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14 October 2021

SY170095-02_B01 [A]

Macquarie Telecom Pty Ltd
C/- Giddis Project Management
Matthew Giddy
64A Irrubel Rd
Newport NSW 2106

Dear Matthew,

Re: 17-23 Talavera Road, Macquarie Park – IC3 Super West Development Application – Flood Assessment

Northrop Consulting Engineers have been appointed by Macquarie Data Centres (MDC) to undertake the Flood Assessment for the proposed development of the Macquarie Park Data Centre Campus IC3 Super West site at 17-23 Talavera Road, Macquarie Park.

This Flood Assessment serves to support the State Significant Development Application (SSDA) relating to the proposed development and has been prepared with consideration to the following Policies, Guidelines and Plans.

- Ryde Local Environmental Plan (2014).
- Ryde Development Control Plan (2014).
- Ryde Stormwater Management Technical Manual (2014)
- Australian Rainfall and Runoff 2019 (AR&R 2019).
- Australian Rainfall and Runoff 1987 (ARR1987).
- NSW Flood Prone Land Policy.
- NSW Floodplain Development Manual (DIPNR, 2005).
- Water Management Act 2000 (NSW Government, 2016).

This Flood Assessment has been prepared by Northrop Consulting Engineers on behalf of Macquarie Data Centres (MDC) C/- GIDDIS Project Management and has been produced to support the Environmental Impact Statement (EIS) prepared by Willowtree Planning PTY Ltd (Willowtree Planning).

The EIS has been submitted to the New South Wales (NSW) Department of Planning, Industry and Environment (DPIE), in support of an application for State Significant Development (SSD), for the

		Date
Prepared by	LG	14/10/2021
Checked by	GB	14/10/2021
Admin	BBR	14/10/2021

construction and operation of a data centre, involving earth works, provision of infrastructure and expansion of an existing data centre at 17 – 23 Talavera Road, Macquarie Park (Lot 527 DP 752035).

Secretary's Environmental Assessment Requirements

This Flood Assessment is prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs). The flood related SEARs Key Issues are presented in the below **Table *1***, with a response to each item also provided.

Table 1 - SEARS Flooding Related General Requirements

SEARs Key Issue	Secretary's Environmental Assessment Requirements	Response
Flood Risk	Identification of any flood risk on-site having regard to adopted flood studies, the potential effects of climate change, and any relevant provisions of the NSW Floodplain Development Manual (DIPNR, 2005)	Council's adopted flood study has been used as a basis for the flood investigation including an analysis of flood risk in accordance with the latest ARR 2019 hazard categories. Flood risk across the site is outlined in the Results and Discussion sections of this report while, flood hazard conditions across the subject site are presented in Attachment A. As the proposed FFLs are sited at or above the Probable Maximum Flood (PMF) event, increased rainfall intensities as a result of climate change are not expected to affect the proposed development.
Flood Risk	An assessment of the impacts of the development, including any changes to flood risk on-site or off-site (including the existing overland flow route), and detail design solutions and operational procedures to mitigate flood risk where required.	Flood impacts of the proposed development are discussed in the Flood Impacts Section of this report. Changes in flood risk are presented and discussed in the results and discussion sections of this report. Mitigation measures are presented in the Figures provided in Attachment A and discussed in the Developed Case Model section of this report.

A reply to Council's flood related Response to SEARS Request is also presented in the below Discussion section of this correspondence.

Background

A flood investigation has been performed for the subject site for the purposes of a previous Development Application (DA) (LDA 2018/0322). The previous flood investigation was prepared by Northrop Consulting Engineers Pty. Ltd. and was titled:

"17-23 Talavera Road, Macquarie Park – Updates to Previously Submitted Flood Impact Assessment" dated the 28th of June 2019, herein referred to as the "Previous DA Investigation (Northrop, 2019)".

The modelling prepared as part of the Previous DA Investigation (Northrop, 2019) has been used as the basis for this investigation.

The correspondence presented herein presents any updates to the previously approved modelling. This correspondence should be read in conjunction with the previous Flood Impact Assessments provided as Attachment B.

The Subject Site

The site is described as Lot 527 DP 752035, commonly known as 17 – 23 Talavera Road, Macquarie Park. The site has a total area of approximately 20,000m^2, with access achieved via Talavera Road.

The site forms part of the Macquarie Park Corridor, which is the strategic centre of Macquarie Park, being a health and education precinct and an important economic and employment powerhouse in Sydney's North District.

The site is described through its current commercial setting as an existing Data Centre (LDA/2018/0322), adjoining surrounding commercial premises along Talavera Road, and forming part of the wider Macquarie Park Corridor.

Site topography generally falls in a northerly direction with an average grade in the order of two percent. Steeper topography, in the order of eighteen percent, is observed in the north-western corner of the site, adjacent to the driveway entrance to Talavera Road.

The site is situated approximately 12.5 km northwest of the Sydney CBD and 11.3 km northeast of Parramatta. It is within close proximity to transport infrastructure routes (predominantly the bus and rail networks), as well as sharing direct links with the wider regional road network, including Talavera Road, Lane Cove Road, Epping Road and the M2 Motorway.

These road networks provide enhanced connectivity to the subject site and wider locality. Additionally, the site is located within close proximity to active transport links, such as bicycle routes, providing an additional mode of accessible transport available to the subject site

Figure 1 - Subject Site

The catchment upstream of the subject site is approximately 40.5ha in size and consists primarily of commercial and residential land-use. The topography is moderately sloped in the upper and lower reaches with slopes in the order of one to five percent.

Flows from the upstream catchment enter the site from the south and cross the site via the previously proposed driveway before discharging downstream onto Talavera Road.

The Proposed Development

The proposal represents an extension to the approved data centre (LDA/2018/0322) to allow for additional data storage capacity at the subject site, improving the overall operational efficiencies and provision of technology services to customers and the wider locality.

The proposal involves the construction and operation of an expansion to an existing data centre located at 17-23 Talavera Road, Macquarie Park (Lot 527 in DP 752035), comprising:

- a five-storey building
- ancillary office space and staff amenities
- a back-up power system
- associated infrastructure, car parking, loading docks and landscaping

The subject site is located within the City of Ryde Local Government Area (LGA). The proposal seeks to operate 24 hours per day, seven (7) days per week.

The particulars of this proposal are summarised below:

- Minor earthworks involving cut and fill works
- Infrastructure comprising civil works and utilities servicing
- Construction of a five (5) storey building extension, comprising up to:
- 14 data halls
- 18 backup generators
- Fitout of the building for use as a data centre (on an as-needs basis)

Further information is presented in the Architectural Drawings prepared by HDR Pty Ltd.

Modelling Updates

Existing Case Model

The Existing or Base case model terrain and model setup is presented in the attached Figures A1 and A2 of Attachment A. The previously approved Developed Case scenario presented in the Previous DA Investigation (Northrop, 2019) (provided as Attachment B) has been used as the existing case scenario for this investigation. It is noted that at the time of preparation of this study, construction for the Previous DA (LDA 2018/0322) has not been completed, however the strategy has been approved and is expected to be completed. This previously approved, and soon to be constructed scenario has been considered as the "Existing Case" scenario for this investigation.

Additional details regarding the model changes that have been made to the original Macquarie Park Flood Risk Management Study and Plan (FRMS&P) TUFLOW model (Bewsher, 2011) are discussed in the "Model Updates – Existing Case Model" and "Model Updates - Developed Case Model" sections of the Previous DA Investigation (Northrop, 2019) which are presented in Attachment B.

Developed Case Model

The developed case model terrain and model setup is presented in Figures A3 and A4 of Attachment A. The subject site model terrain is based on a combination of detailed survey, the design surface prepared as part of the previous DA and the latest design surface prepared using 12D software.

Modifications to the terrain have also been entered into the model manually with the bund along the north-western boundary entered included as a 2d_zsh layer. Similarly, the terrain over the proposed fair stair, located adjacent to the existing loading dock and entrance, has been raised above the flood level representing a full obstruction to flow.

Structural shear walls have also been entered into the model by nulling the cells, also representing a total obstruction to flow. No changes are proposed to the existing trunk drainage network through the subject site and as such, the below ground infrastructure presented in Figure A3 remains unchanged when compared to the existing case (Figure A1).

Figure A4 shows surface roughness and boundary fences remain largely unchanged when compared to the existing case. Louvres proposed around the existing building (shown in Figure A2) have been removed as the under-croft area is expected to remain open in the developed case.

Results

Existing Case

During the existing case, overland flow enters the subject site from the southern corner, where flood water initially divides between entering the subject site and filling up the flood storage area located within the property adjacent to the south-eastern boundary. Once this flood storage area is filled, additional flows are forced onto the subject site via a low point near the southern corner. Once flows enter the subject site they continue overland in a north-westerly then north-easterly direction, over the existing driveway and carpark, before discharging to Talavera Road in the northern corner of the subject site.

The 1% AEP and PMF flood depth and elevation contours are presented in the attached Figures A5 and A7 of Attachment A respectively. Flood depths across the subject site during the 1% AEP range from approximately, 0.1 - 0.3m in the driveway and carpark adjacent to the south-western and north-western boundaries while the driveway along the south-eastern boundary remains largely flood free.

Similarly, flood depths during the PMF design storm events range from approximately 0.1 - 0.5m in the driveway and carpark along the south-western and north-western boundaries while depths in excess of 1.0m are observed along the south-eastern boundary.

Flood elevations in the property adjacent to the south-eastern boundary are shown in Figures A5 and A7 as 52.78m AHD and 53.21m AHD during the 1% AEP and PMF design storm events respectively.

Similarly, flood levels along the south-western boundary during the 1% AEP and PMF design storm events range from 52.77m AHD to 53.09m AHD during the 1% AEP and PMF design storm events respectively. Flood elevations at the existing IC2 Loading Dock (FFL of ~52.5m AHD) during the 1% AEP and PMF are 51.99m AHD and 52.21m AHD respectively.

Flood hazard has also been considered for the existing and developed scenarios using the latest AR&R 2016 hazard categories. A summary of these categories is presented in Figure 2 overleaf.

Figure A6 of Attachment A shows the existing flood hazard in the driveway during the 1% AEP is largely H1 with a patch of H2 along the south-western boundary. During the PMF, Figure A8 of Attachment A shows H5 hazard flow at the southern corner and along the south-eastern side of the building. A maximum of H4 is observed in the driveway and carpark along the north-western boundary

which increases to H5 as flows continue down the driveway towards Talavera Road at the northern corner of the subject site.

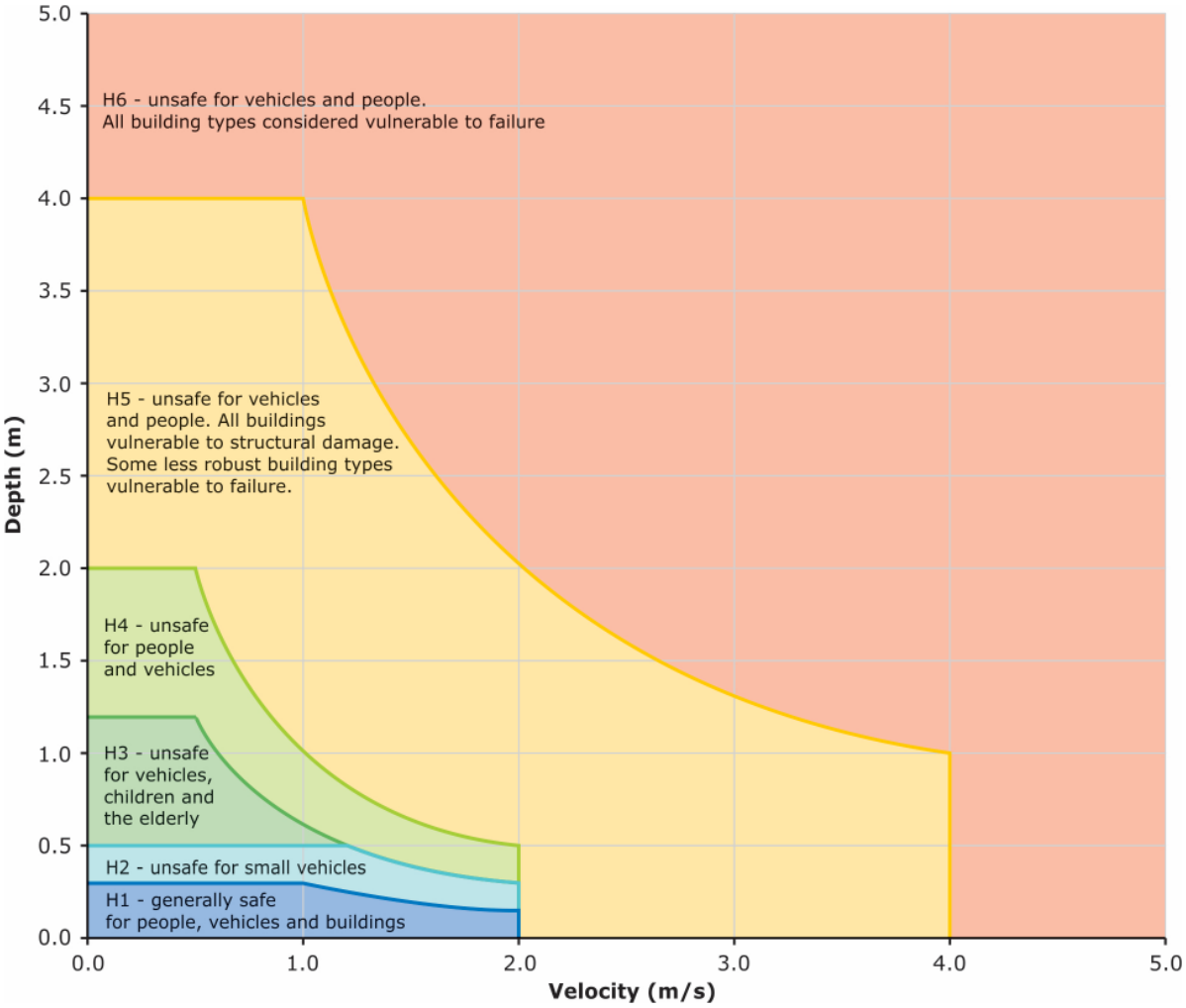


Figure 2 - Flood Hazard Categories (AR&R 2019 - Book 6, Chapter 7)

Developed Case

Flow behaviour during the developed case remains largely un-changed when compared to the existing case. Flows enter the subject site from the southern corner and continue overland in a north-westerly then north-easterly direction over the existing driveway and carpark before discharging to Talavera Road in the northern corner of the subject site.

Adjustments have been made to the design surface within the under-croft area and adjacent to existing IC2 loading dock, in an attempt to reduce the flood hazard conditions in the driveway and carpark and lower the flood levels around the loading dock.

Figures A9 and A11 show the 1% AEP and PMF flood depths and elevation for the developed case. The results show no change in flood elevations in the property adjacent to the south-eastern boundary and adjacent to the southern corner of the site. A reduction in flood depth is observed at the existing IC2 loading dock with a flood level of 51.90m AHD during the 1% AEP (reduced from 51.99m AHD) and 52.16m AHD (reduced from 52.21m AHD) during the PMF.

Figures A10 and A12 of Attachment A shows flood hazard along the south-eastern driveway remains largely unchanged when compared to the existing case however, flood hazard conditions along the north-western boundary have been improved with largely H1 and H2 observed in the under-croft area

during the 1% AEP and PMF design storm events respectively (reduced from H4 in the PMF during the existing case).

Hazard conditions in Talavera Road, adjacent to the subject site during the 1% AEP design storm event is largely H1, increasing to H3 in the sag located adjacent to the northern corner of the site. Some small patches of H5 are also evident which is expected to be due to patches of high velocity. If required, access and egress from the subject site may be possible during the 1% AEP via the access driveway in the eastern corner of the site.

Hazard conditions in Talavera Road during the PMF increase to H5 with patches of H6. It is expected that in a rare or extreme event such as the PMF, staff and visitors will evacuate prior to the event or seek refuge within the building until floodwaters subside. This is reflected in the Flood Emergency Response Plan prepared for the site as part of the previous DA.

Development Impact

The development impact on the existing 1% AEP and PMF design storm events is presented in Figures A13 and A14 of Attachment A. Figure A13 shows a decrease in flood depth of up to 102mm in the property adjacent to the north-western boundary, with this property now flood free during the 1% AEP. This is the result of updating the height of the bund in attempt to improve flood conditions in adjacent properties.

Figure A14 of Attachment A shows the flood impact during the PMF design storm event. Similar to the 1% AEP, a decrease in excess of 300mm is observed in the property adjacent to the north-western boundary as a result of the modified bund/ flood wall height.

A localised increase is observed in Talavera Road during the PMF with up to 400mm but generally less than 50mm observed. Comparing Figures A8 and A12 in Attachment A, this increase is not expected to affect the trafficability in Talavera Road with H5 and H6 hazard conditions already observed in the area (i.e. the increase does not result in the introduction of a new hazard category).

Similarly, localised increases of up to approximately 19mm and 100mm are observed in 19-25 Khartoum Road, downstream of the subject site and Talavera Road. Similar to Talavera Road increases, these are localised and are expected to be the result of a slight change in the flow behaviour downstream of the subject site. Figures A8 and A12 suggest only a minor change in the extent of the existing hazard may occur as a result, however these hazard conditions are already observed in the area.

Given the magnitude of the event and the negligible change in hazard conditions, the increases observed in Talavera Road and Khartoum Road are not expected to result in a significant adverse impact.

Discussion

Flood Planning Levels

The proposed Electrical Plant and Fire Misting Control Valve room located in the eastern corner of the subject site are recommended to be placed at the 1% AEP + 500mm or the PMF (whichever is higher). The maximum flood level adjacent to this facility during the 1% AEP and PMF design storm events are 52.45m AHD and 52.70m AHD respectively. As such, a minimum Finished Floor Level (FFL) of 52.95m AHD (i.e. the 1% AEP + 500mm) is recommended.

No adverse impact to existing Flood Planning Levels is expected to the existing IC2 and IC3-East facilities. The southern portions of IC3-East are sited at a level of 53.66m AHD, reducing to 53.23m AHD at its interface with IC2 and the eastern corner of the facility (in IC2). Maximum flood levels of approximately 53.30m AHD are observed at the southern corner of the building, reducing to 53.21m

AHD along the south-eastern side of the building and approximately 52.9m AHD at the eastern corner during the PMF.

Around the western side of the building, floor levels range from 53.66m AHD in the southern portion of the facility, reducing to 53.23m AHD at its interface with IC2. The lowest portion of the building is at the existing entrance and loading dock in IC2 with the FFL sited at approximately 52.5m AHD. Figures A9 and A11 show flood levels are below these levels with a reduction in flood levels observed around the loading dock as a result of the proposed development.

Development Control Plan Requirements

The following Section assesses the development with respect to the controls outlined in Part 8.2 – Stormwater and Floodplain Management - Section 4.4.6 of the Ryde City Council Development Control Plan (2014).

a) *Commercial development on land subject to flood risk categorised as high will not be permitted unless it can be clearly demonstrated that development under this section can be undertaken on the land without jeopardising public safety and access, property damage or adverse ramifications of the pre-developed flood regime by means of a Flood Impact Statement.*

Response

As mentioned in the previous reports, the subject site is classified as a low to medium flood risk as shown in the Macquarie Park FRMS&P and as such this item is not applicable.

In addition, the proposed development presents improved flood conditions when compared to the previously approved scenario (i.e. the existing case). A reduction in flood elevations (improving freeboard to critical parts of the building) and reduced flood hazard conditions during the PMF are observed as part of the proposed development.

Furthermore, the proposed development is not expected to have a significant adverse impact on the subject site or in adjacent properties.

b) *Floor levels of habitable and non-habitable areas must comply with the freeboard requirements as stated in Table 2.1 of the Stormwater Technical Manual. If these levels cannot be practically achieved for the entire floor area (e.g., for reasons of accessibility from a public space) then a lesser level may be considered subject to consideration of the extent or scale of property damage and risk to public safety.*

Response

The proposed FFLs are sited at a minimum of the 1% AEP + 500mm or the PMF whichever is greater. This exceeds the FFL requirements set out by Council's Stormwater Technical Manual.

c) *New structures subject to flooding and overland flow (excluding those sites located in Overland Flow Precincts) must be designed and constructed to withstand the anticipated hydrostatic forces. For all parts of the development potentially exposed to floodwater, below the minimum freeboard requirement, the development structure must:*

    I. *be constructed of flood compatible building components in accordance with the Stormwater and Floodplain Management Technical Manual. Stormwater and Floodplain Management 8.2 Development Control Plan 2014 Final Adopted 21*

    II. *A structural engineer must certify that the completed works are designed and capable of withstanding forces subject to forces of floodwater, debris, buoyancy forces anticipated by the 100yr ARI flood event.*

Response

External walls subject to loading from overland flows will be designed to be flood proof and will to have the structurally capability to withstand the hydrostatic forces of floodwater, debris, buoyancy, etc. It is expected this will be reviewed at detailed design phase.

d) *Development must not divert major overland flows or reduce flood storage such to adversely impact the neighbouring property or surrounding area. It must be demonstrated the development does not:*

   I. *Reduce the pre-developed level of flood storage.*

   II. *Increase flood levels or velocities such to adversely impact adjoining dwellings.*

Response

As discussed in the Development Impact section of this letter, a review of the flood behaviour has been performed and the proposed development is not expected to have a significant adverse impact in adjacent properties.

e) *If the development under this development type category involves subdivision of the land, it must be demonstrated that potential development of this newly created allotment can comply with controls under this section*

Response

The proposed development does not propose to subdivide the land and therefore, this item is not applicable.

f) *A restrictive covenant must be placed on the title of the land to ensure there are no further significant works and alterations to the landform or development are undertaken without the approval of Council such to impact on flooding.*

Response

Noted. It is expected the previously imposed restrictive covenant will be updated to suite the latest flood extents.

Council's Technical Specification Requirements (Part 2.2.2)

Commentary with respect to the Flooding and Overland Flow Planning Considerations presented in Council's Stormwater Management Technical Manual Part 2.2.2 are summarised in the below Table 2.

Table 2 - Response to Planning Considerations in Council's Technical Manual Part 2.2.2.

Planning Considerations	Response
Flood Regime	A description of the existing and developed case flood regime is provided in the Existing and Developed Case results section of this correspondence.
Floor Levels	Existing and proposed FFLs have been assessed in the Flood Planning Levels section of this correspondence.
Building Components	External walls subject to loading from overland flows will be designed to be flood proof and will to have the structurally capability to withstand the hydrostatic forces of floodwater, debris, buoyancy, etc. as mentioned above.

Planning Considerations	Response
Structural Soundness	Given the subject site may be used as a last resort temporary refuge facility during a flood event, it is recommended that the proposed development be designed to withstand flood forces for events up to and including the PMF. This is also consistent with the consent conditions provided for the previous DA.
Flood Affects	The impact of the proposed development on the existing flood behaviour, both within external properties and for the subject site has been presented in the Developed Case flood behaviour, Development Impact and Flood Planning Levels section of this correspondence. The results presented herein suggests the proposed development is not expected to have a significant adverse impact on the subject site or in adjacent properties.
Evacuation	Commentary with respect to Evacuation from the subject site is provided in the Developed Case Flood Behaviour section of this correspondence. It is recommended that the existing Flood Emergency Response Plan, prepared for the subject site be updated to include the latest development.
Management and Design	A hydrologic and hydraulic assessment is presented herein. The comparison of the pre-developed and post-development results suggests the proposed development is not expected to have a significant adverse impact on the subject site or in adjacent properties. Improvements to the existing flood behaviour are observed on the subject site when compared to the existing case.

It is noted that this investigation has been prepared using Council's adopted flood study and as such, the hydrological, hydraulic modelling requirements presented in Parts 4 and 5 of presented in Council's Stormwater Management Technical Manual are not expected to be applicable. Based on consultation with Council during the previous DA, we expect this approach is the most suitable modelling methodology for the purposes of the investigation.

Council's SEARs Items

Item 1.5: *The applicants proposed flood and overland flow strategy nominates floodwaters to disperse over and through the parking area in the under croft so as to reduce the concentration of flow through the site. This does not comply with Council's DCP Part 8.2 (Stormwater and Floodplain Management) Section 4.4.2 which stipulates open parking areas are to be no less than the 100yr ARI event. Notably vehicles are able to float in floodwaters of some 200mm and allowing flow through a carpark would present a significant concern in relation to not only private property damage but potential flood debris (floating vehicles) blocking the flow path downstream.*

Response

It is recognised that the existing and proposed carpark is located below the 1% AEP design storm event. As this is an existing issue, we are seeking a merits-based assessment with an aim to improve these existing conditions where possible by widening the flow path, therefore reducing the extent of the unfavourable hazard conditions where possible.

Figure A10 of Attachment A presents the developed case flood hazard through the under-croft car park during the 1% AEP. The results demonstrate H1 hazard across the majority of the carpark, with a small patch of H2 adjacent to the existing loading dock & entrance. The above Figure 2 suggests H1 hazard flow behaviour is safe for both pedestrians and vehicles and H2 is safe for pedestrians and large vehicles. It is also noted that the H2 hazard observed in the carpark, is surrounded by H1 flow

conditions with any small vehicles that may become buoyant in this area, unlikely to continue downstream.

During the PMF design storm event, a large proportion of the flood hazard conditions, in the under-croft area have been reduced from up to H4 to a maximum of H2 when compared to the existing case. As a result, hazard conditions during this event are considered an improvement when compared to the existing case with lower potential for vehicles to become unstable and float downstream.

The development also proposes to reduce the number of available parking spaces from 110 to 71 therefore reducing the risk across the subject site.

In addition, a steel palisade fence is located around the subject site which has the potential to prevent vehicles that may become buoyant on the subject site from floating further downstream during a major or significant event.

Item 1.7: *The proposed expansion is considered to conflict with a number of requirements of the DCP and Council's Technical Manual.*

Response

A response to the relevant flood related DCP items as outlined in Part 8.2 – Stormwater and Floodplain Management - Section 4 are presented above.

Commentary with respect to the Flood Regime, Floor Levels, Building Components, Structural Soundness, Flood Affects, Evacuation and Management & Design have also been included herein generally in accordance with Council's Technical Manual Part 2.2.2.

In addition, a response to the DCP requirements for carparks (Section 4.4.2 of Part 8.2 of the DCP) has also been presented in the above Item 1.7.

Item 1.10: The existing pipeline reduces the diameter from 1800mm to 1200mm. It is expected that the new development will possibly divert flows to adjacent properties and increase the flood levels and runoff as well. The existing pipeline in Talavera Road may not have the capacity to convey additional flows. The subject property is located in the 1 in100 year overland flow path therefore the detailed flood study must assess the pipe system and overland flow path for the existing and post-developed situations. The developer must consider providing on site underground flood storage and release a little volume of water into the trunk drainage system.

Response

The below ground network presented in Figures A1 and A3 of Attachment A and overland flow path through the subject site have been assessed herein. The below ground network is based on the data presented in Council's adopted flood study namely the Macquarie Park Flood Risk Management Study and Plan (Bewsher, 2011) while, the overland flow path has been designed using 12D software.

No changes to the existing below ground infrastructure are proposed as part of the development. The results presented herein suggests the proposed development is not expected to result in a significant adverse impact on the subject site or in adjacent properties.

Item 3.1: *New detailed flood study with data files: The subject site is subject to flooding, therefore the applicant must submit a new detailed flood study as part of this planning proposal. The revised flood study shall be prepared in accordance with Council's stormwater and Floodplain Technical Manual and shall demonstrate that the proposed works will not worsen the flooding situation in the area.*

Response

A detailed flood study has been prepared and is presented herein. The study has been prepared based on a previous approved development assessment using Council's adopted flood study – namely the Macquarie Catchment Flood Risk Management Study and Plan (Bewsher, 2011).

The results presented herein suggests the proposed development is not expected to have a significant adverse impact on the subject site or in adjacent properties.

Item 4.2: *Flood Impact: The site is noted to be impacted by flooding and over land flow and therefore will warrant a flood impact assessment to be provided. The flood impact statement must address the requirements in Section 4 of councils DCP part 8.2 (stormwater and floodplain management) and any modelling required by this study must be submitted for review.*

Response

A review of the proposed development with respect to Council's DCP Part 8.2 – Stormwater and Floodplain Management - Section 4 has been performed as presented above. The modelling methodology and results are presented above.

Conclusion

A flood impact assessment has been undertaken for the proposed extension of the existing data centre located at 17-23 Talavera Road, Macquarie Park. Flood modelling has been prepared based on a previous investigation performed for the subject site.

A review of the proposed development has been performed with respect to Council's Development Control Plan, Technical Specification and the Council's SEARs items.

We commend our findings to Council for their review. Should you have any queries regarding this correspondence, please feel free to contact the undersigned on (02) 4943 1777.

Prepared by

Laurence Gitzel
Civil Engineer
BE (Environmental)

Reviewed by

Angus Brien
Civil Engineer
BEng (Civil)

Limitation Statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Macquarie Telecom Pty Ltd.

The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report except where expressly permitted in writing or required by law, no third party may use or rely on this report unless otherwise agreed in writing by Northrop.

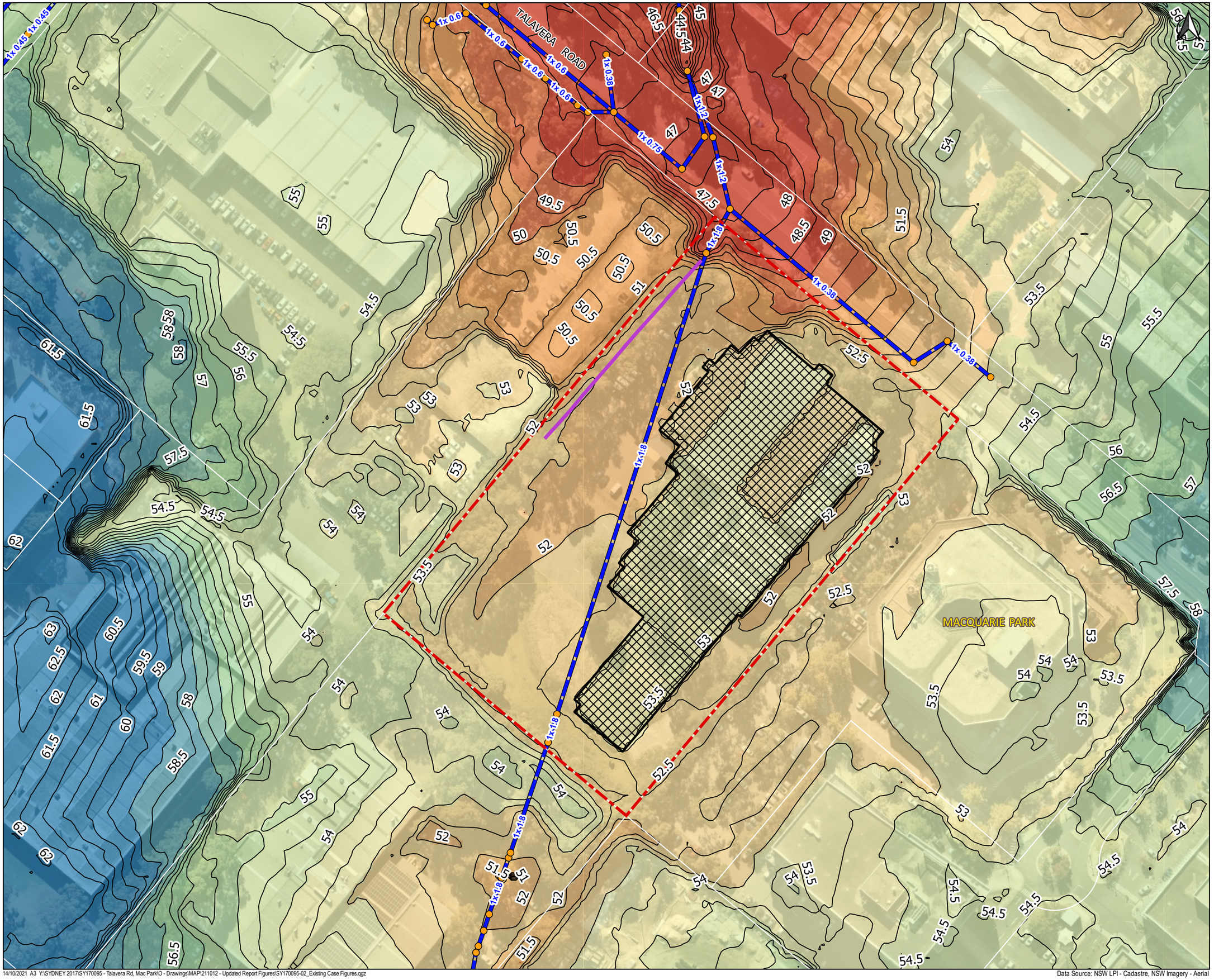
Where this report indicates that information has been provided to Northrop by third parties, Northrop has made no independent verification of this information except as expressly stated in the report. Northrop is not liable for any inaccuracies in or omissions to that information.

The report was prepared on the dates shown and is based on the conditions and information received at the time of preparation.

This report should be read in full, with reference made to all sources. No responsibility is accepted for use of any part of this report in any other context or for any other purpose. Northrop does not purport to give legal advice or financial advice. Appropriate specialist advice should be obtained where required. To the extent permitted by law, Northrop expressly excludes any liability for any loss, damage, cost or expenses suffered by any third party relating to or resulting from the use of, or reliance on, any information contained in this report.

Attachment A – Flood Modelling Figures

Figure List:



Legend

- Pits
- Pipes
- 0.5m Contours
- Bund
- Subject Site
- Buildings

Terrain (m AHD)

- <= 49.00
- 49.00 - 50.00
- 50.00 - 51.00
- 51.00 - 52.00
- 52.00 - 53.00
- 53.00 - 54.00
- 54.00 - 55.00
- 55.00 - 56.00
- 56.00 - 57.00
- 57.00 - 58.00
- 58.00 - 59.00
- > 59.00

0 20 40 Metres

1:1,200

Figure A1 [A]

Existing Case Model Terrain and Infrastructure

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial

Legend

- Subject Site

Fences

- 20% Blockage
- 60% Blockage
- Louvers

Roughness (Manning's)

- Roads (0.020)
- Short Grass (0.030)
- Buildings (20)
- Paved Areas (0.025)

0 20 40 Metres

1:1,200

Figure A2 [A]

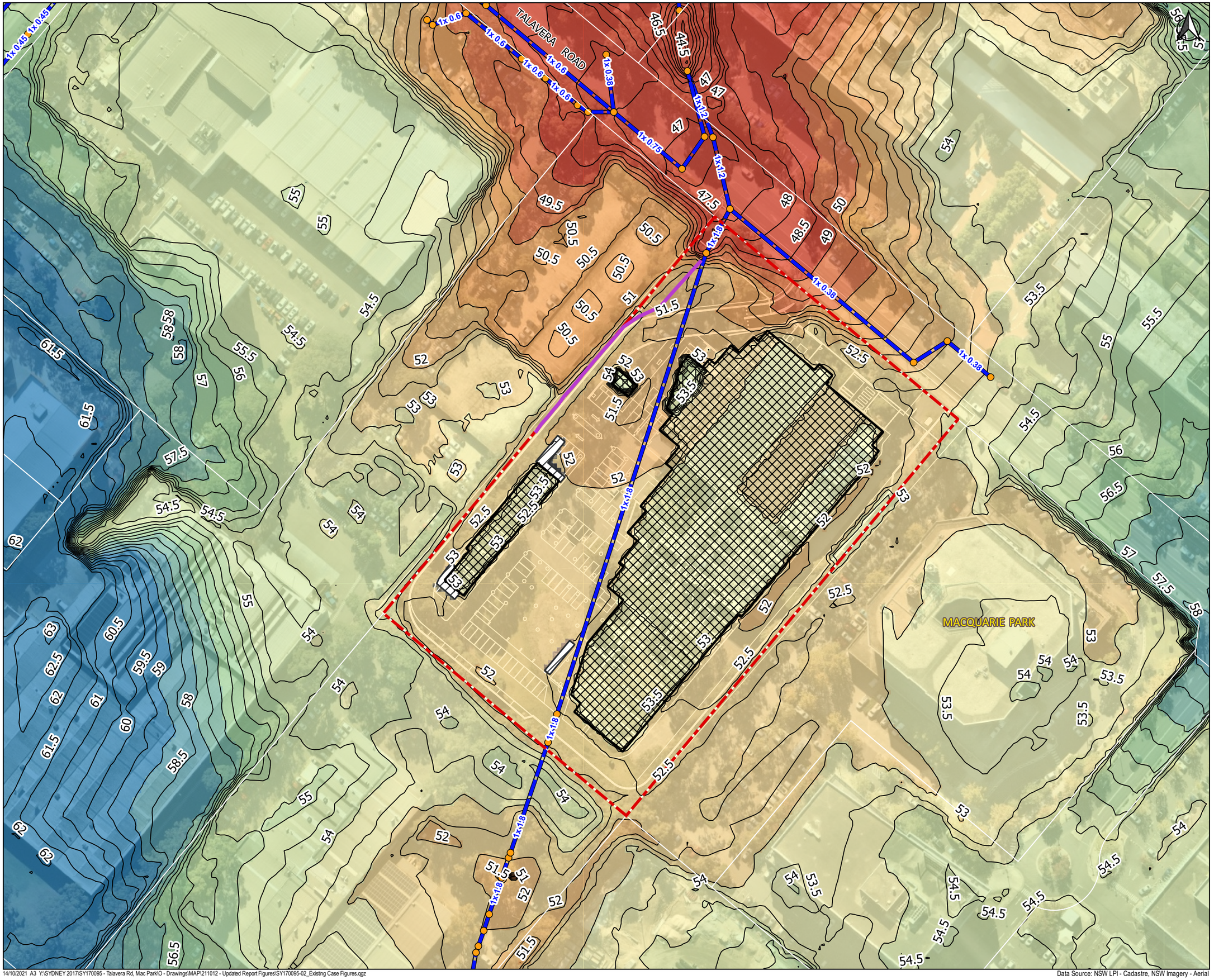
Existing Case Model Landuse and Roughness

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Pits
- Pipes
- Bund
- 0.5m Contours
- Subject Site
- Buildings
- Shear Walls

Terrain (m AHD)

- <= 49.00
- 49.00 - 50.00
- 50.00 - 51.00
- 51.00 - 52.00
- 52.00 - 53.00
- 53.00 - 54.00
- 54.00 - 55.00
- 55.00 - 56.00
- 56.00 - 57.00
- 57.00 - 58.00
- 58.00 - 59.00
- > 59.00

0 20 40 Metres

1:1,200

Figure A3 [A]

Developed Case Model Terrain and Infrastructure

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Legend

Subject Site

Fences

20% Blockage

60% Blockage

Roughness (Manning's)

Roads (0.020)

Short Grass (0.030)

Buildings (20)

Paved Areas (0.025)

0 20 40 Metres

1:1,200

Figure A4 [A]

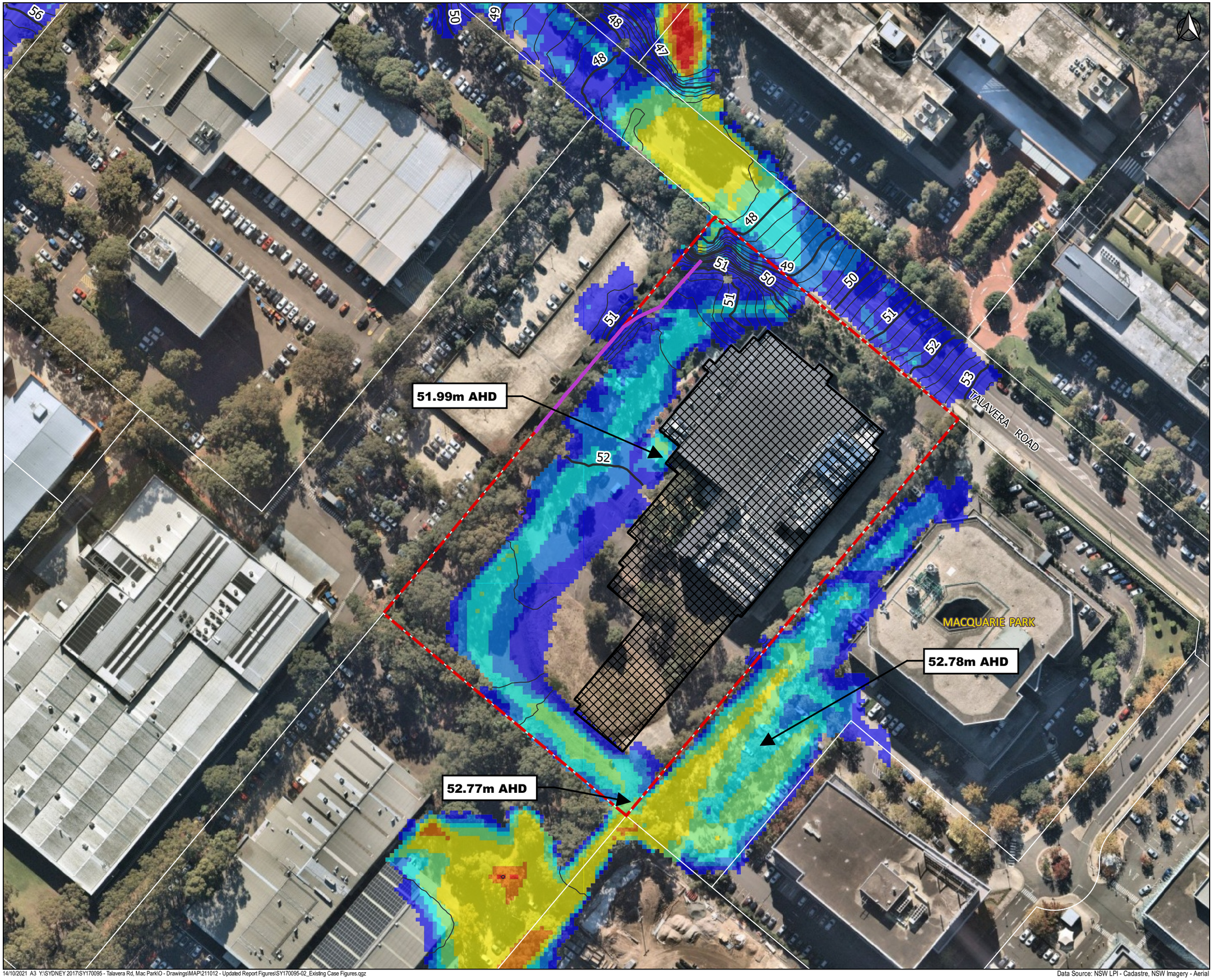
Developed Case Model Landuse and Roughness

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site
- Building
- Contours (1m)
- Contours (200mm)

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 Metres

1:1,200

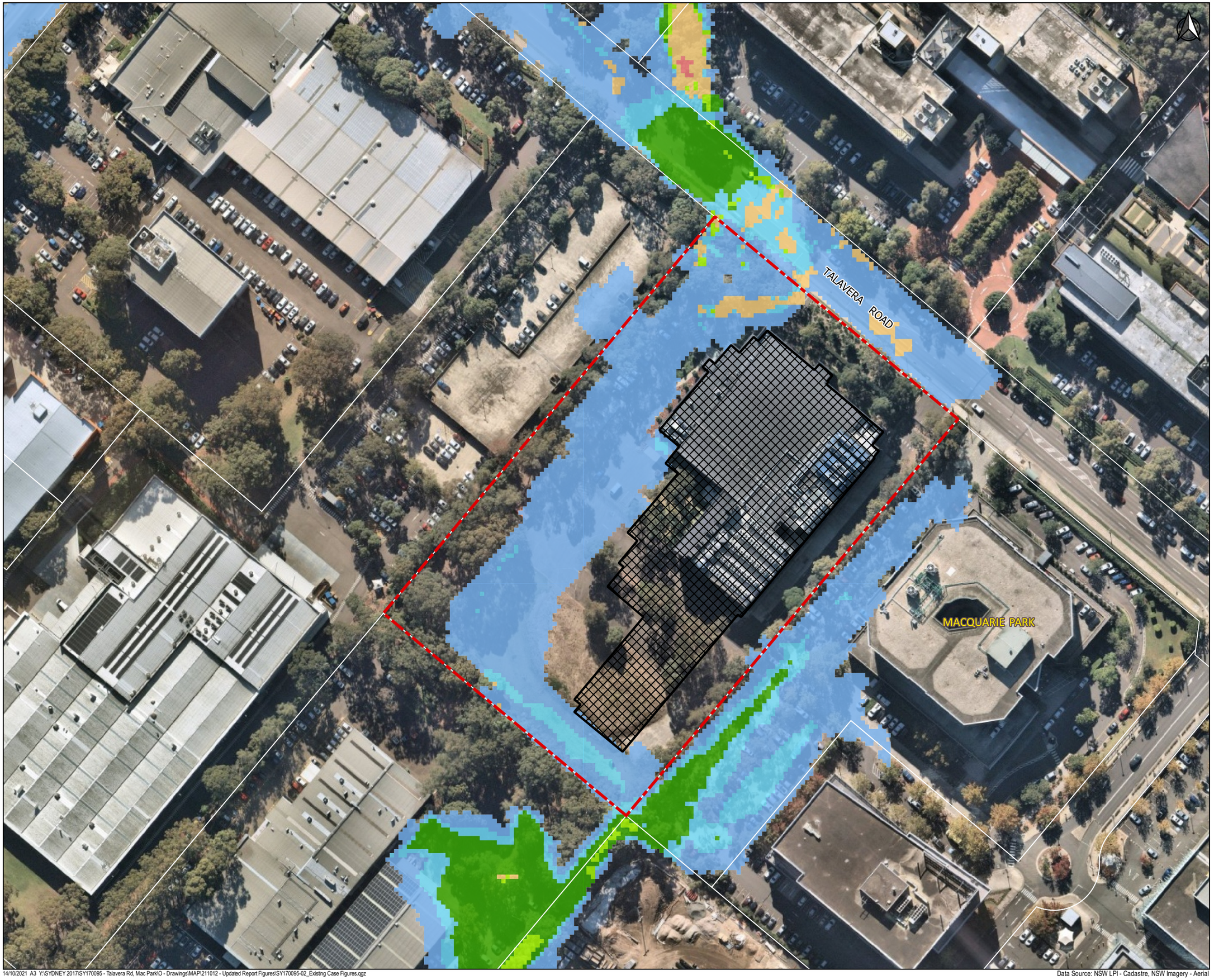
Figure A5 [A]

Existing Case
1% AEP Flood Depth and Elevation

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP



Legend

- Subject Site
- Building

Hazard (ARR 2019)

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 Metres

1:1,200

Figure A6 [A]

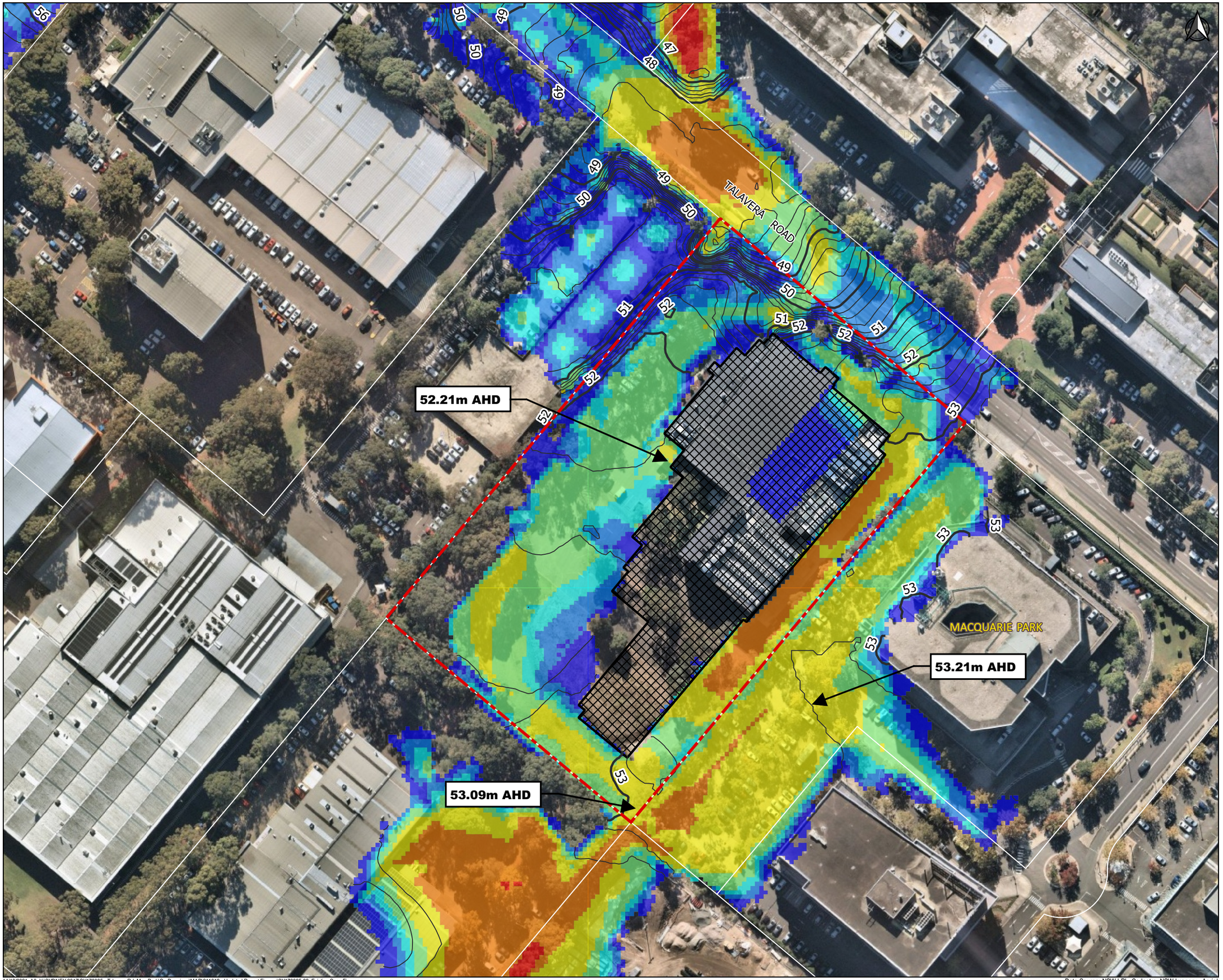
Existing Case
1% AEP Flood Hazard

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site
- Building
- Contours (1m)
- Contours (200mm)

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 Metres

1:1,200

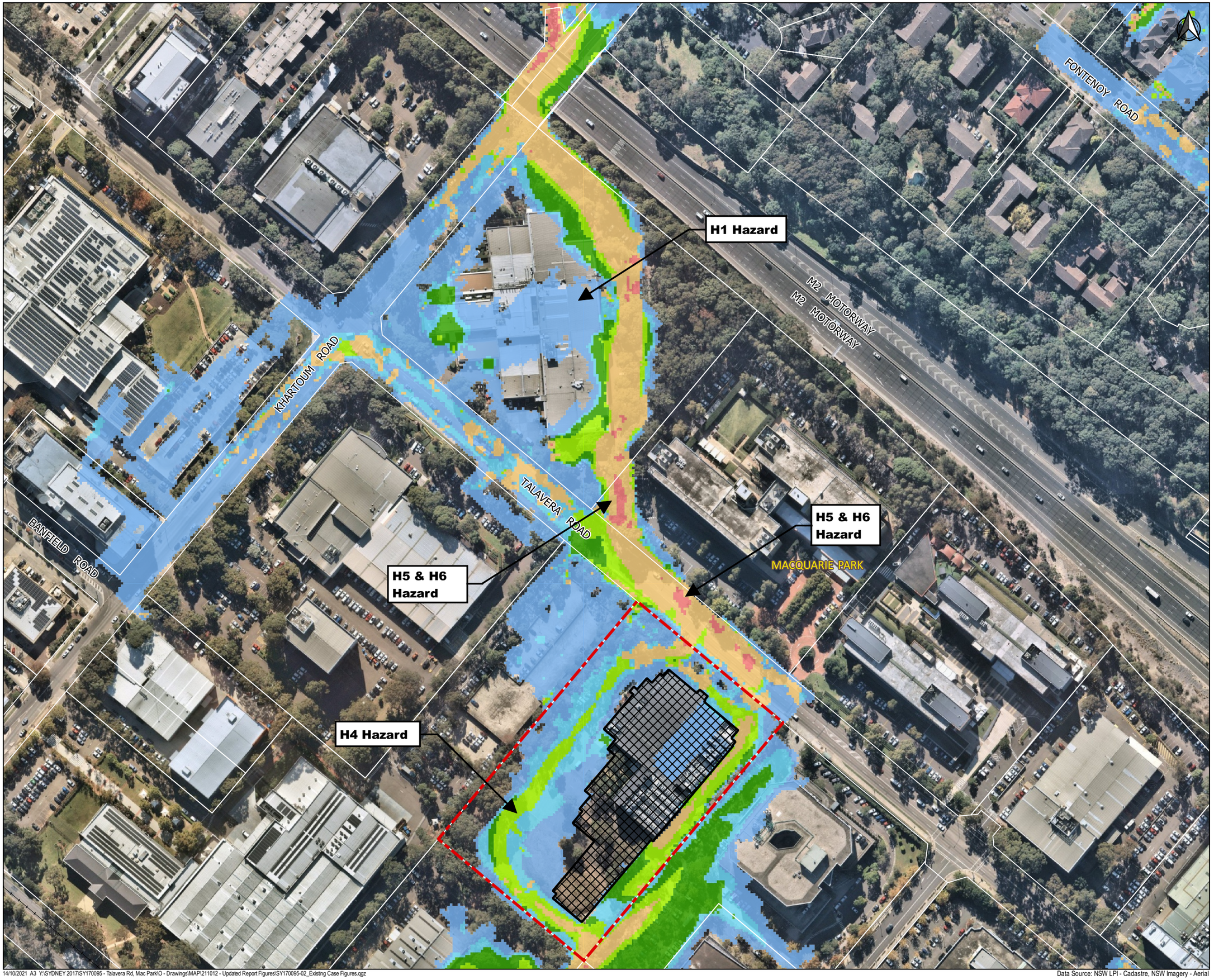
Figure A7 [A]

Existing Case PMF Flood Depth and Elevation

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP



Legend

- Subject Site
- Building

Hazard (ARR 2019)

- H1
- H2
- H3
- H4
- H5
- H6

0 30 60 Metres

1:2,000

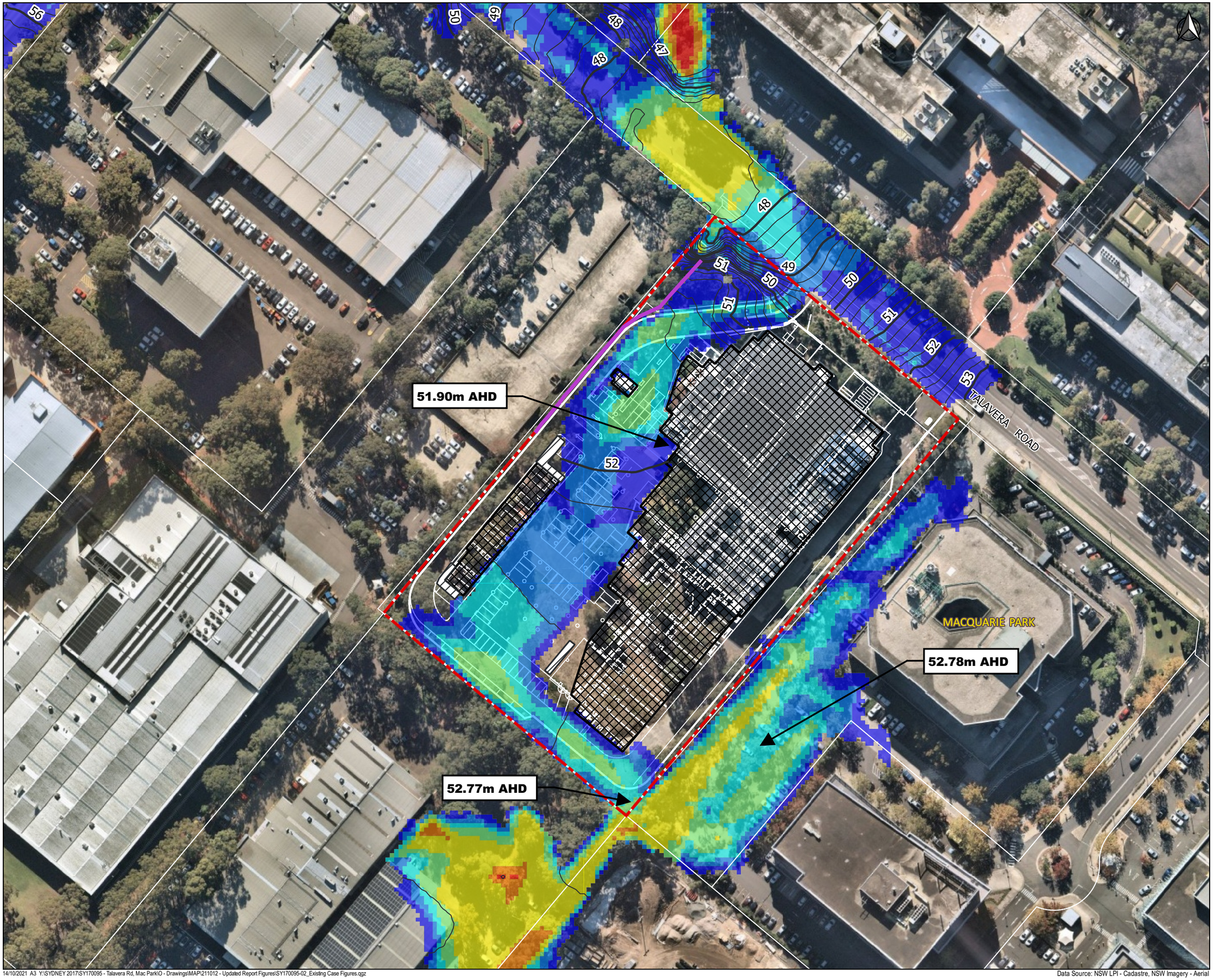
Figure A8 [A]

Existing Case
PMF Flood Hazard

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT
NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site
- Building
- Bund/Wall
- Contours (1m)
- Contours (200mm)

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 Metres

1:1,200

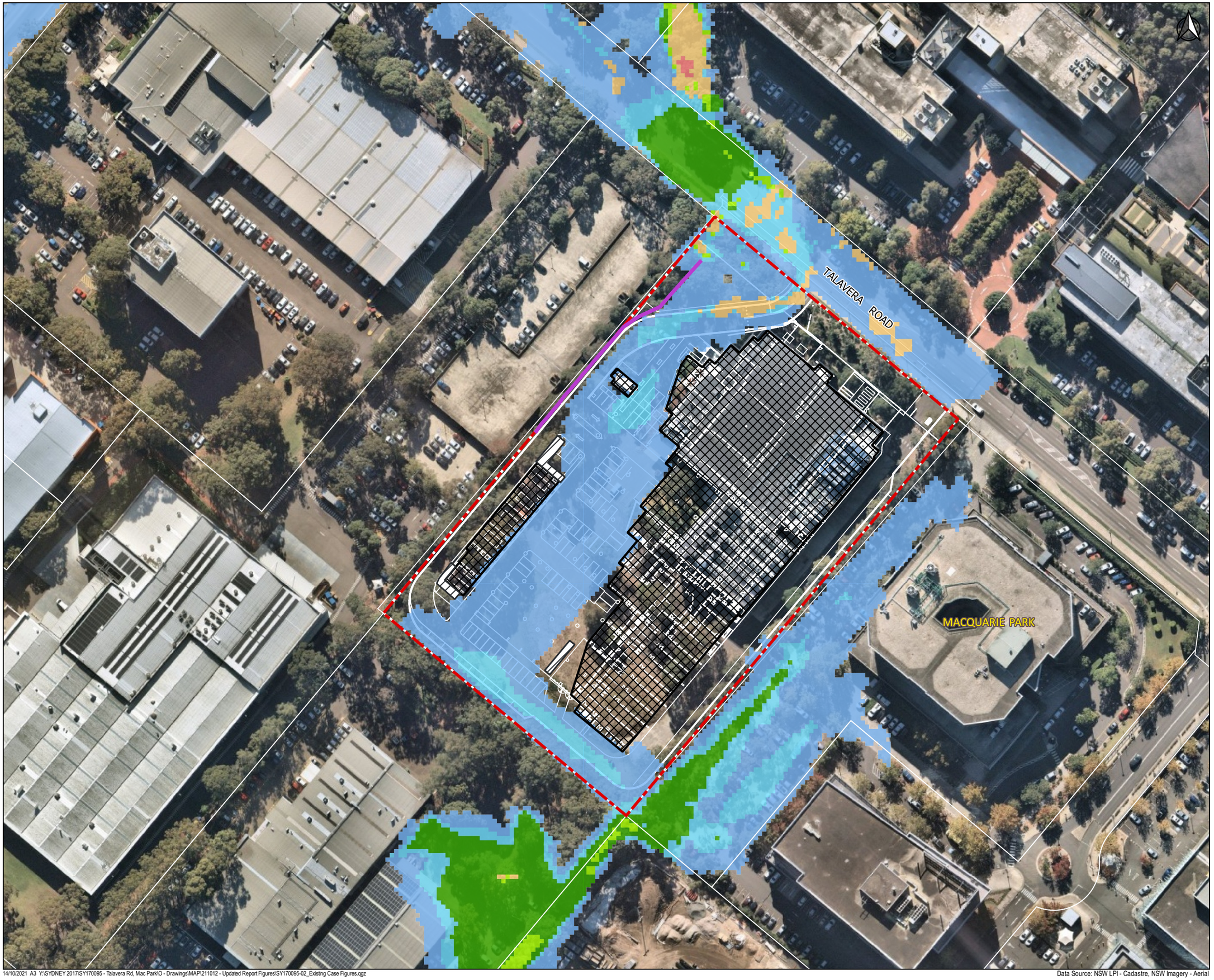
Figure A9 [A]

Developed Case 1% AEP Flood Depth and Elevation

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP



Legend

- Subject Site
- Building
- Bund/Wall

Hazard (ARR 2019)

- H1
- H2
- H3
- H4
- H5
- H6

0 20 40 Metres

1:1,200

Figure A10 [A]

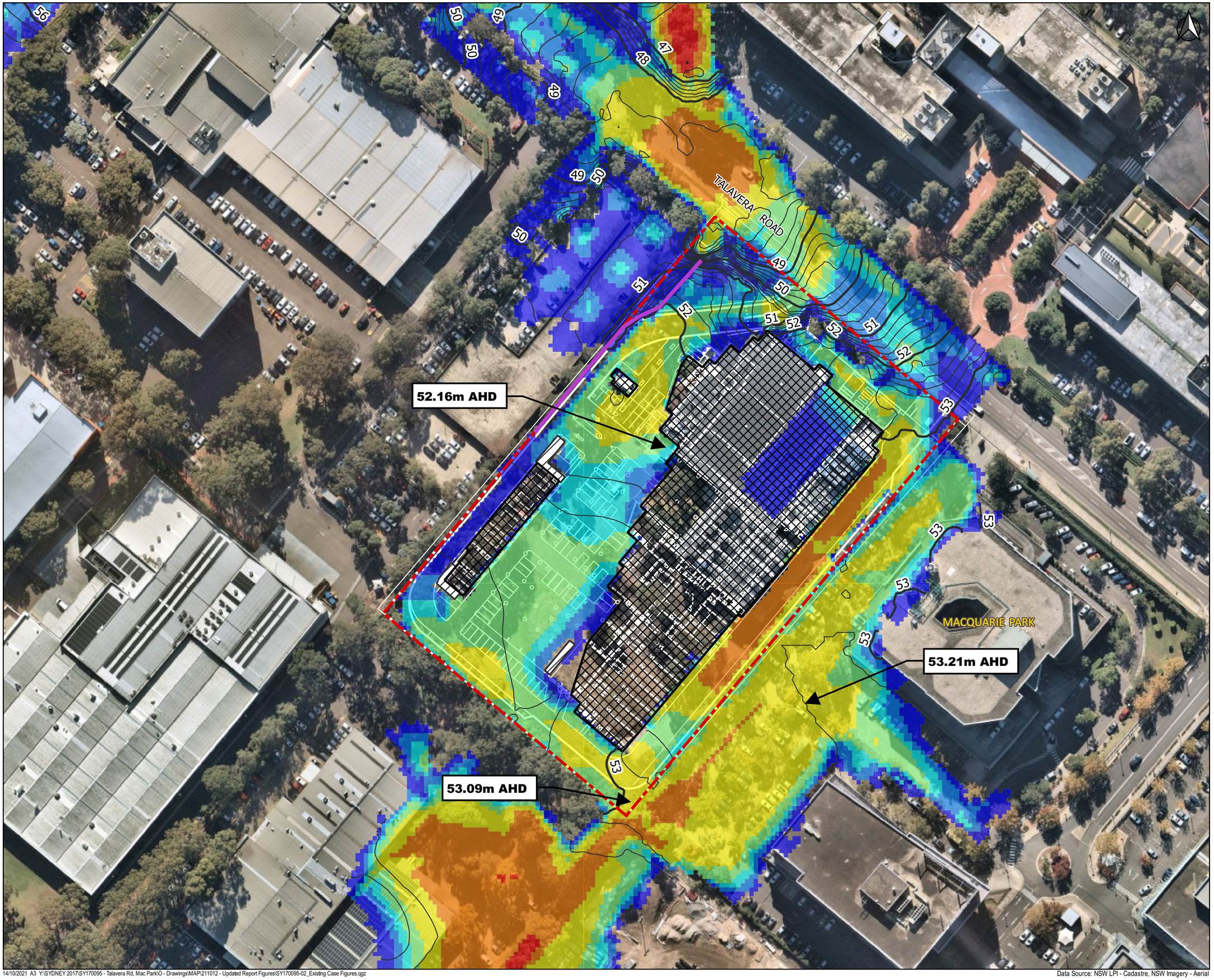
Developed Case
1% AEP Flood Hazard

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site
- Building
- Bund/Wall
- Contours (1m)
- Contours (200mm)

Depth (m)

- Less than 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- Greater than 2.0

0 20 40 Metres

1:1,200

Figure A11 [A]

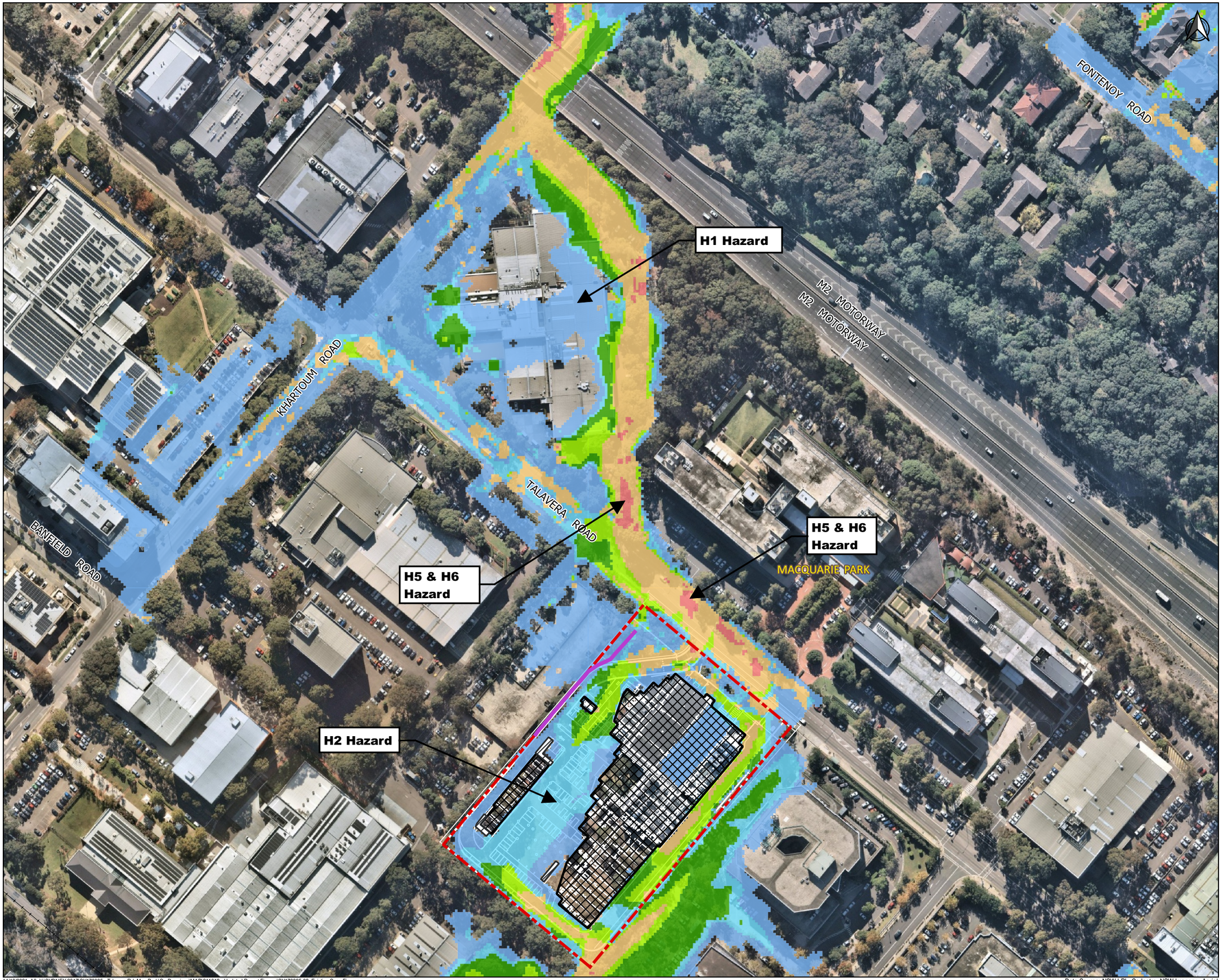
Developed Case PMF Flood Depth and Elevation

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site
- Building
- Bund/Wall

Hazard (ARR 2019)

- H1
- H2
- H3
- H4
- H5
- H6

0 30 60 Metres

1:2,000

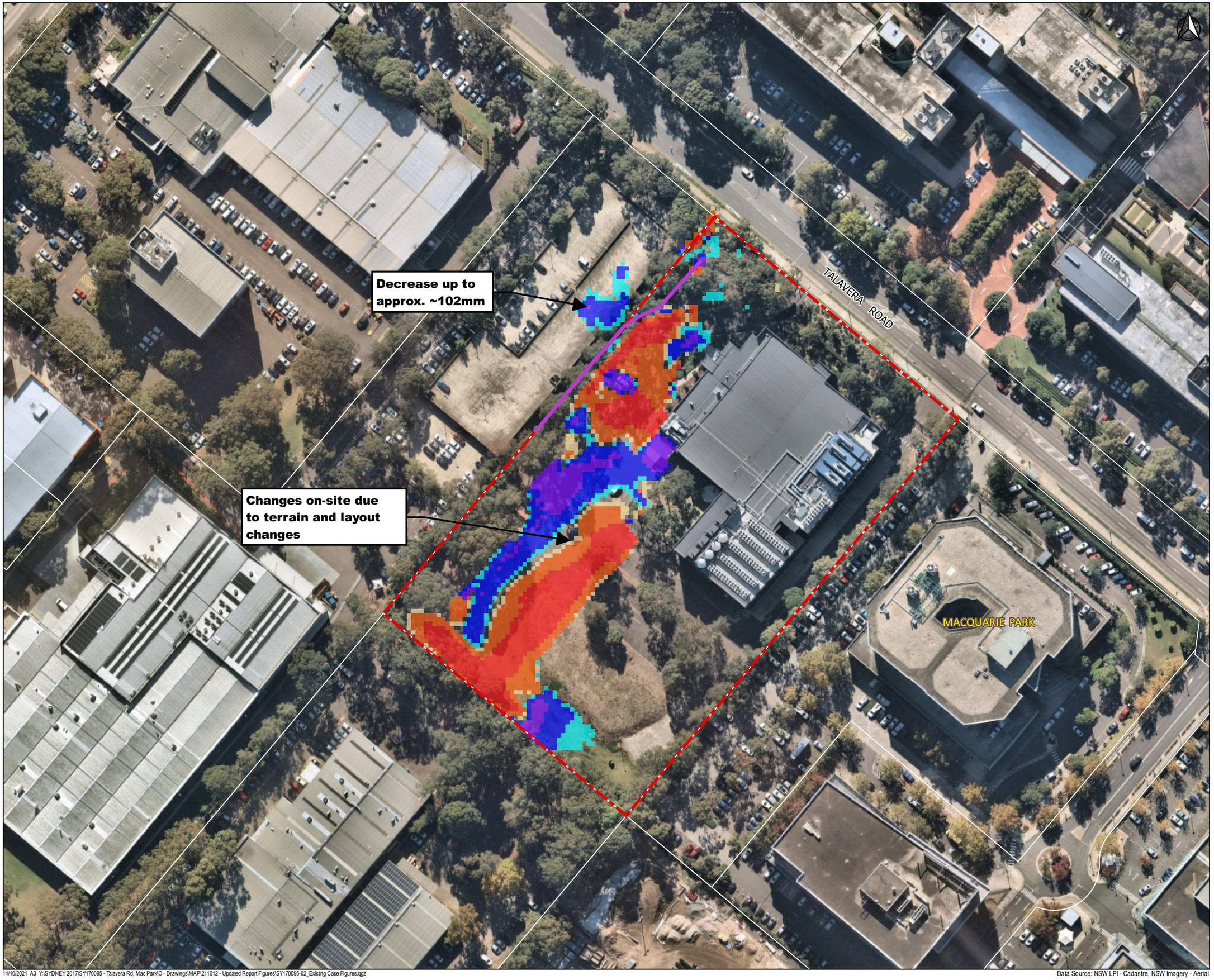
Figure A12 [A]

Developed Case
PMF Flood Hazard

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT
NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site

Depth Difference (m)

- <-0.100
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- >0.100

0 20 40 Metres

1:1,200

Figure A13 [A]

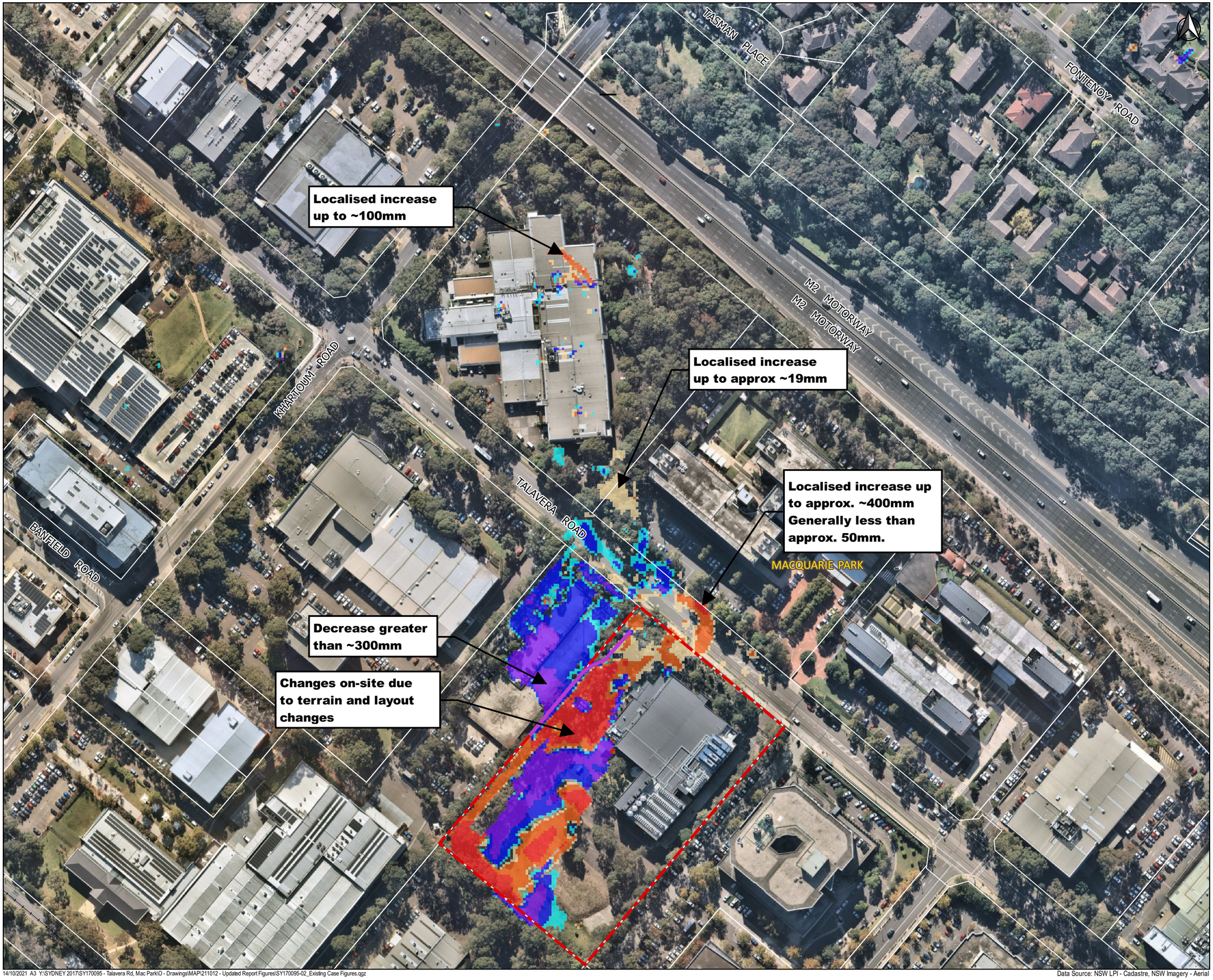
Development Impact
Depth Difference
1% AEP Flood Event

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial



Legend

- Subject Site

Depth Difference (m)

- <-0.100
- -0.025 - -0.100
- -0.010 - -0.025
- -0.010 - 0.010
- 0.010 - 0.025
- 0.025 - 0.100
- >0.100

0 30 60 Metres

1:2,000

Figure A14 [A]

Development Impact
Depth Difference
PMF Flood Event

17-23 Talavera Road
Macquarie Park, NSW

GIDDIS PROJECT MANAGEMENT

NORTHROP

Data Source: NSW LPI - Cadastre, NSW Imagery - Aerial

Attachment B – Previous Studies

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PO Box 180 Charlestown NSW 2290
(02) 4943 1777
newcastle@northrop.com.au
ABN 81 094 433 100

28 June 2019

SY170095 [B]

Macquarie Telecom Pty Ltd
c/- Allens – Rae Mozejko
Level 28, Deutsche Bank Place
128 Phillip Street,
Sydney NSW 2000

Dear Rae,

Re: 17-23 Talavera Road, Macquarie Park – Updates to previously submitted Flood Impact Assessment

Northrop Consulting Engineers have undertaken a flood investigation on behalf of Macquarie Telecom to assess the flood impact of the proposed extension to the existing data facility located at 17-23 Talavera Road, Macquarie Park, herein referred to as the 'subject site'.

The purpose of this correspondence is to summarise and present the additional modelling that has been undertaken in response to a series of Contention Items outlined by Council.

A previous investigation has been performed for the subject site for the purposes of submission for Development Approval. At which stage, a Flood Impact Assessment was prepared and titled *"Proposed Building Extension – 17-23 Talavera Road, Macquarie Park – Flood Impact Assessment"* Revision B dated the 17th of May 2018, herein referred to as 'the original flood impact assessment'. This original flood impact assessment has been included in this correspondence as Attachment B.

The purpose of this correspondence is to outline the updated modelling methodology including the changes made to the original Macquarie Park Floodplain Risk Management Study and Plan (Macquarie Park FRMS&P) TUFLOW model. This correspondence should be read in conjunction with the previous Flood Impact Assessment.

		Date
Prepared by	LG	28/06/2019
Checked by	GB	28/06/2019
Admin	LB	28/06/2019

Background

The original flood impact assessment was prepared as a site-specific model using XP-STORM, which uses the TUFLOW hydrodynamic engine. A peak flow hydrograph for both the 1% AEP and PMF design storm events was provided by Council and extracted from Councils DRAINS model. The 1% AEP and PMF peak flow hydrographs were then scaled back to match the peak flow presented in the Macquarie Park FRMS&P, prepared by Bewsher Consulting Pty. Ltd in 2010. Further details with respect to the original flood impact assessment model setup are presented in Attachment B.

Council have now provided the Macquarie Park FRMS&P TUFLOW model files. The Macquarie Park FRMS&P TUFLOW model has subsequently been used to review the results of the original flood impact assessment and used to prepare an updated flood impact assessment for the proposed development, as described in this report.

Given the Macquarie Park FRMS&P TUFLOW model has been adopted by Council for use across the broader catchment area, the use of this model for the purposes of investigating the flood impact of the proposed development, is considered the most accurate methodology.

Northrop has proposed a number of updates to the Macquarie Park FRMS&P TUFLOW model files to assess the flood impact of the proposed development. Those updates have been made in order to incorporate more accurate and site-specific information regarding topography, land use, fences and retaining walls into the model, and are explained in detail in the next section of this report.

Model Updates

Existing Case Model

The Industrial Creek sub-catchment portion of the Macquarie Park FRMS&P TUFLOW model was received from Council on the 5th of June 2019. Upon receipt of the TUFLOW model an initial review of the model files was performed. During the initial review it was discovered that the original model appeared out-dated with respect the following:

1. The model was originally run using a much older version of TUFLOW namely, Version 2008-08-AK-iSP. It is not possible to run this version of TUFLOW using the latest drivers and dongles. To run the model using this version, TUFLOW holds some of the old dongles that they make available for rent if required;
2. Secondly the model was prepared prior to 2010 and therefore the surface appeared to be outdated and neglects the flow path adjacent to the southern boundary of the site and other land features observed today; and
3. Thirdly, the original surface roughness also appears to be outdated and does not cover the entire extent of the existing case building.

It is possible to run the model using a more recent TUFLOW solver including the latest drivers and dongles however, there is the potential for slightly different results. To minimise the changes, it is possible to include a command to set all defaults to pre-2010. As such, the model has been run using a more recent version of the TUFLOW solver namely the 2018-03-AA-iSP version. Council have provided some initial comments regarding this methodology and suggested it may be a sound approach given the purposes of the study are based around the review of the relative impact.

A comparison of the flood depth has been prepared between the original results (using the 2008 TUFLOW solver) and the latest results (using the 2018 solver) for both the 1% AEP and PMF as shown in Figures H1 and H2 of Attachment A. Note that, all model parameters including topography and surface roughness remain unchanged to those used in the original Macquarie Park FRMS&P TUFLOW model. The comparisons suggest that only very minor changes in flood depth are observed and are generally contained within Talavera Road and downstream of the subject site.

Rather than use the outdated model site topography and land-use, Northrop has considered it preferable to update the base case model to reflect what is observed on-site today, therefore presenting a more realistic pre to post comparison than would be the case if the outdated model site topography and land use was applied. Figures H3 and H4 of Attachment A present the original Macquarie Park FRMS&P model topography and updated model topography respectively. Information regarding the updated model topography has been derived from a detailed survey recently obtained by Macquarie Telecom and provided to Northrop.

Figure H4 highlights some of the more significant updates that are presented in the detailed survey namely; the inclusion of a retaining wall along the south-eastern boundary, the presence of the flow path along the south-western boundary as well as the stepped finished floor levels observed over the existing building.

Council have provided an initial response with respect including the latest detailed survey in the Macquarie Park FRMS&P TUFLOW model and suggested that the base case model should be updated. Note that the comparisons requested by Council's officer are included as part of this correspondence.

It is noted that buildings have been represented by raising the elevation up to the finished floor level with a high roughness above. This is consistent with the methodology adopted in the Macquarie Park FRMS&P and has been adopted for both the existing and developed case scenarios for this assessment.

Figures H5 and H6 of Attachment A present the original Macquarie Park FRMS&P model roughness and updated model roughness respectively. The surface roughness for the existing case building extent has been updated based on detailed survey and aerial photography, while the Manning's roughness values remain unchanged to those used in the Macquarie Park FRMS&P.

Perimeter fences have been included in the model as a thin flow constriction and are presented in Figure H7 of Attachment A. A similar blockage methodology to the original XP-STORM modelling has been considered with a blockage factor of 20% for the majority of the fences. An exception is made for the fence in the southern corner that appeared to be covered by sediment fence and vines at the time of the site inspection. A blockage factor of 60% has been applied to this fence. Further details are presented in the original flood impact assessment provided in Attachment B.

It is noted that a grid size of three meters remains unchanged to what was used in the original Macquarie Park FRMS&P however, the timestep has been reduced to 0.75 and 0.5 seconds for the 1% AEP and PMF design storm events respectively. This has been performed following review of a peak cumulative mass error in excess of 1% and some un-expected changes in isolated areas of the model when reviewing the pre to post comparisons.

Developed Case Model

Following updates to base case model, the developed case model was prepared. Figures H8 and H9 of Attachment A present the developed case topography and surface roughness.

As previously mentioned, the developed case building has been represented by raising elevations above the finished floor levels with a high roughness modelled above. The building surface roughness was updated to cover the extent of the ground flood building footprint.

The developed case surface was created using 12d CAD software and imported into the TUFLOW model as a Digital Elevation Model. An additional earthen bund, approximately 100-300mm high, has been placed along the north-western boundary. This has been introduced to encourage flows away from the adjacent property and towards Talavera Road.

For the developed case scenario, an existing portion of grassed land use located adjacent to the south-western boundary was removed, assuming the entire subject site (other than the building

extent) is paved. A similar assumption has been adopted by the Macquarie Park FRMS&P with the majority of the industrial/commercial zones assumed to be paved.

Figure H10 of Attachment A presents the updated fences with a section along the western boundary removed when compared to the existing case. The Stage 2 louvers have been included in the model which form part of the western extension of the proposed development. These have been modelled as a thin flow constriction with a blockage factor of 80% which is commensurate with the blockage factor adopted in the previous XP-STORM modelling.

Results

Existing Case Comparisons

The results for the updated existing case model for both the 1% AEP and PMF flood depth and elevation contours is presented in the attached Figures H11 and H12 respectively.

Similarly, the existing case Australian Rainfall and Runoff 2019 (ARR 2019) hazard categories for both the 1% AEP and PMF are presented in Figures H13 and H14 respectively. The ARR 2019 hazard categories are presented in the below Figure 1.

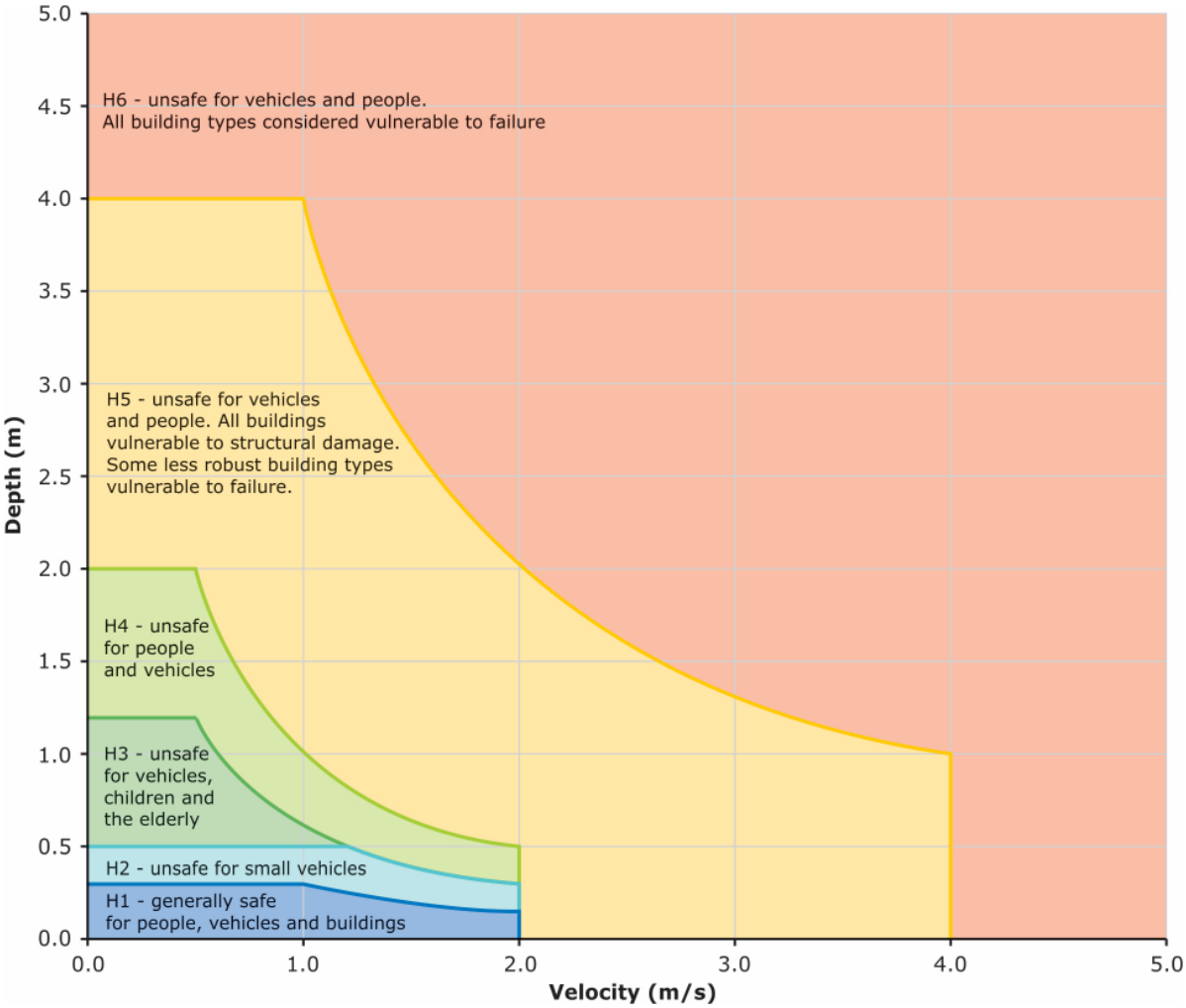


Figure 1 - ARR 2019 Hazard Categories

An elevation comparison between the updated base case (i.e. the updated Macquarie Park FRMS&P TUFLOW model) and original Macquarie Park FRMS&P TUFLOW model results for both the 1% AEP

and PMF design storm events are presented in the attached Figures H15 and H16. For both models, the 2018 TUFLOW solver has been used.

The changes presented in the comparisons are generally commensurate with the changes in topography with the flow path along the south-western boundary observed to be wet during the updated existing case and not wet during the original modelling. Some increases are also observed in Talavera Road which are expected to be due raised surface elevations in this area identified by the detailed survey.

A comparison between the updated base case and the original XP-STORM existing case results has also been presented in the attached Figures H17 and H18 for both the 1% AEP and PMF design storm events respectively.

During the 1% AEP there is a relatively close match between the models with elevations observed in the property adjacent to the south-eastern boundary of up to approximately 19mm. An increase is observed downstream of the subject site within Talavera Road which is expected to be the result of additional inflows entering into the Macquarie Park FRMS&P TUFLOW model at this point as well as the potential for the pit and pipe network upwelling within Talavera Road.

A decrease is observed across most of the PMF comparison as shown in Figure H18 of Attachment A. This is expected to be due to slightly greater peak flow of approximately 26.6m^3/s entering the site at this location in the updated base case TUFLOW model. In comparison the value originally reported in the Macquarie Park FRMS&P was 26.2m^3/s. The increased flow rate observed in the updated base case TUFLOW model is expected to be the result of the reduced time step and the inclusion of the detailed survey.

Developed Case Comparisons

The results for the updated developed case model for both the 1% AEP and PMF flood depth and elevation contours is presented in the attached Figures H19 and H20 respectively. Similarly, the existing case ARR 2019 hazard categories for both the 1% AEP and PMF is presented in Figures H21 and H22 respectively.

A flood depth comparison between the updated developed case and updated base case for both the 1% AEP and PMF design storm events is presented in the attached Figures H23 and H24 of Attachment A respectively.

During the 1% AEP a decrease of up to approximately 21mm is observed in the south-eastern property. This is expected to be due to an increase in the flow capacity along the perimeter road running parallel with the south-western boundary. The additional conveyance capacity is expected to be a combination of the revised grades and reduced surface roughness in the area.

Previous iterations of the developed case modelling suggested there was the potential for an increase to occur in the north-western property during the 1% AEP design storm event. To mitigate these increases, a diversion bund was introduced, running parallel with the north-western boundary and guiding flows towards Talavera Road rather than into the adjacent property. As a result, a decrease is now observed in the north-western property during the developed case with little to no impact on the flood depth within Talavera Road.

During the PMF, a decrease of approximately 25-40mm is observed in the south-eastern property as shown in Figure H24 of Attachment A. Similar to the results of the 1% AEP, it is expected that the additional flow capacity available along the south-western boundary of the subject site results in a decrease in the south-eastern property. In addition, during the PMF, flows are observed to spill over the ridge line along the boundary between the subject site and south-eastern property. As such, it is anticipated that the regrading of the perimeter road adjacent to the south-eastern boundary also contributes to the reduction in flood depth observed in the south-eastern property.

Similarly, a decrease of up to 450mm is observed in the north-western property which is expected to be the result of a combination of the introduction of the bund as well as the re-direction of a portion of the flows away from the northern corner of the site and towards the eastern corner adjacent to Talavera Road.

Increases in flood depth of up to 240mm are observed in Talavera Road during the PMF as presented in Figure H24 of Attachment A. This is expected to be the result of increased volume of flow travelling along the south-eastern boundary, spilling onto Talavera Road at a location further upstream when compared to the existing case.

Review of Figure H14 suggests that H5 and H6 hazard flow is observed within Talavera Road during the PMF under the existing conditions. The above Figure 1 suggests that these flow conditions are un-safe for cars and pedestrians. The results presented in H22 suggests a slight increase the extent of H6 hazard flow is observed during the developed case, however this is not considered to create significant adverse impact as H5 and H6 is already observed in the area.

Moving further downstream of Talavera Road, a decrease is observed of approximately 65mm during the PMF. This decrease is expected to be due to a combination of slight change in timing of the peak between the developed and existing case scenarios and the flood storage introduced on the south-eastern side of the proposed building.

Recommendations made previously with respect to the management of flood emergency response remains un-changed to those presented in the original flood impact assessment. It is recommended that in the event of a predicted 1% AEP or PMF flood event, evacuation and/or closure of the facility occur prior to the commencement of rainfall.

In the event where rainfall has commenced and staff and visitors are still onsite, refuge on-site can be sought in the upper levels of the facility. Given a critical duration of 2 hours for the 1% AEP and 15 minutes for the PMF as stated in the Macquarie Park FRMS&P, inundation of the subject site is not expected to occur over a prolonged period of time.

It is recommended that a Flood Emergency Response Plan be prepared for the subject site. The Flood Emergency Response Plan should:

- Promote satisfactory awareness of the expected flood behaviour and flood risk associated with the subject site.
- Nominate the roles and responsibilities when preparing for and responding to a flood emergency.
- Identify measures to monitor weather forecasts and highlight warning systems available.
- Promote education and awareness material for training programs with respect to flooding of the subject site.
- Identify potential evacuation and evasion procedures including evacuation routes and flood refuge opportunities.

Through preparation of a Flood Emergency Response Plan and implementation of the above emergency response procedure, we consider the risk to life on-site to be appropriately managed.

Conclusion

A revised flood impact assessment has been undertaken for the proposed modifications to the existing data centre located at 17-23 Talavera Road, Macquarie Park. The updated modelling has been prepared in response to Council's Contention items to satisfy Council's concerns regarding the accuracy and methodology adopted by the original flood modelling.

The results presented above demonstrate that an overall improvement in the flooding conditions is observed during the 1% AEP design storm event with a reduction in the flood depth in both the south-eastern and north-western adjacent properties. During the PMF an increase is observed in Talavera Road however, considering the magnitude of the event and the negligible change in hazard conditions, this increase is considered acceptable particularly since it results in a decrease in adjacent properties.

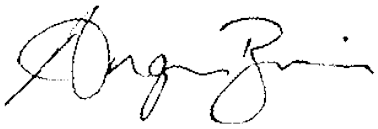
As such, the proposed development is considered to improve the flooding conditions within the vicinity of the subject site by reducing the flood depths in adjacent properties and directing commensurate increases towards already un-safe areas.

We commend our findings to Council for their review. Should you have any queries regarding this correspondence, please feel free to contact the undersigned on (02) 4943 1777.

Prepared by

Laurence Gitzel
Civil Engineer
BE (Environmental)

Reviewed by



Angus Brien
Civil Engineer
BEng (Civil)

Limitation Statement

Northrop Consulting Engineers Pty Ltd (Northrop) has been retained to prepare this report based on specific instructions, scope of work and purpose pursuant to a contract with its client. It has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use by Macquarie Telecom Pty Ltd.

The report is based on generally accepted practices and standards applicable to the scope of work at the time it was prepared. No other warranty, express or implied, is made as to the professional advice included in this report except where expressly permitted in writing or required by law, no third party may use or rely on this report unless otherwise agreed in writing by Northrop.

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Attachment A – Flood Modelling Figures

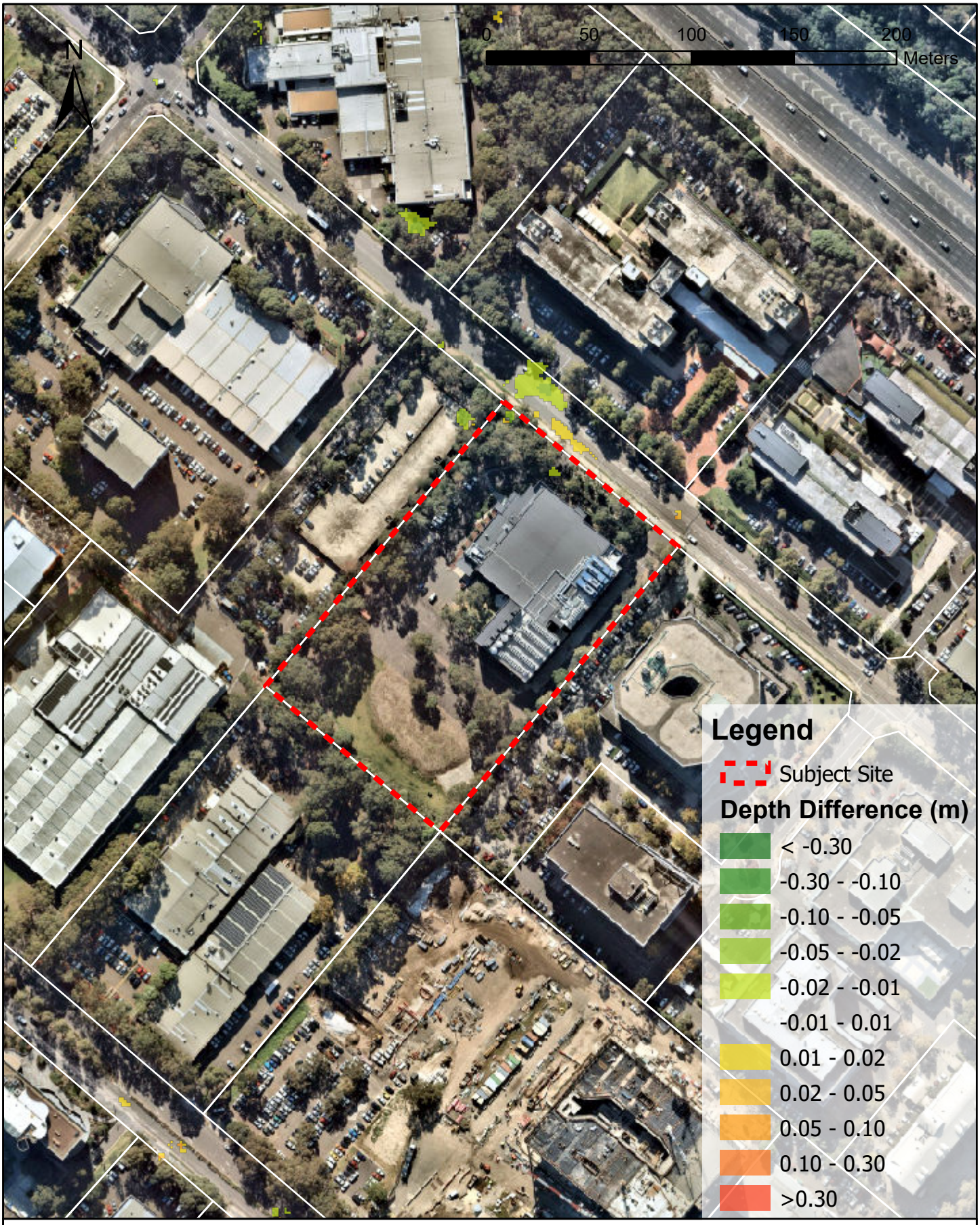

Figure H1 [A]

1% AEP Flood Depth Difference
2018 TUFLOW minus 2008 TUFLOW

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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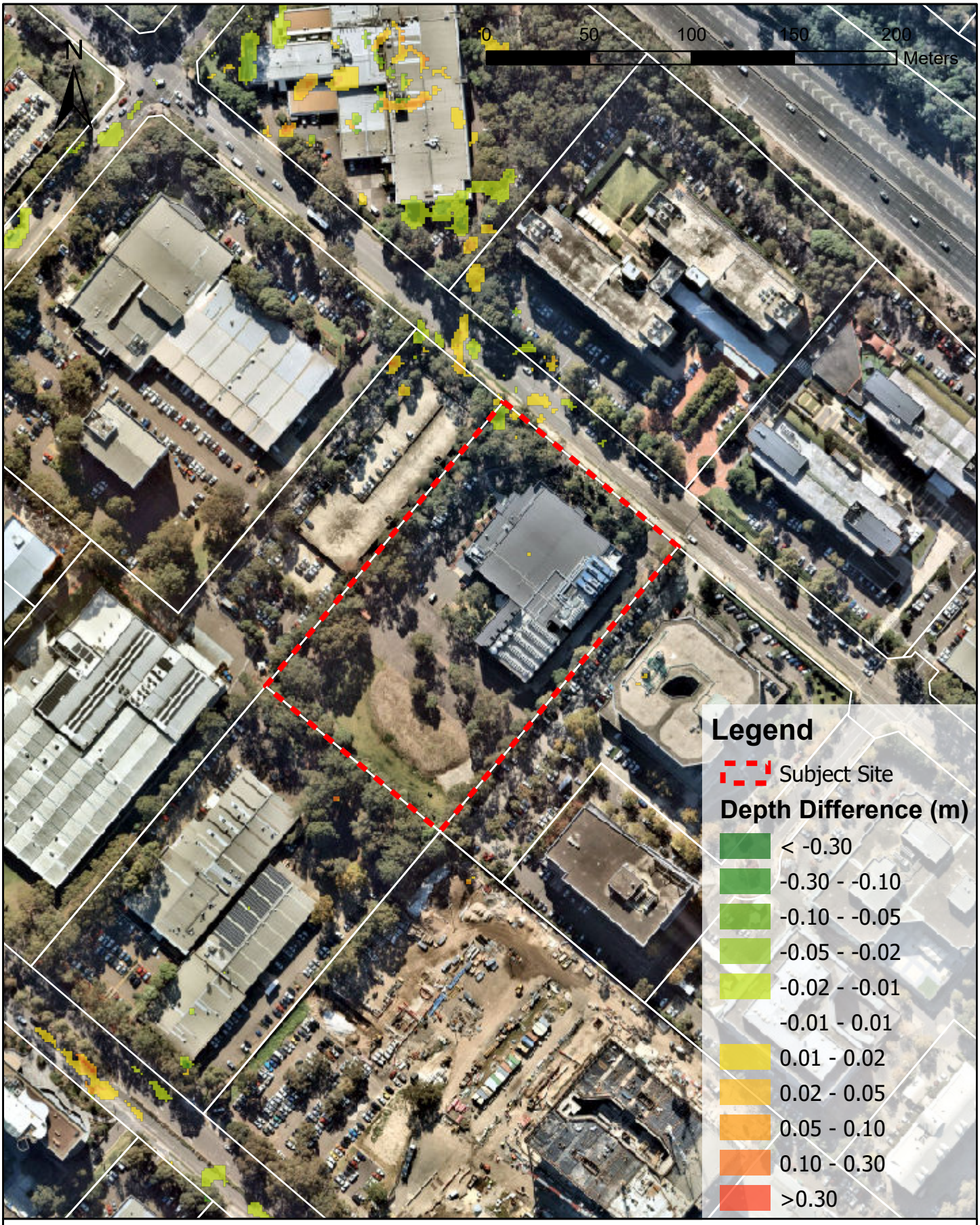

Figure H2 [A]

PMF Flood Depth Difference
2018 TUFLOW minus 2008 TUFLOW

17 Talavera Road,
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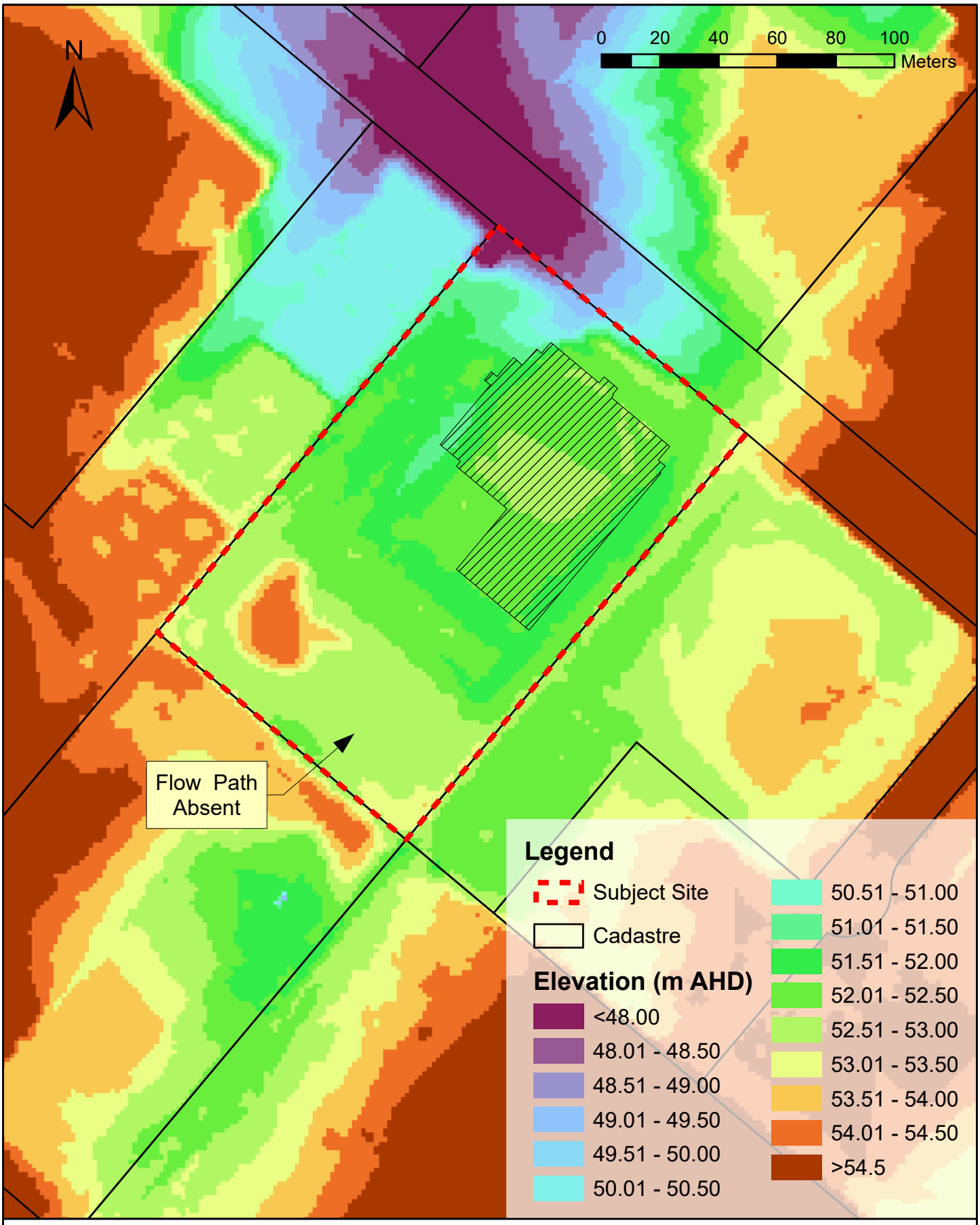

FIGURE H3 [A]

Macquarie Park FRMS&P TUFLOW Model Original Model Topography

17 Talavera Road, Macquarie Park

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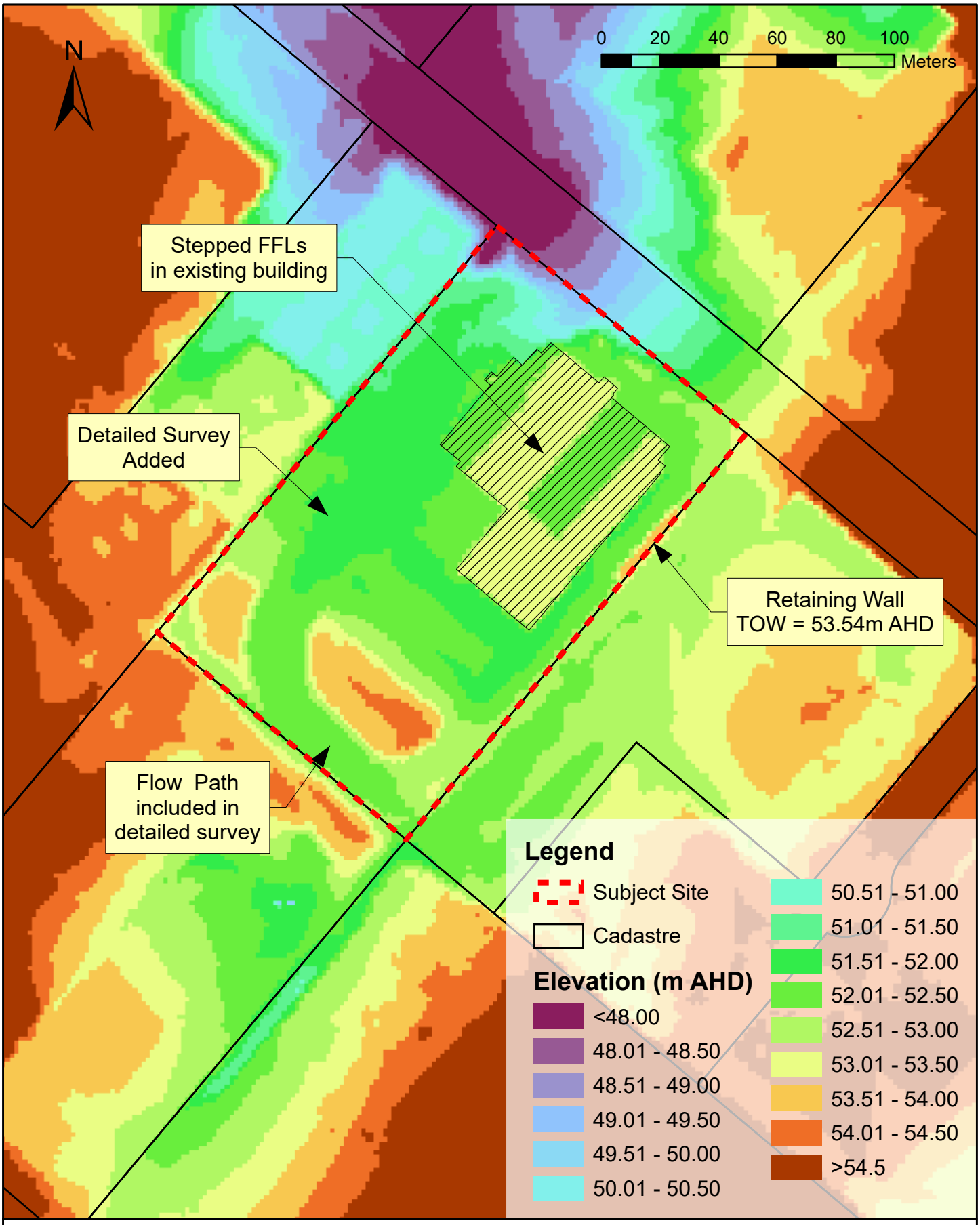

FIGURE H4 [A]

Macquarie Park FRMS&P TUFLOW Updates
Existing Case Model Topography

17 Talavera Road, Macquarie Park

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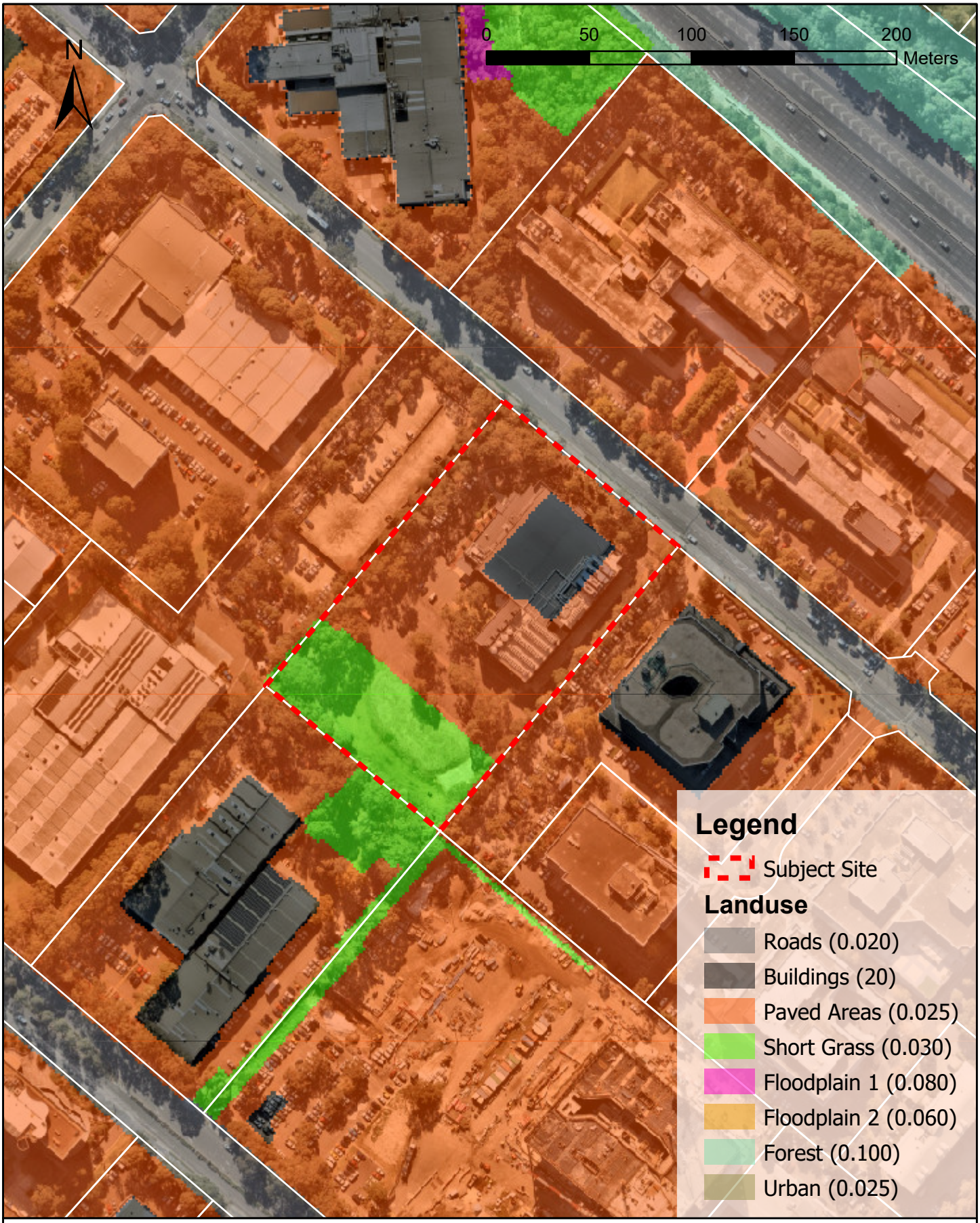

FIGURE H5 [A]

Macquarie Park FRMS&P TUFLOW Model Original Surface Roughness

17 Talavera Road, Macquarie Park

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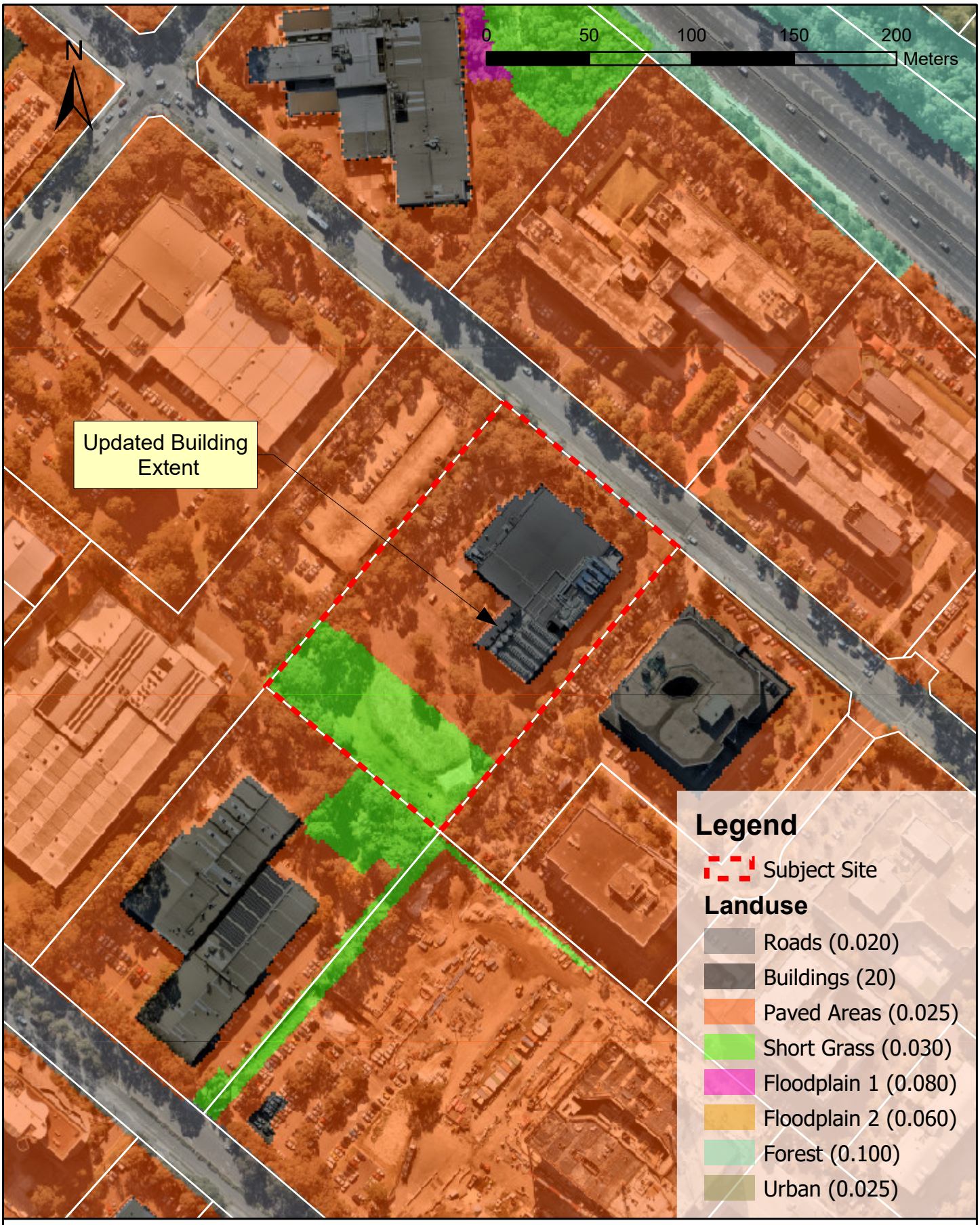

FIGURE H6 [A]

Macquarie Park FRMS&P TUFLOW Updates
Existing Case Surface Roughness

17 Talavera Road, Macquarie Park

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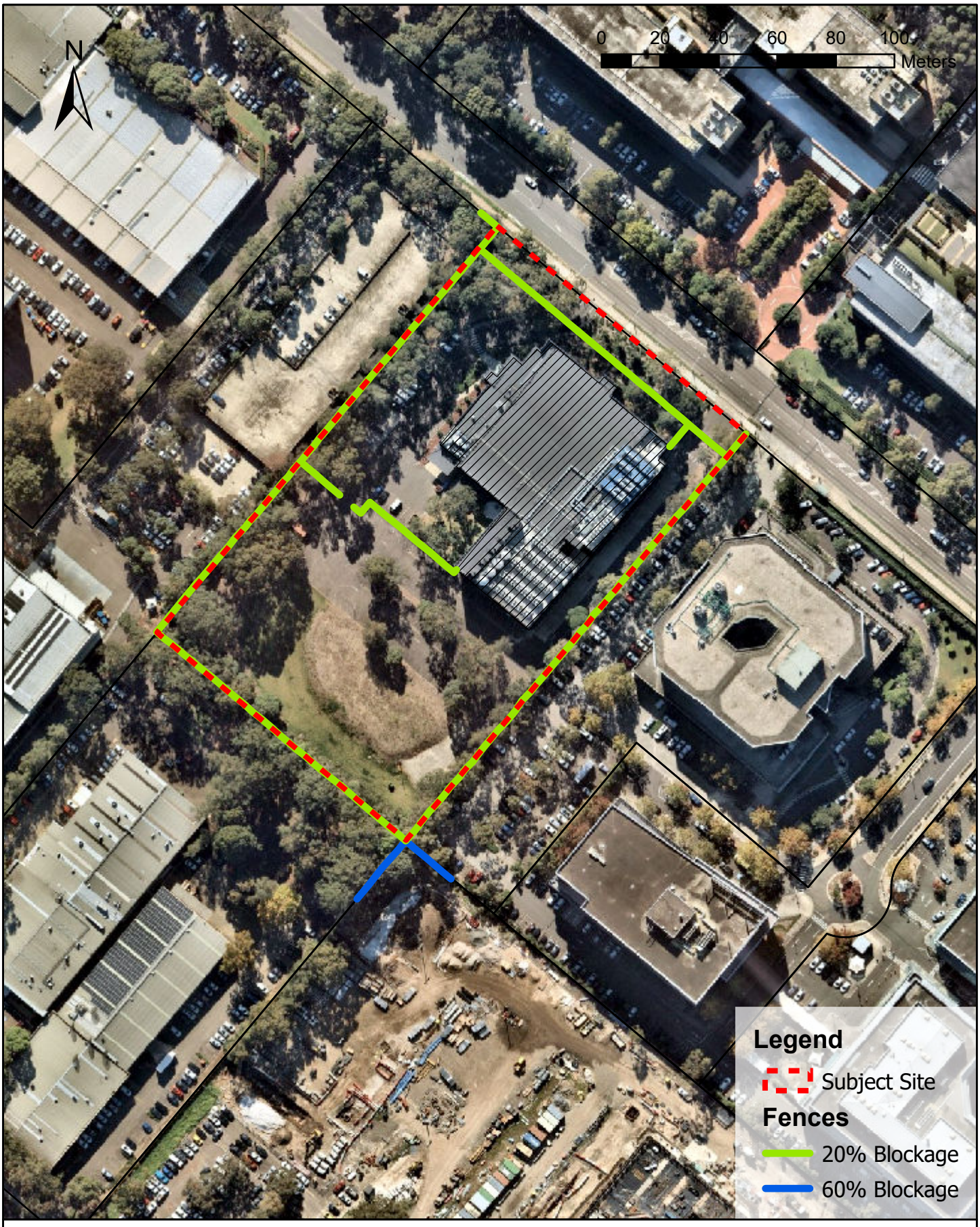

FIGURE H7 [A]

Macquarie Park FRMS&P TUFLOW Updates
Existing Case Additional Model Elements

17 Talavera Road,
Macquarie Park

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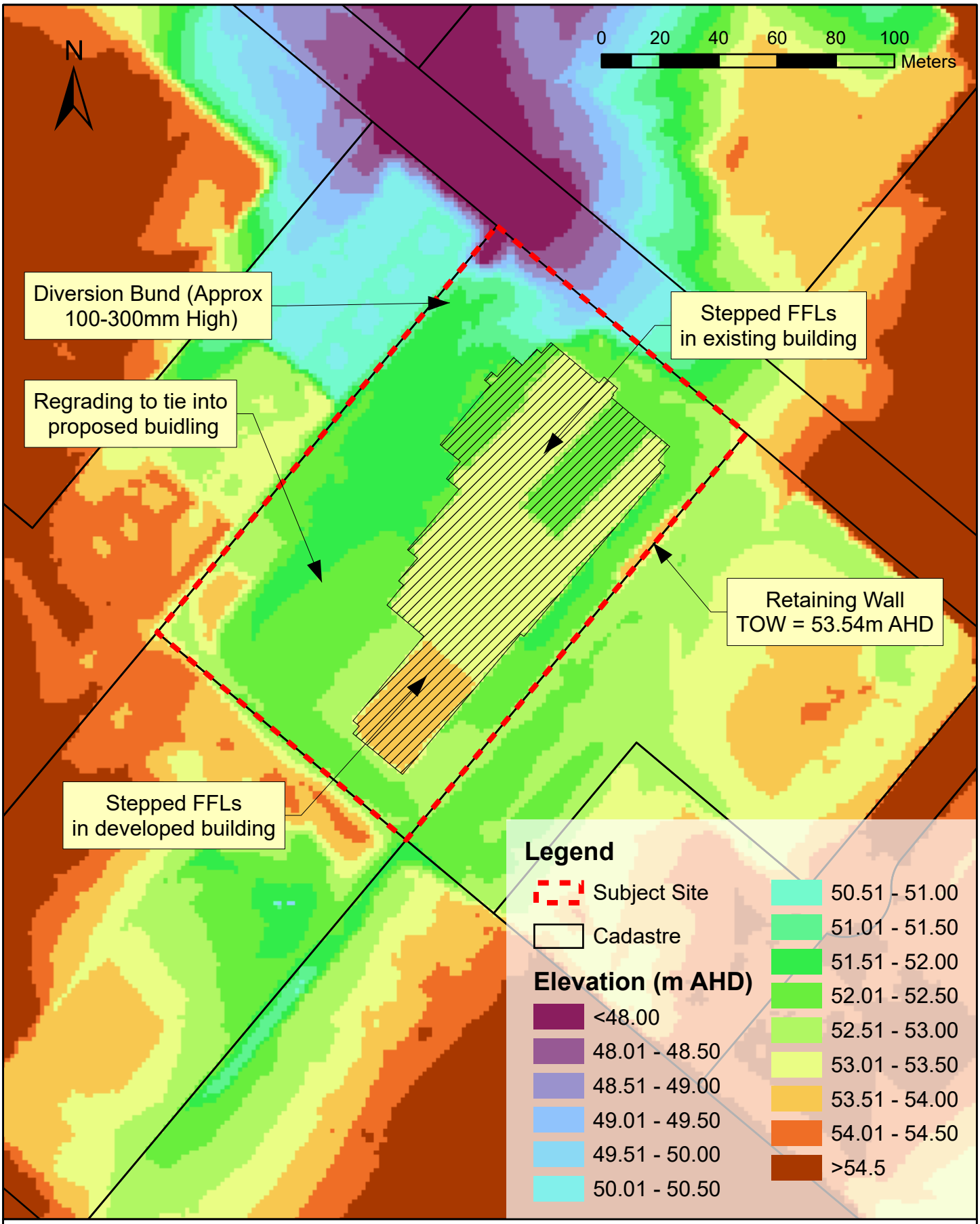

FIGURE H8 [A]

Macquarie Park FRMS&P TUFLOW Updates
Developed Case Model Topography

17 Talavera Road, Macquarie Park

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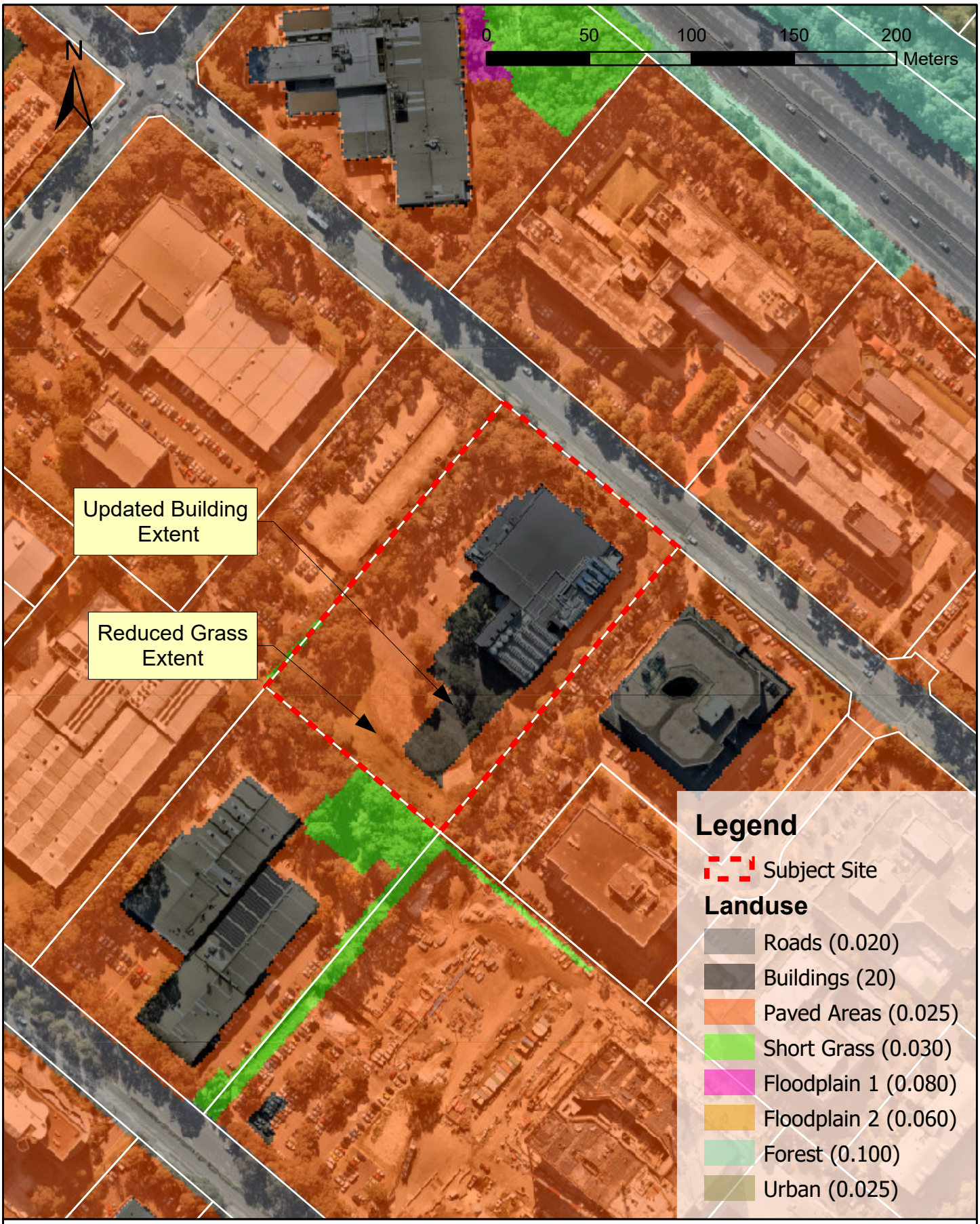

FIGURE H9 [A]

Macquarie Park FRMS&P TUFLOW Updates
Developed Case Surface Roughness

17 Talavera Road, Macquarie Park

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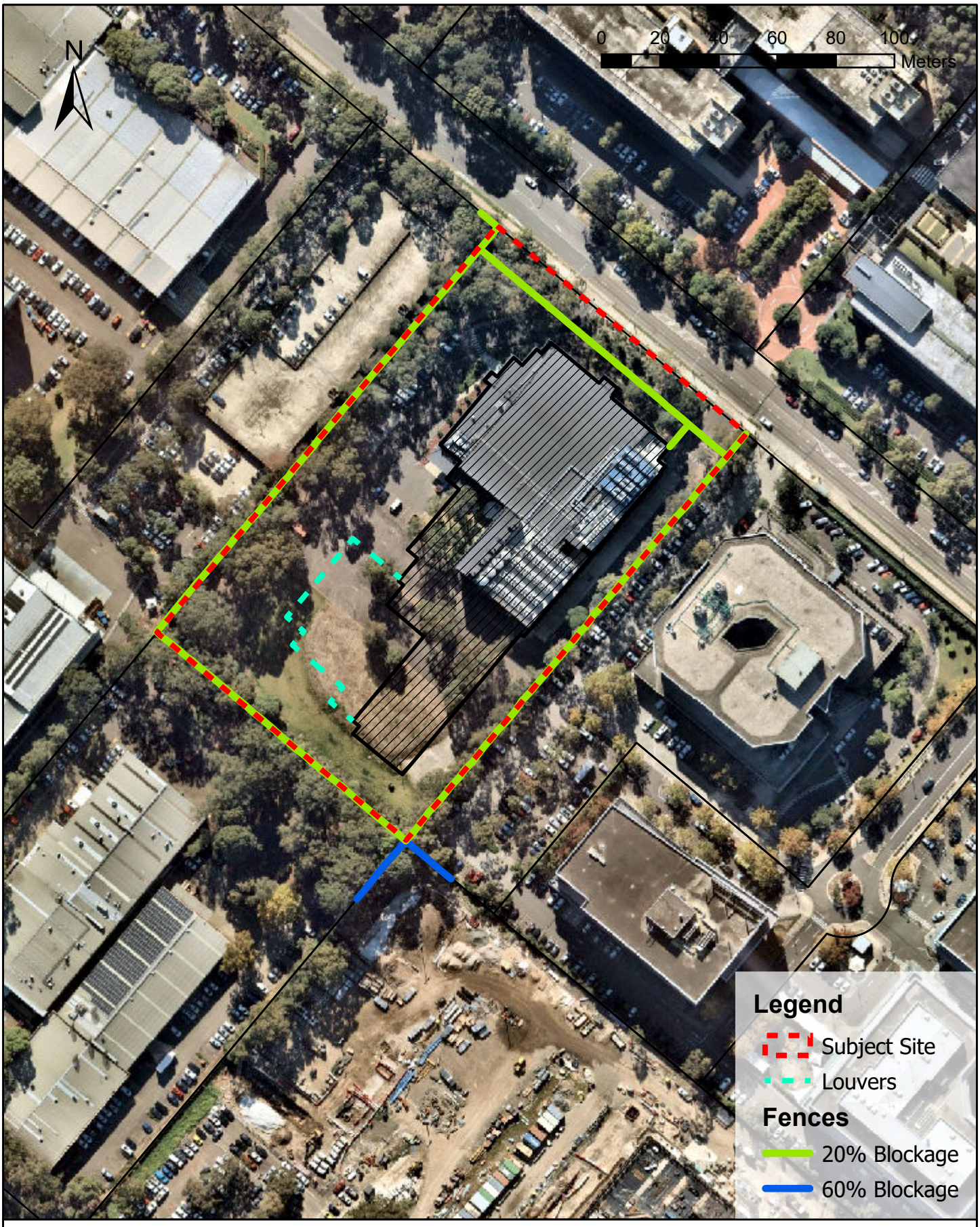

FIGURE H10 [A]

Macquarie Park FRMS&P TUFLOW Updates
Developed Case Additional Model Elements

17 Talavera Road,
Macquarie Park

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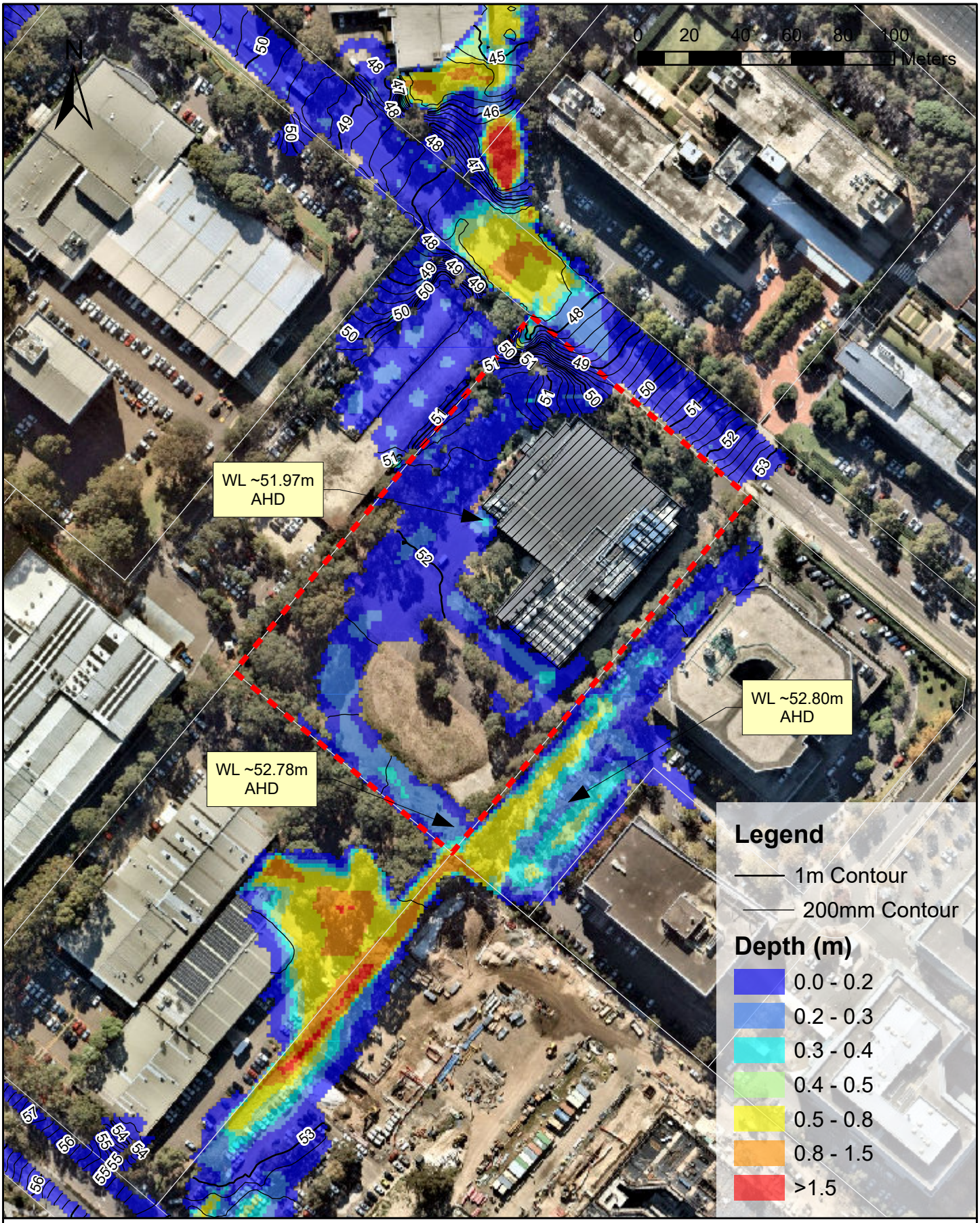

FIGURE H11 [A]

Updated MP FRMS&P - Existing Case 1% AEP Flood Depth and Elevation

17 Talavera Road, Macquarie Park

Job Number: SY170095

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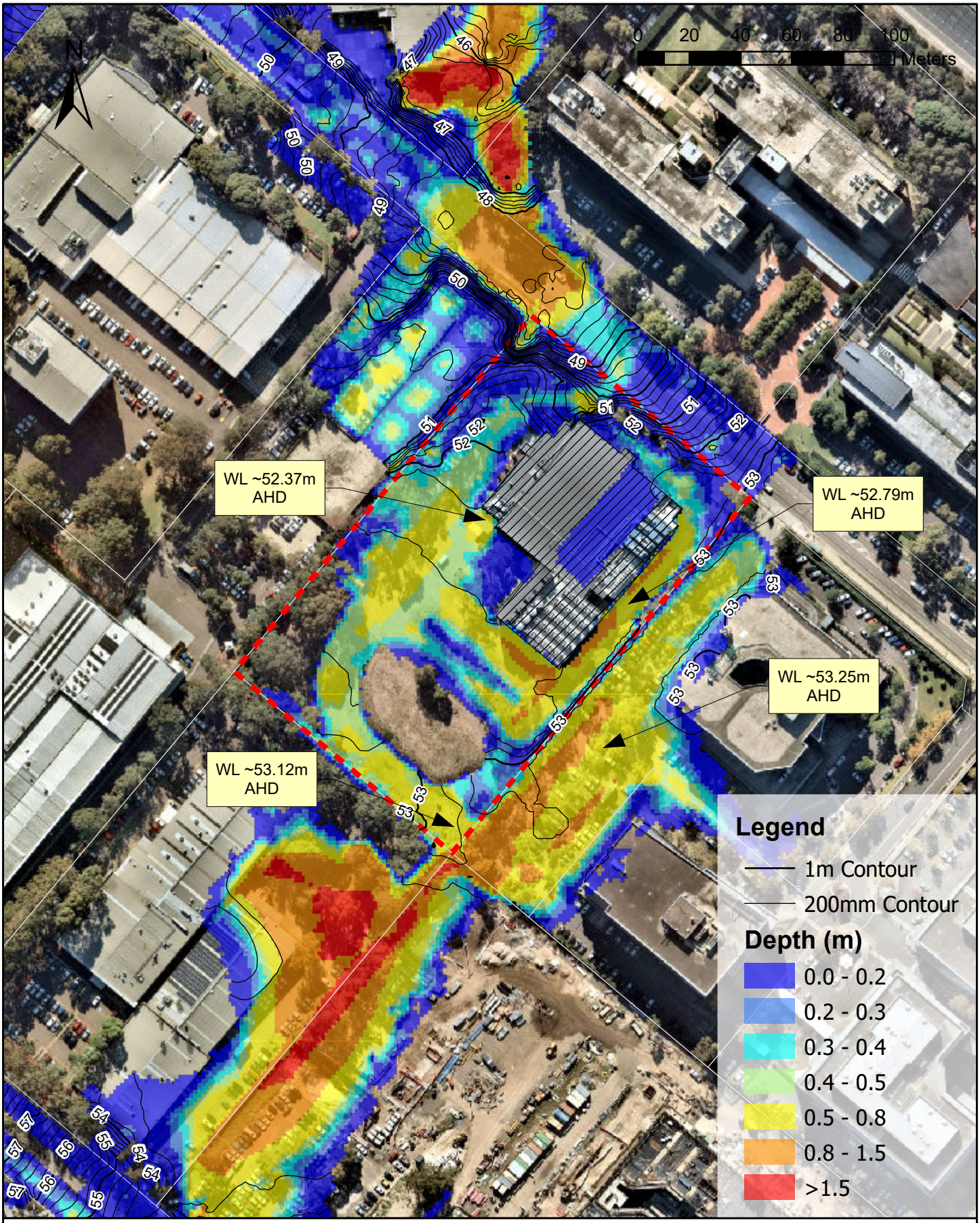

FIGURE H12 [A]

Updated MP FRMS&P - Existing Case PMF Flood Depth and Elevation

17 Talavera Road, Macquarie Park

Job Number: SY170095

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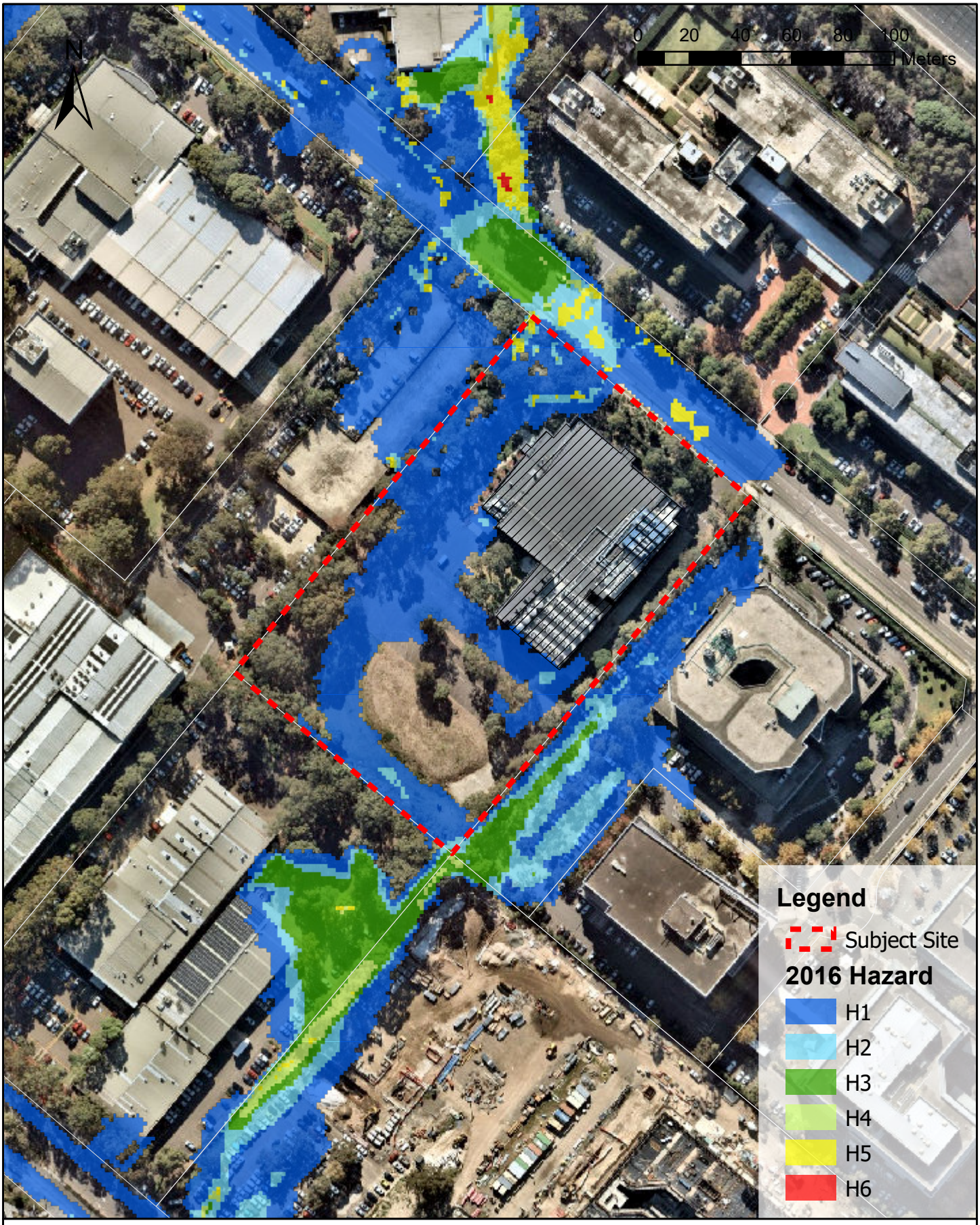

FIGURE H13 [A]

Updated MP FRMS&P - Existing Case
1% AEP ARR 2019 Flood Hazard

17 Talavera Road, Macquarie Park

Job Number: SY170095

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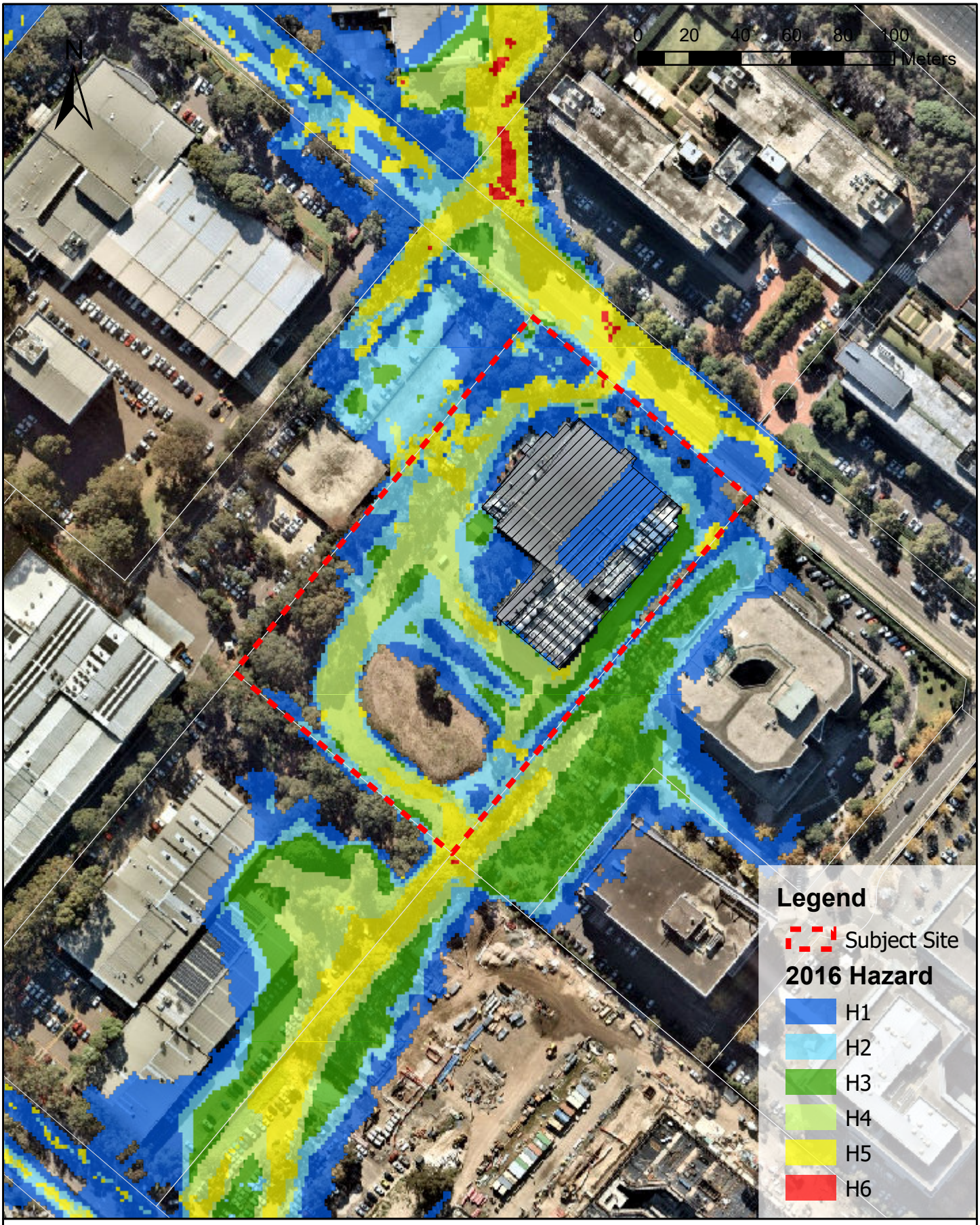

FIGURE H14 [A]

Updated MP FRMS&P - Existing Case
PMF ARR 2019 Flood Hazard

17 Talavera Road, Macquarie Park

Job Number: SY170095

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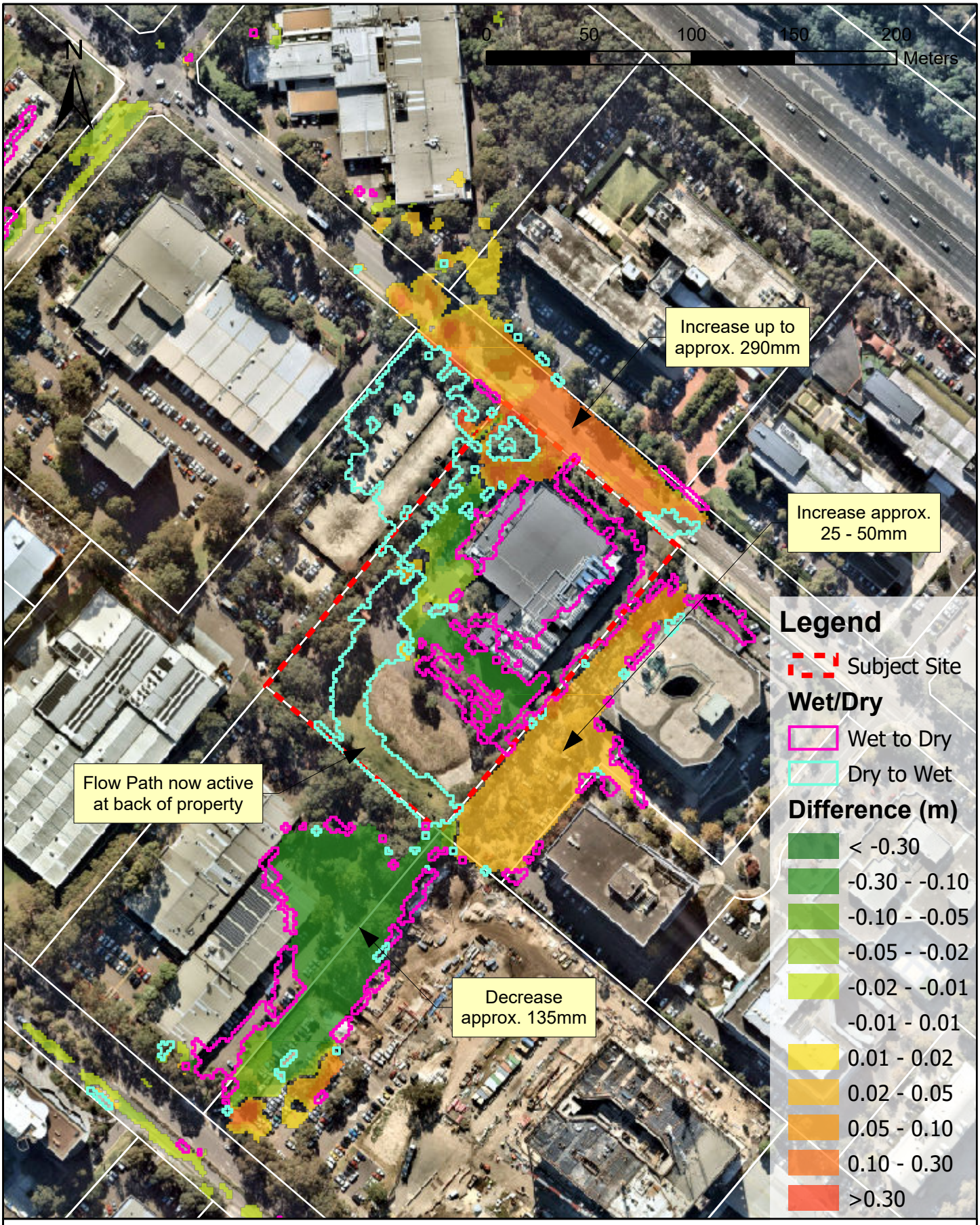

Figure H15 [A]

Existing Case minus Original MP FRMS&P 1% AEP Flood Elevation Difference

17 Talavera Road, Macquarie Park

Job Number: SY170095

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Figure H16 [A]

Existing Case minus Original MP FRMS&P PMF Flood Elevation Difference

17 Talavera Road, Macquarie Park

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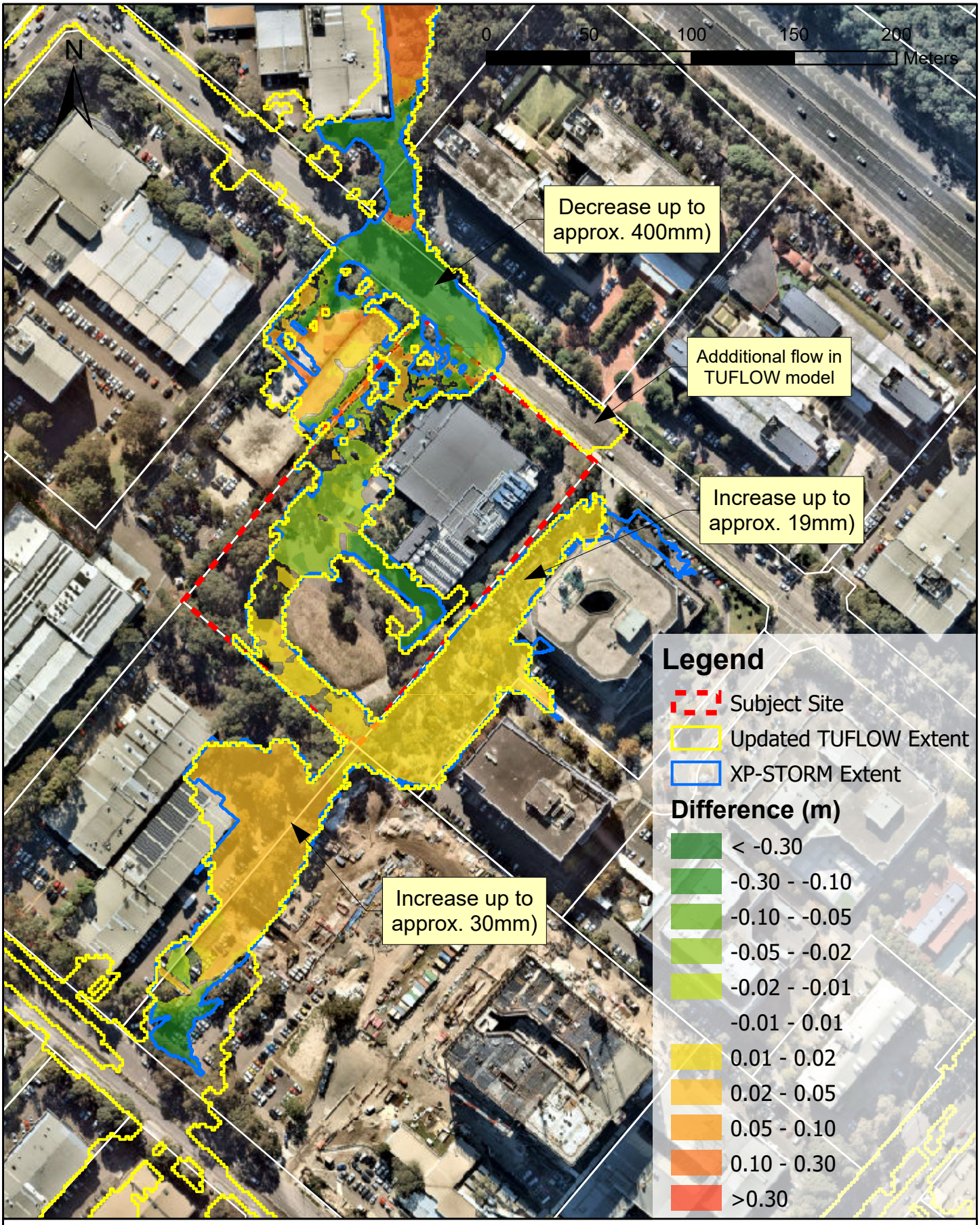

Figure H17 [A]

XP-STORM minus MP FRMS&P TUFLOW 1% AEP Flood Elevation Difference

17 Talavera Road, Macquarie Park

Job Number: SY170095

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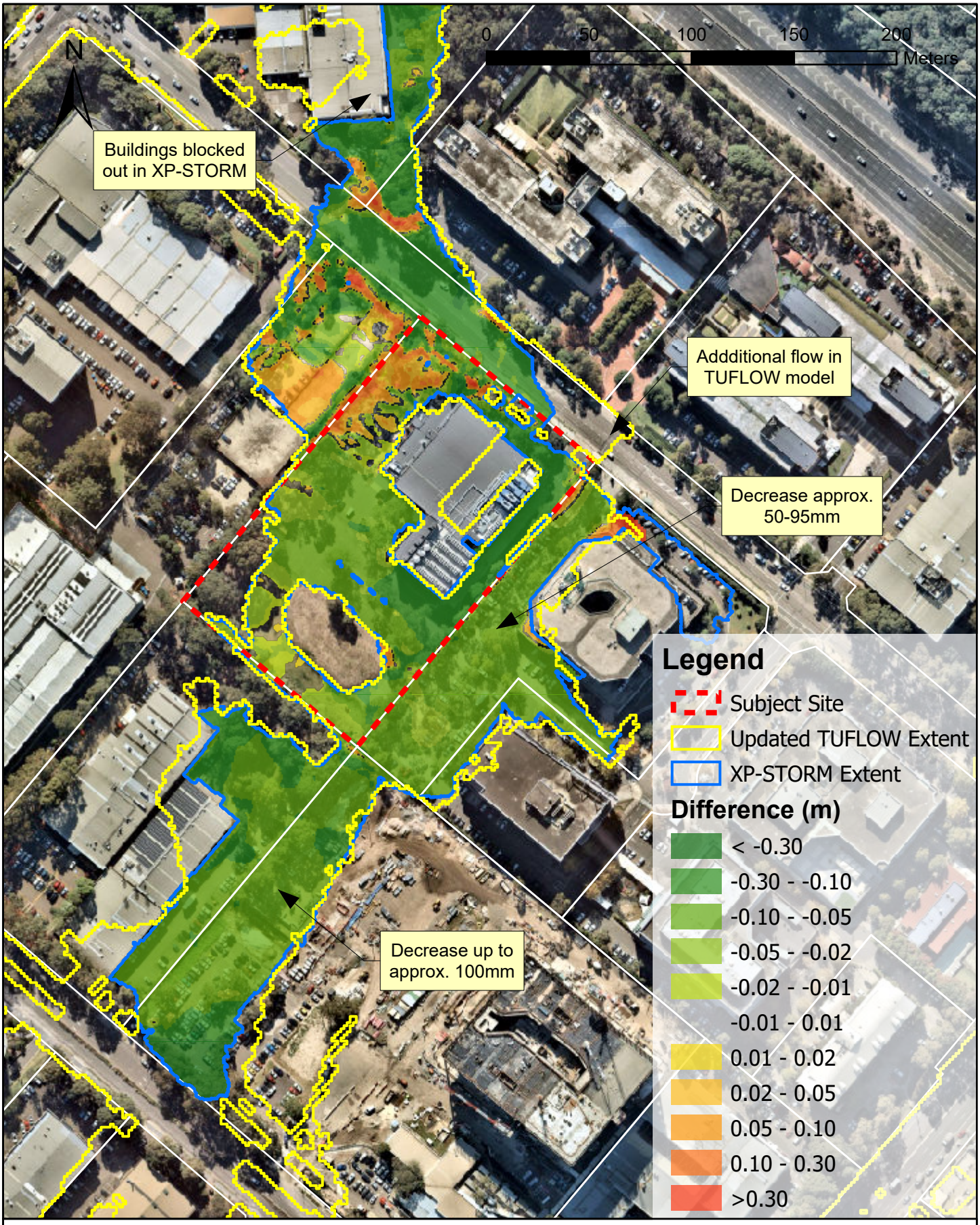

Figure H18 [A]

XP-STORM minus MP FRMS&P TUFLOW PMF Flood Elevation Difference

17 Talavera Road, Macquarie Park

Job Number: SY170095

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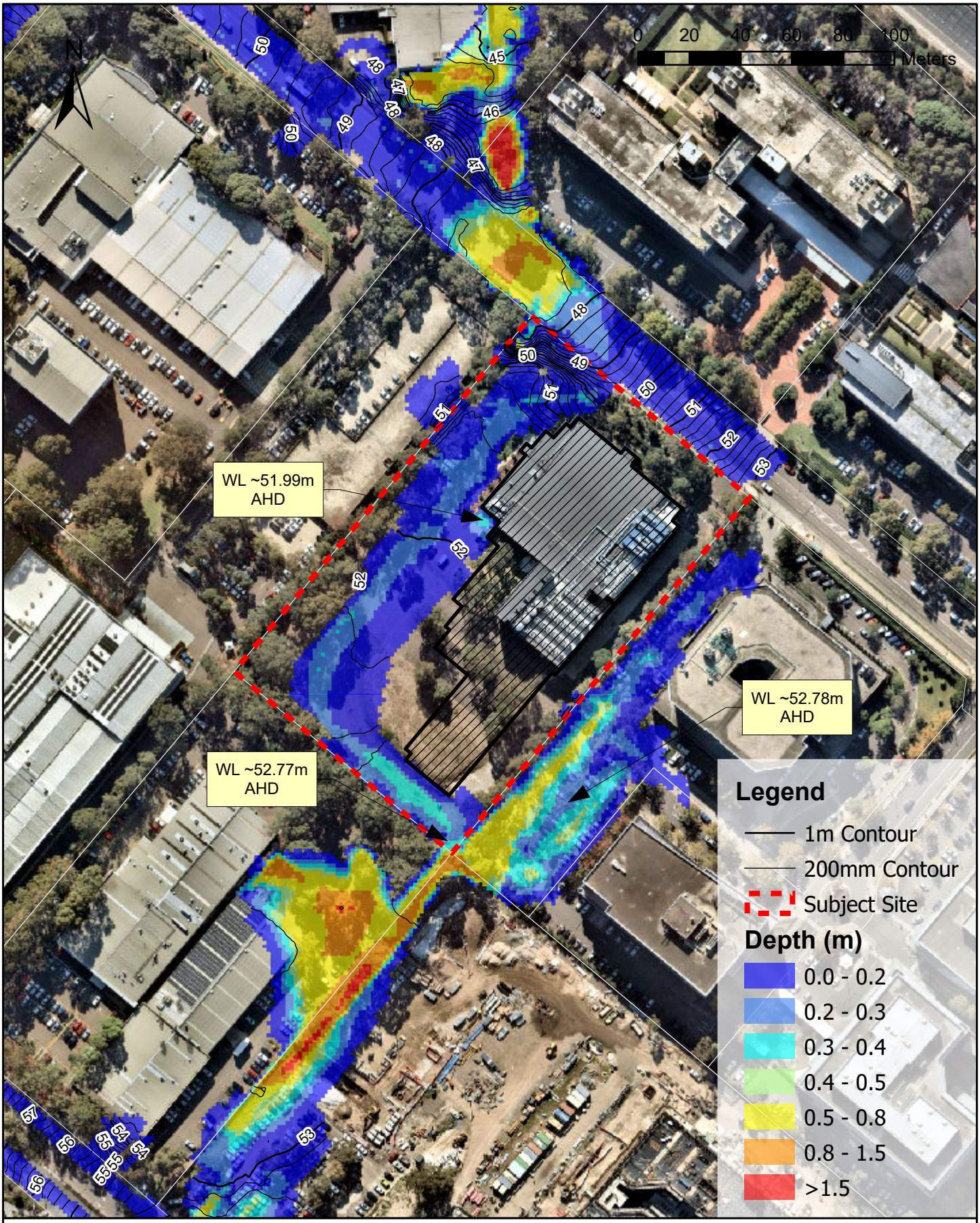

FIGURE H19 [A]

Updated MP FRMS&P - Developed Case 1% AEP Flood Depth and Elevation

17 Talavera Road, Macquarie Park

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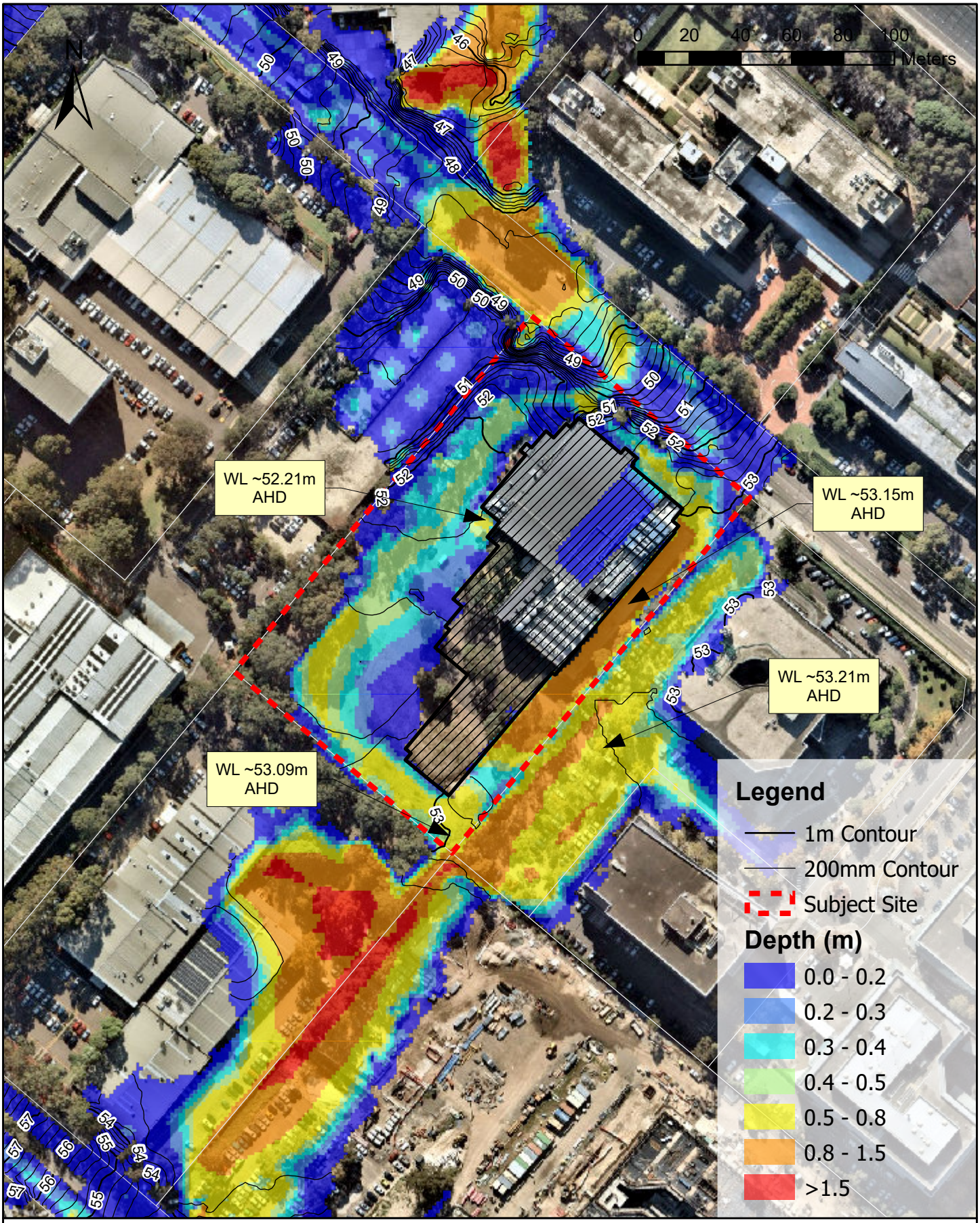

FIGURE H20 [A]

Updated MP FRMS&P - Developed Case PMF Flood Depth and Elevation

17 Talavera Road, Macquarie Park

Job Number: SY170095

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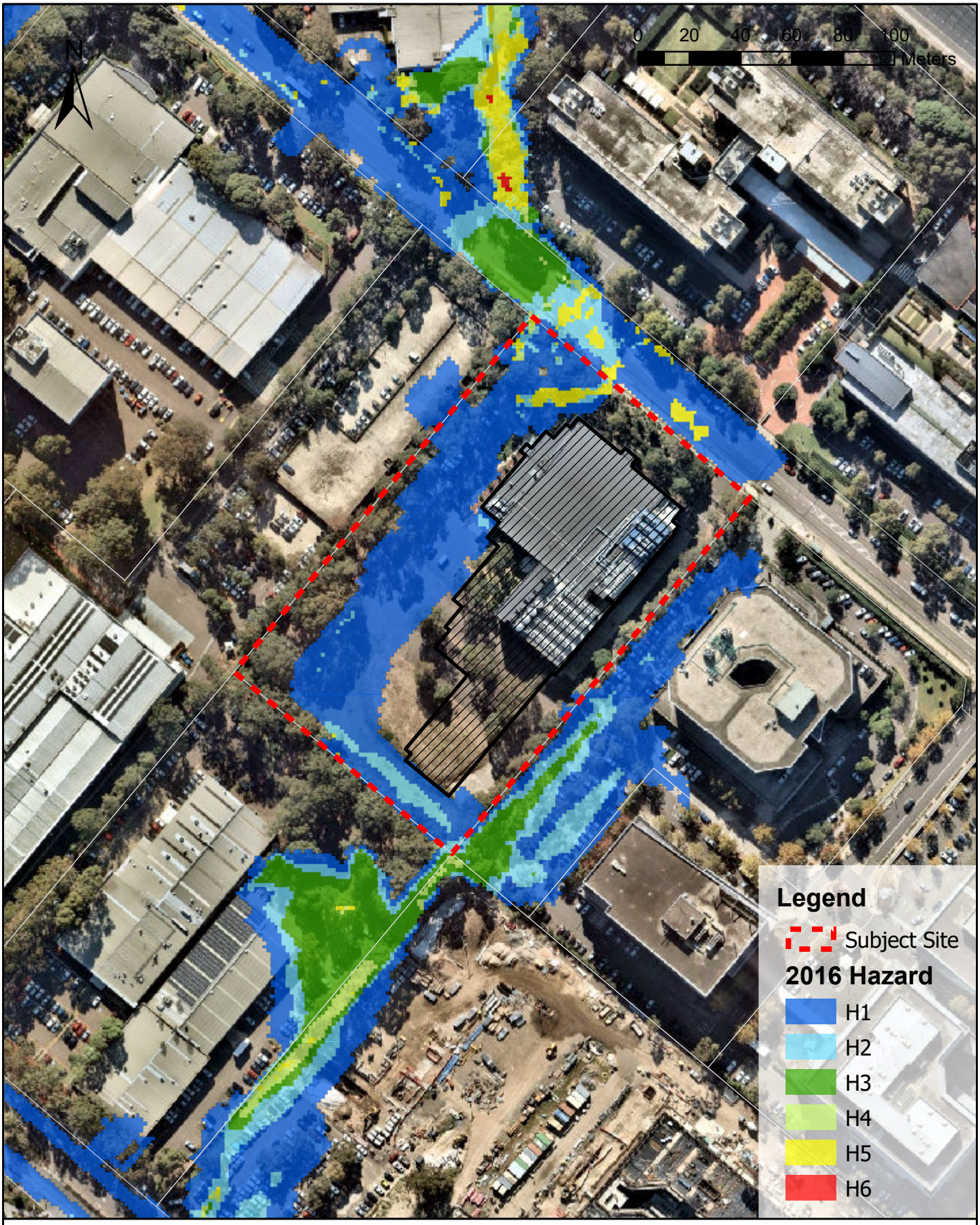

FIGURE H21 [A]

Updated MP FRMS&P - Developed Case 1% AEP ARR 2019 Flood Hazard

17 Talavera Road, Macquarie Park

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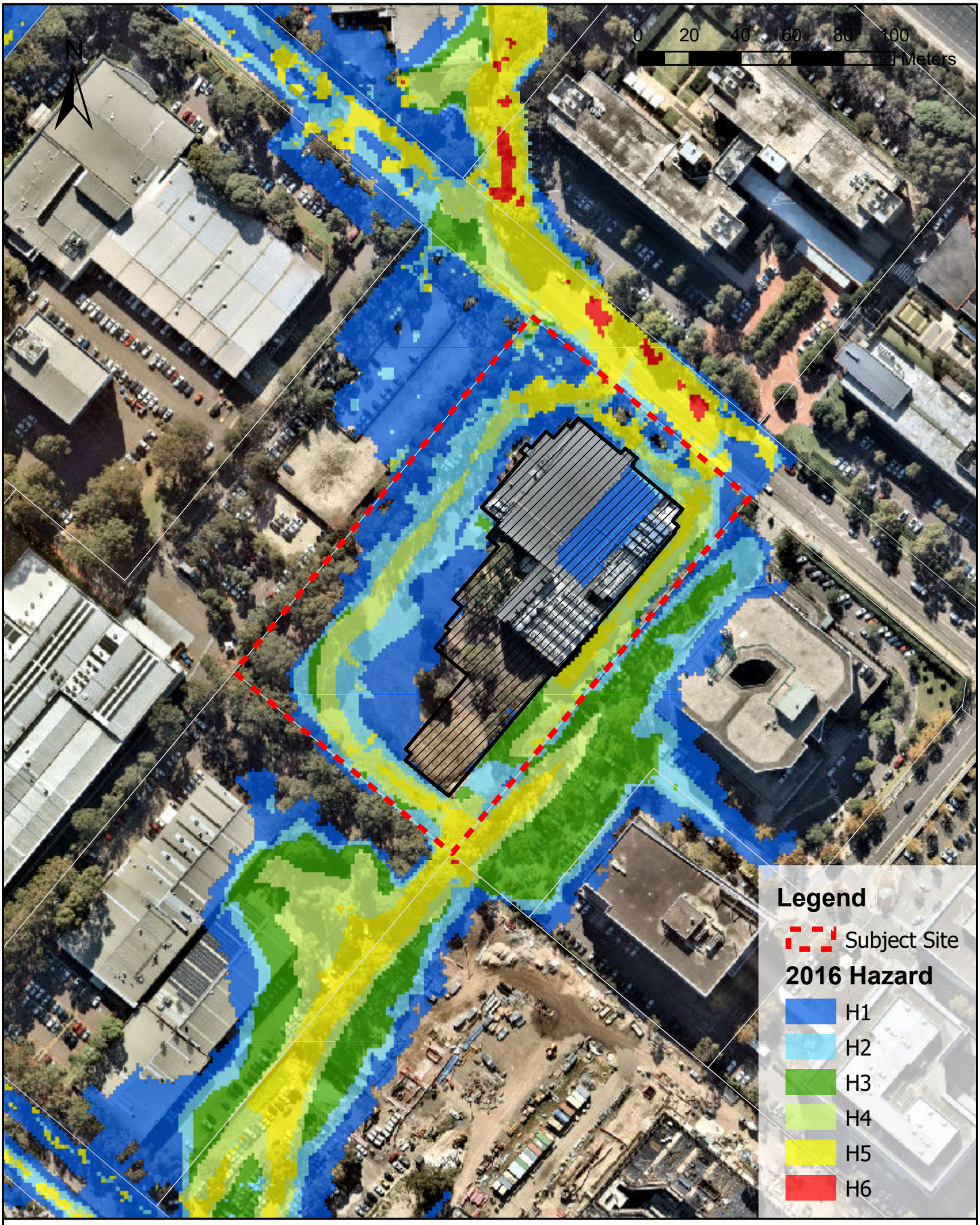

FIGURE H22 [A]

Updated MP FRMS&P - Developed Case PMF ARR 2019 Flood Hazard

17 Talavera Road, Macquarie Park

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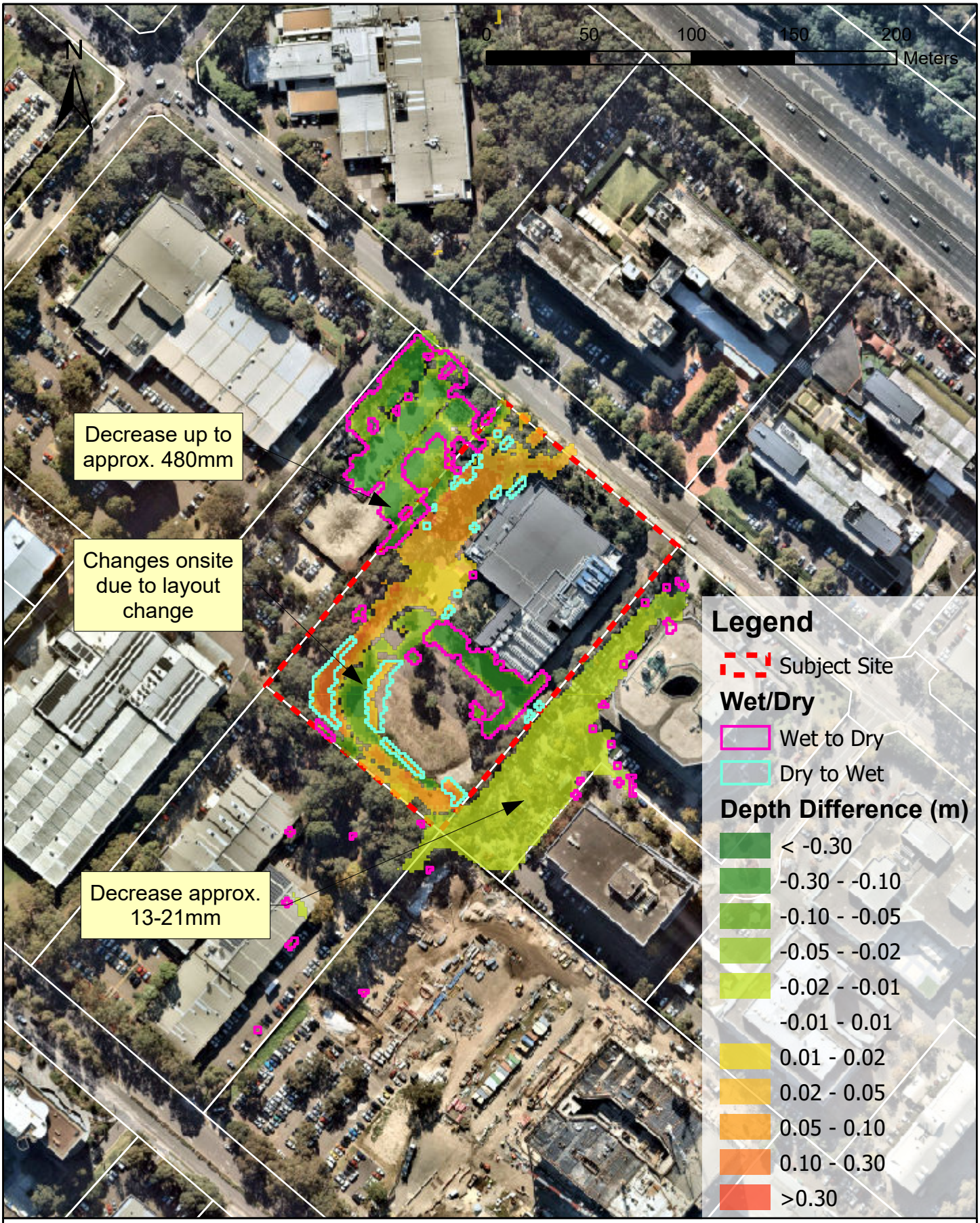

Figure H23 [A]

Updated MP FRMS&P - Comparison 1% AEP Flood Depth Difference

17 Talavera Road, Macquarie Park

Job Number: SY170095

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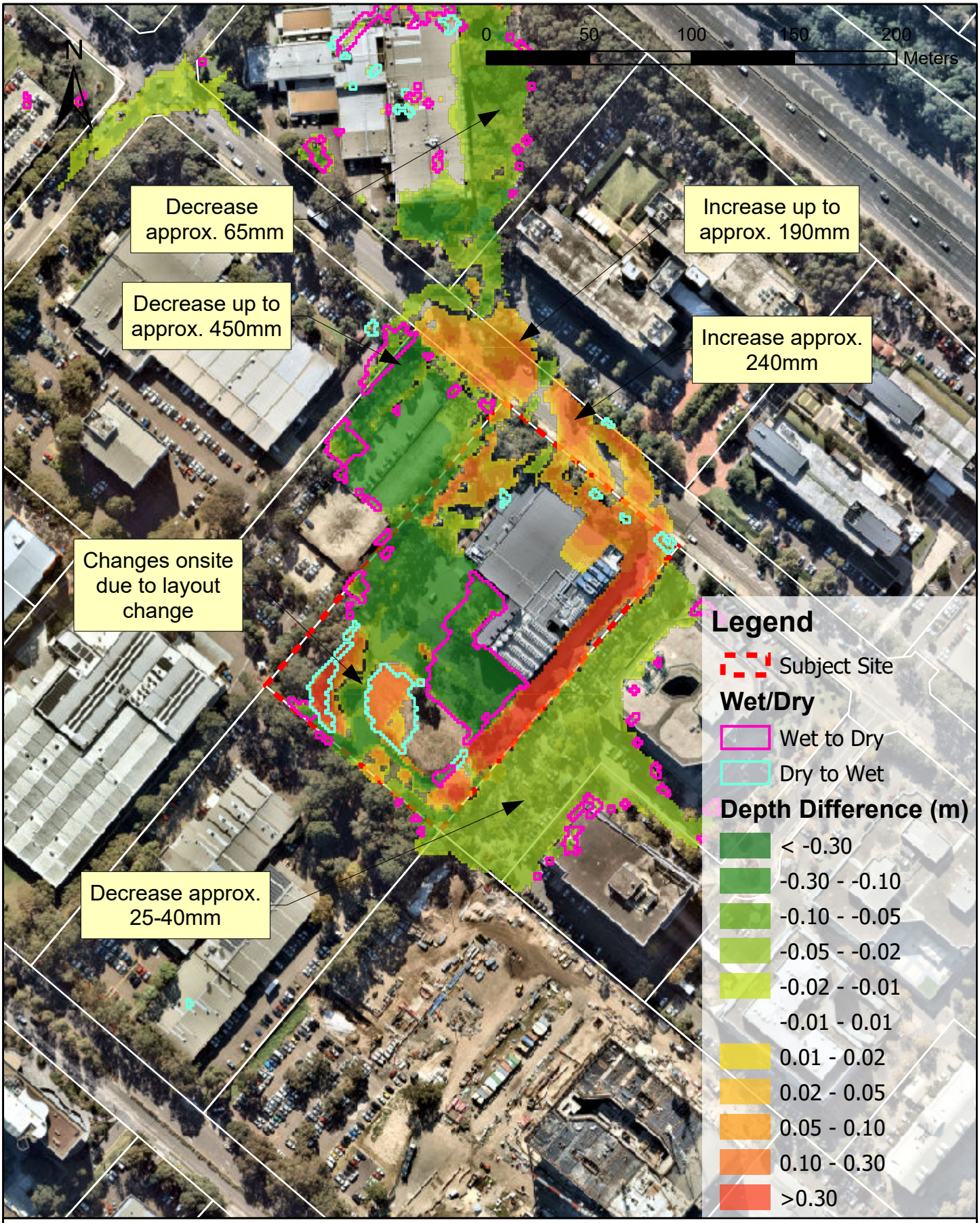

Figure H24 [A]

Updated MP FRMS&P - Comparison PMF Flood Depth Difference

17 Talavera Road, Macquarie Park

Job Number: SY170095

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Appendix B – Original Flood Impact Assessment


NORTHROP
Proposed Building Extension
17-21 Talavera Road,
Macquarie Park
Flood Impact Assessment

Report Details

Project: Proposed Extensions to Existing Data Storage Facility
17-21 Talavera Road, Macquarie Park, NSW
Project Ref: SY170095
File Location: SY170095_Flood Impact Assessment_[B].docx

Revision History

Revision	Report Status	Prepared/Reviewed	Issue Date
A	Issued for Approval	L Gitzel / A Brien	14/05/2018
B	Re-Issued for Approval	L Gitzel / A Brien	17/05/2018

Contents

1 Introduction

Northrop Consulting Engineers have prepared a Flood Impact Assessment for the proposed development located at 17-21 Talavera Road, Macquarie Park, herein referred to as the subject site.

The Macquarie Park Flood Risk Management Study and Plan, carried out by Bewsher Consulting and completed in 2011 has identified the site to be located within a Low to Medium Flood Risk Precinct. As such, the purpose of this assessment is to determine;

- The introduction of the proposed extension does not have a significant impact on the existing flood behaviour within the subject site ; and
- The introduction of the proposed extension does not have a significant impact on the existing flood behaviour within the properties within the vicinity of the subject site.

This assessment has given consideration to the following documents;

- City of Ryde Development Control Plan (DCP) in particular section 8.2 – Stormwater and Floodplain Management;
- The Macquarie Park Flood Risk Management Study and Plan (Bewsher Consulting, 2011);
- Australian Rainfall and Runoff 2016 (AR&R 2016);
- Australian Rainfall and Runoff 1987 (ARR1987) and subsequent updates;
- NSW Government Floodplain Development Manual (NSW Government, 2005); and
- Water Management Act 2000 (NSW Government, 2016).

Contained herein is a description of the subject site and upstream catchment inflows, a summary of the information available to inform our decisions, an outline of the methodology used in undertaking this assessment, and a discussion of the results.

2 Locality Description

2.1 Subject Site

The subject site is located within the Macquarie Park Catchment at Macquarie Park and is known as Lot 527 DP752035. The subject site is approximately 2.0 ha in size and its current land-use includes a data storage facility as well as the associated carpark and landscaping.

Site topography generally falls in a northerly direction with an average grade in the order of two percent. Steeper topography, in the order of eighteen percent, is observed in the north-western corner of the site, adjacent to the driveway entrance to Talavera Road.

The site fronts Talavera Road to the north with the remaining adjacent properties to the east, west and south being largely an industrial/commercial land-use. Flows from the upstream catchment enter from the south and cross the site via a grass lined channel and the driveway before discharging downstream onto Talavera Road.

The catchment upstream of the subject site is approximately 40.5ha in size and consists primarily of commercial and residential land-use. The topography is moderately sloped in the upper and lower reaches with slopes in the order of one to five percent.

2.2 Proposed Site Development

The proposed development includes a two-stage extension to the existing data storage facility including the removal of a portion of the existing carpark.

- **Stage One**: The initial extension to the southern side of the existing IC2 facility including the construction of an additional six storey data storage facility; and
- **Stage Two**: includes an additional six storey extension located adjacent to the western side of the proposed stage one works which includes the removal of a portion of the carparking area. This stage also involves the introduction of additional office space located adjacent to he existing loading bay as well as an under-croft area that allows flow to pass beneath.

Figure A2 of Appendix B demonstrates the difference in extent of the two stages with respect to the ground floor flow obstructions.

3 Methodology

This flood impact assessment was undertaken using the following procedure;

- Desktop review of previous investigations including the review of the Macquarie Park Flood Risk Management Study and Plan (Macquarie Park FRMS&P) completed by Bewsher Consulting in 2011 as well as a flood study completed by Buckton Lysenko in 2011 as part of a previous Development Application for the subject site.
- Obtain and review flow hydrographs provided by Council's DRAINS model for the upstream catchment. These hydrographs were then scaled back based on the peak flow presented in the Macquarie Park FRMS&P for a location just upstream of the subject site (i.e. Location "I2" – Table 13 in the Macquarie Park FRMS&P).
- Preparation of a two-dimensional XP-STORM hydraulic model using the scaled hydrographs for both the 1% AEP (Annual Exceedance Probability), and PMF (Probable Maximum Flood) design storm events;
- Inclusion of both Stages one and two of the proposed extension into the separate two-dimensional hydraulic model to assess the impact of the development on the existing flood behaviour on-site and within the adjacent properties;
- The results of the assessment have been reported herein.

4 Model Parameters

The site hydraulic assessment was undertaken using the XP-STORM computer software, featuring the two-dimensional TUFLOW hydrodynamic engine. The following provides a summary of the parameters used in the development of the two-dimensional flood model.

4.1 Hydrological Model

The hydrological model for both the 1% AEP and PMF design storm events was based on information provided by The City of Ryde Council in the form of an inflow hydrograph for each event.

These hydrographs showed what appeared to be an over-estimation of the peak flow when compared to those presented in Table 13 of the Macquarie Park FRMS&P. A comparison of the peak flows from each model is presented in Table 1 below.

Table 1 – Comparison of Peak Flow Results

Design Storm Event	Macquarie Park FRMS&P Peak Flow (m^3/s)	Council's DRAINS Peak Flow (m^3/s)
1% AEP	6.6	12.9
PMF	26.2	50.4

Due to the discrepancy of the two models and the absence of a hydrograph from the Macquarie Park FRMS&P (Bewsher Consulting, 2011), it was agreed with Council that scaling of the DRAINS hydrograph to the Macquarie Park FRMS&P (Bewsher Consulting, 2011) peak flow would provide an acceptable representation of flood behaviour through the site. Our correspondence with Council is provided in Appendix A. The 1% AEP and PMF hydrographs that were entered into the model, upstream of the subject site, are illustrated below in Figure 1 and Figure 2 respectively.

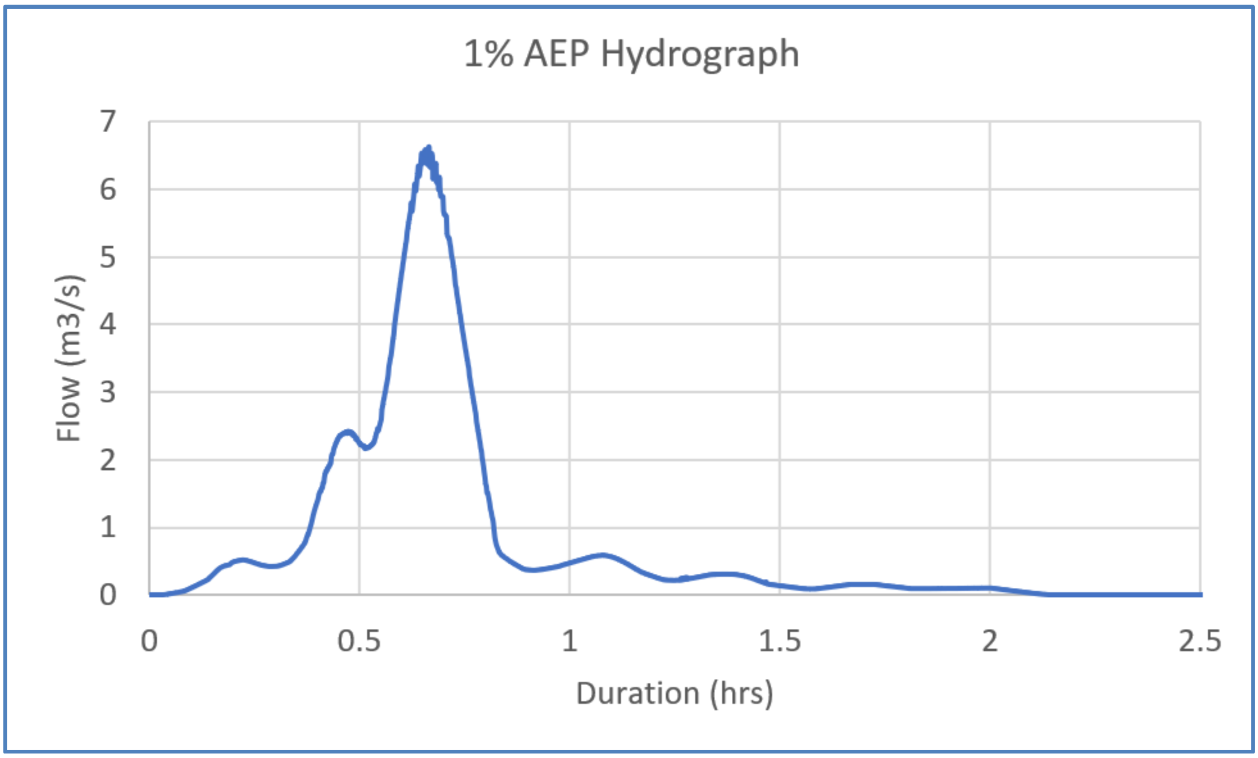

Figure 1 - Scaled 1% AEP Inflow Hydrograph

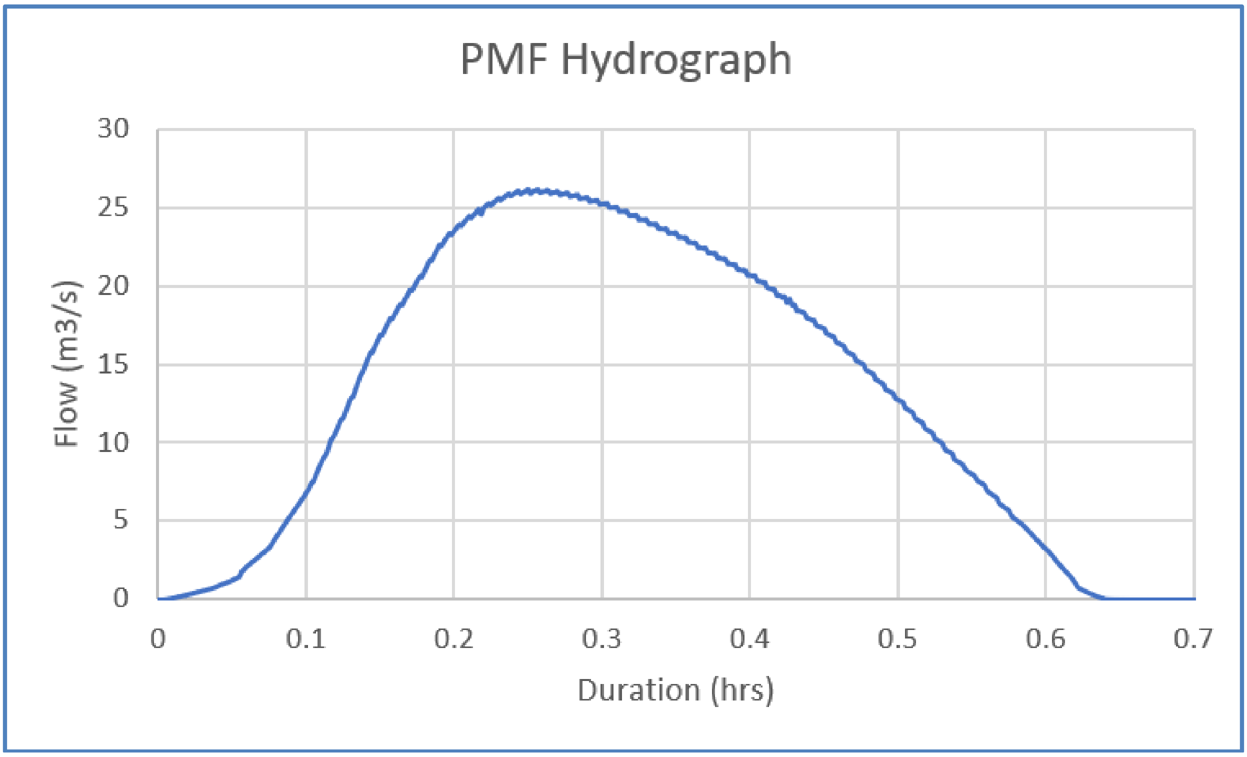

Figure 2 - PMF Inflow Hydrograph

These inflow hydrographs were entered into the model upstream of the subject site at a location commensurate with that of “I2 – Waterloo Road” as shown in the Macquarie Park FRMS&P (Bewsher Consulting, 2011).

4.2 Hydraulic Model

4.2.1 Two Dimensional Model Grid Extents and Size

A grid size of 1m x 1m was adopted for the two-dimensional model to adequately represent flows around buildings and through the overland flow path. A time step of 0.25 seconds was used, and the model was run for 3 hours to capture the full duration of the 1% AEP.

The two-dimensional grid covers the extent of the subject site and surrounding area and extends to Waterloo road to the south, and to the M2 underpass to the north.

4.2.2 Terrain

Terrain data used in the development of the model was a combination LiDAR elevation data and detailed survey. The developed surface was created using 12D and imported into the model. The attached Figures A1 and A2 of Appendix B present the topography used for the existing and developed scenarios respectively.

4.2.3 Boundary Conditions

An inflow hydrograph was entered upstream of the subject site at a location commensurate with that of "I2 – Waterloo Road" as shown in the Macquarie Park FRMS&P (Bewsher Consulting, 2011). This inflow hydrograph was used to apply the scaled back 1% AEP and PMF hydrographs into the model as discussed previously in Section 4.1.

A free outfall tailwater condition was applied downstream of the subject site across Khartoum Road at the underpass to the M1. This location was selected as the surface levels in this location were low enough that it would not impact on the results from the model.

4.2.4 Catchment Roughness and Building Representation

Catchment roughness was determined from a desktop study, an inspection of the subject site and review of hydraulic literature. The attached Figures A3, A4 and A5 of Appendix B present the land-use values used in the existing, stage one and stage two models respectively.

For the assessment of all scenarios, buildings within the model extent were blocked out to more accurately represent flood behaviour around buildings and along the overland flow path. Buildings were digitised in the flood model based on a site visit and aerial photography.

A table showing the adopted Manning's roughness values are shown below in Table 2.

Table 2 – Manning's Roughness

Land Use	Manning's n Roughness
Buildings	Blocked Out
Gardens/Bush	0.060
Grass	0.035
Gravel	0.020
Roads	0.015

Fences around the site include both chain-wire and palisade style. These were included into the model as a flow constriction with a blockage factor applied where it was expected they would have an impact on flood behaviour within or adjacent to the subject site. A typical blockage factor of 20% was applied for the majority of the site fences with an increased blockage of 60% applied for the fence located in the property adjacent to the southern corner of the subject site. The below photo, shown as Figure 3, shows this fence has a considerable covering of vines and what appeared to be sediment fence attached which suggests there is greater potential for blockage in this area.

The louvers located around the proposed under-croft area for Stage two were included in the model as an additional flow constriction with a blockage factor of 80%.

4.2.5 Losses

Given that rainfall losses are considered in the hydrological model provided by Council, no additional infiltration or evaporation losses where applied in the site-specific model.

Figure 3 - Fence in the property adjacent to the southern corner (behind palisade fence)

4.2.6 Below Ground Stormwater Network

The below ground stormwater network was not considered as the peak flows extracted from the Macquarie Park FRMS&P (Bewsher Consulting, 2011) was based on overland flow only. Furthermore, due to the extreme events considered the pit and pipe network can be considered flowing full, having little to no impact on the results of the model.

5 Results

The following is a summary of the flood results for the existing and developed scenarios as well as a brief discussion regarding the change in flood behaviour resulting from the proposed development.

5.1 Flood Behaviour

Two flood storage zones are observed upstream of the subject site, the first being within the property adjacent to the south-western boundary and the second within the property adjacent to the south-eastern boundary. Overland flow is observed to enter the subject site from the southern corner where flood water is shown to initially divide between entering the subject site and filling up the flood storage area located within the property adjacent to the south-eastern boundary. Once this flood storage area is filled, additional flows are forced onto the subject site via a low point near the southern corner of the subject site.

Overland flow during the existing case then continues to drain along the grass lined channel and across the carpark before discharging onto Talavera Road. Similar behaviour is observed during the PMF, however additional flows are directed towards the eastern corner of the subject site towards Talavera Road. Similar flow behaviour is observed during both developed scenarios with a slight increase in the quantity of flows running along the south-eastern side of the building during the PMF.

Flood depths and elevation contours for the existing scenario, for both the 1% AEP and PMF design storm events, are shown in the attached Figures B1 and B2 respectively, and the velocity results are shown in Figures B3 and B4.

Flood depths and elevation contours for the developed stages one and two, for both the 1% AEP and PMF design storm events, are shown in the attached Figures C1 to C4, and the velocity results are shown in Figures C5 to C8.

Flood hazard has also been considered for the existing and developed scenarios using the latest AR&R 2016 hazard categories. A summary of these categories is presented below in Figure 4.

The hazard categories for the existing scenario, for both the 1% AEP and PMF design storm events, are shown in the attached Figures E1 and E2 respectively while, the developed stages one and two results are shown in the attached Figures E3 to E6.

5.2 Development Impact

The developed 1% AEP and PMF flood depth comparisons are shown in the attached Figures D1 to D4, while the results for the velocity comparisons are shown in Figures D5 to D8. Both stages one and two results suggest that during the 1% AEP a minor increase in flood depth of approximately 25mm is observed in the property adjacent to the south-eastern boundary while a decrease of approximately 90mm is observed downstream in Talavera Road. Similar results are observed for both stages during the 1% AEP except for some minor behaviour changes on the subject site where flow comes in contact with the louvers proposed around the under-croft area.

The 25mm increase within the property located adjacent to the south-eastern boundary is expected to be the result of a minor increase of less than 10mm across the western portion of this property causing greater volume of runoff to spill into this sag point.

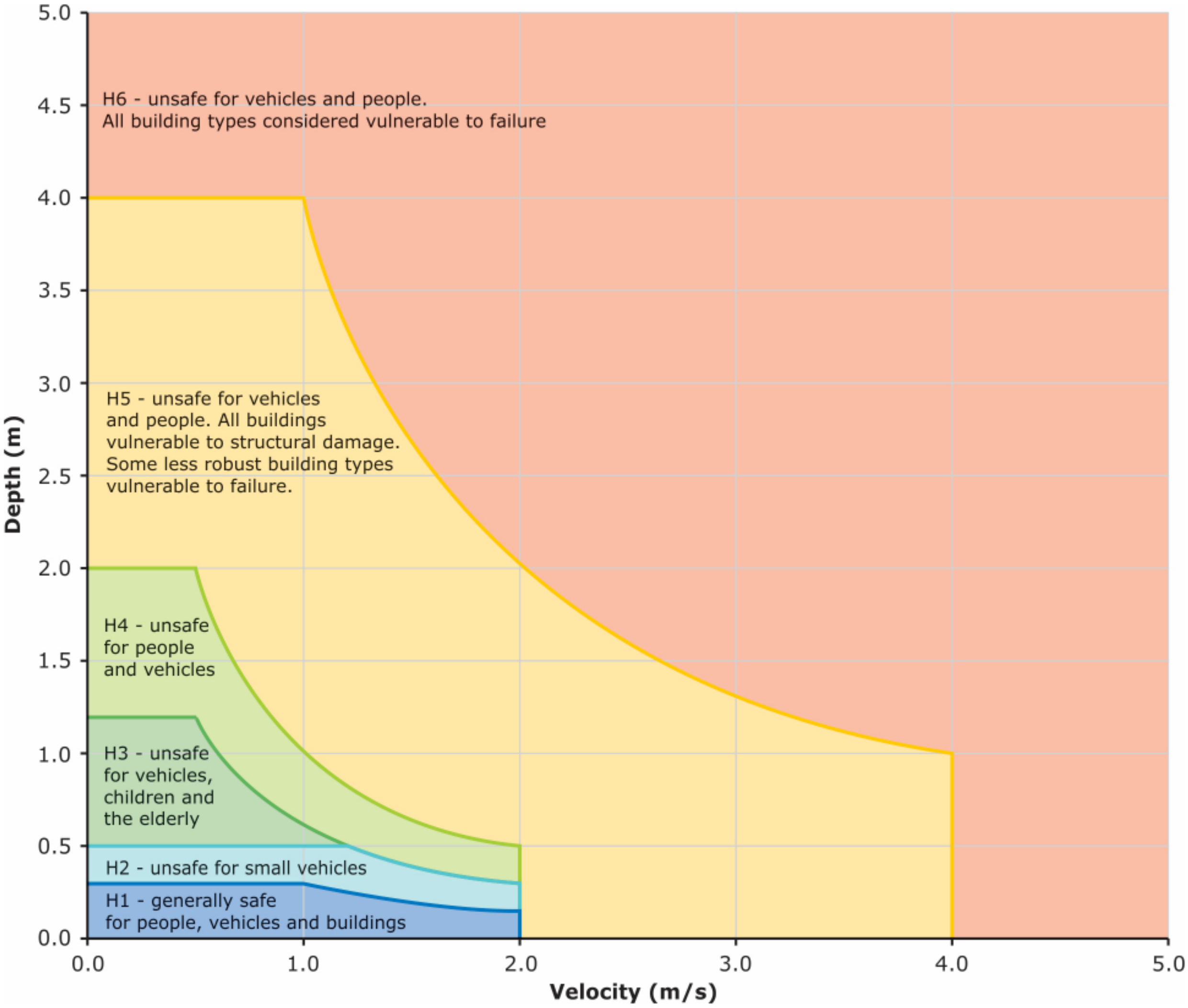

Figure 4 - Flood Hazard Categories (AR&R 2016, Book 6 - Chapter 7)

Similarly, the decrease observed in Talavera Road is expected to be the result the modifications to the site levels when compared to the existing case, marginally reducing the flow capacity across the subject site. Additional increases and decreases observed within the subject site are expected to be due to the modification to the site layout and grading.

During the PMF a maximum increase of approximately 36mm is observed in the property adjacent to the south-eastern boundary for both stages one and two, which is again likely due to the reduced flow capacity across the subject site. An increase of up to 380mm is also observed in Talavera Road which is expected to be the result of the re-direction of a portion of the PMF flood flows along the south-eastern side of the subject site. Similar to the 1% AEP, the PMF results show that for both stages one and two, only minor flow behaviour changes are observed on the subject site where flow comes in contact with the louvers around the under-croft area.

Decreases of up to 300mm are observed in the PMF within the property adjacent to the north-western boundary which is expected to be commensurate with the reduction in the flow capacity across the subject site. Increases and decreases are observed within the subject site during the PMF which is expected to be due to the modification to the site layout and grading.

The 1% AEP and PMF flood hazard comparisons for both stages are shown in the attached Figures E7 to E10 respectively. Figures E7 and E9 suggests that during the 1% AEP the results are similar between the pre to post developed scenarios with the exception of a slight increase in the extent of the H5 category in Talavera Road. This is due to an increase in the extent of flood velocity that is greater than 2m/s in this area. This is not considered to have a significant impact on the trafficablility of Talavera Road as there is already a large portion of H5 hazard flow in this location.

It is important to note that the 25mm and 36mm increase in flood depth within the property adjacent to the south-eastern property during the 1% AEP and PMF design storm events is shown to have little to no change in flood hazard conditions within this property. Similarly, the habitable floor level for this property is located three storeys above ground level and as such the increase in flood depth within this property can be considered to have a minor reduction in the freeboard.

Additional changes in flood hazard classification is observed within the subject site boundaries which is expected to be the result of the change in building layout and site grades.

Figures E8 and E10 show the pre to post hazard comparison for both stages one and two during the PMF design storm event respectively. The results suggest that there is the potential for an increase of up to four hazard categories in Talavera Road. This is the result of an increase in flood flow being directed along the south-eastern side of the building and spilling onto Talavera Road. The increase in this area is not considered to have a significant impact on the trafficability of Talavera Road due to the fact that during the existing case, this section of Talavera Road is already considered un-trafficable. In the existing case both H5 and H6 hazard flow is observed in this area.

Similarly, some minor changes in the extent of hazard categories is observed within the property adjacent to the south-eastern boundary this is likely due to the increase of up to 36mm in this area during the PMF. These changes are not considered significant as the hazard category is not increased, rather only an increase in the extent of the existing hazard categories is observed.

Decreases in the hazard category is also observed in the property adjacent to the north-western boundary with the existence of the H6 hazard category almost completely removed from this property. Further downstream in Talavera Road, additional decreases in the hazard category is shown with a change from H5 to H1 observed along the western edge of the floodplain.

5.3 Finished Floor Level

The finished floor level for the proposed stage one building varies between a level of 53.23m AHD adjacent to the existing building, to a level of 53.66m AHD in the southern-most portion of the proposed extension. Therefore, during a 1% AEP event, a freeboard of approximately 950mm is available for the southern portion of the building, while the section adjacent to the existing building has a freeboard of approximately 1.33m (based on a flood level at the existing loading bay of 51.90m AHD). During the PMF, a freeboard of 40mm is still available for the lowest floor level of 53.23m AHD located adjacent to the existing building.

For stage two, an additional office space is proposed located adjacent to the existing loading bay along the western side of the building. This office space is proposed at a level of 53.23m AHD and is shown to have freeboard of approximately 1.33m when compared to the nearby flood level at the loading bay.

Similarly, the floor level for the existing building is set at 53.23m AHD which includes a freeboard of approximately 40mm when compared to the PMF level along the eastern side of the building and approximately 1.33mm when compared to the 1% AEP flood level at the loading bay along the western side of the building.

5.4 Risk to Property

Risks to property from the proposed development includes inundation of the building floor level, damage to cars parked on the site and impact on adjacent properties due to increased fill and channel modifications. The management measures for these risks are identified in Table 7 below.

Table 3 - Risk to Property Considerations

Risk	**Management Measures**
Inundation of floor level	As mentioned earlier, for the proposed extension of stage one a minimum freeboard of 950mm is proposed above the 1% AEP while a minimum freeboard of 40mm is available during the PMF. For stage two, an additional office space is proposed on the ground floor which will have a freeboard of approximately 1.33m during the 1% AEP and 1.12m during the PMF. Similarly, for the existing building, a freeboard of approximately 40mm is available for the PMF level while approximately 1.33mm is provided for the 1% AEP flood level. Based on this information, floodwaters are not expected to breach the building floor level.
Damage to cars	During the 1% AEP the attached Figures E3 and E5 suggests the majority of the subject site, during the developed case, experiences a flood hazard category of H1 and H2. The above Figure 4 suggests this is generally safe for pedestrians and most cars, while small vehicles can be moved away from the areas expected to experience H2 hazard flow. During the PMF it is recommended that staff and visitors either evacuate early or seek refuge inside the building until flood water subsides. Those that seek refuge onsite are recommended to move vehicles to higher ground that is not expected to be affected by hazard flow greater than H1.
Damage to adjacent properties due to the development	A maximum increase of 25mm and 36mm is observed in the property adjacent to the south-eastern boundary during the 1% AEP and PMF design storm events respectively. This increase is not expected to cause significant damage to the adjacent property as the existing ground-floor land-use is largely carparking with office space located three levels up. As such these minor increases can be considered to reduce freeboard to these habitable floors only and therefore has no significant impact with this regard. Regarding vehicles and materials stored on this property, the minor increases in flood depth produces only a minor increase in the extent of the hazard categories within this property and do not result in an increase in the maximum classification. As such these increases are considered to have no significant impact on vehicles or materials stored onsite.

5.5 Risk to Life

Risk to life has been considered for all events up to the PMF. Management measures are summarised below in Table 8.

Table 4 - Risk to Life Considerations

Risk	Management Measures
Pedestrians or vehicles being swept into the overland flow path	During the 1% AEP the attached Figures E3 and E5 suggests the majority of the subject site, during the developed case, experiences a flood hazard category of H1 and H2. The above Figure 4 suggests this is generally safe for pedestrians and most cars. A portion of H5 is observed in the north-western driveway entrance and it is not recommended to use this in a flood event.. It is expected that in a rare or extreme event such as the 1%AEP or PMF, staff or visitors will either evacuate early, or seek refuge inside the building until flood water subsides.
Isolation in a flood event	Access and egress to and from the site is available via the north-eastern driveway entrance for events up to and including the 1% AEP design storm event. It is expected that refuge will be sought onsite during a 1%AEP or PMF event, if it is too late to evacuate. The flood hydrograph provided by Council suggests a PMF event will last for less than an hour, therefore isolation during the PMF is not expected to occur for a prolonged period of time.

5.6 Flood Access and Evacuation

Flood access and egress to Talavera Road is available during the 1% AEP from the north-eastern access driveway. It is expected that in a rare or extreme event such as a 1%AEP or PMF, staff and visitors evacuate prior to the event or seek refuge within the building until floodwaters subside.

5.7 DCP Requirements

In accordance with Section 8.2 of the City of Ryde DCP 2014, the proposed site development meets the following controls with regards to flooding and overland flow for Commercial or Industrial (subsection 4.4.3) development:

a) *Commercial development on land subject to flood risk categorised as high will not be permitted unless it can be clearly demonstrated that development under this section can be undertaken on the land without jeopardising public safety and access, property damage or adverse ramifications of the pre-developed flood regime by means of a Flood Impact Statement.*

   The subject site is classified as a low to medium flood risk as shown in the Macquarie Park FRMS&P and as such this item is not applicable. Furthermore, this flood impact assessment demonstrates the proposed development will not have a significant impact on the existing flood behaviour or impact public safety and access and egress.

b) *Floor levels of habitable and non-habitable areas must comply with the freeboard requirements as stated in Table 2.1 of the Stormwater Technical Manual. If these levels cannot be practically achieved for the entire floor area (E.g. for reasons of accessibility from a public space) then a*

lesser level may be considered subject to consideration of the extent or scale of property damage and risk to public safety.

Table 2.1 of the Stormwater Technical Manual, does not specify the necessary freeboard for a proposed development if it is located within a Medium Risk Precinct however, it is proposed that the floor level for stage one be placed at level a between 53.23m AHD to 53.66m AHD which, when compared to the 1% AEP flood level includes a minimum freeboard of 950mm while the PMF will have a minimum freeboard of approximately 40mm. For stage two, an additional office space is proposed on the ground floor which will have a freeboard of approximately 1.33m during the 1% AEP and 1.12m during the PMF.

c) *New structures subject to flood waters and major overland flows (excluding those sites located in Overland Flow Precincts) must be designed and constructed to withstand the anticipated hydrostatic forces. For all parts of the development potentially exposed to floodwater, below the minimum freeboard requirement, the development structure must:*
   - *I. be constructed of flood compatible building components in accordance with the Stormwater Technical Manual.*
   - *II. A structural engineer must certify that the completed works are designed and capable of withstanding forces subject to forces of floodwater, debris, buoyancy forces anticipated by the 100yr ARI flood event.*

External walls subject to loading from overland flows will be designed to be flood proof and will to have the structurally capability to withstand the hydrostatic forces of floodwater, debris, buoyancy, etc.

d) *Development must not adversely impact the existing flood regime in terms of diverting major overland flows or reduce flood storage such to adversely impact the surrounding area. The submitted Flood Impact Statement must demonstrate the development does not:*
   - *I. Reduce the pre-developed level of flood storage.*
   - *II. Increase flood levels or velocities such to adversely impact adjoining dwellings.*

As discussed in Sections 0 and 5.5, the proposed development does not have a significant impact on flood storage on the site nor does it have significant impacts on adjacent properties with regards to flood levels and velocities.

e) *All goods and materials must be stored at the minimum habitable floor level, complying with the freeboard requirements as stated in Table 2.1 of the Stormwater Technical Manual, unless the site is located in an Overland Flow Precinct in which case this may be reduced to 500mm above the adjoining ground level. Exemptions from this may be considered if it can be demonstrated in the Flood Impact Statement, that the materials will not adversely impact the surrounding environment or can be damaged if subject to stormwater inundation.*

Noted. It is expected that goods and materials required for the occupation of the site will be stored internally above the PMF.

f) *If the development under this development type category involves subdivision of the land, it must be demonstrated that potential development of this newly created allotment can comply with controls under this section*

Not applicable.

g) *A restrictive covenant must be placed on the title of the land to ensure there are no further significant works and alterations to the landform or development are undertaken without the approval of Council such to impact on floodwaters.*

Noted.

6 Conclusion

A flood impact assessment has been undertaken for the proposed industrial development at 17-23 Talavera Road, Macquarie Park NSW.

It was found that the proposed development had no significant impacts on flood behaviour and affectation in the vicinity of the subject site.

We commend our findings to Council for their review. Should you have any queries regarding this correspondence, please feel free to contact the undersigned on (02) 4943 1777.

Prepared by:

Laurence Gitzel

Civil Engineer

Reviewed by:

Angus Brien

Civil Engineer

APPENDIX A

Rodhan Haughton

From: Guna Veerasingham <GVeerasingham@ryde.nsw.gov.au>
Sent: Friday, 2 March 2018 11:26 AM
To: Rodhan Haughton
Subject: RE: 17-23 Talavera Road Macquarie Park

Follow Up Flag: Follow up
Flag Status: Completed

ok

Guna Veerasingham
Stormwater Coordinator
CIVIL INFRASTRUCTURE & INTEGRATION DEPARTMENT
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City of Ryde

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North Ryde Office Binary Centre, Building 0, Level 1, 3 Richardson Place, North Ryde

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From: Rodhan Haughton [mailto:RHaughton@northrop.com.au]
Sent: Thursday, 1 March 2018 1:59 PM
To: Guna Veerasingham
Cc: Laurence Gitzel
Subject: RE: 17-23 Talavera Road Macquarie Park

Hi Guna,

Will scaling the DRAINS hydrograph down to match the TUFLOW model peak flow rate be sufficient to satisfy Council when it comes to incorporating the Macquarie Park Flood Study results into our site specific model for DA submission?

Regards,

Rodhan Haughton
Civil Engineer
T: 02 9241 4188
D: 02 9156 3026
M: 0407 377 712
Northrop Consulting Engineers Pty Ltd

From: Guna Veerasingham [mailto:GVeerasingham@ryde.nsw.gov.au]
Sent: Thursday, 1 March 2018 1:33 PM
To: Rodhan Haughton <RHaughton@northrop.com.au>
Subject: RE: 17-23 Talavera Road Macquarie Park

Hi Rodhan,

The simple way is to rescale the DRAINS model hydrograph to match with TUFLOW model peak flow rate.

Bewsher scaled down the work is with minimum staff.

Guna Veerasingham
Stormwater Coordinator
CIVIL INFRASTRUCTURE & INTEGRATION DEPARTMENT
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From: Rodhan Haughton [mailto:RHaughton@northrop.com.au]
Sent: Wednesday, 28 February 2018 5:11 PM
To: Guna Veerasingham
Subject: RE: 17-23 Talavera Road Macquarie Park

Hi Guna,

How would we best obtain the Macquarie Park Food Study hydrographs, per our original request?

Our understanding being that Bewsher Consulting were engaged by Council to conduct the flood study, and TUFLOW modelling. We assumed Council would have access to these hydrographs, however it seems that is incorrect. Could Council request Bewsher to provide these hydrographs for our information?

The DRAINS model hydrographs will not be of use as our modelling is based on the Macquarie Park Flood Study (Apr 2010, Bewsher Consulting) results, given:

- Pre-established use of the Macquarie Park Flood Study 6.6m3/s 1%AEP overland flow rate in prior DA documentation for the site, and
- Additional accuracy of TUFLOW modelling vs simplified DRAINS modelling
- Proximity and relevance of Node I2 within the formal Macquarie Park Flood Study, to our development site

Regards,

Rodhan Haughton
Civil Engineer
T: 02 9241 4188
D: 02 9156 3026
M: 0407 377 712
Northrop Consulting Engineers Pty Ltd

From: Guna Veerasingham [mailto:GVeerasingham@ryde.nsw.gov.au]
Sent: Wednesday, 28 February 2018 4:47 PM
To: Rodhan Haughton <RHaughton@northrop.com.au>
Subject: RE: 17-23 Talavera Road Macquarie Park

Hi Rodhan,

The figure in the report is from TUFLOW model.

I provided the DRAINS model hydrograph which is more than the TUFLOW model hydrograph.

We have no resources to provide TUFLOW hydrograph.

Guna Veerasingham
Stormwater Coordinator
CIVIL INFRASTRUCTURE & INTEGRATION DEPARTMENT
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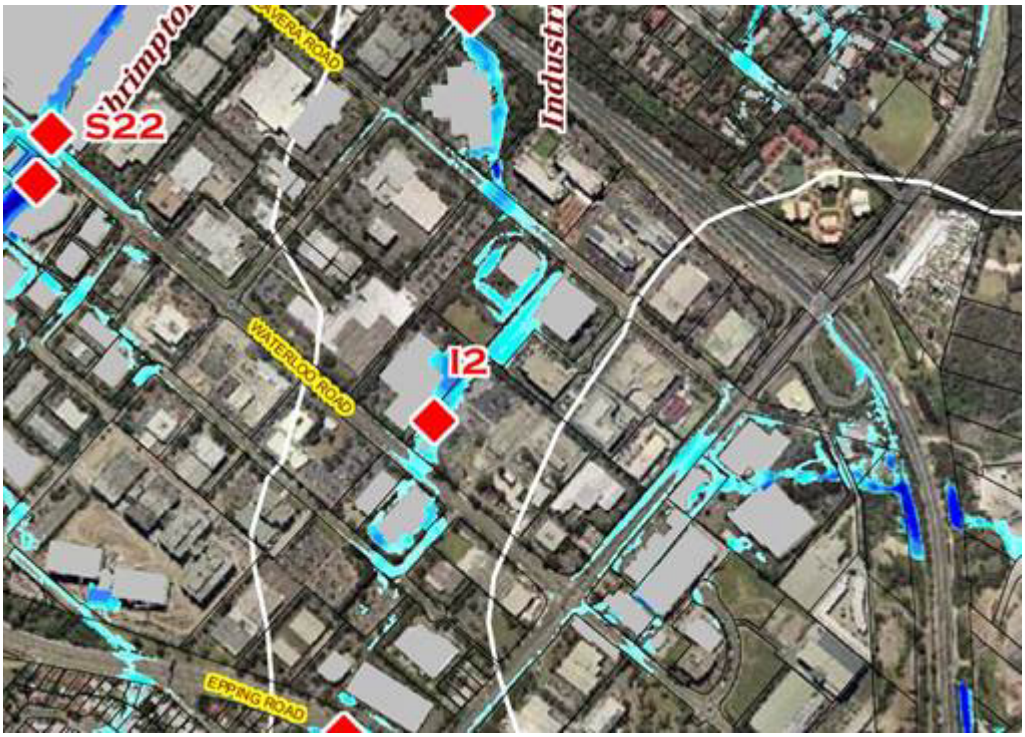
From: Rodhan Haughton [mailto:RHaughton@northrop.com.au]
Sent: Tuesday, 27 February 2018 11:05 AM
To: Guna Veerasingham
Subject: FW: 17-23 Talavera Road Macquarie Park

Hi Guna,

Thanks for sending these through. However the hydrographs don't seem to match the results and figures as documented in the Macquarie Park Floodplain Risk Management Study & Plan (Apr 2010, Bewsher Consulting).

Referencing the figures and tables below from the Bewsher flood study – and the Flood Information Request Form which notes our request to obtain the matching hydrographs from the Bewsher flood study. Node I2 is located immediately upstream of our site and it is these hydrographs we wish to utilise for our DA documentation overland flow modelling.



Location	ID in Figure 10	100 Year 2-hr Unblocked			100 Year 2-hr Blocked			100 Year 9-hr Unblocked		
		Creek + Overland Flow	Conduit Flow	Total Flow	Creek + Overland Flow	Conduit Flow	Total Flow	Creek + Overland Flow	Conduit Flow	Tot Flo
Epping Rd (Industrial Ck)	I1	0.6	1.9	2.4	0.6	1.9	2.4	0.2	1.8	1.9
Waterloo Rd (Industrial Ck)	I2	6.6	3.9	9.0	6.6	3.9	9.1	2.5	3.8	5.5
M2 Motorway (Industrial Ck)	I3	10.5	7.1	17.5	10.5	7.1	17.5	4.2	7.0	11.
Industrial Ck near Durham Close	I4	17.9	0.0	17.9	19.5	0.0	19.5	14.2	0.0	14.
Flowpath near Fontenoy St	I5	7.0	0.0	7.0	7.0	0.0	7.0	3.2	0.0	3.2

Location	ID in Figure 10	PMF 15-min Unblocked			PMF 3-hr Unblocked		
		Creek + Overland Flow	Conduit Flow	Total Flow	Creek + Overland Flow	Conduit Flow	Total Flow
Epping Rd (Industrial Ck)	I1	3.0	2.4	5.0	3.6	2.3	5.8
Waterloo Rd (Industrial Ck)	I2	26.2	3.3	27.8	11.1	4.1	13.1
M2 Motorway (Industrial Ck)	I3	49.2	7.2	56.4	21.0	7.1	28.0
Industrial Ck near Durham Close	I4	61.4	0.0	61.4	31.5	0.0	31.5
Flowpath near Fontenoy St	I5	27.4	0.0	27.4	8.0	0.0	8.0

Could you please obtain and send these relevant hydrographs to us?

Feel free to call if you have any questions.

Regards,

Rodhan Haughton
Civil Engineer
T: 02 9241 4188
D: 02 9156 3026
M: 0407 377 712
Northrop Consulting Engineers Pty Ltd

From: Guna Veerasingham [mailto:GVeerasingham@ryde.nsw.gov.au]
Sent: Tuesday, 27 February 2018 10:38 AM

To: Rodhan Haughton <RHaughton@northrop.com.au>
Subject: FW: 17-23 Talavera Road Macquarie Park

FYI please

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---

From: Guna Veerasingham
Sent: Monday, 26 February 2018 2:26 PM
To: 'rhaugton@northrop.com.au'
Subject: 17-23 Talavera Road Macquarie Park

Hi Rhaugton,

Please find attached hydrograph table for the upstream node of the site.

Regards

Guna Veerasingham
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APPENDIX B

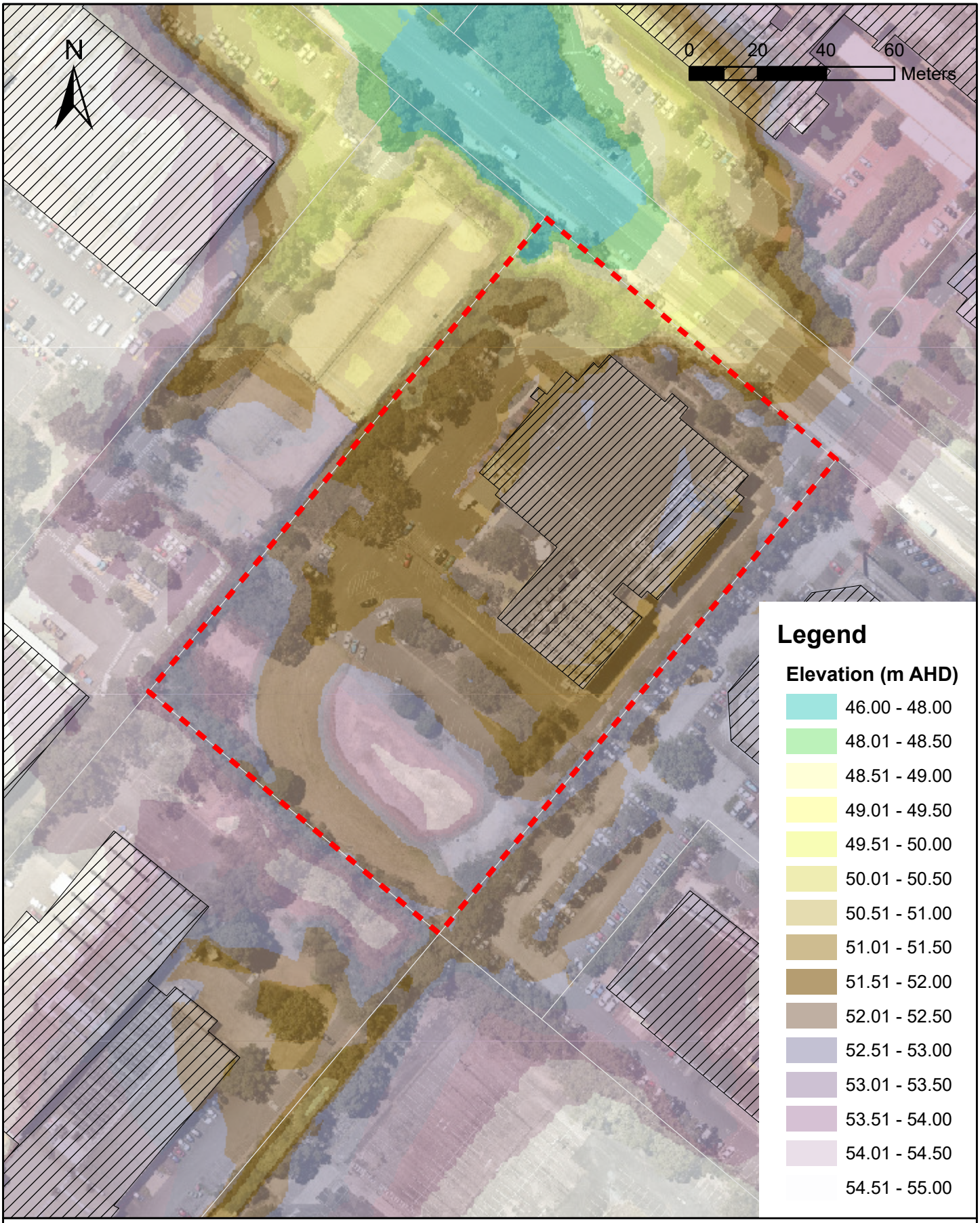

FIGURE A1 [A]

Existing Scenario Model Topography

17 Talavera Road, Macquarie Park

Job Number: SY170095

NORTHROP

Newcastle

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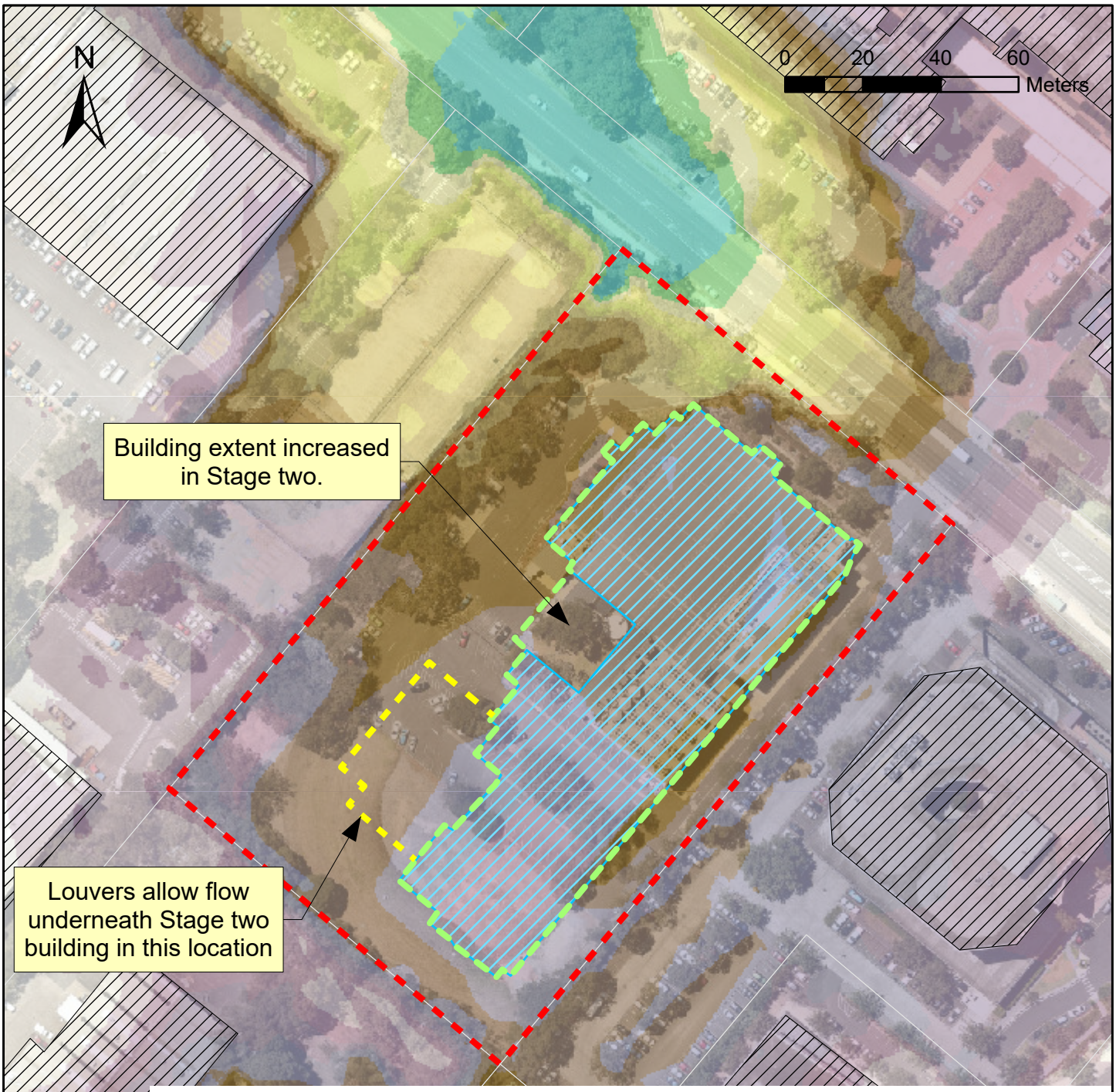

Legend

- Stage 1 Building Extent
- Stage 2 Building Extent
- Louvers (Stage 2 Only)

Elevation (m AHD)

- 46.00 - 48.00
- 48.01 - 48.50
- 48.51 - 49.00
- 49.01 - 49.50
- 49.51 - 50.00
- 50.01 - 50.50
- 50.51 - 51.00
- 51.01 - 51.50
- 51.51 - 52.00
- 52.01 - 52.50
- 52.51 - 53.00
- 53.01 - 53.50
- 53.51 - 54.00
- 54.01 - 54.50
- 54.51 - 55.00

FIGURE A2 [B]

Developed Scenario - Stages 1 & 2 Model Topography

17 Talavera Road, Macquarie Park

Job Number: SY170095

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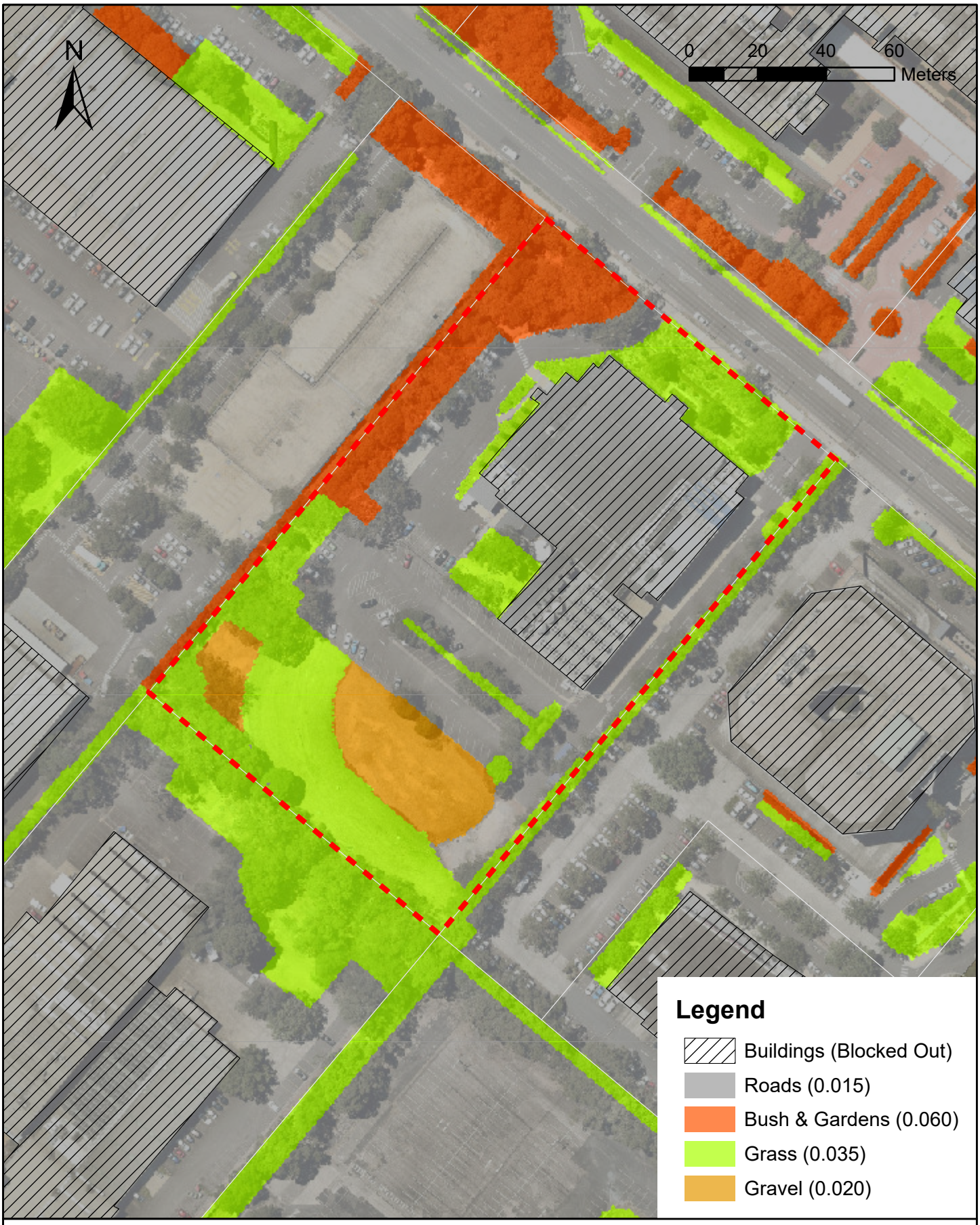

FIGURE A3 [A]

Existing Scenario
Landuse and Surface Roughness

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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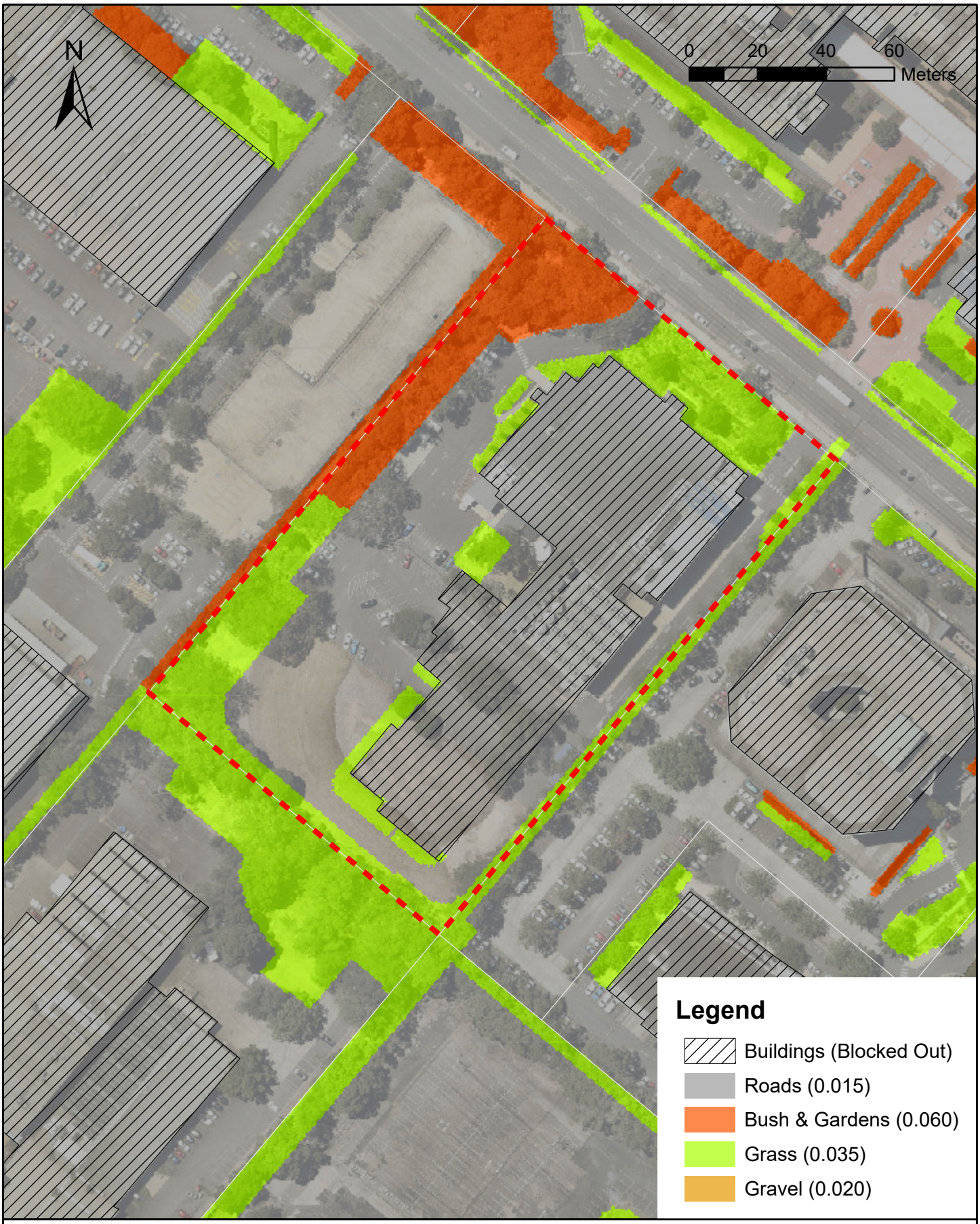

FIGURE A4 [A]

Developed Scenario - Stage 1
Landuse and Surface Roughness

17 Talavera Road,
Macquarie Park

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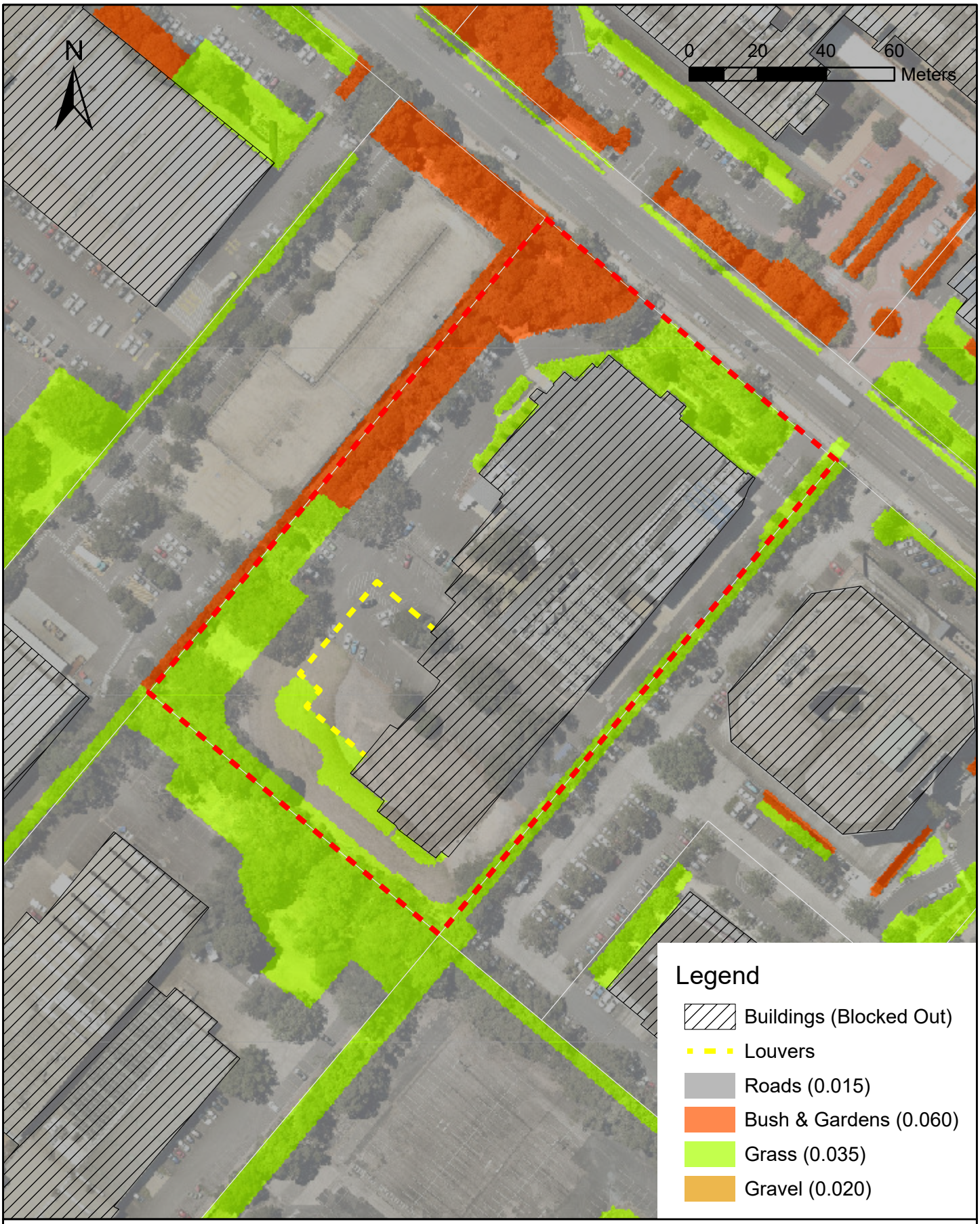

FIGURE A5 [A]

Developed Scenario - Stage 2
Landuse and Surface Roughness

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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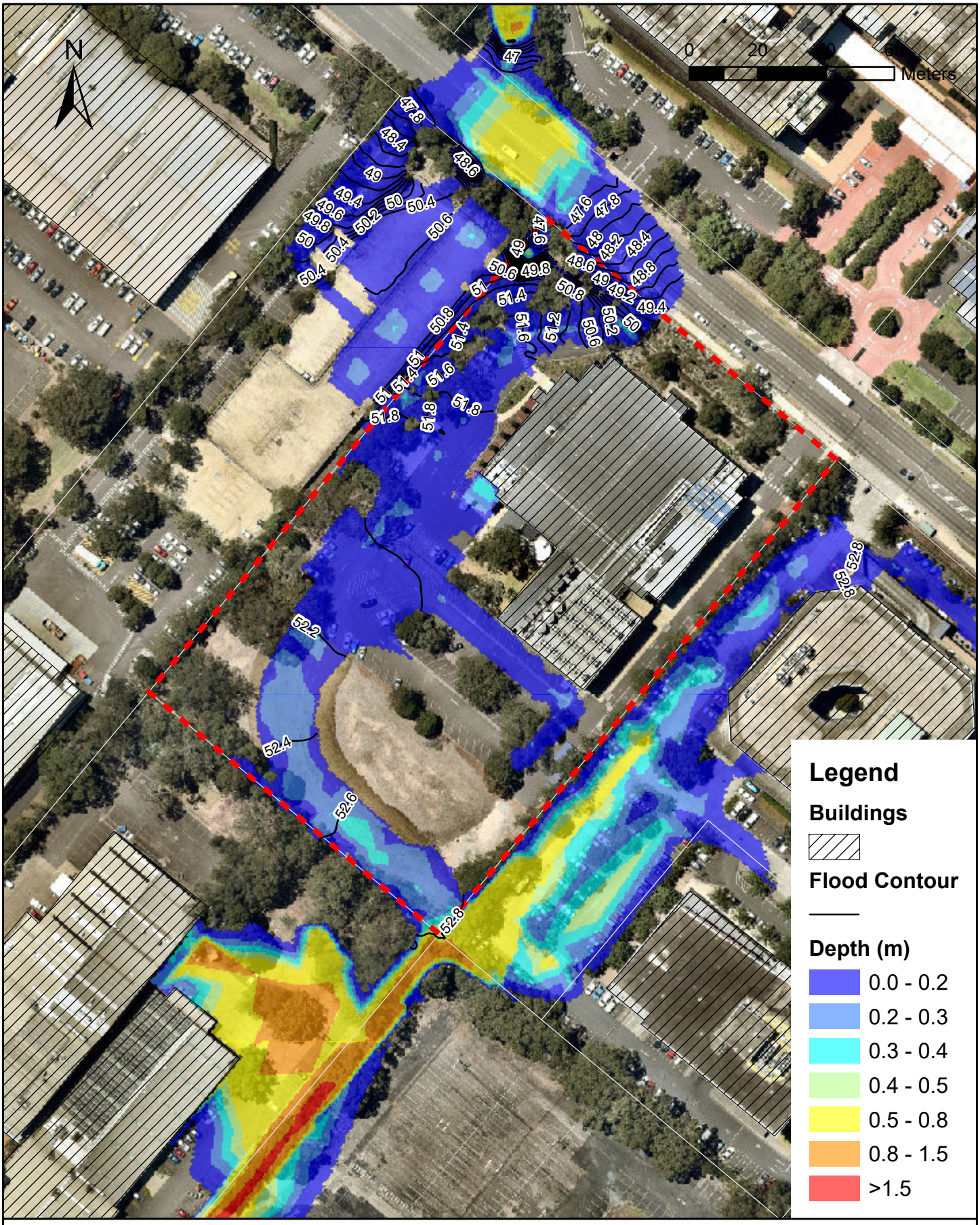

FIGURE B1 [A]

Existing Scenario
1% AEP Flood Depth and Elevation

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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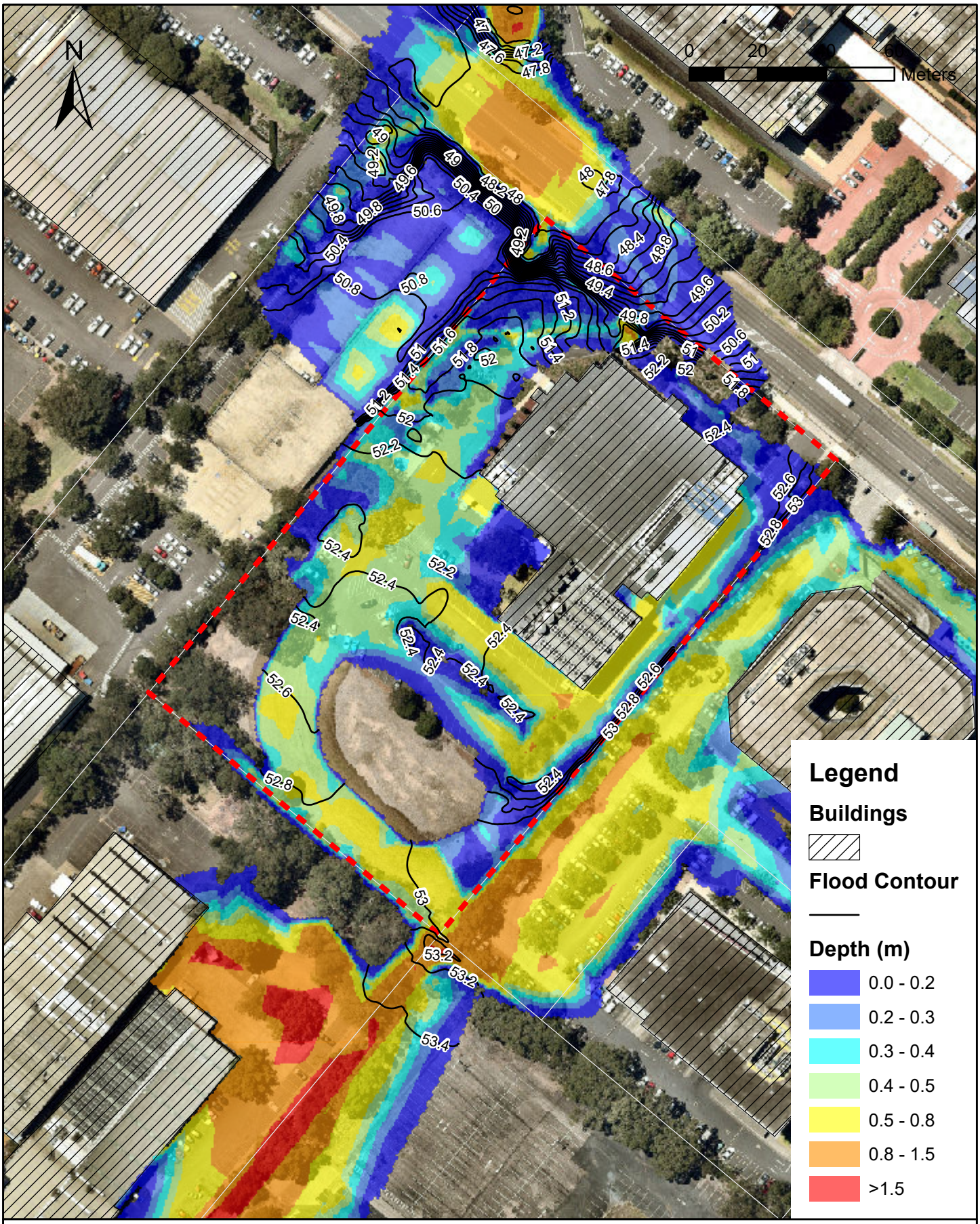

FIGURE B2 [A]

Existing Scenario
PMF Flood Depth and Elevation

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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FIGURE B3 [A]

Existing Scenario
1% AEP Flood Velocity

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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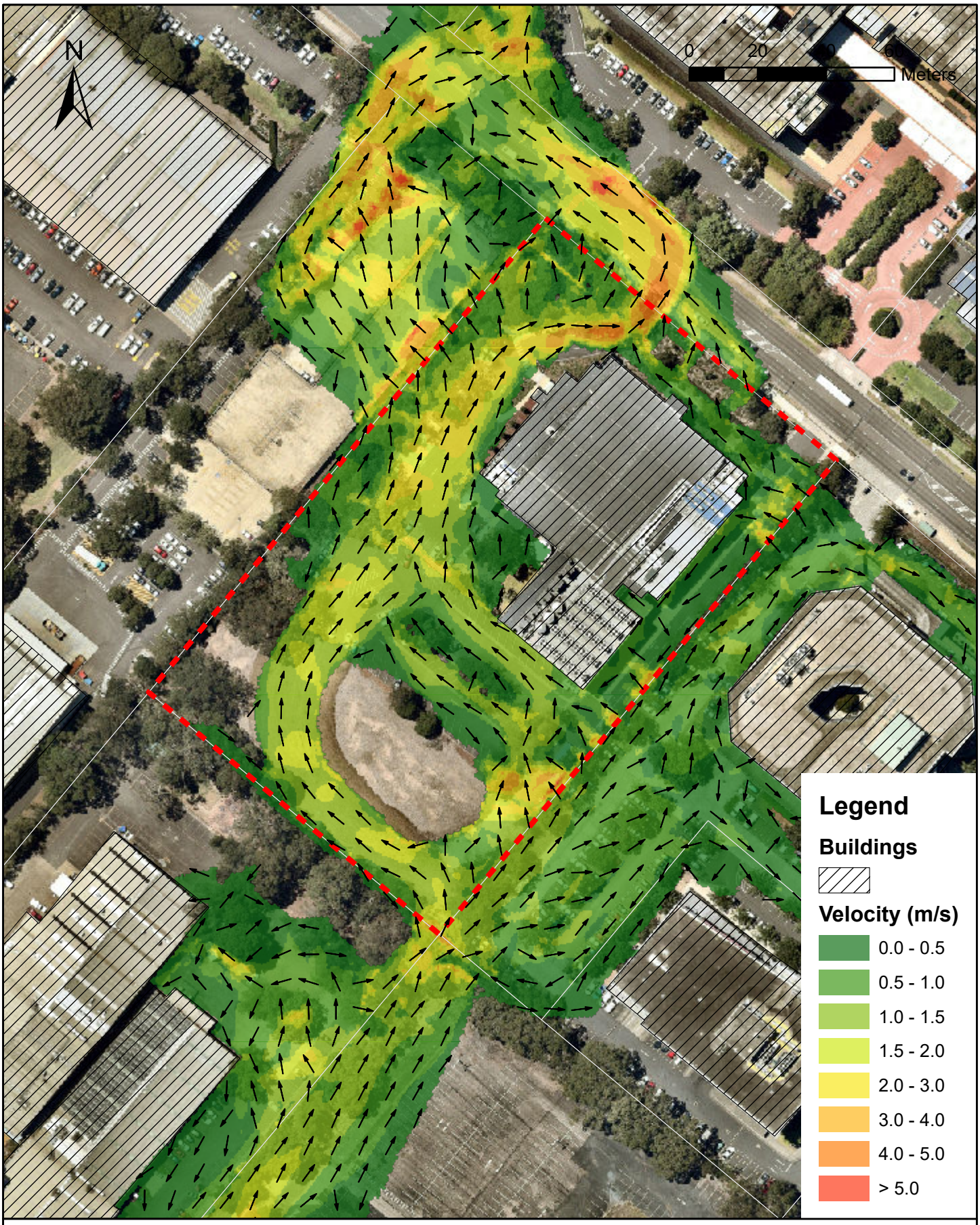

FIGURE B4 [A]

Existing Scenario PMF Flood Velocity

17 Talavera Road, Macquarie Park

Job Number: SY170095

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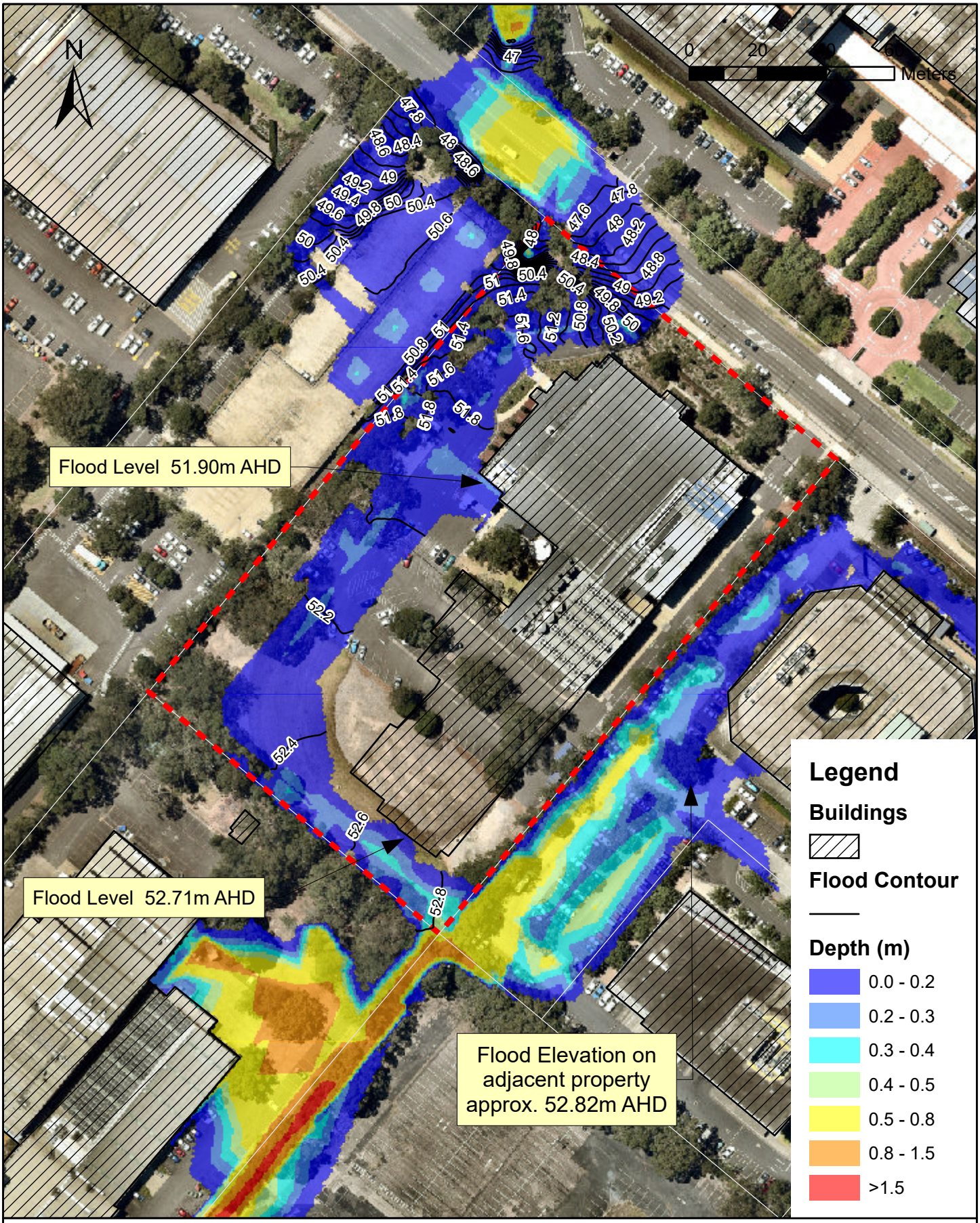

FIGURE C1 [A]

Developed Scenario - Stage 1
1% AEP Flood Depth and Elevation

17 Talavera Road, Macquarie Park

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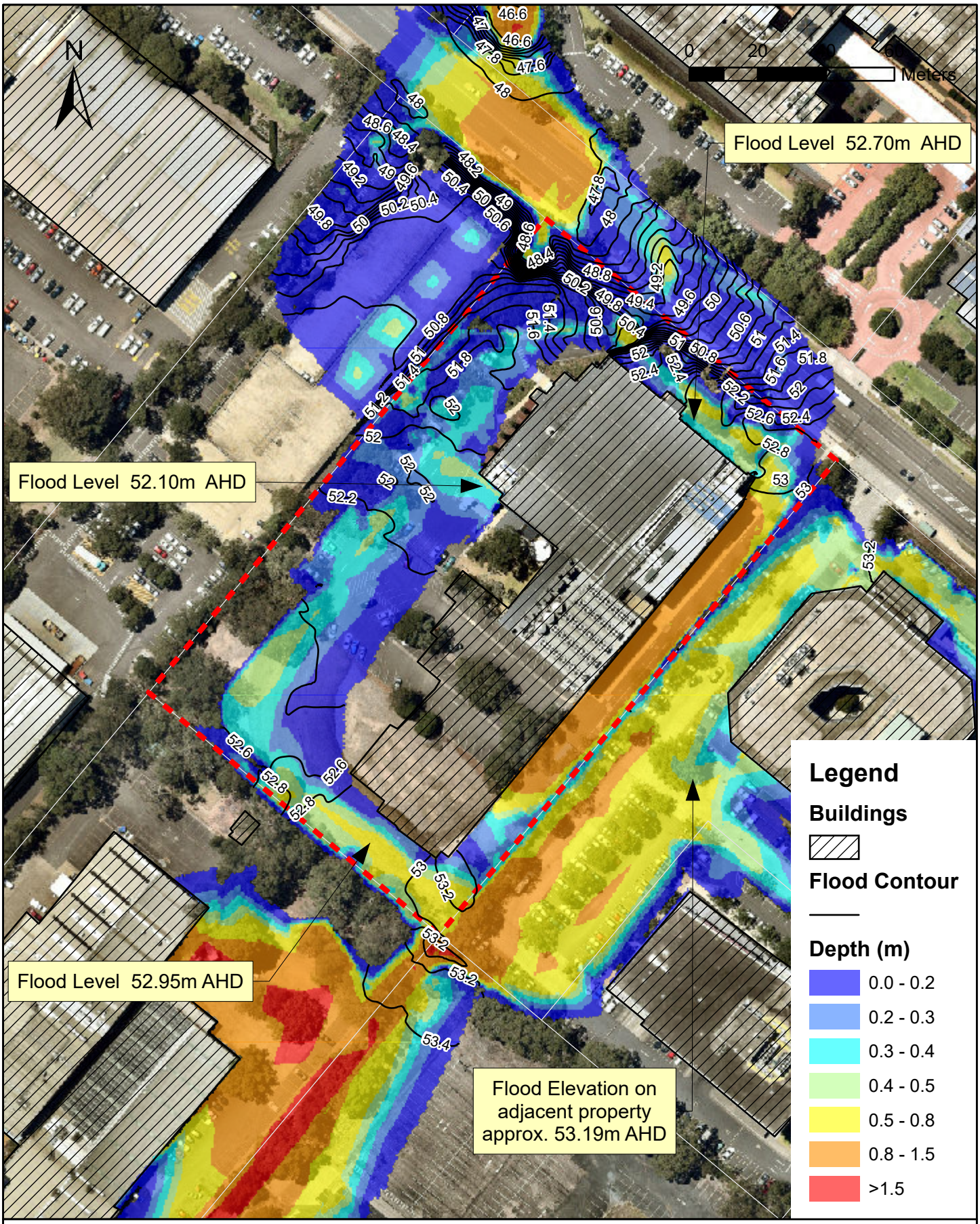

FIGURE C2 [A]

Developed Scenario - Stage 1
PMF Flood Depth and Elevation

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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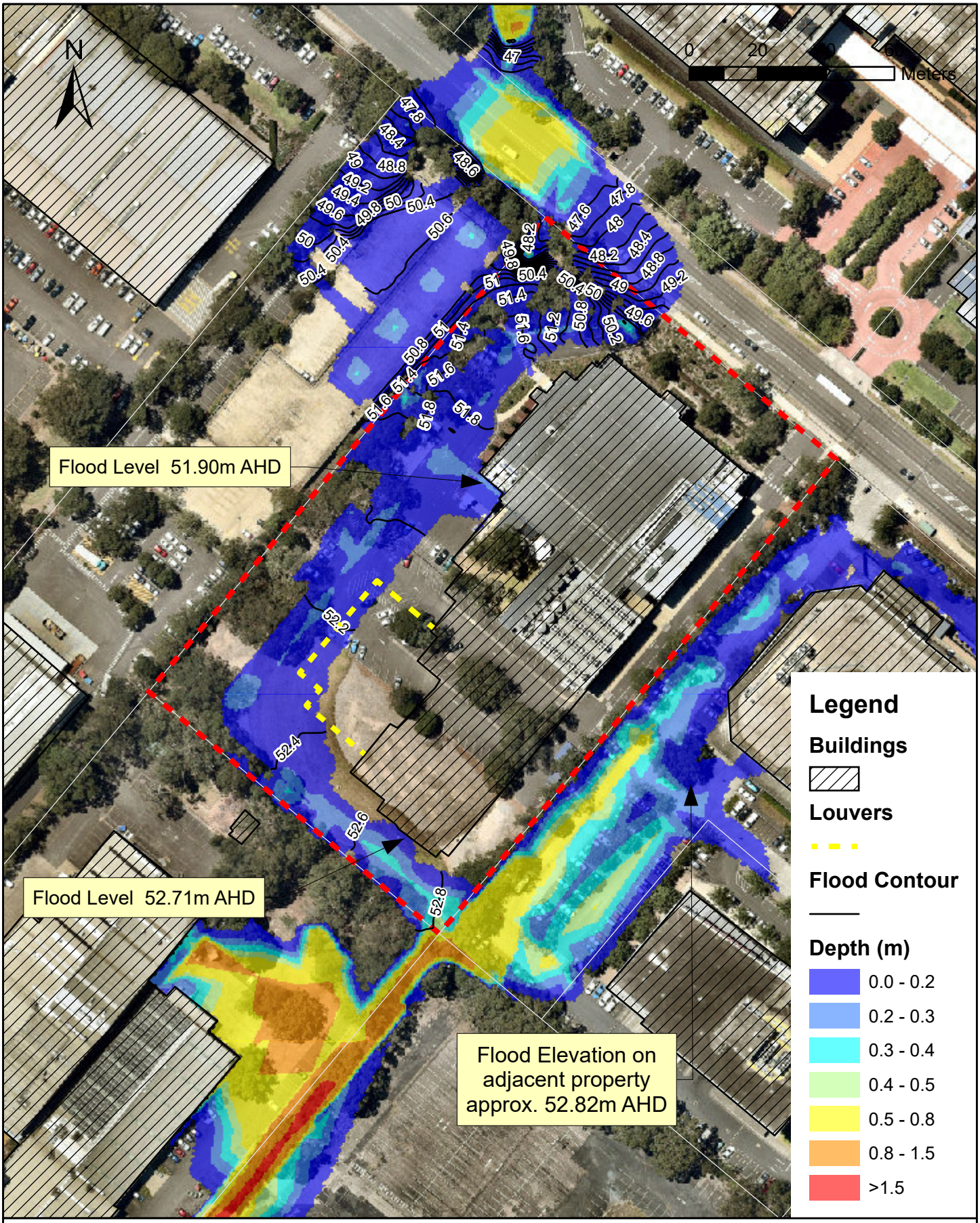

FIGURE C3 [B]

Developed Scenario - Stage 2
1% AEP Flood Depth and Elevation

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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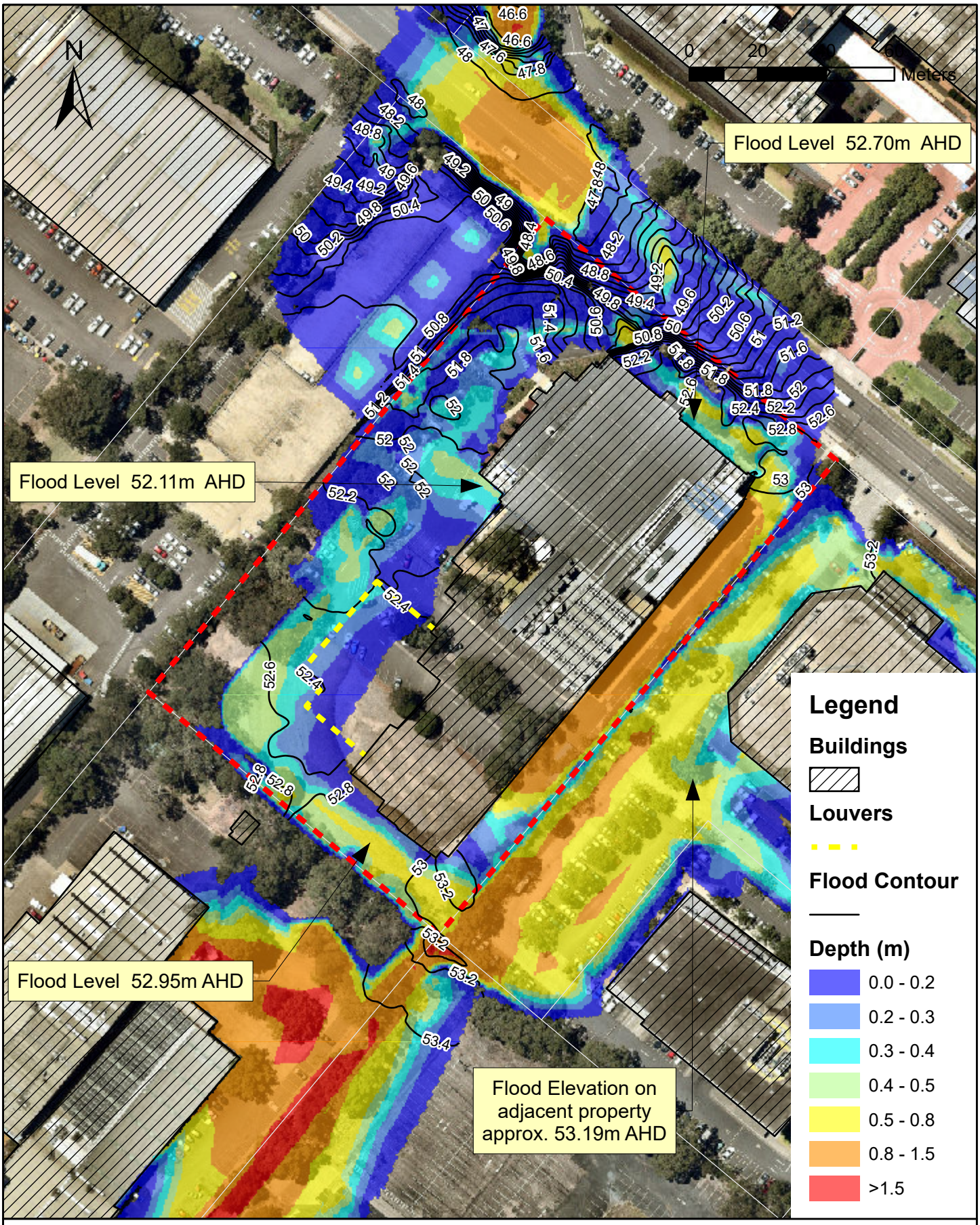

FIGURE C4 [B]

Developed Scenario - Stage 2
PMF Flood Depth and Elevation

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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FIGURE C5 [A]

Developed Scenario - Stage 1
1% AEP Flood Velocity

17 Talavera Road, Macquarie Park

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FIGURE C6 [A]

Developed Scenario - Stage 1
PMF Flood Velocity

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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FIGURE C7 [A]

Developed Scenario - Stage 2
1% AEP Flood Velocity

17 Talavera Road, Macquarie Park

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FIGURE C8 [A]

Developed Scenario - Stage 2
PMF Flood Velocity

17 Talavera Road, Macquarie Park

Job Number: SY170095

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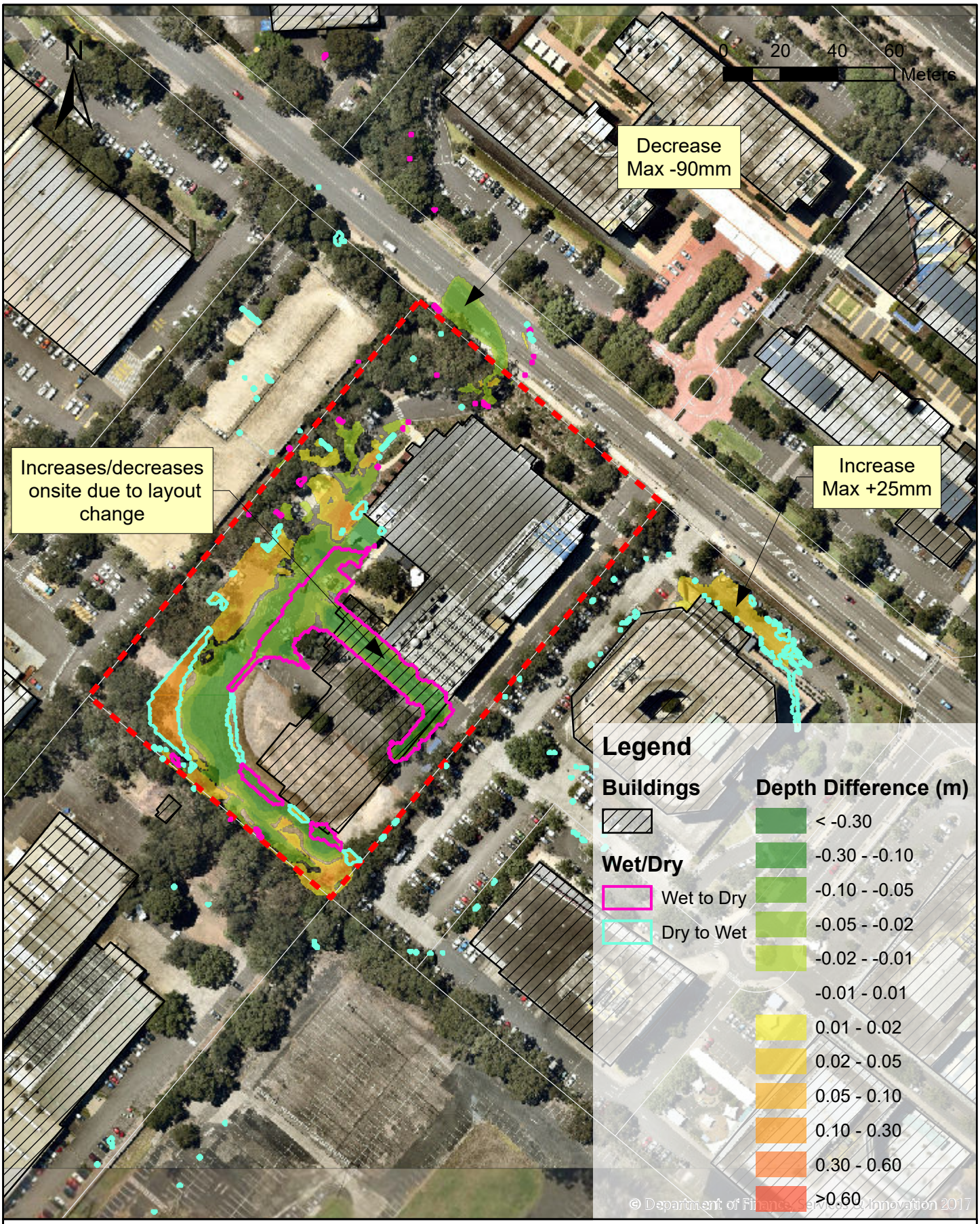

FIGURE D1 [A]

Developed Less Existing - Stage 1
1% AEP Flood Depth

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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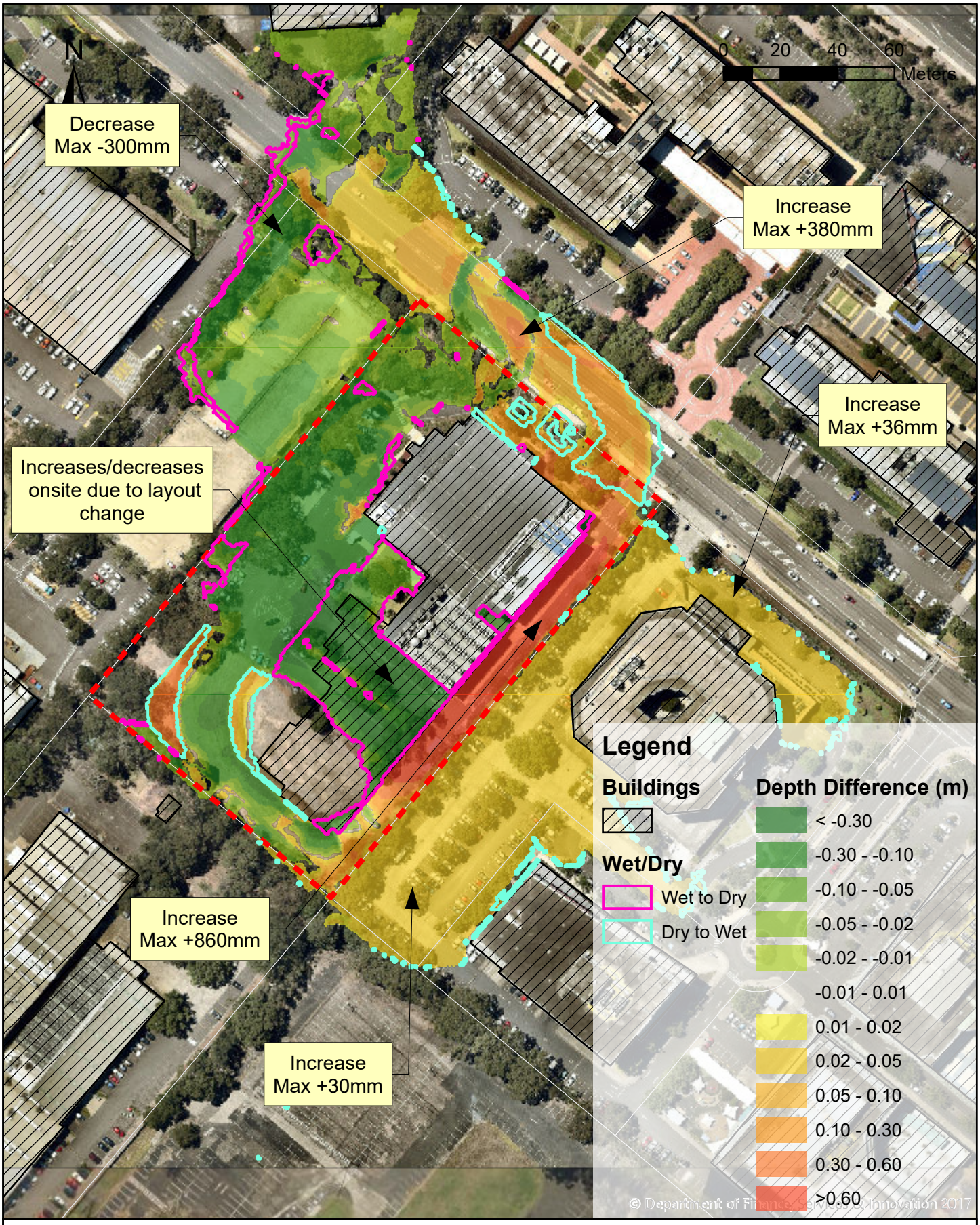

FIGURE D2 [B]

Developed Less Existing - Stage 1 PMF Flood Depth

17 Talavera Road, Macquarie Park

Job Number: SY170095

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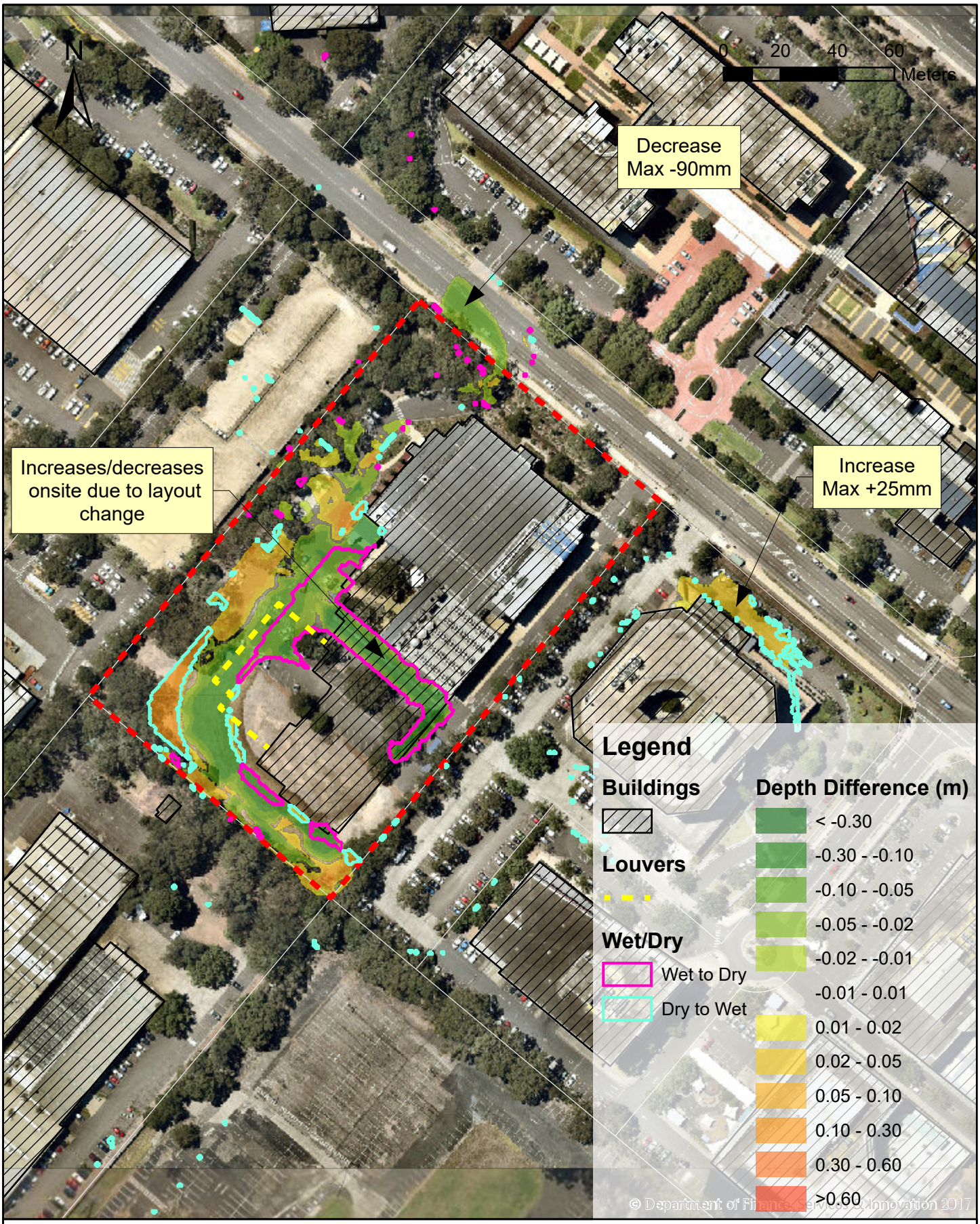

FIGURE D3 [B]

Developed Less Existing - Stage 2
1% AEP Flood Depth

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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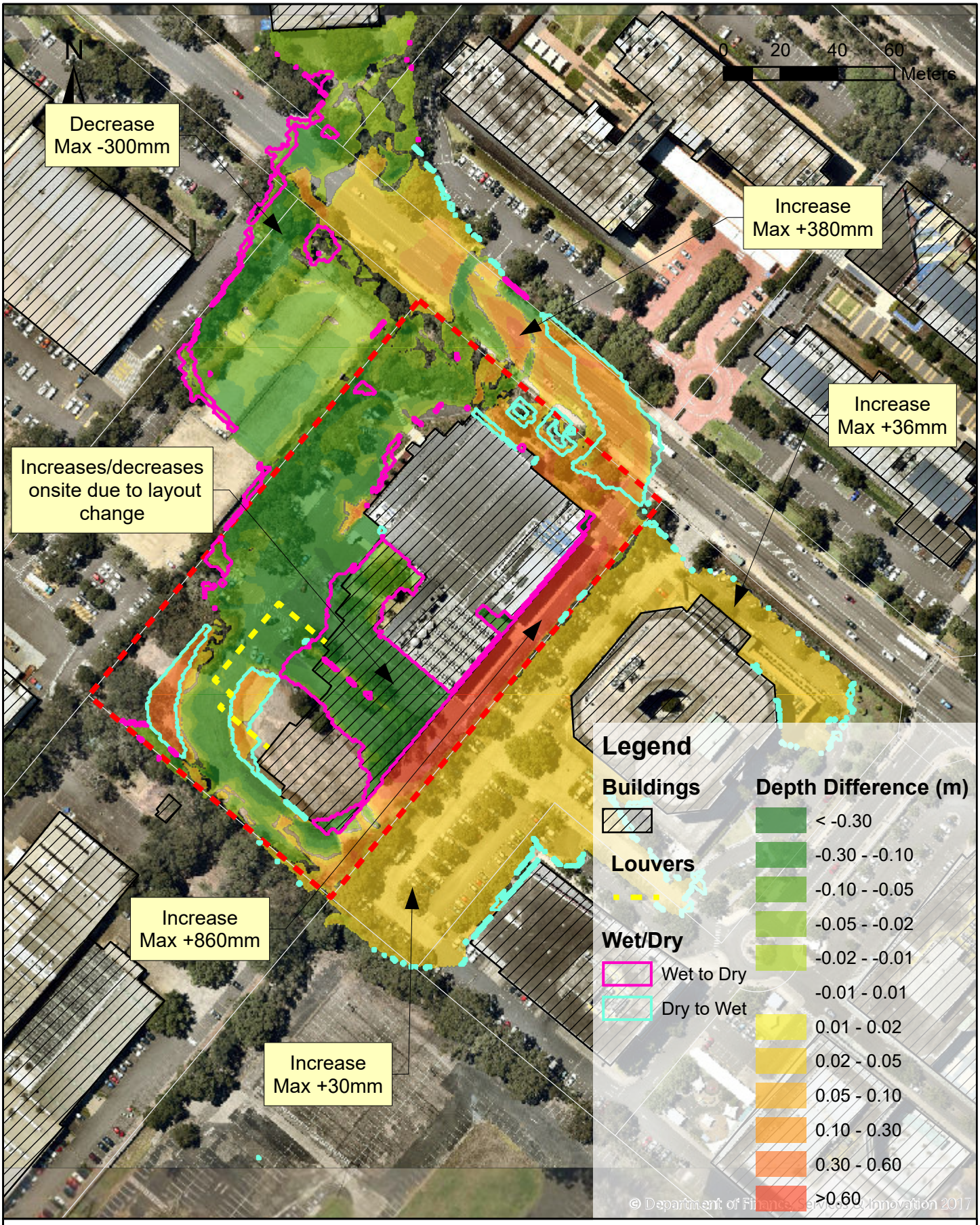

FIGURE D4 [B]

Developed Less Existing - Stage 2 PMF Flood Depth

17 Talavera Road, Macquarie Park

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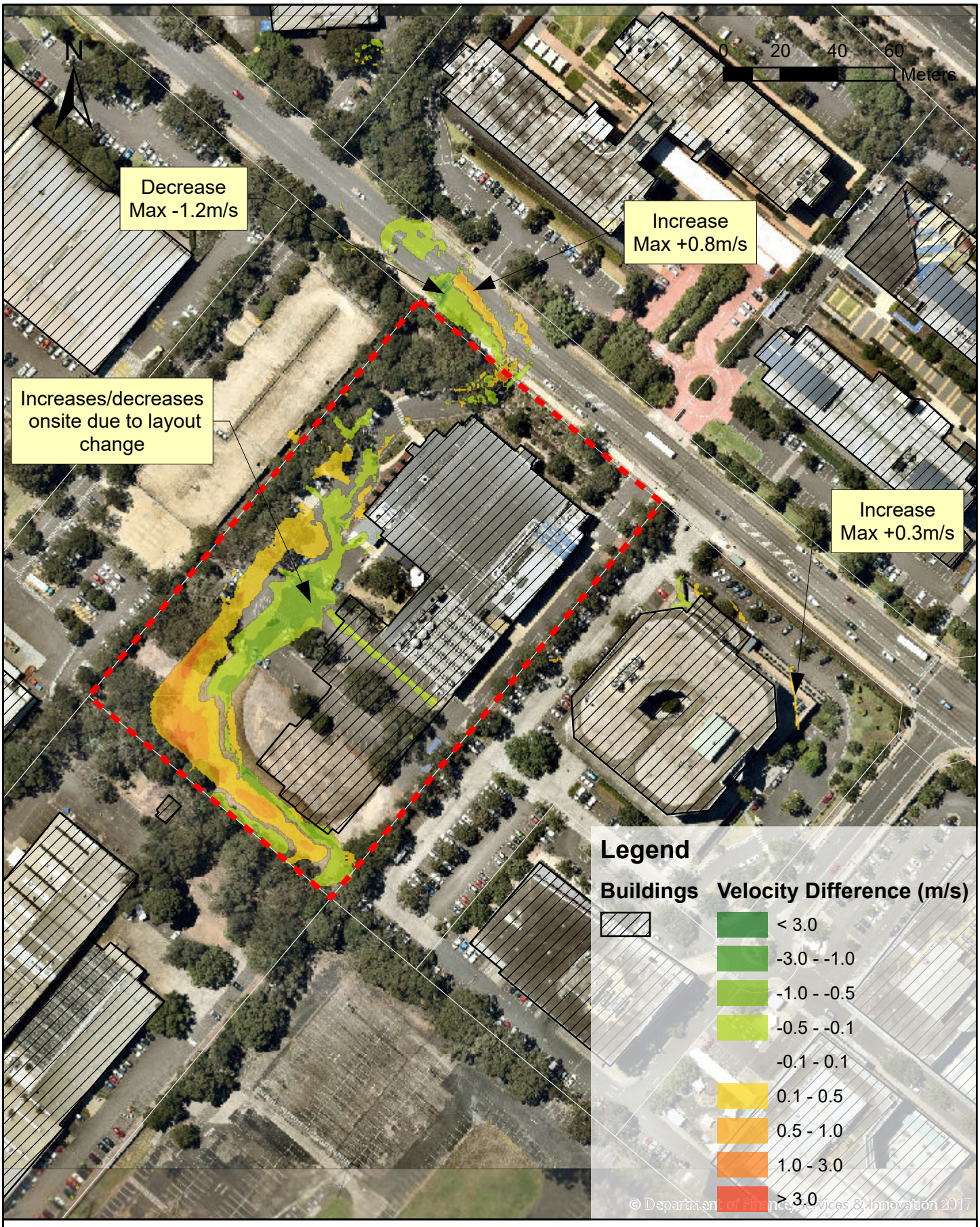

FIGURE D5 [A]

Developed Less Existing - Stage 1
1% AEP Flood Velocity

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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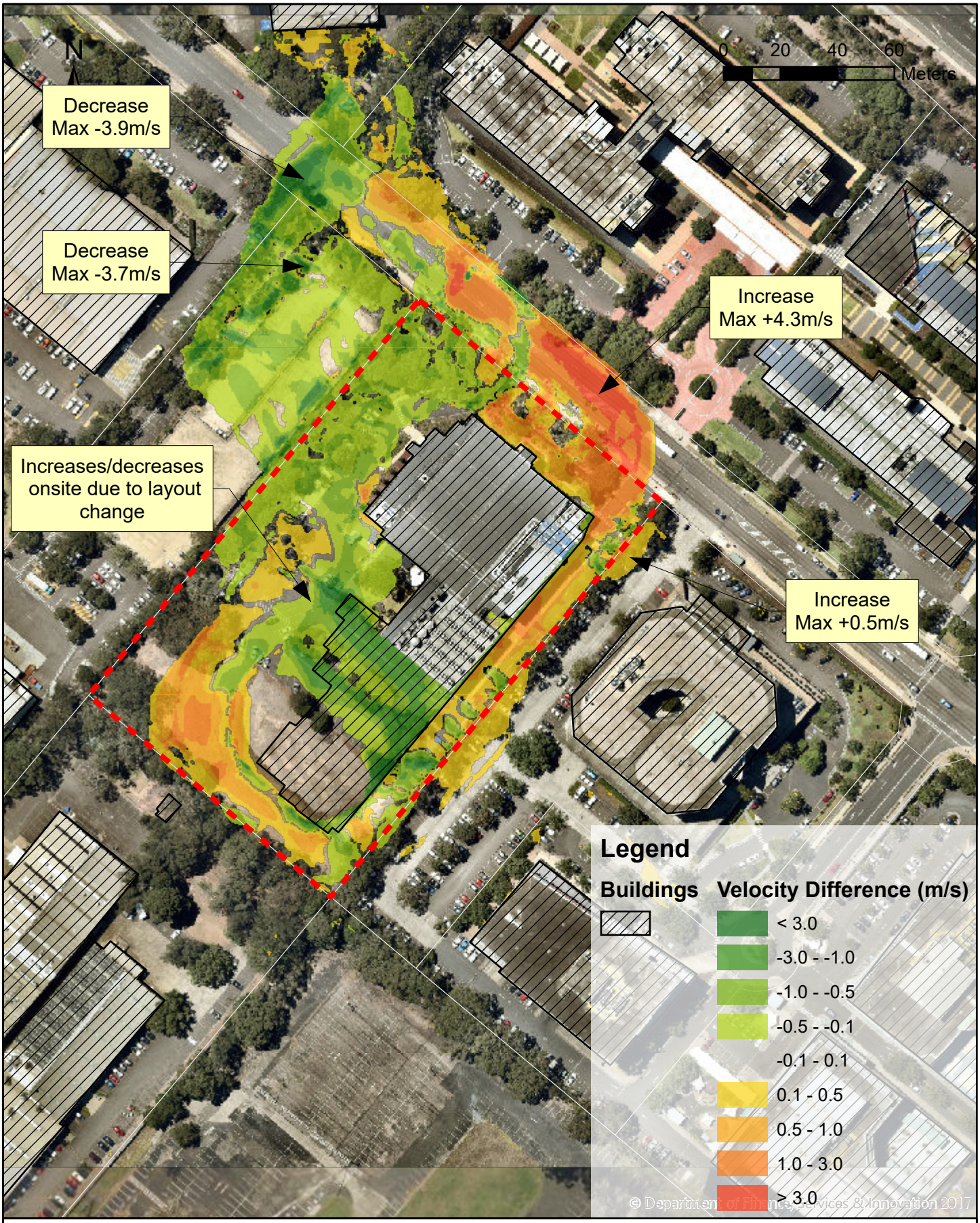

FIGURE D6 [A]

Developed Less Existing - Stage 1 PMF Flood Velocity

17 Talavera Road, Macquarie Park

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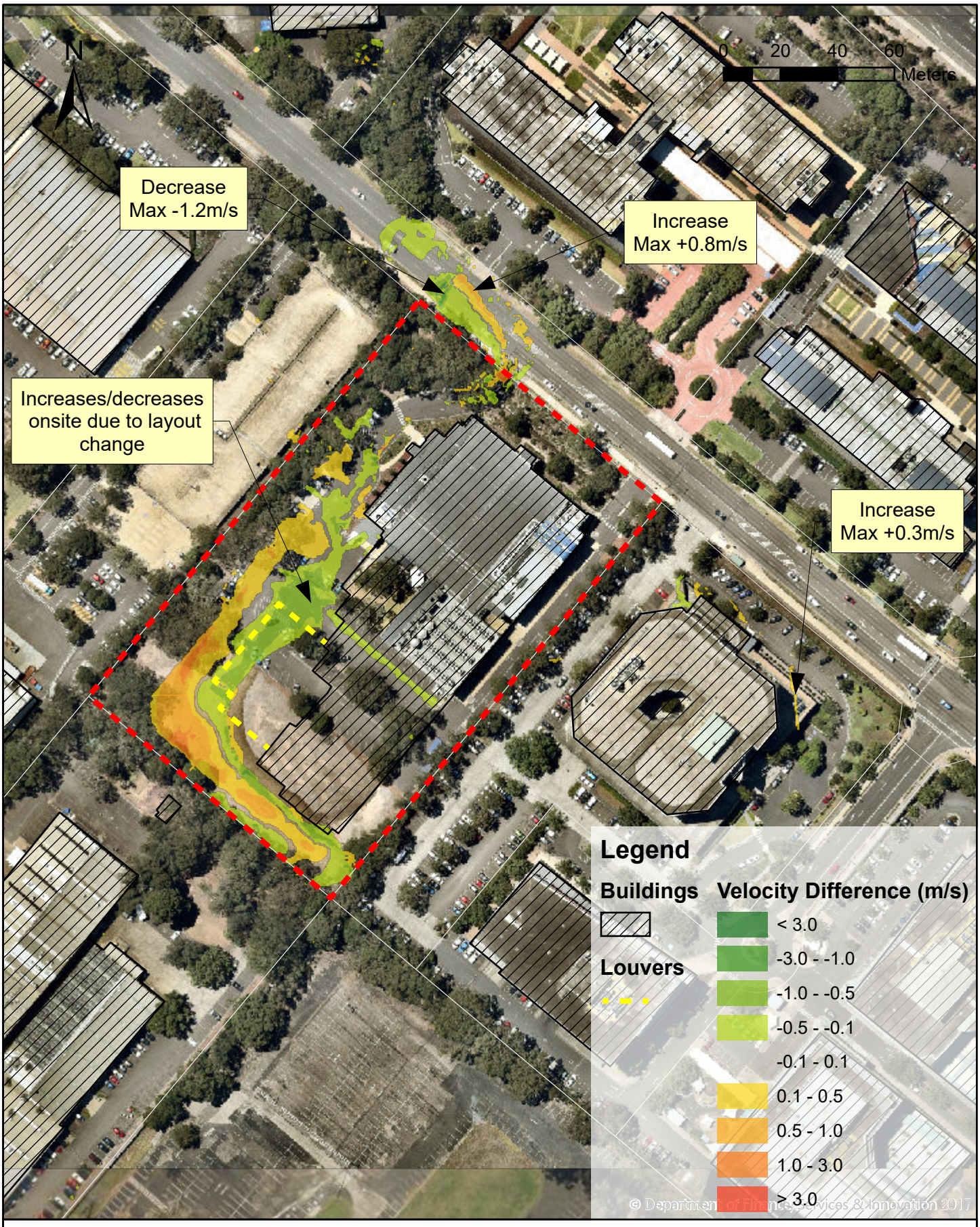

FIGURE D7 [A]

Developed Less Existing - Stage 2
1% AEP Flood Velocity

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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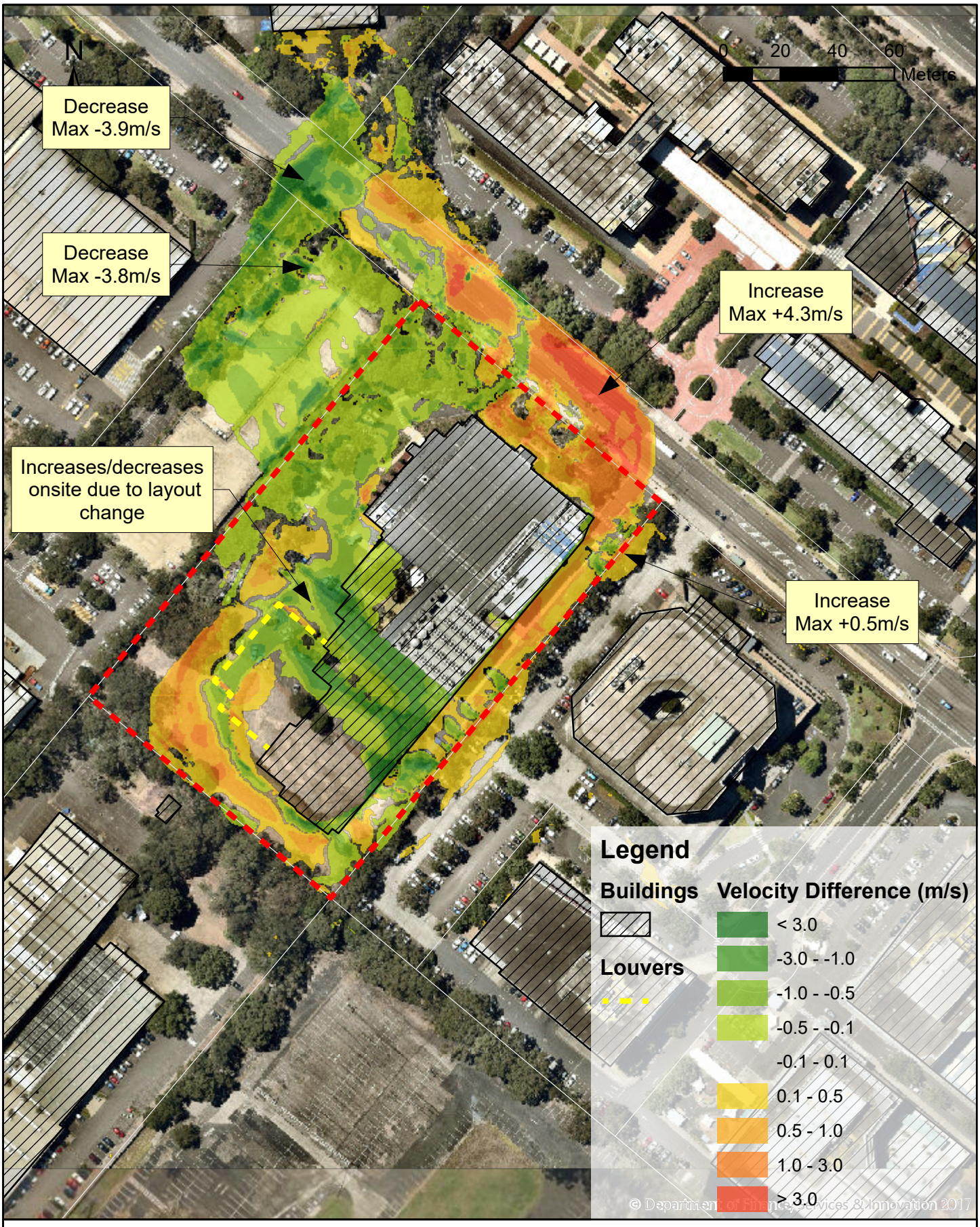

FIGURE D8 [A]

Developed Less Existing - Stage 2 PMF Flood Velocity

17 Talavera Road, Macquarie Park

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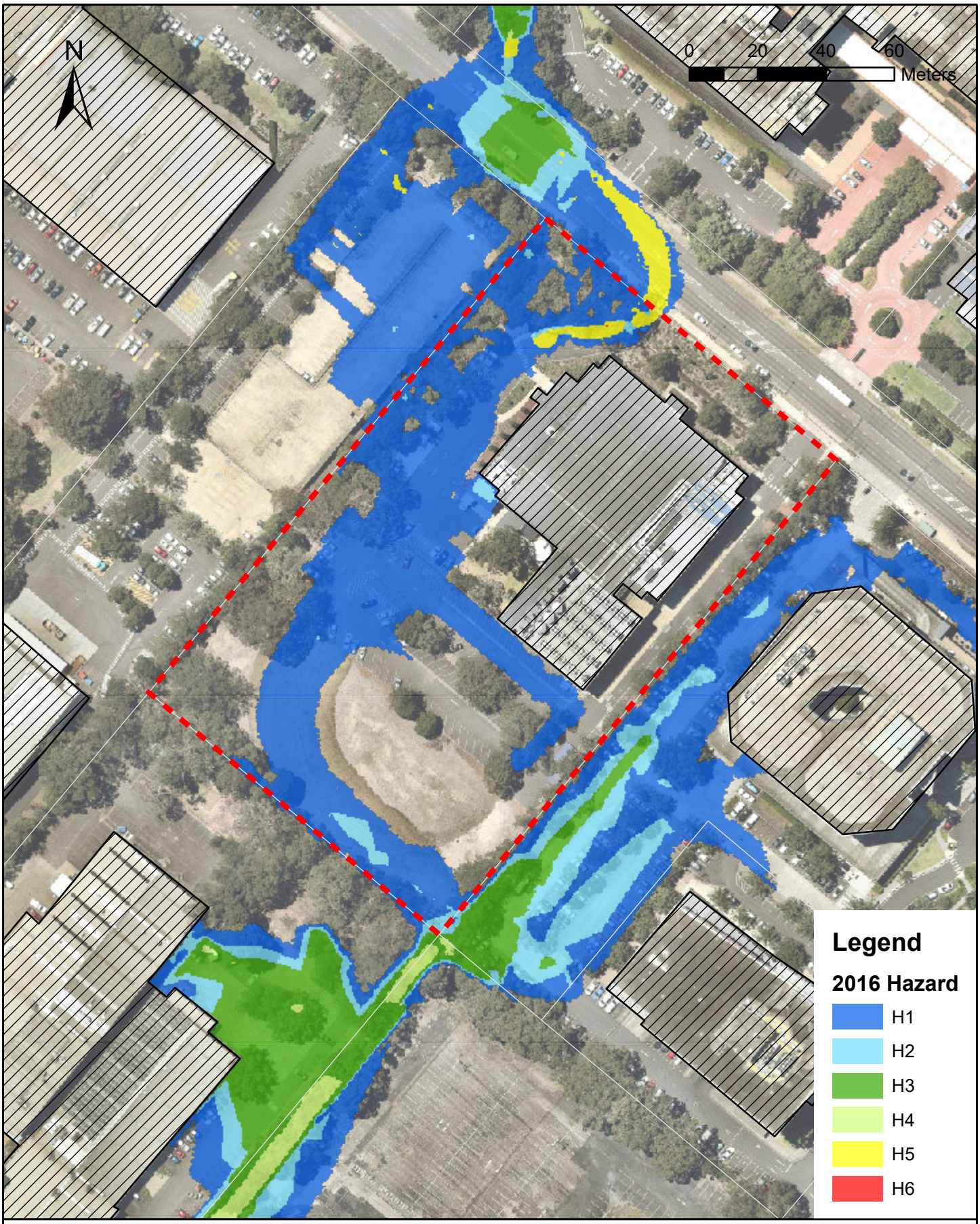

FIGURE E1 [A]

Existing Scenario
1% AEP AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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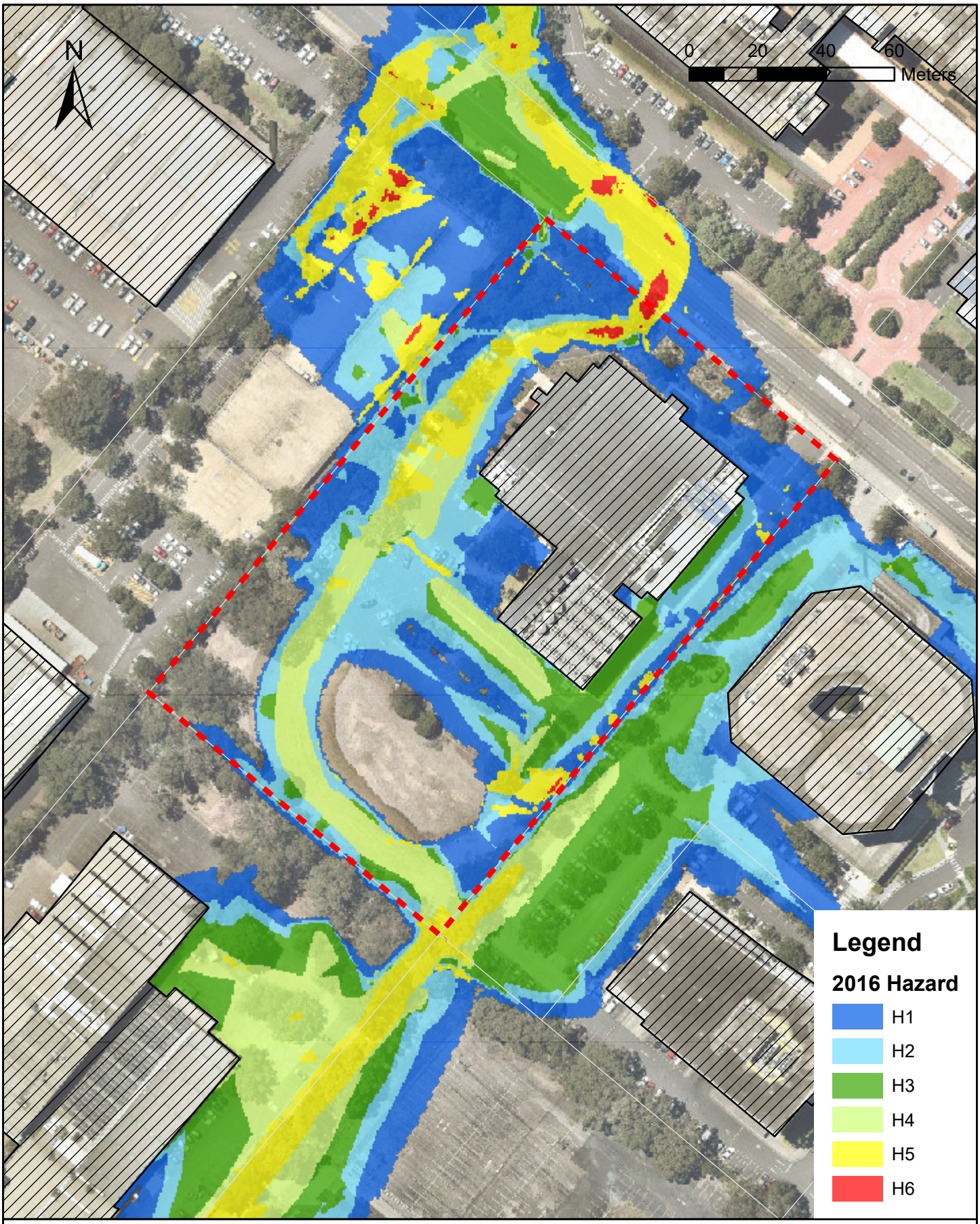

FIGURE E2 [A]

Existing Scenario
PMF AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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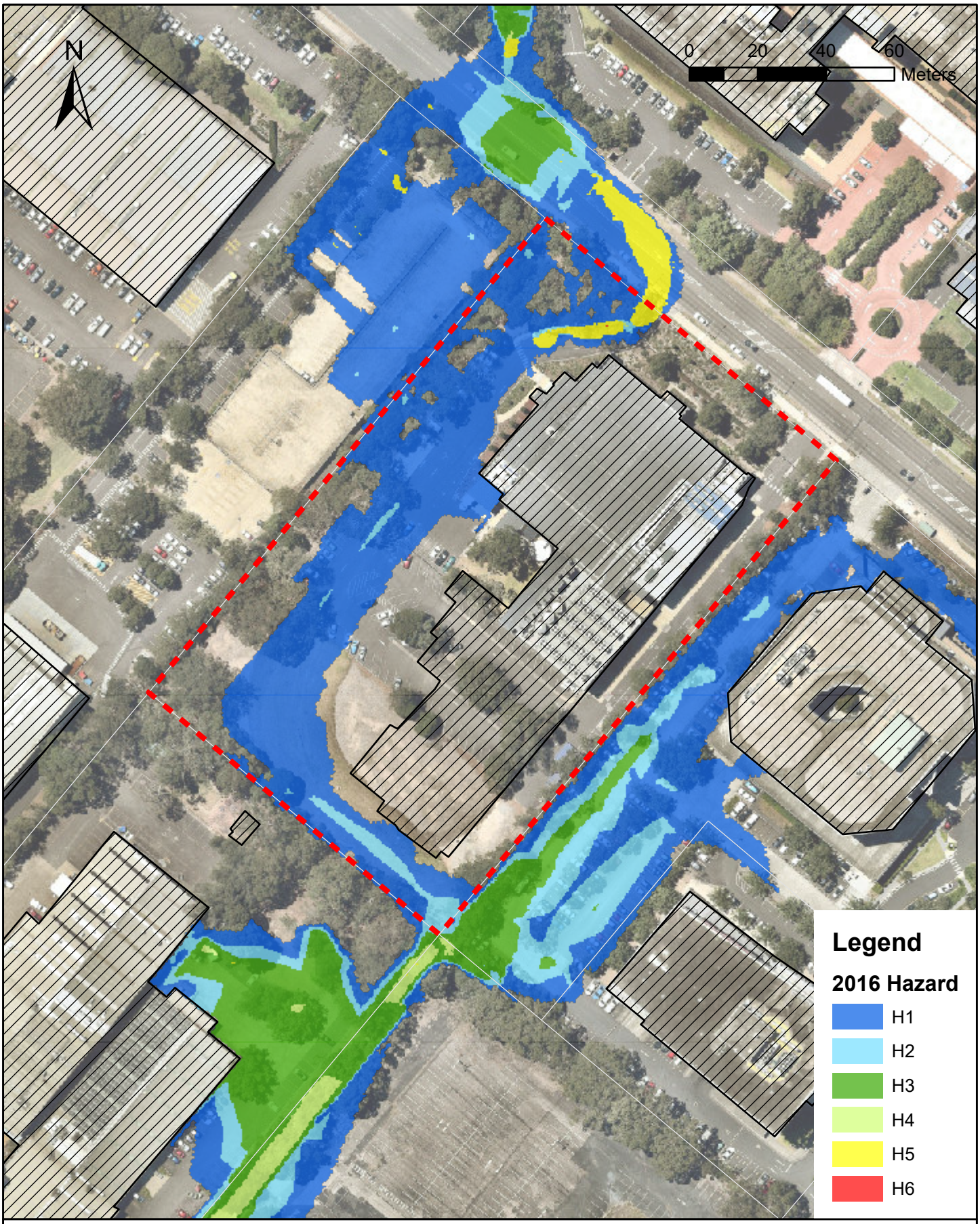

FIGURE E3 [A]

Developed Scenario - Stage 1
1% AEP AR&R 2016 Flood Hazard

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Macquarie Park

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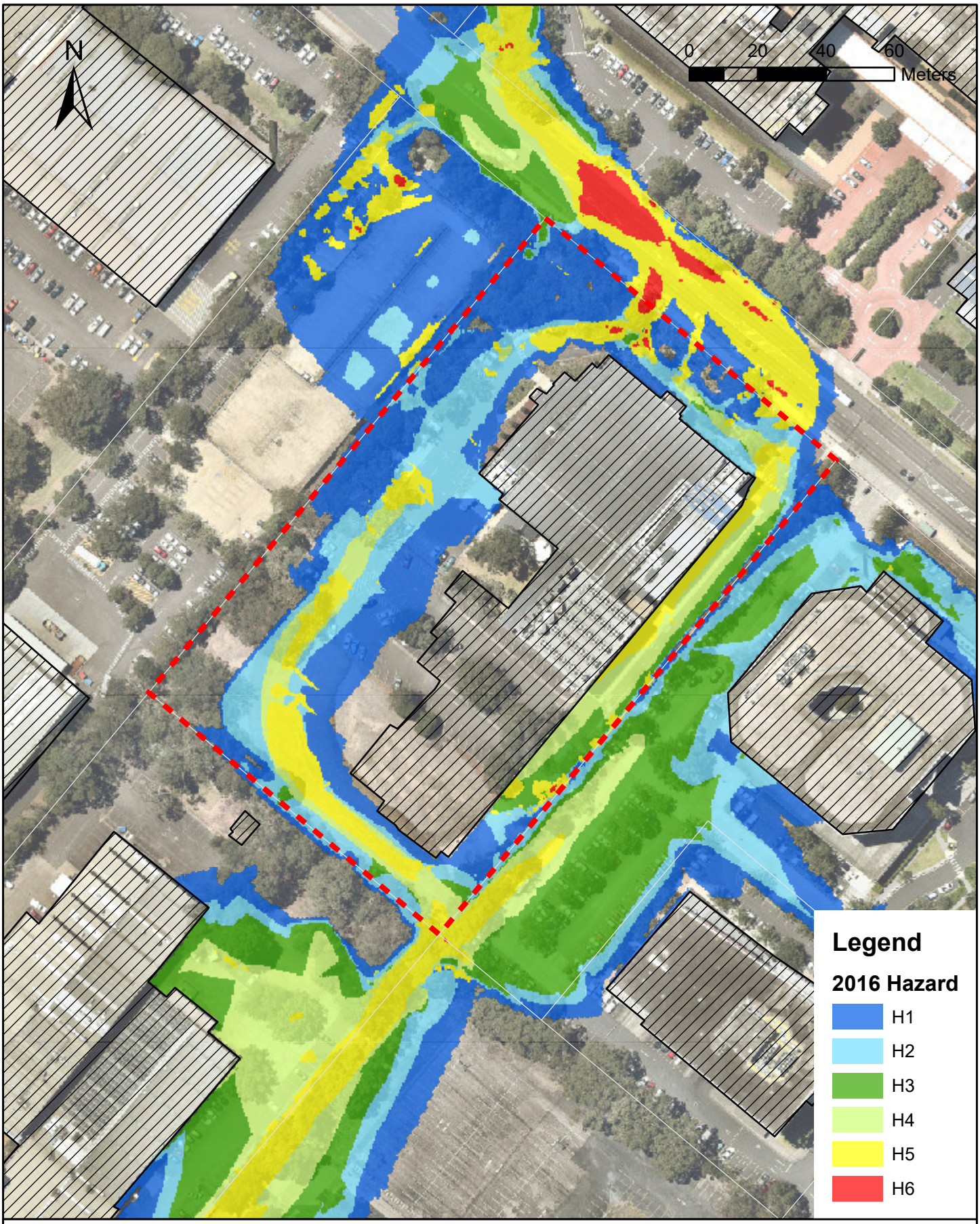

FIGURE E4 [A]

Developed Scenario - Stage 1
PMF AR&R 2016 Flood Hazard

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Macquarie Park

Job Number: SY170095

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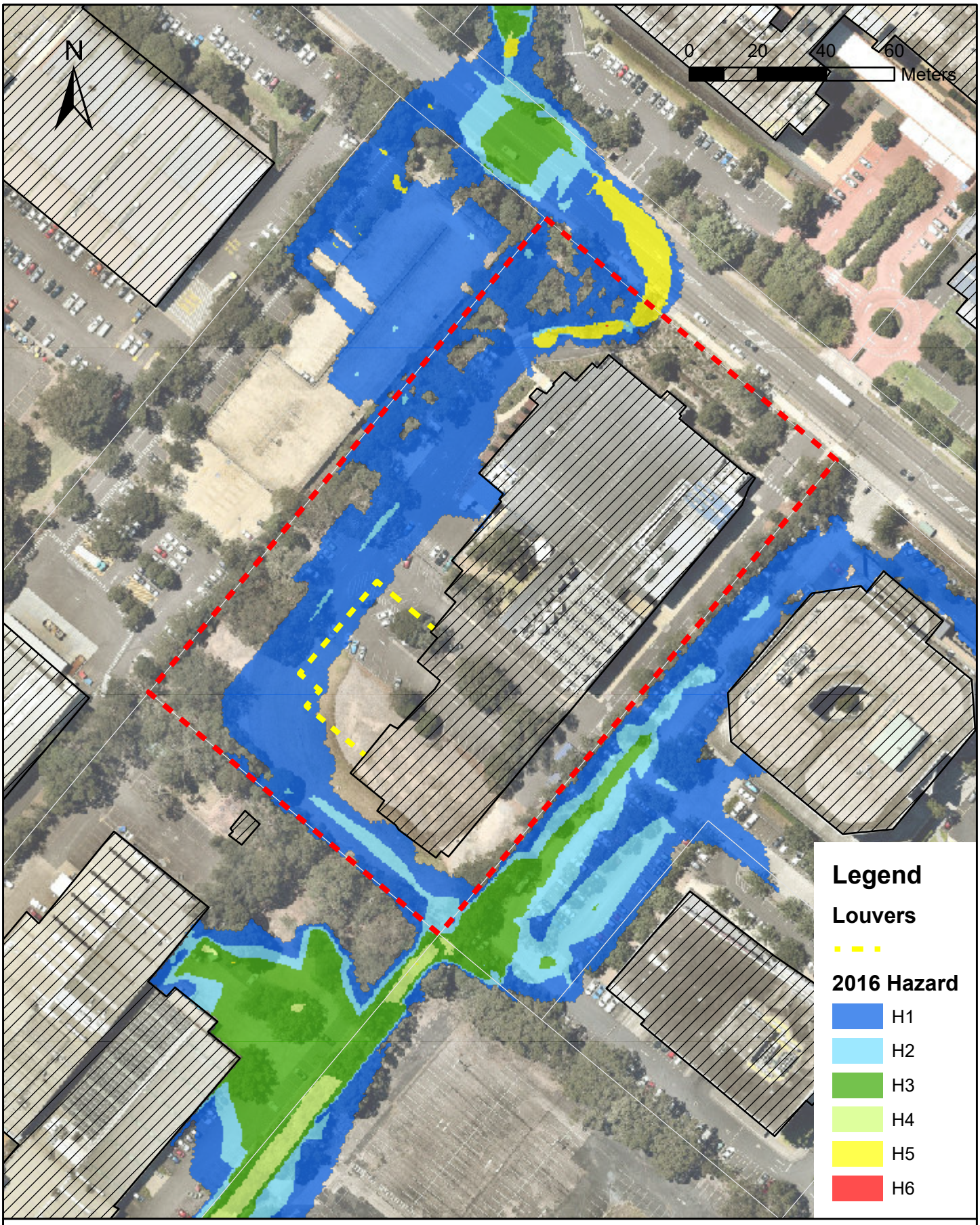

FIGURE E5 [B]

Developed Scenario - Stage 2
1% AEP AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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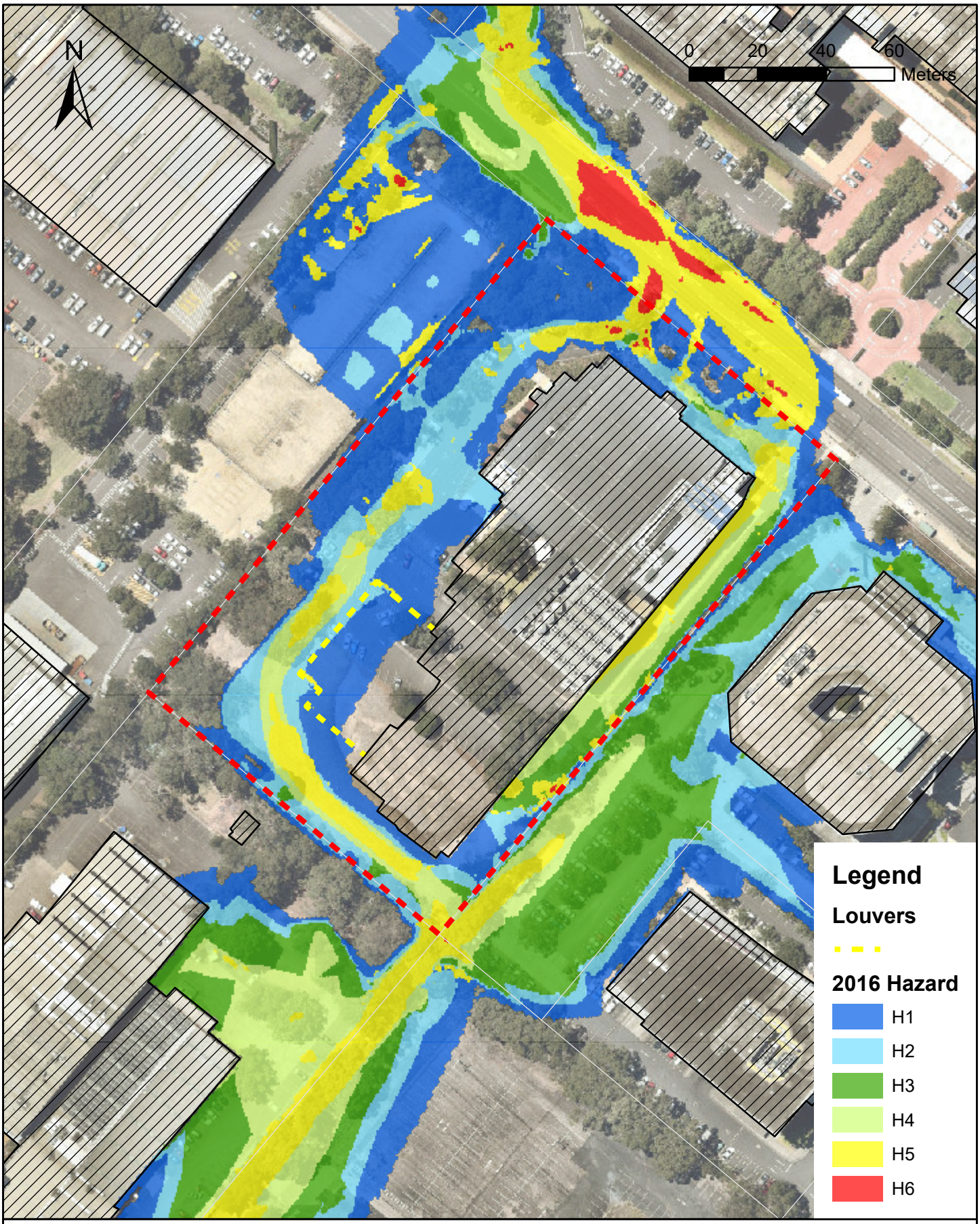

FIGURE E6 [B]

Developed Scenario - Stage 2
PMF AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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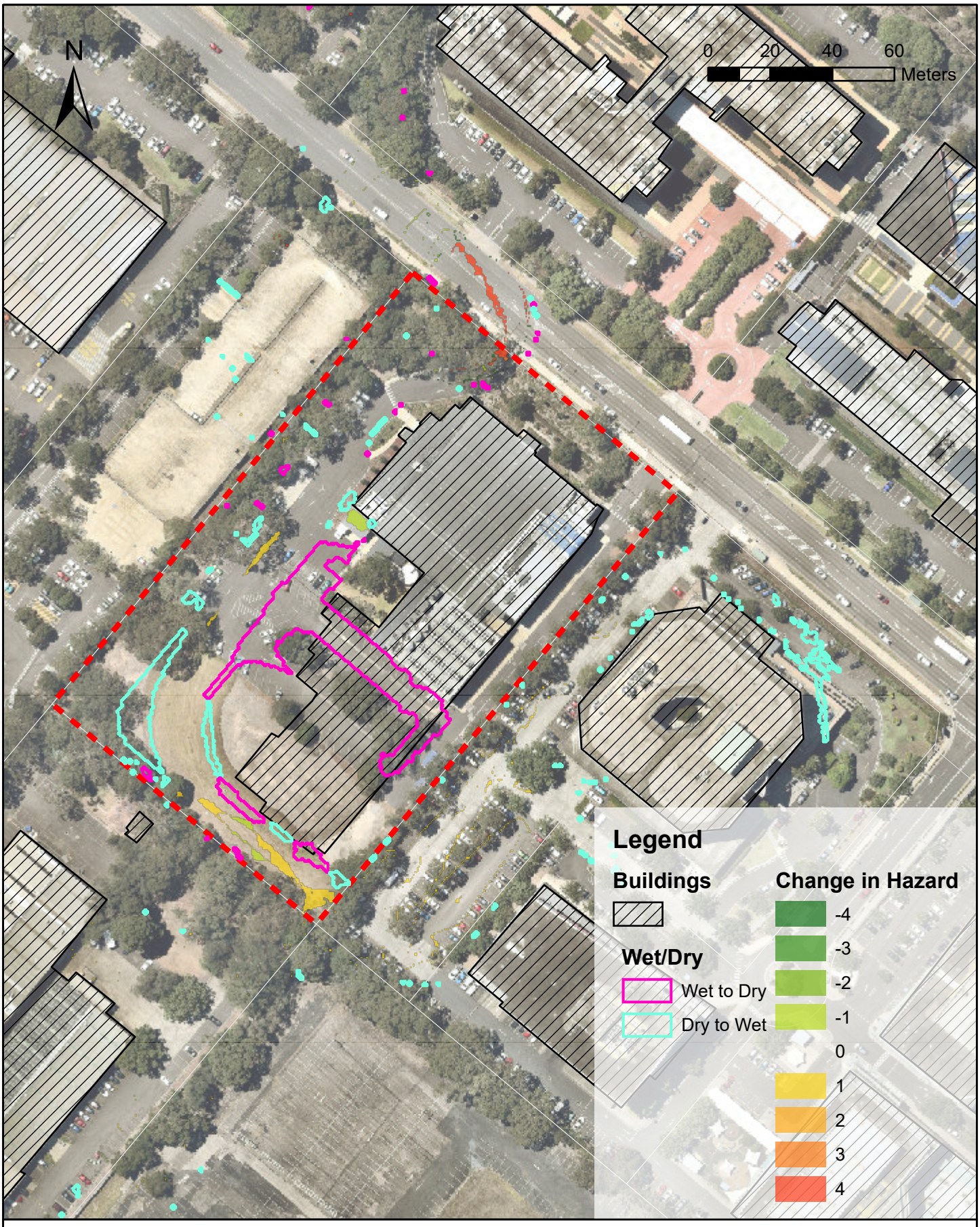

FIGURE E7 [A]

Developed Less Existing - Stage 1
1% AEP AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

NORTHROP

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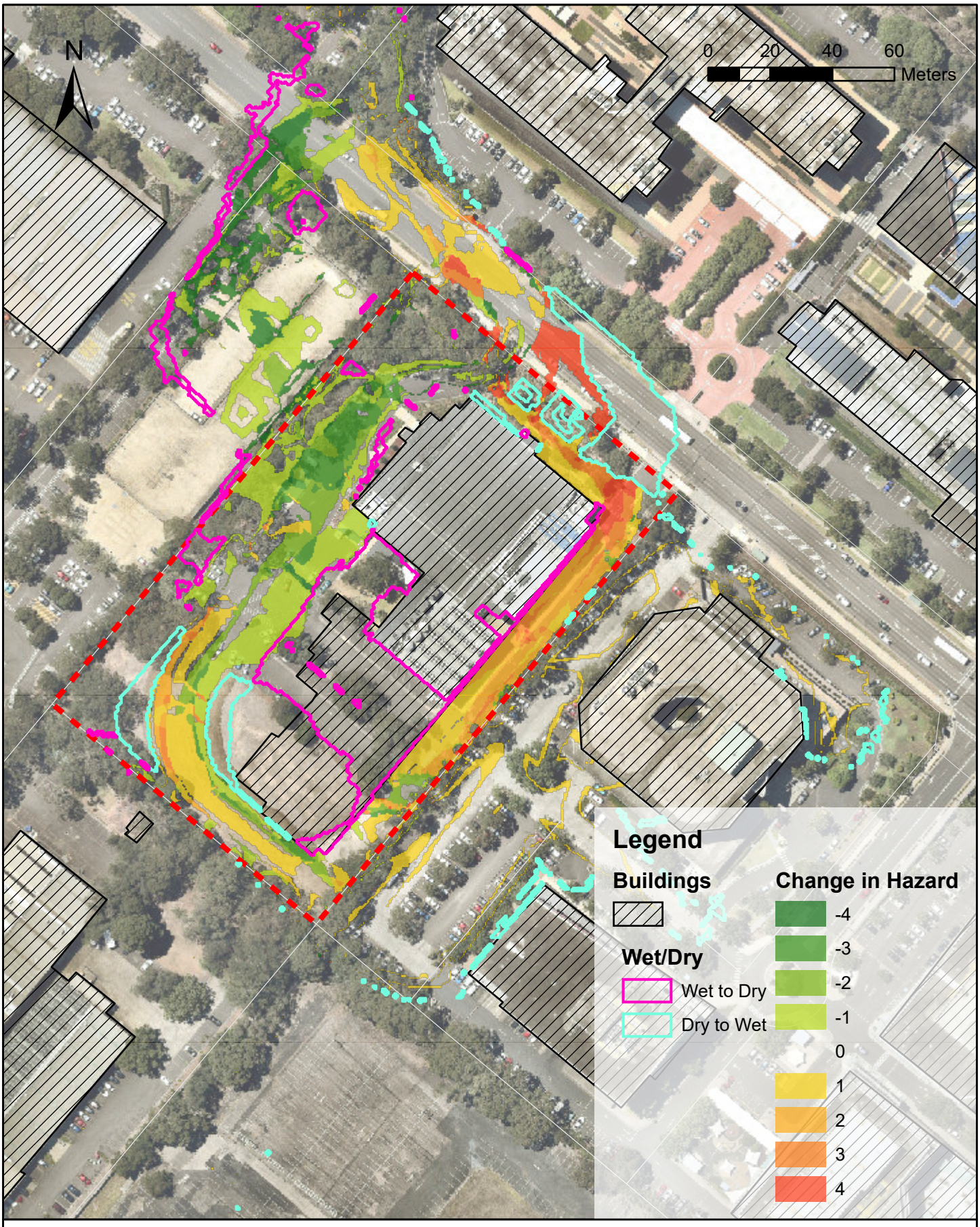

FIGURE E8 [A]

Developed Less Existing - Stage 1
PMF AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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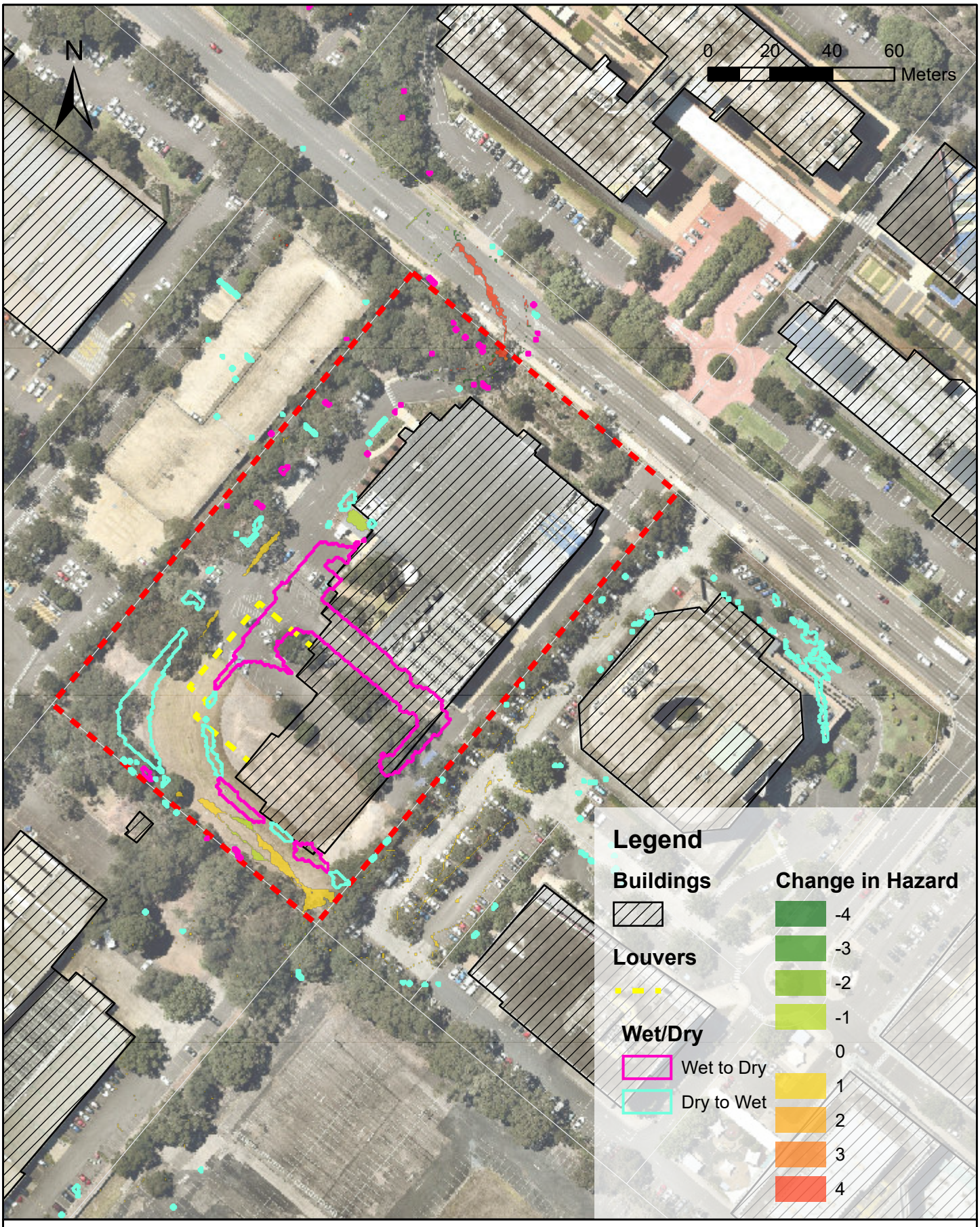

FIGURE E9 [A]

Developed Less Existing - Stage 2
1% AEP AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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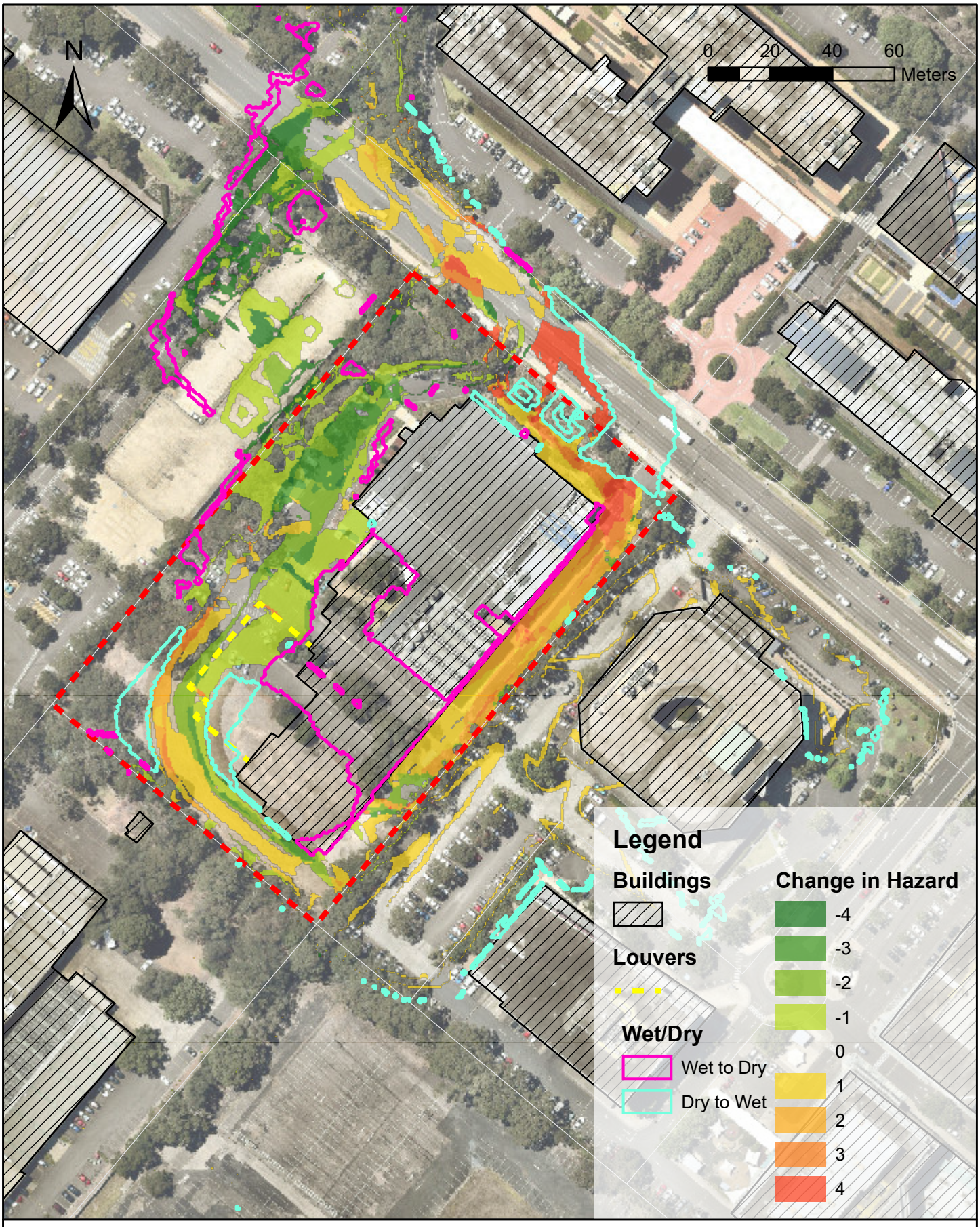

FIGURE E10 [A]

Developed Less Existing - Stage 2
PMF AR&R 2016 Flood Hazard

17 Talavera Road,
Macquarie Park

Job Number: SY170095

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