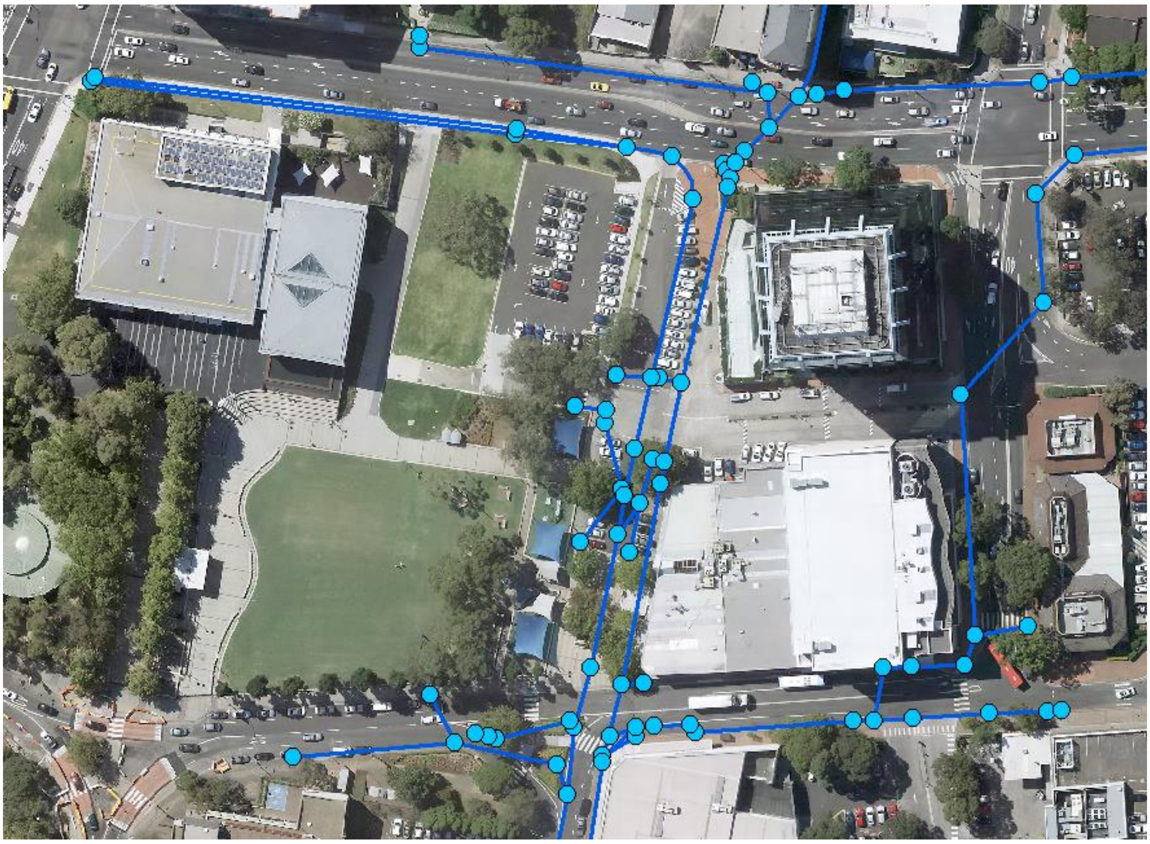
Bankstown CBD MIKE FLOOD model upgrade

Western Sydney University Site Flood Assessment

Final Report



Canterbury-Bankstown Council

Final Report

May 2019

The expert in **WATER ENVIRONMENTS**

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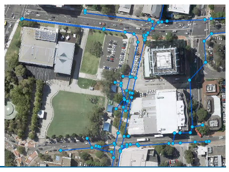

The site for the new WSU campus

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Project number	43803243
Approval date	8 May 2019
Revision	Final v2
Classification	Restricted

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1 Introduction

DHI previously developed a detailed MIKE FLOOD model which couples a 2D surface model (MIKE 21 Flexible Mesh) with a 1D storm drainage network (MIKE Urban) for the Bankstown CBD and ran several drainage upgrade option scenarios. MIKE Urban simulates the detailed storm drainage network including various hydraulic structures such as manholes, basins and valves, while MIKE 21 Flexible Mesh simulates the dynamic flows in the 2D domain in various spatial resolutions. MIKE FLOOD enables the dynamic coupling of the two models and simulates flow exchange through inlet structures from the surface to the storm water drainage network.

Discharge outputs from Council's catchment wide TUFLOW study have been applied to the 2D model as surface boundary conditions. The MIKE FLOOD model does not replace the regional model, however, it can simulate flooding and dynamic flow interaction between the ground surface and the pipe network at a finer scale.

A new campus for Western Sydney University (WSU) is planned to be constructed in the Bankstown CBD, between the Council administration building and the library. DHI Water and Environment (DHI) was engaged by Canterbury-Bankstown Council (Council) to provide detailed flood maps, assess the impact of the new campus on surrounding properties and advise relevant hydraulic parameters required for further planning of the campus building and its surrounds.

The objective of this study is to

- Update the previously developed BASE2 model by incorporating the recent road and drainage upgrades at The Mall for current conditions (**Scenario1**);
- Update the above Scenario1 model by incorporating the WSU campus for future conditions (**Scenario2**);
- Update the existing OPTION2 DESIGN STAGE model by incorporating the recent upgrade of The Mall and the WSU campus for future conditions (**Scenario3**);
- Generate 100 year ARI flood maps comprising:
    - Maximum water depth
    - Contours of maximum water level
    - Maximum product of velocity and water depth (VxD)
    - Hazard categories based on velocity and water depth
    - water level difference maps

This report summarises details of each scenario and modifications made to the models.

2 Model Development for Scenario1

Scenario1 represents the current CBD condition as per March 2019. The BASE 2 model developed during the 2017 study was updated with the following changes.

2.1 Intersection of The Mall and The Appian Way

The intersection of The Mall and The Appian Way was updated with a new layout of the triangular pedestrian crossing and a duplication pipe underneath. Although both the duplication pipe and changes to the surface topography were already included in the BASE2 model, a detailed design of the duplication pipe and inlet structures were not available at that time.

Therefore, the MIKE Urban model was updated to incorporate the datils of the modifications to the drainage as per SHEET No.10 of *The_Mall_Works_As_Executed_25-09-2017.pdf*.

This includes:

- 900mm duplication pipe to the west of the crossing
- 8m long 375mm pipe to the east of the crossing

Figure 1 shows the changes made to the 1D model.

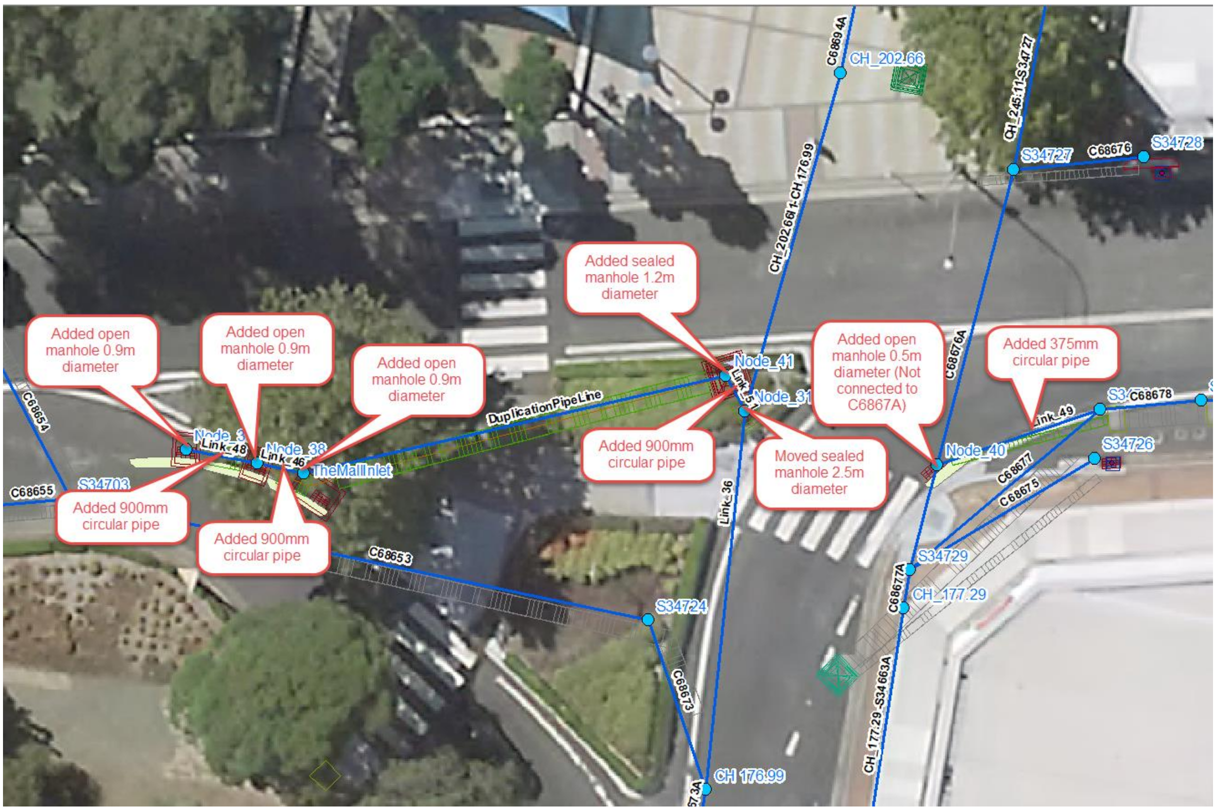


Figure 1 Updates at the intersection of The Mall and The Appian Way

The following inlet structures are incorporated in the MIKE FLOOD model by creating new coupling links to the 2D model or by updating the existing links.

Table 1 Updated/new coupling links

MUID	Length (m)	Length Adjusted (m)	Area (m^2) (estimated blockage of 20%)
S34741*	4.8	4.5	0.36
Node_39	1.8	1.5	0.12
Node_38	1.8	1.5	0.12
TheMallInlet	1.8	1.5	0.12
Node_40	1.8	1.5	0.12
Node_36	2.4	2.1	0.17
Node_37	2.4	2.1	0.17

*Represents the combined area of two lintels (A1 and A2)

As per the previous study, effective areas of kerbside inlets were estimated using the following formula: 0.8 of constriction factor is applied, assuming a blockage rate of 20%.

Area = (Design Lintel Length -0.3 m of length deduction for Lintel supports) * 0.1m height * 0.8 of constriction factor

2.2 Intersection of The Mall and Jacobs Street

An updated surface topography at Jacobs Street was already incorporated in the BASE2 model. The MIKE Urban model was updated to incorporate the details of the modifications to the drainage network as per SHEET No.11 of *The_Mall_Works_As_Executed_25-09-2017.pdf*. Updates of the MIKE Urban model are summarised in Figure 2.

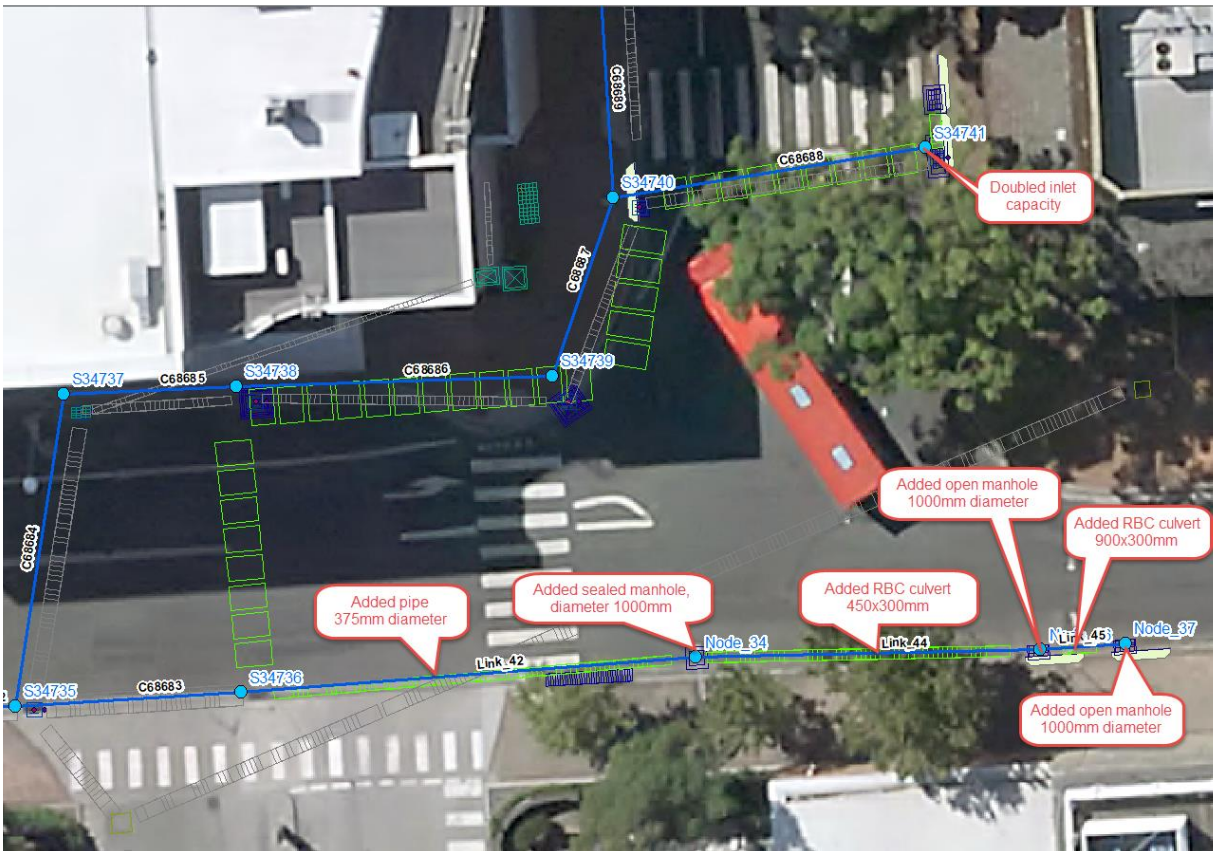


Figure 2 Updates at the Intersection of The Mall and Jacobs Street

2.3 Topography update at the campus site

Initial test runs revealed that the topography in the existing models, which was generated using ALS, did not properly represent the library driveway from Rickard Road. This resulted in a large amount of water flowing through the library driveway towards the underground carpark of the WSU building in the future scenarios. Therefore, for the future scenarios in this study, it was decided to replace the model topography with the surveyed topography around the campus including the library driveway. To be consistent with the future scenarios for result comparison, ground levels were updated at the same location in Scenario1.

Ground elevations were extracted from the *tin survey BONACCI MODIFIED TRIMMED* layer of *WSU_Design_Tin_and_Survey_2019_04_05.dwg* at the element vertices of the existing mesh in the model.

The final mesh elevation is shown in Figure 3, together with the extent of the *BONACCI MODIFIED TRIMMED* layer.

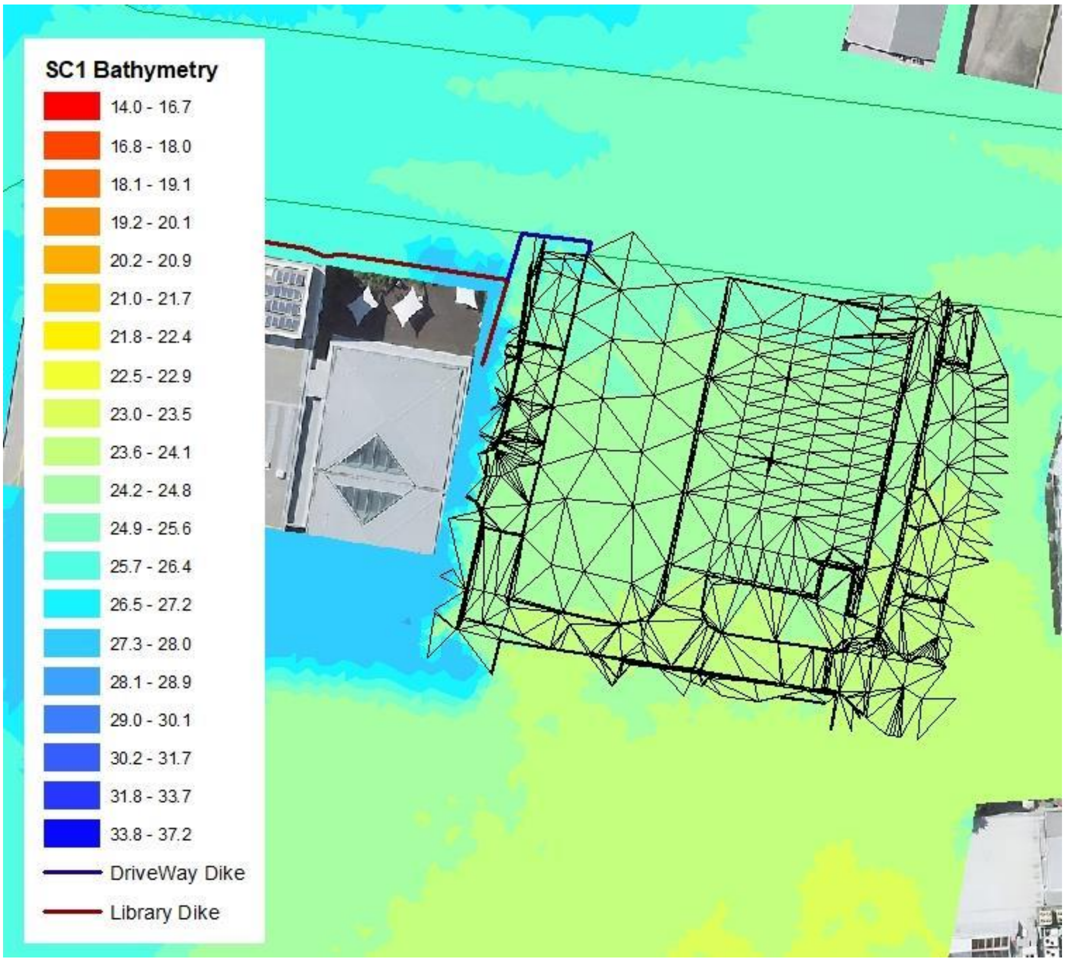


Figure 3 Updated topography for Scenario1

To make sure that the entry level of the driveway is properly represented, a dike structure was implemented in the MIKE 21 model, as shown in Figure 4.

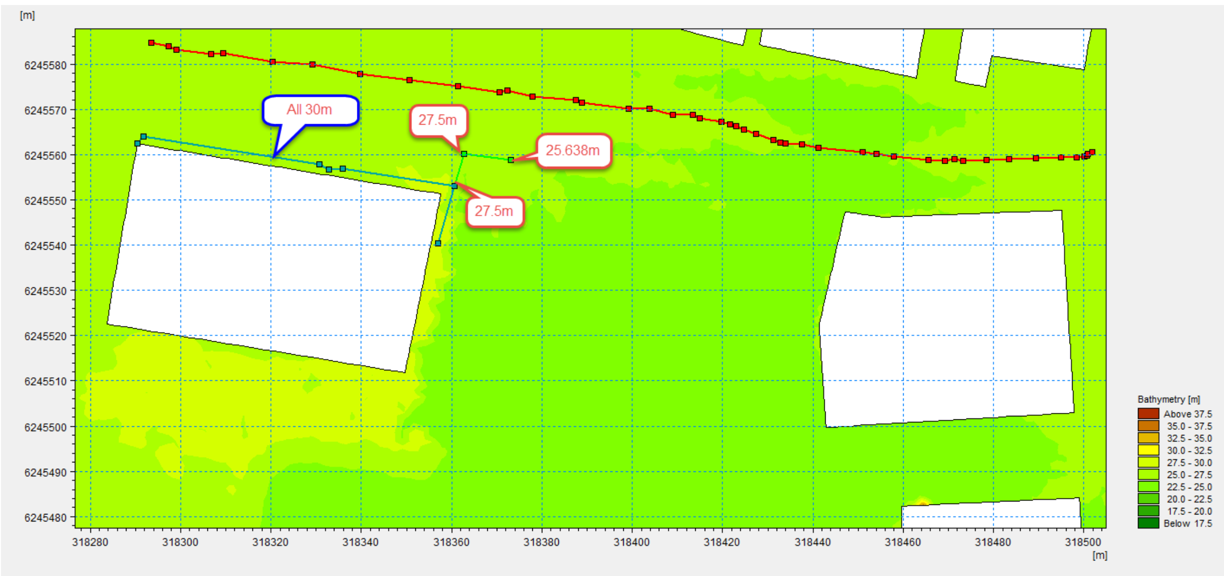


Figure 4 Dike structures representing the library driveway (Scenario1)

3 Model Development for Scenario2

Scenario2 represents the Bankstown CBD with the proposed WSU building. The Scenario2 model was developed by implementing the following changes to the Scenario1 model.

3.1 Topography update for the WSU campus building

The 3D model of the pavement area surrounding the new WSU building was not available for modelling. Therefore, to achieve consistency between scenarios, the same ground surface model was used for Scenario2 as in Scenario1.

The proposed WSU building was incorporated in the mesh using the *tin Design* layer of *WSU_Design_Tin_and_Survey_2019_04_05.dwg*. Elevation of the building was uniformly set to 30m to prevent flooding of the campus building.

Figure 5 shows the updated model topography for Scenario2. The outline of the WSU building is indicated by the red polygons.

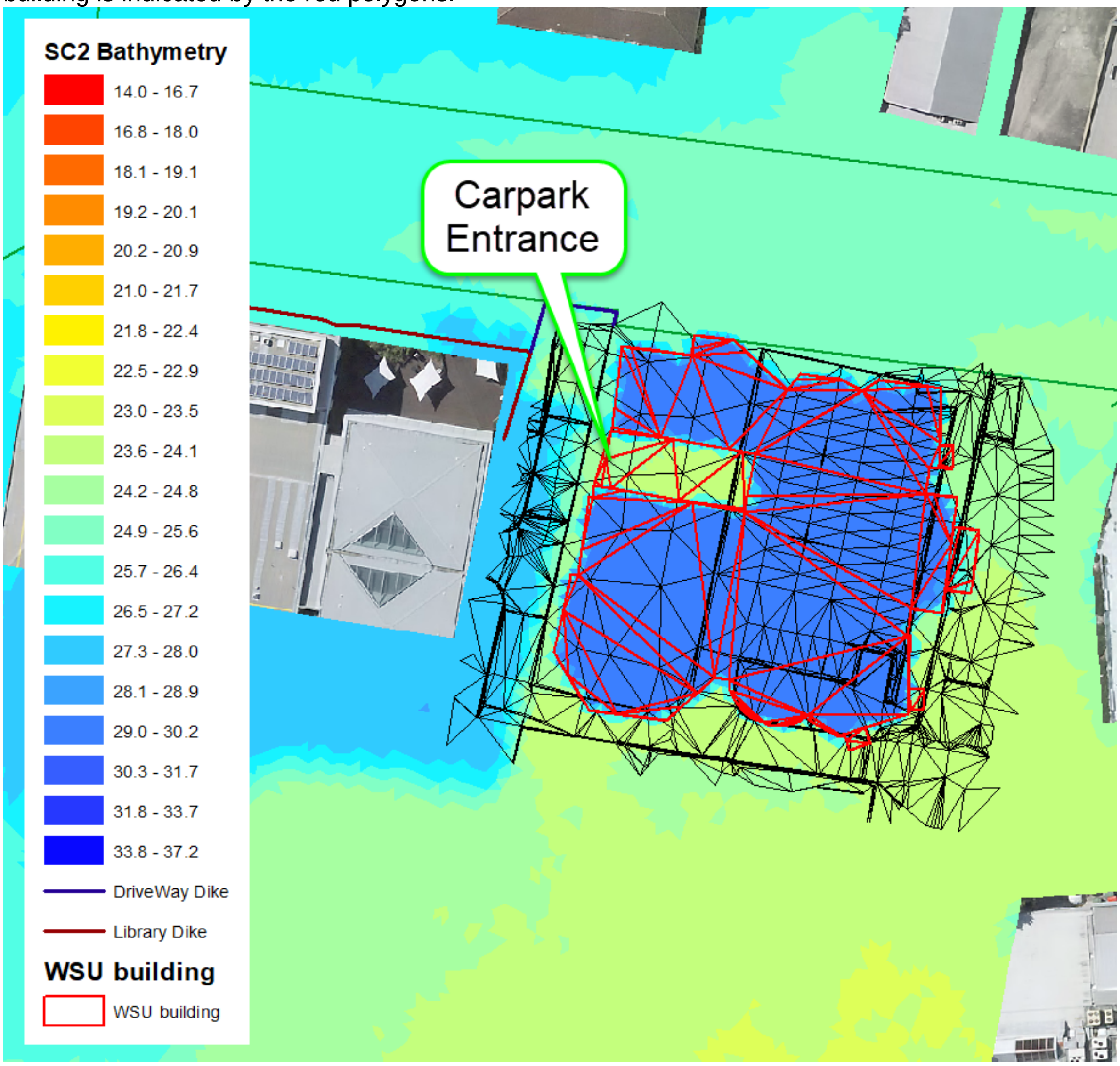


Figure 5 Updated topography for Scenario2

3.2 Library Driveway

The library driveway was updated to include the elevation of the new WSU building platform (Figure 6).

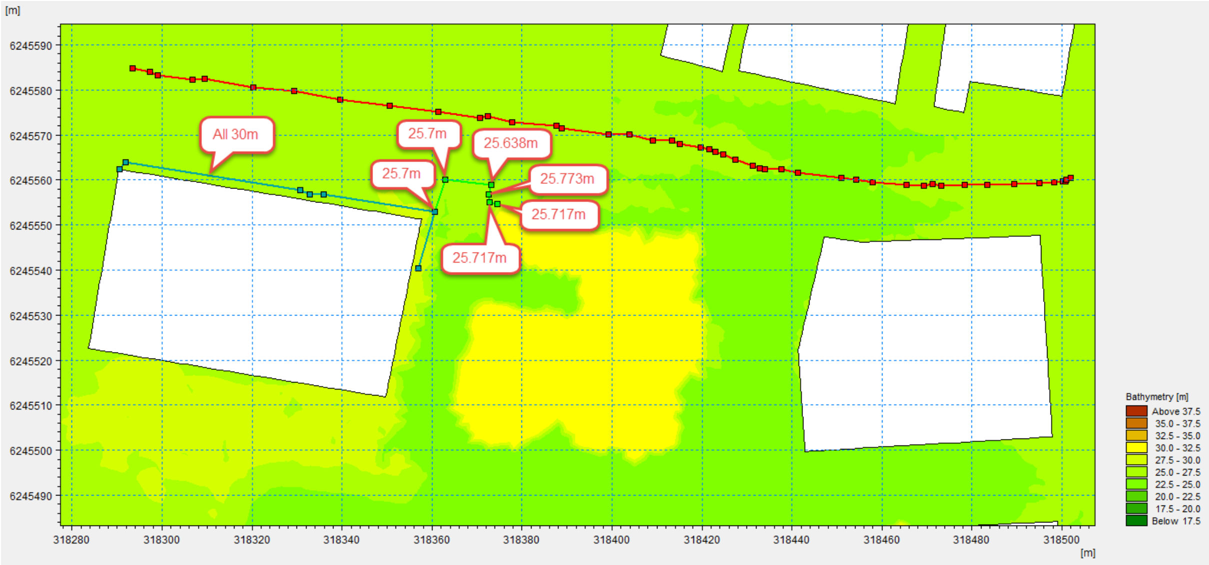


Figure 6 Dike structures representing the library driveway (Scenario2)

4 Model Development for Scenario3

Scenario3 represents the future condition where the proposed WSU building has been constructed and the proposed drainage network upgrades implemented. In the previous study undertaken by DHI in 2017, the proposed drainage network upgrades were simulated as part of the OPTION2 Design model.

These upgrades comprise upgrades of culvert inlet capacity at Rickard Road and French Avenue and culvert duplication at North Terrace.

Using the OPTION2 Design model as a base, the same modifications were made to the Scenario1 and Scenario2 models were applied:

- The drainage updates at the intersection of The Mall and The Appian Way
- The drainage updates at the intersection of The Mall and Jacobs Street
- Mesh topography updates at the campus site and the library driveway using the surveyed ground elevations, as in scenarios 1 and 2
- Mesh topography update to incorporate the proposed WSU building

5 Results

The following 100 year ARI flood maps were produced for each scenario and submitted to Council. These maps are also included in the Appendices.

- Maximum water depth with maximum water level contours
- Hydraulic hazard categories as per Figure L2 in the Floodplain Development Manual (April 2005, Department of Infrastructure, Planning and Natural Resources, New South Wales Government consistent with Council's FRMP)
- Maximum product of velocity and depth (VxD)
- Difference of maximum water levels ('Scenario2 minus Scenario1' and 'Scenario 3 minus Scenario1')

5.1 The impact of the WSU building

Currently (Scenario1), excess storm water from Rickard Road flows towards The Mall through the Council car park where the new campus is planned to be constructed. Under Scenario2 this flow passage becomes largely blocked by the WSU building.

Maximum water depth in The Appian Way between the WSU building site and Council's building generally varies between 0.12 and 0.61m in Scenario1 and 0.03 and 0.87m in Scenario2.

Figure 7 compares the maximum water depths of Scenario1 and Scenario2.

The proposed WSU building results in up to 0.3m higher maximum water depths along Rickard Road near the intersection with The Appian Way and up to 0.59 m in the section of The Appian Way between the new WSU building and the Council administrative building. These locations are marked in red circles in Figure 7. The highest increase of 0.59m is seen approximately half way along the eastern wall of the new WSU building where a part of the structure protrudes into the floodway. This protrusion also appears to have an impact on water depth increase along the western wall of Council's building (up to 0.19m).

Also refer to map D-1 in Appendix D.

Consequently, the hazard category for the section between the new WSU building and the Council administrative building will rise from medium risk to high risk (Figure 8) in the majority of the street section. The maximum velocity-depth product increases from 1.0 to 1.3 at the most affected location at this section.

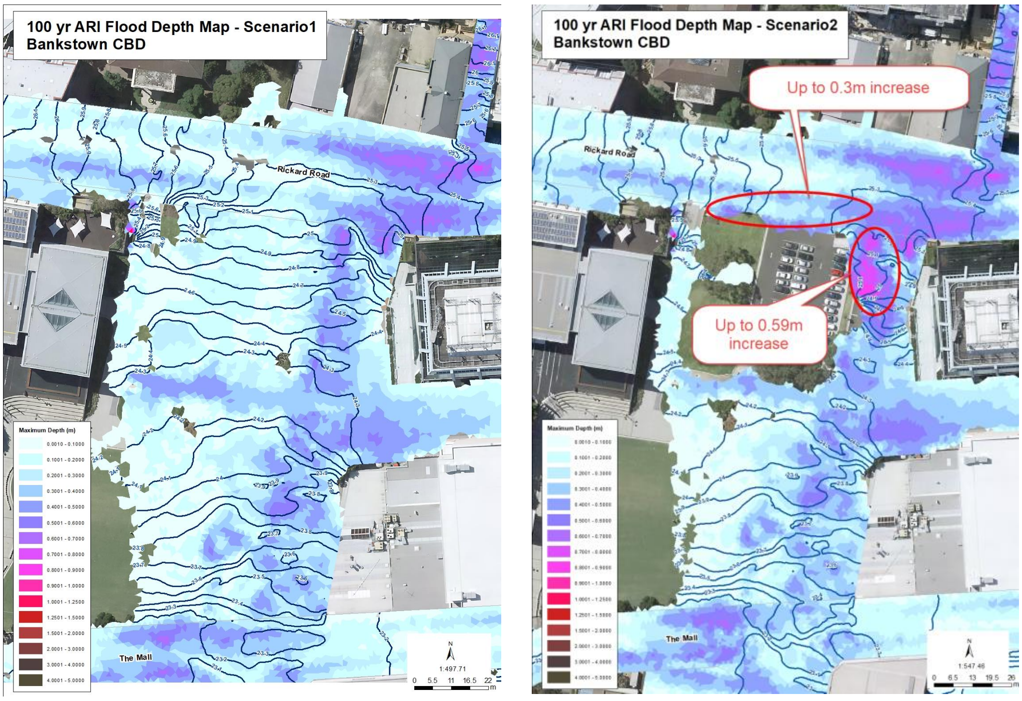


Figure 7 Comparison of maximum water depth under the current condition (left) and the scenario with the new WSU campus constructed (right)

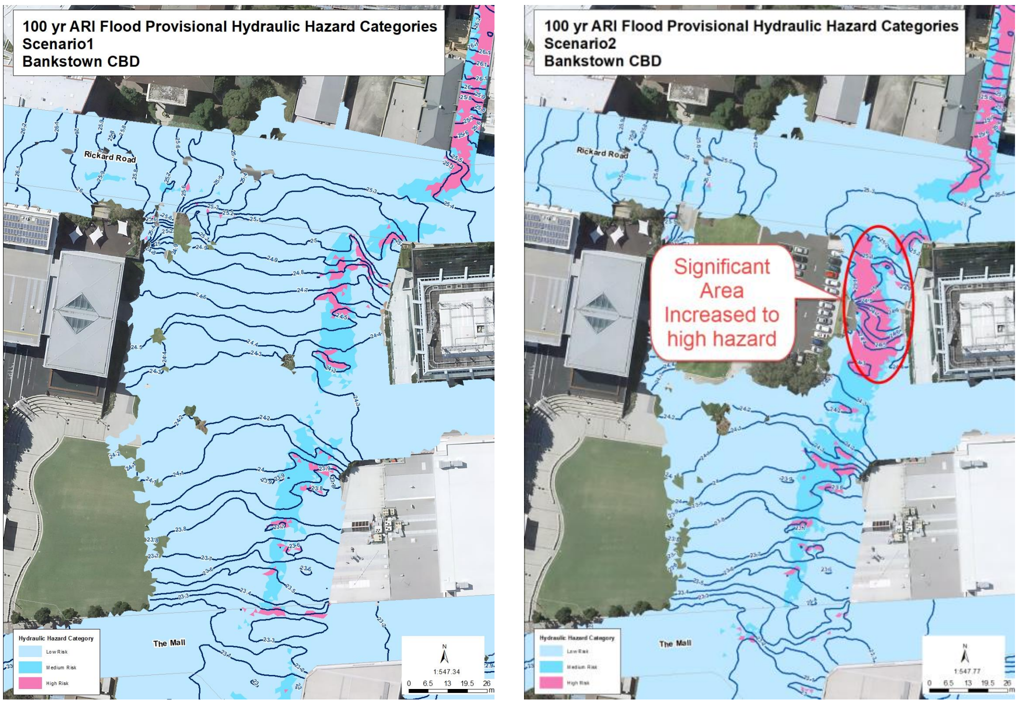


Figure 8 Comparison of hazard categories under the current condition (left) and the scenario with the new WSU campus constructed (right)

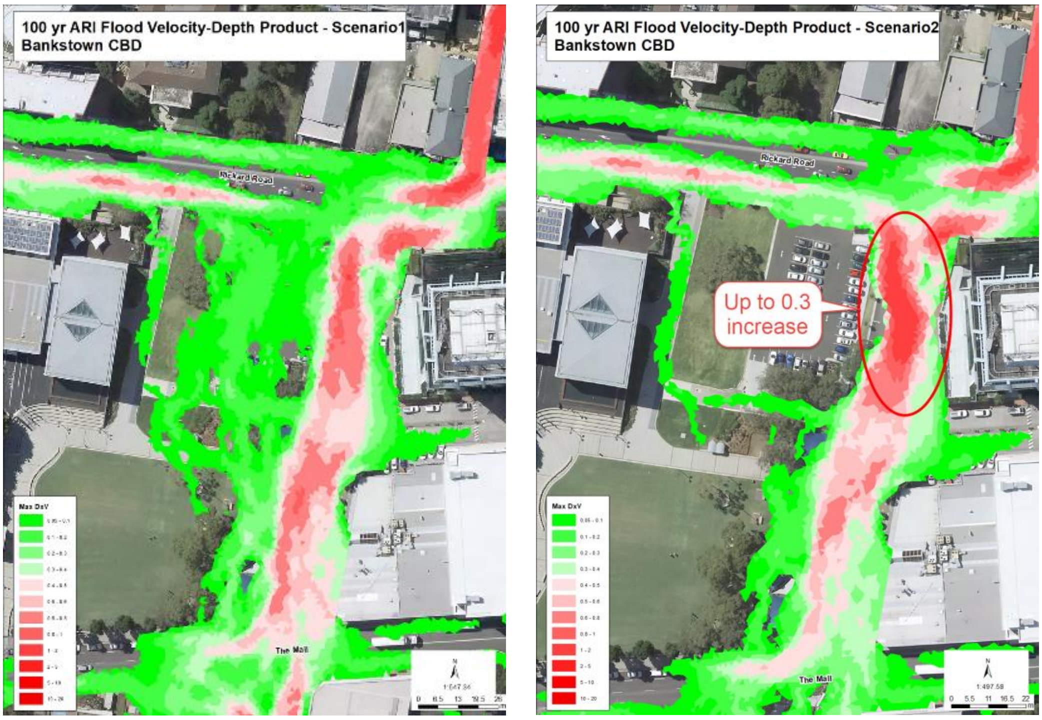


Figure 9 Comparison of maximum velocity-depth product under the current condition (left) and the scenario with the new WSU campus constructed (right)

The simulated water level at Rickard Road near the northern end of the library driveway reaches approximately 25.8mAHD, while the elevation of the driveway entry ramp is 25.7m. Thus, water from the street overtops the ramp and flows along the driveway towards The Mall in the model.

The increase in water depths within the driveway is up to 0.14m, potentially affecting the library carpark.

An entry to the underground carpark of the WSU building also faces this driveway. The simulated water level around the entry to the carpark reaches approximately 24.7m, while the elevation of the carpark entry in the design drawing is 24.64m. This results in water entering into the underground carpark.

5.2 Improvement by the proposed drainage upgrade

Scenario3 incorporating all proposed drainage upgrades reduces flooding significantly. As shown in Figure 10, the maximum water depth is reduced by up to 0.3m at most locations as a result of the drainage upgrade along the eastern and southern walls, compared to the current condition. The impact of the WSU building construction is most significant at the area located at the northern side of the building. The increase of the maximum water depth is 0.05m within Rickard Rd and highest (0.36m) along the building wall. This is partially a result of the lack of the modelling surface grid for the pavement around building which was not available during the study. In real conditions, it is not expected to exceed increases observed within Rickard Rd, should the paved area in front of the building be of the approximately same level as the existing footpath.

A localised increase of up to 0.24m is still present between WSU and Council building as a result of the WSU building protrusion into the floodway, while the increase in the driveway between the WSU building and library is the same as in Scenario2 (up to 0.14m).

Refer to map D-2 in Appendix D.

Water depths along the eastern wall of the WSU building in Scenario3 range between 0.02 and 0.52m, with water surface levels being between 24.2m AHD (south-eastern corner) and 24.8m AHD (north-eastern corner).

The hazard category is lowered from medium risk to low risk at most locations (Figure 11). The maximum velocity-depth product is reduced by 0.2 - 0.8m at the section between the Council building and the new WSU building, compared to the existing condition, as shown in Figure 12.

There is no significant change to the conditions at entry to the building underground car park, compared to Scenario2.

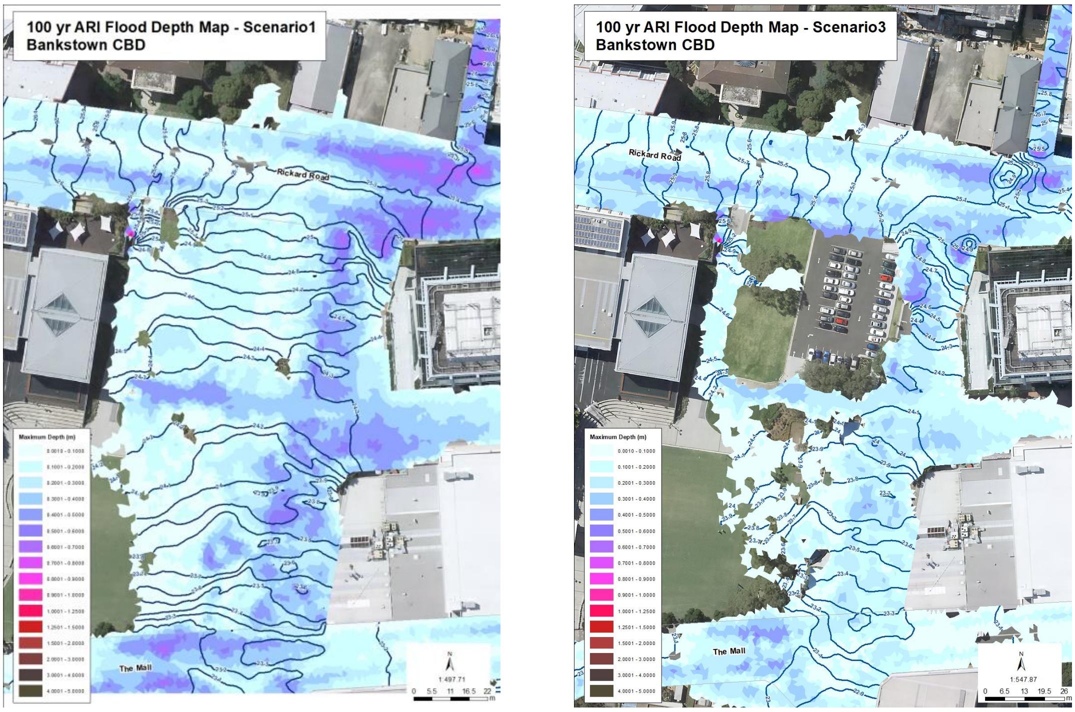


Figure 10 Comparison of maximum water depth between Scenario1 (left) and Scenario3 (right)

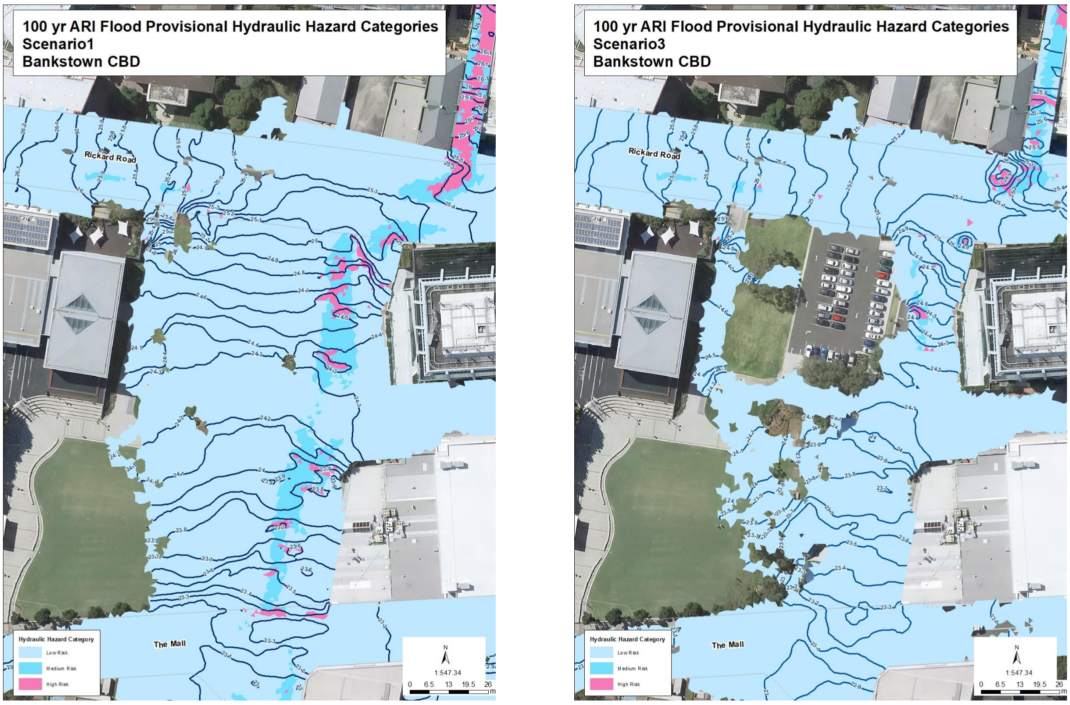


Figure 11 Comparison of hazard categories between Scenario1 (left) and Scenario3 (Right)

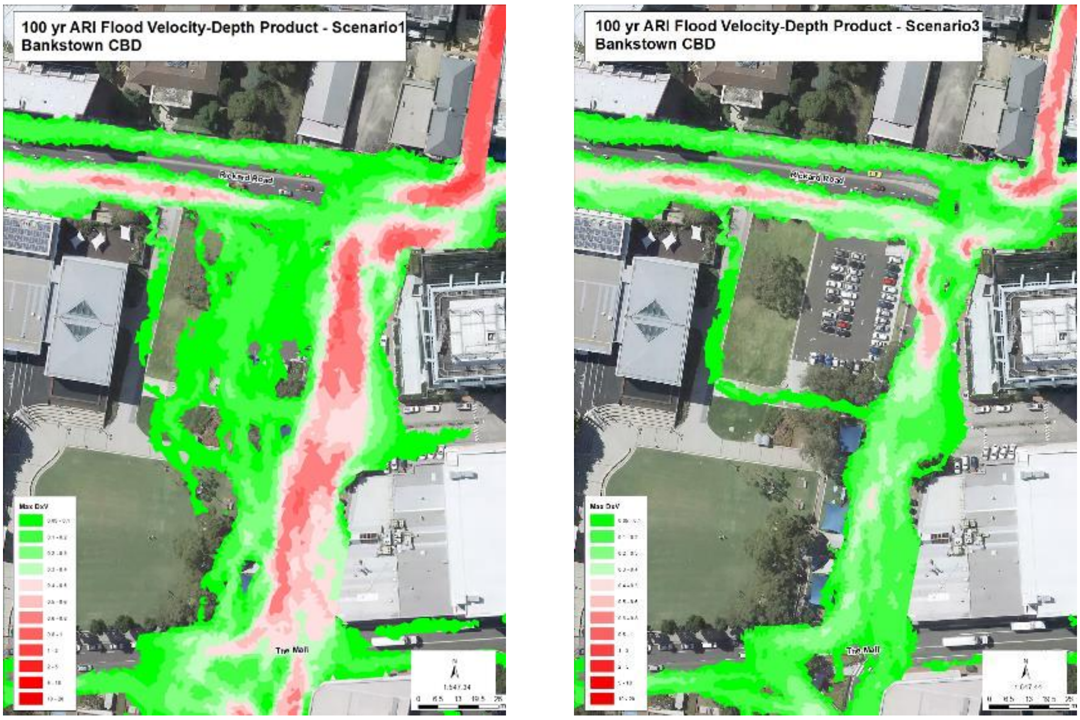


Figure 12 Comparison of velocity-depth product between Scenario1 (left) and Scenario3 (right)

6 Conclusions

The existing MIKE FLOOD model was modified to represent the current condition, the future condition with the WSU campus constructed, and the future condition with the WSU campus and the proposed drainage upgrade implemented.

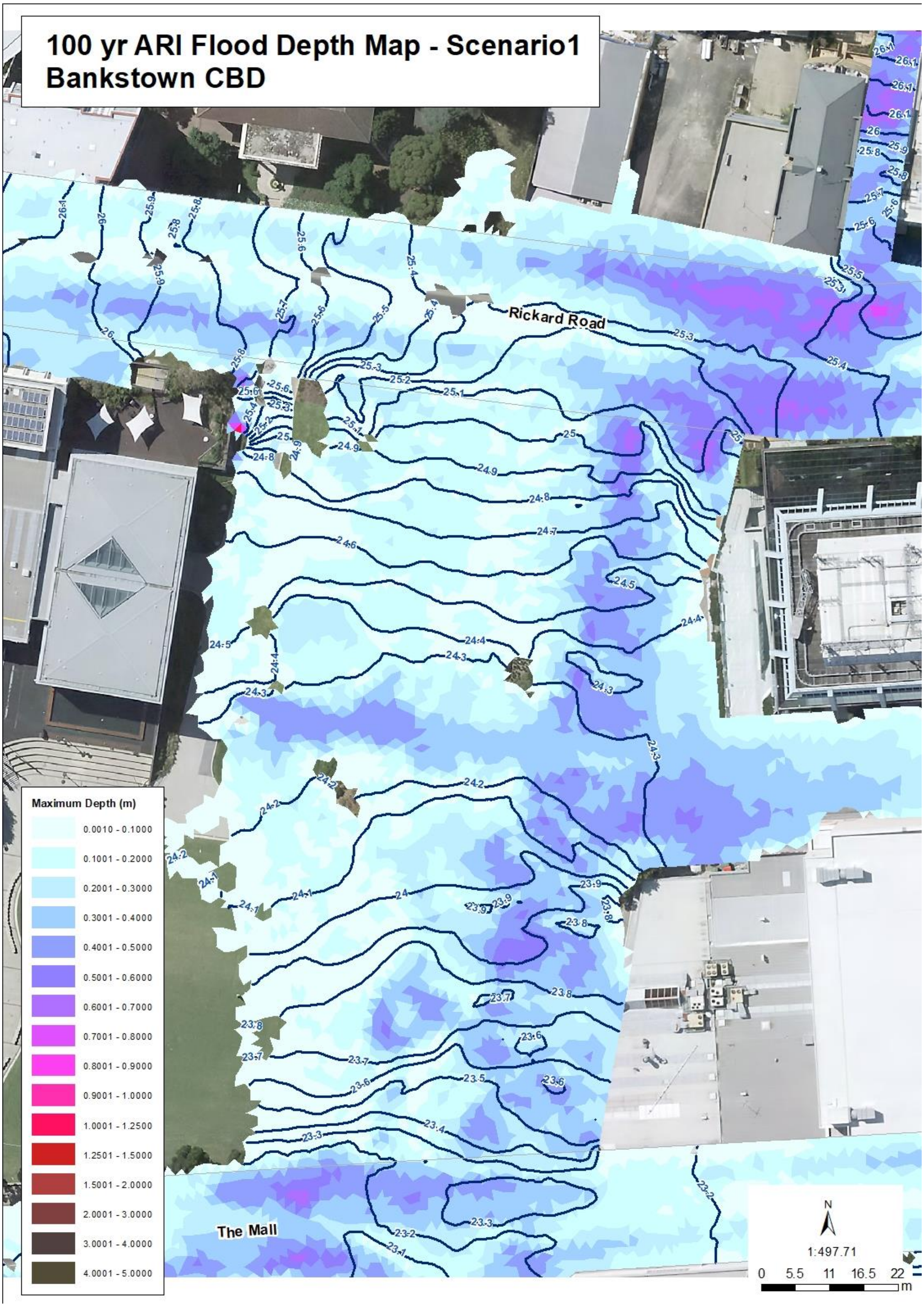
Construction of the WSU building will worsen flooding conditions at Rickard Rd and in particular the section between the Council administrative building and the WSU campus. However, the proposed drainage upgrade is expected to significantly reduce the impact of the WSU campus on flooding in the surrounding area.

APPENDICES

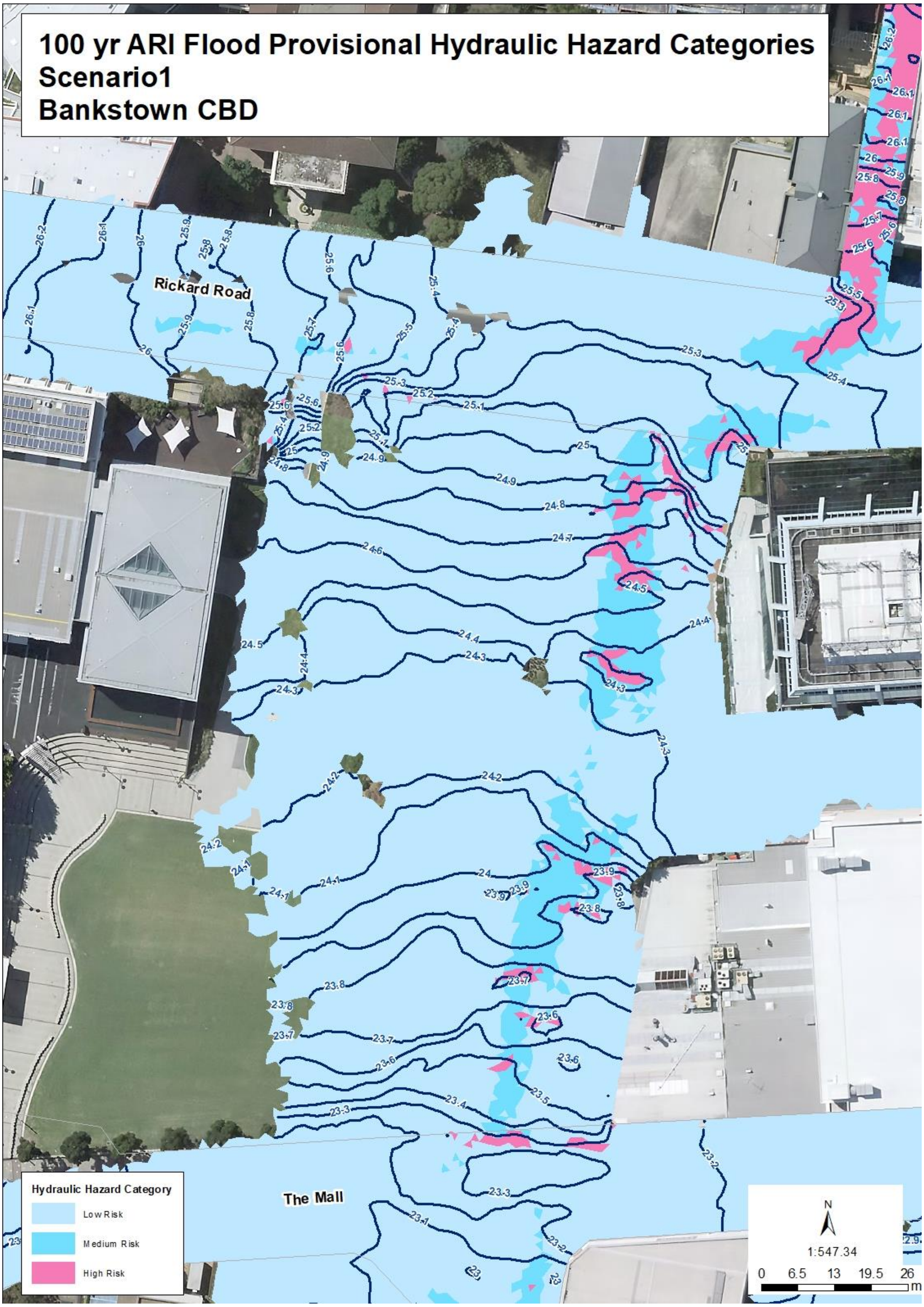
APPENDIX A – Scenario1

Existing Conditions

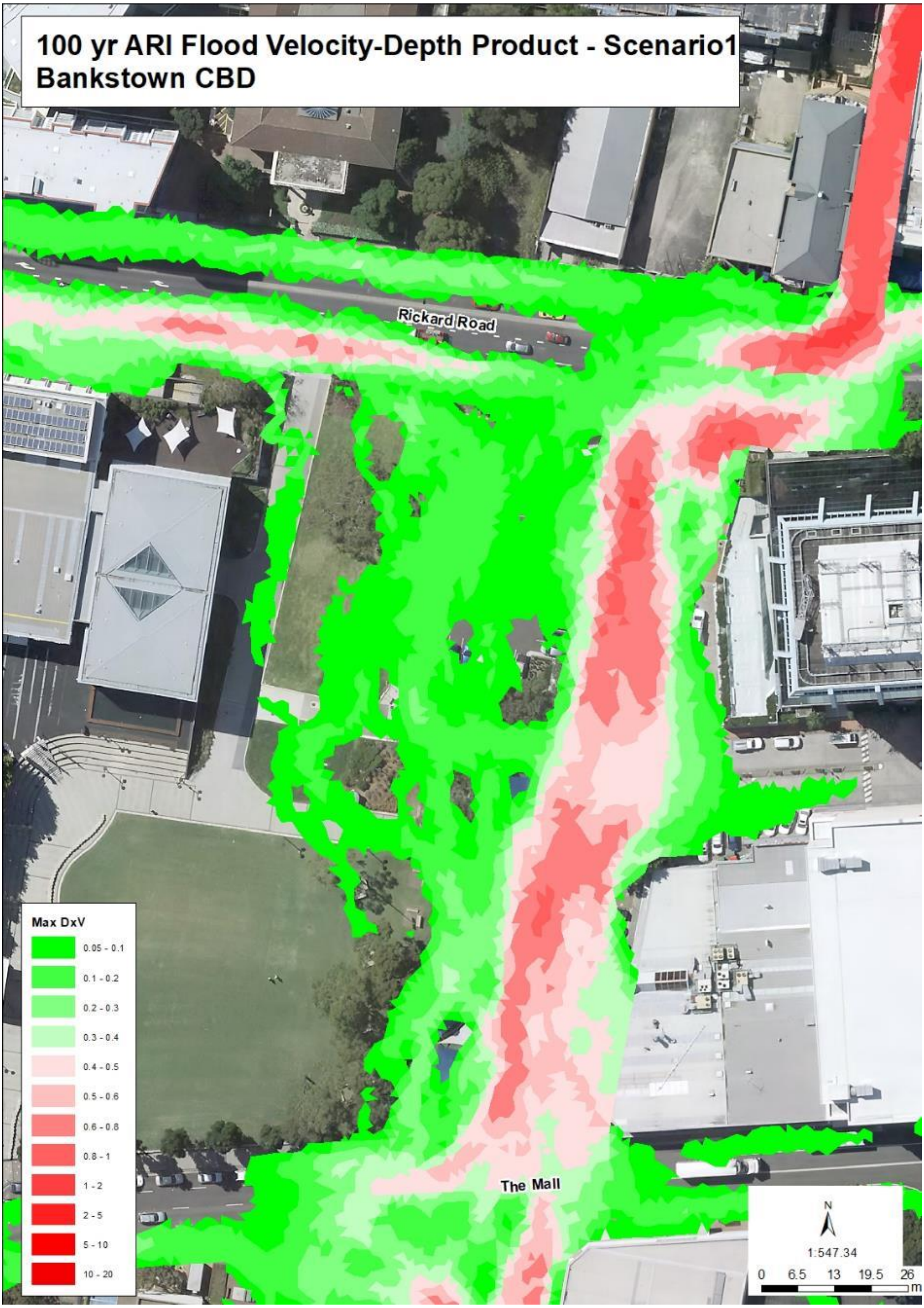
Maximum Water Depth



Maximum Provisional Hydraulic Hazard Categories



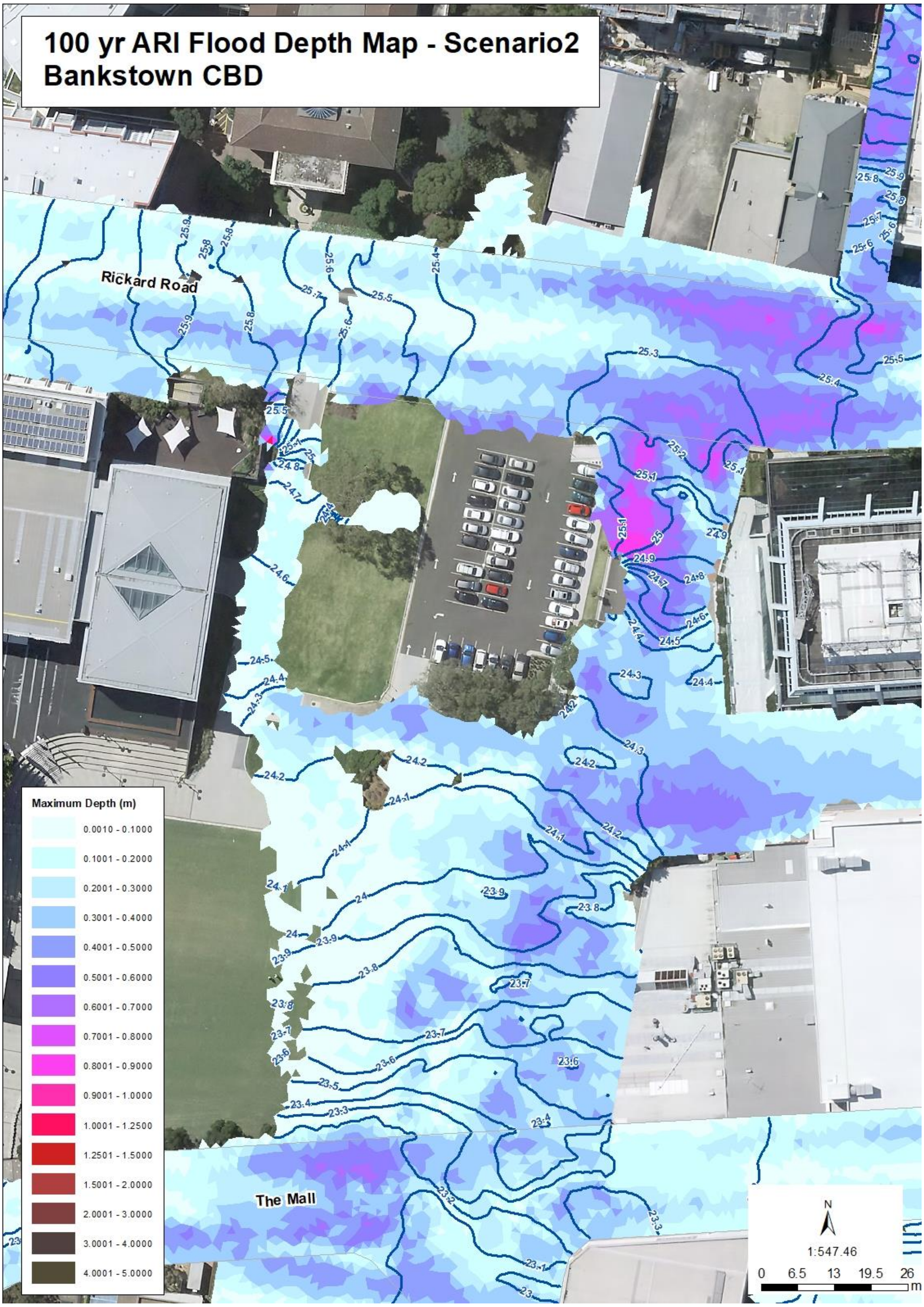
Maximum Velocity-Depth Product



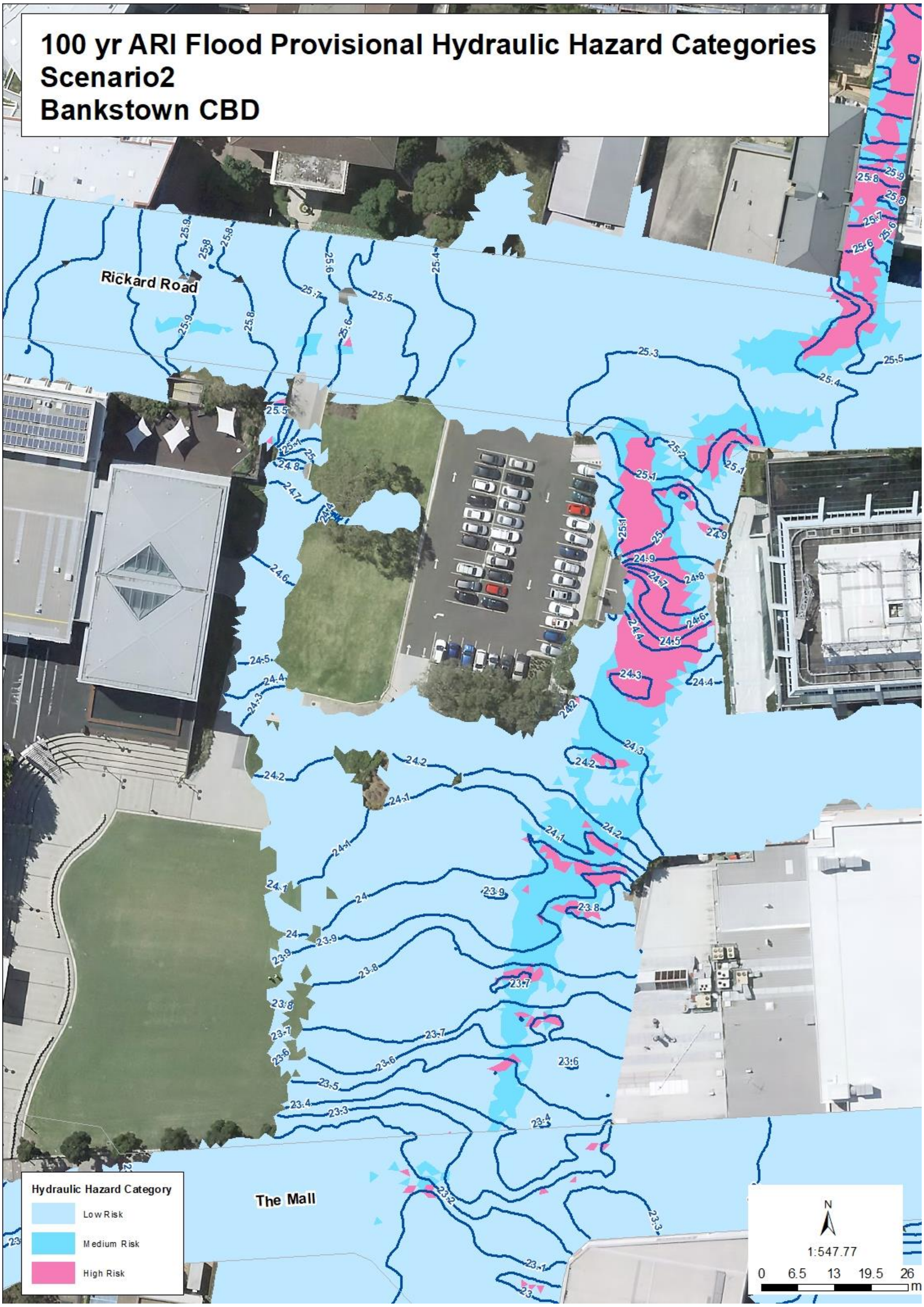
APPENDIX B – Scenario2

Proposed WSU Development

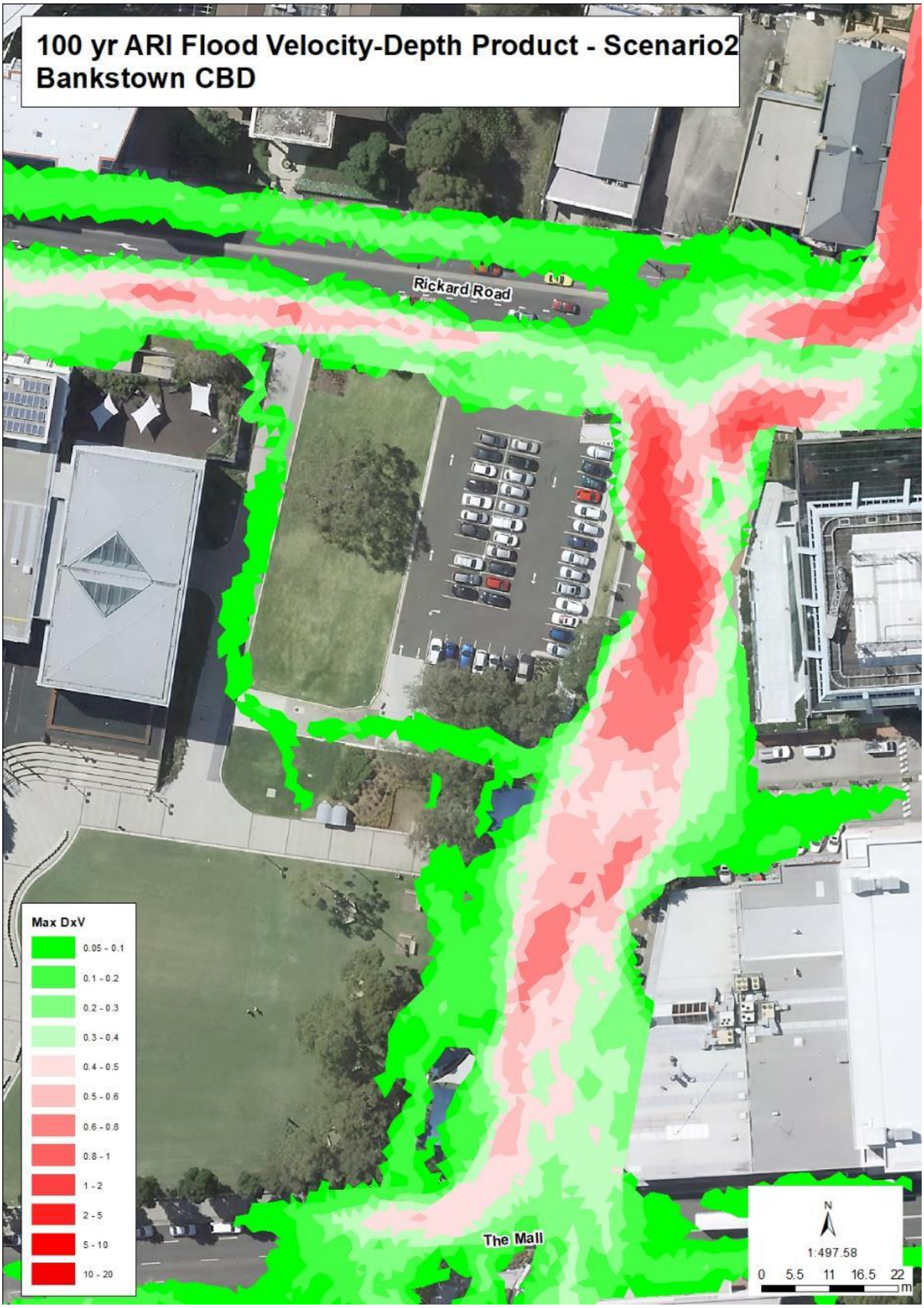
Maximum Water Depth



Maximum Provisional Hydraulic Hazard Categories



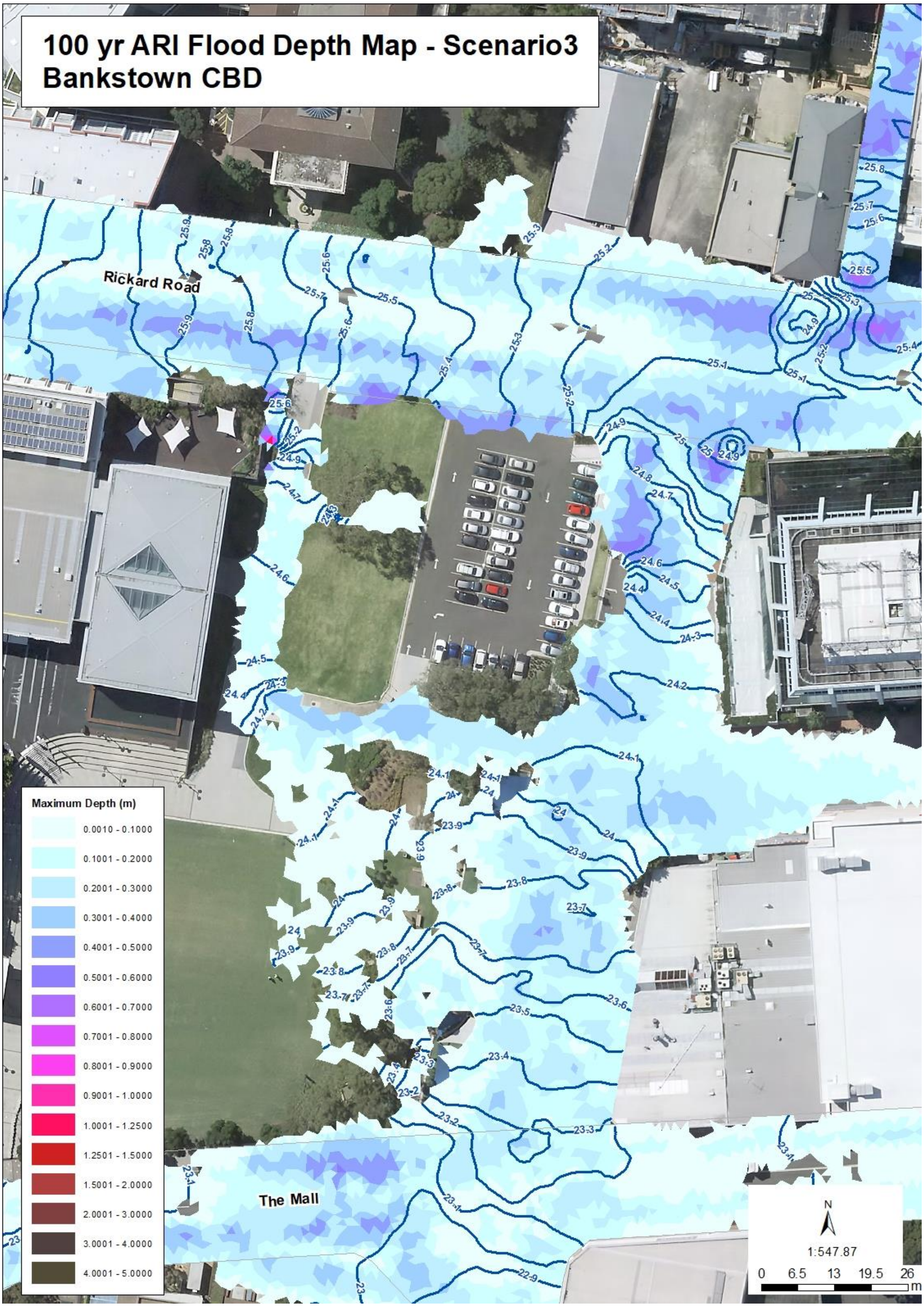
Maximum Velocity-Depth Product



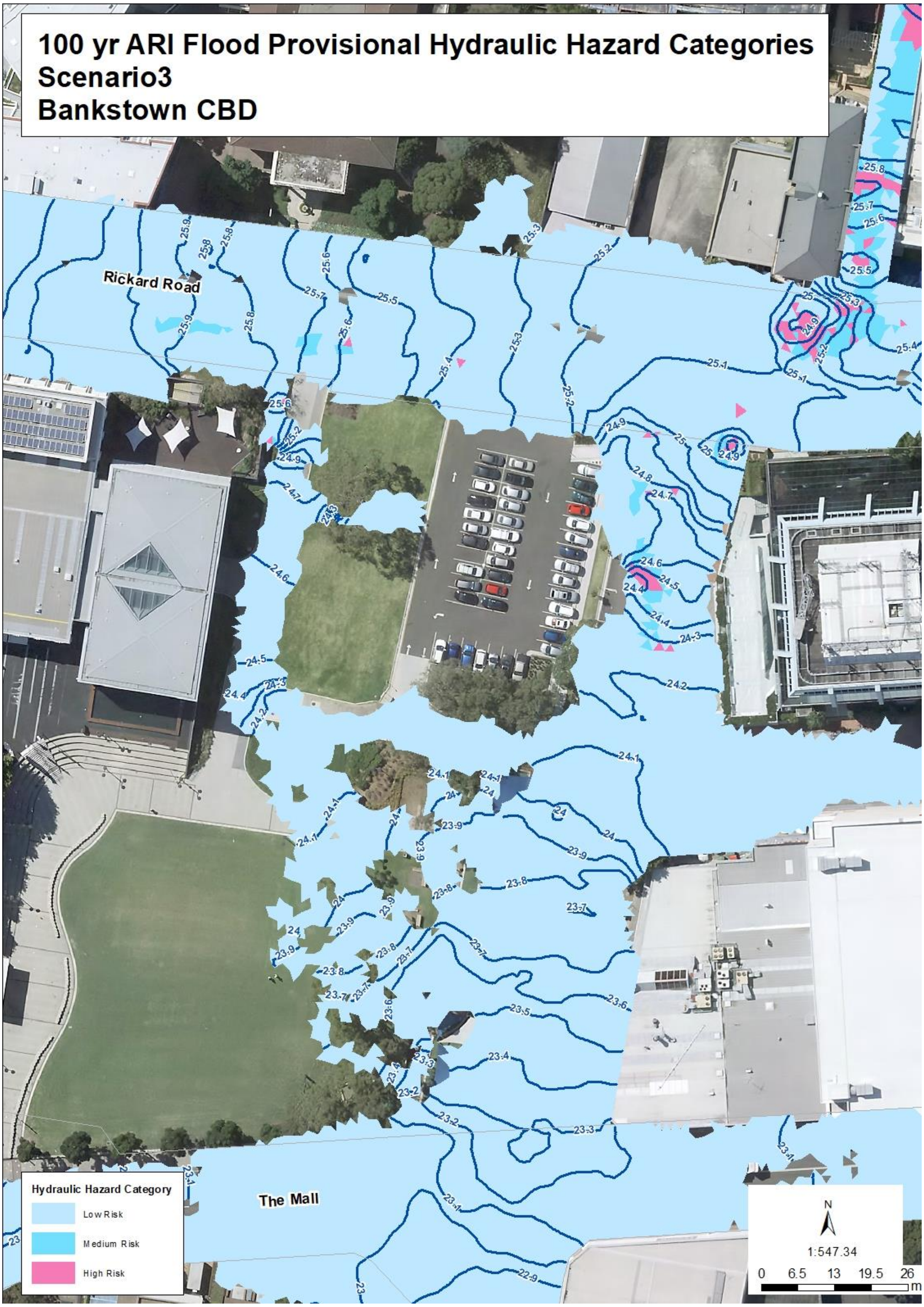
APPENDIX C – Scenario3

Proposed WSU Development with Drainage Network Upgrades

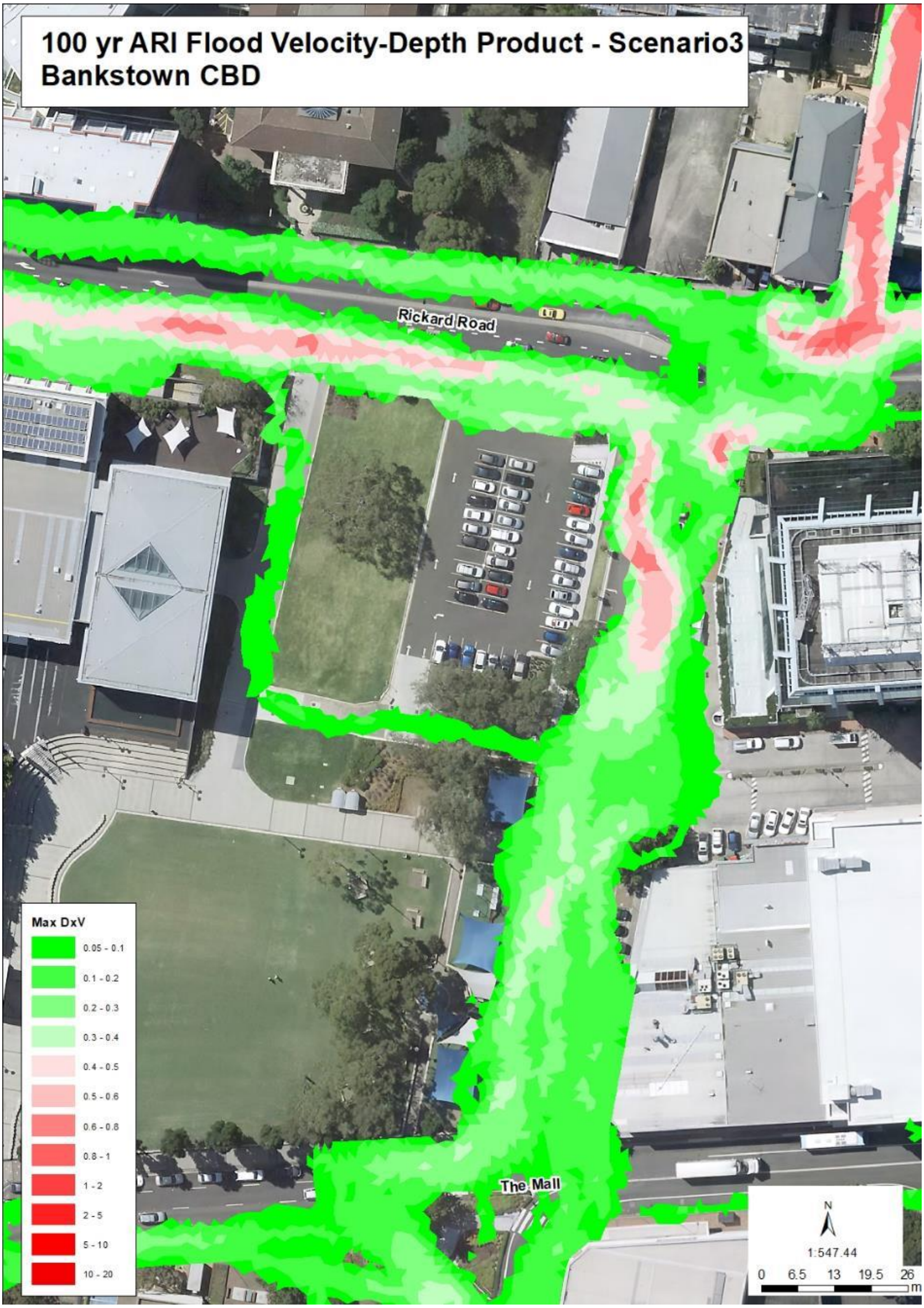
Maximum Water Depth



Maximum Provisional Hydraulic Hazard Categories


100 yr ARI Flood Provisional Hydraulic Hazard Categories
Scenario3
Bankstown CBD
Rickard Road
The Mall
Hydraulic Hazard Category
Low Risk
Medium Risk
High Risk
N
1:547.34
0 6.5 13 19.5 26
m

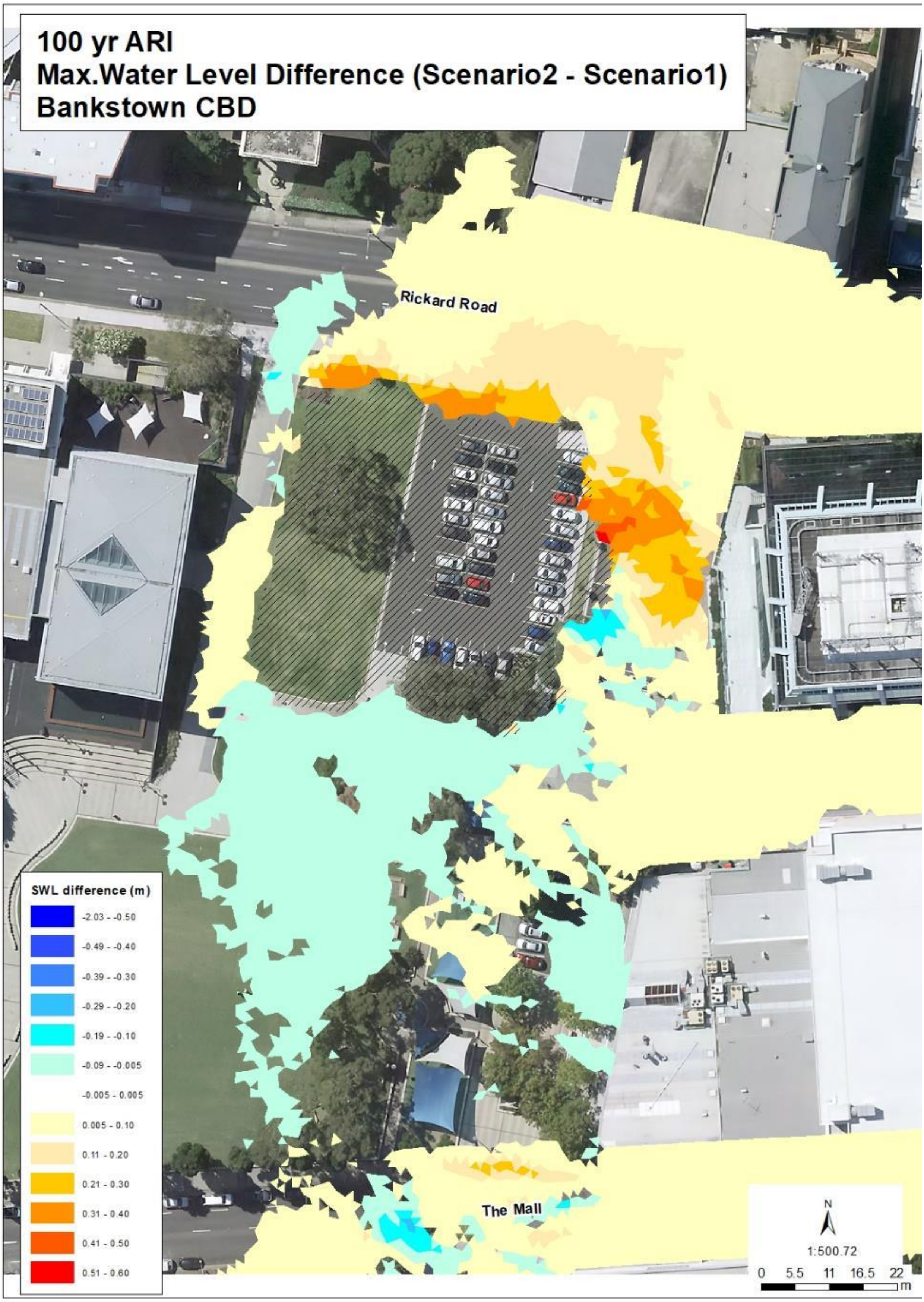
Maximum Velocity-Depth Product



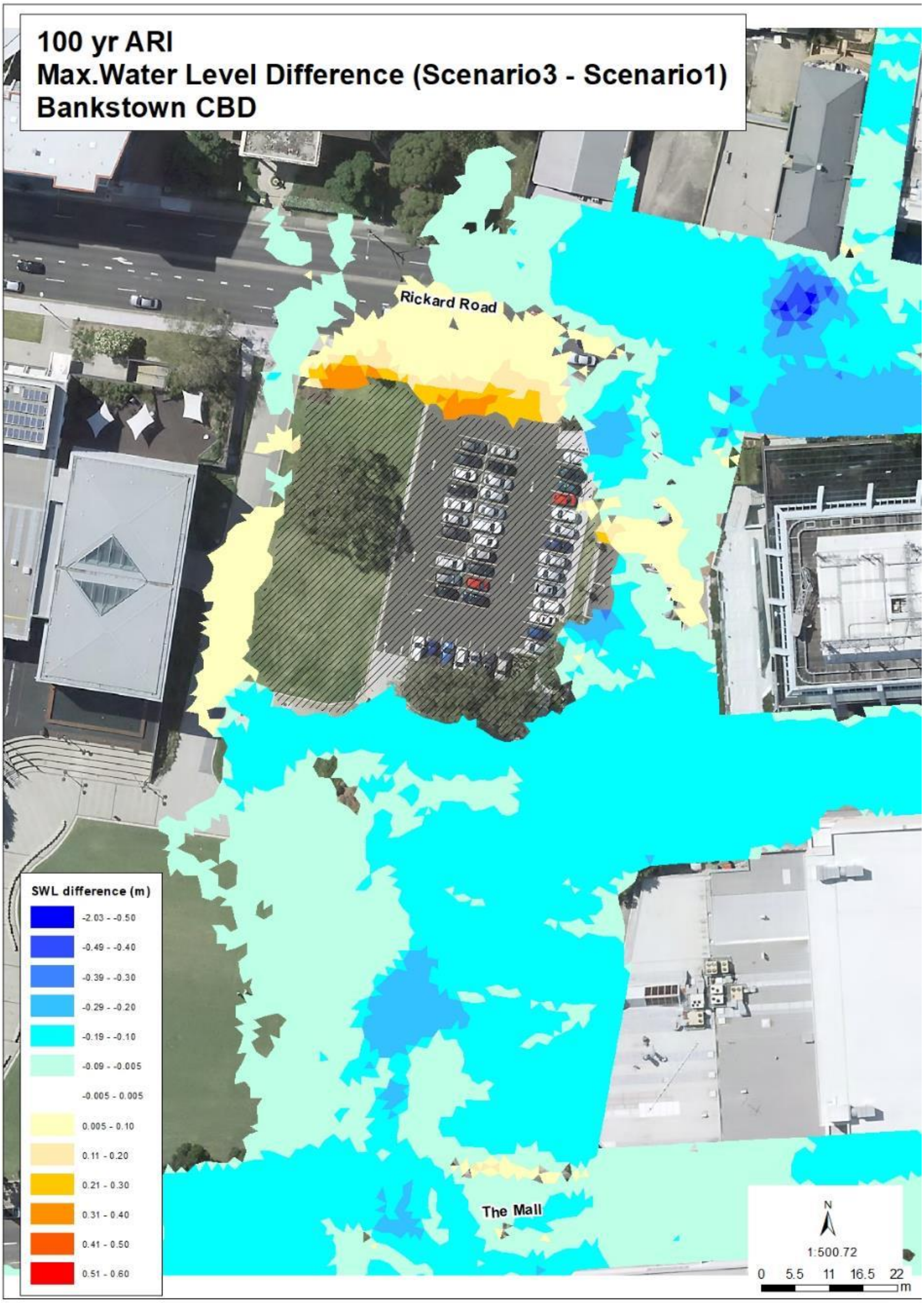
APPENDIX D – Difference Maps

Water Depth difference between scenarios

Scenario2 minus Scenario1



Scenario 3 minus Scenario1



Scenario 3 minus Scenario2