Structural
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Flood Impact and Risk Assessment

1 King Street, Concord West

Prepared for Billbergia / 10th September 2024

221118

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Contents

Rev	Date	Prepared By	Approved By	Remarks
1	06/09/2024	MK	JM	Draft
2	10/09/2024	MK	JM	Final

1.0 Introduction

This Flood Assessment Report has been prepared by Taylor Thomson Whitting (TTW) on behalf of Billbergia to support the development application submission (via a planning proposal) for the proposed development at 1 King Street, Concord West (subject site). This report has been prepared to address Condition 1(d) of the NSW Government's Gateway Determination (Department Ref: PP-2023-1620), as summarised in Table 1 below. This report has been prepared generally in accordance with the Department of Planning's *Flood Impact and Risk Assessment – Flood Risk Management Guide LU01* (2023), Department of Planning's *Flood Risk Management Manual* (2023), Department of Planning's Attachment C of the *Local Environmental Plan Making Guideline* (2023). This report has also referenced and is consistent with other documents/guidelines as summarised in Section 1.3 of this report.

Table 1 – Site Development Flooding Specific Gateway Conditions

Gateway Condition Item	Requirements	Section Reference (This Report)
1(d)	Provide a flood impact and risk assessment (FIRA) that comprehensively addresses the requirements of the Direction and is prepared in accordance with *Flood Impact and Risk Assessment – Flood Risk Management Guide LU01* (2023), *Flood Risk Management Manual* (2023) and Attachment C of the *LEP Making Guideline* (2023). The planning proposal is to be updated in response to the findings of the FIRA.	Previous Powells Creek Flood Study is discussed in Section 2.0. Current flood assessment is discussed in Section 4.1-4.3. Likely impacts of development are discussed in Section 4.3. Potential effects of climate change are discussed in Section 4.4. Flood planning and development controls are discussed in Section 5.0.

Hydraulic modelling has been carried out using the TUFLOW model provided by the City of Canada Bay Council (i.e. understood to be developed as part of the Powells Creek Flood Study in 2022) as part of the assessment. This has been used to confirm compliance with the relevant flooding control requirements of City of Canada Bay Council's 2023 Development Control Plan (DCP) and flooding requirements of the NSW Government's Local Planning Direction 4.1. The details of this report are based on current available information at the time of preparation of this report.

1.1 Existing Site Conditions

The development site is located at 1 King Street, Concord West and is within the Local Government Area (LGA) of City of Canada Bay Council (CCBC). The site is close to the CCBC LGA border with both City of Parramatta and Strathfield LGAs (refer to Figure 1). The site is currently developed, with a two-storey commercial building at the site centre, a three-storey concrete carpark building to the south and external parking areas to the south-east and south-west and landscaping areas around the perimeter of the site. The north-west portion of the site is the 'Only About Children Concord campus', consisting of a 1-storey building, a basketball court (to the north), and an external parking area (to the north-east). Current access to the main site building is via King Street at the north-east or George Street at the south-west of the building, while access to the Only About Children Concord campus building is via Goerge Street to the north-west. The site has a total area of approximately 3.1ha in size.

The site is bounded by George Street to the west, existing residential buildings to the north and south and railway lines to the east, with the Concord West train station located adjacent and north-east of the subject site, as shown in Figure 1.

The site is currently zoned as E4 General Industrial (range of industrial, warehouse and related land uses), while the surrounding land is generally made up of R3 Medium Density Residential, with RE1 Public Recreation out to the west.

According to the LiDAR data adopted in CCBC's TUFLOW model, the site generally slopes towards George Street with the highest point on the site located near the south-east corner at approximately 13.2mAHD. The lowest point of the site is at approximately 2.9mAHD and is located near the mid-point along the site's western property boundary, coinciding with the sag point of George Street (i.e. located adjacent to the site's lowest point). Figure 2 shows the LiDAR data for the subject site and its surrounding area, as adopted in the CCBC's TUFLOW model. The LiDAR shows that elevation falls by approximately 10.3m over a distance of approximately 220m within the site from the south-east corner, and this equates to a slope of approximately 4.7%.

Powells Creek is located approximately 210m west of the subject site and is flows in a northerly direction (refer to Figure 1). Powells Creek discharges into Parramatta River approximately 1.2km north-west of the subject site.

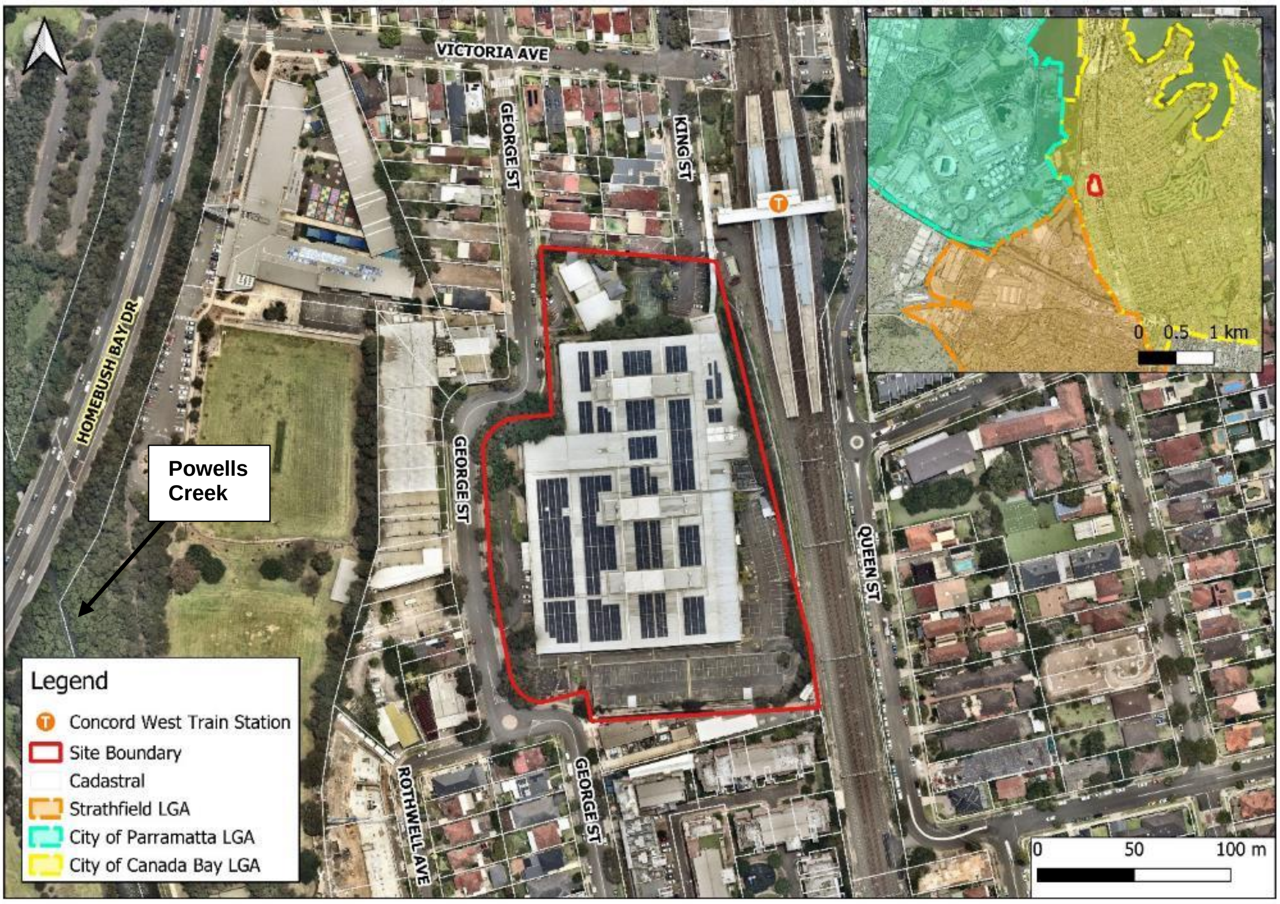

Figure 1: Site Location

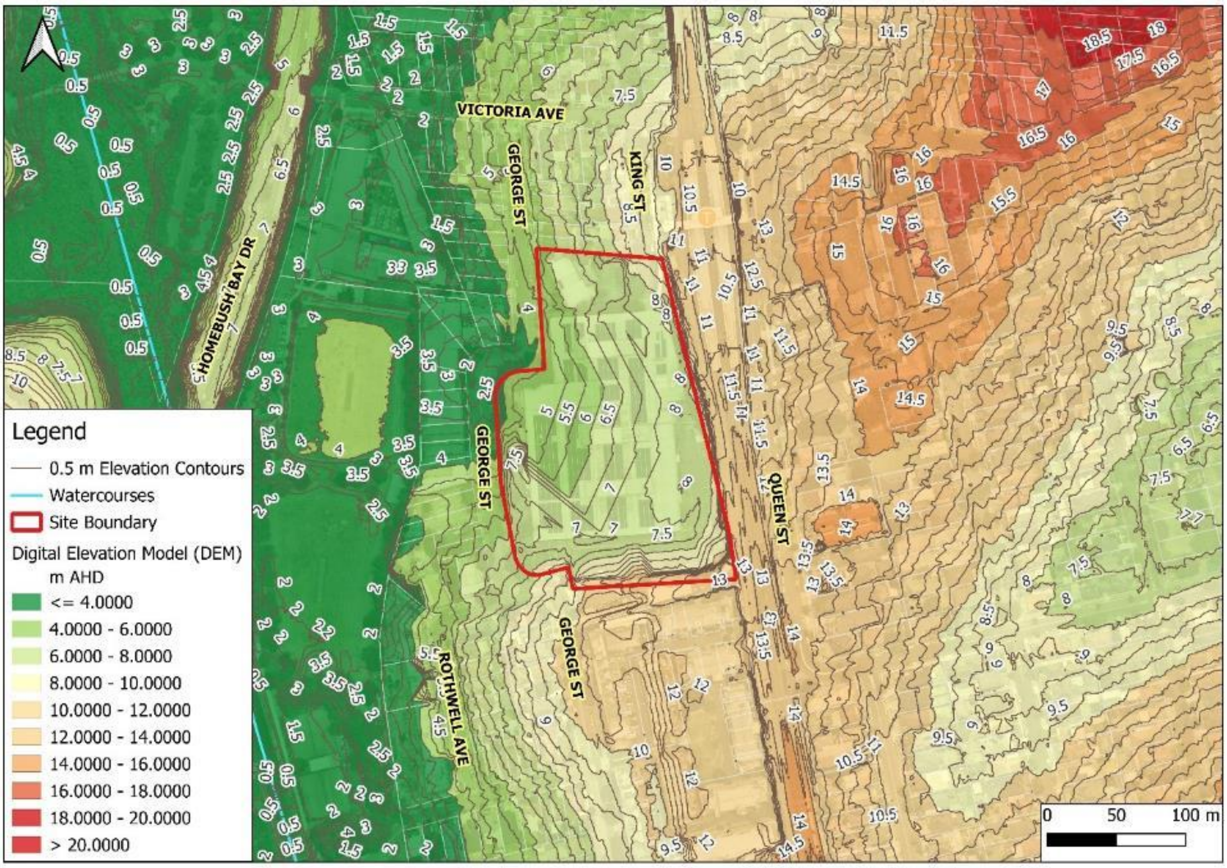

Figure 2: Topography of Site and Surrounding Area

Existing Site Stormwater Drainage

An existing stormwater drainage line owned by CCBC traverses the site from east to west, before connecting to the stormwater system on George Street, west of the subject site. This stormwater system conveys stormwater runoff from the east of the railway lines (i.e. east of the subject site) to the downstream Powells Creek to the west.

Available data at the time of preparation of this report indicate that this existing stormwater drainage line consists of a 900mm diameter pipe that begins at Queen Street, to the east of the railway lines, and traverses the subject site to George Street to the west where the pipe connects to the existing stormwater pit and pipe system on George Street. The stormwater system ultimately discharges into the Powells Creek approximately 260m west of the subject site, crossing, the property at 176-184 George Street, the Victoria Avenue Community Precinct playing field and Homebush Bay Drive. Figure 3 shows the approximate location and extent of the existing 900mm stormwater drainage line that traverses the subject site discussed above.

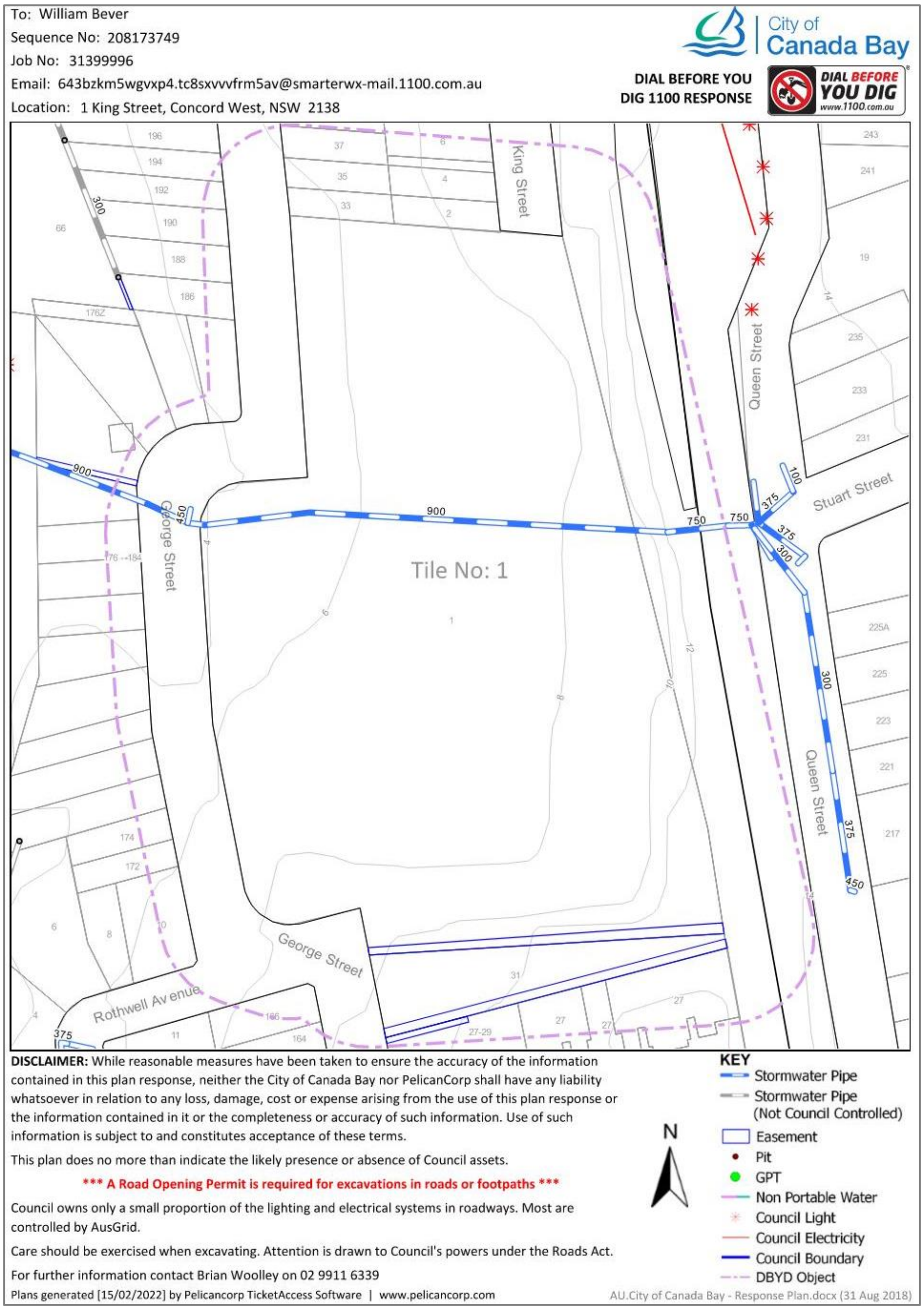

Figure 3: Existing 900mm Diameter Stormwater Drainage Line (Source: DBYD)

Based on available information, at the time of this assessment, flooding on the subject site area is mainly caused by local flooding due to insufficient capacity of the existing underground stormwater system of the subject site area.

1.2 Development Proposal

The subject site is proposed to be developed for high-density mixed-use purposes that includes several multi-storey buildings with internal access roads, a central through site link road connecting King Street to the north-east and George Street to the south-west, basement car parking areas and landscaping areas. There are three entrances proposed for the basement car parking areas. One of these is near the northern end and the remaining two near the southern end of the site (refer to Figure 4 for indicative locations of the entrances to the basement car parking areas). Access to the subject site is proposed to be via King Street from the north-east, George Street from the south-west and George Street from the west.

The proposed architectural ground floor plan of the subject site, by GroupGSA is shown in Figure 4 below.

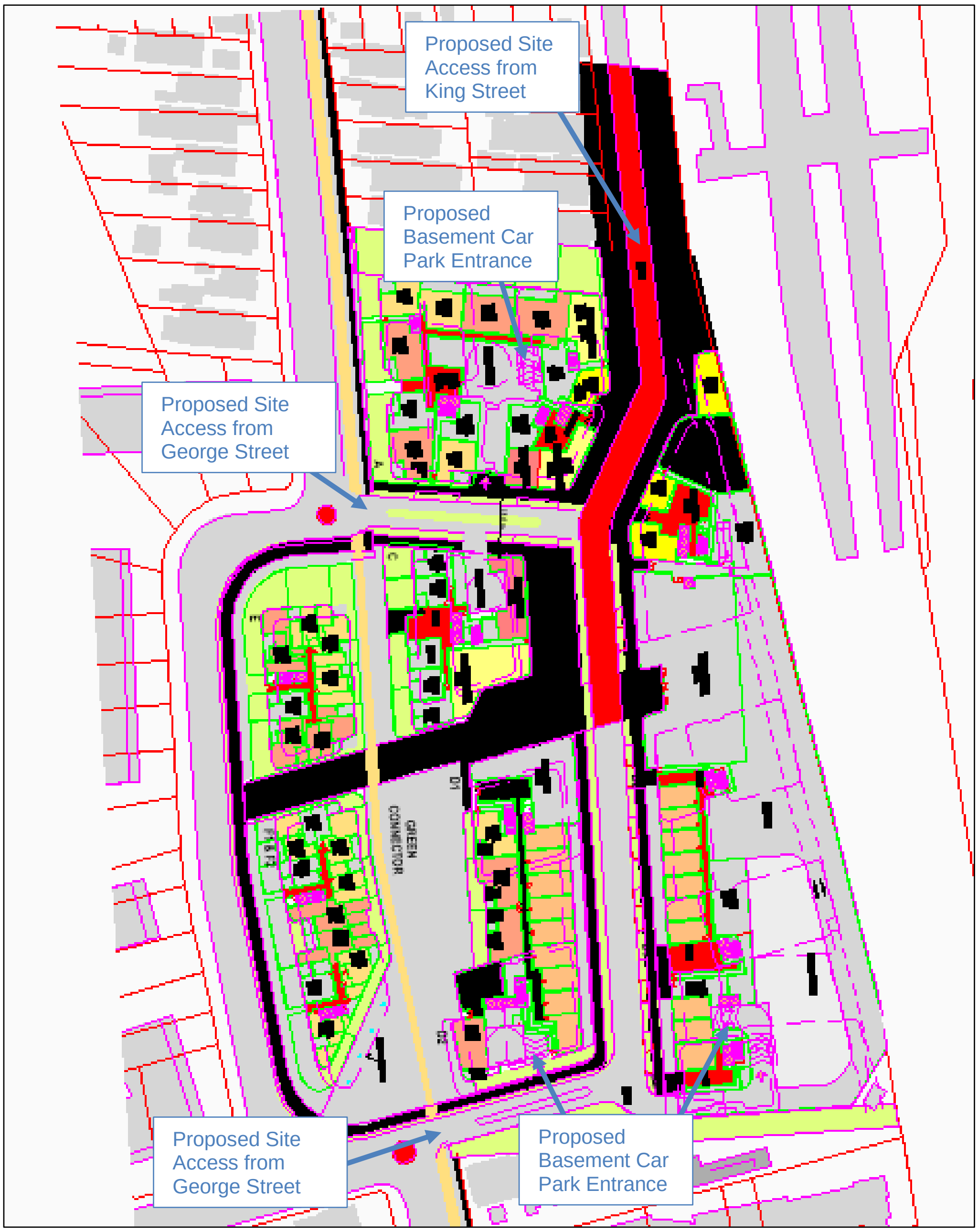

Figure 4: Proposed Ground Floor Architectural Plan

1.3 Guidance Documents

The following documents have been referred to and referenced in preparing this report:

- City of Canada Bay Council's Development Control Plan (DCP) 2023;
- City of Canada Bay Council's Local Environment Plan (LEP) 2013;
- Australian Rainfall and Runoff (ARR) 2019;
- Department of Planning's Attachment C of the Local Environmental Plan Making Guideline 2023;
- Department of Planning's Local Planning Direction 4.1 (commencement date 20 February 2023);
- Department of Planning's Flood Risk Management Manual 2023; and
- Department of Planning's Flood Impact and Risk Assessment – Flood Risk Management Guide LU01 2023.

1.4 Objectives and Methodology

The objective of this report is to assess the site's local flooding conditions and address the flooding requirements of City of Canada Bay Council's DCP with regards to the proposed development on the subject site.

This assessment involved the following methodology:

- Obtaining the City of Canada Bay Council's Powells Creek TUFLOW flood model where the subject site is located within, and update with site specific survey data to form a base case flood model for this assessment.
- Carrying out hydraulic simulations using the base case flood model to determine the site's existing flood characteristics for the 18% AEP, 10% AEP, 2% AEP, 1% AEP, 0.2% AEP and PMF events.
- Incorporating the proposed design into the base case flood model and assessing the site flood characteristics in the proposed site conditions for the 18% AEP, 10% AEP, 2% AEP, 1% AEP, 0.2% AEP and PMF events. Note that the 1% AEP with 20% increase in rainfall intensities (to account for the effects of climate change) has also been simulated and assessed as a sensitivity check to determine the likely increase in flooding conditions for the subject site area.
- Carrying out a flood impact assessment and determining likely flood impacts that the proposed development will have on the surrounding areas for all events up to and including the 1% AEP event.
- Prepare a compliance assessment with relation to the City of Canada Bay Council's DCP flooding control requirements. This included determining the Flood Planning Levels (FPL) for the subject site development.
- Preparing relevant flood maps including flood extents, depths, levels, velocities, hazards and impacts.

2.0 Powells Creek Flood Study

The site falls within Powells Creek catchment, which drains to Homebush Bay on the Parramatta River via an open channel. CCBC commissioned WMAwater to undertake a Flood Study for the Powells Creek catchment, including sections of North Strathfield and Concord West, as required under the NSW Government's Floodplain Management Program. The study identified mainstream and overland flow flooding through the construction of a hydrologic and hydraulic model using the ARR2019 (Australian Rainfall and Runoff 2019) design flood methodology.

The flood study was adopted by Council on 6 December 2022 and is consequently the most up to date reference for local flood behaviour of the Powells Creek catchment, including the subject site area.

2.1 Flood Conditions of George Street

In the flood study, it was noted that major increases in paved areas, modification of natural surface drainage systems and developments within trapped depressions were some of the key causes of flooding issues within the catchment. The flood study highlighted a known drainage 'hotspot' on George Street at the site's western border, as shown in Figure 5. The trapped low point on George Street is a known hotspot created by the existing industrial building on the western side of George Street preventing overland flows over the George Street sag point flowing towards Powells Creek. This sag point is categorised as a floodway in the hydraulic categorisation of the 1% Annual Exceedance Probability (AEP) storm event. Floodway areas are defined in the Floodplain Development Manual as areas of the floodplain where a significant discharge of water occurs during floods and if blocked, would cause a significant redistribution of flood flows.

Figure 5: George Street Sag Point (Source: Google Street View, captured June 2024, facing northwards with the subject site located to the east)

Figure 6 and Figure 7 show the flood extent and level for the 1% AEP and Probable Maximum Flood (PMF) events, respectively. Figure 8 and Figure 9 show the flood hazard rating for the 1% AEP and PMF events.

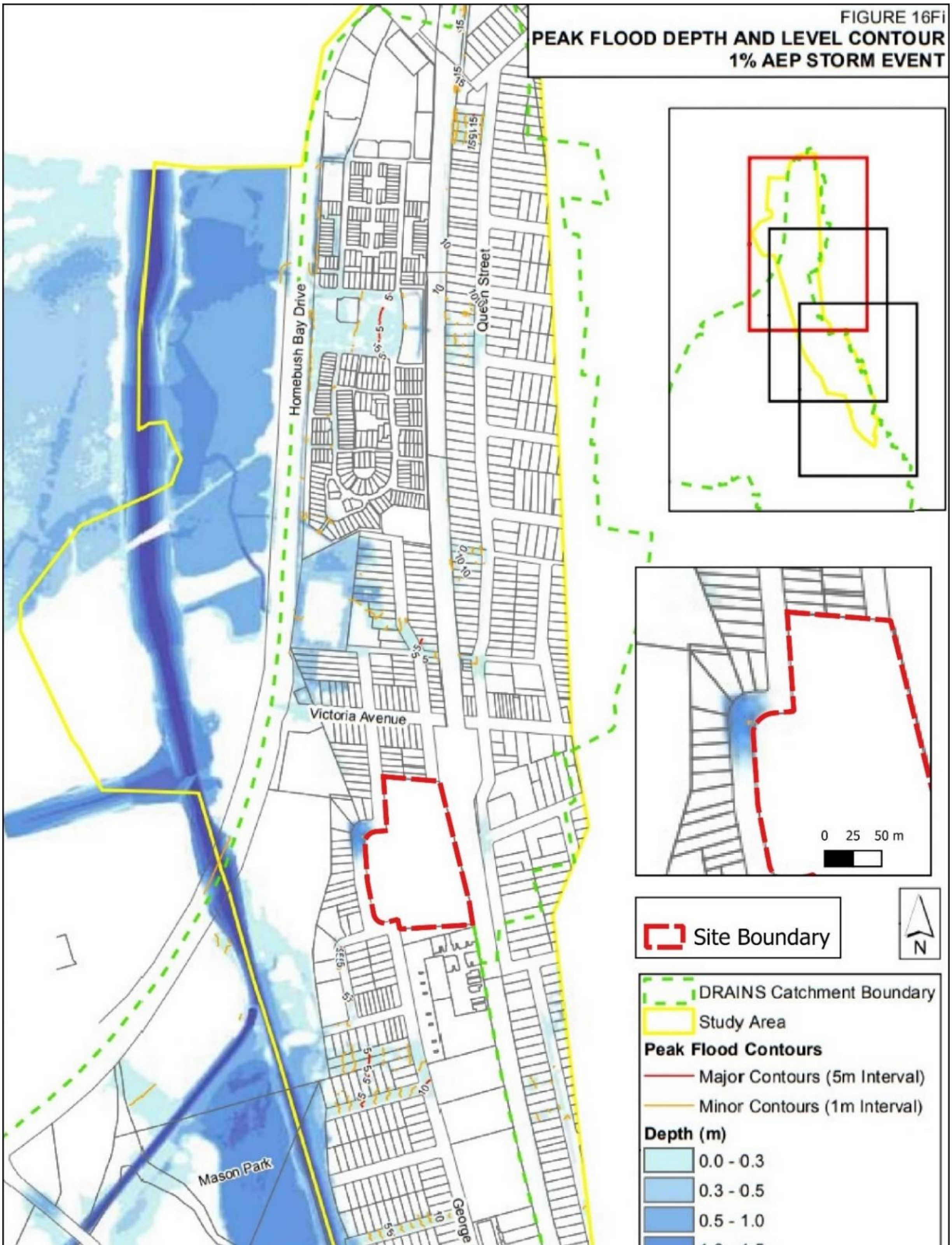

Figure 6: 1% AEP Flood Levels and Depths for Subject Site Area (Source: Powells Creek Flood Study, WMAwater, 2022)

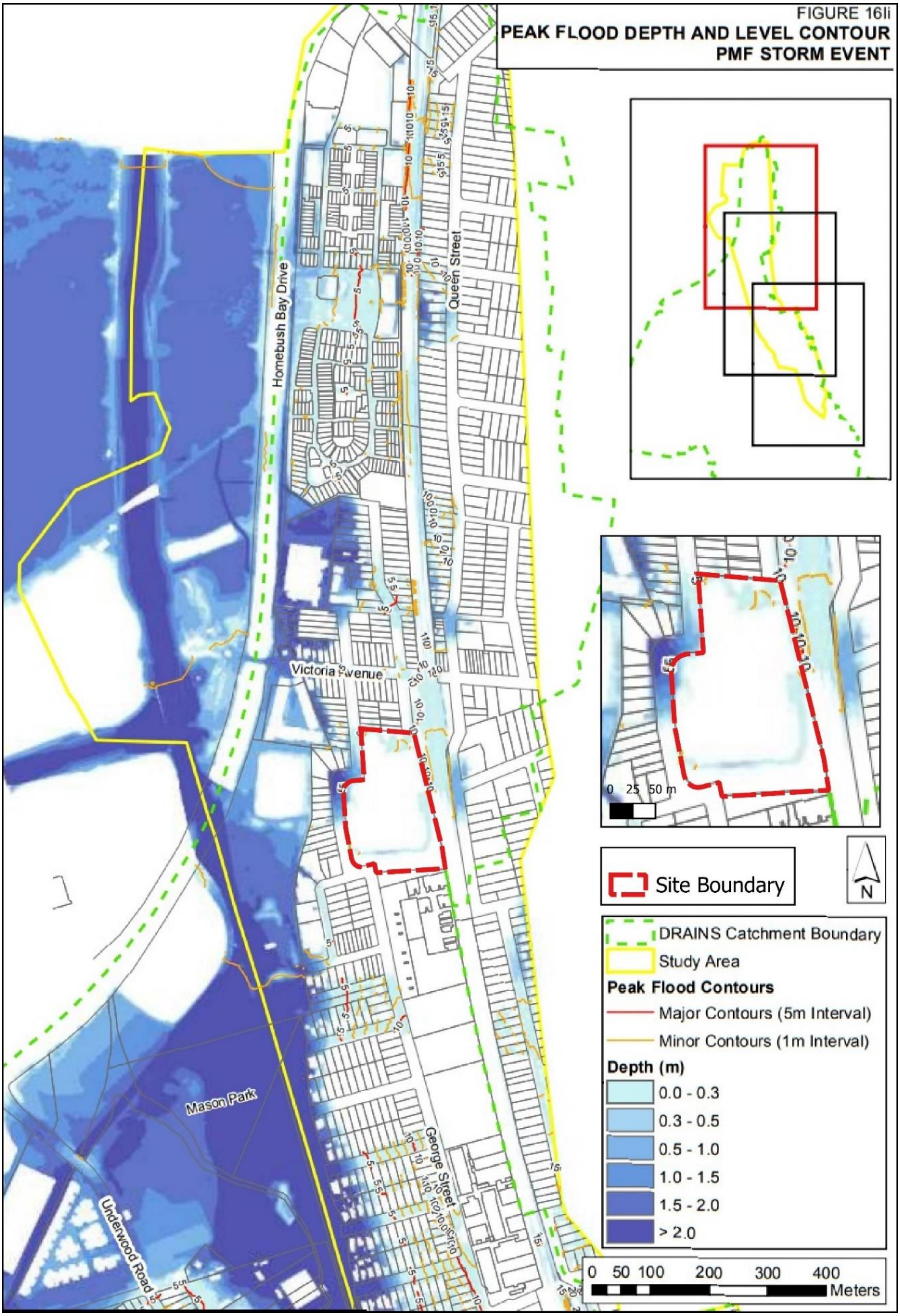

Figure 7: PMF Flood Levels and Depths for Subject Site Area (Source: Powells Creek Flood Study, WMAwater, 2022)

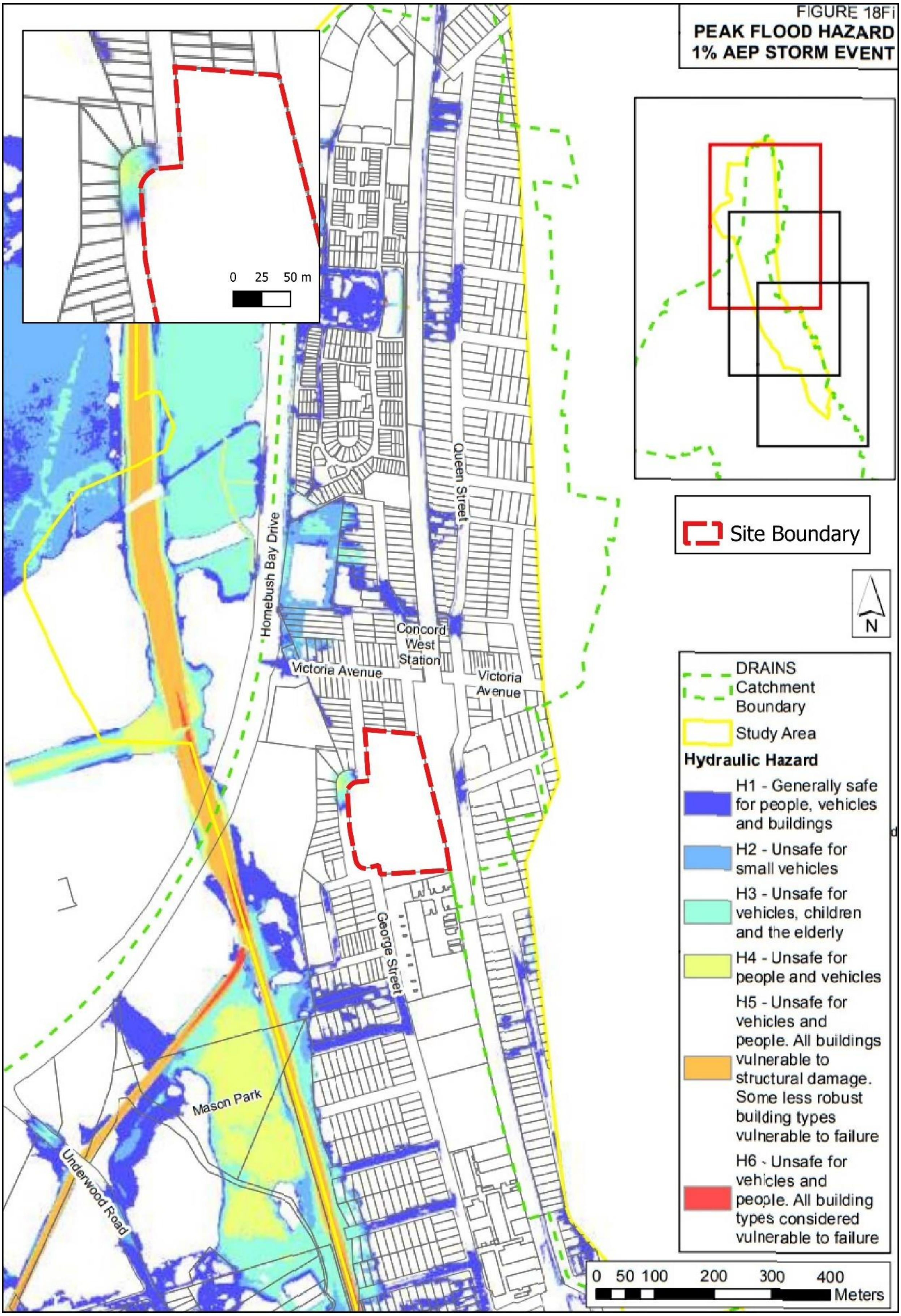

Figure 8: 1% AEP Peak Flood Hazards for Subject Site Area (Source: Powells Creek Flood Study, WMAwater, 2022)

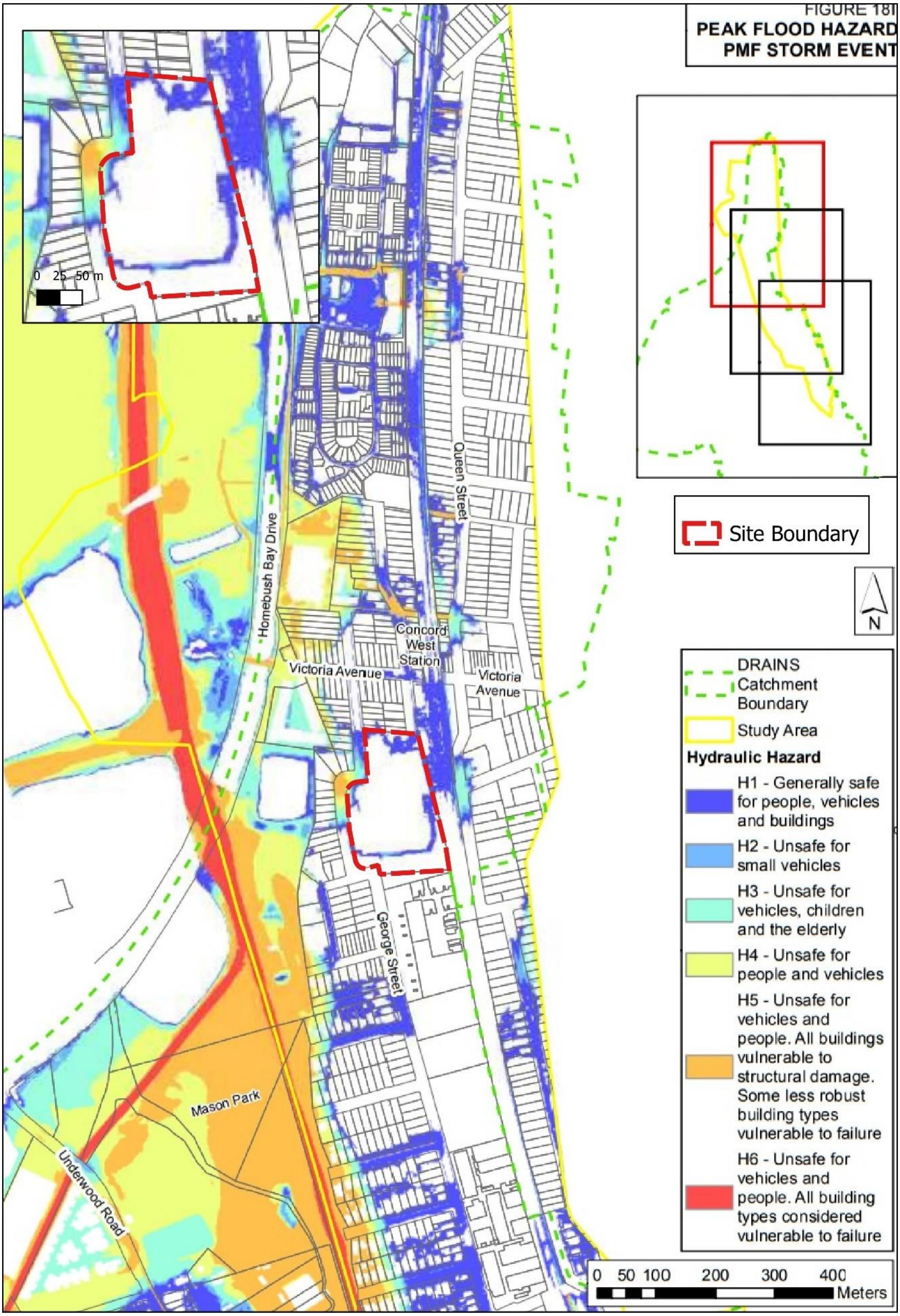

Figure 9: PMF Peak Flood Hazards for Subject Site Area (Source: Powells Creek Flood Study, WMAwater, 2022)

During the 1% AEP event, the sag point has notable flood depths of 1.0m –1.5m, with a hazard rating of H4 (unsafe for people and vehicles), however this flooding does not breach into the existing site boundary. Flooding is significantly increased in the PMF event, with depths at the sag point exceeding 2m and flood hazard rating reaching H5 (all buildings vulnerable to structural damage, some less robust building types vulnerable to failure).

2.2 Flood Conditions of Subject Site

The site itself is directly impacted by floodwaters during the 1% AEP and PMF events. Flooding of the subject site in the 1% AEP event is mainly estimated near the lowest point of the site adjacent to the sag point of George Street to the west. In the PMF event, the flood depths within the subject site are generally less than 0.3m and inundation mainly occur towards the north and south. The flood hazard rating within the site is generally H1, which is considered to be generally safe for people, vehicles and buildings. Although flood inundation is estimated, King Street to the north and George Street to the south are generally considered safe for vehicles (i.e. flood hazard rating of H1).

According to the flood study, flooding within the subject site is generally classified as within the Low Flood Risk Precinct, as shown in Figure 10.

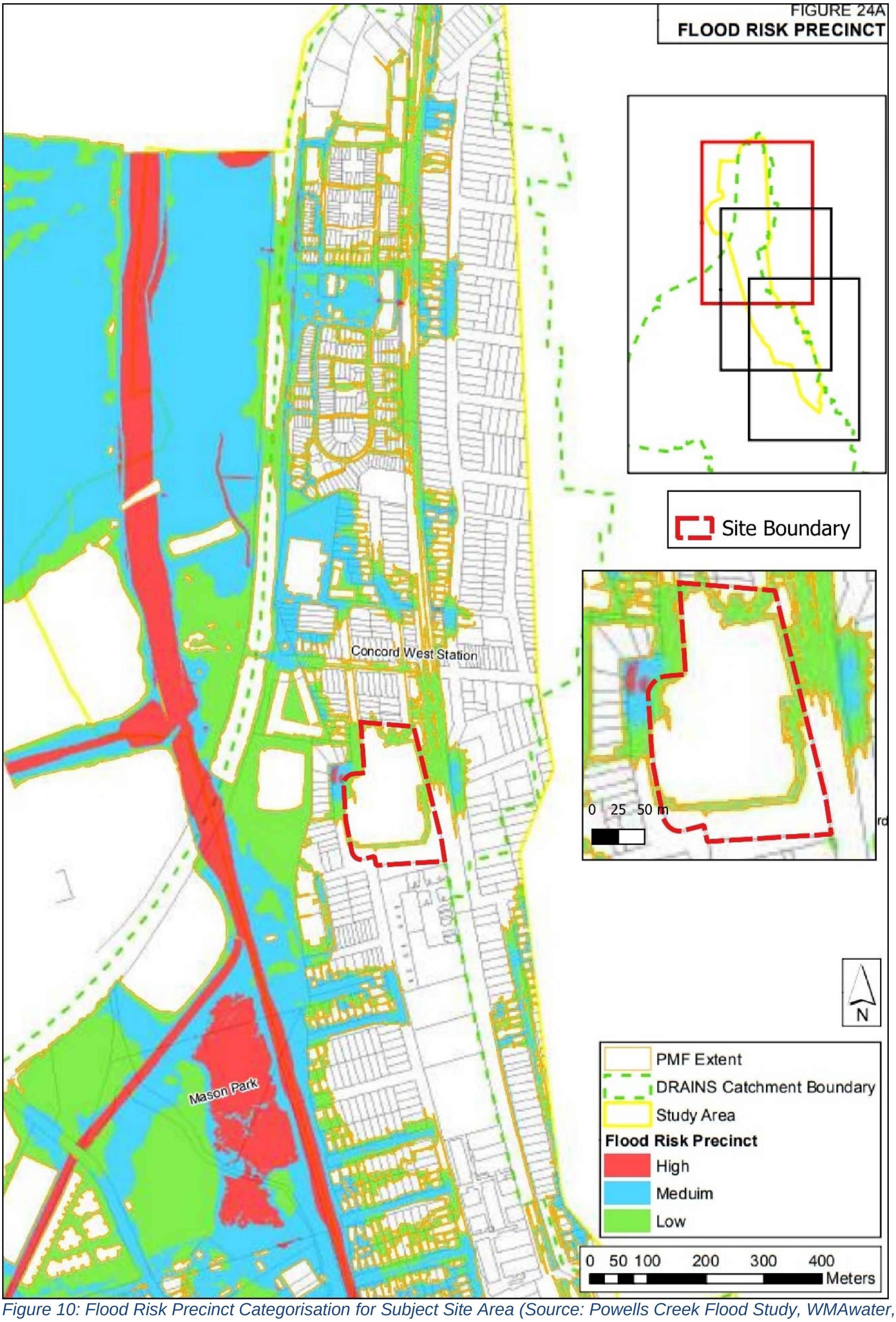

Figure 10: Flood Risk Precinct Categorisation for Subject Site Area (Source: Powells Creek Flood Study, WMAwater, 2022)

3.0 Hydraulic Modelling

TTW has acquired a copy of the TUFLOW flood model from CCBC, that covers the subject site, to carry out the required hydraulic modelling and assessment. The TUFLOW flood model provided by CCBC covers the Powells Creek catchment (referred herein as the Council flood model) and is believed to be developed as part of the Powells Creek Flood Study completed by WMAwater in 2022. This model has been used as the basis to assess the site flooding conditions as part of this assessment.

The Council flood model has been carried out using the TUFLOW version 2020-10-AA single precision in HPC solution scheme. To maintain consistency, this version of TUFLOW and the HPC solution scheme have been adopted for this assessment.

3.1 Model Features

The model domain, as received from CCBC, covers an area of approximately 10km^2 (including the subject site), as shown in Figure 11. The model uses a 1m grid cell size.

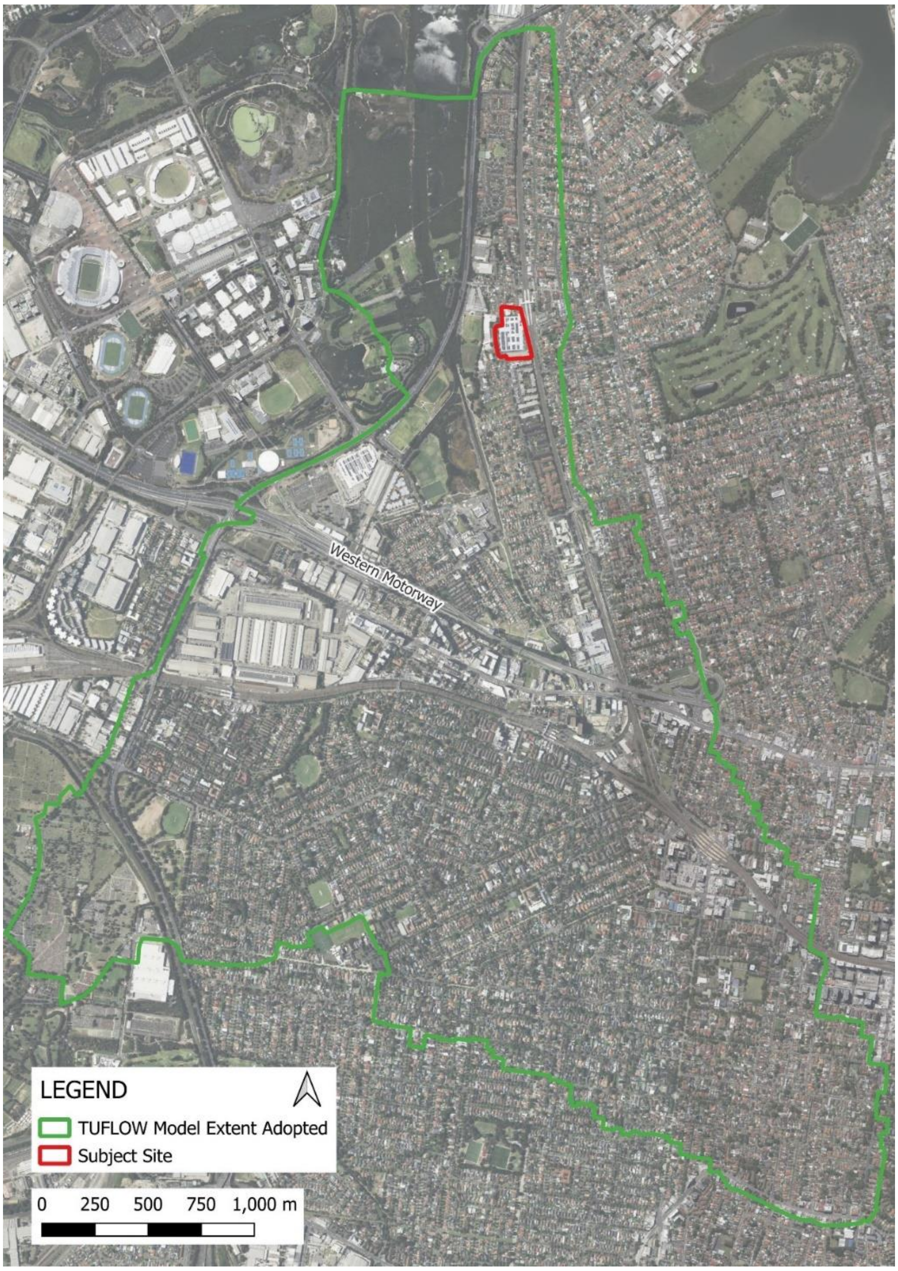

Figure 11: 2D Model Domain Boundary Adopted in Council's TUFLOW Model

Minor changes to model parameters for the subject site area have been made to the model provided by CCBC with majority of the modelling parameters remaining as per the original Council flood model. No hydrological assessment has been carried out as part of this assessment, apart from the additional extraction of design storms for the PMF event to facilitate the preparation of the Flood Emergency and Response Plan (FERP) for the subject site development. This is discussed further in Section 3.2. Changes made to the TUFLOW model as part of this assessment are discussed as follows.

In the pre-development scenario for this study (i.e. existing conditions prior to site proposed development), the detailed survey elevation data of the site and its immediate surrounding areas has been incorporated into the Council flood model to allow better surface elevation representation of the subject site.

This included updating the road gutter levels for George Street and King Street that surround the subject site, based on the survey data (refer to Figure 13 for locations and changes extent). It is worth noting that the Council flood model had adopted a modelling approach whereby building footprint areas have been excluded (i.e. null model area) in the flood model.

This updated TUFLOW model has been used as the pre-development scenario (i.e. base case) for this study. Figure 12 shows the survey data incorporated into the Council flood model as well as the extent of site building footprint excluded in the pre-development scenario flood model for this study.

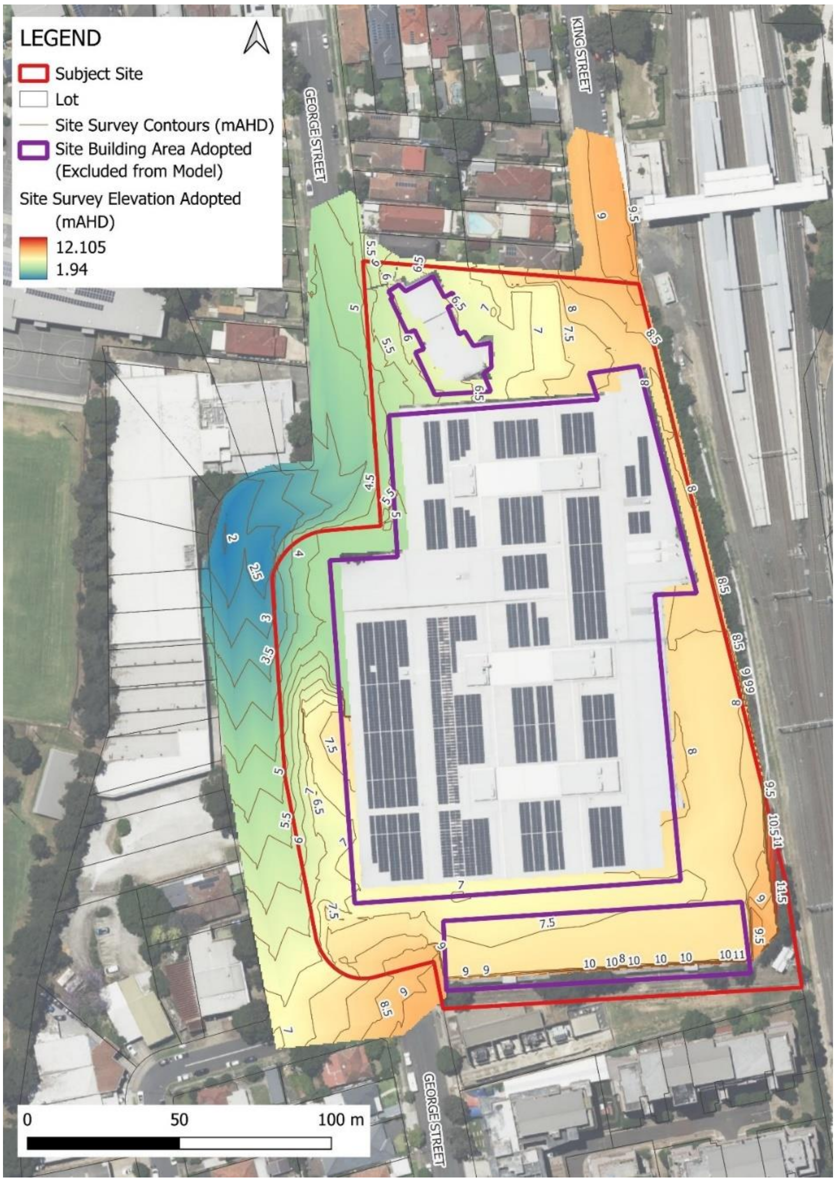

Figure 12: Site Survey Data and Building Footprint Area Adopted – Pre-Development Flood Model

All stormwater pipe systems adopted in the Council flood model has been retained in the base case model for this assessment, including the existing 900mm diameter stormwater pipe system that traverses the subject site from Queen Street on the east to George Street on the west. Figure 13 shows the stormwater network system adopted in the TUFLOW model for this study.

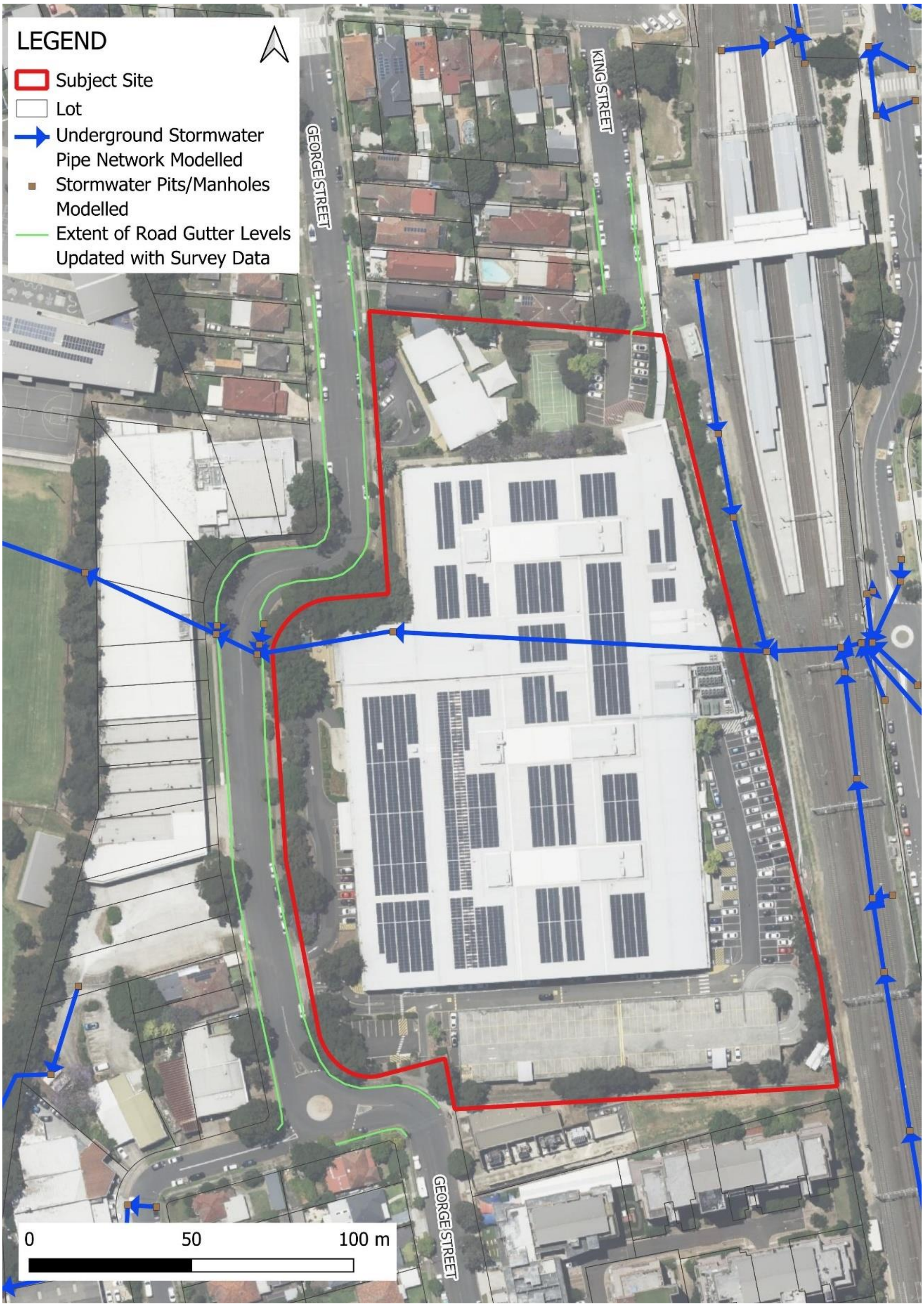

Figure 13: Stormwater Network System Adopted – Pre-Development Flood Model

In the post-developed scenario for this study (post site development), the above updated pre-development scenario flood model has been updated with the following:

- Incorporation of the site design TIN provided by GroupGSA;
- Incorporation of the proposed building footprints, based on the ground floor architectural plan by GroupGSA (as shown in Figure 4);
- Removal of road gutter on George Street at where the two proposed site entrance/exit are connected to; and
- Update surface roughness of proposed site internal roadways with n value of 0.02.

It is understood that the existing 900mm diameter stormwater system that traverses the subject site from the east will be maintained as part of the developed, therefore no changes to this existing stormwater system have been made in the post-development scenario model. Figure 14 shows the changes made to the pre-development scenario flood model for the post-development scenario flood model, as discussed above. This includes the incorporation of the site design TIN as well as the building footprint areas adopted (which has been excluded in the flood model code). It is worth noting that the site design TIN provided and assessed as is of concept nature (i.e. without detailed road and civil design features).

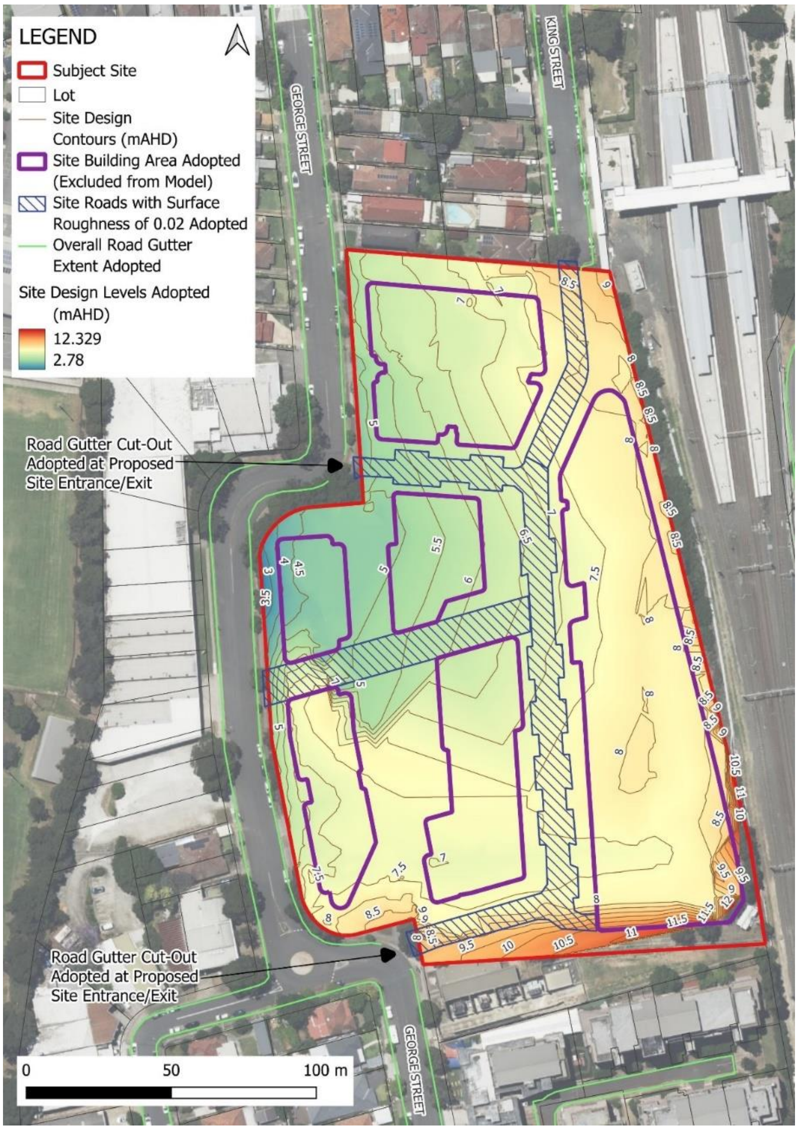

Figure 14: Changes Made for the Post-Development Flood Model

3.2 Flood Modelling Events

A total of five AEP events (18% AEP, 10% AEP, 2% AEP, 1% AEP and PMF events) have been modelled and assessed as part of this study to determine the flood characteristics as well as flood impacts resulting from the proposed development.

Additional climate change modelling has been carried out for the post-development scenario to determine the likely increase in flood impacts for the subject site area in the 1% AEP event. In the climate change assessment, the 1% AEP rainfall intensity has been increased by 20% with the model tailwater level increased by 0.9m (i.e. increased from 1.4mAHD to 2.3mAHD) to align with the current anticipated sea level rise by the year 2100.

The design storm adopted for each AEP event in this study has been based on the critical design storms provided within the Council flood model, with the exception of PMF event where the 30-minute design storm event has been adopted for this study instead of the 60-minute adopted in Council flood model. Table 2 below summarises the design storms simulated, together with the model tailwater levels modelled and assessed as part of this study. Note that the storm and tailwater parameters adopted in this assessment are the same as used in the original Council flood model with the 1% AEP with climate change event adopting a 0.9m increase in sea level rise.

Table 2 – Design Storm Events and Associated Tailwater Adopted

AEP Event	Design Duration Adopted	TP Adopted	Model Tailwater Condition Adopted
18%	45min	TP8	1.2mAHD
10%	60min	TP5	1.2mAHD
2%	60min	TP1	1.4mAHD
1%	60min	TP1	1.4mAHD
1% with Climate Change	60min	TP1	2.3mAHD
PMF	30min	N/A	1.43mAHD

To facilitate the assessment and preparation of the Flood Emergency and Response Plan (FERP) for the subject site development, further modelling has been carried out for the suite of PMF design storm durations (i.e. from 15-minute to 360-minute). As the provided Council flood model only comes with the 60-minute design storm for the PMF event (i.e. deemed critical in the PMF event for the Powells Creek catchment as part of the Powells Creek Flood Study), additional DRAINS hydrological simulations were also carried out to create the suite of design storm durations (i.e. from 15-minute to 360-minute) for the PMF event. The provided Powells Creek DRAINS model was updated to include the derived hyetographs of the 15-minute to 360-minute for the PMF event. The rainfall depth of each design storm duration was derived for the Powells Creek catchment using the GSDM (Generalised Short-Duration Method) and is summarised in Table 3. Note that rainfall depth for the 60-minute design storm has been excluded in the additional hydrological modelling and in Table 3 as this has been provided within Council flood model.

Table 3 – PMF Design Storm Rainfall Depth Adopted

AEP Event	Storm Duration	Rainfall Depth Adopted
PMF	15min	150mm
	30min	220mm
	45min	280mm
	90min	370mm
	120min	420mm
	180min	470mm
	240min	510mm
	300min	550mm
	360min	580mm

The catchment flow hydrographs estimated by DRAINS for each of the PMF storm duration listed in Table 3 were then extracted and incorporated as catchment inflows into the post-development scenario TUFLOW model. Note that the suite of PMF design storm durations were only simulated for the post-development scenario to assist with the assessment and preparation of a FERP.

3.3 Flood Modelling Scenarios

As discussed in Section 3.1, a total of two modelling scenarios have been assessed as part of this assessment, which include:

- Pre-development Scenario – this is the scenario where the subject site has been represented with conditions as it exists now.
- Post-development Scenario – this is the scenario where the proposed site development has been considered and incorporated into the pre-development model. The proposed building footprint area has been updated and incorporated into the pre-development flood model.

4.0 Hydraulic Modelling Results

Modelling results of both the pre-development and post-development scenarios, carried out as part of this assessment, are discussed in the following sections of this report. It is worth noting that the flood hazard category adopted in this assessment, and discussed below, have been based on the flood hazard vulnerability curves set out in '*Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*' of the Australian Disaster Resilience Handbook Collection (2017).

These curves assess the vulnerability of people, vehicles and buildings to flooding based on the velocity and depth of flood flows. The flood hazard categories are outlined in Figure 15, ranging from a level of H1 (generally safe for people, vehicles and buildings) to H6 (unsafe for vehicles and people, with all buildings considered vulnerable to failure). This remained similar to that adopted in the Council flood model provided.

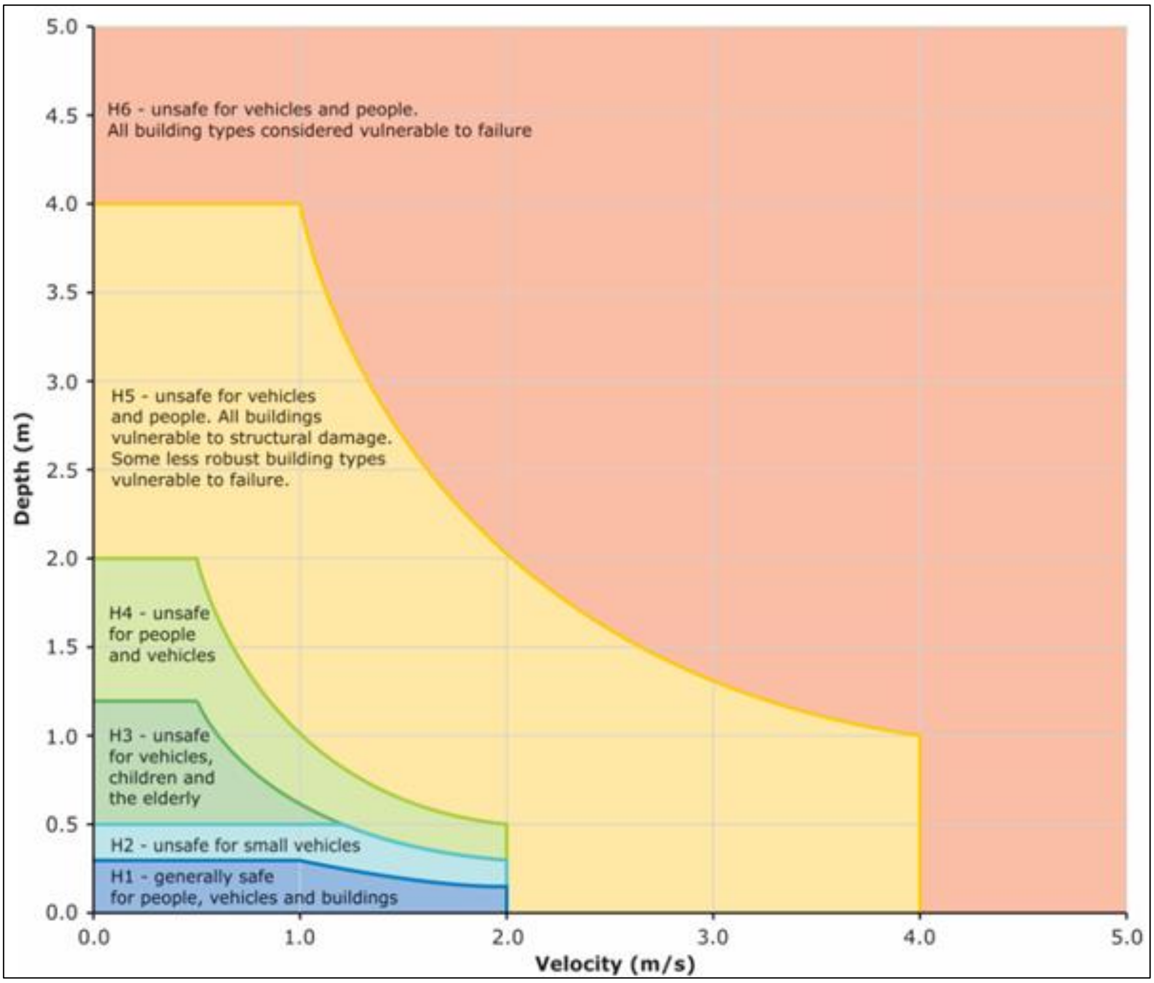

Figure 15: Flood Hazard Vulnerability Curve (Source: Flood Risk Management Guide FB03 - Flood Hazard, NSW Department of Planning and Environment, 2022)

4.1 Pre-Development Scenario

This section summarises and discusses the simulated 1% AEP and PMF events flooding characteristics for the subject site and its immediate surrounding areas. The modelling results of the remaining AEP events modelled and assessed (i.e. 18% AEP, 10% AEP, 2% AEP and 1% AEP with Climate Change events) as part of this assessment are summarised in flood maps attached to Appendix A of this report.

<u>1% AEP Event</u>

Modelling results show that flooding will not affect the existing building areas within the subject site in the 1% AEP event. However, flood inundation is estimated over a small area near the subject site boundary fronting

George Street, near the sag in this road. Flood depths in excess of 750mm are estimated at the lowest point of the site in the 1% AEP event assessed, while flood depths in excess of 1.3m are estimated at the sag of George Street to the west. The results show that floodwater accumulates and stays at this sag location of George Street until additional conveyance capacity of the underground stormwater system is available to drain the floodwater. Flooding at this location is a known issue and has been identified as part of the Powells Creek Flood Study in 2022. The results show that flooding on Queen Street (i.e. to the east of the railway lines) will not overtop the railway lines and impact the subject site in the 1% AEP event assessed.

The majority of the flood inundation areas within the subject site, in the 1% AEP event, are estimated to experience relatively low flow velocities (i.e. generally less than 0.8m/s). Flow velocities of inundated area on the George Street sag location are generally less than 1m/s, with flow velocities higher than 1m/s estimated along the side kerbs and channels of this road. The estimated flood hazards within the subject site are estimated to be generally lower than H3 (unsafe for vehicles, children and the elderly) in the 1% AEP event assessed, with a small area at the lowest point of the site classified at H3. The sag area of George Street to the west is estimated to generally experience a flood hazard of H3 or higher in the 1% AEP event, making this section of the George Street unsafe for vehicles and people.

The 1% AEP flood depths and levels, flow velocities and flood hazards for the pre-development scenario are represented in Figure 16, Figure 17 and Figure 18 respectively.

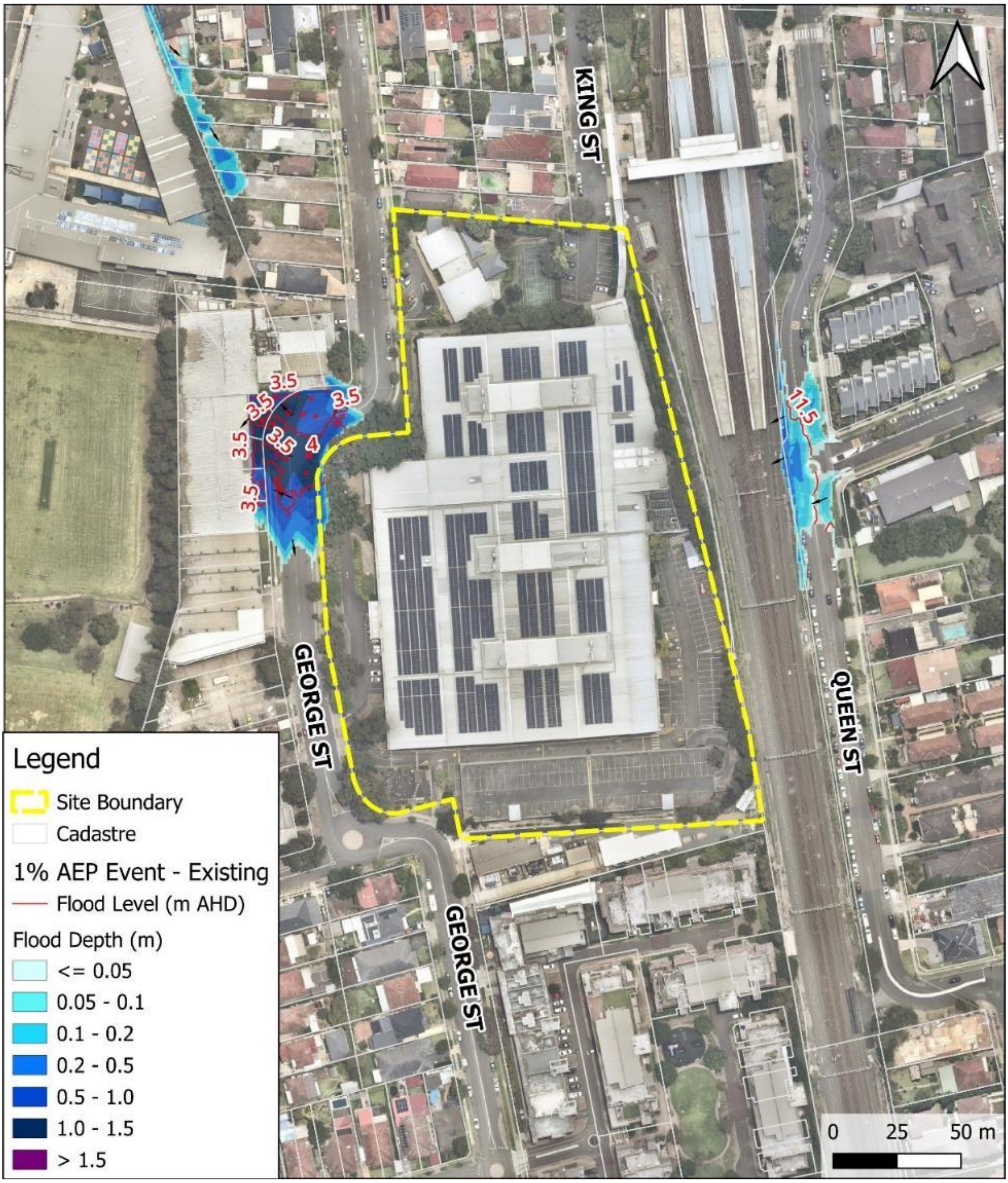

Figure 16: 1% AEP Flood Depths and Levels – Pre-Development Scenario

Figure 17: 1% AEP Flow Velocities – Pre-Development Scenario

Figure 18: 1% AEP Flood Hazards – Pre-Development Scenario

PMF Event

Modelling results show that flooding on Queen Street (i.e. to the east of the railway lines) will overtop the railway lines and impact the subject site in the PMF event assessed. It is worth noting that the existing building areas within the subject site remained flood free in the PMF event, but this is mainly due to these building areas being excluded in the flood model. Therefore, existing building floor levels and manual checks would be required to confirm if over-floor flooding occurs within these existing site buildings.

Nonetheless, flood inundation depths within the subject site are generally estimated to be less than 500mm, except the site's lowest point area to the west, near the sag of George Street, where flood depths in excess of 1.5m are estimated.

The majority of the flood inundation areas within the subject site, during the PMF event, are estimated to experience relatively low flow velocities (i.e. generally less than 1.0m/s). Flow velocities of inundated areas on the George Street sag area are generally less than 1m/s, with flow velocities higher than 1m/s estimated along the side kerbs and channels of this road. The estimated flood hazards within the subject site are estimated to be generally lower than H2 (unsafe for small vehicles) in the PMF event assessed, with a small area at the lowest point of the site classified at H4 which is considered to be unsafe for all people and vehicles. The sag area of George Street to the west is estimated to experience flood hazard as high as H5 in the PMF event, making this section of the George Street not safe for all vehicles and people.

The PMF flood depths and levels, flow velocities and flood hazards for the pre-development scenario are represented in Figure 19, Figure 20 and Figure 21 respectively.

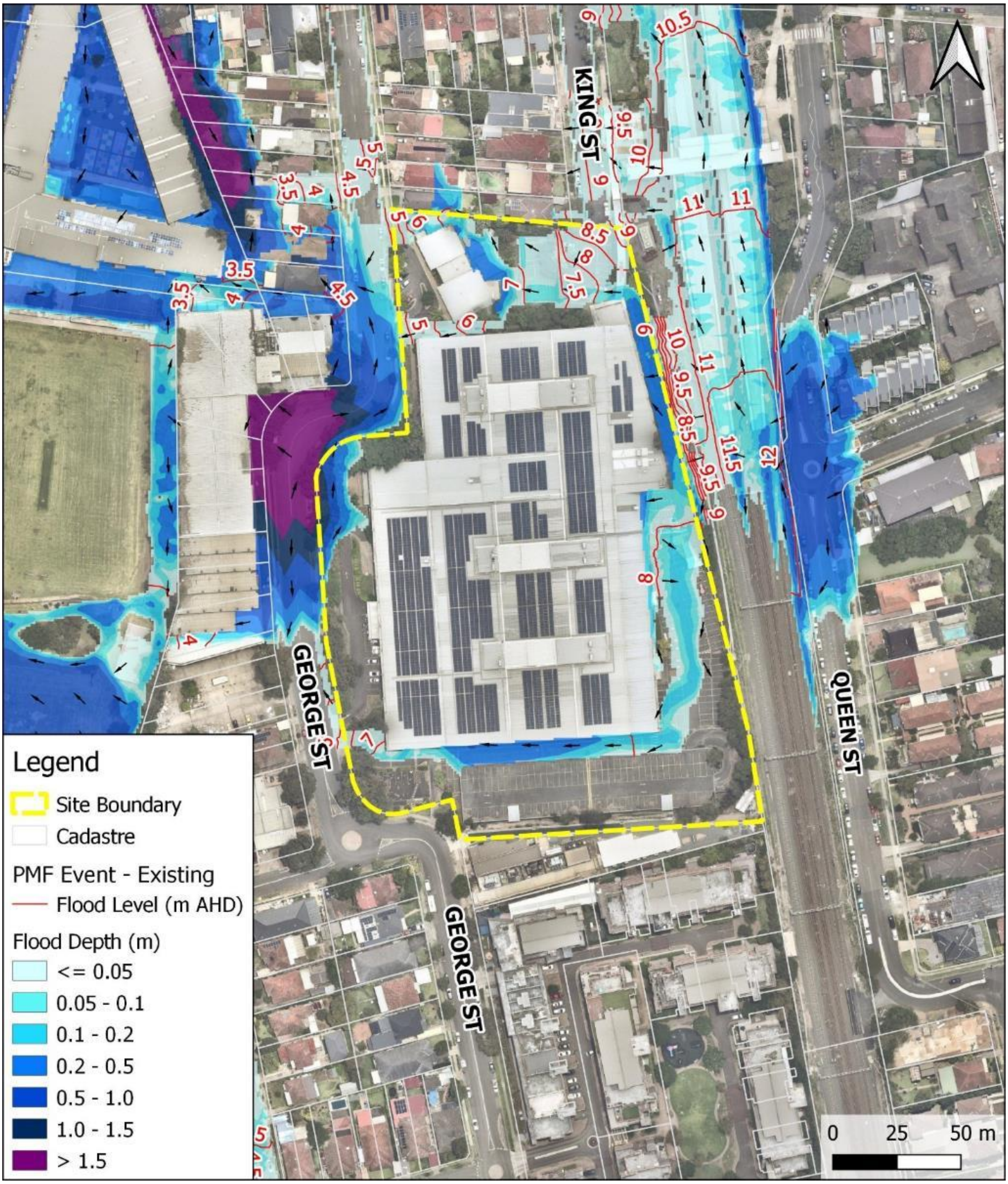

Figure 19: PMF Flood Depths and Levels – Pre-Development Scenario

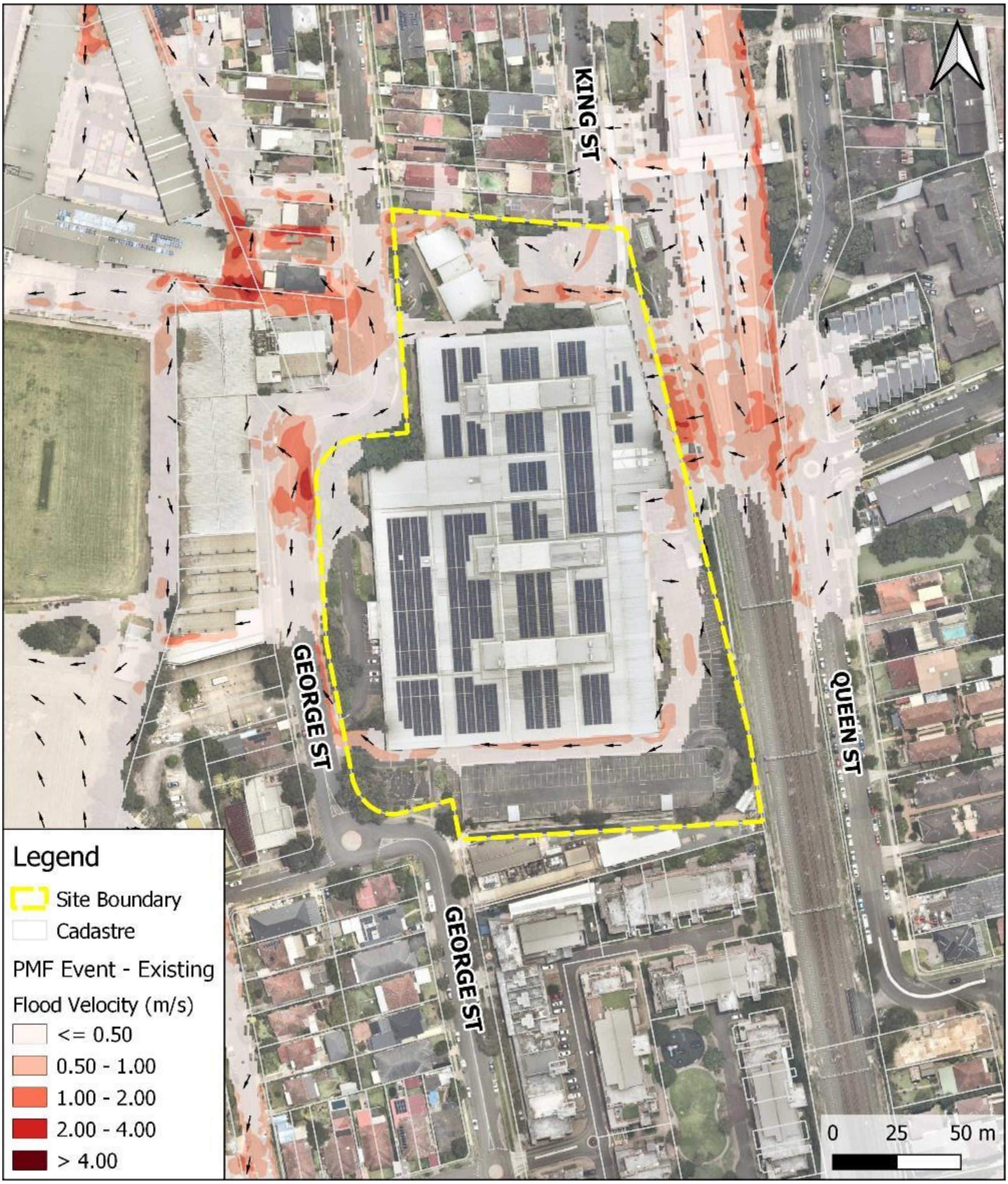

Figure 20: PMF Flow Velocities – Pre-Development Scenario

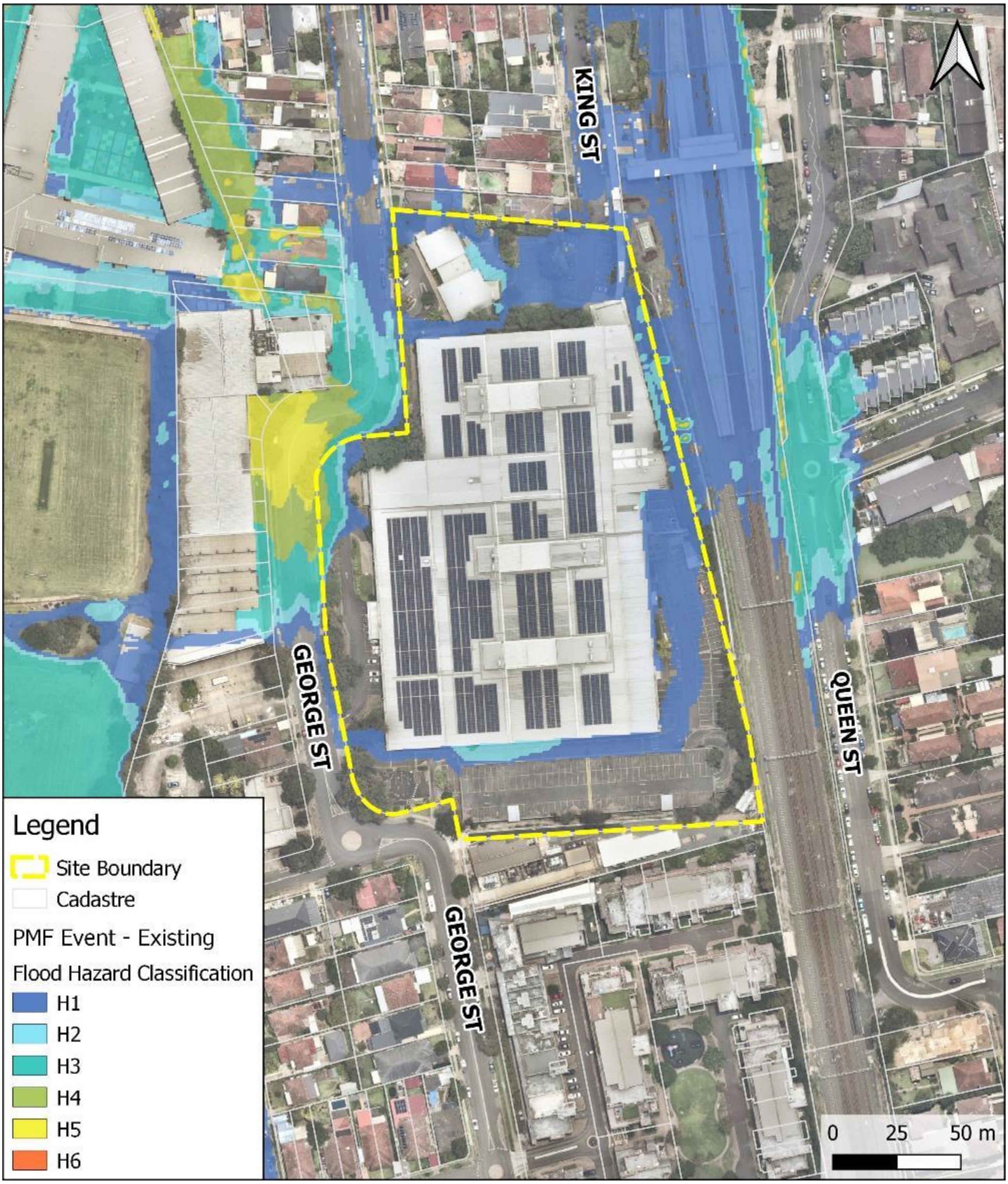

Figure 21: PMF Flood Hazards – Pre-Development Scenario

4.2 Post-Development Scenario

This section summarises and discusses the estimated 1% AEP and PMF events flooding characteristics for the subject site and its immediate surrounding areas in the post-development scenario. The modelling results of the remaining AEP events modelled and assessed (i.e. 18% AEP, 10% AEP, 2% AEP and 1% AEP with Climate Change events) as part of this assessment are summarised in flood maps attached to Appendix B of this report.

1% AEP Event

The modelling results show that flooding conditions surrounding the subject site remain generally similar to that of the pre-development scenario discussed in Section 4.1, during the 1% AEP event assessed. Similarly, the results show that flooding will not affect all proposed building areas within the subject site in the 1% AEP event. However, flood inundation is estimated over a small area near the subject site boundary fronting George Street, near the sag of this road. Flood depths in excess of 750mm are estimated at the lowest point of the site in the 1% AEP event assessed, while flood depths in excess of 1.3m are estimated at the sag of George Street to the west. The results show that floodwaters accumulate and stay at this sag location of George Street until additional conveyance capacity of the underground stormwater system is available to drain the floodwater. The results show that flooding on Queen Street (i.e. to the east of the railway lines) will not overtop the railway lines and impact the subject site in the 1% AEP event assessed.

The majority of the flood inundation areas within the subject site, in the 1% AEP event assessed, are estimated to experience relatively low flow velocities (i.e. generally less than 0.8m/s). Flow velocities of inundated area on the George Street sag location are generally less than 1m/s, with flow velocities higher than 1m/s estimated along the side kerbs and channels of this road. The estimated flood hazards within the subject site are estimated to be generally lower than H3 (unsafe for vehicles, children and the elderly) in the 1% AEP event assessed, with a small area at the lowest point of the site classified as H3. A majority of the sag area of George Street to the west is estimated to generally experience flood hazard of H3 or higher in the 1% AEP event, making this section of the George Street unsafe for vehicles and people.

The 1% AEP flood depths and levels, flow velocities and flood hazards for the post-development scenario are represented in Figure 22, Figure 23 and Figure 24 respectively.

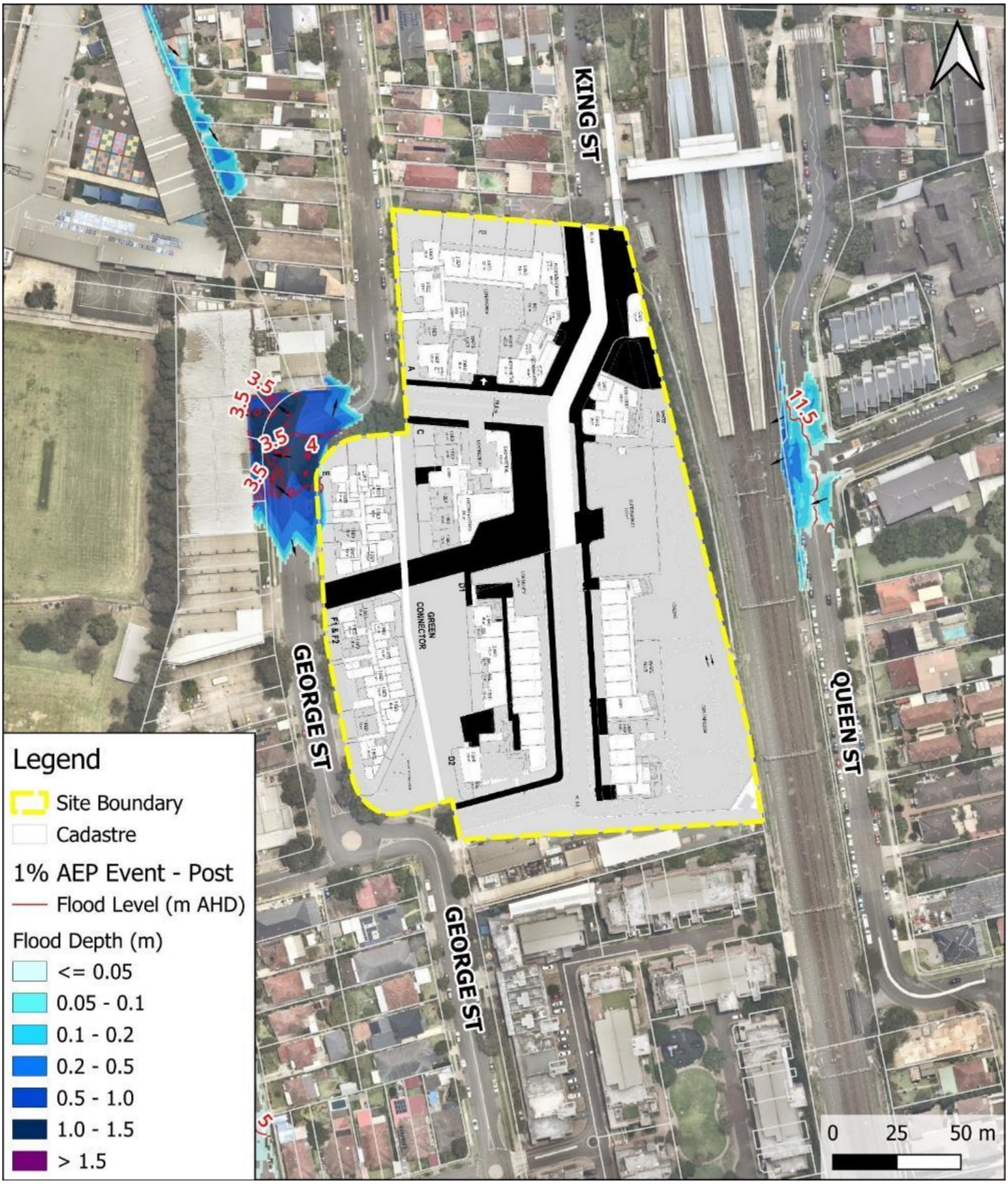

Figure 22: 1% AEP Flood Depths and Levels – Post-Development Scenario

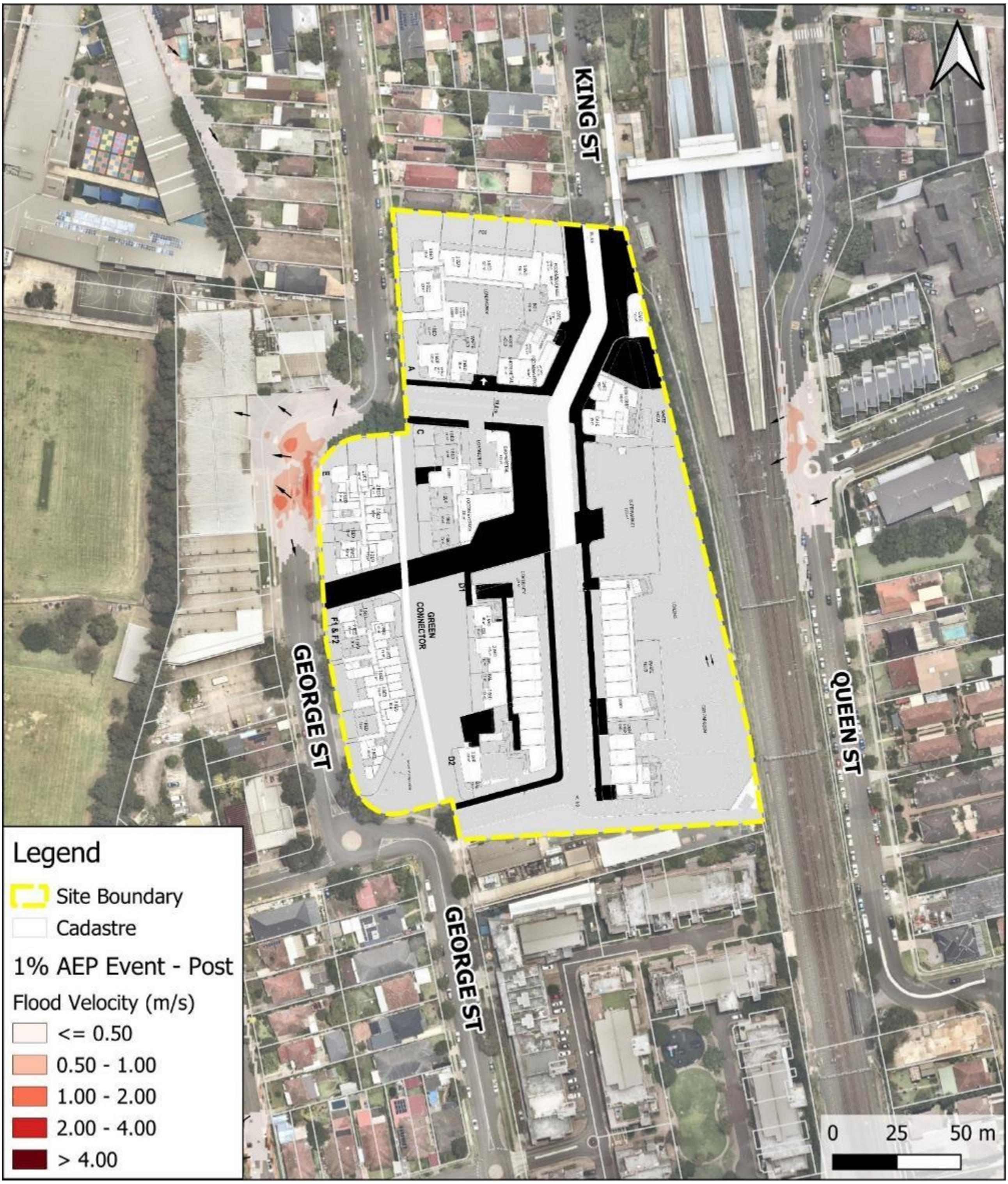

Figure 23: 1% AEP Flow Velocities – Post-Development Scenario

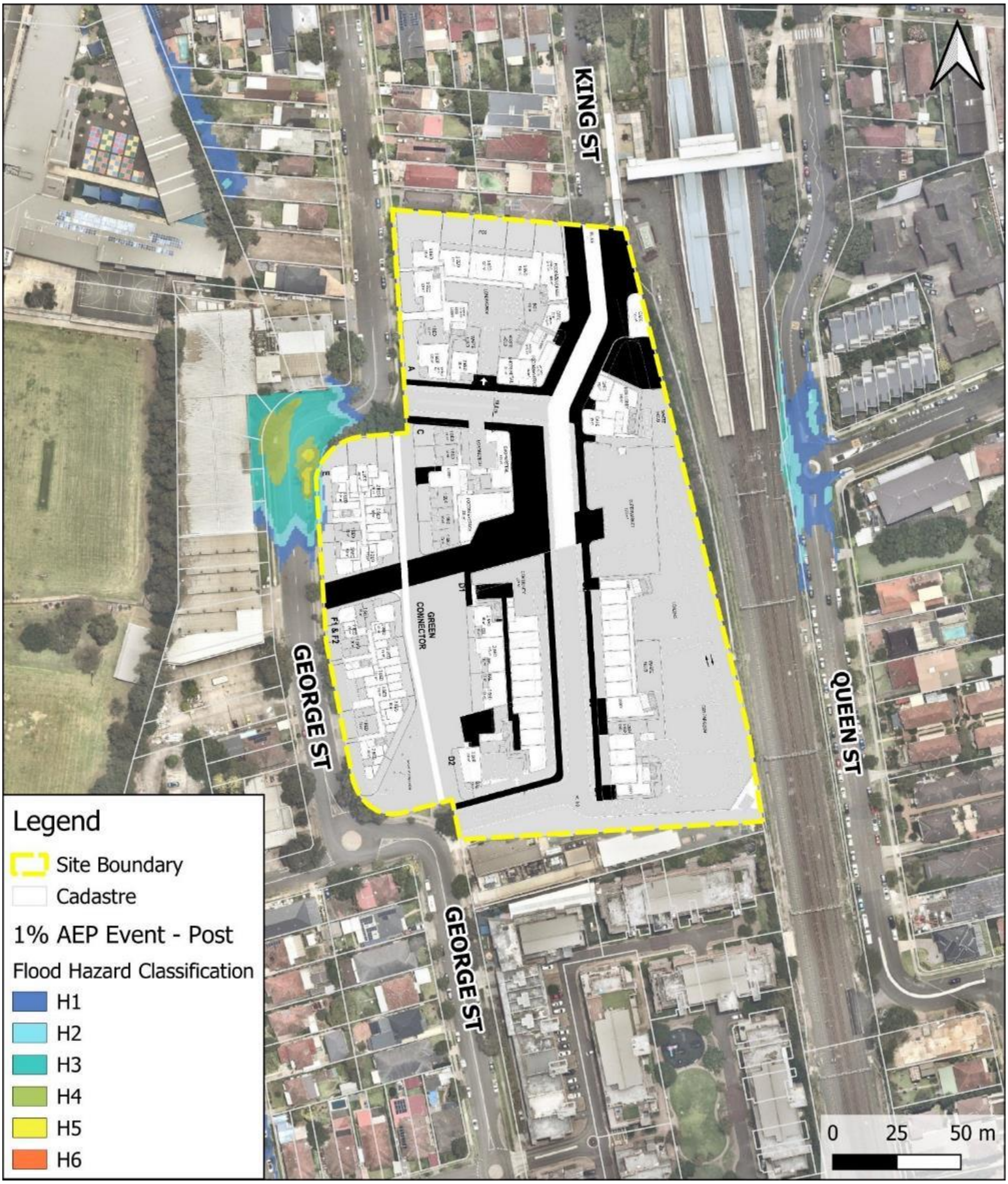

Figure 24: 1% AEP Flood Hazards – Post-Development Scenario

PMF Event

The modelling results show that flood inundation and flooding characteristics at the Geroge Street sag area generally remained similar to that estimated for the pre-development scenario in the PMF event assessed, as discussed in Section 4.1. As with the pre-development scenario, the results show that flooding on Queen Street (i.e. to the east of the railway lines) will overtop the railway lines and impact the subject site in the PMF event assessed. However, flood inundation in the post-development scenario only occur in the northern part of the site as the results show that the proposed building along the eastern property boundary has prevented floodwater to flow south. The results show that inundation of the subject site in the PMF event mainly occurs on proposed internal roads or landscaping area, and it is worth noting that all proposed building areas within the subject site remained flood free. However, this is mainly due to these building areas being excluded in the flood model. Therefore, further checks should be carried out in the subsequent detailed design phase of the development (i.e. when detailed design of the site's internal roads and earthworks design is available) to confirm flood immunity of these proposed site buildings.

Nonetheless, flood inundation depths within the subject site are generally estimated to be less than 500mm, except at the site's lowest point to the west near the sag of George Street where flood depths in excess of 1.5m are estimated as well as the area along the site's eastern property boundary where flood depths as high as 600mm are estimated.

The majority of the flood inundation areas within the subject site, during the PMF event, are estimated to experience relatively low flow velocities (i.e. generally less than 1.0m/s), except at few spots within the proposed internal road that connects King Street to George Street on the west where flow velocities as high as 1.5m/s are estimated. Flow velocities of inundated areas on the George Street sag area are generally less than 1m/s, with flow velocities higher than 1m/s estimated along the side kerbs and channels of this road. The estimated flood hazards within the subject site are estimated to be generally lower than H2 (unsafe for small vehicles) in the PMF event assessed, with a small area at the lowest point of the site classified at H4 which is considered to be unsafe for all people and vehicles. The sag area of George Street to the west is estimated to experience flood hazard as high as H5 in the PMF event (i.e. which is generally similar to that estimated for the pre-development scenario), making this section of the George Street unsafe for all vehicles and people.

The PMF flood depths and levels, flow velocities and flood hazards for the post-development scenario are represented in Figure 25, Figure 26 and Figure 27 respectively.

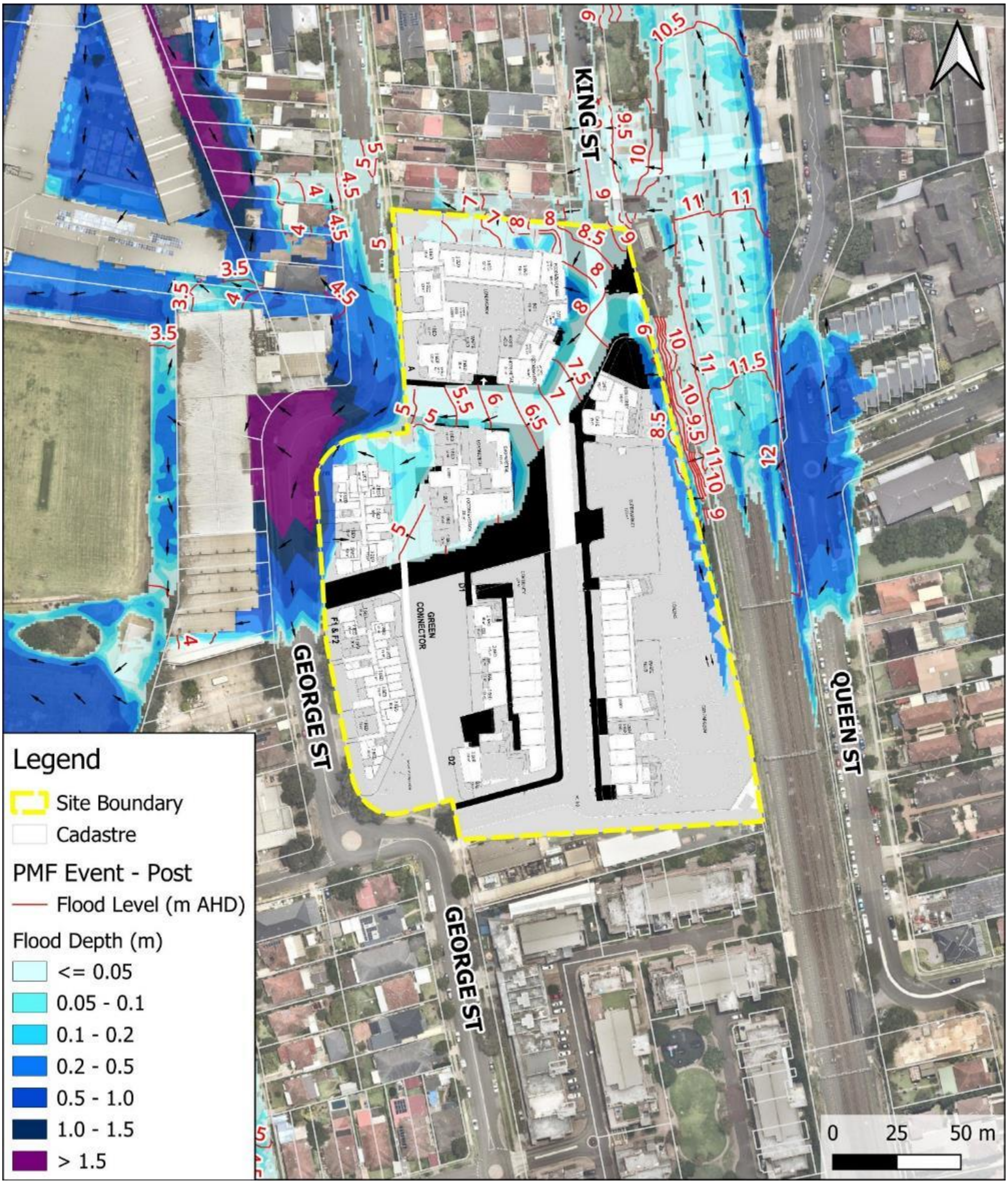

Figure 25: PMF Flood Depths and Levels – Post-Development Scenario

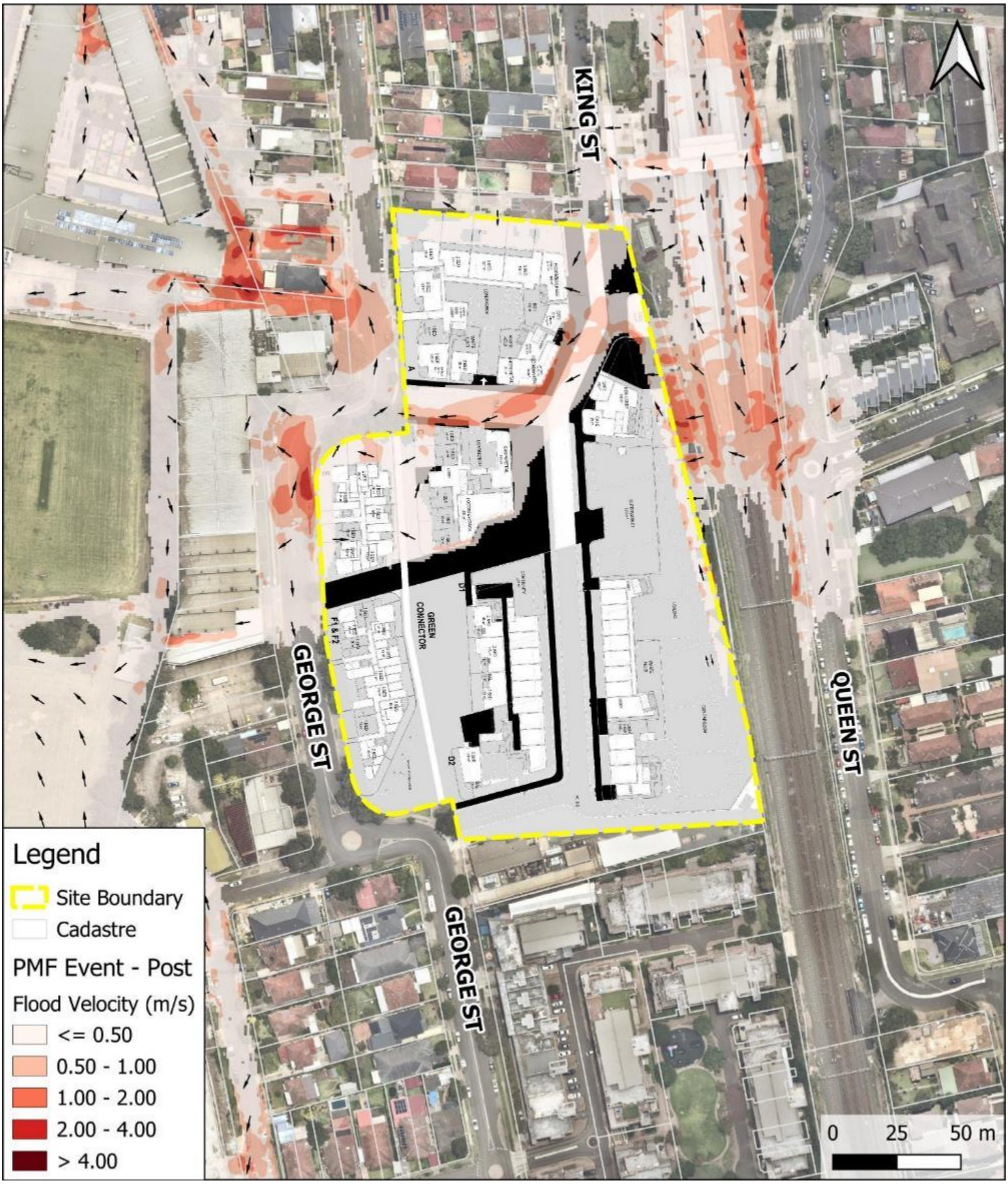

Figure 26: PMF Flow Velocities – Post-Development Scenario

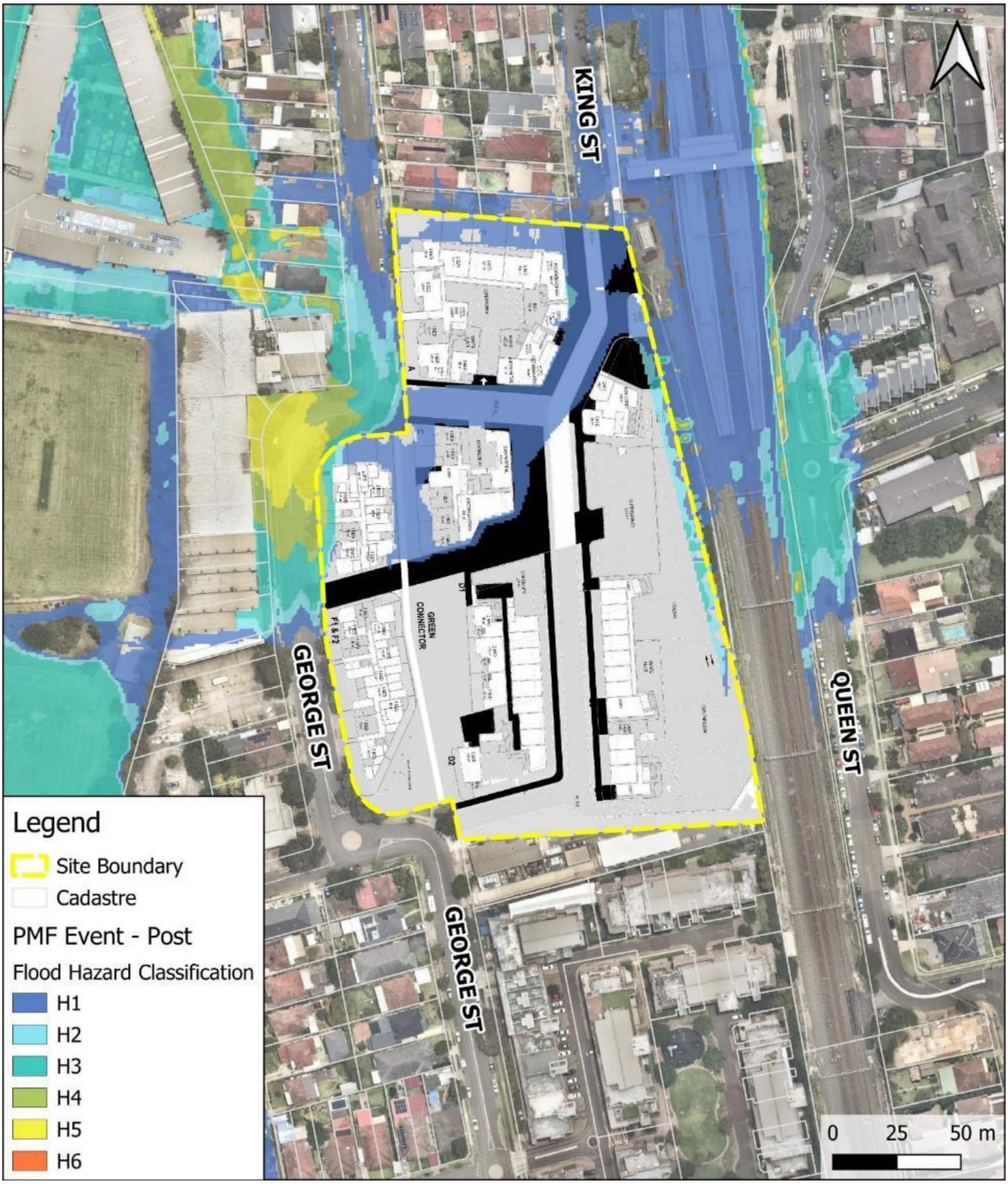

Figure 27: PMF Flood Hazards – Post-Development Scenario

4.3 Offsite Flood Impact Assessment

A flood impact assessment was carried out to ensure that the proposed development on the subject site would not cause any offsite impacts beyond the accepted +10mm on the surrounding properties for all the assessed events, up to and including the 1% AEP event. This is discussed further below.

18% AEP Event

The modelling results show that the proposed development will generally not cause any increases in estimated flood levels (i.e. flood level affluxes) for the immediate surrounding areas (including Queen Street to the east) in the 18% AEP event assessed. Some small pockets of flood level affluxes higher than 30mm are estimated over a few model cells on the eastern road gutter of George Street (i.e. west of site) near the sag location, but the estimated impacted area is generally surrounded by areas with no estimated impacts. Therefore, such small, estimated, flood level afflux area on George Street is considered to be the "noise" of the modelling rather than actual impacts (i.e. likely due to the 1d and 2d connection interface within the Council flood model). The 18% AEP flood level afflux map for the subject site and its immediate surrounding areas is shown in Figure 28.

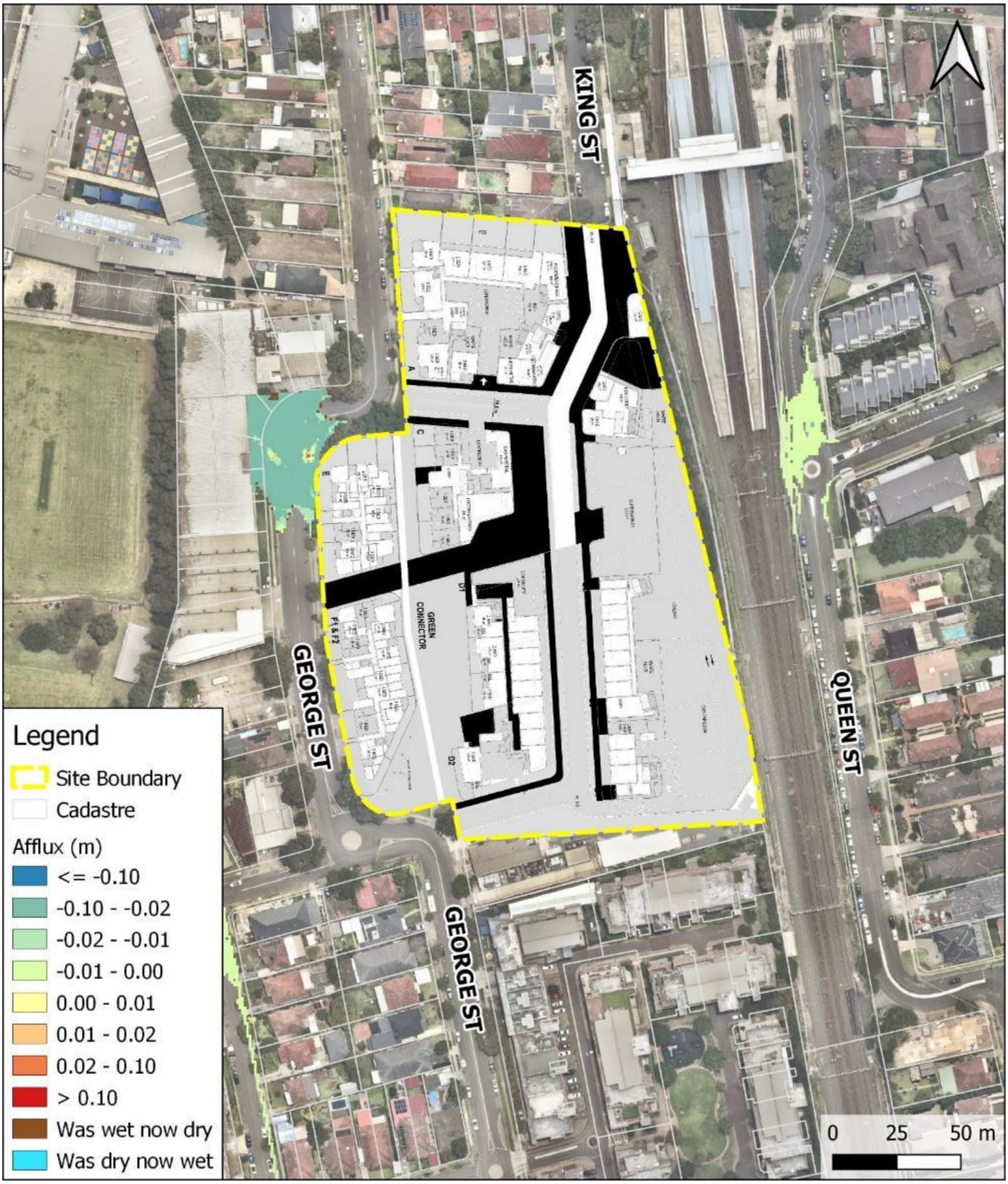

Figure 28: 18% AEP Flood Level Impact (Post-Development – Pre-Development)

<u>10% AEP Event</u>

The modelling results show that the proposed development will generally not cause any increases in estimated flood levels (i.e. flood level affluxes) for the immediate surrounding areas (including Queen Street to the east) in the 10% AEP event assessed. Some small pockets of flood level affluxes higher than 20mm are estimated over a few model cells on the eastern road gutter of George Street (i.e. west of site) near the sag location and eastern road gutter of Queen Street (i.e. east of site) near the intersection with Stuart Street, but these estimated impacted areas, are generally surrounded by areas with no estimated impacts. Therefore, such small, estimated, flood level afflux areas on George Street and Queen Street are considered to be the "noise" of the modelling rather than actual impacts (i.e. likely due to the 1d and 2d connection interface within the Council flood model). Further, flood hazards remained low and unchanged in these areas when compared to the pre-development scenario.

The 10% AEP flood level affluxes map for the subject site and its immediate surrounding areas is shown in Figure 29.

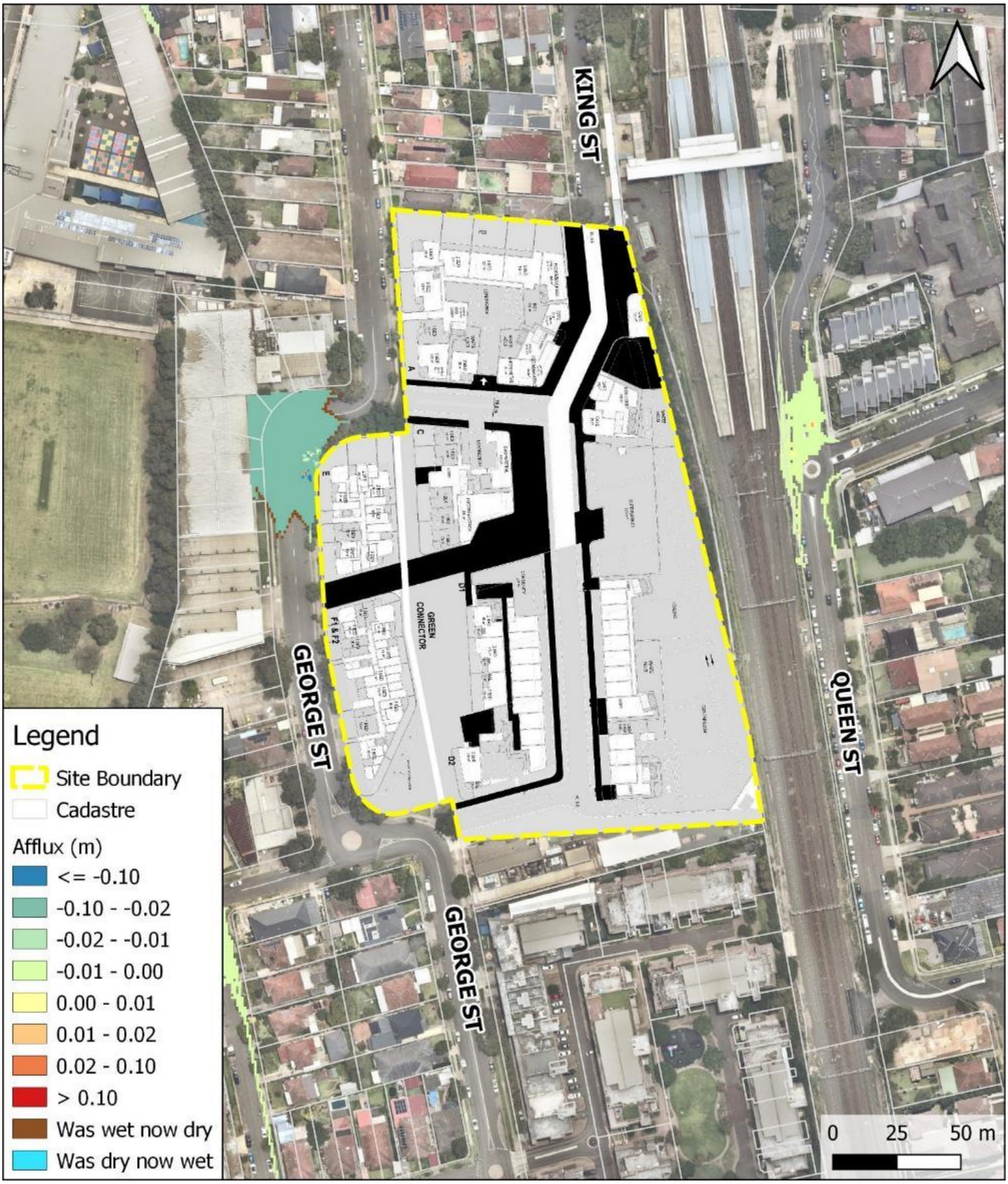

Figure 29: 10% AEP Flood Level Impact (Post-Development – Pre-Development)

2% AEP Event

The modelling results show that the proposed development will generally not cause any increases in estimated flood levels (i.e. flood level affluxes) for the immediate surrounding areas (including Queen Street to the east) in the 2% AEP event assessed. Some small pockets of flood level affluxes higher than 30mm are estimated over few model cells on the eastern road gutter of George Street (i.e. west of site) near the sag location, but these estimated impacted areas are generally surrounded by areas with no estimated impacts. Therefore, such small, estimated, flood level afflux area on George Street is considered to be the “noise” of the modelling rather than actual impacts (i.e. likely due to the 1d and 2d connection interface within the Council flood model). Further, flood hazards in these impacted areas remained similar to that estimated for the pre-development scenario. Hence, the results show that the proposed development will not result in additional flood risks in the 2% AEP event assessed.

The 2% AEP flood level affluxes map for the subject site and its immediate surrounding areas is shown in Figure 30.

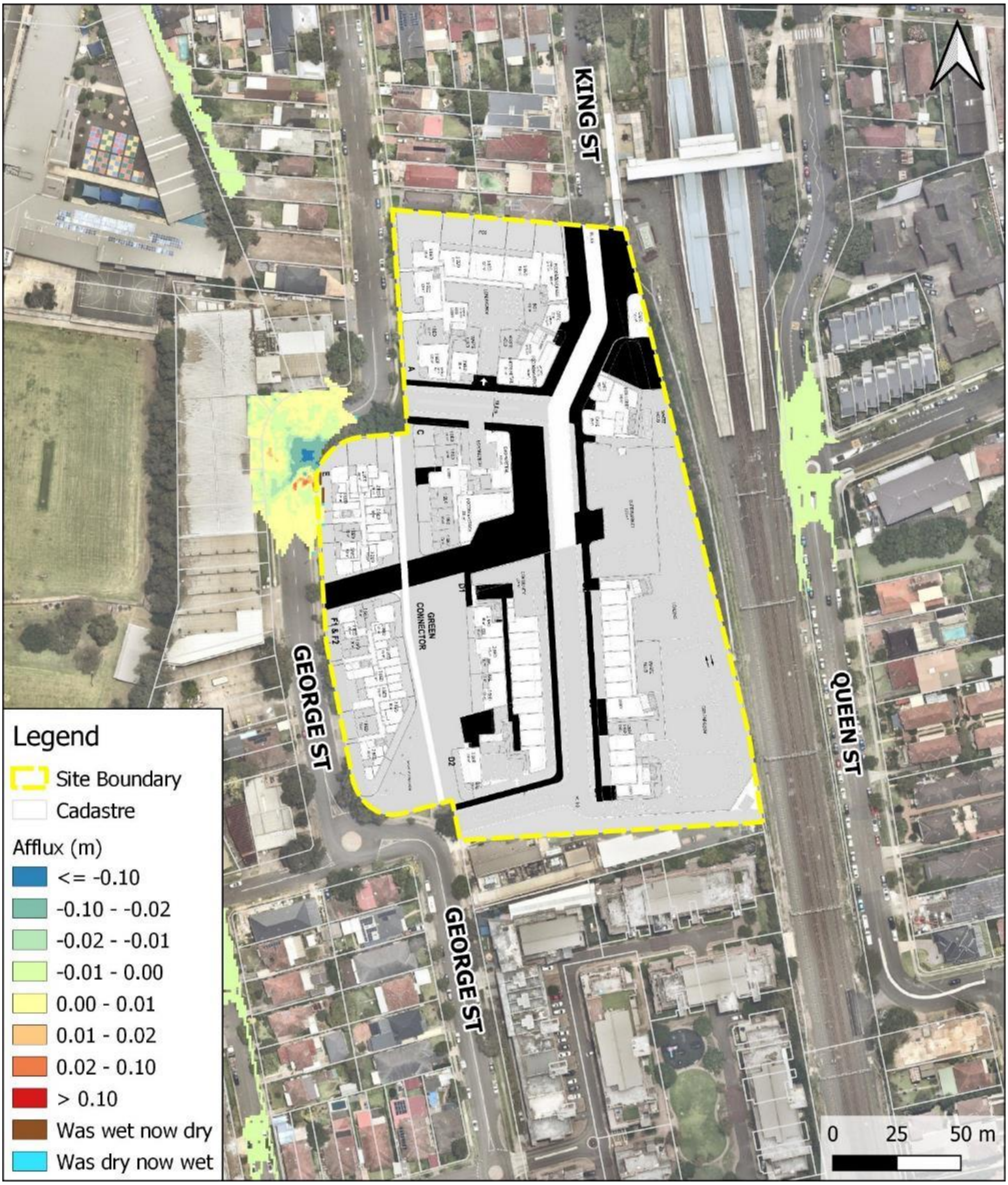

Figure 30: 2% AEP Flood Level Impact (Post-Development – Pre-Development)

<u>1% AEP Event</u>

The modelling results show that the proposed development will generally not cause any increases in estimated flood levels (i.e. flood level affluxes) for the immediate surrounding areas (including Queen Street to the east) in the 1% AEP event assessed. Some small pockets of flood level affluxes higher than 30mm are estimated over a few model cells on George Street (i.e. west of site) near the sag location and on Queen Street (i.e. east of site), but these estimated impacted areas are generally surrounded by areas with no estimated impacts. Therefore, such small, estimated, flood level afflux areas on George Street and Queen Street are considered to be the "noise" of the modelling rather than actual impacts. Further, flood hazards remained generally similar to that estimated for the pre-development scenario. Hence, the results show that the proposed development will not result in additional flood risks for the area in the 1% AEP event assessed.

The 1% AEP flood level affluxes map for the subject site and its immediate surrounding areas is shown in Figure 31.

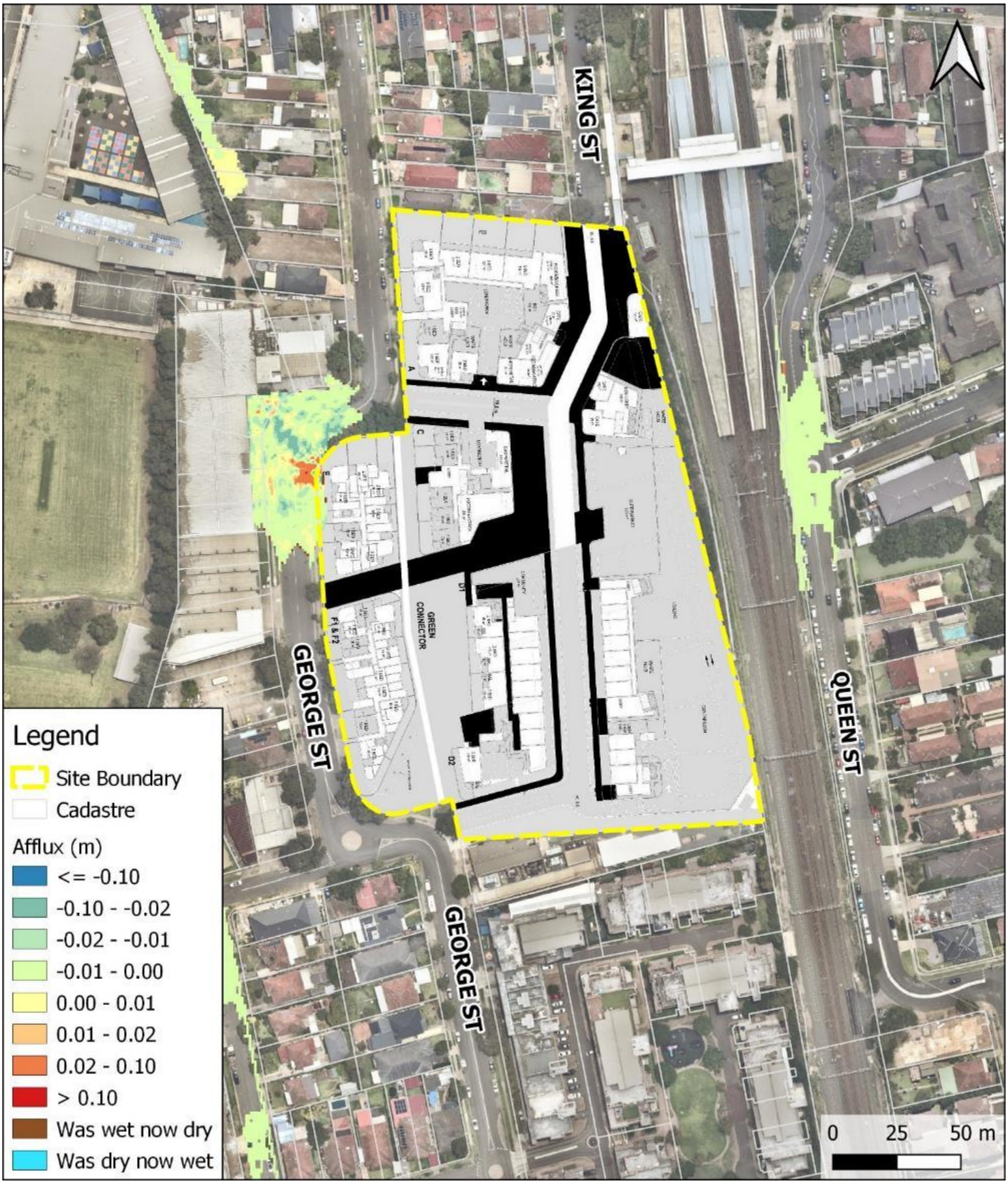

Figure 31: 1% AEP Flood Level Impact (Post-Development – Pre-Development)

4.4 Effects of Climate Change

The modelling results show that additional flood inundation areas are estimated as a result of climate change (i.e. 20% increase in rainfall intensity and 0.9m sea level rise) in the 1% AEP event assessed. The increases in estimated flood levels, as a result of climate change, at the sag of George Street to the west of the subject site, are estimated to be approximately 500mm, while the estimated flood level increases on Queen Street are estimated to be less than 200mm. Such increases in estimated flood levels are mainly due to the increase in sea level rise (i.e. the subject site is close to the outlet of Powells Creek at Parramatta River) as well as increase in rainfall intensity, and the constraints on the conveyance capacity of the existing 900mm diameter stormwater pipe system that traverses the subject site and sag of George Street. Nonetheless, the results show that the increase in estimated flood levels at the sag of George Street is not sufficient for the trapped floodwater to overtop and flow downstream, via the overland flow paths at the north and south, as estimated in the PMF event assessed. Therefore, the results show that floodwater will be trapped at the sag location of George Street until additional conveyance capacity is available in the existing 900mm diameter stormwater pipe system to drain the floodwater away into Powells Creek.

The estimated flood level differences between the 1% AEP with climate change and the 1% AEP events for the post-development site conditions are depicted in Figure 32.

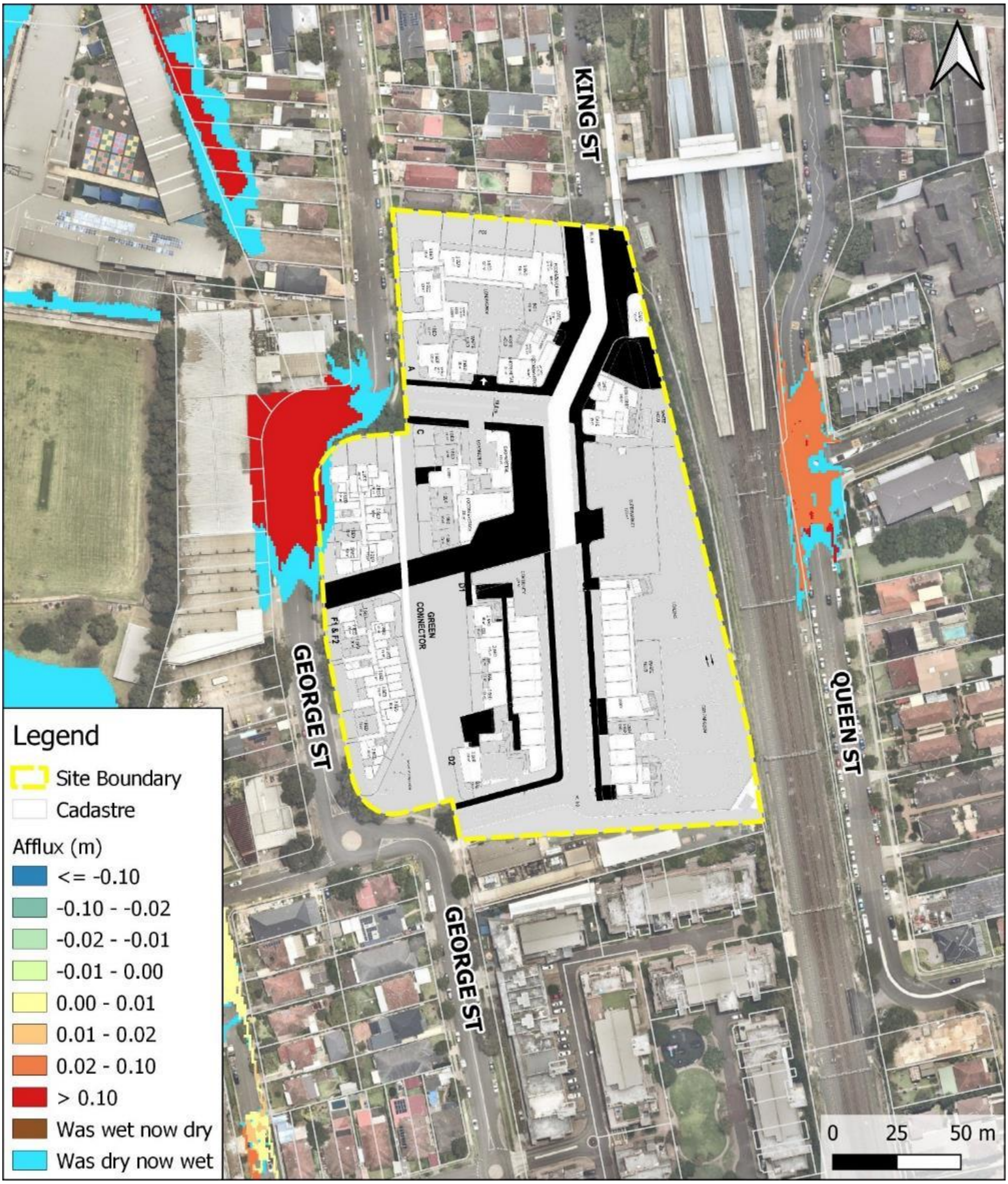

Figure 32: 1% AEP Flood Level Impact Caused by Climate Change (Post-Development)

5.0 Flood Planning Requirements

The current Development Control Plan (DCP) in place for the Concord West area is the City of Canada Bay DCP, effective as of August 2023. The DCP provides detailed planning and design guidelines to support the planning controls set out in the City of Canada Bay Local Environmental Plan (LEP) 2013 when designing a development.

Under Section 4.15 of the Environmental Planning and Assessment Act 1979, the consent authority is required to take into consideration the relevant provisions of the DCP in determining a development application. Section B8 of the CCBC DCP provides a risk-based approach to planning and development in the flood prone lands of the LGA. The New South Wales State Government flood prone land policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

The objectives of the CCBC DCP in relation to flooding are:

- To ensure the proponents of development and the community in general are aware of the potential flood hazard over the whole range of AEP and of the consequent risk and liability associated with the development and use of flood liable land.
- To manage flood liable land in manner that is economically and environmentally sustainable and socially responsible.
- To establish whether or not a proposed development or activity is appropriate to be carried out having regard to the economic, property, environmental and human impacts of flooding.
- To protect community by ensuring that developments with high sensitivity to flood risk (e.g. critical public utilities) are sited and designed to provide reliable access, continued operability during emergencies, quick recovery and to generally minimise risk from flooding.
- To allow development with a lower sensitivity to the flood hazard to be located within the floodplain, subject to appropriate design and siting controls and provided that the potential consequences that could still arise from flooding remain acceptable.
- To prevent intensification of inappropriate development.
- To control the use of 'High Hazard' areas and Floodways, and wherever appropriate and feasible, allow for their conversion to natural waterway corridors.
- To ensure that proposed development does not expose existing development to increased risks associated with flooding.
- To ensure building design and location address flood hazard.
- To ensure that development does not result in unreasonable flood impacts upon the amenity or ecology of an area.
- To incorporate the principles of Ecologically Sustainable Development (ESD).
- To minimise the risk to life and property arising from flooding.
- To ensure the provision of appropriate access to and egress from areas affected by flooding including for extreme events.
- To provide controls to ensure that development is carried out in accordance with this Policy.

- To implement the principles of floodplain risk management as defined by the NSW Government's Flood Prone Land Policy and the FDM 2005.

Table B-R in the DCP is a flood planning matrix which outlines the various flood controls that apply to a site, dependent on its flood risk precinct and land use type. Sections of the site are located within the Low Flood Risk Precinct (refer to Figure 10) and the site is within the Flood Planning Area. The site has multiple intended land uses, including accommodation (residential), shopping centres (commercial) and childcare facilities (sensitive).

Table 4 outlines the residential development controls which apply to the site; Table 5 details the commercial and industrial development controls; and Table 6 details the sensitive uses and facilities development controls which apply to the site.

Table 4 – Residential Land Use Flood Controls Applicable to Site Development

Development Control	Description
Floor level	• Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard.
	• A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5 m above finished ground level, confirming that the subfloor space is not to be enclosed.
Car parking and driveway access	• The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.
	• Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5 m above the 100 year ARI flood level.
	• The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level.
	• Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.
	• Enclosed underground car parks shall have all potential water entry points protected from the PMF. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of inundation is less than 300mm. Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable floor levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the Concord West Flood Study.

Table 5 – Commercial and Industrial Land Use Flood Controls Applicable to Site Development

Development Control	Description
Floor level	• Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard.
	• A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5 m above finished ground level, confirming that the subfloor space is not to be enclosed.
Car parking and	• The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.

driveway access	• Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5 m above the 100 year ARI flood level.
	• The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level.
	• Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.

Table 6 – Sensitive Uses and Facilities Land Use Flood Controls Applicable to Site Development

Development Control	Description
Floor level	• All floor levels to be equal to or greater than the Probable Maximum Flood (PMF) level.
Car parking and driveway access	• The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.
	• Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level.
	• The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level
	• Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.
	• Enclosed underground car parks shall have all potential water entry points protected from the PMF. Council may consider relaxation of this requirement if it can be shown by modelling that the catchment characteristics are such that the maximum depth of inundation is less than 300mm. Because of the particular catchment characteristics of the Concord West Precinct, an additional requirement within that precinct is for habitable floor levels to be at a minimum of RL 3.0m AHD. Refer to sections 9.3.3, 9.3.6, and 10.2.3 of the CWFS.

Based on Table 4 to Table 6 above, the habitable floor levels for all proposed residential and commercial areas within the subject site should be set at or above the 1% AEP flood levels + 500mm, while the habitable floor levels for all proposed sensitive uses and facilities (i.e. childcare facilities) should be set at or above the PMF flood levels. As discussed in Section 3.1 and Section 4.2, the site design levels adopted in this assessment are of concept nature (i.e. without detailed design road profile and earthworks consideration) and the fact that the subject site is not impacted by flooding in the 1% AEP event assessed, the habitable floor levels for all proposed residential and commercial areas should be set at 500mm above the top of kerb levels surrounding the individual proposed building, assuming that the internal stormwater drainage design will be fully contained within the internal roads (i.e. 1% AEP overland flow fully contained within the internal road top of kerb levels).

Similarly, the modelling results show that flood depths within the subject site in the PMF event are generally limited to 500mm, therefore habitable floor levels for all sensitive uses and facilities proposed within the subject site should be set at 500mm above the surrounding area of each proposed building, assuming that the overland flow in the PMF event within the subject site will be fully contained within the internal road corridors.

The three proposed entrances to the basement car parking area (refer to Figure 4 for locations) should be designed to have a crest of at least 500mm above the surrounding top of kerb levels to protect floodwater from entering the basement area in the PMF event.

6.0 Conclusions and Recommendations

TTW has been engaged to carry out a flood assessment in relation to the proposed mixed residential/commercial development at 1 King Street in Concord West to support a Development Application (via a planning proposal) and to address the flooding condition (i.e. Condition 1(d)) of the Gateway. This is discussed further in Section 1.0. Hydraulic modelling has been carried out based on the TUFLOW model provided by City of Canada Bay Council for the Powells Creek catchment, which is believed to be developed as part of the Powells Creek Flood Study completed in 2022.

A range of design events has been simulated, up to the PMF event (i.e. 18% AEP, 10% AEP, 2% AEP, 1% AEP and PMF events) as part of this assessment. The modelling results are discussed in Section 4 of this report. Proposed new site building levels and the crest of entrances to basement car parking area will be designed to be appropriately set referencing to the Flood Planning Level requirements discussed and outlined in Section 5 of this report.

The modelling results show that the proposed development will not result in any unacceptable flood impacts for areas outside the subject site for all the AEP events assessed, up to and including the 1% AEP event. The site is predominantly only affected by overland flow inundation especially when the stormwater runoff exceeds the capacity of the underground stormwater system in the subject site area.

The modelling results also shows that flood hazards for the immediate surrounding areas of the subject site remain similar to that of the pre-development levels. As such, the results suggest that the proposed development will not increase the flood risks for the subject site and its immediate surrounding areas.

Nonetheless, the modelling results show that the sag point of George Street to the west of the subject site are estimated to experience flood hazards of H3 or greater in all AEP events assessed, which is considered not safe for traffic. As the flooding in the area is mainly caused by overland flow, flood inundation of areas will generally occur over a short period of time, therefore a shelter-in-place strategy should be adopted for the development. Since the proposed development will likely increase the people present at the subject site in a flooding event (i.e. when compared to the existing conditions), a Flood Emergency Response Plan (FERP) that provides guidance on flood management for the subject site has also been prepared by TTW to support the Development Application of the subject site.

The modelling results show that majority of the subject site area (i.e. except a small area at the site's lowest point on the west near George Street sag point) is estimated to be flood free in the 1% AEP event assessed, and it is worth noting that this is mainly due to the modelling being carried out without the proposed underground stormwater system within the subject site being considered in the modelling as this information was unavailable at the time of the assessment. Further, the site design levels adopted for the subject site in the TUFLOW model are of concept nature (as discussed in Section 3.1 and Section 4.2). Therefore, further modelling and checks should be carried out in the subsequent detailed design phase when such design data is available (i.e. prior to construction) to confirm that the modelling outcome discussed within this report are maintained, and appropriate levels have been set for the key locations within the subject site that meet the requirements of Council's DCP. In particular, the proposed underground stormwater system for the subject site should be considered in the subsequent modelling to ensure that such design will not cause additional flooding at the subject site, over that simulated within this assessment. Construction carried out on the ground floor, road level and basement car park should also use flood resilient materials.

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Appendix A

PRE-DEVELOPMENT SCENARIO RESULTS

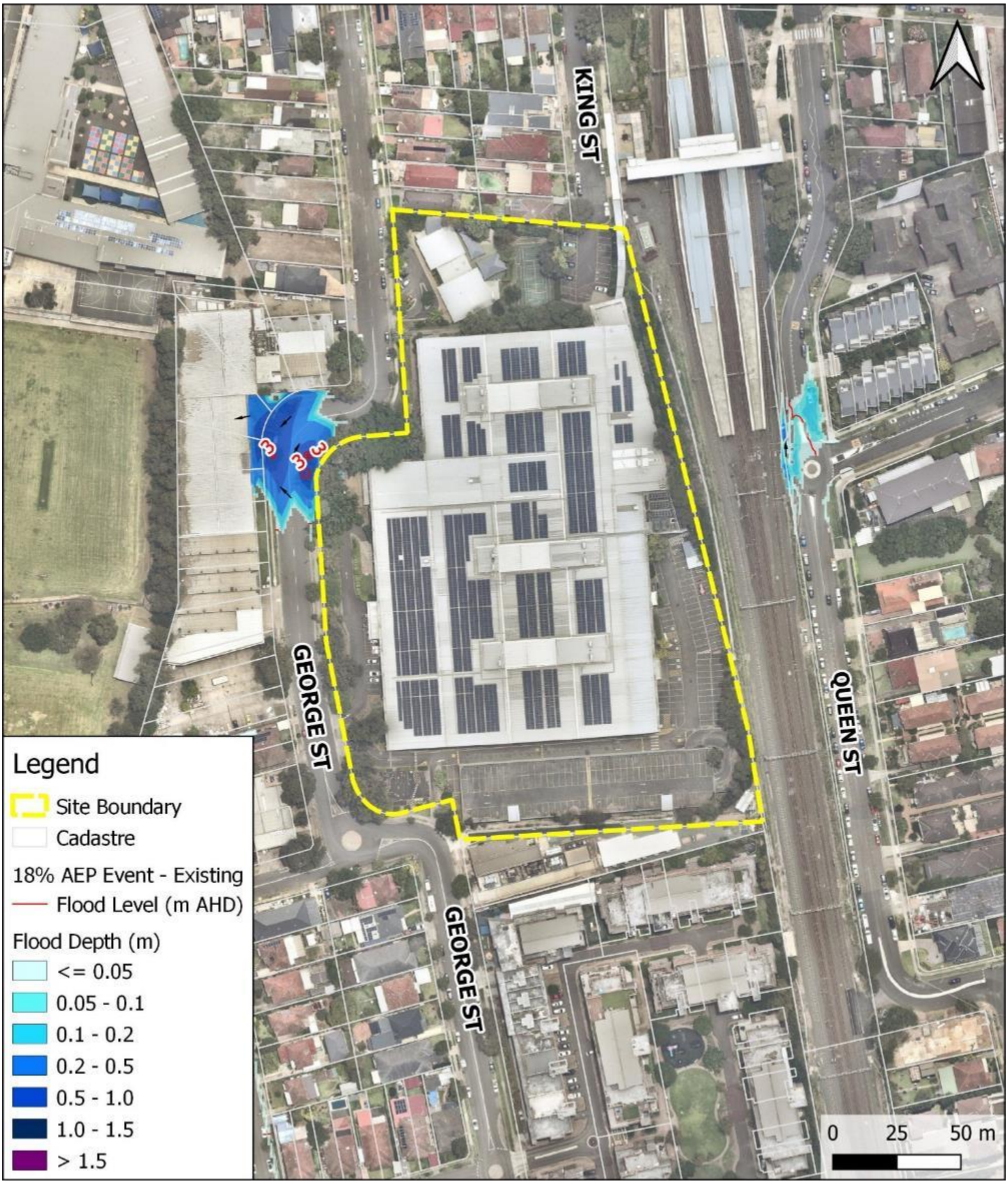

Figure A1: 18% AEP Flood Depths and Levels – Pre-Development Scenario

Figure A2: 18% AEP Flow Velocities – Pre-Development Scenario

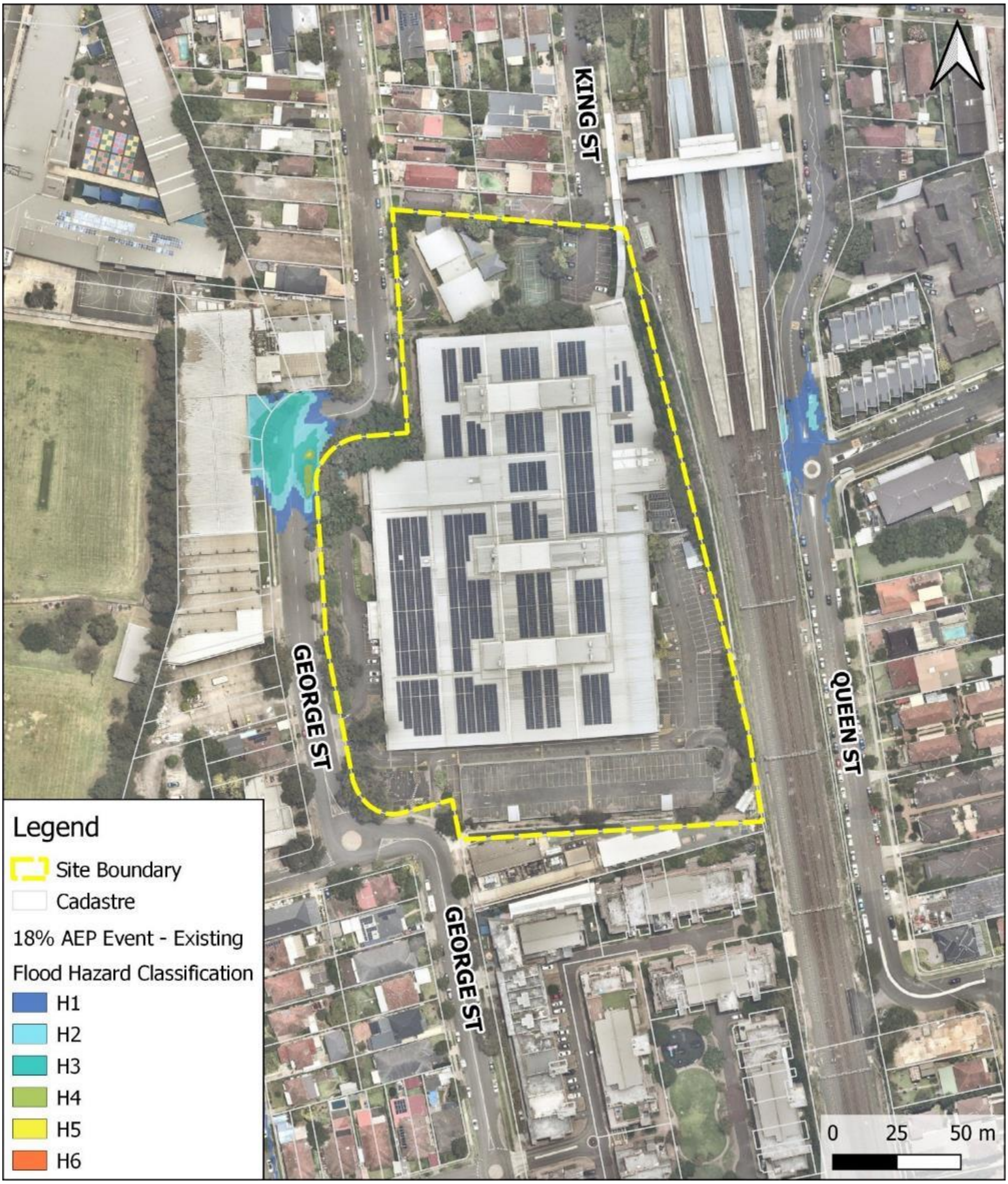

Figure A3: 18% AEP Flood Hazards – Pre-Development Scenario

Figure A4: 10% AEP Flood Depths and Levels – Pre-Development Scenario

Figure A5: 10% AEP Flow Velocities – Pre-Development Scenario

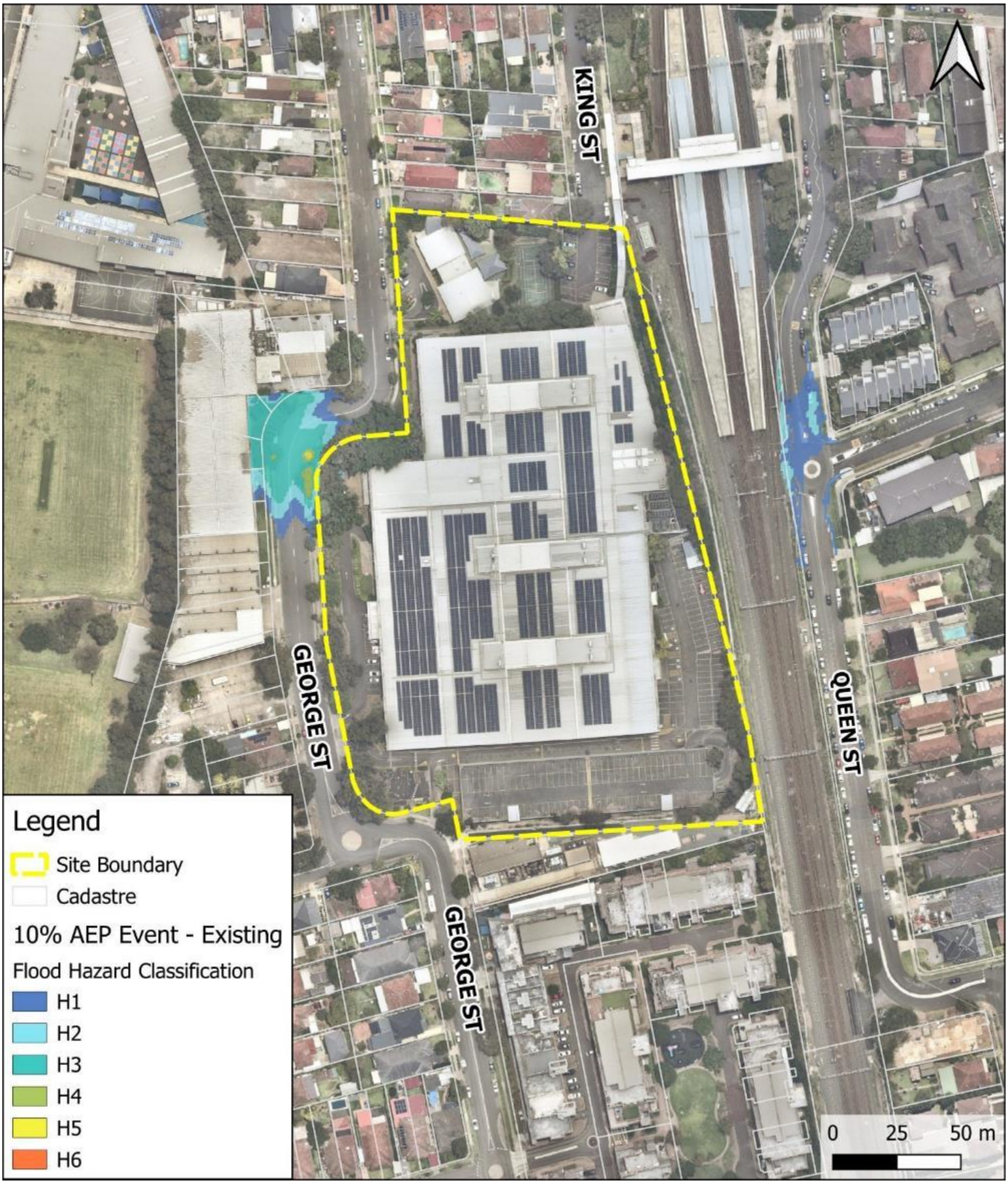

Figure A6: 10% AEP Flood Hazards – Pre-Development Scenario

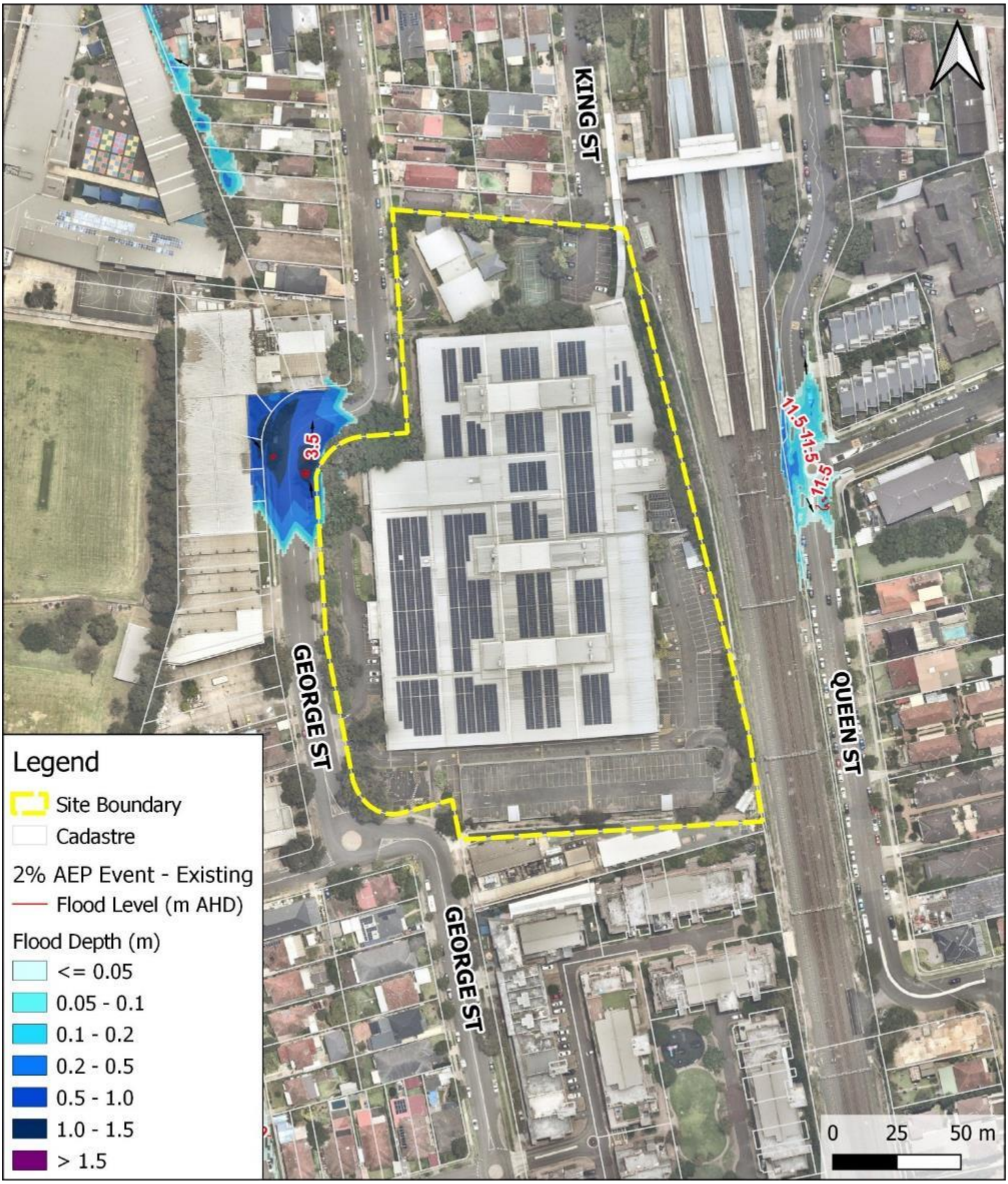

Figure A7: 2% AEP Flood Depths and Levels – Pre-Development Scenario

Figure A8: 2% AEP Flow Velocities – Pre-Development Scenario

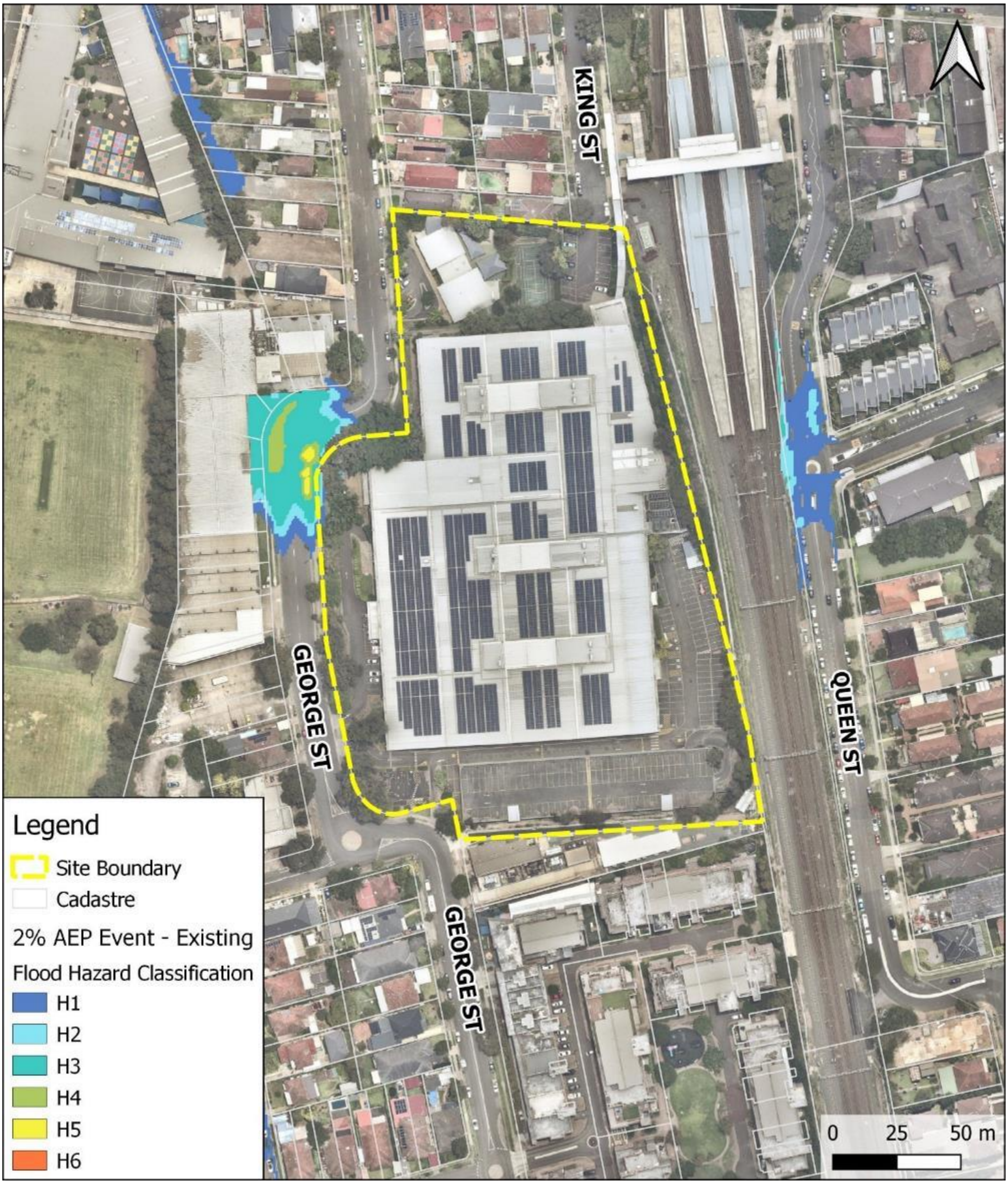

Figure A9: 2% AEP Flood Hazards – Pre-Development Scenario

Appendix B

POST-DEVELOPMENT SCENARIO RESULTS

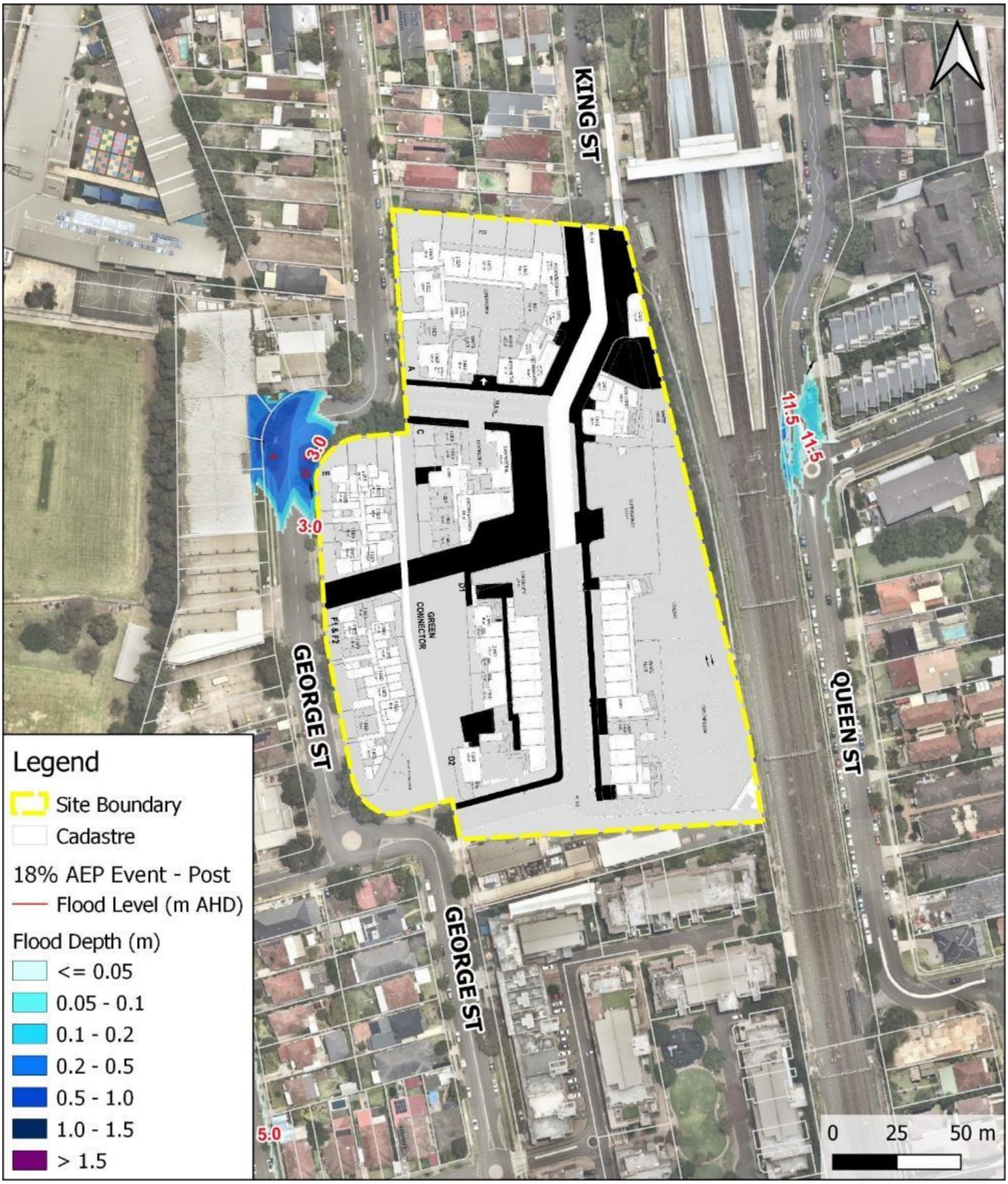

Figure B1: 18% AEP Flood Depths and Levels – Post-Development Scenario

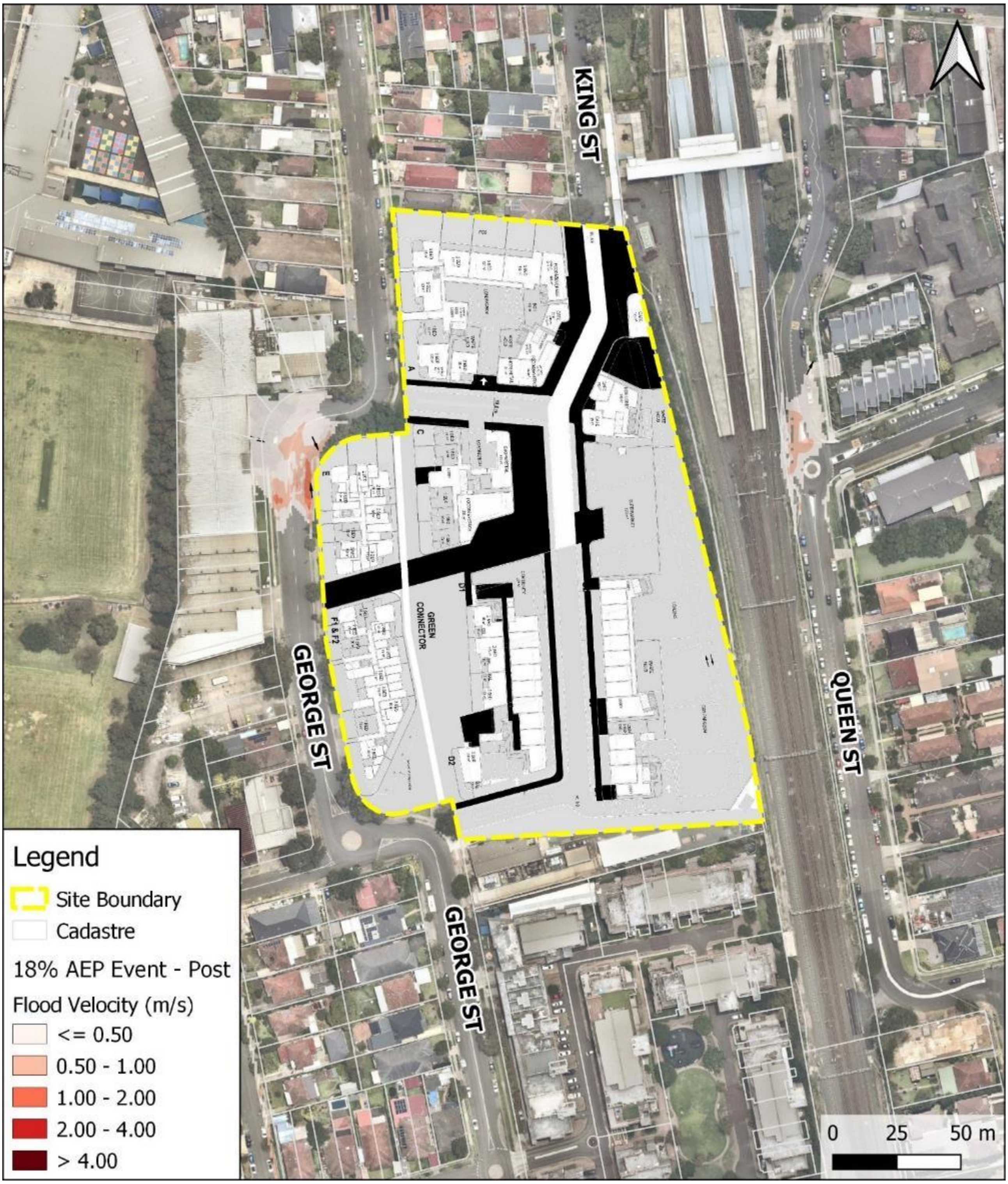

Figure B2: 18% AEP Flow Velocities – Post-Development Scenario

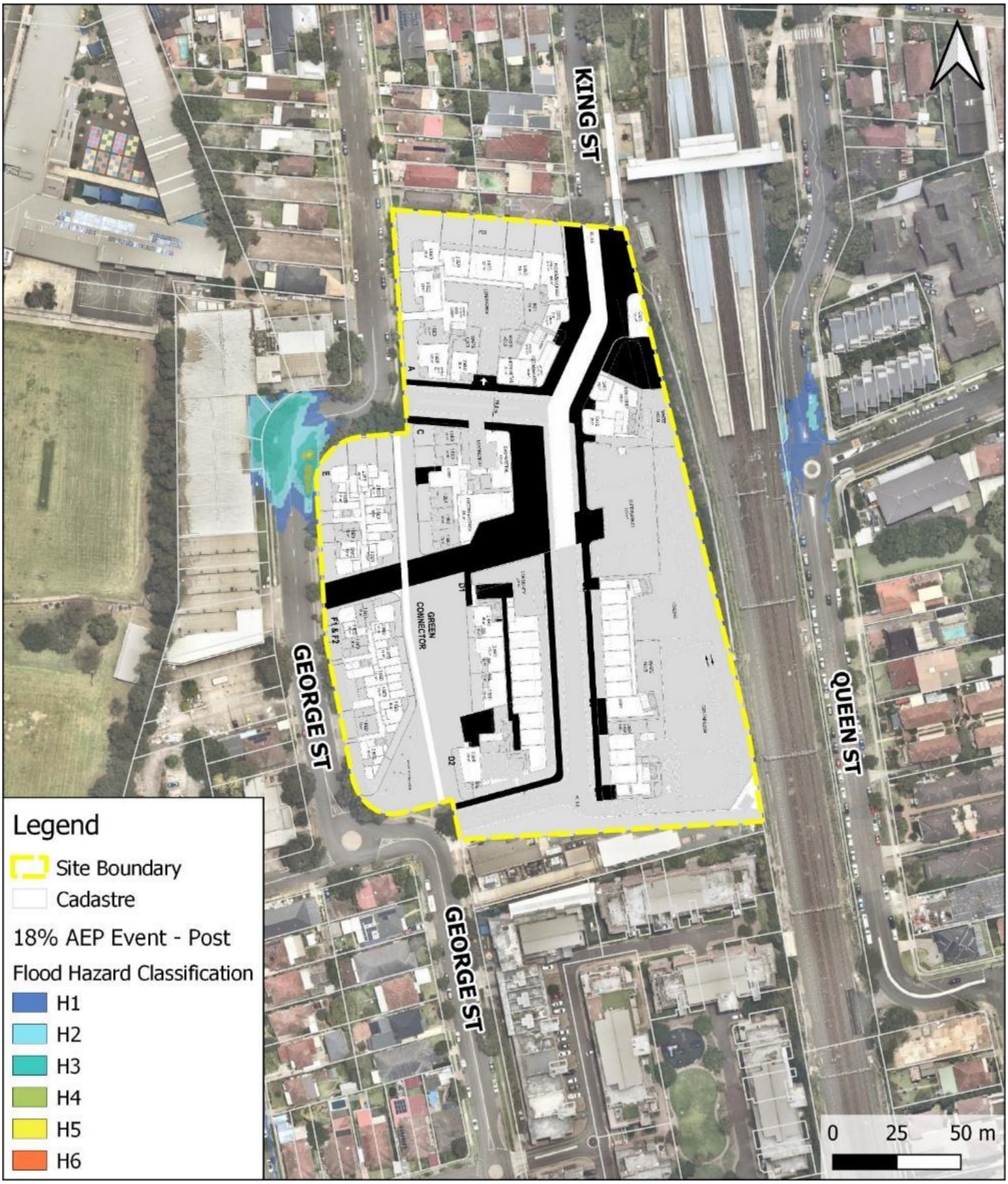

Figure B3: 18% AEP Flood Hazards – Post-Development Scenario

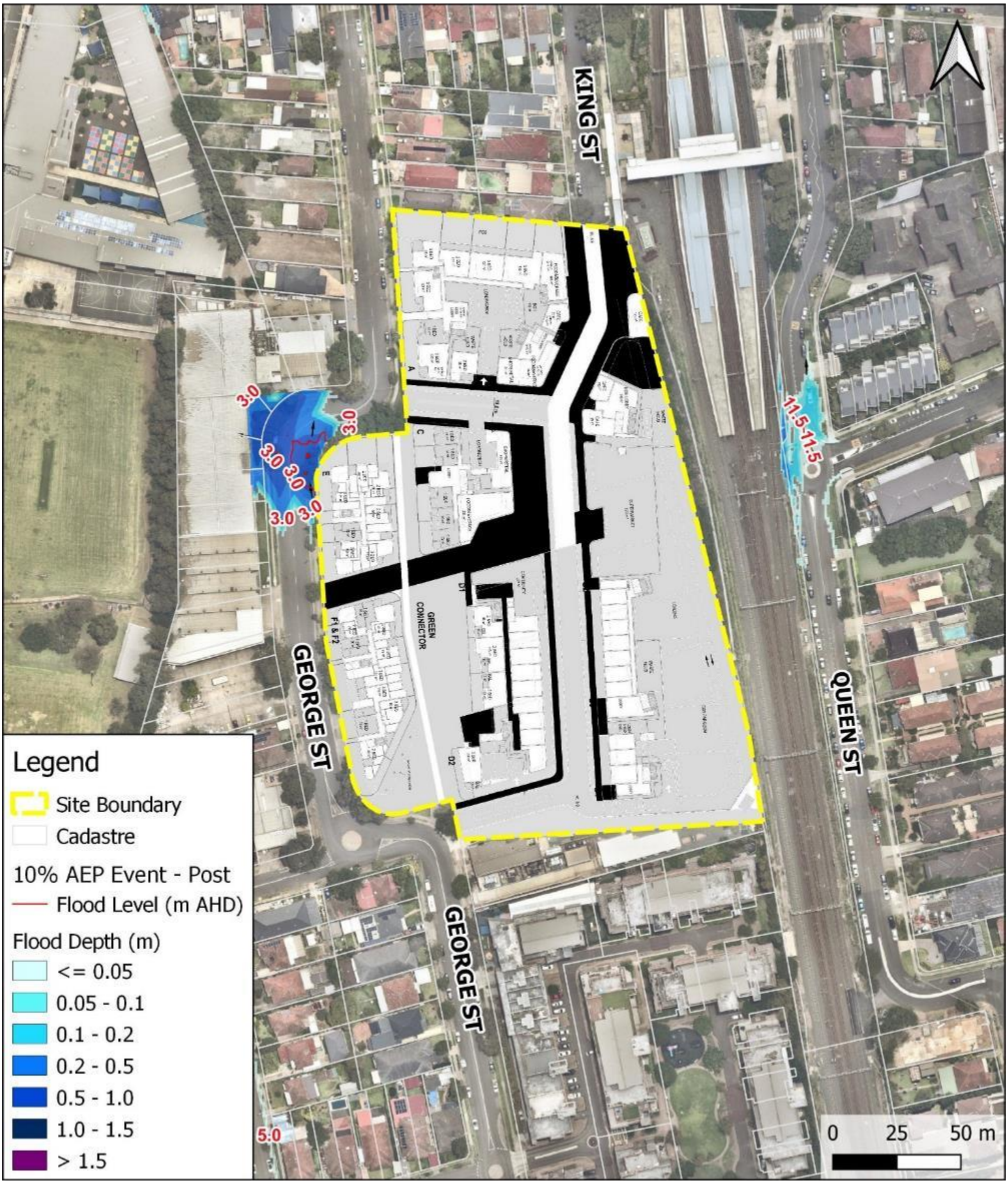

Figure B4: 10% AEP Flood Depths and Levels – Post-Development Scenario

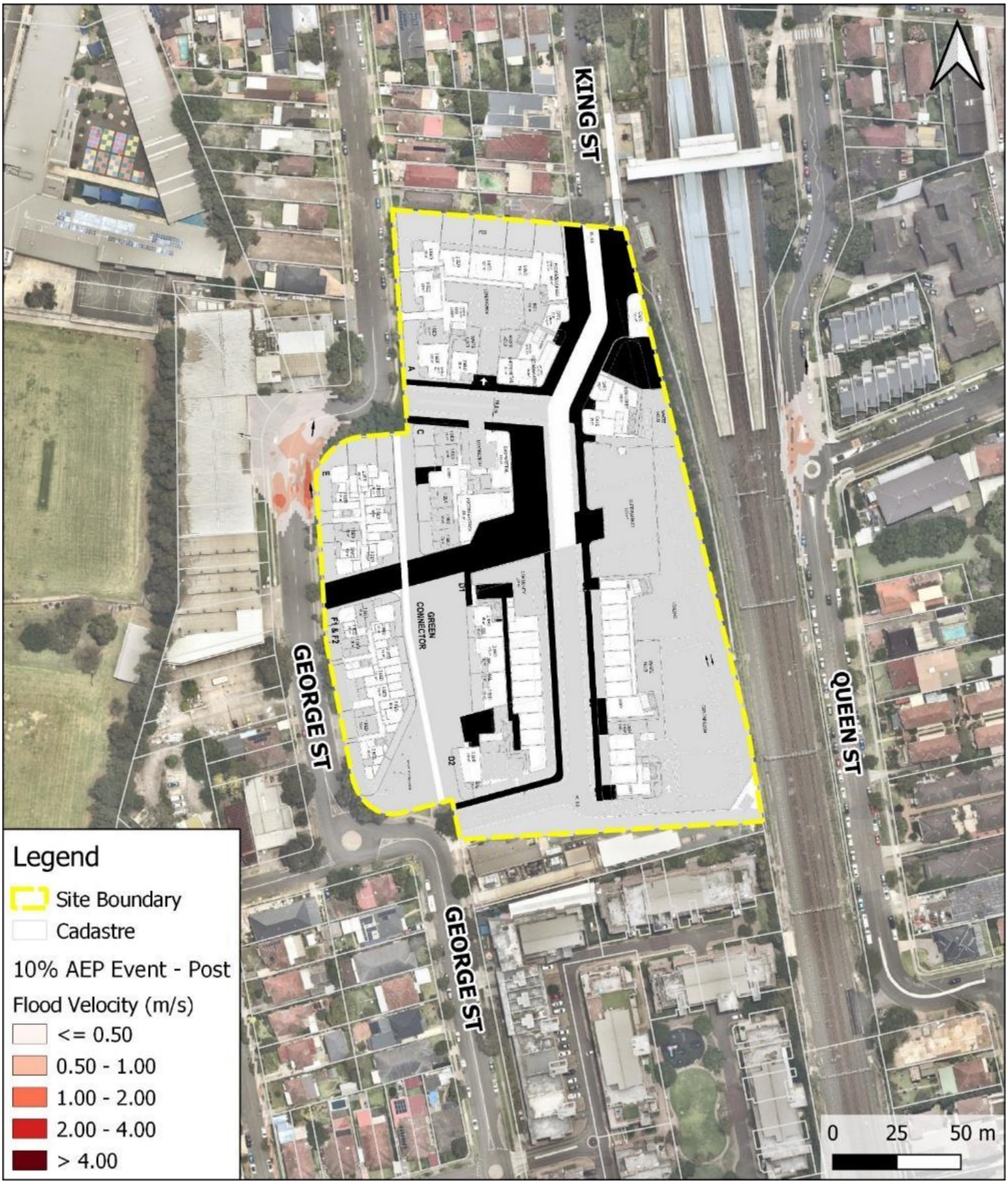

Figure B5: 10% AEP Flow Velocities – Post-Development Scenario

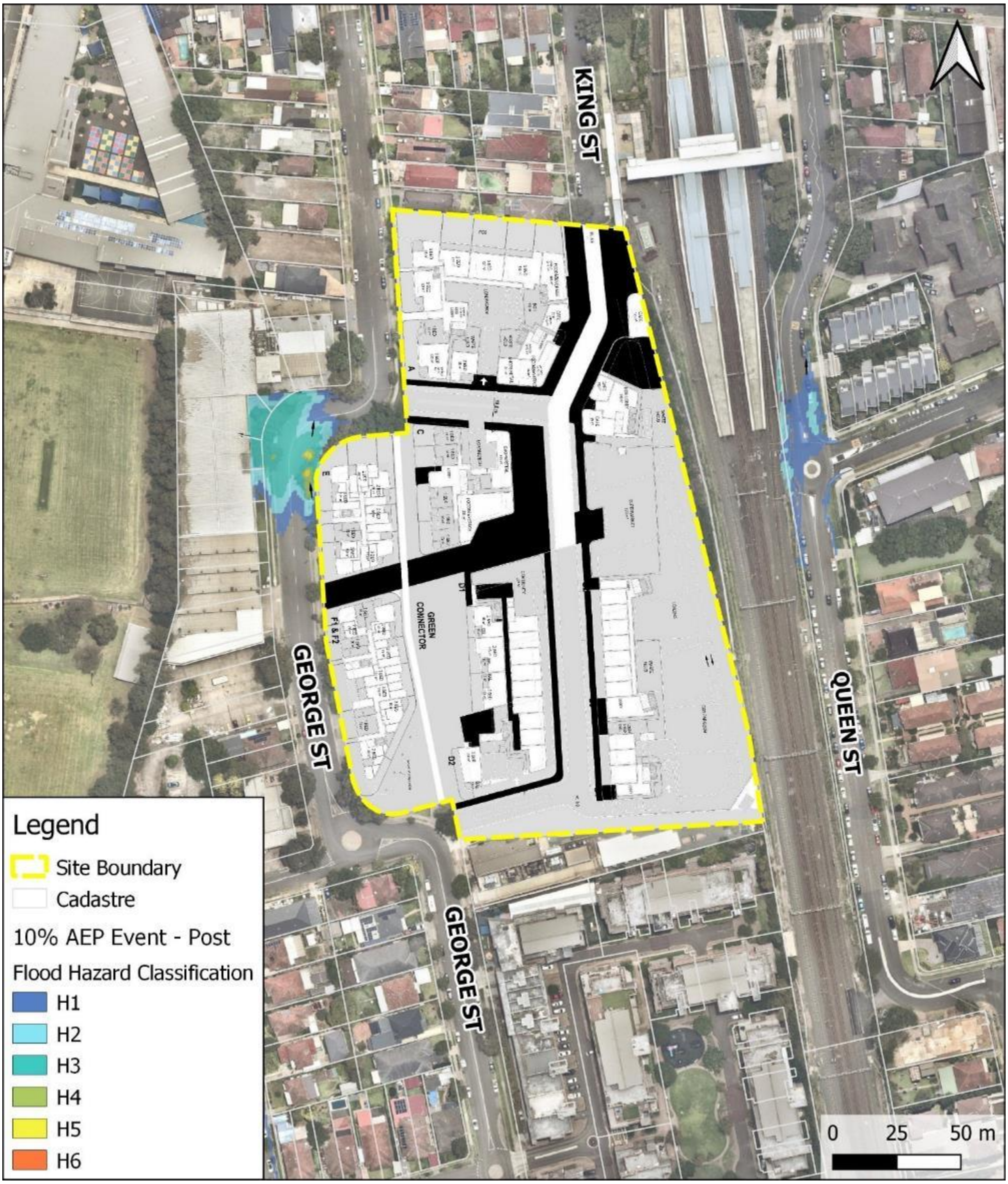

Figure B6: 10% AEP Flood Hazards – Post-Development Scenario

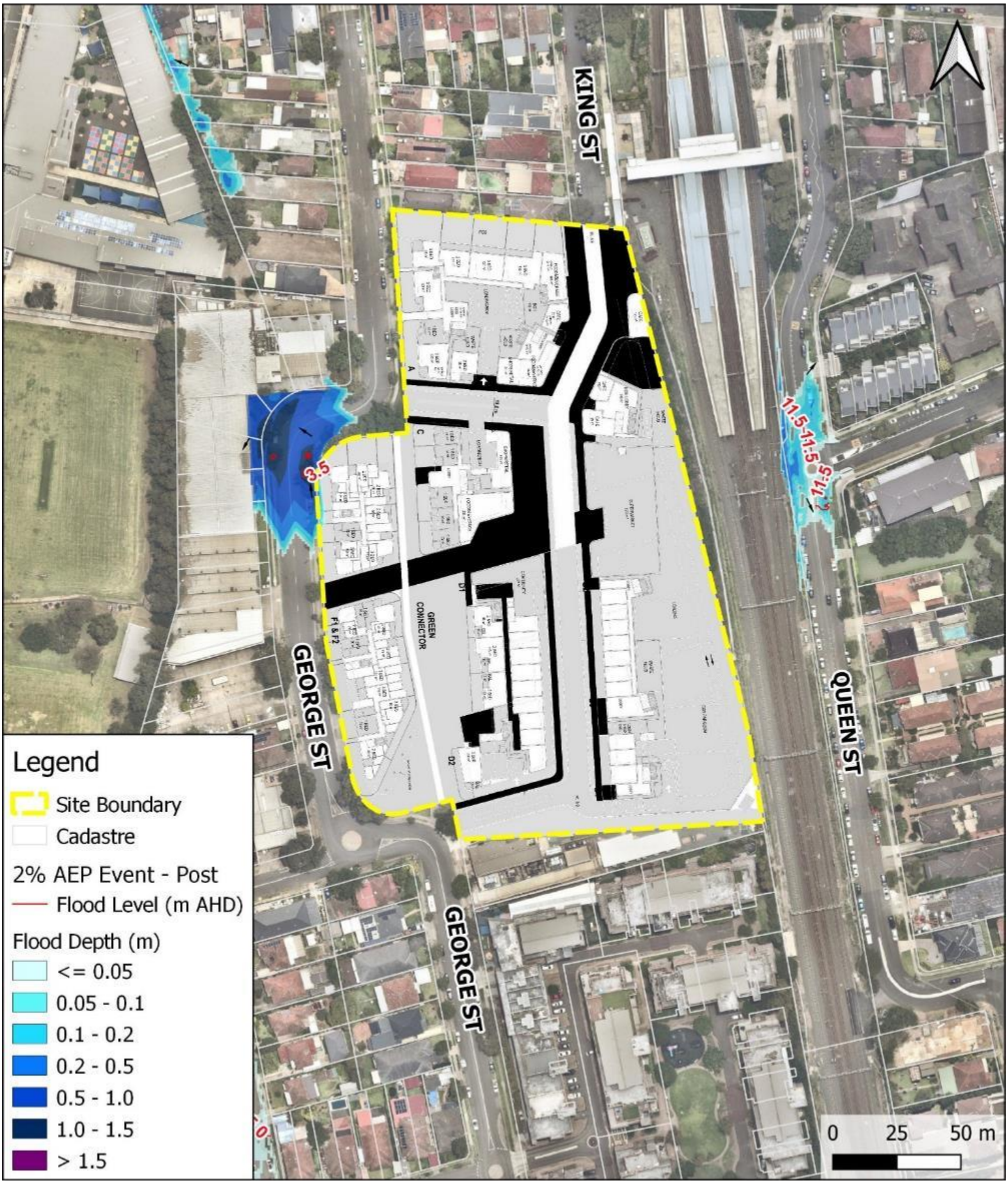

Figure B7: 2% AEP Flood Depths and Levels – Post-Development Scenario

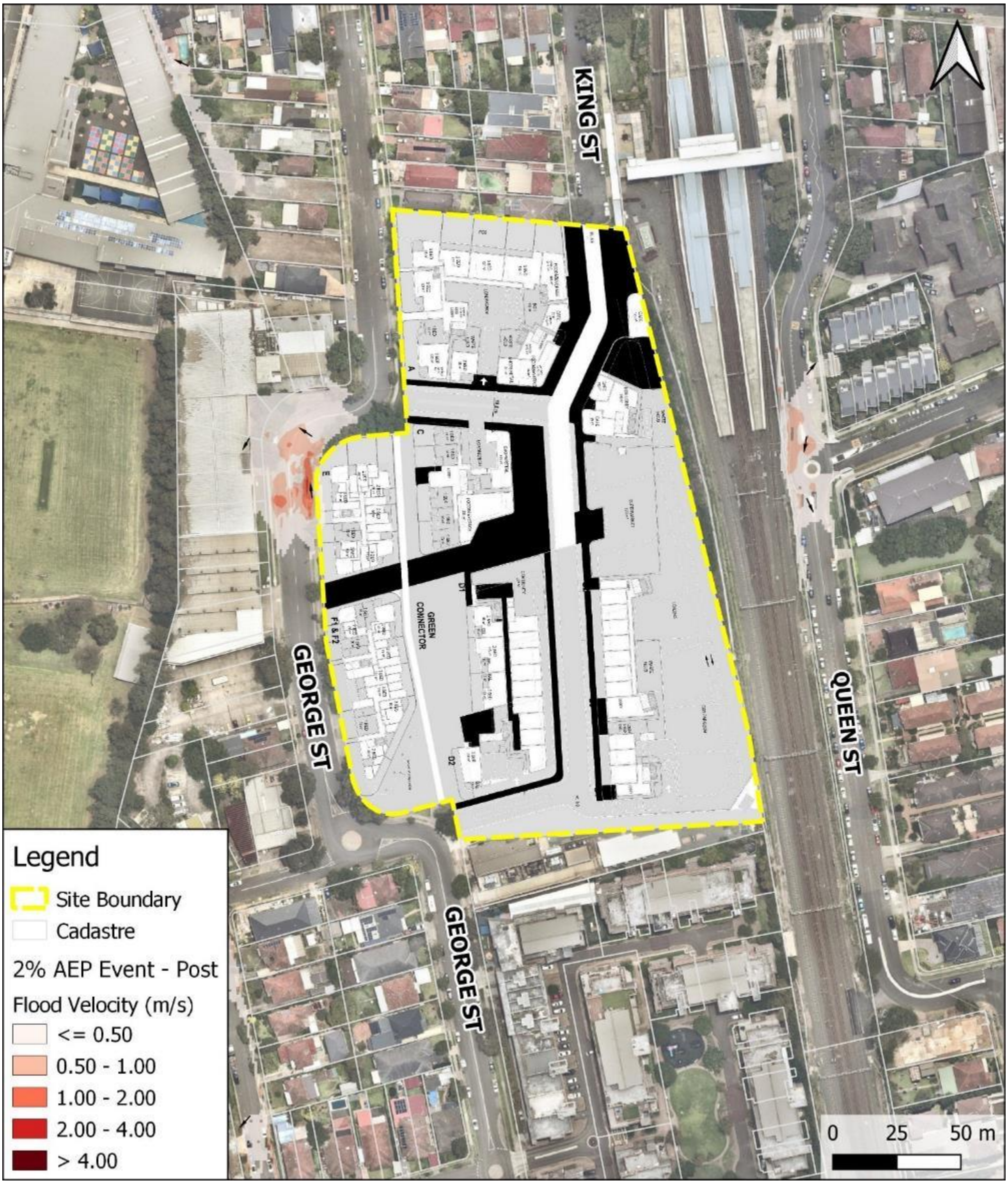

Figure B8: 2% AEP Flow Velocities – Post-Development Scenario

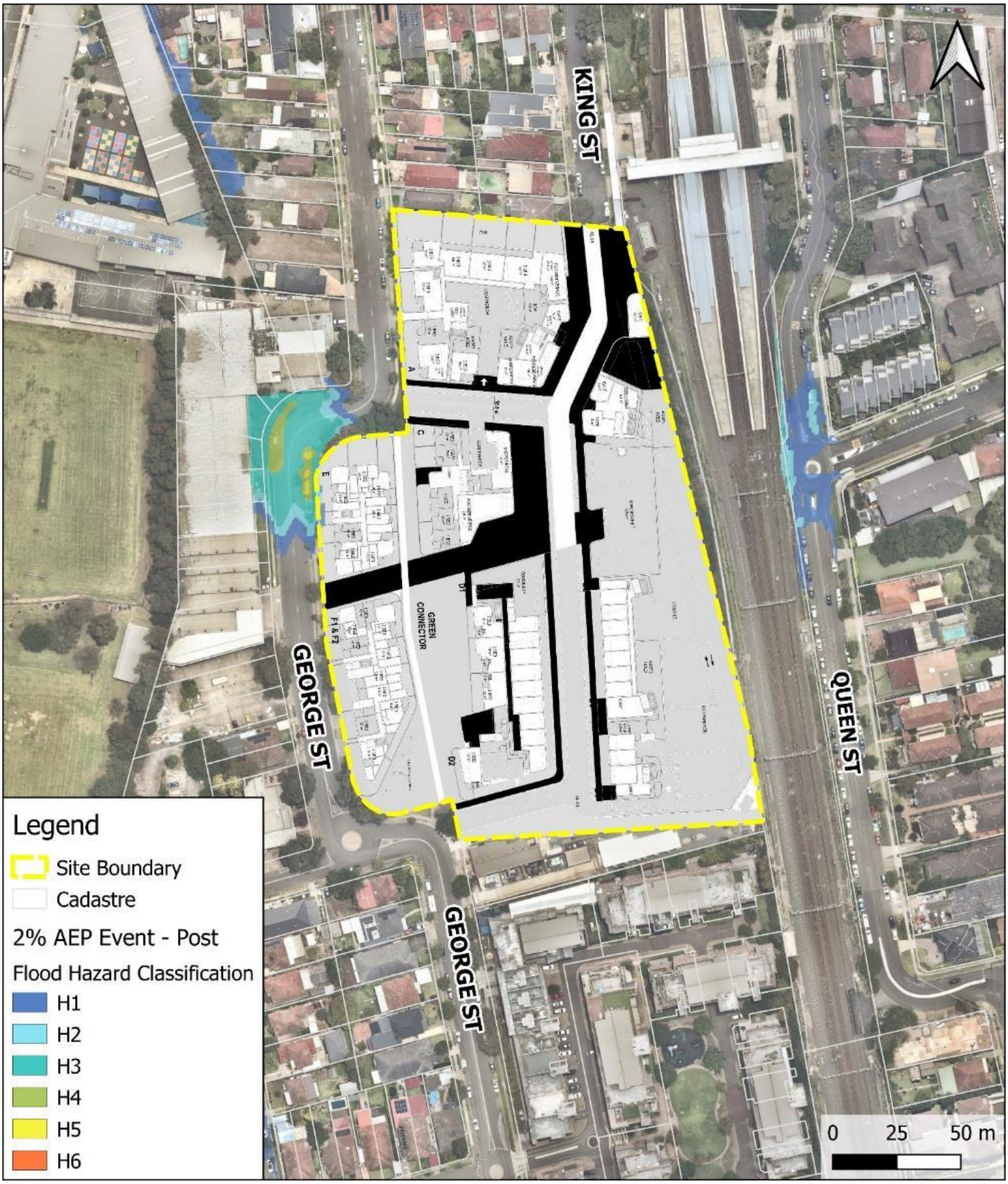

Figure B9: 2% AEP Flood Hazards – Post-Development Scenario

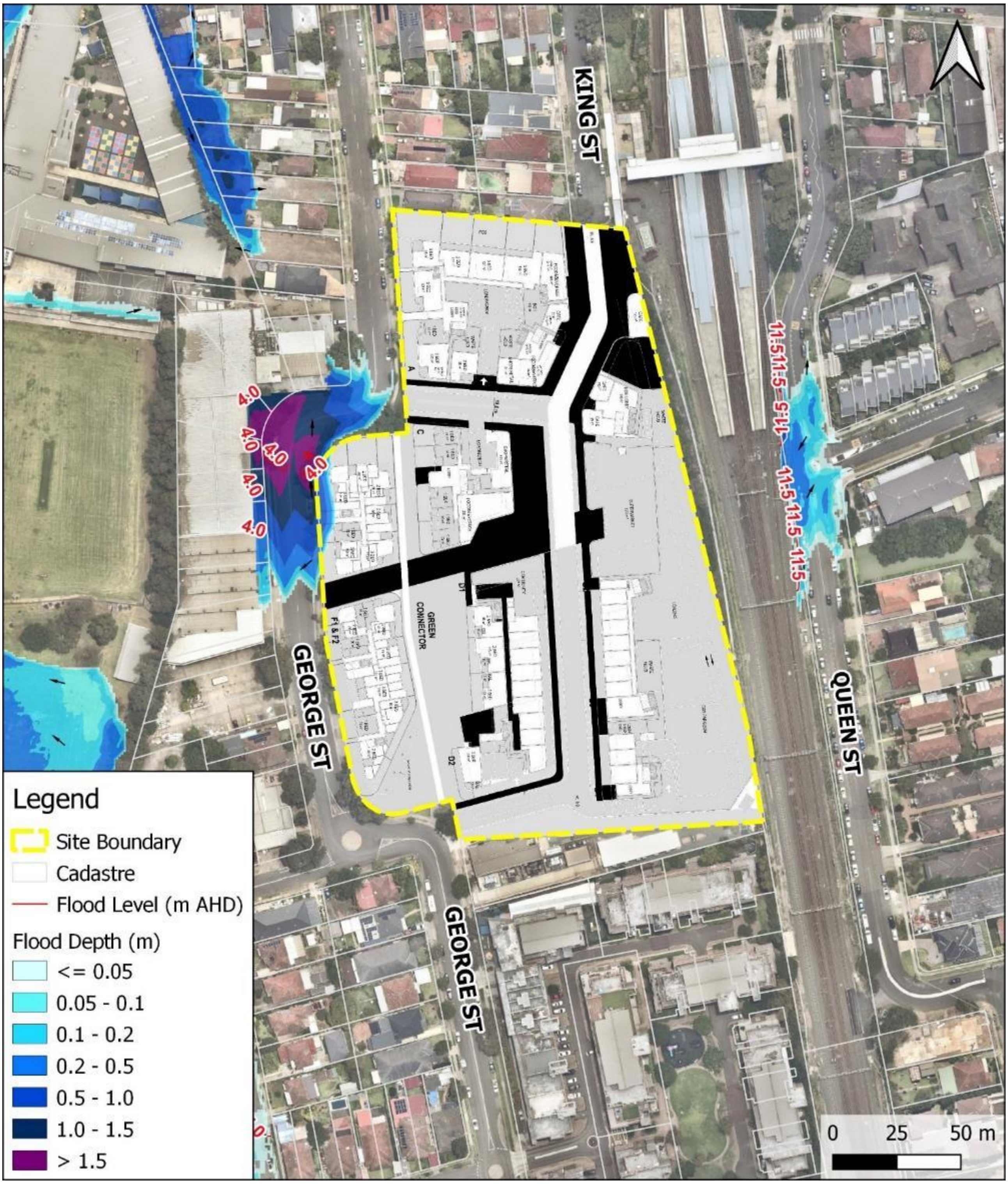

Figure B10: 1% AEP with Climate Change Flood Depths and Levels – Post-Development Scenario

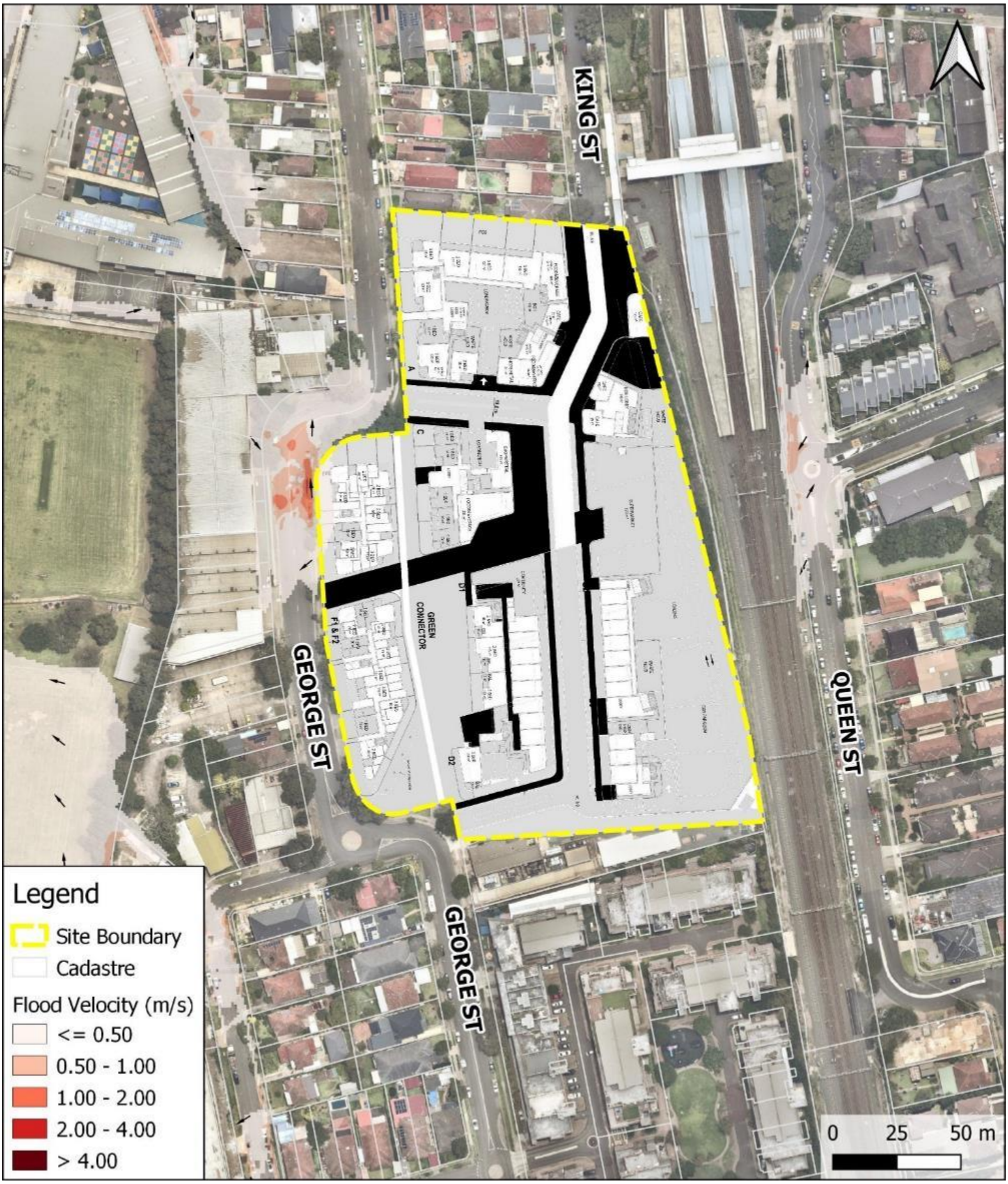

Figure B11: 1% AEP with Climate Change Flow Velocities – Post-Development Scenario

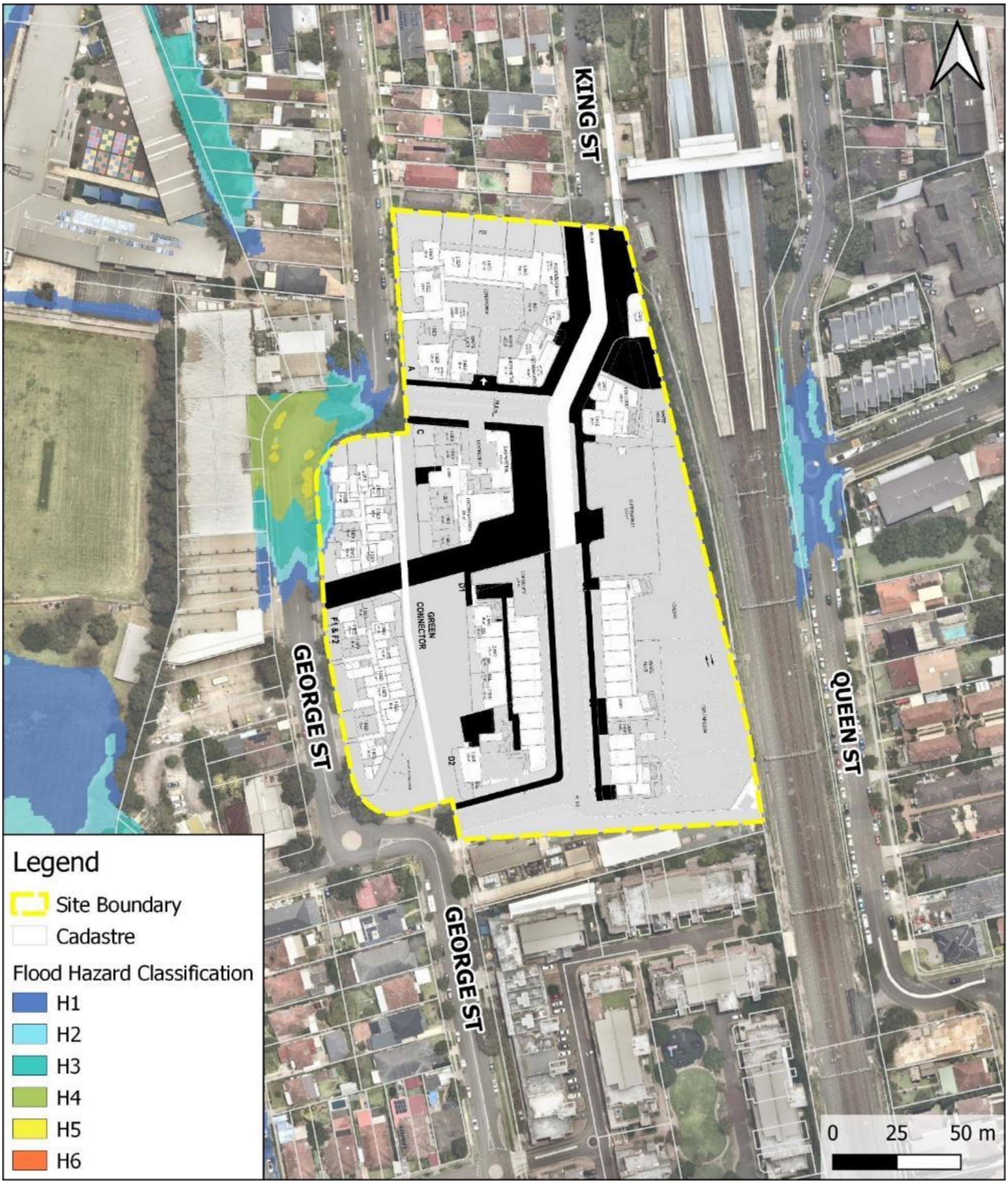

Figure B12: 1% AEP with Climate Change Flood Hazards – Post-Development Scenario