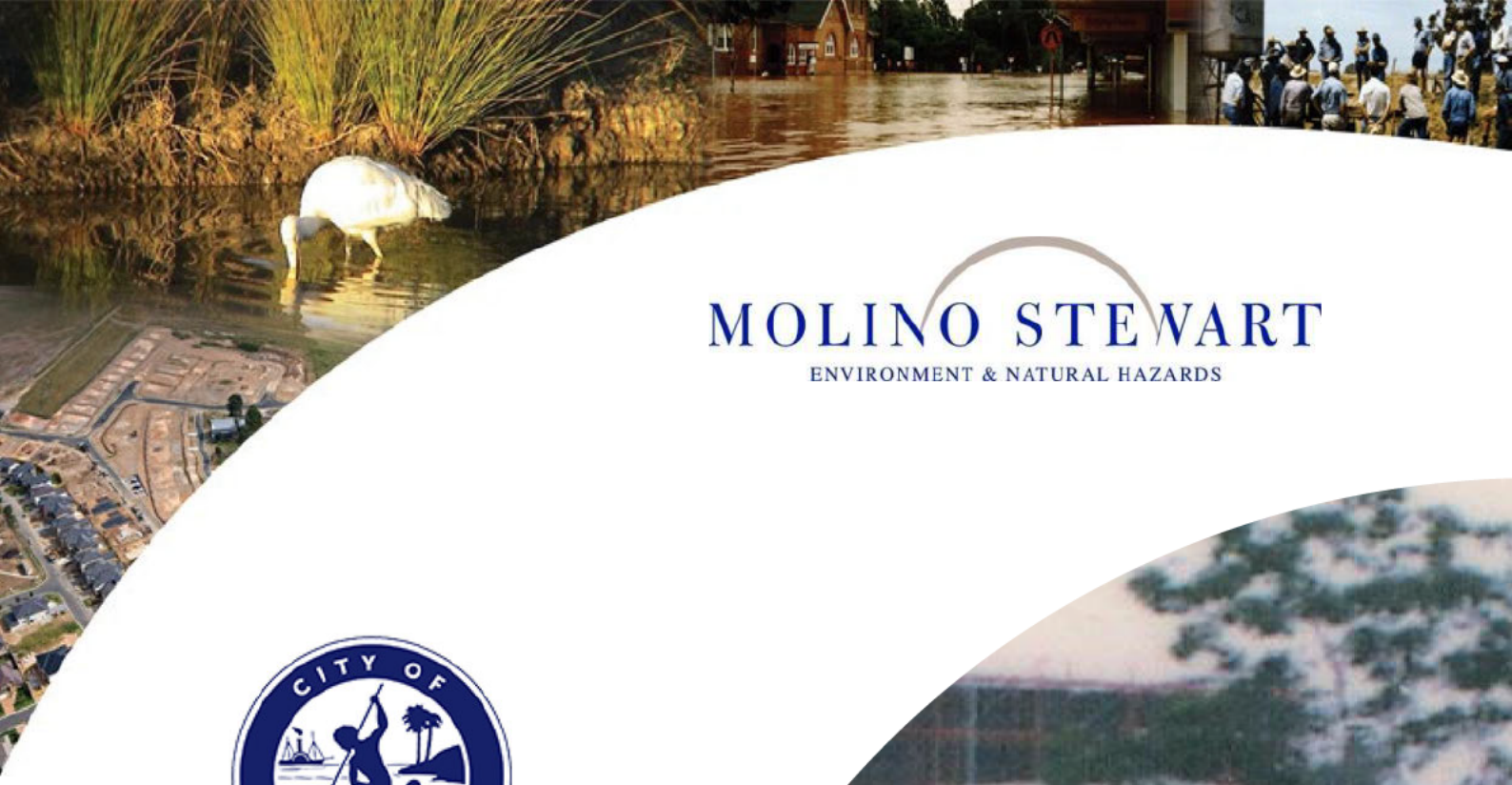

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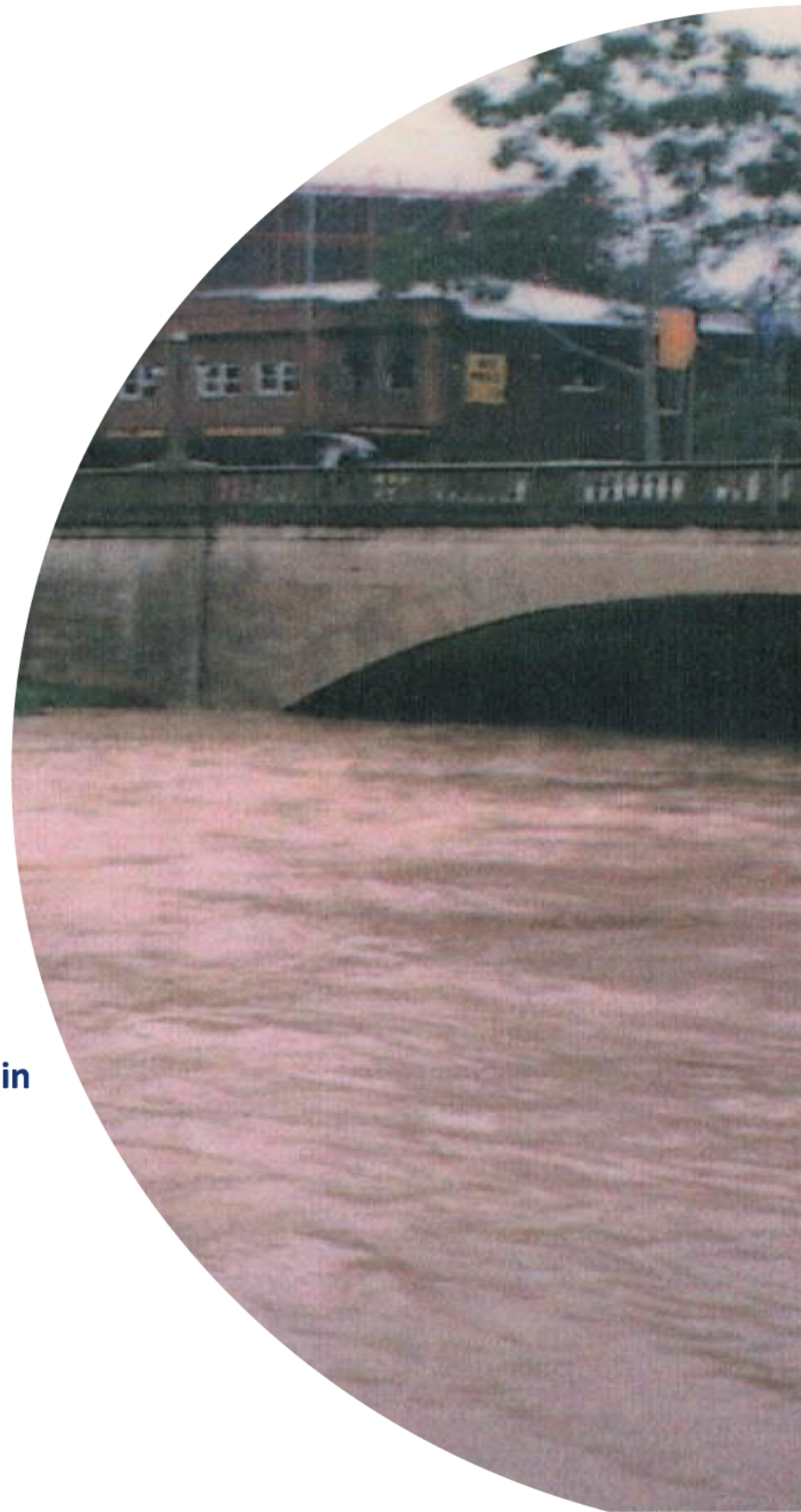

Update of Parramatta Floodplain Risk Management Plans

Final

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Update of Parramatta Floodplain Risk Management Plans

FINAL

for

City of Parramatta Council

by

Molino Stewart Pty Ltd
ACN 067 774 332

OCTOBER 2021

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25/02/2016	4	Steven Molino	*New Section amalgamating similar flood risk categories*
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DOCUMENT APPROVAL

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EXECUTIVE SUMMARY

Parramatta is located geographically and demographically in the centre of Sydney and is often referred to, both officially and unofficially, as Sydney's second central business district (CBD). The NSW Government and City of Parramatta Council have identified Parramatta CBD as a key growth centre for commercial and residential development.

One of the constraints for development within the Parramatta CBD is that a significant proportion of the area is within the floodplain of the Parramatta River and its tributaries.

As part of its vision for growing the Parramatta CBD, the City of Parramatta Council has prepared the Parramatta CBD Planning Strategy, which is a road map to expanding the CBD through amending a number of planning controls, such as floor space ratios and also expanding the CBD boundaries. As part of the Parramatta CBD Planning Strategy, Council is required to submit a Planning Proposal to the Department of Planning, Industry and Environment to make alterations to the current Parramatta Local Environment Plan (LEP) 2011.

The *Environmental Planning and Assessment Act* 1979 sets out a number of requirements that must be met for planning proposals to be approved. One is Section 9.1 Direction 4.3 which deals with development on floodplains. A requirement of the direction is that a planning proposal must not permit a significant increase in development in that area unless it has been prepared in accordance with the NSW Floodplain Development Manual (2005).

Accordingly, Council has engaged Molino Stewart to review the two Floodplain Risk Management Plans that cover the Parramatta CBD area and prepare an updated Floodplain Risk Management Plan. The review and preparation involved the following steps:

- The existing plans were reviewed to determine which measures in those plans were still to be implemented
- Council officers were interviewed and field inspections of the CBD undertaken to identify practical challenges and risks to life and property which have arisen from existing development in the CBD floodplains
- The draft planning proposal was reviewed to identify opportunities which it provides to address existing flood problems and what new risks it presents
- A comprehensive flood risk assessment was completed with particular emphasis on risk to life to determine whether development intensification in the CBD is appropriate and whether it needs to be controlled to manage flood risk
- A detailed evacuation analysis was undertaken to assess the feasibility of various evacuation options and evacuation infrastructure upgrades
- Flood risk management measures were identified in consultation with the Parramatta Floodplain Management Committee
- A draft Parramatta CBD Floodplain Risk Management Plan was prepared.

This report concludes that the intensification of development in the Parramatta CBD represents a tolerable risk to life and property providing that amendments are made to the Parramatta LEP 2011 and Parramatta Development Control Plan (DCP) 2011 to better manage some of the risks of flooding to life. The review has also identified opportunities for DCP amendments to be made which could result in less development restrictions in parts of the floodplain and improved building design outcomes.

The draft plan proposes:

- An application to the Minister for Planning and Open Spaces for exceptional circumstances to impose controls above the Flood Planning Level for development within the Parramatta CBD affected by the Probable Maximum Flood (PMF)
- The development of four (4) risk to life categories for determining the different types of mitigation and response measures required
- The provision of shelter above the PMF level and a building access at or above the 1% AEP flood level within the LEP rather than just in the DCP to ensure that these minimum life safety measures are applied to all developments
- A total of 14 amendments to Parramatta DCP 2011
- A review of policy in relation to fencing and screening within floodways
- Better communication of the detailed flood information available through Section 10.7 certificates
- Encouraging NSW State Emergency Service to complete the update of the Parramatta Local Flood Sub Plan
- Investigation of Section 7.11 contributions to fund flood mitigation projects
- Improved communication and public education regarding flood risk, preparedness, response and recover
- Further development of the flood early warning system for the Parramatta River
- Encouraging Sydney Water to review its channel maintenance programs
- The preparation of a Flood Emergency Response Plan including plans for evacuation for the CBD

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1 INTRODUCTION

1.1 BACKGROUND

Parramatta CBD is currently undergoing significant growth and redevelopment. One of the potentially limiting factors to this growth is the availability of floor space for commercial and residential use. Currently Parramatta CBD has a shortage of prime commercial office space, with vacancy rates far lower than other major centres in Sydney and the Australian average.

The importance of a successful and growing Parramatta CBD is recognised by the NSW State Government, labelling Parramatta as a "CBD of metropolitan significance" (NSW Department of Planning and Environment, 2014). As such, the government considers the growth of Parramatta CBD to be crucial to the growth of Sydney as a whole. It subsequently released the Greater Sydney Region Plan (Greater Sydney Commission, 2018a) and the Central City District Plan (Greater Sydney Commission, 2018b) which further reinforced Parramatta's strategic role for the entire metropolitan region and the importance of future growth in Parramatta.

In response, City of Parramatta Council developed the Parramatta CBD Planning Strategy (the CBD Strategy), which was adopted on 27th April 2015. Key features of the strategy are:

- Expand the boundaries of the Parramatta CBD
- Increase the floor space ratio controls in certain areas
- Alter solar access controls
- Alter building height restrictions
- Expand the commercial core of the CBD

An implementation strategy for the CBD Strategy has been developed, which includes the development of a planning proposal to modify the Parramatta LEP 2011. In order for the planning proposal to be approved, a number of statutory obligations need to be met. This includes the Section 9.1 Direction 4.3 – Flood Prone Land of the *Environmental Planning and Assessment Act 1979* (the direction). Clause 3 of the direction "When this direction applies" states:

"This direction applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land"

The direction goes on to state what the planning authority must do when the direction applies. These requirements are generally in line with the NSW Flood Prone Land Policy and the Floodplain Development Manual (DIPNR, 2005).

One of these requirements is that a planning proposal should not permit a significant increase in development within flood prone land. The direction allows inconsistency with the requirements if the planning proposal is incorporated into a Floodplain Risk Management Plan that has been created in accordance with the principles and guidelines of the Floodplain Development Manual (2005).

Significant areas within Parramatta CBD are flood prone. Floodplain risk management of these flood prone areas is generally undertaken under two existing floodplain risk management plans (the original plans), these are:

- The Floodplain Risk Management Plan for the Upper Parramatta River Catchment, Bewsher Consulting for the Upper Parramatta River Catchment Trust (April 2003)
- The Lower Parramatta Floodplain Risk Management Plan, SKM for City of Parramatta Council (August 2005).

In order to meet the requirements of the direction, Parramatta Council is updating the two original plans in light of the changes that have been made to both the land use and regulatory and planning frameworks as well as the future land use changes proposed by the CBD Strategy.

1.2 OBJECTIVES

The primary objectives of this project are to:

- Update the two original plans in light of the land use and regulatory changes that have occurred since the plans were adopted as well as incorporate the implementation of the plans that has occurred to date.
- Ensure that the planning proposal as part of the CBD Strategy is consistent with Section 9.1 Direction 4.3 of the *Environmental Planning and Assessment Act 1979*.

1.3 STUDY AREA

The study area covered by this project is the planning proposal extent. This area is a subset of the area of the two existing plans, which cover a much larger part of the Parramatta LGA. Some elements of the existing plan review cover areas outside of the planning proposal extent, however, these are not the focus of the study.

Figure 1 shows the extent of the planning proposal area. It also shows the lots that have been identified through preliminary analysis that are likely to be subject to redevelopment as a result of the planning proposal.

The planning proposal area is the subject of the risk assessment that has been undertaken to determine whether the planning proposal meets the requirements of the direction.

1.4 SCOPE OF THE UPDATE

The Floodplain Development Manual (2005) recommends a floodplain management process which involves data collection followed by a flood study then a floodplain risk management study followed by a floodplain risk management plan. This process should be revisited periodically using updated information.

This report is an update of the two existing floodplain risk management plans without new data collection or an update to the flood study or floodplain risk management study.

It relies mostly on data, such as model results, that have been gathered as part of the development of the original plans. The focus of this project is to update the floodplain risk management plan utilising the existing flood data and to apply it in light of:

- Changes to the regulatory framework since the original plans were developed
- Land use changes that have occurred since the original plans were developed and changes that will occur in the future through the planning proposal.
- Changes to the planning environment that has occurred since the development of the Original Plans.

At the time of writing, Council was in the process of finalising a new flood study to cover the Upper and Lower Parramatta River floodplains within the LGA.

It is understood that this new Flood Study will produce significantly more detailed and accurate data for the assessment of flood risks within the LGA. However, it is currently anticipated to be completed in 2020, with an updated floodplain risk management study and plan likely to be completed following that. Therefore this plan update was required to bring the original Plans in line with the new regulatory framework, land use and planning instruments in the interim. It is recommended that this study is reviewed once the new data from this Flood Study has been received.

A draft of this report was forwarded to the then Department of Planning and Environment in support of a request for a Gateway determination on the Draft Parramatta CBD Planning Proposal 2017. That draft of this report recommended that the (then) City of Parramatta Council request that “exceptional circumstances” be granted for the CBD under Section 9.1 Direction 4.3 Flood Prone Land. The Department requested that further investigations be carried out in relation to flood evacuation options to support that request. That report was submitted (Molino Stewart, 2017).

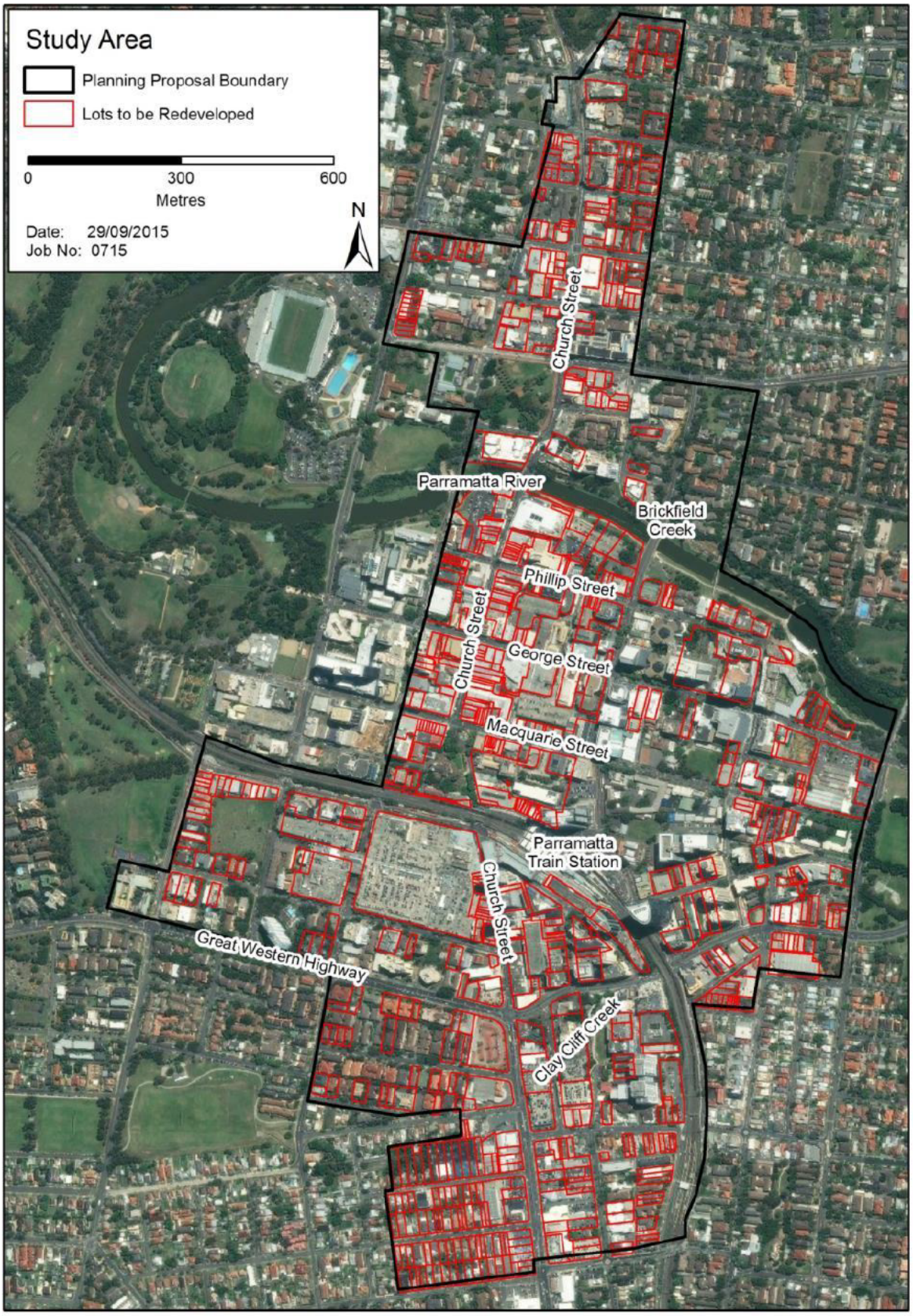

Figure 1: Planning Proposal Extent and potential redevelopment lots

In December 2018, the Department issued a conditional Gateway determination to allow the planning proposal to be updated and consolidated. This included several conditions to seek further clarification or evidence to support the planning proposal.

One of those conditions was that Council:

"update the planning proposal and maps to provide a consolidated explanation of provisions and assessment of the intended outcomes as amended by this Gateway determination, and review the studies that have been prepared to support the planning proposal and update if required."

It also granted exceptional circumstances to enable further agency consultation on the planning controls that will apply to land impacted by the PMF.

To comply with the condition above, the Flood Evacuation Report was updated to incorporate new information which had become available since it was first prepared and this report has been updated to take into account the findings of the Flood Evacuation Report and to incorporate other changes which have occurred since this report was first drafted.

1.5 REPORT FORMAT

This report has been structured in the following way:

- Chapter 2 places the project in the context of the various planning documents and instruments
- Chapter 3 is a review of the existing plan measures, and focuses on whether they have been implemented and which, if any, of those measures need to be carried through or amended in the updated plan
- Chapter 4 describes the planning proposal and outlines its practical implications with regard to flooding
- Chapter 5 is a flood risk assessment which describes the flood risk assessment procedure undertaken on the planning proposal
- Chapter 6 presents the potential Management options arising from the flood risk assessment
- Chapter 7 is the conclusions and recommendations
- Chapter 8 is the recommended Updated Floodplain Risk Management Plan
- Chapter 9 is a list of reference documents used in the project.

2 PLANNING CONTEXT

This chapter sets out the relevant planning documents that have been taken into account when undertaking this project.

2.1 EXISTING FLOODPLAIN MANAGEMENT PLANS

Improvements to floodplain risk management within the study area are currently undertaken according to the two original floodplain risk management plans.

These plans provide a clear set of suggested measures to be undertaken by Council and other authorities in order to reduce the flood risk in the study area. These measures generally fall under three categories:

- Flood Modification Measures: These modify the behaviour of the flood itself by reducing flood levels or velocities
- Property Modification Measures: These modify either the existing buildings (voluntary house purchase/raising) or future development (through development controls) within the floodplain
- Response Modification Measures: These actions modify the response of the population to the flood threat, generally through community education or improvements to emergency management.

Further investigation of potential options may also be measures within a plan.

The original plans have a number of proposed actions that fall into each of these categories. However, since the development of the original plans, a number of these measures have been made redundant, particularly where:

- The regulatory framework has changed such that the suggested measure would no longer be viable (e.g. repeal of REP 28 - Parramatta)
- Further investigations have shown that the suggested measure is not effective or feasible

2.2 STRATEGIC PLANS

The NSW State Government and City of Parramatta have prepared a number of strategies and plans that outline the future growth of Parramatta. These include:

- Greater Sydney Region Plan A Metropolis of Three Cities – connecting people (Greater Sydney Commission 2018a) outlines vision for the Greater Sydney Region, focuses on three cities (Western Parkland, Central River and Eastern Harbour) within the Greater Sydney Region and is based on the expectation that the population will be 8 million residents in 2058. The population in the 'Central River City' is expected to increase from 1.3 million to 1.7 million by 2038.
- Our Greater Sydney 2056 Central City District Plan – connecting communities (GSC 2018b) is a 20 year plan working towards the 40 year vision outlined in the Greater Sydney Region Plan. Parramatta is at the Centre of the Central City District. As part of this strategy an increase of 55,000 to 70,000 jobs throughout Greater Parramatta is planned, to be supported by new development,
- The Economic Development Plan 2017-2021 (City of Parramatta Council 2017) aims to increase the number of jobs in the Parramatta LGA by 20,000 by 2021, 9,500 of which are expected to be in the CBD. This will be supported by the investment and development currently taking place in the CBD, as well as a range of strategies from council.
- The Community Strategic Plan 2018-2038 (City of Parramatta Council, 2018) puts strategies in place to manage the elements of growth that the City can influence, leading to an improved quality of life for all.

In the 2016 Census 137,329 people listed Parramatta as their "Place of Work" with the Economic Development Plan suggesting 47,000 of those were in the Parramatta CBD.

While a significant number of the projected new jobs will be located in various precincts with Parramatta LGA, it is likely that the majority of the growth will occur inside the CBD.

The CBD Strategy has been developed by Council over a number of years as a response to the planned jobs growth and is aimed at amending the planning controls within the CBD. The vision of the strategy is:

"Parramatta will be Australia's next great city, defined by landmark buildings and high quality public spaces with strong connections to regional transport. It will respect its heritage, be an exemplar in design excellence, facilitate job growth and ensure its streets are well activated"

In order to achieve the vision, the CBD strategy proposes to:

- Expand the boundaries of the Parramatta CBD into the neighbouring area.
- Amend planning controls to encourage re-development to create larger buildings. This is achieved through increasing the allowable floor space ratios and removing building height restrictions (where this is not constrained by other factors such as solar access).

2.3 STATE FLOOD PLANNING DOCUMENTS

2.3.1 Environmental Planning and Assessment Act 1979 Section 9.1 Directions

Section 9.1 of the EP&A Act permits the Minister for Planning to issue a direction in relation to the making of local environmental plans. Several of these have been issued including Direction 4.3 which related to flood prone land.

The objectives of the direction are to ensure that the development on flood prone land is consistent with the Flood Prone Land Policy and the Floodplain Development Manual (2005) and also to ensure that the planning proposal considers flood hazard and the flood impacts on and off the subject land.

The requirements of the direction are:

- The planning proposal must be consistent with the NSW Flood Prone Land Policy and Floodplain Development Manual (FDM)
- The planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zone
- The planning proposal must not contain provisions that apply to the planning areas which:
  - permit development in floodway areas
  - permit development that will result in significant flood impacts to other properties
  - permit a significant increase in the development of that land
  - are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services
  - permit development to be carried out without consent except for the purposes of agriculture, roads or exempt development
- The planning proposal must not impose flood related development controls above the residential flood planning level for resident development on land, unless adequately justified
- The planning proposal must not determine a flood planning level that is inconsistent with the FDM

The direction also includes an allowance for inconsistencies. A planning proposal may be inconsistent with the direction if it can satisfy the Department of Planning that:

- The planning proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual (2005)

Or

- The provisions of the planning proposal that are inconsistent are of minor significance

As discussed in previous sections of this report, the aim of the planning proposal is to

essentially permit a significant increase in development within the existing and expanded CBD. Because much of the planning area is floodplain, the planning proposal has the potential to "permit a significant increase in the development of" the floodplain. As such, the planning proposal is not consistent with the direction.

In order to satisfy the requirements of the direction, an updated floodplain risk management plan prepared in accordance with the NSW Floodplain Development Manual, is required.

2.3.2 NSW Flood Prone Land Policy

The NSW Flood Prone Land Policy (2005) outlines the approach taken by the NSW Government to development on floodplains.

The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods where possible.

The policy sets out the roles and responsibilities of those involved in planning and controlling floodplain development. These are:

- Councils are primarily responsible for the management of flood prone land. Their role is to establish planning controls and measures to reduce flood risk by utilising the methods set out in the FDM
- The NSW Government, through the Office of Environment and Heritage, provides financial and technical support to councils to ensure that the approach is applied consistently across the state
- Floodplain Risk Management Committees, community based committees established by Council, are responsible for reviewing the floodplain development process and communicating their aspirations concerning the management of flood prone land.

Some other key sections of the policy include:

- Recognition that flood prone land is a valuable resource and should not be sterilised by unnecessarily precluding its development
- Promotion of a flexible merit based approach to be followed by Council and recognition that if strict criteria are applied then some appropriate proposals may be unreasonably disallowed and alternatively some inappropriate proposals may be approved
- Protection for Council and other public authorities against claims for damages, provided they have acted in accordance with the Policy and the FDM (as per Section 733 of the *Local Government Act, 1993*)

2.3.3 NSW Floodplain Development Manual

The FDM sets out the methodology in which floodplain management is undertaken in NSW. It builds upon the approach set out in the NSW Flood Prone Land Policy and provides guidance on how to enact the principles of the policy.

The manual is built upon a risk management approach. It promotes quantification of the probability (how often will floods occur?) and the consequences (what people and assets are exposed, what is the hazard of the water, what are the tangible and intangible damages) to determine the risk. The manual promotes management measures to reduce the risk, either by decreasing the probability, the consequence or both.

The core of the manual is the Floodplain Risk Management Process which sets out an iterative approach to mitigate the risk, then review and determine if the residual risk can be mitigated. The process generally follows:

- Formation of the Floodplain Risk Management Committee
- Data Collection
- Flood Study
- Floodplain Risk Management Study
- Floodplain Risk Management Plan
- Plan Implementation

Figure 2 concisely outlines the floodplain development process. The floodplain development manual is essentially followed for all floodplain management within NSW.

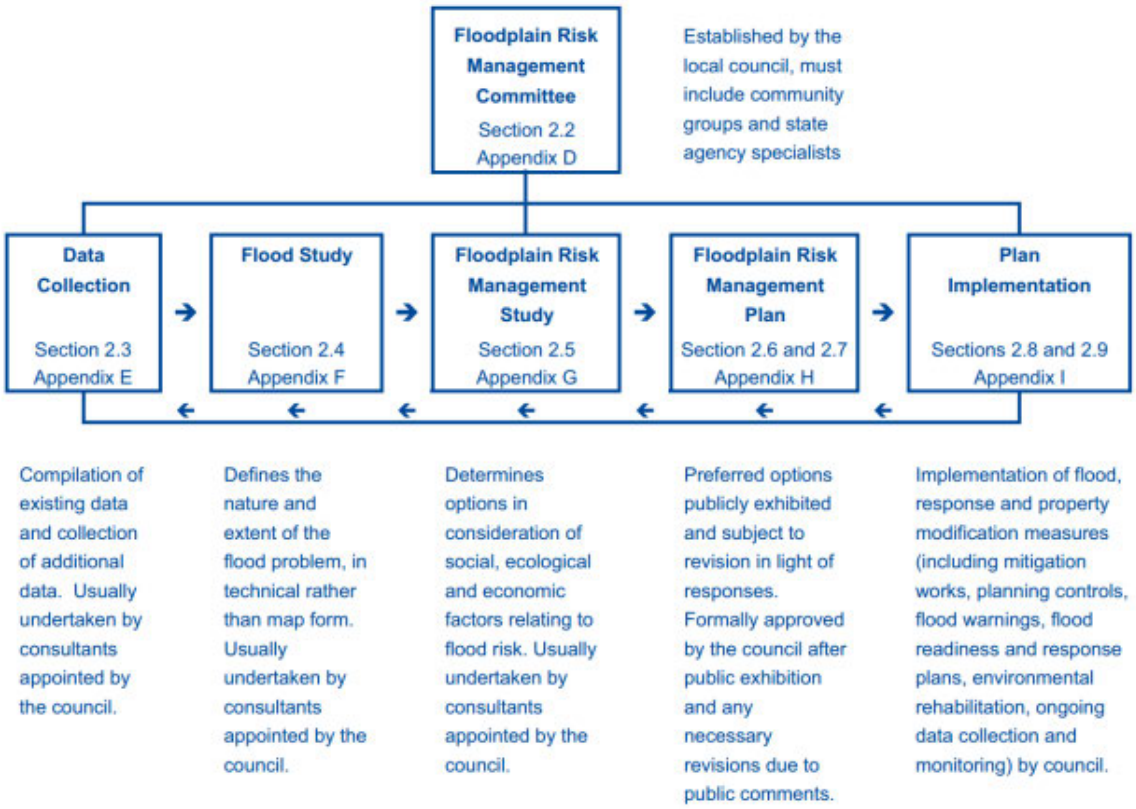

Figure 2: Floodplain Development Process (From DIPNR 2005)

2.4 LOCAL PLANNING INSTRUMENTS

2.4.1 Parramatta Local Environment Plan (LEP) 2011

The Parramatta LEP 2011 applies to the whole area covered by the FRMP. This LEP is a standard instrument LEP and as such the wording and structure are generally set out by the NSW Department of Planning, Industry and Environment. With respect to flood planning, the LEP has a number of conditions that the development must satisfy rather than a number of potential impacts that the consent authority must consider in its determination.

The main conditions for approval are that the development:

- Is compatible with the flood hazard of the land
- Is not likely to significantly adversely affect flood behaviour resulting in increases in the flood affectation of other properties
- Incorporates appropriate measures to manage risk to life from flood
- Is not likely to significantly adversely affect the environment or cause erosion, siltation, destruction of vegetation etc.

The Standard Instrument LEP also sets the flood planning level as the 100 year average recurrence interval (ARI) event plus 0.5 m of freeboard.

2.4.2 Parramatta Development Control Plan (DCP) 2011

The Parramatta DCP 2011 (Included as Appendix B) sets out the development controls with regard to flooding for the Parramatta LEP 2011. One of the aims of the DCP is to assist development in conforming to the requirements of the LEP. Where the LEP lists a requirement for a certain potential impact to be considered, the DCP has been written such that if it is followed, that impact is likely to be minimised.

The DCP uses a matrix of controls depending on the Flood Risk Precinct (Low, Medium or

High) and Land Use Type (Residential, Commercial, Critical Uses & Facilities etc.) and categorises the development controls against a number of aspects, including:

- Floor level
- Building Components
- Structural Soundness
- Flood Affectation
- Car Parking and Driveway Access
- Evacuation
- Management and Design

This approach is consistent with many other Councils within the Sydney Region and is generally considered best practice. However, the Land Use definitions and controls tend to vary between Councils. For example, the Parramatta DCP Matrix would classify a hospital as a "Sensitive Use" while the Fairfield City Wide DCP 2013 and the Bankstown DCP 2015 have classified a hospital as a "Critical Use". The outcome, in terms of planning controls for all three DCPs, is the same for hospitals.

For this project critical controls were compared across the Parramatta, Fairfield and Bankstown DCPs. the controls examined included the floor levels, evacuation and car parking and driveway access controls for the Low and Medium Flood Risk Precincts for Residential and Commercial Development. It was found that the Parramatta DCP was fairly similar to the Fairfield and Bankstown DCPs, with minor variations such as the level of basement car parking (Parramatta uses the 1% AEP plus 0.5 m freeboard, Fairfield the 1% AEP and Bankstown the 1% AEP plus 0.1 m freeboard).

At the time of writing the Parramatta DCP was under review by Council.

The controls set out in the DCP are in line with the objectives of the Floodplain Development Manual 2005.

2.5 PARRAMATTA FLOOD POLICY

Molino Stewart previously reviewed the Parramatta Flood Policy as part of the development of Council's City River Strategy. Council is updating the currently adopted Flood Policy taking into consideration that review.

Four principles influence the current flood policy:

- Flood prone land is a valuable resource that should be managed and developed, subject to a merit approach that provides due consideration to social, economic and environmental criteria, as well as any flooding criteria, as identified in flood studies, independent assessments or strategically developed floodplain risk management studies and plans
- Both mainstream and overland flooding are to be considered when assessing flood risk
- Flood prone land should not be sterilised by unnecessarily precluding development through the application of rigid and prescriptive criteria, however inappropriate proposals should not be accepted
- Measures to increase resilience across the LGA should be encouraged so as to reduce the long term effects of flooding when it occurs.

The Policy is being implemented through the following over-arching processes:

- Preparing co-ordinated development controls
- Establishing a development application process
- Where appropriate and feasible, encouraging the conversion of "High Risk Hazard Zones" or "Floodways" to natural waterway corridors
- Establishing a rolling program of reviews of floodplain risk management studies and plans to ensure flood data is as up-to-date as possible, especially in Council's priority and growth areas
- Establishing an access portal on Council's website to display relevant flood studies, plans and maps adopted by Council

- Implementing a community engagement program, designed to ensure the community in general, and specifically any proponents of development, are aware of the potential flood hazard and consequent risk and liability associated with the use and development of flood liable land.

2.6 FLOOD RESPONSIBILITIES

Table 1 shows the range of organisations involved in floodplain management activities and their diverse responsibilities.

Table 1: Floodplain Management Responsibilities

Floodplain Management Actions		Organisation and its responsibility					
		FMC	**Council**	**DPIE [1]**	**NSW SES**	**Sydney Water Corporation[2]**	**BoM**
Flood Modification	Detention Basins and modifications to drainage infrastructure	Recommend	Approve, Fund, Design, Construct, Maintain	Approve, Co-Fund		Approve, Fund, Design, Construct, Maintain	
	Levees	Recommend	Approve, Fund, Design, Construct, Maintain	Approve, Co-Fund			
	Cleaning Drains	Recommend	Fund and implement			Fund and implement	
Property Modification	Voluntary House Purchase, Voluntary House Raising	Recommend	Approve, Co-Fund	Approve, Co-Fund			
	Planning Controls	Recommend	Draft, Regulate	Approve			
Response Modification	Community Education	Recommend	Approve, Fund, Undertake		Approve, Fund, Undertake		
	Emergency Planning	Recommend	Approve, Fund, Undertake		Approve, Fund, Undertake		
	Flood Warning Systems	Recommend	Approve, Fund, Design, Construct, Operate, Maintain	Approve, Co-Fund	Advise, use		Advise, use

1. DPIE may co-fund some flood mitigation measure using State Government funds or State and Federal Government funds.

2. only has responsibility where drainage assets (principally concrete lined stormwater drains) are SWC assets.

3 EXISTING MANAGEMENT PLAN

3.1 STATUS REVIEW

As part of the update to the Parramatta Floodplain Risk Management Plans, a review of the existing plans was undertaken. The focus of the review was to determine to what extent the existing plan measures have been implemented by Council.

Across the two plan areas there were 39 major recommendations, covering:

- Revisions to planning controls
- Property modifications (voluntary house purchase and house raising)
- Response modifications
- Flood modifications.

A qualitative assessment of the implementation status of the original recommendations follows.

3.1.1 Revisions to Planning Controls

In general, the revisions to planning controls had been completed, or the proposed revisions have become redundant because of changes to planning instruments driven by other considerations.

Some of the issues which have not been fully resolved include:

- changes to wording within the DCP and S10.7 certificates
- investigations into the potential for S7.11 contributions to contribute to flood mitigation measures
- controls on fencing and screening in high hazard and overland flow areas.

3.1.2 Property Modifications

Council has generally implemented the recommended property modifications or upon further investigation has found that they were not feasible.

A number of properties have been voluntarily acquired or raised.

Council is currently undertaking a new flood study that will likely identify a number of areas where further property modifications can be undertaken to mitigate flood risk.

3.1.3 Response Modification

The response modification measures within the plans generally fall within three categories, these are:

- Flood Emergency Response Planning - Council and the NSW SES are continuing to work on the local flood emergency response plans, and significant hydraulic analysis has been undertaken on other areas within the CBD. However, the updates have not been completed because of resourcing constraints, particularly for the Local Flood Plan
- Flood Warning – There is no specific recommendation in either plan regarding flood warning but Council has installed a flood early warning system for the CBD
- Community Awareness and Education - There are a number of recommendations within both plans with respect to community flood risk awareness and community education. Council has implemented its Floodsmart program in association with its warning system implementation. This makes flood related information available of Council's website and there have been other efforts made to disseminate information about flood risks to the community.

3.1.4 Flood Modifications

The existing plans recommended a number of flood modification works, including detention basins and levees and a number of drainage improvements such as culverts and pipes. It was recommended that some be investigated further to determine feasibility. These measures have generally been implemented or otherwise found not to be feasible.

Some investigations are still underway. Some measures have not been put in place because it was determined that it would be more

efficient to resolve the flood problem through re-development.

Additionally, the plans recommended rubbish and vegetation removal and de-snagging within a number of channels. All trunk drainage channels within the CBD area are owned and maintained by Sydney Water. It is understood based on previous advice from Sydney Water that they have a regular operation and maintenance program. Council also requests Sydney Water to clean and remove debris collected within these channels as and when this becomes known to Council and when residents or the general public inform Council through its Service Request System.

3.2 PRACTICAL CHALLENGES

The opportunity was also taken to discuss with Council officers any known practical difficulties or problems which have been identified through implementation of the existing plan.

Discussions with Council officers revealed that the way in which some developments have been built to comply with existing flood planning controls have had unintended consequences or resulted in sub-optimal design outcomes. Issue of main concern are:

3.2.1 Car Parks

If a basement car park is flooded, it will create extremely high hazard waters for anyone that is stuck in the basement or otherwise attempts to access it.

There is a critical difference between basement flooding and over floor flooding. For example, if a normal residence is built at the level of the 1 in 100 Year ARI plus 500 mm freeboard, and a flood level is 0.3 m higher, it will only produce low hazard waters within the dwelling and some property can be protected on tables.

In the same flood, if the flood level is 0.3 m greater than the lip level of a basement car park, it will create an extremely high velocity, high hazard floodway as the floodwaters rush over the lip and into the basement, it will then progressively fill the basement and create extremely deep pools or high hazard water.

For this reason, the DCP discourages basement car parks but if the site requires one it must have be protected to the level of the PMF. Council officers have indicated this can provide significant design challenges.

3.2.2 Critical Infrastructure

As the 2011 floods in Brisbane highlighted, the placement of critical building infrastructure (electricity transformers, lift motors, water pumps) in basements and ground floors can significantly delay the reopening of a building after flooding. Consideration needs to be given to development controls to ensure that this infrastructure is given an appropriate level of flood protection.

3.2.3 Activate Building Edges

An issue which has emerged as developers design buildings in flood prone areas is the connectivity between the footpath and the floor level of the building, particularly in areas where the 1 in 100 Year ARI plus 500 mm freeboard is significantly higher than ground level. This presents an issue for areas such as the CBD where there is typically retail or restaurant development on the ground floor, and the floor level difference presents a barrier to customers. This issue is shown in Figure 3 and Figure 4 where the shop fronts are set back and raised and out of eye level for pedestrians.

Figure 3: Activated Building Edge Example

3.2.4 Fire Exits

There are many examples of recent development in the floodplain where the fire exit door is set at ground level but the minimum building floor level is considerably higher. All fire exits are required to open outwards from the building, however, if the fire door was required to be used during a flood, this door may be impossible to open as it is likely there would be a higher water level outside than inside, and this head (water level) difference would stop the fire exit door from opening. This is highlighted in Figure 4 where the minimum floor level can be seen by the stairs in the blue building, and the fire exit is shown between the two sets of stairs. Figure 5 also shows this where the steel screen on the right is the level of the floodway (these rise during a flood to allow flow underneath) and is shown to be over halfway up the height of the fire exit.

Figure 4: Fire Exit and Ground Level Example 1

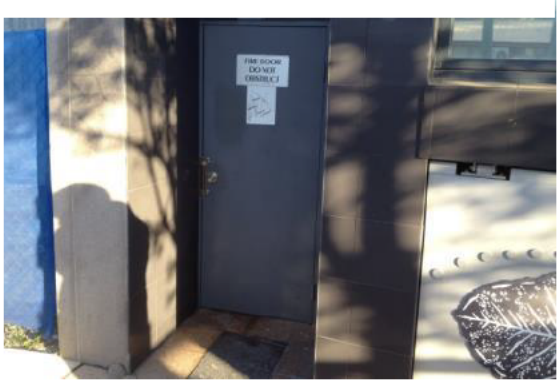

Figure 5: Fire Exit at Ground Level Example 2

3.2.5 Flow Under Buildings

In some areas through the CBD, particularly along Clay Cliff Creek, a number of buildings have been set above the ground level with a gap beneath the building to allow for flow. This has been required as the buildings are situated over floodways and if there was no flow underneath the building it would have an impact on their neighbours.

The issue arises where the area beneath the building is screened off so that there is no access, and these screens, in many cases, would not allow any flow through, as can be seen in Figure 6. In some cases, as shown in Figure 7, the flow area has been further blocked by fencing or other materials in an attempt to enclose the flow area and use it for storage.

Figure 6: Screening Example 1

Figure 7: Screening Example 2

3.2.6 Early Flood Warning

City of Parramatta Council has installed an early flood warning system for the Parramatta River. It has had a slow uptake of subscribers and Council is looking at ways to ensure more people are receiving and understanding flood warning messages as well as improving the accuracy and timeliness of warnings.

3.2.7 DCP Wording

Council officers and others have observed that some of the wording in the DCP is ambiguous or misleading. This includes the reference to "flood risk precincts" which are essentially a mapping of flood probability which is only one contributor to flood risk.

3.2.8 S10.7 Certificate Wording

Council officers have observed that property inquiries and sales generate the production of Section 10.7 certificates. In Parramatta the Section 10.7(2), which legally must accompany any property sale contract, only makes some general statements about the flood affection of the property. A more detailed Section 10.7(5) certificate can be purchased to obtain the more detailed information about flood affection of the property.

Council officers want to consider ways in which it could be made clear that the S10.7(2) certificates do not contain all flooding information. Recommended that a guide to making the decision of purchasing S10.7(2) or S10.7(5) is included within the application form.

3.3 MANAGEMENT OPTIONS

Table 2 shows the potential options to be included in the updated plan. These measures are based on the existing plan review, discussion with council officers and field inspections. Some are updates to measures that were recommended as part of the existing plans.

Table 2: Potential Management Options Arising from the Existing Plan Review

Measure Type	Proposed Measure	Source
Planning Control	Revise the wording of the DCP and S10.7 Certificates	Upper and Lower Parramatta Plan, Council officers
Planning Control	Council to consider ways in which S7.11 contributions could be made towards flood mitigation projects.	Upper and Lower Parramatta Plan, Council officers
Planning Control	Council to develop a policy with respect to fencing and screening within floodways. This policy could result in provision of appropriate staffing levels to allow existing floodways to be inspected to ensure pathways are still clear.	Lower Parramatta Plan, Council officers
Planning Control	Review the requirement for basement car parks to be protected up to the level of the PMF.	Council officers
Planning Control	Consider introducing planning controls for the protection of critical building infrastructure	Council officers
Planning Control	Consider planning controls which enable the activation of building edges at street level	Council officers
Planning Control	Consider planning controls which reduce the risk of fire doors being blocked by floodwaters	Council officers
Response Modification	Council to encourage the NSW SES to finalise development of the Local Flood Sub Plan	Lower Parramatta Plan, Council officers
Response Modification	Council review the availability of flooding data to the public and develop a community awareness and education policy and program for ensuring the population at risk is aware of the flood risks to life and property.	Upper and Lower Parramatta Plan
Response Modification	Council continues developing the Flood Early Warning System for Parramatta CBD and includes a program for review and continuous improvement of the system and means of disseminating more accurate and timely warnings to more people.	Council Officers
Flood Modification	Council to encourage Sydney Water to conduct a review of the maintenance program for the channel including removal of rubbish and excess vegetation	Lower Parramatta Plan

4 THE PLANNING PROPOSAL

The planning proposal for the CBD Strategy is to allow for the expansion of the Parramatta CBD boundary as well as amendments to a number of building controls within both the current CBD and the extended CBD area. Primarily these building controls relate to Floor Space Ratios (FSR) and building height restrictions.

The net effect of the planning proposal is to increase the capacity of the CBD both in terms of commercial and residential floor space. This increase in floor space is effectively on top (i.e. higher) than the current development and does not open up any new areas (green fields) for development.

It should be noted that the current controls on the development within and around the CBD allow for reasonably significant redevelopment of the planning proposal area.

In a general sense, the planning proposal would allow the development in the core part of the development for buildings up to around 50 storeys, as opposed to the existing controls which allow buildings up to around 30 storeys, while around the fringes it would allow buildings up to 10 to 30 storeys where buildings of around 5 storeys are currently allowable.

4.1.1 Built Form

Given the current and projected demands for space within the Parramatta CBD area, all re-development is likely to be for the construction of “high rise” buildings for either commercial office space or for residential apartments. Many of these developments will have retail or hospitality establishments on the ground floor; others may be limited to foyers on the ground floor. Car parking will be located either on basement levels or above the ground floor.

4.1.2 Planning Controls

The Parramatta DCP 2011 would classify the land use as either Commercial or Residential (with respect to flooding). For Residential development, the development could also be considered as within the Concessional Development Land Use category, the controls on concessional development are relatively similar to residential development, with some extra conditions such as maintaining floodways.

The DCP planning considerations for both Residential and Commercial are the same for all flood risk precincts with the exception that in the low flood risk precinct a residential development is required to have reliable pedestrian and vehicle access to an area above the PMF (either on site or off site) whereas for commercial development this is not required.

All new residential and commercial buildings would have to have minimum habitable floor levels above the flood planning level which is 0.5m above the level of the 100 ARI flood.

As all new buildings which are redeveloped as a result of the new CBD Strategy will generally be taller than 10 m, it is expected that the redevelopment would provide areas within each building above the level of the probable maximum flood (PMF).

5 FLOOD RISK ASSESSMENT

In accordance with the requirements of the Section 9.1 Direction 4.3A, a flood risk assessment has been undertaken on the CBD Strategy planning proposal. This has been undertaken in accordance with the principles and guidelines of the NSW Floodplain Development Manual and Flood Prone Land Policy. This chapter explains how it was undertaken and the results of the analysis.

5.1 FLOOD RISK APPROACH

The approach taken to this flood risk assessment conforms to the principles of the NSW Floodplain Development Manual (2005). Where possible we have quantified the change in flood risk due to the planning proposal and where quantitative analysis was not possible or not appropriate we have made some qualitative assessments.

The approach was to define the existing flood risks to the existing population at risk and then examine how both the flood risks and population at risk will change due to the planning proposal and to determine whether these changes are significant.

5.2 DATA USED

5.2.1 Flooding Data

Flooding data was provided by Council covering the two original plan areas. For both areas the data provided was produced by MIKE11 one dimensional models.

For the Lower Parramatta River area, the model was developed over a period of time and updated as part of the Flood Study Review, completed in 2005 by SKM. The model utilised over 600 cross-sections and included detailed representation of the Clay Cliff Creek waterway system.

For the Upper Parramatta River area, the model was first developed by the then Department of Water Resources and the Upper Parramatta River Catchment Trust in the early 1980's. Significant work has been undertaken over the years since then to refine the model. The Draft 8 Version of the model has been adopted by Council and the data from this version has been provided and used as part of this study.

The flooding data that has been provided for the area includes:

- Flooding extents from the 20 Year, 100 Year Average Recurrence Interval (ARI) and PMF design events from the Upper Parramatta River and Lower Parramatta as well as other studies that have been undertaken.
- The low, medium and high hazard areas as defined by Parramatta Council (see section 5.3.3).
- Results from the two MIKE11 models (Upstream and Downstream extents) for a range of events in the native DHI .res11 format

The flood model data has been developed over a long period of time and integrates a significant amount of data and intelligence that has been gathered over that time. However, since the time of its development, the modelling software and techniques that have been used have become dated and no longer represents best practice in floodplain risk management. Therefore, there are some limitations to, and assumptions that have been made in respect of, the analysis that has been undertaken due to the limitations to the model results provided.

Council is in the process of preparing a new two dimensional flood model which would include the CBD study area but that was not available at the time of writing.

5.2.2 Topographic Data

Contour data was provided by Council at a 1 m contour interval. This has then been processed into a Digital Elevation Model (DEM) with a 1 m grid resolution. While this process requires some data interpolation, the DEM, with an appropriate colour ramp, is easier to interpret than contour information.

The contour data would also miss any topographic variations that are less than a metre in range. However, the data has primarily been used to determine the Flood Emergency Response Classification of Communities (see Section 5.5.3) and in this process it is unlikely that small topographic variations would have an impact.

5.2.3 Infrastructure and Administrative Data

Infrastructure and Topographical Data has been provided in GIS vector format for a range of features, including:

- Road Centrelines
- Stormwater Pipe and Pit Network
- Watercourse Lines
- Cadastral Parcels

5.2.4 CBD Strategy Planning Proposal Data

The CBD Strategy Planning Proposal data was provided as a GIS layer with features on a lot scale. The layer included floor surface areas (FSA) under the current planning controls (Current Scenario) and for two future scenarios: one where residential development is allowed in the commercial core (FSAR2), and the other where it isn't (FSAR1).

The analysis removed lots where the potential for redevelopment is low, either due to other constraints (e.g. heritage) or if the ownership is too divided (strata titles with greater than 10 owners). Our analysis was only undertaken on the lots that had been provided as part of the floor space analysis.

We took the floor space areas and converted them into a population at risk using the methodology supplied by Council.

For residential FSA we assumed that there will be:

- One dwelling per 100m^2
- 2.33 people per dwelling

For Commercial FSA (both office space and retail) we assumed that there will be:

- One job per 24m^2

As a way of simplifying the data, and as a conservative estimate, we rounded all population estimates up to the nearest integer (or person).

Subsequently, Molino Stewart was commissioned to undertake a detailed evacuation analysis and for that a more comprehensive estimate of population at risk was prepared. That used current and future development scenarios based on existing FSAs of buildings which are unlikely to be redeveloped in the next 30 years and FSAs derived from the incentive floor space ratios (FSRs) in the draft CBD planning proposal. The methodology is detailed in the Parramatta CBD Flood Evacuation Assessment Report (Molino Stewart, 2019). Where appropriate, in this report refers to these numbers.

5.3 NATURE OF THE FLOODING

5.3.1 Flood Mechanism

The primary source of flooding is from the Parramatta River, with the majority of water sourced from upstream of the CBD. The river rises and breaks its banks and expands laterally into the floodplain through the CBD area.

Some areas within the CBD can also be flooded by local overland flow from intense rainfall overwhelming the drainage system without any significant flooding in the River.

Other areas of the CBD are affected by overbank flooding in the Brickfield Creek and Clay Cliff Creek floodplains.

5.3.2 Flooding Patterns

The first streets to be inundated south of the river are the main roads O'Connell Street, Marsden Street, Church Street, Smith Street, Phillip Street, George Street, and Macquarie Street. These flood because local runoff overwhelms the underground drainage system, particularly if the river level is high or drainage inlets are blocked by debris.

From these main roads the flooding spreads throughout the CBD, cutting off many evacuation routes and creating low and high flood islands. Because the CBD is relatively flat, this flooding is generally low velocity with depths varying depending on the local topography.

In events larger than the 1% AEP flood the river breaks its banks south of the river and spreads high velocity floodwaters through the CBD streets. The initial breakout point is just upstream of O'Connell Street.

Wilde Avenue is the first area north of the river to be inundated. Other than Wilde Avenue, the areas north of the river are gradually flooded as the water spreads north across the floodplain.

Flooding also occurs as a result of overbank flooding in the Clay Cliff Creek floodplain. This flooding generally follows the path of the creek from Ollie Webb Reserve, through the CBD to Robin Thomas Reserve, and then progresses laterally across the floodplain. The areas first affected are around Lansdowne Street, Church Street, Parkes Street, Wigram Street, and Hassall Street. The one dimensional modelling suggests that the 20 year ARI event would flood a wide swathe along either side of Clay Cliff Creek.

Brickfield Creek flooding enters the CBD area by crossing Victoria Road and then down Wilde Avenue towards the Parramatta River. In larger floods, in conjunction with overbank flows from the Parramatta River, it can spread west and flood the area between Victoria Road and the River up to Marsden St

Council's currently adopted flood extents for the 20 and 100 Year ARI and the PMF are shown in Figure 8 and the council defined flood hazard layers are shown in Figure 9.

5.3.3 Flood Depths, Velocities and Hazard

a) Depth

Depths are greatest in the areas directly adjacent to the river and on the roads and vary across the floodplain typically decreasing moving laterally from the river. In some areas there are significant depths within the PMF, where a depth of 3 m would likely inundate the entire bottom floor of a building. Figure 10 shows the distribution of depth through the floodplain for the PMF. It was not possible to produce a similar depth map for other events due to the limitations of the Mike11 outputs.

In areas of shallow flooding the flood extent in Figure 10 does not align exactly with the PMF extent in the other figures because there must be slight differences in the ground level values in the topographic data in the flood model and that which was available for the analysis in this report .

b) Velocity

The current modelling uses a "Section Average" velocity, which essentially applies a velocity to the whole channel, so it assumes that the edges of the floodplain are flowing in the same direction and at the same velocity as the primary channel. In reality it is likely that the river portion of the floodplain will be flowing considerably faster than the areas through the CBD and the edge of the floodplain would have minimal velocity.

Due to this modelling assumption it is difficult to ascertain local velocities through the floodplain.

c) Hazard

Flood Hazard data has been provided by Council and is shown in Figure 9. This hazard representation closely aligns with the extents of the 20 Year ARI for high hazard, 100 Year ARI for medium hazard and PMF for the low hazard. We have used this as the basis for our representation of hazard to be consistent with Council. However it should be noted that the typical approach to flood hazard mapping is to produce hazard variations within a single event. For example, there are areas within the low hazard area that would have water depths of over 4 m in a PMF. A depth of 4 m would be described as high hazard in most circumstances.

It is likely that the hazard data has been produced in this way (extent based, rather than depth and velocity based) due to the limitations of the model software that has been used to develop this data.

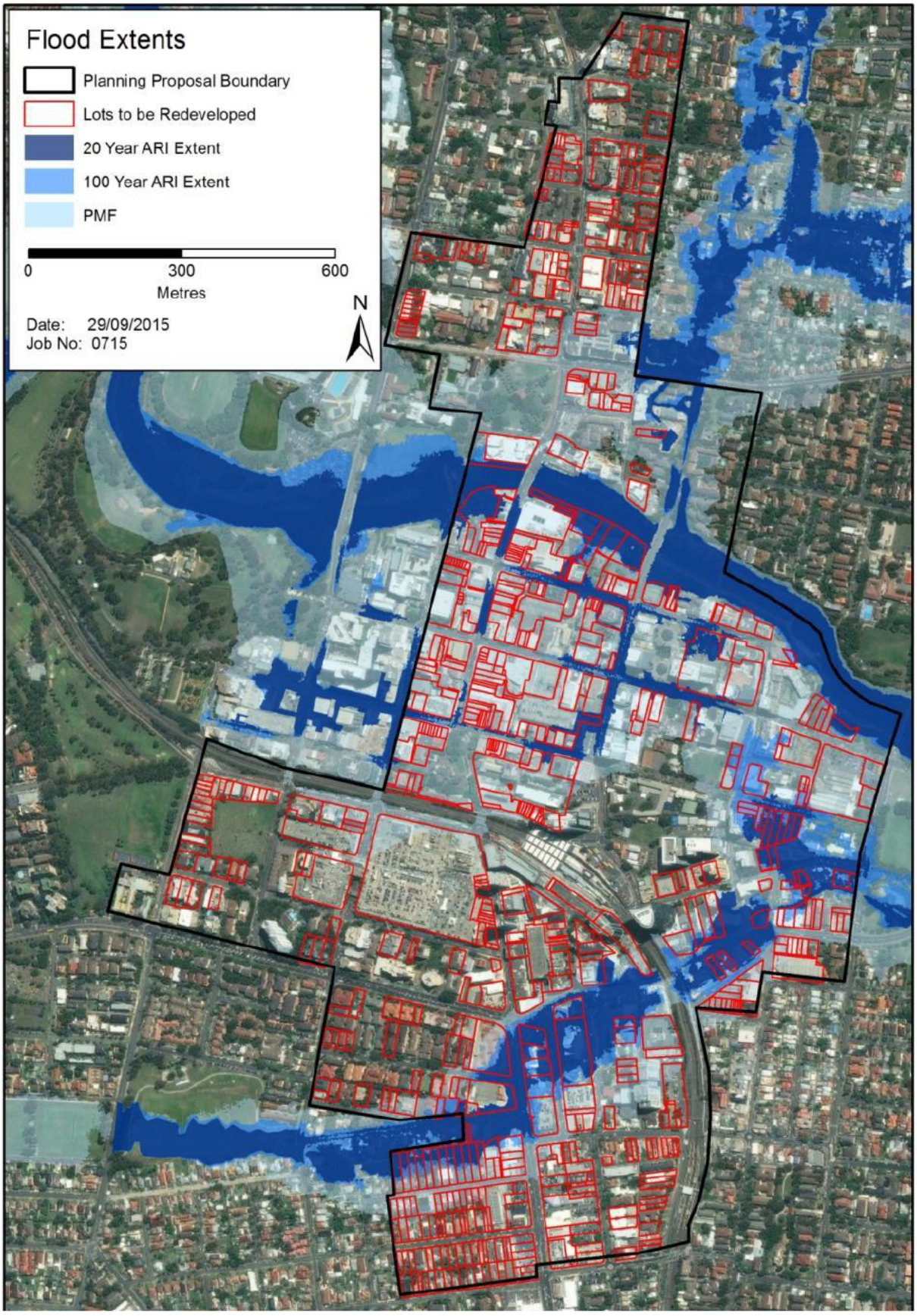

Figure 8: Flood Extents through the study area

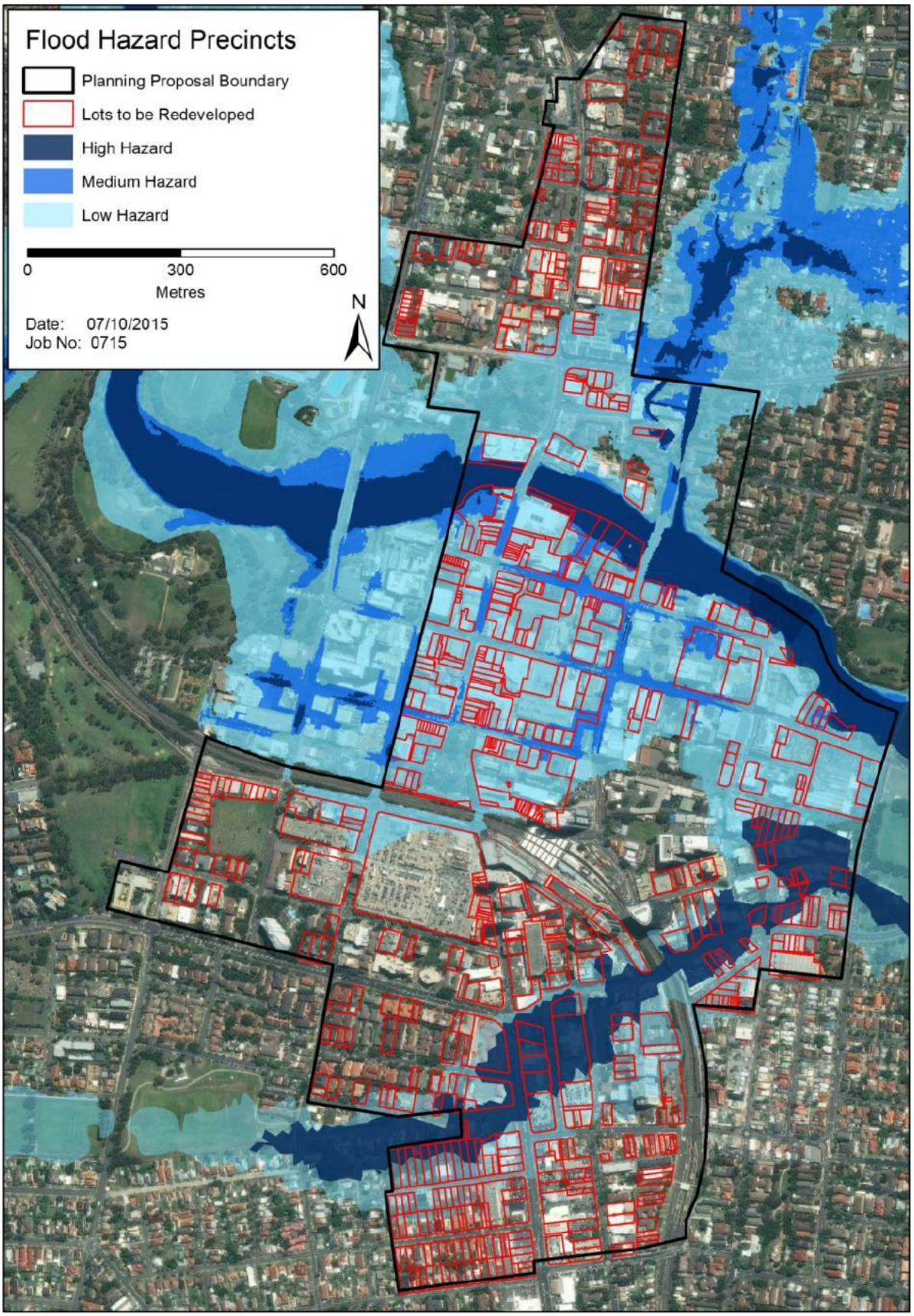

Figure 9: Flood Hazard Precincts

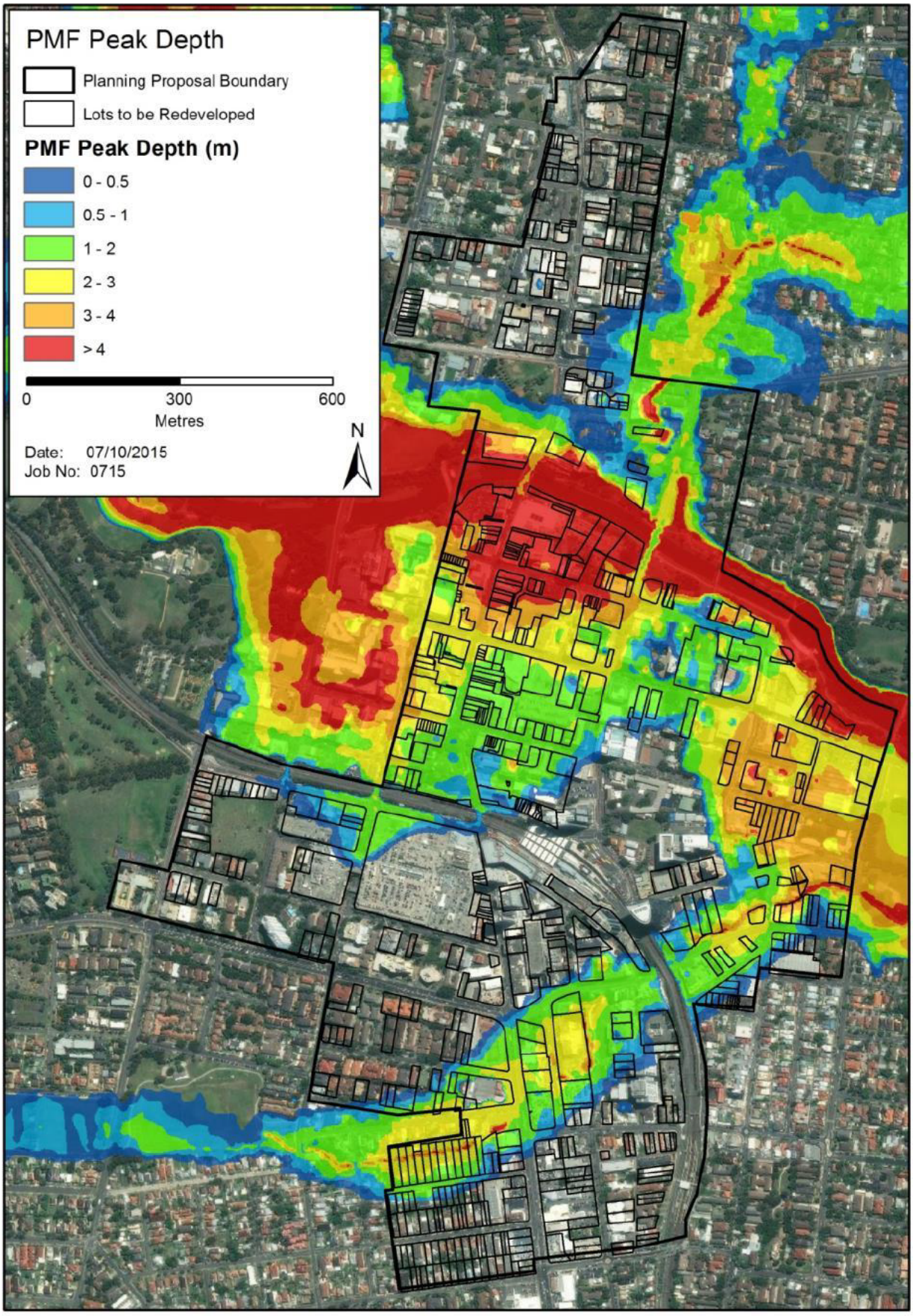

Figure 10: PMF Depth Map

5.3.4 Flood Rate of Rise

The flood rate of rise in the Parramatta River is relatively quick, particularly for the PMF. Figure 11 shows the water surface levels for the 100 Year ARI event and the PMF for just upstream of the Marsden St Weir, which is located just upstream of the study area. Figure 12 shows the same water surface levels for the Charles St Weir, which is at the downstream end of the floodplain.

The average flood rate of rise (across both locations) is around 0.4 m per hour for the 100 Year ARI and 1.6 m per hour for the PMF. The PMF rate of rise is extremely rapid with peak flood levels achieved around five hours after the river has started to rise and levels greater than the peak of the 100 Year ARI event are reached two hours after the river begins to rise.

5.3.5 Flood Durations

Flood durations are the longest in areas directly adjacent to the Parramatta River. These areas are the first to be inundated when the river breaks its banks and would remain under water even when the flood had receded from other areas.

The parts of the CBD with the longest duration of flooding are on Phillip Street between Marsden Street and Smith Street. Lots in this area would be inundated for up to 9.5 hours in the PMF. Figure 13 shows the spatial distribution of the flooding duration for the PMF and Figure 14 shows a frequency distribution for flood durations.

Another area of longer duration flooding is near the northeast end of Clay Cliff Creek. The areas between George Street, Hassall Street, Charles Street and Harris Street would be flooded for between 5 and 6 hours.

Most other areas in the study area would be flooded for less than 5 hours, with an overall average duration of inundation being 4.5 hours in the PMF and over 83% of lots being inundated for less than 6 hours in the PMF

In smaller events, such as the 100 Year ARI flood, only around 27% of the PMF affected lots would be inundated and these would be inundated for a significantly shorter period of time.

5.3.6 Summary of Flood Behaviour

Flooding in the Parramatta CBD is typical of flash flood catchments. Flooding arrives quickly and without significant warning time, while at the same time it also recedes quickly with an average flood duration of less than 5 hours for even the most extreme floods.

In most floods, the flooding is confined to a relatively narrow river corridor. The currently adopted modelling suggests the flood depth in the Clay Cliff Creek floodway will be very high, even in smaller floods such as the 20 Year ARI and this area appears to present the greatest risk to existing and future development. .

In a PMF, which has an estimated 100,000 Year ARI, there is widespread flooding that is relatively deep through large areas of the floodplain.

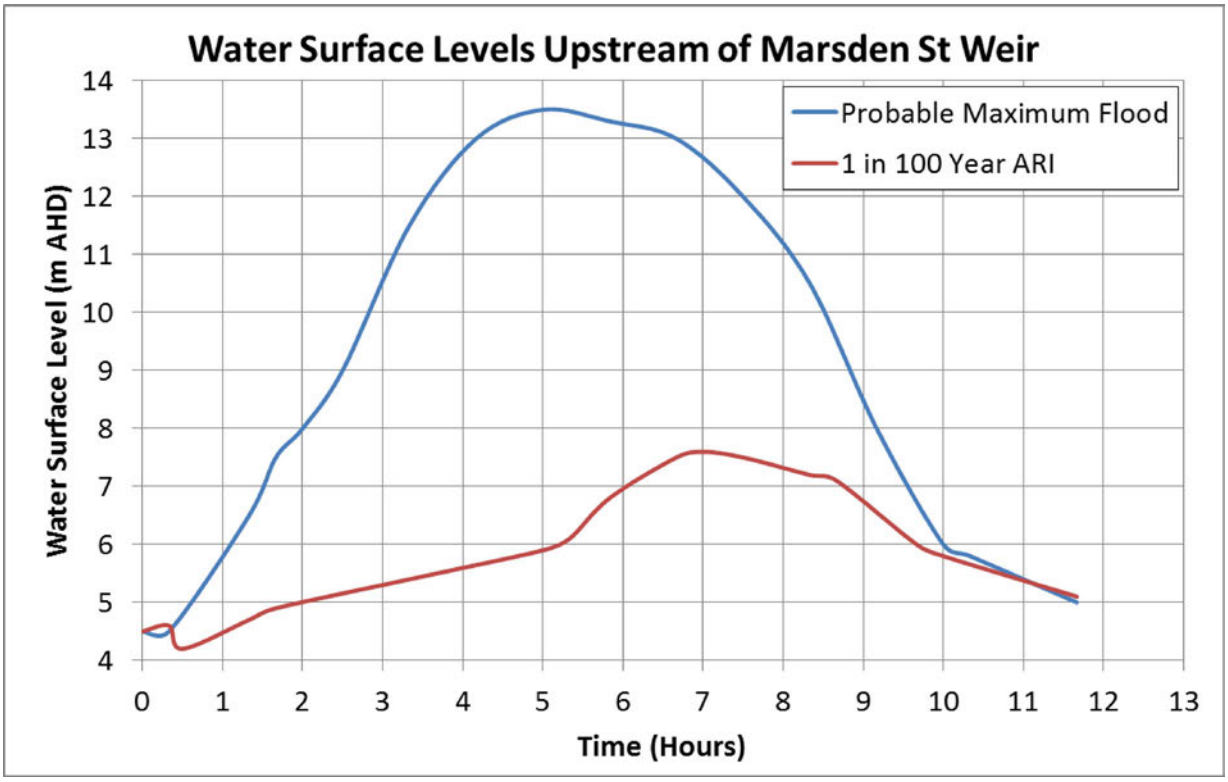

Figure 11: Water Surface Levels Upstream of Marsden St Weir

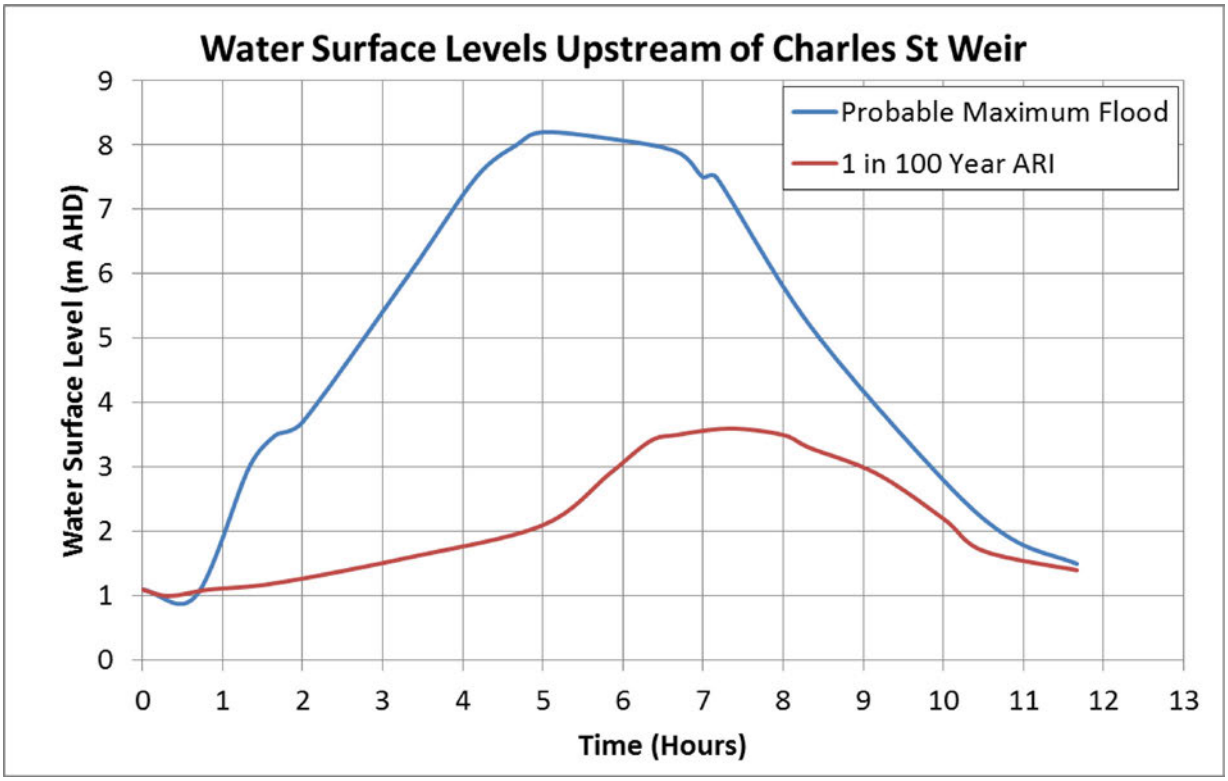

Figure 12: Water Surface Levels Upstream of Charles St Weir

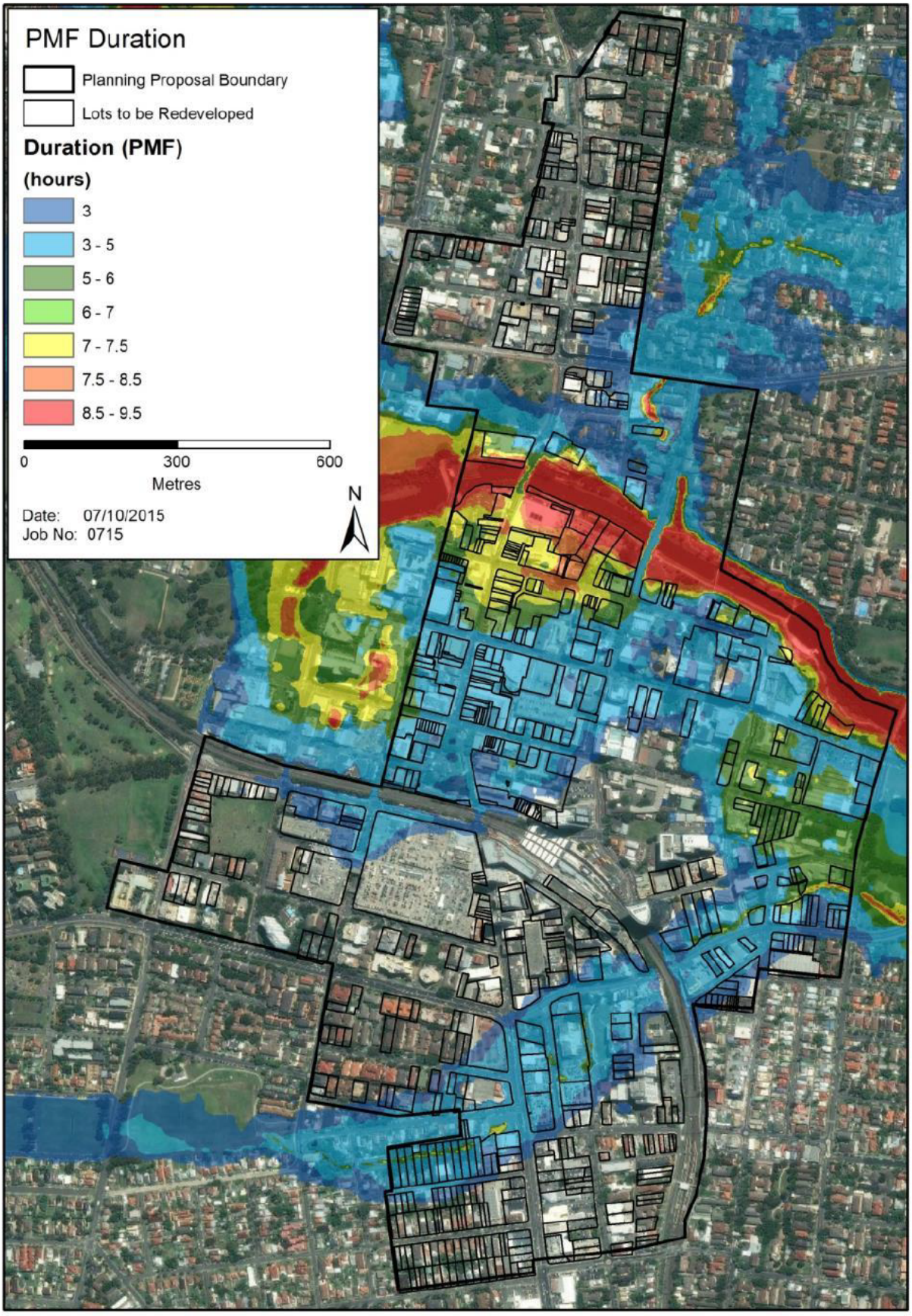

Figure 13: PMF Flood Durations

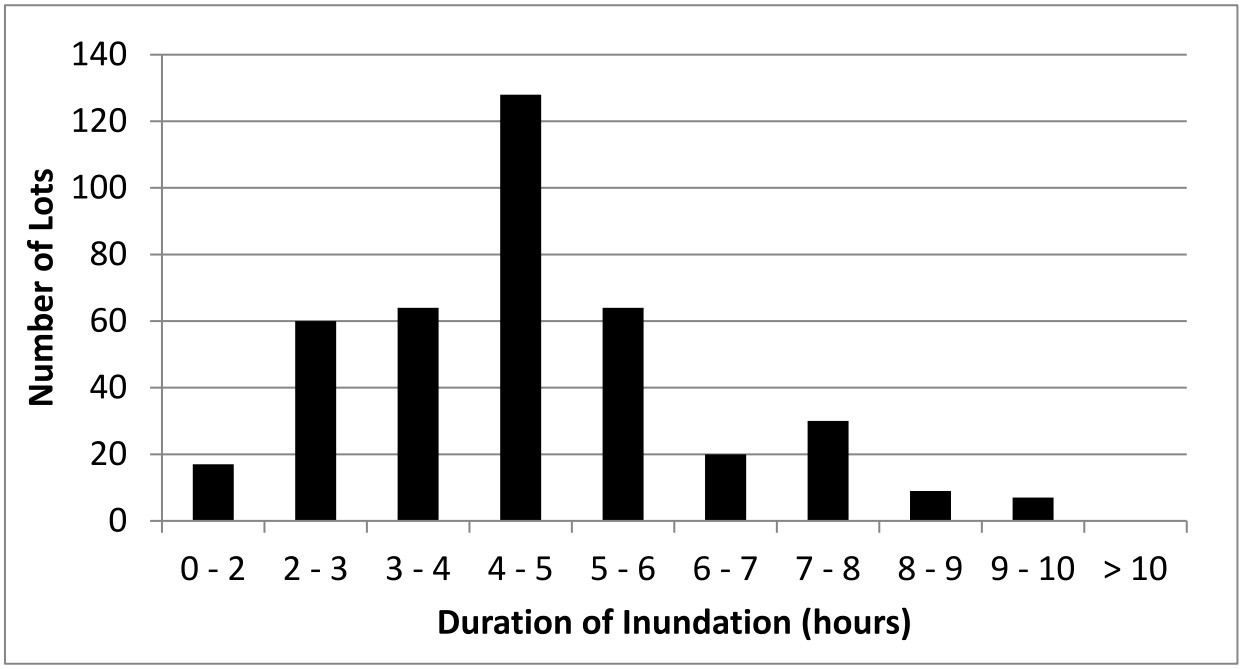

Figure 14: PMF Flood duration distribution

5.4 OTHER PLANNING AREAS

The "Planning Investigation Area" located around the fringes of the planning proposal area is currently being examined for potential changes to the planning controls and to be incorporated into the CBD planning area.

Figure 15 shows the extent of the Planning Investigation Area, and also the Parramatta North Urban Renewal Area (a state managed redevelopment precinct).

It can be seen that the Planning Investigation Area is almost completely flood free and would have limited flooding constraints, should these areas be subject to redevelopment. It is suggested that if flooding constraints are too great in the current planning proposal area, then re-development of the planning investigation area may compensate for any loss of floor space yield.

The new flood study that is being undertaken may identify new areas within the Planning Investigation Area that are flood affected; particularly areas that are subject to local overland flows.

The Parramatta Urban Renewal Area on the other hand is almost entirely within the PMF extent and this needs to be taken into consideration in its planning and the imposition of development controls.

There is also an area of the CBD between Parramatta Park and Marsden Street which is referred to as the "Western Corridor" which is also shown in Figure 15. This area is not included in the Planning Proposal because heritage considerations prevent it from having its building heights increased. Nevertheless, this area would need to evacuate with other parts of the CBD during a flood and accordingly was considered in any CBD evacuation analyses.

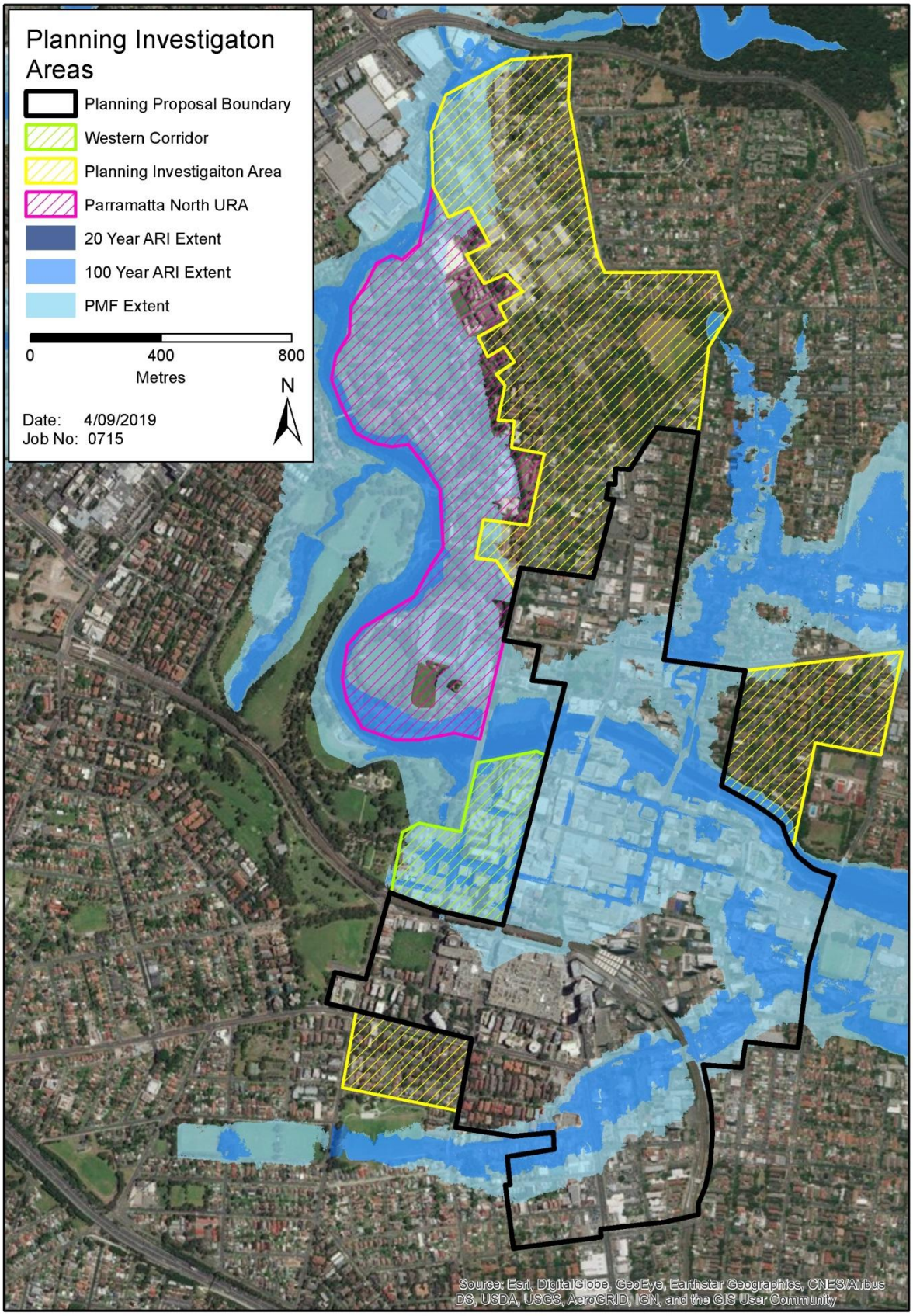

Figure 15: Planning Investigation Areas and Flood Extents

5.5 FLOOD RESPONSE

5.5.1 Available Warning Time

Flood warnings are generally provided by the Bureau of Meteorology (BoM) for developed catchments such as the Parramatta River. However, due to the small size of the catchment and therefore rapid rise of the Parramatta River there is insufficient time for the BoM to issue a warning prior to a flood occurring. Previous studies have shown that it will take approximately 6 hours to develop peak floods levels around the Parramatta CBD area during a large flood (larger than 20 Year ARI) although as discussed in Section 5.3.4 flooding can occur much faster than this.

For this reason the BoM has not developed any flood classification levels (minor, moderate or major) for the Parramatta River nor does it maintain a gauge in the river for flood warning purposes. The State Flood Emergency Sub Plan states that the only warning available for the catchment is a Severe Thunderstorm or Severe Weather Warning provided by BoM. These warning products do not provide a quantified level or time to the flood occurring.

In most circumstances a severe weather warning will not result in significant flooding and therefore the emergency services will generally not mobilise for mass evacuations based on these warnings.

The tributaries that are within the Planning Proposal area, such as Brickfields Creek and Clay Cliff Creek, are significantly smaller than the Parramatta River and flood waters will rise much faster. BoM gives no quantified warnings for them.

Since the preparation of the original draft of this report, City of Parramatta Council developed an early warning system for the River which would potentially provide some warning time for floods on the river. The service issues minor, major and moderate flood warnings for various sub-catchments of the Upper Parramatta River including the CBD. This system is expected to give about two hours warning but this could be considerably less in the more extreme floods which are likely to flood the CBD. It only provides warnings for the Parramatta River and Brickfields Creek but not for Clay Cliff Creek.

5.5.2 Local Flood Planning

The Parramatta Local Emergency Management Plan (EMPLAN) replaced the Parramatta Local Disaster Plan (DISPLAN) which was in place in 2016. The EMPLAN identifies flooding, amongst other hazards, as posing a medium risk to Parramatta. The EMPLAN cross references to a Local Flood Sub Plan but that had not yet been completed by the NSW SES in September, 2019 when the draft of this report was prepared.

The NSW SES receives flood warnings from the Parramatta River Flood Warning System which uses forecast rainfall as part of its suite of inputs to flood forecasting. However, with only about two hours warning available, it would be challenging for NSW SES to co-ordinate a response before the flood has peaked.

It is understood that significant developments within the floodplain have been approved provided that there is an adequate flood emergency management response plan in place for that particular development. Similarly, for large development areas (such as the river foreshore), Council has produced evacuation strategies for the river precinct that any future development must comply with (Parramatta City River Strategy, PCC 2015b).

5.5.3 Emergency Response Classification

The NSW SES, in conjunction with the former NSW Department of Environment and Climate Change, has developed a topographic classification system known as the “Flood Emergency Response Classification of Communities” (DECC, 2007). The classification indicates the flood risks associated with the topography and assists the NSW SES and other floodplain managers in determining which areas should be given priority for evacuation and what challenges the topography presents to evacuation.

For example, a “low flood island” is where the evacuation route for an area is cut before it is subsequently inundated. These areas are generally high risk because if people fail to evacuate until it looks as though their premises are in immediate danger it will be too late and they will then potentially need to be rescued. A “high flood island” is similarly isolated by flooding, however, the occupants could still escape to an area above the flood waters.

“Areas with rising road access” are of less concern, as the occupants can still evacuate by vehicle or on foot along a formed roadway even if they don’t leave their premises until the floodwaters present an imminent danger. Similarly, “Areas with overland escape routes” may not have rising road access but at least they will be able to escape on foot to areas above the level of the PMF.

The lots within the planning proposal area were classified in accordance with this system and the results are show in Figure 16 for the whole planning proposal area and Figure 17 for those lots that have been marked for potential redevelopment. The classification was undertaken based on ground levels in the dataset provided originally.

It should be recognised that buildings in areas classified as low flood islands are effectively high flood islands if they have internal access to areas above the reach of the PMF. Similarly, apartments and offices above the ground floor in areas classified as having rising road access or overland escape routes effectively become flood islands if they fail to evacuate when the ground floor of the building is threatened by flooding.

a) Low Flood Islands

Due to the fact that the roads are some of the first areas to be flooded in the CBD, there are large areas which are classified as low flood islands. The entire area of the CBD between the river to the north, Macquarie Street to the south, Marsden Street to the west and Smith Street to the east is a low flood island. East of here it also extends between the River and George St to Harris St.

North of the river, the lots which would evacuate onto Palmer Street are a low flood island.

b) High Flood Islands

There is only one HFI in this study area. A small area around Lamont Street, north of the river would be cut off from evacuation but still be able to reach flood free land.

c) Overland Escape Rote

Some areas near Parramatta train station would not be able to evacuate by road due to flood waters, but would still be able to evacuate on foot using an overland escape route. These areas are all between Macquarie Street, the rail line, Marsden Street, and Smith Street. People would be able to walk along grass and paved areas near St Johns Anglican Cathedral and Church Street to get to flood free land south of the train line.

d) Rising Road Access

Areas with rising road access are those lots which are able to evacuate by road before the route is cut by floodwater.

There are many areas in the floodplain which are classified as having rising road access.

The areas between Macquarie Street and Campbell Street which have not already been classified have rising road access along either Marsden Street or Smith Street.

There are also some lots between George Street and Hassall Street which have rising road access either to the south along Harris Street or west along Macquarie Street.

All lots along Clay Cliff Creek which are affected by flooding have raising road access either to the north or south of the creek.

e) Not Affected

All lots in the study area which are not directly affected by flooding are classified as “not affected.” These areas are not inundated by floodwaters, do not require evacuation and occupants are theoretically able to come and go at any time during a flood. However, it should be recognised that they may be indirectly impacted by flooding either through loss of utility services or through having some, but not all, of their access routes cut.

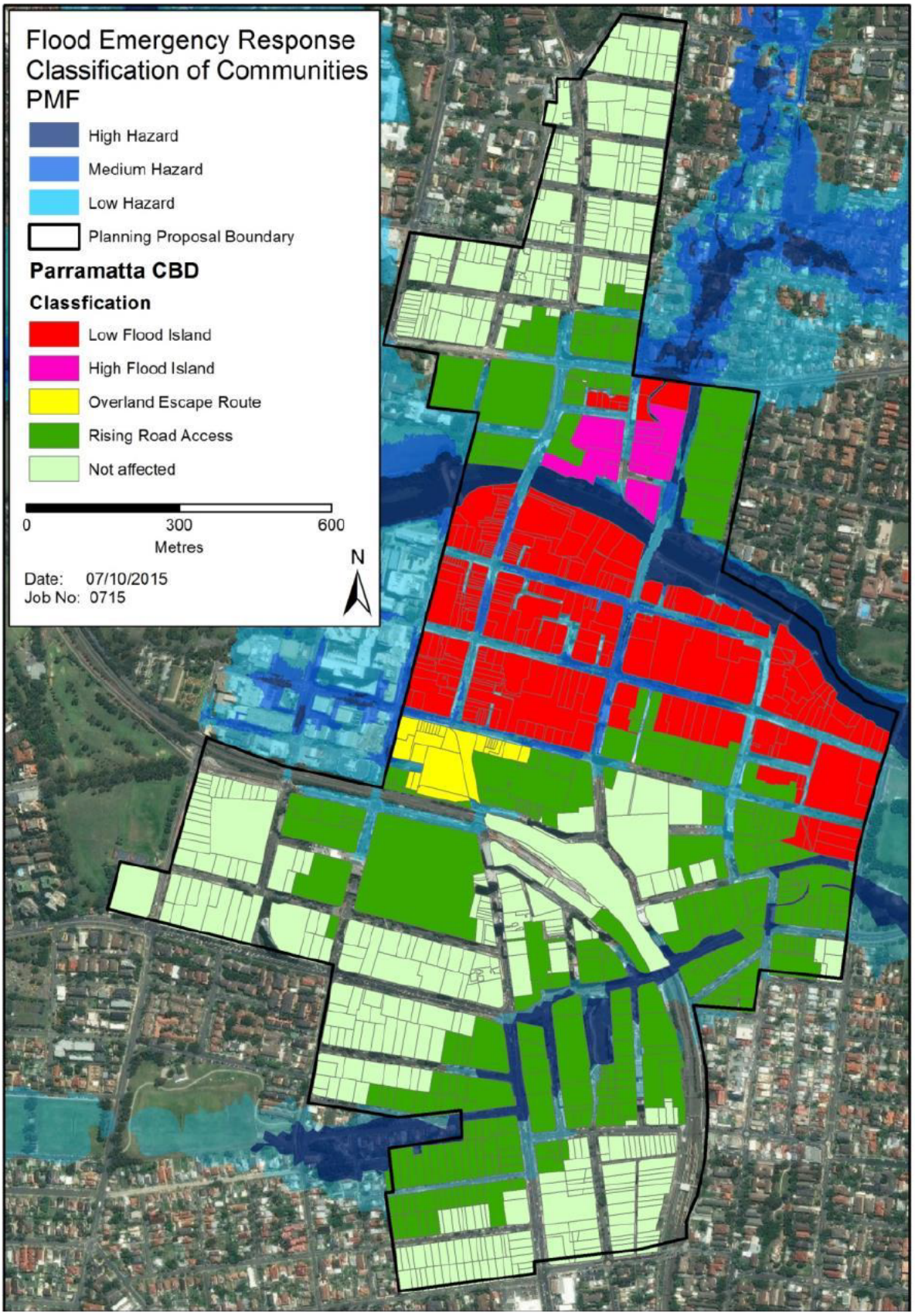

Figure 16: Flood emergency response classification of communities across the CBD

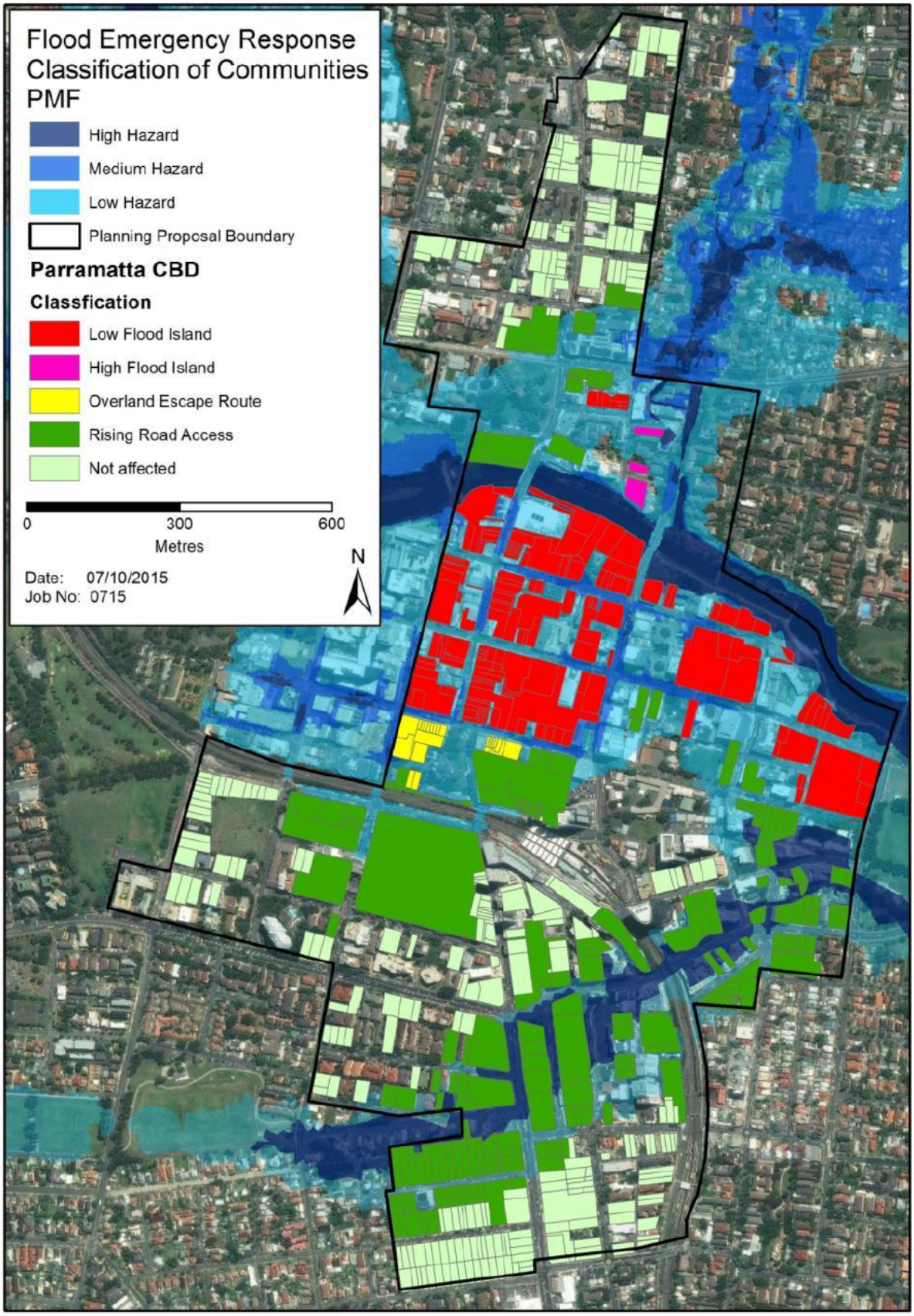

Figure 17: Flood Emergency Response Classification of Communities on developable lots

5.5.4 Evacuation

With respect to flooding, there are generally two main forms of response:

- Evacuation outside of the floodplain to a place of refuge that is above the extent of the flooding
- Shelter in place, sometimes referred to as vertical evacuation, to a location within the building which is above the reach of the PMF.

The NSW SES is primarily responsible for the management of flood emergencies and has a long and strongly held policy of using evacuation outside the floodplain as the primary means of reducing risk to life. The NSW SES is not supportive of new development which relies on sheltering in place as the primary means of reducing risk to life.

However, in the specific case of the evacuation of the Parramatta CBD the preferred SES approach would be problematic for a multitude of reasons. Following completion of the original draft of this report, Molino Stewart was engaged to investigate evacuation options for the CBD in detail (Molino Stewart, 2019). The following is a summary of the findings of the Parramatta CBD Flood Evacuation Assessment report.

a) Vehicular Evacuation

The analysis found that, under existing development, the most number of vehicles would have to evacuate if an evacuation were called during the day. These would principally be workers and visitors in the CBD rather than residents who live in the CBD.

In a 20 Year ARI flood about 9,500 vehicles may need to evacuate, increasing to about 11,500 in the 100 Year ARI flood and increasing to more than 14,000 in a PMF.

About 85% of these vehicles would need to make their way to the Great Western Highway as their principle evacuation route out of the CBD. The other evacuation traffic would be distributed between evacuation routes along Pennant Hills Road, Victoria Road, Church Street and Harris Street.

It was found that trying to safely evacuate all of these vehicles presents several challenges.

1. There are drainage capacity issues within the CBD which would likely flood the local streets early in a flood and prior to them flooding from floodwaters arriving directly from the river.
2. There are multiple traffic signals and one way roads through the CBD, as shown by Figure 18. From the centre of the CBD, around Church St or the car parking facility in Horwood Place, any evacuation would need to go through at least 4 sets of traffic lights which may be inoperable due to loss of power in the flood. This could create gridlock in the road network and floodwaters could overtake people sitting in their cars.
3. The recently developed Parramatta River Flood Warning System is likely to only provide about two hours warning of CBD flooding and possibly less in large, rare flood events in the River. However, the rapid rate of rise of extreme floods means that many of the roads in the CBD would be too dangerous to use before it is known exactly which areas will need to evacuate.
4. The flash flood nature of the flooding means that there would not be the six hours which the NSW SES generally needs to mobilise its staff and volunteers and other emergency responders under its command to conduct door knocking or traffic control operations.
5. There would certainly be no opportunity for the NSW SES or other emergency responders to have time to door knock each building which is the NSW SES preferred method of ensuring most people are reached by an evacuation order.

Figure 18: Traffic Signalling and One Way Roads in the Study Area

6. An evacuation order which has been broadcast by several means (TV, radio, internet, telephone, mobile devices) would have to be relied upon but there is no certainty that all people working in an office environment or sleeping in their apartment would receive the message.
7. The NSW SES, in its evacuation modelling, assumes that it takes two hours for people to begin evacuating once they have received a warning: one hour to accept that the warning is for them and an additional hour to prepare to evacuate. In those two hours the river could have risen to a level which cuts their evacuation routes.
8. Given that it could take two hours for people to be ready to leave in their vehicles and in that time the river could have risen above the 100 year ARI level, water could be on the point of flooding a number of basement car parks which have been constructed under the current planning controls. This could potentially expose people to extreme hazard flood waters as water overtops the lip of the carpark and rapidly floods the basement to great depth.
9. There is no clear and intuitive flood free evacuation route or routes out of the CBD with some roads partially blocked by flooding. Without emergency services directing traffic away from flooding, it is likely that many people in their vehicles will attempt to cross flood waters and become stranded, endangering themselves and blocking the road. However, as pointed out previously, there is unlikely to be sufficient time for emergency service personnel to mobilise.
10. If all of the evacuation routes remained trafficable, it is likely to take more than 8 hours to evacuate the core of the CBD via the Great Western Highway. This is comparable to the total duration of even the more extreme floods. In other words, by the time the last vehicles have evacuated the flooding would have already subsided.
11. If evacuation triggers were set at a lower river level to allow sufficient time for evacuation there would be many circumstances where evacuations would be called and then turn out to be unnecessary.
12. Once vehicles leave the CBD, all of the evacuation routes, other than Pennant Hills Road, require crossing a tributary of the Parramatta River. These are likely to be flooding and therefore vehicles may not be able to get very far past the CBD boundaries
13. There is limited queuing capacity on the evacuation routes above the reach of floodwaters. Given that they may be blocked by flooding then many vehicles could be queued back into the rising floodwaters.
14. If there is other through traffic on the roads then the time to evacuate will be longer and the potential for queuing will be greater.

Despite these many challenges, with effective flood emergency response plans for each development, supported by ongoing community education, it may be possible for vehicular evacuation to occur from some of the fringes of the floodplain where:

- the time to flooding is longer
- there is rising road access
- the distance to flood free roads is short
- the route is unlikely to be blocked by tributary flooding or the vehicle numbers are such that queuing back into the floodwaters is unlikely.

However, it is clear that there are too many things which could go wrong with vehicular evacuation for it to be able to be relied upon for flood emergency response. In much of the floodplain, particularly in the heart of the CBD, it is too risky to even contemplate.

It must also be recognised that while thousands of cars enter Parramatta CBD each day, many thousands of people travel to and from the CBD by bus or train. The peak period services span a time frame of less than three hours and in theory have the capacity to

evacuate all of the people who are reliant on these modes of transport. However, the evacuation may need to occur outside of peak service times or public transport services themselves may be disrupted due to the intense rainfall. In fact, the bus services will share routes as the evacuating cars and will face the same challenges.

Furthermore, those areas which are flood islands may be isolated by floodwaters before people can reach the Parramatta Train Station or the Bus Interchange. With no viable alternative way of getting home, these transport hubs may entice people to walk through floodwaters to get to their means of transport.

A similar situation can arise with people who have parked their cars at one of the many parking stations throughout the CBD which may be remote from the building which they occupy. They too may attempt to traverse floodwaters to reach their vehicles.

b) Pedestrian Evacuation

Pedestrian evacuation would potentially be available for the areas with rising road access or overland escape routes. However for the low flood islands and high flood islands, their escape route would be cut off prior to them attempting to evacuate, unless an evacuation trigger at a lower level is used. Similarly to vehicular evacuation, an earlier trigger may be impractical as the trigger level required to allow enough time would be so low that it is frequently reached while not going on to flood many premises.

Even those areas which are mapped topographically as having rising road access or an overland escape route may become defacto flood islands by the nature of the development. For example, offices or apartments above the ground floor in buildings would be isolated by floodwaters once the ground level floods. Should occupants fail to leave the building before this occurs then they will be trapped in just the same way as people on flood islands. Whether their office acts like a low or a high flood island will depend on whether the highest accessible part of the building is below or above the PMF level respectively.

The Parramatta CBD Flood Evacuation Assessment report (Molino Stewart, 2019) identified those areas where it may be possible to exit a building onto flood free land with rising pedestrian access even if the lower part of the block may be flooding. It did this for the 20 Year ARI and 100 Year ARI floods and the PMF. For those buildings without flood free access, a potential network of elevated pedestrian walkways was investigated and costed as a means of providing flood free access.

Figure 19 and Figure 20 are taken from that report showing the areas which have street level access in the 20 Year ARI flood and PMF respectively and the directions in which evacuees need to travel.

Results show that pedestrian evacuation using elevated walkways would be faster than vehicular evacuation under existing conditions.

Interestingly, the shortest evacuation time (4.4 hours) is achieved in the PMF. This is because the PMF would require a larger network of elevated walkways (because the flood extent is larger), which would result in the CBD evacuees being distributed across a greater number of egress points. For example, in the PMF there would be eight egress points for evacuees heading towards Westfield, while in the 20 year and 100 year ARI events there would be only 4 and 5 respectively.

The challenges with relying upon pedestrian evacuation were found to be:

- Infrastructure cost would be significant and ranging from $94.5 to $324 million
- The elevated walkways would cause major visual impact and overshadowing
- Trees located along the walkway's path may need to be removed and replaced with low-level shrubs
- In events larger than the 20 year ARI, the walkways would need to be directly accessible from the upper levels of each building. This would be difficult to achieve in practice, because floor levels vary between different buildings

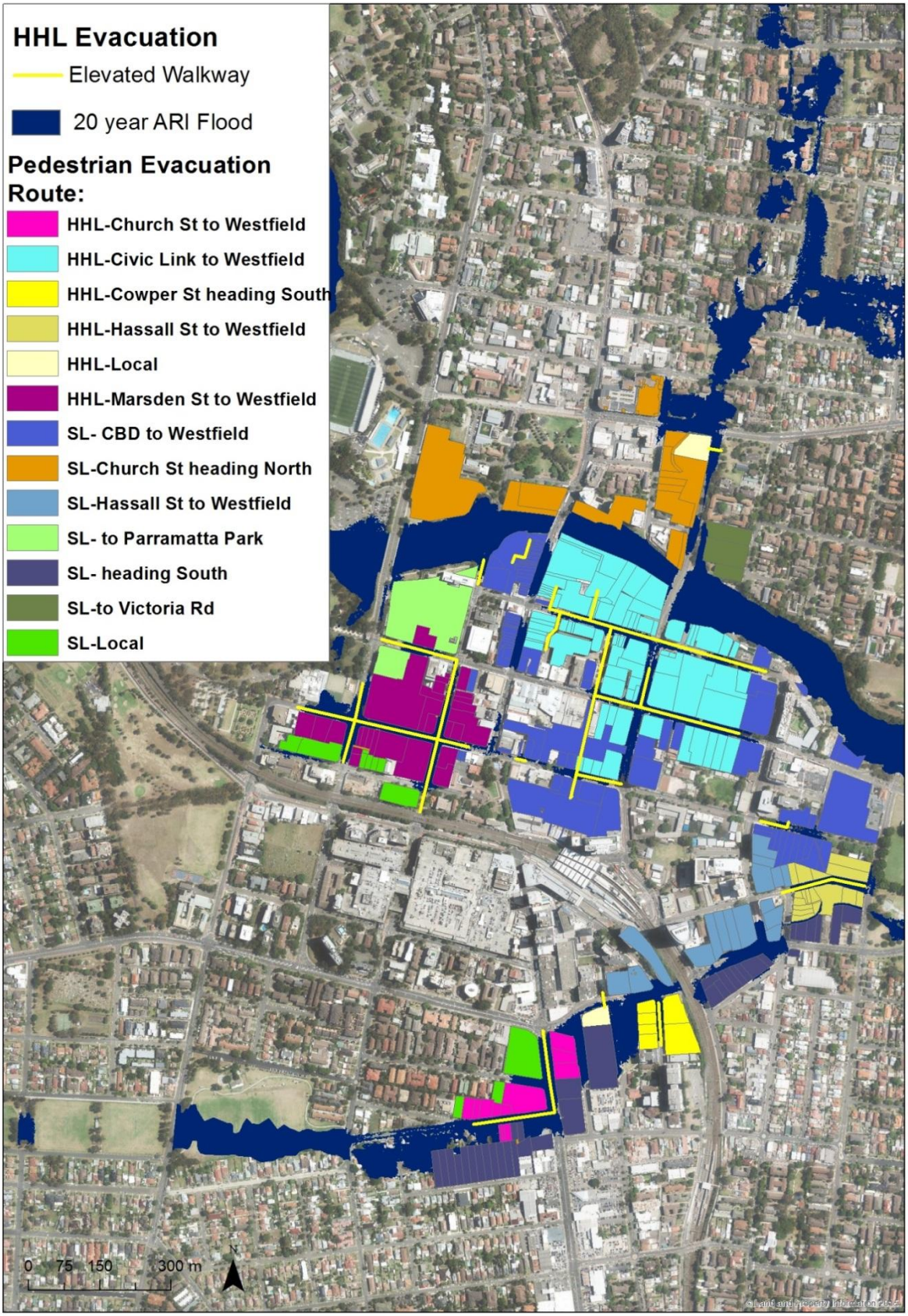

Figure 19: Pedestrian evacuation precincts evacuation routes for buildings affected by the 20 year ARI event.

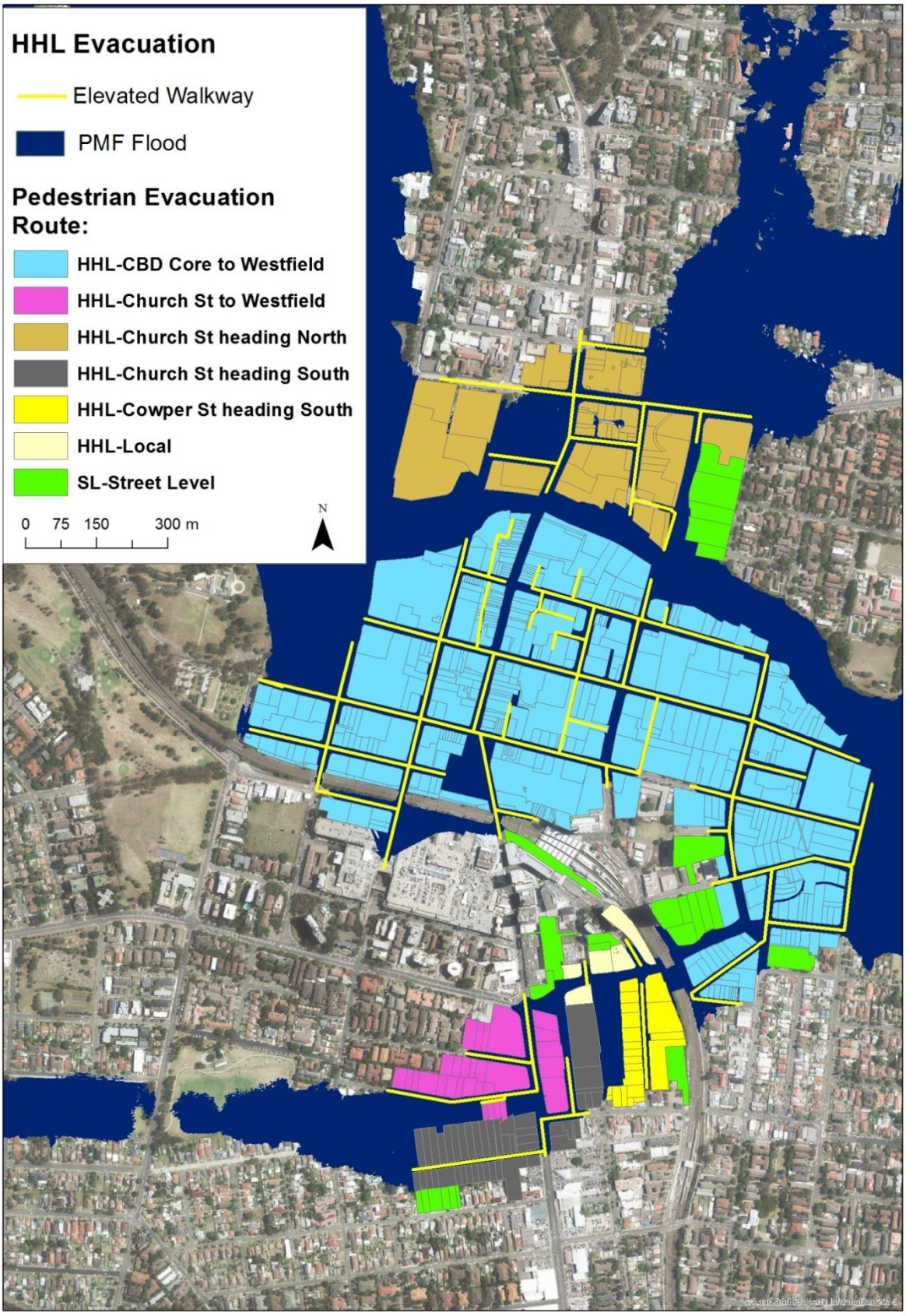

Figure 20: Pedestrian evacuation precincts evacuation routes for buildings affected by the PMF

- Where walkways traverse a road, or a crossroad, large vehicles which are taller than 4.5m would not be able to enter
- It may be a challenge communicating who should use the elevated walkways and who should evacuate at street level
- Pedestrian evacuation times range between 4 to 5 hours and the evacuation process may finish after floodwaters have already receded
- Providing an extensive network of walkways that will not be used on a daily basis, will potentially create issues with informal use and security
- Providing accessibility ramps to the walkways will impact on road layouts within the CBD.
- People will be reluctant to leave a dry building to walk through torrential rain to shelter in another dry building, particularly if they perceive that their building provides shelter above the reach of floodwaters (whether that is true or not);
- Those who arrived by light rail (when it is built) are unlikely to be able to leave by light rail because water across the tracks would stop its operation, many who arrived by bus will not be able to leave by bus because many bus routes will be cut by flooding, those who arrived by train may not be able to leave by train if flooding elsewhere or the inclement weather generally has disrupted rail services. All of these people may be reluctant to leave their buildings if they have no means of leaving Parramatta;
- Residents in particular have demonstrated an unwillingness to evacuate when orders have been given to evacuate in floods throughout Australia in recent years so it may be especially difficult to get people to leave an elevated dwelling in a high rise building on foot in torrential rain.

c) Shelter in Place

Shelter in Place is where the occupants of the building essentially stay where they are until the flood emergency is over. One of the key requirements for successful shelter in place is that all building occupants have access to an appropriate place of refuge. Typically this will be above the level of the PMF in a part of the building which will remain standing in the forces exerted on it by a PMF. Depending on the duration of the isolation and the needs of the occupants, there may need to be emergency provision of electricity, water, food and medications.

The viability of shelter-in-place will depend upon the depth and duration of the flood waters and also the stability of the building itself to flood waters. Additional risks such as the probability of fire or a medical emergency must also be considered, as well as the vulnerability of building occupants and their likely behaviour during a flash flood.

Typically, workers will want to leave the flood threatened building to be able to get home even if the flood duration is only a couple of hours. On the other hand, residents will tend to remain in their dwellings for several hours or more even if they are without services such as electricity. Residents who are outside of the floodplain when the building isolation occurs are very likely to try to reach their homes, risking travelling through hazardous floodwaters in the process.

The current Parramatta Local Emergency Management Plan (EMPLAN) is silent on either shelter in place or evacuation for floods. It is expected that when the Local Flood Sub Plan is prepared that will have more details about specific emergency response actions.

A number of other documents with respect to floodplain management acknowledge the appropriateness of Shelter in Place for flash flood environments. The Flood Preparedness Manual (Australian Emergency Manual Series, prepared by the Attorney-General's Department 1999) states that evacuation is a suitable strategy only when, by evacuating, people are not exposed to greater risks than they would by remaining where they are.

During discussions with the NSW SES for this project, it was acknowledged that flood

evacuation of Parramatta CBD would be impractical, although at the same time shelter in place was not recommended.

In December 2017 the NSW SES wrote to the then Department of Environment and Planning regarding a planning proposal for 180 George St Parramatta. While the letter was specifically responding to that planning proposal, it includes statements such as:

"Despite modifying buildings to reduce the risk, research into human behaviour during actual events has shown that in populations surrounded by a hazard there is always the chance that a person will not behave rationally and remain in place but rather place themselves at unnecessary risk. "

"…where safe evacuation is compromised by a lack of adequate infrastructure and/or warning time, the NSW SES recognises that the situation may result in it being safer for a population at risk to remain in place as long as the building in which the occupants are sheltering is structurally sound and there is sufficient accessible space available above the PMF for all occupants to shelter where adequate services are available and maintained."

"Emergency service response will likely be compromised by the hazardous nature of flash flooding in Parramatta CBD. In this area it is likely that emergency services cannot respond to assist those trapped in buildings due to the rapid onset and hazardous nature of fast flowing floodwater and limitations caused by access and transport issues."

5.5.5 Secondary Emergencies

A secondary emergency is where a non-flood related emergency, such as a building fire or medical emergency, occurs during a flood.

In many cases the flood and secondary emergency will be two unrelated events, however there is potential for floodwaters to damage the electrical system and cause fires or for occupants to use improvised lighting (candles), cooking and heating with naked flames that may also cause fires. The flood could also cause elevated stress levels in occupants that could aggravate pre-existing medical conditions leading to more medical emergencies. At the same time, larger developments are more likely to have emergency sprinkler systems for fire/smoke suppression and designated first aid officers if the building is staffed.

This makes it difficult to quantify the likely chance of a secondary emergency. However, some simple analysis shows that the likelihood is small.

Statistics were unavailable for the chance of building fires locally, however documents produced by the National Fire Protection Association (United States of America) in 2009 suggest that there is approximately a 0.3% chance of a reported (large enough to require assistance) fire in any given household per year (NFPA, 2009). This equals a 1 in 114,000 chance per day that a fire will occur in a household.

Assuming that a flood and fire are independent events, a lot that has a 1 in 100 Year ARI flood probability has roughly a 1 in 4 billion chance that both a flood and a fire would occur in a household on any given day. When the duration of flooding is less than 24 hours then the chance of a fire occurring during a flood is even smaller.

However, as explained above, flooding may increase the probability of a fire. Furthermore, in multiunit buildings a fire in one dwelling is likely to impact on neighbouring dwellings or, in the worst cases, the entire building and even possibly neighbouring buildings.

So while the probability of a fire in a building during a flood is likely to be small, the consequences, should a fire occur, could be significant.

It is also noted that many existing buildings within Parramatta have their fire exits located at ground level and these may not be able to be opened during a flood, as discussed within Section 3.2.4. Redevelopment of these lots would provide potential for this issue to be rectified.

An ambulance emergency is much more likely than a fire. There were on average 2,540 emergency responses per day in NSW during 2013/14 (NSW Ambulance, 2014). At the same time, there were approximately 7.41 million

residents within NSW. This suggests that approximately 1 in 3,000 people will need an ambulance emergency response per day. Given the population of Parramatta is much larger than this, it is likely that there will need to be an emergency response within the CBD during a flood. It should be noted that this data is likely to be significantly skewed by demographic issues, for example, elderly populations are much more likely to require an emergency response, whereas the make-up of Parramatta CBD is likely to be younger. This would particularly be the case during working hours as the vast majority of the working population would be less than 65 years old.

It is noted that the relatively new Westmead Ambulance Station has been built on flood prone land and can be isolated from both Westmead Hospital and Parramatta CBD by flooding in Toongabbie Creek.

While a secondary emergency has a relatively low chance of occurring during a flood, it is important to recognise the potential and manage the risks appropriately with planning controls.

5.6 PLANNING PROPOSAL IMPACTS

5.6.1 Increase in Population

The aim of the planning proposal is to increase the employment and resident population within the CBD. Using the Council supplied parameters, we have estimated the potential increase in population at risk due to the planning proposal.

Table 3 shows the estimated increases in the CBD population under the current planning controls and in the two FSA scenarios described in Section 5.2.4 if the CBD is fully developed. The current estimate for the number of people employed in the entire Parramatta LGA is around 137,000 (ABS 2016) and the number of people living in the suburb of Parramatta is around 26,000 (ABS 2016). Statistics are not available to determine what proportion of these populations is just within the CBD. What the numbers in Table 3 show is that even the existing controls in the CBD will still allow a significant increase in the population should it be fully developed..

It should be acknowledged, however, that the entire commercial population and the entire residential population are unlikely to be occupying the CBD at the same time. During business hours most of the residents will not be at home and when most of the residents are at home (late at night) most of the businesses will be closed.

There will also be a third population in the CBD during office hours and they are visitors who are not counted in either the commercial (jobs) or resident populations. Visitors include patrons of commercial premises, people in the CBD to do business and students at pre-schools, schools and colleges.

As part of the Parramatta CBD Flood Evacuation Assessment (Molino Stewart. 2019) the total number of residents, workers and visitors that would need to evacuate were estimated for 2016, 2036 and 2056 (Table 4). The numbers in Table 4 are not directly comparable with those in Table 3 because the former includes buildings in the Western Corridor and the latter includes buildings in the planning proposal area which do not flood.

Year 2036 was obtained by projecting 20 years into the future the number of evacuees that would be achieved under the existing planning controls, plus some site-specific planning proposals that have at least received Council endorsement to be sent for Gateway determination.

Table 3: Estimated Potential Increase in Population in Planning Proposal Area.

	Commercial	Residential
Existing	35,048	19,576
FSAR1	92,253	58,961
FSAR2	76,096	68,000

Table 4: Estimated Potential Population in Flooded Properties in Planning Proposal Area.

	Residents	Workers	Visitors
2016	10,010	34,931	26,245
2036	32,793	63,130	45,214
2056	50,574	81,826	59,340

It has been demonstrated that neither vehicular nor pedestrian evacuation is viable as a primary flood response across most of the CBD with the current road and pedestrian infrastructure. Providing additional infrastructure for evacuation is problematic

Evacuation would only become more challenging with further development, even for the more modest increases under the current planning rules which are reflected in the 2036 numbers (Table 5).

These times assume that the evacuation routes will remain open for that whole time; which they will not. In the case of pedestrian evacuation it assumes high level walkways will be constructed for flood evacuation.

Table 5: Estimated Vehicular and Pedestrian Evacuation Times.

Year	Event (ARI)	Vehicle (hrs)	Pedestrian (hrs)
2016	20 Year	8.1	4.5
	100 Year	9.0	5.2
	PMF	10.7	4.4
2036	20 Year	8.7	7.3
	100 Year	9.4	8.9
	PMF	10.8	6.8
2056	20 Year	8.9	9.1
	100 Year	9.6	11.2
	PMF	11	7.9

5.6.2 Flood Response Categorisation

The flood emergency response classification of communities, described in Section 5.5.3, has been developed assuming that the occupants are at the ground floor. As described in Section 4.1.1, the planning proposal built form will be high rise buildings where the majority of occupants will be well above the ground level. When taking this into account, essentially all of the new buildings should be considered High Flood Islands.

The reason for this is that the occupants could potentially be unaware of the flooding until they attempt to leave the building, or at least the first sign they will have of flooding is that the ground floor is inundated and their escape route will more than likely be cut off. At the same time, there would be ample opportunity for those occupants to retreat up their stairs to a floor that is above the level of the PMF.

The effect of this change in categorisation depends on the original categorisation, for example:

- If the area was already a high flood island there is essentially no change to the categorisation
- If there was already a building with access to areas above the PMF the building was already a high flood island and the categorisation has not changed
- If the area was previously a low flood island with a building without areas above the PMF, it becomes a high flood island
- If the area was previously a low flood island with a building with areas above the PMF it was effectively a high flood island and that does not change.
- If the area previously had rising road access, or an overland escape route, from a building with areas above the PMF then it was effectively a high flood island and will remain so.
- If the area previously had rising road access, or an overland escape route, from a single storey building then it will effectively become a high flood island.

It should be noted that under the current planning controls, the same type of building (high rise) would be developed in the majority

of these areas, so the planning proposal will not effectively change the flood categorisation of the land or the buildings.

5.6.3 Population at Risk

The planning proposal would increase the potential population at risk within those areas that can flood. When the discussion in Section 5.6.2 is considered, it means that where there was a population on a low flood island that population will be increased but the building will convert the island to a high flood island. This means the population at risk will increase but the risk to each individual in the population at that site will decrease.

In all other areas the population at risk will increase but the risk to individuals in the population will either remain the same or will increase depending on whether it was already a high flood island or previously was low rise with rising road access or an overland escape route.

5.6.4 Risk Reduction Opportunities

The discussion in Section 5.6.3 is based entirely on the flood emergency response classification and a simplistic consideration of final building design and its implications for the population at risk.

It must be recognised that the flood emergency response classification is only one factor in determining flood risk and other considerations such as flood hazard, flood probability and flood duration are also very important.

For example, a building which is isolated by high hazard floodwaters for several hours in a 20 year ARI flood presents a much higher risk than were the same building to be isolated by low hazard floodwaters for less than an hour in a PMF. The planning proposal provides the opportunity to avoid intensification in areas which place people and property at the greatest risk from flooding.

Another consideration is that while an individual building on an individual block may have a particular flood exposure and flood emergency response classification, if a group of buildings or a collection of lots are considered as a whole the exposure and classification may be different.

A broad scale redefinition of floor space ratios, building heights and development controls offers the opportunity for redevelopment to be reconsidered at a precinct level rather than one development at a time and it may provide ways and means of decreasing the population in areas with the greatest flood risks or constructing buildings which collectively change their flood emergency response classification.

This is elaborated upon the in the following sections.

5.7 RISK EVALUATION

5.7.1 Risk to Property

The subject area is all currently developed with a mix of residential and commercial development. In most cases, the development would have occurred prior to the current flood planning controls. Application of current planning controls to redevelopment will result in less flood risk to property.

However, as highlighted in Section 3.2, some of the ways in which new developments have complied with existing flood planning requirements have had unintended outcomes. It will be important that the new planning proposal addresses these without increasing the potential flood risk to property.

Council is currently investigating this issue and examining ways in which the issue can be overcome

Overall it is considered that the planning proposal should be able to be implemented without increasing the flood risk to property.

5.7.2 Risk to Life

Evaluating the risk to life arising from the planning proposal is more complex. Considering the CBD as a whole it will result in more people occupying flood prone areas but in such a way that reduces the probability of them coming in contact with floodwaters inside their building.

Flood behaviour and topography varies across the CBD and an approach is needed which takes this variability into consideration. Given the impracticalities of vehicular evacuation and the challenges of pedestrian evacuation, it is our view that shelter-in-place is the most appropriate flood response for most of the buildings in the Parramatta CBD.

Having said that, it is preferable to encourage development which minimises the chance that people will be frequently isolated in buildings for long periods of time because they may:

- try to leave (or enter) the building through hazardous floodwaters despite advice to the contrary
- need medical assistance
- need to evacuate from a fire

a) Methodology

For the purposes of this project a methodology was developed which considered how frequently buildings are likely to be isolated by flooding, how long they would be isolated and how hazardous surrounding floodwaters would be to those entering or leaving the building on foot.

Table 6 summarises the methodology and criteria used for evaluating the flood risk to life.

The first criterion used was the probability of flooding. This was based on the available modelled flood extents which were limited to the 20 year ARI (5% AEP), 100 year ARI (1% AEP) and the PMF. Flooding above the 100 year ARI (<1% AEP) was considered to be rare flooding and would require minimal measures to manage risk to life. At the other end of the scale flooding more frequent than the 20 year ARI (>5%) would require the greatest controls to manage risk to life.

While flooding larger than the 1% AEP is rare, there have been several examples of major floods within Australia within the past 12 years that have exceeded the flood levels of the 1% AEP design flood, this includes;

- Flooding in King John Creek in Moreton Bay (QLD) in May 2015, which has an estimated 0.1% AEP
- Flooding in Dungog on the Myall Creek and Patterson River in April 2015, which has an estimated 0.2% AEP
- Widespread flooding in Queensland in 2011, including the Brisbane River, Pine River and Lockyer Valley, which has estimates of between the 1% and 0.1% AEP in various catchments
- Widespread flooding in northern Victoria in 2010 and 2011 which has been estimated at less frequent than the 1% AEP with a number of rivers recording 0.5% events
- The “Pasha Bulker” storm in June 2007 which flooded large areas of Newcastle, which has been estimated at much less frequent than 1% AEP.
- A localised storm at Broughton Anglican College near Campbelltown, NSW in April 2007 caused a 0.2% flood
- Rainfall in the Flinders Ranges in South Australia in January 2007 was in the order of a 0.1% event over an area the size of the Sydney Metropolitan Area

The second criterion was depth of flooding in the PMF as this represents the worst case scenario in terms of hazard to anyone trying to enter or leave the building. While hazard is traditionally determined from depth and velocity combinations, the lack of velocity information meant that for this project only depth was used. Two depth thresholds were considered and were based on the most recent Australian research in this area (McLuckie et al, 2014).

A 0.6m threshold was used to represent the depth above which it would be difficult for emergency service vehicles to reach buildings. A depth of 1.2m was used as the other threshold which is the limit at which it is difficult for adults to traverse low velocity flood waters.

Table 6: Flood Risk to Life Evaluation Methodology

Category	Probability (AEP)	PMF Depth (m)	[Depth, Duration] Operator	PMF Duration (hrs)	Flood Emergency Response Classification	Suggested Risk to Life Management Measures
1	< 1%	< 0.6		Any	Rising access	Safe to evacuate or shelter in place. No controls required.
2	< 1%	0.6 < x < 1.2	AND	< 3	Rising access	Safe to evacuate early or shelter in place in accordance with a flood emergency response plan for the building.
3	< 1%	> 1.2	OR	> 3	Rising access	Shelter in place above the PMF in accordance with FERP. Ensure space above PMF for all building occupants to shelter. Provide building fire management system to meet ABCB requirements for high rise building.
4	1%<AEP< 5%	Any		Any	Rising access	Prohibit residential development unless there is internal flood free pedestrian access to development in categories 1 or 2. Permit some types of commercial development below 1% flood level if other planning considerations can justify. Commercial areas shelter in place above the PMF in accordance with FERP or access to development in categories 1 or 2. Provide building fire management system to meet ABCB requirements for high rise building
5	< 1%	< 0.6	AND	< 3	Flood island	Shelter in place in accordance with FERP
6	< 1%	> 0.6	AND	> 3	Flood island	Shelter in place above the PMF in accordance with FERP. Have residential habitable floors above PMF level. Have access to emergency power and water. Provide building fire management system to meet ABCB requirements for high rise building. OR provide internal flood free pedestrian access to development in categories 1 or 2.
7	< 5%	> 0.6	AND	> 8	Flood island	Prohibit residential development unless it has internal flood free pedestrian access to development in categories 1 or 2. OR provide internal flood free pedestrian access to development in categories 5 or 6 AND Shelter in place above the PMF in accordance with FERP. Have residential habitable floors above PMF level. Have access to emergency power and water. Provide building fire management system to meet ABCB requirements for high rise building. Permit some types of commercial development below 1% flood level if other planning considerations can justify providing there is warning system for early evacuation and closure OR flood free pedestrian access to development in categories 1 or 2.
8	> 5%	any	OR	any	Rising access	Prohibit development in these areas unless there is internal flood free pedestrian access to development in categories 1 or 2. No habitable commercial or residential development below 1% flood. Provide building fire management system to meet ABCB requirements for high rise building.
9	> 5%	Any		Any	Flood island	Prohibit development in these areas

The third criterion was duration of PMF flooding as this will determine how long the building and its occupants are likely to be isolated. The available data only allowed us to estimate durations of three hours or less and then hourly increments above that. Given that the NSW SES assumes that it takes two hours for people to be ready to evacuate when ordered to, a threshold of three hours was used to represent a time period in which few people would try and enter or leave the building were it flooded by PMF floodwaters. It would be flooded for less time in small floods.

The next criterion was the emergency response classification with those with either rising road access or an overland escape route considered to be at less risk than those isolated on a flood island.

In combination these criteria produced nine different flood risk categories which need different types of mitigation and response measures.

This flood risk map compares to the three "flood risk" precincts which are currently used for floodplain management in the CBD.

By using all nine categories it enables a gradation of measures to manage risk to life to be used to facilitate intensification of development within the CBD and development in locations which a more simplistic categorisation of the floodplain would prohibit. It would be possible, as part of the planning process, to consolidate some of these categories based on preferred planning controls.

b) Results

Figure 21 maps the results of the nine different combinations of criteria through the planning proposal area and a discussion on recommended measures to manage risk to life in each follows.

Category 1.

It was considered that there would be negligible risk to life in areas with rising access which cannot be flooded to greater than 0.6m depth in a PMF and have less than a 1% chance of being flooded at all. This is because they have a low chance of flooding, they can evacuate on foot ahead of the floodwaters reaching the building, emergency service vehicles could reach the building through floodwaters if needed and people could walk through floodwaters to enter or leave the building if absolutely necessary.

Category 2

Were areas with rising road access to have less than a 1% chance of being flooded but could be flooded to a depth of between 0.6m and 1.2m in a PMF and be flooded for less than three hours these were assessed to have a very low flood risk. This is because they also have a low chance of flooding but might not be able to be reached by emergency vehicles at the peak of a rare flood and if people were to try and walk through the floodwaters they may be at some risk. However, the three hour maximum duration means that there is a low chance of an emergency happening in that time and a low chance of people getting impatient and trying to walk through floodwaters. A building specific flood emergency response plan (FERP) could be used to encourage occupants to evacuate early or shelter in place.

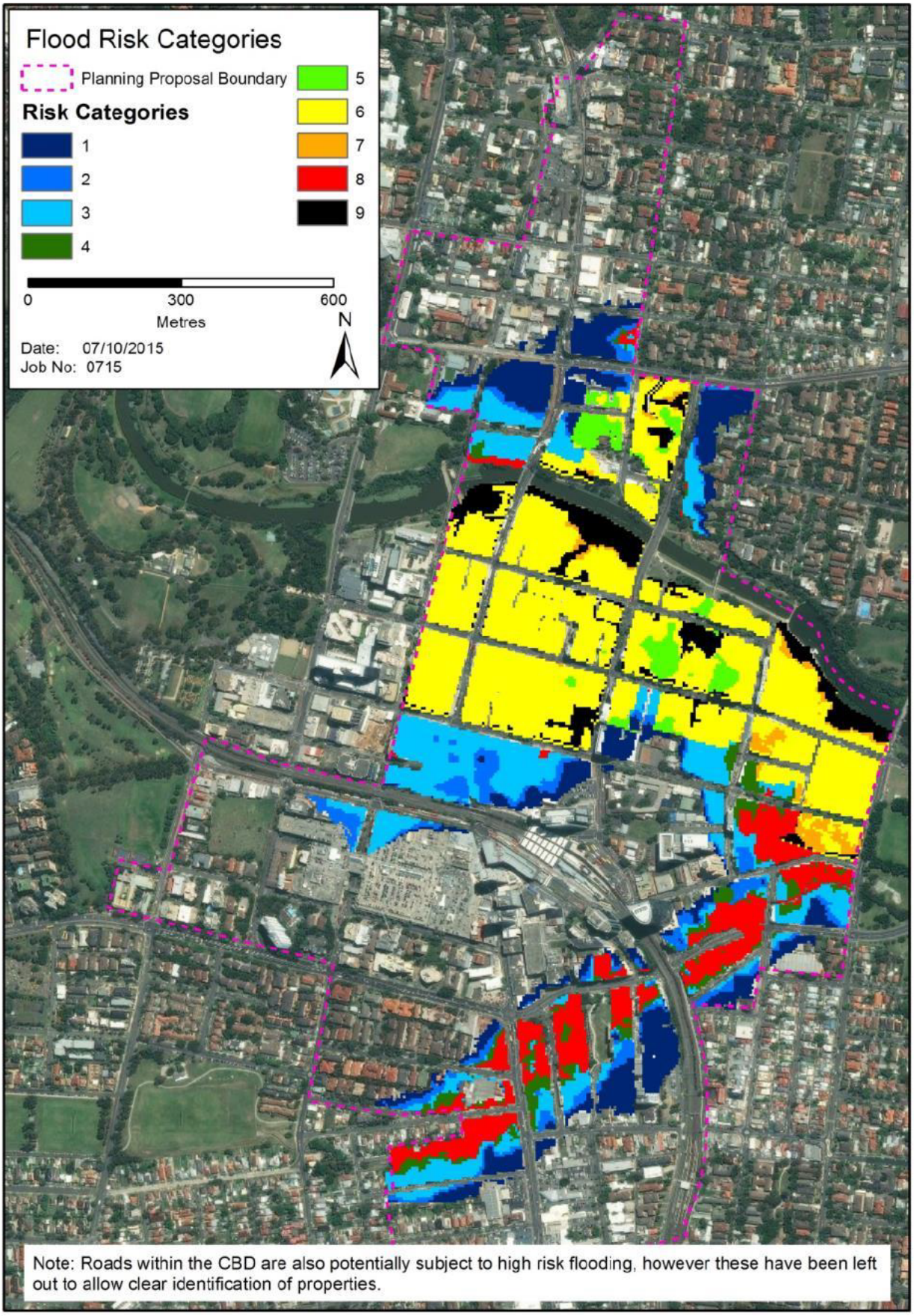

Figure 21: Flood Risk to Life Categorisation of Developable lots

Category 3.

Similar areas where the depth could exceed 1.2m or the duration could be longer than three hours were assessed to have a slightly greater risk because there is a greater chance that people may try and traverse hazardous floodwaters or emergency service cannot reach those needing assistance.

In these locations a FERP would advise people to shelter in place and a fire management system which meets Australian Building Code Board (ABCB) requirements for a high rise building could be used to minimise the chance of a fire in the building placing lives at risk. This would apply even if the building would not be defined as a high rise building (over 25 metres in effective height).

It is noted that in early 2019 the National Construction Code (NCC) was updated. The new NCC has extended the provision of fire sprinklers to lower-rise residential buildings, generally 4-8 storeys. However, non-sprinkler protection is still permitted where other fire safety measures meet the deemed minimum acceptable standard.

It would be necessary to ensure there is sufficient space above the PMF level for all building occupants to shelter.

Category 4

While areas in this category also have a rising road access, they have a much higher chance of being cut off by floodwaters and they will be flooded to greater depths and for longer durations in more extreme floods.

It is our opinion that these areas may be suitable for some commercial development (which has few occupants) below the 1% AEP flood level but above the 5% AEP flood level if there are other overriding planning considerations such as street activation. This could only be permissible if the building were designed to exclude floodwaters from high value assets within the commercial spaces below the 1% level and the commercial areas have free access to a location above the PMF within the building where occupants can shelter. Alternatively they could have internal flood free pedestrian access to development in categories 1 or 2.

Because occupants of commercial spaces may be trapped in the building for some time it would be necessary for the building to have a fire management system which meets ABCB requirements for a high rise building.

Because of the high probability of isolation it is not recommended that residential development be permitted in these areas unless it has internal flood free pedestrian access to development in categories 1 or 2.

The internal flood free access to areas with lower flood risks would mean that the occupants would be able to enter or exit the building through an entrance which has a much lower chance of being cut off by hazardous floodwaters. This access could be achieved by either a contiguous building which spans the flood risk categories or by a covered, elevated walkway connecting the building to a building in the lower flood risk area.

Access to buildings in Category 3 would not be sufficient to permit development in Category 4 areas as they have too high a probability of isolation by high hazard floodwaters and it would not be practical to provide shelter areas above the PMF in an adjacent building.

Category 5

Flood islands create higher risks because there is less of an opportunity to walk to flood free land ahead of floodwaters arriving. With this in mind if these areas have less than a 1% chance of flooding and would have less than 0.6m depth and less than three hours duration of flooding in a PMF they were assessed to have low flood risk because there would not be a significant chance that people would walk through floodwaters to leave or access the building.

However, because there is no opportunity to leave the building and walk ahead of rising flood waters it is recommended that a FERP encourage sheltering in place. No further controls are required.

Category 6

Were either the depth or duration to exceed 0.6m or three hours respectively then the area would be assessed to have a higher flood risk because the long duration increases the

chance that someone will walk through floodwaters and the greater depth increases the chance that doing so would be dangerous.

This requires a FERP which encourages sheltering in place but also the building occupants from commercial floors below the PMF must have free access to a location above the PMF within the building where they can shelter.

It is recommended that in these buildings the minimum habitable floor level of any residential dwellings be above the PMF level plus a freeboard. This should be able to be achieved by specifying that ground floor areas be for non-residential purposes and minimum ceiling heights be placed on those non-residential spaces.

There must be emergency power and water available to the building for the duration of a PMF event.

It would also be necessary for the building to have a fire management system which meets ABCB requirements for a high rise building.

Alternatively, if these buildings have internal flood free access to development in categories 1 or 2 then the controls which apply to those categories only are needed.

Category 7

Flood islands which are below the 1% flood level but above the 5% AEP flood level were all found to have flood depths greater than 0.6m and durations longer than 8 hours in the PMF and therefore present a high risk to life. However, even in these areas there are measures which can be taken to manage risk to life.

Because of the high probability of isolation it is not recommended that residential development be permitted in these areas unless it has internal flood free pedestrian access to development in categories 1 or 2.

Alternatively they can have access to development in categories 5 or 6 providing that:

- habitable floors in the residential dwellings are all above the PMF
- there is access to emergency power and water which would not be affected by the PMF
- There is a fire management system which meets ABCB requirements for a high rise building

Some commercial development below the 1% flood level but above the 5% AEP flood level may be appropriate if there are other overriding planning considerations such as street activation. This could only be permissible if the building were designed to exclude floodwaters from high value assets within the commercial spaces below the 1% AEP level and:

- There is a warning system and FERP which enables the premises to be evacuated and closed with sufficient time for occupants to reach flood free land; or
- There is internal flood free pedestrian access to development in categories 1 or 2.

Category 8

Areas with rising access which are below the 5% AEP flood level and can be flooded to more than 0.6m depth or flooded for longer than three hours were assessed to have a very high flood risk because they would flood relatively frequently and the depth or duration would increase the chance of people trying to traverse hazardous floodwaters.

All development should be prohibited in these areas unless there is internal flood free pedestrian access to development in categories 1 or 2. No habitable commercial or residential development should be permitted below the 1% AEP flood level.

Category 9

Flood islands below the 5% AEP flood level represent an extreme risk to life and habitable commercial and residential development should be prohibited in these areas.

c) Assigning a Category

Figure 21 maps the flood risk categorisation based on the assumption that there is a common access to the building at each location on the map. This will not be the reality. If a single building occupies that lot

then the risk to life which dictates the actual risk to the building occupants will be the one that applies at the entrance of the building which all of the occupants have access to.

Should a building span more than one lot, then it is again the assessed risk at the building common entrance which dictates the risk to life which the development must respond to, an example of where this would potentially be feasible is the Auto Alley area, shown in Figure 22. This provides scope for lot consolidation or building links (e.g. elevated walkways) to reduce the risk to life of a development and reduce the requirements for managing risk to life.

5.8 RATIONALISATION OF RISK CATEGORIES

While the rationale for the risk to life categories is sound and the suggested management measures in Table 6 are appropriate, the use of nine separate life risk categories in a planning scheme is not practical.

Furthermore, the fact that most, if not all, of the redevelopment which will take place in the CBD will be multi-storey, there will be little practical distinction between rising road access and flood islands because dwellings above the ground floor in an area with rising road access will effectively be on a flood island.

Finally, it was recognised that many of the suggested management measures were common across categories with additional measures required as the flood risk to life increased.

In light of these considerations, an alternative flood risk categorisation was developed and a more concise presentation of suggested life risk management measures proposed. These are summarised in Table 7 and an explanation of their rationale follows. Figure 23 is a schematic representation of the various flood emergency management control options in each of the flood risk zones.

Figure 24 shows how they are distributed across the Parramatta CBD after the number of categories were consolidated and micro risk pockets rationalised. Figure 25 has remapped the categories in Figure 24 by cadastral boundary.

For Categories 1, 2, 3 and 4, all buildings located within the PMF must be structurally sound in the full range of floods.

Category 1.

This is as per the original Category 1. In a PMF it would be subject to low hazard, short duration flooding. People would be able to walk away from rising flood waters but should they be trapped by floodwaters it would pose minimal risk to them were they to either shelter in place or choose to leave through the floodwaters.

No particular measures are needed to ensure their safety other than the building being structurally sound in the full range of floods which is not an onerous requirement given the low hazard even in the most extreme events and typical high building construction.

For Categories 2, 3 and 4, shelter in place above the PMF or evacuation to land above the PMF is required.

Category 2.

This category recognised that multistorey development in an area with rising road access is effectively the same as development on a flood island because if occupants above the ground floor fail to evacuate prior to the arrival of floodwaters they are isolated. Using this logic, the original Category 2 presents a similar risk to life as Category 6. The original Category 3 presents a slightly higher risk than these two categories.

Category 5 may appear to have similar flood hazards in the PMF as Category 1, but because it is an island and it may be necessary to traverse higher hazard water away from the site to access flood free ground, it is more logical to group this category into this new Category 2.

The proposed measures for managing life safety are those which apply to category 1 but with some additional requirements to manage the additional risks.

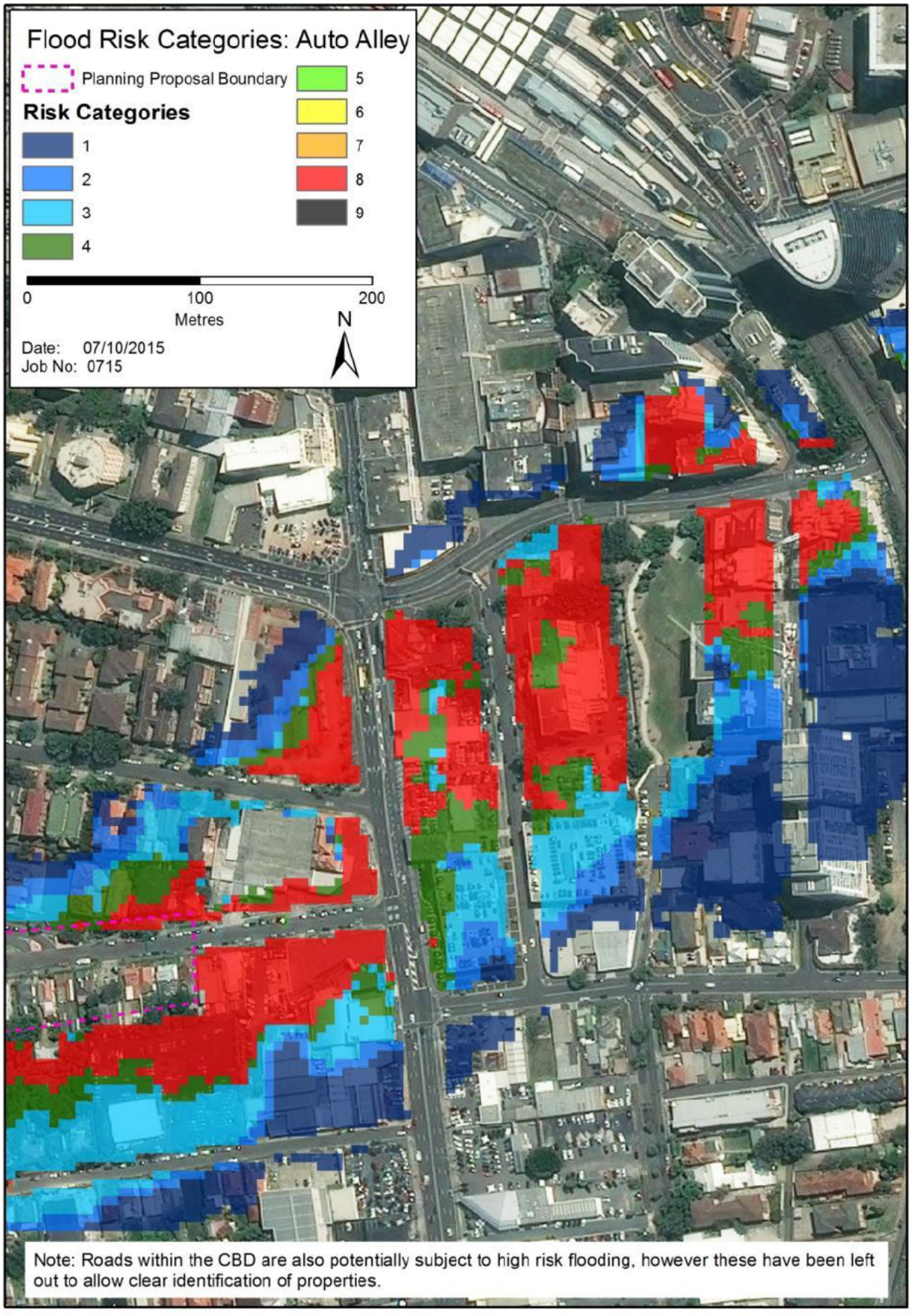

Figure 22: Flood Risk Categories around the Auto Alley Area

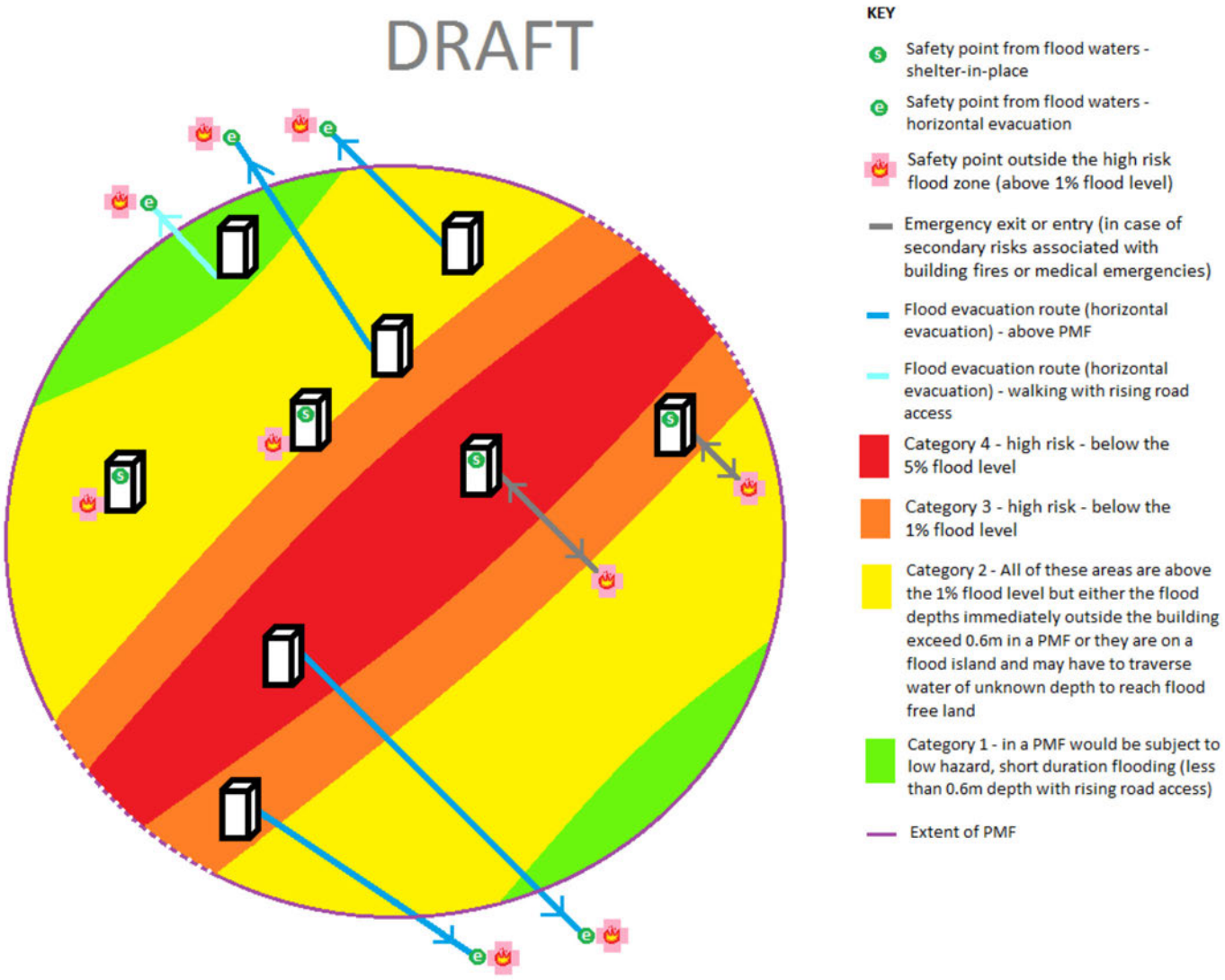

Figure 23: Schematic Diagram of Flood Emergency Response Provisions

Table 7: Concise Life Risk Categorisation and Management Table

			All buildings must do this requirement		AND	All buildings do this	OR	All buildings must do these safety requirements, if indicated by a 'Yes'				AND IF	Commercial included in the building	
Flood Type	**Old Category number**	**New category number**	Building withstand flooding to PMF	Residential floor levels above the 1% flood level plus freeboard		Flood free pedestrain access outside PMF		Shelter for all building occupants above PMF	Fire Safety to ABCB requirements for high rise whether high rise or not	Flood Emergency Response Plan for the Building Maintained by Building Owner or Body Co	Residents able to exit above 1%		Only some forms of commercial development below 1%	Temporarily occupied development only below the 1%
Low Hazard, short duration PMF	1	1	Yes	Yes										
Moderate to High Hazard PMF above 1% AEP (1 In 100 ARI)	2, 3, 5 and 6	2	Yes	Yes		Yes		Yes	Yes	Yes	Yes			
Between 1% AEP (1 in 100 ARI) and 5% AEP (1 in 20 ARI)	4 and 7	3	Yes	Yes		Yes		Yes	Yes	Yes	Yes		Yes	
Greater than 5% AEP (1 in 20 ARI)	8 and 9	4	Yes	Yes		Yes		Yes	Yes	Yes	Yes			Yes

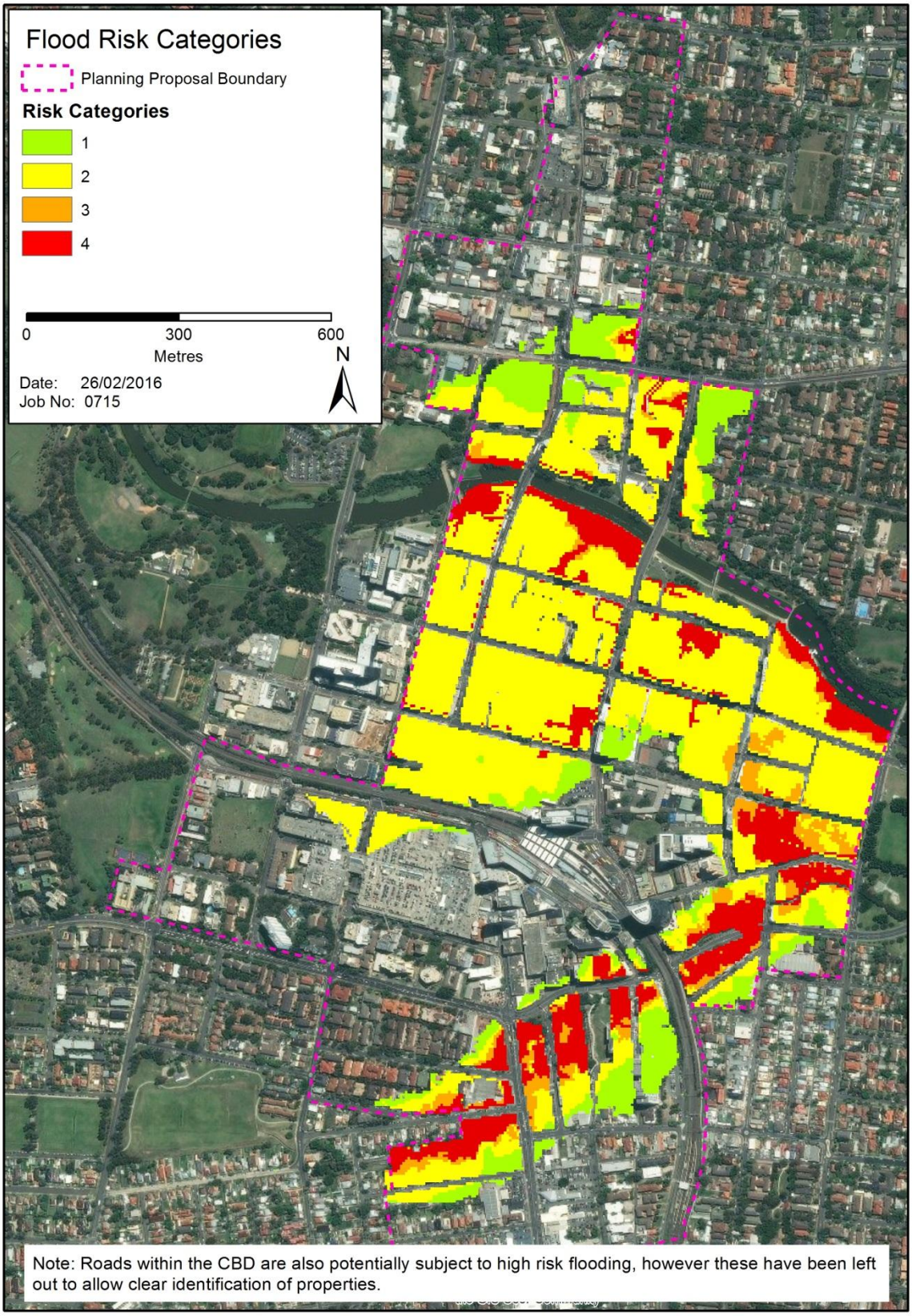

Figure 24: Rationalised Life Risk Categories Mapping

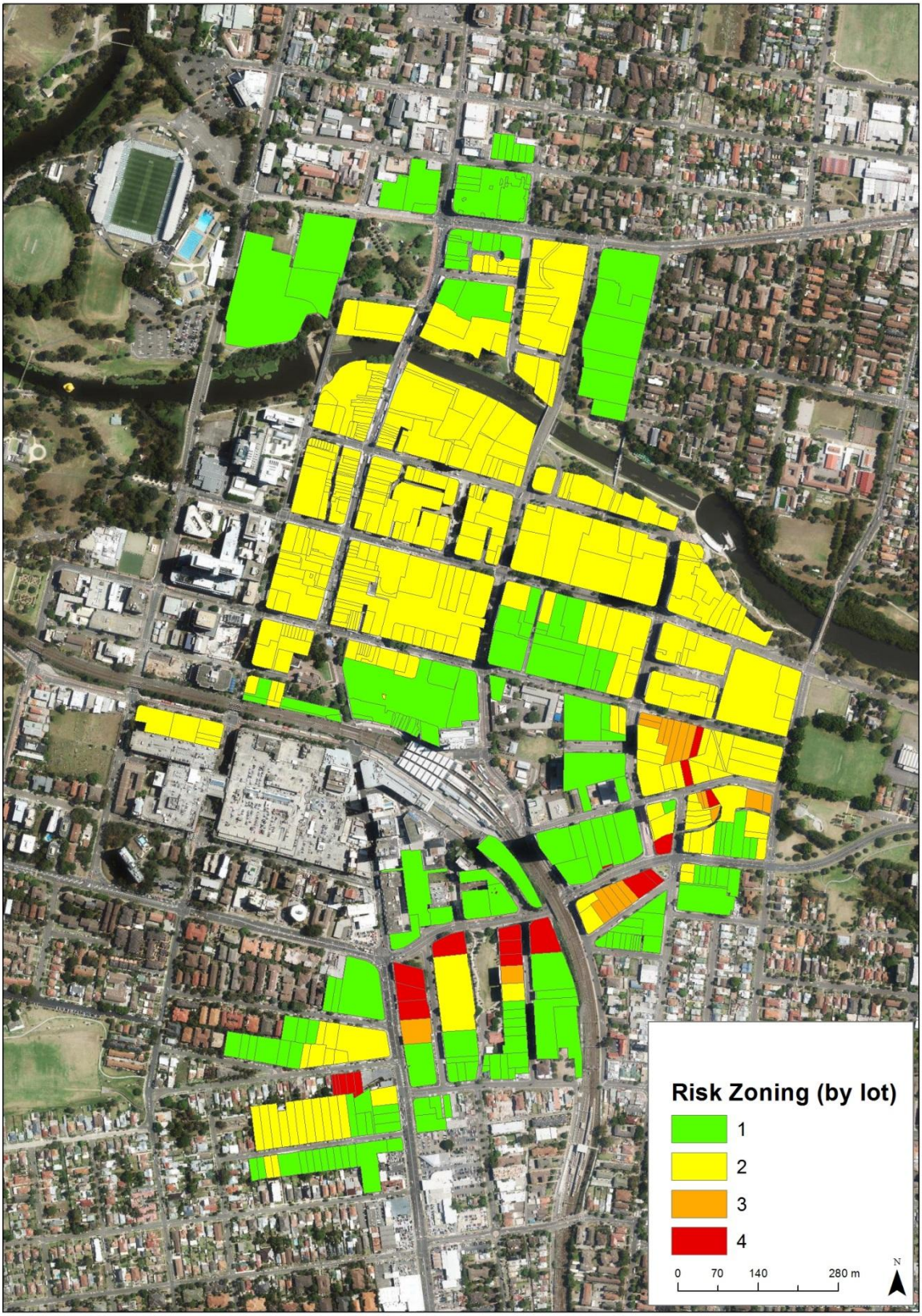

Figure 25: Rationalised Life Risk Categories Mapping by Cadastral Lot:

It is noted that all properties in this category have street frontage to a footpath which is flood free in the 1% AEP flood but they do not necessarily have a current access to a footpath above the 1% AEP flood level. It would have to be a requirement that any redevelopment of these lots has at least one access point, sufficient for fire emergency evacuation of the whole building and accessible for ingress by emergency services personnel which is above the 1% AEP flood level.

If flood free access can be provided for building occupants to an area outside the PMF, then no further controls are required. This could be achieved by having an exit from a building which is above the PMF and is accessible internally to all occupants. Alternatively, it may be achieved by providing a link to a neighbouring building, by means of internal access or a bridge, which has an exit above the PMF.

However, if that is not possible to provide flood free pedestrian access to an area outside the PMF then it would be acceptable for occupants of these buildings to shelter in place provided that:

- There are areas above the PMF sufficient for all building occupants to shelter for up to eight hours and they can be accessed by all building occupants without having to enter floodwaters A flood emergency response plan has been developed for the building and the building owner or body corporate is legally responsible for its maintenance and implementation
- Fire safety features are included within the building to meet the requirements of the ABCB for high rise buildings whether the building is high rise or not.

Category 3.

As with the groupings which make up the new Category 2, it was recognised that the old Category 4 and Category 7 had many things in common, particularly the fact that they lie below the 1% AEP flood level and therefore have a higher probability of being isolated than those in the new Category 2.

It is this particular increased probability of flooding which means that they would be required to have all of the risk management measures of the new Category 2 along with an additional control.

They must have an exit from the building above the 1% AEP flood level which is accessible to all residential occupants such that people would only be trapped inside the building by flooding greater than the 1% flood. In this way, the risk to occupants is brought into line with those in the new Category 2.

This could be achieved through internal access within the building or through a connection to a neighbouring building.

This category also recognises that some types of commercial development may be appropriate below the 1% flood level but that needs to be carefully controlled. For example if other planning considerations such as street activation make a floor level at street level preferable then this could only be permissible if the building were designed to exclude floodwaters from high value assets within the commercial spaces below the 1% level and the commercial areas have free access to a location above the PMF within the building where occupants can shelter.

Category 4.

The new Category 4 replaces the former Category 8 and Category 9. These are areas which are below the 5% AEP flood level and are therefore more frequently flooded and can experience high hazard flooding in larger events.

Occupancy of these areas poses a significant risk to life and property unless carefully controlled. Only temporarily occupied development would be permissible below the 1% flood level here.

In all other respects development in these areas must satisfy all of the controls which apply to Category 3. While at face value this might appear that these highest risk areas are not having stricter controls placed on them, the reality is that it will be more difficult for a development in these areas to meet these requirements. For example higher flow velocities may make it more difficult to construct a building which remains structurally sound within the PMF.

However, a creative design may address this and the other requirements so that a

development in these locations poses no greater risk to life than development elsewhere.

It should also be noted that the available flood data used to map the new Category 4 had less detail than that available to map the other categories. As such the boundaries of the new Category 4 may be somewhat conservative, particularly away from the main channels of the Parramatta River and Clay Cliff Creek.

However, a conservative approach has been taken with the mapping based on Council's currently adopted flood extents.

6 MANAGEMENT OPTIONS

Table 2 summarised required floodplain management actions which have not been implemented from previous floodplain risk management plans as well as issues which council officers advised need to be addressed in a new floodplain risk management plan. In addition, management options need to be developed which appropriately manage any new flood risks which would arise due to the CBD planning proposal.

The scope of this floodplain risk management plan revision was not to undertake detailed investigation of mitigation options. It has therefore been assumed that the required unimplemented actions from the earlier plans will become part of the updated plan. Accordingly, this section focuses on options to resolve issues which relate to challenges arising from current flood planning controls or from the CBD planning proposal.

Community and stakeholder consultation for updating the Floodplain Risk Management Plan was undertaken through the Parramatta Floodplain Risk Management Committee. A committee meeting was held on 20 August 2015 and a presentation was delivered to introduce the committee to the work being undertaken, the implementation challenges with the existing flood planning controls and the risk to life issues in relation to the CBD planning proposal. This had been preceded by a presentation by City of Parramatta Council on investigations into an early flood warning system for the Parramatta River and by the NSW SES on the challenges of flood emergency response in Parramatta.

This was followed by a workshop where ideas and opinions were sought on how to deal with the issues which need to be addressed by the revised floodplain risk management plan. The following discussion has been informed in part by those workshop discussions.

6.1 WORKSHOP IDEAS

6.1.1 Evacuation

The general consensus at the workshop, including from representatives of the NSW SES, was that wholesale vehicular evacuation of Parramatta CBD as a flood response is not practical for all of the reasons given is Section 5.5.4.

It was acknowledged, however, that it is desirable for non-resident occupants to be able to evacuate safely from flooded buildings while it is more realistic to expect residents to choose to shelter within their dwellings. To this end, planning controls are needed which minimise the risk to life of both groups of building occupants.

6.1.2 Development in High Hazard Areas

It was generally accepted by the committee that there were limited opportunities to reduce the potential flood hazard. Amplifying existing channels was suggested, however after discussion it was agreed this was not feasible. The other potential solutions were generally around planning considerations, particularly:

- Using high hazard areas as shared open space
- Using planning mechanisms to encourage lot consolidation to ensure that owners of lots in high hazard areas were not financially penalised.

6.1.3 Flood Isolated Areas

The need for integrating flooding constraints into master planning for the city was stressed by members of the committee.

The committee was generally not opposed to development in flood isolated areas, so long as the following issues were addressed:

- Need to maintain a publically accessible PMF refuge
- Need to ensure services (water, electricity) are maintained

Consideration was also given to placing commercial development within higher risk areas and residential development in lower risk areas.

The concept of having elevated walkways connecting buildings in isolated areas to flood free areas was also explored at length.

6.1.4 Retail Floor Levels

The issue of having retail development disconnected from the street by stairs was discussed and it was agreed by the committee that the issue should be addressed.

A number of potential solutions were discussed, including:

- Use of elevated footpaths to bring the footpath level closer to the local flood planning level
- Having entrance colonnades, or setbacks from the street which allow ramping from the footpath level to the flood planning level inside
- Having terraced floor levels inside the ground floor of the building with flood resistant or easily moved contents on the lower levels (e.g. a restaurant may have its kitchen above the flood planning level but the tables and chairs could be lower)
- A retail space which is sealed watertight when the doors are closed

6.1.5 Other – Street Obstructions

The committee members were given an opportunity to discuss any other potential issues. The NSW SES was concerned that during a flood, there will be a number of obstacles such as street furniture, cars etc. that will impede the passage of flood rescue boats.

The issue was discussed, and potential solutions such as undertaking clear path mapping and some form of barrier to prevent vehicles from floating away were raised. However, given the general need for vehicles and street furniture through the CBD it was agreed that is unlikely that this will be easily resolved.

6.2 NSW SES LETTER

In December 2017 the NSW SES wrote to the then Department of Environment and Planning regarding a planning proposal for 180 George St Parramatta. While the letter was specifically responding to that planning proposal, Appendix 2 of the letter listed site specific design considerations and Parramatta CBD General Design considerations. Both are listed here because the site specific considerations are relevant to many sites in the Parramatta CBD, not just 180 George St.

Site specific design considerations

The site specific design considerations should be applied to this development to assist in minimising additional risk.

1. Residential development: *The habitable floors of any residential development (including aged care) should be located above the PMF with the building structurally designed for the likely flood and debris impacts.*

2. Commercial development (including retail): *To cater for the safety of potential occupants, clients and visitors in commercial development there should be the provision of sufficient readily accessible habitable areas above the PMF.*

3. Child care facilities: *Childcare facilities must be located with floor levels above the PMF level.*

4. Car parking: *Any additional parking should be above ground level and have pedestrian access to a podium level above the PMF.*

5. Making buildings as safe as possible to occupy during flood events. *Ensuring buildings are designed for the potential flood and debris loadings of the PMF so that structural failure is avoided during a flood.*

6. Limiting exposure of people to floodwaters. *This can be aided by providing sufficient readily accessible habitable areas above the PMF to cater for potential occupants, clients, visitors and residents.*

7. Provision of public accessible space for the itinerant population in areas surrounding intensive development in Parramatta CBD. *Provision of publically accessible space or access to space above*

the PMF (with adequate infrastructure to enable the physically impaired to access such space) that is easily accessible 24 hours a day for seven days a week which is clearly identified for this purpose with associated directional signage.

8. Providing adequate services so people are less likely to enter floodwaters. *This includes access to ablutions, water, power and basic first aid equipment. Consideration must be given to the availability of on-site systems to provide for power, water and sewage services for the likely flood duration (up to 12 hours) plus a further period of up to 48 hours to provide allowance for restoration of external services.*

9. Addressing secondary risks of fire and medical emergencies during floods. *Where there is no CBD wide strategy to address secondary risks during flooding. The proponent needs to consult with the relevant emergency service agency.*

Parramatta CBD general considerations

1. Sensitive development including child care: *All new emergency response hospitals, childcare and primary school facilities in Parramatta CBD should be located on land outside the extent of the PMF on land were service interruption is likely to be limited.*

2. Secondary schools and day hospitals: *Ideally new day hospitals and secondary school classrooms should also be located above the PMF level. However, at minimum there should be within a day hospital and high school building, the provision of access to adequate space above the PMF for patients, high school students, staff and visitors.*

3. Reducing human behaviour risks through businesses, schools and childcare centres. *Undertaking regular exercising of a building flood emergency response plan similar to a building fire evacuation drill.*

4. Increasing the flood awareness of current and future communities. *Council should have community awareness strategies that include requiring current and future building owners to participate in increasing this awareness.*

5. Parramatta CBD PA system. *There needs to be consideration given to developing a Parramatta CBD PA system like Sydney CBD to communicate evacuation directions and safety messages to the Parramatta CBD population in the lead up to and during a flood to assist in improving the safety of the community.*

6. Addressing secondary risks of fire and medical emergencies during floods. *To minimise the increased risk of fire and to reduce both the potential for adverse outcomes in the case of a medical emergency and the risks to those who may aid the patient, Council, DPE, NSW SES, Ambulance NSW and the relevant Health Functional area and fire agency servicing the area, should be consulted to determine appropriate risk management strategies during flooding.*

6.3 PLANNING PROVISIONS

The following recommendations take into account the results of the risk evaluation in Section 5.7 and the outcomes of the workshop summarised in Section 6.1 and the recommendations of the NSW SES in Section 6.2. Following is a discussion of recommended planning principles which be applied in the development of the planning proposal for the CBD. It includes some specific measures which should be incorporated into an update of Clause 6.3 of the Parramatta LEP and Section 2.4.2.1 of Parramatta DCP 2011 including Table 2.4.2.1.2 Floodplain Matrix. The revision of the LEP and DCP and the selection of precise wording is a detailed town planning exercise which is beyond the scope of this floodplain risk management plan revision.

It is stressed that these recommendations only relate to the DCP as it applies to the Parramatta CBD and its flood risks. They may not be appropriate for floodplains in other parts of the Parramatta LGA. The LEP provisions would also only apply to the Parramatta CBD.

The following discussion makes reference to the various planning considerations set out in the LEP and DCP.

6.3.1 Flood Risk Precincts

The current DCP divides the floodplain into three flood risk precincts: low, medium and high. However, these are generally defined by the extent of the PMF, 100 Year ARI and 20 Year ARI floods respectively with some consideration of high hazard flooding within the 100 Year ARI extent. They therefore do not so much represent flood risk but mostly flood probability which is only one contributor to risk. As discussed in Section 6.2.6, the current precinct classification results in unnecessarily onerous requirements in some circumstances and inadequate requirements in others with regard to managing risk to life.

There was already a recommendation that the definition of the flood risk precincts be reconsidered.

It is therefore recommended that consideration be given to using criteria in addition to flood probability in defining risk precincts. The method used in Section 5.8 is one approach which could be used but there may be better ways of doing this, particularly when better information is available from the new flood model. Alternatively, additional overlays could be used which define additional considerations to flood probability.

6.3.2 Unsuitable Landuse

Table 2.4.2.1.2 identifies most land uses as being unsuitable in the High Flood Risk Precinct, Critical Uses and Facilities and Sensitive Uses and Facilities as being unsuitable in the Medium Flood Risk Precinct and Sensitive Uses and Facilities being unsuitable in the Low Flood Risk Precinct.

Table 2.4.2.1.1 lists Sensitive Uses and Facilities as: community facilities or public buildings which may provide an important contribution to the flood event; child care centres; hospitals; residential care facilities; senior housing; educational establishments.

This is consistent with the recommendations of the NSW SES as set out in Section 6.2.

It does not have a category called Critical Uses and Facilities but rather Critical Utilities and Uses which includes: Hazardous industries; Hazardous storage establishments; Offensive industries; Offensive storage establishments; Liquid fuel depots; Public utility undertakings which may cause pollution of waterways during flooding, are essential to evacuation during periods of flood or if affected during flood events would unreasonably affect the ability of the community to return to normal activities after flood events; Telecommunication facilities; Waste management facilities.

As it is in the DCP the table can only identify these as being unsuitable not prohibited. Only the LEP is able to prohibit development.

Nevertheless, while there is logic in the identification of these landuses as being unsuitable in some of the flood risk precincts, there are two issues which are overlooked by the DCP.

Firstly, many sites span more than one flood risk precinct and the matrix would suggest they are suitable in one but not the other yet the higher risk precinct gets used to determine the permissibility of a particular development. Council should consider if there is a more appropriate methodology to assess this type of site.

Consideration could be given to setting some additional objective based development controls for some of these land uses.

6.3.3 Minimum Floor Levels

a) Residential

The minimum habitable floor level of residential buildings should be maintained at the 100 year ARI plus 0.5m freeboard. This is consistent with the Section 9.1 Direction. However, it is also recommended that in areas with a chance of hazardous flood depths or longer duration flooding in the PMF that residents shelter in place above the PMF. It is logical that the best place for them to do that would be in their own apartments.

It is therefore recommended that where the street entrance for a dwelling on a flood island could be flooded in a PMF for more than three hours, that the minimum floor level for the dwelling should be constructed at the level of the PMF plus a freeboard.

This would not be consistent with the Section 9.1 Direction which states:

A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).

Exceptional circumstances exist in Parramatta CBD which warrant flood planning controls to residential development above the residential flood planning level. In particular, there are short warning times, rapid rates of rise, and no practical means of evacuating the existing populations from the floodplain. Furthermore, the numbers of people who could be isolated by flooding will increase under the existing planning instruments. This planning proposal provides the opportunity for planning controls to be introduced so that as development takes place the risk to life for individuals is reduced.

Alternatively, the same flood risk management outcomes could be achieved by applying planning requirements for other purposes. For example, stipulating that buildings in particular areas must have commercial development on the ground floor and minimum ceiling heights. By default this will set minimum floor levels for residential dwellings which would be well above the residential flood planning level.

As these recommendations are aimed principally at reducing risk to life, it is arguable that it would be better for these particular provisions to be included in the LEP rather than the DCP. In this way they cannot be easily overridden, particularly as they are not consistent with common practice.

b) Commercial

The current requirement to have all commercial floor levels at the 100 Year ARI flood level plus freeboard fails to recognise the high variability in the nature of commercial premises and the opportunities to use areas below the 100 Year ARI with minimal flood damages. It is also resulting in developments with retail spaces which do not address the street well because they require stepping up from the footpath into the building.

It is therefore recommended that particular classes of retail development be permitted to have areas below the 100 Year ARI level if it can be demonstrated that flooding will not cause significant losses to the contents at that level. For example a restaurant may have its kitchen above the flood planning level but the tables and chairs could be set out at a lower floor level. The tables and chairs (and the floors and walls for that matter) would need to be made of flood compatible materials so that they could be cleaned and reused following a flood.

An even broader range of commercial developments may be appropriate at street levels below the 100 Year ARI if the space can be sealed water tight. We would recommend permitting any retail development with a floor level at street level providing that all of the retail space is sealed watertight when the doors are closed. Provision would have to be made to ensure that occupants can access a flood free location from within the building. There would also have to be engineering standards with which the sealing would have to comply.

It is recognised that this would be a change in direction in Parramatta Council's floodplain management principles. However, flooding is only one consideration in urban planning and design and providing that risk to life can be management appropriately and the commercial risks are outweighed by the commercial benefits, such a change may be justified.

6.3.4 Building Components and Soundness

The existing provisions within the DCP are generally satisfactory. If some retail space below the current flood planning level is permitted (see 6.2.2 b) then the current DCP requires that they be flood compatible which is appropriate. Further provisions may need to be included if it is proposed that it be permissible to dry waterproof some commercial development below the 100 year ARI flood.

6.3.5 Flood Affection

The current DCP requirements with regard to flood affectation are sound. However, the way in which some developments have complied with this requirement in terms of under building flow paths has led to some architecturally unattractive and hydraulically questionable buildings.

We would recommend that provision be included within the DCP which requires more than an engineer's report that it does not affect flooding.

6.3.6 Car Parking and Driveways

The existing provisions in the DCP in relation to car parking and driveways are designed to:

- maximise the opportunity for vehicles to evacuate from premises without driving through high hazard floodwaters
- minimise the chance of multivehicle car parks being inundated
- eliminate the risk of people being exposed to floodwaters cascading into basement carparks.

These are all laudable objectives and the provisions in the DCP are an appropriate way of achieving that.

However, if it is accepted that vehicular evacuation from the CBD, or at least those areas which are flood islands, is not a practical proposition, then a different approach is required.

For example the current DCP requirement of providing a driveway no lower than 0.2m below the 100 year ARI flood level is redundant if the access roads some distance from the building are all lower than this. What is needed in the CBD is a means of preventing vehicles from leaving the car parking areas if water has reached hazardous levels in the access roads. If this is not practical then there needs to be a means of preventing vehicles leaving the car parking areas once the water outside the carpark entrance reaches the level of the footpath.

The DCP currently uses the 100 year ARI flood to define the level of protection afforded to multiple vehicles in a car park. This is an appropriate level of protection given their relative worth compared to building contents which are afforded a similar level of protection. These provisions can be maintained.

The final provision relates to basement car parks with design principle P.14 requiring these, if there is no alternative viable parking arrangement, to be protected from the PMF. This is not to protect the vehicles but to protect people who may be in the carpark from water cascading into the carpark and putting their lives at risk. This is supported as an objective.

Additional guidance may need to be provided in the DCP as to what are acceptable solutions. For example, a car park driveway with its crest above the PMF level would be a failsafe means of ensuring a basement car park does not flood. However, there are other means of keeping floodwaters out which require less space such as flood gates or doors which are triggered by flooding or even are floated into place by rising floodwaters.

These alternatives have some chance of failure and decisions need to be made about the level of reliability which needs to be demonstrated by solutions which might be proposed.

6.3.7 Evacuation

The DCP has three requirements in relation to evacuation of residential and commercial development.

For either type of development in any of the flood risk precincts the "Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan." This is appropriate and should be maintained as a requirement.

For residential development in any flood risk precinct and for commercial development in the medium and high flood risk precinct the requirement is "Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site."

This is not consistent with the results of the analysis undertaken for this project. Table 8 compares the evacuation provisions of the current DCP with those suggested by the

analysis in Section 5.7. As previously discussed, vehicular evacuation is not required, at least in the flood island areas. Furthermore, pedestrian evacuation off site is only recommended where the assessed risk to life was negligible or very low which is at the fringes of the areas with rising access and even in the areas with low risk to life, refuge above the PMF is not essential. At the same time, the Section 5.7 method is suggesting that commercial development above the 100 year ARI level needs access to a location above the PMF where depths or velocities in the PMF are high.

Given that the areas with the lowest levels of risk to life only represent a small part of the floodplain, the simplest interim change to the DCP would be to remove reference to vehicular evacuation and make this requirement apply to all residential and commercial development.

The practical implication of this is that it will not encourage developments to have a building entrance at the location with the lowest flood risk to life and it would also not require development in the high flood risk precinct to have any additional controls over those in the low or medium risk precincts. Additional controls are needed in the DCP to encourage:

- Building entrances at a point of lowest flood risk to life on a lot
- Consolidation of lots where this will connect a lot with a higher flood risk to life with a lot with a lower flood risk to life
- Pedestrian overbridges which give developments access to lots with a lower risk to life which are on the other side of a road

It is strongly recommended that the above listed access points be flood free in at least the 1% AEP flood. This is so that emergency services have a very low probability of not being able to access the building and occupants have an extremely low probability of not being able to exit the building if another emergency arises in the building while there is flooding outside. Given that this is fundamentally about minimising risk to life there is merit in this being included in the LEP rather than the DCP so that it cannot be easily overridden.

Controls are also needed to prohibit isolated developments in the high flood risk precinct.

Redevelopment of the CBD will result in the creation of new areas of public open space or public domain areas and these and existing public spaces are likely to be used by more people, more often. Currently the DCP only requires that these areas have reliable pedestrian access during a 20 year ARI peak flood and that their development is consistent with any relevant flood evacuation strategy.

We would recommend that a flood emergency response strategy be developed for the public areas of Parramatta CBD which considers flooding up to the PMF. We also recommend that the development or redevelopment of any public open space provide pedestrian pathways of sufficient capacity for all users to be able to walk ahead of a flood rising as fast as a PMF to a location above the PMF. We recommend that these paths be continuously rising to at least above the 100 year ARI flood level and thereafter not drop below this level.

It is noted that there are large areas of publicly accessible space around Parramatta Train Station and Bus Interchange which is flood free. Furthermore, Westfield Shopping Centre is also mostly flood free and should be considered, in consultation with the centre management, as a potential place of flood refuge as part of a CBD flood emergency response plan.

Probably the best means of achieving any of these is by offering additional floor space ratio incentives to developments which do one of the above. This will essentially mean that the more people developers want to put in the floodplain, the lower they will have to make the probability that the entry to the building will be cut by hazardous floodwaters.

Table 8: Evacuation Planning Provisions

Probability (AEP)	Existing Flood Risk Precinct	DCP Evacuation requirements for residential and commercial development	Risk to Life Category	Suggested Occupant Response
< 1%	Low	3. Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site (residential only) 4. Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan	1	Safe to evacuate or shelter in place. No evacuation controls required.
			2	Safe to evacuate early or shelter in place above PMF in accordance with a flood emergency response plan for the building.
< 5%	Medium	3. Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site 4. Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan 6. Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES and other authorised emergency services personnel	3	Evacuate early or shelter in place above PMF in accordance with a flood emergency response plan for the building providing flood free access is available to an exit through an area above the 1% flood level.
> 5%	High	As for medium flood risk precinct but only if development qualifies as concessional development	4	Evacuate early or shelter in place above PMF in accordance with a flood emergency response plan for the building providing flood free access is available to an exit through an area above the 1% flood level.

In the case of the high flood risk precinct, development should be prohibited altogether unless all occupants have reliable access to development in the medium flood risk precinct. Alternatively developments in medium or low flood risk precincts could be permitted to have increased floor space ratios if they dedicate land in the high flood risk precinct to open space uses.

Where commercial of residential development is in the medium risk precinct, or either is permitted as concessional development in the high flood risk precinct, it is a requirement that "adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES and other authorised emergency services personnel." This is in addition to the other requirements above, and is appropriate and should be retained.

6.3.8 Management and Design

There are currently no management and design requirements for development in the low flood risk precinct. Residential and commercial development in the medium flood risk precinct or as concessional development in the high flood risk precinct must have:

- A Site Emergency Response Flood Plan
- An area to store goods above the 100 Year ARI flood plus freeboard
- No storage of materials below the 100 year ARI flood.

These are all appropriate but concessions with regard to the latter two requirements would need to be made if commercial development were permitted below the 100 year ARI flood level by any of the means suggested in Section 6.3.2.

We would also recommend the following additional requirements for any development which has a building entry more than 0.6m below the level of the PMF:

- The building have a building fire management system to meet ABC requirements for high rise buildings
- The building management review the Site Emergency Response Flood Plan annually or following a flood exceeding a 20 year ARI event and communicate the plan to all occupants

The exact wording of the provisions would need to be developed as part of the DCP review.

This is also the most appropriate place within the DCP to introduce provisions to prevent the current practice of having fire doors which open at street level and would be at depth in a flood. We would recommend that the fire doors be at least 0.5m above the level of the 100 year ARI flood. This would encourage building design which puts the fire exit on the high side of the building but also could be achieved by having the last part of the fire exit from the building external to the building.

Additionally, we would recommend that the DCP have provisions to the effect that critical building infrastructure, such as critical electrical, sewer, water and lift infrastructure be placed above the level of the PMF. This will reduce the likelihood that power or water would be disabled during a flood and also decrease the time that the building would be unliveable following the flood. The Queensland Reconstruction Authority has recently published guidelines for resilient electrical infrastructure which includes design guidelines for flood resilient electrical infrastructure in multistorey buildings (QRA, 2019).

6.3.9 Other Considerations

a) Controls on Residential Development above the Flood Planning Level

Most of the redevelopment within the Parramatta CBD is likely to be either entirely commercial development or will be mixed use residential and commercial development.

Mixed use development is likely to have commercial development on the ground floor with residential development above it. As discussed in Section 6.3.3, this may be a way of ensuring that minimum residential floor levels are above the PMF in areas where that is appropriate for managing risk to life in a way which does not contravene the provisions of the Section 9.1 Direction without the need for the granting of exceptional circumstances.

Similarly, recommended provisions with regard to refuge above the PMF, fire management systems, emergency power and water, protection of basement car parks and provision of a building specific FERP, could all be imposed as requirements on the commercial development in such a way that they make adequate provision for the residential development.

However, our recommendation that residential development be prohibited in some locations or be conditional upon it being connected to an area of less flood risk may be incompatible with the Section 9.1 Direction.

The Section 9.1 Direction and guideline appear to say three slightly different things in relation to controls on residential development.

The Section 9.1 Direction states:

"A planning proposal must not impose flood related development controls above the residential flood planning level for residential development on land unless a relevant planning authority provides adequate justification for those controls …"

This could be interpreted to permit residential development on top of commercial development without any flood related development controls, even if the land on which the commercial development is built is below the 100 year ARI level, providing that the residential development is above the residential flood planning level.

The Guideline to which the Section 9.1 Direction refers creates more ambiguity as it states:

"Unless there are exceptional circumstances, councils should not impose flood related development controls on residential development on land with a low probability of flooding, that is, land above the residential FPL (low flood risk areas)."

This indicates that the controls cannot be applied where the land has a low probability of flooding (which is not what the Section 9.1 Direction says) but then provides to definitions of what that land is:

- Land above the residential FPL
- Low flood risk areas

The former is defined by the 100 year ARI plus 0.5 metres while the latter is usually defined, as it is in Parramatta's mapping, by the 100 year ARI. In areas which are reasonably flat, as parts of Parramatta CBD are, there can be a significant difference in the extent of the excluded area depending on which definition is used.

Given this ambiguity and the uncertainty around the ability to impose some of the controls it would be beneficial to use the arguments put forward in this report as *"adequate justification for those controls to the satisfaction of the Director-General"*.

b) Public Areas

The flood provisions in the LEP and DCP are very much focussed on managing the flood risks associated with the redevelopment of land within each city block. However, such development increases the use of public transport and increases traffic on the city streets. There is no real mechanism within the NSW planning system to manage flood risks associated with those activities.

The risk of traffic gridlock in Parramatta CBD's streets during a flood is real and, should floodwaters rise above the 100 year ARI level, occupants of those vehicles could have their lives at risk. Intensification of development in the CBD will not increase the maximum number of vehicles which could be so affected because the capacity of the streets will not increase. However, it could increase the chance of it happening because there is a higher probability that the streets would be grid locked.

Parramatta Station and the Bus Interchange are flood free but flooding will disrupt bus access and the flood producing weather is sure to disrupt trains. Intensification of CBD development will not change the probability of that occurring but it will increase the number of people affected by it. This will be people stranded in Parramatta unable to leave and those who wish to travel to Parramatta.

Both of these issues, along with the intensification of use of public domain areas, are emergency response issues which must be managed by a well-developed and resourced emergency response plan for the CBD. Such

an emergency response plan would consider flooding as one of many emergencies which need to be managed.

6.4 EMERGENCY PLANNING

Two of the actions which carry through into the updated floodplain management plan from the original floodplain management plan are:

- Update the local flood plan
- Continue developing the Parramatta River Flood early warning system

Both of these need to be informed by the analysis of life safety risks set out in this report and the recommended evacuation and shelter responses.

While it is proposed that buildings in categories 2 to 4 develop and maintain Flood Emergency Response Plans, these need to be consistent with an overarching Flood Emergency Response Plan for the CBD.

This plan would need to identify, amongst other things, which areas need to be warned and evacuated first, which are the safest evacuation routes and what are the most appropriate means of evacuation. It would also need to identify what areas should not be evacuated and what travel routes should be closed and under what circumstances that should occur.

Given the role of Parramatta as a major public transport hub, special consideration will need to be given to the role of public transport in flood emergency response.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

7.1.1 CBD Planning Proposal

There are existing flooding problems within the CBD that need to be addressed and redevelopment provides opportunities to reduce the level of risk to individuals and property.

With reference to the Section 9.1 Direction, it is acknowledged that the planning proposal contains provisions that apply to the flood planning areas which:

- (6)(a) permit development in floodway areas; and
- (6)(c) permit a significant increase in the development of that land

As provided for in clause (9) of the Section 9.1 Direction, these inconsistencies are permissible if "the planning proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005.

The risk assessment in this report has been carried out in line with the principles and guidelines of the Floodplain Development Manual (2005). It is our view that the planning proposal presents a tolerable flood risk to life and property if the recommendations made within this report, with regard to DCP revisions and other flood risk management measures, are implemented.

This conclusion has been made recognising that while the planning proposal increases the overall population at risk, it will also provide the opportunity to decrease the risk to that population through encouraging re-development which is more compatible with the flood risk.

This work has been undertaken using existing flood modelling information, which is currently being updated by Council through a new flood study. It is recommended that the risk to life assessments undertaken as part of this project be revisited following the completion of the flood study, or as part of a subsequent floodplain risk management study.

7.1.2 Planning Investigation Area

The Planning Investigation Area being considered for expansion of the Parramatta CBD is mostly flood free, and as such there would be almost no flooding constraints for redevelopment. The revisions to the planning controls recommended for the CBD Planning Proposal would be sufficient to manage flood risks in the Planning Investigation Area.

7.1.3 Parramatta North Urban Renewal Area

The Parramatta North Urban Renewal Area is almost completely within the Parramatta River floodplain and therefore careful consideration needs to be given to planning controls for that area. Although this report has not investigated flood risks in the Parramatta North Urban Renewal Area, it is likely that it would need similar planning controls to the Parramatta CBD up to the PMF flood extent.

7.2 RECOMMENDATIONS

It is recommended that the City of Parramatta Council adopt the Floodplain Risk Management Plan set out in Section 8 of this report. This plan:

- Carries forward matters from the current Floodplain Risk Management Plan which have not been completed
- Carries forward matters from the current Floodplain Risk Management Plan which had been investigated and not implement but warrant re-investigation in light of the CBD planning proposal
- Proposes continuing development of the flood early warning system for the Parramatta River
- Proposes the preparation of a Flood Emergency Evacuation Plan for the CBD
- Proposes seeking Ministerial Approval to amend Parramatta LEP 2011 with regard

to controls above the Flood Planning Level

- Proposes a revision of the Parramatta DCP 2011 with regard to flooding

The revision of the LEP should address specific recommendations in this report to ensure the Parramatta CBD Planning Proposal meets the section 9.1 direction and represents a tolerable risk to life and property. In particular, it is recommended that the City of Parramatta Council seek Minister Approval to impose controls for development within the Probable Maximum Flood area to enable occupants of buildings in identified areas that have particular evacuation or emergency response issues to:

(a) shelter within a building above the probable maximum flood level; or

(b) evacuate safely to land located above the probable maximum flood level.

Specific provisions should require that new buildings or significant alterations and additions to existing buildings contains either a safe area with emergency electricity and water for all occupants to take refuge in that is located above the probable maximum flood level, or flood free pedestrian access is available between the building and land that is above the probable maximum flood level; and the building is certified by an engineer to withstand the forces of floodwaters, debris and buoyancy resulting from a probable maximum flood event.

The provision of shelter above the PMF level and a building access at or above the 1% AEP flood level should be included within the LEP rather than just in the DCP to ensure that these minimum life safety measures are applied to all developments.

The revision of the DCP should address specific recommendations in this report to ensure that the Parramatta CBD Planning Proposal represents a tolerable risk to life and property. In particular it is recommended that the following amendments to the DCP provisions be made:

- Planning controls not be triggered solely by flood probabilities but other risk factors such as flood depth, velocity, hazard, rate of rise and duration in the full range of floods. This may require renaming or redefinition of the current flood risk precincts although that may be more appropriate following completion of the new flood study
- Consideration be given to permitting some types of commercial development at street level where this is below the current flood planning level, providing they are designed to minimise damage to property and risk to life
- Where the street entrance for a dwelling could be flooded in a PMF for more than three hours require safe refuge for all occupants above the level of the PMF plus a freeboard
- Where the street entrance for a dwelling could be flooded in a PMF for more than eight hours require that the minimum floor level for the dwelling be constructed above the level of the PMF plus a freeboard and have access to emergency water and power
- Additional requirements be considered with regard to flood affectation provisions to try and eliminate the construction of buildings with under building flow paths which are architecturally unattractive and/or hydraulically questionable
- Remove the requirement for buildings in the CBD to have driveways which allow safe access in a 100 year ARI flood and consider including a provision that prevents vehicles from leaving the car parking areas if water has reached hazardous levels in the access roads
- Remove requirements for vehicular evacuation
- Introduce development incentives such as increased floor space ratios to developments which provide building egress points with a lower depth of flooding in a PMF. This will encourage lot consolidation or elevated walkways to provide pedestrian connection to lower flood risk areas
- Prohibit residential and commercial habitable floors in the current high flood risk precinct unless there is a flood free pedestrian access to a building outside of the high flood risk precinct
- Introduce development incentives such as increased floor space ratios to developments which dedicate high flood risk land to open space uses as an

alternative to habitable buildings on that land

- If commercial developments are permitted at street level below the flood planning level then permit the storage of goods below the flood planning level provided they are protected from floods up to the flood planning level
- Require buildings which have their highest building egress more than 0.6m below the level of the PMF to have:
  - a building fire management system to meet ABC requirements for high rise buildings
  - The building management review the Site Emergency Response Flood Plan annually or following a flood exceeding a 20 year ARI event and communicate the plan to all occupants
- External fire doors be above the level of the 100 year ARI flood plus 0.5m
- Critical services infrastructure that could be damaged by flooding; such as electrical, lift, sewer and water are placed above the PMF.

8 UPDATED FLOODPLAIN RISK MANAGEMENT PLAN

The recommended updated floodplain risk management plan is essentially the sum of the recommended measures within Table 2 and Chapter 6. These have been amalgamated below in Table 9. The responses have been prioritised into High, Medium and Low categories. High priority has been given to measures that could be implemented immediately and would have an impact on the flood risk for the current population at risk. Medium was assigned to measures that could be implemented in the medium term and would reduce the risk of any proposed development.

Table 9: Updated Floodplain Risk Management Plan Measures

Proposed Measure	Measure Type	Priority	Source
Make revisions to the DCP as outlined within Section 6.2 and 7.2 of this report	Planning Control	Medium	Existing Plan Review
Council to develop a policy with respect to fencing and screening within floodways. Consideration should be given to the potential for blockage of the screen and effectiveness of the screen to convey water	Planning Control	Medium	Existing Plan Review
Council to consider ways in which it could be made clear that the S10.7(2) certificates do not contain all flooding information. Recommended that a guide to making the decision of purchasing S10.7(2) or S10.7(5) is included within the application form	Planning Control	Medium	Existing Plan Review
Council to consider ways in which S7.11 contributions could be made towards flood mitigation projects	Planning Control	Medium	Existing Plan Review
Council to encourage the NSW SES finalise their development of the Local Flood Sub Plan	Response Modification	High	Existing Plan Review
Council review the availability of flooding data to the public and develop a community awareness and education policy and program for ensuring the population at risk is aware of the flood risks to life and property	Response Modification	High	Existing Plan Review
Council continues developing the Flood Early Warning System for Parramatta CBD and includes a program for review and continuous improvement of the system	Response Modification	High	Existing Plan Review
Council to encourage Sydney Water to conduct a review of the maintenance program for the channel including removal of rubbish and excess vegetation	Flood Modification	Medium	Existing Plan Review

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10 GLOSSARY

THE AUSTRALIAN BUILDING CODES BOARD (ABCB) The organisation responsible for setting and maintaining the national construction code, which defines the minimum safety and design requirements for the construction of buildings

ANNUAL EXCEEDANCE PROBABILITY (AEP): The likelihood of a flood being exceeded in any given year. For example, a flood with an AEP of 1% or 1 in 100 has a 1 in 100 chance of being exceeded in any given year. Synonymous with

AVERAGE RECURRANCE INTERVAL (ARI): The long-term average number of years between the occurrence of a flood as big as or larger than the selected event. For example, floods with a discharge as great as or greater than the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.

AUSTRALIAN HEIGHT DATUM (AHD): The standard reference level used to express the relative elevation of different features. A height given in metres AHD is essentially the height above sea level.

BACKWATER: An area inundated by water from a river but outside the general flow of the river.

BANKFULL: The condition of a river when flow is so great that no river banks are exposed.

BoM: The Bureau of Meteorology is the Australian Government Agency responsible for providing weather forecasts. Its legislated responsibility includes, "the issue of warnings of gales, storms and other weather conditions likely to endanger life or property, including weather conditions likely to give rise to floods or bush fires."

CATCHMENT: The land surface area that drains into a reservoir or to a specific point in a river system.

CONTRAFLOW: Altering the normal direction of flow of traffic.

DESIGN FLOOD: A flood where the levels at all points along the river have the same chance of occurrence. It is estimated using hydrologic and hydraulic computer models.

DISCHARGE: The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s).

Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

EVACUATION: The movement of people from a place of danger to a place of relative safety, and their eventual return.

EVACUATION TRIGGER: The flood level that triggers evacuation of a particular area, usually given as the when the evacuation route is cut off by floodwaters or when the area is inundated.

FLASH FLOODING: Flooding that occurs without sufficient warning, usually from heavy local rainfall. For its flood warning purposes, the BoM defines it as flooding which occurs six hours or less from the onset of rain.

FLOOD EMERGENCY RESPONSE PLAN: A plan that sets out the actions and triggers for actions in response to a flood emergency. Usually undertaken on a development scale.

FLOOD FREE: An area that is unlikely to become inundated by flood waters even in a PMF.

FLOOD ISLAND: An area that may be inundated by floodwaters but is initially surrounded before becoming inundated.

FLOODPLAIN: That part of a river valley, adjacent to the river channel, over which a river flows in times of flood.

FLOOD PROGRESSION: The way in which the flood moves across an area.

FLOOD STORAGE: Areas within a flow path that provide critical temporary storage of waters during a flood

FLOOD STUDY: A study commissioned by a Council or Developer to determine the flood extents and levels of an area, utilising hydraulic modelling and hydrological calculations.

FLOODWAY: The area within a flow path that carries the majority of the flow and has higher hazard than the other portions of the flow path

FREEBOARD: A factor of safety that is usually expressed as a height above the designed flood level.

GEOGRAPHIC INFORMATION SYSTEM (GIS): A type of software system that is used to interrogate and undertake analysis on spatial data.

HAZARD: Flood hazard is generally defined by the depth and velocity product which is then categorised based on meaningful thresholds.

HYDROGRAPH: A graph showing the variation over time of water levels or flow.

LOCAL FLOODING: Flooding that occurs as a result of rainfall falling directly over the development.

OVERBANK FLOWS: River flows which cannot be contained within a river channel.

PEDESTRIAN EVACUATION: Evacuation by walking. Pedestrian evacuation should not be relied on as a primary means of evacuation, but may be built in to an evacuation plan as a failsafe mechanism should vehicular evacuation fail in extreme or unforeseen circumstances.

PREMISE: A building or development that is likely to be occupied by residents or employees.

PROBABLE MAXIMUM FLOOD (PMF): The largest flood likely to occur.

RISK: Flood risk is defined as the probability of the event occurring multiplied by the consequence, which can be made up of a number of factors (depth, velocity, damage, duration etc.)

RISING ROAD ACCESS: An evacuation route along a road which is constantly rising to a higher level and eventually to a level above the PMF.

RIVERINE: Of or pertaining to a river.

SECONDARY EMERGENCY: An emergency, such as a fire or medical emergency, that occurs during a flood.

SHELTER IN PLACE: A flood emergency response where the occupants of a premise remain in place until the flood has passed.

APPENDIX A– REVIEW OF EXISTING PLANS

Number	Study Area	Measure Type	Proposed Measure	Review Actions	Status	Revised Measure
1	Lower	Planning Controls	Establish a graded set of planning controls for land uses relative to flood risk that is consistent with the floodplain development manual	Reviewed the current DCP, consulted Flood Policy Review report prepared previously by Molino Stewart	This measure has been implemented, however a suggestion of the Parramatta Flood Policy Review undertaken by Molino Stewart is to consider revising the wording of the DCP which lists terms the precincts as "risk" when these are largely based "hazard" categories. However, this terminology has been adopted across a number of Council DCPs throughout NSW.	It is proposed that Council consider the wording of the DCP to better reflect the nature of the precincts
2		Planning Controls	A range of suggested changes to Parramatta REP 28	Review the Parramatta REP 28 and DCP	The legislation with respect to REP has been repealed, the recommended changes for the REP have been largely carried through the relevant clauses of the updated DCP	N/A
3		Planning Controls	Amend the LEP to provide consistent framework for more detailed controls to be provided in DCP	Reviewed the current LEP and DCP	It is understood that Parramatta LEP 2011 uses the Standard Instrument LEP and the wording is essentially dictated by the Department of Planning and Council has very limited scope to modify it. Clause 6.3 of the Parramatta LEP outlines Flood Planning and only applies to land below the 1:100 ARI flood event plus 0.5 m freeboard. The approach in this clause is not consistent with the Floodplain Development Manual which emphasises a merit based approach and consideration of floods up to the PMF. However, aspects of the DCP do consider the full range of floods The suggested amendment to the LEP are generally captured in the Parramatta DCP. However, the DCP doesn't define a scope for Council to consult with relevant agencies such as the NSW Office of Environment or the NSW State Emergency Service.	It is proposed to include a clause within the DCP along the lines of "The Council may consult with and take into consideration, any advice of the Office of Environment and Heritage, the NSW State Emergency Service and any other relevant agency, in relation to the nature of the flood hazard, the necessity and capacity to evacuate persons, and the consequence and suitability of the development." It is recommended Council consider implementing the requirement for basement car parks to be protected up to the level of the PMF and to determine whether this would be in contradiction to the standard instrument LEP
4		Planning Controls	Utilise the foreshore building line provisions within the LEP to provide greater weight to planning decisions with respect to the high flood risk precinct	Review the current LEP and location of the foreshore building line	The plan recommends matching the foreshore building line to the boundary of the high flood risk precinct. Examination of the foreshore building line does not appear to be coincident with the high flood risk precinct (particularly around George Kendall Park). This suggests that this recommendation has not been implemented. Discussion with Council officers suggests that this recommendation has been found to be unfeasible	N/A
5		Planning Controls	Amend current DCP and Policy as per recommendations found within Appendix C	Review the Appendix C of the Plan, the current DCP and Flood Policy	The policy and DCP are generally not as prescriptive as Appendix C, particularly in terms of the Information Required as part of a DA. The planning control matrix found within the DCP is similar to the recommended matrix within Appendix C of the original Plan. There is no mention of requirements with respect to fencing or screening within the DCP	Council to develop a policy with respect to fencing and screening within floodways. During our investigations a number of screens that are intended to allow flood waters to pass below the building would not be effective and would be prone to blockages.
6		Planning Controls	Notations on Section 149(2) Certificates as per UPRC FRMP	Review of current S149 certificates	There is currently an issue with respect to the S149 certificates as a copy of the S149(2) certificate will not contain flooding information. This is generally not explained to those requesting the S149(2) certificate.	Recommendation that a note should be added, or a guide for those applying for the S149 certificate to ensure that if they require flooding information that they are directed to purchase the S149(5)
7		Planning Controls	Consider specific S94 contributions for specific developments	Review the current S94 Plans	The plan suggests limited scope for S94 contributions towards mitigation measures, however, it recommends that this should be monitored for potential opportunities. The River foreshore park improvements are listed in the Civic Improvement Plan the design principles include improvements to the management of flood events.	Given the scale of the flooding problem within the CBD and also the extent of redevelopment currently occurring, it is recommended that the potential for S94 contributions for flood mitigation works is investigated further. This may require innovative and/or large scale works.
8		Property Modification	Proposed Voluntary House Raising and Voluntary House Purchase Policy	Council to advise	Council is currently operating a Voluntary House Purchase and Voluntary Housing Raising Scheme (Local Floodplain Risk Management Policy 2006)	Recommended that the Council await the outcomes of the current Flood Study prior to pursuing further voluntary house purchase of voluntary house raising.
9		Response Modification	Develop NSW SES Local Flood Plan	Check with SES	The Parramatta DISPLAN has some emphasis on flooding and is currently being updated. An SES local flood plan is currently being developed.	Given the nature and scale of the flood risks within Parramatta, it is recommended that resources are provided for the completion of the Local Flood Plan
10		Response Modification	Distribute Flood Risk Precinct Maps to flood affected lots	Check website, Council to advise	Flood Risk Precinct Maps are not readily available on the Council website and are only available through the flood enquiry application. Advice from Council is that these have not been distributed to areas that are at risk.	Council reviews the availability of flooding data to the public and to develop a policy or program for ensuring that the population at risk is aware of the flood risks to life and property.

11		Response Modification	Discussions re early warning system	Council to advise	Council is currently progressing the installation of a flood early warning system for the Parramatta CBD. The design and price of the system has been presented to the Floodplain Risk Management Committee and was approved by the Committee	Council continues the development of the Early Warning system and implements a continuous improvement and review process to ensure that the system is effective
12		Flood Modification	Ollie Webb Reserve detention basin	Council to advise	Constructed	N/A
13		Flood Modification	Thomas Reserve Box Culvert	Council to advise	Not Constructed after further feasibility investigations	N/A
14		Flood Modification	A'Becketts Creek de-snagging and removal of rubbish and veg	Council to advise	Council advises that this was likely done at the time but there is no ongoing action.	Council and Sydney Water conduct review of maintenance program for channel removal of rubbish, excess vegetation
15		Flood Modification	Duck Creek de-snagging and removal of rubbish and veg	Council to advise	Council advises that this was likely done at the time but there is no ongoing action.	As Above
16		Flood Modification	Duck River de-snagging and removal of rubbish and veg	Council to advise	Council advises that this was likely done at the time but there is no ongoing action.	As Above
17	Upper	Flood and Property Modification	Upgrade of Briens Road Culvert, 5 Voluntary Acquisitions (North Wentworthville FRMSP)	Council to advise	Complete	N/A
18		Flood and Property Modification	Bogalara Road Toongabbie – Pipe Upgrade and Augmentation	Council to advise	Complete	N/A
19		Flood and Property Modification	Oakes Road, Old Toongabbie House Raising (6 homes) and Flood Proofing (4 homes).	Council to advise	Complete – a number of properties owners did not participate	N/A
20		Flood and Property Modification	Wentworth Avenue to Burrabogee Rd, Pendle Hill Channel Formalisation, Culvert Upgrade and Construction of Drop Structure	Council to advise	Not Complete, Council is unsure of the status of this proposed work. I.e. whether it has been found to be unfeasible	Council to determine the reason that this work did not proceed
21		Flood and Property Modification	Burrabogee Rd to Barangaroo Rd, Pendle Hill – Pendle Hills Ck Floodway	Council to advise whether this has been constructed	Complete	
22		Flood and Property Modification	Edison Pde to Einstein Ave, Winston Hills Diversion of drainage around existing levee	Council to advise whether this has been constructed	Complete	
23		Flood and Property Modification	Barangaroo Rd to Fitzwilliam Rd, Pendle Hills – channel improvement and additional cell in Fitzwilliam Rd culverts	Council to advise whether this has been constructed	Complete – however no additional cell was included in the Fitzwilliam Rd culverts as it was not found to be feasible	
24		Flood and Property Modification	O'Connell, Ferris, Iron, Barney and Church St, North Parramatta – pipe upgrade and augmentation	Council to advise whether this has been constructed	Not completed – further investigations by Council and its consultant are on going	Council to continue investigating
25		Flood and Property Modification	Bellotti Avenue, Churchill Drive, Jerome Avenue, Defoe Place and Twain Street, Winston Hills— pipe upgrade and augmentation including modification of pits	Council to advise whether this has been constructed	Some works have been undertaken, others found not to be feasible	
26		Flood and Property Modification	Belmore Street transition chamber and Belmore Park, North Parramatta flood retarding basin.	Council to advise whether this has been constructed	Complete	
27		Proposed Investigation	Brickfield Creek FRMS	Check whether completed	Complete	
28		Proposed Investigation	Fletcher Cl, Old Toongabbie – Flood Wall	Council to advise whether this has been constructed	The investigation was completed and it was decided not to undertake the works	

29		Proposed Investigation	Campbell's Cash and Carry at Kleins Road and Boundary Road, Northmead — investigation into pipe augmentation or trunk drainage diversion works.	Council to advise whether this has been undertaken	The investigation was completed and the issues have been resolved through redevelopment	
30		Proposed Investigation	Scott Street, Andrews Avenue and Lamonerie Street, Pendle Hill— pipe augmentation and channel works.	Council to advise whether this has been undertaken	The investigation was completed and the issues have been resolved through redevelopment	
31		Proposed Investigation	Sherwood Street, Old Toongabbie levee (voluntary purchase completed in 1993).	Council to advise whether this has been undertaken	The investigation was completed and some works were implemented, however it was found that the levee was not required	
32		Proposed Investigation	Lister Street, Winston Hills levee extension and pump out — these works would be additional to the major diversion drain constructed in 1990 to prevent flooding from behind the existing levee.	Council to advise whether this has been undertaken	The investigation was completed and some works were implemented, however no pump was installed	
33		Planning Controls	Change REP No.28	Check App A Vol 2	This legislation has been repealed, therefore remove from the updated FRMP	
34		Planning Controls	Change Council LEPs	Check App B Vol 2	Suggests using foreshore building line as per above measure suggested in the Lower Parramatta FRMP, response as per Item 4.	
35		Planning Controls	Adopt and Implement DCPs or Policies consistent with Flood Planning Matrix and Plan	Check Appendix C	Complete	
36		Planning Controls	Review and revise existing 2(e) zonings over flood liable areas	Check LEP	2(e) zones now redundant as Parramatta LEP 2001 has been replaced, Flood Prone Land Map in New LEP appears to be updated	
37		Response Modification	Make up-to-date flood risk precinct maps readily accessible to public.	Check Council Website	Flood Prone Land Maps not available on Councils Website – obtainable through the LEP however this is difficult for members of public and not the intention of the plan	As Per Item 10
38		Response Modification	Define and map flood way limits in critical areas	Council to advise whether this has been undertaken	Council's current approach is to define hazard through mapping and it is the responsibility of the developer if a DA is submitted to determine the floodway extent. In the future the floodway extents will be defined through the new Flood Study that is currently being commissioned.	
39		Response Modification	Review and revise provisional flood risk precincts from Trust in light of access, warning time etc. considerations.	Council to advise whether this has been undertaken	Council has continued to revise flood precincts. A major revision will be undertaken as per the new Flood Study that is currently being commissioned.	
40		Response Modification	Prepare or adapt existing data to produce flood risk precinct maps for other catchments.	Review existing studies and plans	Flood study reviews or catchment management plans undertaken for Subiaco, Vineyard, Duck, Claycliff Creeks as well as Duck River and localised flooding areas, also the Parramatta Flood Study is currently being reviewed	
41		Response Modification	Collate data on local overland flooding for ready access and use.	Look over data provided, discuss with Council	This will be undertaken with the new Flood Study that is currently being commissioned	
42		Response Modification	Prepare and run an ongoing program to raise community awareness of flood risks	Council to advise whether this has been undertaken	Currently community awareness and education is only being undertaken as per the community consultation that is required under the floodplain risk management process.	Council to develop a community awareness and education program, as per Item 10
43		Response Modification	Brochure on flood-related building controls available.	MS Check Website Council to advise whether this has been undertaken	Council is currently preparing a number of brochures internally, however these are not publically available.	Recommended that the production of brochures with respect to building controls are completed alongside the recommendations outlined in Item 10

44		Response Modification	All councils to send flood notification letters to all owners of flood liable properties every 4 years.	Council to advise whether this has been undertaken	This has not been undertaken	As per Item 10
45		Response Modification	Prepare and make widely available a flood information brochure 'Facts about Flooding'.	MS Check Website Council to advise whether this has been undertaken	This has not been undertaken, however some flooding information is now available on Councils website.	As per Item 10
46		Response Modification	Prepare and make widely available a frequently asked questions brochure.	MS Check Website Council to advise whether this has been undertaken	This has not been undertaken	As per Item 10
47		Response Modification	Consider providing flood certificates or equivalent S149 certificates with comprehensive data on flood levels, ground/floor levels and the flood risk precinct.	Request S149 certificate for flood prone property	This information is available through the flood enquiry application. The form for the flood enquiry can be found online.	
48		Response Modification	Consider using proposed wording for S149(2) certificates.	Request S149 certificate for flood prone property	The S149 certificates currently have an issue as per Item 6	As per Item 6
49		Response Modification	Develop and implement a formal process for release and adoption of updated flood data estimates.	Council to advise whether this has been undertaken	This is undertaken as per the Public Exhibition process when a new Flood Study is undertaken.	

APPENDIX B– CURRENT PARRAMATTA DCP (2011) FLOOD PROVISIONS

2.4 Site Considerations

2.4.1 Views and Vistas

The topographical setting of Parramatta, located in a river basin and bounded by hills to the north and west, means that there are significant views and vistas which contribute to the sense of place for Parramatta. Preservation and, where possible, enhancement of public views to landmark and landscape features allows people to interpret and appreciate the special character of Parramatta.

View sharing between properties is also important to balance access to private views from properties.

Objectives

O.1 To preserve and enhance district and local views which reinforce and protect the City's urban form and enhance legibility.

O.2 To encourage view sharing through complementary siting of buildings, responsive design and well-positioned landscaping.

O.3 To ensure highly visible sites are designed in scale with the City's setting and encourage visual integration and connectivity between places.

Design Principles

P.1 Development is to preserve views of significant topographical features such as ridges and natural corridors, the urban skyline, landmark buildings, sites of historical significance and areas of high visibility, particularly those identified in Appendix 2 Views and Vistas. Refer also to Views and Vistas in the Harris Park Heritage Conservation Area in Part 4 and Views and View Corridors in Parramatta City Centre in section 4.3.3.4.

P.2 Buildings should reinforce the landform of the City and be designed to preserve and strengthen areas of high visibility. In some locations, this may be achieved through uniform heights and street walls as a means of delineating the public view corridor.

P.3 Landscaping of streets and parks is to reinforce public view corridors.

P.4 Building design, location and landscaping is to encourage view sharing between properties.

P.5 Views to and from the public domain are to be protected.

NOTE: For certain developments, 3 dimensional computer simulations or photo montages from selected locations may be required to demonstrate how the proposal affects the setting and views and vistas.

2.4.2 Water Management

2.4.2.1 Flooding

Flooding is a significant issue that affects existing and future development in the Parramatta Local Government Area (LGA). This Section establishes Council's approach to floodplain planning and the general flood prone land requirements relating to development control for the whole LGA. The development of Council's approach to flooding has regard to and complies with the New South Wales Government's Floodplain Development Manual (FDM 2005).

The criteria for determining applications for proposals potentially affected by flooding are structured to recognise that different controls are applicable to different land uses and levels of potential flood inundation and hazard. As a first step in the development consent process, proponents are strongly advised to consult with Council officers, particularly for proposals located in the medium and high flood risk categories.

Objectives

O.1 To ensure the proponents of development and the community in general are aware of the potential flood hazard and consequent risk and liability associated with the use and development of flood liable land.

O.2 To manage flood liable land in an economically, environmentally and socially sustainable manner.

O.3 To ensure that developments with high sensitivity to flood risk (eg. critical public utilities) are sited and designed to provide reliable access and minimise risk from flooding.

O.4 To allow development with a lower sensitivity to the flood hazard to be located within the floodplain, subject to appropriate design and siting controls and provided that the potential consequences that could still arise from flooding remain acceptable.

O.5 To prevent any intensification of the development and use of High Flood Risk Precinct or floodways, and wherever appropriate and feasible, allow for their conversion to natural waterway corridors.

O.6 To ensure that the proposed development does not expose existing development to increased risks associated with flooding.

O.7 To ensure building design and location address flood hazard and do not result in adverse flood impact and unreasonable impacts upon the amenity or ecology of an area.

O.8 To minimise the risk to life by ensuring the provision of appropriate access from areas affected by flooding up to extreme events.

O.9 To minimise the damage to property, including motor vehicles, arising from flooding.

O.10 To incorporate the principles of Ecologically Sustainable Development (ESD).

Design Principles

P.1 New development should not result in any increased risk to human life.

P.2 The additional economic and social costs which may arise from damage to property from flooding should not be greater than that which can reasonably be managed by the property owner, property occupants and general community.

P.3 New development should only be permitted where effective warning time and reliable access is available for the evacuation of an area potentially affected by floods to an area free of risk from flooding. Evacuation should be consistent with any relevant flood evacuation strategy where in existence.

P.4 Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with similar developments(s) that are likely to occur within the same catchment.

P.5 New developments must make allowances for motor vehicles to be relocated to an area with substantially less risk from flooding, within an effective warning time.

P.6 New developments must provide an evacuation plan detailing procedures that would be in place for an emergency (such as warning systems, signage or evacuation drills).

P.7 Flood mitigation measures associated with new developments should not result in significant impacts upon the amenity of an area by way of unacceptable overshadowing of adjoining properties, privacy impacts (eg. by unsympathetic house raising) or by being incompatible with the streetscape or character of the locality (including heritage).

P.8 Proposals for raising structures must provide a report from a suitably qualified engineer demonstrating that the raised structure will not be at risk of failure from the forces of floodwaters.

P.9 Development is to be compatible with any relevant Floodplain Risk Management Plan, Flood Studies, or Sub-Catchment Management Plan.

P.10 Development must not divert flood waters, nor interfere with floodwater storage or the natural function of waterways.

P.11 Filling of land up to 1:100 Average Recurrence Interval (ARI) (or flood storage area if determined) is not permitted. Filling of and above 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood fringe) must not adversely impact upon flood behaviour.

P.12 New development must consider the impact of flooding resulting from local overland flooding whether it is a result of Local Drainage or Major Drainage.

P.13 Where hydraulic flood modelling is required, flow hazard categories should be identified and adequately addressed in the design of the development.

P.14 Council strongly discourages basement car parks on properties within the floodplain. Where site conditions require a basement car park on a property within the floodplain, development applications must provide a detailed hydraulic flood study and design demonstrating that the proposed basement car park has been protected from all flooding up to and including the PMF event. An adequate emergency response and evacuation plan must also be provided where basement car parks are proposed in the floodplain.

Design Controls

All proposals are to have regard to the planning matrix at Figure 2.7. The procedure to determine which design standards apply to proposed development involves:

Step 1: identify the land use category of the development from Table 2.6;

Step 2: determine which flood risk category applies to the land (refer to Catchment Management Unit of Council for the Flood Risk Precincts and relevant flood risk mapping); and

Step 3: apply the objectives and design principles as outlined in this section and then the design standards in the planning matrix at Figure 2.7 as applicable to the floodplain and land use category.

NOTE: An evacuation plan is not enough to negate compliance with all building regulations.

Additional guidelines relating to flood risk management and flood prone land are contained in Council's Local Floodplain Risk Management Policy.

Table 2.6: Land Use Category Definitions

NOTE: Refer to the Parramatta LEP 2011 for definitions of each land use.

LAND USE CATEGORIES	IDENTIFIED LAND USES
Sensitive Uses and Facilities	Community facilities or Public administration buildings which may provide an important contribution to the notification and evacuation of the community during flood events; Child care centres; Hospitals; Residential care facilities; Seniors housing; Educational establishments.
Critical Utilities and Uses	Hazardous industries; Hazardous storage establishments; Offensive industries; Offensive storage establishments; Liquid fuel depots; Public utility undertakings which may cause pollution of waterways during flooding, are essential to evacuation during periods of flood or if affected during flood events would unreasonably affect the ability of the community to return to normal activities after flood events; Telecommunication facilities; Waste management facilities.
Subdivisions	Subdivision of land which involves the creation of additional allotments.
Filling	The net importation of fill material onto a site, except where: (i) final surface levels are raised by no more than 100mm over no more than 50% of the site; or (ii) filling is no more than 800mm thick beneath a concrete building slab only. Compensatory earthworks, involving cut and fill, is not considered to be filling provided that: (i) there is no net importation of fill material onto the site; and (ii) there is no net loss of flood storage at all flood levels.
Residential	Backpackers accommodation; Bed and breakfast establishments; Boarding houses; Community facilities (other than sensitive uses and facilities); Dual occupancies; Dwelling houses; Group homes; Health consulting rooms; Home based child care; Home businesses; Hostels; Multi dwelling housing; Neighbourhood shops; Residential flat buildings; Serviced apartments; Public utility undertakings (other than critical utilities).
Commercial or Industrial	Bulky goods premises; Business Premises; Car parks; Depots; Entertainment facilities; Food and drink premises; Freight transport facilities; Funeral chapels; Funeral homes; Function centres; Hardware and building supplies; Heavy industries; Hotel accommodation; Industries; Landscape and garden supplies; Light industries; Materials recycling or recovery centres; Medical centres; Mixed use development; Office premises; Passenger transport facilities; Places of public worship; Public administration buildings (other than an essential community facility); Pubs; Recreation facilities (indoor); Registered clubs; Restricted premises; Retail Premises; Service stations; Sex services premises; Shop top housing; Tourist and visitor accommodation; Vehicle body repair workshops; Vehicle repair stations; Vehicle showrooms; Veterinary hospitals; Warehouse or distribution centres.

Land Use Category Definitions

LAND USE CATEGORIES	DEFINITIONS
Tourist Related Development	Advertising structures; Kiosks; Markets; Information and education facilities; Signage.
Open Space or Non-urban Uses	Animal boarding and training establishments; Boat launching ramps; Boat repair facilities; Boat sheds; Environmental facilities; Helipad; Jetty; Recreation areas and minor ancillary structures (e.g. Toilet blocks or kiosks); Recreation facilities (outdoor).
Concessional Development	Concessional development is any development or redevelopment that would normally not be permitted under this Plan, but may be permitted as a concession provided it: (i) is kept clear of any floodway; and (ii) involves an acceptably small (see below for limits) addition or alteration to an existing development that will not cause a significant increase in potential flood losses, risks or have an adverse impact on adjoining properties; or (iii) redevelopment for the purposes of substantially reducing the extent of flood affectation to the existing building; provided that such redevelopments incorporate to the fullest extent practical, design features and measures to substantially reduce the existing potential for flood losses and personal risks, and avoid any adverse impacts on adjoining properties – especially obstruction or diversion of floodwaters and loss of flood storage. In the case of residential development, The maximum size of a concessional development is: (i) a once-only addition or alteration to an existing dwelling of no more than 10% or 30m^2 (whichever is the lesser) of the habitable floor area which existed at the date of commencement of this Policy or Plan; or (ii) the construction of an outbuilding with a maximum floor area of 20m^2. In the case of other development categories, the maximum size of a concessional development is a once- only addition to existing premises of no more than 10% of the floor area which existed at the date of commencement of this Policy or Plan.

Table 2.7: FLOODPLAIN MATRIX

Planning & Development Controls

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

Not Relevant Unsuitable Land Use * For redevelopment of an existing dwelling refer also to ' Concessional Development' provisions

i. Freeboard equals an additional height of 500mm.

ii. The Parramatta LEP 2011 identifies development permissible with consent in various zones. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. The above matrix identifies where flood risks are likely to determine where certain development types will be considered "unsuitable" due to flood related risks.

iii. Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.

iv. Any fencing that forms part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category.

v. Development within the floodplain may be subject to Clause 6.7 Foreshore Building Line in the Parramatta LEP 2011.

Floor Level	
1	All floor levels to be equal to or greater than the 20 year Average Recurrence Interval (ARI) flood level plus freeboard
2	Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard.
3	All floor levels to be equal to or greater than the Probable Maximum Flood (PMF) level plus freeboard
4	Floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the floor level of existing buildings, or the need for access for persons with disabilities, a lower floor level may be considered. In these circumstances, the floor level is to be as high as practical, and, when undertaking alternations or additions, no lower than the existing floor level.
5	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed.
Building Components & Method	
1	All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard.
2	All structures to have flood compatible building components below the PMF.
Structural Soundness	
1	An engineers report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard.
2	An engineers report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a PMF level.
Flood Affectation	
1	An engineers report is required to certify that the development will not increase flood affectation eleswhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulate impact of multiple potential developments in the vicinity.
2	The impact of the development on flooding elsewhere to be considered having regard to the three factors listed in consideration 1 above.
Car Parking and Driveway Access	
1	The minimum surface level of open spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.
2	The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.3m above the 20 year ARI flood level.
3	Garages capable of accommodating more than 3 motor vehicles on land zones for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level.
4	The driveway providing access between the road and parking spaces shall be as high as practical and generally rising in the egress direction.
5	The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level.
6	Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.
7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood.
Evacuation	
1	Reliable access for pedestrians required during a 20 year ARI peak flood.
2	Reliable access for pedestrians and vehicles required to a publicly accessible location during the PMF peak flood.
3	Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site.
4	Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan.
5	Applicant is to demonstrate that evacuation in accordance with the requirements of this DCP is available for the potential development resulting from the subdivision.
6	Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.
Management and Design	
1	Applicant is to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this the relevant FRMS and FRMP
2	Site Emergency Response Flood plan required where the site is affected by the 100 year ARI flood level, (except for single dwelling-houses).
3	Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard.
4	No storage of materials below the 100 year ARI flood level.

Further Information

Flood Risk Management Plan, Flood Studies, Sub-Catchment Management Plans, and Local Floodplain Risk Management Policy available from Council.

NSW Government's Floodplain Development Manual 2005 – *www.dnr.nsw.gov.au/floodplains/manual.shtml*

Parramatta City Council's Local Floodplain Risk Management Policy, 2006.

2.4.2.2 Protection of Waterways

Objective

O.1 To ensure development contributes to the protection and rehabilitation of waterways in order to improve waterway health and to develop and maintain ecologically sustainable waterways.

Design Principles

P.1 Development is to make provision for buffer areas for the preservation and maintenance of floodway, riparian corridors and habitat protection. Refer to Clause 6.7 Foreshore Building Line and Clause 6.5 Water Protection in the Parramatta LEP 2011.

P.2 Development on land subject to Clause 6.5 Water Protection in the Parramatta LEP 2011 or that abuts a waterway is to be landscaped with local indigenous species, to protect bushland and wildlife corridors and soften the nterface between the natural landscape and the urban environment. Riparian vegetation also plays an important role in stabilising bed and banks and attenuating flood flows.

P.3 The piping, enclosing or artificial channelling of natural watercourses and drainage channels is not permitted. Consideration is to be given to re-opening piped or lined drainage systems wherever feasible.

P.4 Development is to ensure that natural channel design principles are incorporated in any works on or in waterways. Refer to Figure 2.8.

P.5 Ongoing maintenance costs are to be considered in the design of any waterway protection features.

Further Information

Brisbane City Council 2000, *Natural Channel Design Guidelines*

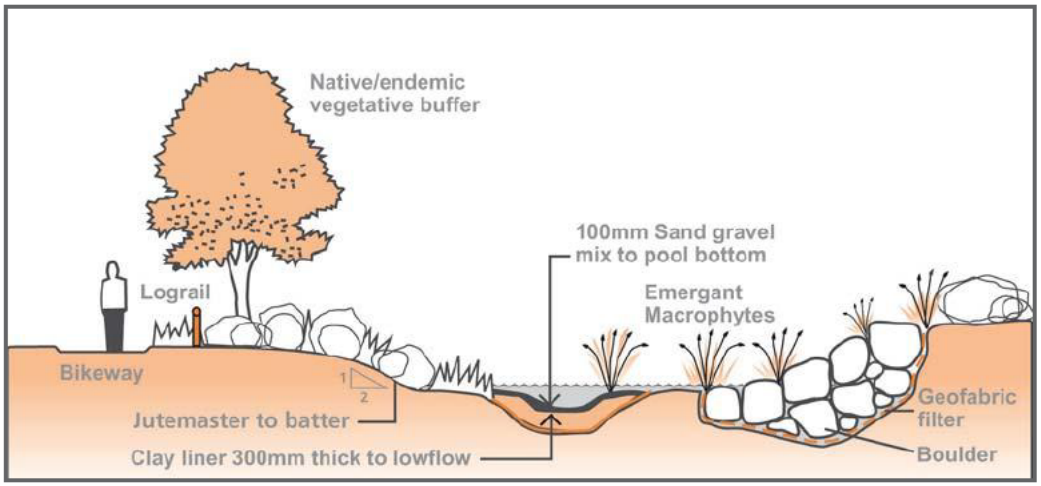

Figure 2.8 *Elements of the Natural Drainage System*
Sources: Stormwater outlets in parks and waterways (Brisbane City Council, 2001)

2.4.2.3 Protection of Groundwater

Objective

O.1 To protect groundwater quality, flows and drainage patterns during demolition, construction and ongoing operation phases of a development.

Design Principles

P.1 Operating practices and technology including dewatering shall not contaminate groundwater or adversely impact on adjoining properties and infrastructure.

P.2 Groundwater is to be recharged where possible while still protecting and/or enhancing groundwater quality.

P.3 Protection measures for groundwater are to be proportional to the risk the development poses. Where the potential risk to groundwater is high, a separate Groundwater Impact and Management Report will be required.

NOTE: The potential risk to groundwater is high when construction involving excavation is below the water table and is within alluvial areas and sandstone environments.

2.4.3 Soil Management

2.4.3.1 Sedimentation

Objectives

O.1 To ensure through effective site controls during and after demolition and construction, that development does not contribute to sedimentation of waterways and drainage systems, or cause wind blown soil loss.

O.2 To ensure that development does not result in environmental damage of waterways and bushland in the City.

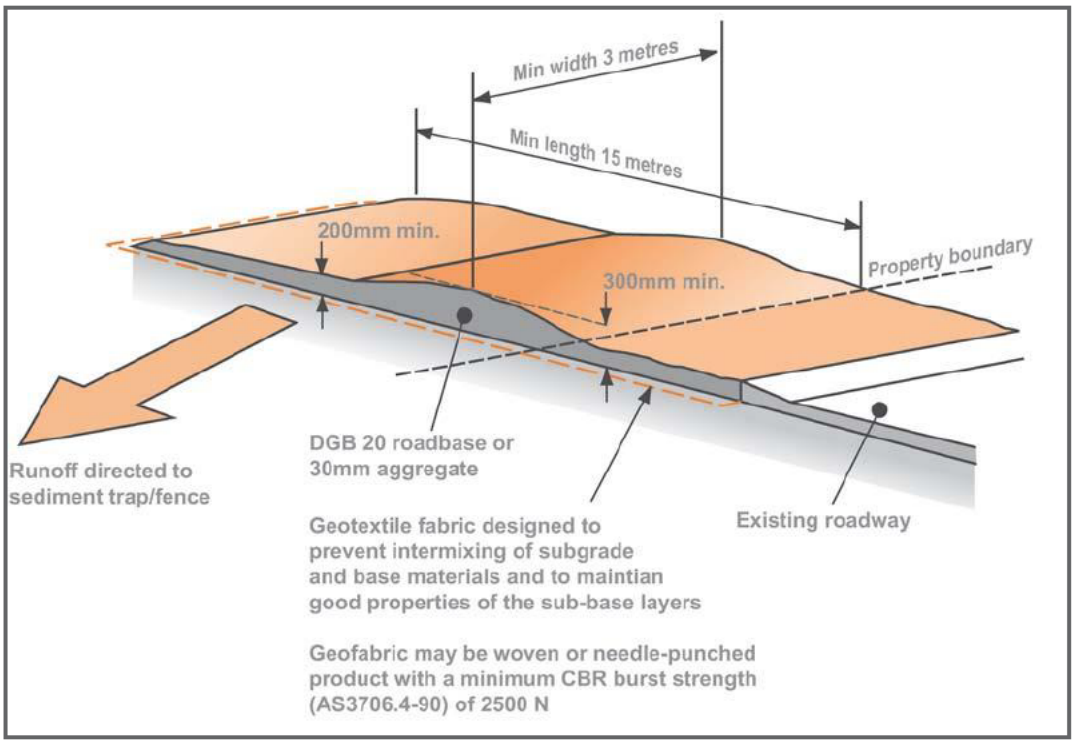

Figure 2.9 *Stabilised Site Access*
Source: Soils and Construction: Managing Urban Stormwater, Landcom, March 2004.