Project:	*Epping Town Centre – Flood Assessment for Planning Proposal*
Project ID:	*210046*
Date:	*24 April 2024*
To:	*Oakstand, Justin Micallef*
Subject:	*April 2024 Revision of Plans*
Version:	*V01*
Author:	*Tomas Steele, Senior Engineer*
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RE: Epping Town Centre – Flood Assessment for Planning Proposal. April 2024 Revision of Plans

GRC Hydro have previously issued a detailed flood risk assessment for a proposed development "Epping Town Centre" at the corner of Rawson Street and Carlingford Road, Epping (the subject site) in the 'Epping Town Centre, Flood Assessment for Planning Proposal', Revision C, GRC Hydro, 5th December 2023 (the flood assessment (GRC Hydro, 2023)). The assessment showed full compliance with the:

- Parramatta Development Control Plan (DCP, 2023);
- Parramatta Local Environmental Plan (LEP, 2023);
- Ministerial Direction 4.1; and
- Flood impact and risk assessment, Flood risk management guideline LU01 (DPE, 2023).

The flood assessment (GRC Hydro, 2023) was based on architectural plans by Oakstand dated 12th May 2023. Oakstand have since updated the plans and provided them via email correspondence on the 23rd April 2024 for comment from GRC Hydro.

GRC Hydro have reviewed the plans and noted no changes that would change the previously presented report or conclusions, as summarised in further detail below. As such, there is no need to update either the modelling or reporting presented in the 'Epping Town Centre, Flood Assessment for Planning Proposal', Revision C, GRC Hydro, 5th December 2023 and this document remains the detailed flood risk assessment for the proposed "Epping Town Centre".

Yours Sincerely,

Steve Gray

Director

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Summary of Flood Risk Assessment

The flood assessment (GRC Hydro, 2023) was conducted using detailed hydrologic and hydraulic modelling of existing catchment conditions and post-development catchment conditions for a wide range of design flood events including the 5% AEP, 1% AEP, 0.5% AEP and PMF. Flood inundation depths, peak floodwater levels, velocities, AIDR hazard category classification and flood function were presented and used to inform a detailed risk assessment of the proposed development's potential impact on the community, infrastructure and the users of the proposed "Epping Town Centre".

It was found the proposed "Epping Town Centre" was a very low flood risk to the community and flooding poses a low risk to both the building and its users, with residual risks manageable through proper emergency management planning. Key items contributing to the assessment were:

- The basement has a passive level of protection to the 1% AEP + 500mm freeboard through the raised entrance crest.
- The basement has a level of protection to the PMF provided through the proposed flood gates.
- The first level with pedestrian access to outside of the site is Ground Floor G which is above the 1% AEP + freeboard and the PMF flood level.
- All floors above Ground Floor G are residential and protected to well above the PMF flood level.
- A shelter-in-place strategy would be the safest approach to protect people during a flood since:
    - The proposed building is safe from the ingress of floodwater for all events.
    - The site has a very short warning time, and a short duration of inundation.

April 2024 Architectural Changes

The flood assessment (GRC Hydro, 2023) was based on architectural plans by Oakstand dated 12th May 2023. Oakstand have since updated the plans and provided them via email correspondence on the 23rd April 2024 for comment from GRC Hydro. GRC Hydro have the following observations and comments:

- Level 1 plan and above has changed to two towers rather than three. This change has no bearing on the previous flood assessment as the levels above Ground Floor G do not interact with floodwater and provide a similar vertical refuge benefit as previously assessed.
- Ground Floor G arrangement has changed, but still maintains an 88.5m AHD ground level and covers the same extent used for the building representation in the previous assessment. As such, the previous hydraulic model representation is still correct and the results, mapping and conclusions drawn from them are still valid.
- The Lower Ground LG is virtually the same with the same layout and carpark entrances to the basement locations and crest heights remain unchanged. Two differences are noted:
    - The service vehicle access has been extended onto Carlingford Rd. Oakstand have provided the following comment on this change in email correspondence on the 18th April 2024:

        > *"Council has agreed to retain the western DCP laneway along the western boundary in the flood affected area, for the use of service vehicles only during non-flood conditions. Flood warning devices will need to be installed and boom gates, bollards, etc will need to be designed and installed to allow the automatic closure of the laneway in a flood event. This will be resolved in detail at DA stage but important for you to know [Council] have now agreed to retain this access point."*

        The noted change does not change the outcomes of the hydraulic model, and the comments from Oakstand have removed the risk associated with the entrance sufficiently to not warrant an update to the previous risk assessment. As such the outcomes of the previous risk assessment, including the evacuation assessment, remain unchanged.

- Road grades remain virtually unchanged, with a very minor variation noted that is too small to be represented in the hydraulic modelling. As such, the previous hydraulic model representation is still correct and the results, mapping and conclusions drawn from them are still valid.

Conclusion

The observations and comments above let us conclude that based on the information presented to GRC Hydro that the flood assessment (GRC Hydro 2023), including the risk assessment and outcomes, are still valid with the proposed changes provided by Oakstand on the 23rd April 2024. No changes have been proposed to the key items contributing to the conclusion of the proposed "Epping Town Centre" being of a low flood risk. As such, there is no need to update either the modelling or reporting presented in the 'Epping Town Centre, Flood Assessment for Planning Proposal', Revision C, GRC Hydro, 5th December 2023.

Yours Sincerely,

Steve Gray

Director

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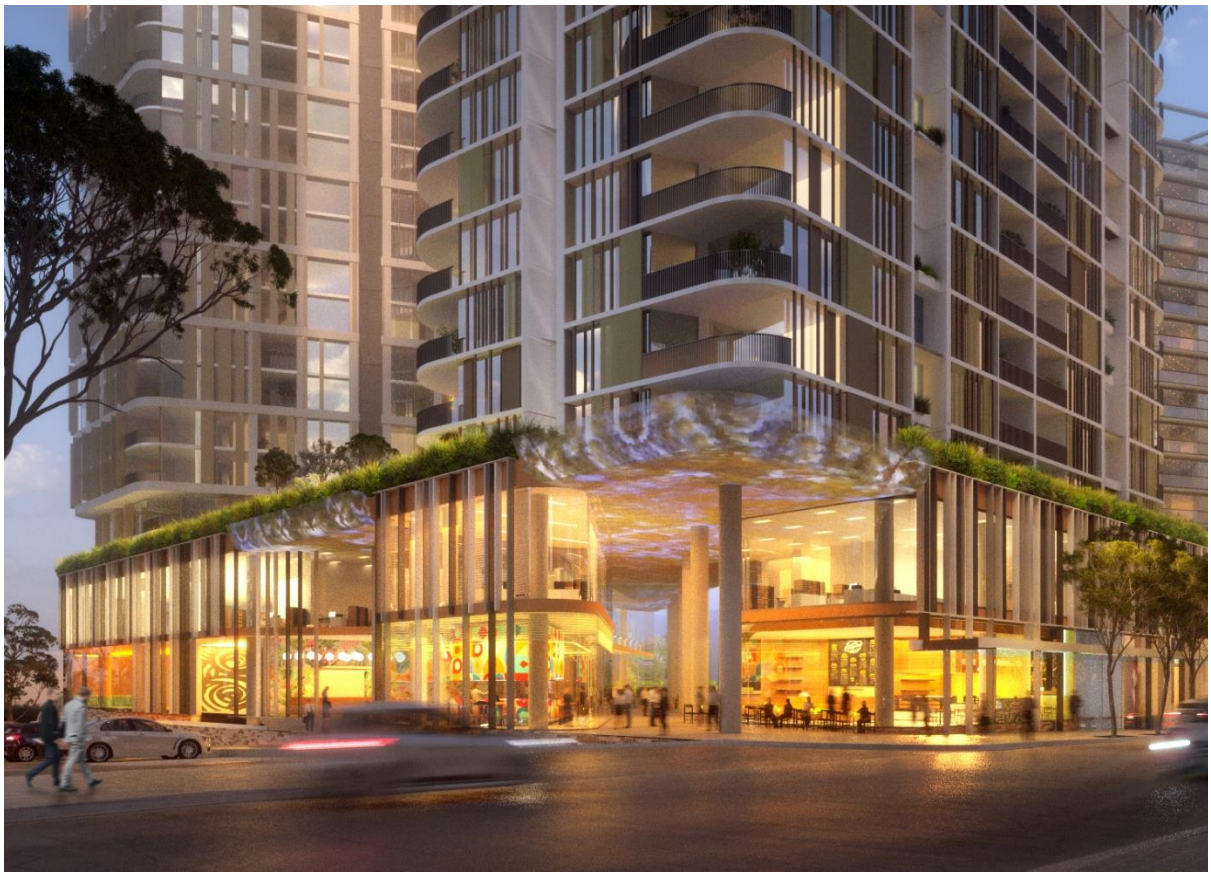
Epping Town Centre

Flood Assessment for Planning Proposal



Oakstand

December 2023

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Epping Town Centre
Flood Assessment for Planning Proposal

Project:	Epping Town Centre
Subject:	Flood Assessment for Planning Proposal
Project Number:	210046
Date:	5 December 2023

Client:	Oakstand
Client Contact:	Justin Micallef

Report Ver:	Revision C
Status:	Draft
Report Author:	Feiya He B. Eng Matthew Faint BEng (Civil & Env), Engineer Tomas Steele B. Eng
Reviewed/Approved:	Stephen Gray BE ME, Director

1. Executive Summary

Development, “Epping Town Centre” is proposed at the corner of Rawson Street and Carlingford Road (the subject site). The site is affected by flooding due to its proximity to Boronia Park Main Channel (the channel).

Pertinent background is that in 2021 Parramatta Council submitted a Planning Proposal for the greater Epping Town Centre, seeking to amend the Planning controls to require a minimum 1:1 non-residential uses for strategic sites within the town centre, in addition to the current floor space control. This proposal was not supported by the Department of Planning.

The proponent Oakstand seeks to submit a new Planning Proposal to achieve the same intent of the 1:1 non-residential floor space proposed by council, but for the subject site in isolation. The proposed development layout is as it was when GRC Hydro completed their 2021 flood report. A feature of the 2021 work was that GRC Hydro had worked with the proponent to ensure a development that was compliant with all applicable controls (Council DCP and LEP).

This revised report provides the following content:

- A summary of the subject site’s hydrologic and topographic context;
- Details on model build work (both hydrologic and hydraulic models have been developed) including a blockage assessment undertaken in line with best practice;
- Flood model results including flood depths, levels, hazard and hydraulic categories;
- Features of the proposed works as they are relevant to the flood situation (for example floor levels, access etc.);
- How the development complies with Council LEP and DCP and also Ministerial Direction 4.1.
- Mapping, results and risk assessment covering the scope from the ‘Flood impact and risk assessment, Flood risk management guideline LU01’ (DPE 2023)

2. Introduction

GRC Hydro Pty Ltd have been engaged to undertake a flood assessment for Epping Town Centre, the corner of Rawson Street and Carlingford Road (the site). The site is affected by flooding due to its proximity to Boronia Park Main Channel (the channel). Hydrologic and hydraulic models have been established to understand the flood behaviour in a range of flood events, and to assess flood risk at the site in both the existing case and considering the potential impact of the proposed development. The results of this flood modelling have been used to assess the proposed development’s compliance with flood planning controls applicable to the site based on the following planning instruments and guidelines:

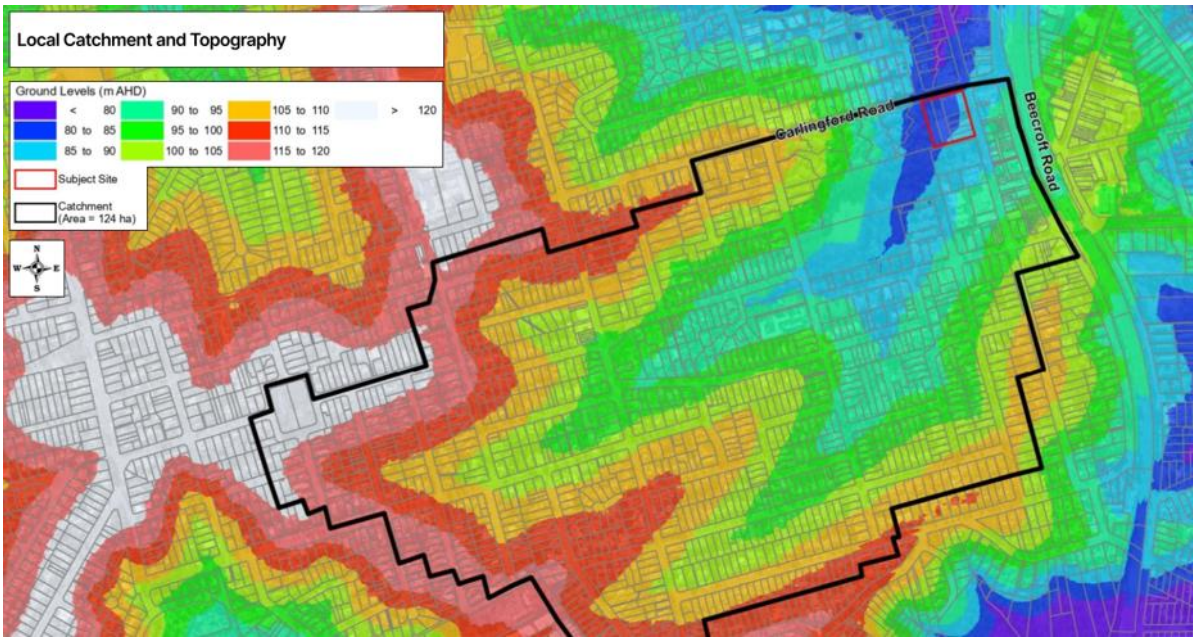
- The Parramatta Development Control Plan (DCP 2023);
- The Parramatta Local Environmental Plan (LEP 2023);
- Ministerial Directions 4.1; and,
- Flood impact and risk assessment, Flood risk management guideline LU01 (DPE 2023)

3. The Site

The site location is shown in Image 1 below. The catchment draining to the site is 124 hectares. The channel is immediately adjacent to the site, to the southwest, and consists of a concrete engineered channel.

The catchment area consists mostly of medium density urban areas with areas of parkland. The catchment has areas of relatively steep grade.

Image 1 – Local Catchment and Topography



4. Existing Flood Affectation

The site is affected by mainstream flooding from Boronia Park Channel, and negligible overland flooding/drainage. Mainstream flooding occurs when the channel that passes through the site from south to north has its capacity exceeded. The channel at the site has a catchment of 124 hectares, which extends south from the site by approximately 1.5 km over predominantly residential land. Flooding can be exacerbated due to Carlingford Road which is slightly higher than parts of the site. Overland flooding at the site occurs when localised rainfall causes flooding on Rawson Street, with some flow then spilling onto the site towards the channel.

Design flood behaviour has been established by a hydrologic and hydraulic model of the area setup as part of this assessment. The 5% AEP, 1% AEP, 0.5% AEP and PMF design flood events have been simulated. Further details in Section 5, including mapping, water level profiles and tabulated values.

In summary then the site is impacted by:

- Mainstream flooding associated with overflow from the channel – this overflow from the channel will depend on blockage rate used at the Carlingford Road culvert; and
- Overland flow flooding with water running down from Rawson Street toward the channel. This overland flow is extremely shallow (less than 150 mm in the main) and is very low hazard (H1 in 1% AEP event) and as such does not endanger anyone (even elderly and small children and small cars are safe in H1).

Section 6 and 7 present the proposed development, including mapping, tabulated values and hydrographs for proposed conditions. The impacts on both levels and hazards are also presented.

Section 8 discusses the flood risk management for the site based on the presented results. This includes results and discussion on climate change. Given the proposed development includes basement car parks, with entrances facing the channel, the key issue for flood risk management at the site are:

1. Ensure adequate flood protection at entrances; and
2. Ensure no impact on mainstream flood levels due to the proposed works.

5. Flood Assessment Methodology

The following work scope has been executed:

- Undertake a site visit;
- Build a DRAINS hydrologic model to derive flows for the 5% AEP, 1% AEP, 0.5% AEP and PMF using the methodologies as outlined in the ARR2019;
- Build a TUFLOW hydraulic model to derive water levels, depths, velocities, and hazard for the 5% AEP, 1% AEP, 0.5% AEP and PMF of existing conditions;
- Assess the flood conditions and risks of 'Existing Conditions' and 'Proposed Conditions' and review model results;
- Model the proposed plan and assess the flood impacts;
- Review pertinent planning documentation for applicable flooding controls;
- Develop flood maps which present and proposed flood depth, level, hazard and flood function for the full range of events. Flood level and hazard impacts for all events are also presented;
- Flood risk assessment, reviewing the presented information, considering climate change and addressing any residual risk items. A recommended approach for emergency management is also presented.
- Undertake internal peer review.

Hydrologic Modelling

A hydrologic model was developed using DRAINS to convert rainfall into runoff for input into the hydraulic model using the methodologies outlined in the Australian Rainfall and Runoff guide for flood estimation (ARR2019). This process involves an analysis of the 124 hectare catchment surrounding the site. The following information was used in this model:

- Digital Elevation Model (DEM) based on LiDAR sourced from ELVIS, used to delineate the sub-catchments.
- Percentage impervious for each catchment based on aerial imagery;
- Bureau of Meteorology 2016 rainfall intensities;
- Flow path length and slope for each catchment based on DEMs;
- ILSAX model in DRAINS has been used with soil type 3;
- A retardance coefficient of 0.015 for impervious area and 0.04 for the remaining area.

For the PMF event, the same DRAINS hydrological model was used but the rainfall data and temporal pattern are derived as per the GSDM method and assuming an initial loss of 1 mm and 0 mm/hour of Continuing Losses.

The DRAINS model was run for a range of durations from 20 minutes to 180 minutes for the 5% AEP and 1% AEP events, and from 20min to 60min for 0.5% AEP, and from 15 minutes to 180 minutes for the PMF event. Critical duration and critical storm assessment are performed in the hydraulic model and is further detailed in the section below.

TUFLOW (Hydraulic) Modelling

TUFLOW is a 2D numerical hydraulic modelling package. This software is widely used and is considered best practice under the NSW Floodplain Risk Management Program. It is used to convert applied flows from the hydrology model to derive flood depths, levels, and velocities.

The 'Existing Conditions' TUFLOW hydraulic model is comprised of the following elements:

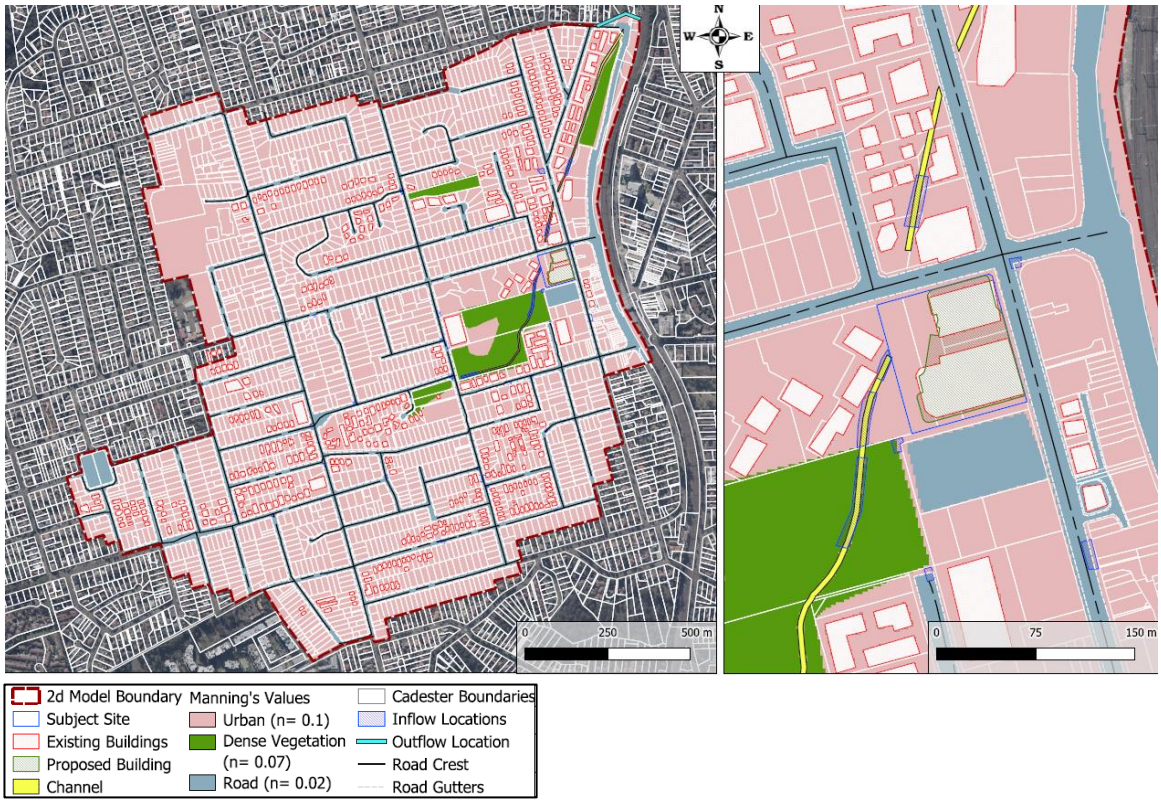
- LiDAR data has been used to generate a 2 m model grid. This data has a typical accuracy of ±0.15 m (1st confidence interval);
- The kerb/gutter and road crests are hydraulic features that have a significant impact on flood behaviour. As such these features have been represented in the model as break lines with invert heights determined by analysis of the LiDAR;
- Buildings can block flood paths and therefore significantly impact flood behaviour. As such, buildings in the vicinity of the subject site were blocked out in the TUFLOW model;
- Manning's 'n' roughness values were applied as follows:
    - Roads - 0.02;
    - Dense Vegetation Area - 0.07;
    - Concrete channel - 0.02;
    - General Residential Area – 0.10 as used in Parramatta River - Ryde Sub-catchments Flood Study and Floodplain Risk Management Plan (SKM, 2013);
- Outside of the channel, stormwater pits and pipes have not been included in the hydraulic model. This is based on a conservative assumption that stormwater pipes are 100% blocked during a flood event. The culverts in the channel use the ARR2019 blockage assessment values in the section below.
- The channel has been modelled as 1D elements. Channel inverts and dimensions were based on Sydney Water dataset, provided survey, site visit and LiDAR elevation data.
- A fixed tailwater was adopted at the catchment's downstream boundary.

A map of the model layout is presented in Image 2 below.

Critical duration and critical storm assessment were undertaken in TUFLOW for the location of the subject site using ARR2019 methods. The critical storm was selected based on a two step process. The temporal pattern producing the median flood level of its respective storm duration was chosen in the first step. All median flood levels are then compared with the critical duration selected from those temporal patterns as the duration producing the highest flood level in the second step. As the PMF does not use ARR2019 temporal patterns, the critical duration was selected based on the duration producing the highest flood level.

The assessment has resulted in a critical duration of 30 minute and critical storm #04 for the 5% AEP event, critical duration of 25 minute and critical storm #03 for the 1% AEP and 0.5% AEP events and critical duration of 15 minute for PMF event.

Image 2 – TUFLOW Model Layout (Existing Conditions) with full model area (Left) and the site (right)



Model Calibration

Unit Flow Rate Comparison

Comparison of study area unit flow rates estimates (also known as the specific yield) for the 1% AEP event have been undertaken as a means of verification of the design flow estimate. The unit flow rate refers to the peak flow generated per unit area and has units of m^3/s per hectare. Across the Sydney Metropolitan area, typical unit flow rates range between 0.3 to 0.6 m3/s per hectare for the 1% AEP event (ARR 1987), depending on the individual catchment characteristics.

Three locations were selected, and the average unit flow rate was calculated as 0.31 m^3/s per hectare. It was found that the calculated unit flow rates align with the calculated flow rates in similar Sydney Metropolitan areas and the specific catchment characteristics. As such, the flood modelling system is producing robust design flow estimates.

Blockage Assessment

The culvert at Carlingford Road is immediately downstream and adjacent to the site. This culvert passes flow downstream under Carlingford Road and is approximately 2.6 (wide) m by 2.3 (high) m. Blockage of this structure can influence the design flood levels on the subject site that are relevant to basement entry levels (entrances LG1 and LG2, see Image 3).

As such, and in line with best practice, GRC have carried out a blockage assessment for this structure in accordance with ARR2019. The blockage assessment is appended to this report as Appendix A. A summary table of results of the blockage analysis is provided below.

Table 1: Summary of Blockage Assessment Results

Event AEP	B_{DES} (%)	B_{DES} (%)	B_{DES} (%)

	Floating	Non-Floating	Final
AEP > 5% (frequent)	*0%*	*0%*	*0%*
AEP 5% - AEP 0.5%	*10%*	*15%*	*15%*
AEP < 0.5%	*20%*	*25%*	*25%*

As can be seen from Table 1 above the applicable blockage rate for the 5% AEP, 1% AEP and 0.5% AEP events is 15%. For the PMF the 25% blockage value is used. These blockage values were adopted for the TUFLOW model in all scenarios.

Existing Conditions Results

The Existing Conditions TUFLOW model was run for the critical durations. Results are presented in Figure Set A with the following figures:

Depths and Levels Maps with Tabulated Results at Key Locations

- A01: 5% AEP 15% Blockage - Peak Depths and Levels (Existing)
- A02: 1% AEP 15% Blockage - Peak Depths and Levels (Existing)
- A03: 0.5% AEP 15% Blockage - Peak Depths and Levels (Existing)
- A04: PMF 25% Blockage - Peak Depths and Levels (Existing)

Velocity Map

- A05: 1% AEP 15% Blockage - Peak Velocities (Existing)

Hazard Maps

- A06: 5% AEP 15% Blockage - Peak Flood Hazard (Existing)
- A07: 1% AEP 15% Blockage - Peak Flood Hazard (Existing)
- A08: 0.5% AEP 15% Blockage - Peak Flood Hazard (Existing)
- A09: PMF 25% Blockage - Peak Flood Hazard (Existing)

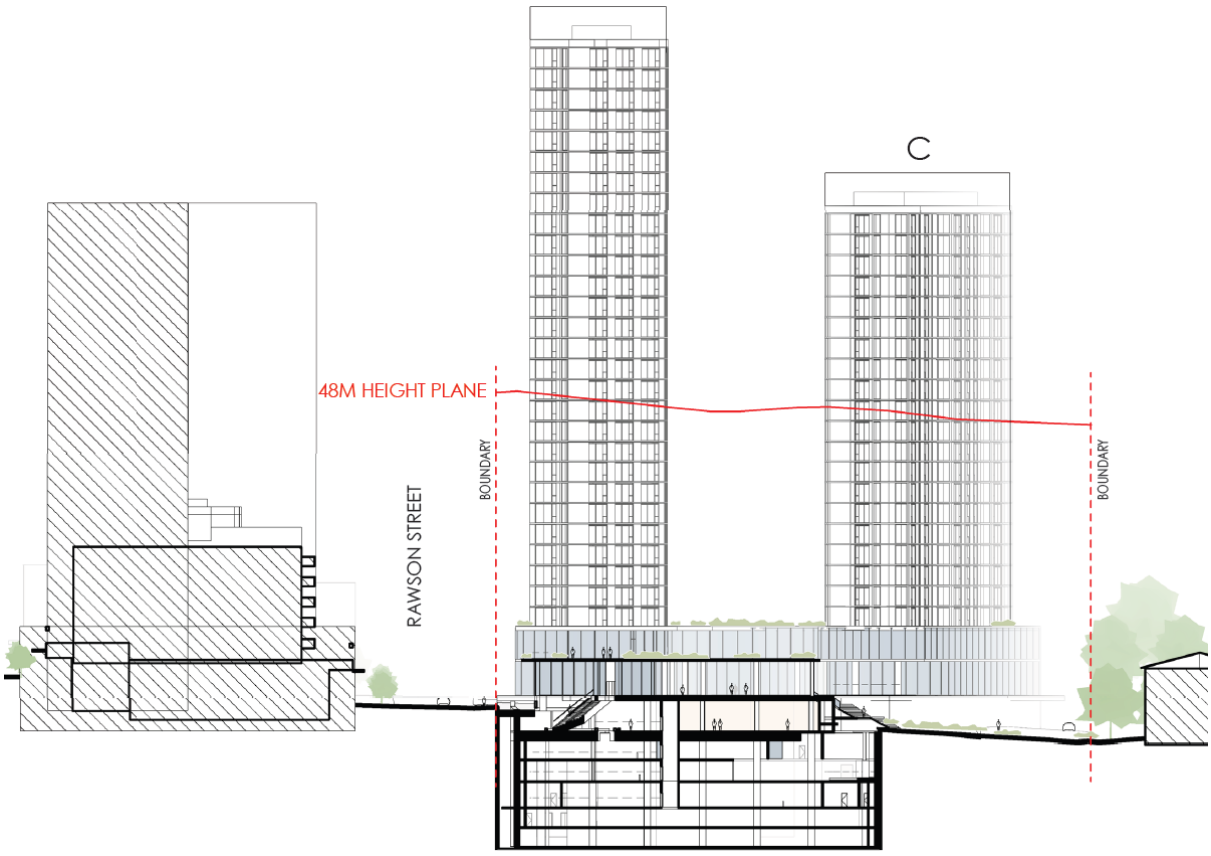
Flood Function Maps

- A10: 5% AEP 15% Blockage - Hydraulic Flood Function (Existing)
- A11: 1% AEP 15% Blockage - Hydraulic Flood Function (Existing)
- A12: 0.5% AEP 15% Blockage - Hydraulic Flood Function (Existing)
- A13: PMF 25% Blockage - Hydraulic Flood Function (Existing)

6. The Proposed Development

A mixed-use development is proposed for the site and the proposed design has been articulated in detail in an Epping Town Centre drawing set prepared by Oakstand (12/05/23). The proposed footprint and sectional elevation is documented in Images 3 and 4 below.

Image 3: Proposed Development – North Elevation (looking in a southerly direction from Carlingford Road)

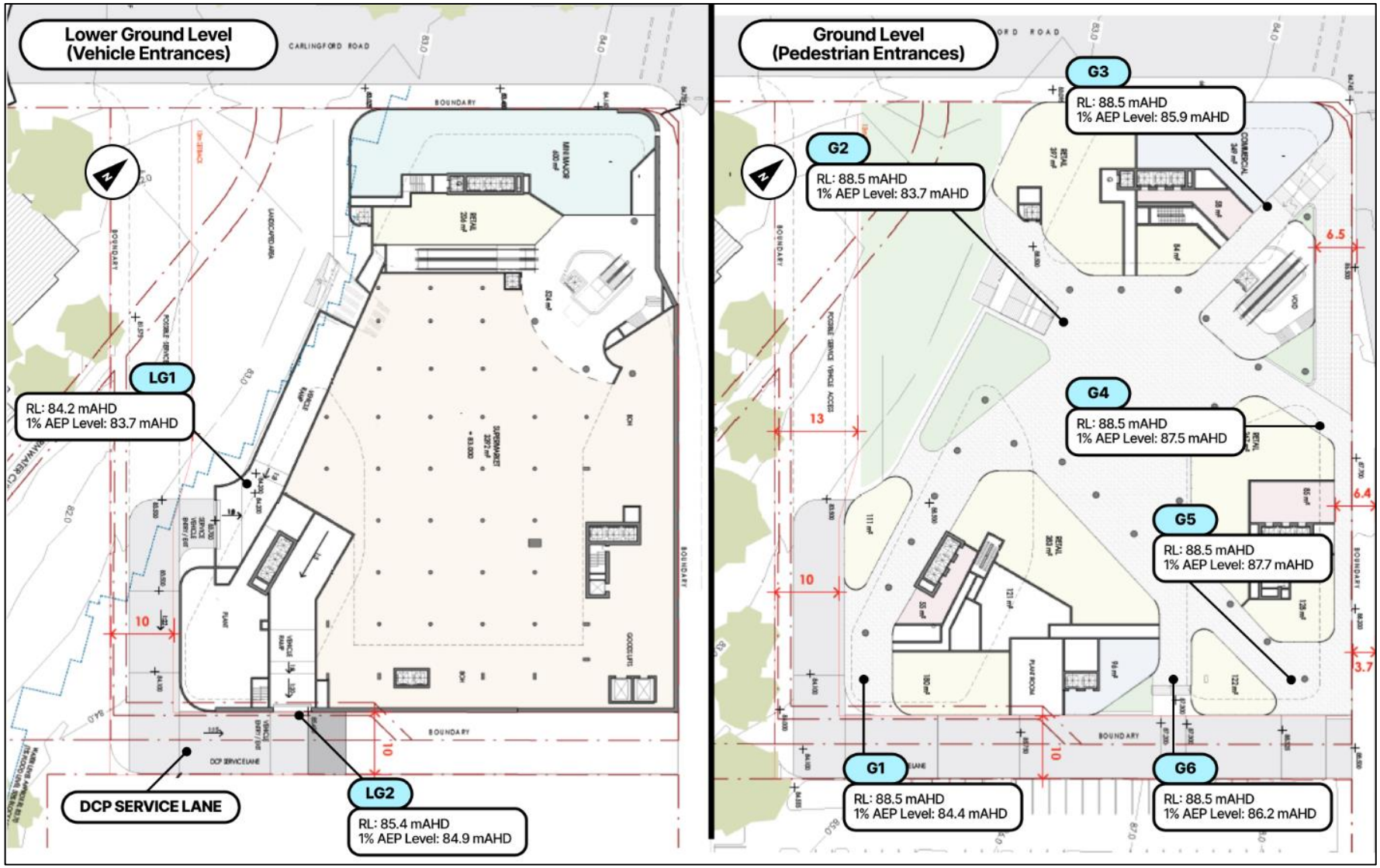


The most relevant features of the proposed works in relation to flooding are as follows:

- Basement Level 3 B3 – this basement is the lowest floor proposed and is at a level of 72.9 mAHD. Access is via Basement 2. 134 car spaces are proposed at B3.
- Basement Level 2 B2 – floor level is 75.9 mAHD and access is via Basement 1. 88 Car spaces and loading dock for supermarket and other facilities.
- Basement Level 1 B1 – floor level is 78.9 mAHD and access is via Lower Ground floor. 70 car spaces are proposed.
- Lower Ground LG – Access is via DCP Service Lane with entrances at west (84.2 mAHD) and at south (85.4 mAHD).
- Ground Floor G – Access is via lower floors or from Rawson Street or DCP Service Lane. Ground Floor level is 88.5 mAHD and the DCP Service Lane entrance is at 87.2 mAHD and the Rawson Street entry is from 86.5 mAHD.

Above these levels is residential development with multiple floors.

Image 4: Proposed Development – Entrance Locations and Relevant Flood Levels (Ground and Lower Ground Floors)



Proposed Development Finished Floor Level (FFL) Requirements

The finished floor levels for the proposed development are documented in Table 2 and Image 4. Flood Planning Level is from the City of Parramatta Council DCP 2023, using planning matrix in Table 5.1.1.2 of 'Part 5: Environmental Management' of the DCP. This requirement sets the floor level to the 1% AEP flood level plus 0.5m freeboard, and below ground car parking areas to have passive protection upto the 1% AEP flood level plus 0.5m freeboard and must be protected from the ingress of floodwater to the PMF level. Basement protection can utilise self-powered flood gates to protect to the PMF level. A full list of the proposed developments compliance is in Section 9.

Table 2 - Proposed Development Finished Floor Level (FFL) Requirements

Entrance Location	1% AEP Level (mAHD)	PMF Level (mAHD)	Flood Planning Level (mAHD)	Proposed Level (mAHD)	Comments
LG1 Basement Carpark Entry	83.7	85.3	84.2	84.2 (Flood gate at 85.3)	Passive flood protection is provided by the entry road having an invert of 84.2 mAHD. PMF protection is provided via a proposed gate to 85.3 mAHD.
LG2 Basement Carpark Entry	84.9	85.6	85.4	85.4 (Flood gate at 85.6)	Passive flood protection is provided by the entry road having an invert of 85.4 mAHD. PMF protection is provided via a proposed gate to 85.6 mAHD.
G1 Commercial	84.4	Not applicable to FPL	84.9	88.5	Proposed floor level is 3.6m above FPL
G2 Commercial	83.7	Not applicable to FPL	84.2	88.5	Proposed floor level is 4.8m above FPL
G3 Commercial	85.9	Not applicable to FPL	86.4	88.5	Proposed floor level is 2.1m above FPL
G4 Commercial	87.5	Not applicable to FPL	88.0	88.5	Proposed floor level is 0.5m above FPL
G5 Commercial	87.7	Not applicable to FPL	88.2	88.5	Proposed floor level is 0.3m above FPL
G6 Commercial	86.2	Not applicable to FPL	86.7	88.5	Proposed floor level is 1.8m above FPL

7. Post-Development Flood Affectation

The 'Existing Conditions' model was updated to the 'Post Development Conditions' model by replacing the existing building extents on the site with the new development extent as null cells (hydraulic model cells which are unable to store or convey flow). The extent of the works that impact the ground surface are shown in all figures below.

All other parameters were maintained from the Existing Conditions TUFLOW model. Post Development Conditions were then produced for the same critical duration events as used for Existing Conditions.

Results

The Proposed Conditions results are presented in Figure Set B with the following figures:

Depths and Levels Maps with Tabulated Results at Key Locations

- B01: 5% AEP 15% Blockage - Peak Depths and Levels (Post Development)
- B02: 1% AEP 15% Blockage - Peak Depths and Levels (Post Development)
- B03: 0.5% AEP 15% Blockage - Peak Depths and Levels (Post Development)
- B04: PMF 25% Blockage - Peak Depths and Levels (Post Development)

Velocity Map

- B05: 1% AEP 15% Blockage - Peak Velocities (Post Development)

Hazard Maps

- B06: 5% AEP 15% Blockage - Peak Flood Hazard (Post Development)
- B07: 1% AEP 15% Blockage - Peak Flood Hazard (Post Development)
- B08: 0.5% AEP 15% Blockage - Peak Flood Hazard (Post Development)
- B09: PMF 25% Blockage - Peak Flood Hazard (Post Development)

Flood Function Maps

- B10: 5% AEP 15% Blockage - Hydraulic Flood Function (Post Development)
- B11: 1% AEP 15% Blockage - Hydraulic Flood Function (Post Development)
- B12: 0.5% AEP 15% Blockage - Hydraulic Flood Function (Post Development)
- B13: PMF 25% Blockage - Hydraulic Flood Function (Post Development)

Impacts

Impacts have been produced by comparing Post Development Conditions results against Existing Conditions. These are presented in Figure Set C for both level impacts and hazard impacts:

Impacts on Water Levels, including a Water Level Profile along the channel

- C01: 5% AEP 15% Blockage - Development Water Levels Impact
- C02: 1% AEP 15% Blockage - Development Water Levels Impact
- C03: 0.5% AEP 15% Blockage - Development Water Levels Impact
- C04: PMF 25% Blockage - Development Water Levels Impact

Impacts on Hazard Categories.

- C05: 5% AEP 15% Blockage - Development Hazard Impact
- C06: 1% AEP 15% Blockage - Development Hazard Impact

- C07: 0.5% AEP 15% Blockage - Development Hazard Impact
- C08: PMF 25% Blockage - Development Hazard Impact

A key component of the proposed works has been to keep any proposed development outside of areas of significant flow in the 1% AEP event, and as such we can see in the attached figures that there are no offsite impacts to private property resulting from the proposed works in events from the 5% AEP up to and including the 0.5% AEP.

In addition to the water level impacts, the hazard impacts have been mapped for all events. These indicate whether there has been a change in the hazard category due to the development, which is an indication of whether the development can cause changes to flood behaviour and risk. For the 5% AEP up to and including the 0.5% AEP, there are no large areas with expected change in hazard and all possible impacts to hazards are affecting very small areas and as such isn't expected to change flood behaviour or risk. This is discussed further in the risk assessment in Section 8.

Minor water level impacts < 0.02m are shown in the PMF, the worst possible flood that can occur at this location with an estimated AEP of between a 0.0001% AEP to 0.00001%. These are classed as minor due to the rarity of this event and the minimal impact this level change has on the flood behaviour at the site for this event. In addition, the PMF hazard impacts indicate some localized increases in hazard category in Rawson St. However, that section of Rawson St is already unsuitable for evacuation before the development and as such the impacts aren't expected to change the evacuation strategy of the site or community. The relevance of these impacts are further discussed in the risk assessment in Section 8.

8. Risk Assessment

Sections 4 and 5 have defined the Existing Conditions for the site and local catchment. Sections 6 and 7 have provided the Proposed Conditions for the site, and the potential impacts due to the development for a wide range of flood events (5% AEP to PMF). Together, these provide sufficient information to discuss the potential risks associated with flooding at the site in the context of:

- Risks to the community. In particular the impacts the development has on the existing population, existing property and infrastructure.
- Risks to the development and its users. The risks discussed are concerning the safety of the people using and residing at the site and any risks associated to the property and it surrounds due to floodwater.

In addition to the above a Climate Change assessment discussing the potential impacts of climate change on the proposed development is presented below.

Risks to the Community

Risks to the community are largely addressed through compliance with the local Council planning documents and requirements. The City of Parramatta Council's DCP and LEP are quite recent, reflecting updated advice on the management of floodwater within their community.

The development is shown to be fully compliant with the:

- The Parramatta Development Control Plan (DCP 2023);
- The Parramatta Local Environmental Plan (LEP 2023);
- Ministerial Directions 4.1;

Details addressing each of the above plans is covered in Section 9.

The above planning documents largely focus on the 1% AEP and PMF, the remainder of this section discusses any residual risk in events over the full range of events (5% AEP to PMF). Table 3 provides a summary.

Table 3: Summary of risk factors due to flood behaviour.

Impact	No Change (range of floods)	Potential Change (range of floods)	Risk Assessment Summary	Relevant References
Flood Levels	*5% AEP to 0.5% AEP*	*PMF*	*Very low risk. Discussed in PMF section below.*	*Impacts: Section 7. Figures: C01 to C04*
Duration of Inundation	*5% AEP to PMF*	*None*	*No risk*	*Discussed below under Risks to the Development: Evacuation*

Flood Extent	*5% AEP to PMF*	*None*	*No risk*	*Covered in flood level figures (see above)*
Warning and Evacuation Time	*5% AEP to PMF*	*None*	*No risk*	*Discussed below under Risks to the Development: Evacuation*
Flood Function	*5% AEP to PMF*	*None*	*No risk*	*Figures: A10 to A13 for Existing Conditions and B10 to B13 for Post Development Conditions*
Hazard	*5% AEP to 0.5% AEP*	*PMF*	*Very low to no risk. Discussed in PMF section below.*	*Impacts: Section 7 Figures: C05 to C08*

As shown in Table 3, all events are showing no impacts except some minor impacts in the PMF. These are discussed further below.

PMF Results

The Probable Maximum Flood (PMF) is the largest flood that could conceivably be expected to occur at a particular location. The estimated AEP for such an event is between a 0.0001% AEP to 0.00001% AEP. In terms of risk, the Flood Risk Management Manual (DPE 2023) provide a useful table, reproduced below as Table 4. This shows the risk associated with events upto the 0.01% AEP, with the chance of experiencing one 0.1% AEP flood in an 80-year period as 0.8%. We can infer from this that the chance of a PMF occurring over an 80 year period is much less than 0.8%.

Table 4: Chance of encountering a given sized flood one or more times in 80 years. (Reproduced from Table 1 of the Flood Risk Management Manual DPE 2023)

Annual exceedance probability %	Average recurrence interval (1 in x years)	Chance of experiencing in an 80-year period	
		at least once %	at least twice %
20	5	100	100
10	10	99.9	99.8
5	20	98.4	91.4
2	50	80.1	47.7
1	100	55.3	19.08
0.5	200	33	6.11
0.2	500	14.8	1.14
0.1	1,000	7.69	0.3
0.01	10,000	0.8	0.003

Given the rarity of the PMF, it is mostly used as a measure of the maximum extent of flood prone land, with applications in evacuation planning for flooding. In Sections 6 and 9, the DCP requires basement parking to have a level of protection up to the PMF, which the proposed development is shown to provide.

The impacts to levels are very minor, with most of the expected change to be <0.02m over an extent within the mainstream flooding occurring in the channel during a PMF, as well as a localised <0.03m increase in the overland flood water in Rawson Street. Neither of these increases impact on any critical or sensitive use facilities and no new buildings are impacted by flooding in the PMF, as the flood extent is very similar.

In addition to the above, the proposed development has no impacts on Hazards within the mainstream flooding occurring within the channel. There are some increases in the hazard categories within Rawson St towards the junction of Carlingford Rd, but as this section of Rawson St is already classed as H5 under Existing Conditions and unsuitable for all vehicles, the proposed development isn't impacting on the evacuation potential through Rawson St. These hazards changes are fully contained within the road extent, and as such do not pose additional risk to any buildings.

Due to the combined factor of:

- The rarity of the PMF;
- The impacts due to levels are very minor; and,
- The impacts on hazard categories are very minor.

It was assessed that the change in flooding impacts during a PMF pose a very low risk to the community.

Risks to the Development and Users

Risks to the development and its proposed users is again mostly addressed through compliance with the local Council planning documents and requirements. In particular, the proposed development has shown:

- The basement has a passive level of protection to the 1% AEP + 500mm freeboard through the raised entrance crest. (see Section 6)
- The basement has a level of protection to the PMF provided through the proposed flood gates. (see Section 6)
- The first level with pedestrian access to outside of the site is Ground Floor G which is above the 1% AEP + 500mm freeboard (see Section 6) with all entrances shown to also be above the PMF flood level.
- All floors above Ground Floor G are residential and protected to well above the PMF flood level.

Given the above design aspects, the building and its occupants are expected to be protected against the ingress of floodwater for all events. The residual risks to address are for the emergency response strategy, including discussion on access to the site in the event of a flood.

Evacuation

The expected warning time is expected to be less than 30 minutes from the onset of the precipitating weather event to peak water levels at the site. As such, site is impacted by flooding classed as 'flash flooding', that is flooding that occurs "… within 6 hours of the precipitating weather event, and often involves rapid water level changes and flood water velocity. This definition excludes flooding caused

by dam failure, storm surge or tsunami although similar emergency management principles may apply to these events"' (AFAC 2018) and extracted from EM01 (DPE 2023).

The expected duration of inundation is also to be relatively short for all events up to and including the PMF, with water levels around the site expected to drop to trafficable conditions within an hour after the precipitation event subsides.

Given the above flood information, the safest approach to protect people during a flood would be for all people located on the site to shelter onsite until the precipitation event finishes and waters subside, and only leaving after confirming with local emergency combat authorities such as the SES. The building itself has been shown to be protected from the ingress of floodwater for all events.

GRC Hydro do not recommend ever driving through floodwater. An assessment of the flood modelling shows that for all events up to and including the 0.5% AEP event both the DCP service lane and Rawson St are subject to flooding hazard class H1 (generally safe for people, vehicles and buildings). The safest evacuation route it to travel south on Rawson St onto Blaxland Rd or Epping Rd. The junction of Rawson St, Carlingford Rd and Ray Rd is unsafe to vehicles during most events. This flood report cannot comment on the safety of roads during a flood beyond the catchment extent. All roads near the site can be unsafe for vehicles during a PMF event, but due to the flash flooding nature of the catchment these hazards persist for less than an hour.

Based on the available flood information this report can conclude:

- The proposed building is safe from the ingress of floodwater for all events.
- As the site has a very short warning time, and a short duration of inundation, the recommended emergency management approach in the event of a flood is to adopt a shelter-in-place strategy.

Given the above, flooding poses a low risk to both the building and its users, with residual risks manageable through proper emergency management planning. The above also demonstrates the proposed building is able to undertake an appropriate emergency flood management response with residual risks associated with a shelter in place strategy minimised through the short duration of inundation times expected.

Risks due to Climate Change

To assess the risk due to climate change, the Existing Conditions and Proposed Conditions TUFLOW models were run with a climate change event, and the impacts assessed. Results are presented in Figure Set D for:

- D01: 1% AEP for RCP8.5 2090 Climate Change - Peak Depths and Levels (Existing)
- D02: 1% AEP for RCP8.5 2090 Climate Change - Peak Depths and Levels (Post Development)
- D03: 1% AEP for RCP8.5 2090 Climate Change - Development Water Levels Impact

The climate change event used was for the RCP 8.5 scenario in 2090, using the ARR2019 recommended rainfall depth multiplier of a 19.8% increase relative to current climate conditions. This is quite a conservative approach as the RCP8.5 is the worst of the current climate change pathways used in flood modelling. An assessment of the effects of sea level rise were considered unnecessary as the site lies well beyond the influences of coastal sea level.

The impacts are comparing the Existing Conditions with Climate Change against the Proposed Conditions with Climate Change, which is a measure of the potential future impact the site could

cause. As shown in figure D03, the proposed development is unlikely to pose a risk to the community in the future with impacts being minor and largely contained onsite.

In addition to the impact assessment, the water levels shown in Figure D02 show that flood levels in the 1% AEP under climate change conditions are unlikely to rise to beyond the current 1% AEP + 500mm freeboard levels. As the building is passively protected to this level, we can also conclude that the site is unlikely to become at risk during the 1% AEP under future climate change conditions.

As the proposed site has been shown to be:

- Unlikely to increase offsite water levels in the future; and,
- Unlikely to have water levels in the future 1% AEP event with climate change higher that the current 1% AEP event + 500mm freeboard.

The proposed development is unlikely to pose either a risk to the community, or be under risk, because of climate change.

9. Development's Suitability Relative to Relevant Planning Requirements

GRC has assessed the proposed development relative to the site's flood affectation with regard to the following relevant planning instruments:

- Parramatta Local Environmental Plan (LEP) (2023) – Section 5.21 - Flooding.
- Parramatta Development Control Plan (DCP) (2011), specifically Table 2.4.2.1.2; and
- Ministerial Directions – 4.1 – Flooding

The flood-related components of these planning instruments are quoted below with GRC responses regarding the compliance of the proposed development included in-line below in blue.

Parramatta Development Control Plan (DCP) (2023)

Flood planning controls for development at the site are set out in Section 5.1.1 of the Parramatta DCP. This report addresses the Flood Risk Management controls.

The 'Controls' C.01 to C.24 have been addressed below with references to specific report sections where possible. The 'Objectives' have been reviewed but found to be addressed through meeting the Controls and no addition comments have been provided regarding them.

The Matrix Development Controls for a Medium Flood Risk Area for the residential and commercial land use types have been addressed after C.24.

Control	GRC Response
C.01: Development is to be compatible with any relevant Floodplain Risk Management Plan and consistent with the current NSW Floodplain Development Manual, unless otherwise accepted by Council.	This report has been prepared with regards to the Flood Risk Management Manual (DPE 2023) and covers the full scope of the Flood Impact and Risk Assessment LU01 guidelines (DPE 2023). The site is outside of any known Floodplain Risk Management Plan.
C.02: Any increased risk to life from development must be mitigated to Council's satisfaction.	Section 8 discusses the management of risks to the community, users, property and infrastructure due to the development. Most risk to life is mitigated through a design showing a level of protection up to the PMF.
C.03: The Flood Planning Level under normal circumstances shall be the higher of the 1% AEP riverine flood level or the 1% AEP overland flow flood level, as accepted by Council, plus a minimum 500mm freeboard safety factor. Council may require additional freeboard to manage risk in exceptional circumstances.	Section 6 details the compliance with a 1% AEP + 500mm freeboard, as well as protection up to the PMF for basement carparking.
C.04: Significant filling or excavation of land below the Flood Planning Level is generally not permitted. If required by Council, development proposals must demonstrate, through detailed hydraulic modelling, that any proposed filling or excavation of land above the Flood Planning Level up to the Probable Maximum Flood (PMF) will not adversely impact flood behaviour.	Section 6 details the proposed design, with a design that minimises any development within the 1% AEP extent. This approach has ensured that in the results presented in Section 7 that the development would not adversely impact flood behaviour.

C.05: Council may require proposals for raising structures to provide a report from a suitably qualified structural engineer demonstrating that the raised structure will not be at risk of failure from the forces of floodwaters.	NA - Outside of the scope of this flood assessment.
C.06: Fencing, landscaping and public domain works are to be constructed in a manner that does not significantly affect the flow of floods.	Landscaping and building works are shown to not affect the flow of floodwater. Fencing outside of the building extent can be addressed once finalised.
C.07: New development is only permitted where reliable access is available for the evacuation of an area potentially affected by floods to an area free of risk from flooding. Evacuation should be consistent with any relevant flood evacuation strategy.	Shelter in place is the best available strategy given the lack of warning (lack of warning pertains to the relatively small catchment which means short time to rise). That said, relatively safe egress to Rawson Street is available in all events. GRC do not recommend anyone should drive during a rare flood event and the site is well placed to shelter people in place until such time as the event has passed (will be sub one hour based on duration of inundation results). Evacuation potential is discussed in Section 8.
C.08: Council requires an applicant to make a Flood Enquiry Application where this information is available. The information supplied to an applicant via a Flood Enquiry Application will inform the applicants DA flood model where deemed necessary.	NA - Outside of the scope of this flood assessment.
C.09: Where hydraulic flood modelling is required, flow hazard categories H1 to H6 as set out in Figure 5.1.1.1 must be identified and adequately addressed in the design of the development. Where available, Council will issue flood and hazard levels to be adopted in any hydraulic flood modelling, unless an alternative approach is agreed with Council. Flood modelling will need to account for any projected changes to flood levels or behaviour as a result of climate change over the design life of the development.	Hazard mapping is consistent with the H1 to H6 approach of classifying floodwater, and uses the AIDR hazard curves. See figures A06-A09 and B06-B09 for the mapped hazard results. Climate change is addressed in Section 8 and figures D01-D03. These show no expected future impacts due to the development and that the future climate change levels remain below the current 1% AEP + 500m freeboard levels.

C.10: Council may require an additional overland flow study to support an application on sites where such flooding is expected to be dominant over flooding from waterways (riverine flooding). Increases in local rainfall intensity and other rainfall and flood behaviour resulting from climate change should be factored into any overland flow modelling undertaken.	The flood modelling presented includes both mainstream and overland flooding. These demonstrate flood levels in Rawson St and along the basement access route remain below the FPL and basement entrance levels as shown in Section 6.
C.11: Development with high sensitivity to flood risk (e.g. critical public utilities) must be sited and designed to provide reliable access and an acceptably minimal risk from flooding.	NA – development is not a critical or sensitive land use type.
C.12: Design responses as part of flood mitigation measures associated with new and existing developments should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (e.g. unsympathetic house raising) or by being incompatible with the streetscape or character of the locality (including heritage).	NA - No proposed flood mitigation measures as part of this development.
C.13: Development must be planned and designed to respond to both riverine (mainstream) flooding and overland flow flooding.	The flood modelling presented includes both mainstream and overland flooding. These demonstrate flood levels in Rawson St and along the basement access route remain below the FPL and basement entrance levels as shown in Section 6.
C.14: Development must not divert flood waters, nor interfere with floodwater storage, nor the natural function of waterways.	Development has been proposed outside of the 1% AEP extent, which removes the interference with the natural function of the waterways. Impacts in Section 7 show this approach has no impacts on the waterway.
C.15: In general, Council will not support proposals for flood flow-through or flood storage chambers within or beneath a new building, and alternate design solutions will be required.	NA – no flood flow-through or flood storage chambers proposed for this development.
C.16: Sensitive Uses and Facilities' and 'Critical Uses and Facilities,' as defined in Table 5.1.1.1, in general, not permitted on land subject to flooding in a PMF event.	NA – development is not a critical or sensitive land use type.

C.17: The following 'Sensitive Uses and facilities' being centre-based child care and aged care facilities that occupy land subject to flooding in a PMF event, may be considered provided Council can be satisfied that: …	NA – development is not a critical or sensitive land use type.
C.18: Unless otherwise advised by Council, all development in the floodplain involving the construction of a new building or significant alterations to an existing building, and or intensification of a use must be supported by flood hazard modelling that is: a) based on the 'General Flood Hazard Vulnerability Curves' in Figure 5.1.1.1 [AIDR 2017 Hazard values] for the 1% AEP flood and the PMF. b) is assessed in terms of the following [H1 to H6] hazard categories and risks of harm:	Hazard mapping is consistent with the H1 to H6 approach of classifying floodwater and uses the AIDR hazard curves. See figures A06-A09 and B06-B09 for the mapped hazard results. Section 8 presents a risk assessment which uses the H1 to H6 to quantify risks of harm.

C.19: Unless otherwise advised by Council, all development in the floodplain involving the construction of a new building or significant alterations to an existing building, and or intensification of a use is to be supported by a merit-based flood hazard and flood impact risk assessment that:
a) Presents evidence-based analysis of the hazard, risk and harm to occupants and those in the surrounds and demonstrates how harmful factors will be mitigated.
b) Includes information on the following aspects as necessary, to enable Council to assess risk and potential for harm:
• 1% AEP and 5% AEP flood levels, flood extents, flow rates, depths and velocities for mainstream and overland flow floods;
• PMF levels, hazard, extent and behaviour for mainstream floods (not overland flow floods);
• modelled hydraulic hazard levels, (H1-H6), extent and behaviour for 1% AEP mainstream and overland flow floods;
• warning times and duration of flooding;
• available warning systems (if any);
• characteristics and vulnerabilities of future occupants; likelihood of multiple storms – and multiple flood peaks;
• 'horizontal' evacuation pathways including accessibility considerations;
• 'vertical' evacuation opportunities and shelter in place facilities above the PMF where permitted;
• emergency services access availability;
• local terrain;
• the development in context; and
• the proposed use and occupation of the development.

a) Section 8 presents a risk assessment supported by flood result evidence to support the analysis of potential hazard, risk and harm to occupants and the surrounding community.

b)

- Results are presented for Existing Conditions in Section 5 and figure set A
- Results are presented for Proposed Conditions in Section 7 and figure set B
- Impacts due to the development are presented in Section 7 and figure set C
- Warning time, and duration of inundation are presented as part of the risk assessment in Section 8
- A recommended evacuation strategy demonstrating that vertical evacuation opportunity is available and able to provide protection for all events including the PMF. Section 7 provides floor levels and the evacuation potential is discussed in Section 8.
- Evacuation from the site is available, but not recommended. Discussed further in Section 8.
- Proposed use and occupation is in Section 6.
- Context and terrain is presented over Sections 1 to 6.
- All of the above considers the a wide range of flood events from the 5% AEP to the PMF.
- Mapped results include flood depths, levels, velocities, hazards and flood function.

C.20: Basement car parks on properties within the floodplain are strongly discouraged and alternate design options should be discussed with Council at the pre-lodgement stage. Where a basement car park on a property within the floodplain is proposed, it must be demonstrated that the proposed basement car park has been protected from all flooding up to and including the PMF event. An adequate flood emergency and risk management plan must also be provided where basement car parks are proposed in the floodplain, please see Flood Warning and Emergency Response Planning section below for requirements.	The proposed basement car park has been shown to provide passive protection upto the 1% AEP + 500mm freeboard and protection upto the PMF in Section 6 through the use of automatic floodgates..
C.21: Where Council allows basement car parking in flood prone land the proposal must demonstrate: a) effective floodproofing and flood exclusion of the basement against all floods up to the PMF; b) adequate safety for occupants of the basement and building including a flood free evacuation path (stairway or other suitable method) from the basement levels to a safe refuge above the PMF; c) adequate safety for occupants at ground and ground floor levels of the building including a flood free evacuation path (stairway or other suitable method) from the ground floor levels to a safe refuge above the PMF; and d) consistency with other Council objectives (such as traffic management).	The proposed basement car park has been shown to provide passive protection upto the 1% AEP + 500mm freeboard and protection upto the PMF in Section 6 through the use of automatic floodgates. The basement carpark has vertical access to higher levels within the building, along a flood free evacuation path.

C.22: Demonstrate the appropriateness of a basement car park within a flood prone area, the following details must be included as a minimum in the Development Application:
a) Demonstration that high hazard floodwaters (H3 or greater) will not occur in a 1% AEP event in the area adjacent to the driveway.
b) The basement must be protected from the ingress of floodwater by passive measures at least up to the flood planning level. These measures are likely to include provision of a driveway crest at or above the flood planning level with associated wing/or bund walls to this level to prevent floodwaters flowing into the basement.
c) The basement must be protected from the ingress of floodwater via the driveway up to the Probable Maximum Flood level. These measures are likely to include provision of a self- triggering and self-powered flood gate at or near the driveway crest that reaches the level of the PMF, together with corresponding wing wall bunds etc. to the same PMF level.
d) The basement must be protected from the ingress of floodwater via stairwells and other openings up to the Probable Maximum Flood level. These measures are likely to include a combination of a self-closing flood doors, flood gates and bund walls. Flood doors may also be fire doors.
e) Provision of flood-free escape stairs from the basement up to a place of refuge within the building above the PMF level with adequate facilities for users during and after a flood.
f) Provision of adequate car parking for the disabled and an escape path that can be followed to safety.
g) Submission of a comprehensive Flood Emergency Response Plan incorporating all of the above.

As shown in figure B07, only H1 hazard is expected at the area adjacent to the driveway in the 1% AEP.
The proposed basement car park has been shown to provide passive protection upto the 1% AEP + 500mm freeboard and protection upto the PMF in Section 6 through the use of automatic floodgates..
The basement carpark has vertical access to higher levels within the building, along a flood free evacuation path.

C.23: The Building Management System and Plan for the development with a proposed basement car park within a flood prone area must include all necessary measures to maintain, test and operate the flood protection devices including flood gates, doors and barriers, flood sensors, flood refuges and FERP.	NA - Outside of the scope of this flood assessment.
C.24: Floodplain Development Matrix	See below

Flood Risk Precincts (FRPs)	Planning Consideration	Floor Level	Building Components	Structural Soundness	Flood Affectation	Car Parking & Driveway Access	Evacuation	Management & Design
High Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	X	X	X	X	X	X	X
	Commercial & Industrial	X	X	X	X	X	X	X
	Open Space & Non-Urban	1	1	1	1	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision	X	X	X	X	X	X	X
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	3, 4, 6	2, 3, 4
Medium Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Commercial & Industrial	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Open Space & Non-Urban	1	1	1	2	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision				1		3, 4, 5	1
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	2, 5	2, 3, 4

Floor Level (2): All habitable floor levels to be equal to or greater than the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.	As shown in Section 6, all floor levels are greater than 1% AEP + 500mm freeboard.

Building Components (1): All structures to have flood compatible building components and construction below the 1% AEP (100 year ARI) flood level plus freeboard.	NA - Outside of the scope of this flood assessment.
Structural Soundness (1): Unless otherwise approved by Council, a structural engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP (100 year ARI) flood level plus freeboard.	NA - Outside of the scope of this flood assessment.
Flood Affectation (1): A hydraulic engineer's report is required to certify that the development will not increase flood affectation elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulative impact of multiple potential developments in the vicinity.	As shown in Section 7, the development is not changing flood behaviour, function, or has impacts on flood levels, flows and velocities.
Car Parking & Driveway Access (1): The minimum surface level of unenclosed parking spaces or carports shall be as high as practical, but no lower than 0.1 metres below the 1% AEP (100 year ARI) flood level. In the case of garages and other enclosed parking areas for less than 3 motor vehicles, the minimum surface level shall be as high as practical, but no lower than the 1% AEP (100 year ARI) flood level, plus 0.15 metres freeboard.	NA – No unenclosed parking spaces proposed or encloses parking areas for less than 3 motor vehicles.
Car Parking & Driveway Access (3): Garages, and other enclosed car parking areas, capable of accommodating more than 3 motor vehicles, must be protected from inundation by floods equal to or greater than the 1% AEP (100 year ARI) flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level. Where below ground car parking is proposed additional measures must achieve protection up to the PMF.	The proposed basement car park has been shown to provide passive protection upto the 1% AEP + 500mm freeboard and protection upto the PMF in Section 6 through the use of automatic floodgates.

Car Parking & Driveway Access (5): Unless otherwise approved by Council and provided this does not obstruct or displace floodwaters, the level of the driveway providing access between the road and parking spaces shall be no lower than 0.2 metres below the 1% AEP (100 year ARI) flood level.	Compliant as depths less than 0.05m shown in the 1% AEP across the driveway access between the road and basement parking entrance. See Figure B02.
Car Parking & Driveway Access (6): Enclosed car parking, and car parking areas accommodating more than 3 motor vehicles, with a floor below the 1% AEP (100 year ARI) flood level, shall have adequate warning systems, signage, exits and evacuation routes. Refer to Flood Warning and emergency Response Planning section for requirements.	Evacuation is discussed in Section 8.
Car Parking & Driveway Access (7): Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 1% AEP (100 year ARI flood.)	All parking areas protected in all events.
Evacuation (3): Reliable access for pedestrians required from the site to an area of refuge (including shelter in place) above the PMF level, on site (e.g. second storey) or off site.	As discussed in Sections 6 and 8, all levels are protected to the PMF allowing a shelter in place strategy to be adopted.
Evacuation (4): Applicant is to demonstrate the development is consistent with any relevant flood emergency response plan, flood risk management plan or similar plan.	No current flood emergency response plans, or similar, are currently applicable to the site.
Evacuation (6): Adequate flood warning is to be available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.	Due to the short warning time, the recommended strategy is to adopt a shelter in place emergency flood response. Subject to emergency combat authorities organising evacuation before the onset of flood causing precipitation, the site has access to Blaxland Rd and Epping Rd which are likely evacuation avenues due to access to emergency facilities at the Ryde Hospital or access to the Hills Motorway.
Management and Design (3): Applicant is to demonstrate that sufficient area is available to store goods above the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.	All floor levels protected to the 1% AEP + 500mm freeboard as shown in Section 6

Management and Design (4): No storage of materials below the Flood Planning Level (1% AEP flood plus 0.5 metre freeboard) which may cause pollution or be potentially hazardous during any flood.	All floor levels protected to the 1% AEP + 500mm freeboard as shown in Section 6. No known hazardous material storage proposed as part of the development.

Ministerial Directions – Section 4.1 - Flooding

Objective	GRC Response
The objectives of this direction are to: *(a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, (now 2023) and*	Compliance with controls and objectives of Parramatta Council DCP and LEP as demonstrated in the tables above clearly indicates that the development is consistent with Government policy and the NSW Floodplain Development Manual (NSW, 2005) and (NSW, 2023).
(b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.	The table above responds to Section 5.21 of the Parramatta City Council LEP.
Application	
This direction applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.	No response required.
Application	
(1) A planning proposal must include provisions that give effect to and are consistent with: *(a) the NSW Flood Prone Land Policy,*	As per the NSW Government website (https://www.environment.nsw.gov.au/topics/water/floodplains/floodplain-manual#:~:text=The%20main%20objective %20of%20the,development%20of%20flood%2Dprone%20land.) …*"The main objective of the Flood Prone Land Policy is to reduce the impact of flooding and flood liability on owners and occupiers of flood-prone property and reduce public and private losses. The policy recognises the benefits of use, occupation and development of flood-prone land."* The proposed works that are described by the Planning Proposal meet FPL (see Section 6) and off-site impact requirements (see Section 7 and figure set C). Egress via Rawson Street avoids all interaction with hazardous mainstream flooding. This condition has been met and responses to the DCP and LEP controls above further illustrate this.

(b) the principles of the Floodplain Development Manual 2005,	Key principles of the NSW FDM are that no development should occur in floodway, floor levels should meet FPL requirements and flood risk should be managed. All three key principles are met by the proposed works. Responses to the DCP and LEP controls above further illustrate this.
(c) the Considering flooding in land use planning guideline 2021, and	The proposed works are consistent with the 2021 guideline in that: the PMF is included in site flood liability analysis, the proposal does not put additional onus on existing flood planning issues, the works are protected from the PMF event (both mainstream and overland flow)
(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.	No such study exists for the site.
(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.	Answered by others.
(3) A planning proposal must not contain provisions that apply to the flood planning area which: *(a) permit development in floodway areas,*	As per Figure A11 no development is proposed in a highly conservative definition of the 1% AEP floodway
(b) permit development that will result in significant flood impacts to other properties,	As per figure set C impact results in the 1% AEP event on adjacent development due to the proposed works
(c) permit development for the purposes of residential accommodation in high hazard areas,	As per figure A07 works aren't proposed in an area of high hazard. Additionally residential levels are well and truly elevated above the 1% AEP mainstream flood level of 83.7 mAHD at the site.
(d) permit a significant increase in the development and/or dwelling density of that land,	Within the FPA as defined by 1% AEP plus 0.5 m the proposed works are minimal. Certainly the dwelling density within the FPA is not being altered by the proposed works. Noting that the FPA includes all areas below 84.2 mAHD based on a FPL of 1% AEP plus 0.5 m.

(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	Development proposed is a mixture of retail and residential. Egress to Rawson Road is readily achieved as is shelter in place. Flood flows pass quickly from the relatively small catchment. Note that the strategy proposed is compliant with DoP EM-01 2022 Guideline "Support for Emergency Services" as the duration of Shelter in Place is minimal.
(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,	Not applicable.
(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	Shelter in place is the only available strategy given the lack of warning. That said relatively safe egress to Rawson Street is available. GRC do not recommend anyone should drive during a rare flood event and the site is well placed to shelter people in place until such time as the event has passed (will be sub one hour given small catchment). Note that the strategy proposed is compliant with DoP EM-01 2022 Guideline "Support for Emergency Services" as the duration of Shelter in Place is minimal.
(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	The development is protected from flooding up to the PMF event and further the proposed usage is a retail area and residential accommodation.

Yours Sincerely,

Steve Gray
Director

Email: gray@grchydro.com.au
Tel: +61 413 631 447

Appendix A

BLOCKAGE ASSESSMENT FORM ARR2016

STRUCTURE: **Carlingford Road Culvert**

OPENING WIDTH: **2.6 m Wide 2.3 m High**

DEBRIS TYPE / MATERIAL / L_{10} / SOURCE AREA

Debris Type/Material	L_{10}	Source Area	How Assessed
Floating	1.5 m	Tree branches and sticks falling into channel from trees adjacent –thick growth	Site visit
Urban	0.5 m	Local drainage debris	Site visit
Non-floating	Fine sediments	Moderate erosion hazard.	Site visit

DEBRIS AVAILABILITY (HML) – *for the selected debris type/size and its source area*

Availability	Typical Source Area Characteristics	Notes
High	• *Dense forest, thick vegetation, extensive canopy, difficult to walk through with considerable fallen limbs, leaves and high levels of floor litter.* • *Streams with boulder/cobble beds and steep bed slopes and banks showing signs of substantial past bed/bank movements.* • *Arid areas, where loose vegetation and exposed loose soils occur and vegetation is sparse.* • *Urban areas that are not well maintained and/or old paling fences, sheds, cars and/or stored loose material etc., are present on the floodplain close to the water course.*	
Medium	• *State forest areas with clear understory, grazing land with stands of trees* • *Source areas generally falling between the High and Low categories.*	
Low	• *Well maintained rural lands and paddocks, with minimal outbuildings* • *Streams with moderate to flat slopes and stable beds and banks.* • *Arid areas where vegetation is deep rooted and soils resistant to scour* • *Urban areas that are well maintained with limited debris present in the source area.*	Floating: Urban well-maintained area. Trees with clear understory close to structure Urban: Well-maintained residential area. Non-Floating: Potential for scour during large rainfall events.

DEBRIS MOBILITY (HML) - *for the selected debris type/size and its source area*

Mobility	Typical Source Area Characteristics	Notes
High	• *Steep source area with fast response times and high annual rainfall and/or storm intensities and/or source areas subject to high rainfall intensities with sparse vegetation cover.* • *Receiving streams that frequently overtop their banks.* • *Main debris source areas close to streams*	
Medium	• *Source areas generally falling between the High and Low categories.*	ALL: Large and flat source areas Receiving streams that frequently overtop their banks

Low	• *Low rainfall intensities and large, flat source areas.* • *Receiving streams that Infrequently overtop their banks.* • *Main source areas well away from streams*	

DEBRIS TRANSPORTABILITY (HML) - *for the selected debris type/size and stream characteristics*

Transportability	Typical Transporting Stream Characteristics	Notes
High	• *Steep bed slopes (> 3%).and/or high stream velocity (V>2.5m/sec)* • *Deep stream relative to vertical debris dimension (D>0.5L10)* • *Wide streams relative to horizontal debris dimension. (W>L10)* • *Streams relatively straight and free of constrictions/snag points.* • *High temporal variability in maximum stream flows*	ALL: Flat bed slope ~ 1% Fast stream velocity > 3m/s Depths: D >0.5L10=0.75m Wide streams: W >L10=1.5m Streams relatively straight
Medium	• *Streams generally falling between High and Low categories*	
Low	• *Flat bed slopes (< 1%).and/or low stream velocity (V<1m/sec)* • *Shallow stream relative to vertical debris dimension (D<0.5L10)* • *Narrow streams relative to horizontal debris dimension. (W<L10)* • *Streams meander with frequent constrictions/snag points.* • *Low temporal variability in maximum stream flows*	

SITE BASED DEBRIS POTENTIAL 1%AEP (HML) - *for the selected debris type/size arriving at the site*

Debris Potential	Combinations of the Above (any order)	Notes		
High	*HHH or HHM*			
Medium	*MMM or HML or HMM or HLL*	LMH	LMH	LMH
Low	*LLL or MML or MLL*			

AEP ADJUSTED SITE DEBRIS POTENTIAL (HML) - *for the selected debris type/size*

Event AEP	At Site 1% AEP Debris Potential			AEP Adjusted at Site Debris Potential		
	High	Medium	Low			
AEP > 5% (frequent)	*Medium*	*Low*	*Low*	Low	Low	Low
AEP 5% - AEP 0.5%	*High*	*Medium*	*Low*	Medium	Medium	Medium
AEP < 0.5%	*High*	*High*	*Medium*	*High*	*High*	*High*

MOST LIKELY DESIGN INLET BLOCKAGE LEVEL (B_{DES}%) *for the selected debris type/size*

Control Dimension Inlet Width W (m)	At Site 1% AEP Debris Potential		
	High	Medium	Low
$W < L_{10}$	*100%*	*50%*	*25%*
$L_{10} \leq W \leq 3L_{10}$	*20%*	*10%*	*0%*
$W > 3L_{10}$	*10%*	*0%*	*0%*

Event AEP	Bdes% Urban
AEP > 5% (frequent)	*0%*
AEP 5% - AEP 0.5%	*10%*
AEP < 0.5%	*20%*

LIKELIHOOD OF SEDIMENT BEING DEPOSITED IN WATERWAY (HML)

Peak Velocity through Structure (m/s)	Particle Type				
	Clay/Silt	Sand	Gravel	Cobbles	Boulders
>= 3	*L*	*L*	*L*	*L*	*M*
1.0 to 3	*L*	*L*	*L*	*M*	*M*
0.5 to 1	*L*	*L*	*L*	*M*	*H*
0.1 to 0.5	*L*	*L*	*M*	*H*	*H*
< 0.1	*L*	*M*	*H*	*H*	*H*

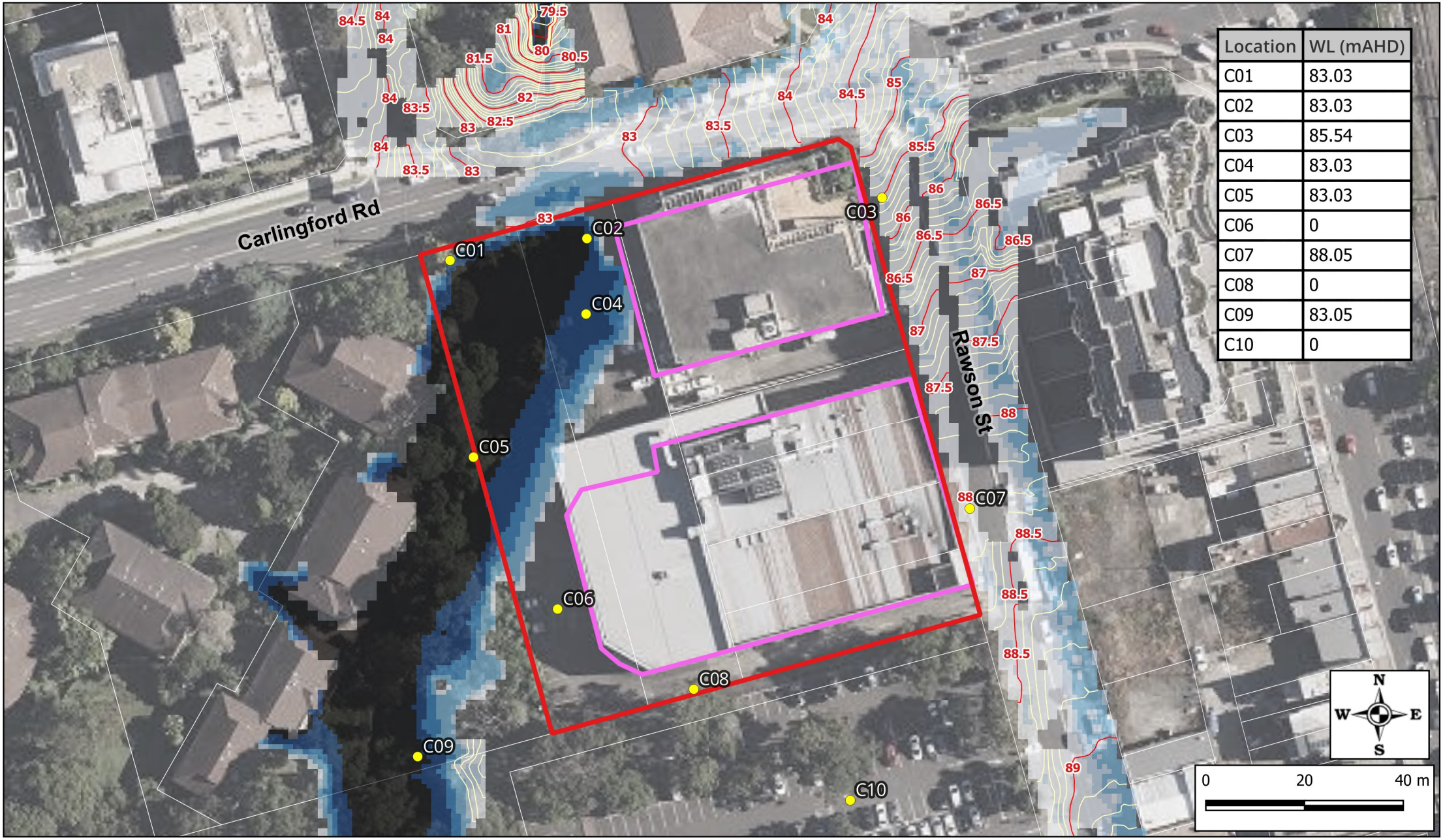
MOST LIKELY DEPOSITIONAL BLOACKAGE LEVELS – B_{DES}%

Likelihood that deposition will occur	AEP Adjusted Debris Potential		
	High	Medium	Low
High	*100%*	*60%*	*25%*
Medium	*60%*	*40%*	*15%*
Low	*25%*	*15%*	*0%*

Event AEP	Bdes% Non-Floating
AEP > 5% (frequent)	*0%*
AEP 5% - AEP 0.5%	*15%*
AEP < 0.5%	*25%*

ESTIMATED BLOCKAGE LEVELS – B_{DES}%

Event AEP	Bdes% Floating	Bdes% Non-Floating	Bdes% Final
AEP > 5% (frequent)	*0%*	*0%*	*0%*
AEP 5% - AEP 0.5%	*10%*	*15%*	*15%*
AEP < 0.5%	*20%*	*25%*	*25%*



Location	WL (mAHD)
C01	83.03
C02	83.03
C03	85.54
C04	83.03
C05	83.03
C06	0
C07	88.05
C08	0
C09	83.05
C10	0

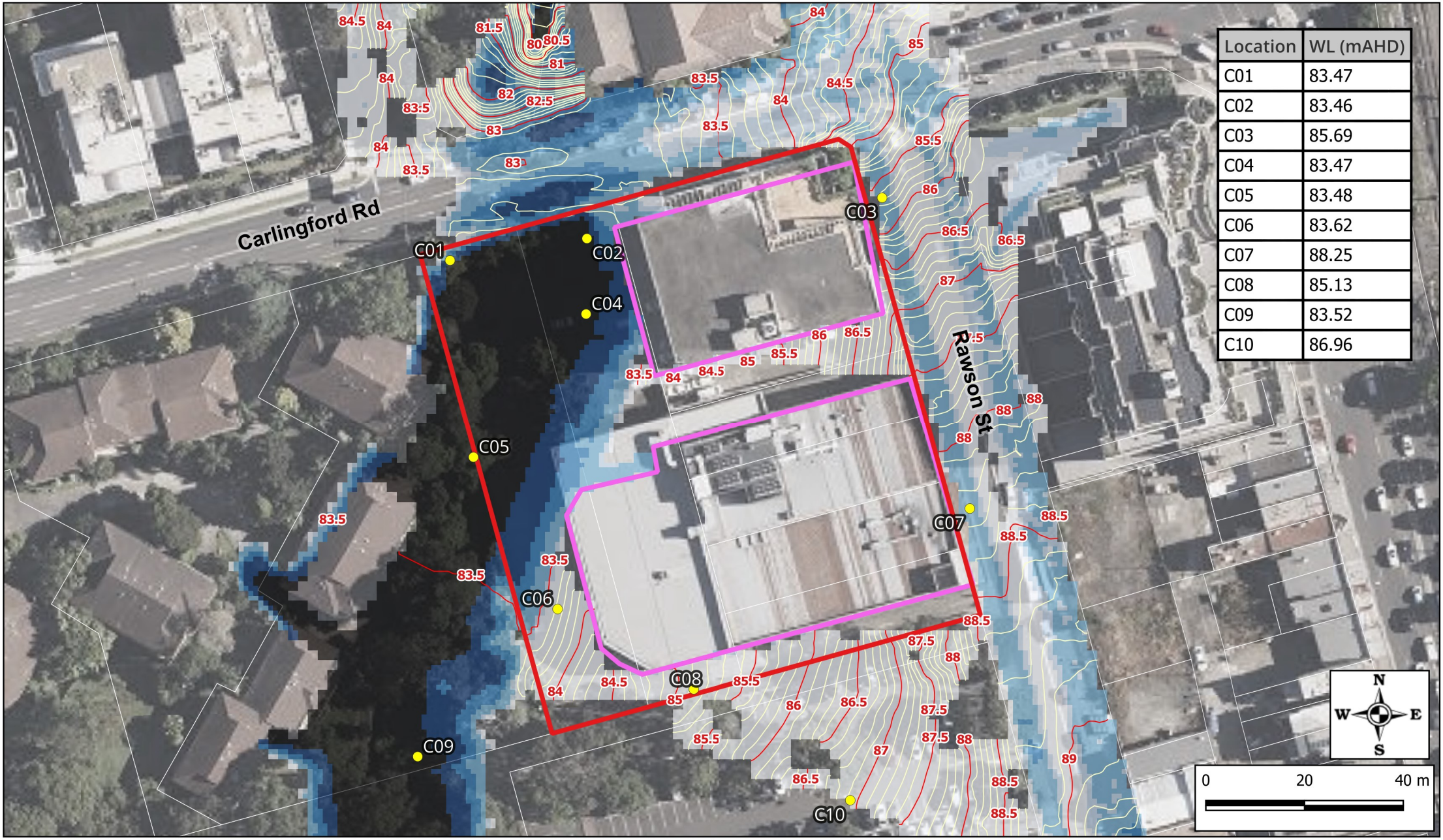
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**5% AEP 15% Blockage - Peak Depths and Levels (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A01**

grc HYDRO



Location	WL (mAHD)
C01	83.47
C02	83.46
C03	85.69
C04	83.47
C05	83.48
C06	83.62
C07	88.25
C08	85.13
C09	83.52
C10	86.96

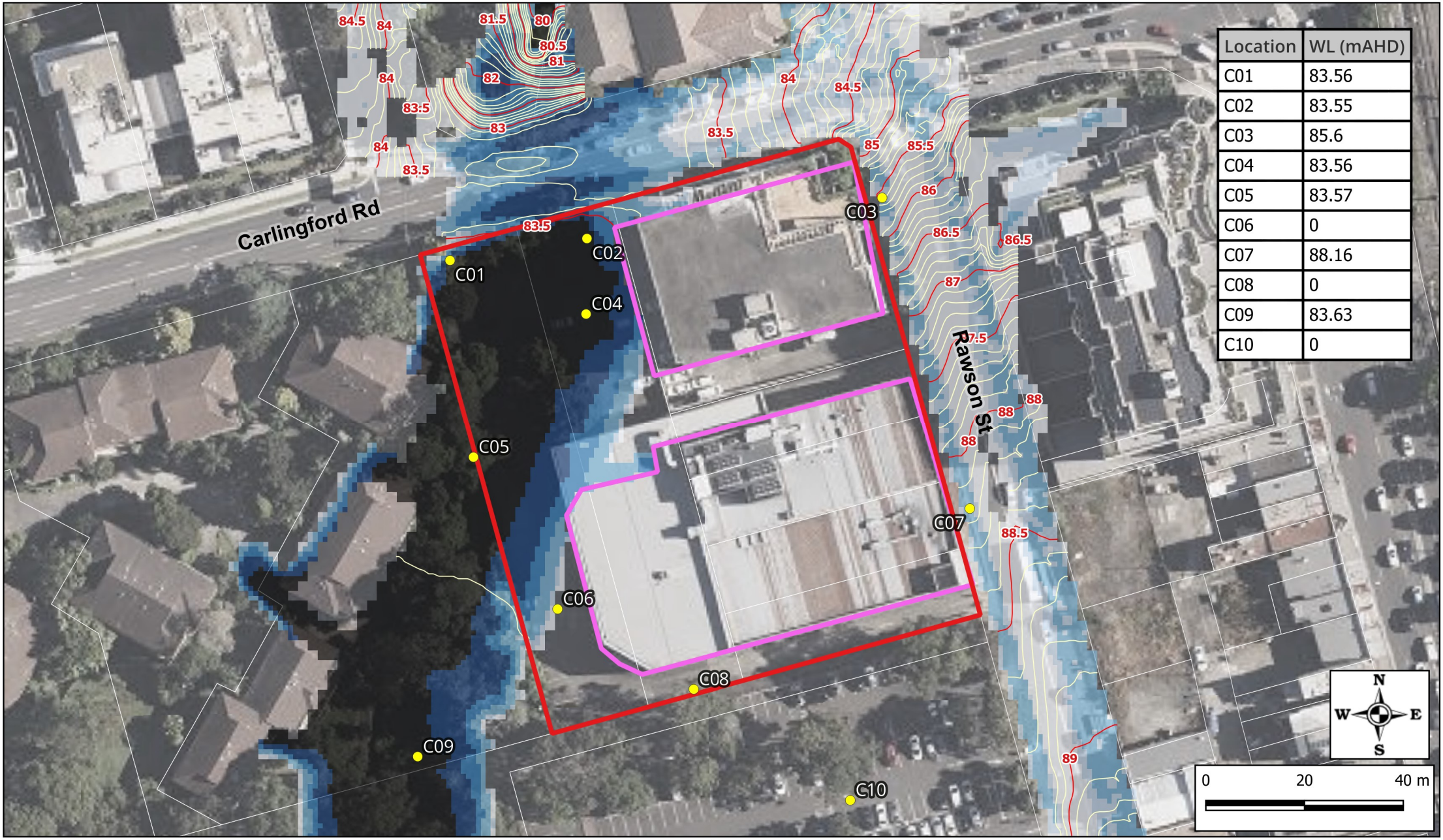
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**1% AEP 15% Blockage - Peak Depths and Levels (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A02**

grc HYDRO



Location	WL (mAHD)
C01	83.56
C02	83.55
C03	85.6
C04	83.56
C05	83.57
C06	0
C07	88.16
C08	0
C09	83.63
C10	0

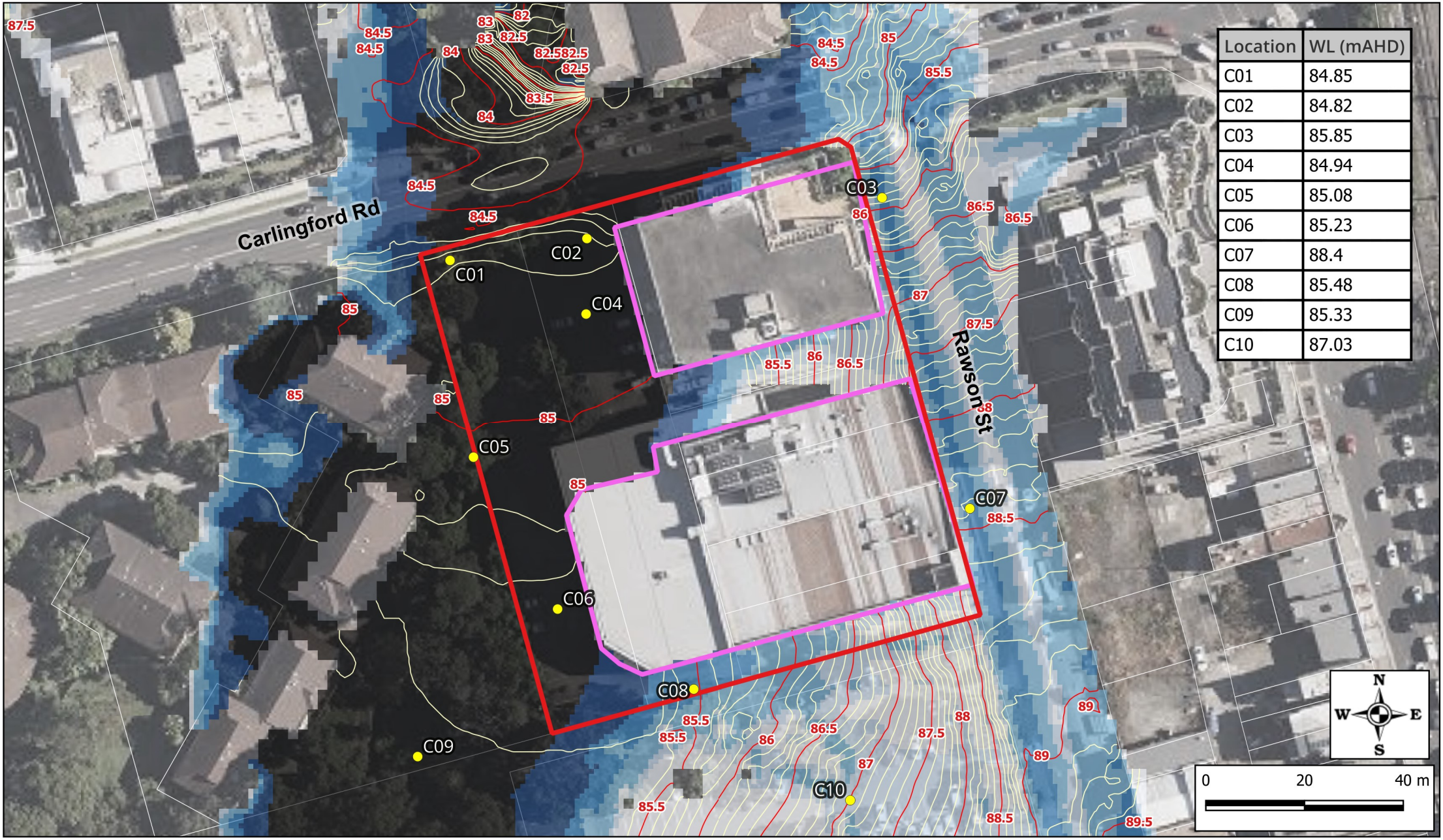
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**0.5% AEP 15% Blockage - Peak Depths and Levels (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A03**

grc HYDRO



Location	WL (mAHD)
C01	84.85
C02	84.82
C03	85.85
C04	84.94
C05	85.08
C06	85.23
C07	88.4
C08	85.48
C09	85.33
C10	87.03

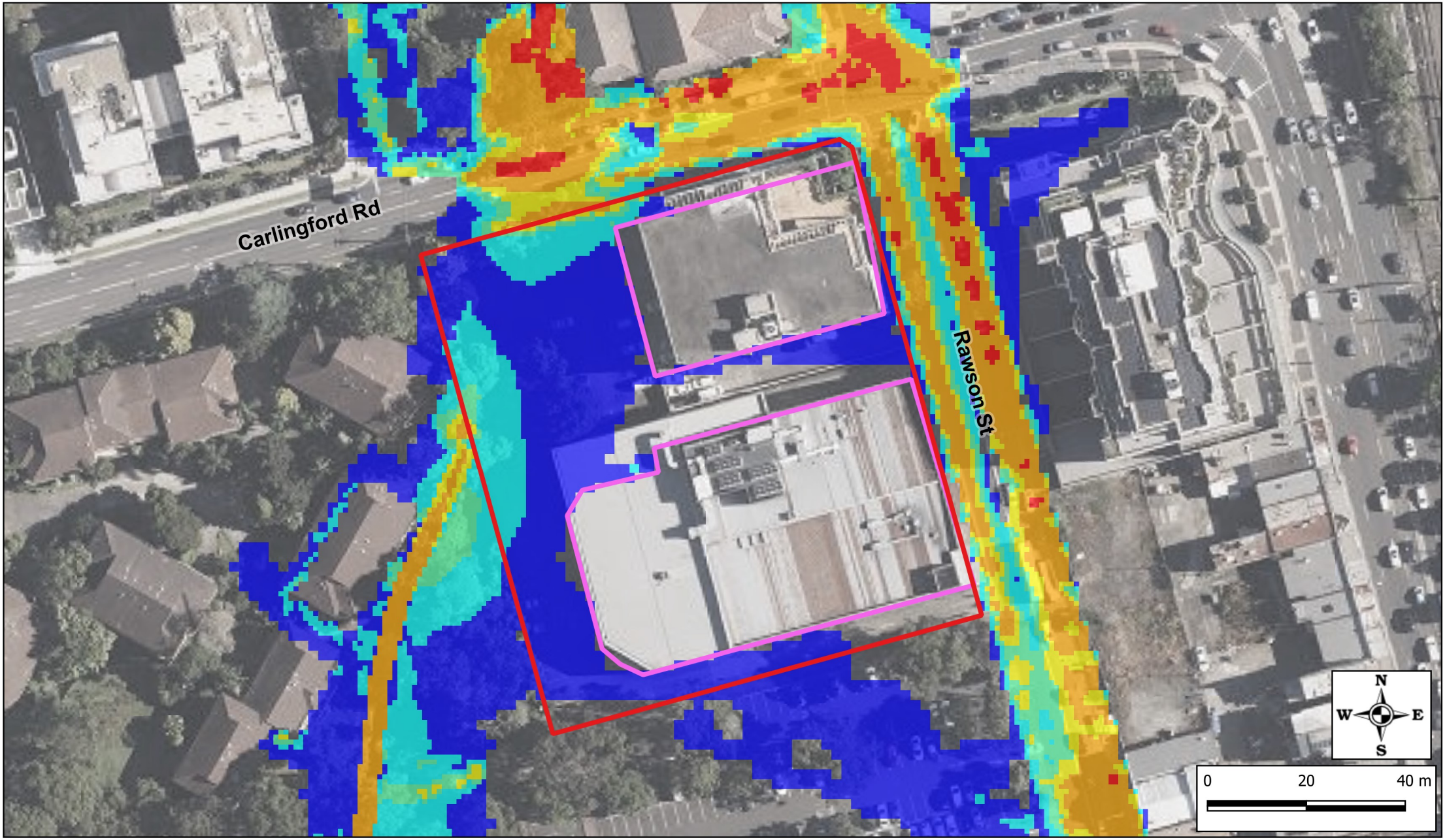
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**PMF 25% Blockage - Peak Depths and Levels (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **A04**	

grc HYDRO



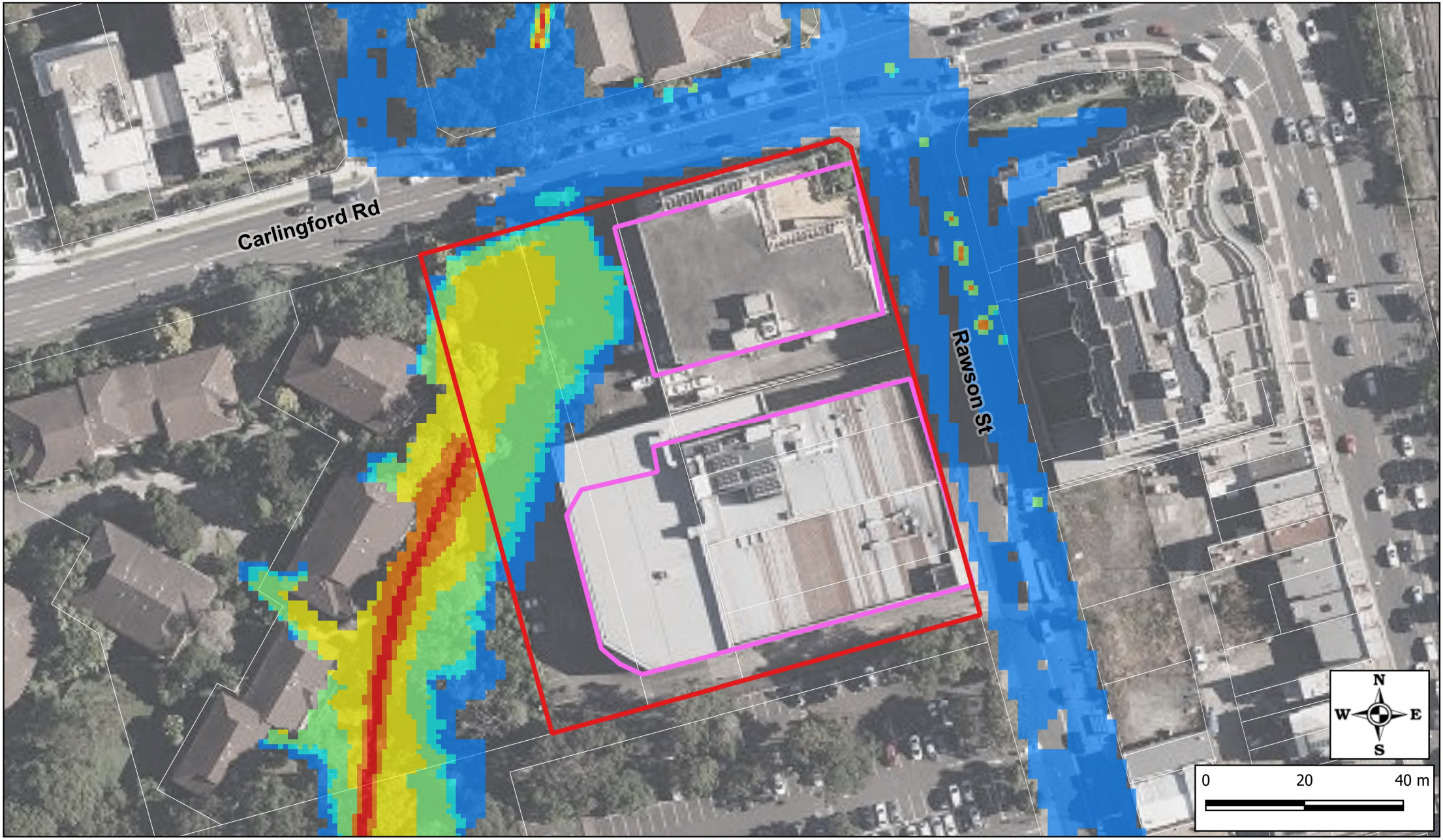
Flood Velocity (m/s)

- < 0.25
- 0.25 to 0.50
- 0.50 to 0.75
- 0.75 to 1.00
- 1.00 to 2.00
- > 2.00

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Peak Velocities (Existing)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**A05**

grc HYDRO



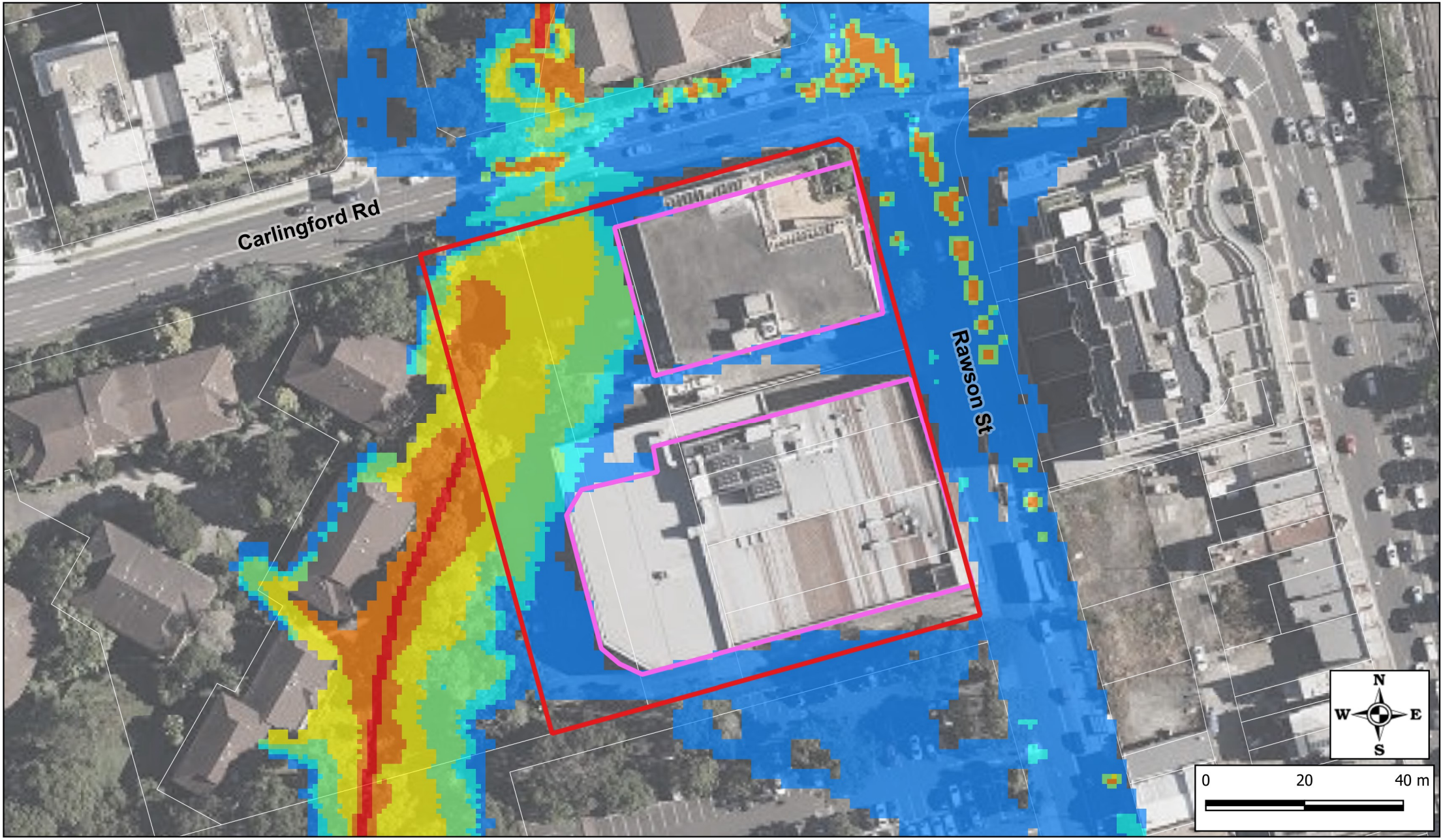
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**5% AEP 15% Blockage - Peak Flood Hazard (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A06**

grc HYDRO



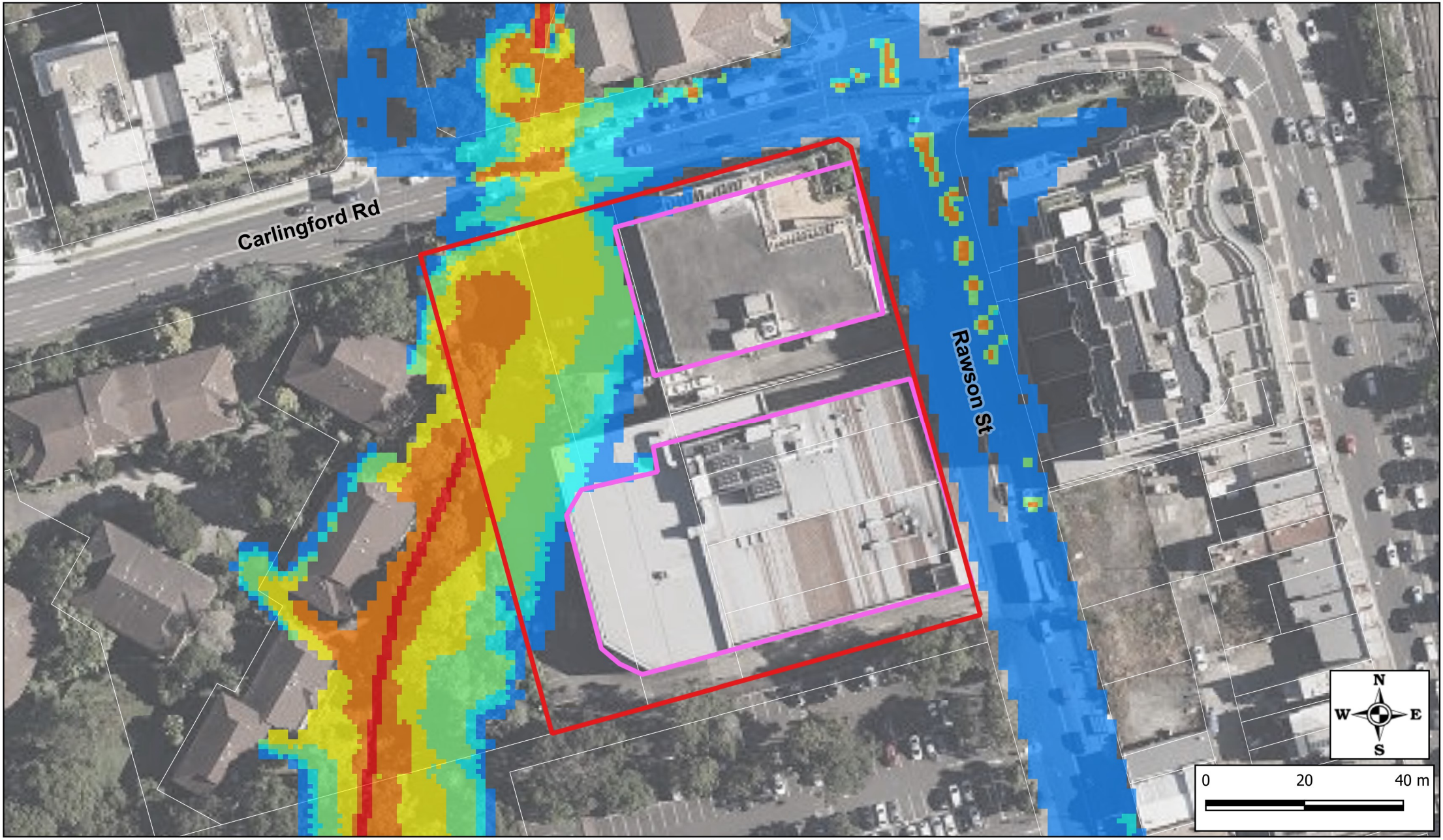
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Peak Flood Hazard (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **A07**	

grc HYDRO



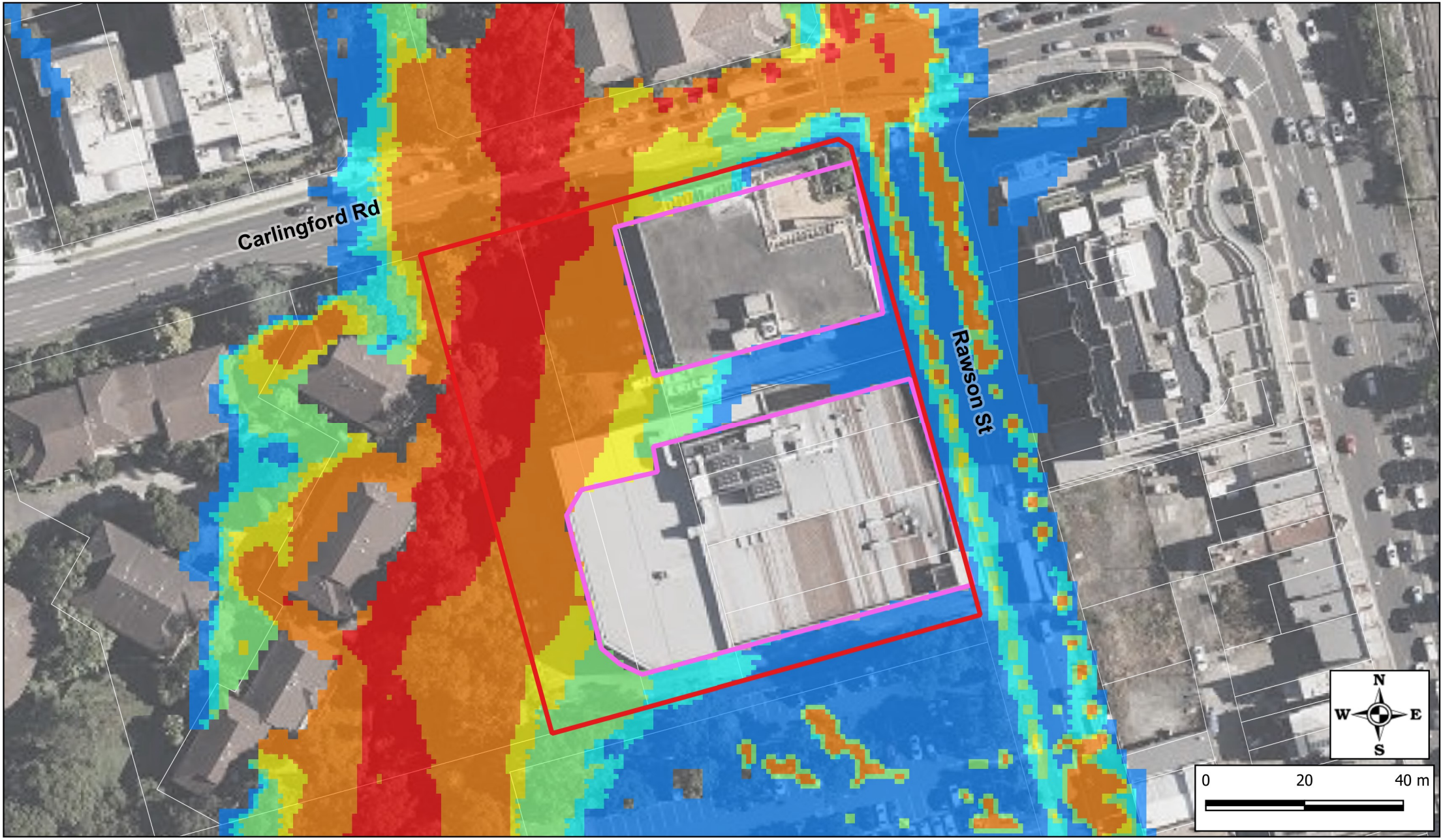
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**0.5% AEP 15% Blockage - Peak Flood Hazard (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **A08**	

grc HYDRO



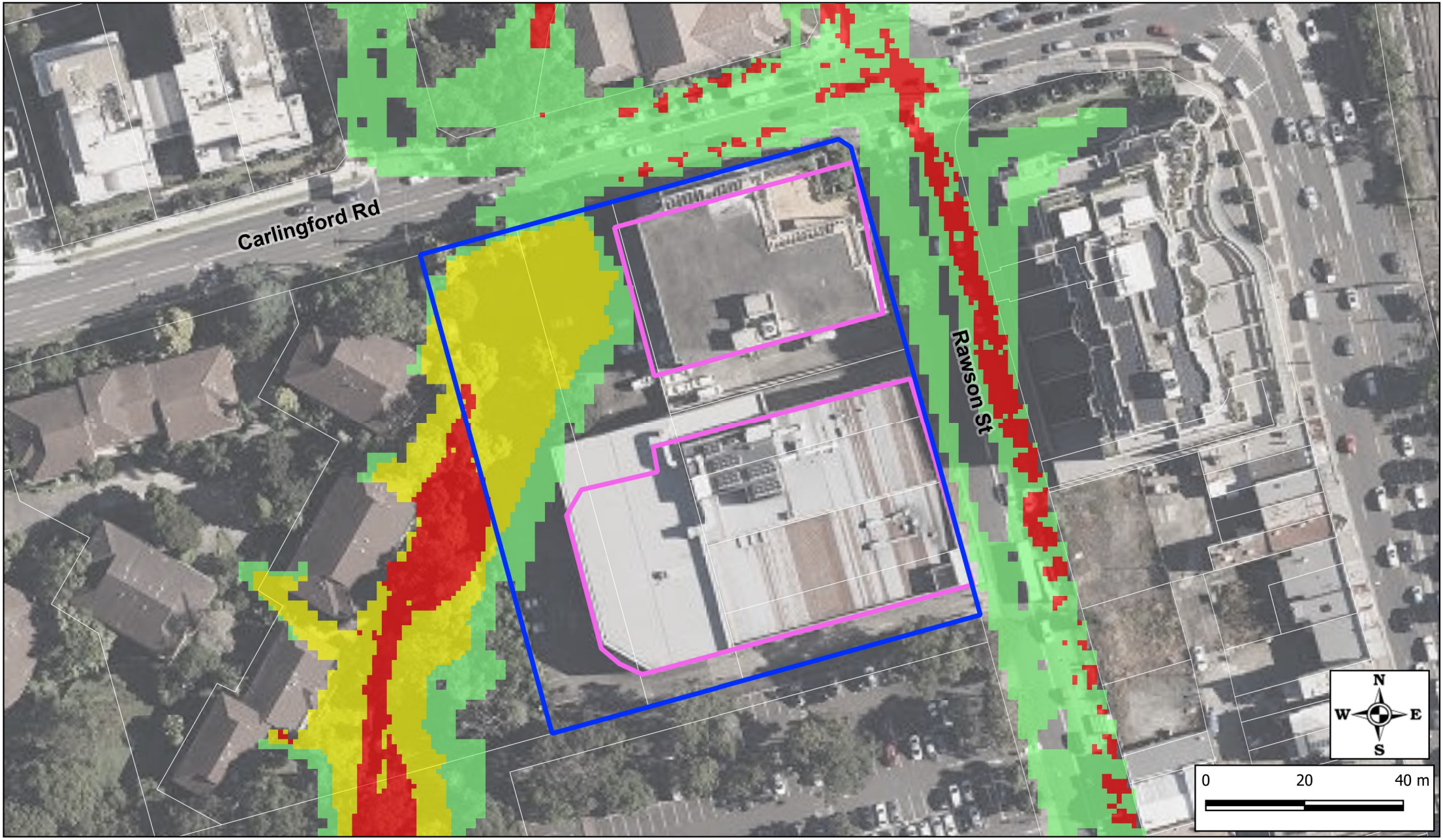
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**PMF 25% Blockage - Peak Flood Hazard (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A09**

grc HYDRO



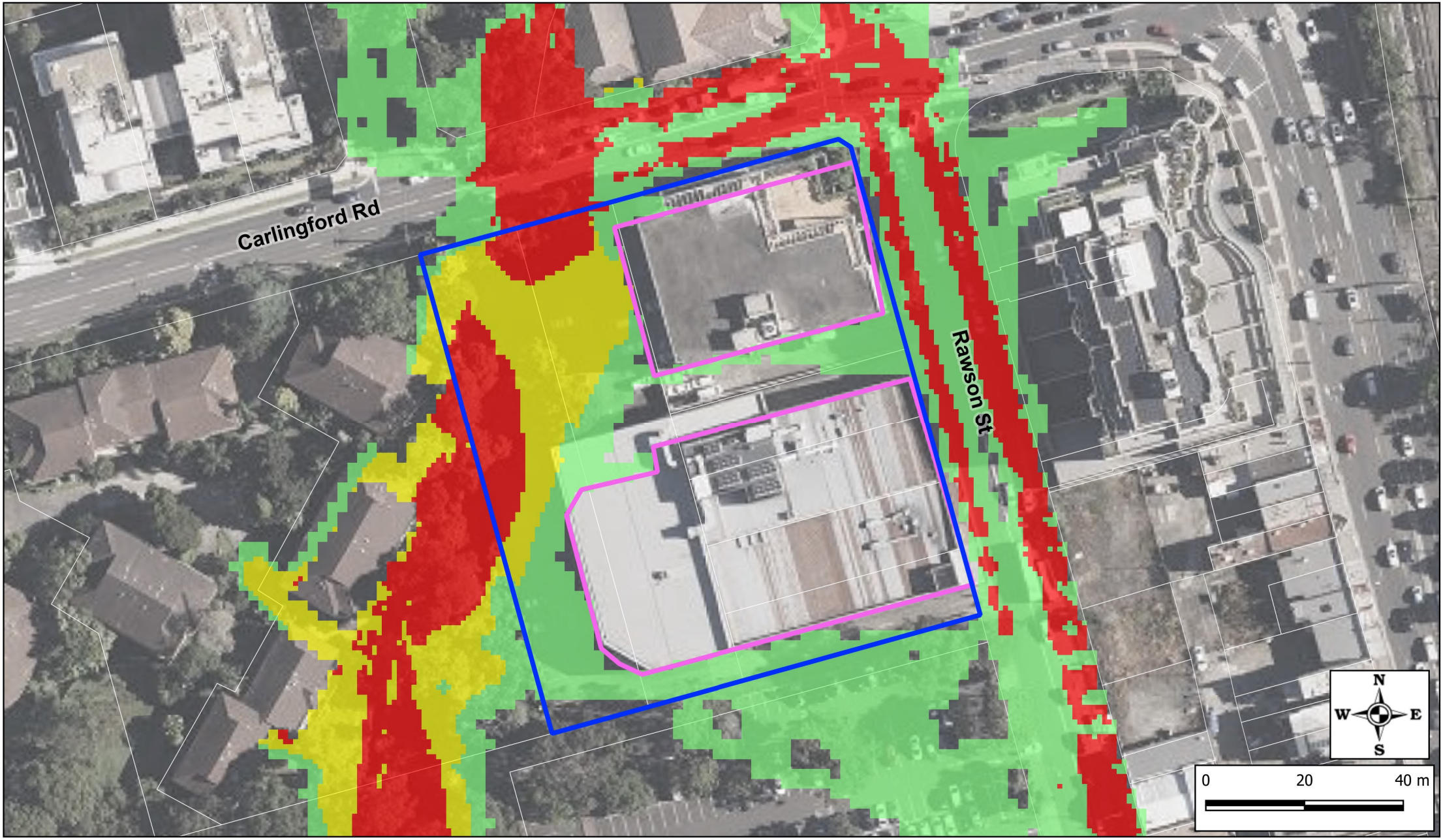
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**5% AEP 15% Blockage - Hydraulic Flood Function (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **A10**

grc HYDRO



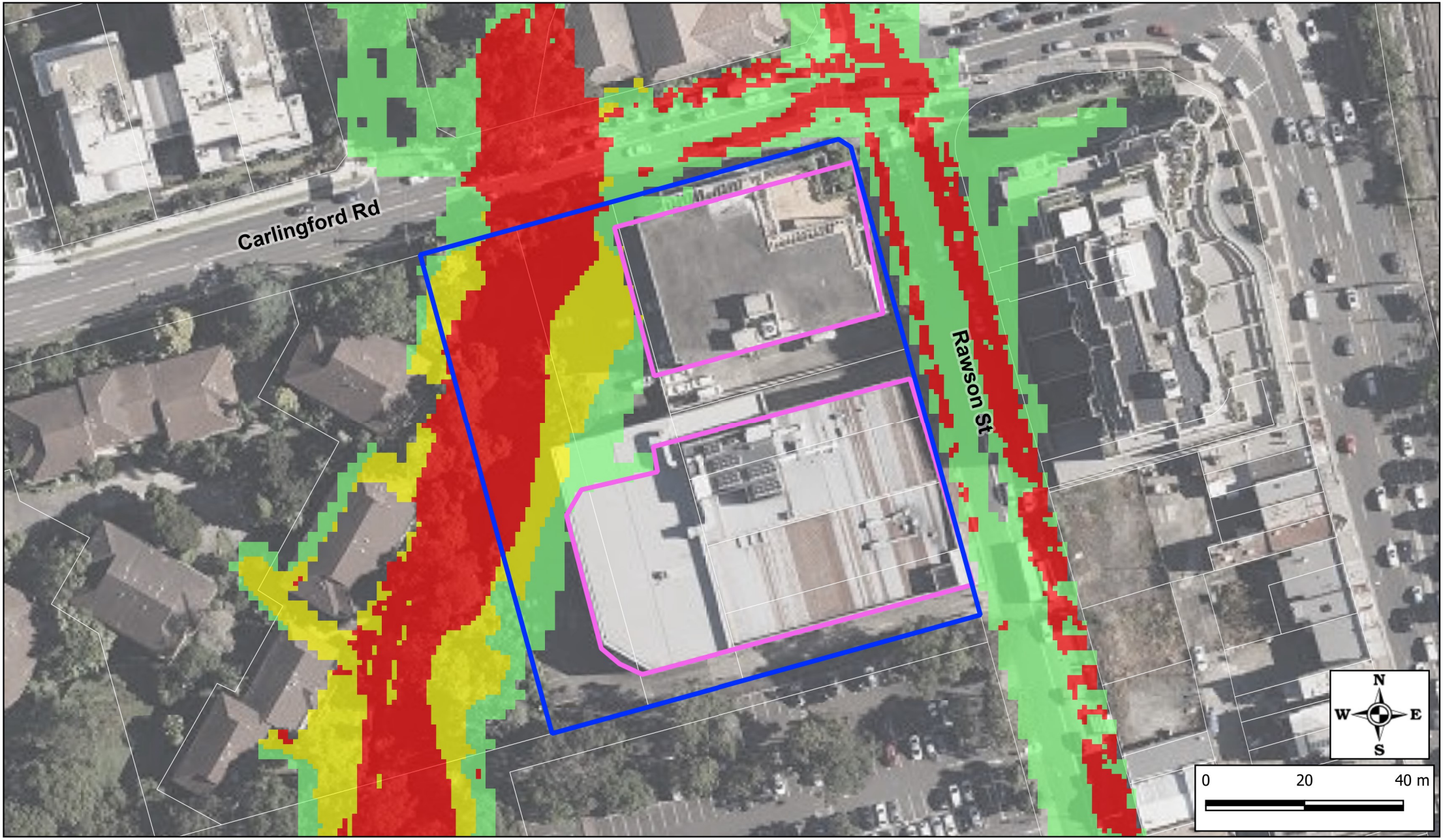
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Hydraulic Flood Function (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **A11**	

grc HYDRO



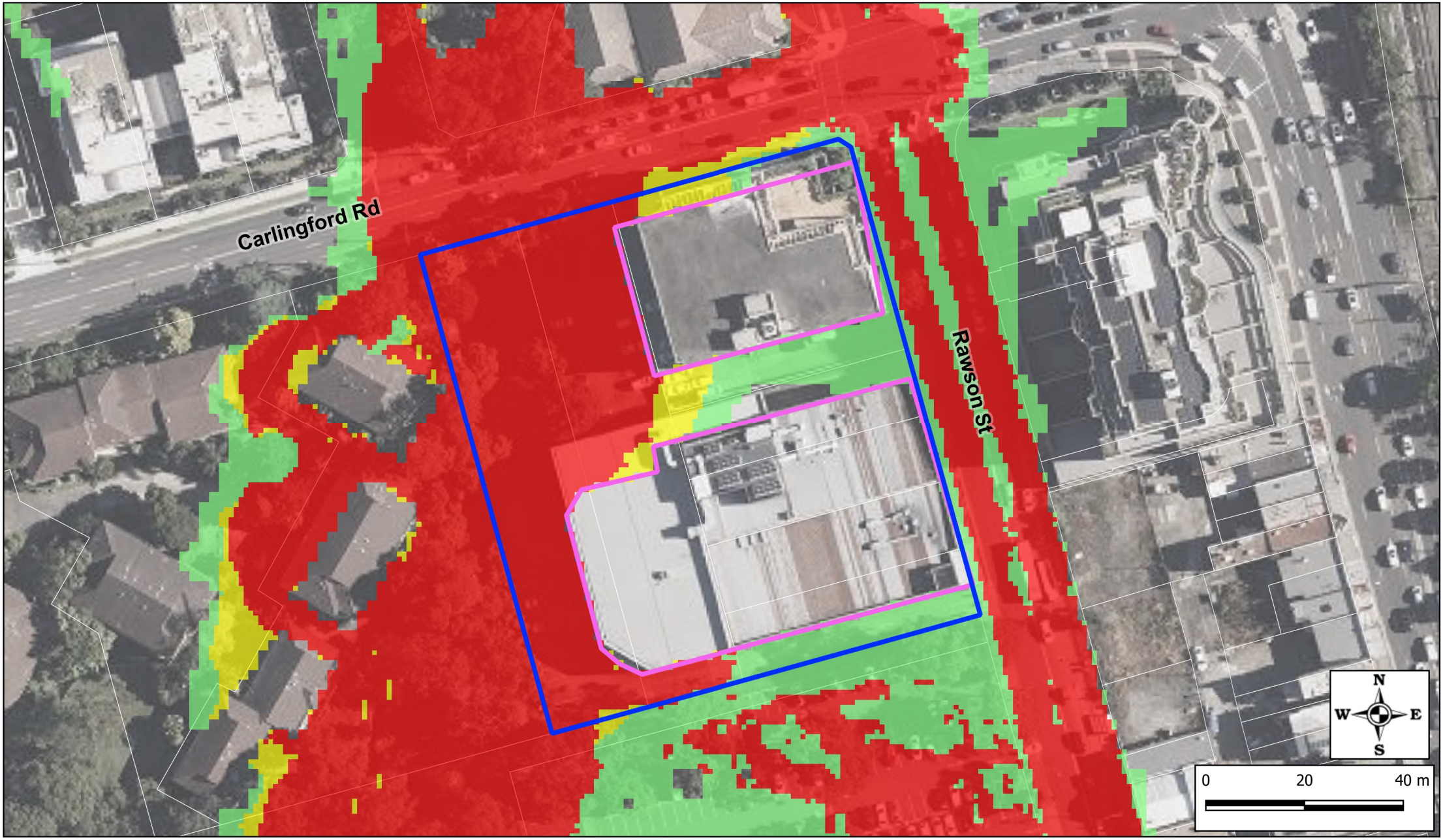
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**0.5% AEP 15% Blockage - Hydraulic Flood Function (Existing)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**A12**

grc HYDRO



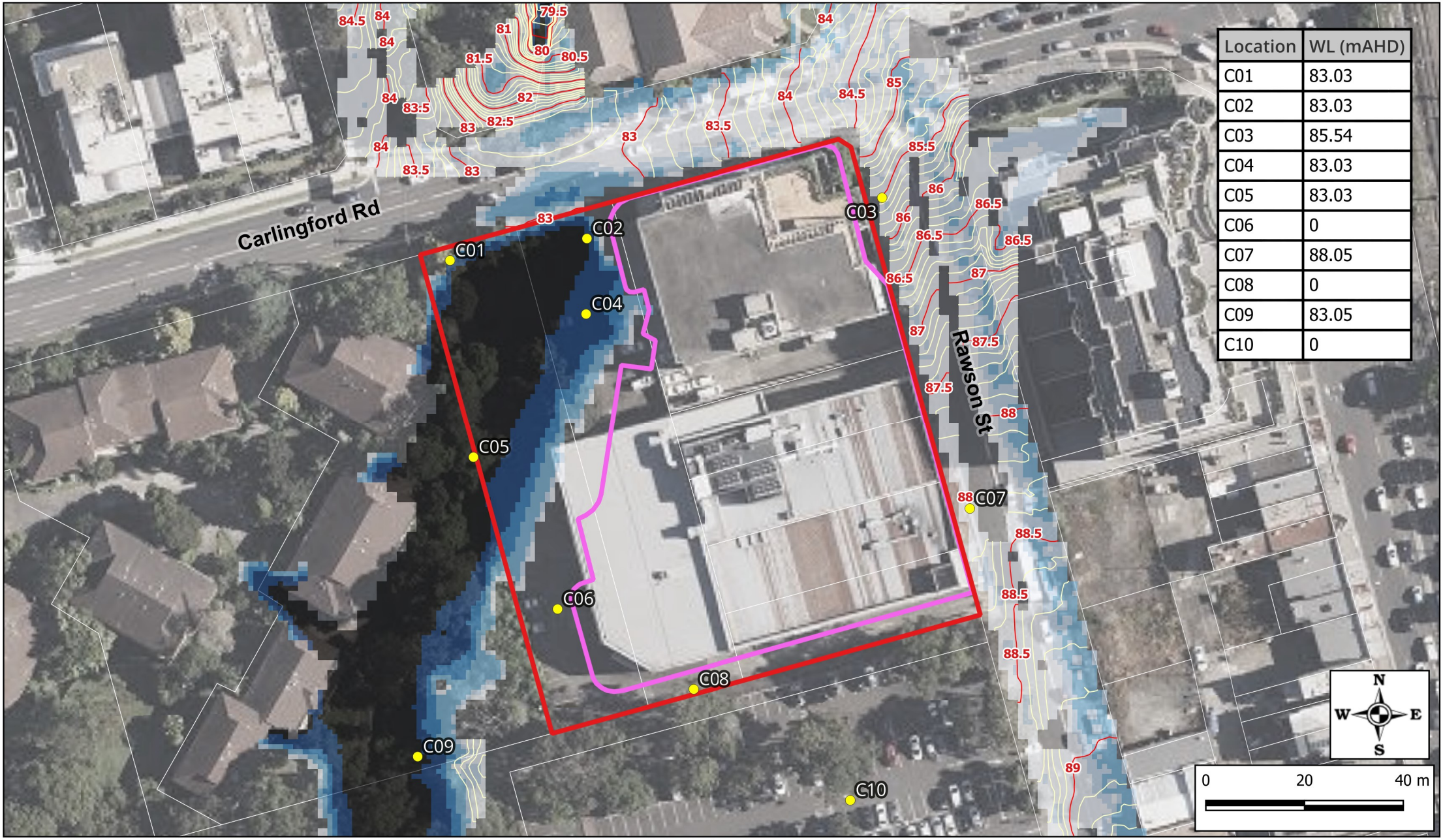
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**PMF 25% Blockage - Hydraulic Flood Function (Existing)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**A13**

grc HYDRO



Location	WL (mAHD)
C01	83.03
C02	83.03
C03	85.54
C04	83.03
C05	83.03
C06	0
C07	88.05
C08	0
C09	83.05
C10	0

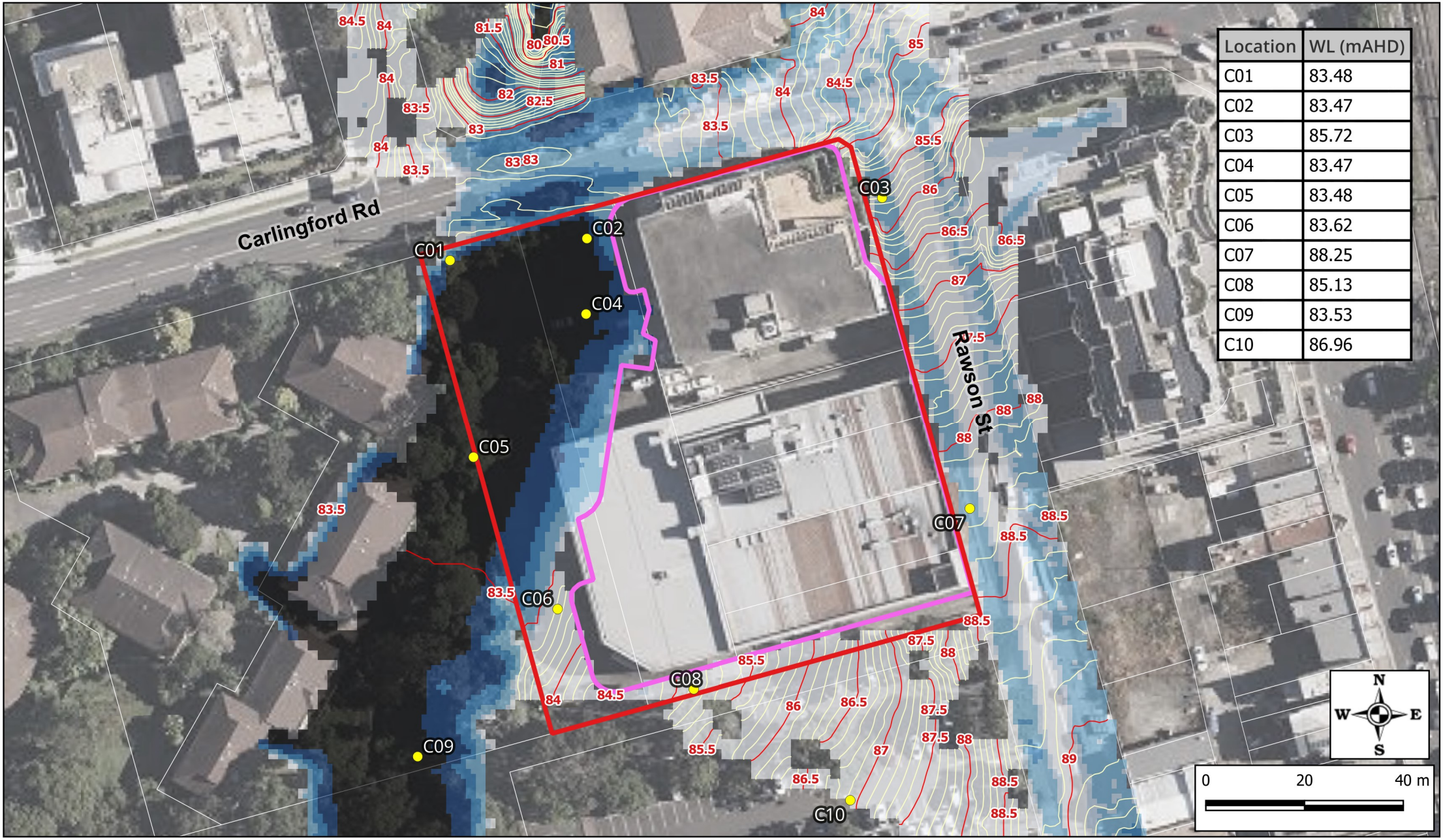
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**5% AEP 15% Blockage - Peak Depths and Levels (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **B01**

grc HYDRO



Location	WL (mAHD)
C01	83.48
C02	83.47
C03	85.72
C04	83.47
C05	83.48
C06	83.62
C07	88.25
C08	85.13
C09	83.53
C10	86.96

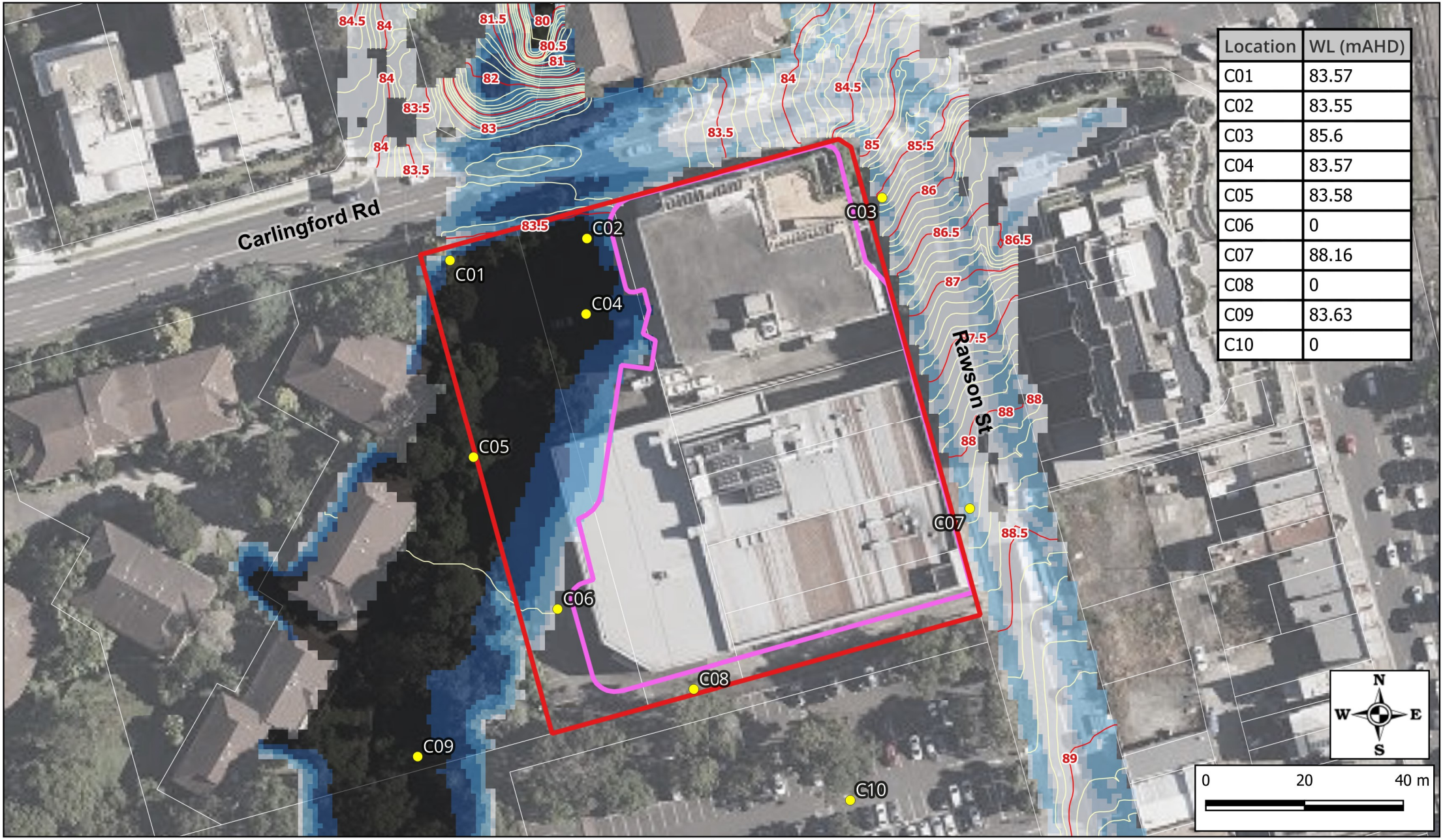
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**1% AEP 15% Blockage - Peak Depths and Levels (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **B02**

grc HYDRO



Location	WL (mAHD)
C01	83.57
C02	83.55
C03	85.6
C04	83.57
C05	83.58
C06	0
C07	88.16
C08	0
C09	83.63
C10	0

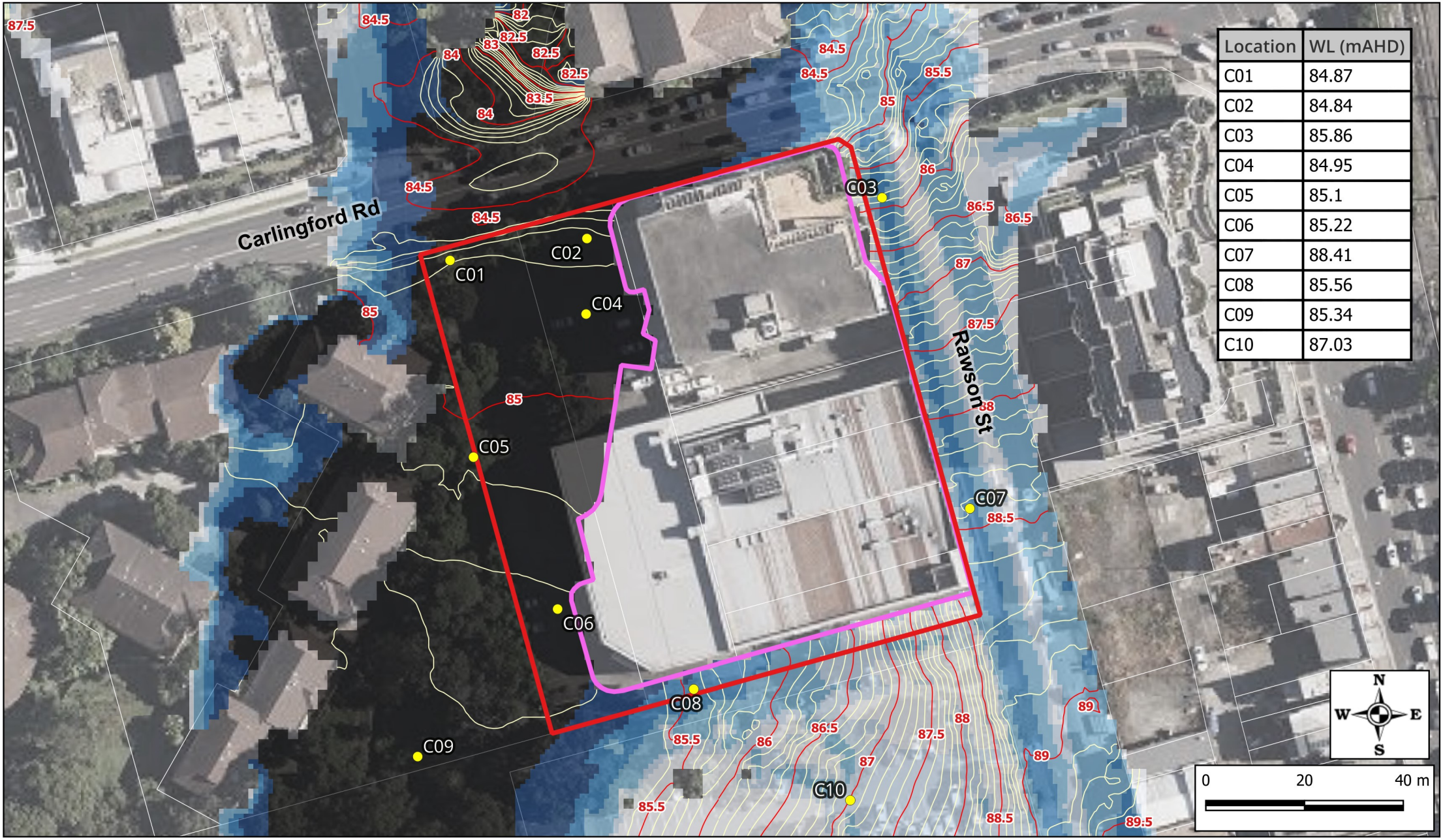
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**0.5% AEP 15% Blockage - Peak Depths and Levels (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **B03**

grc HYDRO



Location	WL (mAHD)
C01	84.87
C02	84.84
C03	85.86
C04	84.95
C05	85.1
C06	85.22
C07	88.41
C08	85.56
C09	85.34
C10	87.03

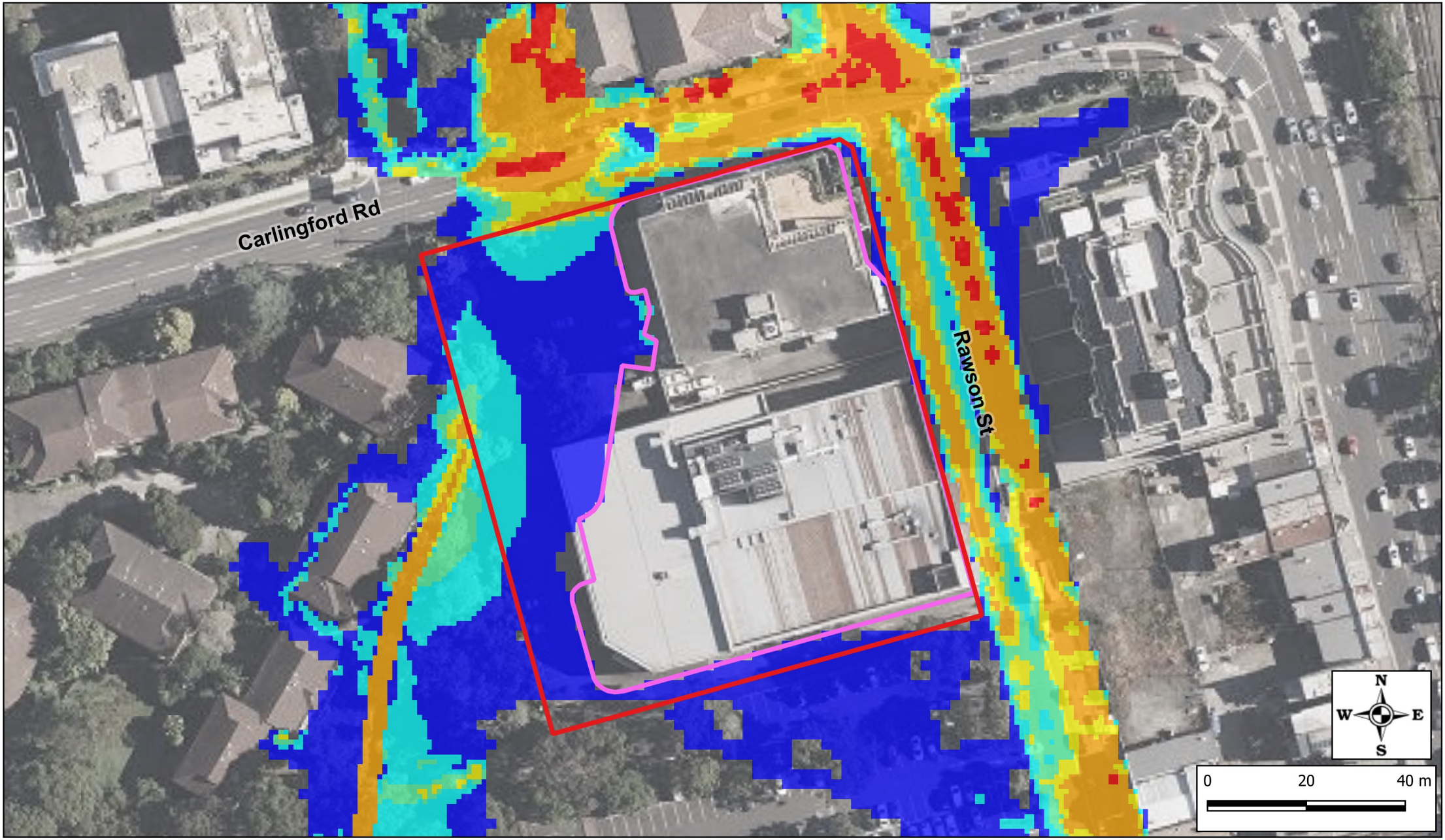
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**PMF 25% Blockage - Peak Depths and Levels (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B04**	

grc HYDRO



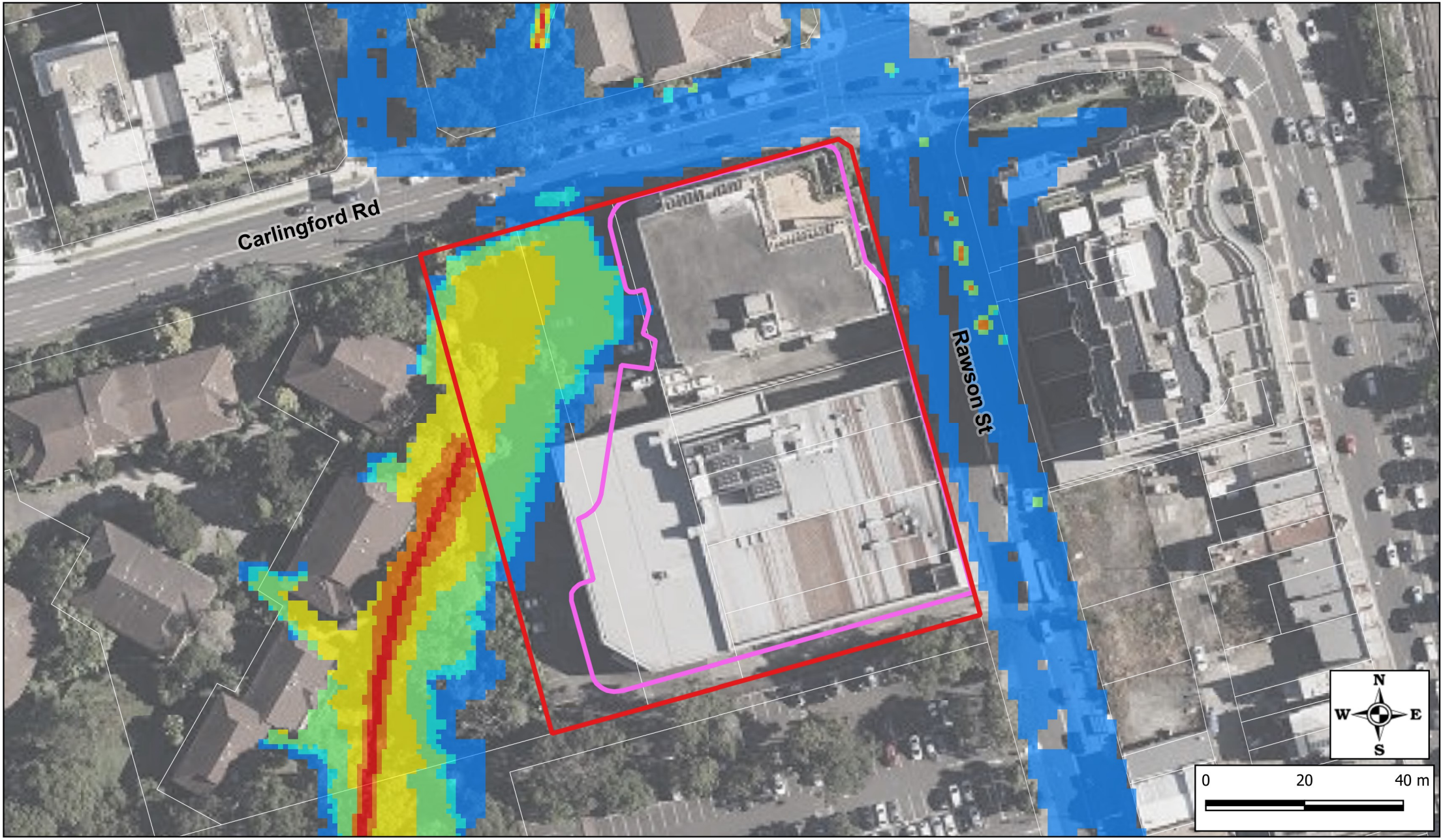
Flood Velocity (m/s)

- < 0.25
- 0.25 to 0.50
- 0.50 to 0.75
- 0.75 to 1.00
- 1.00 to 2.00
- > 2.00

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Peak Velocities (Post Development)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**B05**

grc HYDRO



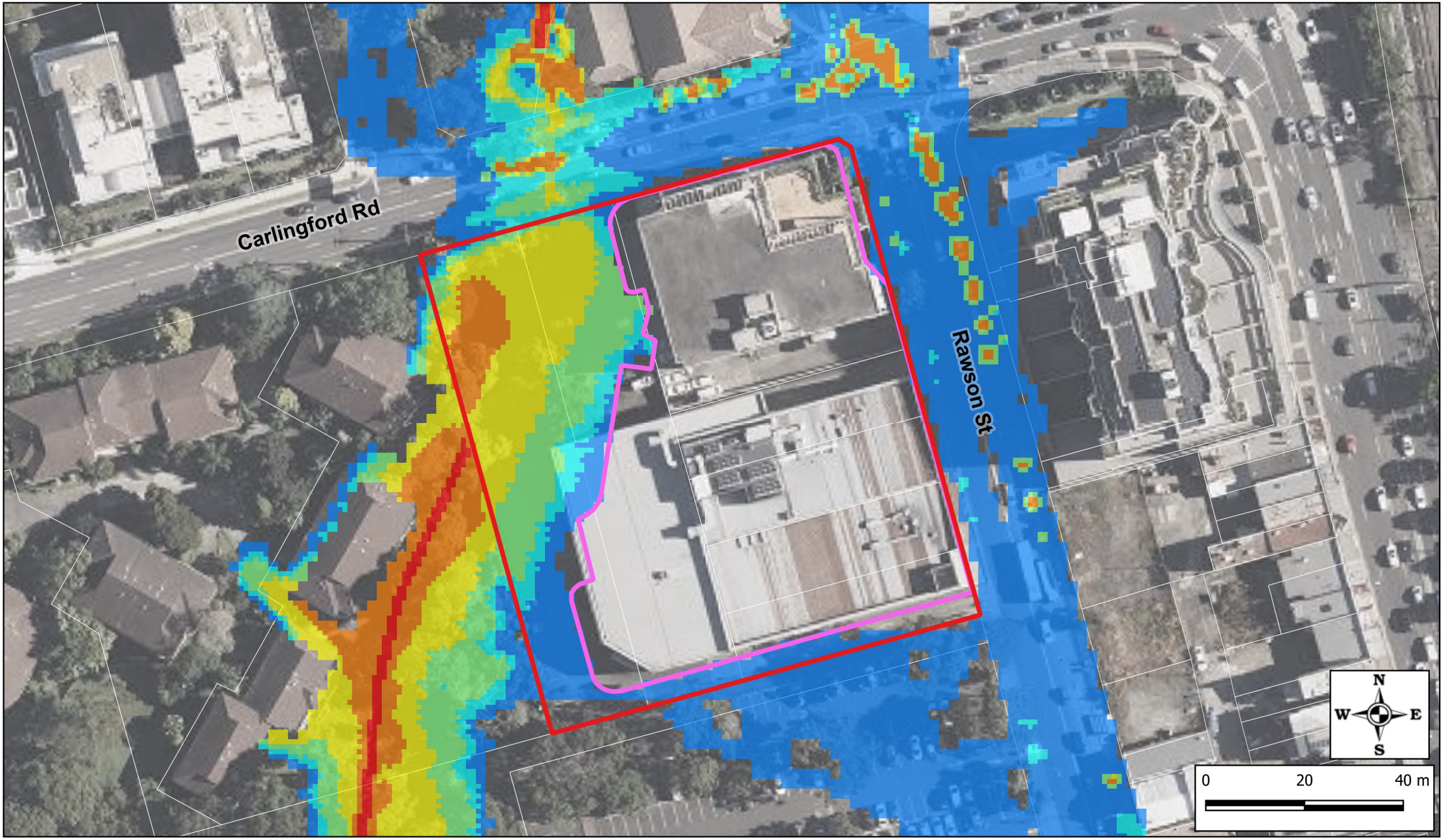
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**5% AEP 15% Blockage - Peak Flood Hazard (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B06**	

grc HYDRO



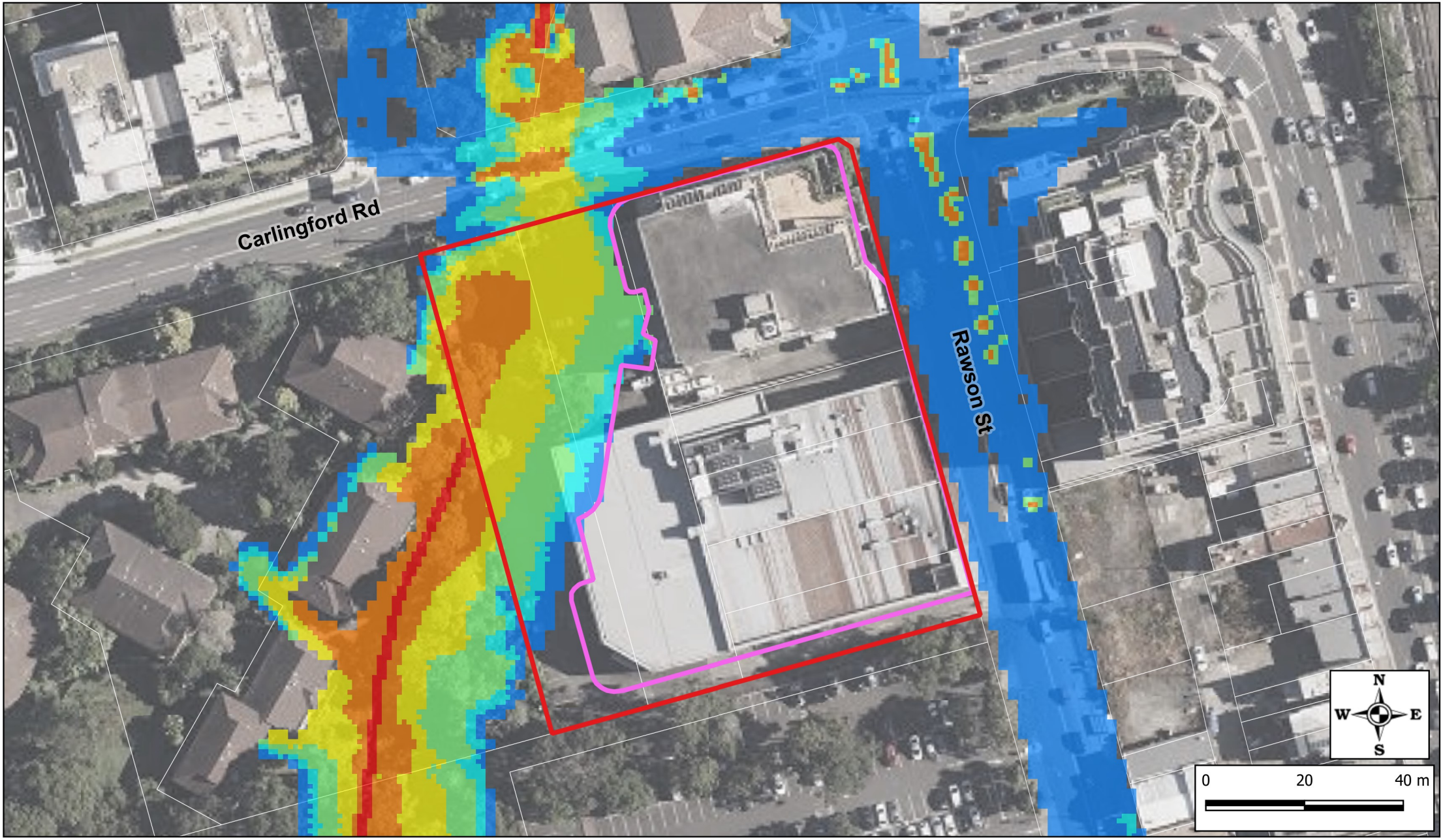
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Peak Flood Hazard (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B07**	

grc HYDRO



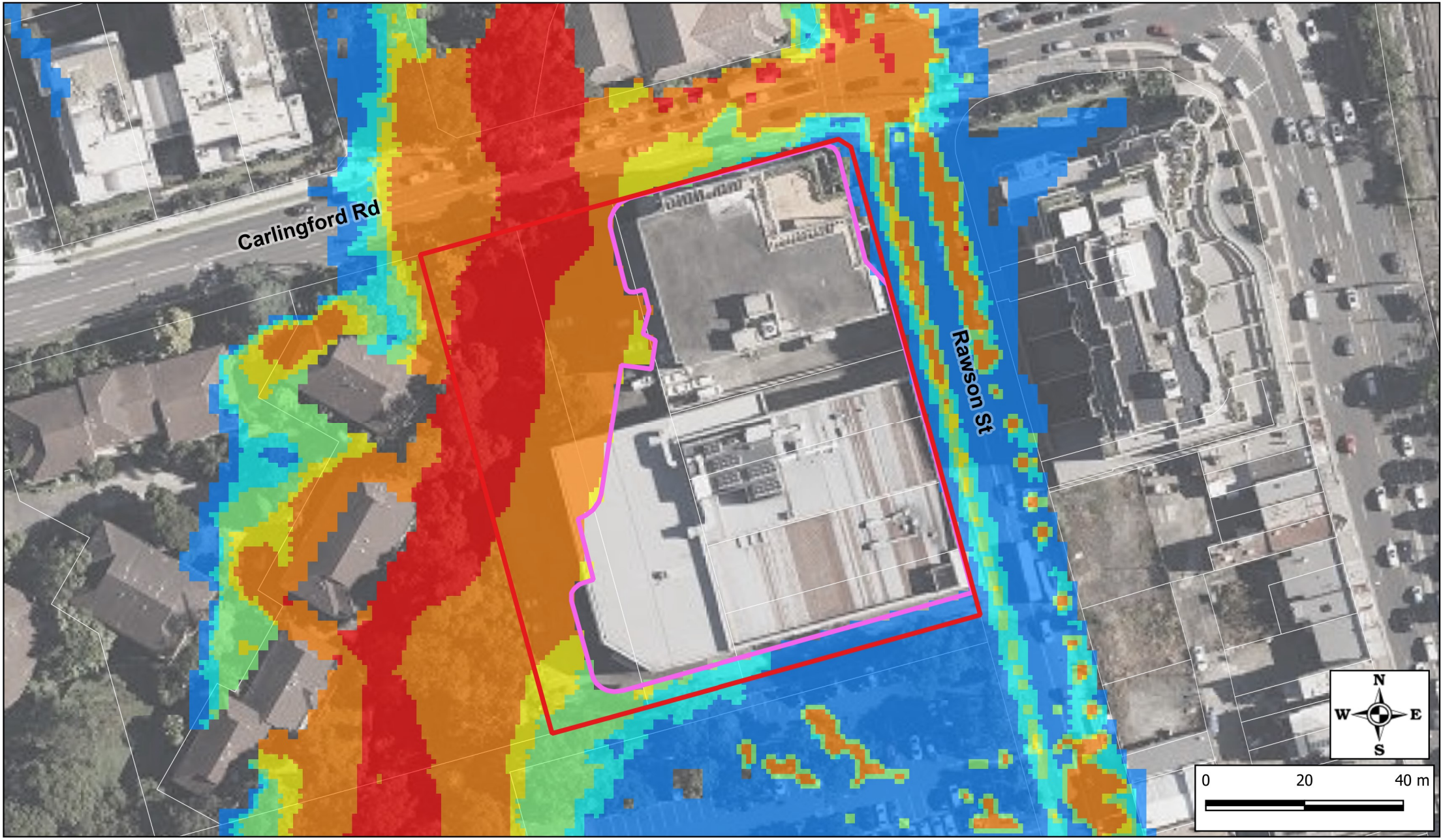
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**0.5% AEP 15% Blockage - Peak Flood Hazard (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B08**	

grc HYDRO



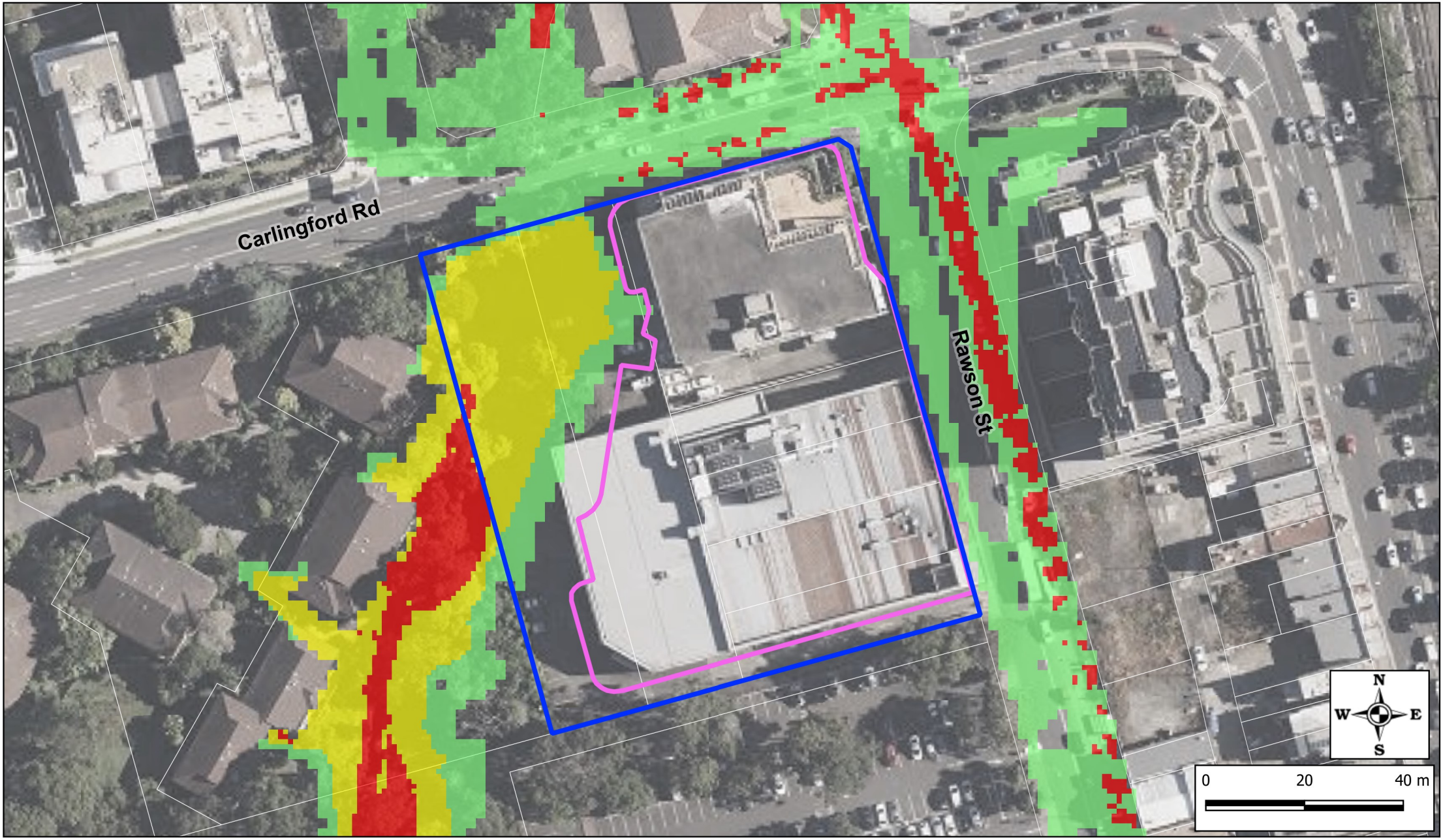
Flood Hazard

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

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**PMF 25% Blockage - Peak Flood Hazard (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B09**	

grc HYDRO



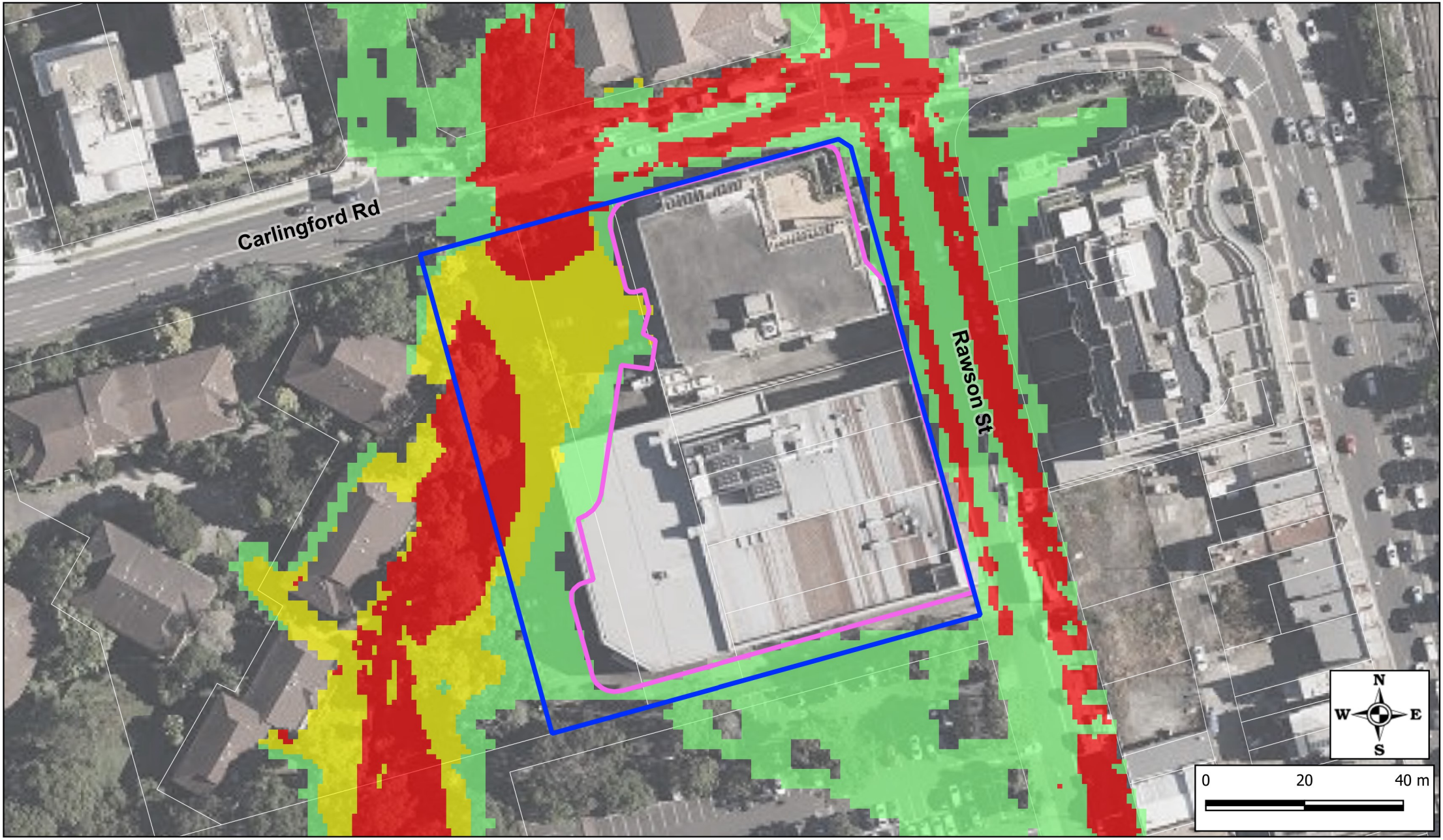
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**5% AEP 15% Blockage - Hydraulic Flood Function (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **B10**

grc HYDRO



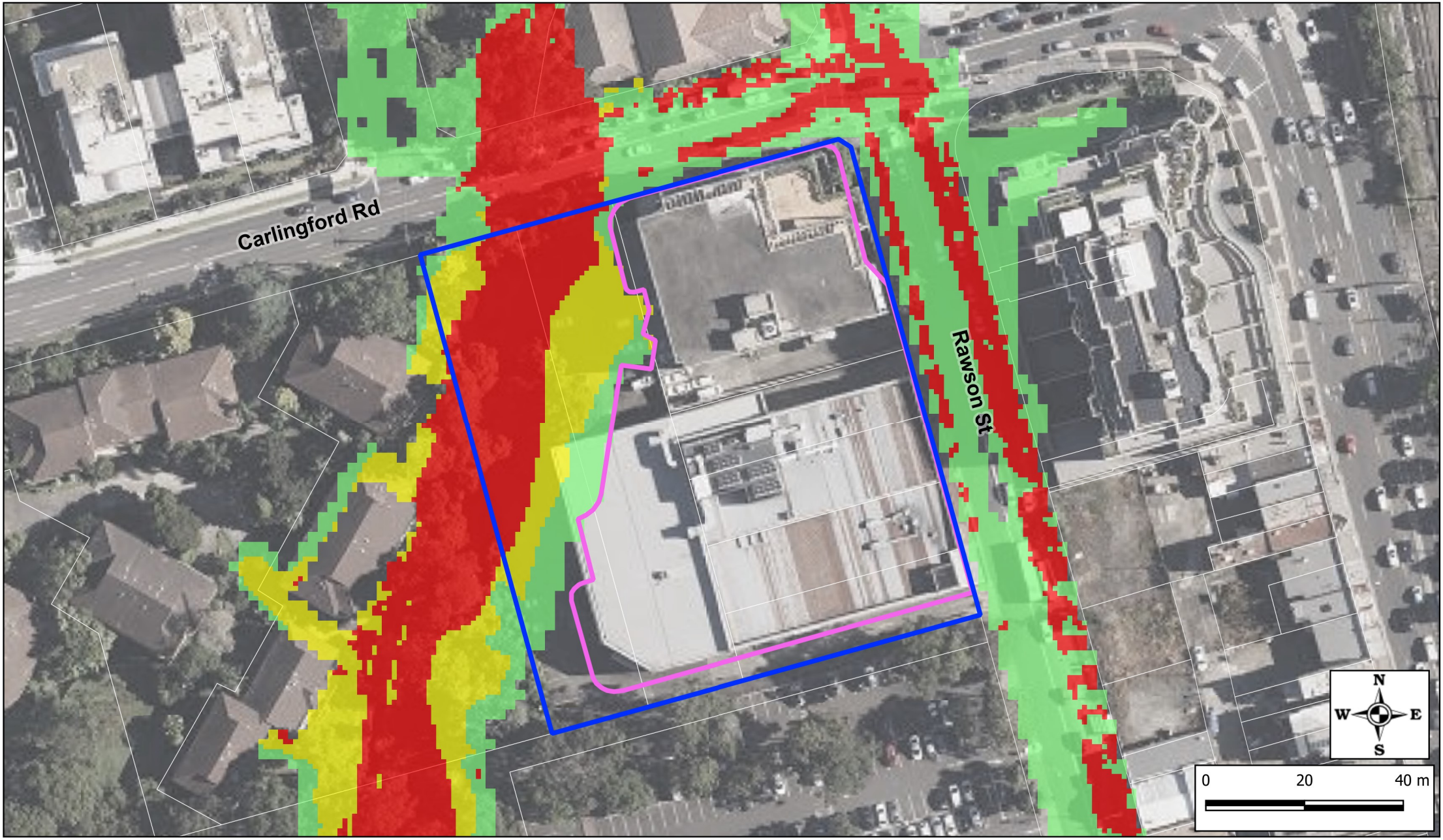
Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Hydraulic Flood Function (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **B11**	

grc HYDRO



Flood Function

- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**0.5% AEP 15% Blockage - Hydraulic Flood Function (Post Development)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**B12**

grc HYDRO

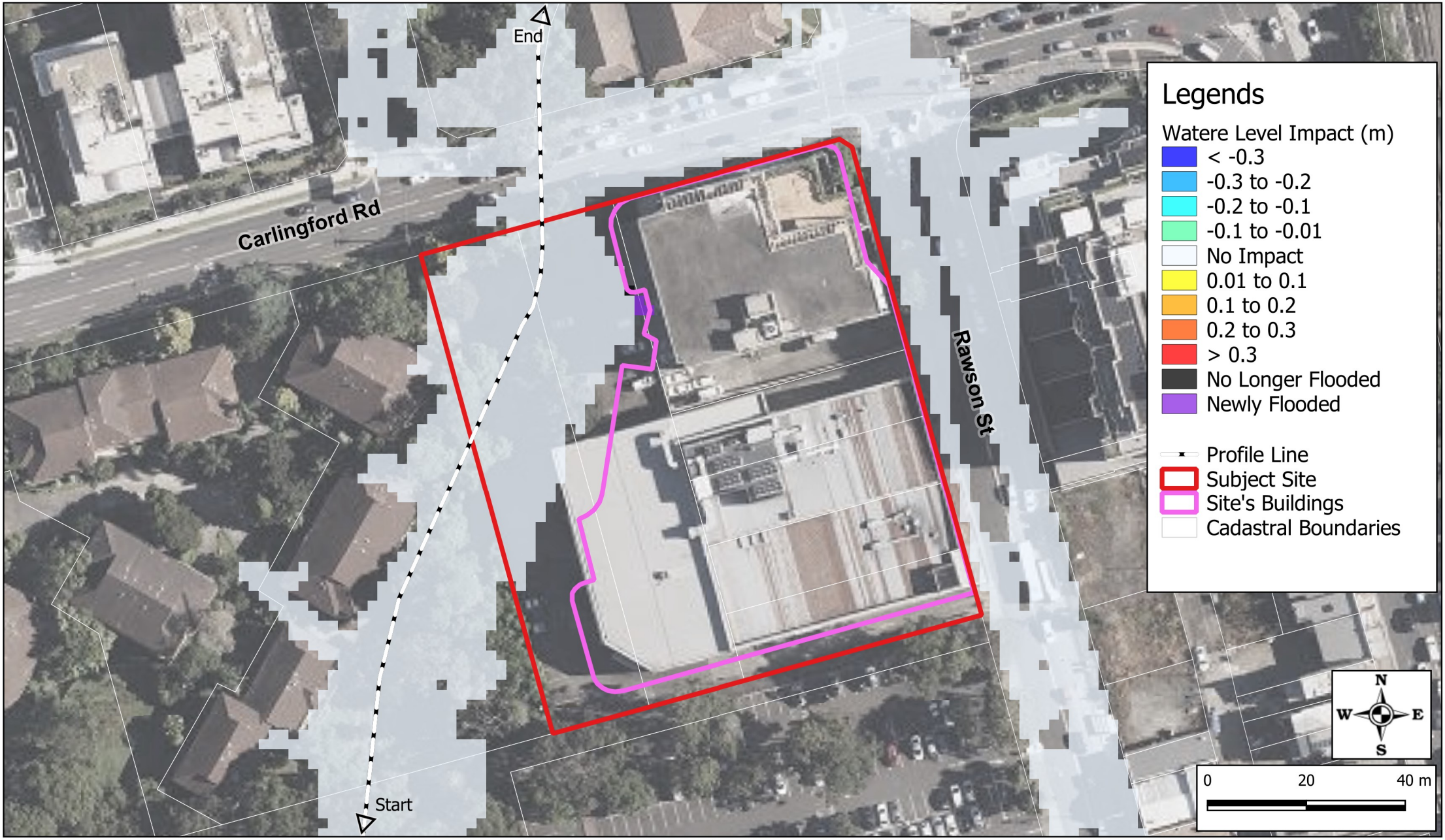
Flood Function

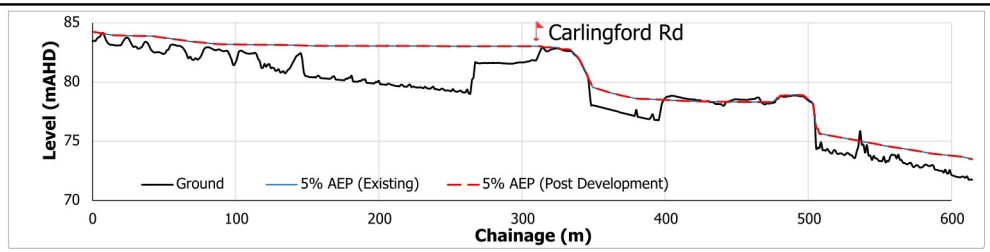
- Flow Conveyance
- Flood Storage
- Flood Fringe

- Subject Site
- Site's Buildings
- Cadastral Boundaries

TITLE:	**PMF 25% Blockage - Hydraulic Flood Function (Post Development)**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**B13**

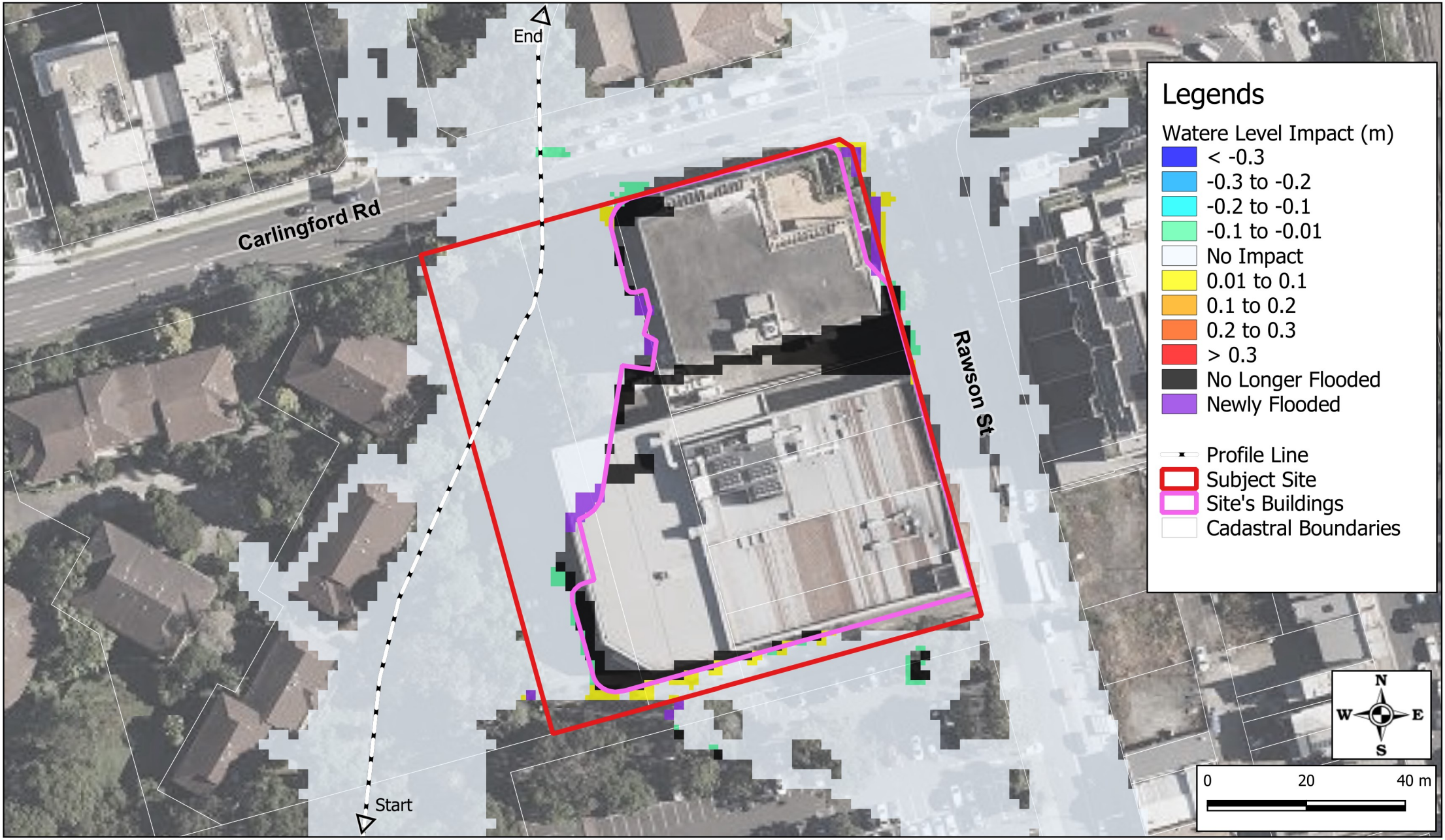
grc HYDRO

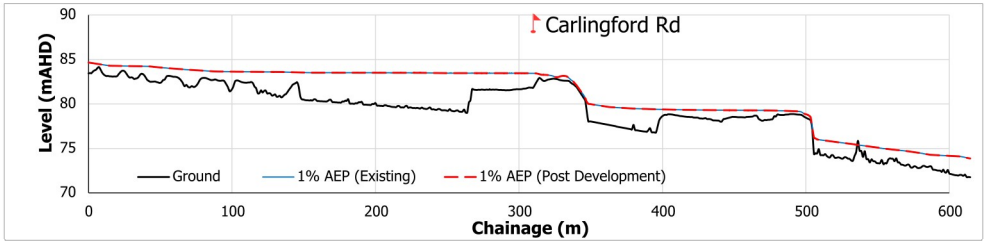




TITLE:	**5% AEP 15% Blockage - Development Water Levels Impact**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No.	**C01**

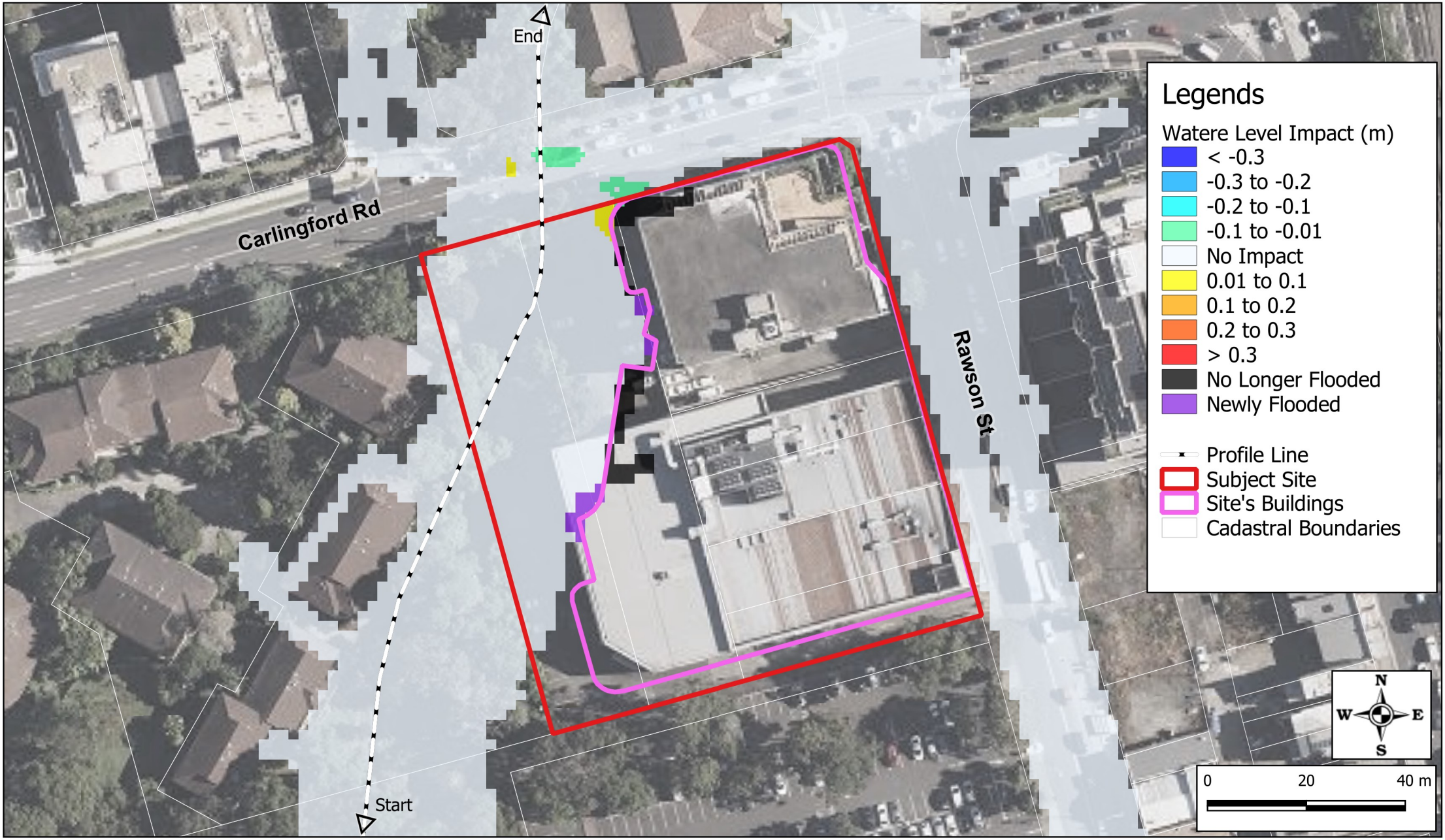
grc HYDRO

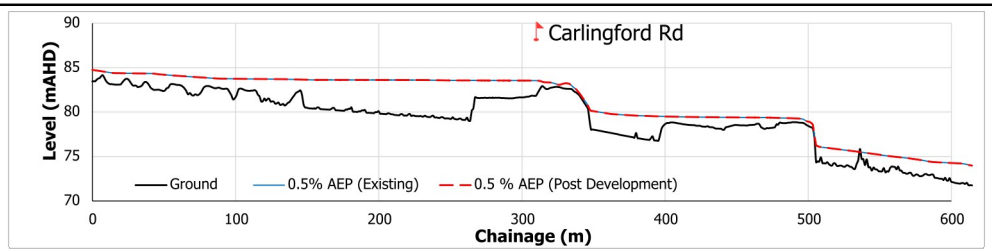




TITLE:	**1% AEP 15% Blockage - Development Water Levels Impact**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No.	**C02**

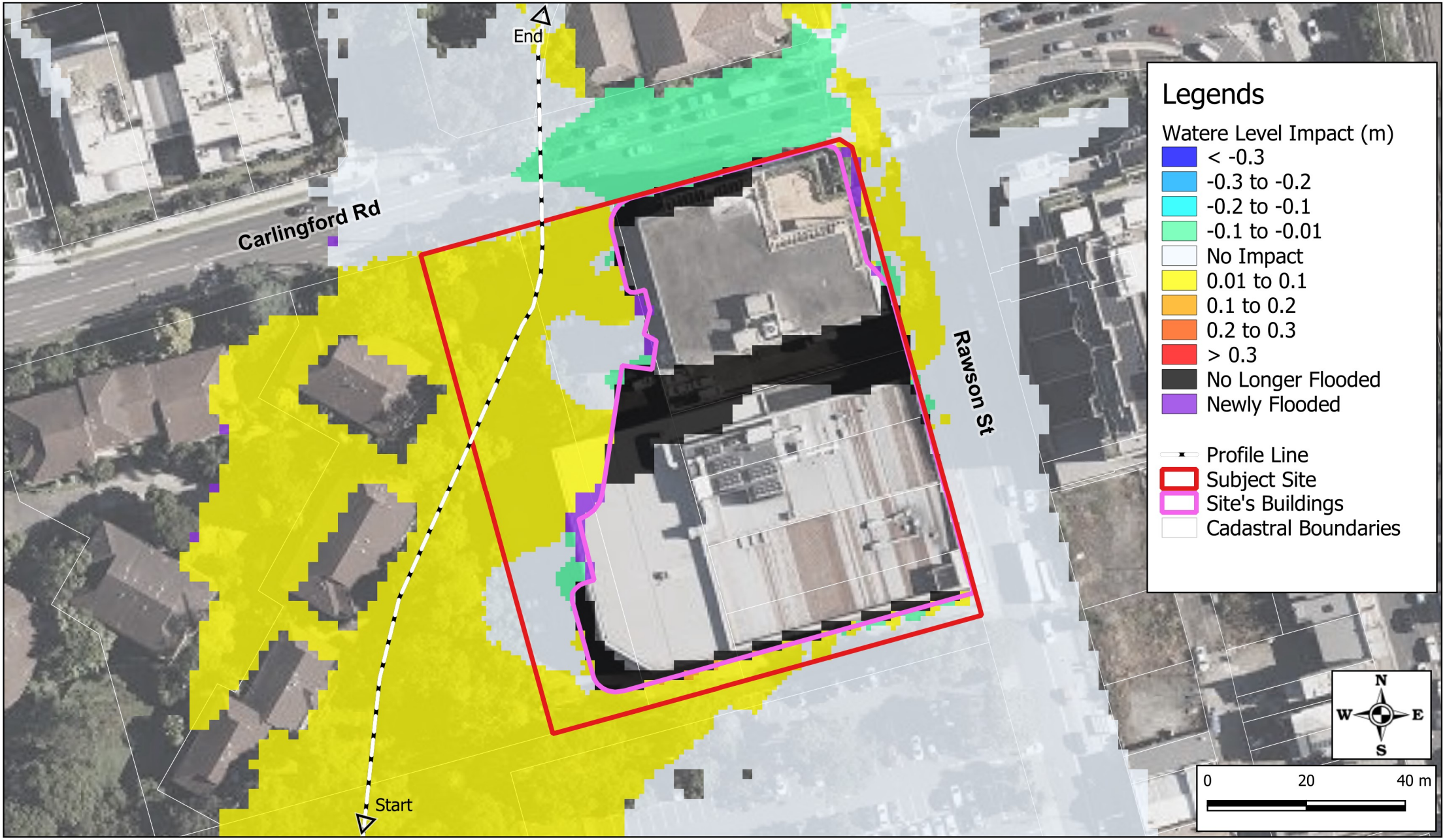
grc HYDRO

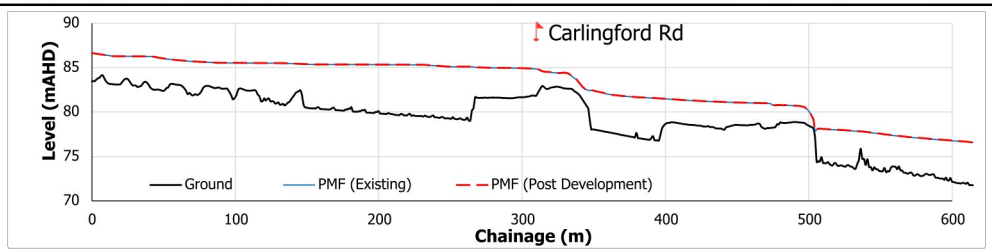




TITLE:	**0.5% AEP 15% Blockage - Development Water Levels Impact**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **C03**	

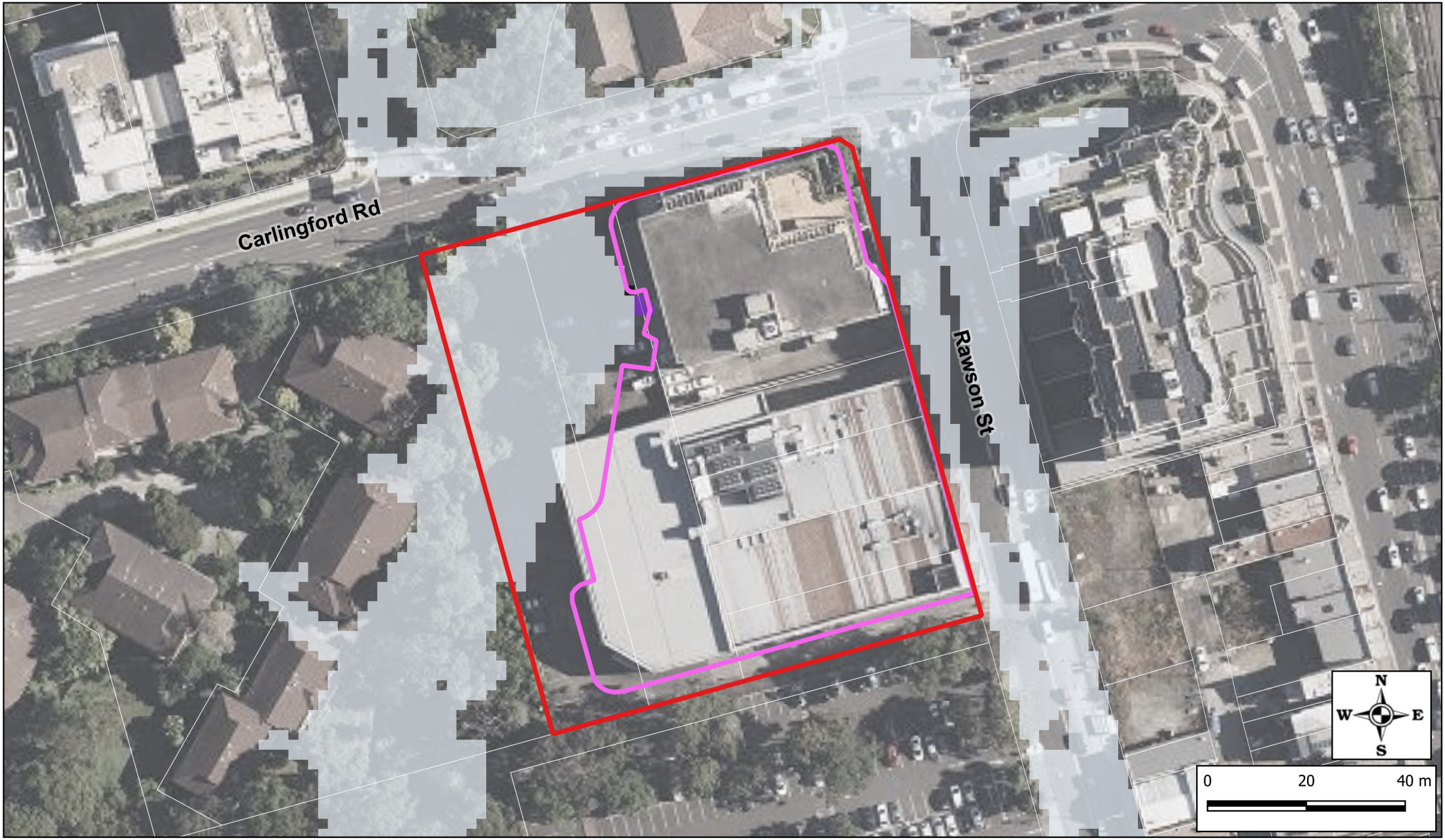
grc HYDRO





TITLE:	**PMF 25% Blockage - Development Water Levels Impact**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No.	**C04**

grc HYDRO

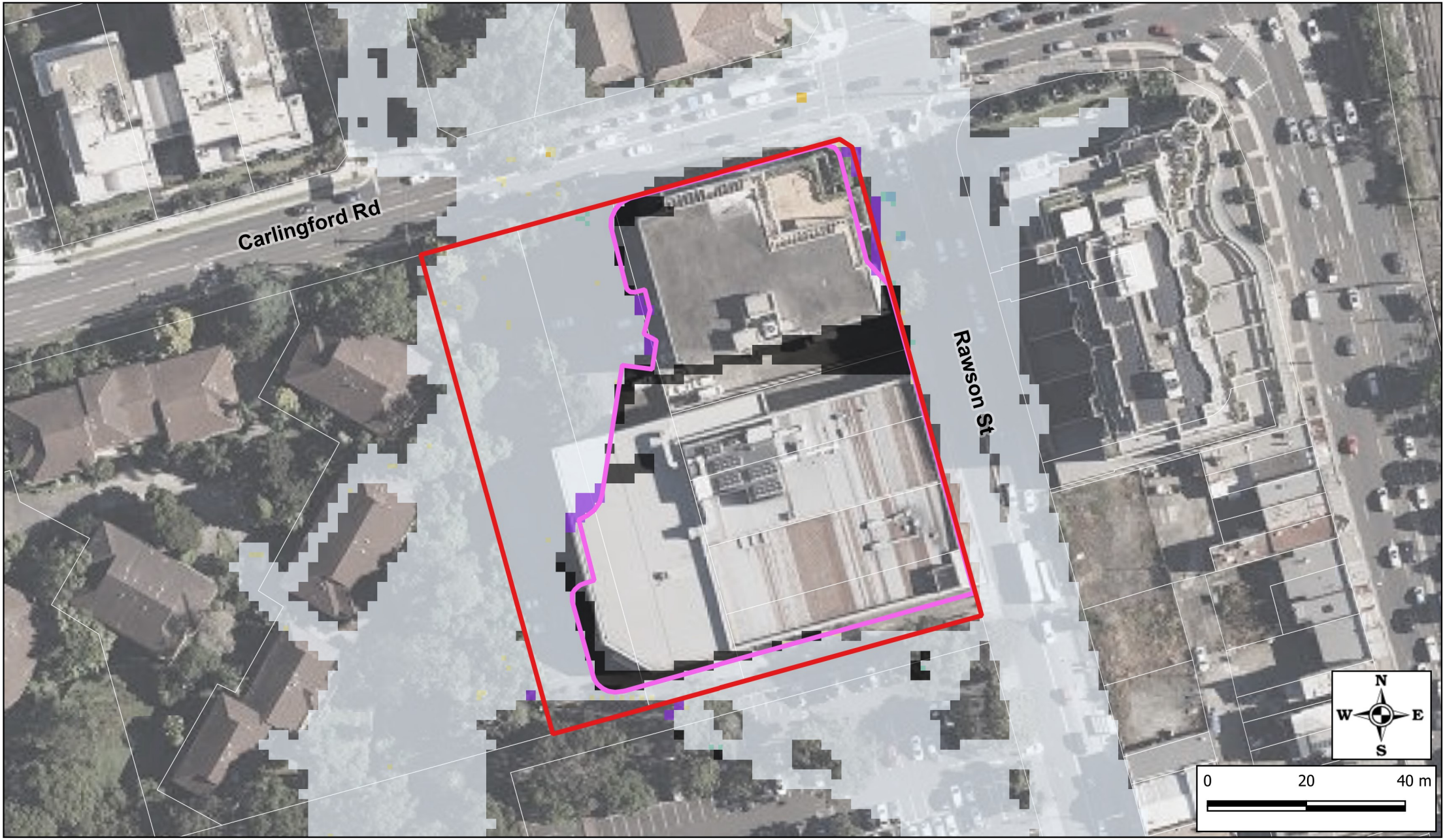


Flood Hazard Impact

-5 (H6 to H1)
-4
-3
-2
-1
No change
+1
+2
+3
+4
+5 (H1 to H6)
Hazard Removed
Hazard Introduced
Subject Site
Site's Buildings
Cadastral Boundaries

TITLE:	**5% AEP 15% Blockage - Development Hazard Impact**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**C05**

grc HYDRO

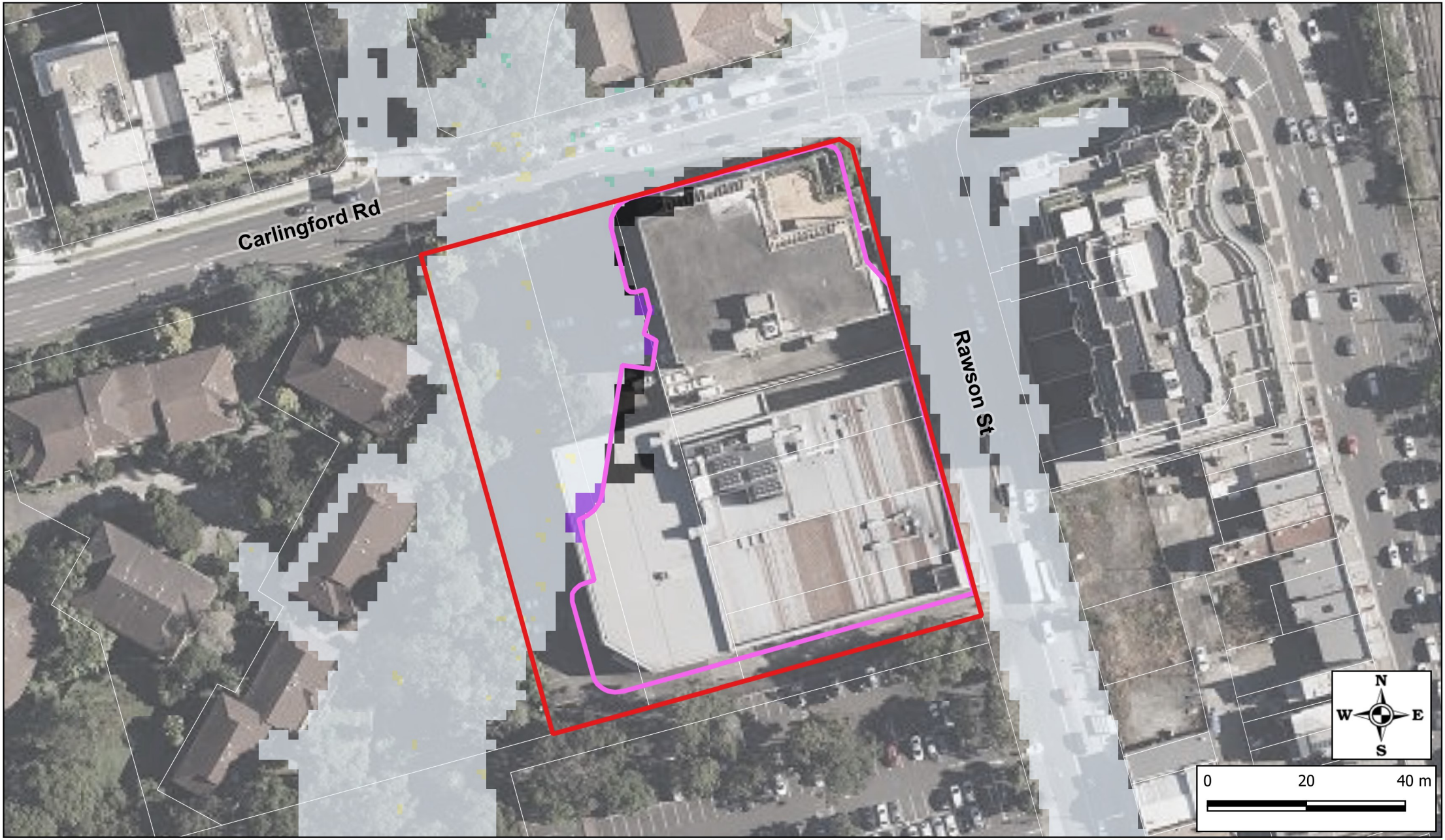


Flood Hazard Impact

-5 (H6 to H1)
-4
-3
-2
-1
No change
+1
+2
+3
+4
+5 (H1 to H6)
Hazard Removed
Hazard Introduced
Subject Site
Site's Buildings
Cadastral Boundaries

TITLE:	**1% AEP 15% Blockage - Development Hazard Impact**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**C06**

grc HYDRO

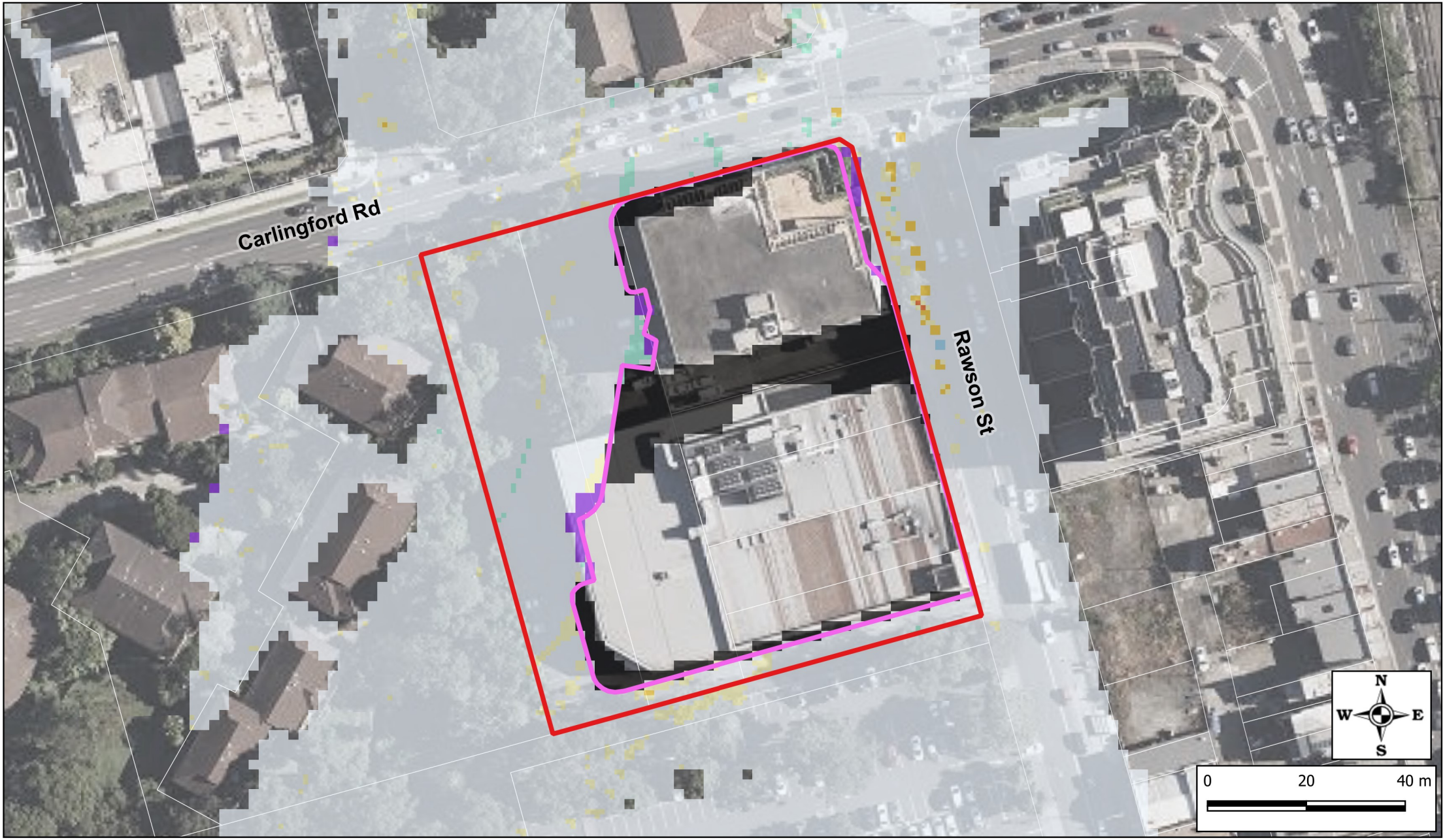


Flood Hazard Impact

-5 (H6 to H1)
-4
-3
-2
-1
No change
+1
+2
+3
+4
+5 (H1 to H6)
Hazard Removed
Hazard Introduced
Subject Site
Site's Buildings
Cadastral Boundaries

TITLE:	**0.5% AEP 15% Blockage - Development Hazard Impact**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**C07**

grc HYDRO

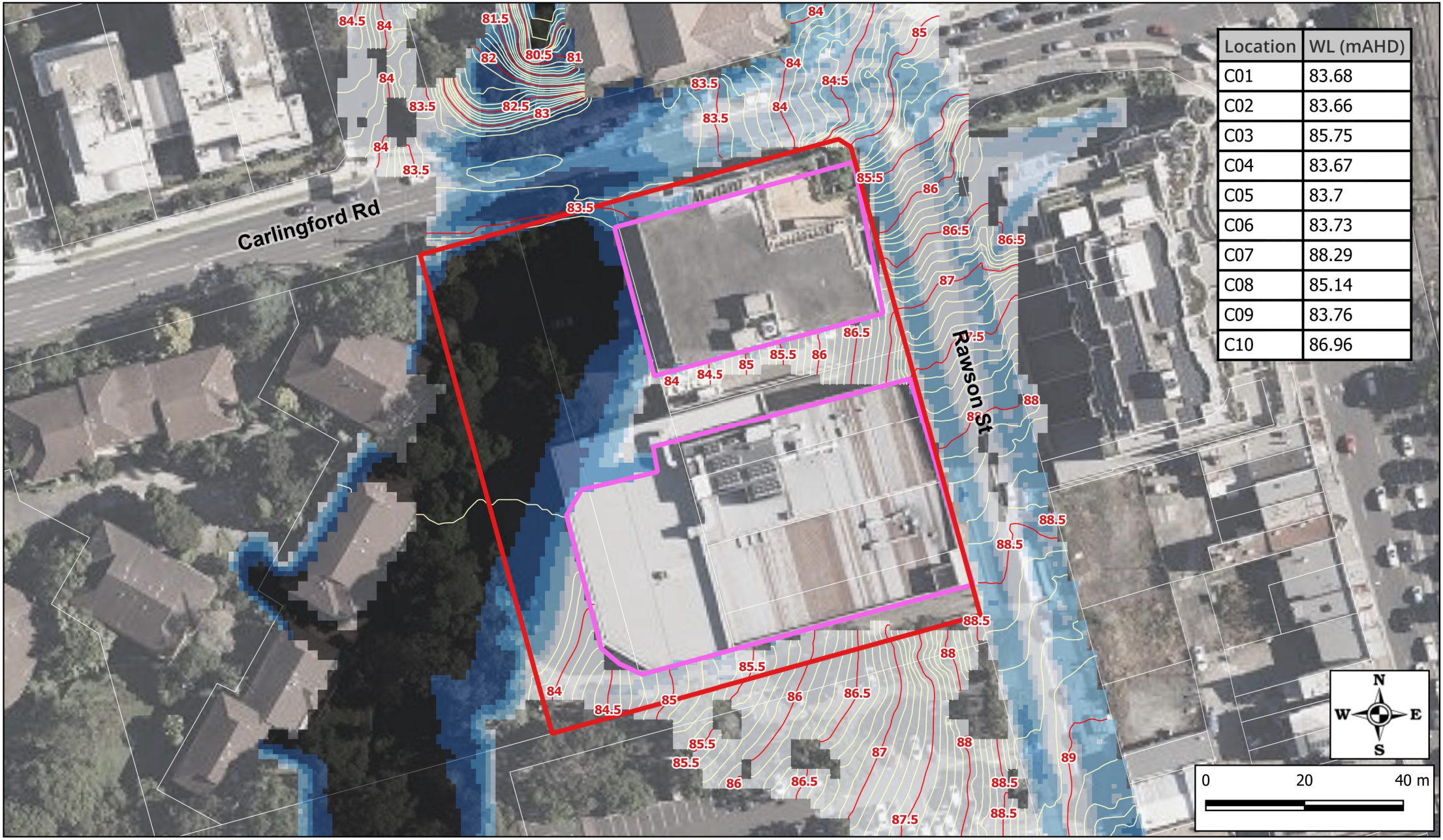


Flood Hazard Impact

-5 (H6 to H1)
-4
-3
-2
-1
No change
+1
+2
+3
+4
+5 (H1 to H6)
Hazard Removed
Hazard Introduced
Subject Site
Site's Buildings
Cadastral Boundaries

TITLE:	**PMF 25% Blockage - Development Hazard Impact**
PROJECT:	**Epping Town Centre**
PROJECT No.	**210046**
DATE:	**11-2023**
SCALE:	1:1,000
FIGURE No.	**C08**

grc HYDRO



Location	WL (mAHD)
C01	83.68
C02	83.66
C03	85.75
C04	83.67
C05	83.7
C06	83.73
C07	88.29
C08	85.14
C09	83.76
C10	86.96

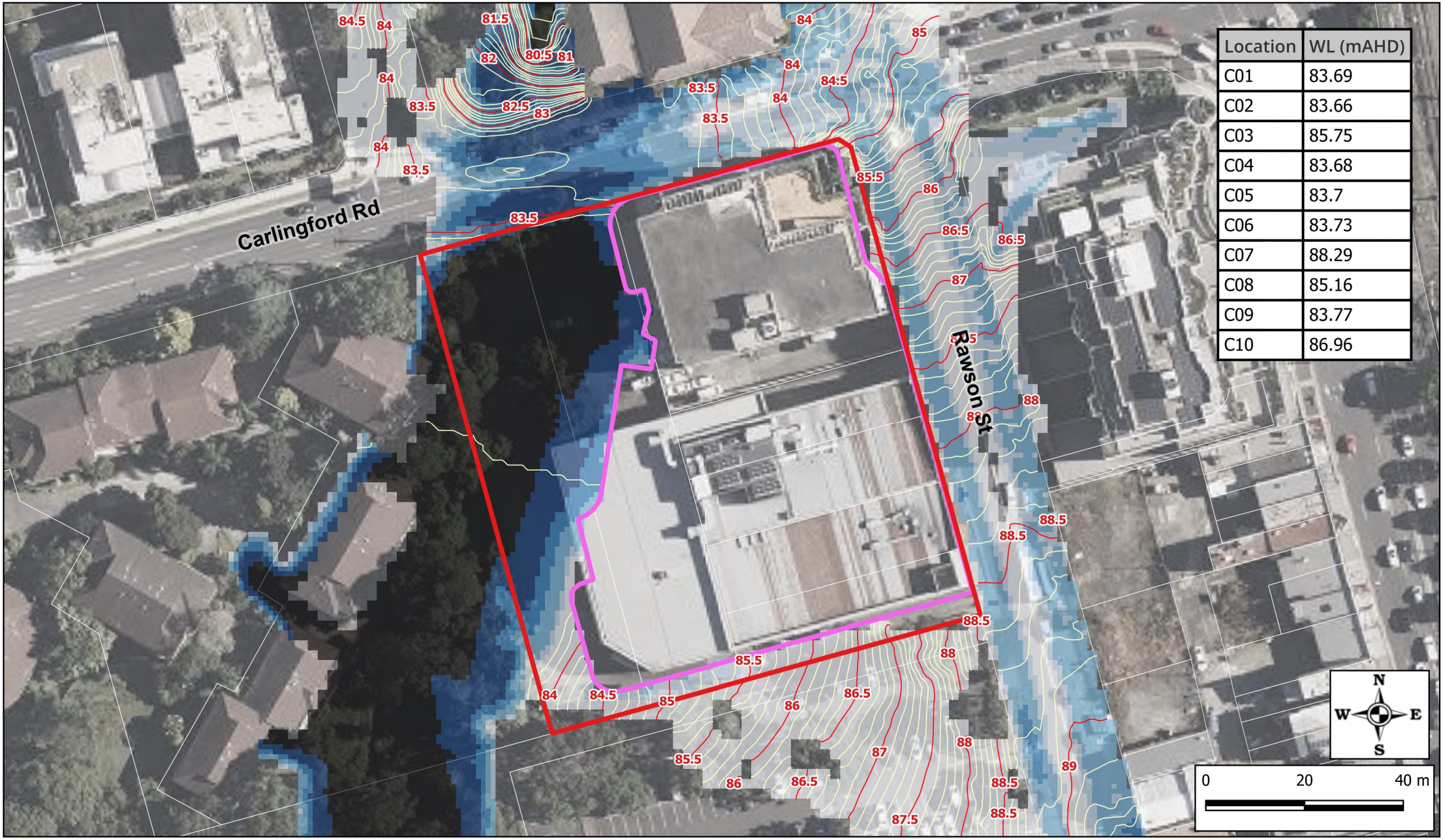
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**1% AEP for RCP8.5 2090 Climate Change - Peak Depths and Levels (Existing)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE:	**11-2023**	SCALE: 1:1,000	FIGURE No. **D01**

grc HYDRO



Location	WL (mAHD)
C01	83.69
C02	83.66
C03	85.75
C04	83.68
C05	83.7
C06	83.73
C07	88.29
C08	85.16
C09	83.77
C10	86.96

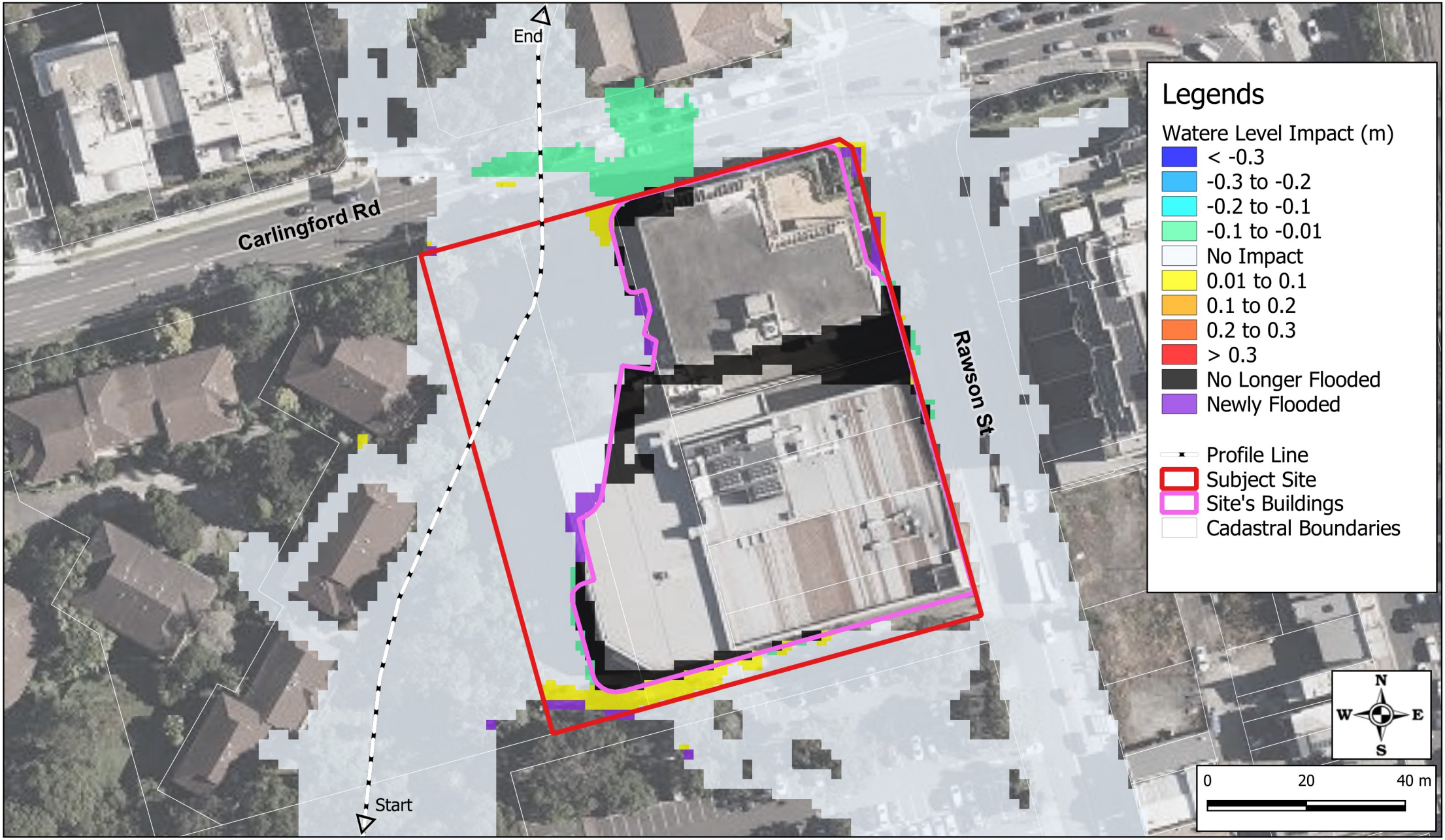
Flood Depths (m)
- 0.00 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

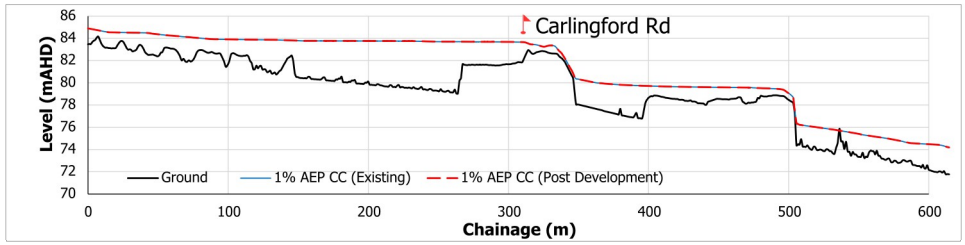
Flood Level Conoturs (mAHD)
- Major (Spacing = 0.50 m)
- Minor (Spacing = 0.10 m)
- Subject Site
- Site's Buildings
- Cadastral Boundaries

Water Level Sample Points

TITLE:	**1% AEP for RCP8.5 2090 Climate Change - Peak Depths and Levels (Post Development)**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No. **D02**	

grc HYDRO





TITLE:	**1% AEP for RCP8.5 2090 Climate Change - Development Water Levels Impact**		
PROJECT:	**Epping Town Centre**		
PROJECT No.	**210046**		
DATE: **11-2023**	SCALE: 1:1,000	FIGURE No.	**D03**

grc HYDRO