Proposed Subdivision of 158-164 Old Bathurst Road, Emu Plains

Flood Impact Assessment

ACOR Consultants Pty Ltd

October 2022

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Project: **Proposed Subdivision of 158-164 Old Bathurst Road, Emu Plains**
Flood Impact Assessment

Rev	Description	Author	Review	Advisian Approval	Date
A	**Draft Report**	LT L To	LC L Collins		16/03/2022
B	**Final Report**	LC L Collins	CRT C Thomas	 Chris Thomas	4/04/2022
C	**Revised Final Report**	LC L Collins	CRT C Thomas	 Chris Thomas	11/10/2022

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Appendices

1 Introduction

Penrith City Council (Council) is planning an industrial subdivision of the former Rocla site at 158-164 Old Bathurst Road, Emu Plains. The proposed redevelopment site is located on the western floodplain of the Lower Nepean River as shown in **Figure 1-1**.

It is understood that Council intends to subdivide the 16 hectares of land into 41 industrial lots, which will involve some localised cut and fill earthworks. Additionally, Transport for NSW (TfNSW) intends to construct a commuter carpark on the two lots located immediately to the east of the site. This carpark development has been included in the 'post-development' scenario modelling that has been undertaken as part of this study.

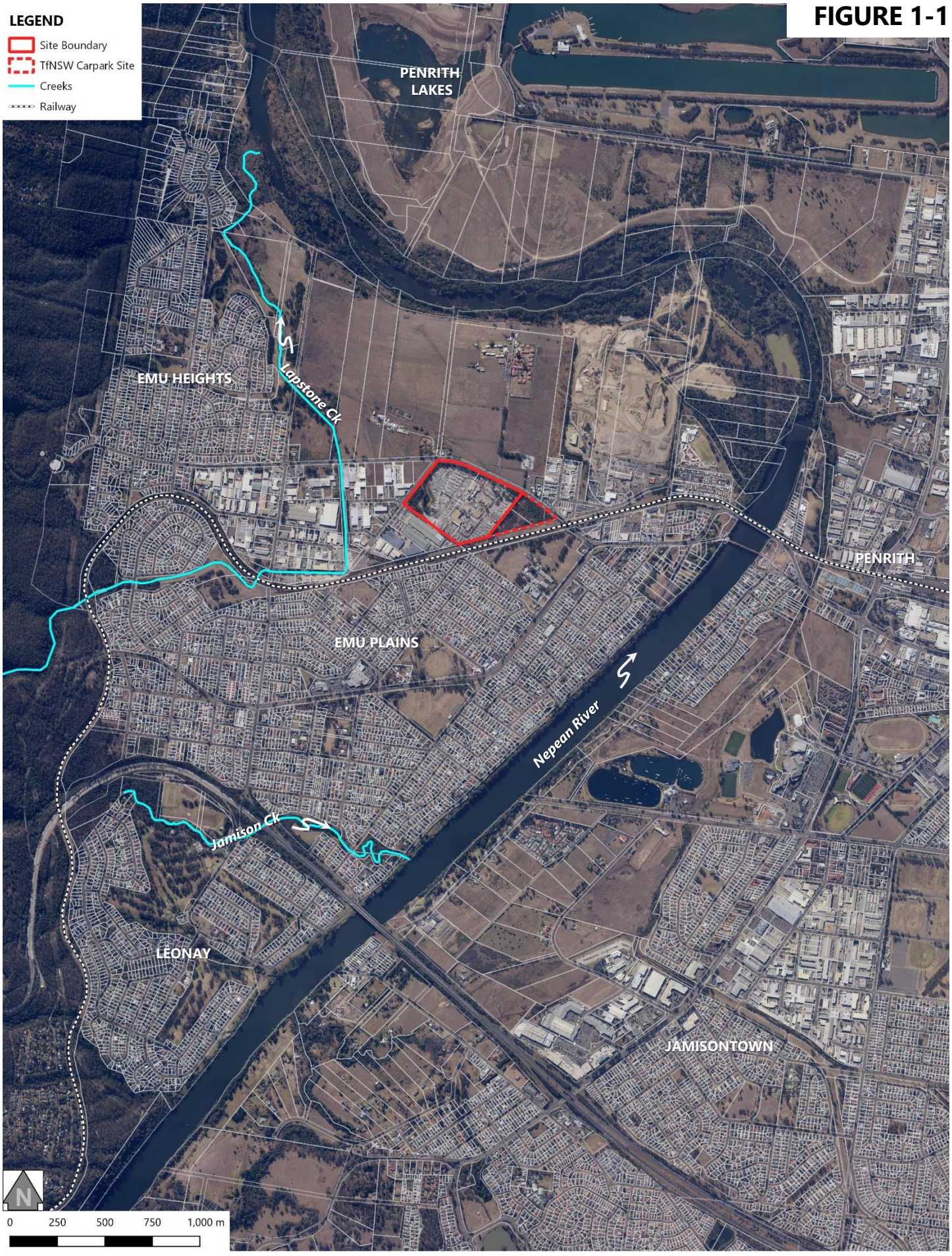
Flood modelling and mapping completed as part of the *Nepean River Flood Study* (Advisian, 2018) indicates that parts of the site are affected by the 1% Annual Exceedance Probability (AEP) design flood event. The development would thus be required to comply with the provisions detailed in Part C1 and C14 in Section C3.5 of the Penrith Development Control Pan 2014 (DCP 2014).

ACOR Consultants Pty Ltd (ACOR) has been engaged by Council to document planning and engineering matters for the project as part of a Development Application, including the consideration of flood-related constraints.

Advisian Pty Ltd (Advisian) was engaged by ACOR to analyse the potential impacts of the proposed industrial subdivision on existing flood behaviour in the vicinity of the site and complete a Flood Impact Assessment (FIA). This report documents the methodology and findings of the FIA.

Advisian was also engaged to complete a Flood Emergency Response Strategy (FERS) for the site which is detailed in a separate report.

FIGURE 1-1



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SITE LOCATION
[LOWER NEPEAN RIVER FLOODPLAIN]

2 Assessment of Existing Flood Behaviour

2.1 Description of the Development Site

The site at 158-164 Old Bathurst Road is located on the western floodplain of the Lower Nepean River at Emu Plains. It is bound by the T1 Western Railway to the south, Old Bathurst Road to the north, David Road to the west, and two currently undeveloped lots to the east (*refer* **Figure 2-2**).

A number of sheds and a large industrial yard can be found within the site. Twin 750mm diameter culverts discharge runoff from the western portion of the site into a small swamp area at the western corner of the site. The swamp is drained by a single box culvert (2.0 m W x 0.8 m H) which runs underneath David Road and Old Bathurst Road before discharging into an undeveloped lot to the north of Old Bathurst Road (*refer* **Figure 2-2**).

The existing topography of the site and its immediate surrounds is shown in **Figure 2-3**. The topography within the site is based on survey data provided by ACOR, while topography for the land surrounding the site is based on Light Detection and Ranging (*LiDAR*) survey data captured in 2017 and obtained via the Geoscience Australia ELVIS portal.

The topography presented in **Figure 2-3** indicates that the site is relatively flat, with elevations typically ranging from about 24 to 25 mAHD across most of the site. The lowest point in the swamp area is at an elevation of approximately 21.8 mAHD. A bund is located near the western boundary of the site with crest elevations ranging from about 27 to 28 mAHD. Overall, the terrain of the area generally slopes from south to north away from the site and toward the Nepean River.

2.2 Previous Flood Related Studies

A brief overview of relevant studies defining flood behaviour in the Nepean River floodplain is provided in the following.

- Nepean River Flood Study (Advisian, 2018)
  - The characteristics of flooding of the Lower Nepean River within the Penrith Local Government Area (LGA) are documented in the *Nepean River Flood Study* (Advisian, 2018) which was prepared for Penrith City Council. This report documents the model and design flood levels currently adopted by Council.
  - The flood study relied on the results of flood modelling undertaken using a two-dimensional flood model that utilised the 'RMA-2' software and evolved over a period of several years. Hydrologic inputs consisted of hydrographs from the RUBICON 1D model of the Lower Nepean and Hawkesbury River system (Webb McKeown 1997) which were applied as boundary conditions at the upstream boundary of the RMA-2 model.
- Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
  - The *Hawkesbury-Nepean Valley Regional Flood Study* (*Regional Flood Study*) was completed for Infrastructure NSW (INSW). It covers a large geographic area extending from Wallacia to Broken Bay and focuses on regional scale flooding and decision making. It does not supersede more detailed local studies such as the *Nepean River Flood Study* (Advisian, 2018).
  - The *Regional Flood Study* adopted an updated version of the existing 1D RUBICON hydraulic model (Webb McKeown 1997).

- A 'Monte Carlo' approach to hydrologic modelling was adopted, generating thousands of potential events to mimic the variability of actual floods in the valley, including the variability of initial water levels in Warragamba Dam.
- INSW has subsequently engaged a consultant to complete a Hawkesbury-Nepean Regional 2D Flood Model using the TUFLOW software. At the time of writing, this work was still ongoing.

- Lower Nepean River Floodplain Risk Management Study (Advisian, 2019-present)
  - Following the completion of the *Nepean River Flood Study* (Advisian, 2018) Advisian was engaged by Council to undertake the *Lower Nepean River Floodplain Risk Management Study & Plan* (FRMS&P).
  - As part of the FRMS&P a 2D TUFLOW hydraulic model was developed and calibrated. This model has been used to simulate design flood events with Monte-Carlo based hydrograph inputs derived by the *HNV Regional Flood Study* (WMAwater 2019).
  - The TUFLOW model and its results have not currently been adopted for flood planning in the Penrith LGA. Before considering their adoption, Council is looking to better understand differences between the design flood results derived using the TUFLOW and RMA-2 flood models. There is also a desire for consistency with the INSW Hawkesbury-Nepean Regional 2D Flood Model which has not yet been completed.

2.3 Flood Modelling Approach

For the purposes of this FIA and the associated FERS (Advisian, 2022), the two-dimensional TUFLOW hydraulic model developed for use in the Lower Nepean River FRMS&P has been adopted. It was considered that this model offers the following advantages over the RMA-2 flood model.

(i) TUFLOW is more readily able to incorporate changes associated with the proposed development

(ii) The TUFLOW model is considered to provide a more detailed and reliable representation of 'over-bank' floodplain areas such as Emu Plains, as:

- it incorporates more recent LiDAR topographic data and samples this data at a higher resolution than the RMA model; and,
- it directly represents culverts as 1D objects while these are approximated as 2D features in RMA-2.

(iii) Some required model outputs (e.g., hazard) are directly output from TUFLOW but not from RMA-2

(iv) Difference mapping is more readily prepared using 'TUFLOW Utilities'

(v) Timeseries outputs for use in the FERS are more easily accessed and reproduced.

Details of the adopted TUFLOW model version are as follows:

- Software version: 2020-10-AA-iSP-w64, HPC
- TUFLOW Control File: LNR_220220_~s1~_~e1~_~s2~.tcf
- Grid Size: 15m grid with sub-grid sampling (SGS) at 2.5m
- Input Hydrograph: Monte-Carlo 1% AEP Hydrograph 4 (Rd04853) at 'Portal'.

The site survey provided by ACOR was incorporated into the TUFLOW model to update the existing conditions at the site.

A comparison of 1% AEP peak flood level results from the RMA-2 and TUFLOW models was undertaken in the vicinity of the site and is presented in **Figure 2-4**. In general, it was found that flood levels at the site were very similar, with peaks of 23.86 mAHD derived using the TUFLOW model, and 23.89 mAHD with the RMA-2 model.

Greater differences between the two models occur along the southern site boundary and to the south of the site. The RMA-2 model indicates that inundation would enter the site from the south with peak flood levels reaching 24.26 mAHD, while TUFLOW indicates a peak flood level of 23.89 mAHD along the southern boundary with no inundation extending into the site. These differences stem from the way the two models simulate flow behaviour along the overland flowpath through Emu Plains.

2.4 Flood Modelling Results

The updated TUFLOW flood model was used to simulate the 1% AEP design flood for existing conditions. The following flood mapping is presented in **Appendix A**.

- **Figure A1-1** and **Figure A1-2**: 1% AEP Peak Flood Levels for Existing Conditions
- **Figure A2-1** and **Figure A2-2**: 1% AEP Peak Flood Depths for Existing Conditions
- **Figure A3-1** and **Figure A3-2**: 1% AEP Peak Flow Velocities for Existing Conditions
- **Figure A4-1** and **Figure A4-2**: 1% AEP Provisional Flood Hazard for Existing Conditions
- **Figure A5-1** and **Figure A5-2**: 1% AEP Hydraulic Categories for Existing Conditions

A summary of the results determined from simulation of the 1% AEP flood for existing conditions is presented in the following.

2.4.1 Peak Flood Levels and Depths

The results of the hydraulic modelling indicate that the peak 1% AEP flood level in the vicinity of the site is predicted to be 23.86 mAHD (*refer* **Figure A1-2**). Floodwaters from the Nepean River are predicted to "back-up" along Lapstone Creek in a southerly direction and cause inundation of areas adjacent to the site. This results in water backing up through the Old Bathurst Road / David Road culvert and filling up the swamp in the western corner of the site. A minor amount of water is also predicted to "back up" into the site culverts and enter the industrial yard.

Old Bathurst Road is expected to be overtopped by floodwaters backing up from the river near the northern site boundary. A small section of the site near the north-eastern site boundary is predicted to be inundated once Old Bathurst Road is overtopped.

As shown in **Figure A2-2**, flooding of the swamp area in the western corner of the site is predicted to reach depths of up to 2.2 metres. Flood depths at other inundated parts of the site do not exceed 0.55 metres.

2.4.2 Peak Flow Velocities

Peak flow velocities for the design 1% AEP flood event were also extracted from the results of the modelling and are presented in **Figure A3-1** and **Figure A3-2**. Flow velocities are expected to be low in the vicinity of the site and typically do not exceed 0.2 m/s.

2.4.3 Flood Hazard

Flood hazard provides a measure of the potential risk to life and property posed by a flood. ARR 2019 presents a set of hazard curves which assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. These curves have been adopted to define flood hazard in this study and are reproduced in **Figure 2-1**.

Flood hazard mapping for existing conditions is presented in **Figure A4-1** and **Figure A4-2**. These figures show that hazard in the vicinity of the site generally ranges from H3 to H5. Despite low velocities near the site, predicted peak 1% AEP flood depths generally exceed 0.5 metres resulting in a minimum hazard category of H3.

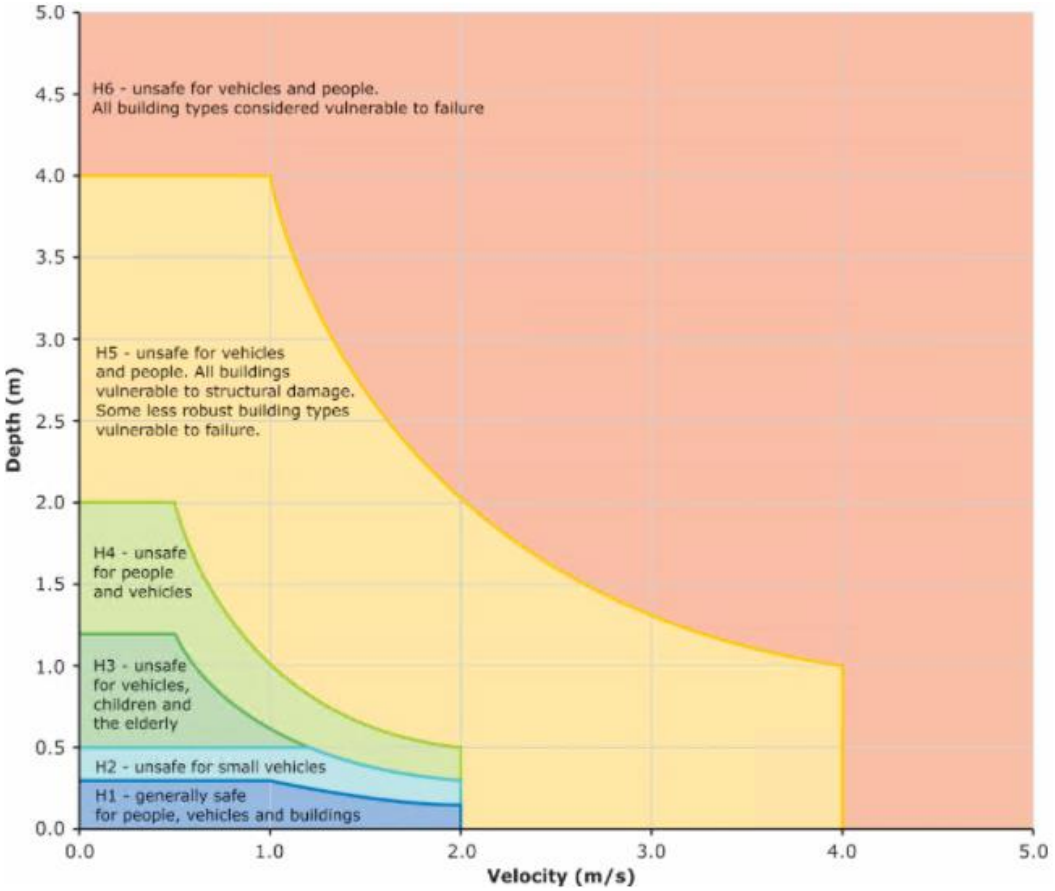

Figure 2-1 ARR 2019 Flood Hazard Categories (Smith et al, 2014)

2.4.4 Hydraulic Categorisation

The NSW Government's *Floodplain Development Manual* (*2005*) divides flood prone land into three hydraulic categories; namely Floodway, Flood Storage and Flood Fringe, which are indicative of the potential for development to impact on existing flood behaviour.

Advisian prepared an assessment of hydraulic categories as part of the *Nepean River Flood Study* (2018). The main river channel and Penrith Lakes were identified as Floodway, while all 'over-bank' floodplain areas including affected parts of the proposed development site were identified as Flood Storage. Floodway areas were determined using velocity-depth relationships which have also been applied in this FIA to produce the hydraulic category mapping shown in **Figure A5-1** and **Figure A5-2**.

FIGURE 2-2

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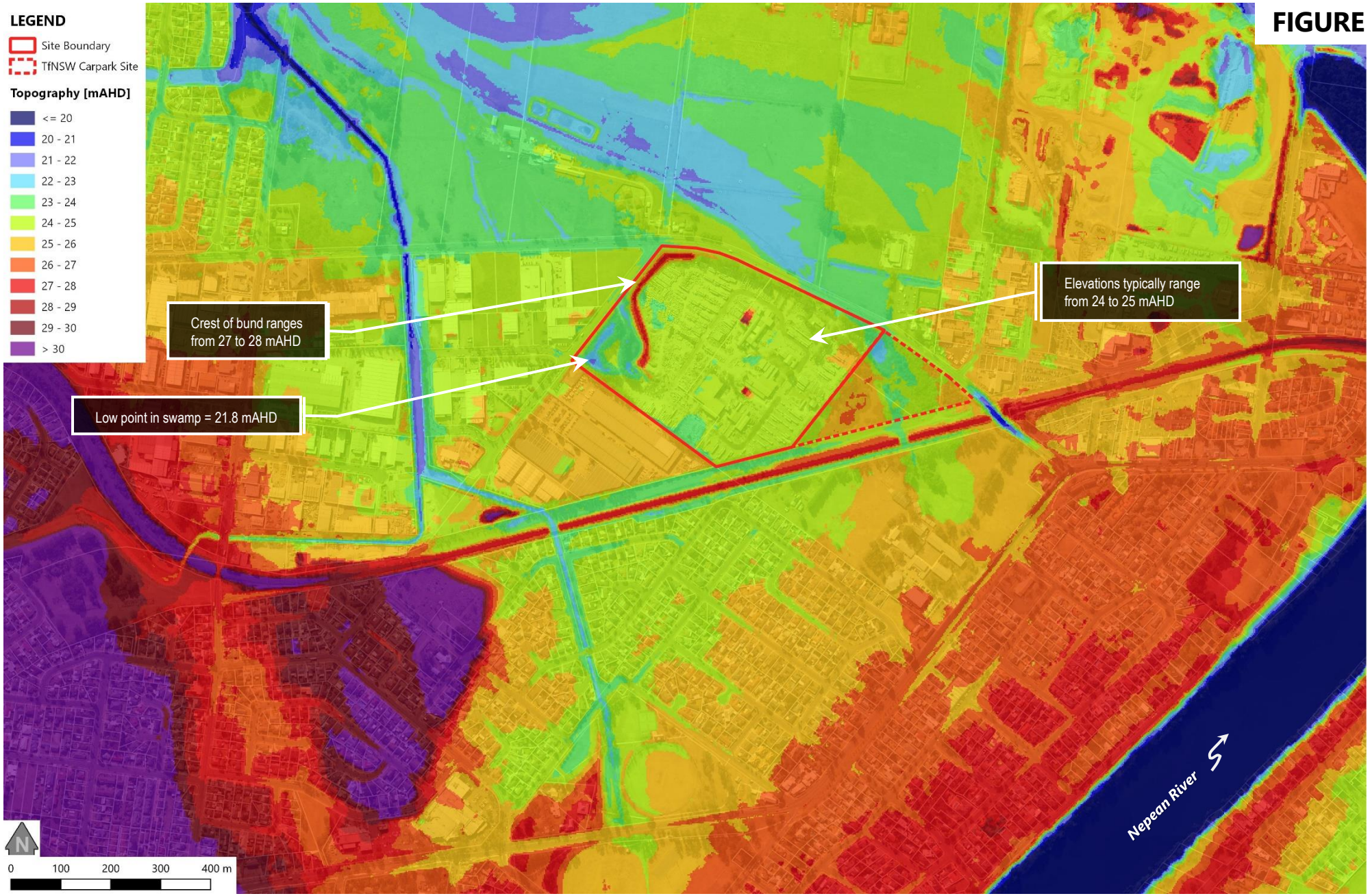
SITE LOCATION [EMU PLAINS]

FIGURE 2-3



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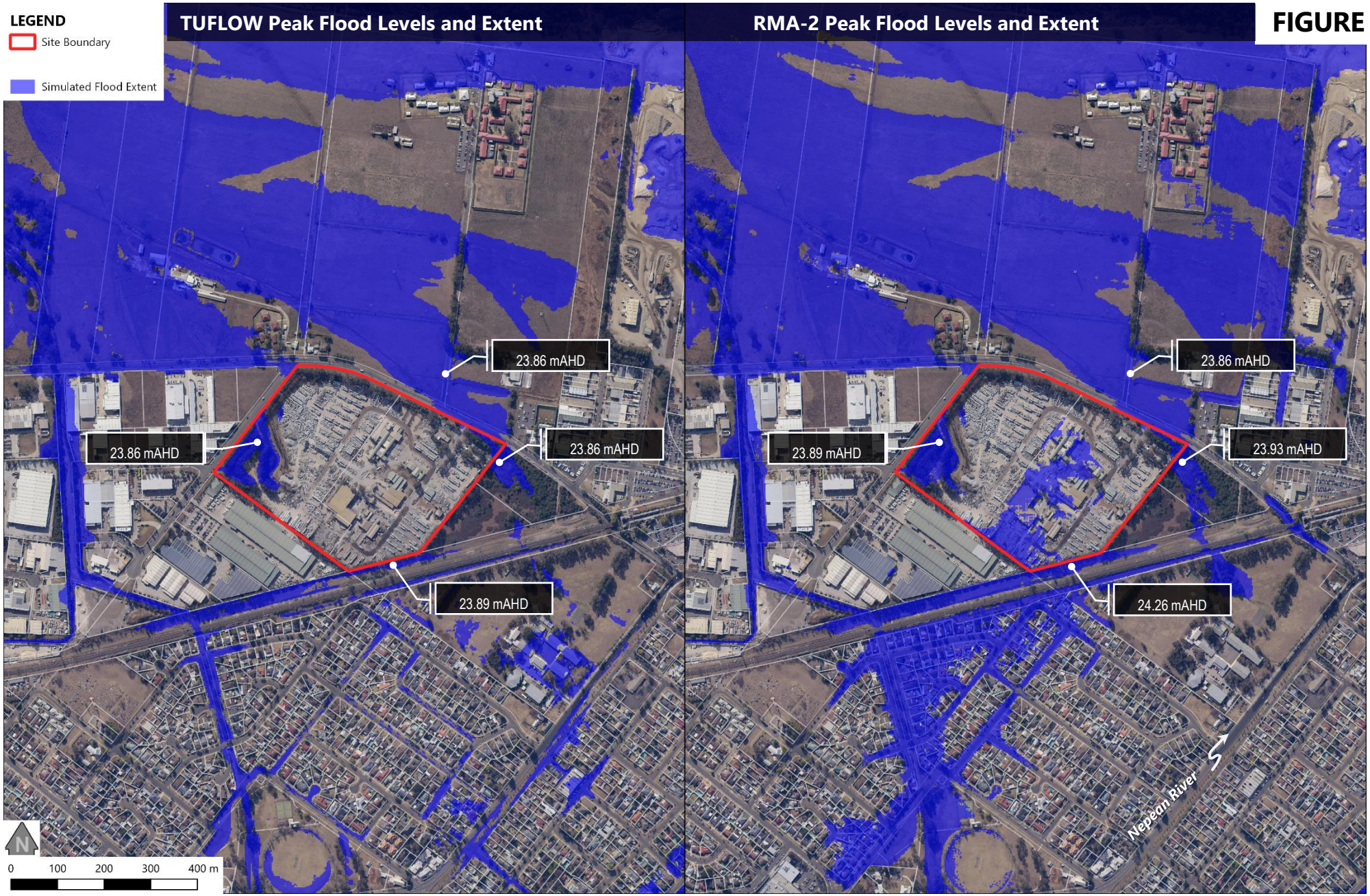
SITE TOPOGRAPHY

FIGURE 2-4



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COMPARISON OF TUFLOW AND RMA-2 SIMULATED 1% AEP PEAK FLOOD LEVELS

3 Potential Impacts of the Proposed Development on Flooding

3.1 Description of the Proposed Development

The development proposal involves the subdivision of the land at 158-164 Old Bathurst Road, Emu Plains to create around 40 industrial lots and one lot to accommodate stormwater infrastructure, together with associated site works, internal roads and street landscaping. The layout of the proposed industrial subdivision is shown in **Figure 3-1**.

Additionally, Transport for NSW (TfNSW) plans to construct a new commuter carpark in the two empty lots to the east of the site (*refer* **Figure 3-1**). An open channel will follow a south to north alignment through the centre of the carpark. The carpark development has been included in the 'post-development' scenario modelling for this FIA.

Some cut and fill earthworks are also proposed as part of the subdivision (*refer* **Figure 3-2**). The majority of the site is proposed to be filled to depths of up to 1.7 metres, while the bund along the western boundary of the site will be removed as part of the works.

The post-development topography is shown in **Figure 3-3**. The ground elevation generally increases towards the southern corner of the site, reaching a maximum of 26.44 mAHD. The swamp area near the western corner of the site will not be filled as part of the development, with the low point in that area remaining at 21.6 mAHD.

The TfNSW carpark will be constructed to finished elevations generally ranging between 25.0 and 25.5 mAHD. The channel through the carpark will slope from south to north, with the lowest point in the channel set at an elevation of 20.45 mAHD (*refer* **Figure 3-3**).

3.2 Post-Development Flood Conditions

In order to quantify the potential impacts of the proposed development, the TUFLOW flood model that was used to assess existing flood behaviour across the site was modified to incorporate the changed landform associated with the development proposal. This also includes the proposed TfNSW carpark in the lots to the east of the site.

The modified flood model was used to simulate the 1% AEP flood in order to assess post-development flood conditions in the vicinity of the site. The following flood mapping for the 1% AEP event under post-development conditions is included in **Appendix B**:

- **Figure B1-1** and **Figure B1-2**: 1% AEP Peak Flood Levels for Post-Development Conditions
- **Figure B2-1** and **Figure B2-2**: 1% AEP Peak Flood Depths for Post-Development Conditions
- **Figure B3-1** and **Figure B3-2**: 1% AEP Peak Flow Velocities for Post-Development Conditions
- **Figure B4-1** and **Figure B4-2**: 1% AEP Provisional Flood Hazard for Post-Development Conditions.

3.3 Impacts of the Proposed Development on Flooding

3.3.1 Impact on 1% AEP Peak Flood Levels

Flood level difference mapping was prepared to quantify any off-site impacts that could be caused by the proposed development and is presented in **Appendix B** (*refer* **Figure B5-1** *and* **Figure B5-2**). The difference maps show changes in peak flood level estimates from the results of model simulations undertaken for 'existing' and 'post-development' scenarios. As indicated by the legend in the top-left hand corner, increases in peak flood level are represented by different shades of red and decreases in peak flood level are represented by shades of blue. The white shading indicates changes in peak flood level that are between +/- 0.01 metres.

As shown in **Figure B5-1** and **Figure B5-2**, the proposed development is predicted to have negligible impacts on peak 1% AEP flood levels near the site. Minor changes in flood extent (*both minor decreases and minor increases*) are expected in the swamp area within the site as well as within and adjacent to the proposed open channel through the TfNSW carpark. These changes in flood extents are generally contained within the site and are attributed to the changed landform. There is no material change in 1% AEP flood storage volume within the site as a result.

A highly localised flood level increase of up to 0.02 metres is indicated at the upstream end of Lapstone Creek at the culverts beneath Old Bathurst Road (*refer* **Figure B5-2**). This increase occurs in an area which is not hydraulically linked to the proposed development site in the 1% AEP event. Investigation of the modelling results determined that this increase in flood level is caused by a minor instability in the 1D culvert element of the TUFLOW model at this location and is not attributable to the development. In any case, the flood level increase threshold of 0.1 m specified in Part C14 of Section 3.5 of the Penrith DCP 2014 is not exceeded.

Otherwise, no flood level increases exceeding 0.01 metres are predicted.

3.3.2 Impact on 1% AEP Peak Flow Velocities

A difference map was also created to quantify any changes in peak flow velocities associated with the proposed development. The velocity difference mapping developed for the 1% AEP flood is presented in **Figure B6-1** and **Figure B6-2**.

The proposed development is predicted to have minimal impacts on peak 1% AEP flow velocities in the vicinity of the site. The white shading in **Figure B6-1** and **Figure B6-2** indicates that changes to flow velocity are generally not expected to exceed 0.1 m/s, and in fact generally do not exceed 0.01 m/s.

A maximum increase of 0.2 m/s is predicted to occur in an extremely localised area within the proposed channel in the TfNSW carpark. This impact is not surprising given that the channel is designed to provide more efficient drainage through the site. The velocity increase is contained entirely within the channel and would not impact on adjacent lots or road reserves.

A localised flow velocity increase of up to 0.2 m/s is also indicated at the upstream end of the Lapstone Creek culverts beneath Old Bathurst Road (*refer* **Figure B6-2**). Similarly to the flood level impact, this flow velocity increase can be attributed to a minor instability in the 1D culvert element of the TUFLOW model at this location and is not related to the proposed development.

FIGURE 3-1

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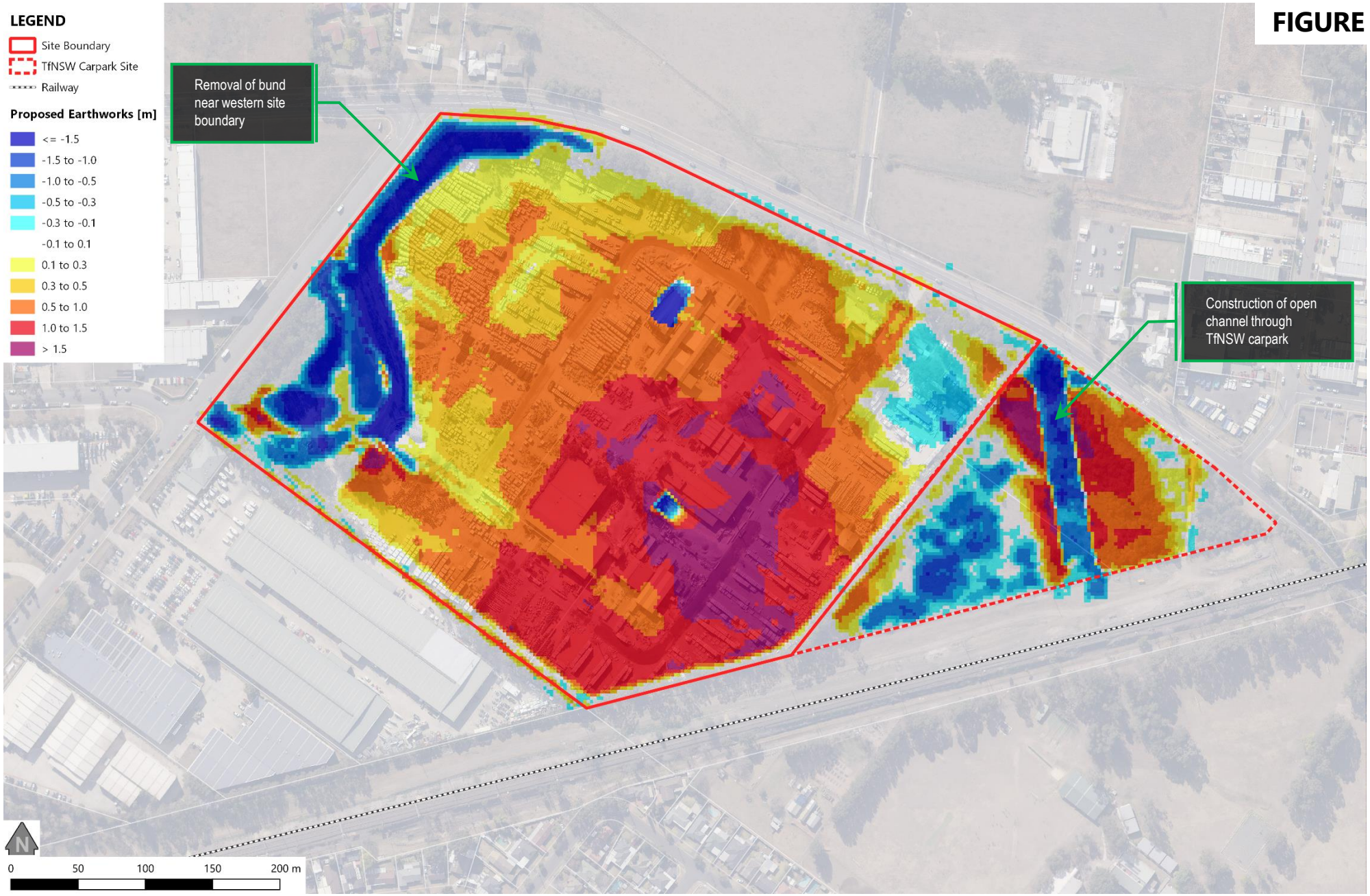
PROPOSED INDUSTRIAL SUBDIVISION LAYOUT

FIGURE 3-2



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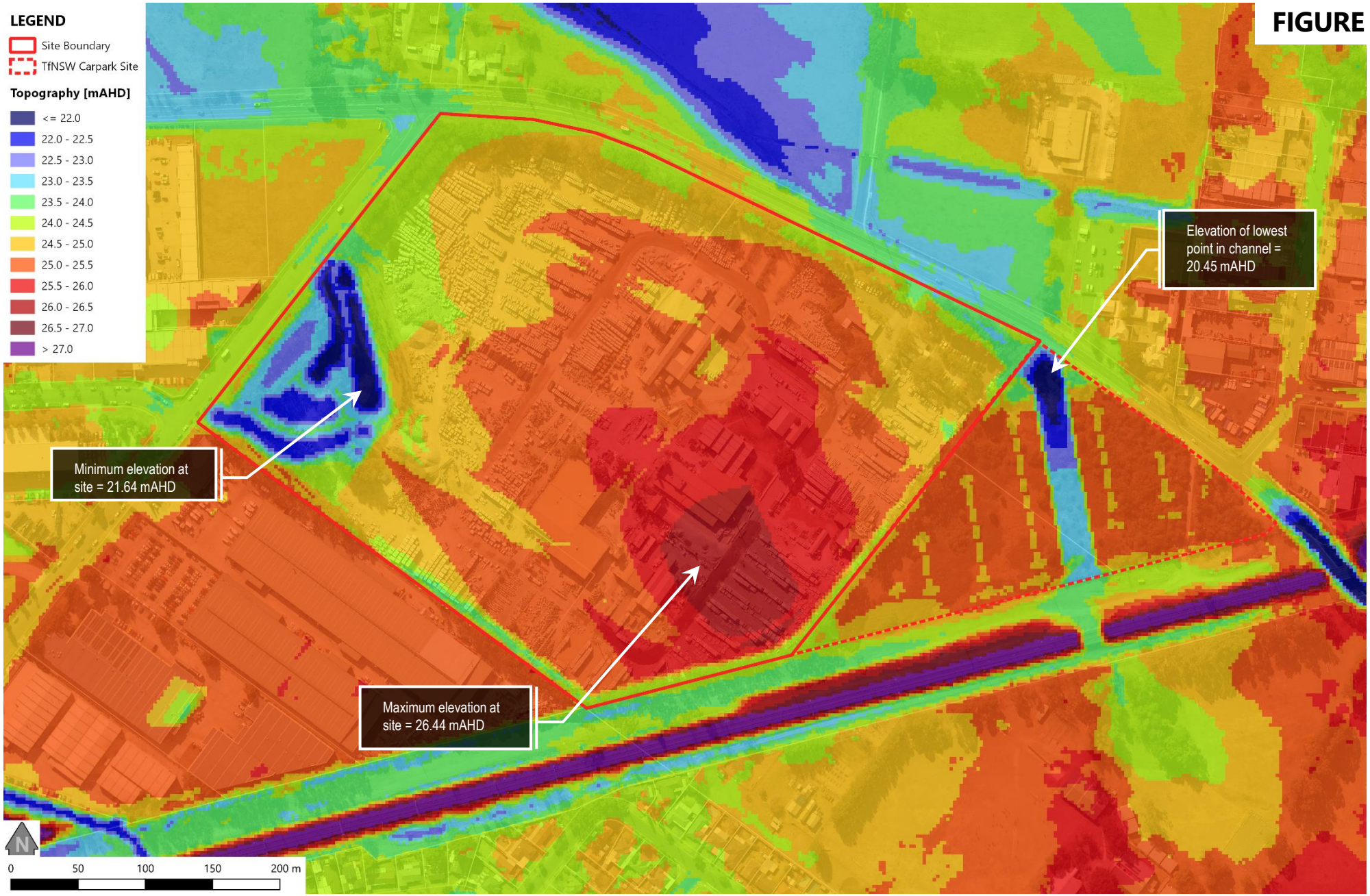
PROPOSED CUT AND FILL EARTHWORKS AT SUBJECT SITE

FIGURE 3-3



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PROPOSED POST-DEVELOPMENT TOPOGRAPHY AT SUBJECT SITE

4 Sensitivity to Climate Change

4.1 Climate Change Scenarios

The Intergovernmental Panel on Climate Change's *Fifth Assessment Report* (IPCC 2013) found that human influence on climate is clear and increasing, with impacts observed across all continents and oceans. While projections vary, there is a general consensus that climate change will alter the severity of flood impacts through sea level rise and an increase in the intensity of heavy rainfall events.

Penrith City Council requested that the following four climate change scenarios be investigated to assess the potential impacts of climate change on flooding at the proposed development site:

- 1% AEP flood with 4.9% increase in rainfall (RCP 8.5 projection for the year 2030)
- 1% AEP flood with 9.1% increase in rainfall (RCP 4.5 projection for the year 2090)
- 1% AEP flood with 13.9% increase in rainfall (RCP 6 projection for the year 2090)
- 1% AEP flood with 18.6% increase in rainfall (RCP 8.5 projection for the year 2090).

These scenarios align with data from the *Climate Change in Australia Technical Report* (CSIRO and BoM 2015) as presented through the *Australian Rainfall & Runoff Data Hub*. Projected increases in rainfall intensity are provided for various time horizons and several Representative Concentration Pathway scenarios (RCPs) including RCP4.5 (i.e., gradual reductions in greenhouse gas emissions), RCP6 (i.e., minor reductions in greenhouse gas emissions) and RCP8.5 (i.e., greenhouse gas emissions continue to increase in the future).

4.2 Flood Modelling Results

Advisian does not have access to the hydrologic model used to derive design flood hydrographs for the Nepean River. To approximate the four climate change scenarios the requested percentage increases in rainfall were applied directly to the 1% AEP design flood flow hydrograph. It is noted that a certain percentage increase in rainfall does not usually translate directly to the same percentage increase in flow. This is due to factors such as rainfall loss rates and the specifics of flow routing behaviour in the particular catchment; e.g., the presence of Warragamba Dam.

The four climate change scenarios were simulated using the TUFLOW hydraulic model for both existing site conditions (i.e., pre-development) and post-development conditions. Peak flood levels along the southern property boundary under the various scenarios are listed in **Table 4-1**. Peak flood extents under post-development conditions are presented in **Figure 4-1**.

The following mapping showing flood level impacts associated with the proposed development under potential climate change scenarios is presented in **Appendix C**:

- **Figure C-1**: Impact on 1% AEP peak flood levels under 4.9% increase in flow scenario
- **Figure C-2**: Impact on 1% AEP peak flood levels under 9.1% increase in flow scenario
- **Figure C-3**: Impact on 1% AEP peak flood levels under 13.9% increase in flow scenario
- **Figure C-4**: Impact on 1% AEP peak flood levels under 18.6% increase in flow scenario.

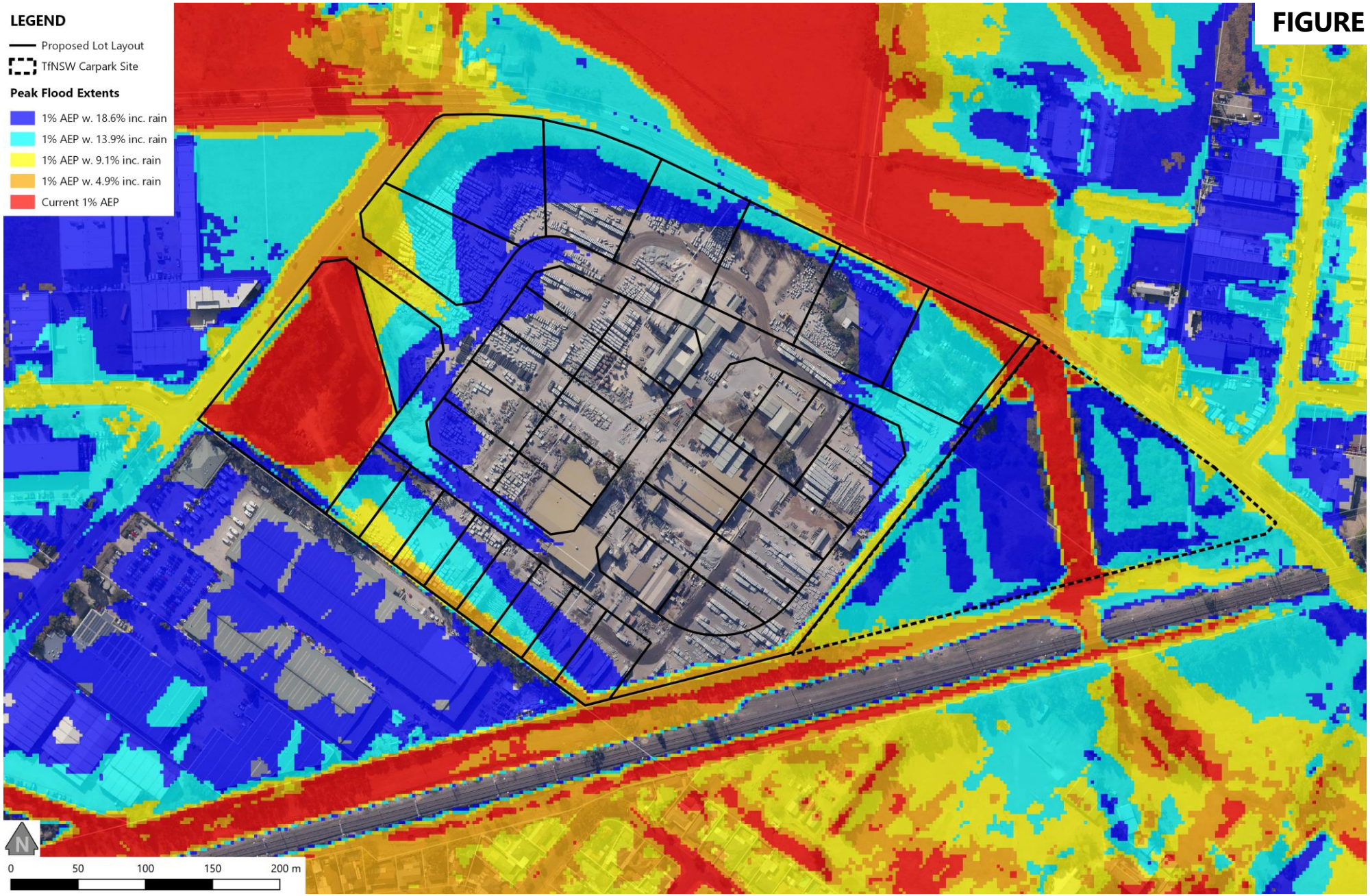
Table 4-1 Simulated 1% AEP peak flood levels under potential climate change and maximum flood level increases along the southern property boundary

Flood Event	Existing Site Conditions		Post-Development Conditions	
	Peak Flood Level (mAHD)	Increase Due to Climate Change (m)	Peak Flood Level (mAHD)	Increase Due to Development (m)
Current 1% AEP	23.89	-	23.89	0.00
1% AEP w. 4.9% increase in flow	24.40	0.51	24.40	0.00
1% AEP w. 9.1% increase in flow	24.72	0.83	24.85	0.13
1% AEP w. 13.9% increase in flow	24.94	1.05	25.23	0.29
1% AEP w. 18.6% increase in flow	25.13	1.25	25.45	0.32

Key findings from the data presented in **Table 4-1**, **Figure 4-1** and **Appendix C** include the following:

- Potential Impact of Climate Change on 1% AEP Peak Flood Levels
  - The investigated climate change scenarios would result in increases in peak flood levels at the site ranging from about 0.5 metres for a 4.9% increase in flow to about 1.3 metres for a 18.6% increase in flow.
  - The proposed finished ground levels of the industrial lots would remain largely flood free under the 4.9% and 9.1% increase in flow scenarios. Under the 13.9% and 18.6% increase in flow scenarios the 1% AEP flood would begin to encroach into the lots bordering the site, while the lots toward the centre of the site would remain flood-free (*refer* **Figure 4-1**).
- Potential Impact of the Development on 1% AEP Peak Flood Levels Under Climate Change
  - The proposed development is not expected to result in any increases in 1% AEP peak flood level under a 4.9% increase in flow scenario (*refer* **Figure C-1**).
  - Under a 9.1% increase in flow scenario the development would be expected to result in a maximum flood level increase of 0.13 m in the drainage easement between the southern property boundary and the railway. This would not impact the railway and would not result in flood level increases of more than 0.1 m on private property (*refer* **Figure C-2**).
  - Under a 13.9% increase in flow scenario the development would be expected to result in a maximum flood level increase of 0.29 m in the drainage easement between the southern property boundary and the railway. This would not impact the railway but would result in flood level increases of more than 0.1 m in parts of 3 private properties (*refer* **Figure C-3**).
  - Under a 18.6% increase in flow scenario the development would be expected to result in a maximum flood level increase of 0.32 m in the drainage easement between the southern property boundary and the railway. This would not impact the railway but would result in flood level increases of more than 0.1 m in parts of 5 private properties (*refer* **Figure C-4**).

FIGURE 4-1



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SIMULATED PEAK 1% AEP FLOOD EXTENTS UNDER CLIMATE CHANGE SCENARIOS

5 Assessment Criteria

Section C3.5 of Council's Development Control Plan (DCP 2014) outlines flood planning requirements for developments within the Penrith LGA. The sections of the DCP which are relevant to the preparation of this FIA are as follows.

- Part C1 of Section C3.5, which sets out some general flood planning provisions.
- Part C14 of Section C3.5, which outlines requirements relevant to filling of land below the Flood Planning Level.

The relevant clauses are summarised in **Table 5-1** below.

Table 5-1 Flood related clauses of the Penrith DCP 2014

Item	Requirement	Section in Penrith DCP 2014
1	The development will not increase the flood hazard or risk to other properties	Part C1 of Section C3.5
2	The buildings are sited in the optimum position to avoid flood waters and allow safe flood access for evacuation.	Part C1 of Section C3.5
3	The proposed redevelopment will not expose any resident to unacceptable levels of risk or any property to unreasonable damage.	Part C1 of Section C3.5
4	Flood levels are not increased by more than 0.1m by the proposed filling.	Part C14 of Section 3.5
5	Downstream velocities are not increased by more than 10% by the proposed filling.	Part C14 of Section 3.5
6	Proposed filling does not redistribute flows by more than 15%.	Part C14 of Section 3.5
7	The potential for cumulative effects of possible filling proposals in that area is minimal.	Part C14 of Section 3.5
8	There are alternative opportunities for flood storage.	Part C14 of Section 3.5
9	The development potential of surrounding properties is not adversely affected by the filling proposal.	Part C14 of Section 3.5
10	The flood liability of buildings on surrounding properties is not increased.	Part C14 of Section 3.5

Responses to each of these clauses are detailed in the following.

Response to Item 1

Requirement: The development will not increase the flood hazard or risk to other properties

A comparison of the post-development flood hazard mapping (*refer* **Figure B4-1** *and* **Figure B4-2**) with the existing conditions flood hazard mapping (*refer* **Figure A4-1** *and* **Figure A4-2**) shows that the proposed subdivision results in no change to the 1% AEP flood hazard categories in areas outside of the subject site or the adjacent TfNSW carpark site.

Response to Item 2

Requirement: The buildings are sited in the optimum position to avoid floodwaters and allow safe flood access for evacuation

The TUFLOW model adopted for this FIA indicates a peak 1% AEP flood level at the site of 23.86 mAHD, while the 2018 RMA-2 model (*refer* **Chapter 2**) suggests peak 1% AEP flood levels of about 23.9 mAHD along the western and northern boundaries of the site, and up to 24.26 mAHD along the southern boundary. Design ground levels for the proposed industrial lots generally exceed 24.4 mAHD across the site (*i.e., are more than 0.5 m above the 1% AEP design flood level*), while lots along the southern boundary have ground levels exceeding 24.8 mAHD (*i.e., are more than 0.5 m above the potential 1% AEP design flood level indicated by the RMA-2 model in this area*).

There are parts of some lots with proposed ground levels of less than 24.4 mAHD. Finished floor levels of any buildings in such areas should have an elevation of not less than 0.5 m above the 1% AEP peak flood level.

Accordingly, buildings are expected to remain unaffected in floods up to and including the 1% AEP design flood.

With regard to provision of safe flood access for evacuation, the proposed development has direct access to Old Bathurst Road which offers an evacuation route to the west to land outside of the Probable Maximum Flood (PMF) extent. Refer to the associated *Flood Emergency Response Strategy* (Advisian, 2022) for further information on warning times and recommended flood emergency response protocols including evacuation procedures.

Response to Item 3

Requirement: The proposed redevelopment will not expose any resident to unacceptable levels of risk or any property to unreasonable damage

Flood hazard mapping prepared for the 1% AEP design flood (*refer* **Figure B4-2**) shows that no property within the proposed industrial redevelopment would be exposed to hazardous or damaging flood conditions in this event. The *Flood Emergency Response Strategy* (Advisian, 2022) also demonstrates that evacuation of the site can be safely achieved in the PMF if appropriate protocols are followed. Accordingly, the redevelopment of the site will not expose tenants or buildings to unacceptable levels of risk in floods up to and including the 1% AEP event.

However, modelling indicates that the site may become inundated in a 1 in 200 AEP flood. Conditions that may cause structural damage to buildings (*i.e., H5 hazard*) may occur in events of a 1 in 1000 AEP magnitude and larger. This should be appropriately considered in the structural design of buildings proposed for the site.

Response to Item 4

Requirement: Flood levels are not increased by more than 0.1m by the proposed filling

The flood level difference mapping presented in **Figure B5-1** and **Figure B5-2** shows that any potential off-site flood level increases associated with the proposed subdivision and carpark development are predicted to be considerably less than 0.1 metres.

Response to Item 5

Requirement: Downstream velocities are not increased by more than 10% by the proposed filling

The flow velocities in the vicinity of the site under existing conditions are predicted to be slow, with peak 1% AEP flood velocities generally in the order of 0.1 to 0.2 m/s. This is expected as the site is not located within or near a floodway or even a major overland flow path. Flooding of the site in the 1% AEP event is the result of floodwaters rising in the Nepean River to the north of the site and slowly backing up into the site.

The flow velocity difference mapping presented in **Figure B6-1** and **Figure B6-2** shows that off-site flow velocity increases associated with the proposed subdivision and carpark developments are expected to be less than 0.1 m/s. Further interrogation indicates that changes of even 0.01 m/s are extremely localised and are more likely to be associated with limitations in the model precision rather than the development itself. Notwithstanding, despite the low velocity environment near the site, these results indicate that a 10% increase in flow velocities could potentially occur. However, if there are any such changes they would be extremely localised and would not result in any material change in flood hazard, erosion potential or flow distribution. Therefore, any potential impacts due to these increases in velocity are considered to be negligible.

Response to Item 6

Requirement: Proposed filling does not redistribute flows by more than 15%

The proposed subdivision and carpark developments are located outside of the 'floodway' in an area designated as 'flood storage' but which could even be considered as 'flood fringe' in the 1% AEP event. There are no significant flows through the site in the 1% AEP and velocities are very low. The potential for any works within the site to cause redistribution of flows in a 1% AEP flood is therefore negligible. This has been confirmed by the flow velocity difference mapping presented in **Figure B6-1** and **Figure B6-2** which does not show any significant changes in flow velocities that could be indicative of flow redistribution.

Response to Item 7

Requirement: The potential for cumulative effects of possible filling proposals in that area is minimal

The majority of the proposed filling occurs outside of and above the 1% AEP flood extent, and therefore results in negligible change in available flood storage. Terrain analysis of available storage within the site (*including the TfNSW carpark*) that falls below the 1% AEP peak flood level of 23.9 mAHD, found that storage increases from 9,980 m^3 under existing conditions to 11,560 m^3 under post-development conditions. The increase in storage volume is largely due to the open channel that is proposed to be constructed through the TfNSW site.

It has also been confirmed that off-site impacts on 1% AEP peak flood levels and velocities are negligible. Accordingly, it is considered that the proposed development would have negligible contribution to any potential cumulative effects of filling proposals in the area under current 1% AEP design flood conditions.

Response to Item 8

Requirement: There are alternative opportunities for flood storage

Terrain analysis of available storage within the site (*including the TfNSW carpark*) below the 1% AEP peak flood level of 23.9 mAHD found that storage increases from 9,980 m^3 under existing conditions to 11,560 m^3 under post-development conditions. Therefore, there is no net loss in flood storage from the 1% AEP floodplain.

Response to Item 9

Requirement: The development potential of surrounding properties is not adversely affected by the filling proposal

It has been demonstrated that, for the 1% AEP design flood, the proposed development does not result in any reduction in flood storage, does not cause any significant off-site increases in peak flood levels or velocities, and does not result in any redistribution of flows. Accordingly, there is no potential for the proposed filling to adversely affect the development potential of surrounding properties.

Response to Item 10

Requirement: The flood liability of buildings on surrounding properties is not increased

The flood level difference mapping discussed in **Section 3.3** shows that the proposed subdivision and neighbouring carpark development does not result in any material increases to flood levels at surrounding properties in the 1% AEP flood.

It has been demonstrated that for the 1% AEP design flood, the proposed development does not cause any significant off-site increases in peak flood levels or velocities. Accordingly, the flood liability of buildings on surrounding properties is not increased.

6 Conclusions

Results extracted from the '*Nepean River Flood Study*' (2018) indicate that parts of the site at 158-164 Old Bathurst Road, Emu Plains, would be inundated during a 1% AEP Nepean River flood. Accordingly, it is necessary to assess the potential impacts of the proposed development on flooding.

An assessment of the potential flood impacts was undertaken using the TUFLOW flood model that has been developed as part of work being completed for the *Lower Nepean River Floodplain Risk Management Study* (*current*). The TUFLOW model was modified to include new survey data to better represent the topography at the site under existing conditions. A separate version of this modified model was created to represent post-development conditions by including a design surface for the site. The 1% AEP event was then simulated to assess flood behaviour for both existing and post-development conditions. The results were compared to establish whether any changes in peak flood level or flow velocity can be expected as a result of the proposed development.

The following conclusions can be drawn from the assessment.

- Under existing conditions, the majority of the site is not expected to be inundated during the 1% AEP event. The swamp area in the western portion of the site is predicted to be inundated by floodwaters backing up from the Nepean River and entering via the culvert under Old Bathurst Road and David Road. A small portion of the north-eastern corner of the site is also predicted to be inundated during the 1% AEP event.
- The peak 1% AEP flood level in the vicinity of the development site is predicted to be about 23.9 mAHD (*refer* **Figure A1-2**).
- Flow velocities at the peak of the 1% AEP event are generally expected to be less than 0.2 m/s in the vicinity of the site (*refer* **Figure A3-2**).
- Flooding near the development site would be classified as being H3 to H5 according to the ARR 2019 flood hazard categories (*refer* **Figure A4-2**). This is attributed to the relatively high flood depths near the site (*generally greater than 0.5 metres depth*).
- Hydraulic category criteria adopted from the '*Nepean River Flood Study*' (Advisian, 2018) indicate that flooding near the site would be classified as Flood Storage (*refer* **Figure A5-2**).
- The proposed subdivision and carpark developments are not expected to result in off-site flood level increases of more than 0.01 metres during the 1% AEP event (*refer* **Figure B5-2**).
- The proposed subdivision and carpark developments are not expected to result in off-site flow velocity increases of more than 0.1 m/s during the 1% AEP event (*refer* **Figure B6-2**).
- The proposed development and associated filling will not result in any loss in the 1% AEP flood storage volume.
- As presented in **Chapter 5**, the proposed development is considered to satisfy the various requirements of relevant flood planning clauses in Part C1 and Part C14 of Section 3.5 of the Penrith Development Control Plan 2014.

Due to the potential for the site to be inundated in major floods, there is a need to ensure the risk to future occupants of the site is minimised by adopting an appropriate flood emergency response plan. Advisian has prepared a *Flood Emergency Response Strategy* for the site as a separate report which provides information on warning times and recommendations for flood emergency response protocols including evacuation procedures.

7 References

Advisian (*2018)*, '*Nepean River Flood Study*', prepared for Penrith City Council.

Advisian (*2022)*, '*Flood Emergency Response Strategy: Proposed Subdivision of 158-164 Old Bathurst Road, Emu Plains*', prepared for Acor Consultants and Penrith City Council.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (*2019*), '*Australian Rainfall and Runoff: A Guide to Flood Estimation*', © Commonwealth of Australia (Geoscience Australia), (ARR 2019).

CSIRO and Bureau of Meteorology (*2015*), *'Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report'*, CSIRO and Bureau of Meteorology, Australia

Intergovernmental Panel on Climate Change (*2013*), '*Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*', Stocker, T.F., and others (Eds.), Cambridge University Press, Cambridge, UK and New York, NY, USA.

Penrith City Council (*2014*), '*Penrith Development Control Plan 2014*', (Penrith DCP 2014).

Webb, McKeown & Associates (1997), *'Hawkesbury Nepean Flood Management Strategy: Engineering Studies to Modify Flood Behaviour'*, prepared for Hawkesbury Nepean Flood Management Advisory Committee.

WMAwater (*2019)*, '*Hawkesbury-Nepean Valley Regional Flood Study*', prepared for Infrastructure NSW.

Appendix A
Design Flood Mapping for Existing Conditions

FIGURE A1-1

LEGEND

Site Boundary

Peak Flood Level [mAHD]

- <= 20
- 20 - 21
- 21 - 22
- 22 - 23
- 23 - 24
- 24 - 25
- 25 - 26
- 26 - 27
- 27 - 28
- 28 - 29
- 29 - 30
- > 30

Refer Figure A1-2

OLD BATHURST ROAD

RAILWAY – T1 WESTERN LINE

GT WESTERN HWY

M4 WESTERN MOTORWAY

Nepean River

EMU PLAINS

PENRITH

N

0 250 500 750 1,000 m

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Design Flows:	Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

1% AEP PEAK FLOOD LEVELS
LOWER NEPEAN RIVER FLOODPLAIN
[EXISTING CONDITIONS]

FIGURE A1-2

LEGEND

Site Boundary

Peak Flood Level [mAHD]

- <= 20
- 20 - 21
- 21 - 22
- 22 - 23
- 23 - 24
- 24 - 25
- 25 - 26
- 26 - 27
- 27 - 28
- 28 - 29
- 29 - 30
- > 30

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Design Flows:		Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)	

1% AEP PEAK FLOOD LEVELS NEAR EMU PLAINS [EXISTING CONDITIONS]

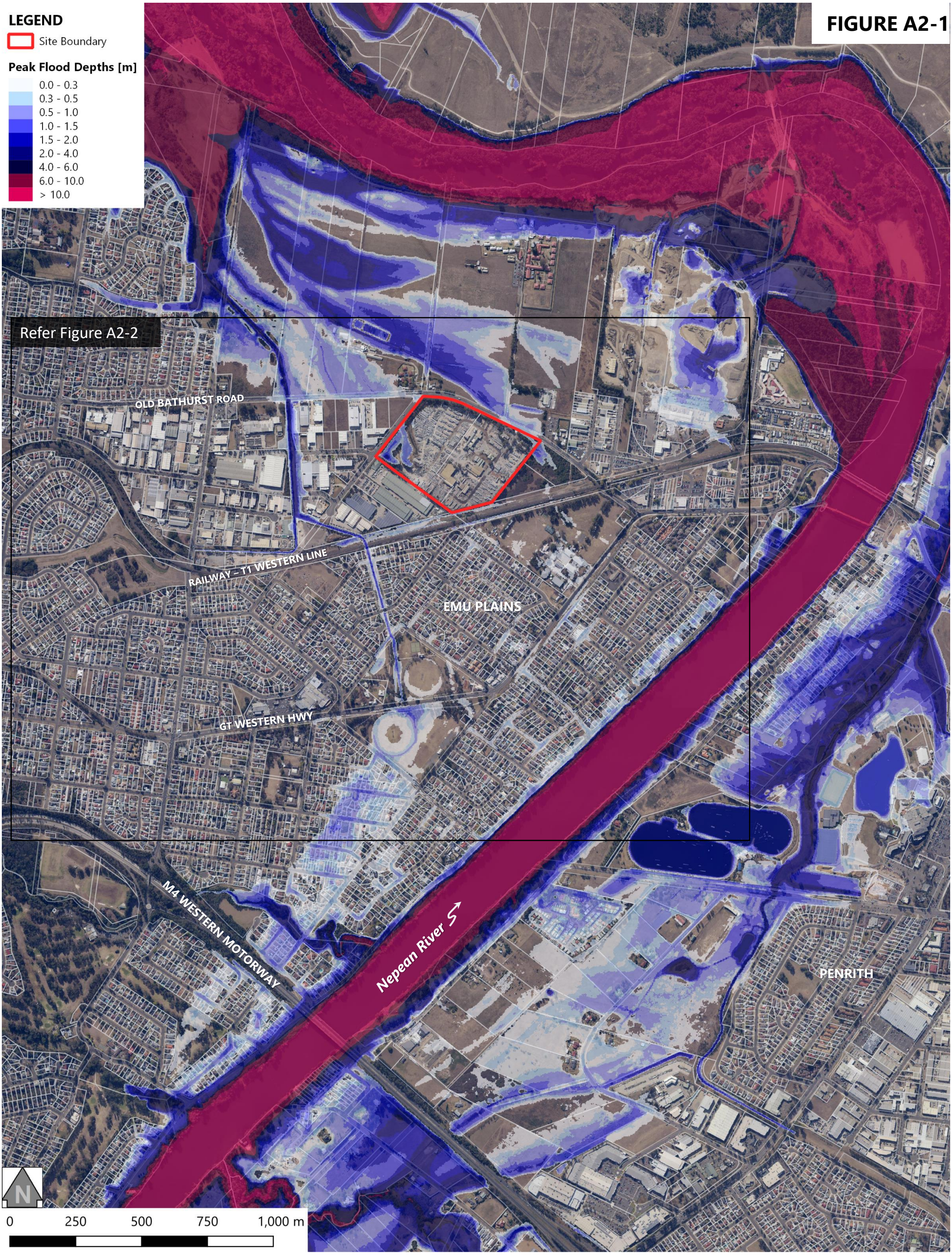
FIGURE A2-1

LEGEND

Site Boundary

Peak Flood Depths [m]

- 0.0 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 10.0
- > 10.0



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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

Date: 06/10/2022

1% AEP PEAK FLOOD DEPTHS LOWER NEPEAN RIVER FLOODPLAIN [EXISTING CONDITIONS]

FIGURE A2-2

LEGEND

Site Boundary

Peak Flood Depth (m)

- 0.0 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 10.0
- > 10.0

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1% AEP PEAK FLOOD DEPTHS NEAR EMU PLAINS [EXISTING CONDITIONS]

FIGURE A3-1

LEGEND

Site Boundary

Peak Flood Velocity [m/s]

- <= 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 10.0
- > 10.0

Refer Figure A3-2

OLD BATHURST ROAD

RAILWAY – T1 WESTERN LINE

EMU PLAINS

GT WESTERN HWY

M4 WESTERN MOTORWAY

Nepean River

PENRITH

N

0 250 500 750 1,000 m

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Design Flows:	Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

1% AEP PEAK FLOOD VELOCITIES LOWER NEPEAN RIVER FLOODPLAIN [EXISTING CONDITIONS]

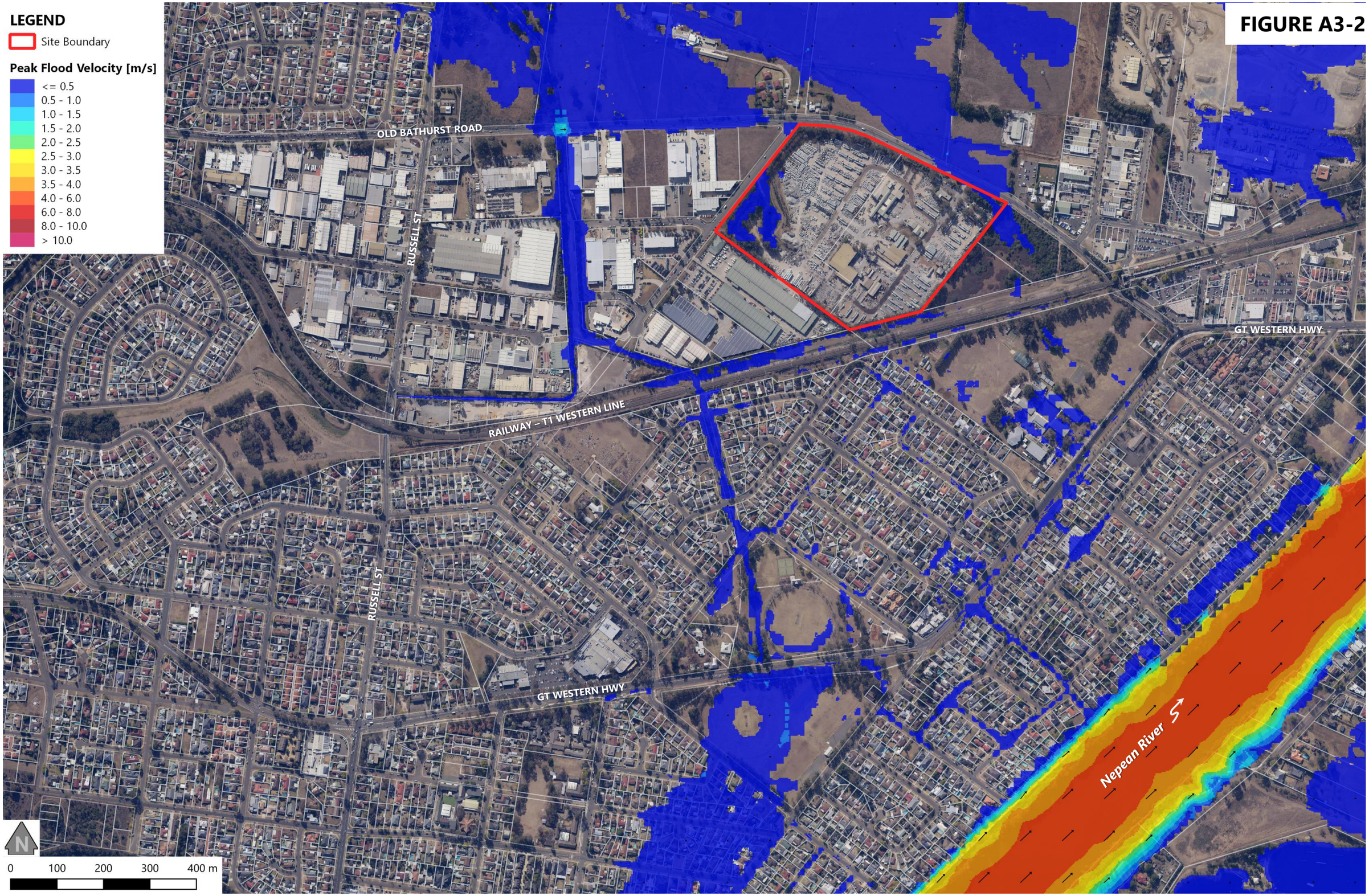
FIGURE A3-2

LEGEND

Site Boundary

Peak Flood Velocity [m/s]

- <= 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 10.0
- > 10.0



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Design Flows:	Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

1% AEP PEAK FLOOD VELOCITIES NEAR EMU PLAINS [EXISTING CONDITIONS]

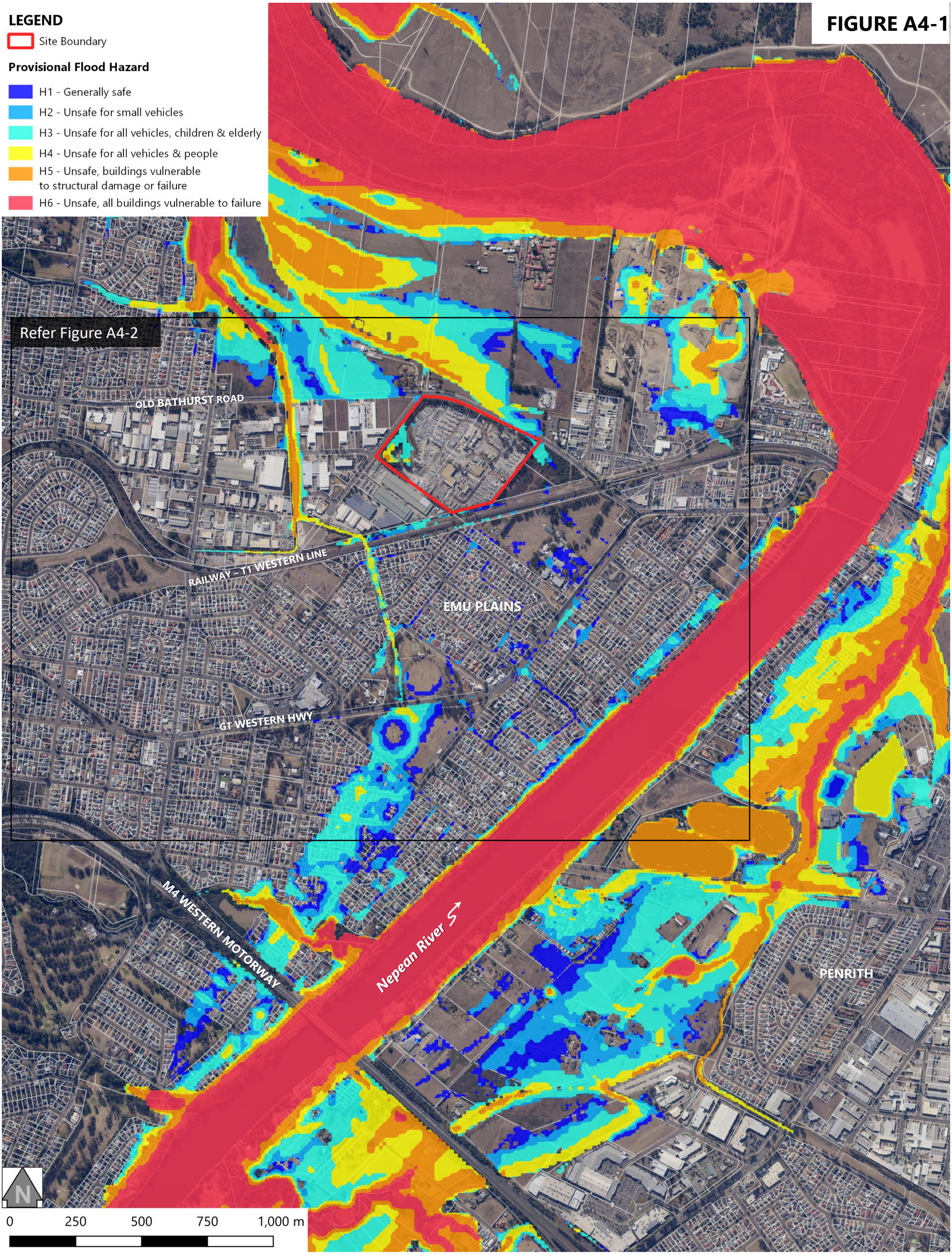
FIGURE A4-1

LEGEND

Site Boundary

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure



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1% AEP PROVISIONAL FLOOD HAZARD LOWER NEPEAN RIVER FLOODPLAIN [EXISTING CONDITIONS]

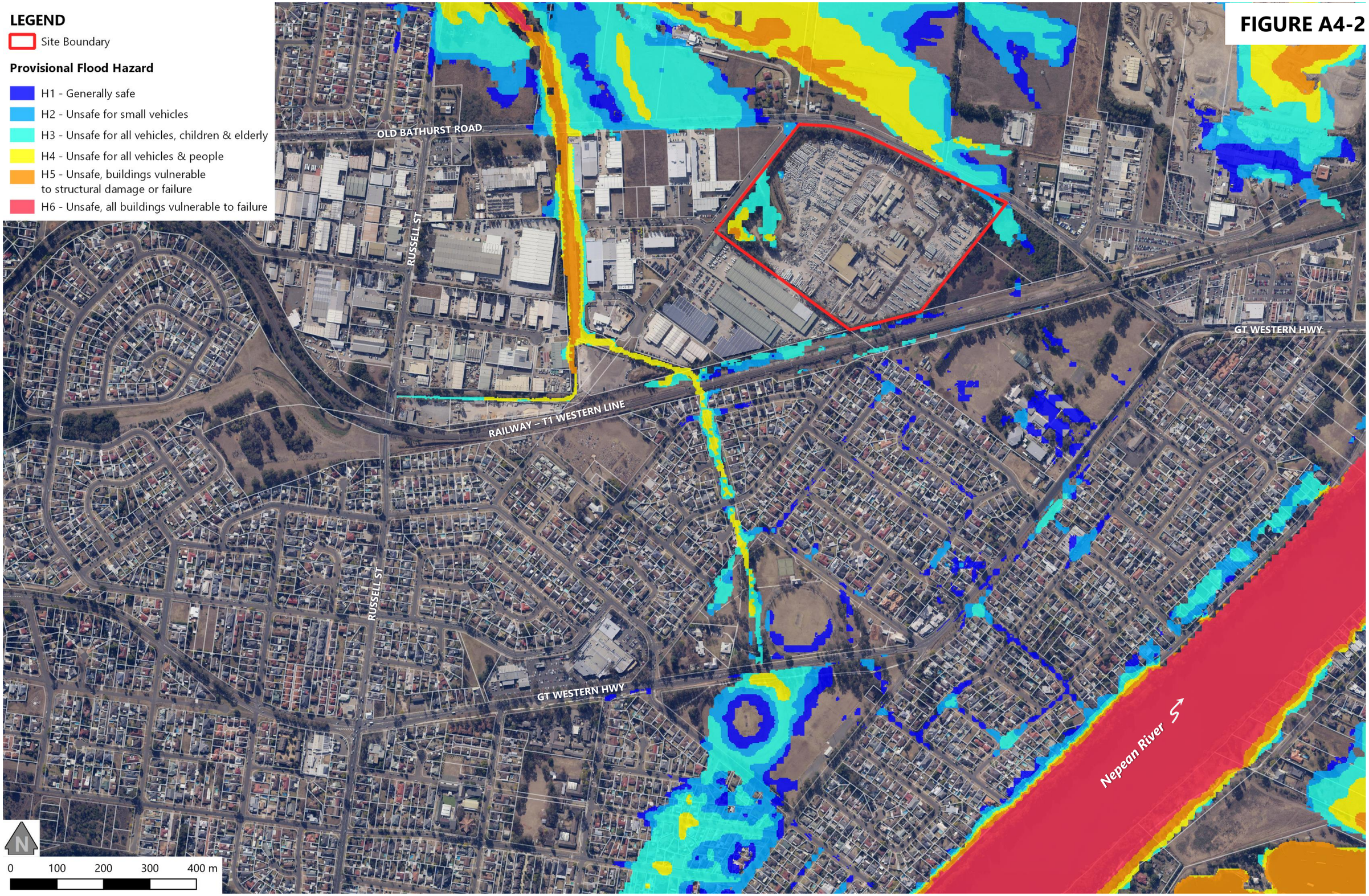
FIGURE A4-2

LEGEND

Site Boundary

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerable to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure



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1% AEP PROVISIONAL FLOOD HAZARD NEAR EMU PLAINS [EXISTING CONDITIONS]

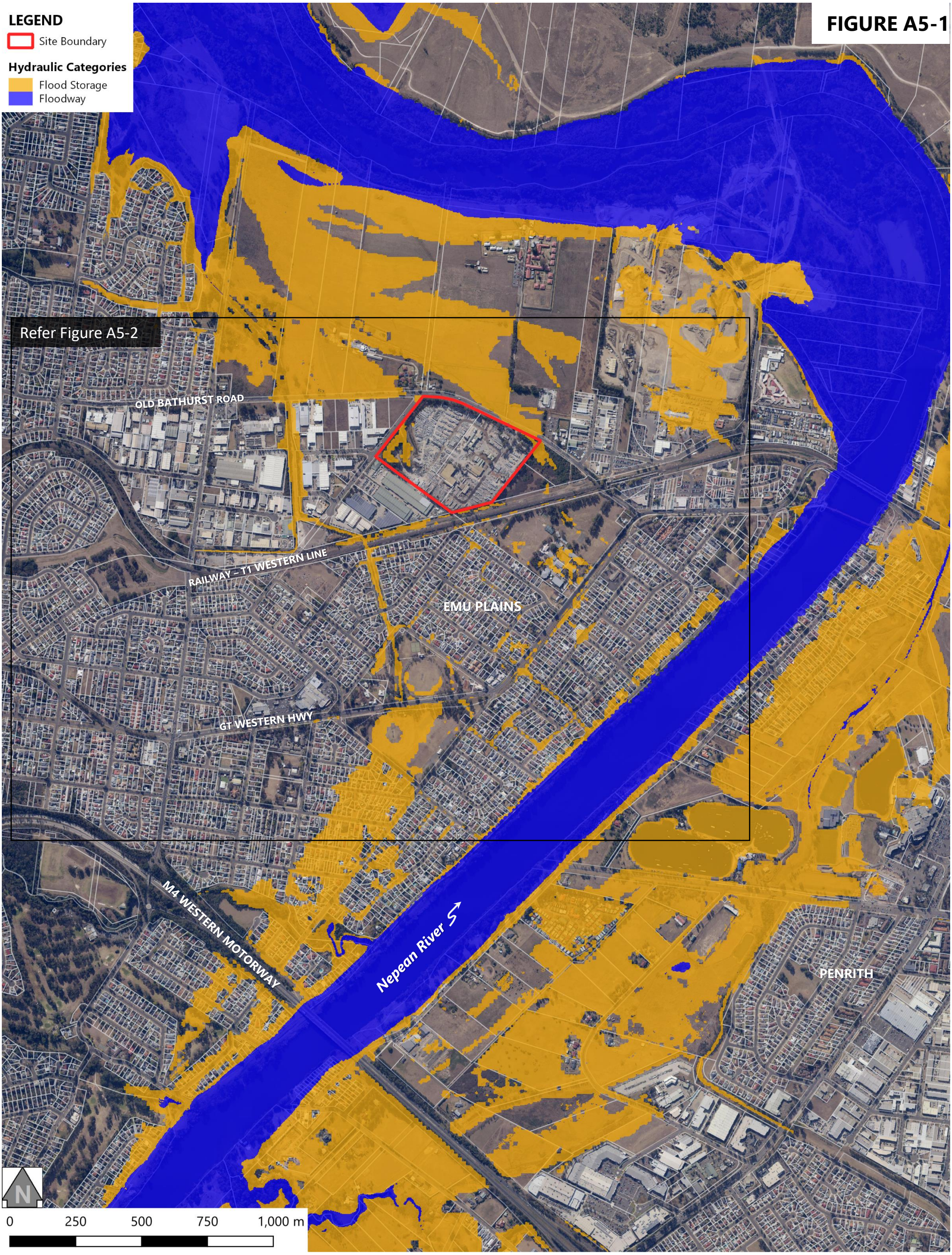
FIGURE A5-1

LEGEND

Site Boundary

Hydraulic Categories

Flood Storage
Floodway



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1% AEP HYDRAULIC CATEGORIES LOWER NEPEAN RIVER FLOODPLAIN [EXISTING CONDITIONS]

FIGURE A5-2

LEGEND

Site Boundary

Hydraulic Categories

Flood Storage

Floodway

OLD BATHURST ROAD

RUSSELL ST

RAILWAY – T1 WESTERN LINE

GT WESTERN HWY

RUSSELL ST

GT WESTERN HWY

Nepean River

N

0 100 200 300 400 m

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Date: 16/03/2022

1% AEP HYDRAULIC CATEGORIES NEAR EMU PLAINS [EXISTING CONDITIONS]

Appendix B
Design Flood and Impact Mapping for Post-Development Conditions

FIGURE B1-1

LEGEND

Site Boundary

Peak Flood Level [mAHD]

- <= 20
- 20 - 21
- 21 - 22
- 22 - 23
- 23 - 24
- 24 - 25
- 25 - 26
- 26 - 27
- 27 - 28
- 28 - 29
- 29 - 30
- > 30

Refer Figure B1-2

OLD BATHURST ROAD

RAILWAY – T1 WESTERN LINE

GT WESTERN HWY

M4 WESTERN MOTORWAY

Nepean River

EMU PLAINS

PENRITH

0 250 500 750 1,000 m

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

1% AEP PEAK FLOOD LEVELS
LOWER NEPEAN RIVER FLOODPLAIN
[POST-DEVELOPMENT CONDITIONS]

FIGURE B1-2

LEGEND

Site Boundary

Peak Flood Level [mAHD]

- <= 20
- 20 - 21
- 21 - 22
- 22 - 23
- 23 - 24
- 24 - 25
- 25 - 26
- 26 - 27
- 27 - 28
- 28 - 29
- 29 - 30
- > 30

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

Date: 06/10/2022

1% AEP PEAK FLOOD LEVELS NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS]

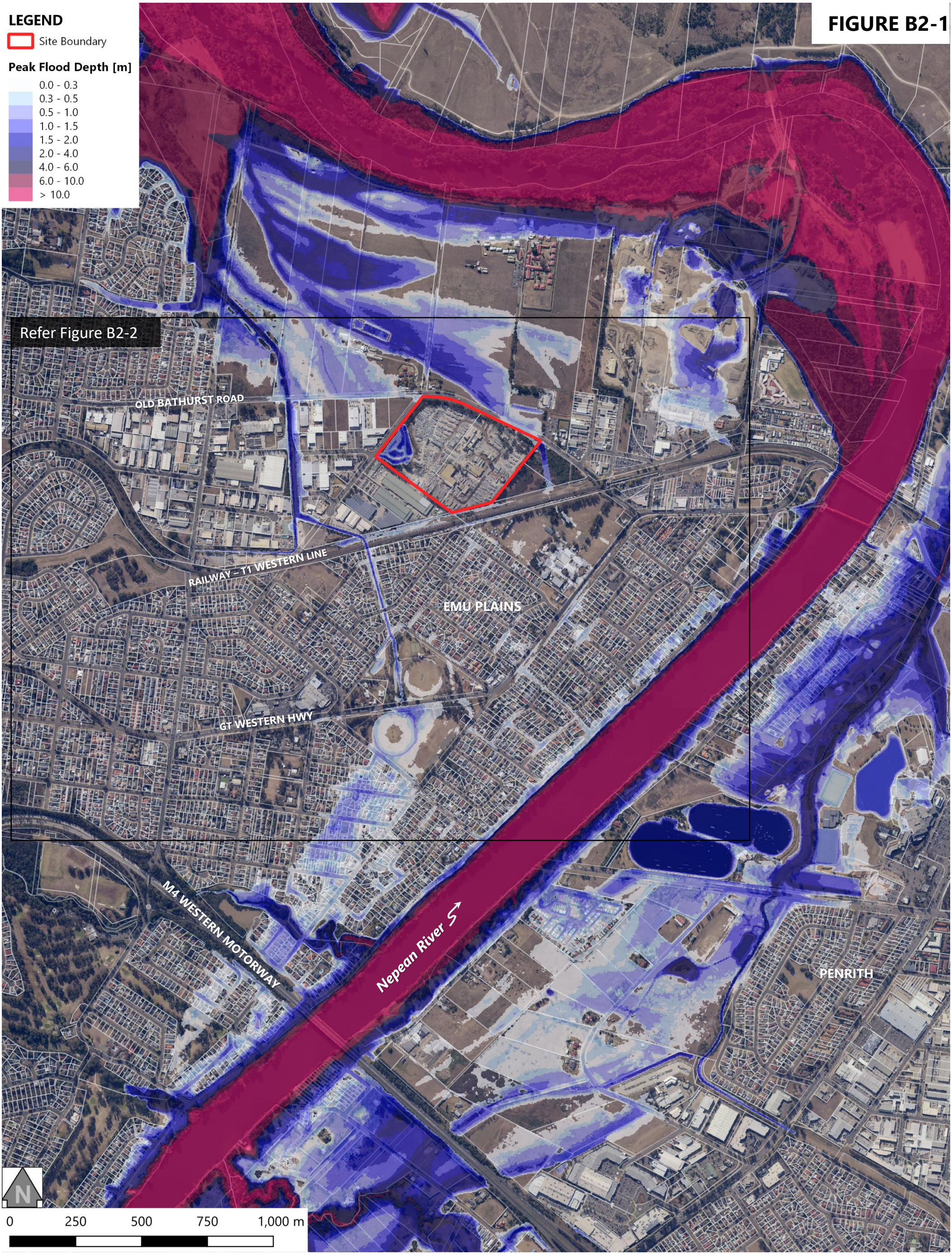
FIGURE B2-1

LEGEND

Site Boundary

Peak Flood Depth [m]

- 0.0 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 10.0
- > 10.0



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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

Date: 06/10/2022

1% AEP PEAK FLOOD DEPTHS LOWER NEPEAN RIVER FLOODPLAIN [POST-DEVELOPMENT CONDITIONS]

FIGURE B2-2

LEGEND

Site Boundary

Peak Flood Depth [m]

- <= 0
- 0.0 - 0.3
- 0.3 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 4.0
- 4.0 - 6.0
- 6.0 - 10.0
- > 10.0

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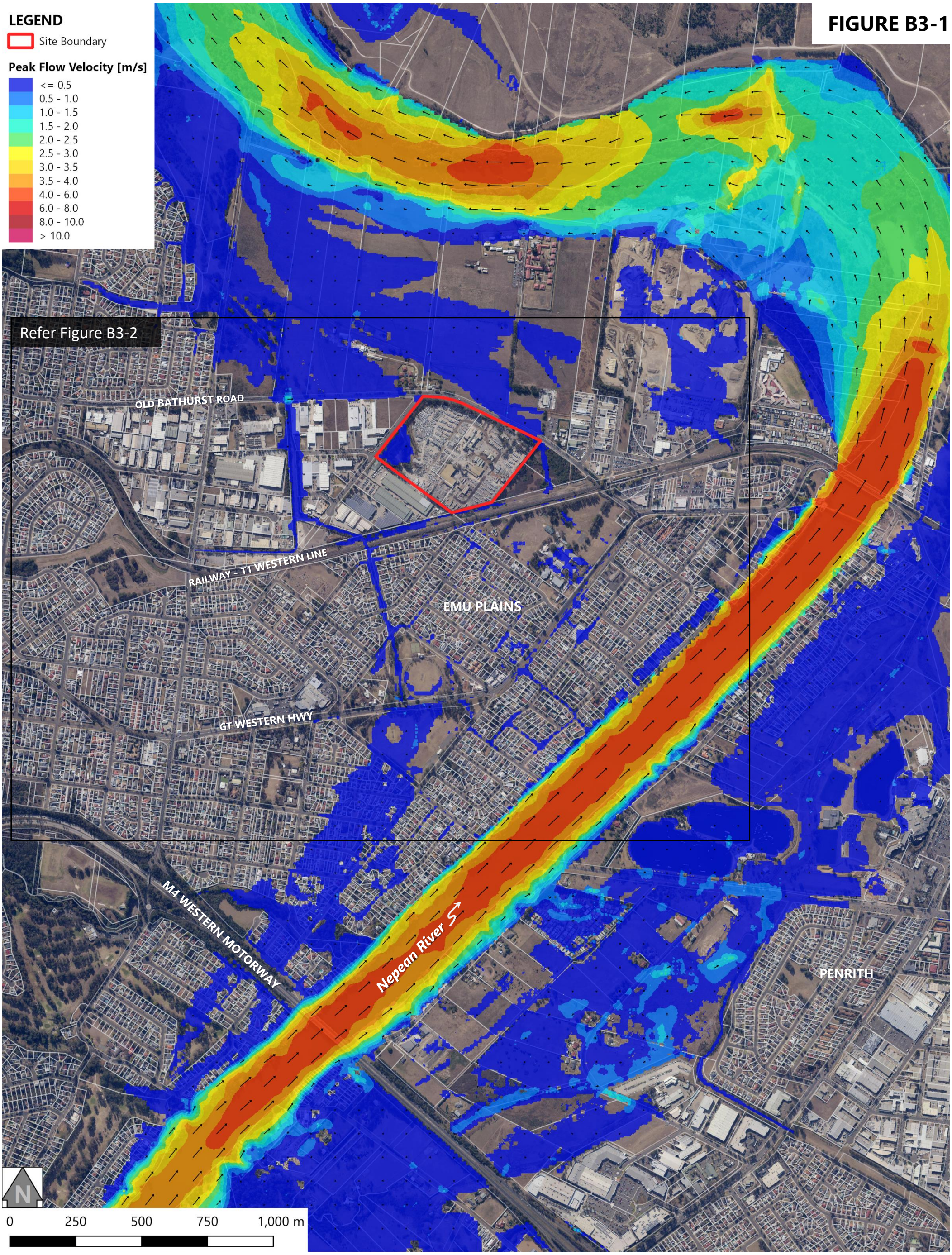
Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

1% AEP PEAK FLOOD DEPTHS NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS]

FIGURE B3-1



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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
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1% AEP PEAK FLOOD VELOCITIES LOWER NEPEAN RIVER FLOODPLAIN [POST-DEVELOPMENT CONDITIONS]

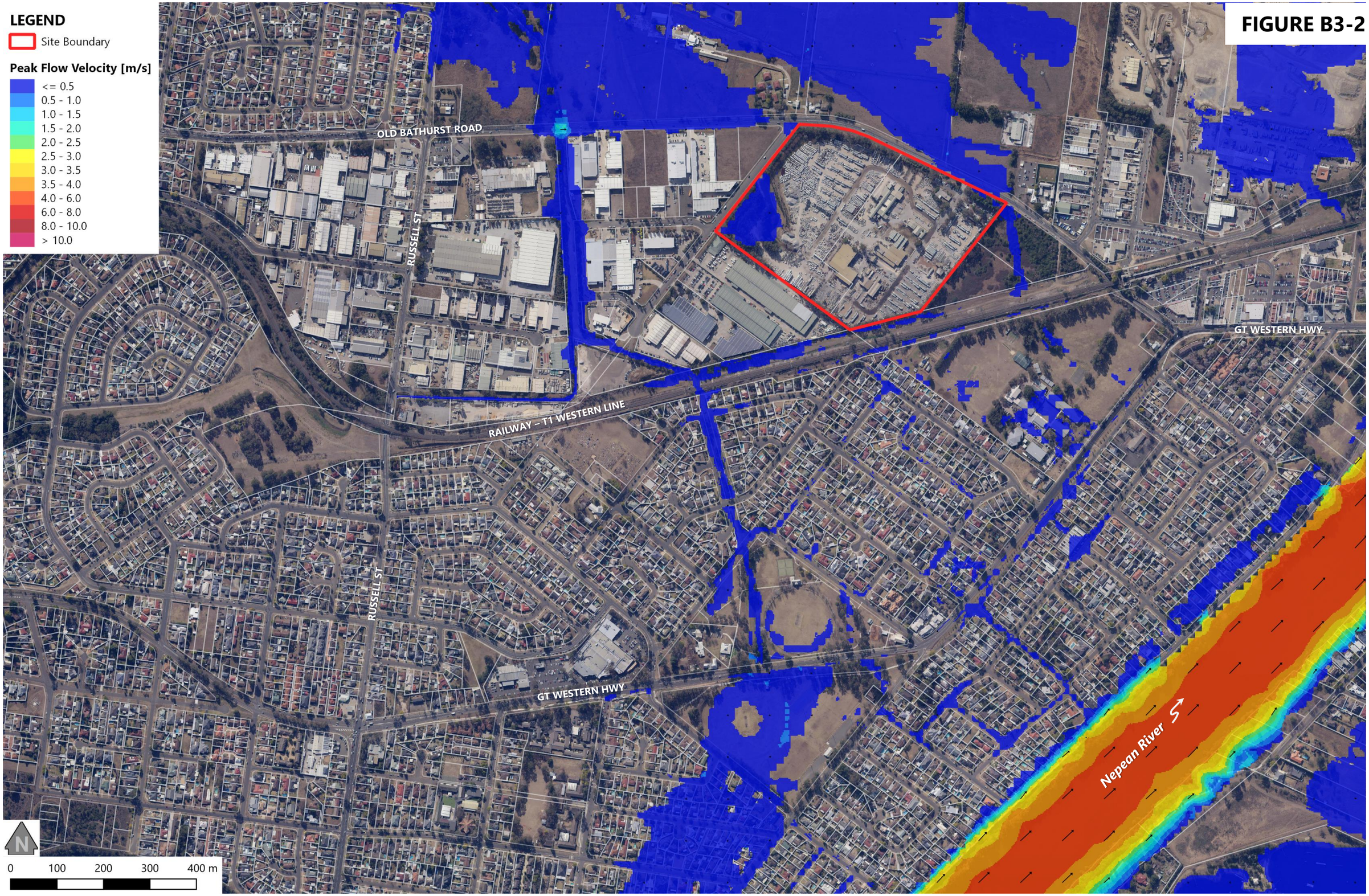
FIGURE B3-2

LEGEND

Site Boundary

Peak Flow Velocity [m/s]

- <= 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 6.0
- 6.0 - 8.0
- 8.0 - 10.0
- > 10.0



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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

1% AEP PEAK FLOOD VELOCITIES NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS]

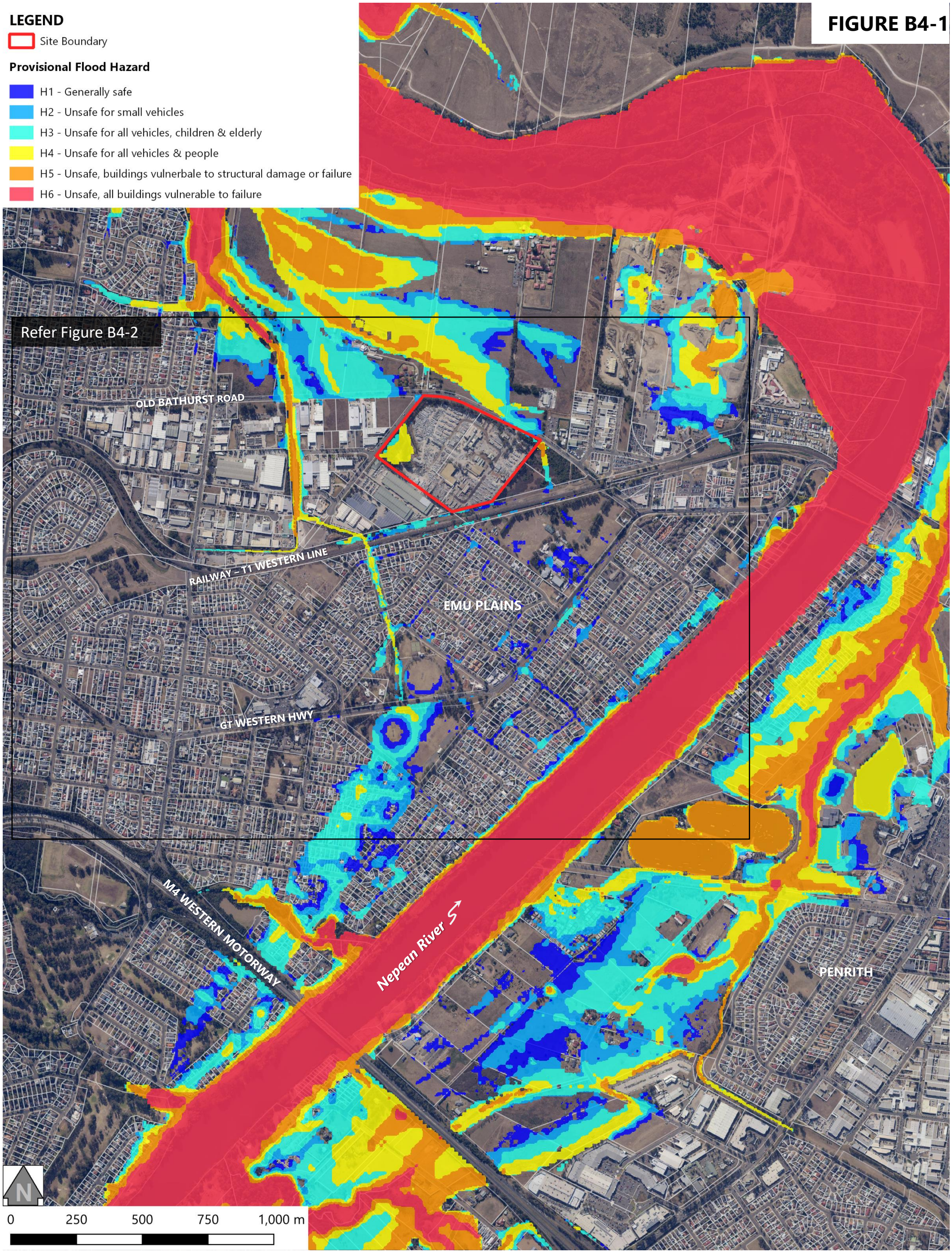
FIGURE B4-1

LEGEND

Site Boundary

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerbale to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure



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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

1% AEP PROVISIONAL FLOOD HAZARD LOWER NEPEAN RIVER FLOODPLAIN [POST-DEVELOPMENT CONDITIONS]

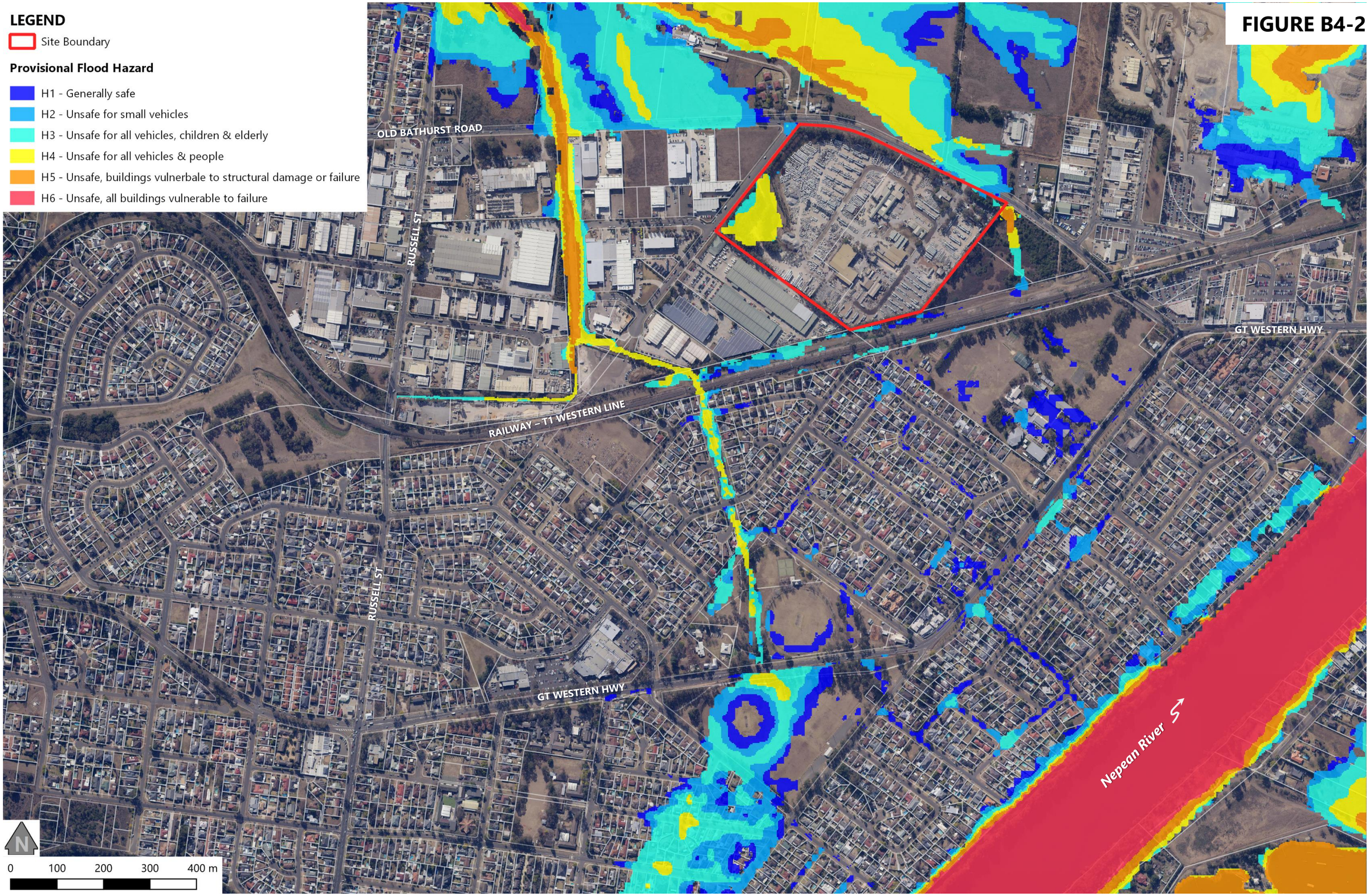
FIGURE B4-2

LEGEND

Site Boundary

Provisional Flood Hazard

- H1 - Generally safe
- H2 - Unsafe for small vehicles
- H3 - Unsafe for all vehicles, children & elderly
- H4 - Unsafe for all vehicles & people
- H5 - Unsafe, buildings vulnerbale to structural damage or failure
- H6 - Unsafe, all buildings vulnerable to failure



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TUFLOW version: ~s3~_LNR_220220_~s1~_~e1~_~s2~.tcf
Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

Date: 06/10/2022

1% AEP PROVISIONAL FLOOD HAZARD NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS]

FIGURE B5-1

LEGEND

Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

Refer Figure B5-2

OLD BATHURST ROAD

RAILWAY – T1 WESTERN LINE

EMU PLAINS

GT WESTERN HWY

M4 WESTERN MOTORWAY

Nepean River

PENRITH

NB: Mapping shows post-development Phase 2 peak flood levels less existing condition peak flood levels

N

0 250 500 750 1,000 m

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

DIFFERENCE IN 1% AEP PEAK FLOOD LEVELS LOWER NEPEAN RIVER FLOODPLAIN [POST-DEVELOPMENT CONDITIONS LESS EXISTING]

FIGURE B5-2

LEGEND

Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

- Highly localised flood level increase of up to 20mm observed.
- Occurs in an area that is not hydraulically linked to the proposed development site in this design flood event.
- The flood level increase was found to be caused by a minor instability in the 1D culvert at this location and is not related to the proposed development.
- Additionally, it is recommended that a 'model threshold' of 20mm be adopted for this study, whereby changes in flood level of less than this magnitude are not to be considered as 'impacts' of the development.

'Newly inundated' area within formalised channel through neighbouring TfNSW carpark

OLD BATHURST ROAD

RUSSELL ST

RAILWAY – T1 WESTERN LINE

GT WESTERN HWY

Nepean River

NB: Mapping shows post-development Phase 2 peak flood levels less existing condition peak flood levels

N

0 100 200 300 400 m

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File:
QGIS Project:
TUFLOW version:
Design Flows:

Date: 06/10/2022
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Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

DIFFERENCE IN 1% AEP PEAK FLOOD LEVELS NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE B6-1

LEGEND

Site Boundary

Difference in Velocity [m/s]

- <= -0.50
- -0.50 to -0.30
- -0.30 to -0.20
- -0.20 to -0.10
- -0.10 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.50
- > 0.50

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

Refer Figure B6-2

OLD BATHURST ROAD

RAILWAY – T1 WESTERN LINE

EMU PLAINS

GT WESTERN HWY

M4 WESTERN MOTORWAY

Nepean River

PENRITH

NB: Mapping shows post-development Phase 2 peak flood levels less existing condition peak flood levels

N

0 250 500 750 1,000 m

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

DIFFERENCE IN 1% AEP PEAK FLOW VELOCITIES LOWER NEPEAN RIVER FLOODPLAIN [POST-DEVELOPMENT CONDITIONS LESS EXISTING]

FIGURE B6-2

LEGEND

Site Boundary

Difference in Velocity [m/s]

- <= -0.50
- -0.50 to -0.30
- -0.30 to -0.20
- -0.20 to -0.10
- -0.10 to 0.10
- 0.10 to 0.20
- 0.20 to 0.30
- 0.30 to 0.50
- > 0.50

Change in Flood Extents

- No Longer Inundated
- Newly Inundated

- Localised flow velocity increase of up to 0.2 m/s observed.
- Occurs in an area that is not hydraulically linked to the proposed development site in this design flood event.
- The flood level increase was found to be caused by a minor instability in the 1D culvert at this location and is not related to the proposed development.
- This is not considered as an impact of the proposed development.

- Localised flow velocity increase of up to 0.2 m/s observed at D/S end of channel through carpark.
- The formalised channel through the carpark site allows a slight increase in flows to back up from Old Bathurst Rd to this location.
- This impact is contained entirely within the channel.

'Newly inundated' area within formalised channel through neighbouring TfNSW carpark

NB: Mapping shows post-development Phase 2 peak flood levels less existing condition peak flood levels

OLD BATHURST ROAD
RUSSELL ST
RAILWAY – T1 WESTERN LINE
GT WESTERN HWY
Nepean River

N

0 100 200 300 400 m

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 06/10/2022

DIFFERENCE IN 1% AEP PEAK FLOOD LEVELS NEAR EMU PLAINS [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

Appendix C
Flood Impact Mapping for Post-Development Conditions Under Climate Change

FIGURE C-1

LEGEND

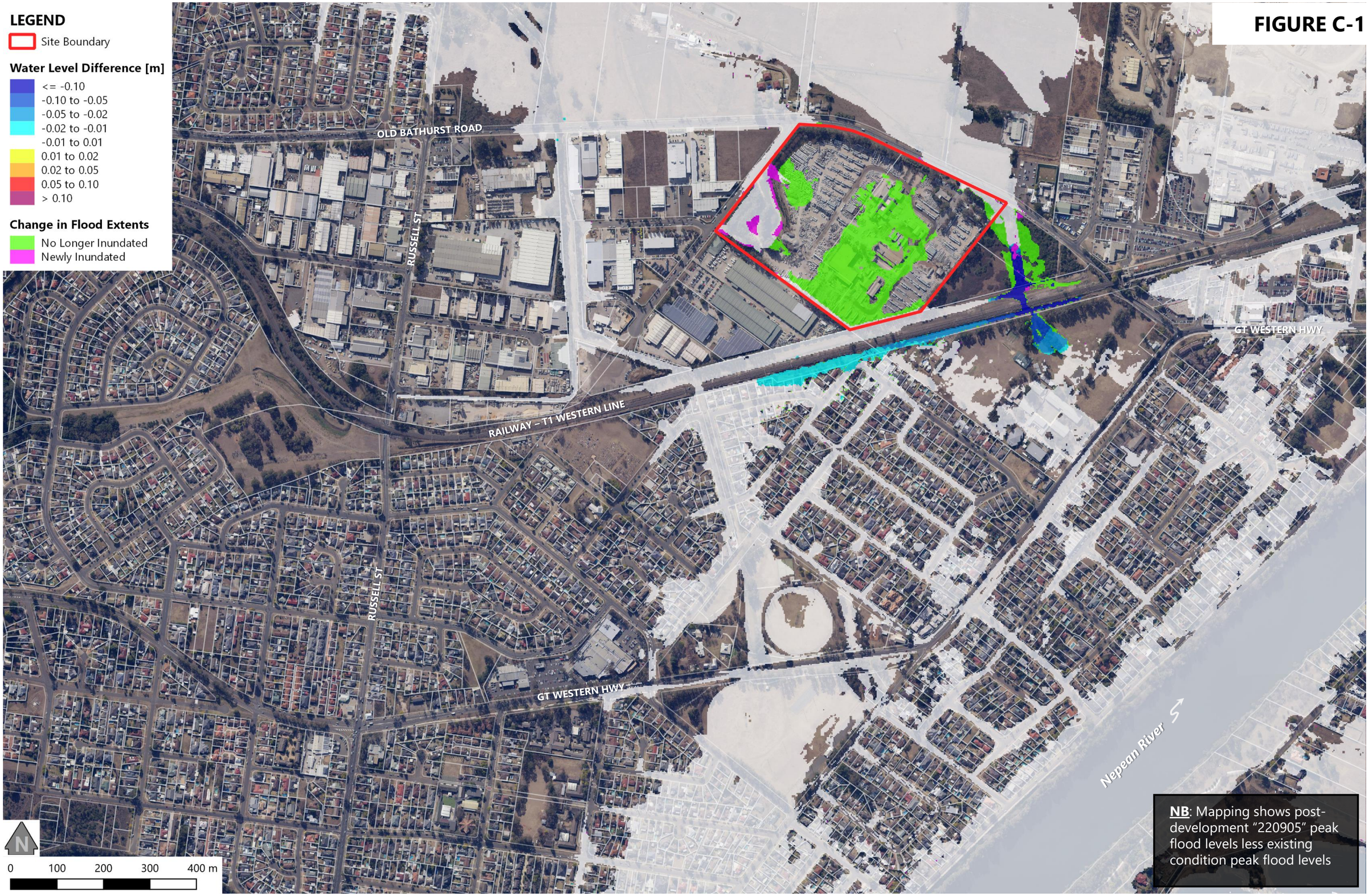
Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated



NB: Mapping shows post-development "220905" peak flood levels less existing condition peak flood levels

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 19/09/2022

IMPACT OF DEVELOPMENT ON 1% AEP PEAK FLOOD LEVELS UNDER 4.9% INCREASE IN FLOW CLIMATE CHANGE SCENARIO [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE C-2

LEGEND

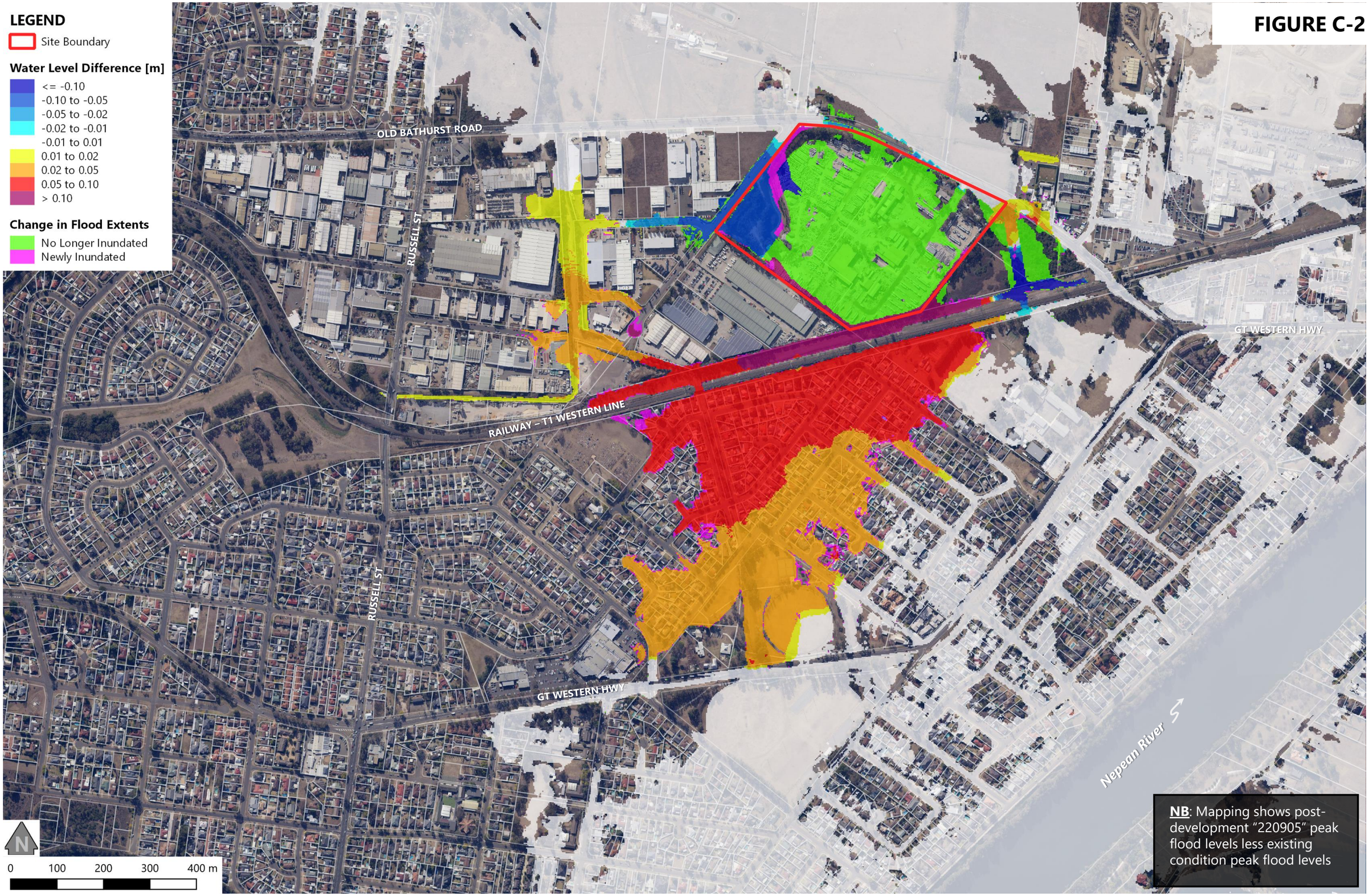
Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated



NB: Mapping shows post-development "220905" peak flood levels less existing condition peak flood levels

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

IMPACT OF DEVELOPMENT ON 1% AEP PEAK FLOOD LEVELS UNDER 9.1% INCREASE IN FLOW CLIMATE CHANGE SCENARIO [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE C-3

LEGEND

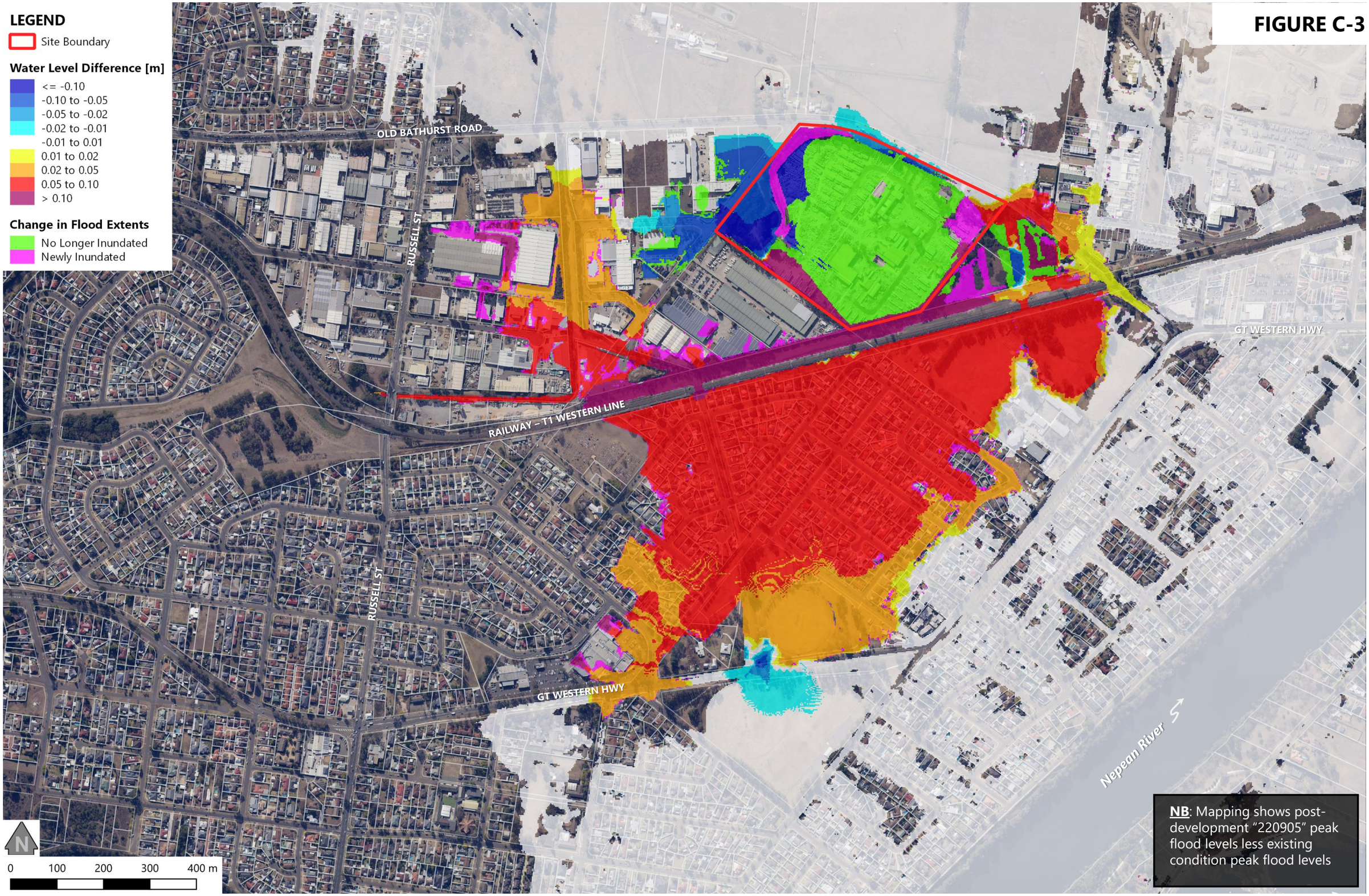
Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated



NB: Mapping shows post-development "220905" peak flood levels less existing condition peak flood levels

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)
Date: 19/09/2022

IMPACT OF DEVELOPMENT ON 1% AEP PEAK FLOOD LEVELS UNDER 13.9% INCREASE IN FLOW CLIMATE CHANGE SCENARIO [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]

FIGURE C-4

LEGEND

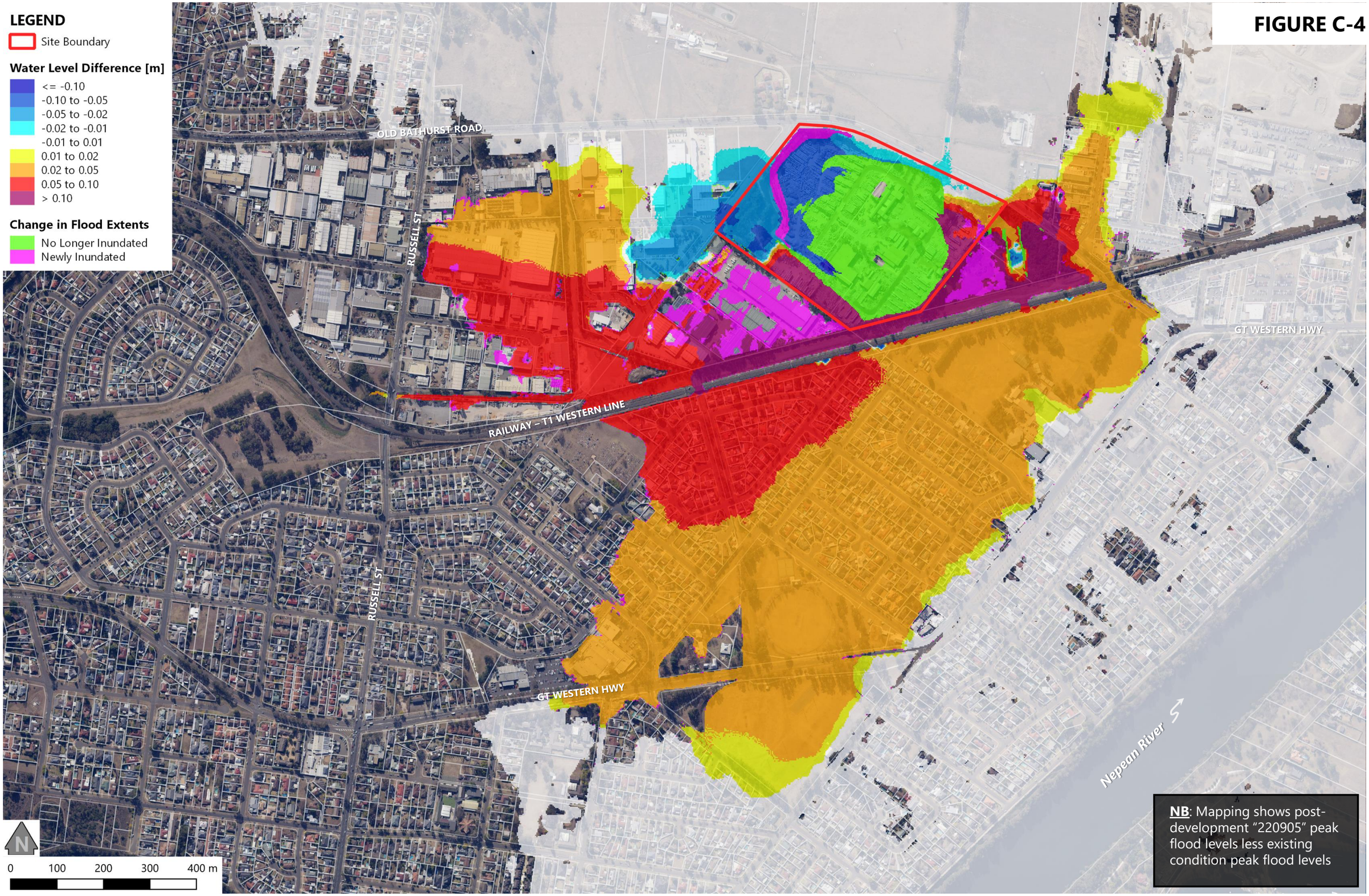
Site Boundary

Water Level Difference [m]

- <= -0.10
- -0.10 to -0.05
- -0.05 to -0.02
- -0.02 to -0.01
- -0.01 to 0.01
- 0.01 to 0.02
- 0.02 to 0.05
- 0.05 to 0.10
- > 0.10

Change in Flood Extents

- No Longer Inundated
- Newly Inundated



NB: Mapping shows post-development "220905" peak flood levels less existing condition peak flood levels

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Design Flows: Hawkesbury-Nepean Valley Regional Flood Study (WMAwater, 2019)

Date: 19/09/2022

IMPACT OF DEVELOPMENT ON 1% AEP PEAK FLOOD LEVELS UNDER 18.6% INCREASE IN FLOW CLIMATE CHANGE SCENARIO [POST-DEVELOPMENT CONDITIONS LESS EXISTING CONDITIONS]