DAVIDSGROUP

60 Charlotte Street, Clemton Park

Flood Study

Date: 07 May 2009

Report No: 5002-AA001875/DN00070

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Hyder Consulting

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60 Charlotte Street, Clemton Park

Flood Study

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Report no: 5002-AA001875/DN00070 **Revision** 02 **Date:** 07 May 2009

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1 Introduction

Hyder Consulting has been commissioned by Davids Group to carry out this Flood Study in support of a Preferred Project Report for the Concept Plan and Project Application submission for 60 Charlotte Street, Clemton Park. The existing site is shown in Figure 1. The proposed concept layout is shown in Figure 3 (included in Section 6 of this report).

- An earlier regional study, 'Cup & Saucer Creek Stormwater Catchment Management Study' (January 1992) carried out by the NSW Water Board identifies that the Charlotte Street site may be impacted by flooding from the Cup & Saucer Creek channel which runs along the southern site boundary. This current study provides more site specific flooding details to facilitate redevelopment purposes, and supports an earlier stormwater management report, '60 Charlotte Street, Clempton Park Stormwater and Flood Management Report' prepared by Hyder Consulting (dated 10 October 2008).

Figure 1: Existing Site

2 Site and Catchment Description

2.1 60 Charlotte Street

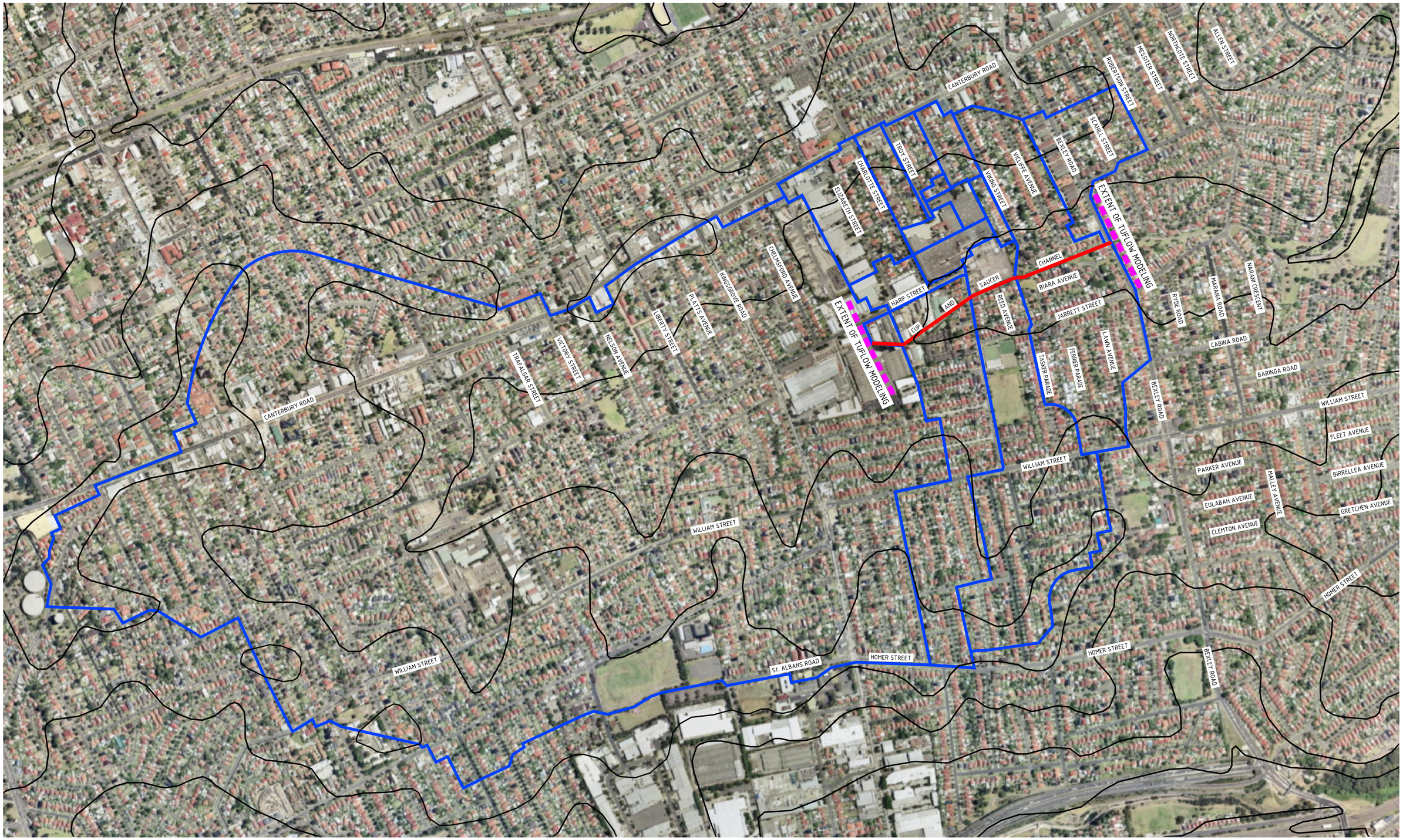
The Figure 1 aerial photograph shows the site which currently accommodates the existing Sunbeam Factory/Warehouse. The site is surrounded by Harp St, Charlotte St, Viking St, Troy/Sunbeam Lane with vehicle access and car parking areas in the north western and south eastern areas. The existing building and paved areas covers the entire site areas thereby providing 100% impervious surfaces.

The site has a general fall from its northern corner southward to the Cup & Saucer Creek stormwater channel. As indicated in Figure 1, a stormwater trunk drainage system conveys external catchment flows from Troy Lane under the existing warehouse building and through the southern car park, and a second system along the eastern site boundary, both systems discharge into the Cup & Saucer Creek open channel.

2.2 Cup & Saucer Creek Catchment

Figure 2 indicates the Cup & Saucer Creek open channel which runs along the southern site boundary, the site location and highly urbanised catchment areas which convey flows that potentially impact on the subject site.

Within this area, Cup & Saucer Creek is an open concrete lined channel with bridge/culvert road crossings. An earlier regional catchment study conducted by Sydney Water Study (January 1992) advises that the Cup & Saucer Creek channel has approximately 2 to 5 year ARI capacity in the vicinity of the site, and that in larger flood events channel flows would enter the southern end of the site.



Issue	Description	Date
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Client: DAVIDSGROUP

Status: **PRELIMINARY**
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Scales	1 : 5000	Current Issue Signatures	
		Drawn BC	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked	
Grid		Approved	

Filename: FIGURE 2 - CLEMTON-PARK-OVERALL-CATCHMENTS.dwg

Project: CLEMTON PARK VILLAGE

Title: CUP AND SAUCER CREEK CATCHMENT PLAN AND EXTENT OF TUFLOW MODEL

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FIGURE 2	AA001875	01

100mm on Original

Date Plotted: 30 Apr 2009 - 09:41AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\FIGURE 2 - CLEMTON-PARK-OVERALL-CATCHMENTS.dwg V1

3 Data Base

The following information has formed the data base for the flood study assessment that this report documents.

- Canterbury City Council documents:
  - Stormwater assets plan (provided electronically during the course of this study)
  - Stormwater Management Manual;
  - Flood Management and Flood Proofing (effective from: 7 November 1997);
  - Specification 9 A Guide to Stormwater Drainage Design (effective from: 10 November 1995).
- Sydney Water (January 1992) 'Cup & Saucer Creek Stormwater Catchment Management Study'.
- Sydney Water Feasibility Letter dated 26 September 2008'
- NSW Floodplain Management Manual (2005).
- Site and street survey carried out by Dunlop Thorpe and Company (28 August 2008).
- Cup & Saucer Creek channel carried out by Dunlop Thorpe and Company (March 2009).
- Aerial Laser Survey provided by AAM Hatch Pty Ltd (March 2009)
- Australian Rainfall and Runoff (2000).
- Architectural concept plans prepared by Marchese + Partners International (Job No. 07033 Dwgs DA 1.01, 2.01-9, 3.01-2 dated 24-09-08 issue B).
- Site inspection during the course of this study (refer to Appendix A photographs).

4 Hydrology

4.1 Assessment Methodology

DRAINS software was used to develop a rainfall runoff model for the catchments discharging to Cup & Saucer Creek. The catchment areas have been based on plans provided by Canterbury Council, Sydney Water and site inspection. Impervious fractions have been estimated using aerial photography. The model includes:

- Design rainfall IFD data provided by Canterbury City Council;
- Paved area depression storage = 1mm;
- Supplementary area depression storage = 1mm;
- Pervious area depression storage = 5mm;
- Antecedent moisture content = 3 (rather wet);
- Soil type = 3 (slow infiltration rates).

Catchment flows have been assessed for 10 year and 100 year average recurrence interval (ARI), and the probable maximum flood (PMF). DRAINS input data is included in Appendix B.

4.2 Results

The DRAINS model flows at several locations are along Cup & Saucer Creek are presented in Table 1 where a comparison is made with the Sydney Water (January 1992) flow estimates. In addition, flows approaching the northern part of the site via Charlotte Street, Troy Lane, Troy Street, Sunbeam Lane and Wade Street have been quantified and serve as input to the TUFLOW hydraulic model.

Table 1: DRAINS Model Flows (m^3/s)

Location	Design Event		
	10 year 60min	**100 year** 60min	**PMF** 45min
Chelmsford Avenue	57 (59)	88 (84)	330 (284)
Alfred Street Bridge	62 (66)	95 (95)	360 (325)
Bexley Road Bridge	74 (79)	115 (114)	430 (393)
Charlotte Street #	2.6	3.8	11
Wade Street #	0.8	1.2	4
Within Site # (d/s of Troy St)	5.3	7.8	24

( ) indicates Sydney Water Design Flow # Peak flows occur in shorter duration events.

DRAINS output data is included in Appendix B.

5 Hydraulic Assessment

5.1 Assessment Methodology

TUFLOW software was used to assess flow regimes through the existing site. The model incorporates:

- a digital terrain model which has been developed using ground survey along the open channel, site survey and aerial laser survey;
- one dimensional elements within the model including the open channel of Cup & Saucer Creek, the trunk drainage system through the site and adjoining street drainage systems to the north of the site;
- waterway and floodplain roughnesses that are shown in Figure C1 (Appendix C). These roughnesses typically include:
  - n=0.015 within the open concrete channel,
  - n=0.022 for open paved/road areas,
  - n=0.035 to 0.08 for open grassed areas,
  - n=1.0 for building footprints;
  - n=20 for the site building footprint (see also sensitivity assessment),
  - n=0.2 to represent developed overbank areas that are anticipated to obstruct flows;
- waterway and floodplain obstructions that are shown in Figure C1 (Appendix C). These obstructions include:
  - 50% blockage of the Bexley Road and Alfred Street culverts and 50% blockage of the fencing/barriers at these road crossing,
  - 50% blockage of the site boundary fencing (up to a maximum height of 1.2m above ground level) along Alfred Street and the Cup & Saucer Creek channel;
  - 50% blockage of the open style fencing downstream of the site (up to a maximum height of 1.2m above ground level) along the Cup & Saucer Creek channel where overbank areas are unobstructed;
- a 2m grid size;
- inflow hydrographs generated from the abovementioned DRAINS modelling;
- assessment of 10 year, 100 year and PMF flood regimes;
- sensitivity modelling that has included;
  - modelling road culvert crossings and associated road barriers with no blockage, and no blockage on open fencing adjacent to channel (downstream of the subject site);
  - removal of blockage from site boundary fencing only;
  - reducing the flow obstruction of the site building (which is constructed over the trunk drainage that extends from Troy Street southward to the Cup & Saucer Creek channel);
  - increased rainfall intensity.

5.1.1 Model Extents

The TUFLOW model extents are indicated in Figure 2. The model starts approximately 350m upstream of Alfred Street where the main upstream catchment hydrograph(s) from the DRAINS modelling is input. The model extends approximately 450m to just downstream of Bexley Road, with the road culvert crossing at Bexley Road operating as a hydraulic control.

5.2 Results

The existing conditions TUFLOW model flow regimes for the 10 year and 100 year ARI events and the PMF are presented in the accompanying Drawings.

The 100 year peak water levels within the site result from the 60 minute duration event in both the southern open car park area adjacent to Cup & Saucer Creek. The 100 year ARI results indicate that significant flooding would occur:

- in the southern open car park adjacent to the Cup & Saucer Creek channel, with depths of up to approximately 0.8m at the downstream (south eastern) corner of the site and up to 0.4m at the upstream (north eastern) corner;
- in the northern site areas and the site building. Flows from the Wade Street area would enter the upper north eastern open car park, then flow westward to combine with additional flows from the Troy Street and Charlotte Street areas. These combined flows would surcharge the street systems and the Sydney Water trunk drainage system which extends through the site (a 1.1m (w) x 1.4m (h) culvert that enlarges to a 2, 1.0m (w) x 1.0m (h) system), resulting in significant ponding in the loading dock area and north western car park since the site building obstructs overland flows. It is estimated that the trunk drainage system would convey approximately 5.1m^3/s, while overland surcharge flows would pond up to approximately 1.0m with a storage volume of 3100m^3.

5.3 Sensitivity Assessment

The following sensitivity assessments have been carried out on using the 100 year ARI event.

5.3.1 Main Channel Flood Levels

Culverts and Open Fencing Unblocked

The channel culvert and road barriers and downstream open fencing adjacent to unobstructed overbank areas that have been assessed with 50% blockage for the adopted modelling results were unblocked and the TUFLOW model re-run. For this condition the 100 year flood levels through the open car park area adjacent to the channel reduced by less than 0.15m.

A comparison of the TUFLOW flood levels with the 1992 Sydney Water levels (which used HEC-RAS software) is included in Appendix D (Table D1).

Alfred Street Site Fencing Unblocked

The site fencing along Alfred Street that has been assessed with 50% blockage for the adopted modelling results was unblocked and the TUFLOW model re-run. For this condition the 100 year flood levels through the open car park area adjacent to the channel generally reduced by up to 0.10m, however a 0.2m increase in water levels was observed just downstream of the Alfred Street culvert.

A comparison of flood levels comparing blocked and unblocked results with the 1992 Sydney Water (which used HEC-RAS software) is included in Appendix D (Table D1).

5.3.2 Site Factory Building

The site building which obstructs overland flows that enter off Troy Lane was reduced in roughness from n=20 (restricting flows from entering the building) to n=1 (allowing some limited flow through the building). The TUFLOW model was re-run with the reduced to n=1, resulting in a reduction in water level at the northern site boundary from 25.8mAHD to 25.7mAHD.

5.3.3 Rainfall Intensity

DRAINS model generated hydrographs for with a 10% increase in peak rainfall and volume was introduced to the TUFLOW. For this condition the 100 year flood levels through the open car park area adjacent to the channel increased by up to 0.1m adjacent to Cup & Saucer Creek, reducing to less than a 0.01m increase in the northern portion of the car park (towards Harp Street).

6 Proposed Development

The proposed concept development layout is shown in Figure 3. As part of the investigation to support this concept development, the existing conditions TUFLOW modelling was adjusted. In particular development potential within the existing southern car park area adjacent to the Cup & Saucer Creek channel was examined, and secondly the impact of removing the informal flood storage within the northern portion of the site was assessed.

6.1 Southern Car Park Area

6.1.1 Assessment Methodology

The existing conditions TUFLOW model was adjusted to include a barrier to flows that represents the proposed development within the existing southern car park area. This portion of the proposed development is to be a suspended slab structure supported by columns, with existing ground levels retained (to serve as car parking). The 100 year ARI event was assessed for:

- the base case existing TUFLOW model which adopts 50% blockage of both the road culverts and barriers and the open style fences; and
- the existing conditions sensitivity model which excluded the Alfred Street fence from the base case model (therefore maximising flows within the site).

6.1.2 Results

The existing conditions sensitivity model (which excluded the Alfred Street fence from the base case model) resulted in the maximum potential flood impact when compared to the proposed development. This flow regime comparison is presented in Drawing No.5. The results indicate a maximum increase in water levels of no greater than 0.01m locally, at approximately 70m downstream of Alfred Street, and negligible increase on the adjacent neighbouring properties.

6.2 Flood Storage

6.2.1 Assessment Methodology

The existing conditions TUFLOW model was adjusted to include a high capacity trunk drainage system conveying 100 year ARI flows (without significant ponding) through the site, extending from Troy Lane to the Cup & Saucer Creek channel. Such a system is representative of the proposed development concept which proposes to extend Troy Street through the site to link with Alfred Street.

6.2.2 Results

The removal of the flood storage increased 100 year ARI water levels along the channel by up to 0.06m. A plot of these results is not included in this report, however the results are available if requested.

6.3 Comments and Conclusions

This flood study indicates that:

- the proposed suspended slab concept building development while retaining existing ground levels within the southern open car park area (future Lot 5) would result in no significant increase in flooding;
- under existing conditions informal flood storage in the northern portion of the site provides a significant flow reduction in the 100 year ARI event, and an associated reduction in downstream flooding along the Cup & Saucer Creek channel.

With these findings in mind we provide the following additional comments.

- The NSW Floodplain Manual (April 2005) defines floodway areas as,

  > "those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that even if only partially blocked would cause a significant redistribution of flood flow or a significant increase in flood levels."

  This flood study indicates that up to the 100 year ARI event the proposed Lot 5 building development, which includes allowance for blockage due to potential debris build-up around the columns, would not result in a significant redistribution of flow or increase in flood levels. Therefore the proposed building is considered to be outside the Cup & Saucer Creek channel floodway.

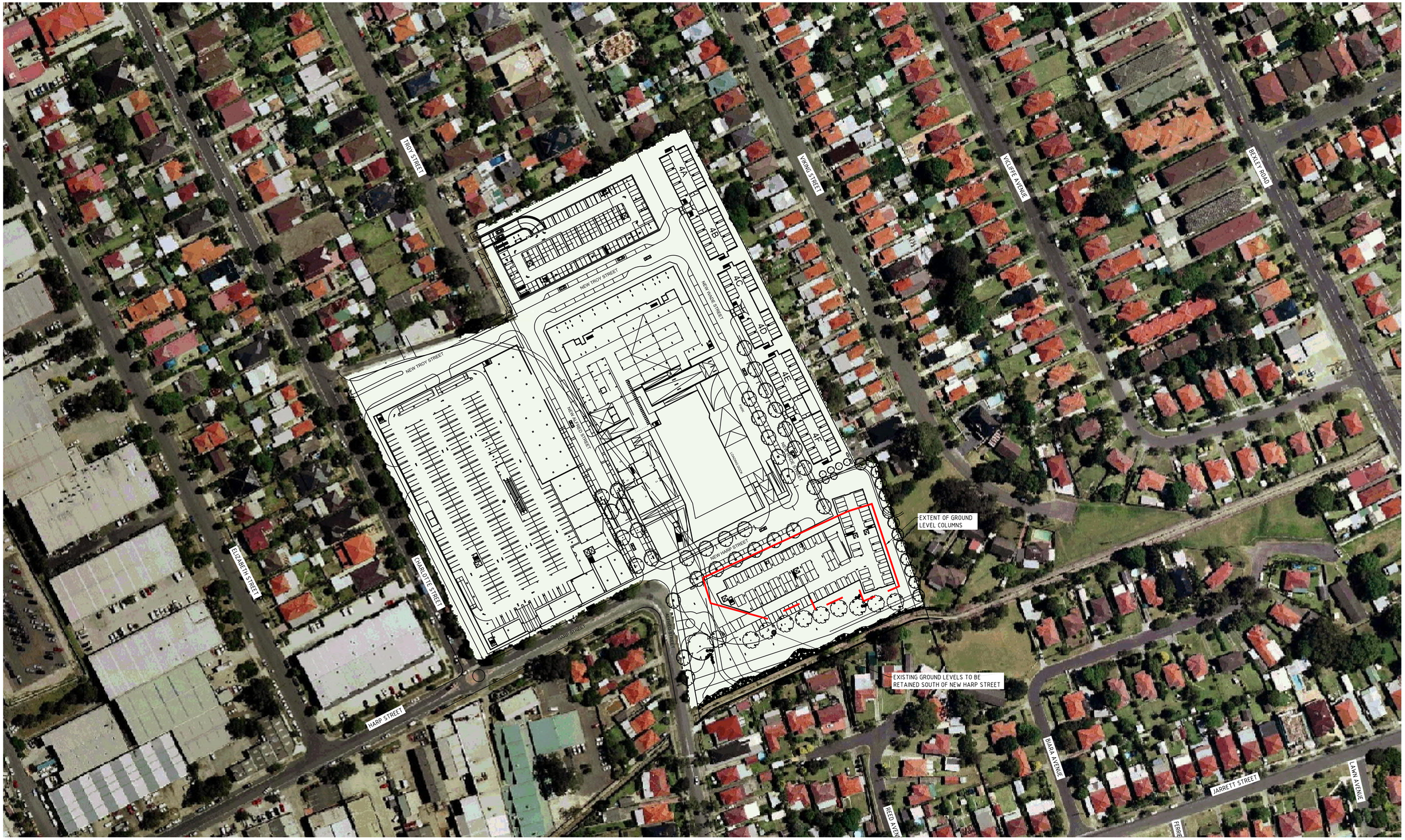
- The location of the proposed Lot 5 building is within the 100 year ARI provisional low risk hydraulic hazard areas (as defined by the NSW Floodplain Manual, April 2005).
- The proposed Lot 5 building being located outside of the Cup & Saucer Creek channel floodway and within provisional low risk hydraulic hazard areas is not considered to be within environmentally sensitive land with respect to flooding, as referred to in Table 1 of SEPP SL 2004.
- Although the ground floor of the proposed development on Lot 5 is above the PMF flood level, an appropriate Flood Emergency and Evacuation Plan will be required for the Lot 5 development.

- Being subject to flooding development details of the existing southern open car park area will require careful consideration. This current flood study assumes existing open fence types, ground levels and surface finishes are retained, and unobstructed flow paths remain unobstructed. Proposed changes to these existing conditions within the flood extents will require assessment as part of detailed design to confirm that any changes would not adversely impact on flood regimes.

- The development will require detention storage to mitigate potential adverse flood impacts. Meeting with Sydney Water to discuss this matter on 27 April 2009, Sydney Water advised that since the site is subject to inundation from regional flows (external to the site), their standard on-site detention requirement is inappropriate, rather the proposed storage (whether dedicated on-site detention or regional) is to be provided and configured in a manner such that the proposed development would not adversely impact on neighbouring/downstream flooding. It is noted that such an approach has been adopted for the '60 Charlotte Street, Clempton Park Stormwater and Flood Management Report' prepared by Hyder Consulting (dated 10 October 2008).

- Typical freeboard requirements above 100 year ARI flooding are expected to be 0.5m with respect to habitable floor levels, and 0.3m with respect to basement car park accesses.

- Flooding in open car park areas is typically limited to a maximum depth of 0.2m in the 100 year ARI event.



Issue	Description	Date
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1 : 1000

Client

DAVIDSGROUP

Status

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked	
Grid		Approved	

Filename: FIGURE 3 - PROPOSED REDEVELOPMENT.dwg

Project

CLEMTON PARK VILLAGE

Title

PROPOSED DEVELOPMENT CONCEPT PLAN

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Drawing No.	Project No.	Issue
FIGURE 3	AA001875	01

Date Plotted: 30 Apr 2009 - 09:42AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\FIGURE 3 - PROPOSED REDEVELOPMENT.dwg V1

Appendix A

Site and Catchment Photographs

Photo 1: Viewing westward (upstream) along Harp Street (at intersection with Alfred Street).

Photo 2: Viewing upstream from Alfred Street culvert.

Photo 3: Alfred Street culvert (viewing south west, upstream)

Photo 4: Viewing upstream from Alfred Street culvert.

Photo 5: Viewing upstream to Alfred Street culvert.

Photo 6: Viewing downstream across Alfred Street above culvert.

Photo 7: Viewing downstream from Alfred Street through site car park.

Photo 8: Viewing northward from Cup & Saucer Creek to site car park

Photo 9: Viewing upstream along Cup & Saucer Creek channel (site in background).

Photo 10: Viewing upstream to Bexley Road culvert

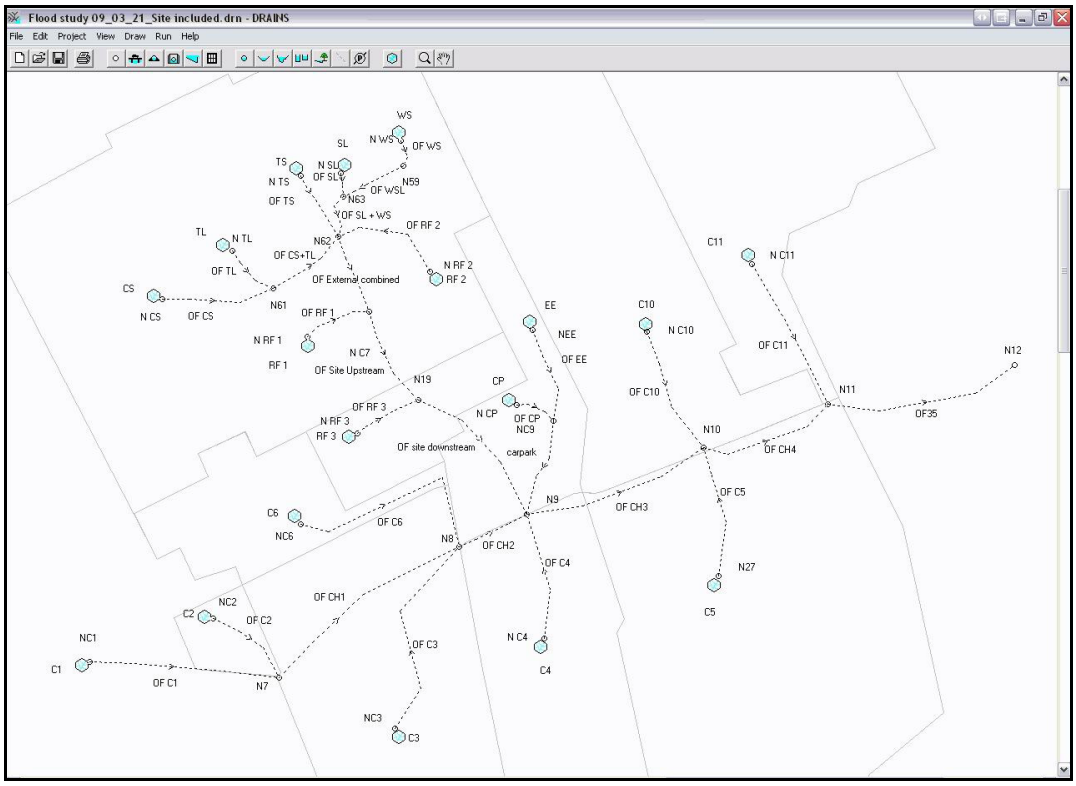
Photo 11: Viewing eastward along Sunbeam Lane from Troy Street.

Photo 12: Main site entrance at intersection of Troy Street and Troy Lane.

Photo 13: Viewing westward along Troy Lane to Charlotte Street.

Appendix B

DRAINS Model Input and Output


Flood study 09_03_21_Site included.drn - DRAINS
File Edit Project View Draw Run Help
WS
N WS
OF WS
SL
N SL
OF SL
TS
N TS
OF TS
N59
OF WSL
N63
OF SL + WS
OF RF 2
N RF 2
RF 2
TL
N TL
OF TL
N62
OF CS+TL
OF External combined
CS
N CS
OF CS
N61
OF RF 1
N RF 1
RF 1
N C7
OF Site Upstream
N19
CP
N CP
OF CP
NC9
EE
NEE
OF EE
C10
N C10
OF C10
C11
N C11
OF C11
N12
N11
OF35
N10
OF CH4
OF RF 3
N RF 3
RF 3
OF site downstream
carpark
OF C5
N9
OF CH3
C6
NC6
OF C6
N8
OF CH2
OF C4
N27
C5
OF CH1
NC2
C2
OF C2
NC1
C1
OF C1
N7
OF C3
N C4
C4
NC3
C3

DRAINS Model Name and File Path:	F:\AA001875\D-Calculations\E-Stormwater\C-DrainsDesignFiles\Flood study 09_03_21_Site included.drn
DRAINS Version:	2008.06-15 May 2008
Modeller's Name:	Darlan Castro
Description:	Clemton Park Redevelopment Flood Study

DATA

PIT / NODE DETAILS — Version 9

Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss
NC1	Node							0		324277.438	6244513.194		7	
N7	Node							0		324472.707	6244496.797		11	
N8	Node							0		324659.033	6244632.442		12	
N9	Node							0		324728.587	6244666.326		13	
N10	Node							0		324911.839	6244734.697		14	
N11	Node							0		325040.627	6244779.415		15	
N12	Node							0		325233.809	6244820.556		16	
NC6	Node							0		324494.818	6244655.974		66	
NC2	Node							0		324404.761	6244558.326		74	
N C7	Node							0		324565.622	6244875.907		97	
N19	Node							0		324616.551	6244783.987		99	
N RF 3	Node							0		324553.821	6244749.827		110	
NC9	Node						0.1	0		324756.435	6244762.783		131	
N C4	Node							0		324746.99	6244537.364		137	
N C10	Node							0		324852.977	6244854.376		141	
N27	Node							0		324927.507	6244601.802		154	
N C11	Node						0.1	0		324961.494	6244925.111		168	
NC3	Node							0		324593.158	6244444.633		189	
N CS	Node							0		324352.342	6244888.881		243	
N TL	Node							0		324424.946	6244938.481		245	
N TS	Node							0		324494.909	6245016.335		247	
N WS	Node							0		324599.099	6245052.555		249	
N RF 2	Node							0		324629.099	6244916.916		251	
N RF 1	Node							0		324501.863	6244849.344		253	
N59	Node							0		324601.707	6245026.074		301	
N61	Node							0		324466.483	6244899.855		329	
N62	Node							0		324534.146	6244953.041		330	
N SL	Node							0		324536.919	6245018.908		331	
N63	Node							0		324539.283	6244994.842		340	
N CP	Node						0.1	0		324718.995	6244778.591		441	
NEE	Node						0.1	0		324734.803	6244856.383		444	

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %
C1	NC1	256.8	70	30	0	30	33	0						
C6	NC6	2.36	80	20	0	6	8	0						
C2	NC2	0.63	90	10	0	3	5	0						
RF 3	N RF 3	1.74	100	0	0	3	0	0						
C4	N C4	23.5	65	35	0	16.3	18.3	0						
C10	N C10	7.3	70	30	0	7	9	0						
C5	N27	13.6	70	30	0	9	11	0						
C11	N C11	7.04	75	25	0	8	11	0						
C3	NC3	18.4	70	30	0	16	18	0						
CS	N CS	7.1	80	20	0	7	9	0						
TL	N TL	2.43	70	30	0	8	10	0						
TS	N TS	2.05	70	30	0	6	8	0						
WS	N WS	2.11	70	30	0	6	8	0						
RF 2	N RF 2	1.03	100	0	0	3	0	0						
RF 1	N RF 1	1.21	100	0	0	3	0	0						
SL	N SL	0.3131	70	30	0	3	4	0						
CP	N CP	1.7	100	0	0	2	0	0						
EE	NEE	0.85	70	30	0	4	6	0						

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Servic (m)	Chg (m)	Bottom Elev (m)	Height of Ser (m)	Chg (m)	Bottom Elev (m)	Height of Ser (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %		id
OF C1	NC1	N7	0.9				Dummy used	0.2	0.05	0.6	1	0		17
OF CH1	N7	N8	2.3				Dummy used	0.2	0.05	0.6	1	0		27
OF CH2	N8	N9	1				Dummy used	0.2	0.05	0.6	1	0		33
OF CH3	N9	N10	2				Dummy used	0.2	0.05	0.6	1	0		40
OF CH4	N10	N11	1.5				Dummy used	0.2	0.05	0.6	1	0		45
OF35	N11	N12	0.1				Dummy used	0.2	0.05	0.6	1	0		50
OF C6	NC6	N8	0.1				Dummy used	0.2	0.05	0.6	1	0		64
OF C2	NC2	N7	0.1				Dummy used	0.2	0.05	0.6	1	0		75
OF Site Upstr	N C7	N19	0.1				Dummy used	0.2	0.05	0.6	1	0		101
OF site down	N19	N9	1.8				Dummy used	0.2	0.05	0.6	1	0		120
OF RF 3	N RF 3	N19	0.1				Dummy used	0.2	0.05	0.6	1	0		112
carpark	NC9	N9	1				Dummy used	0.2	0.05	0.6	1	0		125
OF C4	N C4	N9	0.1				Dummy used	0.2	0.05	0.6	1	0		138
OF C10	N C10	N10	0.1				Dummy used	0.2	0.05	0.6	1	0		143
OF C5	N27	N10	0.1				Dummy used	0.2	0.05	0.6	1	0		150
OF C11	N C11	N11	0.1				Dummy used	0.2	0.05	0.6	1	0		159
OF C3	NC3	N8	0.1				Dummy used	0.2	0.05	0.6	1	0		178
OF CS	N CS	N61	0.1				Dummy used	0.2	0.05	0.6	1	0		255
OF TL	N TL	N61	0.1				Dummy used	0.2	0.05	0.6	1	0		263
OF TS	N TS	N62	0.2				Dummy used	0.2	0.05	0.6	1	0		270
OF WS	N WS	N59	0.1				Dummy used	0.2	0.05	0.6	1	0		282
OF RF 2	N RF 2	N62	0.1				Dummy used	0.2	0.05	0.6	1	0		372
OF RF 1	N RF 1	N C7	0.1				Dummy used	0.2	0.05	0.6	1	0		381
OF WSL	N59	N63	1.5				Dummy used	0.2	0.05	0.6	1	0		307
OF CS+TL	N61	N62	1.5				Dummy used	0.2	0.05	0.6	1	0		360
OF External c	N62	N C7	0.2				Dummy used	0.2	0.05	0.6	1	0		365
OF SL	N SL	N63	0.1				Dummy used	0.2	0.05	0.6	1	0		344
OF SL + WS	N63	N62	0.1				Dummy used	0.2	0.05	0.6	1	0		351
OF CP	N CP	NC9	0.1				Dummy used	0.2	0.05	0.6	1	0		456
OF EE	NEE	NC9	0.1				Dummy used	0.2	0.05	0.6	1	0		448

DRAINS Model Name and File Path:	F:\AA001875\D-Calculations\E-Stormwater\C-DrainsDesignFiles\Flood study 09_03_21_Site included.drn	RESULTS 10 YEAR ARI
DRAINS Version:	2008.06-15 May 2008	
Modeller's Name:	Darlan Castro	
Description:	Clemton Park Redevelopment Flood Study	

DRAINS results prepared 24 April, 2009 from Version 2008.06

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C1	56.784	45.18	13.022	30	33	0	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
C6	1.05	0.877	0.173	6	8	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
C2	0.303	0.276	0.026	3	5	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
RF 3	0.848	0.848	0	3	0	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
C4	6.536	4.932	1.914	16.3	18.3	0	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
C10	3.068	2.29	0.778	7	9	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
C5	5.267	4.059	1.227	9	11	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
C11	2.823	2.302	0.529	8	11	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
C3	5.34	4.204	1.317	16	18	0	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
CS	3.05	2.546	0.504	7	9	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
TL	0.979	0.742	0.237	8	10	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
TS	0.892	0.667	0.225	6	8	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
WS	0.918	0.686	0.231	6	8	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
RF 2	0.502	0.502	0	3	0	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
RF 1	0.59	0.59	0	3	0	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
SL	0.146	0.107	0.04	3	4	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
CP	0.829	0.829	0	2	0	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
EE	0.391	0.29	0.101	4	6	0	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1

Outflow Volumes for Total Catchment (247 impervious + 103 pervious = 350 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff	Impervious Runo cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 10 yea	50481.84	35710.29 (70.	33148.17 (93.1%	2562.12 (17.2%)
AR&R 10 yea	78786.7	61896.93 (78.	53119.44 (95.6%	8777.49 (37.8%)
AR&R 10 yea	99796.48	81658.51 (81.	67943.47 (96.5%	13715.04 (46.7%)
AR&R 10 yea	116721.03	97459.58 (83.	79885.05 (97.0%	17574.52 (51.1%)
AR&R 10 yea	131311.16	110954.38 (8	90179.50 (97.3%	20774.88 (53.7%)
AR&R 10 yea	145317.69	123537.41 (8	100062.21 (97.6	23475.20 (54.9%)
AR&R 10 yea	175956.95	151214.03 (8	121680.58 (98.0	29533.45 (57.0%)
AR&R 10 yea	203094.59	176171.86 (8	140828.30 (98.3	35343.56 (59.1%)
AR&R 10 yea	234259.11	203305.86 (8	162817.22 (98.5	40488.64 (58.7%)
AR&R 10 yea	260521.38	226051.63 (8	181347.31 (98.7	44704.31 (58.3%)
AR&R 10 yea	300439.94	260670.14 (8	209513.00 (98.8	51157.14 (57.8%)
AR&R 10 yea	346661.44	298605.93 (8	242125.91 (99.0	56480.02 (55.3%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF C1	56.784	56.784	0.256	0.23	2.12	49.99	9.24	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
OF CH1	56.851	56.851	0.256	0.23	2.13	49.99	9.25	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
OF CH2	61.38	61.38	0.256	0.23	2.3	49.99	9.98	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
OF CH3	70.593	70.593	0.256	0.23	2.64	49.99	11.48	AR&R 10 year, 1.5 hours storm, average 44.6 mm/h, Zone 1
OF CH4	74.636	74.636	0.256	0.23	2.79	49.99	12.14	AR&R 10 year, 1.5 hours storm, average 44.6 mm/h, Zone 1
OF35	75.853	75.853	0.256	0.23	2.84	49.99	12.34	AR&R 10 year, 1.5 hours storm, average 44.6 mm/h, Zone 1
OF C6	1.05	1.05	0.256	0.088	0.09	21.69	0.98	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF C2	0.303	0.303	0.256	0.053	0.04	14.69	0.69	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF Site Upstr	6.283	6.283	0.256	0.185	0.28	40.91	1.54	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF site downs	6.696	6.696	0.256	0.189	0.3	41.81	1.57	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF RF 3	0.848	0.848	0.256	0.081	0.07	20.25	0.92	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
carpark	1.22	1.22	0.256	0.095	0.09	22.95	1	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF C4	6.536	6.536	0.256	0.187	0.29	41.45	1.56	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
OF C10	3.068	3.068	0.256	0.138	0.18	31.57	1.28	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF C5	5.267	5.267	0.256	0.172	0.25	38.4	1.47	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF C11	2.823	2.823	0.256	0.133	0.17	30.67	1.25	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF C3	5.34	5.34	0.256	0.173	0.26	38.57	1.48	AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1
OF CS	3.05	3.05	0.256	0.138	0.18	31.57	1.28	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF TL	0.979	0.979	0.256	0.087	0.08	21.33	0.94	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF TS	0.892	0.892	0.256	0.083	0.08	20.61	0.93	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF WS	0.918	0.918	0.256	0.084	0.08	20.79	0.94	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF RF 2	0.502	0.502	0.256	0.066	0.05	17.2	0.78	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF RF 1	0.59	0.59	0.256	0.07	0.06	18.1	0.82	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF WSL	0.918	0.918	0.256	0.084	0.08	20.79	0.94	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF CS+TL	4.029	4.029	0.256	0.154	0.21	34.8	1.38	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF External c	5.967	5.967	0.256	0.181	0.27	40.19	1.52	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF SL	0.146	0.146	0.256	0.04	0.02	11.99	0.56	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF SL + WS	0.992	0.992	0.256	0.087	0.08	21.33	0.96	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF CP	0.829	0.829	0.256	0.08	0.07	20.08	0.91	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1
OF EE	0.391	0.391	0.256	0.06	0.04	15.94	0.73	AR&R 10 year, 25 minutes storm, average 90 mm/h, Zone 1

DETENTION BASIN DETAILS					
Name	Max WL	MaxVol	Max Q	Max Q	Max Q
			Total	Low Level	High Level

CONTINUITY CHECK for AR&R 10 year, 1 hour storm, average 58 mm/h, Zone 1				
Node	Inflow	Outflow	Storage Change	Difference
	(cu.m)	(cu.m)	(cu.m)	%
NC1	128744.7	128744.7	0	0
N7	129089.97	129089.97	0	0
N8	139586.59	139586.64	0	0
N9	162020.33	162020.33	0	0
N10	172548.19	172548.22	0	0
N11	176171.86	176171.86	0	0
N12	176171.86	176171.86	0	0
NC6	1241.22	1241.22	0	0
NC2	345.26	345.26	0	0
N C7	8488.83	8488.83	0	0
N19	9480.63	9480.63	0	0
N RF 3	991.8	991.8	0	0
NC9	1397.43	1397.43	0	0
N C4	11555.63	11555.63	0	0
N C10	3678	3678	0	0
N27	6849.87	6849.87	0	0
N C11	3623.65	3623.65	0	0
NC3	9255.42	9255.42	0	0
N CS	3733.82	3733.82	0	0
N TL	1224.1	1224.1	0	0
N TS	1033.01	1033.01	0	0
N WS	1063.25	1063.25	0	0
N RF 2	587.1	587.1	0	0
N RF 1	689.7	689.7	0	0
N59	1063.25	1063.25	0	0
N61	4957.92	4957.92	0	0
N62	7799.13	7799.13	0	0
N SL	157.85	157.85	0	0
N63	1221.09	1221.09	0	0
N CP	969	969	0	0
NEE	428.43	428.43	0	0

Run Log for Flood study 09_03_21_Site included.drn run at 11:05:45 on 24/4/2009

The maximum flow exceeded the safe value in the following overflow routes: OF CP, OF EE, OF RF 1, OF RF 2, OF External combined, OF CS+TL, OF SL + WS, OF WSL, OF WS, OF TS, OF TL, O

DRAINS Model Name and File Path:	F:\AA001875\D-Calculations\E-Stormwater\C-DrainsDesignFiles\Flood study 09_03_21_Site included.drn	RESULTS 100 YEAR ARI
DRAINS Version:	2008.06-15 May 2008	
Modeller's Name:	Darlan Castro	
Description:	Clemton Park Redevelopment Flood Study	

DRAINS results prepared 24 April, 2009 from Version 2008.06

PIT / NODE DETAILS — Version 8

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C1	88.433	67.283	22.981	30	33	0	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
C6	1.465	1.212	0.253	6	8	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
C2	0.435	0.406	0.029	3	5	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
RF 3	1.247	1.247	0	3	0	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
C4	10.134	7.206	3.212	16.3	18.3	0	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
C10	4.321	3.176	1.145	7	9	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
C5	7.654	5.656	1.998	9	11	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
C11	4.062	3.2	0.862	8	11	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
C3	8.204	6.138	2.199	16	18	0	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
CS	4.273	3.53	0.743	7	9	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
TL	1.405	1.031	0.374	8	10	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
TS	1.251	0.921	0.33	6	8	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
WS	1.288	0.948	0.339	6	8	0	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
RF 2	0.738	0.738	0	3	0	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
RF 1	0.867	0.867	0	3	0	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
SL	0.211	0.157	0.054	3	4	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
CP	1.218	1.218	0	2	0	0	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
EE	0.548	0.403	0.144	4	6	0	AR&R 100 year, 15 minutes storm, average 173 mm/h, Zone 1

Outflow Volumes for Total Catchment (247 impervious + 103 pervious = 350 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff	Impervious Ru cu.m (Runoff	Pervious Runoff cu.m (Runoff %)
AR&R 100 ye	75285.06	59757.06 (79.	50648.75 (95.	9108.31 (41.1%)
AR&R 100 ye	118471.84	101258.16 (8	81120.39 (97.	20137.77 (57.7%)
AR&R 100 ye	151445.53	132922.83 (8	104385.84 (9	28536.99 (64.0%)
AR&R 100 ye	177415.95	157706.87 (8	122710.05 (9	34996.82 (67.0%)
AR&R 100 ye	201343.78	180187.04 (8	139592.94 (9	40594.11 (68.5%)
AR&R 100 ye	220602.75	198251.94 (8	153181.66 (9	45070.28 (69.4%)
AR&R 100 ye	273127.22	247864.80 (9	190241.70 (9	57623.10 (71.7%)
AR&R 100 ye	311645.16	284058.25 (9	217419.16 (9	66639.09 (72.6%)
AR&R 100 ye	362418.78	330873.71 (9	253243.80 (9	77629.91 (72.8%)
AR&R 100 ye	399185.94	364133.52 (9	279185.84 (9	84947.67 (72.3%)
AR&R 100 ye	462215.22	421199.13 (9	323657.84 (9	97541.29 (71.7%)
AR&R 100 ye	531022.25	481778.34 (9	372206.91 (9	109571.43 (70.1%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF C1	88.433	88.433	7.665	0.23	3.31	49.99	14.39	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF CH1	88.543	88.543	7.665	0.23	3.31	49.99	14.4	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF CH2	95.107	95.107	7.665	0.23	3.56	49.99	15.47	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF CH3	108.858	108.858	7.665	0.23	4.07	49.99	17.71	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF CH4	114.608	114.608	7.665	0.23	4.29	49.99	18.64	AR&R 100 year, 1.5 hours storm, average 69 mm/h, Zone 1
OF35	116.489	116.489	7.665	0.23	4.36	49.99	18.95	AR&R 100 year, 1.5 hours storm, average 69 mm/h, Zone 1
OF C6	1.465	1.465	7.665	0.102	0.11	24.39	1.06	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF C2	0.435	0.435	7.665	0.062	0.05	16.3	0.77	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF Site Upstr	9.236	9.236	7.665	0.215	0.37	47.02	1.7	AR&R 100 year, 20 minutes storm, average 152 mm/h, Zone 1
OF site downs	9.921	9.921	7.665	0.221	0.38	48.27	1.73	AR&R 100 year, 20 minutes storm, average 152 mm/h, Zone 1
OF RF 3	1.247	1.247	7.665	0.096	0.1	23.13	1.01	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
carpark	1.743	1.743	7.665	0.109	0.12	25.82	1.11	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF C4	10.134	10.134	7.665	0.224	0.39	48.81	1.73	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF C10	4.321	4.321	7.665	0.159	0.22	35.7	1.4	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF C5	7.654	7.654	7.665	0.2	0.32	43.96	1.62	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF C11	4.062	4.062	7.665	0.155	0.21	34.98	1.37	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF C3	8.204	8.204	7.665	0.205	0.34	45.04	1.65	AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1
OF CS	4.273	4.273	7.665	0.158	0.22	35.52	1.4	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF TL	1.405	1.405	7.665	0.1	0.1	24.03	1.05	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF TS	1.251	1.251	7.665	0.096	0.1	23.13	1.01	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF WS	1.288	1.288	7.665	0.097	0.1	23.31	1.02	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF RF 2	0.738	0.738	7.665	0.077	0.07	19.36	0.88	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF RF 1	0.867	0.867	7.665	0.082	0.08	20.43	0.92	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF WSL	1.288	1.288	7.665	0.097	0.1	23.31	1.02	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF CS+TL	5.678	5.678	7.665	0.177	0.27	39.47	1.5	AR&R 100 year, 25 minutes storm, average 138 mm/h, Zone 1
OF External c	8.623	8.623	7.665	0.21	0.35	45.94	1.67	AR&R 100 year, 20 minutes storm, average 152 mm/h, Zone 1
OF SL	0.211	0.211	7.665	0.046	0.03	13.25	0.62	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF SL + WS	1.417	1.417	7.665	0.1	0.11	24.03	1.05	AR&R 100 year, 20 minutes storm, average 152 mm/h, Zone 1
OF CP	1.218	1.218	7.665	0.095	0.09	22.95	1	AR&R 100 year, 5 minutes storm, average 258 mm/h, Zone 1
OF EE	0.548	0.548	7.665	0.068	0.06	17.56	0.82	AR&R 100 year, 15 minutes storm, average 173 mm/h, Zone 1

DETENTION BASIN DETAILS					
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 89 mm/h, Zone 1				
Node	Inflow	Outflow	Storage Char	Difference
	(cu.m)	(cu.m)	(cu.m)	%
NC1	207808.25	207808.25	0	0
N7	208348.64	208348.63	0	0
N8	225250.47	225250.44	0	0
N9	261276.91	261276.86	0	0
N10	278259.25	278259.19	0	0
N11	284058.16	284058.09	0	0
N12	284058.09	284058.09	0	0
NC6	1971.19	1971.19	0	0
NC2	540.39	540.39	0	0
N C7	13511.69	13511.69	0	0
N19	15042.89	15042.89	0	0
N RF 3	1531.2	1531.2	0	0
NC9	2187.2	2187.2	0	0
N C4	18796.37	18796.37	0	0
N C10	5933.01	5933.01	0	0
N27	11049.36	11049.36	0	0
N C11	5798.93	5798.93	0	0
NC3	14930.64	14930.64	0	0
N CS	5929.64	5929.64	0	0
N TL	1974.59	1974.59	0	0
N TS	1666.4	1666.4	0	0
N WS	1715.17	1715.17	0	0
N RF 2	906.4	906.4	0	0
N RF 1	1064.8	1064.8	0	0
N59	1715.17	1715.17	0	0
N61	7904.23	7904.22	0	0
N62	12446.89	12446.89	0	0
N SL	254.7	254.7	0	0
N63	1969.87	1969.87	0	0
N CP	1496	1496	0	0
NEE	691.2	691.2	0	0

Run Log for Flood study 09_03_21_Site included.drn run at 11:07:31 on 24/4/2009

The maximum flow exceeded the safe value in the following overflow routes: OF External combined, OF C3, OF C4, OF site downstream, OF Site Upstream, OF35, OF CH4, OF CH3, OF CH2, OF CH

DRAINS Model Name and File Path:	F:\AA001875\D-Calculations\E-Stormwater\C-DrainsDesignFiles\Flood study 09_03_21_Site included.drn	RESULTS PMF
DRAINS Version:	2008.06-15 May 2008	
Modeller's Name:	Darlan Castro	
Description:	Clemton Park Redevelopment Flood Study	

DRAINS results prepared 24 April, 2009 from Version 2008.06

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C1	332.685	242.676	95.723	30	33	0	PMF 45 minutes
C6	5.237	4.401	1.023	6	8	0	PMF 15 minutes
C2	1.505	1.369	0.143	3	5	0	PMF 15 minutes
RF 3	4.2	4.2	0	3	0	0	PMF 15 minutes
C4	37.226	25.008	12.609	16.3	18.3	0	PMF 30 minutes
C10	15.949	11.731	4.707	7	9	0	PMF 15 minutes
C5	28.958	21.405	8.066	9	11	0	PMF 15 minutes
C11	14.987	11.981	3.479	8	11	0	PMF 15 minutes
C3	29.733	21.936	7.797	16	18	0	PMF 15 minutes
CS	15.607	13.039	3.052	7	9	0	PMF 15 minutes
TL	5.273	3.86	1.519	8	10	0	PMF 15 minutes
TS	4.519	3.345	1.332	6	8	0	PMF 15 minutes
WS	4.651	3.443	1.371	6	8	0	PMF 15 minutes
RF 2	2.486	2.486	0	3	0	0	PMF 15 minutes
RF 1	2.921	2.921	0	3	0	0	PMF 15 minutes
SL	0.748	0.529	0.219	3	4	0	PMF 15 minutes
CP	4.104	4.104	0	2	0	0	PMF 15 minutes
EE	1.931	1.436	0.566	4	6	0	PMF 15 minutes

Outflow Volumes for Total Catchment (247 impervious + 103 pervious = 350 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff	Impervious R cu.m (Runoff	Pervious Runoff cu.m (Runoff %)
PMF 15 minu	576018.25	556987.05 (9	403954.94 (9	153032.11 (90.2%)
PMF 30 minu	821424.25	798635.86 (9	577107.88 (9	221527.98 (91.6%)
PMF 45 minu	1041735.13	1016036.84 (	732554.00 (9	283482.84 (92.4%)
PMF 60 minu	1213606.88	1185521.44 (	853823.06 (9	331698.38 (92.8%)
PMF 1.5 Hou	1384603.25	1352658.84 (	974474.00 (9	378184.84 (92.8%)
PMF 2 Hour	1545094.63	1509651.94 (	1087713.75 (	421938.19 (92.8%)
PMF 2.5 Hou	1642264.88	1603646.56 (	1156274.00 (	447372.56 (92.5%)
PMF 3 Hour	1728054.88	1686367.34 (	1216805.25 (	469562.09 (92.3%)
PMF 4 Hour	1899634.75	1851720.41 (	1337868.75 (	513851.66 (91.9%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF C1	332.685	332.685	0.256	0.23	12.44	49.99	54.12	PMF 45 minutes
OF CH1	333.249	333.249	0.256	0.23	12.47	49.99	54.21	PMF 45 minutes
OF CH2	356.664	356.664	0.256	0.23	13.34	49.99	58.02	PMF 45 minutes
OF CH3	407.331	407.331	0.256	0.23	15.24	49.99	66.26	PMF 45 minutes
OF CH4	427.534	427.534	0.256	0.23	15.99	49.99	69.55	PMF 45 minutes
OF35	433.507	433.507	0.256	0.23	16.22	49.99	70.52	PMF 45 minutes
OF C6	5.237	5.237	0.256	0.171	0.25	38.22	1.47	PMF 15 minutes
OF C2	1.505	1.505	0.256	0.103	0.11	24.57	1.07	PMF 15 minutes
OF Site Upstr	34.464	34.464	0.256	0.23	1.29	49.99	5.61	PMF 15 minutes
OF site downs	37.115	37.115	0.256	0.23	1.39	49.99	6.04	PMF 15 minutes
OF RF 3	4.2	4.2	0.256	0.157	0.22	35.34	1.39	PMF 15 minutes
carpark	5.999	5.999	0.256	0.181	0.28	40.19	1.52	PMF 15 minutes
OF C4	37.226	37.226	0.256	0.23	1.39	49.99	6.06	PMF 30 minutes
OF C10	15.949	15.949	0.256	0.23	0.6	49.99	2.59	PMF 15 minutes
OF C5	28.958	28.958	0.256	0.23	1.08	49.99	4.71	PMF 15 minutes
OF C11	14.987	14.987	0.256	0.23	0.56	49.99	2.44	PMF 15 minutes
OF C3	29.733	29.733	0.256	0.23	1.11	49.99	4.84	PMF 15 minutes
OF CS	15.607	15.607	0.256	0.23	0.58	49.99	2.54	PMF 15 minutes
OF TL	5.273	5.273	0.256	0.172	0.25	38.4	1.47	PMF 15 minutes
OF TS	4.519	4.519	0.256	0.161	0.23	36.24	1.42	PMF 15 minutes
OF WS	4.651	4.651	0.256	0.164	0.23	36.78	1.42	PMF 15 minutes
OF RF 2	2.486	2.486	0.256	0.127	0.15	29.41	1.21	PMF 15 minutes
OF RF 1	2.921	2.921	0.256	0.135	0.17	31.03	1.27	PMF 15 minutes
OF WSL	4.651	4.651	0.256	0.164	0.23	36.78	1.42	PMF 15 minutes
OF CS+TL	20.804	20.804	0.256	0.23	0.78	49.99	3.38	PMF 15 minutes
OF External c	32.386	32.386	0.256	0.23	1.21	49.99	5.27	PMF 15 minutes
OF SL	0.748	0.748	0.256	0.078	0.07	19.54	0.88	PMF 15 minutes
OF SL + WS	5.297	5.297	0.256	0.172	0.25	38.4	1.48	PMF 15 minutes
OF CP	4.104	4.104	0.256	0.156	0.21	35.16	1.37	PMF 15 minutes
OF EE	1.931	1.931	0.256	0.115	0.13	26.9	1.13	PMF 15 minutes

DETENTION BASIN DETAILS					
Name	Max WL	MaxVol	Max Q	Max Q	Max Q
			Total	Low Level	High Level

CONTINUITY CHECK for PMF 15 minutes				
Node	Inflow	Outflow	Storage Chan	Difference
	(cu.m)	(cu.m)	(cu.m)	%
NC1	407784.09	407784.09	0	0
N7	408806.75	408806.78	0	0
N8	441930.69	441930.66	0	0
N9	512318.31	512318.31	0	0
N10	545700.19	545700.19	0	0
N11	556986.94	556986.94	0	0
N12	556986.94	556986.94	0	0
NC6	3800.96	3800.96	0	0
NC2	1022.68	1022.68	0	0
N C7	26127.01	26127.01	0	0
N19	28971.9	28971.91	0	0
N RF 3	2844.9	2844.9	0	0
NC9	4138.99	4138.99	0	0
N C4	37276.8	37276.8	0	0
N C10	11664.38	11664.38	0	0
N27	21717.48	21717.48	0	0
N C11	11286.73	11286.73	0	0
NC3	29322.93	29322.93	0	0
N CS	11432.71	11432.71	0	0
N TL	3881.59	3881.59	0	0
N TS	3276.65	3276.65	0	0
N WS	3372.55	3372.55	0	0
N RF 2	1684.05	1684.05	0	0
N RF 1	1978.35	1978.35	0	0
N59	3372.55	3372.55	0	0
N61	15314.3	15314.3	0	0
N62	24148.65	24148.65	0	0
N SL	501.11	501.11	0	0
N63	3873.66	3873.66	0	0
N CP	2779.5	2779.5	0	0
NEE	1359.49	1359.49	0	0

Run Log for Flood study 09_03_21_Site included.drn run at 11:09:54 on 24/4/2009
The maximum flow exceeded the safe value in the following overflow routes: OF CP, OF EE, OF RF 1, OF RF 2, OF External combined, OF CS+TL, OF SL + WS, OF SL, OF WSL, OF WS, OF TS,

Appendix C

TUFLOW Model Roughnesses and Obstructions

0 30 60 90 120 150m

1 : 1500

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

100mm on Original

URBAN REGION (n=0.2)
RESIDENTIAL (n=1.0)
ROAD (n=0.022)
INDUSTRIAL (n=1.0)
TREES REGION (n=0.08)
SITE (n=20.0)
OPEN SPACE REGION (n=0.04)
EXTENT OF TUFLOW MODELLING

Client: DAVIDSGROUP

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1500	Current Issue Signatures	
		Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked	
Grid		Approved	

Filename: FIGURE C1 - CLEMTON-PARK-ROUGHNESS-MODELLING.dwg

Project: CLEMTON PARK VILLAGE

Title: TUFLOW MODELLING ROUGHNESS

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Drawing No.	Project No.	Issue
FIGURE C1	AA001875	01

Date Plotted: 30 Apr 2009 - 10:24AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\FIGURE C1 - CLEMTON-PARK-ROUGHNESS-MODELLING.dwg V1

Appendix D

Comparison of TUFLOW and Sydney Water Flood Levels

The following Table D1 compares the current TUFLOW water levels with the HEC-RAS water levels (defined in the Sydney Water 1992). In the Sydney Water report there is no mention of culvert blockages having been applied to the analysis. Comparison of 100 year unblocked results indicates that:

- Just upstream of Alfred Street the TUFLOW result is 0.1m higher;
- 69m downstream of Alfred Street the TUFLOW result is 0.6m lower;
- 176m downstream of Alfred Street the TUFLOW result is 0.2m lower;
- Just upstream of Bexley Road the TUFLOW result is the same.

Table D1: Comparison of TUFLOW and Sydney Water Flood Levels

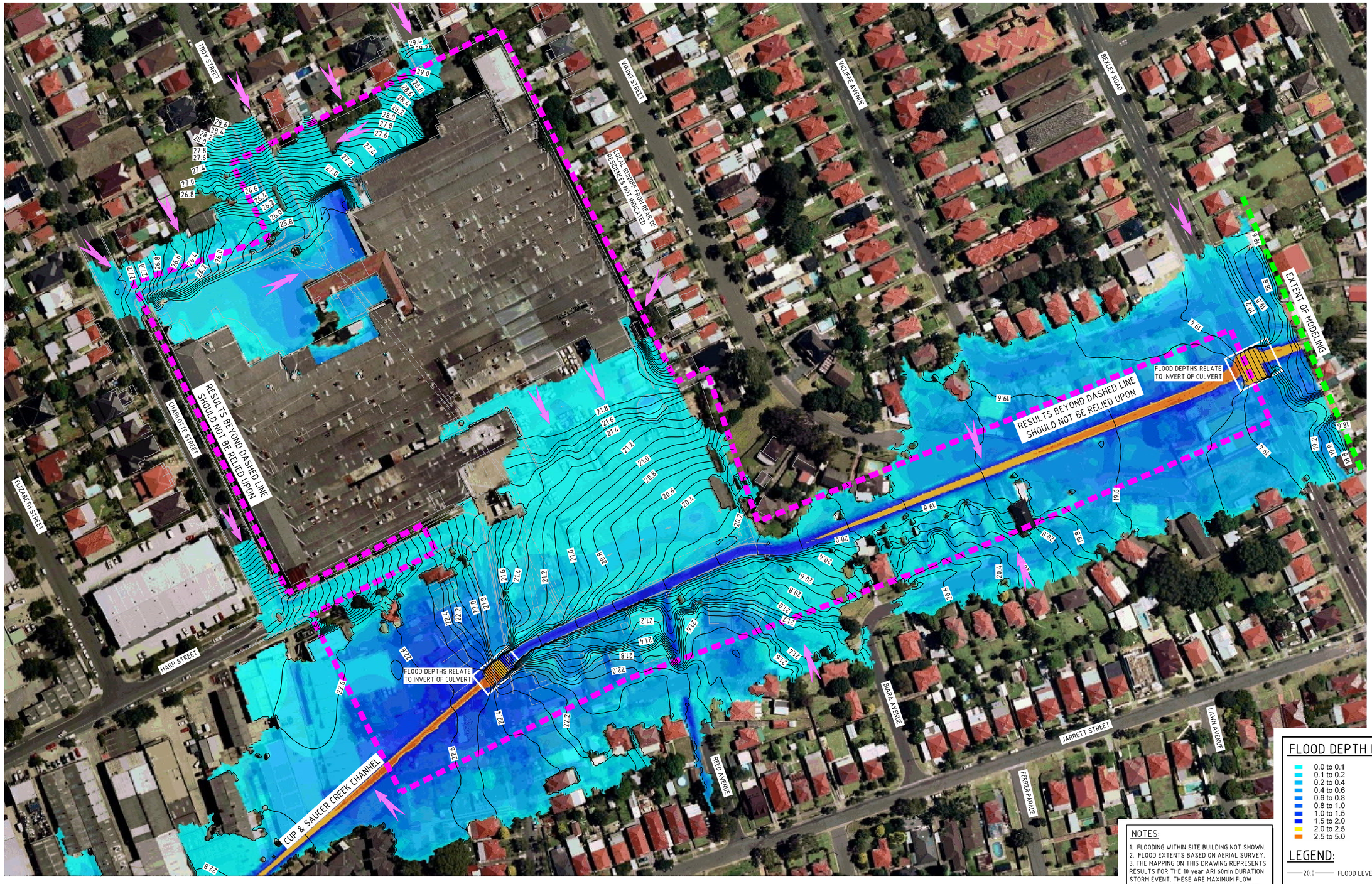
Location	Model	Water Level (mAHD) #		
		10 year	100 year	PMF
At the upstream of Alfred Street	TUFLOW	[22.5]	**22.5** [22.8] (22.8)	[24.0]
	HEC-RAS (Sydney Water)	21.7	22.4	23.6
69m downstream of Alfred Street	TUFLOW	[20.4]	**20.7** [20.8] (20.8)	[22.2]
	HEC-RAS (Sydney Water)	20.7	21.3	22.5
176m downstream of Alfred Street	TUFLOW	[19.9]	**20.2** [20.3] (20.3)	[21.8]
	HEC-RAS (Sydney Water)	19.9	20.4	21.6
At the upstream of Bexley Road	TUFLOW	[19.5]	**19.6** [19.8] (19.8)	[21.1]
	HEC-RAS (Sydney Water)	18.8	19.6	20.8

Water levels are within the Cup & Saucer Creek channel.
22.5 culvert & road crossing barriers and open fencing 0% blocked.
[22.8] culvert & road crossing barriers and open fencing 50% blocked.
(22.8) culvert & road crossing barriers and open fencing (excluding Alfred Street site fencing) 50% blocked.

There is a close matching of 100 year ARI unblocked flood levels at the culvert/road crossings, however the lower TUFLOW model results downstream of Alfred Street adjacent to the subject site would appear to indicate that the HEC-RAS modelling most probably constricted flows to within the Cup & Saucer Creek open channel corridor.

The TUFLOW floodplain modelling which allows flows through the open style site boundary fencing (with 50% blockage) along Alfred Street and the open channel, and therefore through the overbank site car park area within the subject site, is considered more representative of likely flood conditions.

Drawings



NOTES:

1. FLOODING WITHIN SITE BUILDING NOT SHOWN.
2. FLOOD EXTENTS BASED ON AERIAL SURVEY.
3. THE MAPPING ON THIS DRAWING REPRESENTS RESULTS FOR THE 10 year ARI 60min DURATION STORM EVENT. THESE ARE MAXIMUM FLOW REGIMES FOR AREAS ADJACENT TO THE CREEK.
4. TUFLOW MODEL FILE PATH:-
F:\AA001875\D-CALCS-TUFLOW\

FLOOD DEPTH LEGEND (m):

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 5.0

LEGEND:

—20.0— FLOOD LEVEL CONTOURS

INDICATES INFLOW HYDROGRAPH LOCATIONS (MAIN CHANNEL INFLOW LOCATIONS NOT SHOWN)

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

0 20 40 60 80 100m

1 : 1000

Client: DAVIDSGROUP

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked BC	
Grid		Approved	
Filename:	DWG-01-CLEMTON-PARK-10yr.dwg		

Project: CLEMTON PARK VILLAGE

Title: 10 YEAR ARI EXISTING CONDITION FLOW REGIMES, WITH BLOCKAGE (CULVERTS & SITE FENCES)

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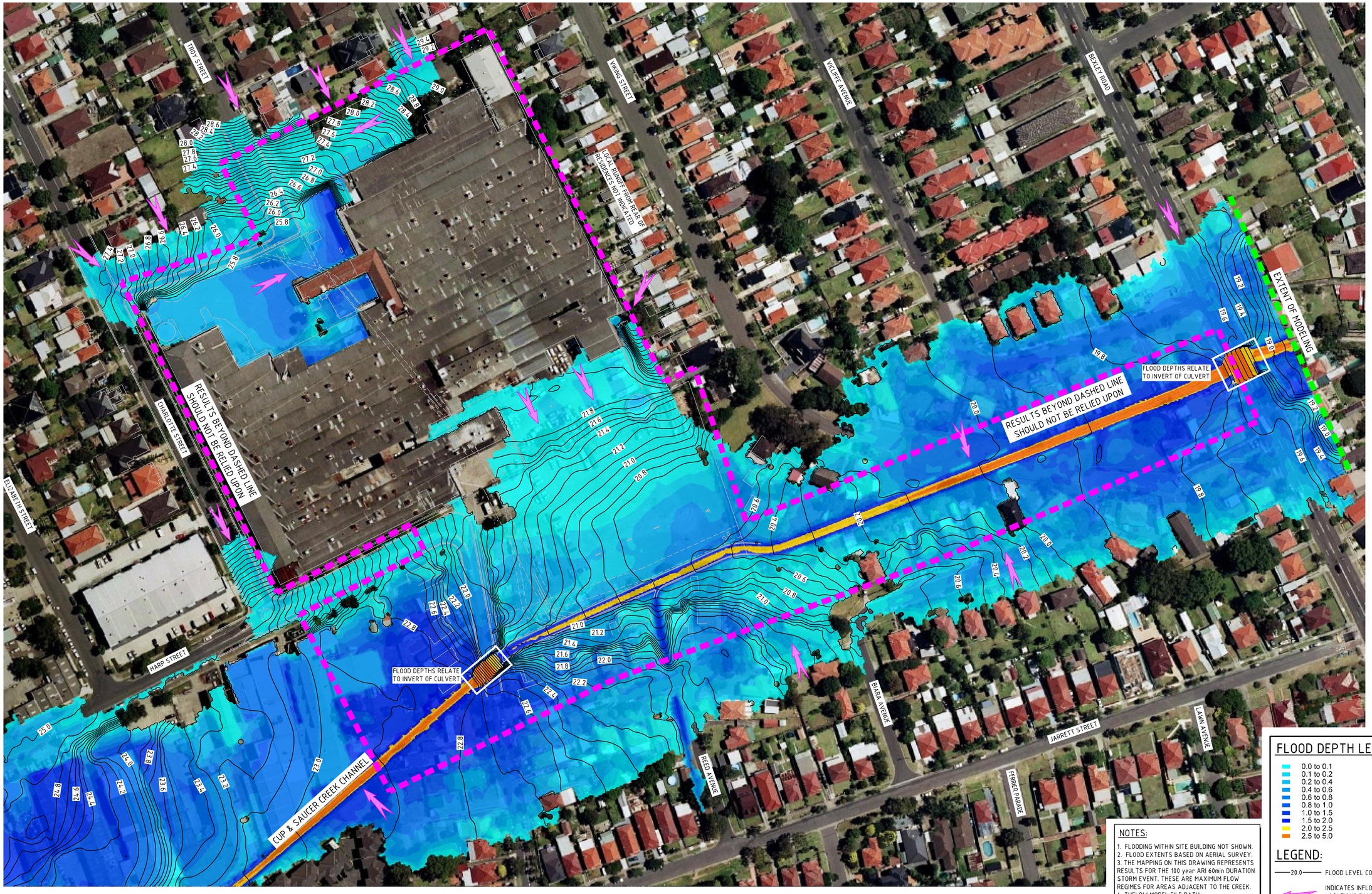
Drawing No.	Project No.	Issue
DWG-01	AA001875	01

100mm on Original

Date Plotted: 30 Apr 2009 - 09:43AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\DWG-01-CLEMTON-PARK-10yr.dwg V1



FLOOD DEPTH LEGEND (m):

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 5.0

LEGEND:

20.0 FLOOD LEVEL CONTOURS

INDICATES INFLOW HYDROGRAPH LOCATIONS (MAIN CHANNEL INFLOW LOCATIONS NOT SHOWN)

NOTES:

1. FLOODING WITHIN SITE BUILDING NOT SHOWN.
2. FLOOD EXTENTS BASED ON AERIAL SURVEY.
3. THE MAPPING ON THIS DRAWING REPRESENTS RESULTS FOR THE 100 year ARI 60min DURATION STORM EVENT. THESE ARE MAXIMUM FLOW REGIMES FOR AREAS ADJACENT TO THE CREEK.
4. TUFLOW MODEL FILE PATH:- F:\AA001875\D-CALCS-TUFLOW\

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

0 20 40 60 80 100m

1 : 1000

Client: DAVIDSGROUP

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn BC	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked	
Grid		Approved	

Filename: DWG-02-CLEMTON-PARK-100yr-ARI-50%-BLOCKAGE.dwg

Project: CLEMTON PARK VILLAGE

Title: 100 YEAR ARI EXISTING CONDITION FLOW REGIMES, WITH BLOCKAGE (CULVERTS & SITE FENCING)

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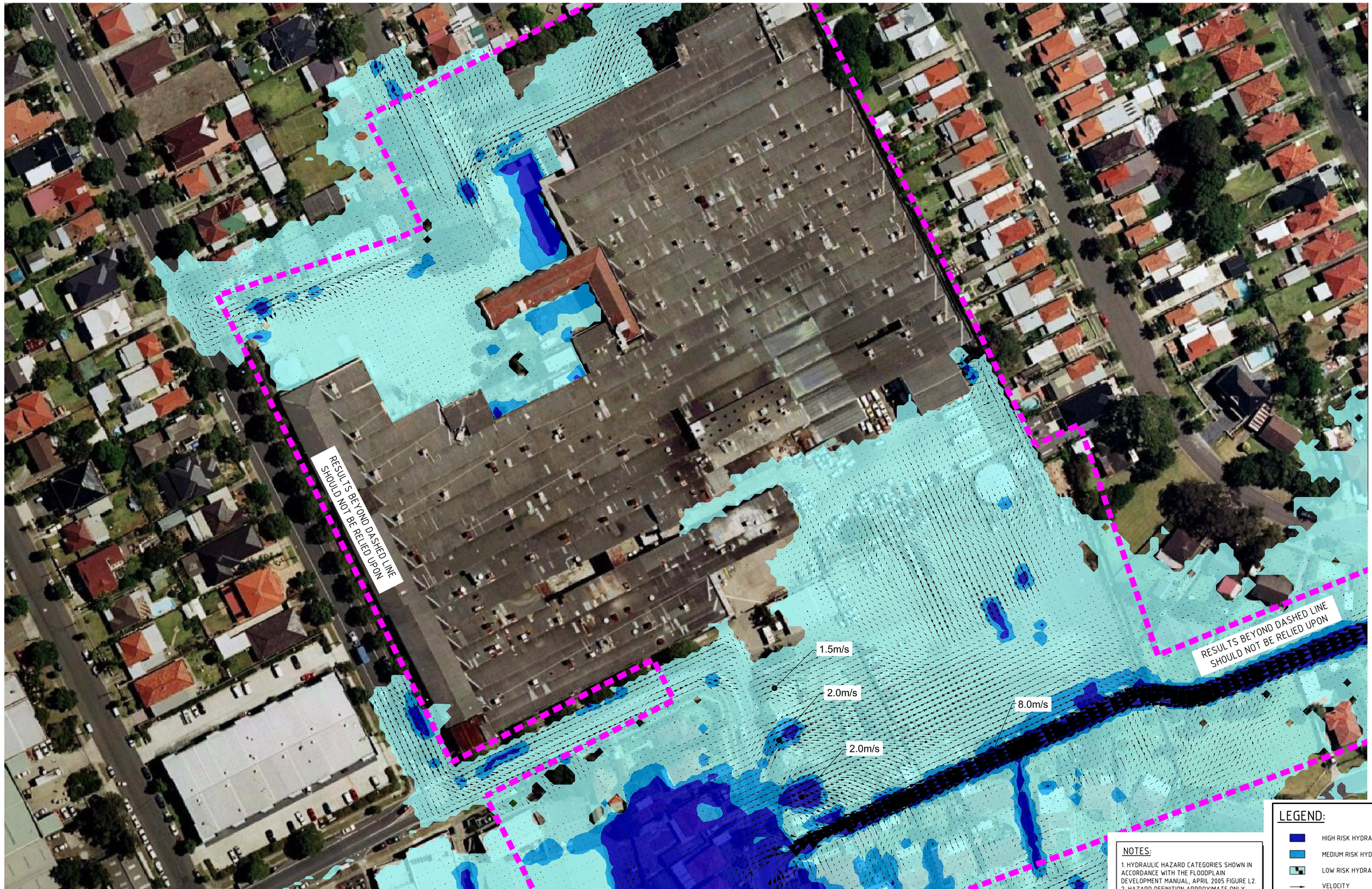
Drawing No.	Project No.	Issue
DWG-02	AA001875	01

100mm on Original

Date Plotted: 30 Apr 2009 - 09:43AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\DWG-02-CLEMTON-PARK-100yr-ARI-50%-BLOCKAGE.dwg V1



NOTES:

1. HYDRAULIC HAZARD CATEGORIES SHOWN IN ACCORDANCE WITH THE FLOODPLAIN DEVELOPMENT MANUAL, APRIL 2005 FIGURE L2.
2. HAZARD DEFINITION APPROXIMATE ONLY.
3. THE MAPPING ON THIS DRAWING REPRESENTS RESULTS FOR THE 100 year ARI 60min DURATION STORM EVENT. THESE ARE MAXIMUM FLOW REGIMES FOR AREAS ADJACENT TO THE CREEK.

LEGEND:

- HIGH RISK HYDRAULIC HAZARD
- MEDIUM RISK HYDRAULIC HAZARD
- LOW RISK HYDRAULIC HAZARD
- VELOCITY

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

0 20 40 60 80 100m

1 : 1000

Client: DAVIDSGROUP

Status: **PRELIMINARY**
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked BC	
Grid		Approved	

Filename: DWG-03-CLEMTON-PARK-EXISTING-HAZARD-CONDITIONS.dwg

Project: CLEMTON PARK VILLAGE

Title: 100 YEAR EXISTING CONDITION HAZARD, WITH BLOCKAGE (CULVERTS & SITE FENCING)

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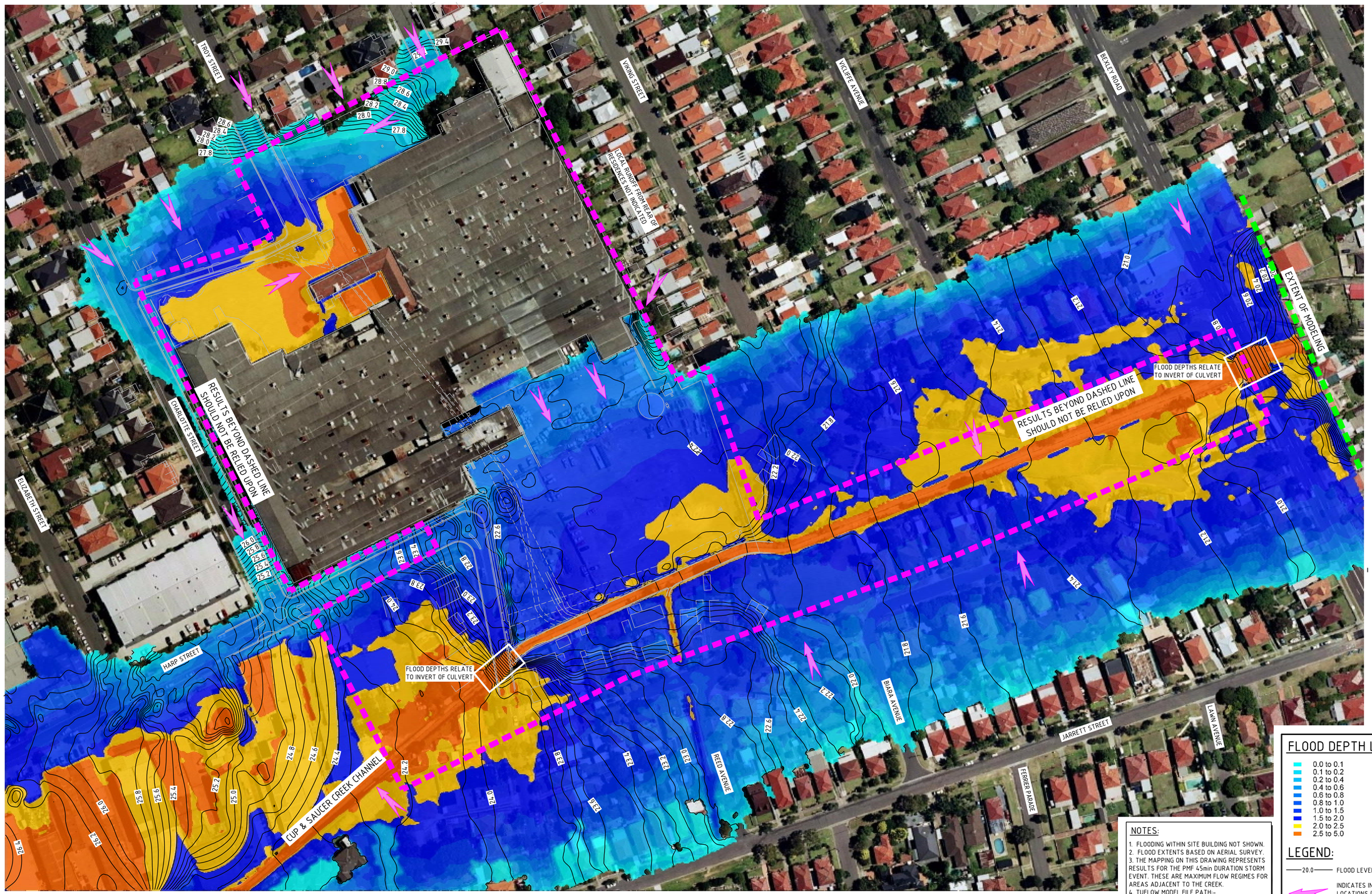
Drawing No.	Project No.	Issue
DWG-03	AA001875	01

100mm on Original

Date Plotted: 30 Apr 2009 - 10:22AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\DWG-03-CLEMTON-PARK-EXISTING-HAZARD-CONDITIONS.dwg V1



FLOOD DEPTH LEGEND (m):

- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.4
- 0.4 to 0.6
- 0.6 to 0.8
- 0.8 to 1.0
- 1.0 to 1.5
- 1.5 to 2.0
- 2.0 to 2.5
- 2.5 to 5.0

LEGEND:

20.0 — FLOOD LEVEL CONTOURS

INDICATES INFLOW HYDROGRAPH LOCATIONS (MAIN CHANNEL INFLOW LOCATIONS NOT SHOWN)

NOTES:

1. FLOODING WITHIN SITE BUILDING NOT SHOWN.
2. FLOOD EXTENTS BASED ON AERIAL SURVEY.
3. THE MAPPING ON THIS DRAWING REPRESENTS RESULTS FOR THE PMF 45min DURATION STORM EVENT. THESE ARE MAXIMUM FLOW REGIMES FOR AREAS ADJACENT TO THE CREEK.
4. TUFLOW MODEL FILE PATH:- F:\AA001875\D-CALCS-TUFLOW\

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

0 20 40 60 80 100m

1 : 1000

Client: DAVIDSGROUP

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1000	Current Issue Signatures	
		Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked BC	
Grid		Approved	
Filename:	DWG-04-CLEMTON-PARK-PMF-FLOWS.dwg		

Project: CLEMTON PARK VILLAGE

Title: PMF EXISTING CONDITION FLOW REGIMES, WITH BLOCKAGE (CULVERT & SITE FENCING)

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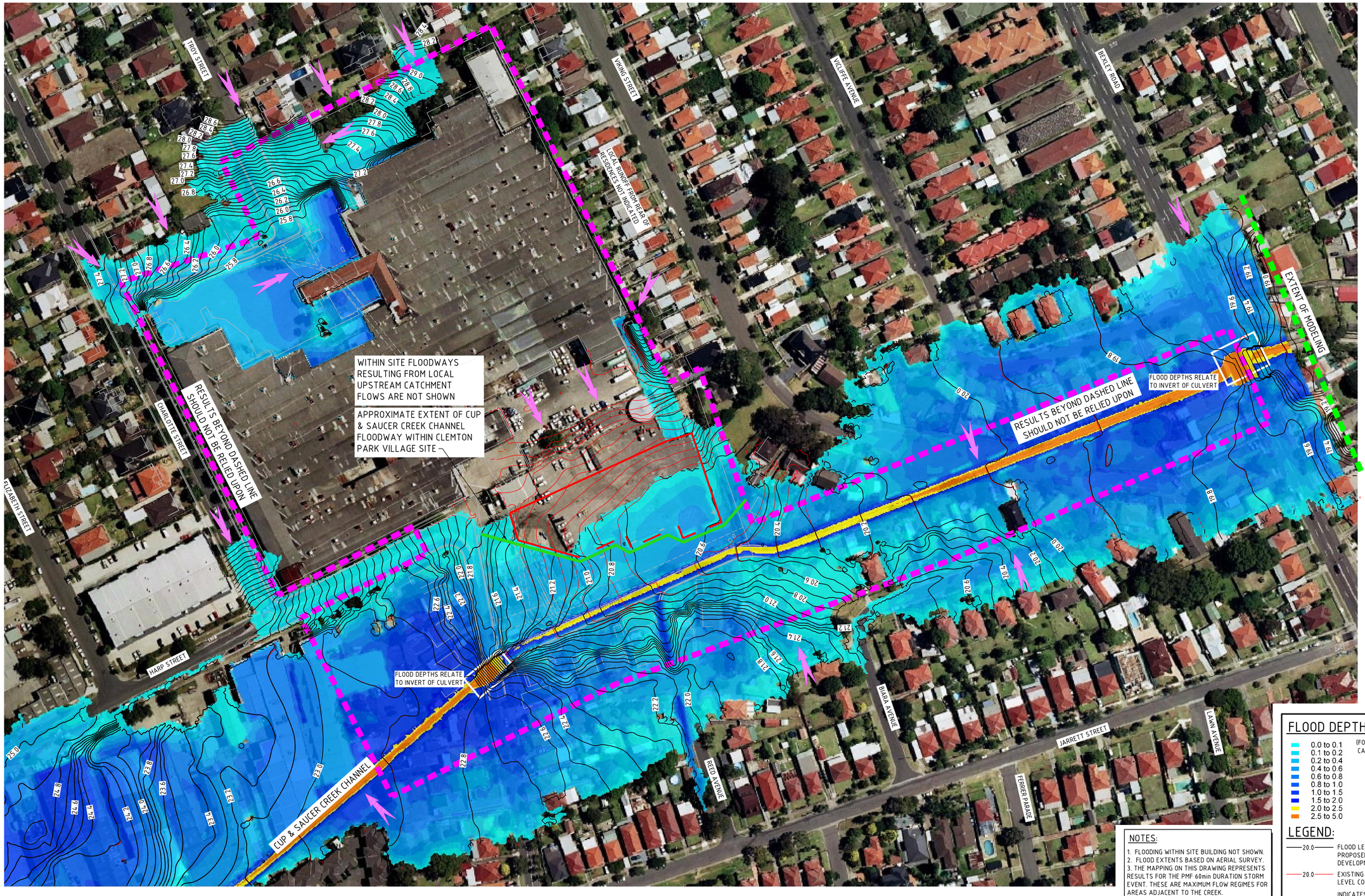
Drawing No.	Project No.	Issue
DWG-04	AA001875	01

100mm on Original

Date Plotted: 30 Apr 2009 - 11:28AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\DWG-04-CLEMTON-PARK-PMF-FLOWS.dwg V1



FLOOD DEPTH LEGEND (m):

0.0 to 0.1	(FOR PROPOSED SOUTHERN CAR PARK DEVELOPMENT)
0.1 to 0.2	
0.2 to 0.4	
0.4 to 0.6	
0.6 to 0.8	
0.8 to 1.0	
1.0 to 1.5	
1.5 to 2.0	
2.0 to 2.5	
2.5 to 5.0	

LEGEND:

- 20.0 — FLOOD LEVEL CONTOURS WITHIN PROPOSED SOUTHER CAR PARK DEVELOPMENT
- 20.0 — EXISTING CONDITION FLOOD LEVEL CONTOURS
- INDICATES INFLOW HYDROGRAPH LOCATIONS (MAIN CHANNEL INFLOW LOCATIONS UPSTREAM NOT SHOWN)

NOTES:

1. FLOODING WITHIN SITE BUILDING NOT SHOWN.
2. FLOOD EXTENTS BASED ON AERIAL SURVEY.
3. THE MAPPING ON THIS DRAWING REPRESENTS RESULTS FOR THE PMF 60min DURATION STORM EVENT. THESE ARE MAXIMUM FLOW REGIMES FOR AREAS ADJACENT TO THE CREEK.
4. TUFLOW MODEL FILE PATH:- F:\AA001875\D-CALCS-TUFLOW\

Issue	Description	Date
01	ISSUE FOR INFORMATION	30/04/09

0 20 40 60 80 100m

1 : 1000

Client: DAVIDSGROUP

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

		Current Issue Signatures	
Scales	1 : 1000	Drawn SM	
Original Size	A1	Designed DC	
Height Datum	AHD	Checked	
Grid		Approved	

Filename: DWG-05-CLEMTON-PARK-COMPARISON.dwg

Project: CLEMTON PARK VILLAGE

Title: 100 YEAR COMPARISON OF EXISTING & PROPOSED DEVELOPEMENT (NO ALFRED ST BDY FENCE)

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Drawing No.	Project No.	Issue
DWG-05	AA001875	01

100mm on Original

Date Plotted: 7 May 2009 - 09:44AM File Name: F:\AA001875\E-CAD\C-Civil\B-Sketches\D-Flood Study\DWG-05-CLEMTON-PARK-COMPARISON.dwg V1