ENGENY

PEET LIMITED
Flagstone City CA3 South

Site-Based Stormwater Management Plan

QC4012_002-REP-004-2

23 AUGUST 2024

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Rev	Date	Description	Author	Reviewer	Project Mgr.	Approver
0	27/02/2024	Draft Issue	Jesse Hunter	Mark Page	Jesse Hunter	Mark Page
1	15/03/2024	Final Issue	Jesse Hunter	Mark Page	Jesse Hunter	Mark Page
2	23/08/2024	Further Issues Response	Jesse Hunter pp. Mark Page	Mark Page RPEQ #15454	Jesse Hunter pp. Mark Page	Mark Page RPEQ #15454
Signatures:						

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1. INTRODUCTION

Engeny Australia Pty Ltd (Engeny) was engaged by Peet Limited (Peet) to prepare a Site-Based Stormwater Management Plan (SBSMP) for the proposed Context Area 3 (CA3) South development at Flagstone City located in Flagstone, Queensland.

1.1 Project Purpose and Scope

This SBSMP was developed to quantify Peet's obligations for the construction of stormwater quality and quantity infrastructure to protect the downstream Environmental Values (EV's) and achieve the Water Quality Objectives (WQOs) for the Site, as outlined in the endorsed Stormwater IMP (Peet, July 2018) (ref. DEV2012/209/6/8).

The scope of the project has included the following:

- Development of a Model for Urban Stormwater Improvement Conceptualisation (MUSIC) model to estimate pollutant loads generated by the proposed development.
- Development of a stormwater quality treatment train at each catchment outlet of the proposed development sized to achieve the required load-based reduction targets (WQOs).
- Development of a local hydrologic WBNM model for the Existing and Developed Scenarios.
- Simulation of the models for the 63.2% AEP design storm event for the critical envelope of durations and the full ensemble of temporal patterns.
- Sizing of detention basins at each catchment outlet to mitigate the Developed Scenario peak flow runoff to the Existing Scenario for the 63.2% AEP only, to achieve the waterway stability requirements over the Site.
- Consideration of stormwater quantity and flooding requirements to manage peak flow increase from the development.
- Preparation of a SBSMP report.

1.2 Site Characteristics

The Flagstone City development is intersected by Flagstone Creek, Sandy Creek and Sandy Gully. The proposed overall development covers a total area of approximately 1,037 ha made up of a combination of future development, future open space and retained natural vegetation, and is estimated to yield approximately 11,000 dwellings. The Flagstone City CA3 South development is located within Context Area 3 between Flagstone Creek and Sandy Creek, and west of CA2 Stages 2-5. The proposed development currently discharges runoff into both waterways and is proposed to maintain this condition in the Developed Scenario. The location of the proposed CA3 South development and its surroundings is shown in Figure 1.1.

The proposed layout prepared by RPS is provided in Appendix A.

1.3 Project History

Peet has received approval for a previous ROL (1 into 2 lots) and Context Plan for Flagstone City Context Area 3 (re. DEV20201154) dated 31 May 2022.

1.4 Project Data and Guidelines

The following data has been utilised for this assessment:

- Flagstone Context Area 3 (ref. 110056-551-B) (RPS, 9 February 2024).
- Flagstone Context Area 3 stormwater catchments (Colliers, 13 February 2024).
- Flagstone City Stormwater Infrastructure Master Plan Version 1.4 (ref. DEV2012/209/6/8) (Peet, July 2018).
- 2021 1-metre LiDAR sourced from Logan City Council (LCC).
- Greenbank Thompson Road station (ID 40659) rainfall data.

The stormwater planning and associated modelling was undertaken in accordance with the following guidelines:

- Queensland Urban Drainage Manual (IPWEA, 2016).
- Australian Rainfall and Runoff (ARR) 2019 (Ball, et al, 2019).
- State Planning Policy (DILGP, 2016).
- MUSIC Modelling Guidelines (Water by Design, 2018).
- Wetland Technical Design Guidelines (Water by Design, 2017).
- Bioretention Technical Design Guidelines (Water by Design, 2014).

1.5 Performance Criteria

Several objectives have been adopted for the Flagstone City development with respect to the management of flooding and stormwater quality. The endorsed Stormwater IMP (Peet, July 2018) (ref. DEV2012/209/6/8) and *Flagstone City – Masterplan Stormwater Management Strategy Report (ref. 8217/43/R10V5) (Cardno, 2014)* outlines the framework and performance criteria for management of stormwater quality and stormwater quantity which are summarised below:

- Stormwater Quality
  - 80% reduction in total suspended solids.
  - 60% reduction in total phosphorus.
  - 45% reduction in total nitrogen.
  - 90% reduction in gross pollutants.
  - Mitigation of the Developed Scenario 63.2% AEP design event peak flow to not exceed the Existing Scenario peak flow.
- Stormwater Quantity
  - No increases to peak flows downstream of the Flagstone City development.
  - No development within the 1% AEP flood extent unless peak flows are appropriately mitigated to ensure no increases across the range of design events.
  - Existing watercourses to be maintained for conveyance of stormwater runoff.

The proposed CA3 South development has also been designed with consideration of the *Flagstone City Total Water Cycle Management Site Strategy (Peet, March 2014)*. It is noted that this document is currently undergoing revision, and an updated version will be lodged with EDQ for assessment shortly after the CA3 South Further Issues response.

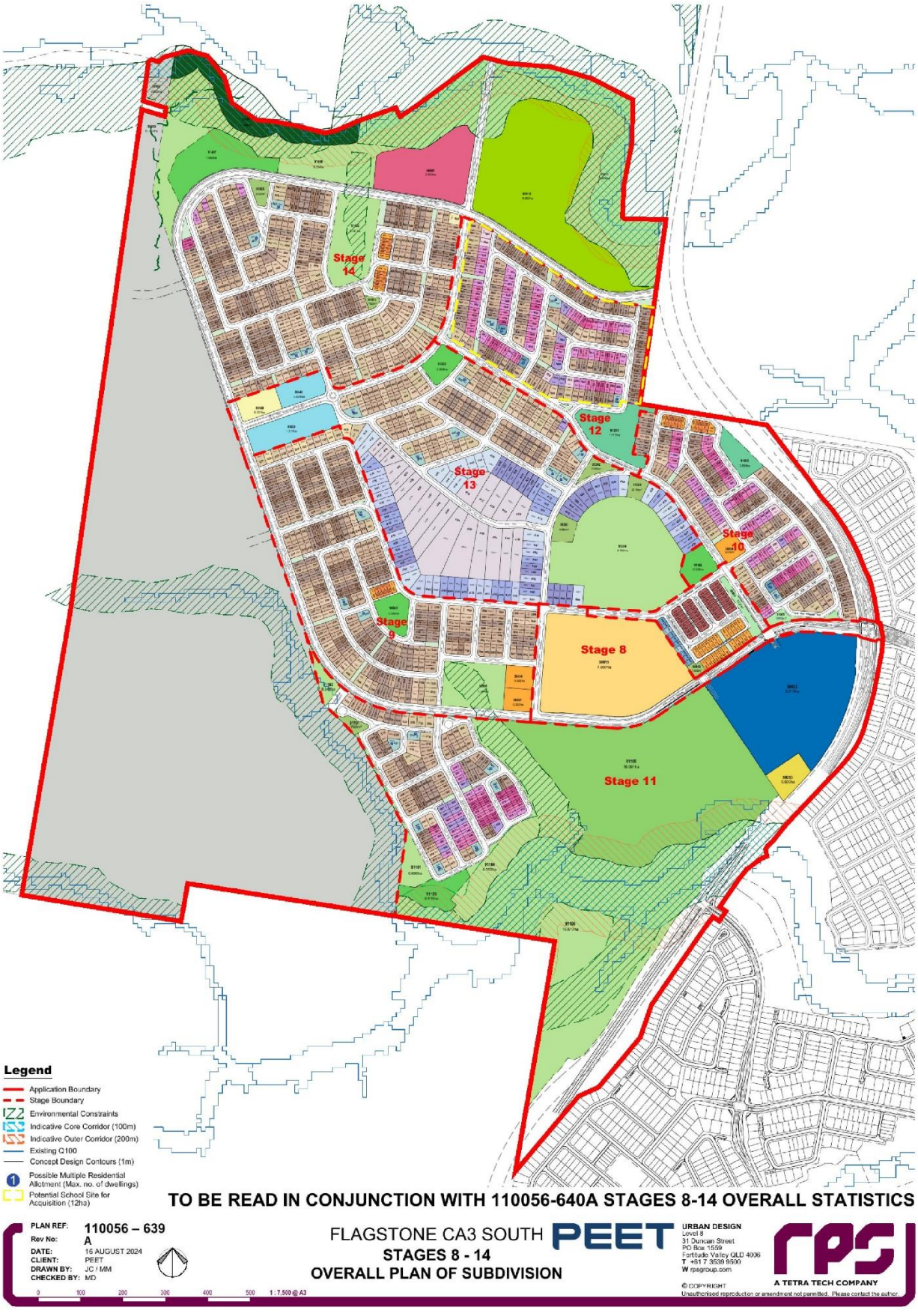

Figure 1.1: CA3 South Study Area

2. STORMWATER QUALITY MANAGAMENT

2.1 Construction Phase

An Erosion and Sediment Control program and plan will be prepared for the construction phase of the development. This will be completed for the Site as part of the site contractor's management of the Site and is to be kept on Site and implemented for the duration of the construction phase.

2.2 Operational Phase

The SPP (July 2017), LCC Stormwater Quality and Flow Management Guidelines (July 2013) and the Logan Planning Scheme (LCC, February 2023) provide the criteria intended to ensure development at the Site is carried out in a way that will achieve the relevant WQOs.

The load-based reduction targets required at the Site are outlined below in Table 2.1.

TABLE 2.1: ADOPTED WATER QUALITY OBJECTIVES

Pollutant	Minimum Load-Based Reduction Target (%)
Total Suspended Solids (TSS)	80
Total Phosphorus (TP)	60
Total Nitrogen (TN)	45
Gross Pollutants (GP)	90

2.2.1 Climate Data

Climate data for the catchment was sourced from the Bureau of Meteorology (BOM). Rainfall data was obtained from the Greenbank Thompson Road station (ID 40659) for the 10 years between 1980 and 1989 at six (6) minute intervals, resulting in a mean annual rainfall of 784 mm.

2.2.2 Catchment Properties

The proposed bioretention basin locations and associated contributing catchment areas for water quality treatment are outlined in Figure 2.1. A lumped catchment approach was adopted for this study and is considered appropriate based on inspection of aerial imagery and the intended use of the Site. The land use of the proposed development area was assumed to be a mix of residential and commercial use. Rainfall-runoff and pollutant-export parameters were adopted from the recommended values identified in *MUSIC Modelling Guidelines (Water by Design, 2018)*.

Table 2.2 provides a summary of the MUSIC model parameters implemented for each catchment. Fraction impervious values were adopted based on the recommended values provided in the *MUSIC Modelling Guidelines (Water by Design, 2018)*.

TABLE 2.2: MUSIC MODEL PARAMETERS

Catchment	Area (ha)	Fraction Impervious (%)
1	2.9	89.7
2_Lower	6.8	74.2
2_Upper	19.5	66.6
3	14.9	10.2
4	8.9	76
5	12.2	77.1
6	9.2	87.8
7	32.3	75.8
8	2.3	77.7
9	13.6	73.9
10	51.4	70.4

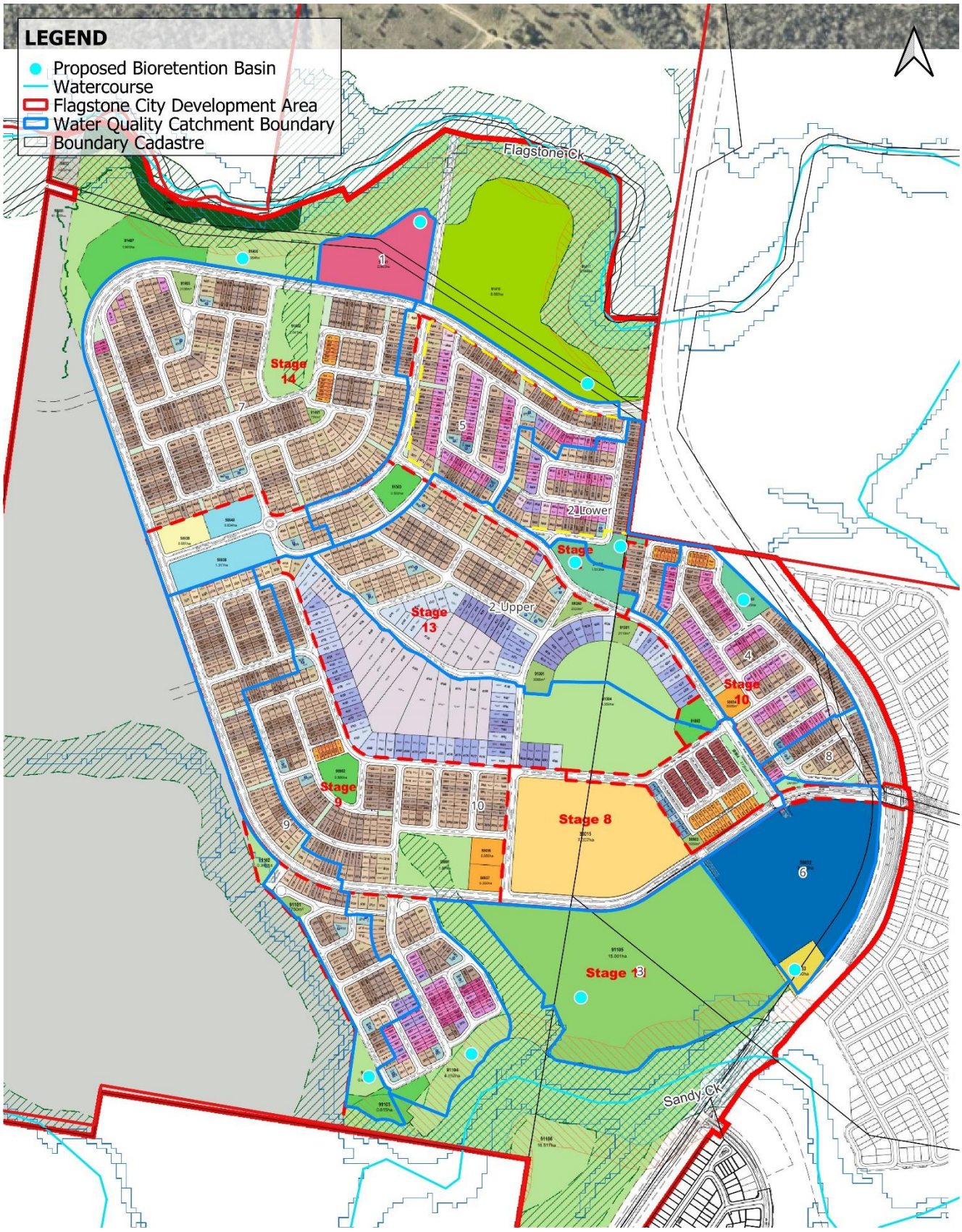

Figure 2.1: MUSIC Modelling Catchments

2.2.3 Treatment System

Stormwater runoff from each catchment will be discharged into a bioretention basin at the catchment outlet upstream of the receiving waterway. Each bioretention basin is proposed to include a coarse sediment inlet pond for contributing catchments exceeding 5 ha, and a coarse sediment forebay for contributing catchment areas between 2 ha and 5 ha. This is in accordance with the *Bioretention Technical Design Guidelines (Water by Design, 2014).*

It is noted that Catchment 1 and Catchment 6, medium-density and health precinct areas, respectively, are anticipated to be some form of community title. As such, the treatment system may be specified in the future as an equivalent proprietary device that will be managed and maintained by the landowner, and not transferred into Councils ownership. Should this proprietary device be proposed in the future, it is expected that sizing of the treatment system will be undertaken to demonstrate the load-based pollutant reduction targets are achieved as outlined in this report. It is requested that any approval conditions are worded in such a way that will allow for a proprietary device to be proposed for these catchments in the future.

2.2.4 Treatment Train and Sizing

The bioretention system has been modelled in MUSIC in accordance with the MUSIC Modelling Guidelines (Water by Design, 2018). The treatment train produced in MUSIC is outlined in Figure 2.2.

Sizing of the coarse sediment inlet ponds and coarse sediment forebays was undertaken in accordance with the equations presented in the *Wetland Technical Design Guidelines (Water by Design, 2017)* for a design removal efficiency of 80%.

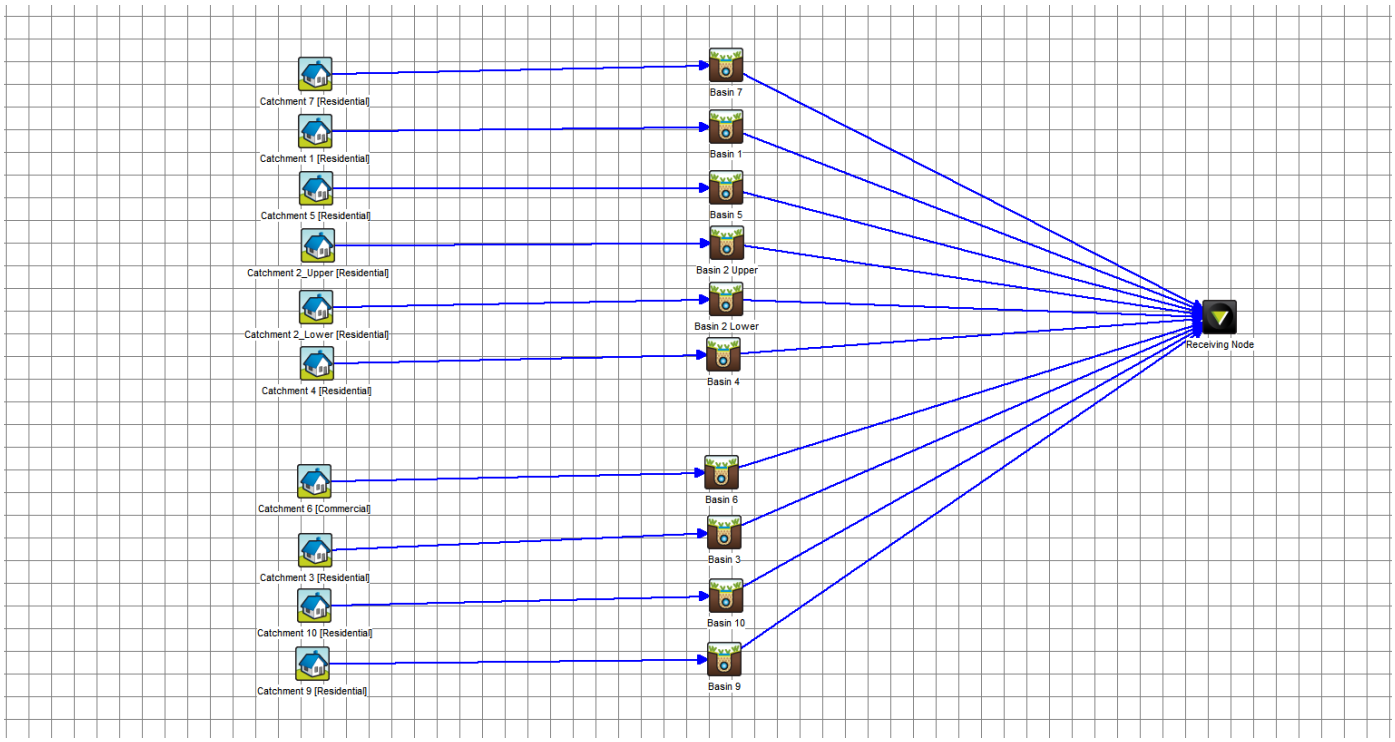

Figure 2.2: MUSIC Model Layout

The details of the proposed treatment train is included in Table 2.3. It is proposed that all basins are constructed with a saturated zone depth of 0.45 m, filter media depth of 0.5 m and extended detention depth of 0.3 m. The table below also includes details of the coarse sediment treatment measures proposed upstream of each bioretention basin. These have been specified based on the following criteria as outlined in the *Bioretention Technical Design Guidelines (WBD, October 2014)*:

- No treatment for catchments smaller than 2 ha.
- Sediment forebays required for catchments greater than 2 ha and less than 5 ha.
- Sediment ponds required for catchments greater than 5 ha.

It's noted that whilst Catchment 2_Lower exceeds 5 ha it is proposed that a sediment forebay is constructed in place of a sediment pond. It is requested that a relaxation of the criteria is approved due to site constraints. It's also noticed that Catchment 8 is proposed to drain east underneath the New Beith Road and connecting into the Stage 5 stormwater network. Suitable allowances were considered for development in Stage 5 to manage the post-developed case stormwater quality criteria. Therefore, no bioretention system was considered for catchment 8.

TABLE 2.3: TREATMENT TRAIN PARAMETERS

Catchment	Filter Media Surface Area (m^2)	Coarse Sediment Removal Device	Coarse Sediment Device Surface Area (m^2)	Sediment Pond Depth (m)	Minimum Sediment Storage Volume (m^3)
1	250	Forebay	N/A	N/A	N/A
2_Lower	480	Forebay	N/A	N/A	N/A
2_Upper	1250	Inlet Pond	60	1.5	9.7
3	860	Inlet Pond	15	1.5	7.2
4	650	Inlet Pond	35	1.5	4.4
5	1000	Inlet Pond	45	1.5	6.2
6	750	Inlet Pond	40	1.5	4.5
7	2200	Inlet Pond	105	1.5	16.0
9	940	Inlet Pond	40	1.5	5.7
10	3200	Inlet Pond	155	1.5	25.5

2.3 MUSIC Modelling Results

Results of the MUSIC model is presented in Table 2.4. The results of the MUSIC modelling indicate that the load-based reduction targets have been achieved with the proposed treatment train. As such, the proposed treatment measures will be adopted for the development Site.

TABLE 2.4: MUSIC MODEL RESULTS

Catchment	TSS Reduction (%)	TP Reduction (%)	TN Reduction (%)	GP Reduction (%)
1	82.1	60.5	49.1	100
2_Lower	81.9	60.1	48.4	100
2_Upper	82.3	60.2	49.8	100
3	84.8	60	56.5	100
4	82.1	61.1	49.5	100
5	83.5	62.5	52	100
6	80.4	64.4	52.1	100
7	82.8	61	50.2	100
9	82.1	60.1	49.5	100
10	82.8	61.8	50.8	100

3. WATERWAY STABILITY MANAGEMENT

A local WBNM hydrologic model was developed to assess the change in peak flows at each of the catchment outlets in the Existing and Developed Scenarios for the 63.2% AEP event. Detention basins were sized such that the Developed Scenario peak flows were mitigated to Existing Scenario flows, this is considered sufficient to address the performance criteria outlined in the *Flagstone City – Masterplan Stormwater Management Strategy Report (ref. 8217/43/R10V5) (Cardno, 2014)*. The following sections summarise the hydrologic model build and results.

3.1 Catchment Delineation

Catchment delineation to each discharge location into Flagstone Creek and Sandy Creek was undertaken using 2021 LiDAR sourced from Logan City Council. Catchment mapping for the Existing and Developed Scenarios is provided in Figure 3.1 and Figure 3.2, parameters are summarised in Table 3.1.

TABLE 3.1: CATCHMENT DETAILS

	Existing Scenario		Developed Scenario	
Catchment	Catchment Area (ha)	Fraction Impervious (%)	Catchment Area (ha)	Fraction Impervious (%)
1	2.9	0	2.9	89.7
2	26	0	-	-
2_Lower	-	-	6.8	74.2
2_Upper	-	-	19.5	66.6
3	35.2	0	14.9	10.2
4	9.2	0	8.9	76
5	11.3	0	12.2	77.1
6	10.8	0	9.2	87.8
7	29.7	0	32.3	75.8
8	5.1	0	2.3	77.7
9	13.2	0	13.6	73.9
10	31.8	0	51.4	70.4

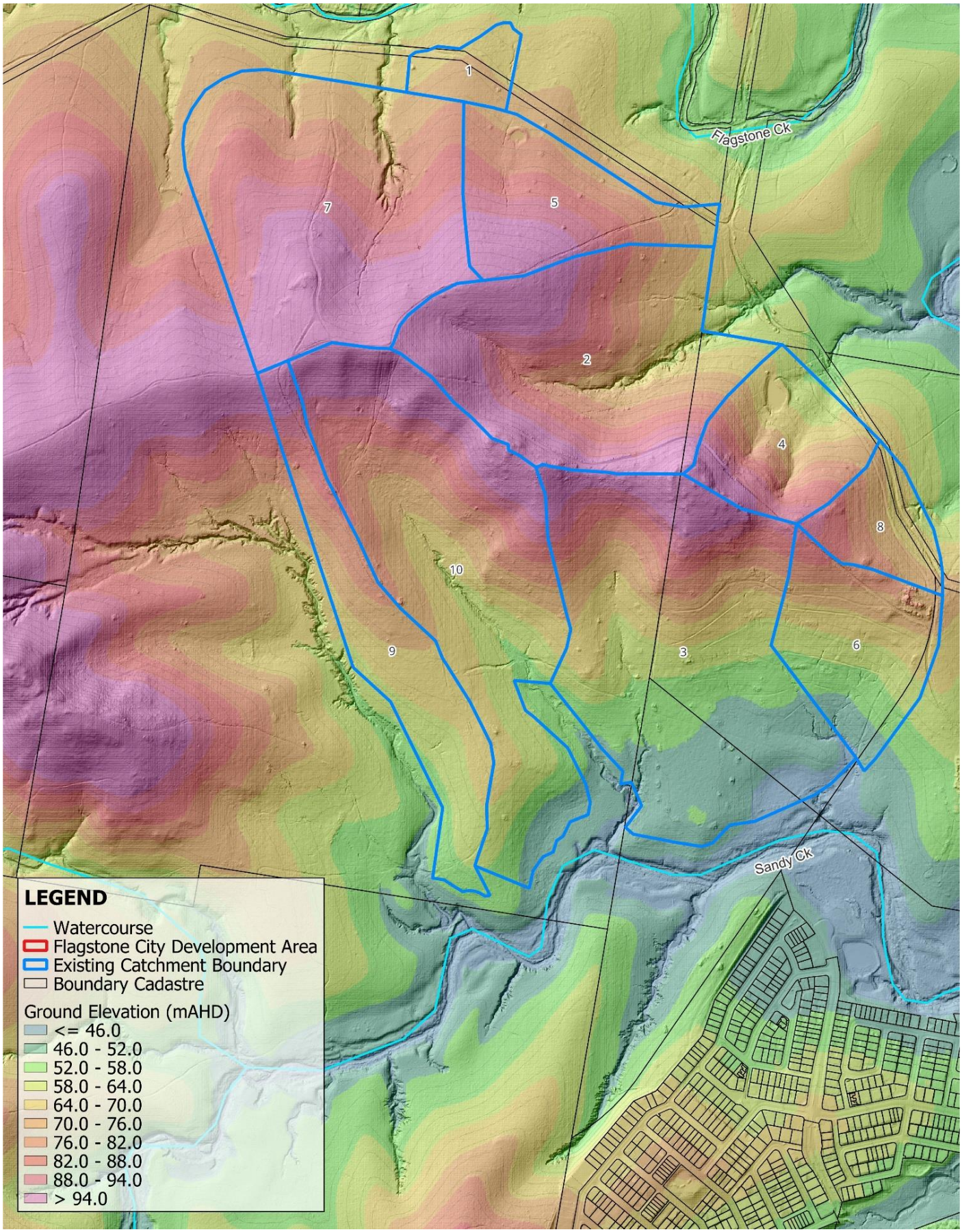

Figure 3.1: Existing Scenario Catchments

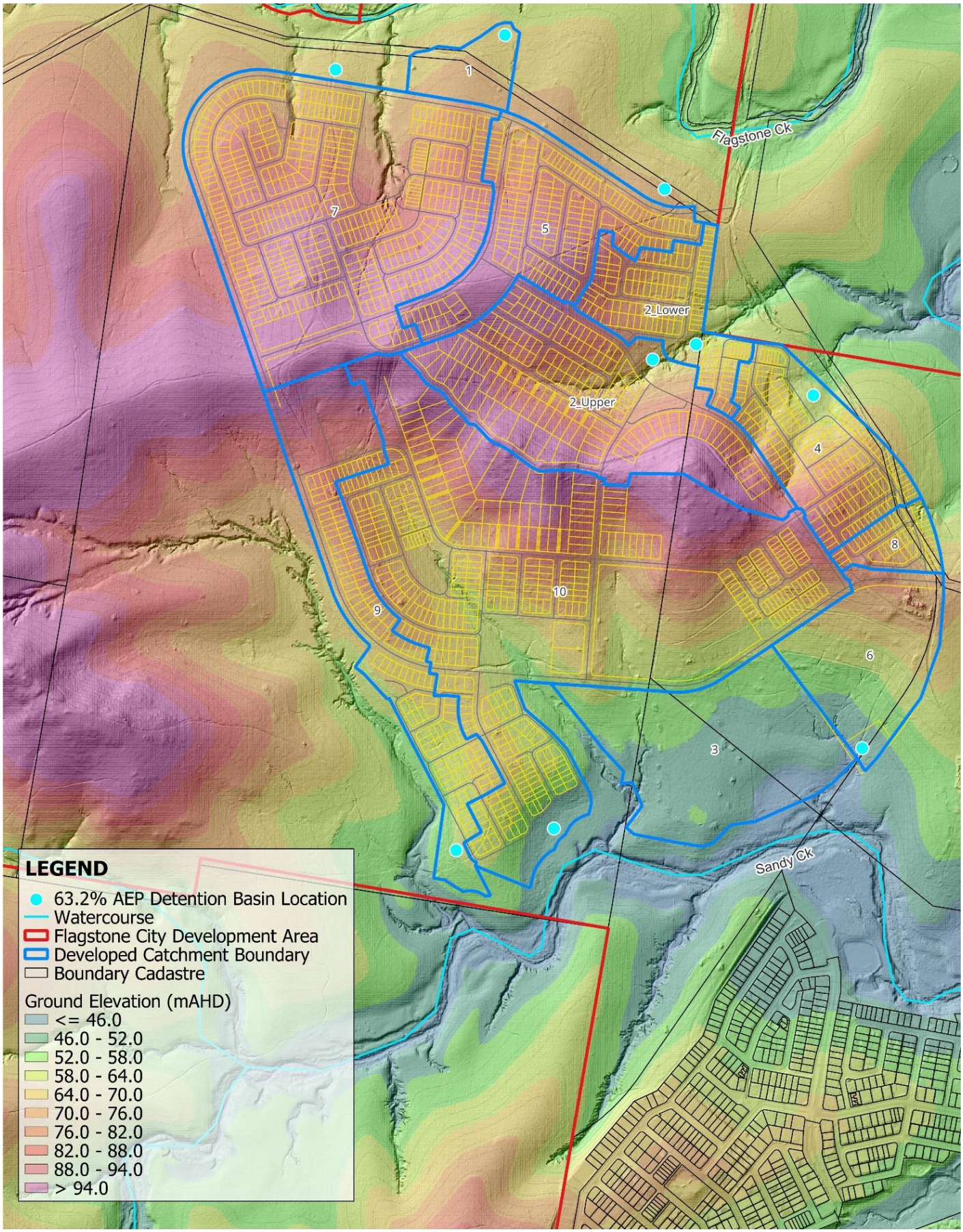

Figure 3.2: Developed Scenario Catchments

3.2 Rainfall-Runoff Parameters

The industry-standard guidelines for determining rainfall-loss parameters were updated since the previous approved version of the Stormwater IMP and flood assessment report, the updated guidelines have been incorporated into this assessment. The key changes to the guidelines between revisions are briefly summarised below:

- Rainfall depths updated.
- Pre-burst rainfall depths introduced.
- Fixed storm losses (initial and continuing) introduced.
- Ensemble of ten (10) temporal patterns introduced.

An investigation into the impact of the changed rainfall found that the design rainfall for the range of storm events and durations has not changed significantly since ARR 1987. However, it was found that the introduction of pre-burst rainfall and fixed storm losses resulted in increased runoff magnitudes. A comparison of the IFDs with consideration of the adopted Cardno storm losses for ARR 1987, and consideration of the fixed storm losses and pre-burst rainfall depths for ARR 2019, is provided in Table 3.2 for storm events between the 10% and 1% AEP. The comparison shows that theoretical runoff in ARR 2019 is up to 24% higher than ARR87 for the 12-hour storm, and up to 16% higher in the 6-hour storm which is critical for the catchment.

TABLE 3.2: MODIFIED RAINFALL COMPARISON

Duration	10%	5%	2%	1%
1-hour	-21%	-15%	-11%	-10%
1.5-hour	-26%	-21%	-7%	1%
2-hour	-21%	-16%	-5%	0%
3-hour	-19%	-15%	7%	18%
4.5-hour	-14%	-9%	7%	16%
6-hour	-8%	-2%	9%	16%
9-hour	-1%	4%	14%	20%
12-hour	6%	10%	19%	24%
18-hour	9%	13%	18%	21%
24-hour	8%	12%	17%	21%
30-hour	7%	10%	15%	19%
36-hour	8%	10%	15%	19%
48-hour	9%	12%	17%	20%

The assumed rainfall-loss parameters adopted in WBNM are summarised as follows:

- Application of storm initial loss of 24 mm, as per ARR 2019 specifications, for all pervious surfaces.
- Application of storm continuing loss of 1.6 mm/h, as per ARR 2019 specifications, for all pervious surfaces.
- Application of initial and continuing losses of 1 mm and 0 mm/h, respectively, for all impervious surfaces.
- Application of ARR 2019 rainfall depths sourced from the Bureau of Meteorology (BoM), as per ARR 2019 specifications.
- Application of ARR 2019 median pre-burst rainfall depths, as per ARR 2019 specifications, prior to main burst.
- Simulation of the full ensemble of ten (10) temporal patterns for the East Coast North region, as per ARR 2019 specifications.
- No application of Aerial Reduction Factors.
- WBNM default value of C = 1.6 was adopted.

The *Slacks and Scrubby Creeks Flood Study (WRM, September 2018)* is a joint-calibrated hydrologic and hydraulic model of a catchment in the region, standard ARR Data Hub initial losses were adopted for design event analysis. However, continuing losses for design event analysis was based on the calibrated continuing losses which was adopted as 1.1 mm/h for catchments less than 30% impervious. This is in an acceptable range of the recommended ARR Data Hub continuing losses which have been selected for design event analyses for the Flagstone Creek and Sandy Creek catchments.

3.3 Detention Basin Sizing

Detention basins are proposed to mitigate the 63.2% AEP peak flow runoff from the Developed Scenario catchments to Existing Scenario flow prior to entering the waterway downstream. The detention volume is proposed to be located above the extended detention depth of the bioretention basins and all outlet pipes are proposed at the extended detention surface level. Details of the proposed detention parameters are summarised below in Table 3.3. It is assumed that events rarer the 63.2% AEP are diverted around the basin, an emergency overflow weir for each basin will be sized at the detailed design phase.

It's noted that basins 2_Lower and 2_Upper are co-located within the same open space area, it is proposed that discharge from the upper basin (Basin 2_Upper) will be diverted around the lower basin (Basin 2_Lower) to avoid any repeat treatment of flows through the treatment train and repeat mitigation of flows. It's also noticed that Catchment 8 is proposed to drain east underneath the New Beith Road and connecting into the Stage 5 stormwater network. Suitable allowances were considered for development in Stage 5 to manage post-developed case 63.2% AEP runoff and therefore no detention basin for catchment 8 was proposed.

TABLE 3.3: DETENTION BASIN PARAMETERS

Catchment	63.2% AEP Peak Volume (m^3)	63.2% AEP Peak Depth (m)	Outlet Configuration
1	380	1.45	225 mm RCP
2_Lower	1000	1.06	300 mm RCP
2_Upper	2270	1.09	525 mm RCP
4	1280	0.91	375 mm RCP
5	1980	1.25	375 mm RCP
6	1440	1.5	375mm RCP
7	4980	1.32	600 mm RCP
9	1820	1.08	450 mm RCP
10	8660	1.55	600 mm RCP

3.4 WBNM Results

The peak flow results at each catchment outlet location into Flagstone Creek and Sandy Creek is provided below in Table 3.4. The results demonstrate that the 63.2% AEP peak flows are sufficiently mitigated in the Developed Scenario such that they do not exceed the Existing Scenario flows. The combined discharge from Catchment 2_Upper and Catchment 2_Lower in the Developed Scenario are assessed at the property boundary (lawful point of discharge) from the Site.

TABLE 3.4: PEAK FLOW RESULTS

Catchment	Existing Scenario 63.2% AEP Peak Flow (m^3/s)	Developed Scenario (Unmitigated) 63.2% AEP Peak Flow (m^3/s)	Developed Scenario (Mitigated) 63.2% AEP Peak Flow (m^3/s)	Peak Flow Difference (m^3/s)
1	0.13	0.48	0.13	0
2	0.86	3.08	0.79	-0.07
3	1.11	0.55	N/A	N/A
4	0.34	1.20	0.28	-0.06
5	0.41	1.71	0.33	-0.08
6	0.39	1.42	0.36	-0.03
7	0.96	4	0.86	-0.1
8	0.22	0.34	N/A	N/A
9	0.47	1.53	0.44	-0.03
10	1.02	3.06	0.94	-0.08

4. STORMWATER QUANTITY MANAGEMENT

Stormwater quantity management is proposed to be achieved through a masterplan solution as outlined in the *Flagstone City Masterplan Flood Management Strategy (FMS) (Engeny, August 2024) (Ref. QC4012_002-REP-001-4)*. It is proposed that the relevant mitigation structures for CA3 South are constructed in accordance with the Masterplan FMS report to achieve the stormwater quantity and flooding objectives. This report was submitted with the Flagstone CA3 South Further Issues response.

5. PERFORMANCE CRITERIA COMPLIANCE

The performance criteria for the development relating to stormwater quality and stormwater quantity was outlined in Section 1 of this report. These performance criteria are outlined in the endorsed *Stormwater IMP (Peet, July 2018) (ref. DEV2012/209/6/8)* and are required to be achieved to facilitate development. The method for satisfying each of the relevant criteria for CA3 South is summarised below:

- Stormwater Quality
  - The load-based reduction targets are achieved through the implementation of ten (10) bioretention basins proposed at the outlet of each developed catchment.
  - The waterway stability targets are achieved through the implementation of nine (9) 63.2% AEP detention basins located at the outlet of each developed catchment which mitigate peak flow in the Developed Scenario to Existing Scenario flows.
- Stormwater Quantity
  - Stormwater quantity is achieved through the implementation of the *Flagstone City Masterplan Flood Management Strategy (FMS) (Engeny, August 2024) (Ref. QC4012_002-REP-001-4).* This report was submitted with the Flagstone CA3 South Further Issues response.

6. SUMMARY AND CONCLUSION

The proposed Flagstone City CA3 South development is required to meet a range of performance criteria associated with stormwater quality and quantity management. The performance criteria are specified in *Flagstone City – Masterplan Stormwater Management Strategy Report (ref. 8217/43/R10V5) (Cardno, 2014)* and have been defined to protect Environmental Values (EVs) of the downstream receiving waterways and achieve the required Water Quality Objectives (WQOs). It is proposed that a total of nine (9) 63.2% AEP detention basins and ten (10) bioretention basins are constructed at the development discharge locations into Flagstone Creek and Sandy Creek. Details of the basins are provided in the sections above and it is considered that the proposed basins are suitable to achieve the performance criteria for the Flagstone City development.

7. QUALIFICATIONS

(a) In preparing this document, including all relevant calculation and modelling, Engeny Australia Pty Ltd (Engeny) has exercised the degree of skill, care and diligence normally exercised by members of the engineering profession and has acted in accordance with accepted practices of engineering principles.

(b) Engeny has used reasonable endeavours to inform itself of the parameters and requirements of the project and has taken reasonable steps to ensure that the works and document is as accurate and comprehensive as possible given the information upon which it has been based including information that may have been provided or obtained by any third party or external sources which has not been independently verified.

(c) Engeny reserves the right to review and amend any aspect of the works performed including any opinions and recommendations from the works included or referred to in the works if:

  (i) Additional sources of information not presently available (for whatever reason) are provided or become known to Engeny; or

  (ii) Engeny considers it prudent to revise any aspect of the works in light of any information which becomes known to it after the date of submission.

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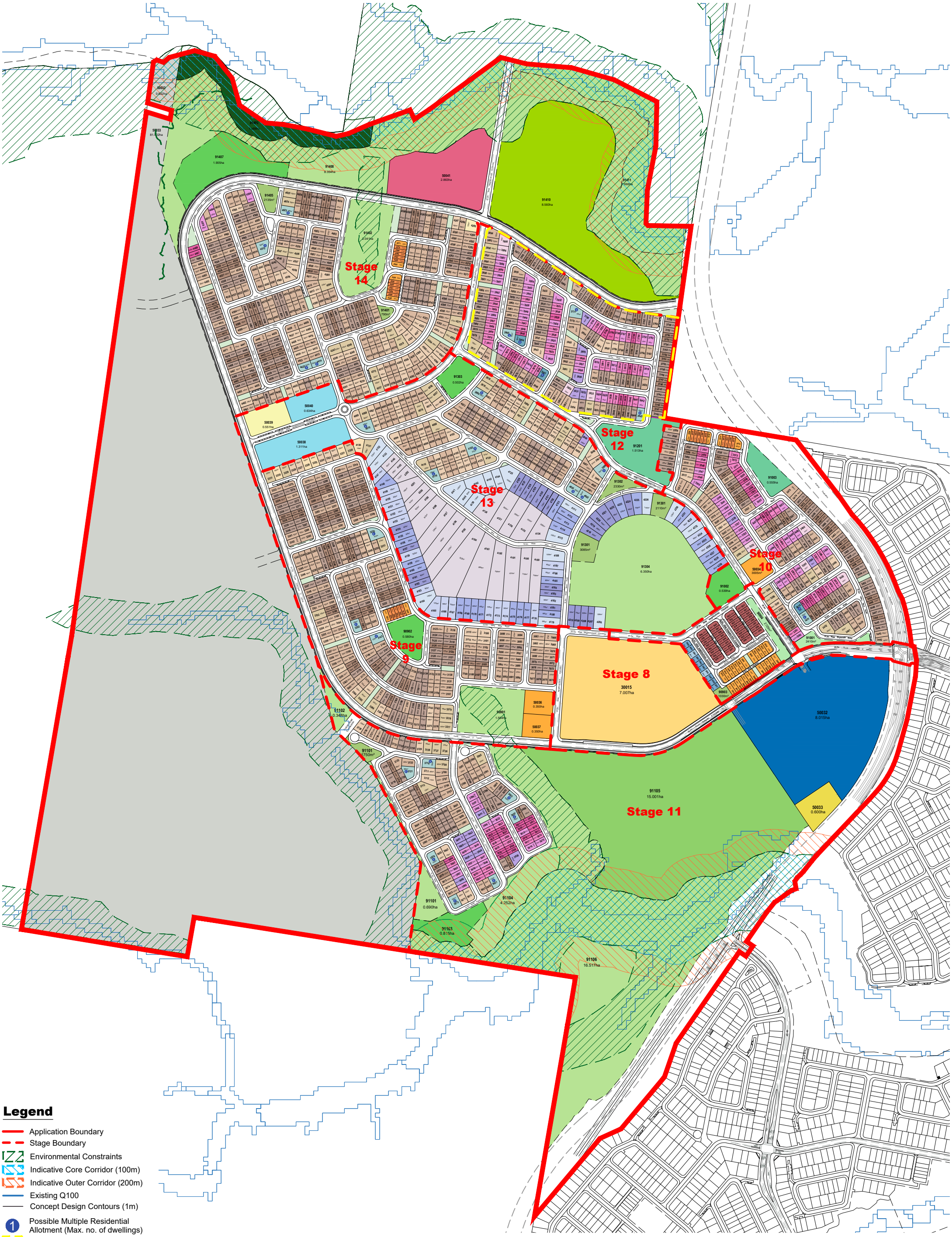
(e) This document is for the use of the party to whom it is addressed and for no other persons. No responsibility is accepted to any third party for the whole or part of the contents of this Report.

(f) If any claim or demand is made by any person against Engeny on the basis of detriment sustained or alleged to have been sustained as a result of reliance upon the Report or information therein, Engeny will rely upon this provision as a defence to any such claim or demand.

(g) This Report does not provide legal advice.

APPENDIX A: CA3 SOUTH LAYOUT



Legend

- Application Boundary
- Stage Boundary
- Environmental Constraints
- Indicative Core Corridor (100m)
- Indicative Outer Corridor (200m)
- Existing Q100
- Concept Design Contours (1m)
- 1 Possible Multiple Residential Allotment (Max. no. of dwellings)
- Potential School Site for Acquisition (12ha)

TO BE READ IN CONJUNCTION WITH 110056-640A STAGES 8-14 OVERALL STATISTICS

PLAN REF:	**110056 – 639**
Rev No:	**A**
DATE:	16 AUGUST 2024
CLIENT:	PEET
DRAWN BY:	JC / MM
CHECKED BY:	MD

0 100 200 300 400 500 **1 : 7,500 @ A3**

FLAGSTONE CA3 SOUTH

STAGES 8 - 14
OVERALL PLAN OF SUBDIVISION

URBAN DESIGN
Level 8
31 Duncan Street
PO Box 1559
Fortitude Valley QLD 4006
T +61 7 3539 9500
W rpsgroup.com

A TETRA TECH COMPANY

CA3 SOUTH - Stage 8 - 14 Yield Breakdown

Lot Type	Stage 8	Stage 9	Stage 10	Stage 11	Stage 12	Stage 13	Stage 14	Overall	
	Yield	Yield	Yield	Yield	Yield	Yield	Yield	Yield	%
25m Deep Terrace Product									
Premium Villa 12.5m Allotment	—	8	—	—	—	—	—	8	**0%**
Courtyard 14m Allotment	—	2	—	—	—	—	—	2	**0%**
Subtotal	**—**	**10**	**—**	**—**	**—**	**—**	**—**	**10**	**1%**
25m Deep Terrace Product									
Terrace 9.5m Allotment	—	32	—	—	—	—	—	32	**2%**
Subtotal	**—**	**32**	**—**	**—**	**—**	**—**	**—**	**32**	**2%**
25m Deep Product									
Villa 10m Allotment	—	—	13	16	10	—	—	39	**2%**
Premium Villa 12.5m Allotment	—	—	23	13	39	—	2	77	**5%**
Courtyard 14m Allotment	—	—	22	17	30	—	3	72	**4%**
Premium Courtyard 16m Allotment	—	—	2	9	5	1	—	17	**1%**
Premium Traditional 20m Allotment	—	—	4	—	4	—	—	8	**0%**
Possible Multiple Residential Allotment	—	—	1	—	2	—	—	3	**0%**
Subtotal	**—**	**—**	**65**	**55**	**90**	**1**	**5**	**216**	**13%**
28m Deep Terrace Product									
Terrace 7.5m Allotment	—	5	9	—	—	—	10	24	**1%**
Terrace 9.5m Allotment	—	26	4	—	—	—	4	34	**2%**
Subtotal	**—**	**31**	**13**	**—**	**—**	**—**	**14**	**58**	**4%**
30m Deep Product									
Villa 10m Allotment	—	58	30	13	26	—	50	177	**11%**
Premium Villa 12.5m Allotment	—	87	51	29	67	22	110	366	**22%**
Courtyard 14m Allotment	—	119	39	34	41	64	153	450	**28%**
Premium Courtyard 16m Allotment	—	24	5	9	7	35	45	125	**8%**
Traditional 18m Allotment	—	4	—	—	—	1	—	5	**0%**
Premium Traditional 20m Allotment	—	11	6	6	4	14	15	56	**3%**
Possible Multiple Residential Allotment	—	2	1	7	3	7	4	24	**1%**
Subtotal	**—**	**305**	**132**	**98**	**148**	**143**	**377**	**1203**	**74%**
50m+ Deep Product									
Courtyard 14m Allotment	—	—	—	—	—	24	—	24	**1%**
Premium Courtyard 16m Allotment	—	—	—	—	—	25	—	25	**2%**
Traditional 18m Allotment	—	—	—	—	—	21	—	21	**1%**
Premium Traditional 20m Allotment	—	—	—	—	—	18	—	18	**1%**
Ridgetop Allotment	—	—	—	—	—	21	—	21	**1%**
Subtotal	**—**	**—**	**—**	**—**	**—**	**109**	**—**	**109**	**7%**
Total Residential Allotments	**—**	**378**	**210**	**153**	**238**	**253**	**396**	**1628**	**100%**
Residential Net Density	**—**	**16.3 dw/ha**	**15.5 dw/ha**	**13.7 dw/ha**	**14.8 dw/ha**	**8.9 dw/ha**	**16.0 dw/ha**	**13.6 dw/ha**	
Super Lots									
Local Centre	—	—	—	—	—	2	—	2	
District Centre	—	—	—	1	—	—	—	1	
Ambulance	—	—	—	1	—	—	—	1	
Child Care	—	2	1	—	—	—	—	3	
Community Centre	—	—	—	—	—	1	—	1	
State Primary School	1	—	—	—	—	—	—	1	
Medium Density Allotment	—	—	—	—	—	—	1	1	
Balance Allotment	—	—	—	—	—	—	2	2	
Subtotal	**1**	**2**	**1**	**2**	**—**	**3**	**3**	**12**	
Total Allotments	**1**	**380**	**211**	**155**	**238**	**256**	**399**	**1640**	
Maximum Potential Residential Dwellings (Includes Multiple Residential Allotments)	**—**	**381**	**212**	**166**	**246**	**266**	**403**	**1674**	
Maximum Potential Net Residential Density	**—**	**16.4 dw/ha**	**15.6 dw/ha**	**14.8 dw/ha**	**15.3 dw/ha**	**9.4 dw/ha**	**16.3 dw/ha**	**14.0 dw/ha**	

CA3 SOUTH - Stage 8 - 14 Land Budget

Land Use	Stage 8	Stage 9	Stage 10	Stage 11	Stage 12	Stage 13	Stage 14	Overall	
	Area	Area	Area	Area	Area	Area	Area	Area	%
	10.176 ha	27.993 ha	16.967 ha	66.313 ha	16.056 ha	37.552 ha	144.019 ha	319.076 ha	100.0%
Saleable Area									
Residential Allotments	—	14.554 ha	7.934 ha	6.274 ha	9.374 ha	21.607 ha	16.542 ha	76.285 ha	23.9%
Medium Density	—	—	—	—	—	—	2.863 ha	2.863 ha	0.9%
Local Centre	—	—	—	—	—	1.945 ha	—	1.945 ha	0.6%
District Centre	—	—	—	8.015 ha	—	—	—	8.015 ha	2.5%
Ambulance	—	—	—	0.600 ha	—	—	—	0.600 ha	0.2%
Child Care	—	0.700 ha	0.301 ha	—	—	—	—	1.001 ha	0.3%
Community Centre	—	—	—	—	—	0.551 ha	—	0.551 ha	0.2%
State Primary School	7.007 ha	—	—	—	—	—	—	7.007 ha	2.2%
Total Area of Allotments	**7.007 ha**	**15.254 ha**	**8.235 ha**	**14.889 ha**	**9.374 ha**	**24.103 ha**	**19.405 ha**	**98.267 ha**	30.8%
Road									
North South Arterial Dedication (incl. batters)	0.266 ha	—	3.079 ha	9.562 ha	—	—	0.132 ha	13.039 ha	4.1%
Trunk Connector 2 Lanes (23.7m)	2.195 ha	2.498 ha	—	0.144 ha	0.028 ha	0.327 ha	4.135 ha	9.327 ha	2.9%
Neighbourhood Connector (20.2m)	0.708 ha	1.748 ha	0.598 ha	0.689 ha	1.753 ha	1.016 ha	0.687 ha	7.199 ha	2.3%
Neighbourhood Access Street (16.5m)	—	5.229 ha	3.513 ha	3.143 ha	3.133 ha	4.372 ha	6.095 ha	25.485 ha	8.0%
Laneway (6.5m)	—	0.380 ha	0.075 ha	—	—	—	0.082 ha	0.537 ha	0.2%
Pedestrian Linkages	—	0.365 ha	0.132 ha	0.088 ha	0.255 ha	0.129 ha	0.642 ha	1.611 ha	0.5%
Total Area of New Road	**3.169 ha**	**10.220 ha**	**7.397 ha**	**13.626 ha**	**5.169 ha**	**5.844 ha**	**11.773 ha**	**57.198 ha**	17.9%
Open Space									
Conservation Buffer	—	—	—	—	—	—	1.988 ha	1.988 ha	0.6%
Corridor Park / Conservation	—	1.564 ha	—	21.807 ha	—	6.350 ha	18.061 ha	47.782 ha	15.0%
Stormwater Management	—	—	0.555 ha	—	1.513 ha	—	—	2.068 ha	0.6%
Regional Sports	—	—	—	15.001 ha	—	—	—	15.001 ha	4.7%
District Sports	—	—	—	—	—	—	8.560 ha	8.560 ha	2.7%
Neighbourhood Recreation Park	—	0.580 ha	0.539 ha	0.815 ha	—	0.502 ha	1.905 ha	4.341 ha	1.4%
Local Recreation Park	—	0.103 ha	—	0.175 ha	—	0.753 ha	0.293 ha	1.324 ha	0.4%
Local Linear Recreation Park	—	0.272 ha	0.241 ha	—	—	—	—	0.513 ha	0.2%
Total Open Space	**—**	**2.519 ha**	**1.335 ha**	**37.798 ha**	**1.513 ha**	**7.605 ha**	**30.807 ha**	**81.577 ha**	25.6%
Balance Allotments									
Balance Allotment	—	—	—	—	—	—	82.034 ha	82.034 ha	25.7%
Total Balance Allotments	**—**	**—**	**—**	**—**	**—**	**—**	**82.034 ha**	**82.034 ha**	25.7%

PLAN REF: **110056 – 640**
Rev No: **A**
DATE: 16 AUGUST 2024
CLIENT: PEET
DRAWN BY: JC / MM
CHECKED BY: MD

Not to Scale @ A3

FLAGSTONE CA3 SOUTH
STAGES 8 - 14
OVERALL PLAN OF SUBDIVISION STATISTICS

PEET

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APPENDIX B: FLAGSTONE CITY MASTERPLAN FLOODING ASSESSMENT (CARDNO, SEPTEMBER 2014)

Flagstone City-Masterplan

Flooding Assessment

721743/032/R1V6

Prepared for
Peet Flagstone City Pty Ltd

5 September 2014

Cardno
Shaping the Future

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Document Information

Prepared for	Peet Flagstone City Pty Ltd
Project Name	Flagstone City-Masterplan
File Reference	O:\7217-43\WP\R1V6_Masterplan_Flooding\R1V6_Masterplan_Flooding.docx
Job Reference	721743/032/R1V6
Date	5 September 2014

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
1	8 August 2012		K. Clayfield	KC	D. Niven	DNN
2	14 August 2012		K. Torres/P. Godiksen	KT/PG	D. Niven	DNN
3	22 March 2013		M. Box	MB	D. Niven	DNN
4	11 April 2014		D. Niven	DNN	M. Giles	MG
5	21 August 2014	Final	N. Ejigayehu	NE	D. Niven	DNN
6	5 September 2014	Final	N. Ejigayehu		D. Niven	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
1		D. Niven	Dnn	8 August 2012
2		D. Niven	DNN	14 August 2012
3		D. Niven	DNN	22 March 2013
4		M. Giles	MG	11 April 2014
5	For submission	D. Niven	DNN	21 August 2014
6	For submission to Council	D. Niven		5 September 2014

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Reference Drawings

Flagstone Structural Plan-DWG 110056-262-Structure_OPT2L DWG # 110056-263-3 Dated 01 July 2014

Appendices

1 Introduction

This flooding assessment report has been prepared by Cardno (Water Resources and Coastal), specialist hydrologic and hydraulic consultants, for Peet Flagstone City Pty Ltd to investigate the hydrologic and hydraulic requirements for the overall Masterplan of the Flagstone City development, located in Logan City Council (LCC) under the Economic Development Queensland (EDQ). This report has been prepared as a supporting document to inform the identification and allocation of stormwater infrastructure for all future development of Flagstone City.

The Flagstone City masterplan comprises of five context plan areas identified as Context Areas 1 to 5 as shown on Figure 1. The current structure plan layout has been provided by RPS and is included in the reference section of this report.

The management of the water quantity and site flooding is proposed to be addressed as a Masterplan solution. This Masterplan solution presents an integrated approach to the flooding to provide the most cost effective solution both in terms of construction and on-going maintenance. This report provides the details of the flood management strategy and the analysis to justify its implementation.

2 Existing Site and Proposed Development

2.1 Existing Site Description

The overall site is approximately 1500ha in area. It is located in an area bounded by the existing Brisbane to Sydney Railway to the east and forested property to the west. The Real Property description is

- Lot 1 on RP35155
- Lot 2 on RP47120
- Lot 4 on RP45728
- Lot 5 on S312569
- Lot 9 on S312569
- Lot 10 on SL6002
- Lot 873 on SP166448
- Lot 875 on SP146552
- Lot 907 on RP819216
- Lot 908 on RP819216
- Lot 910 on RP857850
- Lot 911 on RP857870
- Lot 988 on CP857841
- Lot 989 on RP854074

Parish of Mclean, County Stanley. The site currently does not have a street address but is located off Homestead Road, which connects to Teviot Road, Jimboomba.

The site is currently cleared rural land with vegetation maintained along the creeks and gullies that traverse the site. The site drains into Flagstone and Sandy Creeks, or tributaries of these creek systems. Within the site the elevations range from approximately 32.1m AHD to 170.9m AHD, with a predominate direction of flow in an easterly direction prior to discharging under the existing railway.

An aerial of the current site condition is presented on Figure 1.

2.2 Proposed Masterplan Description

Flagstone City is proposed to be a large master planned mix use development consisting of:

- Residential dwellings;
- Super allotments;
- Mixed use lots;
- Town Centre;
- Schools;
- Parks (including Regional, district and local facilities); and
- Open Space.

The current structure plan layout and staging plan has been provided by RPS and is included in the reference section of this report.

3 Data

The assessments detailed in this report are based on the following data:

- Aerial LiDAR survey data obtained from the Department of Environment and Heritage Protection (DEHP);
- 1:25,000 topographic map ('Undullah'), produced by the Queensland Department of Mapping and Surveying (SUNMAP);
- Stage 14 Site layout provided by Saunders Havill Group Drawing No 6601 P 04 PP F dated 29/10/2012;
- Stage 14 detail design TIN provided in 12d format from Sedgmen Yeats, as detailed on Drawing No YC0434-C1-204 and YC0434-C1-205;
- Stage 15 site layout provided on Cardno Drawing Nos 7506/01/26-102 B, 7214/58/07-105 C, 7214/58/08-105 C, 7214/58/02-103 4, and 7214/58/11-103 F ; and
- Cardno report titled, *'Flagstone Stages 14A, 14B, 15A, 15B, 15C and 15D, Hydraulic Analysis'* dated November 2009 (ref 3503-62).

4 Hydrologic Assessment

A hydrologic assessment has been undertaken to quantify both the pre- and post-development runoff characteristics of the local tributaries. The results of the hydrologic model was used for input into the hydraulic model (TUFLOW).

4.1 Methodology

A detailed hydrologic analysis was undertaken using the Watershed Bounded Network Model (WBNM) 2007 Version 104. WBNM is a non-linear runoff routing software package produced by the University of Wollongong in New South Wales. WBNM has been used in accordance with Council's *'Logan Planning Scheme'* (2011), *'Queensland Urban Drainage Manual'* (2008) and *'Australian Rainfall and Runoff'* (1999), and reference to the Urban Land Development Authority (ULDA) *'Greater Flagstone Urban Development Area Development Scheme' (*2011) and *ULDA Guideline 15*.

The hydrologic model set up includes the full catchment for Sandy Creek, Flagstone Creek and several unamed tributaries to Teviot Road, Jimboomba. The catchment has a total area of approximately 54km^2.

Catchment extents were mapped from the Undullah 1:25,000 topographic map, produced by the Queensland Department of Lands. Sub-catchment boundaries within the site were determined from 5m contours sourced from aerial survey of the area. The WBNM model layout and sub-catchment boundaries for the pre- and post-development (Master Plan) scenarios are shown on Figure 2.

The hydrologic modelling considers the following scenarios:

- **Existing – Calibration (Case EU02d):** This scenario assumes catchments within the site extents as well as the catchments to the west of the Brisbane to Sydney Railway line, in their existing state and remaining catchments external to the site in a developed state. Ultimate land uses were derived from Council's Planning Scheme and existing land uses via satellite imagery from Google Earth (2012). For this scenario, initial loss of 15mm and continuous loss of 2.5mm/hr were adopted for all the catchments external to the site, For the subject site itself (cleared scenario), initial loss of 5mm and continuous loss of 2.5mm/hr were adopted. Figure 2 shows the existing/pre-development catchment layout.
- **Pre-Development (Case EU02e):** This scenario assumes the same catchments and land uses as per the Existing Case. However, initial loss of 15mm was adopted for site areas to model pre-clearing (ie. forested) as recommended by EDQ consultant Jacobs (formerly SKM). Figure 2 shows the pre-development catchment layout; and
- **Post-Development (Case DU03e):** This scenario assumes the same catchment and land uses as per the Pre-Development Case for areas external to the site. While for the subject site, the fraction impervious factors were applied based on the proposed densities. Figure 2 shows the post-development catchment layout. The proposed site densities are shown on in the reference section of the report. The site densities for Stage 14 are shown in the Saunders Havill Group Drawing No 6601 P 04 PP F dated 29/10/2012. The reference drawing showing the site densities for Stage 15 is Cardno Drawing Nos 7506/01/26-102 B, 7214/58/07-105 C, 7214/58/08-105 C, 7214/58/02-103 4, and 7214/58/11-103 F.

4.1.1 Critical Duration Analysis

A hydrologic modelling was undertaken to determine the critical storm durations across the model area. The modelling showed that the 60minute, 180minute, 270 minute and 360minute storms were found to be the critical storms across the model area. Therefore, the final hydrologic and hydraulic analyses have been undertaken for those storm events.

4.2 Model Assumptions

The WBNM model assumes land uses as per Logan City Council Planning Scheme Map and aerial photography. The adopted fraction impervious value for each land use is listed in Table 4-1. The fraction impervious values were adopted from Logan City Council's *'Draft Interim Standards for Stormwater, Overland Flow and Flood Plain Management'* (August 2010).

In accordance with the Draft Interim Standards, with a lot density of approximately 10 lots/ha the proposed Stage 14 development falls under the 'Residential 600' category generally giving a fraction impervious of 60%. Considering that the bulk of the lots within Stage 14 are generally less than 600 square meters, Cardno adopted a conservative measure for the fraction impervious value for the proposed Stage 14 development as shown in Table 4-1 below. Details of the existing and developed catchments are provided in Appendix A.

Table 4-1 Adopted Fraction Impervious Values

Land Use	Fraction Impervious
Forest	0%
External Urban	60%
Conservation	0%
Park Area	2%
Open Space	20%
Residential Low Density	50%
Residential Medium Density	60%
Residential Stage 14	70%
Residential High Density	85%
Schools	70%
Commercial/Town Centre	90%

4.3 Model Calibration

The hydrologic modelling for Flagstone was originally completed in RORB. This previous RORB model is detailed in the Cardno report titled, *'Flagstone Stages 14A, 14B, 15A, 15B, 15C and 15D, Hydraulic Analysis'* dated November 2009 (ref 3503-62). The RORB model used regional relationships for South East Queensland as described in AR&R (1987).

The 2009 RORB modelling adopted initial loss of 0mm and continuous loss of 2.5mm/hr. The current WBNM modelling adopted initial loss of 15mm and continuous loss of 2.5mm/hr. Therefore, in order to compare the two models, the initial and continuous loss parameters in RORB have been modified to match the current WBNM model.

The peak flow rate in Sandy Creek from the RORB model was compared to a Rational Method assessment as presented in Table 4-2. For the analysis of the peak flood levels in Sandy Creek, the higher peak flow rates obtained from the runoff routing model were conservatively adopted for use.

Table 4-2 Predicted Peak Flows, Rational vs RORB, 100 Year Event

Method		Peak Flow Rate (m^3/s)
Rational	Weeks	77.3
	McMahon and Muller	91.5
RORB – Runoff Routing		88.7

For the design event modelling the RORB model was transferred into WBNM to better assess the relative impact of development. As WBNM does not have a regional lag value and in lieu of stream gauge data, the WBNM model was calibrated to the original RORB model.

A comparison between the RORB and WBNM 100 year event peak flows are presented in Table 4-3. Results show a reasonable calibration between the two models was achieved, with WBNM peak flows higher than the RORB model and thus more conservative.

Table 4-3 Predicted Peak Flows, Runoff Routing Model Comparison, 100 Year Event

Location (RORB / WBNM)	RORB Model – Existing		WBNM Model – Existing		Difference (%)
	Peak (m^3/s)	Critical Duration (min)	Peak (m^3/s)	Critical Duration (min)	
Rail Line / RP3	85.8	270	91.9	270	7%
Southern Tributary / SC11	88.7	270	92.5	270	4%
Northern Tributary / E2	10.6	120	11.1	60	5%

Based on the calibration, the initial and continuing losses adopted for the Existing Case WBNM model are shown in Table 4-4. A catchment lag of m = 2.45 was adopted for all ARI events.

Table 4-4 Adopted WBNM Initial and Continual Loss Parameters

ARI (Years)	Pervious		Impervious	
	Initial Loss (mm)	Continuing Loss (mm/hr)	Initial Loss (mm)	Continuing Loss (mm/hr)
100	15	2.5	0	0

5 Hydraulic Assessment

Hydraulic analysis has been performed to determine peak flood levels through the site and to ensure development on the site will remain flood free and not adversely impact on other properties external to the site in accordance with the appropriate design standards.

5.1 Methodology

A two dimensional (2D) model has been setup of the site and surrounds with a grid size of 10m. The model extent is shown on Figure 3. The hydraulic assessment of the site has been undertaken using the TUFLOW (Build 2011-09-AF), a linked one-dimensional/two-dimensional (1D/2D) hydraulic model.

The following scenarios have been considered:

- **Pre-Development Case** (Case E21e): The pre-development topography modelled is shown on Figure 3. The model uses the pre-development hydrologic flows as detailed in Section 4 which assumes the site undeveloped, and ultimate development external to the site. The downstream roughness was also modified to reflect the assumptions in Cardno's 2009 report.
- **Post-Development Master Plan** (Case M32e): This scenario is based on the pre-development case and includes the developed site. This case includes the Sandy Creek road crossing allowing Sandy Creek to drain under Parkside Drive and the inclusion of Stage 14 and 15 works. The post-development topography modelled is shown on Figure 5. The model uses the post-development hydrologic flows as detailed in Section 4.

5.2 Model Setup

5.2.1 Model Topography

The digital terrain model (DTM) of the study site for the Stage 14 and 15 assessment was setup based on the following data sources:

- ALS (Airborne laser scanning) data obtained from the Department of Environment and Heritage Protection (DEHP).
- Bulk earthworks layout plan for stage 15C and 15A, part of the pre developed area, designed by Cardno. The levels of lots 1514, 1515, 1516, 1502, 1503 and 1501 have been updated with the levels from the plan. The plan can be found under the Reference drawings section of this report.
- Detailed design TIN from Sedgmen Yeats for Stage 14 as shown on Drawing No YC0434-C1-204 and YC0434-C1-205

The extent of the TUFLOW study area is shown in Figure 3. A grid with a spacing of 10 metres (i.e. ground levels being represented every 10 metres) was adopted. From a review of the culvert blockage assessment it was determined that the definition of the creek and downstream had not been modelled with sufficient detail.

The modelling for both the pre and post-development scenarios was updated to include additional detail of the creek invert and subsequent 2D modelling of this invert. This generally caused a local lowering of the flood levels through downstream of the site.

5.2.2 Inflows

The discharge hydrographs from the WBNM model has been used as inflow to the TUFLOW model. The hydraulic analysis was conducted with design inflows for the 1 to 100 year ARI events, for the 60minute, 180minute, 270minute, and 360minute storms. The reference drawing showing the increased density incorporated into modelling is the Saunders Havill Group Drawing No 6601 P 04 PP F dated 29/10/2012. Hydrologic analysis is detailed in Section 4. The location of the inflow points in the TUFLOW model are shown in Figure 3 and the same inflow points has been used in the Pre-development and Post-development case.

5.2.3 Tailwater Conditions

A normal depth corresponding to a slope of 1.0% (approximate slope of the creek invert at this location) was assumed as the tail water condition occurring at the eastern boundary of the model. Considering the distance between the tailwater location and the site this assumption is considered appropriate.

5.2.4 Roughness Values

The Manning's n roughness values for the study area were derived from aerial photographs. The pre-development case was modelled as forested areas outside already developed areas with a Manning's n value of 0.15. The developed areas in the pre-development case were modelled as residential areas with a Manning's n value of 0.15 and as cleared land with a Manning's n value of 0.05.

For the reach between the railway and the confluence of Sandy Creek a lower roughness values of 0.05 has been adopted for the river bed and 0.08 for the river banks. These roughness values were based on site inspection and calibration and validation of the hydraulic model documented in the Cardno report - *Flagstone Stages 14A, 14B, 15A, 15B, 15C & 15D Hydraulic Analysis* (ref 3503/62).

Based on Council's request of 27 May 2013, the hydraulic roughness of the creek bed and banks of Sandy Creek downstream of the railway was increased from a Manning's n value of 0.05 to a value of 0.08.

Although the areas within the site change in land use, these are not inundated and therefore the Manning's n value was not changed pre- and post-development.

5.2.5 Structures

The existing structures are based on information obtained from Queensland Rail and Logan City Council. Table 5-1 and Table 5-2 outlines the existing bridge spans and culvert openings for the various roads across the floodplain.

Table 5-1 Existing Structures - Bridges

Description	Bridge Type	Details
Railway crossing – Tributary of sandy creek	-	Obvert level 41.1m AHD
Railway crossing – Sandy creek	-	Obvert level 39m AHD
Railway crossing – Flagstone Creek	-	Obvert level 39m AHD
Teviot Road bridge	Three span bridge	Obvert level 23.64m AHD

Table 5-2 Existing Structures - Culverts

Description	Culvert Type	Details
Culv_Homest	RCBC	4 / 3.6 x 2.7m, length 15m
Culv_Home2	RCP	3 / 1.5 m, length 17m
Culv_BUSHRD	RCP	2 / 1.8m , length 15m
Culv_SandP	RCBC	3 / 3.6 x 3.3m, length 15m
Riv Oak Culv	RCBC	5 / 3.6 x 3.6m, length 20m
Culv_N1	RCP	2 / 1.8m, length 30m
QR_B	RCP	1 / 1.5m, length 10m
QR_C	RCP	1 / 1.5m, length 10m
QR_D	RCP	1 / 1.5m, length 10m
QR_E	RCP	1 / 1.05m, length 10m

5.2.6 Proposed Mitigation Measures

Several mitigation measures have been proposed within the subject site to mitigate the impact of the development on peak flow rates, duration and flood levels external to the site.

The details of the proposed mitigation measures (road crossings and detention basins) are provided in Table 5-3 and Table 5-4. The locations of the proposed structures are shown in Figure 5. The culverts were modelled as one dimensional links, connected to the two dimensional domain.

Table 5-3 Proposed Structures

Structure ID	Culvert Type		Road Level (mAHD)
	Minor Flow Pipe	Major Flow Pipe	
1	900mm RCP, USIL 48.97 mAHD, DSIL 48.7 mAHD	5@1050mm RCPs, USIL 50.5 mAHD, DSIL 50.5 mAHD	52.4
2*	1050mm RCP, USIL 46.15 mAHD, DSIL 46.1 mAHD	5@1050mm RCPs, USIL 47.6 mAHD, DSIL 47.6 mAHD	48.9
3*	1050mm RCP, USIL 44.66 mAHD, DSIL 44.59 mAHD	5@ 1200mm x 1200mm RCBCs, USIL 45.8 mAHD, DSIL 45.8 mAHD	47.5
4	750mm RCP, USIL 52.297 mAHD, DSIL 52.165 mAHD	2@1050mm RCPs, USIL 53.25 mAHD, DSIL 53.25 mAHD	54.9
5	750mm RCP, USIL 54.247 mAHD, DSIL 54.205 mAHD	2@ 1200mm x 1200mm RCBCs, USIL 55.2 mAHD, DSIL 55.2 mAHD	56.3
6	900mm RCP, USIL 46.9 mAHD, DSIL 46.8 mAHD	2@1350mm RCPs, USIL 48.55 mAHD, DSIL 48.55 mAHD	50.5
7	900mm RCP, USIL 41.673 mAHD, DSIL 41.493 mAHD	2@1350mm RCPs, USIL 43.15 mAHD, DSIL 43.15 mAHD	45.1
8	1800mm RCP, USIL 50.65 mAHD, DSIL 50.52 mAHD	n/a	53.1
9	2100mm RCP, USIL 37.11 mAHD, DSIL 36.96 mAHD	n/a	40.4
10	2@1500mm RCPs, USIL 57.06 mAHD, DSIL 56.94 mAHD	n/a	59.8
11	5@ 2700mm x 2400mm RCBCs, USIL 39.73 mAHD, DSIL 39.431 mAHD	n/a	43.75
12	5@ 2700mm x 2400mm RCBCs, USIL 35.62 mAHD, DSIL 35.45 mAHD	n/a	39.2
13	2@2100mm RCP, USIL 60.8 mAHD, DSIL 60.6 mAHD	n/a	63.5
14	2@2100mm RCP, USIL 53.43 mAHD, DSIL 53.05 mAHD	n/a	56.3
15	5@ 2400mm x 2400mm RCBCs, USIL 52.45 mAHD, DSIL 52.2 mAHD	n/a	55.82
16	5@ 2700mm x 2400mm RCBCs, USIL 35 mAHD, DSIL 34.87 mAHD	n/a	39.99
17	1050mm RCPs, USIL 40.47 mAHD, DSIL 39.92 mAHD	n/a	42.8
18*	1050mm RCPs, USIL 44.5 mAHD, DSIL 44.4 mAHD	n/a	46.4
19	2500mm x 3000mm RCBC, USIL 30.2mAHD,DSIL30.125mAHD 2@1500mm x2500mm RCBCs, USIL 31.7mAHD,DSIL31.63mAHD and 3300mm x 3000mm RCBC, USIL 30.2mAHD,DSIL 30.13 mAHD	n/a	34.53

* *indicated proposed bund*

Table 5-4 Proposed Detention Basins

Detention ID	Outlet Structures		Road Level (mAHD)
	Minor Flow Pipe	Major Flow Pipe	
Bas1	750mm RCP, USIL 48.63mAHD, DSIL 48.43mAHD and 750mm RCP, USIL 48.84mAHD, DSIL 48.54mAHD	7m wide weir having crest level of 49.7mAHD And 7m wide weir having crest level of 49.9mAHD	n/a
Bas2	1200mm RCPs, USIL 42.32 mAHD, DSIL 42.085 mAHD	n/a	44.5
Bas3	120mm RCP, USIL 41mAHD, DSIL 40.79Mahd	6m wide weir having crest level of 42.0mAHD	n/a

5.3 Hydraulic Model Results

Maps of post-developed peak flood levels and impacts are shown in Appendix C and D, respectively. Table 5-5 below presents the 100 year ARI pre- and post-development predicted peak flood levels and impacts for key locations within the model extent (refer Appendix B figures for reporting point locations). The Tables in Appendix E and F show the predicted peak flood levels, peak flows and impacts for all the relevant reporting nodes for the 100 Year ARI event. In Appendix F pre and post-developed hydrographs upstream and downstream of the site can be found for the 100 Year ARI event.

Table 5-5 100 Year ARI Predicted Peak Flood Levels

Reporting Node ID	Peak Flood Level (mAHD)		Impact (m)
	Pre-Developed	Post-Developed	
H_SDYCK_DS3_CH9400	24.46	24.41	-0.04
H_SDYCK_DS3_CH8900	25.91	25.88	-0.04
H_SDYCK_DS2_CH7500	29.59	29.52	-0.07
H_SDYCK_CH7000	31.26	31.20	-0.06
H_SDYCK_US1_CH6400	33.11	32.93	-0.18
H_SDYCK_DS1_CH6250	34.12	34.03	-0.10
H_SCBRIDGE_DS_CH5550	36.29	36.17	-0.12
H_SDYCK_BRIDGE1_US_CH5200	37.67	37.57	-0.11
H_SDYCK_CH4200	41.19	41.13	-0.07
H_SDYCK_CH2650_Trib1	59.70	60.18	0.48
H_SDYCK_CH2650_Trib2	57.40	57.57	0.17
H_FSTCK_CH10800	21.74	21.73	-0.02
H_FSTCK_CH10200	23.20	23.18	-0.02
H_FSTCK_CH9700	24.38	24.37	-0.01
H_FSTCK_CH9100	26.07	26.07	-0.01
H_FSTCK_CH8500	28.52	28.52	-0.01
H_FSTCK_CH7500	32.83	32.78	-0.05
H_FSTCK_CH7300_trib1	41.88	42.54	0.66
H_FSTCK_CH7300_trib2	40.70	40.58	-0.12
H_FSTCK_CH6900	36.33	36.26	-0.07
H_FSTCK_CH6700	37.12	37.03	-0.09
H_FSTCK_CH6350	39.19	39.31	0.12
H_FSTCK_CH6250	39.83	40.20	0.37
H_FSTCK_CH5100	45.65	45.62	-0.02
H_FSTCK_CH3800_Trib1	54.37	55.27	0.90
H_FSTCK_CH3800_Trib2	53.51	53.58	0.07
H_FSTCK_CH3350	54.54	54.53	-0.01
H_FSTCK_CH3200	55.67	56.02	0.34
H_FSTCK_CH2800	57.77	57.81	0.04
H_FSTCK_CH2000	61.22	61.23	0.01
H_FSTCH_CH10650_TEVRD_US	22.18	22.16	-0.02

With the current proposed Flagstone City Masterplan, the site external impacts downstream of the site are found to be minimal for the 100 Year ARI event. The proposed culvert under Parkside Drive (see Figure 5) causes impacts upstream of the site but the impacts become negligible when reaching the railway crossing of the Sydney – Brisbane Railway.

6 Consideration of Logan City Council Temporary Local Planning Instrument (TLPI)

Following the January 2011 floods Logan City Council (ICC) implemented their Temporary Local Planning Instrument (30 March 2011). This provides recommendations for flood management. The intent of the flood management for the Flagstone City development has been to comply with the principles and intent of this TLPI, with some minor exceptions.

Overall the proposed development has adopted the practice of maintaining all future development outside the main floodplain. This will maintain the flood storage within the catchment and river system, whilst also maintaining the ecological characteristics of the creeks and significant tributaries.

A change from the TLPI recommendations has been to utilise on-line flood attenuation devices. The mitigation is achieved by providing restricted openings at the Parkside Drive road crossing. There is no additional excavation of the floodplain. This strategy causes a localised raising of flood levels upstream of the crossing with the benefit of reduced flood levels external to and downstream of the site. These localised increases do not significantly change the flood extent, are contained within the overall Flagstone area, and critically are still outside of the development footprint.

The compliance of the development to Table 3 of the TLPI is provided in Table 6-1.

Table 6-1 Specific Outcomes and Probable Solutions for the Flooding and Inundation Area

TLPI Specific Outcomes	Compliance to TLPI
Risk to people and premises	
O1 Development results in— (a) no increase in the number of people at risk from flooding; (b) no increase in the number of people that need evacuation; (c) no increase in the number of premises or significant infrastructure at risk from flooding; (d) existing flood warning times being maintained or increased; and (e) no adverse effect on the ability of traffic to use evacuation routes. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant.
O2 A building is located on premises that is above the flood level of the defined flood event.	Compliant
O3 The floor level of a habitable room in a building has a finished floor level which is a minimum of 500 millimetres above the flood level of the defined flood event where— (a) the building is used for a residential purpose; or (b) the building— i. is used for a non-residential purpose; and ii. is intended to be occupied during, or in the aftermath of a defined flood event.	Compliant
O4 A lot of 2000m 2 or less is located above the flood level of the defined flood event.	Compliant

Column 1 Specific Outcomes	Column 2 Probable Solutions
O5 A lot greater than 2000m 2 provides a development envelope area on the premises that is above the flood level of the defined flood event.	Not Applicable- lots will be above flood level
O6 Public safety and the environment are not adversely affected by the detrimental impacts of floodwater on hazardous materials manufactured or stored in bulk. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome	Compliant.
O7 A material change of use for a car park or car park associated with a development is only located below the flood level of the defined flood event where there is no increase in risk to— (a) pedestrian and vehicular safety; and (b) land. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant
O8 Community infrastructure and essential services infrastructure are able to function effectively during and immediately after flood events. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant. Community and essential services infrastructure will be set at levels necessary to ensure that they function effectively during and immediately after flood events.
Flood storage and discharge capacity	
O9 An existing flood flow path is protected and maintained without adversely affecting adjoining premises.	The creeks and their significant tributaries that drain through the site are protected. Minor gullies within urban areas will be replaced with piped and overland flow drainage networks as necessary to maintain conveyance.
O10 The natural conveyance of flood waters and the natural overland flow path is protected and maintained. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome	The creeks and their significant tributaries that drain through the site are protected
O11 Development does not— (a) cause cumulative flood damage; (b) cause ponding of flood water; or (c) adversely affect the flood discharge capacity. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant.
O12 The loss of flood plain storage is compensated with compensatory storage or excavation that— (a) is of equal volume, creating a balance of cut to fill; (b) is free draining; (c) is located within the premises; (d) does not adversely affect the hydraulic capacity of the flood channel or flood plain; (e) is provided to the corresponding level; and (f) is solely for the purpose of compensatory excavation and storage.	The development will not cause a loss in floodplain storage.
O13 Development relative to the pre-developed state both within and outside of the premises does not change the following flood characteristics for a flood event with a flood level up to and including the defined flood event— (a) peak flow; (b) the flow of any part of the hydrograph before the peak;	Compliant.

Column 1 Specific Outcomes	Column 2 Probable Solutions
(c) flood flow velocity or level of flooding; or (d) the hydrograph time to peak. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	
Extent or severity of flooding or flood risk	
O14 Earthworks are carried out above the defined limit equivalent to the flood level of the 10 year average recurrence interval local flood event.	Compliant.
O15 Stormwater quality treatment devices are located— (a) above the flood level of the 20 year average recurrence interval local flood event; and (b) above the flood level of the 50 year average recurrence interval regional flood event.	Compliant
O16 Stormwater quantity treatment devices are located— (a) above the flood level of the 50 year average recurrence interval local flood event; and (b) above the flood level of the 50 year average recurrence interval regional flood event.	It is proposed to use online storage to ameliorate the impact of development on runoff.
Access	
O17 Development provides access to a road which is— (a) above the flood level of the defined flood event; or (b) below the flood level of the defined flood event where the road— i. has a low flood hazard; ii. remains serviceable and trafficable having regard to the likely traffic densities and loads until another road access to the development may be restored; and iii. connects to a road which is above the flood level of the defined flood event that provides access to the road network. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant
O18 Development provides that the access area to a building or a fill area upon which a building is to be constructed is classified as a low flood hazard in the defined flood event. Note: Division 4, Table 4 provides guidelines for satisfying this specific outcome.	Compliant.

7 Conclusion

The above sections provide details of overall hydrologic and hydraulic models developed over the Flagstone City area. These models have been used to assess the flood impact from Flagstone City Masterplan demonstrating discernible adverse flood impacts downstream of the site due to mitigation of flows by the proposed Culverts and detention basins within the site. Furthermore upstream flood impacts in Sandy creek were found to be negligible at the Brisbane to Sydney Railway crossing.

8 Qualifications

This report has been prepared by Cardno specifically for Peet Limited and specifically to provide advice on Stormwater Management Planning for Flagstone Masterplan development at Teviot Road, Jimboomba.

The Real Property description of the development site includes The Real Property description is Lot 1 on RP35155, Lot 2 on RP47120, Lot 4 on RP45728, Lot 5 on S312569, Lot 9 on S312569, Lot 10 on SL6002, Lot 873 on SP166448, Lot 875 on SP146552, Lot 907 on RP819216, Lot 908 on RP819216, Lot 910 on RP857850, Lot 911 on RP857870, Lot 988 on CP857841 Lot 989 on RP854074 Parish of Mclean, County Stanley.

Our analysis and overall approach has been specifically catered for the particular requirements of Peet Limited, and may not be applicable beyond this scope. For this reason any other third parties are not authorised to utilise this report without further input and advice from Cardno.

Cardno has relied on the following information provided by others:

- Aerial LiDAR survey data obtained from the Department of Environment and Heritage Protection (DEHP);
- 1:25,000 topographic map ('Undullah'), produced by the Queensland Department of Mapping and Surveying (SUNMAP);
- Site layouts provided by RPS;
- Rainfall Data from the Greenbank Thompson Road station obtained from the Bureau of Meteorology; and
- Cardno report titled, *'Flagstone Stages 14A, 14B, 15A, 15B, 15C and 15D, Hydraulic Analysis'* dated November 2009 (ref 3503-62).

The accuracy of the report is dependent upon the accuracy of this information.

While Cardno's report accurately assesses peak flows from design storms, it is an ungauged catchment; consequently future observed flows may vary from that predicted.

9 References

Cardno, November 2009, *'Flagstone Stages 14A, 14B, 15A, 15B, 15C and 15D, Hydraulic Analysis'* (ref 3503-62).

Department of Natural Resources and Water, 2008, *Queensland Urban Drainage Manual*

Logan City Council, 2010, *'Draft Interim Standards for Stormwater, Overland Flow and Flood Plain Management'*

Logan City Council, 2012, *'Temporary Local Planning Instrument No. 1 (Logan Interim Flood Response) 2011'*

FIGURES

Cardno
Shaping the Future

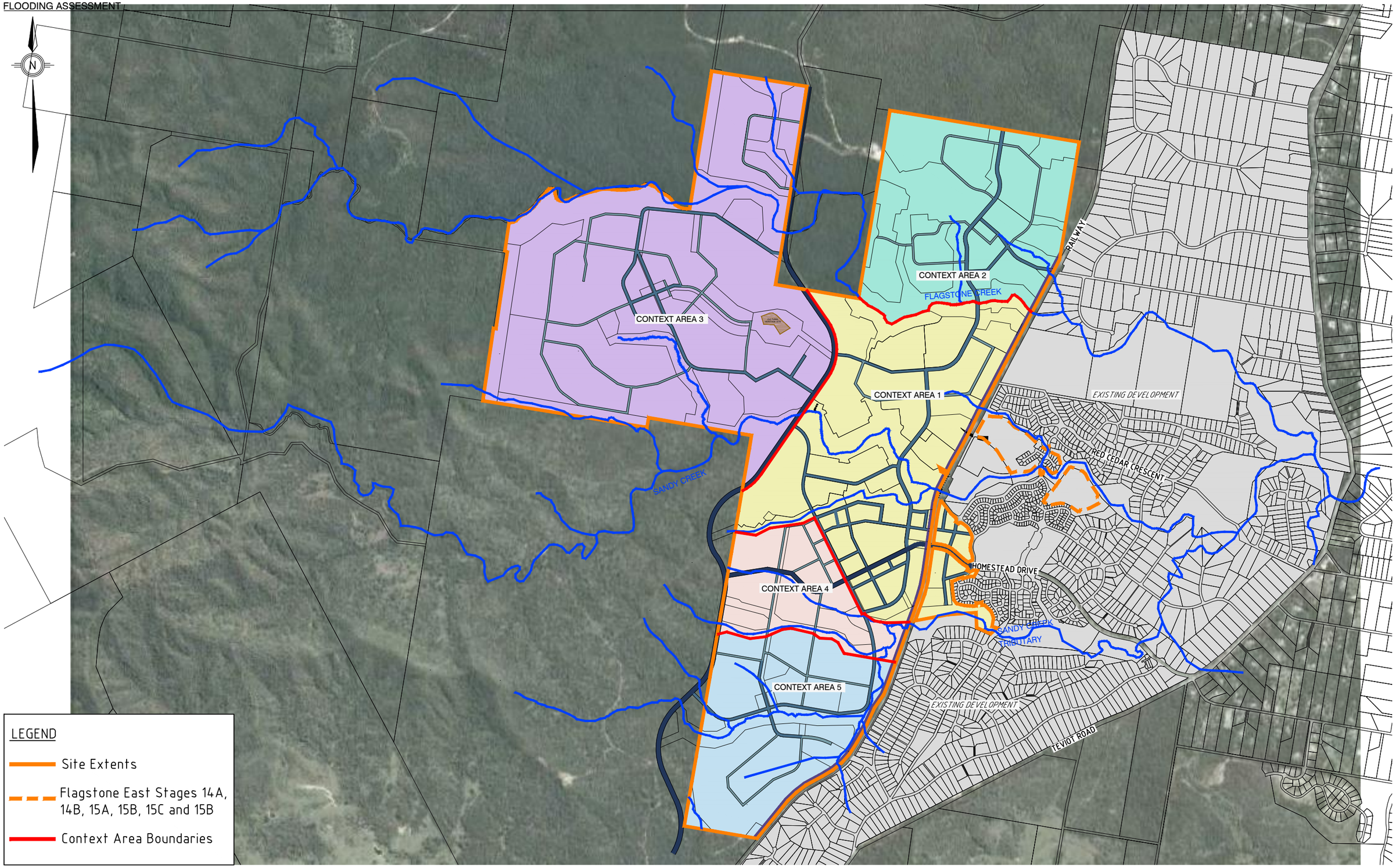

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FIGURE 1
SITE LOCATION AND LAYOUT PLAN

Rev: Orig. Date: August 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

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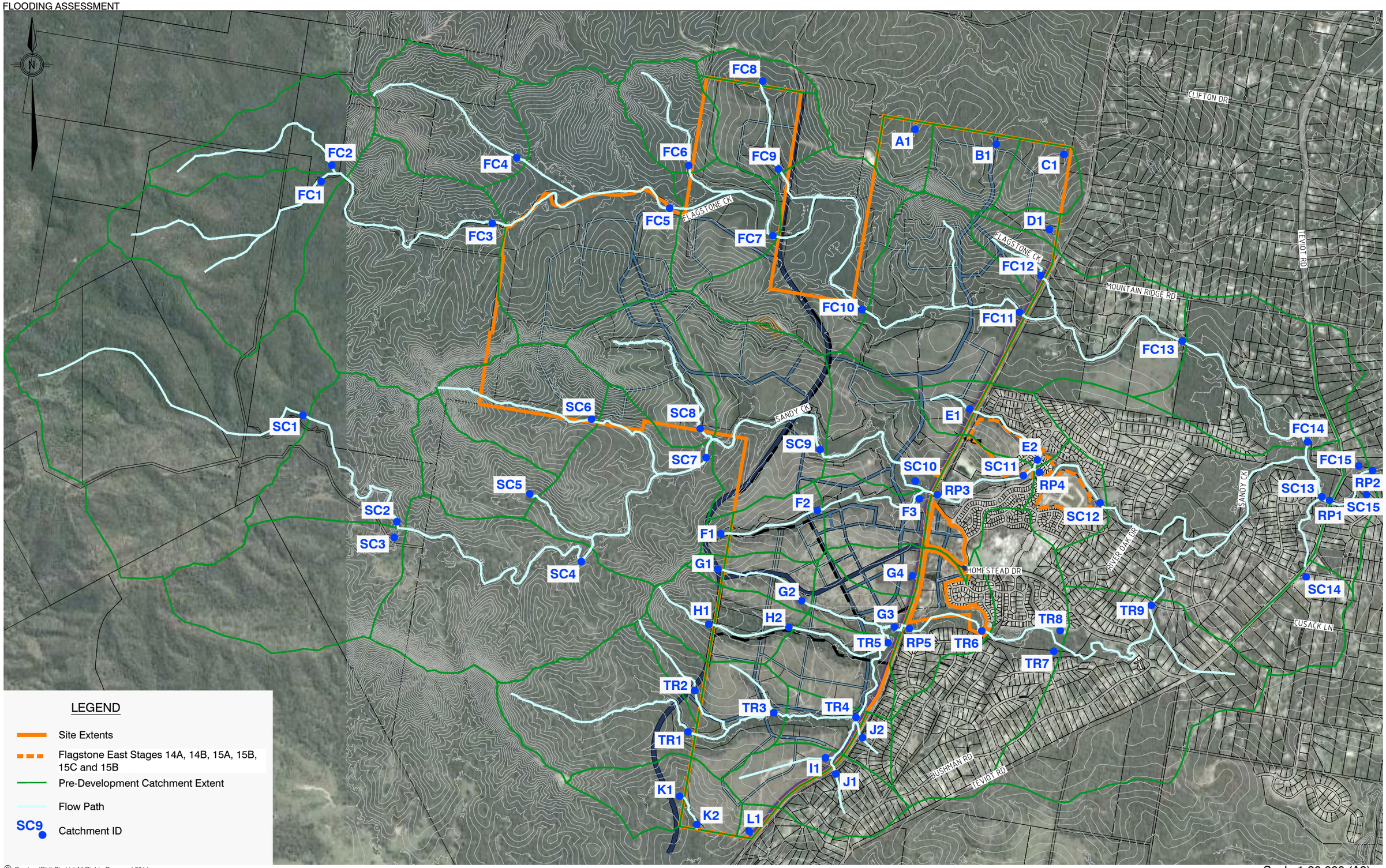
XREF's: 110056-262-STRUCTURE_OPT2L_grey

PRINT DATE: 05 September, 2014 - 12:52pm

FLAGSTONE CITY - MASTERPLAN
FLOODING ASSESSMENT

Cardno



LEGEND

- Site Extents
- Flagstone East Stages 14A, 14B, 15A, 15B, 15C and 15B
- Pre-Development Catchment Extent
- Flow Path
- SC9 Catchment ID

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1:30,000

Scale 1:30,000 (A3)

FIGURE 2
WBNM MODEL - PRE-DEVELOPMENT CATCHMENT LAYOUT

Rev: Orig. Date: AUGUST 2014

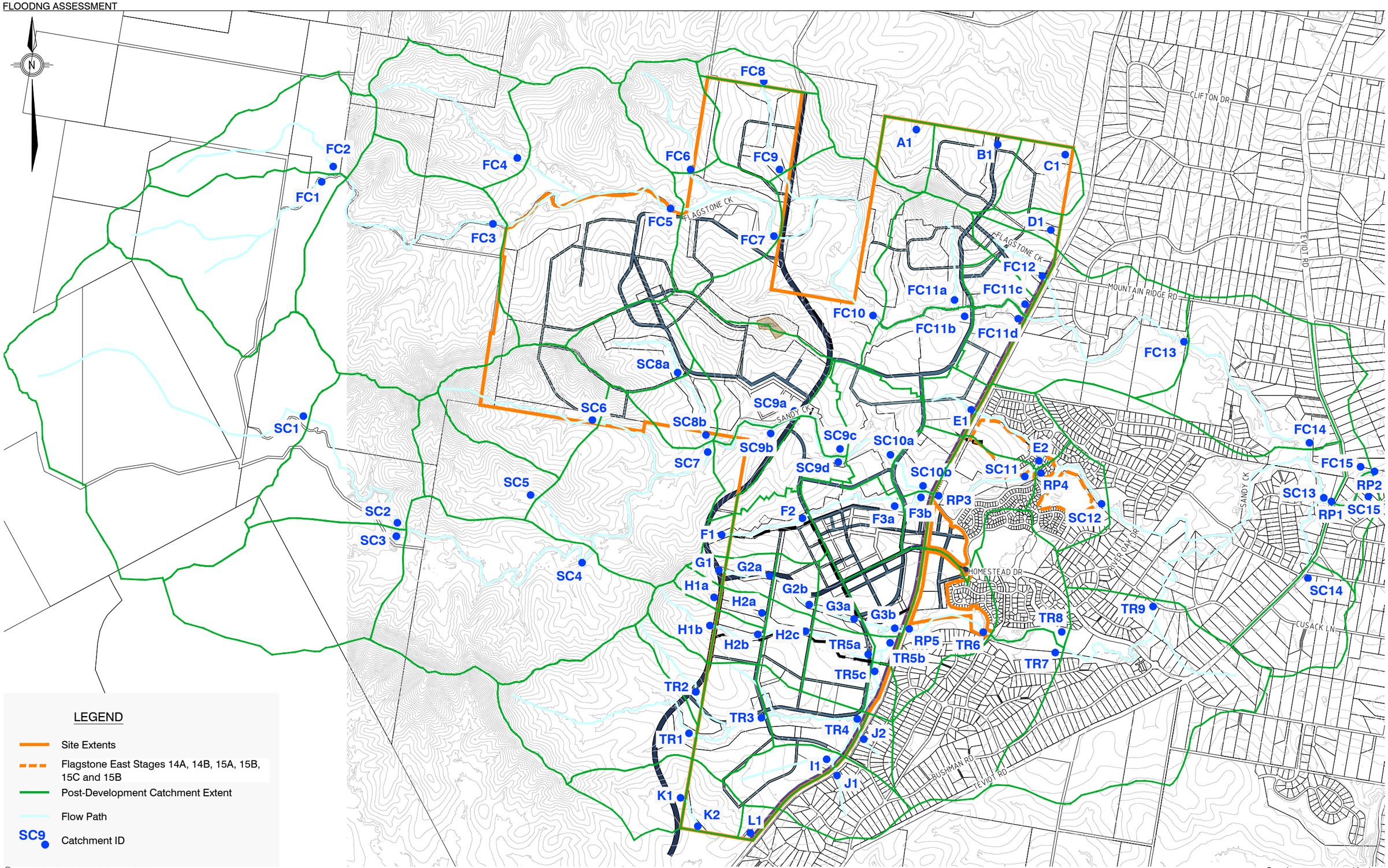
Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Figures\R1V2__Masterplan__ Flooding\Fig 2 and 3 - WBNM Pre and Post Dev.dwg
XREF's: Existing Contours; 110056-262-STRUCTURE__OPT2L__grey; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:44pm

Cardno



LEGEND

- Site Extents
- Flagstone East Stages 14A, 14B, 15A, 15B, 15C and 15B
- Post-Development Catchment Extent
- Flow Path
- SC9 Catchment ID

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1:30,000

Scale 1:30,000 (A3)

FIGURE 3

WBNM MODEL - MASTERPLAN POST-DEVELOPMENT CATCHMENT LAYOUT

Rev: Orig. Date: AUGUST 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Figures\R1V2__Masterplan__ Flooding\Fig 2 and 3 - WBNM Pre and Post Dev.dwg
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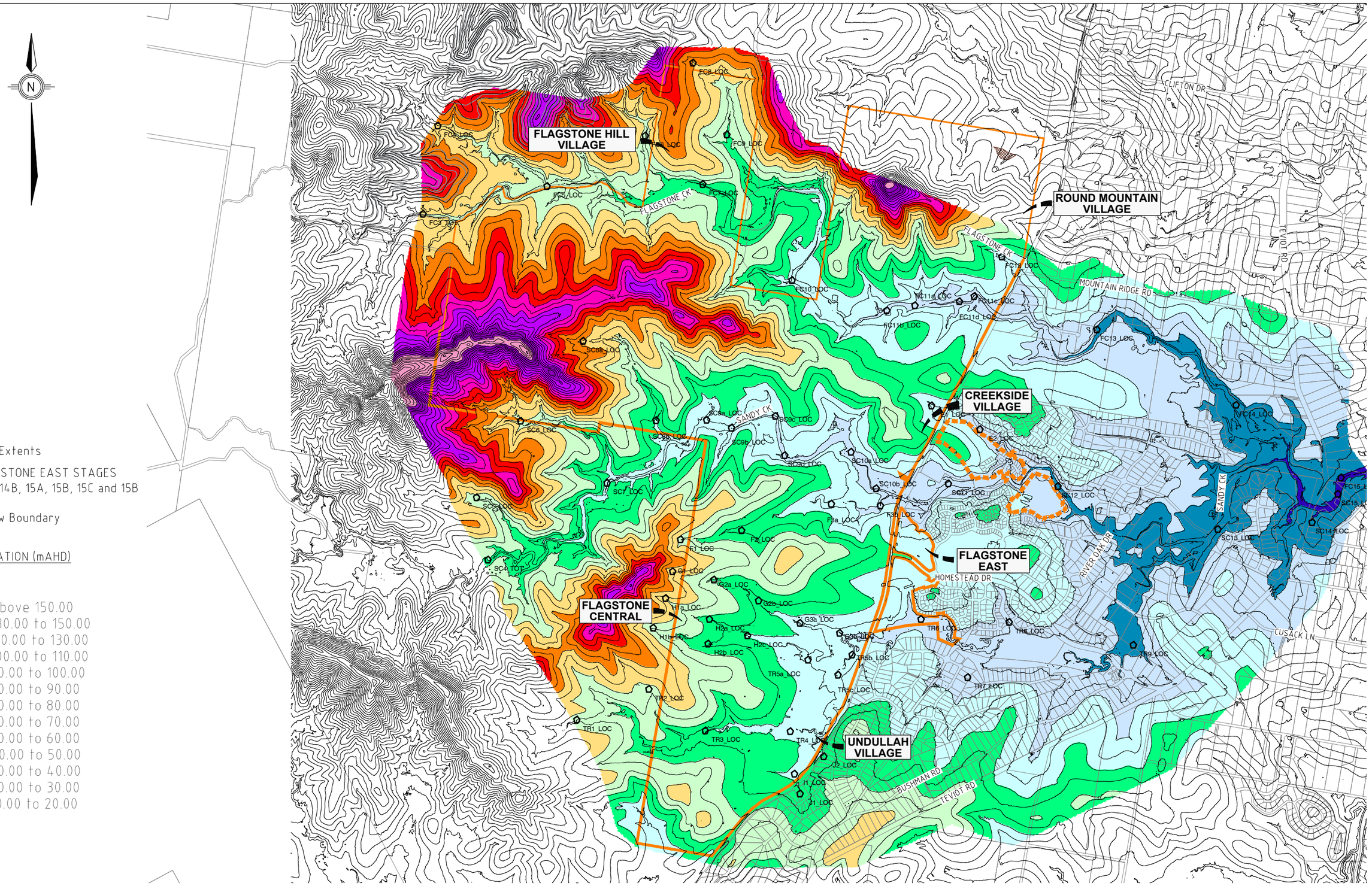

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- FC3_TOT Inflow Boundary

ELEVATION (mAHD)

- Above 150.00
- 130.00 to 150.00
- 110.00 to 130.00
- 100.00 to 110.00
- 90.00 to 100.00
- 80.00 to 90.00
- 70.00 to 80.00
- 60.00 to 70.00
- 50.00 to 60.00
- 40.00 to 50.00
- 30.00 to 40.00
- 20.00 to 30.00
- 10.00 to 20.00

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:30000 (A3)

FIGURE 4

TUFLOW Model - Pre-Development Model Topography and Boundary Locations

Rev: Orig. Date: August 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Figures\R1V2_ Masterplan_ Flooding\Fig 4_TUFLOW Pre-Dev Topo and Bdy Locations2.dwg
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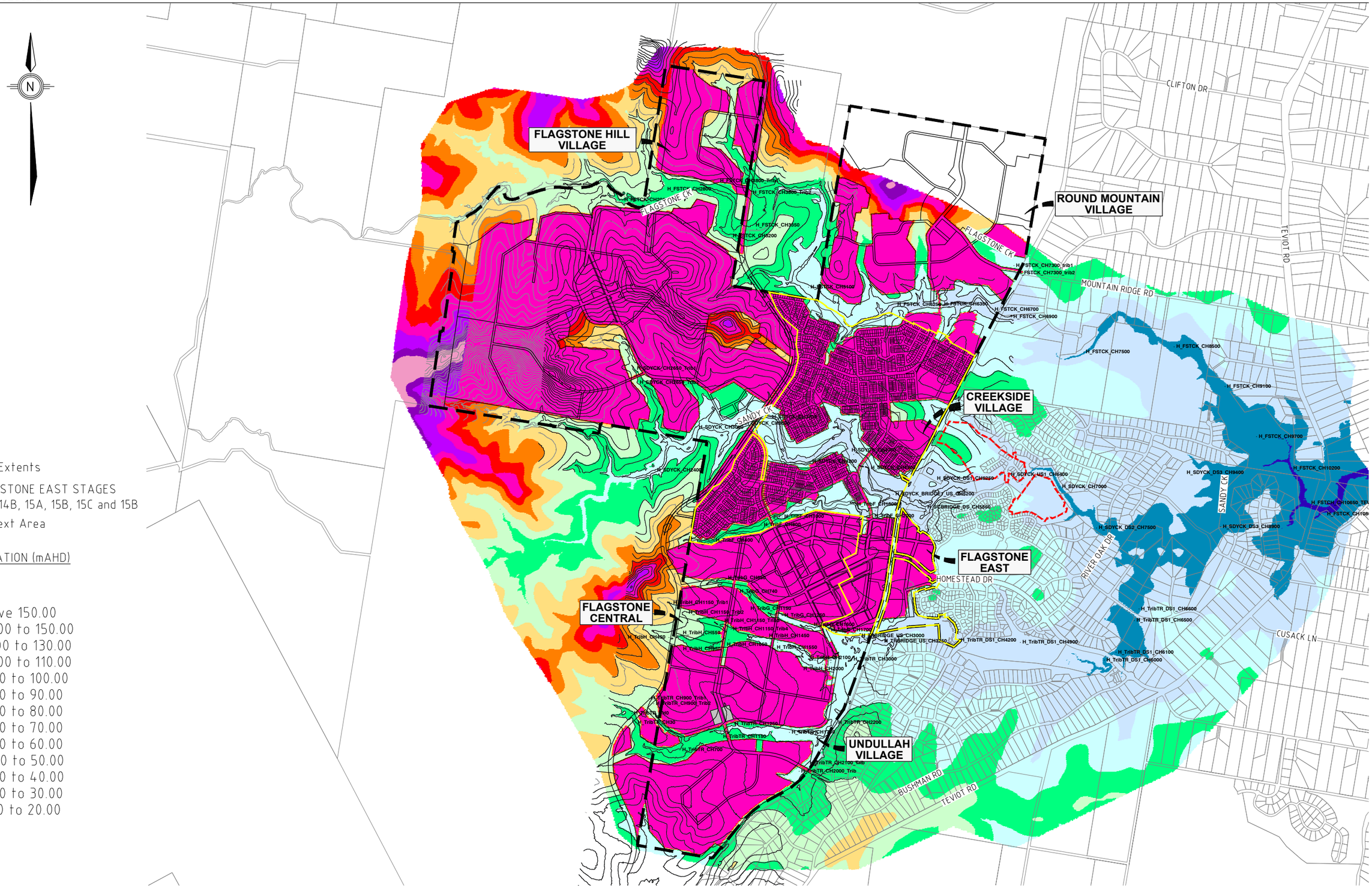

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FIGURE 5

TUFLOW Model - Post-Development Model Topography and Reporting Points

Rev: Orig. Date: August 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

PRINT DATE: 05 September, 2014 - 12:49pm

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Flagstone City-Masterplan

REFERENCE DRAWINGS

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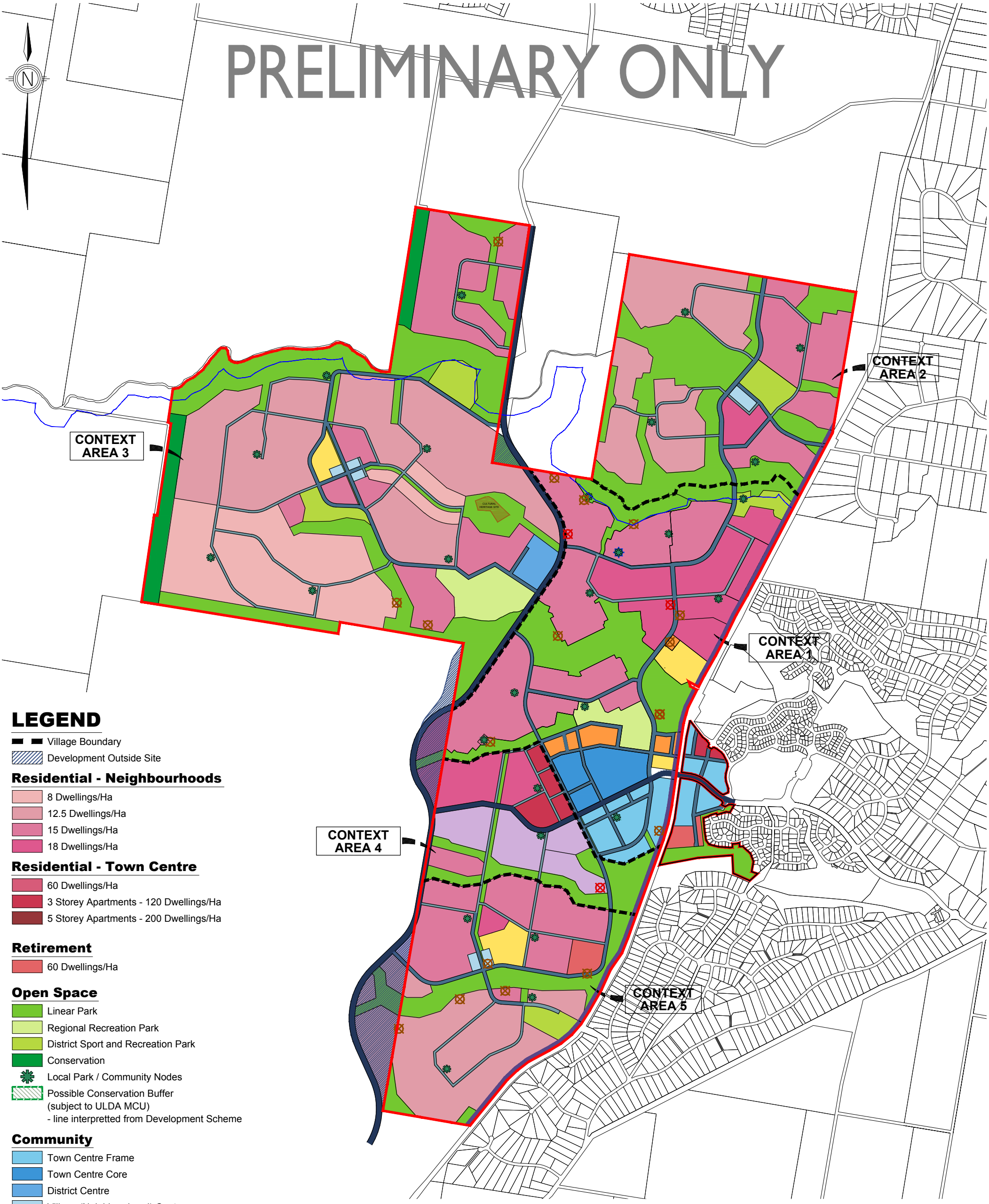
Shaping the Future

PRELIMINARY ONLY



LEGEND

- Village Boundary
- Development Outside Site

Residential - Neighbourhoods

- 8 Dwellings/Ha
- 12.5 Dwellings/Ha
- 15 Dwellings/Ha
- 18 Dwellings/Ha

Residential - Town Centre

- 60 Dwellings/Ha
- 3 Storey Apartments - 120 Dwellings/Ha
- 5 Storey Apartments - 200 Dwellings/Ha

Retirement

- 60 Dwellings/Ha

Open Space

- Linear Park
- Regional Recreation Park
- District Sport and Recreation Park
- Conservation
- Local Park / Community Nodes
- Possible Conservation Buffer (subject to ULDA MCU) - line interpretted from Development Scheme

Community

- Town Centre Frame
- Town Centre Core
- District Centre
- Village (Neighbourhood) Centre
- Mixed Use (Residential & Commercial)
- Employment
- Education

Heritage Sites

- Burial Site
- Test Pit Location
- Surface Collection Location
- Test Trench Location

Road Hierachy

- North-South Arterial (40m Wide)
- Village Connector Roads (24 - 26m Wide)
- Neighbourhood Streets (18.5 - 21m Wide)
- Private or Public Streets (18m Wide)

Rail

- Potential Land Dedication – Salisbury to Beaudesert Rail Corridor
  Note: Refer condition 15 DEV2012/209

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.
Heritage Information: Jagera Daran

RPS

SCALE 1 : 25,000 @ A3

0 200 400 800 1200 1600

STRUCTURE PLAN - OPTION 2L

FLAGSTONE

DATE : 01 July 2014 DWG NAME : 110056-262-STRUCTURE_OPT2L DWG # 110056-262-3

LEGEND

Residential - Neighbourhoods
- 8 Dwellings/Ha
- 12.5 Dwellings/Ha
- 15 Dwellings/Ha
- 18 Dwellings/Ha

Residential - Town Centre
- 3 Storey Apartments - 120 Dwellings/Ha

Retirement
- 60 Dwellings/Ha

Open Space
- Linear Park
- Regional Recreation Park
- District Sport and Recreation Park
- Conservation
- Local Park / Community Nodes

Community
- Town Centre Frame
- Town Centre Core
- District Centre
- Village (Neighbourhood) Centre
- Mixed Use (Residential & Commercial)
- Employment
- Education

Rail
- Potential Land Dedication – Salisbury to Beaudesert Rail Corridor
  Note: Refer condition 15 DEV2012/209

RPS

SCALE 1 : 10,000 @ A1

0 100 200 400 600 800 1000

DATE : 01 July 2014 DWG NAME : 110056-262-STRUCTURE_OPT2L DWG # 110056-262-4

Structure Plan - Option 2L With Aerial

PEET **FLAGSTONE**

Flagstone City-Masterplan

APPENDIX A

WBNM Catchment Details

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Pre-Development (Case EU04a) – Catchment Areas (ha)				
Catchment Name	Forest	External Urban	Total Area	Overall Catchment Fraction Impervious
A1	24.62		24.62	0%
B1	42.22		42.22	0%
C1	35.03		35.03	0%
D1	11.25		11.25	0%
E1	19.99		19.99	0%
E2	12.35	26.18	38.53	41%
F1	7.10		7.10	0%
F2	39.95		39.95	0%
F3	47.08		47.08	0%
G1	5.31		5.31	0%
G2	27.79		27.79	0%
G3	33.87		33.87	0%
G4	25.84		25.84	0%
H1	31.02		31.02	0%
H2	36.48		36.48	0%
I1	32.73		32.73	0%
J1		45.95	45.95	60%
J2		15.43	15.43	60%
K1	42.67		42.67	0%
K2	22.59		22.59	0%
L1	6.04		6.04	0%
TR1	137.87		137.87	0%
TR2	20.78		20.78	0%
TR3	59.02		59.02	0%
TR4	26.59		26.59	0%
TR5	56.09	5.38	61.47	5%
TR6	18.95	49.23	68.18	43%
TR7		132.48	132.48	60%
TR8		62.72	62.72	60%
TR9		244.80	244.80	60%
FC1	174.37		174.37	0%
FC2	102.29		102.29	0%
FC3	281.95		281.95	0%
FC4	116.92		116.92	0%
FC5	268.34		268.34	0%
FC6	58.97		58.97	0%
FC7	74.20		74.20	0%
FC8	21.23		21.23	0%

Pre-Development (Case EU04a) – Catchment Areas (ha)				
Catchment Name	Forest	External Urban	Total Area	Overall Catchment Fraction Impervious
FC9	64.52		64.52	0%
FC10	167.14		167.14	0%
FC11	169.02		169.02	0%
FC12	24.48		24.48	0%
FC13		135.99	135.99	60%
FC14		144.34	144.34	60%
FC15		36.02	36.02	60%
SC1	464.95		464.95	0%
SC2	129.00		129.00	0%
SC3	167.16		167.16	0%
SC4	236.71		236.71	0%
SC5	69.24		69.24	0%
SC6	103.98		103.98	0%
SC7	157.43		157.43	0%
SC8	88.52		88.52	0%
SC9	154.44		154.44	0%
SC10	86.96		86.96	0%
SC11	13.14	45.50	58.64	47%
SC12	11.44	32.90	44.34	45%
SC13		322.82	322.82	60%
SC14		60.76	60.76	60%
SC15		27.18	27.18	60%
Totals	4029.65	1387.68	5417.3	

Post-Development (Case DU03b) – Catchment Areas (ha)												
Catchment	Forest	External Urban	Conservation	Park Area	Open Space	Residential Low Density	Residential Med Density	Residential High Density	Schools	Commercial / Town Centre	Total Area	Catchment Fraction Impervious
A1				5.67			18.95				24.62	46%
B1				11.51			30.71				42.22	44%
C1	5.34			7.06			22.63				35.03	39%
D1				4.60			6.65				11.25	35%
E1							22.18				22.18	60%
E2		38.53									38.53	60%
F1	7.10										7.1	0%
F2				5.41			19.96	5.41		4.75	35.53	59%
F3a				12.88			13.71	1.17		24.09	51.85	60%
F3b				3.19					1.36	5.63	10.18	59%
G1	5.31										5.31	0%
G2a							8.25			5.08	13.33	71%
G2b				0.89			2.31	2.31		10.09	15.6	73%
G3a				2.10						13.74	15.84	78%
G3b				4.92						27.3	32.22	76%
H1a	7.91										7.91	0%
H1b	23.11										23.11	0%
H2a				2.38			2.81			4.72	9.91	60%
H2b				3.03			12.68				15.71	48%
H2c				3.38			16.86		1.76	1.44	23.44	56%
I1				4.37			28.36				32.73	52%
J1		45.95									45.95	60%
J2		15.43									15.43	60%
K1	42.67										42.67	0%

Post-Development (Case DU03b) – Catchment Areas (ha)												
Catchment	Forest	External Urban	Conservation	Park Area	Open Space	Residential Low Density	Residential Med Density	Residential High Density	Schools	Commercial / Town Centre	Total Area	Catchment Fraction Impervious
K2				2.99			19.60				22.59	52%
L1				0.83			5.21				6.04	52%
TR1	137.87										137.87	0%
TR2	20.78										20.78	0%
TR3				8.21			39.13			0.78	48.12	50%
TR4				11.02			17.75		5.33	3.38	37.48	46%
TR5a				4.78			21.14			8.13	34.05	59%
TR5b			4.56								4.56	0%
TR5c		5.40	4.87								10.27	32%
TR6	7.58	41.47	7.98				5.17			5.98	68.18	49%
TR7		132.48									132.48	60%
TR8		62.72									62.72	60%
TR9		244.80									244.8	60%
FC1	174.37										174.37	0%
FC2	102.29										102.29	0%
FC3	274.04		4.95			2.96					281.95	1%
FC4	116.92										116.92	0%
FC5	118.79		5.80	32.29			105.98		4.08	1.4	268.34	26%
FC6	50.81		8.42								59.23	0%
FC7	3.37		32.31				39.24				74.92	31%
FC8	21.23										21.23	0%
FC9	12.74			10.97			39.84				63.55	38%
FC10	78			22.64			77.09				177.73	26%
FC11a				39.9			26.61	3.95		0.21	70.67	28%

Post-Development (Case DU03b) – Catchment Areas (ha)												
Catchment	Forest	External Urban	Conservation	Park Area	Open Space	Residential Low Density	Residential Med Density	Residential High Density	Schools	Commercial / Town Centre	Total Area	Catchment Fraction Impervious
FC11b				15.18			26.31	4.0			45.49	42%
FC11c				7.71			8.23	2.0			17.94	37%
FC11d				11.50				12.81			24.31	45%
FC12				9.77			12.46	0.83		1.42	24.48	39%
FC13		135.99									135.99	60%
FC14		144.34									144.34	60%
FC15		36.02									36.02	60%
SC1	464.95										464.95	0%
SC2	129.00										129	0%
SC3	167.16										167.16	0%
SC4	236.71										236.71	0%
SC5	69.24										69.24	0%
SC6	50.84		4.85	8.28		40.01					103.98	19%
SC7	147.53			3.18		6.72					157.43	2%
SC8a				13.99		33.83	7.58			0.12	55.11	39%
SC8b	5.94			6.63		14.57	6.0				33.41	33%
SC9a	0.94			29.11		31.27	21.3			6.75	89.37	39%
SC9b	13.79			11.35			6.57				28.05	14%
SC9c				5.72			9.61				15.33	38%
SC9d				7.01			24.42				31.43	47%
SC10a				15.05			37.35				52.4	43%
SC10b				7.79			7.42		6.78	0.6	22.59	43%
SC11		49.64		0.15						8.85	58.64	64%
SC12		44.34									44.34	60%

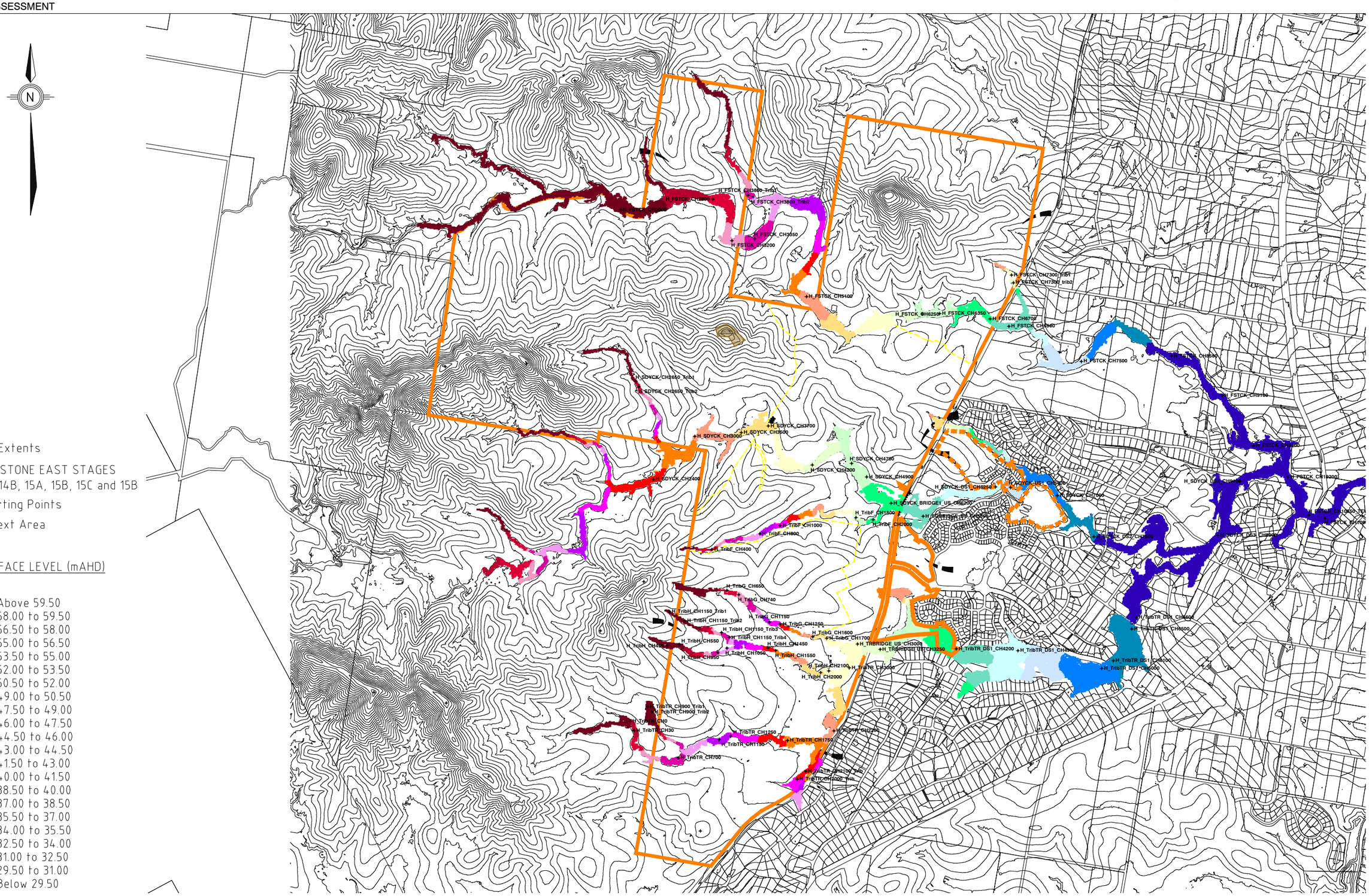
Post-Development (Case DU03b) – Catchment Areas (ha)												
Catchment	Forest	External Urban	Conservation	Park Area	Open Space	Residential Low Density	Residential Med Density	Residential High Density	Schools	Commercial / Town Centre	Total Area	Catchment Fraction Impervious
SC13		322.82									322.82	60%
SC14		60.76									60.76	60%
SC15		27.18									27.18	60%
Total Areas	2501.93	1407.22	369.47	14.09	24.66	111.49	767.57	32.29	26.96	161.62	5417.3	

Flagstone City-Masterplan

APPENDIX B

Pre-Development Flooding Conditions (TUFLOW Results)

Cardno
Shaping the Future



Scale 1:30000 (A3)

FIGURE B1

100 Year ARI - Pre-Development Case E21e - Peak Water Surface Levels

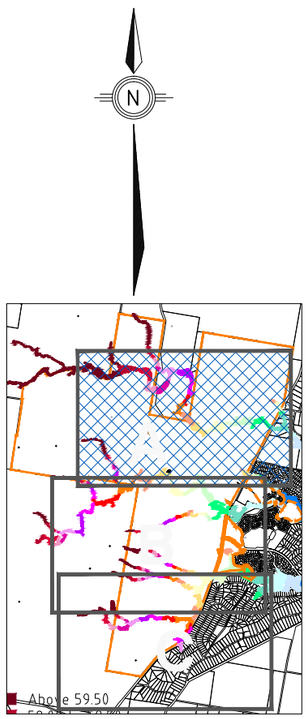
Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase03Z\FloodingMasterPlan\ACAD\Figures\AppB_TUFLOW Pre-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey

PRINT DATE: 05 September, 2014 - 12:09pm



LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50

Scale 1:10000 (A3)

FIGURE B1.1 (A)

100 Year ARI - Pre-Development Case E21e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

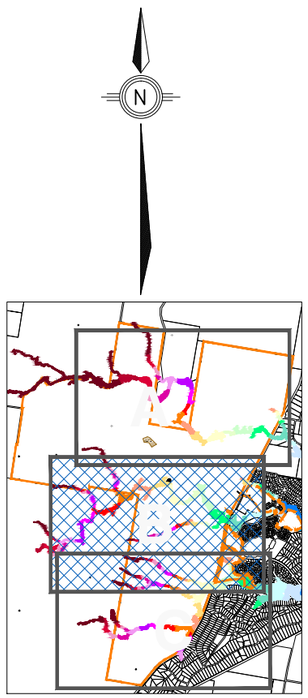
Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppB_TUFLOW Pre-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey

PRINT DATE: 05 September, 2014 - 12:09pm

Cardno



LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50

H_SDYCK_CH2650_Trib1
H_SDYCK_CH2650_Trib2
H_SDYCK_CH3700
H_SDYCK_CH3500
H_SDYCK_CH3000
H_SDYCK_CH4700
H_SDYCK_CH4200
H_SDYCK_CH4900
H_SDYCK_DS1_CH
H_SDYCK_CH2400
H_SDYCK_BRIDGE1_US_CH5200
H_TribF_CH1800
H_SCBRIDGE_DS_CH5
H_TribF_CH2000
H_TribF_CH1000
H_TribF_CH800
H_TribF_CH400
H_TribG_CH650
H_TribG_CH740
H_TribH_CH1150_Trib1
H_TribG_CH1150
H_TribH_CH1150_Trib2
H_TribG_CH1250
H_TribH_CH1150_Trib3
H_TribG_CH1600
H_TribH_CH1150_Trib4
H_TribG_CH1700

100 0 100 200 300 400 500m
1:10,000

Scale 1:10000 (A3)

FIGURE B1.1 (B)

100 Year ARI - Pre-Development Case E21e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppB_TUFLOW Pre-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey

PRINT DATE: 05 September, 2014 - 12:10pm

Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50

H_TribG_CH650
H_TribG_CH740
H_TribH_CH1150_Trib1
H_TribH_CH1150_Trib2
H_TribG_CH1150
H_TribG_CH1250
H_TribH_CH1150_Trib3
H_TribG_CH1600
H_TribH_CH1150_Trib4
H_TribG_CH1700
H_TribH_CH550
H_TRBRIDGE_US_CH3000
H_TribH_CH450
H_TribH_CH1450
H_TRBRIDGE_US_CH3250
H_TribTR_DS1_
H_TribH_CH1050
H_TribH_CH1550
H_TribH_CH950
H_TribH_CH2100
H_TribTR_CH3000
H_TribH_CH2000
H_TribTR_CH900_Trib1
H_TribTR_CH900_Trib2
H_TribTR_CH0
H_TribTR_CH30
H_TribTR_CH1250
H_TribTR_CH2200
H_TribTR_CH1750
H_TribTR_CH1150
H_TribTR_CH700
H_TribTR_CH2100_Trib
H_TribTR_CH2000_Trib

100 0 100 200 300 400 500m
1:10,000

Scale 1:10000 (A3)

FIGURE B1.1 (C)

100 Year ARI - Pre-Development Case E21e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase03ZFloodingMasterPlan\ACAD\Figures\AppB_TUFLOW Pre-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey

PRINT DATE: 05 September, 2014 - 12:10pm

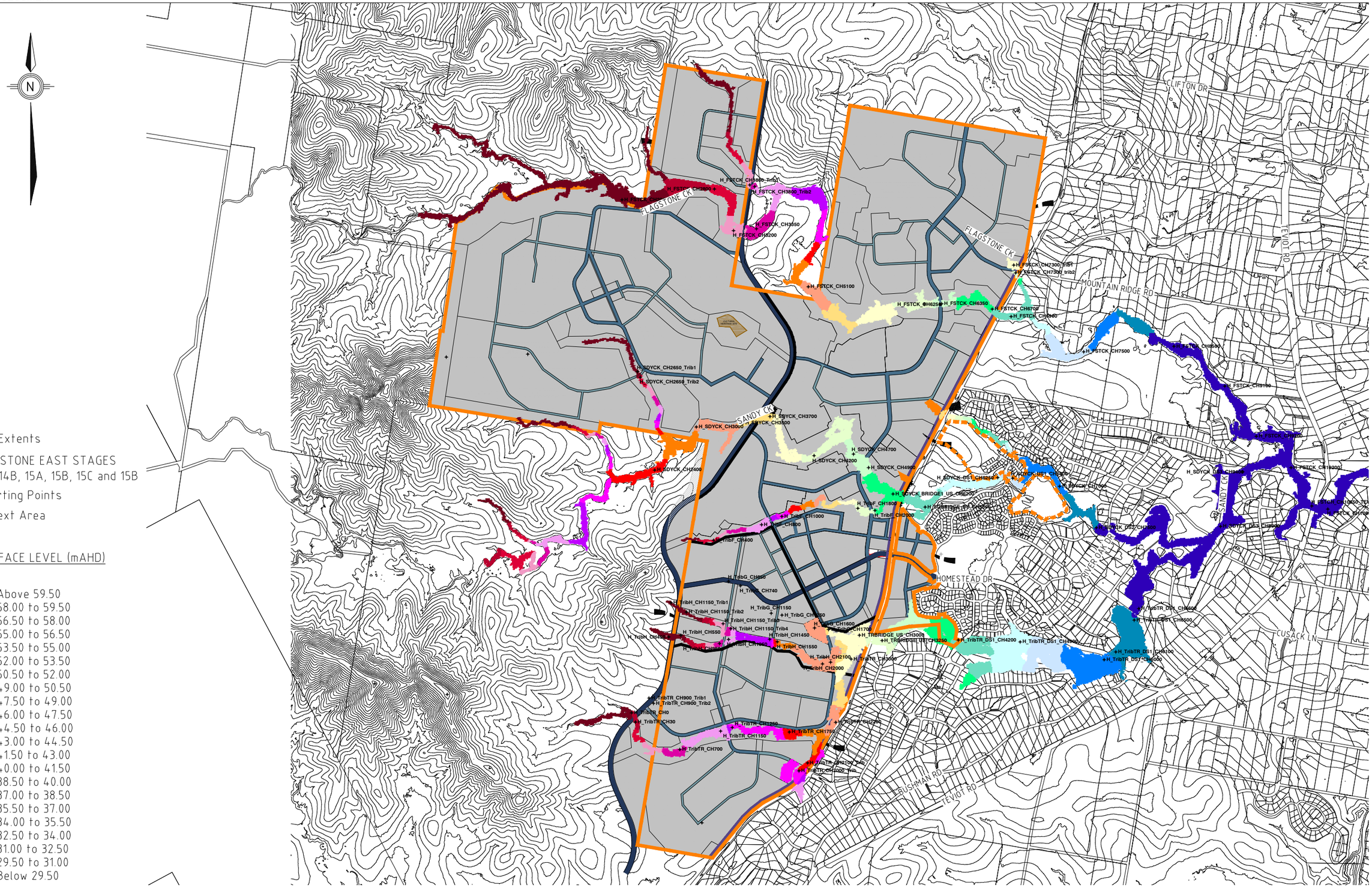
Flagstone City-Masterplan

APPENDIX C

Post-Development Flooding Conditions (TUFLOW Results)

Cardno
Shaping the Future

Cardno



Scale 1:30000 (A3)

FIGURE C1

100 Year ARI - Post-Development Case M32e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

PRINT DATE: 05 September, 2014 - 12:18pm

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppC_TUFLOW Post-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey; X-Road and Creek labels

LEGEND

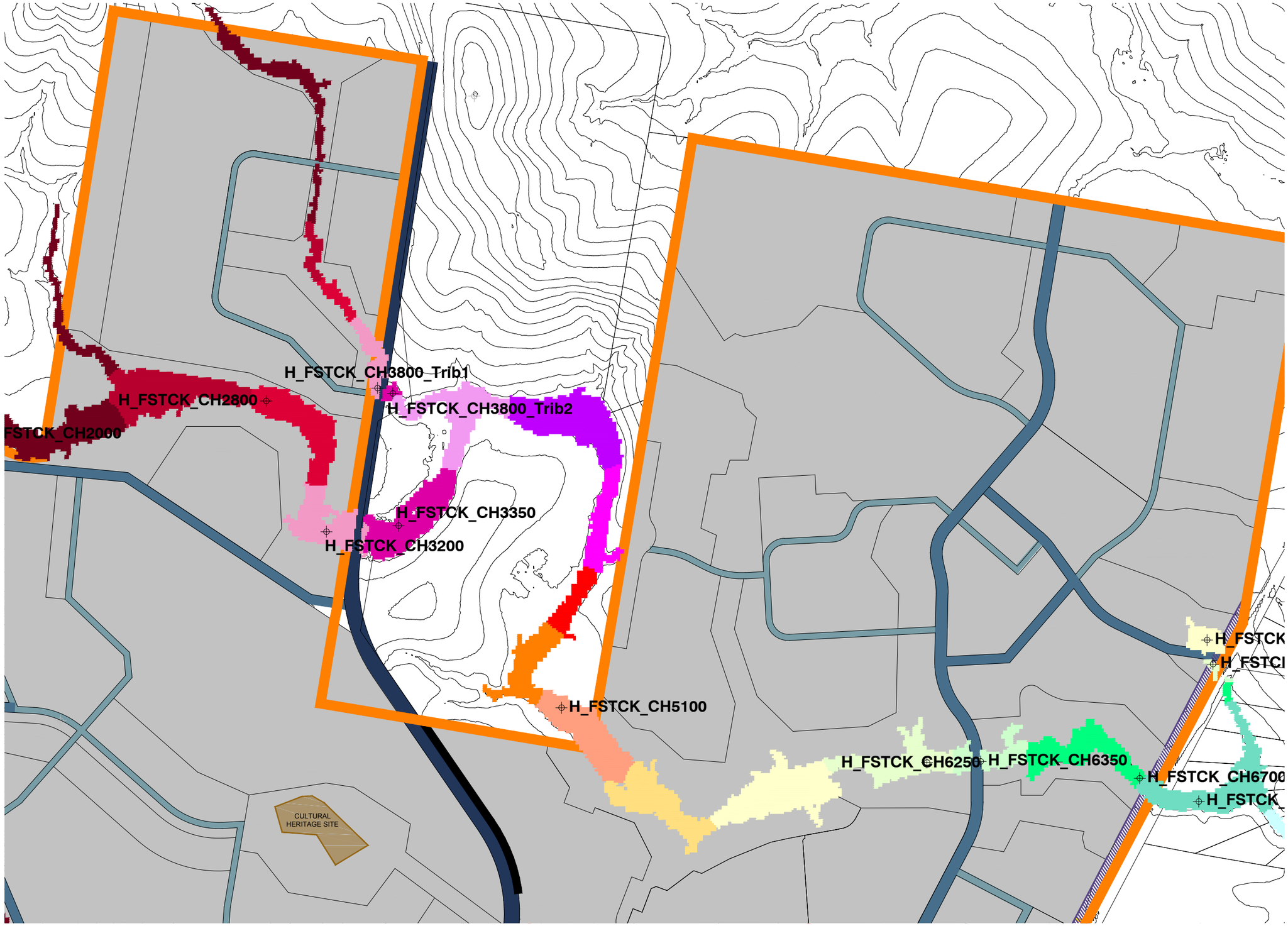
Site Extents

FLAGSTONE EAST STAGES
14A, 14B, 15A, 15B, 15C and 15B

Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50



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1:10,000

Scale 1:10000 (A3)

FIGURE C1.1 (A)

100 Year ARI - Post-Development Case M32e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppC_TUFLOW Post-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:20pm

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50

100 0 100 200 300 400 500m
1:10,000

Scale 1:10000 (A3)

FIGURE C1.1 (B)

100 Year ARI - Post-Development Case M32e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppC_TUFLOW Post-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; E21eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:20pm

Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

WATER SURFACE LEVEL (mAHD)

- Above 59.50
- 58.00 to 59.50
- 56.50 to 58.00
- 55.00 to 56.50
- 53.50 to 55.00
- 52.00 to 53.50
- 50.50 to 52.00
- 49.00 to 50.50
- 47.50 to 49.00
- 46.00 to 47.50
- 44.50 to 46.00
- 43.00 to 44.50
- 41.50 to 43.00
- 40.00 to 41.50
- 38.50 to 40.00
- 37.00 to 38.50
- 35.50 to 37.00
- 34.00 to 35.50
- 32.50 to 34.00
- 31.00 to 32.50
- 29.50 to 31.00
- Below 29.50

100 0 100 200 300 400 500m
1:10,000

Scale 1:10000 (A3)

FIGURE C1.1 (C)

100 Year ARI - Post-Development Case M32e - Peak Water Surface Levels

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase03ZFloodingMasterPlan\ACAD\Figures\AppC_TUFLOW Post-Dev WSL.dwg
XREF's: Existing Contours; WSL_Reporting points_All_Points_moved; EZ1eTuflow_Results; 110056-262-STRUCTURE_OPT2L_grey; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:20pm

Flagstone City-Masterplan

APPENDIX D

Post-Development Predicted Impacts (TUFLOW Results)

Cardno
Shaping the Future

Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Context Area
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:30000 (A3)

FIGURE D1

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

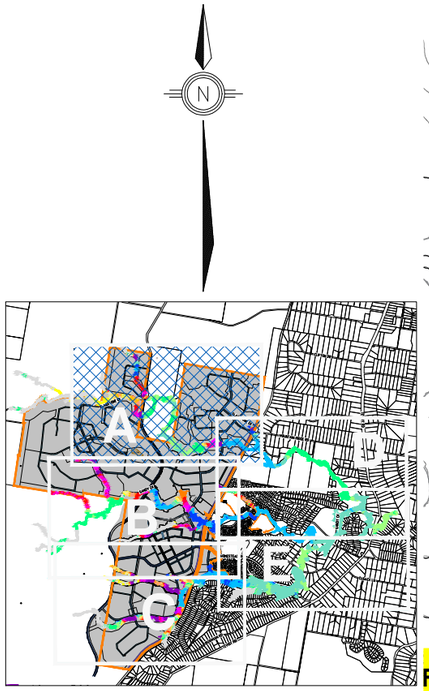
Project No.: 7217/43

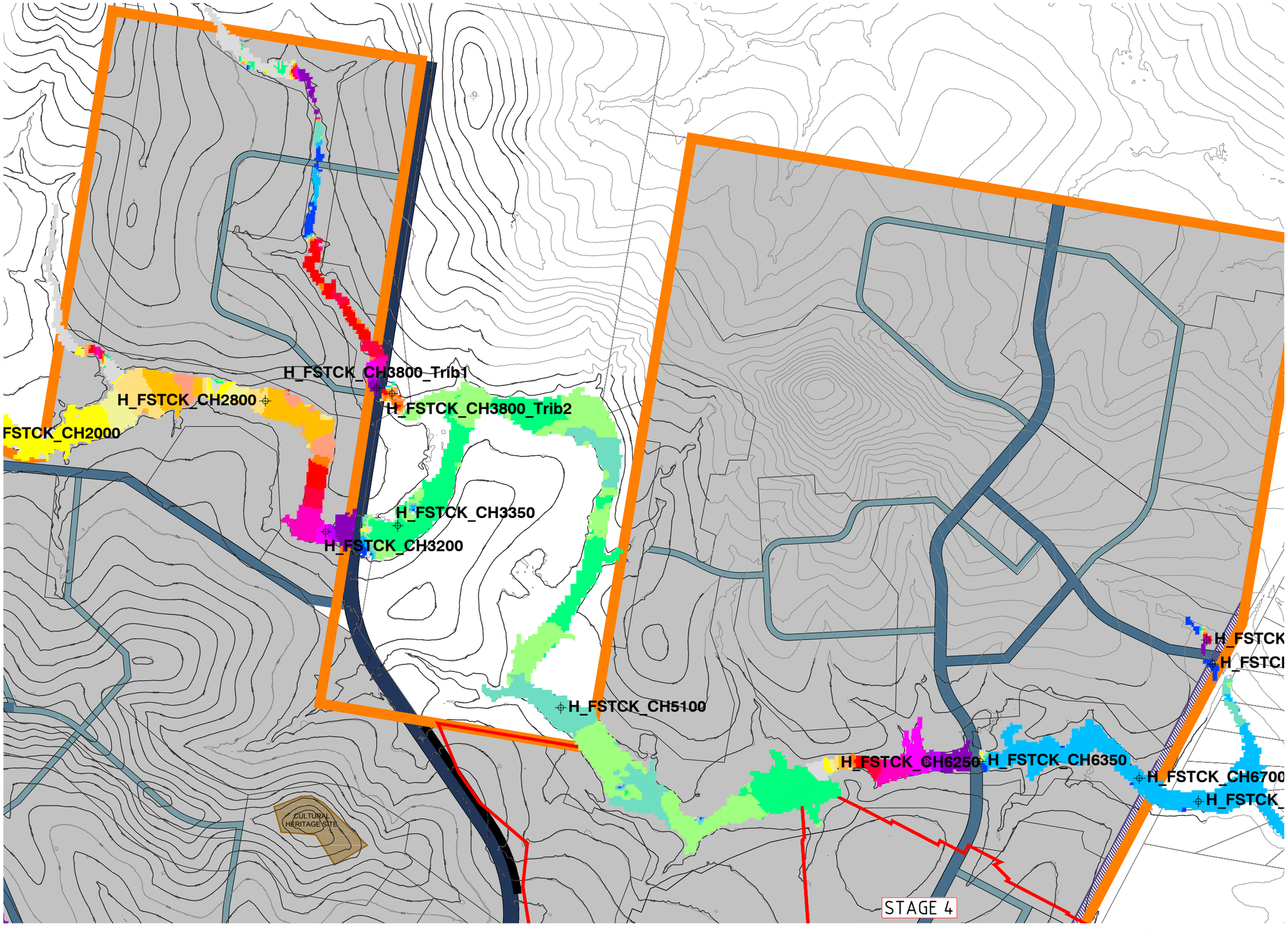
Peet Flagstone City Pty Ltd

PRINT DATE: 05 September, 2014 - 12:29pm

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

Cardno





LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:10000 (A3)

FIGURE D1.1 (A)

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

PRINT DATE: 05 September, 2014 - 12:29pm

CAD FILE: O:\7217-43\Phase03\FloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Context Area
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:10000 (A3)

FIGURE D1.1 (B)

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

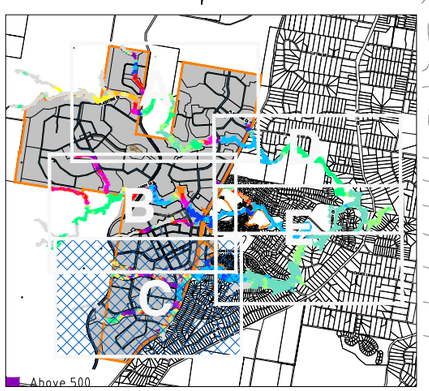
Project No.: 7217/43

Peet Flagstone City Pty Ltd

PRINT DATE: 05 September, 2014 - 12:30pm

CAD FILE: O:\7217-43\Phase03ZFloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREFs: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

Cardno



LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Context Area
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100

STAGE 6

H_TribG_CH650
H_TribG_CH740
H_TribH_CH1150_Trib1
H_TribH_CH1150_Trib2
H_TribG_CH1150
H_TribG_CH1250
H_TribH_CH1150_Trib3
H_TribG_CH1600
H_TribH_CH1150_Trib4
H_TribG_CH1700
H_TribH_CH550
H_TribH_CH450
H_TribH_CH1450
H_TRBRIDGE_US_CH3000
H_TRBRIDGE_US_CH3250
H_TribTR_DS1_
H_TribH_CH950
H_TribH_CH1550
H_TribH_CH2100
H_TribTR_CH3000
H_TribH_CH2000
H_TribTR_CH900_Trib1
H_TribTR_CH900_Trib2
H_TribTR_CH0
H_TribTR_CH30
H_TribTR_CH1250
H_TribTR_CH2200
H_TribTR_CH1750
H_TribTR_CH1150
H_TribTR_CH700
H_TribTR_CH2100_Trib
H_TribTR_CH2000_Trib

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:10000 (A3)

FIGURE D1.1 (C)

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:30pm

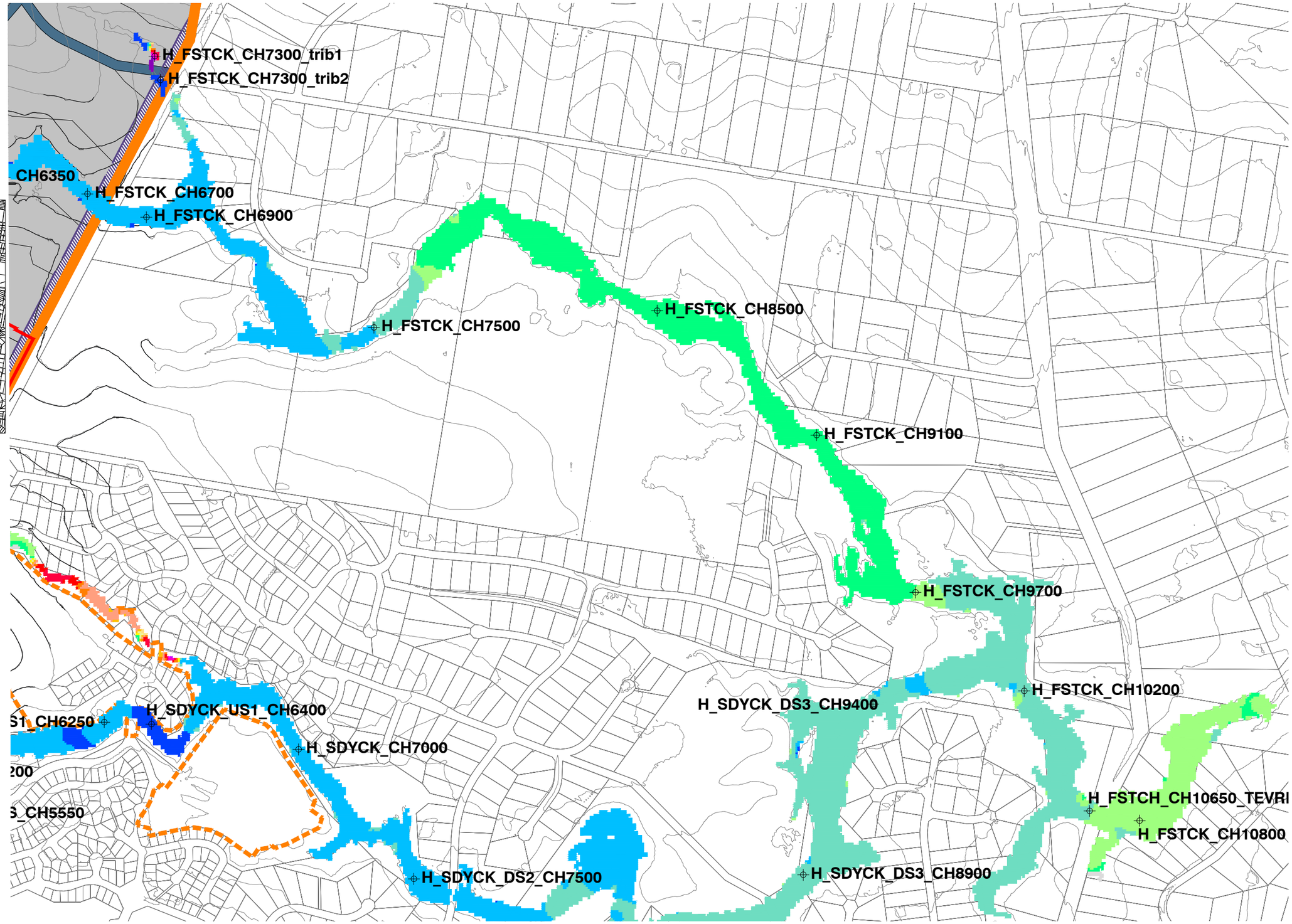
Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100



300 0 300 600 900 1200 1500m
1:30,000

Scale 1:10000 (A3)

FIGURE D1.1 (D)

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:30pm

Cardno

LEGEND

- Site Extents
- FLAGSTONE EAST STAGES 14A, 14B, 15A, 15B, 15C and 15B
- Reporting Points

FLOOD IMPACTS (mm)

- Above 500
- 400 to 500
- 300 to 400
- 200 to 300
- 150 to 200
- 100 to 150
- 75 to 100
- 50 to 75
- 40 to 50
- 30 to 40
- 20 to 30
- 10 to 20
- 0 to 10
- -10 to 0
- -20 to -10
- -50 to -20
- -100 to -50
- Below -100

300 0 300 600 900 1200 1500m
1:30,000

Scale 1:10000 (A3)

FIGURE D1.1 (E)

100 Year ARI - Post-Development (Master Plan) case M32e - Flood Impacts

Rev: Orig. Date: 5 September 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase032FloodingMasterPlan\ACAD\Figures\AppD_TUFLOW Masterplan Impacts.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; WSL_Reporting points_All_Points_moved; Existing Contours; 110056-262-STRUCTURE_OPT2L_grey; M32e Tuflow_Results Afflux; X-Road and Creek labels

PRINT DATE: 05 September, 2014 - 12:31pm

Flagstone City-Masterplan

APPENDIX E

Post-Development Predicted Impacts (TUFLOW Detailed Results)

Cardno
Shaping the Future

Reporting Points	Peak Flood Level (mAHD)		Impact (m)
	Existing Case (E21e)	Developed Case (M32e)	
H_TRBRIDGE_US_CH3250	40.55	40.49	-0.06
H_TRBRIDGE_US_CH3000	41.53	42.59	1.07
H_TribTR_DS1_CH6600	28.95	28.93	-0.02
H_TribTR_DS1_CH6500	29.55	29.52	-0.03
H_TribTR_DS1_CH6100	30.70	30.66	-0.03
H_TribTR_DS1_CH6000	31.28	31.23	-0.04
H_TribTR_DS1_CH4900	34.42	34.39	-0.03
H_TribTR_DS1_CH4200	36.87	36.77	-0.10
H_TribTR_CH3000	42.36	42.31	-0.05
H_TribTR_CH2200	45.23	45.40	0.17
H_TribTR_CH2100_Trib	48.10	48.17	0.07
H_TribTR_CH2000_Trib	48.94	48.98	0.03
H_TribTR_CH1750	47.45	47.65	0.20
H_TribTR_CH1250	50.47	50.41	-0.06
H_TribTR_CH1150	51.02	52.63	1.61
H_TribTR_CH900_Trib1	65.76	65.71	-0.05
H_TribTR_CH900_Trib2	62.75	62.43	-0.32
H_TribTR_CH700	53.81	53.80	-0.01
H_TribTR_CH30	58.93	58.93	0.00
H_TribTR_CH0	59.51	59.51	0.00
H_SDYCK_DS3_CH9400	24.46	24.41	-0.04
H_SDYCK_DS3_CH8900	25.91	25.88	-0.04
H_SDYCK_DS2_CH7500	29.59	29.52	-0.07
H_SDYCK_CH7000	31.26	31.20	-0.06
H_SDYCK_CH4200	41.19	41.13	-0.07
H_SDYCK_CH2650_Trib1	59.70	60.18	0.48
H_SDYCK_CH2650_Trib2	57.40	57.57	0.17
H_FSTCK_CH10800	21.74	21.73	-0.02
H_FSTCK_CH10200	23.20	23.18	-0.02
H_FSTCK_CH9700	24.38	24.37	-0.01
H_FSTCK_CH9100	26.07	26.07	-0.01
H_FSTCK_CH8500	28.52	28.52	-0.01
H_FSTCK_CH7300_trib1	41.88	42.54	0.66
H_FSTCK_CH7300_trib2	40.70	40.58	-0.12
H_FSTCK_CH3800_Trib1	54.37	55.27	0.90
H_FSTCK_CH3800_Trib2	53.51	53.58	0.07

Flagstone City-Masterplan

APPENDIX

F

Pre & Post-Development Hydrographs

Cardno
Shaping the Future

Location*	100 Year ARI Peak Flood Level (mAHD)		Impact (m)
	Existing Case (E21e)	Developed Case (M32e)	
H_TribTR_DS1_CH6000	31.28	31.23	-0.04
H_TribTR_DS1_CH6100	30.70	30.66	-0.03
H_TRBRIDGE_US_CH3000	41.53	42.59	1.07
H_SDYCK_BRIDGE1_US_CH5200	37.67	37.57	-0.11
H_FSTCK_CH6700	37.12	37.03	-0.09
H_FSTCK_CH7300_trib2	40.70	40.58	-0.12
H_FSTCH_CH10650_TEVRD_US	22.18	22.16	-0.02
H_TribTR_DS1_CH6500	29.55	29.52	-0.03
H_TribTR_DS1_CH6500	29.55	29.52	-0.03
H_TribTR_DS1_CH6600	28.95	28.93	-0.02
H_SDYCK_DS1_CH6250	34.12	34.03	-0.10
H_SDYCK_DS2_CH7500	29.59	29.52	-0.07
H_FSTCK_CH10800	21.74	21.73	-0.02
H_TRBRIDGE_US_CH3250	40.55	40.49	-0.06
H_FSTCK_CH6900	36.33	36.26	-0.07
H_SDYCK_US1_CH6400	33.11	32.93	-0.18
H_FSTCK_CH8500	28.52	28.52	-0.01
H_TribTR_DS1_CH4900	34.42	34.39	-0.03
H_TribTR_DS1_CH4200	36.87	36.77	-0.10
H_SDYCK_CH7000	31.26	31.20	-0.06
H_SDYCK_DS3_CH8900	25.91	25.88	-0.04
H_FSTCK_CH9700	24.38	24.37	-0.01
H_FSTCK_CH9100	26.07	26.07	-0.01
H_SDYCK_DS3_CH9400	24.46	24.41	-0.04
H_FSTCK_CH10200	23.20	23.18	-0.02
H_Poinciana Dr RP2	34.65	34.65	0.00
H_Poinciana Dr RP1	34.53	34.53	0.00
H_Poinciana Dr RP3	36.81	36.81	0.00
H_Poinciana Dr RP4	35.15	35.15	0.00
H_FSTCK_CH7500	32.83	32.78	-0.05

*refer to Figure G.1 for locations

Location*	100 Year ARI Peak Flow (m^3/s)		Impact (m^3/s)
	Existing Case (E21e	Developed Case (M32e)	
Q_SDYCK_DS2_CH7500	99.7	95.0	-4.7
Q_SDYCK_BRIDGE1_US_CH5300	97.6	89.7	-7.9
Q_SCBRIDGE_DS_CH5450	97.5	89.8	-7.7
Q_TribTr_BridgeUS_CH3100	48.2	44.5	-3.7
Q_TribTr_BridgeDS_CH3190	48.0	44.4	-3.7
Q_SDYCK_CH6700_Trib	3.2	0.0	-3.2
Q_FSTCH_CH10650_TEVRD_US	265.7	262.3	-3.3
Q_SDYCK_DS3_CH9400	171.8	168.2	-3.6
Q_TribTR_DS1_CH6600	66.2	64.8	-1.4
Q_TribTR_DS1_CH4200	54.0	47.2	-6.7
Q_TribTR_DS1_CH4900	63.7	59.3	-4.4
Q_FSTCK_CH9700	96.8	96.7	-0.1
Q_SDYCK_DS3_CH8900	172.6	169.0	-3.6
Q_FSTCK_CH10200	267.3	263.4	-3.9
Q_FSTCH_CH11000_TEVRD_DS	268.5	265.7	-2.8
Q_SDYCK_DS1_CH6200	97.5	91.4	-6.1
Q_Poinciana Dr	0.0	0.0	0.0
Q_SDYCK_US1_CH6400	97.9	92.2	-5.7
Q_SDYCK_CH7000	100.0	95.4	-4.6
Q_FSTCK_CH7500	92.3	88.5	-3.8

*refer to Figure G.2 for locations

Figure G.1

Flagstone City

Water Level Reporting Points

LEGEND

N
W E
S

- Reporting Points

0 300 600

Metres

Scale: 1:30,000

Cardno
Shaping the Future

Cardno (QLD) Pty Ltd | ABN 57 051 074 992
Level 11, North Tower, 515 St Pauls Terrace
Locked Bag 4006, Fortitude Valley QLD 4006
Tel: 07 3369 9822 Fax: 07 3369 9722

SHEET	**A4**
Project No:	
Date:	
Revision Number:	
Designed by:	
Client Name:	

File Path: O:\7217-43\MapInfo\Figures\ReportingLines.wor

Figure G.2

Flagstone City

Flow Reporting Lines

LEGEND

N
W E
S

Reporting Lines

0 300 600

Metres

Scale: 1:30,000

Cardno
Shaping the Future

Cardno (QLD) Pty Ltd | ABN 57 051 074 992
Level 11, North Tower, 515 St Pauls Terrace
Locked Bag 4006, Fortitude Valley QLD 4006
Tel: 07 3369 9822 Fax: 07 3369 9722

SHEET	**A4**
Project No:	
Date:	
Revision Number:	
Designed by:	
Client Name:	

Figure G.3

Flagstone City
Time Series
Water Level
Reporting Points

LEGEND

N
W E
S

- Reporting Points

0 250 500
Metres
Scale: 1:25,000

Cardno
Shaping the Future

Cardno (QLD) Pty Ltd | ABN 57 051 074 992
Level 11, North Tower, 515 St Pauls Terrace
Locked Bag 4006, Fortitude Valley QLD 4006
Tel: 07 3369 9822 Fax: 07 3369 9722

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Date:	
Revision Number:	
Designed by:	
Client Name:	

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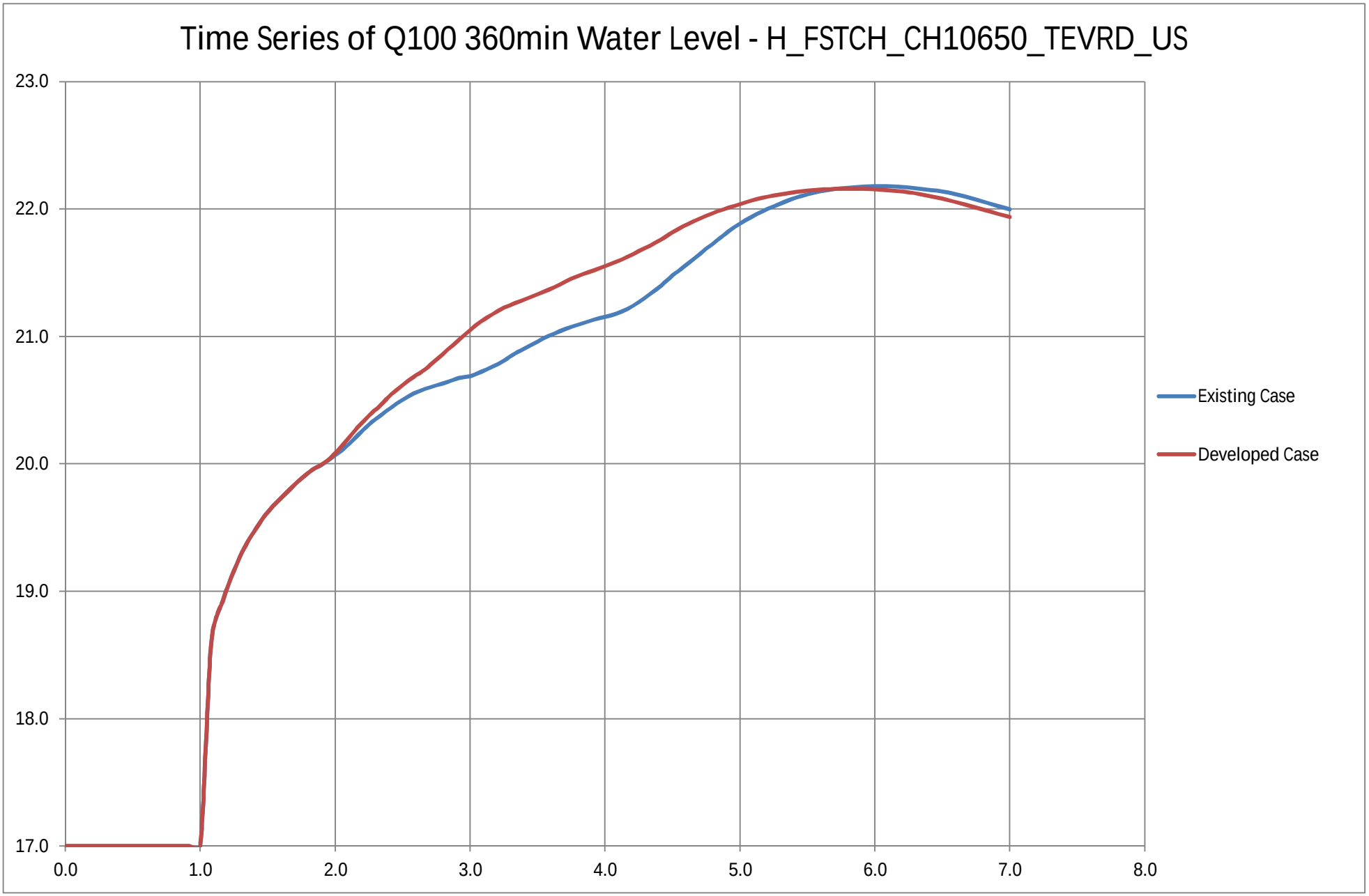
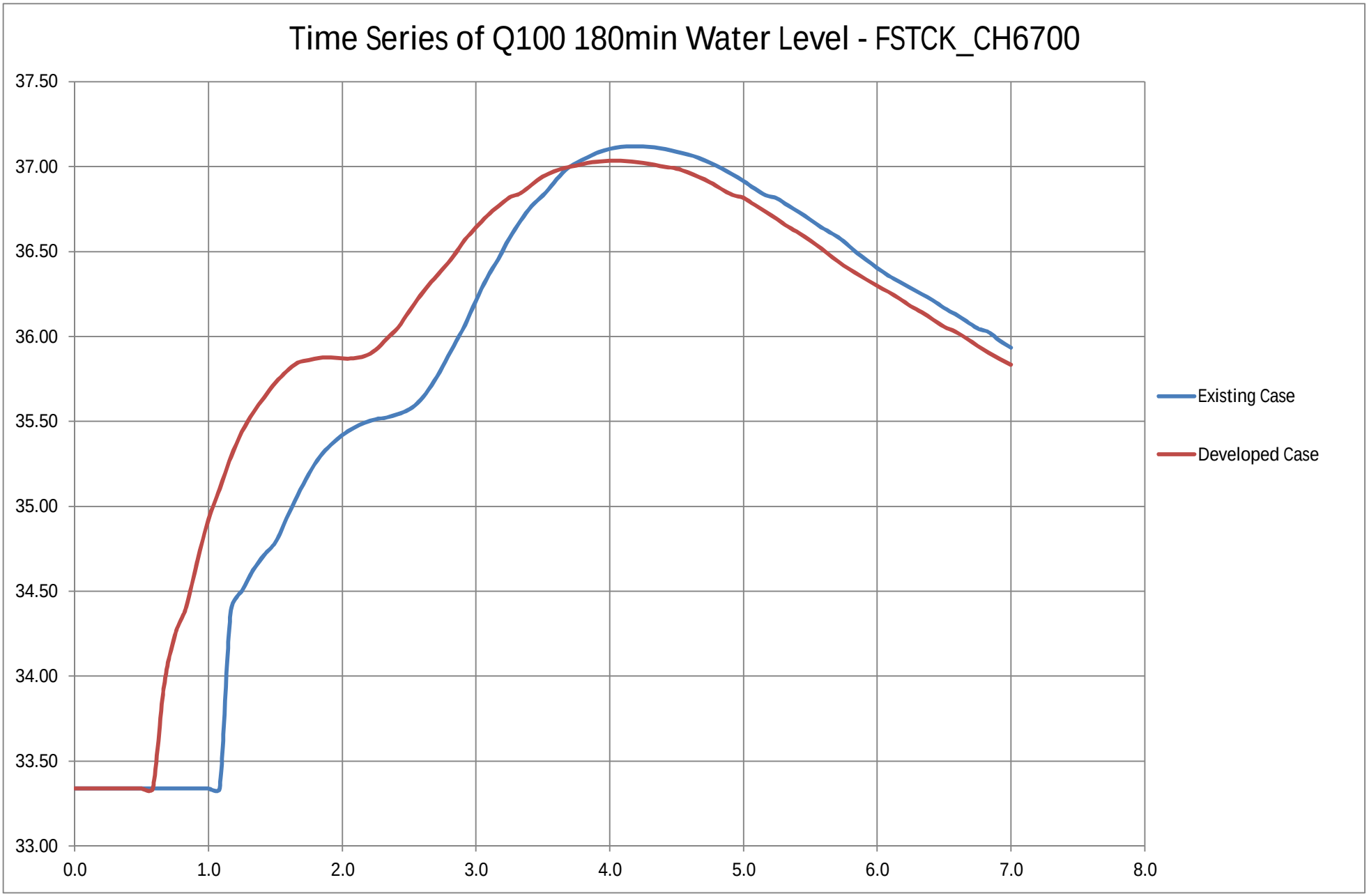
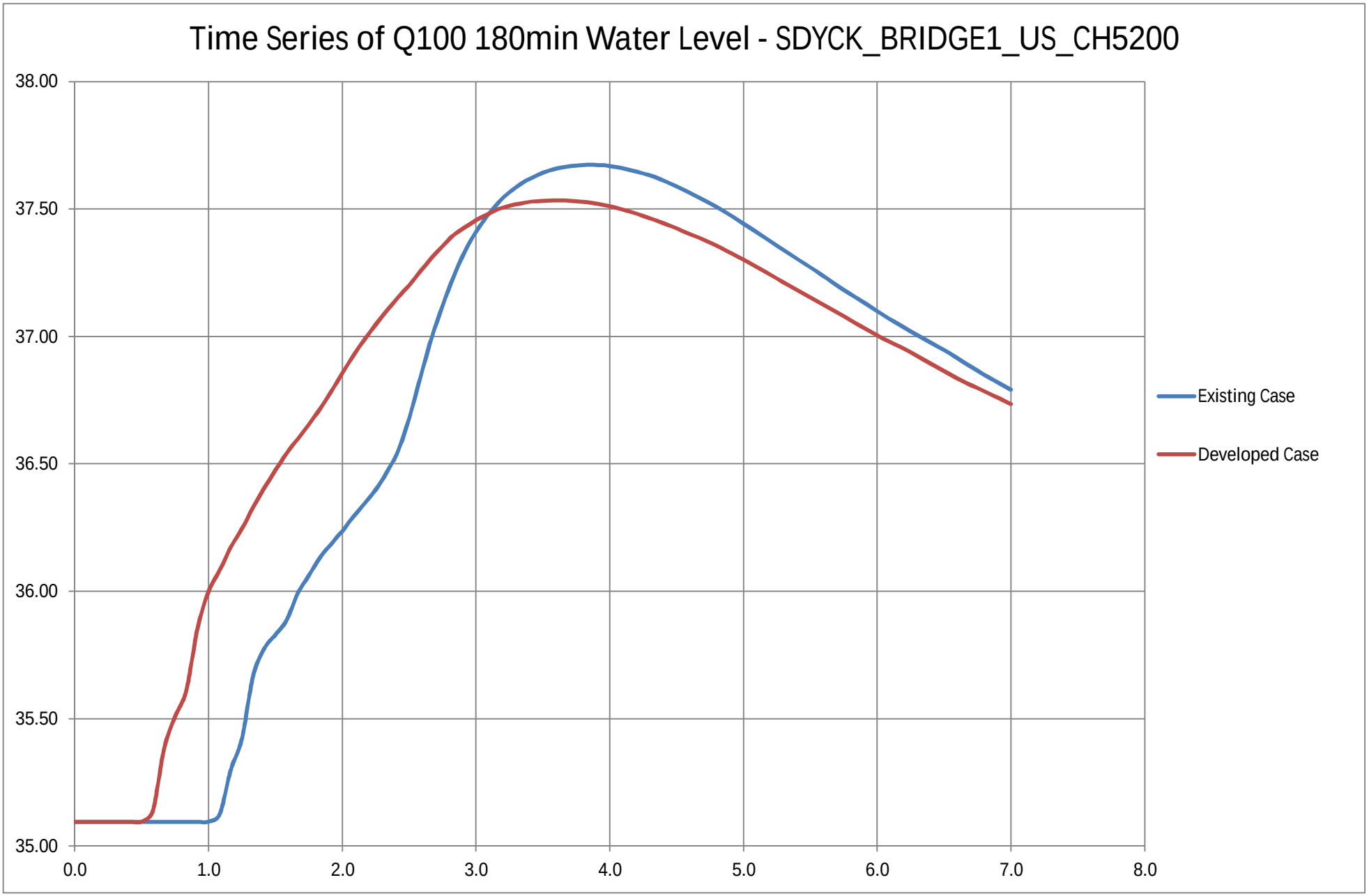
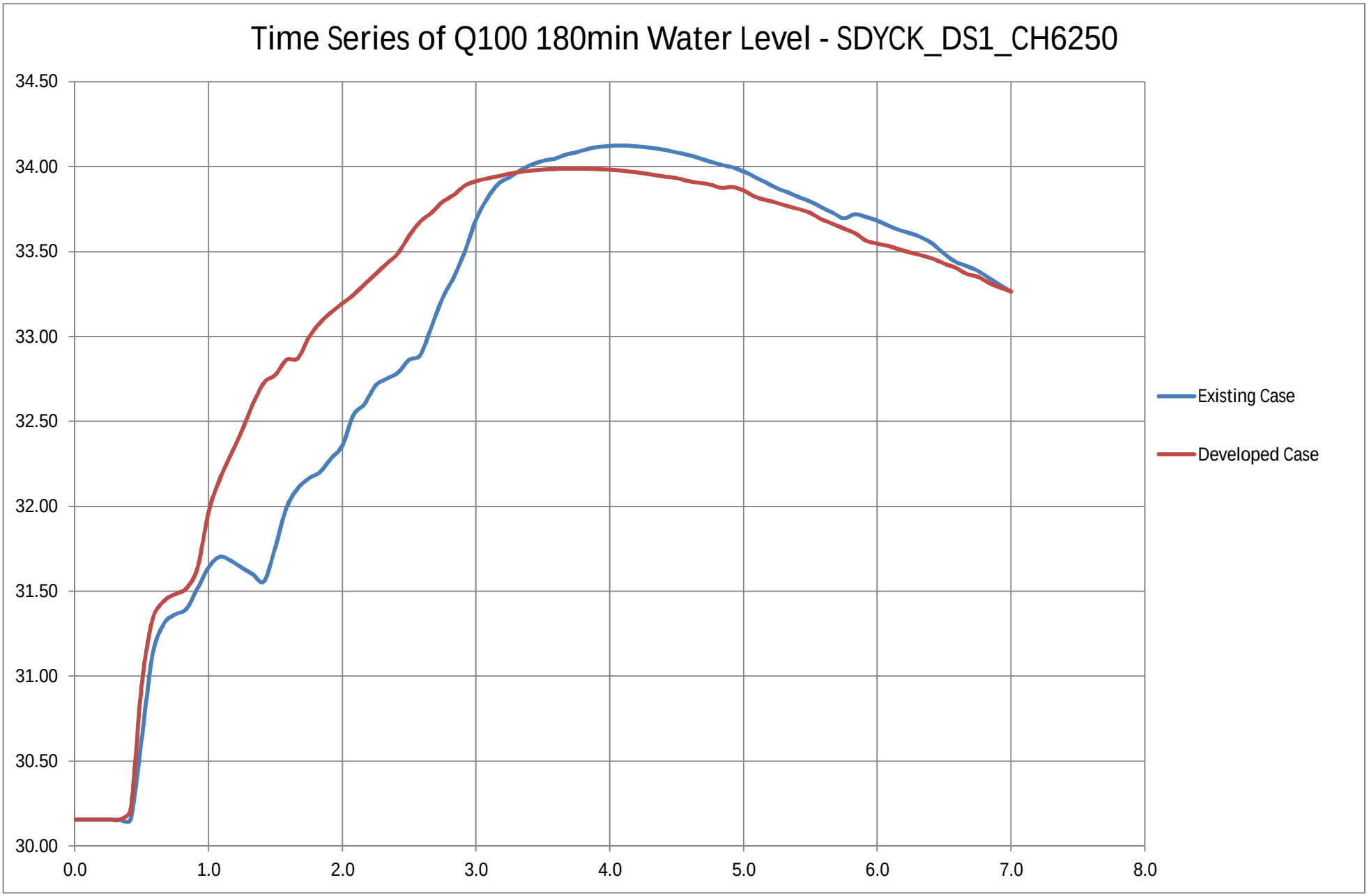
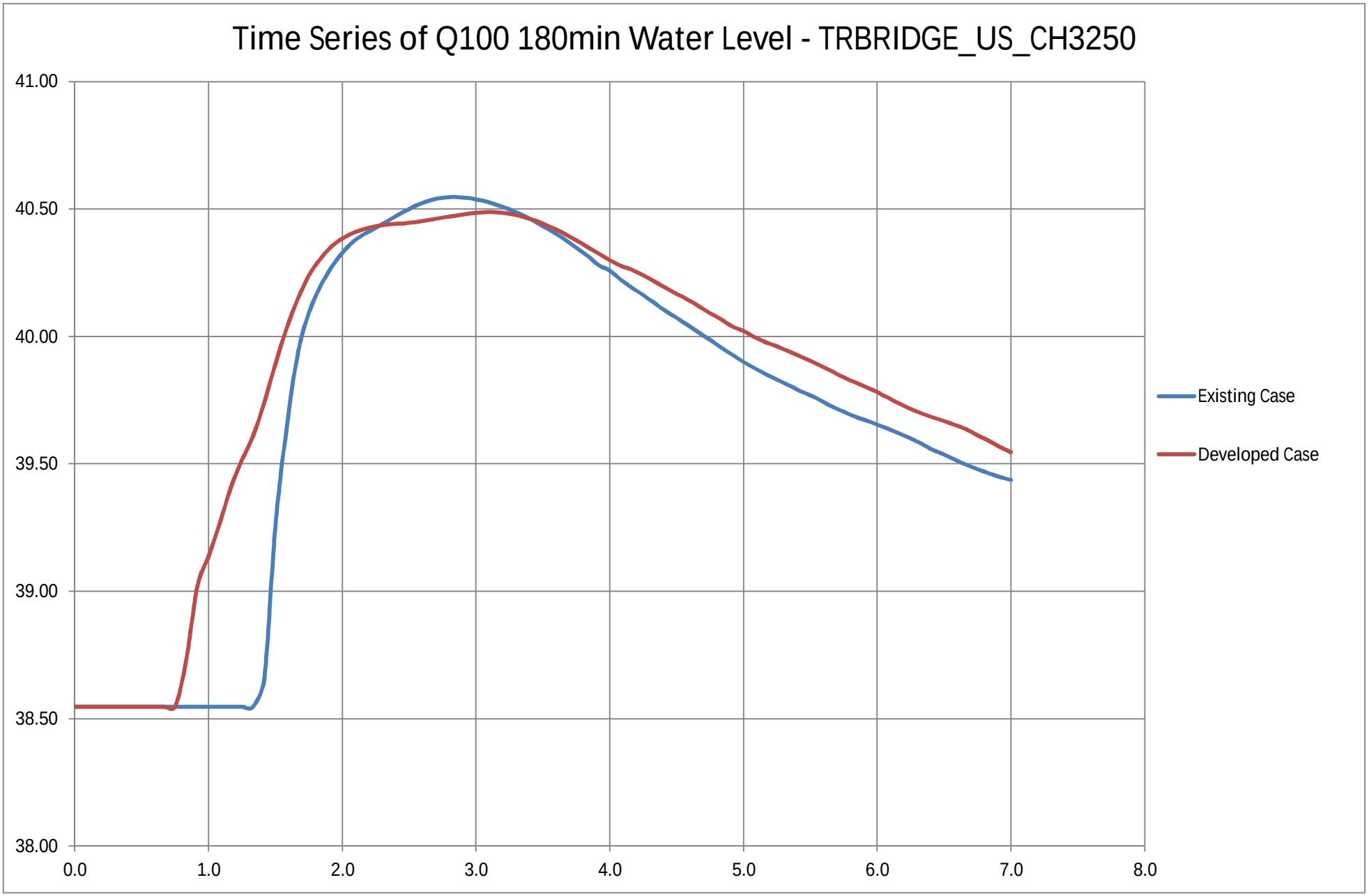
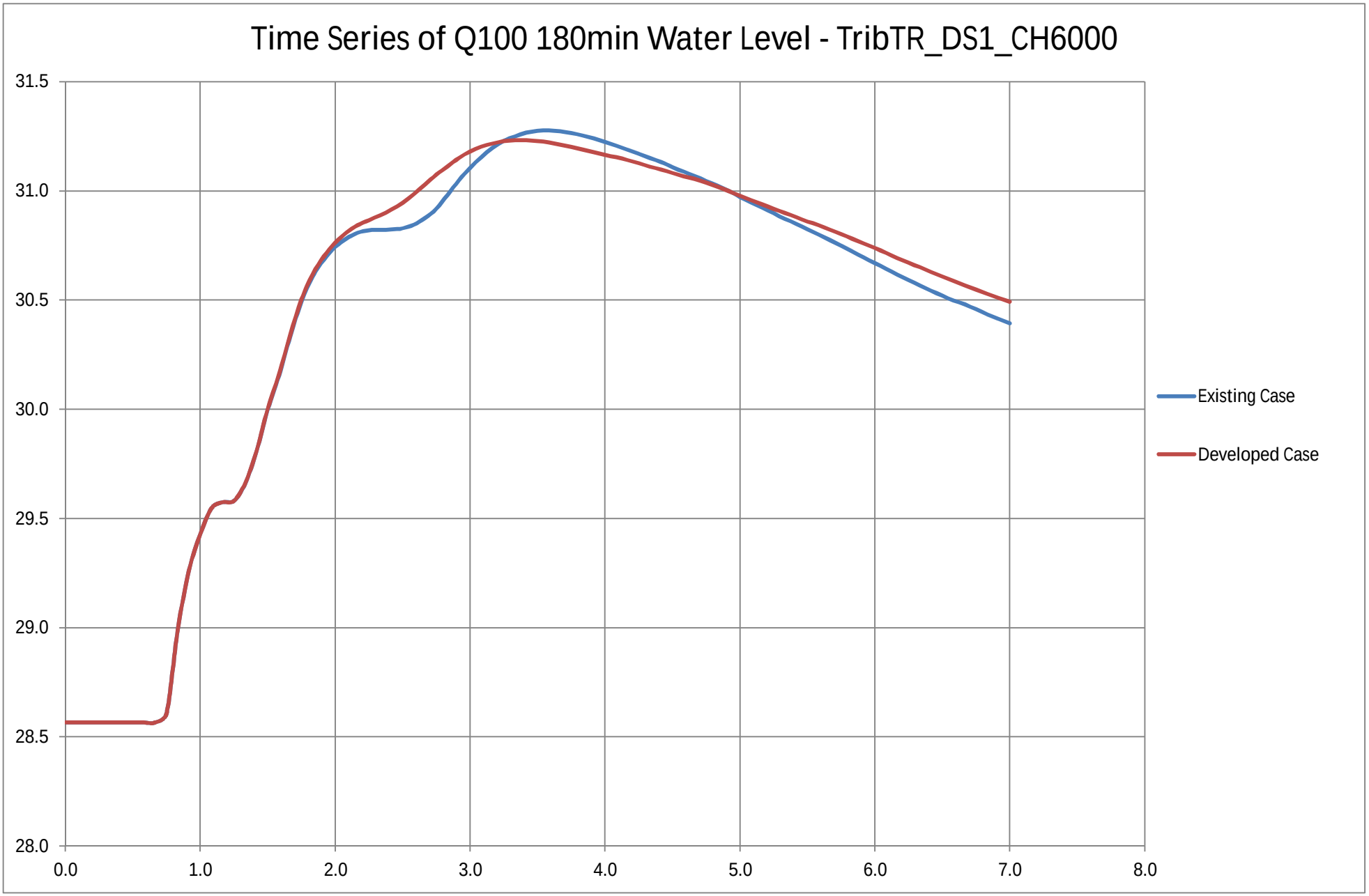

Time Series of Q100 360min Water Level - H_FSTCH_CH10650_TEVRD_US
23.0
22.0
21.0
20.0
19.0
18.0
17.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case

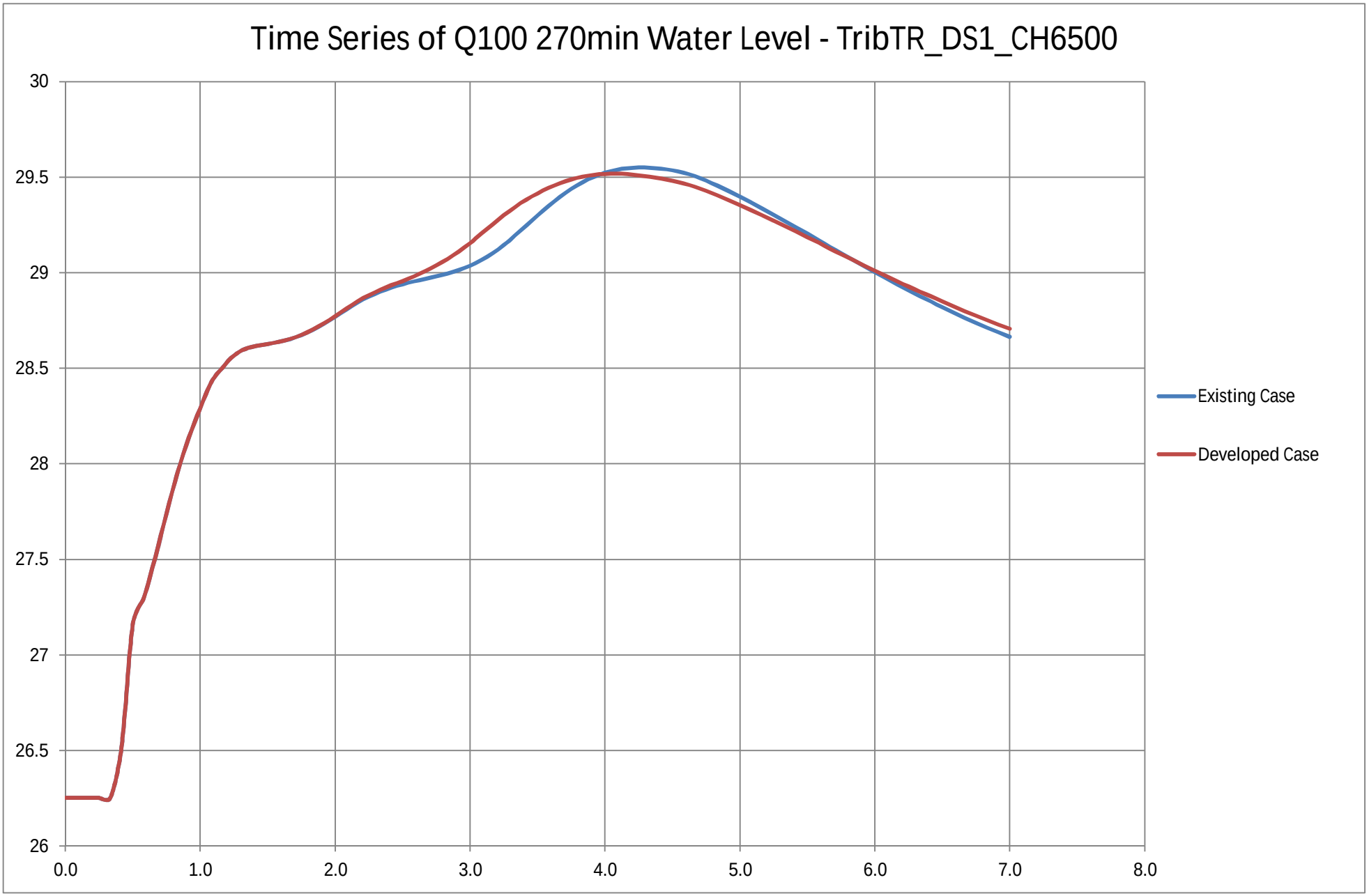

Time Series of Q100 180min Water Level - FSTCK_CH6700
37.50
37.00
36.50
36.00
35.50
35.00
34.50
34.00
33.50
33.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case


Time Series of Q100 180min Water Level - SDYCK_BRIDGE1_US_CH5200
38.00
37.50
37.00
36.50
36.00
35.50
35.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case

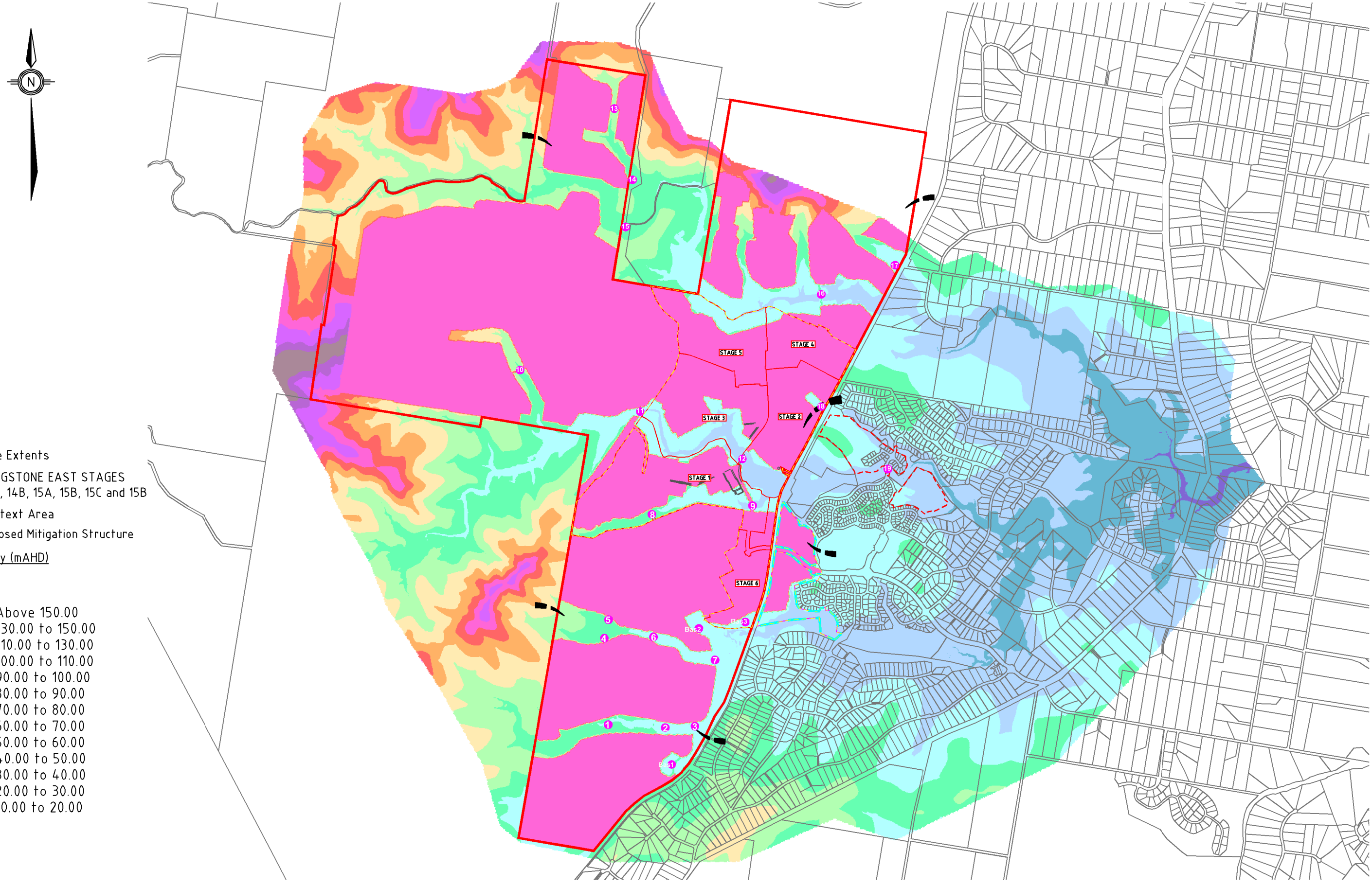

Time Series of Q100 180min Water Level - SDYCK_DS1_CH6250
34.50
34.00
33.50
33.00
32.50
32.00
31.50
31.00
30.50
30.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case


Time Series of Q100 180min Water Level - TRBRIDGE_US_CH3250
41.00
40.50
40.00
39.50
39.00
38.50
38.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case


Time Series of Q100 180min Water Level - TribTR_DS1_CH6000
31.5
31.0
30.5
30.0
29.5
29.0
28.5
28.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case


Time Series of Q100 270min Water Level - TribTR_DS1_CH6500
30
29.5
29
28.5
28
27.5
27
26.5
26
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Existing Case
Developed Case

APPENDIX C: STRUCTURE PLAN (CARDNO, 2014)



Scale 1:30000 (A3)

FIGURE 5

TUFLOW Model Post-Development Topograhy and Proposed Mitigation Structures

Rev: Orig. Date: 19 August 2014

Project No.: 7217/43

Peet Flagstone City Pty Ltd

CAD FILE: O:\7217-43\Phase03ZFloodingMasterPlan\ACAD\Figures\Figure 5.dwg
XREF's: Max_WSL_FLAGST_EXG_100Y_E02; Max_DEPTH_EXG_100Y_E02; 110056-73 and 110056-85 combined; M37e_Topo

PRINT DATE: 20 August, 2014 - 10:59am