Stellen
Civil Engineering

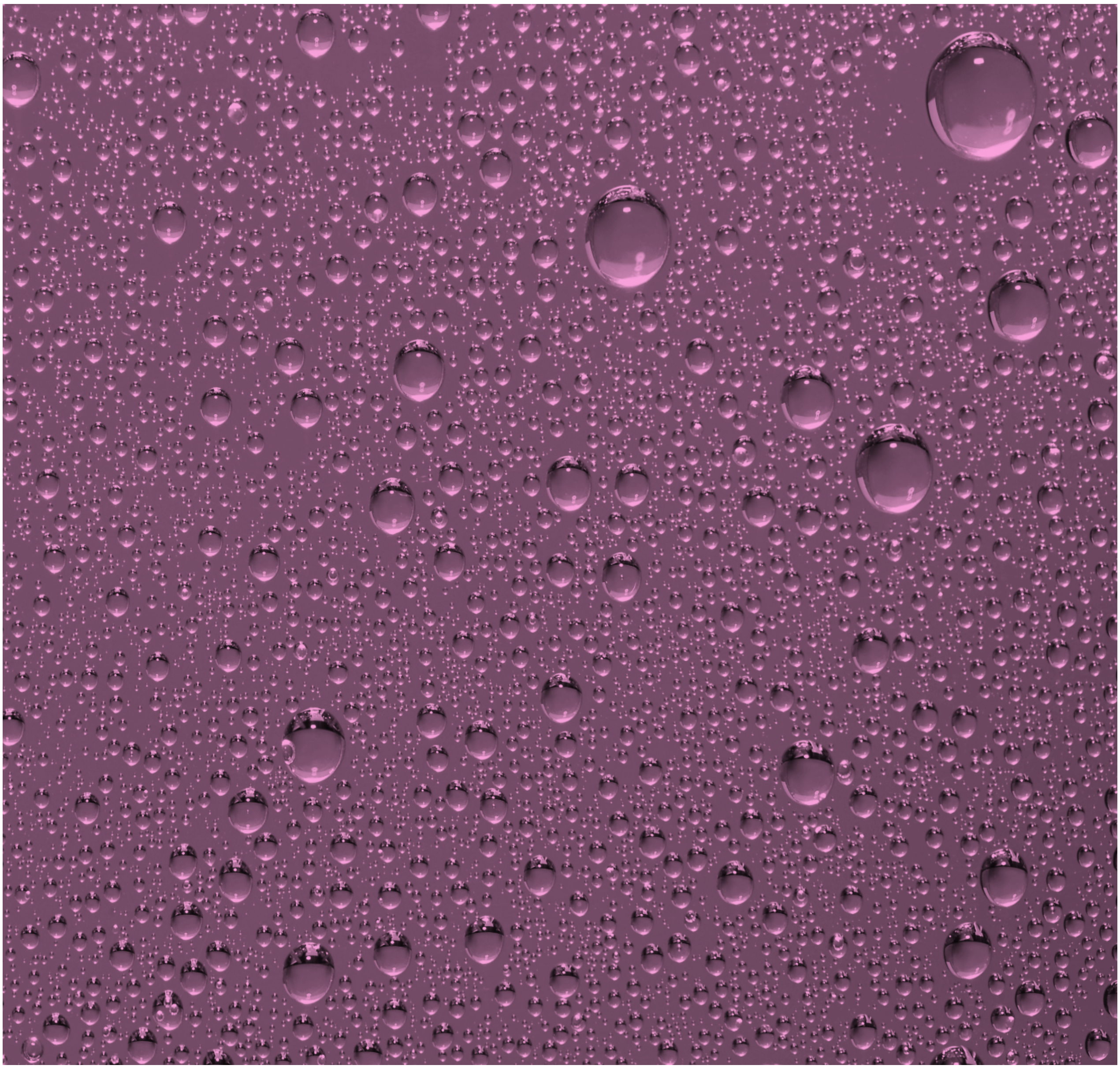
Stellen Consulting
Level 1, 27 Belgrave Street
Manly NSW 2095

PO Box 151
Freshwater NSW 2096

+61 450 460 496 tel
ABN 61 149 095 189

Overland Flow Assessment Report

The Pittwater House Schools, 70 South Creek Road, Collaroy



Overland Flow Assessment

The Pittwater House School 70 South Creek Road Collaroy

Prepared for our clients:

The Pittwater House Schools

Prepared by:

Stellen Consulting

Level 1, 27 Belgrave Street, Manly, NSW 2095, PO Box 151 Freshwater PO, NSW 2096

T. +61 450 460 496

www.stellenconsulting.com.au

ABN 61 149 095 189

25 October 2019

P170688-RP-FL-001-0

Stellen
Civil Engineering

Quality Information

Document	Overland Flow Assessment
Ref	P170688-RP-FL-001
Date	25 October 2019
Prepared by	Logan English-Smith
Reviewed by	Ian Warren

Revision History

Revision	Date	Details	Authorised	
			Name/Position	Signature
0	25.10.2019	DA Issue	Logan English-Smith Senior Engineer	

Executive Summary

Stellen Consulting was engaged to assess the proposed development at The Pittwater House Schools, 70 South Creek Road Collaroy in reference to potential impacts arising from overland flow through the site. This report provides detailed assessment of the flow information specific to the site and supports the proposed development.

A HEC-RAS 2D model was established for pre and post-development conditions based on available survey data and architectural drawings to assess the flow depths and velocities during the 1% annual exceedance probability (AEP) and probable maximum flood (PMF) events. The pre-development model was used to establish a baseline scenario for comparison with the post-development scenario. A 1 m resolution Digital Elevation Model (DEM) was used to generate elevation data for the 2D mesh. This DEM was interpolated from LiDAR data obtained from Geoscience Australia through the Elevation Information System (ELVIS).

Based on the evaluations of the proposed design using the HECRAS 2D flood model developed for the site, the:

- proposed development has a negligible impact on the neighbouring properties with respect to depth, velocity and flood extent during the 1% AEP event
- provisional hazard classifications are largely improved when comparing pre and post development scenarios, and the;
- proposed M-Block alterations and additions are adequately protected against the ingress of floodwaters for all storm events up to and including the probable maximum flood (PMF).

Table of Contents

1.0 Introduction

Stellen Consulting was engaged to assess the proposed development at The Pittwater House Schools campus, 70 South Creek Road Collaroy in reference to potential impacts arising from overland flow through the site. This report provides detailed assessment of the flow information specific to the site and supports the proposed development.

2.0 Information Relied Upon

The following documentation has been used in the preparation of this overland flow assessment report:

- Architectural drawings listed in Appendix A
- Landscape architectural drawings listed in Appendix A
- Site specific survey information listed in Appendix A
- DEM with a resolution of 1m obtained from ELVIS by Geoscience Australia

3.0 Site Description

The campus is located at 70 South Creek Road, Collaroy with a secondary street frontage on Westmoreland Avenue and service access via Parkes Road. The current site is approximately 34,400m^2 and has grown since the school's inception through the piecemeal acquisition of individual residential properties surrounding the site.

The site generally falls toward the south west with the low-lying land along the western boundary forming an existing overland flow path. The overland flow path runs through adjoining properties from upstream of Westmoreland Ave before flowing through the site and under South Creek Road (ultimately into toward Dee Why Lagoon).

Figure 1 - Site locality

4.0 Existing Development

Existing development of the site consists of a number of brick multi-storey buildings, outdoor play areas, a pool, oval and a carparking area adjacent to South Creek Road. The existing site layout is shown below in Figure 2, a detailed survey of the existing site is available in Appendix A.

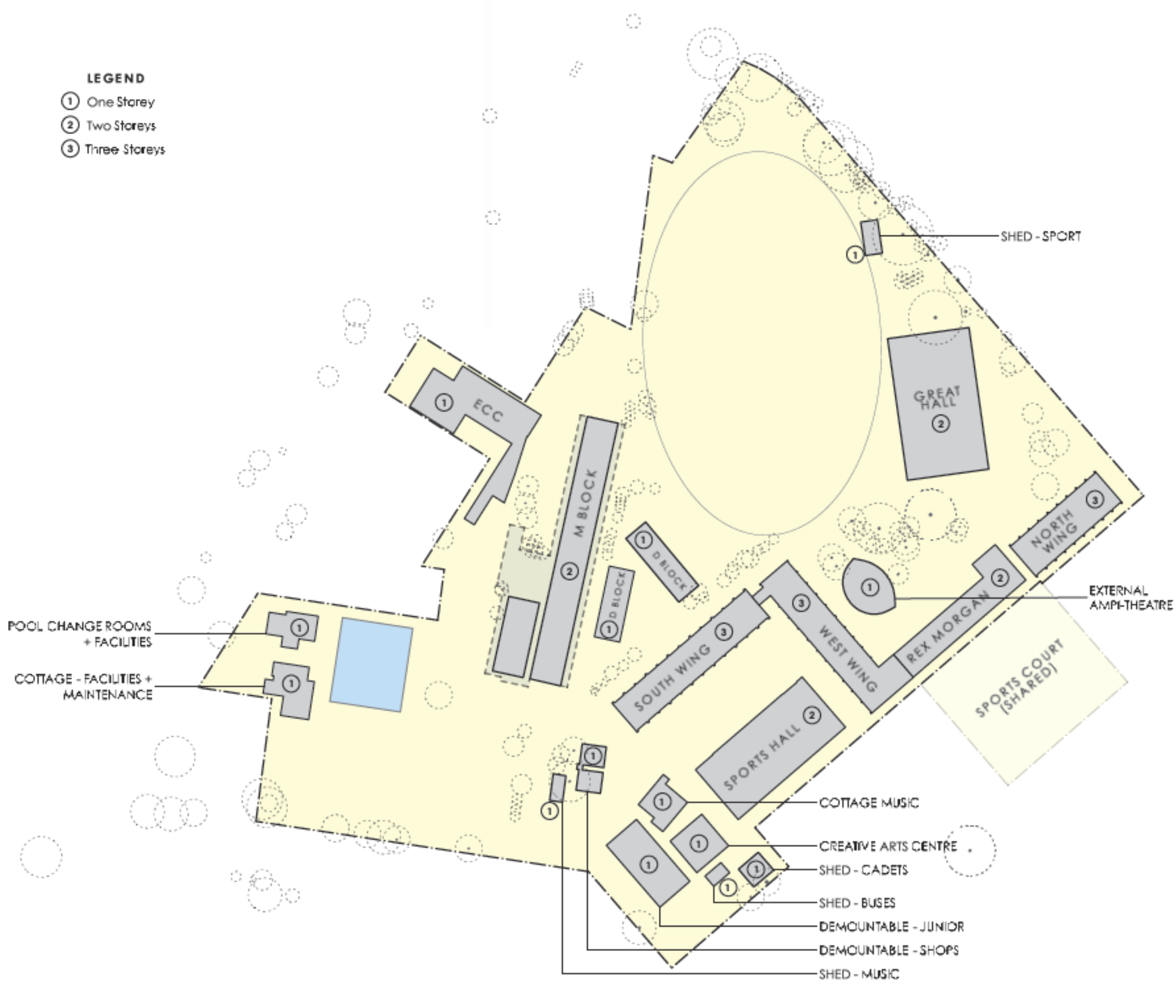


Figure 2 - Current development of the site

5.0 Proposed Development

The proposed development consists of:

- an extension to the existing M-Block and internal reconfiguration of the classrooms
- alterations to the access arrangement of the South Wing building
- creation of a “kiss and drop” area between the existing South Wing and Sports Hall buildings
- reconfiguration of the existing carparking area adjacent to South Creek Road.

- Construction of a new staff parking area to the south accessed from South Creek Road.
- Construction of a new bus parking area adjacent to the Main Hall serviced by Westmoreland Street.
- Demolition of the existing D-Block buildings and lightweight structures to the south.
- Demolition of the existing rendered wall along the South Creek Road frontage and construction of a new fence.

6.0 Overland Flow Modelling

6.1 Introduction

The property is not identified by Council as being a flood control lot but is affected by local runoff as a result of an existing overland flow path through the site, along the western boundary. The site is also burdened by an existing drainage easement in favour of Council (refer Figure 3). To support the development of the site, an assessment of the general flooding constraints and requirements was made.

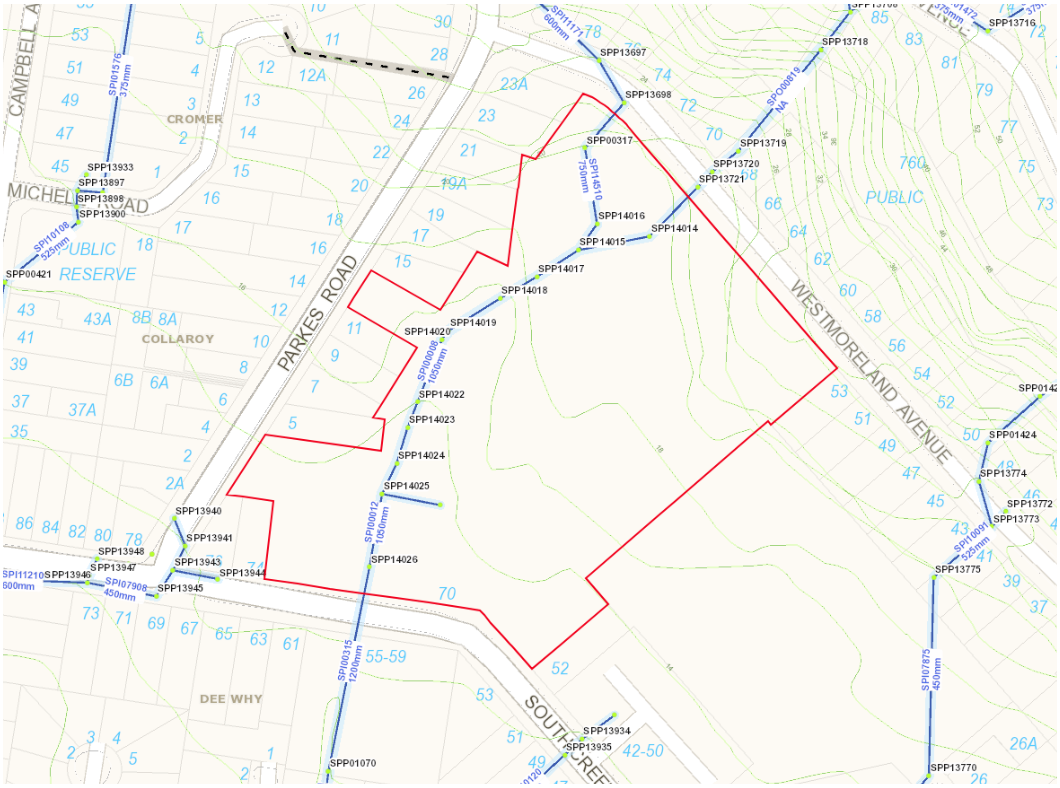


Figure 3 - Existing council stormwater asset burdening the site (Map Data © Northern Beaches Council. Image © Jacobs & Aerometrex)

6.2 Previous Flood Modelling

In November 2005 Lyall & Associates Consulting Water Engineers (Lyall) completed the *"Dee Why and Cur Curl Lagoons Floodplain Risk Management Plan"* for Northern Beaches Council (formerly Warringah Council). This report identified and modelled stormwater flows within the Dee Why Lagoon catchment for a range of storm events. While the site is contained within the Dee Why Lagoon catchment it is located outside of Lyall's study area. As such, a site-specific investigation was undertaken to assess the impact of the theoretical overland flow through the site.

6.3 Overview of Approach

The following steps were taken to quantify the potential overland flow:

1. Define the catchment and calculate the contributing flows for the design rain events arriving at the point in the catchment where the subject property lies.

2. Develop a 2D HECRAS model for both pre-development and post-development scenarios.

3. Compare the post-developed water surface levels, depths, velocities, velocity depth products and hazard classifications with the pre-developed scenario, in particular for impacts on adjacent properties.

6.4 Estimation of the Contributing Flows

The catchments potentially contributing to the overland flow through the site are shown below in Figure 4.

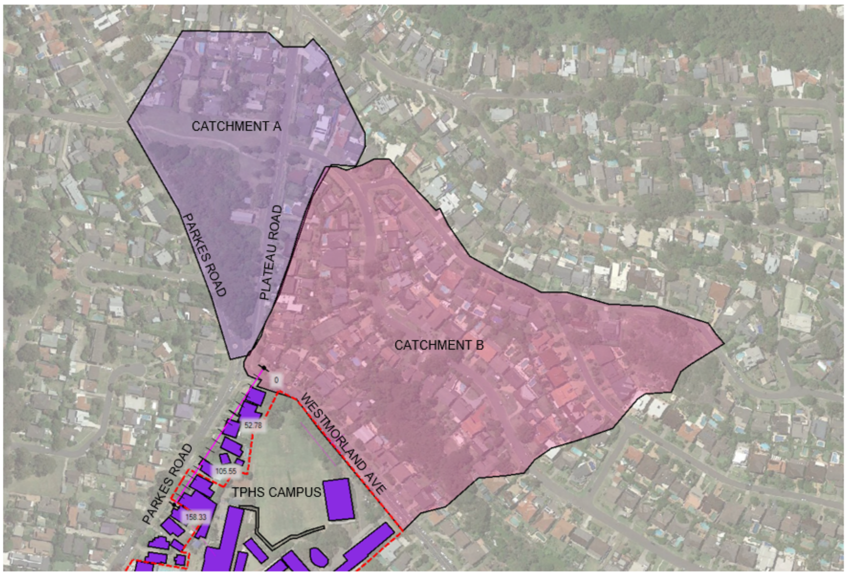


Figure 4 - Catchment plan

The contributing catchments upstream of the development site were calculated using a DEM with a resolution of 1m obtained from ELVIS by Geoscience Australia.

During a site visit, the Parkes Road, Plateau Rd and Westmorland Ave intersection was inspected to assess the likelihood of whether the catchment upstream of this point was contributing to the overland flow through the site or continuing down Parkes Rd. While it appeared likely that the majority of the flow would continue down Parkes Rd due, an additional 2D HEC-RAS model of the catchment upstream of this point.

The contributing flows for the design rain events were estimated using DRAINS hydraulic modelling software by Watercom. Rainfall intensities of from the Bureau of Meteorology (BOM) were used to calculate the contributing flow rates for each of the relevant storm durations.

Table 1 presents the contributing areas and peak flow for Catchment A.

Table 1 – Upstream catchment flows

Catchment ID	Area (m^2)	1% AEP Peak Flow (m^3/s)	PMF Peak Flow (m^3/s)
A (overland)	40,764	2.43 (no blockages)	7.2 (no blockages)

The above flows were then used as inputs to a 2D HEC-RAS model to assess the contribution of Catchment A to B. Figure 5 below shows the upstream 2D model for the PMF scenario. The contributing peak flow to Catchment B (from A) was found by sectioning through the peak flow directed to the site (refer Figure 7). The total flows for Catchment B and the calculation of each is shown below inTable 2. These flows were used as inputs into the 2D HEC-RAS model for the site.

A layout of the DRAINS model is attached in Appendix B.

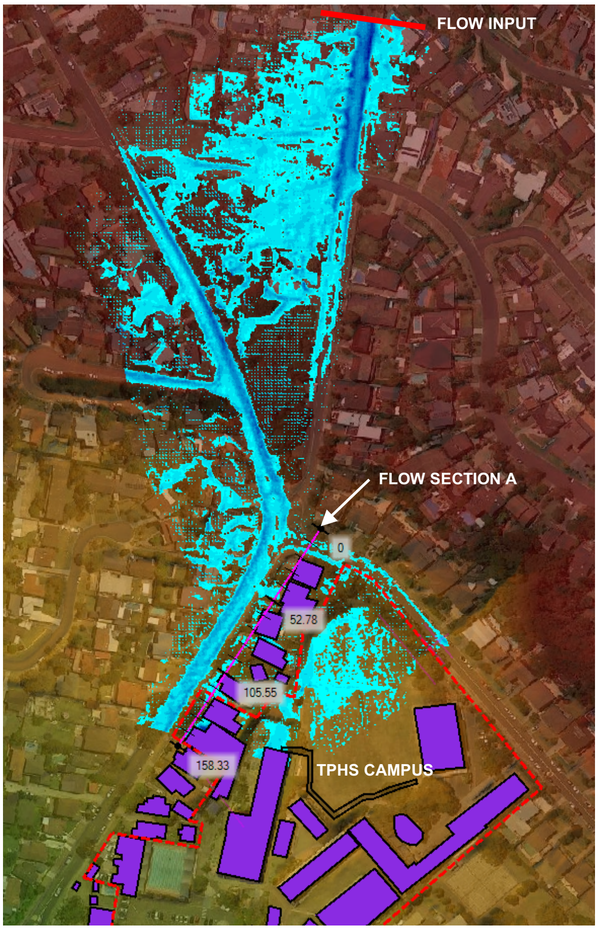


Figure 5 - Catchment A, PMF, Depth, contributing flows

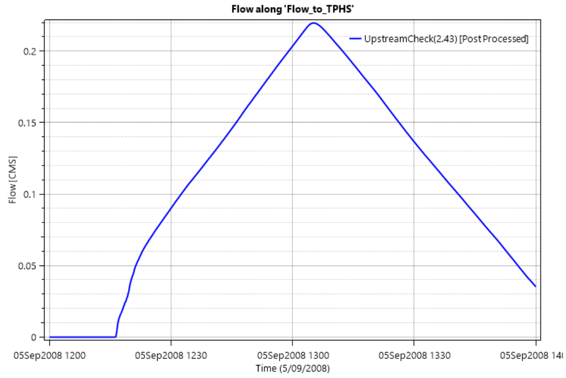


Figure 6 - Catchment A, 1% AEP contributing flows to B

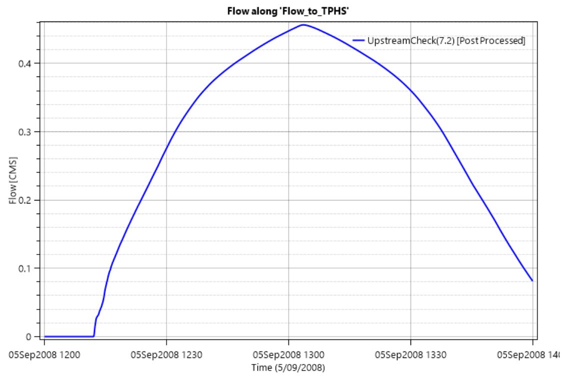


Figure 7 - Catchment A, PMF contributing flows to B

The calculation for each inflow is shown below:

$$Q^{Scenario} = Q_B^{Overland} - Q_B^{Piped} + Q_A^{Overland}$$

Table 2 – Overland flow contributing to the site

Catchment ID	Area (m^2)	1% AEP Peak Flow (m^3/s)	PMF Peak Flow (m^3/s)
B (overland)	81,432	4.42	14.65
B (piped)		1.86 (pits 50% blocked)	1.94 (no blockages)
Catchment A	-	0.22	0.46
Total		2.78	13.17

6.5 Hydraulic Model

A HEC-RAS 2D model was established for pre and post-development conditions based on available survey data and architectural drawings to assess the flow depths and velocities during the 1% AEP and PMF events. A 1m resolution DEM was used to generate elevation data for the 2D model. This DEM was interpolated from LiDAR data obtained from Geoscience Australia through ELVIS. The terrain data was created in QGIS and exported to RAS Mapper.

The HECRAS 2D model was developed from Westmoreland Ave upstream of the site and extends approximately 80m downstream of the development site into South Creek Road. The modelling boundaries are shown in Figure 6.

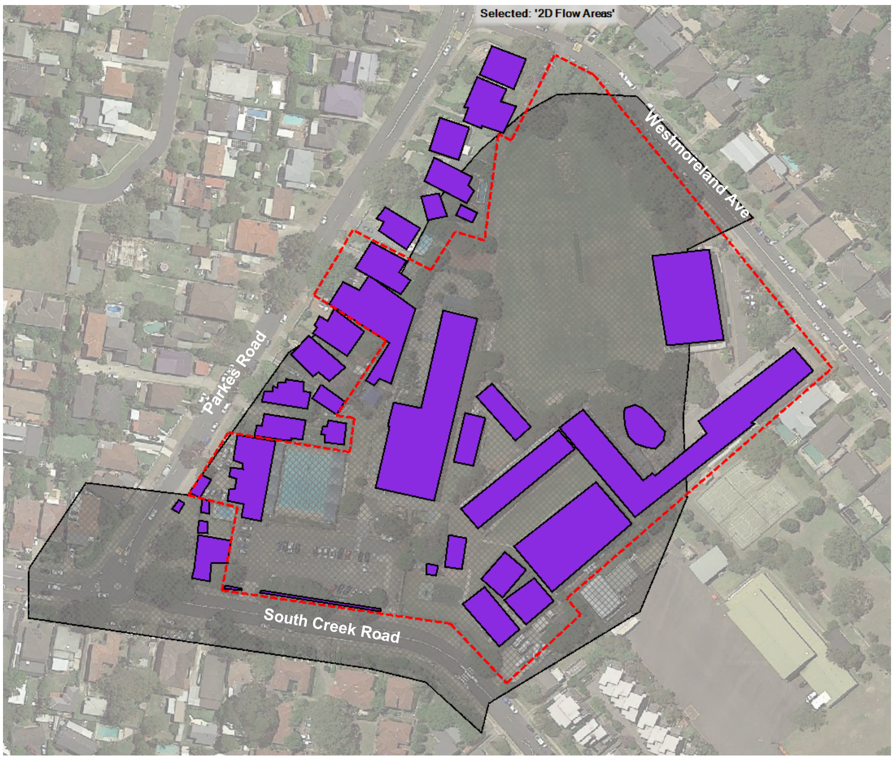


Figure 8 - 2D flow area

Peak flows (calculated in section 6.4) were used as the upstream boundary condition. Normal depth was selected as the downstream boundary condition. The inflows for the model were assigned to the upstream ends of the 2D flow area (0.5m x 0.5m mesh size) in the HEC-RAS model.

Architectural features of the proposed development such as buildings were incorporated into the model. Either through a combination of modifying the cross-sections within the flood model to alter the terrain; or with a high Manning's value (n=10). Break-lines and refinement regions were also used to minimise leakage in the 2D mesh in areas of interest or significance.

A Manning's 'n' roughness value of 0.018 was used for the general catchment surface, with the exception of impervious areas (n=0.012), pervious areas (n=0.025) and buildings (n=10). Figure 9 and Figure 10 show the roughness values used in the pre and post development models.

Figure 9 - Pre-development Manning's values

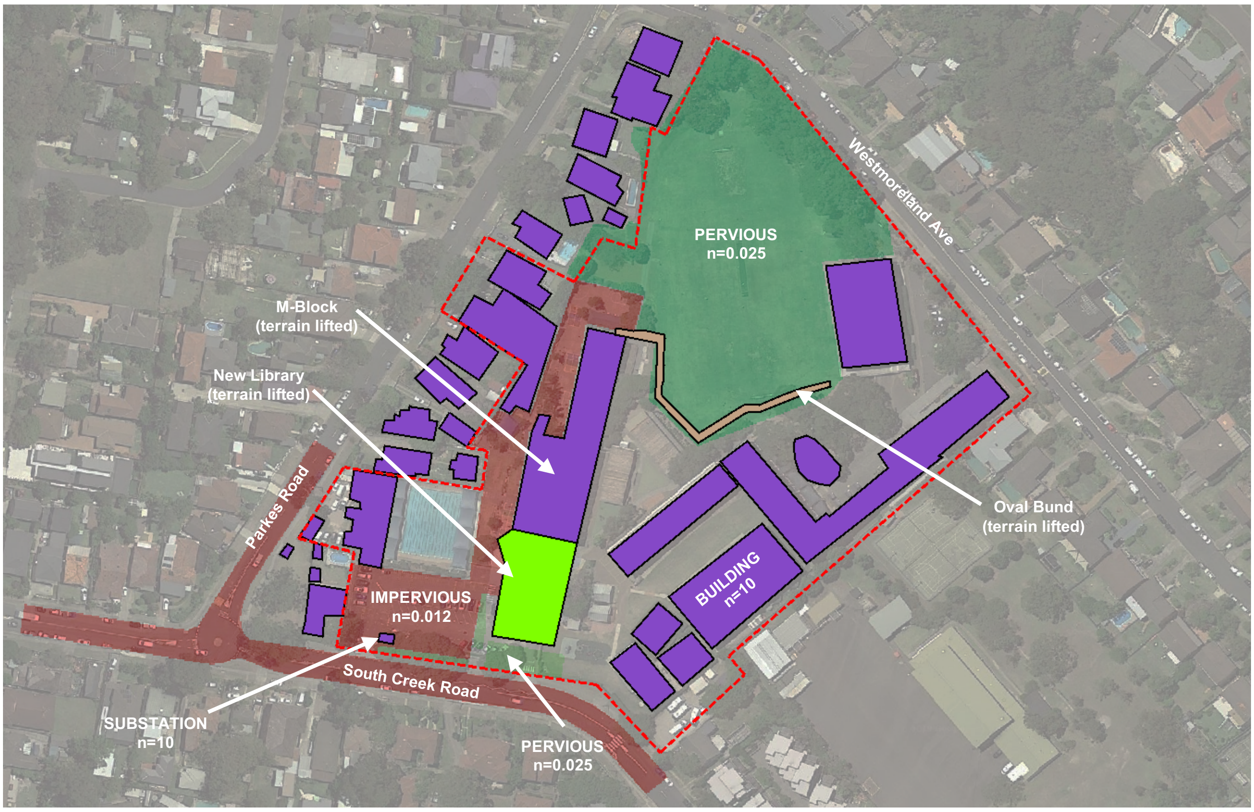


Figure 10 - Post-development Manning's values

7.0 Overland Flow Risk Assessment

7.1 Modelling in Context

The hydraulic model has been prepared with the data available and accessible with reasonable cost and time, given the nature and size of the project. Like any mathematical model, hydraulic modelling is sensitive to a range of inputs and assumptions, each adding some level of uncertainty to the result. Some of these inputs include rainfall intensities, temporal patterns, times of concentration, longitudinal and transverse surfaces, new and existing buildings and the models themselves. The results have been interpreted in the context of the likely model uncertainties, its nature and risks of this project.

7.2 Calibration of Hydraulic Model

The following was performed to troubleshoot any instability in the developed hydraulic model:

- The time step is controlled by the model using the courant condition
- Mass balance of the model was checked for losses
- Refinement regions and break-lines have been used to ensure there is no leakage of flow within the mesh at critical areas within the 2D flow region.

7.3 Post-development Flood Model and Mitigation Measures

The pre-developed HECRAS 2D Model has been used as the base model for this flood study. The model for the post-development scenario was developed by modifying the DEM terrain to incorporate the proposed works into the model. These works included a number of flood mitigation measures outlined below:

- A bund was included around the edge of the existing oval to contain the PMF floodwaters within the oval and direct the flow down the existing overland flow path to the west of M-Block.
- The northern end of M-Block was blocked to prevent the flow of floodwaters down the eastern side of M-Block and to protect the existing building against the PMF event.

A summary of the results is presented in the following section.

7.4 Summary of Results

Using the results of the model, as described above, the impact of the new development on flood behaviour has been examined. Detailed water velocity, water depth and water surface elevation distributions for both the pre and post-development scenarios are provided in Appendix C.

Overall, comparison between modelling results for the existing and post-development conditions show that there is a decrease in flood hazard downstream of the development site but a small increase to the flood affectation of South Creek Road (refer Figure 11). This minor theoretical increase is considered acceptable for the following reasons:

- While the model predicts that overland flow will overtop the kerb in South Creek Road, this is unlikely as the existing kerb is 200mm high and the predicted flow is 15 - 50 mm (refer Figure 11 and Image 1). In reality, the predicted flow is fully contained within the existing kerb.

- Within the pre-development model the existing rendered wall at the front of the site is modelled as fully blocked. In reality, an amount of water would leak below the wall as a result of its construction and a number of gaps below the existing wall observed on-site (refer images on page 11 and 12). The photos indicate (scouring) that surface water already runs below the wall at these locations.

- The wall is constructed in an existing floodway and blocks the natural flow of floodwaters through the site, the removal of the wall returns the catchment flow regime to a state more closely resembling its natural state.

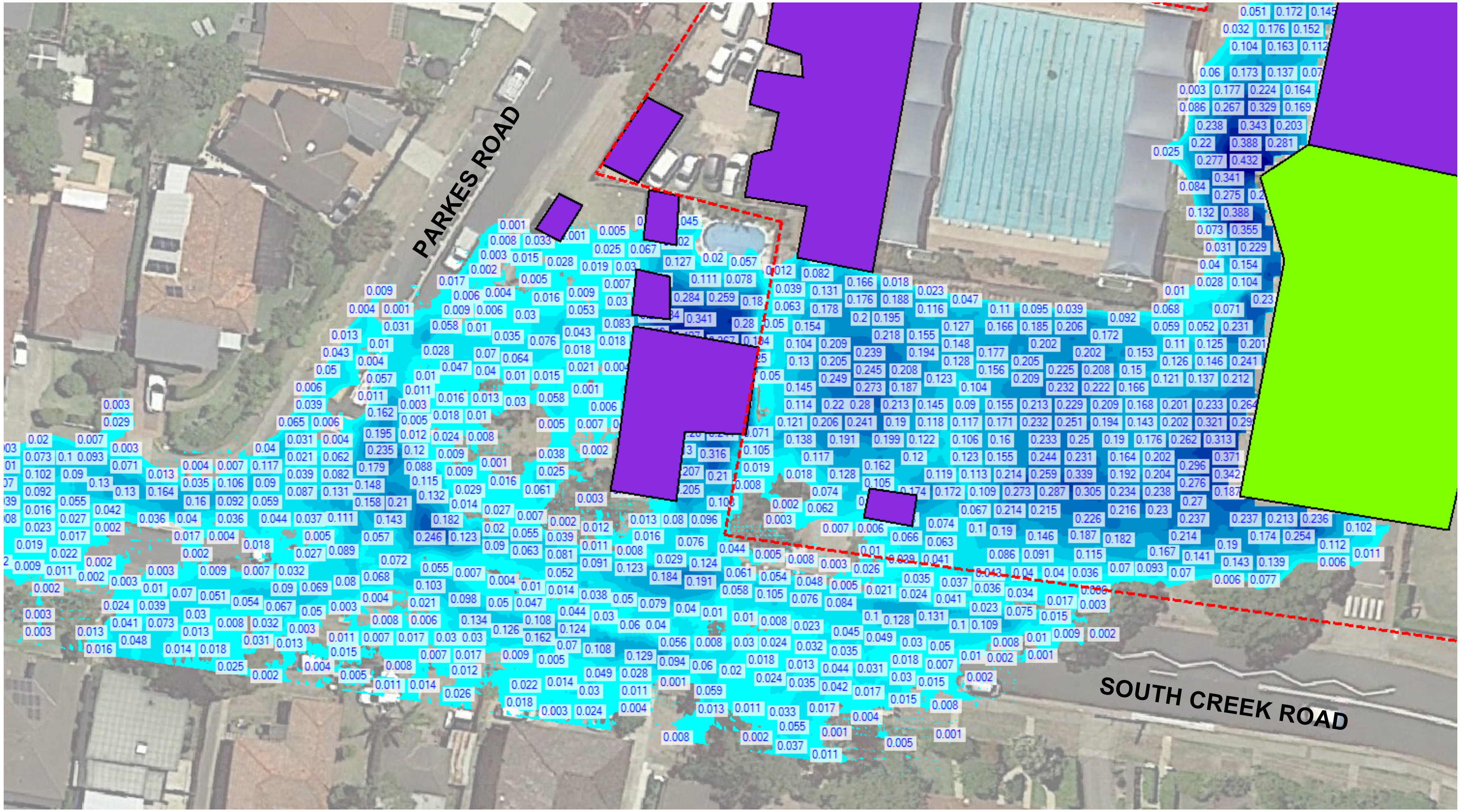


Figure 11 - Post-development, 1% AEP (blocked), depth at South Creek Road

Stellen
Civil Engineering

Image 1 - Kerb height, South Creek Road (south alignment)

Image 2 - Gaps below existing wall (South Creek Rd)

Image 3 - Gap below existing wall (South Creek Rd)

Image 4 - Evidence of scouring along existing wall (South Creek Rd), looking west

Image 5 - Gap below existing wall (South Creek Rd), evidence of scouring

7.5 Hydraulic Hazard

Hydraulic classification maps were prepared with hydraulic hazards assigned in accordance with the recommendations outlined in ARR 2019 (Book 6, Chapter 7 – Table 6.7.3, 6.7.4 & Figure 6.7.9). Pre and post-development hydraulic hazard maps are shown side by side in Figure 12 below and show a significant reduction in the overall hazard classification of the overland flow in downstream properties. When compared to the pre-development model the post-development model:

- Location 1: Hazard classification is largely unchanged along the western side of the existing M-Block.
- Location 2: Shifts the H5 zone, previously below the proposed library, to the west, extent largely unchanged.
- Location 3: Reduces the extent of the H5 classification within the pinch point between the development site and adjacent property.
- Location 4: Reduces the extent of the H5 classification downstream of the Parkes Rd / South Creek Road intersection.

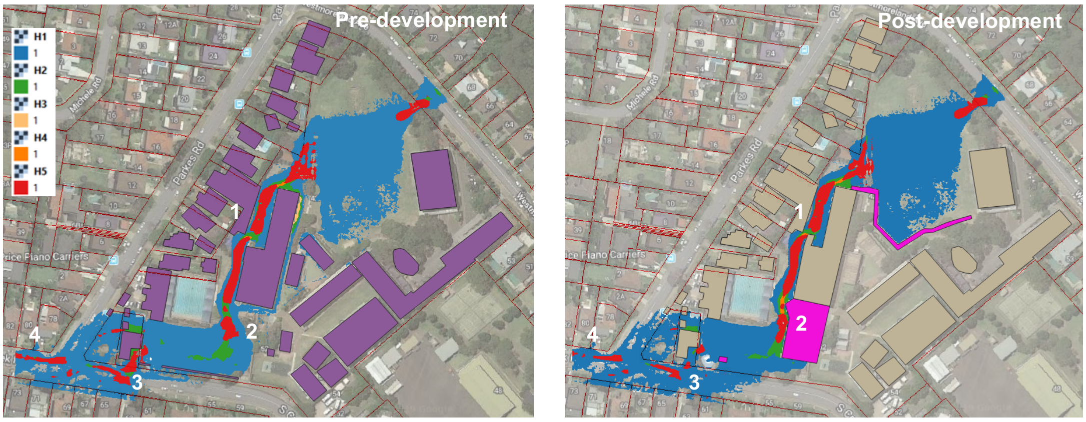


Figure 12 - 1% AEP Pre vs. Post-development Flood Hazard Classification

In general, the post development scenario remains largely unchanged with regard to the hazard classification of the site and surrounding locality with the flood model predicting some small improvements downstream of the site

7.6 Flood Planning Level

The flood model predicts that during large rain events, the site will be subject to overland flow from Westmoreland Ave. As a result of this the ground floor area of the development must be adequately protected against the inundation of floodwaters. Given the topography of the site and nature of overland flow, the flood planning level applicable to the development varies across the site.

All aspects of the proposed development are categorised as vunerable use and high-risk. In accordance with Warringah Council DCP sE.11, the development must be flood proofed to the PMF water level. The predicted PMF water surface levels are shown in Figure 13.

Stellen
Civil Engineering

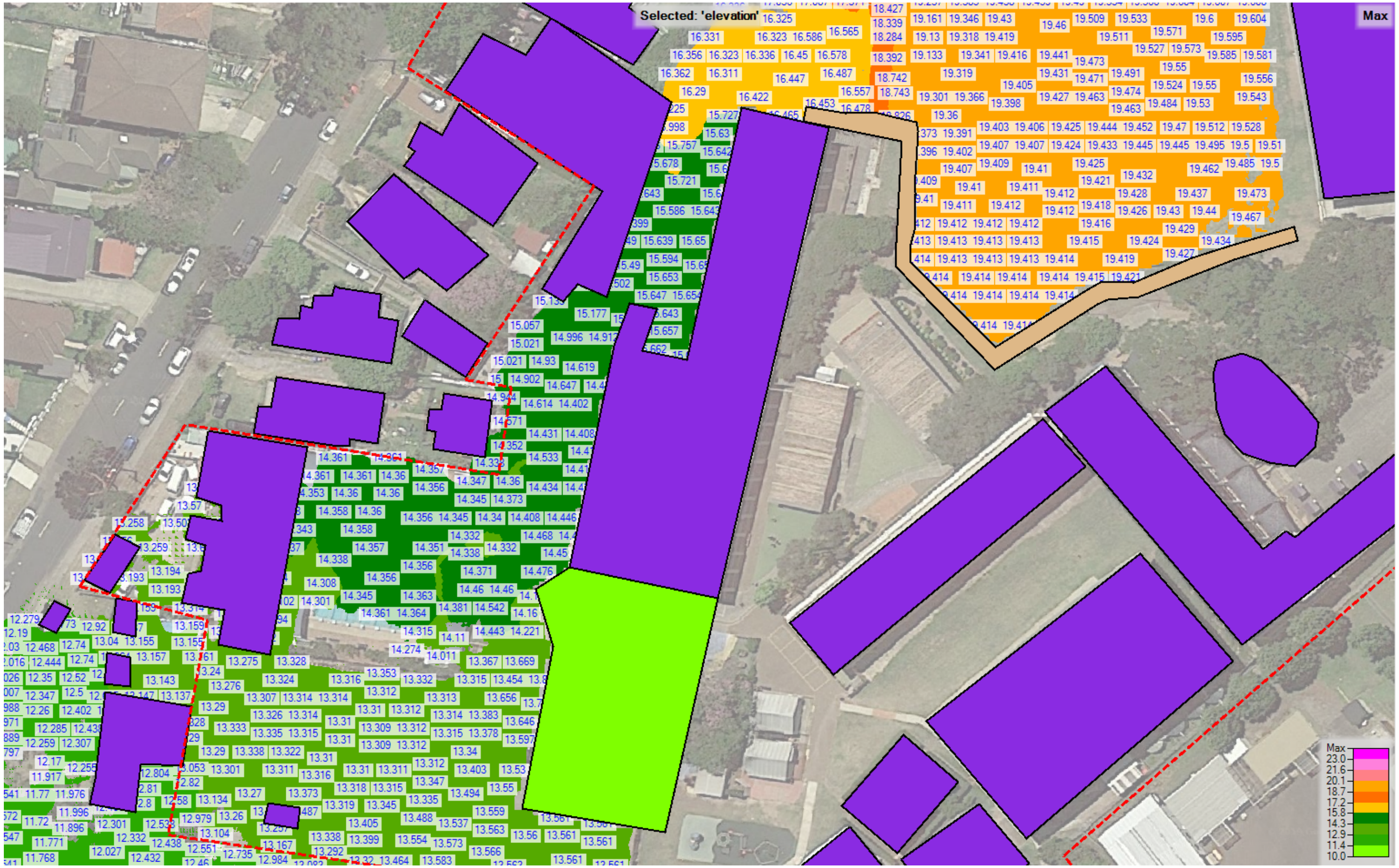


Figure 13 - Post-development, PMF, WSE (mAHD)

Stellen
Civil Engineering

Based on the predicted PMF water surface levels in Figure 13 the following FPLs shall be adopted for the site:

Existing M-Block: 14.92 – 16.55 mAHD (varies refer Figure 13)

Proposed M-Block Library Extension: 14.50 mAHD (NW corner)

Substation Kiosk: 13.50 mAHD

7.7 Assessment of Council Flood Controls

All aspects of the proposed development are categorised as vunerable use and high-risk. In accordance with Warringah Council DCP sE.11, flood controls are applicable to the development.

Table 2 provides a summary of the applicable controls for the proposed development

Table 3. DCP flood controls, Medium flood risk precinct, concessional development

#	Prescriptive controls	Compliance with controls			Relevant Controls
		NA	Yes	No	
A	Flood effects caused by development		✔		A1, A3, A4
B	Drainage infrastructure and creek works		✔		B1, B2
C	Building components and structural		✔		C1, C2, C3
D	Storage of goods		✔		D1, D2
E	Flood emergency response		✔		E1, E2, E3
F	Floor levels		✔		F2, F3, F7
G	Car parking			✔	G1, G4, G6, G7, G9, G10
H	Fencing		✔		H1
I	Pools	✔			I1

NA – Not Applicable

7.7.1 Addressing the Controls

Control A - Flood effects caused by development

A2. The certification shall be provided in accordance with Northern Beaches Council's Standard Hydraulic Certification Form (Forms A and A1 of Northern Beaches Council’s Guidelines for preparing a Flood Management Report) to the effect that the works have been designed and can be constructed to adequately address flood risk management issues.

Refer to attached Form 1 (Appendix D)

A3. Some filling of the land and modifications to the existing surface layout of the site are proposed. The proposed filling will not adversly impact on adjacent propertiy owners (refer s7.4 for a detailed discussion of the flood modelling results)

Stellen
Civil Engineering

Control B – Drainage infrastructure and creek works

B1. Some flood mitigation measures (oval bund and M-Block walls) are proposed and discussed in s7.3. No additional adverse impact of the surround properites are expected.

B2. It is recommended that a restrictive covenant be place on the property title for all flood mitigation works prior to the issue of an occupancy certificate for the development.

Control C - Building components and structural

C1. The proposed new library, shall be designed / checked by a structural engineer and constructed of flood compatible materials in accordance with Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas, Hawkesbury-Nepean Floodplain Management Steering Committee (2006).

C2. All structures must be designed and constructed to ensure structural integrity up to the PMF (14.50 mAHD), taking into account the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion. The structural certification shall be provided confirming the above.

C3. All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the PMF. It is reccomended that all existing electrical equipment and power points located below the Flood Planning Level must have residual current devices installed that turn off all electricity supply to the property when flood waters are detected.

Control D - Storage of goods

D1. Hazardous or potentially polluting materials shall not be stored in any area below the 1% AEP level (such as the subfloor area of the proposed library) unless adequately protected from floodwaters in accordance with industry standards.

D2. Goods, materials or other products which may be highly susceptible to water damage are to be located/stored above the 1% AEP flood level + 0.5 m freeboard.

Control E - Flood emergency response

E1. The recommended emergency response for M-Block is to shelter in place. The ground floor of the proposed library and existing M-Block is flood proofed to the PMF. In the event that floodwaters overtop the boundary adjacent to Westmoreland Ave and begin to traverse the oval, the recommended actions are:

- The occupants of M-Block shall be directed to remain within the building, which is above the PMF water surface level.
- Emergency services shall be contacted stating the property's location; the situation faced, number of people on the property and any evacuation measures to be carried out.

E2. Adequate area within the existing M-Block and proposed new library is available to safely shelter in place above the PMF level and internal access to all parts of M-Block is available from all areas within the development area.

E3. Warning Systems, Signage and Exits shall be installed to allow safe and orderly evacuation without reliance upon the SES or other authorised emergency services personnel.

Control F - Floor levels

F2. The proposed development will not adversely impact any adjacent property owners, refer s7.4 for a detailed discussion of the flood modelling results.

F3. Not applicable - No proposed or existing structure is elevated to allow the passage of floodwaters beneath it.

F7. All proposed new floor levels are set at or above the PMF.

Control G - Not applicable

G1. The existing car is located within the overland flow path, the location is considered acceptable for the following reasons:

- The hazard classification through the area is H1-H2 which is generally safe for vehicles and pedestrians.
- Only a small portion of the area is classed H5 which is unsafe for vehicles and pedestrians but is considered accepted as it isolated to the edge of the carpark.
- The existing carpark is already in this location and presents no additional risk to the occupants of the site/carpark the hazard classification or which remains largely unchanged when compared to the pre-development scenario.

G4. Not applicable – the predicted peak depth during the 1% AEP rain event is approximately 280 mm.

G6. Not applicable – no carports are proposed.

G7. Not applicable – no modifications to the existing driveway are proposed.

G9. Not applicable – no enclosed parking areas are proposed.

G10. Not applicable – no enclosed garage areas are proposed.

Control H - Not applicable

H1. Any proposed fencing located within the 1% AEP flood extent most be open style and contructed to allow the passage of floodwaters through the site (unless specifically noted as a flood mittigation measure).

Control I - Not applicable

I1. Not application – no modifications to the existing pool are proposed.

8.0 Conclusions and Recommendations for Design

Detailed flood modelling of the proposed development has been completed. It was found that provided the flood mitigation measures outlined in s7.3 are implemented, the proposed development will reduce the extent of the H5 hazard classification areas downstream of the site on South Creek Road.

It is recommended that the following be implemented in the final design:

- The proposed entry ground floor level of the new M-Block library is set at 14.50 mAHD and flood proofed to the PMF.
- All aspects of the proposed development at or below the PMF level will be constructed of flood compatible materials in accordance with the *"Stormwater Technical Manual"* and the *"Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas",* Hawkesbury-Nepean Floodplain Management Steering Committee (2006).
- All aspects of the proposed development at or below the PMF flood levels will be designed and certified by a structural engineer as capable of withstanding forces subject to floodwater, debris, buoyancy forces anticipated by the PMF event.
- All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the PMF. It is reccomended that all existing electrical equipment and power points located below the Flood Planning Level must have residual current devices installed that turn isolate the circuits when exposed to water.
- Hazardous or potentially polluting materials shall not be stored in any area below the 1% AEP level (such as the subfloor area of the proposed library) unless adequately protected from floodwaters in accordance with industry standards.
- A restrictive covenant must be placed upon the title of the land prior to the commencement of use to ensure there are no further significant works and alterations to the landform or development are undertaken without the approval of Council such to impact on floodwaters.
- Open style fencing be adopted throughout the flood affected portion of the site to ensure no blockages/obstructions to external flows.
- Shelter-in-place be adopted as the flood emergency response plan for the development
- Warning Systems, Signage and Exits shall be installed to allow safe and orderly evacuation without reliance upon the SES or other authorised emergency services personnel.

References

Australian Institute for Disaster Resilience, 2014, *Technical Flood Risk Management Guideline: Flood emergency response classification of the floodplain*, Australian Disaster Resilience Handbook Collection, Handbook 7.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2016, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia.

DECC (NSW Department of Environment and Climate Change), 2007, *Floodplain Risk Management Guideline*, Flood Emergency Response Classification of Communities, DECC, Sydney.

New South Wales Government, 2005, *Floodplain Development Manual: For Management of Flood Liable Land*.

Beretta, R., Ravazzani, G., Maiorano, C. and Mancini, M. (2018). *Simulating the Influence of Buildings on Flood Inundation in Urban Areas*. Geosciences, 8(2), p.77.

Lyall & Associates Consulting Water Engineers (2005). *Dee Why and Cur Curl Lagoons Floodplain Risk Management Plan*

Stellen
Civil Engineering

Appendix A

Architectural Drawings & Survey

Appendix A – Architectural Plans by Neeson Murcutt + NEILLE

All dated: 23.10.2019

DRAWING No.	DRAWING TITLE
DA 01	COVER SHEET
DA 02	SITE ANALYSIS
DA 03	SITE ANALYSIS
DA 04	SITE PLAN
DA 05	DEMOLITION PLANS
DA 06	LIBRARY + STUDENT SERVICES PLANS
DA 07	LIBRARY + STUDENT SERVICES ELEVATIONS + SECTIONS
DA 08	SOUTH + WEST WING UNIVERSAL CORE PLANS
DA 09	TRAFFIC
DA 10	SHADOW DIAGRAMS
DA 11	SCHEDULE OF COLOURS AND MATERIALS
DA 12.1	NOTIFICATION PLAN
DA 12.2	NOTIFICATION PLAN
DA 13.1	CONSTRUCTION METHODOLOGY

Appendix A – Landscape Architectural Plans by jila

All dated: 25.10.2019 (Issued for DA)

DRAWING SHEETS:

L-DA-000	COVERSHEET
L-DA-001	LEGEND AND SCHEDULE
L-DA-002	LEGEND AND PLANT SCHEDULE
L-DA-003	LANDSCAPE MASTERPLAN
L-DA-011	PRECEDENT 01
L-DA-012	PRECEDENT 02
L-DA-013	PRECEDENT 03
L-DA-101	LANDSCAPE DETAIL PLAN 01
L-DA-102	LANDSCAPE DETAIL PLAN 02
L-DA-103	LANDSCAPE DETAIL PLAN 03
L-DA-104	LANDSCAPE DETAIL PLAN 04
L-DA-105	LANDSCAPE DETAIL PLAN 05
L-DA-106	LANDSCAPE DETAIL PLAN 06
L-DA-107	LANDSCAPE DETAIL PLAN 07
L-DA-108	LANDSCAPE DETAIL PLAN 08
L-DA-109	LANDSCAPE DETAIL PLAN 09
L-DA-110	LANDSCAPE DETAIL PLAN 10
L-DA-111	LANDSCAPE DETAIL PLAN 11
L-DA-112	LANDSCAPE DETAIL PLAN 12
L-DA-500	SECTION LOCATION PLAN
L-DA-501	LANDSCAPE SECTIONS 01
L-DA-502	LANDSCAPE SECTIONS / ELEVATION 02
L-DA-503	LANDSCAPE SECTIONS / ELEVATION 03
L-DA-504	LANDSCAPE SECTIONS 04
L-DA-505	LANDSCAPE SECTIONS 05
L-DA-506	LANDSCAPE SECTIONS 06
L-DA-507	LANDSCAPE SECTIONS 07

Appendix A – Site Survey by CMS

Project #: 4883G

Sheets 1 through 12 all dated 10.05.2018

Stellen
Civil Engineering

Appendix B

DRAINS Model

Appendix D – DRAINS Model

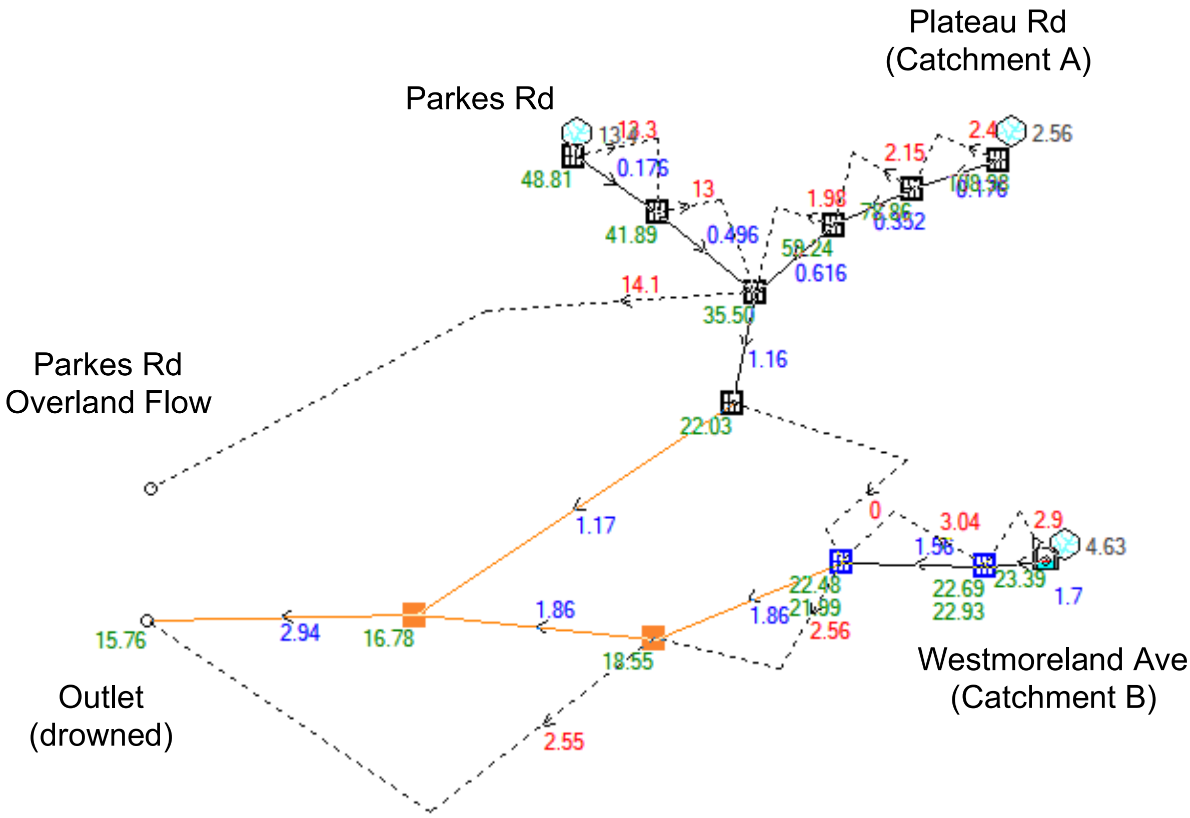


Figure 14 - DRAINS Model, 1% AEP 50% pit blockage

Stellen
Civil Engineering

Appendix C

HECRAS 2D Results

Appendix C – Table of Figures

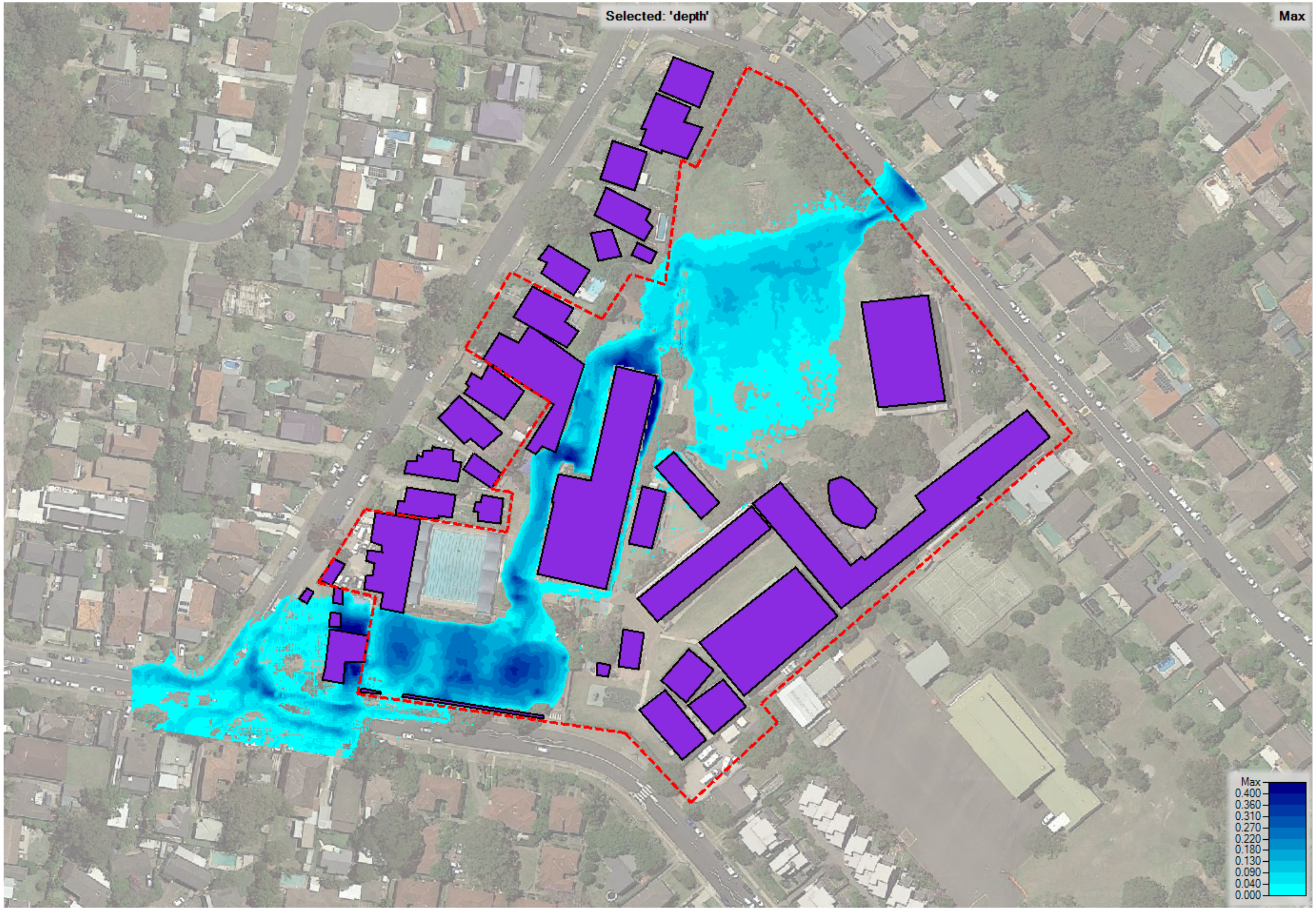


Figure 15 - Pre-development, 1%AEP (blocked), Depth (m)

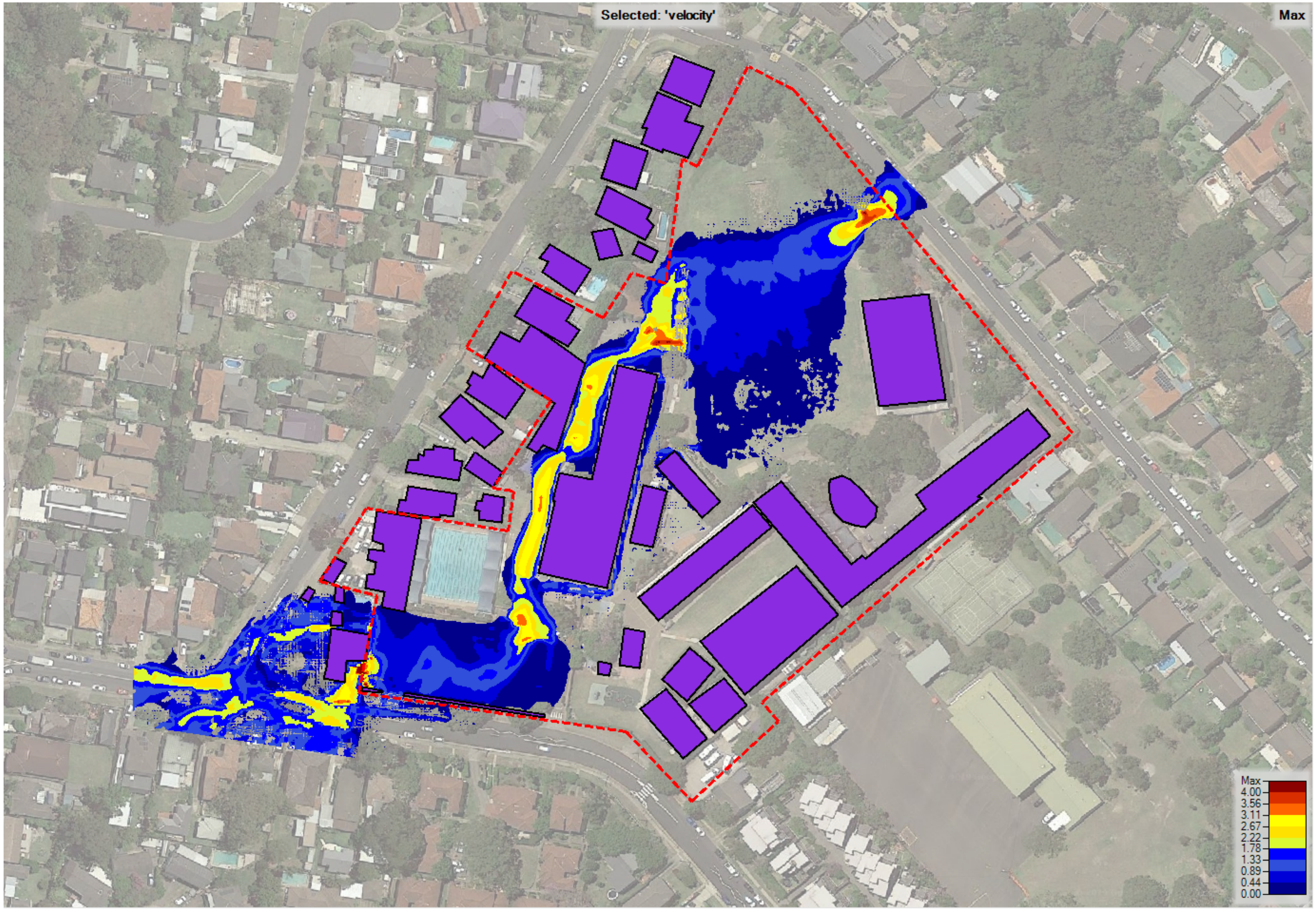


Figure 16 - Pre-development, 1%AEP (blocked), Velocity (m/s)

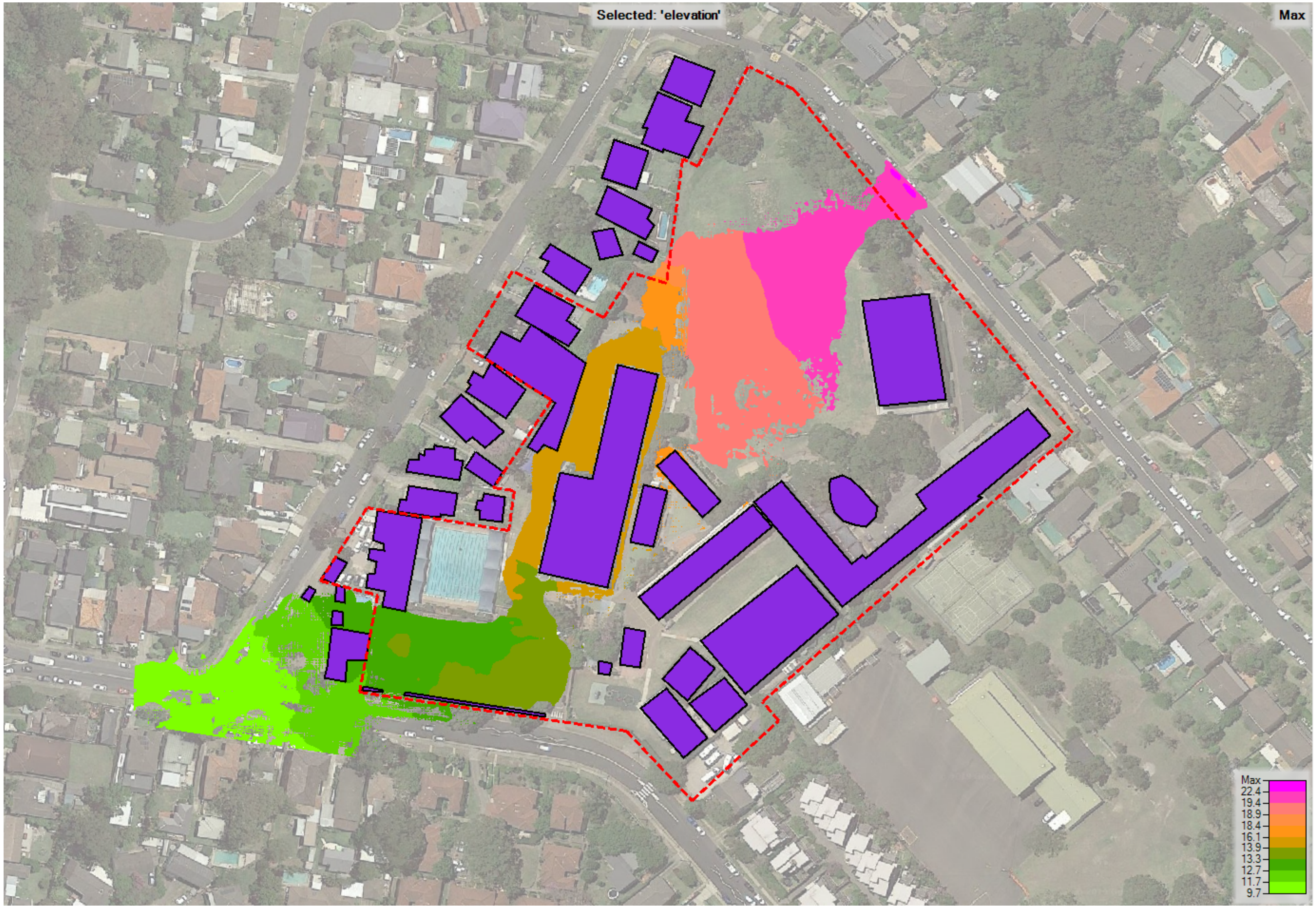


Figure 17 - Pre-development, 1%AEP (blocked), Water Surface Elevation (mAHD)

Stellen
Civil Engineering

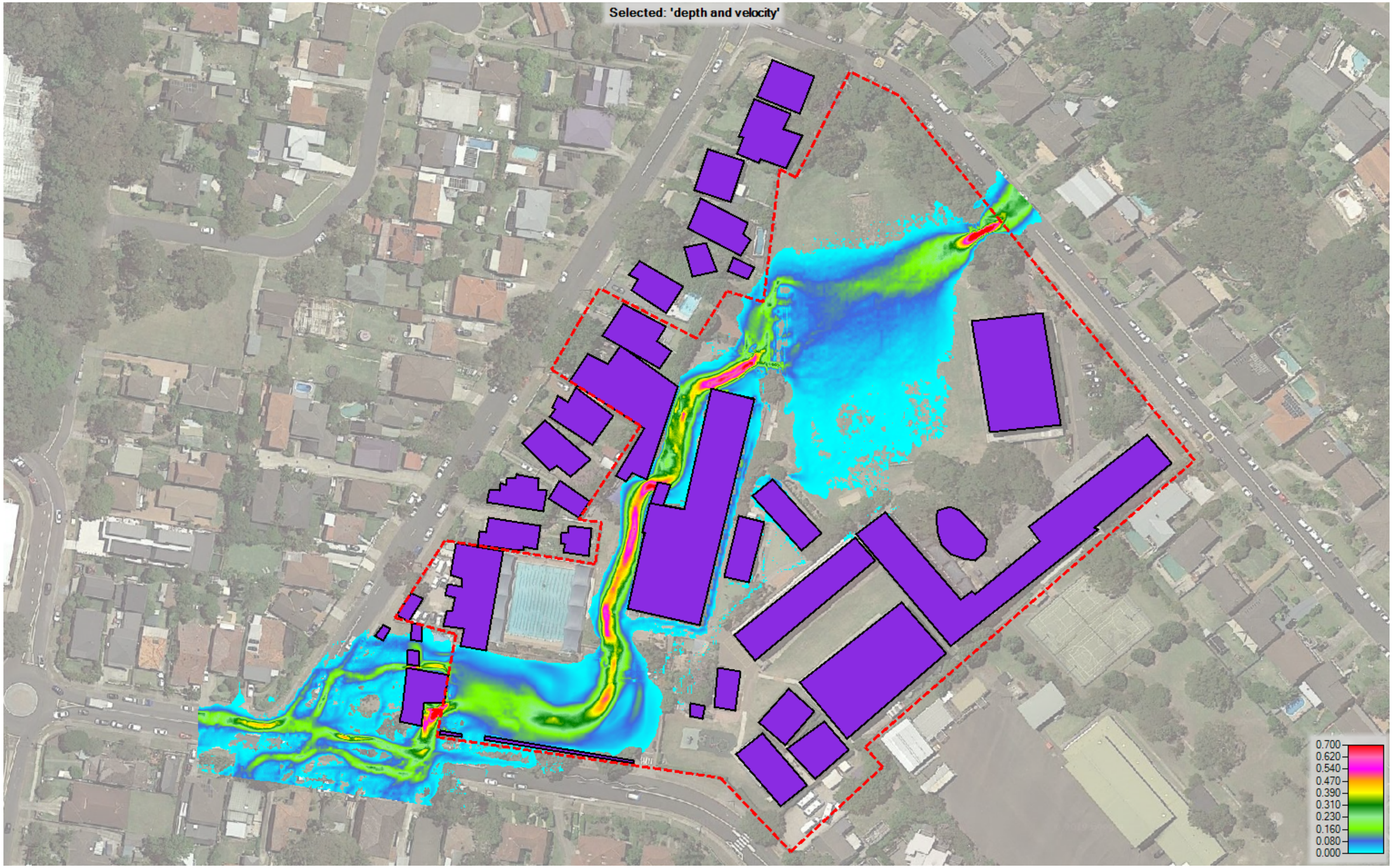


Figure 18 - Pre-development, 1%AEP (blocked), Velocity Depth Product (m^2/s)

Stellen
Civil Engineering

Figure 19 - Pre-development, 1% AEP (blocked), Flood Hazard

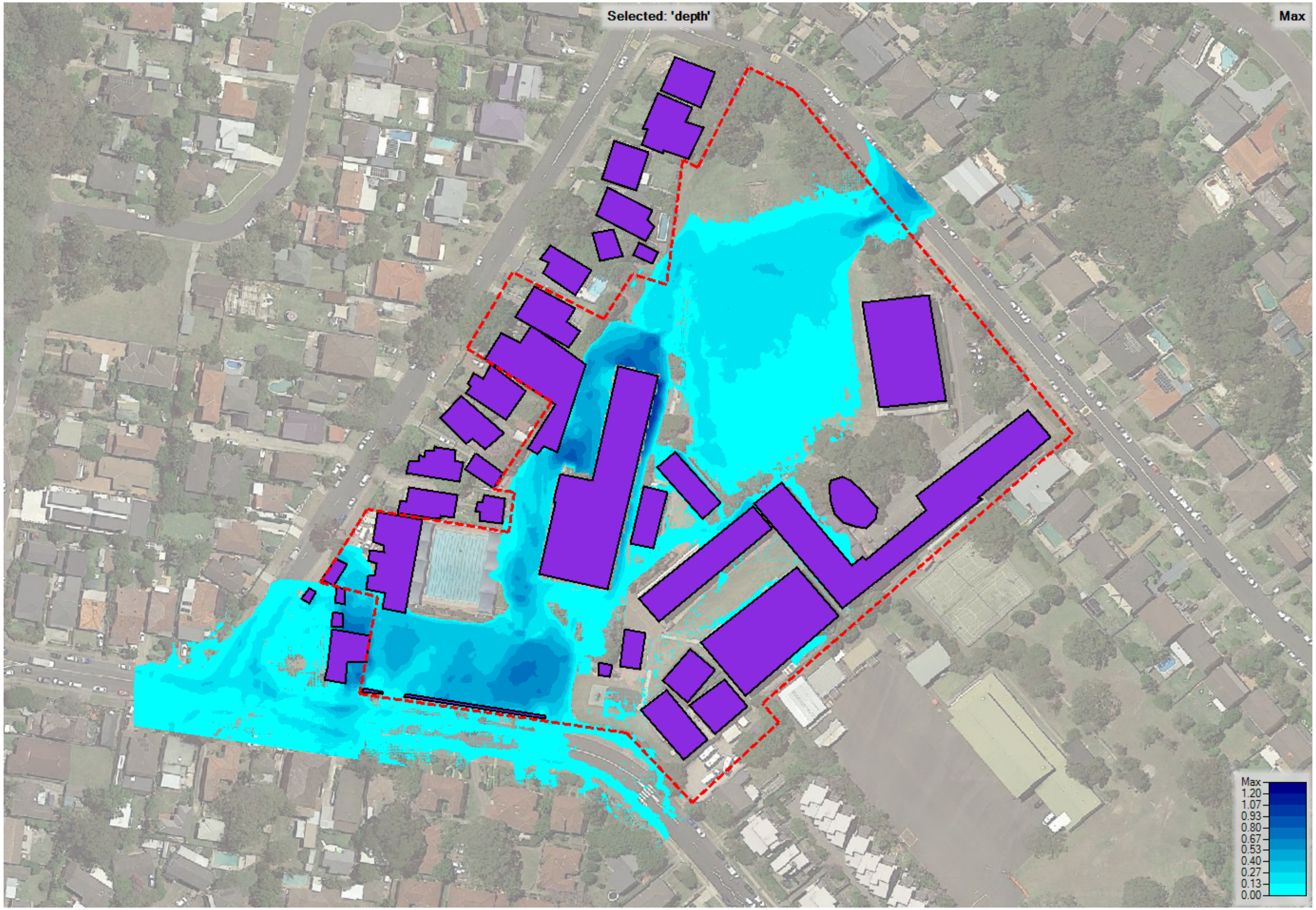


Figure 20 - Pre-development, PMF, Depth (m)

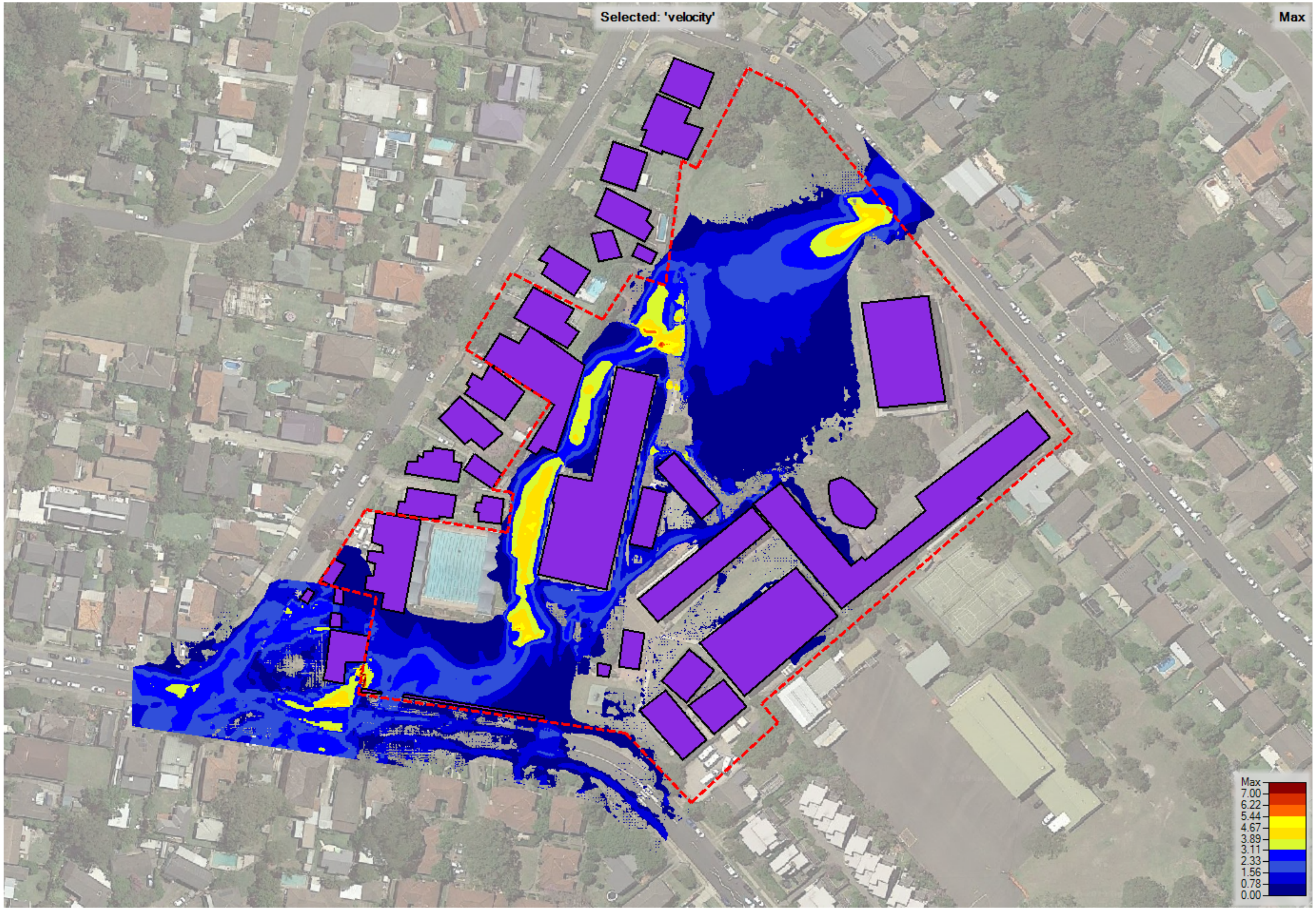


Figure 21 - Pre-development, PMF, Velocity (m/s)

Stellen
Civil Engineering

Figure 22 - Pre-development, PMF, Water Surface Elevation (mAHD)

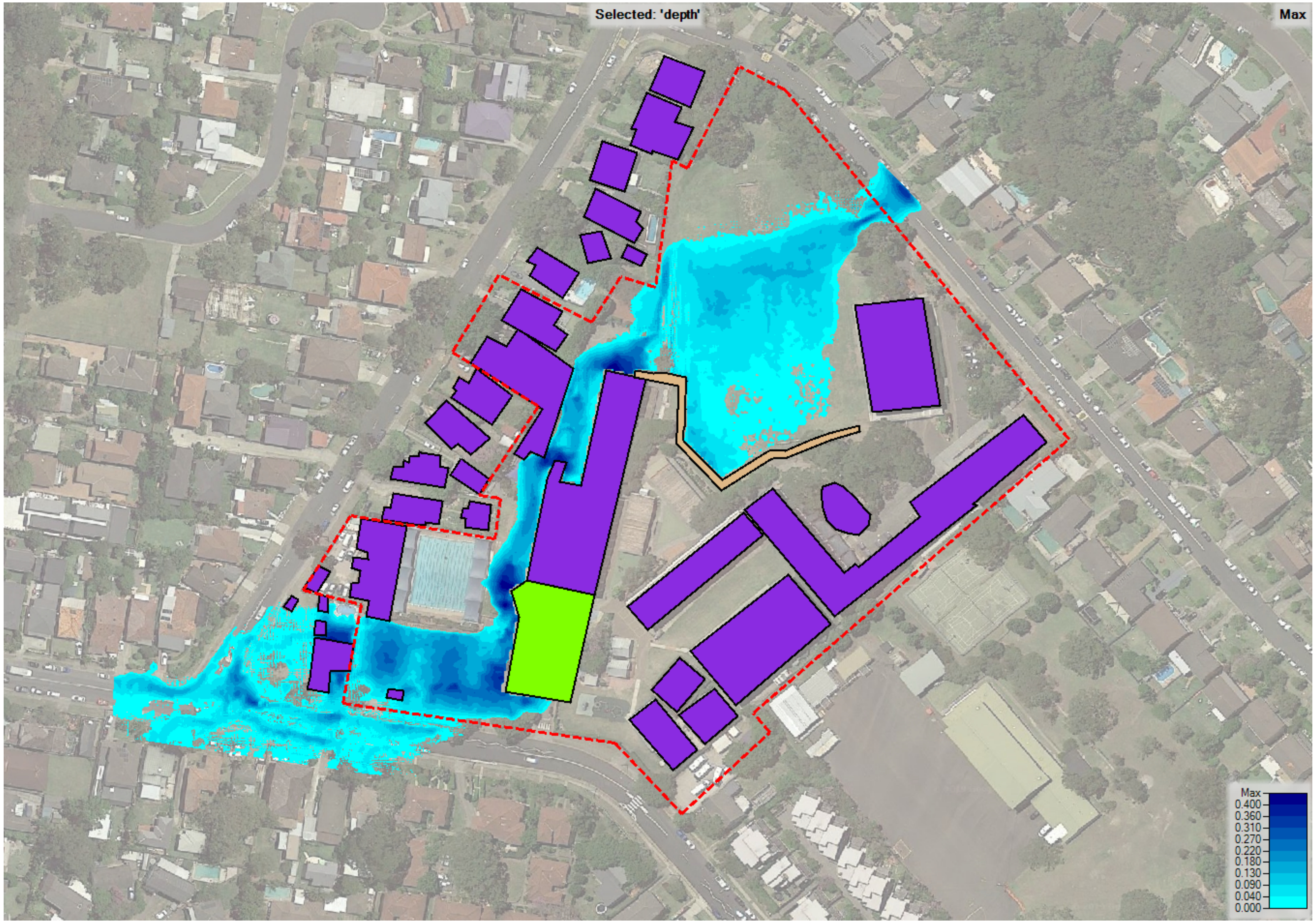


Figure 23 - Post-development, 1% AEP (blocked), Depth (m)

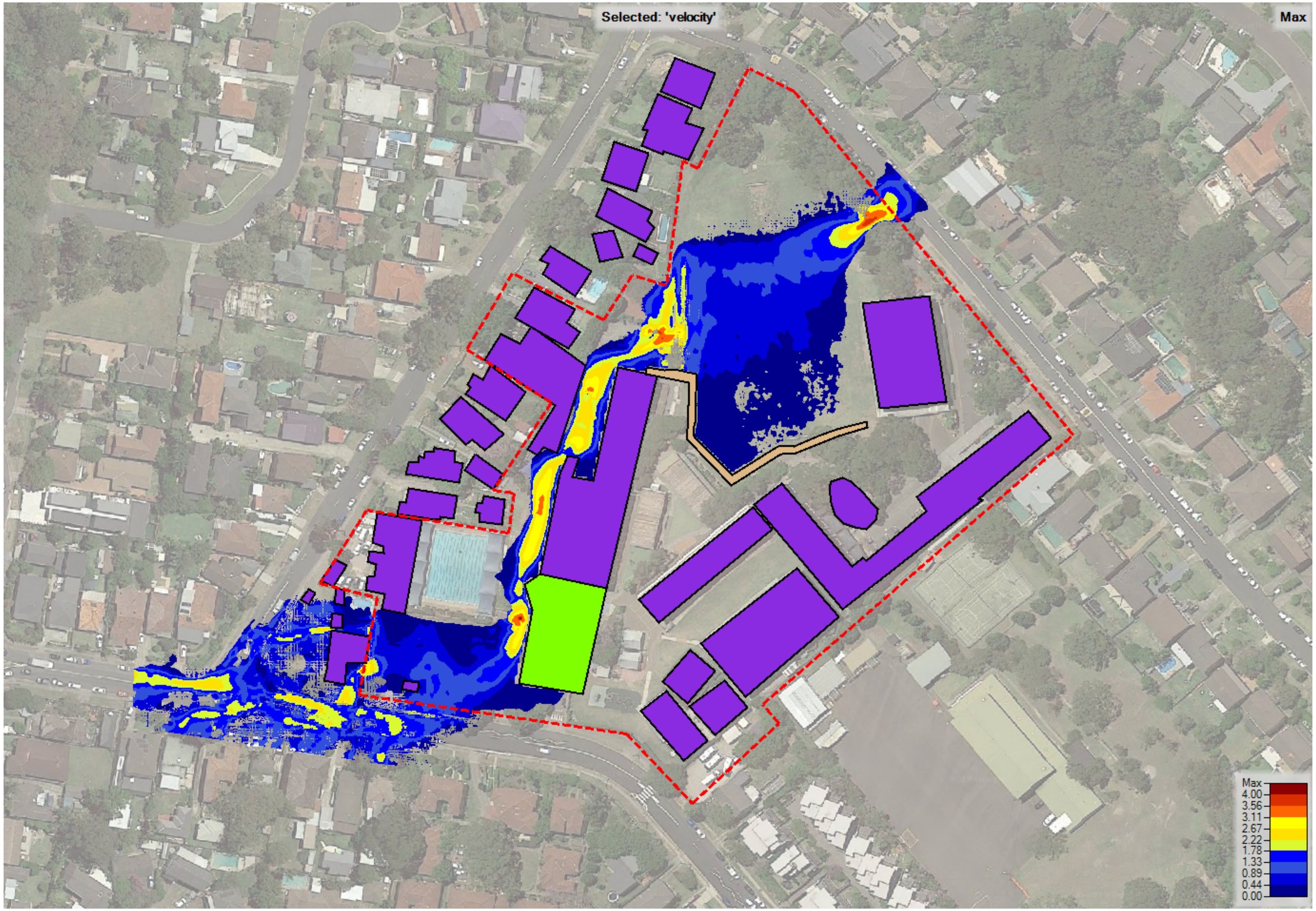


Figure 24 - Post-development, 1% AEP (blocked), Velocity (m/s)

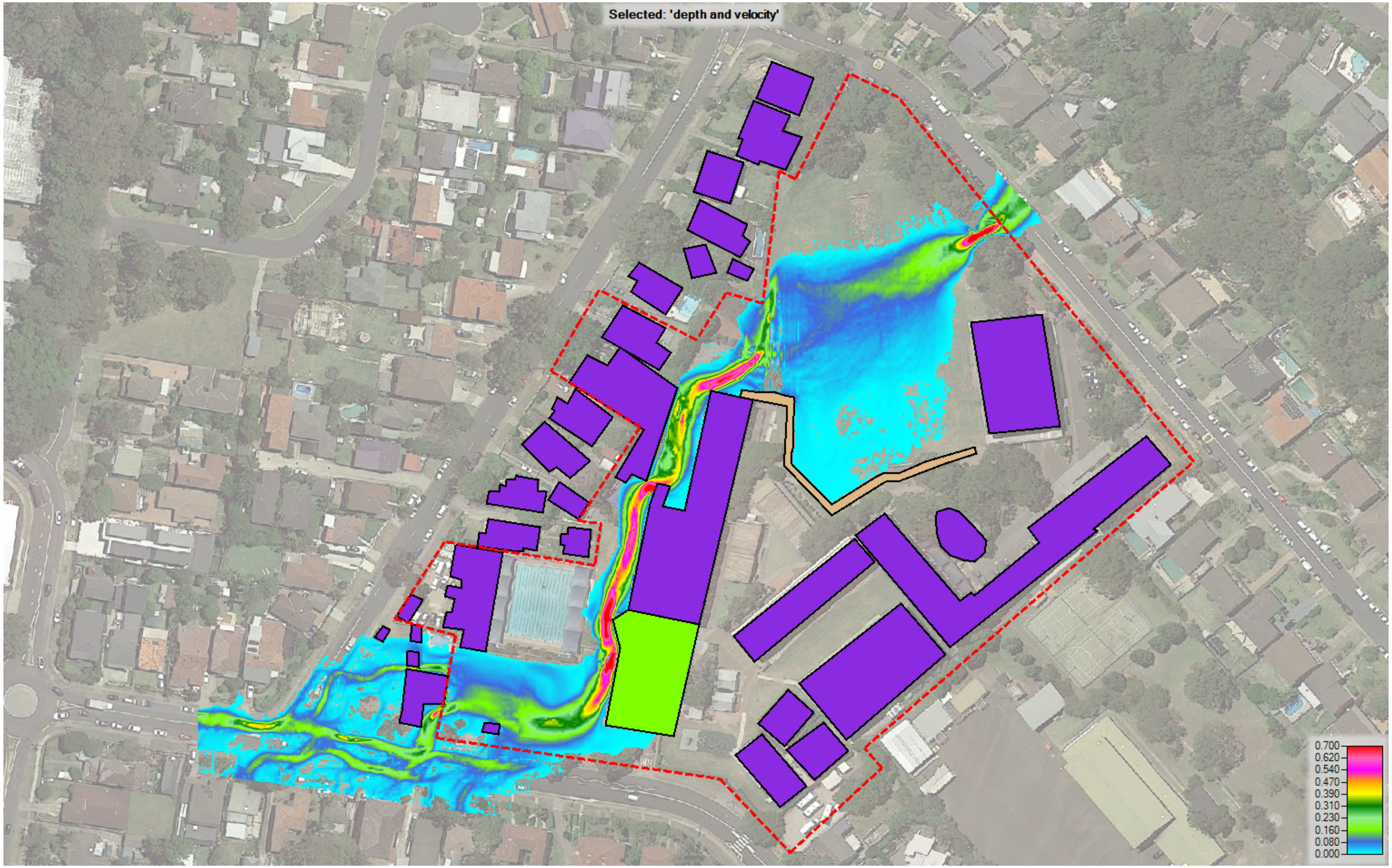


Figure 25 - Post-development, 1%AEP (blocked), Velocity Depth Product (m^2/s)

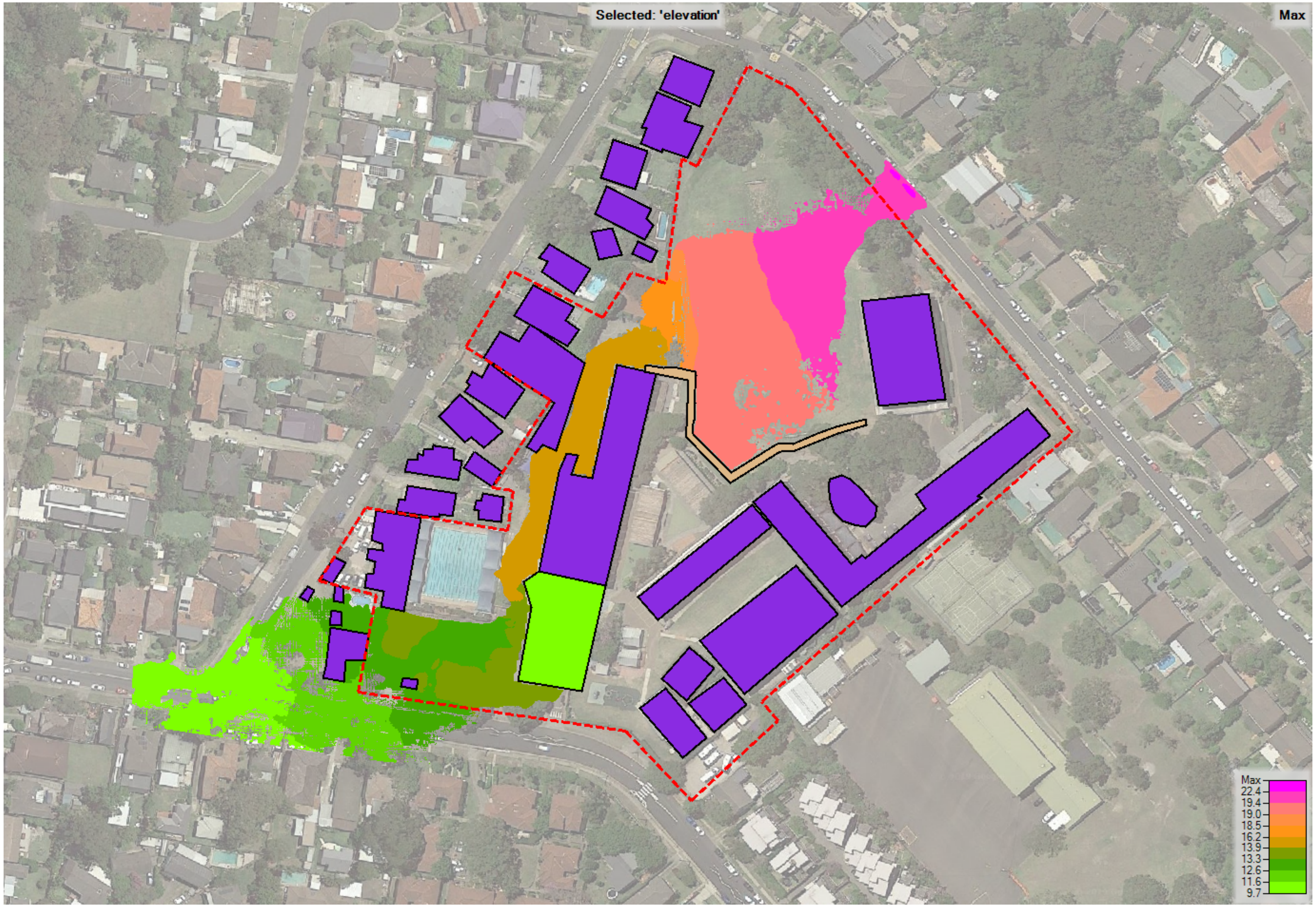


Figure 26 - Post-development, 1% AEP (blocked), Water Surface Elevation (mAHD)

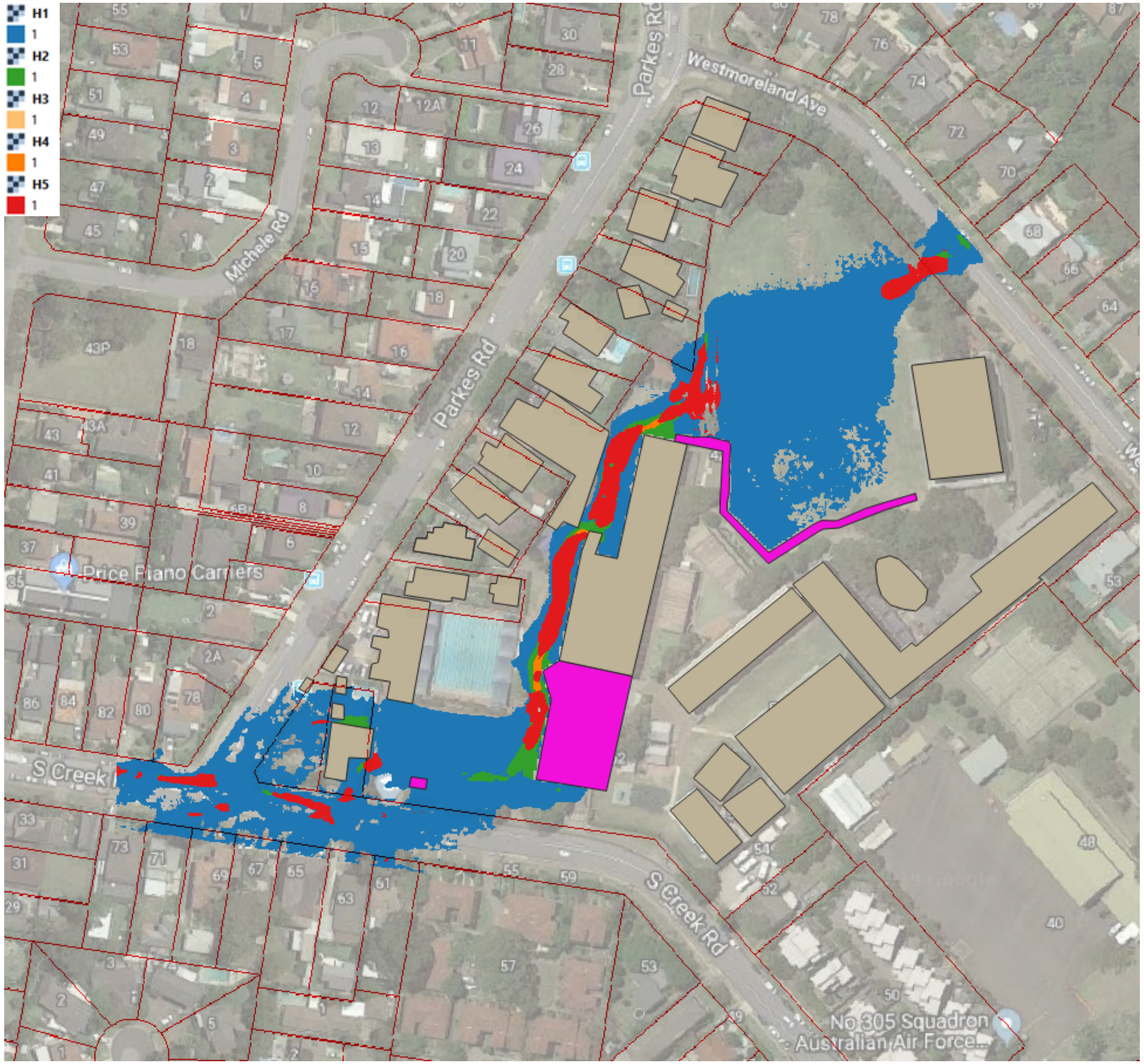


Figure 27 - Post-development 1% AEP (blocked), Flood Hazard

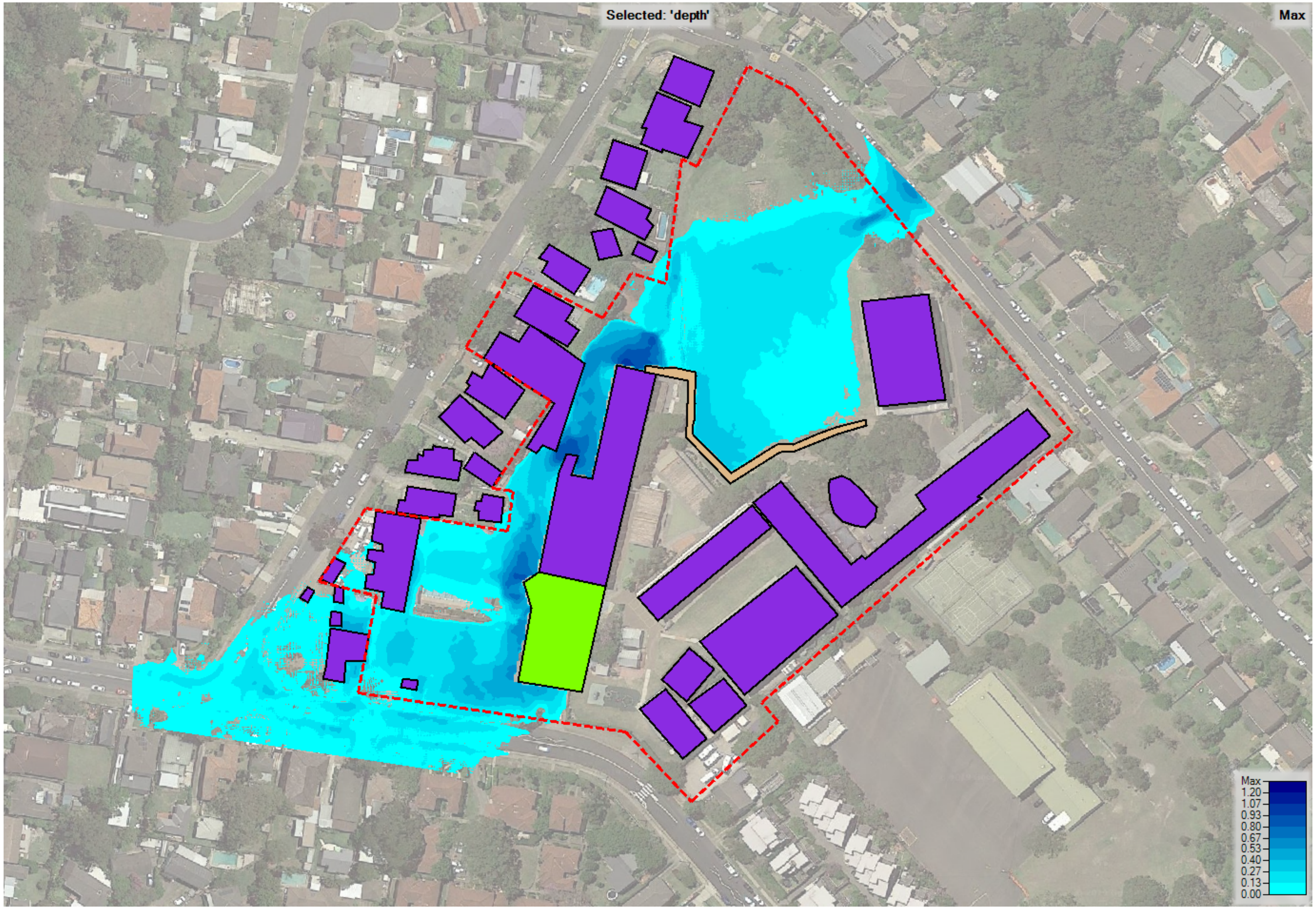


Figure 28 - Post-development, PMF, Depth (m)

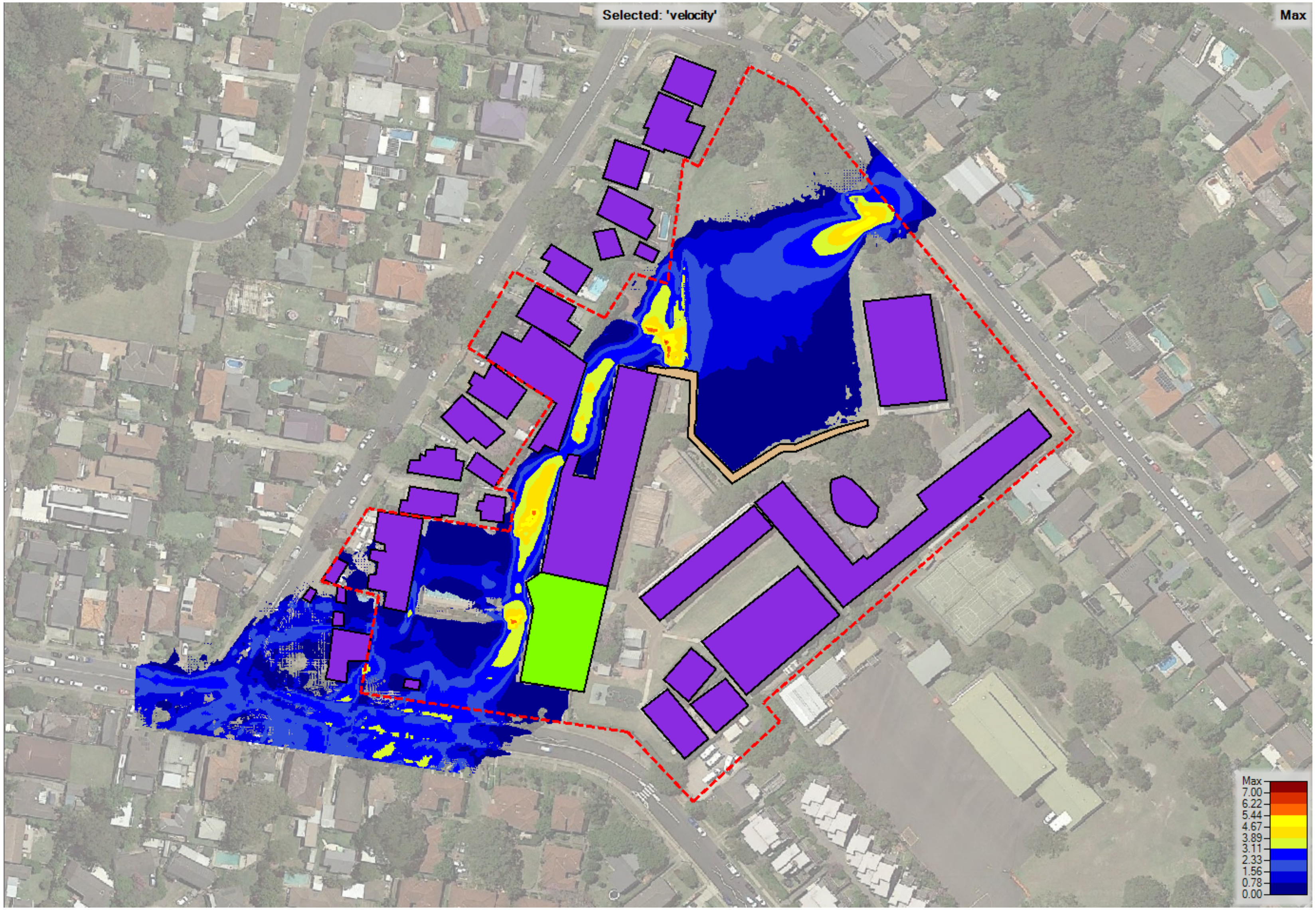


Figure 29 - Post-development, PMF, Velocity (m/s)

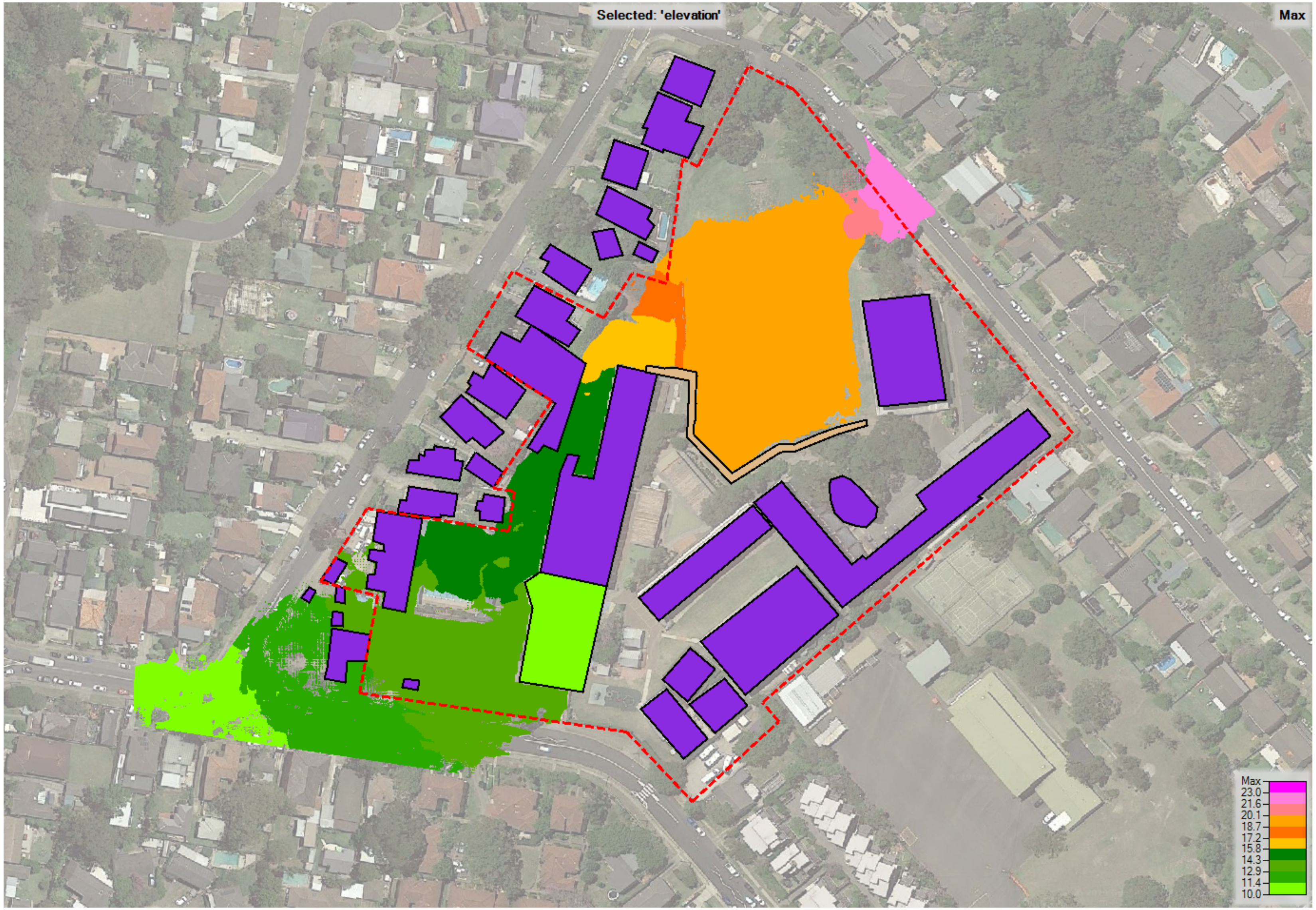


Figure 30 - Post-development, PMF, Water Surface Elevation (mAHD)

Stellen
Civil Engineering

Appendix D

Form 1

Attachment A

NORTHERN BEACHES COUNCIL
STANDARD HYDRAULIC CERTIFICATION FORM
FORM A/A1 – To be submitted with Development Application

Development Application for

Address of site: 70 South Creek Road, Collaroy

Declaration made by hydraulic engineer or professional consultant specialising in flooding/flood risk management as part of undertaking the Flood Management Report:

I, Logan English-Smith on behalf of Stellen Consulting
(Insert Name) (Trading or Business/ Company Name)

on this the 25.10.2019 certify that I am engineer or a
(Date)
professional consultant specialising in flooding and I am authorised by the above organisation/ company to issue this document and to certify that the organisation/ company has a current professional indemnity policy of at least $2 million.

***Flood Management Report* Details:**

Report Title:

Overland Flow Assessment, The Pittwater House School
………...

Report Date: 25.10.2019 …………………………………………………………..……..

Author: Logan English-Smith ………………………………………………….…………...

Author's Company/Organisation: ……………………………………………….……..

I: Logan English-Smith
(Insert Name)
Please tick all that are applicable (more than one box can be ticked)

☐ have obtained and included flood information from Council (must be less than 12 months old) (**This is mandatory**) No flood information for the site available

☑ have followed Council's Guidelines for Preparing a Flood Management Report

☑ have requested a variation to one or more of the flood related development controls. Details are provided in the *Flood Management Report*.

Signature …………………………………………………………………….…………………….……..

Name Logan English-Smith …………………………………………………………..…………………………..