Attachment A9

Preliminary Flooding Report

Sydney Metro West:

Planning Proposal for Hunter Street Over Station Development Preliminary Flooding Report

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Glossary

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<tr><th>Term</th><th>Definition</th></tr>
<tr><td>Afflux</td><td>Change in water level, with positive afflux representing an increase in level and a negative afflux representing a reduced level.</td></tr>
<tr><td>Australian Height Datum (AHD)</td><td>A common national surface level datum approximately corresponding to mean sea level.</td></tr>
<tr><td>Annual Exceedance Probability (AEP)</td><td>The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. In this study AEP has been used consistently to define the probability of occurrence of flooding. The following relationships between AEP and ARI applies to this study (Ball et al, 2019).
<table>
<tr><th>Frequency Descriptor</th><th>EY</th><th>AEP (%)</th><th>AEP (1 in x)</th><th>ARI</th></tr>
<tr><td rowspan="6">Very frequent</td><td>12</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>99.75</td><td>1.002</td><td>0.17</td></tr>
<tr><td>4</td><td>98.17</td><td>1.02</td><td>0.25</td></tr>
<tr><td>3</td><td>95.02</td><td>1.05</td><td>0.33</td></tr>
<tr><td>2</td><td>86.47</td><td>1.16</td><td>0.50</td></tr>
<tr><td>1</td><td>63.2</td><td>1.58</td><td>1.00</td></tr>
<tr><td rowspan="5">Frequent</td><td>0.69</td><td>50.00</td><td>2</td><td>1.44</td></tr>
<tr><td>0.5</td><td>39.35</td><td>2.54</td><td>2.00</td></tr>
<tr><td>0.22</td><td>20.00</td><td>5</td><td>4.48</td></tr>
<tr><td>0.2</td><td>18.13</td><td>5.52</td><td>5.00</td></tr>
<tr><td>0.11</td><td>10.00</td><td>10.00</td><td>9.49</td></tr>
<tr><td rowspan="3">Infrequent</td><td>0.05</td><td>5.00</td><td>20</td><td>20.0</td></tr>
<tr><td>0.02</td><td>2.00</td><td>50</td><td>50.0</td></tr>
<tr><td>0.01</td><td>1.00</td><td>100</td><td>100</td></tr>
<tr><td rowspan="4">Rare</td><td>0.005</td><td>0.50</td><td>200</td><td>200</td></tr>
<tr><td>0.002</td><td>0.20</td><td>500</td><td>500</td></tr>
<tr><td>0.001</td><td>0.10</td><td>1000</td><td>1000</td></tr>
<tr><td>0.0005</td><td>0.05</td><td>2000</td><td>2000</td></tr>
<tr><td rowspan="5">Extremely Rare</td><td>0.0002</td><td>0.02</td><td>5000</td><td>5000</td></tr>
<tr><td></td><td></td><td rowspan="4">↓</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Extreme</td><td></td><td></td><td>PMP</td><td></td></tr>
</table>
</td></tr>
<tr><td>ARR</td><td>Australian Rainfall and Runoff (ARR) is a national guideline document used for the estimation of design flood characteristics in Australia. Reference is made to either ARR1987 (3rd edition) or ARR2019 (4th edition) as specified.</td></tr>
<tr><td>Average Recurrence Interval (ARI)</td><td>The long-term average number of years between the occurrences of a flood as big as or larger than the selected flood event. For example, floods with a discharge as great as or greater than the 20-year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. Also refer to Average Exceedance Probability (AEP), which is the industry standard terminology for definition of design flood events.</td></tr>
</table>

Term	Definition
Catchment	The land area draining through the mainstream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Exceedances per year (EY)	The number of times a flood event is likely to occur or be exceeded within any given year.
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below. Existing flood risk: the risk a community is exposed to due to its location on the floodplain. Future flood risk: the risk a community may be exposed to due to new development on the floodplain. Continuing flood risk: the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.
Hydrologic modelling	Hydrologic modelling refers to the conversion of the design rainfall and runoff into flow hydrographs that are applied to the hydraulic model to define flood depths, flood extents, velocities and hazards for a range of design storms.
Hydrology	The study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
Hydraulic modelling	Hydraulic modelling uses the rainfall, catchment and watercourse topography to predict flood behaviour including flood levels, flood extents, flood velocities and the duration of inundation in the catchment and watercourse.
ISD	Integrated station development.
Matter of national environmental significance (MNES)	A matter of national environmental significance (MNES) protected by a provision of Part 3 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
OSD	Over station development.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. The PMF defines the extent of flood prone land, that is, the floodplain.
Rain on grid hydraulic model	In these studies, hydrological assessment has been incorporated directly into the hydraulic models, rather than employing a separate hydrological model to derive flow hydrographs. Along with topographic information and model parameters reflecting the catchment and watercourse, flood behaviour including flood levels, flood extents, flood velocities and the duration of inundation in the catchment and watercourse can be predicted.
SSD	State Significant Development.
TUFLOW	TUFLOW is a computer program which is used to simulate free-surface flow for flood and tidal wave propagation. It provides coupled 1D and 2D hydraulic solutions using a powerful and robust computation. The engine has seamless interfacing with GIS and is widely used across Australia. There are two schemes available for solving the two-dimensional Shallow Water Equation (SWE). Testing indicates that Classic and HPC produce results with are consistent with each other (BMT, 2019). There is no exact solution to the SWE, which is why there are several solvers available.
TUFLOW Classic	TUFLOW classic is the original TUFLOW solver which uses a 2nd order implicit finite difference solution. It uses a fixed timestep. The Classic solver's turbulence model is dependent on cell size with a fixed timestep.

Term	Definition
TUFLOW HPC	The TUFLOW HPC (Heavily Parallelised Compute) solver uses a 2nd order explicit finite volume solution. TUFLOW HPC has increased stability with an adaptive timestep compared with Classic. The HPC model uses an updated turbulence scheme, which is cell size insensitive.

Executive summary

The Planning Proposal for the Hunter Street Over Station Development (OSD), has been prepared to support an amendment to the Sydney Local Environmental Plan (LEP) 2012 and is consistent with the Planning Proposal: Central Sydney.

This Preliminary Flooding Assessment has been undertaken to satisfy the planning requirements of the City of Sydney Council's Interim Floodplain Management Policy. The scope of this report is to summarise existing flooding conditions and detail required upgrades, infrastructure and protection measures to satisfy the flood assessment criteria. Assessment of the potential impacts of the Hunter Street OSD on flooding considers selected flood events up to the Probable Maximum Flood (PMF), and focuses upon:

- Potential increases in flood risk and flood affectation on adjacent properties and assets as well as potential impacts to any emergency management arrangements.
- Land use compatibility in relation to flood hazard.
- Compatibility with council floodplain risk management in terms of safe velocities and depths for pedestrians and vehicles.
- Where required mitigation and management measures have been identified.

These results demonstrate that the Hunter Street OSD would not adversely affect flood behaviour resulting in affectation of other properties assets and infrastructure and would generally provide the required flood immunity of the Interim Floodplain Management Policy and where that is not the case would make provision for shelter in place arrangements.

These results are premised on the basis that flood protection measures would be employed to provide the necessary immunity to critical infrastructure for the Hunter Street (Sydney CBD) Station as part of the previous Sydney Metro West planning application and that the design and operation of the Hunter Street OSD would not compromise metro station flood immunity.

Any residual risk to the retail spaces would require an operational flood emergency response plan.

Input to the Design Guide for Hunter Street, Sydney Metro has captured the relevant requirements to manage compliance with the Interim Floodplain Management Policy and the protection the flood immunity of the Hunter Street (Sydney CBD) Station.

1 Introduction

1.1 Purpose

The Sydney Metro West Hunter Street Station Over Station Development (OSD) Planning Proposal Request seeks to amend the maximum building height and maximum floor space ratio permitted for both the east and west sites under the *Sydney Local Environmental Plan 2012* (SLEP 2012). This Flooding Assessment report forms part of the planning proposal request submitted for the Sydney Metro Hunter Street Station OSD.

This report addresses the requirement to satisfy the planning requirements of the City of Sydney Council's Interim Floodplain Management Policy within the context of the not compromising the required flood immunity of the related but separate Hunter Street (Sydney CBD) Station.

1.2 Objectives and intended outcomes

The Planning Proposal Request has been prepared to address the following objectives for future development on the Eastern and Western sites:

- Be a catalyst for positive change by regenerating and invigorating the city with new development that engages with the precinct, raises the urban quality and enhances the overall experience of the city.
- Facilitate future development that promotes design excellence and is consistent with the objectives of the Central Sydney Planning Framework.
- Deliver high quality employment generating floorspace that aligns with the objectives for development within the tower cluster areas identified within the Central Sydney Planning Framework.
- Contribute towards the establishment of an integrated transport hub within the Sydney CBD which strengthens Sydney's rail network improving connectivity.
- Delivers employment density alongside the delivery of significant new public transport infrastructure servicing the site and surrounding precinct.

The intended outcomes of the requested amendments include:

- To amend the maximum building height and maximum floor space ratio (FSR) permitted for both the east and west sites under the *Sydney Local Environmental Plan 2012* (Sydney LEP 2012) and allow an alternative approach to design excellence to deliver integrated station development that optimises the development potential of both sites
- To facilitate new development that demonstrates an appropriate distribution of built form and floor space as part of the delivery of the integrated station development.

1.3 Planning process

1.3.1 State Significant Infrastructure

Sydney Metro West was declared as State Significant Infrastructure (SSI) and Critical State Significant Infrastructure (CSSI) under sections 5.12(4) and 5.13 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) respectively on 23 September 2020.

Sydney Metro West is being assessed as a staged infrastructure application under Section 5.20 of the *Environment Planning & Assessment Act 1979*. The approved Concept and major civil construction work for Sydney Metro West between Westmead and The Bays (Stage 1 of the planning approval process application number SSI-10038) were approved on 11 March 2021.

Stage 2 of the planning approval process (application number SSI-19238057) includes all major civil construction work, including station excavation and tunnelling, between The Bays and Sydney CBD (an Environmental Impact Statement for this application was exhibited between 3 November and 15 December 2021).

Stage 3 of the planning approval process (application number SSI-22765520, being the application for the tunnel fit-out, construction of stations, ancillary facilities and station precincts, and operation and maintenance of the Sydney Metro West line. This application seeks approval for the construction of the Hunter Street Station, including above and below ground structures, public domain works, and spatial provisioning and works to facilitate the construction and operation of an OSD above the two station entries which are described further in this report.

1.3.2 Over Station Development

The OSD components of the Hunter Street integrated station development are not declared as SSI or CSSI under *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). As such, separate development consent is required to be granted for the construction and operation of development above the Hunter Street Station.

The primary land use of the OSD sites is anticipated to be 'commercial premises' which has a capital investment value of more than $30 million, and which are located within a rail corridor and/or are associated with railway infrastructure. Consequently, the future OSD will be classified as State Significant Development. The Sydney LEP 2012 is a relevant environmental planning instrument for the future development, though the Sydney Development Control Plan 2012 (Sydney DCP 2012) will not apply to the OSD sites.

To inform the planning controls relevant for the Hunter Street OSD sites, amendments are proposed to the Sydney LEP 2012 to provide additional Maximum Height of Building and floor space ratio (FSR) controls. Further, as the Sydney DCP 2012 does not apply to the land, the Proponent will prepare a design and amenity guideline to support the planning proposal to inform the future built form on the site including details such as street frontage heights, setbacks, massing and tapering, development adjacent to heritage items, building exteriors, and managing wind impact.

The inter-relationship of the scope of Sydney Metro EIS 3 (part of Critical State Significant Infrastructure CSSI) and this planning proposal is illustrated in Figure 1-1.

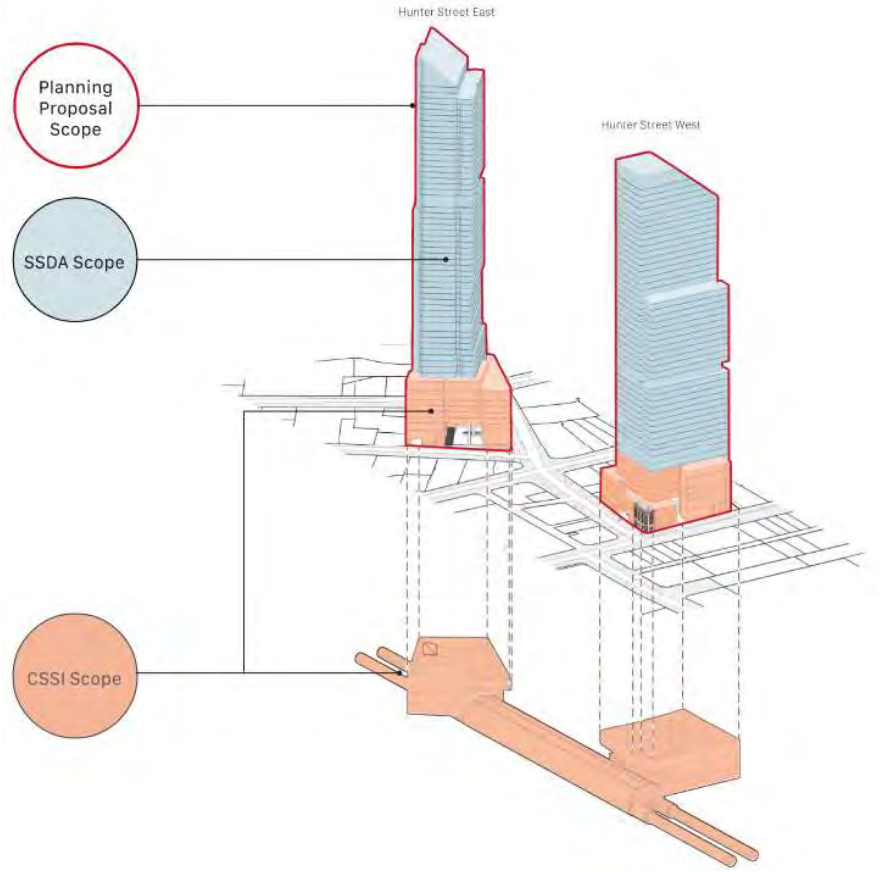

Figure 1-1 Hunter Street Station and Proposed OSD

1.3.3 Planning Proposal

The planning proposal seeks to amend the *Sydney Local Environmental Plan 2012* to enable development on the site(s) as follows:

- Establish a maximum Height of Buildings control and maximum FSR control on the identified land, being the Hunter Street Station East and West sites.
- Enable the development of a commercial office building on the Hunter Street Station East and West sites
- Integration with the Hunter Street Station, the subject of a separate application process
- Adaptive reuse of the existing Former Skinners Family Hotel within the overall development on the West site
- Include site-specific controls which ensure the provision of employment and other non-residential land uses only on both the Hunter Street Station East and West sites.
- Include site-specific control allowing the provision of up to a maximum of 70 car parking spaces maximum total across both the Hunter Street Station East and West sites.
- Include a site-specific design guideline within the site-specific controls to guide future development sought under a State Significant Development Application process.

- Establish an alternative design excellence process for the Hunter Street Station East and West sites that responds to the integration of the development with the Sydney Metro West project and specifically the Hunter Street Station.

A summary of the key development outcomes resulting from the Planning Proposal is set out in Table 1-1 below.

Table 1-1: Proposed concept built form outcomes

Built Form Component	Proposed Development Outcome
East Site	**Based on a Site Area of 3,666 sqm**
Height	Building height of 257.7m (RL 269.10)
FSR	22.82:1
GFA	Up to 84,287 sqm of GFA
Land Use(s)	Non-residential land uses only
West Site	**Based on a Site Area of 3,735 sqm**
Height	Building height of 213.0m (RL 220.00), including a setback interface from the heritage-listed Skinner Family Hotel
FSR	18.71:1
GFA	Up to 69,912 sqm of GFA
Land Use(s)	Non-residential land uses only
Cl 7.6 – Carparking for Office and Business premises	• Up to 70 car parking spaces, maximum total across both the Eastern and Western sites

1.4 Site context

1.4.1 The Site

The Hunter Street integrated station development is located in the northern part of the Sydney CBD, within the commercial core precinct of Central Sydney, within the Sydney Local Government Area.

The east site is located on the corner of O'Connell Street, Hunter Street and Bligh Street adjacent to the existing CBD and South East Light Rail that extends from Circular Quay to Moore Park, Kensington and Kingsford. The east site is adjacent to the new Martin Place Station which forms part of the Sydney Metro City and Southwest, Australia's biggest public transport project connecting Chatswood to Sydenham and extending to Bankstown.

The west site is located on the corner of George and Hunter Street, including De Mestre Place and land predominantly occupied by the existing Hunter Connection retail plaza.

Refer to Figure 1-2 below which illustrates the location of the Hunter Street Station within its regional context.

Figure 1-2 Location of the new Sydney Metro West station at Hunter Street

1.4.2 Local context

The Sydney CBD is a highly developed commercial core with a ride range of commercial, retail, health, government and community-based uses, as well as high density residential developments.

A number of key commercial buildings are located in or around the Sydney CBD, including educational facilities, historic buildings and structures, law courts, public gathering spaces and places of worship. Significant areas of open space, such as the Botanical Gardens, the Domain and Hyde Park are also located within or near the Sydney CBD area, as well as the World Heritage Sydney Opera House and iconic Sydney Harbour Bridge.

Land uses surrounding the Hunter Street Station (Sydney CBD) sites include:

- North of the sites is a major commercial area comprising high density commercial towers along George Street, Pitt Street, and Bridge Street, including the MetCentre and Australia Square buildings. The area also comprises tourism and entertainment related uses including hotels, shops, restaurants, cafes, nightclubs and bars, with the area around Circular Quay and the Rocks a major tourism precinct and providing significant support for the night time economy.
- East of the sites are major commercial towers along Hunter Street, including Chifley Tower, 8 Chifley Square, Aurora Place and Deutsche Bank Place. Beyond Hunter Street, the State Library of NSW and the NSW Parliament

House front onto Macquarie Street, and beyond that lies the public open space of The Domain.

- South of the sites, the land use remains predominantly multi-storey commercial offices but also includes cafes, bars and nightclubs, including the Ivy complex. Martin Place is a significant east–west pedestrian thoroughfare which contains many culturally significant buildings and structures including the Cenotaph memorial and the General Post Office building, as well as Martin Place Station. Beyond Martin Place the Sydney CBD continues towards Town Hall, Haymarket and the Central Station precinct.
- West of the sites, the land use remains predominantly high-density commercial offices, anchored by Wynyard Station. George Street contains the Sydney Light Rail (L2 Randwick Line and L3 Kingsford Line) and is a major north–south axis through the CBD, and along with Pitt Street connects Circular Quay, Wynyard, Town Hall and Central. East of Wynyard, the CBD continues towards the major commercial and entertainment areas around King Street Wharf and Barangaroo, which also contain significant high density residential apartment buildings.

1.4.3 Site description

The Hunter Street (Sydney CBD) ISD relates to the following properties:

- 28 O'Connell Street, 48 Hunter Street, and 37 Bligh Street, Sydney (East Site); and
- 296 George Street, 300 George Street, 312 George Street, 314-318 George Street, 5010 De Mestre Place (Over Pass), 5 Hunter Street, 7-13 Hunter Street, 9 Hunter Street and De Mestre Place, Sydney (West Site).

Table 1-2 and Table 1-3 below set out the address, legal description and area of the parcels of land that comprise the Hunter Street Station (Sydney CBD) land that is the subject of this Planning Proposal.

Table 1-2 Legal description of Hunter Street Station (Sydney CBD) East Site

Address	Lot and DP
28 O'Connell Street, Sydney	Lot 1, DP217112
28 O'Connell Street, Sydney	Lot 1, DP536538
28 O'Connell Street, Sydney	Lot 1, DP1107981
48 Hunter Street, Sydney	Lot 1, DP59871
48 Hunter Street, Sydney	Lot 2, DP217112
33 Bligh Street, Sydney	Lot 1, DP626651
37 Bligh Street, Sydney	CP and Lots 1-14, 21-31, 33-36, and 40, SP58859
37 Bligh Street, Sydney	CP and Lots 41-49, SP61852
37 Bligh Street, Sydney	CP and Lots 50-57, SP61922
37 Bligh Street, Sydney	CP and Lots 58-65, SP61923
37 Bligh Street, Sydney	CP and Lots 66 and 67, SP63146
37 Bligh Street, Sydney	CP and Lots 67-70, SP63147
37 Bligh Street, Sydney	CP and Lot 72, SP74004

Address	Lot and DP
37 Bligh Street, Sydney	CP and Lots 75-82, SP87437
37 Bligh Street, Sydney	CP and Lots 73-74, SP87628
	Total Area: 3,694 sqm

Table 1-3 Legal description of Hunter Street Station (Sydney CBD) West Site

Address	Lot and DP
296 George Street, Sydney	Lot 1, DP438188
300 George Street, Sydney	CP and Lots 1-43, SP596
312 George Street, Sydney	Lot 1, DP211120
314-318 George Street, Sydney	Lot 13, DP622968
5010 De Mestre Place, Sydney (Over Pass)	Lot 1, DP1003818
9 Hunter Street, Sydney	Lot 2, DP850895
5 Hunter Street, Sydney (Leda House & Hunter Arcade)	CP and Lots 1-63, SP71068
5 Hunter Street, Sydney (Leda House & Hunter Arcade)	CP and Lots 1-14, SP65054
7-13 Hunter Street, Sydney (Hunter Connection)	CP and Lots 1-53, SP50276
7-13 Hunter Street, Sydney (Hunter Connection)	Lots 57 and 58, SP61007
7-13 Hunter Street, Sydney (Hunter Connection)	Lots 54, 55 and 56, SP60441
7-13 Hunter Street, Sydney (Hunter Connection)	Lots 59, 60 and 61, SP62889
7-13 Hunter Street, Sydney (Hunter Connection)	Lots 62, 63, 64 and 65, SP69300
7-13 Hunter Street, Sydney (Hunter Connection)	Lots 66 and 67, SP77409
7-13 Hunter Street, Sydney (Hunter Connection)	Lot 2, SP50276
De Mestre Place, Sydney	N/A
	Total Area: 3,735 sqm

2 Scope of assessment

The scope of this report is to summarise existing flooding conditions and detail required upgrades, infrastructure and protection measures to satisfy the flood assessment criteria. Assessment of the potential impacts of the Hunter Street OSD on flooding considers selected flood events up to the PMF, and focuses upon:

- Potential increases in flood risk and flood affectation on adjacent properties and assets as well as potential impacts to any emergency management arrangements.
- Land use compatibility in relation to flood hazard.
- Compatibility with council floodplain risk management in terms of safe velocities and depths for pedestrians and vehicles.
- Where required mitigation and management measures have been identified.

The assessment presented in this report was undertaken for the Environmental Impact Statement of the separate but related proposal for the Sydney Metro West Rail infrastructure, stations, precincts and operations between Westmead and Sydney CBD (SSI-22765520). In comparison, the Hunter Street OSD presents no additional footprint where there could be further flood impacts on adjacent properties and assets. There are potential risks in relation to the use of some aspects of the Hunter Street OSD and potential for design or operation of the Hunter Street OSD to impact on the flood immunity of the Hunter Street (Sydney CBD) Station. These will be outlined in later sections along with mitigation measures where required.

2.1 Flood assessment criteria

The flooding assessment has been undertaken to satisfy State and Local Government guidelines. The flood criteria applicable to this study are set out below.

City of Sydney Council's Interim Floodplain Management Policy has the following general and flood planning level requirements which are applicable to this proposal. They include that:

- proposed commercial buildings and car parking areas must meet the Flood Planning Level requirements outlined in the policy
- proposed car park should not increase the risk of vehicle damage by flooding inundation
- proposed commercial development or car parking areas should not increase the likelihood of flooding on other developments, properties or infrastructure
- developments which have a lifespan of more than fifty years shall consider the impact due to sea level rise and impacts due to increased rainfall intensities
- the Flood Planning Level for commercial developments would be the one per cent Annual Exceedance Probability (1% AEP) flood event
- the Flood Planning Level for below ground garage/ car park would be the greater of the Probable Maximum Flood (PMF) event, or the 1% AEP flood level with an allowance for freeboard of 0.5 metres
- the Flood Planning Level for retail developments would be a balance of protection from the 1% AEP flood event and achieving urban design outcomes.

Sydney Metro West Rail infrastructure, stations, precincts and operations between Westmead and Sydney CBD proposal requirements (derived from various sources) expect that:

- Climate change would be incorporated directly into the flood assessment with:
    - Allowance for climate change consistent with Representative Concentration Pathways (RCP) 8.5 out to 2100 (IPCC, 2014)
    - Sea level rise of 0.9metres over a period to 2100 (Sydney Metro, 2020)
    - Rainfall intensity uplift 21.3% determined accordance with Australian Rainfall and Runoff 2019 (Ball et al, 2019).
- Critical infrastructure[1] would be protected from the PMF event, or the 1% AEP flood event level with an allowance for freeboard of 0.5 metres (whichever is greater)
- The flood events considered include the five per cent Annual Exceedance Probability with climate change allowance flood event (5% AEP climate change flood event), one per cent Annual Exceedance Probability with climate change allowance flood event (1% AEP climate change flood event) and Probable Maximum Flood event (PMF event)
- increases in flood levels due to temporary and permanent infrastructure are minimised during flood events up to and including the 1% AEP climate change flood event
- Not worsening of flooding on properties or infrastructure up to the 1% AEP climate change flood event where not worsening is defined as:
    - A maximum increase in flood levels of 50mm.
    - A maximum increase in time of inundation on one hour.
    - No increase in potential soil erosion and scouring from any increase in flow velocity.
- Dedicated evacuation routes would not be adversely impacted in flood events up to and including the PMF flood event
- Relevant Business and System Requirements Specification items.

Consequently, the resulting criteria which would apply to the Hunter Street OSD are as follows:

- The proposal shall not have an adverse impact on the flood immunity of the Hunter Street (Sydney CBD) Station including the shared loading dock and car parking facilities and any services or other access points which connect to these areas or any other areas of the metro station
- proposed commercial development would not increase the likelihood of flooding on other developments, properties or infrastructure
- the Flood Planning Level for commercial developments would be at least equal to the 1% AEP climate change flood event

[1] Hunter Street (Sydney CBD) Station including the shared basement car parking facilities and any services or other access points which connect to these areas or any other areas of the metro station

- the Flood Planning Level for retail developments would be a balance of protection from the 1% AEP climate change flood event and achieving urban design outcomes.

2.2 Methodology

A TUFLOW one dimensional/two dimensional hydraulic model, from relevant studies indicated in Section 3.3, has been adapted for use in this assessment. Two scenarios are considered – "baseline" (without Hunter Street OSD) and "with Hunter Street OSD". The baseline case was amended to reflect work that would be carried out under the previous Sydney Metro West planning application (Sydney Metro, 2021) i.e. this would be the end state scenario. The "with Hunter Street OSD" scenario would be no different as there is no additional footprint as it is fully contained within the Hunter Street (Sydney CBD) Station. Both scenarios reflect flood protection measures to protect the flood immunity of the metro station.

These models apply rainfall directly to the digital elevation model (DEM) therefore no flow hydrographs need to be derived separately. The Australian Rainfall and Runoff Datahub (Babister et al, 2016) was the source of the hydrological modelling parameters used to update the hydrology (rain-on-grid) aspect of the hydraulic models as indicated below.

Table 2-1 Hunter Street OSD rainfall intensity-frequency-duration

Duration	63% AEP	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
5 min	2.08	2.35	3.18	3.76	4.33	5.10	5.70
10 min	11.2	12.7	17.3	20.5	23.7	27.9	31.1
15 min	14.0	15.8	21.7	25.7	29.6	34.8	38.9
20 min	16.0	18.1	24.8	29.3	33.8	39.7	44.3
25 min	17.6	19.9	27.1	32.0	36.9	43.4	48.5
30 min	19.0	21.4	29.0	34.2	39.4	46.4	51.8
45 min	22.0	24.6	33.1	39.1	45.0	52.9	59.0
1 hour	24.2	27.1	36.2	42.5	48.9	57.6	64.4
1.5 hour	27.7	30.8	40.8	47.9	55.1	65.0	72.8
2 hour	30.5	33.8	44.6	52.4	60.3	71.2	80.0
3 hour	35.0	38.8	51.2	60.1	69.3	82.2	92.6
4.5 hour	40.7	45.1	59.7	70.3	81.3	96.9	110
6 hour	45.4	50.5	67.3	79.5	92.3	110	125
9 hour	53.5	59.7	80.7	96.1	112	135	153

Duration	63% AEP	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
12 hour	60.2	67.6	92.4	111	130	157	178

Increases to rainfall intensity to reflect the impact of climate change have been derived from the approach outlined in ARR2019. The guidance for practitioners in ARR2019 on climate change considerations derives from a number of sources including the findings from the fifth assessment report of the Intergovernmental Panel on Climate Change. Therefore, it is considered appropriate to apply the approach outlined in ARR2019 to reflect the impact of climate change on rainfall intensities.

Further detail on the development of these models is contained in supporting documentation for the CSSI Stage 2 (Sydney Metro, 2021) and Stage 3 (Sydney Metro, 2022) of the planning approval process.

Flood maps have been developed with flood hazard categories in accordance with the Australian Institute of Disaster Resilience (2017b) Guideline 7-3. The hazard classifications are based on a combination of flow velocity and flood depth as shown on the diagram in Figure 2-1.

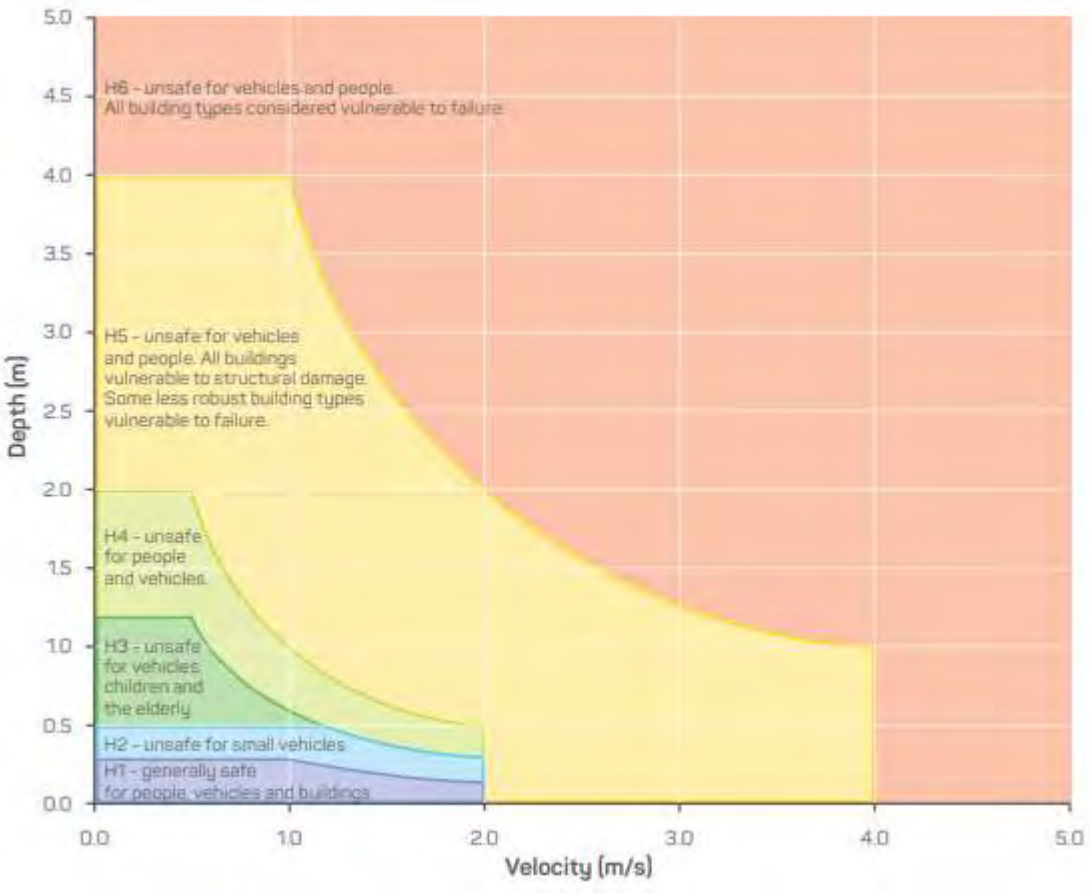

Figure 2-1 Flood hazard classifications

The hazard conditions shown in the figure are defined below:

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people

- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

2.3 Assumptions, dependencies and constraints

Modelling and analysis outlined in this report has been carried out based on the methodology previously outlined and in the context of the available information at the time of the assessment.

The Ecologically Sustainable Development Report (SMWSTEDS-SMD-SCB-SN100-SB-RPT-044003) outlines the approach to achieving a climate responsive design for the Hunter Street OSD.

The Climate Change Risk Assessment Report (SMWSTEDS-SMD-SW000-SB-RPT-044002) summarise the climate change risk assessment carried out to date on the broader Sydney Metro West project.

Technical assumptions, dependencies and constraints for Hunter Street (Sydney CBD) Station are contained within the RAIDOC register (SMWSTEDS-SMD-NL000-SN-REG-044001).

These have been used in developing the flooding design, additionally they have been used in detailing future design work that is required in future stages.

2.4 Consultation

Due to the preliminary nature of the civil design so far, consultation has been limited. More thorough co-ordination and consultation would be required in future design stages to ensure the design is compliant with each authority and stakeholder requirements.

3 Baseline investigations

3.1 Existing site description

The Hunter Street (Sydney CBD) integrated station development is located in the northern part of the Sydney CBD, within the commercial core precinct of Central Sydney, within the Sydney Local Government Area.

The east site is located on the corner of O'Connell Street, Hunter Street and Bligh Street adjacent to the existing CBD and South East Light Rail that extends from Circular Quay to Moore Park, Kensington and Kingsford. The east site is adjacent to the new Martin Place Station which forms part of the Sydney Metro City and Southwest, Australia's biggest public transport project connecting Chatswood to Sydenham and extending to Bankstown.

The west site is located on the corner of George and Hunter Street, including De Mestre Place and land predominantly occupied by the existing Hunter Connection retail plaza.

3.2 Catchment and topography

Hunter Street (Sydney CBD) Station is situated in an urban area, heavily disturbed by human activity and falls towards Pitt Street from south to north. The disturbed areas are often landscaped and artificially drained. Local relief is generally usually less than two metres, but up to 10 metres at some locations. The urban areas surrounding Hunter Street Station (Sydney CBD) have slopes of less than three per cent.

3.3 Existing flood conditions

The City Area Catchment Flood Study (BMT WBM, 2014) describes flooding behaviour across the broader area in which the Hunter Street OSD would be located and along with the City Area Catchment Floodplain Risk Management Plan (WMAwater, 2016) establish a basis for future development within this floodplain.

George Street and nearby Pitt Street are floodways in all events considered. Hunter Street and various lanes off Pitt Street become floodways in the PMF flood event.

4 Flooding assessment and discussion

4.1 Baseline scenario

The baseline scenario was modelled for the three design events noted in section 2.2. Flood depth and flood hazard mapping are presented in Appendix A – Baseline Flooding Conditions. A summary of the baseline scenario results for the Hunter Street (Sydney CBD) Station end state is presented below.

- Flood depths for each site are as follows:
  - West site: flood depths up to 0.35 metres occur in the 1% AEP Climate Change flood event at the north eastern portion of the site between the northern site boundary and Hunter Street. However, the 5% AEP Climate Change flood event has much shallower depths up to 0.04m. Outside of the northern boundary, there are flood depths up to 0.2 metres between the western boundary and George Street in the 1% AEP Climate Change flood event. A similar trend is seen in the PMF flood event with the worst-case flooding occurring at the northern boundary with depths up to one metre. The western boundary is inundated up to 0.4 metres in the PMF flood event.
  - East site: flood depths up to 0.06 metres occur in the 5% AEP Climate Change flood event and 0.25 metres occur in the 1% AEP Climate Change flood event between the southern boundary and Bligh Street. Elsewhere Hunter Street is inundated up to 0.07 metres in the 1% AEP Climate Change flood event and O'Connell Street experiences less than 0.1 metres. Flooding with the 5% AEP Climate Change flood event in these roads are very minor (0.02m). In the PMF flood event both Hunter Street and the southern portion of the site have flood depths up to 0.3 metres whilst O'Connell Street has depths up to 0.15 metres.
- Flood hazard categorisation for each site are outlined below:
  - West site: In the 5% AEP Climate Change flood event all roads surrounding the site are within a low H1 hazard category. In the 1% AEP Climate Change flood event the northern portion of the site along Hunter Street has a H5 hazard along with a small section of George Street. The remainder of the site surrounds appears to be within the low H1 hazard category (generally safe for vehicles, people and buildings) and as expected, the PMF flood event produces higher hazard categories of H5 and H6 with only pockets of the streets falling within the low hazard (H1) category.
  - East site: In the 5% AEP Climate Change flood event all roads surrounding the site are within a low H1 hazard category. In both the 1% AEP Climate Change and PMF flood events, Hunter Street falls within a H5 hazard category whereas O'Connell and Bligh Street are both within the H1 hazard category.

4.2 Hunter Street Over Station Development scenario

The Hunter Street OSD scenario was modelled for the three design events noted in section 2.2. Flood depth and flood hazard mapping are presented in Appendix B – Post-developed flooding conditions.

A summary of the Hunter Street OSD scenario results is presented below for the 5% AEP climate change, 1% AEP climate change and PMF flood events:

- Hydraulic impact maps included in Appendix C – Post-developed flood impacts show that the proposal has negligible impacts on existing flooding behaviour. Generally, there is no increase in flood levels in all events due to the Hunter Street OSD.
- No additional private properties would be impacted.

These results are premised on the basis that flood protection measures are employed to provide the necessary protection to critical infrastructure as outlined in Section 2.1. At both the east and west site, the loading dock and car parking areas would meet the requirement outlined in the *Interim Floodplain Management Policy* as the immunity requirements are the same as for the metro station. At the east site, flood protection measures would ensure that the entry to the commercial and retail areas off Bligh Street would exceed the requirements outlined in the *Interim Floodplain Management Policy.* At the west site, flood protection measures would ensure that access to the retail from the George Street level concourse would have greater than the necessary requirement outlined in the *Interim Floodplain Management Policy.* Flood protection measures in these instances would provide immunity to the 1% AEP climate change flood event with 0.5 metres freeboard with the exception of the west loading dock entrance which would provide immunity to the PMF event.

It is noted that the design of the flood protection measures is ongoing with some details requiring further resolution including the interface between the west site and the existing building on George Street.

The commercial area at the west site would meet the requirements of the *Interim Floodplain Management Policy* though without further flood protection this area would need to be quarantined from the flood protection measures to protect the immunity of the metro station.

At the west site, the floor level of the retail areas on Hunter Street is consistent with the 1% AEP Climate Change flood event and therefore satisfies the *Interim Floodplain Management Policy*. At the east site, the retail areas off O'Connell and Hunter Street have been located at street level to facilitate urban design outcomes for street level activation. They would require additional provisions, as outlined in Section 5.2, to ensure occupants could shelter in place safely.

These results demonstrate that the Hunter Street OSD would not adversely affect flood behaviour resulting in affectation of other properties assets and infrastructure and would generally provide the required flood immunity of the *Interim Floodplain Management Policy* and where that is not the case mitigation measures are outlined in Section 5.2.

The impact of flood protection measures for the metro station, such as flood barriers, at the street entrances of the Hunter Street (Sydney CBD) Station has been accounted for in the modelling and is generally associated with the separate Sydney Metro West planning application.

Components of the previous Sydney Metro West planning application are subject to further design development, and changes may be made during the ongoing design which would take into account the outcomes of community and stakeholder engagement and environmental investigations.

5 Mitigation measures

5.1 Flood planning levels

As outlined in Section 4.2, the subject sites require flood protection in order to achieve the desired outcomes. Active flood measures would be installed where required at locations such as loading docks, building entrances and lift structures that are connected to the metro station. Depending on final design levels, alternate measures may be suitable such as sloping the car parking entrance floor upwards to the required flood protection height before sloping down to the back of house areas. Car parking areas share facilities with the metro station and therefore require the same immunity. Retail areas set at levels below the 1% AEP climate change flood event to support street activation would require access to higher ground such as an elevated area within the premises.

Where active flood mitigation measures are proposed, they would be employed such that:

- Flood waters would be prevented from entering the station and excluded from underground areas.
- The solution at each access point includes a secondary redundant measure in case of failure of the primary measure.
- Operations, maintenance and replacement plans are developed to ensure that these measures continue to be in full working order for the life of the metro station.

Flood protection measures would be required to be implemented to protect the metro station at the following locations:

- Bligh Street station and OSD entrance.
- O'Connell Street entrance.
- East Basement entrance from O'Connell Street
- George Street station and OSD entrance.
- Hunter Street station entrance.
- West basement entrance from Hunter Street.

The indicative Flood Planning Level[2] (FPL) at each of the sites is shown on Figure 5-1, Figure 5-2, Figure 5-3 and Figure 5-4.

[2] The following figure notes should be read in conjunction with the referenced figures:
- Red dashed outline indicates lot boundary
- Blue outline indicates areas which are considered the extent of the metro station
- Grey shading indicates plant areas.

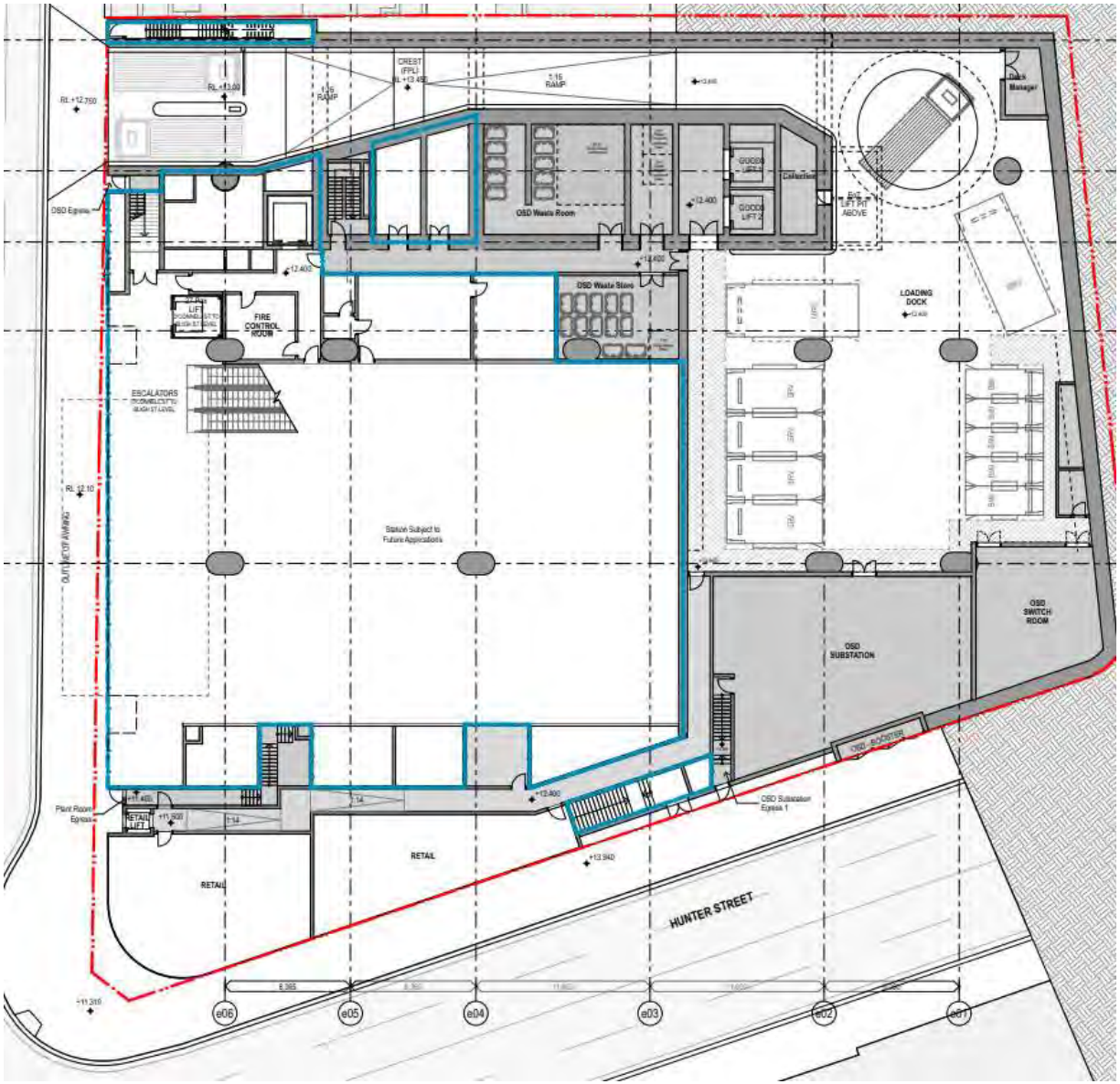

Figure 5-1 East Hunter St Station and OSD ingress location at O'Connell Street

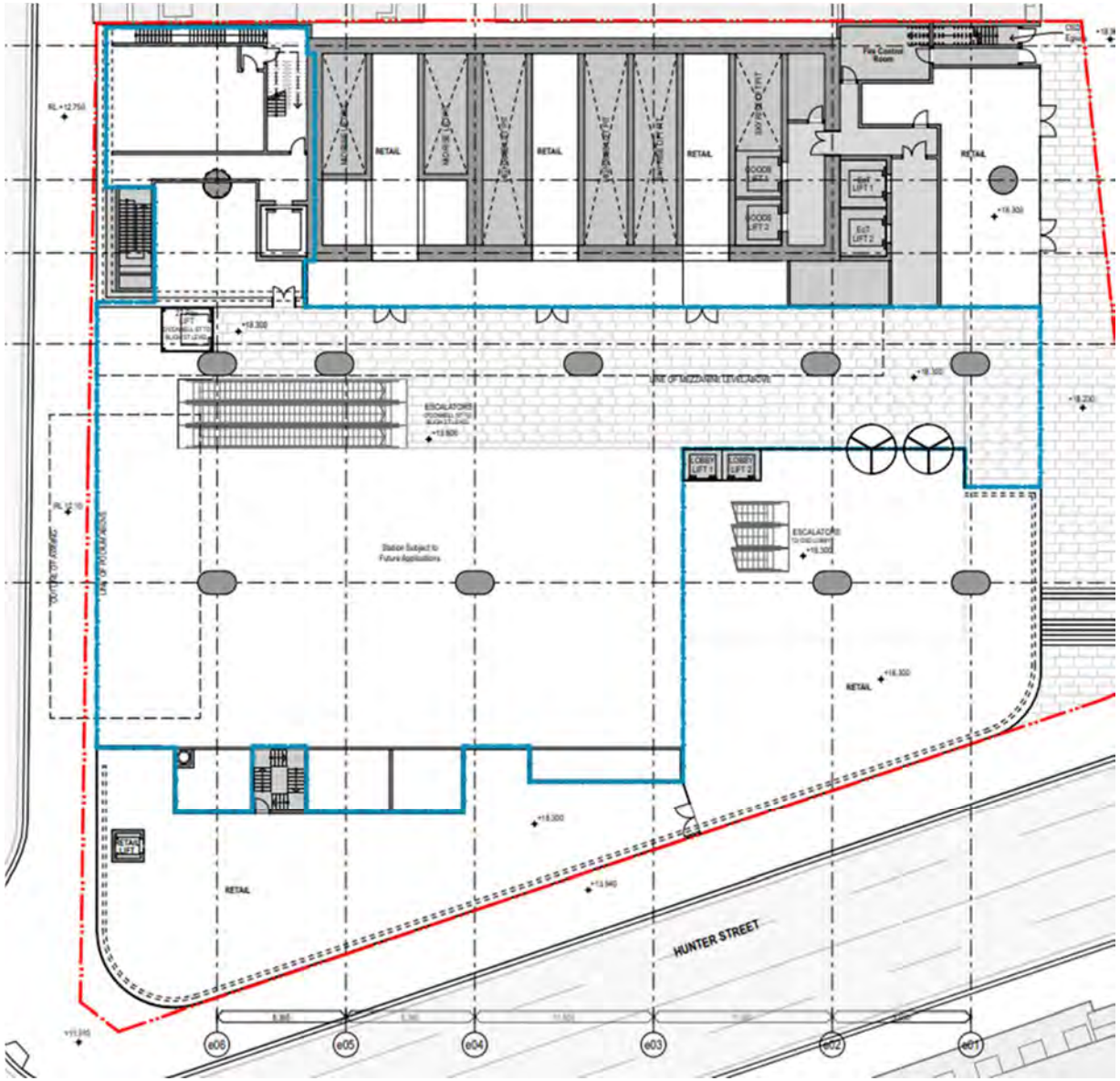

Figure 5-2 East Hunter St Station and OSD ingress locations at Bligh Street

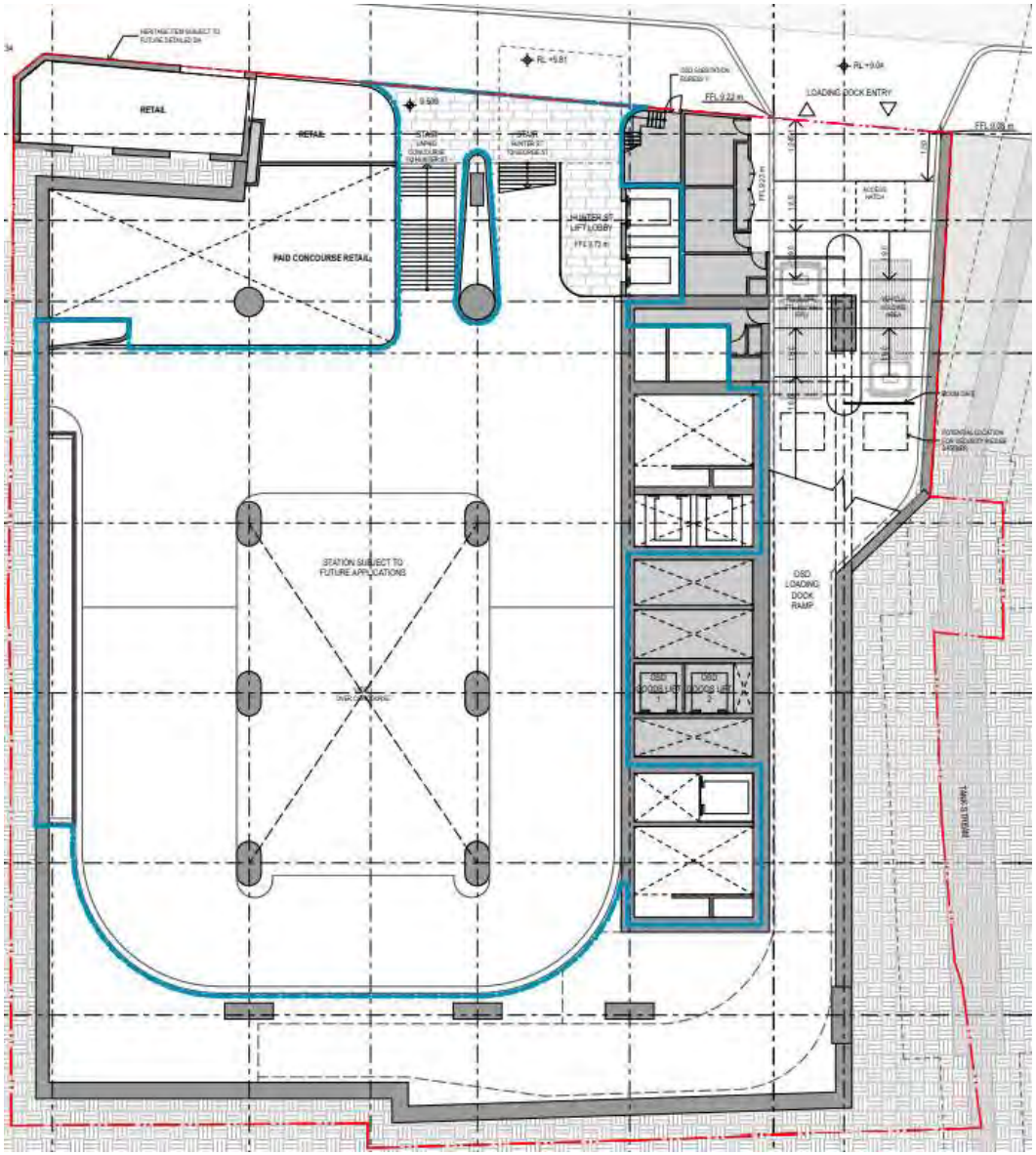

Figure 5-3 West Hunter St Station and OSD ingress locations at Hunter Street

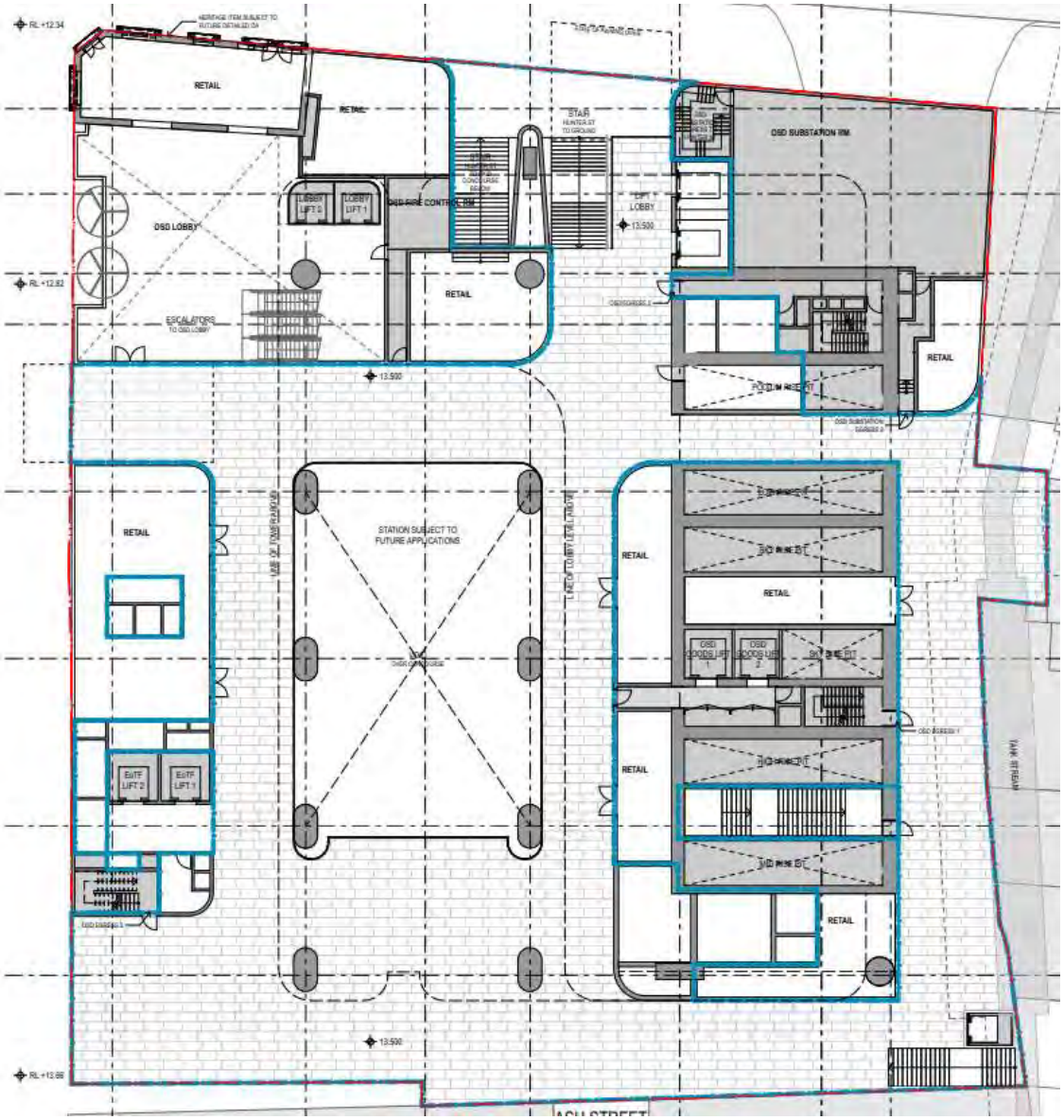

Figure 5-4 West Hunter Street Station and OSD ingress locations at George Street

5.2 Flood emergency management

Passive or active flood measures are proposed at both sites. The active flood measures proposed are triggered from rising flood waters. When activated people would not be able to enter or leave the metro station. The construction of the metro station is under a separate planning approval but it is suggested that an appropriate operational response for the metro station is developed to manage the number of people who may be exiting the station during a flood event.

Any residual risk to the retail spaces would require an operational flood emergency response plan. Future work should be undertaken to:

- Develop an operational flood emergency management response plan. The plan would, at a minimum confirm the most appropriate response strategy, nominate shelter locations or muster points, plot the recommended evacuation routes, consider the timeline to execute the plan, identify trigger conditions for initiating the plan, and assign specific responsibilities.
- Consult the local State Emergency Service and other emergency services.
- Communicate the plan to the building occupants.

Sydney & North Sydney CBD Central Business Districts Evacuation Management Subplan applies to the subject sites. Being co-located with the Hunter Street (Sydney CBD) Station would afford easy access for building occupants if there was a city or precinct wide evacuation order.

5.3 Input to design guide

The following overarching objectives and guidelines relating to the flood mitigation strategy have been recommended for inclusion in the Design Guide for Hunter Street, Sydney Metro to capture the issues outlined in this report and ensure that they are adequately addressed.

Objectives

- Flood immunity of the development must be consistent with the City of Sydney's Interim Floodplain Management Policy
- Detailed design of this development to address flooding must be consistent the relevant best practice guidelines
- Detailed design of this development to address flooding must appropriately account for climate change
- The development must be designed to protect against flood impacts in such as way that it does not compromise the flood immunity requirements of the co-located Hunter Street (Sydney CBD) Station
- Development must be designed to ensure that there is no worsening of flooding to existing properties or infrastructure, up to the 1% AEP climate change flood event, caused by the impact of the development
- Development must be designed to ensure that people can egress safely

Guidance

- The flood immunity of the co-located Hunter Street (Sydney CBD) Station shall be to a level which is the greater of either the PMF or 1% AEP climate change with 500mm freeboard flood events
- The co-located Hunter Street (Sydney CBD) Station flood immunity shall apply to common areas such as carpark/loading dock and any access openings (for

people, vehicles and/or services) which would allow water to enter any part of the metro station

- The design of active flood measures must ensure that:
    - Flood waters would be prevented from entering the metro station and excluded from all underground areas connected to the metro station
    - The solution at each access point includes a secondary redundant measure in case of failure of the primary measure
    - there is ready access to undertake the maintenance specified by the supplier and that elements that would require replacement over the life of the design can be accessed for replacement to occur as and when required during operational period of the metro station
    - the inclusion of such measures at relevant access points does not interfere with the egress strategy nor does it bring people into areas where they would be potentially exposed to dangerous flood waters
    - there is adequate space for people to shelter in place
- Operations, maintenance and replacement plans are developed to ensure that these measures continue to be in full working order for the life of the metro station
- Emergency management arrangements would need to be developed to manage flood risks to people and vehicles accessing the development. Ideally, these arrangements would be coordinated with emergency management arrangements for the metro station.

6 Conclusion

This Flooding Assessment report has been written to satisfy the planning requirements of the City of Sydney Council's *Interim Floodplain Management Policy* in support of the Hunter Street Planning Proposal Request.

Flood assessment criteria have been identified and hydraulic flood models were developed to assess the flooding for the subject site. The outcomes are consistent with the *Interim Floodplain Management Policy* and the existing floodplain management plan.

These results demonstrate that the Hunter Street OSD would not adversely affect flood behaviour resulting in affectation of other properties assets and infrastructure and would generally provide the required flood immunity of the *Interim Floodplain Management Policy* and where that is not the case would make provision for shelter in place arrangements.

These results are premised on the basis that flood protection measures would be employed to provide the necessary immunity to critical infrastructure for the Hunter Street (Sydney CBD) Station as part of the Sydney Metro West (SSI-22765520) planning application and that the design and operation of the Hunter Street OSD would not compromise metro station flood immunity.

Any residual risk to the retail spaces would require an operational flood emergency response plan.

Input to the Hunter Street Station OSD Design Guidelines has also captured the relevant requirements to manage compliance with the *Interim Floodplain Management Policy* and the protection the flood immunity of the Hunter Street (Sydney CBD) Station.

7 References

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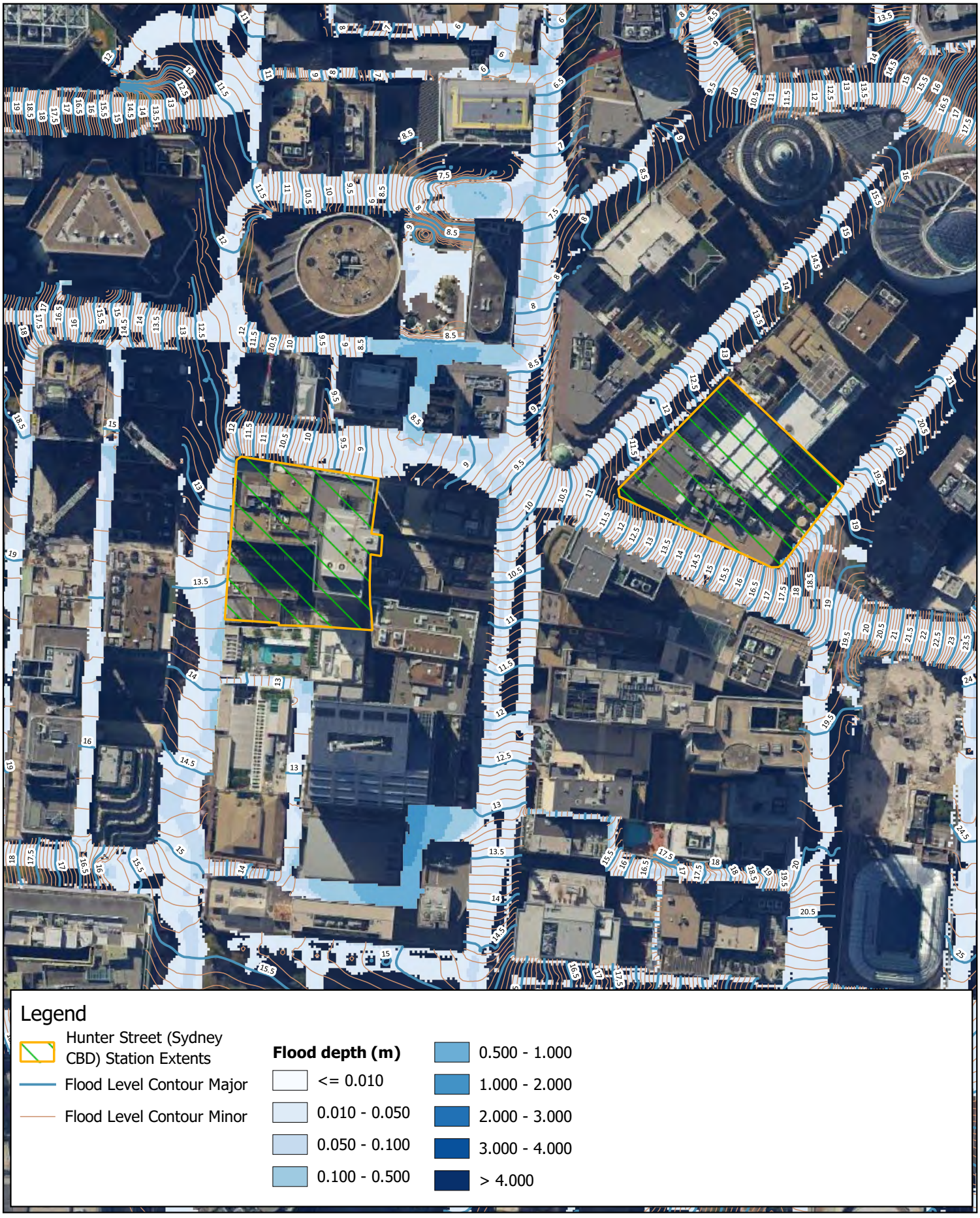
Appendix A – Baseline Flooding Conditions

Appendix A – Baseline Flooding Conditions



TITLE

Figure A-1
5% AEP Baseline Climate Change
Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

TITLE

Figure A-2
5% AEP Baseline Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
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TITLE

Figure A-3
1% AEP Baseline Climate Change Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

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17/12/2021	SH	FH	JM	1 : 2000	1

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Figure A-4
1% AEP Baseline Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

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17/12/2021	SH	FH	JM	1 : 2000	1

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Figure A-5
PMF Baseline Climate Change
Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

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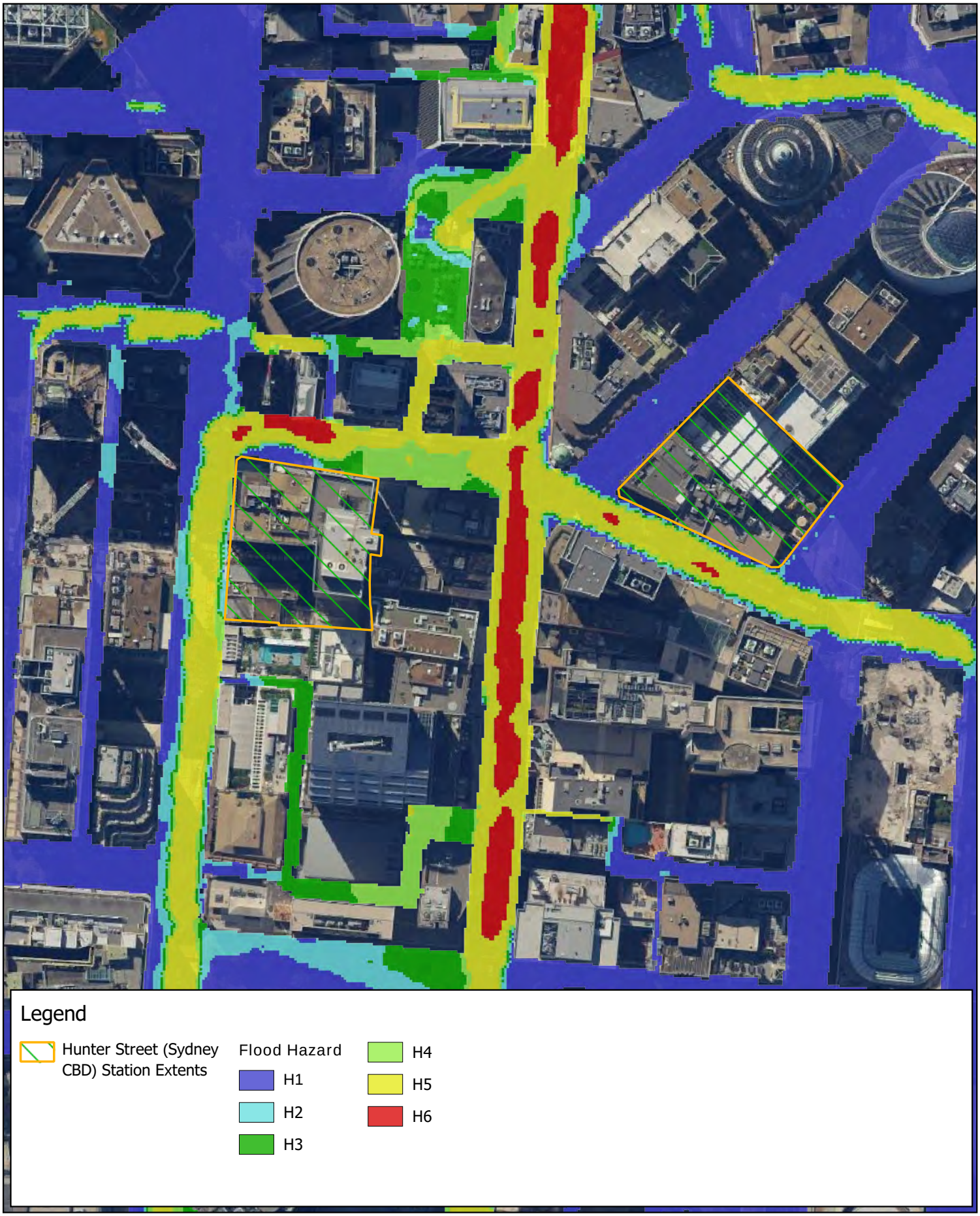

TITLE

Figure A-6
PMF Baseline Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

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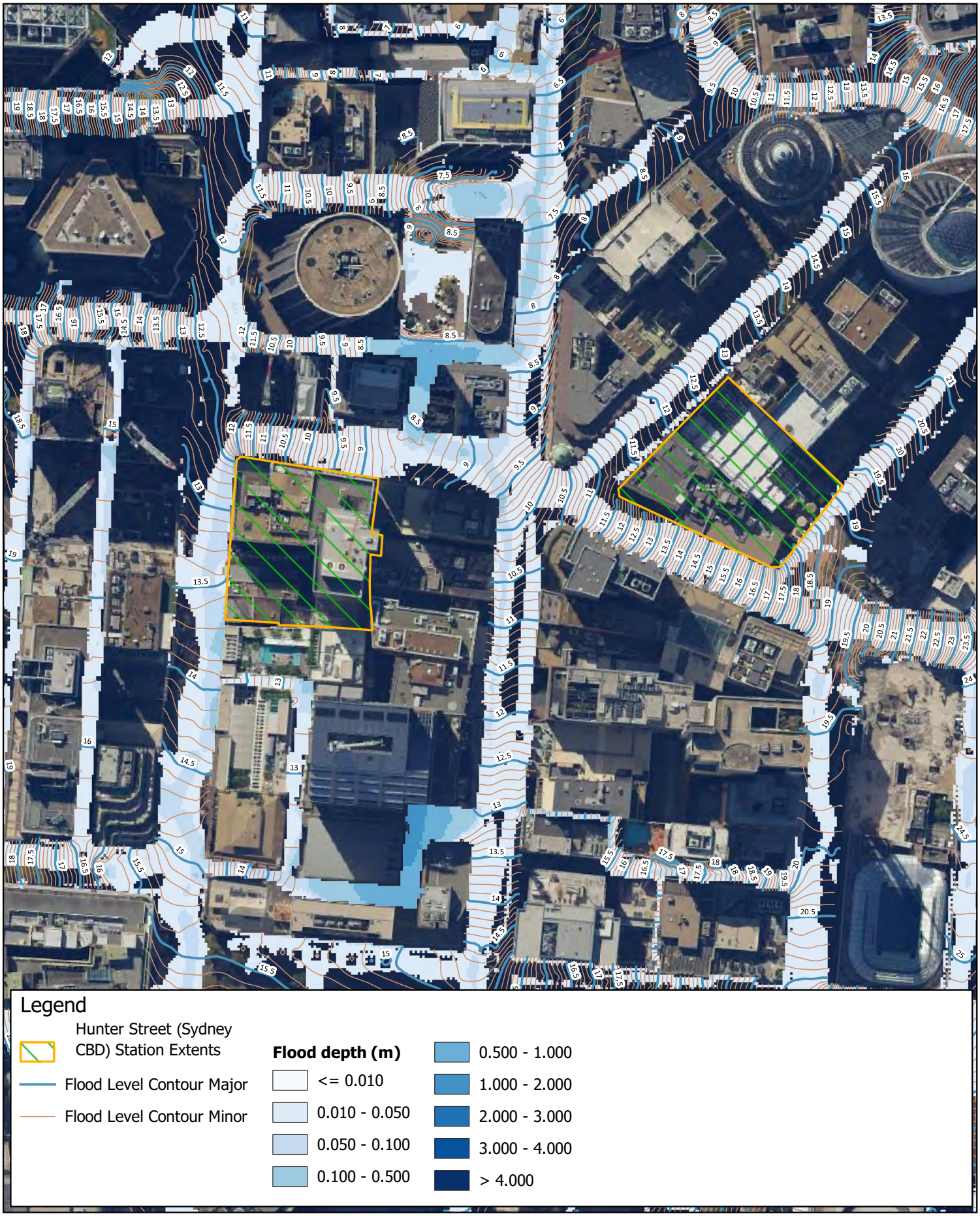
Appendix B – Post-developed flooding conditions

Appendix B – Post-Developed Flooding Conditions



TITLE

Figure B-1
5% AEP Developed Scenario
Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

TITLE

Figure B-2
5% AEP Developed Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

TITLE

Figure B-3
1% AEP Developed Climate Change Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

TITLE

Figure B-4
1% AEP Developed Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

TITLE

Figure B-5
PMF Developed Climate Change Flood Depth

PROJECT

EDS - SWM - Hunter Street

0 50 100 m

NSW GOVERNMENT | sydney METRO

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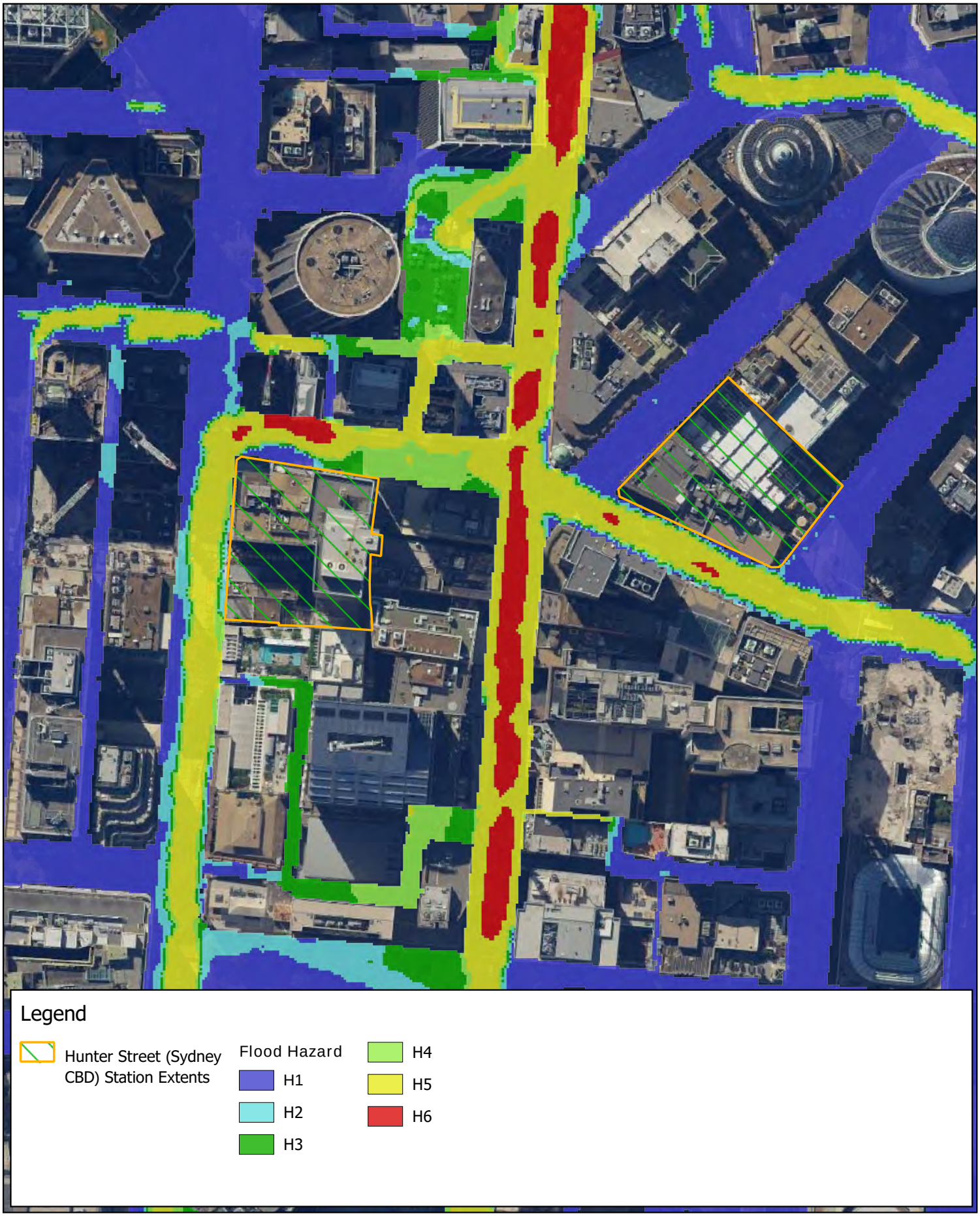


TITLE

Figure B-6
PMF Developed Climate Change Flood Hazard

PROJECT

EDS - SWM - Hunter Street

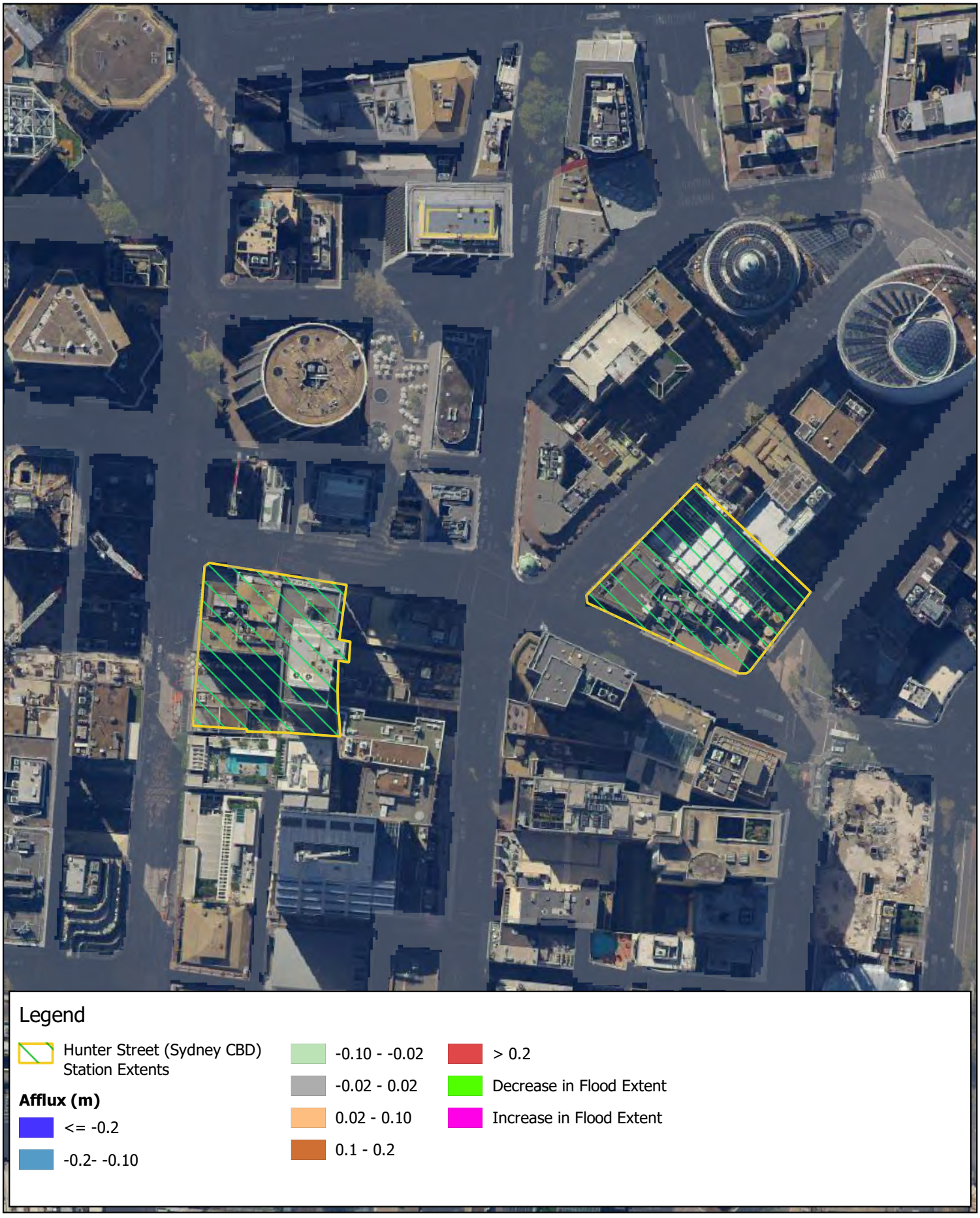
0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
17/12/2021	SH	FH	JM	1 : 2000	1

Appendix C – Post-developed flood impacts

Appendix C – Post-Developed Flood Impacts



TITLE

Figure C-1
5% AEP Developed Climate Change Scenario Flood Impact

PROJECT

EDS - SWM - Hunter St

0 50 100 m

NSW GOVERNMENT | sydney METRO

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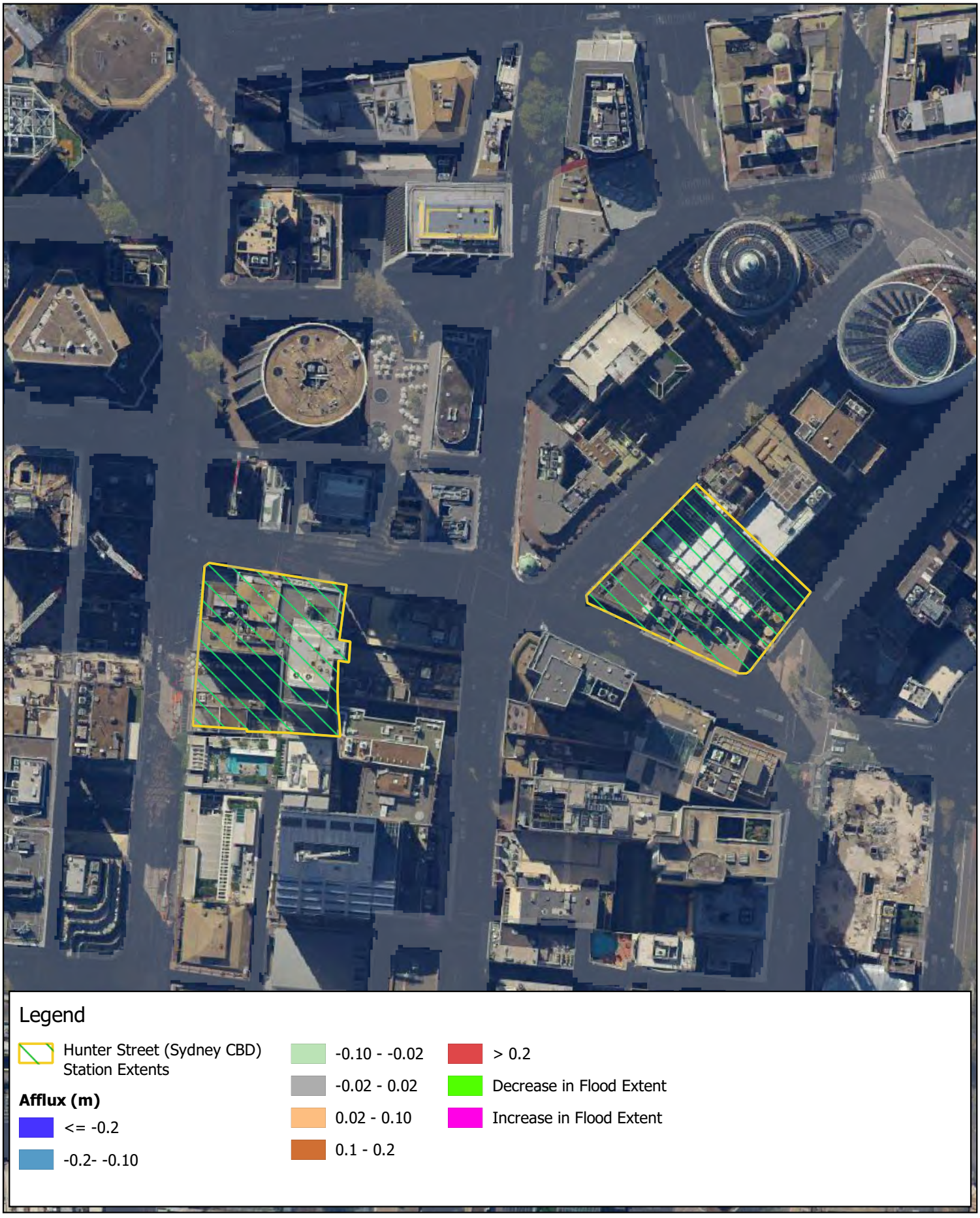

TITLE

Figure C-2
1% AEP Developed Climate Change Scenario Flood Impact

PROJECT

EDS - SWM - Hunter St

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
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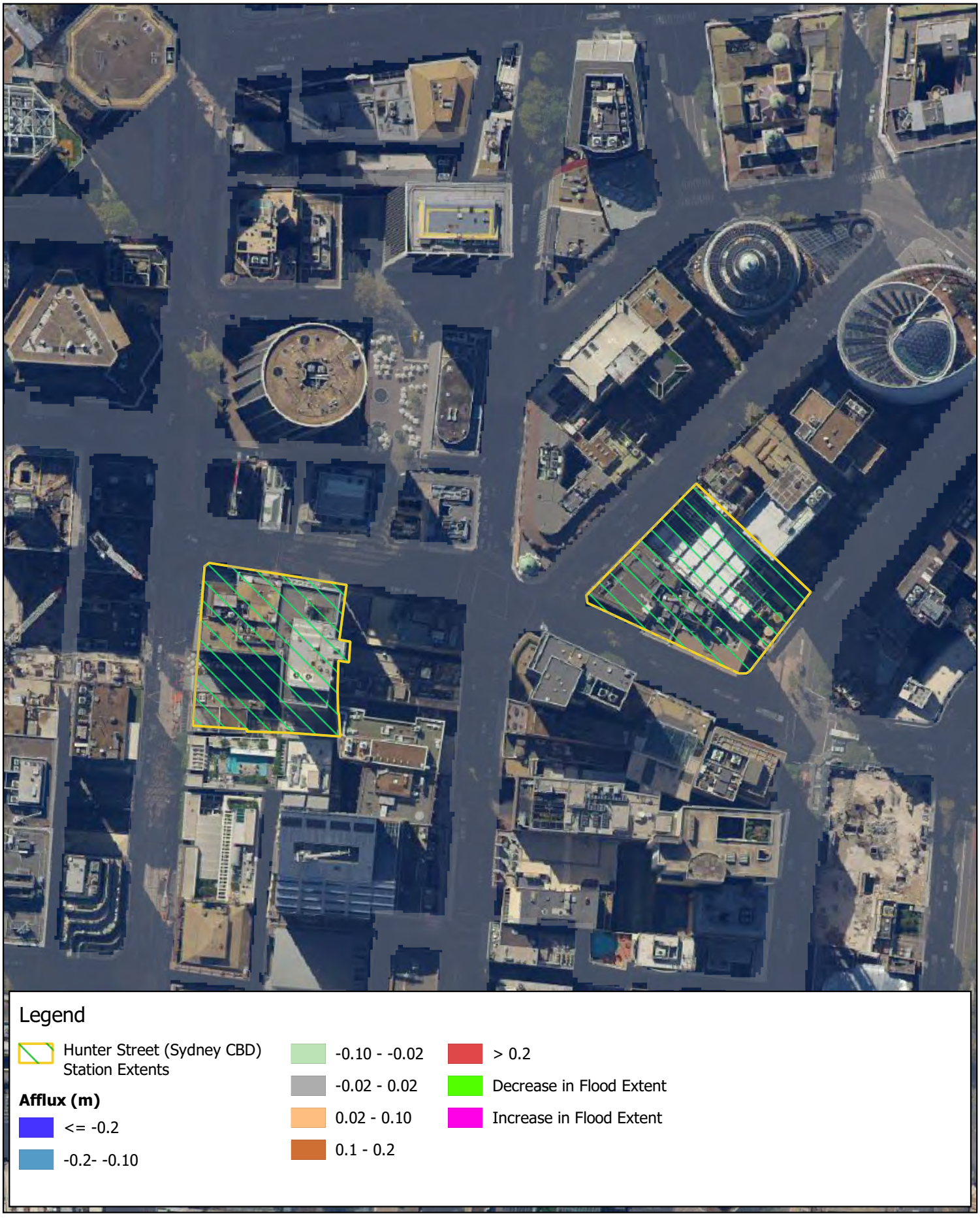

TITLE

Figure C-3
PMF Developed Scenario
Flood Impact

PROJECT

EDS - SWM - Hunter St

0 50 100 m

NSW GOVERNMENT | sydney METRO

Date	Drawn	Check	Approved	Scale	Rev
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