MOTT MACDONALD

4-6 Bligh Street, Flood Report

December 2022

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1 Introduction

1.1 Purpose of Report

This report has been prepared to accompany a detailed State Significant Development Application (SSDA) for the mixed-use redevelopment proposal located at 4-6 Bligh Street, Sydney (SSD- 48674209).

The Council of the City of Sydney, as delegate for the Minister for Planning and Public Spaces (the Minister), is the Consent Authority for the SSDA under an Instrument of Delegation issued by the Minister on 3 October 2019.

The application seeks consent for the construction of a 59-storey mixed-use hotel and commercial development. The purpose of the project is to revitalise the site and deliver new commercial floorspace and public realm improvements consistent with the City's vision to strengthen the role of Central Sydney as an international tourism and commercial destination.

A separate development consent (D/2018/892) relating to early works for the proposed application was granted for the site on 31 January 2020. Consent was granted for the demolition of the existing site structures, excavation and shoring of the site for three basement levels (to a depth of RL9.38m) to accommodate the proposed mixed-use hotel and commercial development. As such, this application does not seek consent for these components and instead seeks to rely upon and activate D/2018/892 for early works.

Specifically, development consent is sought for:

- Site establishment, including removal of three existing trees along the Bligh Street frontage and de-commissioning and removal of an existing substation (s2041) on the site.
- Construction of a 59-storey hotel and commercial office tower. The tower will have a maximum building height of RL225.88 (205m) and a total gross floor area (GFA) provision of 26,796sqm, and will include the following elements:
  - Five basement levels accommodating a substation, rainwater tank, hotel back of house, plant and services. A porte cochere and four service bays will be provided on basement level 1, in addition to 137 bicycle spaces and end of trip facilities on basement level 2, and 28 car parking spaces.
  - A 12-storey podium accommodating hotel concierge and arrival at ground level, conference facilities, eight levels of commercial floor space and co-working facilities, and hotel amenities including a pool and gymnasium at level 12.
  - 42 tower levels of hotel facilities including 417 hotel keys comprising standard rooms, suites and a penthouse.
  - Two tower levels accommodating restaurant, bar, back of house and a landscaped terrace at level 57.
  - Plant, servicing and BMU at level 59 and rooftop.
- Increase to the width of the existing Bligh Street vehicular crossover to 4.25m and provision of an additional 4m vehicular crossover on Bligh Street to provide one-way access to the porte cochere and service bays on basement level 1.
- Landscaping and public domain improvements including:
  - Replacement planting of three street trees in the Bligh Street frontage,
  - Construction of a landscape pergola structure on the vertical façade of the north-eastern and south-eastern podium elevations,

  - Awning and podium planters, and
  - Provision of a feature tree at the level 57 terrace.
- Identification of two top of awning building identification signage zones with a maximum dimension of 1200mm x 300mm. Consent for detailed signage installation will form part of a separate development application.
- Utilities and service provision.
- Installation of public art on the site, indicatively located at ground level.

This report has been prepared in response to the requirements contained within the Secretary's Environmental Assessment Requirements (SEARs) dated 1 October 2022 and issued for the SSDA (SSD48674209). Specifically, this report has been prepared to respond to the SEARs requirement issued below.

Table 1.1: SEARs

Secretary's Environmental Assessment Requirements – 15. Flooding Risk	**Refer Report Section**
Identify any flood risk on-site having regard to adopted flood studies, the potential effects of climate change, and any relevant provisions of the *NSW Floodplain Development Manual*.	Section 4.1 – adopted flood studies Sections 3.4 and 6.3 – relevant planning provisions Section 7.9 – climate change effects
Assess the impacts of the development, including any changes to flood risk on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required	Sections 7.6 and 7.10 – flood risk and mitigation Sections 7.4, 7.7, and 8 – flood impacts

2 The Physical Environment

2.1 The Site

The site for the purposes of this SSDA is a single allotment identified as 4-6 Bligh Street, Sydney and known as Lot 1 in Deposited Plan 1244245. The site has an area of 1,218sqm, and is identified in Figure 2.1.

The site is relatively flat, with a slight slope ranging from 21m AHD in the north-western corner to 19.5m AHD in the south-western corner.

The site is located within the north-eastern part of Central Sydney in a block bound by Bligh Street to the west, Hunter Street to the south, Chifley Square/Phillip Street to the east, and Bent Street to the north. The surrounding buildings are generally characterised by a mix of commercial office and hotel uses with ground level retail, restaurant and café uses and are of varying heights, ages and styles, including a number of State and local listed heritage buildings.

The site is also located in proximity to a number of Sydney Metro City & Southwest (opening 2024) and Sydney Metro West (opening 2030) station sites.

Specifically, the site is located to the immediate east of the Sydney Metro Hunter Street station (east site), which is located on the corner of Hunter Street and Bligh Street, and approximately 350m east of the Sydney Metro Hunter Street station (west site). The Hunter Street station sites are part of the Sydney Metro West project. SEARs for the preparation of Concept SSDAs for the sites were issued in August 2022.

Approximately 150m to the south of the site is Sydney Metro Martin Place Station site, located to the south of Hunter Street between Castlereagh Street and Elizabeth Street. The Martin Place Station site is currently under construction and forms part of the Sydney Metro City & Southwest project.

The site is occupied by a vacant commercial office building with ground floor retail and basement car parking known as “Bligh House”. Completed in 1964, Bligh House is a 17-storey tower inclusive of a three-storey podium with the podium levels built to the Bligh Street alignment and the tower setback from the street frontage. The building was designed by Peddle Thorp and Walker and was constructed as part of the post-World War II development boom in the Sydney CBD. The podium overhang along the footpath provides continuous pedestrian protection. Vehicle access to the site is off Bligh Street via a single 2.6m wide driveway that is restricted by a security gate under one-lane, two-way access arrangements. The driveway provides access to the basement car park, containing 21 car parking spaces.

The site contains no vegetation; however, two existing street trees are located adjacent to the site boundary on Bligh Street.

Development consent for the demolition of the existing site structures, excavation and shoring of the site for three basement levels (to a depth of RL9.38m) was granted by City of Sydney on 31 January 2022 (D/2018/892).

Figure 2.1: Site Boundary Location

Source: Urbis

2.2 Existing Conditions

In its existing state, the site is comprised entirely of impervious surfaces with one driveway flushed to the footpath and a layback graded towards the street as shown in Figure 2.2 . There is a crest on Bligh Street approximately 10m south of the intersection of Bligh and Bent Street, indicating that a small portion of the Bligh Street catchment runoff will discharge to Bent Street and the remaining area to Hunter Street.

The existing stormwater network on Bligh Street is comprised of circular and oviform pipes that drain away from the site to the intersecting streets in the north and south.

Figure 2.2: Bligh Street Driveway

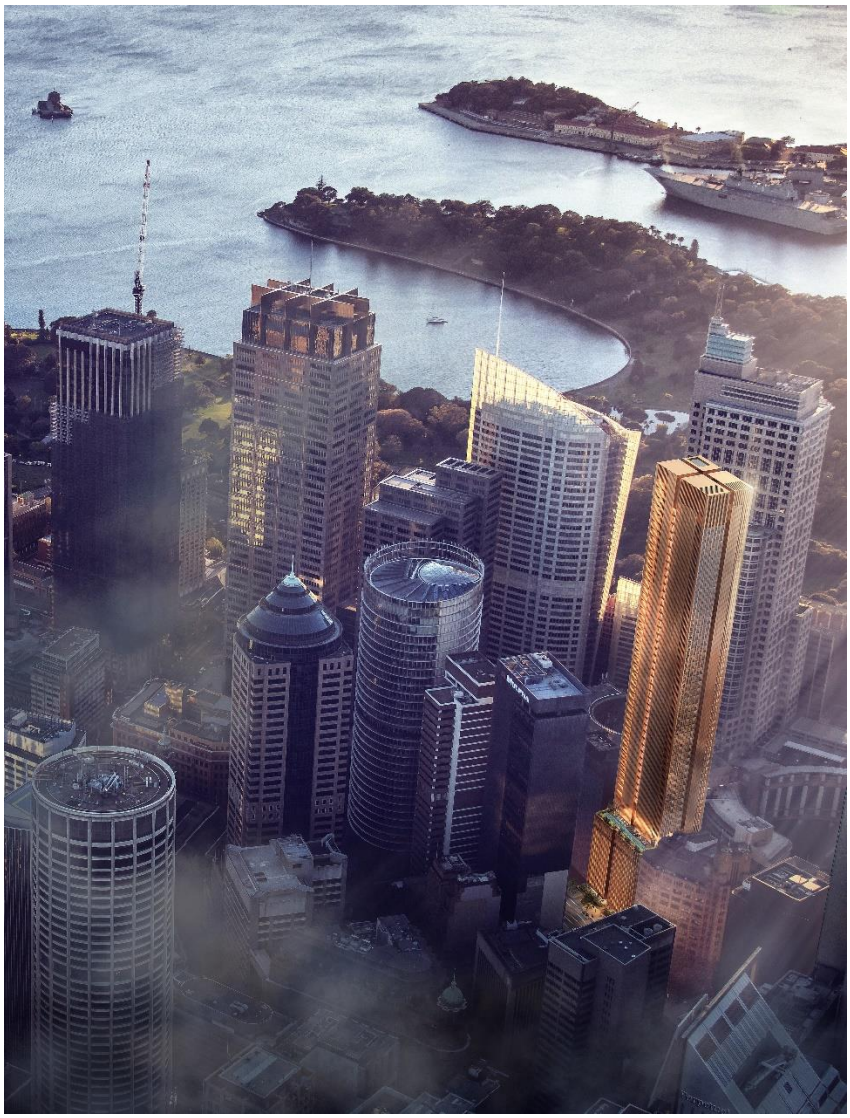
Source: Streetview Imagery ©Google(2018)

2.3 Proposed Layout

The existing building is to be replaced with a 59-storey mixed-use high-rise building that will be Sydney's first luxury hotel in 20 years. The development will incorporate the following (see Figure 2.3):

- Hotel
- Basement Loading Dock and Porte Cochere drop off
- Commercial podium
- F&B Lounges
- Gym and Pool
- Roof Terrace, Restaurant and Bar

Figure 2.3: Reference Design



Source: Woods Bagot

3 Design Controls

3.1 Australian Rainfall and Runoff – (2016)

Prepared by the Institution of Engineers, Australian Rainfall, and Runoff – *A Guide to Flood Estimation* was written to provide "Australian designers with the best available information on design flood estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events as well as design methods for urban stormwater drainage systems. The document has been updated from the previously used 2001 version with a more refined methodology for hydrological analysis based on the latest hydrological data gathered.

According to the document, good water management master planning should consider:

- Hydrological and hydraulic processes;
- Land capabilities;
- Present and future land uses;
- Public attitudes and concerns;
- Environmental matters;
- Costs and finances; and
- Legal obligations and other aspects.

3.2 Floodplain Risk Management Guideline: Practical Consideration of Climate Change – Department of Environment and Climate Change (2007)

This guideline is designed to be used in addition to the Floodplain Development Manual (2005) and provides recommendations and methodologies for examining flood risk to developments considering the projected impacts of climate change on sea levels and design rainfall events. The report recommends that sensitivity analysis is undertaken to using 10, 20 and 30% increases to rainfall intensities, with an appropriate level adopted based on the outcomes of this analysis. Previous studies on surrounding precincts in the NWGC have adopted a percentage increase of 15%.

3.3 City of Sydney Council Documents

3.3.1 Sydney Development Control Plan (2012)

An integral part of the master planning process for developments, the *Sydney Development Control Plan 2012* provides the necessary controls for the redevelopment of the site. Whilst the Sydney DCP 2012 does not apply to the assessment of this SSDA, the relevant provisions have been considered in relation to the flooding and storm water elements of the site. Water management requirements include:

- Compliance with Council's A4- Drainage Design;
- Compliance with Council's *Interim Floodplain Management System*; and
- Adoption of the principles of WSUD (including a water cycle management plan).

3.3.2 City of Sydney Councils A4-Drainage Design Manual (2016)

Council's *Drainage Design* manual sets out their requirements for the design of stormwater drainage for urban and rural areas. The manual outlines the broad objectives of the policy of:

- Retention of the existing stormwater system where possible;
- A high level of safety for all users;

- Acceptable levels of amenity and protection from the impact of flooding;
- Consideration is given to the effect of floods greater than the design flood;
- A controlled rate of discharge to reduce downstream flooding impacts;
- Protection of the environment from adverse impacts as a result of the development;
- Maintenance of and enhancement of the regional water quality;
- Sustainability of infrastructure; and
- Economy of construction and maintenance.

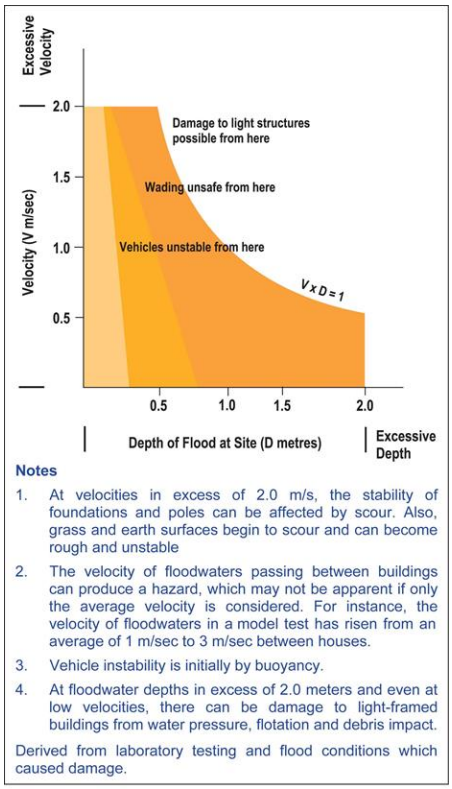
The policy also provides detailed requirements for the hydrologic and hydraulic design and analyses of the developed water management system including standard calculation factors and drawings.

3.4 NSW Floodplain Development Manual (April 2005)

The NSW Government's *Floodplain Development Manual – the Management of Flood Liable Land (2005)* is concerned with the management of the consequences of flooding as they relate to the human occupation of urban and rural developments. The manual outlines the floodplain risk management process and assigns roles and responsibilities for the various stakeholders.

The manual applies to the development, in particular Appendix L – *Hydraulic and Hazard Categorisation* for ensuring safe overland flow paths are provided (see Figure L1 below).

Figure 3.1: Velocity Depth Relationships, FDM



Source: NSW *Floodplain Development Manual*, 2004 (Dept. of Infrastructure, Planning & Natural Resources)

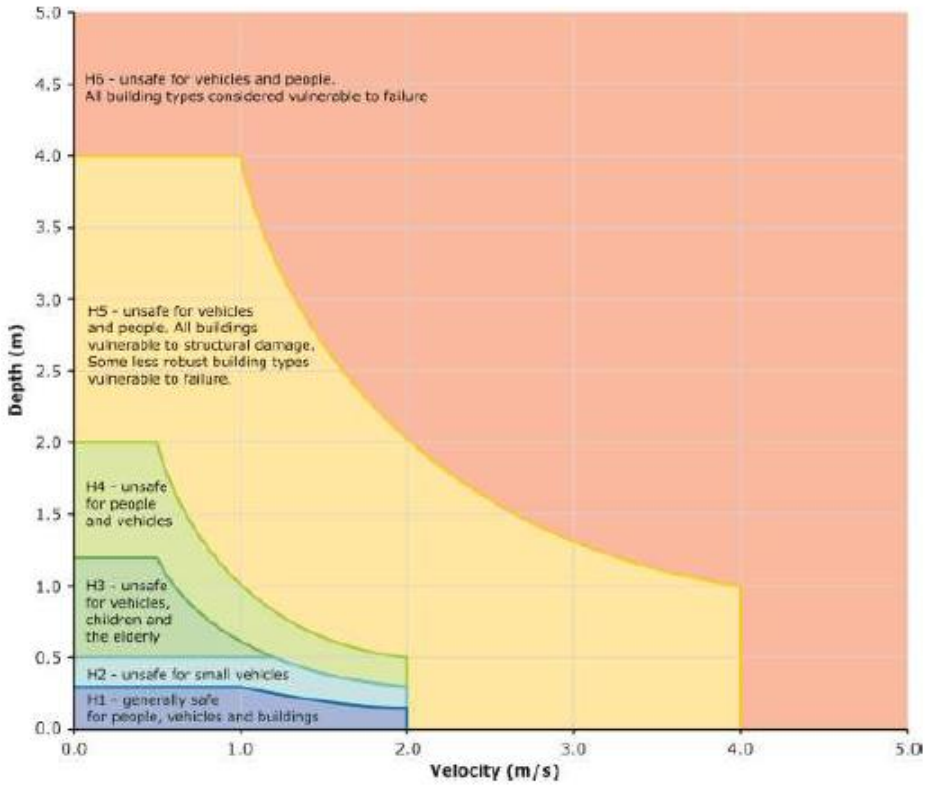
An updated hazard category has been developed by Australian Emergency Management Institute in 2014, defining hazard into the following 6 categories:

Table 3.1: Hazard Classifications

Hazard Class	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles
H3	Unsafe for all vehicles, children and the elderly
H4	Unsafe for people and all vehicles
H5	Unsafe for all people and all vehicles. Buildings require special engineering design and construction
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

Source: Australian Emergency Management Institute (2014)

Figure 3.2: ZAEM1 – Hazard Categories



Source: Australian Institute for Disaster Resilience

4 Review of Previous Studies

4.1 City Area Catchment Floodplain Risk Management Study (2016)

For the purpose of this flood assessment, reports and models from the *City Area Catchment Floodplain Risk Management Study* were sourced from the City of Sydney.

In 2016 WMAwater prepared a Floodplain Risk Management Study for the City of Sydney which included a flood risk management study and plan. The study aims to provide the basis for future management of those parts of the catchments which are flood liable. The Floodplain Risk Management Study (FRMS) assess floodplain management issues in the city area and provides potential mitigation measures in flood prone parts of the catchment.

The City Area catchment covers approximately 199 hectares and drains into the Sydney Harbour at various inlet locations, majority of the catchment discharges to Sydney Cove via Sydney Water Corporation's (SWC) trunk drainage system.

The study provides a full assessment of the existing flood risk within the catchments and subsequent impacts on commercial and industrial properties as well as emergency response options during the flood event. Flood risk management options were assessed based on their efficiency across a range of criteria to form the basis of the Floodplain Risk Management Plan for the City Area. Some of the viable options included pit and pipe networks, emergency management options and property modifications e.g. raising house floor levels or sealing property entrances.

Within the City Area catchment, a number of locations are flood prone in rainfall events exceeding 0.5 EY (Exceedances per Year). A potential cause of this is the development throughout the catchment occurred prior to the installation of the drainage network in the 19th century resulting in buildings being constructed within significant overland flow paths or gullies. Any sags/depressions present within the topography have no overland escape routes to use when the drainage network is running full and or blocked. In some instances, this creates a drainage/flooding problem in areas throughout the catchments causing pedestrian safety risk.

Although there are approximately 118 properties and several streets within the catchment that will be subject to inundation in the 1% AEP (Annual Exceedance Probability), neither the site or Bligh Street have not been identified to be at risk of flooding.

Fourteen options were considered in detail for the larger scale mitigation measures in attempt to reduce the catchment wide flooding. Options such as trunk drainage upgrade, adding additional stormwater pits and surface grading works have been suggested as potential flooding mitigation measures. The results from each option were assessed with model impacts and evaluation to determine which option would have the greatest impact on flood mitigation.

Results from the previous study have been used as the basis of flood analysis for the new development with slight alterations to the lidar following detailed survey of 4-6 Bligh Street.

Although there is no clear mention of which ARR version was used as the primary guidance for the hydrology, it can be inferred that ARR16 is being used based on the City Area FRMS using 'AEP/EY' to define events instead of the superseded 'ARI'. This will be the guidance used moving forward as it is a Council approved model/flood study.

5 Water Quantity Modelling

A combined 1D/2D hydrodynamic modelling software package, TUFLOW was selected to model both the hydrologic and hydraulic components of the catchment in the previous FRMS. A 1D/2D model using the “direct rainfall” approach has been used for the model build. The City Area catchment was modelled in the 2d domain with 27km of subsurface pipe network modelled as 1D elements linked to the 2D domain.

Historical flood events were used for model calibration and verification to ensure accurate flood behaviours. The study undertook sensitivity testing and considered impacts of climate change on design events.

5.1 On-Site Detention

To manage the flood risk impact on downstream properties, detention basins are constructed for water quantity management. Mott Macdonald have been previously requested to determine whether an On-site detention (OSD) system was required for the site.

MM have already approached Sydney Water about their OSD requirements for the proposed development and Sydney Water have stated that “On Site Detention is not required for any development at 4-6 Bligh Street, Sydney” see Appendix E.

In terms of the City of Sydney OSD requirements, CoS Drainage Design 2016 Section 4.14.2.2 discharge limits states that “the maximum permitted discharge (PSD) from any property is 25L/s for storms up to and including the 20 year ARI” and “where property discharge exceeds the maximum permitted kerb outlet discharge, the property shall be directly connected to the stormwater network”.

MM have run a hydraulic model to see what the maximum flow discharge from the proposed development will be and have found this to be 64 L/s for a 20yr ARI. As this is greater than City of Sydney’s maximum permitted discharge of 25L/s, the requirement is to connect the property discharge directly into the stormwater network.

The following are viable design options to satisfy CoS discharge requirements.

Option 1:

SWC hydra plan (Figure 5.1) shows an existing DN300 stormwater drainage pipe running along Bligh Street which connects to the main drainage channel running diagonal to the street. As the existing pipe runs adjacent to the front of the property, there is scope for an outlet pipe to connect directly into the network.

Figure 5.1: Hydra Plan

Source: Sydney Water Hydra Plan

Option 2:

An OSD system can be used on site to reduce the site discharge to 25l/s so that flows can be directly discharged to the kerb.

As Sydney Water have confirmed that an OSD is not required for the site, Mott Macdonald recommends Option 1 as the preferred design solution.

To move forward with Option 1 permission should be granted from Sydney Water to connect into the DN200 stormwater pipe fronting the development. An ‘Adjustment and Deviation’ application will need to be submitted to Sydney Water to allow for connection into their system.

6 Flood Evaluation

6.1 Existing Flood Behaviour

The general topography within the City Area catchment varies from steep surface slopes in excess of 15% on the western side to less than 1% in catchment near Circular Quay and other Sydney Harbour locations. The catchment therefore has regions where surface water runoff has high velocities and shallow depths.

As the subject site is well elevated from its surrounding streets it does not appear to be flood prone, this is confirmed by the *City Area Study* flood maps which indicate no flooding within the subject site. Flood depths <100mm are experienced within Bligh Street and are generally contained within the road corridor and do not appear to encroach into the building.

The existing stormwater network is exceeded in most storm events. Half of the area's drainage run full in a 0.5EY event and around 80% of the pipes are running full in a 10% AEP event.

6.2 TUFLOW Software Package

TUFLOW is a one and two-dimensional (1D/2D) hydraulic modelling program that simulates the flow of water across a landscape and through any conveyance structures such as pipes or culverts.

The 2D component of the *TUFLOW* software package determines overland flow paths by dividing the landscape into a grid of individual cells. The flow of water between cells is then computed repeatedly at regular time steps by solving two-dimensional shallow water equations to estimate the spread and flow of the water. Flows are routed in the direction water that will naturally follow the modelled topography.

The 1D component (called *ESTRY)* is a separate calculation engine incorporated into *TUFLOW* to handle flows through structures which cannot be accurately represented with 2d grid cells. *ESTRY* is a network dynamic flow program suitable for mathematically modelling floods and tides (and/or surges) in a virtually unlimited number of combinations. *ESTRY* has been developed in conjunction with *TUFLOW* to resolve complex 1D-2D flows across the floodplain interface.

The flood assessment was modelled using TUFLOW build 2013-12-AA-w64. To ensure model consistency with the base City of Sydney catchment model.

6.3 Flood Planning Requirements

Re-development of the site will require adherence to Council's flood planning controls, including compliance with:

- Sydney Local Environment Plan (LEP) 2012;
- Sydney Development Control Plan (DCP) 2012;
- City of Sydney's Interim Floodplain Management Policy (2014); and
- NSW State Government's Flood Prone Land Policy.

Clause 5.21 of the Sydney LEP (2012) requires the consent authority to be satisfied that all proposed development adequately protects the safety of property and life, and avoids adverse impacts on stormwater drainage, flood behaviour and the environment. This includes:

- That proposed development will not experience undue flood risk; and

- That existing development will not be adversely flood affected through increased damage or hazard as a result of any new development.

To satisfy Council that the development complies with these requirements a flood study *may* need to be undertaken as part of the Development Application submission in addition to establishing flood planning levels for the development. Council requires the following ancillary development issues to be considered in the assessment of proposed development of flood prone land of residential and industrial/commercial properties:

Table 6.1: Ancillary Requirements

Development Type/Aspect	Objective	Requirement
Residential properties	• To minimise the damage to residential properties from flooding; and • To minimise risk to human life from the inundation of residential properties and to minimise economic cost to the community resulting from flooding.	• The proposed residential building or dwelling must be free from flooding up to and including the 1% AEP flood and must meet the Flood Planning Level Requirements; and • The proposed residential building or dwelling should not increase the likelihood of flooding on other developments, properties or infrastructure.
Industrial and Commercial Properties	• To minimise the damage to industrial and commercial properties from flooding; and • To minimise risk to human life from the inundation of industrial and commercial properties and to minimise economic cost to the community resulting from flooding	• The City may consider merits-based approaches presented by the applicant. The proposed industrial or commercial buildings must meet the Flood Planning Level Requirements; and • The proposed industrial or commercial development should not increase the likelihood of flooding on other developments, properties or infrastructure.
Car Parking	• To minimise the damage to motor vehicles from flooding; • To ensure that motor vehicles do not become moving debris during floods, which threaten the integrity or blockage of structures of the safety of people, or damage other property; and • To minimise risk to human life from the inundation of basement and other car park or driveway areas.	• The proposed car park should not increase the risk of vehicle damage by flooding inundation; • The proposed garage or car park should not increase the likelihood of flooding on other developments, properties or infrastructure; • The proposed garage or car park must meet the Flood Planning Level Requirements; and • Open car parking- The minimum surface level of open space car parking subject to inundation should be designed giving regard to vehicle stability in terms of depths and velocity during inundation by flood waters. Where this is not possible, it shall be demonstrated how the objectives will be met.
Filling of Flood Prone Land	• To ensure that any filling of land that is permitted as part of a development consent does not have a negative impact on the floodplain.	• Unless a floodplain risk management plan for the catchment has been adopted, which allows filling to occur, filling for any purpose, including the raising of a building platform in flood-prone areas is not permitted without Council approval. Application for any must be supported by a flood assessment report from a suitably qualified engineer which certifies that the filling will not increase flood affection elsewhere.

Source: Section 5 of Council's *Interim Floodplain Management Policy* (2014)

In addition to the above requirements, the following building floor level requirements are to be met for Industrial/Commercial developments as per Council's *Interim Floodplain Management Policy (2014)*:

Table 6.2: Flood Planning Levels

Development Type/ Aspect	Objective	Type of Flooding	Flood Planning Level
Industrial / Commercial	Business	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP Flood level.
	Residential floors within tourist establishments	Mainstream or local drainage flooding	1% AEP Flood + 0.5m
	Retail Floor Levels	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Below-ground garage/car park	Single property owner with not more than 2 spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5m

Source: Council's *Interim Floodplain Management Policy* (2014)

Building floor levels as provided by *Woods Bagot* will be assessed against flood levels from the *City Area FRMS* in section 7.8 of this report.

7 Hydraulic Modelling

7.1 Model Approach

TUFLOW models for the *City Area* catchment were based on the following:

- **Existing conditions**: An assessment of the current flooding conditions based on a Lidar survey of the site.
- **Existing conditions with mitigation measures**: An amendment to the existing conditions model was built applying potential mitigation options to reduce flooding at various locations in the catchment.

For the purpose of this flood assessment only the existing conditions model was analysed, as the mitigation model proposes future stormwater upgrades which may not have been implemented on site. In addition to this, the mitigation measures are generally downstream of the site and therefore may have minimal bearing to the flood properties on site. Bligh street is approximately 19m higher than the point of discharge (Sydney Harbour) meaning potential back water from the harbour will have negligible impacts on the site.

The 1% AEP and the PMF (the PMF is the largest flood that could conceivably occur at a location and defines the extent of flood-prone land) were the focus of report as they relate to the flood planning levels for the building. As discussed above, minor storms have been analysed in the *City Area* study to assess the effectiveness of the 1d network.

7.2 Model Build

7.2.1 Digital Terrain Model

Model topography is based on 2007 LiDAR data. Comparisons to ground survey and another LiDAR dataset show that the data used in the TUFLOW model is generally accurate.

The previous TUFLOW model was updated based on the availability of new data. The following updates were made:

- Minor revision to the Mannings ‘n’ to represent Martin Place
- Revision to the pit and pipe data based on updated survey information
- Buildings have been more accurately represented in the model

7.2.2 Blockage

The stormwater network’s function is largely determined by the degree of blockage in regard to pit and pipes in any particular event. To emulate realistic blockages for the network a value of 20% for on grade kerb inlet pits and 50% for sag pits have been applied in both the 1% AEP and PMF.

7.2.3 Modifications to the existing model

Site survey specific to 4-6 Bligh Street has been obtained following the completion of the City Area model.

Levels from the survey were used to provide a more accurate lidar triangulation to represent the Bligh Street road profile. Levels obtained from the modified TUFLOW model were cross checked with the results provided by the City of Sydney and appear to be consistent.

7.3 Model Results

The critical duration of the storm as per the *City Area FRMS (2016)* is between 1 to 2 hours across majority of the catchment therefore 90min duration results were analysed for the 1% AEP and the PMF. This is consistent with previous analyses for flood risk in the catchment.

The information contained in the following sections of this report are based on a review of the *City Area FRMS (2016)*. Results for the 1% AEP storm event have been discussed to provide informed planning decisions, and results for the PMF have been discussed to provide insight into flood evacuation.

7.4 Flood Depths

The 1% AEP 90min storm is mostly contained within the Bligh Street road corridor with average depths of 60mm and maximum depths of 70mm fronting Bligh Street see Appendix A. Flood depths at the intersection of Hunter and Bligh Streets are slightly higher as there is a localised low point, with depths up to 100mm however this is still contained within the kerb and gutter. As expected, flood depths are almost negligible at the crest of Bligh Street and around 20mm at the intersection of Bent and Bligh Streets.

Similar to the 1% AEP flood depths produced in the PMF are contained within the road corridor with average depths of 130mm and maximum depths of 140mm fronting the building.

7.5 Water Level

The water level in the 1% AEP event on Bligh Street ranges between RL 19.6 and 20.4 m AHD (see Appendix B for flood height contours), adjacent the site.

As expected, the PMF shows higher water levels of up to 20.8 m AHD fronting the site. This flood level will form the basis of the evacuation route see section 7.11 and Appendix C.

7.6 Flood Hazard

Provisional flood hazard is determined through a relationship developed between the depth and velocity of floodwaters. *The NSW Floodplain Development Manual (2005)* defines two categories for provisional hazard- High and Low as defined in Section 3.4.

As shown in Appendix D, the subject site doesn't fall under any of the above hazard categories in either the 1% AEP or the PMF. Beyond the site there are pockets of low and high hazard present on Hunter Street resulting from flow discharging from intersecting streets.

7.7 Hydraulic Categories

The 2005 NSW Government Floodplain Development Manual defines the following three hydraulic categories:

- Floodway: *Floodway describes areas of significant discharge during floods, which, if partially blocked, would cause a significant redistribution of flood flow – City Area FRMS*
- Flood Storage: *Flood Storage areas are used for temporary storage of floodwaters during a flood – City Area FRMS*
- Flood Fringe: Any other flood prone land

Figure 7.1 aims to numerically define the hydraulic categories based on depths and velocities

Figure 7.1: Hydraulic Categories

Floodway:		Velocity x Depth > 0.25 m^2/s AND Velocity >0.25 m/s
	OR	Velocity > 1 m/s
Flood Storage:		Land outside the floodway where Depth > 0.2m
Flood Fringe		Land outside the floodway where Depth < 0.2m

Source: City Area *FRMS*

Appendix E shows the Hydraulic Categorisation for the catchment in the 1% AEP and PMF. In both instances it appears the area surrounding the site is not classified under any of the above categories. Therefore, there are no additional flooding requirements as a result of impacts to existing flood regimes.

7.8 Flood Planning Levels

As shown in Table 6.2, the flood planning level for “Retail floor” is to be greater than or equal to the 1% AEP flood level. Whilst the below ground carpark is to be at 1% AEP + 500mm.

Floor level

The ground level of the proposed development comprises an entry hall and concierge area prior to a lift lobby at RL 20.6m (Woods Bagot architectural drawings). The adjacent flood level in the 1% AEP is approximately RL20.0m AHD, therefore the design satisfies the Council’s *Interim Floodplain Management Policy* criteria with regard to flood planning level.

Driveway/Carpark

The northern and southern ramp entries meet the existing back of verge levels of RL20.8m and RL19.8m respectively. This results in freeboard of 400mm and 200mm respectively. To ensure the flood planning level is met without altering the existing verge profiles adjacent the site, a reduction of the freeboard allowance is proposed.

The *NSW Floodplain Development Manual* notes that ‘*Freeboard acts as a factor of safety... however freeboard may be different for: different parts of the floodplain, may vary with location’.* Given that the site is in a low risk area with very shallow flows and a small upstream catchment there is minimal risk of flood levels in the 1% AEP encroaching into the building under any potential blockage scenario. The minimal risk is a result of the relatively steep grade of Bligh Street to the south, with potential obstructions or blockages within the main flow path unlikely to cause increases in flooding beyond the eastern kerb line due to the predominant fall of the road reserve down towards the western verge.

The potential incorporation of a basement ramp flood gate/barrier is an option resulting in strict compliance with the flood planning level, comprising a hydraulic flood gate, self-operated and automatically triggered following a large rainfall event. The gates would be folded into a concealed steel grate placed at the entry of the driveway and would rise following water ingress in a major storm. The height of the flood barrier would be at RL 20.9 and 20.1m AHD in the northern and southern ramps respectively.

Note that installation of flood gates/barriers would require consideration of proper evacuation plans to redirect basement occupants to evacuate via stairs in the major storm event. The flood gate would require maintenance and guidelines for operation. With gates in place, the property owner is to be made aware that in a major storm event where the gates are triggered, the basement ramps will not be operational.

It is Mott Macdonald's view that the provision of a flood gate to the basement ramps is not required and the site can operate safely in major flood events despite the minor reduction in freeboard allowance.

7.9 Climate Change

To satisfy Sydney LEP's criteria of consideration of projected effects of climate change, a base multiplied rainfall event had been run in TUFLOW. The event modelled projected rainfall patterns for 2050 and 2100. Results are for analysis only and are accounted for in the building freeboard levels.

Overall the impacts of climate change are observed to be minor, considering overland flow paths in the vicinity are a result of localised rainfall from very small upstream contributing catchments. Where increases in rainfall intensity contribute to greater overland flows, resulting increases in flood levels are negligible given that flow paths are typically limited to the confines of the kerb and gutter of Bligh Street.

7.10 Cumulative Impacts

Given there are no impacts of the proposed development on flooding there are very little cumulative impacts arising from similar development in the area. This is a result of the location very high in the urban subcatchments, with runoff in adjacent road reserves comprising very shallow gutter flows and only lasting the duration of the intense rainfall event.

7.11 Flood Evacuation Strategy

Consideration for escape from hazardous areas due to flood waters must be outlined in the *City Area Catchment Floodplain Risk Management Plan* to ensure the development doesn't jeopardise public safety. The site must have access to a safe refuge point above the PMF event, which is available to building occupants and visitors within the structure itself. For the safe refuge of people external to the building see Appendix C for the evacuation plan.

8 Conclusion

This report aims to ensure that the construction of the new building at 4-6 Bligh Street will not cause flood inundation within the site and surrounds. As mentioned above the site sits several metres above its surrounding streets with flood waters draining away from the site to the adjoining streets (Hunter and Bent Street).

An assessment of the flood levels using the Council approved flood model shows that the site is at low risk to flooding in both the 1% AEP and PMF. A high point on Bligh Street provides a safe refuge point for pedestrians in a large-scale storm event. In addition to this, finished floor levels of the building address the flooding SEARs requirement as they are compliant with both NSW Floodplain Development Manual and Council's Interim Floodplain Management Policy (2014).

Overall as the verge and building levels largely mimic the existing conditions there isn't a significant impact on flood inundation in and around the site with the construction of the new development. No mitigation measures are required to manage impacts resulting from the proposed development.

A. Appendix A

Bligh Street

1% AEP Flood Depth (m)

Legend

- Subject Boundary

1% Peak AEP Flood Depth (m)

- 0
- 0.15
- 0.3
- 0.5
- 0.8
- >1

25.09.2019 | REF: MMD-00-W-GIS-001

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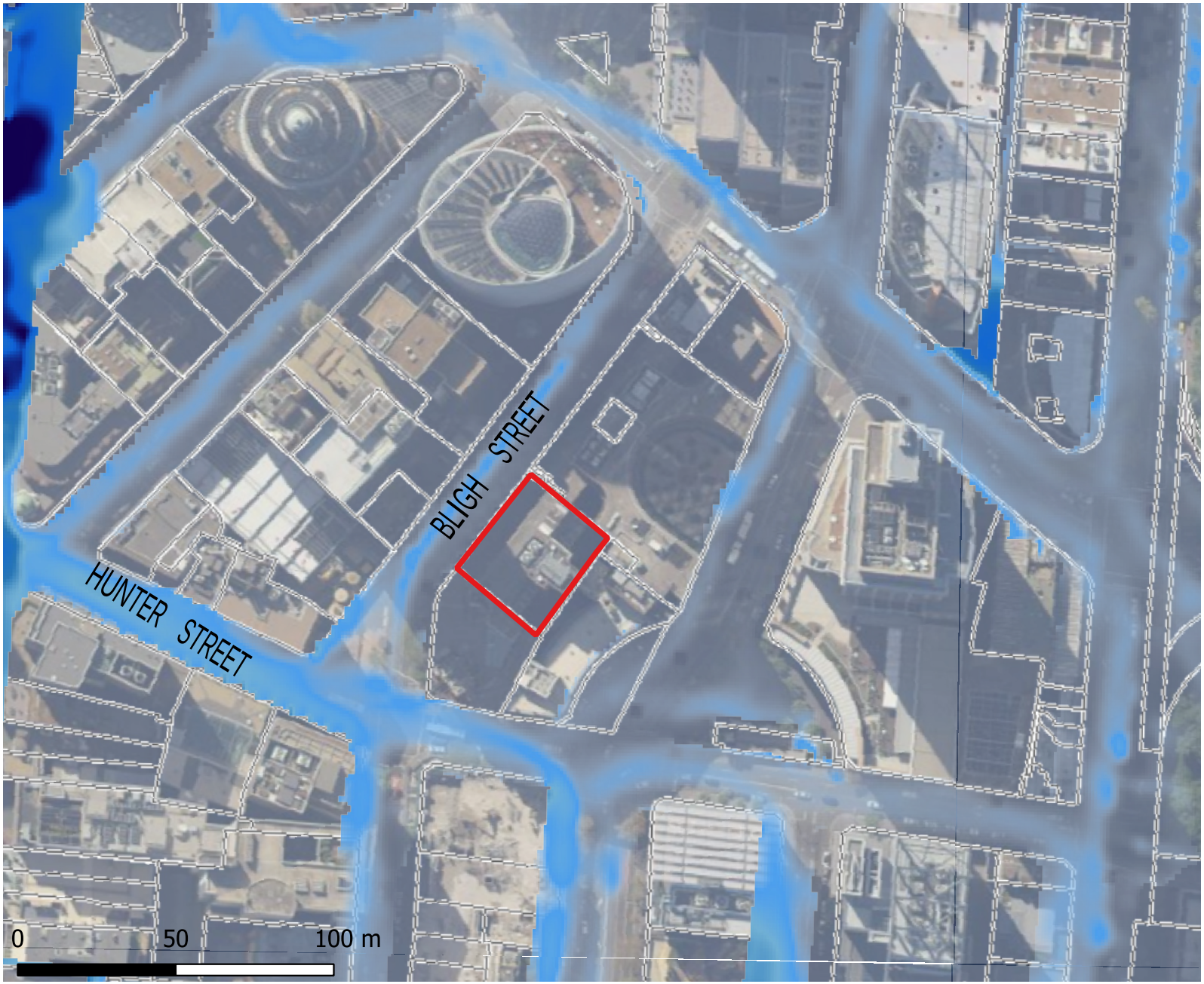

Bligh Street
PMF Flood Depth (m)

Legend

Study Area

PMF Peak Flood Depth (m)

- 0
- 0.15
- 0.3
- 0.5
- 0.8
- >1

25.09.2019 | REF: MMD-00-W-GIS-001

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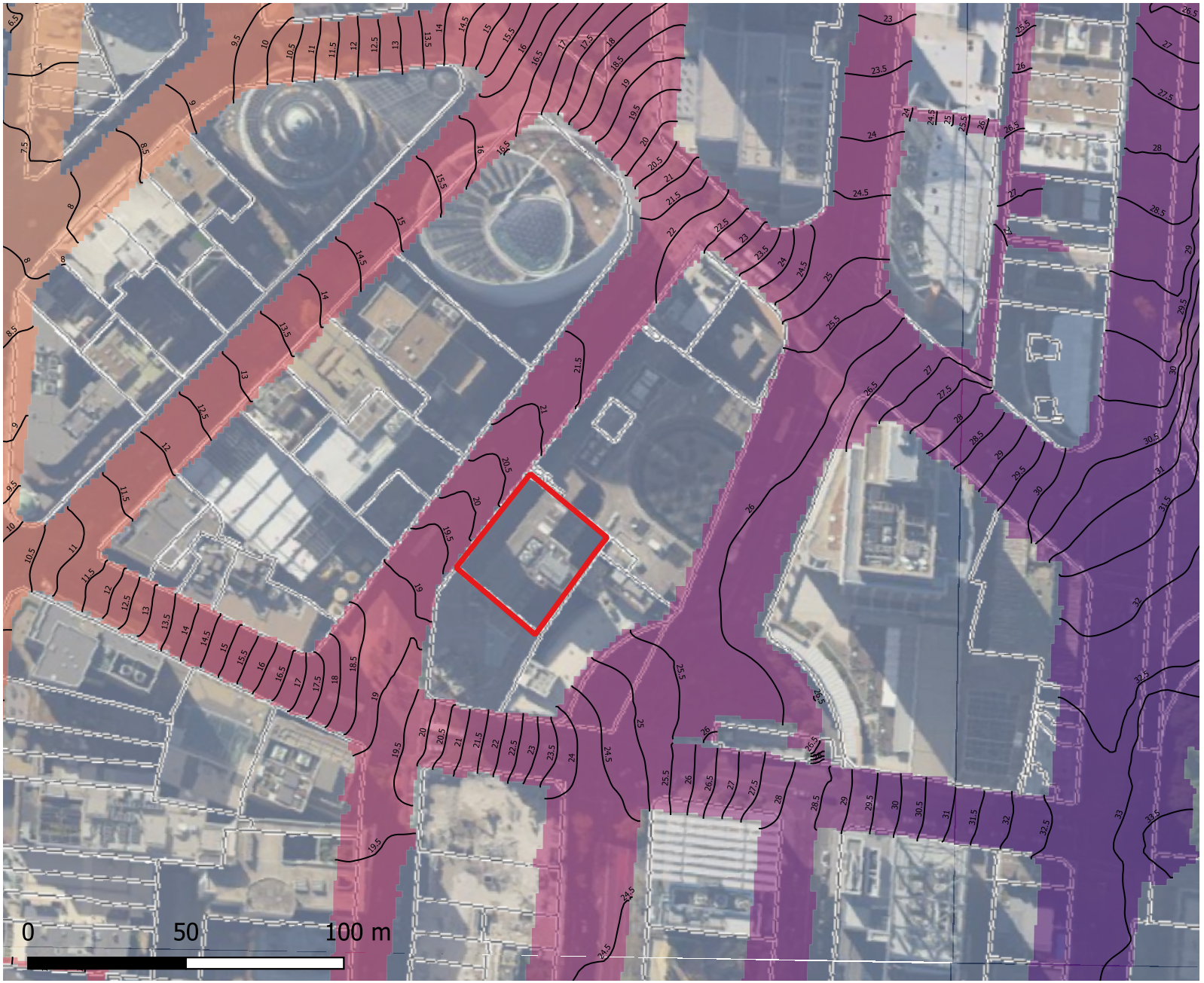
B. Appendix B



Bligh Street

1% AEP Flood Level (m AHD)

Legend

- Subject Boundary

1% AEP Peak H max (m AHD)

- 1.5
- 5
- 10
- 15
- 25
- 30
- 35
- 40
- 45

10.08.2018 | REF: MMD-00-W-GIS-001

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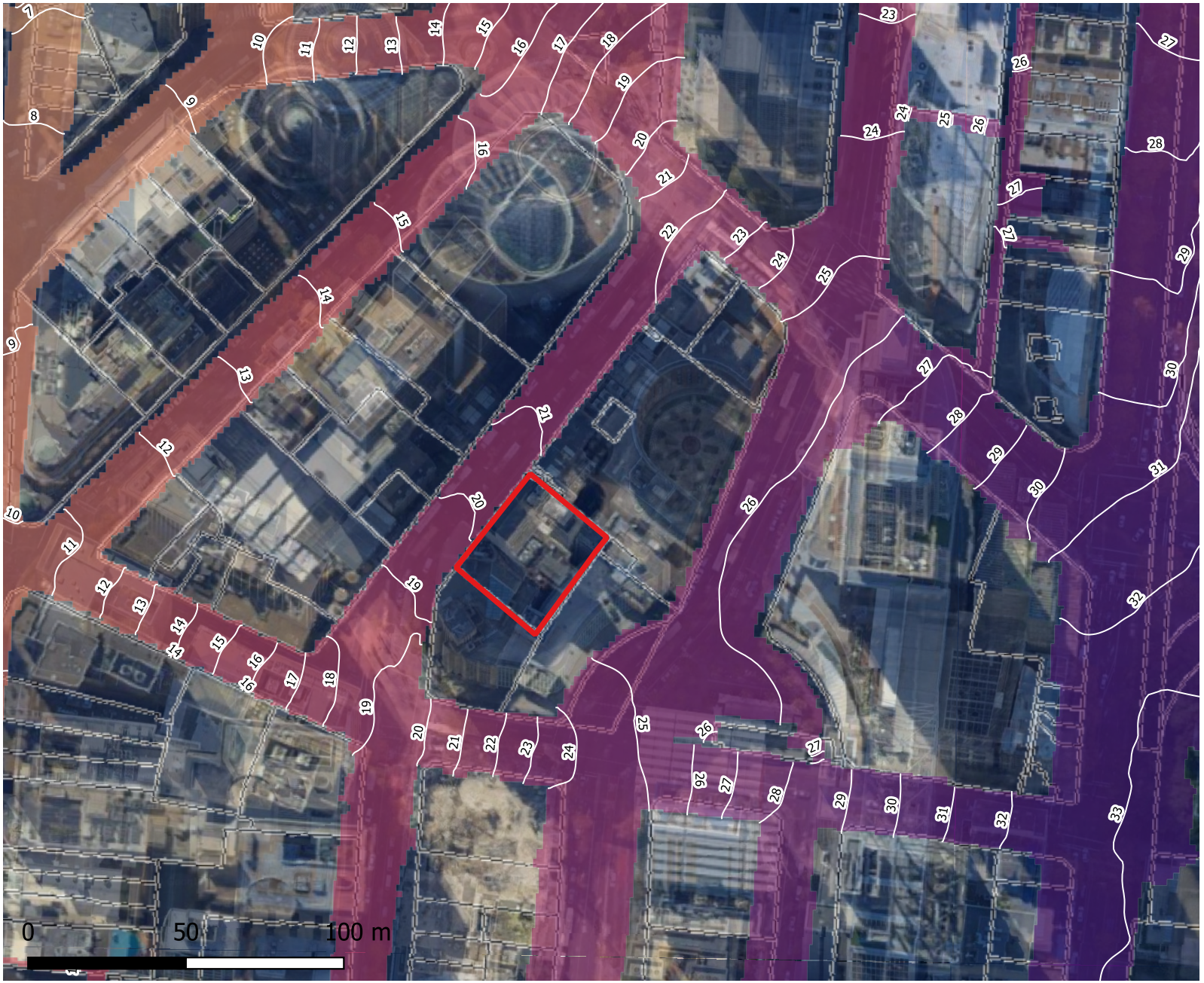

Bligh Street

PMF Flood Level (m AHD)

Legend

Study Area

PMF Peak Flood Level (m AHD)

- 1.5
- 5
- 10
- 15
- 25
- 30
- 35
- 40
- 45

09.09.2019 | REF: MMD-00-W-GIS-001

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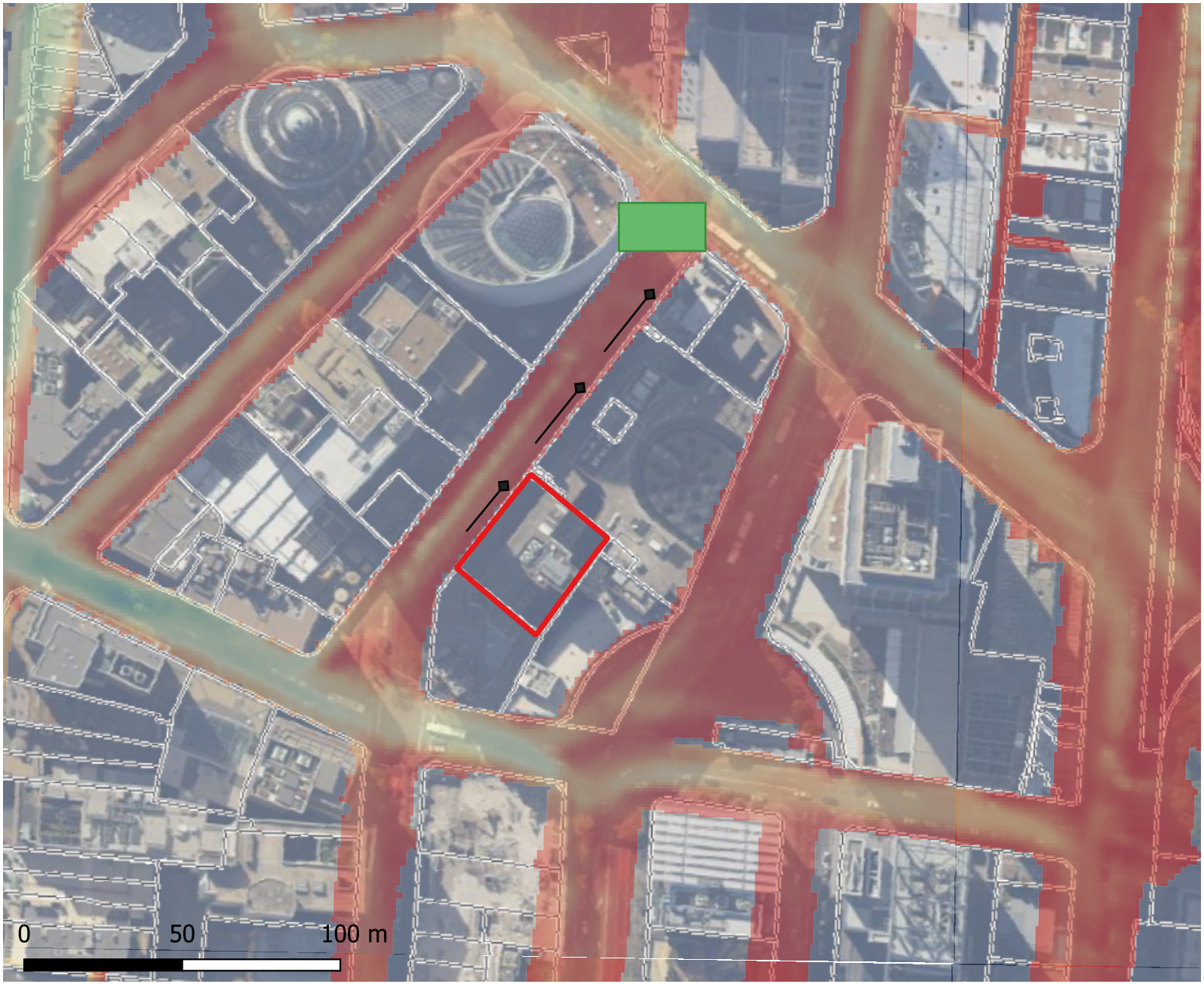
C. Appendix C

Bligh Street

EVACUATION PLAN



Legend

- Subject Boundary
- 1% AEP Peak Velocity (m2/s)
  - 0
  - 1
  - 2
  - 3
  - 5
- Safe Refuge Island
- Evacuation Route

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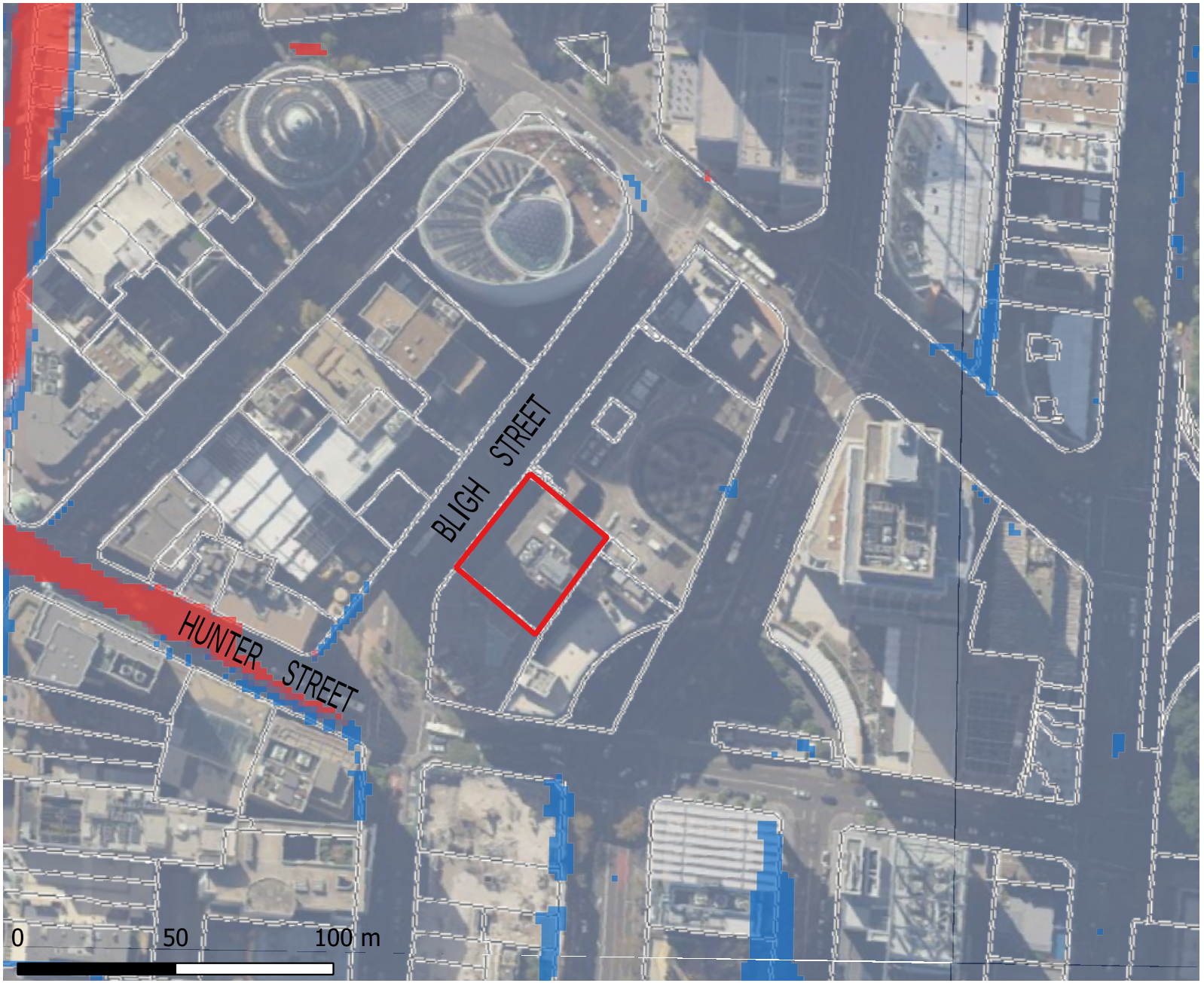
D. Appendix D



Bligh Street
1% AEP Flood Hazard

Legend

- Study Area

Flood Hazard

- Low Hazard
- High Hazard

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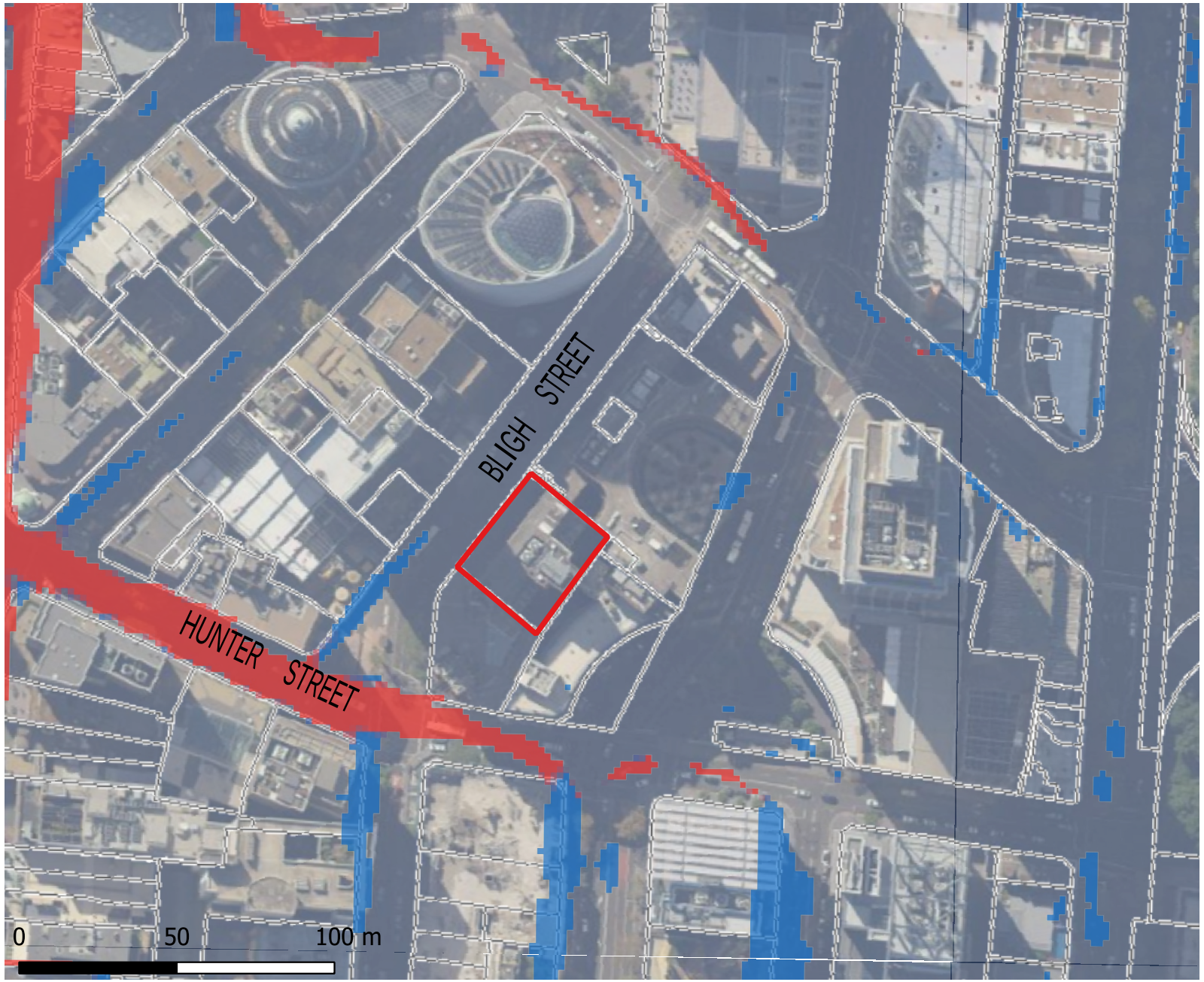

Bligh Street
PMF Flood Hazard

Legend

- Study Area

Flood Hazard

- Low Hazard
- High Hazard

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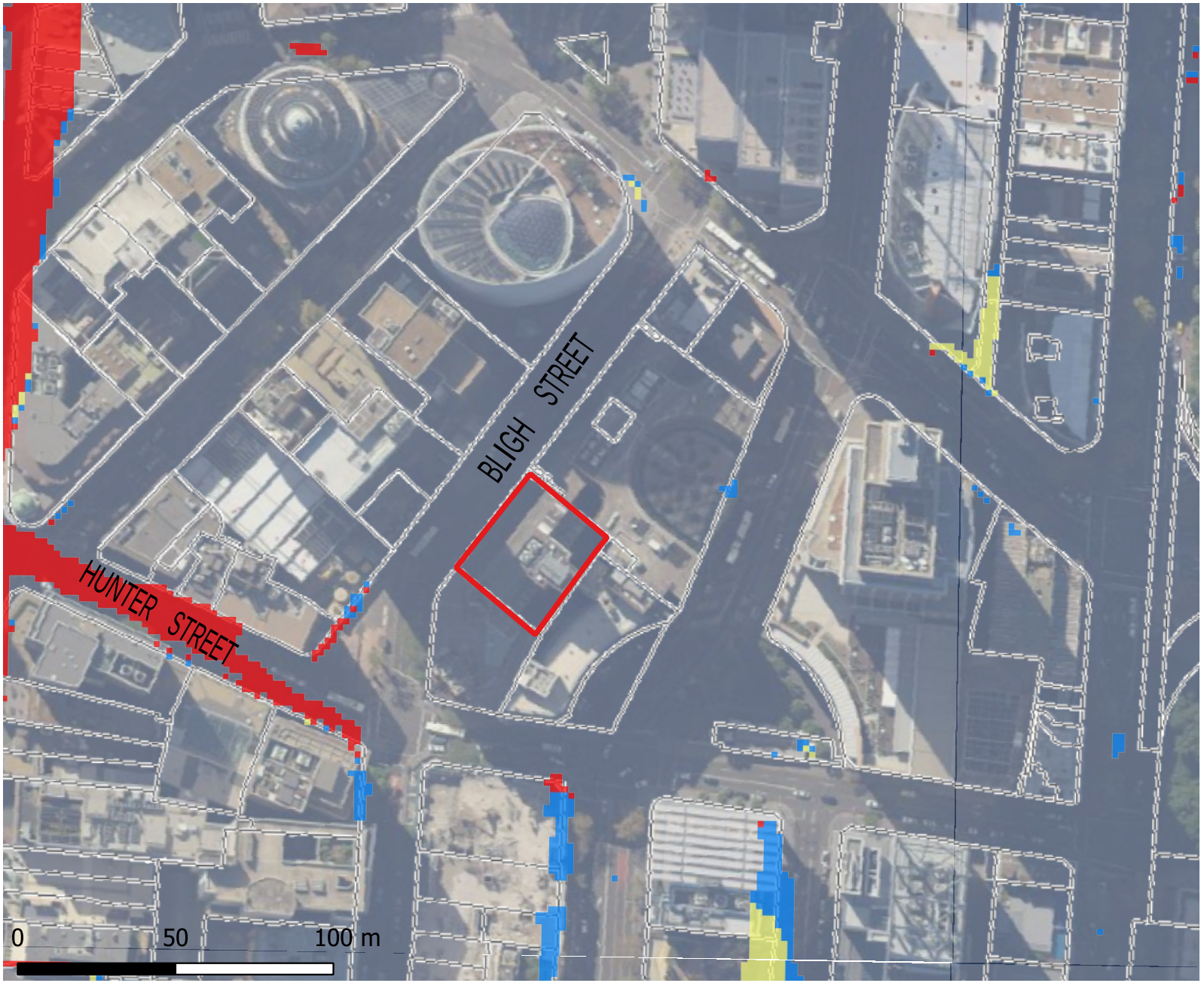
E. Appendix E



Bligh Street
1% AEP Hydraulic Categories

Legend

Study Area

Hydraulic Categorisation

- Floodway
- Flood Storage
- Flood Fringe

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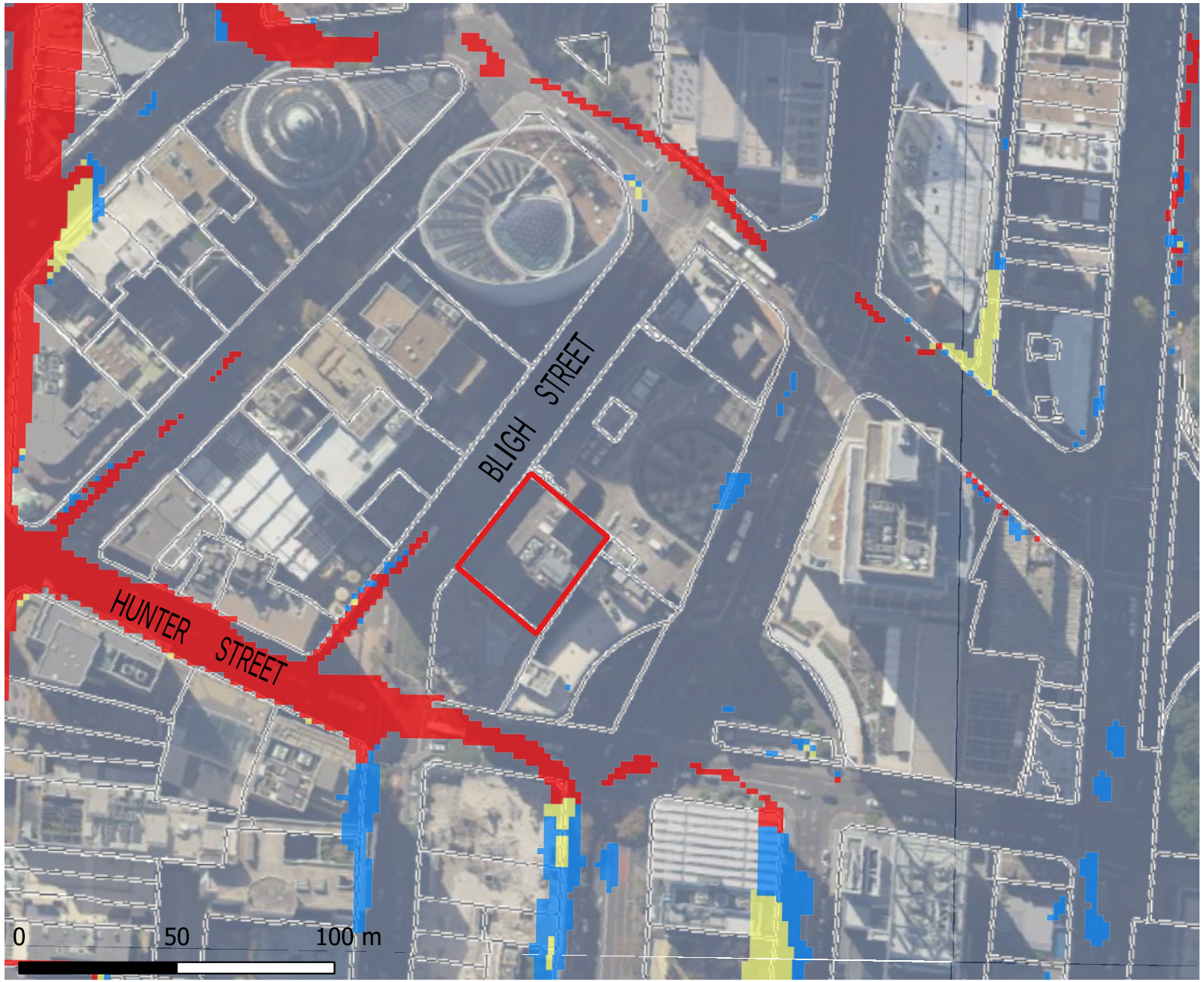

Bligh Street
PMF Hydraulic Categories

Legend

Study Area

Hydraulic Categorisation

- Floodway
- Flood Storage
- Flood Fringe

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F. Appendix F

Chris,

On Site Detention is not required for any development at 4-6 Bligh Street, Sydney.

Best Regards

Sydney WATER

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