0810-DA-SK17 STORMWATER MANAGEMENT DETAILS SHEET 2 OF 2.dwg 13.06.2025 Letter (8.50 x 11.00 Inches) None Jai Waters

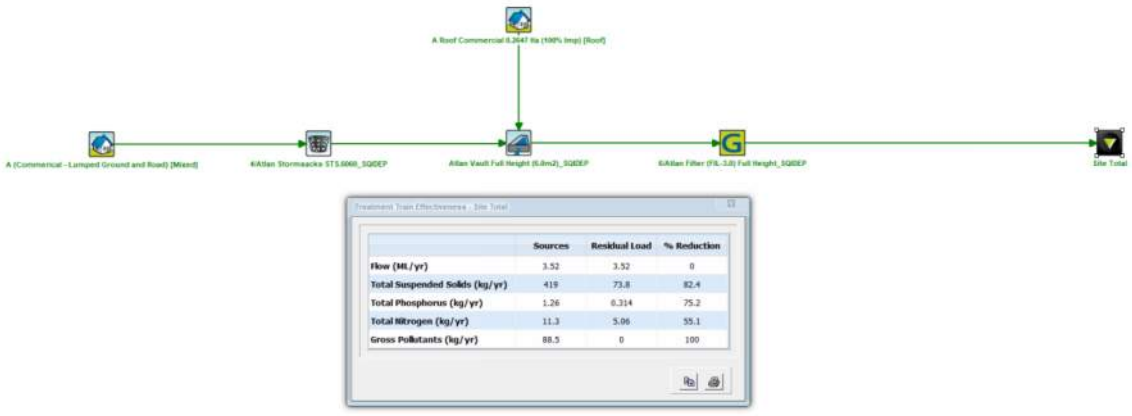
Appendix F

MUSIC Model Results

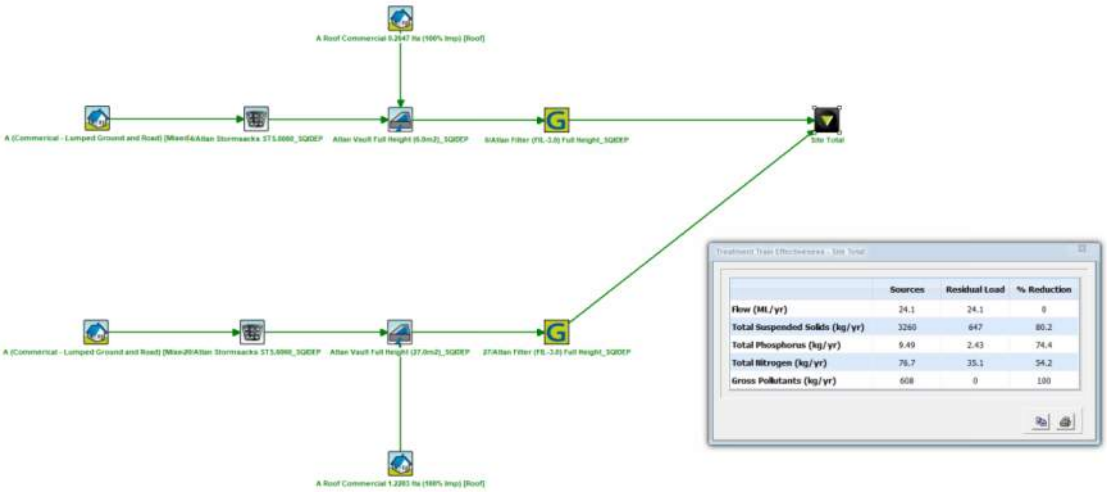
Catchment B1 Treatment Tank



Catchment B2 Treatment and Detention Tank



Catchment B Total / On-site Treatment Total



	Sources	Residual Load	% Reduction
Flow (ML/yr)	24.1	24.1	0
Total Suspended Solids (kg/yr)	3260	647	80.2
Total Phosphorus (kg/yr)	9.49	2.43	74.4
Total Nitrogen (kg/yr)	76.7	35.1	54.2
Gross Pollutants (kg/yr)	608	0	100

PINNACLE ENGINEERING GROUP

Appendix G

LCC Maps

PROPERTY FLOOD REPORT

Property Details

Address: Lot 25009 Hollows Road FLAGSTONE QLD 4280

Lot/Plan: Lot 25009 SP 303120

Size/Area: 61,402 m^2

Property Key: 390590

Catchment(s): Logan River, Sandy Creek

View Logan's catchments and waterways map (PDF)

Summary Flood Assessment

The table below presents the flood risks applicable to the selected property. There may be multiple studies and flood scenarios affecting the property, particularly for larger sites.

Assessment	Details
Other information	GREATER FLAGSTONE - This property is in the Greater Flagstone Priority Development Area (PDA). Please contact Economic Development Queensland Development for advice about development. This report is for flood risk awareness only. EDQ PDA - Greater Flagstone
Risk area(s)	Moderate, Low
Investigation area	Not applicable
Isolation risk	Not applicable
River flooding	Not applicable
Creek flooding	1% chance of a flood this size or larger happening in any given year
Overland flow	Applies. It is possible that flooding from a local waterway which has not yet been studied may also impact the property. Please contact Council for further advice. Overland flow is water (stormwater run-off) that travels over land during heavy rainfall events. It generally occurs quickly and for short durations.

Latest Flood Risk

The extract below comes from the flood risk map based on the latest (most recent) flood studies accepted by Council applicable for this property.

LEGEND

High

Floodwaters may be deep or fast flowing, or have a relatively high chance of occurrence (e.g. 80% chance in 30 years). Conditions may pose a risk to life and cause damage to buildings, possibly severe. Limited development may be considered if not increasing the flood risk exposure for people or property. These areas are generally better suited to environmental, recreational and some agricultural uses.

Moderate

Less frequently affected by flooding or if more frequent, with shallow or slower moving floodwater. Conditions may pose an unacceptable risk to people or property if not mitigated. Development may be tolerable if measures are taken to address flood impacts, protect people and limit damage.

Low

Extremely unlikely chance of flooding (1% chance or less over a 30 year period) and/or relatively shallow or benign flooding conditions. Development is generally acceptable except for essential community infrastructure (e.g. emergency services). Vulnerable uses (e.g. childcare, aged care) may be ok subject to building, site access and safe shelter mitigation measures. Shows the full floodplain under the largest flood that could conceivably occur.

Investigation area

Locations where a current flood study has not been delivered and information to determine flood risk is not available. The approximation of the floodplain in these areas is based on a citywide overland flow study. Development should avoid these areas until further investigation (updated flood study or localised risk assessment) is completed.

The flood studies this map is based on consider the impacts of climate change, as required by Queensland's planning legislation and policies. The map considers the whole floodplain for Logan and reflects a risk-based approach that takes into account:

- How likely a flood of a given size is in any given year, and
- What the impact or level of danger of that flood is.

Flood Levels

The table below displays flood levels from the most recently accepted flood studies affecting this property. To view the flood study documents please see the Flood page on Council's website.

The levels are measured in Australian Height Datum (AHD), where sea level is approximately zero (0) metres. The level displayed in the table below is the maximum flood level on the property for that event (likelihood). For some properties, particularly large properties or those on a significant slope, flood levels can vary significantly.

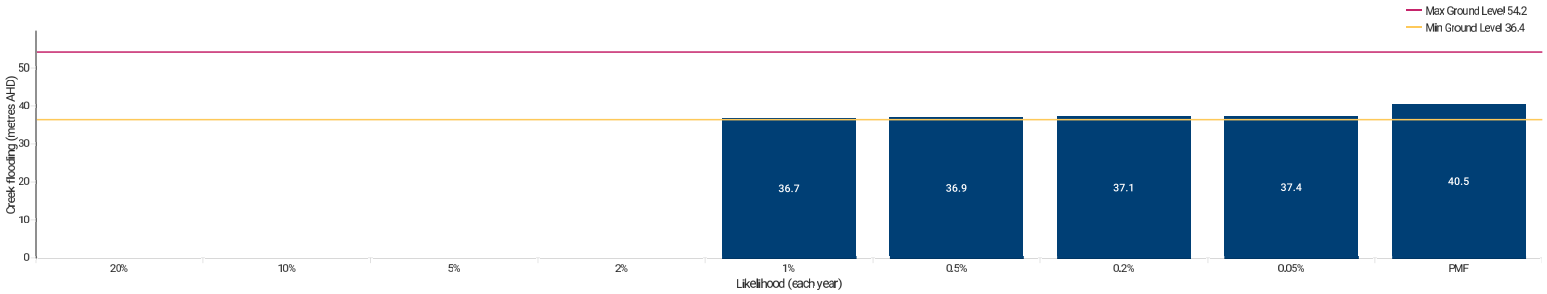
The most likely flood scenarios is shown at the top of the table, with the Probable Maximum Flood (PMF) at the bottom, being the least likely but most serious flood scenario.

Some properties may be impacted by only river flooding or only creek flooding, and some may be impacted by both. There may also be other sources of inundation that may impact the property and affect flood levels, based on overland flow or local creeks where studies have not yet been completed.

Study: Flagstone & Sandy Creeks Flood Study 2025

Likelihood (each year)	Creek flooding
20% chance	Not applicable
10% chance	Not applicable
5% chance	Not applicable
2% chance	Not applicable
1% chance	36.7 metres AHD
0.5% chance	36.9 metres AHD
0.2% chance	37.1 metres AHD
0.05% chance	37.4 metres AHD
PMF	40.5 metres AHD

Flood and Ground Levels in metres AHD



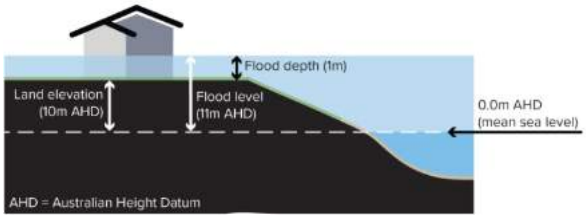
Ground Levels

Ground levels are based on an aerial LiDAR (Light Detection and Ranging) survey, which uses millions of laser point measurements to build a model of the ground surface. The source of the data is displayed in the table below so that you know when the survey was conducted.

Ground level	Details
Minimum ground level	36.4 metres AHD
Maximum ground level	54.2 metres AHD

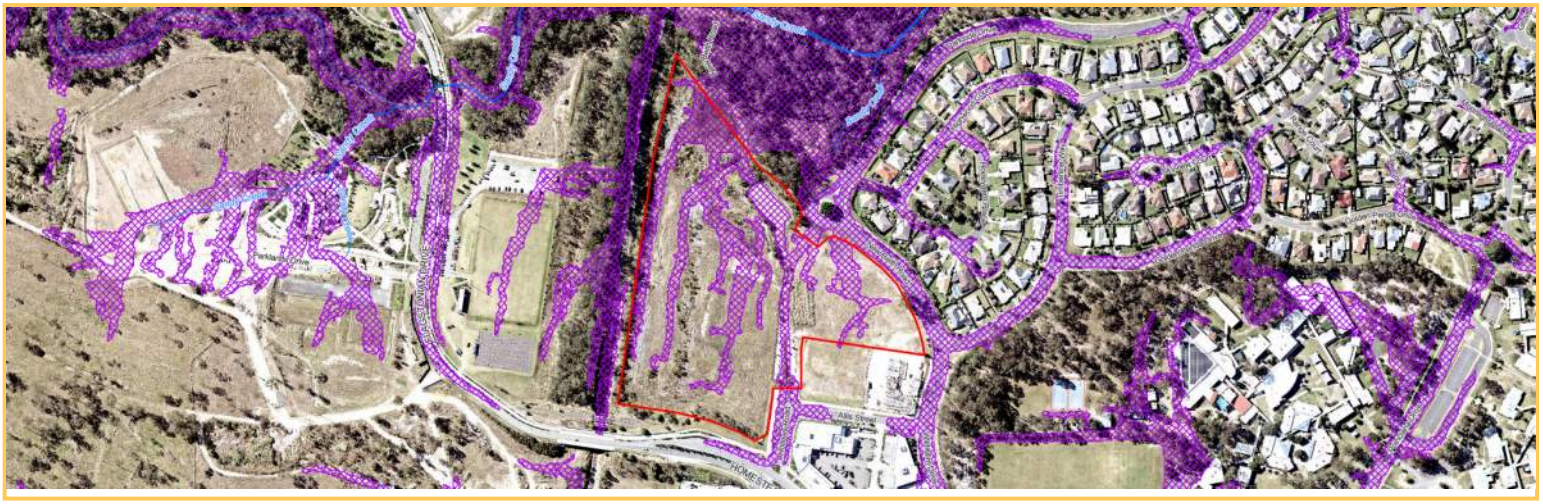
Source: 2021 Digital elevation model (1 metre grid)

The projected flood depth (how deep the water may be above ground, in metres) is the difference between the flood levels in the section above and the ground levels in this table. The diagram below provides an example (land elevation is ground level).



Overland Flow

Overland flow is water (stormwater/rainfall run-off) that exceeds the capacity of drains, pipes and channels during heavy rainfall events and travels over land towards waterways. It generally occurs quickly and for shorter periods of time. The impact of overland flow is dependent on local conditions, so the mapping is a guide only. It is possible that flooding from a local waterway which has not yet been studied may also impact the property. Please contact Council for further advice.



LEGEND

Overland flow extent (areas possibly impacted)

Future Climate Scenarios

This extract comes from the map showing the projected extent of flooding (affected areas) for multiple flood scenarios for all relevant flood studies, **including the projected impacts of climate change**. This map corresponds with the flood levels provided in the table above for the 5%, 2%, 1%, 0.5%, 0.05% and Probable Maximum Flood (PMF) scenarios.

LEGEND

5% chance
The areas modelled to be impacted by a flood that has a 5% (or 1 in 20) chance of happening in any given year, or 80% chance over a 30 year period, which is the common term of a mortgage. This modelling **includes the impacts of climate change** and represents our understanding of future risk.

2% chance
The areas modelled to be impacted by a flood that has a 2% (or 1 in 50) chance of happening in any given year, or 45% chance over a 30 year period, which is the common term of a mortgage. This modelling **includes the impacts of climate change** and represents our understanding of future risk.

1% chance
The areas modelled to be impacted by a flood that has a 1% (or 1 in 100) chance of happening in any given year, or 25% chance over a 30 year period, which is the common term of a mortgage. This modelling **includes the impacts of climate change** and represents our understanding of future risk.

0.5% chance
The areas modelled to be impacted by a flood that has a 0.5% (or 1 in 200) chance of happening in any given year, or 15% chance over a 30 year period, which is the common term of a mortgage. This modelling **includes the impacts of climate change** and represents our understanding of future risk.

0.05% chance
The areas modelled to be impacted by a flood that has a 0.05% (or 1 in 2000) chance of happening in any given year. This is an extremely unlikely flood event with a 1% chance of happening over a 30 year period, not including the impacts of climate change.

PMF
The PMF or probable maximum flood scenario represents the full extent of the floodplain, or the most serious flood that could be expected to occur. This is usually estimated based on the probable maximum rainfall, not including the impacts of climate change.

Investigation area
Locations where a current flood study has not been delivered and information to determine flood risk is not available. The approximation of the floodplain in these areas is based on a citywide overland flow study. Further investigation is needed.

Current Climate Scenarios

This extract comes from the map showing flood affected areas **without** considering the impacts of climate change. This map represents modelled flooding under current conditions, and can be used for insurance purposes.

LEGEND

5% chance
The areas modelled to be impacted by a flood that has a 5% (or 1 in 20) chance of happening in any given year, or 80% chance over a 30 year period, which is the common term of a mortgage. This modelling is based on **current (present day) conditions** and does not take into account the impacts of climate change.

2% chance
The areas modelled to be impacted by a flood that has a 2% (or 1 in 50) chance of happening in any given year, or 45% chance over a 30 year period, which is the common term of a mortgage. This modelling is based on **current (present day) conditions** and does not take into account the impacts of climate change.

1% chance
The areas modelled to be impacted by a flood that has a 1% (or 1 in 100) chance of happening in any given year, or 25% chance over a 30 year period, which is the common term of a mortgage. This modelling is based on **current (present day) conditions** and does not take into account the impacts of climate change.

0.5% chance
The areas modelled to be impacted by a flood that has a 0.5% (or 1 in 200) chance of happening in any given year, or 15% chance over a 30 year period, which is the common term of a mortgage. This modelling is based on **current (present day) conditions** and does not take into account the impacts of climate change.

0.05% chance
The areas modelled to be impacted by a flood that has a 0.05% (or 1 in 2000) chance of happening in any given year. This is an extremely unlikely flood event with a 1% chance of happening over a 30 year period, not including the impacts of climate change.

PMF
The PMF or probable maximum flood scenario represents the full extent of the floodplain, or the most serious flood that could be expected to occur. This is usually estimated based on the probable maximum rainfall, not including the impacts of climate change

Investigation area
Locations where a current flood study has not been delivered and information to determine flood risk is not available. The approximation of the floodplain in these areas is based on a citywide overland flow study. Further investigation is needed.

Historic Flood Events

Based on the best information available to Council, the table below indicates whether or not the selected property may have been impacted by significant historic flood events. It is possible that other creek flooding or overland flow, which is not included in Council's mapping of these events, may have impacted the property.

Flood event	Property impacted
1974	No
2017 (after ex Tropical Cyclone Debbie)	No
2022 (late February / early March)	No

Planning Scheme Maps

The selected property is shown below on an extract of the Flood Overlay Maps from the Logan Planning Scheme 2015 V9.1 with TLPI No. 1/2024. Various provisions of the planning scheme which refer to properties affected by the Flood Overlay Maps will apply to the flood affected areas for the purposes of planning and development. This may include, for example, raised building floor levels and achieving safe vehicle access to the road network.

OM-05.01 Isolated islands

OM-05.02 High flow area

OM-05.04 Flood risk areas

MAP LEGEND

High

Floodwaters may be deep or fast flowing, or have a relatively high chance of occurrence (e.g. 80% chance in 30 years). Conditions may pose a risk to life and cause damage to buildings, possibly severe. Limited development may be considered if not increasing the flood risk exposure for people or property. These areas are generally better suited to environmental, recreational and some agricultural uses.

Moderate

Less frequently affected by flooding or if more frequent, with shallow or slower moving floodwater. Conditions may pose an unacceptable risk to people or property if not mitigated. Development may be tolerable if measures are taken to address flood impacts, protect people and limit damage.

Low

Extremely unlikely chance of flooding (1% chance or less over a 30 year period) and/or relatively shallow or benign flooding conditions. Development is generally acceptable except for essential community infrastructure (e.g. emergency services). Vulnerable uses (e.g. childcare, aged care) may be ok subject to building, site access and safe shelter mitigation measures. Shows the full floodplain under the largest flood that could conceivably occur.

Investigation area

Locations where a current flood study has not been delivered and information to determine flood risk is not available. The approximation of the floodplain in these areas is based on a citywide overland flow study. Development should avoid these areas until further investigation (updated flood study or localised risk assessment) is completed.

CITY OF LOGAN

MAP LEGEND

High flow area
High hazard areas of flooding where significant (deeper, faster) flow of water occurs and in which a building is vulnerable to structural damage or failure from floodwater. Classified as H5 or H6 in the Australian Institute of Disaster Resilience (AIDR) Guideline 7-3 'Flood Hazard'.

High flood island
Areas which are isolated from flood-free land (surrounded by floodwater) but retain a portion of the area as flood free in a probable maximum flood (PMF).

Low flood island
Areas which are surrounded by floodwater and at first isolated from flood-free land, then completely inundated by floodwater (submerged) as the flood continues to rise.

Meadowbrook flood assessment area
Area where the function of important community infrastructure needs to be maintained. Flood mitigation measures and comprehensive emergency management planning is required to adequately manage the risk for flood events.

If more recent flood studies have been completed and accepted by Council, the Latest Flood Risk Map shown at the top of this report may be different from the planning scheme map. The latest flood information should be used to inform development decisions and will be incorporated into the planning scheme in a future amendment.

Further Information

1. Floods are highly unpredictable and variable, and properties may be affected by other sources of potential flooding. Each flood and its impact is different. Areas that were not flooded previously may be affected by future events. Areas that have been previously flooded may be impacted in different ways. This online report cannot take all of this into account.
2. The flood mapping and levels in this report are based on data from flood studies undertaken at a particular time and are subject to change. For example, if the method for calculating flood levels is updated, industry guidelines are updated or more recent information becomes available, this may result in changes to the information in this report. In areas where development is ongoing, the flood mapping and levels may not reflect developed conditions.
3. Flood studies do not create risk. They help us to understand the risk, based on relevant legislation and Queensland Government policies and guidelines. Flood studies also consider a range of other factors such as rainfall and river level information from recent events, climate change and trends, the impacts of development, changes to catchment conditions, new technologies and industry best practice (which help to improve accuracy).
4. Flood studies and models are developed from the best information available at the time. They do not tell you how the flood waters might behave, how quickly they may rise, or how dangerous the flooding will be. The models also cannot represent changes that have occurred since they were developed which may impact flood behaviour, such as earthworks, new developments or road infrastructure.
5. This report is not a substitute for independent professional advice. You should engage the services of a Registered Professional Engineer of Queensland (RPEQ) to get site specific information regarding the flood risk to your property, and how that might affect any proposed building or development work.
6. While Logan City Council takes reasonable care in producing this report, it does not guarantee that the information is accurate, complete or current. Logan City Council does not accept any responsibility for any loss or damage (however it was caused) in connection with the use of or reliance on the information in this report.

Contact Information

Where to go for further information depends on the type of information you need. Please refer to the Flood Risk Fact Sheet or contact Council using the details below.

Topic	Contact Details
Flood studies and modelling information, and the flood risk on your property	Contact Council on 07 3412 3412 or email council@logan.qld.gov.au. Further information about flooding and flood studies is available on the Flood page on Council's website.
Planning and development enquiries or proposals	Contact Council on 07 3412 3412 or email development@logan.qld.gov.au. Before lodging a development application, pre-lodgement advice is recommended.
Building information	Contact Council on 07 3412 3412 or email council@logan.qld.gov.au. You can also contact a private building certifier.
Properties in Priority Development Areas	Contact Economic Development Queensland. Council is not the planning authority for these properties.
Independent advice about flooding on your property	Contact a registered engineer through the Board of Professional Engineers of Queensland: Phone: 07 3210 3100 Email: admin@bpeq.qld.gov.au Web: Home - Board of Professional Engineers Queensland (bpeq.qld.gov.au)

PINNACLE ENGINEERING GROUP

Appendix H

Peak Urban Reporting

TECHNICAL MEMO

TO:	Kim Munro (PEET)
FROM:	Dan Collins (PEAKURBAN)
SUBJECT:	Flagstone Stage 7A-G – Stormwater Management Strategy
DATE:	18 December 2020
OUR REFERENCE:	20-0178.TM02.DC.DOCX

1 STORMWATER MANAGEMENT

PEAKURBAN have been appointed by PEET Flagstone City Pty Ltd to prepare a technical memo to summarise the intent of the amended stormwater management strategy for Flagstone Stages 7A-G.

The development has previously had multiple stormwater management plans documented for varying superseded development layouts for Stages 7A-G.

For the existing detailed modelling of the stormwater management strategy, we refer to previously approved Reports Flagstone City – Stage 7 Stormwater Management Report 7217/43/R11V1 Version 2 and Flagstone City – Masterplan Flooding Assessment 721743/032/R1V6 Version 6 prepared by Cardno. In addition, we refer to Stormwater Management Plan at Flagstone Stage 7 North prepared by Bradlees for specific details on the northern area of Stage 7.

We note that current approved reports document that Lots 25021 & 25022 are required to provide water quality treatment and detention storage within the development lots and that any future applications over those lots will be required to be supported by a Stormwater Management Plan.

PEAKURBAN are currently in the process of preparing an amended Stormwater Management Plan for the recently approved plan of subdivision (110056-270 Rev K) prepared by RPS and dated 8 October 2020 enclosed within **Attachment A**.

The intended stormwater management strategy that is being assessed as a part of the amended Stormwater Management Plan is documented on the Concept Stormwater Management Plan 20-0178-SK004 enclosed within **Attachment B**.

The strategy is intending to optimise the proposed stormwater quality and quantity location in Lot 905 on SP216472 to treat the area identified as Catchment A which will include Lot 25021 for stormwater quality and quantity. We note that the stormwater treatment works in Lot 905 on SP216472 are triggered by the development of either Lot 25021 or Lot 25009, whichever is developed first.

Due to existing topography constraints and the increased area of treatment it is proposed that Lot 25022 is treated as a separate catchment with stormwater quality and quantity measures implemented within the lot boundary before discharging to the north.

It is expected that Lot 25022 will need to provide approximately 1,750m^3 of stormwater detention and 750m^2 of filter area for stormwater quality treatment. Please note that these are subject to the finalisation of modelling for the amended Stormwater Management Plan and are noted as indicative only.

Depending on the end use application for Lot 25022 there is an opportunity to increase development footprint within the lot by deviating from a detention and bio-retention basin option for stormwater quality and quantity treatment, to a proprietary product and underground storage system.

It is expected to have a completed Stormwater Management Plan for submission to EDQ for endorsement in February 2021.

ATTACHMENTS:

Attachment A	Plan of Subdivision (110056-270 Rev K prepared by RPS)
Attachment B	Engineering Concept Plan 20-0178-SK004

Attachment A Plan of Subdivision

Land Budget Stage 7

Land Use	Stage 7A	Stage 7B	Stage 7C	Stage 7D	Stage 7E	Stage 7F	Stage 7G	Stage 7I	Overall	
	Area	Area	Area	Area	Area	Area	Area	Area	Area	Percentage
Area of Subject Site	**3.280 ha**	**1.770 ha**	**0.815 ha**	**1.316 ha**	**0.298 ha**	**0.357 ha**	**4.871 ha**	**3.161 ha**	**15.868 ha**	**100.0%**
Saleable Area										
Town Centre Frame Allotments	2.253 ha	1.265 ha	0.800 ha	0.997 ha	0.192 ha	0.357 ha	4.681 ha	2.206 ha	**12.751 ha**	**80.4%**
Service Allotments	—	—	—	—	—	—	—	0.016 ha	**0.016 ha**	**0.1%**
Balance Super Allotments	—	—	—	—	—	—	0.030 ha	0.415 ha	**0.445 ha**	**2.8%**
Total Area of Allotments	**2.253 ha**	**1.265 ha**	**0.800 ha**	**0.997 ha**	**0.192 ha**	**0.357 ha**	**4.711 ha**	**2.637 ha**	**13.212 ha**	**83.3%**
Road										
Collector Road	—	0.223 ha	—	0.307 ha	—	—	0.160 ha	—	**0.690 ha**	**4.3%**
Local Road	0.953 ha	0.262 ha	—	—	0.106 ha	—	—	0.524 ha	**1.845 ha**	**11.6%**
Road Widening	0.074 ha	0.020 ha	0.015 ha	0.012 ha	—	—	—	—	**0.121 ha**	**0.8%**
Total Area of New Road	**1.027 ha**	**0.505 ha**	**0.015 ha**	**0.319 ha**	**0.106 ha**	**—**	**0.160 ha**	**0.524 ha**	**2.656 ha**	**16.7%**

Notes:
Stage 7I approved under separate EDQ application (DEV2018/917).
Stage 7H approved under separate Logan City Council application (COM/3/2020).

Yield Breakdown Stage 7

Allotments	Stage 7A	Stage 7B	Stage 7C	Stage 7D	Stage 7E	Stage 7F	Stage 7G	Stage 7I	Overall
Super Lots	**Lots**	**Lots**	**Lots**	**Lots**	**Lots**	**Lots**	**Lots**	**Lots**	**Lots**
Town Centre Frame	2	3	2	1	1	1	2	11	**23**
Service Allotments	—	—	—	—	—	—	—	1	**1**
Balance Super Allotments	—	—	—	—	—	—	1	1	**2**
Total Allotments	**2**	**3**	**2**	**1**	**1**	**1**	**3**	**13**	**26**

Notes:
Stage 7I approved under separate EDQ application (DEV2018/917).
Stage 7H approved under separate Logan City Council application (COM/3/2020).

Legend

- Site Boundary
- Stage Boundary
- Q5 Flood Line
- Q100 Flood Line
- Category B area (Remnant Vegetation)
- Access Easement
- Sewer Easement
- Road Widening
- Area Subject to Separate Development Approval
- Mixed Business, Service and Light Industry Allotments
- Environmental Management and Conservation
- Drainage

Note:
All dimensions and areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:
Site boundaries: Registered Survey Plans
Adjoining information: DCDB

REVISION

A: 06/05/2015 RFI Response
B: 18/05/15 Amend Staging
C: 18/09/15 Amend Layout
D: 13/05/16 Amend Lots Stage 7A
E: 21/02/17 Amend Staging
F: 22/02/17 Amend Staging and Lots
G: 28/02/18 Amend Layout
H: 12/03/18 Amend Layout
I: 08/05/18 Amend Footpath
J: 27/07/18 Amend Stage 7C
K: 08/10/20 Amend Staging and Layout

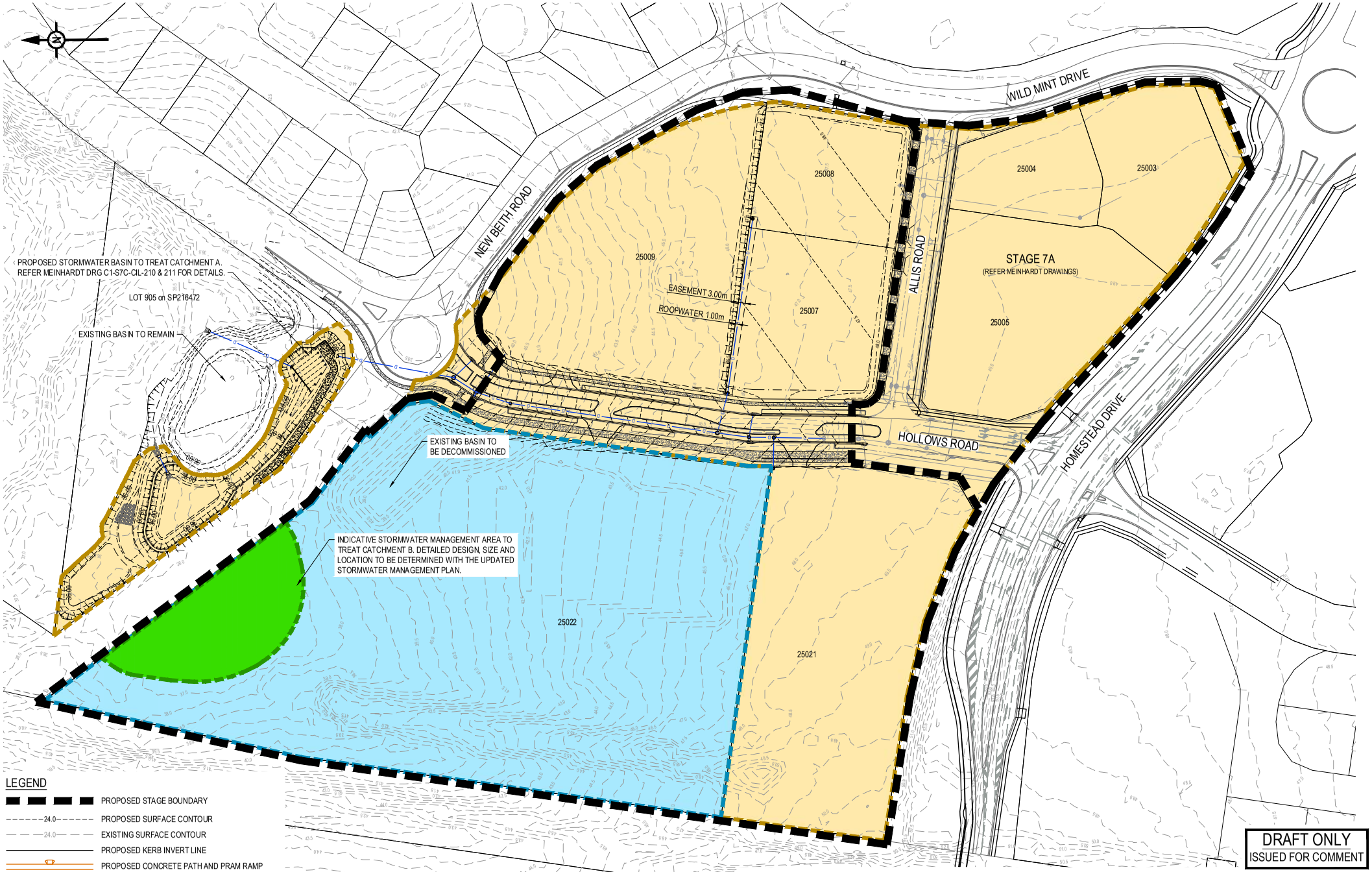
PLAN REF: 110056 – 270
Rev No: K
DATE: 08 OCT 2020
CLIENT: PEET
DRAWN BY: WNW / MD
CHECKED BY: MD

0 20 40 60 80 100 **1 : 1,500 @ A1**

FLAGSTONE
PLAN OF SUBDIVISION
STAGE 7 - TOWN CENTRE EAST

URBAN DESIGN
Level 4 HQ South
520 Wickham Street
PO Box 1559
Fortitude Valley QLD 4006
T +61 7 3539 9500
W rpsgroup.com

Attachment B Engineering Concept Plan



REV	DATE
1	18.12.20

PEAKURBAN
DEVELOPMENT ENGINEERS + ADVISORS
SKETCH PLAN
ENQUIRIES@PEAKURBAN.COM.AU

SCALE
1:750 15 0 15 30 A1
1:1500 A3

CLIENT: PEET

PROJECT NAME: FLAGSTONE STAGES 7CD

DRAWING TITLE: CONCEPT STORMWATER MANAGEMENT PLAN

PROJECT No.	DRAWING No.	REVISION
20-0178	SK004	1

Stormwater Management Plan

Flagstone - Stages 7C/D/G

Peet Flagstone City Pty Ltd

PEAKURBAN
Achieve more.

20-0178SMP01-V1
1 March 2021

COMMERCIAL IN CONFIDENCE

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DOCUMENT CONTROL
20-0178SMP01-V1

Version	Date	Details	Prepared	Checked	Approved	Signed	RPEQ
1	1/3/21	Original	DM	RB	KM		09298

CONTENTS

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APPENDICES

1. INTRODUCTION

PEAKURBAN Pty Ltd has been engaged by Peet Flagstone City Pty Ltd (Peet) to prepare a Stormwater Management Plan that supports the development application for the proposed northern subdivision at Flagstone - Stages 7C/D/G.

1.1. Site Location

The site is located on the corner of Homestead and Mint Drive in the Logan City Council (LCC) Local Government Area (LGA) and is described as Lots 906, 25003-25005 on SP290276. The site is approximately 8.77 ha and currently contains a commercial precinct in the lower south-east corner. The remaining 80 percent of the site has been cleared. **Figure 1-1** (below) shows the site location.

Figure 1-1. Site Location [Source: Queensland Globe, n.d.].

1.2. Project Context

The development, Flagstone – Stages 7C/D/G, forms part of Peet's Flagstone City multi-phase development. As Peet has an approved Master Plan for Flagstone City, this Stormwater Management Plan will supplement the Stormwater Management Plan outlined in the Peet's Stormwater Infrastructure Master Plan (IMP; Peet, 2018). The proposed lot configuration, as per RPS' drawing: 110056-272[K], has been adopted for this investigation (see **Figure 1-2**).

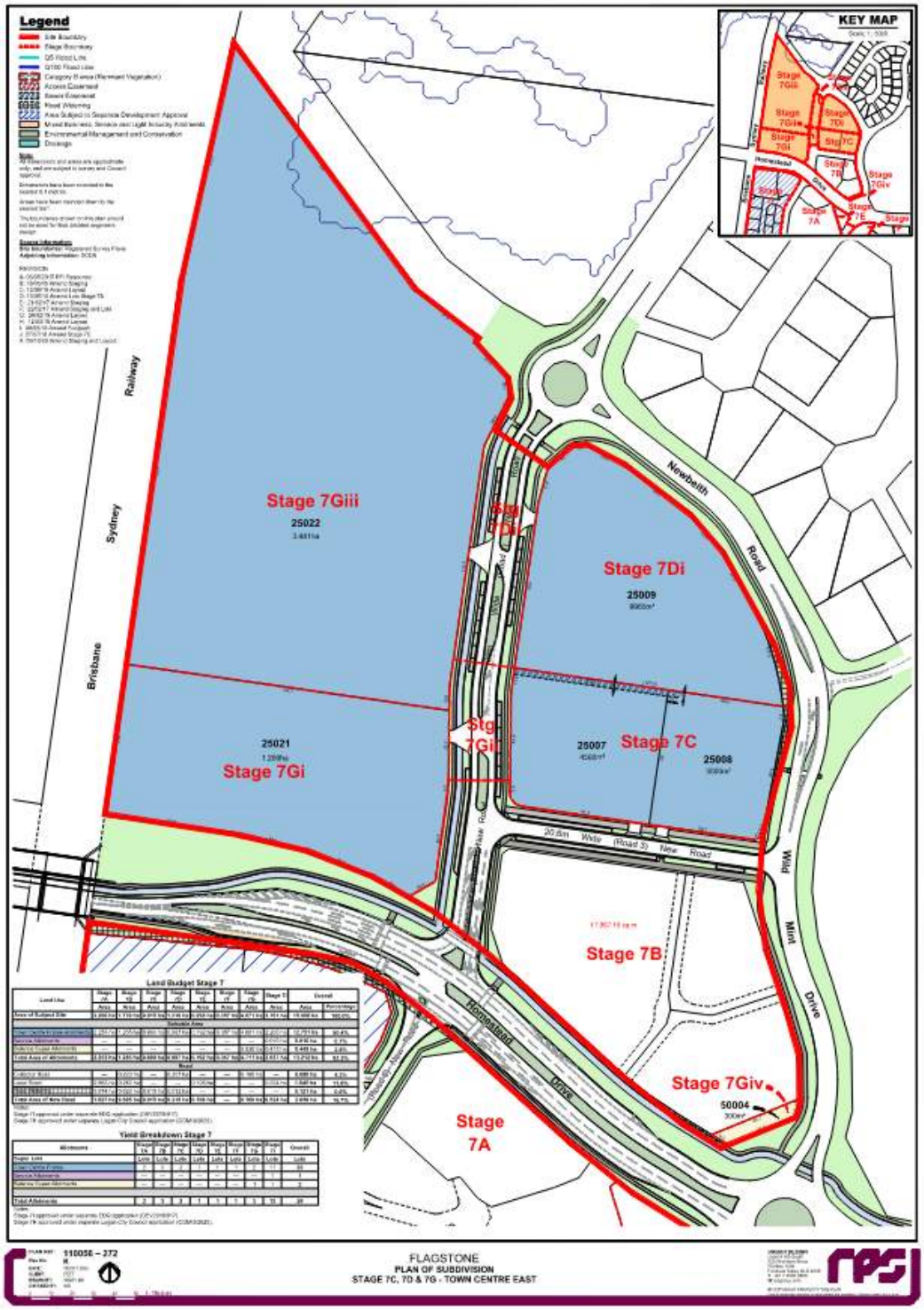


Figure 1-2. Lot Configuration as supplied by RPS. Drawing Number: 110056-272[K].

An existing preliminary assessment, undertaken by Bradlees Consulting, has proposed a stormwater management strategy for Stages 7B, C and G (now referred to as Giv). At the time of publishing, it was assumed that the remainder of the development be managed onsite, in Lot 7Giii. As the development has progressed, the stormwater management strategy has changed. It is now proposed that Stages 7 Di, Dii, Gi and Gii are also all managed offsite and only 7Giii will be managed onsite. Refer to "*Stormwater Management Plan at Flagstone: Stage 7 North",* dated March 2017 (ref: 15-891[A]) for further details.

1.3. Report Objectives

The purpose of this report is to assess the impact that the additional lots have on the previous design and to determine the bioretention requirements for Stage 7Giii. As requested by Peet, this report will:

- Detail the proposed stormwater quality management strategy and outline how the load reduction objectives specified by the State Planning Policy (SSP; 2017) are achieved during the operational phase of the development;
- Outline the maintenance requirements for the proposed stormwater quality improvement devices;
- Detail the proposed stormwater quantity management strategy and outline how it complies with the Queensland Urban Drainage Manual's (QUDM's) principles (2017)and Schedule 6 – Part 3.6 requirements of Logan City Council's Planning Scheme (2015)
- Outline the maintenance requirements for the proposed stormwater quantity management devices; and
- Demonstrate how the lawful point of discharge requirements for the site are compliant as per Section 3.9 of the QUDM (2017).

1.4. Report Structure

The remainder of this report is divided into two sections and concludes with a summary. Section 2 is devoted to stormwater quality. It outlines the relevant water quality objectives for the site; summarises the critical elements of the water quality analysis and results; outlines the water quality management strategy; and provides water quality device maintenance recommendations. Section 3 is a similarly structured section devoted to water stormwater quantity. It outlines the governing water quantity management design objectives; summarises the critical findings and assumptions of the water quality analysis; outlines the water quantity management strategy; provides water quantity device maintenance recommendations; and demonstrates compliance with Lawful Point of Discharge requirements. Section 4 provides a summary of the investigation.

2. STORMWATER QUALITY MANAGEMENT

2.1. Stormwater Quality Design Objectives

This section identifies the stormwater quality management objectives for the operational phase (post-construction phase) of the proposed development. Construction based stormwater quality management objectives will need to be addressed as part of operational works documentation.

The LCC's Planning Scheme requires water quality objectives to be, at a minimum, equivalent to those stated in the State Planning Policy (SPP; Section 3.6.1.5(1), LCC, 2020). The Water Quality Objective (WQO's) mean annual load reduction targets adopted for this assessment is provided in **Table 2-1.**

Table 2-1: Water Quality Objectives for South East Queensland [Source: (Department of Infrastructure, Local Government and Planning (DILGP), 2014)].

Minimum reductions in mean annual loads from unmitigated development (%)			
Total Suspended Solids (TSS)	**Total Phosphorous (TP)**	**Total Nitrogen (TN)**	**Gross pollutants >5 mm**
80	60	45	90

2.2. Stormwater Quality Management Strategy

It is proposed that runoff from the development be treated via end of line bioretention basin(s) prior to discharge to the environment. An area has been identified for the location of a basin within Lot 905 on SP216472. Lot 905, however, is constrained with an existing basin (not associated with this development) and may not be able to accommodate the required bioretention basin area. Therefore, it is proposed that if the required bioretention basin size for Lot Giii cannot fit in Lot 905, its stormwater runoff could be treated onsite (in Lot 906 SP290276), and the remaining lots will be treated offsite in a bio-retention basin located in Lot 905.

2.3. Stormwater Quality Analysis

The LCC requires all stormwater quality modelling to be in accordance with the latest Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Modelling Guidelines and is to be modelled using the latest MUSIC program (Section 2.4.1.3(e), LCC, 2020). The versions adopted for this report and analysis were MUSIC Modelling Guidelines - Version 1 (2010) and MUSIC Version 6.3.0.

The Stormwater Quality analysis was completed in two parts. Part 1 designed the bioretention basin required to treat stormwater runoff from Stages 7D-Gii and Giv. Part 2 designed the bioretention basin required for the treatment of Giii. Refer to **Figure 2-1** for Bioretention Basin Catchment Plan. Blue areas denote the stormwater runoff to be treated offsite and yellow denotes the catchment, Giii, that will be treated onsite.

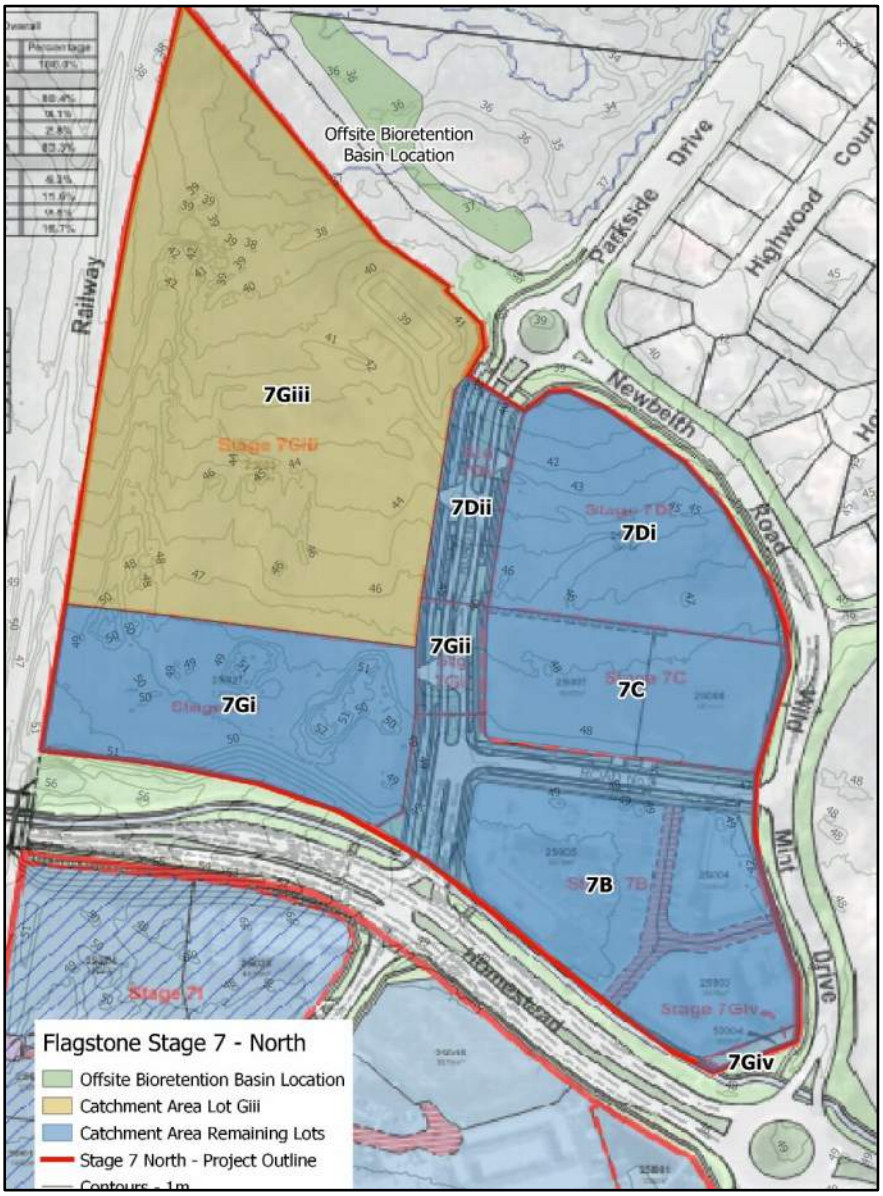


Figure 2-1. Bioretention Basin Catchment Plan: blue – balance 7 nth, yellow - 7Giii.

2.3.1. MUSIC Model

The impervious fractions and pollutant export parameters adopted in the previous analysis were determined using the split catchment source nodes and land use tables found in the MUSIC Modelling Guidelines (2010). As detailed lot layouts have not been provided, this assessment adopts lumped commercial land use source node parameters as found in Tables 3.6, 3.7 and 3.9 of the MUSIC Modelling Guidelines (2010) (Water by Design, 2010, p. 14, 15 and 19). The road reserve sub-catchments (7Dii and 7Gii) fraction imperviousness have been calculated based on RPS's *Plan of Subdivision* drawing (Number:10056-272 [Rev K]. The adopted source node parameters have been summarised in **Table 2-2**.

Table 2-2: Source Node Configuration

Source Node	Zoning	Area (ha)	% Impervious
Stage 7B and Giv	Commercial	1.800	80
Stage 7C	Commercial	0.800	80
Stage 7Di	Commercial	0.997	80
Stage 7Dii	Road Reserve	0.319	82
Stage 7Gi	Commercial	1.200	80
Stage 7Gii	Road Reserve	0.160	82
Stage 7Giii	Commercial	3.481	80

2.3.1.1. MUSIC Model Part One – Offsite Treatment

Stormwater runoff from Stages 7B to Gii and Giv were modelled and it was determined that a 500m^2 bioretention basin was required to meet WQOs. The MUSIC model layout is shown in **Figure 2-2** and **Figure 2-3** shows the treatment train effectiveness. The bioretention basin parameters required to achieve these results are shown in **Figure 2-4.**

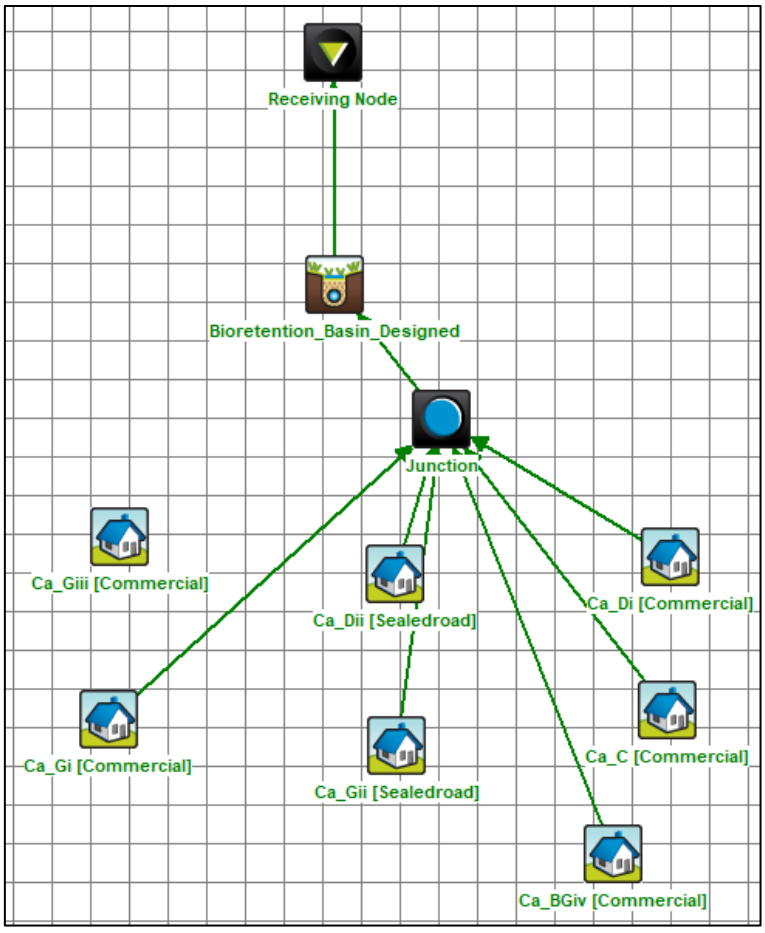
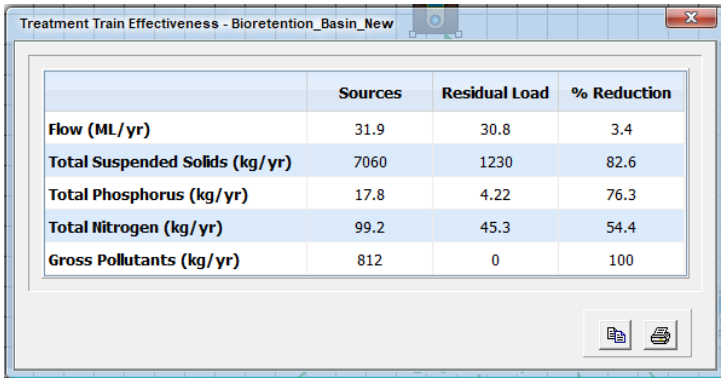


Figure 2-2. Part One: Offsite Treatment MUSIC Model - Layout.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	31.9	30.8	3.4
Total Suspended Solids (kg/yr)	7060	1230	82.6
Total Phosphorus (kg/yr)	17.8	4.22	76.3
Total Nitrogen (kg/yr)	99.2	45.3	54.4
Gross Pollutants (kg/yr)	812	0	100

Figure 2-3. Part One: Offsite Treatment MUSIC Model –- Results.

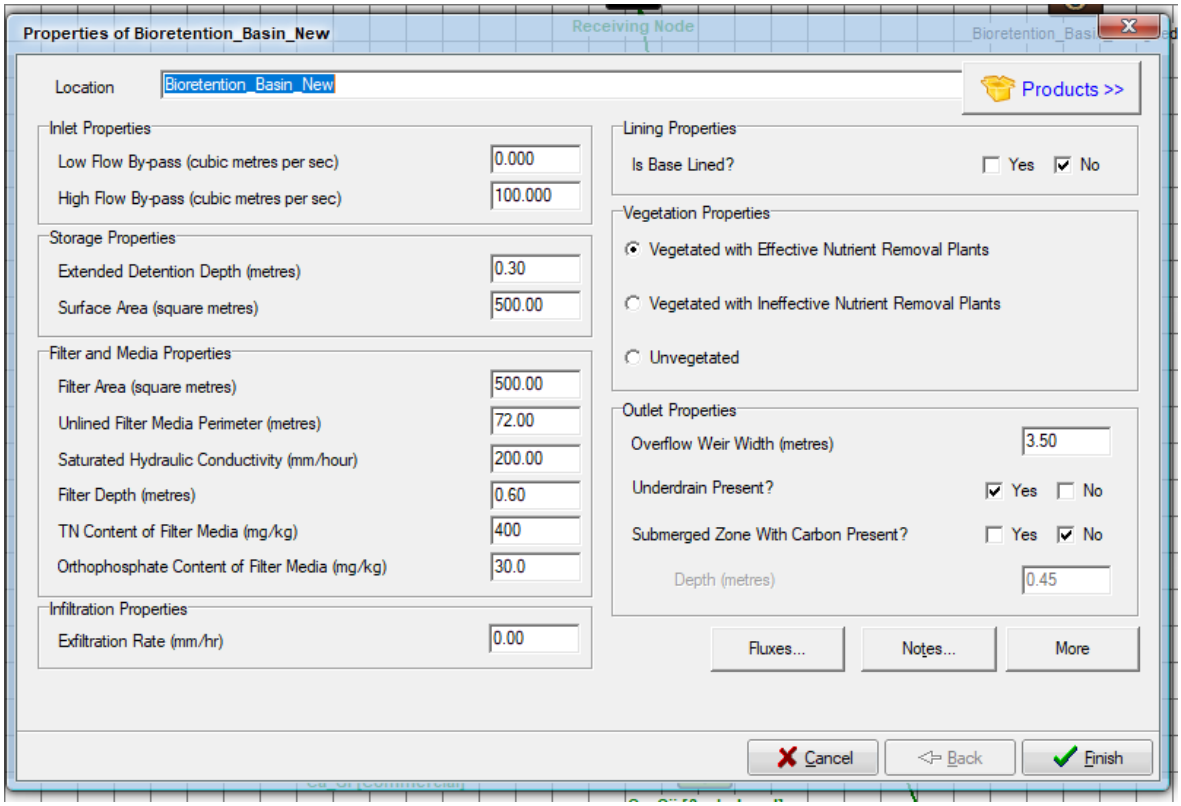


Figure 2-4. Part One: Offsite Treatment – Basin Parameters.

2.3.1.2. *MUSIC Model Part Two – Allotment 7Giii*

A bioretention basin has been proposed to treat stormwater runoff from Lot Giii. The MUSIC Model layout is shown in **Figure 2-5**. The MUSIC analysis shows that a basin size of 320m^2 is required to meet WQOs. The treatment train effectiveness is shown in **Figure 2-6** and the basin design parameters are shown in **Figure 2-7**.

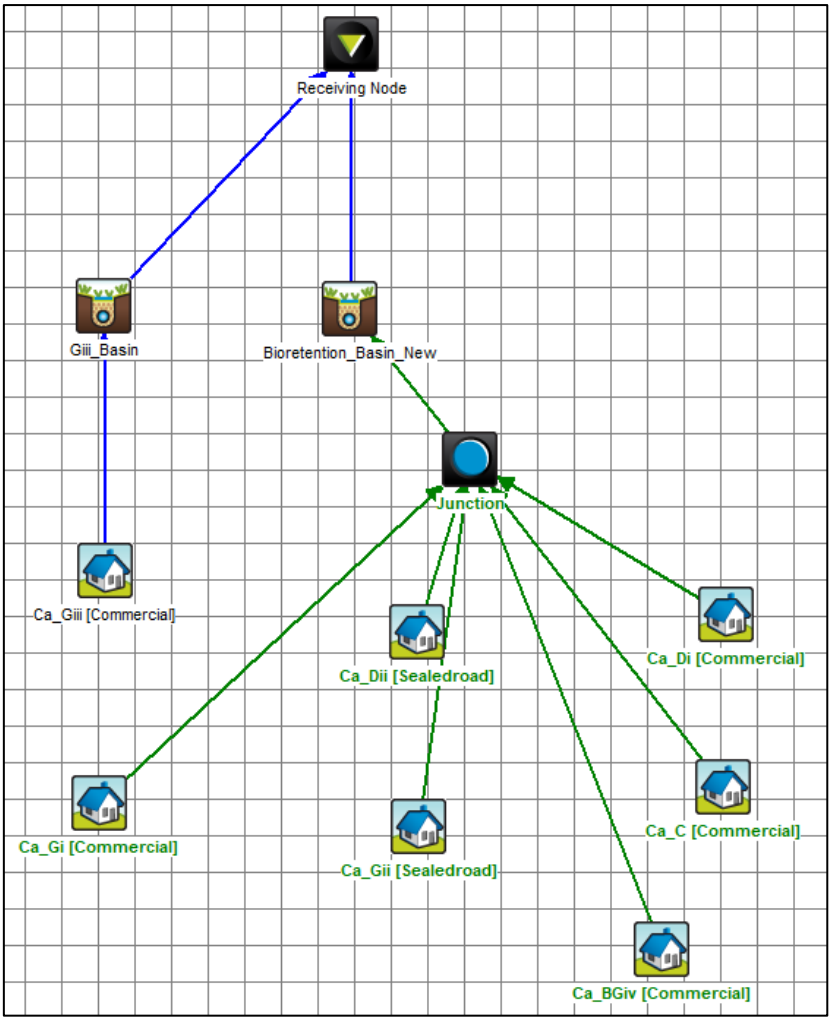
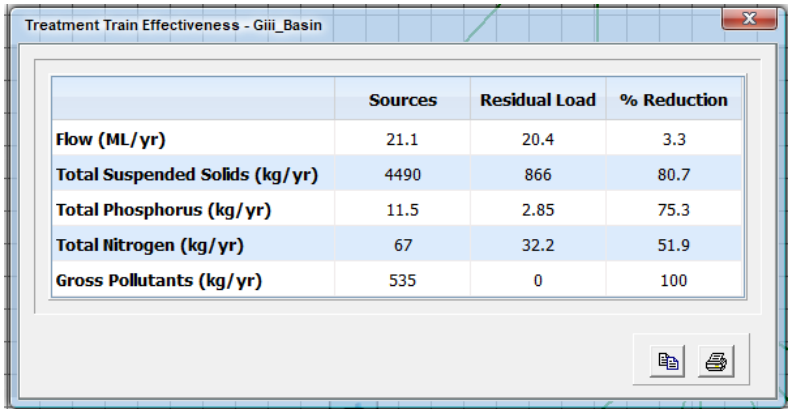


Figure 2-5. Part Two: Onsite Treatment – Layout.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	21.1	20.4	3.3
Total Suspended Solids (kg/yr)	4490	866	80.7
Total Phosphorus (kg/yr)	11.5	2.85	75.3
Total Nitrogen (kg/yr)	67	32.2	51.9
Gross Pollutants (kg/yr)	535	0	100

Figure 2-6. Part Two: Onsite Treatment – Results.

.

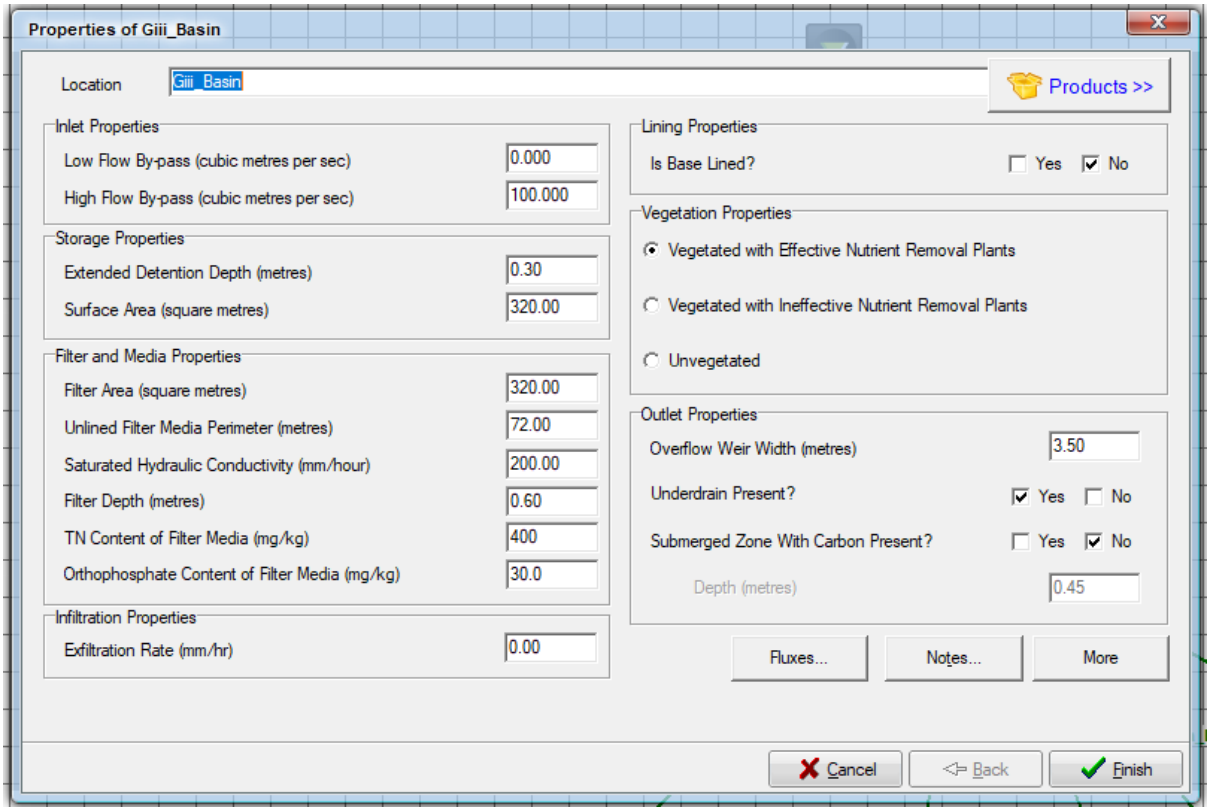


Figure 2-7. Part Two: Onsite Treatment – Basin Parameters.

2.3.2. Treatment Measures

Runoff from the development will be treated via two bioretention basins. The locality of the treatment device is shown in **Figure 2-8. Table 2-3** details the proposed bioretention treatment devices. It is noted that the larger bioretention basin may be required to be split into two cells in order to be accommodated within the available area.

Table 2-3: Bioretention Device Parameters

Parameter	Bioretention Basin Lot Giii	Bioretention Basin Remaining Lots
Number of Devices	1	1
Filter Area (m²)	320	500
Extended Detention Depth (m)	0.3	0.3
Filter Depth (m)	0.6	0.6

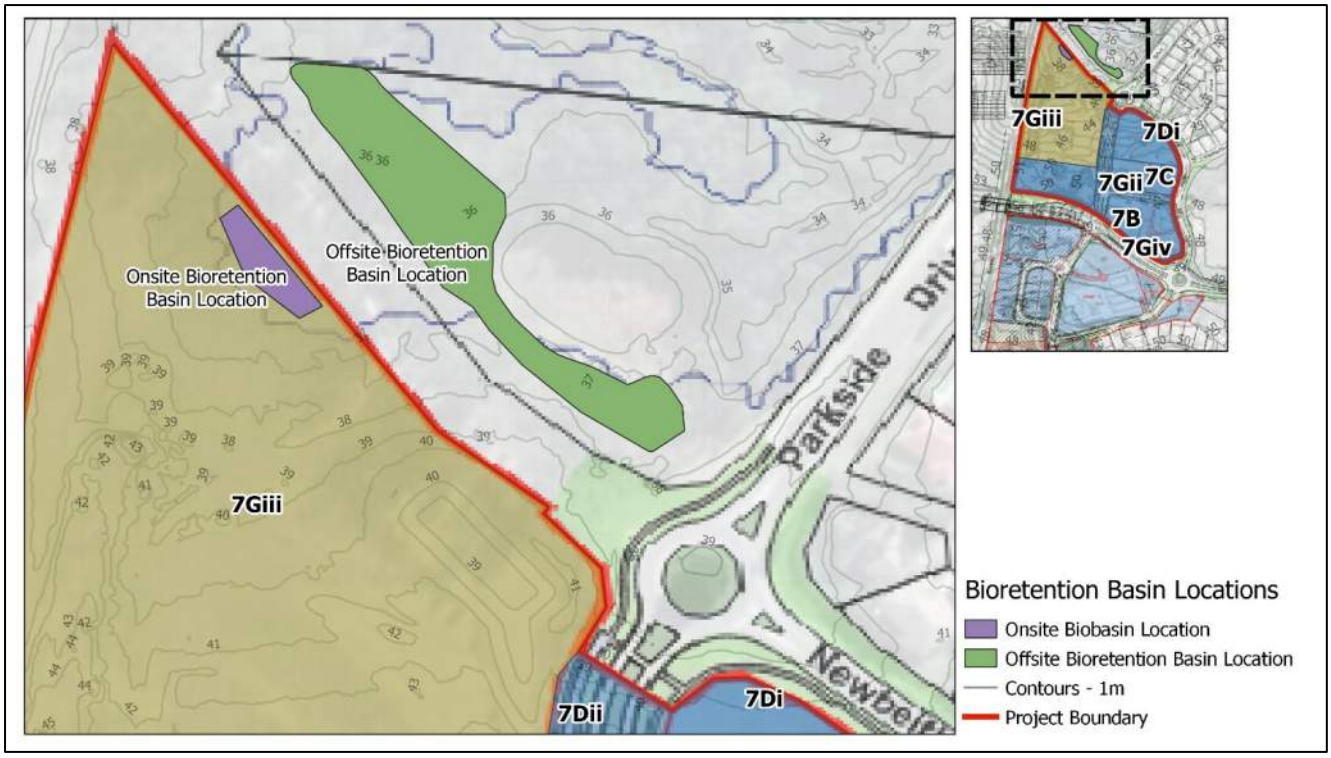


Figure 2-8: Bioretention Basin Locations

If Stage Giii is developed as a single lot, runoff could be treated via proprietary product sized by the manufacturers to achieve the required WQOs. In this instance the treatment would remain the responsibility of the property owner. Options for treatment include cartridge filters (such as SPEL or Ocean Protect) which can be installed underground or high efficiency biofiltration (Filterra by Ocean Protect) which potentially reduce the designated area required for the basin.

2.3.3. MUSIC Model Results – Summary

Results from the MUSIC model are presented in **Table 2-4.** As shown, the load reduction targets have been achieved.

Table 2-4: MUSIC Model Results

Case One: Offsite Treatment (7D to Gii and Giv)			
Pollutant	Target Reduction	Reduction Achieved	Compliance
TSS	80.00	82.60	✓
TP	60.00	76.30	✓
TN	45.00	54.40	✓
GP	90.00	100.00	✓
Case Two: Onsite Treatment (7Giii)			
Pollutant	Target Reduction	Reduction Achieved	Compliance
TSS	80.00	80.70	✓
TP	60.00	75.30	✓
TN	45.00	51.90	✓
GP	90.00	100.00	✓

2.4. Stormwater Quality Device Maintenance

To ensure the proposed treatment train will function as per the design intent, periodic inspections and maintenance of the stormwater quality improvement devices will be required. When undertaking maintenance or rectifications works of the proposed bioretention devices, reference should be made to the following guidelines in addition to this report:

- *Maintaining Vegetated Stormwater Assets* (Water by Design, 2012);
- *Rectifying Vegetated Stormwater Assets* (Water by Design 2012);
- *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands* (Water by Design 2010); and
- *Guidelines for Filter Media in Biofiltration Systems* (Facility for Advancing Water Biofiltration, 2009)

2.4.1.1. Construction and Establishment Phase

To minimise the long-term maintenance of the proposed bioretention devices it is critical to protect the filter media during the construction phases. As detailed in the Construction and Establishment Guidelines (Water by Design 2012) there are four options for protecting the bioretention devices during the construction phase:

- **Option 1** – Surface Protection. The filter media of the bioretention basin is protected by a filter cloth and turf layer which is removed after 80% of the contributing catchment is built out.
- **Option 2** – Bypass and early establishment. Flows are diverted around the bioretention system (or isolated from the filter media). When over 80% of the contributing catchment is built out the bypass is removed
- **Option 3** – Sediment Basin and Bioretention. This strategy combines with Option 2 with a sediment basin upstream of the proposed bioretention basin (with surface protection). However, this option is only practical where there is sufficient room for both devices.
- **Option 4** – Leave as sediment basin. Instead of installing the bioretention media the basin is allowed to operate as a sediment basin during the built out period in the contributing catchment. Once 80% of the building work is completed the bioretention under drainage and media is installed.

For this proposed development, the following measures are proposed:

- **Bioretention Basin** – surface protection to be installed once bioretention basin construction is complete; and
- **Tree Pits** – bypass and early establishment. The proposed tree pits will be kept offline from the contributing catchment during the building construction phase by blocking the inlet with a sandbag or small bund.

2.4.1.2. Operational Maintenance

Routine inspection and maintenance of the bioretention devices will be required to maintain their water quality function. **Table 2-5** details the operational inspection and maintenance requirements for the bioretention devices.

Table 2-5: Operational Maintenance Requirements (Modified from FAWB 2008)

Item	Task	Frequency
Filter Media Inspection		
Sediment Deposition	Remove sediment build up from coarse forebays in bioretention basins and from the surface of the filter media in bioretention street trees.	Quarterly
Scouring of Filter Media	Check for evidence of scour or erosion of filter media. Provide additional rock or erosion protection if required	Quarterly
Filter Media Porosity/Hydraulic Conductivity	Inspect filter media to ensure that ponded water after rainfall events drains after a few hours. Repair minor sediment accumulation that may have formed by raking media surface. Remove accumulated leaf litter. If filter media continues to drain poorly, refer to *Rectifying Vegetated Stormwater Assets* (Water by Design 2012) for further guidance.	Quarterly
Litter	Inspect forebays and filter media surface for accumulation of litter and debris, remove as required.	Quarterly
Vegetation Management		
Pest and Diseases	Inspect plants for signs of pests and diseases. Treat and replace plants as required	Quarterly
Plant Density	Ensure sufficient plant density is maintained with the basin (6 to 10 plants per square metre). Undertake infill planting if required.	Quarterly
Weeds	Inspect for signs of weeds and remove manually where possible. Application of herbicides to be avoid where practical	Quarterly
Drainage Tasks		
Under drainage pipes	Ensure slotted under drainages pipes are functioning correctly and not blocked. A small steady flow of water should be observed a few hours after rainfall events. In the event pipes are blocked undertake flushing of underdrainage using cleanout points or CCTV to determine cause of blockage	6 Monthly
Inlet and outlet structure, overflow weirs and embankments	Ensure outlet structures are clear of debris. Remove sediment from inlet structures. Inspect embankment and overflow weir for signs of scouring. Provide additional scour protection if required.	Annually and after large rainfall events.

3. STORMWATER QUANTITY MANAGEMENT

3.1. Stormwater Quantity Design Objectives

As Flagstone - Stage 7 is part of PEET's Flagstone City Development, the stormwater quantity management strategy will be designed in accordance with the overall IMP. As per Section 5.1, "the management of stormwater quantity and site flooding is proposed to be addressed through a whole of site master plan" (PEET, 2018, p. 6). As such, the detention basins for Stage 7 will be sized to return 1-year ARI flows to pre-development. Basins elements, including the spillway will be sized to receive and safely pass events up to the 10-year ARI to accommodate the stormwater drainage design for the development. Major stormwater events, including 100-year ARI flows, will bypass the basin and be managed through PEET's IMP.

3.2. Hydrological Modelling

The hydrological modelling was undertaken using the Water Bound Network Modelling (WBNM) program. The offsite detention basin is intended to mitigate all Q1 flows from Stage 7 North – including flows from Lot Giii. An initial check on the basin volume designed by Bradlees was performed, however, it was found that the storage capacity of the basin was not sufficient to mitigate the increase in flows from Stages 7Di, Dii, Gi, Gii and Giii. The Bradlees concept basin design included an area of compensatory cut directly next to the basin, it is proposed that the storage capacity of the basin be extended into this area and a new storage-curve was obtained.

A conceptual basin layout is provided in Appendix A.

3.2.1. WBNM Parameters

The following sections outline the model and catchment parameters adopted in WBNM. **Table 3-1** details the catchment areas and fraction impervious adopted in the hydrological analysis.

Table 3-1: Catchment Parameters

Catchment	Area (ha)	% Impervious	
		Pre	*Post/Mitigated*
Stage 7Giii	3.490	0.00	80.00
Stage 7 Remaining Lots	**5.290**		
- 7B	1.770	0.00	80.00
- 7C	0.800	0.00	80.00
- 7Di	1.010	0.00	80.00
- 7Dii	0.310	0.00	82.00
- 7Gi	1.200	0.00	80.00
- 7Gii	0.170	0.00	82.00
- 7Giv	0.03	0.00	80.00

The intensity-frequency-duration (IFD) parameters adopted for this report were taken from the Beaudesert as this was the closest rain gauge to the site. Rainfall intensities have been

generated in WBNM using the IFD parameters specified in **Table 3-2**. **Table 3-3** outlines the parameters adopted in the WBNM Model.

Table 3-2: WBNM IFD Parameters

Parameter	Value
2-year ARI 1hour	44.50
2-year ARI 12 hour	7.00
2-year ARI 72 hour	2.00
50-year ARI 1hour	80.20
50-year ARI 12 hour	13.90
50-year ARI 72 hour	4.30
F2 Factor	4.39
F50 Factor	17.07
Skewness Coefficient	0.15

Table 3-3: WBNM Parameters

Lag Parameter (C Value)	Calculation Timestep (min)	Flowpath Routing Parameter (R)	Initial Loss (mm)	Continuing Loss (mm/hr)
1.6	1.00	1.00	15.00	2.50

3.2.2. Detention Basin

As it is proposed that the detention basin be extended into the area previously indicated to be compensatory cut a concept layout and new storage-curve were derived. The details of the storage curve are presented in **Table 3-4**. A conceptual basin layout is provided in Appendix A.

Table 3-4. Extended Detention Basin Storage Curve.

Elevation (mAHD)	Volume (m^3)
34.400	0.000
35.250	1.000
35.400	11.930
35.600	154.164
35.800	448.623
36.000	774.640
36.200	1254.204
36.400	1791.570
36.600	2385.986

The conceptual detention basin layout provides a storage capacity of approximately 2,386m^3. The WBNM analysis determined that the proposed basin volume successfully mitigated post development 1-yr ARI peak flows to ensure non worsening with respect to the

predevelopment conditions (See **Table 3-5)**. Therefore, the proposed detention basin is sufficient to reduce flows to the pre-development state for the entire northern catchment area. See Appendix B for detailed WBNM Results. The proposed basin outlet configuration to achieve this reduction in peak flows is presented in **Table 3-6.**

Table 3-5.Peak Flow Results

Case	Value				
Pre-development	*Critical Storm*	1-yr 60 min	2-yr 60 min	5-yr 60 min	10-yr 60 min
	Qout Peak (m3/sec)	1.364	1.792	2.331	2.653
Post Development	*Critical Storm*	1-yr 25 min	2-yr 25 min	5-yr 25 min	10-yr 25min
	Qout Peak (m3/sec)	2.239	2.886	3.656	4.112
Mitigated	*Critical Storm*	1-yr 60 min	2-yr 60 min	5-yr 60 min	10-yr 60 min
	Qout Peak (m3/sec)	1.155	1.507	2.271	2.719
	Change in Peak (m3/sec)	**-0.209**	**-0.285**	**-0.060**	**0.066**
	Max. Volume Stored	**742**	**1127**	**1366**	**1474**
	Max. Water Elev. (mAHD)	**35.980**	**36.147**	**36.282**	**36.282***

**Provides 300mm of freeboard to the embankment at 36.6mAHD.*

Table 3-6. Basin Outlet Configuration.

Parameter	Outlet 1	Outlet 2	Outlet 3
Type of Outlet	Pipe	Pipe	Weir
Invert [mAHD]	34.400	35.25	36.1
No. Barrels	1	1	-
Dia./(Width)[m]	0.6	0.45	10

A maximum depth of 1.05m was predicted in the basin for the maximum 10-year ARI storm event. This is in generally in accordance with the 1.2m recommended within QUDM for the 20year ARI storm event to minimise safety risks to pedestrians. The proposed basin utilises batters at 1 on 4 to maximise storage within the constrained footprint. It is recognised that batters of 1 on 6 are preferred within QUDM however, in order to achieve the required flooding outcomes some relaxation of batter slope may be required. QUDM recommends that steps or a handrail may be required to facilitate safe egress from the basin for slopes up to 1 on 4.

A sensitivity analysis considering the outlet structures 100% blocked was undertaken. This model found the maximum water level of this scenario reaches 36.426mAHD, which is 174mm less than the proposed embankment height. This indicates the proposed weir is suitable to convey the maximum design storm at the basin in the unlikely event of complete blockage.

3.3. Stormwater Quantity Management Strategy

Based on the above findings, it is proposed that a basin with 2386m^3 is required to mitigate the increase in 1-yr ARI peak flows for the entire Stage 7 – North catchment. Refer to **Table 3-4** for storage-curve details.

3.4. Lawful Point of Discharge

As per the LCC's Planning Scheme Policy 5, "all developments shall discharge to a lawful point of discharge in accordance with the Queensland Urban Drainage Manual" (QUDM; Section 3.6.2.3, 2020). As outlined by the *QUDM – 4th Edition*, one of three criteria must be met to determine whether a lawful point of discharge (LPOD) exists (Institute of Public Works Engineering Australasia, Queensland (IPWEAQ), 2017).

The three criteria for determining the lawful point of discharge (LPOD) are:

(i) Will the proposed development alter the site's stormwater discharge characteristics in a manner that may substantially damage a third-party property?
- If not, then no further steps are required to obtain tenure for a lawful point of discharge (assuming any previous circumstances and changes were lawful).

(ii) Is the location of the discharge from the development site under the lawful control of the local government or other statutory authority from whom permission to discharge has been received?
- If so, then no further steps are required to obtain tenure for a lawful point of discharge.
- If not, then consider issue (iii).

(iii) An authority to discharge over affected properties will be necessary. In descending order of certainty, an authority may be in the form of:
- Dedication of a drainage reserve or park;
- A registered easement for stormwater discharge/works; or
- Written discharge approval.

(IPWEAQ, 2017)

The proposed LPOD locations are within the development boundary. Based on this stormwater management plan and the overarching IMP, it is anticipated that the site's two discharge points will not create a nuisance downstream. The detention basin associated with this development has been designed to detain stormwater such that 1yr ARI peak flows will reflect pre-development flows. Larger flows, such as the 100yr ARI, have been managed under the IMP.

4. CONCLUSION

PEAKURBAN Pty Ltd has been engaged by Peet Flagstone City Pty Ltd (Peet) to prepare a Stormwater Management Plan that supports the development application for the proposed northern subdivision at Flagstone - Stages 7C/D/G.

This plan demonstrates that effective treatment of stormwater at the proposed development can be achieved through the integration of Water Sensitive Urban Design (WSUD) principles. Through the incorporation of a co-located bioretention/detention basin and a stand-alone bioretention basin, the plan successfully demonstrates:

- Compliance with LCC's and the SPP's mean annual pollutant load reduction targets. To achieve the relevant WQOs, two bioretention basins that are 320m^2 and 500m^2 are required to treat Lot 7Giii and the remaining lots, respectively. As the water quantity management strategy of the site requires a larger detention basin footprint than previously designed, it is possible that all of Stage 7 – North may be treated in the basin footprint. This result should be further investigated in the conceptual analysis, and if it is determined that it will not fit, the treatment of Lot 7Giii should remain onsite.
- The post development 1-yr ARI flows from the entire catchment can be mitigated by incorporating a detention basin within Lot 906 at the northern end of the development. The proposed basin successfully attenuates the 1yr ARI peak flows to predevelopment conditions and safely conveys the 10yr ARI storm with 300mm freeboard to the basin embankment. An appropriate storage-curve has been proposed with this report.
- A lawful point of discharge has been achieved as proven in Section 3.5 of this report.

5. REFERENCES

- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design 2010)
- Construction and Establishment Guidelines (Water by Design 2012).
- DILGP. (2014). *State Planning Policy*. www.dilgp.qld.gov.au
- Guidelines for Filter Media in Biofiltration Systems (Facility for Advancing Water Biofiltration, 2009)
- IPWEAQ. (2016). *Queensland Urban Drainage Manual*.
- LCC. (2020). *Logan Planning Scheme* (pp. 1–88)
- Maintaining Vegetated Stormwater Assets (Water by Design, 2012)
- MUSIC Modelling Guidelines (Water by Design, 2010)
- QLD Globe, n.d https://qldglobe.information.qld.gov.au/ accessed 15/02/2021
- Rectifying Vegetated Stormwater Assets (Water by Design 2012)

APPENDICES

Appendix A Concept Basin Layout

DATE:	03/03/2021
CREATED BY:	K. MCKENDRY
REVISION:	A
STATUS:	FOR ISSUE

PAGE SIZE: A3 SCALE: 1:500
COORDINATE SYSTEM: GDA 94 / MGA ZONE 56

N

CONSULTANT: PEAKURBAN
DEVELOPMENT ENGINEERS + ADVISORS

PROJECT TITLE: STORMWATER MANAGEMENT PLAN - FLAGSTONE STAGE 7 NORTH

PROJECT NO: 20-0178

CLIENT:

FIGURE TITLE: STAGE 7 NORTH BASIN CONCEPT

FIGURE NO: 001A

Appendix B WBNM Summary

iWBNM Lite

1 Project Details

Project ID	20-0178	All Lots	Pre
Project Description	Flagstone		
Project Location	Logan		

2 General Parameters

Lag Parameter (C)	1.6	
Stream Lag Factor	1	
Calculation Timestep	1	mins
Initial Loss	0	mm
Continuing Loss Rate	2.5	mm/hr

3 Rain Gauge Data

Choose Rain Gauge from Database

Q_Beaudesert

Add to Database: Name Zone Add

	2yr	50yr			
1 hr				F2	Ave Rain
12 hr				F50	%Rough
72 hr				G	MAF (0.0-1.0)

4 Topology

	Subarea	Name	Connects to	Area ha	Impervious %
1	7Giv	7B	0.03	0	
2	7B	7Gii	1.77	0	
3	7Gi	7Gii	1.2	0	
4	7C	7Gii	0.8	0	
5	7Gii	7Dii	1.2	0	
6	7Di	7Dii	1.01	0	
7	7Dii	Basin	0.31	0	
8	7Giii	Basin	3.49	0	
9	Basin	SINK	0.00	0	
10					
Total			9.8	0.0	

5 Structure Data

	Subarea	IWL	D-Fact	Type			Elevation	Storage
							m	m^3
Weir	**1**	**2**	**Pipe/Box**	**1**	**2**	**3**		
Diverts to Sub			Diverts to Sub					
Crest Elev [m]			Invert [m]					
Length [m]			No. Barrels					
Weir Coeff			Ent. Type					
Disch-Factor			Dia/(Width)[mm]					
Directed to			(Height)[mm]					
Delay [mins]			Disch-Factor					
			Directed to					
			Delay [mins]					

6 Storm Data

Storm	ARI	Duration [mins]
1	1	60
2	2	60
3	5	60
4	10	60
5		
6		
7		
8		

7 Save & Run

Save & Run

Shortcut: Shift + Ctrl + L

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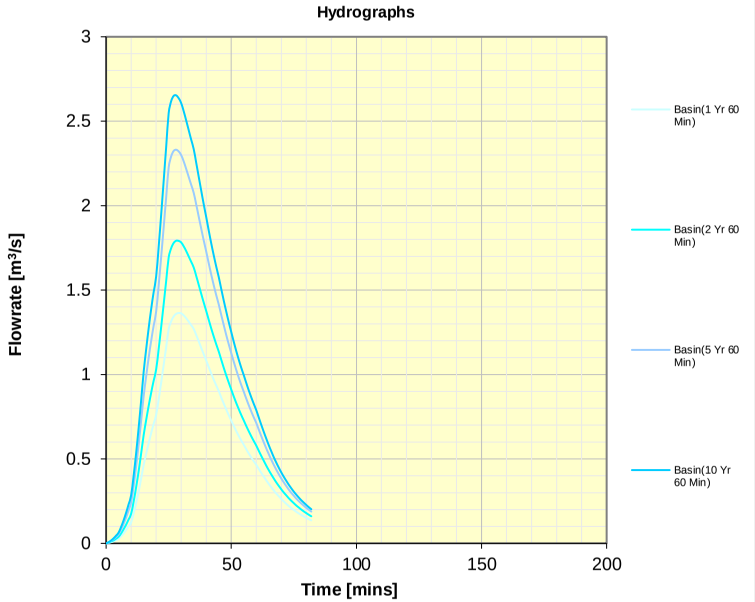
Storm	1	2	3	4	5	6	7	8	
	1 Yr 60 Min	2 Yr 60 Min	5 Yr 60 Min	10 Yr 60 Min					
Peak Flowrates at Subarea Outlet [Q m^3/s]									
7Giv	0.007	0.010	0.012	0.014					
7B	0.286	0.376	0.487	0.554					
7Gi	0.207	0.271	0.350	0.397					
7C	0.148	0.193	0.248	0.281					
7Gii	0.721	0.947	1.23	1.399					
7Di	0.18	0.235	0.302	0.343					
7Dii	0.912	1.196	1.553	1.767					
7Giii	0.48	0.634	0.827	0.943					
Basin	1.364	1.792	2.331	2.653					
Inflow Peak									m^3/s
Outflow Peak									m^3/s
Inflow Volume									m^3
Max Vol Stored									m^3
Max Water Elev									m



iWBNM Lite

1 Project Details

Project ID	20-0178	All Lots	Post
Project Description	Flagstone		
Project Location	Logan		

2 General Parameters

Lag Parameter (C)	1.6	
Stream Lag Factor	1	
Calculation Timestep	1	mins
Initial Loss	0	mm
Continuing Loss Rate	2.5	mm/hr

3 Rain Gauge Data

Choose Rain Gauge from Database

Q_Beaudesert

Add to Database: Name Zone Add

	2yr	50yr			
1 hr				F2	Ave Rain
12 hr				F50	%Rough
72 hr				G	MAF (0.0-1.0)

4 Topology

	Subarea	Name	Connects to	Area ha	Impervious %
1	7Giv	7B	0.03	80	
2	7B	7Gii	1.77	80	
3	7Gi	7Gii	1.2	80	
4	7C	7Gii	0.8	80	
5	7Gii	7Dii	1.2	82	
6	7Di	7Dii	1.01	80	
7	7Dii	Basin	0.31	82	
8	7Giii	Basin	3.49	80	
9	Basin	SINK	0.00	0	
10					
Total			9.8	80.3	

5 Structure Data

	Subarea	IWL	D-Fact	Type			Elevation m	Storage m^3
Weir	**1**	**2**	**Pipe/Box**	**1**	**2**	**3**		
Diverts to Sub			Diverts to Sub					
Crest Elev [m]			Invert [m]					
Length [m]			No. Barrels					
Weir Coeff			Ent. Type					
Disch-Factor			Dia/(Width)[mm]					
Directed to			(Height)[mm]					
Delay [mins]			Disch-Factor					
			Directed to					
			Delay [mins]					

6 Storm Data

Storm	ARI	Duration [mins]
1	1	25
2	2	25
3	5	25
4	10	25
5		
6		
7		
8		

7 Save & Run

Save & Run

Shortcut: Shift + Ctrl + L

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8 Results

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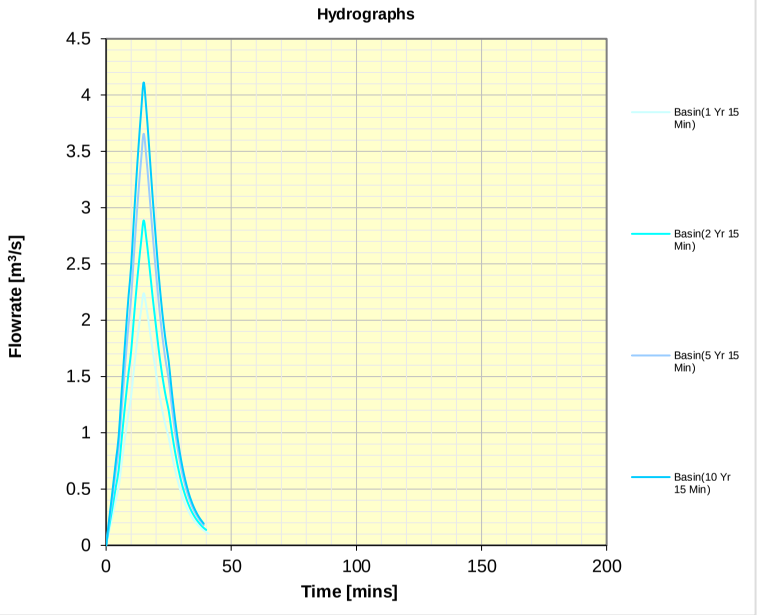
Storm	1	2	3	4	5	6	7	8	
	1 Yr 25 Min	2 Yr 25 Min	5 Yr 25 Min	10 Yr 25 Min					
Peak Flowrates at Subarea Outlet [Q m^3/s]									
7Giv	0.009	0.011	0.014	0.016					
7B	0.481	0.612	0.767	0.859					
7Gi	0.331	0.421	0.527	0.590					
7C	0.225	0.286	0.358	0.4					
7Gii	1.129	1.458	1.851	2.083					
7Di	0.281	0.358	0.448	0.501					
7Dii	1.37	1.773	2.254	2.539					
7Giii	0.899	1.145	1.436	1.607					
Basin	2.239	2.886	3.656	4.112					
Inflow Peak									m^3/s
Outflow Peak									m^3/s
Inflow Volume									m^3
Max Vol Stored									m^3
Max Water Elev									m



iWBNM Lite

1 Project Details

Project ID	20-0178	7BCDiDiiGiGiiGiii	Mitigated
Project Description	Flagstone		450 pipe,300d
Project Location	Logan		

2 General Parameters

Lag Parameter (C)	1.6	
Stream Lag Factor	1	
Calculation Timestep	1	mins
Initial Loss	0	mm
Continuing Loss Rate	2.5	mm/hr

3 Rain Gauge Data

Choose Rain Gauge from Database

Q_Beaudesert

Add to Database: Name Zone Add

	2yr	50yr			
1 hr				F2	Ave Rain
12 hr				F50	%Rough
72 hr				G	MAF (0.0-1.0)

4 Topology

	Subarea	Name	Connects to	Area ha	Impervious %
1	7Giv	7B	0.03	80	
2	7B	7Gii	1.77	80	
3	7Gi	7Gii	1.2	80	
4	7C	7Gii	0.8	80	
5	7Gii	7Dii	1.2	82	
6	7Di	7Dii	1.01	80	
7	7Dii	Basin	0.31	82	
8	7Giii	Basin	3.49	80	
9	Basin	SINK	0.00	0	
10					
Total			9.8	80.3	

5 Structure Data

	Subarea	IWL	D-Fact	Type		
	Basin	34.400	1	OUTLET		

Weir	1	2	Pipe/Box	1	2	3
Diverts to Sub	SINK		Diverts to Sub	SINK	SINK	
Crest Elev [m]	36.100		Invert [m]	34.400	35.25	
Length [m]	10		No. Barrels	1	1	
Weir Coeff	1.6		Ent. Type	1	1	
Disch-Factor	1		Dia/(Width)[mm]	600	450	
Directed to	TOP		(Height)[mm]			
Delay [mins]	0		Disch-Factor	1	1	
			Directed to	TOP	TOP	
			Delay [mins]	0	0	

Elevation m	Storage m^3
34.400	0.000
35.250	1.000
35.400	11.930
35.600	154.164
35.800	448.623
36.000	774.640
36.200	1254.204
36.400	1791.570
36.600	2385.986

6 Storm Data

Storm	ARI	Duration [mins]
1	1	60
2	2	60
3	5	60
4	10	60
5		
6		
7		
8		

7 Save & Run

Save & Run

Shortcut: Shift + Ctrl + L

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8 Results

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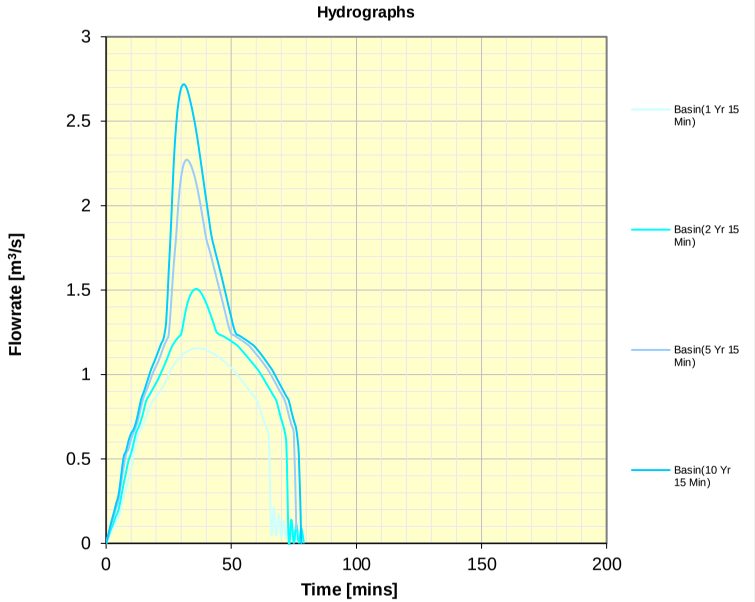
Storm	1	2	3	4	5	6	7	8	
	1 Yr 60 Min	2 Yr 60 Min	5 Yr 60 Min	10 Yr 60 Min					
Peak Flowrates at Subarea Outlet [Q m^3/s]									
7Giv	0.008	0.010	0.013	0.014					
7B	0.421	0.534	0.670	0.751					
7Gi	0.290	0.366	0.460	0.515					
7C	0.197	0.249	0.312	0.35					
7Gii	1.006	1.286	1.628	1.832					
7Di	0.246	0.311	0.39	0.437					
7Dii	1.238	1.585	2.011	2.263					
7Giii	0.791	1.002	1.259	1.411					
Basin	1.155	1.507	2.271	2.719					
Inflow Peak	1.996	2.547	3.221	3.621					m^3/s
Outflow Peak	1.155	1.507	2.271	2.719					m^3/s
Inflow Volume	3357	4247	5330	5967					m^3
Max Vol Stored	742	1127	1366	1474					m^3
Max Water Elev	35.98	36.147	36.242	36.282					m

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