Western Sydney University

Bankstown City Campus Development

SEARS Report

Civil Stormwater and Flooding Report

Revision: 05

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Report Amendment Register

Rev. No.	Section & Page No.	Issue/Amendment	Author/Initials		Reviewer/Initials		Date
1		SD Report	JH		SN		12/03/19
2		SEARS Report	JH		VC		21/06/19
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4		Final SEARS Report	JH		VC		19/07/19
5		Final SEARS Report	JH		VC		23/08/19

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1. Executive Summary

Bonacci Group have prepared this Secretary's Environmental Assessment Requirements (SEARs) report for the preparation of an Environmental Impact Statement (EIS) for New Western Sydney University Bankstown City Campus at 74 Rickard Road Bankstown along with a portion of 375 Chapel Road (SSD 9831). The site includes 74 Rickard Road (being Lot 5 DP 777510) and a portion of 375 Chapel Street (being part Lot 6 DP 777510), in addition public domain works are proposing to Rickard Road, 70 Rickard Road (being part Lot 7 DP777510) and access is proposed via 80 Rickard Road (being Lot 12 DP566924). The proposed development consists of a new building, 2 levels of basement carparking and retail space on the ground floor.

The site is situated at a low point on a major overland flood path and is subsequently impacted by the 100-year ARI overland flood flow. The requirements from a civil perspective include the following in accordance with Canterbury Bankstown Council DCP, SEARS, Green building Code of Australia and Canterbury Bankstown Stormwater System Report:

1. Habitable floor levels are to be 500mm above the 100 year ARI flood level;

2. Driveways to basement car parking areas are to incorporate a crest point with a surface level of at least 100mm above the 100 year ARI water surface level

3. Determine impact of the development on 100 year flood inundation levels and on adjoining properties

4. On-Site Detention (OSD) must be designed and constructed to control stormwater runoff from development sites such that for 5 to 100 year ARI events, peak stormwater discharges from the site do not exceed pre-development stormwater discharges

5. Water quality pollutant reduction targets to the following per Green Building Code of Australia:

    - Gross Pollutants 85%
    - Total Nitrogen 30%
    - Total Phosphorous 30%

Preliminary findings from the hydrologic and hydraulic modelling of the site for the existing and proposed scenarios have been documented in this report. Water quantity, water quality and flooding requirements have been modelled using DRAINS, MUSIC and TUFLOW computer software respectively and findings have demonstrated that it is be possible to achieve the above criteria.

2. INTRODUCTION

This civil report has been prepared by Bonacci Group (NSW) Pty Ltd to describe the civil systems associated with the Western Sydney University Bankstown City Campus Development, including civil works, stormwater quantity, water quality and flooding.

2.1. Objectives

The objective of this report is to demonstrate compliance with *SEARS for New Western Sydney University Bankstown City Campus, Canterbury Bankstown Council DCP, Bankstown City Council 2009 Development Engineering Standards, Green Building Council of Australia Green Star- Design & As built Stormwater, Bankstown Development Control Plan 2015 Part B12 Flood Risk Management, Canterbury Bankstown Stormwater System Report* and *Landcom 2004 Soils and Water Managing Urban Stormwater*. The objectives are:

- To design a stormwater drainage system for the site to accommodate the stormwater runoff up to and including 20 year ARI storm events.
- To maintain the permissible site discharge (peak flows from existing site) for the site due to development from 5 year ARI (minor storm events) up to and including 100 year ARI (major storm events) storm events.
- To design an on-site detention (OSD) tank up to and including the 100 year ARI storm events and to design a safe overflow conveyance measure from the OSD tank.
- To provide functional Water Sensitive Urban Design (WSUD) treatment for the site to improve water quality and achieve water quality requirements nominated by Canterbury Bankstown Council.
- To provide functional WSUD measure for the site to improve water quality and achieve water quality targets nominated by Green Building Code of Australia.
- To design habitable floor levels to be 500mm above the 100 year ARI flood level;
- To design driveways to basement car parking areas to incorporate a crest point with a surface level of at least 100mm above the 100 year ARI water surface level;
- To demonstrate that the development will not increase flooding effects elsewhere.
- To design a new shared roadway at The Appian Way to replace the existing shared roadway, with new crossover to Rickard Road.

3. Site Description

3.1. Location

The site includes 74 Rickard Road (being Lot 5 DP 777510) and a portion of 375 Chapel Street (being part Lot 6 DP 777510), in addition public domain works are proposing to Rickard Road, 70 Rickard Road (being part Lot 7 DP777510) and access is proposed via 80 Rickard Road (being Lot 12 DP566924). The site is located within Canterbury Bankstown Council and is bordered by Rickard Road to the north, Paul Keating Park to the south, Bankstown Library to the west and Appian Way and Bankstown Community Services Centre to the east. The locality map of the site is shown in *Figure 3-1* below.

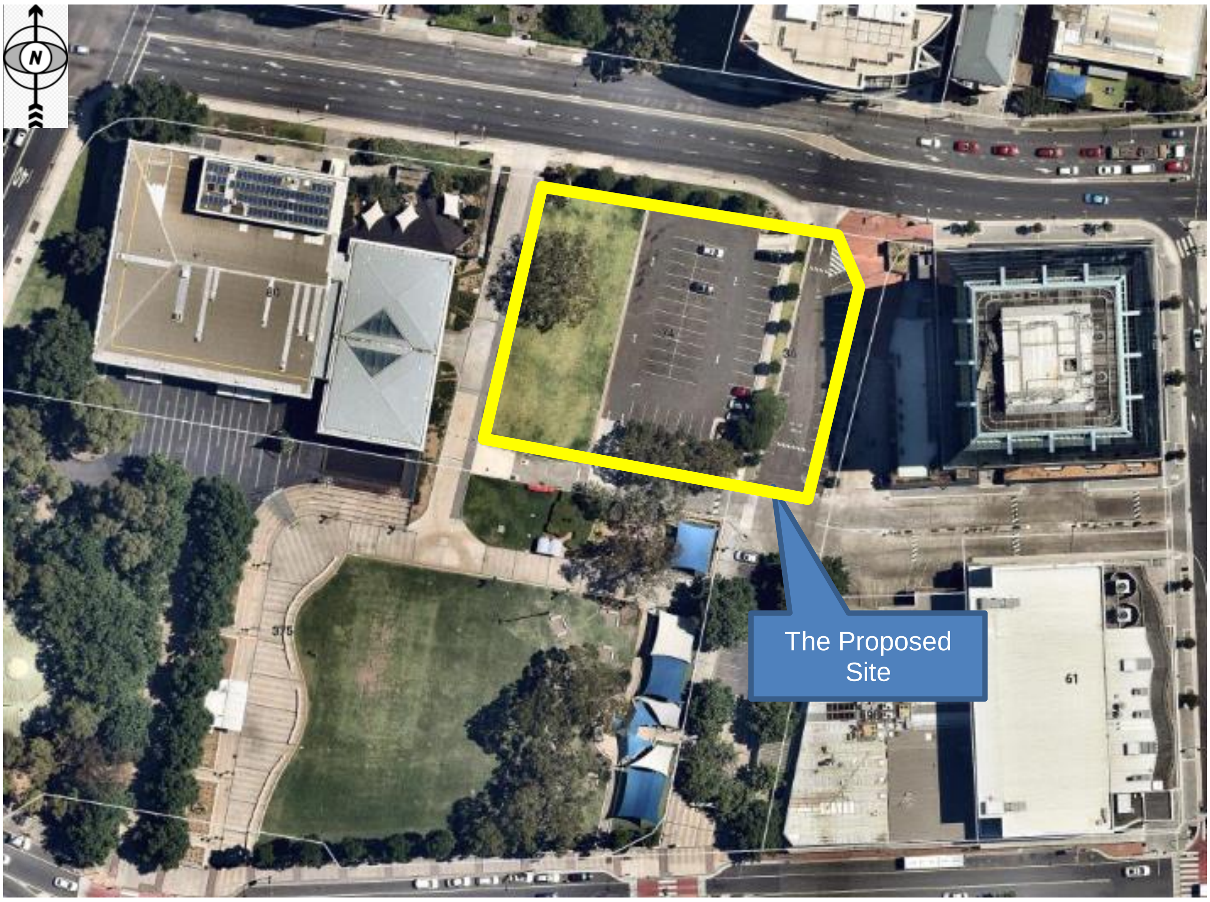


Figure 3-1: The Locality Map of the Site (Source: Nearmaps)

3.2. Existing Topography and Drainage

The existing site consists of carparking and associated landscaping, driveway and footpath. The site slopes down from north to south, particularly on Appian Way which forms a major overland flow path from a sag pit located on Rickard Road. The site is impacted by 100 year overland flooding. Much of the site sheet-flows across the carpark, landscaping and Appian Way to the south where stormwater is captured by a pit and pipe network. The pit and pipe network are assumed to ultimately discharge to the 2.4m(W) x 1.5m(H) culvert running north to south located east of the site. The main discharge point for the site stormwater, which is incorporated into the proposed building design is located at the south east corner of the site. An existing OSD tank is located at the south west corner of the site and is assumed to service Bankstown Library. The existing OSD is outside of site boundary and therefore is not believed to be impacted by the proposed development.

Survey drawings have shown a twin 1200mm RCP going through the site from Rickard Road. MGP Building and Infrastructure services Pty Ltd (project appointed Water Servicing Coordinator) has provided work-as-constructed plans showing disuse of the pipe. It is believed that the pipe has been replaced by another 2.4mx1.22m box culvert located parallel (west of) to the 2.4mx1.5m box culvert.

3.3. Existing Documentation

The following relevant existing documentation has been referenced for the proposed design:

- Topographical survey including in ground services by RPS Australia East Pty Ltd.
- Report on Detail Site Investigation (Ref: 86462.00.R.003.Rev1) by Douglas Partners Pty Ltd, August 2018.
- Canterbury Bankstown Council response letter titled “Re: Western Sydney University Bankstown City Campus Development” reference PLAN-101-4902 dated 25 January 2018
- Canterbury Bankstown Council Stormwater System Report 74 Rickard Road Bankstown NSW 2200

4. PROPOSED DEVELOPMENT

The proposed development consists of a new building with retail space on the ground floor and 2 levels of basement carparking with driveway access on the west side of the building. The Architectural ground plan for the proposed development is shown in *Figure 4-1* below.

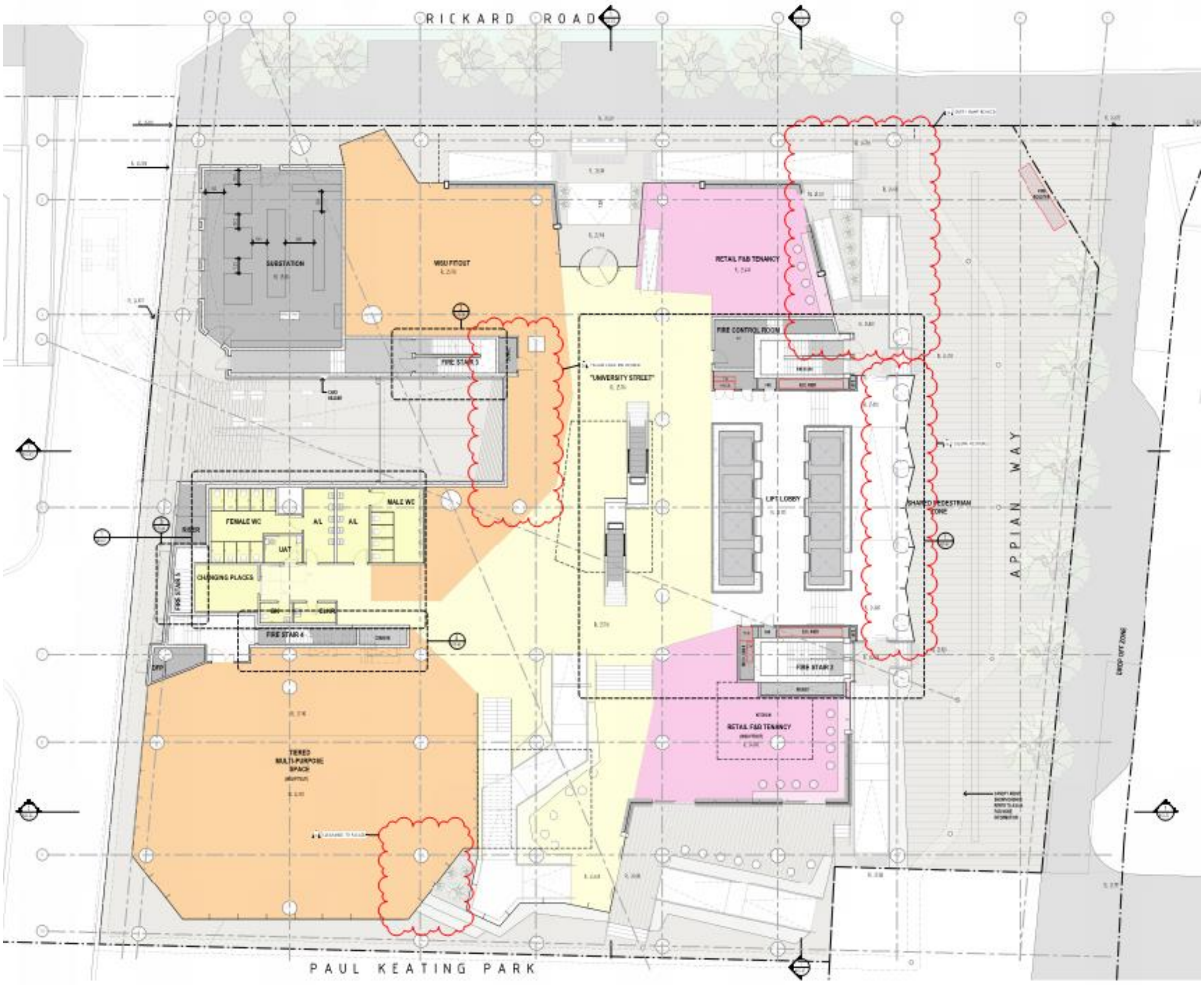


Figure 4-1: The Architectural Site Plan –Ground Floor (by Lyons Architects)

4.1. Civil Siteworks

The civil site works include repaving of the shared pedestrian and drop off area on Appian Way. Custom concrete pavers are proposed as the pavement finish for Appian way. The new pavement may be extended to the edge of building at 66 Rickard Road subject to agreement with adjoining land owner(s). Refer to Civil drawing C00-41 for more details.

Two existing laybacks from Rickard Road (one to Appian way and one down Bankstown Library) are to be modified/extended to cater for the swept paths of service vehicles required for the development. The eastern wing of the Bankstown library layback is to be extended by approximately 800mm. The Appian way layback is to be extended by approximately 8.7m to the east to cater for the new realigned Appian Way road which has been shifted to the east. Refer to Civil drawing C00-41 showing layback extents. The existing 4.2m wide kerb inlet pit lintel on Rickard Road is to be reconstructed and the lintel size is to be maintained. The laybacks have been coordinated with the traffic consultant.

A new layback to the proposed basement is to be provided from the Bankstown Library ramp. The layback is approximately 14.1m long based on swept path analysis of a MRV. No other works along the library ramp are proposed.

New public footpath and bicycle parking is proposed in the public domain areas adjacent to Rickard Road. The footpath is proposed to be widened from existing 1.5m to 3m.

The Rickard Road slip lane to Appian Way is to be repurposed as a 24-hour loading zone (subject to Council/Road Authority approval). New loading zone and no-parking signage is proposed to delineate extent of loading zone. New C1 and L3 line marking is proposed on Rickard Road. Refer to signage and line marking plan C00-90 for more details.

Flush kerbs are proposed along the Appian Way (being a shared pedestrian traffic zone) to the extent shown on Civil siteworks plan C00-41. Bollards are proposed on either side of the flush kerb to delineate traffic path and to enhance pedestrian safety.

4.2. Water Quantity

4.2.1. Catchment Delineation

The Proposed Site is approximately 3673m^2 in area. The existing site is approximately 41% pervious (due to existing landscaping, road verge and plantation). The existing catchment plan is shown in Figure 4-2. The site will be redeveloped into a new educational commercial building. Refer to architectural plans for details. Majority of the post developed site is roofed/impervious with some areas of landscaping on Appian Way and green space on upper levels of the building. It has been assumed for the design of the OSD that the proposed non-roofed area is 95% impervious. The proposed catchment plan is shown in Figure 4-3.

Figure 4-2: Existing Catchment Plan

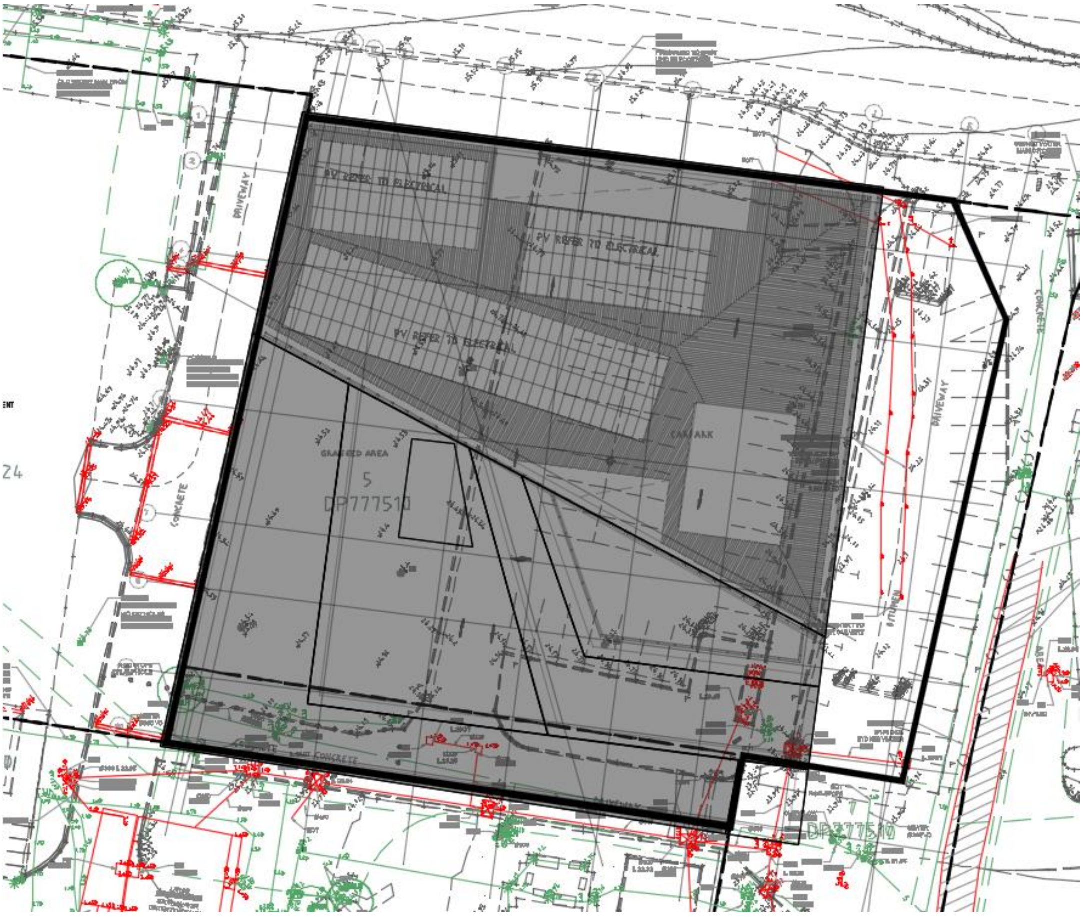


Figure 4-3: Proposed Catchment Plan (hatching represents roof catchment)

4.2.2. Hydrology and Hydraulics

Canterbury Bankstown Council has on-site detention (OSD) requirements. Bankstown City Council Development Engineering Standards states the following:

OSD must be designed and constructed to control stormwater runoff from development sites such that for 5 to 100 year ARI events, peak stormwater discharges from the site do not exceed pre-development stormwater discharges.

OSD storage volume shall be provided such that the total OSD discharge and bypass flow from the site does not exceed the maximum permissible site discharge determined using one of the Council approved calculation methods.

Much of the site is subject to 100 year overland flooding and an OSD is required to be situated above the 100 year ARI flood extent for it to operate. Dispensation for the requirement of an OSD has been requested to Council however disapproved in the letter dated 25 January 2018 on the basis that the OSD would be concealed within the building. Based on this condition, the proposed OSD is shown located on level 1, above the 100 year flood level (refer to civil stormwater drawing).

The hydrology and hydraulic analysis for the proposed site was established using a DRAINS (computer program for hydrological and hydraulic assessment) model in accordance with Council Development Engineering Standards. The Kinematic Wave Equation was used to calculate the time of concentration for each storm event. However given the relatively small site catchment, the time of concentration of 5 minutes (minimum in accordance with Australian Rainfall & Runoff) has been adopted.

The intensity-frequency-duration (IFD) data for the site was extracted from Bureau of Meterorology's data from Australian Rainfall and Runoff 2016 with 10 temporal patterns for each storm duration. The IFD data is provided in **Appendix B**. The percent impervious area for the existing and proposed site was calculated using survey plans by RPS Australia East Pty Ltd and architectural Ground Floor plan revision 24 dated 18.06.2019.

The DRAINS model was used to obtain permissible site discharge (PSD) for existing scenarios in accordance with Bankstown City Council 2009 Development Engineering Standards and as well as to design the on-site detention tank located in level 1 maintaining PSD. The DRAINS model flows were obtained for 5 year, 20 year and 100 year ARI storm events.

With regard to the tailwater level, the OSD outlets to a new stormwater pit constructed over an existing stormwater line. From a flood analysis of the site, the 100 year flood level at the connection pit is nominally RL24.2. This level sets the tail water level at the outlet for hydraulic analysis using DRAINS for the 100 year ARI storms. The 5 year ARI tail water level has been set to freely discharge to atmosphere tailwater level in the 5 year as it is not expected to produce significant backwater effects to an OSD located on level 1. The DRAINS results are provided in **Appendix B**. The Civil and Stormwater Drawings for the site is provided in **Appendix A**.

4.2.3. Permissible Site Discharge (PSD)

The 5, 20 and 100 year permissible site discharges (existing site discharge) are summarised in a tabular format below. As catchments external to the site do not drain to the proposed OSD (located within the building), external catchments have been excluded from the OSD design and DRAINS modelling. A schematic diagram of DRAINS model for the existing and proposed scenario is shown below in Figure 4-4. The 5 and 100 year PSD DRAINS results are shown in Figure 4-5,Figure 4-6 and Table 4-1.

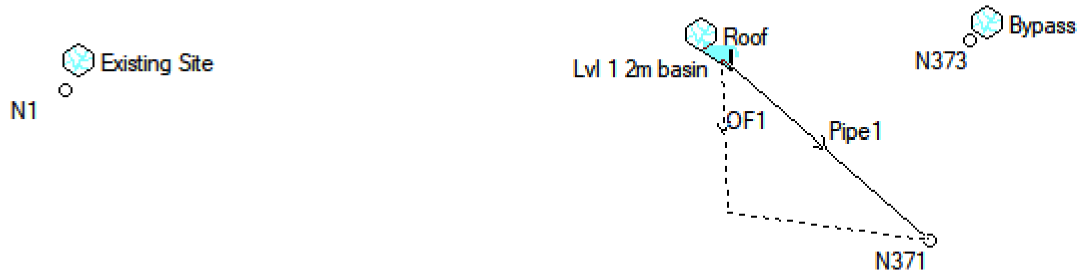


Figure 4-4: A Schematic diagram of DRAINS (Hydrological and Hydraulics) Model for existing and proposed scenario

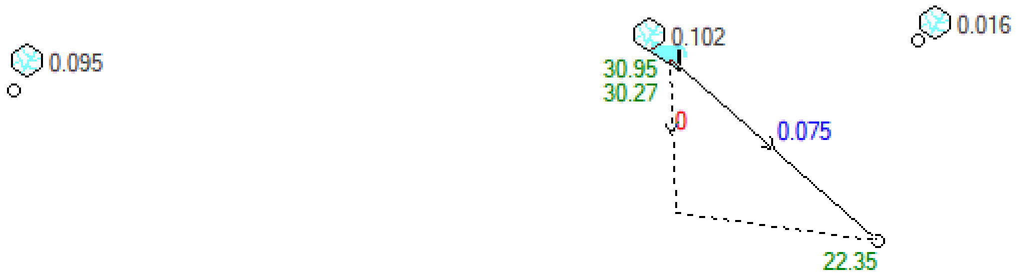


Figure 4-5 5 year DRAINS result

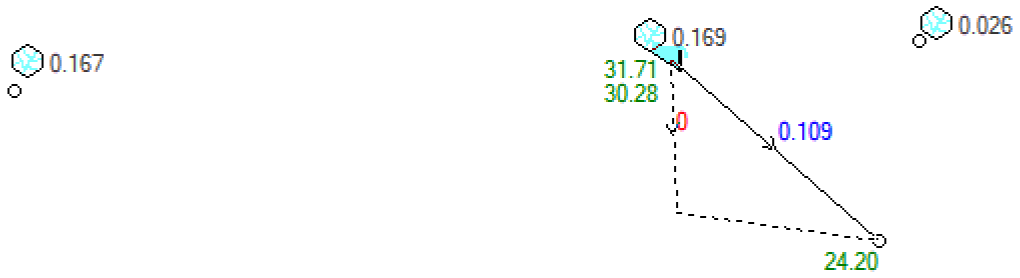


Figure 4-6 100 year DRAINS result

Table 4-1: Summary of PSD for the Site

Nodes	Area (ha)	PSD (Permissible Site Discharge) (m3/s)			Time of Concentration (t_c) minutes
		5yr	20yr	100yr	
Existing	0.3673	0.095	0.136	0.167	5

4.2.4. On-Site Detention (OSD)

The proposed on-site detention tank (OSD) is located on level 1 within the proposed building. The OSD accepts overflows from the rainwater tank which captures runoff from the entire roof catchment. The rainwater tank is assumed full when modelling 5, 20 and 100 year storm events. All the stormwater runoff from building roof and terraces (approximately 3169m^2) drain to proposed OSD through downpipes (to be designed by the hydraulic engineer). On grade areas outside the footprint of the building (which are subject to overland flooding) bypasses the OSD. A comparison in peak flows from the site are summarised in Table 4-2 below showing that there is a reduction in peak flows with provision of the OSD tank.

Table 4-2: Summary of the Existing and Proposed Peak Flows at Site Outlet

Scenarios	Area (ha)	PSD (Permissible Site Discharge)* (m3/s)			Time of Concentration (t_c) minutes
		5yr	20yr	100yr	
Existing	0.3673	0.095	0.136	0.167	5
Proposed OSD + bypass		0.091	0.114	0.135	5

The details of proposed OSD system to detain peak flows and provide storage requirements are summarised in a tabular format below.

Table 4-3: The proposed OSD System (Designed using DRAINS Model)

Items		Design Storm Events (ARI)		
		5yr	20yr	100yr
Peak Flows from OSD (m^3/s)		0.075	0.093	0.109
Total volume provided (m^3)		35		
Top water Levels (m AHD)		30.948	31.298	31.709
Discharge Control Outlets	Primary	209mm dia. Orifice @ RL 30.35 centre		
	Secondary	N/A		
High Early Discharge [HED] Pit		N/A		
Surcharge Pit		1 x 900mm x 900mm SQ Stormwater Pit		
Maintenance Hatch		900mm x900mm SQ Stormwater access to provide maintenance and access to the OSD		

The above results demonstrate that, the proposed OSD has reduced the peak flows to PSD. The OSD design is in accordance with *Development Engineering Standards, 2009 by Bankstown City Council* and fulfils the following SEARs requirements:

1. Stormwater plans detailing proposed methods of drainage without impacting on the downstream properties.
2. The EIS must assess the impact of the development on hydrology including mitigating effects of the proposed stormwater after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options (refer to water quality section for re-use).

4.3. Water Quality

SSD9831 SEARS state the following:

- *Detail measures to minimize operation water quality impacts on surface waters and groundwater.*

- *The EIS must assess the impacts of the development on water quality including the nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the water quality objectives where they are currently being achieved, and contributes towards achievement of the water quality objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater during (refer to Sediment Erosion Section of this report) and after construction.*

- *The EIS should assess, quantify and report on water conservation, including practical opportunities to implement water sensitive urban design principles.*

The requirements from section 9.3.8 of Bankstown City Council 2009 *Development Engineering Standards* in relation to stormwater quality and pollution control specify that trash screens and silt arrestors are to be provided at the last stormwater pit discharging to the Council's drainage network. Whilst there are no specific pollutant reduction targets specified in Bankstown City Council Development Engineering Standards, Column A of Green Building Council of Australia *Green Star- Design & As built Stormwater* specify the following pollutant reduction targets in order to qualify for green star credit. These targets provide greater controls on stormwater quality than Council and as such, the proposed development shall be demonstrated to meet these pollutant reduction targets by Green Building Council of Australia:

- *Reduction of Mean annual Load of Gross Pollutants – 85%*
- *Reduction of Mean annual Load of Total Suspended Solids – 80%*
- *Reduction of Mean annual Load of Total Phosphorous –30%*
- *Reduction of Mean annual Load of Total Nitrogen – 30%*

4.3.1. Water Quality Strategy

Majority of the site is currently used for carparking. The site does not currently have any water quality treatment measures. The conversion of the carpark into a new building with roofed catchments already provides significant water quality improvements to the existing situation. The proposed development shall demonstrate water sensitive urban design (WSUD) and shall demonstrate further improvements to water quality by meeting the water quality targets specified above by Green Building Council of Australia.

The proposed site has been distributed into sub-catchments based on the specific WSUD measures required for the site. The sub catchments include a roofed area of approximately 0.316ha and remaining pedestrian area along Appian Way. The entire roof area drains to a 45kL rainwater tank where treatment is provided in the form of rainwater reuse (reuse data supplied by the Hydraulic Engineer which indicated nominally 12959.1kL/yr). Overflow from rainwater tank is routed to the OSD tank before discharging to an enviropod located on Appian Way and then discharging out of the site. The remaining site area (Appian Way) drains to the same stormwater pit fitted with an enviropod. Refer to civil siteworks and stormwater plan for detail. This strategy provides water quality measures for the roof as well as treatment measures for Appian Way.

The water quality model for the site is established using MUSIC (version 6.3). For water quality modelling purposes, only site catchment areas are modelled, and the upstream external catchments have been excluded as treatments only pertain to the subject development No Council MUSIC Link models are available therefore the closest available 6 minute rainfall and evapotranspiration data, being Sydney Airport, has been adopted for the model. The rainfall runoff parameters have been adopted from Sydney Catchment Authority *Using MUSIC in Sydney's Drinking Water* Catchment with silty clay being the dominant soil description as per Douglas Partners Geotechnical Report. The pollutant generation parameters, rainwater tank, enviropod and soil properties adopted in MUSIC are provided in **Appendix C.** A screenshot of the MUSIC model is shown in Figure 4-7. Table 4-4 summarises the water quality catchments used in the MUSIC model.

Table 4-4: Summary of Sub-catchments and Water Quality Measures for overall Site

Sub-catchments	Area (ha)	Impervious Fraction (%)	WSUD Treatment Measures	Comments
Roof	0.316	100	Rainwater Reuse, Enviropod	
Urban (Appian Way)	0.050	95	Enviropod	
Total	0.366	-		

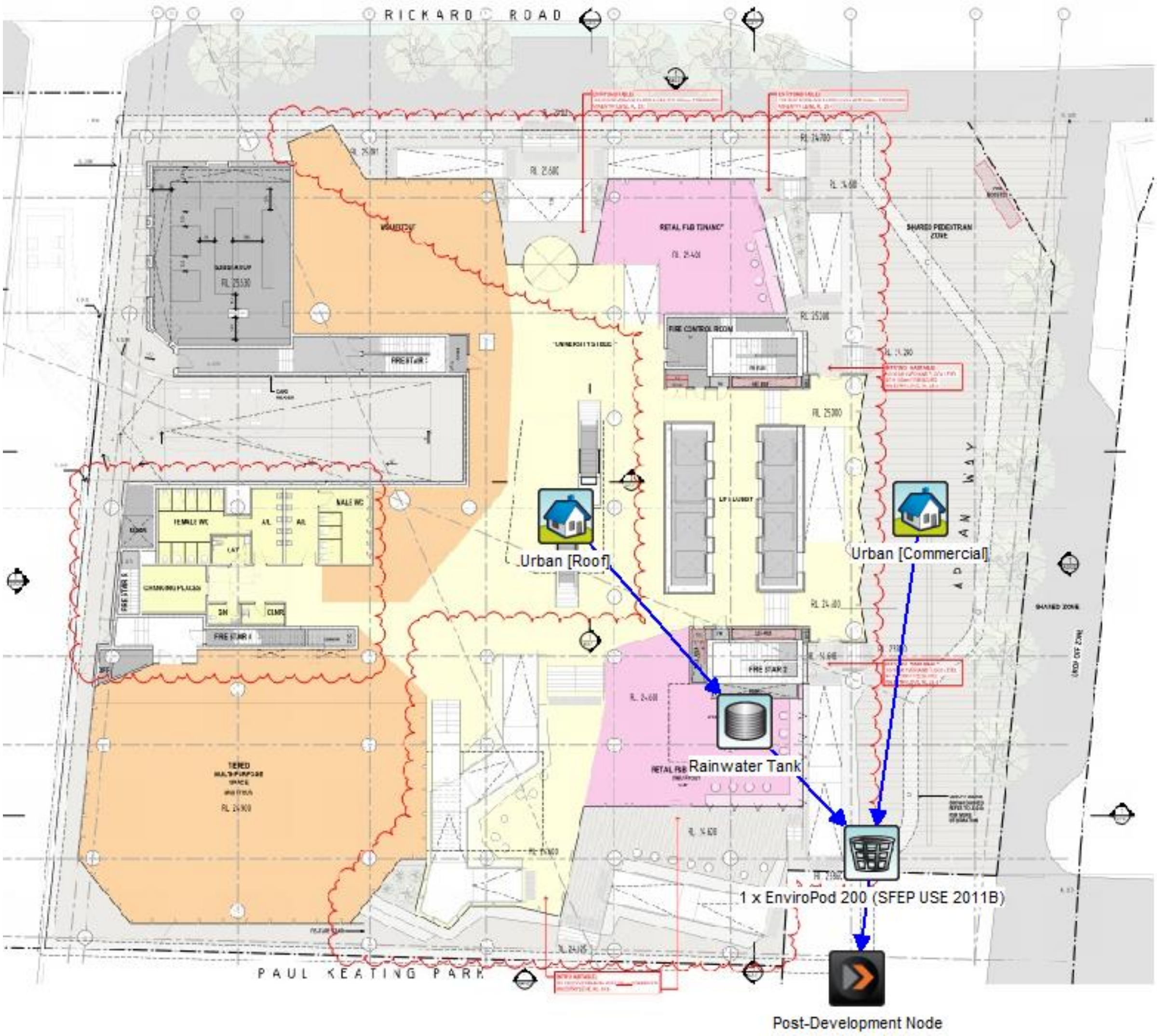


Figure 4-7: A Schematic Diagram of the Music Model Showing Existing and Proposed Scenario

4.3.2. Water Quality Results

The results of MUSIC modelling show that surface waters have been treated and the pollutant removal rate achieves pollutant reduction targets provided in *Section 4.3*. The results from the MUSIC model are shown below in Figure 4-8 as a screen shot. Douglas Partners Geotechnical report has indicated that ground water is sufficiently deep (approx. 8m below). It is not envisaged that the development would have any negative impacts on groundwater quality.

Treatment Train Effectiveness - Post-Development Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	2.69	1.03	61.6
Total Suspended Solids (kg/yr)	121	22.6	81.3
Total Phosphorus (kg/yr)	0.454	0.144	68.2
Total Nitrogen (kg/yr)	5.93	1.82	69.3
Gross Pollutants (kg/yr)	80.2	0.0905	99.9

Figure 4-8: Music model Results

4.4. Flooding

4.4.1. Objectives

The Secretary's Environmental Assessment Requirements are as follows:

1. Provide an assessment of any flood and stormwater flow risk on site and beyond the site and consideration of potential effects of climate change, sea level rise and rainfall intensity. This should take into consideration risks on the safety of people, particularly within the public domain areas downstream from the site.

2. The EIS must map the following features relevant to flooding as described in the Floodplain Development Manual 2005 including flood prone land, flood planning area, hydraulic categorization and flood hazard

3. The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events including a minimum of the 5% AEP, 1% AEP and the probable maximum flood (PMF).

4. The EIS must model the effects of the proposed development on the flood behavior under the following scenarios:

    - *Current flood behavior for a range of design events as identified above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall due to climate change.*

5. Modelling in the EIS must consider and document:

- *Existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies.*
- *The impact on existing flood behaviour for a full range of flood events including up to the PMF*
- *Impacts of the development on flood behaviour resulting in detrimental changes in potential flood affectation of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazard categories and hydraulic categories*
- *Relevant provisions of the NSW Floodplain Development Manual 2005.*

6. The EIS must assess the impacts on the proposed development on flood behavior including:
    - *Whether there will be detrimental increases in the potential flood affectation of other properties, assets and infrastructure.*
    - *Consistency with Council floodplain risk management plans.*
    - *Consistency with any Rural floodplain management plans*
    - *Compatibility with the flood hazard of the land.*
    - *Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land.*
    - *Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.*
    - *Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*
    - *Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.*
    - *Whether the proposal incorporates specific measures to management risk to life from flood. These matters are to be discussed with the NSW SES and Council.*
    - *Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood). These matters are to be discussed with and have the support of Council and the NSW SES.*
    - *Any impacts the development may have on the social and economic costs to the community as a consequence of flooding.*

Canterbury Bankstown Council DCP and Canterbury Bankstown Stormwater System Report has the following requirements:

7. Habitable floor levels are to be 500mm above the 100 year ARI flood level;
8. Driveways to basement car parking areas are to incorporate a crest point with a surface level of at least 100mm above the 100 year ARI water surface level;
9. Determine the impact of the development on the 100 year ARI inundation levels and on adjoining properties.

4.4.2. Scope

This report details a local overland flood study consistent with Salt Pan Creek Flood Study The scope includes:

10. Prepare a hydraulic model (TUFLOW) for overland flood study for the existing site;

11. Prepare a hydraulic model (TUFLOW) for overland flood study for the proposed site;

12. Show flood behaviors in terms of flood depths, levels, hazard and afflux (i.e. impact) at and around the subject site for 5%, 1%, PMF, 0.5%, 0.2% AEP events;

13. Comment on measures needed to comply with Authority's requirements.

4.4.3. Catchment Description

The site is located within the Salt Pan Creek catchment which is a tributary of Georges River in Sydney's south. The catchment is approximately 26km^2 and the site is subject to overland flooding in the 100 year ARI event (refer to the Salt Pan Creek Stormwater Catchment Study by BMT WBM and Bewsher in 2011). Upstream catchment falls to a local sag kerb inlet pit on Rickard Road which is assumed to be connected to a 2.4m wide culvert. In major storms, flood waters overtop the crest and flows down Appian way towards Bankstown Station. Parts of the overland flows are captured by a series of pit and pipe network further south of the site which are assumed to also be connected to the 2.4m culvert. Due to this, it is imperative that the overland flow path is maintained and remains unobstructed such that no adverse flooding impacts occur at neighbouring properties. The site is subject to overland flooding and is unlikely to be affected by backwater conditions from Salt Pan Creek.

The existing Council flood study (BMT WBM 2011 Salt Pan Creek Stormwater Catchment Study) defined existing flood behaviours throughout the Salt Pan Creek study area including the analysis of surface runoffs, flows within underground pipe drainage networks and flooding within open drains and watercourses. The subject site falls within the flood prone land of the study area. The study has provided existing flood depths and levels at the site. The figures below have been extracted from the study and shows the extent of PMF inundation (flood prone land), hydraulic categorisation and hazard. The figures show much of the existing site is a medium flood risk precinct with Appian Way (currently zoned for shared pedestrian and traffic) being a high flood risk precinct.

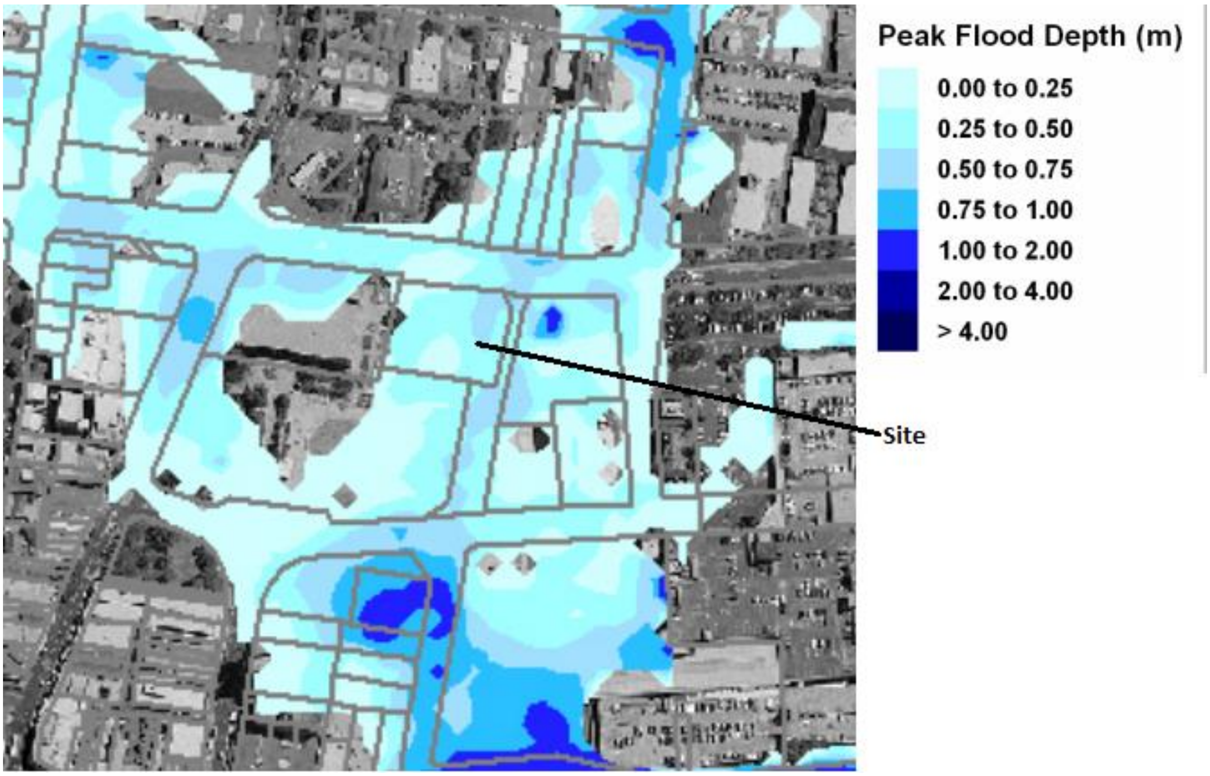


Figure 4-9 PMF Extent (Flood prone land) extract from BMT WBM SPC Flood Study

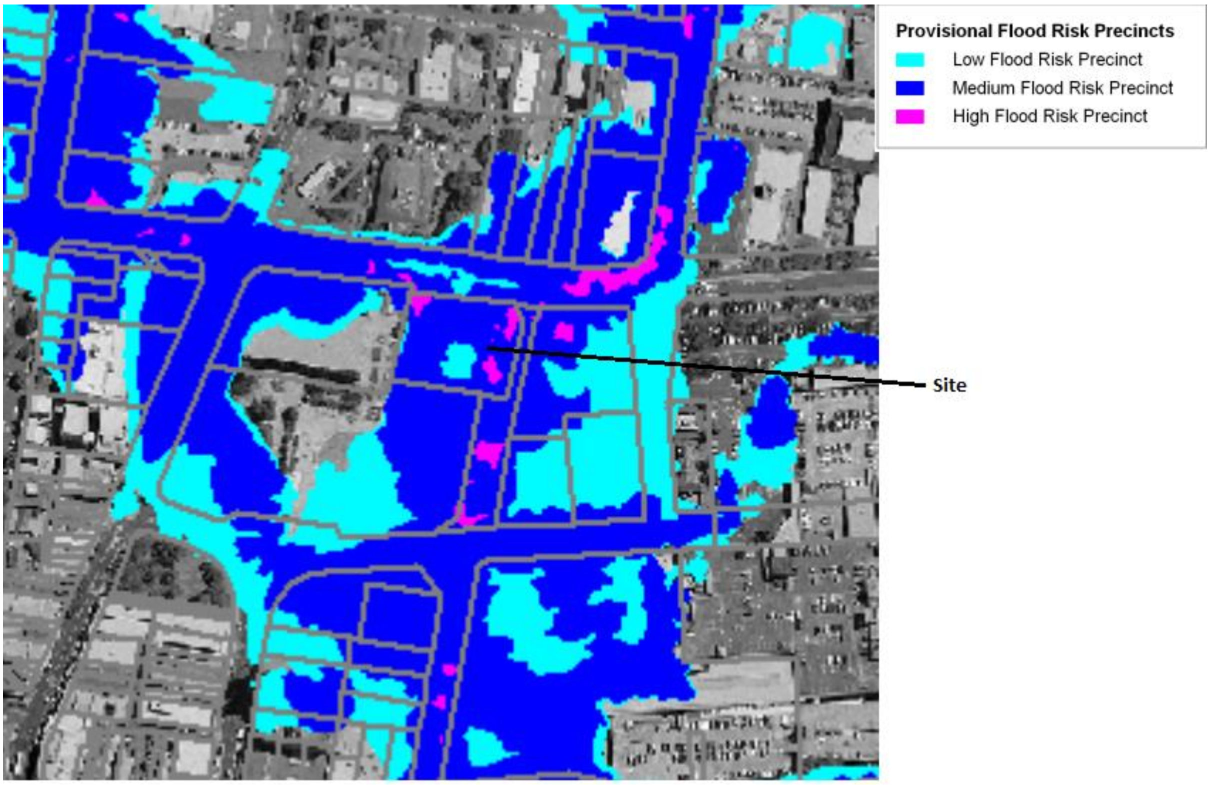


Figure 4-10 Provision Flood Risk Precinct Map extract from BMT WBM SPC Flood Study

4.4.4. Available Data

Canterbury Bankstown Council has provided to Bonacci TUFLOW PO line from the Salt Pan Creek Flood Study to be used as model inflow boundaries for a site-specific overland flood analysis. The supplied PO lines include the 5% AEP 2hr, 1% 2hr and PMF 2hr hydrographs at specified locations upstream of the subject site.

To generate 0.5% 2hr and 0.2% 2hr AEP hydrographs, a multiplication factor has been applied based on the Council supplied 1% AEP flood hydrograph. The multiplication factor is based on the 2016 IFD data from BOM (Figure 4-11). The multiplication factor for 0.5% and 0.2% AEP is 10% and 24% respectively. It should be noted this is only an approximation to the 0.5% and 0.2% AEP events for the purposes of using these events as proxies for climate change as required by SEARS.

	Annual Exceedance Probability (1 in x)				
Duration	**1 in 100**	**1 in 200**	**1 in 500**	**1 in 1000**	**1 in 2000**
1 min	5.08	5.54	6.27	6.83	7.39
2 min	7.85	8.64	9.80	10.7	11.6
3 min	11.1	12.2	13.8	15.0	16.3
4 min	14.2	15.5	17.5	19.1	20.7
5 min	17.0	18.6	21.0	22.9	24.8
10 min	27.7	30.1	34.1	37.1	40.1
15 min	34.6	37.7	42.6	46.4	50.2
20 min	39.5	43.1	48.7	53.0	57.4
25 min	43.2	47.2	53.4	58.2	63.0
30 min	46.3	50.6	57.3	62.4	67.6
45 min	53.3	58.3	66.0	72.0	78.0
1 hour	58.6	64.2	72.7	79.2	85.8
1.5 hour	67.3	73.6	83.3	90.8	98.4
2 hour	74.8	81.7	92.5	101	109

Figure 4-11 2016 IFD from BOM

The model inflow boundaries are routed through a digital elevation model (DEM). 1 metre LIDAR and ground survey data has been used to form the DEM. The LIDAR has been obtained from ELVIS (Elevation Information System) NSW Government Spatial Services and the ground survey has been patched over the LIDAR to more accurately represent the existing carparking terrain conditions.

The roughness of the floodplain is represented in the model using the Manning's roughness coefficient n. The Salt Pan Creek Flood Study Manning's roughness has been adopted in this study to maintain consistency within Council's modelling protocols.

4.4.5. Model Build

Bonacci has prepared the site-specific hydraulic model using the hydrodynamic modelling program TUFLOW to be consistent with the Salt Pan Creek Stormwater Catchment Study 2011 by BMT WBM.

The ground surface terrain of the model has been built using 1m LIDAR data from NSW Government Spatial Services and ground survey produced by RPS Australia East Pty Ltd. A 1m grid size has been adopted and the Council-supplied hydrographs have been routed through the above ground surface model to produce existing and proposed flood results. As the storage and conveyance capacities of 1d drainage networks have already been incorporated into TUFLOW PO lines (containing the hydrographs) supplied by Council, this site-specific flood study details the routing of flood waters through 3d ground surface for overland flow analysis only so the effects of 1d drainage networks are not duplicated.

Existing buildings have been modelled using raised elevations representing the existing finish floor levels. The extent and layout of the buildings have been based on google maps. Finer ground features which play a role in the control of water flow such as kerbs and walls have been digitised via 2d_zsh breaklines. For example, the wall adjacent to the Bankstown library ramp wall off Rickard Road prevents some of the flood waters from entering down the ramp directly. This is shown in figure below.

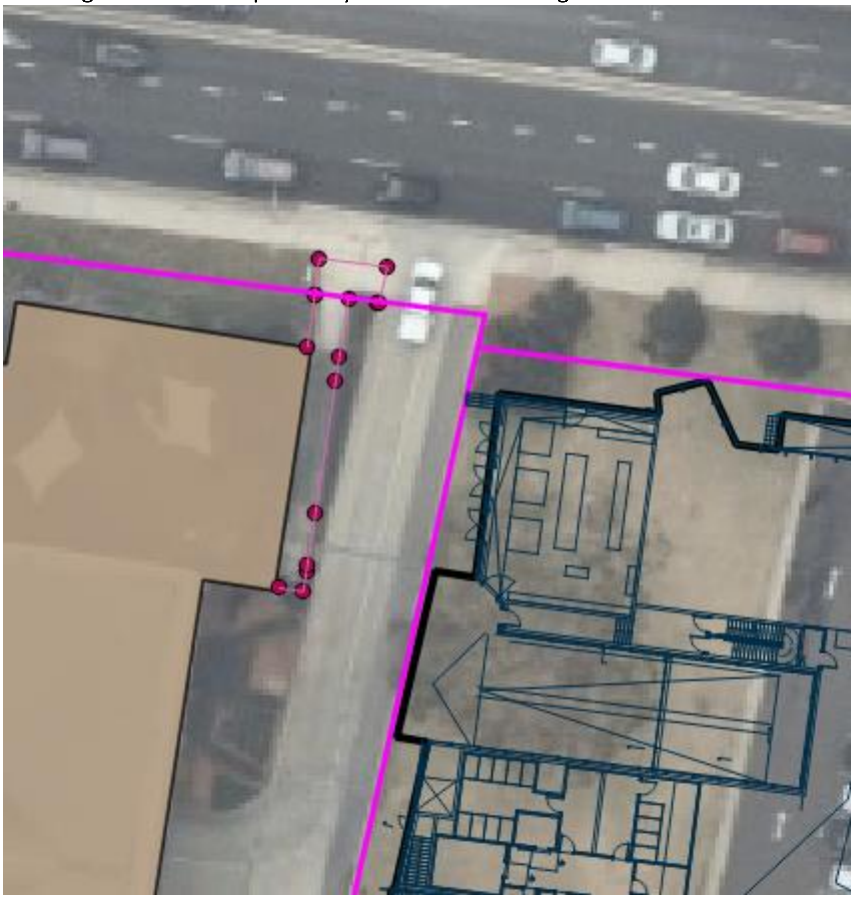


Figure 4-12 Digitisation of wall adjacent to Bankstown library ramp

Checks in relation to mass balance errors have been made to confirm the validity of the model. As the HPC (heavily Parallelised Compute) method has been used, checks for mass balance have been made against the timestep of the model. The timestep used in the model were within the acceptable range (typically >0.1s) (refer to TUFLOW 2017 manual). The site specific hydraulic model is therefore considered stable.

4.4.6. Model Results

The proposed building is located on a major overland flow path and it is envisaged that any major forms of blockage in this overland flow path would cause adverse flooding impacts to adjacent properties. Consequent to this, the shape of the building plays a major role in facilitating this overland flow path. Additionally, since flow paths have become restricted by the new building and flood waters have become displaced by the proposed building, it is essential that compensatory lowering of the ground level on Appian way is provided to reduce flood impact to adjacent properties. Any forms of blockages should be minimised on Appian way.

Preliminary Appian way ground levels have been modelled in TUFLOW (refer to civil siteworks and stormwater plan for detailed levels and contours) which took into consideration levels and gradients needed for DDA compliance as well as levels needed to have nil adverse flood impact. These ground levels produced associated flood depths, heights, afflux and flood hazard which are shown in figures below. The ground surface design is subject to other constraints including compliance with the landscape architect's strategy, DDA compliance and compliance with traffic and urban design objectives.

Figure 4-13 - Figure 4-15 shows the 5% AEP, 1% AEP & PMF flood depths and flood levels of the existing site (refer to appendix for the full map). For events up to 1% AEP, majority of the flow is concentrated at Appian Way while the carpark itself experiences shallow sheet flow. Incorporation of the walls at the Bankstown library ramp suggest that the ramp and Bankstown library ramp is not impacted by the 1% flood. The modelled flood extents are largely consistent with results from Salt Pan Creek Flood Study. Discrepancies can be attributed to the following:

14. Ground survey has been adopted in the site specific TUFLOW model providing greater accuracy of the current and existing terrain.

15. Ground surface has changed due to development in the area between the time when Salt Pan Creek Flood Study was completed till today.

16. Different grid size has been used between the catchment wide flood study and the site specific flood study.

17. Different versions of the TUFLOW software being used. The site-specific model has been run using the more up to date HPC TUFLOW version 2018-03-AC.

The proposed 5% AEP, 1% AEP and PMF flood maps are shown in Figure 4-16-Figure 4-18.

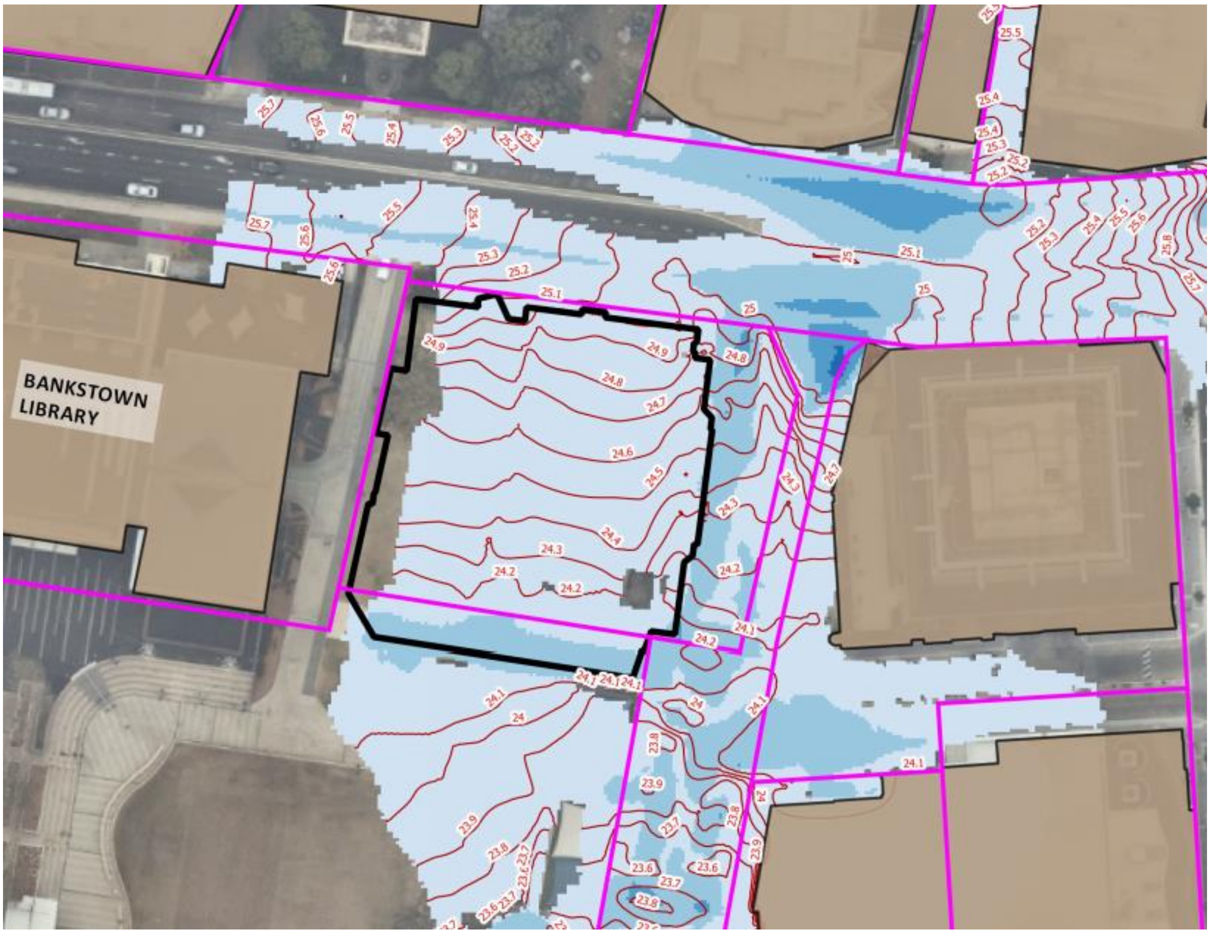


Figure 4-13 5% AEP Flood Depth Existing

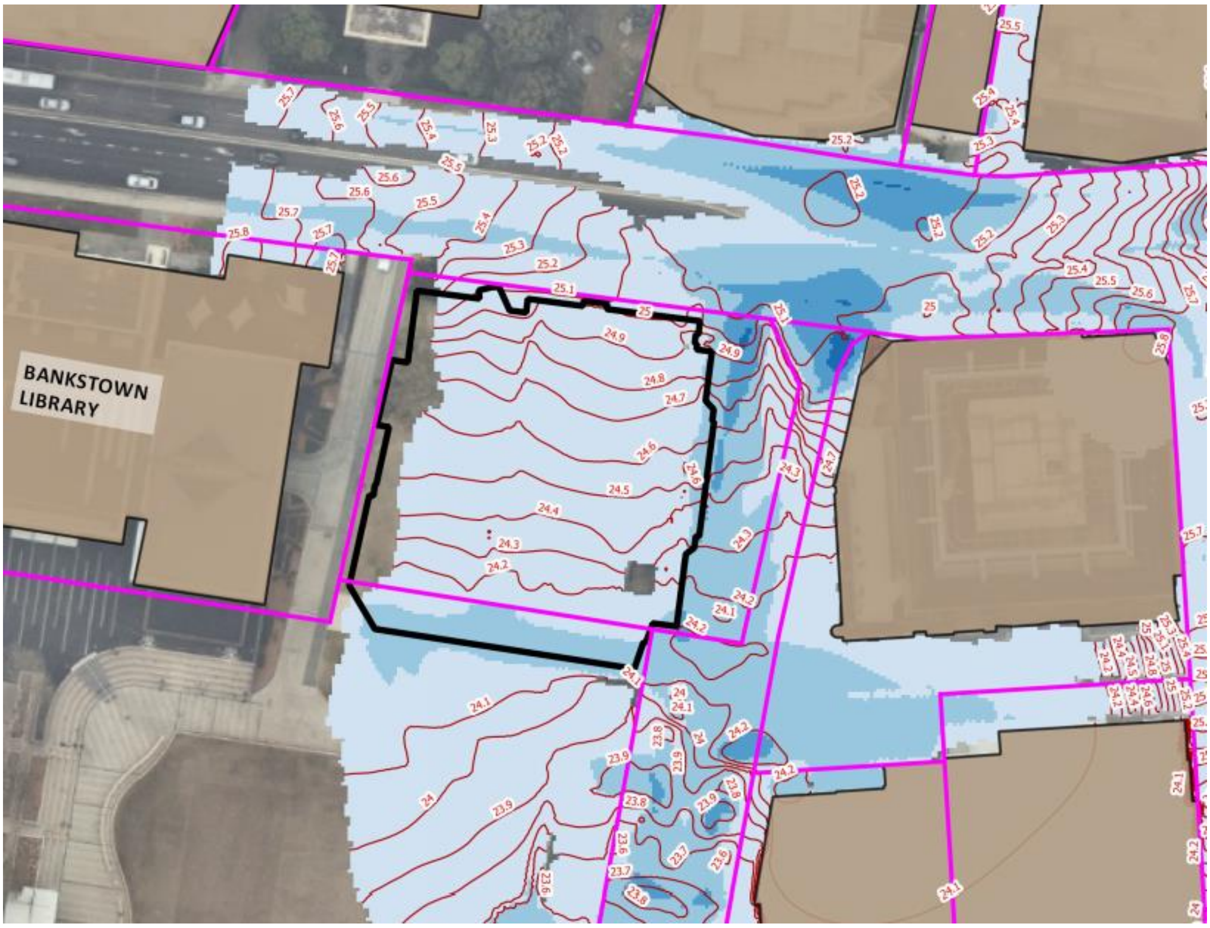


Figure 4-14 1% AEP Flood Depth Existing

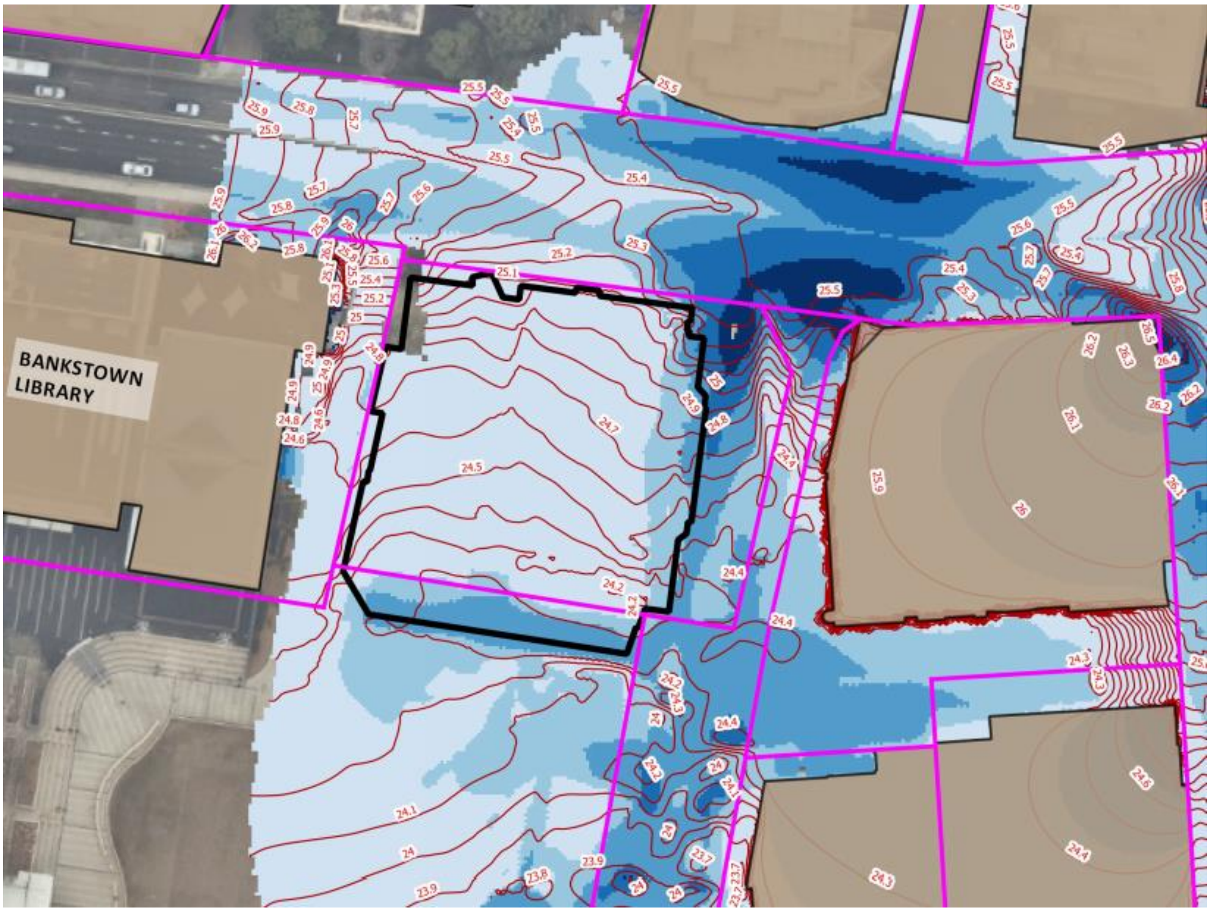


Figure 4-15 PMF Flood Depth Existing

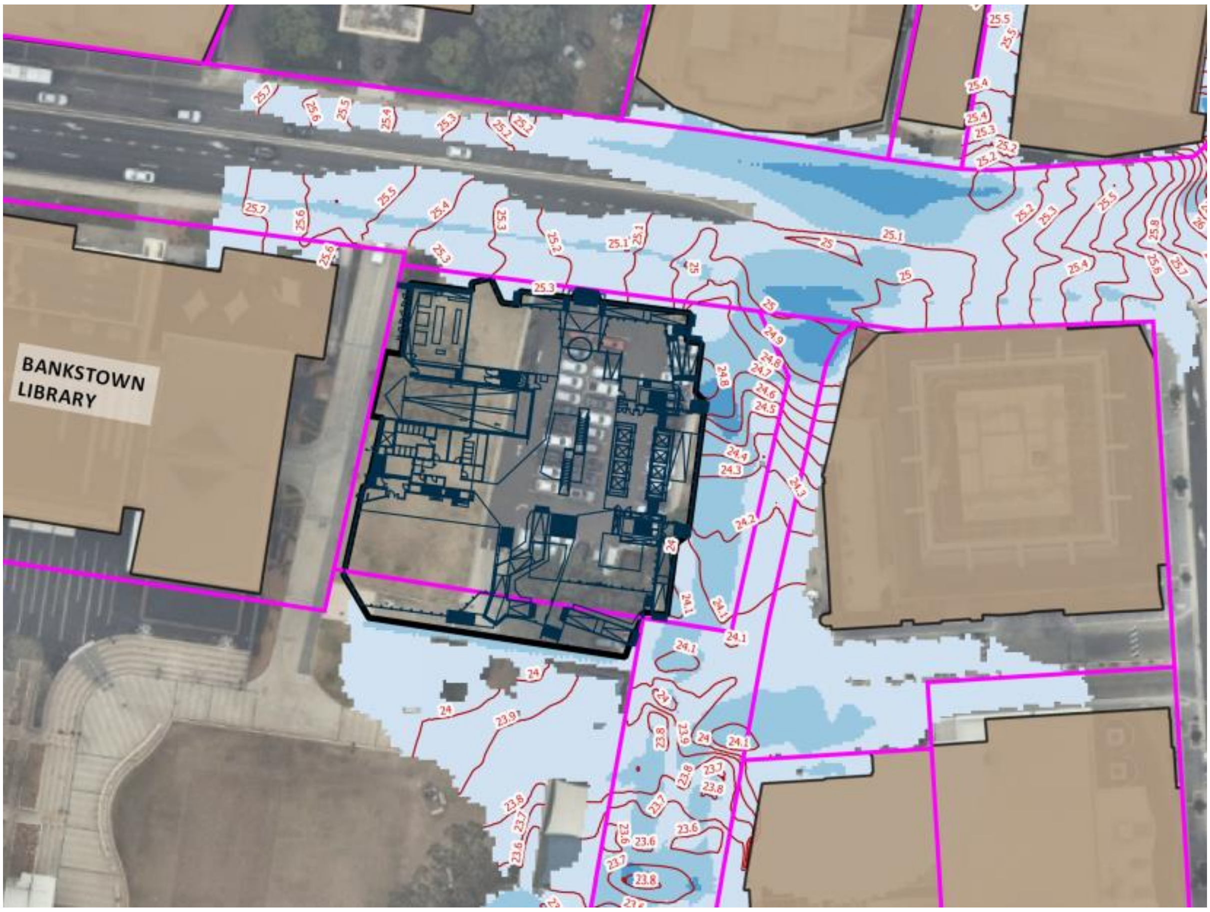


Figure 4-16 5% Flood Depth Proposed

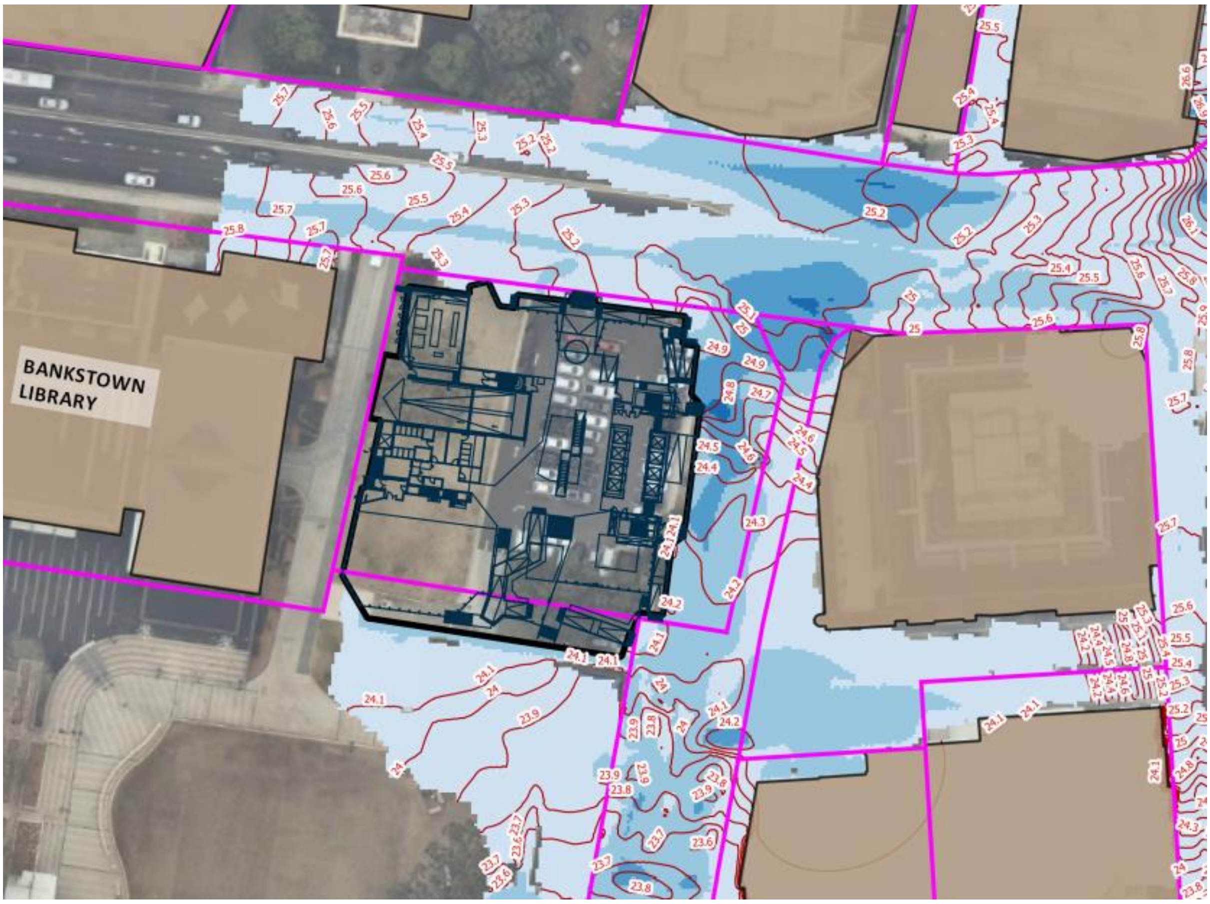


Figure 4-17 1% AEP Flood Depth Proposed

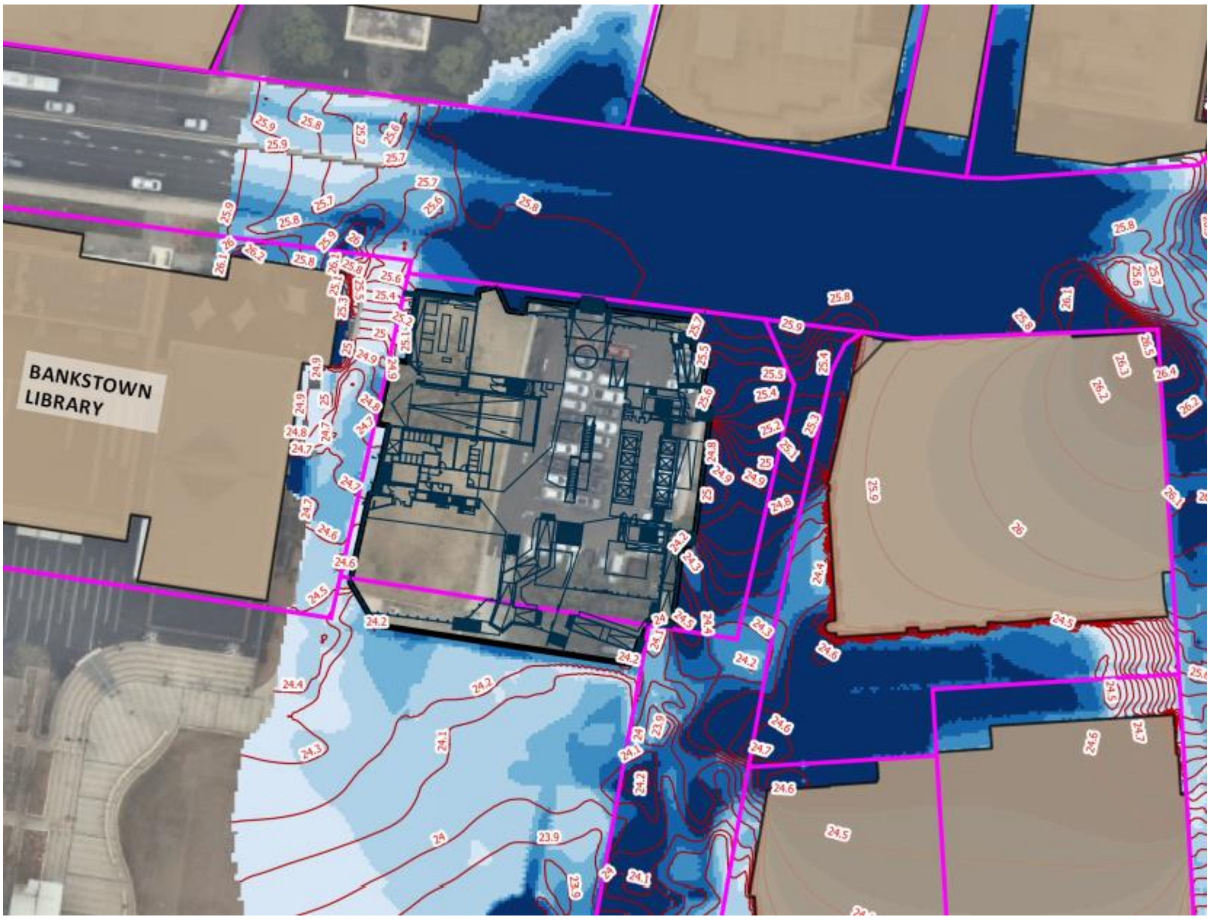


Figure 4-18 PMF Flood Depth Proposed

Canterbury Bankstown Council requires the impact of the development on the 100 year ARI inundation levels and on adjoining properties as per the Stormwater Systems Report dated 17/7/18. The 100 year impact (afflux) flood map is shown in Figure 4-19. Adverse flood impact is represented by yellow, orange or red shading (where flood impact exceeds 10mm). Positive flood impact (i.e. reduction in 100 year ARI flood levels) is represented by blue and light blue shading. Grey represents negligible change. Green represents areas which was flooded but will no longer flood due to the development and brown represents areas which was not flooded but will flood due to the development.

The map shows an overall compliance with Council’s flood impact requirement and this result is achieved due to a compensatory lowering of Appian way ground levels. It can be seen that areas of increased flood is localised on Appian way/Rickard Road and the areas surrounding adjoining properties have all received either a reduction or nil change in flood levels. There are significant areas downstream of the site which have shown green indicating that it is currently flooded but will be dry due to the development. This occurs as the proposed building shields a portion of the flood waters upstream on Rickard Road. To compensate for this, Appian way ground levels have been lowered to increase conveyance and flood storage.

Canterbury Bankstown Council requires habitable floor levels to have 500mm above the 1% AEP flood event at entry points into the building and basement driveways to have 100mm freeboard above the 1% AEP event. 500mm freeboard has been provided at the main north entry with the FFL being RL25.70. Retail FFL adjacent to Appian Way has been set at 500mm above the 1% AEP RL nearest to the entrance. Refer to Siteworks and

Stormwater plan for detailed locations of flood level and corresponding freeboards. At fire stair entrances which provides egress into the basement, 100mm freeboard above the 1% AEP flood RL has been provided. Overall, the design achieves Council's habitable floor freeboard requirements.

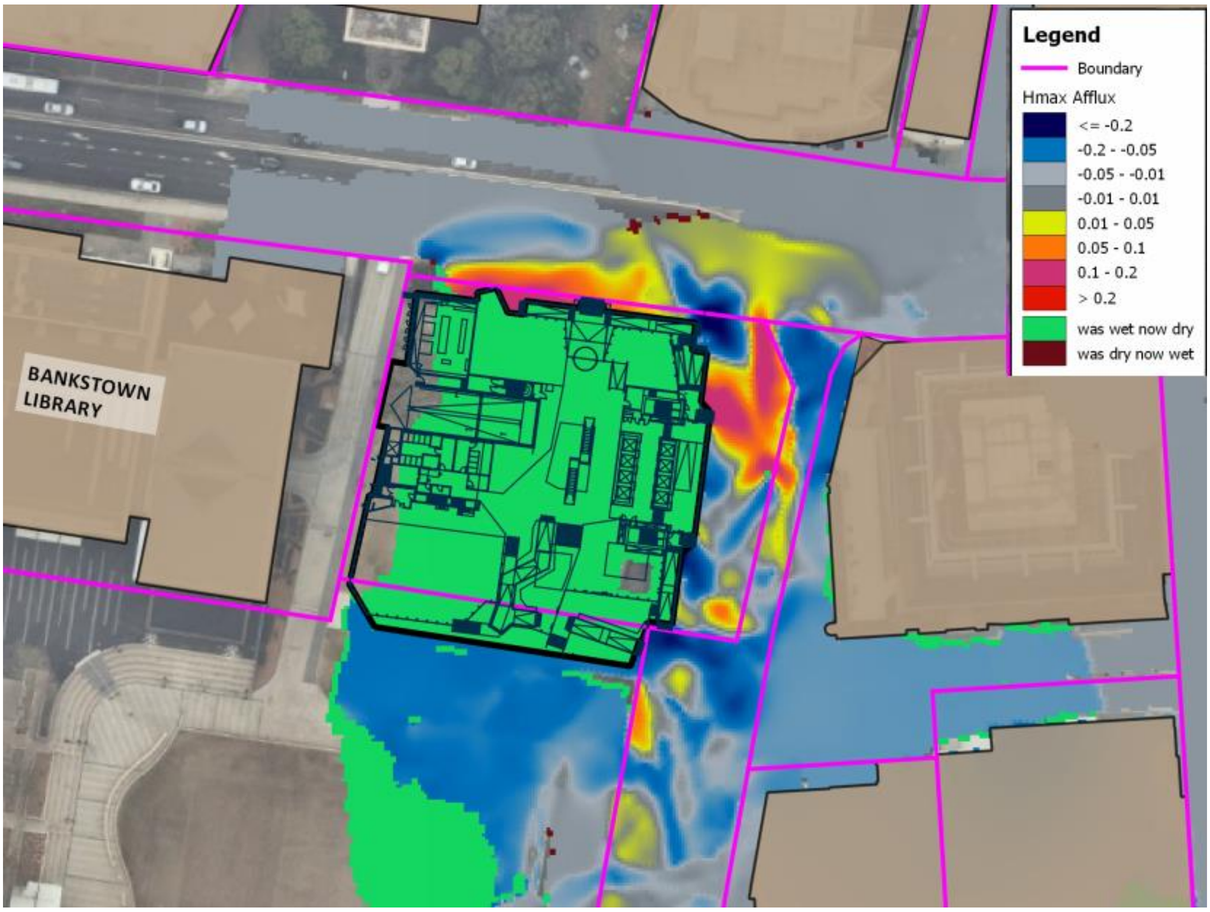


Figure 4-19 1% AEP Afflux Map

Figure 4-20 and Figure 4-21 compares the proposed and existing flood hazard respectively (hazard mapping produced in accordance with the NSW Floodplain Management Manual 2005). Appian Way is currently zoned as shared pedestrian and traffic. Hazard maps show that there is a reduction in flood hazard on the northern section of Appian Way (near existing Bankstown Community Services Centre) in the proposed scenario, offset by a slight increase on Rickard Road. In summary, the high hazard areas have been shifted approximately 30m north away from the existing building towards Rickard Road. The removal of high hazard adjacent to the neighbouring property is a positive outcome from the development. The high hazard is generally consistent in pre and post scenarios.

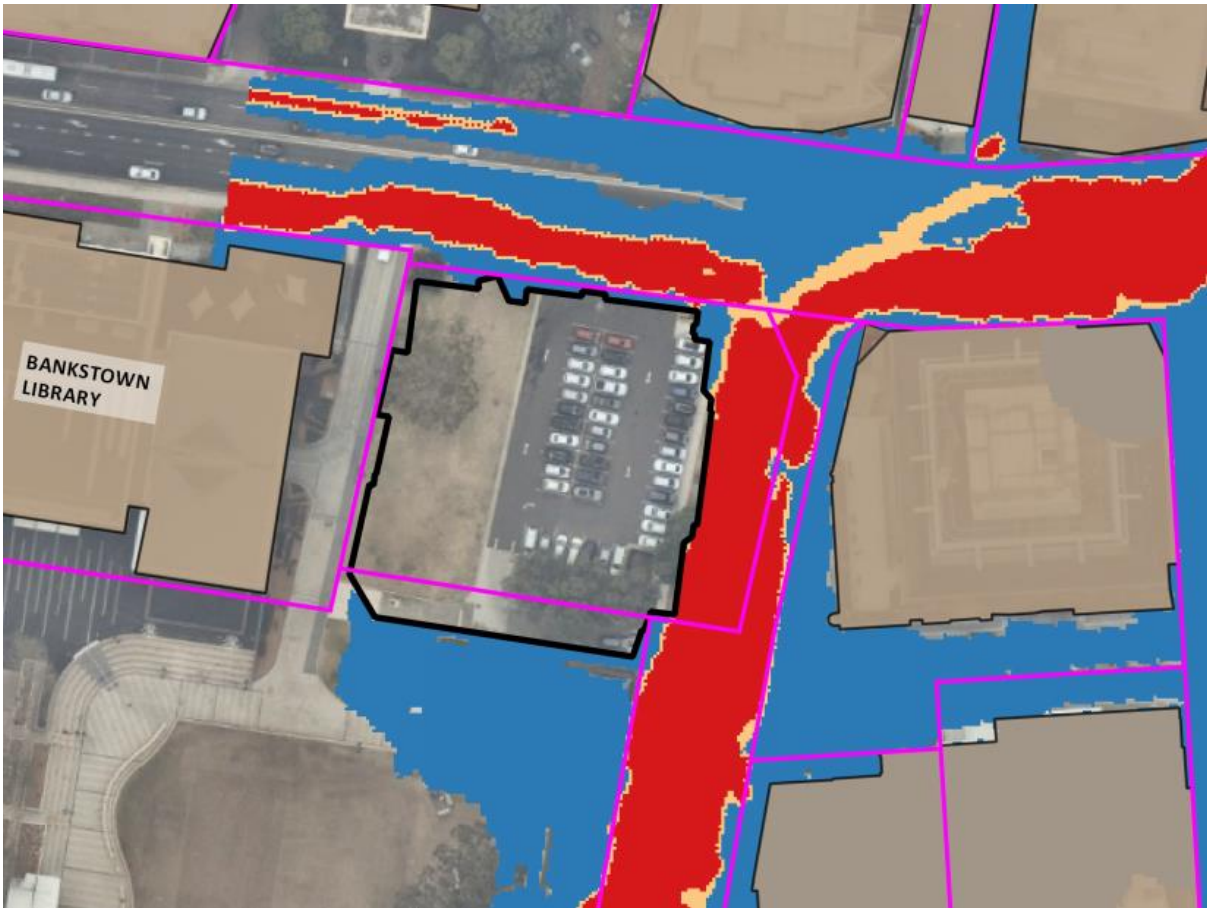


Figure 4-20 Flood Hazard classification (NSW Floodplain Mgmt Manual 2005) proposed design

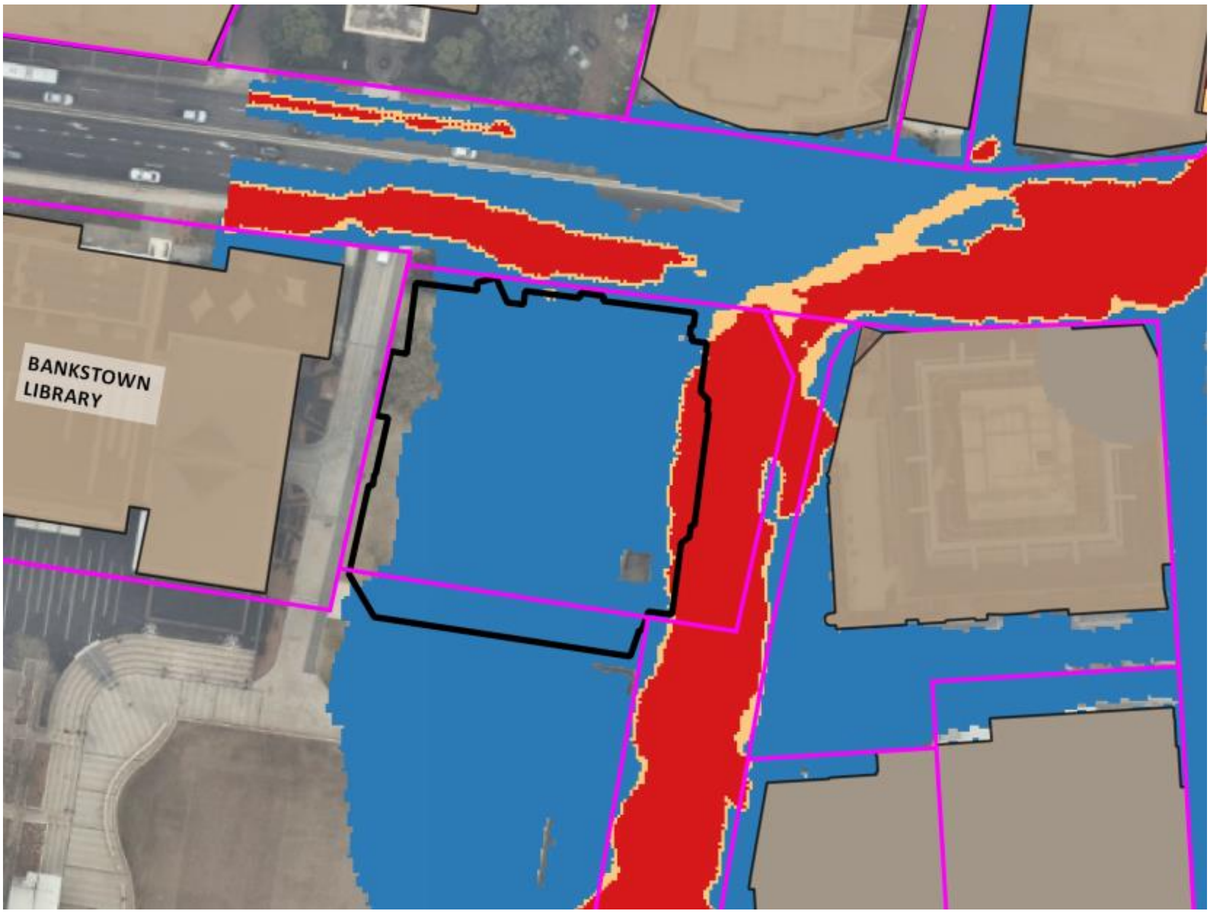


Figure 4-21 Flood Hazard classification (NSW Floodplain Mgmt Manual 2005) existing

4.4.7. Climate Change

0.5% AEP and 0.2% AEP event are to be used as proxies for climate change as per SEARs. The modelled results are shown in figures below for the proposed scenario. Table summarises flood levels at key locations around the proposed site for different AEP events to demonstrate the impact climate change has on the proposed building. The biggest increase in flood level due to climate change is approximately 30mm at the north east building corner.

Table 4-5 Climate Change RLs

Location	1% AEP Flood RL	0.5% AEP Flood RL	0.2% AEP Flood RL
Main North Entry	25.243	24.256	24.27

Location	1% AEP Flood RL	0.5% AEP Flood RL	0.2% AEP Flood RL
North East Building Corner	24.84	24.855	24.875
South East Building Corner	24.065	24.066	24.066
South Main Entry	24.134	24.138	24.140

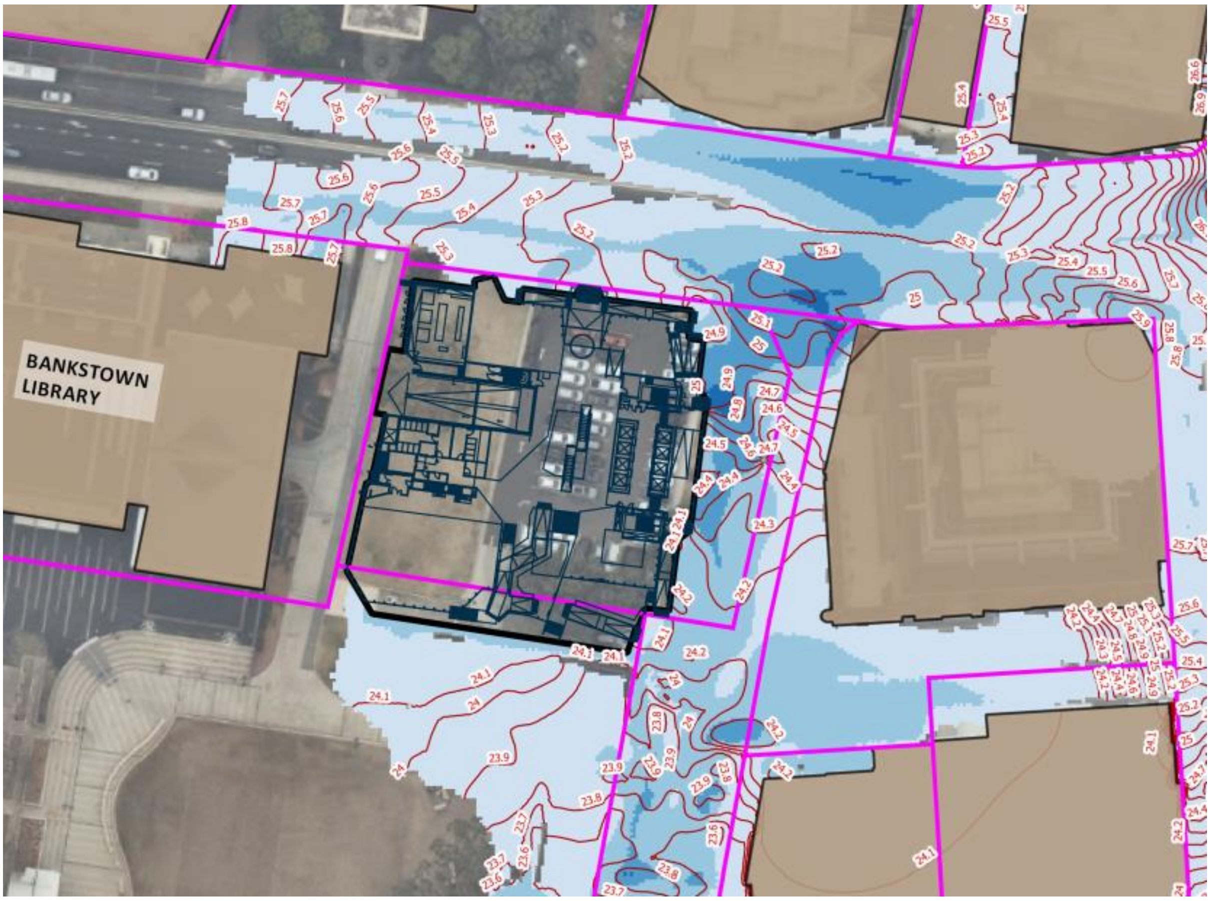


Figure 4-22 0.5% AEP flood depth proposed

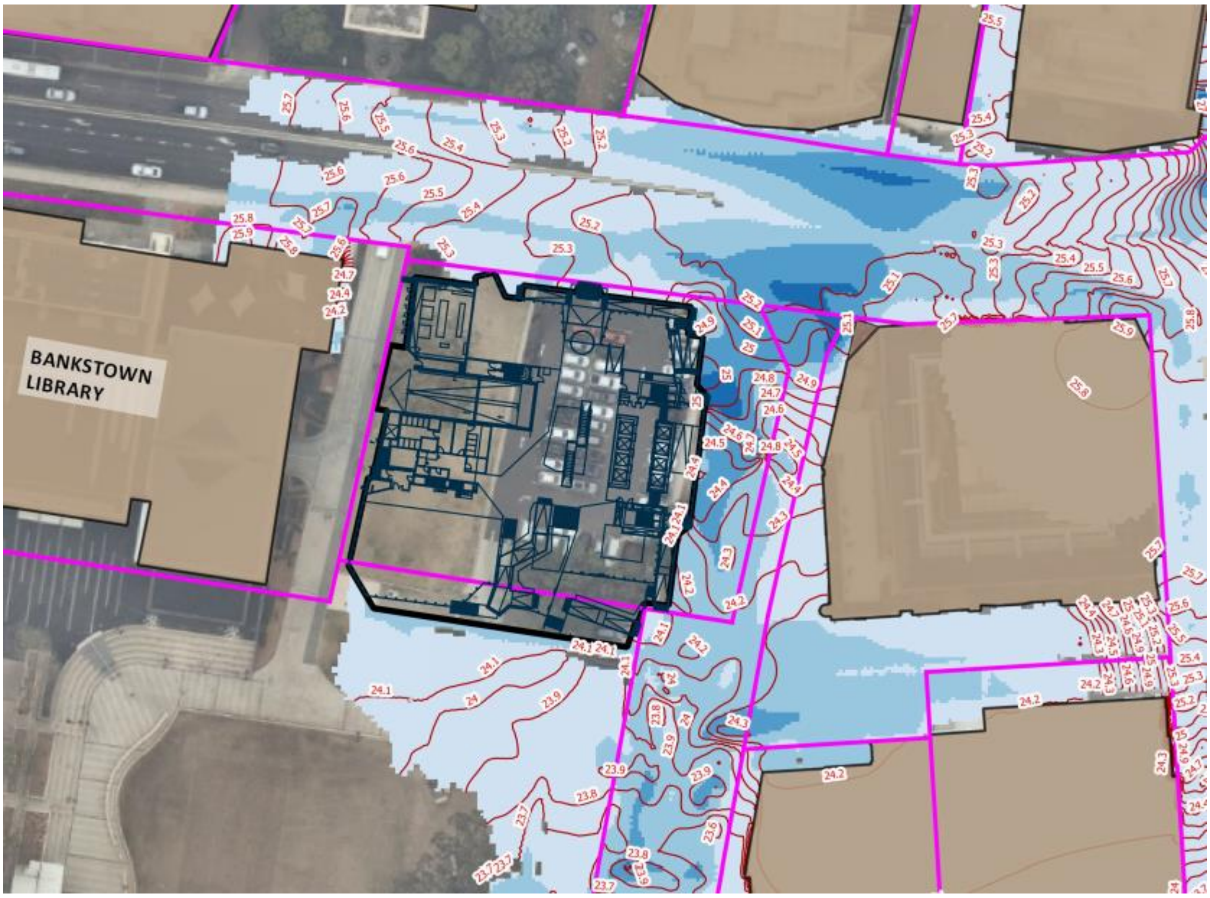


Figure 4-23 0.2% AEP flood depth proposed

4.4.8. Flood Emergency Response Plan

For the following SEARs requirements, refer to the Flood Emergency Response Plan.

- *Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.*
- *Whether the proposal incorporates specific measures to management risk to life from flood. These matters are to be discussed with the NSW SES and Council.*
- *Emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood). These matters are to be discussed with and have the support of Council and the NSW SES.*

4.5. Sediment and Erosion Control

The Secretary's Environmental Assessment Requirements state the following:

18. Detail measures and procedures to minimise and manage the generation and off-set transmission of sediment, dust and fine particles.

19. The EIS must include sediment and erosion control plan.

20. The EIS should assess, quantify and report on runoff impacts during demolition, site preparation, bulk excavation, construction and construction related work.

The bulk earthworks for the proposed development will be subject to an early works development application to be assessed by Canterbury Bankstown Council and are indicatively detailed for information purposes on Drawing No's C00-10, C00-20 and C00-21. Shoring walls are to be provided around the perimeter of basement for excavation. The approximate volume of cut is 25510m^3.

The erosion and sediment control measures for the site will be implemented during construction. The design of these measures is in accordance with the Landcom "Blue Book". Refer to drawings **C00-05** and **C00-06** for the erosion and sediment control plans and typical Detailing.

For erosion and sediment control of the site, the following measures are provided to minimise the risk of sediments being washed into neighbourhood property and erosion of the site.

- *A sediment fence to be provided around the site*
- *catch drain (or diversion bund) diverting external catchment away from site*
- *Temporary access to site with shaker pad*
- *An indicative stockpile area with sediment fence around it during construction. The stockpile must be located out of water flow paths (and be protected by earth banks/drains as required).*
- *Field inlet pit filters or sandbags to be placed around existing stormwater pits.*
- *The excavation of the basement can be used as temporary sediment basin to ensure sediment laden waters are settled/flocculated prior to discharge.*
- *Water cart to spray excavated surfaces to reduce dust pollution.*

5. SUMMARY

The civil design described in this report complies with Canterbury Bankstown Council DCP, SEARS, Bankstown City Council 2009 Development Engineering Standards, Green Building Council of Australia Green Star- Design & As built Stormwater, Australian Standards and best-practiced principles.

The proposed stormwater strategy for this SSDA addresses water quantity by providing an on-site detention tank to reduce peak flow limiting PSD for events up to and including 100 year ARI storm.

The proposed water quality improvement measures (demonstrated in *Section 4.3*) not only improves the existing water quality condition but also meets Green Building Council of Australia “Green Star- Design & As built” Stormwater pollutant reduction targets which provides greater water quality control over and above the requirements from Canterbury Bankstown Council.

The current Appian way ground levels have demonstrated nil flooding impact to adjacent properties. Flood freeboard requirements to the proposed finished floor levels have been met.

Appendix A – IFD Data and DRAINS Results

IFD DATA

Copyright Commonwealth of Australia 2016 Bureau of Meteorology (ABN 92 637 533 532)								
IFD Design Rainfall Depth (mm)								
Issued:	16-Oct-18							
Location								
Requested	Latitude	-33.915	Longitude	151.0357				
Nearest gr	Latitude	33.9125(S	Longitude	151.0375(E)				
		Annual Exceedance Probability (AEP)						
Duration	Duration in	63.20%	50%#	20%*	10%	5%	2%	1%
1 min	1	2.19	2.42	3.12	3.59	4.04	4.63	5.08
2 min	2	3.61	3.91	4.9	5.58	6.27	7.16	7.85
3 min	3	5.01	5.46	6.88	7.86	8.83	10.1	11.1
4 min	4	6.3	6.89	8.75	10	11.3	12.9	14.2
5 min	5	7.45	8.18	10.5	12	13.5	15.5	17
10 min	10	11.8	13.1	17	19.5	22	25.2	27.7
15 min	15	14.7	16.3	21.2	24.4	27.5	31.5	34.6
20 min	20	16.9	18.7	24.2	27.9	31.4	36	39.5
25 min	25	18.6	20.5	26.6	30.6	34.5	39.5	43.2
30 min	30	20	22.1	28.5	32.8	36.9	42.3	46.3
35 min	35	21.2	23.4	30.1	34.6	39	44.6	48.9
40 min	40	22.3	24.6	31.5	36.2	40.8	46.7	51.2
1 hour	60	25.8	28.2	36	41.3	46.5	53.4	58.6
2 hour	120	32.8	35.7	45.2	51.9	58.6	67.7	74.8
3 hour	180	38	41.4	52.5	60.5	68.5	79.5	88.2
4 hour	240	42.4	46.3	59	68.2	77.5	90.3	101
6 hour	360	49.8	54.7	70.7	82.1	93.8	110	123
12 hour	720	66.7	74.4	99.2	117	135	160	181
24 hour	1440	89.1	101	140	168	196	235	265
48 hour	2880	115	132	189	229	270	323	364
72 hour	4320	129	150	216	262	308	367	412
96 hour	5760	138	160	231	280	328	390	437
120 hour	7200	145	168	240	289	338	401	448
144 hour	8640	150	173	245	294	343	405	453
168 hour	10080	154	176	248	296	344	405	453

Copyright Commonwealth of Australia 2016 Bureau of Meteorology (ABN 92 637 533 532)									
Very Frequent Design Rainfall Depth (mm)									
Issued:	16-Oct-18								
Location									
Requested	Latitude	-33.915	Longitude	151.0357					
Nearest gr	Latitude	33.9125(S)	Longitude	151.0375(E)					
		Exceedance per Year (EY)							
Duration	Duration in	12EY	6EY	4EY	3EY	2EY	1EY	0.5EY#	0.2EY*
1 min	1	0.951	1.08	1.31	1.48	1.73	2.19	2.68	3.18
2 min	2	1.67	1.89	2.27	2.54	2.93	3.61	4.34	4.99
3 min	3	2.28	2.59	3.13	3.51	4.06	5.01	6.06	7.01
4 min	4	2.8	3.19	3.88	4.37	5.07	6.3	7.64	8.93
5 min	5	3.25	3.72	4.54	5.13	5.98	7.45	9.08	10.7
10 min	10	4.9	5.65	6.98	7.94	9.33	11.8	14.5	17.3
15 min	15	6.01	6.94	8.59	9.8	11.6	14.7	18.1	21.6
20 min	20	6.84	7.9	9.8	11.2	13.2	16.9	20.7	24.7
25 min	25	7.51	8.68	10.8	12.3	14.5	18.6	22.8	27.1
30 min	30	8.08	9.34	11.6	13.2	15.6	20	24.5	29.1
35 min	35	8.58	9.91	12.3	14	16.6	21.2	26	30.7
40 min	40	9.02	10.4	12.9	14.7	17.4	22.3	27.3	32.2
1 hour	60	10.4	12.1	14.9	17	20.1	25.8	31.3	36.7
2 hour	120	13.3	15.3	19	21.7	25.6	32.8	39.7	46.2
3 hour	180	15.3	17.6	21.9	25	29.6	38	45.9	53.6
4 hour	240	16.9	19.5	24.3	27.8	33	42.4	51.4	60.2
6 hour	360	19.5	22.6	28.3	32.4	38.6	49.8	60.7	72.1
12 hour	720	24.9	29.2	36.9	42.6	51.1	66.7	82.6	101
24 hour	1440	31.4	37.2	47.6	55.5	67.2	89.1	112	143
48 hour	2880	38.1	45.6	59.4	69.8	85.3	115	147	193
72 hour	4320	41.3	50	65.8	77.7	95.5	129	166	220
96 hour	5760	43	52.5	69.7	82.6	102	138	178	235
120 hour	7200	43.9	53.9	72.3	86	107	145	186	245
144 hour	8640	44.4	54.8	74.1	88.5	110	150	192	250
168 hour	10080	44.5	55.3	75.4	90.4	113	154	196	253

DRAINS RESULTS

5 year:

DRAINS results prepared from Version 2018.09

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow
	Constraint					

		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)
			(cu.m/s) (cu.m)	(m)		
N371	22.35		0.000			

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm	
Existing Site		0.095	0.063	0.032	5.00	5.00	5.00	0.2EY AEP, 10 min burst, Storm 8
Roof	0.102	0.102	0.000	5.00	5.00	5.00	0.2EY AEP, 5 min burst, Storm 1	
Bypass	0.016	0.015	0.000	5.00	5.00	5.00	0.2EY AEP, 5 min burst, Storm 1	

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe1	0.075	8.67	30.419	22.349	0.2EY AEP, 10 min burst, Storm 8

CHANNEL DETAILS

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

OVERFLOW ROUTE DETAILS

Name	Max Q U/S		Max Q D/S		Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF1	0	0	0.565	0	0	0	0			

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q	Max Q	Max Q
			Total	Low Level	High Level
Lvl 1 2m basin	30.95	12.7	0.075	0.075	0.000

Run Log for 181016 WSU v4.drn run at 12:07:04 on 7/3/2019

Flows were safe in all overflow routes.

100 year:

DRAINS results prepared from Version 2018.09

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond	Max Surface		Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving		Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)			
N371	24.20		0.000					

SUB-CATCHMENT DETAILS

Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm	
	Flow Q	Max Q	Max Q	Tc	Tc	Tc		
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)		
Existing Site		0.167	0.114	0.060	5.00	5.00	5.00	1% AEP, 10 min burst, Storm 1
Roof	0.169	0.169	0.000	5.00	5.00	5.00	1% AEP, 5 min burst, Storm 1	

Bypass	0.026	0.026	0.001	5.00	5.00	5.00	1% AEP, 5 min burst, Storm 1

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm
Pipe1	0.109	0.99	31.006	24.200	1% AEP, 15 min burst, Storm 8

CHANNEL DETAILS

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

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF1	0	0	1.939	0	0	0	0	

DETENTION BASIN DETAILS

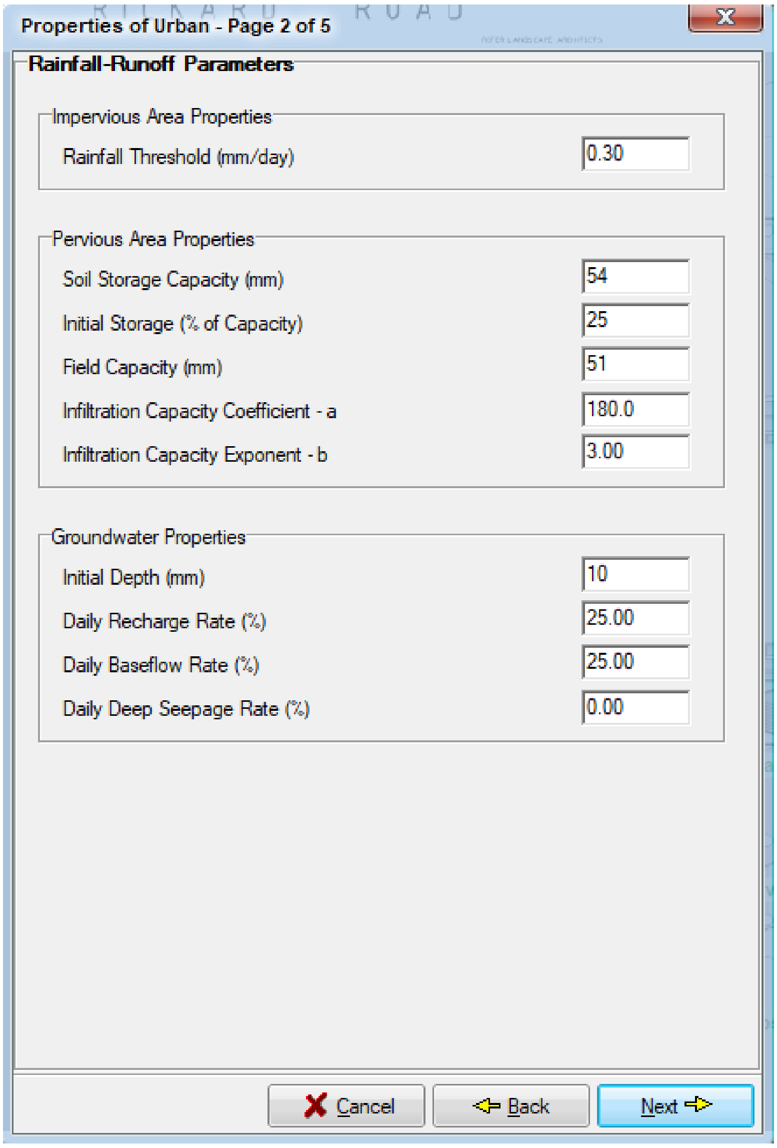
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level	
Lvl 1 2m basin		31.71	26.1	0.109	0.109	0.000

Run Log for 181016 WSU v4.drn run at 12:08:01 on 7/3/2019

Flows were safe in all overflow routes.

Appendix B – MUSIC Model Source Parameters and MUSIC Link Report

MUSIC Rainfall – Runoff Parameters for Penrith



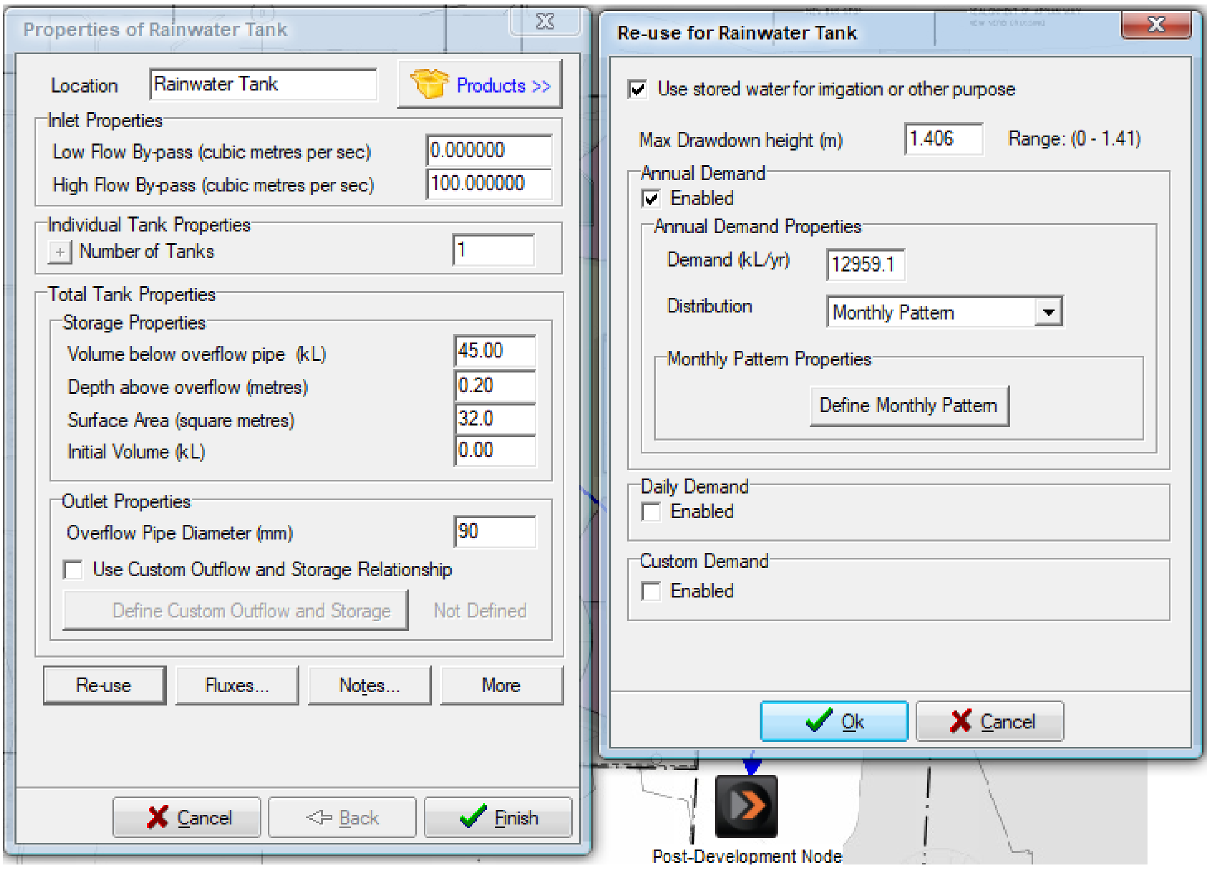
Stormwater Quality Parameters for Source Nodes

Characteristics of WSUD Measures for the Site:

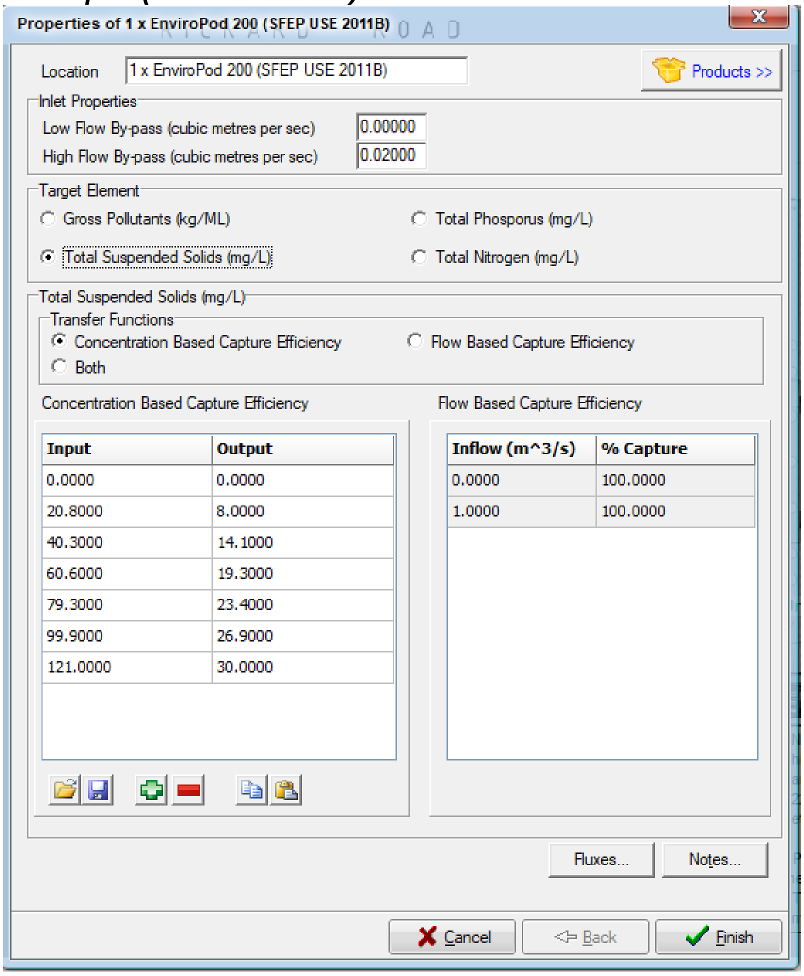
Land-use category		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
Roof Areas	Mean	1.3	0	-0.89	0	0.3	0

Land-use category		Log10 TSS (mg/L)		Log10 TP (mg/L)		Log10 TN (mg/L)	
		Storm Flow	Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow
	Std Dev	0.32	0	0.25	0	0.19	0
Commercial (Shared Pedestrian Appian Way)	Mean	2.15	1.2	-0.6	-0.85	0.30	0.11

Rainwater Tank



Enviropod (Stormwater 360)



Appendix C – FLOOD MAPS

RUN: BON034 (EXISTING)

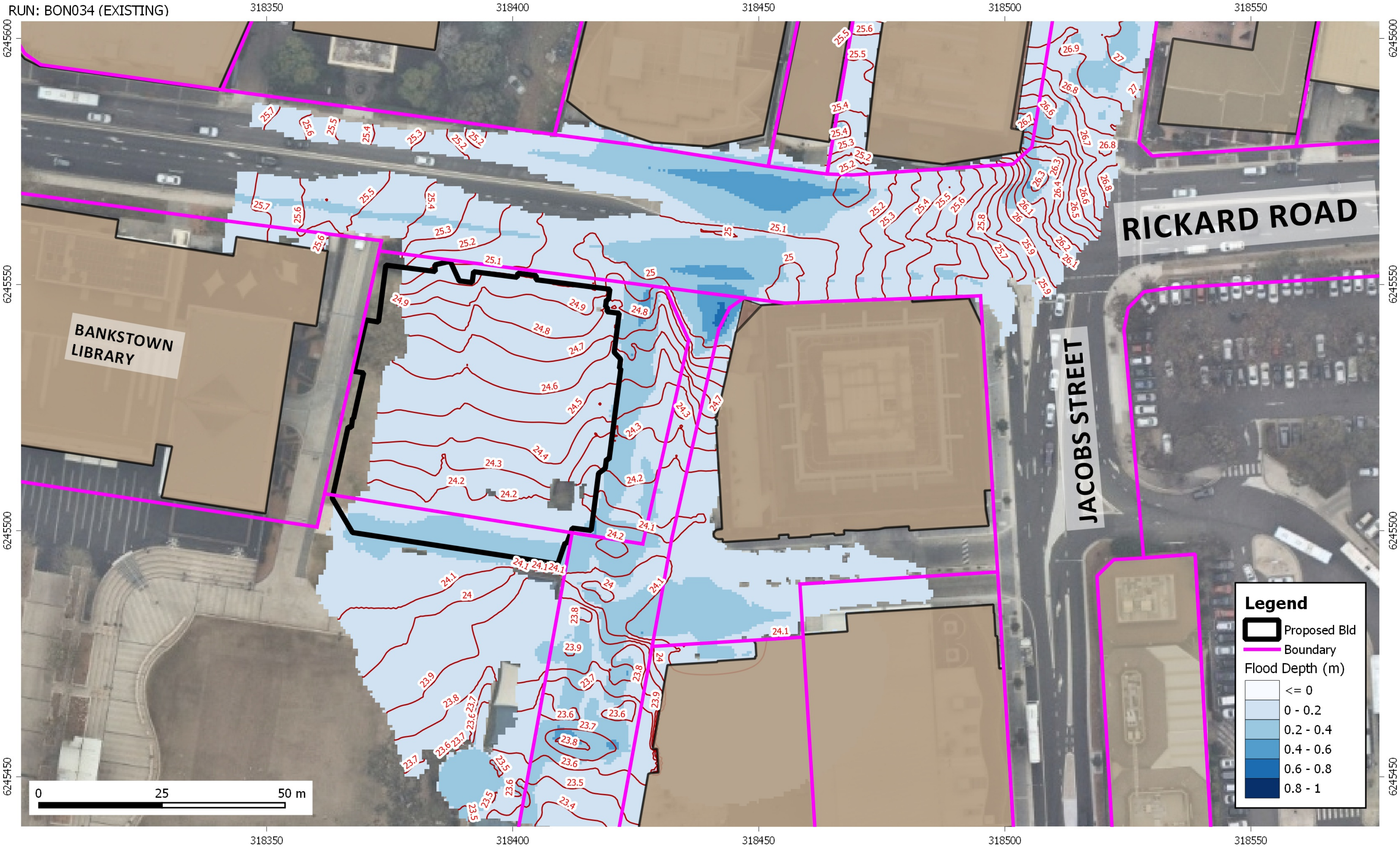


Figure 25: Existing 5% AEP Maximum Flood Depth & Height

RUN: BON034 (EXISTING)

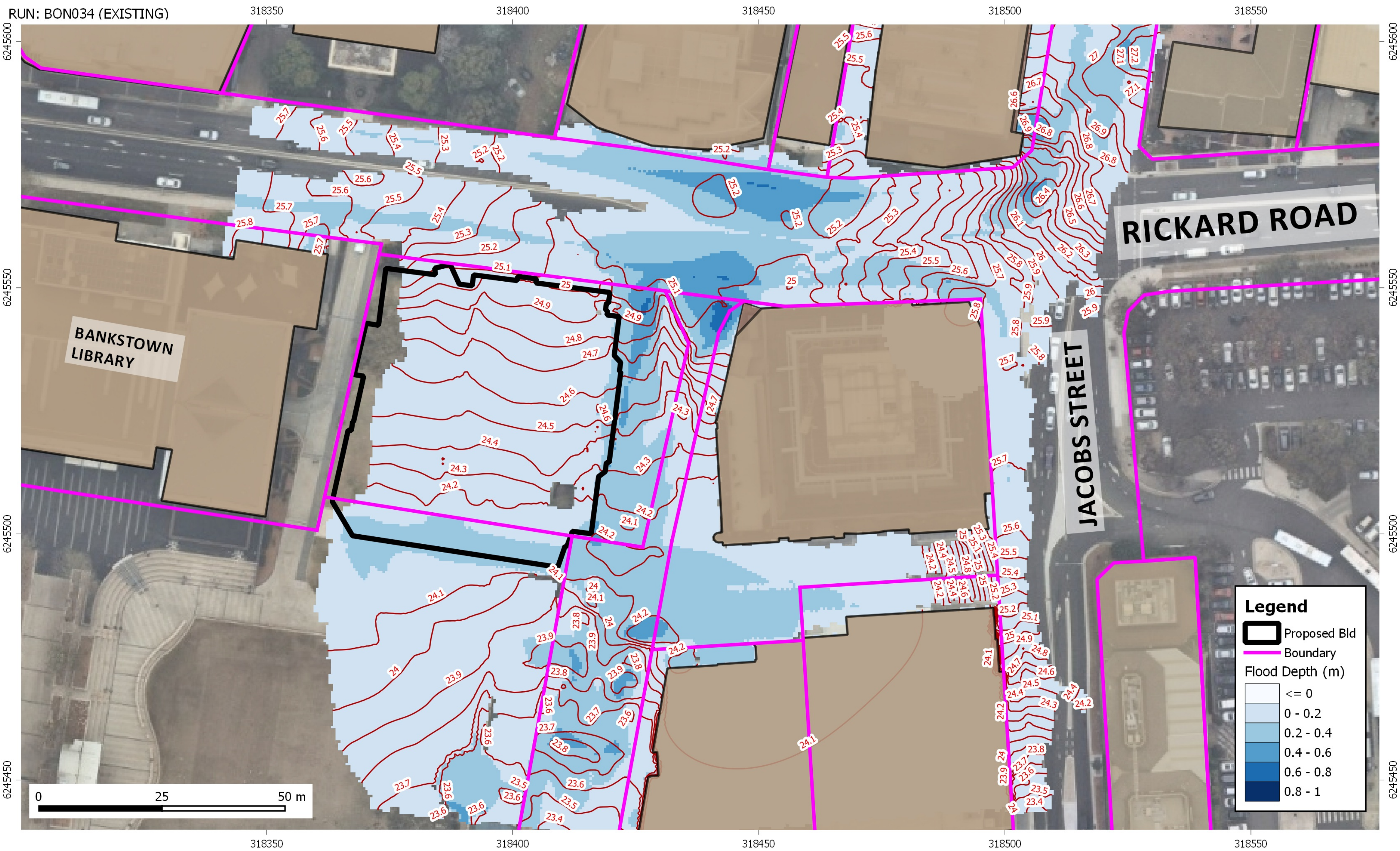


Figure 26: Existing 1% AEP Maximum Flood Depth & Height

RUN: BON034 (EXISTING)

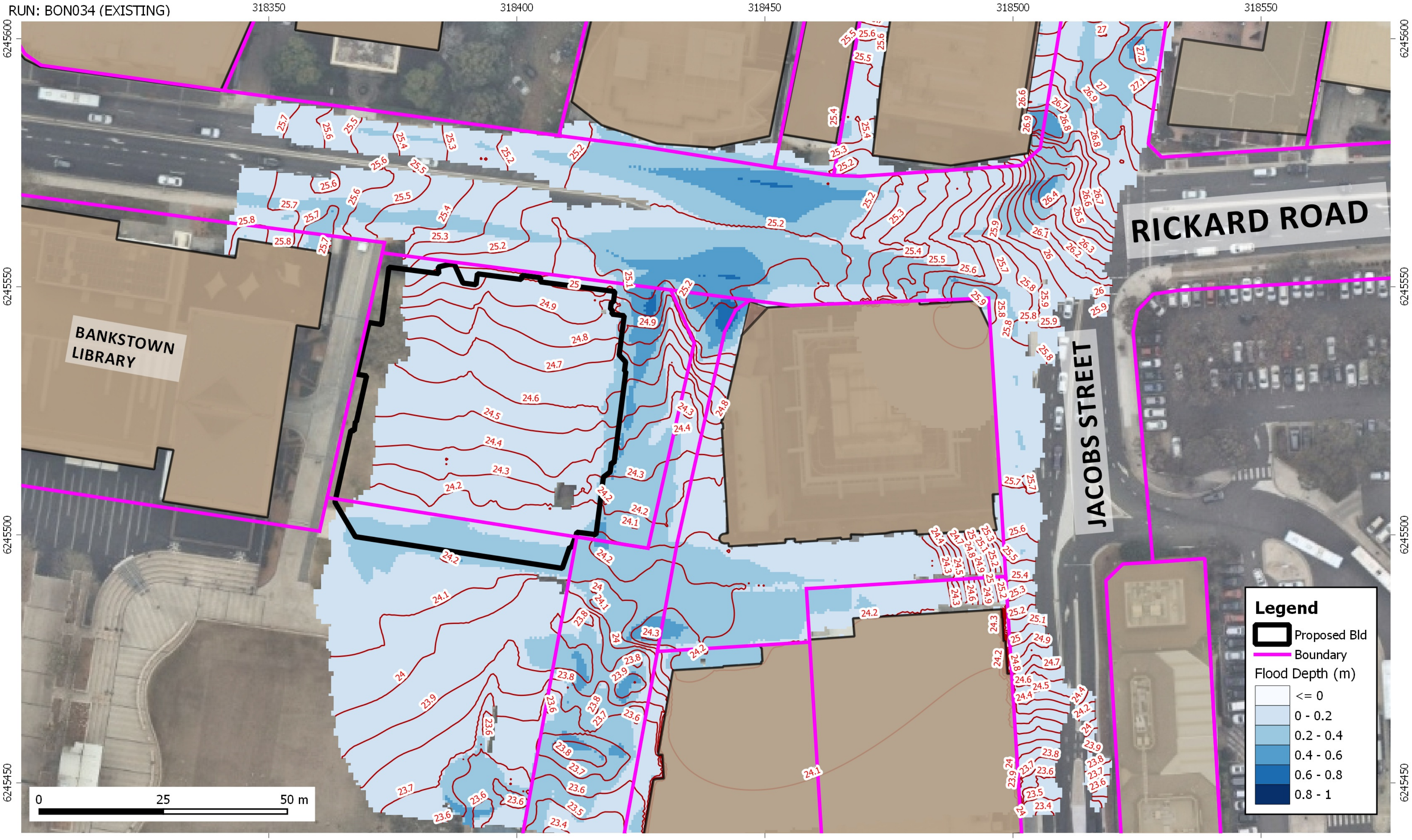


Figure 27: Existing 0.5% AEP Maximum Flood Depth & Height

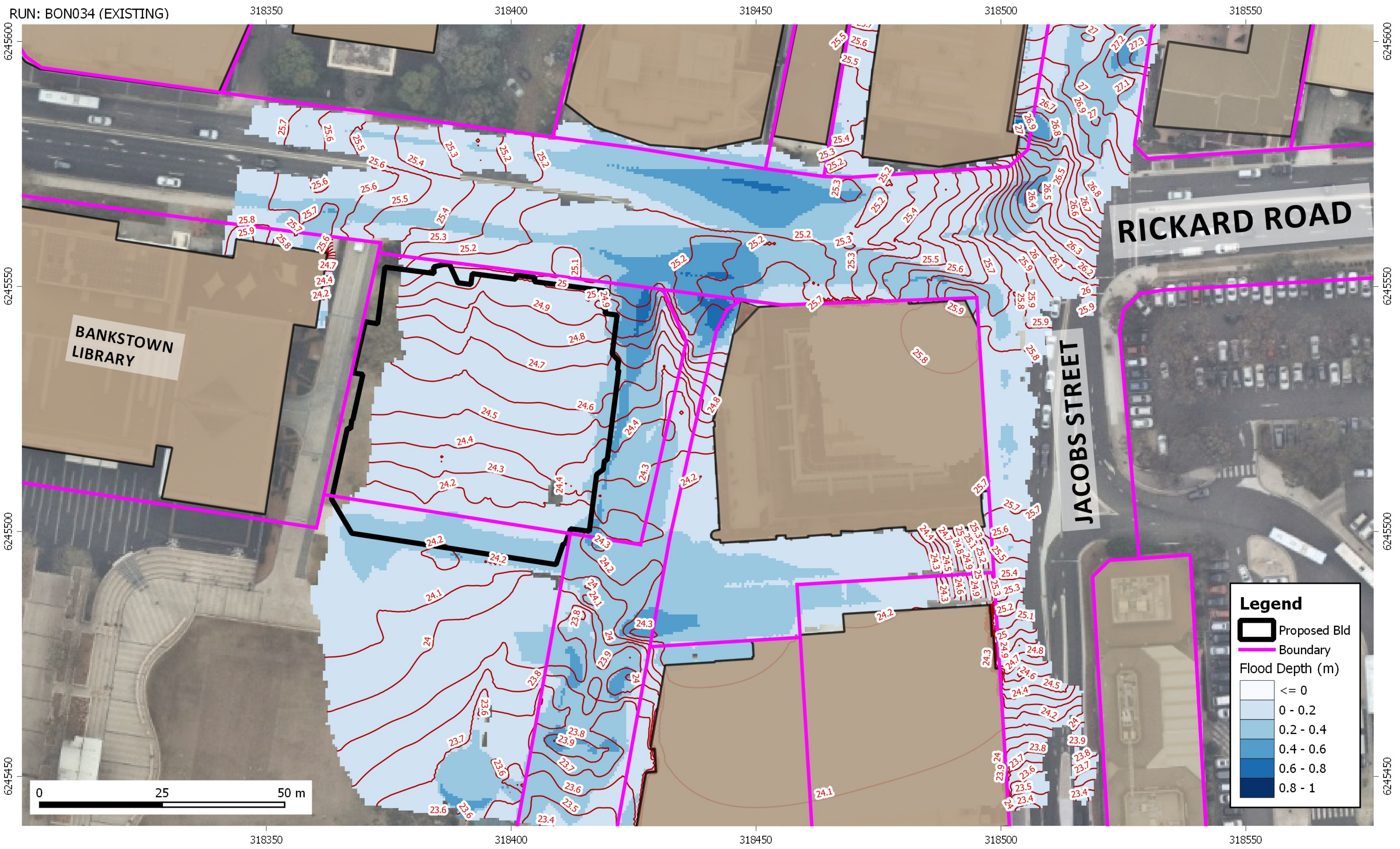


Figure 28: Existing 0.2% AEP Maximum Flood Depth & Height

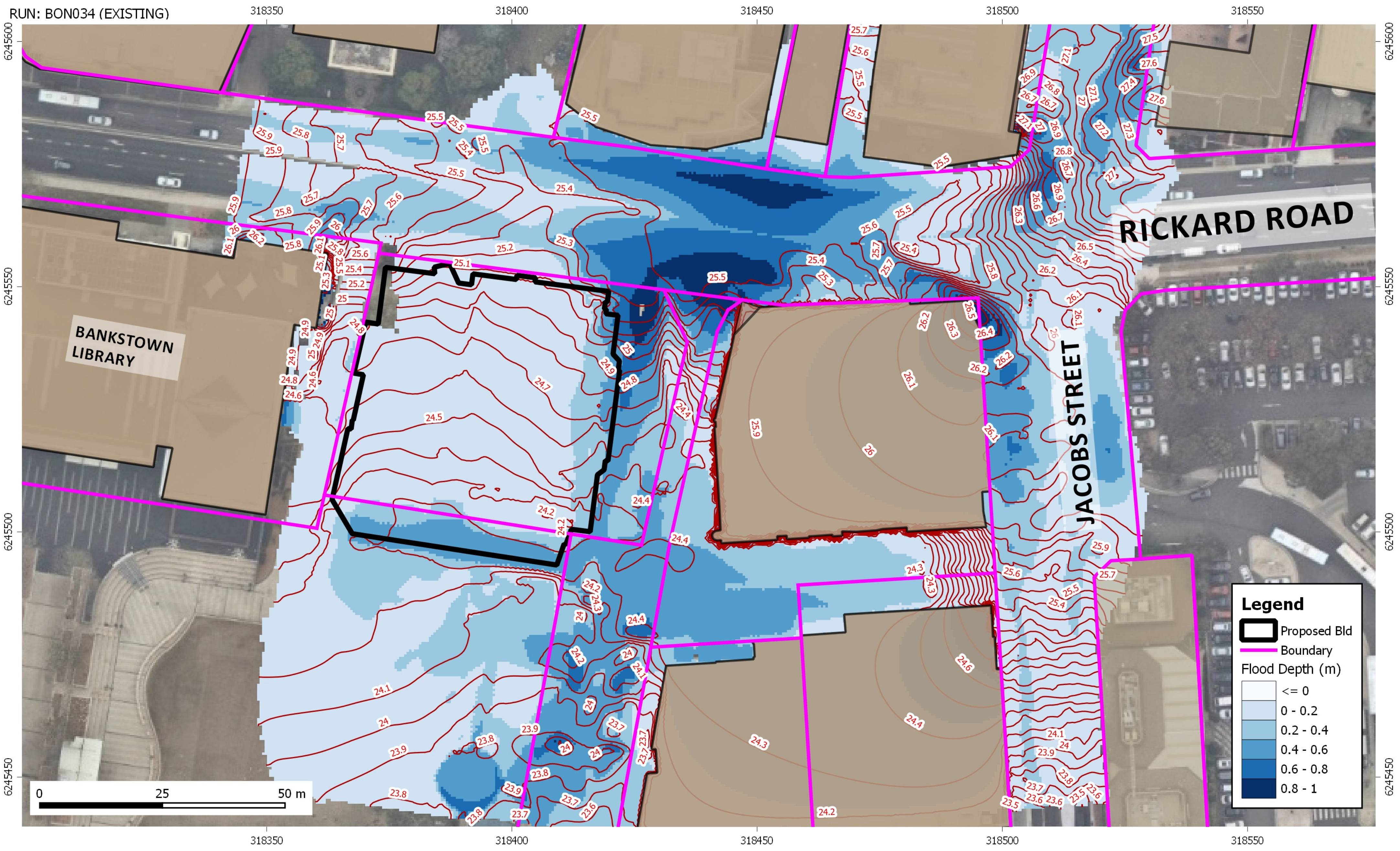


Figure 29: Existing PMF Maximum Flood Depth & Height

RUN: BON035

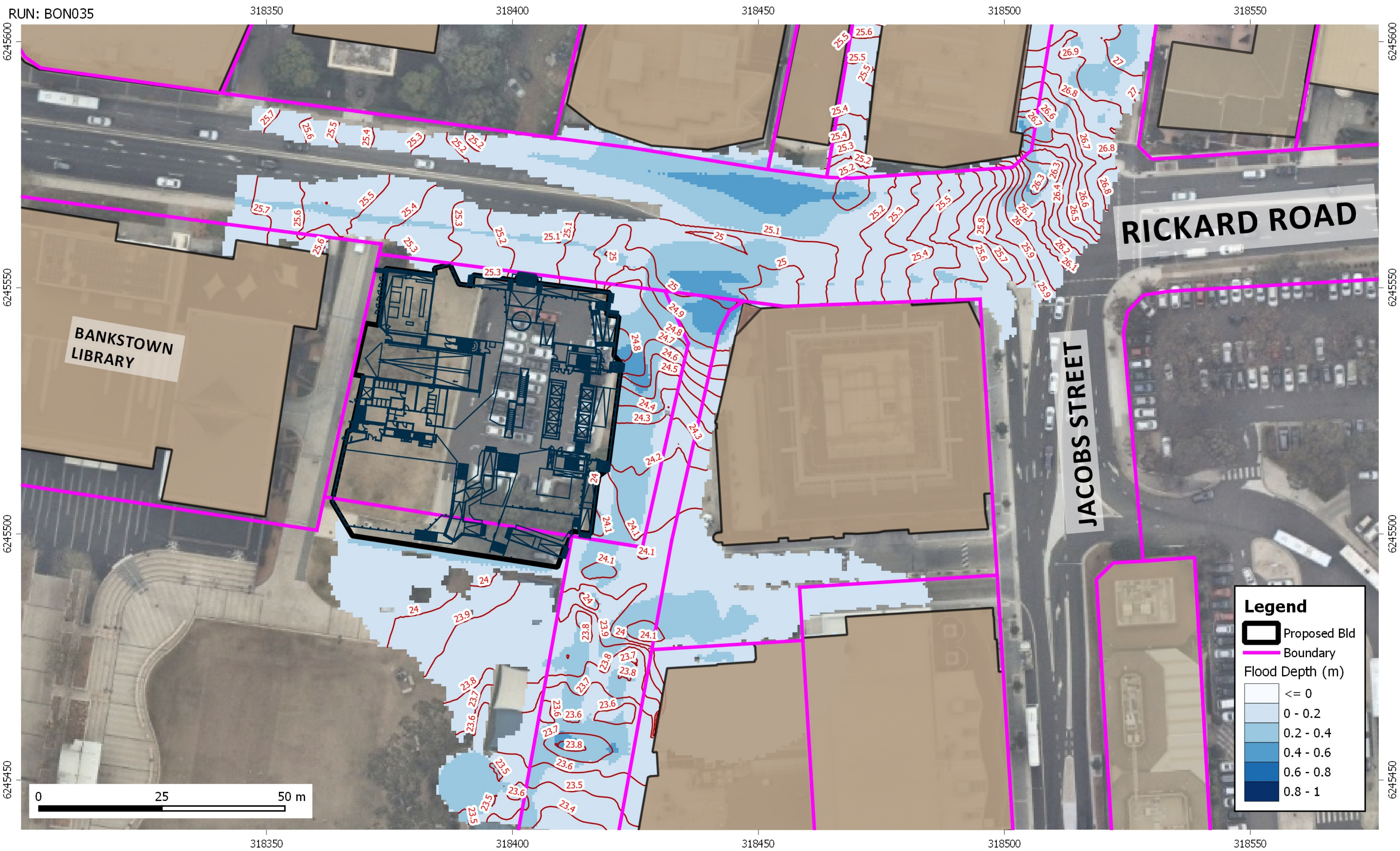


Figure 30: Proposed 5% AEP Maximum Flood Depth & Height

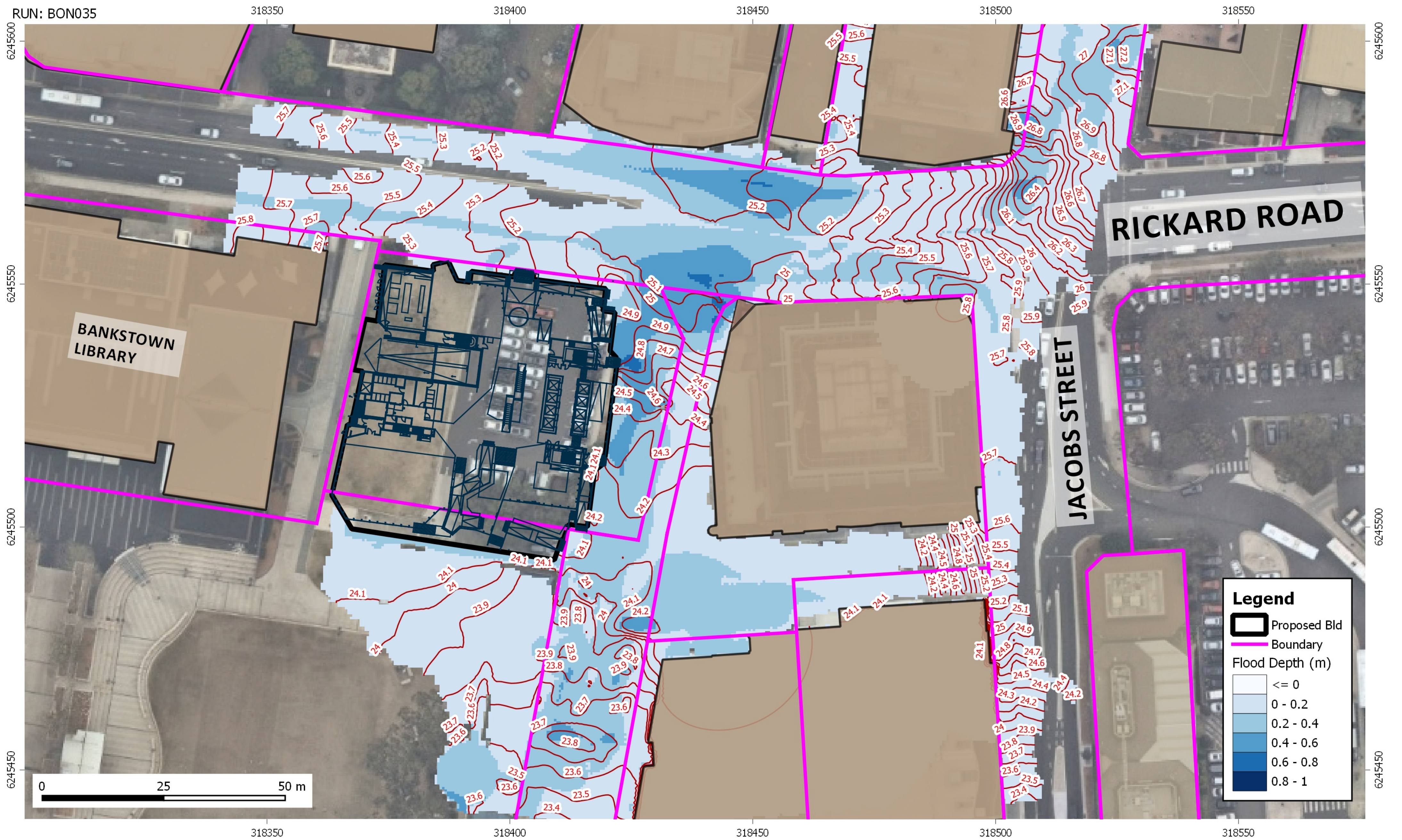


Figure 31: Proposed 1% AEP Maximum Flood Depth & Height

RUN: BON035

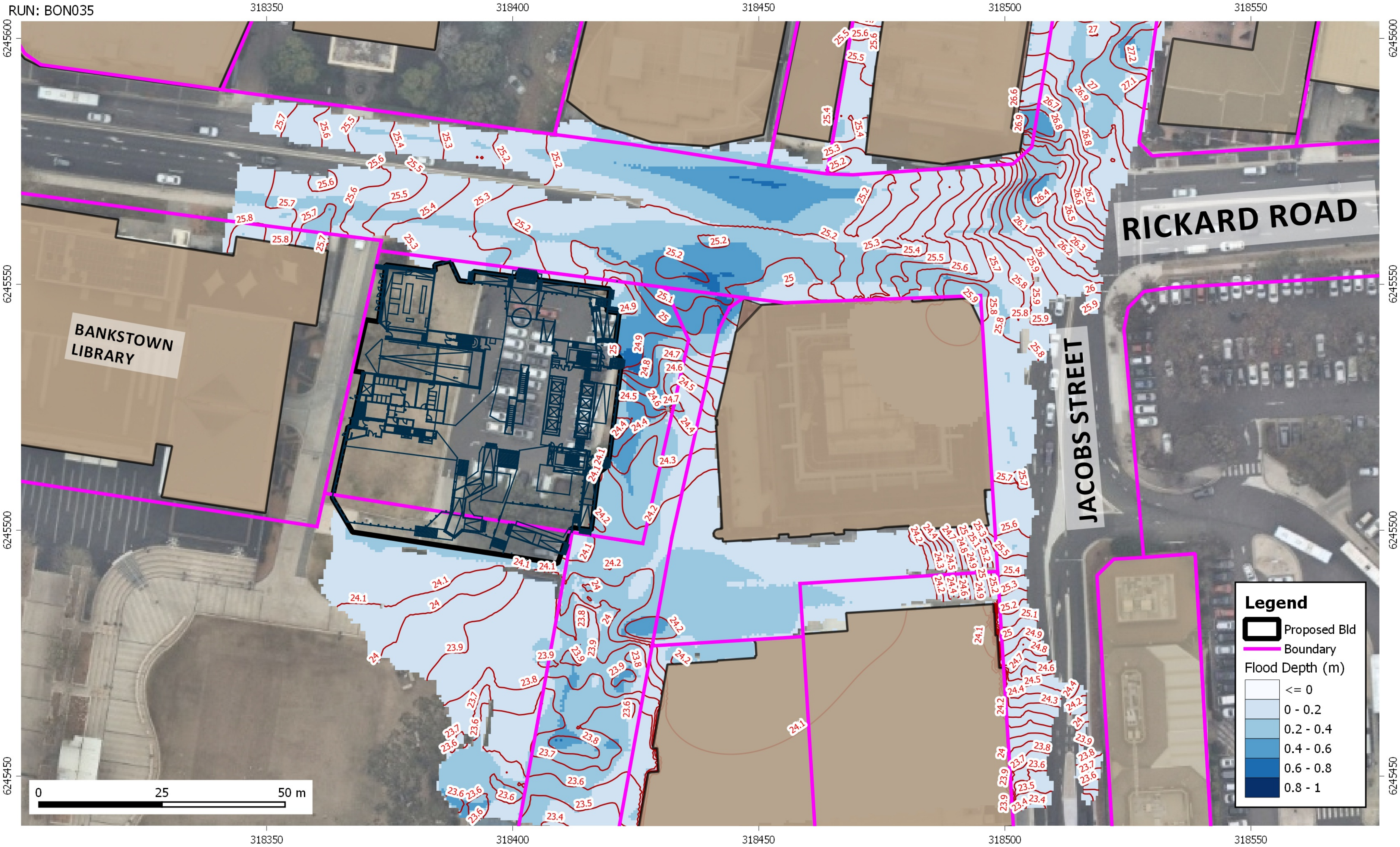


Figure 32: Proposed 0.5% AEP Maximum Flood Depth & Height

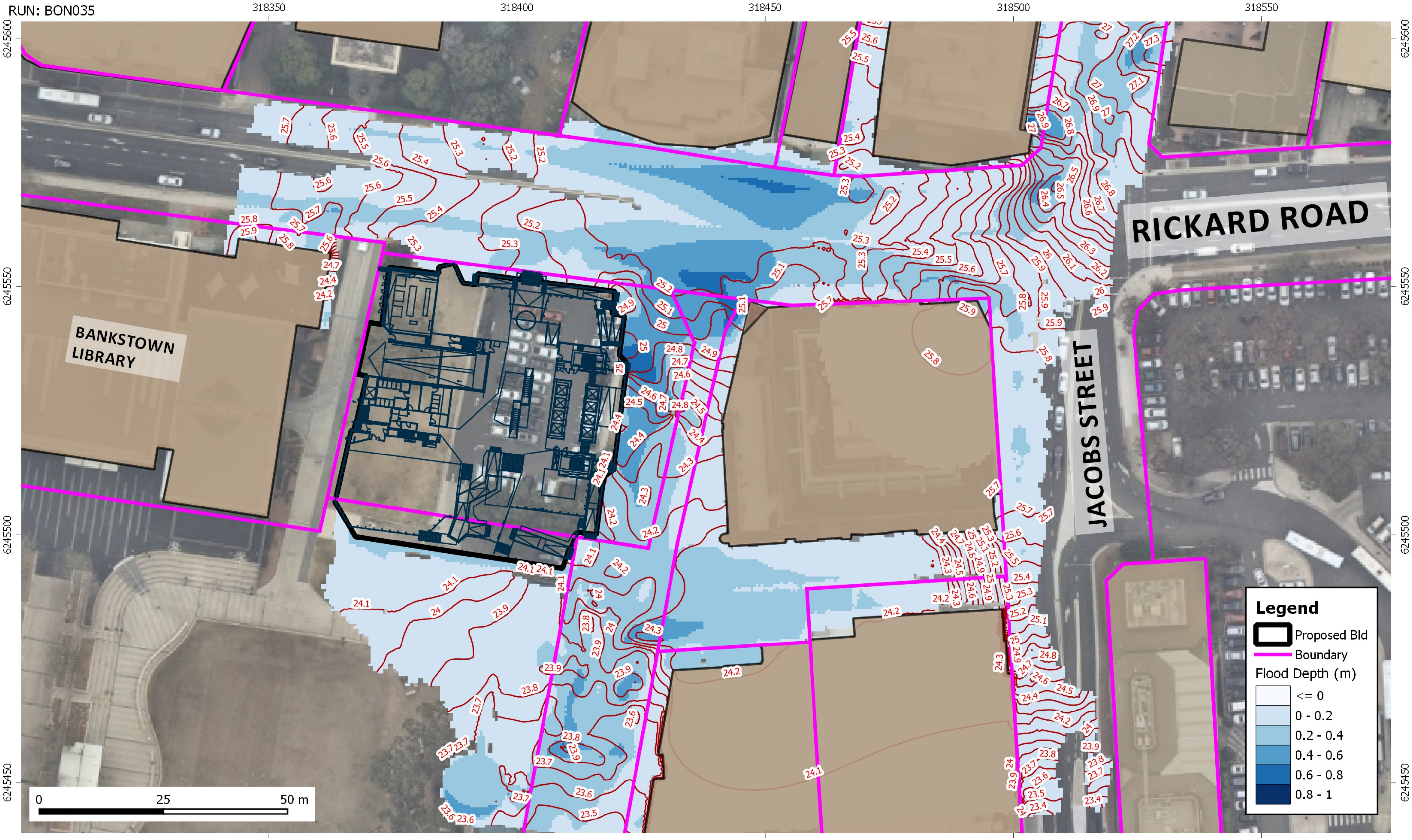


Figure 33: Proposed 0.2% AEP Maximum Flood Depth & Height

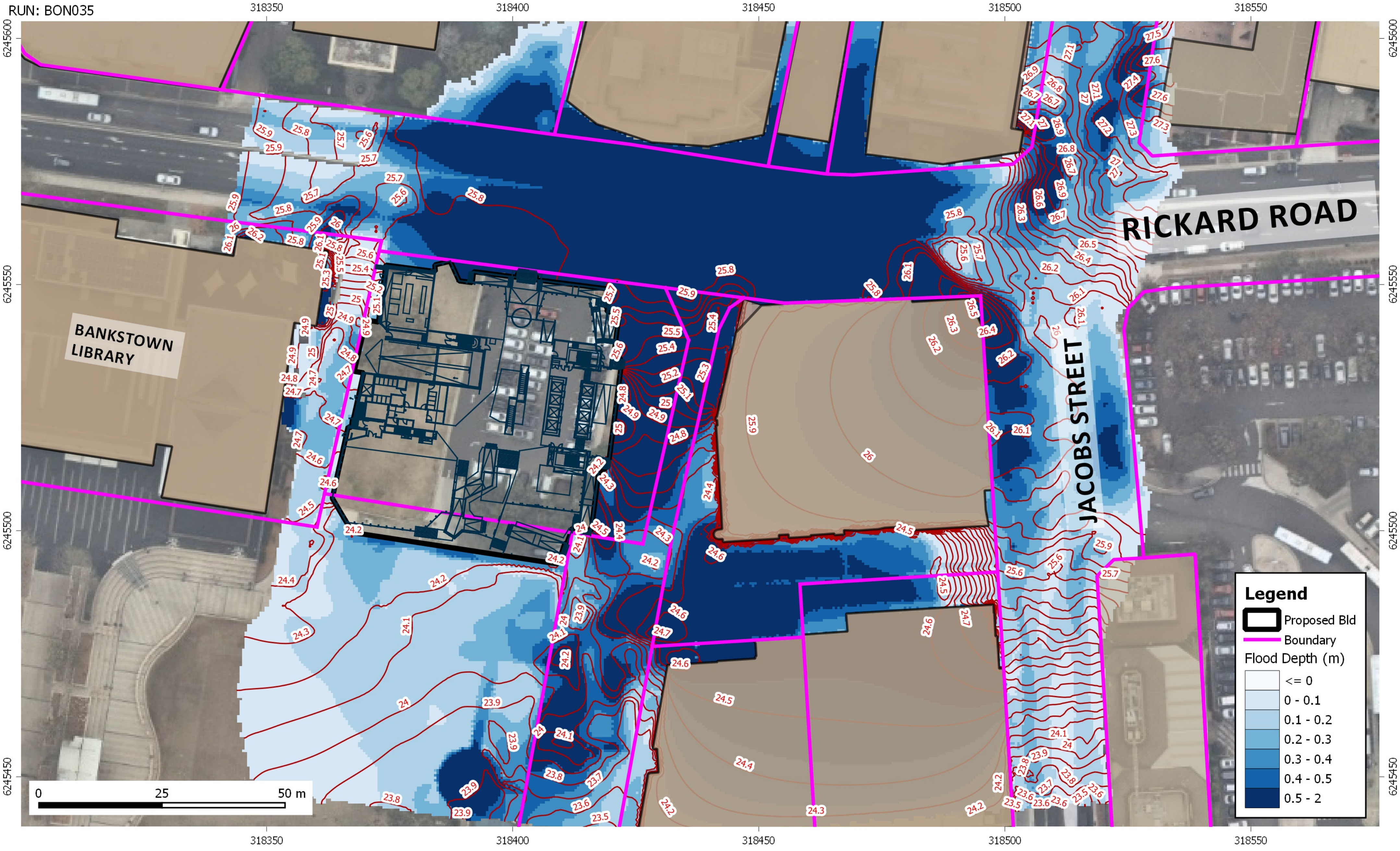


Figure 34: Proposed PMF Maximum Flood Depth & Height

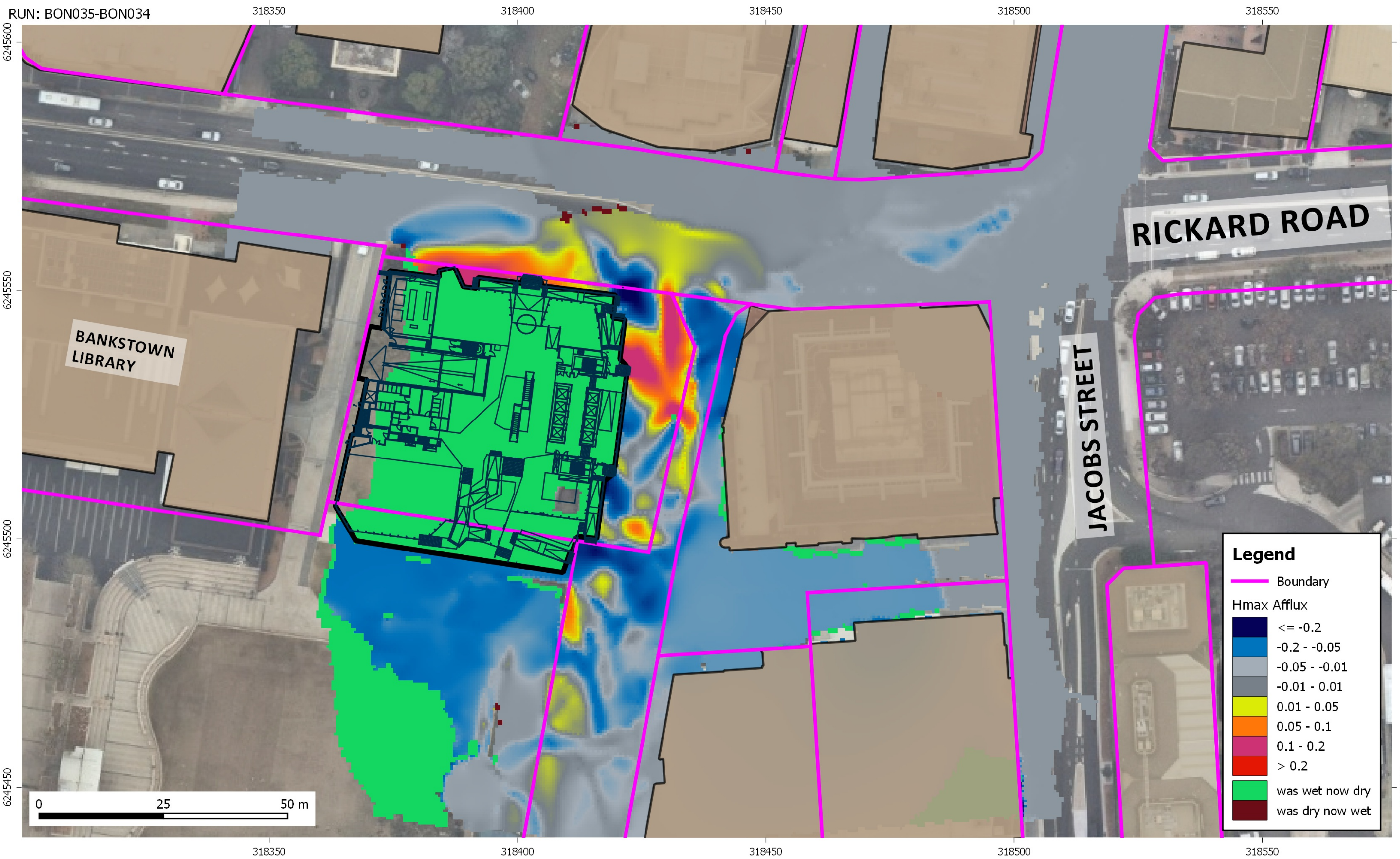


Figure 35: (BON035-BON034) 1% AEP Maximum Flood Height (Hmax) Afflux

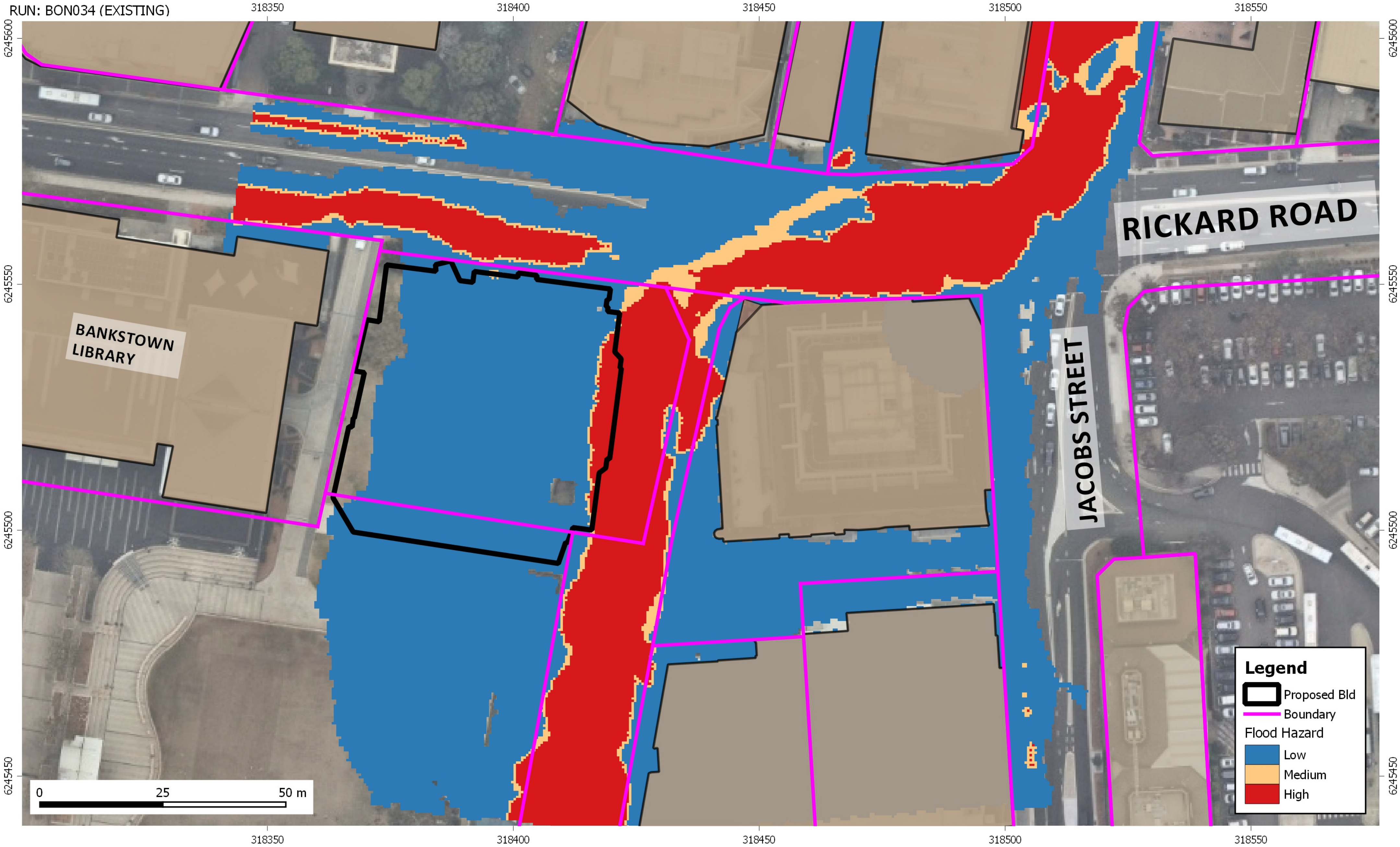


Figure 36: Existing 1% AEP Flood Hazard (NSW Floodplain Development Manual 2005)

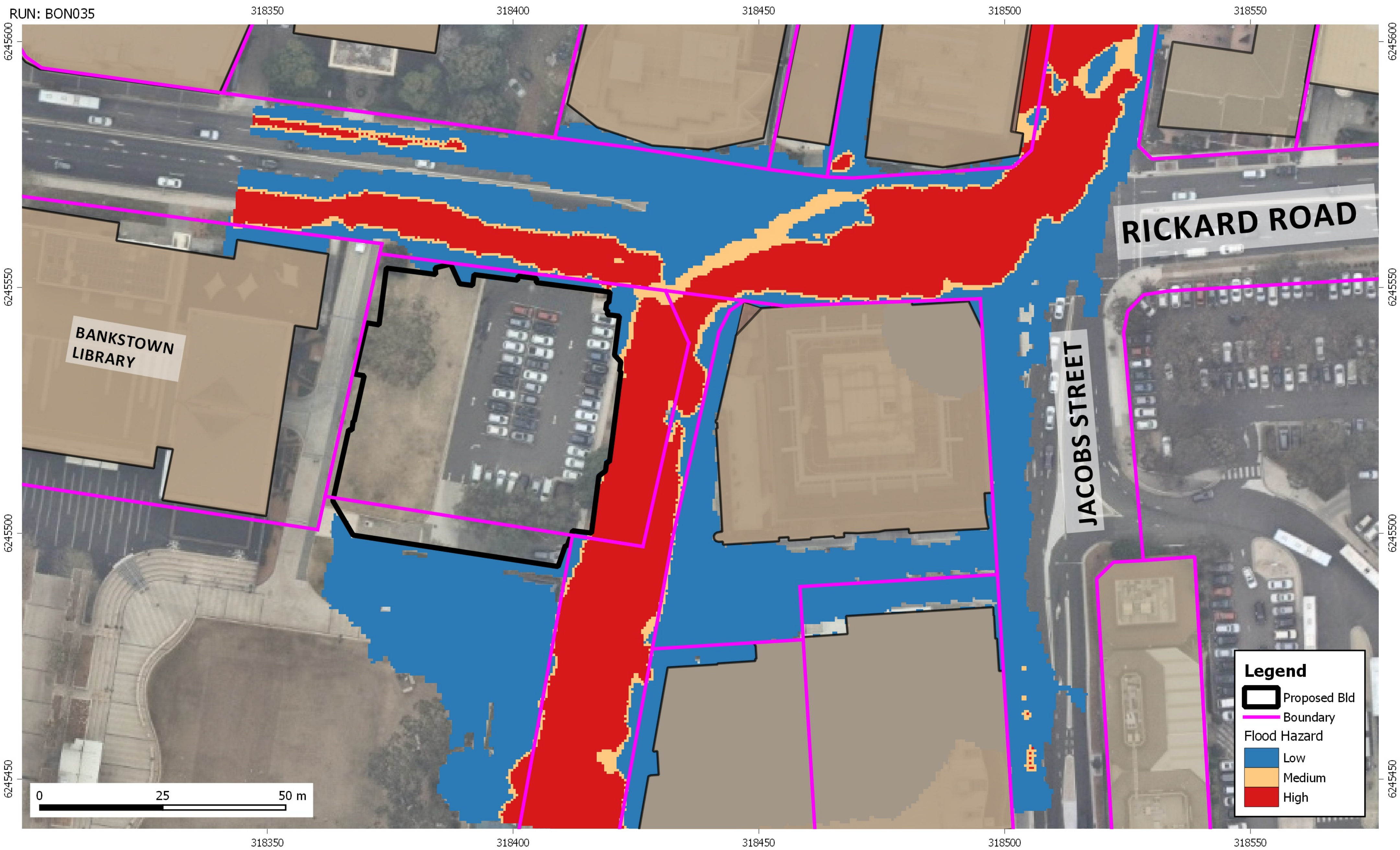


Figure 37: Proposed 1% AEP Flood Hazard (NSW Floodplain Development Manual 2005)