Minor Hydraulic Flood Report

Hamell (QLD) Pty Ltd

C/- Tam Dang Planning

1304 Old Cleveland Road

Carindale

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1 Introduction

1.1. Purpose and Scope

Inertia Engineering has been commissioned by Hamell (QLD) Pty Ltd to prepare a Minor Hydraulic Flood Report for 1304 Old Cleveland Road, Carindale (the subject site).

The principle objective of this study is to determine the flood levels within the subject site and to assess the impacts of the proposed development on the flooding characteristics in the area. The findings of this report are based on data on rainfall, drainage and local topography obtained from a number of sources as referenced.

Detailed 2D modelling has been undertaken to confirm the above objectives.

1.2. Report Limitations

This report has been prepared by Inertia Engineering Pty Ltd for Hamell (QLD) Pty Ltd and may only be used and relied on by Hamell (QLD) Pty Ltd for the purpose agreed between Inertia Engineering and Hamell (QLD) Pty Ltd as detailed within this report.

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2 Site Characteristics

The land contained within the site is described as follows:

Title Details:	Lot 1 on RP168799
Street Address:	1304 Old Cleveland Road, Carindale
Site Area:	0.1248 ha

2.1. Location

The subject site is located in Carindale, approximately 10km south-east from Brisbane CBD and lies within BCC's low density residential zone (LDR). The subject site is bound by a nursing home to the north and east, Scrub Road on the west and Old Cleveland Road to the south.

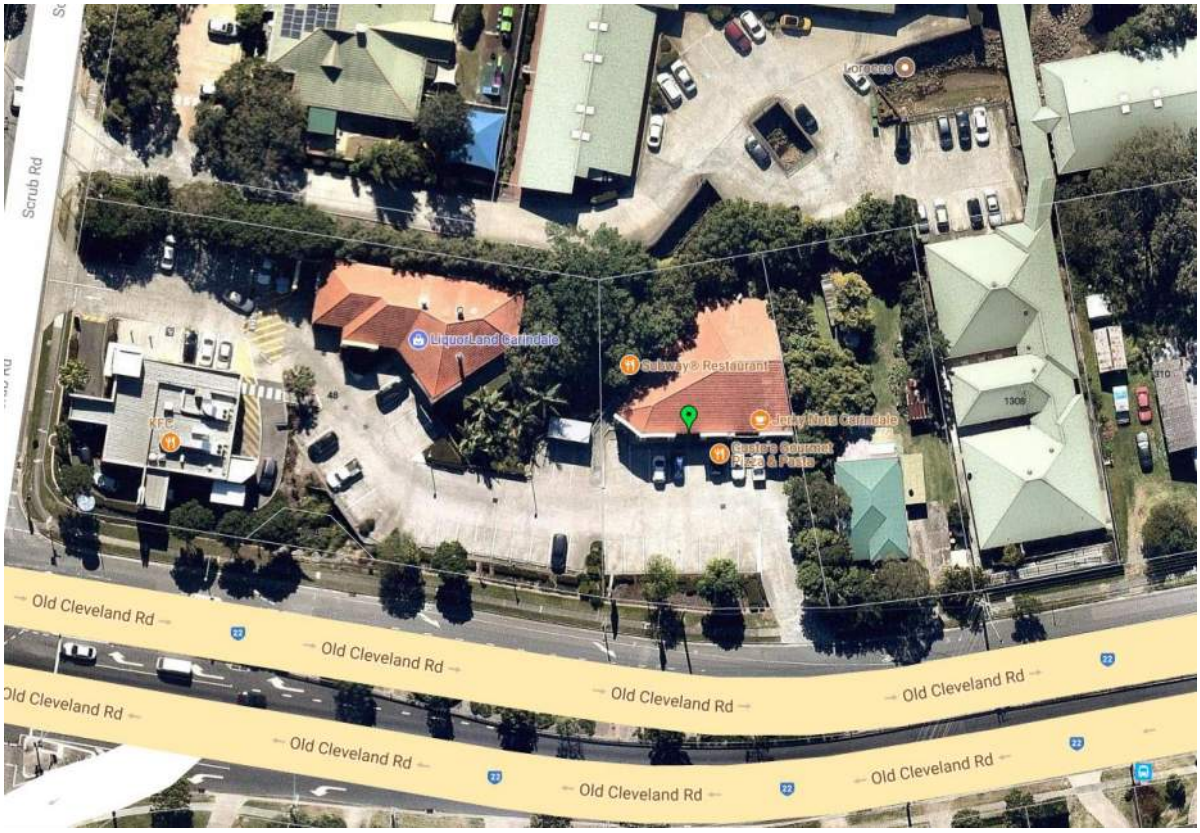


Figure 2-1 - Location Plan

2.2. Topography and Drainage

The subject site grades from 7.6m AHD in the south-east corner to 3.5m AHD on the northern boundary of the subject site with an average grade of 8%.

A series of gully pits within the upstream catchment collects runoff and directs it through the waterway that runs through the north-western corner of the subject site, ultimately discharging into Bulimba Creek.

Please refer to Appendix B for the stormwater network in the vicinity of the site, which has been sourced from Brisbane City Council eBimaps (BCC 2017c).

2.3. Existing Use

The existing site consists of a building with various tenants using it for commercial purposes. It also has an associated car park which joins with the adjacent development to allow for access and egress from Scrub Road and egress only from Old Cleveland Road.

2.4. Development Layout

There is an existing building on the subject site which will be demolished and a proposed 227m^2 fast food restaurant will be constructed. This will also entail the additional carparking and a drive through access for the subject site.

The new building and drive though will be completely suspended over the existing waterway.

Vehicle access and egress will remain as per existing conditions with an entry and exit from Scrub Road and a secondary exit only onto Old Cleveland Road.

Please refer to Appendix C for the proposed development plans.

3 Flood Data

Brisbane City Council's Floodwise Property Report (BCC 2016a) has flagged the subject site to be susceptible to flooding from creek/waterway and overland flow flooding. The flood levels from the Floodwise Property Report have been reproduced below in Table 3-1 - Floodwise Property Report flood levels (BCC, 2017a). The subject site lies within flood planning areas 1 and 3-5 of creek/waterway flooding and Table 3-2 identifies the depth and depth x velocity values for each category.

Table 3-1 - Floodwise Property Report flood levels (BCC, 2017a)

Description	Level (m AHD)	Flooding Source
20% AEP	4.8	Creek/Waterway
5% AEP	5.5	Creek/Waterway
2% AEP	5.9	Creek/Waterway
1% AEP	6.2	Creek/Waterway
DFL	6.2	Creek/Waterway

Table 3-2 - Flood planning area sub-categories (BCC, 2014)

	Brisbane River flooding		Creek/waterway flooding
FPA 1 sub-category	Within the 10% AEP Brisbane River flood extent; and DV>1.2m^2/s in RFL		Within the 10% AEP flood extent; and DV>1.2m^2/s in 1% AEP flood
FPA 2 sub-category	>1.2m deep; or DV>1.2m^2/s in RFL	FPA2A sub-category >2m deep in RFL	Deeper than 1.2m in 1% AEP flood; or DV>1.2m^2/s in 1% AEP flood
		FPA2B sub-category 1.2m to 2m deep in RFL	
FPA 3 sub-category	0.6-1.2m deep in RFL; or DV between 0.6m^2/s and 1.2m^2/s in RFL		0.6-1.2m deep in 1% AEP flood; or DV between 0.6m^2/s and 1.2m^2/s in 1% AEP flood
FPA 4 sub-category	0-0.6m deep in RFL; or DV less than 0.6m^2/s in RFL		0-0.6m deep in 1% AEP flood; or DV less than 0.6m^2/s in 1% AEP flood
FPA 5 sub-category	From the RFL extent to the 0.2% AEP flood extent		1% AEP flood extent to the 0.2% AEP flood extent

* RFL – Residential Flood Level, AEP – Annual Exceedance Probability, DV – Depth Velocity Product

Refer to Appendix A for the flood awareness map of the site.

4 Hydrology

4.1. Methodology

The XPRAFTS runoff-routing model been has used to estimate the design discharges for the 1% AEP storm event within the study area. Each sub-catchment is defined by its pervious (undeveloped) and impervious (developed), fraction impervious and catchment slope. The net rainfall is routed through the network after appropriate losses (initial and continuing) and roughness factors are applied, resulting in a surface runoff hydrograph for each sub-catchment.

The XPRAFTS model was used to estimate the 1% AEP storm event.

A Rational Method assessment was undertaken and used to compare the peak discharges for each sub-catchment.

4.2. Adopted Design Rainfalls

Design rainfall patterns and intensities for the area were determined using standard procedures given in Australian Rainfall and Runoff (IEAust, 1998). The Zone 3 ARR temporal patterns were applied to this assessment. The design IFD data was sourced from the Bureau of Meteorology and is shown below:

Table 4-1 – Design IFD Data

2 year ARI Intensities	50 year ARI Intensities	Skewness and Geographical Factors
1 hour – 47.51 mm/hr	1 hour – 91.97 mm/hr	Location Skew – 0.11
12 hour – 8.92 mm/hr	12 hour – 18.85 mm/hr	Geographical Factor F2 – 4.4
72 hour – 2.92 mm/hr	72 hour – 6.49 mm/hr	Geographical Factor F50 – 17.26

4.3. Hydrologic Model Configuration

4.3.1. Configuration

Eleven (11) sub-catchments were used to represent runoff from the contributing catchments that influence the flooding regime of the site. The sub-catchments have been delineated to accurately represent the inflow locations and their impact on the proposed development layout.

Please refer to Appendix D showing the catchment configuration within the XPRAFTS model.

4.3.2. Mannings Roughness

Manning's n values have been applied to represent the undeveloped and developed portions of the catchment. XPRAFTS allows a range to be applied to represent the varied degree of roughness that could be expected within the catchment. The following values have been applied:

- Impervious area n=0.015; and
- Pervious area n= 0.05 – 0.06 (Urban and Bushland values)

4.3.3. Rainfall Losses

Initial loss (IL) and continuing losses (CL) have been applied to the model, with the values varying for the impervious and pervious portions of the catchment. The following values have been applied:

- Impervious IL = 1mm CL = 0mm/hr; and
- Pervious IL = 15mm CL = 2.5mm/hr

4.4. Model Parameters

Table 4-1 shows the XPRAFTS parameters adopted for the catchment conditions. The catchment slopes were estimated from 1m contours for the catchments.

Table 4-2 - XPRAFTS Sub-catchment Parameters

Sub-catchment	Area (ha)	Impervious %	Slope %
C1	2.146	60	1.7
C2	5.927	5	14
C3	2.807	60	7.6
C3 (Developed)	2.807	66	7.6
C4	10.144	60	2.4
C5	4.735	60	4
C6	2.566	5	20
C7	7.931	60	2.3
C8	5.463	60	3.4
C9	16.172	5	20
C10	17.085	60	5.5
C11	10.548	5	20

4.5. Model Calibration

The Rational Method was used to compare the XPRAFTS estimates of design discharges for the existing conditions at the discharge points for each catchment.

Based on QUDM (2013) guidelines, C10 values were selected based on the land use mixture within each catchment, with values ranging from 0.74 for rural/environmental protection areas to 0.88 for commercial areas.

Table 4-3 shows a comparison of Rational Method and XPRAFTS model discharges estimated at the points of discharge for each catchment.

Table 4-3 - Comparison of Rational Method and XPRAFTS Model Peak Discharges

Event (AEP)	Catchment ID	Rational (m^3/s)	XPRAFTS (m^3/s)	Difference
1%	C1	1.362	1.568	+15%
	C2	2.717	2.94	+8%
	C3	2.013	1.903	-5%
	C3 (Developed)	2.045	1.956	-4%
	C4	5.834	5.487	-6%
	C5	2.901	2.879	-1%
	C6	1.410	1.55	+10%
	C7	4.095	4.328	+6%
	C8	3.347	3.214	-4%
	C9	8.054	7.765	-4%
	C10	10.133	9.97	-2%
	C11	4.964	5.387	+9%

The XPRAFTS model discharges generally compare well to the Rational Method discharges and the XPRAFTS model has been considered to be adequately calibrated for the purposes of this flood study.

5 Hydraulic Analysis

5.1. Objectives

The objectives for the assessment have been set in accordance with Brisbane City Council's City Plan 2014 - Flood Planning Scheme Policy and Flood Overlay Code (BCC, 2014), and the Queensland Urban Drainage Manual (QUDM, 2013).

XPSWMM has been used for this analysis. XPSWMM is an industry standard two-dimensional analysis model used to estimate flood characteristics such as flood level, velocity and flood depth and the impacts the proposed development has on the surrounding properties.

5.2. Model Scenarios

The following scenarios were modelled as a part of the hydraulic analysis of the subject site and the surrounding area.

Table 5-1 – Hydraulic model scenarios

Scenario	Flood Event	Additional Scenario Parameters
1	1% AEP	N/A
2	1% AEP	50% blockage factor to Sirroco Place culverts (2/2400x1500 RCBC)

5.3. Model Setup

5.3.1. Model Extent, Grid Size and Time

The XPSWMM model was established to estimate the flood depths across the subject site and the following is of note;

- The extent of the model is from 70 Scrub Rd to Settlers Street Park;
- The XPSWMM model adopted a grid cell size of 1m;
- A timestep of 0.5 seconds was adopted for model stability; and
- The model was run for a 2 hour duration.

Refer to Appendix E showing the model configuration.

5.3.2. Topography

The XPSWMM model topography has been created from LIDAR data supplied by the Department of Natural Resources and Mines (DNRM). The LIDAR data provided was from the 2009 South East Queensland LIDAR capture project within the Brisbane City Council Local Government Area (LGA).

The DTM created within XPSWMM from the LIDAR data was compared to the site survey undertaken by East Coast Surveys in March 2017. The waterway located downstream of the existing box culverts on site was found to be poorly represented due to the presence of vegetation in the waterway.

Elevation shapes were used to manipulate the ground levels to tie in with the site survey to ensure an accurate reflection of the surface in the area.

5.3.3. Mannings 'n' Roughness

The following Manning's n values have been adopted:

- Roads = 0.015
- Buildings = 0.15
- Waterway = 0.075
- Verge = 0.03
- Backyard Vegetation = 0.06 (Default)
- Dense Waterway = 0.12
- Concrete = 0.013
- Avg Grass = 0.035
- Suspended Slab = 0.15

5.3.4. Stormwater Network

The trunk stormwater networks surrounding the subject site and the upstream catchment were represented within XPSWMM as a part of the hydraulic model. The stormwater culverts were modelled as 1D elements within XPSWMM to ensure that the capacity was accurately represented.

All invert levels, pipe sizes, pipe grades and material types were sourced from information from BCC's eBimaps mapping service and site inspections. Entry and exit losses from the box culverts were determined in accordance with QUDM recommendations.

5.4. Boundary Conditions

5.4.1. Hydrologic Inputs

Three inflow locations were used to represent runoff from the contributing catchments that influence the flooding regime of the site. The sub-catchments have been delineated to accurately represent the inflow locations and their impact on the proposed development layout.

Refer to Appendix D showing the catchment configuration within the XPSWMM model.

5.4.2. Tailwater Conditions

A 2D head boundary has been applied to the XPSWMM model 300m downstream of the subject site in Settlers Street Park. The 2D head boundary is a polyline representing a time dependant head within the XPSWMM model.

To simulate free outfall conditions within the XPSWMM model, the 2D head boundary was set to a level 1 metre lower than the DTM (2.0m AHD) for the duration of the simulation.

5.5. Model Sensitivity

The following scenarios were run within the XPSWMM to test the sensitivity of the model:

- Adjusting inflow locations within the model;
- Adjustments to Mannings roughness values;
- Adjustments to tailwater conditions;

The adjustments to the inflow location of catchments (C4-11) had an impact on the runoff estimated to be flowing over Old Cleveland Rd. The adjustments to the two upstream inflow locations had negligible changes to the water depths and velocities in the area.

The adjustments to Mannings roughness values had a minor impact on the water elevations and the velocities in the waterway. BCC's modified Cowan method was used to determine the Mannings roughness of the waterway and was eventually adopted in the model.

The adjustments to tailwater conditions had a larger impact on the flood levels estimated through the waterway, as the large majority of the flood storage available in the area. The outfall conditions were eventually adopted as the development is located in the lower reaches on Bulimba Creek and will not coincide with the flooding of Bulimba Creek and was found to be a better fit to the nominated 1% AEP creek/waterway flood levels nominated in Floodwise property reports in the surrounding area.

The model characteristics shown in Section 5.3 and 5.4 were eventually adopted.

5.6. Results

Appendix F shows the results of the flood model for the 1% AEP flood event for both scenarios.

5.6.1. Scenario 1 – Design Levels

The 1% AEP flood level across the subject site varies between 6.5m AHD in the existing car park to 6.04m AHD at the eastern property boundary in the waterway.

The existing 2/3300x1500 RCBCs running underneath the carpark have a peak capacity of 24.4m^3/s before water overtops into the carpark with a peak of 8.2m^3/s running north-east across the carpark and wiering back into the waterway.

The maximum velocities of flood waters through the carpark are estimated to be up to 1.6m/s, with flooding depths up to 430mm deep and a maximum hydraulic hazard of 0.55m^2/s.

Based on the existing contours, the maximum flood depths underneath the existing suspended building are 1.5m deep and the maximum velocity of floodwaters is 1.2m/s, resulting in a maximum depth velocity product (DV) of 2.1m^2/s, which is considered to be a high flood hazard area.

5.6.2. Scenario 2 – 50% Blockage of Sirocco Place Culvert

The 1% AEP flood level across the subject site varies between 6.64m AHD in the existing car park to 6.5m AHD at the eastern property boundary in the waterway.

Based on the existing contours, the maximum flood depths underneath the existing suspended building are 1.98m deep and the maximum velocity of floodwaters is 1.0m/s, resulting in a maximum depth velocity product (DV) of 1.8m^2/s, which is still considered to be a high flood hazard area.

The maximum velocities of flood waters through the carpark are estimated to be up to 1.9m/s, with flooding depths up to 580mm deep.

An assessment of both box culverts was undertaken to assess the potential for blockages during a major storm event. The assessment was undertaken in accordance with the AR&R Blockage Assessment Form which takes into factors such as debris availability, mobility and transportability to determine the design blockage factor.

With the majority of flows entering the site from piped networks and the approval of the neighbouring development to be suspended over the waterway, the only remaining major area for debris generation is the nearby vegetated area adjacent to the existing culverts (highlighted below in Figure 5-1). The assessment determined that the 1% AEP design blockage factor should be 0%. Therefore, it was deemed appropriate for Scenario 1 to be adopted for all further assessments.

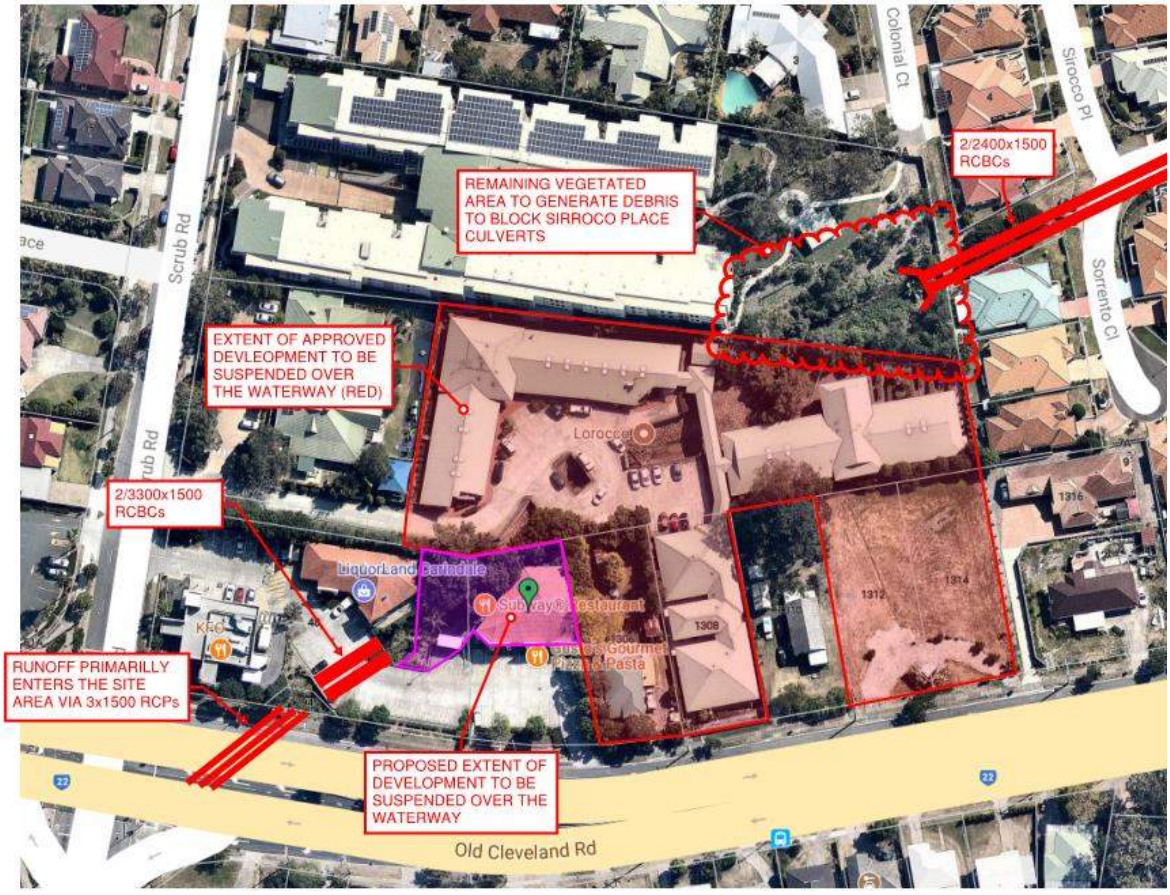


Figure 5-1 – Catchment Overview highlighting debris potential

6 Guidelines for Required Flood Immunity Levels

6.1. Minimum Design Levels

Brisbane City Council's City Plan 2014 Flood Overlay Code (BCC, 2014), Table 8.2.11.3.D nominates the flood planning category relevant to each building classification of the Building Code of Australia. The BCC flood categories nominated for a fast food restaurant (BCA Building Class 5) are described in Table 6-1 below.

Table 6-1 - BCC Flood Categories

BCA Building Classification	Development types and design levels	BCC Flood Category
Class 5	Building floor level	Category C
	Garage or carpark located in the building undercroft	Category C
	Carport or unroofed carpark	Category D
	Vehicular access and manoeuvring areas	Category D
	Basement parking entry	Category C
	Essential electrical services	Category A

The minimum floor levels should be set in accordance with BCC's City Plan 2014 Flood Overlay Code (BCC, 2014), Table 8.2.11.3.L. The required minimum design levels for the proposed development are described in Table 6-2 below.

Table 6-2 - Minimum design levels for flood categories

Flooding Source	Minimum design floor or pavement levels (m AHD)				
	Category A	Category B	Category C	Category D	Category E
Brisbane River	RFL + 500mm	RFL + 300mm	DFL	5% AEP level	5% AEP level
Creek/waterway	1% AEP level + 500mm	1% AEP level + 300mm	1% AEP level	1% AEP level	5% AEP level
Overland flow	2% AEP level + 500mm	2% AEP level + 300mm	2% AEP level	2% AEP level	5% AEP level

6.2. Undercroft Requirements

In accordance with Brisbane City Council's City Plan 2014 Flood Overlay Code (BCC, 2014), Table 8.2.11.3.E, the required building undercroft clearances are described in Table 6-3.

Table 6-3 - Building undercroft clearances

Flooding Source	Minimum Clearance Requirements
Overland flow– Hydraulic Hazard (DV <0.6 m^2/s and depth <600mm in 2% AEP flood event)	Lowest floor level is to be 1.5m above the highest ground elevation in undercroft area
Overland flow– Hydraulic Hazard (DV >0.6 m^2/s or depth >600mm in 2% AEP flood event)	Lowest floor level is to be 2.5m above the highest ground elevation in undercroft area
Creek/waterway (Flood planning area 1, 2 or 3 sub-categories)	Lowest floor level is to be 2.5m above the highest ground elevation in undercroft area
Creek/waterway (Flood planning area 4 sub-category)	Lowest floor level is to be 1.5m above the highest ground elevation in undercroft area

To achieve an acceptable outcome for the undercroft requirements in the Flood Overlay Code, the lowest floor level of the suspended portion of the development would be required to be 2.5m above the highest ground elevation in the undercroft area.

6.3. Vehicle Parking

In accordance with the BCC's Flood PSP, uncovered short-term vehicle parking immunity standards can be relaxed where there is compliance with the following:

- The maximum flood depth is 300mm in a 1% AEP flood;
- Flooding no more frequent than a 10% AEP flood;
- DV product is acceptable in accordance with QUDM;
- Driveway and roads providing egress from the parking area achieve acceptable flood immunity;
- There is minimal chance of vehicles being washed away and blocking stormwater drains, channels and culverts in severe storms greater than the defined flood event. Alternatively, mitigation is provided such as the use of bollards between parking areas and an overland flow path or creek/waterways.

6.4. Recommended Design Levels

The 1% AEP flood level across the subject site varies between 6.5m AHD in the existing car park to 6.04m AHD at the eastern property boundary in the waterway.

The building floor level is proposed to be at 7.0m AHD, which will satisfy the minimum flood immunity requirements for essential electrical services and building floors for a Class 5 building.

A performance solution is sought for a relaxation on the building undercroft requirements. There are earthworks proposed to be undertaken within the undercroft area to both increase the clearance in the building undercroft and to allow for additional capacity in the waterway overbank area. While the 2.5m undercroft clearance cannot be achieved for the entire suspended slab, the clearances underneath the building (minimum 1.9m) do ensure that there is sufficient height for maintenance after a major flood event and that the area remains free draining back to the existing channel with a minimum grade of 1%. The finished floor level of the building already achieves a 950mm freeboard above the 1% AEP flood level in the waterway (550mm clearance to the underside of the suspended slab) and the AR&R assessment of blockage factors determined that the potential for debris in this portion of the catchment is limited.

The new short-term car parks are proposed to be limited to 300mm maximum flooding depth and a safe DV product under developed conditions. The egress from the site is flood free and can be used to evacuate from the drive-through or the carpark.

To help minimise the risk to vehicles parked in the existing carparks, it is recommended that bollards are installed on the northern edge of the carpark adjacent to the waterway to ensure that cars cannot be swept into the waterway. It is also recommended that the signage is installed in the existing carpark that informs customers that the carpark is subject to flooding during periods of intense rainfall.

As a suspended slab structure is proposed to be built over the flood plain and excavation is proposed to be undertaken in the waterway, a flood impact assessment has been undertaken to determine the impact on the conveyance of flood waters, increase flood levels or concentrate flows towards upstream, downstream or neighbouring properties.

Refer to Appendix C for the proposed earthworks to be undertaken in the open channel area including the realignment of a retaining wall.

7 Flood Impact Assessment

The proposed development consists of removing the existing building on site to construct a fast food restaurant and drive through. The drive through and the restaurant will be suspended over the existing waterway on a suspended slab.

It is proposed to undertake some additional cutting in the waterway overbank area to increase to undercroft clearances underneath the suspended slab. While the 2.5m undercroft clearance cannot be achieved for the entire suspended slab, the clearances underneath the building (minimum 1.9m) do ensure that there is sufficient height for maintenance after a major flood event and that the area remains free draining back to the existing channel with a minimum grade of 1%.

To assess the impact the proposed development will have on surrounding properties, the XPSWMM model has been run for both the existing and developed scenarios with 50 inspection points located at critical locations within the surrounding area to assess the impacts on the flooding characteristics.

Please refer to Appendix G for the location of the reference points and Appendix H for the tabulation of results and plots of the impacts to water elevation and hydraulic hazard.

7.1. Hydraulic Model Configuration

Under developed conditions, the following adjustments were made to the hydraulic model:

Suspended Slab and Building

Preliminary structural advice was sought to determine the thickness of the suspended slab and the number of piers required to support the structure. The preliminary design consists of rows of five 450mm dia. piers facing the direction of the waterway (no skew) and a 400mm thick slab.

The suspended slab and building were represented in the hydraulic model as two 2D flow constrictions:

- A 2D flow constriction polygon (yellow outline) was used to model the proposed suspended slab and columns for the drive through ramp and new carparks. The 2D flow constriction was split into two layers:
    - The piers – 10% cell blockage with a Form Loss Coefficient (FLC) of 0.007. The layer is from the existing waterway levels to the underside of the slab.
    - The suspended slab – 100% cell blockage with a FLC of 0.08. The slab ramps from existing carpark levels at 6.2m AHD and ramps up to 7.0m AHD and is 400mm thick.
- A 2D flow constriction polygon (green outline) was used to model the proposed suspended slab and columns of the building and drive through at 7.0m AHD. The 2D flow constriction was split into two layers:
    - The columns – 10% cell blockage with a FLC of 0.006. The layer is from the existing waterway levels to the underside of the slab at 6.6m AHD.

- The suspended slab – 100% cell blockage with a FLC of 0.07. The slab begins at 6.6m AHD and is 400mm thick.

Figure 7-1 – 2D Flow Constrictions

Earthworks & Block Wall

The proposed amendments to the waterway overbank surface and amendments to retaining walls were represented using elevation shapes and polylines in the hydraulic model. The earthworks and new walls proposed to be undertaken are shown in the earthworks plans in Appendix C.

The landuses were also amended in the hydraulic model to reflect developed conditions.

As it is proposed to discharge runoff unmitigated to the waterway under proposed conditions, the increase in impervious area was represented within the XPRAFTS model with the new inflows being included in the developed scenario.

7.2. Results and Design Recommendations

The results show that under developed conditions the changes to the maximum water elevations are contained within the existing carpark and the waterway. The maximum increase in the waterway underneath the building is 95mm due to the changes in flow area from the proposed piers. The proposed changes to the maximum water elevation are due to the reduction in area for floodwaters to weir back into the waterway from the carpark under developed conditions. This causes some additional ponding depths in the existing vehicle manoeuvring area, albeit with very low velocities (0.1-0.2m/s).

There are some changes to the maximum hydraulic hazard in the waterway under developed conditions, which is caused by the earthworks proposed and the addition of the piers for the suspended slab. The changes are primarily kept within the waterway within the site area, however there is an increase of approximately 0.1m^2/s (from 0.5m^2/s under existing conditions to 0.6m^2/s) in the waterway overbank area in the adjacent property. As there is a future development proposed to be wholly suspended over this area, there are no adverse impacts that would arise from such a change in the hydraulic hazard. Should the development not proceed, the area would still be considered to be a high flood hazard area, with flooding depths in excess of 1m deep. Therefore, the adjustments to the hydraulic hazard in that area would not change the usability nor the accessibility of that portion of land.

Car Parking & Vehicle Manoeuvring Areas

Under existing conditions, the maximum flooding depth through the carparks and vehicle manoeuvring area is approximately 430mm deep, with a maximum depth velocity product of 0.55m^2/s. There are seven existing carparks that are either prone to flooding depths that exceed 300mm deep or a DV product exceeding 0.3m^2/s. These seven carparks are located within the Council easement where the existing 2/3300x1500 RCBCs run underneath the carpark, shown in Figure 7-3 below in red.

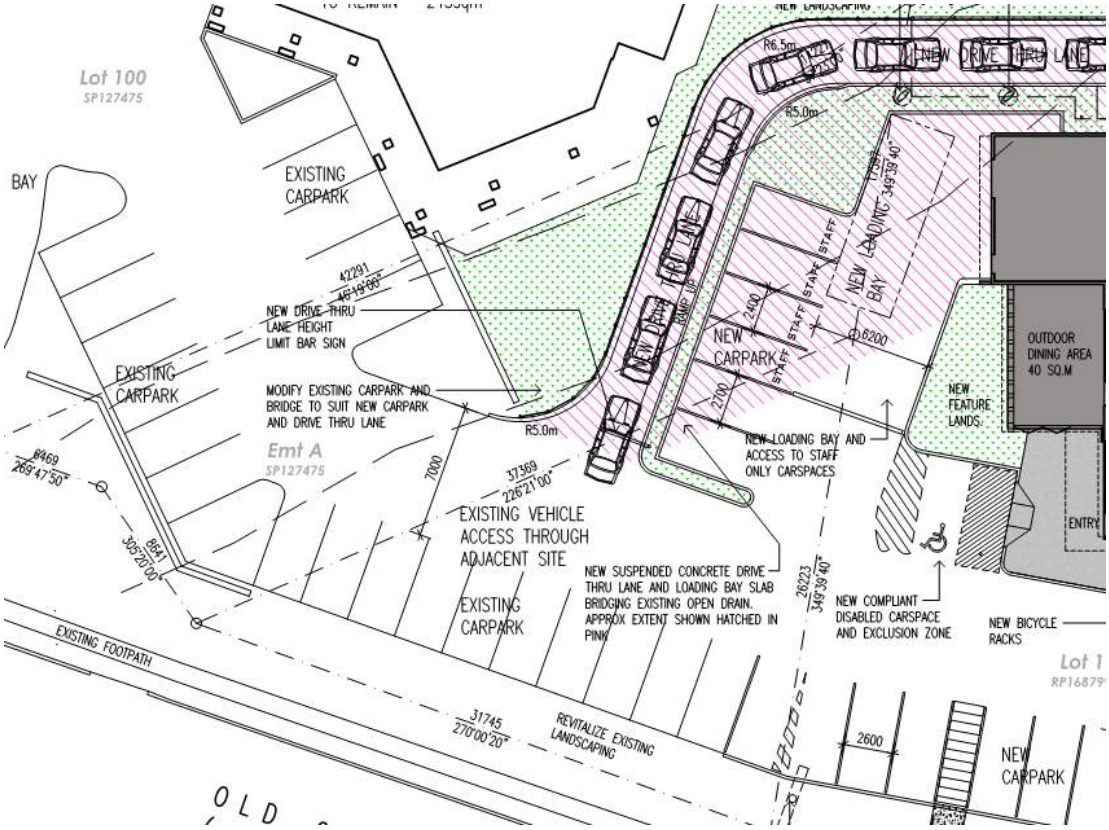


Figure 7-2 – Carparks prone to non-trafficable flooding conditions during 1% AEP flood event

Under proposed conditions, the maximum flooding depth through the carparks and vehicle manoeuvring area is approximately 440mm deep, with a maximum depth velocity product of 0.58m^2/s. There is an increase in flooding depths in the vehicle manoeuvring area to the east of the waterway crossing to 320mm deep which is due to the reduction in area for water to weir back into the waterway from the car park. However, the vehicle manoeuvring area will already be cut off by the flooding conditions at the waterway crossing, so no vehicles could drive through that area. The remaining carparks to the east of the waterway and the new carparks all remain with flooding depths and hazards that are considered trafficable during the 1% AEP.

Based on the stability criteria of vehicles outlined in AR&R (shown below in Table 7-1), small and large passenger vehicles parked in the seven existing carparks highlighted in Figure 7-3 would be at risk of floating or sliding during the peak of the 1% AEP flood event under both existing and developed conditions.

Table 7-1 – AR&R 2016 Stability Criteria for Vehicles

Class of Vehicle	Kerb Weight (kg)	Ground Clearance (m)	Limiting Still Water Depth (m)	Limiting velocity (m/s)	Equation of Stability
Small Passenger	<1250	<0.12	0.3	3.0	DV ≤ 0.3
Large Passenger	>1250	>0.12	0.4	3.0	DV ≤ 0.45
Large 4WD	>2000	>0.22	0.5	3.0	DV ≤ 0.6

To help minimise the risk to vehicles parked in these existing carparks, it is recommended that bollards are installed on the northern edge of the carpark adjacent to the waterway to ensure that cars cannot be swept into the waterway. It is also recommended that the signage is installed in the existing carpark that informs customers that the carpark is subject to flooding during periods of intense rainfall.

Vehicle Access & Egress

Vehicles accessing the existing shops on the subject site are required to enter from Scrub Road and drive over the waterway to the existing carpark. Under existing conditions, the flooding characteristics through the carpark are non-trafficable for a period of 17 minutes during the 1% AEP flood event.

There is no change to the time of closure under proposed conditions with the carpark remaining non-trafficable for a period of 17 minutes. Any vehicles already located on the proposed drive-through at the peak of the flood event can safely evacuate the drive-through and the site by continuing out of the drive-through and out to Old Cleveland Road without needing to drive through any flood waters.

Flood Immunity Levels

The 1% AEP flood level in the existing car park is 6.58m AHD under developed conditions. Therefore, to satisfy the minimum flood immunity requirements for essential electrical services, it is recommended that they are located above 7.08m AHD.

8 Conclusions

Inertia Engineering was commissioned by Hamell (QLD) Pty Ltd to prepare a Minor Hydraulic Flood Report for the proposed development at 1304 Old Cleveland Road, Carindale to support the development application.

Brisbane City Council's Floodwise Property report flagged the site to be susceptible to creek/waterway and overland flow flooding, so the proposed development is to be measured against the 1% AEP storm event. 2D flood modelling has estimated the 1% AEP flood level across the subject site under developed conditions to vary from 6.58m AHD in the existing car park to 6.04m AHD at the eastern property boundary in the waterway.

The new building floor level is proposed to be at 7.0m AHD, which will satisfy the minimum flood immunity requirements for Class 5 building floors and all essential electrical services must sit above 7.08m AHD.

A performance solution is sought for a relaxation on the building undercroft requirements. Earthworks are proposed to be undertaken within the undercroft area to both increase the clearance of the building undercroft and to allow for additional capacity in the waterway overbank area. This creates an undercroft clearance of 1.9m. This is considered a sufficient height for maintenance after a major flood event given the undercroft area drains freely (at a 1% grade) down to the existing channel, there is a 550mm clearance from the 1% AEP food level to the underside of the suspended slab and the debris loading will be minimal given the site flow enter the undercroft area via culverts and over Old Cleveland Road.

The new short-term car parks are proposed to be limited to 300mm maximum flooding depth and a safe DV product under developed conditions. The egress from the site is flood free and can be used to evacuate from the drive-through or the carpark.

To help minimise the risk to vehicles parked in the existing carparks, it is recommended that bollards are installed on the northern edge of the carpark adjacent to the waterway to ensure that cars cannot be swept into the waterway. It is also recommended that the signage is installed in the existing carpark that informs customers that the carpark is subject to flooding during periods of intense rainfall.

A flood impact assessment was undertaken and determined that the proposed development does not materially worsen the flooding characteristics to any properties located upstream, downstream or adjacent to the subject site during the defined flood event.

The maximum velocities of flood waters within the waterway are estimated to be up to 2.8m/s, with flooding depths up to 2.6m deep. It is recommended that the appropriate professionals are engaged to ensure that the design of the structural elements for the proposed development take into consideration the characteristics of the flood waters.

Provided that the minimum design levels and earthworks are met, the proposed development can comply with BCC's City Plan 2014 (BCC, 2014) with regards to flooding.

9 References

BCC (2014) – Brisbane City Plan 2014 – Schedule 6.11 Flood Planning Scheme Policy and Part 8.2.11 Flood Overlay Code

BCC (2017a) – Brisbane City Council Flood Wise Property Report

BCC (2017b) – Brisbane City Council Flood Awareness Map

BCC (2017c) – Brisbane City Council eBimaps

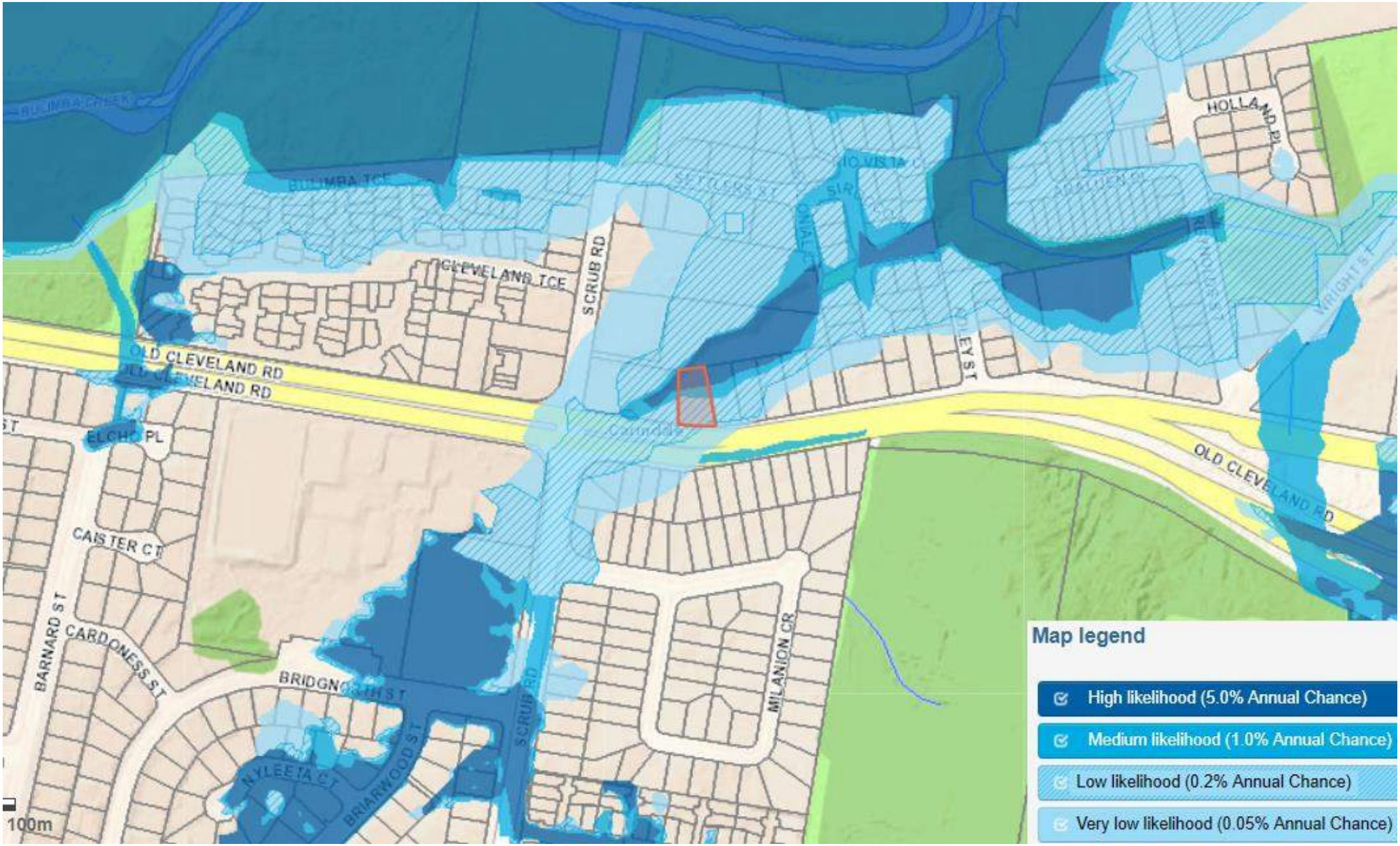
DNRM (2017) – Department of Natural Resources and Mines LIDAR Data

QUDM (2013) – Queensland Urban Drainage Manual Third Edition, 2013

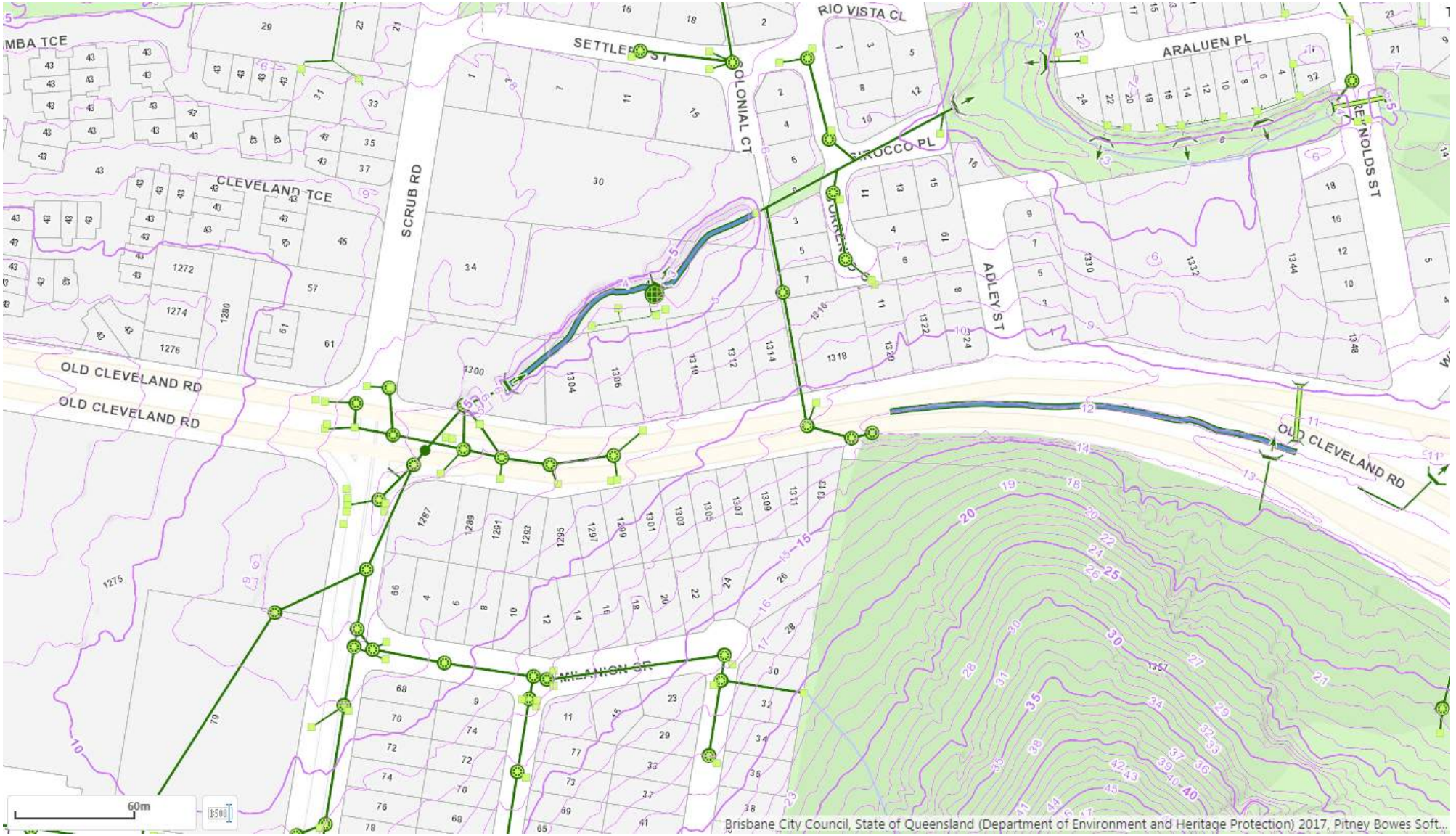
XPRAFTS (2016) – XP Solutions, V2016

XPSWMM (2017) – XP Solutions, V2017.2

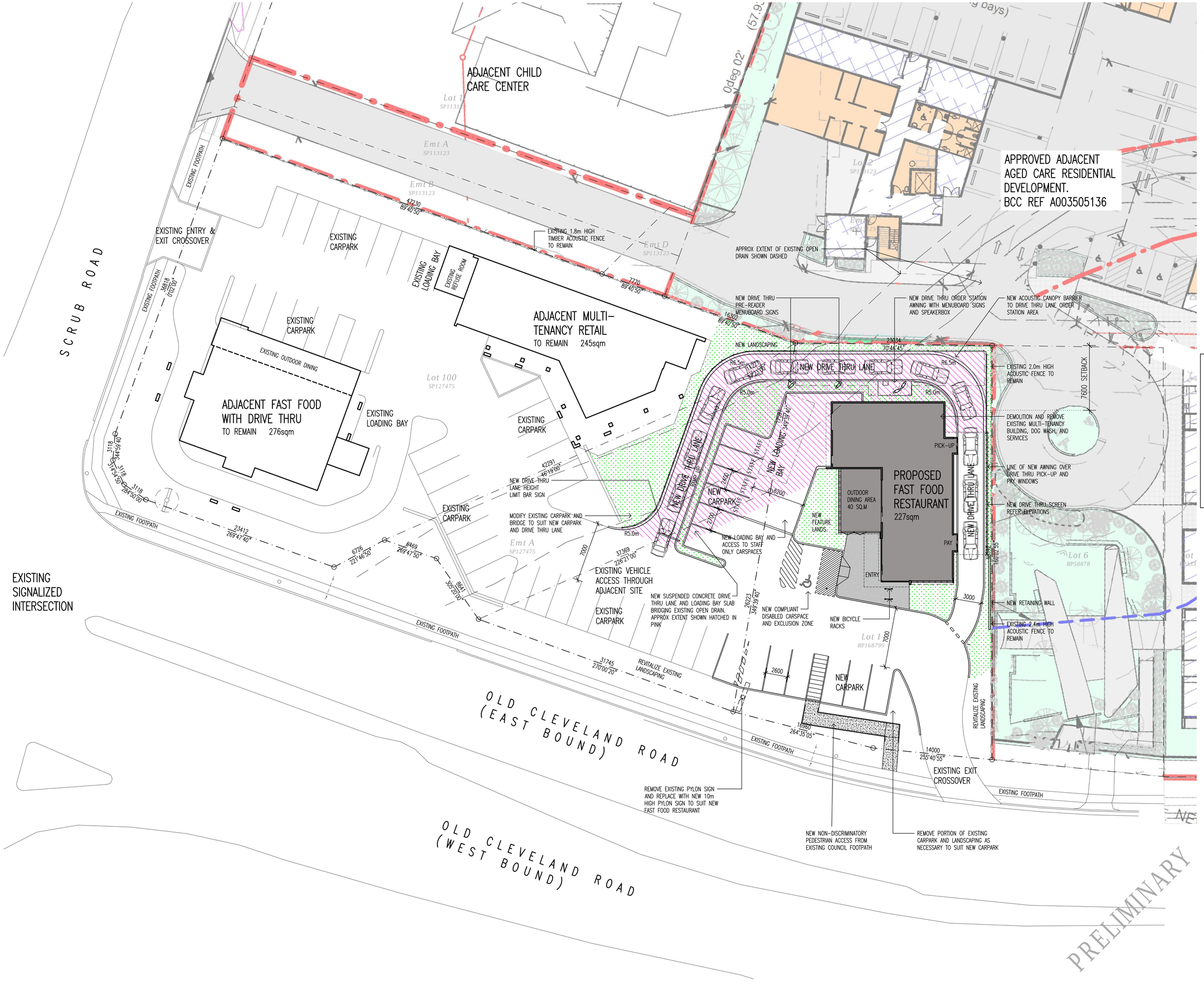
Appendix A – Flood Awareness Mapping


CLEVELAND TCE
SCRUB RD
OLD CLEVELAND RD
OLD CLEVELAND RD
CAISTER CT
BARNARD ST
CARDONESS ST
BRIDGNORTH ST
NYLEETA CT
BRIARWOOD ST
SCRUB RD
MILANION CR
EY ST
OLD CLEVELAND RD
HOLLAND PL
WRIGHT ST
100m
Map legend
High likelihood (5.0% Annual Chance)
Medium likelihood (1.0% Annual Chance)
Low likelihood (0.2% Annual Chance)
Very low likelihood (0.05% Annual Chance)

Appendix B – Stormwater Network


RIO VISTA CL
SETTLER ST
COLONIAL CT
ARALUEN PL
REYNOLDS ST
CLEVELAND TCE
SCRUB RD
TURRELLO CL
BIRUCCO PL
ADLEY ST
OLD CLEVELAND RD
OLD CLEVELAND RD
OLD CLEVELAND RD
MILANION CR
60m
1:500
Brisbane City Council, State of Queensland (Department of Environment and Heritage Protection) 2017, Pitney Bowes Soft...

Appendix C – Proposed Development Plans



amendments

issue	details	date	initial
1	INITIAL PRELIMINARY ISSUE	11/08/17	PL
2	ENTRY CROSSOVER REMOVED, ADJACENT DEVELOPMENT ADDED	15/08/17	PL
3	DEVELOPMENT SUMMARY TABLE ADDED	17/08/17	PL
4	UPDATED DRIVE THRU LANE, PEDESTRIAN RAMP ADDED, DISABLED CARPARK REVISED, NOTES UPDATED	24/08/17	PL
5	UPDATED DRIVE THRU LANE, ACOUSTIC CANOPY ADDED, CARPARK REVISED, NOTES UPDATED	14/11/17	PL
6	REVISED DESIGN	08/12/17	IM

RPD

LOT 1 ON RP168799
PARISH OF TINGALPA
COUNTY OF STANLEY

DEVELOPMENT SUMMARY
(All figures are approximate based on original design drawings)

EXISTING TOTAL GFA:	788sqm
EXISTING GFA OF REMOVED BUILDING:	267sqm
PROPOSED TOTAL GFA:	748sqm
PROPOSED GFA OF NEW BUILDING:	227sqm
EXISTING CARPARK SPACES:	53 spaces
PROPOSED CARPARK SPACES:	49 spaces
EXISTING SITE COVER:	17.9%
PROPOSED SITE COVER:	17.0%
EXISTING SITE AREA:	4410sqm

wbp architects
architecture & interior design

A.B.N. 29 700 673 003

P 07 3832 4433 F 07 3832 4848
E mail@wbparchitects.com.au

Suite 4 Portman Place, 220 Boundary Street,
SPRING HILL, QLD 4000

PROPOSED EXTENSIONS TO EXISTING SHOPPING CENTRE

for RIVOLI INVESTMENTS

1304 OLD CLEVELAND ROAD, CARINDALE, QLD

date	SEPTEMBER 2016
drawn	PL
designed by	JV
scale	1:200 AT A1 SIZE

Figured dimensions to be taken in preference to scaled readings. Confirm all dimensions on site

drawing tittle

PROPOSED SITE PLAN

file	project	drawing no	amdt
2388-001	SK2	6	

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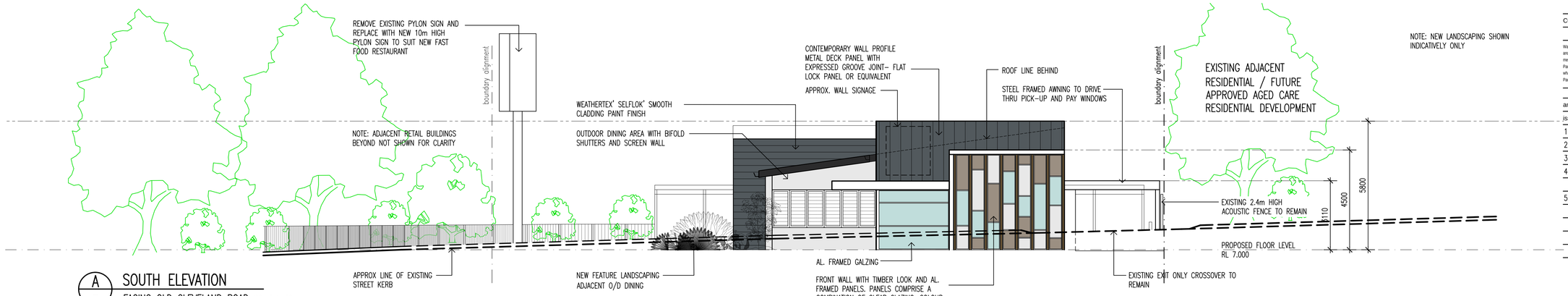

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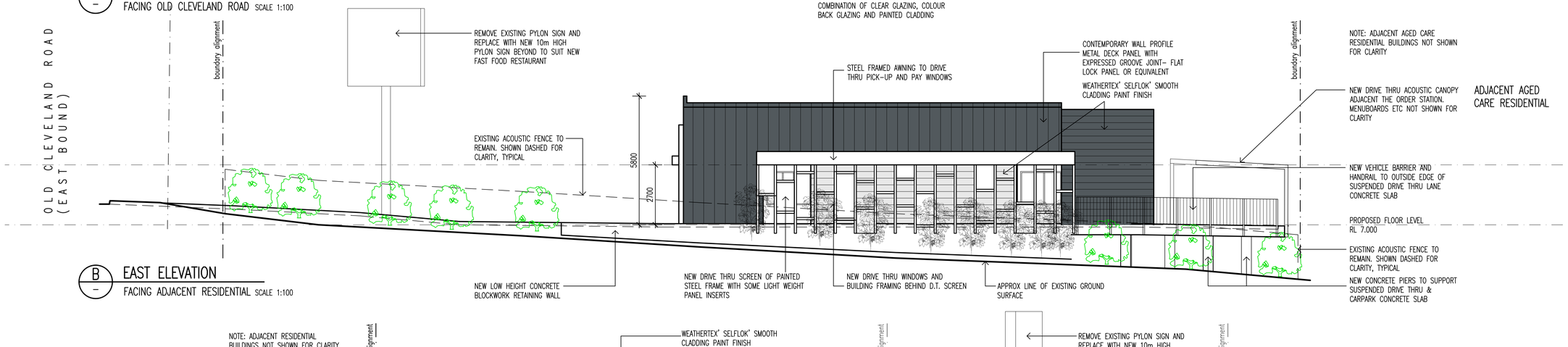
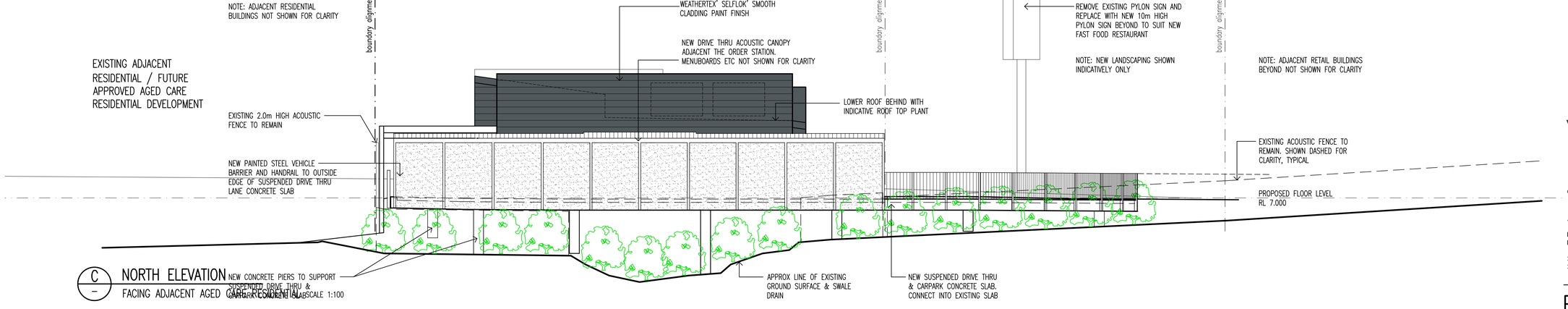
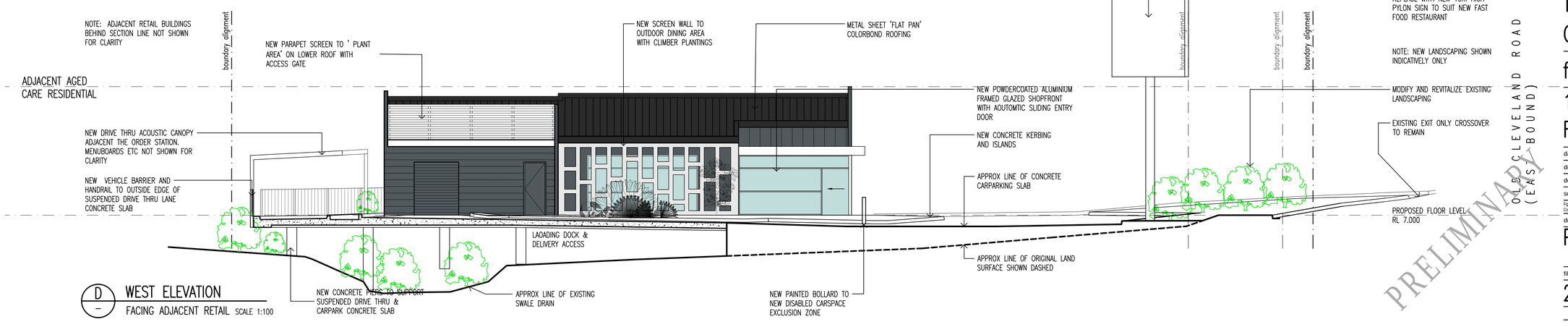


B – EAST ELEVATION
FACING ADJACENT RESIDENTIAL SCALE 1:100



C – NORTH ELEVATION
FACING ADJACENT AGED CARE RESIDENTIAL SCALE 1:100



D – WEST ELEVATION
FACING ADJACENT RETAIL SCALE 1:100

amendments

issue	details	date	initial
1	INITIAL PRELIMINARY ISSUE	11/08/17	PL
2	ENTRY CROSSOVER REMOVED	15/08/17	PL
3	UPDATED DRIVE THRU BARRIERS	24/08/17	PL
4	DRIVE THRU ACOUSTIC CANOPY ADDED, BARRIER & NOTES UPDATED	14/11/17	PL
5	REVISED DESIGN	08/12/17	IM

RPD

LOT 1 ON RP168799
LOT 100 SP127475
PARISH OF TINGALPA
COUNTY OF STANLEY

wbp architects
architecture & interior design
A.B.N. 29 700 673 003
P 07 3832 4433 F 07 3832 4848
E mail@wbparchitects.com.au
Suite 4 Portman Place, 220 Boundary Street, SPRING HILL, QLD 4000

PROPOSED EXTENSIONS TO EXISTING SHOPPING CENTRE

for RIVOLI INVESTMENTS

1304 OLD CLEVELAND ROAD, CARINDALE, QLD

date	SEPTEMBER 2016
drawn	PL
designed by	JV
scale	1:100 AT A1 SIZE

Figured dimensions to be taken in preference to scaled readings. Confirm all dimensions on site

drawing tittle

PROPOSED ELEVATIONS

file	project	drawing no	amdt
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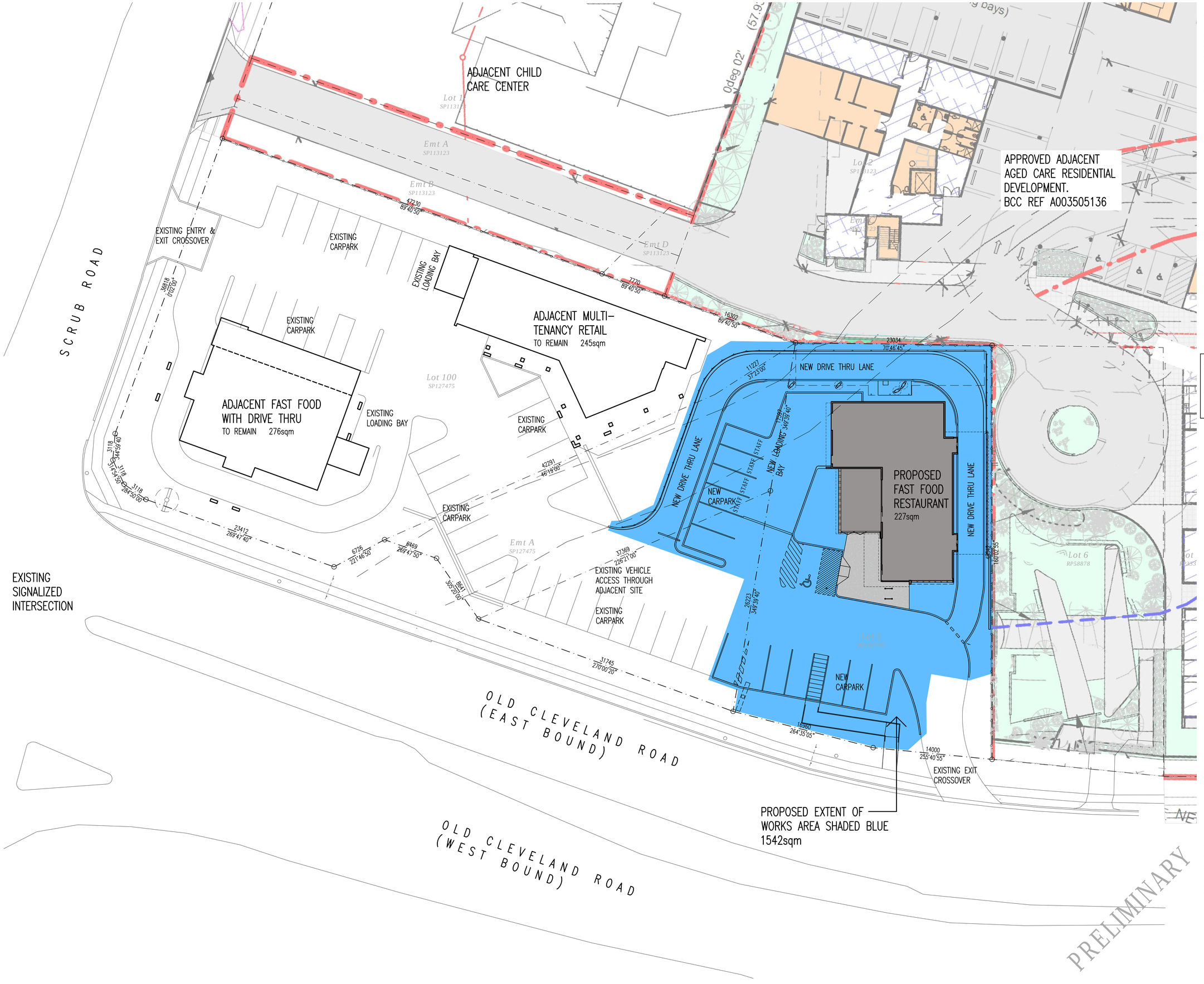

amendments

issue	details	date	initial
1	INITIAL PRELIMINARY ISSUE	14/11/17	PL
2	UPDATED	08/12/17	IM

N

RPD

LOT 1 ON RP168799
PARISH OF TINGALPA
COUNTY OF STANLEY

DEVELOPMENT SUMMARY
(All figures are approximate based on original design drawings)

EXTENT OF WORKS AREA:	1542sqm
EXISTING SITE AREA:	4410sqm

wbp architects
architecture & interior design

A.B.N. 29 700 673 003

P 07 3832 4433 F 07 3832 4848
E mail@wbparchitects.com.au

Suite 4 Portman Place, 220 Boundary Street,
SPRING HILL, QLD 4000

PROPOSED EXTENSIONS TO EXISTING SHOPPING CENTRE

for RIVOLI INVESTMENTS

1304 OLD CLEVELAND ROAD, CARINDALE, QLD

date	SEPTEMBER 2016
drawn	PL
designed by	JV
scale	1:200 AT A1 SIZE

Figured dimensions to be taken in preference to scaled readings.
Confirm all dimensions on site

drawing title

EXTENT OF WORKS PLAN

file	project	drawing no	amdt
2388-001		SK2.2	2

DRAWN SCALE
100mm
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LEGEND

- SITE BOUNDARY
- xx.xx — EXISTING CONTOURS (AT 0.25m INTERVALS)
- ExS — EXISTING SEWERAGE
- ExW — EXISTING WATER
- ExT — EXISTING TELSTRA
- ExSW — EXISTING STORMWATER
- ExG — EXISTING GAS
- EXISTING PROPERTY BOUNDARY
- 4.10 — PROPOSED CONTOURS (AT 0.10m INTERVALS)
- EXTENT OF CUT EXCAVATION

EXISTING SERVICES NOTE

EXISTING SERVICES MAY BE PLOTTED FROM BCC RECORDS AND 'D.B.Y.D'. LOCATION OF ALL EXISTING SERVICES ARE TO BE CONFIRMED ON SITE PRIOR TO CONSTRUCTION. CONTRACTOR TO CONTACT 'DIAL BEFORE YOU DIG' FOR THE LOCATION OF EXISTING PUBLIC UTILITIES PRIOR TO EXCAVATION. ANY DAMAGE TO EXISTING SERVICES WILL BE REPAIRED BY AUTHORITIES AT THE CONTRACTORS EXPENSE.

NOTE:

THE ORIGINAL OF THIS DRAWING WAS PRODUCED USING COLOUR SEPARATION FOR GREATER CLARITY. WORKING WITH A BLACK AND WHITE COPY MAY CAUSE ERRORS. IF THIS DRAWING IS NOT IN COLOUR THEN YOU DO NOT HAVE THE CORRECT PRESENTATION AND SHOULD CONTACT INERTIA ENGINEERING ON (07) 3857 7868.

LOT 2
SP113123

LOT 6
RP58878

LOT 1
RP168799

LOT 100
SP127475

LOT 100
SP127475

LOT 562
SL9180

PROPOSED DRIVE THRU

PROPOSED BUILDING

PROPOSED DRIVE THRU

PROPOSED CARPARK

STAFF

STAFF

STAFF

PROPOSED CARPARK

A SK007

B SK007

C SK007

D SK007

FOR APPROVAL

REV	DESCRIPTION	DATE	DRAWN	APPROVED
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1	PRELIMINARY ISSUE	12/12/17	R.H	E.C

NORTH POINT:

ARCHITECT: WPB ARCHITECTS

CLIENT: HAMELL PTY LTD

Inertia
Unit 5B/85 Hudson Road
Albion, QLD 4010
ABN 82 115 498 023
E-mail: info@inertiaeng.com.au
Phone: 3857 7868
Fax: 3262 7359

SCALE BARS: 0 1 2 3 4 5 6m
SCALE 1:125 @ A1

PROJECT: PROPOSED DEVELOPMENT
1304 OLD CLEVELAND ROAD
CARINDALE, QLD, 4152

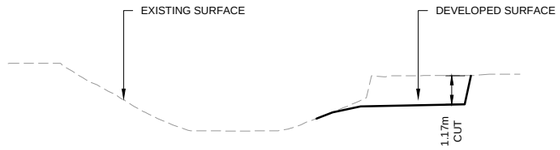
DRAWING TITLE: EARTHWORKS LAYOUT

DESIGNED: B. GOETTLER
APPROVED: E.CLEMENTS
RPEQ No. 8614

7707 JOB No.
SK006 DWG. No.
03 REVISION

Dec 13, 2017 - 4:05pm V:\7000 - 8000\7701 - 7800\7707 - 1304 Old Cleveland Road\5. Civil\3. CAD\3. Production Drawings\Q0706_Earths Layout.dwg

NOTE:
THE ORIGINAL OF THIS DRAWING WAS PRODUCED USING COLOUR SEPARATION FOR GREATER CLARITY. WORKING WITH A BLACK AND WHITE COPY MAY CAUSE ERRORS. IF THIS DRAWING IS NOT IN COLOUR THEN YOU DO NOT HAVE THE CORRECT PRESENTATION AND SHOULD CONTACT INERTIA ENGINEERING ON (07) 3857 7868.



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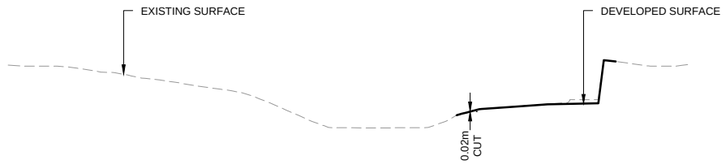
SK006



DATUM 0.000

SECTION B
SCALE 1:125
SK006

DATUM 0.000

SECTION C
SCALE 1:125
SK006

DATUM 0.000

SECTION D
SCALE 1:125
SK006

FOR APPROVAL

REV	DESCRIPTION	DATE	DRAWN	APPROVED
3	FOR APPROVAL	13/12/17	B.G	E.C
1	PRELIMINARY ISSUE	12/12/17	R.H	E.C

NORTH POINT:

ARCHITECT:
WPB ARCHITECTS

CLIENT:
HAMELL PTY LTD

Inertia
ABN 82 115 498 023
E-mail: info@inertiaeng.com.au
Unit 5B/85 Hudson Road
Albion, QLD 4010
Phone: 3857 7868
Fax: 3262 7359

SCALE BARS:
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SCALE 1:125 @ A1

PROJECT:
PROPOSED DEVELOPMENT
1304 OLD CLEVELAND ROAD
CARINDALE, QLD, 4152

DRAWING TITLE:
EARTHWORKS
SECTIONS

DESIGNED: B. GOETTLER
APPROVED: E.CLEMENTS
RPEQ No. 8614

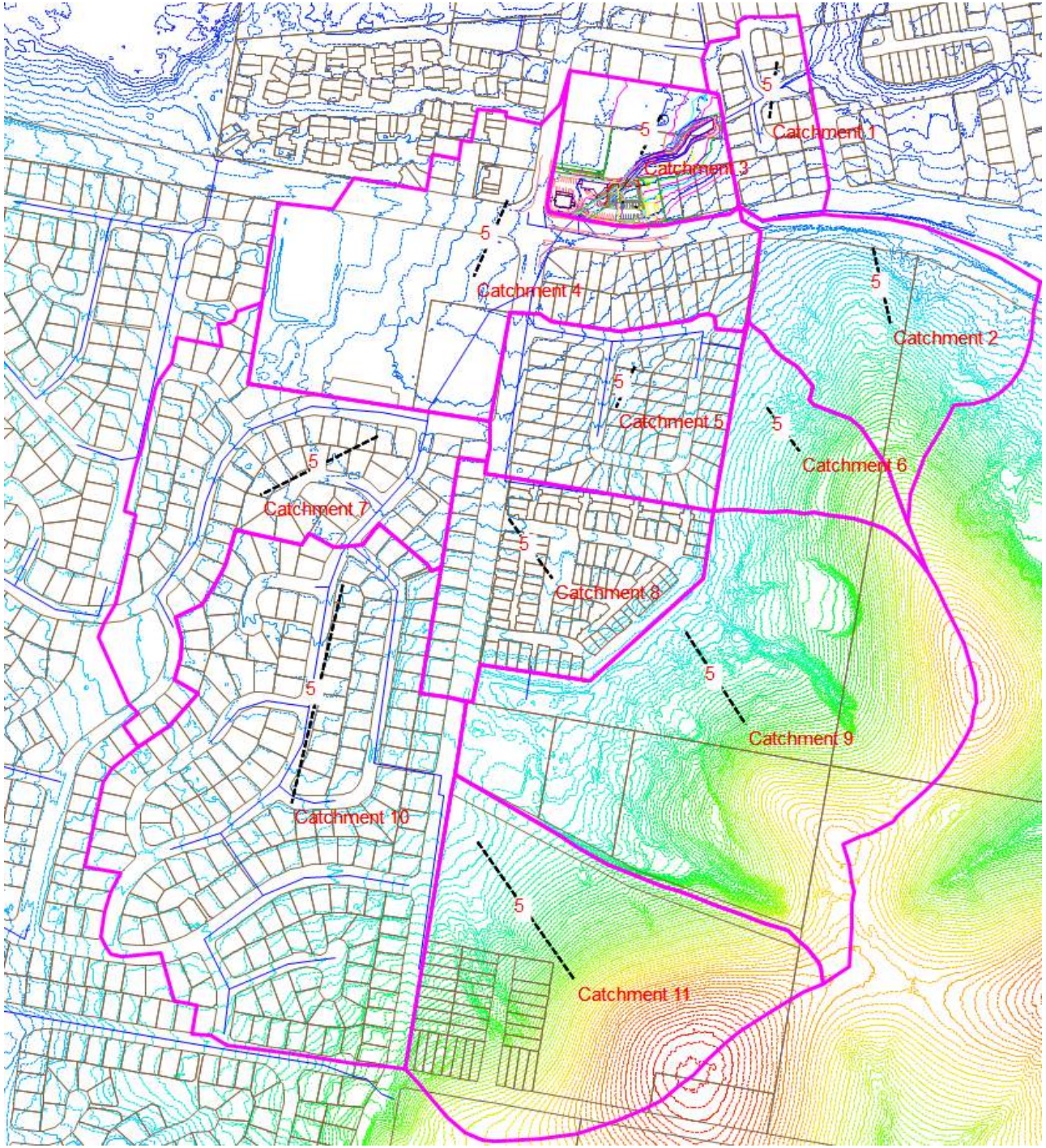
7707
JOB No.

SK007
DWG. No.

03
REVISION

Date: 13/12/2017 - 4:08pm V:\7001 - 8000\7701 - 7800\7707 - 1304 Old Cleveland Road\5. Civil\3. CAD\3. Production Drawings\3D007_Earths Sections.dwg

Appendix D – Catchment Plan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Catchment 1
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Catchment 8
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Catchment 9
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Catchment 10
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Catchment 11

Appendix E – XPSWMM Modelling Extent

Figure E.1 – Hydraulic Model Configuration

Figure E.2 – Landuses

Appendix F – XPSWMM Results (Existing Scenario)

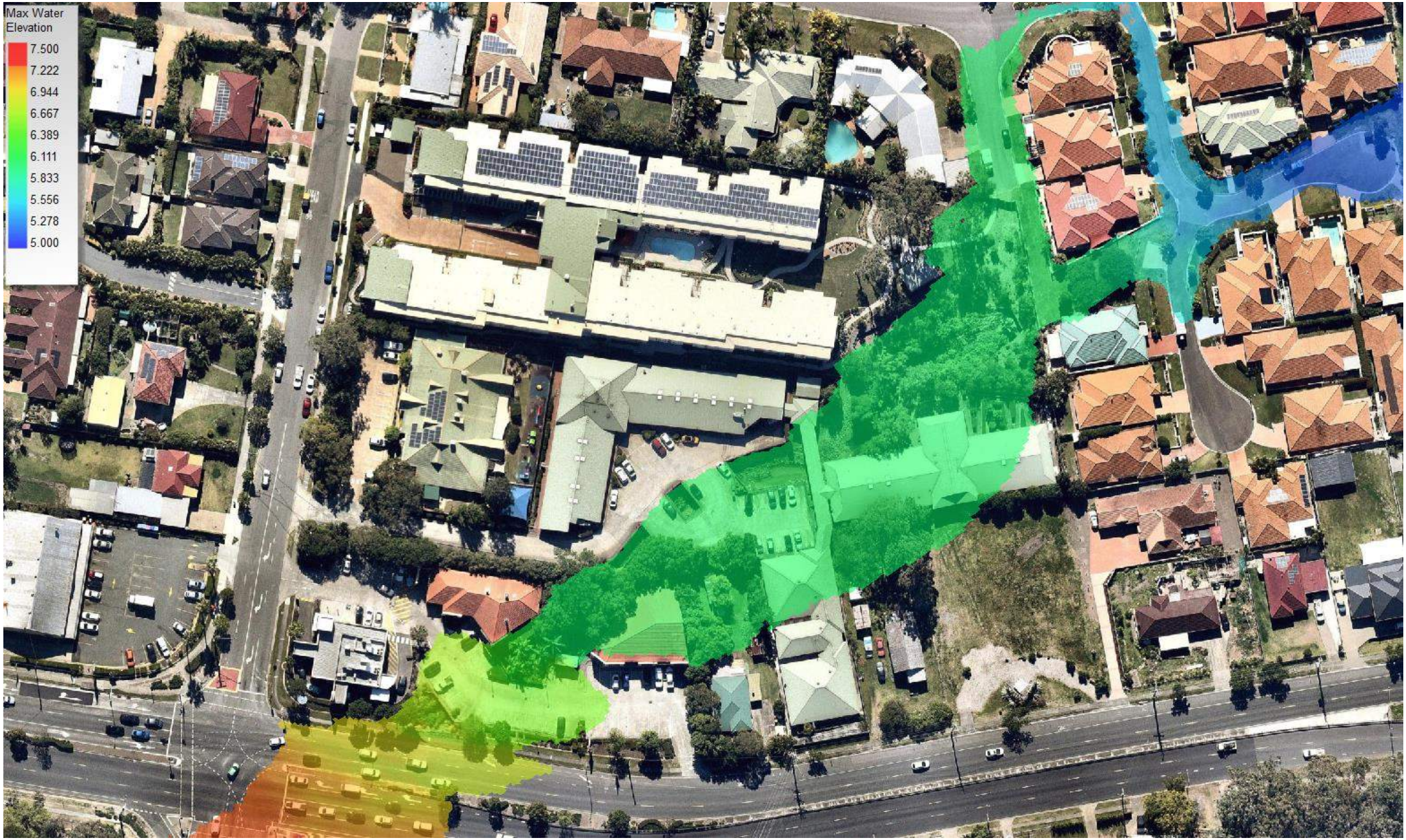

Figure F.1 – Scenario 1 – 1% AEP – Maximum Water Elevation (Model Overview)

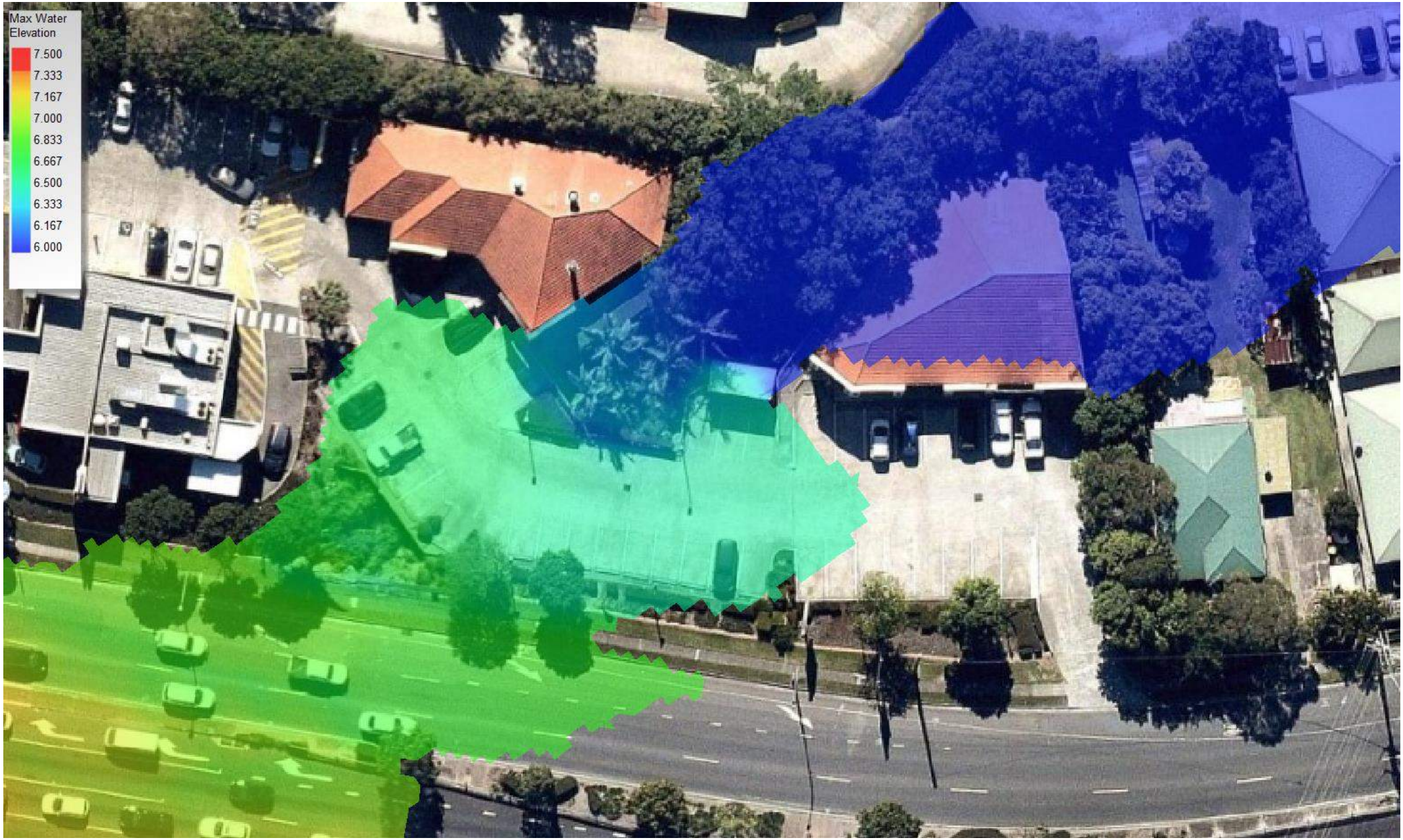

Figure F.2 – Scenario 1 – 1% AEP – Maximum Water Elevation (Subject Site)

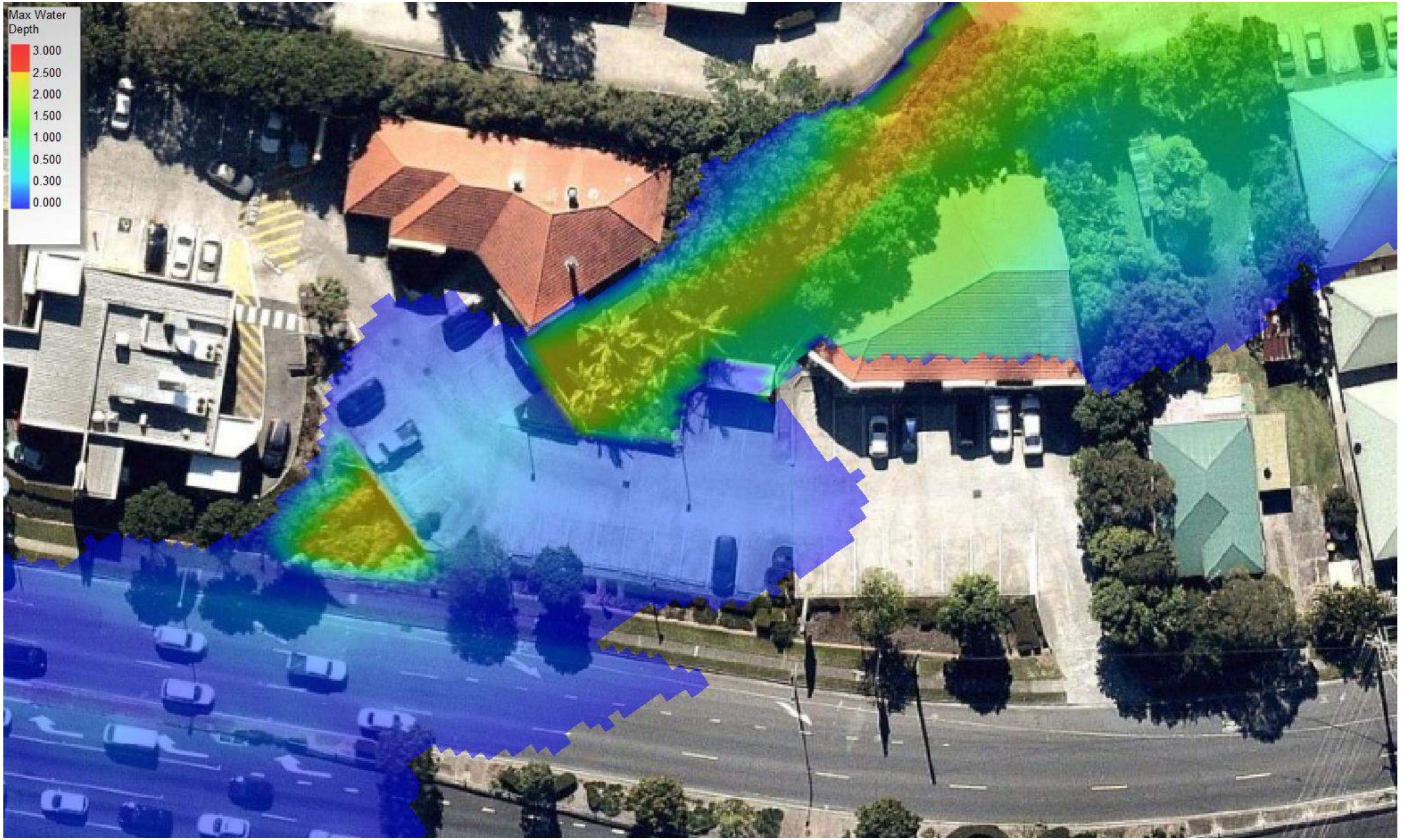

Figure F.3 – Scenario 1 – 1% AEP – Maximum Water Depth (Subject Site)

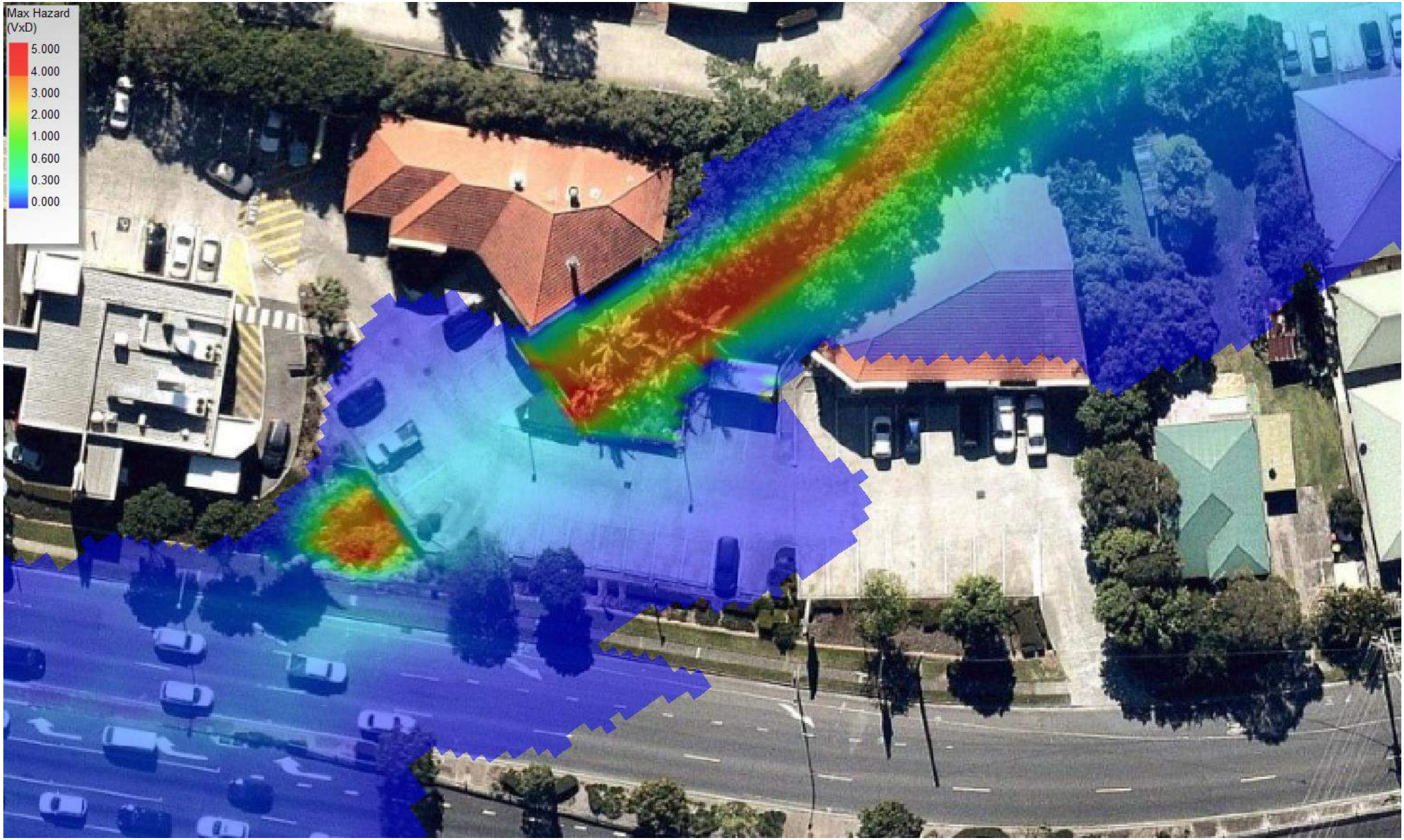

Figure F.4 – Scenario 1 – 1% AEP – Maximum Hydraulic Hazard (Subject Site)

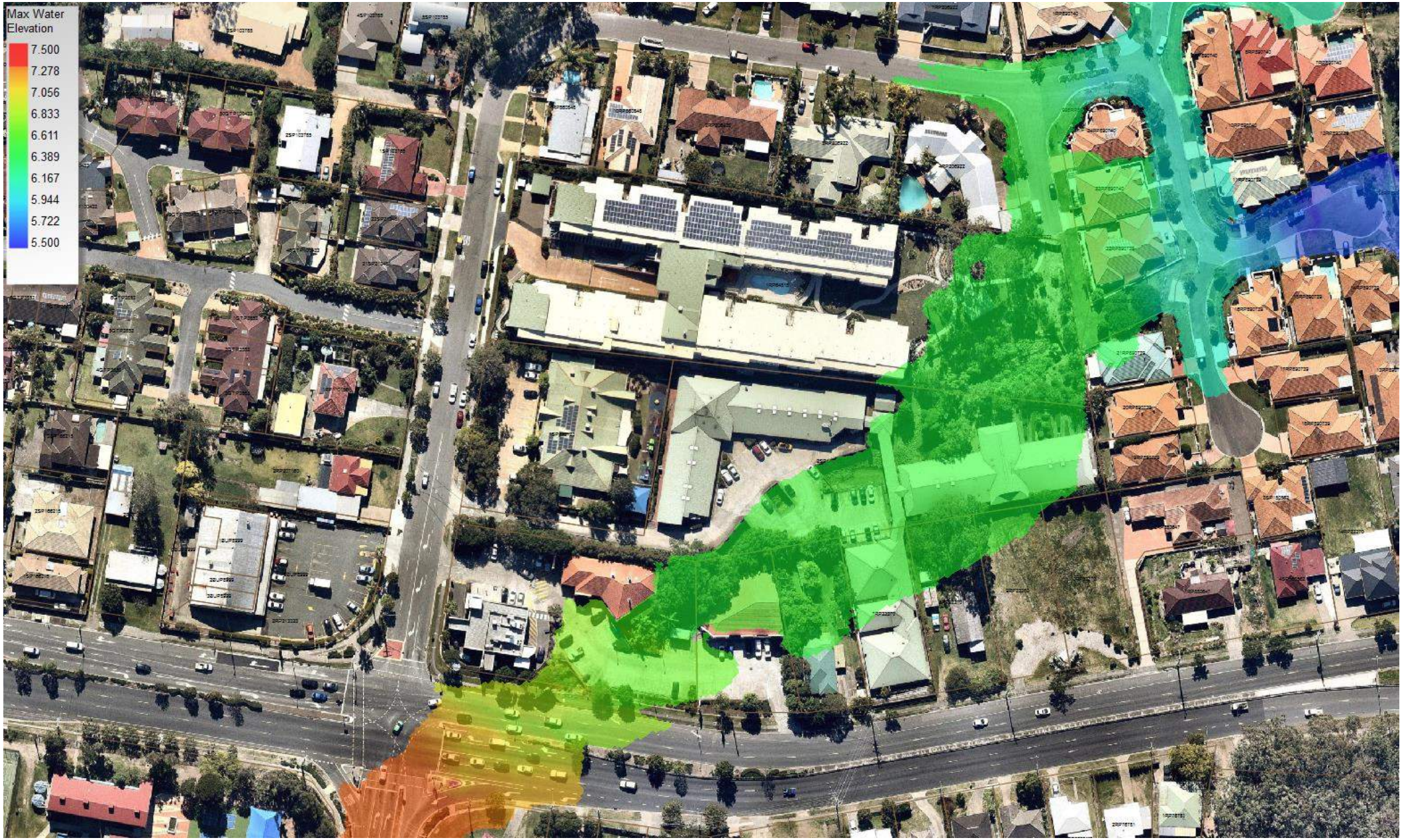

Figure F.5 – Scenario 2 – 1% AEP – Maximum Water Elevation (Model Overview)

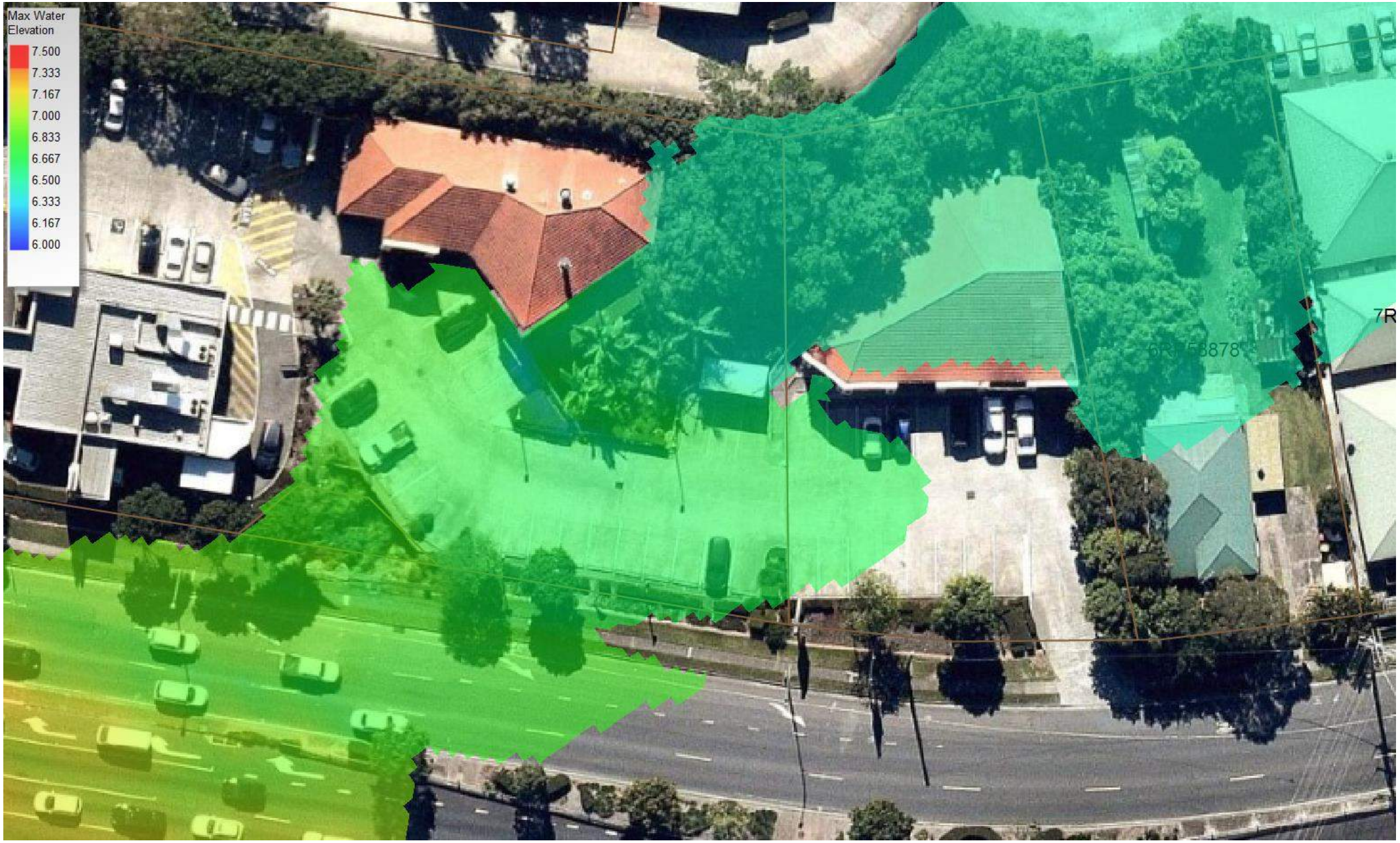

Figure F.6 – Scenario 2 – 1% AEP – Maximum Water Elevation (Subject Site)

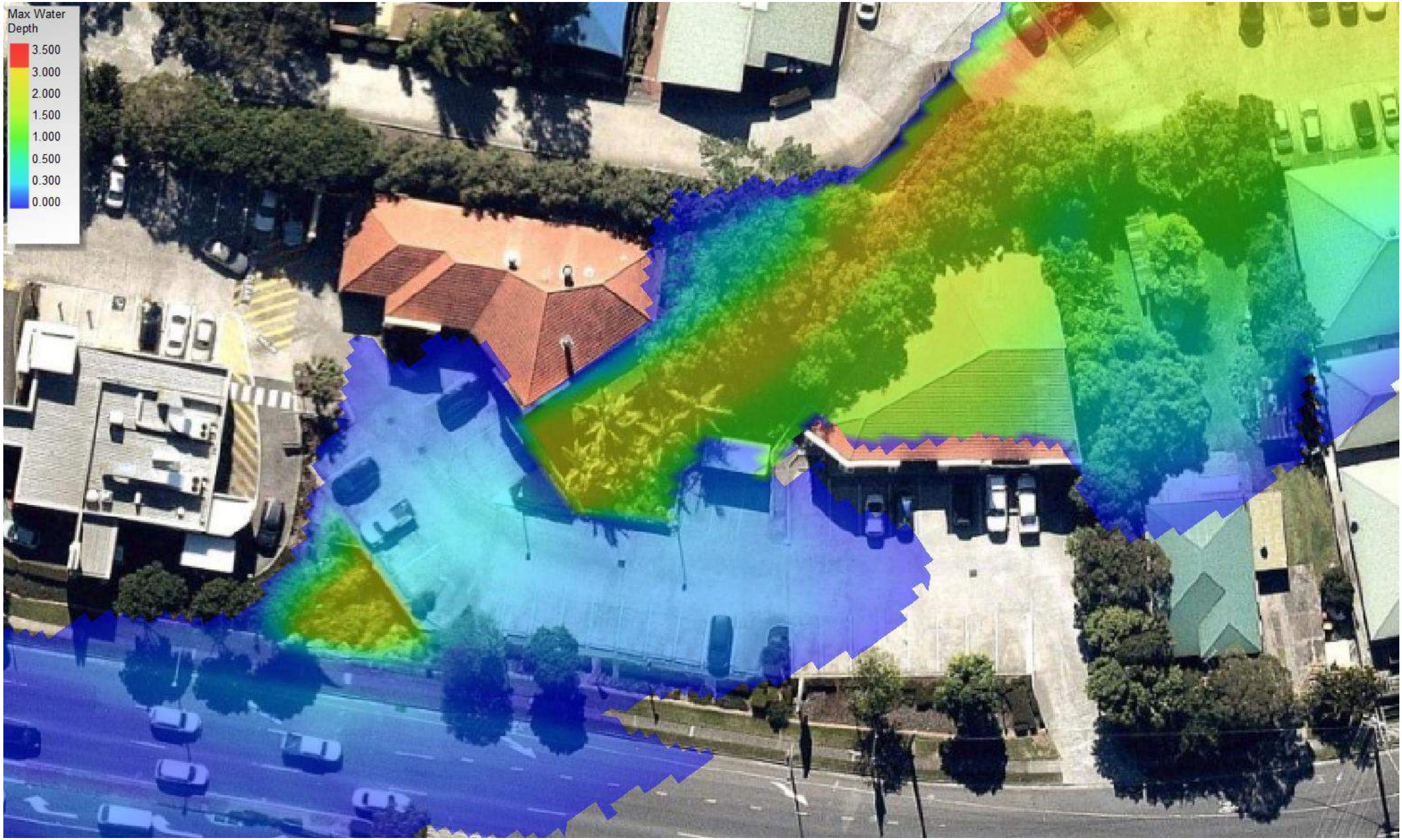

Figure F.7 – Scenario 2 – 1% AEP – Maximum Water Depth (Subject Site)

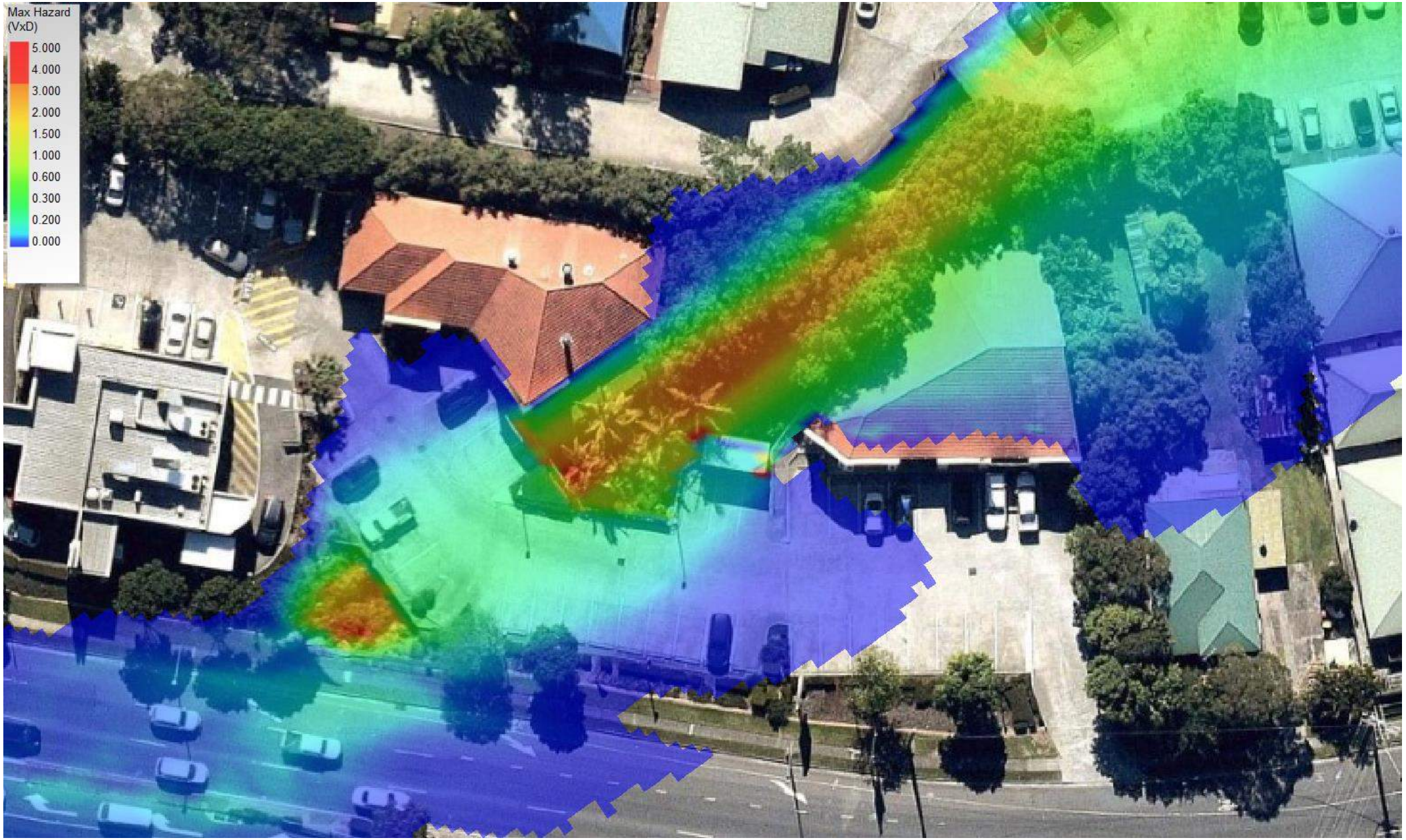

Figure F.8 – Scenario 2 – 1% AEP – Maximum Hydraulic Hazard (Subject Site)

Appendix G – Impact Assessment Reference Points


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Appendix H – Impact Assessment Results

Table H.1 – Scenario 1 – Flood Impact Assessment Results

Inspection Point	Existing Flood Level (m AHD)	Proposed Flood Level (m AHD)	Difference (mm)	Existing Max Velocity (m/s)	Proposed Max Velocity (m/s)	Difference (m/s)
1	7.325	7.325	0	0.642	0.662	0.02
2	7.077	7.076	-1	1.449	1.454	0.005
3	7.012	7.009	-3	1.228	1.231	0.003
4	6.827	6.826	-1	1.961	1.97	0.009
5	6.87	6.87	0	0.867	0.86	-0.007
6	6.583	6.574	-9	2.163	2.169	0.006
7	6.653	6.652	-1	1.385	1.393	0.008
8	6.625	6.635	10	0.931	0.821	-0.11
9	6.58	6.604	**24**	1.522	1.536	0.014
10	6.504	6.58	**76**	1.224	0.926	-0.298
11	6.498	6.581	**83**	0.509	0.553	0.044
12	6.267	6.205	-62	2.501	2.503	0.002
13	6.115	6.111	-4	2.43	2.142	-0.288
14	6.049	6.061	**12**	2.404	2.246	-0.158
15	6.056	6.056	0	0.798	1.623	**0.825**
16	6.047	6.058	**11**	0.237	0.272	0.035
17	6.045	6.045	0	2.028	2.112	0.084
18	6.046	6.052	6	0.559	0.935	**0.376**
19	6.042	6.044	2	1.705	1.646	-0.059
20	6.037	6.035	-2	0.87	1.134	**0.264**
21	6.034	6.026	-8	0.74	0.991	**0.251**
22	6.038	6.027	-11	0.383	0.072	-0.311
23	6.04	6.039	-1	1.658	1.654	-0.004
24	6.032	6.031	-1	0.707	0.727	0.02
25	6.032	6.03	-2	0.581	0.633	0.052
26	6.04	6.038	-2	1.525	1.526	0.001
27	6.03	6.029	-1	1.088	1.085	-0.003
28	6.03	6.029	-1	0.341	0.367	0.026
29	6.032	6.03	-2	1.506	1.507	0.001

30	6.027	6.025	-2	0.501	0.5	-0.001
31	6.027	6.027	0	0.25	0.266	0.016
32	6.022	6.02	-2	1.261	1.26	-0.001
33	6.024	6.022	-2	0.415	0.414	-0.001
34	6.024	6.021	-3	0.065	0.071	0.006
35	6.016	6.014	-2	1.246	1.245	-0.001
36	6.022	6.02	-2	0.245	0.242	-0.003
37	6.023	6.02	-3	0.169	0.17	0.001
38	6.009	6.007	-2	1.365	1.367	0.002
39	6.008	6.006	-2	0.26	0.259	-0.001
40	6.006	6.004	-2	0.166	0.166	0
41	6.007	6.005	-2	1.039	1.039	0
42	5.973	5.971	-2	1.034	1.038	0.004
43	6.002	6	-2	0.165	0.168	0.003
44	5.994	5.991	-3	0.384	0.38	-0.004
45	5.875	5.873	-2	0.96	0.956	-0.004
46	5.517	5.514	-3	1.121	1.1	-0.021
47	5.458	5.455	-3	1.75	1.707	-0.043
48	5.286	5.285	-1	1.634	1.631	-0.003
49	5.227	5.225	-2	0.678	0.662	-0.016
50	3.629	3.628	-1	1.838	1.837	-0.001

Figure H.2 – Scenario 1 – 1% AEP Water Elevation Impact

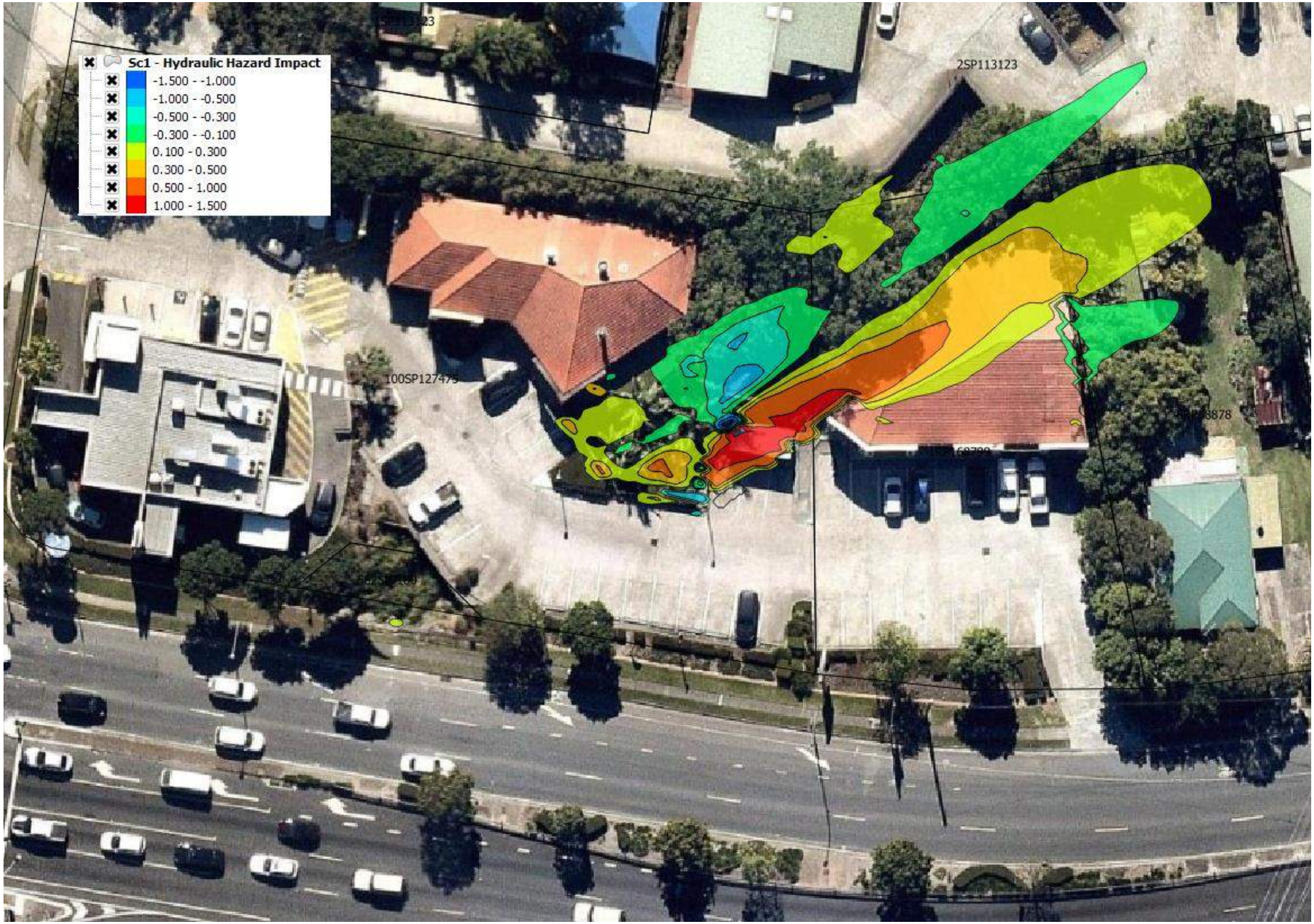

Figure H.2 – Scenario 1 – 1% AEP Hydraulic Hazard Impact

Appendix I – BCC Code Compliance Responses

Project Location: 1304 Old Cleveland Rd, Carindale Job Reference: 7707

Flood Overlay Code

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
Section A—If for accepted development subject to compliance with identified requirements (acceptable outcomes only) or assessable development for a dwelling house including any secondary dwelling Note—Development for a dwelling house does not require assessment against any other sections of this code.				
PO1 Development involving any habitable or non-habitable part of a dwelling house, including any secondary dwelling, is located and designed to: a) minimise the risk to people from flood hazard; b) achieve acceptable flood immunity; c) minimise property impacts from a flood event up to and including the defined flood event; d) minimise disruption to residents, recovery time and rebuilding or restoration costs after a flood event up to and including the defined flood event.	**AO1.1** Development for a dwelling house including any secondary dwelling: (a) is not located in the Brisbane River flood planning area 1, 2a or 2b sub-categories or the Creek/waterway flood planning area 1 or 2 sub-categories; or (b) is only located in these sub-categories, if a Registered Professional Engineer Queensland certifies that the dwelling house and any secondary dwelling are structurally designed to be able to resist hydrostatic and hydrodynamic loads associated with flooding up to and including the defined flood event.	**N/A**	Not applicable to this development.	
	AO1.2 Development for a dwelling house and any secondary dwelling complies with the minimum flood planning levels in Table 8.2.11.3.B.	**N/A**	Not applicable to this development.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	Note—If located in an area that has no flood level information available from the Council such as an overland flow path, a Registered Professional Engineer of Queensland with expertise in undertaking flood studies is to certify that the flood level and development levels for the dwelling house and any secondary dwelling achieve the required flood planning levels in Table 8.2.11.3.B.			
	AO1.3 Development involving a building undercroft complies with the minimum clearance requirements in Table 8.2.11.3.E. Editor's note—For creek/waterway, storm-tide and river flooding, applicable flood planning information is available from Council's FloodWise Property Report. Note—The Flood planning scheme policy provides guidance on undercroft design.	**N/A**	Not applicable to this development.	
PO2 Development within the Creek/waterway flood planning area sub-categories or Overland flow flood planning area sub-category: a) maintains the conveyance of flood waters to allow flow and debris to pass predominantly unimpeded through the site; b) does not concentrate, intensify or divert floodwater onto upstream, downstream or adjacent properties;	**AO2** Development: (a) is not located within the Creek/waterway flood planning area 1, 2 or 3 sub-categories or the Overland flow flood planning area sub-category; or (b) provides an open undercroft area from natural ground level to habitable floor level for any area inundated by the defined flood event; or	**N/A**	Not applicable to this development.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
c) will not result in a material increase in flood levels or flood hazard on upstream, downstream or adjacent properties.	Note—This undercroft area is not suitable for providing non-habitable rooms, secure storage of valuables, or future enclosing for storage or car parking. The clear area may include structural elements such as columns and floor substructure. The Flood planning scheme policy provides guidance on undercroft design. Editor's note—An open undercroft design may be achieved through a 'valance' treatment around the perimeter of an otherwise internally clear undercroft. Editor's note—For Creek/waterway, storm-tide and river flooding, applicable flood planning information is available from Council's FloodWise Property Report. (c) a report from a Registered Professional Engineer Queensland certifies that the development in the Creek/waterway flood planning area or Overland flow flood planning area sub-categories will not result in a material increase in flood level or flood hazard on upstream, downstream or adjacent properties. Note—Flood studies demonstrate that the development and engineering design methods conform to the principles within the Flood planning scheme policy and the Infrastructure design planning scheme policy.			

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
Section B—If accepted development subject to compliance with identified requirements (acceptable outcomes only) or assessable development other than for a dwelling house or reconfiguring a lot Note—If development that is accepted development subject to compliance with identified requirements complies with the acceptable outcomes of this part, no further assessment against this code is required.				
PO3 Development: a) is compatible with flood hazard in a defined flood event; b) minimises the risk to people from flood hazard; c) does not reduce the ability of evacuation resources including emergency services to access and evacuate the site in a flood emergency, with consideration to the scale of the development; d) minimises impacts on property from flooding; e) minimises disruption to residents, business or site operations and recovery time due to flooding; f) minimises the need to rebuild structures after a flood event greater than the defined flood event. Note—Where Table 8.2.11.3.C identifies that a flood risk assessment is required, compliance with this performance outcome can be achieved by submitting a flood risk assessment, which may be included within a flood study, addressing the criteria within this performance solution. Preparing flood risk assessments	**AO3** Development for a material change of use is identified in Table 8.2.11.3.C as compatible with the flood hazard in the relevant flood planning area.	**A/S**	The site is flagged to be within FPA1, 3, 4 & 5 for creek/waterway flooding and overland flow flooding. However, the flood planning area flags are trigged from the waterway which runs through the subject site. There are no changes to the time of closure for the existing carpark. Bollards and signage are proposed to minimize the risk to any cars parked in the existing car parks that may be at risk of floating during the peak of the 1% AEP flood. There is sufficient access for emergency services to enter the site via the egress on Old Cleveland Rd if required in an emergency. A flood impact assessment was undertaken and determined that the proposed development does not materially worsen the flooding characteristics to any properties located upstream, downstream or adjacent to the subject site during the defined flood event.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
and flood studies is required to be in accordance with the Flood planning scheme policy. Note—An emergency management plan prepared in accordance with the Flood planning scheme policy, which sets out procedures for evacuation due to flooding may be used to demonstrate compliance with this performance outcome.				
PO4 Development for a park ensures that the design of a park and location of structures and facilities responds to the flood hazard and balances the safety of intended users with: a) maintaining continuity of operations; b) impacts of flooding on asset life and ongoing maintenance costs; c) efficient recovery after flood events; d) recreational benefits to the city; e) availability of suitable land within the park.	**AO4.1** Development involving a building or structure in a park complies with the flood planning levels specified in Table 8.2.11.3.D.	**N/A**	Not applicable to this development.	
	AO4.2 Development involving a building or structure in a park where Table 8.2.11.3.D does not apply: a) is not located within the 20% AEP flood extent of any creek/waterway or overland flow path; or b) is located above the 20% AEP flood level of any creek/waterway or overland flow path.	**N/A**	Not applicable to this development.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
Section C—If for assessable development other than for a dwelling house				
PO5 Development is located and designed to: a) minimise the risk to people from flood hazard on the site; b) minimise flood damage to the development and contents of buildings up to the defined flood event; c) provide suitable amenity; d) minimise disruption to residents, recovery time and the need to rebuild structures after a flood event up to and including the defined flood event.	**AO5.1** Development complies with the flood planning levels specified in Table 8.2.11.3.D. Note—If located in an area with no Council-derived flood levels such as an overland flow path, a Registered Professional Engineer Queensland with expertise in undertaking flood studies is to derive the applicable flood level and certify that the development meets the required flood planning levels in Table 8.2.11.3.D. The study is to demonstrate that the development and engineering design methods conform to the principles within the Flood planning scheme policy and the Infrastructure design planning scheme policy.	**A/S**	The development complies with the flood planning areas specified in the flood overlay code for all building levels. The new short term car parks will achieve the relaxation criteria listed in the Flood PSP for vehicle parking.	
	AO5.2 Development is: a) not located in the: (i) Brisbane River flood planning area 1, 2a, or 2b sub-categories; (ii) Creek/waterway flood planning area 1 or 2 sub-categories; (iii) Overland flow flood planning area sub-category; or b) only located in these sub-categories if a Registered Professional Engineer Queensland with expertise in undertaking flood studies certifies that: (i) the development design, siting and any mitigation measures will ensure the	**A/S**	The development will be suspended above the waterway, with the risks managed to an acceptable level.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	development is structurally adequate to resist hydrostatic, hydrodynamic and debris impact loads associated with flooding up to the defined flood event; and (ii) the risk to people is managed to an acceptable level.			
PO6 Development involving essential electrical services or a basement storage area is suitably located and designed to ensure public safety and minimise flood recovery and economic consequences of damage during a flood.	**AO6.1** Development ensures that: a) all areas containing essential electrical services comply with the flood planning levels in Table 8.2.11.3.D; or b) if a basement contains essential electrical services or a private basement storage area, the basement is a waterproof structure with walls and floors impermeable to the passage of water with all entry points and services located at or above the relevant flood planning level in Table 8.2.11.3.D. Note—A basement storage area does not include a bike storage room, change room, building maintenance storage and non-critical electrical services.	**A**	The development will ensure essential electrical services are located above 7.08m AHD.	
	AO6.2 Development involving a basement that relies on a pumping solution to manage floodwater ingress or for dewatering after a flood provides a secondary pump system with a backup power source for the pump.	**N/A**	Not applicable to this development.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
PO7 Development does not directly or indirectly create a material adverse impact on flood behaviour or drainage on properties that are upstream, downstream or adjacent to the development.	**AO7.1** Development: a) does not block, or divert floodwaters for any area affected by creek/waterway or overland flow flooding, excluding storm-tide flooding and Brisbane River flooding sources; or b) does not result in a material increase in flood level or hydraulic hazard on upstream, downstream or adjacent properties. Note—Compliance with this acceptable solution can be demonstrated by the submission of a flood study by a Registered Professional Engineer of Queensland with expertise in undertaking flood studies demonstrating that the development and engineering design methods conform to the principles within the Flood planning scheme policy and the Infrastructure design planning scheme policy.	**A/S**	A flood impact assessment was undertaken and determined that the proposed development does not materially worsen the flooding characteristics to any properties located upstream, downstream or adjacent to the subject site during the defined flood event. There are some changes to the maximum hydraulic hazard in the waterway under developed conditions, which is caused by the earthworks proposed and the addition of the piers for the suspended slab. The changes are primarily kept within the waterway within the site area, however there is an increase of approximately $0.1m^2/s$ (from $0.5m^2/s$ under existing conditions to $0.6m^2/s$) in the waterway overbank area in the adjacent property. As there is a future development proposed to be wholly suspended over this area, there are no adverse impacts that would arise from such a change in the hydraulic hazard. Should the development not proceed, the area would still be considered to be a high flood hazard area, with flooding depths in excess of 1m deep. Therefore, the adjustments to the hydraulic hazard in that area would not change the usability nor the accessibility of that portion of land.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	AO7.2 Development retains existing overland flow paths and does not rely wholly on piped solutions to manage major flows.	**A**	The development retains the existing overland flow path.	
	AO7.3 Development which creates a new overland flow path or significantly modifies an existing overland flow path via earthworks does not materially worsen hydraulic hazard on the site from existing conditions. Note—Compliance with this acceptable solution can be demonstrated by the submission of a flood study by a Registered Professional Engineer of Queensland with expertise in undertaking flood studies demonstrating that the development and engineering design methods conform to the principles within the Flood planning scheme policy and the Infrastructure design planning scheme policy.	**N/A**	The development does not alter the existing overland flow path.	
PO8 Development for filling or excavation in an area affected by creek/waterway flooding does not directly, indirectly or cumulatively cause any material increase in flooding or hydraulic hazard or involve significant redistribution of flood storage from high to lower areas in the floodplain. Note—This can be demonstrated by undertaking earthworks in compliance	**AO8** Development ensures that no filling or excavation greater than 100mm is located in the Creek/waterway flood planning area 1, 2 or 3 sub-categories if contained in the 5% AEP flood extent of any Creek/waterway flood planning area sub-category for which no waterway corridor has been mapped in the Waterway corridors overlay.	**A/S**	A flood impact assessment was undertaken and determined that the proposed development does not materially worsen the flooding characteristics to any properties located upstream, downstream or adjacent to the subject site during the defined flood event.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
with the Compensatory earthworks planning scheme policy. Note—This part of the code applies to all development other than a dwelling house and any secondary dwelling which involves filling or excavation, whether or not the development application comprises a separate development application for operational work involving filling or excavation.				
PO9 Development ensures that the building and site design: a) maintains the conveyance capacity of existing overland flow paths and creek/waterways; b) ensures floodwaters and flood debris can pass predominantly unimpeded under a structure or building to minimise property or building damage, including for a flood larger than the defined flood event; c) mitigates flood impacts by ensuring that filling, excavation and location of services are designed to allow for the conveyance of floodwater across the site. Note—The Flood planning scheme policy provides guidance on relevant considerations in determining minimum undercroft clearances and treatment of	**AO9.1** Development involving a building undercroft in the Creek/waterway flood planning area sub-categories or the Overland flow flood planning area sub-category: a) complies with the minimum building undercroft clearance requirements in Table 8.2.11.3.E; b) not located directly above any part of a waterway corridor as mapped in the Waterway corridors overlay.	**A/S**	A performance solution is sought for a relaxation on the building undercroft requirements. There are earthworks proposed to be undertaken within the undercroft area to both increase the clearance in the building undercroft and to allow for additional capacity in the waterway overbank area. While the 2.5m undercroft clearance cannot be achieved for the entire suspended slab, the clearances underneath the building (minimum 1.9m) do ensure that there is sufficient height for maintenance after a major flood event and that the area remains free draining back to the existing channel with a minimum grade of 1%. The finished floor level of the building already achieves a 950mm freeboard above the 1% AEP flood level in the waterway (550mm clearance to the underside of the suspended slab) and the AR&R assessment of blockage factors	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
ground level in undercroft areas where floodwater conveyance is required underneath development.			determined that the potential for debris in this portion of the catchment is limited.	
	AO9.2 Development involving a building undercroft in the Creek/waterway flood planning area sub-categories or the Overland flow flood planning area sub category: (a) has a ground level within the undercroft area that is free draining; (b) does not involve excavation below ground level of more than 300mm within the undercroft area.	**A/S**	The existing free draining undercroft will be maintained. A flood impact assessment was undertaken and determined that the proposed development does not materially worsen the flooding characteristics to any properties located upstream, downstream or adjacent to the subject site during the defined flood event.	
PO10 Development for vulnerable uses, difficult to evacuate uses or assembly uses optimises vehicular access and efficient evacuation from the development to parts of the road network unaffected by flood hazard, in order to: a) protect safety of users and emergency services personnel; b) support efficient emergency services access and site evacuation with consideration to the scale of development.	**AO10** Development for vulnerable uses, difficult to evacuate uses or assembly uses: a) is not isolated in any event up to the relevant flood planning level specified in Table 8.2.11.3.L; or b) has direct vehicle access to a critical route or interim critical route in the Critical infrastructure and movement network overlay for evacuation in a flood; or c) can achieve vehicular evacuation to a suitable flood-free location. Note—A suitable flood-free location is of a size and nature sufficient to provide for the	**N/A**	The development is not for vulnerable, difficult to evacuate or assembly uses.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
Note—A flood risk assessment may be required to address the performance outcomes or acceptable solutions which deal with evacuation and isolation arrangements, and the ability to take refuge. The Flood planning scheme policy provides information for undertaking flood risk assessments.	size and characteristics of the population likely to need evacuation to that area.			
PO11 Development has access which, having regard to hydraulic hazard, provides for safe vehicular and pedestrian movement and emergency services access to adjoining roads.	**AO11.1** Development provides an access or driveway into the site which is: a) trafficable during the defined flood event; b) not located in the Creek/waterway flood planning area 1 sub-category; c) not located in the Overland flow flood planning area sub-category if the hydraulic hazard is unsafe in the defined flood event; d) the access or driveway is not inundated by a 10% AEP flood.	**A/S**	The existing access is non-trafficable for a period of 17mins under both existing and proposed conditions in the 1% AEP flood event. The flooding depths and hydraulic hazard in the carpark subject to flooding are not categorized as unsafe hydraulic hazard by BCC's classifications.	
	AO11.2 Development located in the Creek/waterway flood planning area 1, 2, 3 or 4 sub-categories locates any disabled access in the highest part of the site. Note—explanation of hydraulic hazard provided in the Flood planning scheme policy.	**A**	The existing access/egress points are located at the highest points on site will not change under developed conditions.	
PO12 Development involving a new road, a bridge or culvert is designed to minimise impacts to flood behaviour, minimise	**AO12** Development involving a new road complies with the flood planning levels in Table 8.2.11.3.F.	**N/A**	The development does not involve a new road.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
disruption to traffic during a flood and allow for emergency access.				
PO13 Development for pedestrian and cyclist paths: a) provides a suitable level of trafficability; b) manages the impacts of flooding on asset life and ongoing maintenance costs; c) balances route availability with recreational and transport connectivity benefits to the city.	**AO13.1** Development for cyclist and pedestrian facilities other than on public roads, including those traversing through a park and adjacent to a watercourse and overland flow path, are located above the 39% AEP (2 year ARI) flood immunity from all flooding sources. Note—If the site is subject to more than one type of flooding, the requirement that affords the greatest level of protection will apply.	**N/A**	The development does not involve cyclist and pedestrian facilities.	
	AO13.2 All new on-road cyclist and pedestrian facilities comply with the flood planning levels and trafficability standards for the applicable category of road in Table 8.2.11.3.F or Table 8.2.11.3.K.	**N/A**	The development does not involve cyclist and pedestrian facilities.	
PO14 Development which increases the residential population within the Brisbane River flood planning area sub-categories minimises the risk to people in all flood events with consideration to flood hazard, including warning time.	**AO14** Development in the Brisbane River flood planning area sub-categories in areas where the residential flood level is greater than 12.8m AHD involving: a) an increase in the number of residential dwellings; or b) additional residential lots is not subject to an unsafe hydraulic hazard in the 0.2% AEP flood event.	**N/A**	The development is not located within this flood planning sub-category.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	Note—Explanation of a hydraulic hazard is provided in the Flood planning scheme policy.			
Additional performance outcomes and acceptable outcomes for essential community infrastructure				
PO15 Development involving essential community infrastructure: a) remains functional to serve community need during and immediately after a flood event, or is part of a network that is able to maintain the function of the essential community infrastructure when parts of the development are unable to function during or after a flood; b) is designed, sited and operated to avoid adverse impacts on the community or the environment due to the impacts of flooding on infrastructure, facilities or access and egress routes; c) is able to remain functional or is part of a network which is able to remain functional even when other infrastructure or services (such as electricity supply) may be compromised in a flood event; d) contains mitigation measures which are not entirely dependent on human activation to respond to a flood event.	**AO15** Development involving essential community infrastructure: a) is ancillary to and not relied upon for the provision of the essential service during a flood; or b) is located above the flood planning levels in Table 8.2.11.3.G; c) has access to or provides the necessary back-up emergency electricity and communications supply in times of flood; d) is designed and constructed to resist hydrostatic and hydrodynamic forces as a result of inundation by the flood event listed for the development type in Table 8.2.11.3.G; e) that services a local area: (i) is able to be accessed in times of flood to service local community needs up to the event listed for that development type in Table 8.2.11.3.G; or (ii) has a service continuity plan that demonstrates the continued provision of service during the relevant flood event.	**N/A**	The development does not involve essential community infrastructure.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
Note—Protection of function is required up to and including the flood event in Table 8.2.11.3.G.				
Additional performance outcomes and acceptable outcomes if development involves the processes in Table 8.2.11.3.H				
PO16 Development involving the storage and handling of hazardous materials avoids or minimises risks to public health and safety and the environment, by: a) protecting underground tanks for hazardous materials against the forces of buoyancy, velocity flow and debris impacts; b) securing above-ground tanks for hazardous materials against flotation and lateral movement; c) preventing damage to hazardous materials pipework or entry of floodwater into hazardous materials pipework; d) preventing damage to or off-site release of packages, drums or containers storing hazardous materials. Note—A chemical hazards flood risk report prepared in accordance with the Management of hazardous chemicals in flood prone areas planning scheme policy can assist in demonstrating	**AO16** a) Development does not include the storage or handling of hazardous chemicals that are equivalent to or exceed the threshold quantities in Table 8.2.11.3.M. b) Development involving the processes listed in Table 8.2.11.3.H: (i) where located in the Flood overlay area, occurs only in the Creek/waterway flood planning area 5 sub-category or the Brisbane River flood planning area 5 sub-category; or (ii) is consistent with the standards contained in the Management of hazardous chemicals in flood prone areas planning scheme policy and can operate without risk of environmental harm during a flood event. Note—The Management of hazardous chemicals in flood prone areas planning scheme policy sets out further information and processes including risk assessment for the management of hazardous chemicals in flood planning areas.	**N/A**	The development does not include the storage or handling of hazardous chemicals that are equivalent to or exceed the threshold quantities in Table 8.2.11.3.M. The development does not involve the processes in Table 8.2.11.3.H.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
achievement of this performance outcome. Note—A pump drainage system is not an acceptable measure to meet the performance outcome.				
Additional performance outcomes and acceptable outcomes for reconfiguring a lot				
PO17 Development locates and designs all lots resulting from reconfiguring a lot to: a) minimise the risk to people from flood hazard; b) minimise damage to property from flood hazard; c) facilitate safe and efficient evacuation. Note— • Consideration of all floods up to the probable maximum flood is relevant to minimising the risk to people. • Flood warning time is not considered sufficient in the Creek/waterway planning area sub-categories or the Overland flow flood planning area sub-category. • Filling above the flood planning level for a flood event greater than the defined flood event cannot be assumed to mitigate the flood hazard.	**AO17.1** Development creating new lots is identified in Table 8.2.11.3.I as suitable within the relevant flood planning area.	**N/A**	The development does not involve the reconfiguration of a lot.	
	AO17.2 Development provides for reconfiguring a lot design that achieves a road and lot layout which: a) provides trafficable vehicular egress for evacuation during a defined flood event; b) optimises hazard-free movement away from sources of flood hazard within the development. Note—Further advice on road and lot layout is contained in theFlood planning scheme policy.	**N/A**	The development does not involve the reconfiguration of a lot.	
	AO17.3 Development which creates a new residential lot in an area subject to Brisbane River flooding, if the residential flood level is greater than 12.8m AHD is not subject to a hydraulic hazard greater than 0.6m^2/s DV or 0.6m deep in a 0.2% AEP flood.	**N/A**	The development does not involve the reconfiguration of a lot.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	Note—Refer to the Flood planning scheme policy for further explanation on the 0.2% AEP flood.			
PO18 Development involving reconfiguring a lot: a) minimises the risk to people from flood hazard; b) creates safe evacuation routes or avoids isolation of the development during a flood greater than the defined flood event; c) minimises damage to property and services; d) provides lots and roads that are not frequently flooded or subject to nuisance ponding or seepage; e) ensures lots created for park or private open space minimise the risk to people from flood hazard and are fit for purpose; f) provides a lot that is not substantially burdened by flood mitigation infrastructure.	**AO18.1** Development involving reconfiguring a lot ensures: (a) all lots comply with the flood planning levels in Table 8.2.11.3.J; (b) a new road complies with the flood planning levels in Table 8.2.11.3.F.	**N/A**	The development does not involve the reconfiguration of a lot.	
	AO18.2 Development involving reconfiguring a lot creating more than 6 residential lots or a lot for industry ensures the flood planning levels of a dedicated road fronting the development or providing primary access within 200m of the development: a) complies with Table 8.2.11.3.K; or b) has acceptable trafficability in accordance with the requirements in the Flood planning scheme policy and the Queensland Urban Drainage Manual. Note—The Flood planning scheme policy contains supporting information about trafficability on existing roads and serviceability during floods.	**N/A**	The development does not involve the reconfiguration of a lot.	

Performance outcomes	Acceptable outcomes	Outcome	Comments	Council Use
	AO18.3 Development protects the conveyance of flood hazard area by providing an easement over the: a) 2% AEP flood extent for overland flow flooding; b) (b) 1% AEP flood extent for creek/waterway flooding.	**N/A**	The development does not involve the reconfiguration of a lot.	

* **SOLUTIONS**: A – Acceptable Solution; A/S – Alternate Solution; N/A – Not Applicable

INERTIA ENGINEERING PTY LTD

5B 85 Hudson Rd, ALBION QLD 4010

P I 07 3857 7868 F I 07 3262 7359 E I info@inertiaeng.com.au