DEPARTMENT OF PLANNING, HOUSING AND INFRASTRUCTURE

PYRMONT AND ULTIMO PLANNING PROPOSAL – FLOOD IMPACT AND RISK ASSESSMENT

FINAL REPORT

AUGUST 2024

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Project Pyrmont and Ultimo Planning Proposal – Flood Impact and Risk Assessment	**Project Number** 124030
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Cover Image: Pyrmont Peninsula looking south, Source: Google Maps 2024

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AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
BW	Blackwattle Bay
CoS	City of Sydney
DCP	Development Control Plan
DH	Darling Harbour
DPHI	NSW Department of Planning, Housing and Infrastructure
EY	Exceedances per Year
FFL	Finished Floor Level
FIRA	Flood Impact and Risk Assessment
FPA	Flood Planning Area
FPL	Flood Planning Level
FRMS&P	Floodplain Risk Management Studies and Plan
LEP	Local Environmental Plan
LGA	Local Government Area
OSD	On-Site Detention
PMF	Probable Maximum Flood
SWC	Sydney Water Corporation

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EXECUTIVE SUMMARY

The City of Sydney has prepared Planning Proposal the sets new planning controls for sites that are under the control of City of Sydney within the suburbs of Ultimo and Pyrmont. The aim of these planning changes is to provide floor space capacity for 8,500 new residents and up to 23,000 new jobs in the area. The Planning Proposal consists of two rezonings in addition to 57 sites in which Local Environmental Plan changes to maximum building height and floor space ratio are proposed. An opportunity for 120 small lots to develop new dwellings fronting rear lanes was identified by City of Sydney and is included in the Planning Proposal. Some of the sites identified are flood prone, and it is therefore necessary to determine whether the Planning Proposal meets the relevant legislative requirements relating to flooding.

NSW Department of Planning, Housing and Infrastructure engaged WMAwater to prepare a flood impact and risk assessment for the Planning Proposal (this document).

The detailed breakdown of the sites in Section 4 show that Pyrmont and Ultimo has varying degrees of flood affectation. It should be noted that the sites that are shown to be flood affected are currently developed and occupied. The most significant constraints for flood affected sites are achieving minimum floor level requirements and site access and evacuation requirements. The Planning Proposal may improve the feasibility of redevelopment in those lots as it may enable less sensitive uses of the ground floor in mixed use developments and increased height restrictions may allow for building floor levels to be raised to meet flood planning level requirements. Redevelopment of some buildings may also enable emergency access to be incorporated, with internal connections enabling flood free frontages to be accessed from any point within the building. In most cases, the requirement for deep soil areas has the potential to improve local flood conditions. The redevelopment of the lots identified is likely to allow for a design that caters for the flood conditions of the site.

WMAwater considers that the Planning Proposal is consistent with the objectives of the Ministerial Directions for flood prone land (see Section 2.2 and Section 6 for detailed discussion). The Planning Proposal is consistent with other relevant legislation and Council's strategic planning framework for flood planning, in that the flood-related development controls enforced through that framework are not significantly altered by the Planning Proposal. It is recommended that consultation is undertaken with relevant public agencies (such as the NSW State Emergency Service, the Department of Climate Change, Energy, the Environment and Water, and the Department of Planning, Housing and Infrastructure) following Gateway determination. Comments from these public agencies regarding specific constraints or development controls can be addressed as part of the site-specific development control plans.

This review does not include detailed flood modelling of potential development or building layouts, and does not constitute a flood impact assessment for specific development sites. Future development proposals for flood prone sites will need to be accompanied by site specific flood assessments demonstrating compliance with Council's flood-related development controls.

1. INTRODUCTION

1.1. Overview

On 29 July 2022, the NSW Government issued a Ministerial Direction to guide the preparation of planning controls for Ultimo and Pyrmont. This was in response to the NSW Government's Pyrmont Peninsula Place Strategy. This strategy aims to provide floor space capacity for 8,500 new residents and up to 23,000 new jobs within Ultimo and Pyrmont. City of Sydney (CoS or Council) subsequently prepared a Planning Proposal (Reference 1) in response to the strategy. The Planning Proposal sets new planning controls for sites that are under the control of CoS. The Planning Proposal consists of two rezonings (1-33 Saunders Street, Pyrmont and 20-28 Bulwara Road, Pyrmont), in addition to 57 sites in which Local Environmental Plan (LEP) changes to maximum building height and floor space ratio (FSR) are proposed. These sites are referred to as the large lot sites. An opportunity for small lot housing fronting rear lanes was identified by CoS and is included in the Planning Proposal. The small lot housing changes will allow the subdivision of land and construction of a secondary dwelling with a frontage to a rear lane of an existing lot. There were 120 small lots identified. The Planning Proposal would facilitate additional capacity for 1,150 new dwellings and 6,000 new jobs.

The NSW Department of Planning, Housing and Infrastructure (DPHI) engaged WMAwater to prepare a flood impact and risk assessment (FIRA) for the Planning Proposal. The FIRA was undertaken in accordance with the 2023 NSW Flood Risk Management Manual (Reference 2). Utilising existing flood information, the flood affectation of each of the sites was reviewed and the proposed changes under the Planning Proposal were assessed against. WMAwater has reviewed and summarised the flood constraints with a view to providing sufficient information for the Planning Proposal to proceed to Gateway Determination.

This review does not include detailed flood modelling of potential development or building layouts, and does not constitute a flood impact assessment for specific development sites. Future development proposals for flood prone sites will need to be accompanied by site specific flood assessments demonstrating compliance with Council's flood-related development controls.

1.2. Study Area

The sites are within the suburbs of Pyrmont and Ultimo, located in the CoS local government area (LGA). The area is fully developed with a mix of terrace housing, medium to high density residential and commercial property. A number of locations within the catchment are flood liable. This flood liability mainly relates to the nature of the topography within the study area as well as the capacity of service provided by drainage assets. The topography of the catchment is steep in the upper areas, steep and undulating in the middle sections, and then flat particularly in the lower regions close to Sydney Harbour. In the upper regions of the catchment the maximum elevation is approximately 60 mAHD, with runoff from the area ultimately discharging at sea level. The Pyrmont Peninsula has a ridge that approximately runs along Mount Street and Bulwara Road. The eastern portion drains to Cockle Bay (Darling Harbour) and the western portion drains to Blackwattle Bay. The very northern end of the peninsula drains to two smaller bays called

Elizabeth MacArthur Bay and Jones Bay.

Urbanisation throughout the catchment occurred prior to the installation of road drainage systems in the 1900s and many buildings have been constructed on overland flow paths or in localised sag points (in some cases with contiguous terrace housing adjacent to the sag point). Due to these drainage restrictions, topographic depressions can cause localised flooding as excess flows have no opportunity to escape via overland flow paths. This creates a significant drainage/flooding problem in many areas throughout the catchment. In other areas that are free to drain, flooding is typically shallow and along streets.

1.3. Sites

The sites subject to this FIRA are located within the Ultimo and Pyrmont study area, located in the CoS LGA. The Planning Proposal relates to 59 large lots and 120 small lots, as shown in Figure 1. For the purpose of showing flood model results in detail, several areas have been identified for which detailed flood results are provided, covering multiple sites. These areas are indicated in Figure 2.

2. BACKGROUND

2.1. Planning Proposal Description

The Planning Proposal (Reference 1) seeks to:

- Rezone 1-33 Saunders Street, Pyrmont from E2 Commercial Centre to MU1 Mixed Use,
- Rezone 20-28 Bulwarra Road, Pyrmont from R1 General Residential to MU1 Mixed Use,
- Amend the maximum height and FSR for 57 large lot sites,
- Enable the subdivision of land and construction of a detached dwelling for 120 small lot sites with a frontage to a rear lane.

In addition to the above, changes are proposed to protect sun access to Wentworth Park, ensure affordable housing contributions and other minor amendments. The implementation of these changes would be through proposed amendments to the Sydney LEP 2012 (Reference 3), in addition to amendments to the Sydney Development Control Plan (DCP) 2012 (Reference 4) for the specific sites within the Planning Proposal.

2.2. Relevant Legislation

The Planning Proposal is required to comply with Directions issued by the Minister for Planning under section 9.1(2) of the Environmental Planning and Assessment Act 1979 (previously section 117(2)). The applicable directions for flooding are found in Direction 4.1 (Reference 5), which commenced 20 February 2023, and are repeated below.

4.1 Flooding

Objectives

The objectives of this direction are to:

(a) ensure that development of flood prone land is consistent with the NSW Government's Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005, and

(b) ensure that the provisions of an LEP that apply to flood prone land are commensurate with flood behaviour and includes consideration of the potential flood impacts both on and off the subject land.

Application

This direction applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.

Direction 4.1

(1) A planning proposal must include provisions that give effect to and are consistent with:

(a) the NSW Flood Prone Land Policy,

(b) the principles of the Floodplain Development Manual 2005,

(c) the Considering flooding in land use planning guideline 2021, and

(d) any adopted flood study and/or floodplain risk management plan prepared in accordance with the principles of the Floodplain Development Manual 2005 and adopted by the relevant council.

(2) A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Conservation Zones to a Residential, Employment, Mixed Use, W4 Working Waterfront or Special Purpose Zones.

(3) A planning proposal must not contain provisions that apply to the flood planning area which:

(a) permit development in floodway areas,

(b) permit development that will result in significant flood impacts to other properties,

(c) permit development for the purposes of residential accommodation in high hazard areas,

(d) permit a significant increase in the development and/or dwelling density of that land,

(e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,

(f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require development consent,

(g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or

(h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.

(4) A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which:

(a) permit development in floodway areas,

(b) permit development that will result in significant flood impacts to other properties,

(c) permit a significant increase in the dwelling density of that land,

(d) permit the development of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,

(e) are likely to affect the safe occupation of and efficient evacuation of the lot, or

(f) are likely to result in a significantly increased requirement for government spending on emergency management services, and flood mitigation and emergency response measures, which can include but not limited to road infrastructure, flood mitigation infrastructure and utilities.

(5) For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.

Consistency

A planning proposal may be inconsistent with this direction only if the planning proposal authority can satisfy the Planning Secretary (or their nominee) that:

(a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant council in accordance with the principles and guidelines of the *Floodplain Development Manual 2005*, or

(b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the *Floodplain Development Manual 2005* or

(c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of *the Floodplain Development Manual 2005* and consistent with the relevant planning authorities' requirements, or

(d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

Note: In this direction:

(a) "flood prone land" "flood storage" "floodway" and "high hazard" have the same meaning as in the Floodplain Development Manual 2005.

(b) "flood planning level" "flood behaviour" and "flood planning area" has the same meaning as in the Considering flooding in land use planning guideline 2021.

(c) Special flood considerations are outlined in the Considering flooding in land use planning guideline 2021 and an optional clause in the *Standard Instrument (Local Environmental Plans) Order 2006*.

(d) Under the floodplain risk management process outlined in the NSW Government's Floodplain Development Manual 2005, councils may produce a flood study followed by a floodplain risk management study and floodplain risk management plan.

Date commenced: 20 February 2023

The directions require the development to be consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (Reference 6), as per clause 1. It is recognised that the NSW Government released the Flood Risk Management Manual (Reference 7) in June 2023 (after the directions commenced), and this document supersedes the 2005 Floodplain Development Manual. The underlying principles of the manual, however, remain similar. The primary objective of NSW Flood Risk Management, as expressed within the NSW Flood Prone Lands Policy (Reference 7, page 2) is as follows:

> "*To reduce the impact of flooding and flood liability on communities and individual owners and occupiers flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. In doing so, community resilience to flooding is improved.*"

The NSW Flood Prone Land Policy, as produced within the 2023 Flood Risk Management Manual (Reference 7) is consistent with that first introduced in 1984, which places the primary responsibility for implementation on local councils. The implementation of flood risk management in the relevant areas of CoS is through the Sydney LEP 2012 (Reference 3) and Sydney DCP 2012 (Reference 4). While the general principles and objectives of flood management are contained in these documents, it is CoS's 2014 Interim Floodplain Management Policy (Reference 8) that contains specific controls. These are to ensure that any new development will not experience undue flood risk and existing development will not be adversely flood affected through increased damage or hazard as a result of any new development. Hence, enforcing compliance with the Interim Floodplain Management Policy is the primary mechanism by which CoS ensures that development will be consistent with the NSW Flood Prone Land Policy and the principles of the 2005 Floodplain Development Manual and new 2023 Flood Risk Management Manual.

In general, there are three floodplain management principles for new developments:

1. Ensuring that a development is adequately protected from flooding by:
    a. Setting minimum floor levels to protect new development from inundation to an acceptable level of risk (typically referred to as the flood planning level (FPL)).
    b. Ensuring flood compatible materials are used for building and electrical components below the FPL.

   c. Ensuring that developments can withstand the forces of floodwater including hydrostatic pressure, hydrodynamic pressure, impact of debris and buoyancy forces.
2. Ensuring that a development does not adversely affect flood behaviour on neighbouring properties considering:
   a. Diversion of floodwaters or interference with existing flood regimes.
   b. Displacement of floodwater by filling within the floodplain.
   c. Changes to velocity and duration of inundation.
3. Minimise the risk to life by considering (in addition to principle 1 and 2):
   a. Management of the residual risk at the site when flood levels exceed the floor level. The two responses are off-site evacuation and shelter-in-place (or vertical evacuation).
   b. Considering access to and from the site during a flood event, for both vehicles and people. If isolated, this includes consideration of the duration of isolation.

These three principles are espoused within the CoS Interim Floodplain Management Policy.

2.3. Previous Studies

The Planning Proposal sites cover two catchments, for which CoS has prepared flood studies and floodplain risk management studies and plans (FRMS&Ps), as described below. Due to the difference in age and adopted modelling techniques, the two catchment models have differing outputs produced by the studies, which is also discussed below.

2.3.1. Darling Harbour Catchment Flood Study

The Darling Harbour Catchment Flood Study (Reference 9) was undertaken by BMT WBM on behalf of CoS, in accordance with the NSW Government's Flood Policy. The study defined the existing flood behaviour in the Darling Harbour (DH) catchment (covering approximately 307 hectares) through the establishment of computer models. The study adopted Australian Rainfall and Runoff (ARR) 1987 guidelines (Reference 10) and developed a 'direct rainfall' TUFLOW model, in which rainfall is applied directly within the hydraulic model to simulate depths, levels and velocities of floodwater. The model covered the entire DH catchment (including the eastern half of the Pyrmont peninsula) and included features such as roads, buildings and the drainage network, comprising open channels, covered channels, culverts, subsurface pipes and pits.

The majority of the trunk drainage is owned by Sydney Water Corporation (SWC) and CoS. Two historical flood events (8 November 1984 and 26 January 1991) were used for model calibration and the 8 March 2012 event for model verification. The model was found to provide a good representation of the observed flood behaviour. Design flood behaviour for the 2 year average recurrence interval (ARI), 5 year ARI, 10% annual exceedance probability (AEP), 5% AEP, 2% AEP, 1% AEP, 0.2% AEP and probable maximum flood (PMF) events were defined using the model. The study also undertook sensitivity testing of adopted model parameters. One of the 'hotspots' identified by the study was Pyrmont Street between Jones Bay Road and Union Street, within the Planning Proposal study area. This is a trapped low point which is sensitive to pit

blockage. The pipes have 5 year ARI capacity, however, the peak depth increases by 0.7 m from the 5 year ARI to 10% AEP event (driven by blockage assumptions) and the flood depth exceeds 1 m in the 1% AEP event.

2.3.2. Darling Harbour Catchment Floodplain Risk Management Study

The study (Reference 11) followed on from the Darling Harbour Catchment Flood Study and was undertaken in accordance with the NSW Government's Flood Policy. A full assessment of the existing flood risk in the catchment was carried out, including flood hazard across the catchment, flood function, over floor flooding of residential, commercial and industrial properties, road flooding and emergency response during a flood event. The study utilised the model developed for the flood study, with only minor updates made to the model. This is the latest catchment-wide flood modelling that has been undertaken for the DH catchment and the flood model results produced as part of this study were utilised for this FIRA.

The study investigated flood risk mitigation options and one option was proposed for Pyrmont Street (FM-DH06), which consisted of additional pit and pipe infrastructure to drain the Pyrmont Road sag point. This is discussed further in Section 5.4.1 and was adopted with a low priority in the subsequent Floodplain Risk Management Plan, which is the current plan for the catchment.

2.3.3. Blackwattle Bay Catchment Flood Study

The Blackwattle Bay Catchment Flood Study (Reference 12) was undertaken by WMAwater and completed in 2015. It was undertaken on behalf of CoS, in accordance with the NSW Government's Flood Policy. The study defined the existing flood behaviour in the Blackwattle Bay (BW) catchment (covering approximately 315 hectares) through the establishment of computer models. The study adopted ARR 1987 guidelines (Reference 10) and developed a 'direct rainfall' TUFLOW model, with rainfall runoff applied at areas where flow concentrates (such as stormwater pits). The model simulates the movement of the runoff, including depths, levels and velocities. The model covered the entire BW catchment (including the western half of the Pyrmont peninsula) and included features such as roads, buildings and the drainage network, comprising open channels, covered channels, culverts, subsurface pipes and pits.

The majority of the trunk drainage is owned by SWC and CoS. A limited model calibration was undertaken using the 26 January 1991 event and verification using the 17 February 1993 event. Design flood behaviour for the 2 year ARI, 5 year ARI, 10% AEP, 5% AEP, 2% AEP, 1% AEP and PMF events was defined using the model. The study also undertook sensitivity testing of adopted model parameters. One of the 'hotspots' identified by the study was Wattle Street within the Planning Proposal study area, which serves as a major overland flow path for upstream waters to reach the outlet (the other being Wentworth Park Road). However, inundation of adjacent properties was only estimated to occur in the PMF event.

2.3.4. Blackwattle Bay Catchment Floodplain Risk Management Study

The study (Reference 13) followed on from the Blackwattle Bay Catchment Flood Study and was undertaken in accordance with the NSW Government's Flood Policy. The existing flood risk in the

catchment was assessed, including flood hazard, flood function, flood damages and emergency response planning. The model utilised the model developed for the flood study, with only minor updates made to the model.

The study investigated flood risk mitigation options and one option was proposed for an underground storage tank at the Council Depot (FM-BB06), located at the upstream end of Wentworth Park, adjacent to Wattle Street. This option alone was not recommended for further investigation, due to the complexities associated with construction of an underground tank. Another option was investigated consisting of this storage tank together with a drainage upgrade from Cleveland Street to Wentworth Park (FM-BB07). These options are discussed further in Section 5.4.2. Both of these options were adopted with a low priority in the subsequent Floodplain Risk Management Plan, which is the current plan for the catchment.

2.3.5. Blackwattle Bay Catchment – Flood Study Model Update ARR2019 Hydrology

The Blackwattle Bay Catchment Flood Study Model Update ARR2019 Hydrology (Reference 14) was prepared by WMAwater for CoS to provide an updated comprehensive catchment-wide flood model for the BW catchment. The update intended to ensure recent and approved (at the time of the study) major developments were accurately accounted for, as well as incorporating current best practice data and methods for estimating design floods.

The Blackwattle Bay FRMS model was updated to include more detailed ground and aerial survey information, additional stormwater infrastructure and refinement of the model grid size to 1 m. The model inputs were also updated to utilise ARR 2019 guidelines (Reference 15), including new design rainfall data, temporal patterns and rainfall losses. The updates typically resulted in lower design flood levels, by approximately 0.3 m to 0.4 m across the catchment in the 1% AEP event. Flood damages were also estimated and reduced by approximately 12% compared to the previous FRMS. This is the latest catchment-wide flood modelling that has been undertaken for the BW catchment and the flood model results produced as part of this study were utilised for this FIRA.

3. FLOOD CONSTRAINTS REVIEW

3.1. Overview of Flood Behaviour and Risks

Generally, the sites affected by the Planning Proposal are subject to flood behaviour that is usually referred to as “overland flow”. In urban environments with significant impervious surfaces and a pit and pipe drainage network for stormwater, overland flow occurs when the amount of runoff from the catchment exceeds the capacity of the subsurface drainage network. In most of the older developed areas of Sydney (such as Pyrmont and Ultimo), the drainage network capacity is often only sufficient for rainfall events up to around 20% AEP (1 in 5 chance per year). Across the study area, a large majority of stormwater pipes are at capacity in a 2 year ARI event, or 0.5 exceedances per year (EY) (Reference 11 and Reference 13).

In more intense events, such as the 1% AEP event generally used as the risk standard for new development in NSW, overland flow will occur along whatever remains of the pre-development creek-line or valley. Depending on the development layout, this overland flow may occur along remnant creek lines through parks/reserves, down roadways, or through private development.

Overland flow flood affectation is usually characterised as “flash flooding.” It is of relatively short duration and often relatively shallow and fast flowing. It can occur with little to no warning prior to the occurrence of an intense flood-producing storm.

Often, in older areas where the layout of the road network, private development lots and stormwater system was constructed decades ago, the capital costs of broad-scale upgrades to the drainage infrastructure is prohibitive. Typical floodplain management practice in these areas is to rely on development controls to maintain existing overland flow paths by ensuring they are not obstructed or diverted by new development. The risks to new development are managed by ensuring that floor levels of new buildings are sufficiently above the relevant flood risk standard.

In many flash flood areas of Sydney where existing development does not meet these standards, the most effective long-term measure to reduce the flood risk is through redevelopment. This is frequently facilitated by consolidation of development lots for higher intensity uses, since the larger development scale provides more flexibility for retaining the existing overland flow paths, while meeting the required standards for the new buildings.

The main objectives for flood-related controls on new development, as reflected in the relevant planning legislation discussed in Section 2.2, are:

1. Mitigating the risk of damage to new development by raising building floor levels and basement entry points to minimum heights above the relevant flood levels,
2. Ensuring that new development does not exacerbate flooding problems elsewhere, and
3. Mitigating the risk to life for occupants/users of new development, by ensuring the development is compatible the flood hazard of the land, and considering evacuation requirements for the full range of flood risk, including extremely rare events with more severe flooding than the primary 1% AEP standard.

Flood planning concepts relevant to achieving these objectives are discussed in the following

Sections (3.3 to 3.6). A review of the relevant flood information specific to each site is provided in Section 4.

3.2. Adopted Flood Modelling

The adopted flood modelling for the FIRA of the Planning Proposal is as follows:

- DH catchment utilises flood modelling from the FRMS (Reference 11). The adopted pit blockage scenario consists of 20% blockage of on-grade pits and 50% blockage of sag pits. This scenario was adopted for testing of mitigation options in the FRMS. It is recognised that the flood study (Reference 9) adopted a pit blockage scenario consisting of 50% blockage of on-grade pits and 100% blockage of sag pits. This scenario was also adopted for the development of flood hazard outputs for the FRMS (Reference 11). The use of 100% blockage of inlet pits at sag points is considered excessive and a more reasonable blockage factor of 50% was used for the current assessment that is in line with more recent flood modelling undertaken for CoS (including the BW catchment). A sensitivity to the adopted blockage factor and implications for specific sites is discussed in Section 5.1. The critical 90 minute storm was adopted as per the FRMS, in addition to the coincident tailwater levels for the downstream boundary.
- BW catchment utilises flood modelling from the latest flood study update (Reference 14). The adopted pit blockage scenario consists of 20% blockage of on-grade pits and 50% blockage of sag pits, as adopted for design flood event modelling in the study. The 30 minute and 60 minute critical storms were adopted as per the study, in addition to the coincident tailwater levels for the downstream boundary.

For the DH catchment flood modelling in particular, the direct rainfall approach simulates all active model cells as ‘wet’. Therefore, the results require filtering of shallow depths to more clearly display flow paths and flooding rather than local runoff that occurs everywhere. This is also beneficial for the BW catchment flood modelling, where shallow flows are also modelled across much of the catchment. In order to more clearly map areas of ‘flooding’, shallow flows less than 0.1 m deep were removed from the maps. This is in between the cutoff depths applied for DH (0.05m) and BW (0.15 m) in the relevant studies. Water deeper than 0.1 m begins to approach the top of the gutter (standard height of 0.15 m) and where runoff can be considered as ‘flooding’.

The model boundaries adopted for the DH and BW models overlap, such that there are areas of the Pyrmont peninsula that have flood results from both models. The true catchment boundary (ridge line) was determined based on available LiDAR data and a review of the model setup and results. This catchment boundary is shown in Figure 1 and flood model results for both DH and BW were trimmed using the respective catchment boundary such that only one set of model results covers any particular site.

The existing flood model results were used as-is, with no updates made to the models and no simulation of potential changes to lots subject to the Planning Proposal. The assessment uses the most recent available flood modelling adopted by CoS to review flood behaviour at each site. Flood behaviour (depth, level and hazard) is shown in Figure 3 to Figure 27, for the five different areas mapped (see Figure 2 for area extents). Peak flood depths for the 10% AEP, 1% AEP and PMF events are provided, as well as hydraulic hazard for the 1% AEP and PMF events (5 maps

per area).

3.3. Flood Function

The mapping of flood function, or hydraulic categories, as part of catchment-wide flood studies provides a broad scale estimate of the areas that could potentially exacerbate existing flood risk if redeveloped. This categorisation is defined by the Flood Risk Management Manual (Reference 2) as:

- **Floodways** are generally those areas which convey a significant portion of water during floods and are particularly sensitive to changes that impact flow conveyance. They often align with naturally defined channels.
- **Flood Storage** are areas outside of floodways, which are generally areas that store a significant proportion of the volume of water and where flood behaviour is sensitive to changes that impact on the storage of water during a flood.
- **Flood Fringe** are areas within the extent of flooding for the event but which are outside floodways and flood storage areas. Flood fringe areas are not sensitive to changes in either flow conveyance or storage.

Definition of flood function is subjective, particularly in an urban catchment where the depths of inundation are relatively shallow and the peak flows small. However, blocking even a minor overland flow path can re-direct flow onto adjoining properties and so adversely affect the adjoining property, and therefore be considered floodway. This is frequently the case where the historical creek line and the stormwater drainage network runs through private property. Floodways are not necessarily always defined as high hazard areas. Hazard reflects the potential harm to life and property due to flooding, whilst floodways reflect areas where if filled or modified will produce a significant adverse hydraulic impact on others.

While flood function can provide an indication of where obstruction of filling of flow paths may be problematic, it does not mean that the area cannot be developed. For minor flow paths (even if classified as floodway), it may be possible to divert or modify the flow path within the development extent such that adverse impacts off-site are avoided. This can be demonstrated by doing a “flood impact assessment” whereby the catchment flood models are altered to represent the new development, and the resulting flood behaviour is compared with existing flood behaviour to demonstrate it is not worsened. Council generally endeavours to ensure that any new development takes this into account by requiring a FIRA to be undertaken to assess the potential hydraulic impacts of the development.

Any filling on the floodplain or blocking of a flow path will affect flood levels to some degree, however it is impractical for Council to monitor every development on the floodplain as many will have only a very minor impact.

Flood function was defined in the relevant DH and BW studies (References 11 and 14) using an indicator technique. The following criteria was adopted:

- Floodway is defined as areas where:
    - the peak value of velocity multiplied by depth (V x D) > 0.25 m^2/s **AND** peak velocity

> 0.25 m/s, **OR**
- peak velocity > 1.0 m/s

The remainder of the floodplain is either Flood Storage or Flood Fringe,

- Flood Storage comprises areas outside the floodway where peak depth > 0.2 m; and
- Flood Fringe comprises areas outside the Floodway where peak depth < 0.2 m.

The 1% AEP flood function is shown in Figure 28. The above criteria result in no sites containing a floodway in the 1% AEP event. This is a key concern for the local planning directions (Reference 5), in which a Planning Proposal must not permit development in floodway areas (Clause 3(a) and 4(a)). The main floodways within the study area are the flow paths from Wattle Street to Blackwattle Bay, via Wentworth Park Road (BW catchment) and Hay Street to Darling Harbour via Tumbalong Boulevard (DH catchment). In the 1% AEP the floodway remains within the road corridor and does not occupy adjacent sites.

The BW floodway flows past sites within the Planning Proposal from 430-453 Wattle Street (Section 4.23, 4.24, 4.25 and 4.31). At this point the floodway has not covered the entirety of the road, with the modelling suggesting the deepest flows occurring in the western gutter, with the immediate footpath accessible to occupants on the eastern side. The Darling Harbour floodway is a significant distance from any site nominated in the Planning Proposal.

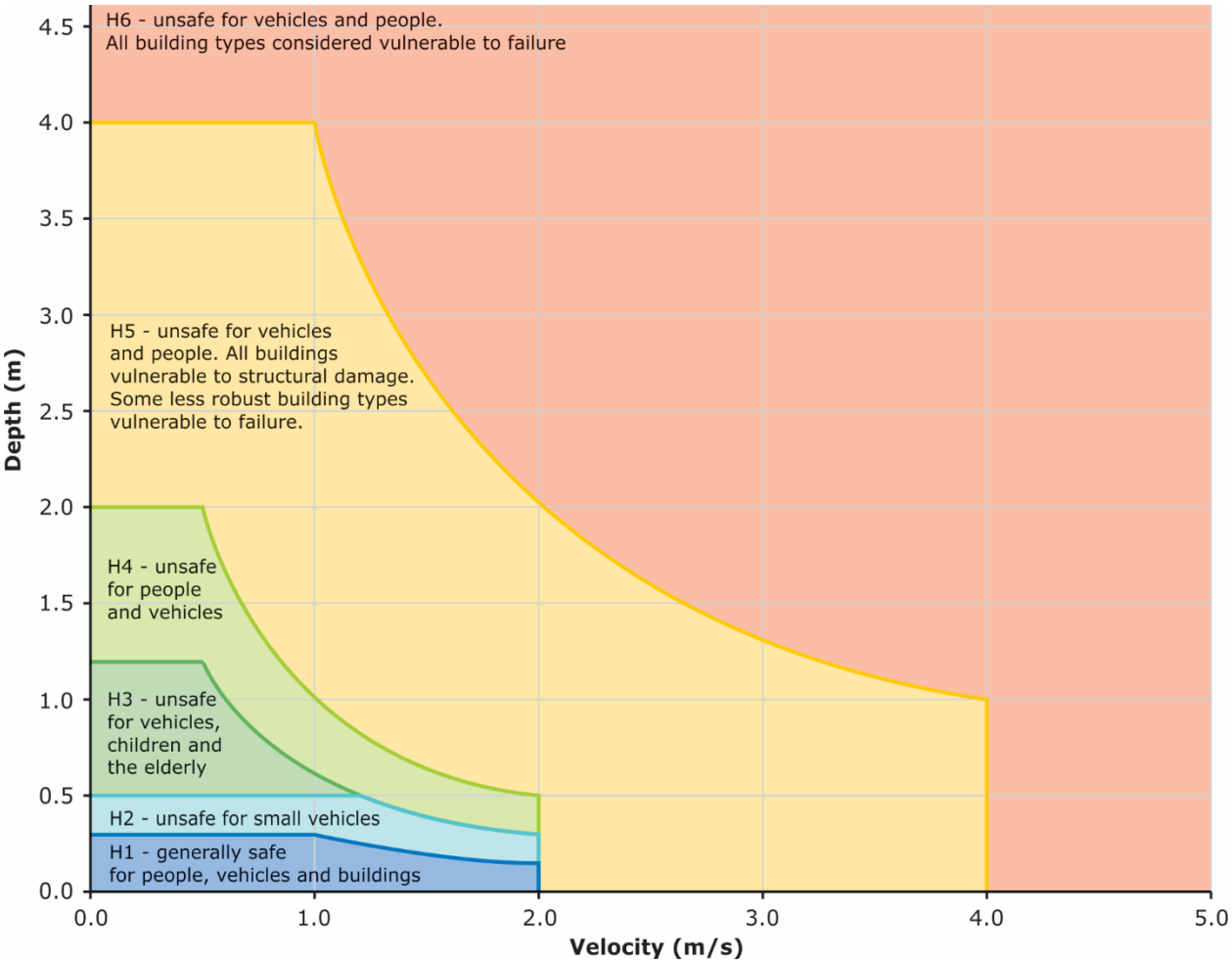
Sites that are within proximity to 1% AEP flood storage include 46-48 Pyrmont Bridge Road (4.1), 2 Edward Street (4.3), 100 Harris Street (4.14), and 28-64 Wattle Street (4.15 & 4.16). It is noted that at each of these sites the flood storage is adjacent to the site and not inclusive of the site. However, at 48 Pirrama Road (4.13) the modelling shows that the site is affected by flood storage, however, this is considered to be a modelling artefact, discussed further in Section 4.13. Most lots are currently fully developed and occupied. Construction of new buildings on these sites would not displace any floodwaters elsewhere. On other lots, it is typically only runoff generated from the site itself that flows through open areas of the site such that there is expected to be negligible flood impacts.

3.4. Hydraulic Hazard Classification

Hydraulic hazard is a measure of potential risk to life and property damage from flood. Hydraulic hazard is typically determined by considering the depth and velocity of floodwaters.

In recent years, there have been a number of developments in the classification of hazards. Research has been undertaken to assess the hazard to people, vehicles and buildings based on flood depth, velocity and velocity depth product. The findings of this research are incorporated into revised categories for hazard classification presented in the Australian Disaster Resilience Handbook Collection (*Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia*). The supporting guideline 7-3 (Reference 16) contains information relating to the categorisation of flood hazard. A summary of this categorisation is provided in Diagram 1.

Diagram 1: General flood hazard vulnerability curves (ADR)



This classification provides a more detailed distinction and practical application of hazard categories, identifying the following 6 classes of hazard:

- H1 – Generally safe for people, vehicles and buildings;
- H2 – Unsafe for small vehicles;
- H3 – Unsafe for vehicles, children and the elderly;
- H4 – Unsafe for people and vehicles;
- H5 – Unsafe for people and vehicles. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure; and
- H6 – Unsafe for people and vehicles. All building types considered vulnerable to failure.

The BW catchment study (Reference 14) provided hydraulic hazard based on this categorisation, however, the DH catchment study (Reference 11) did not provide hazard classification based on this categorisation. The peak velocity, depth and velocity-depth product grids were used to derive the hydraulic hazard for the 1% AEP event, in a similar manner to that undertaken for the BW catchment.

3.5. Emergency Management and Risk to Life

Flooding in the DH and BW catchments will generally occur quite rapidly in response to very heavy rain (referred to as “flash flooding”). The Bureau of Meteorology (BoM) does not issue quantitative

flood warnings for flash-flood catchments, such as these study areas, defined as rain-to-flood times of less than six hours. The BoM does issue severe weather warnings whenever severe weather is occurring in an area or expected to develop or move into an area. This includes very heavy rain that may lead to flash flooding. The warnings describe the area under threat and the expected hazards. Warnings are issued with varying lead-times, depending on the weather situation, and can be from 1 hour to 24 hours or more. The BoM also issues detailed severe thunderstorm warnings that may produce heavy rainfall causing flash flooding.

The SES is the legislated combat agency for floods and is responsible for the control of flood operations. This includes the coordination of other agencies and organisations for flood management tasks. The SES Local Controller is responsible for dealing with floods as detailed in the State Flood Plan.

Given the flash flood nature of the catchments and the lack of warning time for flooding, the SES is unlikely to mobilise volunteers to any specific locations in the area in anticipation of flooding, except possibly at major roads with previous significant flood affectation. The SES will generally only respond to specific calls for assistance or observed flooding in flash flood areas.

Generally, the most effective way to mitigate flood risk to human life in this environment is to ensure that buildings are built to withstand flood forces to enable people to remain indoors during the intense storm events, and to discourage people from attempting to drive or walk through floodwaters. This is best achieved by effective design of each building to ensure it remains flood free without requiring active measures such as the deployment of barriers or flood gates, so that people can remain inside until flooding has subsided. Since flash flooding is usually of relatively short duration, the risks arising from isolation during flooding are relatively low.

3.6. Extreme Flood Events and the Probable Maximum Flood

Generally, planning controls in NSW are focussed on a 1% AEP or “1 in 100” standard for development, with a freeboard allowance above the 1% AEP level for setting floor levels. However both the NSW Flood Risk Management Manual (Reference 7) and Council’s Interim Floodplain Management Policy (Reference 8) recognise that the residual or “continuing” risk of more extreme events should be considered as part of development planning. The Flood Risk Management Manual (Reference 7) states that residual risks will remain after management measures and development controls have been applied. This may include situations where the flood range between the defined flood event (typically the 1% AEP) and the PMF is greater than the freeboard. In these situations, consideration needs to be given to the residual risks to people and the development itself. The Interim Floodplain Management Policy’s performance criteria (Reference 8) states that a proposed development should “incorporate appropriate measures to manage risk to life from flood considering controls for risk to life for floods greater than the Flood Planning Level.” (p.8).

The PMF is the largest flood that could conceivably occur at a particular location, and defines the extent of flood prone land. In the areas between the Flood Planning Area (FPA) and PMF extent, development controls are not prescribed for most types of development, but there may be a need for risk to life considerations, such as evacuation and emergency access.

For this reason, mapping of the PMF depth and hazard has been included in this assessment and is considered in the discussion of each precinct. The PMF requires measured consideration, because it represents risk that is a combination of extremely low probability (in the order of a 1 in 10 million chance per year for this study area), combined with extreme consequences (because the PMF often involves widespread high hazard flooding in places that are flood free up to the 1% AEP development standard). It is necessary to remember that even relatively extreme events such as a 1 in 1000 (0.1% AEP) design event will generally be significantly closer to the 1% AEP than the PMF in terms of flood extents and hazard. The purpose of considering the PMF flood behaviour is to identify and manage the full range of residual risk above the 1% AEP development standard, for land uses where there is a lower tolerance for risk than for typical development. Examples of this contained within the Interim Floodplain Management Policy (Reference 8) is the application of the PMF level for housing for elderly and people with disabilities, below ground carparks and critical facilities (such as police, fire, hospitals and critical services).

3.7. Flood Planning Level

The flood levels and hydraulic hazards presented in this assessment are taken from either the DH or BW catchment wide studies. The levels are indicative only and may vary across the lot or across different road frontages. The minimum floor level required for a particular development is based on the relevant flood level (either a point on site or on the immediate surrounds) and the appropriate freeboard. This level is referred to as the FPL. The CoS Interim Floodplain Management Policy (Reference 8) specifies the relevant FPL depending on the severity of flooding and the type of development.

Minimum floor level controls from the CoS Interim Floodplain Management Policy (Reference 8) are summarised in Table 1 below. The table indicates the minimum building floor level or Finished Floor Level (FFL) required, based on the land-use type and flood type. The report uses the CoS Interim Floodplain Management Policy (Reference 8) classification of “flood type” as follows:

- **Local drainage flooding** –
    - Occurs where the maximum cross-sectional depth of flooding in the local overland flow path through and upstream of the site is less than 0.25m for the 1% AEP flood;
    - The development is at least 0.5m above the 1% AEP flood level at the nearest downstream trapped low point.
    - The development does not adjoin the nearest upstream trapped low point; and
    - Blockage of an upstream trapped low point is unlikely to increase the depth of flow past the property to greater than 0.25m in the 1% AEP flood.
- **Mainstream flooding** –
    - Occurs where the local drainage flooding criteria cannot be satisfied.
- **Outside the Floodplain** –
    - Considered to be outside the floodplain where it is above the mainstream and local drainage FPLs including freeboard.

In general, where flood depths are less than 0.15 m on the adjacent road (i.e. within a standard gutter), the classification of the site is considered to be ‘outside the floodplain’.

Table 1: Flood planning levels (Reference 8)

Development		**Type of flooding**	**Flood Planning Level**
Residential	Habitable rooms	Mainstream flooding	1% AEP flood level + 0.5 m
		Local drainage flooding	1% AEP flood level + 0.5 m or Two times the depth of flow with a minimum of 0.3 m above the surrounding surface[1] if the depth of flow in the 1% AEP flood is less than 0.25 m
		Outside floodplain	0.3 m above surrounding ground[1]
	Non-habitable rooms such as a laundry or garage (excluding below-ground car parks)	Mainstream or local drainage flooding	1% AEP flood level
Industrial or Commercial	Business	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level
	Schools and child care facilities	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 1% AEP flood level + 0.5m
	Residential floors within tourist establishments	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m
	Housing for older people or people with disabilities	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m or a the PMF, whichever is the higher
	Retail Floor Levels	Mainstream or local drainage flooding	Merits approach presented by the applicant with a minimum of the 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 car spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m
	All other below-ground car parks	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
Above ground carpark	Enclosed car parks	Mainstream or local drainage flooding	1% AEP flood level
	Open car parks	Mainstream or local drainage	5% AEP flood level
Critical Facilities	Floor level	Mainstream or local drainage flooding	1% AEP flood level + 0.5m or the PMF (whichever is higher)
	Access to and from critical facility within development site	Mainstream or local drainage flooding	1% AEP flood level

1. Taken to be the gutter invert where adjacent to a road.

For each site, a preliminary FPL was determined for the purpose of assessing if a redevelopment would be practical based on the minimum floor level controls. These FPLs should not be relied upon for a specific development and a site-specific flood assessment should be undertaken to determine FPLs.

3.7.1. Flood Tagging

WMAwater was previously engaged by CoS to review the available flood studies across the LGA and to identify lots subject to Section 10.7 flood tagging notifications using a consistent approach across all catchments (Reference 17). The review was in part prompted by updates to legislation and planning guidelines outlined in Planning Circular PS 21-006 issued by the NSW Department of Planning Industry and Environment on 14 July 2021. The circular provides information about changes to Clause 7A (now Clause 9) of Schedule 4 of *Environmental Planning and Assessment Regulation 2000* (the Regulation), contained in the *Environmental Planning and Assessment Amendment (Flood Planning) Regulation 2021* (the Amendment).

The updated legislation does not change the primary mechanism by which flooding is considered as part of land-use planning in NSW. The previous legislation also required identification of lots on planning certificates (known as Section 149 certificates before being changed to Section 10.7 certificates) but was more rigid in the description of the FPA. The primary changes resulting from the new legislation are:

- An altered definition of the FPA, to be consistent with that in the Floodplain Development Manual. Properties subject to flood-related development controls within the FPA require notification on Section 10.7 certificates under Clause 9(1) of the Regulation, and
- An additional clause allowing the application of flood-related development controls to land between the FPA and PMF extents, for hazardous or sensitive uses, or situations where there is a particular risk to life or flood-related evacuation consideration. Properties subject to these controls require notification on Section 10.7 certificates under Clause 9(2) of the Regulation.

The primary objective of the study was to develop and apply a consistent lot-based flood tagging methodology across the CoS, answering the following questions for each lot:

1. Is the 1% AEP flood inundation of the lot (including freeboard consideration) sufficient to warrant flood-related development controls for a majority of land uses (Clause 9(1)); and
2. Is the PMF flood inundation of the lot sufficient to warrant flood-related development controls for vulnerable land uses (Clause 9(2)).

These questions were answered for each lot based on a GIS algorithm, followed by a review of flood behaviour and a detailed site analysis at an individual lot scale. The tagging status of lots determines which lots would be subject to flood related development controls. The tagging status of sites as part of this assessment was included as a way of understanding flood affectation of sites.

4. PLANNING PROPOSAL SITE ASSESSMENT

For each site, an assessment of the flood risk was undertaken. The following information is provided for each site:

- Planning Proposal changes
- Flood behaviour
- Flood Planning Levels
- Impact Considerations
- Hazard Considerations

The last three points address those floodplain management principles identified in Section 2.2.

4.1. 46-48 Pyrmont Bridge Road

The site (Photo 1) is a large commercial lot at the southern end of a row of terrace housing, on both Bulwara Road and Little Mount Street. The lot has frontages to Bulwara Road and Little Mount Street in addition to Pyrmont Bridge Road. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

Photo 1: 46-48 Pyrmont Bridge Road with Bulwara Road (left) & Pyrmont Bridge Road (right), facing northeast. *Google Streetview*.

4.1.1. Planning Proposal Changes

Planning Propsal changes to this lot are summarised in Table 2 below.

Table 2: Proposed planning controls for 46-48 Pyrmont Bridge Road

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Commercial	B4 - MU	Commercial
Floor space ratio	1.61 approx.	2.0	3.91 + DesEx[1]
Height of building	12 m	12 m	37 m
Height in storeys	2	3	9
Deep soil	0%	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.1.2. Site Characteristics and Flood Behaviour

Two sub-catchments confluence at the southern corner of the lot, potentially leading to ponding against the southern and western sides of the building in the 1% AEP event. Water flows south, from Miller Street, down Bulwara Road and ponds at the cul-de-sac, which is a sag point. This occurs in frequent events such as the 10% AEP. In the 1% AEP event, this flows across the access path to Pyrmont Bridge Road. This is joined by flows from Pyrmont Street, that flow southwest along Pyrmont Bridge Road. The modelling indicates flow may reach the building from a pedestrian layback at the corner of Pyrmont Bridge Road and Little Mount Street in the 1% AEP event, although this affectation is minor. The water flows from the confluence point, southwest away from the lot towards Blackwattle Bay. The existing structure footprint occupies 100% of the lot, indicating nil capacity to infiltrate local run-off. The flood tagging status of the lot is shown in Table 3 and flood characteristics for the site are shown in Table 4. The site is classified as ‘mainstream flooding’ due to the depth of ponding occurring at the southwest lot corner which exceeds 0.4 m.

Table 3: Flood tagging for 46-48 Pyrmont Bridge Road

Clause 9(1)	Clause 9(2)
No	Yes

Table 4: Indicative site flood characteristics for 46-48 Pyrmont Bridge Road)

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Mainstream Flooding[1]	9.5	9.6	H2	H2-H3

Note: at the Bulwara Road sag point

4.1.3. Flood Planning Levels

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

The northeastern lot corner is likely to set the highest minimum floor level. As this frontage is likely

to be ‘outside the floodplain’, no floor level controls would apply for commercial development. However, it would be prudent to consider a height of 0.3 m above the surrounding ground, as would be applicable for a residential development. This should be readily achievable. Given this height, meeting minimum floor level requirements for Bulwara Road should be straightforward given the fall of the terrain (a difference in level of almost 2 m between Little Mount Street and Bulwara Road), unless a split-level design is adopted. Even if this is the case, the minimum commercial floor levels for Bulwara Road should be easily met, being the 1% AEP flood level. If this is to be the primary vehicle entrance and basement carparking is proposed, meeting the requirement of 1% AEP flood level + 0.5 m would be more difficult, but not impossible. This is approximately 0.7 m – 0.9 m above the adjacent ground. Any vehicle entrance on Bulwara Road would be best placed at the northern end of the site. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.1.4. Impact Considerations

The existing structure utilises 100% of the lot, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions (potential reduction in peak flood levels). Further, the required setbacks on the north side of the lot could create a relief point for the potential trapped ponding water in the residential backyards.

4.1.5. Hazard Consideration

The modelling indicates that access to the eastern and southeastern frontage is available during the 1% AEP and PMF events, with the hazard being H1. The ponding at the southwestern corner of the lot triggers H2 hazard in the 1% AEP event and is most likely difficult to resolve with development of the site. However, the area of ponding can generally be avoided by placing entrances (including vehicle entrances) at the northern end of the lot fronting Bulwara Road, where hazardous ponding is not present even in the PMF event. This would enable both vehicular and pedestrian access to the building in the PMF event.

4.2. 20-28 Bulwara Road

The site is an existing substation (Photo 2). The lot connects Bulwara Road west and Little Mount Street east. The neighbouring lots to the north and south are terrace housing. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

Photo 2: East facing across 20-28 Bulwara Road, *Google Streetview*

4.2.1. Planning Proposal Changes

Planning Propsal changes to this lot are summarised in Table 5 below.

Table 5: Proposed planning controls for 20-28 Bulwara Road

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Substation	R1 – GR	Commercial
Floor space ratio	<0.2	1.0	1.4
Height of building	8 m	9 m	14 m
Height in storeys	2	2	4
Deep soil	0%	10%	15%

4.2.2. Site Characteristics and Flood Behaviour

The site is located high within its local sub-catchment and is bounded by Little Mount Street to the east and Bulwara Road to the west. The natural landform slopes towards the southwest across the site. The gutters on Little Mount Street do not overtop in either the 1% AEP or PMF events. There are no significant flows through the lot or within the gutter of the adjacent road network. As such, the site is considered to be ‘outside the floodplain’. The flood tagging status of the lot is shown in Table 6.

Table 6: Flood tagging for 20-28 Bulwara Road

Clause 9(1)	Clause 9(2)
No	Yes

4.2.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain' are:

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

A detailed site-specific flood impact assessment may determine that the lot is outside of the floodplain and as such, there may be no minimum floor level controls for commercial developments. Any other type of floor (such as a basement carpark or habitable floor) should be readily achievable. Meeting minimum FFL requirements is considered reasonable and practical for construction based on the indicative flood levels and existing site topography.

4.2.4. Impact Considerations

The site is entirely impervious although largely open (approximately 55%), however, is not subject to inundation in the PMF event. The site is currently 100% impervious and the proposed changes would require a minimum of 15% deep soil landscaping, increasing infiltration capacity. There would be no adverse flood impacts resulting from redevelopment of the site with the Planning Proposal.

4.2.5. Hazard Consideration

Access is available to the site in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street (< 0.1 m).

4.3. 2 Edward Street & 60 Union Street

The adjacent lots (Photo 3 and Photo 4) are bounded by Pirrama Road to the north, Edward Street to the west, Union Street to the south and an accessway to the east, with frontages to each of these. The Pirrama Road frontage is on a lower level than the Edward Street, Union Street and eastern walkway building access. The light rail line crosses under the building at this lower level, with the Pyrmont Bay light rail stop being located under the adjacent building to the east (1-27 Murray Street). Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

Photo 3: South facing over 2 Edward Street, *Google Streetview*

Photo 4: Northeast facing over 60 Union Street, *Google Streetview*

4.3.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 7 below.

Table 7: Proposed planning controls for 2 Edward Street & 60 Union Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
2 Edward Street			
Land use & zoning	Commercial	B3 - CC	Commercial
Floor space ratio	4.12	4.0	7.7 + DesEx[1]
Height of building	25.5 m	24 m	RL86
Height in storeys	6	5	20^
Deep soil	0%	10%	15%
60 Union Street			
Land use & zoning	Commercial	B3 - CC	Commercial
Floor space ratio	4.67	4.0	7.08 + DesEx[1]
Height of building	38 m	33 m	RL94
Height in storeys	9	8	21^
Deep soil	0%	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

^ Excluding plant

4.3.2. Site Characteristics and Flood Behaviour

The local catchment drains via the road network from Pyrmont Street in the west, Pyrmont Bridge Road in the south and east. Water ponds over the light rail tracks, at the low point of Edward Street (north) and in Pirrama Road, at the northwest corner of 2 Edward Street (Photo 5). In the 1% AEP event the inundation overtops the gutters of the road network surrounding 2 Edward Street, with flood depths approximately 0.3 m – 0.4 m at the low points. Due to the fall on Edward Street, 60 Union Street is located largely outside of the street flooding. There is some inundation greater than 0.1 m in the eastern pedestrian accessway, approximately 0.1 m – 0.15 m (1% AEP) and 0.15 m – 0.2 m (PMF). The flood tagging status is shown in Table 8 and Table 9 with the flood characteristics for the site are shown in Table 10 and Table 11. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively.

Photo 5: North facing at the end of Edward Street, across the light rail tracks with 2 Edward Street on the right, *Google Streetview*

Table 8: Flood tagging for 2 Edward Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 9: Flood tagging for 60 Union Street

Clause 9(1)	Clause 9(2)
No	Yes

Table 10: Indicative site flood characteristics for 2 Edward Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Mainstream Flooding	2.9	3.1 – 3.2	H2-H3	H2-H4

Table 11: Indicative site flood characteristics for 60 Union Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Local Drainage	-	-	Nil-H1	H1

4.3.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)

- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

Minimum FFL requirements for Local Drainage:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking – 1% AEP flood level
- Open parking – 5% AEP flood level

The minimum FFL of the Pirrama Road frontage and basement parking from Edward Street is affected by the ponding at the low points surrounding the site. Development to the existing control FFL is achievable and is considered practicable for construction based on the indicative flood levels and existing site topography, with commercial floors to be approximately 0.1 m above ground level, or sensitive uses and basement carparking to be 0.6 m above the ground. It is likely however, that basement entry points would be located on Edward Street (as per the current site configuration). The very southern corner of 2 Edward Street is not inundated and would provide an adequate access point for basement carparking without needing to ramp up too high to meet minimum crest levels. Flood levels derived from the blockage modelling should be considered for the flood planning (discussed further in Section 5.2). Due to the shallow inundation affecting 60 Union Street, meeting minimum floor level requirements would not be a significant constraint. Meeting minimum FFL requirements for these lots is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.3.4. Impact Considerations

The existing structures utilises close to 100% of the lots, with the exception of a portion of the eastern accessway that is within the site boundary. The proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage or conveyance and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions. Redevelopment of the site could incorporate regrading of the eastern walkway to reduce the shallow ponding that is modelled to occur currently. This would reduce flood hazard and ensure that access is maintained during extreme events.

4.3.5. Hazard Consideration

During an extreme flood event, Pirrama Street and Edward Street access is not available for 2 Edward Street. During the PMF event, Edward Street from Union Street is high hazard due to high velocity overland flows such that the northbound lanes would be hazardous for vehicles. The southbound lanes may still be accessible with the flood depths being less than 0.1 m deep. While the flood hazard at the low points reach H2 to H4, the very southern end of 2 Edward Street may still have access up Edward Street to Union Street. A basement carpark entrance should be located as far south as possible to avoid hazardous flooding at the low point. It may be, however, that vehicular access to 2 Edward Street is cut off in the PMF event. The isolation would be of relatively short duration and the risks of occupants requiring emergency evacuation or supplies

during the flood would typically be low. It is noted that emergency vehicles may be able to drive along the eastern walkway if a bollard is removed, providing access to the eastern side of the building.

The eastern walkway is mostly free of flooding and should be relatively safe for foot traffic to move south towards Union Street. Evacuations from the buildings should be towards Union Street and not south towards Pirrama Road. The building consists of a lower level that contains the Pyrmont Bay light rail station.

4.4. 1-27 Murray Street

The lot fronts Pirrama Road and Murray Street (Photo 6), adjoining 2 Edward Street and 60 Union Street, connected by an existing accessway to the west of this lot. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

Photo 6: West facing across 1-27 Murray Street, *Google Streetview*

4.4.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 12 below.

Table 12: Proposed planning controls for 1-27 Murray Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	B4 – MU	Commercial
Floor space ratio	2.74	2.5	6.55 + DesEx[1]
Height of building	22.5 m	30 m	RL90
Height in storeys	7	8	21^
Deep soil	0%	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.4.2. Site Characteristics and Flood Behaviour

Runoff flows north down Murray Street, then west along Pirrama Road to a sag point in front of the adjacent lot (2 Edward Street). In the 1% AEP event the inundation overtops the gutters of the road network surrounding 2 Edward Street, with flood depths approximately 0.3 m – 0.4 m and the extent reaches the northwest corner of the lot. In the 1% AEP event, the water remains within the gutter surrounding the lot, however, in the PMF event, the northwest corner of the building may have shallow inundation reaching the building. There is some minor inundation on the western pedestrian accessway, approximately 0.1 m – 0.15 m (1% AEP) and 0.15 m – 0.2 m (PMF). The flood tagging status of the lot is shown in Table 13 and flood characteristics for the site are shown in Table 14. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively. The site is considered to be affected by mainstream flooding due to proximity to the Pirrama Road sag point.

Table 13: Flood tagging for 1-27 Murray Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 14: Indicative site flood characteristics for 1-27 Murray Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Mainstream flooding	2.9	3.0	H1	H1-H2

4.4.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

The site's proximity to inundation at the Pirrama Road sag point is the primary concern for the site, likely triggering a mainstream affectation classification. A detailed site-specific flood assessment may determine that the lot is local drainage if the building floor levels are high enough.

In general, it is a reasonably low risk site, compared to the western neighbouring site. Meeting minimum FFL requirements for these lots is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. Flood levels derived from the blockage modelling should be considered for the flood planning.

4.4.4. Impact Considerations

The existing site occupies much of the site, with the exception of the western accessway and a small portion of the southeast corner of the lot. Changes to the site layout are unlikely to change flood behaviour surrounding the site. Local runoff characteristics may be influenced by changes to these open areas, however, the proposed changes would require a minimum of 15% deep soil landscaping, likely to increase flood storage and infiltration capacity. Redevelopment of the site could incorporate regrading of the western walkway to reduce the shallow ponding that is modelled to occur currently. This would reduce flood hazard and ensure that access is maintained during extreme events.

4.4.5. Hazard Consideration

The roads surrounding the lot are primarily rated as low hazard or not subject to ‘flooding’ (depths less than 0.1 m). Access is available to the northern and eastern frontage in the 1% AEP and PMF events, with only the northwestern corner of the site potentially being inaccessible. The western accessway is mostly free of flooding and should be safe for foot traffic to move south towards Union Street. Small vehicle access may be difficult due to high velocity (albeit shallow) overland flows on Murray Street, however, this is not considered to be a significant constraint. Pedestrian and vehicular access would be possible even in the PMF event to the south to Union Street and Pyrmont Bridge Road.

4.5. 13A-29 Union Street & 69-72 Edward Street

The lots (Photo 7) occupy much of the land bounded by Union Street, Edward Street and Pyrmont Street, with frontage on all three streets. There are also existing buildings adjoining these sites at the northeast and southern corners of the block. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

Photo 7: Southeast facing at the Union Street and Pyrmont Street intersection

4.5.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 15 below.

Table 15: Proposed planning controls for 13A-29 Union Street & 69-72 Edward Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
13A-29 Union Street			
Land use & zoning	Commercial	B4 - MU	Commercial
Floor space ratio	0.45	3.5	3.75 + DesEx[1]
Height of building	11.5 m	24 m	44 m
Height in storeys	2	5	10^
Deep soil	0%	10%	15%
69-72 Edward Street			
Land use & zoning	Commercial	B4 - MU	Commercial
Floor space ratio	3.18	4.0	5.67 + DesEx[1]
Height of building	19 m	24 m	38 m
Height in storeys	4	5	8^
Deep soil	0%	10%	n/a

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.5.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding

the site. The landform falls north, and the surface flow is expected to follow the road gutter towards Edward Street. The site is considered to be 'outside the floodplain'. The existing structure footprint occupies 100% of the lot, indicating nil capacity to infiltrate local run-off. The flood tagging status of the lot is shown in Table 16 and Table 17.

Table 16: Flood tagging for 13A-29 Union Street

Clause 9(1)	Clause 9(2)
No	No

Table 17: Flood tagging for 69-72 Edward Street

Clause 9(1)	Clause 9(2)
No	No

4.5.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

The sites are 'outside the floodplain' and as such flood related FFL are not applicable for commercial sites (except basement level parking or any habitable floors). It is advisable in such conditions that a minimum of 0.3 m freeboard be constructed above the adjacent landform, usually taken from the gutter invert. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.5.4. Impact Considerations

The existing structures utilises 100% of the respective lots, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could result in a net positive impact for the local flood conditions.

4.5.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.6. 55-65 Murray Street

The three adjoining lots are located between Murray Street and Harwood Lane, north of Bunn Street. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17.

4.6.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 18 below.

Table 18: Proposed planning controls for 13A-29 Union Street & 69-72 Edward Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Commercial	MU1 - MU	Residential
Floor space ratio	3.46	4.0	4.83 + DesEx[1]
Height of building	18 m	30 m	39 m
Height in storeys	4	8	11
Deep soil	0%	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.6.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls north and the surface flow is expected to follow the road gutter towards Union Street. The site is considered to be 'outside the floodplain'. The existing structure footprint occupies 100% of the lot, indicating nil capacity to infiltrate local run-off. The flood tagging status of the lot is shown in Table 19.

Table 19: Flood tagging for 13A-29 Union Street & 69-72 Edward Street

Clause 9(1)	Clause 9(2)
No	No

4.6.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.6.4. Impact Considerations

The existing structures utilises 100% of the respective lots, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could result in a net positive impact for the local flood conditions.

4.6.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.7. 1-33 Saunders Street & 140-148 Bank Street

The adjacent lots (Photo 8) are bounded by Bank Street, Quarry Master Drive and Saunders

Street. The Western Distributor is elevated adjacent to the site along Bank Street. Flood depth and hazard mapping are in Area A Figure 3 to Figure 7.

Photo 8: Southeast facing, Quarry Master Drive (left) & Bank Street (right). *Google Streetview*

4.7.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 20 below.

Table 20: Proposed planning controls for 1-33 Saunders Street & 140-148 Bank Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
1-33 Saunders Street			
Land use & zoning	Commercial	B3 – CC	Mixed Use
Floor space ratio	2.61	4.0	4.21 + DesEx[1] 4.14 residential 0.49 non-residential
Height of building	35 m	33 m	54 m
Height in storeys	8	9	15
Deep soil	0%	10%	15%
140-148 Bank Street			
Land use & zoning	Commercial	B3 - CC	Commercial
Floor space ratio	1.81	4.0	10.9 + DesEx[1]
Height of building	11 m	33 m	85 m
Height in storeys	2	9	21
Deep soil	0%	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.7.2. Site Characteristics and Flood Behaviour

The eastern portion of the site has minor overland flows in the street (Saunders Street, Bank Street and a small portion of Miller Street) that do not overtop the gutter in the 1% AEP, with depths reaching 0.1 m – 0.2 m on Bank Street in the PMF in isolated locations. The existing footprint occupies a large portion of the lot, however there is an open area that fronts Saunders Street that is currently a park space (City West Office Park) with paved areas, grassed areas and gardens (Photo 9). The flood tagging status of the lot is shown in Table 21 and Table 22, with the flood characteristics for the site shown in Table 23.

Photo 9: South facing on Saunders Street toward the open space on the site. *Google Streetview*

Table 21: Flood tagging for 1-33 Saunders Street

Clause 9(1)	Clause 9(2)
No	No

Table 22: Flood tagging for 140-148 Bank Street

Clause 9(1)	Clause 9(2)
No	Yes

Table 23: Indicative site flood characteristics for 1-33 Saunders Street & 140-148 Bank Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Outside the floodplain	-	4.5	H1	H1

4.7.3. Flood Planning

Minimum FFL requirements for ‘outside the floodplain’:

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Based on the current modelling, the site is likely to be classified as ‘outside the floodplain’,

however, this would be confirmed with a site-specific flood assessment. In particular, the representation of flood conditions on Bank Street, where the deepest flooding in the vicinity of the site occurs, would need to be confirmed, particularly due to the presence of the elevated Western Distributor which is likely to obstruct accurate LiDAR capture of ground levels. Nonetheless, with the 'outside the floodplain' classification, minimum FFLs are not applicable for commercial sites (except basement level parking or any habitable floors). It is advisable in such conditions that a minimum of 0.3 m freeboard be incorporated above the adjacent landform, usually taken from the gutter invert. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.7.4. Impact Considerations

The existing site configuration has some open space in the centre of the lot. Changes to the site layout are unlikely to change flood behaviour surrounding the site. Local runoff characteristics may be influenced by changes to the open area of the site, however, these changes would be minimal.

4.7.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. The most flood affected location is Bank Street, in which the hazard is H1 in the PMF event and access should not be significantly restricted to both pedestrians and vehicles.

4.8. 26-38 Saunders Street

The site (Photo 10) occupies the area bound by Saunders Street to the south and enclosed by Quarry Master Drive to the north, east and west. Flood depth and hazard mapping are in Area A, Figure 3 to Figure 7.

Photo 10: West facing on Quarry Master Drive toward the open space of 26-38 Saunders Street. *Google Streetview*

4.8.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 24 below.

Table 24: Proposed planning controls for 26-38 Saunders Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	R1 – GR	Mixed Use
Floor space ratio	2.56	3.0	6.67 + DesEx[1]
Height of building	19.5 m	24 m	108 m
Height in storeys	6	7	33
Deep soil	n/a	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.8.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls south and the surface flow is expected to follow the road gutter towards Bank Street. The site is considered to be ‘outside the floodplain’. The flood tagging status of the lot is shown in Table 25.

Table 25: Flood tagging for 26-38 Saunders Street

Clause 9(1)	Clause 9(2)
No	No

4.8.3. Flood Planning

Minimum FFL requirements for ‘outside the floodplain’:

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.8.4. Impact Considerations

The existing site configuration has some open space in the eastern portion of the lot, although this is elevated above the street level such that it would not be inundated from the street. Changes to the site layout are unlikely to change flood behaviour surrounding the site. Local runoff characteristics may be influenced by changes to the open area of the site, however, these changes would be minimal.

4.8.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.9. 14 Quary Master Drive

The site (Photo 11) is east of the Quarry Master Drive and north of Saunders Street. To the east of the site the light rail line is a significant elevation drop below the floor level of the existing structure. Flood depth and hazard mapping are in Area A, Figure 3 to Figure 7.

Photo 11: East facing at the intersection of Saunders Street and Quarry Master Drive. *Google Streetview*

4.9.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 26 below.

Table 26: Proposed planning controls for 14 Quary Master Drive

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	R1 – GR	Mixed Use
Floor space ratio		3.5	3.88 + DesEx[1]
Height of building	26.5 m	27 m	35 m
Height in storeys	8	8	10
Deep soil		10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.9.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls south, and the surface flow is expected to follow the road gutter towards Bank Street. The site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 27. Deep flooding in the vicinity of the site is inundation of the light rail line that is cut some 8 m below the ground level surrounding the site.

Table 27: Flood tagging for 14 Quarry Master Drive

Clause 9(1)	Clause 9(2)
No	No

4.9.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.9.4. Impact Considerations

The existing building utilises 100% of the respective lots and the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.9.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.10. 80-84 Harris Street

These three adjacent lots (Photo 12) are located to the southeast of the Harris Street and John Street intersection and front Harris Street. This site does not include the first three terrace buildings immediately south of John Street. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

Photo 12: East facing on Harris Street to no. 80-84. *Google Streetview*

4.10.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 28 below.

Table 28: Proposed planning controls for 80-84 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Comm & Res	MU1 – MU	Mixed Use
Floor space ratio	2.13	1.25	2.75 + DesEx[1]
Height of building	15 m	9 m	32 m
Height in storeys	4	2	8
Deep soil	TBC	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that

demonstrate design excellence and achieve a positive outcome.

4.10.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls south and east, with surface flow expected to follow the road gutter towards Union Street and the Pyrmont Street sag point. The site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 29.

Table 29: Flood tagging for 80-84 Harris Street

Clause 9(1)	Clause 9(2)
No	No

4.10.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.10.4. Impact Considerations

The existing structures utilises 100% of the respective lots, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.10.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.11. 79-93 John Street

The eight adjacent lots (Photo 13) are located on the southern side of John Street, between Harris Street and Pyrmont Street. It does not include the lots fronting Harris Street and Pyrmont Street. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

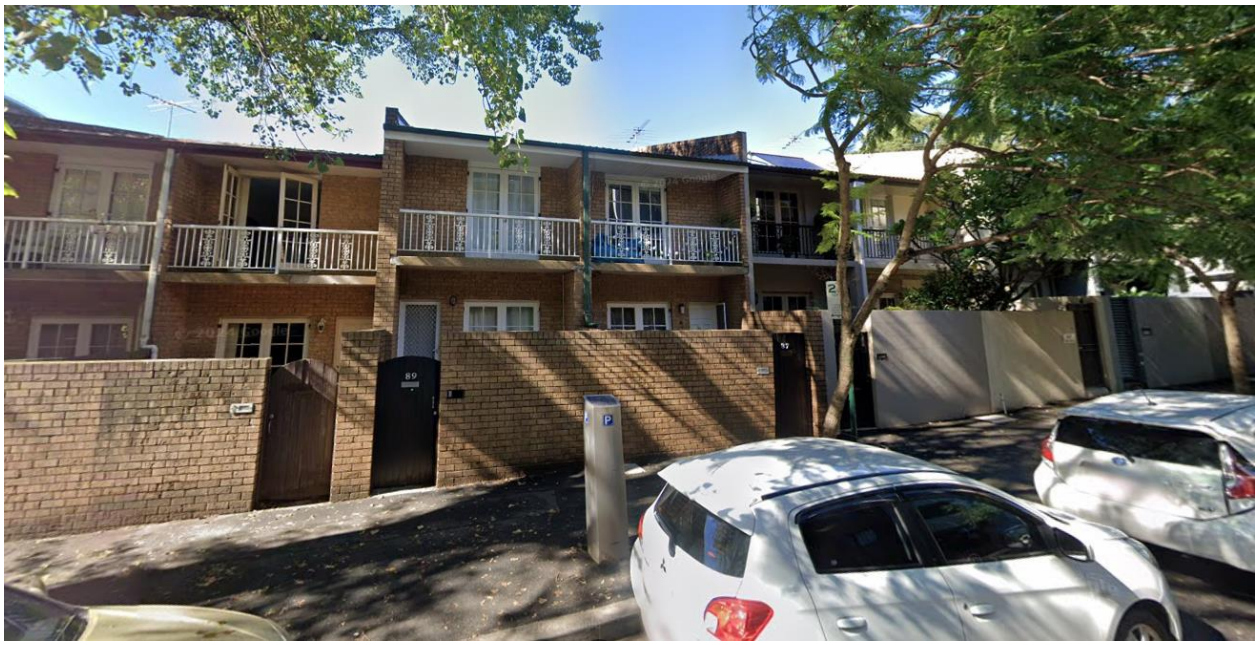


Photo 13: South facing on John Street to no. 79-93. *Google Streetview*

4.11.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 30 below.

Table 30: Proposed planning controls for 79-93 John Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
79-81 John Street			
Land use & zoning	Residential	B4 – MU	Mixed Use
Floor space ratio	1.15	1.25	3.04
Height of building	8 m	9 m	28 m
Height in storeys	2	2	7
Deep soil	-	16 m^2 min	15%
83-85 John Street			
Land use & zoning	Residential	B4 – MU	Mixed Use
Floor space ratio	1.03	1.25	2.71
Height of building	8 m	9 m	25 m
Height in storeys	2	2	6
Deep soil	-	16 m^2 min	15%
87-89 John Street			
Land use & zoning	Residential	B4 – MU	Mixed Use
Floor space ratio	1.03	1.25	2.52
Height of building	9 m	9 m	25 m
Height in storeys	2	2	6
Deep soil	-	16 m^2 min	15%
91-93 John Street			
Land use & zoning	Residential	B4 – MU	Mixed Use
Floor space ratio	1.03	1.25	2.02
Height of building	9 m	9 m	22 m
Height in storeys	2	2	5
Deep soil	-	16 m^2 min	15%

4.11.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls east, and the surface flow is expected to follow the road gutter towards Pyrmont Street. The site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 31.

Table 31: Flood tagging for 79-93 John Street

Clause 9(1)	Clause 9(2)
No	No

4.11.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.11.4. Impact Considerations

The existing structures utilises 100% of the respective lots, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.11.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.12. 12 Pyrmont Street

The site (Photo 14) is bounded by Jones Bay Road to the south and Pyrmont Street to the west. The site has an existing structure that is built on top of several lots. The three lots neighbouring the site to the south have heritage listed structures and are not included in the Planning Proposal. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

Photo 14: East facing on Pyrmont Street to no. 12. *Google Streetview.*

4.12.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 32 below.

Table 32: Proposed planning controls for 12 Pyrmont Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Unoccupied	B3 – CC	Commercial
Floor space ratio		1.75	3.50 + DesEx[1]
Height of building	17 m	22 m	52 m
Height in storeys	3	-	11
Deep soil	TBC	10%	Min. 20%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.12.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. Runoff is expected to remain within the road gutters surrounding the site. The landform falls southeast and the surface flow is expected to follow the road gutter towards Pirrama Road (east) and the Pyrmont Street sag point (south). The site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 33.

Table 33: Flood tagging for 12 Pyrmont Street

Clause 9(1)	Clause 9(2)
No	No

4.12.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

The sites are outside the floodplain and as such flood related FFL are not applicable for commercial sites (except basement level parking or habitable floors). It is advisable in such conditions that a minimum of 0.3 m freeboard be constructed above the adjacent landform, usually taken from the gutter invert.

4.12.4. Impact Considerations

The proposed changes would require a minimum of 20% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could result in a net positive impact for the local flood conditions.

4.12.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.13. 48 Pirrama Road

To the east of this lot, the existing building has a small promenade and immediately adjoins Pyrmont Bay. The site (Photo 15) is bounded by Trouton Place to the north and Pirrama Road to the southwest. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

Photo 15: North facing 48 Pirrima Road, *Google Streetview.*

4.13.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 34 below.

Table 34: Proposed planning controls for 48 Pirrama Road

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Commercial	B3 - CC	Commercial
Floor space ratio	3.66	4.5	4.5 + DesEx[1]
Height of building	27 m	24 m	52 m
Height in storeys	6	5	12
Deep soil	-	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.13.2. Site Characteristics and Flood Behaviour

The site is located low in the local sub-catchment (Photo 16 and Photo 17), receiving surface flows from as high as Harris Street. Water ponds on Pirrama Road at a sag point adjacent to the site. The flood modelling indicates that when the gutter is overtopped, the existing building blocks the flow path from exiting to Pyrmont Bay and the southwest corner of the lot is impacted. The southern and eastern face of the building is modelled to be affected by ponding water in the 1% AEP and PMF events before water eventually flows into the bay. Inundation depths exceed 1 m in both 1% AEP and PMF events.

The modelled inundation surrounding the existing building appears to be a result of inaccurate LiDAR ground levels adjacent to the building, rather than a real flood risk. It is anticipated that the sag point on Pirrama Road would be relieved across the southern side of the building, which is

currently open (Photo 16). Additionally, water that does find its way to the eastern side of the building is unlikely to pond to significant depths, as it does in the model. The promenade is level with the building floor level and appears to gently slope toward the bay (Photo 17). So while the ponding and overflow from Pirrama Road is considered to be accurate, the flooding modelled to occur surrounding the building is not considered to be accurate and was neglected for the purpose of this assessment.

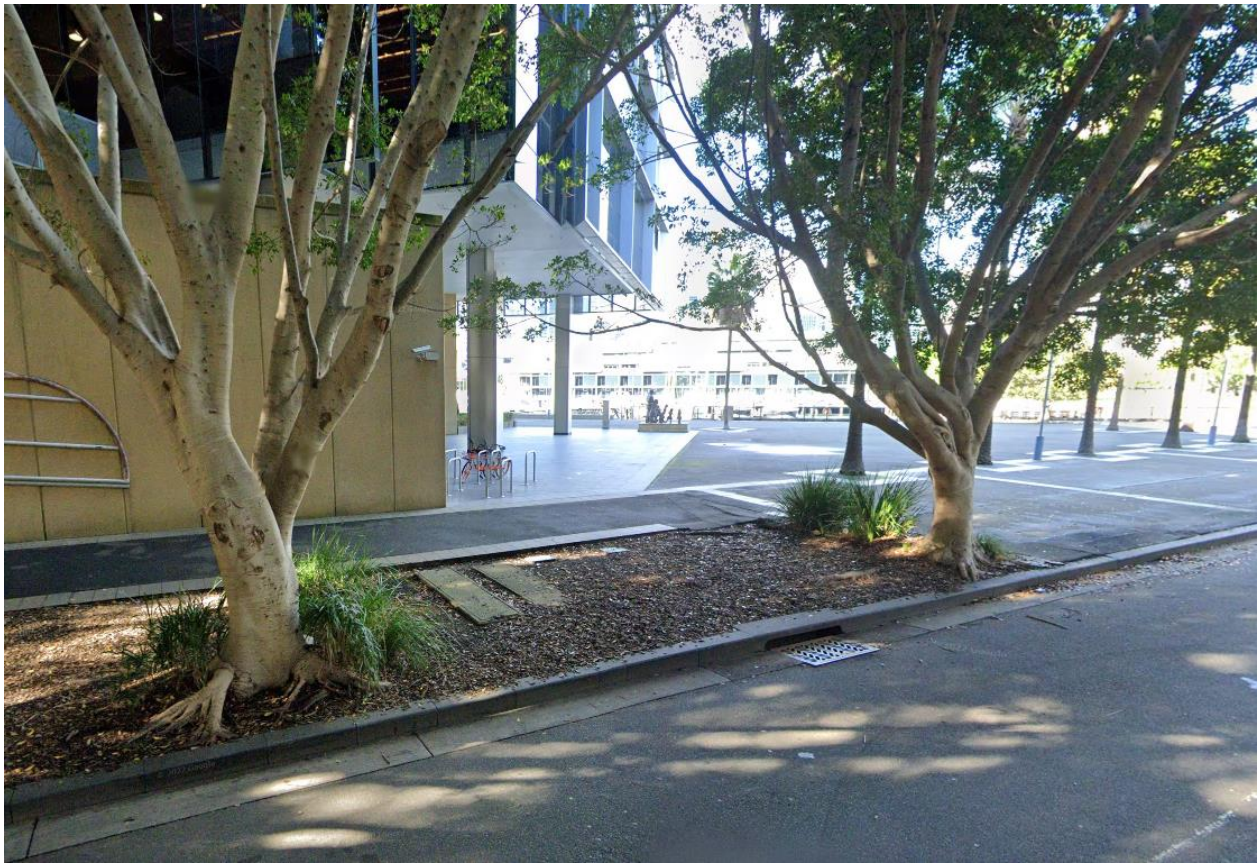


Photo 16: East facing from the Pirrama Road sag point (pit location) with overflows likely to flow across the open undercroft area at the southern end of 48 Pirrima Road, *Google Streetview*.

Photo 17: South facing on the eastern side of 48 Pirrama Road, along the promenade, *Google Streetview*.

The north face of the structure is relatively free of inundation. The existing structure footprint occupies almost the entire lot, with nil capacity to infiltrate local run-off. The flood tagging status of the lot is shown in Table 35 and flood characteristics for the site are shown in Table 36, using the flooding on Pirrama Road only. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). See Section 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively.

Table 35: Flood tagging for 48 Pirrama Road

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 36: Indicative site flood characteristics for 48 Pirrama Road

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Mainstream Flooding	2.7	2.8	H3	H3

4.13.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level

- Open parking – 5% AEP flood level

The existing building has floor levels at natural ground level on the southern and eastern sides to provide activation to the waterfront promenade area. Based on the current modelling, non-sensitive uses (for example restaurants) would likely need to be approximately 0.2 m above the promenade level to meet minimum FFL requirements. This is considered to be achievable whilst still maintaining activation with the promenade. With a site-specific flood assessment (correcting the anomalies noted in Section 4.13.2), the minimum FFL may be reduced if the flood affectation of the site is reduced. The northeast corner of the site has the highest ground levels (near the roundabout). This would be the ideal location for underground carparking or sensitive uses (for example electrical substation equipment). This is how the existing building is configured.

4.13.4. Impact Considerations

The existing structures utilises close to 100% of the lot, the proposed changes would require a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. A redesign of the building could accommodate the overflow from the Pirrama Road sag point such that the building would have a lower risk of inundation than the current building. This could be achieved with increased drainage or a relief point and overland flow path. As such, redevelopment of the site could see a net positive impact on the local flood conditions. Downstream flood impacts are not a concern, since the site discharges directly to Pyrmont Bay.

4.13.5. Hazard Consideration

In a 1% AEP and PMF event, Pirrama Road is H3 hazard at the sag point, with H2 over the road. This would likely cut off access for vehicles, and pedestrians may not be able to access the building directly at the sag point. However, this is fairly localised and it is anticipated that with updated flood modelling, access to the remaining sides of the building would be maintained, including pedestrian access to the promenade and vehicle access to Trouton Place. Wider vehicular access along Pirrama Road is restricted by the sag point at the intersection with Edward Street (discussed in Section 4.3), such that access to and from the site in an extreme flood event would be from the north in any case.

4.14. 100 Harris Street

Most of 100 Harris Street (Photo 18) is occupied by a heritage listed building and the Planning Proposal changes only apply to the southern section. The site has Harris Street to the west and Pyrmont Street to the east. There is approximately 12 m difference in elevation between the streets, with Pyrmont Street being the lower of the two. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

Photo 18: 100 Harris Street, north facing on Pyrmont Street towards sag point. *Google Streetview.*

4.14.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 37 below.

Table 37: Proposed planning controls for 100 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Commercial	E2 – CC	Commercial
Floor space ratio	1.4	3.5	3.32 + DesEx[1]
Height of building	26 m	24 m	39 m
Height in storeys	8	5	10
Deep soil	0%	10%	600 m^2 (Green Roof)

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.14.2. Site Characteristics and Flood Behaviour

Harris Street (to the west) is flood free up to and including the PMF (depths < 0.1 m). The natural landform falls east, and the surface flow is expected to follow the road gutter towards Union Street (south). It is noted that the flood modelling (completed in 2016) had an overflow through the southern portion of the site which consisted of a carpark. Since then, a building has been constructed in a contiguous fashion such that this flow path no longer remains (Photo 19). The flow through the carpark was shallow in nature and blocking this flow path is expected to divert all water down Harris Street to Union Street.

Photo 19: 100 Harris Street, north facing on Harris Street in 2015 (top) and 2022 (bottom). *Google Streetview.*

Comparatively, there is a trapped sag point on Pyrmont Street, adjacent to the site where runoff ponds in events greater than the 10% AEP, when the capacity of the stormwater (with 50% blockage of pits considered) is exceeded. The sag point is drained by a 2.25 m (W) x 1.9 m (H) box culvert that conveys flows to the north, discharging to Pyrmont Bay. The flood depths at the Pyrmont Street sag reach 0.4 m and 1.9 m in the 1% AEP and PMF events, respectively. There is no overland relief point for inundation and as such, ponding increases (subject to the performance of the drainage network) until overflows commence down Jones Bay Road (to the north), followed closely by overflows down Union Street (to the south). Flood depths need to exceed approximately 4 m at the sag point for these overflow points to be activated.

The flood tagging status of the lot is shown in Table 38 and flood characteristics for the site are shown in Table 39. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). When considering blockage to the pits on Pyrmont Street there is an expected increase to the flood depth by approximately 0.8 m and >2.0 m in the 1% AEP and

PMF events, respectively. See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively.

Table 38: Flood tagging for 100 Harris Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 39: Indicative site flood characteristics for 100 Harris Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Mainstream Flooding	6.7[1]	8.2[1]	H3	H4

1. Taken at Pyrmont Street sag point, considering 50% blockage of sag pits

4.14.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

Due to the elevation difference between Harris Street and Pyrmont Street, development meeting the minimum FFL requirements is achievable and is considered practical for construction based on the indicative flood levels and existing site topography. Entrances on Pyrmont Street, however, may need to be elevated above the footpath level. Non-sensitive commercial uses may only need to be raised approximately 0.3 m above the ground. It is not recommended to have sensitive uses on the ground floor fronting Pyrmont Street, due to the elevation required above street level (approximately 0.8 m) when this could be accommodated on other floors or the Harris Street frontage. Similarly, basement carparking would require a crest level more than 2 m above the street level. As such, vehicular entrances from Harris Street would be more feasible. Blockage considerations affect the site and are discussed further in Sections 5.1.

4.14.4. Impact Considerations

The existing building occupies 100% of the lot and as such, any redevelopment would not change the flood behaviour in the surrounding streets. There would be no adverse flood impacts resulting from redevelopment of the site with the Planning Proposal.

4.14.5. Hazard Consideration

During a rare flood event, or in circumstances when the inlet pits on Pyrmont Street are blocked, access to Pyrmont Street would be cut off, for both vehicles and pedestrians with the potential for high hazard floodwater due to the depth of inundation. Access, however, would be maintained on the Harris Street frontage for both pedestrians and vehicles in events up to and including the PMF. If the entrance to basement carparking is provided on Harris Street, then occupants would be able

to evacuate the site using vehicles.

4.15. 20-48 Wattle Street

The large, heritage listed, northern structure is to remain unchanged. The proposed Planning Changes apply to the smaller neighbouring structure 44-48 Wattle Street, as seen in Photo 20. There is access to the site from Wattle Street and Jones Street (Photo 21), with an approximate elevation difference of 18 m between the two. There is a driveway between the two buildings, although due to the elevation difference, these are on two separate levels and not directly connected (Photo 22). It is unclear if connectivity is maintained throughout the building from Wattle Street to Jones Street. Flood depth and hazard mapping are in Area D, Figure 18 to Figure 22.

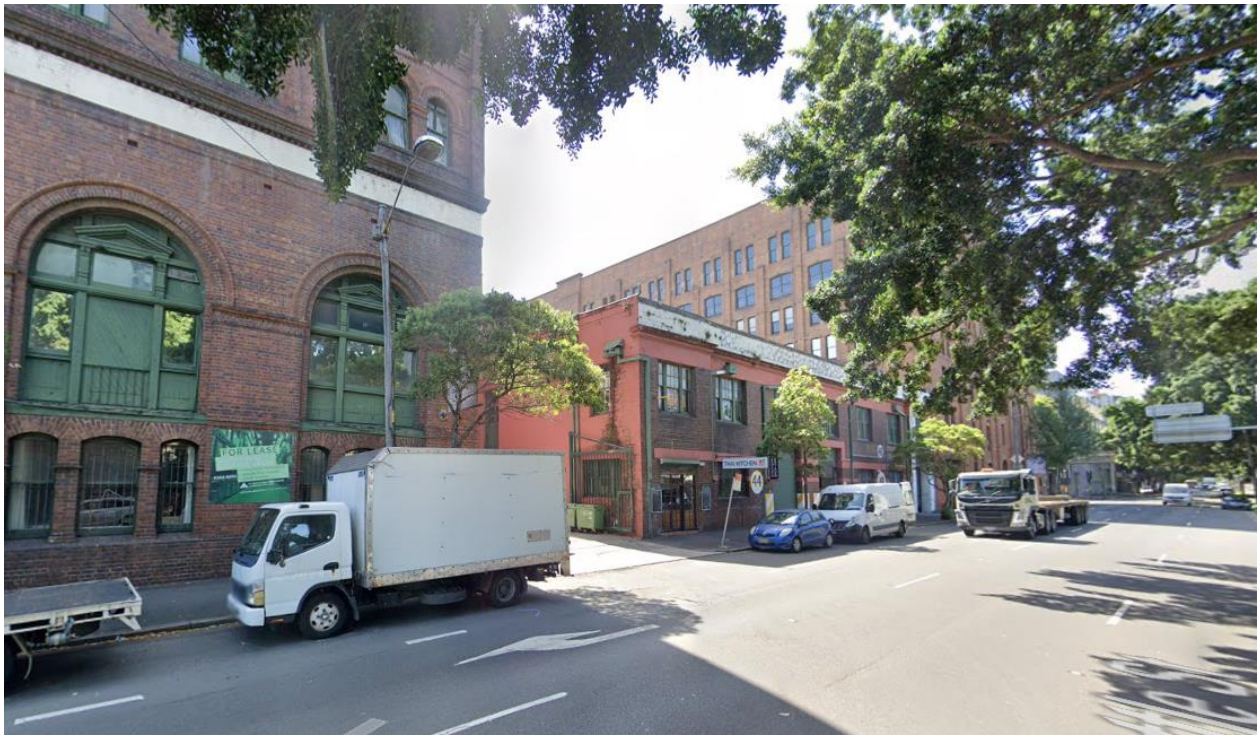


Photo 20: Wattle Street No. 20-48 east facing. *Google Streetview.*

Photo 21: Jones Street frontage to Wattle Street No. 20-48 west facing. *Google Streetview.*

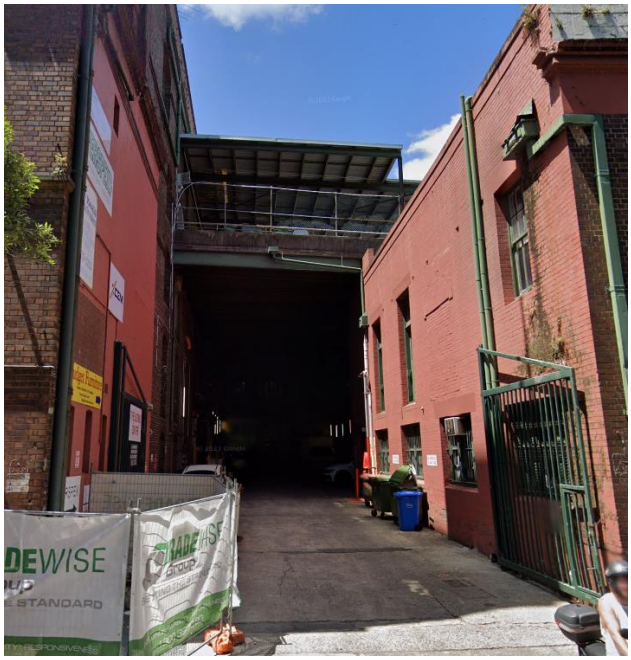


Photo 22: Wattle Street driveway entrance (left) and Jones Street driveway entrance (right) to Wattle Street No. 20-48. *Google Streetview.*

4.15.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 40 below.

Table 40: Proposed planning controls for 20-48 Wattle Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Mixed Use	B4 – MU	Commercial
Floor space ratio	3.18	4.0	4.09 + DesEx[1]
Height of building	24 m	27 m	RL56
Height in storeys	5	7	12
Deep soil	0%	10%	15%[2]

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.
2. Green roof used as alternative

4.15.2. Site Characteristics and Flood Behaviour

There is no modelled inundation of Jones Street adjacent to the site. Wattle Street has significant inundation in the 1% AEP and PMF events. The street is a significant conduit of surface flows from a large catchment, including further south than Cleveland Street. The water is modelled to flow north along Wattle Street, around Wentworth Park which is raised in comparison. Wentworth Park Road (on the western side of the park) also acts as a flow path, with both discharging across Bridge Road into Blackwattle Bay. While Wentworth Park Road is categorised as a floodway, Wattle Street (north of Quarry Street) is categorised as a flood storage area. The inundation at the site along its western frontage is 0.2 m – 0.5 m deep in the 1% AEP event and 1.3 m – 1.4 m deep in the PMF. The gutter would be overtopped adjacent to the site in the 1% AEP event, with water ponding against the building. The hazard rating is H2 – H3 (1% AEP) and H5 (PMF). The flood tagging status of the lot is shown in Table 41 and flood characteristics for the site are shown in Table 42. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively.

Table 41: Flood tagging for 20-48 Wattle Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 42: Indicative site flood characteristics for 20-48 Wattle Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Mainstream Flooding	2.6	3.5	H2 – H3	H4-H5

4.15.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

At the southern end of the lot (where redevelopment is proposed), non-sensitive uses (such as commercial development) would be required to be elevated approximately 0.2 m above the surrounding ground, which is considered reasonable. Any other development (such as habitable floors or sensitive uses) would need to be elevated approximately 0.7 m above the surrounding ground level. This may be achievable since the site rises steeply to the east, however, may not be practical. If a basement carpark entry is proposed on Wattle Street, it would need to be elevated over 1 m above the surrounding ground level. Again, this is achievable, however, may not be practical depending on the redevelopment proposed.

A sensible redevelopment of this lot would consider ground floors fronting Wattle Street to be a non-sensitive use (such as a lobby), with upper floors housing the main occupants of the site, with access to Jones Street from the building. Basement carparking should also be considered from Jones Street rather than Wattle Street, or else ramp up internally to meet minimum crest levels.

4.15.4. Impact Considerations

The existing building occupies almost the entire site, with the exception of the driveway (Photo 22). The 1% AEP event is modelled to enter this driveway slightly and redevelopment of the site may remove this small area of inundation. However, given the volume of water on Wattle Street, this is unlikely to have any discernible impact on flood levels. Any site changes are likely to have a negligible impact on existing flood behaviour.

4.15.5. Hazard Consideration

In the 1% AEP event, the southern portion of the site (where redevelopment is proposed) is subject to H1 hazard on Wattle Street, with H2 hazard in the gutter. It is likely that vehicular access to the site from Wattle Street would not be possible. It may be accessible for large vehicles such as emergency vehicles, although at the intersection with Fig Street, Wattle Street would not be trafficable for any vehicles. This is important as Wattle Street is one way (northbound), such that access to the site may be possible via Wattle Street, but exiting the site would likely not be possible. In the PMF event, the entire length of Wattle Street (from MacArthur Street to Bridge Road would be hazardous to vehicles and pedestrians.

Redevelopment of the site should consider internal access to both Wattle Street and Jones Street, such that Jones Street would be the primary access to and from the site in the event of flooding. The Jones Street entrance would remain accessible to vehicles and pedestrians even in the PMF event. Significant inundation of the ground floor fronting Wattle Street is expected in the PMF event such that upper levels should serve as a flood refuge, with access to be maintained for all occupants to Jones Street. Emergency management for the site should consider this (for example, fire exits).

4.16. 50-54 Wattle Street

The site (Photo 23) is located immediately to the north of the Wattle Street and Quarry Street junction. It has frontages on Wattle Street, Quarry Street and Jones Street. Much of the proposed changes to the site involves keeping the existing façade unchanged. Flood depth and hazard

mapping are in Area D, Figure 18 to Figure 22.

Photo 23: No. 50-54 Wattle Street, with Wattle Street (left) and Quarry Street (right), northeast facing. *Google Streetview.*

4.16.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 43Table 7 below.

Table 43: Proposed planning controls for 50-54 Wattle Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls[1]
Land use & zoning	Mixed Use	B4 – MU	Commercial
Floor space ratio	3.38	4.0	4.36 + DesEx[2]
Height of building	34 m	33 m	RL36.5
Height in storeys	7	8	7
Deep soil	0%	10%	10%

1. The proposed controls are to maintain the existing building height and exterior
2. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.16.2. Site Characteristics and Flood Behaviour

There is minimal affectation of the site on the Jones Street frontage, with flood depths typically less than 0.1 m in the 1% AEP event. Water from Jones Street flows to Quarry Street, which descends steeply to Wattle Street. There is flow modelled down Quarry Street, with depths exceeding 0.1 m only within the gutter adjacent to the site. Wattle Street has significant inundation in the 1% AEP and PMF events. The street is a significant conduit of surface flows from a large catchment, including further south than Cleveland Street. The water is modelled to flow north along Wattle Street, around Wentworth Park which is raised in comparison. Wentworth Park Road

(on the western side of the park) also acts as a flow path, with both discharging across Bridge Road into Blackwattle Bay. While Wentworth Park Road is categorised as a floodway, Wattle Street (north of Quarry Street) is categorised as a flood storage area.

The inundation at the site along its western frontage is 0.1 m – 0.3 m deep in the 1% AEP event and 1.0 m – 1.2 m deep in the PMF. The gutter would be overtopped adjacent to the site in the 1% AEP event, although due to the grade of the footpath, may not reach the building. The hazard rating is H2 – H3 (1% AEP) and H5 (PMF). While there is a narrow strip of flooding down Quarry Street greater than 0.1 m with very high velocities (triggering H5 and H6 hazard), this is not considered to be the primary flood risk to the site, rather the flooding on Wattle Street is. The flood tagging status of the lot is shown in Table 44 and flood characteristics for the site are shown in Table 46. The site is sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively.

Table 44: Flood tagging for 20-48 Wattle Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 45: Indicative site flood characteristics for 20-48 Wattle Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Mainstream Flooding	2.6 – 2.8	3.6	H1 – H2	H5

4.16.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

Non-sensitive commercial floors fronting Wattle Street would be achievable and likely to be similar to the existing ground floor level at the building. Currently, it appears that there are no pedestrian entrances to the building on Wattle Street, and only service rooms with entrances on Wattle Street. As such, the existing floor levels may be adequate for the flood behaviour on Wattle Street, as long as the proposed use of the ground floor is not sensitive to inundation (as the PMF may reach 1 m inside the building). There is a carpark entrance at the northern end of the site on Wattle Street. The entrance rises steeply internally to a level that is likely to be above the Wattle Street PMF (Photo 24). This carpark entrance may also be retained given it is likely to meet minimum FFL requirements, although consideration should be given to maintaining internal connection with the carpark entrance on Quarry Street for emergency access and evacuation.

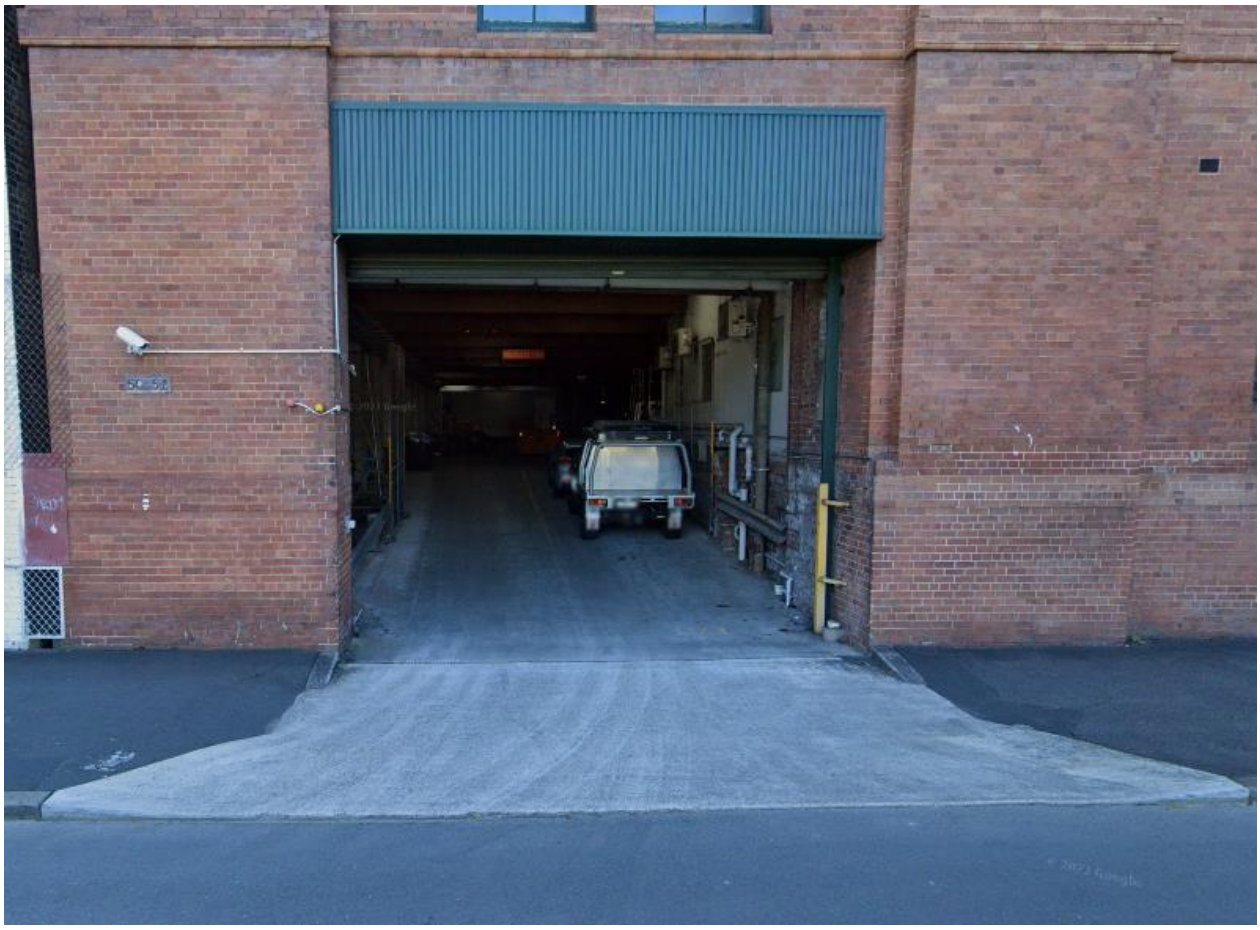


Photo 24: Wattle Street carpark entrance at No. 50-54 Wattle Street. *Google Streetview.*

4.16.4. Impact Considerations

The existing building occupies 100% of the lot and as such, any redevelopment would not change the flood behaviour in the surrounding streets. There would be no adverse flood impacts resulting from redevelopment of the site with the Planning Proposal.

4.16.5. Hazard Consideration

In the 1% AEP event, Wattle Street adjacent to the site is primarily H1, although reaches H2 in the gutter. It may be that vehicle access to the site from Wattle Street would not be possible, although likely to be accessible for large vehicles such as emergency vehicles. The site would be the limit of the trafficable extent of Wattle Street, with hazards increasing to the north such that H3 hazard exists at the intersection with Fig Street. This is important as Wattle Street is one way (northbound), such that access to the site may be possible via Wattle Street, but exiting the site would likely not be possible. In the PMF event, H5 hazard on Wattle Street would preclude vehicle and pedestrian access.

However, there is also currently vehicle access to the building from Quarry Street. It is unclear if these two access points are connected internally, however, during redevelopment the linking of the internal carpark areas would provide the benefit of maintaining vehicle access to the building during flood events when Wattle Street is inundated. It is noted that the modelling indicates H5 and H6 hazard within the gutter on Quarry Street. This is triggered by high velocities and the depth

of flooding is shallow (<0.2 m) even in the PMF. Although this velocity can cause cars to be unstable, the whole car would not be subject to this at one time – it would only be as the wheels cross the gutter such that it is possible that vehicle access would be maintained.

Redevelopment of the site should consider internal access to Wattle Street, Quarry Street and Jones Street, such that Jones Street would be the primary pedestrian access to and from the site in the event of flooding. The Jones Street entrance would remain accessible to vehicles (although not internally with the current configuration) and pedestrians even in the PMF event. Significant inundation of the ground floor fronting Wattle Street is expected in the PMF event such that upper levels should serve as a flood refuge, with access to be maintained for all occupants to Jones Street. Emergency management for the site should consider this (for example, fire exits).

4.17. 469-483 Harris Street

This site (Photo 25 and Photo 26) consists of seven adjoining lots of two-story commercial terraces. They are bounded by Harris Street to the east and Kirk Street to the west. There are frontages to both, with Harris Street containing shop fronts and Kirk Street containing garage entrances. There is an existing accessway connecting Kirk Street to Harris Street immediately south of the site. Flood depth and hazard mapping are in Area D, Figure 18 to Figure 22.

Photo 25: No. 469-483 Harris Street, south facing on Harris Street. *Google Streetview.*

Photo 26: No. 469-483 Harris Street, north facing on Kirk Street. *Google Streetview.*

4.17.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 46 below.

Table 46: Proposed planning controls for 469-483 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
469-471 Harris Street			
Land use & zoning	Com & Res	MU1 – MU	Mixed Use
Floor space ratio	1.59	1.5	2.43 + DesEx[1]
Height of building	8 m	9 m	27 m
Height in storeys	2	2	7
Deep soil	-	10%	15%
473-475 Harris Street			
Land use & zoning	Com & Res	MU1 – MU	Mixed Use
Floor space ratio	1.48	1.5	2.50 + DesEx[1]
Height of building	7 m	9 m	27 m
Height in storeys	2	2	7
Deep soil	-	10%	15%
477-479 Harris Street			
Land use & zoning	Com & Res	MU1 – MU	Mixed Use
Floor space ratio	2.0	1.5	2.40 + DesEx[1]
Height of building	7 m	9 m	27 m
Height in storeys	2	2	7
Deep soil	-	10%	15%
481-483 Harris Street			
Land use & zoning	Com & Res	MU1 – MU	Mixed Use
Floor space ratio	1.75	1.5	1.61 + DesEx[1]
Height of building	8 m	9 m	18 m
Height in storeys	2	2	4
Deep soil	-	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.17.2. Site Characteristics and Flood Behaviour

There is minimal modelled inundation surrounding the building in the 1% AEP and PMF events. There is some ponding of water modelled on the eastern side of Kirk Street, adjacent to the site. This is considered to be a result of the direct rainfall approach in the DH model and the representation of the terrain in the LiDAR data with the brick walls and garages at the rear of the site. This minor inundation would not occur in reality for the following reasons:

- The LiDAR indicates that Kirk Street is on-grade, such that water would flow from south to north along the gutter toward Quarry Street, with no sag point where water would pond to any substantial depth.
- Water at the southern end of Kirk Street can discharge to Harris Street via a walkway (Photo 27). This was not contained in the flood model since it was constructed circa 2017-2019. It was previously a building such that flows were not able to discharge to Harris Street.
- There is a small gap between no. 475 and 477 Harris Street (Photo 28), at the location where the ponding is modelled such that if there was water here, it would be relieved through this gap. This gap is small and was not included in the DH flood model. This would act as a relief point for any local ponding of water.

Given the above, the site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 47.

Table 47: Flood tagging for 469-483 Harris Street

Clause 9(1)	Clause 9(2)
No	No

Photo 27: Walkway between Harris Street and Kirk Street, adjacent to No. 469-483 Harris Street, viewed from Harris Street. *Google Streetview.*

Photo 28: Small gap between no. 475 and 477 Harris Street, viewed from Harris Street. *Google Streetview.*

4.17.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. Although there are no minimum FFL requirements for commercial developments, the existing shop fronts step up from Harris Street such that they would be protected from any shallow inundation. On Kirk Street, any redevelopment can reform the gutter adjacent to the site to ensure free drainage toward Quarry Street.

4.17.4. Impact Considerations

The existing structures utilises 100% of the respective lots (with the exception of the gap between no 475 and 477) and the Planning Proposal requires a minimum of 15% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.17.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.18. 535-547 Harris Street

This lot (Photo 29) comprises seven adjoined two-storey terrace housing. It is bounded by Harris Street to the east and Hackett Street to the west, with an approximate 2 m elevation difference between the two. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 29: No. 535-547 Harris Street, southwest facing. *Google Streetview.*

4.18.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 48 below.

Table 48: Proposed planning controls for 535-547 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Vacant & Res	B1 – NC	Mixed Use
Floor space ratio	Varies	3.5	3.33 + DesEx[1]
Height of building	7.5 m	22 m	41.5 m
Height in storeys	2	5	12
Deep soil	-	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.18.2. Site Characteristics and Flood Behaviour

There is no modelled inundation around the site that overtops the gutters in the 1% AEP and PMF events. Flow in the gutter is between 0.1 m and 0.15 m deep in the PMF on Hackett Street. The landform falls east, and the surface flow is expected to follow the road gutter on Hackett Street and Harris Street towards MacArthur Street. The site is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 49.

Table 49: Flood tagging for 535-547 Harris Street

Clause 9(1)	Clause 9(2)
No	No

4.18.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.18.4. Impact Considerations

The existing structures utilises approximately 50% of the respective lots, with rear yards fronting Hackett Street. There is no modelled overtopping of the Hackett Street gutter, such that the rear yards are flood free. As such, development on the site is not likely to have any impact on local flood conditions in the street.

4.18.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. The hazard only reaches H1 on Hackett Street and there is no hazard rating on Harris Street due to the low flow depth in the street. There are no access constraints for the site.

4.19. 549-559 Harris Street

The site (Photo 30) consists of an individual lot with an existing commercial building. The site is bounded by Harris Street to the east and Hackett Street to the west, with an approximate 2 m elevation difference between the two. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 30: No. 549-559 Harris Street, southwest facing. *Google Streetview.*

4.19.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 50 below.

Table 50: Proposed planning controls for 549-559 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Comm & Industrial	B1 – NC	Mixed Use
Floor space ratio	4.41	4.0	3.62 + DesEx[1]
Height of building	22 m	22 m	41.5 m
Height in storeys	2	5	12
Deep soil	-	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.19.2. Site Characteristics and Flood Behaviour

There is no modelled inundation around the site that overtops the gutters in the 1% AEP event. The deepest flooding occurs on Hackett Street, reaching up to 0.15 m deep in the 1% AEP, and 0.2 m deep in the PMF event (likely to just overtop the gutter). The landform falls east and the surface flow is expected to follow the road gutter on both Hackett Street and Harris Street towards MacArthur Street. The site is considered to be ‘outside the floodplain’. The flood tagging status of the lot is shown in Table 51.

Table 51: Flood tagging for 549-559 Harris Street

Clause 9(1)	Clause 9(2)
No	No

4.19.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. The existing building has one vehicle garage and one pedestrian entrance on Hackett Street, at the northern end (Photo 31). The flood depths at this location are approximately 0.15 m in the PMF event. The driveway and pedestrian entrance are both elevated above the gutter level such that they would be protected from inundation in the PMF event. Entry points, even considering 0.3 m above the gutter invert are likely to be achievable and at a similar level to the existing entry points on Hackett Street.

Photo 31: No. 549-559 Harris Street, existing Hackett Street entry points. *Google Streetview.*

The entrances on Harris Street are also elevated above the gutter level, due to the kerb and slope of the footpath. It is likely that the existing entry points are also 0.3 m above the gutter invert, demonstrating that compliance with minimum FFL requirements is reasonable.

4.19.4. Impact Considerations

The existing structure utilises 100% of the lot and the Planning Proposal would require a minimum of 10% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.19.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. The hazard only reaches H1 on Hackett Street and there is no hazard rating on Harris Street due to the low flow depth in the street. There are no access constraints for the site.

4.20. 561-577 & 579-583 Harris Street

At this site (Photo 32 and Photo 33) there are two existing commercial buildings located over 4 lots. The site is bounded by Harris Street to the east and Hackett Street to the west, with an approximate 2.5 m elevation difference between the two. The southern building has a frontage to MacArthur Street to the south. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 32: No. 579-583 Harris Street from MacArthur Street looking up Hackett Street with Harris Street to the right, facing north. *Google Streetview*

Photo 33: No. 561-583 Harris Street, with Harris Street (right) and MacArthur Street (left), facing northwest. *Google Streetview*.

4.20.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 52 below.

Table 52: Proposed planning controls for 561-577 & 579-583 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
561-577 Harris Street			
Land use & zoning	Commercial	B1 – NC	Mixed Use
Floor space ratio	1.95	4.0	3.40 + DesEx[1]
Height of building	17.5 m	22 m	41.5 m
Height in storeys	3	5	12
Deep soil	-	10%	15%
579-583 Harris Street			
Land use & zoning	Commercial	B1 – NC	Mixed Use
Floor space ratio	6.47	6.3	6.41 + DesEx[1]
Height of building	29 m	35 m	38 m
Height in storeys	7	9	10
Deep soil	0%	10%	-

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.20.2. Site Characteristics and Flood Behaviour

On the western face, north of the Hackett Street and MacArthur Street intersection, water is modelled to reach up to 0.2 m deep in the 1% AEP event and 0.3 m deep in the PMF event. The gutter is expected to be overtopped according to the modelling. A site-specific flood assessment

may find that with a refined digital elevation model and flood model, that the depth may be lower. This is because Hackett Street is on-grade and it may be limitations of the existing flood model that are causing deeper flooding to be simulated at particular points adjacent to the site. The flood depth at the intersection of Hackett Street and MacArthur Street is approximately 0.1 m. Based on the current modelling, however, the site would be classified as 'Local Drainage' due to the flooding on Hackett Street. On the eastern (Harris Street) and southern (MacArthur Street) sides of the site, the depth of inundation is modelled to be less than 0.1 m. The flood tagging status of the lot is shown in Table 53 and flood characteristics for the site are shown in Table 54.

Table 53: Flood tagging for 561-577 & 579-583 Harris Street

Clause 9(1)	Clause 9(2)
No	No

Table 54: Indicative site flood characteristics for 561-577 & 579-583 Harris Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Local Drainage	16.8	16.9	H1	H1

Note: Taken along Hackett Street, at the location of deepest floodwater.

4.20.3. Flood Planning

Minimum FFL requirements for 'Local Drainage':

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking – 1% AEP flood level
- Open parking – 5% AEP flood level

The inundation on Hackett Street is unlikely to significantly influence the FFL, particularly for non-sensitive commercial development. At the location of the existing rear garage the 1% AEP flood is approximately 0.2 m deep, with the existing FFL estimated to already be satisfying the requirements for the commercial FFL (Photo 34). Basement level carpark entrances should be provided from Harris Street, due to minimal inundation, unless a site-specific flood assessment can demonstrate similar flood behaviour for Hackett Street. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

Photo 34: Existing garage entrance on Hackett Street facing southeast. *Google Streetview*

4.20.4. Impact Considerations

The existing structures utilises 100% of the respective lots, the Planning Proposal requires a minimum of 15% deep soil landscaping (561-577 Harris Street only), adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.20.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. The hazard only just reaches H2 on Hackett Street in a small location and there is no hazard rating on Harris Street and MacArthur Street due to the low flow depth in the street. The site is considered to be accessible for pedestrians and vehicles in all events up to the PMF.

4.21. 562-570 Harris Street

The site (Photo 35) comprises an existing commercial building and a rear (south) yard and carpark area. The site has a frontage to Harris Street (west), MacArthur Street (north) and Systrum Street (east). The main shop fronts are located on Harris Street and at the corner of Harris Street and MacArthur Street, with a garage entrance on MacArthur Street and the rear carpark accessible from Systrum Street. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 35: No. 562-570 Harris Street with Systrum Street (left), MacArthur Street (right). *Google Streetview.*

4.21.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 55 below.

Table 55: Proposed planning controls for 562-570 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Commercial	MU1 – MU	Mixed Use
Floor space ratio	0.65	1.0 & 1.5	1.98 + DesEx[1]
Height of building	10 m	9 m	23.5 m
Height in storeys	2	2	6
Deep soil	-	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.21.2. Site Characteristics and Flood Behaviour

The Systrum Street gutter is at capacity in the 1% AEP event (approximately 0.15 m deep) and expected to overtop in the PMF event (approximately 0.2 m deep). This occurs in the eastern gutter, away from the site, due to the cross fall of the road. The small carpark at the southern end of the lot, conveys flow from Harris Street to Systrum Street in the model, however, a site-specific flood assessment with refined modelling is likely to indicate that the Harris Street gutter is not overtopped and water from the street is not conveyed through the site. Rather, due to the direct rainfall approach, runoff generated within the rear yard flows overland toward Systrum Street. This would be expected to be shallow flow even in the PMF event (<0.1 m deep). The flooding on Harris Street and MacArthur Street is modelled to be less than 0.1 m deep. The landform falls southeast, and the surface flow is expected to follow the road gutter south towards Mary Ann

Street. The site is considered to be 'Local Drainage'. The flood tagging status of the lot is shown in Table 56 and flood characteristics for the site are shown in Table 57.

Table 56: Flood tagging for 562-570 Harris Street

Clause 9(1)	Clause 9(2)
No	Yes

Table 57: Indicative site flood characteristics for 562-570 Harris Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Local Drainage	-	9.3	H1	H1

Note: Taken at the middle of the site on Systrum Street

4.21.3. Flood Planning

Minimum FFL requirements for Local Drainage:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking – 1% AEP flood level
- Open parking – 5% AEP flood level

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. Minimum floor levels on Systrum Street are likely to be achievable due to the cross fall of the street and the existing gutter providing ground elevations at the site above the PMF. Frontages on Harris Street and MacArthur Street are 'outside the floodplain' and minimum FFL would be readily achievable if applicable.

4.21.4. Impact Considerations

The site is assumed to be entirely impervious with a large open impervious carpark and yard at the rear, covering approximately 32% of the lot. The potential for adverse impacts resulting from developing this open space is limited by the following:

- The potential for conveyance of flow through the carpark is limited by flood depths remaining within the gutter on Harris Street.
- The potential for flood storage within the carpark area under existing conditions is limited. The flood extent on Systrum Street does not backwater into the carpark area.
- Flooding within the carpark is likely to be from the site's local runoff only.

The development of this open space into a building would likely have minimal affectation on local flood behaviour in the surrounding streets due to the above. The existing building occupies the remainder of the site and any alterations to the structure would not have any adverse impact on flood behaviour.

4.21.5. Hazard Consideration

Harris Street and MacArthur Street access is available to the building in both the 1% AEP and PMF events, for pedestrians and vehicles. Systrum Steet access is estimated to be H1 hazard and still accessible. As such, there are no access constraints for the site.

4.22. 383-389 Bulwara Road

The site (Photo 36) fronts Bulwara Road to the east, Mary Ann Park to the south and enclosed by development to the north and west. The site is currently occupied by short stay accommodation. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 36: 383-389 Bulwara Road, south facing over the sites frontage. *Google Streetview.*

4.22.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 58 below.

Table 58: Proposed planning controls for 383-389 Bulwara Road

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Accommodation	R1 – GR	Residential
Floor space ratio	1.86	2.0	3.05 + DesEx[1]
Height of building	21 m	18 m	35 m
Height in storeys	5	4	10
Deep soil	TBC	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.22.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur in the vicinity of the site in events up to and including the PMF event. The site is located essentially on the Pyrmont peninsula ridge line, with land falling away from the site to the west, south and east. Surface flow is expected to follow the road gutter along Bulwara Road south towards Mary Ann Street. The site is considered to be 'outside the floodplain'.

It is noted in the flood model that the existing basement carpark entrance (Photo 37) is represented in the landform as a trapped low point, becoming flood storage in the 1% AEP and PMF event. This is a result of rainfall falling directly on the driveway and ponding at the entrance, since the basement and internal drainage of the site is not represented in the flood model. The modelled flood behaviour of the basement is not considered to be representative of actual flood behaviour. The flood tagging status of the lot is shown in Table 59. It is noted that the Clause 9(2) tagging is likely due to the ponding at the basement with the site identified by automated GIS algorithms.

Photo 37: 383-389 Bulwara Road basement parking access, facing west. *Google Streetview.*

Table 59: Flood tagging for 383-389 Bulwara Road

Clause 9(1)	Clause 9(2)
No	Yes

4.22.3. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground
- Basement parking – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.22.4. Impact Considerations

The existing site has existing open areas (impervious and pervious) facing Bulwara Road. Changes to the site layout could change stormwater runoff from the site, however, changes within the site boundary would not affect any water within the street, as it is expected to be within the gutter.

4.22.5. Hazard Consideration

Access is available to the building in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.23. 446-456 Wattle Street

This site (Photo 38) comprises six adjacent lots on the eastern side of Wattle Street, with Wattle Lane to the rear (east). There is approximately 2 m elevation difference (Photo 39) between Wattle Lane and Wattle Street. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

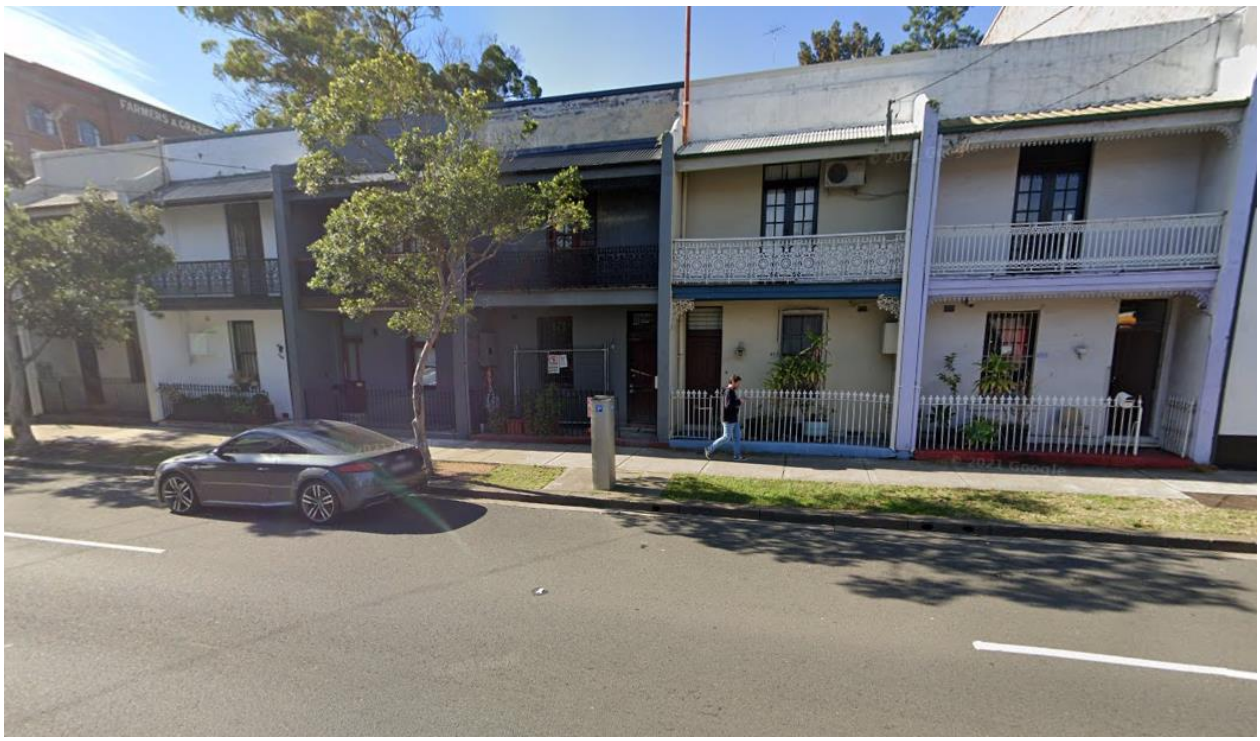


Photo 38: East facing on Wattle Street to no. 446-456. *Google Streetview*

Photo 39: Elevation difference between Wattle Street and Wattle Lane. Wattle Street (right), MacArthur Street (left), southeast facing. *Google Streetview*

4.23.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 60 below.

Table 60: Proposed planning controls for 446-456 Wattle Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	MU1 – MU	Mixed Use
Floor space ratio	1.07	1.0	3.76 + DesEx[1]
Height of building	7.5 m	9 m	36 m
Height in storeys	2	2	10
Deep soil	n/a	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.23.2. Site Characteristics and Flood Behaviour

There is no flood affectation modelled at the site for the Wattle Lane frontage. The site is located at the crest of Wattle Lane, with the road grading down to the north (toward MacArthur Street) and south (toward Mary Ann Street) away from the site. Wattle Street, however, has significant inundation in the 1% AEP and PMF events. The street is a significant conduit of surface flows from a large catchment, including further south than Cleveland Street. The water is modelled to flow north along Wattle Street toward Wentworth Park. The low point of this flow path is Blackwattle Lane (to the east), although Mountain Street and Wattle Street (either side of Blackwattle Lane) also convey a substantial amount of flow.

At the site location, the gutters on the western side of Wattle Street overtop in the 1% AEP event,

and both the east and west gutters in the PMF event. At the site, flooding does not reach the footpath adjacent to the site with the hazard remaining H1 in the 1% AEP event (although reaches H2 on the western side of the road). Wattle Street has depths up to 1 m in the PMF with a hazard rating of H5. The flood tagging status of the lot is shown in Table 61 and flood characteristics for the site are shown in Table 62. The site is sensitive to changes in rainfall intensity (climate change). See Section 5.2 for discussion on climate change sensitivity. The site is considered to be 'Mainstream Flooding'.

Table 61: Flood tagging for 446-456 Wattle Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 62: Indicative site flood characteristics for 446-456 Wattle Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Mainstream Flooding	4.6	5.4	H1	H5

Note: Taken at the middle of the site on Wattle Street

4.23.3. Flood Planning

Minimum FFL requirements for Mainstream Flooding:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

The floodway on Wattle Street is on the opposite (western) side of the road. On the eastern side the 4.6 mAHD flood level appears to be below the top of kerb. Due to the shallow inundation on Wattle Street, meeting minimum floor level requirements would not be a significant constraint, assuming ground level commercial occupancy. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. A basement carpark entrance crest would need to be more than 0.5 m above the existing footpath height, which may be difficult to achieve, however, there are frontages to MacArthur Street and Wattle Lane that can accommodate basement carparking easily although descending to a basement from this elevated position may be the challenge at this location.

4.23.4. Impact Considerations

The existing terrace buildings form a contiguous barrier along Wattle Street such that any development along this frontage is unlikely to alter the existing flood behaviour, with water still being confined to the Wattle Street corridor. There is no flooding on Wattle Lane to consider for flood impacts.

4.23.5. Hazard Consideration

Access to the Wattle Street footpath from the site is available in the 1% AEP event. Vehicular access to Wattle Street would also be possible for the eastern lanes. However, it is noted that Wattle Street is one way, such that access to the site via Wattle Street (from the south) is possible, however, at the intersection with MacArthur Street the hazard is H2, likely restricting vehicular access leaving the site via Wattle Street.

In the PMF event the Wattle Street footpath would be inundated by more than 0.5 m and the hazard on the road is H5. This would restrict both pedestrian and vehicular access. However, an appropriate building design for the site can utilise MacArthur Street and Wattle Lane for emergency access and evacuation during a flood event. Given the depth of inundation on Wattle Street, flood refuge should be provided above the PMF level for occupants. Wattle Street will be unsafe for all vehicles and people in an extreme flood event and this should be considered in emergency planning for the site (such as fire exits). Pedestrian and vehicular access would be possible via Wattle Lane in the PMF event, noting that it is only the gutters of MacArthur Street and Mary Ann Street that have high hazards, triggered by high velocity. Although this velocity can cause cars to be unstable, the whole car would not be subject to this at one time – it would only be as the wheels cross the gutter such that it is possible that vehicle access would be maintained.

4.24. 458-468 Wattle Street

The site (Photo 40) comprises one lot with frontages to Wattle Street (west) and Wattle Lane to the rear (east). There is an approximate 2 m elevation difference between the front and rear of the site. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 40: East facing on Wattle Street to no. 458-468. *Google Streetview*

4.24.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 63 below.

Table 63: Proposed planning controls for 458-468 Wattle Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	MU1 – MU	Mixed Use
Floor space ratio	3.11	2.5	3.82 + DesEx[1]
Height of building	18.5 m	15 m	36 m
Height in storeys	4	3	10
Deep soil	n/a	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.24.2. Site Characteristics and Flood Behaviour

There is no flood affectation modelled at the site for the Wattle Lane frontage. The site is located near the crest of Wattle Lane, with the road grading down to the south (toward Mary Ann Street) away from the site. Wattle Street, however, has significant inundation in the 1% AEP and PMF events. The street is a significant conduit of surface flows from a large catchment, including further south than Cleveland Street. The water is modelled to flow north along Wattle Street toward Wentworth Park. The low point of this flow path is Blackwattle Lane (to the east), although Mountain Street and Wattle Street (either side of Blackwattle Lane) also convey a substantial amount of flow.

At the site location, the gutters on the western side of Wattle Street overtop in the 1% AEP event, and both the east and west gutters in the PMF event. At the site, flooding does not reach the footpath adjacent to the site with the hazard remaining H1 in the 1% AEP event (although reaches H2 on the western side of the road). Wattle Street has depths up to 1 m in the PMF with a hazard rating of H5. The flood tagging status of the lot is shown in Table 64 and flood characteristics for the site are shown in Table 65. The site is sensitive to changes in rainfall intensity (climate change). See Section 5.2 for discussion on climate change sensitivity. The site is considered to be ‘Local Drainage’.

Table 64: Flood tagging for 458-468 Wattle Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 65: Indicative site flood characteristics for 458-468 Wattle Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Local Drainage	4.7	5.5	H1	H5

Note: Taken at the middle of the site on Wattle Street

4.24.3. Flood Planning

Minimum FFL requirements for Local Drainage:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

The floodway in Wattle Street is on the opposite (western) side of the road. On the eastern side the 4.7 mAHD flood level appears to be below the top of kerb. Due to the shallow inundation on Wattle Street, meeting minimum floor level requirements would not be a significant constraint, assuming ground level commercial occupancy. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. A basement carpark entrance crest would need to be more than 0.5 m above the existing footpath height, which may be difficult to achieve, however, the frontages to Wattle Lane can accommodate basement carparking easily, although descending to a basement from this elevated position may be the challenge at this location.

4.24.4. Impact Considerations

The existing structure utilises 100% of the lot and the Planning Proposal would require a minimum of 10% deep soil landscaping, adding flood storage and infiltration capacity. As such, redevelopment of the site could see a net positive impact for the local flood conditions.

4.24.5. Hazard Consideration

Access to the Wattle Street footpath from the site is available in the 1% AEP event. Vehicular access to Wattle Street would also be possible for the eastern lanes. However, it is noted that Wattle Street is one way, such that access to the site via Wattle Street (from the south) is possible, however, at the intersection with MacArthur Street the hazard is H2, likely restricting vehicular access leaving the site via Wattle Street.

In the PMF event the Wattle Street footpath would be inundated by more than 0.5 m and the hazard on the road is H5. This would restrict both pedestrian and vehicular access. However, an appropriate building design for the site can utilise Wattle Lane for emergency access and evacuation during a flood event. Given the depth of inundation on Wattle Street, flood refuge should be provided above the PMF level for occupants. Wattle Street will be unsafe for all vehicles and people in an extreme flood event and this should be considered in emergency planning for the site (such as fire exits). Pedestrian and vehicular access would be possible via Wattle Lane in the PMF event, noting that it is only the gutters of MacArthur Street and Mary Ann Street that have high hazards, triggered by high velocity. Although this velocity can cause cars to be unstable, the whole car would not be subject to this at one time – it would only be as the wheels cross the gutter such that it is possible that vehicle access would be maintained.

4.25. 470 Wattle Street

The site (Photo 41) comprises one lot with frontages to Wattle Street (west) and Wattle Lane to the rear (east). There is an approximate 2 m elevation difference between the front and rear of the site. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

Photo 41: East facing on Wattle Street to no. 470. *Google Streetview*

4.25.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 66 below.

Table 66: Proposed planning controls for 470 Wattle Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Residential	MU1 – MU	Mixed Use
Floor space ratio	3.11	2.5	3.82 + DesEx[1]
Height of building	18.5 m	15 m	36 m
Height in storeys	4	3	10
Deep soil	n/a	10%	10%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.25.2. Site Characteristics and Flood Behaviour

There is no flood affectation modelled at the site for the Wattle Lane frontage. The site is located near the crest of Wattle Lane, with the road grading down to the south (toward Mary Ann Street) away from the site. Wattle Street, however, has significant inundation in the 1% AEP and PMF events. The street is a significant conduit of surface flows from a large catchment, including further south than Cleveland Street. The water is modelled to flow north along Wattle Street toward

Wentworth Park. The low point of this flow path is Blackwattle Lane (to the east), although Mountain Street and Wattle Street (either side of Blackwattle Lane) also convey a substantial amount of flow.

At the site location, the gutters on the western side of Wattle Street overtop in the 1% AEP event, and both the east and west gutters in the PMF event. At the site, flooding does not reach the footpath adjacent to the site with the hazard remaining H1 in the 1% AEP event (although reaches H2 on the western side of the road). Wattle Street has depths up to 0.9 m in the PMF with a hazard rating of H5. The flood tagging status of the lot is shown in Table 67 and flood characteristics for the site are shown in Table 68. The site is sensitive to changes in rainfall intensity (climate change). See section 5.2 for discussion on climate change sensitivity. The site is considered to be 'Local Drainage'.

Table 67: Flood tagging for 470 Wattle Street

Clause 9(1)	Clause 9(2)
Yes	Yes

Table 68: Indicative site flood characteristics for 470 Wattle Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
BW	Local Drainage	4.8	5.5	H1	H5

Note: Taken at the middle of the site on Wattle Street

4.25.3. Flood Planning

Minimum FFL requirements for Local Drainage:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking (above ground) – 1% AEP flood level
- Open parking – 5% AEP flood level

The floodway in Wattle Street is on the opposite (western) side of the road. On the eastern side the 4.8 mAHD flood level appears to be below the top of kerb. Due to the shallow inundation on Wattle Street, meeting minimum floor level requirements would not be a significant constraint, assuming ground level commercial occupancy. Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. A basement carpark entrance crest would need to be more than 0.5 m above the existing footpath height, which may be difficult to achieve, however, the frontages to Wattle Lane can accommodate basement carparking easily, although descending to a basement from this elevated position may be the challenge at this location.

4.25.4. Impact Considerations

The existing structure utilises 100% of the lot and the Planning Proposal would require a minimum of 10% deep soil landscaping, adding flood storage and infiltration capacity. As such,

redevelopment of the site could see a net positive impact for the local flood conditions. It is noted that in the existing model, the site is modelled as open, representing a carpark that existed on the site at the time of the LiDAR capture. The current building was constructed circa 2014. The inundation modelled on the site no longer exists such that there would be no flood impacts from changes to the built form.

4.25.5. Hazard Consideration

Access to the Wattle Street footpath from the site is available in the 1% AEP event. Vehicular access to Wattle Street would also be possible for the eastern lanes. However, it is noted that Wattle Street is one way, such that access to the site via Wattle Street (from the south) is possible, however, at the intersection with MacArthur Street the hazard is H2, likely restricting vehicular access leaving the site via Wattle Street.

In the PMF event the Wattle Street footpath would be inundated by more than 0.5 m and the hazard on the road is H5. This would restrict both pedestrian and vehicular access. However, an appropriate building design for the site can utilise Wattle Lane for emergency access and evacuation during a flood event. Given the depth of inundation on Wattle Street, flood refuge should be provided above the PMF level for occupants. Wattle Street will be unsafe for all vehicles and people in an extreme flood event and this should be considered in emergency planning for the site (such as fire exits). Pedestrian and vehicular access would be possible via Wattle Lane in the PMF event, noting that it is only the gutters of MacArthur Street and Mary Ann Street that have high hazards, triggered by high velocity. Although this velocity can cause cars to be unstable, the whole car would not be subject to this at one time – it would only be as the wheels cross the gutter such that it is possible that vehicle access would be maintained.

4.26. 86-92 Harris Street

Most of the site at 86-92 Harris Street (Photo 42 and Photo 43) is occupied by an open carpark, with access to both east (Pyrmont Street) and west (Harris Street) frontages. There is an approximate 12 m elevation difference between the streets. Flood depth and hazard mapping are in Area B, Figure 8 to Figure 12.

Photo 42: No. 86-92 Harris Street, east facing on Harris Street. *Google Streetview*

Photo 43: Pyrmont Street access to no. 86-92 Harris Street in relation to Pyrmont Street sag point. Southeast facing. *Google Streetview*

It is understood that there is an existing development application approved for the site.

4.26.1. Planning Proposal Changes

Planning Proposal changes to this lot are summarised in Table 69 below.

Table 69: Proposed planning controls for 86-92 Harris Street

Planning Aspect	Existing Building	Existing Controls	Proposed Controls
Land use & zoning	Vacant	E2 – CC	Commercial
Floor space ratio	0	2.0	2.3 + DesEx[1]
Height of building	n/a	15 m	27 m
Height in storeys	n/a	3	7
Deep soil	n/a	10%	15%

1. DesEx = Design Excellence. An allowance to increase the floor space ratio for developments that demonstrate design excellence and achieve a positive outcome.

4.26.2. Site Characteristics and Flood Behaviour

No inundation greater than 0.1 m deep is modelled to occur on Harris Street in the vicinity of the site in events up to and including the PMF event. The natural landform falls east, and the surface flow is expected to follow the road gutter towards Union Street (south). Water is not expected to overtop the Harris Street gutter and flow through the site, however, runoff generated locally over the carpark would shed quickly towards Pyrmont Street. The flood modelling indicates ponding of this runoff against buildings to the east of the site, however, in reality water would be conveyed through gaps between the buildings. For example, at the location of deepest ponding, the carpark is elevated above the lots on Pyrmont Street and this ponding would not occur (Photo 44).

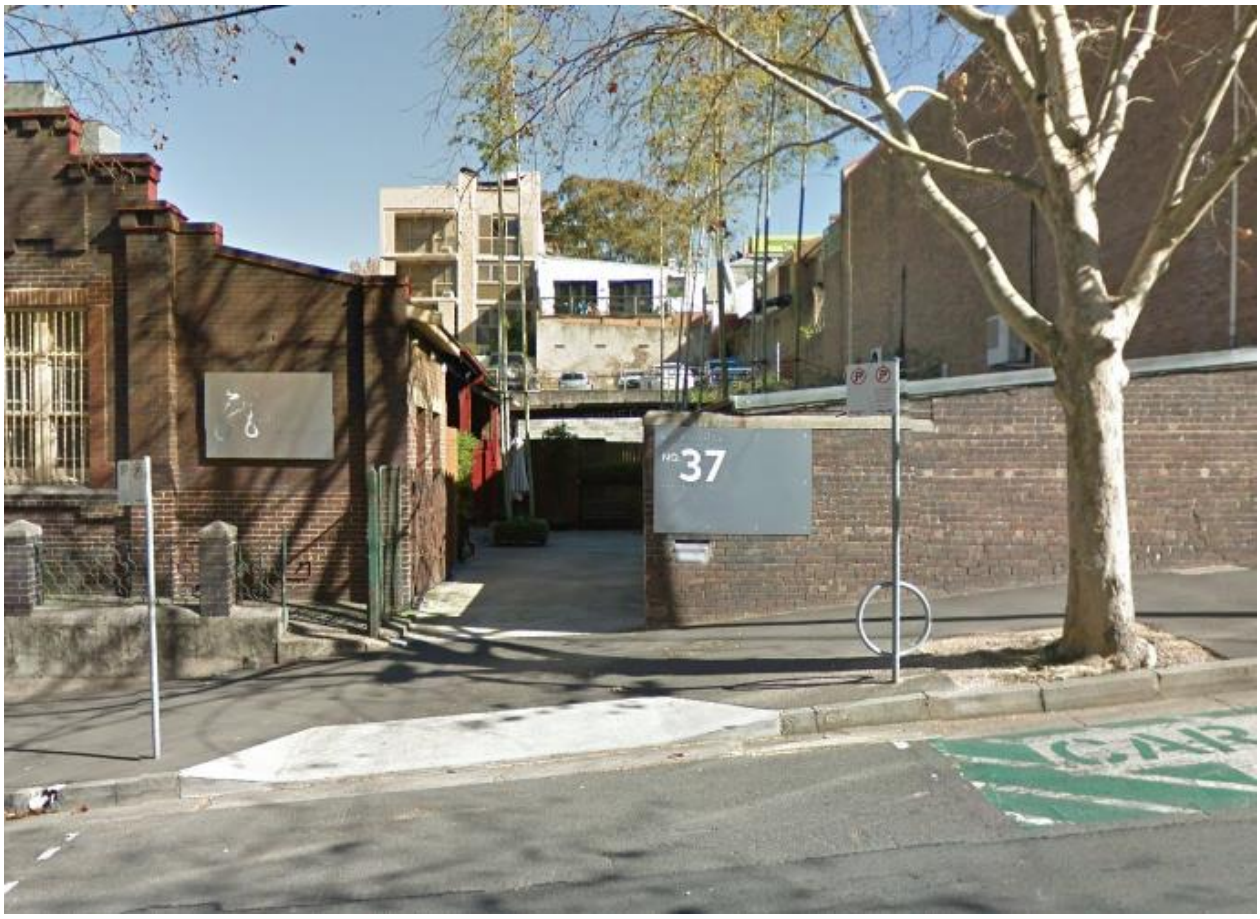


Photo 44: Carpark of no. 86-92 Harris Street, viewed through no. 37 Pyrmont Street. *Google Streetview*

A sag point on Pyrmont Street exists, adjacent to 100 Harris Street (to the south of the site), in which water ponds in events greater than 10% AEP, when the capacity of the stormwater (with 50% blockage of pits considered) is exceeded. There is no overland relief point for inundation and as such, ponding increases (subject to the performance of the drainage network) until overflows commence down Jones Bay Road (to the north), followed closely by overflows down Union Street (to the south). Flood depths need to exceed approximately 4 m at the sag point for these overflow points to be activated. When this is the case, the existing driveway entrance to the site is inundated, although this does not extend into the main portion of the site, due to the steep slope from Pyrmont Street to Harris Street (Photo 45).

The flood tagging status of the lot is shown in Table 70 and flood characteristics for the site are shown in Table 71. Pyrmont Street is highly sensitive to changes in rainfall intensity (climate change) and drainage conditions (blockage). When considering blockage to the pits on Pyrmont Street there is an expected increase to the flood depth by approximately 0.8 m and >2.0 m in the 1% AEP and PMF events, respectively. See Sections 5.1 and 5.2 for discussion on blockage and climate change sensitivity, respectively. The site is considered to be ‘local drainage’.

Photo 45: Pyrmont Street access to no. 86-92 Harris Street, through to Harris Street. West facing. *Google Streetview*

Table 70: Flood tagging for 86-92 Harris Street

Clause 9(1)	Clause 9(2)
No	Yes

Table 71: Indicative site flood characteristics for 86-92 Harris Street

Model	Type of Flooding	Peak Flood Level (mAHD)		Hazard	
		1% AEP	PMF	1% AEP	PMF
DH	Local Drainage	-	8.2	-	-

Note: Taken at Pyrmont Street sag flood extent, eastern lot boundary

4.26.3. Flood Planning

Minimum FFL requirements for Local Drainage:

- Non-sensitive use – 1% AEP flood level
- Sensitive use – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Basement parking – 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)
- Enclosed parking – 1% AEP flood level
- Open parking – 5% AEP flood level

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography. Much of the site is elevated far above the Pyrmont Street sag point, which is the primary flood risk for the site.

4.26.4. Impact Considerations

The site is largely impervious, covered by the existing carpark. The potential for adverse impacts resulting from developing this open space is limited by the following:

- The potential for conveyance of flow through the carpark is limited by flood depths remaining within the gutter on Harris Street.
- The potential for flood storage within the carpark area under existing conditions is limited. The flood extent at the Pyrmont Street sag point, even in the PMF event with 100% blockage of pits, the flooding only extends 10 m into the site up the driveway.
- Flooding within the carpark is likely to be from the site's local runoff only.

The development of this open space into a building would likely have minimal affectation on local flood behaviour in the surrounding streets due to the above. Development under the Planning Proposal requires 15% deep soil landscaping, such that it may add flood storage and infiltration capacity. There are not expected to be any adverse flood impacts due to the development of this site.

4.26.5. Hazard Consideration

During a rare flood event, or in circumstances when the inlet pits on Pyrmont Street are blocked, access south via Pyrmont Street would be cut off, for both vehicles and pedestrians with the potential for high hazard floodwater due to the depth of inundation. In most circumstances, however, access from the site north via Pyrmont Street would be possible, even in a PMF event. It would only be in a PMF event with 100% blockage of sag pits that the driveway access from the site to Pyrmont Street would be cut off. Access to Harris Street would be maintained in all events up to and including the PMF, for both vehicles and pedestrians. There are very few constraints for access to the site in flood events.

4.27. Small Lot Area 1

Small Lot Area 1 includes three lots. All three lots front John Street, between Jones Street and Mount Street. The elevation of the area is approximately 24 mAHD to 27 mAHD. Flood depth and hazard mapping are in Area A, Figure 3 to Figure 7.

4.27.1. Site Characteristics and Flood Behaviour

The highest elevation for the area is at the junction of John Street and Cadigal Avenue. From this point the surface water flows in the local gutter network to the east and west along John Street, and north along Cadigal Avenue. Being so high in the catchment, the flows remain in the gutter, not exceeding 0.05 m even in the PMF event. The area is considered to be 'outside the floodplain'. The flood tagging status of the lot is shown in Table 72.

Table 72: Flood tagging for small lot area 1

Clause 9(1)	Clause 9(2)
No	No

4.27.2. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.27.3. Impact Considerations

Since flooding is restricted to the road corridors, changes to the built form within the lots will not have any adverse impacts on surrounding flood levels. The development of the three proposed lots in terms of the increase in impervious surfaces would likely result in negligible difference to the local flood behaviour.

4.27.4. Hazard Consideration

Access is available to all lots in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.28. Small Lot Area 2

Small Lot Area 2 includes 32 lots. The lots are bounded by Miller Street (north), Pyrmont Bridge Road (south), Pyrmont Street (east) and Bulwara Road (west). The elevation of the area is approximately 13 mAHD to 19 mAHD. Flood depth and hazard mapping are in Area C, Figure 13 to Figure 17. The lots are located on Pyrmont Street, Harris Street and Miller Street. New dwellings would front Paternoster Row, Little Mount Street and one lot to Bulwara Road.

4.28.1. Site Characteristics and Flood Behaviour

Harris Street essentially forms the catchment divide at the northern end, with surface water flows east on Union Street toward Darling Harbour and west on Miller Street toward Blackwattle Bay. At the southern end, Pyrmont Street forms the catchment divide. Runoff from the area generally flows south along the streets of interest to Pyrmont Bridge Road, where it then flows west to

Blackwattle Bay. These lots are located high in the catchment and the area is generally free from 'flooding', with surface flows being less than 0.05 m deep and remaining in the gutter. The flood tagging status of the lots is shown in Table 73. The only area modelled with any significant inundation is 201-203 Harris Street, where flooding at the corner of Harris Street and Pyrmont Bridge Road is modelled to be up to 0.2 m in the PMF event, although still unlikely to affect properties on Harris Street. It is also noted that for these lots, new dwellings would front Little Mount Street, which is unaffected. These lots are considered to be 'outside the floodplain'.

Table 73: Flood tagging for small lot area 2

Clause 9(1)	Clause 9(2)
No	No

4.28.2. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.28.3. Impact Considerations

Since flooding is restricted to the road corridors, changes to the built form within the lots will not have any adverse impacts on surrounding flood levels. The development of the proposed lots in terms of the increase in impervious surfaces would likely result in minor differences in local flood behaviour. Many sites redeveloping their existing open spaces in such a concentrated area could influence the downstream flood behaviour and impacts could be mitigated by the on-site detention (OSD) requirements for dual occupancy lots, although the size of the lots (<250 m^2) could make the design and installation of OSD difficult to achieve and limit occupants pursuing such developments.

4.28.4. Hazard Consideration

Access is available to all lots in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.29. Small Lot Area 3

Small Lot Area 3 includes 28 lots. The lots are bounded by Fig Street (north), Quarry Street (south), Harris Street (east) and Jones Street (west). The elevation of the area is approximately 16 mAHD to 22 mAHD. Flood depth and hazard mapping are in Area D, Figure 18 to Figure 22. The lots are located on Harris Street, Ada Place, Bulwara Road and Quarry Street (non-vehicle access). New dwellings would front Ada Place, Bulwara Road, Fig Lane, Henry Avenue and Quarry Lane.

4.29.1. Site Characteristics and Flood Behaviour

The catchment divide in this area is essentially Bulwara Road, with the DH catchment to the east and BW catchment to the west. The highest elevation in this area is the middle of Bulwara Road, between Fig Street and Quarry Street such that runoff on Bulwara Road (and parallel streets) is split between flowing north to Fig Street or south to Quarry Street. These lots are located high in the catchment and the area is generally free from 'flooding', with surface flows being less than 0.05 m deep and remaining in the gutter. The flood tagging status of the lot is shown in Table 74. These lots are considered to be 'outside the floodplain'.

Table 74: Flood tagging for small lot area 3

Clause 9(1)	Clause 9(2)
No	No

4.29.2. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.29.3. Impact Considerations

Since flooding is restricted to the road corridors, changes to the built form within the lots will not have any adverse impacts on surrounding flood levels. The development of the proposed lots in terms of the increase in impervious surfaces would likely result in minor differences in local flood behaviour. Many sites redeveloping their existing open spaces in such a concentrated area could influence the downstream flood behaviour and impacts could be mitigated by the OSD requirements for dual occupancy lots, although the size of the lots (<250 m^2) could make the design and installation of OSD difficult to achieve and limit occupants pursuing such developments.

4.29.4. Hazard Consideration

Access is available to all lots in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street and there are no access constraints.

4.30. Small Lot Area 4

Small Lot Area 4 includes eight lots – seven bounded by Hackett Street and Harris Street, with the remaining lot located on the southeastern corner of the junction between William Henry Street and Bulwara Road. The elevation of the area is approximately 9 mAHD to 21 mAHD. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27. The majority of lots are located on Harris Street, with new dwellings to be located on Hackett Street. The remaining are corner blocks, with new dwellings to be located on MacArthur Street, Hackett Street and Bulwara Road.

4.30.1. Site Characteristics and Flood Behaviour

The catchment divide in this area is essentially Bulwara Road, separating the DH and BW catchments. Runoff from the area generally flows south along the road corridors to the nearest cross street, where it then flows east toward Darling Harbour. These lots are located high in the catchment and the area is generally free from 'flooding', with surface flows being less than 0.05 m deep and remaining in the gutter. The flood tagging status of the lot is shown in Table 75. The lots are considered to be 'outside the floodplain'. The only lots modelled with any significant inundation are:

- 599 Harris Street – This lot is on the corner of Harris Street and MacArthur Street. The modelling suggests there is ponding against the MacArthur Street frontage in the 1% AEP and PMF event. This appears to be an anomaly due to the direct rainfall method of modelling and water ponding in trapped cells. The rear yard of 599 Harris Street is lower than MacArthur Street and due to the model grid, some cells that pick up ground levels from the yard are modelled adjacent to the footpath and water is artificially trapped, ponding to a level greater than 0.5 m. In reality, MacArthur Street is on-grade and this ponding would not occur.
- 629-633 Harris Street – these lots are the southern three lots on Harris Street and Hackett Street. Flows in the gutter on Hackett Street (rear of the lots) is approximately 0.18 m in the PMF event and may just overtop the kerb. The grade of Hackett Street changes at the location of these lots such that flow down Hackett Street slows and flood depths increase. This, however, poses a very low risk to these lots.

Table 75: Flood tagging for small lot area 4

Clause 9(1)	Clause 9(2)
No	No[1]

1. Except 599 Harris Street, Clause 9(2) tagged 'Yes', likely due to the GIS algorithm automatically detecting the ponding discussed above.

4.30.2. Flood Planning

Minimum FFL requirements for 'outside the floodplain':

- Habitable floors – 0.3 m above surrounding ground

Meeting minimum FFL requirements is considered reasonable and practicable for construction based on the indicative flood levels and existing site topography.

4.30.3. Impact Considerations

Since flooding is restricted to the road corridors, changes to the built form within the lots will not have any adverse impacts on surrounding flood levels. The development of the proposed lots in terms of the increase in impervious surfaces would likely result in minor differences in local flood behaviour. Many sites redeveloping their existing open spaces in such a concentrated area could influence the downstream flood behaviour and impacts could be mitigated by the OSD requirements for dual occupancy lots, although the size of the lots (<250 m^2) could make the design and installation of OSD difficult to achieve and limit occupants pursuing such

developments.

4.30.4. Hazard Consideration

Access is available to all lots in both the 1% AEP and PMF events. There is no hazard rating due to the low flow depth in the street, except for 629-633 Harris Street, which just has H1 hazard commencing at these lots on Hackett Street. Regardless, there are no access constraints.

4.31. Small Lot Area 5

Small Lot Area 5 includes 49 lots. The lots are bounded by MacArthur Street (north), Mary Ann Street (south), Jones Street (east) and Wattle Street (west). An additional two lots are northeast of the MacArthur Street and Jones Street intersection. The elevation of the area is approximately 4 mAHD to 16 mAHD. The lots are located on Jones Street, Wattle Street and MacArthur Street. New dwellings would front McKee Street, Wattle Lane and Henson Lane. Flood depth and hazard mapping are in Area E, Figure 23 to Figure 27.

4.31.1. Site Characteristics and Flood Behaviour

Flood behaviour varies across the local region. The flood tagging status of the lot is shown in Table 76. A summary of flood affectation is as follows:

- 430-444 Wattle Street – Wattle Street conveys significant flows in the 1% AEP and PMF events. The flood behaviour was discussed for the adjacent sites in Sections 4.23, 4.24 and 4.25. At the lots, the flow in Wattle Street is approximately 0.25 m deep in the 1% AEP event and 1.0 m in the PMF event. However, the Planning Proposal is for dwellings at the rear of the lots, with a frontage to Wattle Lane. Wattle Lane does not have any modelled inundation greater than 0.05 m up to and including the PMF event. Given the slope of the lots, it is likely that a dwelling at the rear of the lot would be above the Wattle Street PMF level.
- 111-187 Jones Street – Jones Street falls south towards Mary Anne Street, water is modelled to be deeper than the western gutter at several locations along Jones Street. The most severe is where the road pavement ends (at approximately 169-175 Jones Street) and a gravel pedestrian path and park area connects Jones Street and Mary Ann Street. At the end of the sealed road, water ponds to depths of up to 0.4 m in the gutter in the 1% AEP, and 0.5 m in the PMF event. However, McKee Street to the rear of the lots where new dwellings would be located is not flooded (depths less than 0.1 m) in the 1% AEP event. In the PMF event, properties south of 179 Jones Street have flood depths in the McKee Street gutter of 0.1 m – 0.2 m in the 1% AEP and PMF events. Due to the slope of the land, it is unlikely that these depths would even reach the property boundary.
- 50-52 MacArthur Street – There is no modelled flooding greater than 0.1 m depth and any runoff is expected to be contained within the gutter in events up to and including the PMF. The landform falls southwest and the surface flow is expected to follow the road gutter towards Wattle Street. The lots are considered to be ‘outside the floodplain’.

Table 76: Flood tagging for small lot area 5

Street	Clause 9(1)	Clause 9(2)
Wattle Street	Yes	Yes
Jones Street	No	No[1]
MacArthur Street	No	No

1. With the exception of no. 137-149 which are tagged 'Yes'

4.31.2. Flood Planning

Flood planning for the local region varies. Classification of lots is estimated to be:

- Mainstream flooding – 430-444 Wattle Street & 159-187 Jones Street.
    - Minimum floor level requirements for the rear of these lots should be achievable given their distance and/or elevation from the primary flood affectation at the front of the lot. Subdivision of the lot may define this separation clearly such that the classification of the subdivided rear lot is likely to be 'outside the floodplain'.
- Local Drainage – 111-157 Jones Street
    - Minimum floor level requirements for the rear of these lots should be achievable given their distance from the primary flood affectation at the front of the lot. Subdivision of the lot may define this separation clearly such that the classification of the subdivided rear lot is likely to be 'outside the floodplain'.
- Outside floodplain – 50-52 MacArthur Street
    - Minimum floor level requirements easily achievable.

Adherence to respective FPLs would depend on individual lot proposals, including the subdivision and dwelling design. A detailed site-specific flood assessment would provide the required detail to understand specific flood behaviour.

4.31.3. Impact Considerations

Since flooding is restricted to the road corridors, changes to the built form within the lots will not have any adverse impacts on surrounding flood levels. The development of the proposed lots in terms of the increase in impervious surfaces would likely result in minor differences in local flood behaviour. Many sites redeveloping their existing open spaces in such a concentrated area could influence the downstream flood behaviour and impacts could be mitigated by the OSD requirements for dual occupancy lots, although the size of the lots (<250 m^2) could make the design and installation of OSD difficult to achieve and limit occupants pursuing such developments.

4.31.4. Hazard Consideration

Wattle Street is H5 hazard in the PMF and there are parts of Jones Street subject to H2 hazard in the PMF event. While these streets have restricted or cut off access, the proposed development of the rear of the lots, with frontages to Wattle Lane and McKee Street ensure that access from the new dwelling is maintained in all events, with only minor H1 hazard on a small section of McKee Street in the PMF event. Likewise, Henson Lane also has no hazard rating due to shallow depths less than 0.1 m. For all of the proposed frontages, there are no access constraints, with

access available in the PMF event.

4.32. Site Constraint Summary

A summary is tabulated of the key constraints considered for each site, as given in Table 77 and described below.

Flood Planning constraint rating

- Nil Constraints
  - Site is free from inundation affecting FPLs.
- Minor Constraints
  - Site is affected by 1% or PMF inundation.
  - FPLs easily achievable.
- Moderate Constraints
  - Site is affected by 1% AEP inundation.
  - FPLs partially or fully achievable with an appropriate design.
- Major Constraints
  - Site is heavily flood affected, with FPLs elevated high above the ground.
  - FPLs difficult to achieve.

Impacts constraint rating

- Nil Constraints
  - No adverse flood level changes anticipated from redevelopment of the site.
- Minor Constraints
  - Potential for minor adverse flood level changes post-development.
  - Impact of redevelopment fully resolvable with an appropriate design.
- Moderate Constraints
  - Potential for moderate adverse flood level changes post-development.
  - Impact of redevelopment partially or fully resolvable and may require a unique design incorporating flood mitigation measures.
- Major Constraints
  - Potential for significant adverse flood level changes post-development.
  - Impacts of redevelopment difficult to resolve.

Hazard constraint rating

- Nil Constraints
  - Site is free from inundation constraining immediate access or affecting occupant safety.
- Minor Constraints
  - Access to and from site affected during PMF event (road inundation).
- Moderate Constraints
  - Access to and from site affected during 1% AEP event (road inundation).
  - Direct access (footpath) to the site is partially affected (inundation above gutter) in the PMF.

- Major Constraints
    - Site isolated during 1% AEP event.

Table 77: Summary Table of Site Constraints

Site Ref.	Site	Summary	Constraint Rating		
			FPL	Impact	Hazard
4.1	46-48 Pyrmont Bridge Road	Affected by mainstream flooding during a 1% AEP event. Ponding against southern lot boundary.	Moderate	Nil	Moderate
4.2	20-28 Bulwara Road	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.3	2 Edward Street	Affected by mainstream flooding during a 1% AEP event. Ponding at the northern end of the site.	Moderate	Nil	Moderate
	60 Union Street	Not affected by mainstream flooding in the PMF. Lower (northern) parts of Edward Street inundated that does not affect site.	Minor	Nil	Minor
4.4	1-27 Murray Street	Affected by mainstream flooding during a 1% AEP event.	Minor	Nil	Minor
4.5	13A-29 Union Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
	69-72 Edward Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.6	55-65 Murray Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.7	1-33 Saunders Street	Not affected by 1% AEP event, Minor affectation in the PMF.	Nil	Minor	Nil
	140-148 Bank Street	Not affected by 1% AEP event, Minor affectation in the PMF.	Nil	Minor	Nil
4.8	26-38 Saunders Street	Not affected by PMF mainstream flooding.	Nil	Minor	Nil
4.9	14 Quarry Master Drive	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.10	80-84 Harris Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.11	79-93 John Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.12	12 Pyrmont Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.13	48 Pirrama Road	Affected by mainstream flooding during a 1% AEP event.	Moderate	Minor	Moderate
4.14	100 Harris Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Nil	Moderate
4.15	20-28 Wattle Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Minor	Moderate
4.16	50-54 Wattle Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Nil	Moderate
4.17	469-483 Harris Street	Not affected by PMF mainstream flooding.	Nil	Nil	Nil
4.18	535-547 Harris Street	Not affected by PMF mainstream flooding.	Nil	Minor	Nil

Site Ref.	Site	Summary	Constraint Rating		
			FPL	Impact	Hazard
4.19	549-559 Harris Street	Minor affectation in the PMF.	Nil	Nil	Nil
4.20	561-577 Harris Street	Minor affectation in the PMF event on Hackett Street.	Minor	Nil	Minor
	579-583 Harris Street	Minor affectation in the PMF event on Hackett Street.	Minor	Nil	Minor
4.21	562-570 Harris Street	Minor affectation in the PMF event on Systrum Street.	Nil	Minor	Nil
4.22	383-389 Bulwara Road	Not affected by PMF mainstream flooding.	Nil	Minor	Nil
4.23	446-456 Wattle Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Nil	Moderate
4.24	458-468 Wattle Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Nil	Moderate
4.25	470 Wattle Street	Affected by mainstream flooding during a 1% AEP event.	Moderate	Nil	Moderate
4.26	86-92 Harris Street	Not affected by PMF mainstream flooding.	Nil	Minor	Minor
4.27	Small Lot Area 1	Not affected by PMF mainstream flooding.	Nil	Nil[1]	Nil
4.28	Small Lot Area 2	Not affected by PMF mainstream flooding.	Nil	Nil[1]	Nil
4.29	Small Lot Area 3	Not affected by PMF mainstream flooding.	Nil	Nil[1]	Nil
4.30	Small Lot Area 4	Not affected by PMF mainstream flooding.	Nil	Nil[1]	Nil
4.31	Small Lot Area 5	Some lots affected by mainstream flooding at the front, but the rear remains flood free.	Nil-Moderate	Nil[1]	Nil

1. Except for increase in impervious area considerations that are typically catered for by OSD

In general, the lots are not heavily constrained by flooding. If there were any constraints to FPLs, flood impacts or flood hazard that were classified as ‘major’, it would provide reason to not pursue intensification of a lot. Those lots that do have ‘moderate’ constraints include sites that front areas with deep floodwaters on:

- Pyrmont Bridge Road
- Pirrama Road
- Pyrmont Street
- Wattle Street

The lots on these road frontages were identified as having ‘moderate’ constraints, however, in each case, the site has more than one frontage to a road and is located on terrain steep enough that a large portion of the site rises from the frontage that experiences inundation. In this way, FPLs can be met as a raised floor is typically required for the remainder of the site to cater for rising ground levels away from the inundated road. Less sensitive uses (such as commercial) of the ground floor fronting flood affected roads would be a way to reduce the required minimum floor level in addition to avoiding basement carpark entrances on flooded roads (which would also benefit site access in flood events). Access to multiple frontages and the topography of the sites

also assist with hazard constraints, where access from the site can be maintained with an appropriate building design. The Planning Proposal allows for multiple storeys such that flood refuge is also possible even if the ground floor is inundated. There are no sites with ‘moderate’ flood impact constraints.

The issues associated with flooding at these locations (in terms of redevelopment and intensification potential) would require a design that considers flood affectation of the site at an early stage in the design process to develop solutions to the requirements for minimum floor levels and/or access requirements. In each case, however, the constraint is not considered to preclude development of the lot. Rather, a building design is possible at each site that minimises the flood risk to the building itself (minimum floor levels) and its occupants (ensuring adequate on-site refuge and access to and from the site is maintained).

5. FACTORS AFFECTING FLOOD BEHAVIOUR

5.1. Blockage Sensitivity

Blockage sensitivity was analysed across the DH and BW catchments. The 1% AEP change in flood level with increased blockage is shown in Figure 29. The mapping shows a high blockage scenario (50% blockage of on-grade pits and 100% blockage of sag pits) compared to the adopted base model flood levels (20% blockage of on-grade pits and 50% blockage of sag pits). It is noted that the DH Flood Study design flood results (Reference 9) and hazard mapping for the DH FRMS&P (Reference 11) adopted the high blockage scenario. Conversely, the BW catchment Flood Study Update (Reference 14) adopted the base case blockage used in this assessment for design flood results. It is considered that 100% blockage of sag pits is overly conservative and is not reflective of blockage factors adopted in the CoS's more recent flood studies. Section 3.7.1 (4) of the DCP (Reference 4) states the requirement for a site-specific flood study is modelling the 'worst case scenario' with the respective 50% and 100% blockage factors included for kerb inlets and sag pits.

Pit blockage, although not specifically addressed in ARR 2019 (Reference 15), the ARR update project related to blockage (Project 11, Reference 18) recommends a blockage factor of sag pits of 20% for kerb inlets, 50% for grates inlets, and 100% blockage of the grate only (kerb inlet functioning normally. None of the design blockage factors from the research in this project suggest that a blockage factor of 100% is reasonable.

Most of the sites nominated in the Planning Proposal are unaffected by pit blockage assumptions (< 0.02 m change), with no new sites identified as constrained. However, the sites previously found to be constrained by flooding at sag points are adversely affected by blockage. The sites with notable differences include those on Wattle Street (increase up to 0.05 m) and Pirrama Road (increase up to 0.09 m). At both of these locations, blockage assumptions would not have a significant impact on FPLs or site access constraints. Most significantly, 100 Harris Street (4.14) is highly sensitive to the increase in pit blockage. The flood depth at the sag point on Pyrmont Road increases by 0.8 m and >2.0 m in the 1% AEP and PMF respectively. This is a significant increase in required FFL and although probably achievable, would need to have considerable thought put into the design of the building to achieve these levels. It is recognised, however, that this blockage scenario requires all of the 6+ pits located on Pyrmont Street to be 100% blocked such that there are no flows in the large 2.55 m x 1.9 m box culvert that drains the sag point. Notwithstanding this, the blockage sensitivity modelling indicates that the requirement to include a high blockage factor would not preclude any site from pursuing redevelopment under the Planning Proposal.

5.2. Climate Change

The lifespan of a medium to high density residential building may be in the order of 50 to 80 years. If allowing time for design, development and construction, many of the listed sites would be expected to still be occupied towards the end of the 21st century (2080+). By this time, climate change is projected to increase the intensity and frequency of flash flood events as well as sea levels. The increased flood risk due to climate change should be considered for potential

developments, especially in critical or sensitive use cases.

Sensitivity analysis of an increase in rainfall intensity was undertaken by comparing the 0.2% AEP events with the 1% AEP event. This represents approximately a 23% increase in rainfall intensity for the critical durations for the DH and BW catchments, as demonstrated in Table 78. Such events are commonly used as proxies to assess a catchment's sensitivity to an increase in rainfall intensity (Reference 7).

Table 78: Design Rainfall Intensities for the 1% AEP, 0.5% AEP and 0.2% AEP events (Pyrmont NSW)

Duration	Rainfall Intensity mm/h			% Increase	
	1% AEP	0.5% AEP	0.2% AEP	1% AEP to 0.5% AEP	1% AEP to 0.2% AEP
30 mins	114	123	140	8%	23%
60 mins	73.4	79.9	90.4	9%	23%
90 mins	56.5	61.5	69.6	9%	23%

Note: adopted critical durations for BW were 30 minutes and 60 minutes and the representative critical duration for DH was 90 minutes

The Interim Floodplain Management Policy was adopted in 2014, and since then, ARR 2019 has been issued with guidance on climate change. To model climate change Book 1 Chapter 6 of ARR 2019 (the current guidance) recommends increasing rainfall intensity or depth based on the Representative Concentration Pathway (RCP) 4.5 and 8.5 (Reference 15). The climate change factors for the Pyrmont area for a 40–60-year development lifespan are shown in Table 79 below. Using this guidance, adopting the 0.2% AEP event, representing a 23% increase in rainfall intensity is considered to be reasonable approach.

Table 79: ARR Datahub Interim Climate Change Factors (Pyrmont NSW)

Horizon	RCP 4.5	RCP 6	RCP 8.5
2070	1.676 (8.5%)	1.691 (8.6%)	2.722 (14.2%)
2080	1.810 (9.2%)	1.944 (9.9%)	3.209 (16.9%)
2090	1.862 (9.5%)	2.227 (11.5%)	3.679 (19.7%)

Figure 30 shows the flood level impact mapping of the comparative events (0.2% AEP compared to the 1% AEP event). The sites most sensitive to the increase in flood risk from climate change are those fronting Pirrama Road, Wattle Street and Pyrmont Road. The sites include 4.1, 4.3, 4.4, 4.13, 4.15, 4.16, 4.23, 4.24, 4.25, and the small lots fronting Wattle Street of 4.31. These increases are up to 0.05 m on Pirrama Road, 0.15 m on Wattle Street and 0.22 m at the Pyrmont Road sag point. These increases would not substantially change the outcome of the assessment that has been undertaken. That is, the FPLs could accommodate these increases, there would be no change to the development impact and given the nature of flooding at these locations, it would not affect the hazard assessment or substantially change site access.

Potential sea level rises were examined in the Darling Harbour and Blackwattle Bay flood studies (Reference 9 & Reference 14). It was found the catchment was most sensitive towards the outlets to Blackwattle Bay and Tumbalong Park. The impacted areas from sea level rise were concentrated to those areas adjacent to the ocean or in low-lying areas. The increases in peak

flood levels due to sea level rise (considering a 0.9 m increase, representing approximately a 2100 projection) only affected Wattle Street, in which a 0.12 m increase was modelled between Fig Street and Quarry Street, affecting sites 4.15 and 4.16. All other sites had no increase or the increases were minor (up to 0.02 m due to reduced drainage efficiency). The increases on Wattle Street would not substantially change the outcome of the assessment that has been undertaken.

Climate change has the potential to increase the extent of hazardous flooding adjacent to sites and reduce the available freeboard for buildings if constructed to current day conditions. This increases the flood risk at particular sites.

The existing controls are guided by the CoS LEP 2012 5.21 (3)(a), in which any development must demonstrate satisfactory compliance to the flood planning provisions considering future climate change conditions (Reference 3). The Interim Floodplain Management Policy is more prescriptive in its requirements for developments (Reference 8). Three requirements are given to prevent the potential impact of climate change:

- For those developments which have a lifespan of more than fifty years the impact due to sea level rise and impacts due to increased rainfall intensities shall be considered.
- Meet the allowances for sea level rise as recommended in the NSW Government Coastal Planning Guideline: Adopting Sea Level Rise 2010 (now withdrawn from publication). Specifically, this shall include and allowance of 40cm by 2050 and a 90cm by 2100 from the 2009 Mean Sea Level.
- Where in the opinion of the City the proposed development is of reasonable impact to regional or catchment trunk drainage, the drainage system design shall allow for a minimum of 10% increased rainfall.

5.3. Increase in Impervious Surfaces

When considering flood behaviour, unmitigated intensification of the land correlates with potential adverse flood level impacts. That is, the increase in (or establishment of) more impervious surfaces, results in more stormwater run-off concentrating in the surrounding flow paths and potentially raising neighbouring flood levels. In the case of the Planning Proposal there is little to negligible intensification projected in terms of new impervious surfaces. Most of the catchment is already highly urbanised. In most cases 100% of the site is utilised by the existing structure and/or hardstand (i.e. carpark). In general, the existing urbanised conditions suggest that there is limited potential for increasing stormwater run-off post-development. Included in the Planning Proposal is a requirement of 10-15% deep soils for most sites. Where most sites currently exist with 100% imperviousness, the increase in deep soils allows for infiltration of water locally, reducing run-off entering downstream. Therefore, if implemented as proposed the changes could have a net reduction in flood levels, an inverse on the historical outcome of unmitigated intensification.

There are two locations where there is change in land use, although in terms of flood risk, is likely to have minimal impact. The two sites are 20-28 Bulwara (4.2) and 86-92 Harris Street (4.26). Both similarly are currently open, impervious areas. Neither is located in a classified floodway or flood storage area, however, there is still potential that the sites currently act as minor localised flood storage for onsite run-off, depending on local hydraulic features. If unaccounted for in design, there is potential for adverse impacts on the downstream flows. However, it should be practical to

achieve pre-development flood conditions for the proposed intensification of the sites. In addition to these sites, the proposed small lot sites may also have a localised impact on runoff characteristics. OSD should be considered for these sites where practical to ensure that there are no increases in downstream flow rates that result in adverse cumulative impacts.

5.4. Flood Risk Management Measures

The two FRMS&Ps that were undertaken for the DH and BW catchments were reviewed to determine the potential for flood modification (infrastructure) options within the Planning Proposal study area. These are discussed in the following sections.

5.4.1. Darling Harbour Flood Modification Measures

The lot nominated at 100 Harris Street (Section 4.14), is directly adjacent to one of the options investigated in the Darling Harbour FRMS (Reference 11). The option 'FM-DH06' 'examined upgrading the trunk drainage and pit inlet capacity at the sag point on Pyrmont Street. The drainage was proposed to reduce inundation to the 10% AEP event, in line with Council's objectives to mitigate road inundation up to the 10% AEP event. The upgrade consisted of additional pit inlet capacity at the sag on Pyrmont Street to drain an additional 0.2 m^3/s into the existing drainage line, additional drainage on Jones Bay Road consisting of a 1.5 m x 1.5 m box culvert and additional drainage from Jones Bay Road to the outlet consisting of a twin 1.5 m x 1.5 m box culvert. The reduction in peak flood levels on Pyrmont Street in the 10% AEP event was between 0.2 m and 0.3 m, which essentially removed flooding of Pyrmont Street.

The improvement to flooding primarily affected road serviceability and hence a cost-benefit analysis was not undertaken as it did not significantly reduce flood damages. Capital costs were estimated to be approximately $3.9M (at the time of the study), and it was recommended as a low priority and long-term option for Cos and SWC to investigate in the subsequent Floodplain Risk Management Plan.

5.4.2. Blackwattle Bay Flood Modification Measures

The lots on Wattle Street are impacted by options investigated in the Blackwattle Bay FRMS (Reference 13). The option 'FM-BB06' investigated an underground storage tank located at the site of Council's Depot at the upstream (southern) end of Wentworth Park. A tank with a capacity of 40,000 m^3 was modelled to alleviate flooding on surrounding streets including Wattle Street and reducing flood liability for nearby properties. The tank was estimated to cost approximately $10M at the time of the study, with a benefit-cost ratio of just 0.1.

A second option was investigated which looked at the storage tank in addition to trunk drain upgrades from Cleveland Street to Wentworth Park. The upgrades consist of large diameter pipes and box culverts (up to 8 x 3 m x 2.7 m at Wentworth Park) to convey the 5% AEP event. Peak overland flow on Wattle Street in the 5% AEP event was reduced from 8.4 m^3/s to 0.2 m^3/s. The cost of this option was estimated to be approximately $36M at the time of the study, with a benefit-cost ratio of 1.46. These options ranked in the lower half of the options assessed (primarily due to costing and feasibility), however, were recommended as low priority options for a long term

timeframe for CoS and SWC to investigate in the subsequent Floodplain Risk Management Plan.

Additional options considered in the FRMS include an open channel up to Wentworth Park Road, which resulted in up to 0.05 m reduction on Wattle Street adjacent to Wentworth Park. This option was discarded without ranking due to contaminated fill in Wentworth Park outweighing the benefits. Another option considered was a detention basin in south Wentworth Park. This also produced up to 0.05 m reduction on Wattle Street adjacent to Wentworth Park and was similarly discarded due to issues with contaminated fill (and loss of public space) outweighing the limited benefit to flood levels.

6. CONSISTENCY WITH MINISTERIAL DIRECTIONS

Direction 4.1 (1) & (5) – The Planning Proposal and referenced flood studies (& FRMS&Ps) are consistent with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, and the Considering flooding in land use planning guideline 2021.

Direction 4.1 (2) – No site in the Planning Proposal is currently zoned Recreation, Rural, Special Purpose or Conservation Zones.

Direction 4.1 (3) (a) and (e) – The Planning Proposal does not include sites within floodway areas, nor in high hazard areas.

Direction 4.1 (3) (b) – The existing requirements of the LEP/DCP/Interim Floodplain Management Policy ensure that there are no adverse impacts of potential developments. It will be necessary for future development applications to demonstrate the proposed works will not result in significant flood impacts to other developments, through modelling as part of a flood impact assessment where appropriate. Satisfaction of this requirement depends on the details of the proposed development as is enforced through Council's strategic planning framework at the DA stage. These controls already apply to the land under consideration, and the nature of the controls and the development constraints presented by the controls would not be altered by the Planning Proposal. The approval of the Planning Proposal does not provide a guarantee or an implication that these requirements can be waived at subsequent development approval stages.

Direction 4.1 (3) (d) – It is unclear in this context what "significant increase in the development and/or dwelling density of that land" means. From the perspective of flood risk, the land is generally fully urbanised, and primarily covered by hardstand and buildings. The Planning Proposal will not significantly increase the development with regards to how much runoff will occur from the area. The proposed development will increase the development of the land in terms of intensity of floor space and the population density in the area – that is the entire purpose of the Planning Proposal. With regards to flood risk, this increase in population density is largely offset by the following considerations:

i. The increase in floor space will be primarily related to additional building storeys that are not at risk of damage from flooding, or new buildings that are located outside the floodplain.
ii. With appropriate building design, some level of access to and from each site can be maintained in the PMF event.
iii. In some areas the increase in population density will be associated with higher density land use zoning. It is more likely that consolidated high-density re-development of some lots would be able to resolve these flood issues (such as evacuation), compared to existing uses. The change in zoning (for example to mixed use) may allow less sensitive development on the ground floor (such as commercial facilities) and more sensitive development on upper floors (such as residential apartments). Rezoning of the flood affected lots and consolidation of buildings would generally be an effective long-term strategy for reducing flood risks in the areas under consideration, as a higher density development proposal with a larger building is more likely to be able to provide a design solution that complies with the LEP/DCP requirements.

iv. New buildings would need to comply with minimum floor level controls and protection of basement areas, which in many cases are not satisfied by the existing buildings. Redevelopment of the land will therefore reduce the likely flood damages for the ground floor and basement levels, as well as reducing the risk to life to people within the buildings, despite the concurrent increase in total population.

Re-development of urbanised areas is an inevitable result of increases to population in the Sydney metropolitan area. The NSW Flood Prone Land Policy recognises that:

> *"Flood prone land is a valuable resource and that development applications and proposals for rezoning of flood prone land should be the subject of careful assessment which incorporates consideration of local circumstances."*

The Floodplain Risk Management Manual indicates that development within the floodplain should be undertaken on a merit-based approach, ensuring that the development is compatible with the flood hazard of the land. Based on the review of available flood information as part of this assessment, the Planning Proposal improves the likelihood that redevelopment of the subject land can meet the required development controls and be compatible with the flood hazard, relative to existing zoning and height/FSR controls.

Direction 4.1 (3) (e) – In areas where evacuation was considered a 'moderate' constraint, it is recommended that sensitive development, including centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing (where applicable based on zoning), not be permitted, unless safe and effective evacuation can be demonstrated in the PMF event. This direction applies to the following sites: 2 Edward Street (4.3), 48 Pirrama Road (4.13), 100 Harris Street (4.14), 20-48 Wattle Street (4.15), and 50-54 Wattle Street (4.16). The sites' proximity to inundation in the 1% AEP event may make evacuation difficult in the 1% AEP event, depending on the specific design of the building.

Direction 4.1 (3) (f) – WMAwater understands that the development indicated in the Planning Proposal will require development consent.

Direction 4.1 (3) (g) – The development resulting from the Planning Proposal is unlikely to result in substantially increased requirement for government spending on emergency management or flood mitigation measures. The primary flood risk mitigation measure to reduce existing flood risks in this region would be to redevelop land to be consistent with the planning controls, including increasing the building floor levels up to the relevant standard, which is achieved through re-development of the land in accordance with the Planning Proposal. No site would require a significant increase in government spending to allow redevelopment to comply with the existing LEP/DCP/Interim floodplain management controls and the existing floodplain risk management measures identified for the catchments (Section 5.4) would remain.

Direction 4.1 (3) (h) – Based on the proposed changes, there should be no hazardous industries or hazardous storage establishments.

Direction 4.1 (4) (a) – As discussed for Direction 4.1 (3) (a).

Direction 4.1 (4) (b) – As discussed for Direction 4.1 (3) (b).

Direction 4.1 (4) (c) – As discussed for Direction 4.1 (3) (d), with specific application to the additional lots of 46-48 Pyrmont Bridge Road (4.1) and 446-470 Wattle Street (4.23, 4.24 and 4.25.1). The sites' proximity to inundation in the PMF may make evacuation difficult in the PMF event, depending on the specific design of the building.

Direction 4.1 (4) (d) – As discussed for Direction 4.1 (3) (e).

Direction 4.1 (4) (e) – As discussed for Direction 4.1 (3) (e). While there are some sites that may be inundated in the PMF event (subject to specific building design and FFLs), CoS's Interim Floodplain Management Policy will dictate the required FFL's and hence the associated acceptable level of risk of inundation depending on the proposed use of the floor. These minimum floor levels are considered to be reasonable and commensurate with the flood risk in the Pyrmont and Ultimo area. The FPLs are consistent with the principals of the Flood Risk Management Manual. Evacuation of these lots is a concern, given the hazardous flooding that may be present in the streets adjacent to the building. However, each lot has at least one frontage with access in the PMF event, such that an appropriate building design can ensure access is maintained to the building even in the most extreme flood event.

Direction 4.1 (4) (f) – As discussed for Direction 4.1 (3) (g).

The Planning Proposal is therefore consistent with the Section 9.1 Ministerial Directions, with the exception of Directions 4.1 (3) (d) and 4.1 (4) (c) – that is, permitting a significant increase in the development and/or dwelling density of that land. It has been demonstrated that although the Planning Proposal seeks to increase the development of some land within Pyrmont and Ultimo that is flood affected, the increase in floor space will typically not be flood affected (additional stories above flood levels or buildings outside the floodplain), access to and from the sites can be maintained during flood events with appropriate building design and redevelopment of the sites will typically result in a building that is more commensurate with the flood risk, having regard for the relevant flood-related development controls. As such, the Planning Proposal is considered to be consistent with the objectives of the Section 9.1 Ministerial Directions.

7. ADEQUACY OF EXISTING FLOOD PLANNING CONTROLS

The existing flood planning controls, as described in Section 2.2, are generally considered adequate. In particular, the minimum floor level controls and impact assessment requirements contained in the CoS Interim Floodplain Management Policy (Reference 8) are adequate to reduce flood risk to proposed buildings and neighbouring properties. However, the following should be considered for the sites contained within the Planning Proposal:

1. Emergency management and access: The Interim Floodplain Management Policy contains very broad information regarding details for considering emergency management and evacuation (risk to life). Section 3.1 item (c) requires that the development "incorporates appropriate measures to manage the risk to life from flooding considering the followings (sic):
    i. The proposed development should not result in any increased risk to human life
    ii. Controls for risk to life for floods up to the Flood Planning Level
    iii. Controls for risk to life for floods greater than the Flood Planning Level
    iv. Existing floor levels of development in relation to the Flood Planning Level and floods greater than the Flood Planning Level
    v. Council's duty of care – Proposals to address and limit
    vi. What level of flooding should apply to the development (e.g. 1 in 100 year, etc)
    vii. Effective flood access and evacuation issues
    viii. Flood readiness – Methods to ensure relative flood information is available to current and future occupants and visitors"

    While this incorporates the key principles for risk to life considerations, it does not provide details about requirements. Such requirements could consider:
    - Provision of a flood refuge above the PMF event where a building is expected to be inundated. Flood refuge requirements can be specified (such as minimum floor areas, self-sufficiency requirements (such as facilities required), maximum duration of isolation) and building structural soundness requirements for the PMF.
    - Provision of reliable access for pedestrians and/or vehicles from the building. Evacuation requirements can be specified, such as routes from the lowest floor level to an evacuation point within the building (for on-site shelter in place) or off site, reliability of the route (e.g. does not require electricity for lifts), accessibility (e.g. for people with disability) and access for emergency services if flood refuge is provided (e.g. in the event of a medical emergency)
    - Requirement for a Flood Risk Management Plan or Emergency Response Flood Plan for the site that details the above for future occupants of the site.

2. Blockage and Climate Change: It is recognised that there are a number of sites sensitive to blockage assumptions and climate change. The CoS DCP specifies blockage requirements for a site-specific flood assessment, however, this is considered to be overly conservative (100% blockage of sag pits in particular) and does not align with the latest guidelines and recent flood modelling undertaken by CoS. This primarily affects 100 Harris Street and site-specific guidance could be given for this site and the blockage factors to be considered. The Interim Floodplain Management Policy specifies requirements for climate change, however, as is the case with emergency management, the requirement is

broad. In Section 3.1 (g) the development should “adequately consider the impact of climate change”. General requirements in Section 4 require developments with a lifespan of more than fifty years to consider impacts due to sea level rise and increased rainfall intensities. Specific guidance on sea level rise is provided in the form of 2050 sea level rise (0.4 m) and 2100 sea level rise (0.9 m) and a minimum rainfall intensity increase of 10% where the development may impact regional or catchment trunk drainage (for the purpose of drainage system design). Consideration could be given to specifying FPLs with regard to a specific climate change scenario to ensure the building is protected into the future.

8. CONCLUSIONS

Some sites are affected by flood constraints. The details and constraints of each site have been discussed in Section 4, with a summary presented in Section 4.32. Where flood constraints are identified, there are no instances where redevelopment of the sites is wholly prohibitive, either under the existing LEP/DCP/Interim Floodplain Management Policy or under the amendments resulting from the Planning Proposal. However, future developments at these sites would still be required to demonstrate compliance to the existing LEP/DCP/Interim Floodplain Management Policy.

The current LEP/DCP provisions and controls are not prohibitive to redevelopment of the sites within the Planning Proposal. Where sites are affected by flood constraints the controls in the DCP and Interim Floodplain Management Policy ensure the development is compatible with the flood risk for the site and an acceptable level of detail is required as to how the flood risks are managed with any proposed development. The nature of these constraints and the solutions to satisfy the development controls are not significantly altered by the Planning Proposal. However, as with the current LEP zoning, height allowances and maximum FSR, the flood constraints may preclude full development of some sites to the maximum allowable density. This is because compliance with various flood controls (such as basement carpark entrances or minimum ground floor levels) may reduce the achievable floor space ratio or number of building storeys within a given site.

The detailed breakdown of the sites in Section 4 show that Pyrmont and Ultimo has varying degrees of flood affectation. It should be noted that the sites that are shown to be flood affected are currently developed and occupied. The most significant constraints for flood affected sites are achieving minimum floor level requirements and site access and evacuation requirements. The Planning Proposal may improve the feasibility of redevelopment in those lots as it may enable less sensitive uses of the ground floor in mixed use developments and increased height restrictions may allow for building floor levels to be raised to meet FPL requirements. Redevelopment of some buildings may also enable emergency access to be incorporated, with internal connections enabling flood free frontages to be accessed from any point within the building. In most cases, the requirement for deep soil areas has the potential to improve local flood conditions. The redevelopment of the lots identified is likely to allow for a design that caters for the flood conditions of the site.

WMAwater considers that the Planning Proposal is consistent with the Ministerial Directions for flood prone land (see Section 2.2 and Section 6 for detailed discussion), with the exception of permitting a significant increase in the development and/or dwelling density of that land. It was demonstrated that the increase in floor space will typically not be flood affected (additional stories above flood levels or buildings outside the floodplain), access to and from the sites can be maintained during flood events with appropriate building design and redevelopment of the sites will typically result in a building that is more commensurate with the flood risk, having regard for the relevant flood-related development controls. As such, the Planning Proposal is considered to be consistent with the objectives of the Section 9.1 Ministerial Directions.

The Planning Proposal is consistent with other relevant legislation and Council's strategic planning framework for flood planning, in that the flood-related development controls enforced through that

framework are not significantly altered by the Planning Proposal. It is recommended that consultation is undertaken with relevant public agencies (such as the NSW State Emergency Service, the Department of Climate Change, Energy, the Environment and Water, and the Department of Planning, Housing and Infrastructure) following Gateway determination. Comments from these public agencies regarding specific constraints or development controls can be addressed as part of the site-specific DCPs.

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FIGURES

FIGURE 1
STUDY AREA AND SITES

N

4.13
4.12
4.11
4.26
4.27
4.14
4.8
4.9
4.7
4.3
4.4
4.5
4.2
4.28
4.6
4.1
4.15
4.16
4.29
4.17
4.18
4.20
4.30
4.21
4.22
4.31
4.23
4.25

Small Lot Area 1
Small Lot Area 2
Small Lot Area 3
Small Lot Area 4
Small Lot Area 5

Small Lot Areas
Small sites
Large Sites
BW Catchment Area
DH Catchment Area

0 300 600 m

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FIGURE 2
MAP EXTENTS

N

PIRRAMA ROAD
REFINERY DRIVE
BOWMAN STREET
HARRIS STREET
PYRMONT STREET
WESTERN DISTRIBUTOR
BANK STREET
LITTLE MOUNT STREET
HARRIS STREET
MURRAY STREET
DARLING DRIVE
COOK STREET
FORSYTH LANE
FERRY ROAD
FERRY LANE
BRIDGE ROAD
DARLING STREET
ADA PLACE
WATTLE STREET
JONES STREET
MCKEE STREET
WATTLE LANE
HACKETT STREET
SYDNEY STREET
QUEEN STREET
CROWN STREET
GLEBE STREET
GLEBE LANE
DERWENT LANE
DERWENT STREET

Area A
Area B
Area C
Area D
Area E

Large Sites
Small Sites

0 300 600 m

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FIGURE 3
AREA A
PEAK FLOOD DEPTH
10% AEP EVENT

N

BOWMAN STREET
REFINERY DRIVE
TAMBUA STREET
DISTILLERY DRIVE
JONES STREET
CADIGAL AVENUE
HARVEY STREET
JOHN STREET
JONES BAY ROAD
MOUNT STREET
QUARRY MASTER DRIVE
SAUNDERS STREET
BANK STREET
WESTERN DISTRIBUTOR
MILLER STREET
MILLER LANE
HARRIS STREET
PYRMONT STREET
UNION STREET
PATERNOSTER ROW
LITTLE MOUNT STREET
BULWARA ROAD

4.27
4.11
4.10
4.26
4.14
4.8
4.9
4.7
4.2
4.28
4.1

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 4
AREA A
PEAK FLOOD DEPTH
1% AEP EVENT

N

BOWMAN STREET
REFINERY DRIVE
TAMBUA STREET
JONES STREET
CADIGAL AVENUE
HARVEY STREET
JOHN STREET
JONES BAY ROAD
DISTILLERY DRIVE
QUARRY MASTER DRIVE
MOUNT STREET
PYRMONT STREET
HARRIS STREET
UNION STREET
SAUNDERS STREET
JONES STREET
MILLER STREET
PATERNOSTER ROW
BANK STREET
WESTERN DISTRIBUTOR
MILLER LANE
BULWARA ROAD
LITTLE MOUNT STREET

4.1
4.2
4.4
4.7
4.8
4.9
4.10
4.11
4.14
4.26
4.27
4.28

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 5
AREA A
PEAK FLOOD DEPTH
PMF EVENT

N

BOWMAN STREET
REFINERY DRIVE
TAMBUA STREET
JONES STREET
CADIGAL AVENUE
HARVEY STREET
JOHN STREET
JONES BAY ROAD
DISTILLERY DRIVE
QUARRY MASTER DRIVE
MOUNT STREET
PYRMONT STREET
HARRIS STREET
UNION STREET
SAUNDERS STREET
MILLER STREET
PATERNOSTER ROW
BANK STREET
WESTERN DISTRIBUTOR
MILLER LANE
BULWARA ROAD
LITTLE MOUNT STREET

4.1
4.10
4.11
4.14
4.2
4.26
4.27
4.28
4.7
4.8
4.9

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 6
AREA A
PEAK HYDRAULIC HAZARD
1% AEP EVENT

N

BOWMAN STREET
REFINERY DRIVE
TAMBUA STREET
DISTILLERY DRIVE
JONES STREET
CADIGAL AVENUE
HARVEY STREET
JOHN STREET
MOUNT STREET
JONES BAY ROAD
PYRMONT STREET
HARRIS STREET
UNION STREET
QUARRY MASTER DRIVE
SAUNDERS STREET
BANK STREET
WESTERN DISTRIBUTOR
MILLER STREET
MILLER LANE
BULWARA ROAD
LITTLE MOUNT ST
PATERNOSTER ROW

4.27
4.11
4.10
4.26
4.14
4.8
4.9
4.7
4.2
4.28

Large Sites
Small Sites

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6 - Unsafe for vehicles and people. All building types consider vulnerable to failure

0 150 300 m

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FIGURE 7
AREA A
PEAK HYDRAULIC HAZARD
PMF EVENT

N

BOWMAN STREET
REFINERY DRIVE
TAMBUA STREET
DISTILLERY DRIVE
JONES STREET
CADIGAL AVENUE
HARVEY STREET
JOHN STREET
JONES BAY ROAD
MOUNT STREET
PYRMONT STREET
HARRIS STREET
UNION STREET
QUARRY MASTER DRIVE
SAUNDERS STREET
JONES STREET
MILLER STREET
BANK STREET
WESTERN DISTRIBUTOR
MILLER LANE
BULWARA ROAD
PATERNOSTER ROW
LITTLE MOUNT ST

4.11
4.10
4.26
4.27
4.14
4.8
4.9
4.7
4.2
4.28

Large Sites
Small Sites

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 150 300 m

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FIGURE 8
AREA B
PEAK FLOOD DEPTH
10% AEP EVENT

N

HERBERT STREET
PIRRAMA ROAD
BAYVIEW STREET
MILL STREET
WAYS TERRACE
BOWMAN STREET
POINT STREET
CROSS STREET
SCOTT STREET
HARVEY STREET
JOHN STREET
HARRIS STREET
MOUNT STREET
MILLER STREET
DARLING ISLAND ROAD
WHARF CRESCENT
TROUTON PLACE
JONES BAY ROAD
PYRMONT STREET
EDWARD STREET
MURRAY STREET
UNION STREET

4.10
4.11
4.12
4.13
4.14
4.26
4.3
4.4

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 9
AREA B
PEAK FLOOD DEPTH
1% AEP EVENT

N

HERBERT STREET
PIRRAMA ROAD
BAYVIEW STREET
MILL STREET
WAYS TERRACE
BOWMAN STREET
POINT STREET
CROSS STREET
SCOTT STREET
HARVEY STREET
JOHN STREET
HARRIS STREET
MOUNT STREET
MILLER STREET
DARLING ISLAND ROAD
WHARF CRESCENT
TROUTON PLACE
JONES BAY ROAD
PIRRAMA ROAD
PYRMONT STREET
EDWARD STREET
MURRAY STREET
UNION STREET

4.10
4.11
4.12
4.13
4.14
4.26
4.3
4.4

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 10
AREA B
PEAK FLOOD DEPTH
PMF EVENT

N

4.10
4.11
4.12
4.13
4.14
4.26
4.3
4.4

HERBERT STREET
PIRRAMA ROAD
BAYVIEW STREET
MILL STREET
WAYS TERRACE
BOWMAN STREET
POINT STREET
CROSS STREET
SCOTT STREET
HARVEY STREET
JOHN STREET
HARRIS STREET
MOUNT STREET
MILLER STREET
PYRMONT STREET
JONES BAY ROAD
DARLING ISLAND ROAD
WHARF CRESCENT
TROUTON PLACE
EDWARD STREET
MURRAY STREET
UNION STREET

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 11
AREA B
PEAK HYDRAULIC HAZARD
1% AEP EVENT

N

HERBERT STREET
BAYVIEW STREET
MILL STREET
PIRRAMA ROAD
BOWMAN STREET
WAYS TERRACE
POINT STREET
DARLING ISLAND ROAD
WHARF CRESCENT
TROUTON PLACE
CROSS STREET
SCOTT STREET
HARVEY STREET
JONES BAY ROAD
JOHN STREET
HARRIS STREET
MOUNT STREET
PYRMONT STREET
EDWARD STREET
MURRAY STREET
UNION STREET
MILLER STREET

4.10
4.11
4.12
4.13
4.14
4.26
4.3
4.4

Large Sites
Small Sites

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6 - Unsafe for vehicles and people. All building types consider vulnerable to failure

0 150 300 m

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FIGURE 12
AREA B
PEAK HYDRAULIC HAZARD
PMF EVENT

N

HERBERT STREET
PIRRAMA ROAD
BAYVIEW STREET
MILL STREET
WAYS TERRACE
BOWMAN STREET
POINT STREET
CROSS STREET
SCOTT STREET
HARVEY STREET
JOHN STREET
MARRIS STREET
MOUNT STREET
MILLER STREET
DARLING ISLAND ROAD
WHARF CRESCENT
TROUTON PLACE
JONES BAY ROAD
PIRRAMA ROAD
PYRMONT STREET
EDWARD STREET
MURRAY STREET
UNION STREET

4.10
4.11
4.12
4.13
4.14
4.26
4.3
4.4

Large Sites
Small Sites

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 150 300 m

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FIGURE 13
AREA C
PEAK FLOOD DEPTH
10% AEP EVENT

N

4.26
4.14
4.3
4.4
4.5
4.2
4.28
4.1
4.6

PIRRAMA ROAD
MOUNT STREET
MILLER STREET
EDWARD STREET
UNION STREET
PATERNOSTER ROW
HARRIS STREET
PYRMONT STREET
UNION LANE
LITTLE EDWARD STREET
HARWOOD STREET
HARWOOD LANE
MURRAY STREET
EDWARD LANE
BUNN STREET
GIPPS STREET
BUNN LANE
MILLER LANE
LITTLE MOUNT STREET
BULWARA ROAD
PYRMONT BRIDGE ROAD
BANK STREET
WESTERN DISTRIBUTOR
EXPERIMENT STREET
ADA PLACE
DARLING DRIVE

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 14
AREA C
PEAK FLOOD DEPTH
1% AEP EVENT

N

4.26
4.14
4.3
4.4
4.5
4.2
4.28
4.1
4.6

PIRRAMA ROAD
MOUNT STREET
MILLER STREET
EDWARD STREET
UNION STREET
PATERNOSTER ROW
HARRIS STREET
PYRMONT STREET
UNION LANE
LITTLE EDWARD STREET
HARWOOD STREET
HARWOOD LANE
MURRAY STREET
EDWARD LANE
BUNN STREET
GIPPS STREET
BUNN LANE
MILLER LANE
LITTLE MOUNT STREET
BULWARA ROAD
PYRMONT BRIDGE ROAD
BANK STREET
WESTERN DISTRIBUTOR
EXPERIMENT STREET
ADA PLACE
DARLING DRIVE

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 15
AREA C
PEAK FLOOD DEPTH
PMF EVENT

N

4.26
4.14
4.3
4.4
4.5
4.2
4.28
4.1
4.6

PIRRAMA ROAD
MOUNT STREET
MILLER STREET
UNION STREET
EDWARD STREET
PATERNOSTER ROW
HARRIS STREET
LITTLE MOUNT STREET
PYRMONT STREET
UNION LANE
LITTLE EDWARD STREET
HARWOOD STREET
HARWOOD LANE
MURRAY STREET
EDWARD LANE
BUNN STREET
GIPPS STREET
BUNN LANE
MILLER LANE
BULWARA ROAD
BANK STREET
WESTERN DISTRIBUTOR
PYRMONT BRIDGE ROAD
EXPERMENT STREET
ADA PLACE
DARLING DRIVE

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 16
AREA C
PEAK HYDRAULIC HAZARD
1% AEP EVENT

N

4.26
4.14
4.3
4.4
4.5
4.2
4.28
4.1
4.6

PIRRAMA ROAD
MOUNT STREET
MILLER STREET
EDWARD STREET
UNION STREET
PATERNOSTER ROW
HARRIS STREET
LITTLE MOUNT STREET
PYRMONT STREET
UNION LANE
LITTLE EDWARD STREET
HARWOOD STREET
HARWOOD LANE
MURRAY STREET
EDWARD LANE
BUNN STREET
GIPPS STREET
BUNN LANE
MILLER LANE
BULWARA ROAD
BANK STREET
WESTERN DISTRIBUTOR
PYRMONT BRIDGE ROAD
EXPERIMENT STREET
ADA PLACE
DARLING DRIVE

Large Sites
Small Sites

Hydraulic Hazard
- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6 - Unsafe for vehicles and people. All building types consider vulnerable to failure

0 150 300 m

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FIGURE 17
AREA C
PEAK HYDRAULIC HAZARD
PMF EVENT

N

4.26
4.14
4.3
4.4
4.5
4.2
4.28
4.1
4.6

PIRRAMA ROAD
MOUNT STREET
MOUNT STREET
MILLER STREET
EDWARD STREET
UNION STREET
PATERNOSTER ROW
HARRIS STREET
LITTLE MOUNT STREET
MILLER LANE
BULWARA ROAD
PYRMONT STREET
LITTLE EDWARD STREET
HARWOOD STREET
HARWOOD LANE
MURRAY STREET
UNION LANE
EDWARD LANE
BUNN STREET
GIPPS STREET
BUNN LANE
PYRMONT BRIDGE ROAD
BANK STREET
WESTERN DISTRIBUTOR
BANK STREET
BULWARA ROAD
ADA PLACE
EXPERMENT STREET
DARLING DRIVE
DARLING DRIVE

Large Sites
Small Sites

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6 - Unsafe for vehicles and people. All building types consider vulnerable to failure

0 150 300 m

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FIGURE 18
AREA D
PEAK FLOOD DEPTH
10% AEP EVENT

N

WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WATTLE CRESCENT
JONES LANE
FIG STREET
FIG LANE
HENRY AVENUE
ADAH PLACE
QUARRY LANE
BULWARA ROAD
QUARRY STREET
HARRIS STREET
KIRK STREET
PYRMONT STREET
TUMBALONG BOULEVARD
MORIARTY WALK
DARLING DRIVE
DARLING DRIVE
PIER STREET
WATTLE STREET
JONES STREET
QUARRY STREET
WILLIAM HENRY STREET
HACKETT STREET
WENTWORTH PARK ROAD
4.15
4.16
4.17
4.18
4.19
4.29
6
10
3

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 19
AREA D
PEAK FLOOD DEPTH
1% AEP EVENT

N

WATTLE CRESCENT
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
JONES LANE
FIG STREET
FIG LANE
HENRY AVENUE
ADAIT PLACE
PYRMONT STREET
TUMBALONG BOULEVARD
MORIARTY WALK
QUARRY LANE
BULWARA ROAD
QUARRY STREET
HARRIS STREET
KIRK STREET
DARLING DRIVE
DARLING DRIVE
WATTLE STREET
JONES STREET
QUARRY STREET
PIER STREET
WILLIAM HENRY STREET
HACKETT STREET
WENTWORTH PARK ROAD

4.29
4.15
4.16
4.17
4.18
4.19

5
10
4
3
3
3
6
6

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 20
AREA D
PEAK FLOOD DEPTH
PMF EVENT

N

WATTLE CRESCENT
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
JONES LANE
FIG STREET
FIG LANE
HENRY AVENUE
ADAI PLACE
PYRMONT STREET
TUMBALONG BOULEVARD
MORIARTY WALK
QUARRY LANE
BULWARA ROAD
QUARRY STREET
HARRIS STREET
KIRK STREET
DARLING DRIVE
DARLING DRIVE
PIER STREET
WATTLE STREET
JONES STREET
QUARRY STREET
WILLIAM HENRY STREET
HACKETT STREET
WENTWORTH PARK ROAD

4.29
4.15
4.16
4.17
4.18
4.19

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
- <= 0.15
- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

0 150 300 m

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FIGURE 21
AREA D
PEAK HYDRAULIC HAZARD
1% AEP EVENT

WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WATTLE CRESCENT
JONES LANE
FIG STREET
FIG LANE
HENRY AVENUE
ADAJ PLACE
PYRMONT STREET
TUMBALONG BOULEVARD
MORIARTY WALK
QUARRY LANE
BULWARA ROAD
QUARRY STREET
HARRIS STREET
KIRK STREET
DARLING DRIVE
DARLING DRIVE
PIER STREET
WATTLE STREET
JONES STREET
QUARRY STREET
WILLIAM HENRY STREET
HACKETT STREET
WENTWORTH PARK ROAD
4.29
4.15
4.16
4.17
4.18
4.19
N

Large Sites
Small Sites

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 150 300 m

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FIGURE 22
AREA D
PEAK HYDRAULIC HAZARD
PMF EVENT

WATTLE CRESCENT
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
WESTERN DISTRIBUTOR
JONES LANE
FIG STREET
FIG LANE
HENRY AVENUE
ADAI PLACE
PYRMONT STREET
TUMBALONG BOULEVARD
MORIARTY WALK
DARLING DRIVE
DARLING DRIVE
QUARRY LANE
BULWARA ROAD
QUARRY STREET
HARRIS STREET
KIRK STREET
JONES STREET
QUARRY STREET
WATTLE STREET
PIER STREET
WILLIAM HENRY STREET
HACKETT STREET
WENTWORTH PARK ROAD

4.29
4.15
4.16
4.17
4.18
4.19

N

Large Sites
Small Sites

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 150 300 m

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FIGURE 23
AREA E
PEAK FLOOD DEPTH
10% AEP EVENT

N

4.18
4.19
4.20
4.21
4.22
4.23
4.24
4.25
4.30
4.31

QUARRY STREET
WILLIAM HENRY STREET
PIER STREET
DARLING DRIVE
ZOLLNER CIRCUIT
TUMBALONG BOULEVARD
NICOLLE WALK
STEAM MILL LANE
LITTLE HAY STREET
HAY STREET
QUAY STREET
BULWARA ROAD
PARBURY LANE
HACKETT STREET
MACARTHUR STREET
HENSON LANE
JONES STREET
WATTLE STREET
OMNIBUS LANE
HARRIS STREET
SYDNEY STREET
MCKEE STREET
WATTLE LANE
MARY ANN STREET
ULTIMO ROAD
BAY LANE
BAY STREET
MOUNTAIN STREET
MOUNTAIN LANE
KELLY STREET
BLACKWATTLE LANE
WEST END LANE

3
4
5

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 24
AREA E
PEAK FLOOD DEPTH
1% AEP EVENT

N

4.18
4.19
4.20
4.21
4.22
4.23
4.24
4.25
4.30
4.31

QUARRY STREET
WILLIAM HENRY STREET
DARLING DRIVE
PIER STREET
ZOLLNER CIRCUIT
TUMBALONG BOULEVARD
NICOLLE WALK
STEAM MILL LANE
LITTLE HAY STREET
HAY STREET
QUAY STREET
PARBURY LANE
BULWARA ROAD
HACKETT STREET
JONES STREET
HENSON LANE
MACARTHUR STREET
OMNIBUS LANE
HARRIS STREET
SYDNEY STREET
WATTLE STREET
MOKEE STREET
WATTLE LANE
BAY LANE
BAY STREET
MOUNTAIN STREET
BLACKWATTLE LANE
KELLY STREET
MOUNTAIN LANE
WEST END LANE
MARY ANN STREET
ULTIMO ROAD

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 25
AREA E
PEAK FLOOD DEPTH
PMF EVENT

N

4.18
4.19
4.20
4.21
4.22
4.23
4.24
4.25
4.30
4.31

QUARRY STREET
WILLIAM HENRY STREET
DARLING DRIVE
PIER STREET
ZOLLNER CIRCUIT
TUMBALONG BOULEVARD
NICOLLE WALK
STEAM MILL LANE
LITTLE HAY STREET
HAY STREET
QUAY STREET
BULWARA ROAD
PARBURY LANE
JONES STREET
HENSON LANE
MACARTHUR STREET
HACKETT STREET
HARRIS STREET
OMNIBUS LANE
SYDNEY STREET
ULTIMO ROAD
WATTLE STREET
BAY LANE
BAY STREET
MOUNTAIN STREET
MOUNTAIN LANE
BLACKWATTLE LANE
KELLY STREET
WEST END LANE
WATTLE LANE
MCKEE STREET
MARY ANN STREET

Large Sites
Small Sites
Flood Level Contour (1m Interval)

Depth (m)
<= 0.15
0.15 - 0.30
0.30 - 0.50
0.50 - 1.00
1.00 - 2.00
> 2.00

0 150 300 m

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FIGURE 26
AREA E
PEAK HYDRAULIC HAZARD
1% AEP EVENT

N

4.18
4.19
4.20
4.21
4.22
4.23
4.24
4.25
4.30
4.31

QUARRY STREET
WILLIAM HENRY STREET
PIER STREET
DARLING DRIVE
ZOLLNER CIRCUIT
TUMBALONG BOULEVARD
NICOLLE WALK
STEAM MILL LANE
LITTLE HAY STREET
HAY STREET
BULWARA ROAD
PARBURY LANE
HACKETT STREET
MACARTHUR STREET
OMNIBUS LANE
HARRIS STREET
SYDNEY STREET
QUAY STREET
JONES STREET
HENSON LANE
WATTLE STREET
MCKEE STREET
WATTLE LANE
BAY LANE
BAY STREET
MOUNTAIN STREET
MOUNTAIN LANE
BLACKWATTLE LANE
KELLY STREET
WEST END LANE
MARY ANN STREET

Large Sites
Small Sites

Hydraulic Hazard

H1 - Generally safe for people, vehicles and buildings
H2 - Unsafe for vehicles
H3 - Unsafe for vehicles, children and the elderly
H4 - Unsafe for people and vehicles
H5 - Unsafe for vehicles and people.
All buildings vulnerable to structural damage.
Some less robust building types vulnerable to failure
H6 - Unsafe for vehicles and people.
All building types consider vulnerable to failure

0 150 300 m

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FIGURE 27
AREA E
PEAK HYDRAULIC HAZARD
PMF EVENT

N

4.18
4.19
4.20
4.21
4.22
4.23
4.24
4.25
4.30
4.31

QUARRY STREET
WILLIAM HENRY STREET
WATTLE STREET
JONES STREET
PARBURY LANE
BULWARA ROAD
HENSON LANE
HACKETT STREET
MACARTHUR STREET
HARRIS STREET
OMNIBUS LANE
SYDNEY STREET
DARLING DRIVE
PIER STREET
ZOLLNER CIRCUIT
STEAM MILL LANE
TUMBALONG BOULEVARD
NICOLLE WALK
LITTLE HAY STREET
HAY STREET
QUAY STREET
MCKEE STREET
MARY ANN STREET
WATTLE LANE
BAY LANE
BAY STREET
BLACKWATTLE LANE
MOUNTAIN STREET
MOUNTAIN LANE
KELLY STREET
WEST END LANE

Large Sites
Small Sites

Hydraulic Hazard

- H1 - Generally safe for people, vehicles and buildings
- H2 - Unsafe for vehicles
- H3 - Unsafe for vehicles, children and the elderly
- H4 - Unsafe for people and vehicles
- H5 - Unsafe for vehicles and people.
  All buildings vulnerable to structural damage.
  Some less robust building types vulnerable to failure
- H6 - Unsafe for vehicles and people.
  All building types consider vulnerable to failure

0 150 300 m

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FIGURE 28
FLOOD FUNCTION
1% AEP EVENT

N

PIRRAMA ROAD
REFINERY DRIVE
BOWMAN STREET
MOUNT STREET
HARRIS STREET
PYRMONT STREET
WESTERN DISTRIBUTOR
BANK STREET
COOK STREET
FORSYTH LANE
FERRY ROAD
FERRY LANE
BRIDGE ROAD
DARLING STREET
DERWENT LANE
DERWENT STREET
GLEBE LANE
BULWARA ROAD
ADA PLACE
EXPERIMENT STREET
MURRAY STREET
DARLING DRIVE
WATTLE STREET
QUEEN STREET
CROWN STREET
GLEBE STREET
JONES STREET
HACKETT STREET
MORIARTY WALK

4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 4.11 4.12 4.13 4.14 4.15 4.16 4.17 4.19 4.20 4.21 4.22 4.23 4.25 4.26 4.27 4.28 4.29 4.30 4.31

Large Sites
Small Sites
Hydraulic Category
Floodway
Flood Storage
Flood Fringe

0 300 600 m

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FIGURE 29

PIT BLOCKAGE SENSITIVITY
1% AEP EVENT
WITH HIGH BLOCKAGE

N

DH Catchment Area
- Large Sites
- Small Sites

Impact (m)
- <= -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- > 0.3

0 300 600 m

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FIGURE 30

CLIMATE CHANGE SENSITIVITY
0.2% AEP EVENT VS
1% AEP EVENT

N

4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 4.11 4.12 4.13 4.14 4.15 4.16 4.17 4.19 4.20 4.21 4.22 4.23 4.25 4.26 4.27 4.28 4.29 4.30 4.31

PIRRAMA ROAD
REFINERY DRIVE
BOWMAN STREET
JONES STREET
MOUNT STREET
HARRIS STREET
PYRMONT STREET
PATERNOSTER ROW
WESTERN DISTRIBUTOR
BANK STREET
BULWARA ROAD
ADA PLACE
EXPERIMENT STREET
MURRAY STREET
DARLING DRIVE
WHEAT ROAD
COOK STREET
FORSYTH LANE
FERRY ROAD
FERRY LANE
BRIDGE ROAD
DARLING STREET
BELLEVUE LANE
GLEBE LANE
QUEEN STREET
CROWN STREET
WATTLE STREET
MORIARTY WALK
HAY STREET
HACKETT STREET

Large Sites
Small Sites

Impact (m)
- <= -0.3
- -0.3 - -0.1
- -0.1 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.1
- 0.1 - 0.3
- > 0.3

0 300 600 m

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