Queensland Government

TECHNICAL MEMORANDUM

To:	Richard Bender - EDQ
From:	Ralph Williams - DesignFlow
Reviewed:	Shaun Leinster (RPEQ15637) - DesignFlow
Date:	10 October 2019
Subject:	Carseldine Urban Village – Local flood assessment to support Stage 1 development
Attachments	1. Peak flood depths – Existing case - 50%, 5%, 1% AEP event 2. Peak flood depths – Proposed case 50%, 5%, 1% AEP 3. Peak flood level impacts – 50%, 5%, 1% AEP

1 INTRODUCTION

This technical memorandum provides a summary of local flood assessments for the Carseldine Urban Village to support Stage 1 development. This modelling captures in detail the potential local flood impacts and potential drainage upgrades at the following locations:

- Beams Road;
- Railway at the eastern boundary of the site; and
- Local drainage to Cabbage Tree Creek

The outcomes of this assessment provide minimum drainage requirements associated with Stage 1 development to manage local flood impacts. Outcomes from this assessment are to inform the detail design of the Stage 1.

When reading this technical memorandum reference should be made to *Carseldine Urban Village – Updated Stormwater Management Plan* (DesignFlow report Version 3 2019). Figure 1 shows the current masterplan for the development from which this assessment has been based, including the Stage 1 development boundary.

2 BACKGROUND

The regional flood assessment of the Carseldine Urban Village development has been completed, as outlined in *Carseldine Urban Village – Updated Stormwater Management Plan* (DesignFlow report Version 3 2019), based on Brisbane City Council (BCC) supplied URBS and TUFLOW regional flood models for Cabbage Tree Creek. These models were updated as necessary to make suitable for regional flood impact assessment of the Carseldine Urban Village development.

The Cabbage Tree Creek modelling is at a regional scale and not suitable for a detailed assessment of the various local catchments that influence the site. Therefore, a separate local scale flood modelling exercise has been completed to capture potential flood impacts associated with the development, including local impacts at Beams Road and the railway at the eastern boundary of the site. Additional drainage survey was completed at the northern boundary of the site along Beams Rd and within the site to inform this local flood modelling.

This technical memorandum provides a summary of the local flood modelling.

Figure 1 – Carseldine Urban Village masterplan (source: RPS)

3 EXISTING CASE MODELLING

Local modelling has been carried out using a WBNM rainfall runoff model that feeds local catchment hydrographs into a 1D/2D TUFLOW hydraulic model. The existing case WBNM model sub-catchments are shown on Figure 2 which also indicates the general direction of overland flow (yellow arrows). Figure 2 also shows the existing pipe drainage network as modelled in TUFLOW for this investigation (aqua/black lines). It is noted that in some areas these drainage lines have been laid against the natural fall of the land and therefore their alignment does not necessarily match that of the overland flow as represented by the yellow arrows. Sub-catchment details are provided on Table 1.

A summary of the existing site drainage characteristics is as follows:

- The existing Beams Rd catchments flow to the east and north away from the site.
- Catchment B1 drains to the West Outfall Pipe to Cabbage Tree Creek (refer Figure 2). When this pipe is at capacity, runoff flows eastwards through the site.
- The majority of the proposed development area currently drains to the East Outfall Pipe to Cabbage Tree Creek (refer Figure 2). When this pipe is at capacity, site runoff will generally collect over the low-lying areas around the playing fields. Runoff will then drain southwards via the open drain adjacent to the railway. Modelling also predicts that during large events, overland flow from the site heads north and east toward the railway and Beams Rd.
- The Cabbage Tree Creek outfall pipes are predicted to flow in reverse direction when Cabbage Tree Creek flood levels are high.

Figure 2 - Existing case WBNM sub-catchments

Table 1 - Existing case WBNM sub-catchment details

WBNM ID	Area (ha)	Fraction Impervious (%)	Downstream ID
A1	10.546	59.64	A3
A2	4.582	65.43	A3
A3	3.424	28.42	A4
A4	0.902	45.53	A5
A5	0.799	49.91	A6
A6	2.738	83.29	A7
A7	13.295	52.13	SINK
B1	10.021	9.47	B2
B2	3.177	18.72	B3
B3	5.454	5.56	B6
B4A	1.291	84.66	B4B
B4B	1.054	20.26	B4C
B4C	2.282	12.26	B5
B5	2.514	0.00	B7
B6	1.746	0.00	B7
B7	3.345	4.20	B8
B8	5.174	3.63	SINK

The WBNM model has been run using ARR2016 ensemble patterns with burst durations ranging from 5 minutes to 6 hours. The results of the WBNM model have then been used to select ensemble patterns with a central tendency for the following durations that have then been run in the TUFLOW model; 15min, 30min, 45min, 60min, 120min and 180min. These durations were selected based on a review of critical durations across the local catchment study area. Modelling has been carried out for the 1%, 5% and 50% AEP events.

A WBNM lag parameter of 1.4 has been selected based on a Rational Method validation of peak flows at WBNM ID B8 (refer Validation Section for details).

Rainfall intensities and loss rates are based on values from the ARR 2016 data hub. Rainfall intensities relevant to the Carseldine site for varying AEP and storm durations are provided in Table 2.

Table 2 – Rainfall intensities (mm/hr) - Carseldine

	AEP						
Duration	63.20%	50%	20%	10%	5%	2%	1%
5 min	115.20	129.60	176.40	207.60	237.60	278.40	309.60
10 min	94.20	106.20	144.00	169.20	193.20	225.00	248.40
15 min	80.00	90.40	122.00	143.20	163.60	190.40	210.40
20 min	69.60	78.60	106.50	124.80	142.80	166.20	183.90
25 min	61.92	69.84	94.56	111.12	127.20	148.32	164.16
30 min	55.80	63.00	85.40	100.40	115.00	134.40	149.00
45 min	43.60	49.20	66.80	78.80	90.67	106.27	118.40
1 hour	36.10	40.80	55.60	65.70	75.70	89.10	99.60
1.5 hour	27.40	31.00	42.40	50.33	58.27	68.67	77.33
2 hour	22.45	25.40	34.90	41.55	48.20	57.50	64.50
3 hour	16.90	19.17	26.50	31.70	37.00	44.33	50.00
4.5 hour	12.78	14.51	20.24	24.22	28.44	34.22	38.89
6 hour	10.50	11.97	16.83	20.33	23.83	28.67	32.67
9 hour	8.02	9.18	13.00	15.78	18.67	22.56	25.67
12 hour	6.65	7.64	10.92	13.25	15.75	19.08	21.83
18 hour	5.12	5.94	8.56	10.50	12.44	15.22	17.44
24 hour	4.25	4.96	7.21	8.88	10.58	12.96	14.92
30 hour	3.70	4.30	6.33	7.80	9.30	11.43	13.20
36 hour	3.28	3.83	5.67	6.97	8.36	10.31	11.92
48 hour	2.71	3.17	4.73	5.85	7.02	8.69	10.08
72 hour	2.03	2.39	3.58	4.47	5.38	6.69	7.81

An initial loss/continuing loss approach is adopted. Initial and continuing losses for impervious areas are taken at 0mm/hr, whilst continuing losses for pervious areas are taken at 2.2mm/hr. Initial losses for pervious areas vary depending on the AEP and the storm duration. These are listed in Table 3.

Table 3 Pervious area initial loss (mm) modelled

Duration	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
10 min	10.4	7.6	5.8	4.1	2.9	2.1
15 min	10.4	7.6	5.8	4.1	2.9	2.1
20 min	10.4	7.6	5.8	4.1	2.9	2.1
25 min	10.4	7.6	5.8	4.1	2.9	2.1
30 min	10.4	7.6	5.8	4.1	2.9	2.1
45 min	10.4	7.6	5.8	4.1	2.9	2.1
1 hour	10.4	7.6	5.8	4.1	2.9	2.1
1.50 hour	11.1	3.2	0	0	0	3.2
2 hours	11.9	3.7	0	0	0	0
3 hours	8.9	0	0	0	0	0
6 hours	5.9	0	0	0	0	0
12 hours	8.3	0	0	0	0	0
18 hours	7.7	0	0	0	0	0
24 hours	6.3	2.9	0.6	0	0	0
36 hours	13	8	4.7	1.6	0	0
48 hours	13	9.5	7.2	5	0	0
72 hours	13	12.3	11.8	11.4	3.3	0

Local catchment inflow hydrographs from the existing case WBNM model have been input to the existing case TUFLOW model. The existing case TUFLOW model layout is shown on Figure 3 and details are summarised below:

- TUFLOW HPC Build 2018-03-AB_64_iSP.
- Model grid size of 1m to provide detail resolution of potential flood impacts
- Run for 1%, 5% and 50% AEP events for ensemble temporal patterns with a central tendency for the events durations ranging from 15 minutes to 3 hours.
- WBNM local catchment inflow hydrographs are input to TUFLOW using TUFLOW's 2d_sa polygon approach.
- Topography based on aerial LiDAR survey and defined using a TUFLOW 1m grid.
- Manning's 'n' values of; Road – 0.02, Urban Lots – 0.18, Vegetated Area – 0.075, Cleared Open space – 0.03
- Existing on-site pipe drainage associated with the two existing outfalls to Cabbage Tree Creek have been incorporated using 1D pipe elements. Details are based on a recent survey completed by Land Partners (June, 2019). In addition to survey of the main site drainage lines, additional pipe network data has been sourced from BCC records. The existing drainage pipes included in the existing case TUFLOW modelling are shown on Figure 4. Pipe diameters shown in metres.
- Cabbage Tree Creek upstream boundary is a Q5 flow rate extracted from the Cabbage Tree Creek regional model. The Cabbage Tree Creek downstream boundary is a Q5 water level. The remaining two external boundary conditions are normal depth rating curves calculated by TUFLOW based on a slope of 1%. Note: a Q5 boundary condition is in accordance with standard modelling procedures for coincident regional flood events for local modelling. The ratio of local to regional catchment associated with the Carseldine Urban Village is 0.018.

Peak depth maps for the Existing Case modelling are provided in Attachment 1.

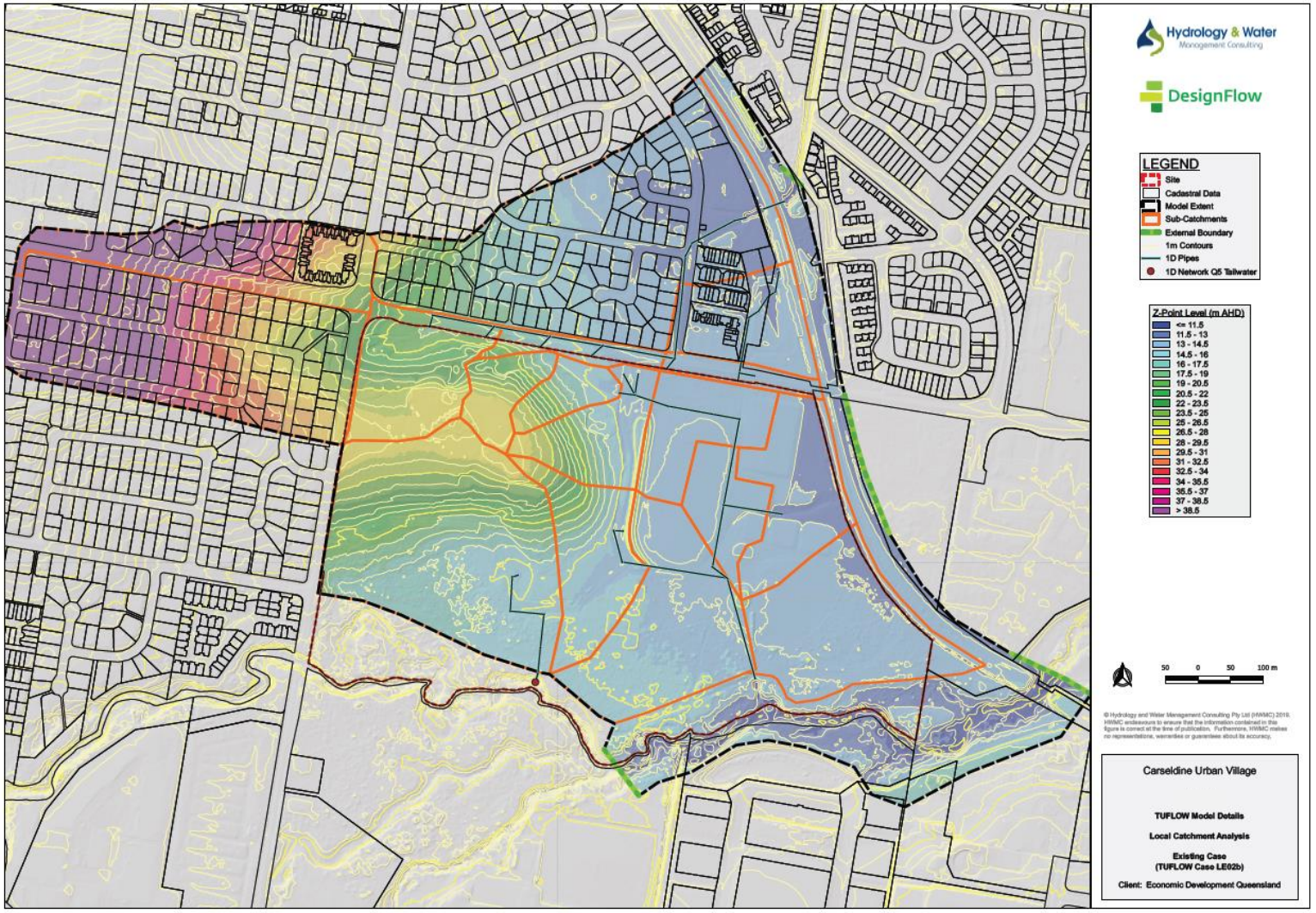

Figure 3 Existing case TUFLOW model layout

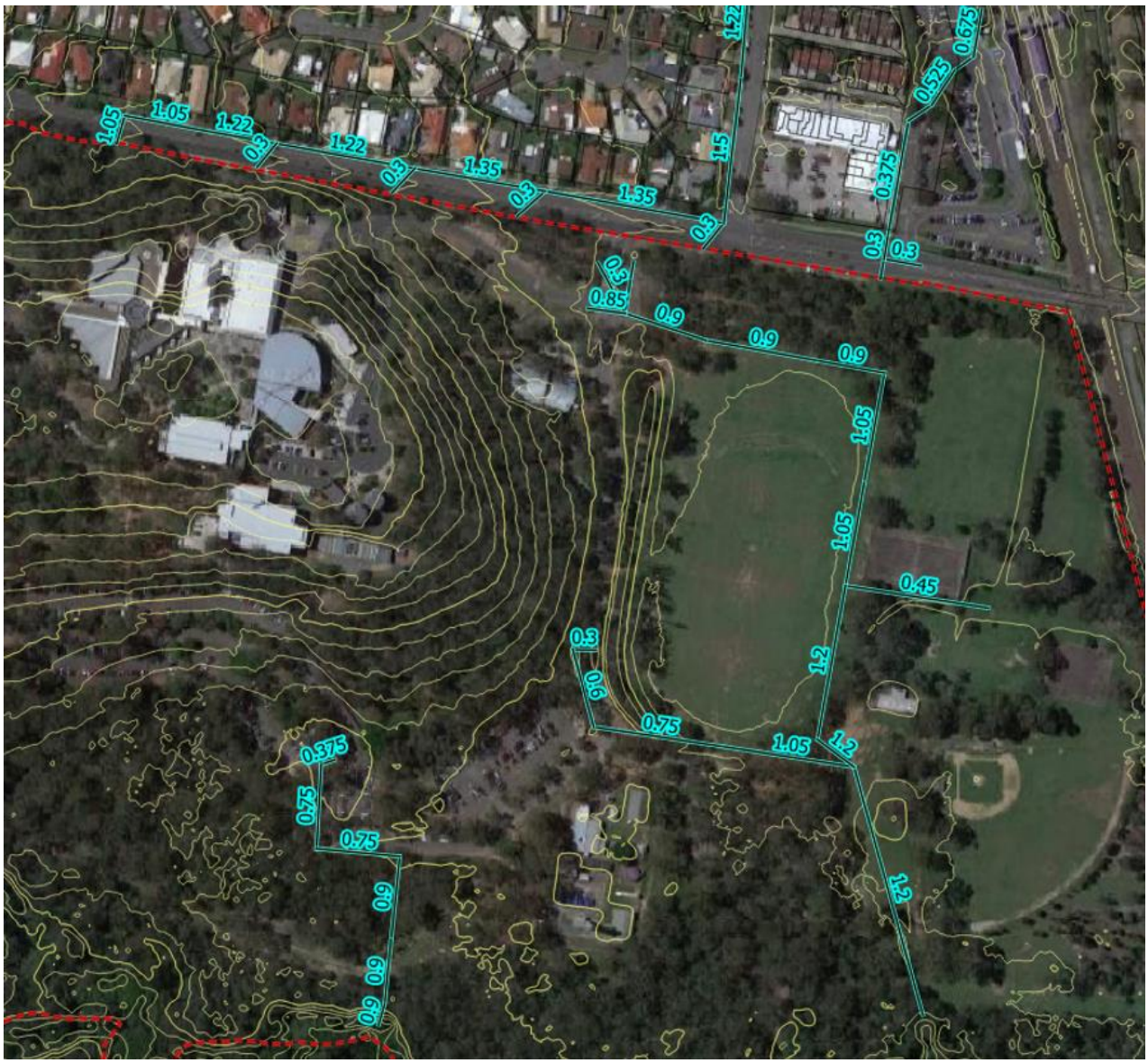

Figure 4 - Existing case pipe drainage and diameters (m)

4 VALIDATION

It is not possible to validate peak flows or levels in the hydraulic model because of storage effects and breakout flows from the defined hydrologic flow paths. Instead, a Rational Method peak flow validation has been carried out based on the existing case WBNM peak flows at the local catchment outlet near Cabbage Tree Creek (WBNM ID B8).

The 1% AEP Rational Method peak flow calculated at the outlet of B8 is 10.4 m^3/s. This is based on a Tc of 43 minutes, a catchment area of 36.1 Ha and a C10 value of 0.71. The peak flow predicted by the WBNM model at this location is 10.5 m^3/s which compares well.

5 DEVELOPED CASE MODELLING

The WBNM sub-catchments were updated to reflect the proposed development. For the purpose of this assessment to inform Stage 1 development, the ultimate site development has been applied to the hydrology model (refer to Figure 1 – Carseldine Urban Village Masterplan). All development areas have been assigned a Fraction Impervious of 90%. The proposed case WBNM sub-catchments are shown on Figure 5 and details are provided in Table 4.

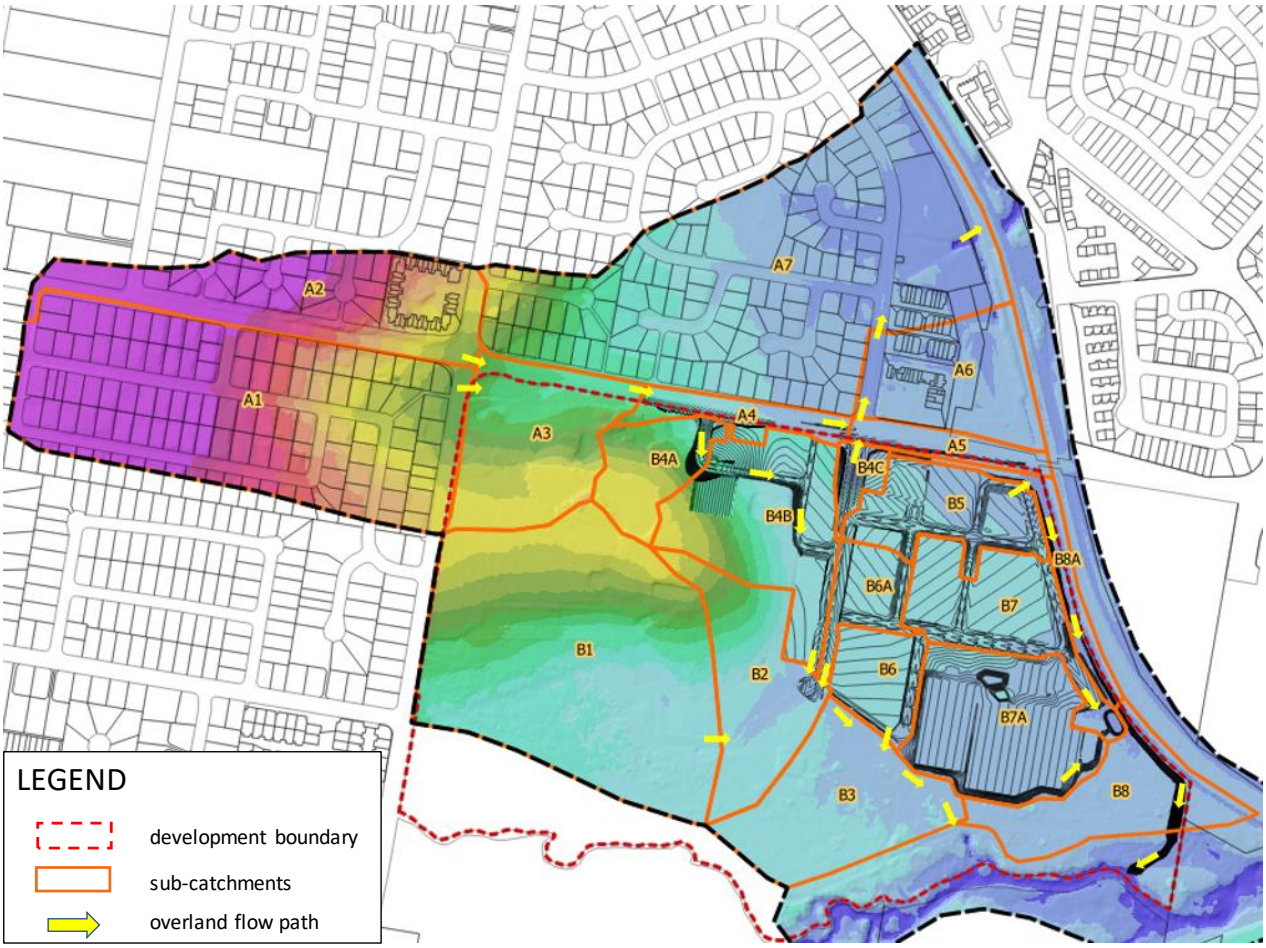

Figure 5 - Proposed case WBNM sub-catchments

Table 4 - Developed case WBNM sub-catchment details

WBNM ID	Area (ha)	Fraction Impervious (%)
A1	10.546	59.64
A2	4.582	65.43
A3	3.424	28.40
A4	0.958	57.19
A5	0.799	49.89
A6	2.738	83.29
A7	13.295	52.13
B1	10.021	9.48
B2	2.952	22.21
B3	3.504	8.63
B4A	1.481	89.20
B4B	3.679	75.04
B4C	0.452	88.32
B5	2.099	89.93
B6	1.235	84.88
B6	1.014	90.00
B7	2.545	83.70
B7A	3.528	22.59
B8	2.567	5.20
B8A	0.927	31.15

The developed case TUFLOW model is shown on Figure 6. It is equivalent to that of the existing case except for the following changes that have been made to represent the development site:

- Run with developed case WBNM hydrology
- Latest earthworks design tin by Calibre has been incorporated into the model topography (June 2019) – note bioretention extended detention depth is excluded from the flood storage
- Overland flow paths through the site have a Manning's 'n' value of 0.075 (medium vegetation).
- A bund with a crest a RL 13.7 has been applied across the south eastern outlet drain. This crest level ties in approximately with the natural ground level at this location. A one-way flapped 1200mm dia RCP has been placed through this bund.

  Note: this outlet arrangement has been designed to allow development flows to discharge to Cabbage Tree Creek, but prevent Cabbage Tree Creek flows from backing up northwards through this drain and into the development zone. Inclusion of the one-way flap valve was deemed necessary based on scenario testing of frequent local storm events, coupled with a relatively high

creek water level in Cabbage Tree Creek, which may cause local flooding (e.g. a 2 year local event with a 5 year tailwater level in Cabbage Tree Creek).

- Diversion of runoff from the north west of the site (CatB4A) via the new drainage network that discharges flows to Cabbage Tree Creek – this diversion manages development flows as well as existing drainage that reports to the Stage 1 western entry road from beams road (CatB4A). This diversion is designed to avoid flood impacts at Beams Road.
- Drainage of flows from the new eastern access road along Beams Rd (Cat B4C) to the existing Beams Rd drainage network via 450mm RCP
- Drainage sump at the low point just south of Stage 1 Lot 3
- Duplication of the existing 1200mm dia outfall to Cabbage Tree Creek

Peak depth maps for the Developed Case modelling are provided in Attachment 2.

Figure 6 TUFLOW developed case model setup

6 IMPACT ASSESSMENT

Peak flood level impact maps are provided in Attachment 3. In summary the flowing is noted:

- Flood level reductions are predicted at Beams Rd and areas to the north for all events modelled.
- Flood level reductions are predicted along the rail corridor for all events modelled.

Note: Impacts shown within Cabbage Tree Creek are not realistic and should be dismissed because Cabbage Tree Creek has been run in steady state for the purpose of assigning a tailwater level of the local catchment analysis. Therefore, catchment timing effects are not properly considered in the local hydraulic model. The separate Cabbage Tree Creek regional flood analysis (refer to Carseldine Urban Village Updated Stormwater Management plan (DesignFlow Version 3 2019) has demonstrated that the increased runoff from the proposed development site is not expected to coincide with peak flows in the creek and that no adverse impacts are predicted.

7 RECOMMENDATIONS

Based on the local flood modelling results for the Carseldine Urban Village the following is recommended to be implemented as part of Stage 1 works:

- All flows associated with the Stage 1 north western entry road are diverted south to discharge to Cabbage Tree Creek. This includes the existing catchment to the west of this entry road (CatB4A – refer to Figure 5), where 1% AEP flows of up to 1.4m^3/s are to be captured and directed southward.
- Existing drainage pipes impacted by the development are connected to the new drainage and adequately allowed for in the drainage design based on the general drainage assumptions outlined in this document.
- The minor catchment draining to the new eastern Stage 1 entry road off Beams Rd (CatB4C – refer to Figure 5) can be connected to the existing Beams Road drainage network to the north (450mm dia pipe connection). This should only occur after the drainage at the western entrance road is constructed to avoid an impact on the Beams Rd drainage.
- Ensure Stage 1 flows (except for the eastern entry road as mentioned above) are discharged to Cabbage Tree Creek. The drainage system must have capacity to discharge development flows as well as existing discharges that are connected to the Stage 1 drainage.
- Include a drainage pit that connects to the new drainage for Stage 1 in the low lying area south of Stage 1 lot 3 to manage flooding in this low lying zone.
- Final development fill levels and finished floor levels should be based on whatever is the highest flood level from the following:
    - Cabbage Tree Creek regional flooding (refer to the *Carseldine Urban Village – Updated Stormwater Management Plan*, DesignFlow 2019)
    - Local catchment flooding (this assessment)
    - Internal road drainage (future detail design)

ATTACHMENT 1 – PEAK FLOOD DEPTHS – EXISTING CASE

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Pipes - Existing
- 1m Contour (LiDAR)

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Existing Case
(TUFLOW Case LE02c)

50%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Pipes - Existing
- 1m Contour (LiDAR)

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Existing Case
(TUFLOW Case LE02b)

5%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- 1D Pipes - Existing
- 1m Contour (LiDAR)

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Existing Case
(TUFLOW Case LE02b)

1%AEP Event

Client: Economic Development Queensland

ATTACHMENT 2 – PEAK FLOOD DEPTHS – PROPOSED CASE

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Proposed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Proposed Case
(TUFLOW Case LP02d)

50%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Proposed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Proposed Case
(TUFLOW Case LP02c)

5%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Proposed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Depth (m)

- <= 0.2
- 0.2 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- > 2

40 0 40 80 m

Carseldine Urban Village

Peak Flood Depths
Local Catchment Analysis

Proposed Case
(TUFLOW Case LP02c)

1%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Developed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -0.02 to -0.05
- -0.01 to -0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

40 0 40 80 m

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP02d Vs LE02c)

50%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Developed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -0.02 to -0.05
- -0.01 to -0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

40 0 40 80 m

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP02c Vs LE02b)

5%AEP Event

Client: Economic Development Queensland

Hydrology & Water Management Consulting

DesignFlow

LEGEND

- Site
- Cadastral Data
- Model Extent
- External Boundary
- Design Conts (0.1m)
- Developed Case Z-Point Modifiers
- 1D Pipes - Existing
- 1D Pipes - Proposed

Impact (m)

- Less than -0.2
- -0.1 to -0.2
- -0.05 to -0.1
- -0.02 to -0.05
- -0.01 to -0.02
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- Greater than 0.2
- Was Wet - Now Dry
- Was Dry - Now Wet

40 0 40 80 m

Carseldine Urban Village

Peak Flood Level Impacts
Local Catchment Analysis

(TUFLOW Case LP02c Vs LE02b)

1%AEP Event

Client: Economic Development Queensland