ELECTRONIC ATTACHMENTS

for

BUSINESS PAPER

6.30PM, TUESDAY, 9 APRIL, 2024

PAGE NO.

Haberfield Development Control Plan

Engagement Outcomes Report

28 November 2023 to 11 February 2024

Contents

Summary

The community was invited to provide feedback on proposed amendments to the site-specific Development Control Plan (DCP) for Haberfield between 29 November 2023 and 11 February 2024.

During the engagement period, there were 763 unique visitors to the Your Say Inner West project (YSIW) page and the draft DCP document was downloaded 116 times.
Two in-person meetings were held between Council officers and representatives of the resident organisation – The Haberfield Association.

A total of 78 responses were received throughout the engagement period.

- 19 participants completed the online survey on YSIW
- 56 emails were received from individual stakeholders
  - 10 emails sent directly by individuals
  - 46 sent via 'Sydney YIMBY' email form
- 3 emails were received from community groups

All responses were reviewed carefully by the project team.

Results summary

Overall, of the 78 submissions received:

- 15 (19%) supported the proposed amendment
- 55 (71%) did not support the proposed amendment (see note below re responses via 'Sydney YIMBY' email form)
- 3 (4%) were unsure
- 5 (6%) did not state a position but provided relevant comments on the proposed DCP

Summary of responses via 'Sydney YIMBY' email form

On 11 January 2024 the 'Sydney YIMBY' organisation published a blog post campaign requesting IWC to change the controls on the site 140a Hawthorne Parade to permit apartments. The post included a form for people to submit an email directly to IWC

Haberfield Defence Land

You may have seen us in the news this week talking about how Sydney's heritage protections are a major constraint on building the homes we need.

Some of the defenders of the status quo have said that heritage doesn't have an effect on housing affordability. We know that's not true: by significantly restricting what you can build, you increase prices and limit supply.

This is a live issue. The Australian Department of Defence has a 2 hectare site on Hawthorne Parade, Haberfield that it is looking to sell. The current plan is for the site to be subdivided into 900sqm lots for the construction of single family homes.

In the current market, they would be expected to sell for around $3 million each. You would need a household income of around $500,000 a year to be able to buy such a property with a mortgage. Fewer than 1% of Australian households have that kind of income.

Under federal Finance Department policy, the sale of land suitable for housing should include affordable housing initiatives.

This is clearly a case where heritage protections, which prevent medium density uses, are leading to worse housing outcomes.

We have written a letter to Australia's Defence Minister, Richard Marles, to offer the land to either the state government or to Inner West Council, to develop as social housing, on the condition that the medium density development is allowed.

You can help by writing to Inner West Council below, asking them to change the controls on the site to permit apartments. This will help with affordability in the area and will increase housing diversity. This is especially important when the whole suburb is huge houses on 800sqm blocks, and the population is ageing rapidly— many are going to need to downsize in the coming years and it's important they be able to do so locally.

Support apartments in Haberfield

Where do you live?

Enter residential address

Compose your email

Name

First

Last

Email

Email Tips

Subject: Haberfield DCP amendments: allow apartments on defence land

By supporting this campaign you give permission for Sydney YIMBY to contact you.

Source: https://www.sydney.yimby.au/blog/haberfield-defence-land

We received 46 emails via the 'Sydney YIMBY' email form:

- 1 response supported the proposed document
- 45 responses do not support the proposed document

The main theme expressed by those who did not support the proposed document was the need to address housing affordability and provide higher density residential development on the Defence land at 140a Hawthorne Parade.

Summary of responses from submitters who stated they are Haberfield residents

	Total received	Support proposal	Provided suggested changes but did not state a position	Do not support
Received online via YSIW	6	6		
Received via email from individuals	7	3	4	
Received via 'Sydney Yimby' email form	1			1
Totals	14	9 (64%)	4 (29%)	1 (7%)

Project background

The draft site-specific Haberfield Development Control Plan (DCP) is a proposed amendment to the Comprehensive Inner West DCP 2016 for Ashbury, Ashfield, Croydon, Croydon Park, Haberfield, Hurlstone Park, and Summer Hill.

The controls for Haberfield were updated to aid interpretation and account for new dwellings on the land at 140a Hawthorne Parade.

At its meeting on 21 November 2023, Council resolved to publicly exhibit the draft for a period of 28 days and seek community feedback.

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Promotion and engagement methods

The public exhibition ran for an extended period of 75 days to account for the NSW school holidays in accordance with the Inner West Community Engagement Strategy 2022-24

Residents, occupiers, and property owners were notified of the engagement via letter and invited to make submissions via the Your Say Inner West page, email, phone, or mail.

Promotion method	Stakeholders engaged
Your Say Inner West	**763** visitors to the project page **116** downloads of the draft document
Letters to key stakeholders	Approximately **3360** notification letters distributed to properties in Haberfield and property owners living elsewhere
Engagement method	**Stakeholders engaged**
Online survey at Your Say Inner West	**19** surveys completed
Direct contact from stakeholders	**56** emails from stakeholders **3** emails from community organisations

Who did we hear from?

Online survey

Council gathers basic demographic information as part of the participant registration process online at Your Say Inner West. We use this information to understand who has responded and whether we need to engage further on the proposal.

We received 19 responses through the online survey.

Age

Age	Contributors	% of Contributors
10-14	1	5.26
15-19	1	5.26
25-29	5	26.32
30-34	2	10.53
35-39	3	15.79
45-49	2	10.53
55-59	2	10.53
60-64	2	10.53
Not specified	1	5.26

Location

Location	Contributors	% of Contributors
Haberfield	6	31.58
Enmore	2	10.53
Chiswick	2	10.53
Stanmore	2	10.53
Marrickville South	2	10.53
Petersham North	1	5.26
Epping	1	5.26
Summer Hill	1	5.26
Concord	1	5.26
Bradbury	1	5.26

Email

We received 56 emails in total :

- 7 individuals indicated they lived in Haberfield
- 3 individuals indicated they lived elsewhere in the Inner West
- 46 respondents via the 'Sydney YIMBY' email form:
  - 27 did not specify where they live
  - 1 respondent lived in Haberfield
  - 5 respondents lived in the Inner West
  - 13 respondents lived outside of the Inner West in Greater Sydney, the Hunter Region and outside of the New South Wales

The remaining 3 emails were sent on behalf of community organisations:

- Haberfield Association
- Burwood & District Historical Society
- Resident Action Coalition

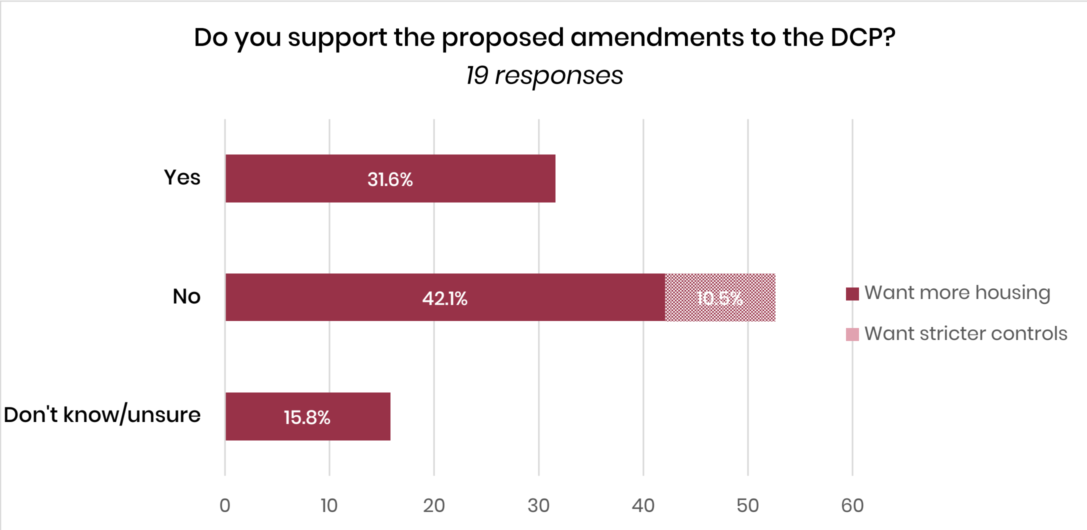
Summary of individual feedback

In total, 75 individual submissions were received through the YSIW page survey and email. (Read about the three community group submission at the end of this document).

Online survey at YSIW

The survey asked participants "Do you support the proposed amendments to the Haberfield DCP?"" and included a required follow up question, "Please explain your answer." Council officer responses to the matters raised can be found later in this document.

We asked	You said
Do you support the proposed amendments to the Haberfield DCP? *19 responses*	**6 people (31.6%) responded "Yes"** All 6 people are residents of Haberfield and appreciate controls that protect the suburb's heritage value. **10 people (52.6%) responded "No"** • 2 did not support the changes as they wanted stricter heritage controls • 8 did not support the changes as they believe they would restrict housing supply and affordability in the area. **3 people (15.8%) responded "Don't know/unsure"**



Email

We received 10 emails from individuals:

- 6 responses (60%) support the proposed document
- 4 responses (40%) did not state a position but provided valuable comments on the proposed controls

We received 46 emails via the 'Sydney YIMBY' email form:

- 1 response supported the proposed document
- 45 responses do not support the proposed document

Issue raised	Council response
The 'Sydney YIMBY' campaign calls for IWC to permit apartments on the land at 140a Hawthorne Parade to support affordability and increased housing diversity in the area. Many submissions specifically advocate for three storey apartment buildings on the Defence land with some requesting that a portion of the land to be allocated to affordable or social housing. They highlight the site's proximity to public transport and open space.	Permitted land uses are determined by the Local Environmental Plan (LEP). The proposed controls respond to current LEP provisions and development consent to subdivide the land at 140a Hawthorne Parade issued in 2001. There is a systematic process for Council to investigate future housing opportunities through its Local Housing Strategy. Haberfield was not identified as a housing investigation area in the most recent Inner West Local Housing Strategy. Reforms to create additional

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	housing are being investigated by State government. The DCP cannot require affordable or public housing to be built; this is a matter for State government.

Council responses to key themes raised in the YSIW online survey and email submissions

The table below presents the key ideas expressed in the survey responses and email submissions with a corresponding Council response.

Key idea	You said	Council response
Housing supply and affordability	The controls should allow for higher density residential development and subdivision in Haberfield to increase housing supply and support housing diversity and affordability.	Land use permissibility is governed by *Inner West Local Environmental Plan 2022*, not the DCP. Regardless of the controls contained within the DCP the LEP restricts the type of housing permitted in Haberfield.
Parking and access	New dwellings at 140a Hawthorne Parade will worsen on-street parking conditions on surrounding local roads. Parking restrictions should be introduced to mitigate this.	Each dwelling has the potential for onsite parking thus it is not clear how their construction will worsen on-street parking on surrounding roads. A resident parking scheme can be investigated in the future if required.
Landscaping	Urban greening including trees should be maximised.	Urban greening is maximised in Haberfield - Clause 6.20 (3)(d) of the Inner West LEP requires 50% of each lot to be landscaped – higher than elsewhere in Inner West to reflect Haberfield's status as the garden suburb.
Contamination	The remediation of 140a Hawthorne Parade must be confirmed to ensure that the land is suitable for the proposed use before the DCP is endorsed.	The subdivision certificate cannot be issued until the site has been remediated and is suitable for residential use.
Flooding	Council must ensure that property owners of new dwellings at 140a Hawthorne Parade are notified	The site is identified as being affected by flooding on the planning certificate that is attached to the contract of sale of

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	about the flood status of the site and the need to maintain drains.	the lots. The details of any easements on the site will be on the relevant certificate of title and survey plan.
Heritage conservation	Planning controls should protect development that reflects the heritage significance of Haberfield and require new development to be consistent with the existing character.	The proposed planning controls aim to do just that and were developed with the assistance of the Haberfield Association.
Institutions	The section with controls for commercial buildings should be expanded to include institutions.	The section heading will be changed from "*Commercial Buildings*" to "*Commercial Buildings and Institutions*". Introductory text will be edited to reflect this change.
Built form controls	Slate should be included as a permissible roof material for new dwellings if the controls are to be consistent with historical construction materials in Haberfield.	Agree. The control will be amended as follows: *New buildings are to have roofs that reflect the size, mass, shape, and pitch of the typical neighbouring original roofs in Haberfield. Roof materials are to be consistent with C18 of this section of the DCP.*
	Aluminium doors and windows should not be permitted as they are inconsistent with heritage construction materials.	Windows and doors in the original parts of houses should be timber and match the original windows and doors. Aluminium in new development is a suitable option if the proposed design is of appropriate detail and vertical in proportion as hollow box section sashes resemble the visual weight and dimensions of timber. The control will be amended for clarity as follows: *The use of box section aluminium doors and windows using sash sections and pre-finished colours is permitted in extensions and new dwellings, subject to appropriately matching the existing design. It is*

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		not permitted in original parts of rooms of existing houses.
	Basement levels should not be permitted as they are detrimental to Haberfield's heritage character and may cause damage to neighbouring heritage properties.	Basement levels on sloping sites have been constructed in Haberfield since its origin. C24 ensures that sub-floor and basement development does not significantly impact on the building's scale or contribution to the streetscape. Applications will be assessed to ensure that there is no risk to adjacent heritage buildings.
	The required 4 metre front setback for dwellings at 140a Hawthorne Parade is not substantial and inconsistent with the rest of Haberfield. The subdivision pattern should change to accommodate a larger setback.	It is noted that a set back of 4m is less than what is typical elsewhere in Haberfield however a lower front setback enables development to comply with other development standards and is not readily from outside the subdivision. Development consent for the subdivision of 140a Hawthorne Parade was issued in 2001 and cannot change now without the owner's consent.

Stakeholder group response

We received three submissions from community groups.

1. Haberfield Association
2. Burwood and District Historical Society
3. Resident Action Coalition

Haberfield Association

The group made a submission on behalf of their members which contained a reworked draft DCP including suggested amendments and new content (see **Appendix**). The table below summarises the recommendations from this document and Council officers' response. Any references to controls align with the numbering in the document provided by Haberfield Association.

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Suggested amendments	Council response
Haberfield Association believes that the Statement of Significance for Haberfield Heritage Conservation Area (HCA) contains factual errors and excludes elements of Haberfield's history.	The suggested Statement of Significance is lengthy and hinders practical application. The Statement of Significance included in Council's State Heritage Listing application for Haberfield will be reinstated. Supplementary descriptive statements of important elements have been kept in their respective sections to provide context.
Terms such as *HCA*, *Desired Future Character* and *Neighbourhood* are not defined in this section of the DCP.	The term 'HCA' refers to Heritage Conservation Areas. Minor changes to wording will be made to clarify this. Definitions for Desired Future Character and Neighbourhood will be added to Chapter G – Definitions of the Comprehensive DCP 2016 for Ashbury, Ashfield, Croydon, Croydon Park, Haberfield, Hurlstone Park, and Summer Hill as follows: *Desired Future Character*: The set of objectives and controls prescribed to a Neighbourhood to ensure that development outcomes enhance the key features and qualities of the area. *Neighbourhood*: An area with a distinct character defined by the dominant or unique topography, estate and street pattern, land uses, environmental quality, heritage significance and built form.
The formatting of the document could be improved to distinguish between sections.	Noted and modified as requested.
Some controls for new dwellings repeat controls that apply to all properties within the Haberfield Neighbourhood and Haberfield Heritage Conservation Area	Controls will be removed or amended to ensure that there are no duplicate controls.
Fencing should be restricted to a height of 1.2 metres	Noted. C74 and C105 will be modified to reflect this change.
Controls C17 and C97 lack explicit metrics for roof extensions and setbacks respectively.	Amended C17 as follows: "*Roof extensions are to be considerably lower than the original roof and clearly differentiated from the original section.* ***A setdown of 500 mm is generally acceptable.***"

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	C97 will not be changed. Setting a numerical control for front and rear setbacks is not appropriate as setbacks vary throughout the suburb. It is preferred to reference the setbacks of adjoining properties to ensure a more consistent streetscape.
Wording in controls C19, C74 and C96 could be improved to assist interpretation.	Amended C19 as follows: "*C19. Roof details such as finials, ridge capping, are to be maintained, repaired and/or reinstated* ***as required.***" Amended C74 as follows: "*New front fences of timber are encouraged. They should be between 1m to 1.4m in height. The timber should be* ***painted in colours historically used in Haberfield.***" Amended C96 as follows: "*Any alterations and additions to the shape, scale and materials of non-conforming houses should respond to the form of surrounding original dwellings* ***and must be compatible with the general pattern of development within the conservation area and its distinctive character.***"
The commercial area to which C89 applies should be specified.	The commercial area refers to the land zoned E1 at the intersection of Ramsay and Dalhousie Street. An advisory note to this effect will be included.
The site-specific controls for 140a Hawthorne Parade are not substantive enough to address flood risk. Haberfield Association suggests adding controls that: a. Require fence designs that enable stormwater flow b. Require non-habitable spaces to be at the subdivision level c. Do not permit structures over or enclosing the surrounding easement	Future development on the Defence land will be designed in accordance with relevant controls in Part A3 – Flood Hazard of the Comprehensive DCP 2016 for Ashbury, Ashfield, Croydon, Croydon Park, Haberfield, Hurlstone Park, and Summer Hill. a. An advisory note to this effect will be included in the DCP. b. It is not feasible for this site specific DCP to conflict with the existing flood controls. *c.* Existing controls in *Chapter A15 – Stormwater Management* of the Ashfield

	DCP already do not permit structures above drainage lines and within easements.
Diagrams illustrating the subdivision pattern of 140a Hawthorne Parade should be included in the DCP to improve interpretation of controls.	An annotated plan of 140a Hawthorne Parade will be included in the amended DCP. Finished floor levels are not finalised at this stage and have therefore been omitted from the diagram.

Next steps

As outlined in the *Summary of feedback* section of this document, comments from the community have informed edits to the content of the draft DCP including:

- Changes to wording and formatting to improve clarity and aid interpretation
- Removal of repetition
- Additional diagrams and definitions to aid interpretation and application
- Additional advisory notes for the site-specific controls relating to 140a Hawthorne Parade relating to flooding

The revised site specific DCP for Haberfield, this Engagement Outcomes Report and supporting documents will be reported to Council at the meeting on 9 April 2024. Council will decide whether to endorse the proposed amendments to commence 30 April 2024.

All community members who participated in this engagement and provided contact details will be notified of the Council meeting date.

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Engagement Outcomes Report – Appendix

Haberfield Development Control Plan

28 November 2023 to 11 February 2024

Your Say Inner West survey responses

Survey participants were asked “Do you support the proposed amendments to the DCP?” Identifying details have been redacted.

Answer	Please explain your answer.
Housing supply and affordability	
No	We need more housing in Sydney. 2 bedroom apartments are selling for $1.5 million. Please use this rare opportunity to build affordable housing not more mansions.
No	I support the changes to all except Clause 6.20 for the Defence Land - this land has more potential to offer the community through the provision of more housing, while retaining the ratio of open space. A limit of 4 storeys could be applied, which could also adhere to period appropriate design detail and suit the character of the period, even in a slightly different typology.
No	The current proposal to allow only large, single-story houses on 900sqm lots, aligning with the heritage conservation area, seems to be a missed opportunity for more inclusive housing. This approach doesn’t consider the need for diverse and affordable housing. Restricting this significant land area to single-story houses is an inefficient use of space in an urban setting where diversity in housing options is crucial. Haberfield needs more than just large, expensive homes; it needs affordable and varied living options to cater to a broader demographic, ensuring a vibrant community. I urge the council to revisit these plans. Permitting three-story apartment buildings would be a more beneficial approach, offering a mix of housing options and catering to a wider range of residents. This not only aligns with the urgent need for affordable housing but also promotes a diverse, inclusive community. It’s essential that our urban planning adapts to the changing needs of our population. The current proposal, while preserving a certain aesthetic, fails to address the broader community needs. By allowing for more varied housing, we can create a more inclusive Haberfield,

	catering to all residents, not just those who can afford large homes. I hope the council will consider the long-term benefits of diversity in housing over the existing single-use, low-density proposal. Thank you for considering my perspective.
No	There is no good reason for stringent appearance-related controls to apply to newly available land. Character can be maintained through smart aesthetic choices while allowing buildings higher than a single storey to be built. Suburb-wide legal protection for the flatness of a building, at the expense of people who would live on the second or third storeys if allowed — in the context of a housing crisis — is cruel and absurd. It is appropriate for safety controls to apply.
No	More housing should be allowed in heritage protection areas. The heritage protection area should be rezoned to B4 allowing 20-30 storey apartments. By heritage listing buildings you are protecting the Haberfield of the 1950s not the embracing the change that has to come to provide housing to people who desperately need it.
No	In a time of housing crisis in Sydney, the idea of refusing to allow subdividing the lots because it would be 'detrimental to the heritage significance' of Haberfield is frankly absurd.
No	The restrictions contained in the proposed amendments present another lost opportunity to deliver much needed housing in an acute housing crisis. The restrictions on density, building height and land use are overly burdensome. The lack of affordable and high density housing locks key workers out of Haberfield. Heritage concerns should not be used to waste prime real estate that should be used to deliver much needed density, different types of housing, and more affordable housing options in the area.
No	The imposition of additional control on subdivision, preventing the construction of new dwellings during an acute housing shortage is inappropriate. I would urge council to redirect its attention from the placement of carports and towards maximising the number of houses constructed for people to live in.

Don't know/unsure	The amendments need to also allow flexibility to accommodate apartments and higher density living. The area needs to include more diversity in housing options to maintain and attract more diverse people (primarily younger) with more affordable options for the population. Infrastructure in the area is excellent and can accommodate more density. With the right master plan concept this could become another wonderful centre for Haberfield and the inner west. This does not mean tall towering apartment towers designed in a modern architectural style, but a style with a modern reimagining of federation - with a 3-5 storey maximum with appropriate setbacks in-keeping with the broader area. Consideration of an aged care facility or retirement village is also of merit. The suburb needs to do it is part in responsibly helping deliver more housing to the area. It will also help bring more vitality and a new centre to the area. I say this with the best interests of the broader community at heart, including those in Haberfield. I am a long term rate payer (25 + years) and also property owner and former resident in the Council. This is an unbiased view genuinely seeking what is right for all.
Heritage conservation	
Yes	Haberfield is a unique area and its heritage architecture should be preserved for residents and the increasing number of visitors who enjoy the cafes, restaurants and park lands. More recently there seems to be confusion and inconsistency when applying the DCP to developments and renovations so clearer guidelines and definitions would be beneficial.
Yes	I like the suburb's houses' styles and controls will be good to make sure it stays as 'the garden suburb'
Yes	Maintaining the character and charm of Haberfield is culturally important to the nation and to the residents
Yes	New developments should be controlled to a maximum extent to preserve the heritage value of the area. Even rear facades of new dwellings should NOT be modern in design. Brickwork should NOT be dark and should match colouring

	of original heritage bricks. Attached garages should not be permitted.
Yes	I support the proposed amended controls to ensure that any new builds are generally in keeping with the character of the suburb
Yes	The new buildings on the defence land must be in keeping with the existing homes originally built in Haberfield.
No	Development should be extremely strict and new dwellings should be built strictly in the style of the area and that any idea and proposals of any increased density should be strongly opposed.
No	Feedback should be that development should be extremely strict and new dwellings should be built strictly in the style of the area and that you think the idea of any increased density should be strongly opposed.
Urban greening	
Don't know/unsure	Would like to make sure whatever works or project undertake in. Urban greening is maximised., lots of trees!!
Contamination and flood risk	
Don't know/unsure	With regard to the Defence land in Haberfield, Council needs to get an unredacted report on site contamination. The Defence Dept is responsible for the remediation of this site so the IWC needs to make sure they get this unredacted report. This land is also subject to a once in a 100 years flood and if the land is going to be used for housing the drainage on the site needs to be maintained and potential home owners need to know about these two important issues. Access to this drainage needs to be in a legally binding document so that surrounding neighbours are not affected and these drains can be maintained.

Individual email responses

Identifying details have been redacted.

Heritage conservation
I was one of the many people who was devastated at the loss of so many fine homes for the West Connex project. I support the Haberfield Association's call to maintain the Haberfield Conversation Area; it is such a significant part of Inner West's heritage. I believe a site specific DCP for the "army land site" in Hawthorne Parade should be reinstated.
I am very concerned about the preservation of Haberfield as a Heritage Garden suburb. Thank you for the opportunity to provide feedback on the draft review of the Haberfield DCP. I, like many others am concerned about the housing crisis, but also the crises in good planning and heritage management. Housing growth and Heritage can work together as seen in many European cities. It does not have to be either or. Haberfield is the seminal suburb in the creation of a Conservation Area under the Environment, Planning and Assessment Act, 1979 and is of State Significance. I support the Haberfield Association in maintaining the current DCP for the Haberfield Conservation Area. I also support their position that the new specific clauses for "new dwellings" and "140a Hawthorne Parade" apply specifically only to that land in Hawthorne Parade which we understand had a site specific DCP applied to it in 2002 (and subsequently disappeared when the councils were forcibly amalgamated). As a senior long term resident of the Inner West I'm very concerned about the idea that has been floated that only old people live there and that the old houses (and the old people) should go in order to develop this most precious site. I hope that Haberfield's important heritage protections remain in place and that the council continues to support the Inner West's diverse historic suburbs that contribute to its diversity and distinctive character.
As a resident and long-standing property owner in Haberfield, I support the Haberfield chapter of the DCP. I support the new sub-sections caused by the 140a Hawthorne Parade site. **Why IWC current exhibition was triggered?** Application is pending for the land, known as 'the army site' 140a Hawthorne Parade, to be put up for sale. The Ashfield Council c2000 rezoning of this land included a site specific DCP.

When the Councils were amalgamed the site specific DCP disappeared. The community has been urging the Council since the amalgamation to reinstate a site specific DCP for this site to guide any potential development on this land. Council staff took this as an opportunity for the Haberfield DCP chapter to conform with its amalgamated DCP template. Hence the entire Haberfield chapter went on exhibition. The Haberfield chapter is largely the same. Council staff inserted new sub-sections dealing with • commercial zone arising from the car wash court cases, • new houses, • specifically for 140a Hawthorne Parade. **A brief summary of the making of the Haberfield DCP** The NSW Department of Planning instigated a Commission of Enquiry under the Environmental Planning & Assessment Act into the making of the Ashfield LEP: this confirmed the standing of the Haberfield Conservation Area and its significance. The gazettal of the 1985 Ashfield LEP contained clauses for the Haberfield Conservation Area and as mapped in the statutory instrument. A departmental directive at that time required there be a DCP. The Haberfield Conservation Area was placed on the Australian Register of the National Estate in 1991 for seminal significance. The IWC DCP, inclusive of the Haberfield Conservation Area, is cited on any land sale contract and has been a legislative requirement since 1985 – this will be 40 years in 2025. Haberfield Conservation Area is of State Significance. Both Ashfield Council and more recently IWC resolved consistently support the Haberfield Conservation Area and its State listing, which was acknowledged by the NSW Heritage Council minute 31st January 2022 subsequent to its "current priority area of First Nations heritage and LGBTIQA+ places". In conclusion, this is a procedural matter brought about by Council amalgamation. It is a vital need for the IWC in its duty to manage the land and specifically for any pending proposals for the site at 140a Hawthorne Parade. I urge impartial support by all councillors.
I fully support the Haberfield DCP as a proud resident of this suburb and proudly support the Haberfield association in its endeavours over 40 years to advocate for this through the Ashfield Council over time and I would expect the merged Inner west Council would also respect it as well for the future. Haberfield today is

what it is today and what it will be into the future through the far sightedness of those who advocated for this. It therefore should be maintained to respect the heritage of the suburb & those who fought against the odds to obtain it. It is a constant fight to maintain the status of our suburb and what it stands for in terms of good urban planning, social amenity and the maintenance of our strong community.
Built form controls
C29 - New control - To make it clear that face brick and commons brick walls shall not be rendered with cement or plaster: I don't know if there's an existing control re. painting face brick and commons brick wall but, if not, I think this should be included for most Haberfield homes, with exemptions for homes like mine - an 1880's Victorian terrace which requires the external walls to be painted as they're made of porous sandstock brick with no cavity between the double bricks, allowing water to seep through.
On the additional Controls C95 - C107, I have a comment on C97. Historically, the original roofs could be either Marseilles pattern OR slate. In C97 Slate seems to have been omitted. I recognise that the use of 'actual' slate would be unlikely because of its cost. However it should be permitted, even if controls are then imposed on 'pseudo slate'.
Other
I support the draft DCP for Haberfield Conservation Area. I understand there has been a concerted campaign by pro-developer people outside the area to oppose this.
sewerage arrangements - it is not clear to me in relation to the Defence Land, that the sewerage arrangements have been properly considered. When we renovated our property some 14 years ago we had to instal (as a condition of the DA approval) a sewerage mechanism in our backyard -apparently the Haberfield sewerage system is very old, and was not designed for the number of properties that it has to service today. With the high number of new dwellings on the Defence Dept land, I doubt that the current sewerage system will cope and don't want sewerage overflows in existing properties. Is the council requiring the Defence Land developers to instal a new system? parking - as you may be aware, all residents in Hawthorne Parade within about 200-300 meters from Marion Street experience severe parking difficulties due to the constant year round influx of people attending soccer practice or games-this really is constant (ie right up until 22 Dec!) and the soccer people take all the parks. With the Defence Land residents, this will bring more cars to Hawthorne

Parade and its surrounds, and exacerbate the parking issues. While I have no problem with the Defence Dept development in keeping with the character of the area, I do think it is time for the council to introduce residents parking restrictions in Hawthorne Parade and its surrounds (ie 2 car permit where no off-street parking and 1 car permit where there is off street parking). The soccer club unduly impact local residents - I have 75 year old neighbours forced to park in Ramsey Street and carry their groceries to their Hawthorne Parade properties because the soccer folk have taken all the parks. The same thing has happened to me. Parking should be restricted to 2 hours from 8am to 10pm 7 days a week (because the soccer folk are there those hours 7 days a week for about 50 weeks of the year).
I support the Haberfield Association Inc. submission. My suggestion is to add to the Haberfield Association submission for the heading 'Commercial Buildings' to read as 'Commercial and Institutional Buildings'. Noted the existing IWC DCP E2 already contains a section, and images, about commercial buildings. Further, the Statement of Significance discusses the importance of separation of land uses and describes Haberfield with its "commercial core, surrounded by institutions, then the single story houses". So in both instances this is a logical heading adjustment. I highlight this heading as 'Commercial and Institutions' because both arise from court decisions.

Attachment A

Date: 11 February 2024

My ref: HFDCP-2024-001

Subject: Feedback to the proposed amendments to the Haberfield Development Control Plan (DCP)

Background

1) The webpage titled "Proposed amendments to the Haberfield Development Control Plan (DCP)"[1] ("**Webpage**"), on the Inner West Council's website, seeks community feedback in relation to the proposed Haberfield Development Control Plan (DCP) ("**Proposed DCP**"). This document provides my feedback to the Proposed DCP.

2) The Website notes that "At its meeting on 21 November 2023 Council resolved to place the proposed amendments to the Haberfield Development Control Plan (DCP) on public exhibition for community feedback."

3) The Website includes a heading titled "More information" and a hyperlink under that heading named "Read the Council report", with the hyperlink as follows: https://innerwest.infocouncil.biz/Open/2023/11/C_21112023_AGN_4014_AT.htm#PDF2_ReportName_64063

4) The document available at the hyperlink is specified as the agenda and minutes for the InnerWest Council meeting for Tuesday 21 November 2023. Under heading titled "C1123(1) Item 7, Updated Site Specific Development Control Plan for Haberfield", there is a table identified as the substantive changes to the development controls and the reasons why. The table ("**Table**") reads as follows:

Clause	*Change*	*Reason*
C4	*New control*	To make it clear that subdivision of existing allotments is not permitted as it would be detrimental to the heritage significance of the Garden Suburb by changing its historic pattern.
C20	*Updated control*	To clarify when basement levels are permitted
C29	*New control*	To make it clear that face brick and commons brick walls shall not be rendered with cement or plaster.
C41	*New control*	The use of box section, aluminum doors and windows using pre-finished colours is permitted in extensions and new dwellings, but not in original parts of rooms of existing houses.
C56	*Amended control*	Garage doors are to be simple timber or metal cladding in a recessive dark colour.
2.33(d)	*Delete control*	Carports forward of the building line are not permitted elsewhere Inner West
C95-C107	*Added – New Dwellings*	There are currently no controls in Ashfield DCP that relate to the form of new dwellings for Haberfield.
2.3.1	*Added – controls for 140a Hawthorne Parade, Haberfield*	A consistent front setback of 4m is proposed – while this is less than the typical front setback within Haberfield it is considered sufficient to allow the other development standards to be met – a greater setback would make compliance with these difficult to achieve. Driveways for lots 16 and 17 are required to be on the southern side of the dwellings to allow for adequate manoeuvering.

5) The minutes also include an attachment specified as "Draft Updated Haberfield DCP", being a document of 21 pages in length. This appears to be the Proposed DCP.

[1] 'Proposed amendments to the Haberfield Development Control Plan (DCP)', *Inner West* (Web Page) <https://yoursay.innerwest.nsw.gov.au/proposed-amendments-haberfield-development-control-plan>.

6) On the Website:
   a) the text of the abovementioned Table is reproduced; and
   b) a document titled "Updated Haberfield DCP" is included, which also appears to be the Proposed DCP.

7) As I understand it, the current Development Control Plan is set out in “The Comprehensive Inner West Development Control Plan (DCP) 2016 for Ashbury, Ashfield, Croydon, Croydon Park, Haberfield, Hurlstone Park and Summer Hill”[2] (“**Current DCP**”), with Chapter E2 relevant to Haberfield.

Error in the Table

8) The Table in the minutes and on the Website contains material errors when compared to the Proposed DCP, in that:
   a) C20 in the Table includes an incorrect reason; and
   b) there is no C24 specified in the Table, which C24 involving a substantive change to the Current DCP comprising the addition of approximately 72 words and the deletion of approximately 41 words. This change is omitted from the Table in the minutes and on the Website.

9) Further, the reason specified for updating C20 is “To clarify when basement levels are permitted”, yet the original C20 and the update to it is unrelated to basements. C24 relates to basements, accordingly I assume the reason against C20 should be specified for C24. The reason for the change to C20 is not specified and is unknown to me.

10) It follows from the above that as the Table is incorrect and it is used in the minutes and on the Website:

    a) the minutes are incorrect and I assume the Council will need to take steps to publicly correct or highlight the error in those minutes;

    b) the Website should be updated to specify a correct Table; and

    c) there is a serious risk that any person relying on the Table in the minutes or on the Website will be misled as to the reason for control changes without conducting a reconciliation between the Current DCP and Proposed DCP.

11) Given that a Table with errors is on the Website on 11 February 2024, I assume the errors in the Table have not been raised previously during working hours with the Council, otherwise I assume it would have been changed on the Website (time permitting). It appears likely that submissions that do not self-identify the errors are at risk of relying on an incorrect Table.

12) **Important note 1**: Given what appears to be material errors in the Table, which is in the minutes and on the Website, Council should repeat the community feedback process, including by making public a correct Table and writing to those that made submissions that the process is being repeated. Please note Comment 11 below regarding the Council providing additional information, which should apply to any repeat feedback process.

Comments to the Proposed DCP

My comments to the Proposed DCP are based on the view that Haberfield is a suburb of strong heritage significance to NSW and Australia. Given that Haberfield’s creation was, I understand, based on views of garden cities current at that time in England and other countries, I believe it reasonable to take the view that Haberfield’s heritage has international significance. Maintaining this heritage builds a sense of connectedness and belonging to a larger story, it builds community and social wellbeing and the enjoyment derived from Haberfield’s purposeful beautiful architecture fires the imagination and reminds us what cities could be. Even minor derogations to controls risk progressive de-gradation of that heritage. As a result, I believe the Council should hold firm and ensure that Haberfield's heritage obtains clear protection with limited compromise.

[2] 'Ashfield DCP', *Inner West* (Web Page, 22 Aug 2023) <https://www.innerwest.nsw.gov.au/develop/plans-policies-and-controls/development-controls-lep-and-dcp/development-control-plans-dcp/ashfield-dcp>.

Recent news stories report views that Sydney's housing crisis means that Haberfield's heritage values should be relaxed, such as by permitting new residential developments in back yards. I believe such views are extremely short sighted and wrong. Such developments would at best provide a relatively minute change to the housing crisis at the cost of losing a unique and irreplaceable heritage that has significantly greater value to us all. Further, allowing new developments will attract a corresponding increase in parked cars and car traffic, degrading the quality of the suburb in circumstances where there is already limited parking and a tendency for drivers to rush between stops and roundabouts. Finally, I view Sydney's story as one of lament, the constant lament as to why did previous generations continually destroy heritage. There are suburbs in the Inner West or other parts of Sydney where such development is far better suited and that is where it should be carried out, not Haberfield.

My detailed comments regarding the Proposed DSP are as follows:

Clause	*Change*	*Council's comment*	*My comment*
C4	*New control*	To make it clear that subdivision of existing allotments is not permitted as it would be detrimental to the heritage significance of the Garden Suburb by changing its historic pattern.	**Comment 1**: C4 is strongly supported because a subdivision of an existing allotment would be a serious detriment to Haberfield's heritage.
C20	*Updated control*	To clarify when basement levels are permitted	C20 does no relate to basements and C20 in the Proposed DCP reads: "The established pattern of front and side setbacks should be kept. Nil side setbacks were rare" **Comment 2**: It appears that the addition to C20 favours heritage preservation and on that assumption the update is supported.
C24	*Updated control*	None provided, but assume it is "To clarify when basement levels are permitted"	The new text for C24 is shown in italics: "Where natural land slope allows, sub-floor and basement development is permitted for use as laundries, storerooms, workrooms or garages. *Habitable rooms may be considered but must not change the single storey scale of a building; openings (windows and doors) are only permitted in the rear elevation. A basement level is only permitted if enabled by the site topology; the floor level of the ground floor of the dwelling must be at the same level and significant excavation to provide adequate floor to ceiling heights in the basement level is not permitted.*" Further, it appears that the following text in the Current DCP has been deleted from the Proposed DCP: "Where land slope or the existing plate height allows, split level development is permitted so long as the structure complies with Clauses 2.7 - 2.9 'Roof Forms' of this Plan, and does not result in visible of otherwise explicit two-storey development." **Comment 3**: Regarding the abovementioned new text, one reading is that it permits new basement levels that meet the specified requirements. If this is not the intent it should be clarified and after that clarification, the proposed amendment is supported. If the intent is to permit

Clause	Change	Council's comment	My comment
			such developments, it is strongly opposed because it would be a serious detriment to Haberfield's heritage and, despite best intentions, risk damaging adjacent heritage properties and foundations. **Comment 4**: The above mentioned deletion is strongly supported because a new split level development would be a serious detriment to Haberfield's heritage.
C29	*New control*	To make it clear that face brick and commons brick walls shall not be rendered with cement or plaster.	**Comment 5**: C29 is strongly supported.
C41	*New control*	The use of box section, aluminum doors and windows using pre-finished colours is permitted in extensions and new dwellings, but not in original parts of rooms of existing houses.	**Comment 6**: C41 is strongly opposed because aluminum doors and windows are clearly inconsistent with original construction materials or their reconstruction. This change would be a serious detriment to Haberfield's heritage.
C56	*Amended control*	Garage doors are to be simple timber or metal cladding in a recessive dark colour.	**Comment 7**: C56 is strongly supported.
2.33(d)	*Delete control*	Carports forward of the building line are not permitted elsewhere Inner West	**Comment 8**: Deleting 2.33(d) is strongly supported**.**
C95-C107	*Added – New Dwellings*	There are currently no controls in Ashfield DCP that relate to the form of new dwellings for Haberfield.	**Comment 9**: On the assumption these new controls appear generally consistent with Haberfield's heritage adapted to modern conditions and other comments on related controls in this document are supported, these controls are supported.
2.3.1	*Added – controls for 140a Hawthorne Parade, Haberfield*	A consistent front setback of 4m is proposed – while this is less than the typical front setback within Haberfield it is considered sufficient to allow the other development standards to be met – a greater setback would make compliance with these difficult to achieve. Driveways for lots 16 and 17 are required to be on the southern side of the dwellings to allow for adequate manoeuvering.	New control C108 is as follows: "The dwelling must be set back 4 metres from the front boundary of the lot." As noted in the left hand column, 4 metres is typically less than the typical front setback within Haberfield, but is required to allow other development standards to be met. There is no explanation why other development standards cannot be met and this should be explained by the Council. I assume it is because the subdivisions are too small, which indicates they are not fit to meet the intent of the Current DCP is it applied to new developments. If this assumption is correct, why were subdivisions approved that cannot meet the intent of the Current DCP? How has this been allowed to happen? The better process is that after the Proposed DCP is finalised and approved, then subdivisions are determined to meet it. **Comment 10**: Control C108 is strongly opposed because it would be a serious detriment to Haberfield's heritage and a greater set-back is

Clause	Change	Council's comment	My comment
			required. The result will be that 140a Hawthorne Parade will not match much of Haberfield. It means the new development will be compromised from inception. **Comment 11**: There is no explanation why other development standards cannot be met and this should be explained by the Council in the documents available for comment. **Comment 12**: If the subdivisions are too small or too numerous to meet the intent of the Current DCP, then the sub-divisions should be changed to meet the final DCP with C108 specifying a greater set back.

Responses to the 'Sydney YIMBY' online campaign

Identifying details have been redacted.

Housing supply and affordability
I do not support the DCP updates for the Haberfield defence land at 140A Hawthorne Pde because they do not allow for meaningful new density on the site. Instead they repeat the same pattern of single storey houses on huge lots that characterises the rest of the suburb. These houses will doubtless sell for $3m - well beyond the capacity for any ordinary person to buy. I write instead to ask you to permit apartment buildings on these lots such that we can (a) add housing at a more affordable price point to an area which has none; and (b) increase housing diversity in Haberfield. This is particularly important because as an ageing suburb with no apartments it will be very difficult for residents to age in place once they can no longer maintain four bedroom houses with large gardens. While noting that flooding considerations may make it difficult to build very tall buildings, there's no reason 3 storey units couldn't be allowed as these do not require deep foundations. These could be done with a similar lot coverage to that canvassed for the single storey houses (i.e., 50% of lot area being landscaping). I also note the very close proximity of the Marion light rail stop to this site: this is perfect for transit-oriented development.
I am writing to express my concerns regarding the current development plans for the 2ha of defence land for sale in Haberfield. While I understand the council's intent to maintain consistency with the neighbouring lots in the heritage conservation area, I believe this approach significantly misses a crucial opportunity for our community. The proposed restriction to single-story houses not only overlooks the pressing need for more diverse housing options but also seems to be an inefficient use of valuable urban land. Our area is in dire need of increased density and affordable housing options, which are currently non-existent. The demand for varied housing, including apartments, is not just a preference but a necessity for creating a vibrant, inclusive, and sustainable community. In light of this, I strongly urge the council to reconsider the proposed development controls. Allowing for the construction of three-story apartment buildings on this site would be a far more beneficial use of the space. This would not only cater to a wider demographic, but also provide more affordable

housing options, which are essential for the diversity and vitality of our community. I trust that the council will take into account the long-term benefits of diverse housing solutions over the current single-use, low-density approach. It is imperative that we adapt our urban planning strategies to meet the evolving needs of our residents, ensuring Haberfield remains a thriving and inclusive community for all. Thank you for considering my views on this matter. I look forward to the council's response and am hopeful for a positive outcome that reflects the needs and aspirations of our community.
I am writing to express my dismay that your provisions that new development in Haberfield to be single storey houses - I would like to see 3-6 story apartment building permitted. I believe that such a change would bring numerous benefits to the community and contribute to the ongoing development and improvement of the area. Haberfield, with its rich history and unique character, stands as a testament to the vibrant cultural tapestry that defines the Inner West. However, in light of the increasing demand for housing in Sydney and the need for sustainable urban development, I propose that the council considers revisiting the current zoning restrictions to allow for taller residential structures. The current lack of housing diversity in the suburb has led to the median house price in the area being 2.9 million dollars. This is completely unaffordable for people without inherited wealth. It also means that the aging members of the community are out of options if they want to downsize and stay in the area. Here are some key points to consider in support of this proposal: Increased Housing Supply: Sydney is facing a housing shortage, and by allowing 3 to 6-story apartment buildings in Haberfield, we can contribute to meeting the growing demand for housing in the Inner West. This would not only benefit current residents but also attract new individuals and families to the area. Transit: The area is well serviced by the inner-west light rail. By allowing taller buildings in Haberfield, the proximity to public transport will mean new residents will not need to own the council average of around 2 cars, contributing to a more sustainable urban environment. Economic Growth: The increased population density can attract new commercial ventures, further enhancing the economic vitality of Haberfield. I understand that zoning changes are significant decisions that require careful consideration. I appreciate your dedication to maintaining the unique identity of the Inner West while addressing the challenges of urban growth. I hope you will seriously consider the benefits of allowing apartment buildings in Haberfield,

ultimately contributing to a more sustainable, inclusive, and prosperous community. Thank you for your time and consideration. I look forward to seeing positive changes that will benefit the residents and future generations of the Inner West.
I'm emailing to express my strong concern for the Haberfield defence land development plan. This is a location well situated near green space, higher order public transportation and other amenities. With our current housing shortage in Sydney it's very short sighted to develop a limited number of single family homes that will only be attainable by the wealthy. This site is a perfect opportunity to have a mix of multiplexes, 3-4 storey apartments and terrace houses. This would greatly diversify the housing stock in the area and a number of units could be set aside as affordable housing. Further a small scale commercial space (convenience store, etc) could serve this site. As a student and resident in the Inner West I constantly face the prospect of being priced out of the area I call home. I would love to see sites like this thoughtfully utilized so that people like me have a better chance of securing housing in the future.
Please allow this. It's a very high priority for this site and all Infill Govt owned or related department controlled land in all our cities
I write to object to proposed development constraints of large lots with large single-story housing for on the 2ha Surplus Defence Land on Hawthorne Parade, Haberfield NSW. The unique 'enclosed' site needs to be zoned for a new urban village, with a perimeter urban forest, to permit and enable social housing (for example to 3 levels, or 11m) through design excellence competition. The cultural, architectural and horticultural qualities of the Haberfield Heritage Conservation Area can be retained in principal and particularly as street-frontage. This site needs to be provided to NSW Govt or Council to treat differently to achieve well-designed and considered infill housing with social and affordable benefits. I look forward to your advice on this rezoning request.
As a young person who wants to see a more affordable and vibrant Sydney, I am writing to echo the letter on behalf of Sydney YIMBY. I urge you to donate the army lands 140A Hawthorne Parade, Haberfield to the local council or state government, with the provision that they build medium-to-high density social housing there, rather than expensive large homes. We need more housing and density in the inner city, and to make these areas more affordable for younger and lower-income people. Haberfield is completely

locked down from development by restrictive heritage zoning, meaning this is a rare opportunity to build more urgently needed housing.
We are in a housing affordability crisis, climate crisis and obesity epidemic. It is essential that we create housing that is affordable, in locations that are walkable, and minimise our environmental footprint. Research by TfNSW (unpublished) and Professor Bille-Giles Corti shows that the most walkable places have less than 30% single dwellings. This, combined with mixed land use, and >45 intersections per sqkm, accounts for 55% of all walking. Based on this evidence, I strongly recommend that Council increase the housing density to a minimum of 30% single dwellings, and ensures at least 20% affordable housing.
I'm writing to request that Inner West Council change the development controls for the Department of Defence owned site on Hawthorne Pde, Haberfield, to allow denser development. I am also requesting that IWC lobby the Department and Minister to gift the land to either IWC or the NSW Land and Housing Corporation, so that it can be developed as 100% social housing. The case for both requests should hardly need to be made. The Albanese and Minns Governments have both set clear objectives for increasing housing supply, and the location of this site is well-suited for medium density housing. There is also a chronic shortage of social housing in NSW, and in this location in particular: there are currently more than 1500 applicants for social housing in the Inner West allocation zone, facing a wait of at least 10 years. Both the Albanese and Minns Governments have expressed a desire for not just more housing, but more social housing, with the former establishing the $2b Social Housing Accelerator and Housing Australia Future Fund. This funding can be used to its maximum effect by building 100% social housing on sites like this -- surplus public land. I hope that you will take this request forward and I look forward to your response.
This initiative could be part of a clear whole-of-government mindset that could be rolled out entirely across other key inner urban Defence sites such as DSM in Maribyrnong, Melbourne and Bulimba, Brisbane.
I am writing to flag my concern that a 2 hectare site in Haberfield owned by the defence force is to be subdivided into single family lots. I am a young Australian who wants to own my own home one day. We can expect these single family homes to sell for $3 million. I'd need a salary of $500,00 a year to afford that! That's just unsustainable.

Do you want your council to become a council of just the ultra-wealthy? Because by building more single-family detached dwellings here, that's precisely what you're signalling to the public. I know that I don't live in your council, but frankly, I can never expect to given decisions like this. You should subdivide this land for medium density townhouses or even apartments. It's a prime location in the inner city where plenty of young people such as myself would like to live. Only allowing single family homes will aid in the departure of many young Australians such as myself to other capital cities. Sydney's economic activity and cultural vibrancy will die. This is more than a 2 hectare piece of land; this is a housing crisis, an Australian crisis. I promise that Sydney will regret decisions like this in the future. I beg you to listen to voices from everywhere, not just in your council. Don't just maintain the status quo. Don't just believe that the Inner West Council has already done enough, because every council can do more. I sincerely thank you for reading my email and considering my views.
I strongly support the use of this land for public housing or at the very least low rise medium density housing to support Sydney's growing population.
I disagree with the provisions that require new development in the area to be single storey houses, and would like to see three storey apartment buildings permitted instead. The current lack of housing diversity in Haberfield (which is all huge $3m houses), unaffordability of these houses and the need for this ageing community to have appropriate local options if they want to downsize.
I am writing to express my support for the Sydney YIMBY position that Haberfield land should be used for median density housing, public or otherwise. It should not be used for low density single story housing, which will, by definition, house far fewer residents. We are in the middle of a housing crisis, and increasing supply is the best way to ensure that people from all backgrounds have more options to live where they want to live.
I was deeply disappointed to learn of the planned development controls for defence land in Haberfield. The proposal to limit lot sizes to 900sqm is frankly ridiculous. That would put the price at upwards of $3million dollars, which is an astronomical amount of money and would require an annual income of at least $500k to service a mortgage. Less than 1% of the population could afford that. Is the plan to create a suburb only for the super wealthy in defiance of Defence

policies that call for the creation of affordable housing with defence land that is sold off? By embracing these development controls Inner West Council is yet again proving that it prioritises heritage over housing and the desires of a small number of rich homeowners over the community as a whole.
While I do not live in the inner west or Haberfield I did spend about a decade in the inner west and am fairly familiar with Haberfield. People need a place to live, people need places to thrive not just survive and not leave the city for greener pastures. My partner is a nurse and if we had kids we would not be able to afford to live in Sydney, many of his colleagues are going through that decision making process now. This land is a great opportunity for apartments. Also, I think locals will find once it's done they actually like the change more people and you her people bring. It's amazing to walk to get groceries, or to a wine bar or to have dinner. I live in Zetland and my parents are in their late 60s. When they stay at our place they love it, when their friends visit they love it and these are people that live in houses in the suburbs but they appreciate the option to walk places rather than getting in a car. Development done right is a benefit to everyone.
I am writing to express my disapproval of the current planning controls for the 2 hectare land up for sale. Allowing only single storey homes on 900sqm lots to be built there, especially ones that'll be worth $3m is not productive use of that land. Seeing as Australia is currently in the midst of a rental and housing crisis, I believe it makes more sense to allow for as many three storey apartments buildings as possible to be built on that land. Also, Haberfield doesn't have a lot of diverse housing as the only homes there are massive $3M mansions. This makes Haberfield extremely unaffordable and limits the options for this ageing community to have appropriate local options if they want to downsize. Please reconsider the current proposal and instead go for allowing as many three storey apartments buildings as possible on that land.
I am writing to express my strong disagreement with the proposed development controls for the 2 hectares of defence land currently for sale in Haberfield. While I understand the desire to maintain consistency with the neighbouring heritage conservation area, I believe limiting the development to large houses on 900sqm lots is a missed opportunity to address the significant housing challenges facing our community.

Haberfield is currently suffering from a severe lack of housing diversity. Habberfield's streets are dominated by large, expensive houses, often exceeding $3 million in value. This makes it virtually impossible for young families, low-income earners, and our ageing population to find suitable housing within the suburb. For many, downsizing within Haberfield simply isn't an option, forcing them to leave their established community and support networks. The development of this defence land presents a crucial opportunity to inject much-needed diversity into our housing landscape. Instead of perpetuating the existing pattern of single-storey homes, I urge the council to consider permitting three-storey apartment buildings on this site. This would provide a range of housing options at different price points, making Haberfield more accessible to a broader demographic. Three-storey apartment buildings can be designed to integrate seamlessly with the existing streetscape. Modern architectural design allows for buildings that respect the scale and character of the neighbouring homes while offering contemporary living spaces. Additionally, incorporating green spaces and communal areas within the development can foster a sense of community and enhance the overall atmosphere. Of course, any development must carefully consider heritage, environment, and traffic concerns. However, with thoughtful planning and community consultation, I believe a three-storey apartment development can be a positive addition to Haberfield. It would create much-needed housing options, revitalize the area, and allow our ageing population to downsize within their own community. I urge you to reconsider the proposed development controls and explore the potential of three-storey apartment buildings on this site. Let's make Haberfield a truly inclusive and diverse community where everyone has the opportunity to find a place to call home.
Three storey apartments in Haberfield are much needed. It is right next to the Greenway and the light rail and more people deserve access to these great amenities. New developments should not be limited to large blocks with single storey houses as that will exclude everyone but the incredibly rich from the suburb, something that has already begun to happen due to the lack of housing diversity. As a teacher who is currently in the process of leaving Sydney due to its lack of affordability, I can attest to the negative impact of the housing crisis which is worsened by restricting the amount of affordable housing that can be built.

I am writing to express my deep concern and disagreement with the current provisions that mandate new developments in our community to be limited to single-storey houses. Beyond the immediate impact on Haberfield, I believe there are broader implications that should be considered for the greater good of Sydney. The current lack of housing diversity in Haberfield, primarily consisting of large, expensive houses valued at around $3 million, has created a situation of unaffordability for many residents. This issue extends beyond our community, contributing to the broader challenge of housing unaffordability across Sydney. Young people, in particular, find it increasingly difficult to afford suitable housing, hindering their ability to start families and contribute to the growth and vitality of our city. This also impacts the ageing population seeking more manageable and affordable housing options. The lack of appropriate alternatives hinders the ability of the community to downsize and remain within the locality they have called home for many years. Moreover, as a society that promises immigrants a better life, it is our responsibility to provide them with more than just opportunities but also a roof over their heads. It is expected that 250'000 people will arrive in Australia in 2024. Restricting housing options to single-storey houses limits the availability of affordable and diverse housing, making it challenging for newcomers to establish themselves in Sydney. In proposing the consideration of three-storey apartment buildings, I believe we can initiate a positive shift in addressing housing unaffordability not just in Haberfield but also in Sydney at large. By providing a mix of housing types, we can create opportunities for young families and immigrants to find affordable and suitable living arrangements. I understand the importance of maintaining the aesthetic appeal of our community, but adapting to the evolving needs of our residents is equally crucial. Allowing for increased housing diversity does not mean that the buildings have to be brutalist/post-modernist. Many Australians flock to Europe specially to enjoy the beauty of their architecture; much of it 5-6 story apartment buildings. There is no reason why we cannot create a softer, heritage themed apartment complex. I urge the council to reevaluate the current provisions with a broader perspective, considering the long-term benefits for both Haberfield and Sydney as a whole. Thank you for your attention to this matter, and I look forward to positive changes that will address the pressing issue of housing unaffordability.
The prevailing focus on single-storey houses has caught my attention, and it's time for a good old rethink. This approach not only limits our housing options but

also contributes to urban sprawl, putting a strain on our transportation network. Let's consider a shift in our housing policies to welcome three-storey apartment buildings, broadening the scope of affordable living. Beyond the matter of affordability, the inefficiency in land use tied to single-storey homes poses a dual challenge. Urban sprawl not only reduces access to affordable public transport but also disrupts the walkability of our community. The decline in children walking to school, thanks to this sprawl, contributes to increased traffic congestion and a loss of community cohesion. Permitting the construction of three-storey apartments would optimize land use, fostering a more sustainable and walkable community. Our elderly population faces distinctive challenges due to the lack of housing diversity. With limited downsizing options, many elderly residents find themselves stuck in larger homes, hindering their ability to age in place within their community. The absence of smaller apartments exacerbates the issue, often forcing our elderly to leave their friends and familiar surroundings. Introducing smaller apartments within three-storey buildings would offer a practical solution, allowing our elderly community members to downsize without sacrificing their connections. On a broader scale, embracing more sustainable and compact development practices aligns with our commitment to environmental responsibility. This approach minimizes the need for extensive land development, mitigating deforestation and preserving natural habitats. Compact living spaces in apartments often lead to more energy-efficient structures, and centralized services in urban areas can be more sustainable. In contrast, urban sprawl, with its low-density development, heightens the demand for land, results in longer commutes, and contributes to the loss of green spaces, leading to elevated energy consumption, air pollution, and overall environmental degradation. While preserving our community's character remains a priority, adapting to the evolving needs of our residents is equally essential. I advocate for a comprehensive reconsideration of our current housing provisions, considering affordability, environmental sustainability, and the holistic well-being of all community members. Thank you for your service to our community, and I am optimistic that positive changes can be implemented to enhance the overall quality of life for all residents.
Rather than exacerbate Sydney's housing crisis, the defence land on Hawthorne Parade in Haberfield needs to be set aside for high density affordable housing. I walk past that spot every day and it is infuriating how a tiny handful of fuddy-

duddy NIMBYs have stopped Haberfield from becoming a thriving and interesting suburb like those around it.
I support the initiative to construct apartments on this land. Heritage protection needs to be more selective and balance need for housing demand. The balance is not correct at the moment
I am writing to express my objection to the council's plan to create low density millionaire mansions on the defence land in Haberfield. The land should be gifted to the State Government to deliver high density social and affordable housing. Council continues to place petty heritage and NIMBY concerns above the very real need for working class people to access housing near employment opportunities. NSW is in an acute housing shortage with young people permanently locked out of home ownership. There is a shortage of affordable and social housing in the inner west for people to rent. This land represents a unique opportunity for council to deliver much needed housing choice. Selling public land to build more mansions for millionaires in Haberfield would be an extremely disappointing decision and I urge council to reconsider their plans.
Just joining the chorus for DCP amendments to allow apartments on that land that Defence will hopefully give you. Revitalise the place! Do some good for the families who are living in homeless camps because of the people who oppose every housing development! Pretty please.
Regarding the Australian Department of Defence's 2 hectare site on Hawthorne Parade, Haberfield, I would like to express my opposition to the current plan for sale of the site to result in subdivision into 900sqm lots for the construction of single family homes. In the current market, these lots would be expected to sell for around $3 million each. A household income of around $500,000 a year would be needed to buy such a property with a mortgage. Fewer than 1% of Australian households have that kind of income. I understand that under Department of Finance policy, the sale of Commonwealth land suitable for housing should include affordable housing initiatives. I agree with Sydney YIMBY that the land would be better offered to either the state government or to your council, to develop as social housing, with medium density development allowed. Please consider changing the controls on the site to permit apartments. This will help with affordability in the area and will increase housing diversity. This affordability and diversity is very important when the whole suburb consists of

large houses on 800sqm blocks, and the population is ageing rapidly, with many residents needing to downsize (preferably locally) in the coming years.
I am writing to you as a concerned citizen who is interested in the issue of social housing development on the land currently owned by Defence Australia in Haberfield, Sydney. I have learned from the Defence website1 that the former Haberfield Army Reserve Depot is surplus to Defence requirements and will be divested in accordance with the Commonwealth Property Disposal Policy. I have also read from the ABC News2 that the property is 1.9 hectare located at 140A Hawthorne Parade in the suburb of Haberfield, and that work is underway to divide the land into 21 lots that can be developed into residential homes3. I appreciate the important role that Defence Australia plays in providing suitable housing solutions for Defence members and their families, as well as private owners, through the Defence Housing Australia (DHA) program. However, I also believe that there is a pressing need for more social housing development in Sydney, especially in areas where there is a shortage of affordable and accessible housing options for low-income and vulnerable people. According to the Australian Institute of Health and Welfare, there were about 116,000 people experiencing homelessness on census night in 2016, and more than 140,000 households on social housing waiting lists in 2018-19. These figures indicate that there is a significant gap between the demand and supply of social housing in Australia, and that many people are facing housing stress and insecurity. One of the potential solutions to address this issue is to use some of the land currently owned by Defence Australia in Haberfield for social housing development. I understand that Haberfield is a federation suburb recognised by the National Trust of Australia, and that developments in Haberfield are bound by strict rules to preserve its character. However, I also think that social housing development can be compatible with the heritage and aesthetic values of Haberfield, if done with proper consultation and design. For example, social housing development can be limited to single-storey buildings, using similar materials and shapes as the existing homes in Haberfield, and incorporating green spaces and nature strips. Social housing development can also benefit the local community, by providing more diversity, inclusivity, and social cohesion, as well as reducing the environmental impact of urban sprawl. Therefore, I urge you to reconsider the current and future plans of DHA and Defence Australia regarding the use of their land in Haberfield, and to allocate some of it for social housing development. This would be a win-win situation for both Defence Australia and the Sydney public, as it would demonstrate Defence

Australia's commitment to social responsibility and community engagement, as well as help address the housing crisis and reduce homelessness in Sydney.
Please allow the inner west to have affordable housing - medium density apartments that promote shared green spaces, active transport connections and diversity in our community.
I am writing to express my strong disagreement with the current provisions in Haberfield that restrict new developments to single-storey houses. While preserving the suburb's character is important, I believe it is essential to reconsider these restrictions and allow for three-storey apartment buildings. Haberfield's housing landscape is characterized by large, expensive houses, making it unaffordable for many younger individuals to own a home in the area. The lack of housing diversity limits options for the younger demographic, hindering their ability to establish roots in the community. I urge the council to review and revise the existing provisions to permit three-storey apartment buildings. This change would not only address the affordability crisis but also contribute to a more diverse housing market in Haberfield, providing opportunities for younger people to live in and contribute to the community. Thank you for your attention to this matter. I look forward to positive developments that will enhance housing opportunities for the younger generation in our suburb.
Regarding the training of the Defence site in Haberfield. I have chosen to live in medium density housing all my adult life and have raised a family in tro of the places I have lived. There are so many advantages. I grew up in suburbia in low density housing and got out as soon as I could, the only saving grace was that the backyard was National Park. Large family homes will always be available for those who choose but we need much more variety in housing choice. Please allow more housing choice in Haberfield and rezone the Defense site to encourage this.
As you would be aware, Sydney has a housing crisis. We need more homes built and at higher density. It would be of great benefit to the area to build more mid-density housing. Apartments like the ones in Williams Parade Dulwich Hill would be great in the space in Haberfield. Apartments that aren't to high, house many and have green spaces.
I strongly disagree with your provisions that require new development in the area to be single storey houses. I would like to see three storey apartment buildings permitted instead.

Due to the current lack of housing diversity in Haberfield (which is all huge $3m houses) and the unaffordability of these houses, there is a great need for the ageing community to have appropriate local options if they want to downsize.
I am writing to you about the current plan for the Defence Land site on 140a Hawthorne Pde. As I understand it, any development on that land would be restricted to single-storey level with the regulations that are currently proposed. This will severely restrict the diversity of dwellings that could be built on this site and will do little to alleviate the affordability problem we have here in the Inner West. Haberfield is a beautiful suburb to live in, but also a very expensive one. As someone who grew up in Haberfield, I am now in a position where I could not afford to buy a house here, since the median house price is just under $3million. While I think it is admirable that the council seeks to conserve the heritage of the suburb through the appearance of the dwellings, I would think that preserving the diverse community that has made this suburb what it is, is more important. By refusing to allow higher density housing, the council is ensuring that stand-alone houses are the only option available which appeal only to certain demographics. This suburb has a rich history and a significant elderly population who can find single-storey houses difficult to maintain with a retirement income and declining health. If there was more dwelling diversity, they wouldn't have to chose between moving out of the community they've lived in their whole life and having accommodation appropriate for their needs. This would also mean existing homes become available for new people to be able to buy in to the suburb. Given how well-connected Haberfield is to public transport with the bus network and light-rail, higher-density and public housing would be very desirable to all sorts of people who work in or around the Sydney CBD. This would bring more people into the suburb and benefit the local economy. It is striking to me that just across Parramatta Rd we have Summer Hill, which has more high density housing around its main shopping area than Haberfield does, most recently with the old Flour Mill development. Especially between Parramatta Rd and the train line, there are multiple apartment blocks. Having used both shopping areas regularly over the years, Summer Hill feels consistently busier, more welcoming, and more representative of the community spirit in the Inner West. If there was more housing diversity like this in Haberfield, we could increase the community life in the suburb. It's not like there's no precedent for different types of development in the Haberfield either, there are a few apartment buildings around, I live across from one. I say all this to implore the council to amend the regulations for the Defence Land site to allow for multi-storey development on the site. It will only benefit the

suburb and be more effective in reducing the housing crisis that is affecting us at the moment. This would be one step in sustaining the community that is Haberfield, which is infinitely more valuable than the appearance of houses. Do the right thing now, so that in the future, people from all walks of life can experience life in the Haberfield community.
I am writing to urge you to amend controls to allow apartments to be built on the unused defence land in Haberfield. Too many people are living in cars, couch surfing, staying in a domestic violence situation because there is not affordable housing available to them. As a Council you are responsible for providing housing for the less privileged of your community. All of us residents of Sydney must let go our privileged NIMBYism in favour of a higher value, which is everyone's right to a home of their own. It will be a great legacy for Inner West Council to lead the way in this.
Hi IWC, we're in a housing emergency, it's a disgrace that we're only targeting 23 homes on this defence land. It's close to the light rail. It's close to parks. Let more people live here. It'll make Haberfield more vibrant, having more people live in it. It just might even save their high street.
I walk through Haberfield fairly often. It's really a lovely area and many of the heritage buildings are beautiful. But opening up this defence land to similar single story houses with gardens is just not the way forward. Firstly, these new houses are never going to look the same as the heritage-listed houses - we just don't build houses like that anymore. So the idea of zoning the area for this style of house when they're already going to be different to the "character" of the neighbourhood seems insane. But secondly and more importantly, building big houses with huge backyards in a suburb so close to the city is both creating more unaffordable housing in a crisis and is a poor use of the land. I'm a young-ish person living nearby and I would love to be able to buy a flat in the inner west. I just can't look at real estate websites anymore without feeling a great sense of depression about the future, and it doesn't seem like there is a concerted effort to do anything about building more in this area or anything else that might increase supply or reduce prices. Would you really take the ability to live in an affordable home in Haberfield away from someone when any new building is going to look different from the houses that are currently there anyway? Why not embrace this? We have the opportunity to build apartment buildings and community areas that allow young (and young-ish) people like myself the opportunity to bring fresh new life and ideas into the old suburb. The people in these heritage-listed houses who have voiced their opposition in the

newspapers will not be around forever, and we cannot stop progress on a vacant block for the sake of people who are not the future of this city.
I am writing to request that IW Council change the controls on the Hawthorn Parade Defence site to permit apartments. Australia has a severe lack of housing and any increase in supply of housing will help provide the shelter which human beings need. Only you have the power to help address this issue to provide more safe, secure shelter for families in Sydney!
Writing the voice my disagreement with the existing provisions requiring new developments in the area to be just single-storeys, particularly with relevance to the DoD owned land up for sale soon on Hawthorne Parade, Haberfield. I voice my support and call for the height of new developments allowed to be raised to three storeys at least to allow for apartments. This would support with the current lack of housing diversity in Haberfield (in which essentially only large single-storey dwellings exist at very high prices), and the need for an ageing community to have appropriate local options if they want to downsize, as well as the opportunity for those who would love to call Haberfield home the opportunity too via lower prices/more varied dwelling supply.
While any new supply in well-located areas is welcome news, it is concerning proposed new development on defence land is limited to single storey houses. Given the current lack of housing diversity in Haberfield (which are all huge $3m+ houses) and the concurrent unaffordability of these houses, it would be significantly preferable this medium density housing e.g. 3 storey apartments or townhouses were to be permitted on this site, ideally as social or public housing to address ongoing housing supply issues.
I disagree with the provision for new development on the Haberfield Army Land to be restricted to single storey houses. Higher density zoning can generate greater revenue for council, all while lowering rates on each household. This means more money for council to wield, so the council can be made even better. It will mean very slightly more wear on non-congested roads, so a slight increase in road maintenance may be required. Nonetheless, the increased revenue far outweighs that. Therefore, for the benefit of all of the people of the Inner West, please consider allowing medium density development here.
With regards to the upcoming sale of the Haberfield defence land off Hawthorne Parade, I implore you not to release this land for more low density housing.

Rather I would ask all of you to consider the future of Haberfield, and indeed Sydney by looking to rezone this land for suitable medium density apartments and townhouses. As Sydney (and indeed the rest of Australia) faces an unprecedented housing affordability crisis, rezoning this land for medium density mixed us will help to allow younger Sydneysiders to move back to Haberfield and revitalise the area which is rapidly ageing. Similarly for the ageing residents of Haberfield who may be looking to downsize, having new stock of well-built and suitable apartments and townhouses gives them the opportunity to stay within the community they love without the hassle of managing a larger property. This is an incredible opportunity to do right by Haberfield, younger Australians and by Sydney in general. Let's keep Haberfield beautiful and futureproofed.
the need for high density housing in the inner west is clear, we need to provide well designed apartments to house the significant increase in population, small lot sizes with single homes are not a satisfactory use of the available land. gardening activity can be provided by community gardens and or significant balcony sizes.
Given the current state of the housing crisis, which only looks to worsen, we must find ways at all points to increase density of housing throughout Sydney. Using Haberfield to build more single storey houses, which only 1% of would-be buyers in Sydney could plausibly afford, is an absolute waste of an opportunity. The provisions that prevent building medium density housing (such as three storey apartment buildings) instead actively harm the city's future development in this regard. The Haberfield Department of Defence land should not be used for single-storey standalone housing but a well planned set of medium density apartment blocks. Efforts should be made to ensure this occurs.
The Australian Department of Defence has a 2 hectare site on Hawthorne Parade, Haberfield that it is looking to sell. The current plan is for the site to be subdivided into 900sqm lots for the construction of single family homes, due to the Inner West Councils restrictive low density zoning. In the current market, they would be expected to sell for around $3 million each. This is not affordable, which would be defying Defence's own official policy to sell land for housing that is affordable. Please gift the land to the Inner West Council on the condition of medium-high density social and affordable (i.e. below market-rate housing managed by Community Housing Providers) apartments.

This is not something that is warranted because of the housing crisis - we must enable Defence to exercise their existing and reasonable policy. The council's planning restrictions stands in the way of Defence, and of affordable housing.
I encourage the building of apartments on defence land in Haberfield, on the land above the expressway entrance in William St Darlinghurst and other underutilised sites
Parking and access
This yimby movement has zero insight into the infrastructure challenges of putting apartments into hawthorn parade. There is only one street in and out with the traffic daily at a standstill every weekday morning. Adding substantial new residents and their cars will only compound this. The YIMBY movement must be stopped before they rip up every piece of vibrant history we have in Sydney.

Stakeholder group responses

Burwood and District Historical Society

Burwood & District Historical Society would like to comment on the proposed amendments to Haberfield DCP to urge Inner West Council ensure the ongoing protection of the heritage of Haberfield. The DCP amendments appear reasonable. In the current planning environment, with increasing public attacks on heritage conservation, it is crucial that Council maintains the high standard of heritage planning controls over Haberfield, one of the earliest gazetted Heritage Conservation Areas in NSW.

Resident Action Coalition

Thank you for allowing us to provide feedback on the draft review of the Haberfield DCP. We are a new coalition of groups and individuals from the Inner West and surrounds concerned, not only about the housing crisis, but also the crises in good planning and heritage management. Haberfield is the seminal suburb in the creation of a Conservation Area under the Environment, Planning and Assessment Act, 1979 and is of State Significance. We support the Haberfield Association in maintaining the current DCP for the Haberfield Conservation Area. We also support their position that the new specific clauses for "new dwellings" and "140a Hawthorn parade " apply specifically only to that land in Hawthorne Parade which we understand had a site specific DCP applied to it in 2002 (and subsequently disappeared when the councils were forcibly amalgamated). We hope that Haberfield's important heritage protections remain in place and that the council continues to support the Inner West's diverse historic suburbs the contribute to its diversity and distinctive character. The Residents Action Coalition, a newly formed alliance of individuals and groups from across the Inner West and surrounding precincts, including, but not limited to, representatives from The Ashfield and District Historical Society, Balmain Association, Burwood and District Historical Society, Cooks River Valley Association, Glebe Society, Haberfield Association, Hurlstone Park Association, Lungs of Leichhardt and Save Marrickville.

Haberfield Association

The document with suggested amendments prepared by Haberfield Association found on the next pages of this document.

A couple of specific comments:

1. In relation to the issue we discussed regarding the application of general controls to new buildings/dwellings and the site at 140A Hawthorne Parade we have suggested wording to confirm that all controls apply to the extent they are relevant and are not modified by specific controls set out in the new buildings/dwellings or 140A Hawthorne Parade section of the DCP as appropriate.

   Alternatively you could specify the controls that apply and do not apply to these developments. From our review we consider that:

   i. the following controls can and should apply to them:
   C1, C4, C5, C11, C16, C20 – C24, C29, C41 (if not deleted), C44, C49, C52 – C56, C58- C65, C67, C70, C73 – C78, C81 – C87 and

   ii. these controls are not applicable
   C2, C3, C6 – C10, C12 – C15, C17 – CC19, C25 – C28, C30 – C40, C42, C43, C45 – C48, C50, C57, C66, C68, C69, C71, C72, C79 and C80.

2. Terms such as 'building' 'dwelling' and 'development' are used interchangeably throughout the document. Care should be taken when drafting the new DCP to clearly identify the types of structures and developments to which each control should apply. We have not have the opportunity to fully consider this in preparing our response but would be happy to discuss further with you if that would assist.

NOTE to reviewers/Council Officers:

A. LEP

1. See IWC LEP 2022 Inner West Local Environmental Plan 2022 - NSW Legislation Dictionary for terminologies used e.g. "landscaped area means a part of a site used for growing plants, grasses and trees, but does not include any building, structure or hard paved area."

2. NOTE IWC LEP 2022 clause 6.20 (3)

(a) if the development involves an existing dwelling, or alterations or additions to an existing building

(i) development above the existing ground floor level will not exceed the development contained within the existing roof space, and (ii) development below the existing ground floor level will not exceed 25% of the gross floor area of the existing ground floor" , as well as (c) the development will not involve the installation of dormer or gable window. B. Dwelling/Building/Development References When using the word 'dwelling' or 'building', consider that a building has a much wider application than 'dwelling' e.g. it includes residential, commercial, institutional and e.g. the car wash. • The word 'structure' has even wider application e.g. pergolas and low garden walls. • The word 'development' ditto is wider still • Not all objectives or controls refer to a 'dwelling'. Where they do they do not capture e.g. commercial buildings • The word 'residential' refers to all types of residential, not just a house. And a house may contain more than one 'dwelling' e.g. the former Police station now contains 2 Dept Housing 'dwellings'.

Chapter E2: Haberfield Neighbourhood

NOTE to reviewers: see also IWC LEP 2022 Inner West Local Environmental Plan 2022 - NSW Legislation Dictionary for terminologies used e.g. "*landscaped area* means a part of a site used for growing plants, grasses and trees, but does not include any building, structure or hard paved area."

Application

This chapter applies to the Haberfield neighbourhood as shown on Figure 4.10.1.1 below.

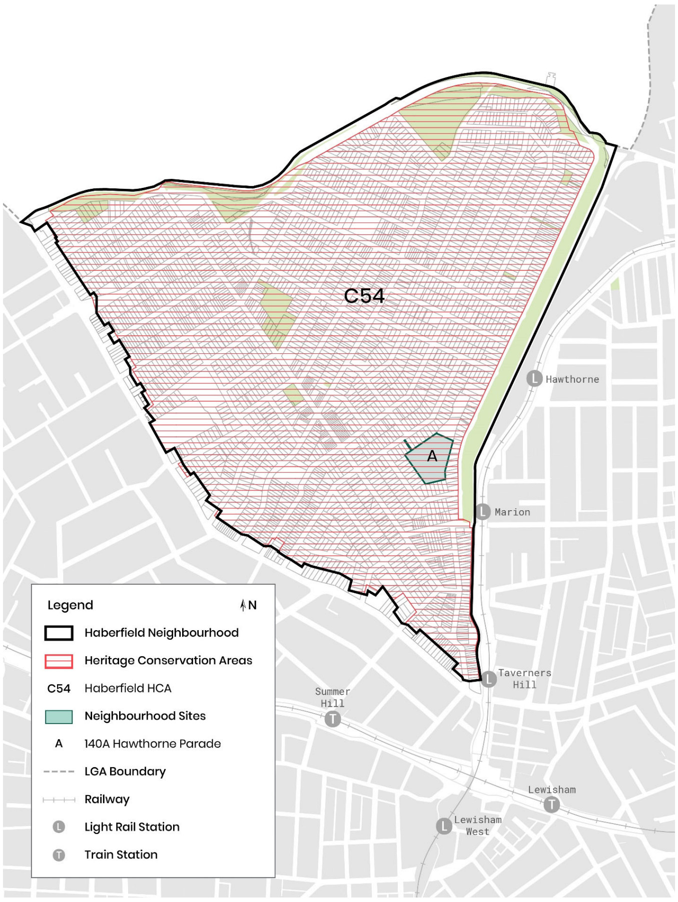


Figure 4.10.1.1. Map of Haberfield Neighbourhood

The controls for:

- Haberfield Heritage Conservation Area apply to the land listed as C54; and

- 140a Hawthorne Parade, Haberfield apply to the land marked 'A'.

Background and Existing Character

Haberfield development as Australia's first Garden Suburb is due to the successive purchase and development by R Stanton and W H Nicholls, real estate agents of Summer Hill. Stanton's Haberfield estate was the first successful Garden Suburb in Australia, predating the first in Britain (Hampstead) by five years.

Stanton and Nicholls purchased fifty acres from two Ramsay children in 1901 and laid out the estate on Stanton's own principles of garden suburb design and management. He set aside land for commercial purposes (there were to be no hotels, no corner shops, and no factories in this model suburb); laid out the roads (named for members of the new Federal Government - Turner, Barton, Forrest, Kingston & O'Connor - and the generous allotments; established an integrated drainage and sewerage system at the back of the lots and planted the street trees. High quality modest houses designed by estate architects, Spencer, Stansfield and Wormald, were built for sale, and title covenants were placed on vacant allotments to ensure a continuation of Stanton's overall design intentions - single storey cottages, one per allotment, uniform setbacks, and quality materials, brick and stone, slate, or tiles. Gardens were laid out by estate gardeners before owners moved in.

It is unusual for any subdivision to be fully developed immediately, but the Stanton Estates were remarkable for the short time frame in which most of them were built upon. Where vacant lots remained, these were built on in the 1920s, 1930s and 1940s, and an examination of the period of each house can provide an interesting history lesson in the progressive development of the suburb.

Amongst the single-family dwellings Stanton also included semi-detached pairs of cottages, carefully designed to appear as one house, so that with consistent forms, setbacks and gardens the pattern of development was maintained.

By the 1960s and 1970s some of the original houses had been demolished for flats or larger houses. Others have changed so extensively, including reskinning of outer walls, that only their original roof shape and footprint remains beneath.

As a result of Stanton's commitment to quality construction and design, and to his application of title covenants the residential parts of Haberfield are characterised today by single storey brick houses on generous garden lots with uniform setbacks and a similarity of form and materials. Stanton's interpretation of Garden Suburb concepts and his consistent development strategy continue to set Haberfield apart.

Within Stanton's strong planning concept, the architectural character and detail of its individual houses, including later 1920s and 1930s bungalows, is richly varied but harmonious, of great visual cohesion and consistency – achieved through the uniformity of materials, scale and forms. Through the sustained efforts of Councillors, the community and its homeowners, Haberfield has strengthened and maintained its identity and rich heritage values for present and future generations.

Statement of Significance

Developed at the turn of the twentieth century, the Garden Suburb of Haberfield is of significance in the history of Australian town planning as a comprehensively planned and designed 'model garden suburb' influenced by the international Garden City movement and the nascent 'art and science' of the modern town planning movement. Marketed as 'slumless, laneless, and publess', as Australia's first Garden Suburb, it was coherently and pragmatically planned to address the social, physical, aesthetic, and economic planning issues as a direct consequence of the ills of unfettered city growth.

Haberfield demonstrates the garden suburb separation of land uses. The commercial core is of attached two storeys in the Federation styles and use of materials. Surrounding the shops are institutional uses, then singe storey residential housing.

Realisation of Haberfield occurred at a time when the principles of Garden City movement were still emerging in Europe. It predates international exemplars, such as Letchworth (1904) and Hampstead

Garden Suburb (1907), and Colonial Light Gardens in South Australia (1921). It was influential in shaping the state's emergent town planning discourse, future legislation, and the design and planning of subsequent 'model suburbs', including Daceyville, Roseberry Appian Way Precinct in Burwood, Lang Road and Martin Road in Centennial Park, Hamilton South Garden Suburb in Newcastle and Colonel Light Gardens (1921) in Adelaide, South Australia..

Haberfield has a strong historical association with auctioneer, real estate entrepreneur, town planning advocate, Richard Stanton (1862–1943) who was the visionary behind the suburb's development. A reformer and staunch advocate for Federation, Haberfield is representative of Stanton's interest in city 'improvement' and in the planning of healthy social and physical environments for 'betterment' and moral reform in New South Wales. Land use of the emerging garden suburb philosophy is exhibited by the commercial core of attached two storeys, then institutional uses, both surrounded by single storey housing.

Haberfield demonstrates the commercial, social, aesthetic and broader civic values of Stanton's innovative approach to town planning through a comprehensive and clever vertically integrated system from land purchase, zoning principles, strict covenants for built form design, and intervening spaces between houses, spatial relationships, landscape controls, infrastructure provision prior to house construction, supplier of building products, a dedicated labour force and providing mortgages.

Stanton and his family resided in The Bunyas, a grand Federation-period residence displaying Arts and Crafts stylistic influences that was designed by Stanton and Sons' architect, John Spencer-Stansfield. As the architect for the Haberfield Estates between 1905 and 1914, he designed several floorplan templates but no two are alike being individualised using Estate materials and the Estate carpentry works in Forrest Street. Initial Estate architect was D. Wormald.

Haberfield has an historical association with Dr David Ramsay (1794–1860), a medical practitioner and merchant associated with the historic property, Yasmar House and Estate. Several streets in the area retain names reflecting the historical association with the Ramsay family, including Ramsay Street and Dalhousie Street (reflective of the Ramsay's historical connections to Scotland). Stanton purchased land from the Estate heirs when much of the suburb was called 'Ramsay's bush'.

Haberfield has historical associations with other individuals of note in the history of New South Wales, including Joseph Neal Grace, the founder of Grace Brothers department store, and the composer, Peter Dodds McCormick, who wrote the national anthem, Advance Australia Fair.

Haberfield is a major research repository of the Federation era, as a collective and for the application of Garden Suburb principles. Haberfield is a formally designed and planned suburban living environment that is integral to understanding the development of Australian town planning.

Within New South Wales, Haberfield is an early and outstanding example of both a design landscape and environmental forethought for comprehensiveness in Australian suburban planning - with landscape design given equal priority to the design of built fabric. Both sit within the collection of interrelated public and private spaces, Haberfield is a formally designed and planned suburban living environment that is integral to understanding the development of Australian town planning. The landscape significance of Haberfield is encapsulated by four principal elements:

- the extant street pattern of the suburb's original layout;
- the extant residential allotment proportions developed in Haberfield's original layout and ensure space and spatial rhythm between built forms;
- remnant hard and soft garden fabric from original residential garden layouts, and historical plantings in those gardens; and
- street tree plantings from the first phase of the suburb's development.

Through its overall landscape setting and design, combined with the composition and arrangement of built form and spatial relationships, Haberfield is simultaneously cohesive and unique, demonstrating the Garden City principle of 'unity but not uniformity'. Setbacks from the street and between houses were specific and are uniform. , with I Landscaped front gardens and low front fences ensuring long park-like views along street alignments. Detailed design for civic works, including road verges, trees locations with timber guards, stone kerb and guttering, nature strips with concrete paths and street lighting ensure visual harmony and consistency.

Haberfield is important in demonstrating aesthetic characteristics that define the Garden Suburb, as well as several Federation architectural styles within New South Wales. Overall, the suburb's residential architecture presents as a collection of well-detailed and crafted period houses that evidence an overarching visual coherence in design, form, materiality and colour. The suburb is characterised by its ability to demonstrate a collection of distinctive Federation period architectural styles within New South Wales in its residential architecture. Houses were designed under covenants which ensured that each was of similar form, materials, scale and setbacks. Materials the Company catalogue provide visual unity yet combined to be is aesthetically individually distinctive demonstrating visually pleasing arrangements that have sensory appeal. Federation-era houses designed in the Queen Anne and Arts and Crafts styles integrate demonstrate the culmination of these styles' vernacular motifs, including rising sun motifs, waratah, flannel flowers and the first Australian coat of arms. The composition of forms and textural arrangements of materiality demonstrates a high degree of mastery.

The Haberfield HCA has a strong connection to the community through the Haberfield Association, which has advocated consistently for the protection and conservation of the area since 1980. for over four decades. Haberfield has strong associations with Italian cultural traditions and culinary influence along Ramsay Street, shaped by mass Italian post-war migration to Australia and settlement in the area. Haberfield is representative of the course and pattern of migration to NSW in the mid-twentieth century.

Haberfield is of significance to the state of New South Wales and displays historical, associative, aesthetic, and representative qualities and research potential that are rare or unique within the state of New south Wales.

Note: Avoid even minor alterations (such as removing finials) or additions (such as enclosing a verandah) and unsympathetic changes to building details that reduce the historical, architectural, and real estate value of the individual building. These will reduce its relationship with neighbouring buildings and diminish the overall heritage value of Haberfield which has such a strong common design theme.

Building Form

Commented [1]: Significance statements from the current DCP for each specific subject have been included here as they add to the guidance and provide importance context for each set of controls.

Historically the houses of Haberfield are significant as they form part of the first comprehensively planned and successfully marketed model Garden Suburb in Australia.

Architecturally the earlier houses, although of individual design, are strongly related to one another and are collectively significant for the homogeneity of their bulk and single storey built form. Individually, the houses are significant for their rich variety of architectural detail and excellence of design. The architectural style of each house identifies the period of its construction and documents the development history of the suburb.

Roof Forms

The roof shape and materials, as an integral part of the design of the house, help identify the architectural style and period in which the house was built.

The complex roof forms and decorative detail are important identifying characteristics of the Federation house..

The tall chimneys and ridge decoration provide a visually interesting skyline and identify the suburb from afar.

Siting, Setbacks and Levels

The uniform pattern of site coverage and setbacks is one of the most significant aspects of Haberfield, demonstrating Stanton's Garden Suburb ideals and establishing the principles for Australian suburban development. The close relationship between ground floor and natural ground level means that the overall built form of Haberfield reflects the underlying natural topography.

Walls

The brick walls of Haberfield reflect Stanton's covenants on building materials and the extension of those covenants onto later adjoining suburban development. The use of cavity brick walls was innovative for its time.

Within the limitations imposed by the sole use of brick, a variety of wall treatments and decoration contribute to the distinctive character of the suburb.

Chimneys

Chimneys are essential elements in the design of the houses of Haberfield: their height helps to balance and articulate the massive forms of the roofs; they create a distinctive skyline identifying the Federation suburb from afar. Chimneys also provide a means of elaborate architectural expression reflecting the stylistic influences of the time.

Joinery

Internal and external decorative timber work is an integral part of the distinctive detailed design of Federation house and of houses in the 1920s. It was a way of expressing the individuality of houses which were otherwise similar in scale and shape, and in decorative themes.

Commented [2]: Note new text

It provides a light and textured contrast to the solid brick walls of houses and shops and their slate and tiled roofs. The interplay of sun and shadow through the decorative timber creates ever changing patterns on the buildings.

Windows and Doors

Windows and doors are an integral part of the design of each building in Haberfield. Their design reflects the relative importance o f the room to which they belong.

The extensive use of coloured and decorative glazing to windows and doors illustrates the architectural detailing of the period, and the aspirations of the original owners. Haberfield is important today because it houses in situ a rich collection of this decorative art.

Window Sunhoods, Blinds and Awnings

Sunscreening devices are part of the individualised decorative detailing on each house, and contribute to their architectural importance and visual interest.

Verandahs

Verandahs are a very important integral part of the design and use of Federation and 1920s and 1930s houses. They provide extra outdoor rooms to a house generally outside the scale of the roof: the floor space of the house therefore is often larger than the main roof suggests.

Haberfield's verandahs are a focus for timber craftmanship employing great originality of design in the use of posts, brackets, valances and balustrades, and motifs.

Garages and Carports

Commented [3]: Note: Some of the current description has been omitted - it is not clear why.

The garages, carports and sheds found I Haberfield provide evidence of the impact of the early years of motor vehicle ownership upon the suburb and its residents. Older garages in particular show how modern car accommodation can be designed to reflect the original practice of garaging in the suburb.

Outbuildings: Studios, Secondary Dwellings, Garden Sheds

Early garden sheds and outhouses are important in demonstrating the way in which pre-1950s suburban residents used their allotments.

Colour Schemes

The use of original or traditional colour schemes enhances the presentation of the house and the HCA and augment the public's visual appreciation of its Federation and early 20th century domestic architecture.

Commented [4]: New text. HCA is not defined in this section of the DCP.

Unpainted masonry walls are an integral part of the architecture of Federation, Bungalow and the pre-1950s periods in general. The inter-relationship of painted timber and guttering on the natural tones of stone, brick, slate and tile is a most important decorative element in the appreciation of pre-1950s domestic architecture.

Fences & Gates

Fences define each individual garden allotment and illustrate the major principle of the Garden Suburb – one house, one lot.

Front fences and side fences in front of the house are a very important part of the integrated design of house and front garden and of its presentation to the public view.

Garden Elements, Including Paving, Driveways, Pergolas and Pools

The light structures which enclose and furnish Haberfield's gardens are an integral part of the suburb's garden heritage and character.

Garden elements contribute to a better understanding of Stanton's vision, and the contemporary impact that "The Garden Suburb" ethos had in its time.

Commercial Buildings

Haberfield's commercial centres demonstrate Stanton's ideal of separating land uses so that the amenity of residential areas was ensured. The commercial buildings are remarkable for their diversity of design within a harmonious two-storey streetscape. The consistent streetscape comes from the original above-awning facades which feature recessed balconies, arched verandah openings, bay windows and roof-screening parapets above.

At ground level the few remaining shopfronts provide evidence of stained glass and leadlight windows, heavy copper or brass mouldings, glazed tiles below the display window, central entryways and porches embellished with tessellated tiles.

The Haberfield Main Street Heritage Study is a valuable reference indicating the style and significance of original commercial facades.

A legacy of some non-conforming uses and structures in and near the neighbourhood shops. Even so the goals and objectives for the Haberfield Conservation Area apply to alterations, additions and new structures.

Pattern of Development & Existing Character

Haberfield's character is due to its intact visual cohesion and consistency – achieved through the uniformity of its spatial relationships, scale, forms and use of materials. This is because Haberfield is the seminal realised application of the Garden Suburb philosophy in Australia, that predated the first in Britain, at Hampstead, by five years. Haberfield demonstrates how influential it was then and continued to be throughout the 20th century, via the application of early town planning principles prior to government regulation, and which became the basis of local government legislation after 1918, including providing infra-structure on new estates.

Haberfield's distinctive pattern of development is a product of these factors.

Conceived by Richard Stanton, real estate agent of Summer Hill, and financed by the Nicholls family, they formed the Haberfield Proprietary Company to purchase fifty acres from two Ramsay family heirs in 1901. Stanton was a founding member of the fledging Real Estate Institute and Town Planning Association, the latter having its basis in the Garden Suburb philosophy. Haberfield was laid out according to Stanton's own principles of Garden Suburb design and as a 'model' total package that integrated all aspects guiding private and public lands.

Haberfield deliberately differed from the preceding Victorian-era inner suburbs. Factories and hotels were specifically excluded as a reaction against the grimness of the 19th century industrial city. The Garden Suburb philosophy-specifically separated residential from other types of land uses. On the periphery of Haberfield's commercial core are institution buildings, then single storey houses.
Decisive too was for each free standing family home to have a uniform front setback of approximately 6 metres, similar site coverage, and ample side setbacks to enable access to natural ventilation and sunlight, to ensure views remained between houses and to emphasis on the garden setting.

Also the antithesis of 19th century speculative subdivisions was installation of infrastructure prior to house and land package sales: sealed, kerbed and guttered roads (named for most members of the first Federal Government); planting shade street trees in the carriageway and grass nature strips; pioneering connections to sewerage, running water, gas and electricity. Stanton foresaw the motor car by siting houses off-centre on each lot to enable a side driveway to a rear 'motor house'. Serpentine paths and gardens were laid out by estate gardeners before owners moved in.

Spatial cohesiveness was also via single storey houses to ensure a house did not dominate the garden setting. Estate architects, Spencer-Stansfield and Wormald used floor plan templates each individualised by use of company standard products so that no two are alike.

Title covenants were placed on vacant allotments to ensure a continuation of Stanton's overall design intentions - single storey cottages, one per allotment, uniform setbacks, and use of quality materials of brick and stone, slate, or tiles.

It is unusual for any subdivision to be fully realised in a short time frame, hence the harmonious legacy seen today. Haberfield was so socially and financially successful, the Stanton model was quickly copied. An examination of the period of each house is an interesting history lesson in the suburb's evolution. Interrupted by World War One, remaining vacant lots in the 1920s, 1930s and 1940s were occupied by bungalow forms, based upon the same model. The Haymarket Proprietary Company continued Stanton's consistency of built forms, setbacks, site coverage and spatial rhythm, although it included semi-detached pairs of cottages, carefully designed to appear as one house. Infill on the former Haberfield golf course occurred at this time.

During the 1960s and 1970s some original houses were demolished for flats (several demolished for WestConnex in 2019?) or rebuilt in 'immigrant nostalgia' styles. Others were changed so extensively, including reskinning of outer walls, that only their original roof shape and footprint remain beneath. These actions triggered considerable community action for conservation and a Commission of Inquiry in 1980. Through the sustained efforts of Councillors and homeowners, Haberfield has strengthened and maintained its identity and rich heritage values for present and future generations.

Objectives

O1. To facilitate development that is consistent with the Desired Future Character and Controls for the Neighbourhood.

O2. To maintain the heritage significance of Haberfield and remove or reverse detrimental works that detract from that heritage significance where possible.

O3. To ensure that where new buildings can be constructed, they are carefully designed to fit in with the heritage significance and character of Haberfield as a whole.

O4. Provide controls for buildings and their landscape that will ensure that the single storey appearance of each dwelling in the Haberfield Heritage Conservation Area is maintained, and the garden suburb character of Haberfield is conserved.

Note: The same careful consideration should be given to changes to the back of houses and shops as are given to changes to those visible from the street or a public place because they could alter the harmonious proportion and scale common to the suburb.

O5. Any proposal for change, such as alterations and extensions to existing buildings, must be compatible with the contribution of those buildings to the heritage significance of Haberfield and must not remove or detract from the special qualities that contribute to the heritage significance of Haberfield or have any ill effect on the heritage significance of Haberfield as a whole.

O6. To encourage the removal and reversal of those components which detract from the heritage significance of Haberfield.

Desired Future Character

Controls

C1. Any new development (whether it is a new dwelling or extension to an existing dwelling) shall result in site coverage that is similar in pattern and size to the site coverage established by the original development of the suburb.

C2. Extensions shall not conceal, dominate, or otherwise compete with the original shape, height, proportion and scale or architectural character of the existing building.

C3. Extensions are only permitted to the rear of the existing dwelling; extensions are not permitted to the side of an existing dwelling. Extensions to the rear of the existing dwelling must not be any wider than the existing dwelling, i.e., the rear extension should not be visible when the dwelling is viewed from the street. Side setback areas and gardens should not be filled in.

Commented [5]: All stated objectives have been combined in this section. Confirm if there are any other overall objectives to include here.

Commented [6]: Note: The interpretation section with definitions has been omitted from this draft on the basis all terms are already defined in the DCP or other planning documents eg Model Guidelines. Suggestion to check and confirm if any definitions should be reinstated to aid interpretation of the DCP.

Commented [7]: The capitalised terms are not defined in this section. Clarify what they mean.

Commented [8]: This section addresses new dwellings. The New Homes section later should clarify what DCP controls apply to new dwellings . There is no reason that new dwellings cannot comply with the vast majority of these controls - refer to covering email.

Commented [9]: Ensure there is an appropriate hierarchy of headings and there is clear differentiation between main (eg Desired Future Characterand subsidiary (eg Controls headings. Consider using numbering to differentiate between topics.

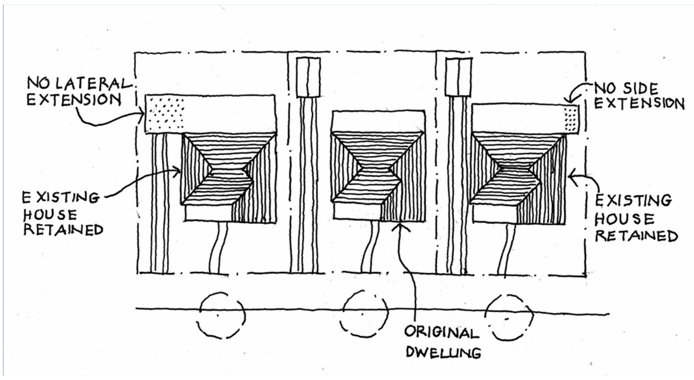


Figure 4.10.1.2. Where additions should be located.

C4. Subdivision of existing allotments is not permitted as it would be detrimental to the heritage significance of the Garden Suburb by changing its historic pattern.

C5. Any new development (new dwelling or extension to an existing dwelling) shall produce site coverage similar in pattern and size to the site coverage established by the original development of the suburb. No new structures are to be built forward of the existing building line; new car ports or garages in the front setback are not supported. Side setbacks must reflect those in the area and nil side setbacks are not appropriate.

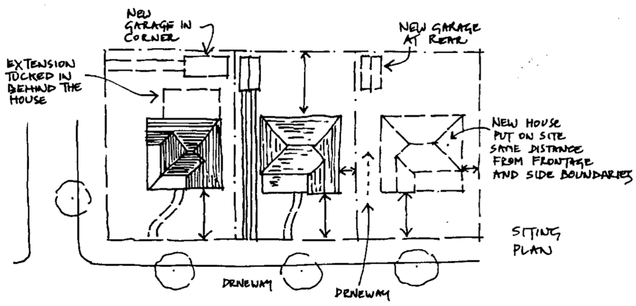


Figure 4.10.1.3. Where new structures should be located in Haberfield

Building Form

Residential buildings in Haberfield are uniformly single storey and of a similar bulk. They are built of a restricted range of building materials (bricks, slate or unglazed tiles) and are of a similar shape but individually designed.

The style of their architecture is mostly Federation, but it includes many 1920s and 1930s bungalows, through to the pink brick cottage of the 1940s. Some houses have lost their original stylistic character through later changes.

Controls

Commented [10]: Not all diagrams from the current DCP have been carried over. Suggestion it to check and confirm no important or relevant diagrams have been inadvertently left out.

Commented [11]: Note: new text

Commented [12]: This is an amalgamation of various controls that are set out elsewhere eg C20 - C25. LEP 50% coverage requirement should be included or referenced.

NOTE: IWC LEP 2022 clause 6.20 (3) (d) "the development will not involve excavation in excess of 3m below the existing ground floor".

C6. Alterations to the original main part of a building (other than a non-conforming building), including front and side facades, verandahs and roof forms, are not permitted.

C7. Where a building, other than a non-conforming building has undergone limited change, restoration, and repair of the original front of the building is encouraged.

C8. Where a building, other than a non-conforming building has suffered major alteration, careful reinstatement is encouraged. When no surviving physical or documentary evidence of the original can be found, reconstruction similar to the neighbouring or other original Haberfield houses is encouraged.

C9. Where extensions are involved, new roofs are to be lower than the main roof form with a maximum height considerably less than the principal ridge point.

C10. The overall length of any extension is to be less than, and secondary to, the original house.

C11. Attic rooms can be built within the main roof shape where they do not involve alteration of the roof shape. They are to be modest in scale and comprise one (1) or at the most two (2) rooms capable of habitation. Skylights are not permitted in the front or side faces of the main roof. Dormer windows, Juliet balconies and similar protrusions are not permitted.

C12. Rear extensions containing an attic may be considered where the attic does not cause the extension to compete with the scale and shape of the main roof and is not visible from a public place.

C13. Where extensions to existing roofs are being undertaken, modestly sized in-plane skylights may be considered in the side and rear planes of the extension only and limited to one such window per roof plane.

C14. Extensions shall not employ any major or prominent design elements that compete with the architectural features of the existing building.

Roof Forms

Roofs of the Federation Period are steeply pitched (30º-40º) and often massive in form. After the First World War roofs were built to a lower pitch (25º-35º) because of changes in style and the need for economy.

The roofs are complex in design, and this accentuates the single storey scale of the house. The mass and bulk of the roof generally extends only over the main rooms of a house, with skillion roofs or lower hips to the rear. This allows the house to maintain a visual balance and not dominate its garden setting.

Tall chimneys help to balance the complex forms of the roof.

Roofs can be characterised by a picturesque arrangement of a variety of gables, gablets, vents, hips, conical turrets and deep jutting eaves and decorated with terra cotta finials, crests and ridge cappings. Gables are used at the front (and sides on corner lots) with hips and skillions used at the rear. Some roofs are fairly plain, while others are intricately detailed. Architectural details, such as finials, ridge cappings and the detailing of exposed eaves, are among the most visible characteristics of Haberfield houses and an important part of their picturesque qualities.

Commented [13]: Note: new text

Stanton's covenants restricted roof materials to slates or unglazed terra cotta Marseilles pattern tiles, with unglazed terra cotta finials, crests and ridge cappings. Corrugated galvanised iron was used at the rear on skillions and lean-to rooms built soon after the brick house was finished. Areas not covered by Stanton's covenants also had main roofs of corrugated iron, asbestos cement and shingle tiles.

Some roofs have been altered over time. In many instances the original roof shape can be reinstated where it can be based on documentary or physical evidence.

Controls

NOTE IWC LEP 2022 clause 6.20 (3)
(a) if the development involves an existing dwelling, or alterations or additions to an existing building
(i) development above the existing ground floor level will not exceed the development contained within the existing roof space, and
(ii) development below the existing ground floor level will not exceed 25% of the gross floor area of the existing ground floor"
(c) the development will not involve the installation of dormer or gable window.

C15. Roof extensions are to relate sympathetically and subordinately to the original roof in shape, pitch, proportion, and materials.

C16. New buildings are to have roofs that reflect the size, mass, shape, and pitch of the neighbouring original roofs. Gables to the rear are not permitted as hips and skillion roof forms are more typically used at the rear. Fully glazed gables are not permitted.

C17. Roof extensions are to be considerably lower than the original roof and clearly differentiated from the original section.

C18. Replacement roof materials are to match original materials or are to employ approved alternative materials. Suitable roof materials are:

a. unglazed terra cotta Marseilles tiles

b. unglazed terracotta shingle tiles

c. Welsh slate

d. corrugated non-reflective galvanised steel sheeting (painted or natural) (at the rear/on skillion roofs)

C19. Roof details such as finials, ridge capping, are to be maintained, repaired and/or reinstated.

Figure 4.10.1.4. Roofs in Haberfield

Siting, Setbacks and Levels

Haberfield is notable for the uniformity of its building site-coverage and siting. Most houses are free standing with car access down one side, and a traditional tradesmen's path down the other side.

Development on corner sites is usually sensitive to the pivotal position they occupy in both streetscapes.

Houses are set back approximately six metres from the footpath alignment. This provides for a front garden in which to present the house and allows for privacy.

Haberfield houses are set close to natural ground level. There is usually no substantial difference between the main floor levels of adjacent houses.

Some houses, located on sloping sites, have a sub-floor or basement level located within the foundations. The lower level does not compete with the main level of the house. Basement doors and windows are small, plainly treated, and are not visible from outside the property. The space within the below-floor area was used for laundries, store or workrooms or sometimes garages, but not for extra living areas.

Controls

NOTE: IWC LEP clause 6.20 (3) (d) "at least 50% of the site will be landscaped area."

Commented [14]: Various terms are used to refer to new residential buildings eg new buildings, dwellings, houses. Use dwellings as a global term. Note: house is used extensively, including in the updated statement of significance - change 'dwelling' to 'house'?

Commented [15]: Note: new text

Commented [16]: This is an example of a control for new dwellings that is in the general section not the specific section or new dwellings.It should apply to all buildings not just dwellings

Commented [17]: Define the height differential required with more precision so its meaning is clear and not open to debate. Other guides do specify a vertical height e.g. at least 2 tile lengths otherwise a merit assessment due to the variety of built form types

Commented [18]: Note: reference to 'approved fibrous cement tiles' deleted.

Commented [19]: Note: new text.

Commented [20]: All references to 'where necessary' removed as the term is not sufficiently precise. Consider alternative where the context permits eg 'as required'

C20. The established pattern of front and side setbacks should be kept. Nil side setbacks were rare and are not consistent with Garden Suburb principles.

Commented [21]: Note: new text.

C21. New residential buildings or extensions should not be built forward of existing front building lines.

C22. Site coverage should be similar to the traditional pattern of development, leaving generous green garden space to the front and back areas.

C23. There should be no substantial or visible difference between the main floor levels of adjacent houses unless natural ground levels require this.

C24. Where natural land slope allows, sub-floor and basement development is permitted for use as laundries, storerooms, workrooms or garages. Habitable rooms may be considered but must not change the single storey scale of a building; openings (windows and doors) are only permitted in the rear elevation. A basement level is only permitted if enabled by the site topology; the floor level of the ground floor of the dwelling must be at the same level and significant excavation to provide adequate floor to ceiling heights in the basement level is not permitted.

Commented [22]: Note: new text.

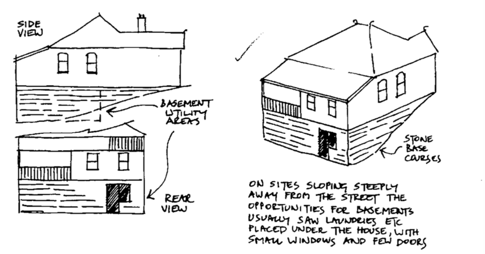


Figure 4.10.1.5. Characteristics of basement levels

Walls

Stanton's covenants required that the main walls be built of brick. This uniformity of materials is part of the distinctive character of Haberfield today.

The houses are built of cavity brick walls, an innovation at that time, with machine-made smooth-faced bricks. The precision of the brickwork is accentuated on the main elevation by the use of tuck-pointing, usually in white or black.

The front elevation commonly makes decorative use of bricks such as shaped and moulded brick profiles, or two-toned brickwork, sometimes roughcast and shingle work is used. Side and rear walls are generally built of common bricks.

The walls of the houses in Haberfield are often divided horizontally into two or three distinct sections, for example, the base course can be rough cut sandstone or mock ashlar (rendered brickwork) with the main wall of tuck-pointed facebrick or commons, and occasionally an upper section of contrasting roughcast finish, often accented with a frieze of brick bands. The front gable ends often feature brick or timber strapwork, and timber ventilating panels of louvres framed by fretwork shapes.

Commented [23]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Controls

C25. The original shape and materials of the front and side walls shall not be altered.

C26. The removal of the external skin or rendering of an exterior wall is not permitted unless an essential part of approved reconstruction and authentic restoration works.

C27. Unpainted surfaces shall not be painted.

C28. Reconstruction of walls previously re-skinned must use machined smooth faced bricks similar in colour to those on original Haberfield houses. The "Common" bricks typically used at the rear should be matched.

C29. Face brick and commons brick walls shall not be rendered with cement or plaster.

Commented [24]: Note: new text - appears to be positive.

Commented [25]: New text for consideration - appears to be positive.

Commented [26]: Reinstate significance statement in full from DCP 2016 here, or incorporate it into the significance statement at the beginning of this section.

Chimneys

Federation houses commonly have three or more tall chimneys, heightened by terra cotta chimney pots. Houses of the 1920s and 1930s have fewer chimneys and they are not as tall. Although many chimneys are no longer used, they remain essential elements in the design of each house and in its architectural decoration. They stand out on the skyline.

Controls

C30. Chimneys cannot be demolished unless they are structurally or materially unsound and demolition is followed by immediate reconstruction using the original design.

C31. All chimneys are to be retained internally and externally. Chimneys should be repaired even if the fireplace is no longer in use.

C32. Reconstruction of original chimneys is encouraged.

Note: Archived plans and photographs are held in Council's library collections.

Joinery

Commented [27]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Decorative timber work is used on verandahs, gables, vents, bargeboards, windows, doors, screens and fences. It is used boldly and painted various colours.

Controls

C33. Existing joinery is to be kept, maintained and repaired.

C34. Authentic reconstruction or reinstatement of missing joinery is encouraged, based on evidence.

Commented [28]: Note: new text

C35. Timber detailing on extensions and alterations shall respect the existing detailing but avoid excessive copying and over embellishment. Simpler approaches are best and the typology of the houses in Haberfield Heritage Conservation Area should be followed. Detailing at the rear is usually simpler.

Commented [29]: Note: new text

Windows and Doors

Window and doors are an integral part of the design of each building in Haberfield. Their design reflects the relative importance of the room to which they belong.

The extensive use of coloured and decorative glazing to windows and doors illustrates the architectural detailing of the period, and the aspirations of the original owners. Haberfield is important today because it houses in situ a rich collection of this decorative art.

The use of bullnose sill bricks and arch-shape header brickwork is characteristic.

The extensive use of decorative glazing and coloured glass is an important feature. Multi-coloured or textured glass are used in the upper fanlights to doors and windows. Leadlight glazing in Art Nouveau designs is prominent. It was expensive and is generally limited to windows facing the street where it could be admired by passers-by.

Windows and external doors are made of timber and are invariably painted. Doors frequently feature decorative mouldings with the detail painted in contrasting colours. Internally, doors and windows were often "grained" i.e., painted in simulation of expensive timbers like English Oak.

Commented [30]: Note: new text

Controls

C36. Original doors and windows are to be kept, maintained, and repaired. Authentic reconstruction is encouraged.

C37. Original leadlight and coloured glass panes are to be kept and restored, matched, or reconstructed.

C38. The size and style of new doors and windows should reflect the relative importance of the room to which they belong.

C39. New doors and windows are to reflect the proportion, location, size, sill heights, header treatment, materials, detailing and glazing pattern of the original doors and windows on the house to which they belong.

C40. If no indication of original treatment is available, new doors or windows should be vertical and be kept simple.

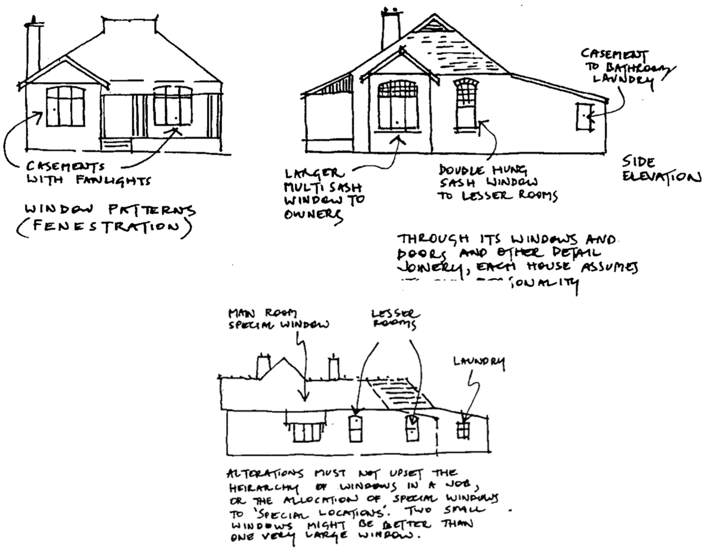


Figure 4.10.1.6. Hierarchy of windows and doors in Haberfield

Window Sunhoods, Blinds and Awnings

Commented [31]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Various sun screening devices are used in Haberfield. They provide important practical and decorative features. Window awnings or window hoods with timber fretwork frames and various roofing materials are the most noticeable. External timber window pelmets are also common. Verandahs often have wooden venetians or canvas roll-up blinds.

Controls

C41. Original sunhoods, blinds and awnings are to be retained and repaired.

C42. Authentic restoration, reinstatement or reproduction is encouraged, based on evidence on the house itself, or on photos.

C43. Modern-style security grilles, roll-up metal screens, metal window awnings, and non-characteristic shade treatments are not acceptable on the exterior of Haberfield cottages.

Verandahs

Commented [32]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Verandahs are an integral part of the design and use of Haberfield houses. On Federation houses they are marked by a change in roof slope, angle, or gable. In many instances the verandah itself includes a turret, bay, shaped balustrade, or similar effect for visual variety. Back verandahs, under iron skillion roofs, are often enclosed to make extra rooms. This was often done at the time the houses were built or soon after. Bungalow verandahs, where they are small, often have flat roofs; and they are incorporated under the main roof of the house, like an outdoor room.

The shadow or created by the verandah provides a sharp contrast to the solidity of the single storey roofed brick buildings. Verandahs are uses as an effective way to ameliorate the hot, wet Sydney climate, and provide outdoor "rooms" popular in the first decades of this century.

Verandah floors were either tongue and groove timber boarding or tessellated tiles with slate, terrazzo, or marble edging, often incorporating entry steps with risers of patterned glazed tile.

Controls

C44. Existing original verandahs are to be kept and repaired or reinstated.

C45. Removal, or infill of verandahs visible from a public place is not permitted.

C46. Authentic reconstruction of verandahs is encouraged.

C47. Verandah additions are to be simple in design and are not to compete with the importance of the original verandah. New rear verandahs are to be generally simpler than the front main verandahs, and not to challenge the street presentation of the house.

C48. The design of any new dwelling shall take into account the architectural significance and design techniques of verandahs as used in Haberfield.

Commented [33]: Control 2.30 d) in current DCP reinstated here.

C49. The roof of a verandah should not continue the main roof but should be a skillion roof or similar to minimise bulk.

Commented [34]: Note: new text

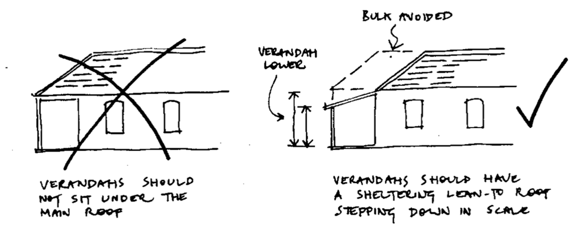


Figure 4.10.1.7. Design of verandahs in Haberfield

Garages and Carports

Commented [35]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

The freestanding houses in Haberfield allowed early car owners to drive down the side to the "motor house" at the back. Some of these older garages dating from the 1920s still survive. They are located at the back of the house away from public view from the street. They were utility buildings, designed to be less important than the house; they often had roofs of a pitch lower than the house.

Controls

C50. The retention, repair and reconstruction of significant early garages, carports and sheds is encouraged.

C51. New garages and carports are to be located at the back or at the side of the house.

C52. Where a garage or carport cannot be located elsewhere, it may be permitted at the side of the house provided it is at least 3 metres back from the main front wall of the house.

C53. Garages and carports are to be free standing.

C54. Garages and carports shall be of simple utilitarian design. They shall not challenge the mass or bulk of the individual house.

C55. Attached garages which form part of a basement level must be located at the rear of the house and not visible from a public place, but only where they would not conflict with other considerations in this Plan.

C56. Garage doors are to be simple timber or metal cladding in a recessive dark colour.

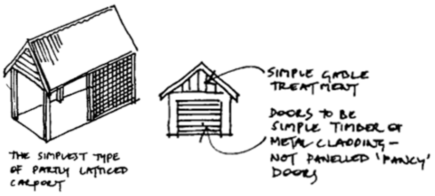


Figure 4.10.1.8. Design of garages/carports in Haberfield

Outbuildings: Studios, Secondary dwellings, Garden Sheds

Outbuildings are located at the rear of houses away from public view. They were traditionally used to store garden tools, seeds, fertilisers, bicycles, canvas covered garden furniture etc: use of the garden to grow vegetables and prize flowers for exhibition at the Gardening Club was an integral part of suburban life before the 1950s. Often the laundry was in a separate outbuilding in the back garden. When the outbuilding might be visible from the street, a variety of screening devices are used, such as suitably plain fences, lattice work, hedges, or other screen planting.

In scale and form Haberfield outbuildings are small, functional, and simply built, with gable, hipped or skillion roofs. Materials used were inferior to those in the houses, with timber or fibro being the most common wall cladding. Their scale did not challenge that of the house they served and did not dominate views from neighbouring properties.

Controls

C57. The retention, repair and reconstruction of significant early garden sheds and outhouses is encouraged.

C58. New outbuildings shall be located at the rear of the allotment. The location shall respect boundaries, tree-planting and other site details.

C59. New outbuildings shall be sited to minimise visibility from the street and from neighbouring properties.

Commented [36]: Note: new text

Commented [37]: Note: new text

Commented [38]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Commented [39]: Note: new general term used

Commented [40]: Note: new text

Commented [41]: Some of the current description in the DCP has been omitted from here.

C60. New outbuildings shall be subordinate to the main house. They shall not challenge the shape, size, form, or decoration.

C61. The floor plan for new outbuildings shall be simple, not complex.

C62. The roof form of new outbuildings shall be simple and practical in scale. The pitch shall be lower than the roof pitch of the house and shall use skillion, hip, or gable forms. Storerooms and outhouses attached to the main house or garage are encouraged where lean-to skillion roofs can shelter them.

C63. Construction materials shall be brick, weatherboard, or fibre cement sheeting with cover battens. Roofs shall be of unglazed terra cotta Marseilles tiles or corrugated metal. Kit garden sheds of metal construction are acceptable subject to screening from the street or a public place.

Commented [42]: Note: new text

C64. Windows to outbuildings shall be of vertical proportions and shall be timber framed.

C65. Merging outbuildings into the landscape by use of planting and screen elements is encouraged.

Colour Schemes

Large parts of the house were never painted, such as all brickwork, exposed bricks on chimneys, slate verandah edging and steps.

On timber and render a comparatively narrow range of exterior paint colours was used to enhance the natural colours of the bricks and stone. Paint technology at the time could not produce a bright white so shades of cream predominated. Authentic colour schemes usually consist of one or two lighter tones, with one much darker colour for contrast. An additional trim colour might also be used.

Careful scraping of protected, difficult-to-paint areas such as behind eaves or under windowsills might reveal the colours originally used. Such evidence might also survive under layers of later paint. Old photographs also can provide valuable evidence of the original paint treatment, particularly the use of contrasting colours for the various elements of the building.

Controls

C66. Paint shall not be applied to any brickwork, stonework, exposed bricks on chimneys, terra cotta chimneypots, tessellated or glazed tiling, slate verandah edging and steps that have not already been painted.

Commented [43]: Note: new text

C67. New exterior brickwork is to remain unpainted.

C68. On an existing house Council encourages owners to identify and use the original colour scheme.

C69. On an existing house, where the original colour scheme or traditional colour scheme is not to be used, the scheme should be simple, consisting of one or two lighter tones and a darker colour for contrast. A trim colour may be used.

C70. New dwellings and outbuildings should use colours that harmonise with the traditional colour schemes.

Fences & Gates

Commented [44]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Fences define each individual garden allotment and illustrate the major principle of the Garden Suburb – one house, one lot.

Commented [45]: Note: new text

The front fence is of modest height (1m to 1.4m), with hedges often planted behind. They were designed to match both the house they serve and their streetscape.

They are not solid but allow the public to see the front garden, and the front of the house – the status symbol for the suburban resident pre-1950s.

Documentary evidence and surviving original fences provide clues to the great variety of fence designs: most feature decorative timberwork in beams, shapes and panels, often with gates to match. Picket fences were not common. Chain mesh within timber frames and fancy woven wire fences were also used.

Haberfield brick fences display brickwork techniques similar to that used in the houses, such as the decorative use of moulded bricks. These are also used in the footings for timber and chain mesh fences. A number of original front brick fences survive in Haberfield. Other early brick fences use galvanised pipe as a railing between brick piers.

Dividing fences and side fences on corner allotments traditionally used timber palings (rough or reasonably dressed).

The use of "colorbond" fencing, modern metal 'spear' and similar topped pickets, aluminium lacework panels, bagging of masonry and similar effects are relatively new treatments and are not appropriate materials or designs in the Haberfield Conservation Area.

Commented [46]: Some of the description content in the current DCP has been deleted in this version.

Controls

C71. Original front fences and gates are to be kept and repaired.

C72. Reconstruction of lost fences to their early design and detail is encouraged. It needs to be based on documentary evidence (photographs, descriptions). Demolition should only be permitted where accurate reconstruction is to occur immediately.

C73. New front fences which are not reconstructions of an earlier fence should be simple in design and decoration and fit in with the design of traditional fences in Haberfield.

C74. New front fences of timber are encouraged. They should be between 1m to 1.4m in height. The timber should be painted and in an appropriate colour.

Commented [47]: Cross reference to colour schemes has been deleted - why?.

C75. High brick fences on front alignments are not permitted in Haberfield.

C76. Materials and designs inappropriate to the age of the house or to the character of Haberfield Conservation Area will not be considered.

C77. Brick dividing fences are not permitted unless there are overriding environmental, safety or fire separation reasons for such use.

C78. Swimming pool safety fencing must not be visible from a public place.

Commented [48]: Note: text has been modified.

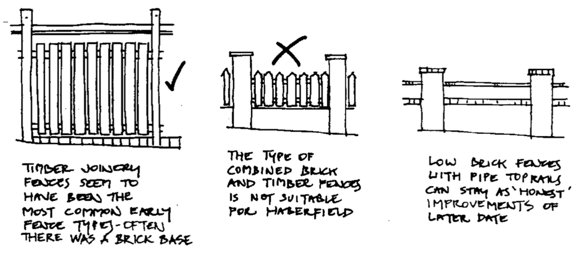


Figure 4.10.1.9. Appropriate fences in Haberfield.

Garden Elements, Including Paving, Driveways, Pergolas and Pools

Commented [49]: Significance statement in the current DCP was deleted but we have reinstated it in the Statement of Significance section above

Richard Stanton paid great attention to all aspects of this Haberfield's subdivision including the treatment of gardens: the grounds of each new house built by his company were laid out before the owners moved in. He consistently promoted Haberfield as "The Garden Suburb".

Original Haberfield gardens are bounded by front fences of timber with handsome joinery gates, or brick fences with wrought iron palisades. Through these fences can be seen ornamental trees and shrubs, typically in tidy beds amid neat buffalo lawn. Specimen plantings were supported on arbours of timber or metal.

A gently curving front path leads from a single, or wicket, gate to the front entry. This path is often made of tessellated tiles in elaborate patterns to match the front verandah, or more economically in coloured concrete with brick borders and garden edging.

Driveways, with double gate in the front fence, usually consist of two sealed strips with a central section of grass or garden in between which allows for onsite drainage.

Commented [50]: References to gravel deleted.

Side and rear paving is extremely minimal. Frames and lattice-screened fences and gates are often used to close off, disguise and protect access to the back yard.

Uncovered pergolas are secondary to the house and fit into the garden setting. Haberfield's original pergolas were used as a garden element and, along with other more modern elements, are not detrimental to the soft landscaping on the site.

The percentage of site coverage used by such elements should not dominate or overwhelm the garden of which they are part.

Controls

C79. The surviving original garden elements in Haberfield are to be kept and repaired.

C80. Reconstruction of lost garden elements is encouraged where it can be based on documentary evidence (photos, plans).

C81. Paving, hard surfacing and secondary outbuildings shall be kept to an absolute minimum on individual sites.

C82. Materials for new front paths shall be only tessellated tiles or smooth-textured, red-tinted concrete.

C83. Driveways shall consist of two (2) strips of hard surface brick paving or concrete with grass, or garden in between.

C84. Concrete paving for driveway strips is to be natural off-white, pale grey or have a red-tinted finish. Bright white concrete is not permitted.

C85. Swimming pools shall be at the rear of the property and shall be small enough to retain an adequate garden setting.

Commented [51]: These drawings should appear after the previous section - Fences and gates

C86.

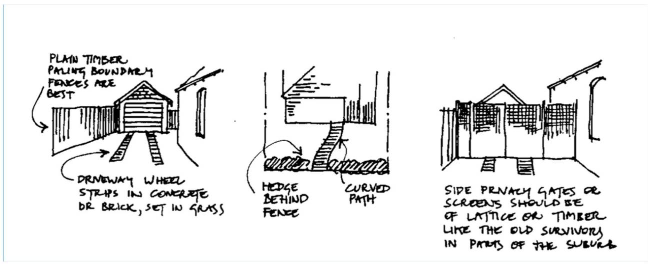


Figure 4.10.1.10. Appropriate garden elements in Haberfield

Figure 4.10.1.11.

Modern Technological Developments

Stanton's original concept for Haberfield included up to date services such as sewerage and water on tap. The services were integrated with the development and were most unobtrusive. Solar hot water systems, photo-voltaic systems, telecommunication structures and other modern technologies are more recent inventions. Further, there is community awareness of the need to conserve water, and rainwater storage tanks are becoming more popular. It is important that the placement of such structures be discreet and not intrusive.

Controls

C87. Hot water tanks should not be located externally on the roof but be within the roof space or within the building envelope. Solar hot water system tanks should not be located externally on the roof but be within the roof space or screened from public view if placed at ground level.

C88. Rainwater tanks are to be located behind the building line of any road frontage.

Commercial Buildings

One of the principles of the Garden City movement and the subsequent Garden suburbs was the separation of land uses: industry, housing, commerce, open space, were all contained in different areas. Haberfield was different from the residential areas which preceded it – it had no corner store, and no pubs, and shops were grouped together in two small centres.

Controls

C89. The existing siting pattern within the commercial area surrounding the intersection of Ramsay Street and Dalhousie Street is to be maintained. The notion of a forecourt or entrance area to a commercial building is not appropriate as these interrupts the continuity and strength of the streetscape siting pattern.

C90. Removal of or alteration to original facades is not permitted.

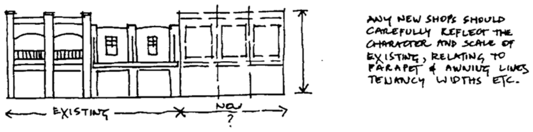
C91. Retention, repair, and restoration of original above-awning facades is encouraged.

C92. Below awning level, new work is to be in sympathy with, and not detract from, the style and character of the building and streetscape. Designs, including materials, colours, signage, etc should reflect the original facades of the commercial buildings of Haberfield.

C93. Reinstatement of the original street-level facades is encouraged, including the reinstatement of posted verandahs.

C94. The design of any new commercial building may include verandah or awning facades to improve or consolidate streetscape and footpath shelter.

C95. The design and use for any alterations, additions or new commercial development outside the commercial shopping area must not impact neighbouring properties, the residential character of the surrounding streetscape or the heritage significance of the Haberfield Conservation Area. The development must be compatible with the settlement and development pattern and the distinctive character and significance of the Haberfield Conservation Area.



Commented [52]: Text has been modified

Commented [53]: Other controls over solar panels deleted - presumably due to SEPP

Commented [54]: Revert to existing control.

Commented [55]: The existing provisions only apply to existing buildings on the shopping strips. We propose that the controls are expanded to address any other non-conforming or new commercial buildings or development anywhere in the area so it is clear what general and specific controls apply to those properties. This has been an issue with some developments in the recent past eg Crystal Car Wash. The draft wording is compatible with Council submissions to court, case law and old provisions of the Ashfield LEP.

Commented [56]: The commercial area to which the current controls apply should be defined in some way - this is my suggestion

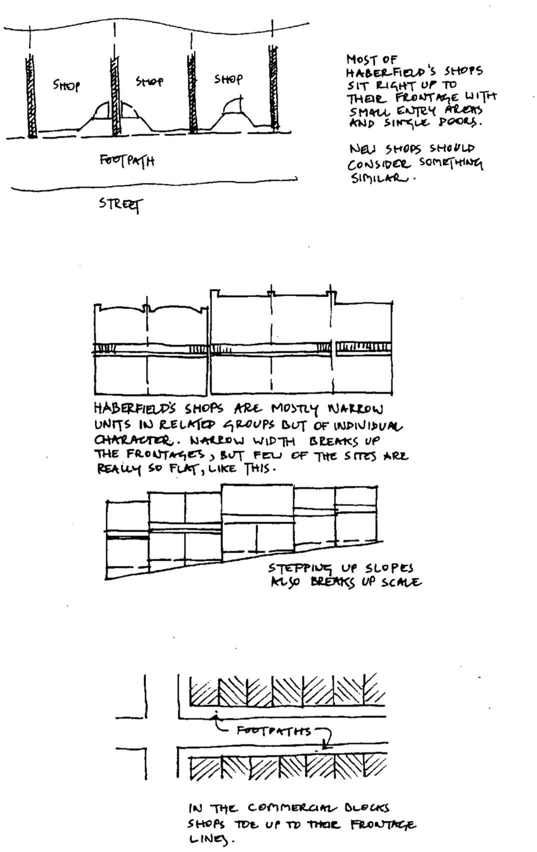


Figure 4.10.1.12. Commercial buildings in Haberfield

Non-Conforming Houses

Some parts of the Haberfield Conservation Area contain houses which are of post Federation and post 1920s construction. Such houses are usually single storey, low set and of brick and tile construction. This scale and use of materials lets them blend in with the character of Haberfield.

A small number of original houses have been demolished and replaced in recent years by two storey houses or by blocks of flats. These are non-conforming buildings and are out of character with the surrounding dwellings, and with the Conservation Area.

Note: New dwellings are not non – conforming houses of the purposes of this Development Control Plan. Refer to the separate section on New Dwellings below.

Controls

C96. Any alterations and additions to the shape, scale and materials of non-conforming houses should respond to the form of surrounding original dwellings and must be compatible with the general pattern of development within the conservation area and its distinctive character.

New dwellings

New dwellings within Haberfield must be very carefully designed and controlled to protect and complement its unique heritage status as Australia's first garden suburb. The architectural language must be compatible with the Haberfield HCAs "Queen Anne" style federation houses with each dwelling being individually designed to suit the specific site. Every dwelling must be placed within a garden suburb setting and exhibit common style elements that result in a streetscape appearance of single storey scale, roof form, bulk, and materials.

Some basic traditional architectural canons must be followed, such as a tripartite composition which has:

- The 'base' is the part of the building from the ground-to-ground floor level, often incorporating a plinth.
- The 'body' comprises the main walling and its window and door opening fenestrations, including shadowed areas such as verandas
- The 'top' is the complex of roof forms including eaves, which forms the 'crown' of the building.

The front part of the house must be the prominent part and must have a pitched tiled roof. The rear part of the house must be subservient in scale to the front part.

Controls

Note: These Controls [C95 to C107]are in addition to, and not in substitution of, the other controls set out in this DCP, except to the extent they are inconsistent with or have been specifically modified by Controls [C95 to C107]

C97. Any new development must produce site coverage similar in pattern and size to the site coverage established by the original development of the suburb. That is, free standing single storey scale brick houses in a garden setting with uniform front setbacks, a 3m wide side setback for driveway access to a garage, a smaller side setback for a traditional tradesmen's path down the other side, and a generous rear setback.

Note: Nil side setbacks were rare, depart from Garden Suburb principles and are not permitted.

C98. The shape, scale, form, and materials of new dwellings should be sympathetic to those of surrounding original dwellings.

C99. New dwellings are to have roofs that reflect the size, mass, shape, and pitch of the typical neighbouring original roofs in Haberfield. Roof materials are to be unglazed terra cotta Marseilles pattern. Corrugated iron (traditional profile) is acceptable for the rear (skillion) portion of a roof.

C100. The main front part of houses facing the street are to have pitched roof at minimum of 30 degrees placed over a footprint of a minimum of four rooms. Beyond this the rear part of houses are to be subservient in scale to the front part.

C101. Attic rooms can be incorporated into the main roof shape. They are to be modest in scale and comprise one (1) or at the most two (2) rooms capable of habitation in the main roof shape. Attic windows must be modest timber framed flush "in plane" skylights only – maximum one skylight per side or rear roof elevation. Dormer windows, Juliet balconies and similar protrusions are not permitted.

Commented [57]: A statement such as this is required to avoid any argument that new dwellings are simply non conforming houses and therefore not captured by many of the controls that apply.

Commented [58]: Amendment proposed to explicitly require that development is consistent with the form and character of the conservation area.

Commented [59]: A new separate section has been included for all new dwellings and it contains most of the controls that will cover 140A. This approach does complicate the drafting as set minimum standards should be set for all new development in line with the controls for existing houses, and any modification for 140A army land should be limited to derogations required by the nature of the site and its limitations. Either (a) a statement should be included here to clarify that these controls are in addition to all the others and that the rest of the DCP controls also apply to new dwellings as far as it is practicable to do so - and to any future modifications of these dwellings or (b) the controls that do and don't apply to new developments should be listed in this section - refer to covering email.. The DCP also needs a clause to clarify that all general controls apply... [1]

Commented [60]: Again this term is not defined.

Commented [1]: Most of these controls are the same or similar to controls set out elsewhere. They should be deleted if they are already covered or amended to reflect any differences ... [2]

Commented [62]: Ideally a minimum setback should be specified for all new dwellings - otherwise the requirement is unclear and open to ... [3]

Commented [63]: What does this mean? Is there a better and more precise way to define this requirement?

Commented [64]: This control overlaps with C1 and aspects of controls in various sections. Suggest it should be amended to just modify any specific requirements in existing controls.

Commented [65]: What does this mean? Is there a better and more precise way to define this requirement?

Commented [66]: This control overlaps with C16 and C18. Is there any reason why a separate control is required?

Commented [67]: New control for consideration

Commented [68]: Note: new text

Commented [69]: This is almost identical to C11 so is not required. Any minor variance in wording should be removed unless there is a reason it is required.

C102. Light and ventilation can be provided to rooms within roof extensions via one modestly sized in-plane skylight per roof plane.

C103. Walls must not be painted or rendered and are to be clad with machine made smooth faced bricks similar in colour to those used on original Haberfield houses.

C104. Joinery, doors and windows are to reflect the materials, proportions, location, size, sill heights, header treatment, materials, detailing and glazing patterns of original Haberfield houses.

C105. New dwellings should use colours that harmonise with the traditional colour schemes in Haberfield. Colours of timber trim and other external (non-brick) elements are to harmonise with these traditional colour schemes.

C106. Garages and carports are to comply with the following:

a. free standing, low in scale and simple in form to not challenge the mass or bulk of the house

b. garages must be located at the back (rear) of the house

c. car ports can be located at the side of the house if setback at least 1 metre from the main front building alignment and maximum 3m width

d. materials to match those used in dwelling

e. Garage doors are to be simple timber or metal cladding in a recessive dark colour.

C107. Front fences, and side fences within the front building setback are critical due to their prominence in the streetscape. Accordingly, all dwellings are to contain a front fence; front fences are to comprise traditional style timber joinery fences of simple design, up to 1.4m in height, and painted in traditional colours.

C108. Rear and side fences behind the front building line are to be constructed of timber palings to a maximum height of 1.8m.

C109. Front paths are to be curved and comprise tessellated tiles or smooth-textured, red-tinted concrete.

Site Specific Planning Controls

140a Hawthorne Parade, Haberfield

A subdivision/ road layout plan for the land was conditionally approved by Council on 18 December 2001. The subdivision is to be Torrens title for each of the proposed residential lots. An area of public open space is provided as a central focal point to the future development. The roads, public reserve, and provision for drainage easements and infrastructure are to be dedicated from the Commonwealth to Council.

The approved subdivision lot pattern reflects, as far as possible, the principles of the existing surrounding subdivisions and the garden suburb ideal which dates from Richard Stanton's first Haberfield Estate of 1901 and its 1905 extension.

The subject site, including house lots and public reserve, is susceptible to stormwater inundation events. Therefore, minimum required elevated ground floor levels are necessary to ensure dwelling-house habitable living areas are above stormwater inundation levels associated with 1 in 100-year ARI events. Also, minimum required levels for all electrical wiring/power points/switches are detailed for all house lots. Building designs are required to be accompanied with a hydraulic engineering report to establish the minimum floor levels of structures.

Objectives

O7. Ensure new development does not detract from the heritage significance of Haberfield.

Commented [70]: This control should apply generally so incorporate it into C11 and delete it here.

Commented [71]: Meaning of this term is unclear - is there a more precise term that can used for greater clarity?

Commented [72]: These types of controls make sense as they explain how existing controls that do not contemplate or address new dwellings should apply to new developments.

Commented [73]: This is a summary of the existing controls. Is there any reason that the existing controls cannot apply in their current form?

Commented [74]: Why is this 1.4m not 1.2m?

Commented [75]: Overlaps with C82

Commented [76]: Consider if there are any other specific controls set out in the previous site specific DCP that should continue to apply to this site

Commented [77]: These requirements should be set out as specific controls to the extent they are not captured by controls elsewhere in the DCP. Regardless explicit cross references should be made to other DCP sections where applicable eg flooding, contamination etc to draw the readers attention to them and avoid any suggestion or argument that the drafting infers that the chapter sets out all the controls that apply to the site

O8. Ensure vehicles can manoeuvre in accordance with the relevant Australian Standards.

O9. Establish appropriate uniform front setback for subdivision to enable garden setting to be established.

Controls

Commented [78]: Add a specific control for fences to allow runoff, and clarify that only habitable buildings can have an elevated floor height - refer below

Note: These Controls[C108 to C110] are in addition to, and not in substitution of, the other controls set out in this DCP, except to the extent they are inconsistent with or have been modified by Controls [C108 to C110]

C110. Each dwelling must be set back 4 metres from the front boundary of the lot.

C111. Driveways on subdivision lots 16 and 17 must be located on the southern side of the dwelling.

C112. Front garden levels within the required building setback are to generally match the levels of the adjacent public footpath to achieve a uniform, cohesive garden setting throughout the development.

Include:

<<New and different control for Flood Fences – the fences must be open to allow for overland flows, Suggest open fence design on the lower 1 meter.

<< new control Only habitable space to conform to the finished floor heights – ie to avoid flooding – space buildings, eg garages and pool pergolas are not be at the floor height of the livable space.

Also suggest the following:

C1. Only habitable space is to conform to finished floor heights as supported by a lot engineering report and flood mitigation impact statement.

C2. Any non-habitable space, including hard surfaces and driveways, parking and garden structures, other miscellaneous lot elements and the like, are not to be elevated or raised above finished subdivision level.

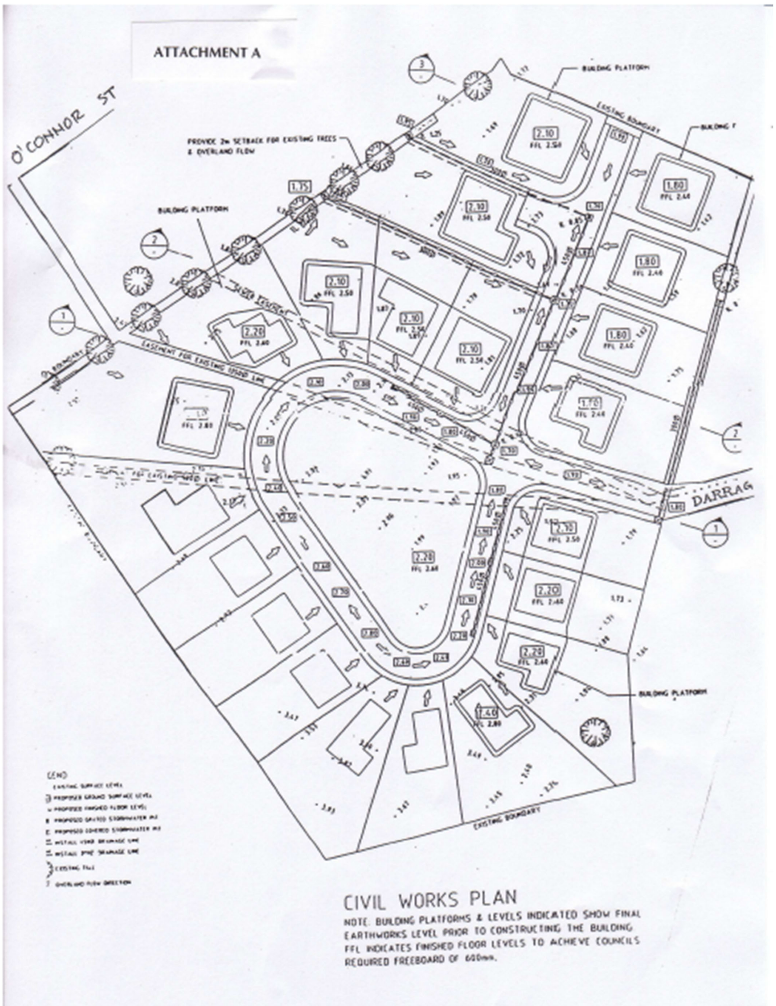
C3. Each dwelling must be set back 4 metres from the front boundary of the lot.

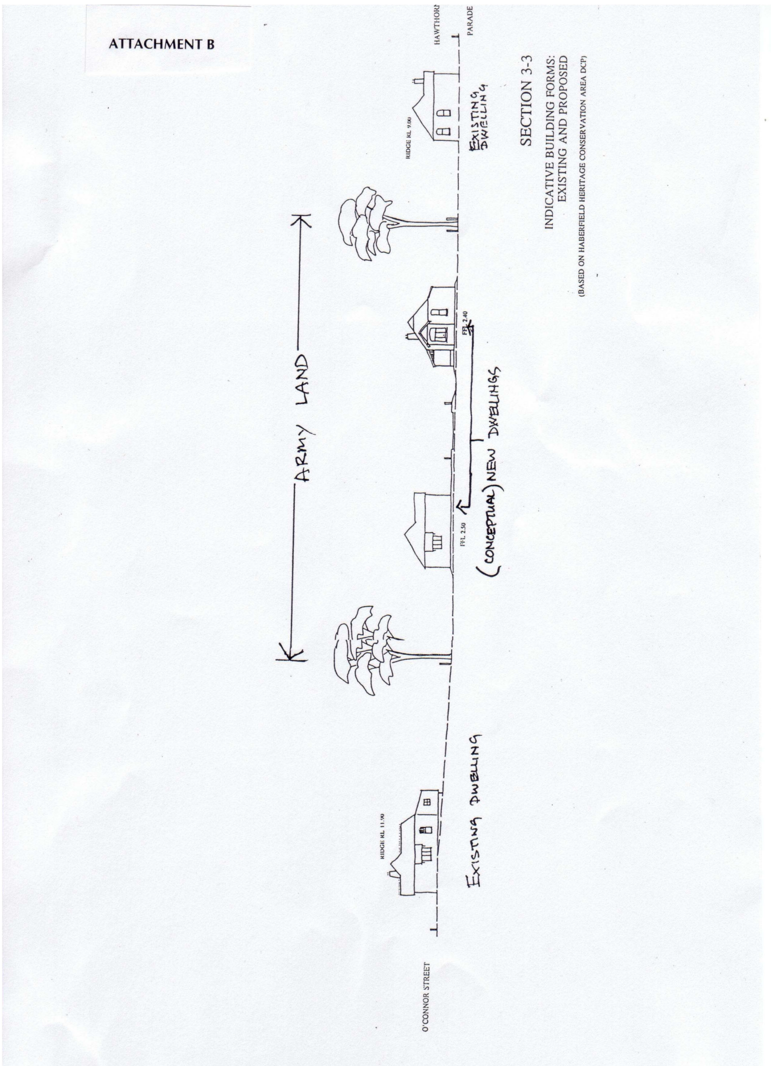
C4. Driveways on subdivision lots 16 and 17 must be located on the southern side of the dwelling.

C5. Front garden levels within the required building setback are to match the levels of the adjacent public footpath to achieve a uniform, cohesive garden setting throughout the development. Rear yard levels are not to be raised or intrude upon the subdivision drainage canal.

C6. Some boundary fences may be considered for an alternative design supported by a site engineering and flood mitigation impact statement. For example the lower 1 metre open to allow for overland flows.

There is to be no structure built over or enclosing of the subdivision perimeter drain


ATTACHMENT A
O'CONNOR ST
PROVIDE 2m SETBACK FOR EXISTING TREES & OVERLAND FLOW
BUILDING PLATFORM
EXISTING BOUNDARY
DARRAG
CIVIL WORKS PLAN
NOTE: BUILDING PLATFORMS & LEVELS INDICATED SHOW FINAL EARTHWORKS LEVEL PRIOR TO CONSTRUCTING THE BUILDING
FFL INDICATES FINISHED FLOOR LEVELS TO ACHIEVE COUNCILS REQUIRED FREEBOARD OF 600mm.


ATTACHMENT B
HAWTHOR
PARADE
SECTION 3-3
INDICATIVE BUILDING FORMS:
EXISTING AND PROPOSED
(BASED ON HABERFIELD HERITAGE CONSERVATION AREA DCP)
EXISTING DWELLING
ARMY LAND
(CONCEPTUAL) NEW DWELLINGS
EXISTING DWELLING
O'CONNOR STREET

Page 22: [1] Commented

A new separate section has been included for all new dwellings and it contains most of the controls that will cover 140A. This approach does complicate the drafting as set minimum standards should be set for all new development in line with the controls for existing houses, and any modification for 140A army land should be limited to derogations required by the nature of the site and its limitations. Either (a) a statement should be included here to clarify that these controls are in addition to all the others and that the rest of the DCP controls also apply to new dwellings as far as it is practicable to do so - and to any future modifications of these dwellings or (b) the controls that do and don't apply to new developments should be listed in this section - refer to covering email.. The DCP also needs a clause to clarify that all general controls apply except to the extent they are modified by specific controls

Page 22: [2] Commented

Most of these controls are the same or similar to controls set out elsewhere. They should be deleted if they are already covered or amended to reflect any differences that are specific to new dwellings. EG C97 is covered by C16 and C99 by C11. Refer to our general covering comments in this regard.

Page 22: [3] Commented

Ideally a minimum setback should be specified for all new dwellings - otherwise the requirement is unclear and open to debate or practice may vary between developments..

Revised Good Neighbour Policy Public Exhibition

Engagement Outcomes Report

29/1/24 – 26/2/24

Summary

From 29/1/24 to 26/2/24, the community was invited to provide feedback on the draft revised Good Neighbour Policy

During the engagement period:

478 people visited the Your Say project page.

119 participants downloaded the draft policy.

In total 8 people provided responses.

7 participants completed the online form, and 1 person submitted a response via email:

- 3 respondents supported the draft
- 2 respondents did not support the draft
- 3 respondents were unsure/did not know

Project background

The Good Neighbour Policy was officially adopted by Council in 2013 in response to the Annandale Hotel facing financial difficulties, which were partly attributed to challenges with noise regulation and disturbance complaints. Subsequently, Inner West Council adopted the Policy in 2019.

The Policy sets out a process that, when complaints are received Council officers facilitate a discussion between neighbours who are impacted by the operation of a venue and live music and licensed venue operators with the purpose being to explore potential resolutions rather than resorting to enforcement or legal measures in the first instance.

Following on from the success of the Enmore Road Special Entertainment Precinct, this draft revised Policy sets out a regulatory escalation process like the Enmore Road Sound Management Plan to ensure consistency and transparency in decision making across the Inner West.

Consultation with the Regulatory Services Division was conducted throughout October to identify the regulatory implications associated with the expansion of this Policy to include creative spaces, sporting clubs and commercial businesses.

The outcome was positive and consistent with the approach being employed more generally by officers as attempts are made to resolve community complaints when a local business is involved.

There have been numerous occasions when the use of the Good Neighbour Policy has enabled the business to understand an impact which they had been unaware of and through the mediation approach mutual solutions were identified to resolve the issues. It also assists when an impact is one off or transitory in nature to provide an explanation to the community.

The policy was amended as follows:

Content chapter number	Content Chapter Name	Detail of amendment
1	Purpose	Amended to reflect the Council resolution.
2	Scope	No changes
3	Definitions	Expanded - with new relevant definitions

4	Statement	Abbreviated to reflect the intention of the policy – previously this section set out the steps around the policy implementation
5	Objectives	This is a new section setting out the objectives of the policy in accordance with the council resolution.
6	Compliance Procedures	This is a new section setting out in detail the steps in lodging complaints and how they will be attended to.
7	Breaches of this policy	No change
8	Administrative Changes	No change
9	Version Control	Updates to reflect new version

Promotion and engagement methods

Promotion method	
Project page on Your Say Inner West	**478** people viewed the project page **119** downloads of the draft document

Engagement method	
Online survey	**7** surveys completed
Direct contact from residents	**1** email from an individual

INNER WEST

Who did we hear from?

Council gathers basic demographic information as part of the participant registration process online at **Your Say Inner West.**

Gender

- 6 men
- 1 woman

Location

Location	Postcode	Contributors
Birchgrove	2041	2
Surry Hills	2010	1
Stanmore	2048	1
Ashfield	2131	1
Dulwich Hill	2203	1
Marrickville South	2204	1

Summary of feedback

7 participants completed the online form, and 1 person submitted a response via email.

- 3 respondents supported the draft
- 2 respondents did not support the draft
- 3 respondents were unsure/did not know

Received	Support	Comment	IWC Comment
Online	Yes	Nil	NA
Online	Yes	Nil	NA
Online	Yes	I am writing to express my support for the venues that contribute to the vibrant nightlife of Sydney's inner west. These venues should not be penalised for operating within their existing licenses, especially when they have been established long before new residents moved in nearby. Sydney's nightlife is recovering from the impacts of the pandemic and the lockout laws, and the Inner West Council should do everything in its power to facilitate its growth and diversity. Residents who choose to live near these venues are aware of the potential noise and activity that come with living in a lively area, and they accept some degree of risk that the venues may change or expand in the future. Buying a property is always a gamble, and this is one of the trade-offs that buyers have to consider. I urge the council to adopt a balanced and fair approach to the revised good neighbour policy, and to recognise the value and importance of the inner westies cultural and entertainment scene. Thank you.	Noted. No amendments to Policy proposed.
Online	No	The current draft policy requires 3 refinements.	Transport for NSW are the appropriate

		1. Include water-borne noise disturbance from party boats and other craft, which are commercial operations and/or licensed operations (similar to a hotel or pub). These vessels increasingly cause widespread noise disturbance to Inner West Council areas including Balmain East, Balmain and Birchgrove. Information should be provided in the policy on complaint hierarchies (Transport for NSW, Maritime; NSW Police marine area command, Liquor and Gaming and Inner West Council. 2. An expectation stated in the policy that residents should make concessions of closing their windows or doors to keep out commercial noise and accept occasional higher noise levels should not be codified in a council policy. Inner West residents fought long and hard to resist powerful interests making that very suggestion around noise from aircraft using Kingsford-Smith airport. 3. The policy should be titled Commercial neighbour noise policy for accuracy.	regulatory authority to manage noise from vessels on Sydney Harbour. Any request that is reported to Council regarding these types of matters are responded to accordingly. Noted. No amendments to Policy title proposed.
Email	No	I am writing to provide feedback on the proposed Good Neighbour Policy, with a specific focus on enhancing support for residents when licensees fail to adhere to agreements made during mediation. While the policy outlines commendable objectives aimed at fostering harmonious relationships within our community, it falls short in providing adequate mechanisms to address breaches of agreements by licensees. One crucial aspect that requires attention is the lack of robust measures to hold licensees accountable for their commitments following mediation sessions. It is imperative that residents feel	Section 6 of the Policy outlines the complaint handling procedure, specifically 6.5 and 6.6 where matters can be escalated to the Police and Liquor & Gaming NSW.

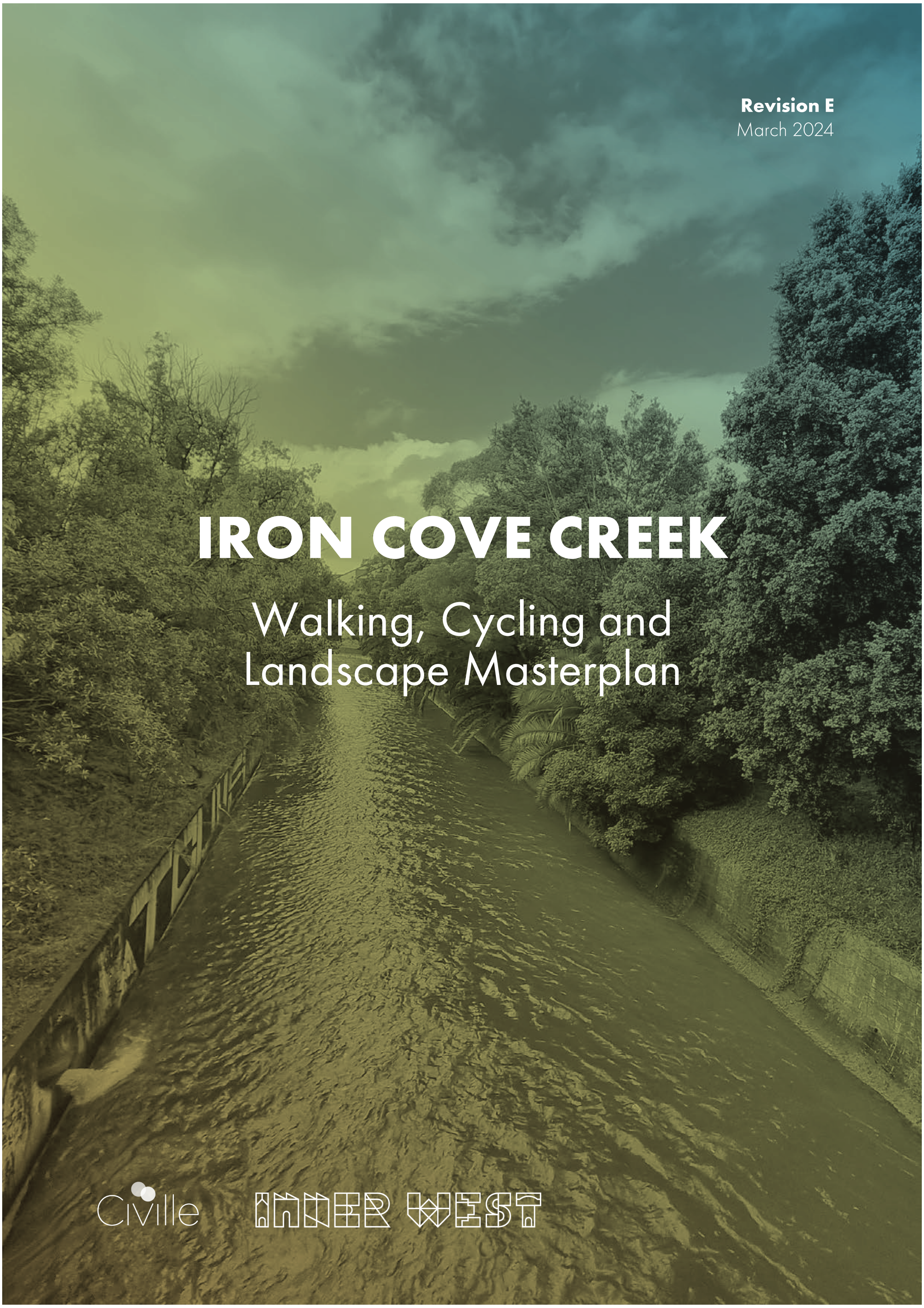
INNER WEST

		empowered and supported in ensuring that the agreements reached during mediation are upheld. However, the current policy does not offer sufficient guidance or recourse in cases where licensees fail to fulfill their obligations. To address this issue effectively, I propose the following amendments to the policy: 1. Clear Enforcement Mechanisms: The policy should clearly outline the steps that residents can take in the event of non-compliance by licensees. This could include the establishment of a formal reporting process and a designated authority responsible for enforcing compliance. 2. Timely Resolution Procedures: There should be provisions in place to expedite the resolution of disputes arising from breaches of agreements. Delays in addressing non-compliance can exacerbate tensions and undermine the effectiveness of the mediation process. 3. Supportive Resources for Residents: Residents should have access to resources and support services to navigate the process of addressing non-compliance effectively. This could include guidance on documenting violations, legal advice, and assistance in escalating unresolved issues. 4. Consequences for Repeat Offenders: Repeat offenders should face escalating consequences for their failure to comply with mediation agreements. This may include penalties, revocation of licenses, or other measures deemed appropriate by the Council. 5. Transparency and Accountability: The Council should ensure transparency in its enforcement efforts and regularly update residents on the status of reported violations	Noted. Council investigations and decision making are governed by Council's Code of Conduct, Compliance and Enforcement Policy and Service Charter. No amendments to Policy proposed.

INNER WEST

		and the actions taken to address them. This fosters trust and confidence in the effectiveness of the policy. By implementing these amendments, the Inner West Council can strengthen the Good Neighbour Policy and better support residents in resolving disputes with non-compliant licensees. It is essential to create a framework that promotes accountability, fairness, and the overall well-being of our community. Thank you for considering these suggestions. I look forward to seeing an improved policy that truly serves the needs of Inner West residents.	
Online	Unsure/don't know	It all seems a bit obvious and nanny state.	Noted. No amendments to Policy proposed .
Online	Unsure/don't know	People who move very close to pubs and live music venues should not be able to then use a complaint system to close them down.	Noted. No amendments to Policy proposed.
Online	Unsure/don't know	The premises at the subject of the complaint should have more input into the process outlined in the flow chart. While there are 1 or 2 sentences mentioning that residents may need to change their behaviour too, in my view balancing the possible need for change from BOTH parties should be a clearly articulated part of the process. The inner west is a thriving, vibrant community known for its live music and night time culture - the community value of these kinds of premises should not be overlooked. Too many venues across Sydney over the years have had to close because of 1 or 2 persistently complaining neighbours. It would be a real	Consultation between both parties is built into the mediation process as per Section 6.3. No amendment to Policy proposed.

		shame if this were to happen in the inner west.	



Revision E
March 2024

IRON COVE CREEK

Walking, Cycling and Landscape Masterplan

Civille

Client:	Inner West Council
Project Name:	Iron Cove Creek Corridor Walking, Cycling and Landscape Masterplan
Project Number:	2180
Date:	06.03.2024
Report Contact:	Alexa McAuley
Report Authors:	David Knights, Alexa McAuley
Consultants:	Civille

Revision	Status	Date	By	Checked
A	Initial draft	01.03.2023	AM, DK	DK
B	Draft	11.04.2023	AM, DK	DK
C	Draft	17.07.2023	AM, DK	AM
D	Draft for Public Exhibition	25.07.2023	AM, DK	AM
E	Final following Public Exhibition	06.03.2024	AM, DK	AM

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Acknowledgement of Country

Inner West Council acknowledges the Gadigal and Wangal peoples of the Sydney Basin who are the Traditional Custodians of the lands in which the Inner West Local government area is situated.

We celebrate the survival of Aboriginal and Torres Strait Islander cultures, heritage, beliefs and their relationship with the land and water. We acknowledge the continuing importance of this relationship to Aboriginal and Torres Strait Islander peoples living today, despite the devastating impacts of European invasion. We express our sorrow for past injustices and support the rights of Aboriginal and Torres Strait Islander peoples to self-determination.

Inner West Council understands our responsibilities and role in working with Aboriginal community to promote cultural heritage and history, address areas of disadvantage, and protect and preserve the environment as well as sites of significance to Aboriginal and Torres Strait Islander peoples. In doing so we acknowledge that Aboriginal and Torres Strait Islander cultures continue to strengthen and enrich our community.

Today, diverse groups of Aboriginal and Torres Strait Islander peoples live and work across the Inner West. We admire the resilience displayed in their significant achievements and in making immense contributions to both Council and the broader community.

Inner West Council is committed to embedding the values and perspectives of the Aboriginal and Torres Strait Islander communities to ensure we learn from the mistakes of our past and forge a positive future of long-lasting value built on mutual respect, equality, and opportunity.

Executive Summary

Iron Cove Creek runs approximately 3.5 km between Liverpool Road and Iron Cove, along the boundary between Ashfield and Croydon in its upper reaches, and between Haberfield and Five Dock in its lower reaches. Iron Cove Creek itself is an open concrete lined channel. In its upper reaches it is narrow and confined; as it travels downstream its corridor widens to include a strip of open space, and in its lower reaches it is set within surrounding parkland.

This Masterplan proposes the transformation of the Iron Cove Creek corridor to facilitate improved access to and along the corridor, as well as improvements to green space along the corridor, to create more natural habitat and places for people to connect, recreate and relax. Key opportunities for the Iron Cove Creek corridor include:

- Improving connections to local facilities
- Making it easier to walk and cycle in the local area
- Unlocking access to the Iron Cove Creek corridor
- Making it easier to cross Parramatta Road
- Improving local green space
- Improving connections to regional green space.

The corridor has been identified as a potential green grid link in the Eastern Sydney District Plan and in Inner West Council's strategic plans for the area. Improving the creek corridor and providing better walking and cycling access are inherently connected to the NSW Government's and Inner West Council's liveability goals.

Local residents would like to improve opportunities for walking and cycling in the area. Local community group the Friends of Iron Cove Creek has said: "The path will connect Ashfield Pool to Iron Cove Bay and make our local area a better place to live, support our health, and improve our environment." Community engagement conducted during the preparation of this Masterplan indicated 95 percent of respondents support the idea of a walking and cycling path along the canal linking the Bay Ran and Ashfield Aquatic Centre; and 81 percent of respondents identified a preference for a path along the canal rather than on-street facilities.

Six objectives have been proposed in this Masterplan:

- A route that is walkable by all
- A route that supports safe and low-speed bike riding
- Providing opportunities for local placemaking
- Providing opportunities for experiencing urban water and ecology
- Respecting surrounding residents' privacy, amenity and security
- A feasible plan

The Masterplan divides the route into six segments with different character:

1. **Precinct 1** includes the section of Iron Cove Creek from Heighway Avenue, under the Main Western railway line, to Elizabeth Street, adjacent to Ashfield Aquatic Centre. In Precinct 1 a shared path is proposed along Frederick Street and Elizabeth Street.
2. **Precinct 2** includes the section of Iron Cove Creek between Elizabeth Street and John Street. In this precinct a Quietway is proposed along Etonville Parade then an elevated structure over the channel linking Etonville Parade to John Street. There is no open space adjacent to the channel but landscaping is proposed along Etonville Parade.
3. **Precinct 3** includes the section of Iron Cove Creek between John Street and Church Street. Here the channel is set within a corridor of open space and it is proposed to open this space to public access and build a shared path adjacent to the creek, with associated landscaping of the open space. A secondary link to Bede Spillane Reserve is also proposed.
4. **Precinct 4**, between Church Street and Parramatta Road, also includes a corridor of open space adjacent to the channel, including land on one side that is owned by Inner West Council. Here a shared path and landscaping are also proposed within this corridor.
5. **Precinct 5** includes the section of Iron Cove Creek between Parramatta Road and Ramsay Road, where Iron Cove Creek runs adjacent to Jegorow Reserve. It is proposed to upgrade the path through Jegorow Reserve, as well as other improvements to the reserve.
6. **Precinct 6** includes the section of Iron Cove Creek between Ramsay Road and Iron Cove. In this section, the channel follows the boundary between Inner West and Canada Bay LGAs. Here, works are proposed by Sydney Water, Transport for NSW and the City of Canada Bay to improve the link between Ramsay Road and the Bay Run.

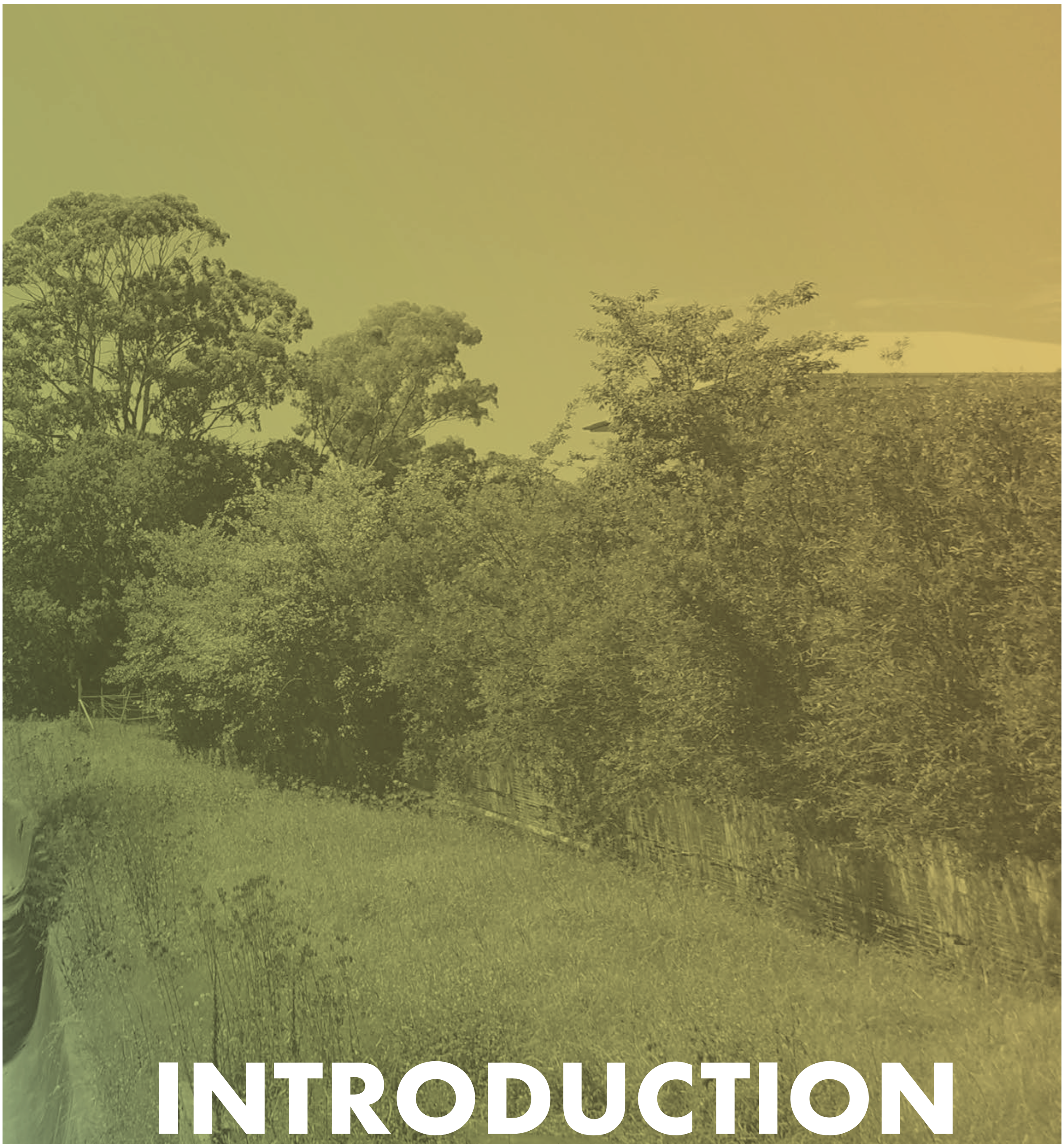
Between each precinct, works are also proposed to improve road crossings. At most locations, a new or modified at-grade crossing is proposed, to improve provision for people walking and cycling along the corridor. However, the most significant road crossing along the corridor is Parramatta Road and here the options will need further investigation. Future transformation of Parramatta Road may enable an improved at-grade crossing. This Masterplan recommends that grade-separated options should also be considered.

A cost estimate for the proposed works includes:

– $16.1 million for the main corridor between Heighway Avenue and Ramsay Road (excluding the improved crossing of Parramatta Road, where options will need further investigation).
– $1.9 million for an additional alternative route (separated cycleway) along Frederick Street between Elizabeth Street and Parramatta Road.

Contents


01



INTRODUCTION

1.1 THE IRON COVE CREEK CORRIDOR

The Iron Cove Creek corridor links Ashfield, Croydon, Haberfield and Five Dock with Iron Cove.

Sydney is growing and facing challenges associated with densification, while communities are also experiencing external shocks and stresses including a changing climate. Better use of public assets like streets, parks and urban waterways can support local communities to adapt and build resilience.

> ***"A great way to promote physical activity and community engagement"***
> ***- Community member***

This Masterplan outlines a plan to improve the Iron Cove Creek corridor to create more natural habitat and places for people to connect, recreate and relax. The Iron Cove Creek corridor is approximately 3.5 km long, extending from Liverpool Road to Iron Cove - see Figure 2. It follows the boundary between Ashfield and Croydon for approximately 2 km and between Haberfield and Five Dock for approximately 1.5 km, following the alignment of Iron Cove Creek.

Iron Cove Creek itself is an open concrete lined channel. In its upper reaches it is narrow and confined; as it travels downstream its corridor widens, and in its lower reaches it is set within surrounding parkland. In its middle section (pictured in Figure 1) there is a narrow strip of open space either side of the channel, but this is not currently accessible to the public.

This Masterplan proposes the transformation of the Iron Cove Creek corridor to facilitate improved access to and along the corridor, as well as improvements to green space along the corridor. Improving the creek corridor and providing better walking and cycling access are inherently connected to the NSW Government's and Inner West Council's liveability goals.

Whilst the Masterplan outlines inevitable challenges faced in an established urban environment, it also provides options for exploring the delivery of better walking and cycling access, waterway naturalisation, more landscaping and public space, and a more attractive local environment.

Figure 1: A view of the Iron Cove Creek corridor between John Street and

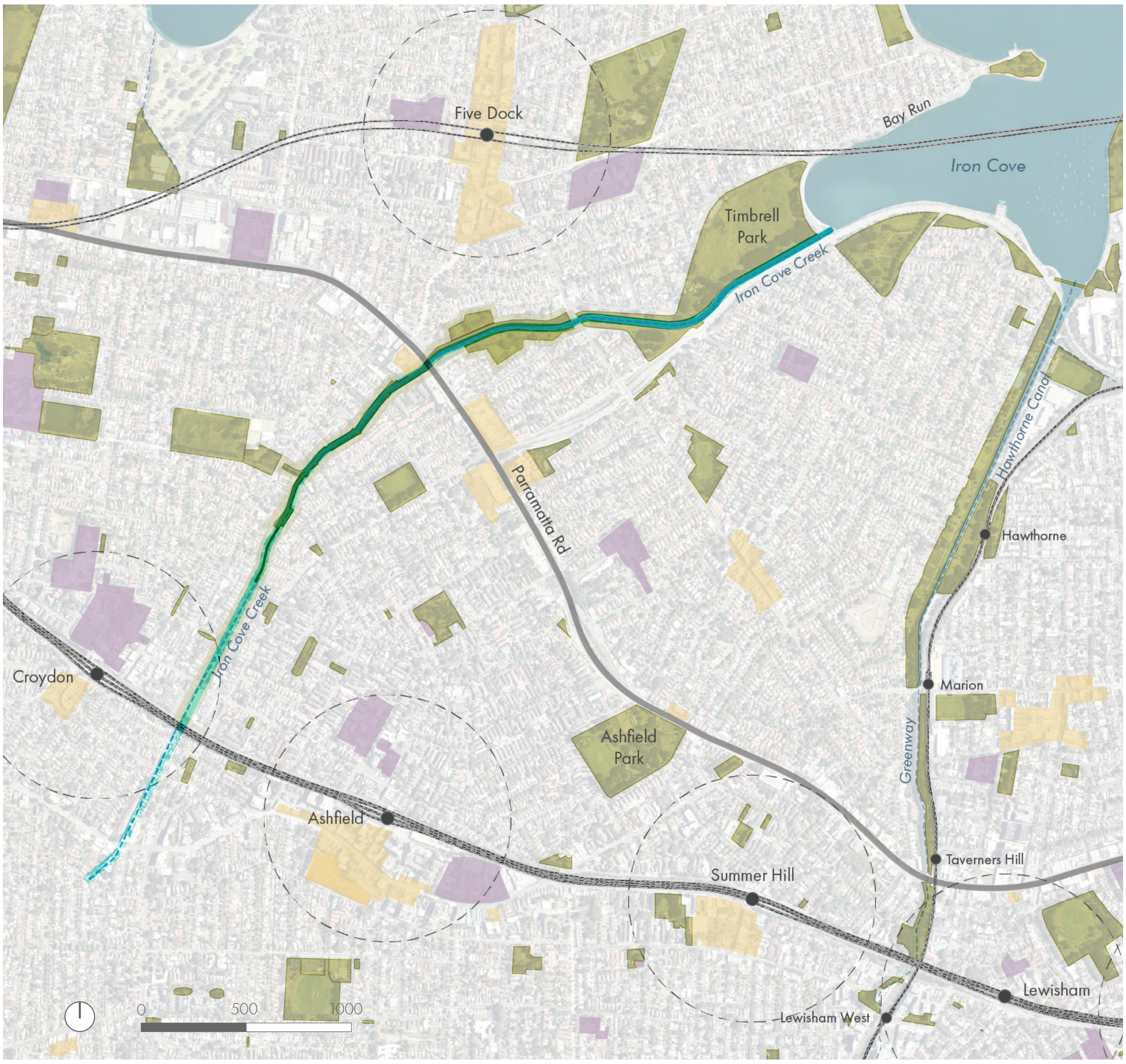


Figure 2: Context map of the Iron Cove Creek corridor

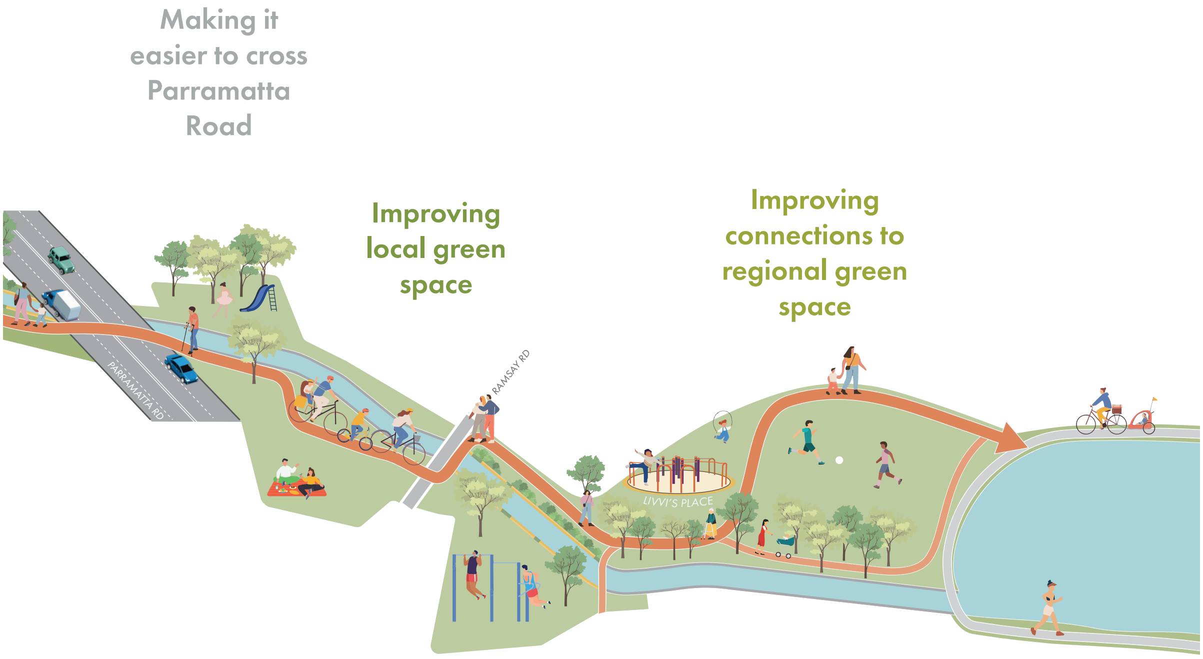
1.2 KEY OPPORTUNITIES

Key opportunities for the Iron Cove Creek corridor are illustrated in Figure 3, including:

- Improving connections to local facilities
- Making it easier to walk and cycle in the local area
- Unlocking access to the Iron Cove Creek corridor
- Making it easier to cross Parramatta Road
- Improving local green space
- Improving connections to regional green space.

Figure 3: Key opportunities for the Iron Cove Creek corridor

"Such a great proposal to open up this area and make it more accessible and safe for residents"
- Community member



1.3 OBJECTIVES FOR THE CORRIDOR

The local community wants safe spaces to walk and ride, and the Iron Cove Creek corridor provides the opportunity to deliver connections.

"The path will connect Ashfield Pool to Iron Cove Bay and make our local area a better place to live, support our health, and improve our environment."
- Friends of Iron Cove Creek

Local residents would like to improve opportunities for walking and cycling in the area. The local streets are car-dominated, offering limited amenity to people walking and cycling. Parramatta Road is a major barrier to movement, dividing Ashfield and Croydon from Haberfield and Five Dock.

A walking and cycling corridor along Iron Cove Creek has the potential to facilitate active transport and recreation, improving access to local parks, shops, schools, public transport nodes and recreation facilities including Ashfield Aquatic Centre and the Bay Run.

Six key objectives have been identified to achieve the best outcomes for future users of the Iron Cove walking and cycling corridor. These objectives have informed the Masterplan and form the basis on which further decision making would be based.

At times it will likely be necessary to reconcile differing demands for limited space or conflicting issues, and these objectives aim to provide a clear framework for assessing any future proposals.

Future design development should also refer to relevant guidelines that outline how to meet these objectives. For example the Transport for NSW Walking Space Guide (July 2020), the Cycleway Design Toolbox (December 2020), the Design of Roads and Streets guide (December 2022) and Network Planning in Precincts Guide (July 2022) provide tools for shifting the emphasis away from a hierarchy of roads towards a road and street network that integrates with the people and places in the area. The Design of Roads and Streets guide is a practical 'how to' manual explaining how roads and streets can be designed with better understanding their local role and context.

The Transport for NSW Road User Space Allocation Policy (January 2021) considers the place, function and movement requirements of roads and the limited amount of space available to accommodate the needs of different road users. When allocating road user space for the network vision, it specifies the following order of consideration:

- Walking including equitable access for people of all abilities,
- Bicycles and micro-mobility devices,
- Public transport,
- Freight and deliveries,
- Point to point transport such as taxi and ride share services,
- General traffic and on-street parking for private motorised vehicles.

Objectives		Enablers
	A route that is walkable by all	• Connectivity • Accessibility • Safe and direct road crossings • Pleasant microclimate
	A route that supports safe and low-speed bike riding	• Clear priority to people walking • Appropriate width for safe passing • Good sightlines
	Providing opportunities for local placemaking	• Places of interest • Facilities • Seating, park furniture, exercise equipment
	Increase trees, habitat and landscaping	• Green and blue infrastructure • Habitat restoration • Ecological diversity
	Respecting surrounding residents' privacy, amenity and security	• Clear separation between public and private space • Physical barriers where required
	A feasible plan	• Acceptability to land and asset holders, • Technical feasibility • Value for money

1.4 POLICY ALIGNMENT

The Iron Cove Creek Corridor is aligned with Inner West and NSW Government policy directions including the Sydney Green Grid in the District Plans and the Eastern Harbour Strategic Cycling Corridors.

Sydney Green Grid

The NSW Government's Six Cities Region Plan outlines six region shapers to connect people and place, green the cities and embed the wisdom of First Nations people. Through Planning Priority E17 the Eastern District Plan aims to increase the urban tree canopy and deliver Green Grid connections.

The Green Grid is to be a network of high-quality green spaces linking centres, public transport hubs and major residential areas. It will help keep the city cool, encourage healthy living and enhance biodiversity.

The Iron Cove Creek green link is one of four links identified in the Inner West within the Eastern District Plan (Figure 4).

Each link is identified as holding dominant recreational, ecological or hydrological values and Iron Cove Creek is recognised as having potential recreational value to provide the following:

- Increased access to open space including across major roads and infrastructure barriers
- Encouraging sustainable transport connections and promoting active living with a network of walking trails, cycle paths and open spaces along river and creek corridors
- Creating a high quality public realm integrating civic spaces and destinations with public transport opportunities.

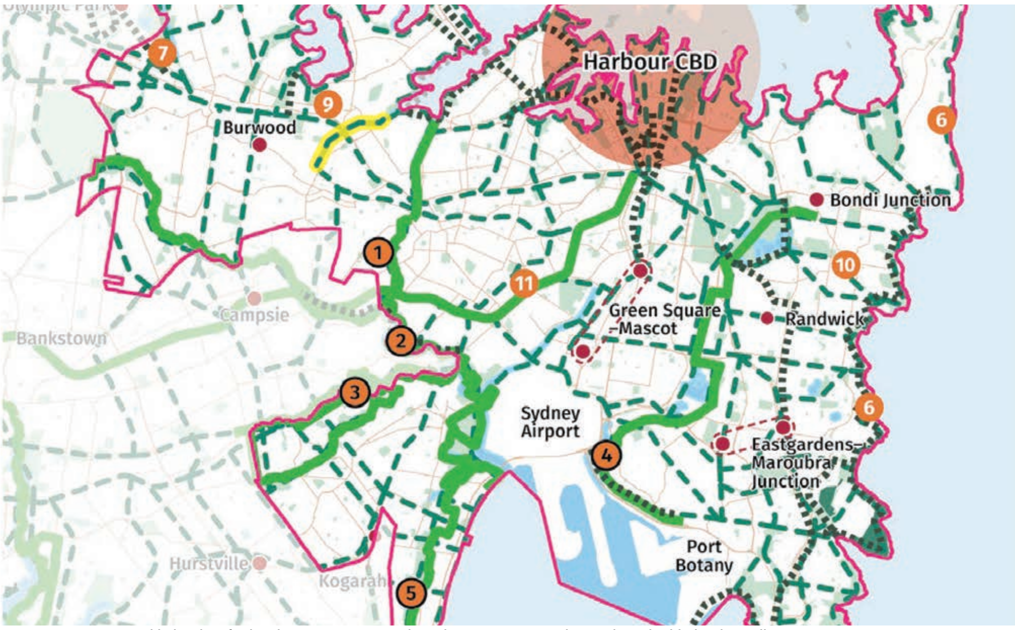


Figure 4: Green Grid links identified in the Eastern District Plan. The Iron Cove Creek corridor is highlighted in yellow

Parramatta Road Corridor Urban Transformation Strategy

The Parramatta Road Corridor Urban Transformation Strategy (PRCUTS) is an integrated land use and transport plan to transform Parramatta Road between Granville and Camperdown with more homes, workplaces and better transport and public domain.

The PRCUTS is led by the Department of Planning and Environment and councils with land along Parramatta Road are accepting planning proposals for development along the corridor while Transport for NSW is preparing a business case to deliver place-based active and public transport improvements.

The Kings Bay precinct straddles the Inner West and Canada Bay LGA boundary immediately adjacent to Iron Cove Creek. Kings Bay is intended to be a new residential and mixed use village, served by Metro West and better transport on Parramatta Road. Inner West Council and the City of Canada Bay are finalising changes to planning controls for growth in Kings Bay. The Sydney Metro West station currently under construction in Five Dock centre will dramatically improve public transport capacity for the precinct and become a key destination within reach of the Iron Cove Creek corridor.

Future Transport Strategy

The NSW Future Transport Strategy (2022) sets a long-term strategic vision supporting support car-free, active, sustainable transport options and managing street space as public space by improving every part of the transport system with more choices and better access using zero emissions transport. It recognises the importance of releasing the potential of infrastructure, including blue and green infrastructure, to create better places and resilient communities.

The Future Transport Strategy outlines the Strategic Cycleway Corridors in Greater Sydney as an outcome of the vision. One of the strategic cycling links identified in the Eastern Harbour City is a link between centres in Five Dock and Ashfield - overlapping with the Iron Cove Creek corridor.

Active Transport Strategy

The NSW Active Transport Strategy, released in 2022, draws on the Future Transport Strategy's vision for walking and bike riding, and provides a guide for the planning and investment of active transport in NSW. It outlines ambitions and priority moves for active transport in including creating walkable connected 15-minute neighbourhoods, increasing the percentage of short trips made on foot, helping children to travel independently with safer walking and bike riding options and doubling the number of children walking or riding to school. Especially relevant to Iron Cove Creek is the ambition to accelerate the delivery of active transport projects by cutting red tape and providing resources.

Inner West Council Strategic Plans

Inner West Council's **Community Strategic Plan** (CSP, 2022) outlines the community's aspirations for liveable connected neighbourhoods and sustainable transport. It states that the community wants to see an ecologically sustainable Inner West with liveable, connected neighbourhoods and active transport. The plan outlines intended outcomes that include people walking and cycling with ease, and managing the road network to prioritise active and public transport over private motor vehicle use.

The Inner West **Local Strategic Planning Statement** (LSPS, 2020) provides the land-use planning framework for the Inner West by establishing a vision for the area in 2036 as well as actions to be taken to achieve this vision. Based around the six themes, it identifies the challenges and opportunities for our communities in the context of changing technology and a growing population. Its themes are:

- An ecologically sustainable Inner West
- Unique liveable, networked neighbourhoods
- Sustainable transport
- Progressive local leadership
- Creative communities and a strong economy
- Caring happy healthy communities

The LSPS prioritises actions for improved and accessible sustainable transport infrastructure, including the Inner West Blue/Green Grid which builds on the Sydney Green Grid to create a more dense network of green and blue infrastructure connections.

Supporting the CSP and LSPS are the Inner West **Climate and Renewables Strategy** (2019), which responds to the climate change emergency by working to foster zero-emissions mobility, and the **Integrated Transport Strategy** (2020), which aims to shift away from single vehicle travel towards greater active transport participation.

1.5 THIS MASTERPLAN

Outline of this document

This Masterplan provides an overview of the investigations, community consultation, route options and works proposed to transform the Iron Cove Creek corridor to a place for people to walk, ride, recreate and relax.

The Masterplan includes the following sections (also shown in Figure 5:

1. **Introduction** - This section provides a brief overview of the Masterplan and its strategic context
2. **Local Context**: This section provides an overview of the context of Iron Cove including local destinations, a description of the waterway and the transport context including active transport and the local traffic context
3. **Route Segments**: This section provides a description of the 6 different precincts for the Corridor and the existing conditions of each of the precincts along the Corridor including the adjacent open space and land ownership
4. **Precinct Plans**: This section provides a description of the route options that were explored for each precinct including along Iron Creek, linkages to and from Iron Cove Creek, key road and rail crossings as well as on-road options and provides an overview of the proposed path and open space upgrades in each of the precincts.
5. **Stakeholder Engagement**: This section provides an overview of the feedback received from the community and stakeholders on the Iron Cove Creek corridor
6. **Implementation**: This section includes a cost estimate for the proposed works, including a prioritisation for each element, which informs the implementation and realisation of the Iron Cove Creek corridor.

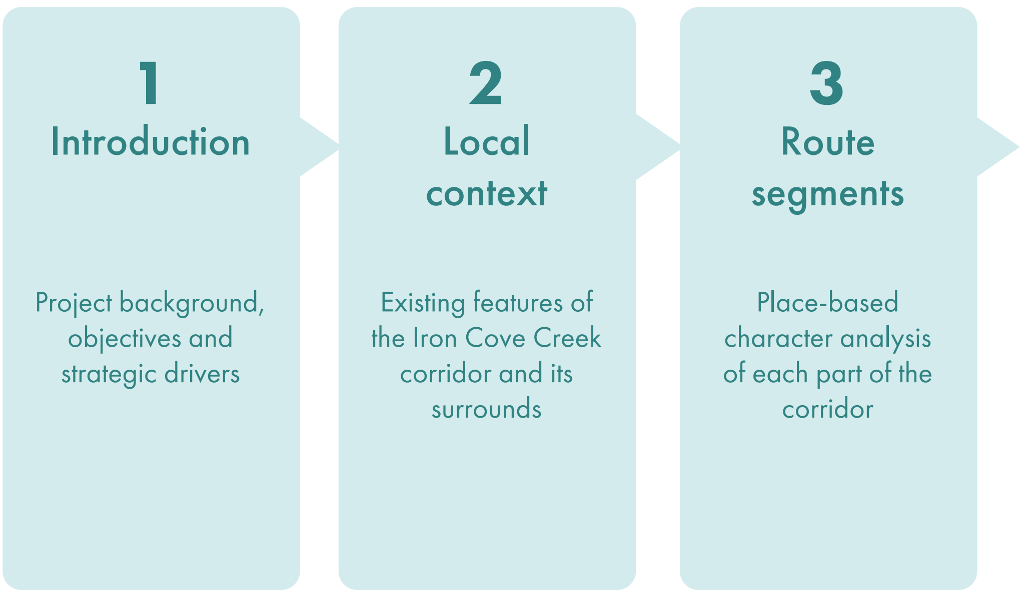


Figure 5: Masterplan outline

4
Precinct plans

Route options and precinct plans with proposed route

5
Stakeholder engagement

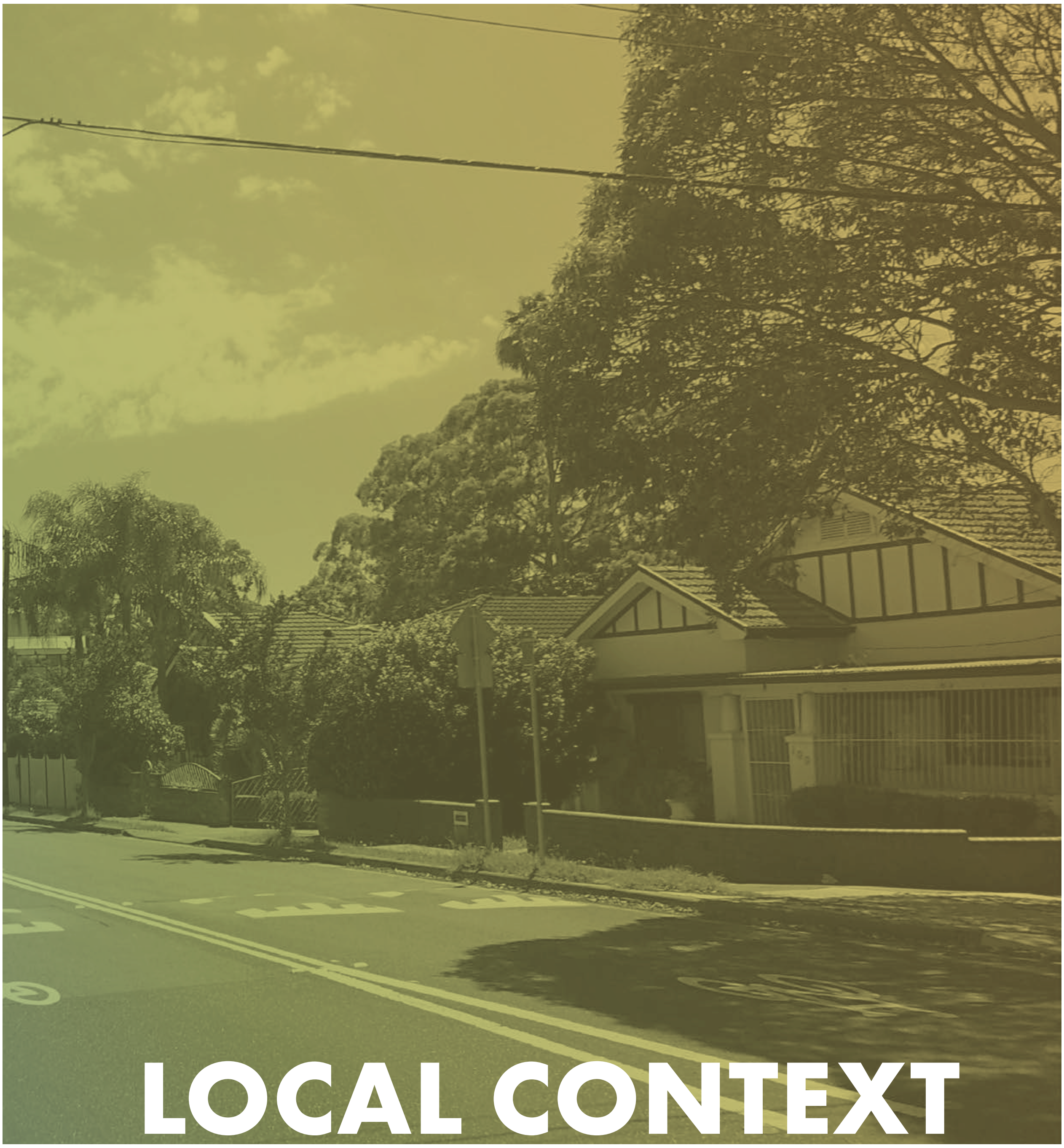
Summary of community and other stakeholder engagement outcomes

6
Implementation

Priorities for implementation of the Masterplan including a cost estimate


02

Item 5



Attachment 1

2.1 THE EXISTING CORRIDOR

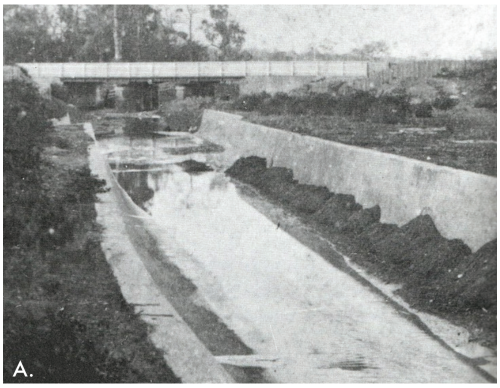
The existing Iron Cove Creek Corridor is highly varied along the length of the route. This variation reflects the construction of the channel in stages over a 40 year period from the 1890s to the 1930s

Work on the construction of the stormwater channel began in 1892 into 1894. Work was completed up to John Street, Ashfield. The channel was extended north to Iron Cove in the 1920s. The stormwater channel is identified as a local heritage item Sydney Water's heritage register.

Prior to the 1890s Iron Cove Creek was in its natural state. With urban development the creek became a receptacle of sewage from the populations which had settled in the expanding suburbs. In 1890, the Minister for Public Works, appalled at the extremely unhealthy conditions prevailing at the time, proposed a separate system of stormwater drains, including Iron Cove Creek be built to help alleviate the problem. The channel is a representative example of one of the first stormwater channels built in the 1890's to alleviate the city's severe public health problems. The different sections, built at various times, illustrate the various construction methods used over a period of 100 years.

The existing channel and its corridor varies in character along its length:

- In its upper section, upstream of John Street, there is no open space around the channel - it is directly bordered by fences of properties.
- In the middle section of the corridor, between John Street and Parramatta Road, there is an area of open space adjacent to the channel, which is owned partly by Sydney Water and partly by Inner West Council. This space is not publicly accessible. Part of this space was shown in Figure 1.
- At the downstream end near Iron Cove, there is public open space and parklands adjacent to the channel (see Figure 7).



A.

Iron Cove Creek Canal at Ashfield with Church Street Bridge

B.

Iron Cove Creek Canal at Ashfield before canalisation

Figure 6: Iron Cove Creek corridor overview

Highway
Parks
Railway
Locations of historical photos (below)
Waterways

Parramatta Road crossing Iron Cove Creek

Iron Cove Creek Canal at Ramsay Road

2.2 LOCAL DESTINATIONS

The Iron Cove Creek Corridor can deliver on the Sydney Green Grid vision: "a network of high quality green areas that connect centres, public transport and public spaces to green infrastructure and landscape features".

The corridor travels through low and medium density housing around Ashfield, Croydon and Parramatta Road. Also on Parramatta Road is a range of commercial activity known as 'Productivity Support' uses. The corridor is surrounded by local designations and adjacent to an area intended for growth on Parramatta Road.

Local destinations

Local designations potentially served by an active transport corridor include schools and childcare centres, local centres, a range of recreational facilities and a future transport hub to be created by Metro West and the transformation of Parramatta Road. Figure 7 shows key locations.

Croydon Public School and a large private school are located less than a kilometre from the corridor and number of childcare centres are located around Croydon Road. Centenary Park on Croydon Road supports weekly team sports for children and the adjacent dog park in Bede Spillane Reserve is popular with local pet owners. Ashfield Aquatic Centre, which adjoins the corridor, was reopened in 2020 following a significant renovation creating a popular regional facility with swimming pools, gym and other recreational facilities.

The Bay Run, a popular regional destination, provides a foreshore circuit on the Parramatta River for walkers, joggers, dog owners and bike riders. A path along the Iron Cove Creek corridor would link with the Bay Run through Timbrell Park in Canada Bay LGA and connect popular parks with active and passive recreation.

Centres and future development

Ashfield centre, at the south-eastern end of the corridor is identified as a Local Centre in the Eastern City District Plan and a Major Centre in the Inner West Local Strategic Planning Statement (LSPS). The centre is served by the T2 Inner West rail line and is identified for increased in density. Ashfield is also a popular local destination for dining and shopping services and three schools are located within less than a kilometre of the corridor.

Croydon centre, on the rail line at the south-western end of the corridor, is envisaged in the LSPS to be an area of increasing density in the longer term.

Five Dock centre in the Canada Bay LGA and Kings Bay on Parramatta Road, are intended to accommodate increased housing and jobs over the longer term as the Metro West station at Five Dock is scheduled to be opened in 2030.

A walking and bike riding link along Iron Cove Creek would provide much needed active transport accessibility between these areas of existing and future growth.

Figure 7: Local destinations around the Iron Cove Creek corridor

Shops
Parks
Schools
Highway
Railway
Waterways
Aquatic Centre

2.3 THE WATERWAY

Iron Cove Creek drains into Iron Cove. It collects stormwater from the suburbs of Haberfield, Leichhardt, Burwood, Croydon and Ashfield, including a catchment of approximately 800 hectares.

Sydney Water owns the trunk drainage assets including the open channel sections of Iron Cove Creek. The existing stormwater channel varies significantly:

- At the downstream section of the creek, east of Parramatta Road, the channel is more than 15m wide and is tidal. The entire base of the channel is inundated with water from Iron Cove at high tide. The banks of the channel are sloping at approximately 45 degrees
- In the middle section, between Parramatta Road and John Street, the channel is approximately 6-10m wide and is generally not influenced by the tide. There is a small low flow channel in the centre of the channel. The banks of the channel are generally vertical in this section.
- In the upper section, west of John Street , the channel is approximately 3m wide and is not influenced by the tide. The banks of the channel are generally vertical in this section of the creek and are higher than the banks in the downstream section.

Sydney Water is proposing to naturalise a portion of Iron Cove Creek west of Ramsay Road, between Timbrell Park and Reg Coady Reserve. The naturalisation plans include pathways to the north and south side of the creek as part of the naturalisation works. This provides opportunity for a connection between Timbrell Park and Ramsay Road.

In 2014 the former Ashfield Council undertook a flood study for Iron Cove Creek (Dobroyd Canal). The study provides results for flood behaviour in terms of design flood levels, depths, velocities, flows and flood extents along the creek and provides maps of hydraulic categories and provisional hazard categories. The design flood modelling indicates that significant flood depths may occur in a number of locations including in the vicinity of Heighway Avenue with the railway line restricting flows and exacerbating flooding.

The open space adjacent to the canal is flood affected. The Dobroyd Canal Floodplain Risk Management Study in 2019 identifies that there were no works that could reduce the flooding impact. Any work carried out on the open space land would need approval from Sydney Water and would need to demonstrate here is no worsening of flood outcomes for other properties.


A.


B.


C.

Local Context

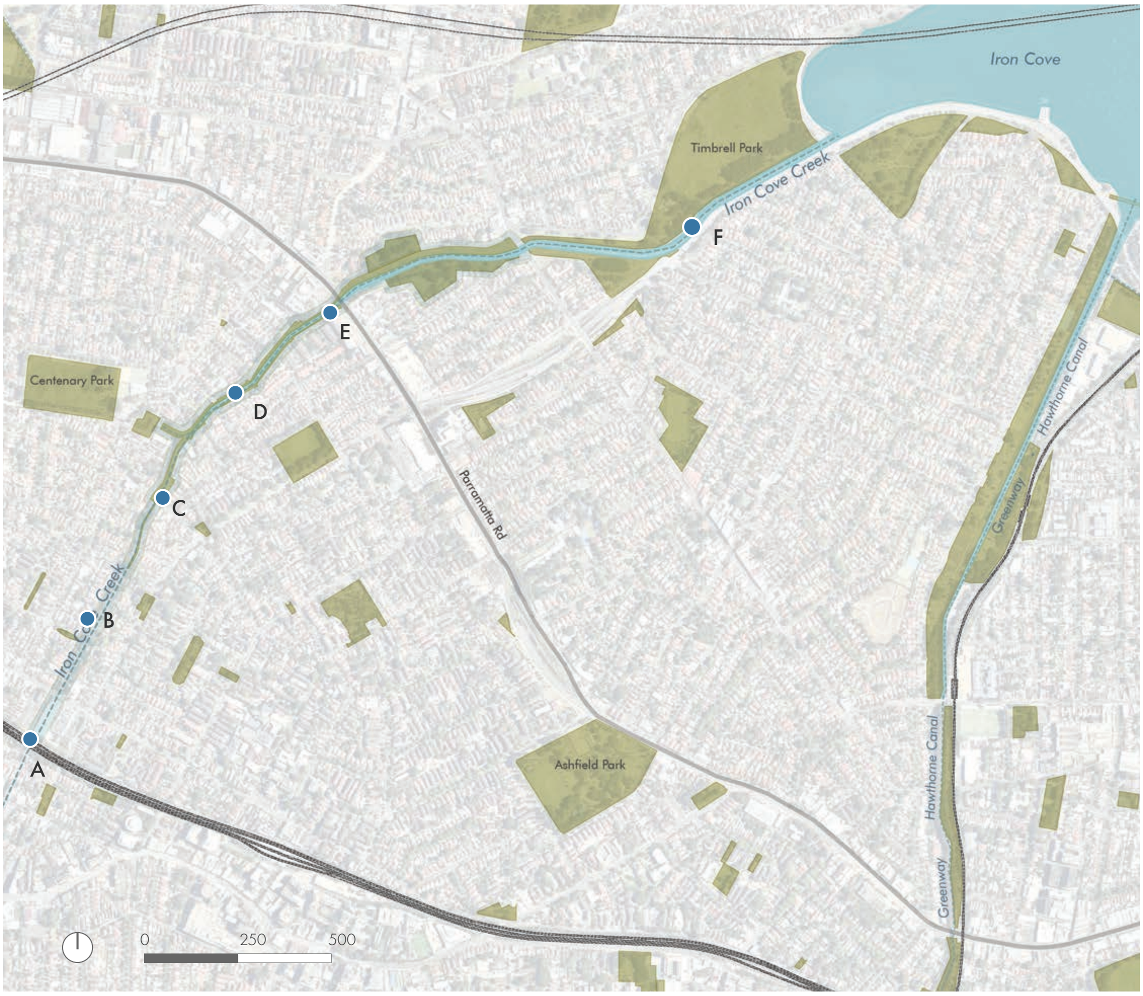


Figure 8: Iron Cove Creek waterway with photos along the corridor

Location of photos (shown below) | Railway | Parks | Waterways | Highway

2.4 WALKING AND CYCLING ROUTES

The current walking environment around Iron Cove Creek is unpleasant and fragmented and there is a distinct lack of safe cycling infrastructure.

The streets surrounding the Iron Cove corridor, especially Frederick Street and Croydon Road, provide uninviting conditions for people to walk and cycle due to the speed and volume of traffic, limited road crossings and poor overall footpath amenity. Crossings of Frederick Street are infrequent while crossings of Parramatta Road impose long waiting times and a hostile footpath environment on either side.

Local streets around the Iron Cove channel do not provide safe cycling access and streets like Church Street and John Street are commonly used for 'rat running' by drivers moving between surrounding suburbs or avoiding traffic signals. Existing bike riders necessarily use routes that provide access across barriers, like Parramatta Road, Iron Cove Creek and the rail line, resulting in dangerous, high-stress cycling conditions. Existing options for people cycling (see Figure 9) include:

- Croydon Road between Elizabeth Street and Parramatta Road: one of few direct north-south routes to cross Parramatta Road, however it experiences high volumes of through traffic as well as cross movements.
- Elizabeth Street linking Ashfield and Croydon: an east-west route used by a high volume of predominantly through traffic traveling parallel to the rail line.
- Church Street: an east-west route that crosses the creek corridor and provides traffic signals to safely cross at Frederick Street.

North of Parramatta Road, paths in Jegorow Reserve and Timbrell Park provide access for walking and cycling. However, the crossing at Ramsay Road requires a diversion and involves two additional road crossings to access the existing signalised crossing near Harrabrook Avenue. In Timbrell Park a narrow bridge provides access over Iron Cove Creek to Waratah Street Haberfield and a shared path on the eastern side of Wattle Street.

"There is a lack of a separated bike path for north-south connections, in particular to Five Dock. As Parramatta Road undergoes redevelopment as per the Parramatta Road Urban Transformation Strategy, it would be ideal to strengthen active transport connections between the new precincts and existing centres, as well as creating linear parks for leisure."
Community member

The NSW Household Travel Survey (2018-19) shows that 60 percent of car trips in the Inner West on an average weekday are less than 5km in distance – that is 175,000 short car journeys each day – and data collected by Inner West Council in 2022 shows 70 percent of car journeys to Ashfield centre, Ashfield station and recreational facilities on the Bay Run are less than 5km in length. Experiences in Sydney and other cities around the world have shown that without safe high-quality cycling infrastructure, riding a bike will remain a travel option only for people brave and fit enough to mix with motor vehicles. The absence of cycling infrastructure is likely to be a limiting factor for local trips by bicycle.

Figure 9: Existing cycle routes in the vicinity of Iron Cove Creek

On-road cycle routes. High traffic
On-road cycle routes. Low-Medium traffic
Off-road cycle routes.

2.5 WALKING AND CYCLING DATA

Parramatta Road is a significant barrier for people walking and cycling around the local area.

Data derived from Strava Metro shows walking and cycling routes taken around the corridor - see Figure 10 and Figure 11. While this data provides only information from people sharing data with the Strava platform it provides both recreational and commuting trips and indicates viable routes used by people walking and cycling. The data represents only people who currently walk or cycle and does not show active transport trips not taken because of the unpleasant and stressful street environment.

In terms of cycling the data reflects the following:

- That Croydon Road provides the preferred north-south connection between Elizabeth Street and Parramatta Road
- That Elizabeth Street provides the only direct east-west connection between Croydon Station and Ashfield Station
- The moderate use of Frederick Street reflects the high stress environment and poor access for walking and cycling across Parramatta Road
- Inversely, the higher amount of cycling activity in and around the Bay Run, including Timbrell Park, reflects the safer more pleasant cycling conditions
- That Parramatta Road creates a significant barrier between the two cycling clusters in Croydon/Ashfield and the Bay Run.

For walking the Strava Metro data shows that:

- Croydon Road is the most popular route with connectivity across Parramatta Road
- Frederick Street is predominantly used only up to Parramatta Road
- Elizabeth Street provides one of few direct walking routes to the Croydon and Ashfield centres
- There is a large amount of movement in and around Croydon centre, to Ashfield Aquatic Centre and eastward along Elizabeth Street.

Local parks are popular recreational destinations for walking, particularly Centenary Park and Hammond Park, with walking popularity declining as it approaches Parramatta Road.

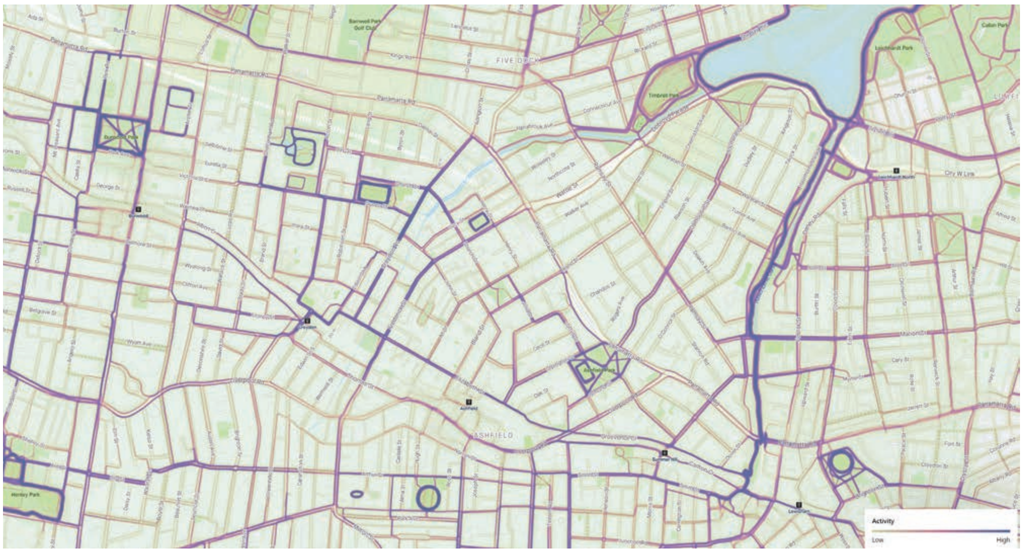


Figure 10: Strava data - walking

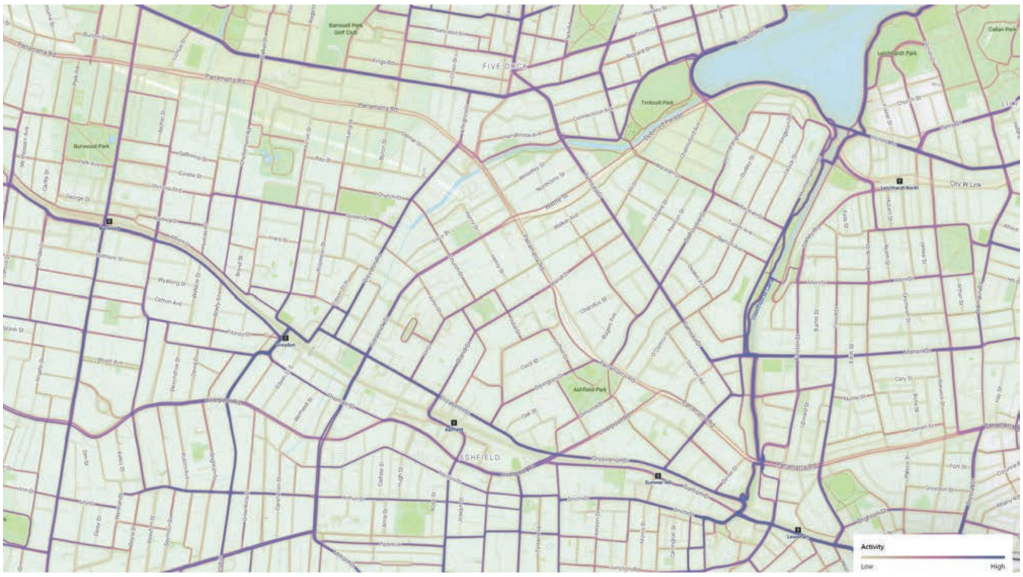


Figure 11: Strava data - cycling

2.6 TRAFFIC

The Iron Cove Corridor road network is significantly influenced by Parramatta Road and Frederick Street, which are key routes for vehicle traffic.

There are a number of high traffic roads that border the corridor including Parramatta Road, one of Sydney's main arterial routes, with more than 25,000 vehicles per day and with high use by heavy vehicles. Local streets with notable traffic volumes include:

- **Frederick Street**, a state classified road, between Parramatta Road and Liverpool Road, providing an underpass under the Main Western railway line with more than 25,000 vehicles per day and providing north-south connectivity. Frederick Street also serves a number of bus routes.
- **Croydon Road**, between Croydon town centre and Parramatta Road, with between 5,000 and 25,000 vehicles per day and providing north-south connectivity. Croydon Road is on a local school bus route.
- **Elizabeth Street** is the main street in the corridor providing east west connectivity. It carries between 2000 and 5000 vehicles per day west of Frederick Street and more than 5000 vehicles per day east of Frederick Street.
- **Ramsay Road**, with between 5,000 to 25,000 vehicles per day, providing north-south connectivity at the eastern end of the corridor.
- **Etonville Parade** and **Hunt Street** are low volume traffic streets with less than 500 vehicles per day while John Street and Church Street have low to moderate traffic volumes between 2000 and 5000 vehicles per day.

Figure 12 shows daily traffic volumes on these streets.

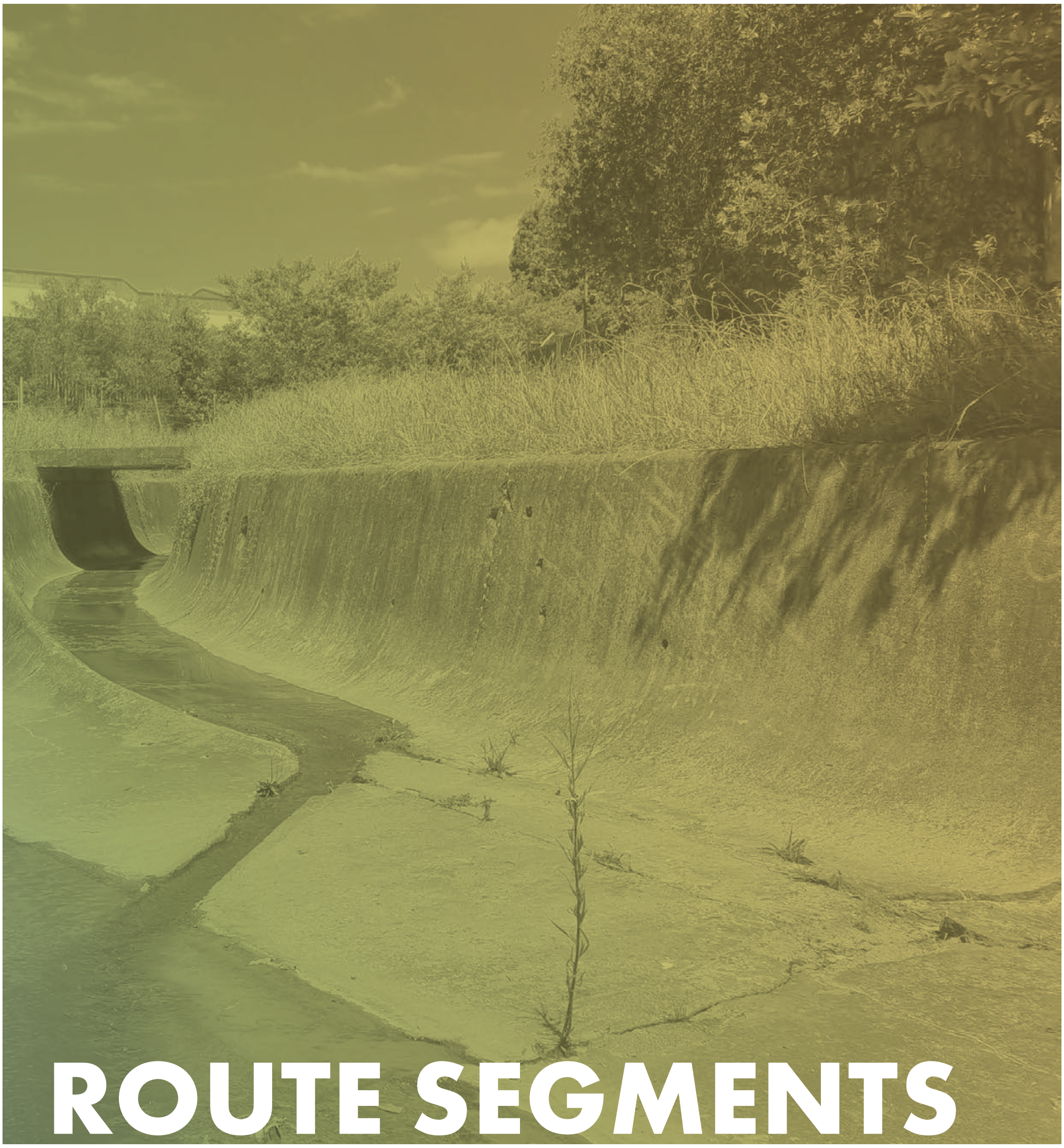
Comments from community consultation indicate that people walking and cycling experience the local road environment as busy and sometimes hostile, with roads difficult to cross and several comments describing intersections and pedestrian crossings as dangerous.

Figure 12: Traffic volumes per day

Traffic Volumes (per day)

- 0 - 1000
- 1000 - 2500
- 2500 - 5000
- 5000 - 25000
- 25000 - 50000


03



ROUTE SEGMENTS

3.1 OVERVIEW

The character of the Iron Cove Creek corridor varies substantially from its upper reach between Ashfield and Croydon to its lower reach near Iron Cove.

Precincts

This chapter provides an overview of the existing conditions of Iron Cove Creek Corridor. The character of both the creek channel and its adjacent land use and open space vary along the corridor, contributing to very different characteristics of the corridor along its length.

To capture this variability in its character, the Iron Cove Creek corridor has been be divided into six precincts (Figure 13). Each section of the corridor has a distinct character as well as different opportunities and constraints. The precincts are primarily separated at roadway crossings of the corridor. These roadway crossings currently physically divide the six different precincts.

The six precincts include:

1. Heighway Avenue to Elizabeth Street
2. Elizabeth Street to John Street
3. John Street to Church Street
4. Church Street to Parramatta Road
5. Parramatta Road to Ramsay Road
6. Ramsay Road to Iron Cove

The following sections describe each of these precincts in detail.

Figure 13: Precincts overview diagram


Iron Cove
Iron Cove Creek
RAMSAY ST
PARRAMATTA ROAD
4.
5.
6.
Greenway
Hawthorne Canal
Western Railway Corridor

3.2 HEIGHWAY AVENUE TO ELIZABETH STREET

Precinct 1 includes the section of Iron Cove Creek between Heighway Avenue, south of the Main Western railway line, and Elizabeth Street, adjacent to Ashfield Aquatic Centre. Precinct 1 includes the Main Western railway line running from east to west.

Land use

South of the rail corridor is primarily low-density residential development. To the north of the rail corridor is the Ashfield Aquatic Centre and an associated large car park on either side of the aquatic centre. Adjacent to the aquatic centre north of the rail line there is some medium density residential development including three storey walk-ups.

Immediately to the west of the proposed corridor is Croydon station, Croydon centre, Presbyterian Ladies College, and Croydon Public School. To the east of the corridor is Ashfield town centre, a major strategic hub of the Inner West identified for future urban growth.

Creek character

The creek under the Main Western railway line corridor consists of:

- The original 1890s oviform channel, which contains some of the only remaining parts of the original brick construction. At its widest point, this channel is approximately 3.6m wide and at its highest point it is approximately 4.95m high.
- A more recently constructed box culvert, which is 3m high by 1.7m wide.

The open channel continues adjacent to the western edge of the aquatic centre. Property boundaries extend to the edges of the channel on both sides of the Main Western railway line.

The flood study conducted for Iron Cove Creek (Dobroyd Canal) identifies a flooding hotspot immediately upstream of the Main Western railway line around Heighway Avenue. Flooding has been identified as a high hazard in this location. The oviform channel flows full in a 10% AEP event with significant water depth and velocities exceeding 2 metres per second. 1% AEP flood depths are shown in Figure 14. The Annual Exceedance Probability (AEP) refers to the probability of a flood event occurring in any year.

Road context

Frederick Street, which runs north-south under the Main Western railway line is a busy, arterial link and includes a bus route. It provides a traffic link between Parramatta Road and Liverpool Road south of the railway line. There are footpaths running along both sides of Frederick Street, however these are narrow and there is no verge, so pedestrians have very little protection from the heavy traffic on Frederick Street.

> ***"[The Frederick Street railway underpass is] extremely dangerous. Path too narrow for both cyclists and pedestrians, requiring cyclists to use road. Heavy traffic, and speed limit is too high."***
>
> ***Community member***

The intersection between Frederick Street and Elizabeth Street is signalised, including pedestrian signals on all 4 legs, however it includes limited space for pedestrians waiting to cross.

Elizabeth Street is a moderately busy local road, with a dedicated pedestrian crossing at the Ashfield Aquatic Centre. It is well used by people walking and cycling.

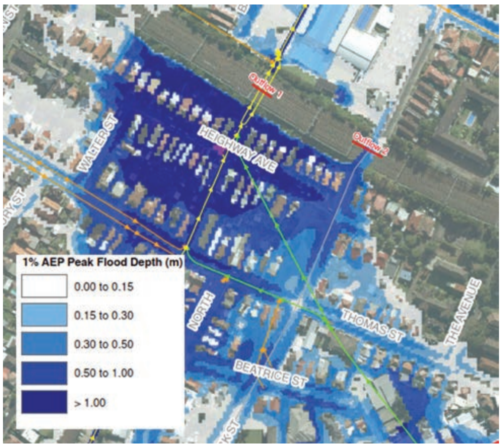
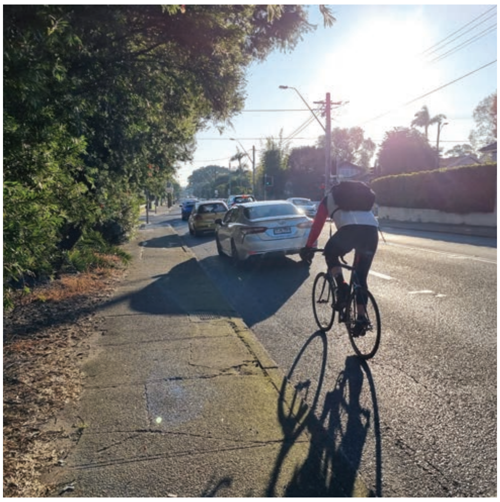


Figure 14: Flood depth mapping from Dobroyd Canal study shows that the depth of flooding in the 1% AEP is greater than 1m above the existing top of bank


Channel under Main Western railway line


Channel alongside Ashfield Aquatic Centre


Frederick Street Underpass of Main Western railway line


Frederick Street adjacent to Ashfield Aquatic Centre


Frederick Street/Elizabeth Street intersection

Pedestrian crossing on Elizabeth Street at the Aquatic Centre

3.3 ELIZABETH STREET TO JOHN STREET

Precinct 2 includes the section of Iron Cove Creek between Elizabeth Street adjacent to Ashfield pool and John Street. In this precinct the Iron Cove Creek channel runs alongside Etonville Parade then between properties from the end of Etonville Parade to John Street. There is no open space adjacent to the channel.

Land use

The urban form between these two roads along the corridor is almost exclusively low density residential development, permeated by pocket parks such as Frederick Street reserve at Frederick Street/Bank Street and Anthony Street Reserve at Etonville Parade/ Anthony Street.

There is a pocket of medium density residential development bordering Frederick Street at Albert Parade opposite Frederick Street reserve. At the intersection of John Street and Croydon Road, there is a small amount of low-density commercial operations occurring including shops and cafes.

Creek character

The open channel continues northward under Elizabeth Street along Etonville Parade and is located in between the adjacent properties and the footpath, with several private vehicle bridge crossings over the canal.

The is a relatively narrow, relatively deep concrete channel with fencing to both sides. It then carries on northward as Etonville Parade diverts westward towards Croydon Road. The channel is located between low density residential development until John Street. Between John Street and Etonville Parade, the corridor is currently inaccessible to the public and is gated off, except for a narrow pedestrian bridge between Hedger Avenue and Gregory Avenue.

Road context

Etonville Parade, a quiet residential street with low traffic volumes and on street parking. It has a row of established street trees adjacent to the channel which provides a pleasant character to the street. Unfortunately the footpath under these trees is too narrow to be walkable and so most pedestrians use the western side of the street which has no street trees.

The surrounding roads are busy east and west of the corridor, with Frederick Street to the east and Croydon Road to the west.

Croydon Road has painted on-road bike symbols but no dedicated cycling infrastructure, requiring riding on-road in a mixed traffic environment. It is a well used cycling and walking route as it is one of the few streets travelling north south and links to Croydon centre and local parks.

Frederick Street continues as an arterial corridor. It also has a some use by cyclists along the corridor due to its direct link to Parramatta Road.

"Croydon Road is marked with bike stencils to indicate it's meant to be cycled, but it's scary to ride in the traffic along it.."
Community member


View north along Etonville Parade


Channel downstream from Elizabeth Street


Street trees alongside channel at Etonville Parade


Croydon Road, near Ranger Road


Channel at downstream end of Etonville Parade


Channel looking upstream from John Street

3.4 JOHN STREET TO CHURCH STREET

Precinct 3 includes the section of Iron Cove Creek between John Street and Church Street and it has open space adjacent to the creek.

Land use

The primary character of the land use is low density residential, with a few small businesses and local services, a child care centre, as well as two significant parks.

Between John Street and Church Street there are two significant parklands in proximity to the corridor. To the west across Croydon Road is Bede Spillane Reserve and Centenary Park, and to the east between Lucy Street and Frederick Street is Hammond Park. Both parks are well used for recreation.

Adjacent to the creek corridor and opposite Bede Spillane Reserve is the Croydon Zone electrical substation. Along Frederick Street in this part of the corridor is also an aged care facility and medium density residential.

Creek character

North of John Street, the character of the creek corridor changes significantly. The land opens to between 12-22m and has open, mown turf either side of the corridor. The mown lawn slopes steeply down to the creek. The creek corridor also has a junction at Croydon electrical substation, and contains a small western tributary with adjacent open space which connects to Croydon Road opposite Bell Spillane reserve. This tributary also has a similar 20m wide corridor with mown grass either side of the channel.

The creek and its adjacent open space is typically 1 to 2m below than the surrounding streetscape and property boundaries The creek itself also starts to slowly move turn from north northeast to northeast here.

In this section of the corridor there is also a 750mm diameter underground water main running along the west side of the creek within the open space adjacent to the channel.

Along the east side of the corridor here is a 300mm diameter sewer main.

Water main

Along the western side of the channel, there is a major Sydney Water 750mm water main. Any path works within this area will need to avoid impacts on the water main. Key considerations will include:

- Maintaining access to the water main for Sydney Water, including access for routine maintenance/inspections as well as emergencies. Due to the critical nature of the asset, Sydney Water is likely to require the ability to access the water main in short time frames.
- Minimising construction impacts on the water main (e.g. minimising vibration).
- Maintaining adequate cover to protect the water main.

As far as possible, the design should consider how to avoid the need for building structures over the water main. With the construction of new structures over the water main, or significant reductions in cover over the water main, Sydney Water would require protection of the asset and/or potential relocation to avoid impacts.

Building a path over the water main is therefore likely to involve significant work in design development and approvals, as well as significant additional construction costs if relocating the water main is required. This does not preclude the delivery of a path however these implications need to be understood by Inner West Council in planning this section of the route.

Road context

The road context is similar to Precinct 2 with Croydon Road and Frederick Street corridors running parallel to the corridor on either side and low traffic residential streets in between. Croydon Road remains a well used walking route and on road cycling route. Frederick Street remains a moderately used walking and on road cycling route but begins to reduce in use further north of John Street. Lucy Street, Alexandra Street, Lucy Crescent, and a private laneway run between these two streets. These local streets are characterised by low traffic volumes and low speeds with on street parking.

The Church Street corridor is a local road with low to medium traffic volumes, It is well utilised by pedestrians and is a moderately used on road cycling route, however comments from the community consultation indicate that people find it too busy and narrow for comfortable cycling.

Channel downstream of John Street

Channel junction looking upstream

View from Croydon Road opposite Bede Spillane Reserve, along the branch channel towards Iron Cove Creek

Channel looking downstream to Church Street

Looking south under the Church Street bridge, on the western side of the channel

View from Church Street looking upstream, showing approx. 2m open space on the eastern side of the channel and 5-6m on the western side

3.5 CHURCH STREET TO PARRAMATTA ROAD

Precinct 4, between Church Street and Parramatta Road, provides open space adjacent to Iron Cove Creek including land owned by Inner West Council.

Land use

At this part of the corridor the character of the surrounding land use changes with the built form to the immediate east of the corridor featuring higher density apartments, known as Green Trees, and main road commercial uses on Parramatta Road such as petrol stations and drive-in retail and take away food outlets. To the west of the corridor, the built form includes lower scale residential and light industry as it approaches Parramatta Road.

The 'Productivity Support' zone immediately adjacent to the creek at the Kings Bay on Parramatta Road is earmarked for redevelopment as part of the Parramatta Road strategy.

Creek character

The creek character is generally similar to Precinct 3 with an open channel adjacent to a grass area, with the concrete channel gradually widening as it approaches Parramatta Road.

There is open space on each side of the channel. On the western side the open space stops at West Street, 100 metres from Parramatta Road. In this location there is communications tower and vertical concrete wall alongside the channel. On the eastern side in this precinct is land, approximately 3m in width and known as John Pope Reserve, owned by Inner West Council which was acquired with development of the Green Trees apartments during the 1990s.

Parramatta Road crosses the creek elevated above the adjacent open space, with a height difference of approximately 2m between the grass area and footpath level.

Furthermore, the underground water main mentioned in Precinct 3 continues along the western edge of the creek, running under the embankment and diverting northwest at West Street.

Road context

Similar to Precincts 2 and 3, Croydon Road and Frederick Street travel each side of the corridor. As Croydon Road approaches the Parramatta Road intersection, it changes to a 2-lane road northbound with no kerbside parking. Frederick Street also expands to include additional lanes.

Parramatta Road is one of Sydney's major arterial roads providing regional road travel between the inner city and western Sydney, including heavy vehicle freight throughout the day. It is a major barrier to pedestrians and people on bikes.

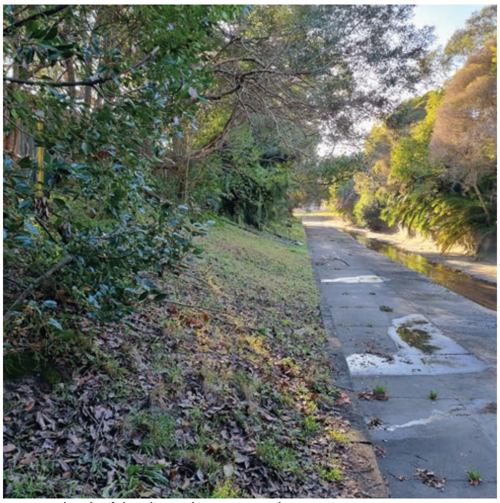
The only crossings over Parramatta Road in the vicinity of Iron Cove Creek are at Croydon Road (200m west), opposite Great North Road (75m west) and at Frederick Street (380m east). Great North Road is the closest to Iron Cove Creek at approximately 75m away, but is an awkward crossing for pedestrians, which also requires crossing over Great North Road.

"The Parramatta Road pedestrian crossing is terrible here. It takes two long waits to get across... and there is no shelter or protection... Please can this project implement a pedestrian and cycle pathway either over or under Parramatta Road."

Community member

Channel looking downstream from Church Street


Eastern bank of the channel near Church Street


Western bank of the channel near Australia Street


Eastern bank of the channel near Australia Street


Channel at Parramatta Road


Signalised pedestrian crossing over Parramatta Road at Great North Road

3.6 PARRAMATTA ROAD TO RAMSAY ROAD

Precinct 5 includes the section of Iron Cove Creek between Parramatta Road and Ramsay Road. The Iron Cove Creek channel runs adjacent to Jegorow Reserve.

Land use

Along Parramatta Road, there is a strip of large lot commercial development. Beyond this the land use is low density residential, however it is only a short distance to both the Kings Bay precinct along Parramatta Road and the proposed Five Dock metro station near the Great North Road. In both these areas, future development is proposed.

There is a significant area of green space bordering the channel in this precinct, including:

- Croker Park, in Canada Bay LGA, on the northern side of the channel across Henley Marine Drive.
- Wadim (Bill) Jegorow Reserve ("Jegorow Reserve") on the southern side of the channel.

Croker Park has tennis courts and a playground and scattered trees.

Jegorow Reserve includes a path between Cove Street and Wolseley Street running parallel to the creek, scattered trees, seating and picnic tables. Transport for NSW owns part of the open space on the southern side of the reserve.

At the western end of Jegorow Reserve, between the channel and Cove Street, there is an Inner West Council depot.

There is also a pocket of low-density commercial interspersing the residential areas, with a small commercial cluster at Henley Marine Drive and Ramsay Road to the north of the Ramsay Road bridge at the east of the precinct.

Creek character

The creek channel itself continues to widen past Parramatta Road. It is bordered on one side by Henley Marine Drive, with a steep transition to the concrete channel edge. The southern side is bordered by parkland, with some unused space between the channel and Dobroyd Parade immediately east of Parramatta Road.

Road context

This precinct is bordered by two busy roads, Parramatta Road to the west and Ramsay Road to the east.

Ramsay Road is a dual lane arterial route feeding onto the City West Link to the south and heading northward toward Five Dock centre northward and services buses. It is also used as an on road cycling route as it provides a direct link north south.

There is currently no dedicated crossing for people walking and cycling across Ramsay Road at the creek corridor. There is a signalised crossing about 100m to the north of the creek channel near Harrabrook Avenue.

Running along the north-western side of the creek between Parramatta Road and Ramsay Road is Henley Marine Drive. This street has no footpaths and so although it is next to the creek it is not currently attractive as a walking route.

On the southern side of the creek, Dobroyd Parade is a quiet street running 100m between Parramatta Road and Jegorow Reserve, beside the Inner West Council depot. Alongside the depot, there is rear-to-kerb parking, no footpath and a lot of litter. There is a footpath on the other side of the street but pedestrians were also observed walking in the road here.


Entrance to Jegorow Reserve from Dobroyd Parade


Channel looking downstream across to Jegorow Reserve


Jegorow Reserve


Jegorow Reserve entrance from Ramsay Road


Dobroyd Parade


Existing signalised crossing over Ramsay Road

3.7 RAMSAY ROAD TO IRON COVE

Precinct 6 includes the section of Iron Cove Creek between Ramsay Road and Iron Cove. In this section, the channel follows the boundary between Inner West and Canada Bay LGAs.

Land use

This precinct has a large amount of open space. On the northern side of the channel is Timbrell Park, a major park within Canada Bay LGA. Timbrell Park includes 'Livvi's Place' playground and café; it also has several sports fields and a circuit path. Along the southern side of Timbrell Park adjacent to the Iron Cove Creek channel, there is a stand of significant trees creating a small urban forest. Note that the City of Canada Bay is currently preparing a Masterplan for Timbrell Park and this is discussed in Section 4.7.

On the southern side of the channel there is a smaller park - Reg Coady Reserve - in Inner West LGA. Part of this space is currently being used for construction access associated with the M4-M5 Link motorway tunnels.

Beyond Reg Coady Reserve the City West Link road is immediately adjacent to the channel.

Creek character

The creek continues as a concrete open channel. Sydney water proposes to naturalise the channel from Ramsay Road to Ingham Avenue due to the current poor condition of the channel.

Road and path context

At either end of this precinct, Ramsay Road and Timbrell Drive are both major roads with significant traffic volumes. People walking and cycling can cross Ramsay Road at an existing signalised crossing near Harrabrook Avenue (see Section 3.6) and they can cross Timbrell Drive either at a pedestrian refuge near Henley Marine Drive or a signalised intersection with the City West Link.

On the northern side of the precinct, Henley Marine Drive provides a link between Ramsay Road and the Bay Run, but people walking and cycling can also use paths through Timbrell Park. There is an existing path around the perimeter of Timbrell Park, providing two alternative routes around either side of the park. These routes have been earmarked for upgrade as part of the City of Canada Bay's draft Masterplan for the park - see Section 4.7.

On the southern side of the precinct, the City West Link (a 6-lane arterial road) dominates the space, but people walking and cycling can also use Martin Street and Dobroyd Parade to travel between Ramsay Road and Iron Cove. These are quiet streets and Dobroyd Parade includes filtered permeability to enable walking and cycling while excluding through traffic. However, this route involves crossing the City West Link twice (at two signalised intersections) so is less attractive than the routes through Timbrell Park. It is a useful alternative for people to access the corridor from Dobroyd Point.

Between Ramsay Rod and Timbrell Drive there is one other opportunity for people walking or cycling to cross over Iron Cove Creek, at a narrow footbridge near the Livvi's Place playground. This connects to a signalised crossing over the City West Link. This footbridge is also earmarked for an upgrade - see Section 4.7.


Looking downstream along the channel from Ramsay Road


Northern bank of the channel

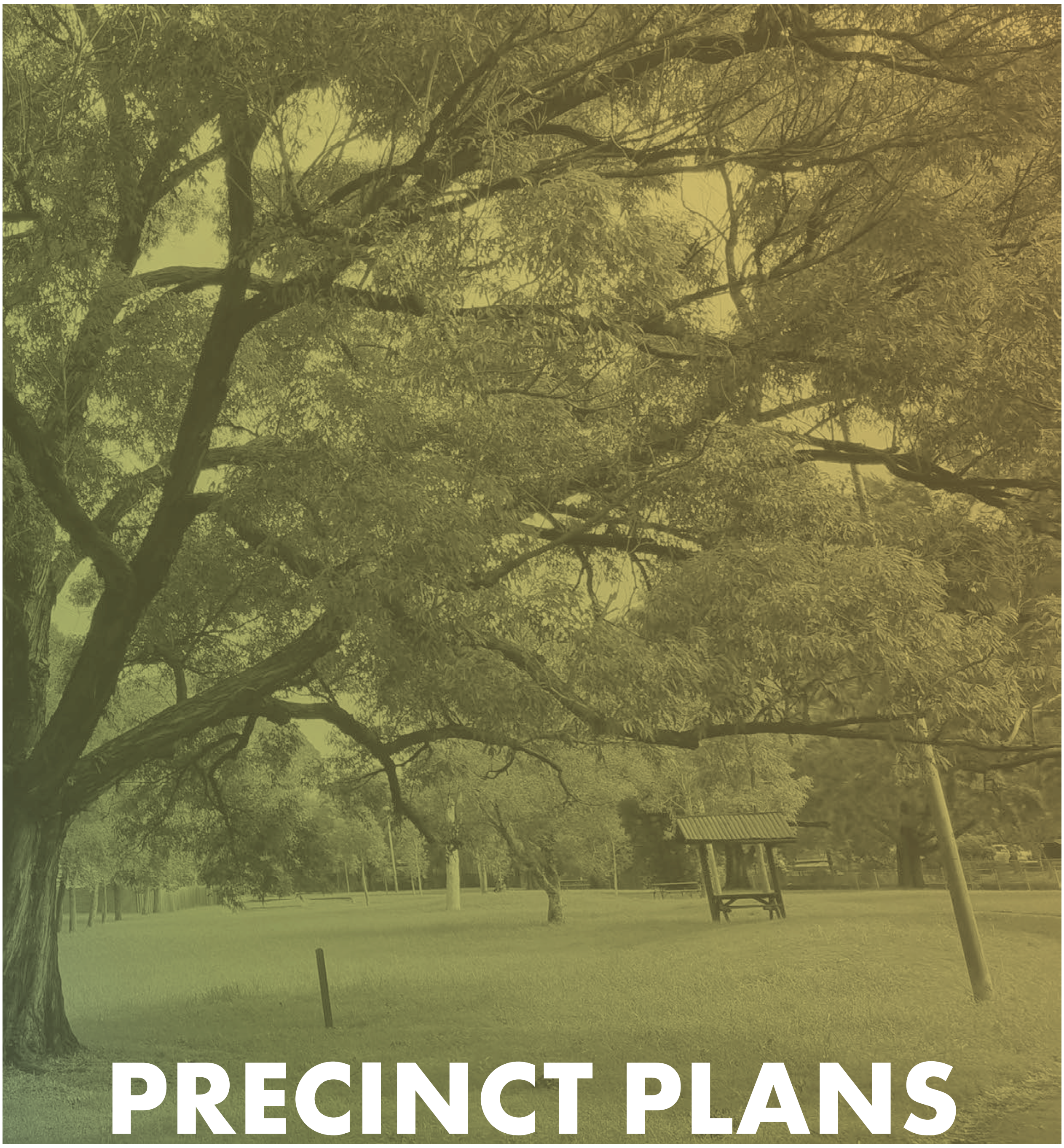

Existing bridge across channel near Waratah Street


Path around the northern side of Timbrell Reserve


Existing crossing between Timbrell Park and the Bay Run


The Bay Run path


04



PRECINCT PLANS

4.1 OVERVIEW

Plans have been prepared for the six precincts described in Section 3, identifying a preferred route for walking and cycling and other proposed improvements in each precinct.

The Masterplan is presented for six precincts, as shown in Figure 15. The character of each precinct has informed the proposed route and other improvements:

- **From Heighway Avenue to Elizabeth Street (Precinct 1)**, the channel is very confined and the only option for the proposed walking and cycling route is to use existing streets, converting footpaths to shared paths.
- **From Elizabeth Street to John Street (Precinct 2)**, Etonville Parade has the potential to become a pleasant Quietway beside the channel. Between Etonville Parade and John Street, it is hoped that a path can be build directly over the channel.
- **From John Street to Parramatta Road (Precincts 3 and 4)**, the proposed route uses the more generous channel corridor, where there is space on either side of the channel.
- **From Parramatta Road to Iron Cove (Precincts 5 and 6)**, the proposed route links existing parks, with improved crossings proposed at Parramatta Road and Ramsay Road.

Figure 15: Iron Cove Creek corridor overview & precincts


Ramsay Road
Parramatta Road
Church Street
3.
4.
5.
6.

4.2 HEIGHWAY AVENUE TO ELIZABETH STREET

Precinct 1 includes the Main Western railway line, which poses a significant barrier to north-south movement. The Masterplan proposes to widen the path on the western side of Frederick Street and convert it to a shared path.

Within this precinct, the route needs to pass under the Main Western railway line. The only option at the moment is to cross under the railway at Frederick Street, where the traffic is heavy and there is only a narrow footpath separated from the road by a basic barrier (see Section 3.2).

An option was investigated to follow Iron Cove Creek under the railway line. A 2.5m wide path, with a 2.6m height clearance would be able to physically fit through the oviform channel, however a structure within the channel would restrict water flow through the channel and create the potential for trapping debris, with the risk that this would raise flood levels upstream in Heighway Avenue. This flood risk would also pose dangers to people using a path within the oviform channel. Due to this risk, a path passing through the oviform channel is not considered feasible.

Therefore, the preferred route is along Frederick Street and Elizabeth Street, with improvements recommended to provide better walking and cycling access. These improvements are shown in Figure 16.

Frederick Street shared path

This Masterplan proposes to reconfigure Frederick Street to create a wider path on the western side of the street, which can be converted to a shared path. It proposes to achieve this by reducing the width of the traffic lanes.

Frederick Street generally has a total width of approximately 15m, including footpaths each side approximately 2.2-2.4m wide, and traffic lanes each approximately 5.1-5.3m wide. Between Heighway Avenue and Elizabeth Street, Frederick Street is generally only one lane wide in each direction.

If the traffic lane widths can be reduced then a shared path can be created with adequate space for pedestrians and people on bikes. Safer driving speed limits should also be considered for Frederick Street.

There is no on-street parking on Frederick Street and hence there would be no loss of on-street parking.

The following sections provide specific recommendations for each part of Frederick Street between Heighway Avenue and Elizabeth Street.

Heighway Avenue to Main Western railway line

This section of Frederick Street is one lane each way with traffic lane widths of approximately 4.9-5.0m and footpath widths of approximately 2.1-2.4m.

If the traffic lane widths can be reduced to 4.3-4.4 m wide and the road centreline adjusted, there would be space for a 4.0m wide shared path on the western side of the street, while retaining the existing footpath on the eastern side. This is illustrated in Figure 17 (Section B).

This configuration could continue further south on Frederick Street, it is shown in Figure 16 extending as far as Thomas Street.

Under the Main Western railway line

A widened and improved path through the rail underpass is especially warranted.

Frederick Street is narrower under the railway line, with a total width of approximately 12m, including footpaths approximately 1.5m wide and traffic lanes approximately 4.5m wide. The effective footpath width is further reduced by the presence of a traffic barrier on the edge of the footpath.

If the traffic lane widths can be reduced to 3.5m, then there would be space for a 3.5m wide path on the western side of the street. This is shown in Figure 17 (Section B).

This Masterplan also recommends replacing the traffic barrier with an Elsholz kerb, which can provide an effective traffic barrier without taking up space on the path.

Figure 16: Precinct plan for Heighway Avenue to Elizabeth Street (Precinct 1)

Main Western railway line to Elizabeth Street

This section of Frederick Street is generally one lane each way, however there is a section near Elizabeth Street where it also includes a right turn lane.

In this area (with the right turn lane), the existing footpath width along Fredrick Street is approximately 2.2m wide and the south bound lane is approximately 5.2m wide. There is potential to narrow the southbound lane to 3.5m width for a 3.9m wide shared path on the western side of Frederick Street. This would require adjusting the road centre line 1.7m to the east.

Frederick Street / Elizabeth Street intersection

At this intersection, more space is needed for pedestrians using the signalised crossing, particularly if the paths either side are converted to shared paths and there is additional bike traffic. Due to its proximity to the aquatic centre it is often used by groups of people, including children, and the existing conditions require vigilance to endure the waiting time and get across the road while cars proceed before the signal changes again.

Elizabeth Street shared path

The Masterplan proposes to reconfigure Elizabeth Street between Frederick Street and Etonville Parade, to reduce the width of the traffic lanes and create a wider path on one side of the street, which can be converted to a shared path.

The absence of existing street parking in this location means lane widths can be reduced and there would be no loss of car parking.

Two different configurations are proposed in two separate sections of Elizabeth Street, either side of the pedestrian crossing. These are described below.

This Masterplan also proposes to upgrade the Elizabeth Street pedestrian crossing to a shared pedestrian and bike crossing. At a regular pedestrian crossing, cyclists are required to dismount. If the crossing can be widened then it can be modified to a shared pedestrian and bike crossing.

Frederick Street to existing pedestrian crossing

Here, the shared path is proposed on the southern side of Elizabeth Street. The existing footpath width is approximately 3.5m and the west bound lane is approximately 5.0m wide, creating potential to narrow the west bound lane width to 3.5m width and increasing the path width to 5m wide adjacent to the aquatic centre. This provides opportunities for additional activation and landscaping in front of the aquatic centre, to provide shade around the entrance area.

Pedestrian crossing to Etonville Parade

The existing footpath width is approximately 2.6m and the eastbound lane is approximately 4.6m wide. If the traffic lane can be reduced to 3.5m wide, then the path could be widened to 3.7m.

Section A

Section B

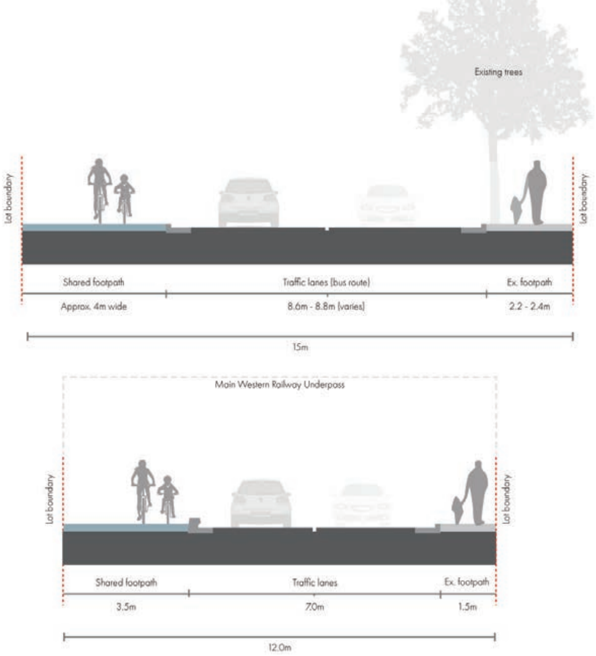


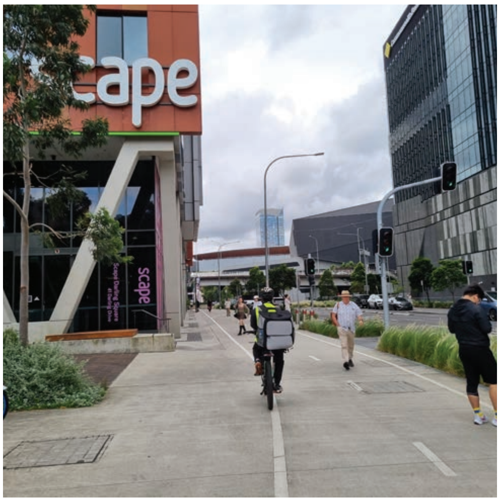
Figure 17: Frederick Street cross-sections including shared path (A) general section Thomas Street to Elizabeth Street; (B) section at railway underpass

Shared path in Lilyfield

Shared path in Willoughby LGA

Shared pedestrian and bike crossing - Wigram Road

Shared pedestrian and bike crossing in Sutherland LGA



Shared path Haymarket

Shared path entrance Haymarket

4.3 ELIZABETH STREET TO JOHN STREET

With no open space beside the channel in Precinct 2, improvements in Etonville Parade would provide a new public place, increased landscaping and better access for people walking and bike riding.

In Precinct 2 there is no open space along Iron Cove Creek, therefore it is proposed to utilise Etonville Parade beside the channel, converting this street to a Quietway. Proposed works are shown in Figure 19.

Between Etonville Parade and John Street, it is hoped that a path can be built over the channel, supported on the channel itself.

At John Street, a raised pedestrian and bicycle crossing is proposed, with associated traffic calming along John Street. A low-cost intervention to provide filtered access of John Street should be explored to reduce short-cutting by drivers.

Etonville Parade Quietway

Etonville Parade is a local street with a low volume of traffic, but conditions could be improved for walking and cycling.

A landscaped Quietway would involve traffic calming measures and safer driving speed limits, so that people on bikes could comfortably and safely share the roadway with vehicular traffic.

Figure 18 shows a typical section of the proposed Etonville Parade Quietway, including:

- Coloured asphalt on the roadway indicating the Quietway as a distinctly different traffic environment.

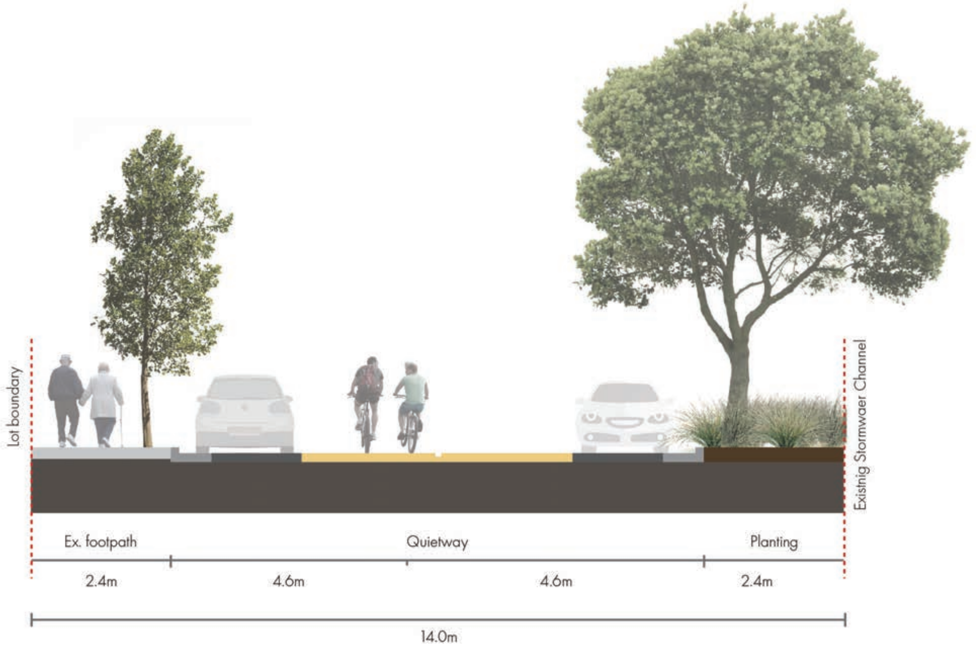


Figure 18: Etonville Parade cross-section

Figure 19: Precinct plan for Elizabeth Street to John Street (Precinct 2)

- New tree planting on the western side of the street, along the pedestrian path, to improve amenity for people walking along the street.
- Understorey planting under the existing brushboxes along the eastern side of the street, to replace the concrete that does not function as an effective footpath.

As part of the Quietway, a new pocket park is proposed at the southern end of Etonville Parade near Elizabeth Street. This would provide filtered permeability - it would limit vehicle access while supporting walking and bicycle access. It would also provide a new public place for the local community.

Boardwalk over the channel

Between Etonville Parade and John Street, a length of approximately 200m, the preferred route would involve building a boardwalk directly over the channel, supported on the channel walls. Here, the channel is confined to a narrow corridor between adjacent residential properties. Fencelines are located on or immediately next to the channel walls - see Figure 19.

While this is not a straightforward proposal, it is preferred here because the alternatives are poor, involving a major deviation from the channel and significant constraints:

- Via Banks Street, Frederick Street and John Street the route would be approximately 480m. While a Frederick Street cycleway is explored in Section 4.9, this is a state road and any works here would be dependent on State Government support, which is uncertain.
- Via Hunt Street, Croydon Road and John Street the route would be approximately 400m. Croydon Road is very constrained with high traffic volumes (see Section 2.6) and limited space. The traffic conditions are not appropriate for a Quietway, a separated cycleway would involve significant loss of parking (unlikely to be supported) and a shared path would create significant conflict with outdoor dining at the John Street intersection, as well as conflicting with trees along the length of the street. Numerous driveway crossings are also a safety issue.

John Street is also challenging with moderate traffic volumes and limited space for appropriate cycling infrastructure.

Sydney Water's as-built drawings of the channel show that at Etonville Parade, the internal width of channel is approx. 3.7m, and it narrows down to approx 3.1m at John Street. The width of the walls is an additional 0.3m on either side.

Council's cadastral data shows that Sydney Water owns a parcel of land approximately 4-5m in width between the private properties, however even if there is a small area of Sydney Water land beyond the channel in some places, this would not provide enough space to support a path.

Sydney Water's standard conditions for building adjacent to their assets require that any structures are to be set at least 1m away from a stormwater channel and clearly this would not be possible here without encroaching into private property.

Potentially, a structure could be built directly on top of the channel, supported on the channel walls. This would require approval from Sydney Water, and detailed consideration of the following issues:

- Ensuring the path structure would not cause damage to the channel
- Ensuring Sydney Water could access the channel for routine maintenance
- Enabling future renewal of the channel when required
- Ensuring no increase in flood impacts to surrounding properties
- Ensuring the structure itself is able to withstand flooding including forces associated with flood flows, debris and buoyancy.
- Managing the risks that flooding would pose to people using the path. Provisions for flood warning and safe evacuation would need to be considered.
- Constructability of the path over the channel with limited access.

This option would require significant work in design development and approvals, as it would require the support of Sydney Water for a design that deviates from their usual requirements. It would be important to work with Sydney Water to understand the structural capability of the channel and assess the options in relation to flooding.

Item 5


Shared zone and filtered permeability


Street park with filtered permeability


Filtered permeability with established mid block street park


Quietway - walking, cycling & cars


Elevated structure over a stormwater channel


Filtered permeability and road closure at Bridge Street Erskineville

Attachment 1

4.4 JOHN STREET TO CHURCH STREET

Precinct 3 provides an opportunity for the shared path to pass through a new publicly accessible linear park alongside Iron Cove Creek. Key constraints include private property boundaries and an existing water main.

Proposed works between John Street and Church Street are shown in Figure 20.

Path on western side of channel

In Precinct 3, from John Street to Church Street, the Iron Cove Creek channel sits within a corridor of open space. Its width varies on either side of the channel:

- On the western side of the channel there is a continuous 5 to 6m open space corridor adjacent to the channel between the private property boundary and the edge of the channel.
- On the eastern side of the channel there is generally less space, with the private property boundary extending down to the top of the bank of the channel in two separate locations. The route would not be feasible on the eastern side of the channel without acquisition of private property.

Therefore, in this section the proposed route follows the western side of the channel, utilising the more generous space on this side. For most of the 300m length between John Street and Church Street, a shared path could be constructed as a simple on-grade path. In some locations, regrading (and potential retaining structures) would be required to create a level path.

Sections A to D, shown in Figure 20, illustrate how a 3m wide shared path could be accommodated at grade on the western side of the channel. Path widths and levels would need to be confirmed during further design development.

Bede Spillane Reserve connection

In this precinct there is also the opportunity to create a 60m link along a separate branch of the channel, which is shown in . This branch of the channel meets Croydon Road opposite Bede Spillane Reserve, providing connectivity to the Centenary Park sports precinct.

To connect to Croydon Road an elevated ramp structure of approximately 40m in length would be required as there is an approximate 2m level difference between the open space along the channel and Croydon Road.

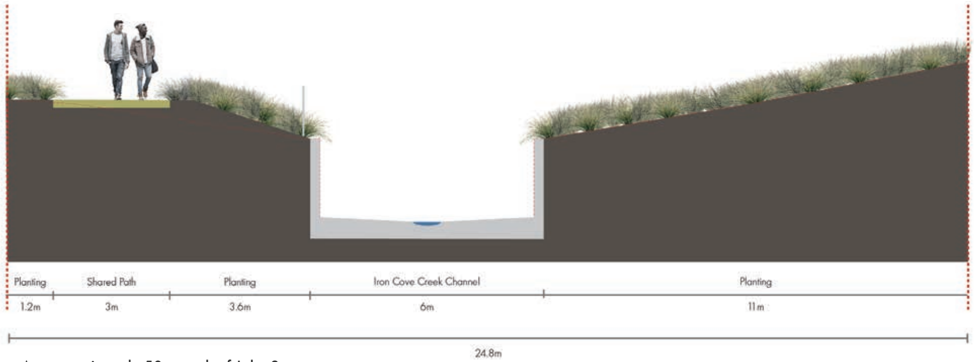
There is little difference in available land width between the northern and southern sides of the tributary and the southern side contains a sewer main. This suggests the northern side may be preferable for any future path.

Other proposed works in this precinct include:

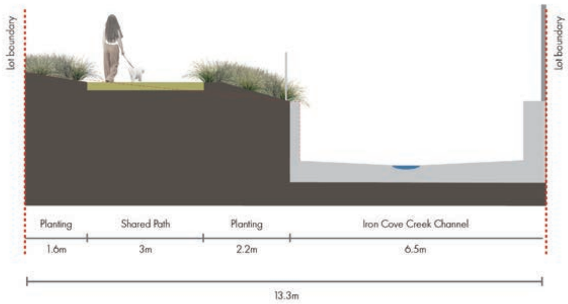
- Traffic calming/filtered vehicular access at John Street to reduce short-cutting by drivers & improve safety for people walking and cycling.
- A walking and cycling bridge over the tributary channel joining Iron Cove Creek approximately halfway along the route.
- An underpass under Church Street. The underpass under Church Street would require lowering the existing surface levels to provide enough vertical clearance to the underside of the existing bridge structure (see Section 3.4 and in particular the image at bottom left on p.43).
- Alternatively, an at grade pedestrian & bicycle crossing could be provided over Church Street, with a narrowed crossing point using planted medians and other traffic calming devices.

If an at-grade crossing is provided over Church Street, this would require a ramp on either side of the street for access in and out of the creek corridor. Even if the main route utilises an underpass under Church Street, ramps linking to Church Street are still a worthwhile consideration to improve connectivity at this point.

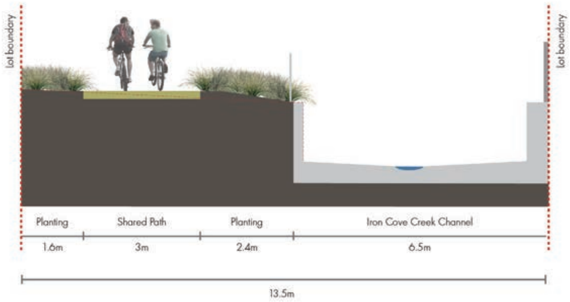
Figure 20: Precinct plan for John Street to Church Street (Precinct 3)



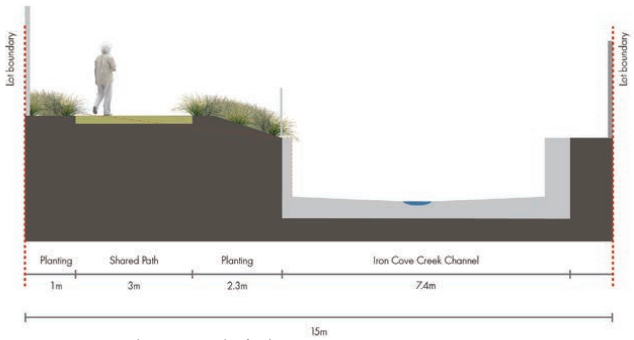
Section A, approximately 50m north of John Street



Section B, approximately 100m north of John Street

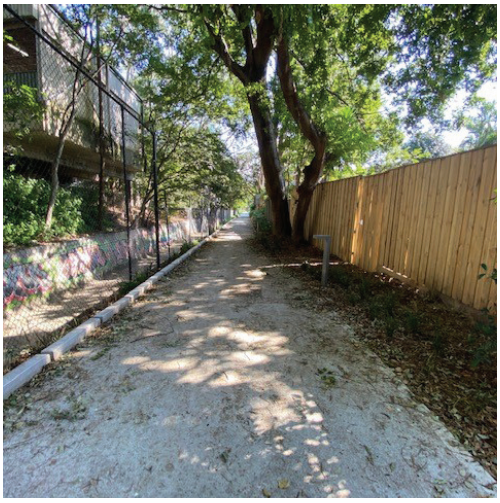


Section C, approximately 200m north of John Street



Section D, approximately 250m north of John Street

Figure 21: Sections between John Street and Church Street


Shared path - Johnston Creek

Gateway signage


Bridge over stormwater channel at Cahill Park, Wolli Creek


Shared path - Richard Murden Reserve


Native planting


Shared path - Adelaide

4.5 CHURCH STREET TO PARRAMATTA ROAD

In Precinct 4, from Church Street to Parramatta Road, the proposed route uses open space alongside Iron Cove Creek. An improved crossing of Parramatta Road is a critical element in this part of the corridor.

In Precinct 4, as in Precinct 3, Iron Cove Creek continues in a corridor of open space that is wider than the concrete channel itself. Proposed works are shown in Figure 22.

In this Precinct, there is a reasonable width of open space on both sides of the channel, however there are other constraints to be considered, some of which will only become clear after additional site investigations (including survey and specialist studies). These include:

- The water main on the western side of the channel (refer to Section 3).
- Other services including a sewer on the eastern side of the channel.
- Mature trees on both sides of the channel.
- Levels either side of the channel - in some places there is a significant gradient between the channel edge and the property boundary.
- Adjacent private property levels and privacy implications.

Therefore it is not yet clear exactly where the best location for the path will be. Figure 22 shows a proposed route but there are other options, as described below.

Figure 23 includes cross-sections illustrating how - at least in some areas where there is a steep gradient - the path would need to be constructed as an elevated boardwalk.

Main path

Near Church Street, the proposed route is shown continuing along the western side of the channel as per Precinct 3, so it would continue from the underpass proposed under Church Street. Approximately 110m downstream of Church Street, a link to Australia Street should be explored.

Between West Street and Parramatta Road, there are several major constraints on the western side of the channel including a mobile phone tower compound, a Sydney Water concrete access ramp into the base of the channel, then a stretch where the private property boundary extends down to the edge of the channel and there is no open space. Therefore for 130m south of Parramatta Road the path would have to be located along the eastern side of the channel as shown in Figure 22.

The path is shown crossing the channel just south of West Street. During design development, the location of this crossing could be refined - it could potentially be located anywhere between Church Street and West Street.

Secondary path/alternative routes

The land on the eastern side of the channel between Church Street and Parramatta Road is owned by Council, which potentially provides an opportunity for Council to deliver improved access in the short-term, without the need for major works or approvals. This could be achieved with a simple walking path at-grade, retaining existing trees. It would need to include fencing along the channel edge and either steps or ramps linking pedestrians to Parramatta Road and Church Street.

On the western side of the channel, between West Street and Parramatta Road, the draft Inner West Development Control Plan (DCP) specifies a setback along the channel for the site facing Parramatta Road, known as Opportunity Site 3, 582-584 Parramatta Road, Croydon. The DCP recognises the Iron Cove Creek active green transport link and specifies a minimum 8m wide public corridor incorporating a 4m walking and cycling path with a landscaped area as well as seating, lighting and drinking fountain. If and when this site is redeveloped, it may therefore open up the options along the western side of the channel.

Figure 22: Precinct plan for Church Street to Parramatta Road (Precinct 4)

Precinct Plans

Section A

Section B

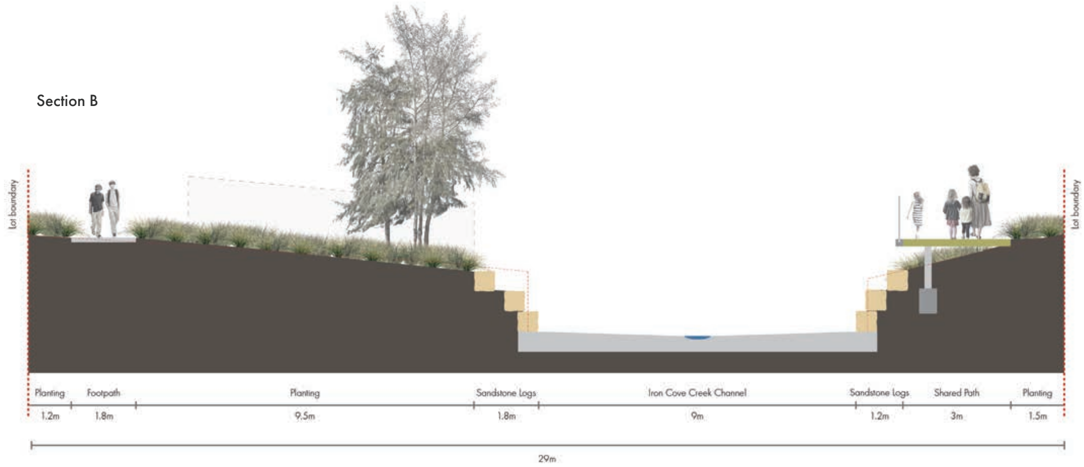


Figure 23: Sections between Church Street and Parramatta Road (A) near Church Street; (B) near Parramatta Road


Shared path adjacent to residential dwellings - Adelaide


Shared path bridge/ elevated structure (Cooks River)


Bank restoration - steep slope


Planting and path adjacent to channel (Alexandria)


Underpass, River Torrens shared path, Adelaide

Underpass, Cooks River, Tempe

Parramatta Road crossing

Parramatta Road poses a major barrier for people walking and cycling in this area and this was a strong and recurring comment made during community engagement conducted in November 2022.

The NSW Government and councils along Parramatta Road are currently taking action to implement the Parramatta Road Corridor Urban Transformation Strategy (PRCUTS) to provide more homes and jobs and better transport along and around Parramatta Road. Kings Bay, the Parramatta Road precinct adjoining Iron Cove Creek, will accommodate a new residential and mixed-use urban village supported by the Sydney Metro West station at Five Dock. Accordingly an improved crossing of Parramatta Road is recommended to facilitate the green grid link while also increasing the catchment of Metro West and access to open space for future Kings Bay residents.

In 2022 a Transport Plan prepared by the Department of Planning and Environment for the Inner West recognises the limited crossing opportunities for pedestrians on Parramatta Road and the importance of Iron Cove Creek as part of a Strategic Pedestrian Network. Recommended actions include investigating and providing pedestrian crossings of Parramatta Road, including at Iron Cove Creek.

At-grade options

In general, Council supports at-grade crossings wherever possible, as they are generally more direct, accessible and easy to use for people walking and cycling. An example is shown in Figure 24.

An improved at-grade crossing of Parramatta Road is supported by the Future Transport Strategy and the Transport for NSW Road User Space Allocation Policy (January 2021) which applies to existing classified roads such as Parramatta Road which are controlled by the NSW Government. The policy applies to both physical space and how time is allocated such as the time given at traffic signals. It recognises measures can be implemented over time to achieve the strategic intent and outcomes identified as part of strategies or plans – like Future Transport Strategy and PRCUTS. The Policy is supported by a procedure document (Road User Space Allocation Procedure) which outlines mechanisms to implement the policy, and cross-agency work now underway for Parramatta Road provides a real and immediate opportunity to take action in accordance with the policy and procedure. Furthermore, Sydney's growing underground motorway network and public transport network provide a real and immediate opportunity for this to be explored.

Figure 24: A signalised intersection at Albert Street/Landsdowne Street in Melbourne (Image source: Streets Alive Yarra)

Grade separated options

While an improved at-grade crossing of Parramatta Road would be welcome, it is likely to remain a significant challenge to create a direct, timely, and comfortable crossing which serves the Iron Cove Creek corridor well, while also meeting other future needs. Therefore, this Masterplan recommends that a grade separated crossing of Parramatta Road should also be given serious consideration. Three potential options to provide a grade separated crossing at Parramatta Road are:

1. **An underpass** under Parramatta Road. The dimensions of the channel at Parramatta Road are approximately 8.5m wide by 3.3m high. A key constraint for passing under the existing road bridge is the requirement for a structure to pass in front of a box culvert discharging into the channel immediately upstream of the road bridge. Any underpass structure would need to be both robust to flood flows and not exacerbate flooding. An underpass on the eastern side of the channel, with elevated structure descending from the top of the channel alongside the channel, could be explored however it needs to be recognised as a potentially timely and costly process that may not achieve the desired results.
2. **A bridge** over Parramatta Road. The bridge would need to provide a suitable clearance for heavy vehicles using Parramatta Road and hence would require a deck level of approximately 6m above the road level. As the top of bank is lower than the road level this would require a bridge which rises approximately 7m in elevation. A ramp structure at a grade of 5% grade (1 in 20) would require a length of approximately 150m on both approaches to Parramatta Road and a total bridge length of approximately 330m. An example is shown in Figure 25.
3. **A bridge with stairs and a lift on either side** suitable for pedestrian and cyclists to use (i.e. large enough for several bikes including cargo bikes). The lift and stairs avoids issues with flooding with the underpass and the long lengths of ramp required for an overpass and provides a compact footprint. A similar approach was adopted at Gadigal Reserve as part of the works for the Inner West Light Rail. However, a lift is generally not preferable for high volumes of pedestrian and bike traffic.

"A walking/cycling bridge over Parramatta Road... would be a game changer"
Community member

Figure 25: Lachlan's Line bridge over Delhi Road and the M2 in North Ryde (Image source: Tensile Design and Construct)

4.6 PARRAMATTA ROAD TO RAMSAY ROAD

Precinct 5 traverses Jegorow Reserve which provides an opportunity for a destination park along the Iron Cove Corridor.

Recreation

In Precinct 5, from the crossing of Parramatta Road, the proposed route travels through Jegorow Reserve. The route continues along the southern side of the channel for approximately 380 metres through the reserve. Within Jegorow Reserve there is an existing approximately 2 to 2.5m wide asphalt path that traverses through the park and a 30 to 40m linear corridor of open space with trees, seating, picnic tables and lighting, providing opportunities for passive recreation and rest points along the Iron Cove corridor.

Examples of park improvements and placemaking opportunities include community gardens, playgrounds, tables and seats, nature play, and exercise equipment. The scale of new elements should remain small and in keeping with the park's quiet character.

Naturalisation

There is a sufficiently wide open space corridor within Jegorow Reserve for future naturalisation of the channel. Hence, future path works should allow sufficient space between the path and the bank of the creek to allow for naturalisation works. Channel naturalisation would provide improved amenity, and more natural habitat for fauna.

In Sydney Water's proposed works downstream of Ramsay Road Sydney Water have proposed to reinstate riparian vegetation and salt marsh benches and the extents of naturalisation works vary between 10m to 15m in additional width to the current channel. Thus providing a corridor adjacent to the channel of approximately 15m in width is recommended to provide flexibility for future naturalisation works, particularly given that on the northern side of the channel there is limited open space. Furthermore the banks

Shared path - Prince Alfred Park

Night time lighting along the Johnston Creek shared path on the northern side of the channel opposite Jegorow Reserve are steep and significantly limit opportunities for naturalisation of the northern bank.

Depot relocation

There is an opportunity to extend the linear parkland all the way from Ramsay Road to Parramatta Road by relocating the existing Inner West Council depot. The depot occupies a stretch of approximately 100m immediately adjacent to the channel. If the depot could be relocated this would extend Jegorow Reserve and provide for an off-road route all the way between Parramatta Road and Ramsay Road. There may be potential to relocate the depot locally within Jegorow Reserve to provide a similar footprint to enable this strategically located section of land to be used as public open space, provide for future naturalisation and to be used as part of the Iron Cove Corridor.

Henley Marine Drive

The northern side of the canal in this precinct is within Canada Bay Council. The northern side has minimal open space between the channel bank and the kerb line of Henley Marine Drive, limiting any opportunities for an off-road path. There is potential for Henley Marine Drive to adopt filtered permeability and as a Shared Zone or Quietway restricting its use as a 'rat-run' for traffic between Parramatta Road and Ramsay Road however this needs to be accompanied by an area wide traffic assessment to identify potential impacts as a number of streets between Parramatta Road and Ramsay Road are used for 'rat-running' by motorist .

Ramsay Road crossing

At Ramsay Road it is proposed to provide an at-grade (on street) crossing providing a more direct link between Jegorow Reserve and paths proposed as part of Sydney Water's works as well as connectivity to Timbrell Park, Reg. Coady Reserve and the Bay Run. A signalised crossing with kerb extensions to reduce the road width would be preferable to replace the existing pedestrian signals located near Harrabrook Avenue. A new signalised crossing on the road bridge would require assessment of the capacity of the bridge to accommodate the necessary infrastructure and, alternatively whilst it would provide less direct access, a crossing at Wolseley Street could instead be explored along with measures to mitigate the impacts imposed by the significant through-running traffic using Wolseley Street.

Nature play

Channel naturalisation

Figure 26: Precinct plan for Parramatta Road to Ramsay Road (Precinct 5)


5.10
Install new direct crossing of Ramsay Road (investigate relocation of signalised crossing)
HARRABROOK AVENUE
RAMSAY ROAD
HENLEY MARINE DRIVE
HENLEY MARINE DRIVE
IRON COVE CREEK
JEGOROW RESERVE
MARTIN STREET
RAMSAY STREET
5.8
Iron Cove Creek gateway signage
WOLSELEY STREET
5.5
Nature play area
5.6
Park furniture, including seating, picnic tables, water bubbler/ bottle refill stations, litter bins, etc.
5.7
Exercise stations
NORTHCOTE STREET
WATTLE STREET

4.7 RAMSAY ROAD TO IRON COVE

Between Ramsay Road and Iron Cove, works proposed by others will complete the link between Iron Cove Creek and the Bay Run.

In Precinct 6, from Ramsay Road for approximately 380m downstream, Sydney Water has developed designs for channel naturalisation. Their concept design is shown in Figure 27. This has now been developed into a detailed design including the same main elements. The detailed design drawings include a 3.5m wide concrete shared path on the northern side of the channel and a 2m wide asphalt pedestrian path on the southern side of the channel.

Figure 29 shows the City of Canada Bay's draft Masterplan for Timbrell Park which includes new paths in the park as well as a connection over the canal to a walking and cycling bridge proposed by Transport for NSW over Dobroyd Parade. This Masterplan proposes that Inner West Council and Canada Bay Council provided an widened bridge over the canal at Waratah Street Haberfield.

The plan also includes other proposed improvements to enhance recreation opportunities in the park.

This plan was on public exhibition between 10 May - 20 June 2023 and is currently being finalised by the City of Canada Bay.

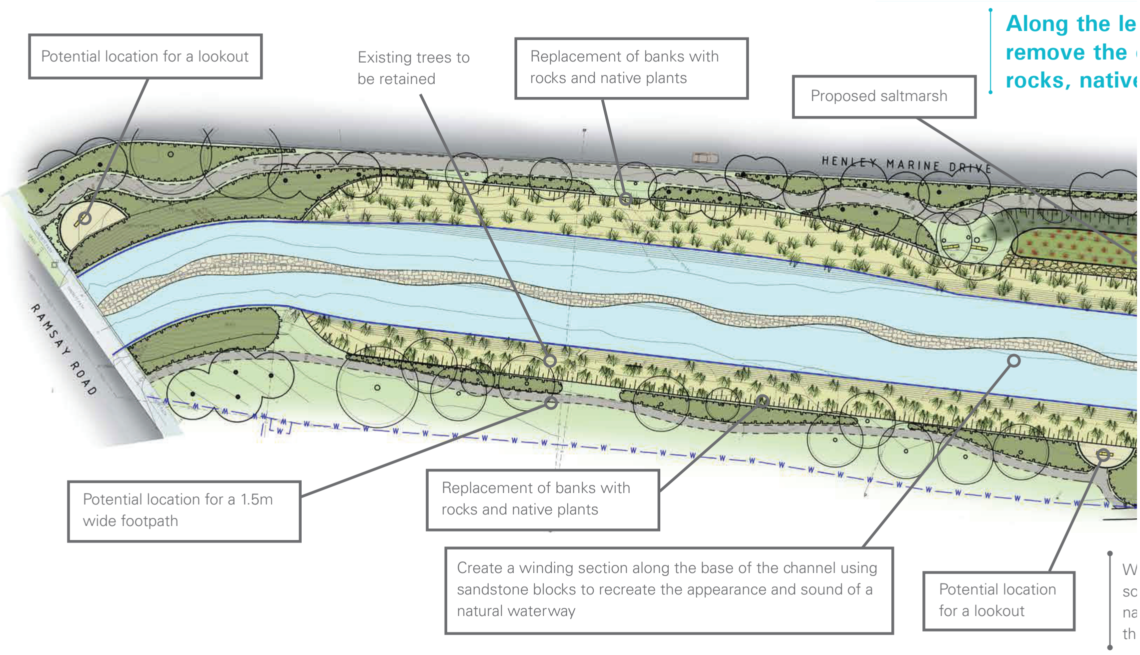
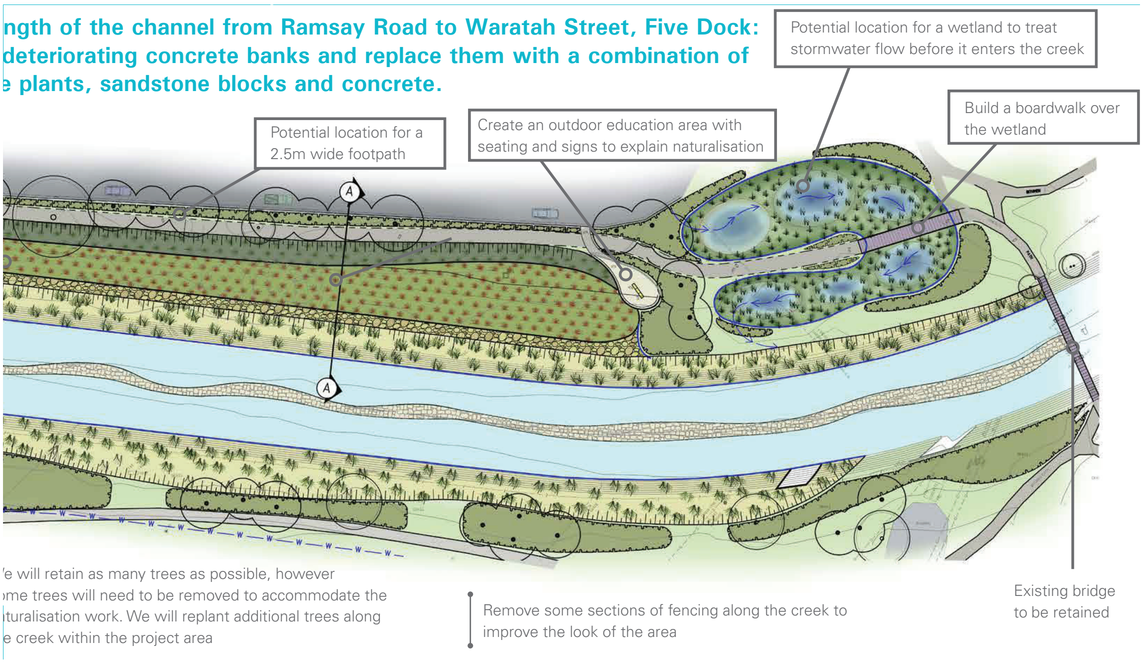


Figure 27: Sydney Water Concept Design for Iron Cove Creek naturalisation

At the downstream end of Sydney Water's works opposite Waratah Street there is an existing pedestrian bridge across the channel and a new bridge has been proposed by Transport for NSW as part of its Haberfield Ashfield and Leichhardt Local Network Improvements. Figure 28 shares the preferred option outlined in the Review of Environmental Factors (Pedestrian Bridge – across Dobroyd Parade at Waratah Street intersection) which was publicly exhibited in November 2023. The new bridge is proposed to cross over Dobroyd Parade but not the canal and this Masterplan proposes that Inner West Council and Canada Bay Council provided a widened bridge over the canal connecting with the bridge proposed by Transport for NSW.

Figure 28: New Dobroyd Parade pedestrian bridge proposed by TfNSW



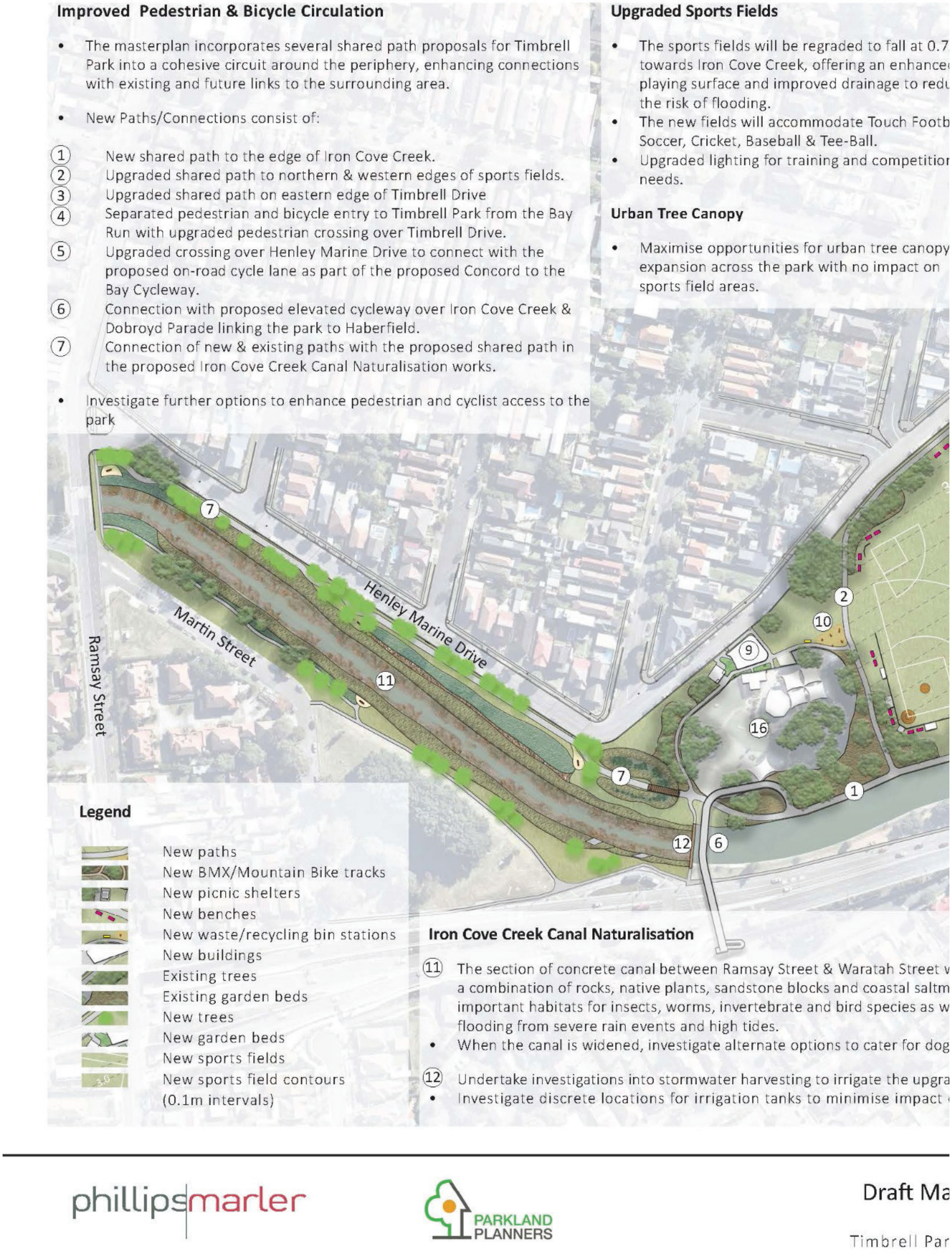


Figure 29: City of Canada Bay's draft Masterplan for Timbrell Park (as published for public exhibition, May-June 2023)


New Amenities/Storage Buildings
(8) The new amenities buildings on Henley Marine Drive will provide expanded and enhanced change rooms, public toilets, a new canteen, covered spectator areas, multiple storerooms for the various sporting organisations the use the park and a general-use community room.
(9) The 'Living Room' will replace the existing demountable Cafe adjacent to Livvi's Playspace with a permanent facility with a larger kitchen/prep space, indoor & covered outdoor seating options, additional storage rooms and an additional indoor general-use community space.
Fitness Zone
(10) Located adjacent to Livvi's Playspace, the fitness zone will offer a variety of exercise equipment suitable for all ages.
Parking Strategy
• Investigate options to increase parking capacity to mitigate the impact on local streets and residents.
Henley Marine Drive
The Bay Run
Iron Cove
Timbrell Drive
Iron Cove Creek
Dobroyd Parade
City-West Link Road
3.5
3.0
2.5
New BMX/Mountain Bike Trails
(13) The existing BMX/mountain bike path will be replaced with formalised trails with multiple circuit variations and obstacles, catering for a wide range of skill levels. Access for maintenance vehicles via new Iron Cove Creek shared Path (1).
(14) Several breakout spaces with seating and shelters will be located between the new shared path and trails.
Passive Recreation
(15) New Picnic Shelters will be positioned on the upgraded shared path beside Timbrell Drive (3). They will be set back from the road, allowing for quieter/ passive recreation activities.
Livvi's Playspace Upgrade
(16) Livvi's Playspace proposed for upgrade to meet current inclusive standards and simplify maintenance requirements.
vill be replaced with
arsh flats, providing
ell as minimising
exercise.
ded sports fields.
on views.
isterplan
k, Five Dock
Scale: 1:2500 @ A3
0 25 50 75 100m
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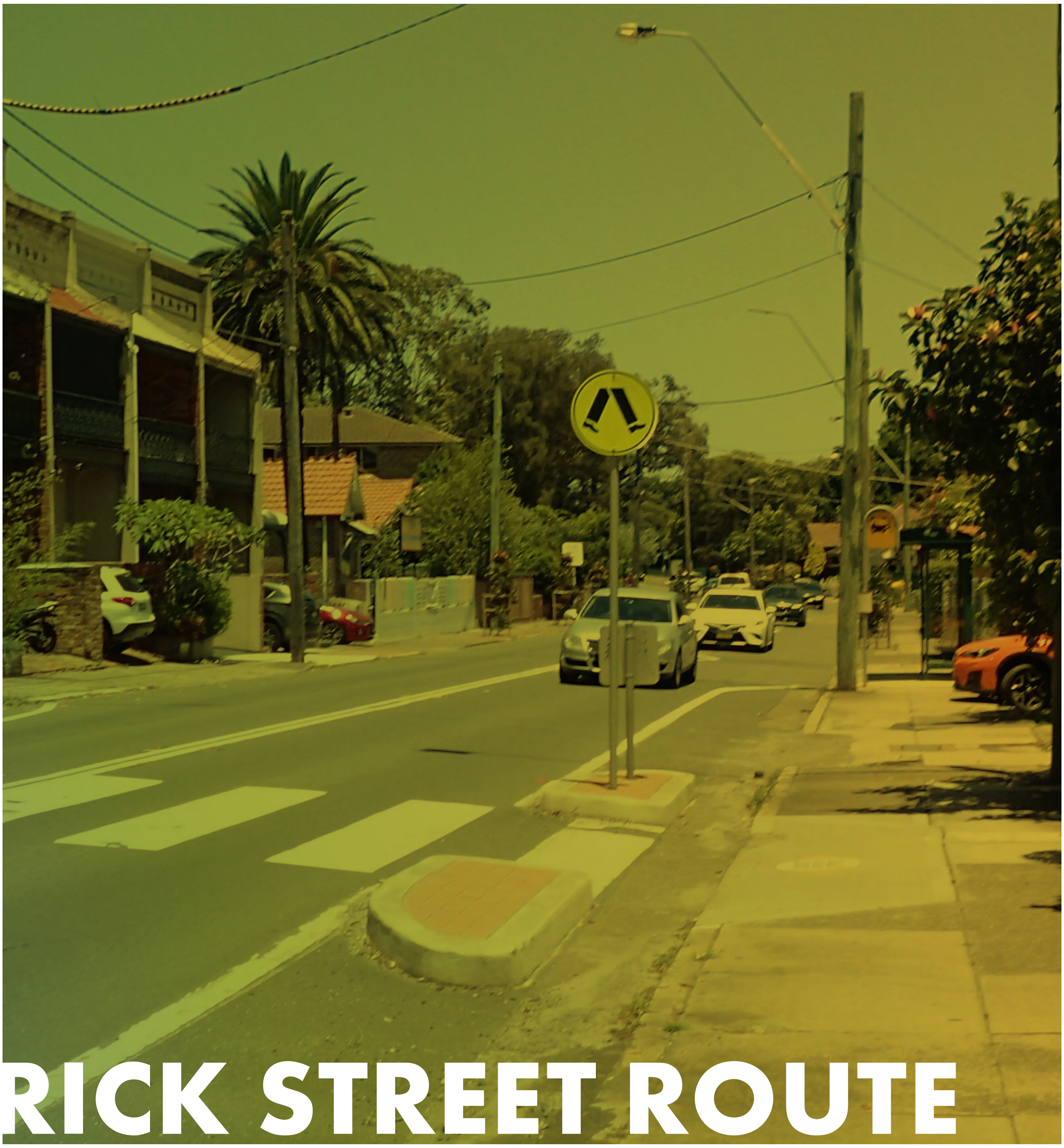
Date: 13.07.2022
Issue: Draft for Review
City of Canada Bay
P 1


05
FREDE


RICK STREET ROUTE

5.1 FREDERICK STREET ROUTE

Improvements to Frederick Street are for recommended exploration to improve walking and cycling access in a route parallel to the canal corridor.

Whilst the large majority of community respondents expressed a preference for a path adjacent to the channel, improved walking and cycling access on Frederick Street is recommended for exploration and implementation in parallel with the Iron Cove Creek corridor route. Frederick Street could provide an efficient direct route for bike riders, connecting with the Wattle Street shared path.

The NSW Government's Road User Space Allocation Policy provides a mechanism to implement changes on Frederick Street catering for people walking and cycling. The Policy applies to Classified Roads, like Frederick Street, which are controlled by the NSW Government and specifies walking, cycling and public transport as having priority on these roads.

The following sections describe how Frederick Street could be modified to provide safer cycling conditions, especially commuter riders, as a movement corridor while the canal corridor would provide a place for walking, stopping and low-speed bike riding. Indicative cross-sections are shown in Figure 30. Plans are shown in Figure 31 and Figure 32.

Thomas Street to Eccles Avenue

In Precinct 1, it is recommended to create a shared path along Frederick Street between Thomas Street and Elizabeth Street by widening the western footpath and reducing the width of the roadway.

The section between Elizabeth Street and Eccles Avenue currently includes a right turning lane for southbound vehicles turning right onto Elizabeth Street. Assuming this needs to be retained, the southbound configuration could remain unchanged while the 4.3m wide north bound lane could be narrowed to 3.2m and the footpath could be widened to a 3.5m wide shared path - see Figure 30, Section A. This would maintain the minimum desirable lane width of 3.2m for a bus route.

Eccles Avenue to Henry Street

Between Eccles Avenue and Henry Street, Frederick Street has wide traffic lanes with no kerbside parking. Frederick Street is typically 15m wide, consisting of 2 x 2.4m wide footpaths and 2 traffic lanes 5.1m in width. Lighting poles, power poles, trees and bus stops are placed within the 2.4m wide footpath narrowing the footpath to 1.2m.

There is potential to narrow the traffic lanes to 3.6m wide, providing space for a 2.6m separated bicycle path. This is illustrated in Figure 30, Section B.

Note that in this section of Frederick Street, in-lane bus stops would require consideration and site-specific design including the following factors as specified by Transport for NSW:

- Average daily traffic volumes
- Route service frequency and passenger loading times
- Street parking demand (not applicable on Frederick Street)
- Footpath obstructions such as overhanging trees that prevent buses from manoeuvring close to the kerb (limited applicability at Frederick Street)

In this part of the street, the option to widen the footpath and provide a shared path has been explored but this would result in unsafe situations where the pathway narrows and approximately 20 street trees would need to be removed.

Henry Street to Parramatta Road

Between Henry Street and Parramatta Road, the number of traffic lanes expands from 2 to 7 and space in the roadway becomes more contested. In this section, to connect with the existing Wattle Street shared path (on the eastern side of Wattle Street), it would also make sense for people cycling on Frederick Street to cross over to the eastern side of the street.

Therefore, options were investigated on either side of the street. The option recommended in Figure 32 is a shared path on the eastern side of the street between Henry Street and Parramatta Road.

Other considerations in Frederick Street

Safer driving speed limits and safer crossings for pedestrians need to be key considerations in this residential street.

In April 2022 Inner West Council asked for overdue pedestrian safety upgrades to Frederick Street following the death of a man earlier in the year. In May 2023, a new speed limit of 50km/h was installed on Frederick Street reducing the speed limit from 60km/h.

The WestConnex Local Area Improvement Strategy prepared by Council in 2018 identifies previous pedestrian crashes on Frederick Street and outlines traffic filters to mitigate the impact of the WestConnex motorways, including in John Street. Traffic filters in John Street at Frederick Street outlined in the WestConnex Local Area Improvement Strategy are recommended for implementation.

Section A

Section B

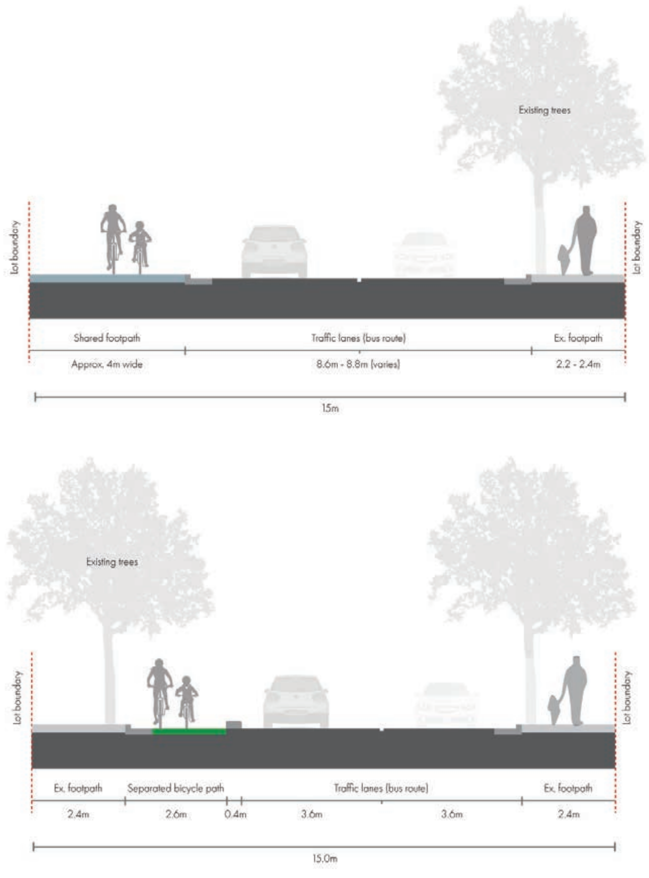
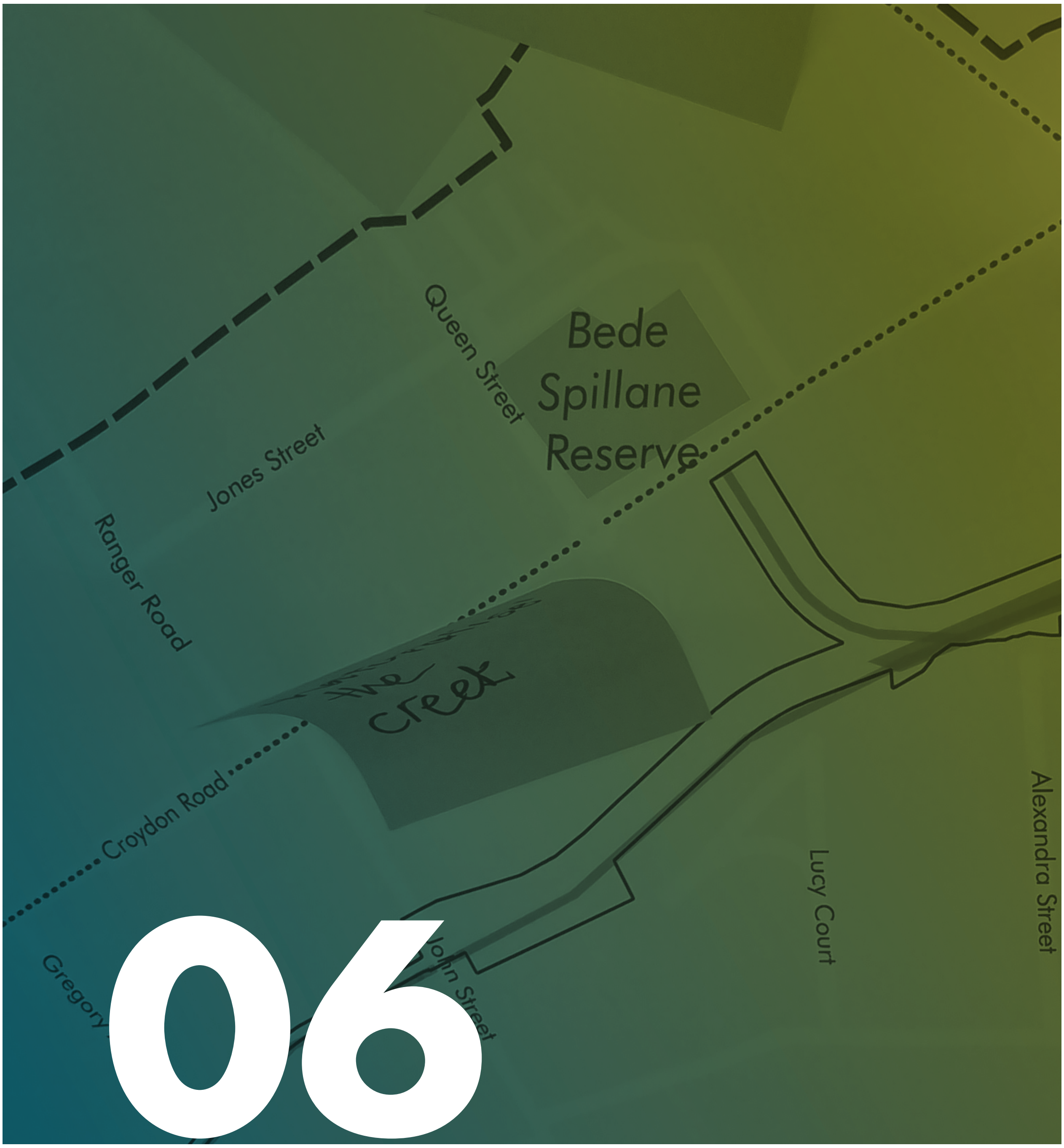
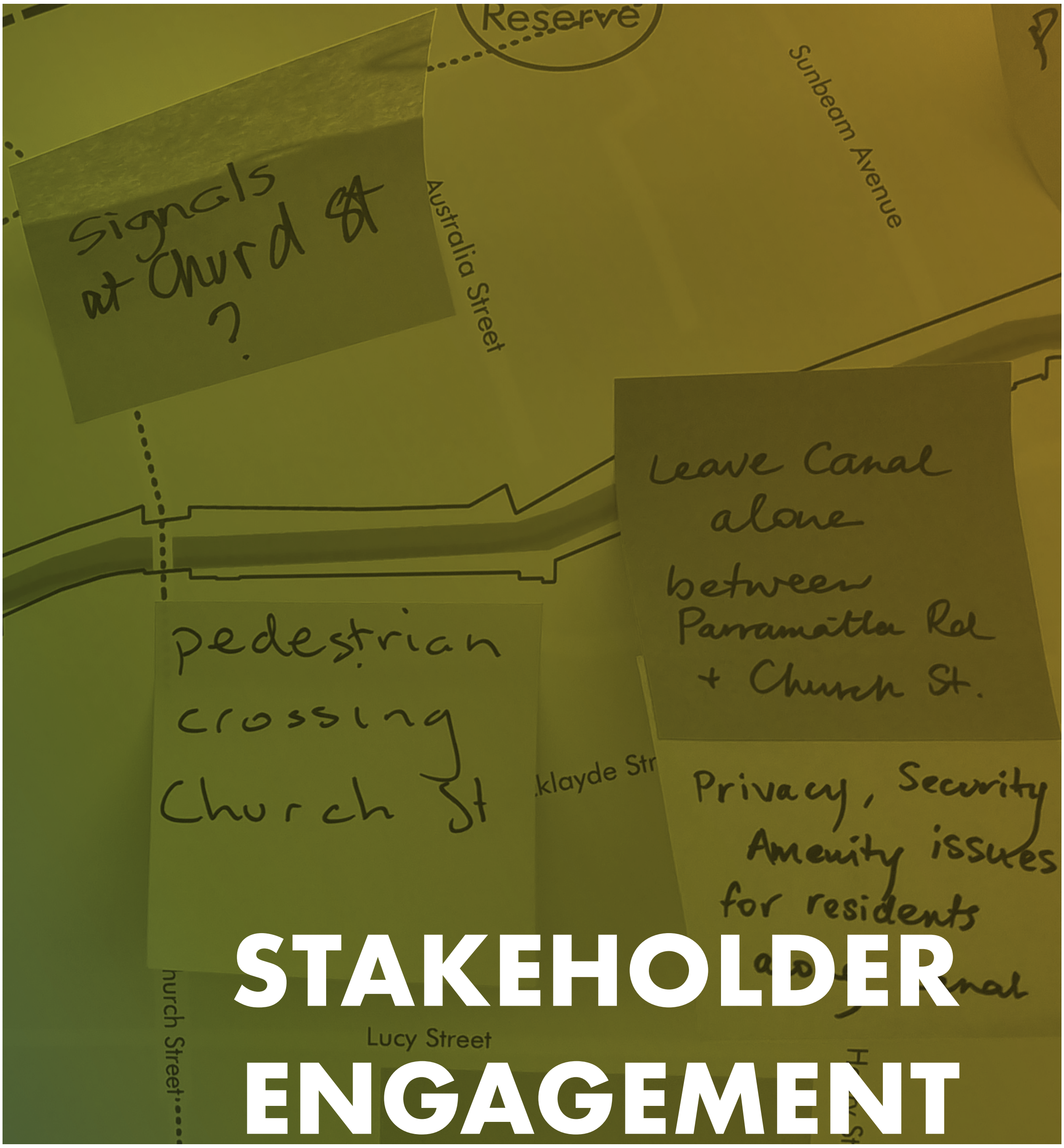


Figure 30: Indicative proposed sections - Frederick Street

Figure 31: Proposed Precinct Plan for Frederick Street Route (Elizabeth Street to John Street)

Figure 32: Proposed Precinct Plan for Frederick Street Route (John Street to Parramatta Road)


Bede
Spillane
Reserve
Queen Street
Jones Street
Ranger Road
the Creek
Croydon Road
Gregory
John Street
Lucy Court
Alexandra Street
06



STAKEHOLDER ENGAGEMENT

6.1 COMMUNITY ENGAGEMENT

The Friends of Iron Cove Creek have played an important role in shaping the vision, and the local community has continued to be engaged throughout the development of this Masterplan.

Friends of Iron Cove Creek

The Friends of Iron Cove Creek formed in May 2020 after the idea for a walking and cycling route was listed in Inner West Council's 20 year Integrated Transport Plan. The Friends group distributed 6,000 flyers and released a survey in January 2021, revealing strong interest in the project within the local community. By July 2022 they had received over 1,100 responses to their survey, revealing:

- Overwhelming support (98%) for a dedicated walking and cycling path
- Strong resistance to walking and cycling at Croydon Road and Frederick Street due to traffic.
- Strong support for connecting the Bay Run to Ashfield and Croydon centres.
- Strong support in favour of revitalising the stormwater channel

When Council began to prepare this Masterplan, the project team met representatives of the Friends of Iron Cove Creek on site, to walk key sections of the corridor together and for the project team to hear from the Friends' representatives about:

- Issues and concerns for people walking and cycling navigating the local streets.
- Their vision for the corridor.
- Ideas and opportunities they saw for the Masterplan.

Broader community

Inner West Council conducted community engagement between 24 October and 27 November 2022. This included:

- Letter boxing approximately 2,000 properties in the project area
- An online survey on Your Say Inner West, including 8 questions and a map for site-specific comments
- An on-site session in a local park, Bell Reserve.

236 comments were submitted via the online survey, 175 comments were made on the map, 11 emails were received by project staff and approximately 50 people attended the on site session.

Responses indicated:

- 95 percent of respondents support the idea of a walking and cycling path along the canal linking the Bay Ran and Ashfield Aquatic Centre.
- 81 percent of respondents identified a preference for a path along the canal rather than on-street facilities.
- The Bay Run and Ashfield Aquatic Centre would be popular destinations, followed by Five Dock (location of a future Metro station) and Croydon shops/station and Ashfield shops/station (Figure 33).
- Popular activities would include dog walking, walking and cycling with children, relaxing in green space and picnic/BBQ-ing (Figure 34).
- Important issues to manage in the project's development would include lighting for safety at night, managing walking and cycling conflicts as well as litter and waste (Figure 35).

The draft Masterplan was publicly exhibited in November 2023. In addition to strong community support for the Masterplan a number of concerns were raised by local community members about potential impacts of any further work. Additionally Sydney Water identified a number of issues for consideration associated with its asset. Comments received from the community and key stakeholders have been incorporated into the final Masterplan accordingly. The Engagement Outcomes Report on Council's Your Say Inner West website outlines all comments received and Council's response.

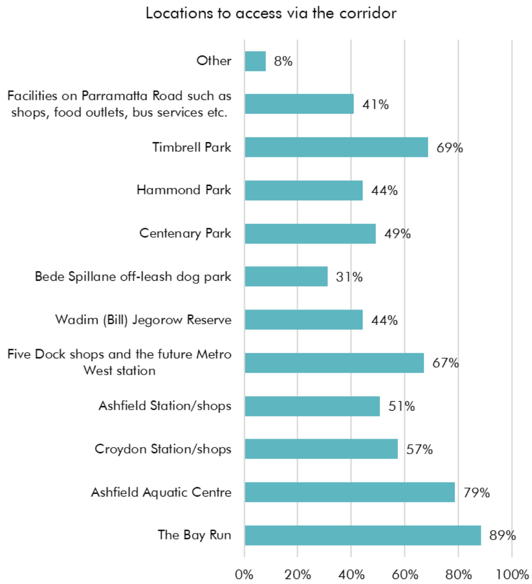


Figure 33: Locations respondents would access using a potential path along the canal

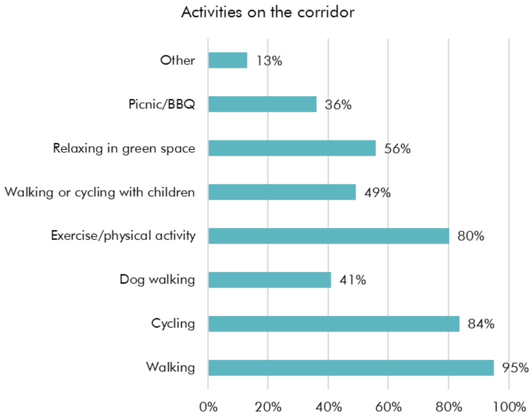


Figure 34: Activities respondents would do on a potential path and public space

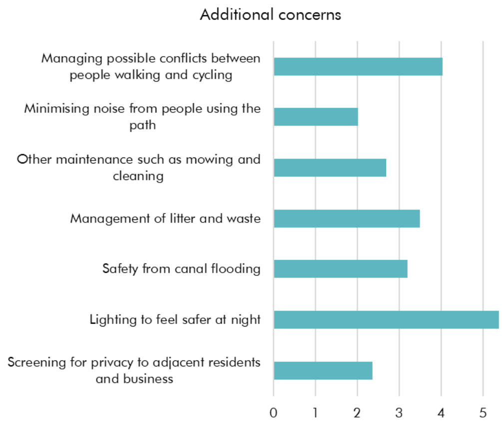


Figure 35: Other concerns to be consider with preparation of the Masterplan

6.2 STAKEHOLDER ENGAGEMENT

As part of developing this Masterplan, Council has conducted initial consultation with key stakeholders including relevant NSW Government agencies, the City of Canada Bay and teams within Inner West Council.

NSW Government agencies

Engagement was conducted with NSW Government agencies that own and/or control land along the channel, including public roads.

Transport for NSW is responsible for Parramatta Road and Frederick Street. Along Frederick Street there is a historical easement for road widening from the County of Cumberland Planning Scheme developed in the 1940s. Transport for NSW also has long standing ownership of open space adjacent to Jegorow Reserve.

Council met with Transport for NSW and it was explained that with the WestConnex motorway network soon to be opened there would be a period of review to determine the impacts on traffic volumes in surrounding streets before the requirements of roads such as Frederick Street can be assessed. Comments from Transport for NSW about the open space adjacent to Jegorow Reserve were unable to be obtained.

Sydney Water owns the Iron Cove Creek stormwater channel and the land on which this channel sits, including some land on either side of the channel. Sydney Water also owns underground infrastructure within the corridor including water supply and wastewater services such as a water main on the western side of the channel between Etonville Parade and West Street.

Council met with Sydney Water to understand its requirements and approval processes for works within its land and in proximity to its assets. Sydney Water explained that access for maintenance of its assets, including routine maintenance, emergency repairs and future renewal works is a key requirement on which any proposal for works would be assessed.

Local Government agencies

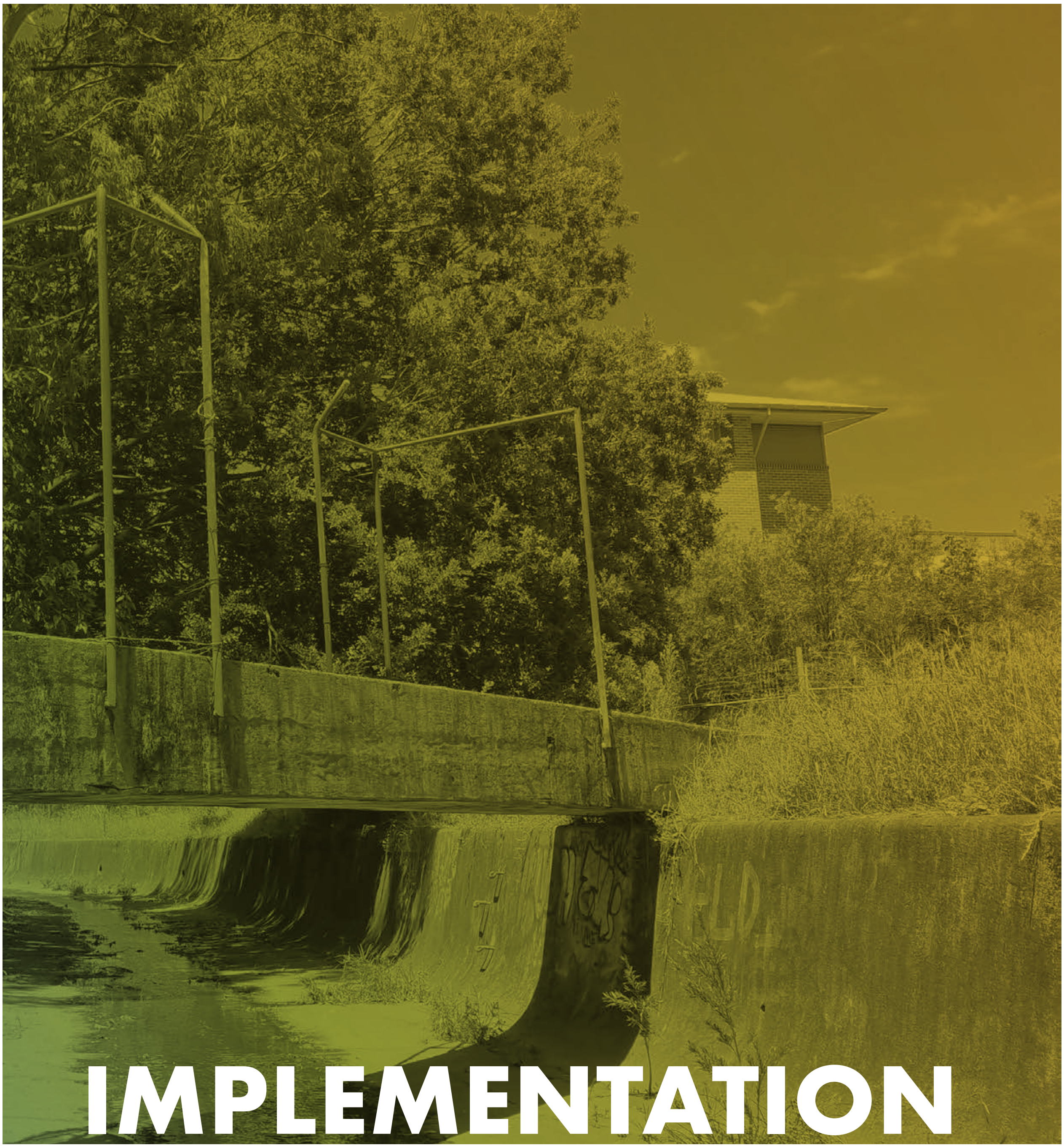
Engagement with staff from the City of Canada Bay and Inner West Council focussed on assets and issues owned or controlled by councils such as parks, trees, local roads and local stormwater management.

Iron Cove canal is fed by stormwater infrastructure owned and managed by local government authorities. Staff from Inner West Council's stormwater team provided information about stormwater flow and known flooding issues and Council's coordinator of public trees stated the importance of retaining established trees. Staff from Inner West Council's traffic team provided insights about traffic and car parking on local roads as well as the positioning of a potential traffic filter in Etonville Parade to reduce parking impacts. A meeting with staff from the City of Canada Bay's parks and traffic teams provided information about Henley Marine Drive between Parramatta Road and Ramsay Road and planning issues for Timbrell Park.

Figure 36: Publicly owned land along the Iron Cove Creek corridor

Publicly owned land   Parks   Channel


07



IMPLEMENTATION

7.1 IMPLEMENTING THE MASTERPLAN

The initiatives in the Masterplan would need to be implemented in a series of stages because of various factors such as land ownership, community consultation and deliverability.

Overview of prioritisation

Due to the various complexities of the different precincts and the funding requirements for implementation, an initial prioritisation of works has been undertaken. This prioritisation is preliminary only as other opportunities may arise over time such as future capital works by Inner West Council or other government agencies or future re-development along the channel.

Works proposed in this Masterplan are not currently funded. Many of the proposed works would require external funding beyond Inner West Council such as the Metropolitan Greenspace Program, Get NSW Active funding program or the Urban Rivers and Catchments Program.

As part of any future works, further community engagement will be undertaken to inform the design, understand the local opportunities and constraints and minimise impacts on local residents and business owners.

Prioritisation criteria

Prioritisation of works has been undertaken based on the following criteria:

– Land under Council control and ownership
– Other publicly owned land
– Contribution to a connected network
– Overall contribution to placemaking and open space
– Ease of implementation and construction
– Stakeholder approval timeframes
– Construction costs

Works on Council owned land

The following works could be implemented by Inner West Council without significant investigation and approval processes involving other government agencies such as Sydney Water and Transport for NSW.

Precinct 1:

– Filtered permeability in Etonville Parade providing access for people walking and cycling.
– A street park in Etonville Parade providing a local place and increased green space.
– Street landscaping in Etonville Parade such as understorey planting beneath the existing brushbox trees.
– Narrowing of a road lane and widening of the footpath in Elizabeth Street between Frederick Street and Etonville Parade to provide a Shared Path with landscaping and improved tree canopy.
– Modification to the existing pedestrian crossing on Elizabeth Street to include a bicycle crossing and, conversion of the Elizabeth Street footpaths to Shared Paths.

Precinct 4:

Provide walking access in John Pope Reserve on the eastern side of the canal between Church Street and Parramatta Road including a walking path (at-grade wherever possible) with appropriate materials, access to the Parramatta Road and Church Street footpaths, additional planting and appropriate safety fencing to meet Sydney Water requirements.

Precinct 5:

Upgraded shared path through Jegorow Reserve to increase width and overall quality of path.

- Provide a widened and improved path through Jegorow Reserve.
- Extend the existing path in Jegorow Reserve through Council's depot site, adjacent to the canal and connecting with the Parramatta Road footpath.
- Provide facilities in Jegorow Reserve to create a place for people such as park furniture, a children's playground and exercise equipment
- Provide a direct pedestrian and bicycle crossing of Ramsay Road linking the Jegorow Reserve path with canal naturalisation works proposed by Sydney Water in Reg Coady Reserve and Timbrell Park

Longer term works on land owned or controlled by other authorities

The following outlines possible longer term works which could be led by Inner West Council but involve impacts on other land or asset owners and would therefore require significant stakeholder engagement during design development.

Precinct 3:

- Facilitate access to the corridor between John Street and Church Street including investigation of an underpass at Church Street and installation of an at grade (on street) crossing of John Street.
- Facilitate access to Croydon Road with a bridge crossing at the tributary canal and ramp access to Croydon Road and the installation of a pedestrian and bike crossing on Croydon Road connecting with Bede Spillane Reserve.
- Associated landscaping of the canal corridor and asset protection works as required by Sydney Water and other asset owners.

Precinct 4:

Landscaped shared path along the western side of corridor between Church Street and Parramatta Road with a bridge crossing of the canal to access John Pope Reserve as well as asset protection works as required by Sydney Water and other asset owners.

Significant works requiring extensive investigations

The works listed below require significant investigation due to the technical complexity of the suggested works and the need for other agencies to support their implementation.

- Elevated boardwalk structure located over the canal between Etonville Parade and John Street
- An improved at-grade crossing of Parramatta Road or a grade-separated crossing
- Widened Shared Path on Frederick Street between Thomas Street or Heighway Avenue and Elizabeth Street
- Separated bike path and footpath on Frederick Street between Eccles Avenue and Henry Street and a Shared Path between Henry Street to Parramatta Road.

7.2 PRELIMINARY COST ESTIMATE

A high level cost estimate per precinct has been prepared for the various items discussed in this Masterplan.

Costs for each precinct are summarised in the table below. The following pages include more detail.

Note that the total costs exclude the following:

- Improved crossing of Parramatta Road (due to uncertainty regarding its future design).
- Works downstream of Ramsay Road, which are proposed by others as described in Section 4.7.

Cost estimate summary

Precinct	Estimated Cost
1. Heighway Avenue to Elizabeth Street	$ 688,090
2. Elizabeth Street to John Street	$ 3,936,363
3. John Street to Church Street	$ 2,274,704
4. Church Street to Parramatta Road	$ 6,414,288
5. Parramatta Road to Ramsay Road	$ 1,639,750
6. Ramsay Road to Iron Cove	-
7. Frederick Street route (Elizabeth Street to Parramatta Road)	$ 1,939,717
Total	**$ 18,109,606**

1 Heighway Avenue to Elizabeth Street

Item	Description	Quantity	Unit	Rate	Cost
1.1	Narrow the traffic lanes on Frederick Street between Thomas Street and Elizabeth Street and adjust the position of the centreline	260	No.	$200	$52,000
1.2	Widen the footpath to provide a new 3.5-4.0m wide shared path along Frederick Street between Thomas Street and Elizabeth Street	260	Lm	$600	$156,000
1.3	Improve the crossing at Heighway Avenue. Investigate potential for raised threshold treatment giving priority to people walking and cycling	1	No.	$40,000	$40,000
1.4	In the underpass under the Main Western railway line, reduce lane widths to 3.5m	1	No.	$20,000	$20,000
1.5	In the underpass, expand the western side footpath to 3.5m. Provide an Elsholz kerb as a barrier instead of replacing the existing barrier	40	Lm	$700	$28,000
1.6	Narrow Elizabeth Street lane widths to make room for shared path	108	Lm	$100	$10,800
1.7	Widen footpath to 3.5m for a new shared path on Elizabeth Street	108	Lm	$400	$43,200
1.8	Modify the existing pedestrian crossing to a shared pedestrian and bike crossing	1	No.	$25,000	$25,000
1.9	New street trees along Elizabeth Street including cutouts, soil and planting	10	No.	$2,000	$20,000
	Subtotal				**$395,000**
	Allowance for design and approval fees (12%)			12%	$47,400
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$86,900
	Subtotal				**$529,300**
	Contingency (30%)			30%	$158,790
	Total				**$688,090**

2 Elizabeth Street to John Street

Item	Description	Quantity	Unit	Rate	Cost
2.1	New pocket park creating filtered traffic permeability (excluding vehicles, allowing walking and cycling access) between Etonville Parade and Elizabeth Street	1	No.	$100,000	$100,000
2.2	Resurface Etonville Parade with coloured asphalt, include pavement markings and traffic signage to create a Quietway	384	Lm	$750	$288,000
2.3	Landscaping and native grass understorey planting under the existing Brushbox trees alongside the channel including topsoil and mulch	1152	m2	$65	$74,880
2.3A	Allow for disposal of existing concrete and subbase	288	m3	$350	$100,800
2.4	Include threshold treatments (e.g. raised threshold with pavers/stamped asphalt) at each intersection on Etonville Parade (Anthony Street, Banks Street, Hunt Street).	3	No.	$40,000	$120,000
2.5	Street tree planting to western side of Etonville Parade to improve pedestrian amenity including cutouts, soil and planting	18	No.	$2,000	$36,000
2.6	Elevated boardwalk structure located over the narrow section of Iron Cove Creek between Etonville Parade and John Street, assume 2.5m wide	200	Lm	$7,500	$1,500,000
2.7	Include connections to Gregory Avenue and Hedger Avenue	2	No.	$20,000	$40,000
	Subtotal				$2,259,680
	Allowance for design and approval fees (12%)			12%	$271,162
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$497,130
	Subtotal				$3,027,971
	Contingency (30%)			30%	$908,391
	Total				$3,936,363

3 John Street to Church Street

Item	Description	Quantity	Unit	Rate	Cost
3.1	At grade pedestrian and bike crossing at John Street	1	No.	$40,000	$40,000
3.2	Traffic calming/filtered traffic access device on John Street	1	No.	$30,000	$30,000
3.3	At-grade shared path on western side of the channel (assume 3m wide), allowing for concrete path, subbase and all jointing	300	Lm	$450	$135,000
3.3A	Allow for disposal of spoil for at grade path	270	m3	$350	$94,500
3.4	Pedestrian and cycle bridge over the tributary channel, assume 3m wide	10	Lm	$7,500	$75,000
3.5	Elevated structure with shared path to connect up to Croydon Road, assume 3m wide	50	Lm	$7,500	$375,000
3.6	New at grade of crossing at Croydon Road	1	No	$40,000	$40,000
3.7	Underpass under Church Street including allowance for excavation, walls, protection of services. Assumes no service relocation required	1	No.	$150,000	$150,000
3.7A	Allow for disposal of spoil (assume GSW)	135	cum	$350	$47,250
3.8	Iron Cove Creek gateway signage and wayfinding (at each end and throughout the link where required)	2	No.	$30,000	$60,000
3.9	New seating along tributary	2	No.	$7,500	$15,000
3.10	New drinking fountain / water refill station including connection for water	1	No.	$30,000	$30,000
3.11	Landscaping and native grass understorey planting alongside the channel including allowance for top soil and mulch and 12 month establishment	2370	m2	$65	$154,050
3.12	Fencing along edges of channel to Sydney Water standards	400	Lm	$150	$60,000
	Subtotal				**$1,305,800**
	Allowance for design and approval fees (12%)			12%	$156,696
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$287,276
	Subtotal				**$1,749,772**
	Contingency (30%)			30%	$524,932
	Total				**$2,274,704**

4 Church Street to Parramatta Road

Item	Description	Quantity	Unit	Rate	Cost
4.1	Elevated shared path on western side of the channel, assumed 3m wide	280	Lm	$7,500	$2,100,000
4.2	Pedestrian and cycle bridge to cross over the channel	15	Lm	$7,500	$112,500
4.3	Elevated shared path located on the eastern side of the channel	140	Lm	$7,500	$1,050,000
4.4	Parramatta Road crossing (design TBC) - cost excluded from this estimate*				
4.5	New footpath on eastern side of channel (assumes 1.8m wide)	280	Lm.	$270	$75,600
4.5A	Allow for disposal of spoil (assumes GSW)	126	m3	$350	$44,100
4.6	New fences along channel edges to Sydney Water standards	700	Lm.	$150	$105,000
4.7	Landscaping and native grass understorey planting alongside the channel including allowance for top soil and mulch and 12 month establishment	2076	m2	$65	$134,940
4.8	Iron Cove Creek gateway signage and wayfinding (at each end and throughout the link where required)	2	No.	$30,000	$60,000
	Subtotal				**$3,682,140**
	Allowance for design and approval fees (12%)			12%	$441,857
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$810,071
	Subtotal				**$4,934,068**
	Contingency (30%)			30%	$1,480,220
	Total				**$6,414,288**

* Costs for the Parramatta Road crossing have been excluded from this estimate, as its design is highly uncertain at this stage. A grade-separated crossing would be tens of millions, however an improved at-grade crossing would only become feasible in the context of other major changes to the road.

5 Parramatta Road to Ramsay Road

Item	Description	Quantity	Unit	Rate	Cost
5.1	New on-grade shared path on southern side of the channel assumes 3m wide, allow for concrete, subbase and jointing	180	Lm	$450	$81,000
5.2	Upgrade the existing path assumes 3m wide, allow for concrete, subbase and jointing	320	Lm	$450	$144,000
5.2A	Allow for disposal of spoil for path works	125	cum	$350	$43,750
5.3	Expand parklands in existing depot location (remove depot, regrading, earthworks, provide plant growing media, lawn, trees, mass planting etc.)	3540	m2	$150	$531,000
5.4	Allow space for future channel naturalisation - cost excluded				
5.5	Allowance for nature play area including all equipment, paths, soft fall and furniture	1	No.	$400,000	$400,000
5.6	Allowance for park furniture including seating, picnic tables, water bubbler/bottle refill stations, litter bins	1	No.	$100,000	$100,000
5.7	Allowance for exercise stations	1	No.	$80,000	$80,000
5.8	Iron Cove Creek gateway signage and wayfinding (at each end and throughout the link where required)	2	No.	$30,000	$60,000
5.9	Install new direct crossing of Ramsay Road (investigate relocation of signalised crossing)	1	No.	$50,000	$50,000
	Subtotal				$1,639,750
	Allowance for design and approval fees (12%)			12%	$196,770
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$360,745
	Subtotal				$2,197,265
	Contingency (30%)			30%	$659,180
	Total				$2,856,445

6 Ramsay Road to Iron Cove

Item	Description	Cost
6.1	Upgrade and widen existing pedestrian/cycling bridge at Waratah Street	To be determined via more detailed assessment and competitive processes

Downstream of Ramsay Road, the works proposed to complete the walking and cycling link along the Iron Cove corridor are to be carried out by others including:

- Sydney Water's channel naturalisation project between Ramsay Road and Waratah Street.
- The City of Canada Bay's proposed improvements to Timbrell Park.
- Transport for NSW's proposed works including the new bridge proposed at Waratah Street.

7 Frederick Street route (Elizabeth Street to Parramatta Road)

Item	Description	Quantity	Unit	Rate	Cost
7.1	Narrow northbound lane to 3.2 m	70	Lm	$200	$14,000
7.2	Provide 3.5m wide shared path	70	Lm	$500	$35,000
7.3	Narrow traffic lanes from 5.1m to 3.6m (between Eccles Avenue and Henry Street)	900	Lm	$200	$180,000
7.4	Provide a separated 2.6m wide bicycle path including 0.4m wide barrier	900	Lm	$500	$450,000
7.5	Special treatment at bus stops including sections of shared path behind bus stop	4	No.	$8,000	$32,000
7.6	Improve provision for people walking and cycling across each intersection (John Street, Hedger Avenue and MacKay Street)	3	No.	$40,000	$120,000
7.7	Upgrade pedestrian signals at Church Street to include bike lanterns	1	No.	$30,000	$30,000
7.8	Upgrade pedestrian crossing to a shared pedestrian and bike crossing	1	No.	$25,000	$25,000
7.9	Improve provision for people walking and cycling across Henry Street	1	No.	$40,000	$40,000
7.10	Narrow southbound lane to 3.2 m	100	Lm	$200	$20,000
7.11	Provide a 3.5 m shared path	190	Lm	$500	$95,000
7.12	Upgrade pedestrian signals to include bike lanterns	1	No.	$30,000	$30,000
7.13	Provide 3.5 m wide shared path connecting to existing Wattle Street shared path	25	Lm	$500	$12,500
7.14	Provide wayfinding signage (at each end and throughout the link where required)	1	No.	$30,000	$30,000
	Subtotal				$1,113,500
	Allowance for design and approval fees (12%)			12%	$133,620
	Allowance for: - Preliminaries (6%) - Completion & post-completion (2%) - Escalation allowance (4%) - Builders margin (10%)			22%	$244,970
	Subtotal				$1,492,090
	Contingency (30%)			30%	$447,627
	Total				$1,939,717


Civille

Draft Iron Cove Creek Masterplan

Public Exhibition November-December 2023

Engagement Outcomes Report

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Summary

From 27 October to 8 December 2023, the community was invited to provide feedback on the draft Iron Cove Creek Masterplan.

During the engagement period, 1,938 people visited the Your Say Inner West page. 225 people completed the online survey, 35 people provided feedback by phone or email and three letters were received from key stakeholders.

93% of the online respondents and 60% of the email submissions supported the draft masterplan.

Key comments received include the following:

- Overall support for safer walking and cycling access in the area
- Concerns about impacts such as water management and flooding, privacy, lighting, construction impacts and tree loss
- Support for increased trees and green space
- More detail requested about any street park in Etonville Parade, Croydon including car parking impacts
- Concerns about existing rat-running in Wolseley Street, Haberfield and the potential impacts of the masterplan on this issue.

Project background

Following advocacy by members of the local community, in April 2021 Council resolved to prepare the Iron Cove Creek Masterplan to explore the provision of a walking and cycling path along Iron Cove Creek canal between Ashfield Aquatic Centre and the Bay Run.

The Masterplan supports strategic directions in Inner West Council's Community Strategic Plan (CSP) and Local Strategic Planning Statement (LSPS), and builds on the NSW Government's strategic plans for a growing city outlined in the following documents:

- Greater Sydney Region Plan—A Metropolis of Three Cities (2018)
- Eastern City District Plan (2018)
- Future Transport Strategy 2056
- Sydney Green Grid (2017).

In November 2022 as the draft masterplan was prepared, Council undertook community engagement asking for community input to inform the masterplan. The draft masterplan incorporated this community feedback wherever possible. The draft masterplan was presented to Council at its meeting on 12 September 2023 seeking endorsement for public exhibition. The public exhibition allowed the community to view the draft masterplan and provide feedback.

The draft masterplan divides the corridor between Heighway Avenue, Ashfield and Timbrell Park, Haberfield into six precincts each with different characteristics and opportunities. In Precinct 6, between Ramsay Road and Iron Cove, the canal follows the boundary between Inner West and Canada Bay Councils and work is proposed by Sydney Water to naturalise the canal with improvements proposed in both council areas.

The draft masterplans outlines opportunities to explore the following:

- Make it safer and easier to walk and cycle in the local area
- Improve connections to local parks and recreational facilities
- Unlock access to the Iron Cove Creek corridor
- Make it easier to cross Parramatta Road
- Provide more trees and habitat

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Promotion and engagement methods

Promotion method	Stakeholders engaged
Project page on Your Say Inner West	- 1,938 people viewed the YSIW page - Page was visited 3,038 times - Documents were downloaded 817 times
Emails sent	- 537 registered members on the Your Say Inner West platform - 116 people who provided feedback during the initial engagement
Council's social media	Facebook posts: -7,978 people reached - 81 likes - 3 shares Instagram posts: - 5,683 people reached - 138 likes - 7 shares
Letter	2500 copies distributed to nearby residences

Engagement method	Stakeholders engaged
Online survey	225 surveys completed.
Direct contact with staff by phone and email	- Emails and/or phone calls from 35 individuals - 3 letters from key stakeholders

Who did we hear from?

Council gathers basic demographic information as part of the participant registration process online at Your Say Inner West. We use this information to understand who has responded and whether we need to engage further on the proposal.

Gender

48% of respondents were female, 44% were male and 9% preferred not to say or identified with a different term.

Age

People aged between 20 years and over 85 years made contributions on Your Say Inner West, with the majority of respondents aged being between 30 and 54 years of age. The largest proportion of contributors were aged between 35 and 44 years and 50 and 54 years.

Location

Contributions were received from people throughout the Inner West including Dulwich Hill, Leichhardt, Summer Hill, Enmore and Petersham. The largest proportions of participants lived in Croydon (29%) and Ashfield (24%).

Summary of feedback

Online survey on Your Say Inner West

We asked	You said
Do you support the draft Master Plan?	93% said yes 5% said no 2% said unsure

Participants were asked to provide either general comments about the overall draft masterplan or comments about specific precincts. The comments received have been reviewed by Council staff and the broad themes of comments are outlined below. Verbatim comments can be found in the appendix.

General comments about the masterplan

You said	Council response
Support for more trees and vegetation	Noted. This is an objective of the masterplan.
Concerns about flooding impacts	The masterplan represents one initial step in a possible future process and any further work would involve flood modelling to test possible options as well as intensive involvement of Sydney Water.
Support for protecting existing natural habitat	Noted. Existing habitat would be protected as much as possible while also aiming to provide increased habitat. Increased trees and habitat are an objective of the masterplan.
Call for safer and more convenient walking and cycling access in the area	Noted. This is an objective of the masterplan.
Overall support for the masterplan and implementation as soon as possible	Noted.
Concerns from surrounding residents about safety, security, and car parking impacts	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the potential impacts. Designs would be publicly

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	exhibited and revised as necessary following input from the local community.
Requests to extend a path to Cooks River	The masterplan aims to connect the Bay Run and Ashfield Aquatic Centre. The implementation of links identified in the masterplan is recommended before any further studies are initiated for additional links. The NSW Government's Sydney Green Grid recognises this corridor may eventually connect with Cooks River however this will be subject to separate investigation.

Precinct 1 - Heighway Avenue to Elizabeth Street

You said	Council response
Frederick Street path under the rail bridge needs to be improved for people walking and cycling	The masterplan outlines narrowing of the road lanes to provide a wider footpath on Frederick Street with a kerb type (such as Elsholz kerb) providing an effective traffic barrier without taking up space on the path.
Elizabeth Street needs less car traffic, and better thought for people walking and riding bikes	This has been referred to Council's Traffic Team for consideration. The masterplan includes Elizabeth Street around the Aquatic Centre and outlines more space at the Frederick Street intersection with reconfiguration of the road between Frederick Street and Etonville Parade to create wider paths linking with the existing pedestrian crossing. It also outlines upgrading the existing pedestrian crossing near the Aquatic Centre to provide a shared pedestrian and bike crossing. x
The intersection of Frederick Street and Elizabeth Street are busy with pedestrians and need to be made safer and better	The masterplan outlines more space at the Elizabeth Street and Frederick Street intersection and reconfiguration of the

	road in Elizabeth Street creating wider paths so people can better access the Aquatic Centre.
Frederick Street is dangerous and unpleasant for walking	Section 4.8 of the draft masterplan outlines improved walking and cycling access along Frederick Street for exploration and implementation. This would be considered in addition to a path along the canal and is consistent with the NSW Government's policies which prioritise walking and cycling on roads controlled by the NSW Government.
The path should continue along the canal beside Ashfield swimming pool and under the railway line to Liverpool Road with a crossing of Liverpool Road	Potential significant flood risk means a path along the canal within the existing structures under the rail line could not be considered. Whilst the creation of a wider path under the rail line could be considered, it would be a significant engineering and financial undertaking and, for now the masterplan outlines improved path access on Frederick Street.

Precent 2 – Elizabeth Street to John Street

You said	Council response
Concerns about car parking impacts from a pocket park in Etonville Parade	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the impacts such as car parking. Designs would be publicly exhibited and revised as necessary following input from the local community.
Support for more tree planting	Noted. Increased tree canopy and habitat is an objective of the masterplan.
Support for pocket park Etonville Parade as a traffic filter	Noted.

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Support for a boardwalk over the canal between Hunt Street and John St	A boardwalk over the canal is outlined in the masterplan because the community has expressed a clear preference for a path within the canal corridor however, there are a number of significant barriers and engineering challenges to be solved prior to commitment being made to a boardwalk over the canal as outlined in Section 4.3 of the draft masterplan.

Precinct 3 - John Street to Church Street

You said	Council response
Support for filtered traffic access on John St	Noted.
Concern about flooding of underpass at Church St	The masterplan represents one initial step in a possible future process and any further work would involve flood modelling to test possible options as well as intensive involvement of Sydney Water.
Support for traffic filter and/or crossing on John St	Noted.

Precinct 4 - Church Street to Parramatta Road

You said	Council response
Support for better crossing of Parramatta Road and improving the intersection of Parramatta Road and Great North Road for walking cycling	Noted.
Protect the vegetation and bird sanctuary along the canal. The trees and wildlife should not be compromised by an elevated path.	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the potential impacts. Existing habitat would be

	protected as much as possible while also aiming to provide increased habitat.
Concerns about the privacy, safety and security impacts of people living along the canal	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the potential impacts. Designs would be publicly exhibited and revised as necessary following input from the local community.
Even light rain causes run-off from surrounding streets becoming a series of small waterfalls over the canal wall	The masterplan represents one initial step in a possible future process and any further work would involve flood modelling to test possible options as well as intensive involvement of Sydney Water.
Opposition to use of a lift at a Parramatta Rd crossing	The masterplan represents one initial step in a possible future process and any further work would involve design exploration to consider possible crossings of Parramatta Rd.

Precinct 5 - Parramatta Road to Ramsay Rd

You said	Council response
Support for canal naturalisation	Noted.
Support for nature play and water play, exercise stations, picnic tables and native plantings.	Noted.
Support for direct crossing of Ramsay Road	Noted.
Concerns the peace and tranquillity of Bill Jegerow Reserve would be diminished	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the potential impacts. Designs would be publicly exhibited and revised as necessary following input from the local community.
Concerns that a quietway/bike boulevard in Henley Marine Drive would worsen	Council's Traffic Team is aware of these concerns and the comments received

existing rat running on other streets between Parramatta Road and Ramsay Road	have been referred to the relevant members of the traffic team. Changes will be made to the masterplan requiring an area wide traffic assessment ahead of any considerations for Henley Marine Drive between Parramatta Rd and Ramsay Rd. However, it should be noted that a route in Jegorow Reserve is the proposed route as stated in Section 4.6.
The existing path in Jegorow Reserve should be upgraded to a separated bicycle and walking path	Noted. The masterplan represents one initial step in a possible future process and any further work would involve design development. The types and details of infrastructure would be considered in any subsequent design stages.

Precinct 6 – Ramsay Rd to Iron Cove

You said	Council response
Support for naturalisation works proposed by Sydney Water	Noted.
The footpath on Wattle Street at the canal is scary and small for an electric cargo bike carrying children. It is terrifying to use and needs to be moved towards Iron Cove Creek.	Works proposed by Sydney Water will provide an alternative path. Council has engaged extensively with TfNSW about works to reinstate the area following use by WestConnex trucks and with the proposed overhead bridge. Council has repeatedly requested improved and safer access for people walking and cycling.
Opposition to shared path in Reg Coady Reserve. Walking and cycling should be separated.	Noted.
Additional trees should be installed alongside Dobroyd Parade to act as a sound screen	This has been referred to Council's Public Trees team for consideration.

The footpath surrounding Timbrell Park is needs to be widened	Timbrell Park is located in the Canada Bay Council area and this has been referred to Canada Bay Council for consideration.
A proper bridge is required across Iron Cove Creek between Reg Coady and Timbrell Park.	The draft masterplan will be amended to include an upgraded bridge over the canal between Reg Coady Reserve and Timbrell Park. Canada Bay Council's draft masterplan for Timbrell Park identifies this connection and Council would need to work with Canada Bay Council and Sydney Water for any proposal to upgrade the bridge.

Phone, emails and letters

Direct contact with staff by phone and email was made by 38 people including three letters received from key stakeholders. 21 direct contacts expressed support for the masterplan, 8 direct contacts expressed clear opposition while 9 direct contacts requested further information about specific sections or raised other issues affecting the immediate area. The broad themes of comments are outlined below.

You said	Council response
More detail is needed on a street park in Etonville Parade Croydon including the potential for people to stay in the area, traffic impacts and car parking impacts	The masterplan represents one initial step in a possible future process and any further work would involve design development to explore options and refine the details. Designs would be publicly exhibited and revised as necessary following input from the local community.
Stormwater and flood water impacts	The masterplan represents one initial step in a possible future process and any further work would involve flood modelling to test possible options as well as intensive involvement of Sydney Water.
Concerns about security and lighting impacts for people living alongside the canal	The masterplan represents one initial step in a possible future process and any further work would involve design development to mitigate the potential

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	impacts. Designs would be publicly exhibited and revised as necessary following input from the local community.
Rat running by drivers in Wolseley Street Haberfield	Council's Traffic Team is aware of these concerns and the comments received have been referred to the relevant members of the Traffic Team. Changes will be made to the masterplan requiring an area wide traffic assessment ahead of any considerations for Henley Marine Drive between Parramatta Road and Ramsay Road. However, it should be noted that a route in Jegorow Reserve is the proposed route as stated in Section 4.6.
The canal is a Sydney Water asset and the masterplan fails to mention Sydney Water's involvement in the project.	Part 5.2 of the masterplan discusses involvement of Sydney Water. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations.

Letters from key stakeholders

Letters were received from 3 key stakeholder. Key messages are summarised below and the letters are shown in the appendix.

You said	Council response
Sydney Water	
While Sydney Water aspires to naturalise its open stormwater channels, canal naturalisation is subject to a variety of assessments. Naturalisation would generally not be viable from Etonville Parade to West Street due to the existing watermain and potential flood impacts.	Noted. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations. The masterplan builds on the NSW Government's work to identify strategic opportunities for creating the Sydney

	Green Grid. The *Sydney Green Grid* (2017) recognises that historically asset management has been separated for purposes of efficiency and ease of operations by asset owners. The *Sydney Green Grid* and the masterplan provide opportunities for state and local government agencies to work together by building new capabilities and exploring different approaches to support a growing city and increase resilience.
Sydney Water is generally not supportive of elevated pathways atop of channels.	Noted. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations.
An in-channel crossing beneath Parramatta Road does not seem viable.	Noted. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations.
There are significant obstacles for constructing a path atop the water main between John Street and West Street.	Noted. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations.
Providing public access to Sydney Water's land from John Street to Parramatta Road would need safety fencing.	Noted. Section 6.1 of the draft masterplan recognises safety fencing. Sydney Water would be significantly involved in any further considerations.
17 specific comments or corrections were provided	Noted. The suggested changes will be considered for incorporation in the final masterplan wherever possible. The masterplan represents one initial step in a possible future process and Sydney Water would be significantly involved in any further considerations.
Friends of Iron Cove Creek	

Approximately 600 community comments received by the Friends of Iron Cove Creek demonstrate support for a safe walking-cycling route along the canal	Noted.
Comments received also expressed concern about: • Urban heat and insufficient shade • Unsafe walking and cycling conditions • The lack of safe crossings of Parramatta Road • Wait times of signalised intersections • Noise of fast-moving cars on arterial streets • Narrow and dangerous walking environment under the rail line on Frederick St	Noted. Such items will be considered as more detailed designs are progressed.
With exhibition of the draft masterplan in November 2023 5,000 flyers were distributed and 6 stalls were held to notify residents about the opportunity to provide feedback.	Noted.
The Friends of Iron Cove Creek endorses the draft master plan and makes the following points: • A path along the canal is strongly preferred over Frederick St • An underpass crossing of Parramatta Rd is preferred followed by an overpass with ramps. An overpass with lifts is not acceptable. • Once adopted the masterplan should be implemented as soon as possible	Noted. The masterplan represents one initial step in a possible future process and significant further work is required to explore possible infrastructure options.
Bicycle NSW (BNSW)	
BNSW supports the ambitions of the masterplan and does not have major issues or objections.	Noted.
BNSW does not consider an at-grade crossing of Parramatta Road to be	Noted.

unfeasible. An at-grade crossing would be the fairest solution.	
BNSW supports development of links along the canal and on Frederick St.	Noted.
The masterplan needs to better align with the TfNSW proposal for a bridge over Dobroyd Parade near Waratah Street, Haberfield.	The masterplan incorporates canal naturalisation works proposed by Sydney Water between Ramsay Rd and Timbrell Park. The masterplan will be amended to ensure it aligns with the TfNSW proposal, Sydney Water plans and Canada Bay Council's draft Plan of Management and Masterplan for Timbrell Park, publicly exhibited in June 2023 which identifies a connection from Timbrell Park to the bridge proposed by TfNSW.
The existing walking/cycling bridge over the canal at Waratah Street should be upgraded and this should be integrated into the TfNSW project for a bridge over Dobroyd Pde.	The masterplan incorporates canal naturalisation works proposed by Sydney Water between Ramsay Rd and Timbrell Park. The masterplan will be amended to ensure it aligns with the TfNSW proposal, Sydney Water plans and Canada Bay Council's draft Plan of Management and Masterplan for Timbrell Park, publicly exhibited in June 2023 which identifies a connection from Timbrell Park to the bridge proposed by TfNSW.

Next steps

Where appropriate and feasible, feedback will be incorporated into the draft masterplan to form the final version of the masterplan. This final version of the masterplan is scheduled to go to Council for endorsement at its meeting in April 2024.

People who participated in the engagement will be notified of the meeting details and informed about how they can speak at the meeting if they wish.

Draft Final FRMS&P Report

Alexandra Canal Flood Risk Management Study and Plan

304600163

Prepared for
Inner West Council

6 February 2024

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Document Information

Prepared for	Inner West Council
Project Name	Alexandra Canal Flood Risk Management Study and Plan
File Reference	304600163 R004 Alexandra Canal FRMS&P Draft Final.docx
Job Reference	304600163
Date	6 February 2024
Version Number	V1

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Effective Date 6/02/2024

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Date Approved 6/02/2024

Document History

Version	Effective Date	Description of Revision	Prepared by	Reviewed by
R001	21/05/2021	Stage 1 Draft Report	MG	SC
R002	7/07/2023	Interim Stage 4 Report	AP	MG
R003	23/12/2023	Draft FRMSP	AP, AC, & HR	MG
R004	6/02/2024	Draft Final FRMS&P	AP, AC, HR & MG	TWG (NSW DCCEW & IWC)

Foreword

The primary objective of the NSW Flood Prone Land Policy 2021 is to reduce the impact of flooding and flood liability on communities and individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

The previous policy formed part of the New South Wales (NSW) Floodplain Development Manual (FDM) in 2005. Recently, two changes have occurred in flood risk management in NSW:

> The 2021 Flood Prone Land Package Update was released in July 2021. The Flood Prone Land package included a new planning direction, planning circular, guideline, standard flood-related Local Environment Plan (LEP) instruments, and several planning legislation changes.

> The finalised and gazetted Flood Risk Management (FRM) Manual was adopted on 30 June 2023. The Manual replaces the FDM 2005 and a number of previous technical guides. The manual provides advice to local councils on the management of flood risk in their local government areas through the flood risk management framework and flood risk management process. This update builds on the 2005 manual and guides. It considers lessons learnt from floods and the application of the flood risk management process and manual since 2005. It considers a range of work on managing natural hazards across government, including relevant national and international frameworks, strategies and best practice guidance. Accompanying the manual is eight FRM Guidelines that comprise a new toolkit to provide guidance for local councils and their consultants.

Under the 2021 policy, councils are primarily responsible for managing flood risk to reduce the risk to life, property damage and other impacts in their local government areas. The State Government subsidises flood management measures to alleviate existing flooding problems and provides specialist technical advice to assist councils in the discharge of their flood risk management responsibilities. The Commonwealth Government also assists with the subsidy of floodplain modification measures. The new policy identifies the following flood risk management 'process' for the identification and management of flood risks:

1. Data Collection - Aims to gather the information needed to support the study being undertaken.
2. Flood Study - Aims to define flood behaviour in sufficient detail to support the understanding and management of flood risk.
3. *Flood Risk Management Study (FRMS) - Provides the basis for examining and recommending FRM measures to manage risks to the existing and growing community, people and built environment. The measures aim to limit the residual flood risk to the community and how this may change over time.*
4. *Flood Risk Management Plan (FRMP) - Builds on the recommendations of the FRM study by clearly outlining council's decision on how it intends to effectively manage flood risk in the study area.*

This Alexandra Canal Flood Risk Management Study and Plan falls within steps 3 and 4 in the FRM process and has been developed from the previous Flood Study, completed in 2017. An illustration of the FRM process from the FRM Manual is shown below. Beyond the FRM process, councils must also implement, review and update the studies.

Executive Summary

Stantec Australia Pty Ltd (formerly Cardno) was commissioned by Inner West Council ('Council', or IWC) to undertake a Flood Risk Management Study and Plan (FRMS&P) for the Alexandra Canal Study Area. The Study Area is focused around the part of the Alexandra Canal catchment that is contained within the former Marrickville Council LGA, and extends from Gardeners Road crossing of the Canal upstream, to the confluence with the Cooks River downstream.

Community Consultation

Consultation with the community and stakeholders is an important component in the development of a Flood Risk Management Study and Plan. Consultation provides an opportunity to collect feedback and observations from the community on problem areas and potential flood risk management measures. It also provides a mechanism to inform the community about the current study and flood risk within the Study Area and seeks to improve their awareness and readiness for dealing with flooding.

The consultation strategy has been divided into three key sections:

> Consultation in FRMS&P development: This occurs during the initial stages of the project **1.4**and involves both informing the community and stakeholders of the project and gathering information on existing flooding issues and suggestions for flood risk management options.

> Review of possible flood management options with key stakeholder groups including Council Engineers, Council Planners, NSW SES, NSW DCCEW and community representatives within Council's Flood Risk Management Advisory Committee.

> Public exhibition of Draft FRMS&P: This occurs in the final stage of the project, with comments sought from the community and stakeholders on the Draft FRMS&P report with this input reviewed and incorporated into the final FRMS&P.

Information regarding the projects was advertised on Councils website on the Have Your Say portal. For Alexandra Canal, 414 unique visitors engaged with the public consultation materials online, with three attendees at in-person drop in sessions and one online submission.

Impact of Flooding

The number of flood affected properties for five design events are summarised in the below table. Two forms of property tagging analysis have been considered – tagging of properties with any flood affectation , and tagging of properties where the flood extent covers at least 10% of the property area, as was applied under the Alexandra Canal Flood Study.

A review of the number of properties affected between the "10% affectation" and the "any affectation" scenarios, and the relative flood hazard affecting these properties, it was considered that the 10% affectation scenario sufficiently addressed the flood risk, requiring no updates to the flood affected lot tagging currently adopted by Council.

Property Tagging	Base Case Flood Affected Property				
	20% AEP	5% AEP	2% AEP	1% AEP	PMF
Flood Affected	134	167	180	188	303
>10% Area Affectation	36	42	51	56	147
				Total Properties in Catchment	1023

In the PMF event using the 10% property area approach, there are a total of 147 flood affected properties, or 14.4% of the total 1,023 properties in the study area. In the 1% AEP the total number of affected properties is 56, or 5.5% of all properties.

With respect to economic impacts of flooding in the study area, the Average Annual Damages (AAD) and damage totals for five design flood events is summarised in the following table. The AAD for Alexandra Canal Catchment is over $6.3 million. More than half (56%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing a further 26% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 2 – 9% of AAD contribution. Though these events result in far higher flood damage totals, particularly the PMF event, their relatively low likelihood means they contribute less to the AAD.

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$8,852,340	**$3,558,226**	56%
5%	0.05	$12,955,774	**$1,642,015**	26%
2%	0.02	$14,167,888	**$406,855**	6%
1%	0.01	$16,101,295	**$151,625**	2%
PMF	0.0000001	$98,917,671	**$574,520**	9%
		Total AAD	**$6,333,241**	

Flood Emergency Response Review

Due to the short duration of both the critical storm affecting the catchment and the time to peak flood depth, there is limited opportunity to stand up an emergency management centre and begin directed evacuation of residents prior to the onset of flooding. Based on a detailed review of flood emergency response provisions and the flash flooding nature of the study area, it is unlikely, almost impossible, that SES doorknocked evacuation will be able to effectively evacuate residents prior to flooding. From this review, potential measures have been identified that could improve flood emergency response potential for the study area:

> Improved flood awareness – Limited knowledge of an individual's potential risk from flooding and the associated lack of planning can cause significant delays to community evacuation due to both acceptance and lag time. A comprehensive flood awareness program for the Study Area, educating residents of the seriousness of the flood risk and the flash flooding nature of the catchment could improve the flood risk to the community.

> Alternative flood warning systems - There are noted difficulties of flood warning systems in flash flooding environments. As forecasting and modelling technology improves, options may be considered for the development of flood warning systems for the Study Area, particularly in the emergency management hotspot areas.

> Self-managed evacuation - Where SES assisted evacuation is not an option, self-managed evacuation is a potential alternative. This describes where people make their own decision to evacuate earlier and move to alternate accommodation, using their own transport. These plans would typically be prepared using information available from Council and with support of the local SES unit, using SES templates such as FloodSafe. The advantage of this approach would be that people can evacuate more quickly than SES assisted evacuation, and as a result reduces the strain on SES and does not rely on a centralised evacuation order. However, self-managed evacuation can also pose a risk if not conducted in an appropriate way. Residents could place themselves at higher risk for example if they evacuate to a location which is even more flood affected, drive through flood waters, or could increase traffic congestion if the wrong route is selected.

Flood Planning Review

The outcomes of the flood planning review were as follows:

> Compared to the requirements for planning proposals outlined within the 2021 Flood Prone Land Policy Update, the current development controls are generally in agreement.

> Compared to the Flood Planning Constraints Categories (FPCC) approach from the 2023 Flood Risk Management (FRM) Manual Guide FB01, current Flood Risk Precincts of the Development Control Plan (DCP) are generally aligned however potentially adopting FPCC offers some potential benefits. These benefits include splitting the current High-risk precinct into FPCC1 and FPCC2 where development can be precluded in FPCC1 and more tailored controls can be applied to FPCC2 areas.

> Compared to the requirements for Flood Impact Risk Assessment (FIRA) from the 2023 FRM Manual Guide LU01. Generally, the current development controls are in agreement with the proposed requirements in the guide with some exceptions:

- The current controls do not require consideration of climate change in assessments.
- The current controls do not specify flood impacts be considered not just for flood levels but also duration, velocity, evacuation, flood function or hazard categorisation.

- The current controls do not specifically require a consideration of residual risk of proposed developments to confirm if flood risk is lower than existing based on proposed risk management measures for developments.

Ultimately the current development controls are considered suitable, and generally in accordance with recent guidance both within the 2021 Flood Prone Land Policy Update and the 2023 FRM Manual Guide LU01. However, there are some minor alterations listed in the bullet points above that may improve an applicant's understanding of the controls and provide a more comprehensive assessment of flood risk in future development submissions.

Flood Risk Management Options Background

Three main types of Flood Risk Management (FRM) options were considered:

> Flood modification measures – Flood modification measures are options aimed at preventing / avoiding or reducing the likelihood of flood risks. These options reduce the risk through modification of the flood behaviour in the catchment.

> Property modification measures – Property modification measures are focused on preventing / avoiding and reducing consequences of flood risks. Rather than necessarily modify the flood behaviour, these options aim to modify properties (both existing and future) so that there is a reduction in flood risk.

> Emergency response modification measures – Emergency response modification measures aim to reduce the consequences of flood risks. These measures generally aim to modify the behaviour of people during a flood event.

The assessment of FRM options should consider inputs from people in the community, the economy, social and cultural aspects, services to the community and the natural environment. Relating to the development of FRM options, the following stages were applied in this project:

> Option identification and preliminary option assessment and optimisation – The identification of an inclusive range of FRM options to address local or broad FRM issues for the existing community and new development. Having identified the FRM issues to address and an inclusive range of FRM options worthy of consideration, the viability of these options was discussed with Council, the Committee and other stakeholders in several workshops to determine if they warranted more detailed assessment.

> Detailed option assessment – Detailed assessment and subsequent optimisation of FRM options and packages of options needs to consider their costs, benefits and disbenefits in managing risk. The detailed assessment included flood modelling of options, damages assessment of option benefits, preliminary costing and a Multi-Criteria Assessment (MCA) that considers a broad range of factors quantitatively or qualitatively.

> Recommendation in FRM studies and decision-making in FRM plans

Detailed Assessment of Options

Following the preliminary option assessment, nine options were selected for detailed assessment, with the final options listed in the table below.

Option Type	Option ID/Name
Flood Modification (FM)	AC4 – Station Street, Tempe Drainage Upgrade
	AC6 – Bay Street, Tempe Drainage Upgrade
	AC11 – Princes Highway, St Peters Drainage Upgrade
	AC14 – Talbot Street, Sydenham Drainage Upgrade
Property Modification (PM)	PM6 – Targeted Stormwater Maintenance
Emergency Management Modification (EM)	EM2 – Review of Local Flood Planning and Information Transfer to NSW SES
	EM3 – Community Flood Awareness
	EM5 – Flood Markers and Signage
	EM6 – Flood Data and Debrief

The detailed assessment of these 9 FRM options was conducted including:

> Hydraulic modelling of five design events – 20%, 5%, 2%, 1% AEP and PMF (for FM options),

- Flood damages benefits assessment (for FM options) involving adopting water level impact results compared to the existing flood damages to determine the potential benefits of the option in the 5 modelled events. The AAD of damage benefits were calculated and the Net Present Worth (NPW) of benefits for all options were calculated assuming a 5% discount rate and 30 year life cycle for the option.
- Cost estimation was conducted for all options for both capital and ongoing / maintenance costs. The process for capital cost estimation was based on quantities for construction estimated from preliminary design for the 4 FM options as they were modelled in the TUFLOW model. Unit rates were initially estimated by Stantec and reviewed and updated by Council staff in some instances to match current cost rates for the local area. A 50% contingency has been applied to all estimates given uncertainty on eventual design refinement and quantities. For other measures (EM and PM), costs were estimated only on the basis of cost to implement, and were done for the purpose of comparison in the multi-criteria assessment. The total cost of the options was calculated for Net Present Worth using a 5% discount rate and an implementation period of 30 years.
- Benefit Cost Ratio - The economic evaluation of each option was performed by considering the reduction in the amount of flood damages incurred for the design events and then comparing this value with the cost of implementing the option. The benefit-cost ratio provides an insight into how the damage savings from a measure relate to its cost of construction and maintenance. Where the benefit-cost ratio is greater than one (BCR >1) the economic benefits are greater than the cost of implementing the measure. For all FM options it is possible to quantify, at least at a high-level, both damage benefits and costs of implementation for each option, therefore a BCR is able to be calculated. For PM and EM options, the damage benefits are not easily quantifiable, though there would be some economic benefits of these options in the form of reduced risk to life and resultant reduction in flood damage for loss of life. Therefore in lieu of any damage benefit information, the economic analysis of these options has assumed that BCR is 1.0. The Benefit Cost Ration outcomes for all detailed options have been summarised in the table below.

Option	NPW of AAD Reduction Benefits	NPW of Cost of Implementation of Option	Benefit Cost Ratio
AC4 – Station Street Drainage Upgrade	$291,418	$1,065,173	0.27
AC6 – Bay Street Drainage Upgrade	$925,163	$1,122,555	0.82
AC11 – Princes Highway Drainage Upgrade**	$69,216	$828,821	0.08
AC14 – Talbot Street Drainage Upgrade	$1,731,887	$1,970,291	0.88
PM6 – Targeted Stormwater Maintenance	*	$2,334,873	1.0*
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES		$137,794	1.0*
EM3 – Community Flood Awareness		$751,761	1.0*
EM5 – Flood Markers and Signage		$265,294	1.0*
EM6 – Flood Data and Debrief		$275,587	1.0*

*In lieu of benefit values for EM options, due to flood risk reduction BCR value assumed to be 1.0

**AC11 has potential flood damage benefits for buildings outside of the study area, therefore this damage benefit may be an underestimate.

The BCR results show that of FM options, AC6 and AC14 both have BCR values slightly under 1.0, therefore the costs only slightly exceed the calculated benefits. For AC11, the potential benefits of this option for private properties on the west side of Princes Highway have not been quantified and considered in damages assessment. Therefore, it is likely that the BCR score for that option is an underestimate.

Option PM6 is for the targeted increased maintenance of the stormwater network. Inner West Council, in accordance with its responsibility as owner of the majority of the drainage assets within the study area, has a significant maintenance schedule already in place for all of its stormwater assets. This includes timely responses to community requests or notes relating to any drainage blockage or damage. Option PM6 involves potential additional targeted maintenance of greater frequency than is currently applied at key locations. The potential benefits of the PM6 option for targeted stormwater maintenance was assessed using modelling assuming no blockage of pipes. This is a best-case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes. Therefore, due to this uncertainty, the modelling outcomes in the form of damage benefits were not applied to the BCR outcome for this option PM6.

Multi-Criteria Assessment

To assist Council in identifying the FRM options that provide the most benefits for the society, environment and economy all options need to be compared against each other based on factors relevant to the study area. Evaluating what constitutes an appropriate strategy for floodplain management is a significant analytical and policy challenge. Such challenges have led to the exploration of alternative policy analysis tools, one being Multi Criteria Assessments (MCA). The goal of MCA is to attempt to directly incorporate multiple values held by community and stakeholders into the analysis of management alternatives while avoiding the reduction of those values into a standard monetary unit. In doing so, one can consider different FRM options in the context of economic criteria as well as other criteria such as social, or environmental aspects. Community and stakeholders can also assign explicit weights to those values to reflect their preferences and priorities. Therefore, MCA provides opportunities for the direct participation of community and stakeholders in the analysis.

An MCA approach has been used for the comparative assessment of all options identified. Each option is given a score according to how well the option meets specific considerations. In order to keep the scoring system simple, a framework has been developed for each criterion.

The selection of criteria and weighting has been completed by involving the technical working group (TWG). A scoring system with 11 criteria (five economic, four social and two environmental) was established for each criterion with scores ranging from +2 for options that represented a significant improvement on existing conditions for any given criteria, to -2 for options that represented a significant worsening of existing conditions. It is noted that for two criteria (Benefit-Cost Ratio and Reduction in Risk to Property or damage) scoring systems was based on quantifiable assessment outcomes, for all other criteria scoring was more qualitative although supported by sound judgement.

The highest scoring options were all emergency management modification options (EM) due to their relatively minor cost involvement and ease of implementation. In the top half of ranked options, three of the four were EM options.

Option AC6 Bay Street drainage upgrade was the highest scoring FM option due to this being an area of noted frequent flooding (even during king tide events), its relative ease in terms of feasibility and complexity for relatively greater benefits compared to other FM options.

The lowest scoring options were AC14 Talbot Street drainage upgrade which was marginally lower due to its complexity, and AC4 Station Street drainage upgrade which was much lower due to low relative benefits and BCR.

Implementation Plan

The list of recommended management options has been transformed into an implementation plan provided in the table below. It lists the following information relevant to the implementation of each adopted FRM option:

> Type and sub-catchment location of option and MCA score;

> The priority for implementation (high, medium, or low) and rank as an outcome of the FRMS&P;

> An estimate of implementation costs including capital and ongoing costs per annum;

> Potential funding mechanism or organisation; and

> Required economic assessment level during Investigation and Design (I&D) stage.

The flood risk management options identified in the table below represent a capital cost of approximately $5.3M, with the flood modification options making up $4.9M of this cost. High priority options have combined capital costs of $1.33M.

It is noted that the implementation plan does not outline a specific timeframe for each project. Rather, the implementation plan provides a body of projects to inform future advocacy, budgeting, and planning in order that Council may be able to undertake works in a prioritised manner as funding becomes available, or other opportunities arise in a specific location associated with a proposed option.

Option ID	Option Type	MCA Weighted Score	Option Rank	Implementation Priority	Capital Costs (incl. GST)	Ongoing Costs (p.a incl. GST)	Economic Assessment Level for I&D
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	1.10	1	High	$ 22,500	$7,500	Level 1 (FRMS&P)
EM3 – Community Flood Awareness	EM	0.95	2	High	$ 60,000	$ 45,000	Level 1
EM5 – Flood Markers and Signage	EM	0.95	2	High	$ 150,000	$ 7,500	Level 1=
Option AC6 - Bay Street, Tempe Drainage Upgrade	Flood Management (FM)	0.60	4	High	$ 1,094,884	$ 1,800	Level 2 (Detailed damages)
PM6 –AC Targeted Stormwater Maintenance	Property Modification (PM)	0.50	5	Medium	$ 142,610	$ 142,610	Level 1
EM6 – Flood Data and Debrief	EM	0.45	6	Medium	$ 45,000	$ 15,000	Level 1
Option AC11 - Princes Highway, St Peters Drainage Upgrade	FM	0.45	6	Medium	$ 828,821	$ -	Level 1
Option AC14 - Talbot Street, Sydenham Drainage Upgrade	FM	0.40	8	Medium	$ 1,947,232	$ 1,500	Level 2
Option AC4 - Station Street, Tempe Drainage Upgrade	FM	-0.40	9	Low	$ 1,053,643	$ 750	Level 2
				Total	**$ 5,344,690**	**$ 221,660**	

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Tables

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Abbreviations

1D	One-dimensional
2D	Two-dimensional
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AHIP	Aboriginal Heritage Impact Permit
AMC	Antecedent Moisture Content
ARI	Average Recurrence Interval
AR&R	Australian Rainfall and Runoff
ASS	Acid Sulfate Soils
BCR	Benefit Cost Ratio
BoM	Australian Bureau of Meteorology
DAWE	Australian Department of Agriculture, Water and Environment.
DCCEW	NSW Department of Climate Change, Energy and Water
DCP	Development Control Plan
DEM	Digital Elevation Model
DPHI	NSW Department of Planning, Housing and Infrastructure
ELVIS	Elevation Information System
EPA	NSW Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FDM	Floodplain Development Manual
FRM	Flood Risk Management
FRMS&P	Flood Risk Management Study and Plan
FPL	Flood Planning Level
FPA	Flood Planning Area
GIS	Geographical Information Systems
IFD	Intensity-Frequency-Duration
IWC	Inner West Council
LEP	Local Environment Plan
LGA	Local Government Area
LIDAR	Light Detection and Ranging
NPV	Net Present Value
NSW	New South Wales
PCT	Plant Community Types
PMF	Probable Maximum Flood
PMST	Protected Matters Search Tool
SEPP	State Environmental Planning Policy
SES	NSW State Emergency Service
TEC	Threatened Ecological Community

Glossary

Acid Sulfate Soils (ASS)	Acid sulfate soils (ASS) are naturally occurring sediments and soils containing iron sulfides (mostly pyrite). When these sediments are exposed to the air by excavation or drainage of overlying water, the iron sulfides oxidise and form sulphuric acid. ASSs are widespread among low lying coastal areas of NSW, in estuarine floodplains and coastal lowlands.
Annual Exceedance Probability (AEP)	The probability of an event occurring or being exceeded within a year. For example, a 5% AEP flood would have a 5% chance of occurring in any year. An approximate conversion between ARI and AEP is provided.
Australian Height Datum (AHD)	A standard national surface level datum approximately corresponding to mean sea level.
Average Recurrence Interval (ARI)	The long-term average period between occurrences equalling or exceeding a given value. For example, a 20 year ARI flood would occur on average once every 20 years.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events. E.g. some roads may be designed to be overtopped in the 1% AEP flood event.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Elevation Information System (ELVIS)	ELVIS was launched by Geoscience Australia in 2016 to replace the existing National Elevation Data Framework (NEDF) and to open access to elevation datasets to a wider user base. With the online ELVIS portal, users can now easily download continent-wide elevation data.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain which causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.

AEP / ARI conversion (within the Annual Exceedance Probability (AEP) entry):

AEP	ARI
63.2 %	1 year
39.3 %	2 year
18.1 %	5 year
10 %	10 year
5 %	20 year
2 %	50 year
1 %	100 year
0.5 %	200 year
0.2 %	500 year

Flood fringe	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood hazard	Potential risk to life and limb caused by flooding.
Flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land. Flood Risk Management Plans encompass all flood prone land, rather than being restricted to land subject to designated flood events.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Floodplain management measures	The full range of techniques available to floodplain managers.
Floodplain management options	The measures which might be feasible for the management of a particular area.
Flood Planning Area (FPA)	The area of land below the flood planning level and thus subject to flood related development controls.
Flood planning levels (FPLs)	Flood levels selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of land use and for different flood plains. The concept of FPLs supersedes the "Standard flood event" of the first edition of the Manual. As FPLs do not necessarily extend to the limits of flood prone land (as defined by the probable maximum flood), floodplain management plans may apply to flood prone land beyond the defined FPLs.
Flood storages	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often, but not always, aligned with naturally defined channels. Floodways are areas which, even if only partially blocked, would cause a significant redistribution of flood flow, or significant increase in flood levels. Floodways are often, but not necessarily, areas of deeper flow or areas where higher velocities occur. As for flood storage areas, the extent and behaviour of floodways may change with flood severity. Areas that are benign for small floods may cater for much greater and more hazardous flows during larger floods. Hence, it is necessary to investigate a range of flood sizes before adopting a design flood event to define floodway areas.
Geographical Information Systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
High hazard	Flood conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Low hazard	Flood conditions such that should it be necessary, people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Mathematical/computer models	The mathematical representation of the physical processes involved in runoff and stream flow. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with rainfall, runoff, pipe and overland stream flow.
Overland Flow	The local runoff, travelling through properties and /or roads, before it discharges into a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The flood calculated to be the maximum that is likely to occur.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a more detailed explanation see AEP and Average Recurrence Interval.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Stormwater flooding	Inundation by local runoff. Stormwater flooding can be caused by local runoff exceeding the capacity of an urban stormwater drainage system or by the backwater effects of mainstream flooding causing the urban stormwater drainage system to overflow.
Topography	A surface which defines the ground level of a chosen area.

1 Introduction

Stantec Australia Pty Ltd (formerly Cardno (NSW/ACT) Pty Ltd) (‘Stantec’) was commissioned by Inner West Council (‘Council’) to undertake a Flood Risk Management Study and Plan (FRMS&P) for the Alexandra Canal Study Area (**Figure 2-1**). The Study Area is within the Inner West Local Government Area (LGA), located approximately 7.5km south of the Sydney Central Business District (CBD). The Study Area is focused around the part of the Alexandra Canal catchment that is contained within the former Marrickville Council LGA, and extends from Gardeners Road crossing of the Canal upstream, to the confluence with the Cooks River downstream.

This report is Draft Final FRMS&P report for Alexandra Canal.

1.1 Study Context

As outlined within the Floodplain Risk Management (FRM) Manual 2023, like all councils in NSW, Inner West Council is responsible for local land use planning including management of both mainstream and overland flooding within the LGA. In response to the objectives of the New South Wales (NSW) Government’s Flood Prone Land Policy, Council has an ongoing commitment to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the Department of Climate Change, Energy and Water (DCCEW, formerly Department of Planning and Environment, DPE) and the State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding and land use planning matters. The FRM Manual 2023 guides councils in the strategic management of flood risk across their LGAs through the FRM framework. This supports councils in meeting their responsibilities for a range of FRM activities and their strategic consideration of flooding.

The FRM process is a key element of the FRM framework. Studies and plans under the process support the understanding of flooding, the examination of measures to manage flood risk and informed decisions on how to manage flood risk into the future. They also support the consideration of flooding in broader activities under the FRM framework. The FRM process progresses through four (4) steps in an iterative process:

1. Data Collection
2. Flood Study
3. ***Flood Risk Management Study***
4. ***Flood Risk Management Plan***

The study currently being undertaken addresses steps three and four of the process. The Alexandra Canal Flood Study was prepared in 2017 by WMAwater for Inner West Council provide the second step listed above to define the flood behaviour in the Study Area. The Flood Study form the basis of the flood data used for this FRMS&P.

1.2 Study Objectives

The primary objective of this study is to develop a Flood Risk Management Study & Plan that addresses the existing, future and continuing flood problems, taking into account the potential impacts of climate change, in accordance with the NSW Government's Flood Prone Land Policy and the FRM Manual 2023.

The specific project objectives are to:

> Review the Alexandra Canal Flood Study (WMAwater 2017) in accordance with the updated requirements of AR&R 2019 and any recent changes in topography in the Study Area;
> Review Council's adopted flood planning area mapping;
> Review the existing emergency response situation and limitations;
> Review effectiveness of current flood management measures;
> Identify floodplain management measures aimed at reducing the social, environmental and economic impacts of flooding and the losses caused by flooding on development and the community, both existing and future;
> Examination of the existing flood warning systems, community flood awareness and emergency response measures in the context of the NSW State Emergency Service's (SES's) developments and disaster planning requirements;
> Reduce the flood hazard and risk to people and property in the existing community and to ensure future development is controlled in a manner consistent with the flood hazard and risk (taking into account the potential impacts of climate change);
> Reduce private and public losses due to flooding; and
> Establish a program for implementation and suggest a mechanism for the funding of the plan which should include funding sources, priorities, staging, funding, responsibilities, constraints, and monitoring.

1.3 Flood Risk Management Principles

Beyond the specific objectives of this study listed above, the FRM Manual 2023 outlines ten (10) principles for flood risk management in NSW:

1. Establish sustainable governance arrangements,
2. Think and plan strategically,
3. Be consultative,
4. Make flood information available,
5. Understand flood behaviour and constraints,
6. Understand flood risk and how it may change,
7. Consider variability and uncertainty,
8. Maintain natural flood functions,
9. Manage flood risk effectively, and,
10. Continually improve the management of flood risk.

The objectives of this study align with these principles, and through the proposed study methodology attempts to account for all of these principles, either directly or indirectly.

1.4 Project Summary

The Alexandra Canal Flood Risk Management Study and Plan project includes the following stages:

> Stage 1 – Data Collection and Review;

> Stage 2 – Additional Data Collection;

> Stage 3 – Community Engagement;

> Stage 4 – Options Identification and Assessment;

> Stage 5 – Draft Flood Risk Management Study and Plan;

> Stage 6 – Public Exhibition of Study and Plan; and

> Stage 7 – Completion of Flood Risk Management Study and Plan.

The Alexandra Canal Flood Risk Management Study and Plan has been undertaken across five stages, outlined in the sections below:

> Study Area description including topography, flora and fauna, heritage, demographics (**Section 2**);

> Initial data collection and review process including review of the Flood Study model in accordance with the updated analysis of ARR2019 (**Section 3**);

> Summary of the community consultation process (**Section 4**);

> Existing flood risk review including flood planning review (**Section 5**), economic impacts of flooding (**Section 6**), and a flood emergency response review (**Section 7**).

> Summary of flood modification options development and selection of detailed options (**Section 8**).

> Description of detailed assessment of options including modelling, cost estimation, damages benefits and Multi-Criteria Assessment (MCA) (**Section 9**), and implementation program for these detailed options to provide Council guidance on the future implementation of these options (**Section 10**).

2 Study Area Description

2.1 Catchment Background

Alexandra Canal which drains a large portion of inner south Sydney has a total catchment area of approximately 1,565 ha, which drains into the Alexandra Canal and Cooks River. The catchment area comprises local government areas under the management of:

- City of Sydney Council (1,140ha);
- Inner West Council (230ha);
- Bayside Council (51ha); and,
- Randwick Council (51ha).

The Study Area for this FRMS&P, shown in **Figure 2-1**, contains the portion of the Alexandra Canal catchment that lies within the Inner West LGA (or the former Marrickville LGA). The Study Area is a fully developed urban area, with predominantly industrial areas and semi-detached and terrace housing. There are some areas of large open space located within the Study Area such as:

- Tempe Recreational Reserve;
- Kendrick Park;
- Tempe Golf Driving Range;
- Tempe Park; and
- Other open industrial use areas such as Boral Concrete.

2.1.1 History of the Catchment and Flooding

Located in one of the older areas of Sydney, the Study Areas were first settled in the early 19th Century. The original natural drainage system comprised rock gullies draining to small pockets of mangroves along the shoreline at the head of various bays. As development proceeded, the natural drainage lines were subsumed into the constructed drainage system of open channels. Eventually, by the late 19th Century, much of the channel system was progressively covered over and piped, with much of the original system forming the backbone of the present-day stormwater drainage system.

Given the age of the existing stormwater drainage network, there is a prevalence of antiquated drainage systems. In many streets, underground pipe systems do not exist and in their place are high kerbs and/or dish gutters to convey the stormwater, with - minor converter networks only located beneath intersections to carry stormwater below the road at the intersection.

Where there are existing drainage pipelines within a street, many of these pipelines are running at capacity by the 50% AEP and 20% AEP flood events, resulting in high volumes of surface flows runoff. In addition, the canal is tidal and areas of the catchment at the mouth of the canal and adjacent to Cooks River may be subject to tidal overtopping and king tides.

Historical records indicate flooding within the catchment for events approximating the magnitude of the 20% AEP from the year 2003 onwards. These include 13 May 2003, 7 March 2012, 5 March 2014, 14 October 2014, 25 April 2015 and 30 January 2016. Prior to 2003, there is an estimated 5% to 2% AEP event that occurred on 10 April 1998.

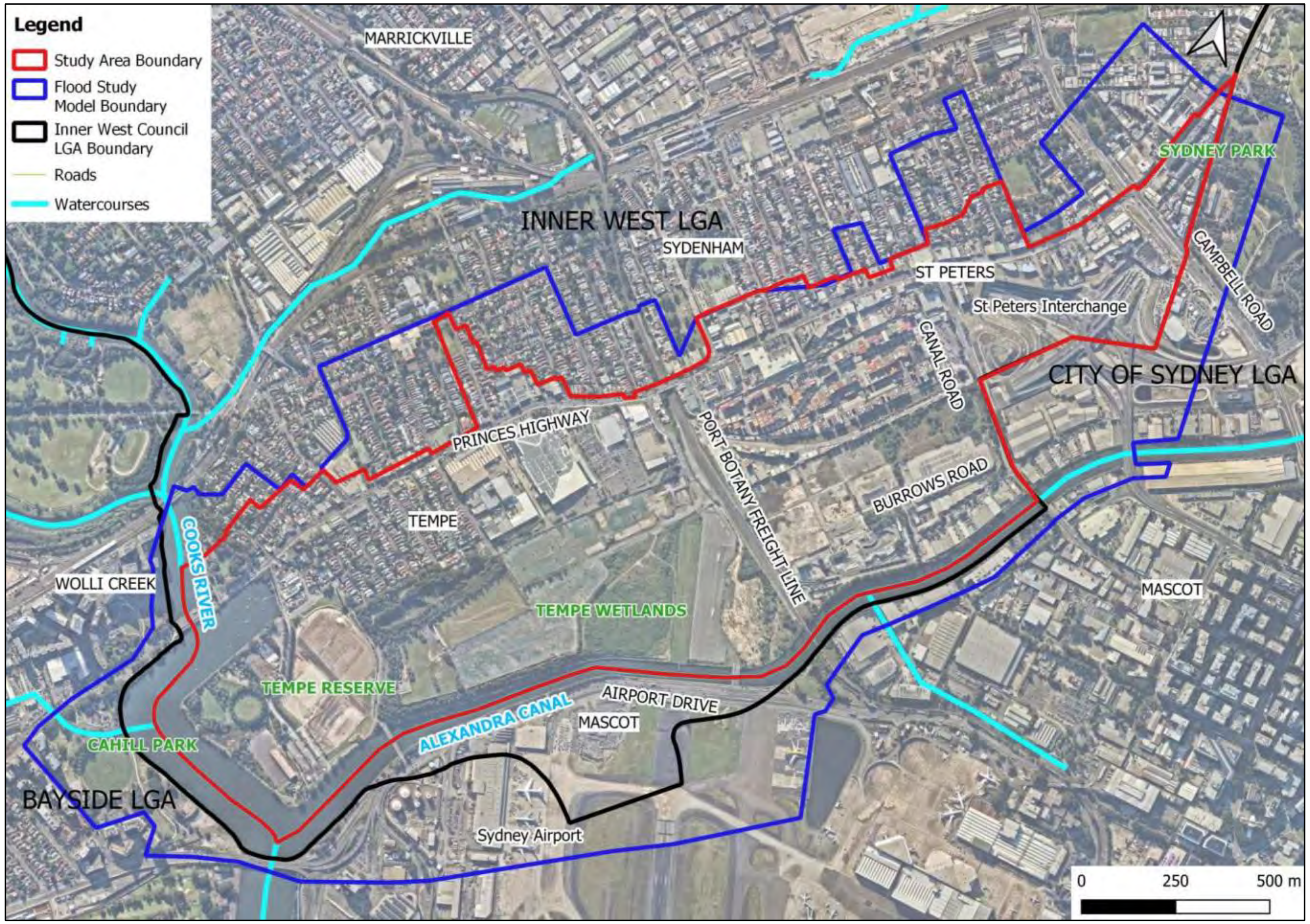

Figure 2-1 Alexandra Canal Study Area

2.1.2 Topography

The Study Area has steep slopes along the north-western boundary, with a low-lying floodplain located in the southern and eastern portions of the catchment. The topography of the Alexandra Canal Study Area is shown in **Figure 2-2**.

The ridgeline that runs along the north-western boundary is up to around 25 m Australian Height Datum (m AHD) in elevation, sloping down to flat floodplain in the eastern and southern portions. The low-lying land adjacent to the canal is around 0-5 m AHD.

The ridgeline along the north-western boundary separates the Alexandra Canal catchment from the Marrickville Valley catchment. A rail line, the Port Botany Freight Line, traverses through the centre of the catchment, which runs under the Princes Highway and adjacent to Bellevue Street. Due to the low-lying nature of the track, it is anticipated that water from the surrounding areas would be directed along the route to the canal to the south-east.

The north-western portion of the Study Area is generally comprised of residential dwellings, with land use in the low-lying south-eastern portion comprised of industrial buildings, storage yard and road corridors. The catchment area is highly disturbed by human activity, with a high proportion of impervious area.

2.1.3 Soil Erosion Potential

A review of soil landscapes mapping from eSpade (DCCEW, 2021) indicates that the Alexandra Canal Study Area contains one soil landscape group; Disturbed Terrain. Disturbed Terrain is characterised by artificial fill materials which can include dredged estuarine sand and mud, demolition rubble, industrial and household waste, but can also include rock and local soil materials. Soil erosion hazard ranges from low to extreme for non-concentrated flow, and low-to-high for concentrated flow.

2.1.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) is the common name for soils that contain metal sulfides. The presence of these soils is more likely in low-lying areas of the floodplain. In an undisturbed and waterlogged state, ASS generally pose no or low risk to the environment. However, when disturbed, an oxidation reaction occurs to produce sulfuric acid which can negatively impact the surrounding environment in a number of ways such as a decline in water quality, fish kills and plant death. Sulfuric acid produced by the soils can also corrode and weaken certain structures and building foundations. Part 6.1 of the *Marrickville LEP 2011* outlines general provisions for development near ASS.

Potential ASS within the former Marrickville LGA are classified into five land classes with each land class indicating the depth where potential ASS may occur. Development consent is required for work in those five classes as described in **Table 2-1**.

Table 2-1 Acid Sulfate Soil Land Classes (Source: Marrickville LEP 2011)

Class of land	Works
1	Any works.
2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Works more than 1 metre below the natural ground surface. Works by which the watertable is likely to be lowered more than 1 metre below the natural ground surface.
4	Works more than 2 metres below the natural ground surface. Works by which the watertable is likely to be lowered more than 2 metres below the natural ground surface.
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

All waterside areas of the catchment are located within Class 1 ASS mapped areas in the LEP. Class 2 ASS mapped areas are located in the low-lying areas of the Study Area, primarily either side of the Alexandra Canal. The remaining area is Class 5 ASS mapped areas which coincide with the higher elevation areas.

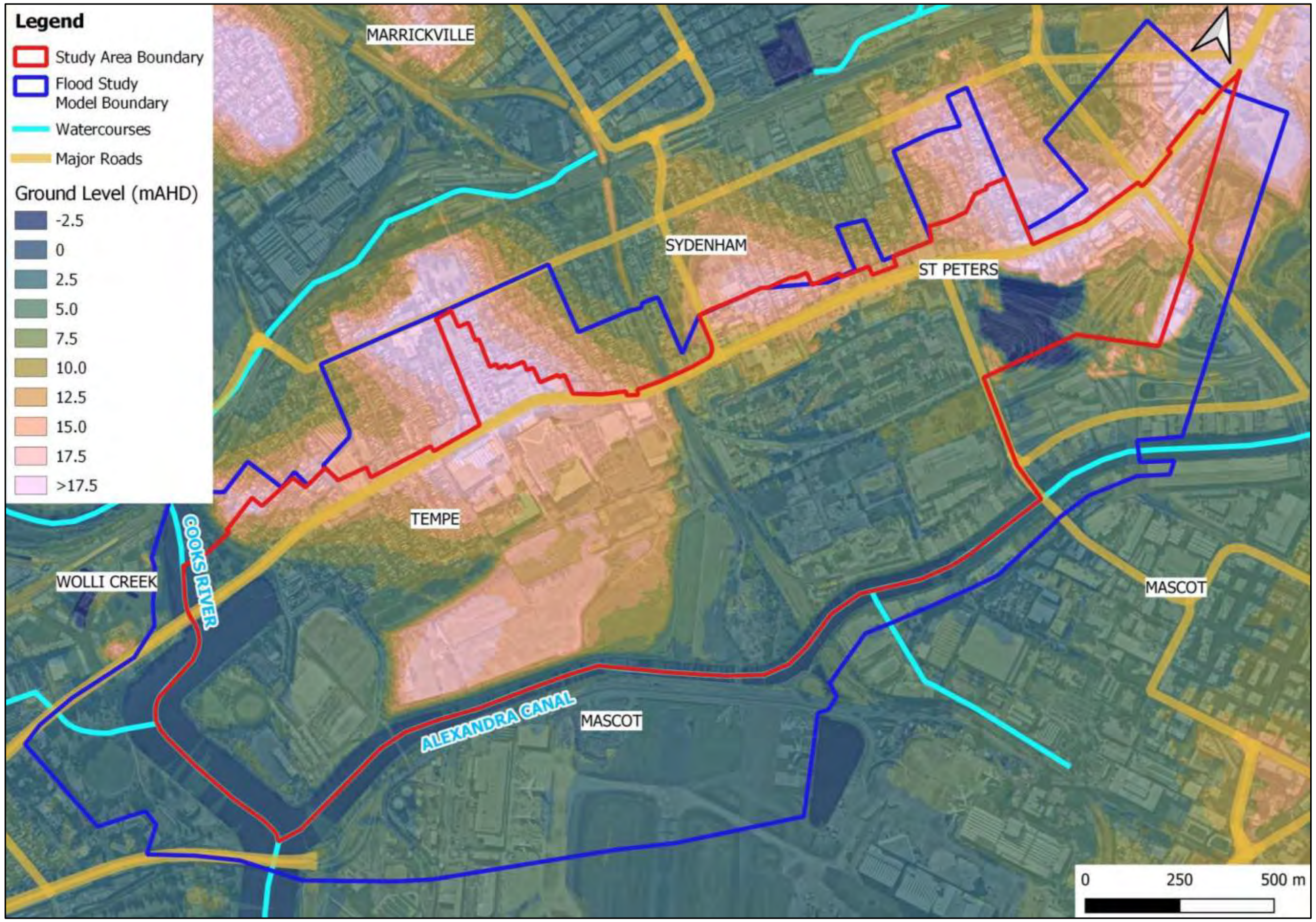

Figure 2-2 Topography of Alexandra Canal Study Area

2.1.5 Contaminated Land

Contaminated land refers to any land which contains a substance at concentrations sufficient to present a human or environmental health risk, as defined in the *Contaminated Land Management Act 1997*. Contamination issues need to be considered at the flood management options development and design stage.

DCCEW regulates contaminated land sites and maintains a record of written notices issued by the NSW Environmental Protection Authority (EPA) in relation to the investigation or remediation of site contamination. Searches were undertaken of the online Contaminated Land Record and the List of NSW Contaminated Sites notified to the EPA on 18 March 2021. A total of three premises were listed within the Study Area:

> Former Tidyburn Facility, 53 Barwon Park Road, St Peters;

> Caltex Service Station, 775 Princes Highway, Tempe; and

> Former Tempe Tip, South Street, Tempe.

Each of these sites have been formerly regulated under the *Contamination Land Management Act 1997*. It is important to note that there are limitations to the registers and there may be contaminated sites that are not listed.

2.2 Threatened Flora and Fauna

There are areas of open space along the northern bank of the Alexandra Canal.

A review of DCCEW's vegetation mapping for the Sydney Metropolitan Area (NSW OEH, 2016) identified the following Plant Community Types (PCTs) as occurring within the Study Area (refer **Figure 2-3**):

> Estuarine Swamp Oak Forest (PCT 1234), which corresponds with Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions which is listed under the NSW Biodiversity Conservation Act 2016 (BC Act);

> Estuarine Reedland (PCT 1808), which corresponds with Sydney Freshwater Wetlands in the Sydney Basin Bioregion and Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions which is listed under the BC Act;

> Coastal Sandstone Heath-Mallee (PCT 1824) which is not associated with a TEC;

> Estuarine Mangrove Forest (PCT 920), which may correspond with Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions listed under the BC Act; and

> Estuarine Saltmarsh (PCT 1126), which corresponds with Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions listed under the BC Act.

A search of the Australian Department of Agriculture, Water and Environment Protected Matters Search Tool (PMST) (DAWE, 2021a) for matters listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was undertaken on 17 March 2021 adopting a 5 km buffer.

The PMST indicated that ten Threatened Ecological Communities (TECs) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are likely to or may occur in the area, namely:

> Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community (Endangered under the BC Act and EPBC Act) – this TEC may occur within the Study Area, potentially as PCT 1234 – Estuarine Swamp Oak Forest;

> Coastal Upland Swamps in the Sydney Basin Bioregion (Endangered under the BC Act and EPBC Act);

> Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion (Endangered under the BC Act and Critically Endangered under the EPBC Act);

> Eastern Suburbs Banksia Scrub of the Sydney Basin Bioregion (Critically Endangered under the BC Act and Endangered under the EPBC Act);

> River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria (Endangered under the BC Act and Critically Endangered under the EPBC Act); and

> Turpentine-Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered under the BC Act and EPBC Act);

> Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion (Critically Endangered under the BC Act and Endangered under the EPBC Act);
> Shale Sandstone Transition Forest of the Sydney Basin Bioregion (Critically Endangered under the BC Act and EPBC Act);
> Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (Endangered under the EPBC Act); and
> Western Sydney Dry Rainforest and Moist Woodland on Shale (Endangered under the BC Act and Critically Endangered under the EPBC Act).

The search identified 21 TECs listed under the BC Act that are known to occur within the LGA.

Of the PCTs present in the Study Area, some have potential to comprise vegetation communities commensurate with TECs listed under the BC Act and/or EPBC Act, including those identified as being likely to occur within the LGA. The following TECs may therefore be present in the Study Area, pending confirmation via ground-truthing by a suitably qualified ecologist:

> Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community (Endangered).

The PMST results indicated a total of 89 threatened species and 79 migratory species listed under the EPBC Act are known, likely or have potential to occur in the area.

- A search of the DCCEW BioNet database was undertaken to obtain flora and fauna records for the Inner West LGA. Results are displayed in **Figure 2-3**. A total of 97 threatened flora species have been recorded in the LGA. A total of 108 threatened and migratory fauna sightings have been recorded in the LGA consisting of:

> Six amphibian species;
> Five reptiles species;
> 70 bird species;
> 23 mammal species;
> Three gastropod species; and
> One insect species.

Of these, the following species have records in the Study Area:

> *Limosa lapponica* (Bar-tailed Godwit) listed as vulnerable under the EPBC Act;
> *Melaleuca deanei* (Deane's Paperbark) listed as vulnerable under the BC Act and EPBC Act;
> *Ranoidea aurea* (Green and Golden Bell Frog) listed as endangered under the BC Act and vulnerable under the EPBC Act;
> *Pteropus poliocephalus* (Grey-headed Flying Fox) listed as vulnerable under the BC Act and EPBC Act;
> *Persoonia hirsute* (Hairy Geebung) listed as endangered under the BC Act and EPBC Act;
> *Miniopterus orianae oceanensis* (Large Bent-winged Bat) listed as vulnerable under the BC Act;
> *Gillinago hardwickii* (Latham's Snipe);
> *Ninox strenua* (Powerful Owl) listed as vulnerable under the BC Act; and
> *Ptilinopus superbus* (Superb Fruit Dove) listed as vulnerable under the BC Act.

The presence of TECs and threatened species that occur (or have the potential to occur) within the Study Area should be considered in the development and implementation of any proposed flood modifications options or flood protection works. The potential for any impacts to threatened communities or species can have implications for the approvals pathway for any structural flood mitigation proposals, and further investigations or offsetting of impacts may be required.

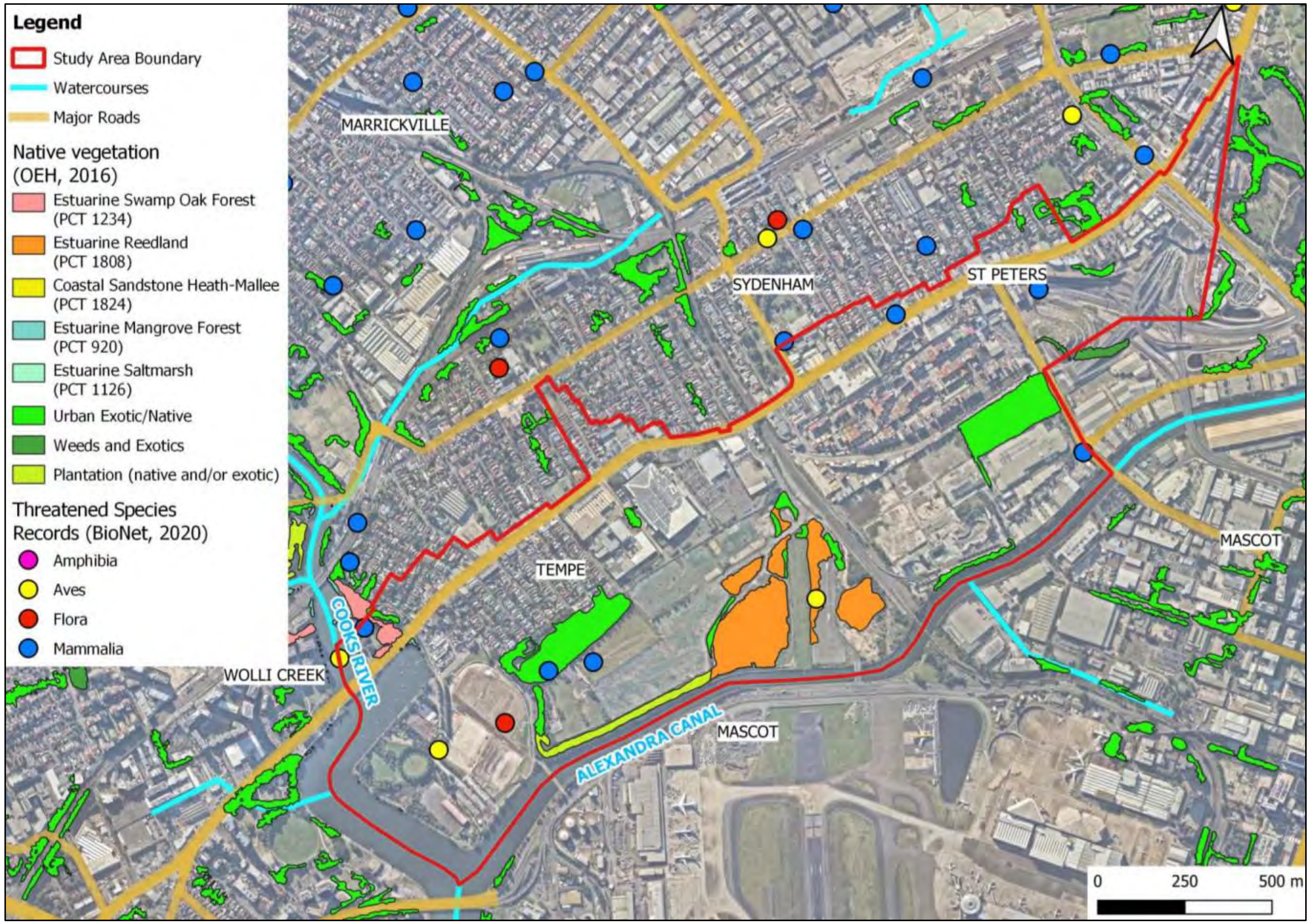

Figure 2-3 Mapping of Alexandra Canal Biodiversity Constraints

2.3 Heritage

2.3.1 Aboriginal Heritage

Australia contains many different and distinct Aboriginal and Torres Strait Islander groups, each with their own culture, language, beliefs and practices (AIATSIS, 2021). The Inner West LGA is situated on the traditional land of the Gadigal and Wangal peoples of the Eora nation. The Study Area is located on Gadigal land and has the Aboriginal name Bulanaming, with the suburbs of St Peters, Sydenham and Tempe known as Gumbramorra swamp (IWC, 2021). The swamp wetlands in this area were important for Aboriginal people as they provided a good source of plants and animals for various uses. Following European settlement, the swamp was drained in the 1890s to facilitate development of the suburb.

At least six sites of Aboriginal archaeological and cultural heritage significance are known from the Study Area based on a search of the Aboriginal Heritage Information Management System. According to the Marrickville Development Control Plan 2011, an Aboriginal Site Survey has identified places of Aboriginal heritage significance with the former Marrickville LGA. Therefore, there is potential for Aboriginal sites and archaeology to exist across the Study Area even though they have not been formally recorded.

All Aboriginal sites are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and therefore any floodplain management options that have potential to impact on protected sites should be assessed via the Aboriginal cultural heritage due diligence assessment process detailed in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Department of Environment, Climate Change and Water NSW, 2010). Impacts to sites should be avoided in the first instance. In the vent a management option would impact an item or site listed under the NPW Act, an Aboriginal Heritage Impact Permit (AHIP) must be sought from DCCEW.

In addition, the Marrickville Development Control Plan 2011 outlines provisions and provides guidance on conservation of Aboriginal heritage.

2.3.2 Non-Aboriginal Heritage

Non-Indigenous heritage can be classified into three statutory listing classifications based on significance, namely Commonwealth, State and local. The significance of an item is a status determined by assessing its historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value.

> A desktop review of non-Indigenous heritage was undertaken for the Inner West LGA. Searches were undertaken of the following databases:

> Australian Heritage Database which incorporates World Heritage List; National Heritage List; Commonwealth Heritage List (DAWE, 2021b);

> State Heritage Register (DCCEW, 2021b); and

> Local Council Heritage as listed on the *Marrickville Local Environmental Plan 2011* (Marrickville Council, 2011a).

> There were no Commonwealth heritage items identified within the Study Area.

The search of the State Heritage Register (DCCEW, 2021) identified 55 items in the Inner West LGA as being listed under the NSW *Heritage Act 1977*, with an additional 29 being listed by Sydney Water under Section 170 of the Act. Of these, two items have been identified within the Study Area (refer **Figure 2-4**):

> Alexandra Canal (SHR no. 01621, Marrickville LEP item I270); and

> St Peters' Anglican Church (SHR no. 00032, Marrickville LEP item I275).

There are more than 300 items of local significance and 36 Heritage Conservation Areas listed on the *Marrickville Local Environmental Plan 2011*, with numerous items located within the Study Area (refer **Figure 2-4**).

Where it is proposed to undertake works that either directly or indirectly impact on a locally listed heritage item or site, the proponent must refer to the *Marrickville Local Environmental Plan 2011* and Part 8 of the *Marrickville Development Control Plan 2011* for heritage provisions and development guidelines relating to locally listed heritage items.

Depending on the nature of any structural food risk management works proposed, a more detailed Statement of Heritage Impact prepared by a suitably qualified specialist may be required to assess potential impacts on these features. Where impacts to listed heritage items are identified, a permit may be required under the NSW *Heritage Act 1977*.

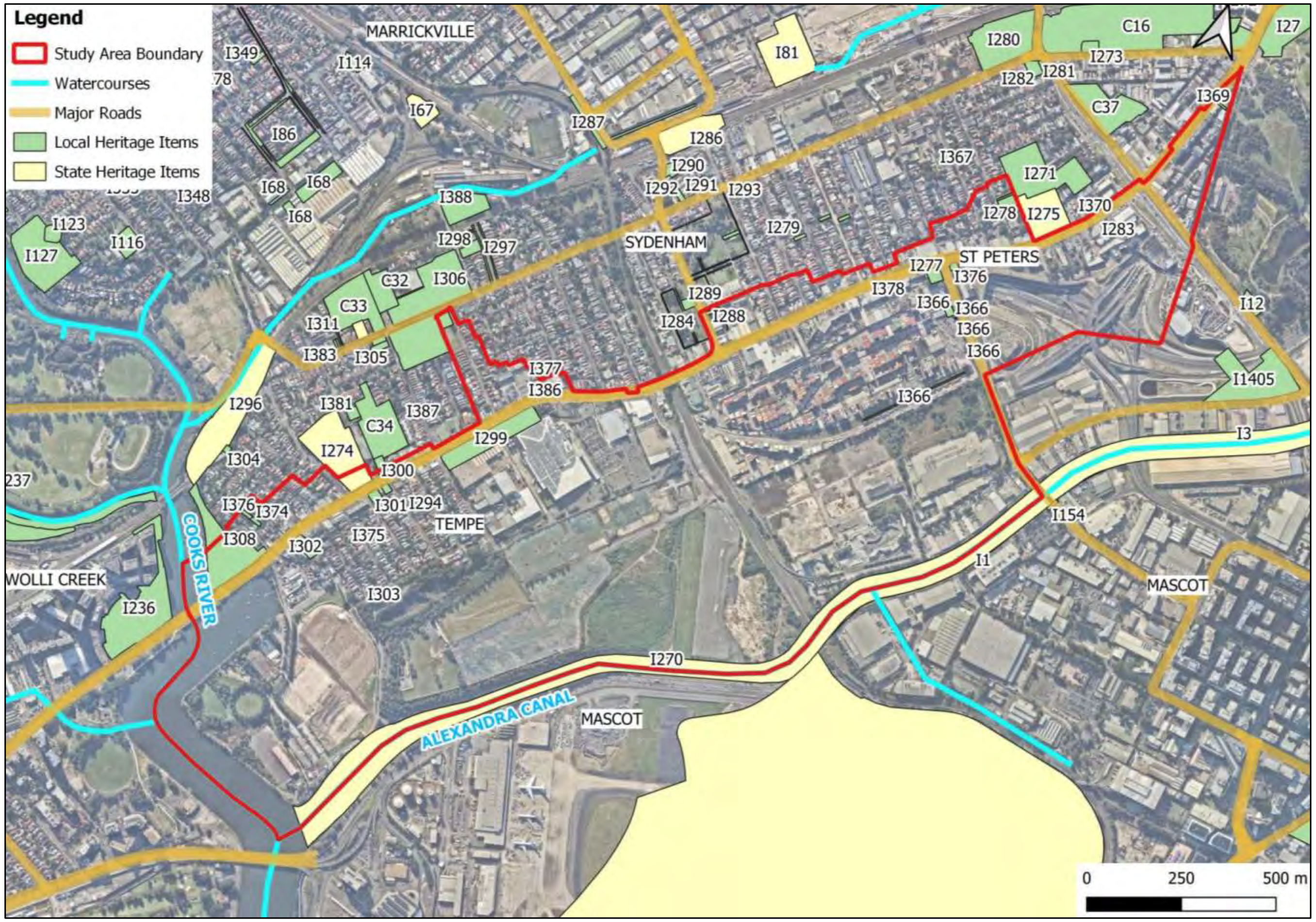

Figure 2-4 Mapping of Alexandra Canal Heritage Constraints

2.4 Demographic Profile

Knowledge of the demographic character of an area enables preparation and evaluation of floodplain management options that are appropriate for the local community. For example, in the consideration of emergency response or evacuation procedures, information may need to be presented in languages other than English and/or additional arrangements may need to be made for less mobile members of the community who may not be able to evacuate efficiently.

Demographic data for Marrickville, Sydenham and Petersham Statistical Area 3 (SA3) from the Australian Bureau of Statistics (ABS) 2016 census was used to identify the social characteristics of the Study Area. All, or part, of the following suburbs are located within the Study Area:

> Dulwich Hill;
> Enmore;
> Lewisham;
> Marrickville;
> Petersham;
> Stanmore;
> St Peters;
> Sydenham; and
> Tempe.

The census data showed that the population of the Marrickville, Sydenham and Petersham SA3 area in 2016 was approximately 54,609, with a median age of 35 years, which is lower than the median for NSW (38 years). Approximately two thirds of the people living in the Marrickville area are aged between 15-54 years, which suggests that the community is likely to be generally able-bodied and able to evacuate effectively. However, very young children (0-4 years) and the elderly (>75 years) make up approximately 11% of the population (approximately 5,900 people) so it is important to consider these members of the community in flood risk management planning.

English was the only language spoken in nearly two-thirds (62%) of homes in the Marrickville SA3. Other languages spoken at home included Greek (5.2%), Vietnamese (4.6%), Arabic (1.9%), Portuguese (1.9%) and Cantonese (1.7%). This suggests that language barriers (e.g. during evacuation, or for flood education) have the potential to be an issue for some households. The inclusion of multi-lingual brochures and personnel may be required in this instance.

Consideration of house prices in Tempe and St Peters may assist in the calculation of economic damages incurred during a flood event. According to data from realestate.com.au (realestate.com.au, 2021) the average median property prices across the Study Area are approximately $1,295,000 for houses and $780,000 for units.

2.5 Major Development Sites

Since the completion of the Flood Study in 2017 there have been two major transport projects within the Study Area that have already or are in the process of significantly changing the landform within portions of the Study Area. A brief summary of these two projects and the impact on the Flood Risk Management Study is included in the following sub-sections.

2.5.1 St Peters Interchange

The St Peters Interchange of Westconnex was transformed from undeveloped industrial area in 2013 to major road interchange site by 2020, with the majority of site alteration assumed to be at or near completion at the date of this report. This has resulted in the significant terrain changes from 2013 to 2020 LiDAR data, not only within the interchange site, but also along portions of Campbell Road north of the interchange that underwent road upgrades. The terrain differences shown in **Figure 3-2** show that there is both significant depths of both cut and fill in the interchange site comparing 2013 and 2020 LiDAR.

Figure 2-5 and **Figure 2-6**, which shows aerial imagery sourced from Google Earth, show the land use and functions of the site have been considerably changed. The pre-development site was mostly an undeveloped industrial land, used as a low-lying stockpiling area. The post-development site is a motorway interchange site which has the following key features:

- To the north of the site there is a tunnel entry to the M8 Motorway towards Parramatta
- To the west of the site there is a tunnel entry to the M8 Motorway towards Liverpool.
- To the east there is a road connection to the intersection of Euston Road and Campbell Road
- To the south-east there is a new road bridge crossing of Alexandra Canal connecting to Gardeners Road.
- To the south-west there is an elevated crossing over Canal Road currently being constructed that will connect to the Sydney Gateway project (see next sub-section).

At the time of this report, the St Peter’s Interchange is near completion and nearly fully operational. The only remaining component not to be fully opened is the link to the Sydney Gateway project, which as shown in the 2023 aerial imagery, the landform and roadway are set, and due for operation soon.

Figure 2-5 St Peters Interchange 2013 Aerial Imagery Showing Mostly Undeveloped Industrial Site (Source:Nearmap)

Figure 2-6 St Peters Interchange 2023 Aerial Imagery Showing Major Motorway Interchange Site near Completion (Source: Nearmap)

Stantec reviewed the Westconnex New M5 – Flood Mitigation Strategy report dated 28 May 2020 sourced from the Westconnex website. The report provided the following summary of the flooding conditions for the St Peter's Interchange site (page 16):

> *The land use of this catchment is highly urbanised with around 50% of the catchment used as industrial sites. The highly urbanised catchments and relatively steep slopes result in rapidly responsive hydrographs, with large amounts of run-off being generated from short duration storm events.*
>
> *In the 1% AEP existing situation areas of the site become inundated from two sources, the first is the regional flooding from the Alexandra Canal. The banks of the canal are overtopped in several locations in the 1% AEP event, particularly near the AusGrid site (off Burrows Road) and upstream of Canal Road, near the Staging Rentals industrial units. The regional flooding from the canal is not able to reach the Quarry. The second source of the flooding is surface water (overland flow), which flooding does inundate the Quarry.*
>
> *The surface water occurs when the drainage network capacity has been exceeded, due to the high intensity rainfall event and possible tidal impacts. The Princes Highway marks the upstream limit of the catchment for the northern side of the site and therefore receives a relatively small volume of overland flow.*
>
> *There is little existing drainage infrastructure in the local road network in the vicinity of Campbell Street from the Princess Highway to the Illawarra Railway line. As such, Campbell Street acts as an overland flow path in minor rain events, with flooding at the intersection of Campbell and May Streets, before the water enters the existing drainage network and the Camdenville detention basin. The basin discharges by the operation of pumps into the existing drainage network under the railway line to the Eastern Channel. An overland flow path along the alignment of the railway line operates during larger events. In the 1% AEP the local roads become inundated by the overland flows with water depths greater than 0.5m in sections of Campbell and May streets.*

As it relates to the post-development site and flood mitigation strategies implemented, the following summary is provided (page 22):

> *During the design development, the hydraulic model identified areas of high afflux and was used to investigate possible solutions. The design development was an ongoing process which relied on an iterative approach between the multidisciplinary teams. The flood modelling was used to guide the MX road design and drainage design to deliver an acceptable flood outcome. The following mitigation measures were considered and incorporated in the final design.*
>
> - *Longitudinal flood relief culvert along Euston Road*
> - *The use of Elsholz kerbs within the median along Euston road.*
> - *Change in section of Euston road from a two-way cross-fall to a one-way cross-fall which would cause a reduction in flow moving in a southerly direction down Euston road*
> - *Non-return valves to new pipe outfalls where required*
> - *Drainage channel north of fire water complex to maintain an existing flow path from a small industrial estate*
> - *Flood relief culverts under Burrows Road*
> - *New road drainage pit and pipe network in the areas of the local road adjustments sized for an acceptable flood outcome*
> - *4000m3 of underground flood storage at Campbell Street to improve surface flooding and to maintain acceptable discharge flows to the Eastern Channel.*
>
> *Water levels generated from the flood report were used to set levels which provide PMF flood immunity for the New M5 carriageways, tunnel portals and the St Peters Motorway Operations Complexes. Mitigation measures adopted at the St Peters Interchange to provide PMF immunity include, a wall around the Norwest of the portal, a bund to the south of the portal, a concrete channel around the Fire Water Complex and grading of the northern ramps from the tunnel portal to Campbell Road*

The flood impacts from the project are limited to increased afflux on roads, parkland and small areas of properties immediately adjacent to the road upgrades. The 1% AEP flood impacts from the 2020 assessment are shown in **Figure 2-7**. An afflux will occur on Canal Road, Burrows Road and Campbell Road, as well as minor impacts on Princes Highway during a 1% AEP event.

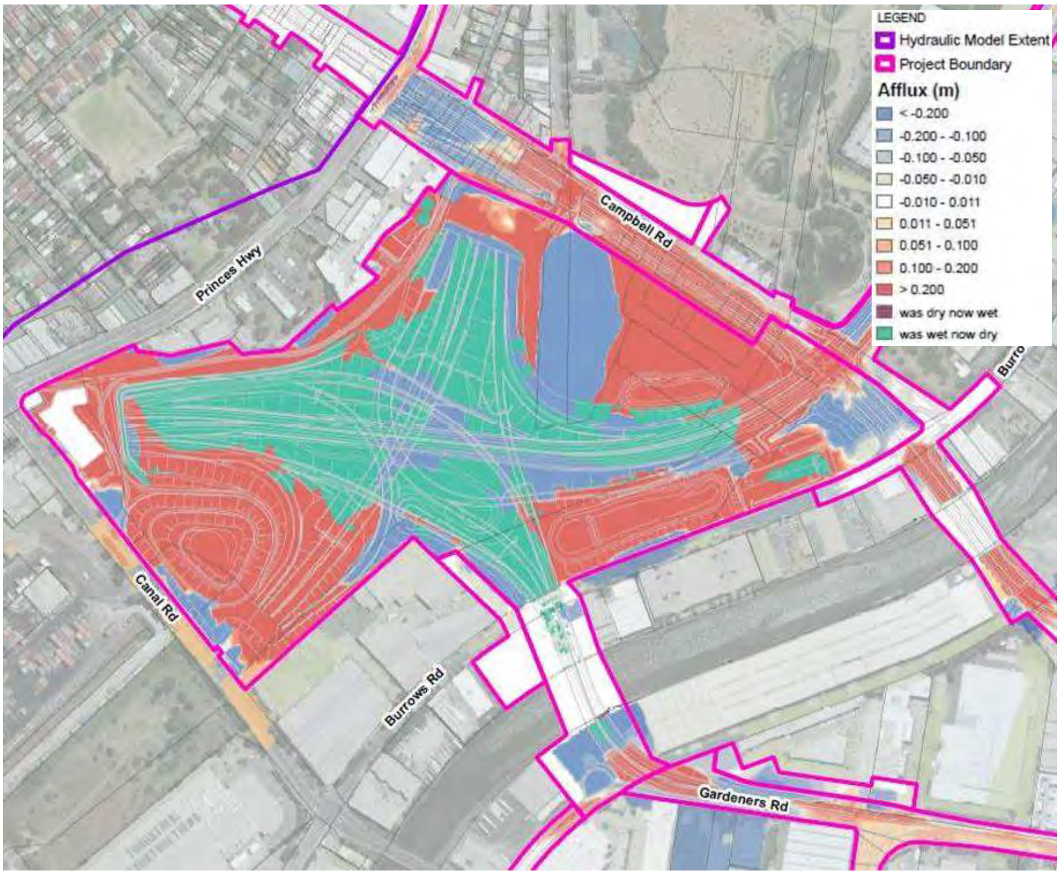

Figure 2-7 Proposed Flood Impacts in 1% AEP Event for Westconnex St Peter's Interchange (Source: Weastconnex JV, 2020)

2.5.2 Sydney Gateway Project

The Sydney Gateway is an approved transport project that is nearing completion and expected to be delivered in 2024. The project will provide a high-capacity connection from Sydney Airport and Port Botany to the new Westconnex St Peters Interchange once completed. The following details relating to the project have been sourced from the Sydney Gateway Stages 1 & 3 Hydrology and Flooding Assessment report (*Sydney Gateway JV*, 2021):

- *"Sydney Gateway comprises three stages:*
  - *Stage 1 - International Terminal and Qantas Drive connection - a new high capacity road connection, linking the Sydney motorway network at St Peters Interchange with Sydney Airport's International Terminal and Qantas Drive*
  - *Stage 2 - Botany Rail Line Duplication - the duplication of three kilometres of freight rail to Port Botany - this stage is being delivered separately by the Australian Rail Track Corporation (ARTC)*
  - *Stage 3 - Domestic Terminals access - an arterial road connection and flyover to Sydney Airport's Domestic Terminals. This includes improvements to existing roads, to relieve congestion and improve connectivity to Sydney Airport Domestic Terminals and towards Port Botany.*
- *Stage 1 comprises a road connection linking the following infrastructure / facilities:*
  - *New M5 and M4-M5 Link via St Peters Interchange at Canal Road*
  - *Sydney Airport International Terminal (T1) via a new link through the former Tempe Tip to the existing Airport Drive*
  - *Qantas Drive via a bridge over Alexandra Canal and Botany Rail Line, tying in with Stage 3 works.*
- *Sydney Gateway Stage 3 comprises arterial road network improvements to relieve congestion and improve connectivity to Sydney Airport Domestic Terminals 2 and 3 (T2/T3), including:*
  - *The widening of Qantas Drive from the interface with Stage 1 to the O'Riordan Street, Joyce Drive, Sir Reginald Ansett Drive intersection*
  - *Providing a grade separated, elevated viaduct access to T2/T3 from Qantas Drive to Sir Reginald Ansett Drive, allowing for the uninterrupted free flow from the Sydney Gateway Stage 1 to the T1/T2 Domestic terminals*
  - *Realignment of the surrounding affected road network including:*
    - *The intersection between Seventh Street, Qantas Drive and Robey Street*
    - *The intersection between Qantas Drive, Sir Reginald Ansett Drive, Joyce Drive and O'Riordan Street*
    - *The intersection of Sir Reginald Ansett Drive and Ross Smith Avenue*
    - *Changes to the vehicle underpass on Shiers Avenue leading to the taxi carparking facility on Seventh Street."*

According to the Infrastructure Pipeline website, "*Stage Two is the Port Botany Rail Duplication, which is being separately delivered by the Australian Rail Track Corporation*" (*Infrastructure Partnerships Australia*, 2021).

Figure 2-8 shows five active sites, at the time of drafting this interim report, including St Peters Interchange, Tempe, Mascot, Domestic Terminal and International Terminal. This figure was sourced from the *Sydney Gateway Project* website (NSW Government) in 2023.

Among the five active sites, only Tempe site and St Peters Interchange site are located within the Study Area. The proposed interaction of St Peters Interchange (and Sydney Gateway project in the form of the proposed elevated crossing of Canal Road is discussed in **Section 2.5.1**. The main developments (shown in **Figure 2-9**) within the Tempe site include:

> Excavation in Tempe Lands: The Sydney Gateway road will pass through Tempe Lands;

> More open space and new recreation facilities at Tempe Lands: The Sydney Gateway Project proposed to potentially provide open space within the project area to the community in Tempe after construction of Sydney Gateway is complete. Potential uses of this space could include sporting courts, amenities, walking

trails, parking and off leash dog exercise area, subject to a further Plan of Management. Cycleway Journey along and over the Alexandra Canal.

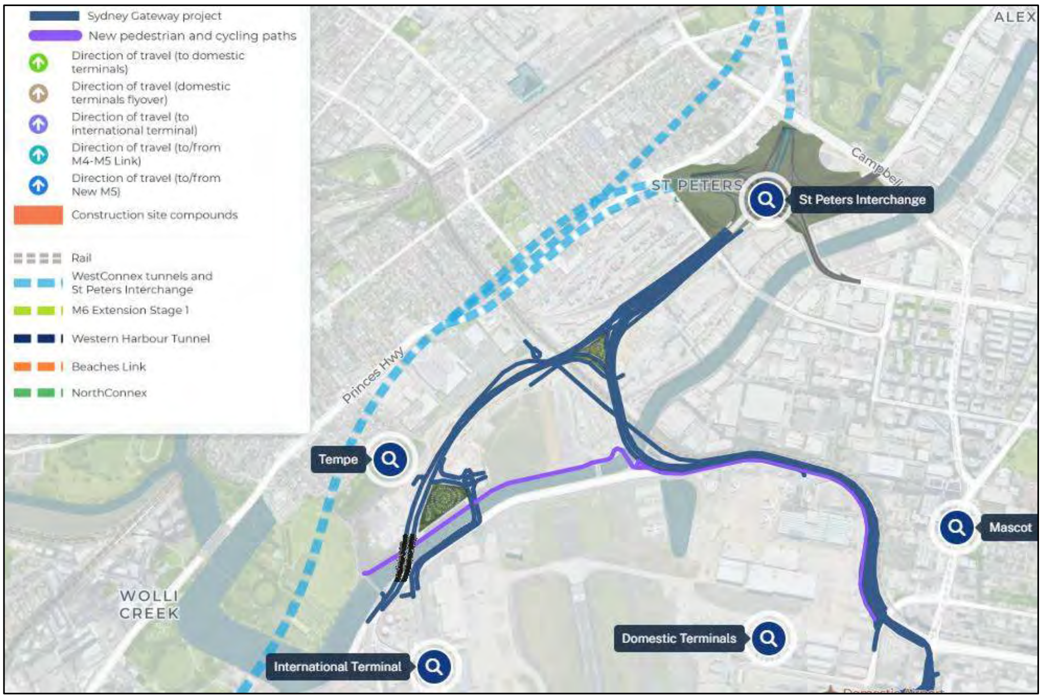

Figure 2-8 Concept Layout for the Proposed Sydney Gateway Project (NSW Government, 2023)

Figure 2-9 Concept layout for active site at Tempe (NSW Government, 2023)

It is noted that a flood study report was prepared during the Environmental Impact Statement (EIS) stage of the Sydney Gateway project (Lyall & Associates, 2019). This study included the development of a range of flood / stormwater mitigation measures in the central portion of the project near the Port Botany Rail Line crossing.

Subsequently, the *Sydney Gateway Stages 1 & 3 Hydrology and Flooding Assessment report* (Sydney Gateway JV, 2021) was released which confirmed details of proposed drainage networks. The proposed drainage network for the central portion of the Sydney Gateway project are shown in **Figure 2-10**. It shows a significant upgrade in the existing drainage network in this area.

Figure 2-10 Proposed Post-Gateway Drainage Network Near Rail Line (Source: Sydney Gateway JV, 2021)

Figure 2-11 and **Figure 2-12** shows water level impacts of the Gateway project for the study area in the 1% AEP and PMF events respectively.

In the 1% AEP flood, the maximum impacts in the FRMS&P study area are between 0.01 - 0.02m, in the PMF event the impacts are more significant with increases greater than 0.2 metres in the central portion of the study area adjacent to Port Botany Rail Line to Burrows Road to the north. The impacts are generally considered negligible as the 1% AEP impacts are very minor at less than 0.02m, though the PMF impacts may significantly alter flood risk or flood hazard in this extreme event.

Figure 2-11 1% AEP Water Level Event Impacts of the Sydney Gateway Project within the Study Area (Sydney Gateway JV, 2021)

Figure 2-12 PMF Water Level Impacts of the Sydney Gateway Project within the Study Area (Sydney Gateway JV, 2021)

3 Review of Available Data

3.1 Alexandra Canal Flood Study

The Alexandra Canal Flood Study was completed in 2017 on behalf of Inner West Council formerly Marrickville Council by WMAwater. The Flood Study defined flood behaviour in the catchment for the 50%, 20%, 10%, 2% and 1% Annual Exceedance Probability (AEP) design storms, and the Probable Maximum Flood (PMF). The 2017 Flood Study modelling forms the basis for this Flood Risk Management Study. Further details on the hydrological and hydraulic modelling approaches are discussed below.

3.1.1 Flood Study Approach

A hydrological model was built in DRAINS to create flow boundary conditions for input in the hydraulic (TUFLOW) model by using design rainfall patterns specified in AR&R 1987 to produce runoff hydrographs. Since there were no streamflow records available in the area, independent calibration for the hydrological model was not possible.

The model included 143 sub-catchments with an average size of 1.5 ha for a total Study Area of 2.20 km^2. A small catchment size was utilised such that overland flow behaviour is generally defined by the hydraulic model as part of a joint modelling approach which was verified against previous studies and alternative methods.

Impervious surface area within was determined based on the proportion of sub-catchment area allocated to a number of land use categories, with each category having an estimated impervious percentage based on aerial observation of a representative area. Rainfall losses were modelled using the initial & continuing loss method – an initial loss of 1.0 mm was adopted and a continuing loss of 5.0 mm.

Comparison with a DRAINS model of the nearby Rose Bay Catchment from a previous study was undertaken to verify the hydrological model. Specific yield (peak discharge divided by upstream catchment area) comparison was undertaken and the Alexandra Canal catchment model was found to have comparable yields.

The availability of high-quality LIDAR data meant that the Study Area was suitable for 2D hydraulic modelling to assess flood behaviour, with the TUFLOW package being adopted in this case. The hydraulic model uses the runoff hydrographs from the hydrology model as boundary conditions in order to provide estimates of flood depths, velocities and hazard within the Study Area. The model was used to define flood behaviour for the 50%, 20%, 10%, 2% and 1% AEP flood events and the Probable Maximum Flood (PMF).

The TUFLOW model boundary is shown in **Figure 2-1**. The TUFLOW model boundary has extended beyond the study area to allow for any complex flood behaviour around the fringes of the catchment to be accounted for. The TUFLOW model had a total area of 3.2 km^2, being approximately bounded at four corners by the rail crossing over the Cooks River, the Giovanni Brunetti Bridge (Marsh St / Airport Dr), the Gardeners Road Bridge, and the Princes Highway / May St intersection. The area includes downstream portions of Bayside Council, such as Cahill Park at the eastern bank of the Cooks River and portions of Sydney Kingsford Smith Airport south of Alexandra Canal, as it was expanded to incorporate water level conditions in the two open channels at the southern boundary of the site.

A grid with 2 m by 2 m cell size was adopted in order to provide sufficient detail for roads and overland flow paths. The grid sampled terrain from a 1 m by 1 m DEM generated from LIDAR data recorded in 2013 (see **Section 3.2** for further discussion). For inflows, local runoff hydrographs were extracted from the DRAINS model and applied to the 2D domain of the TUFLOW model at the downstream end of the sub-catchments.

Downstream boundary conditions for the open channel water levels where determined by determining design storm flood levels for Alexandra Canal from previous flood studies. As is common for coincident flooding for localised catchments and larger mainstream waterways is for tailwater conditions to represent more frequent flood events. A summary of the adopted tailwater conditions for Alexandra Canal is included in **Table 3-1**.

Roughness coefficients within the Flood Study model for different flow paths were adopted based on site inspection and correspondence to similar floodplain environments, and consistency with AR&R 2016 revision guidelines. Buildings and other structures were incorporated into the model as flow path obstructions, with reduced building footprints included in the model to allow for flow between buildings in the model. Bridges were modelled as 1D features within open channels. All pipes equal to or smaller than 300mm in diameter were assumed to be fully blocked and not included in the Flood Study model. The catchment drainage system defined in the model included 225 pipes, 259 pits / nodes, and 288 open channel segments.

Table 3-1 Tailwater Conditions Adopted in the Alexandra Canal Flood Study Model (WMAwater, 2017)

Design Storm AEP	Local Catchment Rainfall Storm AEP	Tailwater Condition
50%	50%	HHWS Ocean Level 1.25m AHD
20%	20%	HHWS Ocean Level 1.25m AHD
10%	10%	HHWS Ocean Level 1.25m AHD
5%	5%	HHWS Ocean Level 1.25m AHD
2%	2%	5% AEP Ocean Level 1.4m AHD
1% (Enveloped)	5%	1% AEP Ocean Level 1.45m AHD
	1%	5% AEP Ocean Level 1.4m AHD
PMF	PMF	1% AEP Ocean Level 1.45m AHD

The joint hydrologic / hydraulic model was calibrated based on the 25th April 2015 event by comparing flood affectation at various locations. The model was found to effectively replicate some degree of flood affectation at those locations when compared to council data. Verification of design storm model results was undertaken through comparison to previous studies.

Sensitivity analyses were conducted for the 1% AEP and 5% AEP models based on hydrologic routing lag, Manning's roughness values, pipe blockage, and climate change both rainfall increase (10%, 20%, and 30%) and sea level rise (0.4m and 0.9m).

Design storm result analysis and mapping included peak depths, levels and velocities. The analysis also included a pipe capacity assessment. In addition, the 20% AEP, 5% AEP, 1% AEP and PMF events also had provisional hydraulic hazard, hydraulic categorisation (floodway, flood storage, and flood fringe) and the 1% AEP and PMF events also had flood emergency response classifications.

A provisional Flood Planning Area (FPA) and Flood Control Lot tagging was conducted for the Study Area. The report also briefly summarised the relevant flood development controls for the Study Area.

Four flooding hotspots were identified in the Flood Study which were:

> Hotspot 1 – Holbeach Avenue, Bay Street and Old Street, Tempe;

> Hotspot 2 – Canal Road and Burrows Road, Tempe;

> Hotspot 3 – Princes Highway, Barwon Park Road and Crown Street, St Peters; and

> Hotspot 4 – Princes Highway, Talbot Street and Bellevue Street, Sydenham.

Refer to **Section 7.5** for a map of the hotspot locations.

3.1.2 Flood Study Data Provided

As part of project inception, Inner West Council provided Stantec with the following data related to the Alexandra Canal Flood Study (WMAwater, 2017):

> DRAINS hydrology models and associated input files for all calibration, sensitivity, and design storm runs. Included in these model inputs is GIS versions of drainage sub-catchments;

> TUFLOW hydraulic models and associated input files for all calibration, sensitivity, and design storm runs. Included within this is GIS such as roughness layers, building polygons, modelled pit and pipe data, model topography, and other relevant model inputs;

> PDF versions of the final report;

> GIS versions of all peak model results for calibration and design storms runs including depth, velocity, water level, provisional hazard, hydraulic categorisation, pipe capacity and others;

> Flood control lots database and GIS layer and the FPA in a GIS layer.

This data provided by Council formed the basis of the review of the Flood Study.

3.2 Survey Information

The Flood Study model (WMAwater, 2017) was constructed utilising the following available data:

> LIDAR data collected in 2013 and obtained from the Land and Property Information (LPI) division of the NSW Government Department of Finance, Services and Innovation. Open water and vegetation also tend to affect the accuracy of LIDAR data. A 1 m x 1 m Digital Elevation Model (DEM) was constructed from the LIDAR to form the basis of the TUFLOW model.

> Ground and floor level survey at select locations from the previous Alexandra Canal Catchment Drainage Study (Lucas Consulting Engineers, 1998), used to verify the LIDAR data and was found to have an average elevation difference of 0.04 m.

> Tempe Wetlands remediation and earthworks construction drawings by Stantec in 2004 – appended to the LIDAR DEM as the high presence of water and vegetation at the wetlands made LIDAR less accurate.

> In addition to these Flood Study model terrains, Stantec sourced several other LiDAR and DEM datasets for this study. Review of the following LiDAR sources has been conducted (refer to **Section 3.6.2**):

> LiDAR points provided by Council from an unknown source and date covering part of the Study Area;

> The ELVIS - Elevation and Depth - Foundation Spatial Data website was accessed with two datasets available from the website. The files appear to have been recorded on the following dates:
  - 2013-04-10 – 1m x 1m ASC grid data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA94 and MGAz56; and
  - 2020-05-10 - 1m x 1m TIFF data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA2020 and MGAz56.

3.3 GIS Data

As part of project inception, Inner West Council provided Stantec with the following GIS data for the study:

> Local Environment Plan (LEP) land use zone mapping and Acid Sulfate Soil (ASS) layer;

> LGA Boundary layer;

> LiDAR data from an unknown source and date covering part of the Study Area;

> Stormwater pit and pipe network;

> State Environmental Planning Policy (SEPP) 2016 Coastal Management layer; and

> Aerial imagery from an unknown source and date.

Aside from these GIS layers provided by Council during the early stages of the project, various other publicly available GIS layers were sourced by Stantec for this study including high quality aerial imagery from NearMap (2021) recorded at various periods for the Study Area and its surrounds. This aided in not only providing details about the current site, but also the historical site at the time of the Flood Study. Another example is the various flora and fauna and heritage GIS databases described in **Section 2**.

3.4 Site Inspection

Site inspections of the Study Area were conducted by Stantec representatives on 14 May 2021. In total, 23 different sites within the Study Area were visited, all in areas identified as flood affected based on Flood Study outcomes. The location of the sites visited is shown in **Figure 3-1**. The site visits provided the opportunity to review the following:

> Review flood hotspots identified in the Flood Study (WMAwater, 2017), and the flood study model results compared to the observed topography and layout of the site;

> Review of site layouts and the elevations of floor levels for buildings in the vicinity of flooded areas to help inform the development of a floor level survey scope;

> Noting of the current development of the Study Area with some large-scale changes in the area recorded such as the St Peters Interchange site, regrading of the sports field at Tempe Recreation Reserve, and the ongoing development on Princes Highway near Campbell Street; and

> Initial review of opportunities and constraints for potential future flood mitigation options.

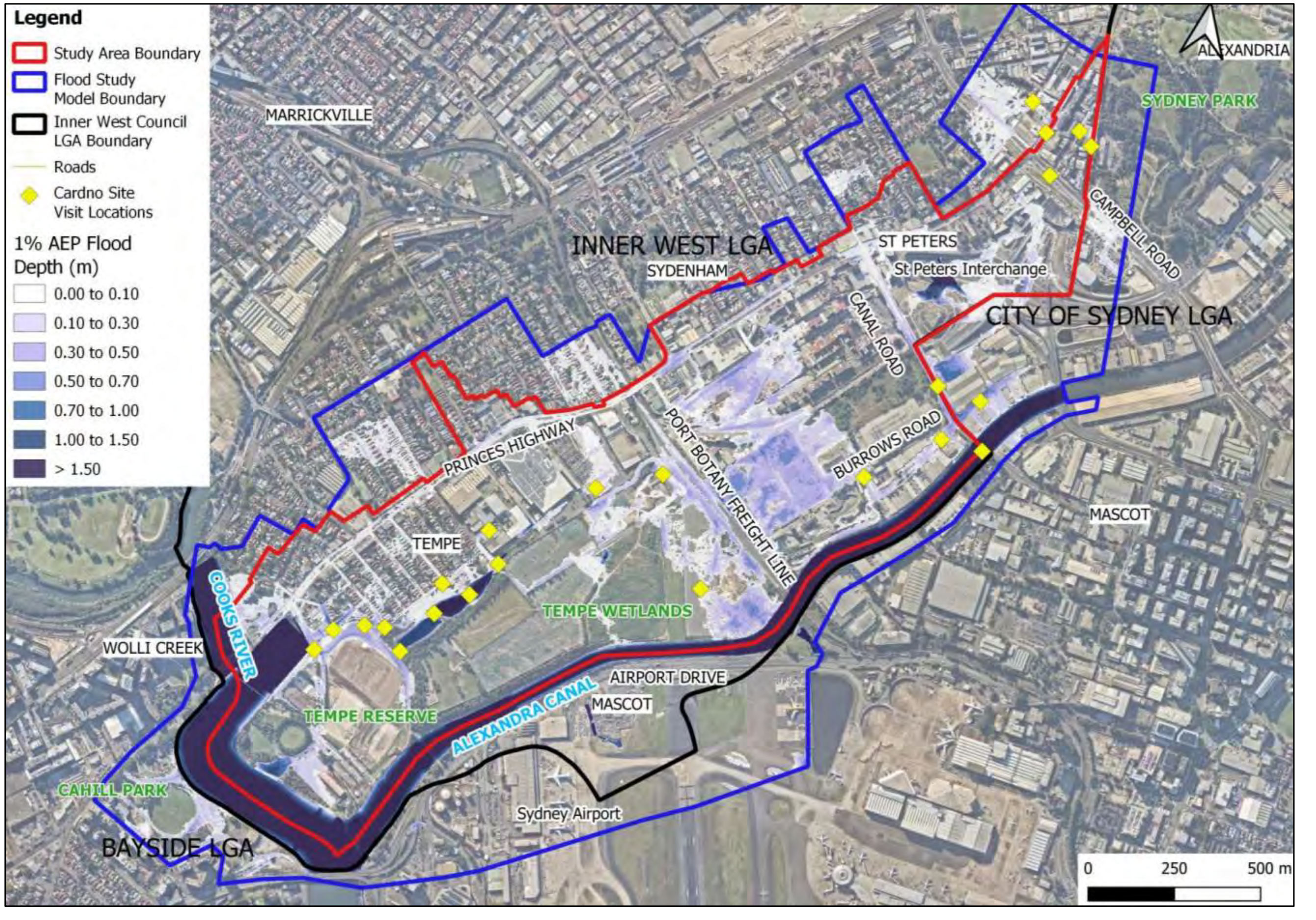

Figure 3-1 Site Locations for Alexandra Canal Study Area Visited by Stantec on 14 May 2021, with Underlay of Peak 1% AEP Depth Results from the Flood Study (WMAwater, 2017). This should be Figure 3-1.

3.5 Floor Level Survey

Floor level survey was prepared for the Alexandra Canal catchment as part of this Study. In total, 36 floor levels were surveyed. For flood affected buildings that did not have surveyed levels from the survey, floor levels were estimated as discussed further in **Section 6.2.3**.

3.6 Flood Study Model Review and Update

Since the completion of the Alexandra Canal Flood Study in 2017, several developments have occurred in both floodplain management guidance and standards and in the Study Area itself. These changes have the potential to impact the suitability of the Flood Study model in accurately representing the Study Area and its flood behaviour. Therefore, in order to confirm these potential impacts of these changes, a model review process has been conducted accounting for these changes in updated 1% AEP and 5% AEP models. The following model updates were included in this review process:

> Adoption of the AR&R 2019 design rainfall method as opposed to the AR&R 1987 method adopted in the Flood Study model;

> Updates to the model topography to reflect development and changes in the Study Area post-2013; and,

> Updates to the model building polygons to reflect development and changes in the Study Area post-2013.

> These updates are detailed further in the following sections with model outcomes from this review discussed in **Section 3.6.5**.

3.6.1 AR&R 2019 Design Rainfall Update

3.6.1.1 Background

An important change has occurred in the development of flood estimation in Australia, with the release of Australian Rainfall and Runoff 2016 (AR&R 2016). On 25 November 2016, Geosciences Australia announced that:

The AR&R 2016 Guidelines have now been officially finalised, providing engineers and consultants with the guidance and datasets necessary to produce more accurate and consistent flood studies and mapping across Australia, now and into the future.

Following this, the AR&R 2019 update was released which included minor updates to AR&R 2016 without changes to the edition. There are specific changes to the methodology for estimation of flood behaviour compared to the AR&R 1987 methodology that was adopted in the Alexandra Canal Flood Study (WMAwater, 2017). These include:

> Rainfall – the Bureau of Meteorology (BoM) has re-analysed all the Intensity-Frequency-Duration (IFD) parameters across Australia, incorporating 30 further years of data and many more rainfall stations. The method of derivation has also changed, meaning the previously used IFD coefficients have been updated. It is also noted that the standard reporting for storm duration has been reduced;

> Design Storms – AR&R 2019 recommends the utilisation of a suite of design rainfall temporal patterns, with ten patterns for each Annual Exceedance Probability (AEP) and duration of event;

> Storm Loss Rates – AR&R 2019 recommends the use of initial and continuing loss rates for design storms, and is no longer recommending the use of runoff coefficients for hydrological modelling. The loss rates provided are also for the entire storm, as opposed to the burst losses adopted in AR&R 1987; and

> Storm Loss Rates – AR&R 2019 provides for the use of three types of area when assessing loss rates - directly connected impervious areas, indirectly connected impervious areas and pervious areas. The document also provides guidance as to the calculation of these areas.

3.6.1.2 Design Rainfall Update

In AR&R 1987, there was a single temporal pattern defined for each storm burst duration of interest. This limited the number of runs required to identify the critical storm burst duration within a catchment. In AR&R 2019, ten temporal patterns are provided for each storm burst duration.

As part of this model review, all ten temporal patterns were run for each storm burst duration and the median peak flow was determined at each location of interest. It is noted that this requires a ten-fold increase in hydrological assessments to identify the critical storm burst duration, which may vary depending on location within the catchment. Furthermore, no single temporal pattern will give the median peak flow and that rather the temporal pattern (which gives the peak flow closest to, but higher than, the median flow) has been adopted for assessment purposes.

As part of this model review, the DRAINS model from the Alexandra Canal Flood Study was updated to AR&R 2019 rainfall for the 1% AEP (1 in 100 year), and 5% AEP (1 in 20 year) events. For both design events all ten temporal patterns were prepared for the 30, 45, 60, and 90 minute and 2 hour storms. Compared to the AR&R 1987 critical duration of 60 minute, these modelled durations provided sufficient scope to encompass any potential shift in critical duration as part of the AR&R 2019 update.

3.6.1.3 Review of Rainfall Loss Approach

AR&R 2019 recommends the use of the initial / continuing loss approach, whereas the Flood Study model used Horton Loss model which is the default loss model for DRAINS with ILSAX hydrology. Stantec conducted a review of the adopted Horton losses from the Flood Study compared to an equivalent initial / continuing loss approach as recommended in AR&R 2019.

The equivalent initial / continuing losses suitable for the Study Area were concluded to be:

> 1% AEP – initial loss 6.4 mm and continuing loss 0.7mm / hour;

> 5% AEP - initial loss 8.5 mm and continuing loss 0.7mm / hour.

The losses were adopted using the Antecedent Moisture Condition (AMC) of 3.0 as adopted in the Flood Study model. In addition, a sensitivity check to an AMC of 3.5 was conducted. The outcomes of the total loss comparison showed for both AMC 3.0 and 3.5 total losses are similar for the shorter durations such as the 15 and 20 minute events. However, as the burst duration increases the Horton Losses becomes higher than that estimated by the Initial-Continuing loss model.

Nevertheless, the comparison shows that the choice of loss model is unlikely to make a significant difference to model results as the critical duration was assumed to be relatively short, the catchments are highly impervious so rainfall losses have less affect, and the rainfall excess is much higher than the losses for the 5% & 1% AEP events.

Therefore, the Horton loss curves from the Flood Study model were retained within the review model.

3.6.1.4 Review of Other Model Assumptions

Stantec also conducted a high-level review of other Flood Study model components. It was found that the model set-up was generally appropriate including surface roughness, impervious percentage, and pit and pipe modelling. For time of concentration calculation, the Kinematic Wave equation was adopted which is not typically utilised for large, piped catchments, however as calculated travel times are in the appropriate range, this was not considered a concern.

3.6.2 Topography Review and Update

Since the Flood Study model was completed, the catchment has undergone a substantial amount of change and development. As covered in **Section 3.2**, the Flood Study model terrain was based on LiDAR data recorded in 2013, sourced from the ELVIS website from 10 April 2013. A review was undertaken to assess the adequacy of the model terrain by comparing to newer LiDAR data collected May 10, 2020 sourced from the ELVIS website (refer to **Section 3.2** for further details).

Comparing the Flood Study model terrain to the newer DEM showed that the terrain differences between 2013 and 2020 data are largely within +/- 0.2 metres outside of building footprints, with notable exceptions where significant development has occurred. A comparison of Flood Study model terrain and 2020 LiDAR data is included in **Figure 3-2**.

Generally across the entire Study Area, it was not clear the 2020 terrain provides better accuracy than the 2013 terrain. Therefore the Flood Study model terrain was thus retained in the updated Flood Study Model for Alexandra Canal Study Area, with exceptions for the specific sites discussed below.

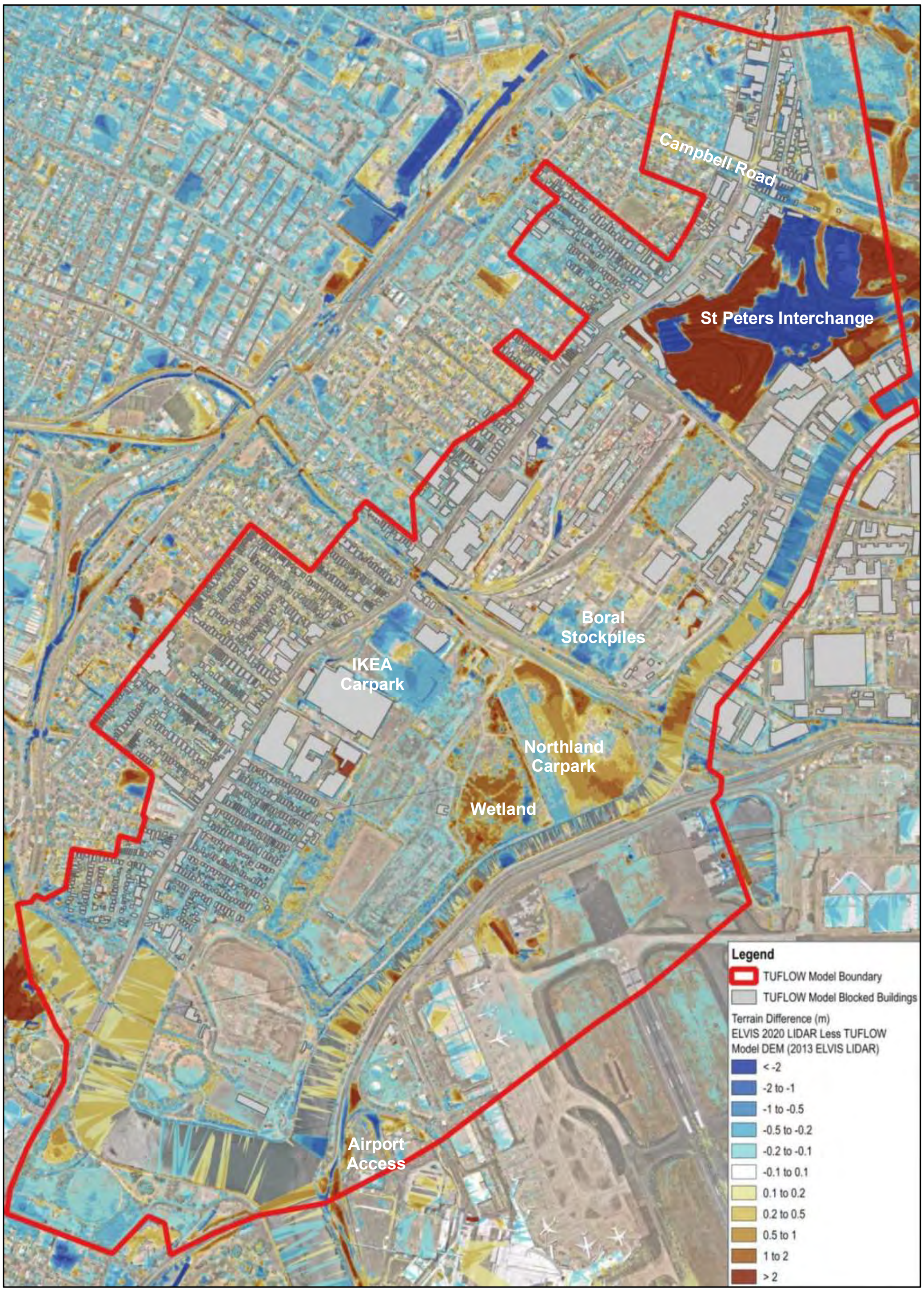

Figure 3-2 Terrain Differences - 2020 LiDAR Less 2013 LiDAR Used in the Alexandra Canal Flood Study with Labels of Key Sites

The sites with significant terrain differences outside of building footprints appear to be:

> The St Peters Interchange: The St Peters Interchange of Westconnex was transformed from undeveloped industrial area in 2013 to major road interchange site by 2020, with the majority of site alteration assumed to be at or near completion at the date of this report. This has resulted in the significant terrain changes from 2013 to 2020 LiDAR data, not only within the interchange site, but also along portions of Campbell Road north of the interchange that underwent road upgrades. Therefore, the terrain has been updated to include the 2020 LiDAR for the St Peters Interchange and adjoining Campbell Road reserve;

> Northland carpark: The Northland carpark was installed on the northern side of Alexandra Canal to provide additional parking for Sydney Airport. This included the construction of the Nigel Love Bridge over Alexandra Canal. This work commenced in 2015 and completed in 2016. Comparing the 2013 and 2020 terrains at this location, it appears the carpark has resulted in fill of between 0.5 – 2 metres above previous ground levels. There is also a triangular stockpile of material located adjacent to the carpark south of the rail corridor with fill depths from 2013 terrain of over 2 metres. Since the 2020 terrain appears to be a reasonable representation for the present-day Northlands Carpark, the updated Flood Study model was revised to include 2020 LiDAR for this area. Waterway opening details for the Nigel Love Bridge over Alexandra Canal were estimated based on Google Streetview images, and it was concluded that the soffit of the bridge was higher than peak flood levels, therefore no flood impacts from the bridge were anticipated. Therefore the bridge was not modelled in the updated model;

> The large heavily vegetated wetland to the west of Northlands Carpark also shows significant terrain differences between 2013 and 2020 (over 2 metre increases in some areas, with decreases of over 2 metres in other areas). As this land use has not changed over this time it is assumed that these terrain differences are resulting from changes in vegetation levels over this time and that the terrain has not actually changed in this wetland area, therefore 2013 LiDAR has been retained;

> International airport access road ramps: On the east side of Alexandra Canal, upgrades have been made to the access roads and ramps to the International Airport since 2013. As this area is on the downstream boundary of the model, outside of the LGA, and near the confluence with Cooks River it is not expected that any terrain changes in this area would materially alter the modelling outcomes or any consideration of potential flood mitigation options. Therefore, the Flood Study model terrain was retained at this location;

> IKEA / Decathlon carpark: The east side of the IKEA carpark shows significant reductions in levels from 2013 to 2020 terrain. This could be attributed to the works on the carpark area from 2017 to 2018 relating to the construction of the Decathlon building. The 2020 terrain appears to be a reasonable representation for present-day IKEA / Decathlon carpark, therefore the updated Flood Study was revised to include 2020 LiDAR for this area;

> The Boral Concrete site has two large areas for material stockpiling located north-east of Northland carpark. The 2020 terrain shows stockpile surfaces of these areas up to 2 metres lower than in 2013. It is assumed that the volumes of stockpiled materials for these areas is constantly fluctuating, however it has been assumed that 2020 terrain, with its lower levels is closer to the permanent site elevation. Therefore the 2020 LiDAR has replaced the model terrain for the stockpile portions of the Boral site; and

> There are some narrow sections of significant differences along the perimeters of the rail corridor. With no knowledge of any major recent works along this corridor, these differences are also presumably due to slight spatial misalignments. The Flood Study model terrain was retained at this location.

3.6.3 Model Building Polygon Review and Update

The Alexandra Canal Flood Study model assumed full blockage of building footprints by removing building polygons from the 2D terrain of the model. Generally, this approach is considered appropriate. A review was conducted of building footprints from the Flood Study TUFLOW model and more recent 2020 Geoscape building footprints provided by DCCEW, offering a detailed and more up-to-date dataset. Review of the building polygons layer showed that in most instances the polygons align with buildings shown in the aerials, but there were particular instances where this is not the case. There are presumably two reasons for building polygons not matching building locations in latest available aerials:

> The base data used in the model building polygon layer did not include some areas; and

> There has been development since the Flood Study with new or removed buildings in the area.

Instances of potential new buildings and extended buildings in Alexandra Canal were reviewed using latest available aerial imagery compared to historical aerials from the time of the Flood Study, if a building was found to have been newly constructed then this polygon was added to the updated model.

Examples of changes to the building polygon layer include:

> The addition of the Decathlon building to the model which was not yet constructed at the time of the Flood Study; and

> Conversely, there are some building footprints along Campbell Road, north of the St Peters Interchange that have been removed as part of those works. Therefore, these polygons were removed from the model to reflect this site change.

3.6.4 Drainage of Major Developments

In addition to the known terrain and building layer alterations that were accounted for in the updated model, as discussed in the previous two sections, the impacts on site drainage for significant current and future development was also considered. There are two notable large-scale projects underway in the Study Area as summarised previously in **Section 2.5**, which were accounted for in the updated model through:

> St Peters Interchange site was modelled through updated terrain to account for post-construction conditions. The assumption was that stormwater drainage was suitably designed to discharge to Alexandra Canal therefore site inflows for the model were discharged directly to Alexandra Canal in the updated model.

> Sydney Gateway project was not accounted for in the updated model set-up. At the time of model set-up there was no publicly available information for the project. The assumption was that appropriate design for the project would take place such that no significant impacts compared to pre-construction conditions would occur, and therefore pre-construction conditions were maintained in the updated model. As shown in the water level impact results for the Sydney Gateway project in **Section 2.5.2**, sourced from a report that was made publicly available subsequent to the updated model set-up, the 1% AEP impacts of the project are at most 0.01 – 0.02m, confirming this assumption.

3.6.5 Model Review Results

The model updates discussed in the above sections were incorporated into a review model for the 1% AEP and 5% AEP events, with the outcomes of this modelling summarised in the following sub-sections.

3.6.5.1 Critical Duration

For both the 1% AEP and 5% AEP events, all ten temporal patterns were prepared for the 30, 45, 60, and 90 minute and 2 hour storms. Of the ten temporal patterns for each duration, the median pattern was selected for each duration, and then these duration median results were combined to create the peak flood results. The critical durations for the 1% AEP and 5% AEP from the updated modelling is shown in **Figure 3-3** and **Figure 3-4** respectively.

The critical duration for the majority of overland flow areas of the Study Area is the 30 minute storm, with some section of 60 minute, 90 minute and 2 hour being critical. Compared to the Flood Study AR&R 1987 critical duration of 60 minute, the shorter critical duration for AR&R 2019 is in keeping with Stantec's past experience on updates to AR&R 2019 where the critical duration has been found to almost always shorten.

3.6.5.2 Peak Water Level Differences

A comparison of peak water level differences for the updated AR&R 2019 model compared to the Flood Study AR&R1987 model for the 1% AEP and 5% AEP from the updated modelling is shown in **Figure 3-5 and Figure 3-6** respectively.

The results show that throughout the Study Area, the proposed revision to AR&R 2019 has resulted in reductions in peak water level results for both the 1% AEP and 5% AEP events. These reductions in peak water level results are in keeping with Stantec's past experience on updates to AR&R 2019 across NSW, where the severity of peak flooding was almost always reduced as a result of AR&R 2019 updates.

Water level reductions from the Flood Study results are not significantly different, typically anywhere from -0.01 metres to -0.2 metres for both the 1% AEP and 5% AEP events. There are some areas of more significant differences such as in the Tempe wetland basins, however these more significant differences are typically quite isolated.

The terrain and building polygon changes do result in some minor areas of water level increases such as near Northland carpark where the change in terrain has caused reduced flooding on the north-west side of the carpark but on the canal side of the carpark water levels are slightly higher.

The removal of inflows into the St Peters Interchange has removed flood affectation of this site as it has been assumed the drainage for this site will discharge stormwater directly into Alexandra Canal. The changes in Campbell Road with the removal of building polygons and change of terrain from the road upgrade altering flow behaviour as expected.

Updated model results also suggest that site changes post-2013 do not have a significant impact on flood behaviour within the Study Area.

In conclusion, the model updates that have been assessed appear to have a relatively minor impact on flood behaviour for the majority of the Study Area. In accordance with Stantec's experience on other AR&R 2019 updates, the peak water level results for the majority of the Study Area are minor reductions (0.01 – 0.2 metres). In this instance, in light of these updated results, the AR&R 1987 Flood Study model may be a slightly conservative estimate of design flooding in the Study Area, however not a significant difference from more up-to-date modelling approaches. .

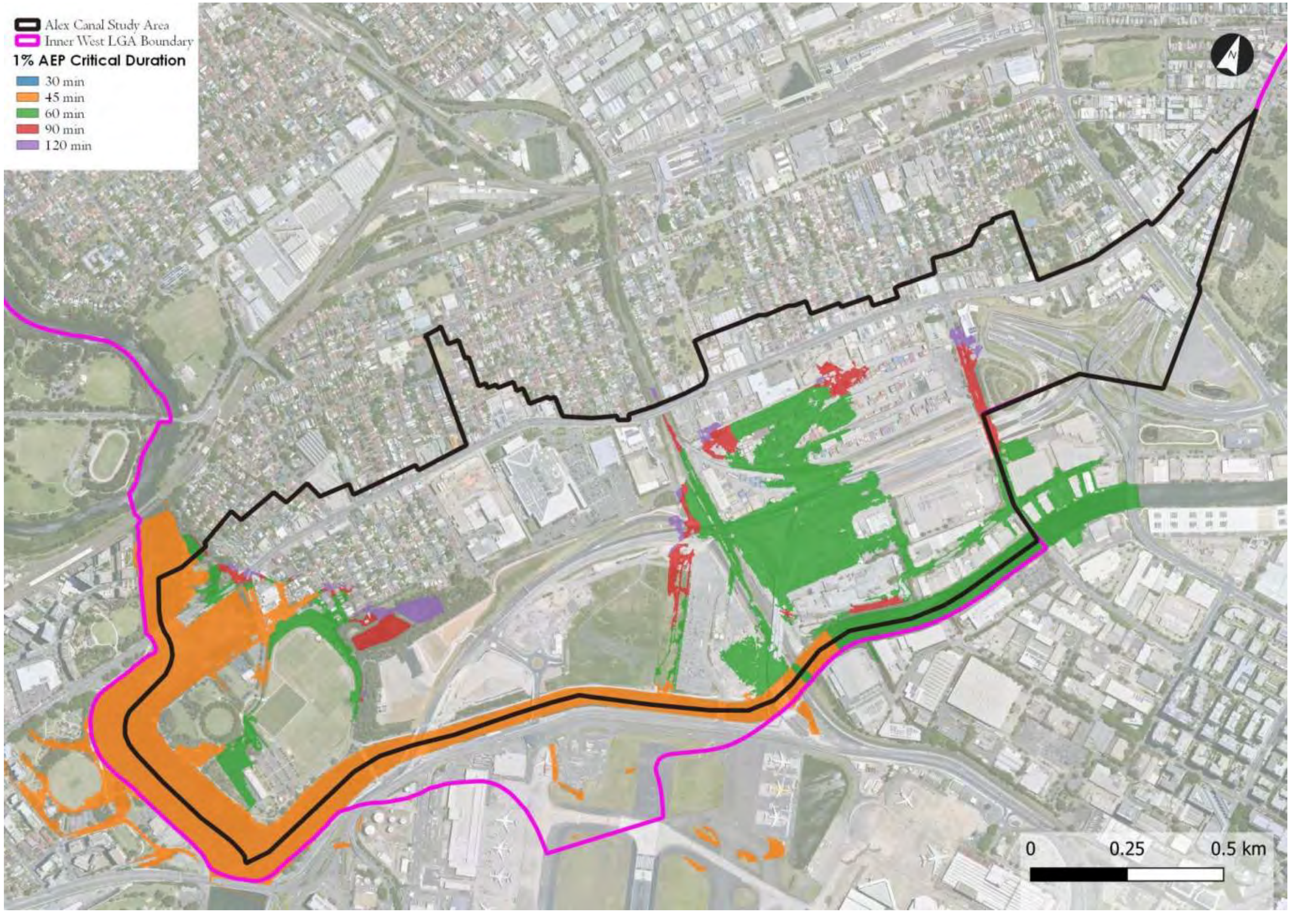

Figure 3-3 1% AEP Critical Duration Storms for Updated Model for Alexandra Canal Study Area Based on AR&R 2019 Design Rainfall Updates

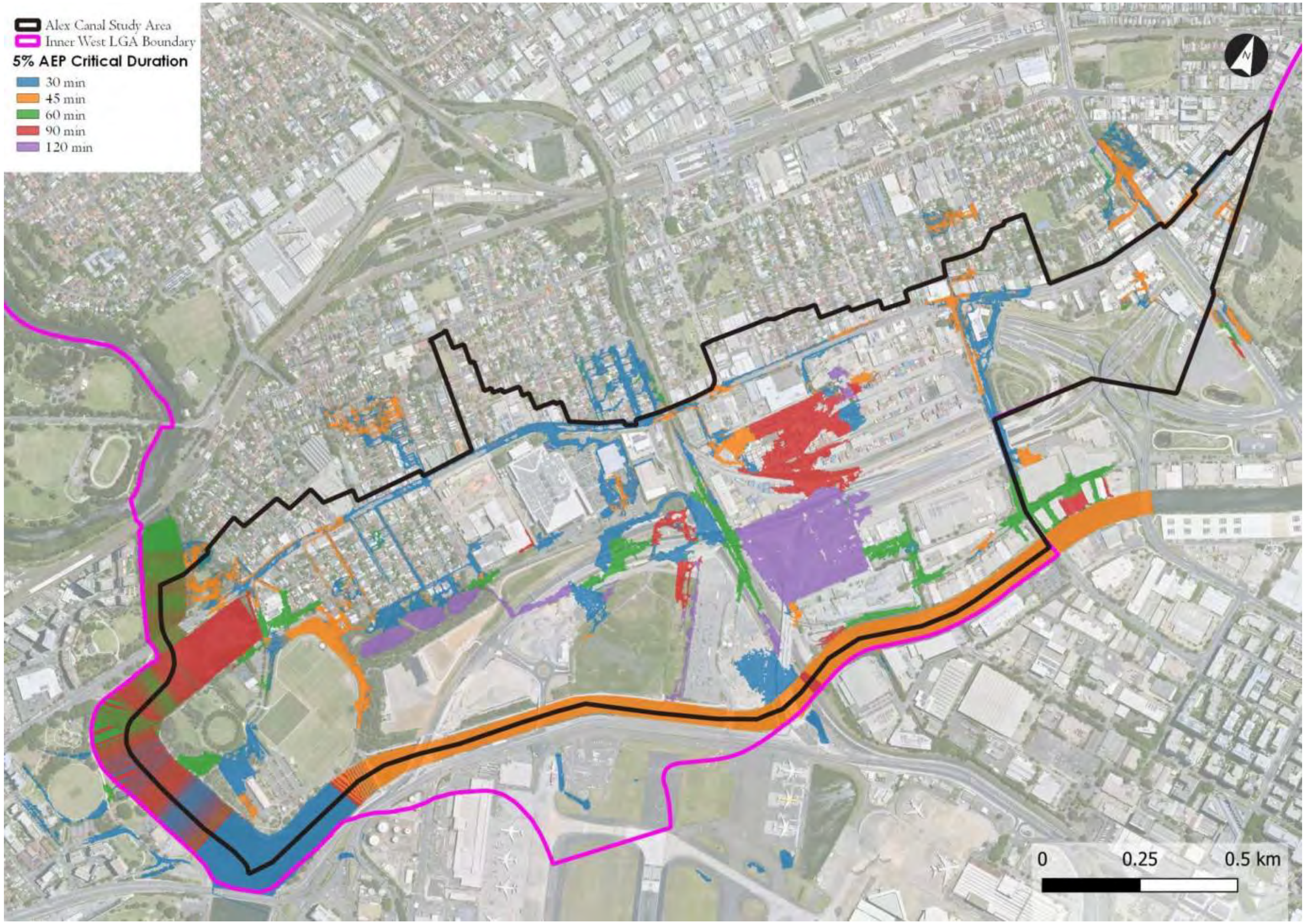

Figure 3-4 5% AEP Critical Duration Storms for Updated Model for Alexandra Canal Study Area Based on AR&R 2019 Design Rainfall Updates

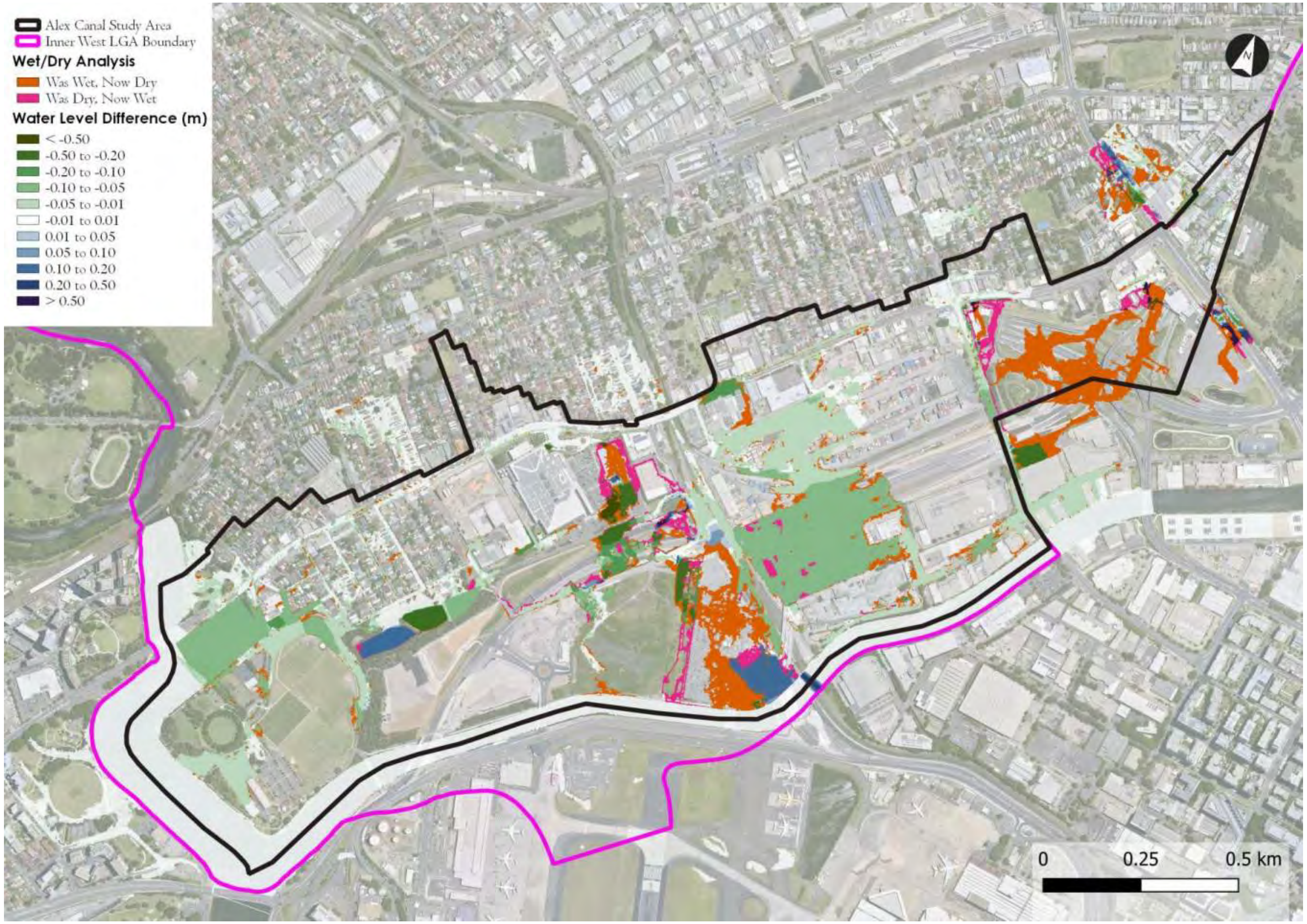

Figure 3-5 1% AEP Peak Water Level Differences – Updated AR&R 2019 Model Less Flood Study AR&R 1987

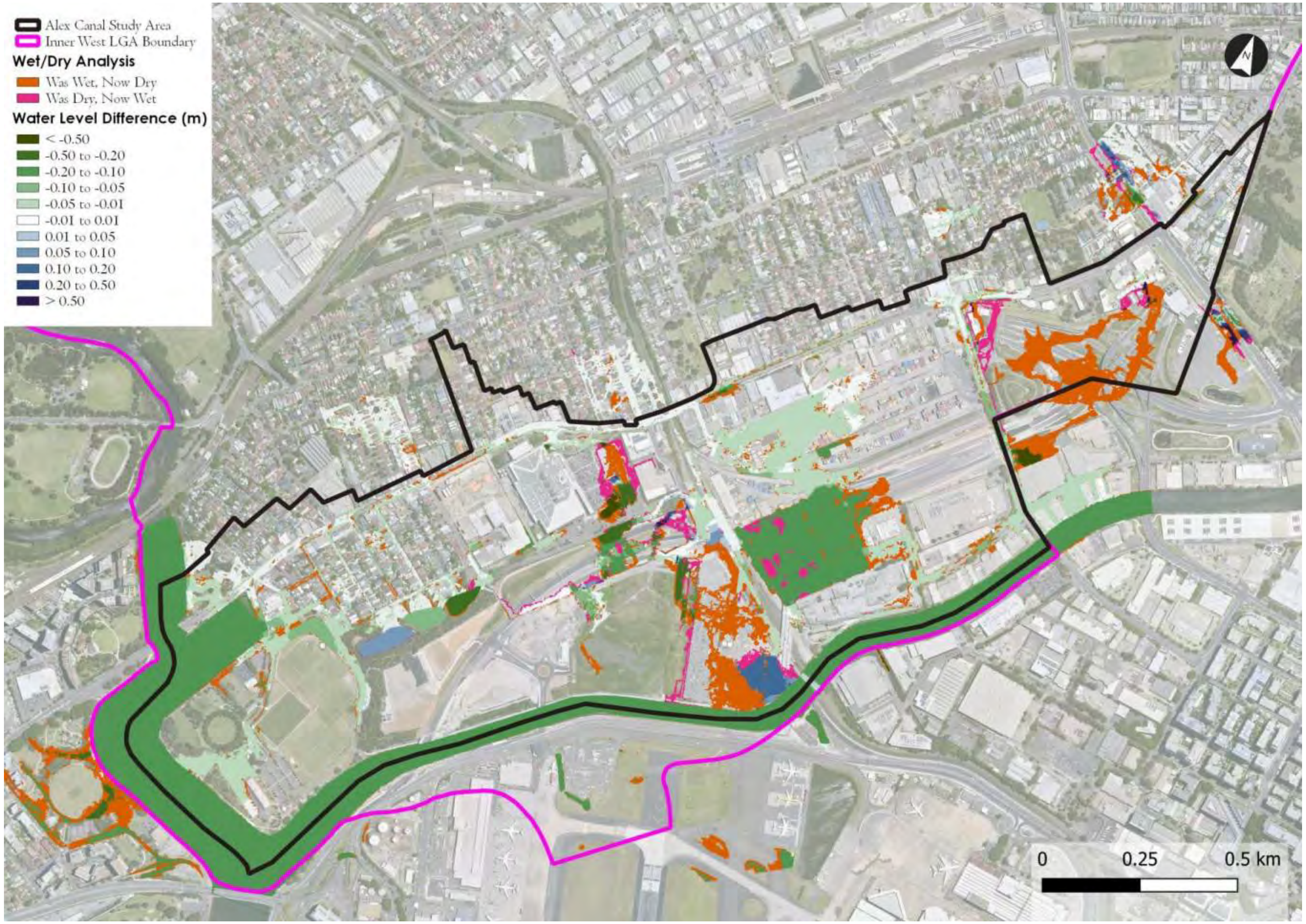

Figure 3-6 5% AEP Peak Water Level Differences – Updated AR&R 2019 Model Less Flood Study AR&R 1987

4 Consultation

4.1 Consultation Process

Consultation with the community and stakeholders is an important component in the development of a Flood Risk Management Study and Plan. Consultation provides an opportunity to collect feedback and observations from the community on problem areas and potential floodplain management measures. It also provides a mechanism to inform the community about the current study and flood risk within the Study Area and seeks to improve their awareness and readiness for dealing with flooding.

The consultation strategy has been divided into three key sections:

> Consultation in FRMS&P development: This occurs during the initial stages of the project **1.4**and involves both informing the community and stakeholders of the project and gathering information on existing flooding issues and suggestions for flood risk management options.

> Review of possible flood management options with key stakeholder groups including Council Engineers, Council Planners, NSW SES, NSW DCCEW and community representatives within Council's Flood Risk Management Advisory Committee.

> Public exhibition of Draft FRMS&P: This occurs in the final stage of the project, with comments sought from the community and stakeholders on the Draft FRMS&P report with this input reviewed and incorporated into the final FRMS&P.

The strategy has been developed in accordance with the IAP2 Quality Assurance Standard and the Inner West Council Community Participation Plan.

4.2 Consultation Plan and Engagement Techniques

A consultation plan was developed in the preliminary stages of this project involving the development of several engagement techniques to achieve the objectives of the two stages of the consultation process. Details of the plan are provided below in **Table 4-1**. The completed or drafted components of the plan to date have been shown in italics in the table.

Table 4-1 Consultation Plan

Task	Description	Expected Outcome
Press Release	Stantec will draft a press release for Council's consideration and publication.	> Public awareness of the study. > Assist in engagement with the community through the newsletter/questionnaire, workshops and public exhibition. > Assist in the public acceptance of the study outcomes and implications for development and food risk management in the future.
Stakeholder Consultation – Council	Relevant Council staff attended the inception meeting to discuss various input to the study and the proposed study approach. Key stakeholders will be consulted in an option development workshop to receive feedback on the preliminary options list.	> All available information is utilized in the preparation of the flood study. > Modelling incorporates the high risk areas. > Council objectives are achieved by the study.
Stakeholder Consultation – Flood Advisory Committee	Stantec will attend and present at four stakeholder meetings (which may include Flood Advisory Committee as deemed suitable) throughout the study.	> Update FRAC on the FRMS&P process. > Provide an opportunity for input from the FRAC on the mitigation options.
Stakeholder Consultation – Agencies	Stantec will contact relevant agency stakeholders (e.g. NSW SES, TfNSW) via letter and follow up email and/or phone.	> Inform the agencies of the study. > Obtain relevant information. > Provide an opportunity for input from the relevant agencies.

Task	Description	Expected Outcome
Community Newsletter and Questionnaire	Stantec will draft a newsletter and questionnaire for Council's consideration. Once finalised Council will print and distribute to target properties within the catchment. Responses will be via a reply-paid envelope. The brochure and survey will also be made available online by Council.	> Inform the community about the study and provide background information. > Identify community concerns and awareness > Gather information from the community on potential flood mitigation options. > Develop and maintain community confidence in the study results.
Website	Council will host a dedicated "have your say" website for the project. The website will be utilised for media release, online newsletter and questionnaire providing residents with an opportunity to locate the area of flooding on a GIS based system and upload an associated photos/videos they may wish to share.	> Collaborative community engagement process. > Provide community opportunities to provide input/feedback. > Provide key information to the community.
Community Workshops	Stantec will prepare materials for and present at 2 community workshops. One workshops will be undertaken during Stage 2 of the study to get community feedback on the preliminary flood options, the other during Public Exhibition (see below).	> Provide the community with an opportunity to comment on flood mitigation options and an understanding of the outcomes of the Draft Study and Plan.
Public Exhibition Period	Stantec to draft a press release for Council's consideration and publication.	> Inform the community of the draft Study and Plan and invite submissions. > Inform the community of the workshop.
	Council will arrange for the public exhibition of the Draft Flood Risk Management Study and Plan. One community workshop will be undertaken during the public exhibition to present the outcomes of the study and receive feedback from the community.	> Provide an opportunity for the community to review and provide comment on the Draft Study and Plan.

4.3 Council Engagement

Given Inner West Council's role in commissioning this FRMS&P, it is important that Stantec maintain constant engagement with Council's project manager throughout the project. Furthermore, NSW Department of Climate Change, Energy and Water (DCCEW) have maintained an active role in project supervision throughout the project. To date, Council engagement has been maintained through the following:

- An online project inception meeting was held on 12 January 2021 with Council and Stantec representatives in attendance. The inception meeting signified the commencement of the project and provided an opportunity for Council to outline the objectives and expectations for the study, and to provide initial guidance and direction.
- Meetings occurred as required between 2021 and 2022 as the project reached critical milestones and review points, however there were delays associated with COVID and the 2022 Flood Response.
- Fortnightly online project update meetings have been conducted since the project recommenced model changes and option analysis in January 2023 with Council, DCCEW and Stantec's project manager in attendance as well as other Stantec staff as needed. The update meetings have provided an opportunity for Stantec to update Council on the ongoing status of the project, and to ask Council for any clarifications or queries that arise during the project.
- Ongoing weekly option development and review workshops with Stantec and Council's technical working groups were held from August through to October. The list of attendees included Council's project managers and NSW DCCEW representatives for the project), as well as relevant stakeholders from technical teams in Council. The goal of the meetings was to seek feedback on the preliminary list of options and refine and identify a set of detailed options for assessment.

- Workshops were held on 13 and 27 July 2023 with Stantec, DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives to present an overview of the FRMS&P and the initial preliminary flood mitigation options.
- Additional weekly workshops were held with Council's project team and NSW DCCEW representatives during option development and modelling to review option outcomes and refinement of options. This allowed the options to be developed in light of Council and DCCEW preferences and advice.

4.4 Flood Risk Management Committee

One of the primary mechanisms by which the study team engaged in consultation with key stakeholders and the community is via the Inner West City Flood Risk Management Advisory Committee (FMAC) convened by Council. The Committee includes membership by the following individuals:

Local community representatives,

Local business representatives,

Staff from Inner West Council who have involvement in the study including coordinators , managers, strategic planners, and engineers .

SES representatives,

Floodplain Engineer from NSW DCCEW.

The first FRAC meeting for the project was held mid-2022 to discuss the progress of the project and to present the outcomes of the Stage 1 report.

Further meetings were undertaken throughout 2023 to review, seek input, and shortlist proposed flood mitigation and management options for detailed assessment and costings.

The Draft FRMS&P was presented to the Committee for feedback and support for community exhibition in early 2024 . The meeting provides an opportunity for the FRM Committee members to ask questions about the FRMS&P.

4.5 Initial Consultation

The initial consultation period was held from 7 March 2023 to 6 April 2023. The initial consultation period for this project was run jointly with the Whites Creek and Johnstons Creek FRMS&P. During this period the following materials were made available to the community:

- A dedicated community engagement page for the catchment on Council's Have Your Say website was posted for the project.. The text for the Have Your Say page has been included in **Appendix A**.
- Press release information for the study was posted to Council's social media and to Council's newsletter.
- Introductory letters were mailed to all owners and occupants of flood affected properties in the study area, which involved mail out to approximately 2,700 properties. The resident letter template provided an introduction to the study, and a link to the Have Your Say page for further information and to complete the online survey. The letter text is included in **Appendix A**.
- A resident online survey / questionnaire was hosted by Council through an online portal, with links to the online survey provided on the projects Have Your Say page. The survey text is included in **Appendix A.**

Three in-person information sessions were hosted by Council and attended by Stantec flood engineers and Council representatives. Notification of the in-person sessions was posted on the Have Your Say page and in the introductory letter (for the first session). The details for the three sessions were:

- St Peters Town Hall, 39 Unwins Road, St Peters on 15 March 2023 from 12.00 – 3.00pm
- St Peters Town Hall, 39 Unwins Road, St Peters on 15 March 2023 from 5.00 – 8.00pm
- Marrickville Pavilion, 313 Marrickville Road, Marrickville on 20 March 2023 from 12.00 – 3.00pm

4.5.1 Consultation Response Outcomes

With respect to Have Your Say outcomes from the initial consultation, there were 473 views of the project page, initiated by 414 unique visitors. The total viewing time of project information was approximately 2 hours. No community members shared their experiences of flooding via the online survey. One person contributed to the interactive map. The adopted Flood Study was downloaded 20 times.

The contribution to the interactive map was a submission noting that stormwater backs up at high tide and floods Bay Street regularly, confirming the modelled flood affectation of this area.

Across the initial consultation period there was 1 recorded response through email responses submitted to Council. In addition, there were 3 community attendees relevant to the Alexandra Canal study area to the three in-person information.

> The email response sender was interested in reviewing and in providing feedback to what Council is proposing. In response, Council replied that the Alexandra Canal Flood Study has been adopted in 2017, providing a link to the study report. Council also advised the resident that Council and its consultant are currently seeking community comments on local experience of flooding and desired measures for reduction or management, and asked the resident to provide comments via the Have Your Say page on Council’s website or to contact Council directly via telephone, email or letter.

> The 3 in-person attendees were residents, one of the 3 attendees was a resident from outside of the study area and asked questions about the flood modelling project. The other two attendees raised matters related to the study area, including one from Tempe East and one from Tempe as their area had been identified as a hot spot and mitigation options considered..

4.6 Public Exhibition Period

The public exhibition period is an important stage of any regional Flood Study or FRMS&P as it provides the community and stakeholders the opportunity to provide comment and feedback on the draft outcomes of the study prior to finalisation.

The public exhibition period for this Draft report is proposed to be conducted in Autumn 2024, for a period of at least four weeks. Comments received from the community will be considered in a Final FRMS&P report to be issued post-exhibition. Outcomes of the public exhibition shall be summarised in this section within the Final FRMS&P.

5 Flood Planning Review

5.1 Flood Affected Properties

A review of flood affected properties has been considered for the study area with a review of changes considered compared to the previous Flood Study property tagging.

The updated property list adopted the original Flood Study model results in creating flood extents. These flood extents apply the flood extent trimming of 0.15 metres depth. This more effectively removes minor sheet flows and shallow overland flows. A comparison of 1% AEP flood extents with and without the 0.15m depths filter is shown in **Figure 5-1**. The comparison shows that the untrimmed flood extents are significantly more widespread than the extents trimmed to 0.15 metre depth, showing there is significant areas of shallow sheet flow modelled in the TUFLOW model.

The number of flood affected properties for five design events are summarised in **Table 5-1**. Two forms of property tagging analysis have been considered:

> Any flood affectation of the property

> Flood extent covers at least 10% of the property area,

A review of the number of properties affected between the "10% affectation" and the "any affectation" scenarios, and the relative flood hazard affecting these properties, it was considered that the 10% affectation scenario sufficiently addressed the flood risk, requiring no updates to the flood affected lot tagging currently adopted by Council.

Table 5-1 Flood Affected Property Numbers for Private and Developed Properties (Excluding Parkland Sites) for All Design Flood Events for Base Case Flood Extents

Property Tagging	Base Case Flood Affected Property				
	20% AEP	5% AEP	2% AEP	1% AEP	PMF
Flood Affected	134	167	180	188	303
>10% Area Affectation	36	42	51	56	147
				Total Properties in Catchment	1023

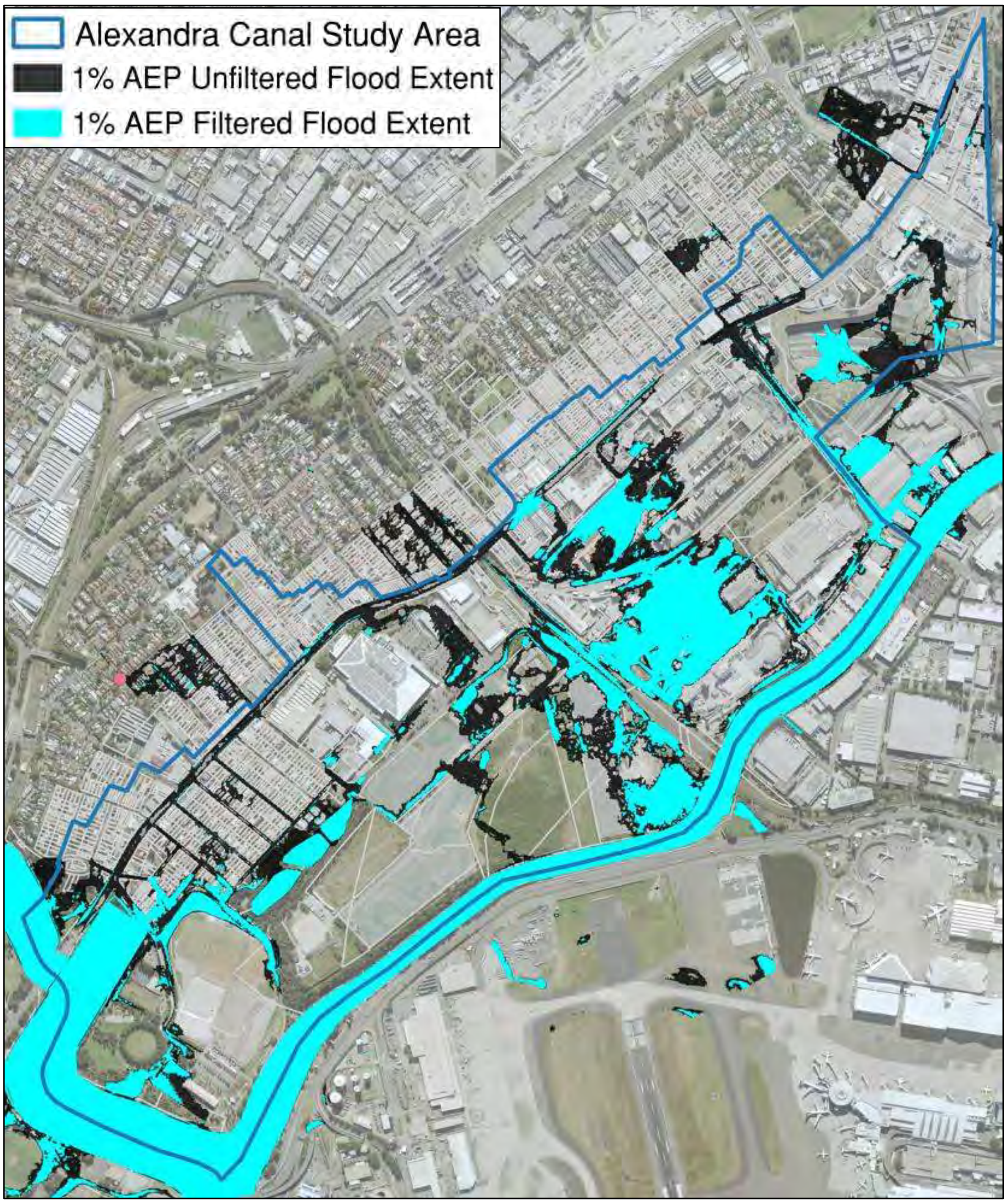

Figure 5-1 Comparison of 1% AEP Flood Extents with and without 0.15m Depth Filter Applied

5.2 Relative Flood Risk for Development Types

The relative vulnerability of development types and their users to flooding should be considered in decision-making as it can influence risk to the community. Vulnerability to flooding can vary between development types and their typical users.

The 2023 FRM Manual guideline for Flood Impact and Risk Assessment (Flood Risk Management Guide FU01) in Table 6 provides a useful resource in providing a high-level summary of flood risk for different development types of users, buildings and their contents for the same flood exposure. The summaries from this guideline for development types relevant to this Study Area have been included in **Table 5-2**.

Table 5-2 Relative Flood Risk & Vulnerability of Land Uses for the Same Flood Exposure (Source: NSW DCCEW, FRM Guide FB01)

Type of Use	Relative Risk Compared to Low Density Residential			Comment
	Users	Buildings	Contents	
Low Density Residential	Base	Base	Base	This is used as a baseline for considering relative impacts in other land uses
Medium/high density	Higher	Lower	Lower	Due to the higher density more people are involved but the buildings may be more structurally resistant to flooding. Contents may be less exposed to flooding as they may be over multiple levels
Emergency response management facility	Lower	Lower	Lower	Lower density of development and people
Aged care facility	Higher	Lower	Higher	Users on average more vulnerable in evacuation. Building may be structurally stronger. Potential for high value medical equipment
School	Higher	Lower	Lower	Users on average more vulnerable in evacuation. However, evacuation arrangements likely to be in place. Buildings and contents generally lower value
Correctional facility	Higher	Lower	Lower	May have challenges in the relocation of users therefore continued operation preferable. This relies on accessibility for staff and utility services. Buildings and contents expected to be generally of lower vulnerability
Commercial	Higher	Lower	Varies	Employees may be able to be trained to assist in response to flooding. Higher density of customers, who are likely to be unfamiliar with location or flood issue and therefore more vulnerable. Buildings expected to be generally of lower vulnerability. Contents varies substantially depending on the specific business
Industrial	Lower	Lower	Varies	Employees may be able to be trained to assist in response to flooding, customer density low, but they are likely to be unfamiliar with location or flood issue. Buildings expected to be generally of lower vulnerability. Contents varies substantially depending on the specific business
Hazardous/ offensive industry	Lower	Lower	Higher	Employees may be able to be trained to assist in response to flooding, customer density low, but they are likely to be unfamiliar with location or flood issue. Buildings expected to be generally of lower vulnerability. However, the impacts of hazardous or offensive materials could be significant and need to be considered. This may require management measures such as avoidance of flood-affected areas or effective containment of hazardous or offensive materials to limit impacts on the community or environment
Recreation	Lower	Lower	Lower	Occupied less and may be weather influenced but could be higher density of people when in use. Users often unfamiliar with flooding in the location. Buildings and contents expected to be generally of lower vulnerability or value

It is noted this guidance is a generalisation for development types, and the flood risk of any development will depend on site specifics and details of the development , not just these broad vulnerability assessments However, this provides a useful resource in understanding the relevant flood risk of different land uses. It should be consulted in the review of current land uses and future development potential in the following sections.

5.3 Future Development Potential in Flood Affected Land

5.3.1 Proposed Future Development Sites

In the preliminary stages of the project, Council reviewed submitted planning proposals within the study area and only one pre-planning proposal has been lodged on 14/12/2021 for 71-75 & 85 Crown Street and 116 Princes Highway St Peters (PPP 2021 0009). This is a pre-planning proposal and Council do not know whether they will receive a planning proposal for this site and whether it will be supported. This site location has been shown in **Figure 5-2**. As this planning proposal is located outside of the 1% AEP or PMF extents the flood risk of the site is negligible, and its consideration is not relevant to this study.

5.3.2 Future Planning Proposal Requirements

In mid-2021, NSW DCCEW released a new Flood Prone Land Policy Update. Included within this policy is a draft set of standard flood-related clauses for Local Environment Plans (LEPs) to assist local Councils. In addition, the update package included a local planning directive outlining flooding requirements in consideration of planning proposals.

A summary of the key requirements of the local planning direction for planning proposals and their relevance to the future development potential of Alexandra Canal Catchment is included in **Table 5-3**.

To assist in the discussion of planning proposal requirements related to floodway and high hazard areas, these two maps for the 1% AEP have been overlaid on current land use zoning as shown in **Figure 5-3** and **Figure 5-4** respectively.

The outcomes from **Table 5-3** suggest that development and particularly potential intensification should be prioritised in the flood free portions of the study area where possible. However, the high-level review suggests there is still redevelopment potential within parts of the floodplain.

The guide on flood risk of development types summarised in **Section 5.2**, should be reviewed as a general guide when assessing potential future changes in land use in the floodplain.

Table 5-3 Planning Proposal Requirements and Relevance to Alexandra Canal Catchment

Planning Proposal Requirement	Relevance to Alexandra Canal Catchment
A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.	Based on this requirement there is limited development potential for the flood affected portions of sites that are currently zoned as recreation or special purpose including parts of Tempe Recreation Reserve and Tempe Lands as well as any zoned Council park sites.
A planning proposal must not contain provisions that apply to the flood planning area which:	
▪ permit development in floodway areas,	Assumed to be the 1% AEP floodway. As shown **Figure 5-3** the floodway extents in the study area are relatively well confined within Alexandra Canal, Cooks River, existing road corridors, and in other small, isolated areas. Therefore, this requirement should not significantly impact many potential redevelopment sites in the study area. Floodway areas also extend to the industrial areas along Princes Highway between Smith Street and Swamp Road and to a smaller extent some residential areas, such as on Bay Street between Quarry Street and Cook Street, as well as Hart Street between Princes Highway and South Street. Development potential for these areas may be limited by this requirement.
▪ permit development that will result in significant flood impacts to other properties,	This requirement would need to be assessed through flood impact assessments on a site-by-site basis with detailed assessment of proposed development plans
▪ permit development for the purposes of residential accommodation in high hazard areas,	Assumed to be the 1% AEP high hazard. As shown in **Figure 5-4** the high hazard extents in the study area are relatively well confined within Alexandra Canal, Cooks River, existing lakes/ponds in Tempe lands, and in other small, isolated areas. Therefore, this requirement should not significantly impact many potential redevelopment sites in the study area.

Planning Proposal Requirement	Relevance to Alexandra Canal Catchment
	An exception to these areas is the high hazard identified at St Peters Interchange. The flood model has not incorporated potential changes to the flooding behaviour in this area introduced by the ongoing construction of the St Peters Interchange.
▪ permit a significant increase in the development and/or dwelling density of that land,	This requirement will need to be considered in potential intensification of development in the floodplain. It is possible that intensification in flood affected areas may be feasible if flood risk is suitably addressed. However potential intensification should be prioritised in flood free portions of the study area.
▪ permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	These vulnerable development types should not be proposed within the 1% AEP floodplain where possible. As discussed further in **Section 7.3.2**, there are a number of these existing vulnerable developments within the floodplain, the alteration of these sites to improve flood risk should be considered.
▪ are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	Further review of flood emergency management concerns for the study area is included in **Section 7**. Development potential in identified flood emergency hotspots should be avoided based on this requirement. That is unless a potential redevelopment could justifiably be shown to reduce the emergency response burden for an existing site.
▪ permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	This is a particular concern for areas in this catchment where the current general industrial zoning in flood affected areas may allow future developments to pose a risk of uncontained hazardous materials. The industrial areas along Princes Highway between Smith Street and Swamp Road are currently predominantly industrial retail outlets.
A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which include items listed above.	Similar to the above response, vulnerable developments should not be prioritised within PMF affected lands where possible. This also relates to critical infrastructure types for flood emergencies (refer to **Section 7.3**).
For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the FRM Manual 2023 or as otherwise determined by a Flood Risk Management Study or Plan adopted by the relevant council.	The flood planning level should be maintained at the 1% AEP plus 0.5 metre freeboard as in the Inner West LEP and is recommended in the current Flood Prone Land Policy Update. There is no clear evidence that flood behaviour in the study area would justify an alternative FPL.

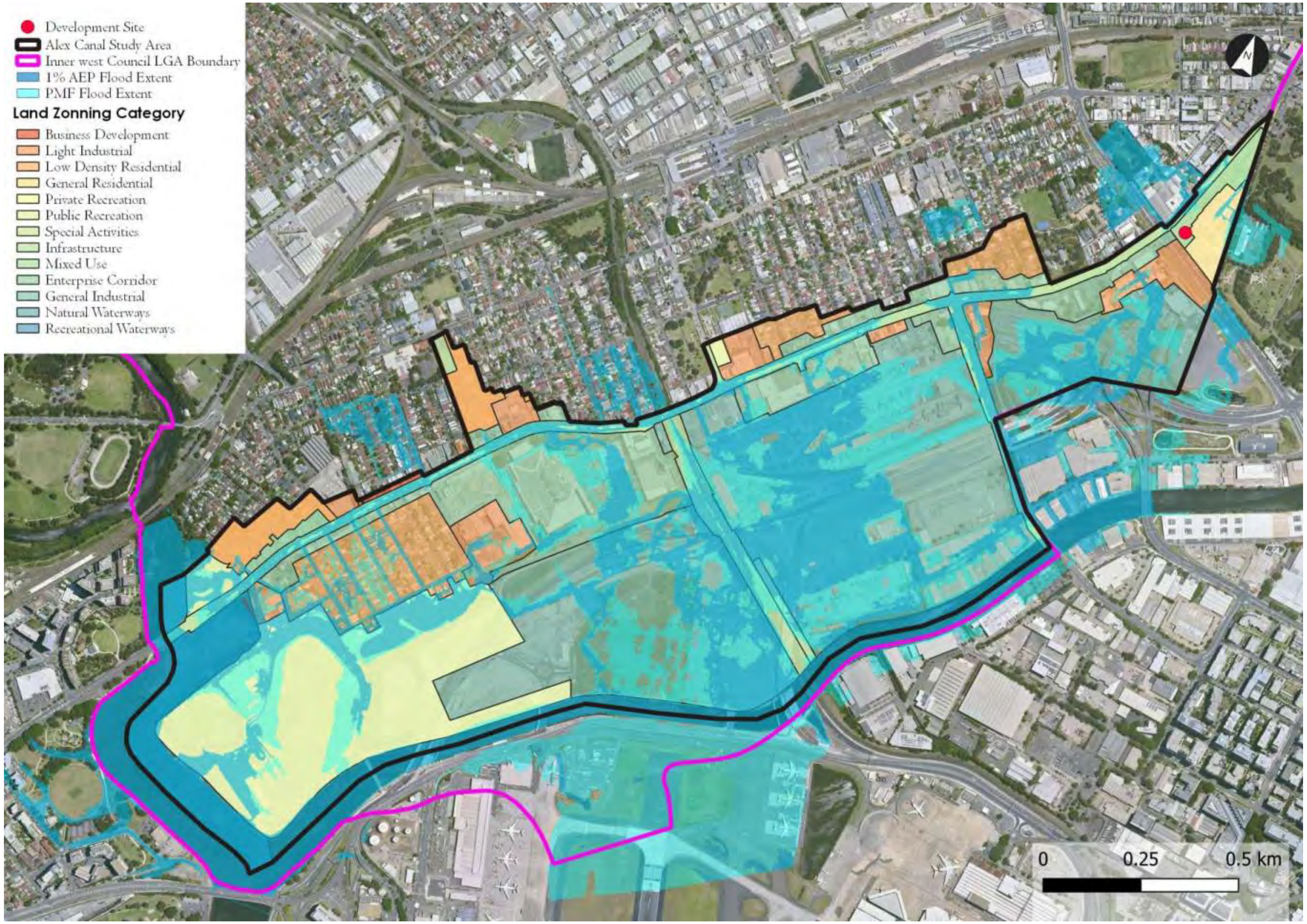

Figure 5-2 Current Land Use Zoning with 1% AEP and PMF Extents

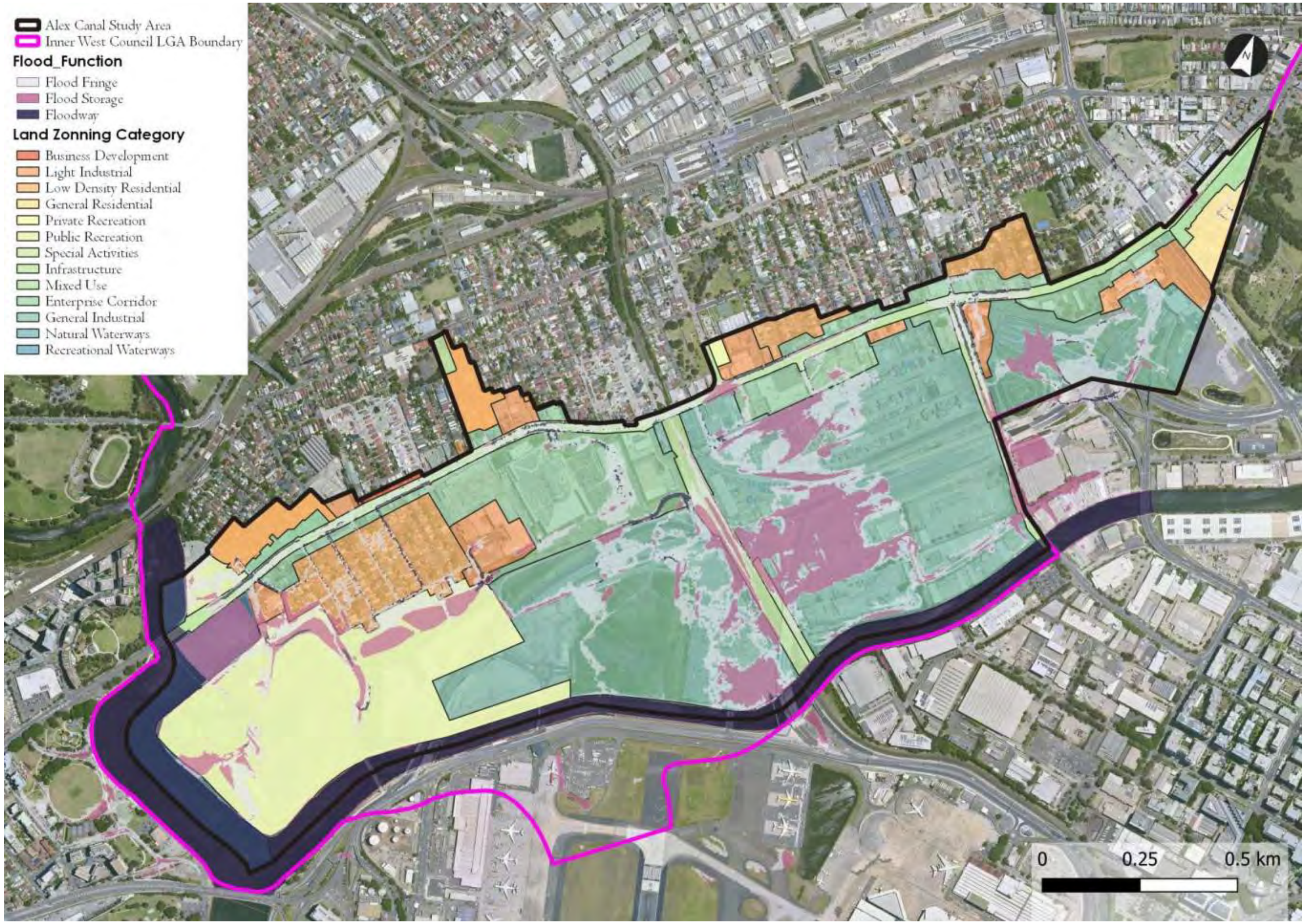

Figure 5-3 1% AEP Flood Function with Floodway on Current Land Use Zoning

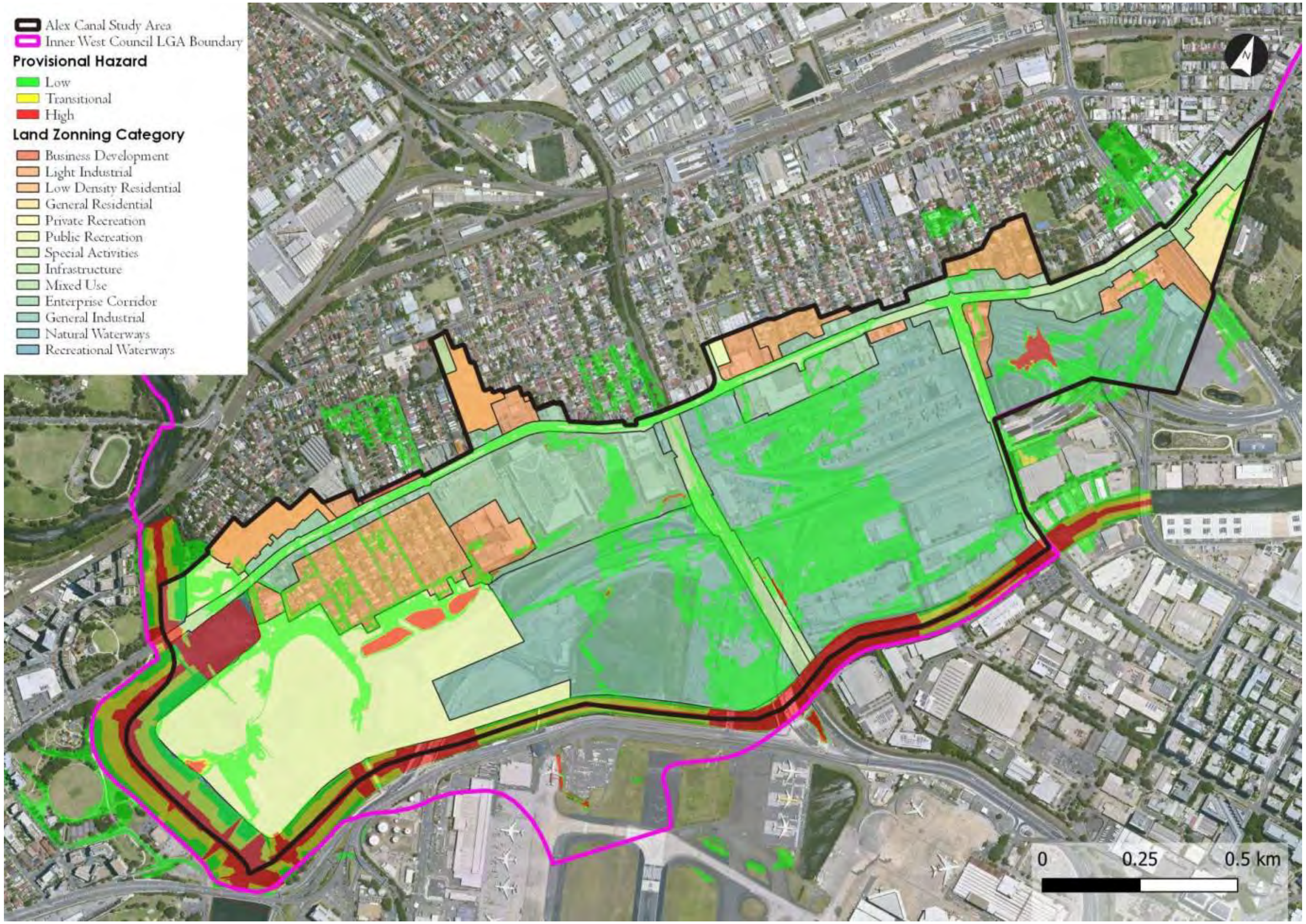

Figure 5-4 1% AEP Provisional Hazard with High Hazard on Current Land Use Zoning

5.4 Flood Related Development Controls

The Alexander Canal Catchment is located in the Inner West LGA where development is controlled through the Local Environment Plans (LEP) and Development Control Plan (DCP). The following sub-sections summarise the flood-related development controls for these documents and provide recommendations.

5.4.1 Local Environment Plan

The Alexandra Canal catchment lies within the Inner West LGA, therefore the relevant document is the Inner West Local Environmental Plan 2022.

As noted in previous sections, in mid-2021, NSW DCCEW released a new Flood Prone Land Policy Update. Included within this policy is a draft set of standard flood-related clauses for Local Environment Plans (LEPs) to assist local Councils. The 2021 package establishes two different categories, and two associated standard Local Environment Plan (LEP) clauses where flood-related development controls may be applied / considered. These are:

> Flood Planning Areas (FPAs): The ‘flood planning’ LEP clause is mandatory and the LEPs of all Councils in NSW were amended on 14 July 2021,

> Special Flood Considerations (SFCs): The ‘special flood consideration’ LEP clause is optional, and Councils decide whether to adopt this clause or not. If Councils choose to adopt the optional standard instrument SFC provision, it must be adopted without variation but subject to any relevant direction in the standard instrument (cl 4(2), SI order).

5.4.1.1 Mandatory LEP Clause - Flood Planning Area

Clause 5.21 outlines the requirements for developments in the FPA which is all land under Flood Planning Level (FPL), which in accordance with the FRM Manual 2023 is typically defined by the 1% AEP (1 in 100 AEP) event with a 0.5 metre freeboard. Councils are permitted to propose alternate FPLs, however they are required to demonstrate and document the merits of any decision based on a risk management approach. The land this clause applies to is essentially unchanged from the previous standard LEP clause.

The main updates to the mandatory standard flood related clause include:

> Several new objectives have been added to the updated text including a reference to cumulative impacts, enabling safe and appropriate uses of land, and enabling safe evacuation from the land,

> The requirements for development consent have been updated with reference to:

- Compatibility to flood function (floodway, flood storage and flood fringe),
- No offsite flood impacts and the impact of the development on projected changes to flood behaviour (accounting for climate change),
- There is a reference to safe occupation and efficient evacuation of people and not to exceed the capacity of existing evacuation routes for the surrounding area. Similarly, also stated in the clause is whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,
- The intended design and scale of buildings resulting from the development, and the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding.

Review of the draft Inner West LEP shows that the wording of the flood planning section 6.3 reflects this updated wording as is mandatory.

5.4.1.2 Optional LEP Clause – Special Flood Considerations

A new optional flood clause 5.22 has been added to the update called the ‘Special Flood Considerations’ (SFC) clause. The clause applies to all land between FPA and the PMF, an area that was not covered within the previous standard LEP clause. The types of development this optional clause would apply to includes vulnerable developments and critical infrastructure. In relation to the Special Flood Considerations (SFC) Clause 5.22, as stated within the guideline document:

> *….this is an optional provision of the Standard Instrument and Councils have the discretion whether to adopt the clause in a LEP in their LGA, provided they have appropriate information and justification to support the flood related development controls. Studies under the FRM process, as well as emergency management planning processes and relevant strategies and plans developed by NSW Government may provide information and support justification for the adoption of the clause.*

Inner West Council has adopted the optional LEP clause 5.22 for land between the FPA and the PMF. Therefore, both LEP clauses 5.21 and 5.22 for the FPA and the PMF will be applicable.

5.4.2 Current Development Control Plan

The Alexandra Canal Catchment lies within the former Marrickville Council LGA, therefore the relevant document was the Marrickville DCP 2011. This review relates to the Marrickville DCP 2011, Part 2.22 - Flood Management.

Section 2.22.2 – Land Affected complements Clause 6.3 (Flood planning) (currently Clause 5.21) of Inner West Local Environmental Plan 2022 (Inner West LEP 2022). It applies to:

> land identified on the DCP 2011 Flood Planning Area Map (**Figure 5-5**). Flood planning area include:
  - Flood planning area (Cooks River) that land likely to be affected by the 1% AEP flood, factoring in a rise in sea level of 400mm to the year 2050, (plus 500mm freeboard) of the Cooks River; and
  - Flood planning area (Overland Flow) that identifies land (in accordance with Council's Flood Tagging Policy) likely to be affected by the 1% AEP flood associated with various locations affected by local overland flooding.

> land identified as being flood liable land on the DCP 2011 Flood Liable Land Map (**Figure 5-6**). Flood liable land identifies land within a flood planning area, and land likely to be affected by the probable maximum flood (PMF) of the Cooks River. This means that the map identifies some land as being within the Cooks River PMF area, but not within the Cooks River 100-year flood (plus 500mm freeboard) area.

It should be mentioned that he Marrickville DCP 2011 incorporates twelve amendments. Amendment No. 7 relates to amendments to Part 2.22 – Flood Management, to incorporate an updated Flood Planning Area Map and an updated Flood Liable Land Map, came into force on 6 July 2018.

Flood classifications have been applied to parts of the Flood Planning Area (Cooks River). The flood classifications are:

> Low hazard: Should it be necessary, people and their possessions could be evacuated by truck. Able bodied adults would have little difficulty wading out of the area.

> High hazard: Possible danger to life, evacuation by truck difficult, potential for structural damage, and social disruption and financial losses could be high. The identified areas, and their flood classifications, are:
  - Riverside Crescent/Tennyson Street area (Marrickville and Dulwich Hill): Low hazard to high hazard.
  - Illawarra Road/Wharf Street area (Marrickville): Low hazard to high hazard.
  - Carrington Road area (Marrickville): Low hazard.
  - Bay Street area (Tempe): Low hazard to high hazard.

Flood management controls apply as follows:

> For land in a flood planning area, the controls apply to all development that requires development consent.

> For land that is flood liable land, but that is not in a flood planning area (land within the Cooks River PMF), the controls also apply to caravan parks, childcare centres, correctional centres, emergency services facilities, hospitals, residential accommodation (except for attached dwellings, dwelling houses, secondary dwellings and semi-detached dwellings), and tourist and visitor accommodation.

The development controls for the former Marrickville LGA (the DCP 2011) are derived from a development nature approach. The procedure to determine what controls apply to proposed development involves:

> Section 2.22.5 of the DCP identifies the category of the development which are grouped into the following:
  - New residential development
  - Residential development – minor additions
  - Non-habitable additions or alterations
  - New non-residential development
  - Non-residential development – additions
  - Change of use of existing buildings
  - Subdivision
  - Filling of land within the Flood Planning Area
  - Land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map
  - Garages, carports, open car parks and basement garages.

There are twenty-nine development controls. **Table 5-1** indicates which flood management control applies to which type of development. Flood management controls are provided in **Appendix B.**

Table 5-1 Development Relevant Flood Management Controls

Development	Flood Management Control
General (applicable to all types of development)	C1, C2, C3, C4
New residential development	C5, C6, C7
Residential development – minor additions	C8, C9, C10
Non-habitable additions or alterations	C11, C12
New non-residential development	C13, C14
Non-residential development – additions	C15, C16
Change of use of existing buildings	C17, C18
Subdivision	C19, C20
Filling of land within the Flood Planning Area	C21
Land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map	C22, C23, C24
Garages, carports, open car parks and basement garages	C25, C26, C27, C28, C29

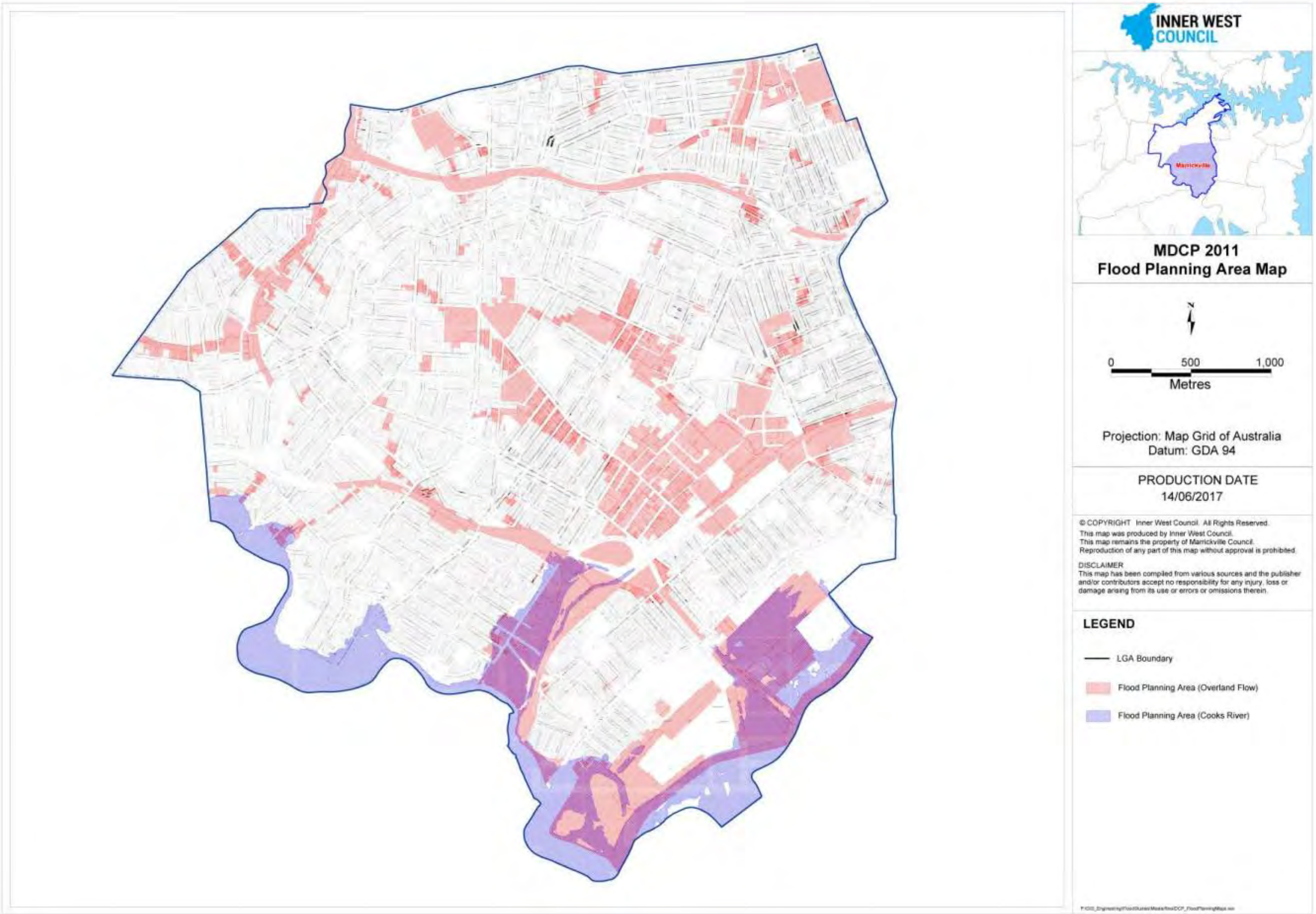

Figure 5-5 The Formerly Marrickville DCP 2011 Flood Planning Area Map

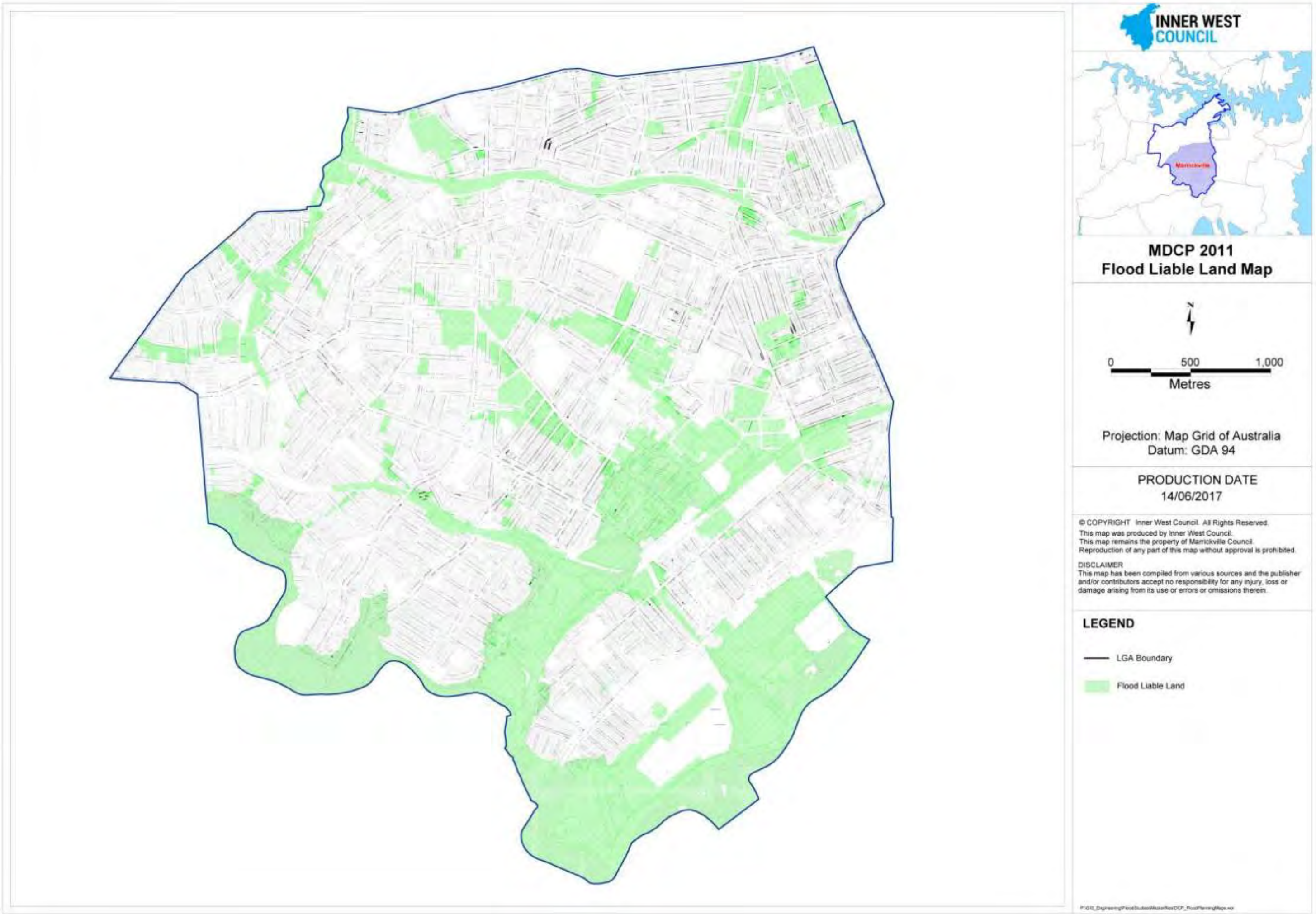

Figure 5-6 The Formerly Marrickville DCP 2011 Flood Liable Land Map

5.4.3 Flood Impact and Risk Assessment Requirements

More recent guidance for applicant flood impact assessments is included within the 2022 FRM Manual guideline for Flood Impact and Risk Assessment (Flood Risk Management Guide FU01). The guideline provides details on the preparation of both simple and detailed Flood Impact and Risk Assessment (FIRA) for developments. The recommended preparation of a FIRA for developments should consider (as outlined in Section 3 of the FU01 guide):

> Proposed development: The proposed development needs to be shown with the necessary detail.

> Existing and developed model scenarios: The consent authority will need to ensure that flood modelling and/or analysis is sufficient to identify and assess the existing flood conditions and to determine post developed flood impacts and risks. Assessment needs to consider the key details of the final proposal, including development type and density (changing runoff characteristics), infrastructure, proposed modification to waterways or floodplain landform or vegetation.

> Impacts to be addressed: The consideration of development impacts is recommended to extend beyond flood level impacts only, with the table of impacts recommended to consider provided in **Table 5-4** below.

Table 5-4 Typical considerations when assessing impacts due to development (Source: NSW DCCEW, FU01 Guide)

Key considerations	Reasons for considering
Flood level change	• May increase inundation and damage to existing development • May inundate additional existing development • May create new or larger floodways or flowpaths • May isolate new areas
Change in duration of flooding	• May increase damage • May increase duration of isolation
Velocity change	• May increase scour potential and/or damage to buildings
Change in warning and evacuation time	• May decrease available warning time and time available for evacuation
Change in frequency of inundation	• Properties may become flood affected in more frequent events • Access may be cut more frequently • Areas may be isolated more frequently
Flood function categorisation change	• May change categorisation (e.g. flood storage to floodway) and change impacts on flooding on existing development
Hazard categorisation change	• May reduce safety to vehicles, people or buildings

> Managing residual flood risk: In many situations there will be opportunities to limit the increase in risk due to development, however, available options will vary depending on the stage and scale of the development being considered. Typical risk considerations include the risks to people, property and infrastructure, including the ability of the occupants to respond in an emergency. Residual risks will remain after management measures and development controls have been applied. A list of measures available to minimise the increase in flood risk to large and small-scale development are in **Table 5-5**.

Table 5-5 Typical measures to minimise impacts due to development (Source: NSW DCCEW, FU01 Guide)

Multi-lot, large-scale development	Individual, small-scale development
Include strategic management considerations and measures: • avoid floodways and flowpaths • avoid other highly flood constrained areas • provide management measures to manage risks to existing development • consider compatibility of land uses/ development types with the flood constraints on the land • determine and apply controls required to manage risk to the development and its users • consider emergency response issues and options and provide management measures consistent with advice from emergency services	Generally: • avoid floodways and flowpaths • avoid other highly flood constrained areas • apply controls to manage the risk to the development and its users: • management and design measures • structural considerations • floor level controls

The guide notes that documentation should ensure the intent of the approval is clear and maintained for the life of the approved development. This may include the need for conditions that consider:

> Limiting impacts and risks posed to the development and future occupants to ensure these have been appropriately managed. Consent conditions are to incorporate the key requirements to ensure these aspects are addressed. This may include the need to apply flood related controls such as those that nominate minimum fill or floor levels, structural considerations, management measures, address site egress, ensure the safety of occupants during flooding, and restrict unapproved modification to key elements of the development as approved in the consent.

> Management measures required to be considered in a staged manner as necessary to manage risks to the existing community.

> Inclusion of all design reports and drawings in the consent to ensure these are consistent with key parameters used in post development modelling and analysis that formed the basis of the FIRA.

> Modification of key design features of the development that may alter flood behaviour. This may require an additional approval with supporting modelling and/or reporting to ensure impacts of post developed flood risks are either in accordance with the original approval or are within the tolerable levels as defined by the consent authority.

> How risks and impacts of the development change with future climatic conditions.

> Any other specific requirements for consideration by the proponent to manage flood risk.

5.4.4 Conclusion of Review of Development Controls

Upon review of the flood-related development controls within the formerly Marrickville DCP 2011, the following general comments are noted:

> Compared to the requirements for planning proposals outlined within the 2021 Flood Prone Land Policy Update (refer to **Section 5.3.2**), the current development controls are generally in agreement with one exception:
  - The controls do not permit (only) filling of floodways or high flood hazard areas. Regarding the policy requirement for no residential accommodation in high hazard areas, there is a relevant control for new residential development enforcing flood free access must be provided where practicable.
  - The controls require filling of land within the Flood Planning Area (Control C21)
    - not increase flood levels by more than 10mm,
    - not increase downstream velocities by more than 10%,
    - not redistribute flows by more than 15%,
    - the potential for cumulative effects of possible filling proposals in that area is minimal,
    - the development potential of surrounding properties is not adversely affected by the filling proposal,
    - not increase the flood liability of buildings on surrounding properties, and
    - no local drainage flow/runoff problems.
    - This is similar to requirements within the policy.
  - Requirements for storage of goods and hazardous materials are consistent.
  - Emergency management requirements are similar, though the controls are more prescriptive outlining refuge and evacuation requirements more specifically which is beneficial to aid applicants.
  - There is not a control that does not permit vulnerable and critical developments below the PMF level, similar to the requirements of the policy relating to these types of developments. Consideration should be given to amending the DCP to specifically address flood risk in vulnerable and critical developments,

> Compared to the requirements for FIRA from the 2022 FRM Manual Guide FU01. Generally, the current development controls are in agreement with the proposed requirements in the guide with some exceptions:
  - The current controls do not require consideration of climate change in assessments.
  - The current controls do not specifically require a consideration of residual risk of proposed developments to confirm if flood risk is lower than existing based on proposed risk management measures for developments.

> The development matrix approach offers a simple platform to be able to apply development controls specific to development types.

Ultimately, the current controls are generally fit for purpose, some alterations to the current development controls should be considered to bring it in accordance with recent guidance both within the 2021 Flood Prone Land Policy Update and the 2022 FRM Manual Guide FU01. This may include the following key changes from the bullet points above:

> setting controls to allow no new residential accommodation in high hazard flood areas

> setting controls to reduce flood hazard and associated risk to existing residential accommodation in high hazard areas,

> setting controls that consider the higher flood risk of vulnerable and critical developments below the PMF level, and

> consideration of climate change in assessments.

6 Economic Impact of Flooding

The economic impact of flooding can be defined by what is commonly referred to as flood damages. Flood damages are generally categorised as either tangible (direct and indirect) or intangible damage types, these types are summarised in **Table 6-1**.

Table 6-1 Types of Flood Damages

Type	Description
Direct	Building contents (internal) Structural damage (building repair) External items (vehicles, contents of sheds, etc.)
Indirect	Building contents (internal) Structural damage (building repair) External items (vehicles, contents of sheds, etc.)
Intangible	Social (increased levels of insecurity, depression, stress) Inconvenience (general difficulties in post-flood stage)

The direct damage costs, as indicated in **Table 6-1**, are just one component of the entire cost of a flood event. There are also indirect costs. Together, direct, and indirect costs are referred to as tangible costs. In addition to tangible costs, there are intangible costs such as social distress. The flood damage values discussed in this report are the tangible damages and do not include an assessment of the intangible costs which are difficult to calculate in economic terms.

The purpose of a flood damage assessment is to support decision-making on FRM options. It provides the basis for understanding the scale of benefits or disbenefits FRM measures may have on flood damages to the community. The damage assessment is not intended to be a precise estimate of damage at a given location. Rather, it is intended to provide a reasonable understanding of the relative scale of damage across the study area (focusing on aspects that will be materially changed by FRM measures) and how this may be altered with the implementation of FRM measures.

6.2 Input Data

6.2.1 Building Footprints

The primary flood damage calculation relates to building damages, being structural, contents, relocation, and clean-up costs. Therefore, building damages have been calculated for each individual building footprint, based on the building footprint layer provided by NSW DCCEW.

Commonly in the past flood damages were calculated on a per property basis rather than a per building basis. The adopted damage per building calculation provides a more accurate determinant of flood affectation due to the following reasons:

- Properties may have multiple buildings in the one property therefore damages can be calculated per building and added together,
- Flood model results can be considered only within the building footprints to provide a more accurate localised picture of flood affectation. On a property basis, flooding far removed from building footprints may misrepresent flood affectation near the building where the majority of flood damages are caused.

Therefore, the bulk of flood damages calculation has been conducted based on NSW DCCEW building footprints data. This includes external (garden) damage which has been considered on a per building basis from ground levels.

6.2.2 Building Types

The adopted damages approach allows for unique classification of flood damages based on the type of building that were able to be determined for each building across the study area. Building types were derived for each building footprint based on building type provided in the NSW DCCEW footprint layer and confirmed through site visit observations, and Google Streetview observations. For example, all 1% AEP flood affected residential classed properties were inspected from site visit photos or Google Streetview to confirm if they were single or double storey. The building types were classified as follows:

> Residential building types:
  - Single storey:
  - Double storey,
  - Multi-unit,
  - Townhouse.
> Non-residential building types:
  - Low to medium being restaurants, cafes, offices, surgeries, retail outlets, service stations, hardware stores,
  - Default average,
  - Medium to high being chemists, electrical goods, bottle shops, electronics.
> Public buildings:
  - School
  - Hospital
  - Other

Note that all secondary buildings such as garden sheds and garages in residential properties were excluded from damages calculations. In total, when removing secondary buildings there were a total of 909 buildings assessed in the flood damages calculation across the catchment.

The number of dwellings per building footprint were also estimated based on aerial images, site visit observations and Google Streetview. In addition, residential properties were grouped by size with small being less than 135 m^2, medium being between 135 – 200 m^2, default being between 200 – 230 m^2 and large being 230 m^2 or greater.

6.2.3 Floor Levels

Floor levels for all building footprints have been adopted in the damages calculation through one of two methods:

- Based on floor levels survey for the building for surveyed buildings in the study area. The floor level survey data is summarised in **Section 3.5**.
- For non-surveyed buildings, the following floor level estimation process was applied:
  - The average ground level for the building footprint was calculated using the TUFLOW model terrain.
  - Using Google Streetview, an approximate floor height above ground levels was estimated. This floor height was typically 0.15 metres for slab-on-ground type construction, 0.3 metres for normal construction and 0.6 metres for higher suspended floor type buildings.
  - The estimated floor level was calculated from average ground floor of the building footprint plus the approximate floor height above ground.

6.2.4 Hydraulic Model Results

To inform the flood damages calculation, a range of base case model results were assessed for all five design flood events, 20%, 5%, 2% and 1% AEP and PMF events. The results were applied as max values across the building footprints:

- Maximum water levels for footprints were determined for each design event,
- Maximum depth results for footprints were determined for each design event, and,
- Maximum H1-H6 hazard category within the footprint were determined for each design event.

In addition, to inform external (garden) damage calculation, the maximum flood depth for properties were calculated for each design event.

6.3 Flood Damages Methodology

Flood damages can be assessed by a number of methods including the use of computer programs such as FLDamage or ANUFLOOD, or via more generic methods using spreadsheets. For the purposes of this project, the recently released 2023 Flood Damages Tool (DT01) prepared by NSW DCCEW as part of the FRM Manual 2023 has been adopted for calculation of building damages, with external damages calculated using in-house spreadsheet analysis as summarised in the following sub-sections.

6.3.1 New Flood Damages Tool

This flood damages analysis has been based on the Flood Damages Tool (DT01) prepared by NSW DCCEW as part of the FRM Manual 2023. The damages tool is supported by Section 3 of the Flood Risk Management Measures - Flood Risk Management Guide MM01 which provides background and guidance on the use of the tool.

The methodology outlined within the damages tool is an improved and more detailed calculations than previous damages tools. The damages tool DT01 provides the following advantages over past damages tools provided by the NSW Government:

- It provides not only residential damages for single and double storey houses similar to past tools, but it also provides damages curves for commercial and public infrastructure buildings and specific public buildings,
- The methodology also allows for calculation of risk to life projected costs based on the H1-H6 hazard categorisation of the building,
- It allows for damages estimation based on building footprint areas providing additional detail in analysis.

Therefore the DT01 damages tool was ultimately considered suitable for adoption in this study.

6.3.2 Calculation Parameters

The damages tool DT01 curves are derived for late 2019, and as part of this Study were updated to represent late 2022 dollars (only quarter 1 2023 inflation data available at the time of this report).

General recommendations in the damages tool and guideline are to adjust values in residential damage curves by Consumer Price Index (CPI). The most recent data for CPI from the Australian Bureau of Statistics at the time of the assessment was for March 2023. Therefore, all ordinates in the residential flood damage curves were updated to March 2023 dollars (CPI 132.7) from December 2023 dollars (CPI 130.9).

Consequently, all ordinates on the damage curves were increased by 1.38% compared to the curves presented in the flood damages tool DT01.

6.3.3 Damage Curves for Overfloor Flooding Depths

Residential and non-residential flood damages are generally assessed based on assessments of structural damage, damage to contents, external damage, relocation costs and clean-up costs. In limited cases, the additional damage costs related to structural integrity due to building failure may also warrant consideration. The adopted flood damages curves for residential single and double storey buildings for the various building sizes are shown in **Figure 6-2** and **Figure 6-2** respectively.

Further details about the formulation of the residential damage curves adopted in the flood damages tool DT01 are included in Section 3.1 of Flood Risk Management Guide MM01.

Non-residential flood damage curves including commercial / industrial and public buildings are shown in **Figure 6-3**. Further details about the formulation of the non-residential damage curves adopted in the flood damages tool DT01 are included in Section 3.2 of Flood Risk Management Guide MM01.

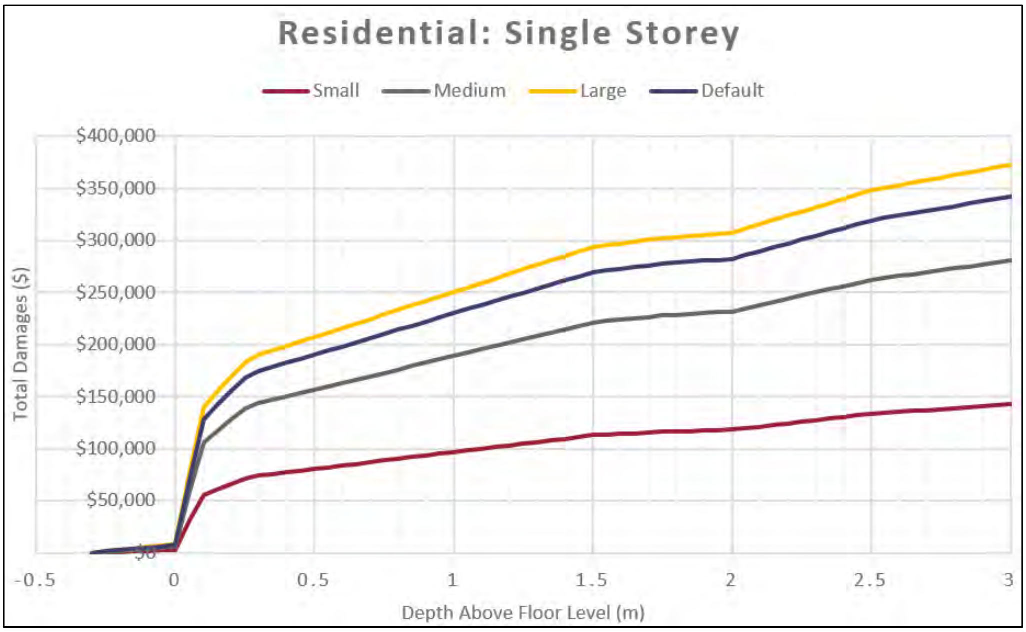

Figure 6-1 Adopted Damage Curves for Residential Single Storey (Source: DT01 Damages Tool)

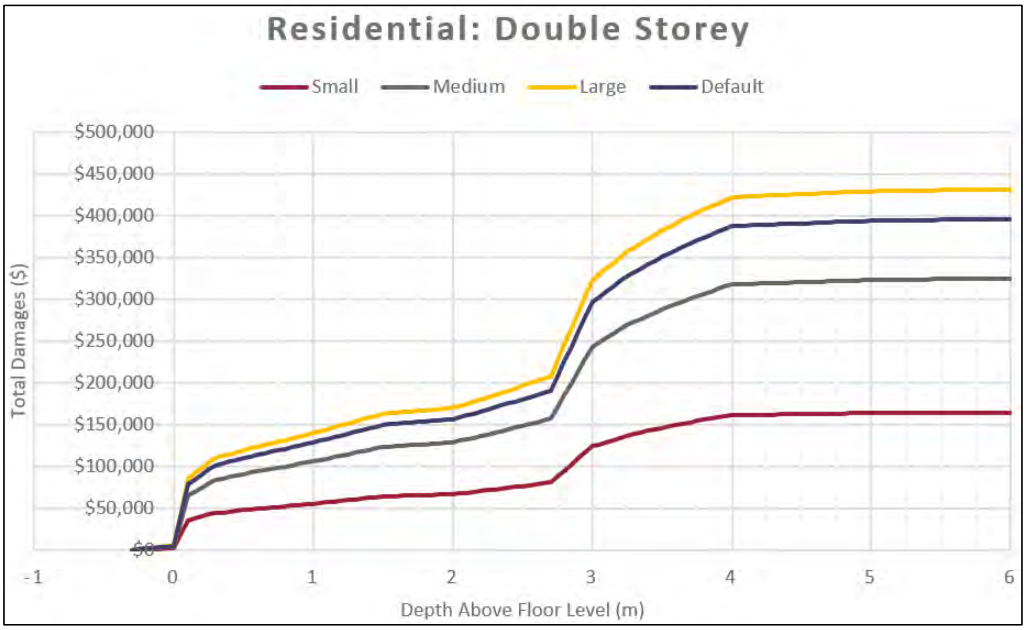

Figure 6-2 Adopted Damage Curves for Residential Double Storey (Source: DT01 Damages Tool)

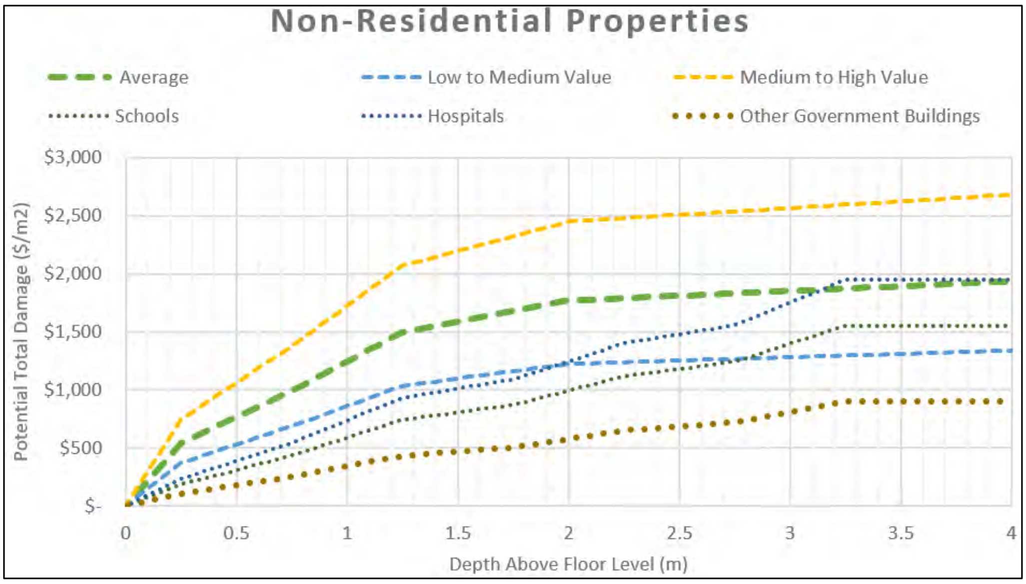

Figure 6-3 Adopted Damage Curves for Commercial Properties (Source: DT01 Damages Tool)

6.3.4 External Damages Calculation

A fixed external damage of $17,234 in 2023 dollars ($17,000 in 2022 dollars) is to be used for each dwelling site and for each site that contains multi-unit dwellings. This is used when flood depths above the ground level adjacent to the building are at least 0.3 metres or are above the habitable floor level of the house.

The trigger for these external damages has been based on average ground levels around the buildings, if the depth results exceed the threshold of the 0.3 metres, then the fixed damage rate has been applied to each property. The basis for external damage calculation has been based on the building footprint layer, and not based on a property layer. Therefore no external damage has been applied to properties without a building.

6.3.5 Adopted Input Parameters

The flood damages tool DT01 provides numerous input parameters to tailor the flood damages analysis. The tool and associated guide provide advice with respect to default values. The input parameters for this flood damages assessment are as follows:

- Actual to potential ratio = 0.9 (default)
- Regional uplift factor = 1.00 (default for Sydney region)
- Infrastructure damages uplift = 10% of residential damages (default)
- Damages downscale for townhouses and units = 30% (default)
- Internal / contents rate = $550 / m^2 (default)
- Residential clean-up costs = $4,500 / property (default)
- Non-residential indirect costs = 30% of direct actual damages, clean-up costs and loss of trading (default),

With respect to risk to life damages calculations, the equations adopted within the flood damages tool DT01 are summarised in **Figure 6-4**.

$$Injuries = 2 \cdot N_z \times \frac{HR \cdot AV}{100} \cdot PV$$

$$Fatalities = 2 \cdot N(I) \times \frac{HR}{100}$$

$$Hazard\ Rating\ [HR] = d \times (v + 0.5)$$

Where,

- N_z Population living in the floodplain
- HR Hazard Rating (Table 12-6)
- AV Area Vulnerability (Table 12-7)
- PV People Vulnerability = {% residents suffering any long-term illness, % aged 75+}
- N(I) Number of injuries
- d Depth of flooding (m)
- v Velocity of floodwaters (m/s)

Figure 6-4 Flood Risk to Life Damages Calculations (Source: NSW DCCEW, 2022)

The adopted flood risk to life parameters are as follows:

The adopted flood risk to life parameters are as follows:

- Estimated cost per fatality = $5,300,000 (default taken from the Office of Best Practice Regulation (Australian Government)
- Estimated cost per injury = $52,962 (default taken from the Office of Best Practice Regulation (Australian Government)
- N(z) average people per household = 2.1 (default from ABS)
- Speed of onset = 3 (rate of rise is less than 1 hour)
- Primary nature of area = 2 (detached residential dwellings)
- Flood Warning Factor = 3 (calculated from P1, P2 and P3)
- Area Vulnerability (AV) = 8
- People Vulnerability = 36% (default)

6.4 Flood Damages Outcomes

6.4.1 Total Damages

The total damages have been calculated for all design events, 20%, 5%, 2%, and 1% AEP and the PMF event. The results are tabulated in **Table 6-2** show that the damages total for Alexandra Canal catchment. The tabulated results also show the building and external damages.

As it relates to contributions from building and external damages, the external component makes up only a fraction (4.7 – 21.2%) of the total damages, with the vast majority being building related damages including structural, risk to life, contents, relocation etc.

The total damage values and number of affected properties / buildings, and average depth of flooding for the 20%, 5%, 2%, and 1% AEP events are shown in **Table 6-2**.

Table 6-2 Existing Total Damages Summary for Design Flood Events

Event	Damage Type	Total Damages	Number of Overfloor / Overground Flooded	Avg. Overfloor/ Overground Depth (m)
20% AEP	Building	**$8,321,540**	**50**	**0.14**
	External	**$530,800**	**80**	**0.33**
	Total	**$8,852,340**		

Event	Damage Type	Total Damages	Number of Overfloor / Overground Flooded	Avg. Overfloor/ Overground Depth (m)
5% AEP	Building	**$12,230,663**	**63**	**0.16**
	External	**$725,111**	**95**	**0.35**
	Total	**$12,955,774**		
2% AEP	Building	**$13,442,777**	**65**	**0.16**
	External	**$725,111**	**103**	**0.35**
	Total	**$14,167,888**		
1% AEP	Building	**$15,224,527**	**74**	**0.17**
	External	**$876,768**	**121**	**0.34**
	Total	**$16,101,295**		
PMF	Building	**$97,017,217**	**187**	**0.32**
	External	**$1,900,454**	**261**	**0.51**
	Total	**$98,917,671**		

6.4.2 Average Annual Damage

Average Annual Damage (AAD) is calculated using a probability approach based on the flood damages calculated for each design event. These damage curves attempt to define the damage experienced on a property for varying depths of flooding. The total damage for a design event is determined by adding all the individual property damages for that event. AAD attempts to quantify the flood damage that a floodplain would receive on average during a single year. It does this using a probability approach.

While the PMF event has a theoretical probability of 0% of occurring, to inform the calculation of AAD a representative probability of 0.0000001 (or 0.00001%) has been adopted for the PMF event (equivalent to a 10,000,000 year ARI event). This is based on guidance from AR&R Book 8 – Estimation of Very Rare to Extreme Events which notes this as the equivalent recurrence event for catchment less than 100 km^2. Through this method, the PMF accounts for extremely rare flood events in the AAD calculation.

For the most frequent event, the 20% AEP event, a lower bound flood damages estimate is required for the next most frequent event. In the DT01 tool it has been assumed that the total damages in the 100% AEP event will be $0 creating the lower bound of the AAD curve as per the default set-up of the tool.

The AAD calculation for the Alexandra Canal catchment is summarised in **Table 6-3**.

Table 6-3 Average Annual Damage Summary for Design Flood Event Contributions

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$8,852,340	**$3,558,226**	56%
5%	0.05	$12,955,774	**$1,642,015**	26%
2%	0.02	$14,167,888	**$406,855**	6%
1%	0.01	$16,101,295	**$151,625**	2%
PMF	0.0000001	$98,917,671	**$574,520**	9%
		Total AAD	**$6,333,241**	

The total AAD for the Alexandra Canal is over $6.3 million. Nearly half (56%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing 26% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 2 – 6% of AAD contribution. Though these events result in far higher flood damage totals, particularly the PMF event, their relatively low likelihood means they contribute less to the AAD.

Therefore, as it relates to damages and AAD, structural flood risk management options that reduce flood damages for the most frequent 20% AEP event are expected to provide the biggest benefits to AAD reductions.

7 Flood Emergency Response Review

When determining the flood risk to life, the flood hazard for an area does not directly imply the danger posed to people in the floodplain. This is due to the capacity for people to respond and react to flooding, ensuring they do not enter floodwaters. This concept is referred to as flood emergency response. To help minimise the flood risk to occupants, it is important that there are provisions for flood emergency response.

The primary strategy for the NSW State Emergency Service is horizontal evacuation of people to an area outside of the effects of flooding that has adequate facilities to maintain the safety of the community. However, during flash floods this may not be possible due to the short warning times.

The emergency response provisions for Inner West Council are outlined in the Inner West Local Emergency Management Plan (EMPLAN) and overseen by the Local Emergency Management Committee. Under the provisions of the EMPLAN, NSW SES are appointed as the lead agency for response to Flooding Emergencies. The NSW SES, in conjunction with the Inner West LEMC is responsible for the preparation and management of the Inner West Council Flood Emergency Sub Plan. These documents are intended to provide information to residents and other authorities relating to identified evacuation centres, evacuation procedures, as well as actions and responsibilities in the event of flooding. A review of these available documents is included in **Section 7.1**. There is also a review of available flood emergency response advice in flash flooding situations in **Section 7.2**.

In addition, a review of the flood emergency response potential for the Alexandra Canal catchment summarised below including key emergency management locations (**Section 7.3**), current and possible flood warning systems (**Section 7.6**), evacuation timeline review (**Section 7.4**), potential for shelter-in-place refuge (**Section 7.7**), and a summary of flood emergency response hotspots (**Section 7.5**).

7.1 Emergency Flood Management Documentation

Emergency Flood Management in NSW is managed by the NSW SES at three levels of scale, at a state-wide level, at a regional level, and a local level. Each subsequent level provides additional local detail in emergency management.

The Inner West catchment is located within the Sydney Metropolitan Emergency Management Region. This region encompasses 8 Local Government Areas of Sydney bounded by Woollahra, Waverley and Randwick to the east and Sutherland Shire to the southwest. The relevant local area with respect to SES emergency planning is the Inner West Local Government Area (LGA).

7.1.1 Local Flood Plan

In December 2021 the SES released Volume I the Inner West Flood Emergency Sub Plan covering operations for flooding within the Inner West Council LGA. Volume I of the plan outlines emergency management arrangements for prevention, preparation, response and initial recovery for flooding in the Inner West LGA.

The local strategies for flood emergency response outlined within Volume I were divided into the four stages of emergency management, prevention / mitigation, preparation, response, and recovery operations. In response to strategies a range of recommended actions are nominated for SES to achieve these strategies. The total number of strategies is 32 and 136 actions, spread across the four stages of emergency management as follows:

- Prevention / mitigation – 2 strategies and 4 actions.
- Preparation – 6 strategies and 22 actions.
- Response – 23 strategies and 105 actions.
- Recovery – 1 strategy and 5 actions.

7.1.2 Local EMPLAN

Inner West Council has established a Local Emergency Management Committee to carry out emergency management as the responsible authority for the Inner West local government area. This committee is responsible for an all-agencies comprehensive approach to emergency planning to prepare the community for disasters. Committee members include Emergency Services and agencies with functional responsibilities.

Inner West Emergency Management Plan has recently been published by NSW SES.

7.1.3 Regional and State Documents

The relevant regional and state emergency management documents are as follows:

- Sydney Metropolitan Region Emergency Management Plan – January 2022
- NSW State Flood Plan – December 2021
- NSW State Emergency Management Plan – December 2018.

The various documents provide more useful information in relation to the roles and responsibilities of various stakeholders in both general emergencies (EMPLANs) and specifically for flood emergencies (Flood Plans).

7.2 Guidance on Emergency Response in Flash Flooding

7.2.1 AFAC Guideline for Emergency Response in Flash Flood Events

In April 2018, the Australasian Fire and Emergency Service Authorities Council (AFAC) released the *Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events*. This guideline for flash flood events provides a useful insight into the position of the national emergency services authorities' council, of which NSW SES is a member. The guideline reflects a consensus on best practice for managing flash flooding, focussing on risk to life. The AFAC define flash flooding as:

> *Flash flooding can be defined as flooding that occurs within six hours or less of the flood-producing rainfall within the affected catchment. This may result in isolation of individuals and communities as time to warn and respond to flash flooding is limited.*
>
> *Flash flood environments are characterised by the rapid onset of flooding from when rainfall begins (often within tens of minutes to a few hours) and by rapid rates of rise and by high flow velocity. The duration of flash flooding is often relatively short by comparison to riverine floods.*

The discussion of flood timing for the Alexandra Canal study area (**Section 7.4.2**) shows the entire floodplain is flash flooding based on the above definition, making this guideline relevant to the catchment. The exception is the lower portions of the study area where tidal conditions from Alexandra Canal or Cooks River may result in riverbank overtopping.

7.2.2 Guidance on Flood Emergency Response Potential in Flash Flood Environments

Effective evacuation typically requires lead times of longer than just a couple of hours and this creates a dilemma for flash flood emergency managers. The following excerpt from the AFAC guideline outlines the dilemma as it relates to the suitability of evacuation and shelter-in-place potential in flash flood environments:

> *Because of the rapid onset of flash flooding and associated high velocity floodwaters, up to 75% of flash flood deaths occur while people are outside buildings attempting to leave or return, and directly exposed to floodwater.*
>
> *This suggests that if evacuation has not occurred prior to the arrival of floodwater, taking refuge inside a building may generally be safer than trying to escape by entering the floodwater. However, some deaths – 25% of the total – occur among people trapped inside buildings. Details are not well documented, and these deaths could be the result of the building filling with flood water to a depth occupants cannot survive or because those trapped inside are swept away when the building fails. Other causes of death could be serious injury or an emergency medical condition while access to emergency assistance is compromised. Fires might also break out in buildings surrounded by floodwater, in which case occupants might not be able to evacuate as they would usually do.*
>
> *For these reasons, remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy for pre-incident planning or incident action planning, even if the buildings are considered likely to withstand the impact of flash flooding. Where the available warning time and resources permit, evacuation should be the primary response strategy.*

This conclusion is similar to advice provided by NSW SES representatives for past studies within Sydney:

> *The NSW SES considers evacuation as the primary response strategy during flooding to protect the at-risk community. This strategy relies on the principles for evacuation that include:*
>
> - *Evacuation completed in sufficient time before the onset of a flood is the safest emergency management strategy.*

- *The primary method of evacuation should be by vehicle where feasible with pedestrian evacuation as a backup option.*
- *Evacuation must not require people to drive or walk through flood water.*
- *The best vehicular evacuation routes are vehicular escape routes that rise steadily and lead away from the flood.*
- *For existing communities, a strategy of having occupants shelter in place may be acceptable, where the decision to evacuate is left too late, as long as the buildings they inhabit are out of the floodwater or are structurally sound.*
- *Emergency management strategies must consider expected human behaviour and the expected range of severity of hazards*
- *Sheltering in place should only be a strategy where the risk if staying is lower than the risk of evacuating.*

The SES's position, continues to be that isolation is dangerous from the moment it commences and the longer the isolation continues, the more opportunity there is for an emergency to develop.

Additionally, secondary emergencies such as fires and medical emergencies may occur in buildings isolated by floodwater. During flooding it is likely there will be a reduced capacity for relevant emergency service agencies to respond. Even relatively brief periods of isolation, in the order of a few hours, can lead to personal medical emergencies.

While the preferred method of emergency response throughout NSW is for evacuation to be assisted and directed by the SES, there are certain emergency situations where there is limited time available to prepare and facilitate a staged evacuation as preferred. One such example is flash flooding where the rate of rise of floodwaters is extremely fast and the ability for SES to co-ordinate a regional evacuation strategy is not possible.

7.2.3 Guidance for New Developments in Flash Flood Environments

Given the life risk posed by flash flooding and the inherent limitations on how it can be managed, the AFAC guideline recommends new development areas:

- *be designed within the limits of existing flash flood forecast capability,*
- *facilitate rapid and safe evacuation from flash flood prone locations,*
- *account for the likelihood that some people might become trapped inside buildings, and*
- *involve a thorough understanding of how people will behave in a flash flood event and their risks*.

This conclusion is similar to advice provided by NSW SES staff for this study for new developments:

- *No increase to the existing risk to life and evacuation or reduces the current continuing or residual risk to life.*
- *Where evacuation cannot be accomplished and 'shelter in place' is proposed, then development that will increase the risk to life of future occupants and increase reliance on emergency services should not be permitted. Development strategies relying on deliberate isolation or sheltering in buildings surrounded by flood water are not equivalent, in risk management terms, to evacuation.*

Self-evacuation of the community should be achievable in a manner which is consistent with the NSW SES's principles for evacuation.

It should be made very clear that in relation to the strategy of sheltering in place the SES has done some work with several councils which have flash flood risk over large urban areas. In this existing flash flood context, and only in that context, it has been recognised that causing residents to attempt to evacuate at the time flash flooding is occurring, could be a serious risk to life. Only in areas where urban redevelopment cannot be prevented under existing planning policy, it has therefore been proposed that the DCP (that applies) for any new or redeveloped dwelling will require an internal refuge area above the level of the PMF (Opper and Toniato, 2008).

7.3 Emergency Management Locations

7.3.1 Emergency Services Locations

Emergency services locations are considered critical during flooding if the infrastructure is relied upon for emergency management on a regional scale or pose a significant hazard to surrounding areas. Therefore, these types of emergency services have been mapped at a regional scale around the Alexandra Canal Catchment as shown in **Figure 7-1**. This map has also been included in **Appendix C**.

The following emergency services have been mapped in the region around the Alexandra catchment:

- Hospitals,
- Ambulance stations,
- Fire stations,
- Police stations, and
- NSW SES facilities.

Within the study area there is NSW SES Marrickville Unit located in Alexandra Canal catchment, and also Marrickville Police Station, NSW ambulance at Farr Street, Pel-Air NSW Air Ambulance, Mascot Police Station and Mascot Fire Station are the emergency stations in closest proximity to the catchment area of Alexandra Canal. The NSW SES Marrickville Unit is flood free in all events up to and including the PMF, However it faces difficulties in access to Alexandra Canal catchment area due to the presence of flood affected roads in its vicinity.

Also shown in **Figure 7-1** with the emergency service locations is the 1% AEP and PMF flood extents, not only for entire Alexandra Canal catchment, but also in close proximity to the study area.

Relative to other overland flooding affected catchments, there are relatively flood free access roads within the Alexandra Canal study area. Central to this is Princes Highway which bisects the study area running south to north. As this regional road generally aligns with a ridgeline and is located in the upper areas of the catchment it is mostly flood free even in a PMF event. However there are several sections with 1% AEP and PMF ponding within the Princes Highway corridor which would impede evacuation in the event of flooding.

Though it was not possible to show the flood extents outside the study area, it is assumed that access to emergency services would be restricted for areas outside the study area. Review of emergency management summary for the Marrickville Valley FRMS&P (Stantec, 2017) located to the west of this study area shows that flood free evacuation routes in that direction are limited. Similarly for the Johnstons and Whites Creek FRMS&P (Stantec, ongoing) covering Newtown to the north, evacuation routes in that direction are mostly flood affected as well. To the south and east, evacuation routes are limited due to Cooks River and Alexandra Canal respectively, with evacuation over these waterbodies during extreme flooding not considered appropriate.

The nearest hospitals would be Marrickville Hospital to the north and Alexandria Specialist Day Hospital to the east. It is assumed that there would be no flood free access to these hospitals in the event of a regional flash flooding event from any part of the study area.

7.3.2 Vulnerable Developments

Vulnerable development relates to the increased risk of loss of life to vulnerable people including children, the elderly and disabled in most of these land use types. These demographics have a significantly greater risk to life when exposed to flood hazard. In addition, there is increased risk to life resulting from periods of isolation from medical emergency services due to pre-existing health conditions. Mobility of the related demographics is also compromised which will impede the effectiveness of both emergency response types. Included in these development types are:

- Schools, Preschools, and Childcare centres,
- Aged care facilities and retirement villages,
- Detention Centres – due to the limited mobility of the detained, these sites make flood evacuation much more difficult, and
- Hotels – the lack of local knowledge of hotel guests, coupled with the number of guests needing to be managed by hotel staff mean these are higher risk sites.

These categories of vulnerable developments match those presented in the 2021 Flood Prone Land Policy Update. Further discussion of the relative vulnerability of development types is in **Section 5.2**.

These sites have been mapped for the Study Area in **Figure 7-2**, which is also included in **Appendix C**.

The mapping shows that most vulnerable developments are suitably located in flood free land, with some of these developments partially affected by flooding, with only some locations significantly flood affected. Due to the permissibility of childcare centres, preschools and retirement communities in various land use zonings, the location of vulnerable developments will change over time. This mapping should be reviewed and updated by Council in the future to have a continued understanding of flood risk vulnerable developments.

7.3.3 Current Emergency Management Procedures for Vulnerable Developments

The NSW SES within the Inner West LGA Local Flood Plan provide the following specific actions within Section 5.8.3 and 5.9.2 as it relates to evacuation of vulnerable developments:

- Health Services Functional Area will coordinate the evacuation of hospitals, health centres and aged care facilities (including nursing homes) in consultation with the NSW SES and Welfare Services.
- School administration offices (Government and Private) will coordinate the evacuation of schools in consultation with the NSW SES and Welfare Services, if not already closed.
- Welfare Services Functional Area will manage evacuation centres for affected residents and travellers in accordance with the Welfare Services Functional Area Supporting Plan.
- Schools Administration (Government and Private) will manage the safety of students directly affected by flooding and will work with the NSW SES in the temporary closure of schools and will coordinate with NSW SES Transport and Welfare Services in the management of school evacuees.

As discussed further in **Section 7.2**, the flash flooding nature of the Study Area will make it difficult for SES to coordinate the evacuation of these vulnerable sites within the time available from the onset of rainfall. It is therefore recommended that individual flood response plans are developed for both existing and future vulnerable developments that are flood affected within the study area.

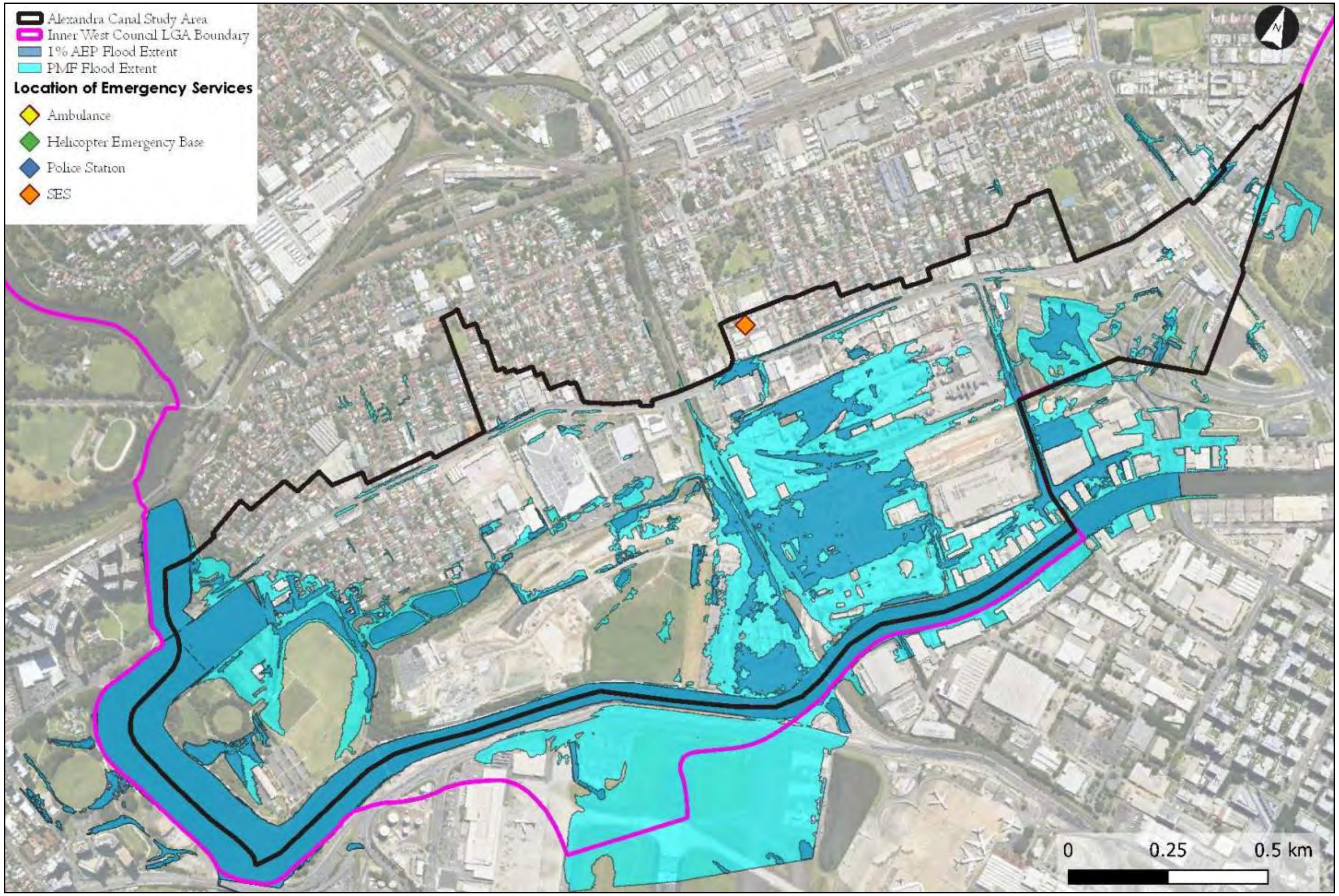

Figure 7-1 Location of Emergency Services in the Region with Inner West LGA 1% AEP and PMF Extents

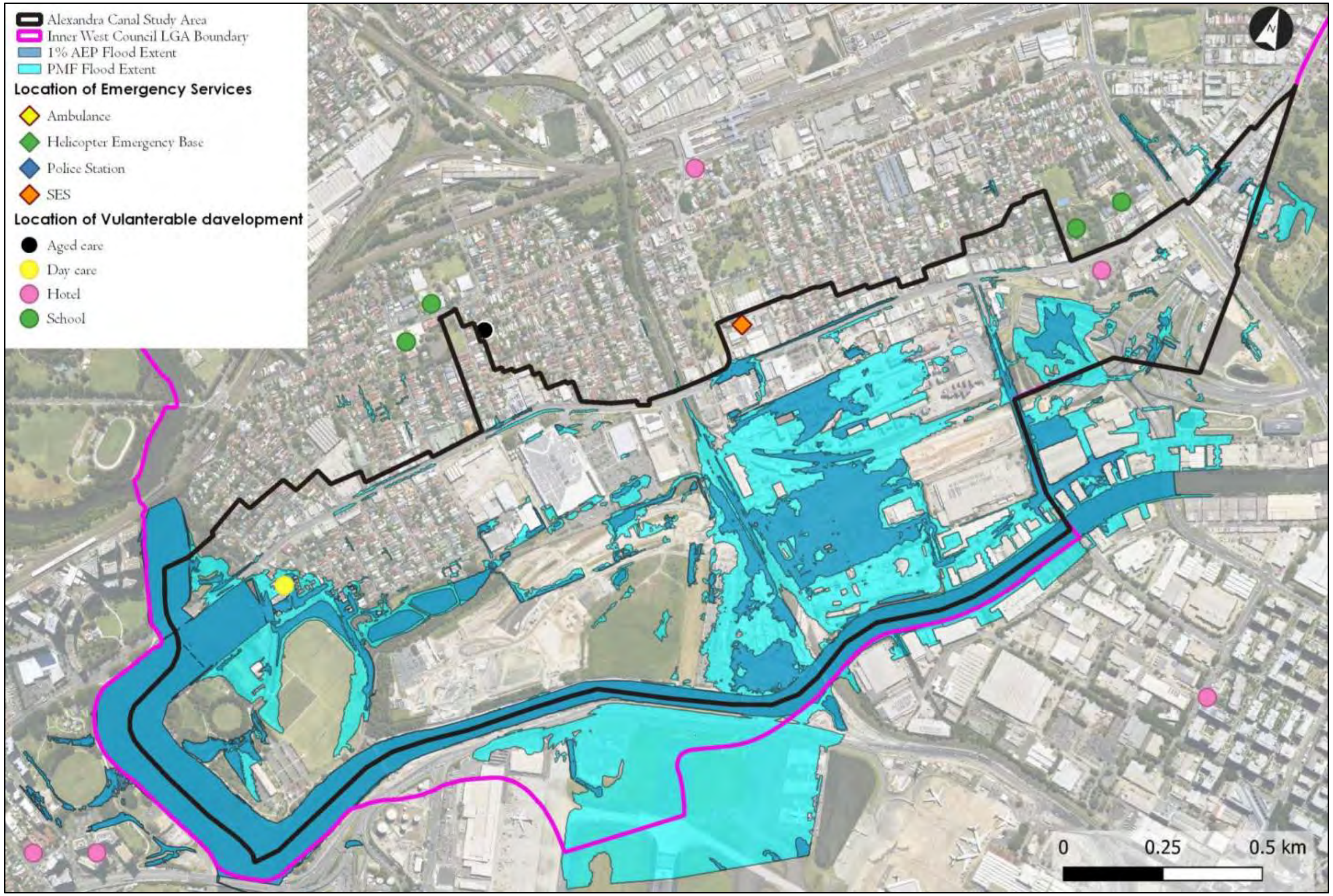

Figure 7-2 Location of Vulnerable Developments and Emergency Services within the Study Area with 1% AEP and PMF Extents

7.4 Evacuation Timeline

7.4.1 Background

The NSW SES Timeline Evacuation Model has been the de facto standard for evacuation calculations in NSW since it was first developed for evacuation planning in the Hawkesbury Nepean Valley. Though the guideline has not yet been released, the paper Technical Guideline for SES Timeline Evacuation Model was prepared by Molino S. et al in 2013 briefing the industry on the application of the guideline.

The timeline assessment of evacuation potential relates to the regional evacuation of floodplains through doorknocking by SES volunteers through to the evacuation of all occupants for the region.

At the centre of the timeline methodology is the following concept:

Surplus Time = Time Available – Time Required

If surplus time is positive then evacuation of all occupants is feasible, while a negative value implies evacuation of all occupants is not likely to be able to be achieved. The determination of the two times, 'Time Available', and 'Time Required' is summarised in the following sections.

7.4.2 Flood Water Levels and Timing

A review of flood timing for the Alexandra Canal catchment has been conducted based on the model results for the 20%, 5%, 2%, and 1% AEP and PMF events at one location. All have a rainfall duration of 1 hour. The flood timing inspection point, shown in **Figure 7-3**, is located on Bay Street which is a low-lying residential area. This selected location generally matches the identified emergency hotspots discussed in **Section 7.5**.

The water level time series results for the inspection point location is shown in **Figure 7-4**.

7.4.3 Rate of Rise

With regards to rate of rise for the PMF event, the Bay Street site begin flooding 10 minutes after the onset of rainfall, with up to 1.2 metres (check the range) of flooding depth within an hour of the onset of rainfall.

For the 1% AEP and smaller design events the rate of rise is slightly slower with flooding not commencing until 30 minutes after the onset of rainfall for the inspection point.

7.4.4 Duration of Flooding

With regards to flooding duration for the PMF event, the model simulation period was set at only 3 hours for the model. These short simulation times allow for the peak of flooding to occur, and as shown in **Figure 7-4**, also allow the falling limb of the PMF flood. For Bay Street (Tempe) the majority of the local overland flooding is expected to be finished within 3 hours of the onset of rainfall.

It is noted that Bay Street presents a unique situation, as it is low lying and has access to Cooks River through stormwater pit and pipe network. The model results in **Figure 7-4**7.4.4 show that longer duration flooding occurs at this location after the overland flooding has passed due to backwaters from Cooks River downstream. Locations such as Bay Street and foreshore areas of Alexandra Canal may be exposed to longer duration flooding from backwaters of Alexandra Canal and Cooks River.

For the 1% AEP and smaller events, the duration of flooding is expected to be less than the PMF, a shown in **Figure 7-4** these events have durations of flooding of less than 1 hour at Bay Street.

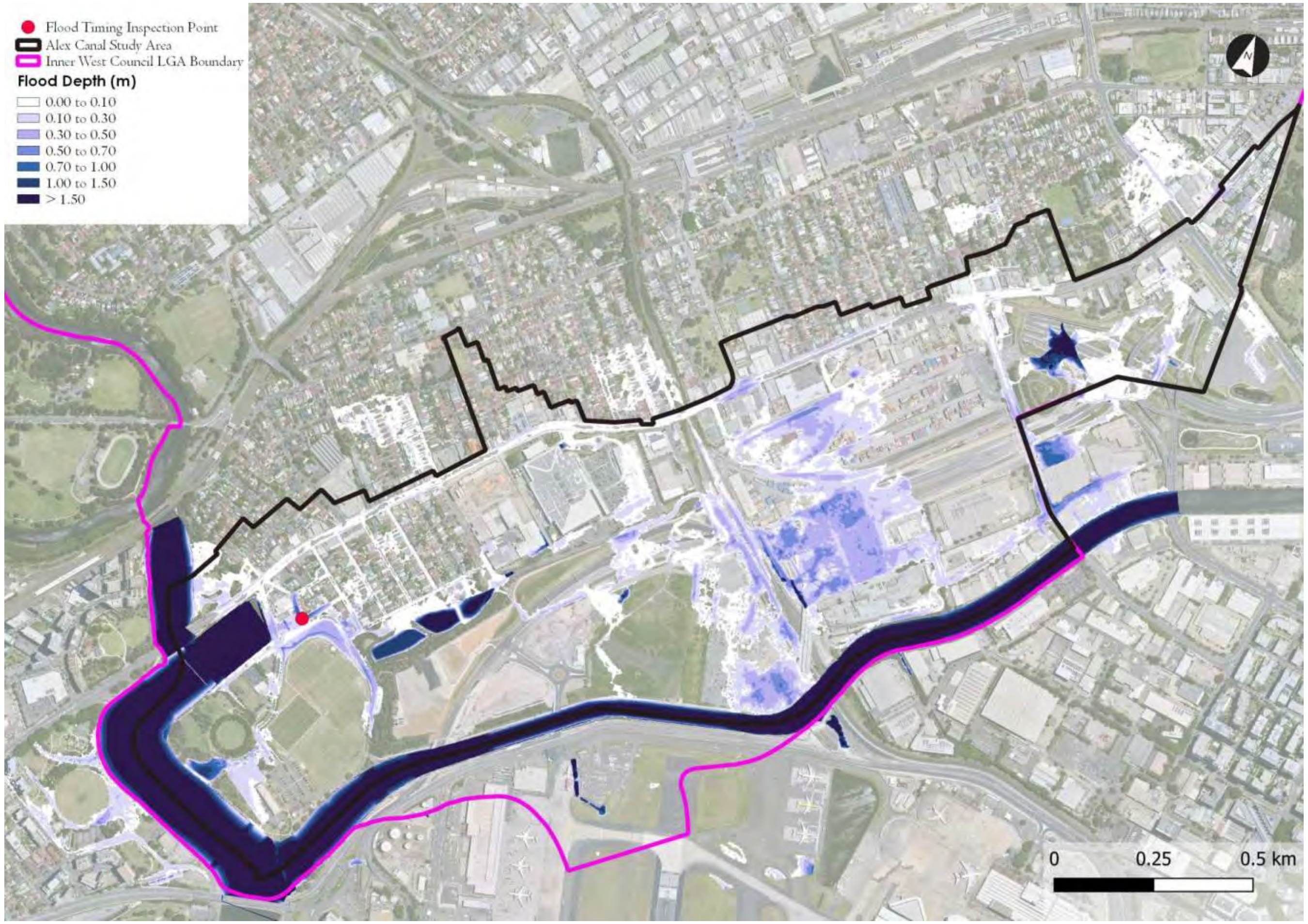

Figure 7-3 Flood Timing Inspection Point (Shown as Yellow Point) with 1% AEP Peak Depth Results

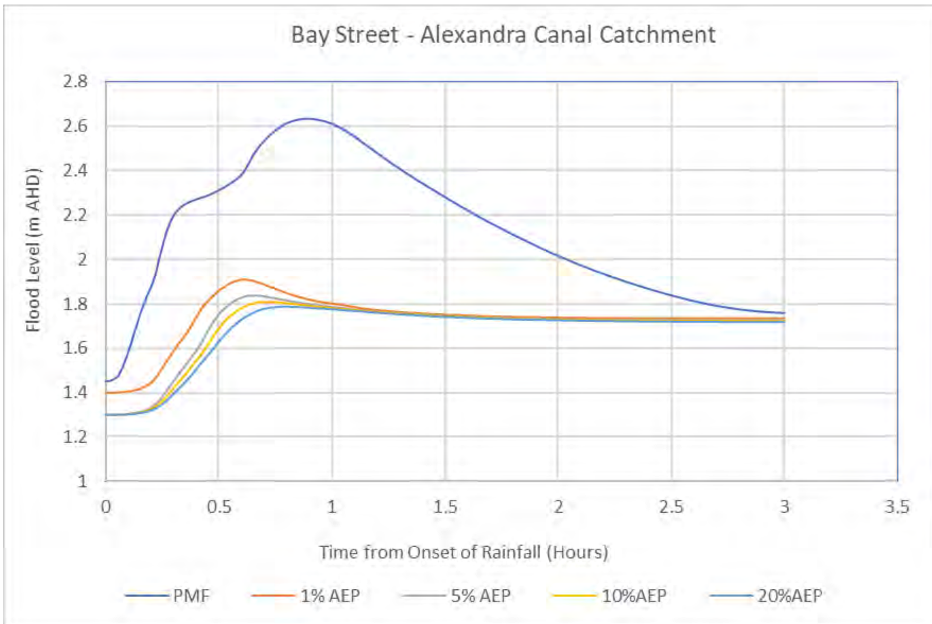

Figure 7-4 Flood Level Time Series Results for Alexandra Catchment Location

7.4.5 Time Available

The 'Time Available' is dependent on rate of rise of waters, meaning it varies for each evacuation scenario. From the flood timing assessment included above, the rate of rise is extreme for the Alexandra Canal Catchment with significant flooding occurring:

- Between 10 – 15 minutes (0.1 – 0.25 hours) from the onset of rainfall for the PMF event,
- Between 20 – 30 minutes (0.2 – 0.5 hours) from the onset of rainfall for the 1% AEP and smaller events.

Therefore, there is very little time available from the onset of storm burst rainfall for evacuation to occur. In addition, the volume of rainfall occurring is extreme in both a 1% AEP and PMF storm. It is unlikely that evacuating during the early stages of a design storm burst rainfall event will be safe as both vehicle safety and pedestrian safety is compromised under such heavy rainfall.

As a result, the only form of flood evacuation trigger for the Study Area that will provide sufficient available time to facilitate evacuation is flood forecasting methods as observed rainfall or flooding means that the opportunity to evacuate low-lying areas has already passed.

7.4.6 Time Required for SES Assisted Evacuation

The SES evacuation timeline model uses the following equation to calculate 'Time Required' to evacuate residents by doorknocking by SES volunteers:

Time Required = Warning Acceptance Factor (WAF) + Warning Lag Time (WLT) + Travel Time (TT) + Travel Safety Factor (TSF)

Where the following values are recommended:

- Warning Acceptance Factor = 1 hour – accounts for the delay between occupants receiving the evacuation warning and acting upon it.
- Warning Lag Time = 1 hour – an allowance for the time taken by occupants to prepare for evacuation such as packing their belongings etc.
- Travel Time = Variable – the number of hours taken for the evacuation of all vehicles based on road capacity. NSW SES recommend a road lane capacity of 600 vehicles per hour.

- Travel Safety Factor = Variable – added to travel time to account for any delays along the evacuation route for example resulting from accidents.

Note that time required is calculated from the time that SES are on site and ready to begin doorknocking. Before this time there is an additional phase of mobilisation of SES staff which is the time taken to coordinate and travel to residences to commence doorknocking. There is no data available on mobilisation time for local SES services. For the purposes of this analysis, it is assumed that it will take half an hour to coordinate SES staff and mobilise them to the flood affected areas.

Based on the above contributors, the overall time required for evacuation of the Alexandra Canal Catchment is a minimum of 2.5 hours (2 hours for WAF and WLT and 0.5 hours for mobilisation). It should be noted that this is a low bound estimate, as various factors such as Travel Time, and Travel Safety Factor have been disregarded. This means that in relation to SES doorknocked evacuation for the Study Area, evacuation needs to be triggered at least 2.5 hours prior to a storm burst rainfall event occurring.

While the Bureau of Meteorology (BoM) provide various flood forecasting tools, it is assumed there are no forecasting tools currently available that can provide the requisite confidence to trigger an evacuation based on flood forecasting 2.5 hours in the future.

Therefore it is concluded that SES doorknocked evacuation is not a reliable emergency response in the Alexandra Canal Catchment. While SES assisted evacuation may be suitable for more long duration rainfall events, for the critical storm burst rainfall events which result in flash flooding this approach is not appropriate.

7.5 Emergency Management Hotspots

As part of initial consultation for this project, NSW SES representatives requested emergency management mapping for hotspot areas in the Study Area. These emergency management maps have been provided in **Appendix C**.

The maps include flood information for the 20% and 1% AEP and PMF events to provide the requested information for the full range of design events. The maps provide the following information to assist SES:

- H1-H6 hazard mapping for the three selected design flood events to show areas of vehicular, pedestrian and building instability,
- Estimated overfloor flooding depth in metres for the three selected design flood events to provide an indication of flood risk sites,
- Indicative evacuation routes to flood free land. A distinction has been made between evacuation routes suitable for vehicles which are preferred and pedestrian only evacuation routes, and,

In total, three emergency management hotspot areas have been identified as shown in **Figure 7-5**. This figure is also replicated in **Appendix C**.

Potential flood risk management options, particularly emergency management focused options, should prioritise these three hotspot areas:

- Hotspot 1 – Areas including Bay Street, Old Street and up to Smith Street in Tempe.
- Hotspot 2 – Industrial areas on Swamp Road in St Peters.
- Hotspot 3 – Section of Princes Highway in St Peters between Princes Highway and Barwon Park Road.
- Hotspot 4 – Princes Highway, Talbot Street and Bellevue Street, Sydenham.

Within these hotspot areas, pockets of low flood island properties have been identified to support SES operations. These are the higher risk areas with limited evacuation potential due to flooding of access roads in accordance with the principles of the Flood Emergency Classification of Communities (FERCC) (outlined in Part C of Flood Risk Management Guide EM01), A distinction has been made for low flood islands in industrial land uses where the risk to life may be different than residential land uses

As noted within AIDR guideline 7.2 that outlines requirements for FERCC there is the following note:

> *The guideline supports decision making at a precinct or community scale, and for rivers and creeks where flow paths can readily be defined. It is not intended for application in local overland flooding at a smaller scale, or to individual structures.*

While the type of flooding in this study area would be defined as overland flooding, the FERCC mapping of specific hotspot areas does help to identify the properties that will have complications with flood emergency response.

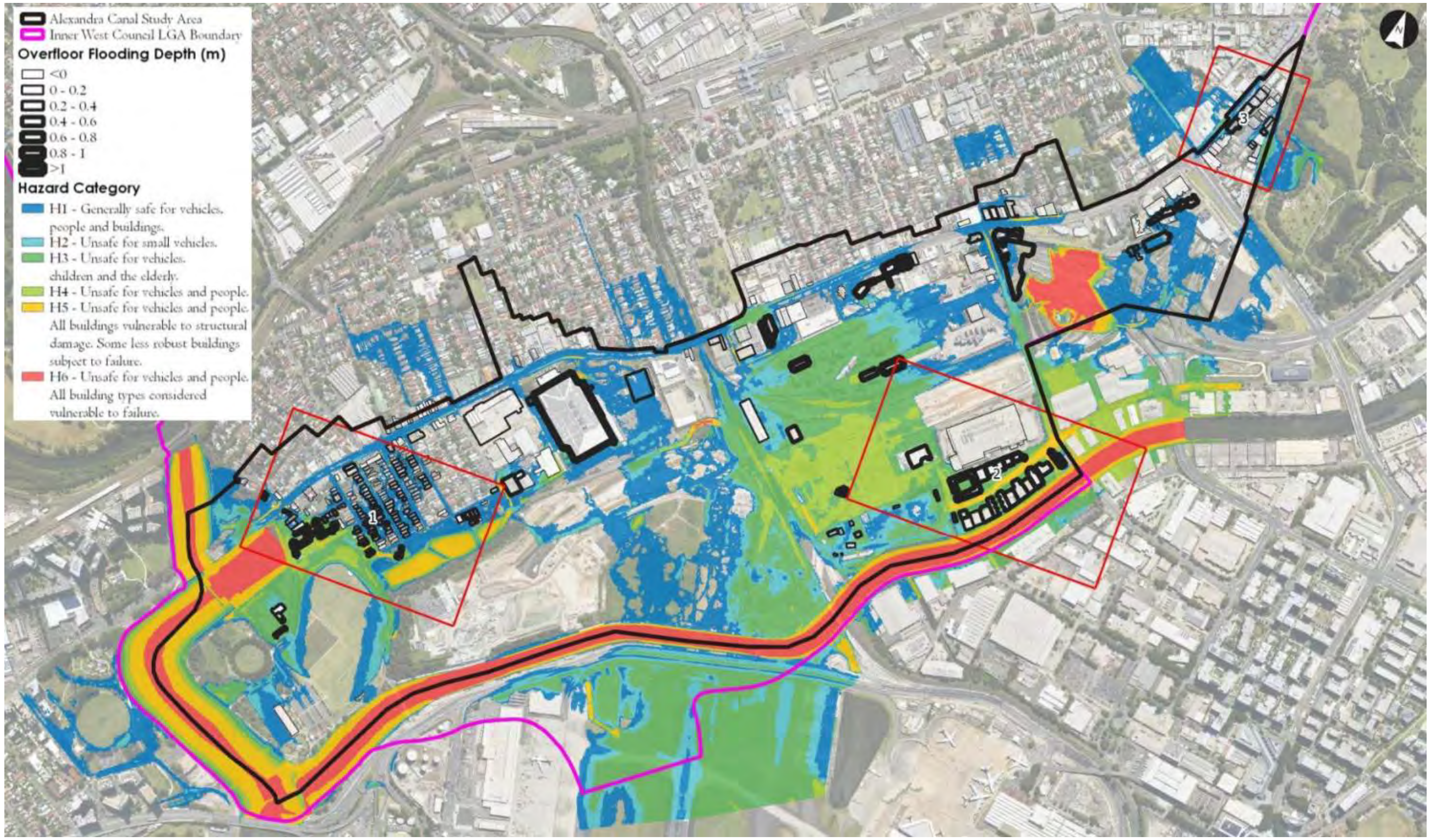

Figure 7-5 Emergency Management Hotspots with PMF H1-H6 Hazard and PMF Overfloor Flooding Depths

7.6 Flood Warning Systems

There are two components to a flood warning system:

- Monitoring of weather and flood conditions to decide when emergency response is required,
- Disseminating this information to residents so that evacuation may commence.

These two components of both current and potential flood warning systems are discussed in the following sub-sections.

7.6.1 Current Flood Warning System

The Inner West LGA Flood Emergency Sub Plan (SES, 2021) under Section 5.4 discusses the range of monitoring and alerts currently adopted by the NSW SES in the local area:

- The BoM issues public weather and flood warning products before and during a flood. These may include:
  - Severe Thunderstorm Warnings with reference to heavy rainfall
  - Regional Severe Thunderstorm Warnings with reference to heavy rainfall
  - Detailed Severe Thunderstorm Warnings (for Sydney/Newcastle/ Wollongong) with reference to heavy rainfall,
  - Severe Weather Warnings with reference to heavy rainfall and/or storm surge,
  - Flood Watches, and
  - Flood Warnings.

In a flash flooding environment, these services can provide pre-emptive warnings of potential flood-causing rainfall, however they are considered less viable for ongoing updates and warnings during a flood event and monitoring of these resources during an event is not considered appropriate.. Further discussion of the reasons for this are included in **Section 7.6.2**.

In addition to these resources that are monitored by the NSW SES, the Flood Plan also notes how these warnings are then disseminated to the community, with the SES providing alerts and flood information through:

- Mobile and fixed public address systems and sirens.
- Two-way radio.
- Emergency Alert (SMS and voice message alerting system).
- Telecommunications (including Auto dial systems).
- Facsimile.
- Standard Emergency Warning Signal.
- Doorknocking.
- Variable message signs.
- Community notices in identified hubs.
- Distribution through established community liaison networks, partnerships and relationships, and
- NSW SES social media and website.
- NSW SES may seek support from agencies and local Council to share the SES social media messages.
- Road closure information will be provided to the community through Transport for NSW 'Live Traffic' website: www.livetraffic.com or 'Transport InfoLine': 131 500. Also, VMS messaging on roadways may also be used to advise motorists.

Several of these options will provide a useful means of almost instantaneously distributing flood warnings to the community. However, some of these means such as doorknocking and social media posts and community notices are unlikely to have the near instantaneous response needed from the community in flash flooding situations.

7.6.2 Discussion of Flood Warning Systems in Flash Flooding Environments

A summary of the considerations for flood warning systems in flash flooding is contained in the below excerpt from the AFAC guideline for flash flooding:

> *Successful evacuation strategies require a warning system that delivers enough lead time to accommodate the operational decisions, the mobilisation of the necessary resources, the warning and the movement of people at risk.*
>
> *Where pre-incident planning identifies existing warning lead times as being non-existent, too short or based on too much uncertainty, improvements to warning systems within existing hydro-meteorological capability should be a priority.*
>
> *Weather forecasting and flash flood prediction is undergoing continual improvement. This is the result of many factors, including better science and the influence of technology. The advent of faster and more 'accurate' weather and hydrological modelling and enhanced real-time observation systems such as Doppler radar are examples of such advances.*
>
> *However, although forecast 'accuracy' is improving for 24 to 72-hour periods, the near-to-real-time period of one to six hours, the period most relevant to flash flood environments, remains a significant forecasting challenge.*
>
> *Effective evacuation typically requires lead times of longer than just a couple of hours and this creates a dilemma for flash flood emergency managers. Due to the nature of flash flood catchments, flash flood warning systems based on detection of rainfall or water level generally yield short lead times (often as short as 30 minutes) and as a result provide limited prospects for using such systems to trigger planned and effective evacuation.*
>
> *Warning systems based on weather forecast can yield longer lead times but provide only a qualitative assessment of the potential for flash flooding over a broad geographical area. A forecast-based warning also inherently provides less certainty in either the location or rainfall volume from which to derive the expected depth and timing of flash flooding. This makes it difficult to provide timely and accurate advice to at-risk communities about flash flooding, regarding advice about who needs to evacuate and when to evacuate.*
>
> *Initiating evacuation of large numbers of people from areas prone to flash flooding based on these uncertain triggers may be theoretically defensible in a purely risk avoidance context but it is likely to be viewed as socially and economically unsustainable. Frequent evacuations in which no flooding occurs, which statistically will be the outcome of forecast-based warning and evacuation, could also lead to a situation where warnings are eventually ignored by the community.*
>
> *These considerations call for flash flood emergency managers to engage with flash flood prone communities, both to discuss and agree on appropriate triggers for agency-led evacuation, and to educate the community on appropriate behaviour in the event of flash flooding occurring with no or very little warning (including messages about the dangers of late evacuation, and strategies such as moving from unsuitable to suitable buildings).*

Within the Inner West, the constraint in deploying an effective flooding warning system is the time available to obtain and process actual rainfall and runoff data to provide an accurate prediction of flood behaviour in a timely manner to residents. Current technologies do not currently provide sufficient time to record and model potential rainfalls and the resulting impact to in time for sufficient community warning. However, this is an area of advancing technology, and improvements may be possible within a medium timeline.

Consequently, a flood warning system is not recommended as an immediate action for this catchment; however, advancements in technology should continue to be monitored for potential medium to long term implementation in the emergency management hotspots discussed in **Section 7.5**.

7.7 Shelter-in-Place Potential

NSW DPE following consultation with NSW SES have released the Draft Shelter-in-Place Guidelines in December 2022. The principles outlined in the guideline for shelter-in-place reflect those included in **Section 7.2**. Essentially that evacuation is the primary response strategy, however in flash flooding areas where evacuation is not possible, shelter-in-place is an alternative, and a last resort for brownfield and greenfield developments.

The guideline provides a list of requirements for potential shelter-in-place. Some requirements relate to development specific considerations such as access to utilities and power during shelter, a minimum flood space area for shelter, and the storage of food, first aid and other resources. However, there are some requirements that relate to the flood affectation of the area, specifically relating to:

- Stability of shelter-in-place structure,
- The duration of flooding of the refuge area, and,
- The feasibility of flood free refuge area.

The potential for shelter-in-place to be implemented for the study area based on these three factors is investigated in the following sections.

The advantage of shelter-in-place is that residents do not require as long to respond for this type of emergency response to be appropriate. As opposed to evacuation where people possibly need to travel a significant distance to reach flood free land, for shelter-in-place people are likely only going to need to access a mezzanine level or first floor within the same building. Thus, the response is more readily available for flash flooding environments and can offer residents a refuge even at night when people are likely to be asleep and not able to respond to evacuation warnings.

As noted within Emergency Management Principle 4 of the 2023 FRM Guide EM01, shelter-in-place should consider the following additional risks for this emergency response type:

- *Isolation – There is no known safe period of isolation in a flood, the longer the period of isolation the greater the risk to occupants who are isolated.*
- *Secondary risks – This includes fire and medical emergencies that can impact on the safety of people isolated by floodwater. The potential risk to occupants needs to be considered and managed.*
- *Consideration of human behaviour – The behaviour of individuals such as choosing not to remain isolated from their family or social network in a building on a floor above the PMF for an extended flood duration, or attempting to return to a building during a flood, needs to be considered when adopting EM strategy.*

7.7.1 Structural Stability

The collapse of a shelter-in-place refuge would result in almost certain loss of life and is not acceptable under any flood event. To determine the likelihood of this occurring the structural stability of shelter-in-place refuges in the event of flooding needs to be assessed.

Hazard categories H5 and H6 both involve structural instability with lower hazard groups H1-H4 being generally considered in a stable range for structures. Mapping of H1-H6 hazard for the 20% and 1% AEP and PMF events for the emergency hotspots is included in **Appendix C**.

The results show that H6 areas where as guided by the hazard definitions building stability is compromised are generally confined to road reserve, backyards and dedicated waterways and channels.

The extent of H5 areas are where standard buildings may be unstable but buildings designed for flood affectation may be stable based on hazard definitions. The H5 extents are more widespread than H6 but in most locations are not within existing building footprints. At these locations any prospective shelter-in-place refuges would need to be specially engineered to withstand flood forces in the PMF event.

7.7.2 Duration of Flooding

The duration of inundation (the time for which the location is submerged) is guided by the water level time series for the Study Area discussed in **Section 7.4.2**. The analysis shows that the duration of flooding for the Study Area is short with most locations flood free less than 3 hours after the onset of rainfall for the PMF event. For more frequent flood events the duration of flooding is a little longer.

As the maximum duration of flooding is expected to be sub-daily for the majority of the floodplain the flood risk to life associated with any prospective shelter-in-place isolation is expected to be manageable through provision of supplies / services to the refuges. However it should be noted from the AFAC guidelines:

> *However, safety of isolation is subjective, and there is no evidence-based method for determining the tolerable duration of isolation that might result from floods. This is to state that the question of what is a safe period of isolation is not resolved.*

Further discussion of duration of isolation is provided within Principle 4 of the 2023 FRM Guide EM01, which notes secondary risks including fire and medical emergencies can impact on the safety of people isolated by floodwater, and consideration of human behaviour in flooding isolation conditions.

7.7.3 Flood Free Refuge

Flood hazard exposure is the main risk to life related to flooding. Therefore, if shelter-in-place is implemented where occupants will remain on site for the duration of the flooding event, it is essential that refuge not expose them to any direct flood hazard, i.e. that the refuge is flood free. As a result, flood refuge should have floor levels located above the PMF water levels.

PMF peak depths throughout the Alexandra Canal study area are relatively shallow compared to riverine or mainstream floodplains. In the upper catchment where overland flow typically occurs and fringe areas of the floodplain PMF depths can be less than 0.5 metres, and even lower than the Flood Planning Level (1% AEP plus 500mm freeboard). In these locations it is not onerous at all to require for shelter-in-place refuge above the PMF level.

In some sections of the floodplain, PMF peak depths may be more significant. For these locations, shelter-in-place refuges become more onerous to construct as they will likely require a mezzanine level or a first floor to be constructed. However, such elevated levels are possibly advantageous to future industrial developments in the area assuming that they can be allowed for within height restrictions for the area.

Sections 7.7.1 to 7.7.3 indicate that the SIP (shelter-in-place) and planned vertical refuge in the flood impacted areas of the Alexandra Canal study area may not possible due to intensity and duration of flooding, though it may be feasible for large portions of the study area. There will be a need for the development of local level resilience at highly impacted properties to address and manage flooding risks. This would include an elevated platform (say 2m) at a flood impacted property based on available space, which could be used by residents to take refuge during flooding events. This will negate the requirements from the SES to mobilise resources and investments. The flood impacted property owners should be incentivised to build such elevated platforms.

7.8 Potential Improvements to Flood Emergency Response

Based on the detailed review of flood emergency response provisions for the Alexandra Canal Catchment, it is unlikely that SES doorknocked evacuation will be able to effectively evacuate residents prior to flooding. From this review, a number of potential measures have been identified that could improve flood emergency response potential for the study area:

- Improved flood awareness.
- Self-managed evacuation,

7.6 These points are discussed further in the following sections.

The potential for early warning systems to reduce the Warning Lag Time is discussed in **Section 7.6**. As noted in this section, current technology does not provide a suitable resource at this time, however newer technologies may provide for rapid modelling and predictions in the mid-term.

Another consideration to improve the emergency timeline is to reduce the Travel Time by utilising a shelter-in-place strategy where evacuation cannot be readily achieved. The suitability of this approach discussed further in **Section 7.7**. As noted in this section, where structural stability, duration of flooding and flood free refuge are feasible, this may be a potential alternative.

It is important to note that all of these potential alternatives are less preferential to SES assisted evacuation, which as per NSW SES and NSW DCCEW guidance is the primary and preferred form of flood emergency response.

These review outcomes have been considered and form the basis of the assessment of Emergency Management (EM) options as discussed in **Section 8.5**.

7.8.1 Self-Managed Evacuation

Where SES assisted evacuation is not an option, self-managed evacuation is a potential alternative. This describes where people make their own decision to evacuate earlier and move to alternate accommodation, using their own transport. These plans would typically be prepared using information available from Council and with support of the local SES unit, using SES templates such as Flood Safe. Self-managed evacuation has a number of advantages:

- People can be evacuated far quicker than SES assisted evacuation as various factors in the evacuation timeline are reduced or removed completely such as accounting for time for SES to mobilise, and doorknocking time.
- Self-managed evacuation reduces the strain on SES resources as part of the floodplain will be evacuated without needing to be doorknocked or otherwise prompted. Also less coordination is required on the part of SES as the scale of the evacuation exercise is lessened by some people being self-reliant.

However, self-managed evacuation can also pose a risk if not conducted in an appropriate way. Residents could place themselves at higher risk for example if they evacuate to a location which is even more flood affected, drive through flood waters, or could increase traffic congestion if the wrong route is selected.

A way for Council to encourage and confirm the adequacy of any self-managed evacuation is through flood emergency response development controls. This could be through implementing requirements for new developments to develop flood emergency response plans particularly large-scale development such as medium and high density residential. Another alternative to improve self-managed evacuation could be requiring site-specific flood warning systems, however these systems typically rely on observed flooding. NSW SES in their advice for this project noted “self-evacuation of the community should be achievable”.

7.8.2 Improved Flood Awareness

For the SES evacuation timeline model, two factors are typically expected to take one hour each in order for residents to evacuate, Warning Acceptance Factor and Warning Lag Time. These two factors both contribute to the poor outcome for the Alexandra Canal Catchment evacuation timeline, however both can feasibly be significantly reduced through improved flood awareness:

- Warning Acceptance Factor, accounts for the delay between occupants receiving the evacuation warning and acting upon it. If people are aware of the flood risk of the area that they live in, then it is reasonable to expect that they will acknowledge the seriousness of any flood warning, and perhaps begin evacuating immediately instead of one hour after receiving the warning.
- Warning Lag Time, an allowance for the time taken by occupants to prepare for evacuation such as packing their belongings etc. If residents are aware of the flash flooding nature of the catchment they are in, then they will know that they have very limited time to respond before flooding commences, leaving the majority of their belongings behind to ensure they evacuate as soon as possible for their own safety.

Based on the above considerations a comprehensive flood awareness program for the Study Area, educating residents of the seriousness of the flood risk and the flash flooding nature of the catchment could improve the evacuation timeline. Currently the processes of residents in evacuation are expected to take on average 2 hours, however this could potentially be reduced to 15 minutes if residents were suitably aware of flood risk in the area.

The crucial safety message to **not enter floodwaters** is relevant to all community members as flash flooding due to overland flow in heavy rainfall events (also referred to as stormwater flooding) is recognised as a high risk to all road users driving on flooded roads across the LGA.

8 Flood Risk Management Options

8.1 Background

8.1.1 Managing Flood Risk

Risk is a combination of the consequences of flooding and the likelihood of these consequences occurring. Flood risk to the community is not static. It can be influenced by Flood Risk Management (FRM) measures, climate change, and future development. It is important to understand these risks and how they may change over time so that this can be considered in management.

Considering flood behaviour with existing measures in place provides a basis for understanding the residual risk to the community with existing conditions, how risks may change into the future, and making informed management decisions. Flood risk can be categorised as existing, future or residual risk as follows:

- Existing Flood Risk – existing buildings and development on flood prone land. Such buildings and developments by virtue of their presence and location are exposed to an 'existing' risk of flooding,
- Future Flood Risk – buildings and developments that may be built on flood prone land in the future. Such buildings and developments would be exposed to a flood risk when they are built, and
- Residual Flood Risk – buildings and development that would be at risk following the implementation of FRM measures. Unless a FRM measure is designed to the PMF, it may be exceeded by a sufficiently large event at some time in the future, meaning in most instances there is still a residual flood risk.

The alternate approaches to managing risk are outlined in **Table 8-1**. The hierarchy of preferred risk approaches is from top to bottom in the approaches listed in the table. This hierarchy is also referenced within Section 3 of the Flood Risk Management Guide FB01.

Table 8-1 Flood Risk Management Alternatives (Source: SCARM, 2000)

Alternative	Examples
Preventing / Avoiding Risk	Appropriate development within the flood extent, setting suitable planning levels.
Reducing likelihood of risk	Measures to reduce flood risk such as drainage augmentation, levees, and detention.
Reducing consequences of risk	Development controls to ensure structures are built to withstand flooding.
Transferring risk	Via insurance – may be applicable in some areas depending on insurer.
Financing risk	Natural disaster funding.
Accepting Risk	Accepting the risk of flooding as a consequence of having the structure where it is.

The relevant emergency response provisions for Inner West Council are established in the Local EMPLAN by the Local Emergency Management Committee (LEMC). The EMPLAN details the combat agency for each hazard and is an all hazards all agencies approach. It refers to sub plans for hazard specific emergency management arrangements and planning. The flood emergency management arrangements that are outlined in the local flood plan (sub plan) expand on the roles and responsibilities of all local stakeholders including LEMC, and the NSW SES local volunteer unit as the combat agency for flooding, this is relevant once the SES stands up an Incident Management Team (activated) by a weather alert by the Bureau of Meteorology.

On all relevant public websites, members of the community within the PMF floodplain are encouraged to know their risk in relation to their local river level gauge. The AWS flood warnings that are issued provide clear statements for actions through Hazard Watch including for residents to stay informed of messaging based on Bureau warnings and reported flood water levels.

The crucial safety message to **not enter floodwaters** is relevant to all community members as flash flooding due to overland flow in heavy rainfall events (also referred to as stormwater flooding) is recognised as a high risk to all road users driving on flooded roads across the LGA. A valuable output of the FRM process to NSW SES flood intelligence is the mapping and tabulation of inundated roads by elevation and depth of flooding at various design storm events (Refer to **Section 8.4.3**).

8.1.2 Options Development Process

As stated within the FRM Guide MM01 the assessment of FRM options should consider:

- Their practicality and feasibility, including the timeframe within which they may be implemented.
- The social, economic, and environmental costs, benefits and disbenefits of FRM measures.
- The upfront, ongoing and complementary work and lifecycle costs involved in implementation.
- Input from the community and the acceptability of measures to the community.
- Consistency with industry guidance and government direction, policy and guidance.

The assessment of FRM options should consider people in the community, the economy, social and cultural aspects, services to the community and the natural environment. Relating to the development of FRM options, the FRM Guide MM01 recommends the following stages within a FRMS&P:

- Option identification and preliminary option assessment and optimization – The identification of an inclusive range of FRM options to address local or broad FRM issues for the existing community and new development. Having identified the FRM issues to address and an inclusive range of FRM options worthy of consideration, the viability of these options needs to be tested to determine if they warrant more detailed assessment. This process is summarised within the following sections.
- Detailed option assessment – Detailed assessment and subsequent optimization of FRM options and packages of options needs to consider their costs, benefits and disbenefits in managing risk. The detailed assessment includes flood modelling of options, damages assessment of option benefits, preliminary costing and a Multi-Criteria Assessment (MCA) that considers a broad range of factors quantitatively or qualitatively.
- Recommendation in FRM studies and decision-making in FRM plans.

8.2 Flood Risk Management Measures

FRM measures (interchangeably referred to as FRM options in this report) which are available for the management of flood risk can be categorised according to the way in which the risk is managed. There are five broad categories outlined within Table 29 of the FRM Guide MM01:

- Flood information - Flood information is essential to understanding flooding. Therefore the continued sourcing of flood information for the study area is considered a stand-alone FRM measure that indirectly influences future flood risk through informing decision-making.
- Flood modification measures – Flood modification measures are options aimed at preventing / avoiding or reducing the likelihood of flood risks. These options reduce the risk through modification of the flood behaviour in the catchment.
- Property modification measures – Property modification measures are focused on preventing / avoiding and reducing consequences of flood risks. Rather than necessarily modify the flood behaviour, these options aim to modify properties (both existing and future) so that there is a reduction in flood risk.
- Emergency response modification measures – Emergency response modification measures aim to reduce the consequences of flood risks. These measures generally aim to modify the behaviour of people during a flood event.
- Environment enhancement – Measures that look to prevent / avoid and reduce consequences of flood risk while also enhance environmental outcomes. Examples include catchment management measures, waterway modification measures, and Water Sensitive Urban Design (WSUD).

8.3 List of Preliminary Flood Modification Options

Opportunities for potential flood modification options were identified by incorporating the following:

- Observations made during the site visit,
- Comments received by the general public during initial consultation, and by project stakeholders including DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives during several workshops, and the FRM Committee. Comment was sought from all of these stakeholders during option identification and development.
- Assessment of the existing terrain, drainage information and 1% AEP and PMF flood hazards provided by Council.

A preliminary and exhaustive list of potential modification options for flood mitigation was developed, with a total of 15 flood modification (structural) options identified within the Alexandra Canal study area. Mapping of the comprehensive list of options are included within **Appendix D**. The flood modification options have been grouped into the following categories:

- Drainage Upgrade,
- Channel Upgrade,
- Bridge Upgrade,
- Detention Basin,
- Road Regrading,
- Drainage Maintenance.

The number of possible flood modification options and option types that were considered for each sub-catchment are summarised in **Table 8-2**. A total of 11, 2 and 2 potential options have been proposed to address hotspots 1, 2 and 3 respectively.

Table 8-2 Number of Flood Modification Options by Type

Catchment	Drainage Upgrade	Drainage Maintenance	Channel Upgrade	Detention Basin	Road Regrading	Total
Alexandra Canal	6	1	1	1	6	**15**

These options have been outlined in the following **Figure 8-1**, **Figure 8-2** and **Figure 8-3**.

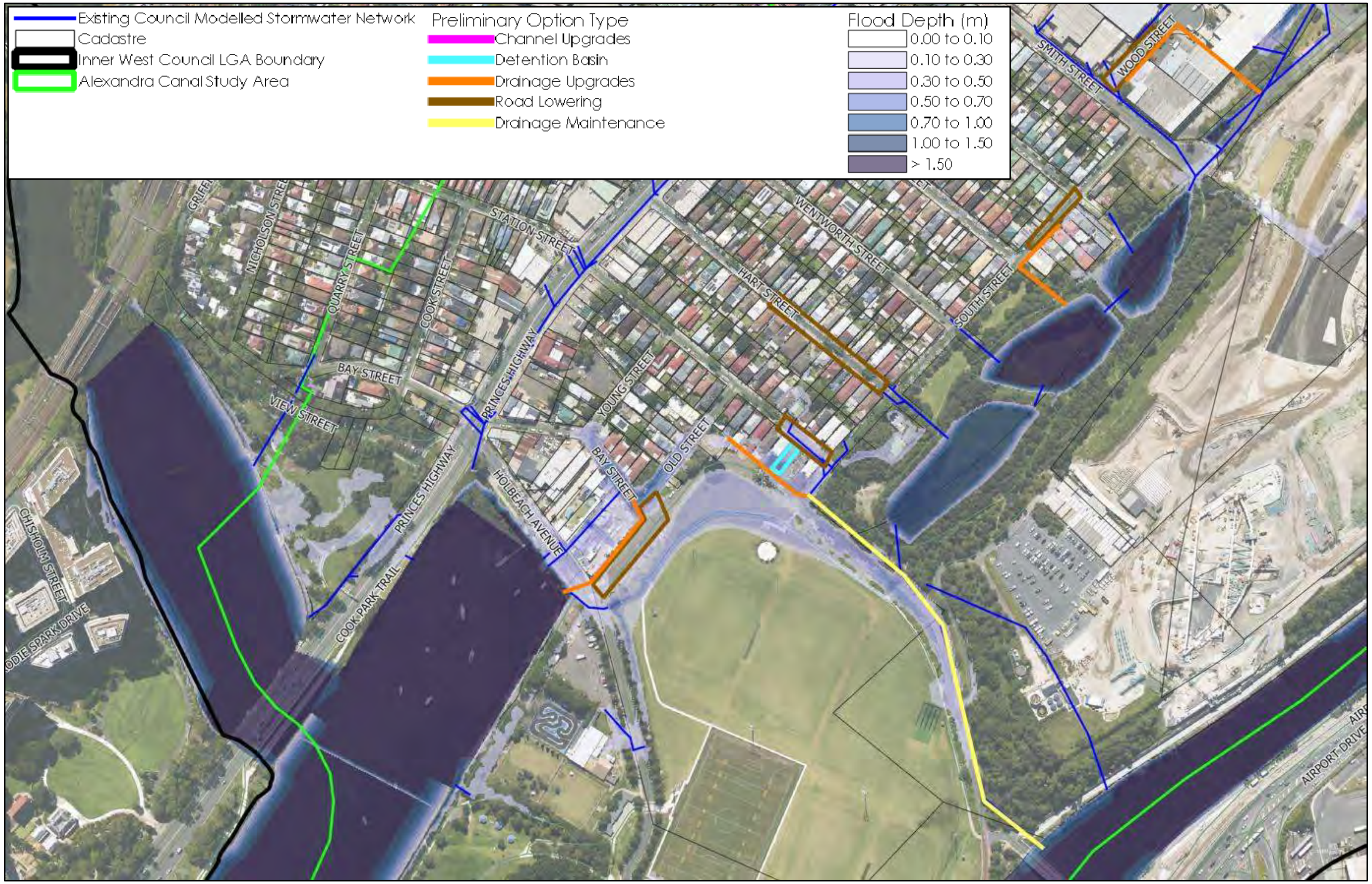

Figure 8-1 Alexandra Canal Hotspot 1 Preliminary Mitigation Options with 1% AEP Existing Peak Depth Results

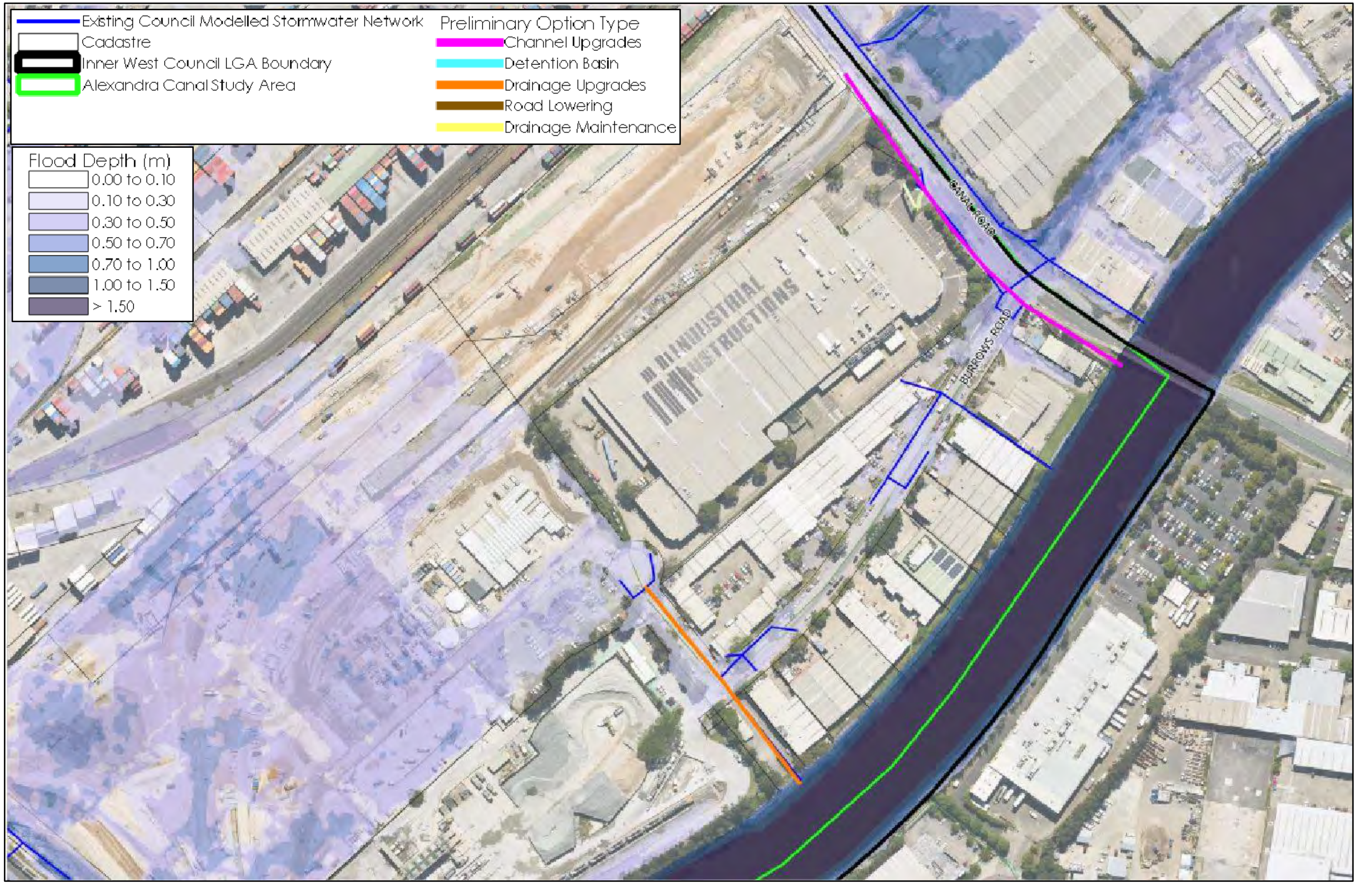

Figure 8-2 Alexandra Canal Hotspot 2 Preliminary Mitigation Options with 1% AEP Existing Peak Depth Results

Figure 8-3 Alexandra Canal Hotspot 3 Preliminary Mitigation Options with 1% AEP Existing Peak Depth Results

8.4 Preliminary Flood Modification Options

8.4.1 Initial Preliminary Flood Modification Options

The comprehensive list of possible flood modification options and option types that were considered are summarised in **Table 8-3.**

Table 8-3 Comprehensive List of Flood Modification Options

Location	Type	Hotspot*	Description
Bay Street, Tempe	Drainage Upgrade	1	Improve drainage capacity to better convey water ponding at the corner of Bay Street and Old Street.
Station Street, Tempe	Drainage Upgrade	1	Improve drainage capacity between South Street and Bay Street to better convey water away from residential properties towards the adjacent parklands.
South Street, Tempe	Drainage Upgrade	1	Improve drainage capacity adjacent Fanning Street to better convey water away from residential properties towards the adjacent parklands.
Wood Street, Tempe	Drainage Upgrade	1	Improve drainage capacity on Wood Street to better convey water towards nearby easements.
Bay Street, Tempe	Road Regrading	1	Regrade the existing road to better convey water ponding at the corner of Bay Street and Old Street.
Station Street, Tempe	Road Regrading	1	Regrade the existing road to better convey water towards nearby ponds/lakes.
Hart Street, Tempe	Road Regrading	1	Regrade the existing road to better convey water towards nearby ponds/lakes.
South Street, Tempe	Road Regrading	1	Regrade the existing road to better convey water towards nearby ponds/lakes.
Wood Street, Tempe	Road Regrading	1	Regrade the existing road to better convey water towards nearby ponds/lakes.
Station Street, Tempe	Drainage Maintenance	1	Carry out routine ongoing maintenance of existing drainage to sustain adequate drainage capacity.
Station Street, Tempe	Detention Basin	1	Construction of a detention basin to reduce flooding of downstream residential properties on South Street.
Burrows Road, St Peters	Drainage Upgrade	2	Improve drainage capacity on Burrows Road to better convey water towards Alexandra Canal.
Canal Road, St Peters	Channel Upgrade	2	Improve the existing channel to better convey water on Canal Road towards Alexandra Canal.
Princes Highway, St Peters	Road Regrading	3	Regrade the existing road to prevent water ponding and affecting properties between Princes Highway and Crown Street.
Barwon Park Road, St Peters	Drainage Upgrade	3	Improve drainage capacity on Barwon Park Road to better convey water towards nearby parklands and ponds/lakes.

Refer to **Section 7.5 for further details of the hotspot locations.*

8.4.2 Selection of Initial Preliminary Flood Modification Options

An initial high-level assessment was carried out for each option relative to other options based on the following qualitative criteria: potential benefits, technical feasibility and costs.

Benefits were assessed based on the expected or potential effects on flood affected areas. The zoning type, number of properties as well as road type/usage were considered. Benefits were categorized as negligible, very low, low, medium and high.

Technical feasibility and cost were assessed based on the specific requirements of each option such as earthworks, roadworks, potential property impacts, length of pipe upgrades, etc. Feasibility and costs were categorized as very low, low, medium and high.

Upon Council review, workshops were held with project stakeholders including DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives during several workshops, and the FRM Committee. The outcome of these discussions was to determine which of these preliminary options are to be adopted for further assessment.

Out of 15 total options, 5 were recommended to be progressed to modelling. Four were proposed Flood Modification (FM) options, while one was the Property Modification (PM) option for increased drainage maintenance. The selected preliminary options are in **Table 8-4**. The flood modification options not selected for detailed assessment, including a brief reason, have been summarised in **Table 8-5**.

Table 8-4 List of Modelled Flood Risk Management Options

Option ID/ Location	Type	Number of Modelling Iterations	Continued to Detailed Assessment (Y/N)
AC4 – Station Street, Tempe	Drainage Upgrade	5	Yes
AC6 – Bay Street, Tempe	Drainage Upgrade	6	Yes
AC11 – Princes Highway, St Peters	Drainage Upgrade	3	Yes
AC14 – Talbot Street, Sydenham	Drainage Upgrade	6	Yes
PM6 – Targeted Stomwater Maintenance	Drainage Maintenance	1	Yes

Table 8-5 Options Not Progressed to Detailed Assessment

Location	Type	Hotspot*	Description
South Street, Tempe	Drainage Upgrade	1	Relatively low technical feasibility/high cost. Scale of works required not suitable for extent of flooding at this location.
Wood Street, Tempe	Drainage Upgrade	1	Relatively low technical feasibility/high cost. Scale of works required not suitable for extent of flooding at this location.
Bay Street, Tempe	Road Regrading	1	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from Bay Street around properties to bay not considered feasible.
Station Street, Tempe	Road Regrading	1	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from Station Street around residential properties to South Street not considered feasible.
Hart Street, Tempe	Road Regrading	1	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from Hart Street around residential properties to South Street not considered feasible.
South Street, Tempe	Road Regrading	1	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from South Street around residential properties not considered feasible.
Wood Street, Tempe	Road Regrading	1	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from Wood Street around commercial properties to Smith Street not considered feasible.
Station Street, Tempe	Drainage Maintenance	1	Included in PM6 for assessment on a catchment-wide scale, therefore specific assessment at this previously blocked location not necessary.

Location	Type	Hotspot*	Description
Station Street, Tempe	Detention Basin	1	Relatively low technical feasibility/high cost. Bugler playground opportunities not deemed feasible for detention basin given limited volumes and potential utilities, and loss of public space.
Burrows Road, St Peters	Drainage Upgrade	2	Relatively low technical feasibility/high cost. This cul de sac services few commercial / industrial properties, and there are flooding issues all along Canal Road so removing this flooding will not provide flood free access.
Canal Road, St Peters	Channel Upgrade	2	Relatively low technical feasibility/high cost. Significant scale of works on TfNSW road and there are flooding issues all along Canal Road so removing this flooding will not provide flood free access.
Princes Highway, St Peters	Road Regrading	3	Relatively low technical feasibility/high cost. Significant scale of works on TfNSW road with works not suitable for potential flood benefits.
Barwon Park Road, St Peters	Drainage Upgrade	3	Relatively low technical feasibility/high cost. Scale of works required not suitable for extent of flooding at this location.

8.4.3 Modelling of Preliminary Flood Modification Options

The 4 flood modification options that were selected for preliminary assessment were developed and modelled with the following methodology:

> 5 design events were considered: 20% AEP, 5% AEP (DSHHWS), 2% AEP, 1% AEP and PMF.

> The PM6 model scenario involved the unblocking off all pipes from the model. The assumption in this model approach is that improved maintenance would potentially remove blockage of pits and pipes, as a theoretical best-case scenario.

> PM6 was used as a base case for the FM options. Details on the PM6 scenario are in **Section 8.5**. The justification for adopting the PM6 option as the base case for the FM options is the removal of blockage. The FM options rely on the effectiveness of the drainage network, therefore assuming an unblocked condition is considered a suitable basis for assessing potential benefits of any drainage upgrades.

> Each option had a unique model scenario established to account for the proposed option details.

- Each option model was based off the base case.
- Drainage upgrades were modelled with updates to the 1D network with duplication of pits and pipes, and creation of new pits and pipes. The details of the proposed network were based on review of existing conditions to develop feasible pipe / culvert dimensions, locations, inverts and pit sizes.

> Each option was then initially modelled for the 20% AEP design event, then selected for detailed assessment based on the 20% AEP flood level difference impacts and other opportunities for improvement identified from the model set up.

> Options that were selected for detailed assessment were then progressed to modelling of all 5 design events.

8.4.4 Development and Optimization of Preliminary Flood Modification Options

As per Section 2.2.4 of the FRM Guide MM01, optimization of options may be used to refine options to improve benefits and reduce costs or disbenefits. This process was conducted for the 4 preliminary flood modification measures developed for this study.

The option as proposed in discussions with Council and NSW DCCEW was initially modelled, and then depending on the outcomes of the initial modelling was often refined and altered to enhance option benefits. In some instances, this led to significant changes in option design through this optimization process.

Optimization not only occurred based on maximising flood benefits, but also in response to other factors that were accounted for in the preliminary option development including:

- Maximising the feasibility of the option. This included consideration of the following:
  - Subsurface utility locations, with proposed earthworks avoiding the vicinity of these utilities where possible.
  - Suitable scale of works justifiable based on the anticipated flood benefits, such as downstream pipe sizes and lengths.
  - Land ownership and avoiding works on private lands where possible.
- Considering the relative cost of the option based on the scale of works, this provides an indication of the economic feasibility of the option.
- Reducing flood affectation and flood risk on private properties, particularly residential properties wherever possible. In some instances this resulted in additional flood risk within publicly owned lands such as road reserves and public open spaces.
- Minimising disturbance of ecological communities and minimising tree removal. The types of vegetation on subject sites were guided by site visit observations and Google Streetview.
- Minimising adverse impacts on private properties or non-publicly owned lands. While some options would result in significant benefits for some properties, it was important they not adversely affect other properties.

For the 4 preliminary flood modification options, a summary of the option outcomes considering the above was provided to Council and NSW DCCEW for their review. These factors were assessed in determining the options to carry into detailed assessment, which is discussed further in the sections below.

8.5 Other Preliminary Options

Beyond the 4 flood modification options that were modelled and assessed, a further twelve non-structural preliminary options were considered:

- Six preliminary Property Modification (PM) measures including Voluntary House Raising (VHR), flood proofing, Voluntary Purchase (VP) and two derivatives (land swap and Council redevelopment) and targeted stormwater maintenance. The options are discussed further in **Table 8-6**.
- Six preliminary Emergency Management Modification (EM) measures including flood prediction and warning, review of Local Flood Planning and information transfer to NSW SES, community flood awareness and school education programs, flood markers and signage and flood data and debrief. The options are discussed further in **Table 8-7**. It is noted that comment on these preliminary options was sought from NSW SES representatives to determine their opinion on the proposed Emergency Management options given the relevance to their operations.

These options were developed based on guidance provided within the FRM Guide MM01, the 2023 FRM Manual and based on past experience with option development in other study areas.

In total, 4 EM options and 1 PM options were recommended/selected for detailed assessment.

Table 8-6 Preliminary Property Modification Options

Option ID	Option Name	Description	Recommendation for Detailed Option
PM1	Voluntary House Raising (VHR)	House raising is a measure designed to reduce the incidence of over-floor flooding of existing buildings through works where Council and NSW DCCEW make contributions to the funding the cost of the work. There are a range of factors that contribute to the feasibility of Voluntary House Raising. The scheme should involve raising residential properties above a minimum design level, assumed to be Council's flood planning level (FPL) meaning 1% AEP plus 0.5 metre freeboard. While house raising can reduce the occurrence of overfloor flooding, there are issues related to the practice, including: > The potential for damage to items on a property other than the raised dwelling are not reduced – such as gardens, sheds, garages, granny flats, decks etc.; > Unless a dwelling is raised above the level of the PMF, and proven to be stable in such a flood event, the potential for above floor flooding still exists – i.e. there will still be a residual risk; > Evacuation may be required during a flood event for a medical emergency or similar, even if no overfloor flooding occurs, and this evacuation is likely to be hampered by floodwaters surrounding a property; > Ensure new footings or piers can withstand flood-related forces; and > Potential conflict with height restrictions imposed for a specific zone or locality within the LGA. The Guidelines for voluntary house raising schemes: Floodplain Management Program (NSW DCCEW, 2020) sets out ineligibility criteria for house raising under the Voluntary House Raising (VHR) scheme. In addition, follow up discussions with NSW DCCEW representatives have provided further information as the potential eligibility of properties for a VHR scheme. The adopted eligibility criteria for this FRMS&P based on these resources is as follows: > Must be residential dwellings to be eligible for funding. Commercial and industrial, public buildings or secondary dwellings are not considered eligible. > Properties that would not achieve a positive benefit through damage reduction relative to cost (i.e. benefit-cost ratio less than 1). > The post-raised building must be stable and therefore not be in a high hazard area. As outlined in the guideline this is defined as areas with PMF hazard of H4 or less being eligible. > Building located in 1% AEP floodway areas are not considered eligible as they represent a significant flow obstruction. > Based on NSW DCCEW guidance, house construction of brick or masonry type are not feasible for raising due to the difficulty of raising floors for such structures. Therefore, only fibro or timber type constructed houses are considered eligible. > Funding is only available for properties where the buildings were approved and constructed prior to 1986, when the original Floodplain Development Manual was gazetted by the State Government. Properties built after this date should have been constructed in accordance with the principles in the manual. > Properties which are already benefiting substantially from other floodplain mitigation measures, such as houses already protected by a levee. There are negligible existing flood mitigation measures in the study area. It is assumed that this requirement does not relate to properties that may benefit from one of the FM options proposed within the FRMS&P as these are not currently implemented mitigation works.	No - Considering the overland flooding nature of the study area, and the limited impact this would provide, and the suitability of the existing housing construction, this option was not considered viable.

Option ID	Option Name	Description	Recommendation for Detailed Option
PM2	Voluntary Purchase (VP)	Voluntary purchase is the optional purchase of pre-selected properties funded jointly by Council and the State Government. It would free both residents and emergency services personnel from the hazard of future floods by removing the risk, and is achieved by the purchase of properties and the removal and demolition of buildings. Properties could be purchased by Council at an equitable price and only when voluntarily offered. Such areas would then need to be re-zoned under the LEP to a flood compatible use, such as recreation or parkland, or possibly redeveloped in a manner that is consistent with the flood hazard (see PM5 below). Voluntary House Purchase is funded by Council with assistance from the State Government. However, due to the relatively expensive nature of such a program, limited availability of Government and/or Council funding can be a major constraint to undertaking Voluntary House Purchases. Typically, only a small number of properties within a floodplain can be considered for Voluntary Purchase, however, more can be assisted if funding is available. The Guidelines for voluntary purchase schemes: Floodplain Management Program (NSW DCCEW, 2020) to assist in determining when and where voluntary purchase schemes may be suitable. The guideline recommends that voluntary purchase be considered where: > There are highly hazardous flood conditions from riverine or overland flooding and the principal objective is to remove people living in these properties and reduce the risk to life of residents and potential rescuers; > A property is located within a floodway and the removal of a building may be part of a floodway clearance program that aims to reduce significant impacts on flood behaviour elsewhere in the floodplain by enabling the floodway to more effectively perform its flow conveyance function; and/or > Purchase of a property enables other flood mitigation works (such as channel improvements or levee construction) to be implemented because the property will impede construction or may be adversely affected by the works with impacts not able to be offset. > Must be residential dwellings to be eligible for funding. Commercial and industrial, public buildings or secondary dwellings are not considered eligible; > Properties that would achieve a positive benefit through damage reduction relative to cost (i.e. benefit cost ratio less than 1).	No Considering the overland flooding nature of the study area, heritage of existing buildings, and likely community expectation, this option was not considered viable.
PM3	Flood Proofing	Flood proofing involves undertaking structural changes and other procedures in order to reduce or eliminate the risk to life and property, and thus the damage caused by flooding. Flood proofing of buildings can be undertaken through a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding. It is primarily suited to industrial or commercial properties. Examples of proofing measures include: > All structural elements below the FPL shall be constructed from flood compatible materials. > All structures must be designed and constructed to ensure structural integrity for immersion and impact of debris up to the 100 years ARI flood event. If the structure is to be relied upon for shelter-in-place evacuation, then structural integrity must be ensured up to the level of the PMF. > All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the FPL. The NSW SES Flash Flood Tool Kit (SES, 2012) provides businesses with a template to create a flood-safe plan and to be prepared to implement flood proofing measures.	No Current DCP provisions should address future development. The number of overfloor flooded properties across the LGA would make this type of scheme not feasible.

Option ID	Option Name	Description	Recommendation for Detailed Option
PM4	Land Swap	An alternative to voluntary purchase is the consideration of a land swap program whereby Council swaps a parcel of land outside of the flood prone area, such as an existing park, for a parcel of flood prone land with the appropriate transfer of any existing facilities to the acquired site. After the land swap, Council would then arrange for demolition of the building and have the land re-zoned under the LEP to open space. Since a detailed floor level survey has not been undertaken and over floor flooding has been estimated based on a desktop assessment, it is recommended that Council undertake a detailed floor level survey to validate if properties identified for voluntary purchase are suitable for land swap.	No – Due to lack of available Council owned land, particularly land that is flood free, therefore land swap not feasible.
PM5	Council Redevelopment	This option also provides an alternative to the Voluntary Purchase scheme. While Council would still purchase the worst affected properties, it would redevelop these properties in a flood compatible manner and re-sell them with a break-even objective.	No - From high level review conducted no properties are immediately apparent for being suitable for a scheme of this type.
PM6	Targeted Stormwater Maintenance	Vegetated roadsides result in significant leaf and branch drop which build up over time and often results in drainage inlet pits blocking rapidly when runoff events occur. This can lead to concentrated and uncontrolled overland flows occurring downslope of these inlets thereby increasing surface flows through streets and private properties. It is recommended that regular street sweeping is undertaken to reduce the potential for the inlets to become blocked and subsequently reduce the frequency of uncontrolled overland flows on streets and through private properties. In addition to regular street sweeping which reduces the potential for inlet pits to become blocked, it is also recommended that stormwater pits in areas subject to flooding are cleaned on a more frequent basis. Suction machines can be used to remove silt and rubbish from the pits. A stormwater maintenance program is currently implemented by Council, with the above tasks routinely conducted. However additional maintenance works could possibly be implemented in the future. It is difficult to quantify the potential benefits that an increased maintenance schedule may have, as the effectiveness of maintenance is reliant on the relative timing of maintenance and flooding. If a flood occurs immediately after a maintenance and cleaning then the benefits in flood reduction may be strongly evident. If flooding occurs after a long period without cleaning then any potential benefits of maintenance would be diminished. Therefore any increase maintenance program should consider the frequency of cleaning and other works. Option PM6 is for the targeted increased maintenance of the stormwater network. Inner West Council, in accordance with its responsibility as owner of the majority of the drainage assets within the study area, has a significant maintenance schedule already in place for all of its stormwater assets. This includes timely responses to community requests or notes relating to any drainage blockage or damage. Option PM6 involves potential additional targeted maintenance of greater frequency than is currently applied at key locations. The potential benefits of the PM6 option for targeted stormwater maintenance would be assessed using modelling assuming no blockage of pipes. This is a best-case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes.	Yes Council currently undertakes maintenance of the stormwater network. The base case model assumes a 100% blockage factor that has been applied to all small diameter pipes. A targeted cleaning program would help reduce the risk of blockage impacting flooding in small diameter pipelines.

Table 8-7 Preliminary Emergency Management Modification Options

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
EM1	Flood Prediction and Warning	The critical duration and response times for the study area floodplain limit the implementation of a flood warning system. The short duration flooding experienced in local systems is not well suited to flood warning systems. Severe weather warnings are likely to be the only assistance for these areas. While flood response times of less than an hour that have been modelled in this study area make any form of warning system seem impossible, there are several factors that may make a scheme worth further investigation: > Flood free land throughout the study area is typically not a long distance. Unlike riverine catchments where the evacuation routes can be kilometres long, as shown in the evacuation route mapping the distance to flood free land does not typically exceed several hundred metres. This means that land above the PMF level could be reached by pedestrians or vehicles in a matter of minutes based on travel time. > Due to the local nature of the flooding, there should be less traffic for evacuation routes as there is not a regional evacuation route that needs to service an entire community. The 2023 FRM Guide EM01 provides advice around the development of a Total Warning System for Flooding (TWSF). The components of a TWSF must be integrated for a system to operate effectively.	Agree that a flood warning system is not feasible. BoM warnings are useful indicators of potential flooding. The NSW SES has adopted the Australian Warning System (AWS) for Riverine Flooding and Tsunami and is planning on extending this to Storms - including Flash flooding	No A local flood warning system may not be feasible due to the flash flooding nature of the study areas. However, the short distance to flood free land means that any advanced warning may provide improved flood risk for the residents. Not progressed as a detailed option as currently not feasible to implement.
EM2	Review of Local Flood Planning and Information Transfer to NSW SES	Having a robust EM plan that can provide the basis for responding to various scales of flood threat and be altered to fit the particular circumstances of an event can assist with flood preparation, response and recovery. The review of local flood plans should also include: > A review of the current flood warning classifications (minor, moderate and major) for the location relative to the impacts on the community and any associated recommendations. > Clarification of the scale of impacts and the scale of the emergency response required in relation to key events and the associated flood timings so this can inform decisions and logistics. For example, for a levee protected community, having a plan in place on how to respond to floods that do not threaten the levee, threaten to result in minor overtopping of the levee, and for extreme floods that overwhelm the levee and town, can provide flexibility. > A review of other key information in the plan in light of the information in this study. The findings of this FRMS&P are an important source of catchment specific information for the NSW SES and Council. Details of flood risks at specific locations are important for planning of operational tasks and for the future review of the Flood Emergency Sub-Plan. The NSW SES have developed a Flood Risk Management Checklist to clearly establish the current expectations for data developed in the FRM process for the purposes of generating reliable flood intelligence to support flood emergency planning. This is a standard across the board and the checklist is	NSW SES is currently revising the way flood planning is addressed in the IW LGA. The current draft VOL 2 of the flood plan is currently on hold and focus is on Pre-Incident Plans (PIPs) for flood rescue hotspots. The planning teams in Marrickville and Ashfield Leichardt units are refining overview documents for hotspot Zones to supplement the PIPs	Yes Providing outcomes from the FRMS&P to NSW SES is essential.

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
		normally adopted upon receiving a formal request via the agency referral process. The checklist relates to three categories; Flood Studies, FRMS&P, and Key Flood Risk Management Issues		
EM3	Community Flood Awareness	Flood awareness is an essential component of flood risk management for people residing in the floodplain, it is important to maintain an adequate level of flood awareness during the extended periods when flooding does not occur. A continuous awareness program is required to ensure new residents are informed, the level of awareness of long-term residents is maintained, and to cater for changing circumstances of flood behaviour and new developments. This option would focus on education of the entire LGA with the objective to educate residents that may be in the floodplain at the time of flooding or may attempt to enter floodwaters. There are a broad range of approaches that can be adopted, which all should be done in close consultation with NSW SES: > Develop FloodSafe Brochure and FloodSafe Toolkit > Develop a post-flood data collection strategy > Hold a FloodSafe launch event > Develop a flood information package for new residents. This option however would not necessitate SES involvement in a Council flood awareness program. It is understood that some flood awareness programs are currently adopted in the local area. Collaboration with SES would be advantageous, as the expectation would be that Council could develop a flood awareness program that provides support and supplements SES flood awareness schemes. The implementation of a flood awareness program may be important in supporting other EM options. For example, the development of a flood warning system (option EM1) would require strong flood awareness, and flood signage and markers (option EM5) would provide best benefits if accompanied with a flood awareness program.	NSW SES supports the development of a council flood awareness program, accompanied by measures outlined in EM5	Yes Recommended outcome of the FRMS&P. Support shown for this option during stakeholder workshop call.
EM4	School Education Program	The SES has developed a tailored program for school children in primary schools. The program, includes teacher's resources, newsletters, activities and games, is designed to deliver knowledge and awareness of floods to young children. SES personnel are also available to visit schools to talk about flooding and flood response. Further details of these programs are available on the SES StormSafe website. Education of parents / carers relating to the flood affectation of the school and the emergency response procedures in place to ensure the safety of their children could be provided directly or through children in the form of brochures etc. Particularly for the study area floodplain it should be reinforced to parents that as all schools have programs in place so they should never enter floodwaters in an attempt to reach their children at school.	NSW SES supports schools who have such programs in place. NSW SES obtains contact details from relevant school authorities.	Supported in Principle Not Recommended for Detailed Analysis Council can engage and advocate on this matter, however only SES and Department of Education can take action.

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
EM5	Flood Markers and Signage	While the above public programs can be effective in improving the long-term awareness of flood risk, in the event of flooding these education programs can easily be forgotten. Therefore, flood warning signage can be an effective tool to remind or inform residents of the risks associated with entering floodwaters, and to also provide practical information in the event of flooding such as recommended evacuation routes. Appropriate flood warning signs should be posted at all locations of significant flooding. These signs may contain information on flooding issues or be depth gauges to inform residents of the flooding depth over roads and paths. Also, evacuation route mapping could be provided on these signs to assist residents. In addition, consultation could be conducted with Transport for NSW (TfNSW) to discuss potential flood signage for flood affected regional roads through the study area. Potential flood affected roads for signage and markers may include: > Princes Highway at several short flood affected ponding areas. This is a potential regional access route with a NSW SES operations centre located nearby. > Bay Street and Holbeach Ave in Tempe > Burrows Road and Canal Road in St Peters	NSW SES supports and encourages the adoption of this measure. Many of the roads affected are high traffic through roads and used by non-residents, so local awareness campaigns are not relevant to these road users. Our flood rescue operators also support these measures as they also indicate to responders the depth of water in the area.	Yes Recommended outcome of the FRMS&P. Support shown for this option during stakeholder workshop call.
EM6	Flood Data and Debrief	A flood event provides an ideal opportunity to capture information on the flood and learn from it. It helps understand the event, the consequences for the community, successes and limitations in current management practices and how the community recovered. Information can be captured in coordinated community surveys. This information should be collated, and a report produced to catalogue what has been captured and its availability and format. The data should be securely stored and made publicly available. The information can be used in both explaining this event to the community and in considering future flood risk, EM and land-use planning decisions within and potentially beyond this community. These tasks are currently part of Council's requirements for flooding response. It is also noted that post-flood funding is also available from NSW DCCEW.	NSW SES supports this measure and considers this information vital to refining flood planning and response alternatives.	Yes Recommended outcome of the FRMS&P. While Council already implements a program of post-flood data collection, continued emphasis of the need for such schemes is recommended. Post flood funding available from NSW DCCEW

Item 16

9 Detailed Assessment of Options

9.1 Options for Detailed Assessment

A total of 9 options were selected for detailed assessment including hydraulic modelling of 5 design events (for 4 FM options and 1 PM option), damages assessment, cost estimation and Multi-Criteria Assessment (MCA). A summary of the 9 options is included in **Table 9-1**. It is noted that detailed options retained their preliminary option ID, therefore the ID numbering of the detailed option list is non-sequential.

Table 9-1 Description of Options for Detailed Assessment

Option Type	Option ID/Name	Modelled Option
Flood Modification (FM)	AC4 – Station Street, Tempe Drainage Upgrade	Yes
	AC6 – Bay Street, Tempe Drainage Upgrade	Yes
	AC11 – Princes Highway, St Peters Drainage Upgrade	Yes
	AC14 – Talbot Street, Sydenham Drainage Upgrade	Yes
Property Modification (PM)	PM6 – Targeted Stormwater Maintenance	Yes
Emergency Management Modification (EM)	EM2 – Review of Local Flood Planning and Information Transfer to NSW SES	No
	EM3 – Community Flood Awareness	No
	EM5 – Flood Markers and Signage	No
	EM6 – Flood Data and Debrief	No

A brief description of the proposed works for the 4 FM options proposed for adoption are summarised in **Table 9-2**. The layout of these FM options is also included in **Appendix E**.

Table 9-2 Description of FM Options for Detailed Assessment

Option ID	Description
AC4 – Station Street, Tempe Drainage Upgrade	Increased pipe diameters (Station St and Holbeach Ave 0.3m to 0.6m, Trunk drainage line to pond outlet changed from 0.75m to 1.2m). Two inlet pits on Station St converted to unlimited capacity, two pits on Holbeach Ave moved to the low point in properties. One-directional flow (CU) was added at downstream end of trunk drainage line and the outlet pipe extended to intersect with 1D channel as there was no interaction with 1D at the channel outlet in the base model.
AC6 – Bay Street, Tempe Drainage Upgrade	A new 1.2m pipe with unlimited pit capacity was added along the road corridor, modelled as one directional pipe to represent flap gate.
AC11 – Princes Highway, St Peters Drainage Upgrade	The existing pipe size was upgraded from 0.3m to 0.525m on Princes Highway.
AC14 – Talbot Street, Sydenham Drainage Upgrade	New drainage network with 0.9m pipes through Princes Hwy and Talbot St. Downstream pipe sizes not under private property increased from 0.9m to 1.2m and west side of Princes Hwy 0.525m to 0.9m. Two pits on west side of Princes Hwy changed to unlimited capacity and all pipes changed to one directional flow.

Attachment 3

Figure 9-1 Location of 4 Detailed Flood Modification Options for Alexandra Canal

9.2 Hydraulic Modelling of Options

The hydraulic modelling of detailed flood modification options reflected the model approach adopted for the preliminary options summarised in **Section 8.4.3**. The 4 detailed flood modification options and one property modification option were modelled for five design flood events – the 20%, 5%, 2% and 1% AEP and PMF events.

The review of hydraulic model results for detailed options included water level difference plots for each option compared to existing conditions for all 5 design events. The extent and scale of water level reductions and complete removal of flooding informed flood risk improvement conclusions for each option. Flood impact maps for all five modelled options for all five design flood events are included in **Appendix E**.

9.3 Preliminary Costing

Preliminary cost estimates have been prepared for all FM options, which allow for an economic assessment via consideration of the cost of implementation and the associated reduction in flood damages. The process for capital cost estimation was as follows:

- Quantities for construction have been estimated from preliminary design for the 4 FM options as they were modelled in the TUFLOW model. This included cut and fill volumes, disturbance footprint areas, and pipe lengths and diameters.
- Unit rates were initially estimated by Stantec based on past project experience. These unit cost rates were reviewed by Council staff and revised in some instances to match current cost rates for the local area.
- Due to the high-level nature of the estimates, a 50% contingency has been applied to all estimates given uncertainty on eventual design refinement and quantities.

Ongoing maintenance costs of FM Options have been estimated based on expected site conditions post-construction. Typically, maintenance works assumed include pit and pipe cleaning, CCTV and mowing and maintenance of open space areas, with only minor expected costs associated. Due to uncertainty on future maintenance requirements and annual costs for Council, a 50% contingency has been applied to ongoing cost estimates as well.

Cost estimates for the Property Modification Option, PM6, the annual drainage maintenance budget for Inner West Council was scaled to the study area as an estimate of potential costs for increased maintenance based on the number of existing stormwater pipes. This amount was applied as both a capital cost and an ongoing maintenance cost for PM6.

For Emergency Management (EM) options, costs were estimated only on the basis of cost to implement, and were done for the purpose of comparison in the multi-criteria assessment. Ongoing costs for EM options were estimated based on expected work needed for each scheme.

Due to uncertainty of potential capital and ongoing costs for all PM and EM options, a 50% contingency has been applied to all, remaining consistent with the assessment of the FM options as well.

A summary of cost estimation outcomes for the 4 FM, 1 PM and 4 EM detailed options is included in **Table 9-3**. All capital and ongoing costs are excluding GST, and account for the 50% contingency.

Table 9-3 Cost Estimates for High-Level Quantitatively Assessed Options

Option	Capital Cost (excl. GST)	Ongoing Annual Cost (excl. GST) *
AC4 – Station Street, Tempe Drainage Upgrade	$1,053,643	$750
AC6 – Bay Street, Tempe Drainage Upgrade	$1,094,884	$1,800
AC11 – Princes Highway, St Peters Drainage Upgrade	$828,821	$-
AC14 – Talbot Street, Sydenham Drainage Upgrade	$1,947,232	$1,500
PM6 – Targeted stormwater maintenance	$142,610	$142,610
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	$22,500	$7,500
EM3 – Community Flood Awareness	$60,000	$45,000
EM5 – Flood Markers and Signage	$150,000	$7,500
EM6 – Flood Data and Debrief	$45,000	$15,000

9.4 Damages Assessment of Options

An assessment of flood damages of the study area for the existing condition was presented in **Section 6**. The 2023 DT01 damage tool provides both a base case tab and an option tab such that damage benefits can be assessed within the tool. The base case is used to compare the performance of modelled options, and through calculation of post-option damages based on hydraulic model results the potential flood damage benefits of each option. The details of all methodology and input data for the option condition damages assessment are unchanged from those summarised in **Section 6**.

The damage assessment for options focussed only on the extent of impacts of the options, not the entire study area, with the total damage benefits calculated from the difference between option and PM6 condition damage totals in these areas of impact.

The new 2023 damages tool optimized external damage calculations by directly assessing them, eliminating the necessity for a separate property layer in the process. The tool features a tab for the base case and an option tab for inputting options data, enhancing the ease of comparing modelled options' performance.

Notably, the total length of assessment utilized a 30-year timeframe, as opposed to the previously employed 50 years, with a discount rate of 5% being considered throughout the analysis in agreement with DT01 defaults.

For PM6, applying existing condition, all pits and pipes were unblocked, achieving the desired PM6 condition to assess the best possible outcomes of increased drainage maintenance. For the PM6 option, the existing case was adopted as the base case. For the four FM options, the PM6 condition assessment was used as the base case.

A summary of damage benefit outcomes for the five modelled design flood events (20%, 5%, 2%, and 1% AEP and PMF) for each of the 4 AC options is included in **Table 9-4**.

The Average Annual Damage (AAD) reduction for each of the 4 AC options has also been calculated in **Table 9-4**. The total combined AAD benefit of all 4 AC option is estimated to be nearly $200,000 per year.

Table 9-4 Reduction in Flood Damages and AAD Associated with each AC Option

Option ID	Total Damages Reduction					Average Annual Damage Reduction
	PMF	1% AEP	2% AEP	5% AEP	20% AEP	
AC4	$0	$0	$0	$0	$34,468	$18,957
AC6	$149,014	$85,014	$124,618	$136,045	$79,732	$60,183
AC11*	$0	$0	$0	$50,029	$0	$4,503
AC14	$30,390	$1,020,346	$1,043,809	$904,837	$0	$112,662
Total	**$180,304**	**$1,105,360**	**$1,168,427**	**$1,090,911**	**$114,200**	**$196,305**

*AC11 has potential flood damage benefits for buildings outside of the study area, therefore this damage benefit may be an underestimate.

9.5 Benefit-Cost Ratio

The economic evaluation of each option was performed by considering the reduction in the amount of flood damages incurred for the design events and then comparing this value with the cost of implementing the option.

Table 9-5 summarises the results of the economic assessment of each of the options. The indicator adopted to assess these measures on economic merit is the benefit-cost ratio (BCR), which is based on the net present worth (NPW) of the benefits (reduction in AAD, refer to **Section 9.4**) and the costs (of implementation, refer to **Section 9.3**). In the calculation of NPW, a 5% discount rate and an implementation period of 30 years have been adopted (default values in the 2023 DT01 Damage Tool).

The benefit-cost ratio provides an insight into how the damage savings from a measure relate to its cost of construction and maintenance.

- Where the benefit-cost ratio is greater than one (BCR >1) the economic benefits are greater than the cost of implementing the measure.
- Where the benefit-cost is less than one but greater than zero (0 < BCR < 1) there is still an economic benefit from implementing the measure, but the cost of implementing the measure is greater than the economic benefit.
- Where the benefit-cost is equal to zero (BCR = 0), there is no economic benefit from implementing the measure.

For all FM options it is possible to quantify, at least at a high-level both damage benefits and costs of implementation for each option, therefore a BCR is able to be calculated. For EM & PM options, the damage benefits are not easily quantifiable, though there would be some economic benefits of these options in the form of reduced risk to life and resultant reduction in flood damage for loss of life. Therefore in lieu of any damage benefit information, the economic analysis of these options has assumed that BCR is 1.0.

Table 9-5 Summary of Net Present Worth of Benefits and Costs and Resultant Benefit Cost Ratio

Option	NPW of AAD Reduction Benefits	NPW of Cost of Implementation of Option	Benefit Cost Ratio
AC4 – Station Street, Tempe Drainage Upgrade	$291,418	$1,065,173	0.27
AC6 – Bay Street, Tempe Drainage Upgrade	$925,163	$1,122,555	0.82
AC11 – Princes Highway, St Peters Drainage Upgrade**	$69,216	$828,821	0.08
AC14 – Talbot Street, Sydenham Drainage Upgrade	$1,731,887	$1,970,291	0.88
PM6 – Targeted stormwater maintenance		$2,334,873	1.0*
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES		$137,794	1.0*
EM3 – Community Flood Awareness		$751,761	1.0*
EM5 – Flood Markers and Signage		$265,294	1.0*
EM6 – Flood Data and Debrief		$275,587	1.0*

*In lieu of benefit values for EM and PM options, due to flood risk reduction BCR value assumed to be 1.0

**AC11 has potential flood damage benefits for buildings outside of the study area, therefore this damage benefit may be an underestimate.

The BCR results show that of FM options, AC6 and AC14 both have BCR values slightly under 1.0, therefore the costs only slightly exceed the calculated benefits. For AC11, the potential benefits of this option for private property are on the west side of Princes Highway and therefore are not picked up in damages assessment. Therefore, it is likely that the BCR score for that option is an underestimate.

The PM6 option cannot be easily assessed as the potential benefits of targeted maintenance are difficult to quantify. A sensitivity modelling scenario has been adopted assuming no blockage of pipes as a result of maintenance. This is a best-case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes. Therefore, due to this uncertainty, the modelling outcomes in the form of damage benefits were not applied to the BCR outcome for this option PM6.

9.6 Multi-Criteria Assessment

To assist Council in identifying the FRM options that provide the most benefits for the community, all options need to be compared against each other based on factors relevant to the study area.

Evaluating what constitutes an appropriate strategy for floodplain management is a significant analytical and policy challenge. Such challenges have led to the exploration of alternative policy analysis tools, one being Multi Criteria Assessments (MCA). The goal of MCA is to attempt to directly incorporate multiple values held by community and stakeholders into the analysis of management alternatives while avoiding the reduction of those values into a standard monetary unit. In doing so, one can consider different FRM options in the context of economic criteria as well as other criteria such as social, or environmental aspects. Community and stakeholders can also assign explicit weights to those values to reflect their preferences and priorities. Therefore, MCA provides opportunities for the direct participation of community and stakeholders in the analysis.

An MCA approach has been used for the comparative assessment of all options identified using a similar approach to that recommended in 2023 FRM Guide MM01. This approach uses a subjective scoring system to assess the merits of each option. The principal value of such a system is that it allows comparisons to be made between alternatives using a common index. In addition, the MCA makes the assessment of alternatives “transparent” (i.e. all important factors are included in the analysis).

However, this approach does not provide an absolute “right” answer as to what should be included in the plan and what should be omitted. Rather, it provides a method by which Council, community and stakeholders can re-examine options and, if necessary, debate the relative scoring assigned.

Each option is given a score according to how well the option meets specific considerations. In order to keep the scoring system simple a framework has been developed for each criterion.

9.6.1 Development of Criteria

A balanced FRMS&P addresses existing, future and continuing risk to reduce residual risk to a level more acceptable to the community and in doing so generally involves assessing, deciding on and prioritising a range of FRM measures.

One way of considering the outcomes of an MCA of different options or packages of options is the establishment of an options assessment matrix that considers a range of criteria that can influence decision-making. The criteria used can vary with the flood situation and community. Some may not be relevant to the circumstances or the options being considered. In addition, different communities, decision-makers and groups may consider different criteria and specific elements to be more or less important. One way of addressing this variation is to weight the relative importance of these criteria so this can be factored into the assessment.

As per the recommendations of Section 2.2.5 of the FRM Guide MM01, the selection of criteria and weighting should be completed independent of scoring and actively involve the FRM committee and its technical working group (TWG).

There are a total of 11 MCA criteria adopted for this FRMS&P:

- 5 economic criteria – Benefit-cost ratio, risk to property, technical feasibility, implementation complexity, and adaptability/long-term performance
- 4 social criteria – Risk to life, emergency access and evacuation, social disruption and public open spaces, and community and stakeholder support
- 2 environment criteria – Flora and fauna impact and heritage impact.

The criteria weightings provided by Council are summarised in **Table 9-6**.

9.6.2 Criteria Scoring System

A scoring system was established for each criteria with scores ranging from +2 for options that represented a significant improvement on existing conditions for any given criteria, to -2 for options that represented a significant worsening of existing conditions. The scoring system for all 10 criteria are summarised in **Table 9-6**. It is noted that for two criteria (Benefit-Cost Ratio and Reduction in Risk to Property) scoring systems was based on quantifiable assessment outcomes, for all other criteria scoring was more subjective.

Table 9-6 Multi-Criteria Assessment – Scoring System Summary

Category	Criterion	Weighting	Description of Criterion Assessment	Score: -2	Score: -1	Score: 0	Score: 1	Score: 2
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0 to 0.25	0.25 to 0.5	0.5 to 1.5	1.5 to 3.0	>3.0
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	Major increase in AAD (>$200,000)	Slight increase in AAD ($200k to $100k)	Negligible Improvement (less than $100k AAD impact)	Slight decrease in AAD ($200k to $100k)	Major decrease in AAD ($>200,000)
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingencies such as land acquisition or agreements with external agencies	There are a number of significant factors that pose an impact on the feasibility of the project	There is a single significant factor or multiple smaller factors that pose a potential impact on the feasibility of the project	May or may not be feasible	Likely to be feasible with management of constraints	Very likely to be feasible with no significant restraint
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	Construction timeframe greater than 1 year Project cannot be broken down into sequential components	Construction timeframe greater than	Key components can be completed in isolation within 12 months	Overall construction timeframe less than 12 months Minor components can be staged	Construction timeframe less than 6 months Major components can be staged
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	Significantly diminished performance long-term or under climate change	Slightly diminished performance long-term or under climate change	Unchanged performance long-term or under climate change	Unchanged or improved performance long-term or under climate change with minor ongoing costs	Unchanged or improved performance long-term or under climate change with negligible ongoing costs
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	Widespread or significant localised increase in risk to life	Localised or slight increase in risk to life	Negligible change in risk to life	Localised or slight reduction of risk to life	Widespread or significant localised reduction of risk to life
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	Widespread or significant localised impact on evacuation and emergency services	Localised or slight localised impact on evacuation and emergency services	Negligible impact on evacuation and emergency services	Localised or slight improvement for evacuation and emergency services	Widespread or significant localised improvement for evacuation and emergency services
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	Significant increase in the frequency of flooding or limitation of the use of a public space or causes significant social disruption	Increase in the frequency of flooding or limitation of the use of a public space or causes social disruption	Negligible impact on public space or social disruption	Reduces the frequency of flooding or provides enhanced use of a public space or causes social benefit	Significantly reduces the frequency of flooding or enhanced use of a public space or causes significant social benefit
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	Strong opposition to the option in multiple submissions	Slight opposition to the option	No response	Slight support to the option	Significant support to the option
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	High negative impact	Slight negative impact	Negligible impact	Some benefit	Considerable benefit
	Impact on Heritage	5%	Impact to Heritage items	Likely impact on State, National, or Aboriginal Heritage item	Likely impact or increased impact on a local heritage item	No impact	Reduces the impact of flooding to heritage item or heritage conservation area	Heritage item no longer flooded

9.6.3 Multi-Criteria Scoring Outcomes

The assignment of a score and brief discussion reasoning for the score for each criterion for the flood modification (FM), property modification (PM), and emergency management (EM) modification options is shown in its entirety in the matrices presented in **Appendix F**.

The unweighted scores of the MCA has a range from 20 to -20 based on 10 criteria each with a score of +2 to -2. The weighted final MCA scores using the criteria weighting (see **Table 9-6**) have a possible range of +2.0 to -2.0. The total weighted and unweighted MCA scores for each detailed option are summarised in **Table 9-7**. The options have been tabulated in order from highest to lowest weighted score.

Due to the relative weighting of the 11 criteria the weighted and unweighted scores for options were not ordered the same. For example PM6 and AC11 both have weighted scores of 0.45, however in terms of unweighted scores PM6 has a score of 9 compared to AC11 score of 4. This provides an insight into the significance of appropriate criteria weighting.

Table 9-7 MCA Outcomes for Weighted and Unweighted Scores for Detailed Options

Option ID	Option Type	Total Unweighted Score (from -20 to 20)	MCA Weighted Score	MCA Rank
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	11	1.10	1
EM3 – Community Flood Awareness	Emergency Management (EM)	10	0.95	2
EM5 – Flood Markers and Signage	Emergency Management (EM)	10	0.95	2
Option AC6 – Bay Street, Tempe Drainage Upgrade	Flood Management (FM)	7	0.60	4
PM6 – Targeted Stormwater Maintenance	Property Modification (PM)	6	0.50	5
EM6 – Flood Data and Debrief	Emergency Management (EM)	5	0.45	6
Option AC11 - Princes Highway, St Peters Drainage Upgrade	Flood Management (FM)	4	0.45	6
Option AC14 - Talbot Street, Sydenham Drainage Upgrade	Flood Management (FM)	3	0.40	8
Option AC4 – Station Street, Tempe Drainage Upgrade	Flood Management (FM)	-3	-0.40	9

The highest scoring options were all emergency management modification options (EM) due to their relatively minor cost and ease of implementation. In the top half of ranked options, three of the four were EM options.

Option AC6 Bay Street drainage upgrade was the highest scoring FM option due to this being an area of noted frequent flooding (even during king tide events), its relative ease in terms of feasibility and complexity for relatively greater benefits compared to other FM options.

The lowest scoring options were AC14 Talbot Street drainage upgrade which was marginally lower due to its complexity, and AC4 Station Street drainage upgrade which was much lower due to low relative benefits and BCR.

10 Implementation Program

The Flood Risk Management options outlined in **Section 9** are recommended for implementation as an outcome of the Floodplain Risk Management Study. In order to achieve the implementation of relevant management actions, a plan of implementation has been developed as outlined in the following sections.

10.1 Steps to Implementation

The steps in progressing the flood risk management process from this point onwards are:

> Formal adoption of FRMS&P: Following public exhibition and FRM Committee approval, Council will formally adopt the final Flood Risk Management Study and Plan;

> Investigation and Design (I&D) stage – Most options will next require an Investigation and Design (I&D) phase to further refine the design and further confirm the feasibility of the option. An equivalent assessment is a 'Feasibility Study' or 'Scoping Study' for programs such as the Voluntary House Raising Scheme. These investigation and design assessments for individual projects should build on the assessment undertaken in the FRM plan. The potential steps of the I&D stage may include:

  - Prior to the I&D stage, grant funding applications for the I&D assessment may need to be submitted by Council when required.
  - Additional investigations may be required to inform feasibility assessment. For example, for Flood Modification options these may include geotechnical investigations, subsurface utility survey, or environmental impact reviews.
  - Concept design of the option.
  - Detailed design of the option.
  - Environmental approvals submissions such as a Review of Environmental Factors (REF) or Environmental Impact Statement (EIS).
  - Economic assessment of options (Level 1, Level 2 or Level 3 guided by the framework discussed in the next sub-section) potentially including further detailed damages benefit assessment, or cost estimation compared to the analyses conducted in this FRMS&P.

> Following I&D stage, if required, a grant funding application will need to be submitted to support the implementation / construction of the option.

> Implementation / construction of the flood risk management option.

10.2 Economic Assessment Framework for Options

Where external funding is required, the FRM economic assessment framework, as shown in **Figure 10-1**, provides the basis for further assessment of the FRM measures as part of the investigation and design phases of implementation.

The framework for the economic assessment of FRM measures from the FRM Guide MM01 is shown in **Figure 10-1**. It provides a summary of the economic assessment of FRM options following on from a FRMS&P into Investigation and Design (I&D) stage and into Implementation stage. This provides useful context into the different levels of detailed assessment required for FRM options once they proceed beyond the FRMS&P stage. There are four levels of economic assessment based on this framework:

> Level 1 assessments are the least detailed form of economic assessment. Level 1 assessments include preliminary costing, damages benefit estimation and an MCA including preliminary cost-benefit summary. These Level 1 assessments are applied at the FRMS&P phase for all FRM options, regardless of expected option cost. For FRM options with expected cost less than $1 million, a level 1 assessment is also appropriate at I&D and implementation stage as no grant approval is required. The Level 1 assessment in this FRMS&P for detailed options is summarised in **Section 9**.

> Level 2 assessments update the Level 1 economic analysis to include cost estimates from I&D stage. Consider whether additional damage assessment factors (not included but likely to influence the outcome) should be included to improve the Level 1 damage assessment, also consider sensitivity assessment to discount rate, and increases, and decreases in benefits and costs. Level 2 assessments relate to FRM options with expected value between $1-$5 million. Level 2 assessments require additional reporting incorporated in I&D reporting to support grant application for implementation.

> Level 3 assessments are similar to Level 2 with updating of Level 1 economic analysis to include cost estimates from I&D stage, but with potential to include more detailed techniques for monetary valuation. Use of more detailed assessment techniques for benefits assessment, for example, evacuation modelling may be appropriate to identify risk to life more readily. More detailed sensitivity analyses than Level 2 with a more detailed stand-alone report or appendix to the I&D report to support grant application. Level 3 assessments relate to FRM options with expected value between $5-$10 million.

> For FRM Options with expected value in excess of $10 million, the option must go through a NSW Treasury gateway review process with more detailed economic assessment and reporting required.

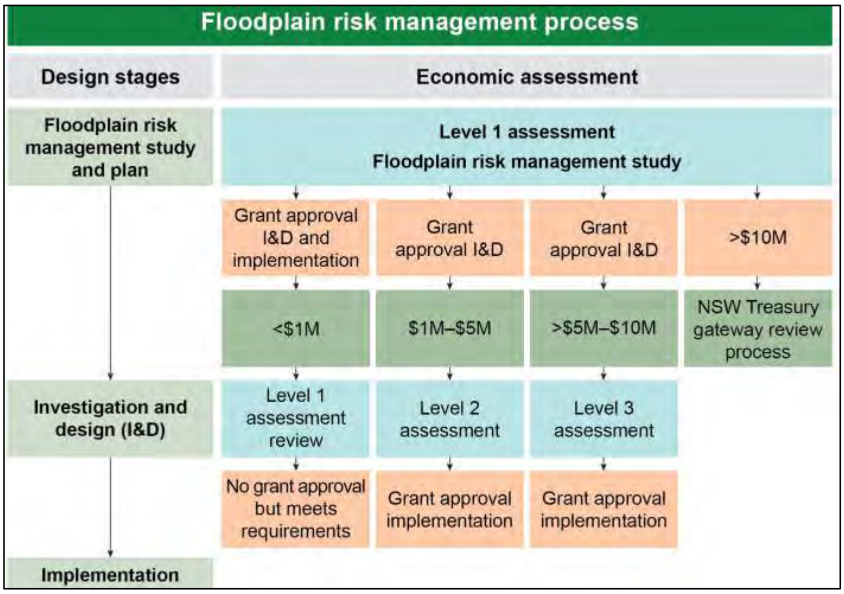

Figure 10-1 Detailed FRM Measure Economic Assessment Framework (Source: FRM Guide MM01)

The expected necessary economic assessment level of each option in this FRMS&P is summarised in the implementation program in **Table 10-1**. The economic assessments will need to be completed during Investigation and Design (I&D) stage for each option.

10.3 Funding Mechanisms for FRM Options

As stated in FRM Guide MM01, FRM plans may recommend a range of implementation measures that are funded through one of the following means:

a. Council funded: Can be implemented within council's own resources, such as updating land-use planning arrangements. Council should progress these measures within their own resources considering the priorities in the plan

b. Funded by Other Agencies: Are the agreed responsibility of, or require agreed input from external parties to implement. Examples include updating EM planning arrangements, or options located within the lands of other stakeholder agencies. Council should work with external parties to support implementation, considering the priorities in the plan.

c. Grant Funded: Will generally require external funding support, such as new or upgraded FRM works, including levees, basins, and flood warning systems. Council will need to apply for these grant funds.

The anticipated funding mechanism for each option adopted within this FRMS&P is summarised in the implementation program in **Table 10-1**. This is an assumed funding source, it is possible that funding sources other than those listed in **Table 10-1** may be considered for any given option at Council's discretion and with the agreement and support from any relevant funding agencies.

10.3.1 Grant Funding

The NSW Government's floodplain management grants support local Councils to manage flood risk. The funding for FRM option implementation from these grants has traditionally comes from two programs:

> NSW Floodplain Management Program, and

> Floodplain Risk Management Grants Scheme (jointly funded by the NSW DCCEW and the Commonwealth Government).

Applications for funding can be made by Council for the implementation of actions identified in a FRMS&P. The information provided in the applications for each management action is used to rank the priority for funding of all actions across NSW. The information presented in this FRMS&P can be used as a starting point to complete the relevant applications for funding.

Sufficient information should be provided in reports to facilitate funding applications for eligible projects under relevant funding programs. Information currently needed to support these applications relates to Council's commitment to FRM, how FRM measures were identified and assessed, community involvement in FRM plan development, and the FRM benefits of the project for the community.

10.4 Ranking and Prioritisation of Options

Based on review of the Multi-Criteria Assessment outcomes summarised in **Section 9.6.2**, the options have been ranked in order of preference. The MCA scores were combined to produce an options implementation preferences list as shown in **Table 10-1**. As shown in the rank column, this table was ordered based on ranking, from highest ranking to lowest ranking option.

In addition, a priority has been assigned to each of the options to inform the implementation strategy. The priority reflects the recommended urgency of the option from a reduction in flood risk perspective, it is possible that the order of implementation that Council adopts may differ from these priority assignments.

The grouping of options into the three priority categories was based on the distribution of MCA scoring, with categories set at points of clear delineation of scoring outcomes. There is an MCA score difference of 1.5 from the worst scoring high priority option and the best medium priority option, with a 0.05 score difference from medium to low. The three priority categories are:

> High – Four options were identified as high priority. Of the high priority options, three are Emergency Management (EM) and one is a Flood Modification (FM) – AC6 Bay Street Drainage Upgrade. The range of MCA scores for high priority options is 1.10 to 0.6 (ranks 1-4)

> Medium – Four options were identified as medium priority. Of the medium priority options, there is one Emergency Management (EM), two Flood Modification (FM) and one Property Modification (PM) options. The range of MCA scores for medium priority options is 0.45 to 0.4 (ranks 5-8); and

> Low – One option was identified as low priority. This option is a Flood Modification (FM) – AC4 Station Street Drainage Upgrade. This option had a MCA score of -0.40 (rank 9). This low score is a result of the only minor flood benefits this option produces.

10.5 Implementation Plan

The list of recommended management options has been transformed into an implementation plan provided in **Table 10-1**. It lists the following information relevant to the implementation of each adopted FRM option:

> Type and sub-catchment location of option and Multi-Criteria Assessment score;

> The priority for implementation (high, medium, or low) and rank as an outcome of the FRMS&P;

> An estimate of implementation costs including capital and ongoing costs per annum;

> Potential funding mechanism or organisation; and

> Required economic assessment level during I&D stage from framework in **Section 10.2**.

The flood risk management options identified in **Table 10-1** represent a capital cost of approximately \$5.3M, with the flood modification options making up \$4.9M of this cost. High priority options have combined capital costs of \$1.3M.

It is noted that a specific timeframe for the implementation plan has not been explicitly identified. Experience with these types of plans has identified that the works are undertaken when and as funding becomes available, as well as when various opportunities might arise specifically for an option.

Table 10-1 Implementation Plan for Alexandra Catchment FRMS&P

Option ID	Option Type	MCA Weighted Score	Option Rank	Implementation Priority	Capital Costs (incl. GST)	Ongoing Costs (p.a incl. GST)	Economic Assessment Level for I&D
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	1.10	1	High	$ 22,500	$7,500	Level 1 (FRMS&P)
EM3 – Community Flood Awareness	Emergency Management (EM)	0.95	2	High	$ 60,000	$ 45,000	Level 1 (FRMS&P)
EM5 – Flood Markers and Signage	Emergency Management (EM)	0.95	2	High	$ 150,000	$ 7,500	Level 1 (FRMS&P)
Option AC6 - Bay Street Drainage Upgrade	Flood Management (FM)	0.60	4	High	$ 1,094,884	$ 1,800	Level 2 (Detailed damages)
PM6 –AC Targeted Stormwater Maintenance	Property Modification (PM)	0.50	5	Medium	$ 142,610	$ 142,610	Level 1 (FRMS&P)
EM6 – Flood Data and Debrief	Emergency Management (EM)	0.45	6	Medium	$ 45,000	$ 15,000	Level 1 (FRMS&P)
Option AC11 - Princes Highway Drainage Upgrade	Flood Management (FM)	0.45	6	Medium	$ 828,821	$ -	Level 1 (FRMS&P)
Option AC14 - Talbot Street Drainage Upgrade	Flood Management (FM)	0.40	8	Medium	$ 1,947,232	$ 1,500	Level 2 (Detailed damages)
Option AC4 - Station Street Drainage Upgrade	Flood Management (FM)	-0.40	9	Low	$ 1,053,643	$ 750	Level 2 (Detailed damages)
				Total	**$ 5,344,690**	**$ 221,660**	

11 Conclusions and Next Steps in Study

This Draft Final Flood Risk Management Study and Plan (FRMS&P) report summarises the outcomes of the study undertaken for Inner West Council for Alexandra Canal Catchment. This includes initial data collection and review process, community consultation, review of the flood study models, existing risk assessments including economic impacts of flooding, flood emergency response review, and flood planning review. It includes a summary of the flood risk management option development process and preliminary option assessment to refine options for adoption. The report also documents the detailed option assessment including modelling, cost estimation, damage benefits assessment, and Multi-Criteria Assessment (MCA) and provides a prioritised list of final options. Finally, the report outlines an implementation program to assist Council in the future implementation of these final options.

The flood study model review process involved the updating of the Flood Study TUFLOW model to account for ARR2019 design rainfall (Flood Study adopted ARR87 rainfall), and updating for present-day terrain in the form of LiDAR. The review concluded that the impacts of the model updates were relatively minor therefore the Flood Study model was appropriate for retention as the base case model for this FRMS&P and the assessment of options.

The flood damages assessment, flood emergency response review and flood planning review all contribute to the understanding of existing flooding as it relates to economic impacts, risk to life, and future development respectively.

A preliminary assessment of flood modification options has also been conducted including flood modelling of Flood Modification (FM) options and consideration of Property Modification (PM) options and Emergency Management Modification (EM) options. In total 27 preliminary options were developed including 15 FM, 6 PM and 6 EM options. From these preliminary options, 9 options have been selected for detailed assessment including 4 FM options, 1 PM option, and 4 EM options.

The detailed option assessment to review the selected final 9 options through flood modelling to assess the impacts of the option, flood damages (both for FM and PM options only, not EM options), cost estimation and Multi-Criteria Assessment (MCA). The outcomes of the MCA have been applied to the implementation plan including a list of priority options with four high priority options, four medium priority options, and one low priority option. Of the high priority options, one is a Flood Modification (FM) – AC6 Bay Street Drainage Upgrade and three are Emergency Management (EM) modification options.

The next phase of the project is for this Draft Final FRMS&P report to be placed on public exhibition, to receive comments and feedback from the community on the draft outcomes of the study prior to finalisation. The public exhibition period is planned for a four-week period (at a minimum) in Autumn 2024. Comments from the community shall be collated and reviewed and incorporated into the Final FRMS&P report.

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APPENDIX

A

CONSULTATION MATERIALS

Alexandra Canal

Flood Management Plan

Managing flood risk in your neighbourhood

Project updates

What we heard about your experiences of flooding?

1 June 2023

Between 7 March and 6 April 2023 we sought your feedback on the Alexandra Canal Flood Risk Management Study and Plan. The purpose of the engagement was to understand resident experiences of stormwater and flooding within the Alexandra Canal catchments and to identify preferences for flood management options.

Key points on the engagement methods and results:

- The Your Say Inner West project page was viewed 650 times
- Five people shared their experiences of flooding via the online survey and two contributed to the interactive map
- Seven people attended a drop-in session to ask questions and share their experiences
- The adopted Flood Study was downloaded 49 times

Feedback received during this engagement has been passed on to Council's consultant and will assist with developing flood mitigation options for these catchments. A detailed study will be prepared and placed on exhibition towards the end of 2023.

Community feedback dates

Tuesday 7 March - Thursday 6 April 2023

Council is exploring options for managing the impact of floods in the Alexandra Canal catchment.

In 2017 Council completed the Alexandra Canal Flood Study. This involved modelling flood behaviour using rainfall data and information from the community about past storm events. The study determined:

- Where flood water will run
- How the existing drainage system will cope.
- Which properties are affected?

The results from this investigation can be found in the completed Flood Study.

What happening now?

Council has engaged specialist flood consultants, Stantec, to prepare a Floodplain Risk Management Study and Plan (the Management Plan) for Alexandra Canal. This involves reviewing the Flood Study and identifying options for reducing flood risk in the catchment.

What does the management plan propose?

The primary objective of the flood Management Plan is to identify options to mitigate and manage flood risk. This will involve consideration of options that seek to:

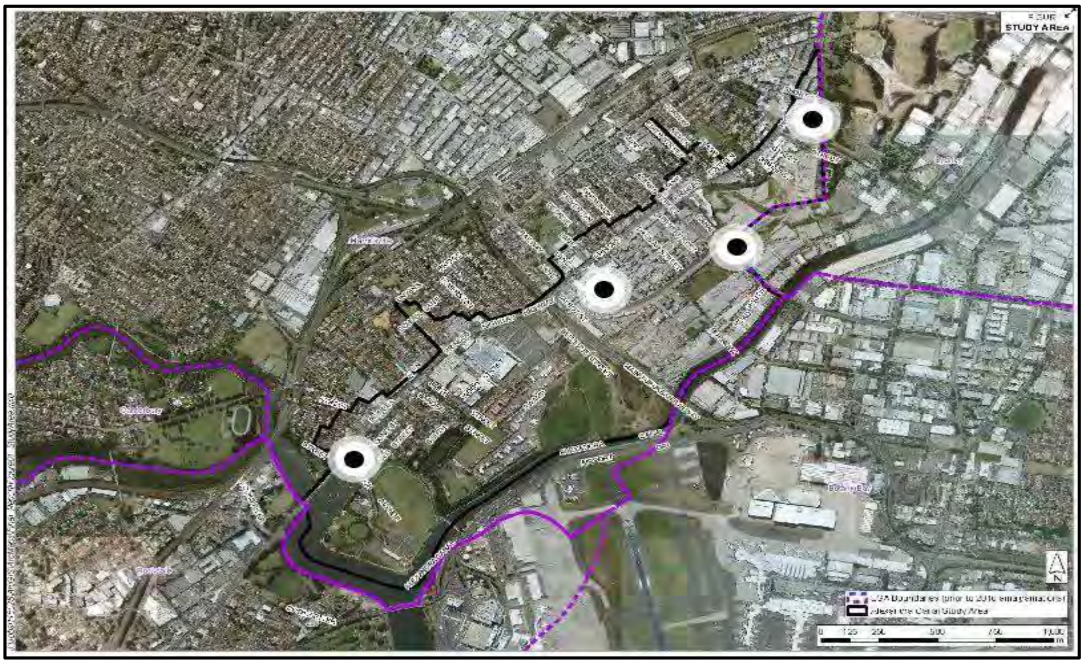
- Modify flood behaviour (e.g. levees, upgrade of stormwater systems)
- Mitigate the impact of flooding on existing properties (e.g. via floor raising)
- Control future development in the floodplain
- Guide emergency management when a flood occurs

Future development on properties that are flood affected may be subject to development controls.

What can you influence?

We asked the community to share their recent experiences of flooding in the Alexandra Canal catchment to ensure the flood management plan reflects current areas of concern.

Community members could also let us know their preferences for flood management options in the catchment area.



Alexandra Canal Flood Study
PDF (50.29 MB)

Alexandra Canal Flood Planning Area Map
PDF (1.04 MB)

Frequently asked questions

Flooding

- Why do floods occur?
- What are the risks associated with flooding?
- When was the last time it flooded?
- What can I do to prepare for a flood event?

What happens next?

The project team is using your feedback and other information to develop the final flood Management Plan. Everyone who provided feedback will be updated via email and on this project page when the Management Plan is available.

Contact us:

Have questions or want to learn more about the project? Contact us below:

Name	Rafaah Georges
Phone	02 9392 5208
Email	rafaah.georges@innerwest.nsw.gov.au

Timeline

Flood study completed
In 2017 Council commissioned a flood study of the Alexandra Canal catchment area.

Community consultation open
We are seeking feedback on flood management options.

Under review
Contributions to this consultation are closed for evaluation and review. The project team will report back on key outcomes.

Final report
The final outcomes of the consultation are documented here. This may include a summary of all contributions collected as well as recommendations for future action.

INNER WEST

7 March 2023

Managing flood risk in your neighbourhood

Alexandra Canal

Council is preparing a plan to manage the impact of floods in the Alexandra Canal area. Management options can include upgrading stormwater systems, controls on future development and guiding emergency response plans.

Find out more and have your say

To learn more, share your experiences or to discuss your preference for flood management options.

- **Online** at yoursay.innerwest.nsw.gov.au
- **In person** at an information session:
  - Wednesday 15 March 2023, 12-3pm and 5-8pm at St Peters Town Hall - Main Hall
  - Monday 20 March 2023, 12-3pm at Marrickville Library - Pavilion Hall
- **Phone** Rafaah Georges on 02 9392 5208
- **Email** floodstudies@innerwest.nsw.gov.au
- **Write to** Rafaah Georges, Inner West Council, PO Box 14 Petersham 2049

The last date to provide feedback is **Thursday 6 April 2023.**

What happens next?

All feedback will be reviewed and inform further investigations of response strategies and possible drainage upgrades. The results will be collated into a Flood Risk Management Plan that will be presented to the community in late 2023.

What else is happening?

Surveyors will be in the neighbourhood during March and April, taking levels in the flood affected areas to help with assessing the merits of the flood management options. Stantec and North Western Surveyors will be undertaking this work on behalf of Council and will be carrying authorisation from Council.

Yours faithfully,

Ryann Midei
Director Infrastructure

Alexandra Canal Resident Online Survey/ Questionnaire

Question 1 **Is your property:**

- ☐ Owner occupier
- ☐ Rented - by yourself
- ☐ Rented - by others
- ☐ A business
- ☐ Other

Question 2 **Have you ever experienced flooding since living/working in the catchment area?**

- ☐ Yes, floodwater has entered my house/business
- ☐ Yes, floodwater has entered my yard
- ☐ Yes, the road was flooded and I couldn't drive my car
- ☐ Yes, the stormwater channel reached capacity and was overflowing
- ☐ Yes, other parts of my neighbourhood have flooded
- ☐ Yes, I saw water flowing out of street drains, pits or manholes
- ☐ No, I haven't experienced flooding

Question 3 **How did the flooding affect you/your business?**

- ☐ Parts of my house/business building were damaged
- ☐ The contents of my house/business were damaged
- ☐ My garden, yard, and/or surrounding property were damaged
- ☐ My car(s) were damaged
- ☐ I couldn't leave the house/business
- ☐ Family members/work mates couldn't leave/return to the house/business
- ☐ The flooding disrupted my daily routine
- ☐ The flooding didn't affect me
- ☐ Not applicable - I have not experienced flooding in the catchment area
- ☐ Other

Question 4 **Please upload any materials or photos to evidence the flooding you experienced.**

Question 5 **What do you believe to be the main cause of flooding in your area?**

- ☐ Stormwater channels reaching capacity and overflowing.
- ☐ Lack of capacity in the stormwater network (e.g., pits and pipes) causing drainage systems to surcharge and backflow.
- ☐ Rainfall runoff flowing to a channel or drain.
- ☐ Other

Question 6 **As a local resident who may have witnessed flooding/drainage problems, you may have your own ideas on how to reduce flood risks. Which of the following management options would you prefer? Select your 5 preferred options.**

- ☐ Stormwater harvesting such as rainwater tanks.
- ☐ Retarding or detention basins; these temporarily hold water and reduce peak flows.
- ☐ Culvert / bridge / increasing pipe size and/or capacity.
- ☐ Levee banks
- ☐ Environmental channel improvements
- ☐ Diversion of channels
- ☐ Planning and flood related development controls to ensure future development does not add to the existing flood risk.

- ☐ Voluntary raising of houses to reduce flood damages by raising floor levels above a design flood.
- ☐ Voluntary purchase of highly affected properties by Council and demolition of any buildings on the property
- ☐ Education of community, providing greater awareness of potential hazards
- ☐ Flood forecasting, flood warning, evacuation planning and emergency response such as early warning systems, improved local SES capabilities/ resources or improved radio and phone communications.

Question 7 **Please specify any other options you believe are suitable.**

Question 8 **Are you concerned about the uncertainty of future climates and the possible impacts on flooding in your area?**

- ☐ Yes
- ☐ No

Question 9 **Do you believe the climate is changing?**

- ☐ Yes, it will have significant effects
- ☐ Yes, but the effects won't be significant
- ☐ Not at all

Question 10 **Are you concerned about the impact of an uncertain climate on future flooding in the study areas?**

- ☐ Yes
- ☐ Somewhat
- ☐ No

Question 11 **Should Council be addressing the impacts of an uncertain future climate on flooding?**

- ☐ Yes
- ☐ No

Question 12 **Enter your email address here if you would like to receive a copy of your submission via email.**

Question 13 **Do you give permission for Cardno or Council to contact you to discuss the information you have provided us?**

- ☐ Yes
- ☐ No

APPENDIX

B

MARRICKVILLE DCP 2011 – FLOOD MANAGEMENT CONTROLS

2.22

GENERIC PROVISIONS
FLOOD MANAGEMENT

Marrickville Development Control Plan 2011

MARRICKVILLE council

Contents

Part 2 Generic Provisions

2.22 Flood Management

A flood is an overflow or accumulation of an expanse of water that submerges land. In the sense of flowing water, the word may also be applied to the inflow of the tide. Floods are a natural and inevitable event that communities must learn to live with while minimising risks to public health and safety, property and infrastructure.

This section recognises that there are some flooding risks that require development controls and guidelines in order to reduce or eliminate their impacts.

2.22.1 Objectives

O1 To maintain the existing flood regime and flow conveyance capacity.

O2 To enable the safe occupation of, and evacuation from, land to which flood management controls apply.

O3 To avoid significant adverse impacts upon flood behaviour.

O4 To avoid significant adverse effects on the environment that would cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of the river bank/watercourse.

O5 To limit uses to those compatible with flow conveyance function and flood hazard.

O6 To minimise risk to human life and damage to property.

2.22.2 Land affected

This section complements Clause 6.3 (Flood planning) of Inner West Local Environmental Plan 2022 (Inner West LEP 2022). It applies to land identified on the DCP 2011 Flood Planning Area Map in Appendix 1 and land identified as being flood liable land on the DCP 2011 Flood Liable Land Map in Appendix 2.

For the purposes of this Section of the DCP:

> Flood planning levels(FPLs) are the combinations of flood levels (derived from significant historical flood events or floods of specific annual exceedance probability (AEP) and freeboards selected for floodplain risk management purposes.
>
> The Standard Flood adopted by Council is the 1% AEP or the 1 in 100 year flood. The Standard Flood has been used to derive the Flood Planning Levels.

The land identified on the DCP 2011 Flood Liable Land Map and on the DCP 2011 Flood Planning Area Map is based on information available to Council when the Plans were prepared. As new information becomes available, the DCP 2011 Flood Planning Area Map and the DCP 2011 Flood Liable Land Map may change.

2.22.2.1 Flood planning area (Cooks River)

The Flood Planning Area (Cooks River) identifies land likely to be affected by the 1% AEP flood, factoring in a rise in sea level of 400mm to the year 2050, (plus 500mm freeboard) of the Cooks River.

PART 2: GENERIC PROVISIONS

2.22.2.2 Flood planning area (Overland Flow)

The Flood Planning Area (Overland Flow) identifies land (in accordance with Council's Flood Tagging Policy) likely to be affected by the 1% AEP flood associated with various locations affected by local overland flooding.

2.22.2.1 Flood planning level

The Flood Planning Level is the 1% AEP flood level plus freeboard. The applicable freeboard is 500mm unless an exception is described within a specific development control.

2.22.2.2 Flood liable land

Land identified on the DCP 2011 Flood Liable Map as flood liable land identifies land within a flood planning area, and land likely to be affected by the probable maximum flood (PMF) of the Cooks River. This means that the map identifies some land as being within the Cooks River PMF area, but not within the Cooks River 100-year flood (plus 500mm freeboard) area.

NB *The 1% AEP flood is a flood that has a one per cent probability of occurring or being exceeded in any year. The probable maximum flood (PMF) is calculated to be the maximum flood likely to occur. Freeboard refers to a factor of safety and is expressed as a height above the flood level. Freeboard tends to compensate for factors such as wave action and localised hydraulic effects.*

2.22.3 Development affected

Flood management controls apply as follows:

- For land in a flood planning area, the controls apply to all development that requires development consent.
- For land that is flood liable land, but that is not in a flood planning area (land within the Cooks River PMF), the controls also apply to caravan parks, child care centres, correctional centres, emergency services facilities, hospitals, residential accommodation (except for attached dwellings, dwelling houses, secondary dwellings and semi-detached dwellings), and tourist and visitor accommodation.

2.22.4 Cooks River flood classification areas

Flood classifications have been applied to parts of the Flood Planning Area (Cooks River). The flood classifications are:

- Low hazard: Should it be necessary, people and their possessions could be evacuated by truck. Able bodied adults would have little difficulty wading out of the area.
- High hazard: Possible danger to life, evacuation by truck difficult, potential for structural damage, and social disruption and financial losses could be high.

The identified areas, and their flood classifications, are:

1. Riverside Crescent/Tennyson Street area (Marrickville and Dulwich Hill): Low hazard to high hazard.
2. Illawarra Road/Wharf Street area (Marrickville): Low hazard to high hazard.
3. Carrington Road area (Marrickville): Low hazard.
4. Bay Street area (Tempe): Low hazard to high hazard.

2.22.5 Controls

General

C1 A *Flood Risk Management Report* must be submitted for applications that are on land identified on the Flood Planning Area Map in Appendix 1 and land identified as flood liable on the Flood Liable Land Map in Appendix 2.

The report must be informed by flood information relevant to the subject property and surrounds, including the 1% AEP flood level, Flood Planning Level, Probable Maximum Flood (PMF) level and the Flood Hazard Category, as obtained from Council.

The report is not required where the assessed value of the works is under $50,000 except where, in the opinion of Council, those works are likely to substantially increase the risk of flood to the subject or adjoining or nearby sites.

The report may be limited to a short report (Flood Risk Management Statement) for single residential dwellings, alterations and additions or change of use developments where the property is confirmed by Council as being subject only to low hazard flooding. The Flood Risk Management Statement must reference the source of flood information; specify the relevant flood information applicable to the site, then describe the proposed development and how it meets the relevant development controls.

If Council is concerned with the apparent loss of flood storage and/or flood or overland flow paths, and/or increase in flow velocities, and/or risk of life, on any type of development, the applicant may be requested to undertake further analysis in support of the proposal and detail it in a new/revised Flood Risk Management Report.

C2 The Flood Risk Management Report must address:

a. Description of the existing stormwater drainage system, including catchment definition.
b. Extent of the 1% AEP flood event in the vicinity of the development.
c. The Flood Hazard Category affecting the subject site and surrounds. Where the site is subject to the high hazard flooding category, the Probable Maximum Flood (PMF) extent must be shown.
d. Long and cross sections showing the Flood Planning Level(s) in relationship to the floor levels of all existing and proposed components of the development.
e. Recommendations on all precautions to minimise risk to personal safety of occupants and the risk of property damage for the total development to address the flood impacts on the site during a 1% AEP flood and PMF event. These precautions must include but not be limited to the following:
    i. Types of materials to be used to ensure the structural integrity of the development for immersion and impact of velocity and debris for the 1% AEP flood event and PMF (for high hazard);
    ii. Waterproofing methods, including electrical equipment, wiring, fuel lines or any other service pipes or connections;
    iii. A flood evacuation strategy (Flood Emergency Response Plan); and

iv. On site response plan to minimise flood damage, and provide adequate storage areas for hazardous materials and valuable goods above the flood level;

f. Details of any flood mitigation works that are proposed to protect the development.

g. Supporting calculations.

h. The architectural/engineering plans on which the assessment is based.

i. The date of inspection.

j. The professional qualifications and experience of the author(s).

C3 All applications for development must be accompanied by a survey plan including relevant levels to AHD (Australian Height Datum). Consideration must be given to whether structures or filling are likely to affect flood behaviour and whether consultation with other authorities is necessary.

C4 Compliance with flood management controls must be balanced by the need to comply with other controls in this DCP.

Controls for new residential development

C5 Floor levels (Flood Planning Levels) of habitable rooms must be a minimum of 500mm above the 1% AEP flood level at that location. For areas of minor overland flow (a depth of 300mm or less or overland flow of 2cum/sec or less) a lower freeboard of 300mm may be considered on its merits.

C6 Any portion of buildings below the Flood Planning Level) must be constructed from flood compatible materials (See Schedule 1).

C7 Flood free access must be provided where practicable.

Controls for residential development – minor additions

C8 Once-only additions with a habitable floor area of up to 30m^2 may be approved with floor levels below the 1% AEP flood level at that location if the applicant can demonstrate that no practical alternatives exist for constructing the extension above the 1% AEP flood level.

C9 Additions greater than 30m^2 will be considered against the requirements for new residential development (refer C5, C6, and C7).

C10 Any portion of buildings below the Flood Planning Level must be constructed from flood compatible materials.

Controls for non-habitable additions or alterations

C11 All flood sensitive equipment must be located above the Flood Planning Level at that location.

C12 Any portion of buildings below the Flood Planning Level must be built from flood compatible materials.

Controls for new non-residential development

C13 Floor levels (except for access-ways) must be at least 500mm above the 1% AEP flood level, or the buildings must be flood-proofed to at least 500mm above the 1% AEP flood level. For areas of minor overland flow (a depth of 300mm or less or overland flow of 2cum/sec or less) a lower freeboard of 300mm may be considered on its merits.

C14 Flood-free access must be provided where practicable.

Controls for non-residential development – additions

C15 Where the proposed development is for an addition to an existing building within the Flood Planning Area, the development may be approved with floor levels below the 1% AEP flood Level if the applicant can demonstrate that all practical measures will be taken to prevent or minimise the impact of flooding. In determining the required floor level, matters which will be considered include:

- i. The nature of the proposed landuse;
- ii. The frequency and depth of possible flooding;
- iii. The potential for life and property loss;
- iv. The suitability of the building for its proposed use; and
- v. Whether the filling of the site or raising of the floor levels would render the development of the site impractical or uneconomical.

C16 Any portion of the proposed addition below the 1% AEP must be built from flood compatible materials.

Controls for change of use of existing buildings

C17 Development consent for change of use of an existing building with floor levels below the 1% AEP flood level will only be given where there is no foreseeable risk of pollution associated with the proposed use of the building in the event that 1% AEP flood event occurs.

C18 In determining whether to grant development consent for change of use of an existing building with floor levels below the1% AEP flood level, consideration will be given to whether the proposed development would result in increased flood risk for the property on which the building is located, or other land. In this regard, the following matters will be considered:

- i. The nature of the proposed use and the manner in which it is proposed to be carried out within the building or on the land; and
- ii. The foreseeable risk of pollution associated with the proposed use of the building/land in the event that the 1% AEP flood event occurs.

Controls for subdivision

C19 Development consent for the subdivision of flood liable land may depend on whether the land to which the proposed development relates is unsuitable for any development made likely by the subdivision, by reason of the land likely to be subject to flooding.

C20 Development consent for the subdivision of flood liable land may depend on whether the carrying out of the subdivision and any associated site works would:

- i. Adversely impede the flow of flood water on the land or land in its vicinity;
- ii. Imperil the safety of persons on that land or land in its vicinity in the event of the land being inundated with flood water; and
- iii. Aggravate the consequences of flood water flowing on that land or land in its immediate vicinity with regard to erosion or siltation.

PART 2: GENERIC PROVISIONS

Controls for filling of land within the Flood Planning Area

C21 Development consent will not be granted to filling of flood ways or high flood hazard areas. Consideration will only be given to granting development consent to the filling of other flood liable land where:

- i. Flood levels are not increased by more than 10mm by the proposed filling.
- ii. Downstream velocities are not increased by more than 10% by the proposed filling.
- iii. Proposed filling does not redistribute flows by more than 15%.
- iv. The potential for cumulative effects of possible filling proposals in that area is minimal.
- v. The development potential of surrounding properties is not adversely affected by the filling proposal.
- vi. The flood liability of buildings on surrounding properties is not increased.
- vii. The filling creates no local drainage flow/runoff problems.

NB *Where the proposal has the potential to increase flood levels, depths, velocities and/or the risk to life or property, through loss of flood storage and/or blockage/ redirection of overland flowpaths, the Flood Risk Management Report supporting the development application must include detailed flood analysis. Such analysis should address compliance with all relevant development controls and include survey cross-sections to provide representative topographic information. The proponent should approach Council to determine available Council flood studies for the area, with the analysis based on or calibrated against relevant studies. In some cases, flood model data can be obtained from Council, subject to application and payment of fees.*

Controls for land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map

C22 A site emergency response flood plan must be prepared in case of a PMF flood.

C23 Adequate flood warning systems, signage and exits must be available to allow safe and orderly evacuation without increased reliance upon the State Emergency Service (SES) or other authorised emergency services personnel.

C24 Reliable access for pedestrians or vehicles must be provided from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF.

Controls for garages, carports, open car parks and basement garages

C25 The floor level of new enclosed garages must be at or above the 1% AEP flood level plus 200mm. In extenuating circumstances, consideration may be given to a floor level at a lower level, being the highest practical level but no lower than 180mm below the 1% AEP flood level, where it can be demonstrated that providing the floor level at the Flood Planning Level is not practical within the constraints of compliance with Australian Standard AS/NZS 2890.1 Parking facilities as amended.

C26 The floor levels of open car park areas and carports must meet the same criteria as above for garages. In extreme circumstances, for single dwelling residential development, a floor level below the 1% AEP flood level minus 180mm may be accepted for a single car space, subject to bollards being provided along the ‘free’ perimeter (excluding the vehicle entry on one side only) at 1.2m intervals and the floor level being raised as high as practical within the constraints of compliance with Australian Standard AS/NZS 2890.1 Parking facilities as amended.

C27 On properties with a low flood hazard classification, basement (below natural ground level) car parking must have all access and potential water entry points above the Flood Planning Level, and a clearly signposted flood free pedestrian evacuation route provided from the basement area separate to the vehicular access ramps. For basement car parking in properties affected by High Hazard flooding further considerations will apply.

C28 Basement garages must include:

a. Suitable pumps must be provided within the garage to allow for the drainage of stormwater should the basement garage become inundated during flooding.
b. Adequate flood warning systems, signage and exits must be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel.

C29 For parking areas servicing more than two parking spaces, reliable access for pedestrians must be provided from all parking areas, to a safe haven which is above the PMF.

PART 2: GENERIC PROVISIONS

2.22.6 SCHEDULE 1 – Flood compatible materials

Building component	Flood compatible material
Flooring and sub-floor	• concrete slab-on-ground monolith
	• suspended reinforced concrete slab
Floor covering	• clay tiles
	• concrete, precast or in situ
	• concrete tiles
	• epoxy, formed-in-place
	• mastic flooring, formed-in-place
	• rubber sheets or tiles with chemicals-set-adhesive
	• silicone floors formed-in-place
	• vinyl sheets or tiles with chemical-set adhesive
	• ceramic tiles, fixed with mortar or chemical-set adhesive
	• asphalt tiles, fixed with water resistant adhesive
Wall structure	• solid brickwork, blockwork, reinforced, concrete or mass concrete
Roofing structure (for situations where the relevant flood level is above the ceiling)	• reinforced concrete construction • galvanised metal construction
Doors	• solid panel with water proof adhesives
	• flush door with marine ply filled with closed cell foam
	• painted metal construction
	• aluminium or galvanised steel frame
Wall and ceiling linings	• fibro-cement board
	• brick, face or glazed
	• clay tile glazed in waterproof mortar
	• concrete
	• concrete block
	• steel with waterproof applications
	• stone, natural solid or veneer, waterproof grout
	• glass blocks
	• glass
	• plastic sheeting or wall with waterproof adhesive
Insulation windows	• foam (closed cell types)
	• aluminium frame with stainless steel rollers or similar corrosion and water resistant material
Nails, bolts, hinges and fittings	• brass, nylon or stainless steel • removable pin hinges • hot dipped galvanised steel wire nails or similar

SCHEDULE 1: Flood compatible materials (cont.)	
Electrical and mechanical equipment For development constructed on land to which this section of the DCP applies, the electrical and mechanical materials, equipment and installation must conform to the following requirements: Main power supply Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, must be located above the relevant flood level. Means must be available to easily disconnect the dwelling from the main power supply. Wiring All wiring, power outlets, switches, must be to the maximum extent possible, located above the maximum flood level. All electrical wiring installed below this level must be suitable for continuous underwater immersion and must contain no fibrous components. Each leakage circuit-breaker (core balance relays) must be installed. Only submersible type splices must be used below maximum flood level. All conduits located below the relevant designated flood level must be so installed that they will be self-draining if subjected to flooding. Equipment All equipment installed below or partially below the relevant flood level must be capable of disconnection by a single plug and socket assembly. Reconnection Should any electrical device and/or part of the wiring be flooded it must be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.	Heating and air conditioning systems Where viable, heating and air conditioning systems should be installed in areas and spaces of the development above maximum flood level. When this is not feasible, every precaution must be taken to minimise the damage caused by submersion according to the following guidelines: Fuel Heating systems using gas or oil as fuel must have a manually operated valve located in the fuel supply line to enable fuel cut-off. Installation Heating equipment and fuel storage tanks must be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks must be vented to an elevation of 600mm above the relevant flood level. Ducting All ductwork located below the relevant flood level must be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, a closure assemble operated from above relevant flood level must protect the ductwork.

Appendix 1 - DCP 2011 Flood Planning Area Map

See the attached map.

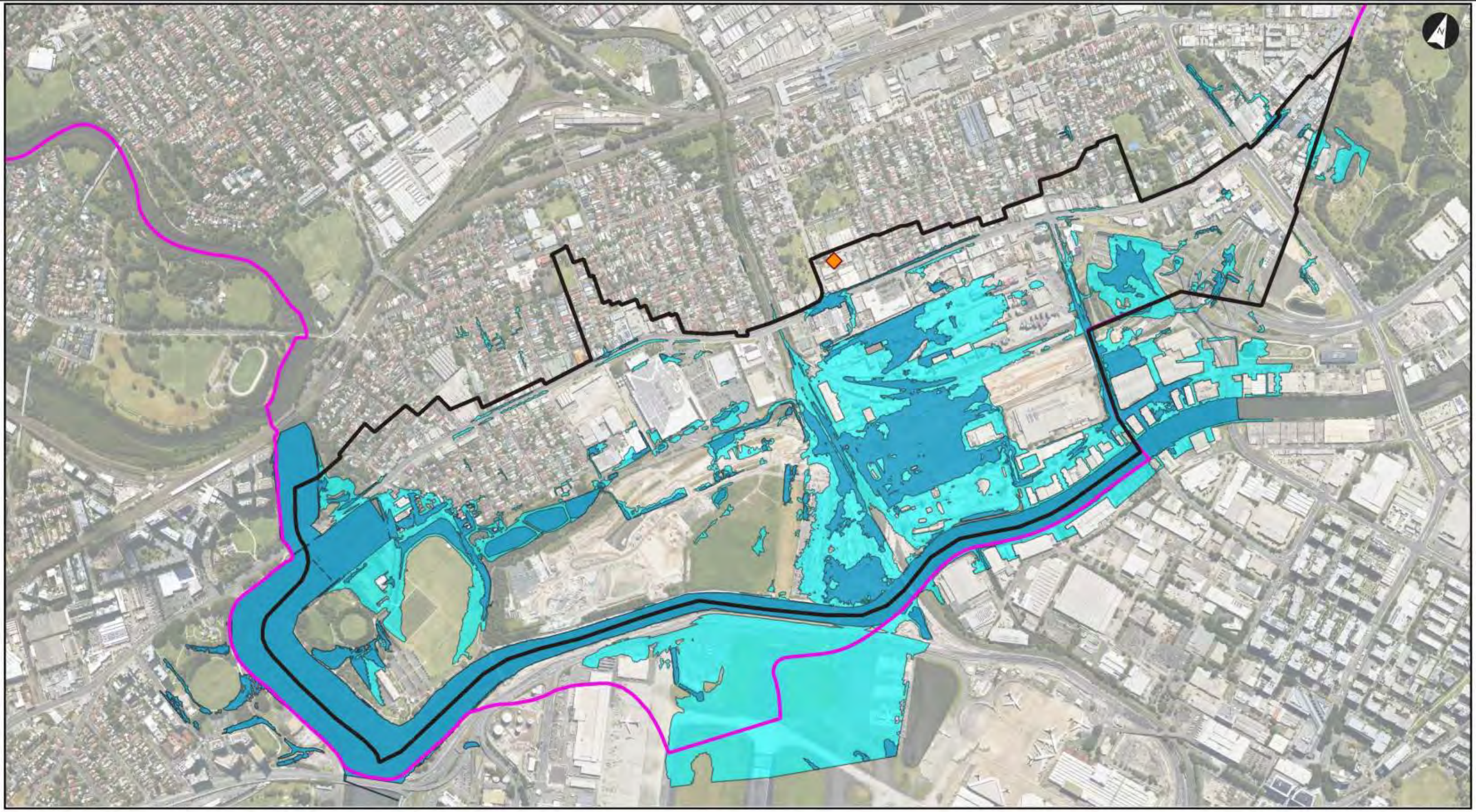
Appendix 2 - DCP 2011 Flood Liable Land Map

See the attached map.

APPENDIX

C

EMERGENCY MANAGEMENT MAPS



Emergency Services within the Study Area with 1% AEP and PMF Extent

Project: Alexandra Canal Flood Risk Management Study & Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-26)
Figure No: 1

Stantec

Legend

- Alexandra Canal Study Area
- Inner West LGA Boundary
- 1% AEP Flood Extent
- PMF Flood Extent

Location of Emergency Services

- Ambulance
- Helicopter Emergency Base
- Police Station
- SES

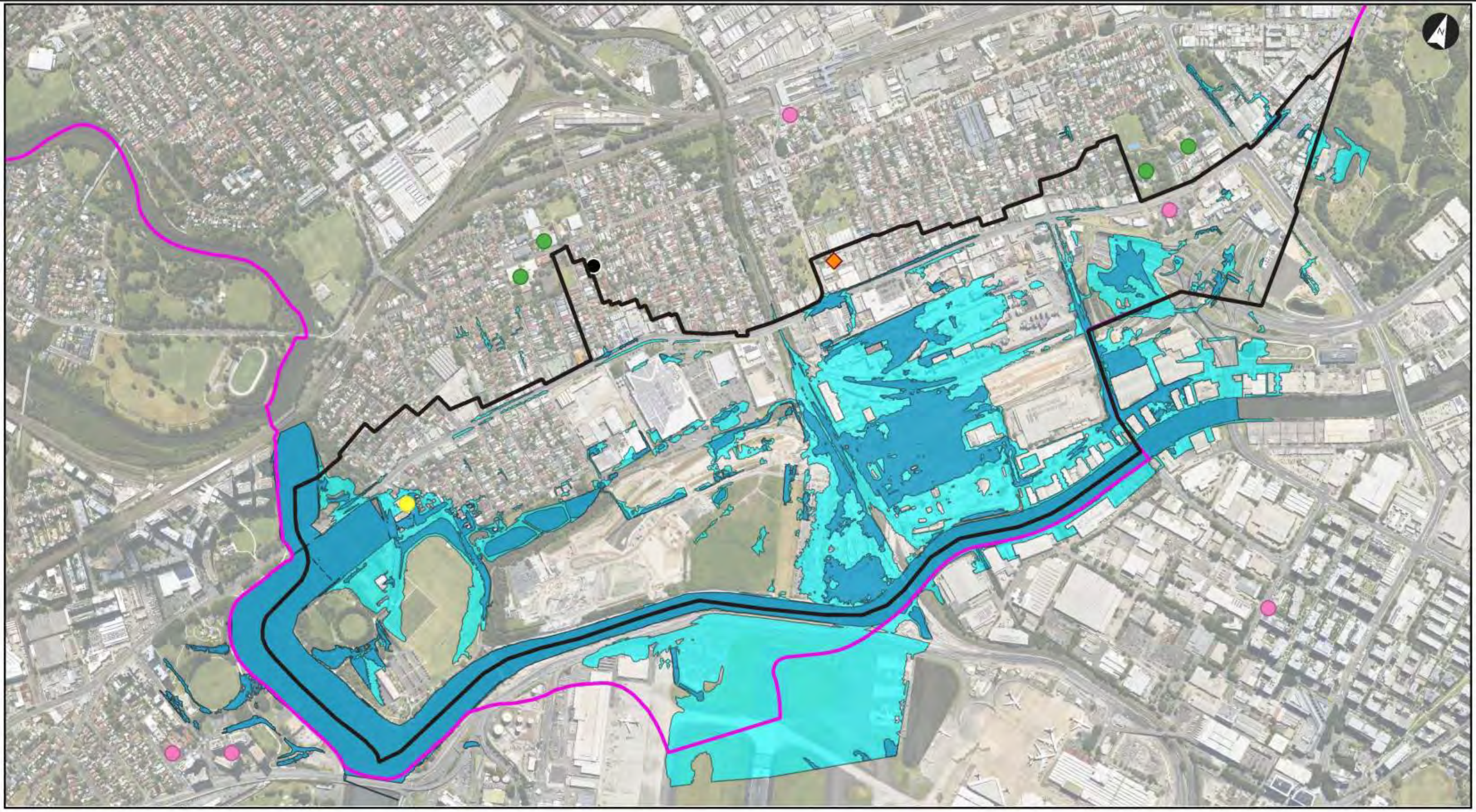
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, March 2023]

DRAFT - Not For Construction

0 0.3 0.6 km

Scale at A3: 1:10000



Vulnerable Development and Emergency Services within the Study Area with 1% AEP and PMF Extent

Project: Alexandra Canal Flood Risk Management Study & Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-26)
Figure No: 2

Stantec

Legend

- Alexandra Canal Study Area
- Inner West LGA Boundary
- 1% AEP Flood Extent
- PMF Flood Extent

Location of Emergency Services

- Ambulance
- Helicopter Emergency Base
- Police Station
- SES

Location of Vulanterable davelopment

- Aged care
- Day care
- Hotel
- School

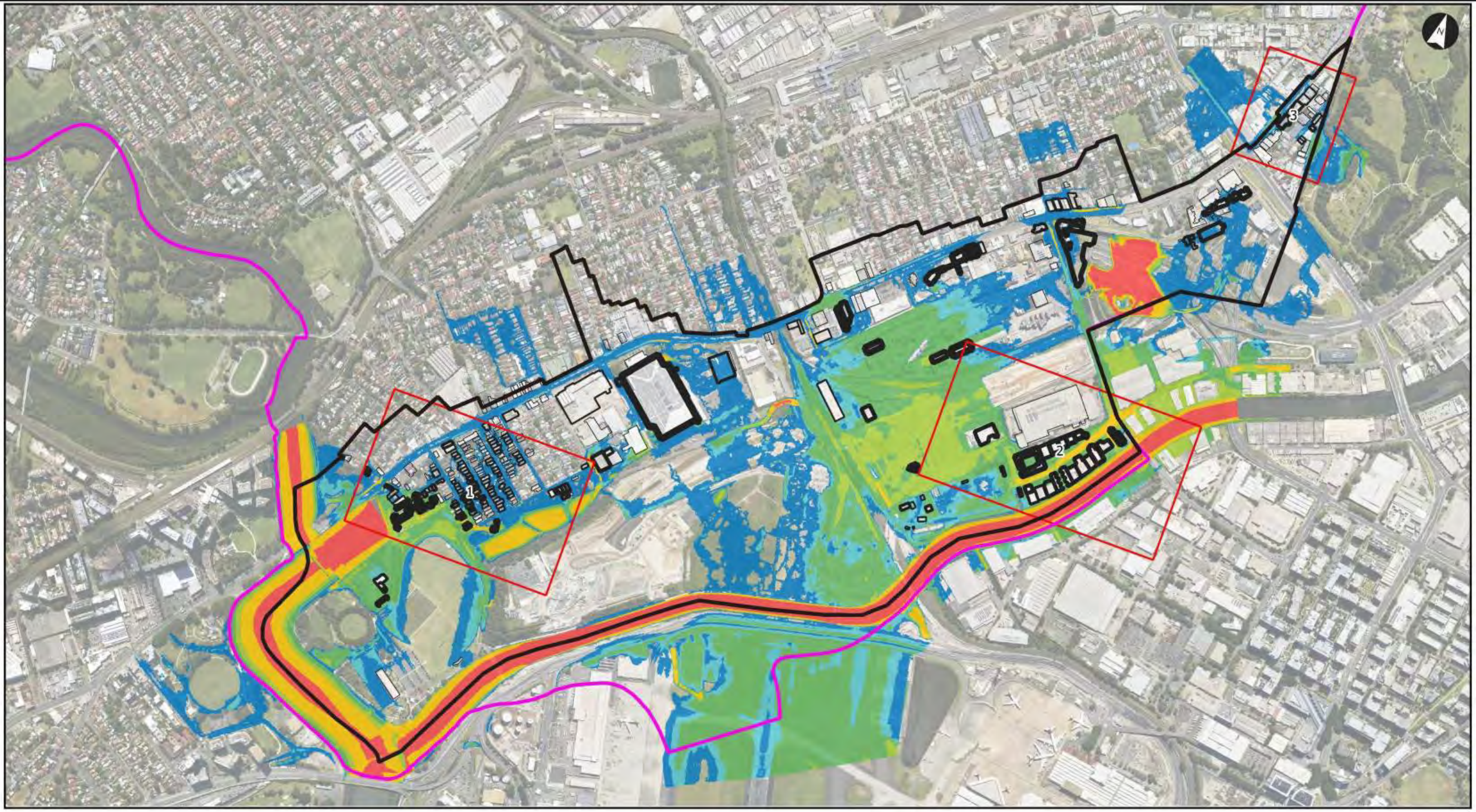
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, March 2023]

DRAFT - Not For Construction

0 0.3 0.6 km

Scale at A3: 1:10000



Emergency Management Hotspot Overview

Project: Alexandra Canal Flood Risk Management Study & Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-26)
Figure No: 1

Stantec

Legend

- Alexandra Canal Study Area
- Inner West Council LGA Boundary
- Emergency Hotspot

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial imagery (Metromap, March 2023)

DRAFT - Not For Construction

0 0.3 0.6 km

Scale at A3: 1:10000

Emergency Management

Hotspot 1 **20% AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 1

Stantec

Legend

Alexandra Canal study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Emergency Management

Hotspot 1 **1% AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 2

Stantec

Legend

Alexandra Canal study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Emergency Management

Hotspot 1 **PMF**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 3

Stantec

Legend

- Alexandra Canal study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Key Map

Emergency Management

Hotspot 2 **20% AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 4

Stantec

Legend

Alexandra Canal study Area

Overfloor Flooding Depth (m)

<0

Evacuation Routes

Vehicular

Commercial Low Flood Island

Hazard Category

H1 - Generally safe for vehicles, people and buildings.

H2 - Unsafe for small vehicles.

H3 - Unsafe for vehicles, children and the elderly.

H4 - Unsafe for vehicles and people.

H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.

H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Emergency Management

Hotspot 2 **1% AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 5

Stantec

Legend

Alexandra Canal study Area

Overfloor Flooding Depth (m)

<0

0 - 0.2

Evacuation Routes

Vehicular

Commercial Low Flood Island

Hazard Category

H1 - Generally safe for vehicles, people and buildings.

H2 - Unsafe for small vehicles.

H3 - Unsafe for vehicles. children and the elderly.

H4 - Unsafe for vehicles and people.

H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.

H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Emergency Management

Hotspot 2 **PMF**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 6

Stantec

Legend

Alexandra Canal study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes

- Vehicular
- Commercial Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.09 0.18 km

Scale at A3: 1:19987

Emergency Management

Hotspot 3 **20%AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 7

Stantec

Legend

Alexandra Canal Study Area

Overfloor Flooding Depth (m)

<0
0 - 0.2

Evacuation Routes

Vehicular
Commercial Low Flood Island
Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

Emergency Management

Hotspot 3 **1% AEP**

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 8

Stantec

Legend

Alexandra Canal Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

Emergency Management

Hotspot 3 PMF

Project: Alexandra Canal Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 9

Stantec

Legend

Alexandra Canal Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

This document has been prepared based on information provided by others as cited in the data sources. Stantec has not verified the accuracy and/or completeness of this information as shall not be help responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and recipient accepts full responsibility for verifying the accuracy and completeness of the data.

APPENDIX

D

PRELIMINARY FLOOD OPTIONS MAPS

Preliminary Mitigation Options Hotspot 1

Project: Alexandra Canal Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 1

Stantec

Legend

- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Alexandra Canal Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

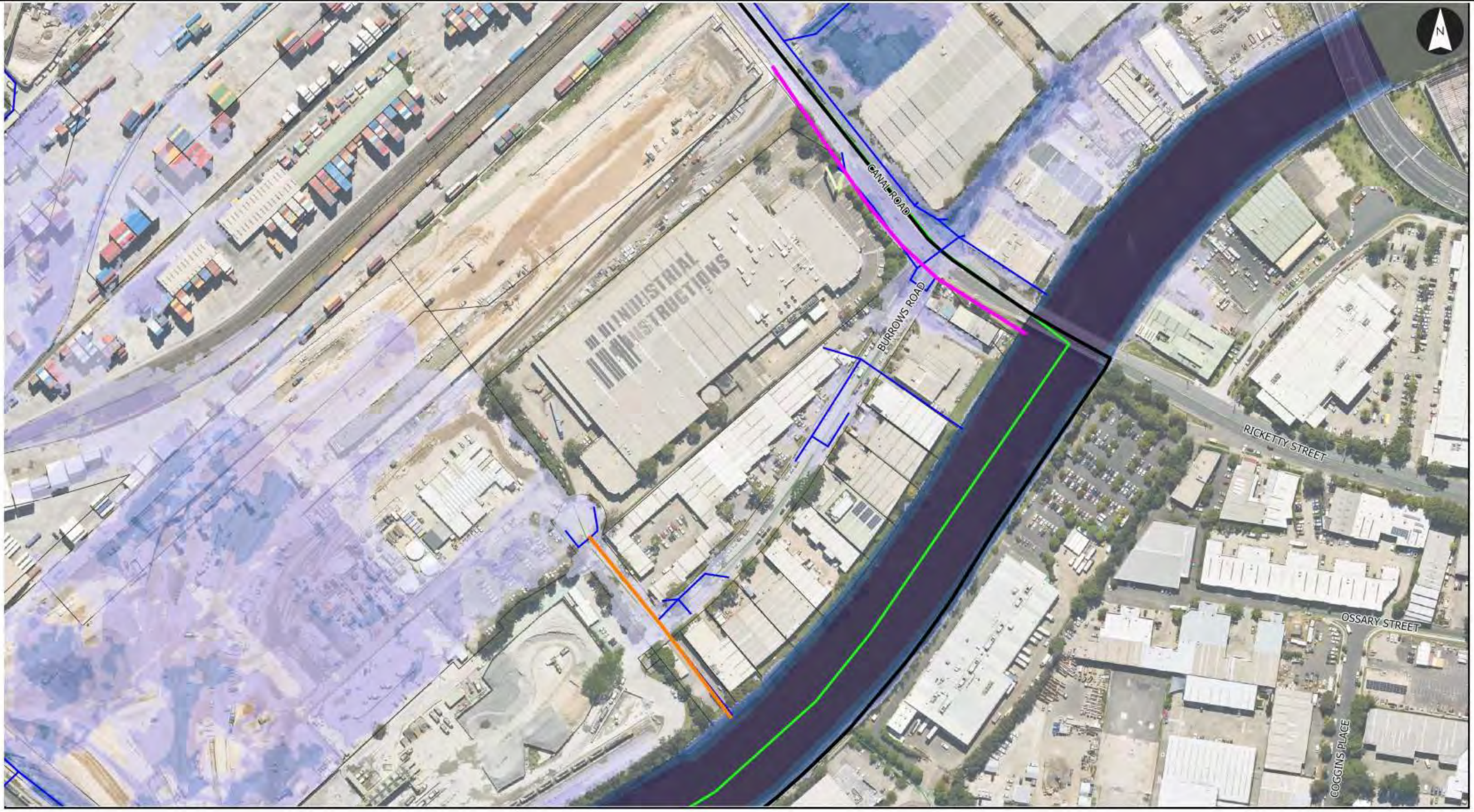
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (Metromap, 2023)

DRAFT - Not For Construction

30 0 30 60 90 120 m

Scale at A3: 1:3200



Preliminary Mitigation Options Hotspot 2

Project: Alexandra Canal Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30095
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 2

Stantec

Legend

- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Alexandra Canal Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (Metromap, 2023)

DRAFT - Not For Construction

30 0 30 60 90 120 m

Scale at A3: 1:2500

Preliminary Mitigation Options
Hotspot 3
Project: Alexandra Canal Floodplain Risk Management Study and Plan

Legend
Existing Council Modelled Stormwater Network
Cadastre
Inner West Council LGA Boundary
Alexandra Canal Study Area
Preliminary Option Type
Channel Upgrades
Detention Basin
Drainage Upgrades
Road Lowering
Drainage Maintenance

Flood Depth (m)
0.00 to 0.10
0.10 to 0.20
0.20 to 0.50
0.50 to 0.70
0.70 to 1.00
1.00 to 1.50
> 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

Client: Inner West Council
Project Code: NW30095
Drawn By: Anson C. Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 3

Stantec

DRAFT - Not For Construction

19 0 19 38 57 76 m

Scale at A3: 1:1600

APPENDIX E

DETAILED FLOOD OPTIONS MAPS

Alexandra Canal Base Case - PM6 Overview

Legend

- Unblocked Pipes
- Blocked Pipes, Now Unblocked
- IWC LGA Boundary
- Study Area
- Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 1

Stantec

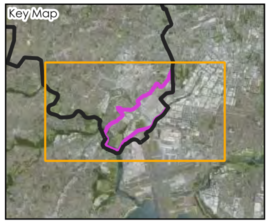
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000



Alexandra Canal Base Case 20% AEP
PM6 Pit and Pipes Unblocked

Legend

Unblocked Pipes
Blocked Pipes, Now Unblocked
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 2

Stantec

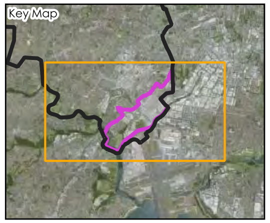
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000



Alexandra Canal Base Case 5% AEP
PM6 Pit and Pipes Unblocked

Legend

- Unblocked Pipes
- Blocked Pipes, Now Unblocked

Change in Flood Extents (Wet/Dry)
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

- IWC LGA Boundary
- Study Area
- Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 3

Stantec

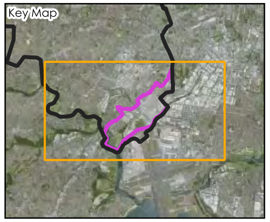
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000



Alexandra Canal Base Case 2% AEP PM6 Pit and Pipes Unblocked

Legend

Unblocked Pipes
Blocked Pipes, Now Unblocked

Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 4

Stantec

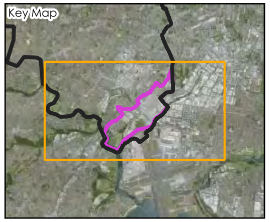
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000



Alexandra Canal Base Case 1% AEP PM6 Pit and Pipes Unblocked

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 5

Stantec

Legend

Unblocked Pipes
Blocked Pipes, Now Unblocked
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

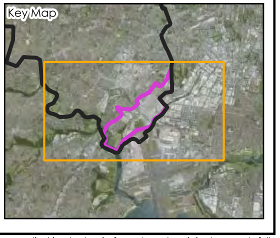
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000



Alexandra Canal Base Case PMF
PM6 Pit and Pipes Unblocked

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 6

Stantec

Legend

Unblocked Pipes
Blocked Pipes, Now Unblocked
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

180 0 180 360 540 720 m

Scale at A3: 1:15000

Alexandra Canal Option - AC4 Overview

Legend

- Proposed Drainage
- Existing Pits and Pipes
- IWC LGA Boundary
- Study Area
- Cadastre

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Project: Alexandra Canal FRMS&P

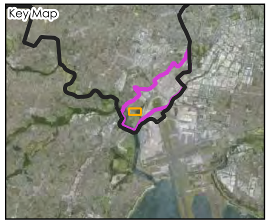
Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 7

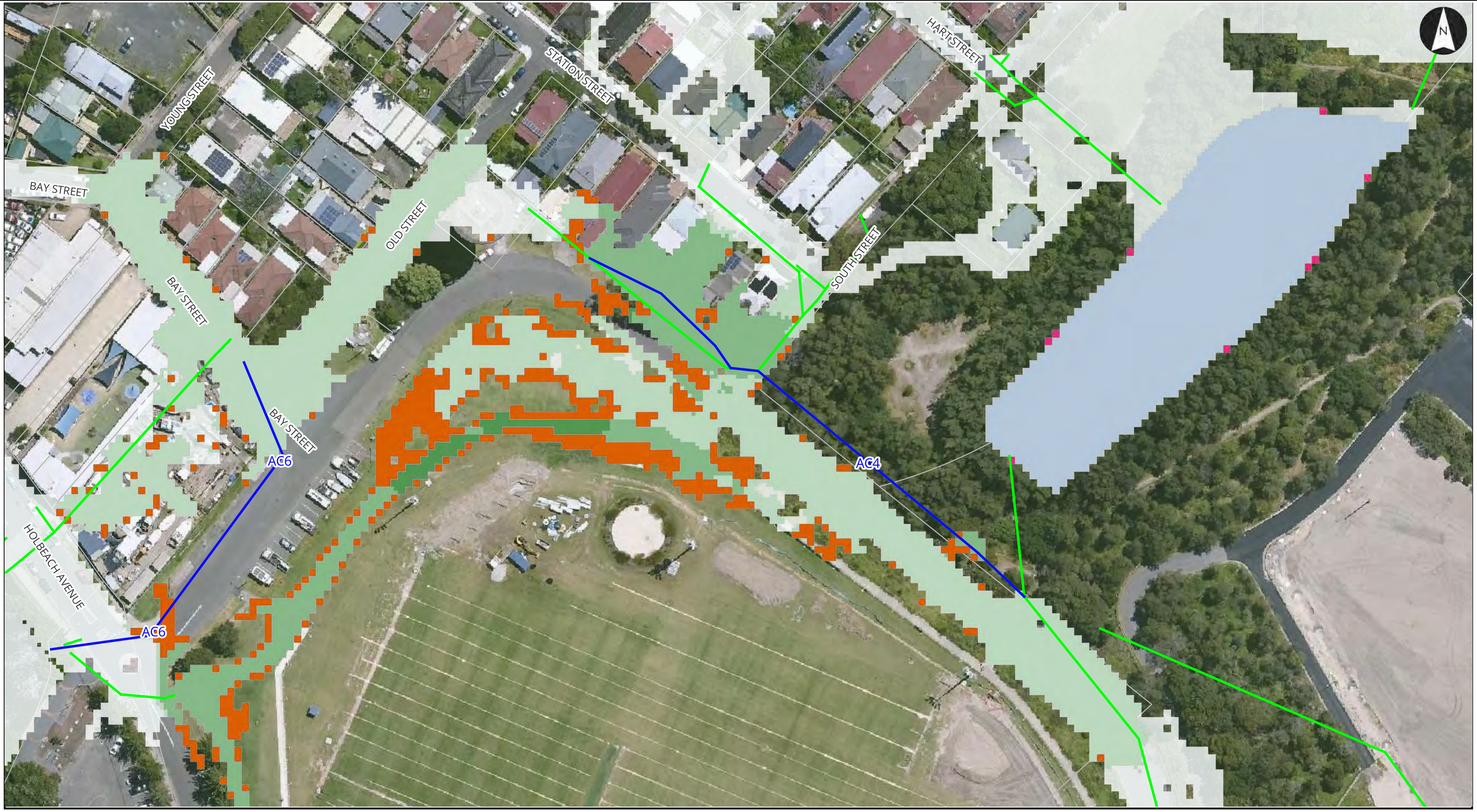
Stantec

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option 20% AEP
AC4 Station Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 8

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

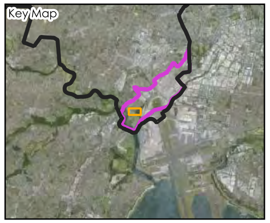
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000



Alexandra Canal Option 5% AEP
AC4 Station Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 9

Legend

- Proposed Drainage
- Existing Pits and Pipes

Change in Flood Extents (Wet/Dry)
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

- IWC LGA Boundary
- Study Area
- Cadastre

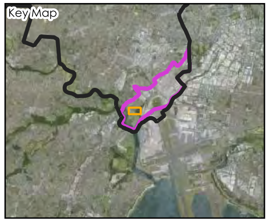
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000



Stantec

Alexandra Canal Option 2% AEP
AC4 Station Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 10

Stantec

Legend

- Proposed Drainage
- Existing Pits and Pipes
- Change in Flood Extents (Wet/Dry)
  - Was Wet, Now Dry
  - Was Dry, Now Wet

Water Level Difference (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

- IWC LGA Boundary
- Study Area
- Cadastre

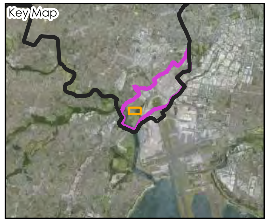
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000



INNER WEST

Alexandra Canal Option 1% AEP
AC4 Station Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 11

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

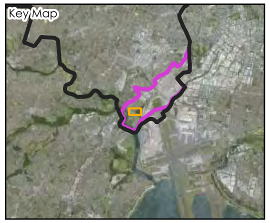
Notes:
1. Map displayed in EPSG:28356

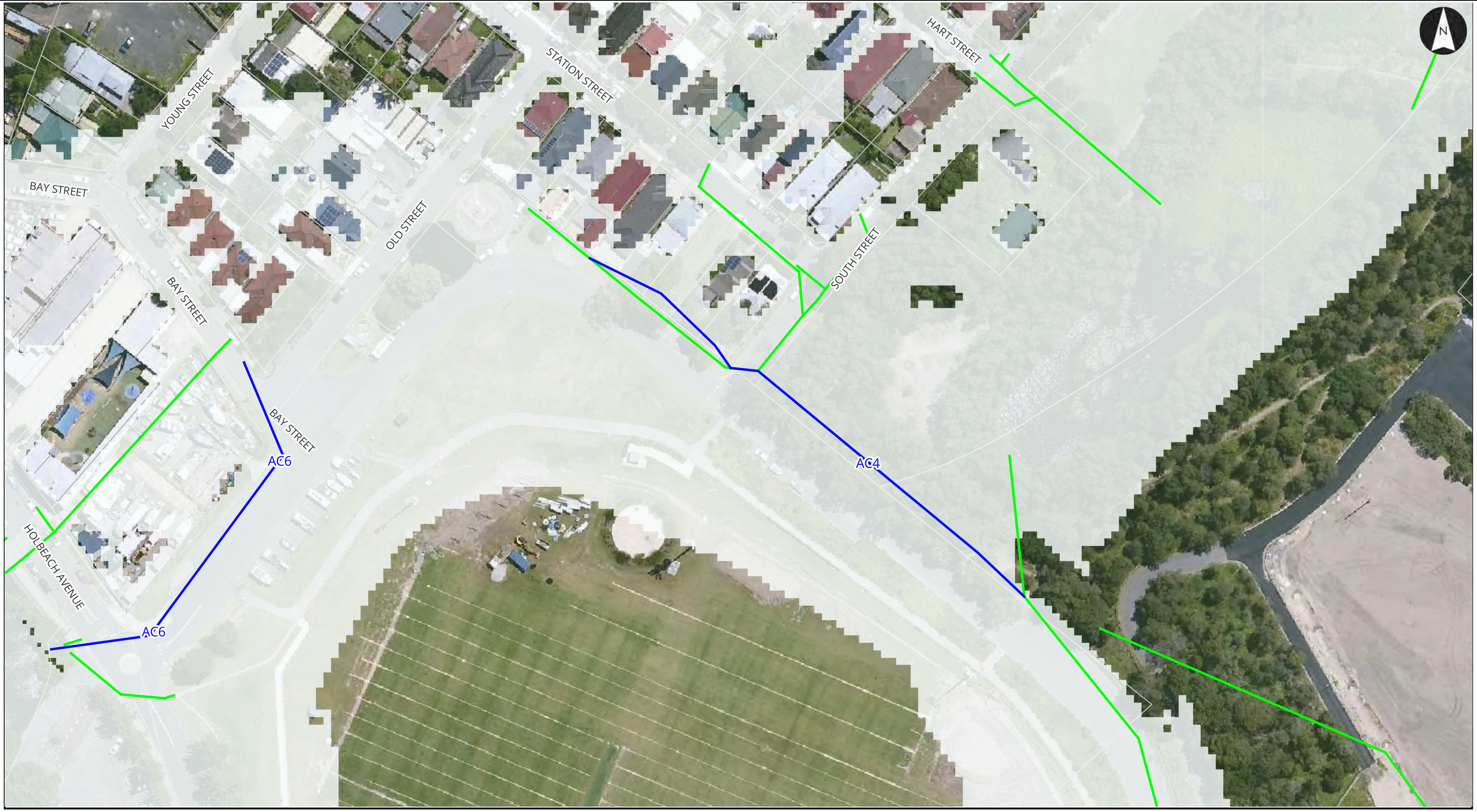
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option PMF
AC4 Station Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 12

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

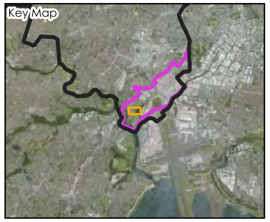
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000



Alexandra Canal Option - AC6 Overview

Legend
Proposed Drainage
Existing Pits and Pipes
IWC LGA Boundary
Study Area
Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 13

Stantec

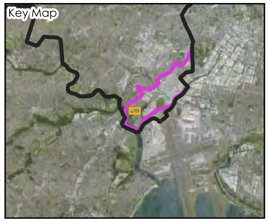
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 20% AEP
AC6 Bay Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 14

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

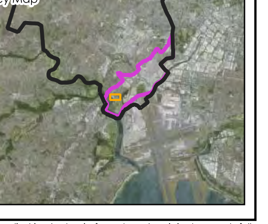
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



INNER WEST

Alexandra Canal Option 5% AEP
AC6 Bay Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 15

Stantec

Legend

- Proposed Drainage
- Existing Pits and Pipes

Change in Flood Extents (Wet/Dry)
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

- IWC LGA Boundary
- Study Area
- Cadastre

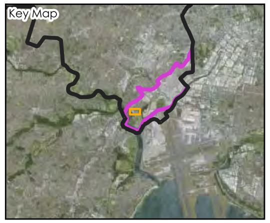
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 2% AEP
AC6 Bay Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 16

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

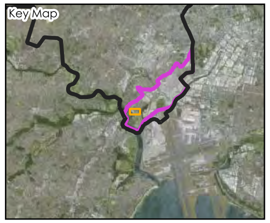
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 1% AEP
AC6 Bay Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 17

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

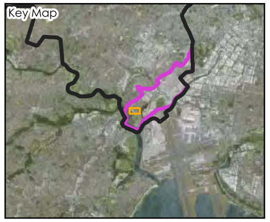
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option PMF
AC6 Bay Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 18

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

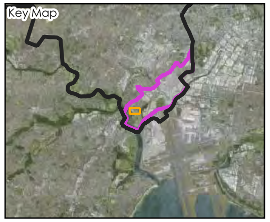
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option - AC11 Overview

Legend

- Proposed Drainage
- Existing Pits and Pipes
- IWC LGA Boundary
- Study Area
- Cadastre

Project: Alexandra Canal FRMS&P
Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 19

Stantec

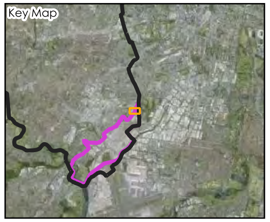
Notes:
1. Map displayed in EPSG:28356

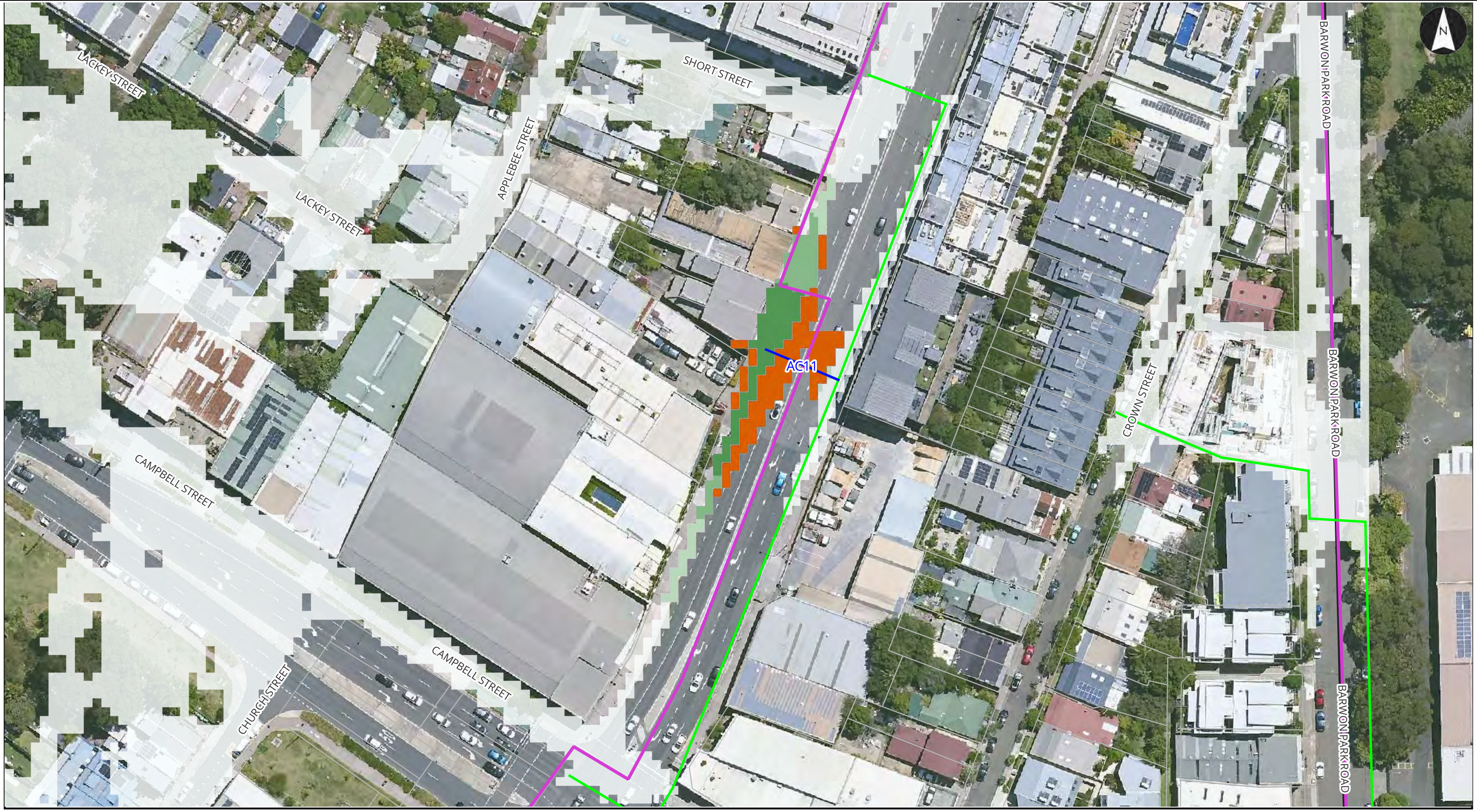
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850





Alexandra Canal Option 20% AEP
AC11 Princes Highway Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 20

Stantec

Legend

- Proposed Drainage
- Existing Pits and Pipes

Change in Flood Extents (Wet/Dry)
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

- IWC LGA Boundary
- Study Area
- Cadastre

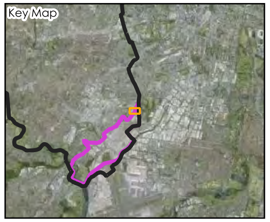
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 5% AEP
AC11 Princes Highway Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 21

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

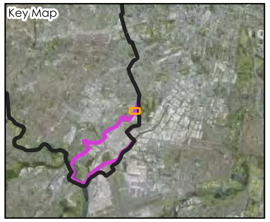
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 2% AEP
AC11 Princes Highway Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 22

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

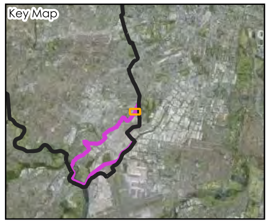
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Alexandra Canal Option 1% AEP
AC11 Princes Highway Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 23

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

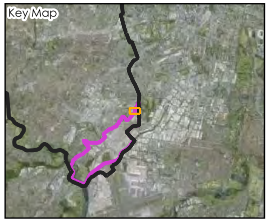
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

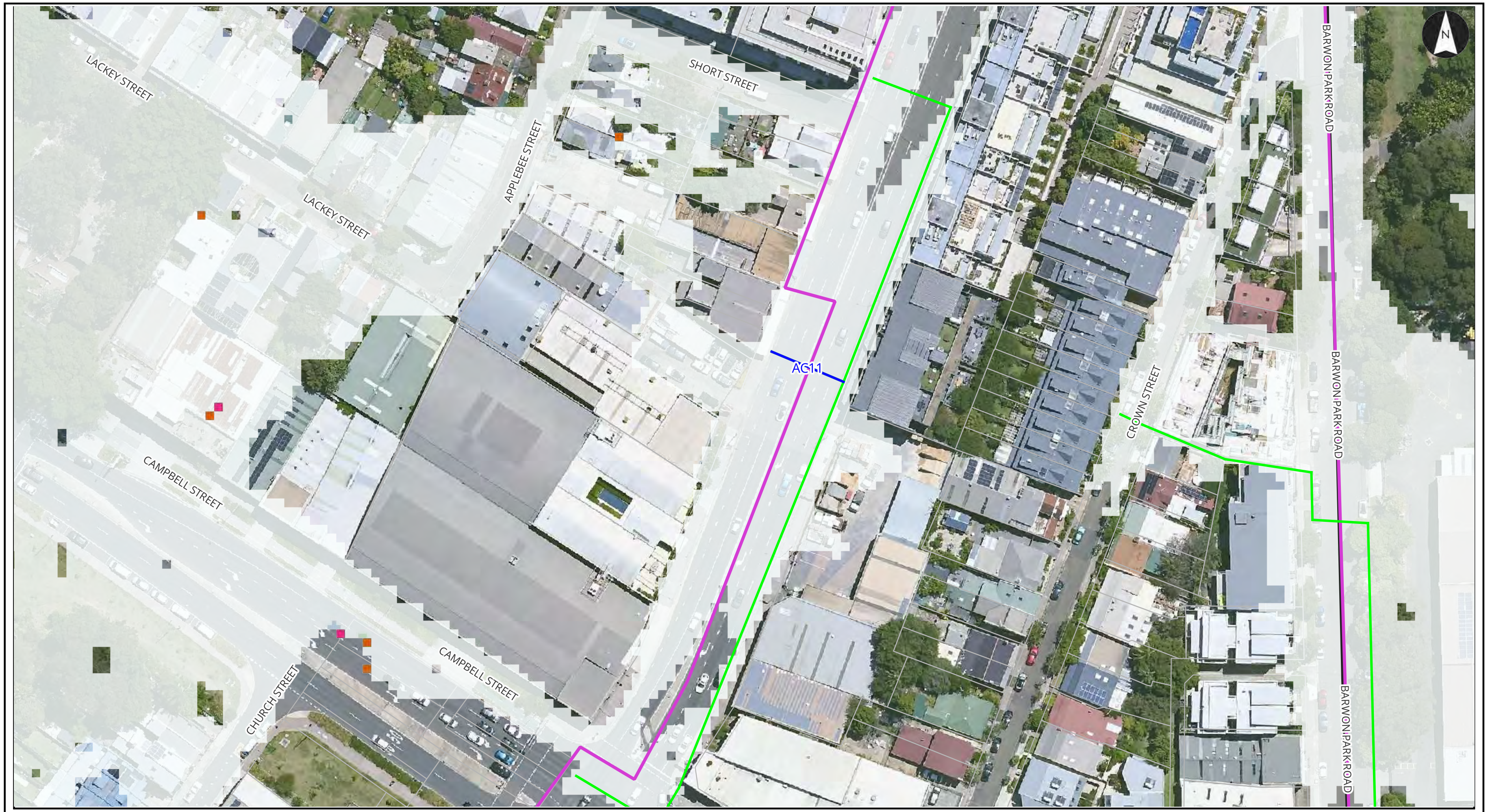
DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850



Stantec



Alexandra Canal Option PMF
AC11 Princes Highway Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 24

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

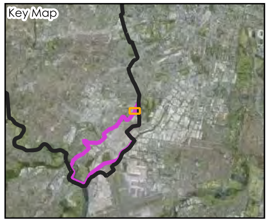
Notes:
1. Map displayed in EPSG:28356

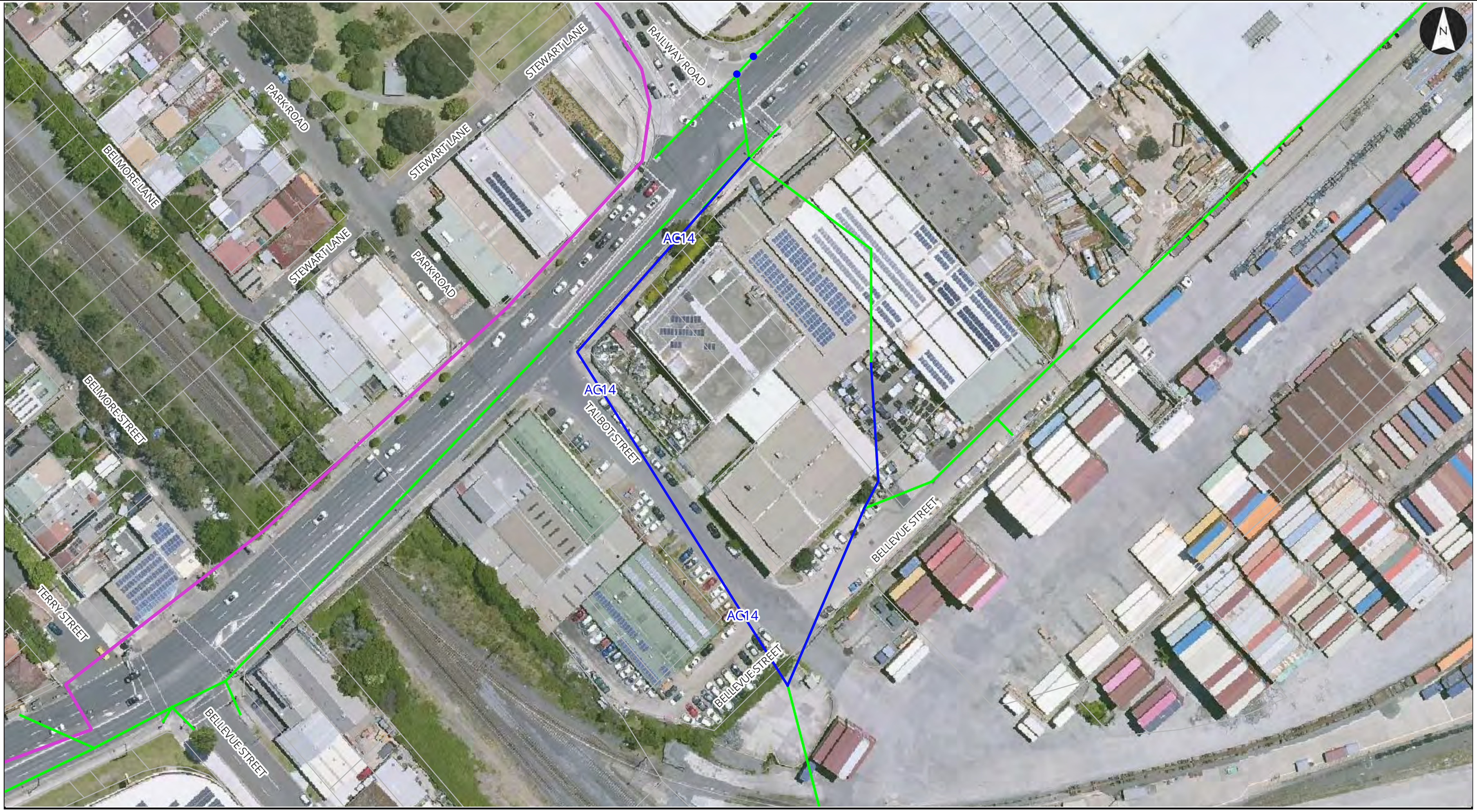
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:850





Alexandra Canal Option - AC14 Overview

Legend
- Proposed Drainage
- Existing Pits and Pipes
- IWC LGA Boundary
- Study Area
- Cadastre

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 25

Stantec

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

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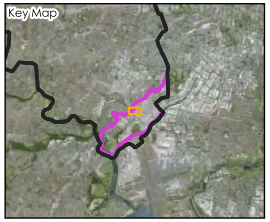
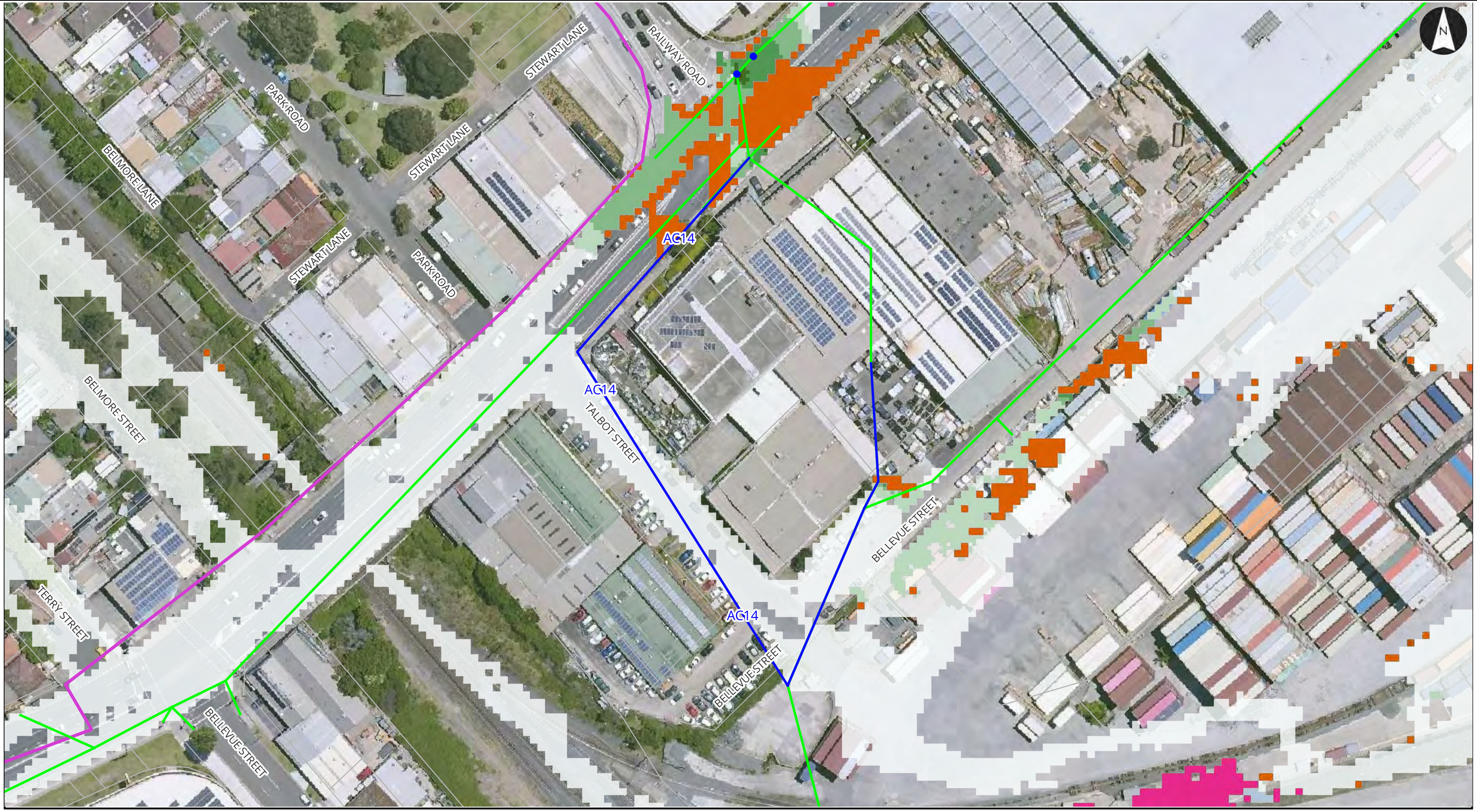
Scale at A3: 1:1000





Alexandra Canal Option 20% AEP
AC14 Talbot Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 26

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

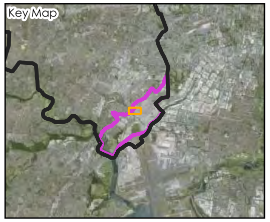
Notes:
1. Map displayed in EPSG:28356

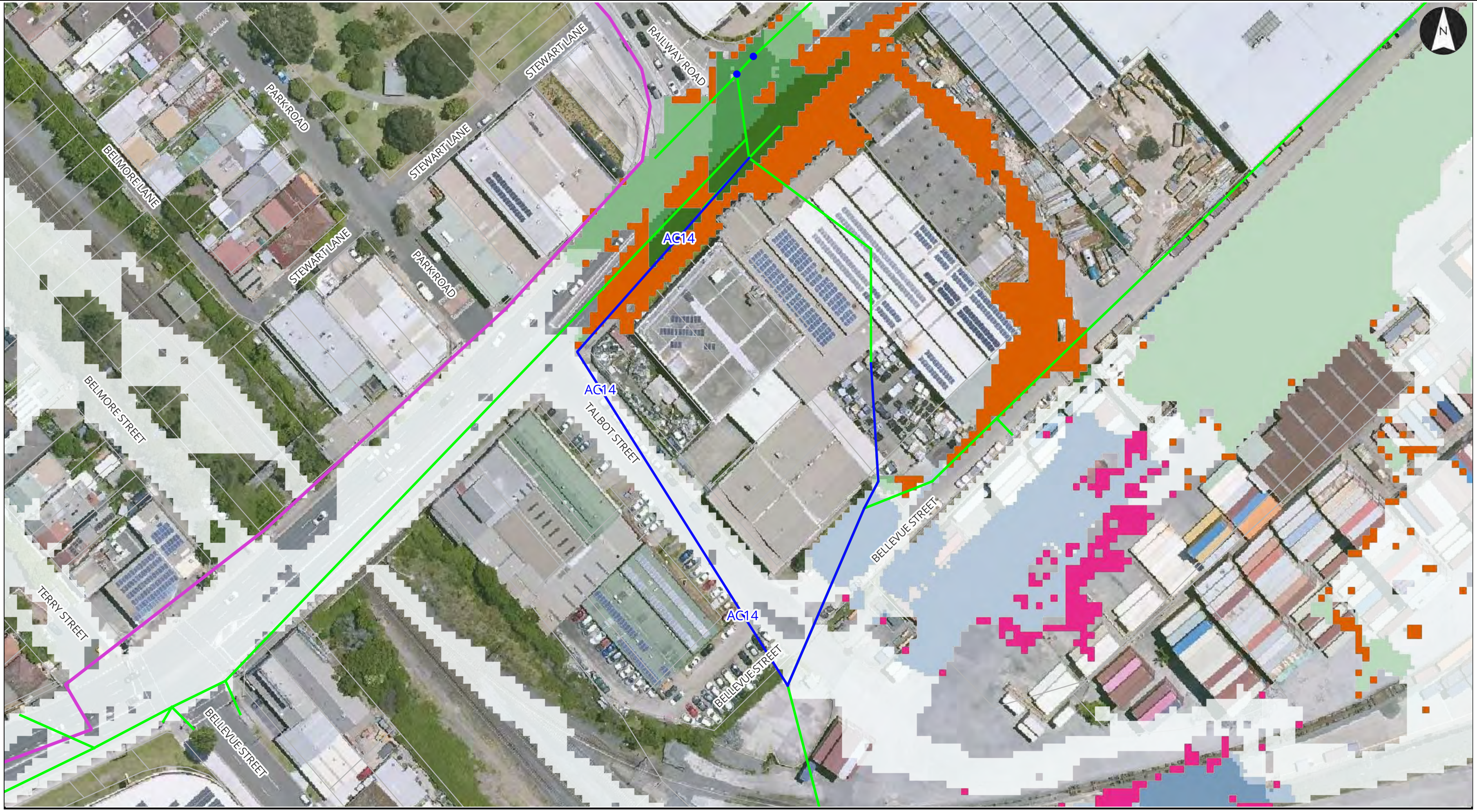
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option 5% AEP
AC14 Talbot Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 27

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

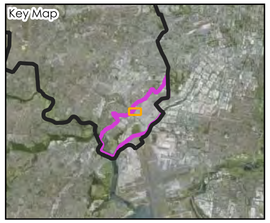
Notes:
1. Map displayed in EPSG:28356

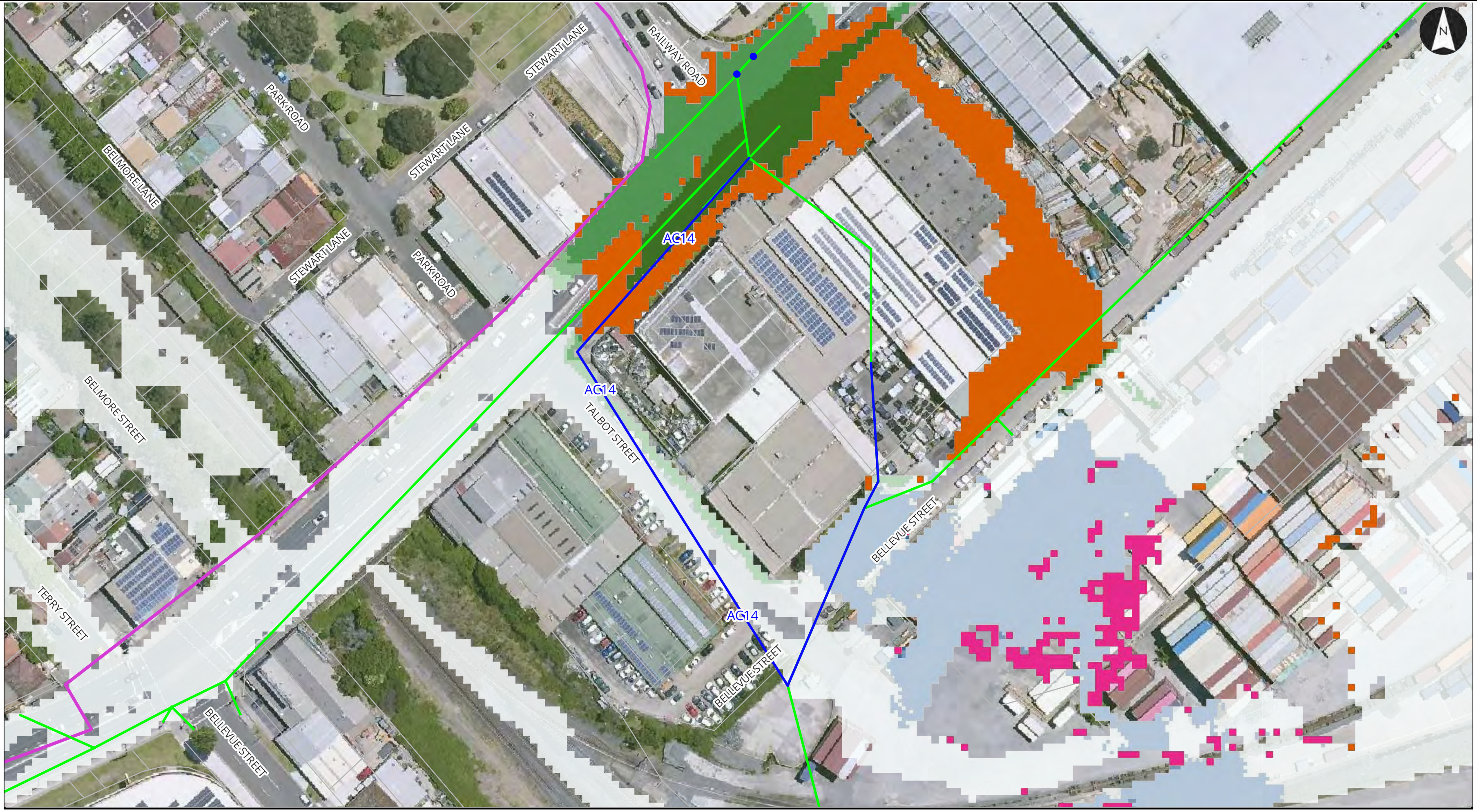
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option 2% AEP
AC14 Talbot Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 28

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

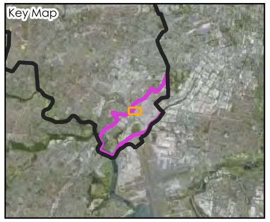
Notes:
1. Map displayed in EPSG:28356

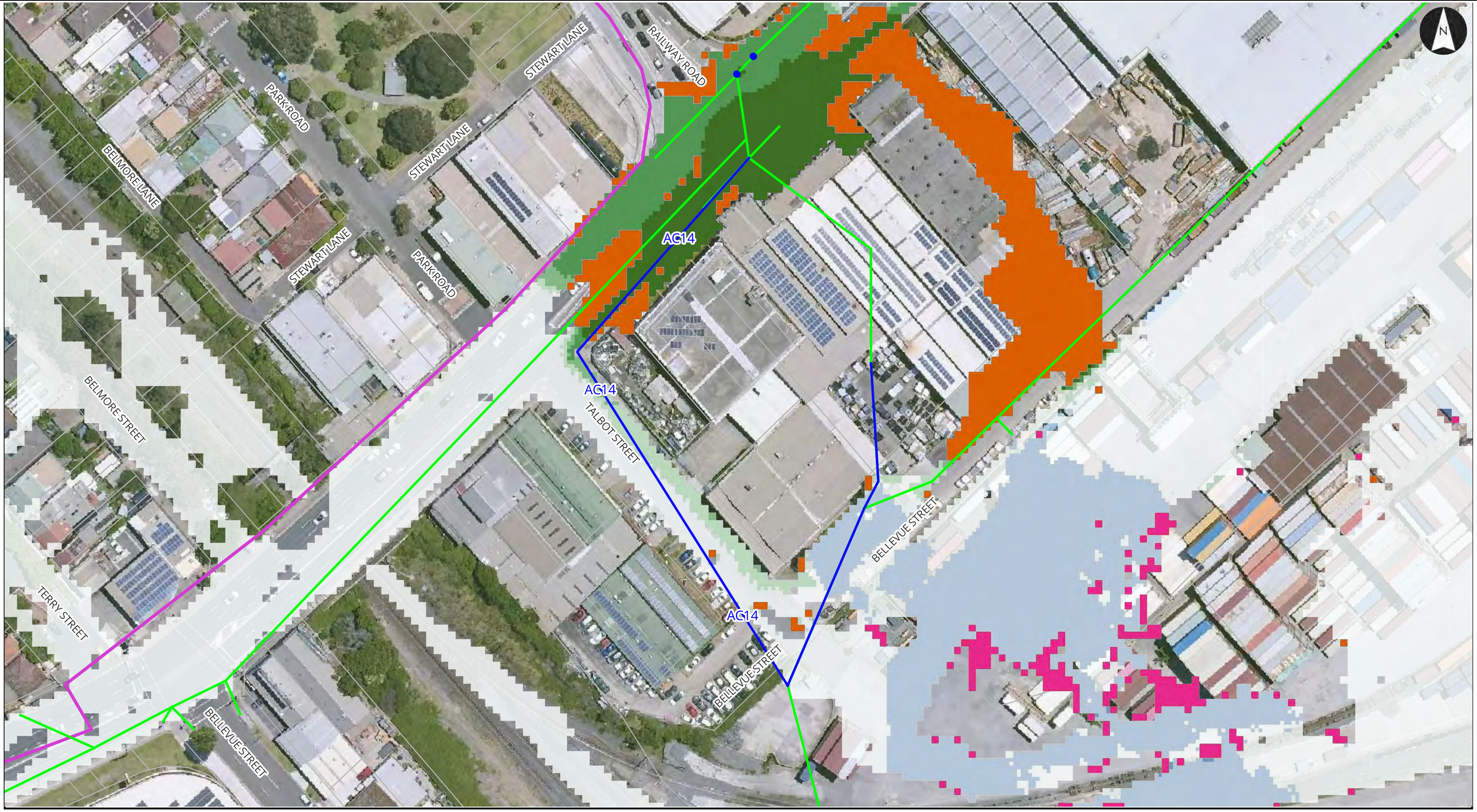
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option 1% AEP
AC14 Talbot Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 29

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

IWC LGA Boundary
Study Area
Cadastre

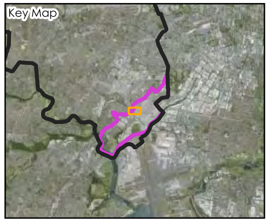
Notes:
1. Map displayed in EPSG:28356

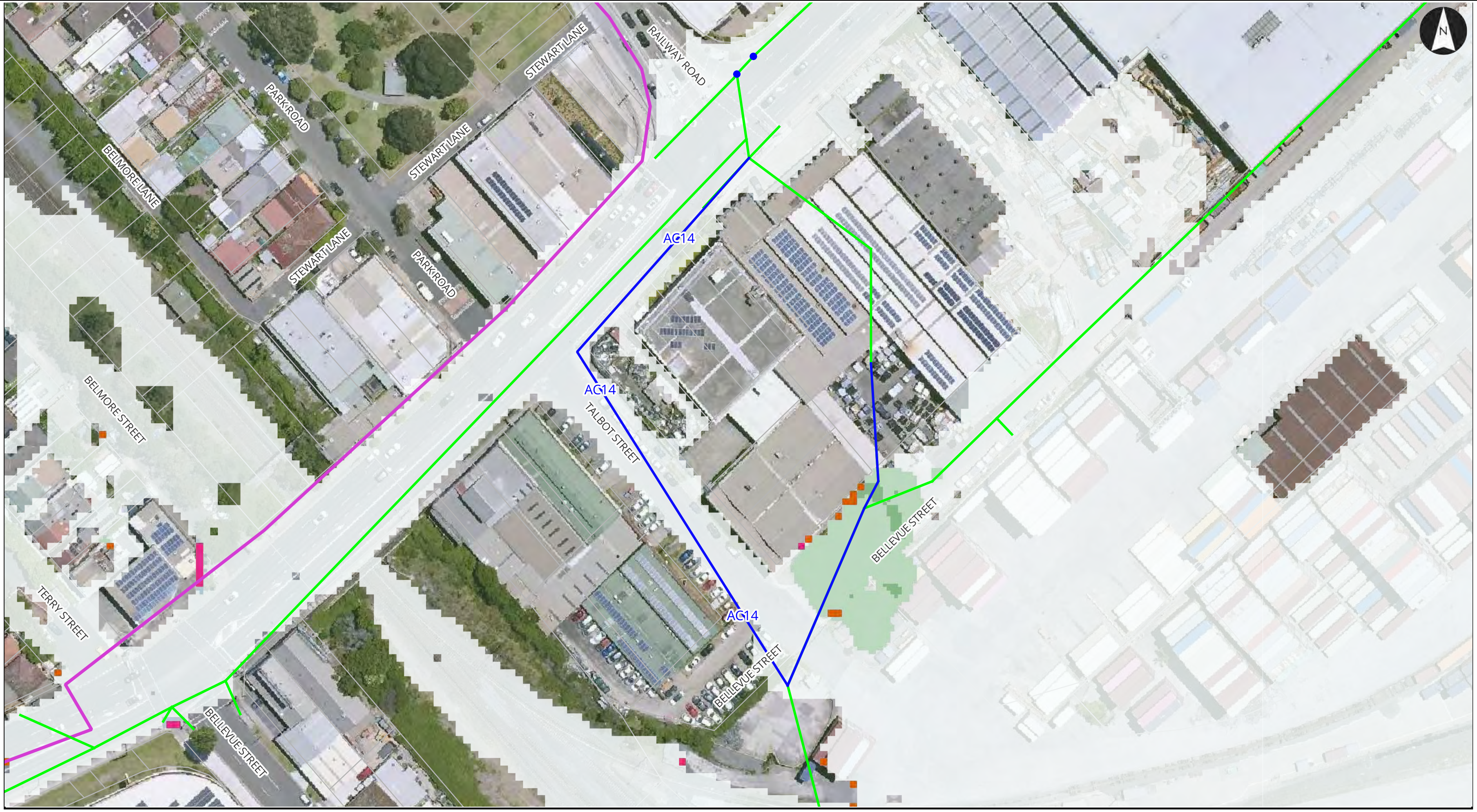
References:
1. Metro map

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000





Alexandra Canal Option PMF
AC14 Talbot Street Drainage Upgrade

Project: Alexandra Canal FRMS&P

Client: Inner West Council
Project Code: 304600163
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 30

Stantec

Legend

Proposed Drainage
Existing Pits and Pipes
Change in Flood Extents (Wet/Dry)
Was Wet, Now Dry
Was Dry, Now Wet

Water Level Difference (m)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50

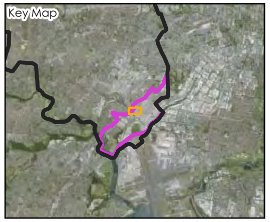
IWC LGA Boundary
Study Area
Cadastre

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

DRAFT - Not For Construction

Scale at A3: 1:1000



APPENDIX

F

MCA SCORING AND IMPLEMENTATION

Table - Multi-Criteria Assessment – Scoring System

Category	Criterion	Weighting	Description of Criterion Assessment	Score				
				-2	-1	0	1	2
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0 to 0.25	0.25 to 0.5	0.5 to 1.5	1.5 to 3.0	>3.0
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	Major increase in AAD (>$200,000)	Slight increase in AAD ($200k to $100k)	Negligible Improvement (less than $100k AAD impact)	Slight decrease in AAD ($200k to $100k)	Major decrease in AAD ($>200,000)
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	There are a number of significant factors that pose an impact on the feasibility of the project	There is a single significant factor or multiple smaller factors that pose a potential impact on the feasibility of the project	May or may not be feasible	Likely to be feasible with management of constraints	Very likely to be feasible with no significant restraint
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	Construction timeframe greater than 1 year Project can not be broken down into sequential components	Construction timeframe greater than	Key components can be completed in isolation within 12 months	Overall construction timeframe less than 12 months Minor components can be staged	Construction timeframe less than 6 months Major components can be staged
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	Significantly diminished performance long-term or under climate change	Slightly diminished performance long-term or under climate change	Unchanged performance long-term or under climate change	Unchanged or improved performance long-term or under climate change with minor ongoing costs	Unchanged or improved performance long-term or under climate change with negligible ongoing costs
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	Widespread or significant localised increase in risk to life	Localised or slight increase in risk to life	Negligible change in risk to life	Localised or slight reduction of risk to life	Widespread or significant localised reduction of risk to life
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	Widespread or significant localised impact on evacuation and emergency services	Localised or slight localised impact on evacuation and emergency services	Negligible impact on evacuation and emergency services	Localised or slight improvement for evacuation and emergency services	Widespread or significant localised improvement for evacuation and emergency services
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	Signficiant increase in the frequency of flooding or limitation of the use of a public space or causes significant social disruption	Increase in the frequency of flooding or limitation of the use of a public space or causes social disruption	Negligible impact on public space or social disruption	Reduces the frequency of flooding or provides enhanced use of a public space or causes social benefit	Significantly reduces the frequency of flooding or enhanced use of a public space or causes significant social benefit
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	Strong opposition to the option in multiple submissions	Slight opposition to the option	No response	Slight support to the option	Significant support to the option
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	High negative impact	Slight negative impact	Negligible impact	Some benefit	Considerable benefit
	Impact on Heritage	5%	Impact to Heritage items	Likely impact on State, National, or Aboriginal Heritage item	Likely impact or increased impact on a local heritage item	No impact	Reduces the impact of flooding to heritage item or heritage conservation area	Heritage item no longer flooded

Table - Multi Criteria Assessment Outcomes – Flood Modification Options - Alexandra Canal

Category	Criterion	Weighting	Description of Criterion Assessment	AC4 - Station St Drainage Upgrade		AC6 - Bay Street Drainage Upgrade		AC11 - Princes Highway Upgrade		AC14 - Talbot St Drainage Upgrade	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	-1	BCR = 0.27	0	BCR = 0.82	0	BCR = 0.08, though damages on west side of Highway not accounted for	0	BCR = 0.88
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	0	AAD increase <$100k	0	AAD increase <$100k	1	AAD increase <$100k, though damages on west side of Highway not accounted for	1	AAD increase $100k-200k
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	-2	Two utility (Sydney Water and Telstra) services crossing proposed option, works in private properties, potential presence of acid sulfate soils	-1	Two utility (Sydney Water and Telstra) services crossing proposed option, potential presence of acid sulfate soils	-1	Three utility (Sydney Water, Uecomm and Telstra) services crossing proposed option, may be feasible depending on clearance between existing pipes and utilities or possible relocation. Highly constrained major highway corridor.	-1	Two utility (Sydney Water and Telstra) services crossing proposed option in multiple locations, long section of pipe, impacts to property access during works. Along major highway corridor.
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	0	Estimated 12 months, easements in private properties	2	Construction timeframe less than 6 months, basic drainage installation in Council owned road corridor	-1	Construction timeframe greater than 12 months that can be staged - temporary lane closures, nightworks. Works in TfNSW corridor (Princes Highway) so would need to be collaboration with TfNSW	-2	Construction timeframe greater than 12 months that can be staged - temporary lane closures, nightworks. Works in TfNSW corridor (Princes Highway) so would need to be collaboration with TfNSW. Easements in private properties
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Slight impact from climate change (considering a lifespan of 30-50 years). Performance of flap gate and tidal flow will help to address sea level rise impacted by climate change	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	0	Only H1-H2 in existing conditions, minimal reduction in water level in local road corridor only	1	H3 in existing conditions, minimal reduction in water level in road corridor only	1	Only H1-H2 in existing conditions, minimal reduction in water level. Option is on Princes Highway (major evacuation route) in road corridor only	1	Minimal areas of H3 in existing conditions, minimal reduction in water level. Option is on Princes Highway (major evacuation route) in road corridor only
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	0	Minimal reduction in water level in road corridor (very localised)	2	Some reduction in water level in local road corridor (very localised). Depth of approx 0.8m in the existing 1% event. Will assist with reduced flooding frequency	2	Minimal reduction in water level. Option is very localised on Princes Highway (major evacuation route) in road corridor	2	Some reduction in water level. Option is very localised on Princes Highway (major evacuation route) in road corridor
	Social Disruption and Public Open Spaces	5.0%	The impact of the risk management option on social disruption and the use of public spaces	1	Reduced flooding of sports fields and minor reduced flooding of local roads	2	Reduced nuisance flooding in road corridor	0	Reduced flooding on Princes Highway, social disruption due to roadworks on Princes Highway	0	Reduced flooding on Princes Highway, social disruption due to roadworks on Princes Highway
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	0	No response from the community in relation to this option. Community member noted this trunk drainage line had collapsed years ago resulting in flooding, but did not request drainage capacity increase.	2	During community consultation, suggestions for a proposed option to address Bay St flooding was received. SES indicated awareness of community complaints regarding flooding in this area	2	SES shared strong support for making the regional evacuation route (Princes Highway) flood free due to SES site located nearby	2	SES shared strong support for making the regional evacuation route (Princes Highway) flood free due to SES site located nearby
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	-1	Potential slight negative impacts (temporary) to nearby trees and wetland environment due to drainage works	-1	Negligible known impacts on fauna and flora. New pipe outlet may need to be designed to avoid existing estuarine vegetation	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora
	Impact on Heritage	5%	Impact to Heritage items	0	No known impact to heritage items	0	No known impact to heritage items	0	No known impact to heritage items	0	No known impact to heritage items
			Total Score (from -22 to 22	**-3**		**7**		**4**		**3**	
			Total Weighted Score (from -2.00 to 2.00)	**-0.40**		**0.60**		**0.45**		**0.40**	

Table - Multi Criteria Assessment Outcomes – Property Modification and Emergency Management Options

Category	Criterion	Weighting	Description of Criterion Assessment	Property Modification (PM) Options		Emergency Management (EM) Options							
				PM6 - Stormwater System Maintenance		EM2 - Review of Local Flood Planning and Info to SES		EM3 - Community Flood Awareness		EM5 - Flood Markers and Signage		EM6 - Flood Data and Debrief	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	2	Council would already have a maintenance schedule in place and can consider increasing frequency. However, should be noted that effectiveness of the maintenance schedule of stormwater system is dependent on timing of a rainfall event and may or may not have a significant impact	2	Straightforward to implement a local flood planning review and allow for sharing of information with NSW SES	1	Depending on the awareness program to be developed, could be some complications with regards to encouraging community engagement with such a program	2	Straightforward to implement and install flood markers and signage	1	Council should already have a flood data collection scheme. Would need to ensure the availability of Council staff to respond to and record flooding at any time
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	2	Straightforward to increase maintenance schedule	2	Straightforward to implement a local flood planning review and allow for sharing of information with NSW SES	1	Depending on the awareness program to be developed, could be some complications with regards to encouraging community engagement with such a program	2	Straightforward to implement and install flood markers and signage	1	Council should already have a flood data collection scheme. Would need to ensure the availability of Council staff to respond to and record flooding at any time
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	No impact of adaptibility of maintenance to climate change conditions	2	Minimal ongoing costs for review. Review can be revised to consider climate change impacts in the future	1	Ongoing costs to maintain the flood awareness program, however following initial engagement ongoing information should be more straightforward. Can be adapted to climate change	2	Minimal ongoing costs for flood markers and signage. Signs can be altered to account for climate change if necessary, however unlikely to be needed	2	Ongoing costs will be variable based on flood event occurrence. Climate change should not significantly influence scheme
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	0	Increased frequency of stormwater system management may or may not have an effect depending on timing of a rainfall event. Modelling results showed limited benefits for residential areas in AC study area.	2	Providing information to SES will assist them in their planning and consequently reduce risk to life	2	Expected reduction in risk to life through better responses of majority of residents	1	Expected reduction in risk to life through residents not attempting to enter floodwaters	0	Negligible direct impact on risk to life
	Emergency Access and Evacuation	10.0%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	1	Increased frequency of stormwater system management may or may not have an effect depending on timing of a rainfall event. Slight benefits if a rainfall event occurs right after scheduled maintenance	2	Providing information to SES will assist them in their planning	2	A flood aware community will limit the number of instances of residents entering floodwaters	2	Will assist residents and the NSW SES identify depth of flooding for some crossings on evacuation routes	0	Negligible direct impact on emergency access and evacuation
	Social Disruption and Public Open Spaces	5.0%	The impact of the risk management option on social disruption and the use of public spaces	0	Near neglible social disruption of residences with more frequent maintenance, no impact on open space or increase in flooding.	0	No direct impact on social disruption or public open space	2	Improved community awareness seen as a social benefit	0	No direct impact on social disruption or public open space	0	No direct impact on social disruption or public open space
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	1	Two responses received during community consultation requesting more frequent stormwater maintenance. Supported by Council engineers	1	NSW SES confirmed support for continued data provision in light of Flood Plan development	1	NSW SES supports the development of a Council led flood awareness program	1	NSW SES supports the development of this measure. Would require TfNSW agreement for signage on major TfNSW roads	1	NSW SES supports continued flood debrief and recording of information
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact
	Impact on Heritage	5%	Impact to Heritage items	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact
Total Score (from -22 to 22				**6**		**11**		**10**		**10**		**5**	
Total Weighted Score (from -2.00 to 2.00)				**0.50**		**1.10**		**0.95**		**0.95**		**0.45**	

Draft Final FRMS&P Report

Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

304600164

Prepared for
Inner West Council

6 February 2024

Stantec

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Document Information

Prepared for	Inner West Council
Project Name	Whites Creek and Johnstons Creek Flood Risk Management Study and Plan
File Reference	304600164 R004 Whites Creek Johnstons Creek FRMS&P Draft Final.docx
Job Reference	304600164
Date	6 February 2024
Version Number	V1

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Effective Date 6/02/2024

Approved By:

Martin Griffin
Group Leader, Water Resources NSW & ACT

Date Approved 6/02/2024

Document History

Version	Effective Date	Description of Revision	Prepared by	Reviewed by
R001	21/05/2021	Stage 1 Draft Report	MG	SC
R002	7/07/2023	Interim Stage 4 Draft Report	AP	MG
R003	3/01/2024	Draft FRMS&P	AP, AC, & HR	MG
R004	6/02/2024	Draft Final FRMS&P	AP, AC, HR & MG	TWG (NSW DCCEW and IWC)

Foreword

The primary objective of the NSW Flood Prone Land Policy 2021 is to reduce the impact of flooding and flood liability on communities and individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

The previous policy formed part of the New South Wales (NSW) Floodplain Development Manual (FDM) in 2005. Recently, two changes have occurred in flood risk management in NSW:

> The 2021 Flood Prone Land Package Update was released in July 2021. The Flood Prone Land package included a new planning direction, planning circular, guideline, standard flood-related Local Environment Plan (LEP) instruments, and several planning legislation changes.

> The finalised and gazetted Flood Risk Management (FRM) Manual was adopted on 30 June 2023. The Manual replaces the FDM 2005 and a number of previous technical guides. The manual provides advice to local councils on the management of flood risk in their local government areas through the flood risk management framework and flood risk management process. This update builds on the 2005 manual and guides. It considers lessons learnt from floods and the application of the flood risk management process and manual since 2005. It considers a range of work on managing natural hazards across government, including relevant national and international frameworks, strategies and best practice guidance. Accompanying the manual is eight FRM Guidelines that comprise a new toolkit to provide guidance for local councils and their consultants.

Under the 2021 policy, councils are primarily responsible for managing flood risk to reduce the risk to life, property damage and other impacts in their local government areas. The State Government subsidises flood management measures to alleviate existing flooding problems and provides specialist technical advice to assist councils in the discharge of their flood risk management responsibilities. The Commonwealth Government also assists with the subsidy of floodplain modification measures. The new policy identifies the following flood risk management 'process' for the identification and management of flood risks:

1. Data Collection - Aims to gather the information needed to support the study being undertaken.
2. Flood Study - Aims to define flood behaviour in sufficient detail to support the understanding and management of flood risk.
3. *Flood Risk Management Study (FRMS) - Provides the basis for examining and recommending FRM measures to manage risks to the existing and growing community, people and built environment. The measures aim to limit the residual flood risk to the community and how this may change over time.*
4. *Flood Risk Management Plan (FRMP) - Builds on the recommendations of the FRM study by clearly outlining council's decision on how it intends to effectively manage flood risk in the study area.*

This Whites Creek and Johnstons Creek Flood Risk Management Study and Plan falls within steps 3 and 4 in the FRM process and has been developed from the previous Flood Study, completed in 2017. An illustration of the FRM process from the FRM Manual is shown below. Beyond the FRM process, councils must also implement, review and update the studies.

Executive Summary

Stantec Australia Pty Ltd (formerly Cardno) was commissioned by Inner West Council ('Council', or IWC) to undertake a Flood Risk Management Study and Plan (FRMS&P) for the Whites Creek and Johnstons Creek Study Areas. The Study Areas are focused around the portions of the two creek catchments that are contained within the former Marrickville Council LGA, south of Parramatta Road.

Community Consultation

Consultation with the community and stakeholders is an important component in the development of a Flood Risk Management Study and Plan. Consultation provides an opportunity to collect feedback and observations from the community on problem areas and potential flood risk management measures. It also provides a mechanism to inform the community about the current study and flood risk within the Study Area and seeks to improve their awareness and readiness for dealing with flooding.

The consultation strategy has been divided into three key sections:

> Consultation in FRMS&P development: This occurs during the initial stages of the project **1.4**and involves both informing the community and stakeholders of the project and gathering information on existing flooding issues and suggestions for flood risk management options.

> Review of possible flood management options with key stakeholder groups including Council Engineers, Council Planners, NSW SES, NSW DCCEW and community representatives within Council's Flood Risk Management Advisory Committee.

> Public exhibition of Draft FRMS&P: This occurs in the final stage of the project, with comments sought from the community and stakeholders on the Draft FRMS&P report with this input reviewed and incorporated into the final FRMS&P.

Information regarding the project was advertised on Councils website on the Have Your Say portal. Outcomes from the initial consultation included, there were 650 views of the project page, initiated by 501 unique visitors. The total viewing time of project information was approximately 7 hours. Two persons contributed to the interactive map. There were three attendees relevant to the Whites Creek and Johnstons Creek study area at the three in-person sessions

Impact of Flooding

The number of flood affected properties for five design events are summarised in the below table. Two forms of property tagging analysis have been considered – tagging of properties with any flood affectation and tagging of properties where the flood extent covers at least 10% of the property area, as was applied under the Johnstons Creek Flood Study.

A review of the number of properties affected between the "10% affectation" and the "any affectation" scenarios, and the relative flood hazard affecting these properties, it was considered that the 10% affectation scenario sufficiently addressed the flood risk, requiring no updates to the flood affected lot tagging currently adopted by Council.

Property Tagging	Base Case Flood Affected Property				
	20% AEP	5% AEP	2% AEP	1% AEP	PMF
Flood Affected	770	1006	1107	1197	1906
>10% Area Affectation	197	300	368	409	913
				Total Properties in Catchment	6976

In the PMF event using the 10% property area approach, there are a total of 913 flood affected properties, or 14.2% of the total 6434 properties in the study area. In the 1% AEP the total number of affected properties is 409, or 6.3% of all properties.

With respect to economic impacts of flooding in the study area, the total Average Annual Damage (AAD) for Whites Creek is over $2 million. More than half (58%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing a further 26% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 2 – 7% of AAD contribution.

For Johnstons Creek, the total AAD is over $28.8 million. Similar to Whites Creek, over half (57%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing 27% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 3 – 7% of AAD contribution. Though these events result in far higher flood damage totals, particularly the PMF event, their relatively low likelihood means they contribute less to the AAD.

Therefore, as it relates to damages and AAD, structural flood risk management options that reduce flood damages for the most frequent 20% AEP event are expected to provide the biggest benefits to AAD reductions. The following tables are summarized AAD calculations for Whites Creek and Johnstons Creek respectively.

Whites Creek

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$3,063,904	**$1,242,852**	58%
5%	0.05	$4,464,671	**$566,565**	26%
2%	0.02	$4,784,009	**$140,084**	7%
1%	0.01	$5,404,352	**$51,276**	2%
PMF	0.0000001	$24,166,397	**$147,706**	7%
	Total AAD		**$2,148,483**	

Johnstons Creek

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$40,992,067	**$16,541,136**	57%
5%	0.05	$62,615,455	**$7,809,006**	27%
2%	0.02	$73,588,421	**$2,060,652**	7%
1%	0.01	$82,892,052	**$783,517**	3%
PMF	0.0000001	$247,421,259	**$1,649,915**	6%
	Total AAD		**$28,844,226**	

Flood Emergency Response Review

Due to the short duration of both the critical storm affecting the catchment and the time to peak flood depth, there is limited opportunity to stand up an emergency management centre and begin directed evacuation of residents prior to the onset of flooding. Based on a detailed review of flood emergency response provisions and the flash flooding nature of the study area, it is unlikely, almost impossible, that SES doorknocked evacuation will be able to effectively evacuate residents prior to flooding. From this review, potential measures have been identified that could improve flood emergency response potential for the study area:

> Improved flood awareness – Limited knowledge of an individual's potential risk from flooding and the associated lack of planning can cause significant delays to community evacuation due to both acceptance and lag time. A comprehensive flood awareness program for the Study Area, educating residents of the seriousness of the flood risk and the flash flooding nature of the catchment could improve the flood risk to the community.

> Alternative flood warning systems- There are noted difficulties of flood warning systems in flash flooding environments. As forecasting and modelling technology improves, options may be considered for the development of flood warning systems for the Study Area, particularly in the emergency management hotspot areas.

> Self-managed evacuation - Where SES assisted evacuation is not an option, self-managed evacuation is a potential alternative. This describes where people make their own decision to evacuate earlier and move to alternate accommodation, using their own transport. These plans would typically be prepared using information available from Council and with support of the local SES unit, using SES templates such as FloodSafe. The advantage of this approach would be that people can evacuate more quickly than SES assisted evacuation, and as a result reduces the strain on SES and does not rely on a centralised evacuation order. However, self-managed evacuation can also pose a risk if not conducted in an appropriate way. Residents could place themselves at higher risk for example if they evacuate to a location which is even more flood affected, drive through flood waters, or could increase traffic congestion if the wrong route is selected.

Item 16

Flood Planning Review

The outcomes of the flood planning review were as follows:

> Compared to the requirements for planning proposals outlined within the 2021 Flood Prone Land Policy Update, the current development controls are generally in agreement.

> Compared to the Flood Planning Constraints Categories (FPCC) approach from the 2023 Flood Risk Management (FRM) Manual Guide FB01, current Flood Risk Precincts of the Development Control Plan (DCP) are generally aligned however potentially adopting FPCC offers some potential benefits. These benefits include splitting the current High risk precinct into FPCC1 and FPCC2 where development can be precluded in FPCC1 and more tailored controls can be applied to FPCC2 areas.

> Compared to the requirements for Flood Impact Risk Assessment (FIRA) from the 2023 FRM Manual Guide LU01. Generally, the current development controls are in agreement with the proposed requirements in the guide with some exceptions:

- The current controls do not require consideration of climate change in assessments.
- The current controls do not specify flood impacts be considered not just for flood levels but also duration, velocity, evacuation, flood function or hazard categorisation.
- The current controls do not specifically require a consideration of residual risk of proposed developments to confirm if flood risk is lower than existing based on proposed risk management measures for developments.

Ultimately the current development controls are considered suitable, and generally in accordance with recent guidance both within the 2021 Flood Prone Land Policy Update and the 2023 FRM Manual Guide LU01. However, there are some minor alterations listed in the bullet points above that may improve an applicant's understanding of the controls and provide a more comprehensive assessment of flood risk in future development submissions.

Flood Risk Management Options Background

Three main types of Flood Risk Management (FRM) options were considered:

> Flood modification measures – Flood modification measures are options aimed at preventing / avoiding or reducing the likelihood of flood risks. These options reduce the risk through modification of the flood behaviour in the catchment.

> Property modification measures – Property modification measures are focused on preventing / avoiding and reducing consequences of flood risks. Rather than necessarily modify the flood behaviour, these options aim to modify properties (both existing and future) so that there is a reduction in flood risk.

> Emergency response modification measures – Emergency response modification measures aim to reduce the consequences of flood risks. These measures generally aim to modify the behaviour of people during a flood event.

The assessment of FRM options should consider inputs from people in the community, the economy, social and cultural aspects, services to the community and the natural environment. Relating to the development of FRM options, the following stages were applied in this project:

> Option identification and preliminary option assessment and optimisation – The identification of an inclusive range of FRM options to address local or broad FRM issues for the existing community and new development. Having identified the FRM issues to address and an inclusive range of FRM options worthy of consideration, the viability of these options were discussed with Council, the Committee and other stakeholders in several workshops to determine if they warranted more detailed assessment.

> Detailed option assessment – Detailed assessment and subsequent optimisation of FRM options and packages of options needs to consider their costs, benefits and disbenefits in managing risk. The detailed assessment included flood modelling of options, damages assessment of option benefits, preliminary costing and a Multi-Criteria Assessment (MCA) that considers a broad range of factors quantitatively or qualitatively.

> Recommendation in FRM studies and decision-making in FRM plans.

Detailed Assessment of Options

Following the preliminary option assessment, twenty options were selected for detailed assessment, with the final options listed in the table below.

Attachment 4

Option Type	Option ID/Name
Flood Modification (FM)	JC1 v1 – Fowler Street, Camperdown Drainage Upgrade
	JC1 v2 – Fowler Street, Camperdown Detention Basin
	JC5 – Bridge Road, Stanmore Drainage Upgrade
	JC6 v1 – Bridge Road, Stanmore Channel Regrading
	JC6 v2– Bridge Road, Stanmore Channel Widening
	JC7 – Bridge Road, Stanmore Detention Basin
	JC10 – Trafalgar Street, Petersham Drainage Upgrade
	JC13 – Gladstone Street, Enmore Drainage Upgrade
	JC14 – Railway Avenue, Stanmore Road Regrading
	JC15 – Probert Street, Newtown Drainage Upgrade
	JC18 v1 – Kingston Road, Camperdown Drainage Upgrade
	JC18 v2 – Kingston Road, Camperdown Drainage Upgrade
	JC20 – Lennox Street, Newtown Drainage Upgrade
	JC23 – Clarendon Lane, Stanmore Drainage Upgrade
	WC1 – Margaret Street, Petersham Drainage Upgrade
Property Modification (PM)	PM6 – Targeted Stormwater Maintenance
Emergency Management Modification (EM)	EM2 – Review of Local Flood Planning and Information Transfer to NSW SES
	EM3 – Community Flood Awareness
	EM5 – Flood Markers and Signage
	EM6 – Flood Data and Debrief

The detailed assessment of these 20 FRM options was conducted including:

- Hydraulic modelling of five design events – 20%, 5%, 2%, 1% AEP and PMF (for FM options),
- Flood damages benefits assessment (for FM options) involving adopting water level impact results compared to the existing flood damages to determine the potential benefits of the option in the 5 modelled events. The AAD of damage benefits were calculated and the Net Present Worth (NPW) of benefits for all options were calculated assuming a 5% discount rate and 30 year life cycle for the option.
- Cost estimation was conducted for all options for both capital and ongoing / maintenance costs. The process for capital cost estimation was based on quantities for construction estimated from preliminary design for the 15 FM options as they were modelled in the TUFLOW model. Unit rates were initially estimated by Stantec and reviewed and updated by Council staff in some instances to match current cost rates for the local area. A 50% contingency has been applied to all estimates given uncertainty on eventual design refinement and quantities. For other measures (EM and PM), costs were estimated only on the basis of cost to implement and were done for the purpose of comparison in the multi-criteria assessment. The total cost of the options was calculated for Net Present Worth using a 5% discount rate and an implementation period of 30 years.
- Benefit Cost Ratio - The economic evaluation of each option was performed by considering the reduction in the amount of flood damages incurred for the design events and then comparing this value with the cost of implementing the option. The benefit-cost ratio provides an insight into how the damage savings from a measure relate to its cost of construction and maintenance. Where the benefit-cost ratio is greater than one (BCR >1) the economic benefits are greater than the cost of implementing the measure. For all FM options it is possible to quantify, at least at a high-level both damage benefits and costs of implementation for each option, therefore a BCR is able to be calculated. For PM and EM options, the damage benefits are not easily quantifiable, though there would be some economic benefits of these options in the form of reduced risk to life and resultant reduction in flood damage for loss of life. Therefore in lieu of any damage benefit information, the economic analysis of these options has assumed that BCR is 1.0. The Benefit Cost Ration outcomes for all detailed options have been summarised in the table below.

Option	NPW of AAD Reduction Benefits	NPW of Cost of Implementation of Option	Benefit Cost Ratio
JC1 v1– Fowler Street, Camperdown Drainage Upgrade	$1,578,818	$397,097	3.98
JC1 v2– Fowler Street, Camperdown Detention Basin	$2,952,404	$2,625,485	1.12
JC5 – Bridge Road, Stanmore Drainage Upgrade	$2,176,794	$7,938,503	0.27
JC6 v1 – Bridge Road, Stanmore Channel Regrading	$7,181,786	$1,911,058	3.76
JC6 v2– Bridge Road, Stanmore Channel Widening	$7,403,263	$5,456,303	1.36
JC7 – Bridge Road, Stanmore Detention Basin	$7,632,909	$1,386,777	5.50
JC10– Trafalgar Street, Petersham Drainage Upgrade	$60,783	$704,768	0.09
JC13 – Gladstone Street, Enmore Drainage Upgrade	$6,582,822	$1,646,592	4.00
JC14 – Railway Avenue, Stanmore Road Regrading	$5,299,041	$2,247,616	2.36
JC15 – Probert Street, Newtown Drainage Upgrade	$1,774,388	$452,519	3.92
JC18 v1 – Kingston Road, Camperdown Drainage Upgrade 1	$3,216,878	$368,877	8.72
JC18 v2 – Kingston Road, Camperdown Drainage Upgrade 2	$4,690,901	$1,198,241	3.91
JC20– Lennox Street, Newtown Drainage Upgrade	$8,366,172	$2,300,761	3.64
JC23 – Clarendon Lane, Stanmore Drainage Upgrade	$324,555	$401,322	0.81
WC1 – Margaret Street, Petersham Drainage Upgrade	$4,990,924	$2,356,821	2.12
PM6 – Targeted Stormwater Maintenance	*	$5,719,990	1.0*
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES		$137,794	1.0*
EM3 – Community Flood Awareness		$751,761	1.0*
EM5 – Flood Markers and Signage		$265,294	1.0*
EM6 – Flood Data and Debrief		$275,587	1.0*

*In lieu of benefit values for EM & PM options, due to flood risk reduction BCR value assumed to be 1.0

The BCR results show that of flood risk management options:

> Eight (8) options have BCR values over 3.0, therefore the costs are significantly lower than the calculated benefits.

> Two (2) options have BCR values over 1.5 to 3.0, therefore the costs are lower than the calculated benefits.

> Eight (8) options have BCR values over 0.5 to 1.5, therefore the costs are comparable to the calculated benefits, five (5) such options are EM and PM options with assumed BCR of 1.0.

> Two (2) options have BCR values less than 0.5, therefore the costs are significantly higher than the calculated benefits.

Option PM6 is for the targeted increased maintenance of the stormwater network. Inner West Council, in accordance with its responsibility as owner of the majority of the drainage assets within the study area, has a significant maintenance schedule already in place for all of its stormwater assets. This includes timely responses to community requests or notes relating to any drainage blockage or damage. Option PM6 involves potential additional targeted maintenance of greater frequency than is currently applied at key locations. The potential benefits of the PM6 option for targeted stormwater maintenance was assessed using modelling assuming no blockage of pipes. This is a best-case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes. Therefore, due to this uncertainty, the modelling outcomes in the form of damage benefits were not applied to the BCR outcome for this option PM6.

Multi-Criteria Assessment

To assist Council in identifying the FRM options that provide the most benefits for the society, environment and economy, all options need to be compared against each other based on factors relevant to the study area. Evaluating what constitutes an appropriate strategy for floodplain management is a significant analytical and policy challenge. Such challenges have led to the exploration of alternative policy analysis tools, one being Multi Criteria Assessments (MCA). The goal of MCA is to attempt to directly incorporate multiple values held by community and stakeholders into the analysis of management alternatives while avoiding the reduction of those values into a standard monetary unit. In doing so, one can consider different FRM options in the context of economic criteria as well as other criteria such as social, or environmental aspects. Community and stakeholders can also assign explicit weights to those values to reflect their preferences and priorities. Therefore, MCA provides opportunities for the direct participation of community and stakeholders in the analysis.

An MCA approach has been used for the comparative assessment of all options identified. Each option is given a score according to how well the option meets specific considerations. To keep the scoring system simple a framework has been developed for each criterion.

The selection of criteria and weighting has been completed by involving the technical working group (TWG). A scoring system with 11 criteria (five economic, four social and two environmental) was established for each criterion with scores ranging from +2 for options that represented a significant improvement on existing conditions for any given criteria, to -2 for options that represented a significant worsening of existing conditions. It is noted that for two criteria (Benefit-Cost Ratio and Reduction in Risk to Property or damage) scoring systems was based on quantifiable assessment outcomes, for all other criteria scoring was more qualitative, although supported by sound judgement.

The highest scoring options typically fall into one of two categories:

> Relatively cost-effective FM) options consisting of drainage upgrades that provide significant flood risk reduction benefits (with the exception of the Bridge Road detention basin option).

> EM options which offer significant flood risk reduction with relatively minor cost. Three of the top seven MCA scoring options are EM options.

The lowest scoring options are typically FM options that do not provide significant flood risk reduction benefits relative to their cost, complexity or other issues. The lowest 5 scoring options are all FM options.

Implementation Plan

The list of recommended management options has been transformed into an implementation plan provided in the table below. It lists the following information relevant to the implementation of each adopted FRM option:

> Type and sub-catchment location of option and MCA score;

> The priority for implementation (high, medium, or low) and rank as an outcome of the FRMS&P;

> An estimate of implementation costs including capital and ongoing costs per annum;

> Potential funding mechanism or organisation; and

> Required economic assessment level during Investigation and Design (I&D) stage.

The flood risk management options identified in the below table represent a capital cost of approximately $17.6M, with the flood modification options making up $17.0M of this cost. High priority options have combined capital costs of $5.9M.

It is noted that the implementation plan does not outline a specific timeframe for the implementation of each project. Plan has not been explicitly identified. Rather, the implementation plan provides a body of projects to inform future advocacy, budgeting, and planning in order that Council may be able to undertake works in a prioritised manner as funding becomes available or other opportunities arise in a specific location associated with a proposed option.

Option ID	Option Type	MCA Weighted Score	Option Rank	Implementation Priority	Capital Costs (incl. GST)	Ongoing Costs (p.a incl. GST)	Economic Assessment Level for I&D
Option JC15 – Probert Street, Newtown Drainage Upgrade	Flood Modification (FM)	1.25	1	High	$ 440,990	$ 750	Level 1 (FRMS&P)
Option JC7 – Bridge Road, Stanmore Detention Basin	FM	1.15	2	High	$ 1,317,600	$ 4,500	Level 2 (Detailed damages)
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	1.10	3	High	$ 22,500	$ 7,500	Level 1
Option JC20 – Lennox Street, Newtown Drainage Upgrade	FM	1.10	3	High	$ 2,266,173	$ 2,250	Level 2
Option JC13 - Gladstone Street, Enmore Drainage Upgrade	FM	1.05	5	High	$ 1,612,003	$ 2,250	Level 2
EM3 – Community Flood Awareness	EM	0.95	6	High	$ 60,000	$ 45,000	Level 1
EM5 – Flood Markers and Signage	EM	0.95	6	High	$ 150,000	$ 7,500	Level 1
Option JC14 - Railway Avenue, Stanmore Road Regrading	FM	0.85	8	Medium	$ 2,247,615	$ -	Level 2
Option JC18 v1 - Minor Kingston Road, Camperdown Drainage Upgrade 1	FM	0.75	9	Medium	$ 368,876	$ -	Level 1
Option JC6 v1 - Bridge Road, Stanmore Channel Upgrade (Re-grading North)	FM	0.70	10	Medium	$ 1,899,528	$ 750	Level 2
PM6 – Targeted Stormwater Maintenance	Property Modification (PM)	0.65	11	Medium	$ 349,367	$ 349,367	Level 1
Option JC23 - Clarendon Lane, Stanmore Drainage Upgrade	FM	0.55	12	Medium	$ 378,263	$ 1,500	Level 1
Option JC18 v2 - Major Kingston Road, Camperdown Drainage Upgrade 2	FM	0.55	12	Medium	$ 1,198,240	$ -	Level 2
Option JC1 v2 - Fowler Street, Camperdown Detention Basin	FM	0.50	14	Medium	$ 2,533,250	$ 6,000	Level 2
EM6 – Flood Data and Debrief	EM	0.45	15	Low	$ 45,000	$ 15,000	Level 1
Option WC1 - Margaret Street, Petersham Drainage Upgrade	FM	0.40	16	Low	$ 2,356,821	$ -	Level 2
Option JC1 v1 -Fowler Street, Camperdown Drainage Upgrade	FM	0.35	17	Low	$ 397,097	$ -	Level 1
				Total	**$ 17,643,323**	**$ 442,367**	

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Appendices

Tables

Figures

Abbreviations

1D	One-dimensional
2D	Two-dimensional
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AHIP	Aboriginal Heritage Impact Permit
ARI	Average Recurrence Interval
AR&R	Australian Rainfall and Runoff
ASS	Acid Sulfate Soils
BCR	Benefit Cost Ratio
BoM	Australian Bureau of Meteorology
DAWE	Australian Department of Agriculture, Water and Environment.
DCCEW	NSW Department of Climate Change, Energy and Water
DCP	Development Control Plan
DEM	Digital Elevation Model
DPHI	NSW Department of Planning, Housing and Infrastructure
ELVIS	Elevation Information System
EPA	NSW Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FDM	Floodplain Development Manual
FRM	Flood Risk Mannagement
FRMS&P	Flood Risk Management Study and Plan
FPL	Flood Planning Level
FPA	Flood Planning Area
GIS	Geographical Information Systems
IFD	Intensity-Frequency-Duration
IWC	Inner West Council
LEP	Local Environment Plan
LGA	Local Government Area
LIDAR	Light Detection and Ranging
NPV	Net Present Value
NSW	New South Wales
PCT	Plant Community Types
PMF	Probable Maximum Flood
PMST	Protected Matters Search Tool
SEPP	State Environmental Planning Policy
SES	NSW State Emergency Service
TEC	Threatened Ecological Community

Glossary

Acid Sulfate Soils (ASS)	Acid sulfate soils (ASS) are naturally occurring sediments and soils containing iron sulfides (mostly pyrite). When these sediments are exposed to the air by excavation or drainage of overlying water, the iron sulfides oxidise and form sulphuric acid. ASSs are widespread among low lying coastal areas of NSW, in estuarine floodplains and coastal lowlands.
Annual Exceedance Probability (AEP)	The probability of an event occurring or being exceeded within a year. For example, a 5% AEP flood would have a 5% chance of occurring in any year. An approximate conversion between ARI and AEP is provided.
Australian Height Datum (AHD)	A standard national surface level datum approximately corresponding to mean sea level.
Average Recurrence Interval (ARI)	The long-term average period between occurrences equalling or exceeding a given value. For example, a 20 year ARI flood would occur on average once every 20 years.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events. E.g. some roads may be designed to be overtopped in the 1% AEP flood event.
Development	The erection of a building or the carrying out of work; or the use of land or of a building or work; or the subdivision of land.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Elevation Information System (ELVIS)	ELVIS was launched by Geoscience Australia in 2016 to replace the existing National Elevation Data Framework (NEDF) and to open access to elevation datasets to a wider user base. With the online ELVIS portal, users can now easily download continent-wide elevation data.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain which causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood fringe	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood hazard	Potential risk to life and limb caused by flooding.
Flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land. Flood Risk Management Plans encompass all flood prone land, rather than being restricted to land subject to designated flood events.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Floodplain management measures	The full range of techniques available to floodplain managers.

Floodplain management options	The measures which might be feasible for the management of a particular area.
Flood Planning Area (FPA)	The area of land below the flood planning level and thus subject to flood related development controls.
Flood planning levels (FPLs)	Flood levels selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also take into account the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of land use and for different flood plains. The concept of FPLs supersedes the "Standard flood event" of the first edition of the Manual. As FPLs do not necessarily extend to the limits of flood prone land (as defined by the probable maximum flood), floodplain management plans may apply to flood prone land beyond the defined FPLs.
Flood storages	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood.
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often, but not always, aligned with naturally defined channels. Floodways are areas which, even if only partially blocked, would cause a significant redistribution of flood flow, or significant increase in flood levels. Floodways are often, but not necessarily, areas of deeper flow or areas where higher velocities occur. As for flood storage areas, the extent and behaviour of floodways may change with flood severity. Areas that are benign for small floods may cater for much greater and more hazardous flows during larger floods. Hence, it is necessary to investigate a range of flood sizes before adopting a design flood event to define floodway areas.
Geographical Information Systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
High hazard	Flood conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Low hazard	Flood conditions such that should it be necessary, people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.
Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Mathematical/computer models	The mathematical representation of the physical processes involved in runoff and stream flow. These models are often run on computers due to the complexity of the mathematical relationships. In this report, the models referred to are mainly involved with rainfall, runoff, pipe and overland stream flow.
Overland Flow	The local runoff, travelling through properties and /or roads, before it discharges into a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.

Probable maximum flood (PMF)	The flood calculated to be the maximum that is likely to occur.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a more detailed explanation see AEP and Average Recurrence Interval.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Stormwater flooding	Inundation by local runoff. Stormwater flooding can be caused by local runoff exceeding the capacity of an urban stormwater drainage system or by the backwater effects of mainstream flooding causing the urban stormwater drainage system to overflow.
Topography	A surface which defines the ground level of a chosen area.

1 Introduction

Stantec Australia Pty Ltd (formerly Cardno (NSW/ACT) Pty Ltd) ('Stantec') was commissioned by Inner West Council ('Council') to undertake a Flood Risk Management Study and Plan (FRMS&P) for the Whites Creek and Johnstons Creek Study Area (**Figure 2-1**). The Study Area is within the Inner West Local Government Area (LGA), located approximately 4km southwest of the Sydney Central Business District (CBD). The Study Area is focused on the portions of Whites Creek and Johnstons Creek located south of Parramatta Road. The remaining areas of these catchments north of Parramatta Road were previously reviewed as part of the Leichhardt Flood Risk Management Study and Plan (Cardno, 2017). **Figure 2-2** outlines the division of the creek catchments between this study and the areas previously completed by Inner West Council and City of Sydney Council, which have been excluded from this study. The Study Area is roughly between Crystal Street in the west and Missenden Road and King Street in the East, extending as far up as Parramatta Road, and south to some areas of Enmore Road and Cambridge Street.

This report is Draft FRMS&P report for Whites Creek and Johnstons Creek.

1.1 Study Context

As outlined within the Floodplain Risk Management (FRM) Manual 2023, like all councils in NSW, Inner West Council is responsible for local land use planning including management of both mainstream and overland flooding within the LGA. In response to the objectives of the New South Wales (NSW) Government's Flood Prone Land Policy, Council has an ongoing commitment to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the Department of Climate Change, Energy and Water (DCCEW, formerly Department of Planning and Environment, DPE) and the State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding and land use planning matters. The FRM Manual 2023 guides councils in the strategic management of flood risk across their LGAs through the FRM framework. This supports councils in meeting their responsibilities for a range of FRM activities and their strategic consideration of flooding.

The FRM process is a key element of the FRM framework. Studies and plans under the process support the understanding of flooding, the examination of measures to manage flood risk and informed decisions on how to manage flood risk into the future. They also support the consideration of flooding in broader activities under the FRM framework. The FRM process progresses through four (4) steps in an iterative process:

1. Data Collection
2. Flood Study
3. ***Flood Risk Management Study***
4. ***Flood Risk Management Plan***

The study currently being undertaken addresses steps three and four of the process. The Whites Creek and Johnstons Creek Flood Study was prepared in 2017 by WMAwater for Inner West Council and provides the second step listed above to define the flood behaviour in the Study Area. The Flood Study form the basis of the flood data used for this FRMS&P.

1.2 Study Objectives

The primary objective of this study is to develop a Flood Risk Management Study & Plan that addresses the existing, future and continuing flood problems, considering the potential impacts of climate change, in accordance with the NSW Government's Flood Prone Land Policy and the FRM Manual 2023.

The specific project objectives are to:

- Review the Whites Creek and Johnstons Creek Flood Study (WMAwater 2017) in accordance with the updated requirements of AR&R 2019 and any recent changes in topography in the Study Area;
- Review Council's adopted flood planning area mapping;
- Review the existing emergency response situation and limitations;
- Review effectiveness of current flood management measures;
- Identify floodplain management measures aimed at reducing the social, environmental and economic impacts of flooding and the losses caused by flooding on development and the community, both existing and future;
- Examination of the existing flood warning systems, community flood awareness and emergency response measures in the context of the NSW State Emergency Service's (SES's) developments and disaster planning requirements;
- Reduce the flood hazard and risk to people and property in the existing community and to ensure future development is controlled in a manner consistent with the flood hazard and risk (taking into account the potential impacts of climate change);
- Reduce private and public losses due to flooding; and
- Establish a program for implementation and suggest a mechanism for the funding of the plan which should include funding sources, priorities, staging, funding, responsibilities, constraints, and monitoring.

1.3 Flood Risk Management Principles

Beyond the specific objectives of this study listed above, the FRM Manual 2023 outlines ten (10) principles for flood risk management in NSW:

1. Establish sustainable governance arrangements,
2. Think and plan strategically,
3. Be consultative,
4. Make flood information available,
5. Understand flood behaviour and constraints,
6. Understand flood risk and how it may change,
7. Consider variability and uncertainty,
8. Maintain natural flood functions,
9. Manage flood risk effectively, and,
10. Continually improve the management of flood risk.

The objectives of this study align with these principles, and through the proposed study methodology attempts to account for all of these principles, either directly or indirectly.

1.4 Project Summary

The Whites Creek and Johnstons Creek Flood Risk Management Study and Plan project include the following stages:

- Stage 1 – Data Collection and Review;
- Stage 2 – Additional Data Collection;
- Stage 3 – Community Engagement;
- Stage 4 – Options Identification and Assessment;
- Stage 5 – Draft Flood Risk Management Study and Plan;
- Stage 6 – Public Exhibition of Study and Plan; and
- Stage 7 – Completion of Flood Risk Management Study and Plan.

The Whites Creek and Johnstons Creek Flood Risk Management Study and Plan has been undertaken across five stages, outlined in the sections below:

- Study Area description including topography, flora and fauna, heritage, demographics (**Section 2**);
- Initial data collection and review process including review of the Flood Study model in accordance with the updated analysis of ARR2019 (**Section 3**);
- Summary of the community consultation process (**Section 4**);
- Existing flood risk review including flood planning review (**Section 5**), economic impacts of flooding (**Section 6**), and a flood emergency response review (**Section 7**).
- Summary of flood modification options development and selection of detailed options (**Section 8**).
- Description of detailed assessment of options including modelling, cost estimation, damages benefits and Multi-Criteria Assessment (MCA) (**Section 9**), and implementation program for these detailed options to provide Council guidance on the future implementation of these options (**Section 10**).

2 Study Area Description

2.1 Catchment Background

Johnstons Creek has a total catchment area of approximately 460 ha which drains into Rozelle Bay. The catchment includes suburbs of Newtown, Camperdown, Stanmore, Annandale, Forrest Lodge and Glebe. The catchment area comprises of LGAs under the control of:

- Inner West Council (352 ha); and
- The City of Sydney (108 ha).

Whites Creek has a total catchment area of approximately 262 ha which drains into Rozelle Bay. The catchment includes suburbs of Petersham, Stanmore, Leichardt, Annandale and Lilyfield. It is all contained within the Inner West LGA (formerly Marrickville LGA). The Study Area is wholly urbanised, mostly consisting of residential areas characterised by detached or terraced houses. There are also large open space areas such as Camperdown Park, O'Dea Reserve, Camperdown Memorial Park, Maundrell Park and Weekly Park.

The catchment is highly modified by human activity, with a high proportion of impermeable, hardstand areas. Water drains from the Study Area via council stormwater drainage systems which include covered channels, in-ground pipes, culverts and kerb inlet pits, and via Sydney Water's two major trunk drainage systems, one for each catchment. The trunk drainage systems discharge into Rozelle Bay from a combination of open and covered channels. The Study Area for this FRMS&P, shown in **Figure 2-1**.

2.1.1 History of the Catchment and Flooding

Located in one of the older areas of Sydney, the Study Areas were first settled in the early 19th Century. The original natural drainage system comprised rock gullies draining to small pockets of mangroves along the shoreline at the head of various bays. As development proceeded, the natural drainage lines were subsumed into the constructed drainage system of open channels. Eventually, by the late 19th Century, much of the channel system was progressively covered over and piped, with much of the original system forming the backbone of the present-day stormwater drainage system.

Given the age of the existing stormwater drainage network, there is a prevalence of antiquated drainage systems. In many streets, underground pipe systems do not exist, and in their place are high kerbs and/or dish gutters to convey the stormwater, with minor converter networks only located beneath intersections to carry stormwater below the road at the intersection.

Where there are existing drainage pipelines within the street, many of these pipelines are running at capacity by the 50% AEP and 20% AEP flood events, resulting in high volumes of surface flows. It is further noted that, most of the urban development within the Study Area took place prior to the major and minor drainage system design concept of Australian Rainfall and Runoff (AR&R). The resulting subdivision patterns and housing types has led to a lack of formal overland flowpaths with limited or, in some cases, no opportunity for overland drainage of adjacent low points within the street network. Consequently, many un-drained sag points result in localised flooding.

Historical records indicate flooding within the Johnstons Creek and Whites Creek catchments at many locations for events in excess of the 50% AEP. Some of the major storm events in the catchment include June 1949, November 1961, March 1975, November 1984, January 1991, February 2001, October 2014 and April 2015. Flooding within these catchments is typically dominated by flash flooding, with limited warning times available between the start of rainfall and peak flood depths, with some roads and properties within the lower areas of the catchment becoming cut off or isolated due to rising flood waters.

2.1.2 Topography

The topography of the Johnstons Creek and Whites Creek Study Area is shown in **Figure 2-1**. The Johnstons Creek catchment has a ridgeline that runs along the southern, eastern and western boundaries of around 45 m Australian Height Datum (m AHD) in elevation, which slopes down to low-lying areas in the northern portion that are adjacent to Johnstons Creek with an elevation of approximately 0-5 mAHD.

Whites Creek catchment, to the north-west of the Johnstons Creek catchment, is similar with a ridgeline along the southern, eastern and western boundaries, with the low-lying areas located in the north. The ridgeline along the southern boundary separates the Johnstons Creek catchment from Marrickville Valley catchment.

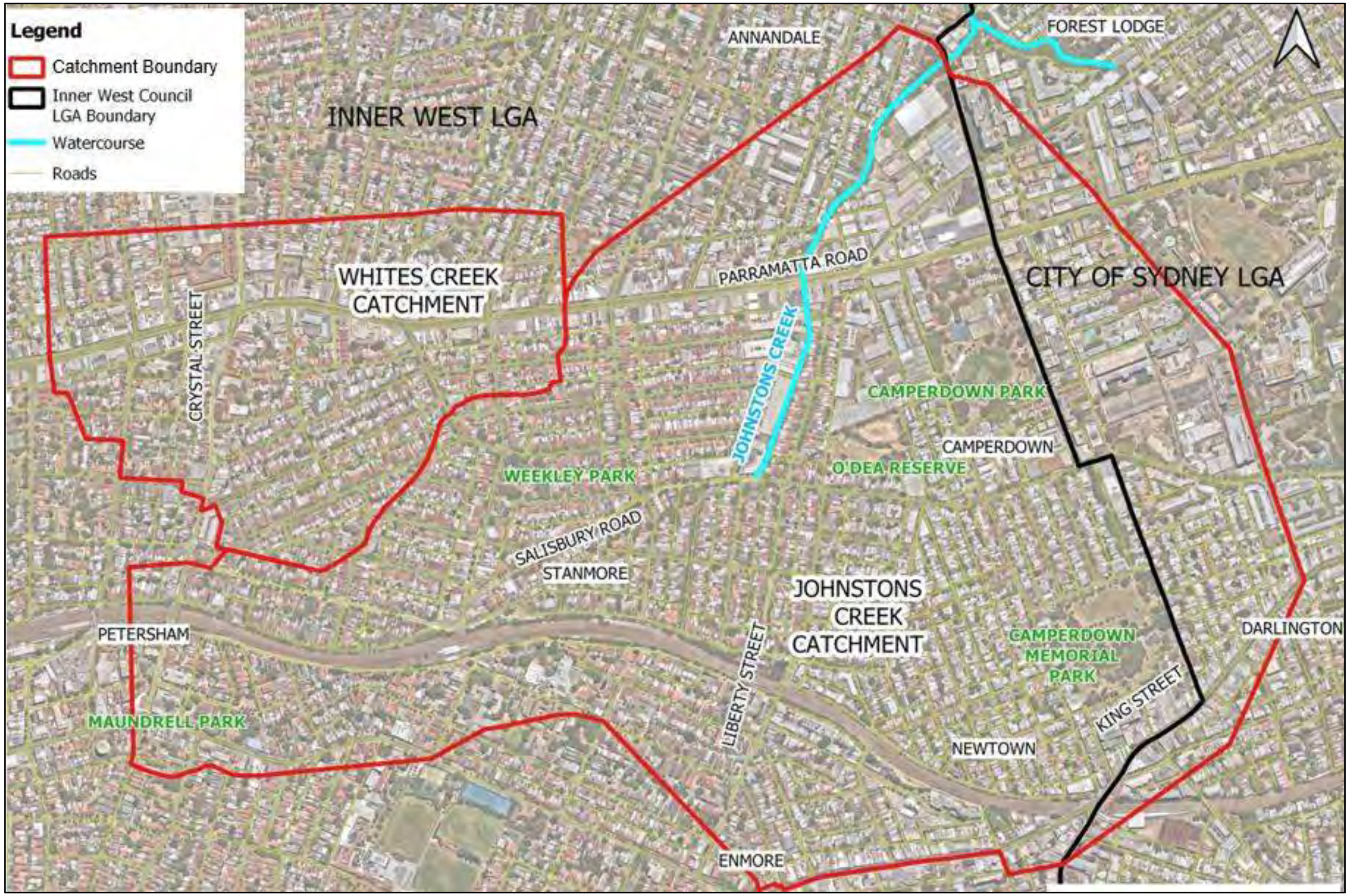

Figure 2-1 Whites Creek and Johnstons Creek Catchment and Study Area

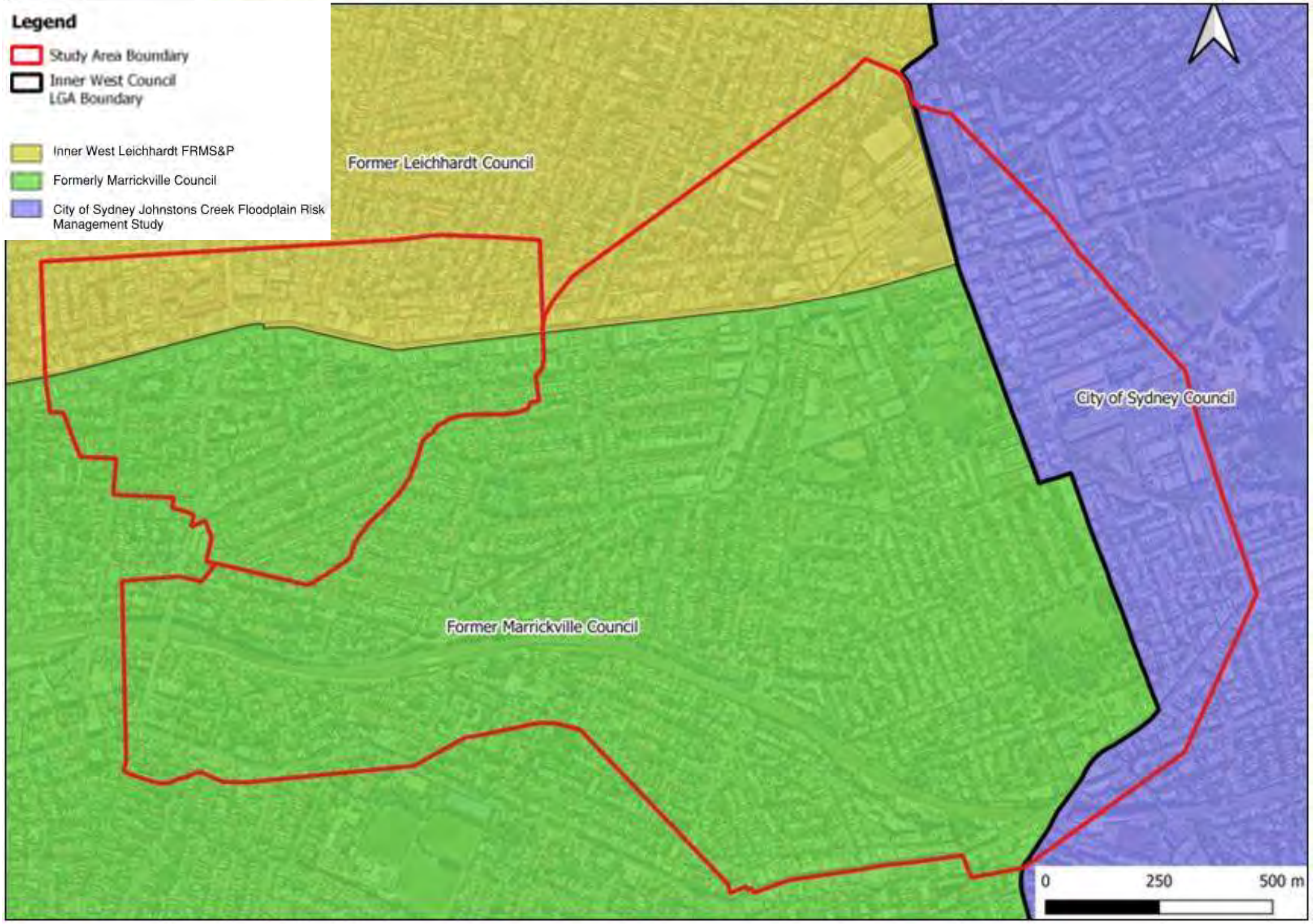
Legend
Study Area Boundary
Inner West Council LGA Boundary
Inner West Leichhardt FRMS&P
Formerly Marrickville Council
City of Sydney Johnstons Creek Floodplain Risk Management Study
Former Leichhardt Council
City of Sydney Council
Former Marrickville Council
0
250
500 m

Figure 2-2 Whites Creek and Johnstons Creek Study Areas Located within the Former Marrickville LGA South of Parramatta Road and West of Mallett Street and Church Street

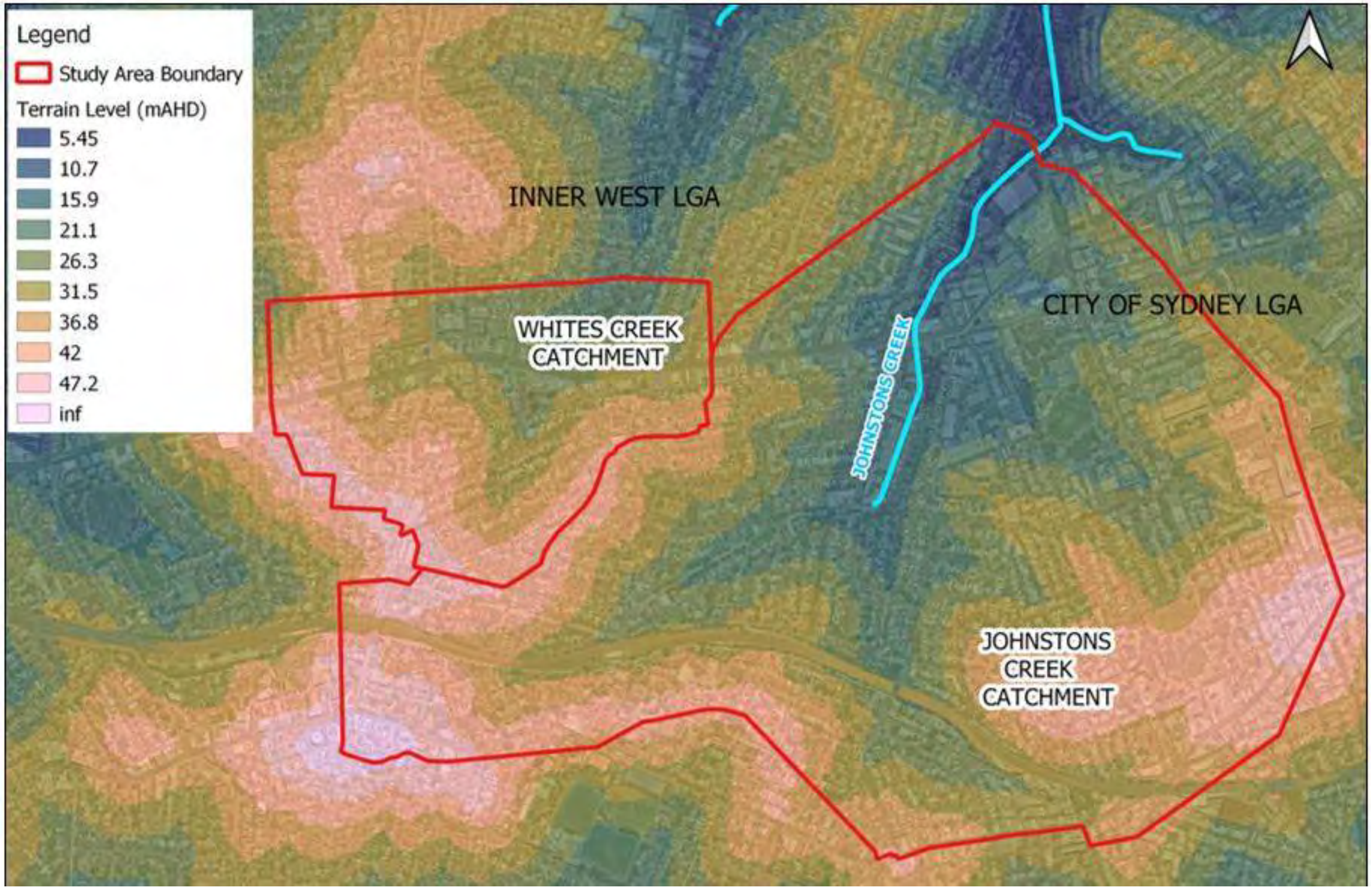

Figure 2-3 Topography of Whites Creek and Johnstons Creek Study Area

2.1.3 Soil Erosion Potential

A review of soil landscapes from eSpade (DPIE, 2021) indicated that the catchment contains two soil landscape groups; Blacktown and Gymea soils. The majority of the Study Area is likely to be underlain by Blacktown soils, which are characterised by shallow to moderately deep red and brown soils on crests, upper slopes and well-drained areas and yellow soils on lower slopes and in areas of poor drainage. Some areas in the northern portion of the Study Area could be underlain by Gymea soils which are characterised by shallow to deep yellow sands on shale lenses.

Blacktown soils are considered to minimal erosion potential as most of the surface is covered by tiles, concrete, bitumen or turf. Soil erosion potential for Gymea soils is high for unsealed surfaces with no stabilising vegetative cover.

2.1.4 Acid Sulfate Soils

Acid Sulfate Soils (ASS) is the common name for soils that contain metal sulfides. The presence of these soils is more likely in low-lying areas of the floodplain. In an undisturbed and waterlogged state, ASS generally pose no or low risk to the environment. However, when disturbed, an oxidation reaction occurs to produce sulfuric acid which can negatively impact the surrounding environment in a number of ways such as a decline in water quality, fish kills and plant death. Sulfuric acid produced by the soils can also corrode and weaken certain structures and building foundations. Part 6.1 of the *Marrickville LEP 2011* outlines general provisions for development near ASS.

Potential ASS within the former Marrickville LGA are classified into five land classes with each land class indicating the depth where potential ASS may occur. Development consent is required for work in those five classes as described in **Table 2-1**.

Table 2-1 Acid Sulfate Soil Land Classes (Source: Marrickville LEP 2011)

Class	Works
1	Any works.
2	Works below the natural ground surface. Works by which the watertable is likely to be lowered.
3	Works more than 1 metre below the natural ground surface. Works by which the watertable is likely to be lowered more than 1 metre below the natural ground surface.
4	Works more than 2 metres below the natural ground surface. Works by which the watertable is likely to be lowered more than 2 metres below the natural ground surface.
5	Works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

2.1.5 Contaminated Land

Contaminated land refers to any land which contains a substance at such concentrations as to present a risk of harm to human or environmental health, as defined in *Contaminated Land Management Act 1997*. Contamination needs to be considered at flood management options development and design stage.

The NSW Department of Planning, Industry and Environment (DPIE) regulates contaminated land sites and maintains a record of written notices issued by the NSW Environmental Protection Authority (NSW EPA) in relation to the investigation or remediation of site contamination. Searches were undertaken of the online Contaminated Land Record and the List of NSW Contaminated Sites notified to the EPA on 18 March 2021. A total of four premises were listed within the Study Area:

- O'Dea Reserve, Salisbury Lane, Camperdown;
- Adjacent to Former Service Station, 79 Wilson Street, Newtown;
- Former Service Station, 81 Wilson Street, Newtown; and
- Aluminium Enterprises, 46 Brocks Lane, Newtown.

The first three of these sites have been formerly regulated under the *Contamination Land Management Act 1997* and the last site has had contamination addressed via the planning process. It is important to note that there are limitations to the registers and there may be contaminated sites that are not listed.

2.2 Threatened Flora and Fauna

A review of DPIE's vegetation mapping for the Sydney Metropolitan Area (NSW OEH, 2016) characterised the vegetation within the Study Area as Urban Exotic / Native (refer **Figure 2-4**). A search of the Australian Department of Agriculture, Water and Environment Protected Matters Search Tool (DAWE, 2021a) for matters listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was undertaken on 17 March 2021 adopting a 5 km buffer. The PMST indicated that ten threatened ecological communities (TECs) are likely to, or may, occur in the area, namely:

- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and SouthEast Queensland ecological community (Endangered under the BC Act and EPBC Act);
- Coastal Upland Swamps in the Sydney Basin Bioregion (Endangered under the BC Act and EPBC Act);
- Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion (Endangered under the BC Act and Critically Endangered under the EPBC Act);
- Eastern Suburbs Banksia Scrub of the Sydney Basin Bioregion (Critically Endangered under the BC Act and Endangered under the EPBC Act);
- River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria (Endangered under the BC Act and Critically Endangered under the EPBC Act); and
- Turpentine-Ironbark Forest of the Sydney Basin Bioregion (Critically Endangered under the BC Act and EPBC Act);
- Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion (Critically Endangered under the BC Act and Endangered under the EPBC Act);
- Shale Sandstone Transition Forest of the Sydney Basin Bioregion (Critically Endangered under the BC Act and EPBC Act);
- Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion (Endangered under the EPBC Act); and
- Western Sydney Dry Rainforest and Moist Woodland on Shale (Endangered under the BC Act and Critically Endangered under the EPBC Act).

A search of the DPIE BioNet database was undertaken to assess the potential for threatened species to occur within the Study Area listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and/or EPBC Act. A total of 97 threatened flora species have been recorded in the LGA, and 108 threatened and migratory fauna sightings have been recorded in the LGA, consisting of:

- Six amphibian species;
- Five reptiles species;
- 70 bird species;
- 23 mammal species;
- Three gastropod species; and
- One insect species.
- Of these, the following species have records in the Study Area:
- *Pteropus poliocephalus* (Grey-headed Flying Fox) listed as vulnerable under BC Act and EPBC Act;
- *Perameles nasuta* (Long-nosed Bandicoot) listed as endangered under the BC Act; and
- *Ptilinopus superbus* (Superb Fruit Dove) listed as vulnerable under the BC Act.

The search identified 21 TECs listed under the BC Act that are known to occur within the LGA, although based on the DPIE vegetation mapping (refer **Figure 2-4**), it is unlikely any of these occur in the Study Area. The potential impacts on vegetation and threatened species that occur or have the potential to occur within the Study Area should be considered in the development and implementation of any proposed flood modifications options or flood protection works.

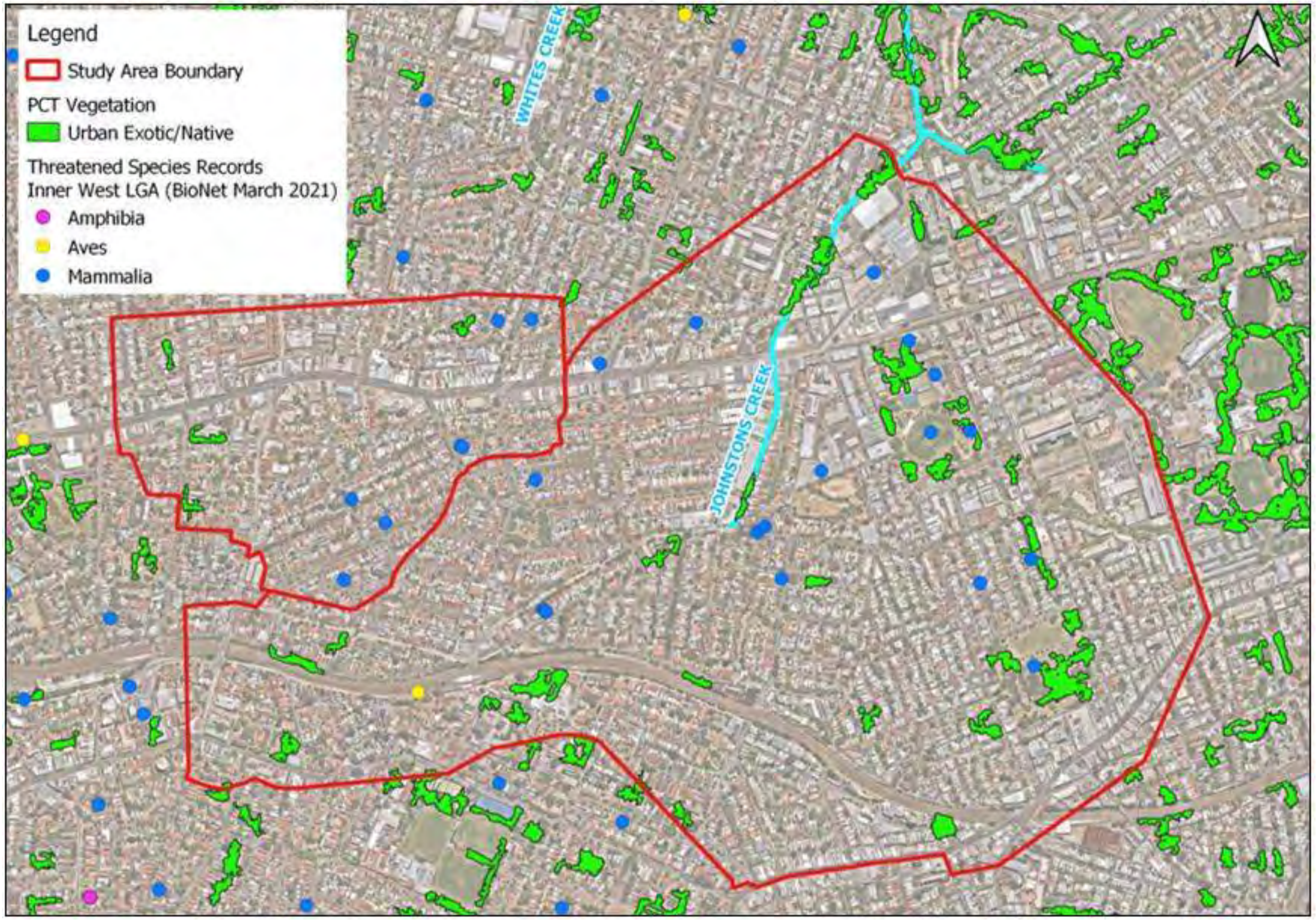

Figure 2-4 Mapping of Whites Creek and Johnstons Creek Biodiversity Constraints

2.3 Heritage

2.3.1 Aboriginal Heritage

Australia contains many different and distinct Aboriginal and Torres Strait Islander groups, each with their own culture, language, beliefs and practices (AIATSIS, 2021). The Inner West LGA is situated on the traditional land of the Gadigal and Wangal peoples of the Eora nation. The Study Area is located on Gadigal land.

A number of sites of Aboriginal archaeological and heritage significance are known (at least one site) are known from the general Study Area based on a search of the Aboriginal Heritage Information Management System. According to the Marrickville Development Control Plan 2011, an Aboriginal Site Survey has identified places of Aboriginal heritage significance with the former Marrickville LGA. Therefore, there is potential for Aboriginal objects to exist across the Study Area even though they have not been formally recorded.

All Aboriginal sites are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and therefore any floodplain management options that have potential to impact on protected sites should be assessed via the Aboriginal cultural heritage due diligence assessment process detailed in the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (DECCW, 2010). Impacts to sites should be avoided in the first instance. In the event a management option would impact an item or site listed under the NPW Act, an Aboriginal Heritage Impact Permit (AHIP) must be sought from DPIE.

In addition, the Marrickville Development Control Plan 2011 outlines provisions and provides guidance on conservation of Aboriginal heritage.

2.3.2 Non-Aboriginal Heritage

Non-Indigenous heritage can be classified into three statutory listing classifications based on significance, namely Commonwealth, State and local. The significance of an item is a status determined by assessing its historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic value.

A desktop review of non-Aboriginal heritage was undertaken for the Inner West LGA. Searches were undertaken of the following databases:

- Australian Heritage Database which incorporates World Heritage List; National Heritage List; Commonwealth Heritage List (DAWE, 2021b);
- State Heritage Register (DCCEW, 2021b); and
- Local Council Heritage as listed on the *Marrickville Local Environmental Plan 2011* (Marrickville Council, 2011a).
- Based on a search of the State Heritage Register (DPIE, 2021) a total of 55 items were found in the IWC LGA were identified as being listed under the NSW *Heritage Act 1977*, with an additional 29 identified as being listed by Sydney Water under Section 170 of the Act. One state heritage items have been identified to be within the Study Area:
- Stanmore Railway Station Group (SHR no. 01251 and Marrickville LEP I248).

There are more than 300 items of local significance and 36 Heritage Conservation Areas listed on the *Marrickville Local Environmental Plan 2011*, with numerous items within the Study Area.

Where it is proposed to undertake works that either directly or indirectly impact on a locally listed heritage item or site, the proponent must refer to the *Marrickville Local Environmental Plan 2011* and Part 8 of the *Marrickville Development Control Plan 2011* for heritage provisions and development guidelines relating to locally listed heritage items.

Figure 2-5 shows Whites Creek and Johnstons Creek Heritage Constraints.

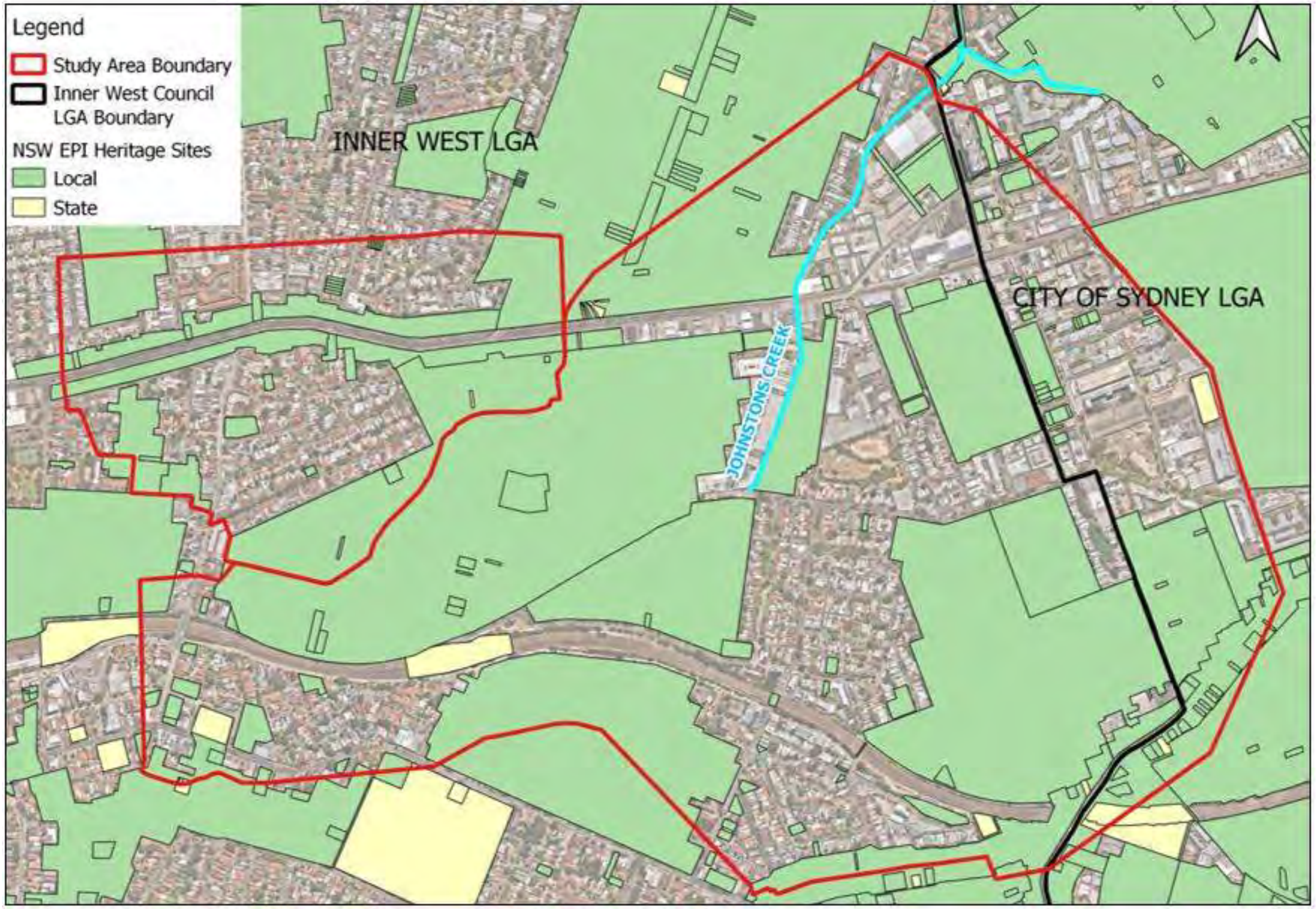

Figure 2-5 Mapping of Whites Creek and Johnstons Creek Heritage Constraints

2.4 Demographic Profile

Knowledge of the demographic character of an area assists in the preparation and evaluation of floodplain management options that are appropriate for the local community. For example, in the consideration of emergency response or evacuation procedures, information may need to be presented in a range of languages and/or additional arrangements may need to be made for less mobile members of the community who may not be able to evacuate efficiently.

Demographic data for the Marrickville and Camperdown area, sourced primarily from the Australian Bureau of Statistics (ABS), was reviewed to gain an appreciation of the social characteristics of the area. The most recent Australian Census was undertaken by ABS in 2016, so this data has been used in the assessment.

The Study Area comprises the Marrickville, Sydenham and Petersham Statistical Area 3 (SA3) and Newtown, Camperdown, Darlington Statistical Area 2 (SA2). All, or part, of the following suburbs are located within the Study Area:

- Enmore;
- Newtown;
- Stanmore;
- Camperdown;
- Petersham;
- Lewisham; and
- Annandale.

Census data showed that the population of the Marrickville, Sydenham and Petersham SA3 in 2016 was approximately 54,609, with a median age of 35 years, which is lower than the median for NSW (38 years). Approximately two thirds of the people living in the Marrickville area are aged between 15-54 years, which suggests that the community is likely to be generally able-bodied and able to evacuate effectively. However, very young children (0-4 years) and the elderly (>75) make up approximately 11% of the population (approximately 5,900 people) so it is important to consider these members of the community in flood risk management planning.

Census data showed that the population of the Newtown, Camperdown and Darlington SA2 in 2016 was approximately 24,839, with a median age of 30 years, which is lower than the median for NSW (38 years). Approximately 80% of the people living in the Camperdown SA3 area are aged between 15-54 years, which suggests that the community is likely to be generally able-bodied and able to evacuate effectively. However, very young children (0-4 years) and the elderly (>75) make up approximately 6% of the population (approximately 1,445 people) so it is important to consider these members of the community in flood risk management planning.

English was the only language spoken in nearly two-thirds (62%) of homes in the Marrickville SA3. Other languages spoken at home included Greek (5.2%), Vietnamese (4.6%), Arabic (1.9%), Portuguese (1.9%) and Cantonese (1.7%). English was the only language spoken in nearly two-thirds (68%) of homes in the Camperdown SA3. Other languages spoken at home included Mandarin (6.6%), Cantonese (1.6%), Spanish (1.2%), Greek (1.2%) and French (0.9%). This suggests that language barriers (e.g. during evacuation, or for flood education) have the potential to be an issue for some households. The inclusion of multi-lingual brochures and personnel may be required in this instance.

Consideration of house prices in Newtown, Camperdown, Stanmore, Annandale and Petersham may assist in the calculation of economic damages incurred during a flood event. According to data from realestate.com.au (realestate.com.au, 2021) the average median property prices across the Study Area are approximately $1,615,000 for houses and $785,000 for units.

3 Review of Available Data

3.1 Whites Creek and Johnstons Creek Flood Study

The Johnstons Creek and Whites Creek Flood Study was completed in 2017 on behalf of Inner West Council formerly Marrickville Council by WMAwater. The Flood Study defined flood behaviour in the catchment for the 50%, 20%, 10%, 2% and 1% Annual Exceedance Probability (AEP) design storms, and the Probable Maximum Flood (PMF). The 2017 Flood Study modelling forms the basis for this Flood Risk Management Study. Further details on the hydrological and hydraulic modelling approaches are discussed below.

3.1.1 Flood Study Approach

Hydrological models were built in DRAINS for each catchment to create flow boundary conditions for input into the hydraulic (TUFLOW) model by using design rainfall patterns specified in AR&R 1987 to produce runoff hydrographs.

The Johnstons Creek model included 240 sub-catchments with an average size of 1.1 ha for a total area of 2.5 km^2, while the Whites Creek model included 48 catchments with an average size of 1.5 ha for a total area of 0.7 km^2. Impervious surface area was determined based on the proportion of sub-catchment area allocated to a number of land use categories, with each category having an estimated impervious percentage based on aerial observation of a representative area. Rainfall losses were modelled using the Horton loss method – with an initial loss of 1.0 mm and a continuing loss of 5.0 mm were adopted.

Comparison with a DRAINS model of the nearby Rose Bay Catchment from a previous study was undertaken to verify the hydrological models. Specific yield (peak discharge divided by upstream catchment area) comparison was undertaken and the Johnstons Creek and Whites Creek catchment models were found to have comparable yields.

The availability of high-quality LIDAR data meant that the Study Area was suitable for 2D hydraulic modelling to assess flood behaviour, with the TUFLOW package being adopted in this case due to wide acceptance in Australia and to ensure consistency with other flood studies previously completed within the (former) Marrickville Council LGA. A separate TUFLOW model was prepared for Johnstons Creek and Whites Creek. The hydraulic models use the runoff hydrographs from the hydrology model as boundary conditions in order to provide estimates of flood depths, velocities and hazard within the Study Area. The models were used to define flood behaviour for the 50%, 20%, 10%, 5%, 2% and 1% AEP flood events and the Probable Maximum Flood (PMF).

The TUFLOW model boundaries are shown in **Figure 2-1**. The TUFLOW model boundary includes the eastern portions of Johnstons Creek catchment, however as these are part of City of Sydney LGA, these areas are not included in the Study Area and will not be considered for flood mitigation options. The Johnstons Creek 2D model had a total area of 2.6 km^2, being approximately bounded at four corners by Missenden Street to the east, Enmore and Stanmore Roads to the south, the Booth St / Mallet St intersection to the north, and Crystal St to the West. The Whites Creek 2D model had a total area of 0.6 km^2 and is approximately bounded by Lorna Lane to the south, and extends to the north an additional 250m past the Study Area boundary of Parramatta Road to include portions of the downstream catchment.

A grid with 2 m by 2 m cell size was adopted for both models in order to provide sufficient detail for roads and overland flow paths. The grid sampled terrain from a 1 m by 1 m DEM generated from LIDAR data (see **Section 3.2** for further discussion). For inflows, local runoff hydrographs were extracted from the DRAINS model and applied to the 2D domain of the TUFLOW model at the downstream end of the sub-catchments. A height versus time boundary was applied to the downstream boundaries (located north of Paramatta Road) of both models to both the 1D and 2D domain.

Roughness coefficients for different flow paths were adopted based on site inspection and correspondence to similar environments, and consistency with ARR 2016 revision guidelines. Buildings and other structures were incorporated into the models based on footprints derived from aerial photography, and modelled as flow path obstructions, while bridges were modelled as 1D features within open channels. All pipes equal to or smaller than 300mm in diameter were assumed to be fully blocked and not included in the Flood Study model. The catchment drainage systems defined in each model included 652 pipes, 659 pits / nodes, and 111 open channel segments for Johnstons Creek, and 114 pipes and 120 pits / nodes for the Whites Creek model.

The joint hydrologic / hydraulic model was calibrated based on the 25th April 2015 event by comparing flood affectation at various locations based on photographs acquired from community consultation and council database flooding complaints. The model was found to effectively replicate some degree of flood affectation at the locations. Comparison was also carried out with previous studies for verification purposes.

Sensitivity analyses were conducted for the 1% AEP and 5% AEP models based on hydrologic routing lag, Manning's roughness values, pipe blockage, and climate change both rainfall increase (10%, 20%, and 30%).

Design storm result analysis and mapping included peak depths, levels and velocities. The analysis also included a pipe capacity assessment. In addition, the 20% AEP, 5% AEP, 1% AEP and PMF events also had provisional hydraulic hazard, hydraulic categorisation (floodway, flood storage, and flood fringe) and the 1% AEP and PMF events also had flood emergency response classifications.

A provisional Flood Planning Area (FPA) and Flood Control Lot tagging was conducted for the Study Area. The report also briefly summarised the relevant flood development controls for the Study Area.

Eleven flooding hotspots were identified in the Flood Study, 10 within Johnstons Creek and one within Whites Creek which were:

- Hotspot 1 – Parramatta Road, Bridge Road and Cardigan Street, Stanmore;
- Hotspot 2 – Salisbury Road near Stafford Street, Stanmore;
- Hotspot 3 – Salisbury Road, Camperdown;
- Hotspot 4 – Mallett Street, Fowler Street and Gibbens Street, Camperdown;
- Hotspot 5 – Cardigan Street, between Salisbury Road and Railway Avenue, Stanmore;
- Hotspot 6 – Liberty Street, Bedford Street and Railway Avenue, Stanmore;
- Hotspot 7 – Lennox Street and Australia Street, Newtown;
- Hotspot 8 – Trafalgar Street near Crammond Park, Petersham;
- Hotspot 9 – Probert St and Probert Ln (near St Marys St), Newtown;
- Hotspot 10– Australia St and Denison St (near Camperdown Park), Camperdown; and
- Hotspot 11 – Parramatta Road near Phillip Street, Stanmore (Whites Creek catchment).

Refer to **Section 7.5** for maps of the hotspot locations.

3.1.2 Flood Study Data Provided

As part of project inception, Inner West Council provided Stantec with the following data related to the Johnstons Creek and Whites Creek Flood Study (WMAwater, 2017):

- LIDAR data collected in 2013 and obtained from the Land and Property Information (LPI) division of the NSW Government Department of Finance, Services and Innovation. Open water and vegetation also tend to affect the accuracy of LIDAR data. A 1 m x 1 m Digital Elevation Model (DEM) was constructed from the LIDAR to form the basis of the TUFLOW model; and
- Ground and floor level survey at select locations from the previous Whites Creek, Johnstons Creek North, Johnstons Creek South (Dalland and Lucas, 1996, 1998 and 1999) and Johnstons Creek West (Stantec, 2008) studies were used to verify the LIDAR data and was found to have an average elevation difference of 0.01 m in the Johnstons Creek catchment and -0.02 m in the Whites Creek catchment.
- In addition to these Flood Study model terrains, Stantec sourced several other LiDAR and DEM datasets for this study. Detailed review of the following LiDAR sources has been conducted (refer to **Section 3.6.2**):
- LiDAR points provided by Council from an unknown source and date covering part of the Study Area;
- The ELVIS - Elevation and Depth - Foundation Spatial Data website was accessed with two datasets available from the website. The files appear to have been recorded on the following dates:
    - 2013-04-10 – 1m x 1m ASC grid data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA94 and MGAz56; and
    - 2020-05-10 - 1m x 1m TIFF data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA2020 and MGAz56.

3.2 Survey Information

The Flood Study model (WMAwater, 2017) was constructed utilising the following available data:

- LIDAR data collected in 2013 and obtained from the Land and Property Information (LPI) division of the NSW Government Department of Finance, Services and Innovation. Open water and vegetation also tend to affect the accuracy of LIDAR data. A 1 m x 1 m Digital Elevation Model (DEM) was constructed from the LIDAR to form the basis of the TUFLOW model; and
- Ground and floor level survey at select locations from the previous Whites Creek, Johnstons Creek North, Johnstons Creek South (Dalland and Lucas, 1996, 1998 and 1999) and Johnstons Creek West (Stantec, 2008) studies were used to verify the LIDAR data and was found to have an average elevation difference of 0.01 m in the Johnstons Creek catchment and -0.02 m in the Whites Creek catchment.
- In addition to these Flood Study model terrains, Stantec sourced several other LiDAR and DEM datasets for this study. Detailed review of the following LiDAR sources has been conducted (refer to **Section 3.6.2**):
- LiDAR points provided by Council from an unknown source and date covering part of the Study Area;
- The ELVIS - Elevation and Depth - Foundation Spatial Data website was accessed with two datasets available from the website. The files appear to have been recorded on the following dates:
  - 2013-04-10 – 1m x 1m ASC grid data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA94 and MGAz56; and
  - 2020-05-10 - 1m x 1m TIFF data set in 2km x 2km with an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal in GDA2020 and MGAz56.

3.3 GIS Data

As part of project inception, Inner West Council provided Stantec with the following GIS data for the study:

- Local Environment Plan (LEP) land use zone mapping and Acid Sulfate Soil (ASS) layer;
- LGA Boundary layer;
- LiDAR data from an unknown source and date covering part of the Study Area;
- Stormwater pit and pipe network;
- State Environmental Planning Policy (SEPP) 2016 Coastal Management layer; and
- Aerial imagery from an unknown source and date.

Aside from these GIS layers, provided by Council during the early stages of the project, various other publicly available GIS layers were sourced by Stantec for this study including high quality aerial imagery from NearMap (2021) recorded at various periods for the Study Area and its surrounds. This aided in not only providing details about the current site, but also the historical site at the time of the Flood Study. Another example is the various flora and fauna and heritage GIS databases described in **Section 2**.

3.4 Site Inspection

Site inspections of the Study Area were conducted by Stantec representatives on 12 May 2021. In total, 33 different sites within the Study Area were visited, all in areas identified as flood affected based on Flood Study outcomes. The location of the sites visited is shown in **Figure 3-1**. The site visits provided the opportunity to review the following:

- Review flood hotspots identified in the Flood Study (WMAwater, 2017), and the flood study model results compared to the observed topography and layout of the site;
- Review of site layouts and the elevations of floor levels for buildings in the vicinity of flooded areas to help inform the development of a floor level survey scope;
- Noting of the current development of the Study Area with some of the changes in sites discussed further in **Section 3.6.2** and **Section 3.6.3**; and
- Initial review of opportunities and constraints for potential future flood mitigation options.

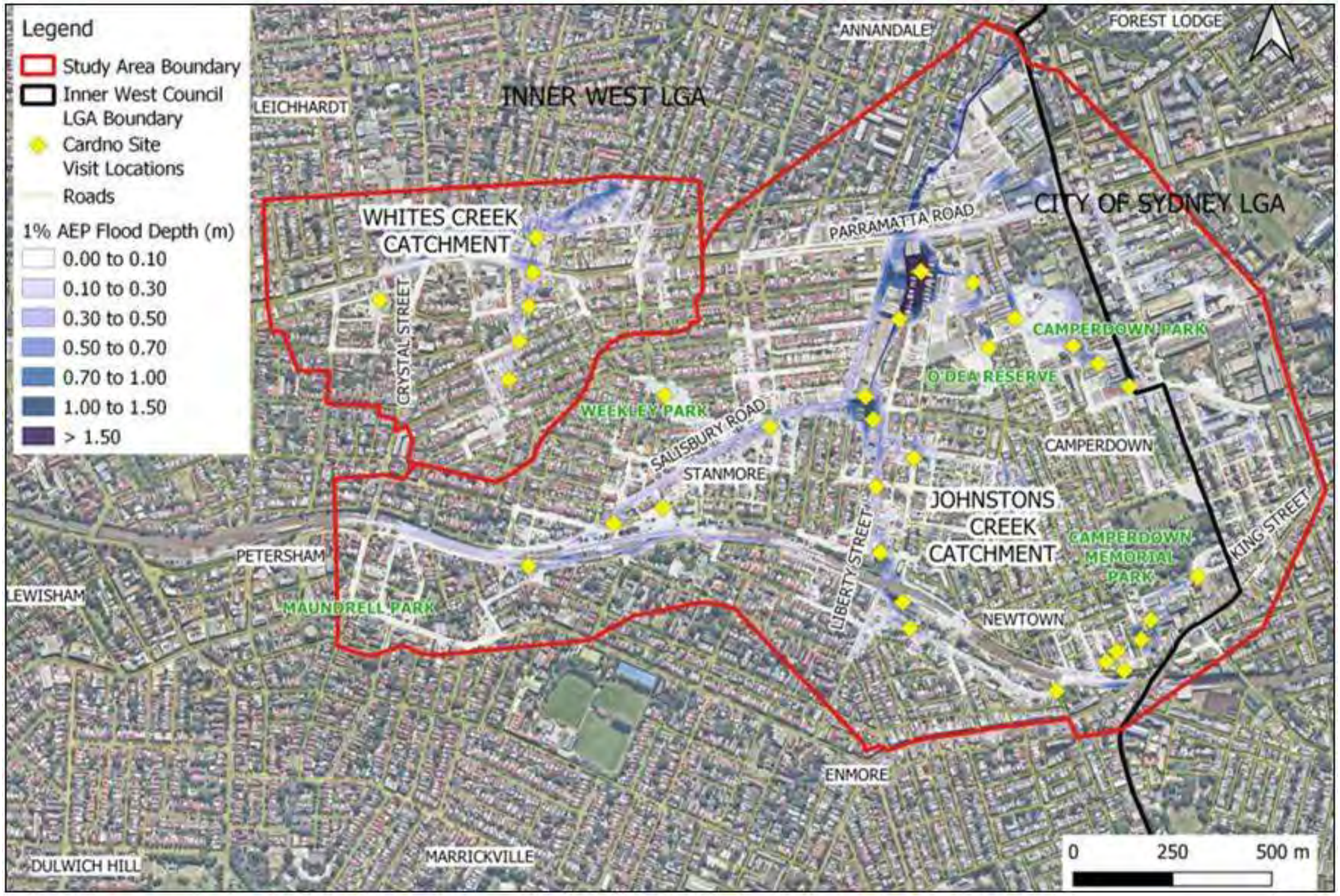

Figure 3-1 Site Locations for Whites Creek & Johnstons Creek Study Area Visited by Stantec on 14/05/2021, with Underlay of Peak 1% AEP Depth Results from the Flood Study (WMAwater, 2017)

3.5 Floor Level Survey

Floor level survey was prepared for the Whites Creek and Johnstons Creek catchment as part of this Study. In total, 403 floor levels were surveyed. For flood affected buildings that did not have surveyed levels from the survey, floor levels were estimated as discussed further in **Section 6.2.3**.

3.6 Flood Study Model Review and Update

Since the completion of the Johnstons Creek and Whites Creek Flood Study in 2017, several developments have occurred in both floodplain management guidance and standards and in the Study Area itself. These changes have the potential to impact the suitability of the Flood Study model in accurately representing the Study Area and its flood behaviour. Therefore, in order to confirm the potential impacts of these changes, a model review process has been conducted accounting for these changes in updated 1% AEP and 5% AEP models. The following model updates were included in this review process:

- Adoption of the AR&R 2019 design rainfall method as opposed to the AR&R 1987 method adopted in the Flood Study model;
- Updates to the model topography to reflect development and changes in the Study Area post-2013; and,
- Updates to the model building polygons to reflect development and changes in the Study Area post-2013.

These updates are detailed further in the following sections with model outcomes from this review discussed in **Section 3.6.4**.

3.6.1 AR&R 2019 Design Rainfall Update

3.6.1.1 Background

An important change has occurred in the development of flood estimation in Australia, with the release of Australian Rainfall and Runoff 2016 (AR&R 2016). On 25 November 2016, Geosciences Australia announced that:

> *The AR&R 2016 Guidelines have now been officially finalised, providing engineers and consultants with the guidance and datasets necessary to produce more accurate and consistent flood studies and mapping across Australia, now and into the future.*

Following this, the AR&R 2019 update was released which included minor updates to AR&R 2016 without changes to the edition. There are specific changes to the methodology for estimation of flood behaviour compared to the AR&R 1987 methodology that was adopted in the Whites Creek and Johnstons Creek Flood Study (WMAwater, 2017). These include:

- Rainfall – the Bureau of Meteorology (BoM) has re-analysed all the Intensity-Frequency-Duration (IFD) parameters across Australia, incorporating 30 further years of data and many more rainfall stations. The method of derivation has also changed, meaning the previously used IFD coefficients have been updated. It is also noted that the standard reporting for storm duration has been reduced;
- Design Storms – AR&R 2019 recommends the utilisation of a suite of design rainfall temporal patterns, with ten patterns for each Annual Exceedance Probability (AEP) and duration of event;
- Storm Loss Rates – AR&R 2019 recommends the use of initial and continuing loss rates for design storms, and is no longer recommending the use of runoff coefficients for hydrological modelling. The loss rates provided are also for the entire storm, as opposed to the burst losses adopted in AR&R 1987; and
- Storm Loss Rates – AR&R 2019 provides for the use of three types of area when assessing loss rates - directly connected impervious areas, indirectly connected impervious areas and pervious areas. The document also provides guidance as to the calculation of these areas.

3.6.1.2 Design Rainfall Update

In AR&R 1987, there was a single temporal pattern defined for each storm burst duration of interest. This limited the number of runs required to identify the critical storm burst duration within a catchment. In AR&R 2019, ten temporal patterns are provided for each storm burst duration.

As part of this model review, all ten temporal patterns were run for each storm burst duration and the median peak flow was determined at each location of interest. It is noted that this requires a ten-fold increase in hydrological assessments to identify the critical storm burst duration, which may vary depending on location within the catchment. Furthermore, no single temporal pattern will give the median peak flow and that rather the temporal pattern (which gives the peak flow closest to, but higher than, the median flow) has been adopted for assessment purposes.

As part of this model review, the DRAINS model from the Johnstons Creek and Whites Creek Flood Study was updated to AR&R 2019 rainfall for the 1% AEP (1 in 100 year), and 5% AEP (1 in 20 year) events. Two DRAINS models were prepared as part of the Flood Study, one for Johnstons Creek and one for Whites Creek.

For the Johnstons Creek model, for the 1% AEP and 5% AEP, all ten temporal patterns were prepared for the 20, 30, 45, 60, and 90 minute storms. Compared to the AR&R 1987 critical duration of 60 minute, these modelled durations provided sufficient scope to encompass any potential shift in critical duration as part of the AR&R 2019 update.

For the Whites Creek model, the smaller catchment size means that the AR&R 1987 has a relatively shorter critical duration of 20 minutes. For the 1% AEP and 5% AEP all ten temporal patterns were prepared for the 10, 20, 30, and 45 minute storms. Due to the expected shorter critical duration for this catchment these modelled durations provided sufficient scope to encompass any potential shift in critical duration as part of the AR&R 2019 update.

3.6.1.3 Review of Rainfall Loss Approach

AR&R 2019 recommends the use of the initial / continuing loss approach, whereas the Flood Study model used Horton Loss model which is the default loss model for DRAINS with ILSAX hydrology. Stantec conducted a review of the adopted Horton losses from the Flood Study compared to an equivalent initial / continuing loss approach as recommended in AR&R 2019.

The equivalent initial / continuing losses suitable for the Study Area were concluded to be:

- 1% AEP – initial loss 6.4 mm and continuing loss 0.7mm / hour;
- 5% AEP - initial loss 8.5 mm and continuing loss 0.7mm / hour.

The losses were adopted using the Antecedent Moisture Condition (AMC) of 3.0 as adopted in the Flood Study model. In addition, a sensitivity check to an AMC of 3.5 was conducted. The outcomes of the total loss comparison showed for both AMC 3.0 and 3.5 total losses are similar for the shorter durations such as the 10 and 20 minute events. However, as the burst duration increases the Horton Losses becomes higher than that estimated by the Initial-Continuing loss model.

Nevertheless, the comparison shows that the choice of loss model is unlikely to make a significant difference to model results the critical duration was assumed to be relatively short, the catchments are highly impervious so rainfall losses have less affect, and the rainfall excess is much higher than the losses for the 5% & 1% AEP events.

Therefore, the Horton loss curves from the Flood Study model were retained within the review models.

3.6.1.4 Review of Other Model Assumptions

Stantec also conducted a high-level review of other Flood Study model components. It was found that the model set-up was generally appropriate including surface roughness, impervious percentage, and pit and pipe modelling. For time of concentration calculation, the Kinematic Wave equation was adopted which is generally not typically utilised for large, piped catchments, however as calculated travel times are in the appropriate range, this was not considered a concern.

3.6.2 Topography Review and Update

Since the Flood Study model was completed, the catchment has undergone a substantial amount of change and development. As covered in **Section 3.2**, the Flood Study model terrain was based on LiDAR data recorded in 2013, sourced from the ELVIS website from 10 April 2013. A review was undertaken to assess the adequacy of the model terrain by comparing to newer LiDAR data collected May 10, 2020 sourced from the ELVIS website (refer to **Section 3.2** for further details).

Comparing the Flood Study model terrain to the newer DEM showed that the terrain differences between 2013 and 2020 data are largely within +/- 0.2 metres outside of building footprints, with some notable exceptions where significant development has occurred. A comparison of Flood Study model terrain and 2020 LiDAR data is included in **Figure 3-2**.

For Johnstons Creek & Whites Creek Study Area the significant terrain differences outside of building footprints appear to be:

- The 2020 data appears to have the bridge over the railway line at Newtown train station. As the bridge would present a negligible flow restriction, it is suitable for the railway line be modelled in the 2D domain of the model and the bridge structure over the highway was disregarded. This was the approach adopted within the Flood Study model therefore no change to the model terrain was required;
- There are narrow sections of significant differences along the perimeters of the rail corridor. Council had noted that there has not been any major recent works along this corridor to suggest these differences reflect changes in topography from 2013 to 2020. Therefore, these differences are presumably due to slight spatial misalignments in the data sets with the steep sides of the corridor resulting in differences. It is not clear upon review that either the 2013 or 2020 are particularly misaligned along this rail corridor more than the other;
- It also appears that the elevated Stanmore station platform has been recorded in the 2013 LiDAR but not the 2020 LiDAR, as this is a solid, permanent structure the 2013 LiDAR is better in this instance; and
- There are significant differences for a site north of Parramatta Road near the corner of Alexandra Drive and Booth Street due to a new building on this site (discussed further in **Section 3.6.3**).

Therefore, it appears there are only minor terrain differences from 2013 to 2020 LiDAR within the Johnstons Creek and Whites Creek Study Area due to development or alteration of sites over that period. It appears that significant terrain differences between the two data sets can be explained by slight misalignment and recording differences, with no clear indication that the 2013 data is in poorer condition than the 2020 data.

As it is not clear that the 2020 terrain provides better accuracy than the 2013 terrain, the Flood Study model terrain was thus retained in the updated Flood Study Model for Johnstons Creek and Whites Creek Study Area.

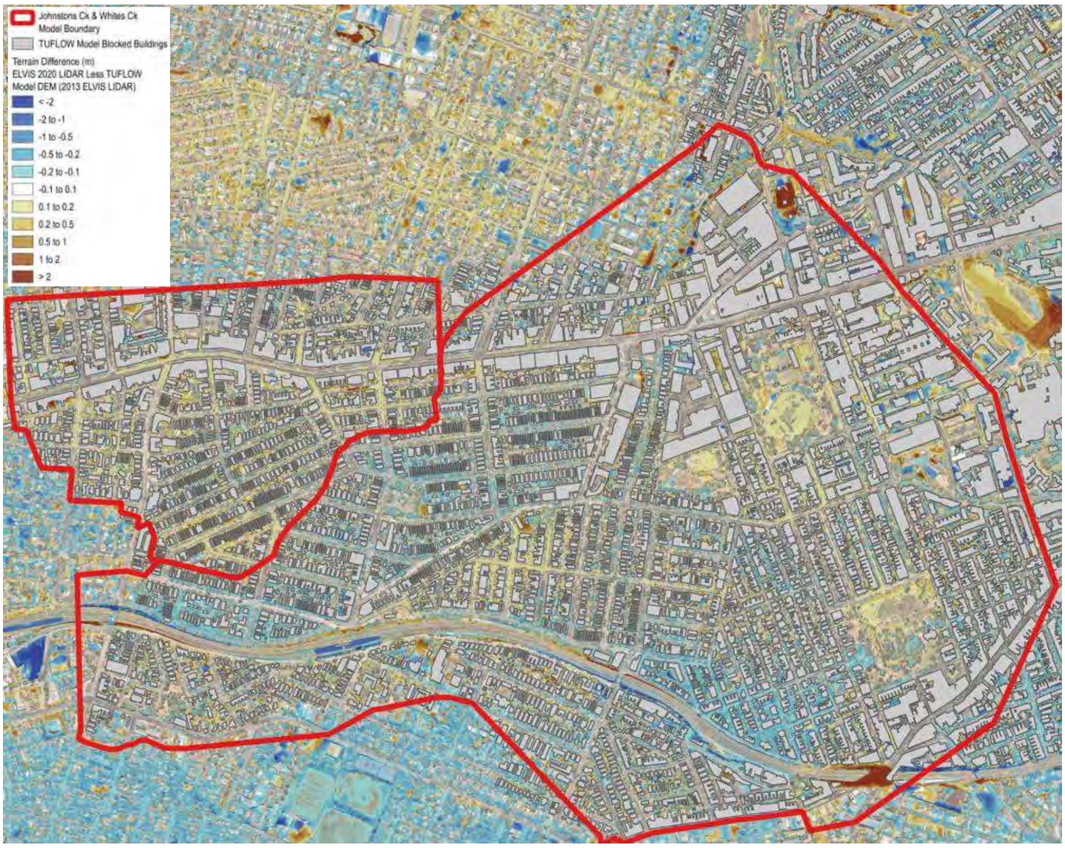

Figure 3-2 Terrain Differences - 2020 LiDAR Less 2013 LiDAR Used in the Whites Creek and Johnstons Creek Flood Study with Labels of Key Sites

3.6.3 Model Building Polygon Review and Update

The Johnstons Creek and Whites Creek Flood Study model assumed full blockage of building footprints by removing building polygons from the 2D terrain of the model. Generally, this approach is considered appropriate. A review was conducted of building footprints from the Flood Study TUFLOW model and more recent 2020 Geoscape building footprints provided by DCCEW, offering a detailed and more up-to-date dataset. Review of the building polygons layer showed that in most instances the polygons align with buildings shown in the aerials, but there were particular instances where this is not the case.

There are presumably two reasons for building polygons not matching building locations in latest available aerials:

> The base data used in the model building polygon layer did not include some areas. The main example of this is where an area of historical buildings along Susan Street in the northern reaches of the Johnstons Creek Study Area have not been included in the polygon layer, presumably because data was not available at this location. Review of the model set-up and results suggest these buildings are only on the fringe of the Johnstons Creek floodplain, however they have been added to the updated model;

> There has been development since the Flood Study with new or removed buildings in the area. Instances of potential new buildings and extended buildings in Johnstons Creek and Whites Creek that have been added to the updated model include:

  - A new building was constructed on a site north of Parramatta Road near the corner of Alexandra Drive and Booth Street. This site is outside the main flood extents but near an overland flow inflow point, though flows do not interact with the site significantly. Nevertheless, the polygon was added to the model;
  - A new building complex has been constructed on the west side of Camperdown Park oval which was added to the updated model;
  - There has been significant redevelopment of sites associated with Royal Alfred Hospital. These sites are within City of Sydney LGA however had potential to alter overland flow downstream within the Inner West LGA, therefore these changes were added to the updated model;
  - In the centre of the Whites Creek catchment just south of Parramatta Road in the middle of the flowpath, an existing car dealership building was expanded. The previous flowpath underneath the building (8m x 0.6m) has been retained in the new building as confirmed on review of design plans for the development approval. This building polygon in the model was expanded;
  - A building fronting Parramatta Road on the north side has been removed in Whites Creek catchment; and
  - Other minor redevelopment sites that are in the floodplain throughout both catchments have been added in such as garages and new and altered building footprints. These site changes were reviewed using latest available aerial imagery compared to historical aerials from the time of the Flood Study.

3.6.4 Model Review Results – Johnstons Creek

The model updates discussed in the above sections were incorporated into a Johnstons Creek review model for the 1% AEP and 5% AEP events, with the outcomes of this modelling summarised in the following sub-sections.

3.6.4.1 Critical Duration

For both the 1% AEP and 5% AEP events, all ten temporal patterns were prepared for the 20, 30, 45, 60, and 90 minute storms. Of the ten temporal patterns for each duration, the median pattern was selected for each duration, and then these duration median results were combined to create the peak flood results. The critical durations for the 1% AEP and 5% AEP from the updated modelling is shown in **Figure 3-3** and **Figure 3-3** respectively.

The critical duration for the majority of the Study Area is the 30 minute storm for the 1% AEP, and the 45 minute for the 5% AEP. For some disconnected ponding areas and for the downstream portion of the Study Area north of Parramatta Road the longer duration storms are critical. Compared to the Flood Study AR&R 1987 critical duration of 60 minute, the shorter critical duration for AR&R 2019 is in keeping with Stantec's past experience on updates to AR&R 2019 where the critical duration has been found to almost always shortens.

3.6.4.2 Peak Water Level Differences

A comparison of peak water level differences for the updated AR&R 2019 model compared to the Flood Study AR&R1987 model for the 1% AEP and 5% AEP from the updated modelling is shown in **Figure 3-5** and **Figure 3-6** respectively.

The results show that throughout the Study Area, the proposed revision to AR&R 2019 has resulted in reductions in peak water level results for both the 1% AEP and 5% AEP throughout the Johnstons Creek catchment. These reductions in peak water level results are in keeping with Stantec's past experience on updates to AR&R 2019, where the severity of peak flooding was almost always reduced as a result of AR&R 2019 updates.

Water level reductions from the Flood Study results are not significantly different for the majority of the Study Area, typically anywhere from -0.01 metres to -0.2 metres for both the 1% AEP and 5% AEP events. The section of Johnstons Creek south of Parramatta Road has more significant reductions of greater than 0.5 metres. It is expected that this is due to this location being the confluence of most runoff from the site resulting in the reductions being more pronounced at this location.

The terrain and building polygon changes do not result in any significant areas of water level increases, the only example is in the immediate vicinity of the new building west of Camperdown Park oval where there are minor localised increases. Therefore updated model results suggest that site changes post-2013 do not have a significant impact on flood behaviour within the Study Area.

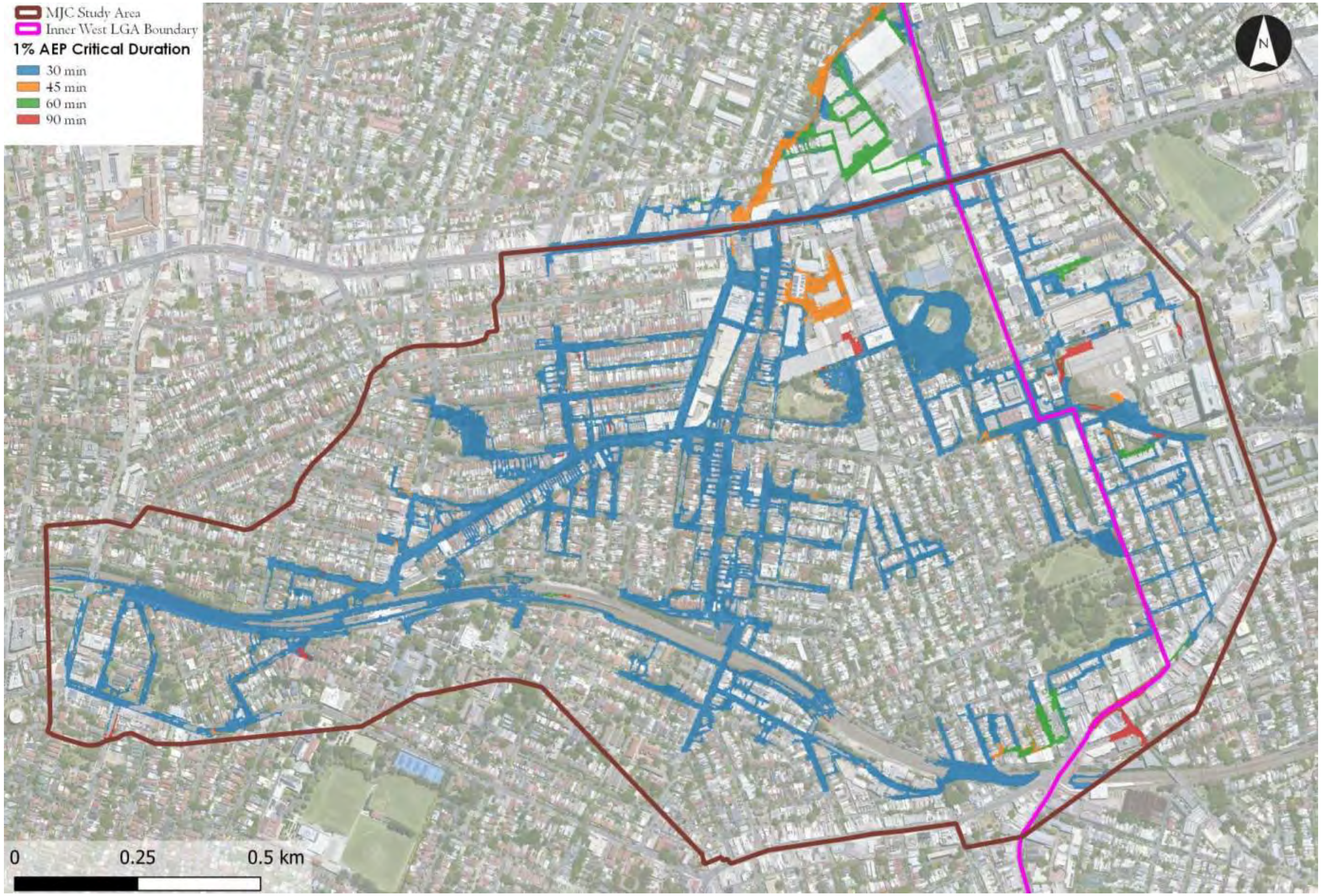

Figure 3-3 1% AEP Critical Duration Storms for Updated Model for Johnstons Creek Study Area Based on AR&R 2019 Design Rainfall Updates

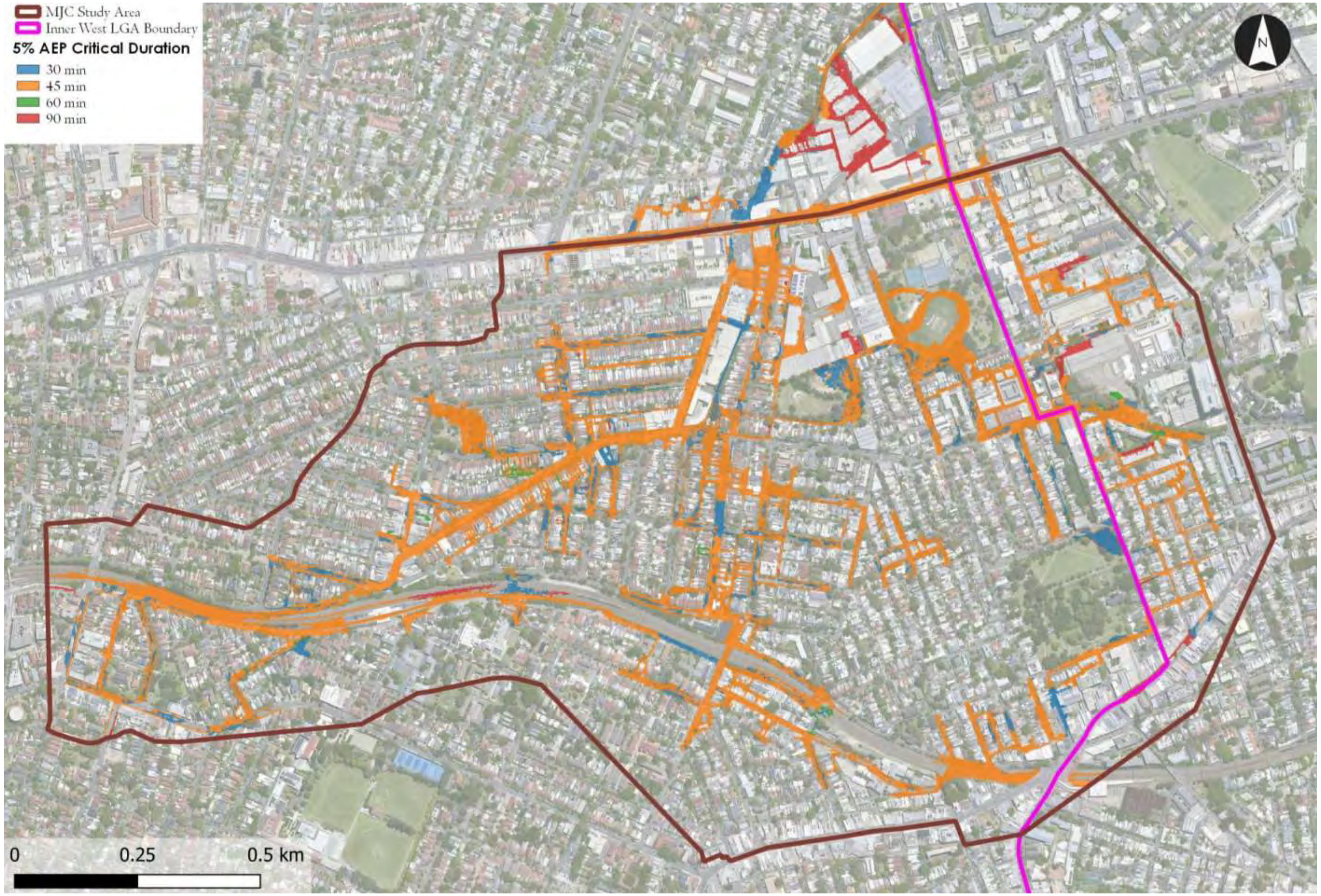

Figure 3-4 5% AEP Critical Duration Storms for Updated Model for Johnstons Creek Study Area Based on AR&R 2019 Design Rainfall Updates

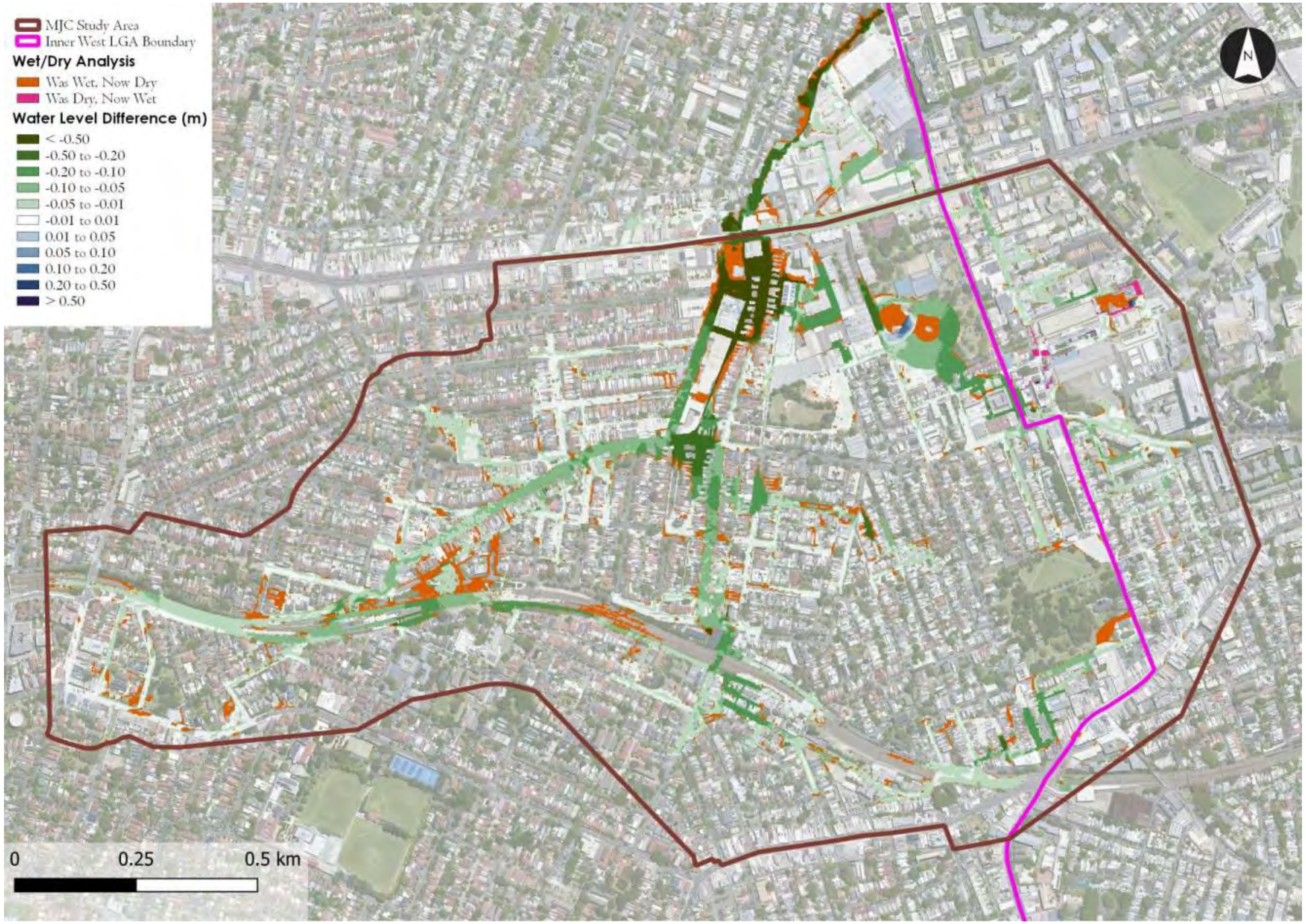

Figure 3-5 1% AEP Peak Water Level Differences – Johnstons Creek - Updated AR&R 2019 Model Less Flood Study AR&R 1987

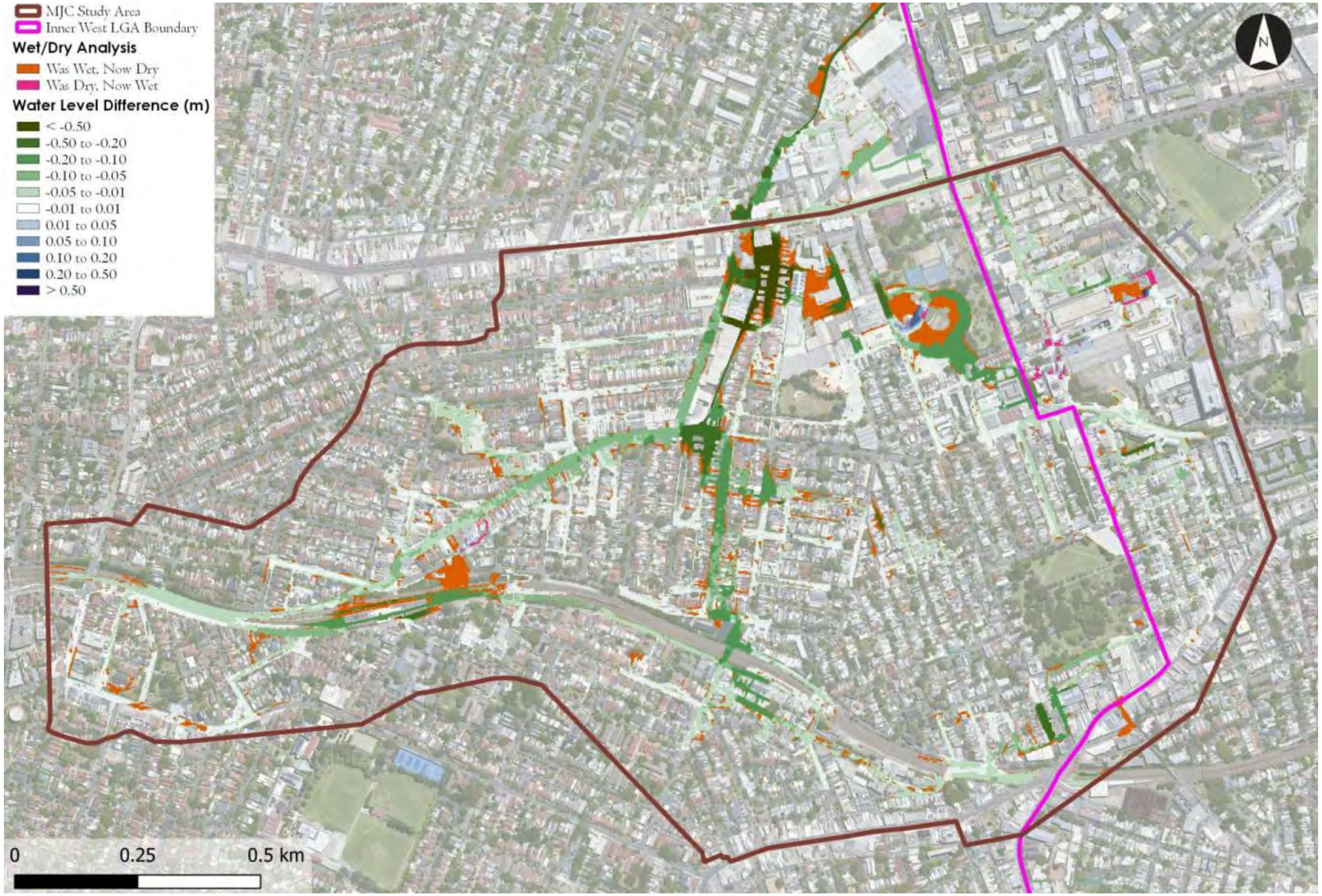

Figure 3-6 5% AEP Peak Water Level Differences – Johnstons Creek - Updated AR&R 2019 Model Less Flood Study AR&R 1987

3.6.5 Model Review Results – Whites Creek

The model updates discussed in the above sections were incorporated into a Whites Creek review model for the 1% AEP and 5% AEP events, with the outcomes of this modelling summarised in the following sub-sections.

3.6.5.1 Critical Duration

For both the 1% AEP and 5% AEP events, all ten temporal patterns were prepared for the 10, 20, 30, 45, and 60 storms. Of the ten temporal patterns for each duration, the median pattern was selected for each duration, and then these duration median results were combined to create the peak flood results. The critical durations for the 1% AEP and 5% AEP from the updated modelling are shown in **Figure 3-7** and **Figure 3-8** respectively.

The critical duration for the majority of the upper catchment the 20 minute storm for the 1% AEP, and the 10 minute for the 5% AEP. For the downstream portion of the Study Area north of Parramatta Road the 30 minute storm is critical for both the 1% AEP and 5% AEP events. Compared to the Flood Study AR&R 1987 critical duration of 20 minute, the critical duration for AR&R 2019 is comparable.

3.6.5.2 Peak Water Level Differences

A comparison of peak water level differences for the updated AR&R 2019 model compared to the Flood Study AR&R1987 model for the 1% AEP and 5% AEP from the updated modelling is shown in **Figure 3-9** and **Figure 3-10** respectively.

The results show that throughout the Study Area, the proposed revision to AR&R 2019 has resulted in reductions in peak water level results for both the 1% AEP and 5% AEP throughout the Whites Creek catchment. These reductions in peak water level results are in keeping with Stantec's past experience on updates to AR&R 2019, where the severity of peak flooding was almost always reduced as a result of AR&R 2019 updates.

Water level reductions from the Flood Study results are not significantly different for the majority of the Study Area, typically anywhere from -0.01 metres to -0.2 metres for both the 1% AEP and 5% AEP events.

The terrain and building polygon changes for the most part do not result in any significant areas of water level increases. The only notable example is a result of the building removal for the north fronting of Parramatta Road, which has opened up a new ponding location for waters to access the rear of these properties. This results in some area of newly flooded area at the rear of the properties. However given this is in the upper portion of the catchment and the flooding is minor it is not seen as a significant change.

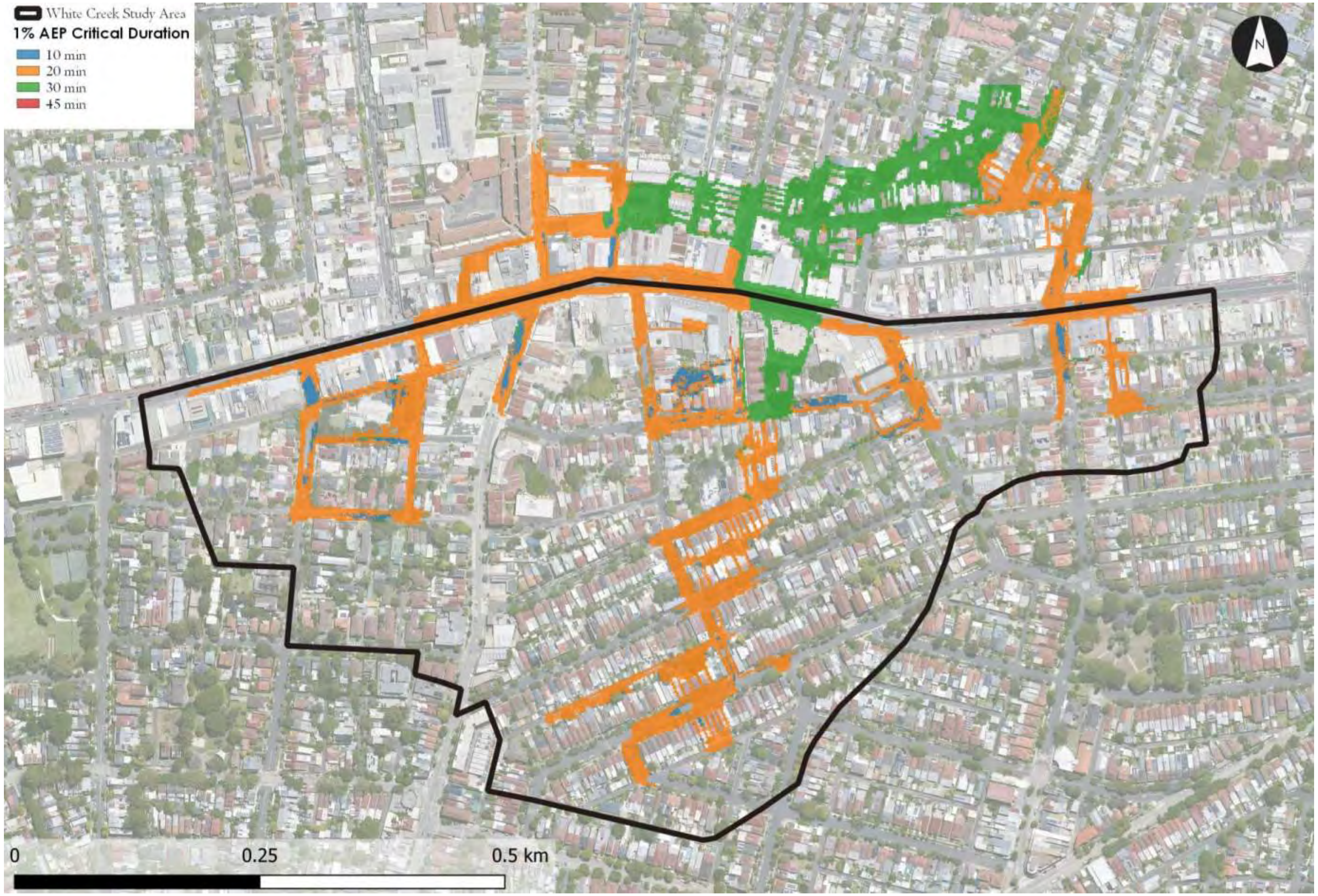

Figure 3-7 1% AEP Critical Duration Storms for Updated Model for Whites Creek Study Area Based on AR&R 2019 Design Rainfall Updates

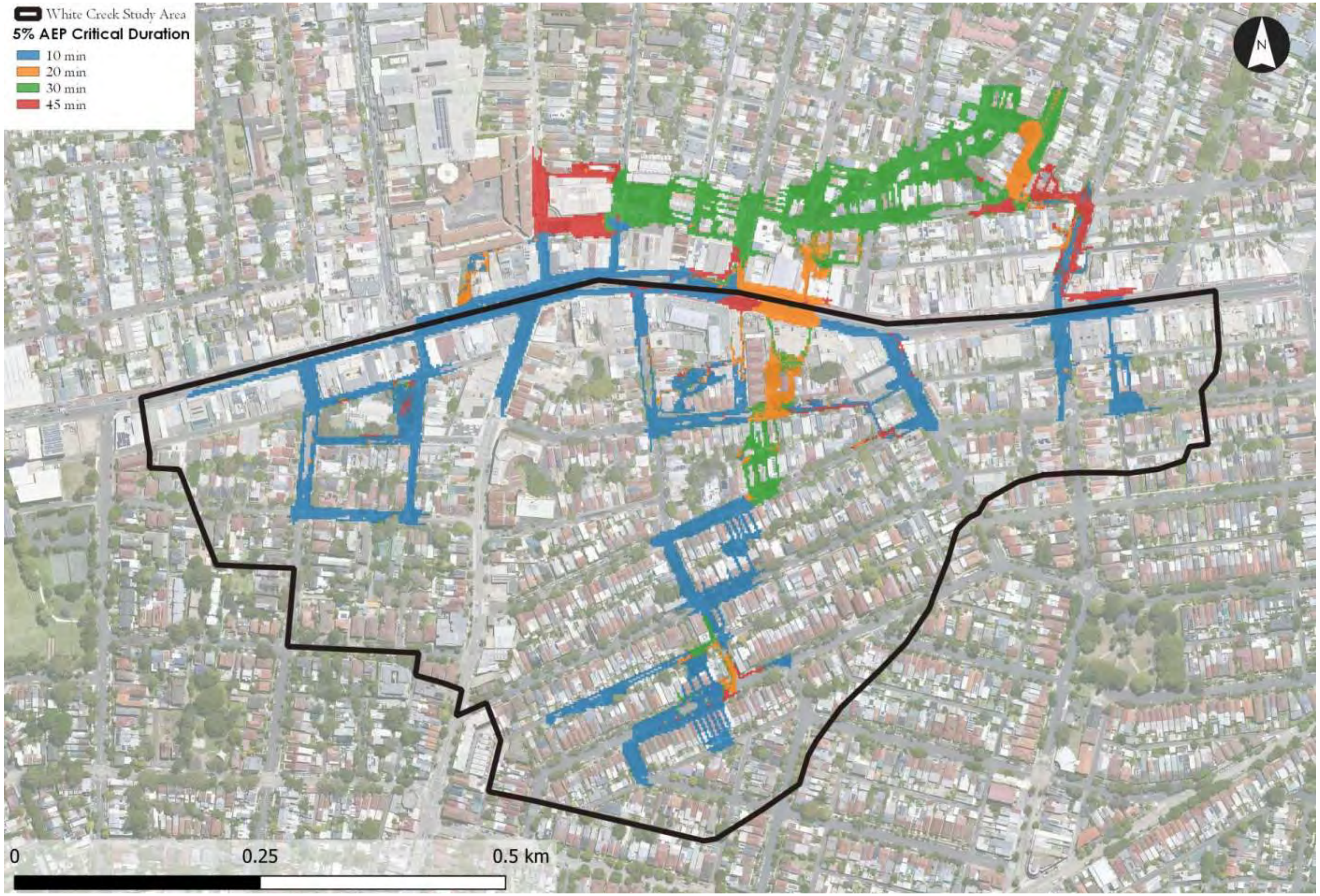

Figure 3-8 5% AEP Critical Duration Storms for Updated Model for Whites Creek Study Area Based on AR&R 2019 Design Rainfall Updates

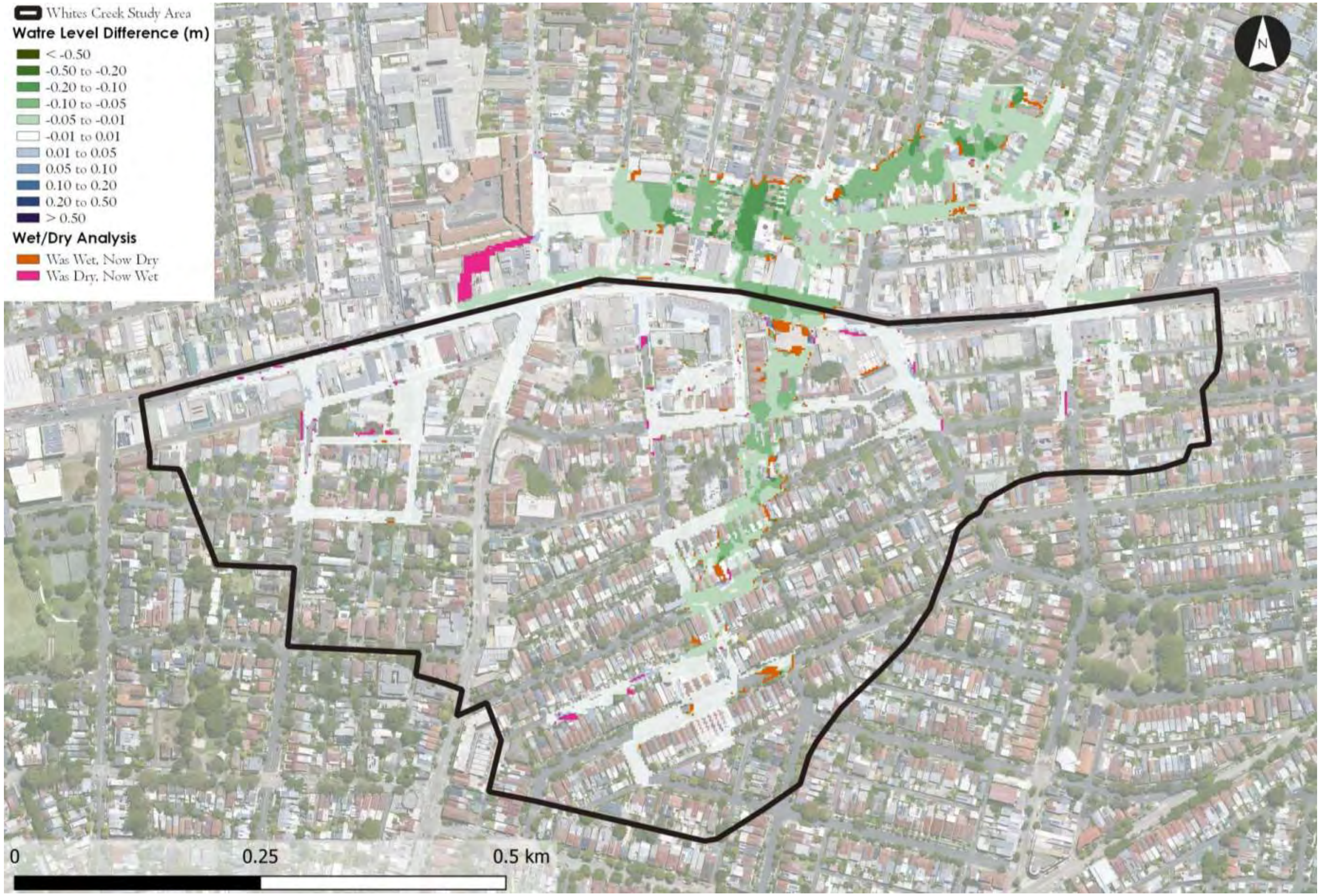

Figure 3-9 1% AEP Peak Water Level Differences – Whites Creek - Updated AR&R 2019 Model Less Flood Study AR&R 1987

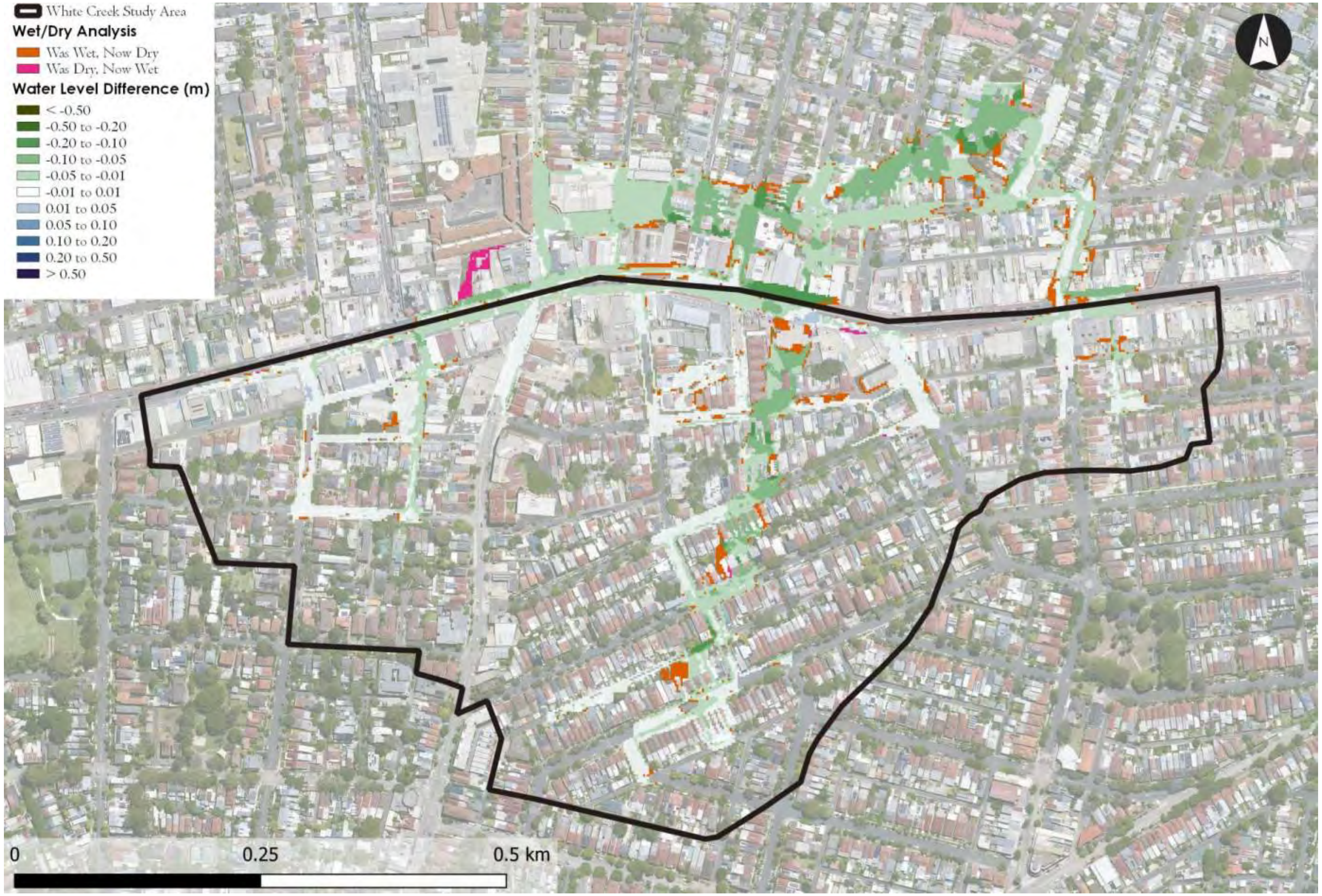

Figure 3-10 5% AEP Peak Water Level Differences – Whites Creek - Updated AR&R 2019 Model Less Flood Study AR&R 1987

4 Consultation

4.1 Consultation Process

Consultation with the community and stakeholders is an important component in the development of a Flood Risk Management Study and Plan. Consultation provides an opportunity to collect feedback and observations from the community on problem areas and potential floodplain management measures. It also provides a mechanism to inform the community about the current study and flood risk within the Study Area and seeks to improve their awareness and readiness for dealing with flooding.

The consultation strategy has been divided into three key sections:

> Consultation in FRMS&P development: This occurs during initials stages of the project **1.4**-and involves both informing the community and stakeholders of the project and gathering information on existing flooding issues and suggestions for flood risk management options.

> Review of possible flood management options with key stakeholder groups including Council Engineers, Council Planners, NSW SES, NSW DCCEW and community representatives within Council's Flood Risk Management Advisory Committee.

> Public exhibition of Draft FRMS&P: This occurs in the final stage of the project, with comments sought from the community and stakeholders on the Draft FRMS&P report with this input reviewed and incorporated into the final FRMS&P.

The strategy has been developed in accordance with the IAP2 Quality Assurance Standard and the Inner West Council Community Participation Plan.

4.2 Consultation Plan and Engagement Techniques

A consultation plan was developed in the preliminary stages of this project involving the development of several engagement techniques to achieve the objectives of the two stages of the consultation process. Details of the plan are provided below in **Table 4-1**. The completed or drafted components of the plan to date have been shown in italics in the table.

Table 4-1 Consultation Plan

Task	Description	Expected Outcome
Press Release	Stantec will draft a press release for Council's consideration and publication.	> Public awareness of the study. > Assist in engagement with the community through the newsletter/questionnaire, workshops and public exhibition. > Assist in the public acceptance of the study outcomes and implications for development and flood risk management in the future.
Stakeholder Consultation – Council	Relevant Council staff attended the inception meeting to discuss various input to the study and the proposed study approach. Key stakeholders will be consulted in an option development workshop to receive feedback on the preliminary options list.	> All available information is utilized in the preparation of the flood study. > Modelling incorporates the high risk areas. > Council objectives are achieved by the study.
Stakeholder Consultation – Flood Advisory Committee	Stantec will attend and present at four stakeholder meetings (which may include Flood Advisory Committee as deemed suitable) throughout the study.	> Update FRAC on the FRMS&P process. > Provide an opportunity for input from the FRAC on the mitigation options.
Stakeholder Consultation – Agencies	Stantec will contact relevant agency stakeholders (e.g. NSW SES, TfNSW) via letter and follow up email and/or phone.	> Inform the agencies of the study. > Obtain relevant information. > Provide an opportunity for input from the relevant agencies.

Task	Description	Expected Outcome
Community Newsletter and Questionnaire	Stantec will draft a newsletter and questionnaire for Council's consideration. Once finalised Council will print and distribute to target properties within the catchment. Responses will be via a reply-paid envelope. The brochure and survey will also be made available online by Council.	> Inform the community about the study and provide background information. > Identify community concerns and awareness > Gather information from the community on potential flood mitigation options. > Develop and maintain community confidence in the study results.
Website	Council will host a dedicated "have your say" website for the project. The website will be utilised for media release, online newsletter and questionnaire providing residents with an opportunity to locate the area of flooding on a GIS based system and upload an associated photos/videos they may wish to share.	> Collaborative community engagement process. > Provide community opportunities to provide input/feedback. > Provide key information to the community.
Community Workshops	Stantec will prepare materials for and present at 2 community workshops. One workshops will be undertaken during Stage 2 of the study to get community feedback on the preliminary flood options, the other during Public Exhibition (see below).	> Provide the community with an opportunity to comment on flood mitigation options and an understanding of the outcomes of the Draft Study and Plan.
Public Exhibition Period	Stantec to draft a press release for Council's consideration and publication.	> Inform the community of the draft Study and Plan and invite submissions. > Inform the community of the workshop.
	Council will arrange for the public exhibition of the Draft Flood Risk Management Study and Plan. One community workshop will be undertaken during the public exhibition to present the outcomes of the study and receive feedback from the community.	> Provide an opportunity for the community to review and provide comment on the Draft Study and Plan.

4.3 Council Engagement

Given Inner West Council's role in commissioning this FRMS&P, it is important that Stantec maintain constant engagement with Council's project manager throughout the project. Furthermore, NSW Department of Climate Change, Energy and Water (DCCEW) have maintained an active role in project supervision throughout the project. To date, Council engagement has been maintained through the following:

- An online project inception meeting was held on 12 January 2021 with Council and Stantec representatives in attendance. The inception meeting signified the commencement of the project and provided an opportunity for Council to outline the objectives and expectations for the study, and to provide initial guidance and direction.
- Meetings occurred as required between 2021 and 2022 as the project reached critical milestones and review points, however there were delays associated with COVID and the 2022 Flood Response.
- Fortnightly online project update meetings have been conducted since project recommenced model changes and option analysis on 24 January 2023 with Council, DCCEW and Stantec's project manager in attendance as well as other Stantec staff as needed. The update meetings have provided an opportunity for Stantec to update Council on the ongoing status of the project, and to ask Council for any clarifications or queries that arise during the project.
- Ongoing weekly option development and review workshops with Stantec and Council's technical working groups were held from August through to October. The list of attendees included Council's project managers and NSW DCCEW representatives for the project), as well as relevant stakeholders from technical teams in Council. The goal of the meetings was to seek feedback on the preliminary list of options and refine and identify a set of detailed options for assessment.

- Workshops were held on 13 and 27 July 2023 with Stantec, DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives to present an overview of the FRMS&P and the initial preliminary flood mitigation options.
- Additional weekly workshops were held with Council's project team and NSW DCCEW representatives during option development and modelling to review option outcomes and refinement of options. This allowed the options to be developed in light of Council and DCCEW preferences and advice.

4.4 Flood Risk Management Committee

One of the primary mechanisms by which the study team engaged in consultation with key stakeholders and the community is via the Inner West Flood Management Advisory Committee (FMAC) convened by Council. The Committee includes membership by the following individuals:

- Local community representatives,
- Local business representatives,
- Staff from Inner West Council who have involvement in the study including coordinators, managers, strategic planners, and engineers.
- SES representatives,
- Floodplain Engineer from NSW DCCEW.

The first FRAC meeting for the project was held mid-2022 to discuss the progress of the project and to present the outcomes of the Stage 1 report.

Further meetings were undertaken throughout 2023 to review, seek input, and shortlist proposed flood mitigation and management options for detailed assessment and costings.

The Draft FRMS&P was presented to the Committee for feedback and support for community exhibition in early 2024. The meeting provides an opportunity for the FRM Committee members to ask questions about the FRMS&P.

4.5 Initial Consultation

The initial consultation period was held from 7 March 2023 to 6 April 2023. The initial consultation period for this project was run jointly with the Alexandra Canal FRMS&P project. During this period the following materials were made available to the community:

> A dedicated community engagement page for the catchment on Council's Have Your Say website.was posted for the project,to inform the community about the project and for feedback. . The text for the Have Your Say page has been included in **Appendix A**.

> Press release information for the study was posted to Council's social media and to Council's newsletter.

> Introductory letters were mailed to all owners and occupants of flood affected properties in the study area, which involved mail out to approximately 2,700 properties. The resident letter template provided an introduction to the study, and a link to the Have Your Say page for further information and a link to complete the online survey. The letter text is included in **Appendix A**.

> A resident online survey / questionnaire was hosted by Council through an online portal, with links to the online survey provided on the projects Have Your Say page. The survey text is included in **Appendix A.**

Three in-person information sessions were hosted by Council and attended by Stantec flood engineers and Council representatives. Notification of the in-person sessions was posted on the Have Your Say page and in the introductory letter (for the first session). The details for the three sessions were:

> St Peters Town Hall, 39 Unwins Bridge Road, St Peters on 15 March 2023 from 12.00 – 3.00pm

> St Peters Town Hall, 39 Unwins Bridge Road, St Peters on 15 March 2023 from 5.00 – 8.00pm

> Marrickville Pavilion, 313 Marrickville Road, Marrickville on 20 March 2023 from 12.00 – 3.00pm

4.5.1 Consultation Response Outcomes

Across the initial consultation period, there were 3 community attendees relevant to the Whites Creek and Johnstons Creek study area to the three in-person information sessions.

One of the 3 attendees was a resident from outside of the study area and asked questions about the flood modelling project. The other two attendees raised matters related to the study area, including one from Enmore as their area had been identified as a hot spot and mitigation options considered. A resident from Stanmore showed flood maps of the area and discussed flooding history, clarified that this is a FRMS&P study not to re-assess existing flood behaviour, clarified that DCP requirements were not applicable to existing dwellings, only the portion of new development, hence the reason the existing structure did not need to be raised in recent alterations.

With respect to Have Your Say outcomes from the initial consultation, there were 650 views of the project page, initiated by 501 unique visitors. The total viewing time of project information was approximately 7 hours. Two persons contributed to the interactive map, including:.

> a submission noting that their property was located at the intersection of Salisbury Rd and Mallet St had experienced previous severe water damage of the lift pit and passenger lift infrastructure as a result of flooding at the intersection, incurring repairs and maintenance costs to the residents.

> a submission noting that road and footpaths on Lennox St Newtown are regularly flooded, even during moderate rainfalls and attached a photo from 2 April 2023 showing overflowing drains and gutters.

The adopted Flood Study was downloaded 49 times.

4.5.2 Online Survey Outcomes

Five community members shared their experiences of flooding via the online survey.

> 100% of respondents (5 of 5) were owner occupiers,

> 80% of respondents (4 of 5) declared that other parts of their neighbourhood had flooded since living/working in the catchment area,

> 80% of respondents (4 of 5) believed the flooding disrupted their daily routine,

> While 20% of respondents (1 of 5) suggested they believed lack of capacity in the stormwater network (e.g. pits and pipes) caused drainage systems to surcharge and backflow, 80% of respondents (4 of 5) believed other reasons were are the main cause of flooding in their area,

> 60% of respondents (3 of 5) would prefer management options of

- culvert / bridge / increasing pipe size and/or capacity, and
- and planning and flood related development controls to ensure future developments does not add to the existing flood risk.

> 80% of respondents (4 of 5) are concerned about the uncertainty of future climates and the possible impacts on flooding in their area,

> 100% of respondents (5 of 5) believed the climate is changing,

> 60% of respondents (3 of 5) are concerned about the impact of an uncertain climate on future flooding in the study areas,

> 100% of respondents (5 of 5) believe Council should be addressing the impacts of an uncertain future climate on flooding,

> 100% of respondents (5 of 5) gave permission for Stantec or Council to contact them to discuss the information they have provided Council.

4.6 Public Exhibition Period

The public exhibition period is an important stage of any regional Flood Study or FRMS&P as it provides the community and stakeholders the opportunity to provide comment and feedback on the draft outcomes of the study prior to finalisation.

The public exhibition period for this Draft report is proposed to be conducted in early 2024, for a period of at least four weeks. Comments received from the community will be considered in a Final FRMS&P report to be issued post-exhibition. Outcomes of the public exhibition shall be summarised in this section within the Final FRMS&P.

5 Flood Planning Review

5.1 Flood Affected Properties

A review of flood affected properties has been considered for the study area with a review of changes considered compared to the previous Flood Study property tagging.

The updated property list adopted the original Flood Study model results in creating flood extents. These flood extents apply the flood extent trimming of 0.15 metres depth. This more effectively removes minor sheet flows and shallow overland flows. A comparison of 1% AEP flood extents with and without the 0.15m depths filter is shown in **Figure 5-1**. The comparison shows that the untrimmed flood extents are significantly more widespread than the extents trimmed to 0.15 metre depth, showing there is significant areas of shallow sheet flow modelled in the TUFLOW model.

The number of floods affected properties for five design events are summarised in **Table 5-1** for Whites Creek and Johnstons Creek. Two forms of property tagging analysis have been considered:

> Any flood affectation of the property

> Flood extent covers at least 10% of the property area,

As has been adopted in other study areas by Council, the use of the 10% area tagged approach has been preferred. In the PMF event using the 10% property area approach, there are a total of 913 flood affected properties, or 14.2% of the total 6434 properties in the study area. In the 1% AEP the total number of affected properties is 409, or 6.3% of all properties.

Table 5-1 Flood Affected Property Numbers for Private and Developed Properties (Excluding Parkland Sites) for All Design Flood Events for Base Case Flood Extents

Property Tagging	Base Case Flood Affected Property				
	20% AEP	5% AEP	2% AEP	1% AEP	PMF
Flood Affected	770	1006	1107	1197	1906
>10% Area Affectation	197	300	368	409	913
				Total Properties in Catchment	6976

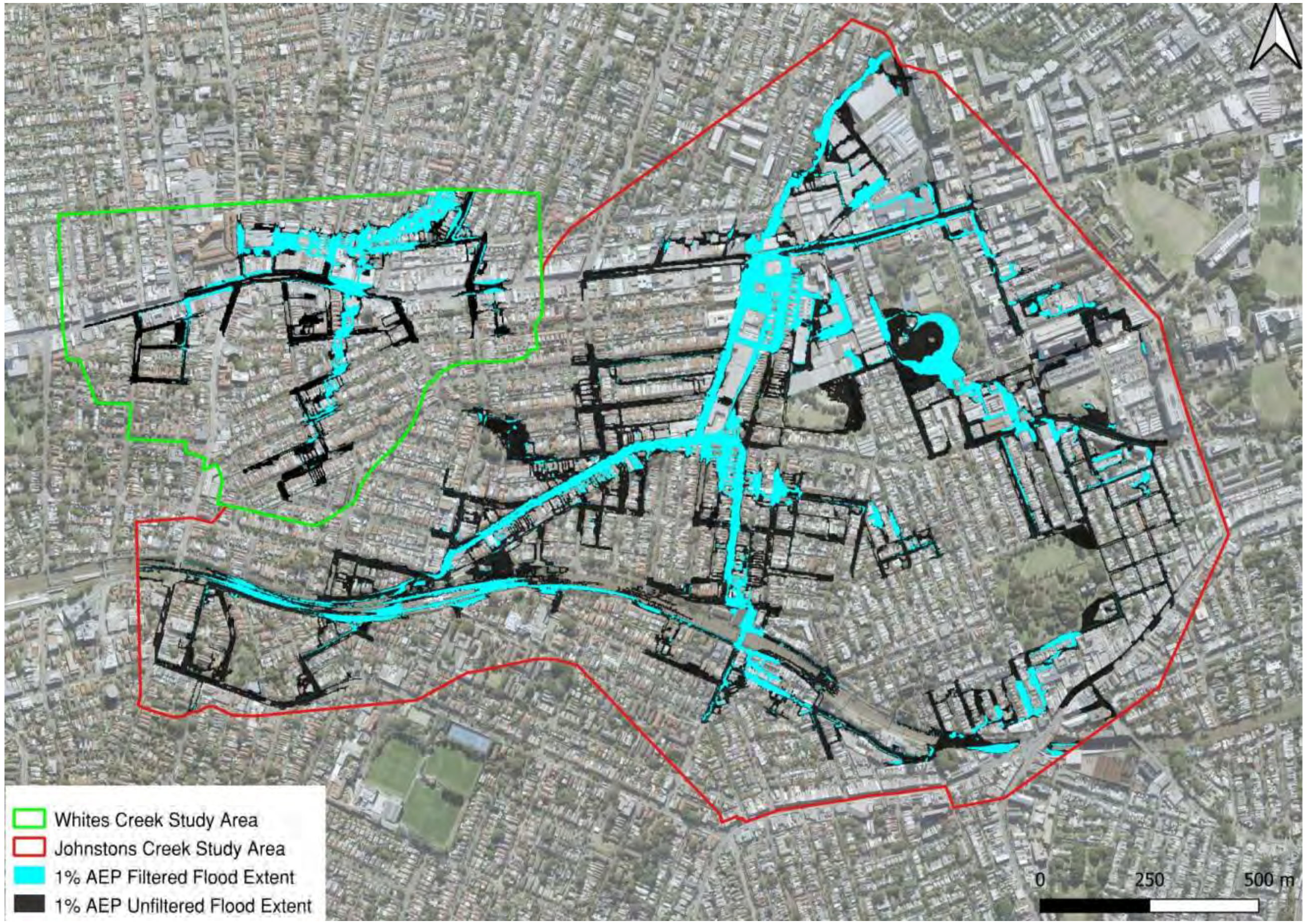

Figure 5-1 Comparison of 1% AEP Flood Extents With and Without 0.15m Depth Filter Applied

5.2 Relative Vulnerability for Development Types

The relative vulnerability of development types and their users to flooding should be considered in decision-making as it can influence risk to the community. Vulnerability to flooding can vary between development types and their typical users.

The 2023 FRM Manual guideline for Flood Impact and Risk Assessment (Flood Risk Management Guide FU01) in Table 6 provides a useful resource in providing a high-level summary of flood risk for different development types of users, buildings and their contents for the same flood exposure. The summaries from this guideline for development types relevant to this Study Area have been included in **Table 5-2**.

It is noted this guidance is a generalisation for development types, and the flood risk of any development will depend on site specifics and details of the development, not just these broad vulnerability assessments. However, this provides a useful resource in understanding the relevant flood risk of different land uses. It should be consulted in the review of current land uses and future development potential in the following sections."

Table 5-2 Relative Flood Risk & Vulnerability of Land Uses for the Same Flood Exposure (Source: NSW DCCEW, FRM Guide FB01)

Type of Use	Relative Risk Compared to Low Density Residential			Comment
	Users	Buildings	Contents	
Low Density Residential	Base	Base	Base	This is used as a baseline for considering relative impacts in other land uses
Medium/high density	Higher	Lower	Lower	Due to the higher density more people are involved but the buildings may be more structurally resistant to flooding. Contents may be less exposed to flooding as they may be over multiple levels
Emergency response management facility	Lower	Lower	Lower	Lower density of development and people
Aged care facility	Higher	Lower	Higher	Users on average more vulnerable in evacuation. Building may be structurally stronger. Potential for high value medical equipment
School	Higher	Lower	Lower	Users on average more vulnerable in evacuation. However, evacuation arrangements likely to be in place. Buildings and contents generally lower value
Correctional facility	Higher	Lower	Lower	May have challenges in the relocation of users therefore continued operation preferable. This relies on accessibility for staff and utility services. Buildings and contents expected to be generally of lower vulnerability
Commercial	Higher	Lower	Varies	Employees may be able to be trained to assist in response to flooding. Higher density of customers, who are likely to be unfamiliar with location or flood issue and therefore more vulnerable. Buildings expected to be generally of lower vulnerability. Contents varies substantially depending on the specific business
Industrial	Lower	Lower	Varies	Employees may be able to be trained to assist in response to flooding, customer density low, but they are likely to be unfamiliar with location or flood issue. Buildings expected to be generally of lower vulnerability. Contents varies substantially depending on the specific business
Hazardous/ offensive industry	Lower	Lower	Higher	Employees may be able to be trained to assist in response to flooding, customer density low, but they are likely to be unfamiliar with location or flood issue. Buildings expected to be generally of lower vulnerability. However, the impacts of hazardous or offensive materials could be significant and need to be considered. This may require management measures such as avoidance of flood-affected areas or effective containment of hazardous or offensive materials to limit impacts on the community or environment
Recreation	Lower	Lower	Lower	Occupied less and may be weather influenced but could be higher density of people when in use. Users often unfamiliar with flooding in the location. Buildings and contents expected to be generally of lower vulnerability or value

5.3 Future Development Potential in Flood Affected Land

5.3.1 Proposed Future Development Sites

In the preliminary stages of the project, Council reviewed submitted planning proposals within the study area and no planning proposal was currently active within the study area.

5.3.2 Future Planning Proposal Requirements

In mid-2021, NSW DCCEW released a new Flood Prone Land Policy Update. Included within this policy is a draft set of standard flood-related clauses for Local Environment Plans (LEPs) to assist local Councils. In addition, the update package included a local planning directive outlining flooding requirements in consideration of planning proposals.

A summary of the key requirements of the local planning direction for planning proposals and their relevance to the future development potential of Whites Creek and Johnstons Creek Catchment is included in **Table 5-3**.

To assist in the discussion of planning proposal requirements related to floodway and high hazard areas, these two maps for the 1% AEP have been overlaid on current land use zoning as shown in **Figure 5-3** and **Figure 5-4** respectively.

The outcomes from **Table 5-3** suggest that development and particularly potential intensification should be prioritised in the flood free portions of the study area where possible. However, the high-level review suggests there is still redevelopment potential within parts of the floodplain.

The guide on flood risk of development types summarised in **Section 5.2**, should be reviewed as a general guide when assessing potential future changes in land use in the floodplain.

Table 5-3 Planning Proposal Requirements and Relevance to Whites Creek and Johnstons Creek Catchment

Planning Proposal Requirement	Relevance to Whites Creek and Johnstons Creek Catchment
A planning proposal must not rezone land within the flood planning area from Recreation, Rural, Special Purpose or Environmental Protection Zones to a Residential, Business, Industrial or Special Purpose Zones.	Based on this requirement there is limited development potential for the flood affected portions of sites that are currently zoned as recreation or special purpose including parts of Stanmore Baptist Church, All Saints Anglican Church, Uniting Church in Australia as well as any zoned Council park sites.
A planning proposal must not contain provisions that apply to the flood planning area which:	
▪ permit development in floodway areas,	Assumed to be the 1% AEP floodway. As shown in **Figure 5-3** the floodway extents in the study area affect various residential areas, business and industrial areas as well as neighbourhood and local centres. Several areas of the Whites Creek and Johnstons Creek catchments may be limited by this requirement.
▪ permit development that will result in significant flood impacts to other properties,	This requirement would need to be assessed through flood impact assessments on a site-by-site basis with detailed assessment of proposed development plans
▪ permit development for the purposes of residential accommodation in high hazard areas,	Assumed to be the 1% AEP high hazard. As shown in **Figure 5-4** there are residential and business areas affected by high flood hazard, which may impact potential redevelopment of these sites in the study area.
▪ permit a significant increase in the development and/or dwelling density of that land,	This requirement will need to be considered in potential intensification of development in the floodplain. It is possible that intensification in flood affected areas may be feasible if flood risk is suitably addressed. However potential intensification should be prioritised in flood free portions of the study area.
▪ permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,	These vulnerable development types should not be proposed within the 1% AEP floodplain where possible. As discussed further in **Section 7.3.2**, there are a number of these existing vulnerable developments within the floodplain, the alteration of these sites to improve flood risk should be considered.
▪ are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or	Further review of flood emergency management concerns for the study area is included in **Section 7**. Development potential in identified flood emergency hotspots should be avoided based on this requirement. That is unless a potential redevelopment could justifiably be shown to reduce the emergency response burden for an existing site.
▪ permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	This may be of concern for the light industrial zoned, flood affected areas in the Johnstons Creek catchment.
A planning proposal must not contain provisions that apply to areas between the flood planning area and probable maximum flood to which Special Flood Considerations apply which include items listed above.	Similar to the above response, vulnerable developments should not be prioritised within PMF affected lands where possible. This also relates to critical infrastructure types for flood emergencies (refer to **Section 7.3**).
For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the FRM Manual 2023 or as otherwise determined by a Flood Risk Management Study or Plan adopted by the relevant council.	The flood planning level should be maintained at the 1% AEP plus 0.5 metre freeboard as in the Inner West LEP and is recommended in the current Flood Prone Land Policy Update. There is no clear evidence that flood behaviour in the study area would justify an alternative FPL.

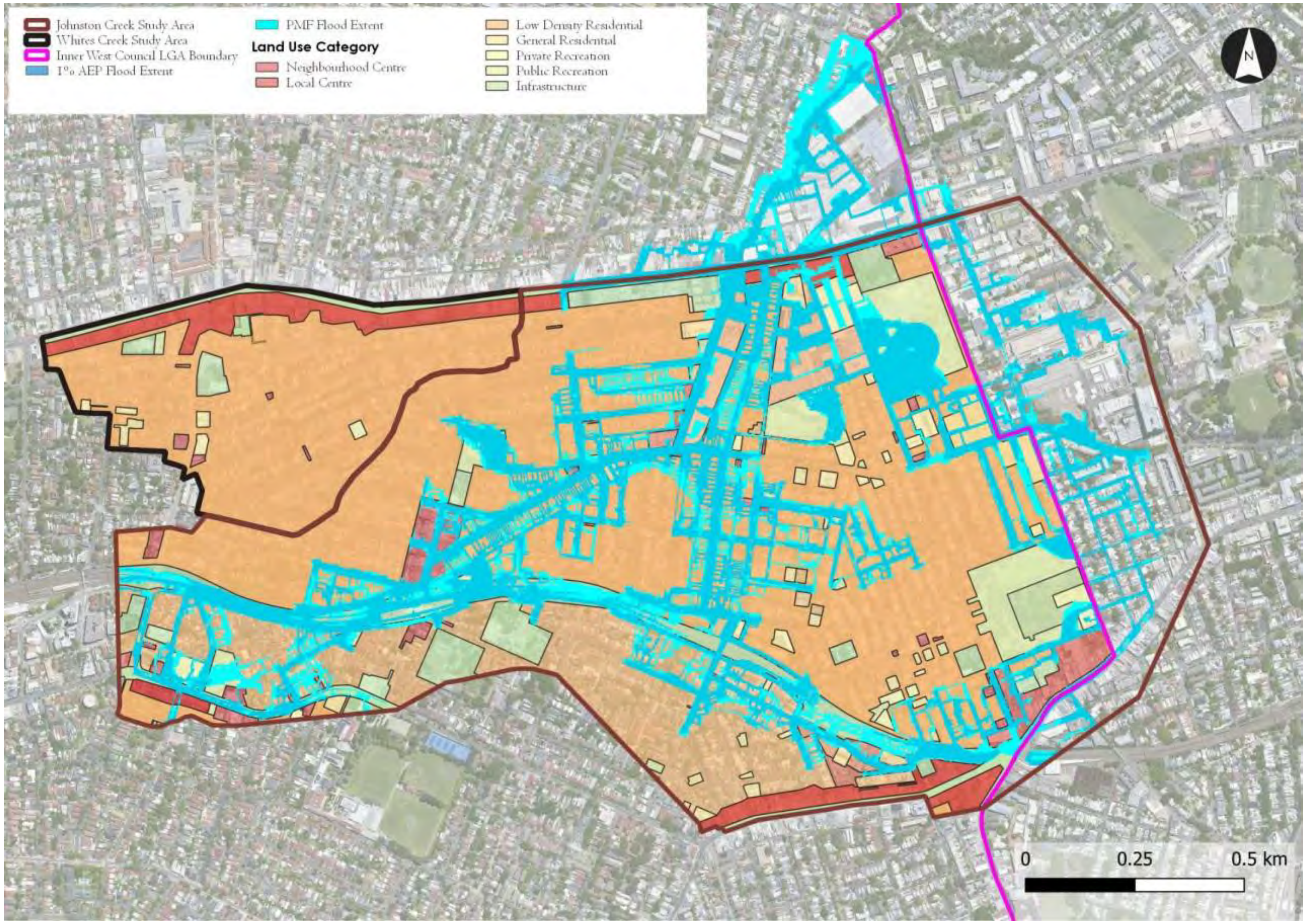

Figure 5-2 Current Land Use Zoning with 1% AEP and PMF Extents

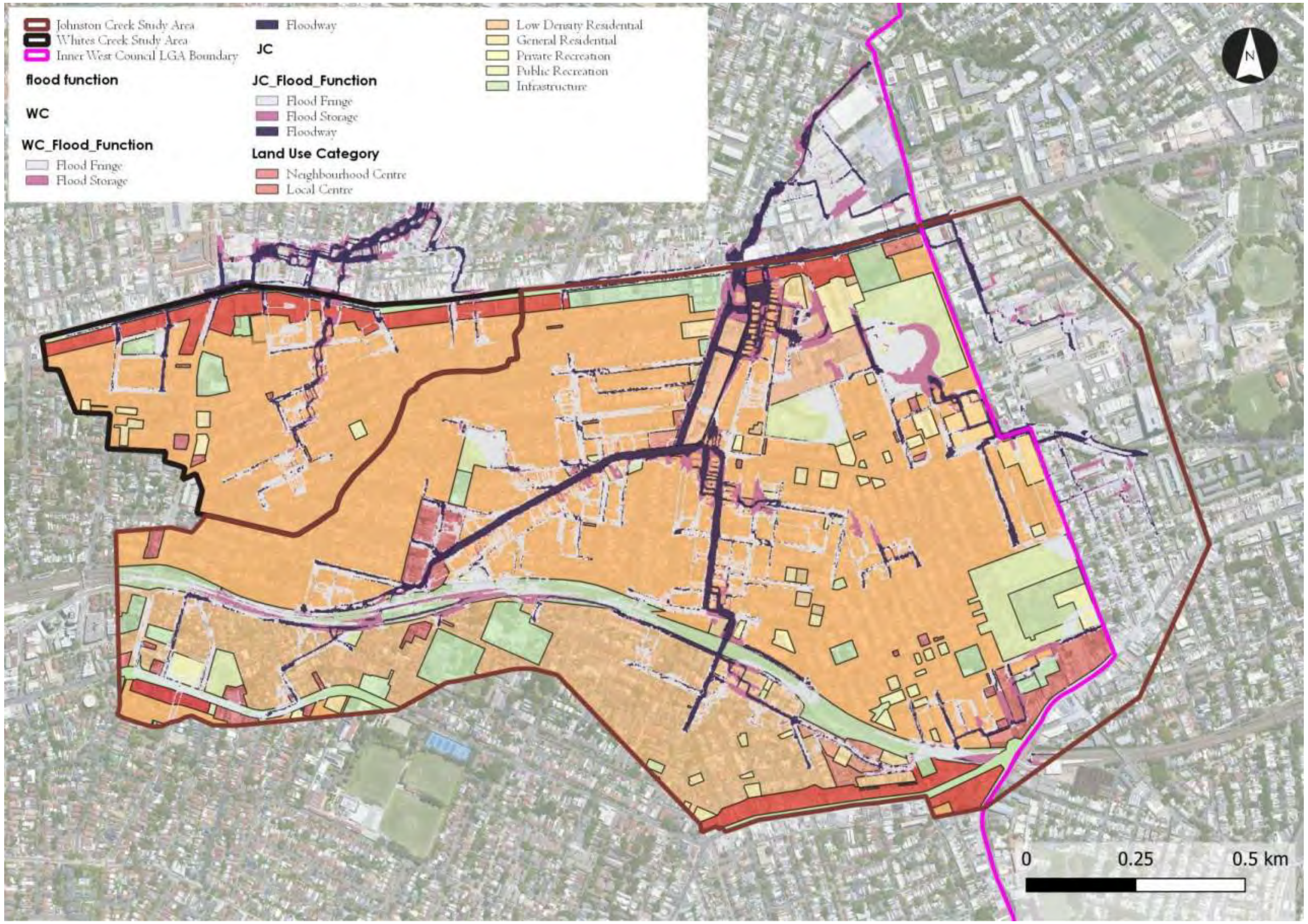

Figure 5-3 1% AEP Flood Function with Floodway on Current Land Use Zoning

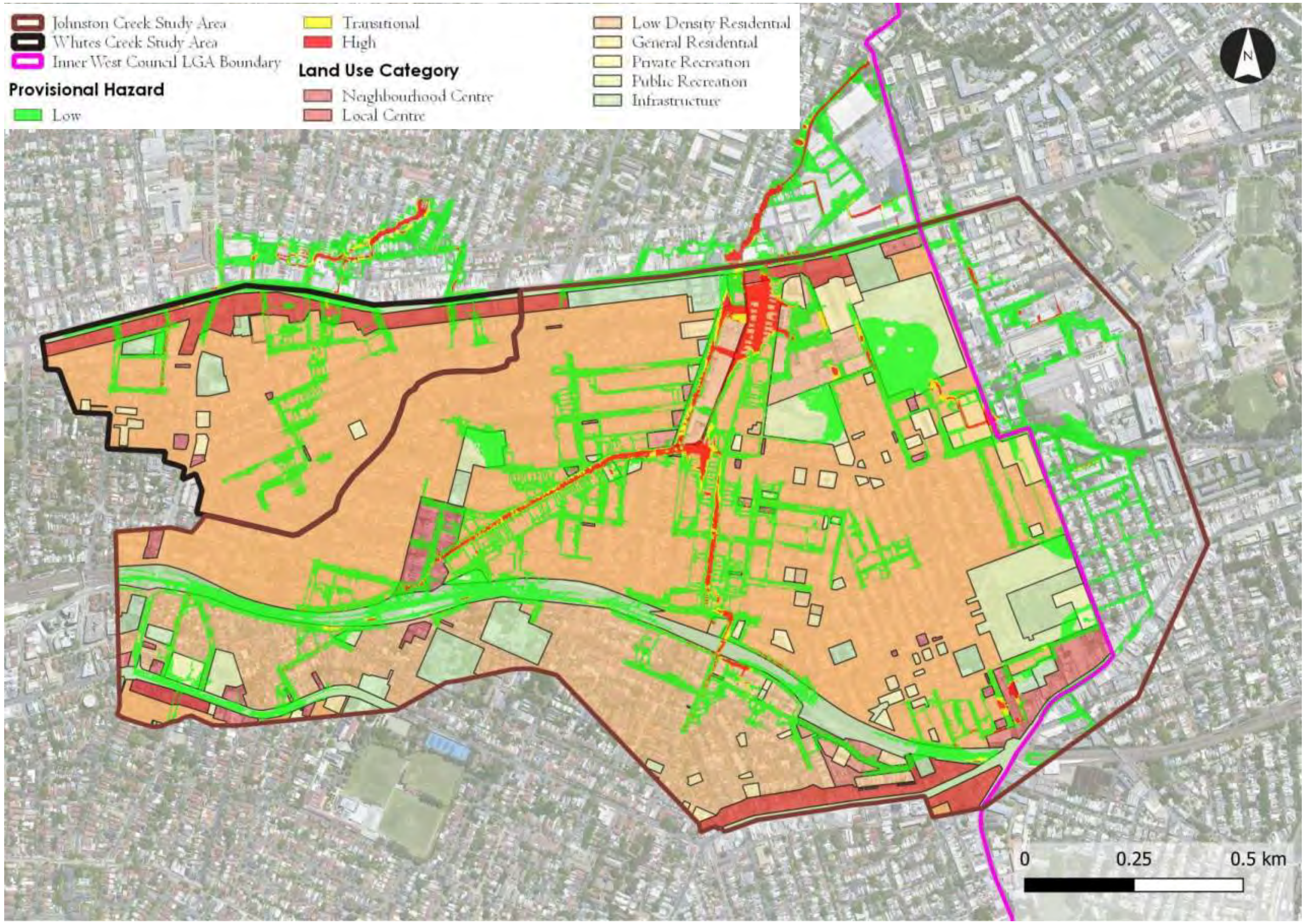

Figure 5-4 1% AEP Provisional Hazard with High Hazard on Current Land Use Zoning

5.4 Flood Related Development Controls

The Whites Creek Catchment and Johnstons Creek Catchment are located in the Inner West LGA where development is controlled through the Local Environment Plans (LEP) and Development Control Plan (DCP). The following sub-sections summarise the flood-related development controls for these documents and provide recommendations.

5.4.1 Local Environment Plan

The Whites Creek Catchment and Johnstons Creek Catchment lie within the Inner West LGA, therefore the relevant document is the Inner West Local Environmental Plan 2022.

As noted in previous sections, in mid-2021, NSW DCCEW released a new Flood Prone Land Policy Update. Included within this policy is a draft set of standard flood-related clauses for Local Environment Plans (LEPs) to assist local Councils. The 2021 package establishes two different categories, and two associated standard Local Environment Plan (LEP) clauses where flood-related development controls may be applied / considered. These are:

> Flood Planning Areas (FPAs): The ‘flood planning’ LEP clause is mandatory and the LEPs of all Councils in NSW were amended on 14 July 2021,

> Special Flood Considerations (SFCs): The ‘special flood consideration’ LEP clause is optional, and Councils decide whether to adopt this clause or not. If Councils choose to adopt the optional standard instrument SFC provision, it must be adopted without variation but subject to any relevant direction in the standard instrument (cl 4(2), SI order).

5.4.1.1 Mandatory LEP Clause - Flood Planning Area

Clause 5.21 outlines the requirements for developments in the FPA which is all land under Flood Planning Level (FPL), which in accordance with the FRM Manual 2023 is typically defined by the 1% AEP (1 in 100 AEP) event with a 0.5 metre freeboard. Councils are permitted to propose alternate FPLs, however they are required to demonstrate and document the merits of any decision based on a risk management approach. The land this clause applies to is essentially unchanged from the previous standard LEP clause.

The main updates to the mandatory standard flood related clause include:

> Several new objectives have been added to the updated text including a reference to cumulative impacts, enabling safe and appropriate uses of land, and enabling safe evacuation from the land,

> The requirements for development consent have been updated with reference to:

- Compatibility to flood function (floodway, flood storage and flood fringe),
- No offsite flood impacts and the impact of the development on projected changes to flood behaviour (accounting for climate change),
- There is a reference to safe occupation and efficient evacuation of people and not to exceed the capacity of existing evacuation routes for the surrounding area. Similarly, also stated in the clause is whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,
- The intended design and scale of buildings resulting from the development, and the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding.

Review of the draft Inner West LEP shows that the wording of the flood planning section 6.3 reflects this updated wording as is mandatory.

5.4.1.2 Optional LEP Clause – Special Flood Considerations

A new optional flood clause 5.22 has been added to the update called the 'Special Flood Considerations' (SFC) clause. The clause applies to all land between FPA and the PMF, an area that was not covered within the previous standard LEP clause. The types of development this optional clause would apply to includes vulnerable developments and critical infrastructure. In relation to the Special Flood Considerations (SFC) Clause 5.22, as stated within the guideline document:

….this is an optional provision of the Standard Instrument and Councils have the discretion whether to adopt the clause in a LEP in their LGA, provided they have appropriate information and justification to support the flood related development controls. Studies under the FRM process, as well as emergency management planning processes and relevant strategies and plans developed by NSW Government may provide information and support justification for the adoption of the clause.

Inner West Council has adopted the optional LEP clause 5.22 for land between the FPA and the PMF. Therefore, both LEP clauses 5.21 and 5.22 for the FPA and the PMF will be applicable.

5.4.2 Current Development Control Plan

The Whites Creek Catchment and Johnstons Creek Catchment lies within the former Marrickville Council LGA, therefore the relevant document was the Marrickville DCP 2011. This review relates to the Marrickville DCP 2011, Part 2.22 - Flood Management.

Section 2.22.2 – Land Affected complements Clause 6.3 (Flood planning) (currently Clause 5.21) of Inner West Local Environmental Plan 2022 (Inner West LEP 2022). It applies to:

> land identified on the DCP 2011 Flood Planning Area Map (**Figure 5-5**). Flood planning area include:
  - Flood planning area (Cooks River) that land likely to be affected by the 1% AEP flood, factoring in a rise in sea level of 400mm to the year 2050, (plus 500mm freeboard) of the Cooks River; and
  - Flood planning area (Overland Flow) that identifies land (in accordance with Council's Flood Tagging Policy) likely to be affected by the 1% AEP flood associated with various locations affected by local overland flooding.

> land identified as being flood liable land on the DCP 2011 Flood Liable Land Map (**Figure 5-6**). Flood liable land identifies land within a flood planning area, and land likely to be affected by the probable maximum flood (PMF) of the Cooks River. This means that the map identifies some land as being within the Cooks River PMF area, but not within the Cooks River 100-year flood (plus 500mm freeboard) area.

It should be mentioned that he Marrickville DCP 2011 incorporates twelve amendments. Amendment No. 7 relates to amendments to Part 2.22 – Flood Management, to incorporate an updated Flood Planning Area Map and an updated Flood Liable Land Map, came into force on 6 July 2018.

Flood classifications have been applied to parts of the Flood Planning Area (Cooks River). The flood classifications are:

> Low hazard: Should it be necessary, people and their possessions could be evacuated by truck. Able bodied adults would have little difficulty wading out of the area.

> High hazard: Possible danger to life, evacuation by truck difficult, potential for structural damage, and social disruption and financial losses could be high.

> The identified areas, and their flood classifications, are:
  - Riverside Crescent/Tennyson Street area (Marrickville and Dulwich Hill): Low hazard to high hazard.
  - Illawarra Road/Wharf Street area (Marrickville): Low hazard to high hazard.
  - Carrington Road area (Marrickville): Low hazard.
  - Bay Street area (Tempe): Low hazard to high hazard.

Flood management controls apply as follows:

> For land in a flood planning area, the controls apply to all development that requires development consent.
> For land that is flood liable land, but that is not in a flood planning area (land within the Cooks River PMF), the controls also apply to caravan parks, childcare centres, correctional centres, emergency services facilities, hospitals, residential accommodation (except for attached dwellings, dwelling houses, secondary dwellings and semi-detached dwellings), and tourist and visitor accommodation.

The development controls for the former Marrickville LGA (the DCP 2011) are derived from a development nature approach. The procedure to determine what controls apply to proposed development involves:

> Section 2.22.5 of the DCP identifies the category of the development which are grouped into the following:
  - New residential development
  - Residential development – minor additions
  - Non-habitable additions or alterations
  - New non-residential development
  - Non-residential development – additions
  - Change of use of existing buildings
  - Subdivision
  - Filling of land within the Flood Planning Area
  - Land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map
  - Garages, carports, open car parks and basement garages.

There are twenty-nine development controls. **Table 5-1** indicates which flood management control applies to which type of development. Flood management controls are provided in **Appendix B**.

Table 5-4 Development Relevant Flood Management Controls

Development	Flood Management Control
General (applicable to all types of development)	C1, C2, C3, C4
New residential development	C5, C6, C7
Residential development – minor additions	C8, C9, C10
Non-habitable additions or alterations	C11, C12
New non-residential development	C13, C14
Non-residential development – additions	C15, C16
Change of use of existing buildings	C17, C18
Subdivision	C19, C20
Filling of land within the Flood Planning Area	C21
Land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map	C22, C23, C24
Garages, carports, open car parks and basement garages	C25, C26, C27, C28, C29

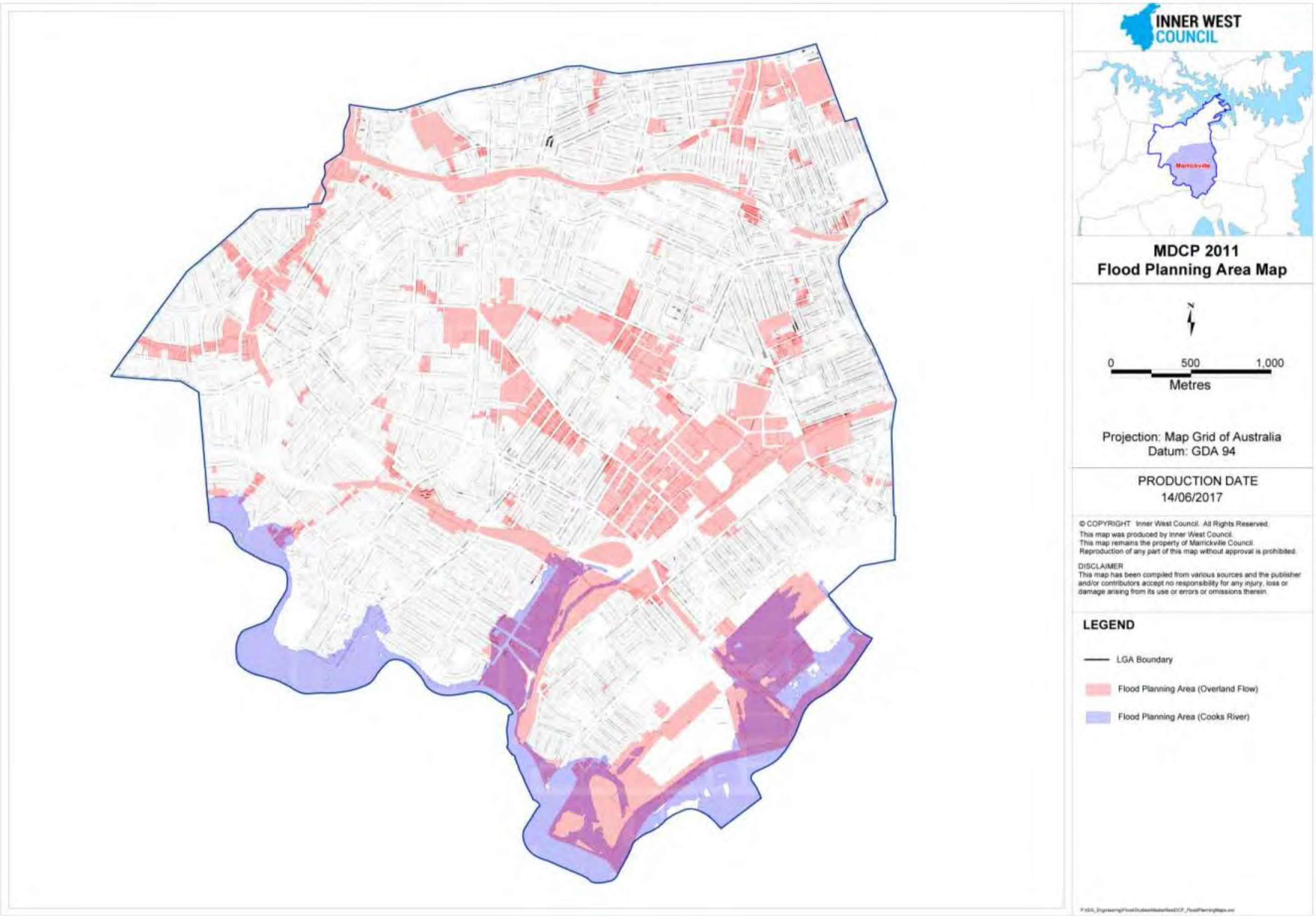

Figure 5-5 Marrickville DCP 2011 Flood Planning Area Map

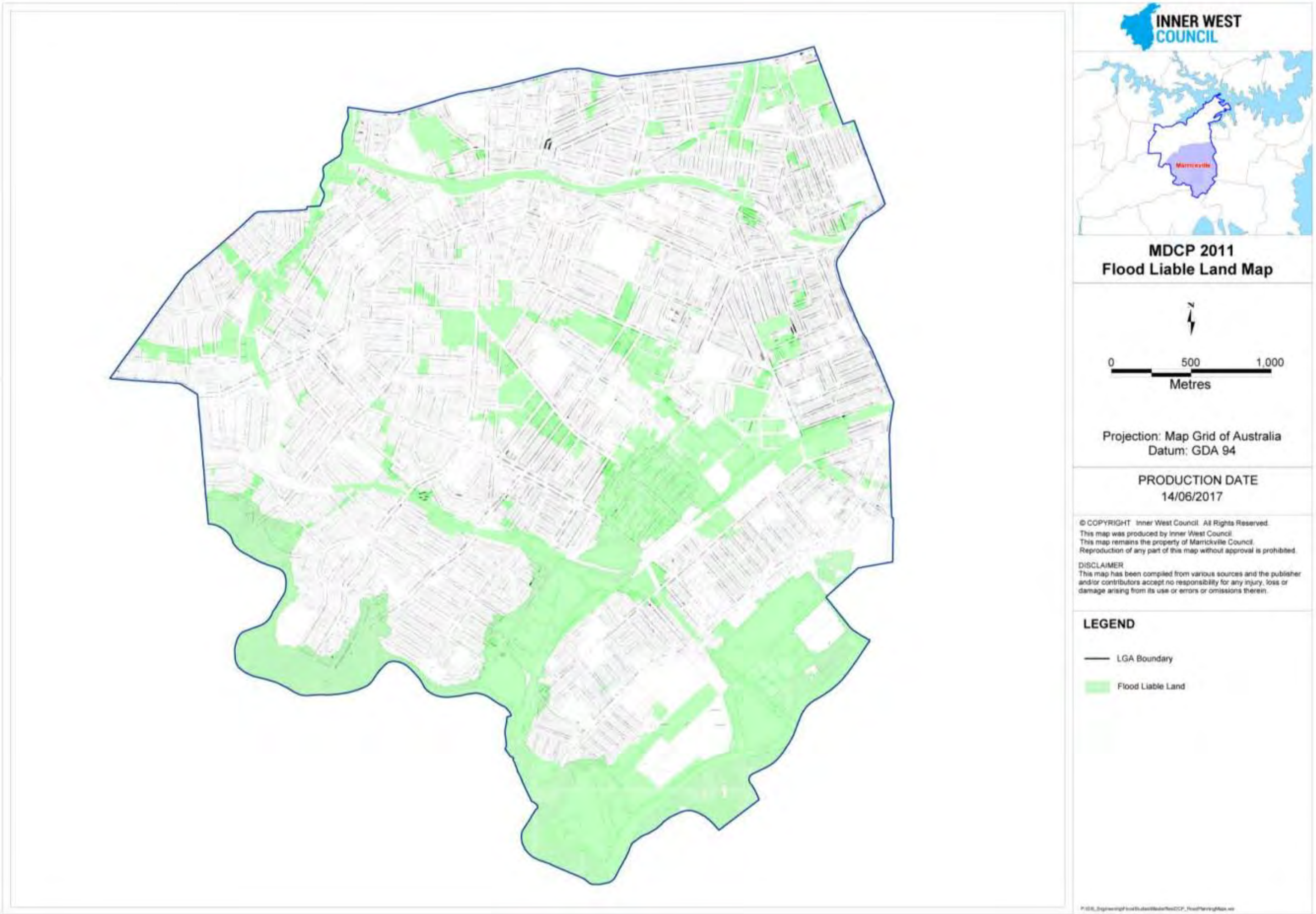

Figure 5-6 Marrickville DCP 2011 Flood Liable Land Map

5.4.3 Flood Impact and Risk Assessment Requirements

More recent guidance for applicant flood impact assessments is included within the 2022 FRM Manual guideline for Flood Impact and Risk Assessment (Flood Risk Management Guide FU01). The guideline provides details on the preparation of both simple and detailed Flood Impact and Risk Assessment (FIRA) for developments. The recommended preparation of a FIRA for developments should consider (as outlined in Section 3 of the FU01 guide):

> Proposed development: The proposed development needs to be shown with the necessary detail.

> Existing and developed model scenarios: The consent authority will need to ensure that flood modelling and/or analysis is sufficient to identify and assess the existing flood conditions and to determine post developed flood impacts and risks. Assessment needs to consider the key details of the final proposal, including development type and density (changing runoff characteristics), infrastructure, proposed modification to waterways or floodplain landform or vegetation.

> Impacts to be addressed: The consideration of development impacts is recommended to extend beyond flood level impacts only, with the table of impacts recommended to consider provided in **Table 5-5** below.

Table 5-5 Typical considerations when assessing impacts due to development (Source: NSW DCCEW, FU01 Guide)

Key considerations	Reasons for considering
Flood level change	• May increase inundation and damage to existing development • May inundate additional existing development • May create new or larger floodways or flowpaths • May isolate new areas
Change in duration of flooding	• May increase damage • May increase duration of isolation
Velocity change	• May increase scour potential and/or damage to buildings
Change in warning and evacuation time	• May decrease available warning time and time available for evacuation
Change in frequency of inundation	• Properties may become flood affected in more frequent events • Access may be cut more frequently • Areas may be isolated more frequently
Flood function categorisation change	• May change categorisation (e.g. flood storage to floodway) and change impacts on flooding on existing development
Hazard categorisation change	• May reduce safety to vehicles, people or buildings

> Managing residual flood risk: In many situations there will be opportunities to limit the increase in risk due to development, however, available options will vary depending on the stage and scale of the development being considered. Typical risk considerations include the risks to people, property and infrastructure, including the ability of the occupants to respond in an emergency. Residual risks will remain after management measures and development controls have been applied. A list of measures available to minimise the increase in flood risk to large and small-scale development are in **Table 5-6**.

Table 5-6 Typical measures to minimise impacts due to development (Source: NSW DCCEW, FU01 Guide)

Multi-lot, large-scale development	Individual, small-scale development
Include strategic management considerations and measures: • avoid floodways and flowpaths • avoid other highly flood constrained areas • provide management measures to manage risks to existing development • consider compatibility of land uses/ development types with the flood constraints on the land • determine and apply controls required to manage risk to the development and its users • consider emergency response issues and options and provide management measures consistent with advice from emergency services	Generally: • avoid floodways and flowpaths • avoid other highly flood constrained areas • apply controls to manage the risk to the development and its users: • management and design measures • structural considerations • floor level controls

The guide notes that documentation should ensure the intent of the approval is clear and maintained for the life of the approved development. This may include the need for conditions that consider:

> Limiting impacts and risks posed to the development and future occupants to ensure these have been appropriately managed. Consent conditions are to incorporate the key requirements to ensure these aspects are addressed. This may include the need to apply flood related controls such as those that nominate minimum fill or floor levels, structural considerations, management measures, address site egress, ensure the safety of occupants during flooding, and restrict unapproved modification to key elements of the development as approved in the consent.

> Management measures required to be considered in a staged manner as necessary to manage risks to the existing community.

> Inclusion of all design reports and drawings in the consent to ensure these are consistent with key parameters used in post development modelling and analysis that formed the basis of the FIRA.

> Modification of key design features of the development that may alter flood behaviour. This may require an additional approval with supporting modelling and/or reporting to ensure impacts of post developed flood risks are either in accordance with the original approval or are within the tolerable levels as defined by the consent authority.

> How risks and impacts of the development change with future climatic conditions.

> Any other specific requirements for consideration by the proponent to manage flood risk.

5.4.4 Conclusion of Review of Development Controls

Upon review of the flood-related development controls within the formerly Marrickville DCP 2011, the following general comments are noted:

> Compared to the requirements for planning proposals outlined within the 2021 Flood Prone Land Policy Update (refer to **Section 5.3.2**), the current development controls are generally in agreement with one exception:
  - The controls do not permit (only) filling of floodways or high flood hazard areas. Regarding the policy requirement for no residential accommodation in high hazard areas, there is a relevant control for new residential development enforcing flood free access must be provided where practicable.
  - The controls require filling of land within the Flood Planning Area (Control C21)
    - not increase flood levels by more than 10mm,
    - not increase downstream velocities by more than 10%,
    - not redistribute flows by more than 15%,
    - the potential for cumulative effects of possible filling proposals in that area is minimal,
    - the development potential of surrounding properties is not adversely affected by the filling proposal,
    - not increase the flood liability of buildings on surrounding properties, and
    - no local drainage flow/runoff problems.

> This is similar to requirements within the policy.
  - Requirements for storage of goods and hazardous materials is consistent.
  - Emergency management requirements are similar, though the controls are more prescriptive outlining refuge and evacuation requirements more specifically which is beneficial to aid applicants.
  - There is not a control that does not permit vulnerable and critical developments below the PMF level, similar to the requirements of the policy relating to these types of developments. Consideration should be given to amending the DCP to specifically address flood risk in vulnerable and critical developments,

> Compared to the requirements for FIRA from the 2022 FRM Manual Guide FU01. Generally, the current development controls are in agreement with the proposed requirements in the guide with some exceptions:
  - The current controls do not require consideration of climate change in assessments.
  - The current controls do not specifically require a consideration of residual risk of proposed developments to confirm if flood risk is lower than existing based on proposed risk management measures for developments.

> The development matrix approach offers a simple platform to be able to apply development controls specific to development types.

Ultimately, the current controls are generally fit for purpose, some alterations to the current development controls should be considered to bring it in accordance with recent guidance both within the 2021 Flood Prone Land Policy Update and the 2022 FRM Manual Guide FU01. This may include the following key changes from the bullet points above:

> setting controls to allow for no new residential accommodation in high hazard areas in accordance with the policy requirement,

> setting controls to reduce flood hazard and associated risk to existing residential accommodation in high hazard areas,

> setting controls that consider the higher flood risk of vulnerable and critical developments below the PMF level, and

> consideration of climate change in assessments.

6 Economic Impact of Flooding

The economic impact of flooding can be defined by what is commonly referred to as flood damages. Flood damages are generally categorised as either tangible (direct and indirect) or intangible damage types, these types are summarised in **Table 6-1**.

Table 6-1 Types of Flood Damages

Type	Description
Direct	Building contents (internal) Structural damage (building repair) External items (vehicles, contents of sheds, etc.)
Indirect	Building contents (internal) Structural damage (building repair) External items (vehicles, contents of sheds, etc.)
Intangible	Social (increased levels of insecurity, depression, stress) Inconvenience (general difficulties in post-flood stage)

The direct damage costs, as indicated in **Table 6-1**, are just one component of the entire cost of a flood event. There are also indirect costs. Together, direct, and indirect costs are referred to as tangible costs. In addition to tangible costs, there are intangible costs such as social distress. The flood damage values discussed in this report are the tangible damages and do not include an assessment of the intangible costs which are difficult to calculate in economic terms.

The purpose of a flood damage assessment is to support decision-making on FRM options. It provides the basis for understanding the scale of benefits or disbenefits FRM measures may have on flood damages to the community. The damage assessment is not intended to be a precise estimate of damage at a given location. Rather, it is intended to provide a reasonable understanding of the relative scale of damage across the study area (focusing on aspects that will be materially changed by FRM measures) and how this may be altered with the implementation of FRM measures.

6.2 Input Data

6.2.1 Building Footprints

The primary flood damage calculation relates to building damages, being structural, contents, relocation, and clean-up costs. Therefore, building damages have been calculated for each individual building footprint, based on the building footprint layer provided by NSW DCCEW.

Commonly in the past flood damages were calculated on a per property basis rather than a per building basis. The adopted damage per building calculation provides a more accurate determinant of flood affectation due to the following reasons:

- Properties may have multiple buildings in the one property therefore damages can be calculated per building and added together,
- Flood model results can be considered only within the building footprints to provide a more accurate localised picture of flood affectation. On a property basis, flooding far removed from building footprints may misrepresent flood affectation near the building where the majority of flood damages are caused.

Therefore, the bulk of flood damages calculation has been conducted based on NSW DCCEW building footprints. The exception is for external (garden) damage which has been considered on a per property basis and then added to the cumulative building damages for each property to create a combined total damage.

6.2.2 Building Types

The adopted damages approach allows for unique classification of flood damages based on the type of building that were able to be determined for each building across the study area. Building types were derived for each building footprint based on building type provided in the NSW DCCEW footprint layer and confirmed through site visit observations, and Google Streetview observations. For example, all 1% AEP flood affected residential classed properties were inspected from site visit photos or Google Streetview to confirm if they were single or double storey. The building types were classified as follows:

> Residential building types:
  - Single storey:
  - Double storey,
  - Multi-unit,
  - Townhouse.
> Non-residential building types:
  - Low to medium being restaurants, cafes, offices, surgeries, retail outlets, service stations, hardware stores,
  - Default average,
  - Medium to high being chemists, electrical goods, bottle shops, electronics.
> Public buildings:
  - School
  - Hospital
  - Other

Note that all secondary buildings such as garden sheds and garages in residential properties were excluded from damages calculations. In total, when removing secondary buildings there were a total of 909 buildings assessed in the flood damages calculation across the catchment.

The number of dwellings per building footprint were also estimated based on aerial images, site visit observations and Google Streetview. In addition, residential properties were grouped by size with small being less than 135 m^2, medium being between 135 – 200 m^2, default being between 200 – 230 m^2 and large being 230 m^2 or greater.

6.2.3 Floor Levels

Floor levels for all building footprints have been adopted in the damages calculation through one of two methods:

- Based on floor levels survey for the building for surveyed buildings in the study area. The floor level survey data is summarised in **Section 3.5**.
- For non-surveyed buildings, the following floor level estimation process was applied:
  - The average ground level for the building footprint was calculated using the TUFLOW model terrain.
  - Using Google Streetview, an approximate floor height above ground levels was estimated. This floor height was typically 0.15 metres for slab-on-ground type construction, 0.3 metres for normal construction and 0.6 metres for higher suspended floor type buildings.
  - The estimated floor level was calculated from average ground floor of the building footprint plus the approximate floor height above ground.

6.2.4 Hydraulic Model Results

To inform the flood damages calculation, a range of base case model results were assessed for all five design flood events, 20%, 5%, 2% and 1% AEP and PMF events. The results were applied as max values across the building footprints:

- Maximum water levels for footprints were determined for each design event,
- Maximum depth results for footprints were determined for each design event, and,
- Maximum H1-H6 hazard category within the footprint were determined for each design event.

In addition, to inform external (garden) damage calculation, the maximum flood depth for properties were calculated for each design event.

6.3 Flood Damages Methodology

Flood damages can be assessed by several methods including the use of computer programs such as FLDamage or ANUFLOOD, or via more generic methods using spreadsheets. For the purposes of this project, the recently released 2023 Flood Damages Tool (DT01) prepared by NSW DCCEW as part of the FRM Manual 2023 has been adopted for calculation of building damages, with external damages calculated using in-house spreadsheet analysis as summarised in the following sub-sections.

6.3.1 New Flood Damages Tool

This flood damages analysis has been based on the Flood Damages Tool (DT01) prepared by NSW DCCEW as part of the FRM Manual 2023. The damages tool is supported by Section 3 of the Flood Risk Management Measures - Flood Risk Management Guide MM01 which provides background and guidance on the use of the tool.

The methodology outlined within the damages tool is an improved and more detailed calculations than previous damages tools. The damages tool DT01 provides the following advantages over past damages tools provided by the NSW Government:

- It provides not only residential damages for single and double storey houses similar to past tools, but it also provides damages curves for commercial and public infrastructure buildings and specific public buildings,
- The methodology also allows for calculation of risk to life projected costs based on the H1-H6 hazard categorisation of the building,
- It allows for damages estimation based on building footprint areas providing additional detail in analysis.

Therefore the DT01 damages tool was ultimately considered suitable for adoption in this study.

6.3.2 Calculation Parameters

The damages tool DT01 curves are derived for late 2019, and as part of this Study were updated to represent late 2022 dollars (only quarter 1 2023 inflation data available at the time of this report).

General recommendations in the damages tool and guideline are to adjust values in residential damage curves by Consumer Price Index (CPI). The most recent data for CPI from the Australian Bureau of Statistics at the time of the assessment was for March 2023. Therefore, all ordinates in the residential flood damage curves were updated to March 2023 dollars (CPI 132.7) from December 2023 dollars (CPI 130.9).

Consequently, all ordinates on the damage curves were increased by 1.38% compared to the curves presented in the flood damages tool DT01.

6.3.3 Damage Curves for Overfloor Flooding Depths

Residential and non-residential flood damages are generally assessed based on assessments of structural damage, damage to contents, external damage, relocation costs and clean-up costs. In limited cases, the additional damage costs related to structural integrity due to building failure may also warrant consideration. The adopted flood damages curves for residential single and double storey buildings for the various building sizes are shown in **Figure 6-2** and **Figure 6-2** respectively.

Further details about the formulation of the residential damage curves adopted in the flood damages tool DT01 are included in Section 3.1 of Flood Risk Management Guide MM01.

Non-residential flood damage curves including commercial / industrial and public buildings are shown in **Figure 6-3**. Further details about the formulation of the non-residential damage curves adopted in the flood damages tool DT01 are included in Section 3.2 of Flood Risk Management Guide MM01.

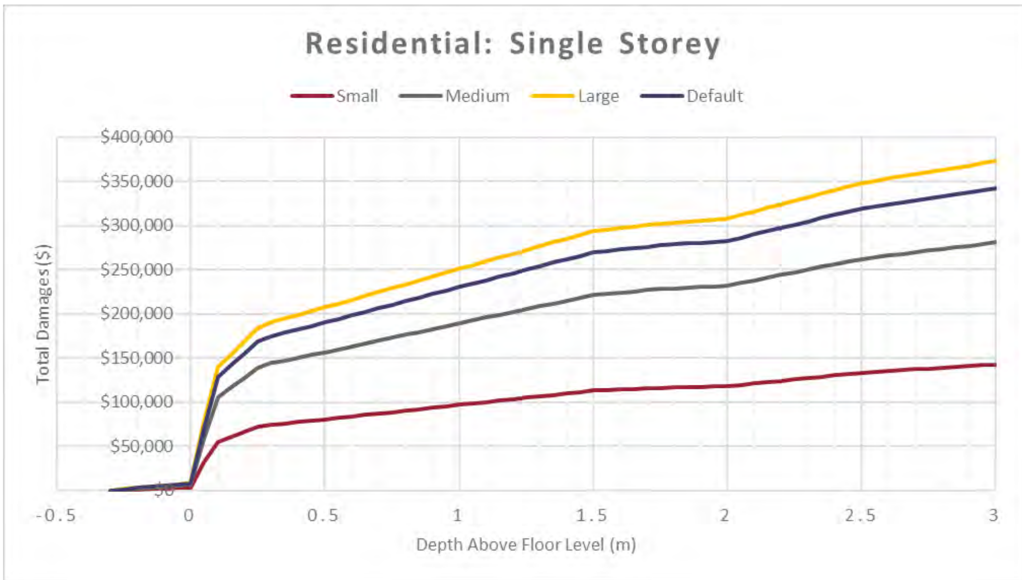

Figure 6-1 Adopted Damage Curves for Residential Single Storey (Source: DT01 Damages Tool)

Figure 6-2 Adopted Damage Curves for Residential Double Storey (Source: DT01 Damages Tool)

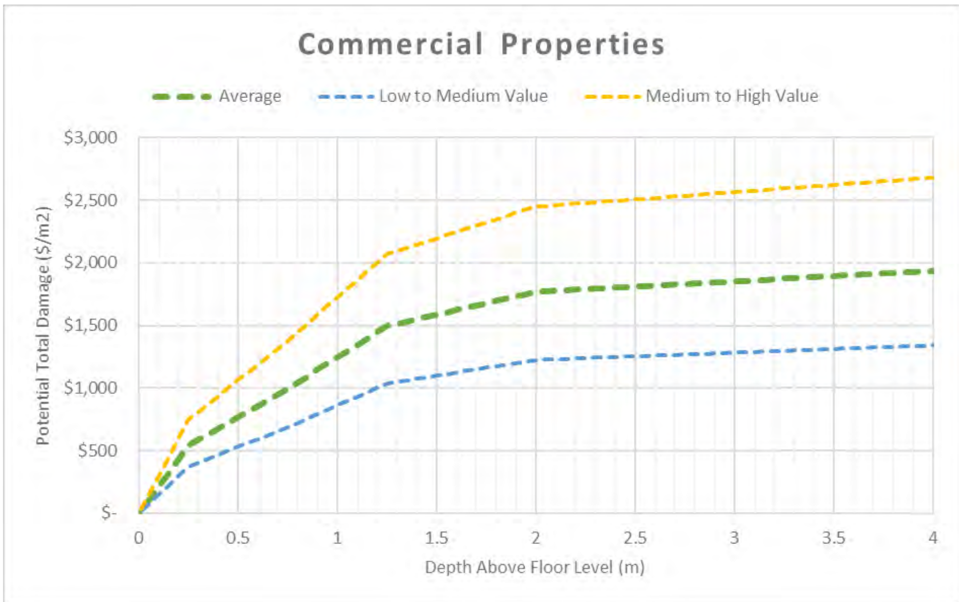

Figure 6-3 Adopted Damage Curves for Commercial and Public Buildings (Source: DT01 Damages Tool)

6.3.4 Property Based Damages Calculation

A fixed external damage of $17,234 in 2023 dollars ($17,000 in 2022 dollars) is to be used for each dwelling site and for each site that contains multi-unit dwellings. This is used when flood depths above the ground level adjacent to the building are at least 0.3 metres or are above the habitable floor level of the house.

The trigger for these external damages has been based on average ground levels around the buildings, if the depth results exceed the threshold of the 0.3 metres, then the fixed damage rate has been applied to each property. The basis for external damage calculation has been based on the building footprint layer, and not based on a property layer. Therefore no external damage has been applied to properties without a building.

6.3.5 Adopted Input Parameters

The flood damages tool DT01 provides numerous input parameters to tailor the flood damages analysis. The tool and associated guide provide advice with respect to default values. The input parameters for this flood damages assessment are as follows:

- Actual to potential ratio = 0.9 (default)
- Regional uplift factor = 1.00 (default for Sydney region)
- Infrastructure damages uplift = 10% of residential damages (default)
- Damages downscale for townhouses and units = 30% (default)
- Internal / contents rate = $550 / m^2 (default)
- Residential clean-up costs = $4,500 / property (default)
- Non-residential indirect costs = 30% of direct actual damages, clean-up costs and loss of trading (default).

With respect to risk to life damages calculations, the equations adopted within the flood damages tool DT01 are summarised in **Figure 6-4**.

$$Injuries = 2 \cdot N_z \times \frac{HR \cdot AV}{100} \cdot PV$$

$$Fatalities = 2 \cdot N(I) \times \frac{HR}{100}$$

$$Hazard\ Rating\ [HR] = d \times (v + 0.5)$$

Where,

N_z	Population living in the floodplain
HR	Hazard Rating (Table 12-6)
AV	Area Vulnerability (Table 12-7)
PV	People Vulnerability = {% residents suffering any long-term illness, % aged 75+}
N(I)	Number of injuries
d	Depth of flooding (m)
v	Velocity of floodwaters (m/s)

Figure 6-4 Flood Risk to Life Damages Calculations (Source: NSW DCCEW, 2023)

The adopted flood risk to life parameters are as follows:

The adopted flood risk to life parameters are as follows:

- Estimated cost per fatality = $5,300,000 (default taken from the Office of Best Practice Regulation (Australian Government)
- Estimated cost per injury = $52,962 (default taken from the Office of Best Practice Regulation (Australian Government)
- N(z) average people per household = 2.1 (default from ABS)
- Speed of onset = 3 (rate of rise is less than 1 hour)
- Primary nature of area = 2 (detached residential dwellings)
- Flood Warning Factor = 3 (calculated from P1, P2 and P3)
- Area Vulnerability (AV) = 8
- People Vulnerability = 36% (default)

6.4 Flood Damages Outcomes

6.4.1 Total Damages

The total damages have been calculated for all design events, 20%, 5%, 2%, and 1% AEP and the PMF event. The results are tabulated in **Table 6-2** and **Table 6-3** show that the damages total for Whites Creek and Johnstons Creek respectively. The tabulated results also show the building and external damages.

As it relates to contributions from building and external damages, the external component makes up only a fraction (8.25% – 13.5%) in Whites Creek and (7.7% – 13.1%) in Johnstons Creek of the total damages, with the vast majority being building related damages including structural, risk to life, contents, relocation etc.

The total damage values and number of affected properties / buildings, and average depth of flooding for the 20%, 5%, 2%, and 1% AEP events are shown **Table 6-2** and **Table 6-3**.

Table 6-2 Existing Total Damages Summary for Design Flood Events for Whites Creek Study Area

Event	Damage Type	Total Damages	Number of Overfloor / Overground Flooded	Avg. Overfloor/ Overground Depth (m)
20% AEP	Building	$2,343,533	39	0.10
	External	$720,371	83	0.34
	Total	$3,063,904		
5% AEP	Building	$3,687,428	48	0.13
	External	$777,243	97	0.34
	Total	$4,464,671		
2% AEP	Building	$3,930,937	52	0.14
	External	$853,071	99	0.36
	Total	$4,784,009		
1% AEP	Building	$4,456,495	59	0.15
	External	$947,857	105	0.37
	Total	$5,404,352		
PMF	Building	$21,749,361	160	0.35
	External	$2,417,036	202	0.61
	Total	$24,166,397		

Table 6-3 Existing Total Damages Summary for Design Flood Events for Johnstons Creek Study Area

Event	Damage Type	Total Damages	Number of Overfloor / Overground Flooded	Avg. Overfloor/ Overground Depth (m)
20% AEP	Building	$36,477,108	272	0.16
	External	$4,514,960	545	0.36
	Total	$40,992,067		
5% AEP	Building	$57,005,721	340	0.22
	External	$5,609,735	633	0.41
	Total	$62,615,455		
2% AEP	Building	$67,308,868	391	0.24
	External	$6,279,554	680	0.43
	Total	$73,588,421		
1% AEP	Building	$76,299,705	419	0.27
	External	$6,592,346	726	0.44
	Total	$82,892,052		
PMF	Building	$234,467,979	835	0.44
	External	$12,953,280	1139	0.63
	Total	$247,421,259		

6.4.2 Average Annual Damage

Average Annual Damage (AAD) is calculated using a probability approach based on the flood damages calculated for each design event. These damage curves attempt to define the damage experienced on a property for varying depths of flooding. The total damage for a design event is determined by adding all the individual property damages for that event. AAD attempts to quantify the flood damage that a floodplain would receive on average during a single year. It does this using a probability approach.

While the PMF event has a theoretical probability of 0% of occurring, to inform the calculation of AAD a representative probability of 0.0000001 (or 0.00001%) has been adopted for the PMF event (equivalent to a 10,000,000 year ARI event). This is based on guidance from AR&R Book 8 – Estimation of Very Rare to Extreme Events which notes this as the equivalent recurrence event for catchment less than 100 km^2. Through this method, the PMF accounts for extremely rare flood events in the AAD calculation.

For the most frequent event, the 20% AEP event, a lower bound flood damages estimate is required for the next most frequent event. In the DT01 tool it has been assumed that the total damages in the 100% AEP event will be $0 creating the lower bound of the AAD curve as per the default set-up of the tool.

The AAD calculation for the Whites Creek and Johnstons Creek catchment is summarised in **Table 6-4** and **Table 6-5.**

Table 6-4 Whites Creek Average Annual Damage Summary for Design Flood Event Contributions

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$3,063,903.96	**$1,242,852.12**	58%
5%	0.05	$4,464,671.08	**$566,565.20**	26%
2%	0.02	$4,784,008.54	**$140,083.55**	7%
1%	0.01	$5,404,351.73	**$51,276.34**	2%
PMF	0.0000001	$24,166,396.99	**$147,705.89**	7%
Total AAD			**$2,148,483.10**	

Table 6-5 Johnstons Creek Average Annual Damage Summary for Design Flood Event Contributions

AEP	Probability	Total Damages	AAD Contribution	AAD Contribution %
20%	0.20	$40,992,067.07	**$16,541,136.30**	57%
5%	0.05	$62,615,455.20	**$7,809,005.61**	27%
2%	0.02	$73,588,421.34	**$2,060,651.80**	7%
1%	0.01	$82,892,051.58	**$783,517.49**	3%
PMF	0.0000001	$247,421,258.99	**$1,649,914.99**	6%
Total AAD			**$28,844,226.18**	

The total AAD for the Whites Creek is over $2 million. Nearly half (58%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing 26% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 2 – 7% of AAD contribution. By looking at Johnstons Creek result we can determine that the total AAD is over $28.8 million. Also, nearly half (57%) of this AAD is a result of the most frequent 20% AEP event, with the next most frequent event, the 5% AEP contributing 27% of the AAD. The less frequent events, the 2% and 1% AEP and PMF provide between 3 – 9% of AAD contribution. Though these events result in far higher flood damage totals, particularly the PMF event, their relatively low likelihood means they contribute less to the AAD.

Therefore, as it relates to damages and AAD, structural flood risk management options that reduce flood damages for the most frequent 20% AEP event are expected to provide the biggest benefits to AAD reductions.

7 Flood Emergency Response Review

When determining the flood risk to life, the flood hazard for an area does not directly imply the danger posed to people in the floodplain. This is due to the capacity for people to respond and react to flooding, ensuring they do not enter floodwaters. This concept is referred to as flood emergency response. To help minimise the flood risk to occupants, it is important that there are provisions for flood emergency response.

The primary strategy for the NSW State Emergency Service is horizontal evacuation of people to an area outside of the effects of flooding that has adequate facilities to maintain the safety of the community. However, during flash floods this may not be possible due to the short warning times.

The emergency response provisions for Inner West Council are outlined in the Inner West Local Emergency Management Plan (EMPLAN) and overseen by the Local Emergency Management Committee. Under the provisions of the EMPLAN, NSW SES are appointed as the lead agency for response to Flooding Emergencies. The NSW SES, in conjunction with the Inner West LEMC is responsible for the preparation and management of the Inner West Council Flood Emergency Sub Plan. These documents are intended to provide information to residents and other authorities relating to identified evacuation centres, evacuation procedures, as well as actions and responsibilities in the event of flooding. A review of these available documents is included in **Section 7.1**. There is also a review of available flood emergency response advice in flash flooding situations in **Section 7.2**.

In addition, a review of the flood emergency response potential for the Whites Creek and Johnstons Creek catchments summarised below including key emergency management locations (**Section 7.3**), current and possible flood warning systems (**Section 7.6**), evacuation timeline review (**Section 7.4**), potential for shelter-in-place refuge (**Section 7.6**), and a summary of flood emergency response hotspots (**Section 7.5**).

7.1 Emergency Flood Management Documentation

Emergency Flood Management in NSW is managed by the NSW SES at three levels of scale, at a state-wide level, at a regional level, and a local level. Each subsequent level provides additional local detail in emergency management.

The Inner West catchment is located within the Sydney Metropolitan Emergency Management Region. This region encompasses 8 Local Government Areas of Sydney bounded by Woollahra, Waverley and Randwick to the east and Sutherland Shire to the southwest. The relevant local area with respect to SES emergency planning is the Inner West Local Government Area (LGA).

7.1.1 Local Flood Plan

In December 2021 the SES released Volume I the Inner West Flood Emergency Sub Plan covering operations for flooding within the Inner West Council LGA. Volume I of the plan outlines emergency management arrangements for prevention, preparation, response and initial recovery for flooding in the Inner West LGA.

The local strategies for flood emergency response outlined within Volume I were divided into the four stages of emergency management, prevention / mitigation, preparation, response, and recovery operations. In response to strategies a range of recommended actions are nominated for SES to achieve these strategies. The total number of strategies is 32 and 136 actions, spread across the four stages of emergency management as follows:

- Prevention / mitigation – 2 strategies and 4 actions.
- Preparation – 6 strategies and 22 actions.
- Response – 23 strategies and 105 actions.
- Recovery – 1 strategy and 5 actions.

7.1.2 Local EMPLAN

Inner West Council has established a Local Emergency Management Committee to carry out emergency management as the responsible authority for the Inner West local government area. This committee is responsible for an all-agencies comprehensive approach to emergency planning to prepare the community for disasters. Committee members include Emergency Services and agencies with functional responsibilities.

Inner West Emergency Management Plan has recently been published by NSW SES.

7.1.3 Regional and State Documents

The relevant regional and state emergency management documents are as follows:

- Sydney Metropolitan Region Emergency Management Plan – January 2022
- NSW State Flood Plan – December 2021
- NSW State Emergency Management Plan – December 2018.

The various documents provide more useful information in relation to the roles and responsibilities of various stakeholders in both general emergencies (EMPLANs) and specifically for flood emergencies (Flood Plans).

7.2 Guidance on Emergency Response in Flash Flooding

7.2.1 AFAC Guideline for Emergency Response in Flash Flood Events

In April 2018, the Australasian Fire and Emergency Service Authorities Council (AFAC) released the *Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events*. This guideline for flash flood events provides a useful insight into the position of the national emergency services authorities' council, of which NSW SES is a member. The guideline reflects a consensus on best practice for managing flash flooding, focussing on risk to life. The AFAC define flash flooding as:

> *Flash flooding can be defined as flooding that occurs within six hours or less of the flood-producing rainfall within the affected catchment. This may result in isolation of individuals and communities as time to warn and respond to flash flooding is limited.*
>
> *Flash flood environments are characterised by the rapid onset of flooding from when rainfall begins (often within tens of minutes to a few hours) and by rapid rates of rise and by high flow velocity. The duration of flash flooding is often relatively short by comparison to riverine floods.*

The discussion of flood timing for the Whites Creek and the Johnstons Creek study area (**Section 7.4.2**) shows the entire floodplain is flash flooding based on the above definition, making this guideline relevant to the catchment.

7.2.2 Guidance on Flood Emergency Response Potential in Flash Flood Environments

Effective evacuation typically requires lead times of longer than just a couple of hours and this creates a dilemma for flash flood emergency managers. The following excerpt from the AFAC guideline outlines the dilemma as it relates to the suitability of evacuation and shelter-in-place potential in flash flood environments:

> *Because of the rapid onset of flash flooding and associated high velocity floodwaters, up to 75% of flash flood deaths occur while people are outside buildings attempting to leave or return, and directly exposed to floodwater.*
>
> *This suggests that if evacuation has not occurred prior to the arrival of floodwater, taking refuge inside a building may generally be safer than trying to escape by entering the floodwater. However, some deaths – 25% of the total – occur among people trapped inside buildings. Details are not well documented, and these deaths could be the result of the building filling with flood water to a depth occupants cannot survive or because those trapped inside are swept away when the building fails. Other causes of death could be serious injury or an emergency medical condition while access to emergency assistance is compromised. Fires might also break out in buildings surrounded by floodwater, in which case occupants might not be able to evacuate as they would usually do.*
>
> *For these reasons, remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy for pre-incident planning or incident action planning, even if the buildings are considered likely to withstand the impact of flash flooding. Where the available warning time and resources permit, evacuation should be the primary response strategy.*

This conclusion is similar to advice provided by NSW SES representatives for past studies within Sydney:

> *The NSW SES considers evacuation as the primary response strategy during flooding to protect the at-risk community. This strategy relies on the principles for evacuation that include:*
>
> - *Evacuation completed in sufficient time before the onset of a flood is the safest emergency management strategy.*
> - *The primary method of evacuation should be by vehicle where feasible with pedestrian evacuation as a backup option.*

- *Evacuation must not require people to drive or walk through flood water.*
- *The best vehicular evacuation routes are vehicular escape routes that rise steadily and lead away from the flood.*
- *For existing communities, a strategy of having occupants shelter in place may be acceptable, where the decision to evacuate is left too late, as long as the buildings they inhabit are out of the floodwater or are structurally sound.*
- *Emergency management strategies must consider expected human behaviour and the expected range of severity of hazards*
- *Sheltering in place should only be a strategy where the risk if staying is lower than the risk of evacuating.*

The SES's position, continues to be that isolation is dangerous from the moment it commences and the longer the isolation continues, the more opportunity there is for an emergency to develop.

Additionally, secondary emergencies such as fires and medical emergencies may occur in buildings isolated by floodwater. During flooding it is likely there will be a reduced capacity for relevant emergency service agencies to respond. Even relatively brief periods of isolation, in the order of a few hours, can lead to personal medical emergencies.

While the preferred method of emergency response throughout NSW is for evacuation to be assisted and directed by the SES, there are certain emergency situations where there is limited time available to prepare and facilitate a staged evacuation as preferred. One such example is flash flooding where the rate of rise of floodwaters is extremely fast and the ability for SES to co-ordinate a regional evacuation strategy is not possible.

7.2.3 Guidance for New Developments in Flash Flood Environments

Given the life risk posed by flash flooding and the inherent limitations on how it can be managed, the AFAC guideline recommends new development areas:

- *be designed within the limits of existing flash flood forecast capability,*
- *facilitate rapid and safe evacuation from flash flood prone locations,*
- *account for the likelihood that some people might become trapped inside buildings, and*
- *involve a thorough understanding of how people will behave in a flash flood event and their risks*.

This conclusion is similar to advice provided by NSW SES staff for past studies for new developments:

- *No increase to the existing risk to life and evacuation or reduces the current continuing or residual risk to life.*
- *Where evacuation cannot be accomplished and 'shelter in place' is proposed, then development that will increase the risk to life of future occupants and increase reliance on emergency services should not be permitted. Development strategies relying on deliberate isolation or sheltering in buildings surrounded by flood water are not equivalent, in risk management terms, to evacuation.*

Self-evacuation of the community should be achievable in a manner which is consistent with the NSW SES's principles for evacuation.

It should be made very clear that in relation to the strategy of sheltering in place the SES has done some work with several councils which have flash flood risk over large urban areas. In this existing flash flood context, and only in that context, it has been recognised that causing residents to attempt to evacuate at the time flash flooding is occurring, could be a serious risk to life. Only in areas where urban redevelopment cannot be prevented under existing planning policy, it has therefore been proposed that the DCP (that applies) for any new or redeveloped dwelling will require an internal refuge area above the level of the PMF (Opper and Toniato, 2008).

7.3 Emergency Management Locations

7.3.1 Emergency Services Locations

Emergency services locations are considered critical during flooding if the infrastructure is relied upon for emergency management on a regional scale or pose a significant hazard to surrounding areas. Therefore, these types of emergency services have been mapped at a regional scale around the Whites Creek and Johnstons Creek Catchment as shown in **Figure 7-1**. This map has also been included in **Appendix C**.

The following emergency services have been mapped in the region around this catchment:

- Hospitals,
- Ambulance stations,
- Fire stations,
- Police stations, and
- NSW SES facilities.

Within the study areas there is the Newtown Police Station, NSW Newtown Fire Station, Street John Ambulance and King George V building Hospital all located in the Johnstons Creek Catchment. The Newtown Police Station and the NSW Newtown Fire Station site are partially flood affected in the 1% AEP and PMF events While Street John Ambulance is flood free in all the events, also Australia Street is flood free from the south but flooded from the south.

Also shown in **Figure 7-1** with the emergency service locations is the 1% AEP and PMF flood extents, not only for the study area, but for the vicinity of Whites Creek and Johnstons Creek. The flood extents show the regional isolation of the study area from emergency services.

Most roads are isolated from overland flooding from within the Study Areas, then other catchments cause road flooding that would further block access to emergency services during a regional overland flood event. Though it was not possible to show the flood extents outside the LGA, it is assumed that access to emergency services would be similarly restricted for areas outside the LGA. The nearest hospitals would be King George V building and Royal Prince Alfred Hospital Emergency Room in the northeast of study area. It is assumed that there would be no flood free access to these hospitals in the event of a regional flash flooding event from any part of the study area.

7.3.2 Vulnerable Developments

Vulnerable development relates to the increased risk of loss of life to vulnerable people including children, the elderly and disabled in most of these land use types. These demographics have a significantly greater risk to life when exposed to flood hazard. In addition, there is increased risk to life resulting from periods of isolation from medical emergency services due to pre-existing health conditions. Mobility of the related demographics is also compromised which will impede the effectiveness of both emergency response types. Included in these development types are:

- Schools, Preschools, and Childcare centres,
- Aged care facilities and retirement villages,
- Detention Centres – due to the limited mobility of the detained, these sites make flood evacuation much more difficult, and
- Hotels – the lack of local knowledge of hotel guests, coupled with the number of guests needing to be managed by hotel staff mean these are higher risk sites.

These categories of vulnerable developments match those presented in the 2021 Flood Prone Land Policy Update. Further discussion of the relative vulnerability of development types is in **Section 5.2**.

These sites have been mapped for the Study Area in **Figure 7-2**, which is also included in **Appendix C**.

The mapping shows that most vulnerable developments are suitably located in flood free land, with some of these developments partially affected by flooding, with only some locations significantly flood affected. Due to the permissibility of childcare centres, preschools and retirement communities in various land use zonings, the location of vulnerable developments will change over time. This mapping should be reviewed and updated by Council in the future to have a continued understanding of flood risk vulnerable developments.

7.3.3 Current Emergency Management Procedures for Vulnerable Developments

The NSW SES within the Inner West LGA Local Flood Plan provide the following specific actions within **Section 5.8.3** and **Section 5.9.2** as it relates to evacuation of vulnerable developments:

- Health Services Functional Area will coordinate the evacuation of hospitals, health centres and aged care facilities (including nursing homes) in consultation with the NSW SES and Welfare Services.
- School administration offices (Government and Private) will coordinate the evacuation of schools in consultation with the NSW SES and Welfare Services, if not already closed.
- Welfare Services Functional Area will manage evacuation centres for affected residents and travellers in accordance with the Welfare Services Functional Area Supporting Plan.
- Schools Administration (Government and Private) will manage the safety of students directly affected by flooding and will work with the NSW SES in the temporary closure of schools and will coordinate with NSW SES Transport and Welfare Services in the management of school evacuees.

As discussed further in **Section 7.4.6**, the flash flooding nature of the Study Area will make it difficult for SES to coordinate the evacuation of these vulnerable sites within the time available from the onset of rainfall. It is therefore recommended that individual flood response plans are developed for both existing and future vulnerable developments that are flood affected within the study area.

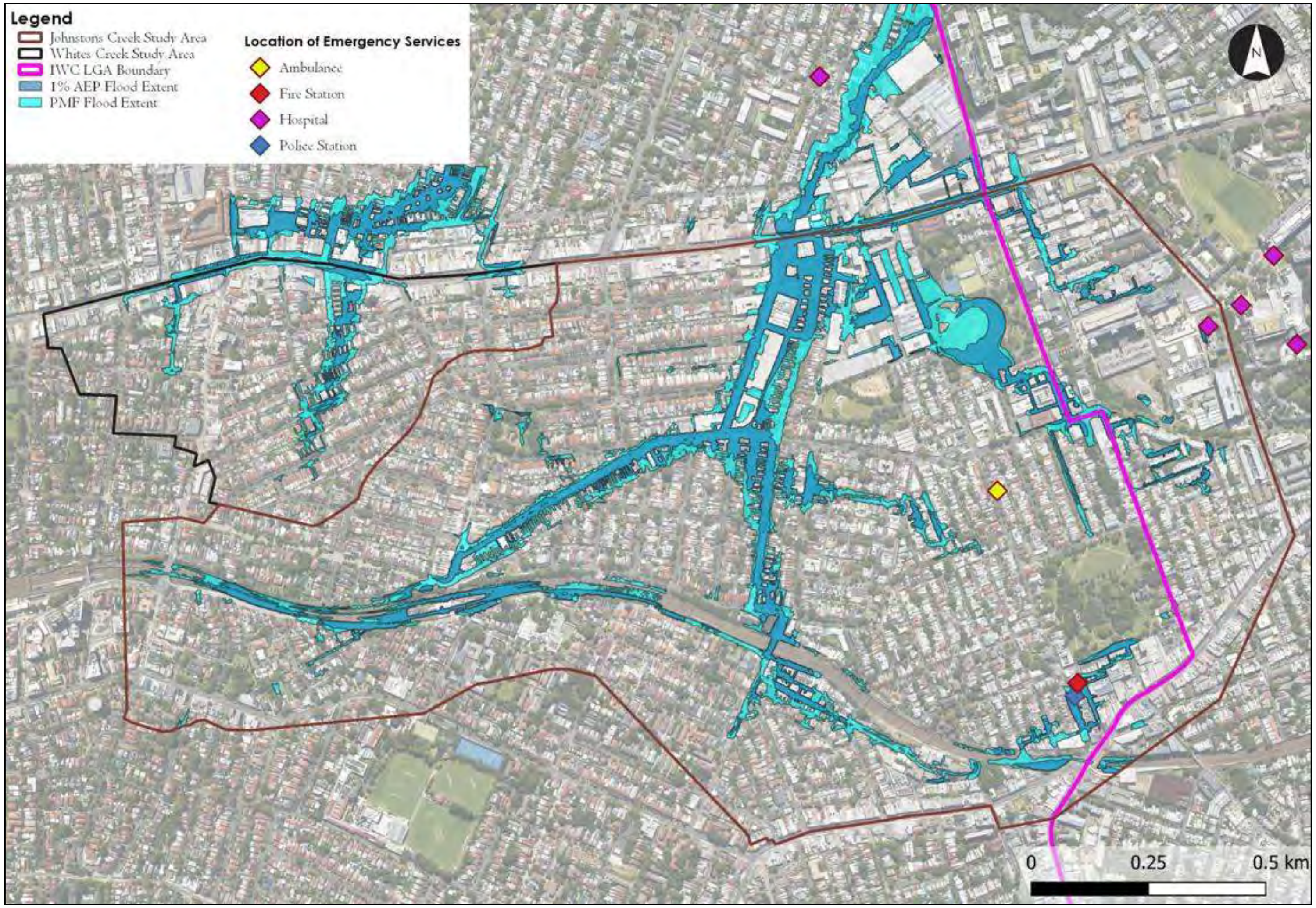

Figure 7-1 Location of Emergency Services in the Region with CBC LGA 1% AEP and PMF Extents

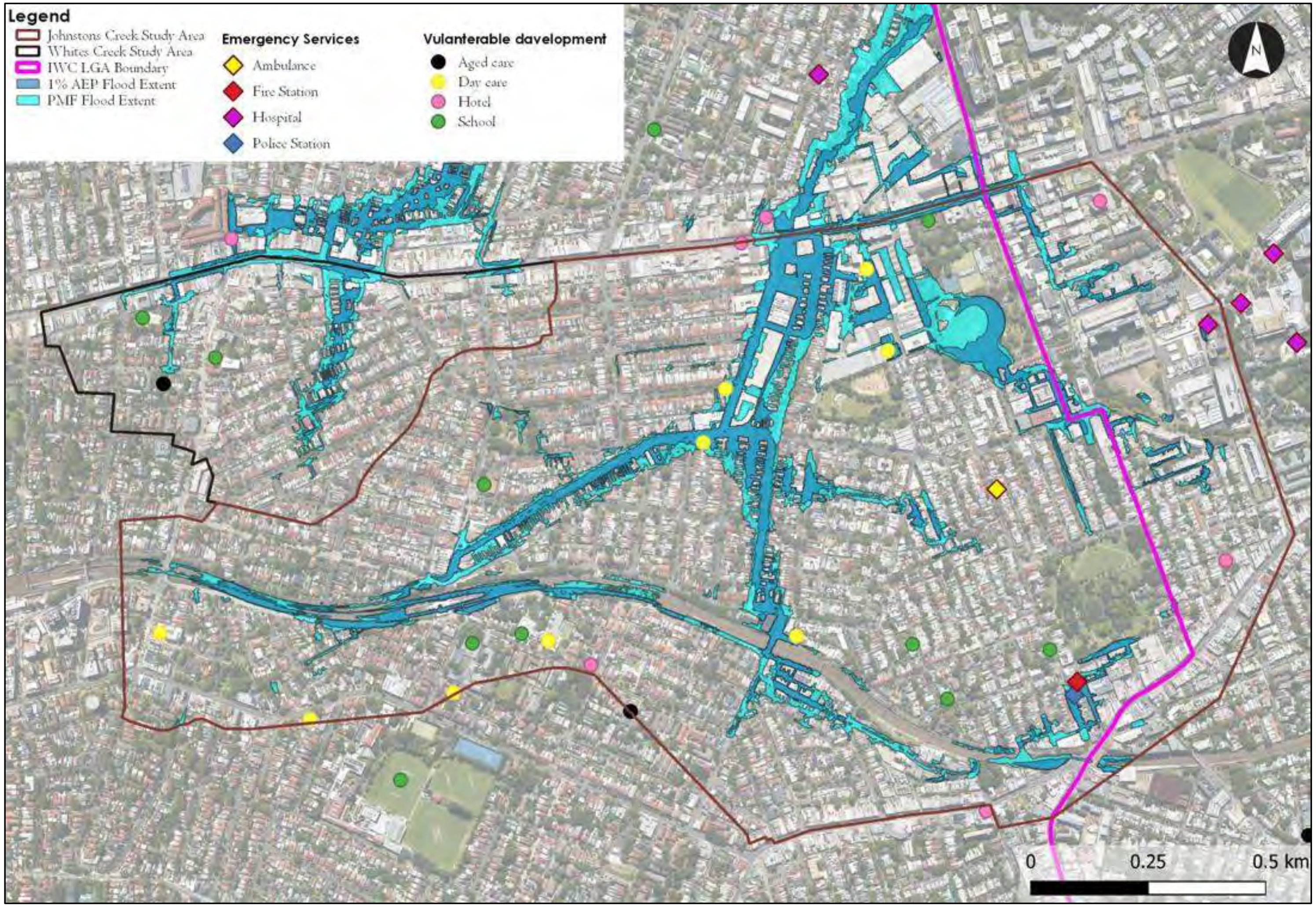

Figure 7-2 Location of Vulnerable Developments and Emergency Services within the Study Area with 1% AEP and PMF Extents

7.4 Evacuation Timeline

7.4.1 Background

The NSW SES Timeline Evacuation Model has been the de facto standard for evacuation calculations in NSW since it was first developed for evacuation planning in the Hawkesbury Nepean Valley. Though the guideline has not yet been released, the paper Technical Guideline for SES Timeline Evacuation Model was prepared by Molino S. et al in 2013 briefing the industry on the application of the guideline.

The timeline assessment of evacuation potential relates to the regional evacuation of floodplains through doorknocking by SES volunteers through to the evacuation of all occupants for the region.

At the centre of the timeline methodology is the following concept:

Surplus Time = Time Available – Time Required

If surplus time is positive then evacuation of all occupants is feasible, while a negative value implies evacuation of all occupants is not likely to be able to be achieved. The determination of the two times, 'Time Available', and 'Time Required' is summarised in the following sections.

7.4.2 Sub-Catchment Flood Water Levels and Timing

A review of flood timing for the Whites Creek and the Johnstons Creek catchments has been conducted based on the model results for the 20%, 5%, 2%, and 1% AEP and PMF events at two locations. All have a rainfall duration of 1 hour. The flood timing inspection points, shown in **Figure 7-3** include one point on Parramatta Road in Whites Creek catchment and other point is on Salisbury Road in Johnstons Creek. This selected location generally matches the identified emergency hotspots discussed in **Section 7.5**.

7.4.3 Rate of Rise

With regards to rate of rise for the PMF event,

- Parramatta Road site in Whites Creek begins flooding in a couple of minutes after the onset of rainfall, with between 1.5 metres of flooding depth within an hour of the onset of rainfall; and
- Salisbury Road Site in Johnstons Creek begin flooding in 10 minutes after the onset of rainfall, with between 2.5 metres of flooding depth within an hour of the onset of rainfall.

For the 1% AEP and smaller design events,

- Parramatta Road site in Whites Creek begin flooding in a few minutes after the onset of rainfall, with up to 0.7 metre of flooding depth within an hour of the onset of rainfall; and
- Salisbury Road Site in Johnstons Creek begin flooding in 20 minutes after the onset of rainfall, with between 1.5 metres of flooding depth within an hour of the onset of rainfall.

7.4.4 Duration of Flooding

With regards to flooding duration for the PMF event, in Whites Creek and Johnston Creek the model simulation period was set at only 0.5 hours for the model. These short simulation times allow for the peak of flooding to occur, and as shown in **Figure 7-4**, also allow the falling limb of the PMF flood.

For the Parramatta Road Site in the Whites Creek catchment much of the local overland flooding has finished within 0.5 hours of the onset of rainfall. For the 1% AEP and smaller events, the duration of flooding is expected to be less than the PMF, a shown in **Figure 7-4** these events have durations of flooding of less than 1 hour.

For the Salisbury Road Site in the Johnstons Creek catchment the majority of the local overland flooding has finished within 2 hours of the onset of rainfall. For the 1% AEP and smaller events, the duration of flooding is expected to be less than the PMF, a shown in **Figure 7-5** these events have durations of flooding of less than 1.5 hour.

The only locations with risk of longer duration flooding are trapped low points that either have no existing stormwater drainage, or drainage that becomes blocked in the event of flooding. With no mechanism for draining these low points its reasonable that ponding may persist until any blockages are removed. Generally throughout the study area the duration of flooding is expected to typically be sub-daily.

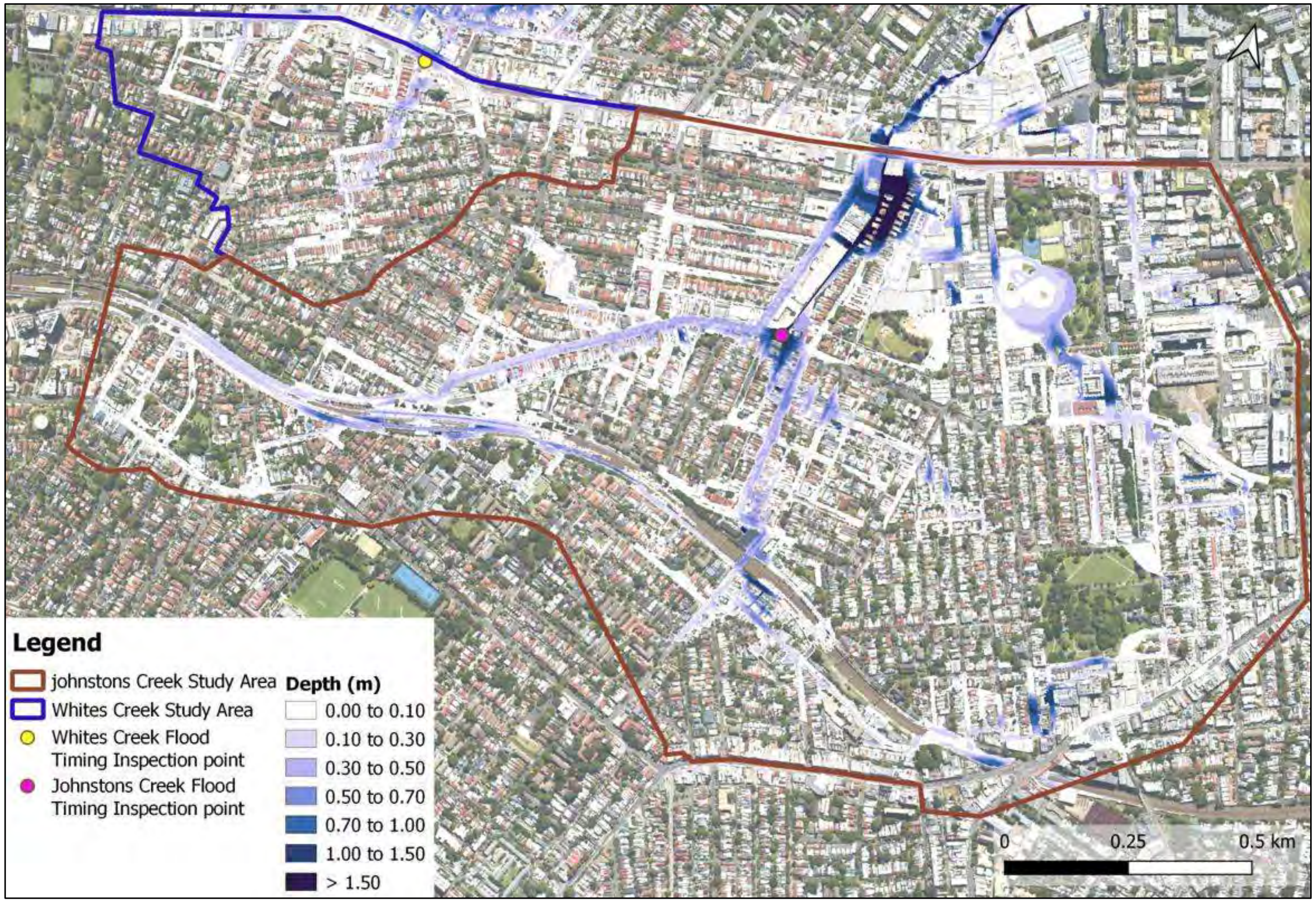

Figure 7-3 Flood Timing Inspection Points with 1% AEP Peak Depth Results

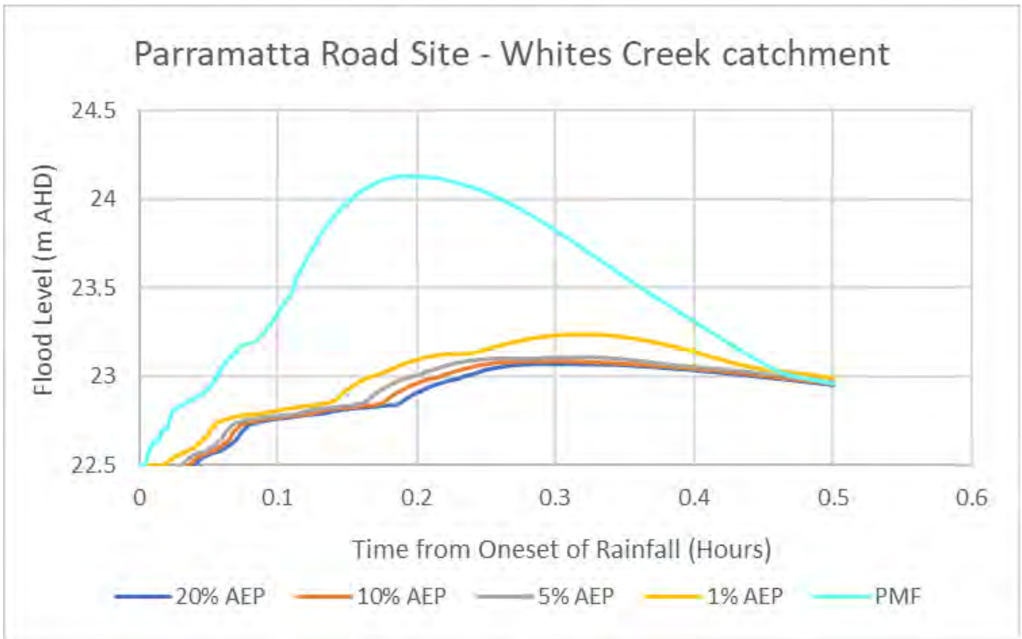

Figure 7-4 Flood Level Time Series Result for Base Case Models for Whites Creek Catchment Location

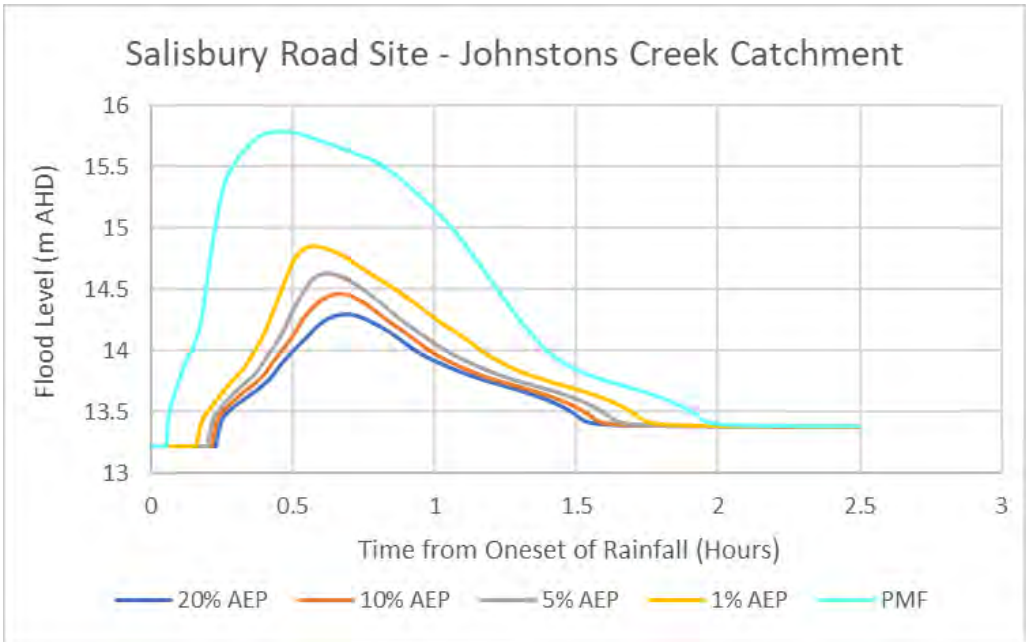

Figure 7-5 Flood Level Time Series Result for Base Case Models for Johnston Creek Catchment Location

7.4.5 Time Available

The 'Time Available' is dependent on rate of rise of waters, meaning it varies for each evacuation scenario. From the flood timing assessment included above, the rate of rise is extreme for the Whites Creek and Johnstons Creek catchments with significant flooding occurring:

> For the Whites Creek catchment
  - A couple of minutes from the onset of rainfall for the PMF event,
  - A few minutes from the onset of rainfall for the 1% AEP and smaller events.

> For the Johnstons Creek catchment
  - Between 5 – 10 minutes (0.1 hours) from the onset of rainfall for the PMF event,
  - Between 10 – 20 minutes (0.1 – 0.2 hours) from the onset of rainfall for the 1% AEP and smaller events.

Therefore there is very little time available from the onset of storm burst rainfall for evacuation to occur. In addition, the volume of rainfall occurring is extreme in both a 1% AEP and PMF storm. It is unlikely that evacuating during the early stages of a design storm burst rainfall event will be safe as both vehicle safety and pedestrian safety is compromised under such heavy rainfall.

As a result, the only form of flood evacuation trigger for the Study Area that will provide sufficient available time to facilitate evacuation is flood forecasting methods as observed rainfall or flooding means that the opportunity to evacuate low-lying areas has already passed.

7.4.6 Time Required for SES Assisted Evacuation

The SES evacuation timeline model uses the following equation to calculate 'Time Required' to evacuate residents by doorknocking by SES volunteers:

Time Required = Warning Acceptance Factor (WAF) + Warning Lag Time (WLT) + Travel Time (TT) + Travel Safety Factor (TSF)

Where the following values are recommended:

- Warning Acceptance Factor = 1 hour – accounts for the delay between occupants receiving the evacuation warning and acting upon it.
- Warning Lag Time = 1 hour – an allowance for the time taken by occupants to prepare for evacuation such as packing their belongings etc.
- Travel Time = Variable – the number of hours taken for the evacuation of all vehicles based on road capacity. NSW SES recommend a road lane capacity of 600 vehicles per hour.
- Travel Safety Factor = Variable – added to travel time to account for any delays along the evacuation route for example resulting from accidents.

Note that time required is calculated from the time that SES are on site and ready to begin doorknocking. Before this time there is an additional phase of mobilisation of SES staff which is the time taken to coordinate and travel to residences to commence doorknocking. There is no data available on mobilisation time for local SES services. For the purposes of this analysis, it is assumed that it will take half an hour to coordinate SES staff and mobilise them to the flood affected areas.

Based on the above contributors, the overall time required for evacuation of the Whites Creek and Johnstons Creek catchments is a minimum of 2.5 hours (2 hours for WAF and WLT and 0.5 hours for mobilisation). It should be noted that this is a low bound estimate, as various factors such as Travel Time, and Travel Safety Factor have been disregarded. This means that in relation to SES doorknocked evacuation for the Study Area, evacuation needs to be triggered at least 2.5 hours prior to a storm burst rainfall event occurring.

While the Bureau of Meteorology (BoM) provide various flood forecasting tools, it is assumed there are no forecasting tools currently available that can provide the requisite confidence to trigger an evacuation based on flood forecasting 2.5 hours in the future.

Therefore, it is concluded that SES doorknocked evacuation is not a reliable emergency response in the Whites Creek and Johnstons Creek catchments. While SES assisted evacuation may be suitable for more long duration rainfall events, for the critical storm burst rainfall events which result in flash flooding this approach is not appropriate.

7.5 Emergency Management Hotspots

As part of initial consultation for this project, NSW SES representatives requested emergency management mapping for hotspot areas in the Study Area. These emergency management maps have been provided in **Appendix C**.

The maps include flood information for the 20% and 1% AEP and PMF events to provide the requested information for the full range of design events. The maps provide the following information to assist SES:

- H1-H6 hazard mapping for the three selected design flood events to show areas of vehicular, pedestrian and building instability,
- Estimated overfloor flooding depth in metres for the three selected design flood events to provide an indication of flood risk sites,
- Indicative evacuation routes to flood free land. A distinction has been made between evacuation routes suitable for vehicles which are preferred and pedestrian only evacuation routes, and,

In total, eight emergency management hotspot areas have been identified as shown in **Figure 7-6**, six in the Johnstons Creek catchment and two in the Whites Creek catchment. This figure is also replicated in **Appendix C**.

Potential flood risk management options, particularly emergency management focused options, should prioritise these eight hotspot areas:

- Hotspot 1 – Johnstons Creek area of Stanmore between Parramatta Road, Mallett Street, Salisbury Road, and Northumberland Avenue.
- Hotspot 2 – Johnstons Creek near Stanmore Railway Station, including Salisbury Road between Douglas Street and Lincoln Street.
- Hotspot 3 – Johnstons Creek between Stanmore and Petersham, from Stanmore Road to Douglas St.
- Hotspot 4 – Johnstons Creek areas of Stanmore and Enmore, from Salisbury Road down to Charles St.
- Hotspot 5 – Johnstons Creek area of Enmore between Camperdown Memorial Rest Park/Cemetery and the railway line.
- Hotspot 6 – Johnstons Creek and Church Street, between King Street and Lucas Street.
- Hotspot 7 – Whites Creek area of Petersham between Temple Street and Parramatta Road.
- Hotspot 8 – Whites Creek area of Petersham between Parramatta Road and Fort Street.

Within these hotspot areas, pockets of low flood island properties have been identified to support SES operations. These are the higher risk areas with limited evacuation potential due to flooding of access roads in accordance with the principles of the Flood Emergency Classification of Communities (FERCC) (outlined in Part C of Flood Risk Management Guide EM01), A distinction has been made for low flood islands in industrial land uses where the risk to life may be different than residential land uses.

As noted within AIDR guideline 7.2 that outlines requirements for FERCC there is the following note:

> *The guideline supports decision making at a precinct or community scale, and for rivers and creeks where flow paths can readily be defined. It is not intended for application in local overland flooding at a smaller scale, or to individual structures.*

While the type of flooding in this study area would be defined as overland flooding, the FERCC mapping of specific hotspot areas does help to identify the properties that will have complications with flood emergency response.

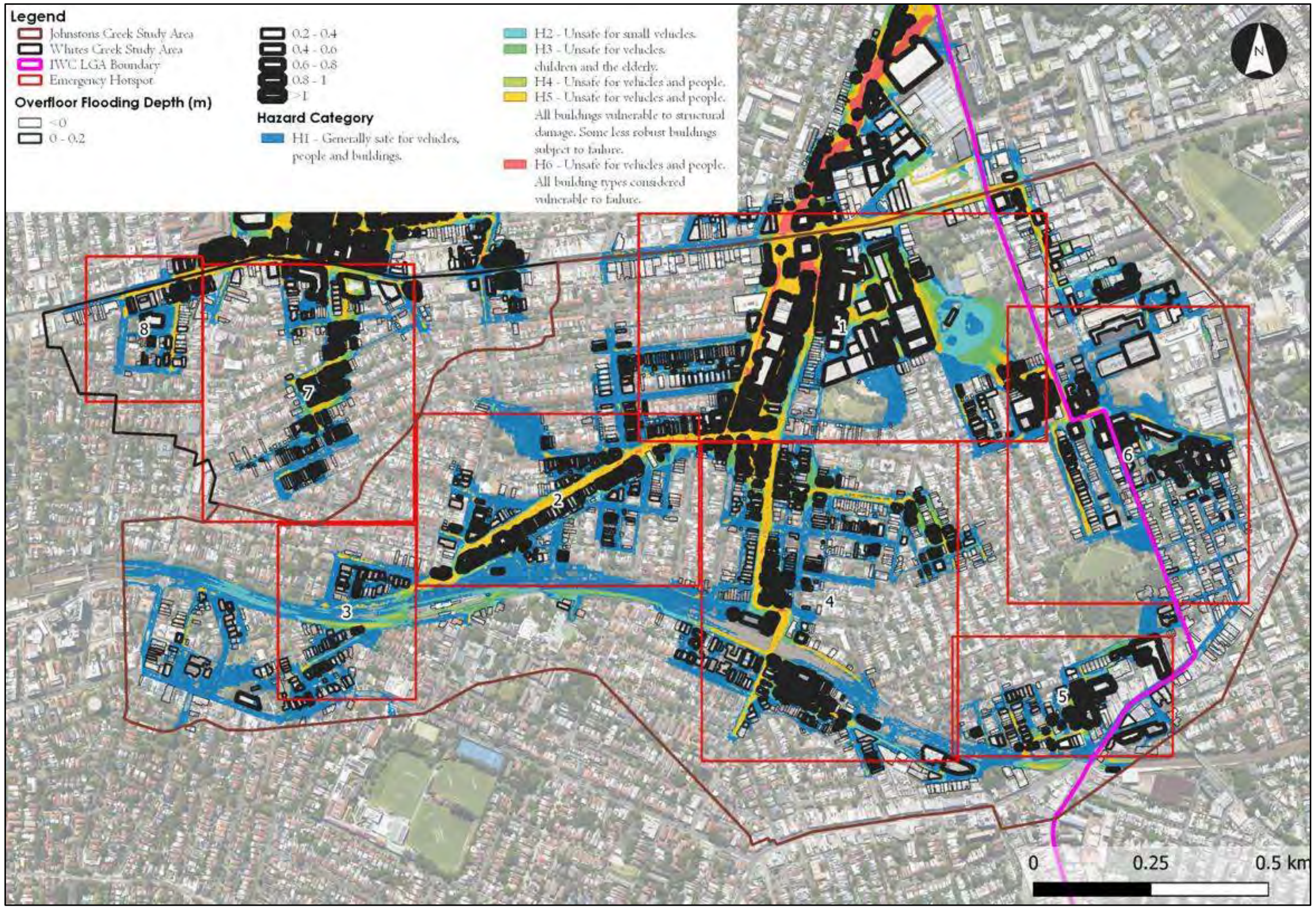

Figure 7-6 Emergency Management Hotspots with PMF H1-H6 Hazard

7.6 Flood Warning Systems

There are two components to a flood warning system:

- Monitoring of weather and flood conditions to decide when emergency response is required,
- Disseminating this information to residents so that evacuation may commence.

These two components of both current and potential flood warning systems are discussed in the following sub-sections.

7.6.1 Current Flood Warning System

The Inner West LGA Flood Emergency Sub Plan (SES, 2021) under Section 5.4 discusses the range of monitoring and alerts currently adopted by the NSW SES in the local area:

- The BoM issues public weather and flood warning products before and during a flood. These may include:
  - Severe Thunderstorm Warnings with reference to heavy rainfall
  - Regional Severe Thunderstorm Warnings with reference to heavy rainfall
  - Detailed Severe Thunderstorm Warnings (for Sydney/Newcastle/ Wollongong) with reference to heavy rainfall,
  - Severe Weather Warnings with reference to heavy rainfall and/or storm surge,
  - Flood Watches, and
  - Flood Warnings.
- In a flash flooding environment, these services can provide pre-emptive warnings of potential flood-causing rainfall, however they are considered less viable for ongoing updates and warnings during a flood event and monitoring of these resources during an event is not considered appropriate. Further discussion of the reasons for this are included in **Section 7.2**.

In addition to these resources that are monitored by the NSW SES, the Flood Plan also notes how these warnings are then disseminated to the community, with the SES providing alerts and flood information through:

- Mobile and fixed public address systems and sirens.
- Two-way radio.
- Emergency Alert (SMS and voice message alerting system).
- Telecommunications (including Auto dial systems).
- Facsimile.
- Standard Emergency Warning Signal.
- Doorknocking.
- Variable message signs.
- Community notices in identified hubs.
- Distribution through established community liaison networks, partnerships, and relationships, and
- NSW SES social media and website.
- NSW SES may seek support from agencies and local Council to share the SES social media messages.
- Road closure information will be provided to the community through Transport for NSW 'Live Traffic' website: www.livetraffic.com or 'Transport InfoLine': 131 500. Also, VMS messaging on roadways may also be used to advise motorists.

Several of these options will provide a useful means of almost instantaneously distributing flood warnings to the community. However, some of these means such as doorknocking and social media posts and community notices are unlikely to have the near instantaneous response needed from the community in flash flooding situations.

7.6.2 Discussion of Flood Warning Systems in Flash Flooding Environments

A summary of the considerations for flood warning systems in flash flooding is contained in the below excerpt from the AFAC guideline for flash flooding:

> *Successful evacuation strategies require a warning system that delivers enough lead time to accommodate the operational decisions, the mobilisation of the necessary resources, the warning and the movement of people at risk.*
>
> *Where pre-incident planning identifies existing warning lead times as being non-existent, too short or based on too much uncertainty, improvements to warning systems within existing hydro-meteorological capability should be a priority.*
>
> *Weather forecasting and flash flood prediction is undergoing continual improvement. This is the result of many factors, including better science and the influence of technology. The advent of faster and more 'accurate' weather and hydrological modelling and enhanced real-time observation systems such as Doppler radar are examples of such advances.*
>
> *However, although forecast 'accuracy' is improving for 24 to 72-hour periods, the near-to-real-time period of one to six hours, the period most relevant to flash flood environments, remains a significant forecasting challenge.*
>
> *Effective evacuation typically requires lead times of longer than just a couple of hours and this creates a dilemma for flash flood emergency managers. Due to the nature of flash flood catchments, flash flood warning systems based on detection of rainfall or water level generally yield short lead times (often as short as 30 minutes) and as a result provide limited prospects for using such systems to trigger planned and effective evacuation.*
>
> *Warning systems based on weather forecast can yield longer lead times but provide only a qualitative assessment of the potential for flash flooding over a broad geographical area. A forecast-based warning also inherently provides less certainty in either the location or rainfall volume from which to derive the expected depth and timing of flash flooding. This makes it difficult to provide timely and accurate advice to at-risk communities about flash flooding, regarding advice about who needs to evacuate and when to evacuate.*
>
> *Initiating evacuation of large numbers of people from areas prone to flash flooding based on these uncertain triggers may be theoretically defensible in a purely risk avoidance context but it is likely to be viewed as socially and economically unsustainable. Frequent evacuations in which no flooding occurs, which statistically will be the outcome of forecast-based warning and evacuation, could also lead to a situation where warnings are eventually ignored by the community.*
>
> *These considerations call for flash flood emergency managers to engage with flash flood prone communities, both to discuss and agree on appropriate triggers for agency-led evacuation, and to educate the community on appropriate behaviour in the event of flash flooding occurring with no or very little warning (including messages about the dangers of late evacuation, and strategies such as moving from unsuitable to suitable buildings).*

Within the Inner West, the constraint in deploying an effective flooding warning system is the time available to obtain and process actual rainfall and runoff data to provide an accurate prediction of flood behaviour in a timely manner to residents. Current technologies do not currently provide sufficient time to record and model potential rainfalls and the resulting impact to in time for sufficient community warning. However, this is an area of advancing technology, and improvements may be possible within a medium timeline.

Consequently, a flood warning system is not recommended as an immediate action for this catchment; however, advancements in technology should continue to be monitored for potential medium to long term implementation in the emergency management hotspots discussed in **Section 7.5**.

7.7 Shelter-in-Place Potential

NSW DPE following consultation with NSW SES have released the Draft Shelter-in-Place Guidelines in December 2022. The principles outlined in the guideline for shelter-in-place reflect those included in **Section 7.2**. Essentially that evacuation is the primary response strategy, however in flash flooding areas where evacuation is not possible, shelter-in-place is an alternative, and a last resort for brownfield and greenfield developments.

The guideline provides a list of requirements for potential shelter-in-place. Some requirements relate to development specific considerations such as access to utilities and power during shelter, a minimum flood space area for shelter, and the storage of food, first aid and other resources. However, there are some requirements that relate to the flood affectation of the area, specifically relating to:

- Stability of shelter-in-place structure,
- The duration of flooding of the refuge area and,
- The feasibility of flood free refuge area.

The potential for shelter-in-place to be implemented for the study area based on these three factors is investigated in the following sections.

The advantage of shelter-in-place is that residents do not require as long to respond for this type of emergency response to be appropriate. As opposed to evacuation where people possibly need to travel a significant distance to reach flood free land, for shelter-in-place people are likely only going to need to access a mezzanine level or first floor within the same building. Thus, the response is more readily available for flash flooding environments and can offer residents a refuge even at night when people are likely to be asleep and not able to respond to evacuation warnings.

As noted within Emergency Management Principle 4 of the 2023 FRM Guide EM01, shelter-in-place should consider the following additional risks for this emergency response type:

- *Isolation – There is no known safe period of isolation in a flood, the longer the period of isolation the greater the risk to occupants who are isolated.*
- *Secondary risks – This includes fire and medical emergencies that can impact on the safety of people isolated by floodwater. The potential risk to occupants needs to be considered and managed.*
- *Consideration of human behaviour – The behaviour of individuals such as choosing not to remain isolated from their family or social network in a building on a floor above the PMF for an extended flood duration, or attempting to return to a building during a flood, needs to be considered when adopting EM strategy.*

7.7.1 Structural Stability

The collapse of a shelter-in-place refuge would result in almost certain loss of life and is not acceptable under any flood event. To determine the likelihood of this occurring the structural stability of shelter-in-place refuges in the event of flooding needs to be assessed.

Hazard categories H5 and H6 both involve structural instability with lower hazard groups H1-H4 being generally considered in a stable range for structures. Mapping of H1-H6 hazard for the 20% and 1% AEP and PMF events for the emergency hotspots is included in **Appendix C**.

The results show that H6 areas where as guided by the hazard definitions building stability is compromised are generally confined to road reserve, backyards and dedicated waterways and channels.

The extent of H5 areas are where standard buildings may be unstable but buildings designed for flood affectation may be stable based on hazard definitions. The H5 extents are more widespread than H6 but in most locations are not within existing building footprints. At these locations any prospective shelter-in-place refuges would need to be specially engineered to withstand flood forces in the PMF event.

7.7.2 Duration of Flooding

The duration of inundation (the time for which the location is submerged) is guided by the water level time series for the Study Area discussed in **Section 7.4.2**. The analysis shows that the duration of flooding for the Study Area is short with most locations flood free less than 1 hour in Whites Creek and 2 hours in Johnstons Creek after the onset of rainfall for the PMF event. For frequent flood events the duration of flooding is same.

As the maximum duration of flooding is expected to be sub-daily for the majority of the floodplain the flood risk to life associated with any prospective shelter-in-place isolation is expected to be manageable through provision of supplies / services to the refuges. However it should be noted from the AFAC guidelines:

> *However, safety of isolation is subjective, and there is no evidence-based method for determining the tolerable duration of isolation that might result from floods. This is to state that the question of what is a safe period of isolation is not resolved.*

Further discussion of duration of isolation is provided within Principle 4 of the 2023 FRM Guide EM01, which notes secondary risks including fire and medical emergencies can impact on the safety of people isolated by floodwater, and consideration of human behaviour in flooding isolation conditions.

7.7.3 Flood Free Refuge

Flood hazard exposure is the main risk to life related to flooding. Therefore if shelter-in-place is implemented where occupants will remain on site for the duration of the flooding event, it is essential that refuge not expose them to any direct flood hazard, i.e. that the refuge is flood free. As a result, flood refuge should have floor levels located above the PMF water levels.

PMF peak depths throughout the Whites Creek and Johnstons Creek study area are relatively shallow compared to riverine or mainstream floodplains. In the upper catchment where overland flow typically occurs and fringe areas of the floodplain PMF depths can be less than 0.5 metres, and even lower than the Flood Planning Level (1% AEP plus 500mm freeboard). In these locations it is not onerous at all to require for shelter-in-place refuge above the PMF level.

In some sections of the floodplain, such as the commercial area along Bridge Road in the northern side of the Johnstons Creek catchment, PMF peak depths may be more significant. For these locations, shelter-in-place refuges become more onerous to construct as they will likely require a mezzanine level or a first floor to be constructed. However, such elevated levels are possibly advantageous to future industrial developments in the area assuming that they can be allowed for within height restrictions for the area.

Sections 7.7.1 to 7.7.3 indicate that the SIP (shelter-in-place) and planned vertical refuge in the flood impacted areas of the Whites Creek and Johnstons Creek study area may not possible due to intensity and duration of flooding, though it may be feasible for large portions of the study area. There will be a need for the development of local level resilience at highly impacted properties to address and manage flooding risks. This would include an elevated platform (say 2m) at a flood impacted property based on available space, which could be used by residents to take refuge during flooding events. This will negate the requirements from the SES to mobilise resources and investments. The flood impacted property owners should be incentivised to build such elevated platforms.

7.8 Potential Improvements to Flood Emergency Response

Based on the detailed review of flood emergency response provisions for the Whites Creek and Johnstons Creek catchments, it is unlikely, almost impossible, that SES doorknocked evacuation will be able to effectively evacuate residents prior to flooding. From this review, a number of potential measures have been identified that could improve flood emergency response potential for the study area:

- Self-managed evacuation,
- Improved flood awareness.**7.6**

These points are discussed further in the following sections.

The potential for early warning systems to reduce the Warning Lag Time is discussed in **Section 7.4**. As noted in this section, current technology does not provide a suitable resource at this time, however newer technologies may provide for rapid modelling and predictions in the mid-term.

Another consideration to improve the emergency timeline is to reduce the Travel Time by utilising a shelter-in-place strategy where evacuation cannot be readily achieved. The suitability of this approach discussed further in in **Section 7.6**. As noted in this section, where structural stability, duration of flooding and flood free refuge are feasible, this may be a potential alternative. It is important to note that all of these potential alternatives are less preferential to SES assisted evacuation, which as per NSW SES and NSW DCCEW guidance is the primary and preferred form of flood emergency response.

These review outcomes have been considered and form the basis of the assessment of Emergency Management (EM) options as discussed in **Section 8.5**.

7.8.1 Self-Managed Evacuation

Where SES assisted evacuation is not an option, self-managed evacuation is a potential alternative. This describes where people make their own decision to evacuate earlier and move to alternate accommodation, using their own transport. These plans would typically be prepared using information available from Council and with support of the local SES unit, using SES templates such as FloodSafe. Self-managed evacuation has a number of advantages:

- People can be evacuated far quicker than SES assisted evacuation as various factors in the evacuation timeline are reduced or removed completely such as accounting for time for SES to mobilise, and doorknocking time.
- Self-managed evacuation reduces the strain on SES resources as part of the floodplain will be evacuated without needing to be doorknocked or otherwise prompted. Also less coordination is required on the part of SES as the scale of the evacuation exercise is lessened by some people being self-reliant.

However, self-managed evacuation can also pose a risk if not conducted in an appropriate way. Residents could place themselves at higher risk for example if they evacuate to a location which is even more flood affected, drive through flood waters, or could increase traffic congestion if the wrong route is selected.

A way for Council to encourage and confirm the adequacy of any self-managed evacuation is through flood emergency response development controls. This could be through implementing requirements for new developments to develop flood emergency response plans particularly large-scale development such as medium and high density residential. Another alternative to improve self-managed evacuation could be requiring site-specific flood warning systems, however these systems typically rely on observed flooding. NSW SES in their advice for this project noted “self-evacuation of the community should be achievable”.

7.8.2 Improved Flood Awareness

For the SES evacuation timeline model, two factors are typically expected to take one hour each in order for residents to evacuate, Warning Acceptance Factor and Warning Lag Time. These two factors both contribute to the poor outcome for the Whites Creek and Johnstons Creek catchments evacuation timeline, however both can feasibly be significantly reduced through improved flood awareness:

- Warning Acceptance Factor, accounts for the delay between occupants receiving the evacuation warning and acting upon it. If people are aware of the flood risk of the area that they live in, then it is reasonable to expect that they will acknowledge the seriousness of any flood warning, and perhaps begin evacuating immediately instead of one hour after receiving the warning.
- Warning Lag Time, an allowance for the time taken by occupants to prepare for evacuation such as packing their belongings etc. If residents are aware of the flash flooding nature of the catchment they are in, then they will know that they have very limited time to respond before flooding commences, leaving the majority of their belongings behind to ensure they evacuate as soon as possible for their own safety.

Based on the above considerations a comprehensive flood awareness program for the Study Area, educating residents of the seriousness of the flood risk and the flash flooding nature of the catchment could improve the evacuation timeline. Currently the processes of residents in evacuation are expected to take on average 2 hours, however this could potentially be reduced to 15 minutes if residents were suitably aware of flood risk in the area.

The crucial safety message to **not enter floodwaters** is relevant to all community members as flash flooding due to overland flow in heavy rainfall events (also referred to as stormwater flooding) is recognised as a high risk to all road users driving on flooded roads across the LGA.

8 Flood Risk Management Options

8.1 Background

8.1.1 Managing Flood Risk

Risk is a combination of the consequences of flooding and the likelihood of these consequences occurring. Flood risk to the community is not static. It can be influenced by Flood Risk Management (FRM) measures, climate change, and future development. It is important to understand these risks and how they may change over time so that this can be considered in management.

Considering flood behaviour with existing measures in place provides a basis for understanding the residual risk to the community with existing conditions, how risks may change into the future, and making informed management decisions. Flood risk can be categorised as existing, future or residual risk as follows:

- Existing Flood Risk – existing buildings and development on flood prone land. Such buildings and developments by virtue of their presence and location are exposed to an 'existing' risk of flooding,
- Future Flood Risk – buildings and developments that may be built on flood prone land in the future. Such buildings and developments would be exposed to a flood risk when they are built, and
- Residual Flood Risk – buildings and development that would be at risk following the implementation of FRM measures. Unless a FRM measure is designed to the PMF, it may be exceeded by a sufficiently large event at some time in the future, meaning in most instances there is still a residual flood risk.

The alternate approaches to managing risk are outlined in **Table 8-1**. The hierarchy of preferred risk approaches is from top to bottom in the approaches listed in the table. This hierarchy is also referenced within Section 3 of the Flood Risk Management Guide FB01.

Table 8-1 Flood Risk Management Alternatives (Source: SCARM, 2000)

Alternative	Examples
Preventing / Avoiding Risk	Appropriate development within the flood extent, setting suitable planning levels.
Reducing likelihood of risk	Measures to reduce flood risk such as drainage augmentation, levees, and detention.
Reducing consequences of risk	Development controls to ensure structures are built to withstand flooding.
Transferring risk	Via insurance – may be applicable in some areas depending on insurer.
Financing risk	Natural disaster funding.
Accepting Risk	Accepting the risk of flooding as a consequence of having the structure where it is.

The relevant emergency response provisions for Inner West Council are established in the Local EMPLAN by the Local Emergency Management Committee (LEMC). The EMPLAN details the combat agency for each hazard and is an all hazards all agencies approach. It refers to sub plans for hazard specific emergency management arrangements and planning. The flood emergency management arrangements that are outlined in the local flood plan (sub plan) expand on the roles and responsibilities of all local stakeholders including LEMC, and the NSW SES local volunteer unit as the combat agency for flooding, this is relevant once the SES stands up an Incident Management Team (activated) by a weather alert by the Bureau of Meteorology.

On all relevant public websites, members of the community within the PMF floodplain are encouraged to know their risk in relation to their local river level gauge. The AWS flood warnings that are issued provide clear statements for actions through Hazard Watch including for residents to stay informed of messaging based on Bureau warnings and reported flood water levels.

The crucial safety message to **not enter floodwaters** is relevant to all community members as flash flooding due to overland flow in heavy rainfall events (also referred to as stormwater flooding) is recognised as a high risk to all road users driving on flooded roads across the LGA. A valuable output of the FRM process to NSW SES flood intelligence is the mapping and tabulation of inundated roads by elevation and depth of flooding at various design storm events.

8.1.2 Options Development Process

As stated within the FRM Guide MM01 the assessment of FRM options should consider:

- Their practicality and feasibility, including the timeframe within which they may be implemented.
- The social, economic, and environmental costs, benefits and disbenefits of FRM measures.
- The upfront, ongoing and complementary work and lifecycle costs involved in implementation.
- Input from the community and the acceptability of measures to the community.
- Consistency with industry guidance and government direction, policy and guidance.

The assessment of FRM options should consider people in the community, the economy, social and cultural aspects, services to the community and the natural environment. Relating to the development of FRM options, the FRM Guide MM01 recommends the following stages within a FRMS&P:

- Option identification and preliminary option assessment and optimisation – The identification of an inclusive range of FRM options to address local or broad FRM issues for the existing community and new development. Having identified the FRM issues to address and an inclusive range of FRM options worthy of consideration, the viability of these options needs to be tested to determine if they warrant more detailed assessment. This process is summarised within the following sections.
- Detailed option assessment – Detailed assessment and subsequent optimisation of FRM options and packages of options needs to consider their costs, benefits and disbenefits in managing risk. The detailed assessment includes flood modelling of options, damages assessment of option benefits, preliminary costing and a Multi-Criteria Assessment (MCA) that considers a broad range of factors quantitatively or qualitatively.
- Recommendation in FRM studies and decision-making in FRM plans.

8.2 Flood Risk Management Measures

FRM measures (interchangeably referred to as FRM options in this report) which are available for the management of flood risk can be categorised according to the way in which the risk is managed. There are five broad categories outlined within Table 29 of the FRM Guide MM01:

- Flood information - Flood information is essential to understanding flooding. Therefore the continued sourcing of flood information for the study area is considered a stand-alone FRM measure that indirectly influences future flood risk through informing decision-making.
- Flood modification measures – Flood modification measures are options aimed at preventing / avoiding or reducing the likelihood of flood risks. These options reduce the risk through modification of the flood behaviour in the catchment.
- Property modification measures – Property modification measures are focused on preventing / avoiding and reducing consequences of flood risks. Rather than necessarily modify the flood behaviour, these options aim to modify properties (both existing and future) so that there is a reduction in flood risk.
- Emergency response modification measures – Emergency response modification measures aim to reduce the consequences of flood risks. These measures generally aim to modify the behaviour of people during a flood event.
- Environment enhancement – Measures that look to prevent / avoid and reduce consequences of flood risk while also enhance environmental outcomes. Examples include catchment management measures, waterway modification measures, and Water Sensitive Urban Design (WSUD).

8.3 List of Flood Modification Options

Opportunities for potential flood modification options were identified by incorporating the following:

- Observations made during the site visit,
- Comments received by the general public during initial consultation, and by project stakeholders including DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives during several workshops, and the Flood Risk Management Committee. Comment was sought from all of these stakeholders during option identification and development.
- Assessment of the existing terrain, drainage information and 1% AEP and PMF flood hazards provided by Council.

A preliminary and exhaustive list of potential modification options for flood mitigation was developed, with a total of 25 flood modification (structural) options identified within the Whites Creek and Johnstons Creek study area. Mapping of the comprehensive list of options are included within **Appendix D**. The flood modification options have been grouped into the following categories:

- Drainage Upgrade,
- Channel Upgrade,
- Bridge Upgrade,
- Detention Basin,
- Road Regrading,
- Drainage Maintenance.

The number of possible flood modification options and option types that were considered for each catchment are summarised in **Table 8-2**.

Table 8-2 Number of Flood Modification Options by Type and Sub-Catchment

Catchment	Drainage Upgrade	Drainage Maintenance	Channel Upgrade	Detention Basin	Road Regrading	Total
Whites Creek	3	0	0	0	0	**3**
Johnstons Creek	9	1	1	4	7	**22**

These options have been outlined in the following **Figure 8-1** to **Figure 8-7**.

Figure 8-1 Johnstons Creek Hotspots 1 and 6 Mitigation Options

Figure 8-2 Johnstons Creek Hotspot 2 Mitigation Options

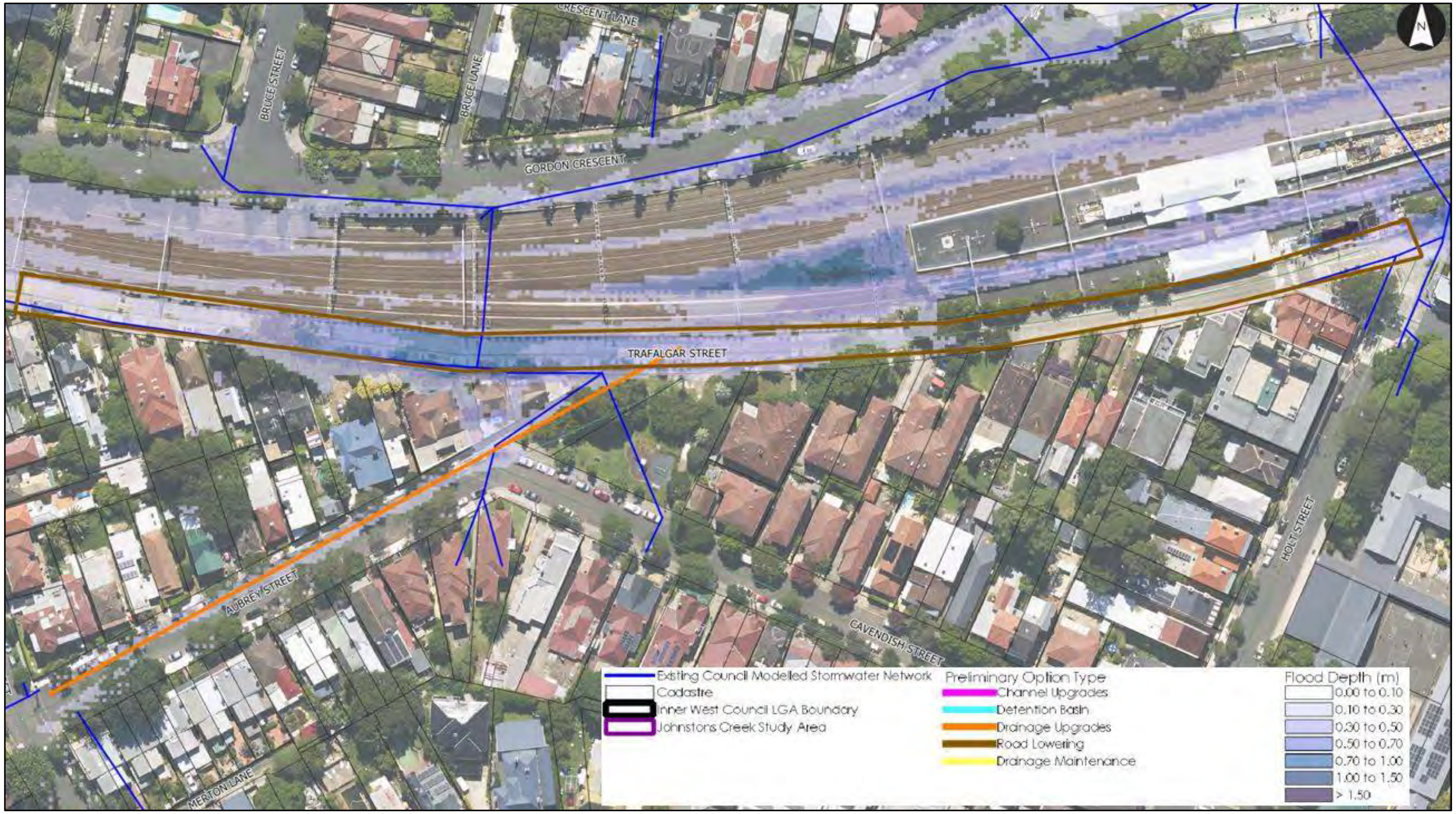

Figure 8-3 Johnstons Creek Hotspot 3 Mitigation Options

Figure 8-4 Johnstons Creek Hotspot 4 Mitigation Options

Figure 8-5 Johnstons Creek Hotspot 5 Mitigation Options

Figure 8-6 Whites Creek Hotspot 7 Mitigation Options

Figure 8-7 Whites Creek Hotspot 8 Mitigation Options

8.4 Preliminary Flood Modification Options

8.4.1 Initial Preliminary Flood Modification Options

The comprehensive list of possible flood modification options and option types that were considered are summarised in **Table 8-3.**

Table 8-3 Comprehensive List of Flood Modification Options

Location	Catchment	Type	Hotspot*	Description
Bridge Road, Stanmore	Johnstons Creek	Drainage Upgrade	1	Improve drainage capacity to better convey water towards the existing channel between Bridge Road and Cardigan Street.
Fowler Lane, Camperdown	Johnstons Creek	Drainage Upgrade	1/6	Improve drainage capacity along Mallett Street and Fowler Lane to reduce flooding impacts to Tooths Place and Fowler Street properties.
Gibbens Street, Camperdown	Johnstons Creek	Road Regrading	1/6	Regrade the existing road to better convey water through to Gibbens Street instead of Fowler Street properties.
Australia Street / Parramatta Road, Stanmore	Johnstons Creek	Road Regrading	1	Regrade the existing Australia Street and Parramatta Road intersection to convey water towards Parramatta Road instead of through properties.
Between Bridge Road and Cardigan Street, Stanmore	Johnstons Creek	Channel Upgrade	1	Improve channel capacity to reduce impacts to surrounding properties.
Camperdown Park, Australia Street, Camperdown	Johnstons Creek	Detention Basin	1/6	Construction of a detention basin to reduce flooding of downstream properties.
Salisbury Road / Douglas Street, Camperdown	Johnstons Creek	Drainage Upgrade	2	Improve drainage capacity to better convey water away from Salisbury Road properties.
Salisbury Road, Camperdown	Johnstons Creek	Drainage Maintenance	2	Carry out routine ongoing maintenance of existing drainage to sustain adequate drainage capacity.
Aubrey Street Trafalgar Street, Petersham	Johnstons Creek	Drainage Upgrade	3	Improve drainage capacity to reduce flooding impacts to the corner of Aubrey Street and Trafalgar Street.
Trafalgar Street, Petersham	Johnstons Creek	Road Regrading	3	Regrade the existing road to prevent ponding near Aubrey Street.
Stafford Street, Stanmore	Johnstons Creek	Drainage Upgrade	4	Improve drainage capacity to reduce water flow through properties.
Stafford Lane, Stanmore	Johnstons Creek	Drainage Upgrade	4	Improve drainage capacity to reduce water flow through properties.
Probert Street / Lane, Newtown	Johnstons Creek	Drainage Upgrade	4	Improve drainage capacity to reduce water flow through properties.
Bishopgate Lane, Camperdown	Johnstons Creek	Road Regrading	4	Regrade the existing road to redirect flow away from properties.
Kingston Road / Salisbury Road, Camperdown	Johnstons Creek	Road Regrading	4	Regrade the existing road to redirect flow away from properties.
Railway Avenue, Stanmore	Johnstons Creek	Road Regrading	4	Regrade the existing road to redirect flow away from properties.
Gladstone Street opp. Philip Lane, Enmore	Johnstons Creek	Detention Basin	4	Construction of a detention basin to reduce flooding of downstream properties.

Location	Catchment	Type	Hotspot*	Description
Gladstone Street adj. Augustus Street, Enmore	Johnstons Creek	Detention Basin	4	Construction of a detention basin to reduce flooding of downstream properties.
Probert Street / Melville Lane, Newtown	Johnstons Creek	Drainage Upgrade	5	Improve drainage capacity to reduce water flow through properties.
Eliza Street / Australia Street, Camperdown	Johnstons Creek	Drainage Upgrade	5	Improve drainage capacity to reduce water flow through properties.
Lennox Street, Newtown	Johnstons Creek	Road Regrading	5	Regrade the existing road to redirect flow away from properties.
Albany Road to Parramatta Road, Stanmore	Whites Creek	Drainage Upgrade	7	Improve drainage capacity to reduce water flow through properties.
Petersham Street, Petersham	Whites Creek	Drainage Upgrade	8	Improve drainage capacity to reduce water flow through properties.
Railway Avenue, Stanmore	Whites Creek	Drainage Upgrade	8	Improve drainage capacity to reduce water flow through properties.

Refer to* ***Section 7.5* *for further details of the hotspot locations.*

Upon Council review, discussions were held to determine which of these preliminary options are to be adopted for further assessment. Details of the selected options are in the below report sections.

8.4.2 Selection of Initial Preliminary Flood Risk Management Options

An initial high-level assessment was carried out for each option based on the following criteria: potential benefits, technical feasibility and costs.

Benefits were assessed based on the expected or potential effects on flood affected areas. The zoning type, number of properties as well as road type/usage were considered. Benefits were categorized as negligible, very low, low, medium and high.

Technical feasibility and cost were assessed based on the specific requirements of each option such as earthworks, roadworks, potential property impacts, length of pipe upgrades, etc. Feasibility and costs were categorized as very low, low, medium and high.

Upon Council review, workshops were held with project stakeholders including DCCEW, SES, City of Sydney Council and Council strategic, engineering and planning representatives during several workshops, and the FRM Committee. The outcome of these discussions was to determine which of these preliminary options are to be adopted for further assessment. Options that scored relatively lower in terms of the above criteria (potential benefits, technical feasibility and costs) were not selected to be progressed.

Out of 23 total FM options (20 for Johnstons Creek and 3 for Whites Creek), 13 were recommended to be progressed to modelling (12 for Johnstons Creek and 1 for Whites Creek). A single Property Modification (PM) option (PM6) for increased drainage maintenance was considered for both study areas. With both PM and FM options the total number of modelled options is 15 (13 for Johnstons Creek and 2 for Whites Creek). The selected preliminary options are in **Table 8-4**. The flood modification options not selected for detailed assessment, including a brief reason, have been summarised in **Table 8-5**.

Table 8-4 List of Modelled Flood Risk Management Options

Option ID/ Location	Type	Number of Modelling Iterations	Continued to Detailed Assessment (Y/N)
JC1 – Fowler Street, Camperdown	Drainage Upgrade/ Detention Basin	5	Yes
JC5 – Bridge Road, Stanmore	Drainage Upgrade	6	Yes
JC6 – Bridge Road, Stanmore	Channel Upgrade	5	Yes
JC7 – Bridge Road, Stanmore	Detention Basin	1	Yes
JC9 – Salisbury Road, Camperdown	Drainage Upgrade	3	No
JC10 – Trafalgar Street, Petersham	Drainage Upgrade	3	Yes
JC13 – Gladstone Street, Enmore	Drainage Upgrade	4	Yes
JC14 – Railway Avenue, Stanmore	Road Regrading	1	Yes
JC15 – Probert Street, Newtown	Drainage Upgrade	2	Yes
JC18 – Kingston Road, Camperdown	Drainage Upgrade	4	Yes
JC20 – Lennox Street, Newtown	Drainage Upgrade	2	Yes
JC23 – Clarendon Lane, Stanmore	Drainage Upgrade	1	Yes
WC1 – Margaret Street, Petersham	Drainage Upgrade	5	Yes
PM6 – Targeted Stormwater Maintenance	Drainage Maintenance	1	Yes

Table 8-5 Options Not Progressed to Detailed Assessment

Location	Catchment	Type	Hotspot*	Reason For Not Progressing
Gibbens Street, Camperdown	Johnstons Creek	Road Regrading	1/6	Relatively low technical feasibility/high cost. Depth of road lowering required to divert flows away from residential properties on Fowler Lane was not feasible.
Australia Street / Parramatta Road, Stanmore	Johnstons Creek	Road Regrading	1	Relatively low technical feasibility/high cost. Length of road lowering and scale of works was significant with an interface with TfNSW road. Potential impacts on properties.
Salisbury Road / Douglas Street, Camperdown	Johnstons Creek	Drainage Upgrade	2	Partially included in JC5 Bridge Road Drainage Upgrade, relatively low technical feasibility Length of pipe upgrades, and limited capacity of downstream Sydney Water channels meant not feasible. Twin existing pipes under road meant limited space for additional capacity.
Salisbury Road, Camperdown	Johnstons Creek	Drainage Maintenance	2	Included in PM6 for assessment on a catchment-wide scale, therefore specific assessment at this high debris location not necessary.
Trafalgar Street, Petersham	Johnstons Creek	Road Regrading	3	Relatively low technical feasibility/high cost. Scale of works required to divert runoff from Aubrey Street around residential properties to Trafalgar Street not considered feasible.
Stafford Street, Stanmore	Johnstons Creek	Drainage Upgrade	4	Partially included in JC18 Kingston Road Drainage Upgrade. Network capacity found to be constrained with no capacity for additional inlet pits, length of pipe upgrades considered not feasible with limited capacity in downstream Sydney Water channels.
Stafford Lane, Stanmore	Johnstons Creek	Drainage Upgrade	4	Partially included in JC18 Kingston Road Drainage Upgrade. Network capacity found to be constrained with no capacity for additional inlet pits, length of pipe upgrades considered not feasible with limited capacity in downstream Sydney Water channels.
Bishopgate Lane, Camperdown	Johnstons Creek	Road Regrading	4	Relatively low technical feasibility/high cost. Depth of cut required to lower road to divert flows away from Probert St not considered feasible. Found that drainage upgrade for additional inlet pit capacity preferred option.
Kingston Road / Salisbury Road, Camperdown	Johnstons Creek	Road Regrading	4	Relatively low technical feasibility/high cost. Length and depth of road lowering to Salisbury Road to divert flows around residential properties was not considered feasible.
Gladstone Street opp. Philip Lane, Enmore	Johnstons Creek	Detention Basin	4	Relatively low technical feasibility/high cost. Rail corridor open space opportunity not deemed feasible for detention basin given potential utilities, contamination and ownership considerations.
Gladstone Street adj. Augustus Street, Enmore	Johnstons Creek	Detention Basin	4	Relatively low technical feasibility/high cost. Bugler playground opportunities not deemed feasible for detention basin given limited volumes and potential utilities, and loss of public space.
Eliza Street / Australia Street, Camperdown	Johnstons Creek	Drainage Upgrade	5	Included in Lennox Street option, rather than upgrading existing line, a diversion of runoff from upstream was deemed the preferred option.
Lennox Street, Newtown	Johnstons Creek	Road Regrading	5	Relatively low technical feasibility/high cost. Length and depth of road lowering to divert flows around properties was not considered feasible.
Petersham Street, Petersham	Whites Creek	Drainage Upgrade	8	Relatively low technical feasibility. Scale of works to increase capacity was not feasible based on existing flood affectation.
Railway Avenue, Stanmore	Whites Creek	Drainage Upgrade	8	Relatively low technical feasibility. Scale of works to increase capacity was not feasible based on existing flood affectation.

8.4.3 Modelling of Preliminary Flood Risk Management Options

The 15 flood risk management options that were selected for preliminary assessment were developed and modelled in the two sub-catchment TUFLOW models for Johnstons Creek and Whites Creek with the following methodology:

> 5 design events were considered: 20% AEP, 5% AEP (DSHHWS), 2% AEP, 1% AEP and PMF.

> The PM6 model scenario involved the unblocking off all pipes from the model. The assumption in this model approach is that improved maintenance would potentially remove blockage of pits and pipes, as a theoretical best-case scenario.

> PM6 was used as a base case for the FM options. Details on the PM6 scenario are in **Section 8.5**. The justification for adopting the PM6 option as the base case for the FM options is the removal of blockage. The FM options rely on the effectiveness of the drainage network, therefore assuming an unblocked condition is considered a suitable basis for assessing potential benefits of any drainage upgrades.

> Each option had a unique model scenario established to account for the proposed option details. Each option model was based off the base case.

> Each option was then initially modelled for the 20% AEP design event, then selected for detailed assessment based on the 20% AEP flood level difference impacts and other opportunities for improvement identified from the model set up.

> Options that were selected for detailed assessment were then progressed to modelling of all 5 design events.

> The methodology for each option accounted for the proposed works in the TUFLOW model as follows:

- Drainage upgrades were modelled with updates to the 1D network with duplication of pits and pipes, and creation of new pits and pipes. The details of the proposed network were based on review of existing conditions to develop feasible pipe / culvert dimensions, locations, inverts and pit sizes.
- Channel upgrades were modelled as 1D irregular channel elements with cross sections as per the base case model. Changes to the channel shapes, inverts, and 1D roughness values were applied to represent proposed changes in channel shape and lining.
- Two types of detention basins were modelled. The inverts of the basins were determined based on review of existing conditions, terrain levels and minimum connection levels to existing stormwater networks.
    - Within the 2D domain of the TUFLOW model with 2D_zshapes applied to create basin shapes
    - Within the 1D pit and pipes network to simulate an underground detention basin, using pit dimensions to set the basin size and a short section of smaller diameter pipe to represent the effects of an overflow weir.
- Road or surface regrading was modelled in the 2D domain of the TUFLOW model with 2D_zshapes, raising or lowering the existing surface to divert flows away from private property and retention in the road reserve.

8.4.4 Development and Optimisation of Preliminary Flood Modification Options

As per Section 2.2.4 of the FRM Guide MM01, optimisation of options may be used to refine options to improve benefits and reduce costs or disbenefits. This process was conducted for the 4 preliminary flood modification measures developed for this study.

The option as proposed in discussions with Council and NSW DCCEW was initially modelled, and then depending on the outcomes of the initial modelling was often refined and altered to enhance option benefits. In some instances, this led to significant changes in option design through this optimisation process.

Optimisation not only occurred based on maximising flood benefits, but also in response to other factors that were accounted for in the preliminary option development including:

- Maximising the feasibility of the option. This included consideration of the following:
  - Subsurface utility locations, with proposed earthworks avoiding the vicinity of these utilities where possible.
  - Suitable scale of works justifiable based on the anticipated flood benefits, such as downstream pipe sizes and lengths.
  - Land ownership and avoiding works on private lands where possible.
- Considering the relative cost of the option based on the scale of works, this provides an indication of the economic feasibility of the option.
- Reducing flood affectation and flood risk on private properties, particularly residential properties wherever possible. In some instances this resulted in additional flood risk within publicly owned lands such as road reserves and public open spaces.
- Minimising disturbance of ecological communities and minimising tree removal. The types of vegetation on subject sites were guided by site visit observations and Google Streetview.
- Minimising adverse impacts on private properties or non-publicly owned lands. While some options would result in significant benefits for some properties, it was important they not adversely affect other properties.

For the 4 preliminary flood modification options, a summary of the option outcomes considering the above factors was provided to Council and NSW DCCEW for their review. As discussed in the sections below, these factors were assessed in determining the options to carry into detailed assessment.

8.5 Other Preliminary Options

Beyond the 14 flood modification options that were modelled and assessed, a further twelve non-structural preliminary options were considered:

- Six preliminary Property Modification (PM) measures including Voluntary House Raising (VHR), flood proofing, Voluntary Purchase (VP) and two derivatives (land swap and Council redevelopment) and targeted stormwater maintenance. The options are discussed further in **Table 8-6**.
- Six preliminary Emergency Management Modification (EM) measures including flood prediction and warning, review of Local Flood Planning and information transfer to NSW SES, community flood awareness and school education programs, flood markers and signage and flood data and debrief. The options are discussed further in **Table 8-7**. It is noted that comment on these preliminary options was sought from NSW SES representatives to determine their opinion on the proposed Emergency Management options given the relevance to their operations.

These options were developed based on guidance provided within the FRM Guide MM01, the 2023 FRM Manual and based on past experience with option development in other study areas.

In total, 4 EM options and 1 PM options were recommended/selected for detailed assessment.

Table 8-6 Preliminary Property Modification Options

Option ID	Option Name	Description	Recommendation for Detailed Option
PM1	Voluntary House Raising (VHR)	House raising is a measure designed to reduce the incidence of over-floor flooding of existing buildings through works where Council and NSW DCCEW make contributions to the funding the cost of the work. There are a range of factors that contribute to the feasibility of Voluntary House Raising. The scheme should involve raising residential properties above a minimum design level, assumed to be Council's flood planning level (FPL) meaning 1% AEP plus 0.5 metre freeboard. While house raising can reduce the occurrence of overfloor flooding, there are issues related to the practice, including: > The potential for damage to items on a property other than the raised dwelling are not reduced – such as gardens, sheds, garages, granny flats, decks etc.; > Unless a dwelling is raised above the level of the PMF, and proven to be stable in such a flood event, the potential for above floor flooding still exists – i.e. there will still be a residual risk; > Evacuation may be required during a flood event for a medical emergency or similar, even if no overfloor flooding occurs, and this evacuation is likely to be hampered by floodwaters surrounding a property; > Ensure new footings or piers can withstand flood-related forces; and > Potential conflict with height restrictions imposed for a specific zone or locality within the LGA. The Guidelines for voluntary house raising schemes: Floodplain Management Program (NSW DCCEW, 2020) sets out ineligibility criteria for house raising under the Voluntary House Raising (VHR) scheme. In addition, follow up discussions with NSW DCCEW representatives have provided further information as the potential eligibility of properties for a VHR scheme. The adopted eligibility criteria for this FRMS&P based on these resources is as follows: > Must be residential dwellings to be eligible for funding. Commercial and industrial, public buildings or secondary dwellings are not considered eligible. > Properties that would not achieve a positive benefit through damage reduction relative to cost (i.e. benefit-cost ratio less than 1). > The post-raised building must be stable and therefore not be in a high hazard area. As outlined in the guideline this is defined as areas with PMF hazard of H4 or less being eligible. > Building located in 1% AEP floodway areas are not considered eligible as they represent a significant flow obstruction. > Based on NSW DCCEW guidance, house construction of brick or masonry type are not feasible for raising due to the difficulty of raising floors for such structures. Therefore, only fibro or timber type constructed houses are considered eligible. > Funding is only available for properties where the buildings were approved and constructed prior to 1986, when the original Floodplain Development Manual was gazetted by the State Government. Properties built after this date should have been constructed in accordance with the principles in the manual. > Properties which are already benefiting substantially from other floodplain mitigation measures, such as houses already protected by a levee. There are negligible existing flood mitigation measures in the study area. It is assumed that this requirement does not relate to properties that may benefit from one of the FM options proposed within the FRMS&P as these are not currently implemented mitigations.	No Considering the overland flooding nature of the study area, and the limited impact this would provide, and the suitability of the existing housing construction, this option was not considered viable.

Option ID	Option Name	Description	Recommendation for Detailed Option
PM2	Voluntary Purchase (VP)	Voluntary purchase is the optional purchase of pre-selected properties funded jointly by Council and the State Government. It would free both residents and emergency services personnel from the hazard of future floods by removing the risk, and is achieved by the purchase of properties and the removal and demolition of buildings. Properties could be purchased by Council at an equitable price and only when voluntarily offered. Such areas would then need to be re-zoned under the LEP to a flood compatible use, such as recreation or parkland, or possibly redeveloped in a manner that is consistent with the flood hazard (see PM5 below). Voluntary House Purchase is funded by Council with assistance from the State Government. However, due to the relatively expensive nature of such a program, limited availability of Government and/or Council funding can be a major constraint to undertaking Voluntary House Purchases. Typically, only a small number of properties within a floodplain can be considered for Voluntary Purchase, however, more can be assisted if funding is available. The Guidelines for voluntary purchase schemes: Floodplain Management Program (NSW DCCEW, 2020) to assist in determining when and where voluntary purchase schemes may be suitable. The guideline recommends that voluntary purchase be considered where: > There are highly hazardous flood conditions from riverine or overland flooding and the principal objective is to remove people living in these properties and reduce the risk to life of residents and potential rescuers; > A property is located within a floodway and the removal of a building may be part of a floodway clearance program that aims to reduce significant impacts on flood behaviour elsewhere in the floodplain by enabling the floodway to more effectively perform its flow conveyance function; and/or > Purchase of a property enables other flood mitigation works (such as channel improvements or levee construction) to be implemented because the property will impede construction or may be adversely affected by the works with impacts not able to be offset. > Must be residential dwellings to be eligible for funding. Commercial and industrial, public buildings or secondary dwellings are not considered eligible; > Properties that would achieve a positive benefit through damage reduction relative to cost (i.e. benefit cost ratio less than 1).	No Considering the overland flooding nature of the study area, heritage of existing buildings, and likely community expectation, this option was not considered viable.
PM3	Flood Proofing	Flood proofing involves undertaking structural changes and other procedures in order to reduce or eliminate the risk to life and property, and thus the damage caused by flooding. Flood proofing of buildings can be undertaken through a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding. It is primarily suited to industrial or commercial properties. Examples of proofing measures include: > All structural elements below the FPL shall be constructed from flood compatible materials. > All structures must be designed and constructed to ensure structural integrity for immersion and impact of debris up to the 100 years ARI flood event. If the structure is to be relied upon for shelter-in-place evacuation, then structural integrity must be ensured up to the level of the PMF. > All electrical equipment, wiring, fuel lines or any other service pipes and connections must be waterproofed to the FPL. The NSW SES Flash Flood Tool Kit (SES, 2012) provides businesses with a template to create a flood-safe plan and to be prepared to implement flood proofing measures.	No Current DCP provisions should address future development. The number of overfloor flooded properties across the LGA would make this type of scheme not feasible.

Option ID	Option Name	Description	Recommendation for Detailed Option
PM4	Land Swap	An alternative to voluntary purchase is the consideration of a land swap program whereby Council swaps a parcel of land outside of the flood prone area, such as an existing park, for a parcel of flood prone land with the appropriate transfer of any existing facilities to the acquired site. After the land swap, Council would then arrange for demolition of the building and have the land re-zoned under the LEP to open space. Since a detailed floor level survey has not been undertaken and over floor flooding has been estimated based on a desktop assessment, it is recommended that Council undertake a detailed floor level survey to validate if properties identified for voluntary purchase are suitable for land swap.	No – Due to lack of available Council owned land, particularly land that is flood free, therefore land swap not feasible.
PM5	Council Re-development	This option also provides an alternative to the Voluntary Purchase scheme. While Council would still purchase the worst affected properties, it would redevelop these properties in a flood compatible manner and re-sell them with a break-even objective.	No - From high level review conducted no properties are immediately apparent for being suitable for a scheme of this type.
PM6	Targeted Stormwater Maintenance	Vegetated roadsides result in significant leaf and branch drop which build up over time and often results in drainage inlet pits blocking rapidly when runoff events occur. This can lead to concentrated and uncontrolled overland flows occurring downslope of these inlets thereby increasing surface flows through streets and private properties. It is recommended that regular street sweeping is undertaken to reduce the potential for the inlets to become blocked and subsequently reduce the frequency of uncontrolled overland flows on streets and through private properties. In addition to regular street sweeping which reduces the potential for inlet pits to become blocked, it is also recommended that stormwater pits in areas subject to flooding are cleaned on a more frequent basis. Suction machines can be used to remove silt and rubbish from the pits. A stormwater maintenance program is currently implemented by Council, with the above tasks routinely conducted. However additional maintenance works could possibly be implemented in the future. It is difficult to quantify the potential benefits that an increased maintenance schedule may have, as the effectiveness of maintenance is reliant on the relative timing of maintenance and flooding. If a flood occurs immediately after a maintenance and cleaning then the benefits in flood reduction may be strongly evident. If flooding occurs after a long period without cleaning then any potential benefits of maintenance would be diminished. Therefore any increase maintenance program should consider the frequency of cleaning and other works. Option PM6 is for the targeted increased maintenance of the stormwater network. Inner West Council, in accordance with its responsibility as owner of the majority of the drainage assets within the study area, has a significant maintenance schedule already in place for all of its stormwater assets. This includes timely responses to community requests or notes relating to any drainage blockage or damage. Option PM6 involves potential additional targeted maintenance of greater frequency than is currently applied at key locations. The potential benefits of the PM6 option for targeted stormwater maintenance would be assessed using modelling assuming no blockage of pipes. This is a best-case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes.	Yes Council currently undertakes maintenance of the stormwater network. The base case model assumes a 100% blockage factor that has been applied to all small diameter pipes. A targeted cleaning program would help reduce the risk of blockage impacting flooding in small diameter pipelines.

Table 8-7 Preliminary Emergency Management Modification Options

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
EM1	Flood Prediction and Warning	The critical duration and response times for the study area floodplain limit the implementation of a flood warning system. The short duration flooding experienced in local systems is not well suited to flood warning systems. Severe weather warnings are likely to be the only assistance for these areas. While flood response times of less than an hour that have been modelled in this study area make any form of warning system seem impossible, there are several factors that may make a scheme worth further investigation: > Flood free land throughout the study area is typically not a long distance. Unlike riverine catchments where the evacuation routes can be kilometres long, as shown in the evacuation route mapping the distance to flood free land does not typically exceed several hundred metres. This means that land above the PMF level could be reached by pedestrians or vehicles in a matter of minutes based on travel time. > Due to the local nature of the flooding, there should be less traffic for evacuation routes as there is not a regional evacuation route that needs to service an entire community. The 2023 FRM Guide EM01 provides advice around the development of a Total Warning System for Flooding (TWSF). The components of a TWSF must be integrated for a system to operate effectively.	Agree that a flood warning system is not feasible. BoM warnings are useful indicators of potential flooding. The NSW SES has adopted the Australian Warning System (AWS) for Riverine Flooding and Tsunami and is planning on extending this to Storms - including Flash flooding	No - A local flood warning system may not be feasible due to the flash flooding nature of the study areas. However, the short distance to flood free land means that any advanced warning may provide improved flood risk for the residents. Not progressed as a detailed option as currently not feasible to implement.
EM2	Review of Local Flood Planning and Information Transfer to NSW SES	Having a robust EM plan that can provide the basis for responding to various scales of flood threat and be altered to fit the particular circumstances of an event can assist with flood preparation, response and recovery. The review of local flood plans should also include: > A review of the current flood warning classifications (minor, moderate and major) for the location relative to the impacts on the community and any associated recommendations. > Clarification of the scale of impacts and the scale of the emergency response required in relation to key events and the associated flood timings so this can inform decisions and logistics. For example, for a levee protected community, having a plan in place on how to respond to floods that do not threaten the levee, threaten to result in minor overtopping of the levee, and for extreme floods that overwhelm the levee and town, can provide flexibility. > A review of other key information in the plan in light of the information in this study. The findings of this FRMS&P are an important source of catchment specific information for the NSW SES and Council. Details of flood risks at specific locations are important for planning of operational tasks and for the future review of the Flood Emergency Sub-Plan. The NSW SES have developed a Flood Risk Management Checklist to clearly establish the current expectations for data developed in the FRM process for the purposes of generating reliable flood intelligence to support flood emergency planning. This is a standard across the board and the checklist	NSW SES is currently revising the way flood planning is addressed in the IW LGA. The current draft VOL 2 of the flood plan is currently on hold and focus is on Pre-Incident Plans (PIPs) for flood rescue hotspots. The planning teams in Marrickville and Ashfield Leichardt units are refining overview documents for hotspot Zones to supplement the PIPs	Yes - Providing outcomes from the FRMS&P to NSW SES is essential.

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
		is normally adopted upon receiving a formal request via the agency referral process. The checklist relates to three categories; Flood Studies, FRMS&P, and Key Flood Risk Management Issues		
EM3	Community Flood Awareness	Flood awareness is an essential component of flood risk management for people residing in the floodplain, it is important to maintain an adequate level of flood awareness during the extended periods when flooding does not occur. A continuous awareness program is required to ensure new residents are informed, the level of awareness of long-term residents is maintained, and to cater for changing circumstances of flood behaviour and new developments. This option would focus on education of the entire LGA with the objective to educate residents that may be in the floodplain at the time of flooding or may attempt to enter floodwaters. There are a broad range of approaches that can be adopted, which all should be done in close consultation with NSW SES: > Develop FloodSafe Brochure and FloodSafe Toolkit > Develop a post-flood data collection strategy > Hold a FloodSafe launch event > Develop a flood information package for new residents. This option however would not necessitate SES involvement in a Council flood awareness program. It is understood that some flood awareness programs are currently adopted in the local area. Collaboration with SES would be advantageous, as the expectation would be that Council could develop a flood awareness program that provides support and supplements SES flood awareness schemes. The implementation of a flood awareness program may be important in supporting other EM options. For example, the development of a flood warning system (option EM1) would require strong flood awareness, and flood signage and markers (option EM5) would provide best benefits if accompanied with a flood awareness program.	NSW SES supports the development of a council flood awareness program, accompanied by measures outlined in EM5	Yes - Recommended outcome of the FRMS&P. Support shown for this option during stakeholder workshop call.
EM4	School Education Program	The SES has developed a tailored program for school children in primary schools. The program, includes teacher's resources, newsletters, activities and games, is designed to deliver knowledge and awareness of floods to young children. SES personnel are also available to visit schools to talk about flooding and flood response. Further details of these programs are available on the SES StormSafe website. Education of parents / carers relating to the flood affectation of the school and the emergency response procedures in place to ensure the safety of their children could be provided directly or through children in the form of brochures etc. Particularly for the study area floodplain it should be reinforced to parents that as all schools have programs in place so they should never enter floodwaters in an attempt to reach their children at school.	NSW SES supports schools who have such programs in place. NSW SES obtains contact details from relevant school authorities.	Supported in Principle Not Recommended for Detailed Analysis – Council can engage and advocate on this matter, however only Considered an SES and Department of Education can take action.

Option ID	Option Name	Description	NSW SES Comment	Recommendation for Detailed Option
EM5	Flood Markers and Signage	While the above public programs can be effective in improving the long-term awareness of flood risk, in the event of flooding these education programs can easily be forgotten. Therefore, flood warning signage can be an effective tool to remind or inform residents of the risks associated with entering floodwaters, and to also provide practical information in the event of flooding such as recommended evacuation routes. Appropriate flood warning signs should be posted at all locations of significant flooding. These signs may contain information on flooding issues or be depth gauges to inform residents of the flooding depth over roads and paths. Also, evacuation route mapping could be provided on these signs to assist residents. In addition, consultation could be conducted with Transport for NSW (TfNSW) to discuss potential flood signage for flood affected regional roads through the study area. Potential flood affected roads for signage and markers may include: > Parramatta Road at the crossing of Johnstons Creek and Whites Creek. This is a potential regional access route for NSW SES operations. > Salisbury Road and Bridge Road in Stanmore at flood affected ponding areas. > Liberty Street railway bridge crossing in Enmore > Lennox Street in Newtown > Fowler Street and Australia Street near Camperdown Oval > Probert Street and Kingston Road ponding areas in Newtown/Camperdown.	NSW SES supports and encourages the adoption of this measure. Many of the roads affected are high traffic through roads and used by non-residents, so local awareness campaigns are not relevant to these road users. Our flood rescue operators also support these measures as they also indicate to responders the depth of water in the area.	Yes - Recommended outcome of the FRMS&P. Support shown for this option during stakeholder workshop call.
EM6	Flood Data and Debrief	A flood event provides an ideal opportunity to capture information on the flood and learn from it. It helps understand the event, the consequences for the community, successes and limitations in current management practices and how the community recovered. Information can be captured in coordinated community surveys. This information should be collated, and a report produced to catalogue what has been captured and its availability and format. The data should be securely stored and made publicly available. The information can be used in both explaining this event to the community and in considering future flood risk, EM and land-use planning decisions within and potentially beyond this community. These tasks are currently part of Council's requirements for flooding response. It is also noted that post-flood funding is also available from NSW DCCEW.	NSW SES supports this measure and considers this information vital to refining flood planning and response alternatives.	Yes - Recommended outcome of the FRMS&P. While Council already implements a program of post-flood data collection, continued emphasis of the need for such schemes is recommended. Post flood funding available from NSW DCCEW

Item 16

9 Detailed Assessment of Options

9.1 Options for Detailed Assessment

A total of 20 options were selected for detailed assessment including hydraulic modelling of 5 design events (for 14 Johnstons Creek and 1 Whites Creek FM options and 1 PM option for each study area), damages assessment, cost estimation and Multi-Criteria Assessment (MCA). A summary of the 20 options is included in **Table 9-1**. It is noted that detailed options retained their preliminary option ID, therefore the ID numbering of the detailed option list is non-sequential.

Table 9-1 Description of Options for Detailed Assessment

Option Type	Option ID/Name	Modelled Option
Flood Modification (FM)	JC1 v1 – Fowler Street, Camperdown Drainage Upgrade	Yes
	JC1 v2 – Fowler Street, Camperdown Detention Basin	Yes
	JC5 – Bridge Road, Stanmore Drainage Upgrade	Yes
	JC6 v1 – Bridge Road, Stanmore Channel Regrading	Yes
	JC6 v2 – Bridge Road, Stanmore Channel Widening	Yes
	JC7 – Bridge Road, Stanmore Detention Basin	Yes
	JC10 – Trafalgar Street, Petersham Drainage Upgrade	Yes
	JC13 – Gladstone Street, Enmore Drainage Upgrade	Yes
	JC14 – Railway Avenue, Stanmore Road Regrading	Yes
	JC15 – Probert Street, Newtown Drainage Upgrade	Yes
	JC18 v1 – Kingston Road, Camperdown Drainage Upgrade	Yes
	JC18 v2 – Kingston Road, Camperdown Drainage Upgrade	Yes
	JC20 – Lennox Street, Newtown Drainage Upgrade	Yes
	JC23 – Clarendon Lane, Stanmore Drainage Upgrade	Yes
	WC1 – Margaret Street, Petersham Drainage Upgrade	Yes
Property Modification (PM)	PM6 – Targeted Stormwater Maintenance	Yes
Emergency Management Modification (EM)	EM2 – Review of Local Flood Planning and Information Transfer to NSW SES	No
	EM3 – Community Flood Awareness	No
	EM5 – Flood Markers and Signage	No
	EM6 – Flood Data and Debrief	No

A brief description of the proposed works for the 15 FM options proposed for adoption are summarised in Table 9-2. The layout of these FM options is also included in **Appendix E**.

Of the 15 flood modification options selected for detailed assessment, 14 are within the Johnstons Creek sub-catchment and 1 is within the Whites Creek sub-catchment. The location of the 15 flood modification options is shown in **Table 9-2**.

There are 2 detention basins proposed (one underground storage and one being a retrofit of an existing private carpark), 10 pit and pipe drainage network updates, 2 stormwater channel upgrades, and 1 road regrading projects. Options may have multiple components of the above option types, for example a detention basin option may also incorporate a pit and pipe drainage alteration.

Attachment 4

Table 9-2 Description of FM Options for Detailed Assessment

Option ID	Sub-Catchment	Description
JC1 v1 – Fowler Street, Camperdown Drainage Upgrade	Johnstons Creek	Various pits on Australia St, Mallett St, Tooth Pl/Ln, Fowler Ln/St and Deniston St changed to unlimited capacity. Pipe to low point on Australia St upgraded from 0.45m to 0.75m. Drainage line from Fowler Ln/St diverted to the other culvert under Camperdown Oval. Two pipes on Deniston St upgraded from 0.3m to 0.75m.
JC1 v2 – Fowler Street, Camperdown Detention Basin	Johnstons Creek	Proposed underground storage pit under Camperdown Oval (2.5m depth, approximate area of 1700m2), incorporating above drainage upgrades.
JC5 – Bridge Road, Stanmore Drainage Upgrade	Johnstons Creek	Proposed and upgraded drainage throughout Bridge Rd with culvert size of 3.6m x 1.2m connected from the existing Salisbury Road intersection drainage network, pits with unlimited capacity throughout. This option does not include the detention basin in JC7.
JC6 v1 – Bridge Road, Stanmore Channel Regrading	Johnstons Creek	Cross sections and invert levels of the 1D irregular channel lowered to achieve 1% grade both north and south of Parramatta Road.
JC6 v2 – Bridge Road, Stanmore Channel Widening	Johnstons Creek	Channel inverts lowered to 0.5% to 0.7% grade south of Parramatta Road only, with widening to the west of the channel by 3m.
JC7 – Bridge Road, Stanmore Detention Basin	Johnstons Creek	Use of the existing basement at 29-31 Bridge Road as a detention basin (3m depth).
JC10 – Trafalgar Street, Petersham Drainage Upgrade	Johnstons Creek	Pipes on Trafalgar Street (eastbound side) upgraded to 0.9m with 5 pits changed to unlimited capacity and one directional intake only (for model stability).
JC13 – Gladstone Street, Enmore Drainage Upgrade	Johnstons Creek	Various pits along Gladstone St, Trafalgar St, Bedford St and Liberty St changed to unlimited capacity. One 0.3m pipe upgraded to 0.6m and one 1.2m pipe with pit added to a low point on Bedford St. Pipe sizes on Liberty St increased from 0.3m to 0.6m.
JC14 – Railway Avenue, Stanmore Road Regrading	Johnstons Creek	Lowering of the Railway Avenue to redirect flow from properties to the road corridor.
JC15 – Probert Street, Newtown Drainage Upgrade	Johnstons Creek	4 pits on Probert Street changed to unlimited capacity and one pipe with 0.9m diameter added to Probert St.
JC18 v1 – Kingston Road, Camperdown Drainage Upgrade 1	Johnstons Creek	Pits at intersection of Cardigan St and Marmion St changed to unlimited capacity. Two 0.3m pipes upstream of the drainage under private properties upgraded to 0.825m.
JC18 v2 – Kingston Road, Camperdown Drainage Upgrade 2	Johnstons Creek	Including above drainage upgrades, plus drainage under the private properties upgraded to 0.9m x 1.5m culvert and 4 additional pits on Cardigan Street changed to unlimited capacity.
JC20 – Lennox Street, Newtown Drainage Upgrade	Johnstons Creek	Proposed drainage on Australia Street, new 1d network with 0.6m diameter pipes added.
JC23 – Clarendon Lane, Stanmore Drainage Upgrade	Johnstons Creek	5 pits changed to unlimited intake and one 0.3m diameter pipe added on Clarendon Lane.
WC1 – Margaret Street, Petersham Drainage Upgrade	Whites Creek	Various pits on Margaret St, Corunna Rd, Westbourne St and Charles St changed to unlimited capacity. Pipes between Margaret St and Corunna Rd upgraded to 0.9m. Pipes between Parramatta Rd and Margaret St upgraded to 1.8m x 1.2m.

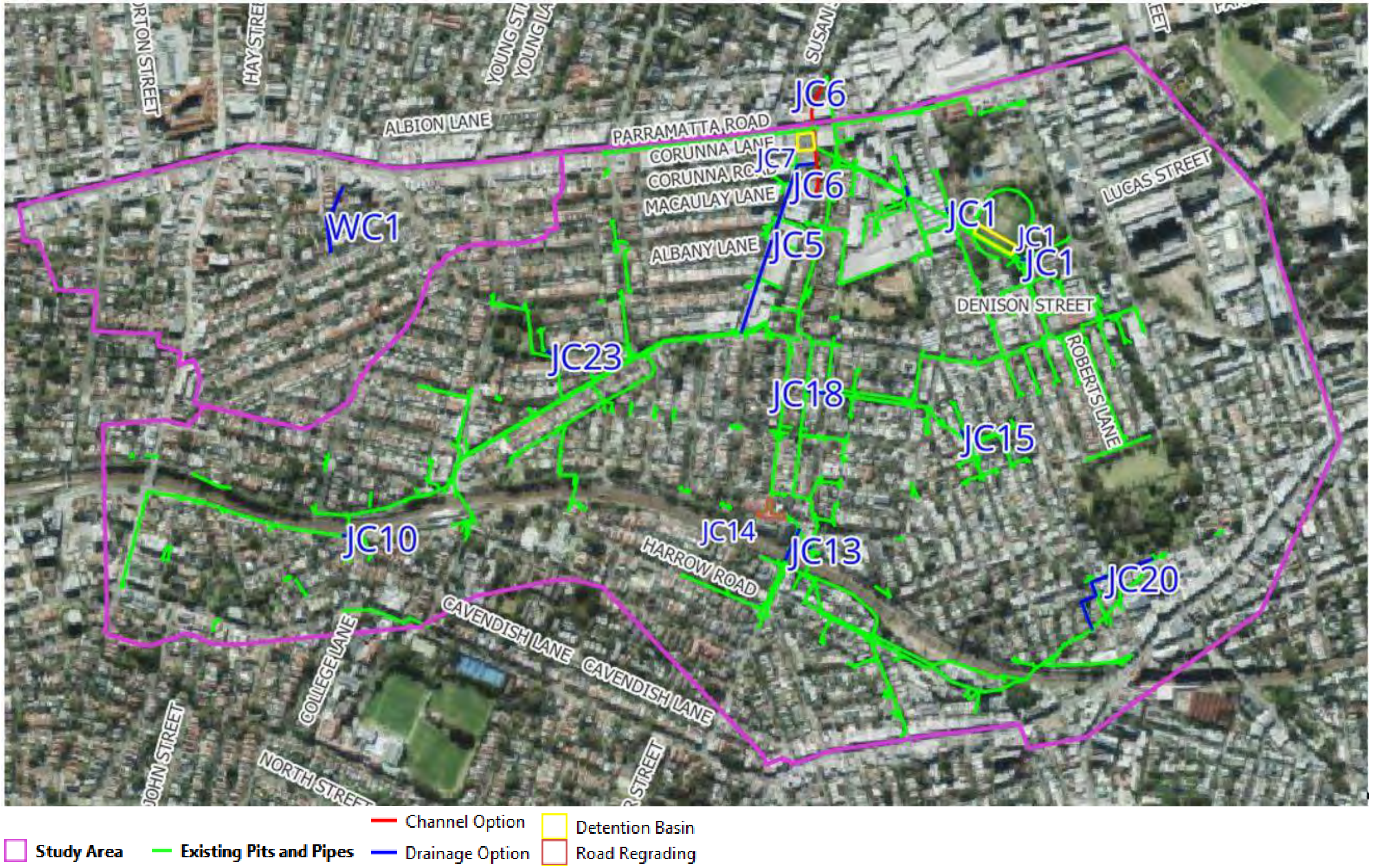

Figure 9-1 Location of 14 Detailed Flood Modification Options for Whites Creek and Johnstons Creek

9.2 Hydraulic Modelling of Options

The hydraulic modelling of detailed flood modification options reflected the model approach adopted for the preliminary options summarised in **Section 8.4.3**. The 13 detailed flood modification options and one property modification option were modelled for five design flood events - the 20%, 5%, 2% and 1% AEP and PMF events.

The review of hydraulic model results for detailed options included water level difference plots for each option compared to the PM6 base case for all 5 design events. The extent and scale of water level reductions and complete removal of flooding informed flood risk improvement conclusions for each option. Flood impact maps for all five modelled options for all five design flood events are included in **Appendix E**.

9.3 Preliminary Costing

Preliminary cost estimates have been prepared for all FM options, which allow for an economic assessment via consideration of the cost of implementation and the associated reduction in flood damages. The process for capital cost estimation was as follows:

- Quantities for construction have been estimated from preliminary design for the 13 FM options as they were modelled in the TUFLOW model. This included cut and fill volumes, disturbance footprint areas, and pipe lengths and diameters.
- Unit rates were initially estimated by Stantec based on past project experience. These unit cost rates were reviewed by Council staff and revised in some instances to match current cost rates for the local area.
- Due to the high-level nature of the estimates, a 50% contingency has been applied to all estimates given uncertainty on eventual design refinement and quantities.

Ongoing maintenance costs of FM Options have been estimated based on expected site conditions post-construction. Typically maintenance works assumed include pit and pipe cleaning, CCTV and mowing and maintenance of open space areas, with only minor expected costs associated. Due to uncertainty on future maintenance requirements and annual costs for Council, a 50% contingency has been applied to ongoing cost estimates as well.

Cost estimates for the Property Modification Option, PM6, the annual drainage maintenance budget for Inner West Council was scaled to the study area as an estimate of potential costs for increased maintenance based on the number of existing stormwater pipes. This amount was applied as both a capital cost and an ongoing maintenance cost for PM6.

For Emergency Management (EM) options, costs were estimated only on the basis of cost to implement, and were done for the purpose of comparison in the multi-criteria assessment. Ongoing costs for EM options were estimated based on expected work needed for each scheme.

Due to uncertainty of potential capital and ongoing costs for all PM and EM options, a 50% contingency has been applied to all, remaining consistent with the assessment of the FM options as well.

A summary of cost estimation outcomes for the 13 FM, 1 PM and 4 EM detailed options are included in **Table 9-3**. All capital and ongoing costs are excluding GST, and account for the 50% contingency.

Table 9-3 Cost Estimates for High-Level Quantitatively Assessed Options

Option	Capital Cost (excl. GST)	Ongoing Annual Cost (excl. GST)*
JC1 v1 – Fowler Street, Camperdown Drainage Upgrade	$397,097	$-
JC1 v2 – Fowler Street, Camperdown Detention Basin	$2,533,250	$6,000
JC5 – Bridge Road, Stanmore Drainage Upgrade	$7,915,444	$1,500
JC6 v1 – Bridge Road, Stanmore Channel Regrading	$1,899,528	$750
JC6 v2 – Bridge Road, Stanmore Channel Widening	$5,444,773	$750
JC7 – Bridge Road, Stanmore Detention Basin	$1,317,600	$4,500
JC10– Trafalgar Street, Petersham Drainage Upgrade	$704,767	$-
JC13 – Gladstone Street, Enmore Drainage Upgrade	$1,612,003	$2,250
JC14 – Railway Avenue, Stanmore Road Regrading	$2,247,615	$-
JC15 – Probert Street, Newtown Drainage Upgrade	$440,990	$750
JC18 v1 – Kingston Road, Camperdown Drainage Upgrade 1	$368,876	$-
JC18 v2 – Kingston Road, Camperdown Drainage Upgrade 2 (with upgrades under private properties)	$1,198,240	$-
JC20– Lennox Street, Newtown Drainage Upgrade	$2,266,173	$2,250
JC23 – Clarendon Lane, Stanmore Drainage Upgrade	$378,263	$1,500
WC1 – Margaret Street, Petersham Drainage Upgrade	$2,356,821	$-
PM6 – Targeted stormwater maintenance	$349,367	$349,367
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	$22,500	$7,500
EM3 – Community Flood Awareness	$60,000	$45,000
EM5 – Flood Markers and Signage	$150,000	$7,500
EM6 – Flood Data and Debrief	$45,000	$15,000

9.4 Damages Assessment of Options

An assessment of flood damages of the study area for the existing condition was presented in **Section 6**. The 2023 DT01 damage tool provides both a base case tab and an option tab such that damage benefits can be assessed within the tool. The base case is used to compare the performance of modelled options, and through calculation of post-option damages based on hydraulic model results the potential flood damage benefits of each option. The details of all methodology and input data for the option condition damages assessment are unchanged from those summarised in **Section 6**.

The damage assessment for options focussed only on the extent of impacts of the options, not the entire study area, with the total damage benefits calculated from the difference between option and PM6 condition damage totals in these areas of impact.

The new 2023 damages tool optimized external damage calculations by directly assessing them, eliminating the necessity for a separate property layer in the process. The tool features a tab for the base case and an option tab for inputting options data, enhancing the ease of comparing modelled options' performance.

Notably, the total length of assessment utilized a 30-year timeframe, as opposed to the previously employed 50 years, with a discount rate of 5% being considered throughout the analysis in agreement with DT01 defaults.

For PM6, applying existing condition, all pits and pipes were unblocked, achieving the desired PM6 condition to assess the best possible outcomes of increased drainage maintenance. For the PM6 option, the existing case was adopted as the base case. For the FM options, the PM6 condition assessment was used as the base case.

A summary of damage benefit outcomes for the five modelled design flood events (20%, 5%, 2%, and 1% AEP and PMF) for each of the 14 JC options and WC option is included in **Table 9-3** and **Table 9-4**.

The Average Annual Damage (AAD) reduction for each of the options has also been calculated in **Table 9-3** and **Table 9-4**. The total combined AAD benefit of 14 JC options is estimated to be nearly $3.9M per year and for WC option is nearly $320,000 per year.

Reduction in Flood Damages and AAD Associated with each Johnstons Creek Option

Option ID	Total Damages Reduction					Average Annual Damage Reduction
	PMF	1% AEP	2% AEP	5% AEP	20% AEP	
JC1 v1	$312,176	$216,803	$119,176	$20,646	$172,248	$102,704
JC1 v2	$78,827	$392,436	$797,530	$212,980	$277,497	$192,058
JC5	$128,968	$164,075	$352,491	$434,254	$169,430	$141,604
JC6 v1	$1,376,171	$1,203,646	$1,590,679	$1,506,617	$510,676	$467,185
JC6 v2	$1,625,581	$1,605,751	$1,353,928	$1,489,613	$538,691	$481,593
JC7	$149,280	$411,217	$1,357,498	$700,338	$729,992	$496,532
JC10	$0	$6,944	$53,643	$25,872	$879	$3,954
JC13	$2,127,043	$1,184,098	$712,851	$956,963	$555,234	$428,222
JC14	$3,431,063	$397,750	$466,465	$502,598	$489,152	$344,710
JC15	$20,170	$26,655	$142,280	$248,752	$163,320	$115,426
JC18 v1	$144,802	$9,424	$14,515	$35,953	$372,580	$209,263
JC18 v2	$1,010,857	$802,299	$589,819	$693,695	$396,096	$305,150
JC20	$173,057	$403,022	$554,971	$1,124,269	$776,464	$544,231
JC23	$0	$0	$35,676	$0	$37,089	$21,113
Total	$10,577,994	$6,824,120	$8,141,522	$7,952,549	$5,189,347	$3,853,745

Table 9-4 Reduction in Flood Damages and AAD Associated with each WC Option

Option ID	Total Damages Reduction					Average Annual Damage Reduction
	PMF	1% AEP	2% AEP	5% AEP	20% AEP	
WC1	$163,419	$419,958	$369,589	$345,327	$511,240	$324,667

In this process, the overflow depth was calculated utilizing the water level difference between the modelled option and PM6. This involved the addition of the water level difference to the PM6 overflow depth. Finally, to obtain the overflow level, the floor level was added to the calculated overflow depth.

The new 2023 damages tool optimized external damage calculations by directly assessing them, eliminating the necessity for a separate property layer in the process. The tool features a tab for the base case and an option tab for inputting options data, enhancing the ease of comparing modelled options' performance.

Notably, the total length of assessment utilized a 30-year timeframe, as opposed to the previously employed 50 years, with a discount rate of 5% being considered throughout the analysis.

9.5 Benefit-Cost Ratio

The economic evaluation of each option was performed by considering the reduction in the amount of flood damages incurred for the design events and then comparing this value with the cost of implementing the option.

Table 9-5 summarises the results of the economic assessment of each of the options. The indicator adopted to assess these measures on economic merit is the benefit-cost ratio (BCR), which is based on the net present worth (NPW) of the benefits (reduction in AAD, refer to **Section 9.4**) and the costs (of implementation, refer to **Section 9.3**). In the calculation of NPW, a 5% discount rate and an implementation period of 30 years have been adopted (default values in the 2023 DT01 Damage Tool).

The benefit-cost ratio provides an insight into how the damage savings from a measure relate to its cost of construction and maintenance.

- Where the benefit-cost ratio is greater than one (BCR >1) the economic benefits are greater than the cost of implementing the measure.
- Where the benefit-cost is less than one but greater than zero (0 < BCR < 1) there is still an economic benefit from implementing the measure, but the cost of implementing the measure is greater than the economic benefit.
- Where the benefit-cost is equal to zero (BCR = 0), there is no economic benefit from implementing the measure.

For all FM options it is possible to quantify, at least at a high-level both damage benefits and costs of implementation for each option, therefore a BCR is able to be calculated. For EM and PM options, the damage benefits are not easily quantifiable, though there would be some economic benefits of these options in the form of reduced risk to life and resultant reduction in flood damage for loss of life. Therefore in lieu of any damage benefit information, the economic analysis of these options has assumed that BCR is 1.0.

Table 9-5 Summary of Net Present Worth of Benefits and Costs and Resultant Benefit Cost Ratio

Option	NPW of AAD Reduction Benefits	NPW of Cost of Implementation of Option	Benefit Cost Ratio
JC1 v1– Fowler Street, Camperdown Drainage Upgrade	$1,578,818	$397,097	3.98
JC1 v2– Fowler Street, Camperdown Detention Basin	$2,952,404	$2,625,485	1.12
JC5 – Bridge Road, Stanmore Drainage Upgrade	$2,176,794	$7,938,503	0.27
JC6 v1 – Bridge Road, Stanmore Channel Regrading	$7,181,786	$1,911,058	3.76
JC6 v2– Bridge Road, Stanmore Channel Widening	$7,403,263	$5,456,303	1.36
JC7 – Bridge Road, Stanmore Detention Basin	$7,632,909	$1,386,777	5.50
JC10– Trafalgar Street, Petersham Drainage Upgrade	$60,783	$704,768	0.09
JC13 – Gladstone Street, Enmore Drainage Upgrade	$6,582,822	$1,646,592	4.00
JC14 – Railway Avenue, Stanmore Road Regrading	$5,299,041	$2,247,616	2.36
JC15 – Probert Street, Newtown Drainage Upgrade	$1,774,388	$452,519	3.92
JC18 v1 – Kingston Road, Camperdown Drainage Upgrade 1	$3,216,878	$368,877	8.72
JC18 v2 – Kingston Road, Camperdown Drainage Upgrade 2	$4,690,901	$1,198,241	3.91
JC20– Lennox Street, Newtown Drainage Upgrade	$8,366,172	$2,300,761	3.64
JC23 – Clarendon Lane, Stanmore Drainage Upgrade	$324,555	$401,322	0.81
WC1 – Margaret Street, Petersham Drainage Upgrade	$4,990,924	$2,356,821	2.12
PM6 – Drainage Maintenance		$5,719,990	1.0*
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES		$137,794	1.0*
EM3 – Community Flood Awareness		$751,761	1.0*
EM5 – Flood Markers and Signage		$265,294	1.0*
EM6 – Flood Data and Debrief		$275,587	1.0*

*In lieu of benefit values for EM options, due to flood risk reduction BCR value assumed to be 1.0

The BCR results show that of flood risk management options:

> Eight (8) options have BCR values over 3.0, therefore the costs are significantly lower than the calculated benefits.

> Two (2) options have BCR values over 1.5 to 3.0, therefore the costs are lower than the calculated benefits.

> Eight (8) options have BCR values over 0.5 to 1.5, therefore the costs are comparable to the calculated benefits, five (5) such options are EM and PM options with assumed BCR of 1.0.

> Two (2) options have BCR values less than 0.5, therefore the costs are significantly higher than the calculated benefits.

The PM6 option cannot be easily assessed as the potential benefits of targeted maintenance are difficult to quantify. A sensitivity modelling scenario has been adopted assuming no blockage of pipes as a result of maintenance. This is a best case scenario, that in reality is unlikely to be achievable. Nevertheless, it does provide an indication of areas of potential benefits, even if the scale of benefits may exceed expected outcomes. Therefore, due to this uncertainty, the modelling outcomes in the form of damage benefits were not applied to the BCR outcome for this option PM6.

9.6 Multi-Criteria Assessment

To assist Council in identifying the FRM options that provide the most benefits for the community, all options need to be compared against each other based on factors relevant to the study area.

Evaluating what constitutes an appropriate strategy for floodplain management is a significant analytical and policy challenge. Such challenges have led to the exploration of alternative policy analysis tools, one being Multi Criteria Assessments (MCA). The goal of MCA is to attempt to directly incorporate multiple values held by community and stakeholders into the analysis of management alternatives while avoiding the reduction of those values into a standard monetary unit. In doing so, one can consider different FRM options in the context of economic criteria as well as other criteria such as social, or environmental aspects. Community and stakeholders can also assign explicit weights to those values to reflect their preferences and priorities. Therefore, MCA provides opportunities for the direct participation of community and stakeholders in the analysis.

An MCA approach has been used for the comparative assessment of all options identified using a similar approach to that recommended in 2023 FRM Guide MM01. This approach uses a subjective scoring system to assess the merits of each option. The principal value of such a system is that it allows comparisons to be made between alternatives using a common index. In addition, the MCA makes the assessment of alternatives “transparent” (i.e. all important factors are included in the analysis).

However, this approach does not provide an absolute “right” answer as to what should be included in the plan and what should be omitted. Rather, it provides a method by which Council, community and stakeholders can re-examine options and, if necessary, debate the relative scoring assigned.

Each option is given a score according to how well the option meets specific considerations. In order to keep the scoring system simple a framework has been developed for each criterion.

9.6.1 Development of Criteria

A balanced FRMS&P addresses existing, future and continuing risk to reduce residual risk to a level more acceptable to the community and in doing so generally involves assessing, deciding on and prioritising a range of FRM measures.

One way of considering the outcomes of an MCA of different options or packages of options is the establishment of an options assessment matrix that considers a range of criteria that can influence decision-making. The criteria used can vary with the flood situation and community. Some may not be relevant to the circumstances or the options being considered. In addition, different communities, decision-makers and groups may consider different criteria and specific elements to be more or less important. One way of addressing this variation is to weight the relative importance of these criteria so this can be factored into the assessment.

As per the recommendations of Section 2.2.5 of the FRM Guide MM01, the selection of criteria and weighting should be completed independent of scoring and actively involve the FRM committee and its technical working group (TWG).

There are a total of 11 MCA criteria adopted for this FRMS&P:

- 5 economic criteria – Benefit-cost ratio, risk to property, technical feasibility, implementation complexity, and adaptability/long-term performance
- 4 social criteria – Risk to life, emergency access and evacuation, social disruption and public open spaces, and community and stakeholder support
- 2 environment criteria – Flora and fauna impact and heritage impact.

The criteria weightings provided by Council are summarised in **Table 9-6**.

9.6.2 Criteria Scoring System

A scoring system was established for each criterion with scores ranging from +2 for options that represented a significant improvement on existing conditions for any given criteria, to -2 for options that represented a significant worsening of existing conditions. The scoring system for all 10 criteria are summarised in **Table 9-6**. It is noted that for two criteria (Benefit-Cost Ratio and Reduction in Risk to Property) scoring systems was based on quantifiable assessment outcomes, for all other criteria scoring was more subjective.

Table 9-6 Multi-Criteria Assessment - Scoring System Summary

Category	Criterion	Weighting	Description of Criterion Assessment	Score				
				-2	-1	0	1	2
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0 to 0.25	0.25 to 0.5	0.5 to 1.5	1.5 to 3.0	>3.0
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	Major increase in AAD (>$200,000)	Slight increase in AAD ($200k to $100k)	Negligible Improvement (less than $100k AAD impact)	Slight decrease in AAD ($200k to $100k)	Major decrease in AAD ($>200,000)
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingencies such as land acquisition or agreements with external agencies	There are a number of significant factors that pose an impact on the feasibility of the project	There is a single significant factor or multiple smaller factors that pose a potential impact on the feasibility of the project	May or may not be feasible	Likely to be feasible with management of constraints	Very likely to be feasible with no significant restraint
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	Construction timeframe greater than 1 year Project cannot be broken down into sequential components	Construction timeframe greater than	Key components can be completed in isolation within 12 months	Overall construction timeframe less than 12 months Minor components can be staged	Construction timeframe less than 6 months Major components can be staged
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	Significantly diminished performance long-term or under climate change	Slightly diminished performance long-term or under climate change	Unchanged performance long-term or under climate change	Unchanged or improved performance long-term or under climate change with minor ongoing costs	Unchanged or improved performance long-term or under climate change with negligible ongoing costs
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	Widespread or significant localised increase in risk to life	Localised or slight increase in risk to life	Negligible change in risk to life	Localised or slight reduction of risk to life	Widespread or significant localised reduction of risk to life
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	Widespread or significant localised impact on evacuation and emergency services	Localised or slight localised impact on evacuation and emergency services	Negligible impact on evacuation and emergency services	Localised or slight improvement for evacuation and emergency services	Widespread or significant localised improvement for evacuation and emergency services
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	Significant increase in the frequency of flooding or limitation of the use of a public space or causes significant social disruption	Increase in the frequency of flooding or limitation of the use of a public space or causes social disruption	Negligible impact on public space or social disruption	Reduces the frequency of flooding or provides enhanced use of a public space or causes social benefit	Significantly reduces the frequency of flooding or enhanced use of a public space or causes significant social benefit
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	Strong opposition to the option in multiple submissions	Slight opposition to the option	No response	Slight support to the option	Significant support to the option
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	High negative impact	Slight negative impact	Negligible impact	Some benefit	Considerable benefit
	Impact on Heritage	5%	Impact to Heritage items	Likely impact on State, National, or Aboriginal Heritage item	Likely impact or increased impact on a local heritage item	No impact	Reduces the impact of flooding to heritage item or heritage conservation area	Heritage item no longer flooded

9.6.3 Multi-Criteria Scoring Outcomes

The assignment of a score and brief discussion reasoning for the score for each criterion for all flood modification (FM), property modification (PM), and emergency management (EM) modification options is shown in its entirety in the matrices presented in **Appendix F**.

The unweighted scores of the MCA has a range from 20 to -20 based on 10 criteria each with a score of +2 to -2. The weighted final MCA scores using the criteria weighting (see **Table 9-6**) have a possible range of +2.0 to -2.0. The total weighted and unweighted MCA scores for each detailed option are summarised in **Table 9-7**. The options have been tabulated in order from highest to lowest weighted score.

Due to the relative weighting of the 10 criteria the weighted and unweighted scores for options are not ordered the same. This provides an insight into the significance of appropriate criteria weighting.

Table 9-7 MCA Outcomes for Weighted and Unweighted Scores for Detailed Options

Option ID	Option Type	Total Unweighted Score (from -20 to 20)	MCA Weighted Score	Final Rank
Option JC15 - Probert Street, Newtown Drainage Upgrade	Flood Management (FM)	12	1.25	1
Option JC7 - Bridge Road, Stanmore Detention Basin	Flood Management (FM)	11	1.15	2
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	11	1.10	3
Option JC20 - Lennox Street, Newtown Drainage Upgrade	Flood Management (FM)	10	1.10	3
Option JC13 - Gladstone Street, Enmore Drainage Upgrade	Flood Management (FM)	9	1.05	5
EM3 – Community Flood Awareness	Emergency Management (EM)	10	0.95	6
EM5 – Flood Markers and Signage	Emergency Management (EM)	10	0.95	6
Option JC14 v2 - Railway Avenue, Stanmore Road Regrading	Flood Management (FM)	7	0.85	8
Option JC18 v1 - Minor Kingston Road, Camperdown Drainage Upgrade	Flood Management (FM)	7	0.75	9
Option JC6 v1 - Bridge Road, Stanmore Channel Upgrade (Re-grading North)	Flood Management (FM)	5	0.70	10
PM6 –Targeted stormwater maintenance	Property Modification (PM)	7	0.65	11
Option JC23 - Clarendon Lane, Stanmore Drainage Upgrade	Flood Management (FM)	7	0.55	12
Option JC18 v2 - Major Kingston Road, Camperdown Drainage Upgrade	Flood Management (FM)	3	0.55	12
Option JC1 v5 - Fowler Street, Camperdown Detention Basin	Flood Management (FM)	5	0.50	14
EM6 – Flood Data and Debrief	Emergency Management (EM)	5	0.45	15
Option WC1 - Margaret Street, Petersham Drainage Upgrade	Flood Management (FM)	1	0.40	16
Option JC1 v1 -Fowler Street, Camperdown Drainage Upgrade	Flood Management (FM)	4	0.35	17
JC6– Bridge Road, Stanmore Channel Widening	Flood Modification (FM)	3	0.30	18
JC10– Trafalgar Street, Petersham Drainage Upgrade	Flood Modification (FM)	5	0.15	19
JC5 – Bridge Road, Stanmore Drainage Upgrade	Flood Modification (FM)	0	0.00	20

The highest scoring options typically fall into one of two categories:

> Relatively cost-effective FM) options consisting of drainage upgrades that provide significant flood risk reduction benefits (with the exception of the Bridge Road detention basin option).

> EM options which offer significant flood risk reduction with relatively minor cost. Three of the top seven MCA scoring options are EM options.

The lowest scoring options are typically FM options that do not provide significant flood risk reduction benefits relative to their cost, complexity or other issues. The lowest 5 scoring options are all FM options.

10 Implementation Program

The Flood Risk Management options outlined in **Section 9** are recommended for implementation as an outcome of the Floodplain Risk Management Study. In order to achieve the implementation of relevant management actions, a plan of implementation has been developed as outlined in the following sections.

10.1 Steps to Implementation

The steps in progressing the flood risk management process from this point onwards are:

> Formal adoption of FRMS&P: Following public exhibition and FRM Committee approval, Council will formally adopt the final Flood Risk Management Study and Plan;

> Investigation and Design (I&D) stage – Most options will next require an Investigation and Design (I&D) phase to further refine the design and further confirm the feasibility of the option. An equivalent assessment is a 'Feasibility Study' or 'Scoping Study' for programs such as the Voluntary House Raising Scheme. These investigation and design assessments for individual projects should build on the assessment undertaken in the FRM plan. The potential steps of the I&D stage may include:

- Prior to the I&D stage, grant funding applications for the I&D assessment may need to be submitted by Council when required.
- Additional investigations may be required to inform feasibility assessment. For example, for Flood Modification options these may include geotechnical investigations, subsurface utility survey, or environmental impact reviews.
- Concept design of the option.
- Detailed design of the option.
- Environmental approvals submissions such as a Review of Environmental Factors (REF) or Environmental Impact Statement (EIS).
- Economic assessment of options (Level 1, Level 2 or Level 3 guided by the framework discussed in the next sub-section) potentially including further detailed damages benefit assessment, or cost estimation compared to the analyses conducted in this FRMS&P.

> Following I&D stage, if required, a grant funding application will need to be submitted to support the implementation / construction of the option.

> Implementation / construction of the flood risk management option.

10.2 Economic Assessment Framework for Options

Where external funding is required, the FRM economic assessment framework, as shown in **Figure 10-1**, provides the basis for further assessment of the FRM measures as part of the investigation and design phases of implementation.

The framework for the economic assessment of FRM measures from the FRM Guide MM01 is shown in **Figure 10-1**. It provides a summary of the economic assessment of FRM options following on from a FRMS&P into Investigation and Design (I&D) stage and into Implementation stage. This provides useful context into the different levels of detailed assessment required for FRM options once they proceed beyond the FRMS&P stage. There are four levels of economic assessment based on this framework:

> Level 1 assessments are the least detailed form of economic assessment. Level 1 assessments include preliminary costing, damages benefit estimation and an MCA including preliminary cost-benefit summary. These Level 1 assessments are applied at the FRMS&P phase for all FRM options, regardless of expected option cost. For FRM options with expected cost less than $1 million, a level 1 assessment is also appropriate at I&D and implementation stage as no grant approval is required. The Level 1 assessment in this FRMS&P for detailed options is summarised in **Section 9.5**.

> Level 2 assessments update the Level 1 economic analysis to include cost estimates from I&D stage. Consider whether additional damage assessment factors (not included but likely to influence the outcome) should be included to improve the Level 1 damage assessment, also consider sensitivity assessment to discount rate, and increases, and decreases in benefits and costs. Level 2 assessments relate to FRM

options with expected value between $1-$5 million. Level 2 assessments require additional reporting incorporated in I&D reporting to support grant application for implementation.

> Level 3 assessments are similar to Level 2 with updating of Level 1 economic analysis to include cost estimates from I&D stage, but with potential to include more detailed techniques for monetary valuation. Use of more detailed assessment techniques for benefits assessment, for example, evacuation modelling may be appropriate to identify risk to life more readily. More detailed sensitivity analyses than Level 2 with a more detailed stand-alone report or appendix to the I&D report to support grant application. Level 3 assessments relate to FRM options with expected value between $5-$10 million.

> For FRM Options with expected value in excess of $10 million, the option must go through a NSW Treasury gateway review process with more detailed economic assessment and reporting required.

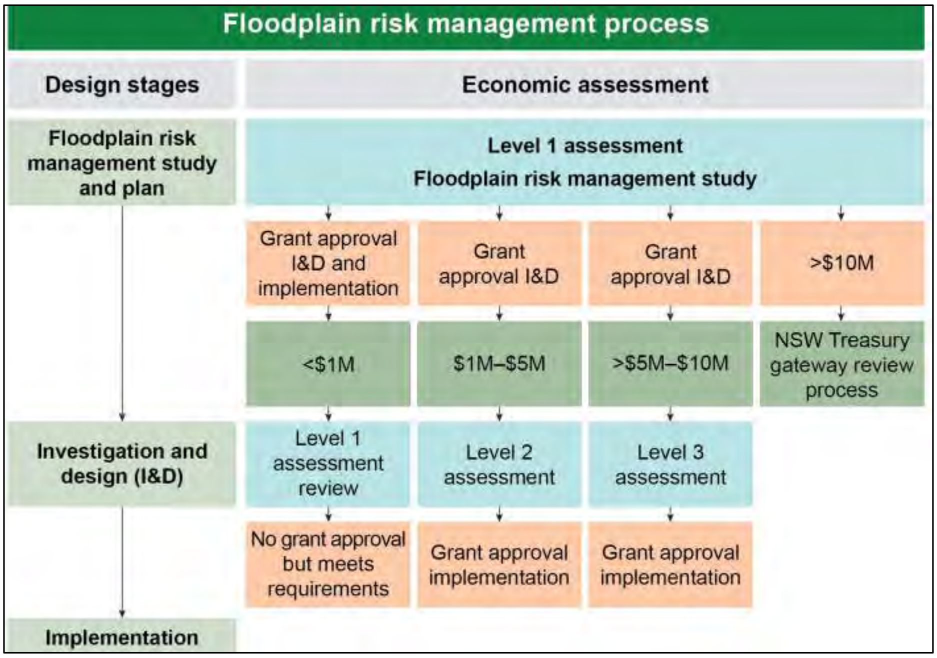

Figure 10-1 Detailed FRM Measure Economic Assessment Framework (Source: FRM Guide MM01)

The expected necessary economic assessment level of each option in this FRMS&P is summarised in the implementation program in **Table 10-1**. The economic assessments will need to be completed during Investigation and Design (I&D) stage for each option.

10.3 Funding Mechanisms for FRM Options

As stated in FRM Guide MM01, FRM plans may recommend a range of implementation measures that are funded through one of the following means:

a. Council funded: Can be implemented within council's own resources, such as updating land-use planning arrangements. Council should progress these measures within their own resources considering the priorities in the plan

b. Funded by Other Agencies: Are the agreed responsibility of, or require agreed input from external parties to implement. Examples include updating EM planning arrangements, or options located within the lands of other stakeholder agencies. Council should work with external parties to support implementation, considering the priorities in the plan.

c. Grant Funded: Will generally require external funding support, such as new or upgraded FRM works, including levees, basins, and flood warning systems. Council will need to apply for these grant funds.

The anticipated funding mechanism for each option adopted within this FRMS&P is summarised in the implementation program in **Table 10-1**. This is an assumed funding source, it is possible that funding sources other than those listed in **Table 10-1** may be considered for any given option at Council's discretion and with the agreement and support from any relevant funding agencies.

10.3.1 Grant Funding

The NSW Government's floodplain management grants support local Councils to manage flood risk. The funding for FRM option implementation from these grants has traditionally comes from two programs:

> NSW Floodplain Management Program, and

> Floodplain Risk Management Grants Scheme (jointly funded by the NSW DCCEW and the Commonwealth Government).

Applications for funding can be made by Council for the implementation of actions identified in a FRMS&P. The information provided in the applications for each management action is used to rank the priority for funding of all actions across NSW. The information presented in this FRMS&P can be used as a starting point to complete the relevant applications for funding.

Sufficient information should be provided in reports to facilitate funding applications for eligible projects under relevant funding programs. Information currently needed to support these applications relates to Council's commitment to FRM, how FRM measures were identified and assessed, community involvement in FRM plan development, and the FRM benefits of the project for the community.

10.4 Ranking and Prioritisation of Options

Based on review of the Multi-Criteria Assessment outcomes summarised in **Section 9.6**, the options have been ranked in order of preference. The MCA scores were combined to produce an options implementation preferences list as shown in **Table 10-1**. As shown in the rank column, this table was ordered based on ranking, from highest ranking to lowest ranking option.

In addition, a priority has been assigned to each of the options to inform the implementation strategy. The priority reflects the recommended urgency of the option from a reduction in flood risk perspective, it is possible that the order of implementation that Council adopts may differ from these priority assignments.

The grouping of options into the three priority categories has been based on the distribution of MCA scoring, with categories set at points of clear delineation of scoring outcomes. There is a MCA score difference of 0.90 from the worst scoring high priority option and the best medium priority option, with a 0.15 score difference from medium to low. The three priority categories are:

> High – Seven options were identified as high priority. Of the high priority options, four are Flood Modification (FM), or structural options and three are Emergency Management (EM) modification options. The range of MCA scores for high priority options is 1.25 to 0.95 (ranks 1-7)

> Medium – Eight options were identified as medium priority. Of the medium priority options, two are Property Modification (PM) options and six are Flood Modification (FM), or structural options. The range of MCA scores for medium priority options is 0.90 to 0.50 (ranks 7-14); and

- Low – Three options were identified as low priority. Of the low priority options, two are Flood Modification (FM), or structural options and two are Emergency Management (EM) options. The range of MCA scores for low priority options is 0.45 to 0.35 (ranks 15-18).

Three Flood Management (FM) options were removed from the implementation plan due to relatively low ranking scores:

- JC6 v1 Bridge Road channel widening upgrade
- JC10 Trafalgar Street drainage upgrade
- JC5 Bridge Road Drainage upgrade.

10.5 Implementation Plan

The list of recommended management options has been transformed into an implementation plan provided in **Table 10-1**. It lists the following information relevant to the implementation of each adopted FRM option:

- Type and sub-catchment location of option and Multi-Criteria Assessment score;
- The priority for implementation (high, medium, or low) and rank as an outcome of the FRMS&P;
- An estimate of implementation costs including capital and ongoing costs per annum;
- Potential funding mechanism or organisation; and
- Required economic assessment level during I&D stage from framework in **Section 10.2**.

The flood risk management options identified in **Table 10-1** represent a capital cost of approximately $17.6M, with the flood modification options making up $17.0M of this cost. High priority options have combined capital costs of $5.9M.

It is noted that the implementation plan does not outline a specific timeframe for each project. Rather, the implementation plan provides a body of projects to inform future advocacy, budgeting, and planning in order that Council may be able to undertake works in a prioritised manner as funding becomes available, or other opportunities arise in a specific location associated with a proposed option.

Table 10-1 Implementation Plan for Whites Creek and Johnstons Creek FRMS&P

Option ID	Option Type	MCA Weighted Score	Option Rank	Implementation Priority	Capital Costs (incl. GST)	Ongoing Costs (p.a incl. GST)	Economic Assessment Level for I&D
Option JC15 - Probert Street, Newtown Drainage Upgrade	Flood Modification (FM)	1.25	1	High	$ 440,990	$ 750	Level 1 (FRMS&P)
Option JC7 - Bridge Road, Stanmore Detention Basin	Flood Modification (FM)	1.15	2	High	$ 1,317,600	$ 4,500	Level 2 (Detailed damages)
EM2 – Review of Local Flood Planning and Info Transfer to NSW SES	Emergency Management (EM)	1.10	3	High	$ 22,500	$ 7,500	Level 1 (FRMS&P)
Option JC20 - Lennox Street, Newtown Drainage Upgrade	Flood Modification (FM)	1.10	3	High	$ 2,266,173	$ 2,250	Level 2 (Detailed damages)
Option JC13 - Gladstone Street, Enmore Drainage Upgrade	Flood Modification (FM)	1.05	5	High	$ 1,612,003	$ 2,250	Level 2 (Detailed damages)
EM3 – Community Flood Awareness	Emergency Management (EM)	0.95	6	High	$ 60,000	$ 45,000	Level 1 (FRMS&P)
EM5 – Flood Markers and Signage	Emergency Management (EM)	0.95	6	High	$ 150,000	$ 7,500	Level 1 (FRMS&P)
Option JC14 - Railway Avenue, Stanmore Road Regrading	Flood Modification (FM)	0.85	8	Medium	$ 2,247,615	$ -	Level 2 (Detailed damages)
Option JC18 v1 - Minor Kingston Road, Camperdown Drainage Upgrade 1	Flood Modification (FM)	0.75	9	Medium	$ 368,876	$ -	Level 1 (FRMS&P)
Option JC6 v1 - Bridge Road, Stanmore Channel Upgrade (Re-grading North)	Flood Modification (FM)	0.70	10	Medium	$ 1,899,528	$ 750	Level 2 (Detailed damages)
PM6 – Targeted stormwater maintenance	Property Modification (PM)	0.65	11	Medium	$ 349,367	$ 349,367	Level 1 (FRMS&P)
Option JC23 - Clarendon Lane, Stanmore Drainage Upgrade	Flood Modification (FM)	0.55	12	Medium	$ 378,263	$ 1,500	Level 1 (FRMS&P)
Option JC18 v2 - Major Kingston Road, Camperdown Drainage Upgrade 2	Flood Modification (FM)	0.55	12	Medium	$ 1,198,240	$ -	Level 2 (Detailed damages)
Option JC1 v2 - Fowler Street, Camperdown Detention Basin	Flood Modification (FM)	0.50	14	Medium	$ 2,533,250	$ 6,000	Level 2 (Detailed damages)
EM6 – Flood Data and Debrief	Emergency Management (EM)	0.45	15	Low	$ 45,000	$ 15,000	Level 1 (FRMS&P)
Option WC1 - Margaret Street, Petersham Drainage Upgrade	Flood Modification (FM)	0.40	16	Low	$ 2,356,821	$ -	Level 2 (Detailed damages)
Option JC1 v1 -Fowler Street, Camperdown Drainage Upgrade	Flood Modification (FM)	0.35	17	Low	$ 397,097	$ -	Level 1 (FRMS&P)
				Total	**$ 17,643,323**	**$ 442,367**	

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11 Conclusions and Next Steps in Study

This Draft Final Flood Risk Management Study and Plan (FRMS&P) report summarises the outcomes of the study undertaken for Inner West Council for Whites Creek and Johnstons Creek Catchments. This includes initial data collection and review process, community consultation, review of the flood study models, existing risk assessments including economic impacts of flooding, flood emergency response review, and flood planning review. It includes a summary of the flood risk management option development process and preliminary option assessment to refine options for adoption. The report also documents the detailed option assessment including modelling, cost estimation, damage benefits assessment, and Multi-Criteria Assessment (MCA) and provides a prioritised list of final options. Finally, the report outlines an implementation program to assist Council in the future implementation of these final options.

The flood study model review process involved the updating of the Flood Study TUFLOW model to account for ARR2019 design rainfall (Flood Study adopted ARR87 rainfall), and updating for present-day terrain in the form of LiDAR. The review concluded that the impacts of the model updates were relatively minor therefore the Flood Study model was appropriate for retention as the base case model for this FRMS&P and the assessment of options.

The flood damages assessment, flood emergency response review and flood planning review all contribute to the understanding of existing flooding as it relates to economic impacts, risk to life, and future development respectively.

A preliminary assessment of flood modification options has also been conducted including flood modelling of Flood Modification (FM) options and consideration of Property Modification (PM) options and Emergency Management Modification (EM) options. In total 37 preliminary options were developed including 25 FM, 6 PM and 6 EM options. From these preliminary options, 20 options have been selected for detailed assessment including 15 FM options, 1 PM options, and 4 EM options.

The detailed option assessment to review the selected final 20 options through flood modelling to assess the impacts of the option, flood damages (both for FM and PM options only, not EM options), cost estimation and Multi-Criteria Assessment (MCA). Three Flood Management (FM) options were removed from the implementation plan due to relatively low ranking scores, leaving a total of 17 options in the implementation plan. The outcomes of the MCA have been applied to the implementation plan including a list of priority options with seven high priority options, seven medium priority options, and three low priority options. Of the high priority options, four are Flood Modification (FM), or structural options and three are Emergency Management (EM) modification options.

The next phase of the project is for this Draft Final FRMS&P report to be placed on public exhibition, to receive comments and feedback from the community on the draft outcomes of the study prior to finalisation. The public exhibition period is planned for a four-week period (at a minimum) in Autumn 2024. Comments from the community shall be collated and reviewed and incorporated into the Final FRMS&P report.

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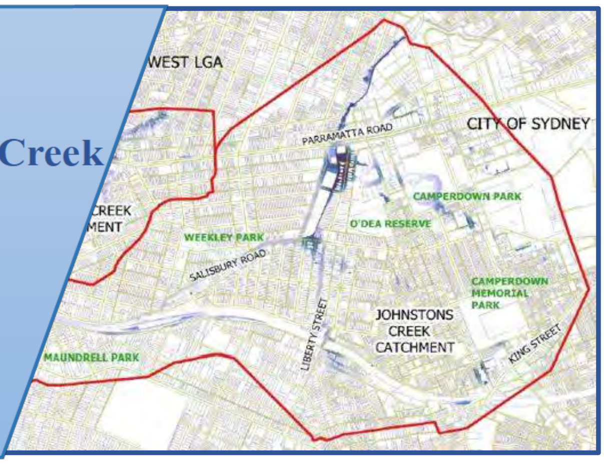
APPENDIX

A

CONSULTATION MATERIALS

Johnstons Creek and Whites Creek Flood Management Plan

Managing flood risk in your neighbourhood



Project updates

What we heard about your experiences of flooding?

1 June 2023

Between 7 March and 6 April 2023 we sought your feedback on the Johnstons Creek & Whites Creek Flood Risk Management Study and Plan. The purpose of the engagement was to understand resident experiences of stormwater and flooding within the Johnstons Creek and Whites Creek catchments and to identify preferences for flood management options.

Key points on the engagement methods and results:

- The Your Say Inner West project page was viewed 650 times
- Five people shared their experiences of flooding via the online survey and two contributed to the interactive map
- Seven people attended a drop-in session to ask questions and share their experiences
- The adopted Flood Study was downloaded 49 times

Feedback received during this engagement has been passed on to Council's consultant and will assist with developing flood mitigation options for these catchments. A detailed study will be prepared and placed on exhibition towards the end of 2023.

Community feedback dates

Tuesday 7 March - Thursday 6 April 2023

Council is exploring options for managing the impact of floods in the Johnstons Creek and Whites Creek catchment.

In 2017 Council completed the Johnstons Creek and Whites Creek Flood Study. This involved modelling flood behaviour using rainfall data and information from the community about past storm events. The study determined:

- Where flood water will run
- How the existing drainage system will cope.
- Which properties are affected?

The results from this investigation can be found in the completed Flood Study.

What happening now?

Council has engaged specialist flood consultants, Stantec, to prepare a Floodplain Risk Management Study and Plan (the Management Plan) for Johnstons and Whites Creeks. This involves reviewing the Flood Study and identifying options for reducing flood risk in the catchment.

What does the management plan propose?

The primary objective of the flood Management Plan is to identify options to mitigate and manage flood risk. This will involve consideration of options that seek to:

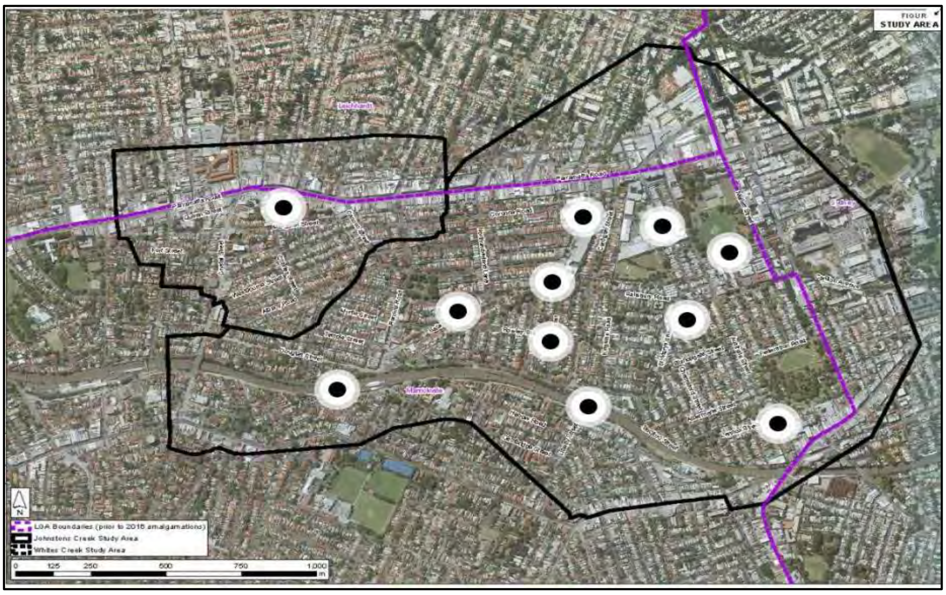
- Modify flood behaviour (e.g. levees, upgrade of stormwater systems)
- Mitigate the impact of flooding on existing properties (e.g. via floor raising)
- Control future development in the floodplain
- Guide emergency management when a flood occurs

Future development on properties that are flood affected may be subject to development controls.

What can you influence?

We asked the community to share their recent experiences of flooding in the Johnstons/Whites Creeks catchment to ensure the flood management plan reflects current areas of concern.

Community members could also let us know their preferences for flood management options in the catchment area.



Johnstons Creek and Whites Creek Flood Study
PDF (55.30 MB)

Johnstons Creek and Whites Creek Flood Planning Area Map.pdf
PDF (868.42 KB)

Frequently asked questions

Flooding

- Why do floods occur?
- What are the risks associated with flooding?
- When was the last time it flooded?
- What can I do to prepare for a flood event?

What happens next?

The project team is using your feedback and other information to develop the final flood Management Plan. Everyone who provided feedback will be updated via email and on this project page when the Management Plan is available.

Contact us:

Have questions or want to learn more about the project? Contact us below:

Name Rafaah Georges

Phone 02 9392 5208

Email rafaah.georges@innerwest.nsw.gov.au

Timeline

Flood study completed
In 2017 Council commissioned a flood study of the Johnstons and Whites Creeks catchment area.

Community consultation open
We are seeking feedback on flood management options.

Under review
Contributions to this consultation are closed for evaluation and review. The project team will report back on key outcomes.

Final report
The final outcomes of the consultation are documented here. This may include a summary of all contributions collected as well as recommendations for future action.

INNER WEST

7 March 2023

Managing flood risk in your neighbourhood

Whites Creek and Johnstons Creek

Council is preparing a plan to manage the impact of floods in the Whites Creek and Johnstons Creek areas. Management options can include upgrading stormwater systems, controls on future development and guiding emergency response plans.

Find out more and have your say

To learn more, share your experiences or to discuss your preference for flood management options.

- **Online** at yoursay.innerwest.nsw.gov.au
- **In person** at an information session:
    - Wednesday 15 March 2023, 12-3pm and 5-8pm at St Peters Town Hall - Main Hall
    - Monday 20 March 2023, 12-3pm at Marrickville Library - Pavilion Hall
- **Phone** Rafaah Georges on 02 9392 5208
- **Email** floodstudies@innerwest.nsw.gov.au
- **Write to** Rafaah Georges, Inner West Council, PO Box 14 Petersham 2049

The last date to provide feedback is **Thursday 6 April 2023.**

What happens next?

All feedback will be reviewed and inform further investigations of response strategies and possible drainage upgrades. The results will be collated into a Flood Risk Management Plan that will be presented to the community in late 2023.

What else is happening?

Surveyors will be in the neighbourhood during March and April, taking levels in the flood affected areas to help with assessing the merits of the flood management options. Stantec and North Western Surveyors will be undertaking this work on behalf of Council and will be carrying authorisation from Council.

Yours faithfully,

Ryann Midei
Director Infrastructure

Inner West Council
innerwest.nsw.gov.au
02 9392 5000

260 Liverpool Rd, Ashfield NSW 2131
7-15 Wetherill St, Leichhardt NSW 2040
2-14 Fisher St PO Box 14, Petersham NSW 2040

Whites Creek and Johnstons Creek Resident Online Survey/ Questionnaire

Question 1 **Is your property:**

- ☐ Owner occupier
- ☐ Rented - by yourself
- ☐ Rented - by others
- ☐ A business
- ☐ Other

Question 2 **Have you ever experienced flooding since living/working in the catchment area?**

- ☐ Yes, floodwater has entered my house/business
- ☐ Yes, floodwater has entered my yard
- ☐ Yes, the road was flooded and I couldn't drive my car
- ☐ Yes, the stormwater channel reached capacity and was overflowing
- ☐ Yes, other parts of my neighbourhood have flooded
- ☐ Yes, I saw water flowing out of street drains, pits or manholes
- ☐ No, I haven't experienced flooding

Question 3 **How did the flooding affect you/your business?**

- ☐ Parts of my house/business building were damaged
- ☐ The contents of my house/business were damaged
- ☐ My garden, yard, and/or surrounding property were damaged
- ☐ My car(s) were damaged
- ☐ I couldn't leave the house/business
- ☐ Family members/work mates couldn't leave/return to the house/business
- ☐ The flooding disrupted my daily routine
- ☐ The flooding didn't affect me
- ☐ Not applicable - I have not experienced flooding in the catchment area
- ☐ Other

Question 4 **Please upload any materials or photos to evidence the flooding you experienced.**

Question 5 **What do you believe to be the main cause of flooding in your area?**

- ☐ Stormwater channels reaching capacity and overflowing.
- ☐ Lack of capacity in the stormwater network (e.g., pits and pipes) causing drainage systems to surcharge and backflow.
- ☐ Rainfall runoff flowing to a channel or drain.
- ☐ Other

Question 6 **As a local resident who may have witnessed flooding/drainage problems, you may have your own ideas on how to reduce flood risks. Which of the following management options would you prefer? Select your 5 preferred options.**

- ☐ Stormwater harvesting such as rainwater tanks.
- ☐ Retarding or detention basins; these temporarily hold water and reduce peak flows.
- ☐ Culvert / bridge / increasing pipe size and/or capacity.
- ☐ Levee banks
- ☐ Environmental channel improvements
- ☐ Diversion of channels
- ☐ Planning and flood related development controls to ensure future development does not add to the existing flood risk.

- ☐ Voluntary raising of houses to reduce flood damages by raising floor levels above a design flood.
- ☐ Voluntary purchase of highly affected properties by Council and demolition of any buildings on the property
- ☐ Education of community, providing greater awareness of potential hazards
- ☐ Flood forecasting, flood warning, evacuation planning and emergency response such as early warning systems, improved local SES capabilities/ resources or improved radio and phone communications.

Question 7 **Please specify any other options you believe are suitable.**

Question 8 **Are you concerned about the uncertainty of future climates and the possible impacts on flooding in your area?**

- ☐ Yes
- ☐ No

Question 9 **Do you believe the climate is changing?**

- ☐ Yes, it will have significant effects
- ☐ Yes, but the effects won't be significant
- ☐ Not at all

Question 10 **Are you concerned about the impact of an uncertain climate on future flooding in the study areas?**

- ☐ Yes
- ☐ Somewhat
- ☐ No

Question 11 **Should Council be addressing the impacts of an uncertain future climate on flooding?**

- ☐ Yes
- ☐ No

Question 12 **Enter your email address here if you would like to receive a copy of your submission via email.**

Question 13 **Do you give permission for Cardno or Council to contact you to discuss the information you have provided us?**

- ☐ Yes
- ☐ No

APPENDIX

B

MARRICKVILLE DCP 2011 – FLOOD MANAGEMENT CONTROLS

Stantec

2.22

GENERIC PROVISIONS
FLOOD MANAGEMENT

Marrickville Development Control Plan 2011

MARRICKVILLE council

Contents

Part 2 Generic Provisions

2.22 Flood Management

A flood is an overflow or accumulation of an expanse of water that submerges land. In the sense of flowing water, the word may also be applied to the inflow of the tide. Floods are a natural and inevitable event that communities must learn to live with while minimising risks to public health and safety, property and infrastructure.

This section recognises that there are some flooding risks that require development controls and guidelines in order to reduce or eliminate their impacts.

2.22.1 Objectives

O1 To maintain the existing flood regime and flow conveyance capacity.

O2 To enable the safe occupation of, and evacuation from, land to which flood management controls apply.

O3 To avoid significant adverse impacts upon flood behaviour.

O4 To avoid significant adverse effects on the environment that would cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of the river bank/watercourse.

O5 To limit uses to those compatible with flow conveyance function and flood hazard.

O6 To minimise risk to human life and damage to property.

2.22.2 Land affected

This section complements Clause 6.3 (Flood planning) of Inner West Local Environmental Plan 2022 (Inner West LEP 2022). It applies to land identified on the DCP 2011 Flood Planning Area Map in Appendix 1 and land identified as being flood liable land on the DCP 2011 Flood Liable Land Map in Appendix 2.

For the purposes of this Section of the DCP:

> Flood planning levels(FPLs) are the combinations of flood levels (derived from significant historical flood events or floods of specific annual exceedance probability (AEP) and freeboards selected for floodplain risk management purposes.
>
> The Standard Flood adopted by Council is the 1% AEP or the 1 in 100 year flood. The Standard Flood has been used to derive the Flood Planning Levels.

The land identified on the DCP 2011 Flood Liable Land Map and on the DCP 2011 Flood Planning Area Map is based on information available to Council when the Plans were prepared. As new information becomes available, the DCP 2011 Flood Planning Area Map and the DCP 2011 Flood Liable Land Map may change.

2.22.2.1 Flood planning area (Cooks River)

The Flood Planning Area (Cooks River) identifies land likely to be affected by the 1% AEP flood, factoring in a rise in sea level of 400mm to the year 2050, (plus 500mm freeboard) of the Cooks River.

2.22.2.2 Flood planning area (Overland Flow)

The Flood Planning Area (Overland Flow) identifies land (in accordance with Council's Flood Tagging Policy) likely to be affected by the 1% AEP flood associated with various locations affected by local overland flooding.

2.22.2.1 Flood planning level

The Flood Planning Level is the 1% AEP flood level plus freeboard. The applicable freeboard is 500mm unless an exception is described within a specific development control.

2.22.2.2 Flood liable land

Land identified on the DCP 2011 Flood Liable Map as flood liable land identifies land within a flood planning area, and land likely to be affected by the probable maximum flood (PMF) of the Cooks River. This means that the map identifies some land as being within the Cooks River PMF area, but not within the Cooks River 100-year flood (plus 500mm freeboard) area.

NB *The 1% AEP flood is a flood that has a one per cent probability of occurring or being exceeded in any year. The probable maximum flood (PMF) is calculated to be the maximum flood likely to occur. Freeboard refers to a factor of safety and is expressed as a height above the flood level. Freeboard tends to compensate for factors such as wave action and localised hydraulic effects.*

2.22.3 Development affected

Flood management controls apply as follows:

- For land in a flood planning area, the controls apply to all development that requires development consent.
- For land that is flood liable land, but that is not in a flood planning area (land within the Cooks River PMF), the controls also apply to caravan parks, child care centres, correctional centres, emergency services facilities, hospitals, residential accommodation (except for attached dwellings, dwelling houses, secondary dwellings and semi-detached dwellings), and tourist and visitor accommodation.

2.22.4 Cooks River flood classification areas

Flood classifications have been applied to parts of the Flood Planning Area (Cooks River). The flood classifications are:

- Low hazard: Should it be necessary, people and their possessions could be evacuated by truck. Able bodied adults would have little difficulty wading out of the area.
- High hazard: Possible danger to life, evacuation by truck difficult, potential for structural damage, and social disruption and financial losses could be high.

The identified areas, and their flood classifications, are:

1. Riverside Crescent/Tennyson Street area (Marrickville and Dulwich Hill): Low hazard to high hazard.
2. Illawarra Road/Wharf Street area (Marrickville): Low hazard to high hazard.
3. Carrington Road area (Marrickville): Low hazard.
4. Bay Street area (Tempe): Low hazard to high hazard.

2.22.5 Controls

General

C1 A *Flood Risk Management Report* must be submitted for applications that are on land identified on the Flood Planning Area Map in Appendix 1 and land identified as flood liable on the Flood Liable Land Map in Appendix 2.

The report must be informed by flood information relevant to the subject property and surrounds, including the 1% AEP flood level, Flood Planning Level, Probable Maximum Flood (PMF) level and the Flood Hazard Category, as obtained from Council.

The report is not required where the assessed value of the works is under $50,000 except where, in the opinion of Council, those works are likely to substantially increase the risk of flood to the subject or adjoining or nearby sites.

The report may be limited to a short report (Flood Risk Management Statement) for single residential dwellings, alterations and additions or change of use developments where the property is confirmed by Council as being subject only to low hazard flooding. The Flood Risk Management Statement must reference the source of flood information; specify the relevant flood information applicable to the site, then describe the proposed development and how it meets the relevant development controls.

If Council is concerned with the apparent loss of flood storage and/or flood or overland flow paths, and/or increase in flow velocities, and/or risk of life, on any type of development, the applicant may be requested to undertake further analysis in support of the proposal and detail it in a new/revised Flood Risk Management Report.

C2 The Flood Risk Management Report must address:

a. Description of the existing stormwater drainage system, including catchment definition.
b. Extent of the 1% AEP flood event in the vicinity of the development.
c. The Flood Hazard Category affecting the subject site and surrounds. Where the site is subject to the high hazard flooding category, the Probable Maximum Flood (PMF) extent must be shown.
d. Long and cross sections showing the Flood Planning Level(s) in relationship to the floor levels of all existing and proposed components of the development.
e. Recommendations on all precautions to minimise risk to personal safety of occupants and the risk of property damage for the total development to address the flood impacts on the site during a 1% AEP flood and PMF event. These precautions must include but not be limited to the following:
    i. Types of materials to be used to ensure the structural integrity of the development for immersion and impact of velocity and debris for the 1% AEP flood event and PMF (for high hazard);
    ii. Waterproofing methods, including electrical equipment, wiring, fuel lines or any other service pipes or connections;
    iii. A flood evacuation strategy (Flood Emergency Response Plan); and

iv. On site response plan to minimise flood damage, and provide adequate storage areas for hazardous materials and valuable goods above the flood level;

f. Details of any flood mitigation works that are proposed to protect the development.

g. Supporting calculations.

h. The architectural/engineering plans on which the assessment is based.

i. The date of inspection.

j. The professional qualifications and experience of the author(s).

C3 All applications for development must be accompanied by a survey plan including relevant levels to AHD (Australian Height Datum). Consideration must be given to whether structures or filling are likely to affect flood behaviour and whether consultation with other authorities is necessary.

C4 Compliance with flood management controls must be balanced by the need to comply with other controls in this DCP.

Controls for new residential development

C5 Floor levels (Flood Planning Levels) of habitable rooms must be a minimum of 500mm above the 1% AEP flood level at that location. For areas of minor overland flow (a depth of 300mm or less or overland flow of 2cum/sec or less) a lower freeboard of 300mm may be considered on its merits.

C6 Any portion of buildings below the Flood Planning Level) must be constructed from flood compatible materials (See Schedule 1).

C7 Flood free access must be provided where practicable.

Controls for residential development – minor additions

C8 Once-only additions with a habitable floor area of up to 30m^2 may be approved with floor levels below the 1% AEP flood level at that location if the applicant can demonstrate that no practical alternatives exist for constructing the extension above the 1% AEP flood level.

C9 Additions greater than 30m^2 will be considered against the requirements for new residential development (refer C5, C6, and C7).

C10 Any portion of buildings below the Flood Planning Level must be constructed from flood compatible materials.

Controls for non-habitable additions or alterations

C11 All flood sensitive equipment must be located above the Flood Planning Level at that location.

C12 Any portion of buildings below the Flood Planning Level must be built from flood compatible materials.

Controls for new non-residential development

C13 Floor levels (except for access-ways) must be at least 500mm above the 1% AEP flood level, or the buildings must be flood-proofed to at least 500mm above the 1% AEP flood level. For areas of minor overland flow (a depth of 300mm or less or overland flow of 2cum/sec or less) a lower freeboard of 300mm may be considered on its merits.

C14 Flood-free access must be provided where practicable.

Controls for non-residential development – additions

C15 Where the proposed development is for an addition to an existing building within the Flood Planning Area, the development may be approved with floor levels below the 1% AEP flood Level if the applicant can demonstrate that all practical measures will be taken to prevent or minimise the impact of flooding. In determining the required floor level, matters which will be considered include:

i. The nature of the proposed landuse;
ii. The frequency and depth of possible flooding;
iii. The potential for life and property loss;
iv. The suitability of the building for its proposed use; and
v. Whether the filling of the site or raising of the floor levels would render the development of the site impractical or uneconomical.

C16 Any portion of the proposed addition below the 1% AEP must be built from flood compatible materials.

Controls for change of use of existing buildings

C17 Development consent for change of use of an existing building with floor levels below the 1% AEP flood level will only be given where there is no foreseeable risk of pollution associated with the proposed use of the building in the event that 1% AEP flood event occurs.

C18 In determining whether to grant development consent for change of use of an existing building with floor levels below the1% AEP flood level, consideration will be given to whether the proposed development would result in increased flood risk for the property on which the building is located, or other land. In this regard, the following matters will be considered:

i. The nature of the proposed use and the manner in which it is proposed to be carried out within the building or on the land; and
ii. The foreseeable risk of pollution associated with the proposed use of the building/land in the event that the 1% AEP flood event occurs.

Controls for subdivision

C19 Development consent for the subdivision of flood liable land may depend on whether the land to which the proposed development relates is unsuitable for any development made likely by the subdivision, by reason of the land likely to be subject to flooding.

C20 Development consent for the subdivision of flood liable land may depend on whether the carrying out of the subdivision and any associated site works would:

i. Adversely impede the flow of flood water on the land or land in its vicinity;
ii. Imperil the safety of persons on that land or land in its vicinity in the event of the land being inundated with flood water; and
iii. Aggravate the consequences of flood water flowing on that land or land in its immediate vicinity with regard to erosion or siltation.

PART 2: GENERIC PROVISIONS

Controls for filling of land within the Flood Planning Area

C21 Development consent will not be granted to filling of flood ways or high flood hazard areas. Consideration will only be given to granting development consent to the filling of other flood liable land where:

i. Flood levels are not increased by more than 10mm by the proposed filling.

ii. Downstream velocities are not increased by more than 10% by the proposed filling.

iii. Proposed filling does not redistribute flows by more than 15%.

iv. The potential for cumulative effects of possible filling proposals in that area is minimal.

v. The development potential of surrounding properties is not adversely affected by the filling proposal.

vi. The flood liability of buildings on surrounding properties is not increased.

vii. The filling creates no local drainage flow/runoff problems.

NB *Where the proposal has the potential to increase flood levels, depths, velocities and/or the risk to life or property, through loss of flood storage and/or blockage/ redirection of overland flowpaths, the Flood Risk Management Report supporting the development application must include detailed flood analysis. Such analysis should address compliance with all relevant development controls and include survey cross-sections to provide representative topographic information. The proponent should approach Council to determine available Council flood studies for the area, with the analysis based on or calibrated against relevant studies. In some cases, flood model data can be obtained from Council, subject to application and payment of fees.*

Controls for land uses on flood liable land identified on the DCP 2011 Flood Liable Land Map

C22 A site emergency response flood plan must be prepared in case of a PMF flood.

C23 Adequate flood warning systems, signage and exits must be available to allow safe and orderly evacuation without increased reliance upon the State Emergency Service (SES) or other authorised emergency services personnel.

C24 Reliable access for pedestrians or vehicles must be provided from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF.

Controls for garages, carports, open car parks and basement garages

C25 The floor level of new enclosed garages must be at or above the 1% AEP flood level plus 200mm. In extenuating circumstances, consideration may be given to a floor level at a lower level, being the highest practical level but no lower than 180mm below the 1% AEP flood level, where it can be demonstrated that providing the floor level at the Flood Planning Level is not practical within the constraints of compliance with Australian Standard AS/NZS 2890.1 Parking facilities as amended.

C26 The floor levels of open car park areas and carports must meet the same criteria as above for garages. In extreme circumstances, for single dwelling residential development, a floor level below the 1% AEP flood level minus 180mm may be accepted for a single car space, subject to bollards being provided along the 'free' perimeter (excluding the vehicle entry on one side only) at 1.2m intervals and the floor level being raised as high as practical within the constraints of compliance with Australian Standard AS/NZS 2890.1 Parking facilities as amended.

C27 On properties with a low flood hazard classification, basement (below natural ground level) car parking must have all access and potential water entry points above the Flood Planning Level, and a clearly signposted flood free pedestrian evacuation route provided from the basement area separate to the vehicular access ramps. For basement car parking in properties affected by High Hazard flooding further considerations will apply.

C28 Basement garages must include:

a. Suitable pumps must be provided within the garage to allow for the drainage of stormwater should the basement garage become inundated during flooding.
b. Adequate flood warning systems, signage and exits must be available to allow safe and orderly evacuation without increased reliance upon the SES or other authorised emergency services personnel.

C29 For parking areas servicing more than two parking spaces, reliable access for pedestrians must be provided from all parking areas, to a safe haven which is above the PMF.

PART 2: GENERIC PROVISIONS

2.22.6 SCHEDULE 1 – Flood compatible materials

Building component	Flood compatible material
Flooring and sub-floor	• concrete slab-on-ground monolith
	• suspended reinforced concrete slab
Floor covering	• clay tiles
	• concrete, precast or in situ
	• concrete tiles
	• epoxy, formed-in-place
	• mastic flooring, formed-in-place
	• rubber sheets or tiles with chemicals-set-adhesive
	• silicone floors formed-in-place
	• vinyl sheets or tiles with chemical-set adhesive
	• ceramic tiles, fixed with mortar or chemical-set adhesive
	• asphalt tiles, fixed with water resistant adhesive
Wall structure	• solid brickwork, blockwork, reinforced, concrete or mass concrete
Roofing structure (for situations where the relevant flood level is above the ceiling)	• reinforced concrete construction • galvanised metal construction
Doors	• solid panel with water proof adhesives
	• flush door with marine ply filled with closed cell foam
	• painted metal construction
	• aluminium or galvanised steel frame
Wall and ceiling linings	• fibro-cement board
	• brick, face or glazed
	• clay tile glazed in waterproof mortar
	• concrete
	• concrete block
	• steel with waterproof applications
	• stone, natural solid or veneer, waterproof grout
	• glass blocks
	• glass
	• plastic sheeting or wall with waterproof adhesive
Insulation windows	• foam (closed cell types)
	• aluminium frame with stainless steel rollers or similar corrosion and water resistant material
Nails, bolts, hinges and fittings	• brass, nylon or stainless steel • removable pin hinges • hot dipped galvanised steel wire nails or similar

SCHEDULE 1: Flood compatible materials (cont.)	
Electrical and mechanical equipment For development constructed on land to which this section of the DCP applies, the electrical and mechanical materials, equipment and installation must conform to the following requirements: Main power supply Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, must be located above the relevant flood level. Means must be available to easily disconnect the dwelling from the main power supply. Wiring All wiring, power outlets, switches, must be to the maximum extent possible, located above the maximum flood level. All electrical wiring installed below this level must be suitable for continuous underwater immersion and must contain no fibrous components. Each leakage circuit-breaker (core balance relays) must be installed. Only submersible type splices must be used below maximum flood level. All conduits located below the relevant designated flood level must be so installed that they will be self-draining if subjected to flooding. Equipment All equipment installed below or partially below the relevant flood level must be capable of disconnection by a single plug and socket assembly. Reconnection Should any electrical device and/or part of the wiring be flooded it must be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.	Heating and air conditioning systems Where viable, heating and air conditioning systems should be installed in areas and spaces of the development above maximum flood level. When this is not feasible, every precaution must be taken to minimise the damage caused by submersion according to the following guidelines: Fuel Heating systems using gas or oil as fuel must have a manually operated valve located in the fuel supply line to enable fuel cut-off. Installation Heating equipment and fuel storage tanks must be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks must be vented to an elevation of 600mm above the relevant flood level. Ducting All ductwork located below the relevant flood level must be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, a closure assemble operated from above relevant flood level must protect the ductwork.

Appendix 1 - DCP 2011 Flood Planning Area Map

See the attached map.

Appendix 2 - DCP 2011 Flood Liable Land Map

See the attached map.

APPENDIX

C

EMERGENCY MANAGEMENT MAPS

Stantec

Emergency Services within the Study Area with 1% AEP and PMF Extent

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-28)
Figure No: 1

Legend

- Johnstons Creek Study Area
- Whites Creek Study Area
- IWC LGA Boundary
- 1% AEP Flood Extent
- PMF Flood Extent

Location of Emergency Services

- Ambulance
- Fire Station
- Hospital
- Police Station

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, March 2023]

DRAFT - Not For Construction

0 0.2 0.4 km

Scale at A3: 1:7000

Stantec

Vulnerable Development and Emergency Services within the Study Area with 1% AEP and PMF Extent

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-28)
Figure No: 2

Stantec

Legend

- Johnstons Creek Study Area
- Whites Creek Study Area
- IWC LGA Boundary
- 1% AEP Flood Extent
- PMF Flood Extent

Location of Emergency Services

- Ambulance
- Fire Station
- Hospital
- Police Station

Location of Vulanterable davelopment

- Aged care
- Day care
- Hotel
- School

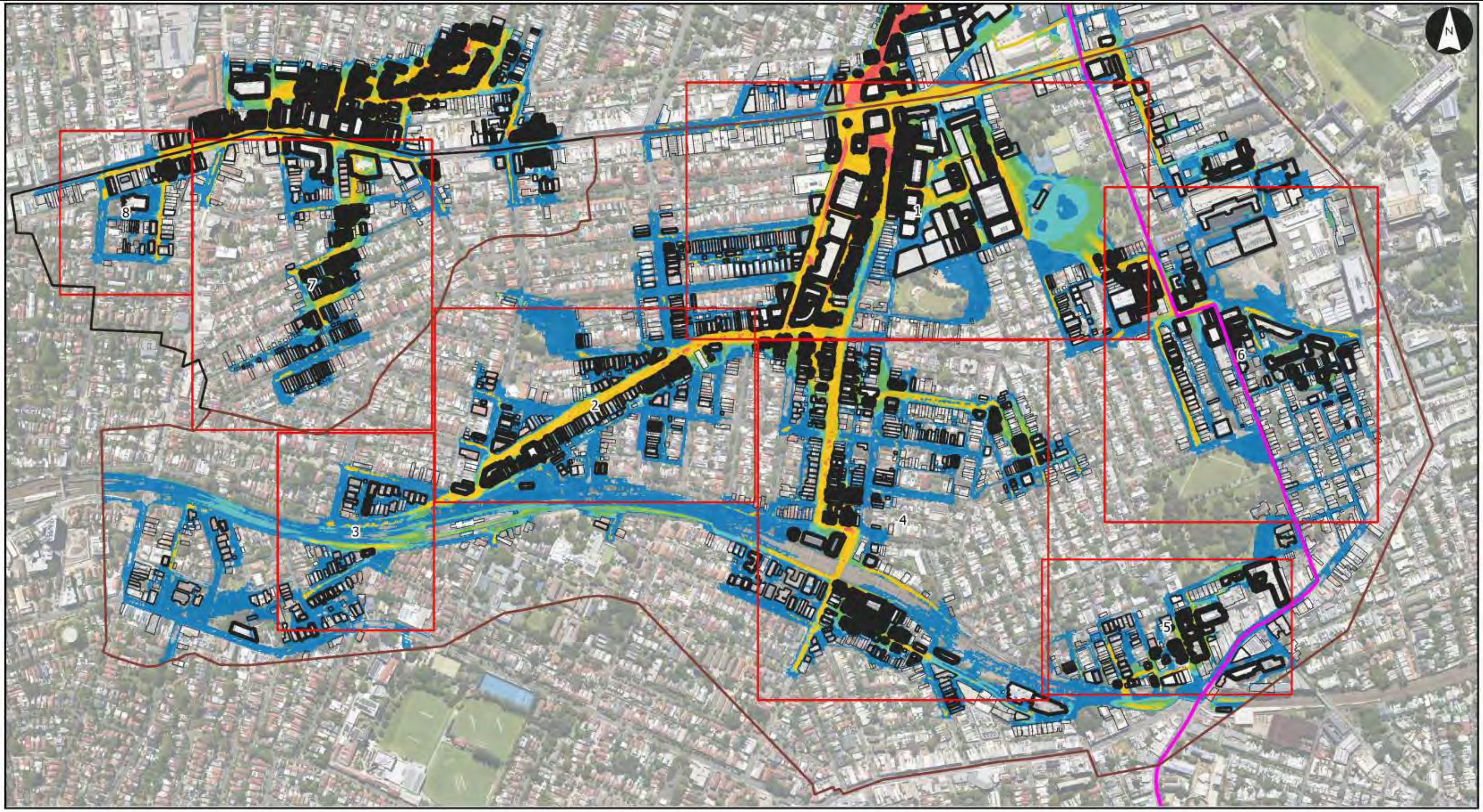
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (Metromap, March 2023)

DRAFT - Not For Construction

0 0.2 0.4 km

Scale at A3: 1:7000



Emergency Management Hotspot Overview

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-06-28)
Figure No: 1

Stantec

Legend

- Johnstons Creek Study Area
- Whites Creek Study Area
- IWC LGA Boundary
- Emergency Hotspot

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (Metromap, March 2023)

DRAFT - Not For Construction

0 0.2 0.4 km

Scale at A3: 1:7000

Emergency Management

Hotspot 1 **20% AEP**

Project: Whites Creek and Johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 1

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes

- Vehicular
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.06 0.12 km

Scale at A3: 1:2300

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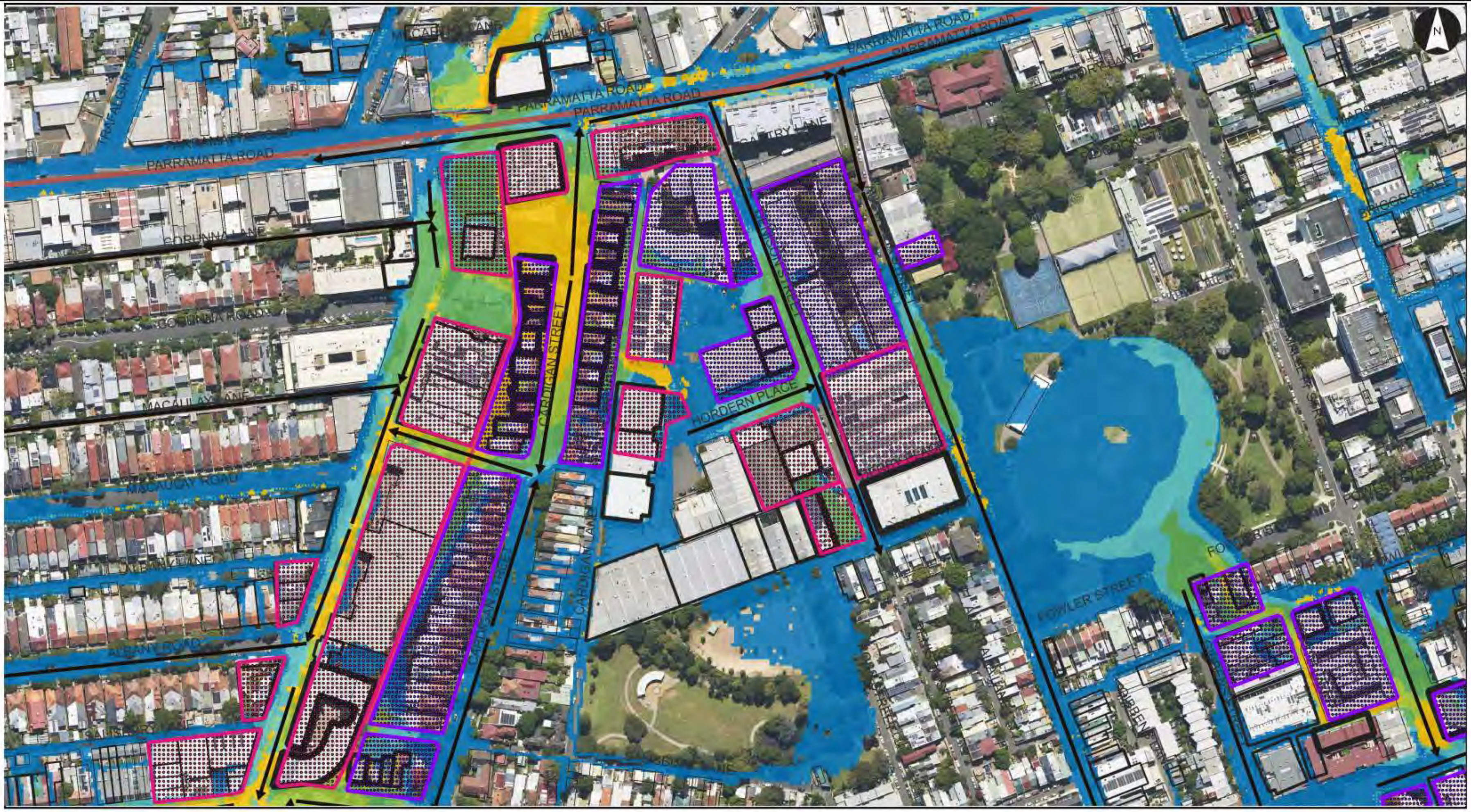

Emergency Management

Hotspot 1 **1% AEP**

Project: Whites Creek and Johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 2

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes
- Vehicular
- Commercial Low Flood Island
- Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.06 0.12 km

Scale at A3: 1:2300

Emergency Management

Hotspot 1 **PMF**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 3

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes
- Vehicular
- Commercial Low Flood Island
- Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.06 0.12 km

Scale at A3: 1:2300

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Emergency Management

Hotspot 2 **20% AEP**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 4

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)

<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6

Evacuation Routes

Vehicular

Commercial Low Flood Island
Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:1800

Emergency Management

Hotspot 2 **1% AEP**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 5

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)

<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
>1

Evacuation Routes

Vehicular
Commercial Low Flood Island
Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:1800

Emergency Management

Hotspot 2 **PMF**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 6

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes
- Vehicular
- Commercial Low Flood Island
- Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:1800

Emergency Management

Hotspot 3 **20% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 7

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)
<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6

Evacuation Routes
Vehicular
Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:29044

Emergency Management

Hotspot 3 **1% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 8

Stantec

Legend
- Johnstons Creek Study Area
- Whites Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Evacuation Routes
- Vehicular
- Low Flood Island

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

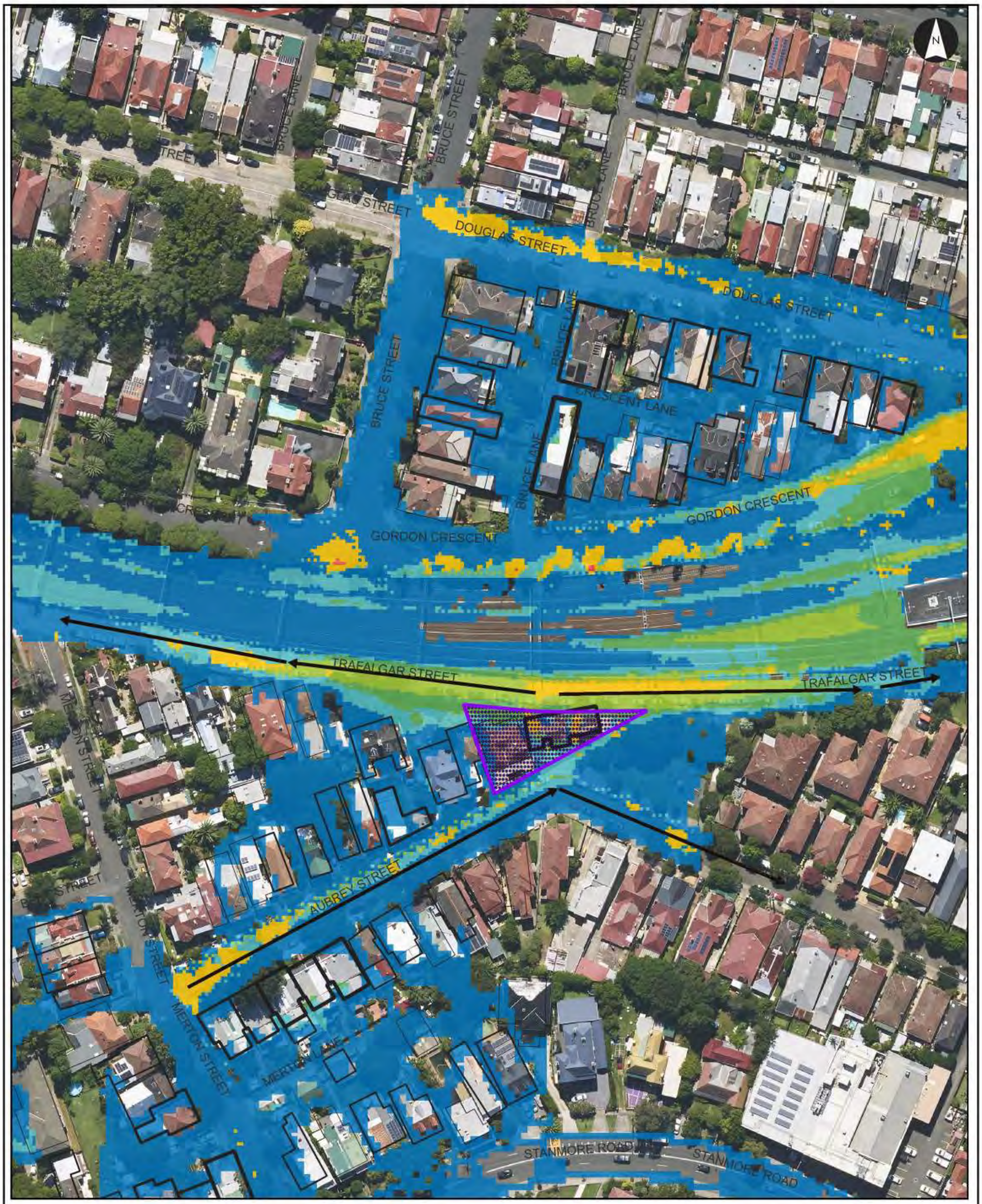
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:29044



Emergency Management

Hotspot 3 **PMF**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 9

Stantec

Legend

- Johnstons Creek Study Area
- Whites Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8

Evacuation Routes

- Vehicular

- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:29044

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Emergency Management

Hotspot 4 **20% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 10

Stantec

Legend

Johnstons Creek Study Area

Low Flood Island

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Hazard Category

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

Evacuation Routes

- Vehicular
- Pedestrain
- Commercial Low Flood Island

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.06 0.12 km

Scale at A3: 1:29044

Emergency Management

Hotspot 4 **1% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 11

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1

Evacuation Routes

- Vehicular
- Pedestrain

Commercial Low Flood Island

Low Flood Island

Hazard Category

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

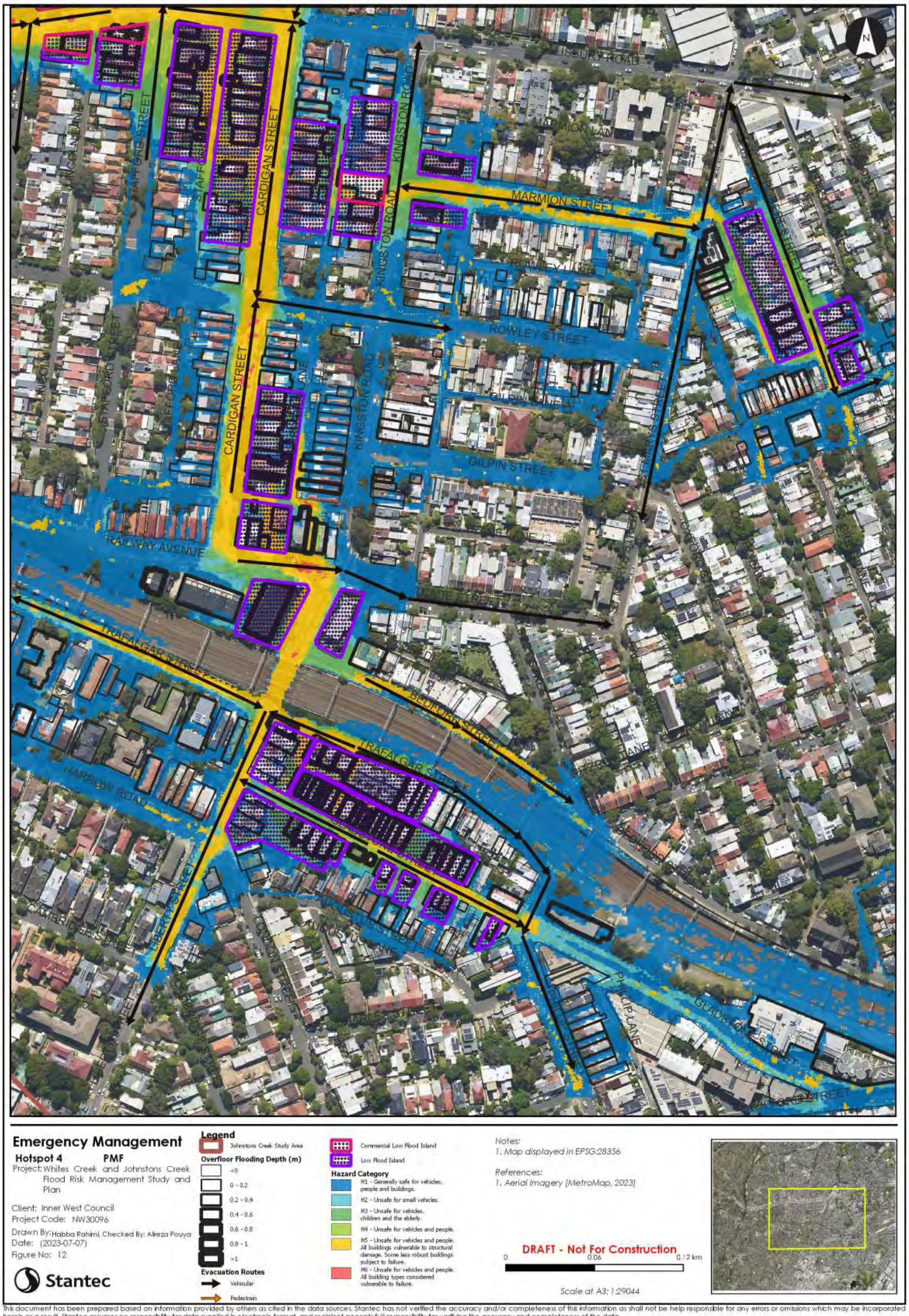
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.06 0.12 km

Scale at A3: 1:29044


MARMION STREET
ROWLEY STREET
GILPIN STREET
CARDIGAN STREET
KINGSTON ROAD
STAFFORD STREET
RAILWAY AVENUE
TRAFALGAR STREET
BEDFORD STREET
HARROW ROAD
PHILLIP LANE
Emergency Management
Hotspot 4 PMF
Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan
Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 12
Stantec
Legend
Johnstons Creek Study Area
Overfloor Flooding Depth (m)
<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
>1
Evacuation Routes
Vehicular
Pedestrain
Commercial Low Flood Island
Low Flood Island
Hazard Category
H1 - Generally safe for vehicles, people and buildings.
H2 - Unsafe for small vehicles.
H3 - Unsafe for vehicles, children and the elderly.
H4 - Unsafe for vehicles and people.
H5 - Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6 - Unsafe for vehicles and people. All building types considered vulnerable to failure.
Notes:
1. Map displayed in EPSG:28356
References:
1. Aerial Imagery [MetroMap, 2023]
DRAFT - Not For Construction
0 0.06 0.12 km
Scale at A3: 1:29044

Emergency Management

Hotspot 5 **20% AEP**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 13

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes

- Vehicular
- Pedestrain
- Commercial Low Flood Island
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:1200

Emergency Management

Hotspot 5 **1% AEP**

Project: Whites Creek and Johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 14

Stantec

Legend

Johnstons Creek Study Area

Overflooring Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes
- Vehicular
- Pedestrain

Commercial Low Flood Island
Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:1200

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Emergency Management

Hotspot 5 **PMF**

Project: Whites Creek and johnstons Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 15

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Evacuation Routes
- Vehicular
- Pedestrain
- Commercial Low Flood Island
- Low Flood Island

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

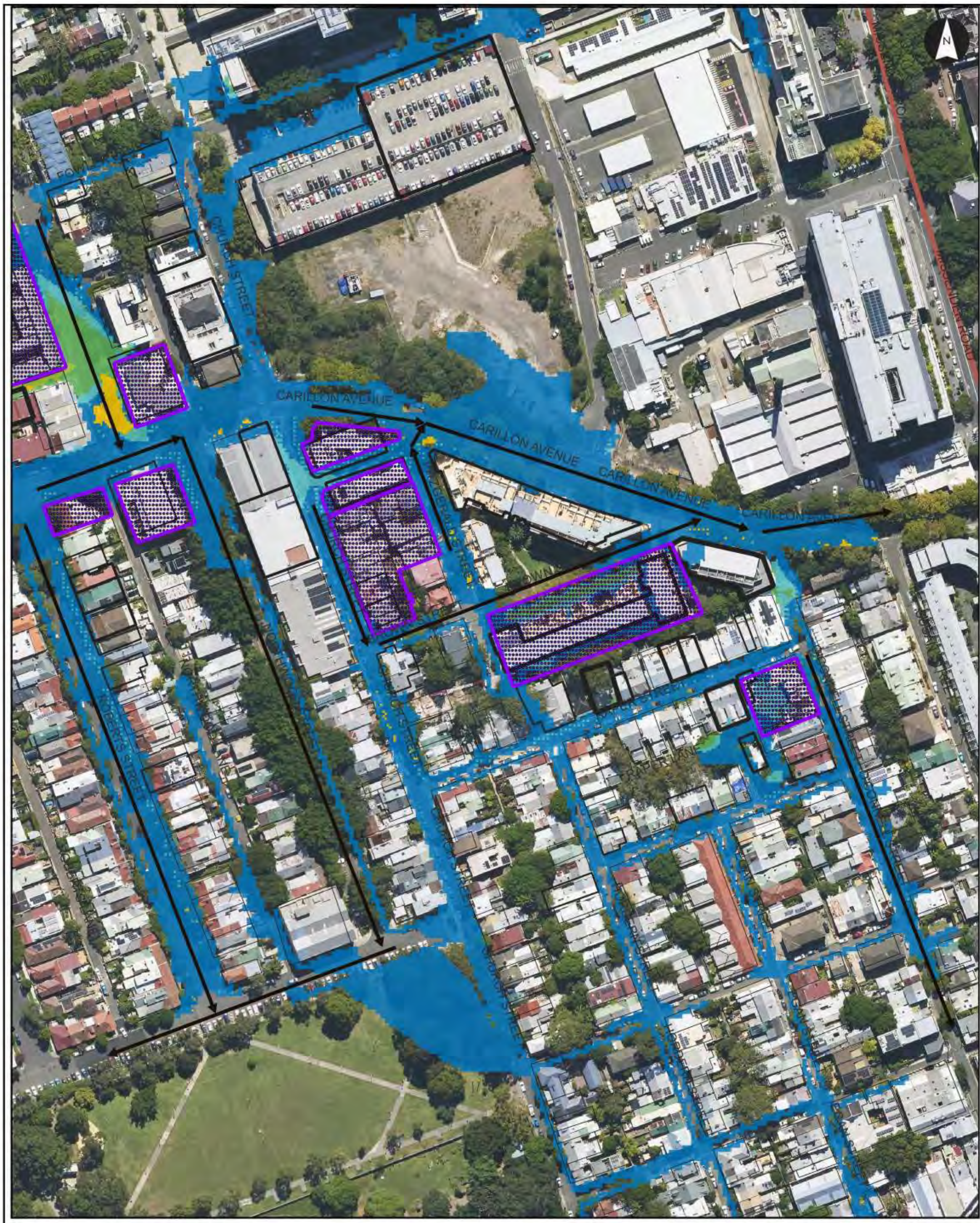
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.03 0.06 km

Scale at A3: 1:1200



Emergency Management

Hotspot 6 **20% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 16

Stantec

Legend

Johnstons Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8

Evacuation Routes

- Vehicular
- Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.04 0.08 km

Scale at A3: 1:29044

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Emergency Management

Hotspot 6 **1% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council

Project Code: NW30096

Drawn By: Habba Rahimi, Checked By: Alireza Pouya

Date: (2023-07-07)

Figure No: 17

Stantec

Legend

Johnstons Creek Study Area

Low Flood Island

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Hazard Category

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

Evacuation Routes

Vehicular

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.04 0.08 km

Scale at A3: 1:29044

Emergency Management

Hotspot 6 **PMF**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 18

Stantec

Legend

Johnstons Creek Study Area

Low Flood Island

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- >1

Hazard Category

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

Evacuation Routes

Vehicular

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.04 0.08 km

Scale at A3: 1:29044

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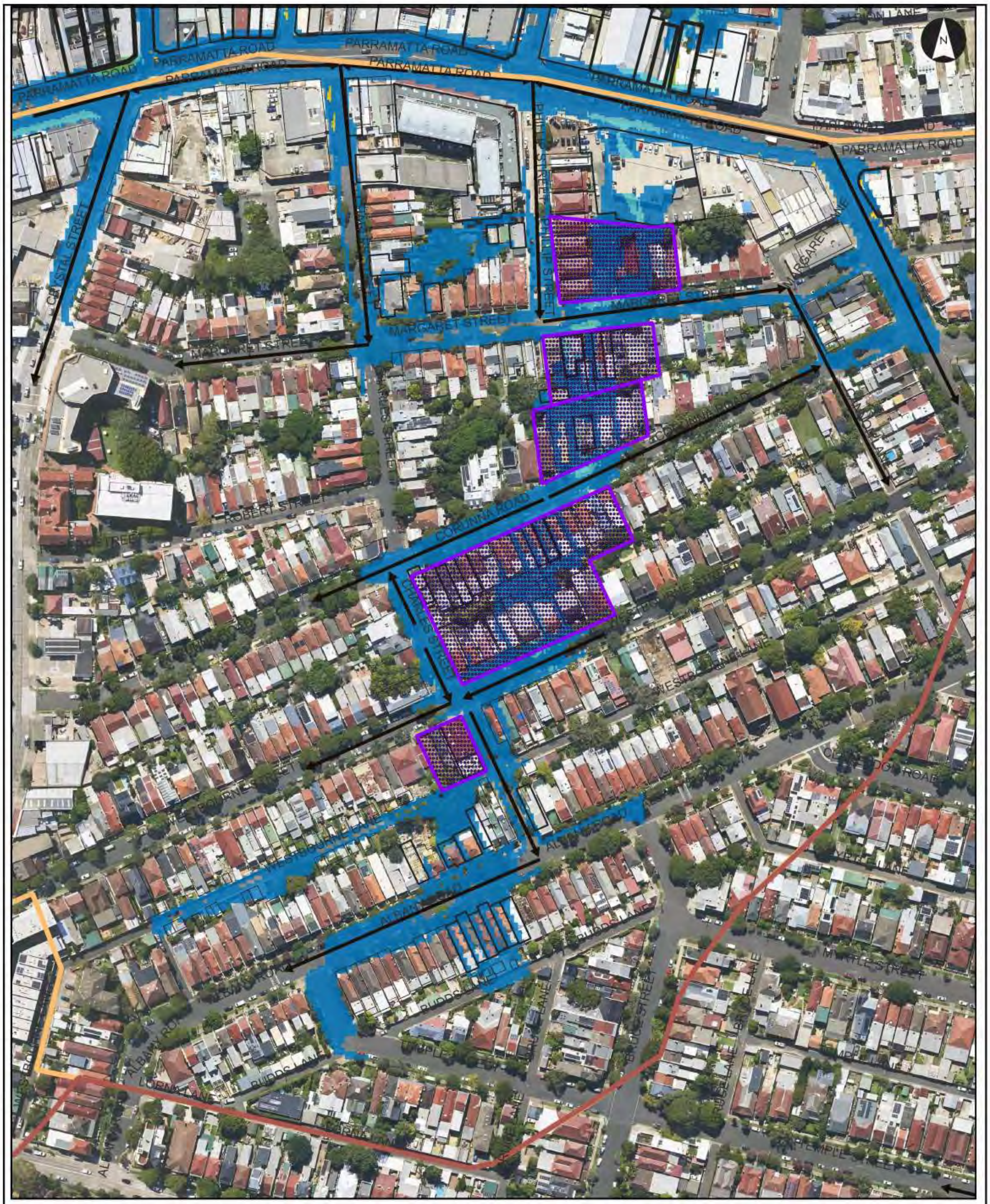

Emergency Management

Hotspot 7 **20% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 19

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1

Evacuation Routes

Vehicular

Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:29044

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Emergency Management

Hotspot 7 **1% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 20

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)

<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
>1

Evacuation Routes

Vehicular
Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:29044

Emergency Management

Hotspot 7 **PMF**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 21

Stantec

Legend

Johnstons Creek Study Area
Whites Creek Study Area

Overfloor Flooding Depth (m)

<0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
>1

Evacuation Routes

Vehicular
Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (MetroMap, 2023)

DRAFT - Not For Construction

0 0.05 0.1 km

Scale at A3: 1:29044

Emergency Management

Hotspot 8 **20% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 22

Stantec

Legend

Whites Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4

Evacuation Routes

- Vehicular
- Commercial Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

Emergency Management

Hotspot 8 **1% AEP**

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 23

Stantec

Legend

Whites Creek Study Area

Overfloor Flooding Depth (m)

- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6

Evacuation Routes

- Vehicular
- Commercial Low Flood Island

Hazard Category

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

Emergency Management

Hotspot 8 PMF

Project: Whites Creek and Johnstons Creek Flood Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Habba Rahimi, Checked By: Alireza Pouya
Date: (2023-07-07)
Figure No: 24

Stantec

Legend

Whites Creek Study Area

Overfloor Flooding Depth (m)
- <0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- >1

Evacuation Routes
- Vehicular

Commercial Low Flood Island

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

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [MetroMap, 2023]

DRAFT - Not For Construction

0 0.02 0.04 km

Scale at A3: 1:29044

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Item 16

APPENDIX

D

PRELIMINARY FLOOD OPTIONS MAPS

Stantec

Attachment 4

Preliminary Mitigation Options Hotspot 1

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 1

Legend

Existing Council Modelled Stormwater Network
Cadastre
Inner West Council LGA Boundary
Johnstons Creek Study Area

Preliminary Option Type
Channel Upgrades
Detention Basin
Drainage Upgrades
Road Lowering
Drainage Maintenance

Flood Depth (m)
0.00 to 0.10
0.10 to 0.30
0.30 to 0.50
0.50 to 0.70
0.70 to 1.00
1.00 to 1.50
> 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

20 0 20 40 60 80 m

Scale at A3: 1:2300

Stantec

Preliminary Mitigation Options Hotspot 2

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 2

Stantec

Legend

Existing Council Modelled Stormwater Network
Cadastre
Inner West Council LGA Boundary
Johnstons Creek Study Area

Preliminary Option Type
Channel Upgrades
Detention Basin
Drainage Upgrades
Road Lowering
Drainage Maintenance

Flood Depth (m)
0.00 to 0.10
0.10 to 0.30
0.30 to 0.50
0.50 to 0.70
0.70 to 1.00
1.00 to 1.50
> 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery (Metromap, 2023)

DRAFT - Not For Construction

20 0 20 40 60 80 m

Scale at A3: 1:1800

Key Map

Preliminary Mitigation Options Hotspot 3

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 3

Legend

- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Johnstons Creek Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1000

Stantec

Preliminary Mitigation Options
Hotspot 4

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson C. Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 4

Stantec

Legend
- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Whites Creek Study Area
- Johnstons Creek Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

20 0 20 40 60 80 m

Scale at A3: 1:2200

Preliminary Mitigation Options Hotspot 5

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson Chang, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 5

Stantec

Legend

- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Johnstons Creek Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

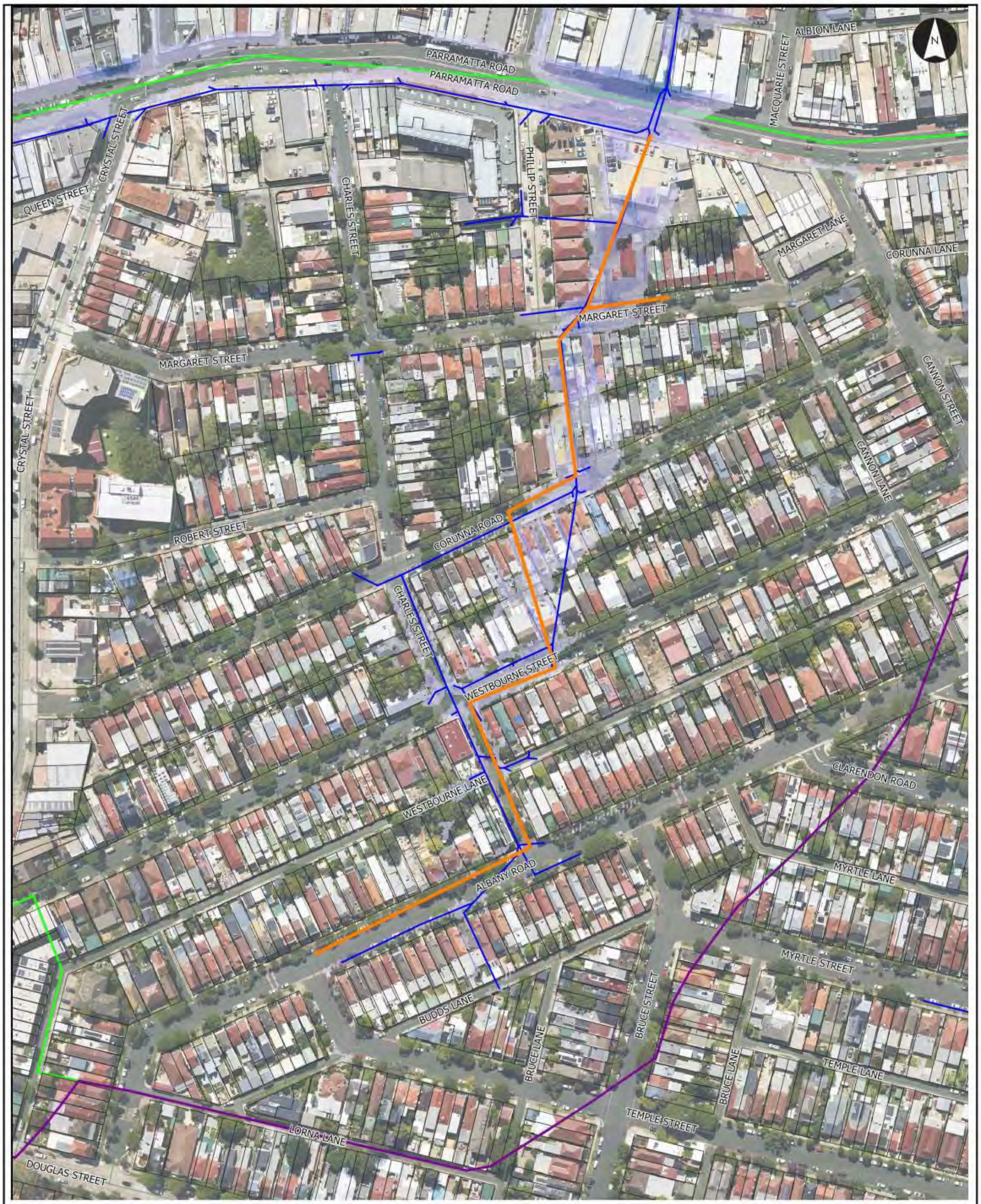
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:1200



Preliminary Mitigation Options
Hotspot 7

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson C. Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 7

Stantec

Legend
- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Whites Creek Study Area
- Johnstons Creek Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

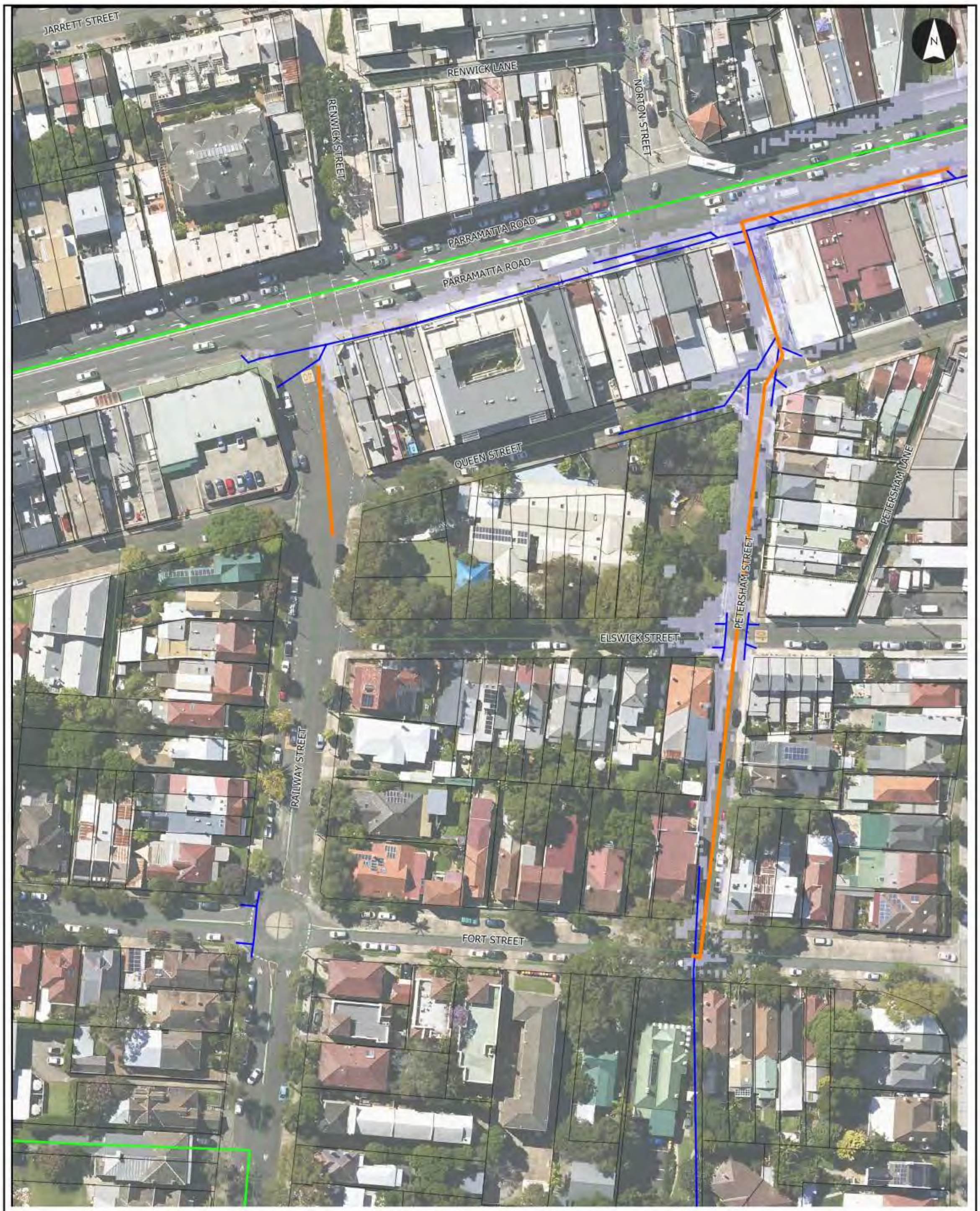
Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

20 0 20 40 60 80 m

Scale at A3: 1:1800



Preliminary Mitigation Options
Hotspot 8

Project: Whites Creek and Johnstons Creek Floodplain Risk Management Study and Plan

Client: Inner West Council
Project Code: NW30096
Drawn By: Anson C, Checked By: Alireza Pouya
Date: (2023-07-05)
Figure No: 8

Stantec

Legend
- Existing Council Modelled Stormwater Network
- Cadastre
- Inner West Council LGA Boundary
- Whites Creek Study Area
- Johnstons Creek Study Area

Preliminary Option Type
- Channel Upgrades
- Detention Basin
- Drainage Upgrades
- Road Lowering
- Drainage Maintenance

Flood Depth (m)
- 0.00 to 0.10
- 0.10 to 0.30
- 0.30 to 0.50
- 0.50 to 0.70
- 0.70 to 1.00
- 1.00 to 1.50
- > 1.50

Notes:
1. Map displayed in EPSG:28356

References:
1. Aerial Imagery [Metromap, 2023]

DRAFT - Not For Construction

10 0 10 20 30 40 m

Scale at A3: 1:900

APPENDIX

E

DETAILED FLOOD OPTION MAPS

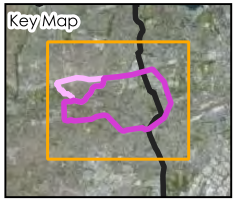
Johnstons Creek Base Case - PM6 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 1

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

120 0 120 240 360 480 m

Scale at A3: 1:15000

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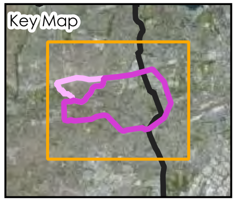
Johnstons Creek Base Case 20% AEP PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 2

Legend

MJC Study Area
MWC Study Area
IWC LGA Boundary
Unblocked Drainage
Blocked Drainage, Now Unblocked
MJC_5y_PM6-Ext_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_5y_PM6-Ext_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

120 0 120 240 360 480 m

Scale at A3: 1:15000

Johnstons Creek Base Case 5% AEP
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 3

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MJC_20y_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

120 0 120 240 360 480 m

Scale at A3: 1:15000

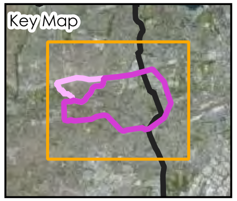
Johnstons Creek Base Case 2% AEP PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 4

Legend

MJC Study Area
MWC Study Area
IWC LGA Boundary
Unblocked Drainage
Blocked Drainage, Now Unblocked
MJC_50y_PM6-Ext_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_50y_PM6-Ext_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

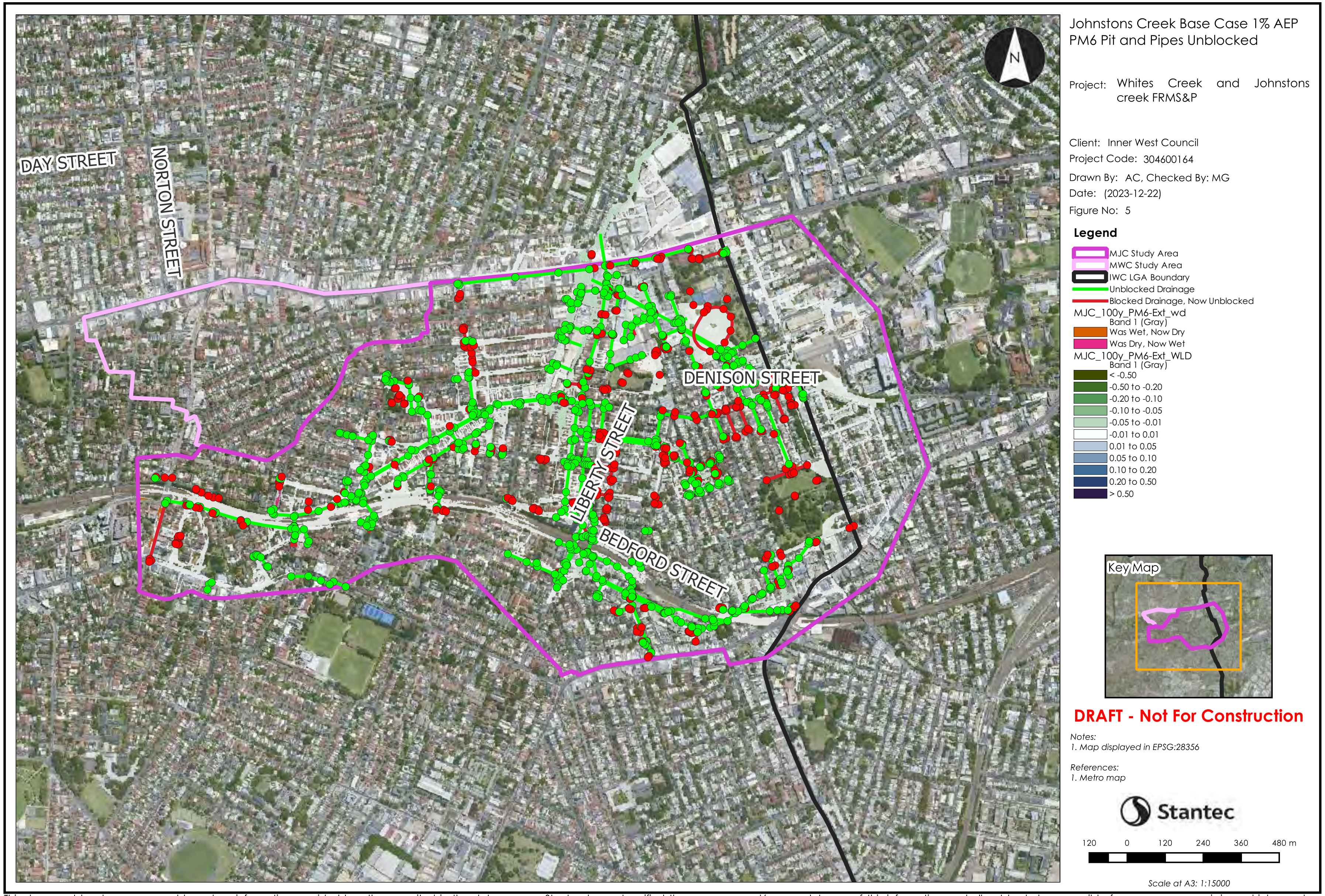
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

120 0 120 240 360 480 m

Scale at A3: 1:15000



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Johnstons Creek Base Case PMF
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

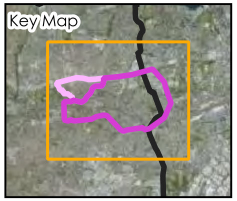
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 6

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MJC_PMF_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

120 0 120 240 360 480 m

Scale at A3: 1:15000

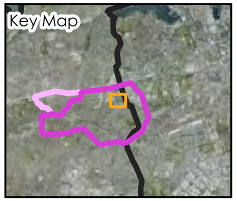
Johnstons Creek Option - JC1 v1 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 7

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

13 0 13 26 38 51 m

Scale at A3: 1:1600

Johnstons Creek Option 20% AEP JC1 v1 Fowler Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council

Project Code: 304600164

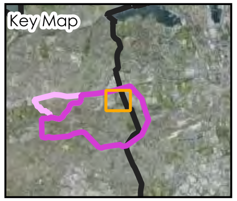
Drawn By: AC, Checked By: MG

Date: (2023-12-22)

Figure No: 8

Legend

MJC Study Area
IWC LGA Boundary
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_5y_JC1_v5-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50
MJC_5y_JC1_v4-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet



DRAFT - Not For Construction

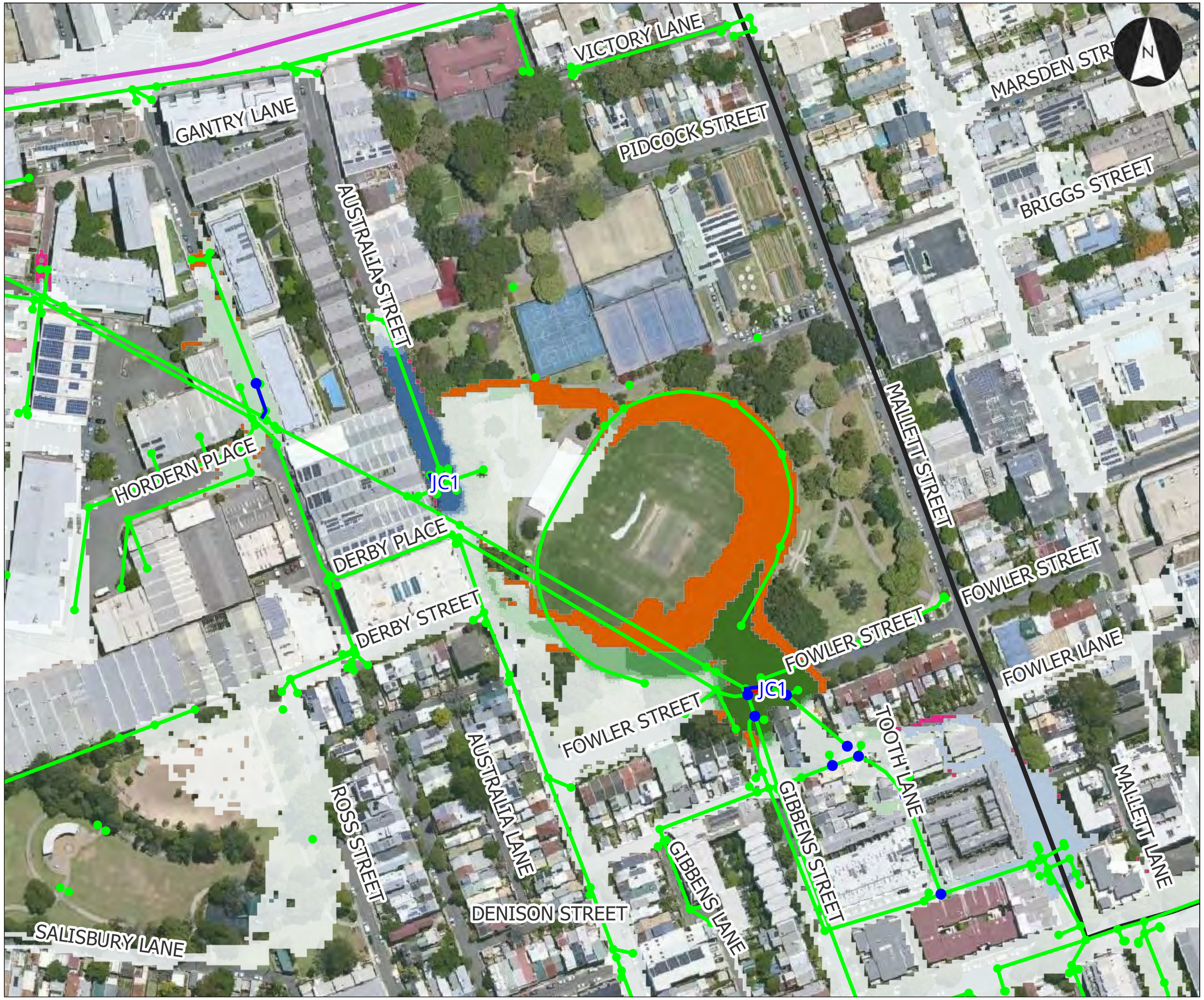
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600



Johnstons Creek Option 5% AEP
JC1 v1 Fowler Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

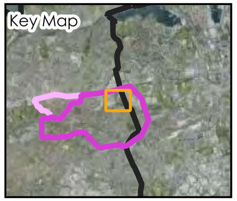
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 9

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_20y_JC1_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC1_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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Johnstons Creek Option 2% AEP
JC1 v1 Fowler Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

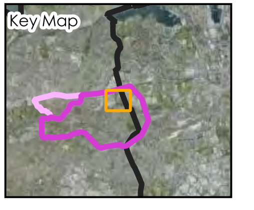
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 10

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_50y_JC1_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC1_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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Johnstons Creek Option 1% AEP
JC1 v1 Fowler Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

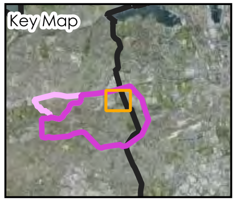
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 11

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_100y_JC1_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC1_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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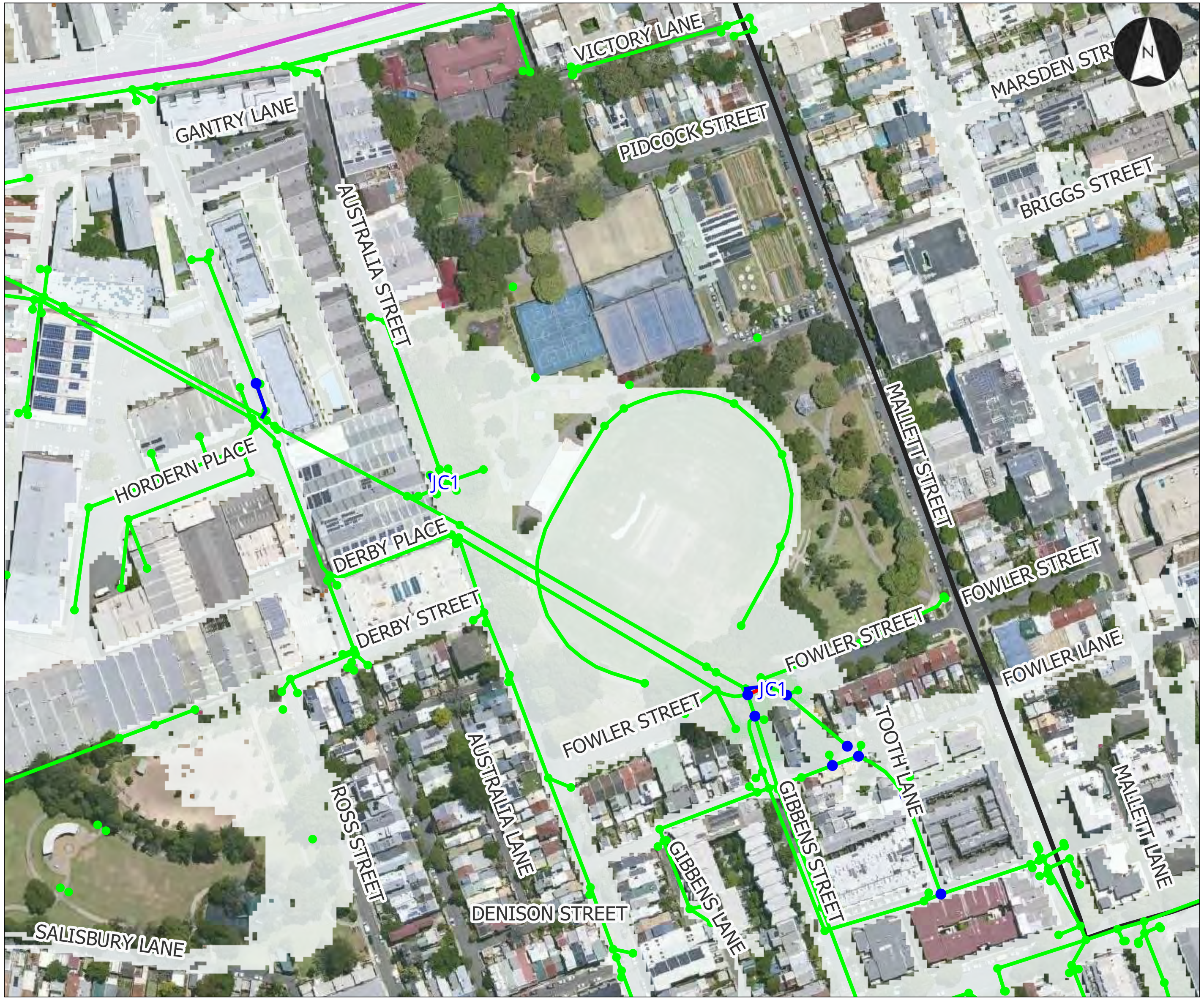


Johnstons Creek Option PMF
JC1 v1 Fowler Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

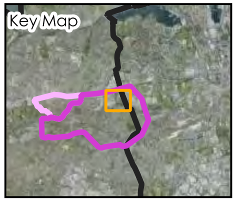
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 12

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_PMF_JC1_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_JC1_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

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21 0 21 42 62 83 m

Scale at A3: 1:2600

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Johnstons Creek Option - JC1 v2 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 13

Legend

- MJC Study Area
- IWC LGA Boundary
- JC1_v4_detbasin
- Detention Basin
- Proposed Drainage
- Removed Drainage
- Existing Drainage

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Notes:
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References:
1. Metro map

Stantec

13 0 13 26 38 51 m

Scale at A3: 1:1600

Johnstons Creek Option 20% AEP
JC1 v2 Fowler Street Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 14

Legend

- MJC Study Area
- IWC LGA Boundary
- JC1_v4_detbasin
  - Detention Basin
- Proposed Drainage
- Removed Drainage
- Existing Drainage
- MJC_5y_JC1_v5-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50
- MJC_5y_JC1_v5-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet

Key Map

DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

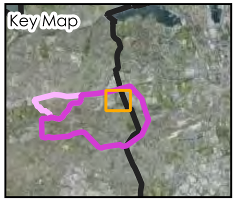
Johnstons Creek Option 5% AEP
JC1 v2 Fowler Street Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 15

Legend

MJC Study Area
IWC LGA Boundary
JC1_v4_detbasin
Detention Basin
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_20y_JC1_v5-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_20y_JC1_v5-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

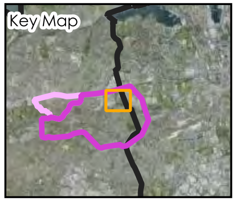
Johnstons Creek Option 2% AEP
JC1 v2 Fowler Street Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 16

Legend

- MJC Study Area
- IWC LGA Boundary
- JC1_v4_detbasin
  - Detention Basin
- Proposed Drainage
- Removed Drainage
- Existing Drainage
- MJC_50y_JC1_v5-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_50y_JC1_v5-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

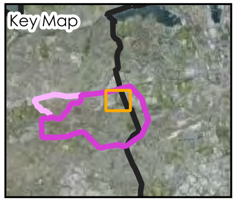
Johnstons Creek Option 1% AEP
JC1 v2 Fowler Street Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 17

Legend

- MJC Study Area
- IWC LGA Boundary
- JC1_v4_detbasin
  - Detention Basin
- Proposed Drainage
- Removed Drainage
- Existing Drainage
- MJC_100y_JC1_v5-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_100y_JC1_v5-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



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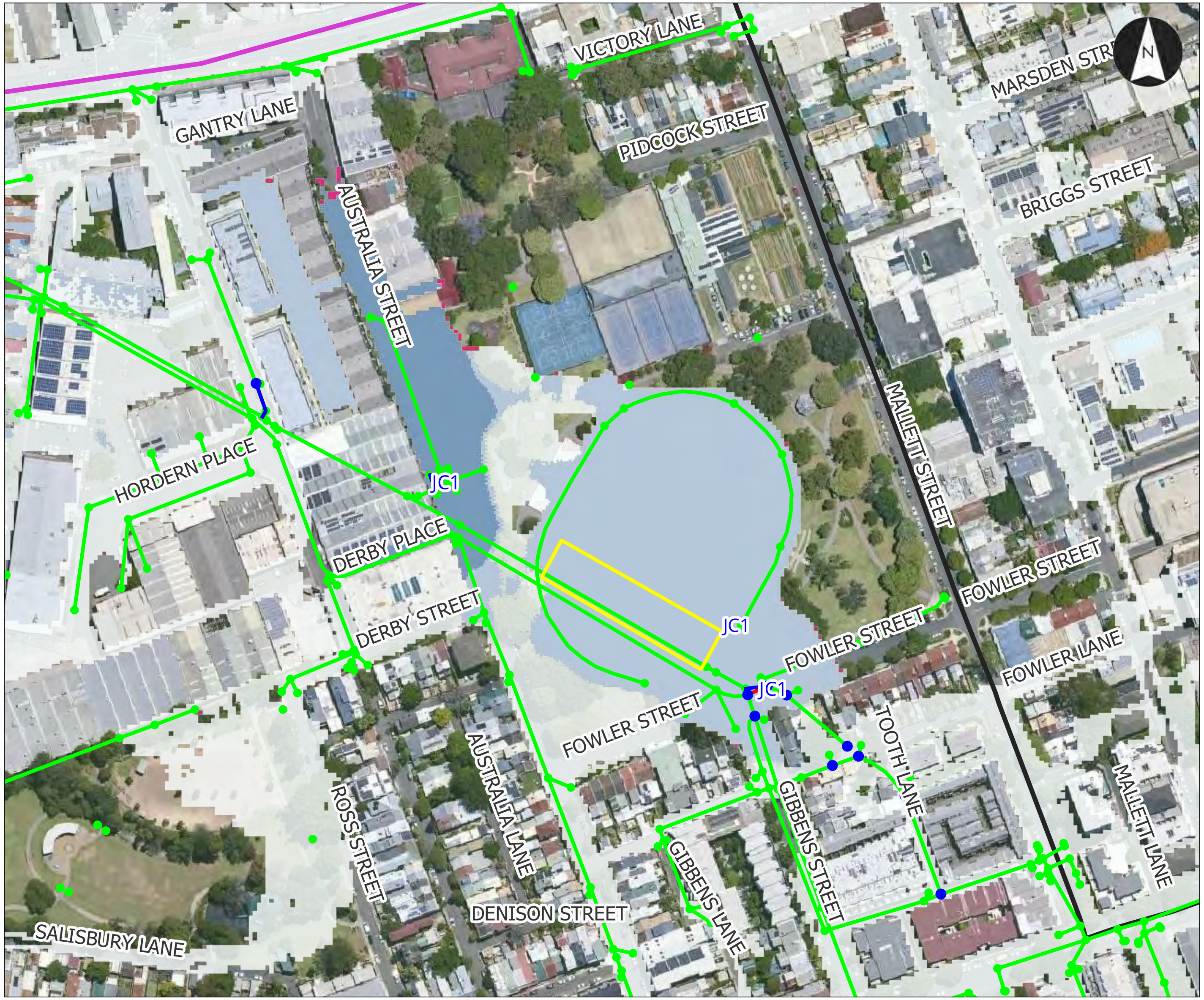
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600



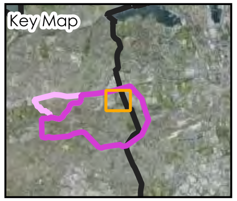
Johnstons Creek Option PMF
JC1 v2 Fowler Street Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 18

Legend

MJC Study Area
IWC LGA Boundary
JC1_v4_detbasin
Detention Basin
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_PMF_JC1_v5-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_PMF_JC1_v5-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



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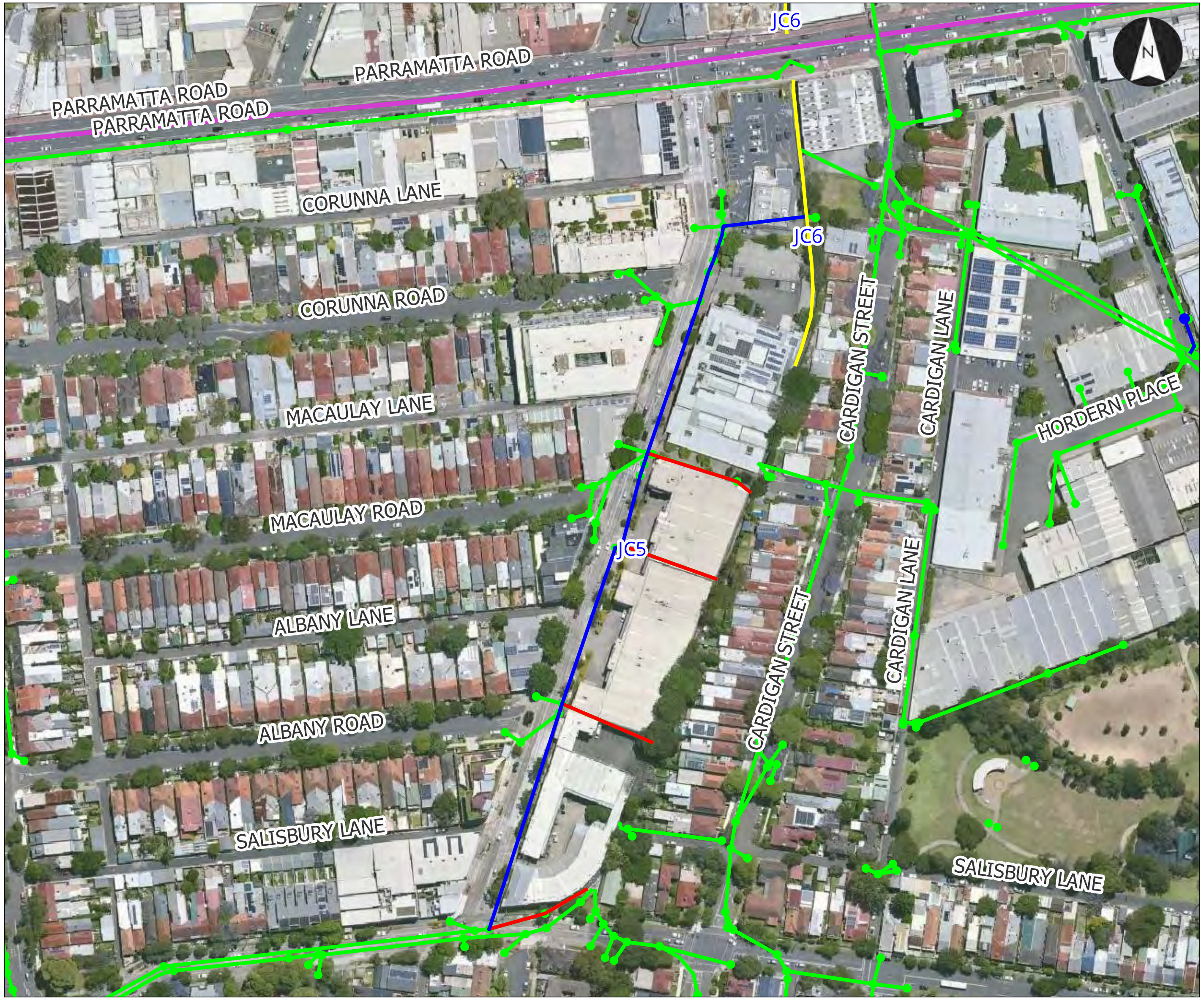
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600



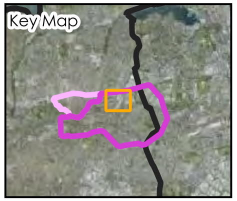
Johnstons Creek Option - JC5 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 19

Legend

- MJC Study Area
- IWC LGA Boundary
- Channel Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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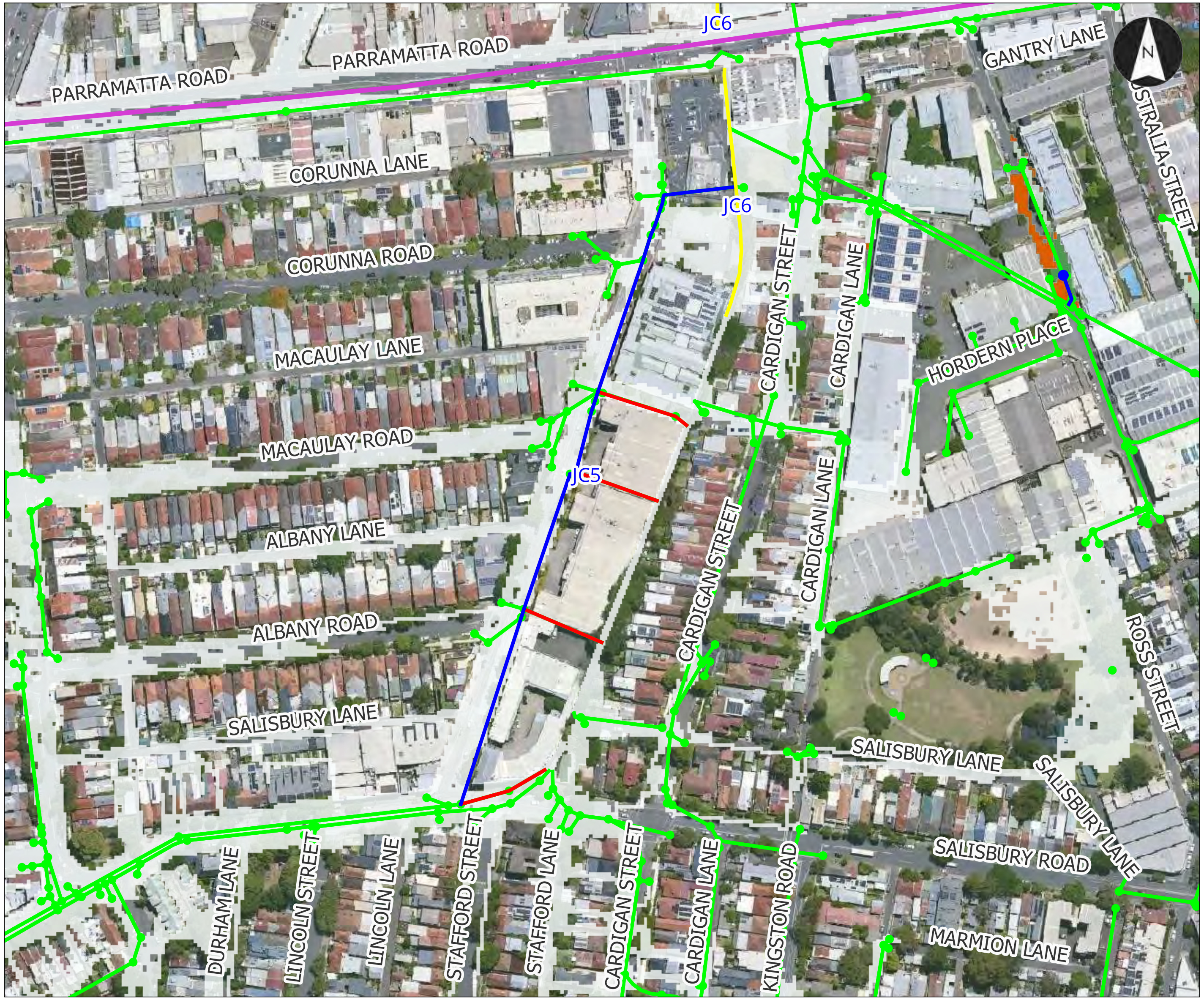


Johnstons Creek Option 20% AEP
JC5 Bridge Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

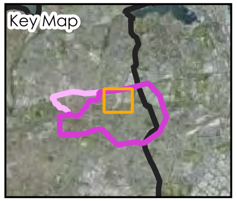
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 20

Legend

- MJC Study Area
- IWC LGA Boundary
- Channel Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_5y_JC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

MJC_5y_JC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet



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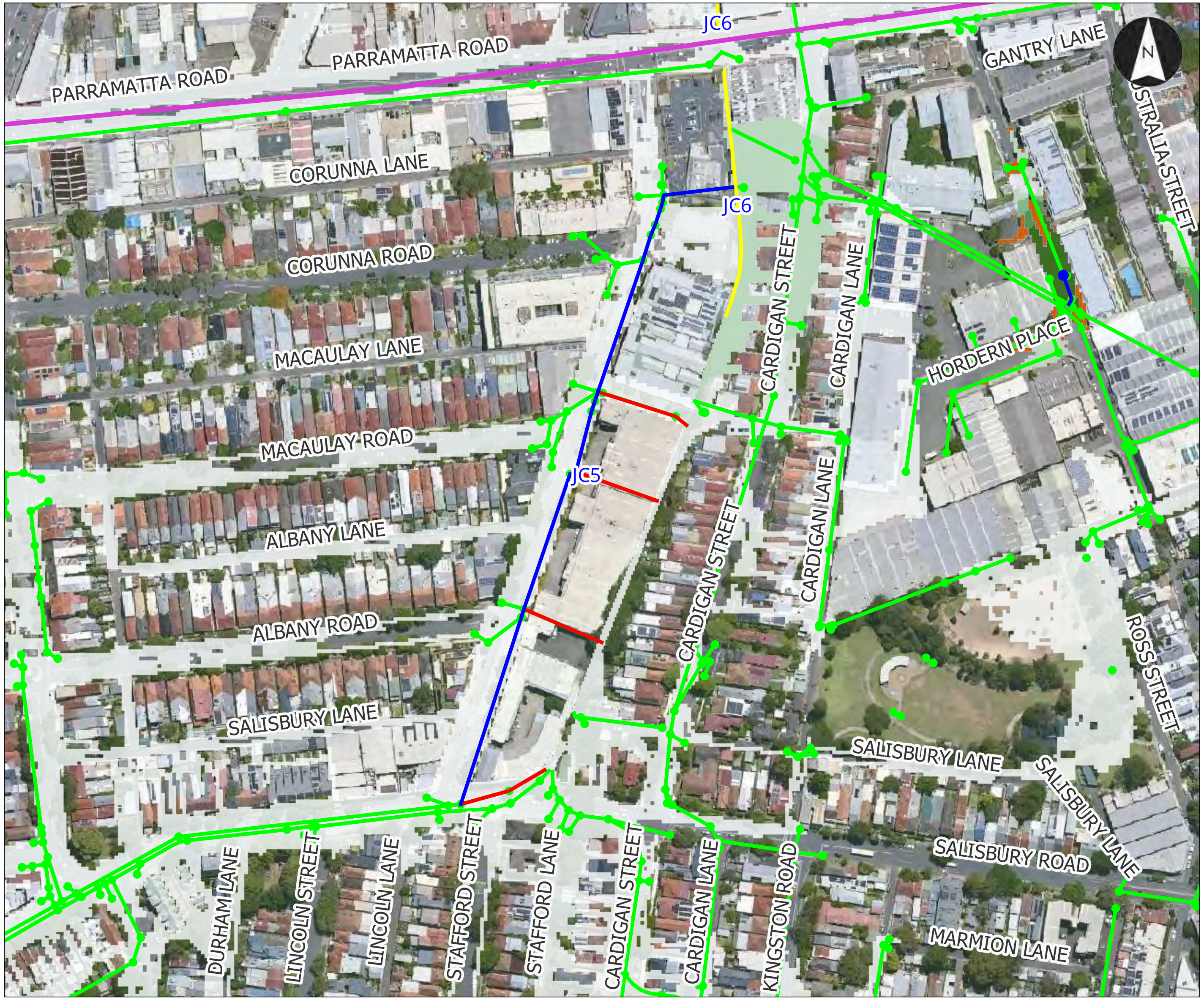
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



Johnstons Creek Option 5% AEP
JC5 Bridge Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

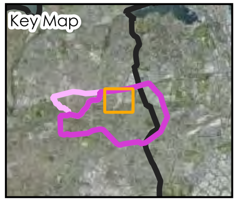
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 21

Legend

- MJC Study Area
- IWC LGA Boundary
- Channel Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_20y_JC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
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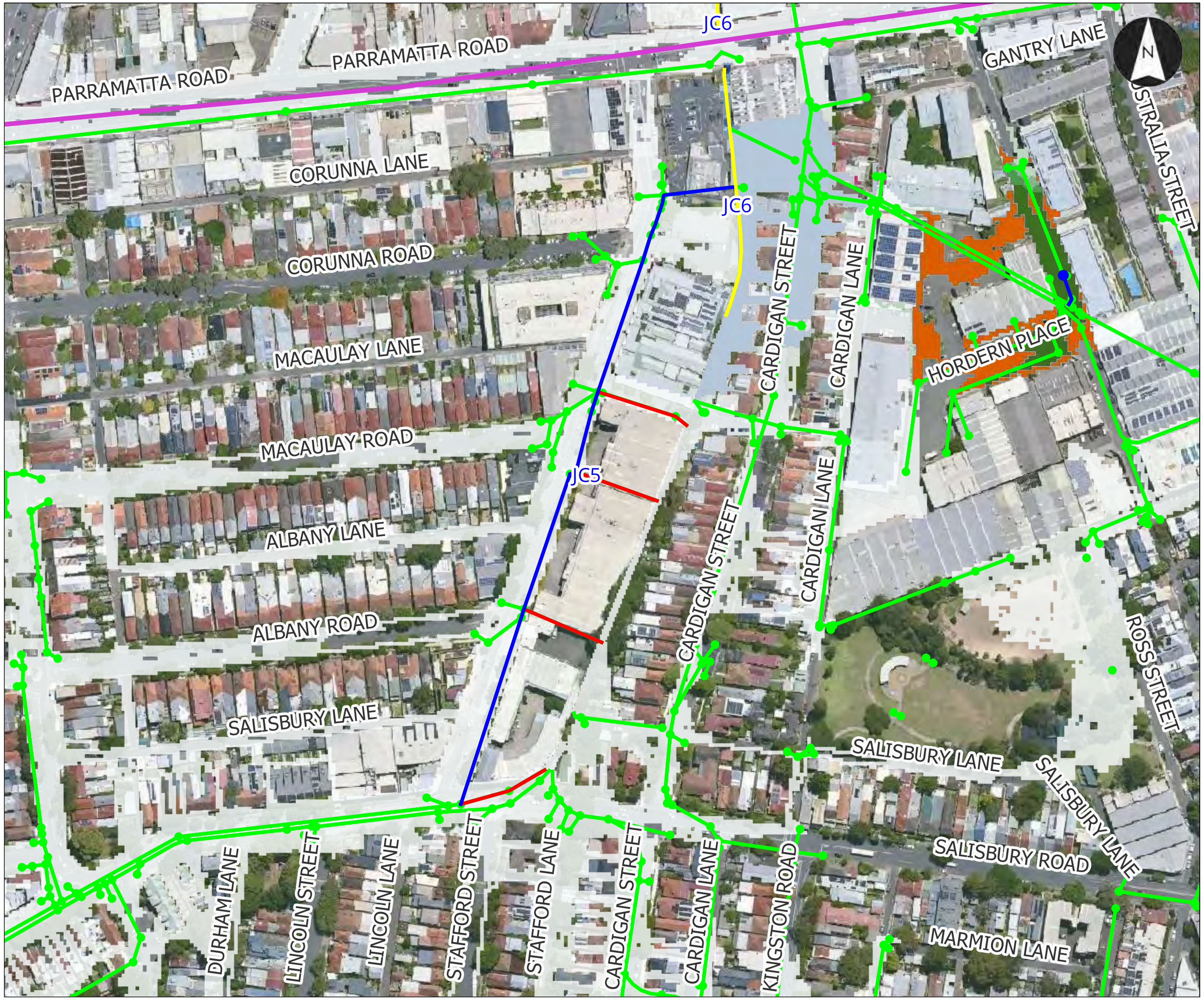
References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



Johnstons Creek Option 2% AEP
JC5 Bridge Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

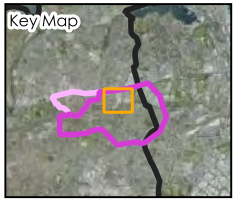
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 22

Legend

- MJC Study Area
- IWC LGA Boundary
- Channel Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_50y_JC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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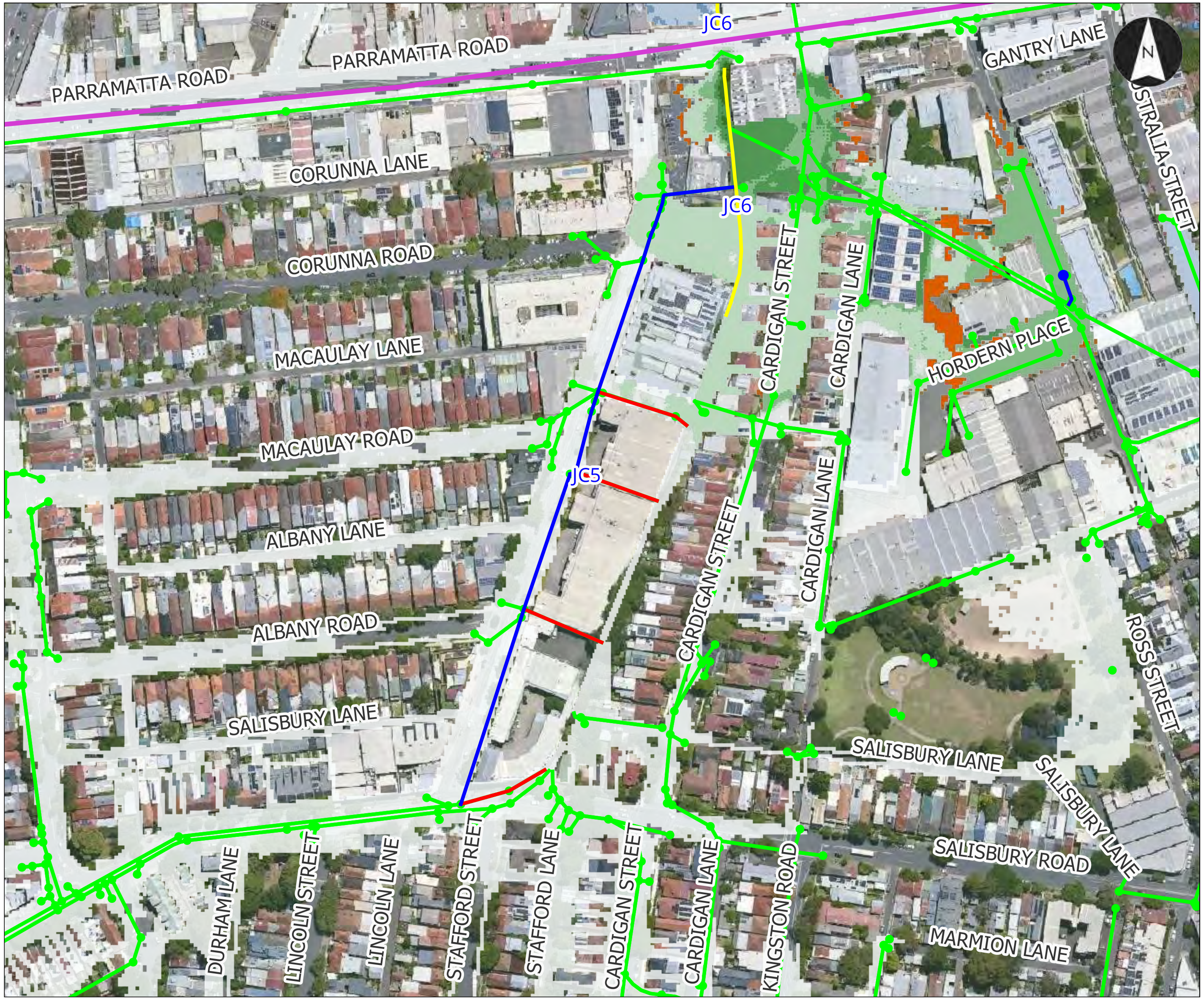


Johnstons Creek Option 1% AEP
JC5 Bridge Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

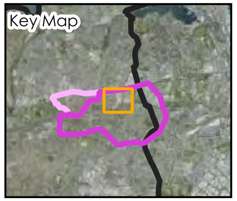
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 23

Legend

- MJC Study Area
- IWC LGA Boundary
- Channel Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_100y_JC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

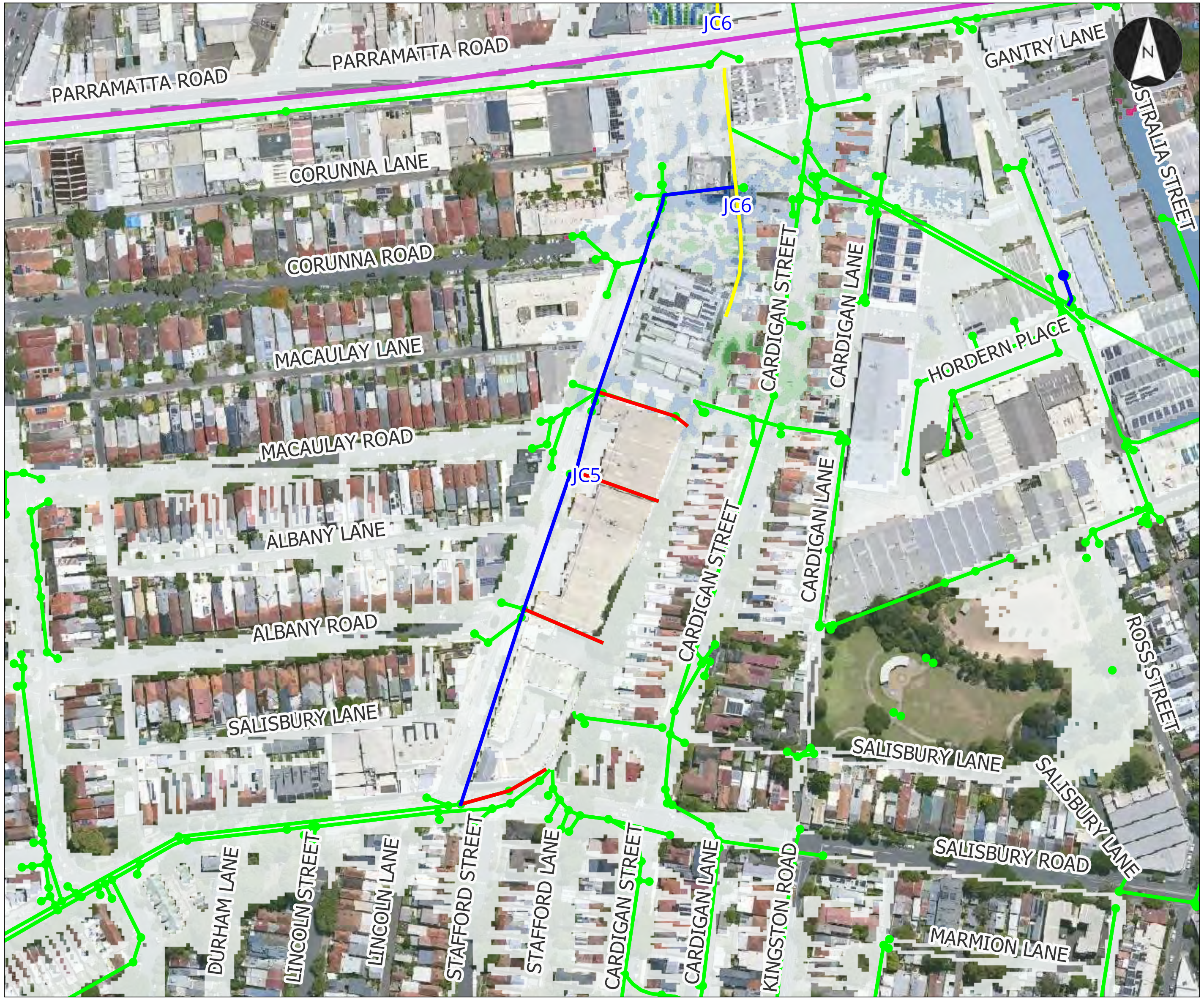
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



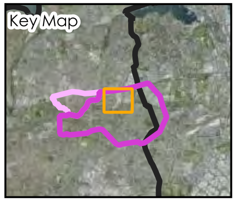
Johnstons Creek Option PMF
JC5 Bridge Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 24

Legend

MJC Study Area
IWC LGA Boundary
Channel Option
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_PMF_JC1_v5-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_PMF_JC1_v5-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

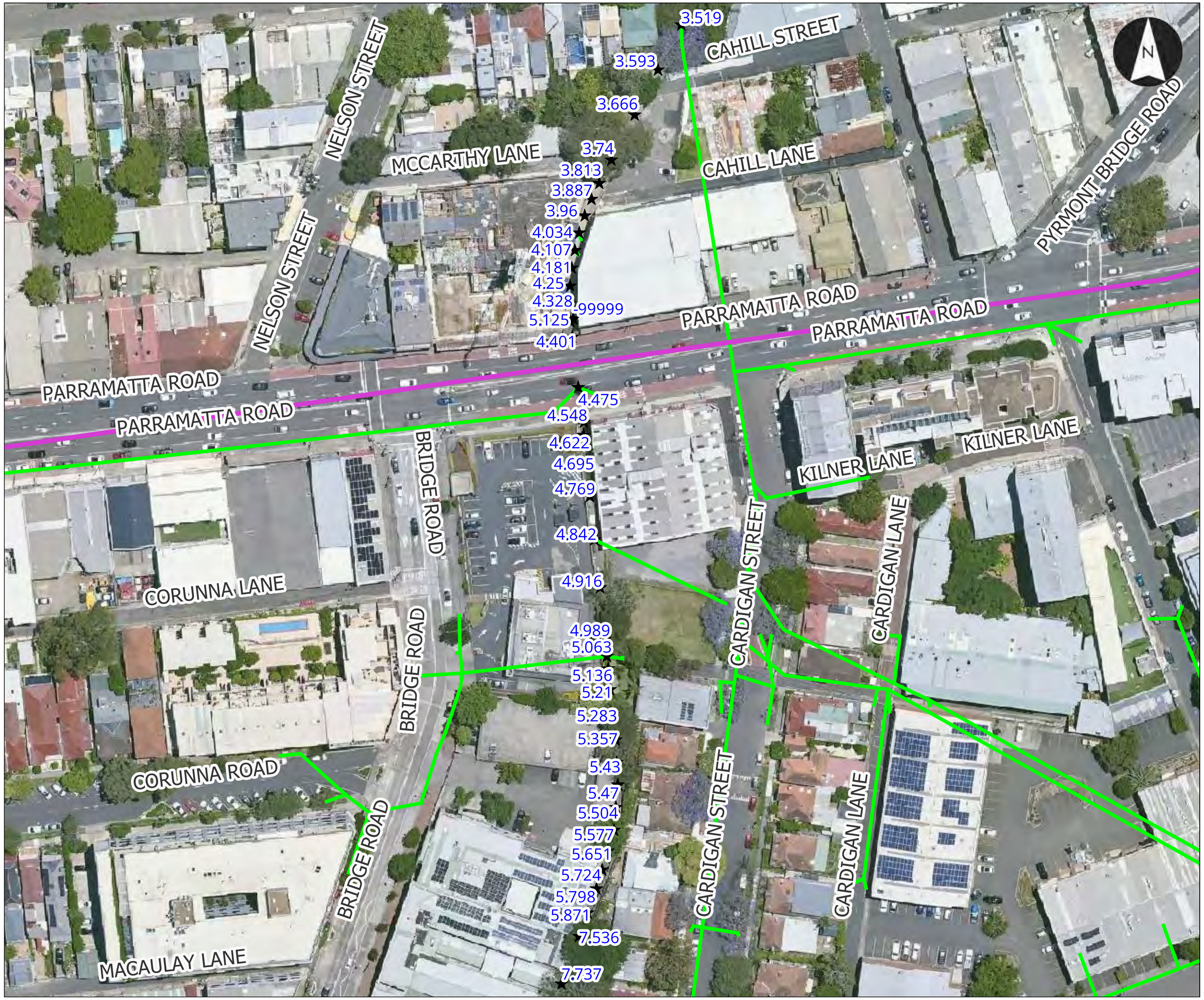
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



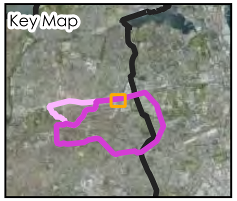
Johnstons Creek Option - JC6 v1 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 25

Legend

MJC Study Area
IWC LGA Boundary
Existing Drainage



DRAFT - Not For Construction

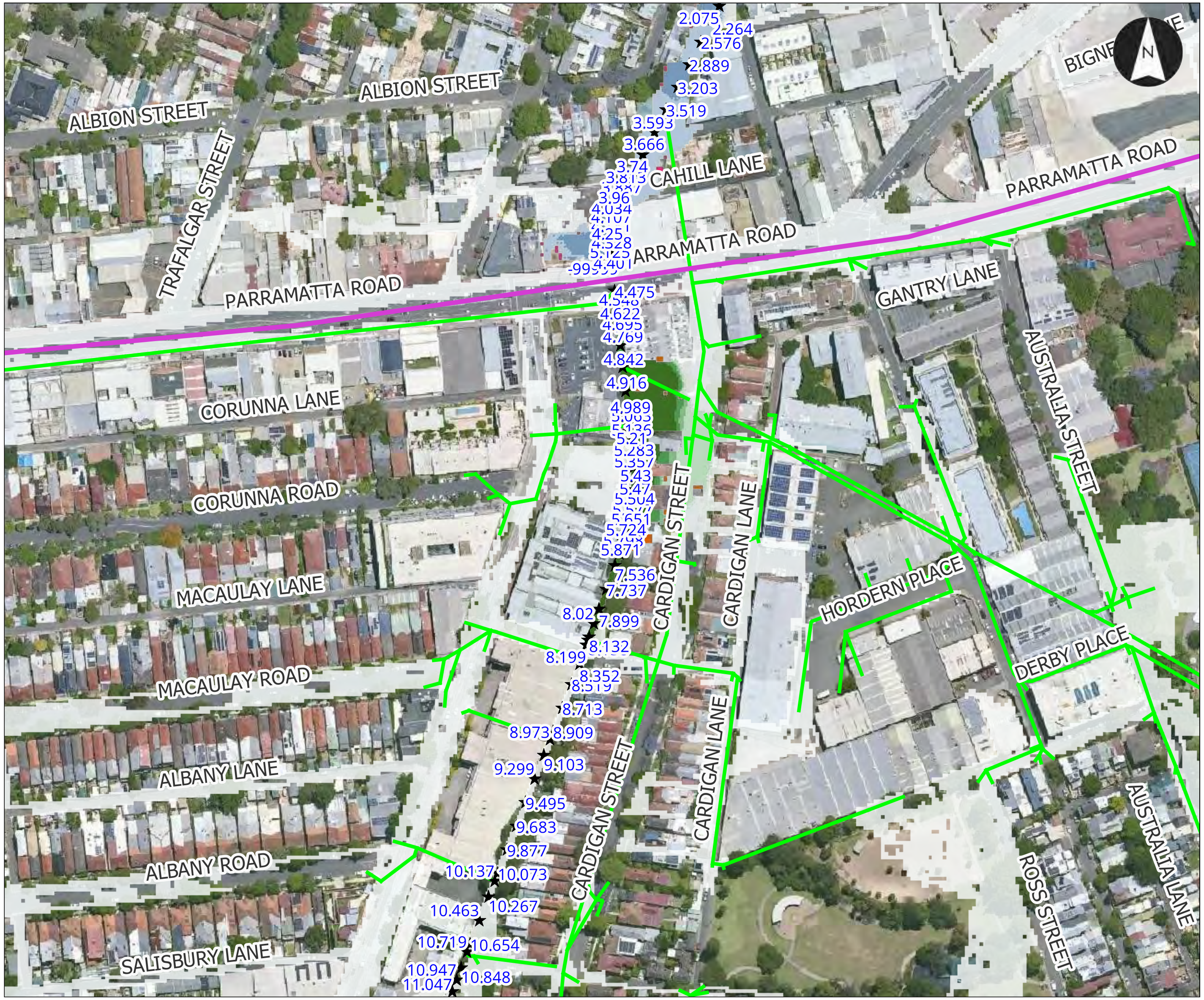
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



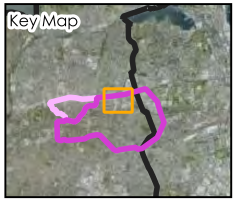
Johnstons Creek Option 20% AEP JC6 v1 Bridge Road Channel Regraging

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 26

Legend

MJC Study Area
IWC LGA Boundary
Existing Drainage
MJC_5y_JC6_v3-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_5y_JC6_v3-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

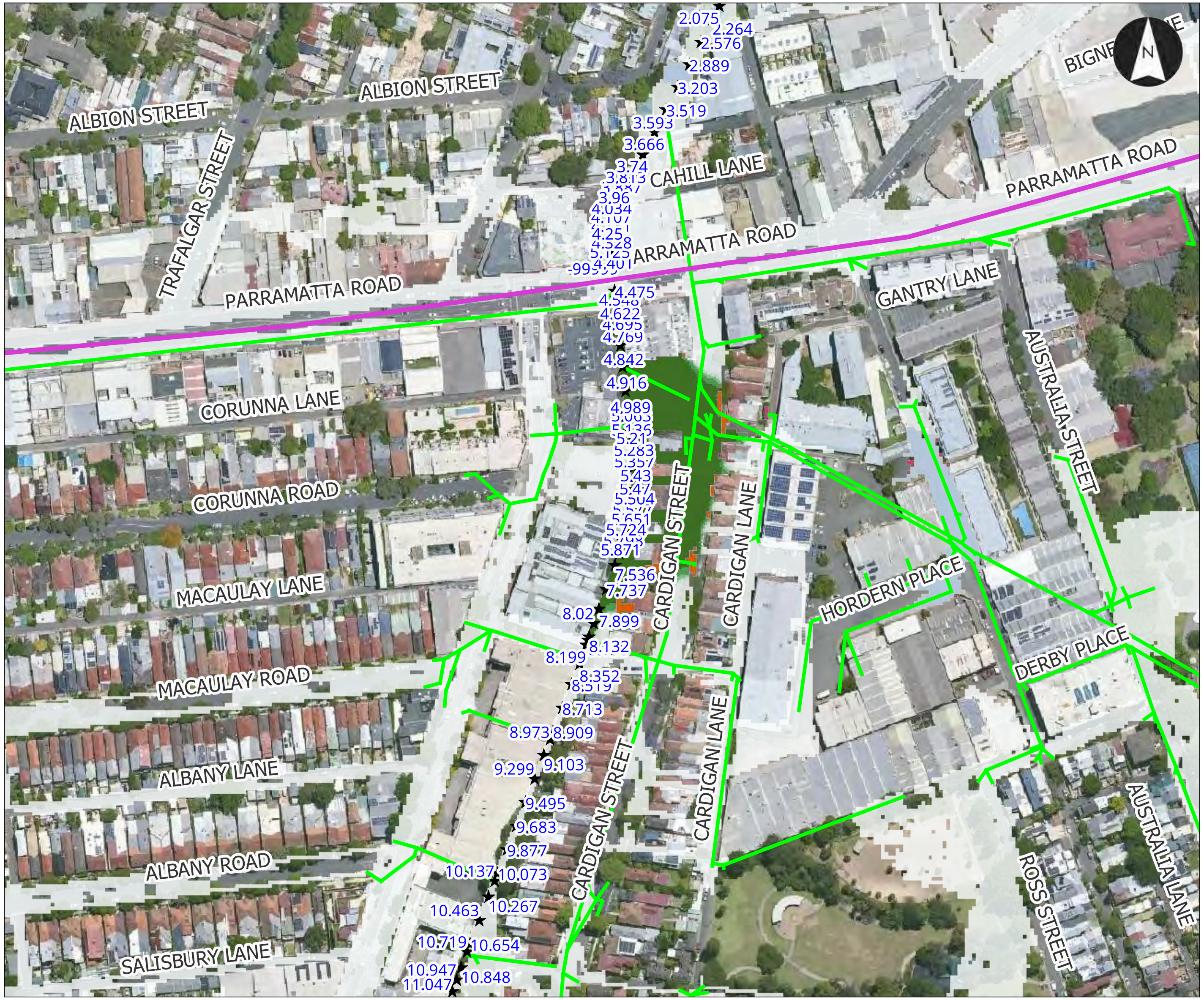
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



Johnstons Creek Option 5% AEP
JC6 v1 Bridge Road Channel Regrading

Project: Whites Creek and Johnstons creek FRMS&P

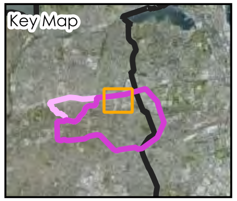
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 27

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage

MJC_20y_JC6_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC6_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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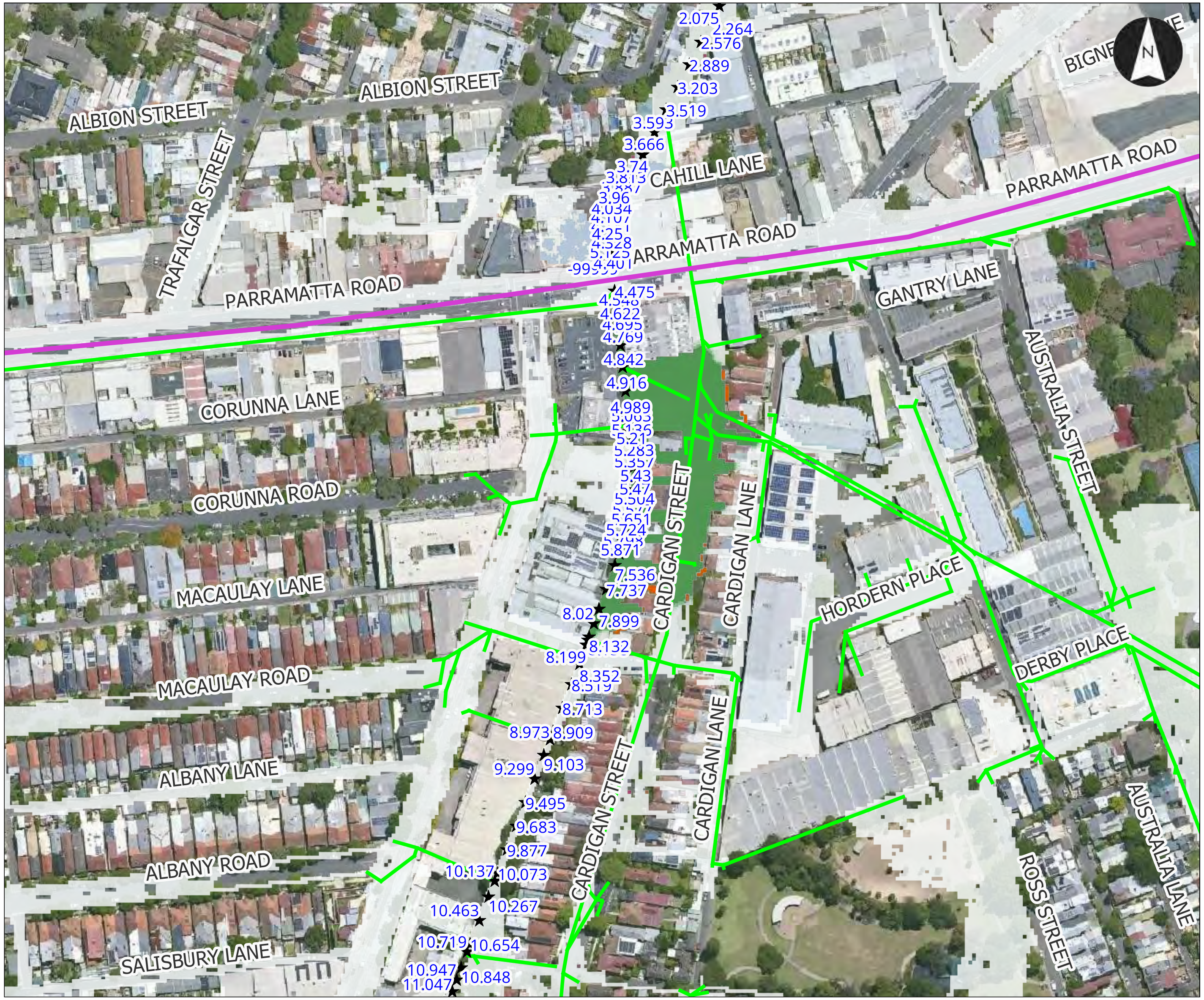


Johnstons Creek Option 2% AEP
JC6 v1 Bridge Road Channel Regrading

Project: Whites Creek and Johnstons creek FRMS&P

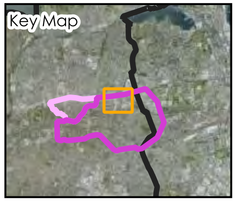
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 28

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage

MJC_50y_JC6_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC6_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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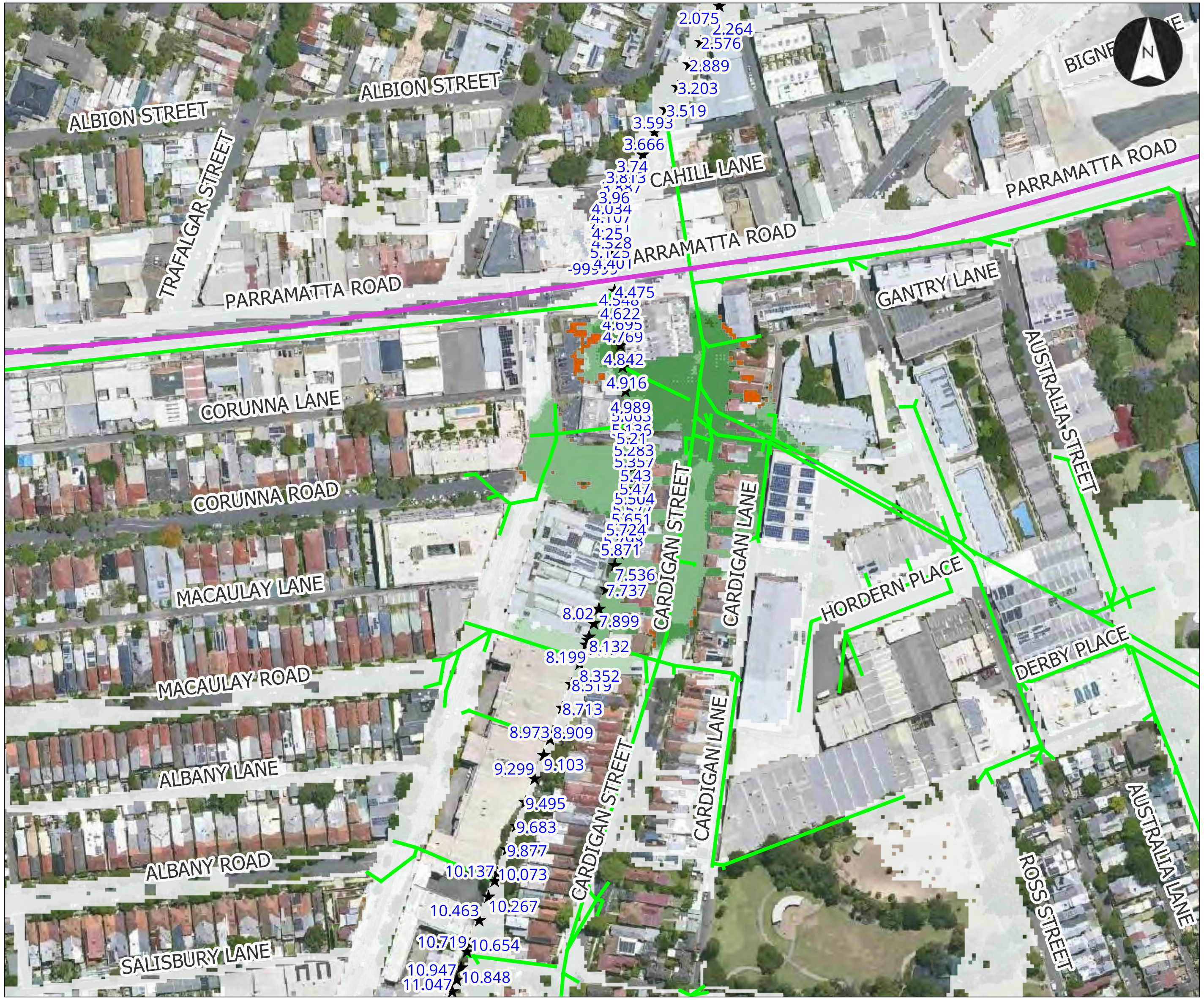
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



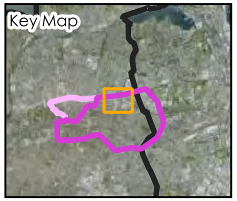
Johnstons Creek Option 1% AEP JC6 v1 Bridge Road Channel Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 29

Legend

MJC Study Area
IWC LGA Boundary
Existing Drainage
MJC_100y_JC6_v3-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_100y_JC6_v3-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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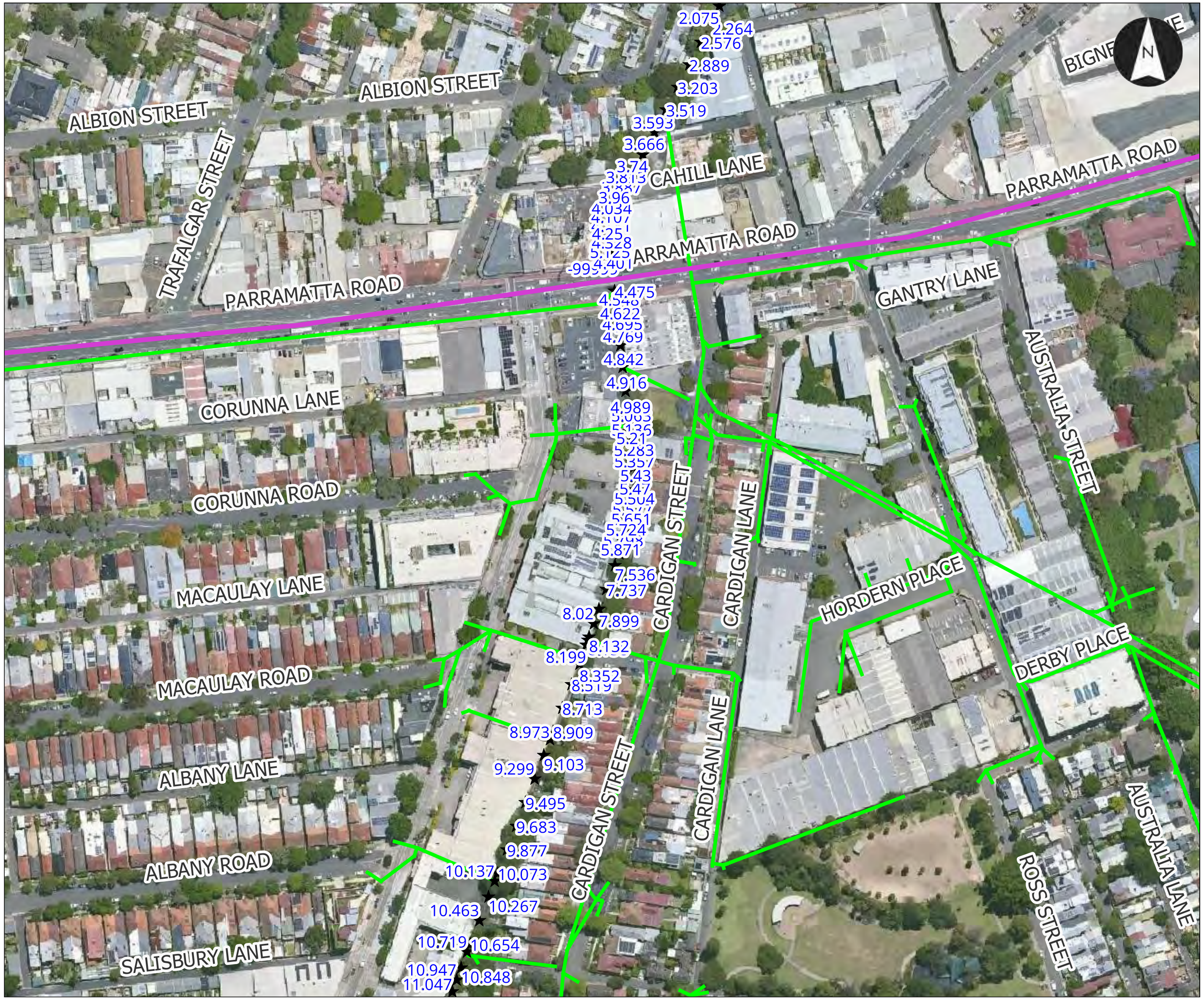

Johnstons Creek Option PMF
JC6 v1 Bridge Road Channel Regraging

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 30

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage

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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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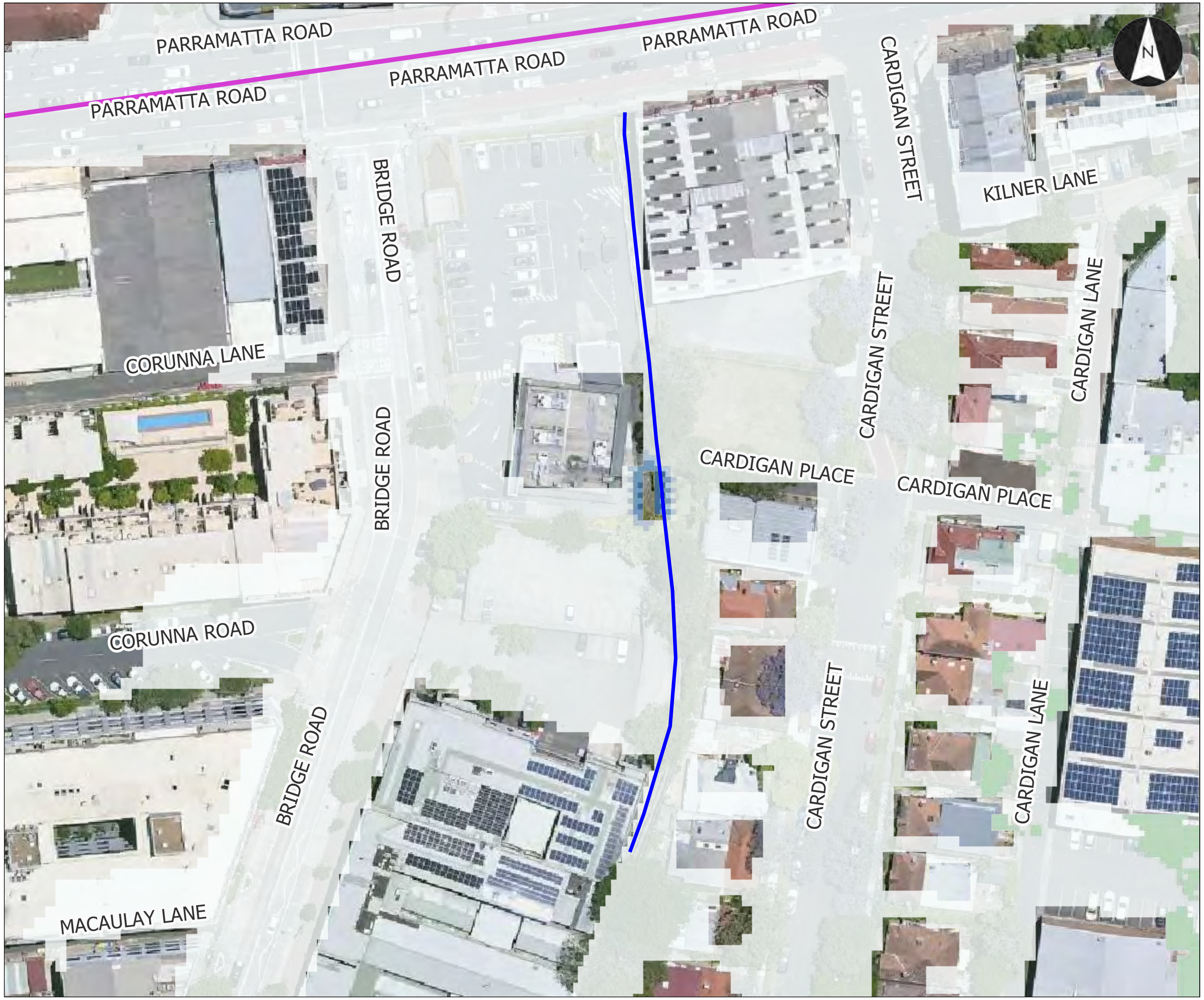


Johnstons Creek Option - JC6 v2 Overview

Project: Whites Creek and Johnstons creek FRMS&P

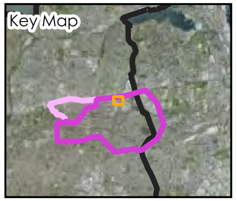
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 31

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel

MJC_PMF_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

Johnstons Creek Option 20% AEP JC6 v2 Bridge Road Channel Widening

Project: Whites Creek and Johnstons creek FRMS&P

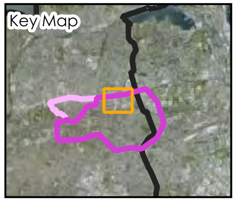
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 32

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Existing Drainage

MJC_5y_JC6_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC6_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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Johnstons Creek Option 5% AEP
JC6 v2 Bridge Road Channel Widening

Project: Whites Creek and Johnstons creek FRMS&P

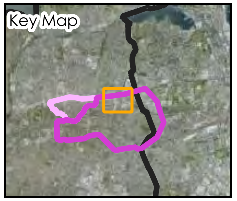
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 33

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Existing Drainage

MJC_20y_JC6_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC6_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

Johnstons Creek Option 2% AEP
JC6 v2 Bridge Road Channel Widening

Project: Whites Creek and Johnstons creek FRMS&P

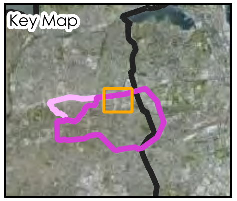
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 34

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Existing Drainage

MJC_50y_JC6_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC6_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

Johnstons Creek Option 1% AEP JC6 v2 Bridge Road Channel Widening

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 35

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Existing Drainage

MJC_100y_JC6_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC6_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50

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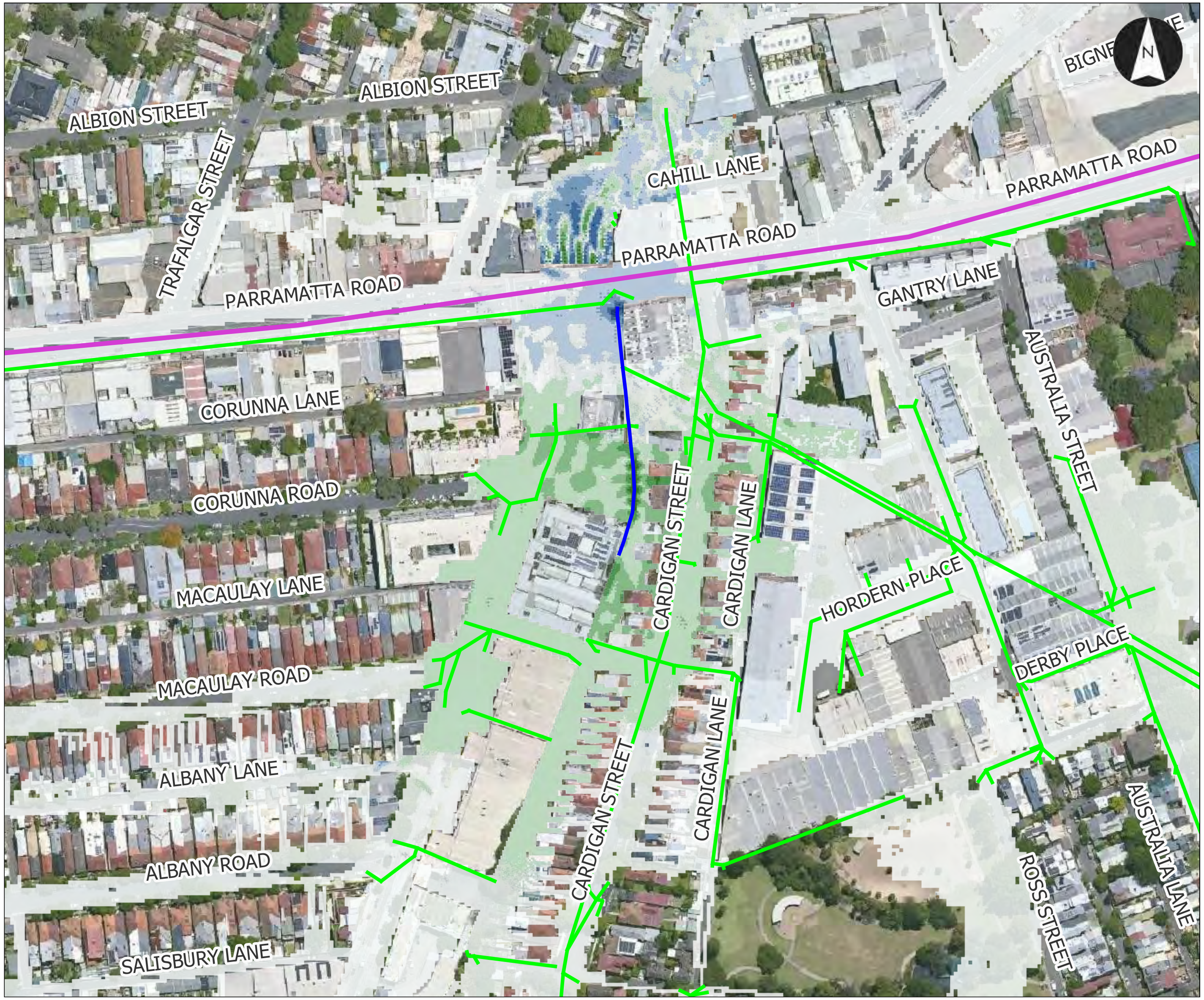
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000



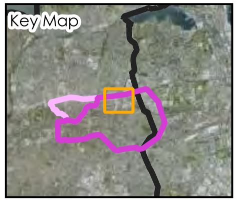
Johnstons Creek Option PMF
JC6 v2 Bridge Road Channel Widening

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 36

Legend

MJC Study Area
IWC LGA Boundary
JC6_v5_Channel
Existing Drainage
MJC_PMF_JC6_v5-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_PMF_JC6_v5-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

24 0 24 48 72 96 m

Scale at A3: 1:3000

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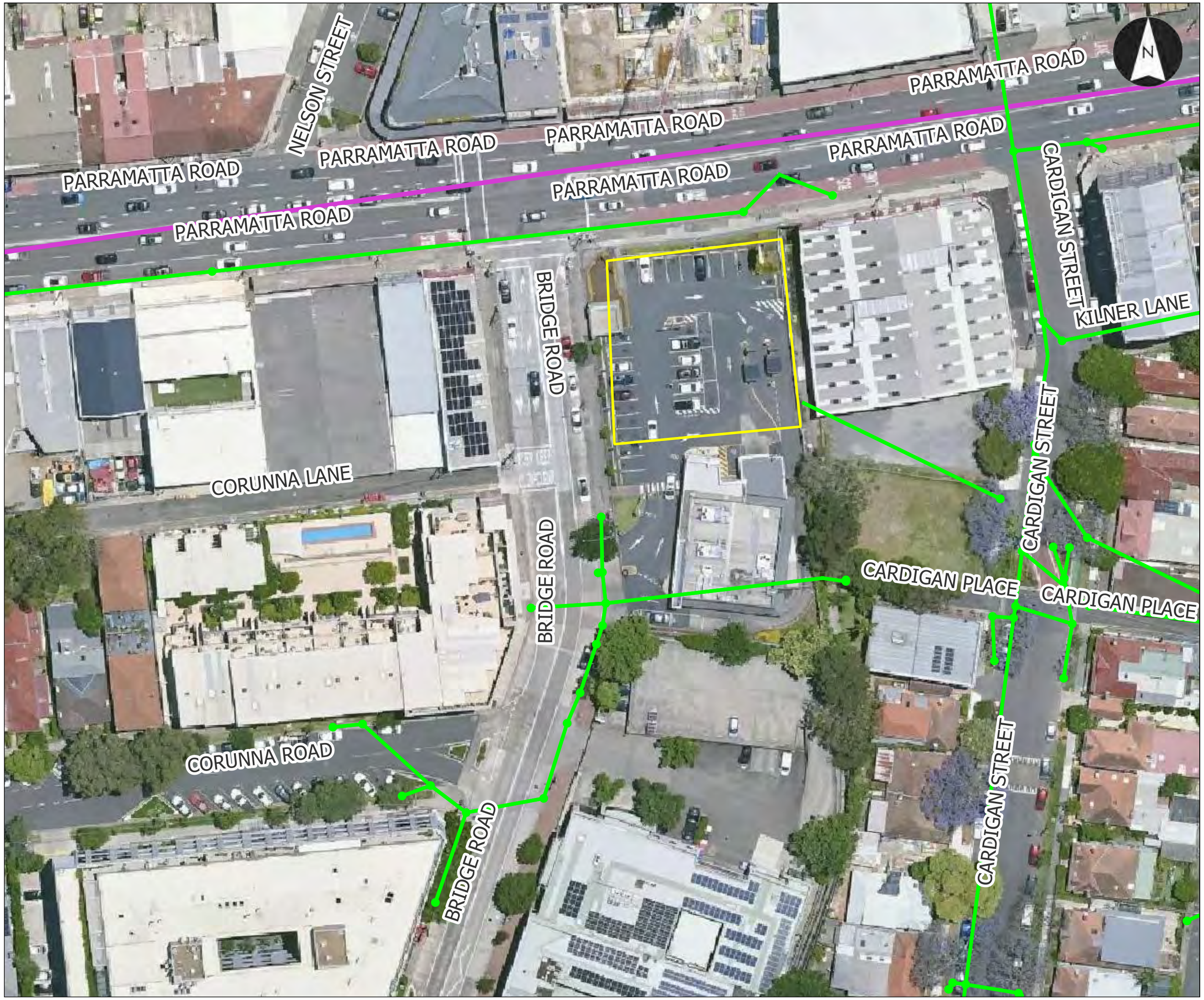


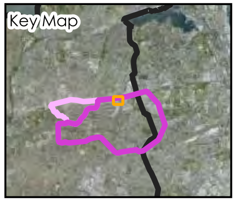
Johnstons Creek Option - JC7 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 37

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- 2d_zsh_JC7_v1



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

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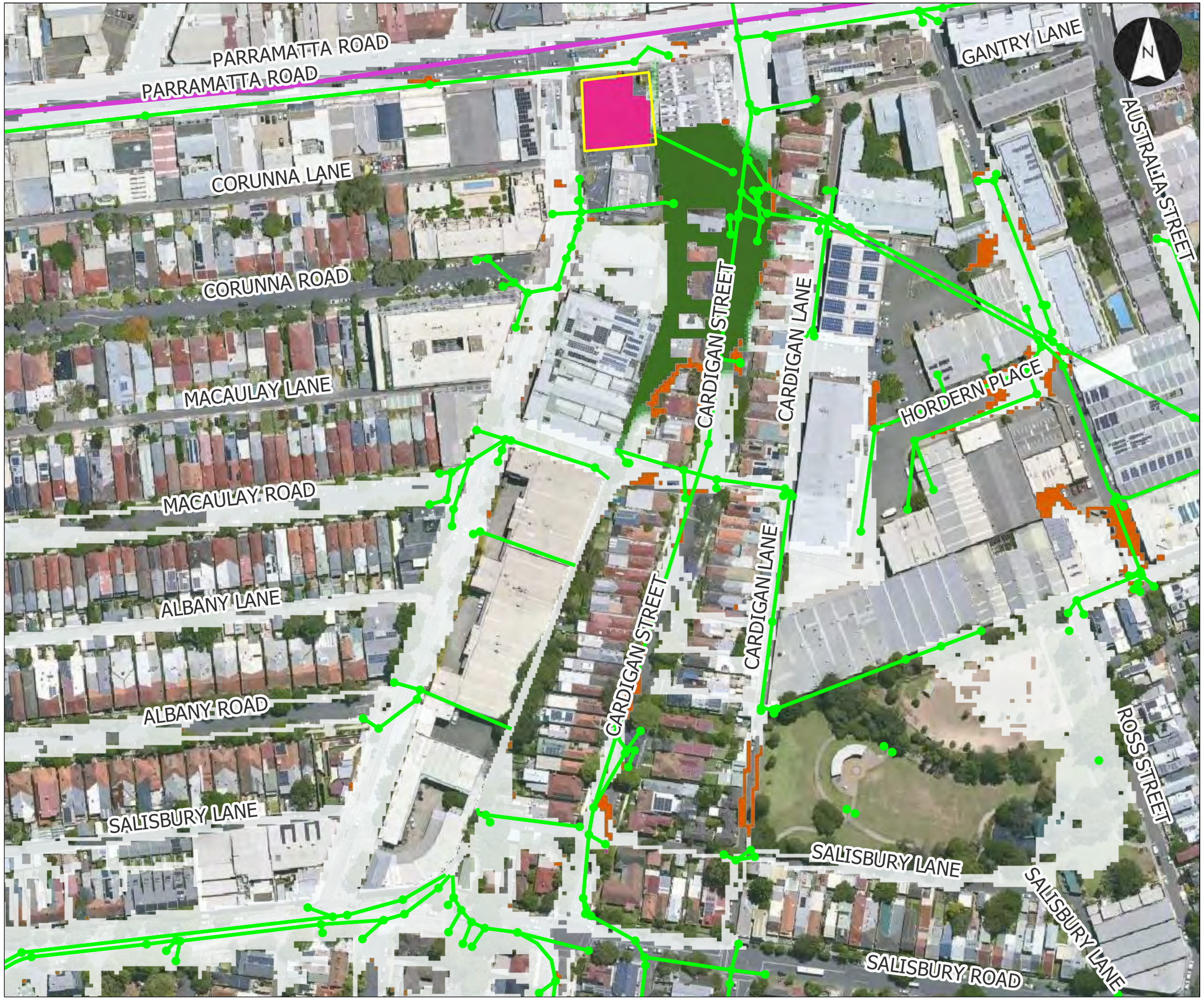


Johnstons Creek Option 20% AEP
JC7 Bridge Road Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

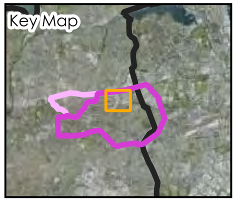
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 38

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- 2d_zsh_JC7_v1

MJC_5y_JC7_v1-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC7_v1-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

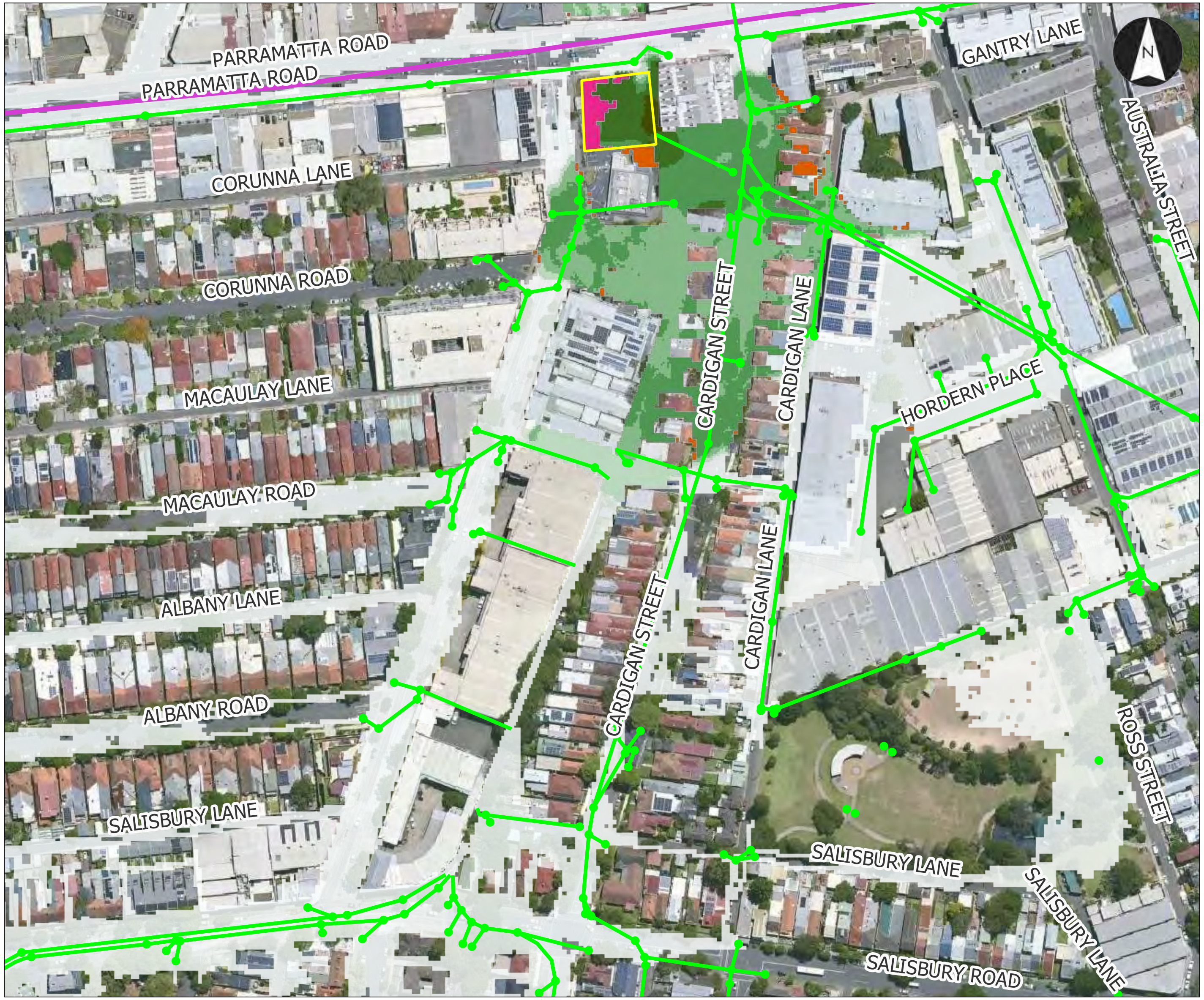
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600



Johnstons Creek Option 5% AEP
JC7 Bridge Road Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 39

Legend

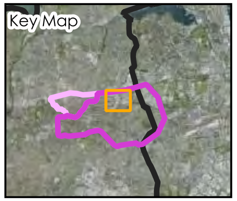
- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- 2d_zsh_JC7_v1

MJC_20y_JC7_v1-PM6_wd
Band 1 (Gray)

- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC7_v1-PM6_WLD
Band 1 (Gray)

- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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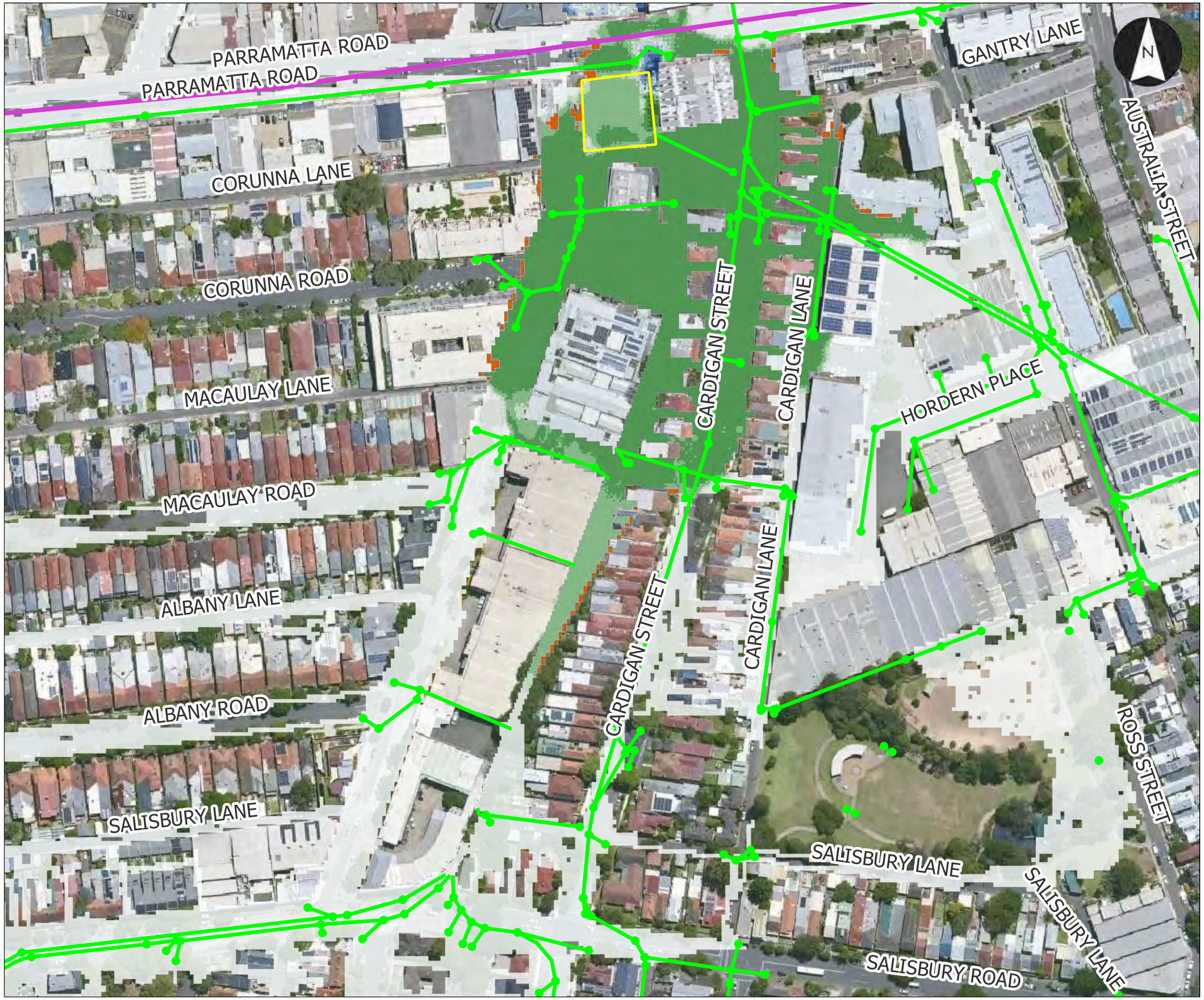


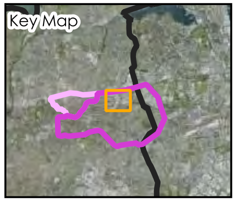
Johnstons Creek Option 2% AEP
JC7 Bridge Road Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 40

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- 2d_zsh_JC7_v1
- MJC_50y_JC7_v1-PM6_wd Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_50y_JC7_v1-PM6_WLD Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

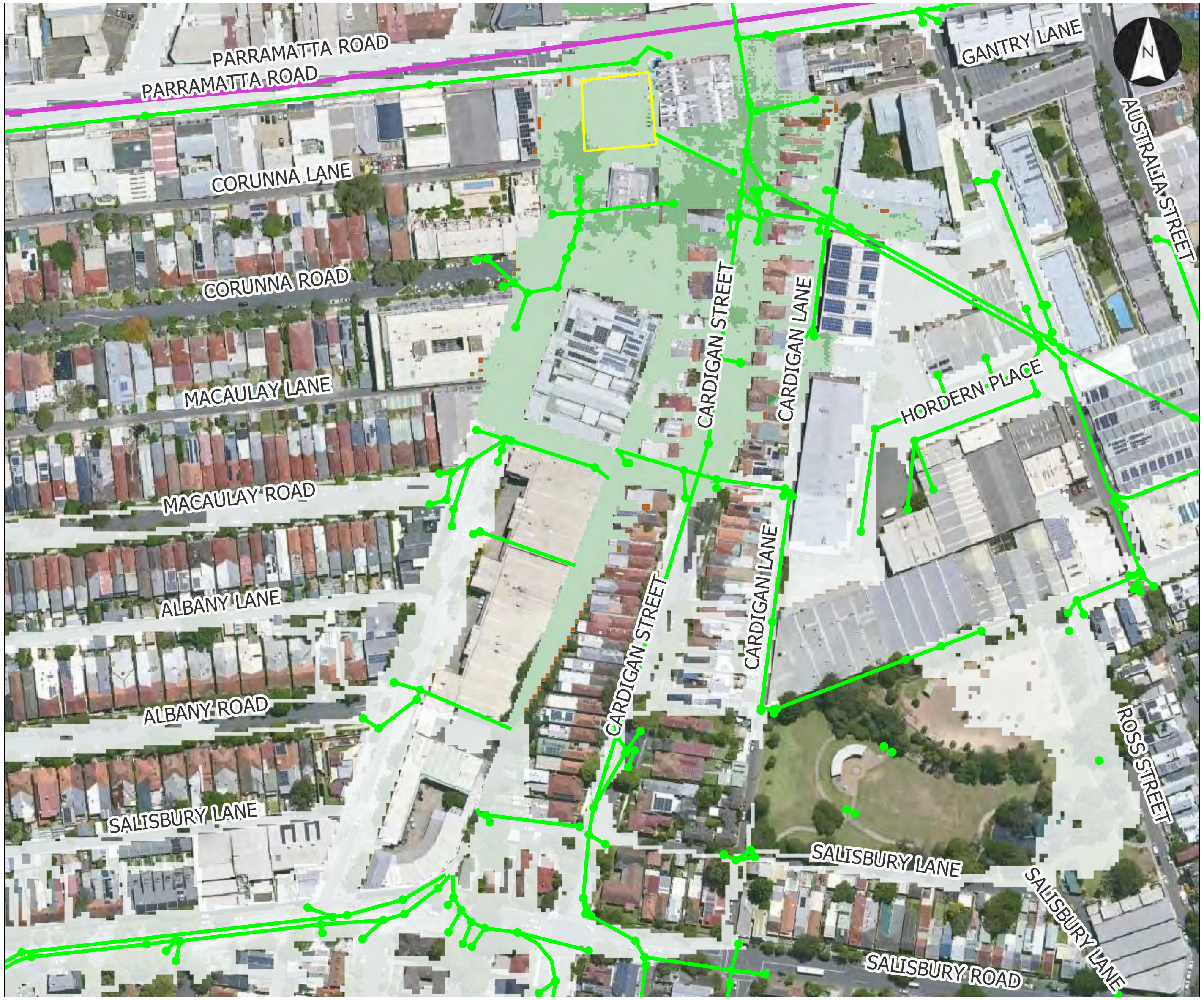
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600



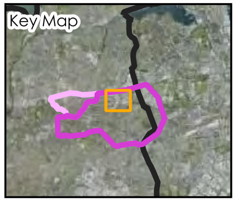
Johnstons Creek Option 1% AEP
JC7 Bridge Road Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 41

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- 2d_zsh_JC7_v1
- MJC_100y_JC7_v1-PM6_wd
  Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_100y_JC7_v1-PM6_WLD
  Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

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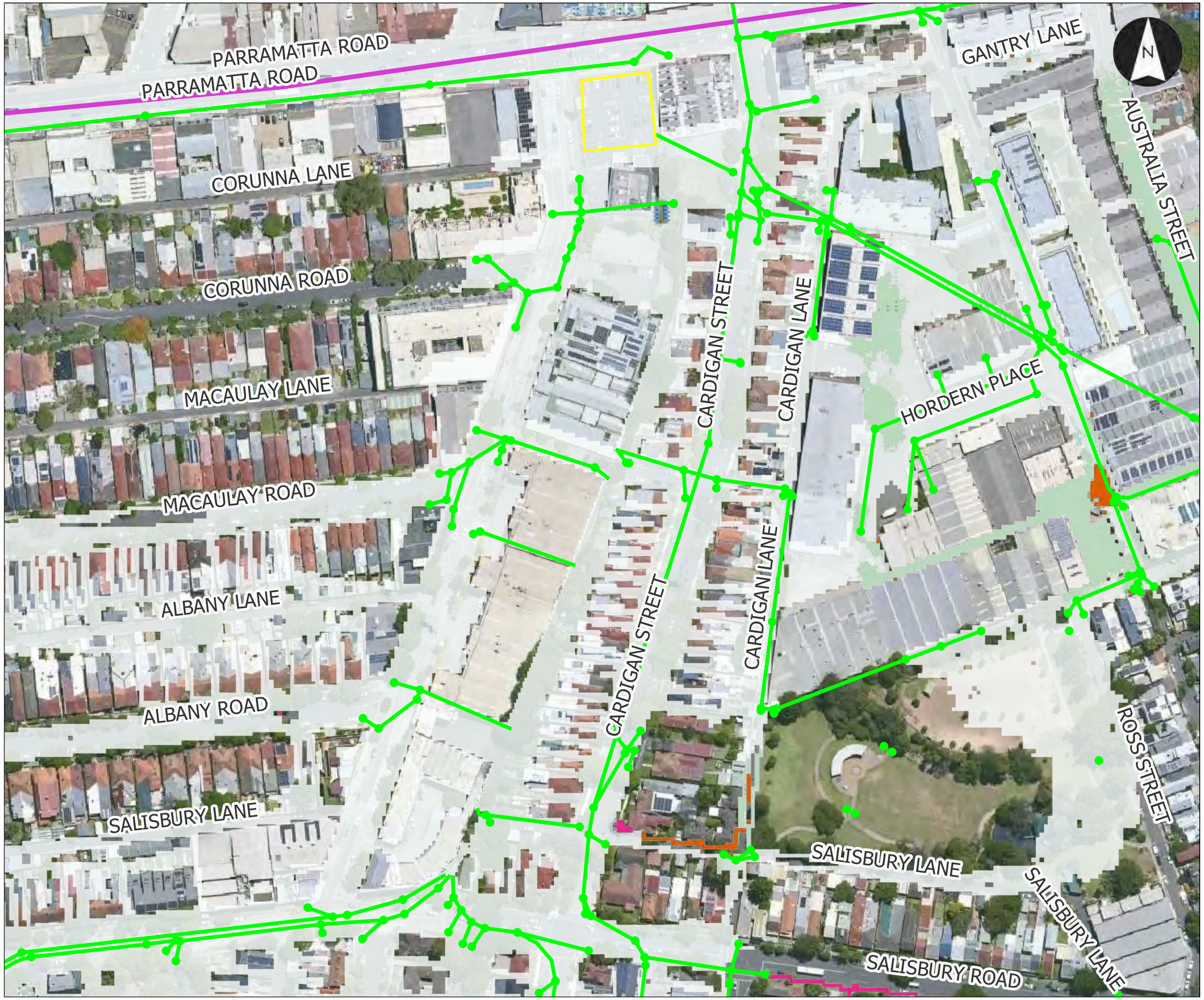


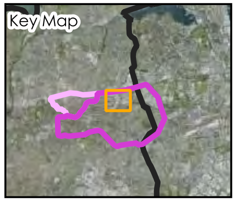
Johnstons Creek Option PMF
JC7 Bridge Road Detention Basin

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 42

Legend

- MJC Study Area
- IWC LGA Boundary
- Existing Drainage
- MJC_PMF_PM6-Ext_wd Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_PMF_PM6-Ext_WLD Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50
- 2d_zsh_JC7_v1



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

21 0 21 42 62 83 m

Scale at A3: 1:2600

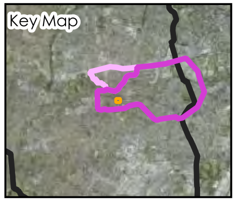
Johnstons Creek Option - JC10 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 43

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

4 0 4 8 12 16 m

Scale at A3: 1:500

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Johnstons Creek Option 20% AEP
JC10 Trafalgar Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

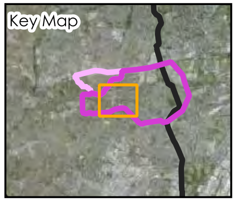
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 44

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_5y_JC10_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC10_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

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Johnstons Creek Option 5% AEP
JC10 Trafalgar Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

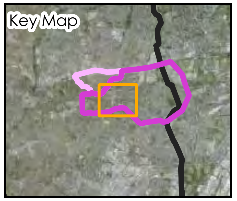
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 45

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_20y_JC10_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC10_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

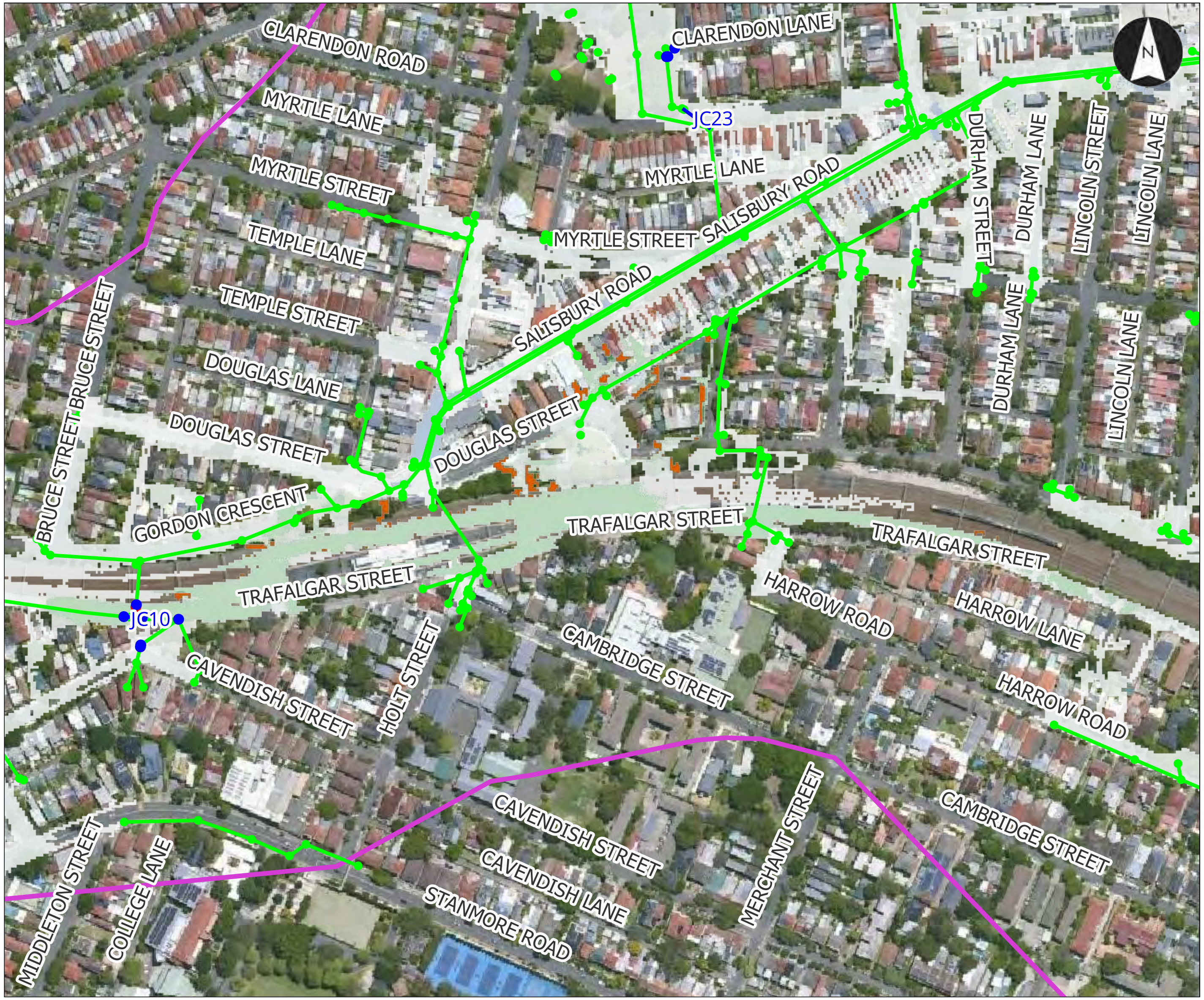
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000



Johnstons Creek Option 2% AEP
JC10 Trafalgar Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

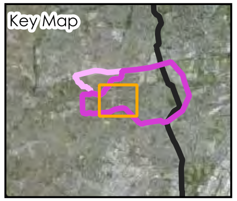
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 46

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_50y_JC10_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC10_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

Johnstons Creek Option 1% AEP
JC10 Trafalgar Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

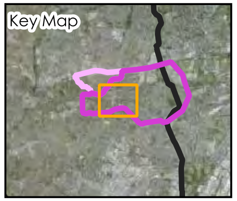
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 47

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_100y_JC10_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC10_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

32 0 32 64 96 128 m

Scale at A3: 1:4000

Johnstons Creek Option PMF
JC10 Trafalgar Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

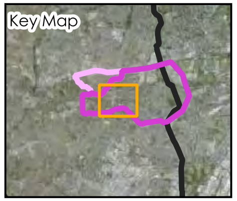
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 48

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_PMF_JC10_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_JC10_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

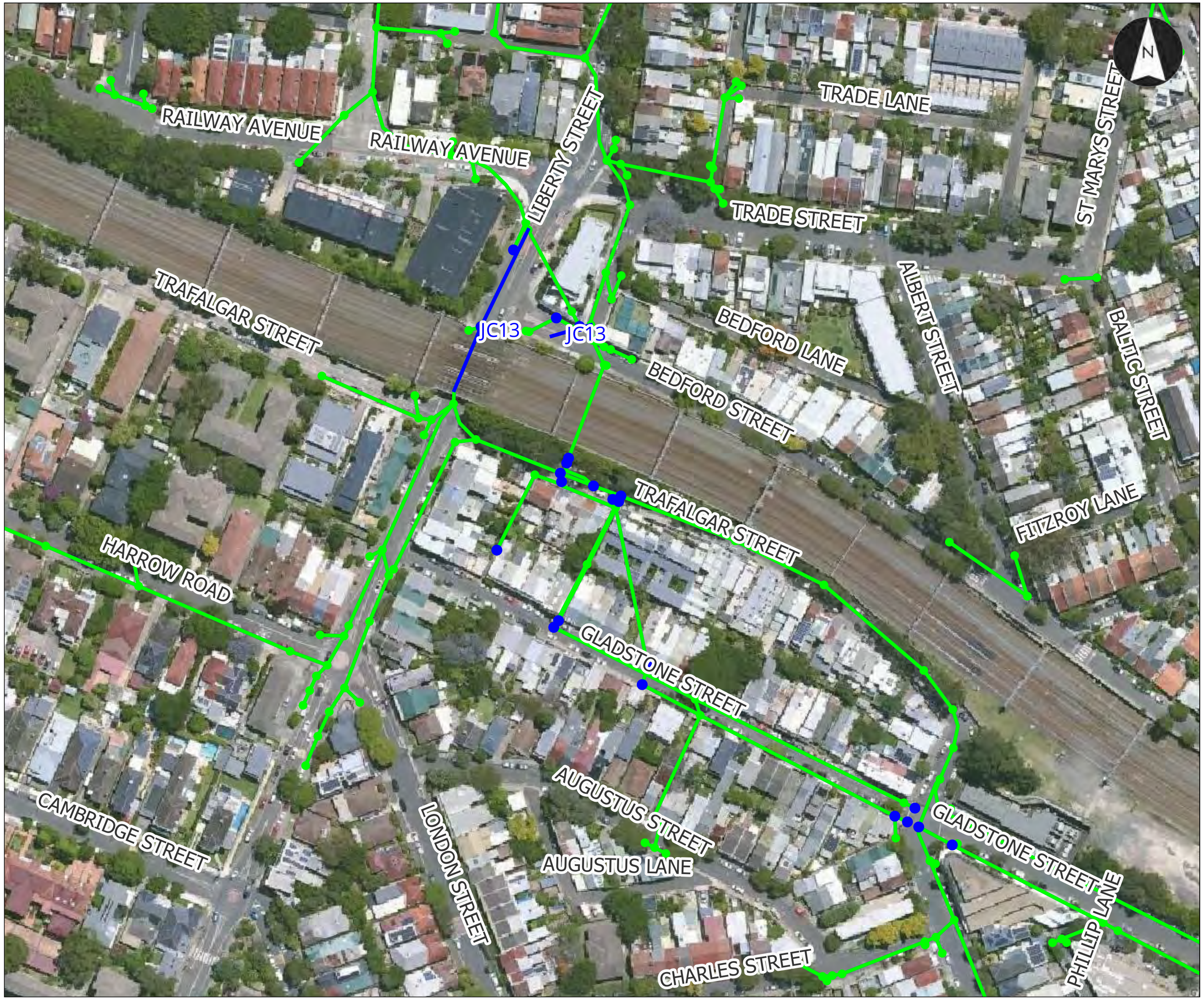
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000



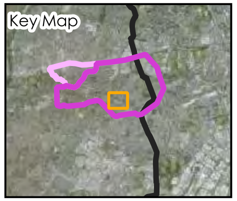
Johnstons Creek Option - JC13 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 49

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage
- 1d_nwk_MJC_pipes_012_JC13_v4



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

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Johnstons Creek Option 20% AEP
JC13 Gladstone Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

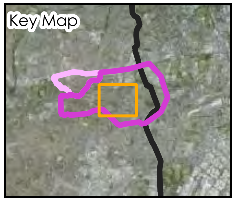
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 50

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage
- 1d_nwk_MJC_pipes_012_JC13_v4

MJC_5y_JC13_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC13_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

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Johnstons Creek Option 5% AEP
JC13 Gladstone Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

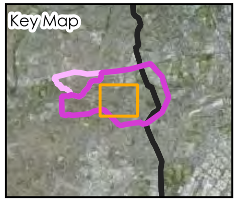
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 51

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_20y_JC13_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC13_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

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Johnstons Creek Option 2% AEP
JC13 Gladstone Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

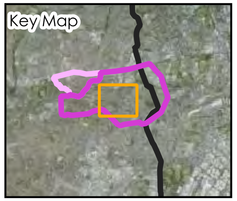
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 52

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_50y_JC13_v4-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC13_v4-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

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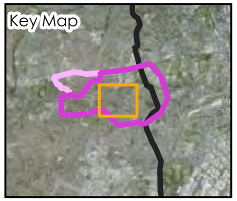
Johnstons Creek Option 1% AEP
JC13 Gladstone Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 53

Legend

MJC Study Area
IWC LGA Boundary
Drainage Option
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_100y_JC13_v4-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_100y_JC13_v4-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

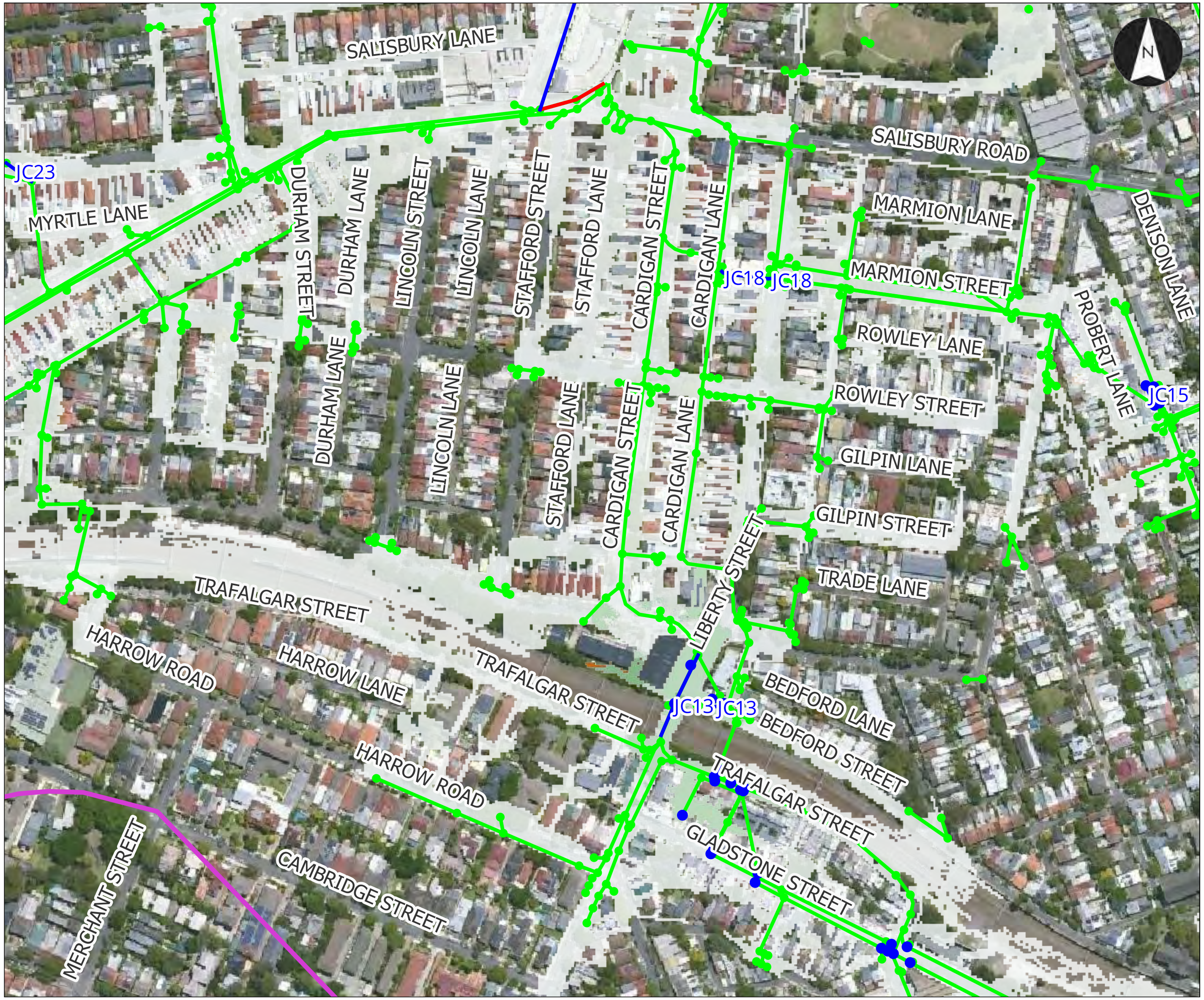
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000



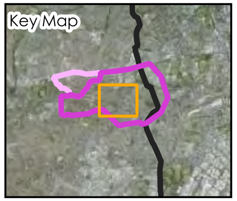
Johnstons Creek Option PMF
JC13 Gladstone Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 54

Legend

MJC Study Area
IWC LGA Boundary
Drainage Option
Proposed Drainage
Removed Drainage
Existing Drainage
MJC_PMF_JC13_v4-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_PMF_JC13_v4-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

32 0 32 64 96 128 m

Scale at A3: 1:4000

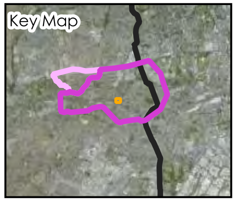
Johnstons Creek Option - JC14 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 55

Legend

- MJC Study Area
- IWC LGA Boundary
- 2d_zsh_JC14_v1



DRAFT - Not For Construction

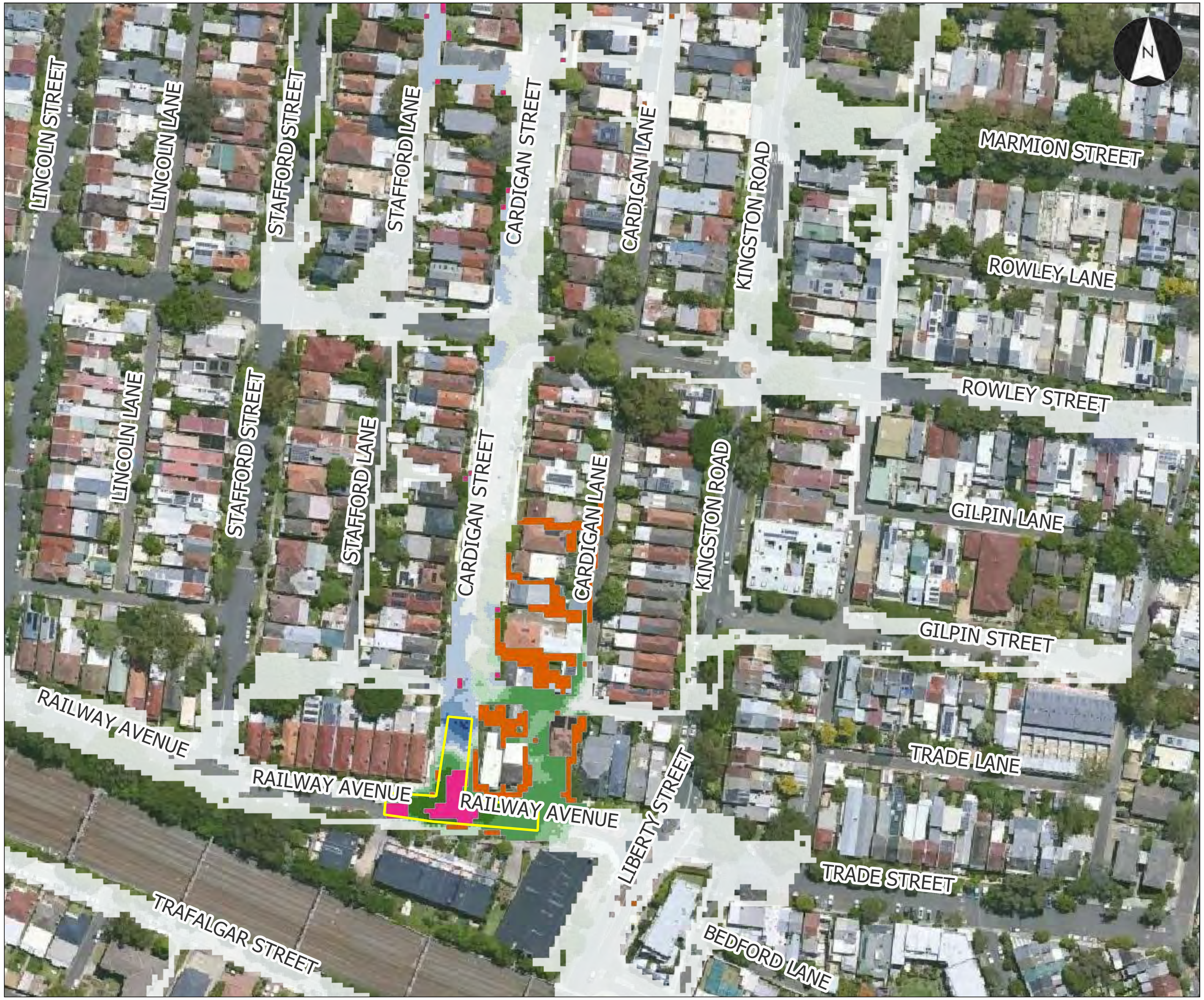
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

4 0 4 8 12 16 m

Scale at A3: 1:500



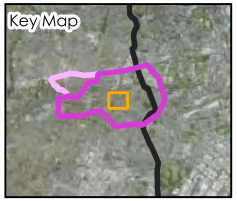
Johnstons Creek Option 20% AEP JC14 Railway Street Road Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 56

Legend

- MJC Study Area
- IWC LGA Boundary
- 2d_zsh_JC14_v1
- MJC_5y_JC14_v1-PM6_wd Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_5y_JC14_v1-PM6_WLD Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

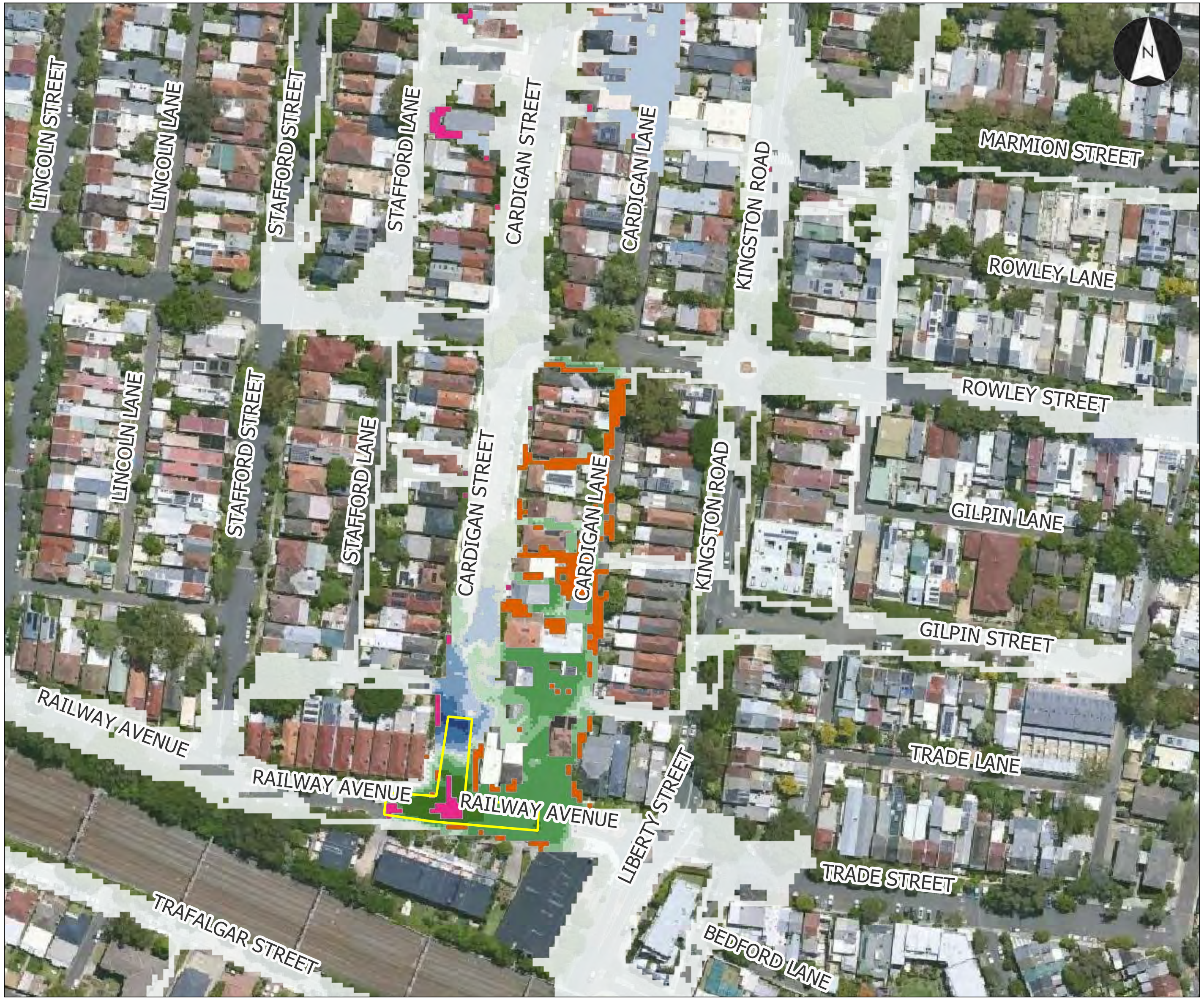
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



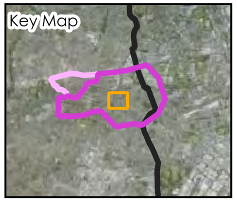
Johnstons Creek Option 5% AEP
JC14 Railway Street Road Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 57

Legend

MJC Study Area
IWC LGA Boundary
2d_zsh_JC14_v1
MJC_20y_JC14_v1-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_20y_JC14_v1-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

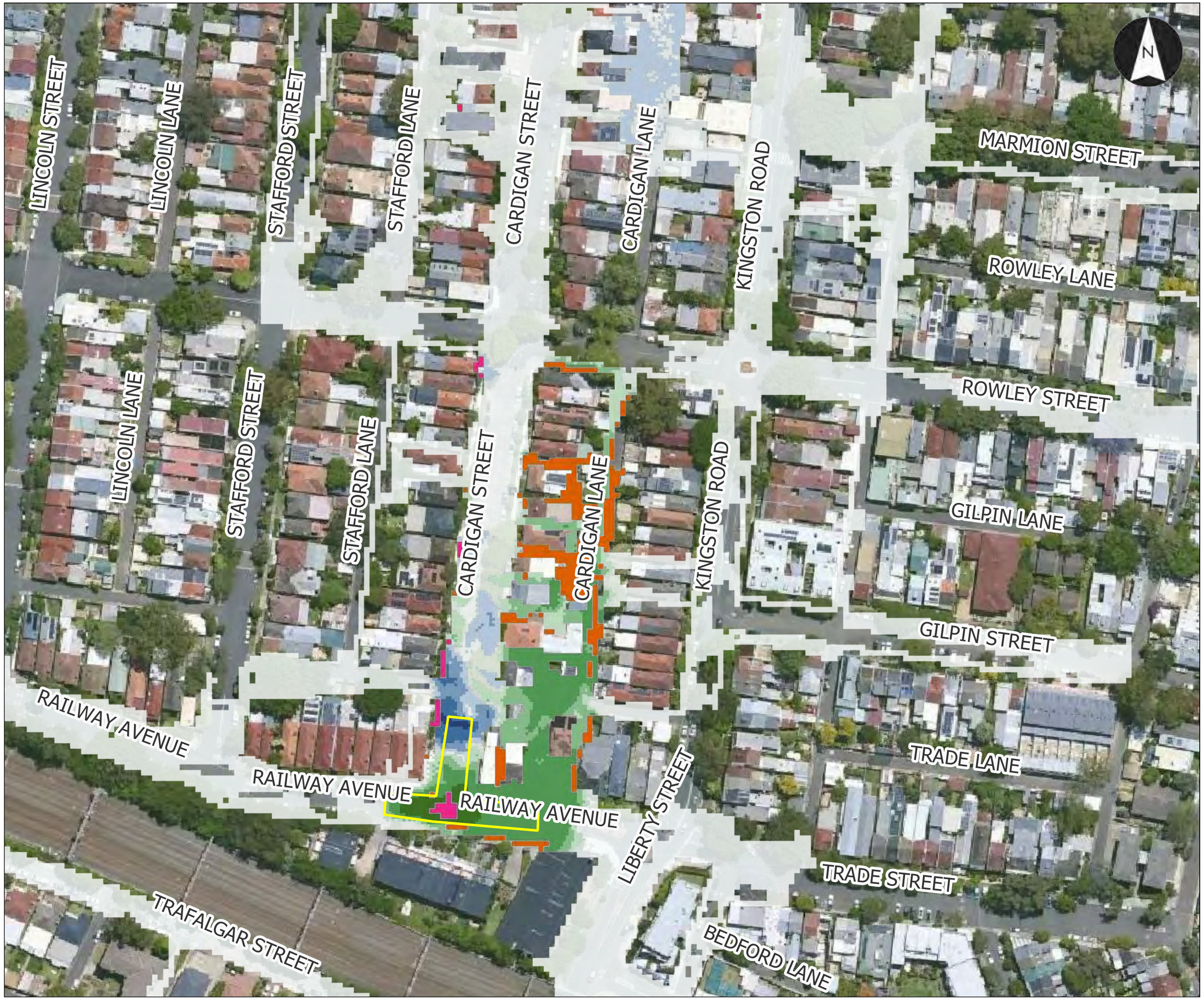
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



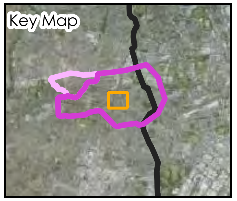
Johnstons Creek Option 2% AEP
JC14 Railway Street Road Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 58

Legend

MJC Study Area
IWC LGA Boundary
2d_zsh_JC14_v1
MJC_50y_JC14_v1-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_50y_JC14_v1-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



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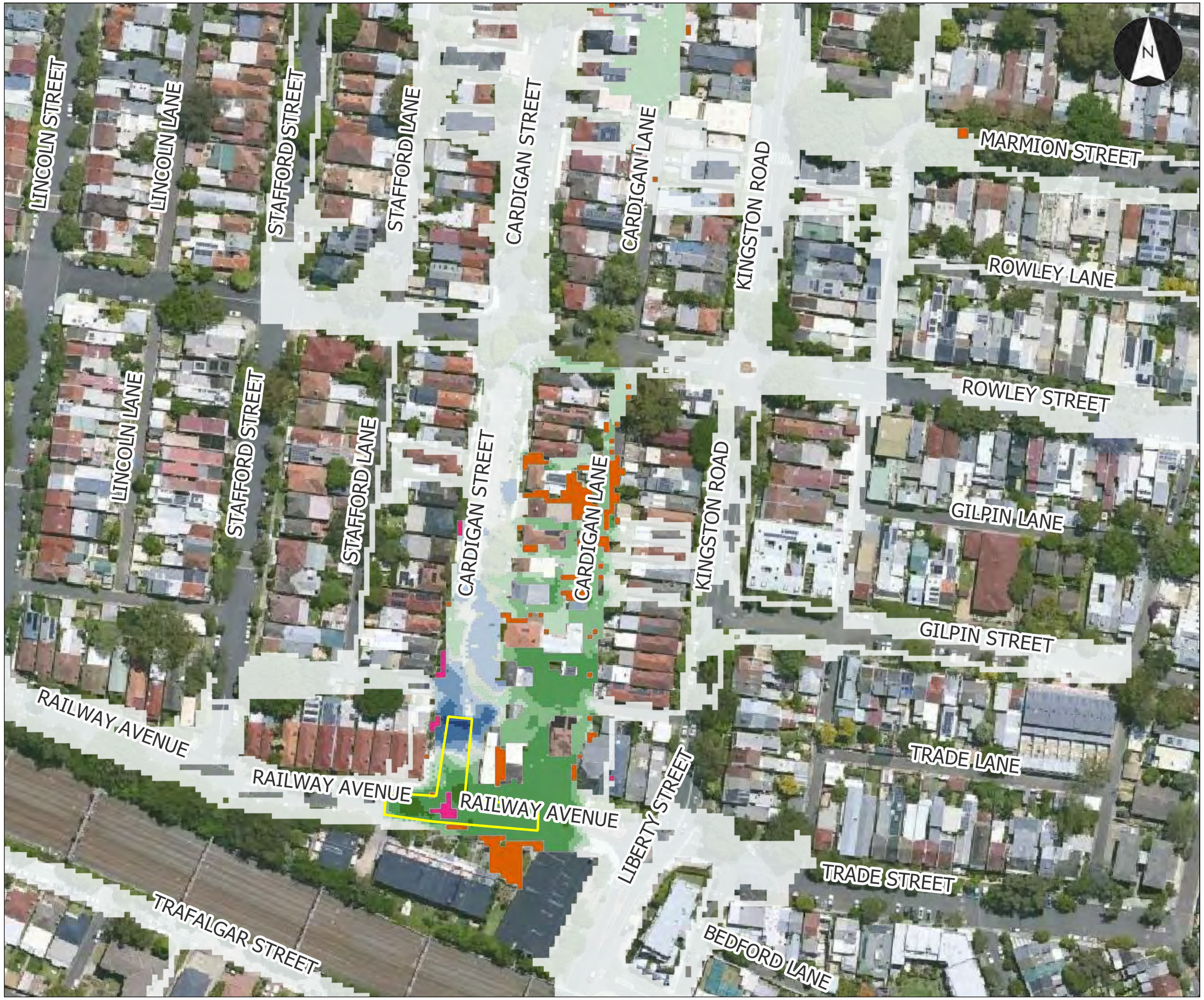
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 1% AEP JC14 Railway Street Road Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 59

Legend

- MJC Study Area
- IWC LGA Boundary
- 2d_zsh_JC14_v1
- MJC_100y_JC14_v1-PM6_wd Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_100y_JC14_v1-PM6_WLD Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50

DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

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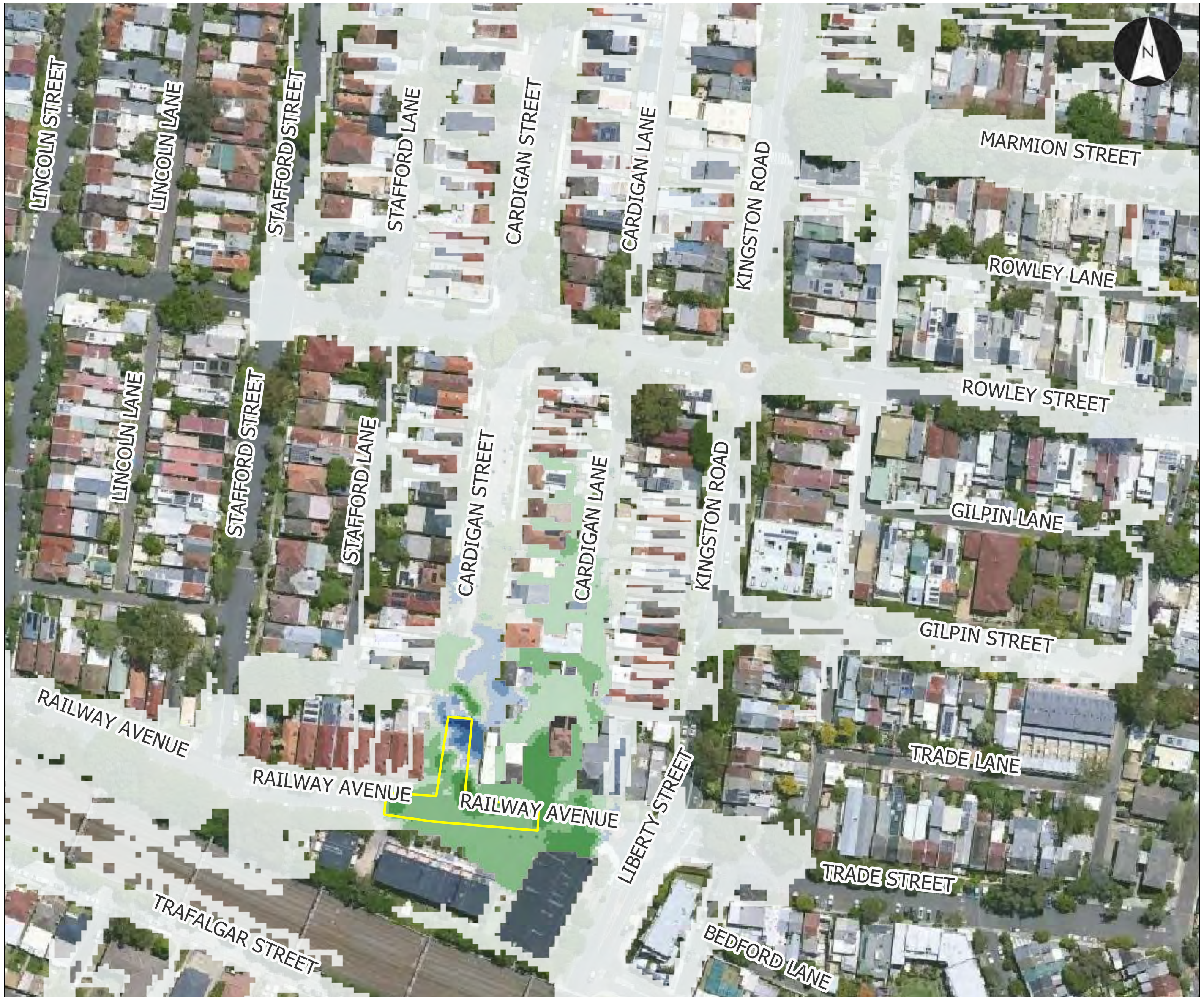


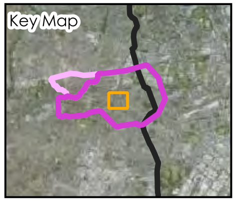
Johnstons Creek Option PMF
JC14 Railway Street Road Regrading

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 60

Legend

- MJC Study Area
- IWC LGA Boundary
- 2d_zsh_JC14_v1
- MJC_PMF_JC14_v1-PM6_WLD
  Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

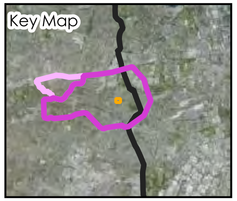
Johnstons Creek Option - JC15 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 61

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage



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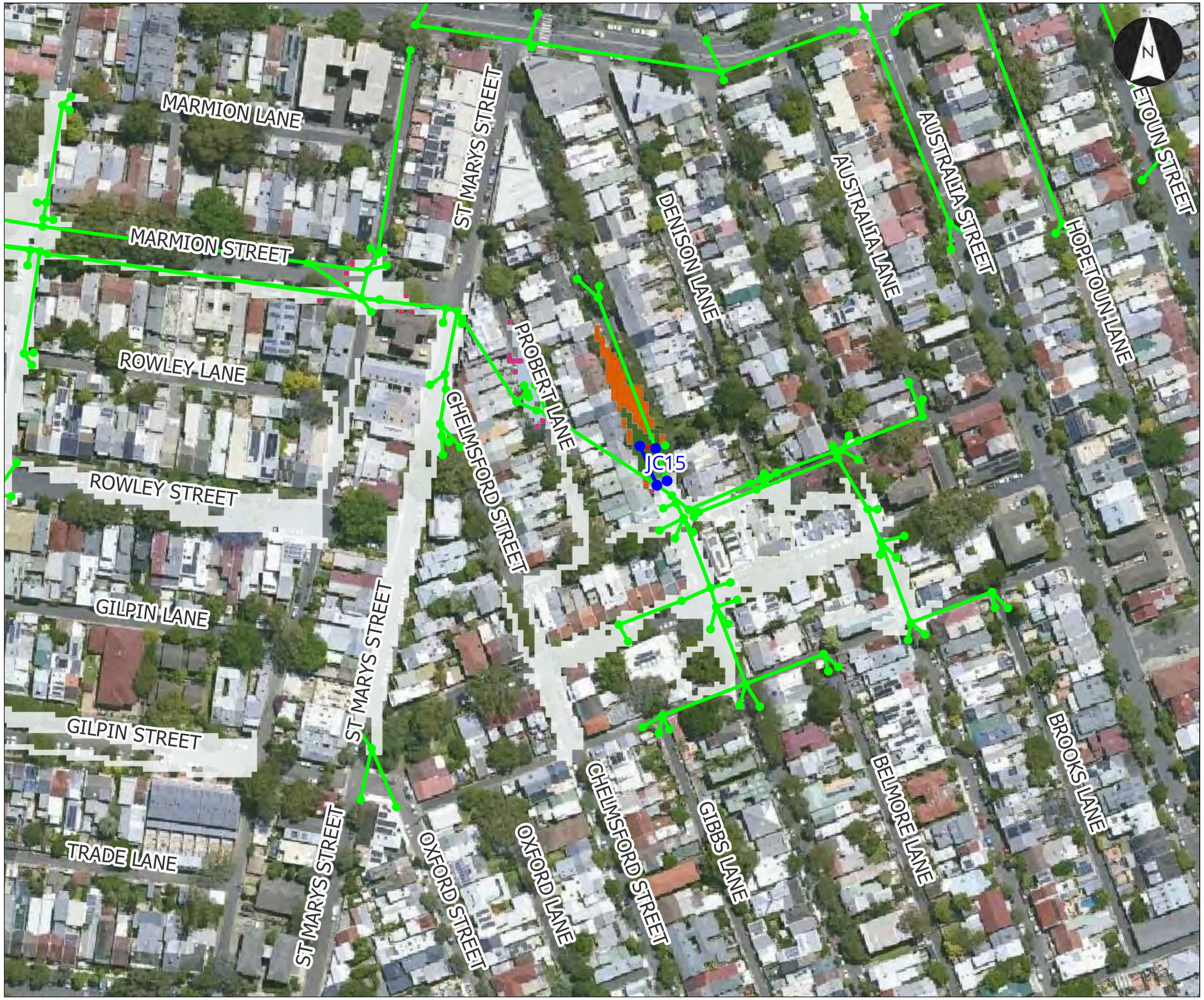
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

4 0 4 8 12 16 m

Scale at A3: 1:500



Johnstons Creek Option 20% AEP
JC15 Probert Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

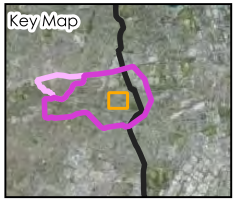
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 62

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_5y_JC15_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC15_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

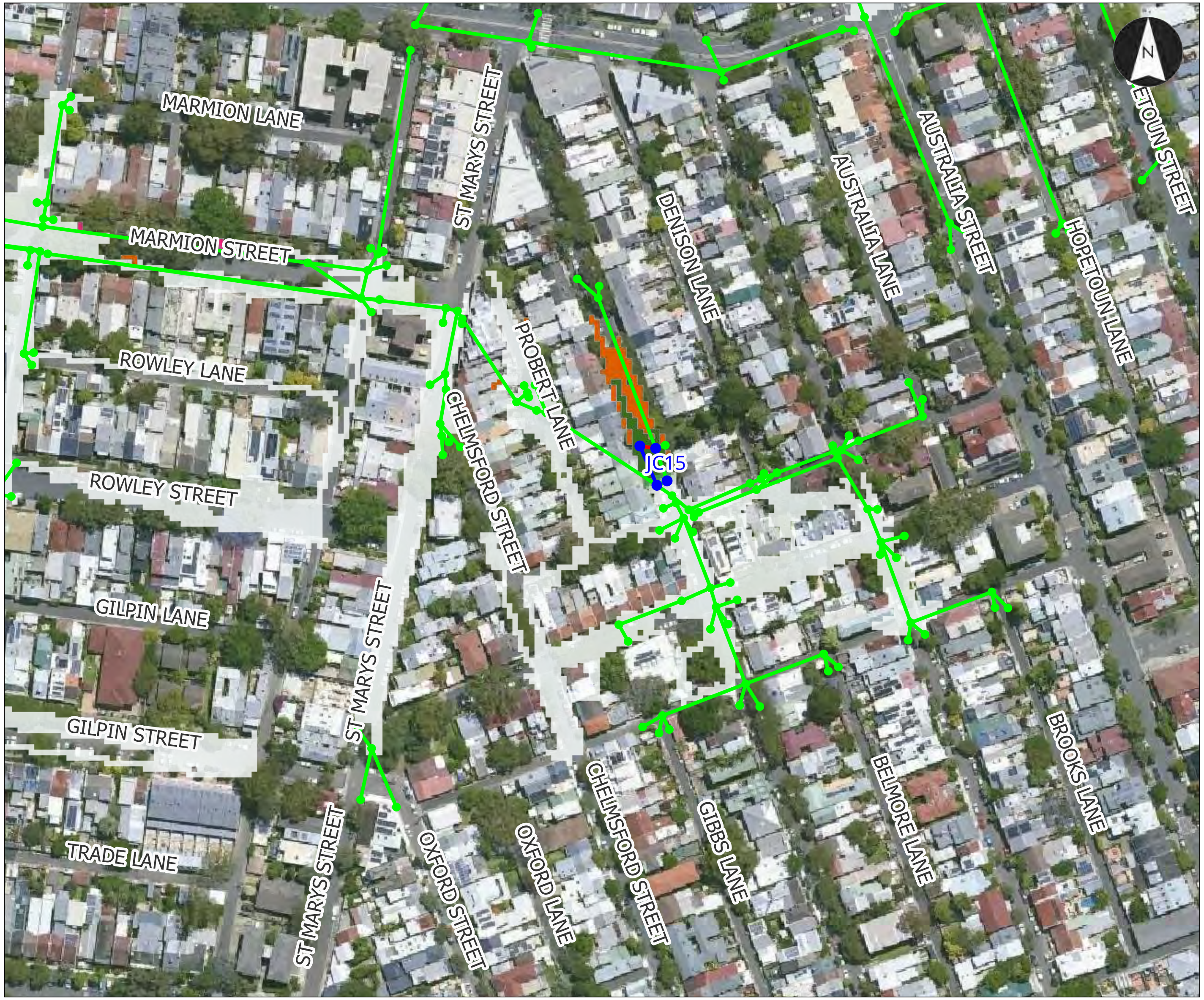
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 5% AEP
JC15 Probert Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

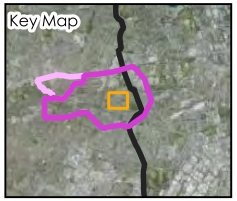
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 63

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_20y_JC15_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC15_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

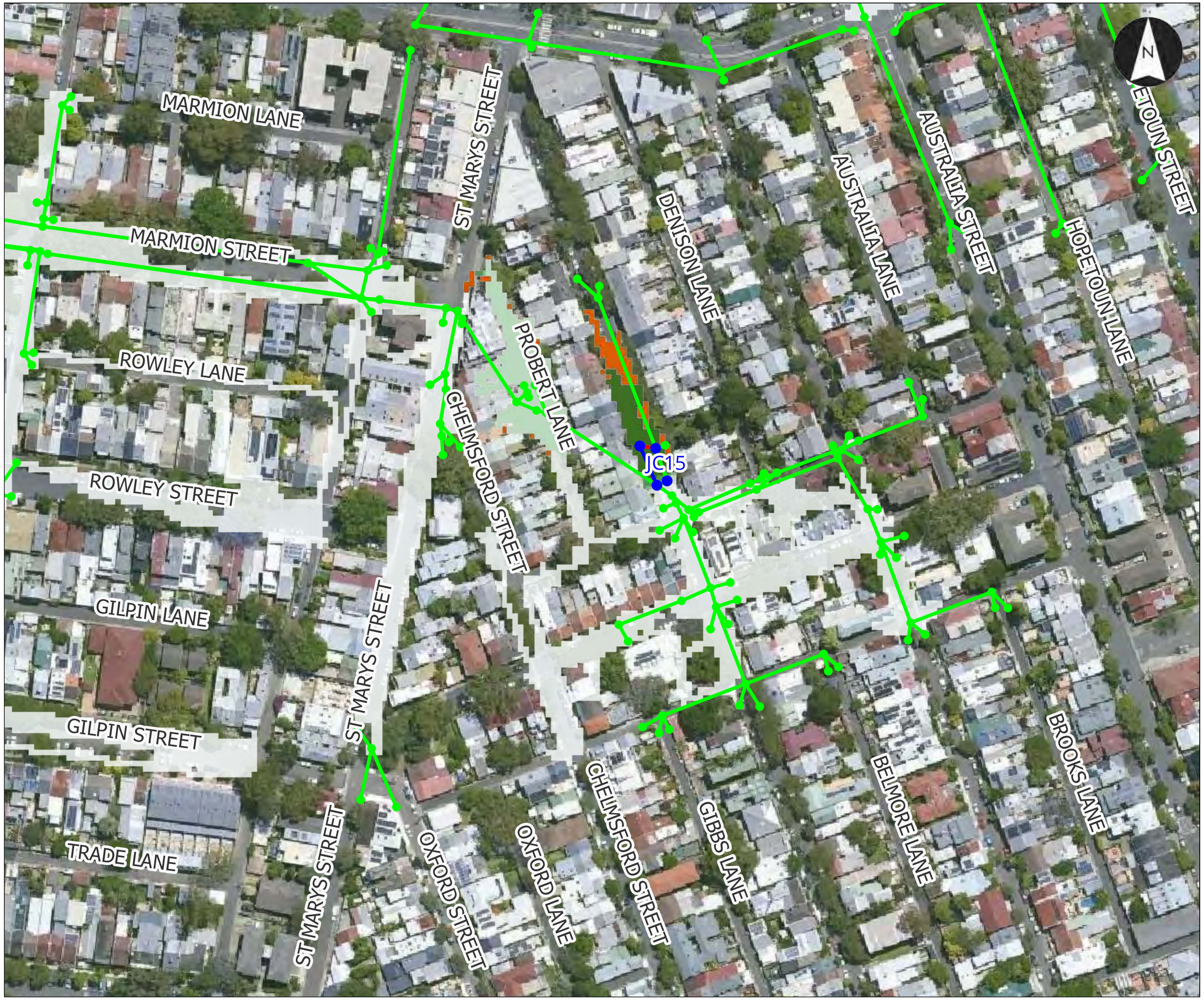
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 2% AEP
JC15 Probert Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

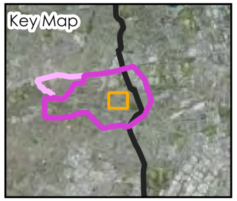
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 64

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_50y_JC15_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC15_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

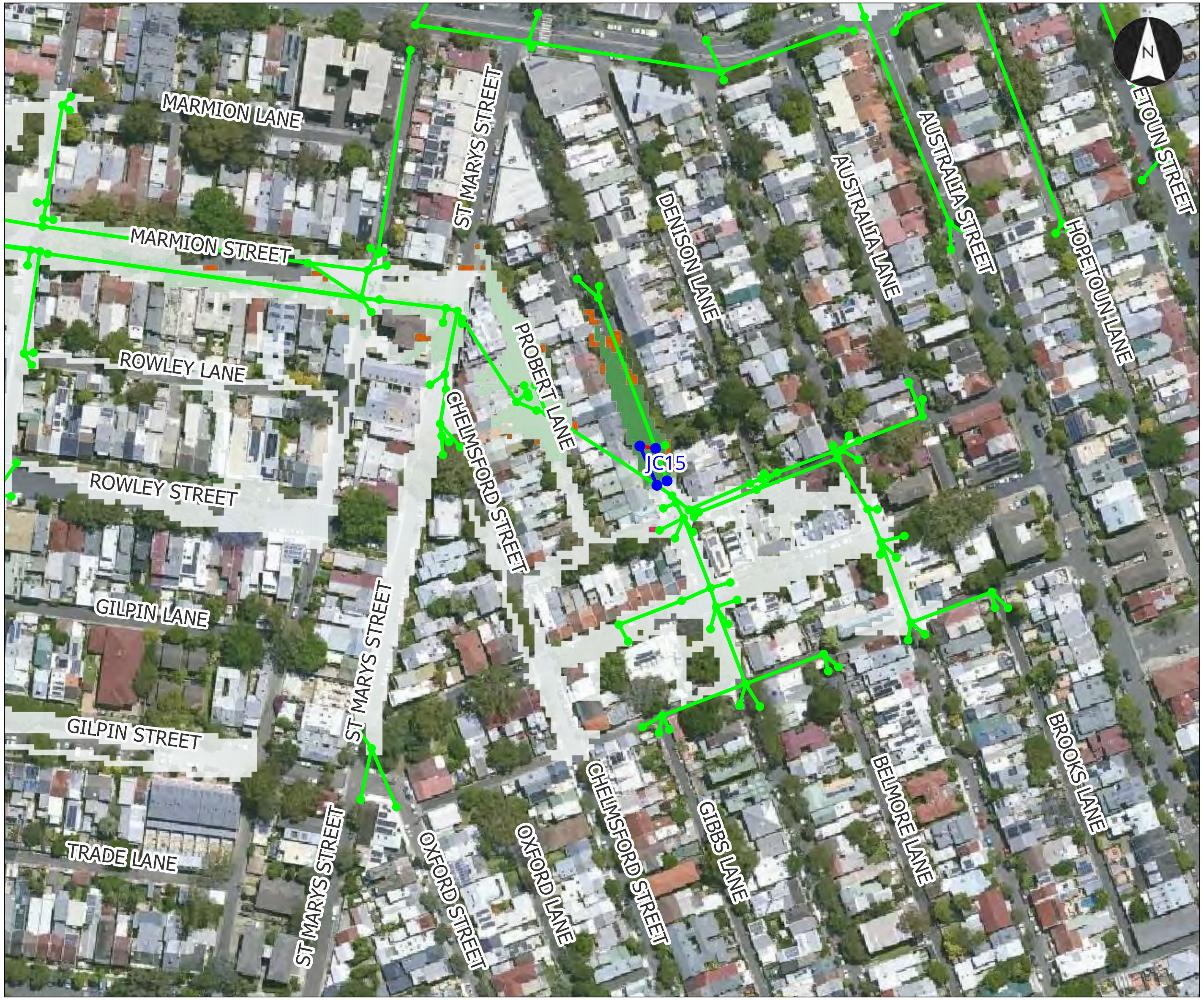
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 1% AEP
JC15 Probert Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

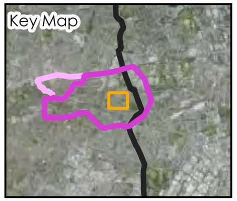
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 65

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_100y_JC15_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC15_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

Johnstons Creek Option PMF
JC15 Probert Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

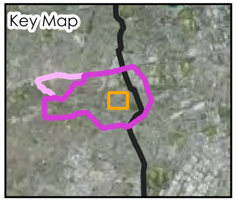
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 66

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_PMF_JC15_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_JC15_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

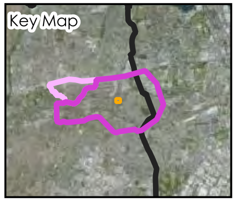
Johnstons Creek Option - JC18 v1 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 67

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Existing Drainage



DRAFT - Not For Construction

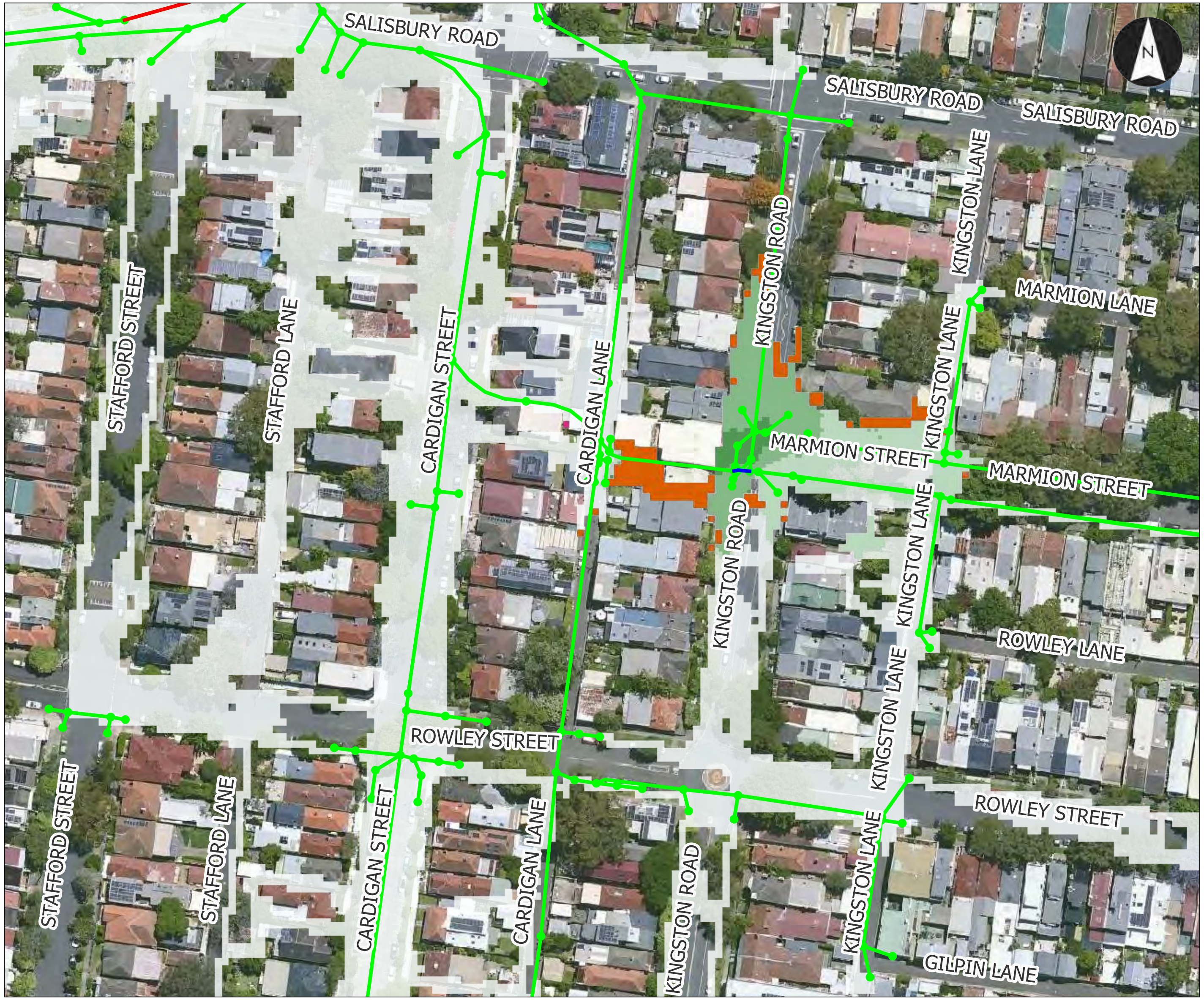
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

4 0 4 8 12 16 m

Scale at A3: 1:500



Johnstons Creek Option 20% AEP JC18 v1 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council

Project Code: 304600164

Drawn By: AC, Checked By: MG

Date: (2023-12-22)

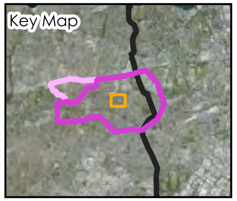
Figure No: 68

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Removed Drainage
- Existing Drainage

MJC_5y_JC18_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC18_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

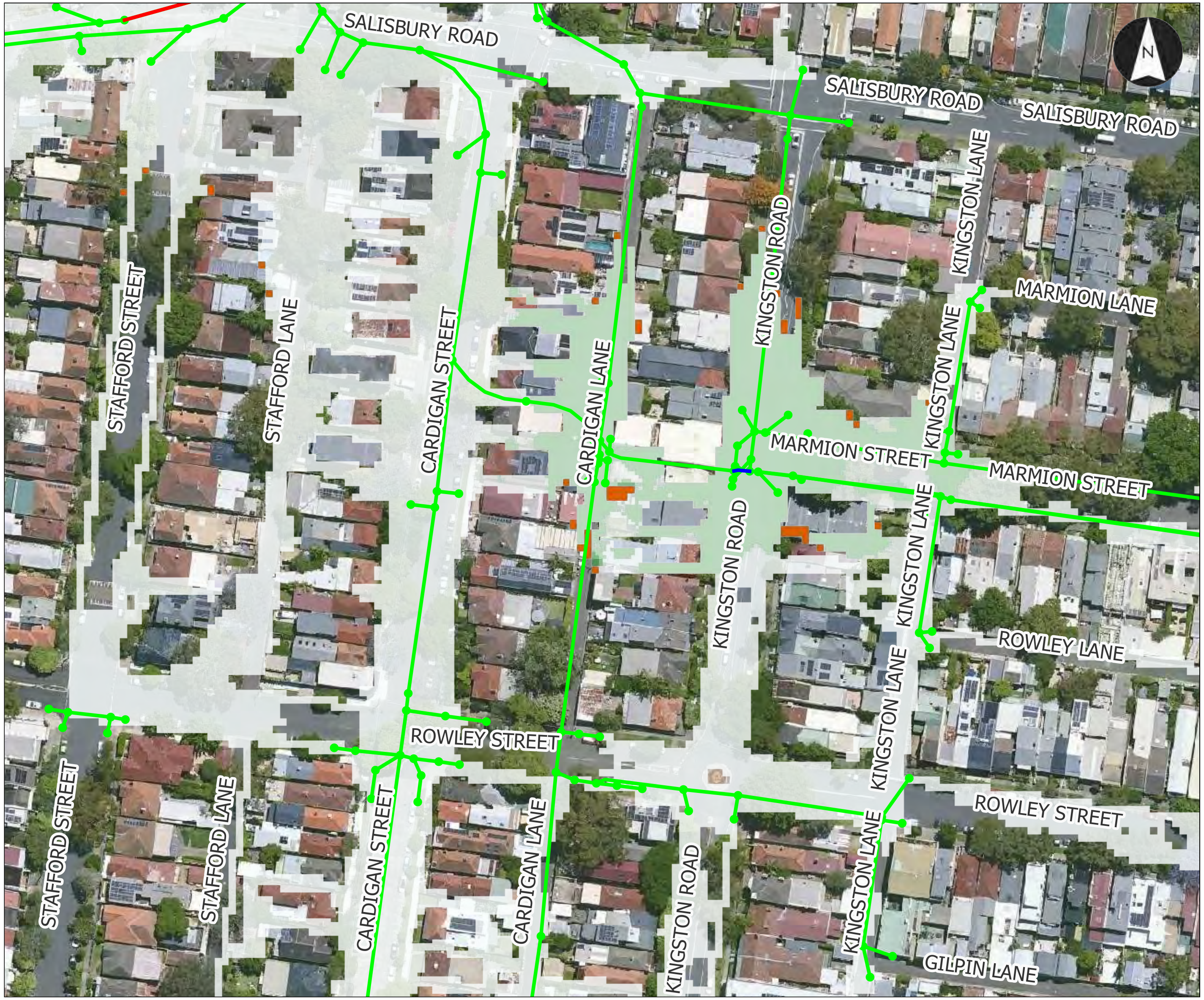
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option 5% AEP
JC18 v1 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

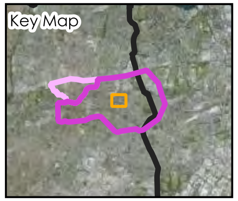
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 69

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Removed Drainage
- Existing Drainage

MJC_20y_JC18_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC18_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500

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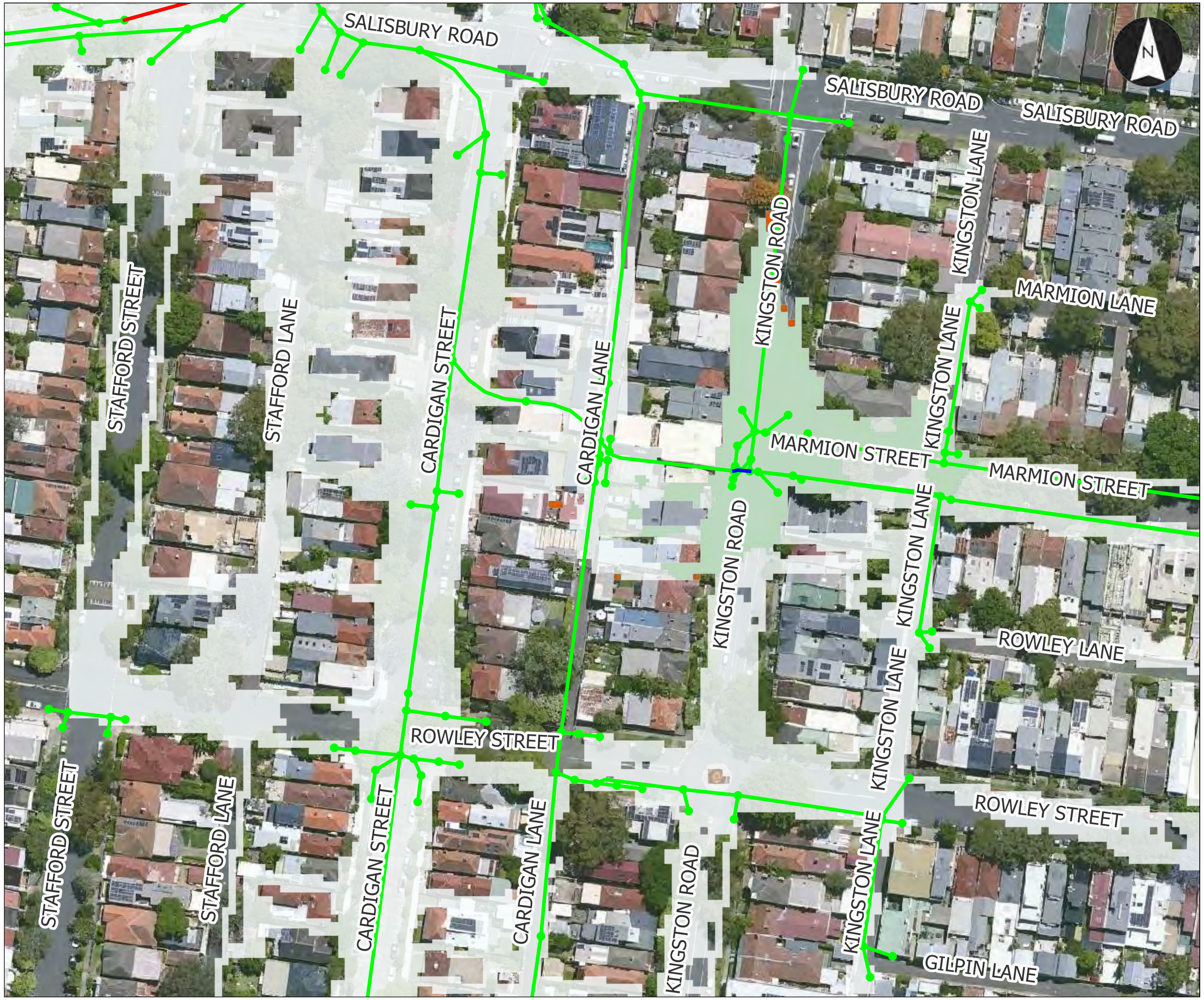


Johnstons Creek Option 2% AEP JC18 v1 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

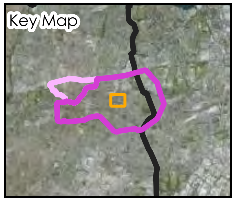
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 70

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Removed Drainage
- Existing Drainage

MJC_50y_JC18_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC18_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

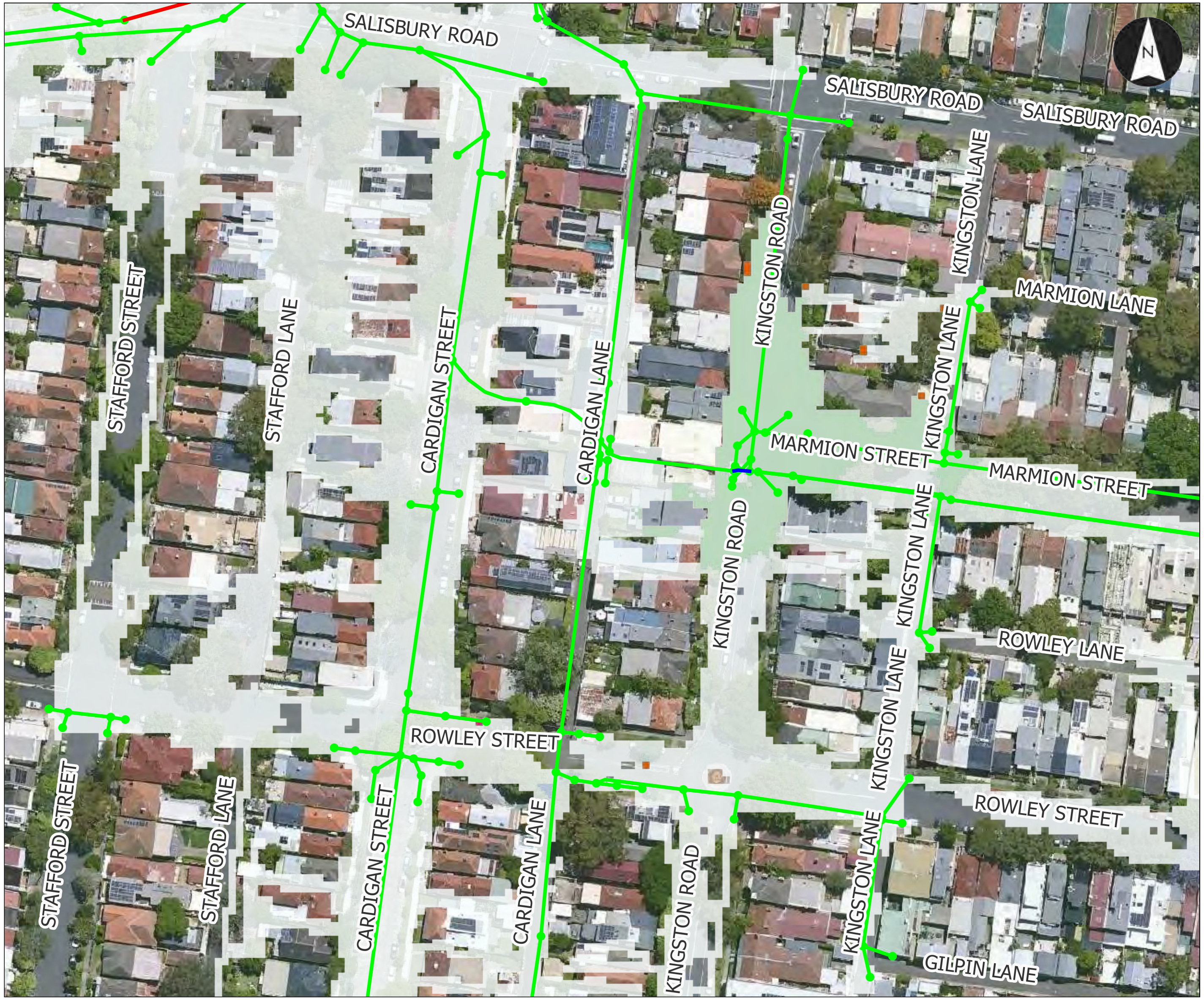
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option 1% AEP
JC18 v1 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

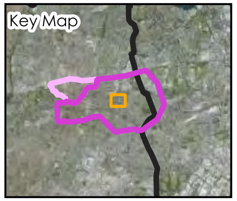
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 71

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Removed Drainage
- Existing Drainage

MJC_100y_JC18_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC18_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

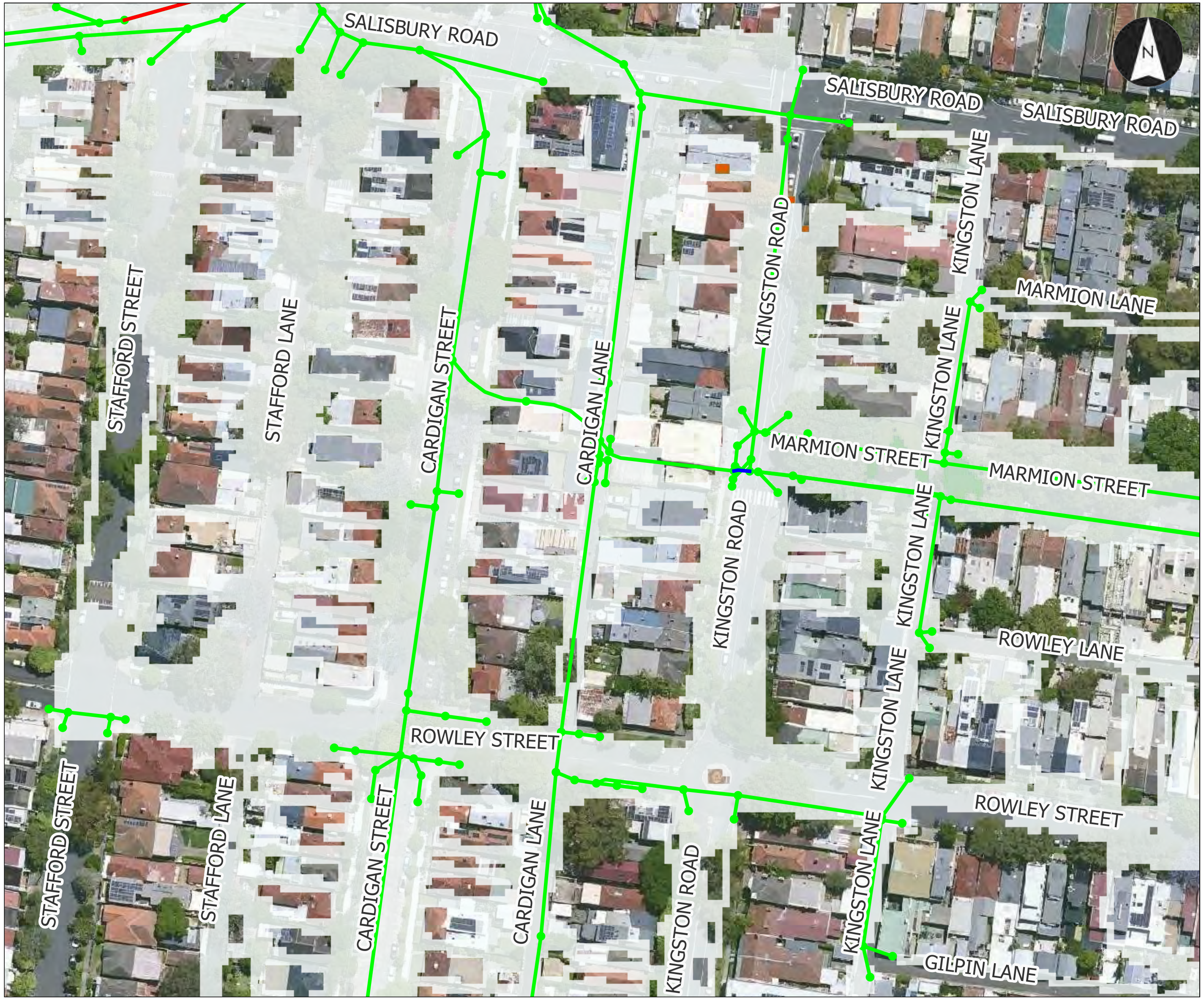
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option PMF
JC18 v1 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

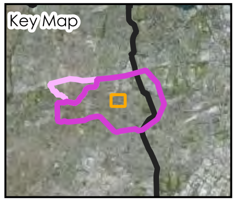
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 72

Legend

- MJC Study Area
- IWC LGA Boundary
- JC6_v5_Channel
- Removed Drainage
- Existing Drainage

MJC_PMF_JC18_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_PMF_JC18_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

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Scale at A3: 1:1500

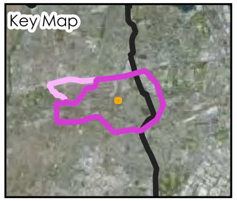
Johnstons Creek Option - JC18 v2 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 73

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Existing Drainage



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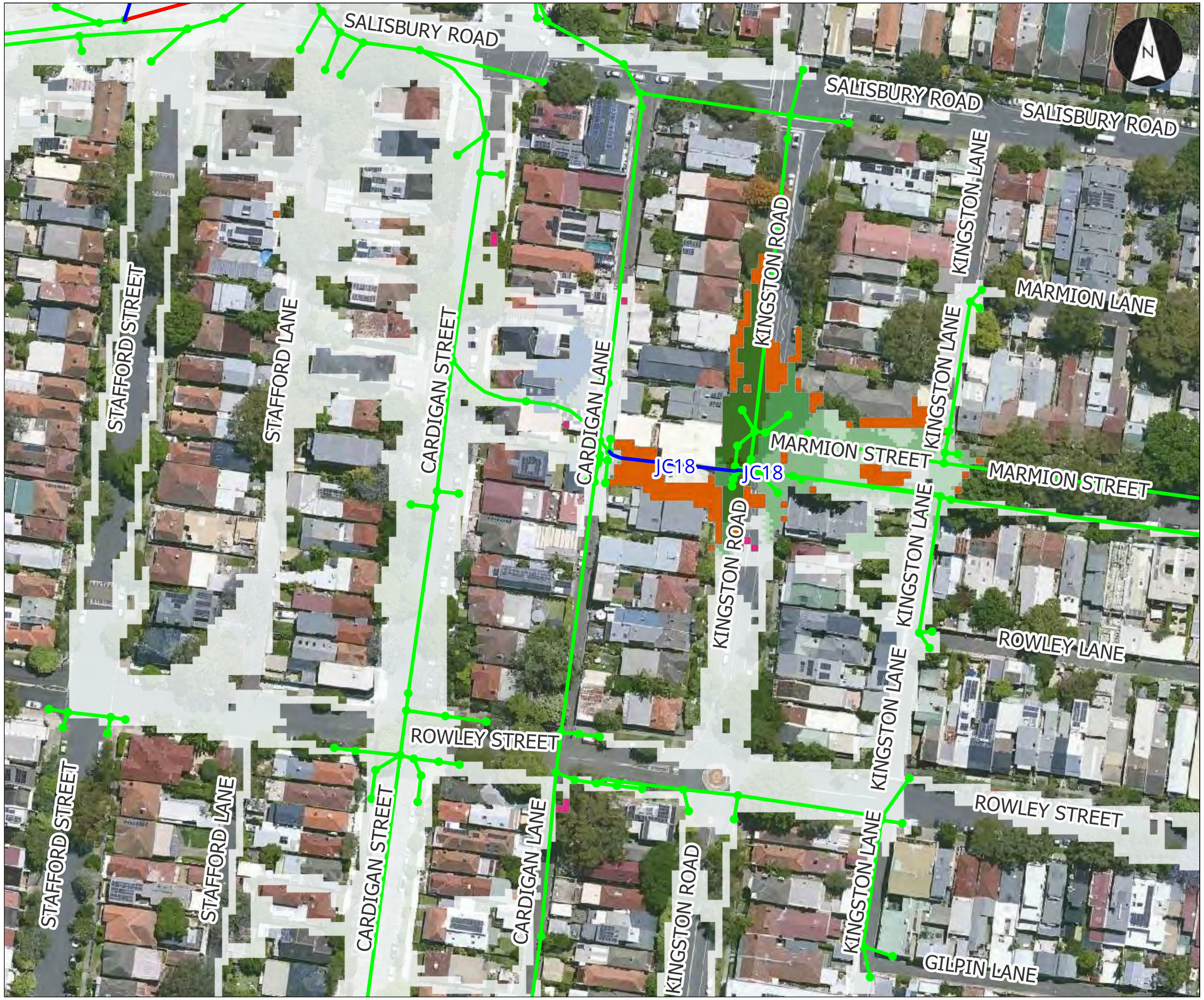
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

4 0 4 8 12 16 m

Scale at A3: 1:500



Johnstons Creek Option 20% AEP JC18 v2 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

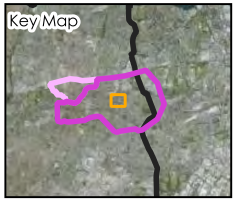
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 74

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_5y_JC18_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC18_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

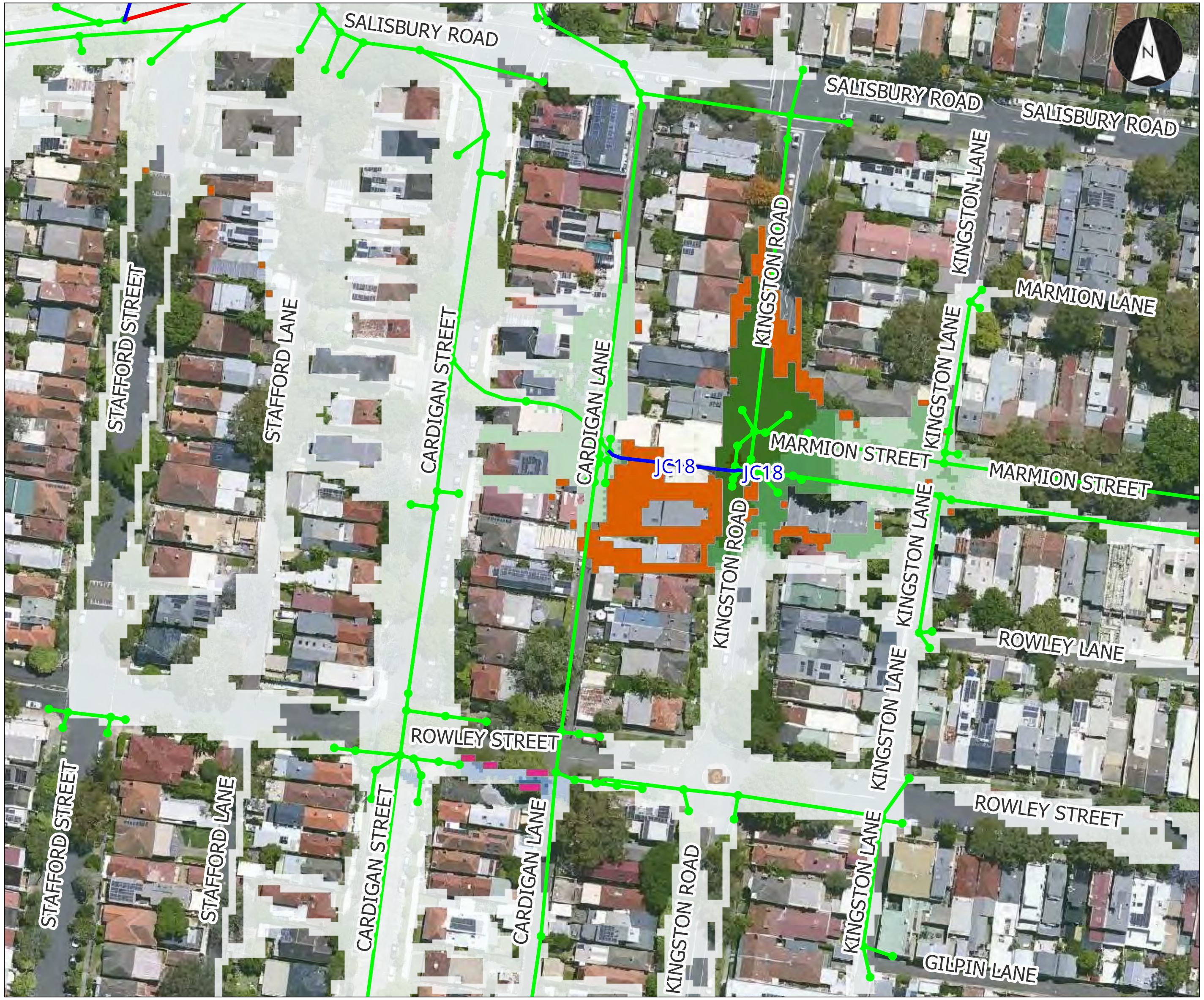
References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500

This document has been prepared based on information provided by others as cited in the data sources. Stantec has not verified the accuracy and/or completeness of this information as shall not be help responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and recipient accepts full responsibility for verifying the accuracy and completeness of the data.



Johnstons Creek Option 5% AEP
JC18 v2 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

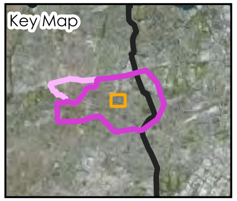
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 75

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_20y_JC18_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC18_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

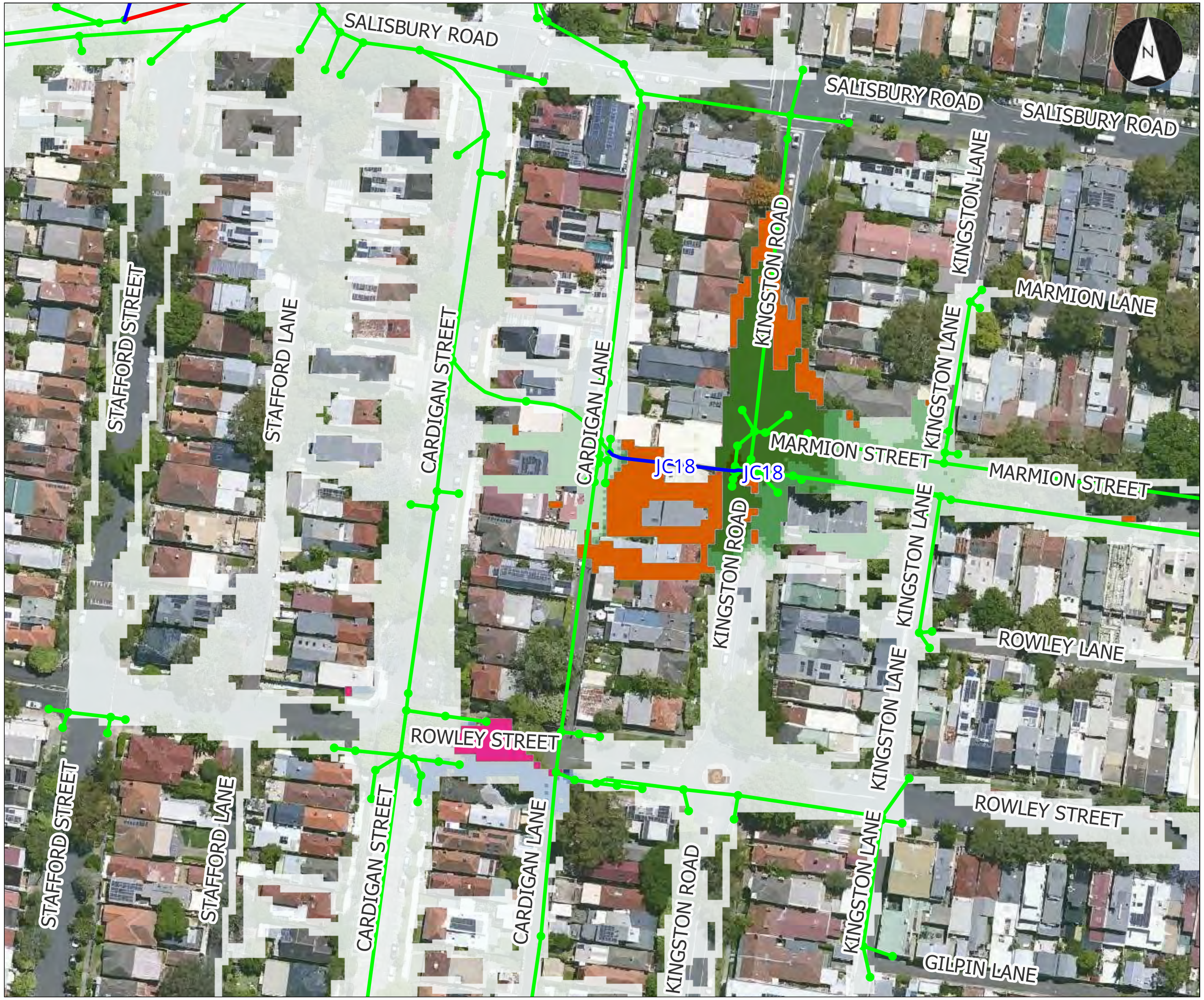
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option 2% AEP
JC18 v2 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

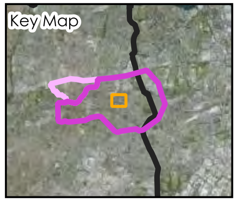
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 76

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_50y_JC18_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC18_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

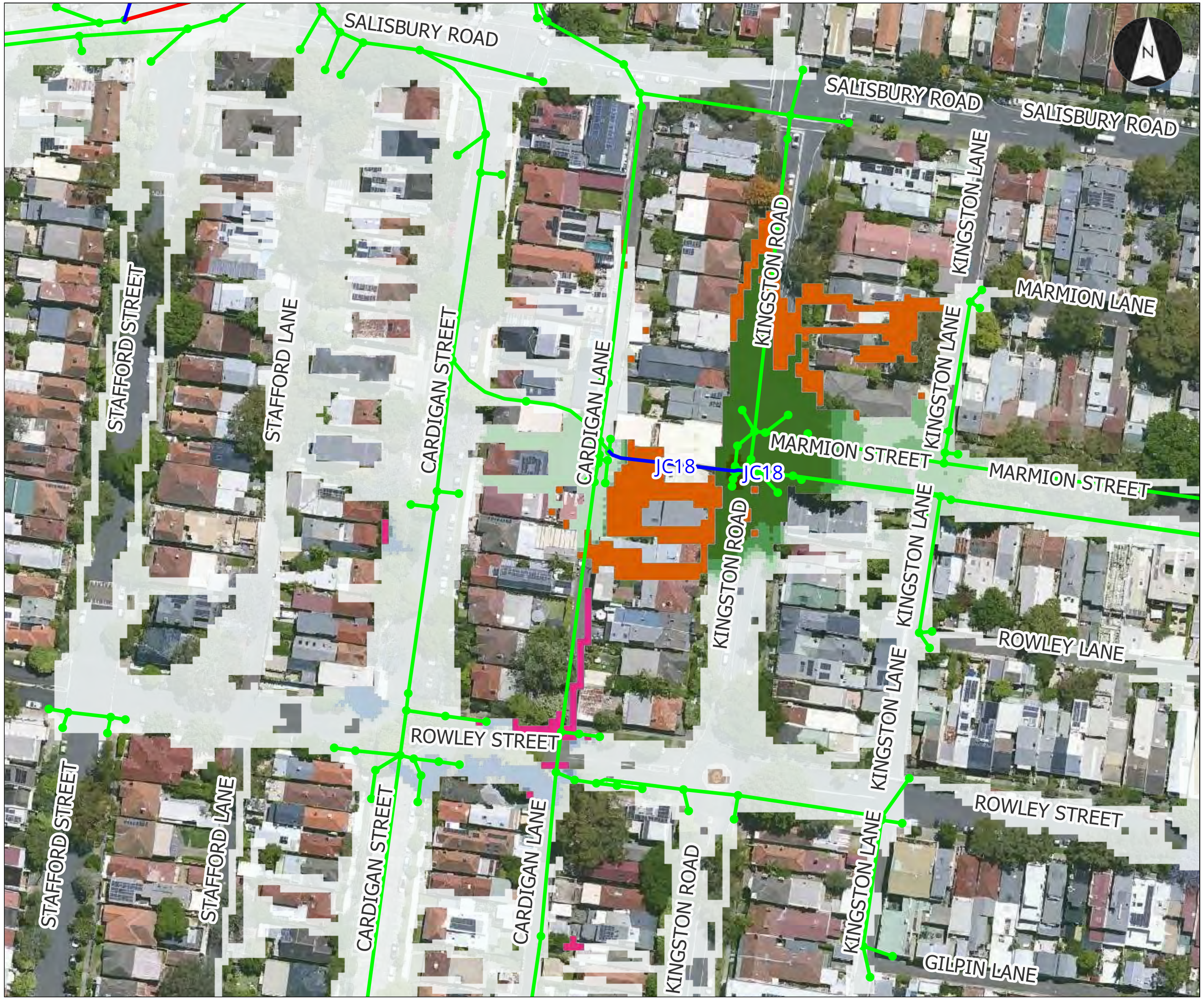
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option 1% AEP JC18 v2 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

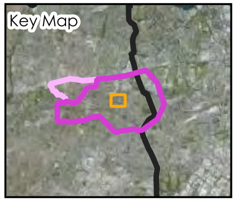
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 77

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- Existing Drainage

MJC_100y_JC18_v3-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC18_v3-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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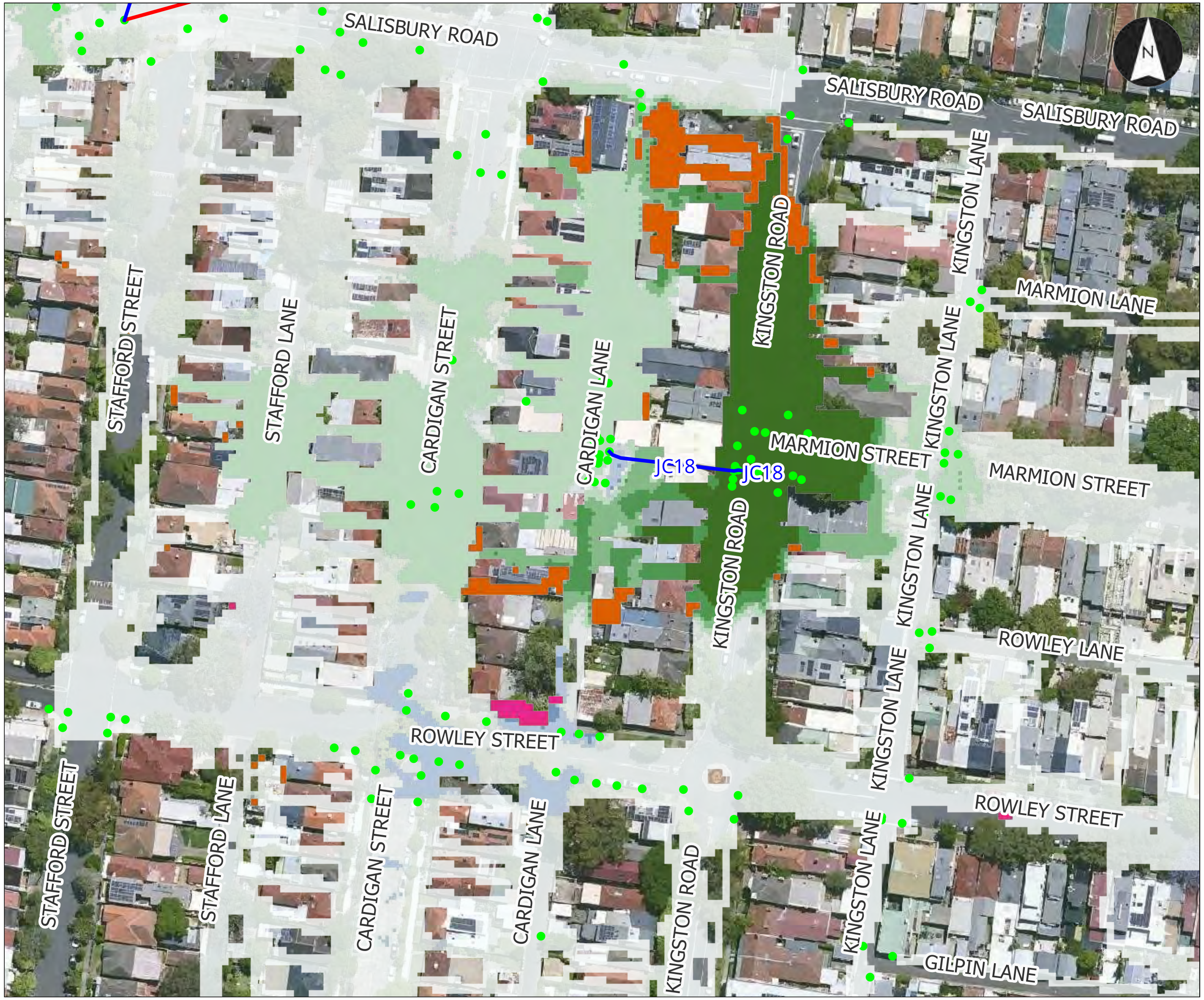
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



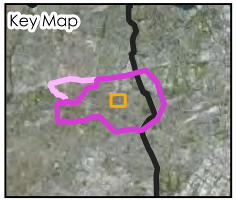
Johnstons Creek Option PMF
JC18 v2 Kingston Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 78

Legend

- MJC Study Area
- IWC LGA Boundary
- Drainage Option
- Proposed Drainage
- Removed Drainage
- MJC_PMF_JC18_v3-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_PMF_JC18_v3-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



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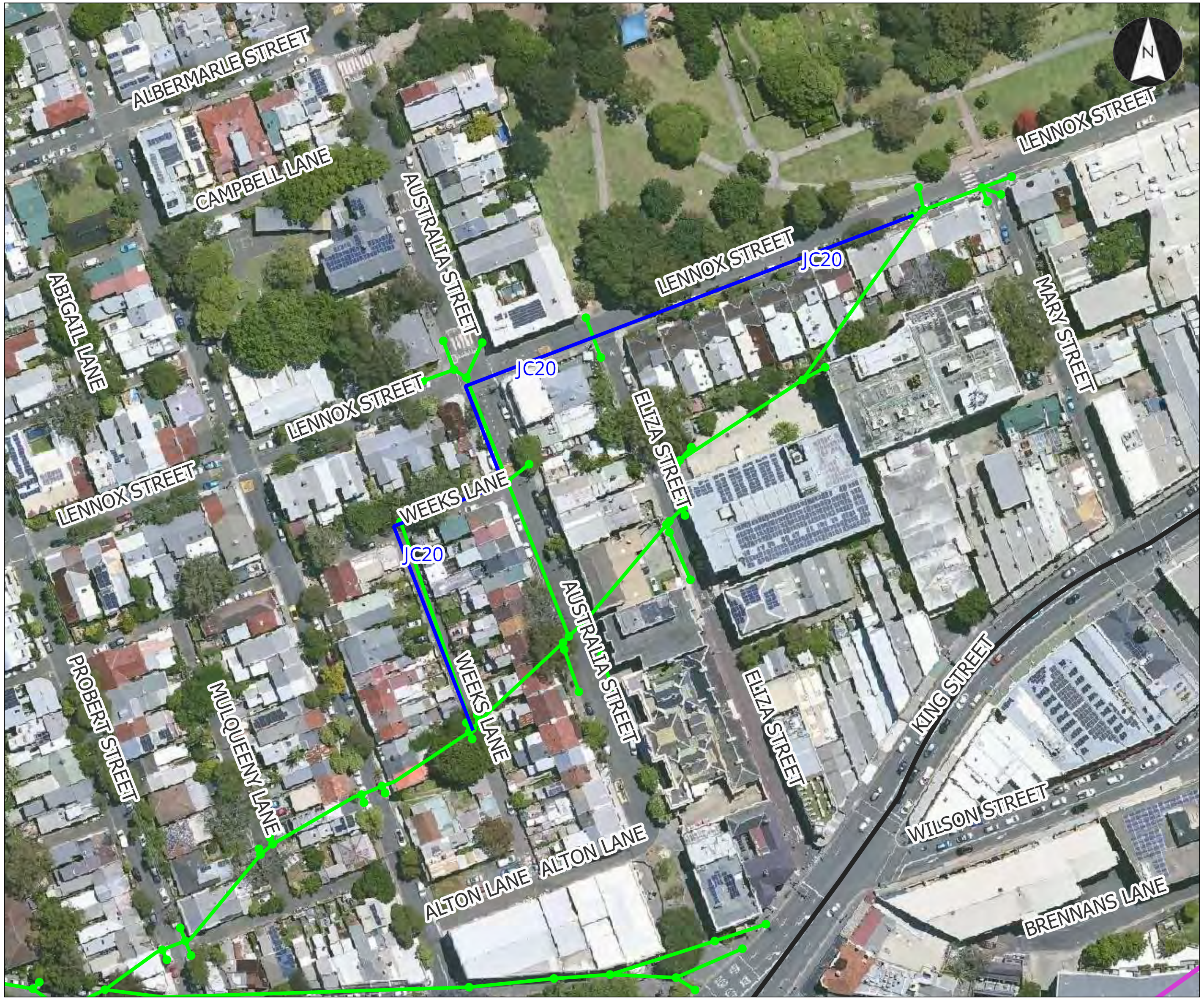
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



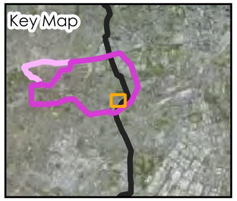
Johnstons Creek Option - JC20 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 79

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage



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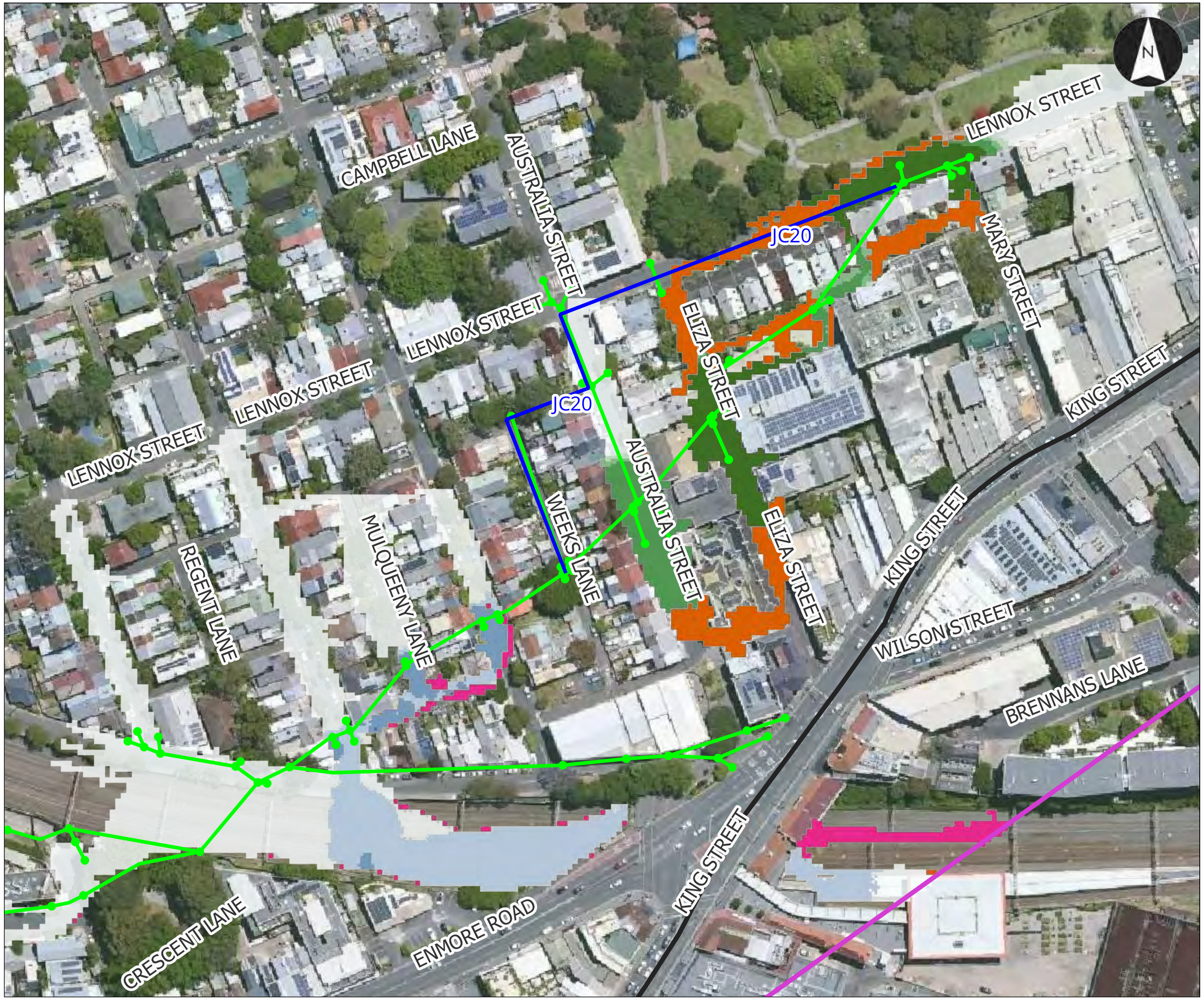
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

12 0 12 24 36 48 m

Scale at A3: 1:1500



Johnstons Creek Option 20% AEP
JC20 Lennox Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

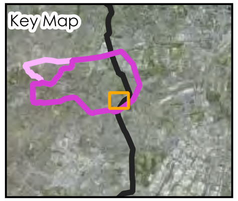
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 80

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_5y_JC20_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC20_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

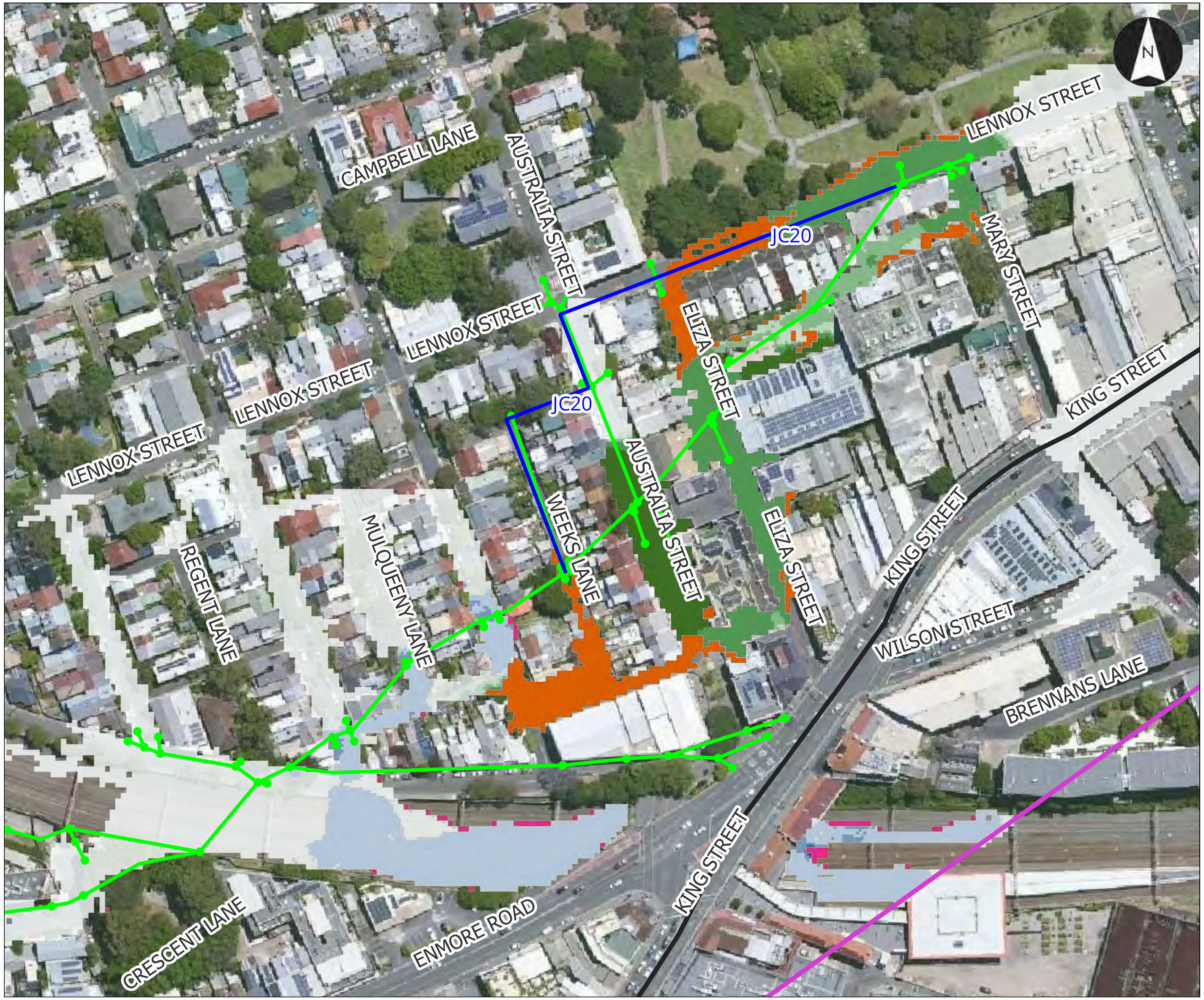
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 5% AEP
JC20 Lennox Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

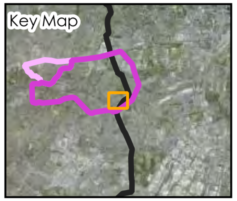
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 81

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_20y_JC20_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_20y_JC20_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

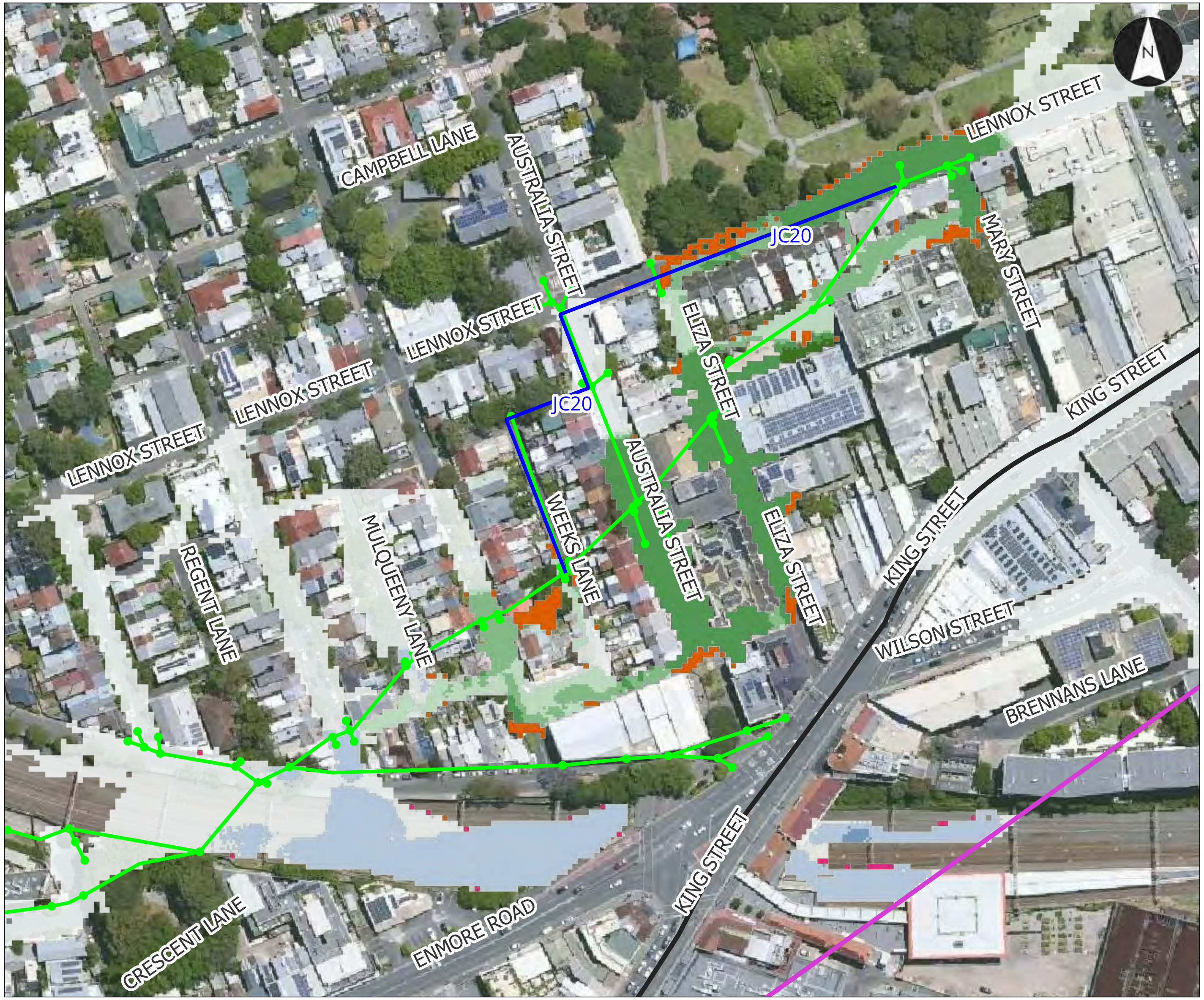
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



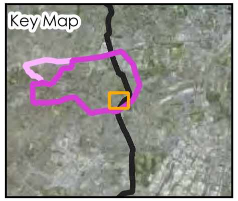
Johnstons Creek Option 2% AEP
JC20 Lennox Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 82

Legend

MJC Study Area
IWC LGA Boundary
Proposed Drainage
Existing Drainage
MJC_50y_JC20_v2-PM6_wd
Band 1 (Gray)
Was Wet, Now Dry
Was Dry, Now Wet
MJC_50y_JC20_v2-PM6_WLD
Band 1 (Gray)
< -0.50
-0.50 to -0.20
-0.20 to -0.10
-0.10 to -0.05
-0.05 to -0.01
-0.01 to 0.01
0.01 to 0.05
0.05 to 0.10
0.10 to 0.20
0.20 to 0.50
> 0.50



DRAFT - Not For Construction

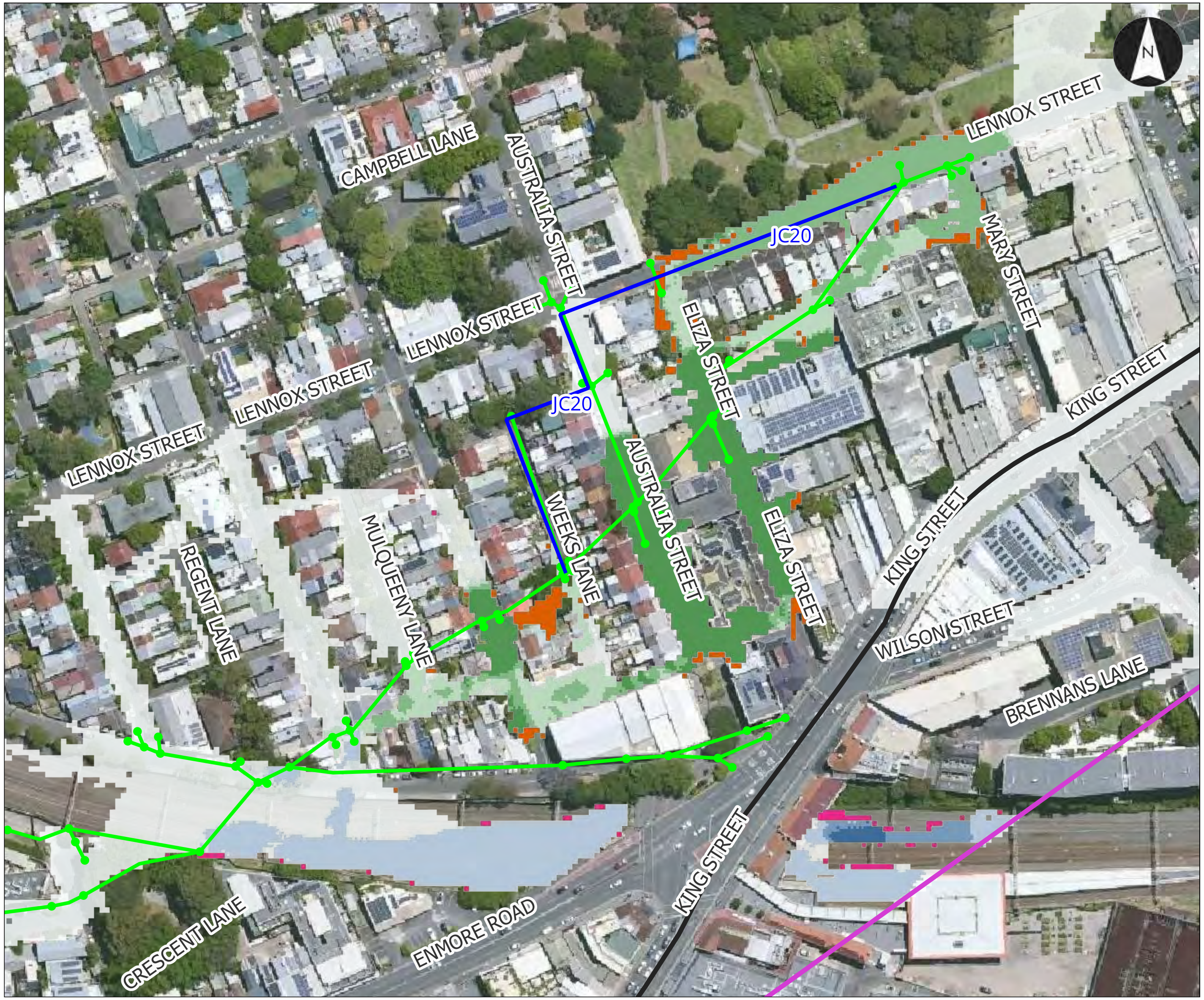
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



Johnstons Creek Option 1% AEP
JC20 Lennox Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

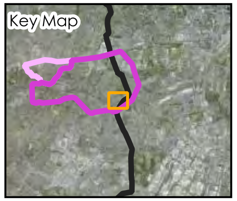
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 83

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_100y_JC20_v2-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_100y_JC20_v2-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

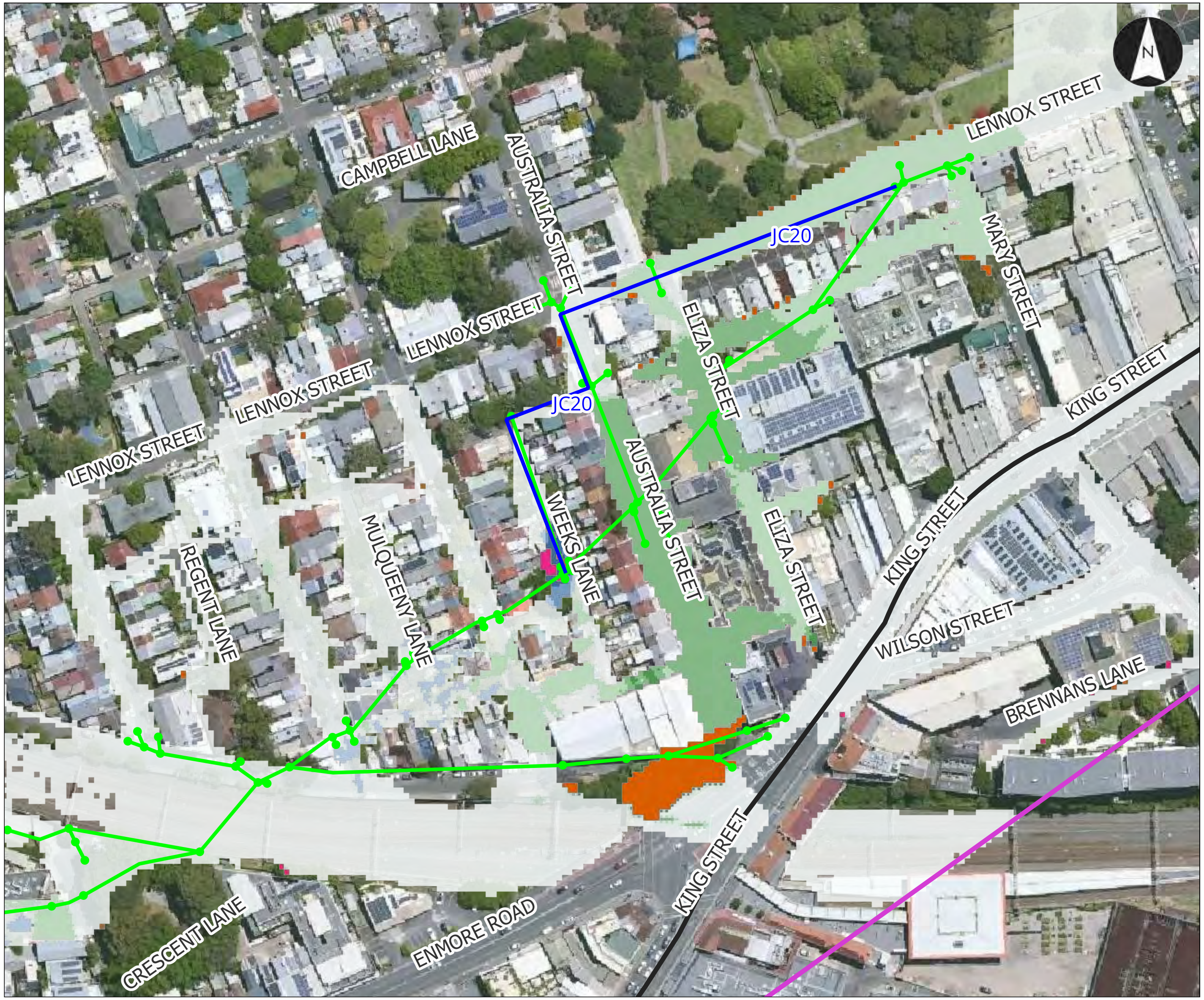
Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000



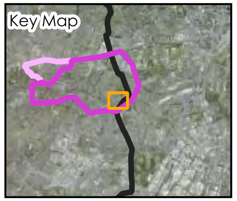
Johnstons Creek Option PMF
JC20 Lennox Street Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 84

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage
- MJC_PMF_JC20_v2-PM6_wd
  Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_PMF_JC20_v2-PM6_WLD
  Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

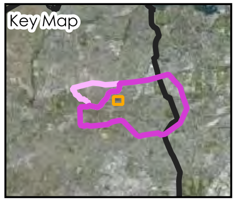
Johnstons Creek Option - JC23 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 85

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

Johnstons Creek Option 20% AEP
JC23 Clarendon Lane Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

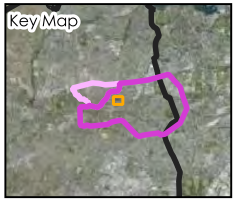
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 86

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_5y_JC23_v1-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_5y_JC23_v1-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

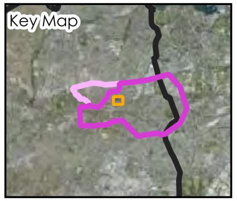
Johnstons Creek Option 5% AEP
JC23 Clarendon Lane Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 87

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage
- MJC_20y_JC23_v1-PM6_wd
  Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet
- MJC_20y_JC23_v1-PM6_WLD
  Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

Johnstons Creek Option 2% AEP
JC23 Clarendon Lane Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

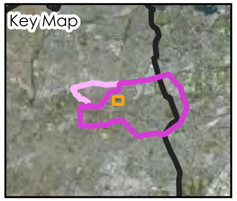
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 88

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MJC_50y_JC23_v1-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MJC_50y_JC23_v1-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

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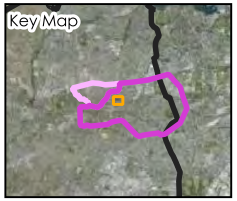
Johnstons Creek Option 1% AEP
JC23 Clarendon Lane Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 89

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage
- MJC_100y_JC23_v1-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_100y_JC23_v1-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

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8 0 8 16 24 32 m

Scale at A3: 1:1000

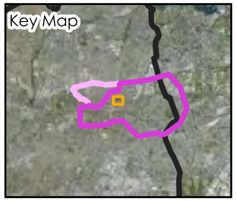
Johnstons Creek Option PMF
JC23 Clarendon Lane Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 90

Legend

- MJC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage
- MJC_PMF_JC23_v1-PM6_wd
  - Band 1 (Gray)
  - Was Wet, Now Dry
  - Was Dry, Now Wet
- MJC_PMF_JC23_v1-PM6_WLD
  - Band 1 (Gray)
  - < -0.50
  - -0.50 to -0.20
  - -0.20 to -0.10
  - -0.10 to -0.05
  - -0.05 to -0.01
  - -0.01 to 0.01
  - 0.01 to 0.05
  - 0.05 to 0.10
  - 0.10 to 0.20
  - 0.20 to 0.50
  - > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

8 0 8 16 24 32 m

Scale at A3: 1:1000

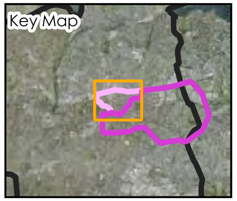
Whites Creek Base Case - PM6 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 91

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

Whites Creek Base Case 20% AEP
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

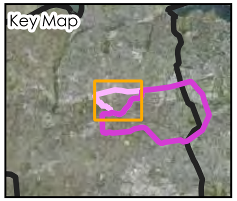
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 92

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MWC_5y_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_5y_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

Whites Creek Base Case 5% AEP
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

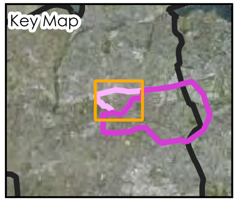
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 93

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MWC_20y_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_20y_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

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Whites Creek Base Case 2% AEP
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

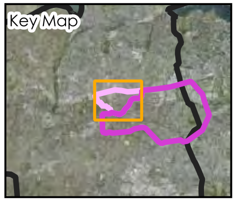
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 94

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MWC_50y_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_50y_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

Whites Creek Base Case 1% AEP
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

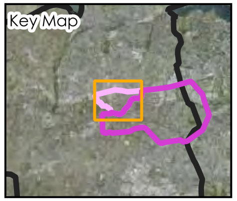
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 95

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MWC_100y_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_100y_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

Whites Creek Base Case PMF
PM6 Pit and Pipes Unblocked

Project: Whites Creek and Johnstons creek FRMS&P

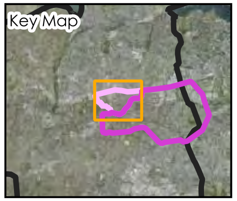
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 96

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Unblocked Drainage
- Blocked Drainage, Now Unblocked

MWC_PMF_PM6-Ext_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_PMF_PM6-Ext_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

40 0 40 80 120 160 m

Scale at A3: 1:5000

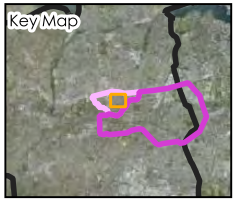
Whites Creek Option - WC1 Overview

Project: Whites Creek and Johnstons creek FRMS&P

Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 97

Legend

- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

13 0 13 26 38 51 m

Scale at A3: 1:1600

Whites Creek Option 20% AEP
WC1 Albany Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

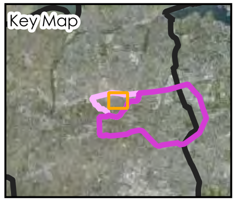
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 98

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MWC_5y_WC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_5y_WC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



DRAFT - Not For Construction

Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

Whites Creek Option 5% AEP
WC1 Albany Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

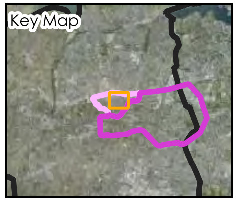
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 99

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MWC_20y_WC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_20y_WC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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References:
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Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

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Whites Creek Option 2% AEP
WC1 Albany Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

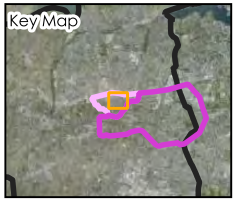
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 100

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MWC_50y_WC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_50y_WC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

Whites Creek Option 1% AEP
WC1 Albany Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

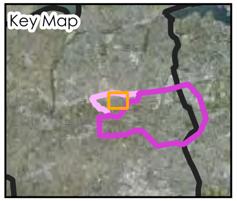
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 101

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MWC_100y_WC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_100y_WC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Notes:
1. Map displayed in EPSG:28356

References:
1. Metro map

Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

Whites Creek Option PMF
WC1 Albany Road Drainage Upgrade

Project: Whites Creek and Johnstons creek FRMS&P

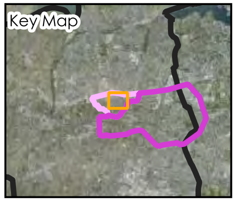
Client: Inner West Council
Project Code: 304600164
Drawn By: AC, Checked By: MG
Date: (2023-12-22)
Figure No: 102

Legend

- MJC Study Area
- MWC Study Area
- IWC LGA Boundary
- Proposed Drainage
- Existing Drainage

MWC_PMF_WC1_v5-PM6_wd
Band 1 (Gray)
- Was Wet, Now Dry
- Was Dry, Now Wet

MWC_PMF_WC1_v5-PM6_WLD
Band 1 (Gray)
- < -0.50
- -0.50 to -0.20
- -0.20 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- > 0.50



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Stantec

16 0 16 32 48 64 m

Scale at A3: 1:2000

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APPENDIX

F

MCA SCORING AND IMPLEMENTATION

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Table - Multi-Criteria Assessment – Scoring System

Category	Criterion	Weighting	Description of Criterion Assessment	Score				
				-2	-1	0	1	2
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0 to 0.25	0.25 to 0.5	0.5 to 1.5	1.5 to 3.0	>3.0
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	Major increase in AAD (>$200,000)	Slight increase in AAD ($200k to $100k)	Negligible Improvement (less than $100k AAD impact)	Slight decrease in AAD ($200k to $100k)	Major decrease in AAD ($>200,000)
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	There are a number of significant factors that pose an impact on the feasibility of the project	There is a single significant factor or multiple smaller factors that pose a potential impact on the feasibility of the project	May or may not be feasible	Likely to be feasible with management of constraints	Very likely to be feasible with no significant restraint
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	Construction timeframe greater than 1 year Project can not be broken down into sequential components	Construction timeframe greater than	Key components can be completed in isolation within 12 months	Overall construction timeframe less than 12 months Minor components can be staged	Construction timeframe less than 6 months Major components can be staged
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	Significantly diminished performance long-term or under climate change	Slightly diminished performance long-term or under climate change	Unchanged performance long-term or under climate change	Unchanged or improved performance long-term or under climate change with minor ongoing costs	Unchanged or improved performance long-term or under climate change with negligible ongoing costs
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	Widespread or significant localised increase in risk to life	Localised or slight increase in risk to life	Negligible change in risk to life	Localised or slight reduction of risk to life	Widespread or significant localised reduction of risk to life
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	Widespread or significant localised impact on evacuation and emergency services	Localised or slight localised impact on evacuation and emergency services	Negligible impact on evacuation and emergency services	Localised or slight improvement for evacuation and emergency services	Widespread or significant localised improvement for evacuation and emergency services
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	Signficiant increase in the frequency of flooding or limitation of the use of a public space or causes significant social disruption	Increase in the frequency of flooding or limitation of the use of a public space or causes social disruption	Negligible impact on public space or social disruption	Reduces the frequency of flooding or provides enhanced use of a public space or causes social benefit	Significantly reduces the frequency of flooding or enhanced use of a public space or causes significant social benefit
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	Strong opposition to the option in multiple submissions	Slight opposition to the option	No response	Slight support to the option	Significant support to the option
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	High negative impact	Slight negative impact	Negligible impact	Some benefit	Considerable benefit
	Impact on Heritage	5%	Impact to Heritage items	Likely impact on State, National, or Aboriginal Heritage item	Likely impact or increased impact on a local heritage item	No impact	Reduces the impact of flooding to heritage item or heritage conservation area	Heritage item no longer flooded

Table - Multi Criteria Assessment Outcomes – Flood Modification Options - Johnstons Creek and Whites Creek

Category	Criterion	Weighting	Description of Criterion Assessment	JC1 – Fowler Street Drainage Upgrade		JC1 – Fowler Street Detention Basin		JC5 – Bridge Road Drainage Upgrade		JC6 – Bridge Road Channel Regrading		JC6– Bridge Road Channel Widening	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	2	BCR = 3.98	0	BCR = 1.12	-1	BCR = 0.27	2	BCR = 3.76	0	BCR = 1.36
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	1	AAD increase $100k-200k	1	AAD increase $100k-200k	1	AAD increase $100k-200k	2	AAD increase >$200k	2	AAD increase >$200k
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingencies such as land acquisition or agreements with external agencies	0	Two utility (Sydney Water Main and Sewer) services crossing proposed option, and close proximity to various other utilities in three areas such as other Sydney Water assets, Sydney Trains HV and NBN though drainage lengths are short. Can be feasible depending on clearance between the channel and utilities or possible relocation.	0	Two utility (Sydney Water Main and Sewer) services crossing proposed option, and close proximity to various other utilities in three areas such as other Sydney Water assets, Sydney Trains HV and NBN though drainage lengths are short. Can be feasible depending on clearance between the channel and utilities or possible relocation.	-2	Long sections of drainage works with close proximity alongside and crossing utilities in multiple locations such as Sydney Water assets, NBN. Can be feasible depending on clearance between the channel and utlitces or possible relocation.	-2	Vocus assets in close proximity running alongside the channel is likely to be impacted due to regrading. Highly constrained channel with residential and commercial buildings on either side. Stabilisation required due to close proximity of buildings to the channel.	-2	Vocus assets in close proximity running alongside the channel will be impacted due to widening. Property impacts up to 3m for multiple commercial lots and buildings, may require stabilisation or demolition. Can be feasible depending on clearance between existing pipes and utilities or possible relocation. Stabilisation may be required due to close proximity of buildings to the channel.
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	2	Construction timeframe less than 6 months, minor drainage upgrades only	2	Construction timeframe less than 6 months, can easily stage the drainage works at different locations and detention basin within Council owned land	-2	Construction timeframe greater than 12 months, large culvert size and various utility coordinations required	-2	Highly constrained channel with residential and commercial buildings on either side. Sydney Water owned channel, approvals required	-2	Highly constrained channel with residential and commercial buildings on either side. Sydney Water owned channel, approvals required. Commercial property acquisitions and stabilization required.
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	-1	Slight reductions in water level in localised H4-H5 spots. Increase to H5 in PMF	2	Significiant decreases in H3 areas downstream with increases in H4-H6 areas due to the detention basin (majority within public open spaces)	1	Slight reductions in upstream H5 along Bridge Rd, with slight increases in downstream H3 areas. Slight increases to H5 in 20% AEP	2	Slight reductions in H5 on Cardigan St in 1% and 20% AEP	2	Significant reduction in H5 on Cardigan St in 1% and 20% AEP
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	-1	Slight and balanced increases and decreases in road corridor. Overall increase across events on Australia Street	1	Slight and balanced increases and decreases in road corridor	1	Slight reductions throughout Bridge Rd and also on Salisbury Rd	2	Reductions in the surrounding road corridor and access to inundated properties	2	Reductions in the surrounding road corridor and access to inundated properties
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	0	Reduced flooding on Camperdown Oval. Some increases to the road corridor	-1	Increased flooding on Camperdown Oval. Also short term closure of Camperdown Oval for drainage works	0	Increases and decreases in road corridor	1	Reductions in the surrounding road corridor	1	Reductions in the surrounding road corridor
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	0	No response	0	No response	2	Noted area of flooding from responses in Flood Study, Council acknowledged area of flooding	-1	Involves Sydney Water Asset in the stormwater channel to be altered. In noted area of flooding from the Flood Study	-1	Involves Sydney Water Asset in the stormwater channel to be altered. In noted area of flooding from the Flood Study
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	0	Potential slight negative impacts (temporary) to nearby trees due to drainage works	-1	Potential slight impacts to threatened mammalia species in Camperdown Oval, nearby trees/parklands due to drainage works	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora
	Impact on Heritage	5%	Impact to Heritage items	1	Reduces the impact of flooding to heritage conservation area. HCA 11 North Kingston Estate Heritage Conservation Area	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 11 North Kingston Estate Heritage Conservation Area	0	Both positive and negative impacts to flooding in different locations within heritage conservation area. HCA 8 Cardigan Street Heritage Conservation Area	1	Reduces the impact of flooding to heritage conservation area. HCA 8 Cardigan Street Heritage Conservation Area	1	Reduces the impact of flooding to heritage conservation area. HCA 8 Cardigan Street Heritage Conservation Area
			Total Score (from -22 to 22	**4**		**5**		**0**		**5**		**3**	
			Total Weighted Score (from -2.00 to 2.00)	**0.35**		**0.50**		**0.00**		**0.70**		**0.30**	

Category	Criterion	Weighting	Description of Criterion Assessment	JC7 – Bridge Road Detention Basin		JC10– Trafalgar Street Drainage Upgrade		JC13 – Gladstone Street Drainage Upgrade		JC14 – Railway Street Road Regrading		JC15 – Probert Street Drainage Upgrade	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	2	BCR = 5.50	-2	BCR = 0.09	2	BCR = 4.00	1	BCR = 2.36	2	BCR = 3.92
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	2	AAD increase >$200k	0	AAD increase <$100k	2	AAD increase >$200k	2	AAD increase >$200k	1	AAD increase $100k-200k
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	0	Vocus assets in close proximity running alongside detention basin. Unlikely for Vocus assets to be impacted within the private property basement carpark. Straightfoward construction method to convert existing basement parking into detention basin. Property acquisition may be required	2	Three utility (Sydney Water Main/Sewer and NBN) services crossing proposed option, may be feasible depending on clearance between existing pipes and utilities or possible relocation. Short drainage length.	0	Crosses Sydney Water Sewer/Main in one location. Likely to be feasible depending on clearance between existing pipes and utilities or possible relocation.	0	Sydney Water Sewer/Main and Sydney Trains HV under the road regrading section and intersection. May be feasible depending on required adjustments to the intersection, existing cover or relocation/increasing cover.	2	Proximity to Sydney Water assets, unlikely to be impacted. Short drainage length
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	1	Straightforward construction timeframe, though property acquisition is required	1	Straightforward drainage upgrade, though approvals may take time due to connection into ARTC culvert under the railway	-1	Drainage upgrades in multiple locations, can be staged	-1	Road regrading will require utility coordination for multiple assets	2	Construction timeframe less than 6 months, minor drainage upgrades only
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	2	Unlike drainage upgrades, this surface flow diversion will provide more lasting flood mitigation in the event of climate change	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	2	Slight reductions in H5 on Cardigan St in 1% and 20% AEP	0	Negligible impact	1	Reductions to H5 areas in both 1% and PMF, widespread reductions in flooding	2	Slight reduction to localised H5 in private properties, diverted flow (increases) in road corridor. Both increases and decreases to H5 in PMF. Reduction in flooding near basement carpark entry	1	Slight reduction to H3 in road corridor only. Some increases to H4-H5 in the road corridor for PMF. Reduced flooding of residential properties
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	2	Reductions in the surrounding road corridor and access to inundated properties	1	Reduction in flooding of roadway	2	Significant reductions in the road corridor at several locations	1	Reduction in flooding near basement carpark entry	1	Slight reduction to H3 in road corridor only. Some increases to H4-H5 in the road corridor for PMF
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	1	Reductions in the surrounding road corridor	1	Reduced flooding of rail corridor and train station, improving serviceability of these services	0	Increases and decreases in road corridor	0	Increases and decreases in road corridor	0	Increases and decreases in road corridor
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	0	Private property impacted. Noted area of flooding from responses in Flood Study, Council acknowledged area of flooding	1	Tying into ARTC assets, reduces flooding of the rail corridor and train station which will be beneficial for ARTC	2	Noted area of flooding from responses in Flood Study, Council acknowledged area of flooding	0	No response	2	Noted area of flooding from responses in Flood Study, Council acknowledged area of flooding
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora	0	Negligible known impacts on fauna and flora
	Impact on Heritage	5%	Impact to Heritage items	1	Reduces the impact of flooding to heritage conservation area. HCA 8 Cardigan Street Heritage Conservation Area	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 17 Kingston South Heritage Conservation Area	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 7 Kingston West Heritage Conservation Area	0	No impact	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 11 North Kingston Estate Heritage Conservation Area (Newtown/Camperdown)
Total Score (from -22 to 22				11		5		9		7		12	
Total Weighted Score (from -2.00 to 2.00)				1.15		0.15		1.05		0.85		1.25	

Category	Criterion	Weighting	Description of Criterion Assessment	JC18 – Kingston Road Drainage Upgrade 1		JC18 – Kingston Road Drainage Upgrade 2 (with upgrades under private properties)		JC20– Lennox Street Drainage Upgrade		JC23 – Clarendon Lane Drainage Upgrade		WC1 – Margaret Street Drainage Upgrade	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	2	BCR = 8.72	2	BCR = 3.91	2	BCR = 3.64	0	BCR = 0.81	1	BCR = 2.12
	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	2	AAD increase >$200k	2	AAD increase >$200k	2	AAD increase >$200k	0	AAD increase <$100k	2	AAD increase >$200k
	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	0	Crosses Sydney Water Sewer/Main in one location, short drainage length. Likely to be feasible depending on clearance between existing pipes and utilities or possible relocation.	-1	Crosses Sydney Water Sewer/Main in one location, short drainage length. Likely to be feasible depending on clearance between existing pipes and utilities or possible relocation. Proposed stormwater pipes under the private properties to be upgraded are Sydney Water Assets.	-1	Close proximity of long sections of drainage and crossing of utilities at multiple locations including Sydney Trains HV, NBN and Sydney Water Mains/Sewer. Through multiple local intersections	2	Crosses Sydney Water Main and NBN, short drainage length. Likely to be feasible depending on clearance between existing pipes and utilties or possible relocation.	-1	Crosses multiple services including Sydney Water assets and NBN at 5 locations including under private properties
	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	2	Construction timeframe less than 6 months, minor drainage upgrades only	-2	works under private properties, acquisition/easement required, Sydney Water asset so relevant approvals will be required.	-1	Long sections of drainage through multiple intersections, can be staged	2	Construction timeframe less than 6 months, minor drainage upgrades only	-1	works under private properties, acquistion/easement required
	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity	0	Climate change may increase frequency of flooding (considering a lifespan of 30-50 years), though this option will help to reduce that flooding severity
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	1	Slight reduction to H3 in road corridor and for commercial and residential properties fronting the intersection	2	Slight reduction H3 in road corridor only and very localised H5 in two properties	2	Slight reduction in H3 in the road corridor (and very localised H5 in small lanes) only. Slight reduction to H4-H5 in PMF	0	Slight reductions to H1 and very localised H2 in low number of private properties	1	Reductions to localised H3. Slight reductions to H5 in PMF
	Emergency Access and Evacuation	10%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	0	Slight reductions in road corridor but H3 only	0	Reductions in road corridor but H3 only	1	Reductions in road corridor but H3 and very localised H5 in local lanes only. Slight reduction to H4-H5 in PMF	0	No impact to road corridor	1	Some reductions on Margaret St but H3 only. Slight reductions to H5 in PMF
	Social Disruption and Public Open Spaces	5%	The impact of the risk management option on social disruption and the use of public spaces	1	Slight decreases in road corridor	2	Decreases in road corridor	2	Decreases in road corridor	0	No impacts to public open spaces	0	Increases and decreases in road corridor
	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	0	Would require tie in to existing Sydney Water asset	-1	Private property and Sydney Water asset impacted	2	a submission noting that road and footpaths on Lennox St are regularly flooded, even during moderate rainfalls and attached a photo from 2 April 2023 showing over flowing drains and gutters.	2	Noted area of nuisance flooding by residents and Council.	0	Private property impacted, however likely support for option for flooding in upper Whites Creek
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	-1	Potential slight impacts to threatened mammalia species due to drainage works	-1	Potential slight impacts to threatened mammalia species due to drainage works	0	Negligible known impacts on fauna and flora	0	Potential slight negative impacts (temporary) to nearby trees due to drainage works	0	Negligible known impacts on fauna and flora
	Impact on Heritage	5%	Impact to Heritage items	0	No impact	0	No impact	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 11 North Kingston Estate Heritage Conservation Area (Newtown/Camperdown)	1	Slightly reduces the impact of flooding to heritage conservation area. HCA 6 Annandale Farm Heritage Conservation Area	0	Both positive and negative impacts to flooding in different locations within heritage conservation area. HCA 5 Parramatta Road Commercial Precinct Heritage Conservation Area
Total Score (from -22 to 22				7		3		10		7		3	
Total Weighted Score (from -2.00 to 2.00)				0.75		0.55		1.10		0.55		0.40	

Table - Multi Criteria Assessment Outcomes – Property Modification and Emergency Management Options

Category	Criterion	Weighting	Description of Criterion Assessment	Property Modification (PM) Options		Emergency Management (EM) Options							
				PM6 - Stormwater System Maintenance		EM2 - Review of Local Flood Planning and Info to SES		EM3 - Community Flood Awareness		EM5 - Flood Markers and Signage		EM6 - Flood Data and Debrief	
				Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment
Economic	Benefit-Cost Ratio	20%	The cost effectiveness of the scheme, i.e. the tangible return on investment	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0	0	BCR = 1.0
Economic	Reduction in Risk to Property	5%	Based on reduction in AAD, it establishes the tangible benefit of an option	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible	0	Unknown impacts on flood damages, conservatively assumed to be negligible
Economic	Technical Feasibility	10%	Establishes the feasibility of options based on likely service constraints, environmental hazards, and programming contingincies such as land acquisition or agreements with external agencies	2	Council would already have a maintenance schedule in place and can consider increasing frequency. However, should be noted that effectiveness of the maintenance schedule of stormwater system is dependent on timing of a rainfall event and may or may not have a significant impact	2	Easy to implement a local flood planning review and allow for sharing of information with NSW SES	1	Depending on the awareness program to be developed, could be some complications with regards to encouraging community engagement with such a program	2	Easy to implement and install flood markers and signage	1	Council should already have a flood data collection scheme. Would need to ensure the availability of Council staff to respond to and record flooding at any time
Economic	Implementation Complexity	5%	Ease of constructability within Council's standard Capital Works Planning	2	Easy to increase maintenance schedule	2	Easy to implement a local flood planning review and allow for sharing of information with NSW SES	1	Depending on the awareness program to be developed, could be some complications with regards to encouraging community engagement with such a program	2	Easy to implement and install flood markers and signage	1	Council should already have a flood data collection scheme. Would need to ensure the availability of Council staff to respond to and record flooding at any time
Economic	Adaptability and long-term performance	10%	The impact the option will have both in terms of feasibility, benefits and cost over the life of the option, and adaptability to climate change conditions	0	No impact of adaptibility of maintenance to climate change conditions	2	Minimal ongoing costs for review. Review can be revised to consider climate change impacts in the future	1	Ongoing costs to maintain the flood awareness program, however following initial engagement ongoing information should be more straightforward. Can be adapted to climate change	2	Minimal ongoing costs for flood markers and signage. Signs can be altered to account for climate change if necessary, however unlikely to be needed	2	Ongoing costs will be variable based on flood event occurrence. Climate change should not significantly influence scheme
Social	Reduction in Risk to Life	15%	The impact on risk to life from the 20% AEP up to the PMF event	1	Increased frequency of stormwater system management may or may not have an effect depending on timing of a rainfall event. Modelling results showed relatively significant impacts in parts of WC & JC study area.	2	Providing information to SES will assist them in their planning and consequently reduce risk to life	2	Expected reduction in risk to life through better responses of majority of residents	1	Expected reduction in risk to life through residents not attempting to enter floodwaters	0	Negligible direct impact on risk to life
Social	Emergency Access and Evacuation	10.0%	The impact on the ability to evacuate or for NSW SES or emergency services under extreme flood conditions	1	Increased frequency of stormwater system management may or may not have an effect depending on timing of a rainfall event. Slight benefits if a rainfall event occurs right after scheduled maintenance	2	Providing information to SES will assist them in their planning	2	A flood aware community will limit the number of instances of residents entering floodwaters	2	Will assist residents and the NSW SES identify depth of flooding for some crossings on evacuation routes	0	Negligible direct impact on emergency access and evacuation
Social	Social Disruption and Public Open Spaces	5.0%	The impact of the risk management option on social disruption and the use of public spaces	0	Near neglible social disruption of residences with more frequent maintenance, no impact on open space or increase in flooding.	0	No direct impact on social disruption or public open space	2	Improved community awareness seen as a social benefit	0	No direct impact on social disruption or public open space	0	No direct impact on social disruption or public open space
Social	Community and Stakeholder Support	10%	Support for the option based on FRM Committee meeting, stakeholder engagement and community consultation outcomes	1	Two responses received during community consultation requesting more frequent stormwater maintenance. Supported by Council engineers	1	NSW SES confirmed support for continued data provision in light of Flood Plan development	1	NSW SES supports the development of a Council led flood awareness program	1	NSW SES supports the development of this measure. Would require TfNSW agreement for signage on major TfNSW roads	1	NSW SES supports continued flood debrief and recording of information
Environment	Impact on Fauna/Flora	5%	Likely impacts on Threatened Ecological Communities and Threatened Species	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact
Environment	Impact on Heritage	5%	Impact to Heritage items	0	Several heritage sites within catchment, negligible impact would be expected from stormwater maintenance	0	Negligible impact	0	Negligible impact	0	Negligible impact	0	Negligible impact
			Total Score (from -22 to 22)	**7**		**11**		**10**		**10**		**5**	
			Total Weighted Score (from -2.00 to 2.00)	**0.65**		**1.10**		**0.95**		**0.95**		**0.45**	

From: Gisele Mesnage
To: "Clr Jessica D"Arienzo"
Cc: "Clr Mark Drury"
Subject: Keep the Kerbs....support for your notice of motion
Date: Wednesday, 27 March 2024 12:49:06 PM
Attachments: Dementia_planning_Expanding_accessibilit-1.pdf
ls_inclusivedesign_continuousfootways_main.pdf

Dear Clr Jessica D'Arienzo,

I was heartened to read that at its March meeting, the Inner West Council approved 11 new zebra crossings in the surrounds of the Cardinal Freman Village.

A special note of thanks to you and Clr Mark Dury for spearheading the motions that led to this amazing outcome.

I write now to support your notice of motion for Council to work with the organisation Better Streets to host a community forum to identify user needs and workshop design solutions to ensure that the design of any new crossings in our LGA meets the needs of all users.

Such a forum could include the Council's LTC, Guide Dogs NSW/ACT, Vision Australia, wheelchair users groups and other disability groups, health professionals, and other stakeholders with an interest in inclusive design for walkability.

As a blind pedestrian, I am especially concerned by the trend of removing kerb ramps at pedestrian crossings so that the footpath is at level surface with the roadway.

I understand that the idea is to create a "continuous footpath", so to reinforce pedestrian priority.

However, these continuous footpaths where I can't tell when I move from the footpath to the roadway make me feel very unsafe when walking with my guide dog, Nyota.

Guide dogs are trained to guide their handler to traffic light poles or kerb ramps, and the handler then feels the kerb ramp underfoot to detect the edge of the roadway and line up with the crossing. It is the handler, not the guide dog, who must make the call when it is safe to cross.

The placement of strips of Warning Tactile Ground Surface Indicators (WTGIs)in leu of kerb ramps do not provide an adequate safeguard in such scenarios, regardless of whether the vision impaired pedestrian uses a guide dog or a white cane or a technology device as a mobility aid.

I attach 2 relevant recent studies for your attention. One study relates to the user experiences of blind and vision impaired pedestrians and the other those of pedestrians with dementia.

The Inner West Council has an opportunity to take a lead here in developing inclusive pedestrian crossings and walkable pathways in our community that could be shared with other LGAs and even globally.

Go well,

Gisele and Nyota

BY SAMANTHA BIGLIERI

DEMENTIA + PLANNING:

EXPANDING ACCESSIBILITY THROUGH DESIGN AND THE PLANNING PROCESS

SUMMARY

Contrary to popular belief, over two thirds of Canadians with dementia live in the community as opposed to congregate living. This begs a question that has not been adequately explored in planning practice or academia: How can we as planners who deal with land-use, community design, and public consultation every day, understand and meet the needs of people with dementia (PWD), who are citizens just like everyone else? After examining existing work on the relationship between the built environment and PWD, I argue a dementia-specific approach to planning practice and research is needed in the Canadian context.

RÉSUMÉ

Contrairement à une idée reçue, plus de deux tiers des Canadiens atteints de démence vivent au sein de la collectivité et non dans des habitations collectives. Cela nous amène à nous poser la question suivante, qui n'a pas suffisamment été étudiée dans la pratique et dans le monde universitaire de l'urbanisme : à titre d'urbaniste, nous gérons au quotidien l'aménagement du territoire et des collectivités, ainsi que des consultations publiques, que pouvons-nous faire pour comprendre et répondre aux besoins des personnes atteintes de démence, qui sont des citoyens comme les autres? Après avoir étudié les travaux déjà réalisés sur le rapport entre l'environnement bâti et les personnes atteintes de démence, j'avance qu'une approche de la pratique de l'urbanisme axée sur les personnes atteintes de démence est nécessaire au Canada.

Imagine you have lived in the same neighbourhood for the majority of your life. One day while out for a walk in your community, you realize that you have forgotten which street to turn at because most of the intersections in your community look the same. You get lost and don't remember how to get home. You feel anxious, frustrated, and disorientated. This is a common experience for Canadians with dementia. Dementia is an umbrella term used to describe a set of symptoms which affect memory, communication, ability to focus, reasoning, judgment, visual perception, and navigation. It is caused by over 100 conditions and diseases, the most common being Alzheimer's disease.[1] The World Health Organization calls dementia "the leading cause of dependency and disability among older persons in both high-income countries and low to middle income countries."[2] Globally, it is estimated that 47 million people currently live with dementia and this number will rise to 115.4 million by 2050.[3] In Canada, there were 747,000 people with dementia in 2011, and there will be 1.4 million by 2031.[4] At the local level, projections in Ontario suggest that suburban municipalities are expected to see the greatest increase in the number of people with dementia (PWD) from 2011-2032 of 250%–270%, compared to the provincial average of 170%.[5] The costs associated with care was $33 billion in 2011 alone, and is projected to rise to $293 billion by 2040 if nothing is done to change the current system.[6]

While many people believe that most PWD live in congregate living, Canadian estimates show that up to two thirds live at home in the community.[7] Combined with the overwhelming desire to age-in-place, this begs the question: what role does the neighbourhood play in the lives of PWD? Furthermore, how can we, as planners who deal with land-use, community design, and public consultation every day, understand and meet the needs of PWD, who are citizens just like everyone else? I believe that a dementia-specific approach to planning practice and research is needed. Such an approach would encompass three interrelated processes: (1) building an evidence base for best practices in design; (2) altering the planning process to being accessible to PWD; and (3) changing the perceptions of PWD by planners and city builders.

Research suggests that for PWD, being enabled to use their neighbourhood provides a sense of freedom and autonomy, dignity and a sense of worth, physical exercise, psychological wellbeing, and social interaction.[8] As we age, our conceptual and physical access to the world shrinks. One study of the mobility of older adults in Israel demonstrated that, on average, an older adult without dementia travelled approximately 1.5km from their home, while an older adult with mild dementia only travelled 400m. Surprisingly, the research on the relationship between the built environment and PWD is scarce, and so far, has only been based in Europe.[9] Policy approaches like age-friendly cities, dementia-friendly cities, and universal design, while good starting points, are insufficient in understanding how PWD experience their cities, and the role of land-use planning and design.[10] We have to find out what may enable or disable PWD in their neighbourhoods in order to build a context-specific evidence base for policy recommendations. Just as we know those in wheelchairs require ramps to access buildings, we have to find out what are the *cognitive ramps* for PWD in our built and social environments.[11]

While the needs of PWD and older adults often intersect, their needs are not identical, indicating the necessity for dementia-specific work. Seminal research from the UK offers 17 recommendations for land-use and urban design, which fall within three overlapping groups: urban design for comfort and safety, walkability and land-use strategies, and wayfinding. Wayfinding in particular is not typically discussed in research on older adults[12] (**Figure 1**).

Item 45

Attachment 4

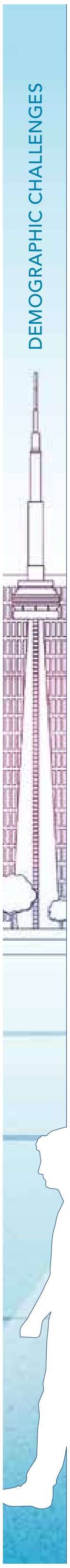


FIGURE 1 – SUMMARY OF DEMENTIA-SPECIFIC DESIGN RECOMMENDATIONS

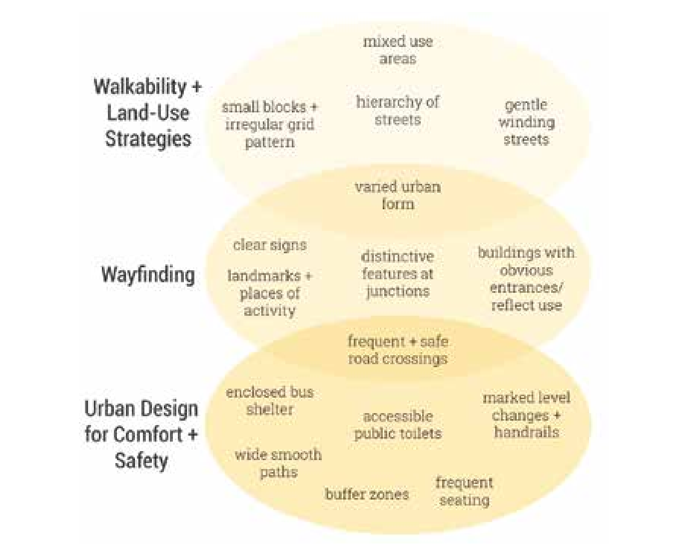
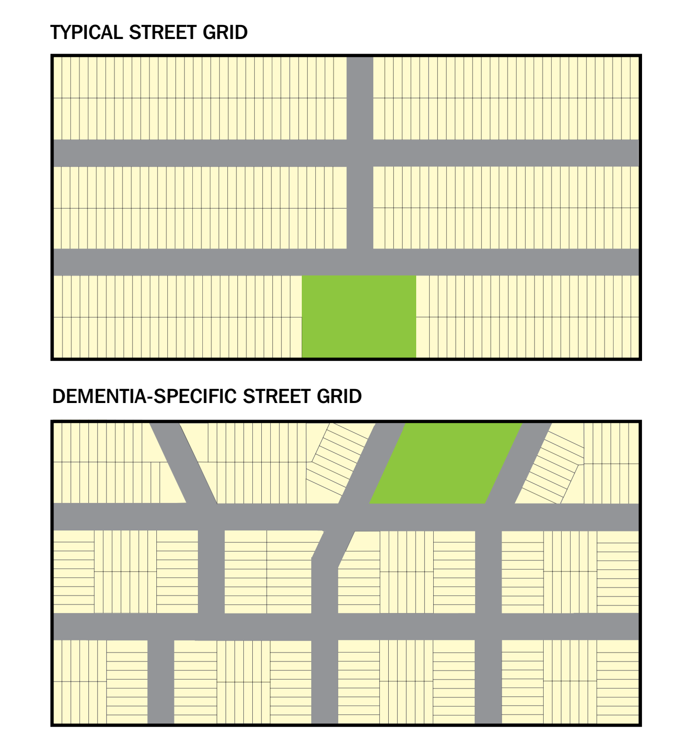


FIGURE 2 – TYPICAL VS. DEMENTIA-SPECIFIC STREET GRID



The issue of wayfinding is important. The status quo method of building a new suburb is to use one style of house with a few small variations with identical crossings and features throughout the development. Even if you are able-bodied, you may have become lost in a suburb before, as everything tends to look similar. As Lynch discussed several decades ago in *The Image of the City*, human beings have navigated using landmarks since the beginning of time, and people today use comparable strategies. PWD rely on landmarks to situate themselves, and those in a monolithic suburb will probably be at a greater disadvantage than someone living in a neighbourhood with recognizable differences. Based on the study in the UK, municipalities could encourage the following to improve the built environment for PWD:

- **A short, irregular grid pattern of streets** to create identifiable intersections and allow residents to visualize their travel path, and provide multiple routes for wayfinding (**Figure 2**);
- **Streets with ample space for pedestrians,** with no drastic changes in colour (which can be perceived by PWD as holes in the sidewalk), and with wide buffer zones between pedestrian paths, cycling paths and roads;
- **Variated architectural styles within the same development, mixed land-use, designs incorporating diverse styles of street furniture, public art, and vegetation** in order to vary the landscape and provide unique landmarks for improved navigation;
- **Improved wayfinding signage** that uses textual information ('5 minute walk to the library') and realistic photos (instead of icons, which can create confusion) (**Figure 3**);
- **Development of memorable landscape features, open public squares, and community facilities** that promote social interaction and foster a sense of belonging.[14]

All 17 of these recommendations when applied to greenfield development were found to be economically feasible, achievable within current Ontario planning frameworks and each supported by at least one peer reviewed study.[15]

In addition to the need to build evidence for what those *cognitive ramps* may look like, there is a strong potential role for planning to enable PWD to exert their power as citizens through the planning process, and to combat the intense stigma that surrounds a diagnosis of dementia. Activists suggest that PWD be considered as people with a disability, with rights to be accommodated.[16] They problematize the negative stigma and demeaning language PWD face, advocate research with PWD rather than only their caregivers or healthcare providers, and reject the idea of 'prescribed disengagement.'[17] Invitation of PWD into the planning process in a meaningful accessible way has the potential to serve as a disruptor to these overarching narratives, by enabling PWD to assert their right to shape their city as a citizen.

There has been a recommendation to the United States government from scholars, to expand the studying of PWD from health and social care to that of urban planning and community development.[18] It is pertinent that all levels of government consider the role of the neighbourhood when developing policy strategies for PWD. While the built form interventions mentioned in this article are a good starting point, it is important to note that they are based on a singular study in the UK. There is a need for research in the Canadian context.

As planning professionals and scholars, we have to look beyond accessibility as solely based on physical or sensory impairments. We have to think about how people with cognitive impairments or intellectual disabilities experience the places they live in, by asking them personally. We have to explore not only how to do this through physical design, but also how to adapt our consultation practices to their preferences and needs. Researchers and planners on the ground need to work together with PWD to help determine best practices in the years to come.

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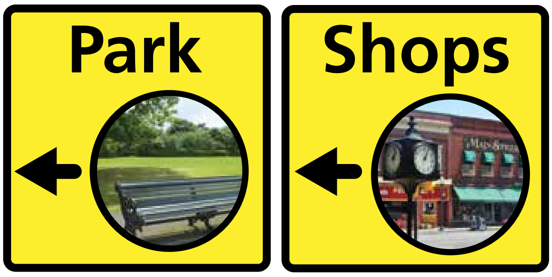
FIGURE 3 – DEMENTIA-SPECIFIC WAYFINDING SIGNAGE



(Endnotes)

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11 The term *cognitive ramps* is a metaphor from Dementia Alliance International member Peter Mittler, from: Graham, J. (2017, March 10). Don't write us off: People with dementia press for more rights – and respect. *StatNews*. Retrieved from: https://www.statnews.com/2017/03/10/dementia-human-rights

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15 Biglieri, S. (2015). *Building a dementia-friendly neighbourhood: An examination of the economic costs of implementing 'dementia-friendly' urban design and land use strategies in Whitby, Ontario* (Major Research Paper). Ryerson University, Toronto, ON.

16 Lin, S. Y., & Lewis, F. M. (2015). Dementia friendly, dementia capable, and dementia positive: concepts to prepare for the future. *The Gerontologist*, 55(2), 237-244.

17 A term coined by Swaffer (2014) to refer to the tendency of doctors when giving a diagnosis of dementia to encourage patients to 'get their lives in order' and begin retreating from their lives. Swaffer (2014)

18 Lin, S. Y., & Lewis, F. M. (2015). Dementia friendly, dementia capable, and dementia positive: concepts to prepare for the future. *The Gerontologist*, 55(2), 237-244.

Inclusive design at continuous footways

OCTOBER 2023

LIVING
STREETS

This report has been produced as part of the Living Streets project “Inclusive Design at Bus Stops and Continuous Footways”. This project is funded by the Scottish Road Research Board (Transport Scotland) and Department for Transport.

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We are Living Streets, the UK charity for everyday walking.

We want to create a nation where walking is the natural choice for everyday, local journeys; free from congested roads and pollution, reducing the risk of preventable illnesses and social isolation. We want to achieve a better walking environment and to inspire people of all generations to enjoy the benefits the simple act of walking brings.

By ‘walking’, we include wheeling.

livingstreets.org.uk

Document version 2.12.3

Acknowledgements

David Spaven, external editorial support

Illustrations (e.g. Figures 6, 16, 18, 25, 26, 28) © Jenny Elliott

We convened a project Reference Group to provide advice and ideas. We'd like to thank its members who are listed below:

Karen Russell, Transport Scotland
Alan Oliver, Transport Scotland
Fiona O'Neill, Department for Transport
Sally Gibbons, Department for Transport
Paul Cronin, Sustrans Scotland (2021-22)
Will Haynes, Sustrans (2023)
Susan Fulton, Mobility and Access Committee Scotland (MACS)
Suzanne Forup, Walk Wheel Cycle Vote
Professor Eva Heinen, University of Leeds (2121-22)
Rurigdh McMeddes, City of Edinburgh Council / SCOTS
Stacey Monteith-Skelton, City of Edinburgh Council / SCOTS (2021-22)
Professor John Parkin, University of the West of England
Caroline Stickland, Transport for All
Sue Sharp, Disabled Persons Transport Advisory Committee (DPTAC)

This report is the work of Living Streets, and the findings it describes are not necessarily endorsed by those listed above, nor any organisations they represent.

Disclaimer

Our remit was to answer the broad question: do bus stop bypasses and continuous footways lead to people being excluded from use of the streets (and bus services), and what would make them more inclusive? We have responded to the challenge by seeking to clearly describe the infrastructure (its key characteristics), desired outcomes, and the user experience for people who walk, wheel, cycle or drive. From the beginning, our underlying assumption has been that if infrastructure excludes people or exposes them to increased road danger then it is not performing well.

This infrastructure is being introduced partly in response to national policy objectives to increase levels of cycling and walking. While clearly the product of a policy environment, the observations, conclusions and recommendations in this report are not a definitive statement of Living Streets' position on bus stop bypasses or continuous footways. In submitting the findings to a wider audience, we hope that this is just the beginning of a much bigger conversation about what changes are needed to make streets more inclusive.

Contents

Executive summary

This work is an in-depth investigation relating to the use of continuous footways. It was prompted by questions around whether these make streets more or less inclusive, and whether particular design features make a difference.

To answer these questions, we used a multi-threaded approach over a project spanning two years. This brought together hard data, softer evidence of real-life behaviours, and learning from literature, consultation, focus groups, and interviews. Initial findings were refined through consultation with people with a range of differing views. The result is a set of conclusions which point to a complex and nuanced situation.

The initial report sections and accompanying appendices present the separate elements of evidence and threads of work that support our findings. The "Discussion of core findings" section of the report brings these together, covering the following issues in depth:

Key conclusions

Key points in the discussion include that:

- There is a very high level of confusion over what is and what is not a continuous footway, how they should be designed, and what their use aims to achieve
- Many of the designs being called continuous footways in Britain do not convincingly continue the footway
- Most of the designs being called continuous footways in Britain do not provide high levels of pedestrian priority
- The use of these designs can create problems not just for some disabled people, but for a wider group
- It can be seen that higher levels of pedestrian priority can more easily be established where there are fewer vehicles, travelling at much lower speeds
- Structures used in other countries to create continuous footways are also used on footway crossovers (private entrances across a footway), creating a more inclusive design than is used at many British footway crossovers
- What in this report we call "real" continuous footways, which unambiguously continue the footway, might be more effective in prioritising pedestrians.

Key design features/limitations

We argue that the unambiguous continuation of a footway, in a "real" continuous footway, will not be sufficient to ensure pedestrian priority, safety, and the inclusivity of a design. We outline, in addition:

- A set of necessary design features
- A set of limits on where continuous footways could successfully be used.

We provide details on the need for:

- The use of physical features which force only low vehicle speeds at the continuous footway (we propose "walking pace" as a rule of thumb)
- Low levels of vehicle use of the side road, and the prevention of simultaneous two-way vehicle movement in and out of the side road
- Appropriate conditions on both the side road and main road (which we describe).

Use of tactile paving

Some discussion around the use of continuous footways has focused on whether tactile paving should be used, and how this should be laid out.

Recommendations are made complex because they must account for:

- The current use of the term "continuous footway" to refer to very different infrastructure designs, used in quite different situations
- The current use of designs which fail to provide high levels of pedestrian priority
- The equivalence of continuous footways and footway crossovers, in practical terms, in situations where there is very low vehicle use and speed
- Questions about future use at "real" continuous footways, where there would be low vehicle use, very low speed and unambiguous pedestrian priority.

We recommend the retro-fitting of standard tactile paving where designs mean pedestrians are not being provided with unambiguous priority, and where they need to respond to risks from vehicles to maintain their safety.

We describe a more complex set of factors to take account of in relation to the use of tactile paving in other situations. Some of these relate to broader navigational challenges, not only questions about pedestrian priority.

We suggest alternatives to standard arrangements could be trialled at sites providing unambiguous pedestrian priority, where/when these exist, as part of a programme seeking a nationally standardised approach.

Building trust

We observed that to some extent designers and organisations representing disabled people might share overall objectives, while being divided into two different camps, with a lack of connection of knowledge-sharing being a significant problem.

It was evident that many concerns about current designs were valid, and have not been sufficiently heeded. However, it was also evident that there is a real risk that opposition to more radical change, from those who have experience of their needs being ignored, may help to entrench the status quo of traffic dominance and low pedestrian priority, making good quality changes less likely.

We recommend that those interested in progress and on improving conditions for pedestrians should build allegiances, connections, and real in-depth knowledge, lessening the divide between designers focused on implementing changes and organisations representing disabled people concerned about them.

The need for wider reform of streets

Overall this work points to some bigger questions around how streets should be designed.

We suggest that the successful use of continuous footways, and the success of many alternative means to improve conditions for pedestrians, will depend on a greater level of reform of our streets.

1 Introduction

This report sets out the results of research carried out by Living Streets into continuous footways. These can be described as *infrastructure designs intended to provide enhanced priority for people walking and wheeling*[1] *by continuing the footway (i.e. the pavement) of a bigger road over the end of a smaller side road.* However, as we shall see, there is much confusion over what is, and what is not, a continuous footway.

The work was funded by the Scottish Road Research Board, Transport Scotland and Department for Transport, starting in 2019 and concluding in May 2023.

Some people and organisations believe that changing the design of a side-road junction, from a more traditional British design into one including a continuous footway, improves conditions for pedestrians. Others disagree, suggesting that continuous footways make streets more difficult to use for disabled people. The research project studied whether continuous footways make streets more inclusive or less inclusive, why they might do so, and what might make the difference between one and the other.

Design guidance is inconsistent in describing continuous footways or provides alternative names for situations where the footway continues. With this confusion in mind, the project studied a wide range of designs in a wide range of locations. We suggest changes to ambiguous designs and make recommendations for the future use and testing of designs that try to create unambiguous continuations of the footway – whether at small private entrances or on somewhat wider entrances or on public roads.

As part of the wider project, we also studied related questions about bus stops where there is a cycle track, and the results of this work are covered in a separate report.[2] Whilst these types of infrastructure are very different, they are associated with one another in some places, and in both cases the research was investigating similar questions around inclusion and accessibility for pedestrians.

[1] Some literature also focuses on how continuous footways support the provision of cycle tracks
[2] Titled 'Inclusive design at bus stops with cycle tracks'

SUMMARY OF RESEARCH PROCESS

To ensure the integrity of our work and to support our access to a wide range of knowledge and expertise, we:

- Regularly consulted a “Reference Group” in which we brought together experts in design, disability, inclusion, and research (membership is listed inside the front cover)
- Worked with the disabled persons organisation “Transport for All” (which was also part of the Reference Group). Transport for All led our engagement and site-visit work with disabled people, and took part in key informant interviews, helping us to analyse these
- Took emerging findings back to people who had been engaged in the research (and three organisations not previously involved) to check these, our reasoning, our understanding, and the way in which we were explaining ourselves.

We used what we have called **a “multi-threaded” approach** in carrying out the research. The need for such an approach arose because:

- Most of the questions we were asking were complex
- Crucial factors around inclusion and exclusion, like how fearful people are, or how they might behave if less fearful, cannot easily be quantified
- It was important to try to understand whether different designs, which do not currently exist in the UK, might work in future – without being able to test these
- We could not observe the experiences of people who had already been excluded by unacceptable designs and thus who were not present
- We needed to understand how infrastructure might exclude people, but it would have been unethical to ask people who felt they were unsafe using infrastructure to do so in order that we could test how much this put them at risk.

The advantage of this approach is that we could bring together learning from across the wide range of ‘threads’ in our work. However, it should be emphasised that this makes reporting back on the field work, analysis, conclusions and recommendations inherently complex. By way of example, there is some overlap in the main threads (and associated report sections and sub-sections) as these are summarised in the bullet points below. For instance we spoke to two key groups of people with relevant professional roles throughout the project: “design-orientated informants” and “user-orientated organisational representatives” (e.g. representatives of the organisations RNIB and Guide Dogs), and some of these people sit simultaneously in both groups. Practically it was one set of interviews, but in terms of reporting on our findings it made sense to separate these sub-threads. (Together we describe these groups as “professional informants” to distinguish these people from the individual members of the public we worked with.)

Details can be found in subsequent sections but, in summary **the main threads** of research comprised:

- A literature review (see Section 3)
- Mapping and recording existing British and foreign continuous footways using a GIS system (see Section 4)
- Structured interviews (and further work) with professional informants (see Section 5)
- Work with disabled people (as individual members of the public) using focus groups and site visits (see Section 6)
- Unstructured in-person study of a wide variety of continuous footways
- Detailed-study site work comprising (i) in-person study of 10 continuous footways, using both structured techniques and less formal approaches and (ii) analysis of behaviours at these sites using fixed-cameras (alongside shorter segments of video footage taken by researchers), supported by the use of artificial intelligence processing (see Section 7).

As an important final stage in the research, we consulted on a summary document that described the conclusions we were drawing from the work. We distributed this to most of those who had previously been consulted or interviewed and ran two consultation workshops with mixed groups of these participants, also inviting feedback and comments by email. At this stage we also met and sought feedback on emerging findings from several other relevant bodies, including specialist consultancy companies and Active Travel England.

Figure 1 on page 9 provides a simplified schematic showing the threads, and key elements of the work within each thread.

This approach means that we have been able to bring together hard data, softer evidence of real-life behaviours, and learning from literature, consultation and interviews. The result is a set of wide-ranging conclusions presented in a narrative form. Because of the depth of the work, important details on problems and solutions are found throughout the report (in particular in the Discussion of core findings section – Section 8) and in the Appendices; however the main Conclusions and Recommendations are summarised in the final section.

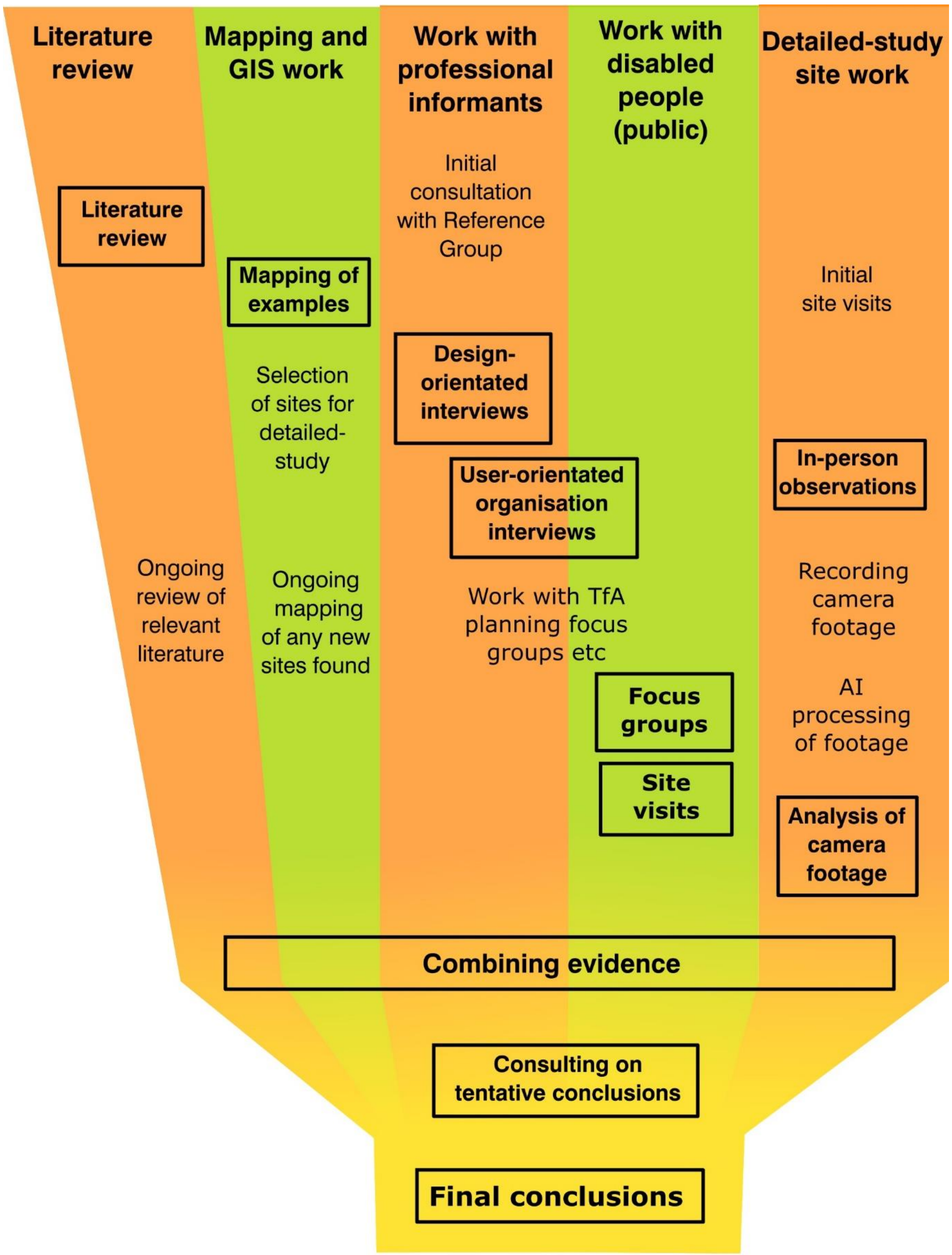
ACCOMPANYING DOCUMENTATION

Accompanying this main report, as separate documents, are:

- Appendix 1, providing information about detailed-study sites and the results of work on these
- Appendices 2-4, providing more information about the challenges involved in studying pedestrian-vehicle interactions, information about ramps, and a summary of proposed limits on the use of continuous footways.
- A literature review.

There is also a separate report ("Inclusive design at bus stops with cycle tracks") which presents the results of the parallel study of bus stops and cycle tracks (including "bus stop bypasses").

Figure 1: Diagram illustrating threads in the multi-threaded approach



2 Definitions and language

We have aimed this document both at those with technical knowledge about street design, and at the wider range of interested parties. A small number of technical terms are used throughout the text, along with some names we have chosen to refer to specific elements of infrastructure, as outlined below.

A “**footway**” is an area for pedestrians associated with a carriageway - commonly called “the pavement”. A “**carriageway**” is the area of a road or street intended for vehicle movement.

Mirroring the way in which we have found the term “**continuous footway**” is currently used, in the report we use it to refer to a broad range of situations, some of which only provide an *ambiguous* area in which it is unclear what is footway and what is carriageway (thus making it unclear whether the footway continues). In order to draw a distinction between these and designs that *unambiguously* continue the footway we refer to the latter as ‘**real’ continuous footways.**

When referring to ambiguous designs in which it is not clear whether or not the footway continues, we use the phrase “**drivable space**” to mean the area available for both pedestrians and vehicles.

Typically a side road junction is understood to be between a main road which is larger or carries more traffic, and a side road which is smaller or carries less traffic. We studied some junctions with continuous footways where this difference in status/size was not obvious – or where both roads were relatively unimportant. For simplicity, in referring to the prioritised road we use the term “**main road**” throughout the report (and corresponding phrases like “**main carriageway**”), even to refer to these quieter less-significant roads.

We use the phrase “**side road entry treatment”** to describe a broad range of designs in which there is a change to the surface of the carriageway of a side road at its junction with a main road. We use the phrase “**raised side road entry treatment**” where a side road entry treatment brings the carriageway of the side road to footway height (but does not continue the footway).

The term “**footway crossover”** is used to refer to situations where a footway continues over a smaller private entrance, such as to a single private driveway, yard, petrol station, or car park. These are sometimes called “vehicle crossovers” or simply “crossovers”. Later in this document we discuss the close relationship between footway crossovers and continuous footways.

The term “**cycle track**” refers to situations where an area is provided specifically for cycling, which is physically separate both from the carriageway and the footway (whereas a “**cycle lane”** is marked on the carriageway). Occasionally we use the word “**bicycle**” because this is familiar, when a more accurate title for the range of bicycles, tricycles, and adapted wheeled devices used for cycling would be “cycle”.

“**Pedestrian”** refers both to people walking and those using wheeled mobility aids such as a wheelchair or mobility scooter.

We use the words “**inclusion**” and “**exclusion**” (and associated terms such as “inclusive”) as shorthand to refer to the way in which design (and wider factors) can make the use of streets easier and safer, or more difficult or impossible for disabled people.

We heard from disabled people who themselves preferred that we wrote about “disabled people” or “blind and partially sighted people” in line with the social model of disability. However, some participants preferred terms like, “people who are blind or partially sighted”. This is a sensitive issue, so we hope that readers will accept that we have chosen one option rather than the other in good faith, and in seeking consistency across the reports, whilst acknowledging the diversity of views on this topic.

3 Literature review summary

At an early stage in the research we conducted a literature review. A full report of this is provided separately, but the key points are summarised below.

For the review we studied formal infrastructure guidance on continuous footways, informal literature, research, and policy documents. The principal focus was on UK literature but, because it has been suggested that UK designs are inspired by those in the Netherlands and Denmark, we also looked at key documents from these countries.

TERMINOLOGY, PURPOSE, AND LEGISLATIVE BACKGROUND

We confirmed that there is significant inconsistency in the terminology used across these documents, and that design guidance differs on key details. However, there is agreement in UK design-orientated literature that continuous footways can be used to prioritise the movement of either pedestrians, or of cyclists (if combined with a cycle track). We noted that many documents only suggest benefits for one of these groups, omitting mention of the other.

Welsh guidance refers to what it calls “blended side road entry treatments” and suggests that at these “the continuous footway strongly indicates to drivers that they should give way to pedestrians using the footway”. The Chartered Institute of Highways and Transportation suggests that at “blended junctions”, “drivers are expected to give way to pedestrians and negotiate the crossing of the footway as they would if using an access to a private site”. Local Transport Note 1/20 (usually known as LTN 1/20), in relation to the use of continuous footways[3] beside cycle tracks, specifies that options providing “design priority” exist so that “cyclists can cross the minor arms of junctions in a safe manner without losing priority.”

Our research confirmed that the situation in the UK is complex regarding rules and legislation which might affect the provision of continuous footways. Continuous footways are *not* covered in the Highway Code, but related expectations around driver behaviour are. We contrast this with the clear and consistent situation, in relation to “exit construction” designs, described in Dutch guidance and in wider Dutch literature – and in their road-use rules.

[3] LTN 1/20 uses the term ‘continuous footway’ only once, but relevant designs are shown in the document (see literature review for details)

EFFECTIVENESS

We found two key UK-focused research reports on designs that are described as providing continuous footway. These highlight a situation where behaviour varied greatly across different sites, with some sites showing improved behaviours, but with most showing a situation in which a significant proportion of drivers do not give way to pedestrians.

The research by the University of the West of England[4] (UWE) recorded rates of "forced yield" – where drivers forced pedestrians to give way to them – varying from none through to 37%. The authors conclude:

> "There are implications for the design of continuous footways arising from the research. Overall, designs need to aim at creating a situation where the [number of occasions that the] turning vehicle driver does not give way are negligibly small. In circumstances where the driver does not give way, the design should ensure that the vehicle speed has to be low such that contact between different road users can be avoided by the driver. These conditions can be achieved by the principles of having: distinctive difference in paving material between the carriageway and the continuous footway in all lighting conditions; ensuring distinctive height difference across the whole continuous footway that is not compromised by the effects of longfall and crossfall[5]; clear separation of cycleways from footways; ensuring well maintained and unambiguous road markings; having radii and height difference that create low motor vehicle speeds; maximising inter-visibility between all road users."

The study also noted that there appeared to be very little agreement between the predictions made by their key informants (who were designers and other experts) and the actual performance of the sites they studied. At one badly performing site, they recorded that pedestrians were forced to yield in 37% of all interactions. Three of the key informants had predicted that this site would perform well, and two had predicted it would perform badly.

All the sites in this study lacked at least two critical design features identified in the research, and most were more problematic (see Table 2 in Section 6.5 of the literature review).

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[4] J. Flower, M. Ricci and J. Parkin, "Evaluating the effectiveness of continuous side road crossings," Centre for Transport and Society, University of the West of England, Bristol, 2020 (see literature review)

[5] 'Longfall' describes a street going up or downhill whereas 'crossfall' is slope toward or away from the centre of the street.

The study concludes that "more examples of good practice continuous footways should be constructed to enable further study of which design factors and flow patterns work best."

LESSONS FROM OUTSIDE THE UK

The project looked for research on the design, functioning, and safety of continuous footways outside the UK.

We could see from less formal literature that Dutch "exit constructions" (which create a continuous footway across an entrance or exit) are a key inspiration for continuous footways in Britain. It also confirmed that these exit constructions have been in use for many decades. Later in the project some designers spoke about taking inspiration from other countries, but our mapping work confirmed that that these designs are only a standard feature of Dutch infrastructure and in most other countries occur rarely.

There appears to be little published research, even in Dutch literature.

What was evident in Dutch literature was that exit constructions are a well-defined element of infrastructure, with a legal definition, a standardised design, and with direct effects on the rules for drivers written into road use regulations. That design includes the use of "entrance kerbs" (in Dutch "inritbanden"), a lack of visible corner radii, the absence of paint markings (i.e. to indicate priority), and the continuity of the footway level and surface.

The little Dutch research we could locate suggested that consistency in design and compliance with national guidance was important if these were to be as safe as junctions with a marked priority.

Dutch research also suggested that the use of exit constructions could best be justified not as a local measure to improve safety at individual junctions but as part of the more significant area-wide changes resulting from their "sustainable safety" policy. It was evident that exit constructions are seen as having a very well-defined role within the wider design framework mandated through this programme (which is a national systemic safety programme): focusing on its effect in producing a gateway to clearly mark the transition between two visually and functionally distinct classes of street, which are specifically (i) those carrying traffic through an area, and (ii) local access streets.

In formal UK literature we found little or no mention of any vision for using continuous footways as a design element in this kind of wider systemic safety approach.

EVIDENCE ON INCLUSION/EXCLUSION

We looked for written accounts of opinions on whether continuous footways have effects on how inclusive[6] British streets are, and for supporting evidence. There is considerable anecdotal evidence, rather than systematic studies, which suggest there may be problems for blind and partially sighted people.

Although there was some limited design guidance on tactile paving, this guidance was inconsistent and contradictory.

However, the absence of research does not imply an absence of problems with inclusion and accessibility for certain groups of disabled people.

DESIGN ISSUES

The literature review highlighted some key design factors which we concluded could influence the function and effectiveness of continuous footways.

A core idea was that the appearance of the continuous footway, and most obviously the sense that the footway continues, would create changes in behaviour. The related idea of design priority was discussed, although the physical features that lead to this were ill-defined.

It was evident that choices of material could have an influence, making the drivable space[7] appear to be part of the surrounding footway or part of the carriageway or something different from both.

Changes in the level of the carriageway or footway might have a similar effect on driver / pedestrian perceptions.

A second core idea was that physical constraints could be used to limit vehicle speeds and affect the complexity of vehicle movements.

The review pointed to the presence of a height difference between carriageway and the drivable space, and the design of ramps to bridge this difference, as potentially important design factors.

It was also evident that corner radii, and the possible paths that vehicles could be driven on, could be significant.

Some literature drew a distinction between sites allowing vehicles to turn in and those allowing exiting vehicles (and thus also sites allowing both). There were

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[6] For an explanation of our use of the words "inclusion" and "exclusion" please see Section 2
[7] See Section 2 for a definition of "drivable space"

suggestions that narrowing of a junction mouth might help to establish pedestrian priority where two-way traffic is allowed.

A simplified list of design factors which were established to be of potential significance is as follows:

- Continuity of main carriageway kerb
- Lack of visible (kerb) radii at the main carriageway
- Continuity of any markings (e.g. yellow line) along the main carriageway edge
- Height difference and ramp design
- Visual continuity of materials and colour of footway and any associated cycle track
- Contrast between footway and carriageway colour and material (and of both with any cycle track)
- Continuity of the level of the footway
- Sight lines (but with no consensus over whether good or poor visibility is desirable/undesirable)
- Constraint of route available for vehicles
- Dimensions of the drivable space (both depth and width, noting that it is difficult to standardise which dimension is understood to be “depth” and which “width”)
- One-way use of the side road (as preferable)
- Mitigations (and specifically narrowing of the entrance) if two-way traffic is allowed on the side road.

A list of related, non-design factors that were established to be of potential significance is as follows:

- A low enough number of crossing vehicles
- A low enough vehicle flow on the main carriageway
- High enough pedestrian numbers (and high enough numbers of cyclists on any associated cycle track parallel to the footway)
- A high ratio of pedestrians/cyclists to vehicles crossing
- Location of the structure acts as a distinct transition between different categories of road (e.g. at the gateway to slow-speed residential streets).

4 Mapping and GIS work

The project used a GIS system to map the locations of over 500 continuous footways, footway crossovers, or footway-like side road entry treatments in Britain. In addition to their location, we also recorded information about the characteristics of the infrastructure at these locations. This:

- Provided information about what designs have been used
- Gave us a more accurate idea of the number sites in Britain at which an attempt has been made to continue a footway over a side road end
- Supported our selection of sites for more detailed study
- Enabled us to give British sites a unique reference number, and a name, for later reference in the study.

4.1 Process

In attempting to map and record continuous footways the project team had to decide what counted as a continuous footway.

As this GIS/mapping work progressed, we confirmed that we could find no set of features that could be used to objectively define whether what we were looking at should be counted as continuous footway.

We came to a decision that the project would try to record:

- Every location in Britain
  - that included a design we thought to be currently described as a continuous footway (by members of the public, designers, or organisations commenting on their use)
  - where members of the public might consider that a physically significant structure continued a footway over the end of a side road.
- Many locations in Britain where less physically significant structures visually suggest a continuation of the footway over the end of a side road
- Some locations in Britain where there seems to be a continuation of the footway over a wider private entrance (including some used by the public, such as to car parks or petrol stations)
- Some locations in other countries where footways appear to be continued over the end of public side roads

- Some locations in other countries, and outside of the Netherlands, where private entrances appear to be constructed with features reminiscent of Dutch exit constructions.

To help us determine the locations of relevant British sites, a range of techniques was used, for example by focusing on those we:

- Already knew about
- Identified by searching social media for the term “continuous footway” and “Copenhagen crossing”
- Identified by searching the internet and social media for discussion of major work redesigning streets, particularly where this work introduced cycle tracks.

The project team used Google Streetview to briefly study all the sites identified, except in a few locations where images were not sufficiently up to date.

For each location we tried to record whether we thought that what we could see fitted with this study as being an example of what might be called a continuous footway. This used a 5-point scale from “definitely not” to “definitely”.

To illustrate the difficulties involved, Figure 2 provides images of six relevant British locations (each providing vehicle access to/from a smaller side street or entrance).

Example 1 is the only image showing a location judged by this study to provide an unambiguous continuation of the footway. For many of the other examples it was difficult to judge whether the footway continued, or whether the drivable space was part of the carriageway (or whether it was neither footway nor carriageway). Example 2 might traditionally be called a “side road entry treatment” because it does not appear designed to continue the footway. Example 3 has been called a continuous footway despite it being visually and physically less significant because of the lack of visual contrast and level access for vehicles. Example 4 is very like Example 1 but is not surfaced as a footway. Example 5 might traditionally be called a “footway crossover” because it provides access to private land. Example 6 might traditionally be called a “raised side road entry treatment”.

Figure 2: A range of designs to show challenges in classification

1) Footway appears to continue in an unambiguous way. Drivable space at footway height. Steep access ramp.

2) Drivable space at carriageway height, but significant contrast with carriageway surface and similarity to footway surface.

3) Little carriageway-footway contrast. Drivable space at carriageway level. Interpreted as continuation of footway?

4) Surface implies break in footway. Steep ramp significantly slows vehicles. Drivable space at footway height.

5) Private entrance over footway. Frequent access by large vans. Footway drops to carriageway level.

6) Surface implies break in footway. Raised drivable space feels like a speed table.

4.2 Learning

The project recorded details of designs at 512 British locations.

THE LACK OF AN IDENTIFIABLE DESIGN OR FUNCTION

Identifying whether or not designs were continuous footways proved very difficult, more so than we had expected.

Of the locations mapped we decided that:

- 40% (around 200) definitely fitted this study
- 24% (around 120) fitted this study to a significant extent (but not entirely)
- 17% were marginal in terms of characteristics
- 10% probably did not fit this study
- 9% definitely did not fit this study.

Our main learning was about how ill-defined continuous footway designs are on British streets. This measure was, as a consequence, inexact and subjective.

In many places we could see designs where there was some sense that the footway continued over the side road end, but the following were also true:

- In many locations:
  - drivers might not really take much notice of what physically was an insignificant barrier to speed or progress
  - it was difficult to decide if the area to be driven on looked like footway, carriageway, or some kind of special area
  - small details made the difference as to whether the area that could be driven on looked like carriageway or footway – such details included the presence or absence of specific paint markings.
- There were designs which:
  - we think were intended to continue the footway, but where the area driven on was of a very different colour and texture, making this area unlike the footway
  - were probably *not* intended to continue the footway, but where the area driven on was of a colour and texture much like the footway.

WALTHAMSTOW DESIGN

Walthamstow in London provides a very specific design that is being used across a wide area, with perhaps 100-200 examples, often with an associated cycle track. The literature review found indications[8] that these were called Copenhagen

[8] Transport for London, "Before and after monitoring of Continuous Footways (Copenhagen Crossings) in Hoe Street, Waltham Forest," Transport for London –(See literature review).

crossings or “blended crossings” by the local authority (and that these were not seen to be continuous footways), but during the project these designs were referenced as continuous footways by participants on several occasions.

We did not find an equivalent situation anywhere else in Britain. We could see that the Walthamstow design tended to provide a larger area at the junction (not just covering the area that can be driven on), with a distinct surface, with a colour and texture different from both the surrounding carriageway and footway. The area that provides vehicle access is at the level of the surrounding carriageway. The judgement over whether this area continues the footway or provides an area that is neither footway nor carriageway, is a very subjective matter.

Figure 3 shows two images of these Walthamstow designs (although difficult to see in the image, the edge of the drivable space is defined by the lack of a kerb along the edge of the main road – an area also marked with the square white “elephants footprint” markings along the edge of the cycle track).

Figure 3: Walthamstow designs (London)

AGE OF CONTINUOUS FOOTWAYS

The use of designs that appear to continue the footway over the end of a side road are not all new, some appearing to have existed for decades. Given the absence of the term in older design literature, we doubt that these were referred to as continuous footways when built. In later work one of our key informants, with a long expertise in this area, suggested the same.

(Note that the project did not attempt to date infrastructure with any accuracy, so the observation above is an informal one, based on our experience of analysing street design and the apparent age of the infrastructure judged by its condition.)

Figure 4 shows images of the entrance to Drury Street in Glasgow, one of our detailed-study sites, which appears to be an example of such a situation.

Figure 4: Drury Street (at Renfield Street, Glasgow)

FOOTWAY CROSSOVERS

Entrances and exits from private land are not all provided by allowing vehicle access over a footway. Many are constructed as if with sections of carriageway, requiring pedestrians to step down a kerb, and up another. We could see little consistency, so that both busy and quiet entrances are designed as both footway crossovers[9] and with a kerbed carriageway.

In Britain, many (probably most) footway crossovers are constructed to have a footway that all slopes toward the carriageway. This slope is often called “crossfall” in technical literature. Figure 22 in Section 8 provides images of footway crossovers.

THE NETHERLANDS

In contrast, it proved simple to classify Dutch junctions and entrances as either having or lacking an “exit construction” (“uitritconstructie”). It was also easy to anticipate where these would be found – confirming that the approach to their use was consistent across the country.

Our literature review demonstrated that Dutch exit constructions are also applied at private entrances. We were surprised that it was difficult to find examples of the kinds of private entrance to driveways of private houses that are common in Britain. We could see that these do exist, but there appear to be few housing estates where they are common.

One key feature making Dutch exit constructions recognisable is the use of a specific ramped kerb (see images in Figure 23, page 86, and more details in Appendix 2). Our review of Dutch literature confirmed that the presence or absence of these “entrance kerbs” (“inritbanden”) is taken as a key indication of the

[9] By way of a reminder, our definition of footway crossover is ‘where a footway continues over a smaller private entrance, such as to a single private driveway, yard or car park’.

presence and status of an exit (which in the practical sense also means an entrance).

In Britain we recorded only a very small number of junctions or private entrances where kerbs similar to Dutch entrance kerbs have been used. Ten to twenty were recorded in Glasgow, all on small lanes or entrances. (Appendix 2 provides a discussion of ramps and the recent use of kerbs supplied by the company Charcon, which are inspired by Dutch entrance kerbs.)

EUROPEAN EXAMPLES

The project conducted a few investigations of the use of relevant designs elsewhere in Europe – mapping locations in Berlin, Brussels, Copenhagen, Dublin and Stockholm. Examples were relatively rare, and some of those found provided only an ambiguous sense that the footway continued.

What we saw in the centre of Barcelona was of particular interest. Within denser areas many smaller lanes or private entrances/exits are designed in a way that is recognisably like Dutch exit constructions. This similarity arose, in particular, from the use of ramped kerbs very much like Dutch entrance kerbs.

5 Discussions with professional informants

In this section we describe our approach to our work with professional informants – people employed in relevant professional roles. This covers two groups, namely design-orientated informants and user-orientated organisational representatives. It sets out who we spoke to, how we did this, and what observations we derive from this work.

Rather than attempting to consult with a large number of organisations representing disabled people and other interest groups, we chose to work more intensively, and in-depth, with a smaller number of key organisations, judging that:

- The extensive literature review meant that the project had already established the views of many key informed/involved organisations
- It was more important to focus on a smaller number of organisations established as having a position on this infrastructure, and to seek a deeper understanding of their knowledge and views
- The project would also work directly with individual disabled members of the public to understand the range of experiences that they encountered (see Section 6).

This part of the research took place mostly after completing the literature review and mapping/GIS work. It was ongoing throughout the remainder of the project.

5.1 Who we spoke to

The title **design-orientated informants** was used to mean people who were involved either in designing or supporting the provision of continuous footways, or who had professional knowledge about them. We spoke to these people primarily for their professional expertise. The title **user-orientated organisational representatives** was used to mean people with a relevant professional or voluntary role with an organisation, whom we could ask about the views of their organisation. Together we describe these groups as “professional informants”, distinguishing these from the individual members of the public we worked with separately.

For simplicity we describe this work as if those involved can be divided easily into these categories. Most design-orientated informants worked for organisations involved in the design or provision of infrastructure. Most organisational representatives worked for bodies organised to support or represent disabled people – however these groups are interconnected. Some of those we worked with were interviewed both for their personal design-related expertise and to understand the position taken by their organisation. People representing their organisations often contributed a wider personal and professional expertise.

A number of the people we worked with have lived experience of disability, and personal experiences were offered as evidence for the project. We report on our learning from such input in Section 6, alongside learning from focus groups and site visits with disabled members of the public.

It should be noted that while this report is focused purely on our work on continuous footways, this was carried out alongside research into the provision of cycle tracks at bus stops. Most of our work with interviewees was simultaneous on both of these themes.

5.2 How we worked

The research work comprised both semi-structured interviews and more informal or ongoing contact. The latter was an important element of our work and helped us to understand what we were learning, and to test out ideas and conclusions. Even where semi-structured interviews were used, these – by design – were followed up with unstructured, informal discussion.

This work included ongoing contact, throughout the research project, with a project **Reference Group** in which we brought together people with a wide range of professional knowledge and a range of differing views, including on design, engineering, inclusion, disability, academic research, the needs of pedestrians and infrastructure for supporting cycling.

We name Reference Group members inside the front cover of this report.

Work with **design-orientated informants** included semi-structured interviews with:

- Four local authority officers managing the installation of relevant new infrastructure in different cities
- An engineering consultant involved in supporting local authorities to install relevant new infrastructure.

We also had discussions with:

- A team in Manchester involved in researching the impact of relevant new infrastructure
- Consultants from five organisations with specialist knowledge about relevant new infrastructure

- A local authority team responsible for a specific project involving the installation of relevant infrastructure in Edinburgh (and for running research into its effects)
- Researchers and others looking at the effects of similar infrastructure in other countries
- Two local authority officers responsible for the installation of relevant new infrastructure in Leeds.

Work with **user-orientated organisational representatives** included semi-structured interviews with:

- Representatives of three national organisations campaigning for improved conditions for blind and partially sighted people
- A representative of a national organisation concerned with cycling for disabled people
- A senior representative of a national organisation campaigning for changes to infrastructure to support cycling
- A senior representative of a national organisation involved in promoting, designing, and funding changes in infrastructure to support cycling and walking.

Work not fitting the above categories included:

- Discussions with two staff employed to teach the use of long-canes or guide dogs (one a long-cane user), and with them a visit to several relevant Scottish junctions (including two of our detailed-study sites)
- Wider discussions (mostly focused on problems crossing cycle tracks) with people involved in providing or coordinating training on the use of long canes or guide dogs, and with a representative of a relevant professional network organisation.

Staff from the organisation Transport for All attended the semi-structured interviews and some of the other discussions. The semi-structured interviews were recorded, and Transport for All helped to analyse these for the key points and themes that had been raised.

Contributors were assured that their input would be strictly confidential, that quotations provided in the report would be anonymous, and that any recordings or transcripts would be deleted at the end of the project. We did this because:

- It was vital that contributors could be honest and open
- We wanted contributors to feel able to be clear about the limitations of their knowledge

- Where contributors were not involved officially as a representative of their employer, we wanted them to be able to speak freely about internal challenges within their organisation
- Where contributors were involved as representatives of their organisations, we wanted also to hear their personal views
- This was not an open consultation to establish what positions were held, but rather an exercise to deepen our understanding of positions already established in the literature review work.

Before approaching organisations involved in campaigning for inclusive streets (where we arranged interviews with their representatives) we had already used the literature review to establish a set of key concerns shared by many of these organisations, and by people they represented. Rather than carrying out another survey of the views of these organisations (and others like them) we chose instead to work with a small number of these organisations, extending our understanding beyond these established positions.

We reassured the organisational representatives that we already understood:

- The importance of kerbs for blind and partially sighted people in defining the edges of a footway
- The importance of tactile paving for marking kerb-free transitions between footway and other areas
- Problems with large areas of tactile paving
- The importance of consistency in the use of tactile paving.

5.3 Learning from design-orientated informants

Below we report observations drawn mostly from interviews with people employed in roles in changing infrastructure (rather than interviews with representatives of user-orientated organisations). These were people employed as designers, engineers, local authority officers, or in similar roles. For the sake of simplicity we are also including learning from interviews with representatives of organisations focused on better cycling infrastructure, even where the organisation was more user-focused than design-focused.

DEFINITIONS AND DESIGN PURPOSES

None of these informants could point to any widely agreed definition of continuous footways – although there was agreement that they were designed to continue a footway over a side road.

Most spoke, in one way or another, about continuous footways being a way to increase the priority of pedestrians over vehicles entering or exiting a side road.

Some provided additional detail. For example, one said that the objective was that pedestrians “don’t even have to look up”. Another said, “I think a continuous footway is where the footway dominates, ultimately the cars feel they have to give priority”.

Some commented on continuous footways providing a kerb-free route, useful to those using wheelchairs or mobility aids.

Some agreed with us when we suggested that continuous footways may often be installed as part of work on cycling, but others disagreed.

Several design-orientated informants commented that continuous footways are being introduced as part of bigger changes to encourage people to walk or cycle, and to discourage them from driving. We asked one senior participant about whether changes to support cycling were putting a lifestyle choice (to cycle) above inclusion. This person disagreed, suggesting that the need to encourage cycling was urgent, not as a lifestyle choice but something necessary because of “the climate emergency”.

One or two participants made a comparison between continuous footways and footway crossovers. One said that before the term continuous footway had become popular they would have called these “driveway crossings”.

Some participants confirmed that continuous footways are being built as part of schemes to support cycling, but some argued that their use wasn’t normally connected to these.

DESIGN FACTORS

We briefly asked for comments about what makes a continuous footway work well. The following were suggested:

- The area to be driven on should look like the rest of the footway, even if constructed using load bearing materials (such as smaller block paving)
- The area of footway that can be driven over should be accessed by ramps (with ramp steepness a factor in slowing vehicles, although this might be limited by the need not to damage vehicles)
- These access ramps should create a visually straight kerb line along the edge of the main road, rather than there being any visible corners
- There is a need to limit the swept path that can be taken by vehicles, ensuring they have to make a tight turn (at slower speed) when entering the side road
- There is a problem creating a visually obvious continuation of a footway in those circumstances where there is little existing visual contrast between asphalt footways and asphalt carriageway

- There is a link between the use of continuous footways and new rules in the Highway Code (Rules 170, 206 and H2)[10].

These suggestions are in line with those detailed in previous research, and particularly in the study by UWE[11], as also summarised in the literature review summary section of this report (Section 3).

Some senior and influential participants were aware of the challenges that continuous footways might create for blind and partially sighted people. One reflected that blind and partially sighted people might “be completely at the mercy of the turning vehicle adhering to the rules”. However even those participants who were aware of this problem were unsure of how to solve it.

In contrast, one senior representative of an organisation involved in support for cycling-related infrastructure, when asked whether continuous footways might not be accessible for everyone (i.e. inclusive), responded, “Is that a problem? It had never occurred to me that that might be a problem”.

We concluded that knowledge about the possible effects of continuous footways on the inclusiveness of streets is variable and limited amongst some groups.

TACTILE PAVING

We discussed the use of tactile paving in some depth with a number of participants and confirmed that design guidance is inconsistent.

Some suggested that tactile paving should not be needed at continuous footways if these are working properly. Others suggested that the problem with providing tactile paving was that it might change the behaviour of pedestrians, making them less likely to walk confidently. One person, who had been involved in changing many junctions, specifically stated that anything that encourages a pedestrian to look up to negotiate passage is unhelpful when they should be claiming their right of way.

Other participants suggested that the problem with tactile paving is that it visually marks the edges of what then looks more like a section of carriageway, thus weakening how the continuous footway is perceived by drivers.

More than one participant spoke about the challenges that blind and partially sighted people face more generally, pointing out that the absence of tactile paving might create problems with overall navigation for those who want to know they have

[10] See literature review document (Section 9.1) for details

[11] J. Flower, M. Ricci and J. Parkin, “Evaluating the effectiveness of continuous side road crossings,” Centre for Transport and Society, University of the West of England, Bristol, 2020 (see literature review for details).

reached a side road. One spoke about how too much tactile paving can become confusing.

Many participants were aware that there is an ongoing debate about how tactile paving ought to be used at continuous footways, and a need to research options.

ROLE OF DESIGN GUIDANCE

The designers we approached considered that they are working from experience as much as guidance, and indicated that we had not missed any key guidance in our literature review.

We confirmed our finding, based on the review, that there is a problem with the inconsistency of different guidance. One participant spoke about the lack of clear rules to follow, and about having to have their own “belief system” to guide their work. We took this to mean that designers who want to make significant improvements to how streets function for pedestrians are not supported by any national plan, philosophy or agreed design principles to that effect.

FACTORS WORKING AGAINST CHANGES TO STREETS

We were told by more than one participant that they faced big challenges in dealing with others within their organisation or authority, and that these held them back from doing better work.

One (from an engineering consultancy) highlighted differences in approach between, on the one hand, those involved in more innovative projects and, on the other hand, “highway engineers”. They explained that the company’s highway engineers were often driven by concerns about “avoiding liability”. This participant suggested that documents like “DMRB” (Design Manual for Roads and Bridges) were seen as “bibles” by the highway engineers. They contrasted this with the apparent lower status of other documents like “Designing Streets” or “Manual for Streets” which were intended, when written, to supplant the use of these for the design in more urban environments[12].

Another participant spoke about those involved in “road safety audits” referencing the “Traffic Signs Manual” as another equivalently influential document. We were told that these people “want things to be legally correct” and that they had been told internally “it’s not you that’s going to end up in court”.

One participant spoke about the value of narrowing the space that can be driven on at a continuous footway so as to produce a “give and go” situation – where only one vehicle can pass through the space at a time. They then described a situation where that approach had been rejected because of fears that traffic on the main road

[12] For details on these documents please refer to the literature review.

would be held up if trying to enter the side road. The street in question was a short cul-de-sac; the “main” road had a speed limit of only 20mph; and in mapping work we had classified the structure provided at the side road end as *not* providing a continuous footway.

RAMP DETECTABILITY

To understand the relationship between ramp steepness and detectability we carried out a site visit with two mobility trainers who work with blind and partially sighted people. One was a long-cane user.

We visited junctions on Sauchiehall Lane (with Holland Street), Scott Street and Pitt Street (with Sauchiehall Street) in Glasgow – two of our detailed-study sites – and a third site similar to that at Sauchiehall Lane site.

Together we checked, informally, whether we felt that a blind or partially sighted pedestrian on the footway would be able to detect the unusually steep ramp defining edge of the continuous footway at Sauchiehall Lane (i.e. between the continued section of footway and the main carriageway).

More detailed experiments are needed to provide better evidence, but we concluded that this ramp was probably detectable – either with a long cane or underfoot. We speculated that most guide dogs would consider this to be the footway edge, although proper evidence is also required to confirm this. It was evident that such a ramp is significantly easier to detect than the edges of the drivable space at our other detailed-study sites (which were flush or with more gentle/low ramps).

5.4 Learning from user-orientated representatives

Below we report observations drawn from interviews with representatives of user-orientated organisations. Also included, for simplicity, is learning from work with those employed in wider roles by such organisations – although we met with this latter group to learn from their individual professional expertise, rather than to discuss the positions of their organisations.

DEFINITIONS AND DESIGN PURPOSES

These interviews confirmed that there has been confusion over exactly what infrastructure is covered by the phrase continuous footway. In general, the organisational representatives had specific locations in mind but little or no knowledge of the many different designs used throughout Britain.

None of these organisational representatives made comparisons between the concepts of a continuous footway, footway crossover, and side road entry treatment, but many expressed confusion over the reasons why specific designs were being used.

Comparisons were often made in these interviews with the idea of "shared space[13]", with many of those we spoke to thinking that the intention of designers was to create ambiguous areas – where pedestrians and drivers negotiate passage with one another. This was an important observation because of the contrast with what we heard from designers, who instead spoke about providing pedestrians with priority. Similarly, in our literature review we had established that the limited guidance available focuses on providing pedestrian priority.

When discussing questions of safety from traffic, all those user-orientated organisational representatives interviewed considered that continuous footways created situations where *pedestrians needed to stay alert, choosing a safe time to cross the side road by observing traffic, or negotiating visually with drivers*.

None of the people interviewed as representatives of organisations focused on disability spoke about continuous footways being deployed as part of more long-term and comprehensive efforts to refocus streets on the needs of pedestrians. This contrasted strongly with responses from those involved in designing and providing continuous footways.

The strongest sense was that people felt changes were ill-thought-through, that these were happening without good reason or because of the incompetence or even obsessions of designers. In some cases, there was a feeling that changes were all being made because of an unreasonable focus on the needs of cyclists, putting these above the needs of others.

Organisational representatives tended to speak about improving streets with the removal of some recent changes, the restoration of kerbs, the addition of dropped kerbs, improvements to maintenance, and the addition of new signalised crossings (i.e. with traffic lights/signals). We heard less about any vision of more profound change.

This contrasted to the way that design-oriented informants involved in the project expressed enthusiasm about more profound change in favour of pedestrians and cycling.

These and other differences in views are summarised in Section 5.5 below.

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[13] An ill-defined phrase which has come to be associated, for many people, with the removal of the distinction between footway and carriageway, the introduction of ambiguity over right of way, or the idea that drivers and pedestrians might negotiate passage with one another

KERBS AND CROSSING TECHNIQUES

We heard a great deal of detail about the importance of kerbs, as a key feature helping blind and partially sighted pedestrians to know where the edges of a footway are. One participant put this simply and very clearly, saying: “Kerbs are really, really important”.

Several interviewees were keen to point out that guide dog users – *not the guide dog* – judge when it is safe to cross the carriageway of a road. As an additional detail, it was confirmed that some experienced guide dogs may act of their own initiative to avoid injury to themselves or to their owners, thus providing some additional reassurance as to whether a carriageway was safe to cross.

It was indicated that some blind and partially sighted people may choose to cross the end of a side road by walking a few metres into the side road, seeking a place where kerbs are at right angles to the direction of crossing, away from the junction mouth and usual desire line. The word “indenting” was sometimes used to cover this practice. We also discussed the practice of walking much further into the side road to cross it well away from the junction.

OTHER PROBLEMS AROUND VISUAL IMPAIRMENT

Some participants spoke about the difficulties that blind and partially sighted people can have when trying to walk in a straight line across a more open area – meaning one not bounded by kerbs, walls, fences or similar structures. With this in mind, one participant highlighted the value of features that can provide a “guide line”, by which we mean something that can be followed easily, with a long-cane or by feeling for it underfoot. Another participant spoke about following guide-line features within a railway station in the Netherlands. (We found it helpful that one of our researchers had also followed such guide-line features along Dutch streets using a long-cane – under the guidance of an experienced long-cane user.)

Figure 5 (overleaf) shows guide-line paving used in a Dutch station and on a Dutch street.

Figure 5: Guide-line paving in the Netherlands

Several participants spoke about mobility training being difficult to access. One explained that the availability of mobility training in one area had had an effect on where they chose to live when they knew they were losing their sight. This participant emphasised how long some other blind and partially sighted people had to wait for training.

STRONGER VIEWS

Representatives of one organisation did not agree to take part in a structured interview but asked to have a discussion during a site visit in Glasgow. Overall, it was clear they were strongly opposed to the concept of continuous footways.

One of their representatives expressed the view that Dutch continuous footways (i.e. exit constructions) do not work well at all, and that they had observed “chaos” at one relevant Dutch junction.

This organisation highlighted particular concerns about the effects of the design at junctions on Sauchiehall Street, one of which was a detailed-study site. Based on our study of this site we agreed with many of their observations about how these junctions worked, and the problems that might result for blind and partially sighted people. However, we had judged that the designs at these junctions provide an ambiguous area rather than an unambiguous continuation of the footway, and we had recorded that the lack of physical features constraining vehicle speeds and paths was a problem.

The same organisation was invited to visit the nearby detailed study-site at Sauchiehall Lane with us as we had observed different conditions and behaviours there, however they declined. With other organisations we discussed what could be learned by studying locations where we'd observed problems but also those where we saw few or no problems.

5.5 Key areas of agreement / disagreement

Table 1 below provides an impression of some of the differences that were apparent in the views expressed by the design-orientated and user-orientated interviewees. The contents of this table are greatly simplified and generalised for clarity (meaning that the comments do not provide a specific indication of the attitudes and ideas expressed by any one person or during any single conversation).

It should be noted that in highlighting differences in views we do not intend to imply that one or other party was correct and the other wrong. Evidence from other parts of this study may be seen to support one or other position. For example, at many of the sites we studied conditions on the ground were closer to those described by user-oriented organisational representatives than they were to the ideal described by the design-orientated informants. It might be concluded that it is the role of user-oriented organisations to represent not theory but the real-life experiences of their members. Similarly, any failure to outline a bigger vision for change might result from a lack of evidence, on the ground, that bigger changes are likely.

In the report discussion section (Section 8.4) we discuss this issue further, putting the onus on those responsible for pursuing changes to streets to work in depth with disabled people and organisations representing them, We conclude that it is in the interests of all that learning takes place in *both* directions.

Table 1: Comparing responses in design/user orientated interviews

Beliefs expressed by design-orientated informants	Beliefs expressed by user-focused organisational representatives
Difficulties with designs arise because of the resistance which exists to reducing the level of priority given to vehicles.	Difficulties with designs arise because of the incompetence of designers, or because they are focused on prioritising cycling (even at the expense of inclusion).
The overall objective of changes like these is to prioritise pedestrians over vehicle movement.	The overall objective of changes like these are unclear, or are to prioritise cycling over other modes of transport.
The aim of a continuous footway is to create a situation where pedestrians have unambiguous priority over vehicle movement (no mention of the idea of "shared space").	The aim of a continuous footway is to create an ambiguous situation where pedestrians need to negotiate with drivers to progress (linked explicitly to the idea of "shared space").
Continuous footways are one element in a much bigger set of changes (beyond maintenance, dropped kerbs, etc) which are required to make streets more inclusive to support both pedestrians and cycling.	The changes that are needed to make streets inclusive include the addition of crossings and dropped kerbs, and the maintenance of existing streets. The bigger changes that have taken place are to support cycling and they generally make streets less inclusive.
Cycling will only become something which is ordinary with changes to infrastructure. Current conditions mean that sometimes people who are cycling behave badly (e.g., cycling on pavements). There are individual people prepared to behave badly and who cycle.	Cycling is a problem because many or most cyclists behave badly (pointing to specific observations such as of cyclists ignoring red traffic signals).
The need for more cycling and for this to be given a higher priority is established in policy and evidence.	The need for more cycling is unproven and contested.

6 Work with disabled individuals

This section reports on our work with disabled pedestrians (in contrast with the previous section that describes our work with design-orientated informants and with organisations representing disabled people). The objective of this thread of the research was to ensure that we heard first-hand about the variety of experiences that different disabled people face.

It should be noted that the broader research project also looked at problems with bus stops where there is a cycle track, and much of the activity listed below was undertaken in a way that investigated experiences related to both types of infrastructure. This work was focused on experiences as a pedestrian – we did not try to investigate the experiences people had when driving.

6.1 Process

Transport for All (TfA) organised and ran four online focus groups and four site visits (each examining both bus stops and continuous footways). Researchers from Living Streets were closely involved in all activity throughout the process.

The partnership enabled:

- The focus groups and site visits to be arranged by a user-led organisation with expertise in ensuring an inclusive “pan-disability” approach
- Focus groups to be facilitated by a disabled facilitator, appointed by TfA
- The concerns of the disabled people participating to be properly heard, and for them to have confidence that they were being treated equitably.

ORGANISATION AND PARTICIPATION

TfA sought contact with people who might be interested in being involved, and selected only some of those replying – seeking to ensure that participants had a range of impairments and ages.

Twenty participants were involved in total, although not all took part in both focus groups and site visits.[14] Five participants had a visual impairment (sometimes alongside other impairments).

[14] The disabled people involved in the focus groups and the site visits were paid £50 each for attending each event.

Two TfA staff attended the London site visits, and a third TfA employee attended the Glasgow site visits. Each of these was themselves a disabled person, one using a wheelchair during the visits.

TfA worked with us to assess the risks involved in organising site visits to look at continuous footways and bus stops. A number of our study sites did not provide the conditions they felt necessary to ensure participants were comfortable and felt safe. TfA also had concerns about managing risks to participants, and about making them comfortable, on busy streets more generally. The sites we did visit with disabled people were not problem-free in this regard. Even here we judged that it would have been irresponsible to suggest to some blind or partially sighted participants that they cross some of the spaces on the streets without support. This underlined the importance of gaining a first-hand perspective.

Sites were chosen (i) to provide a good understanding of what might be more effective designs, and what might be less-effective, and (ii) to be close to available accessible meeting space, enabling more focused conversation as part of the event.

LIST OF EVENTS

The events were as follows:

- Online focus group, London-based participants (continuous footways)
- Online focus group, London-based participants (bus stops)
- Online focus group, Glasgow-based participants (continuous footways)
- Online focus group, London-based participants (bus stops)
- Site visit, London, bus stops (and continuous footways)
- Site visit, London, continuous footways (and bus stops)
- Site visit, Glasgow (bus stops)
- Site visit, Glasgow (continuous footways).

FOLLOW UP SOLUTIONS WORKSHOP

Following the work with disabled members of the public, TfA organised a “solutions workshop”. This was attended by the key Living Streets researchers, four TfA staff (two being access consultants) and a representative of the Mobility and Access Committee for Scotland. This was facilitated by a TfA staff member who had not previously been involved in the project.

During the workshop, improvements to continuous footways that had been suggested by members of the public were analysed for their advantages, disadvantages, practicality, and value.

ADDITIONAL ACTIVITY

Outside of the structured work organised in partnership with TfA, the project's contact with disabled people also included:

- Discussions with a group of disabled people working on the accessibility of public transport.
- Detailed discussions about the personal experiences of a (further) guide dog user, and about the specific techniques that person uses when navigating British streets.

6.2 Suggested solutions

The participants were given the opportunity to suggest solutions which might make the sites we studied with them more inclusive.

Suggestions included:

- The use of steep ramps to slow vehicles
- Signage to instruct pedestrians to look for traffic
- The addition of zebra crossing markings
- The reversal of changes that make the footway appear visually continuous (and the use of various high-contrast effects to emphasise the presence of the drivable space)
- The addition of tactile paving to mark the edges of the drivable space
- Road markings to ask drivers to slow down
- The use of traffic signals
- Work to improve drivers' awareness of the Highway Code
- Mirrors used in places where visibility is restricted.

6.3 Learning

UNDERLYING IDEAS

The following underlying ideas were discussed in connection with the wider use of streets by disabled pedestrians. Some of what was learned from this work was unsurprising – corresponding to what we had understood from previous studies, or what we would expect from any conversation with members of the public. We have called these underlying ideas because they are well understood, not because they are unimportant. They are listed because – although they are well known – many participants had no confidence that anyone was designing according to these principles.

Some of the ideas relate primarily (although not exclusively) to the inclusion of blind and partially sighted pedestrians. These included:

- The particular importance of consistency in infrastructure features (providing predictability and increasing confidence)
- The difficulties that arise in dealing with vehicles or people using devices which are harder to hear, such as electric vehicles, e-scooters, and bicycles, particularly when other traffic noise covers what noise these do make
- The importance of:
  - kerbs and other distinct boundaries in defining a clear path that can be followed, which is known to be separate from vehicles (including bicycles)
  - kerbs as being a consistent, defining feature marking the transitions to and from footway space when pedestrians are crossing carriageway space or cycle tracks.
- The importance of:
  - visual contrast (in both colour and tone) making the difference obvious between areas of footway and areas where vehicles, including bicycles, might be encountered – specifically for partially sighted people, but also for others who might need this transition to be more obvious
  - visual contrast being present in wet weather or after dark (often not the case in practice)
  - signalised crossings (i.e. using traffic lights), not only for blind and partially sighted people, but also for those who need more time to cross, and / or are less able to predict more complex movements of vehicles
  - tactile paving – used correctly and installed consistently – advising the presence of controlled crossing points (with a zebra crossing or traffic signals) and warning of locations with a kerb-free transition between footway and spaces where vehicles might be encountered.

Some ideas related to wider groups of pedestrians. These included:

- Many people, including those using wheelchairs and some other mobility aids, can be hidden behind most vehicles, even small cars
- People do not trust those driving (or cycling) to behave in line with established rules, and consequently rules don't reliably ensure safety
- Poor surface quality makes some journeys impossible or extremely difficult for many people, including those with impairments to their walking or balance or who are wheelchair users
- The value of kerb-free routes for people using wheelchairs and other mobility aids (a potential conflict with some above points)

- A lack of dropped kerbs, or other level access, makes some journeys impossible or extremely difficult for wheelchair users
- The low quality of some dropped kerb arrangements is problematic, particularly where slopes are steeper, slopes are not in the direction of travel, and where surfaces are not sufficiently flush.

DEFINITIONS AND DESIGN PURPOSES

We found that the idea of a continuous footway is not well understood by members of the public. Many of those we spoke to were able to draw learning from other situations, and others related their experiences at different types of entrance, such as at car parks (which might be called footway crossovers).

In discussions around the priority given to pedestrians or motor vehicles in the Highway Code many participants were unsure about which road users have official priority in a range of particular situations. Also, their expectations were that those driving and cycling will, in any case, take little notice of many rules about priority. One person spoke about “people needing to rely on the mindset of a driver on any particular day” and that no matter what the rules say it would always be seen “as the pedestrian’s fault” if they were injured.

Some participants felt that changes introducing new infrastructure were often being put in place to favour limited groups of road users, and particularly to favour those who cycle. They saw that the needs of cyclists were being prioritised, with little regard to the disadvantages arising for a wide range of disabled people. For example, one person suggested that a local authority was trying to create a “cycle-only borough”.

However other participants pointed out that they would not cycle in their city because of the traffic conditions.

EXTENT OF EXCLUSION

Importantly, some people highlighted how the general conditions on British streets can disadvantage or even exclude people:

- One participant spoke about using buses to travel very short distances because of local accessibility issues: “sometimes I just take a bus to cross that bit”
- One blind participant referred to changes in infrastructure meaning that in places where they had previously felt secure, “it’s like a guessing game”
- One participant commented that when moving more slowly, “being able to jump out of the way [e.g. to avoid an oncoming bicycle] is a problem”

- Another participant, asked about problems with parked vehicles blocking the footway, described sometimes having to go home and repeat the journey later in the day hoping the pavement would be clear.

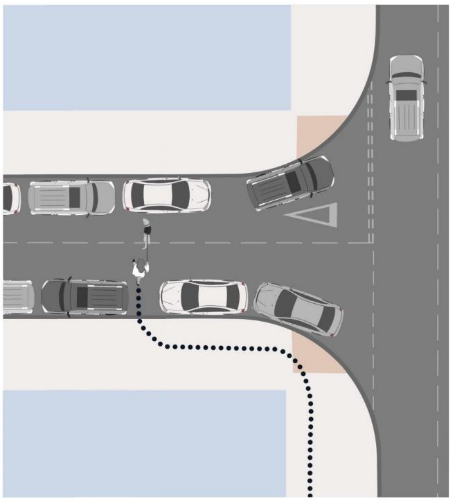
KERBS AND CROSSING TECHNIQUES

As in interviews with organisational representatives, we discussed crossing techniques with several blind and partially sighted participants.

Asked about how parked vehicles affect crossing the end of a side road, one participant contrasted the way in which their guide dog would “bounce” across the road when a view was clear, while only edging forwards if parked vehicles blocked the dog’s view of oncoming vehicles. The same person spoke about reaching out to touch parked vehicles to confirm their presence or to judge where it might be safe to stand in preparing to cross.

Interviewees talked about the problems caused if there are large numbers of parked vehicles along the edges of the carriageway of the side road. One guide dog user explained that it was sometimes impossible to pass between parked vehicles to get onto the carriageway at all. He also described having crossed in a chosen location, only to be faced with parked vehicles preventing access to the far footway (as illustrated in Figure 6). He said he sometimes had to walk back along the actual carriageway to the junction just to get onto this footway.

Figure 6: Problems crossing within side road



WIDER CHALLENGES FOR BLIND AND PARTIALLY SIGHTED PEDESTRIANS

Blind and partially sighted participants highlighted the problems involved in navigating even ordinary streets. Although many of these problems are well known, what was striking was how consistently we were told of the high level of concentration required, and the challenges inherently involved.

Key points were:

- Participants described how counting features to track progress on a journey – while also staying safe – is difficult
- One participant spoke powerfully about his fears about becoming completely lost, having taken a wrong turn, even on very familiar journeys. We were reminded that few other pedestrians (without a visual impairment) face such challenges
- This participant also spoke strongly about how navigation can be easier when there is consistent noise from traffic on a busy road, and that quieter environments are more alarming because there was less noise to orientate by, and more of a sense that they had become lost
- Several participants spoke about their real fear that they would be injured by other people (as opposed to vehicles), for example by those cycling or using e-scooters on a footway, or that their guide dog would be hurt or their long cane damaged
- Some participants pointed out numerous places where it was easy to walk onto a cycle track or carriageway without knowing they had done so
- Partially sighted participants spoke about the additional problems of navigating after dark, due to the decreased visual contrast between key areas, or the loss of more visually obvious features, like a brightly coloured building.

Participants spoke about environments becoming more difficult to navigate when they are more crowded, increasing the risk of a collision with another pedestrian or of a long cane user hitting the feet of another pedestrian. We were told this caused people embarrassment, and some mentioned being wary of the risk of the other pedestrian responding with anger.

According to participants it can be much easier for some partially sighted people to judge risks when the vehicles or bicycles they wish to avoid are arriving from one direction only; and they sometimes face a situation where they cannot see that a driver is trying to communicate by waving through their windscreen.

TACTILE PAVING

Some participants spoke about the way in which tactile paving can help blind and partially sighted people to navigate, but we also discussed its limitations and how it can confuse people when over-used.

We confirmed that tactile paving is often used only to provide a warning of a kerb-free transition between footway and carriageway, and when used in this way it does not necessarily indicate an optimum (or even safe) crossing point.

Several participants explained how, at (standard) junctions with swept kerb corners, they would "indent" into the side road (away from any tactile paving) to a place where kerbs at either side of the carriageway were more parallel to one another. These kerbs then acted as a means of lining up to cross, reducing the risk of deviation from the desired direction.

Figure 7 illustrates standard blister-style tactile paving and shows an example of it used at a place where crossing might be hazardous.

Figure 7: Problems at standard junctions

(Left hand background photo © @Heardinlondon)

It was demonstrated to us that tactile paving at a dropped kerb or controlled crossing is made easier to understand by an associated slope toward the carriageway. This slope gives a sense of direction, making it obvious that to one side is carriageway and to the other is footway.

We confirmed that it is understood that many blind and partially sighted pedestrians struggle to feel the orientation of the blisters on blister-style tactile paving in a way that allows them to orientate themselves (to choose the ideal angle to face for crossing the road). There is also a problem that the slope on dropped kerbs does not typically point in the desired direction of travel (see Figure 7).

The problems with such dropped kerbs include that they can:

- Suggest, to blind and partially sighted pedestrians, a crossing direction that would actually take them out into the main carriageway
- Create risks that wheeled mobility aids, like mobility scooters, tip over (because of being navigated at an angle to the slope).

Participants highlighted the fact that larger level areas of tactile paving are harder to interpret, and that multiple neighbouring areas of tactile paving can produce a confusing situation.

Participants commented that some tactile paving changes its meaning according to its orientation. For example, where “ladder and tramline” arrangements are used to indicate an area intended for cycling – a situation in which the direction of the ridges (along or across the pedestrian’s path) has significance. At some sites we could see that such paving had been used in places where it could be encountered by pedestrians arriving from different directions, making its meaning very difficult to interpret as a result.

We discussed whether alternative tactile paving layouts might be useful in situations where a continuous footway could be proven to unambiguously prioritise pedestrians.

Figure 8 illustrates two sites where alternative arrangements have been used. In both cases the paving is set back from the area where vehicles might be encountered, and in one the paving used is corduroy-style rather than blister-style.

Figure 8: Non-standard layout/style of tactile paving

Participants were concerned about any new arrangements being more confusing and complex than existing standardised approaches. They highlighted that the latter mark the obvious transition between footway and carriageway in a way that is relatively easy to interpret.

Through this discussion we became aware of particular problems that might arise, for pedestrians exiting the side road, if alternative layouts of tactile paving are used.

Pedestrians exiting a standard side road – assuming they are on the desired side of the side road – walk to the end of the side road then turn away from it on the footway beside the carriageway of the main road. While initially on the side road footway their path is bordered by the kerb of the side road. Forward movement is checked when they encounter the kerb of the main road (ahead). The presence of these kerbs simplifies navigation. If navigating a continuous footway, or other arrangement when the surface of the side road is raised to footway height, the detectable kerb to the side of their path is lost before they reach the carriageway of the main road, complicating navigation. Combined with this, any encounters with non-standard tactile paving arrangements may add further confusion.

THE EFFECT ON PEOPLE WITH MULTIPLE IMPAIRMENTS

Inclusive street design must accommodate people who have multiple impairments. One of the biggest challenges raised with us, in relation to continuous footways and other junctions, was about their accessibility to partially sighted people who rely on colour contrast, not on tactile paving.

A good example was one participant who is both partially sighted and a wheelchair user. She spoke about how she cannot see where the edge of many normal footways is when travelling along them. She said “I have to hug the building line” (to stay safe and to avoid falling off the footway).

EFFECTS OF OPEN AREAS ON BLIND AND PARTIALLY SIGHTED PEDESTRIANS

Many people who are blind or partially sighted find it challenging to walk in a straight line over a more open area. The challenge grows greater:

- If there are no clear features to allow a pedestrian to be certain about the direction they are setting off in
- If there are no clear features to indicate when the pedestrian has reached the other side of the wider area
- The larger the area is in which there are no features to navigate by
- The more there are other threats and pressures (such as from traffic or a crowd of people) to deal with at the same time.

These factors are potentially problematic for the navigation of continuous footways.

OTHER PROBLEMS AND COMMENTS

One participant spoke about their experiences with parked vehicles at a footway crossover that had been created to provide access to a car park. She highlighted this because the crossover had removed the clarity of what is footway (and the associated kerbs), so people had begun parking on areas intended to be footway – blocking her use of these.

A significant number of participants described the problems tactile paving cause them because of difficulties with balance or pain as they walk across them. On journeys to and from one site we observed that a participant steered his wheelchair over mid-height kerbs rather than using dropped kerbs that had blister-style tactile paving before them.

Although conversations like this were focused on problems, some of the feedback on new infrastructure was much more positive. One participant spoke about the beneficial effects for wheelchair users when kerbs are removed. Using Sauchiehall Street in Glasgow as an example she explained "I use a wheelchair full time. When I was crossing to get to the restaurant I thought "wow, this is great" because I felt so safe." Notably this street was criticised by participants with visual impairments.

7 Detailed-study site work

Ten junctions were chosen for much more detailed study, referred to throughout this report as **detailed-study sites**.

At these locations we measured dimensions, took standard sets of photographs, recorded behaviours on short and long segments of video, and made structured and unstructured observations of behaviour. This was followed up by the use of fixed-cameras, mounted at height on masts, recording several days of footage of behaviours – which we analysed in detail later.

At all but one of these locations we judged that designers had attempted to prioritise pedestrian movement by continuing the footway of a main[15] road over the end of a smaller side road.

At the tenth site (Simpson Loan, Edinburgh) we concluded that the designer had intended to create a side road entry treatment to try to indicate that pedestrians should be given some priority, without trying to provide a continuation of the footway across the side road. This site was chosen for study as a more standard junction, and to see whether the unusual configuration of the footway here affected user behaviours.

Full details about each detailed-study site can be found in Appendix 2. This section summarises our approach and the key evidence gained.

7.1 Our approach

SITE CHOICE

The detailed-study sites were chosen from those mapped earlier in the research.

To aid the research and offer comparison we chose sites:

- In Scotland, England and Wales
- Which provided examples where the side road carried either two-way traffic, one-way entering traffic, or one-way exiting traffic
- With both very little use by vehicles and a much greater level of use
- With both a complex environment and a simpler environment
- With steep vehicle access ramps, gentle ramps, and a lack of any ramp

[15] A definition of “main road” is given in Section 2

- With changes that created tight corners for those driving, and without tight corners
- Which convincingly created the appearance that the footway continues
- Which failed to convincingly create the appearance that the footway continues.

The phrases "complex environment" and "simple environment" refer mostly to the level of pedestrian use, but also to how pedestrians behave. In this sense complex environments include those where people might be in groups, walking in and out of shops, or where people are walking in many different directions. In contrast, simple environments include those where pedestrians tend walk alone, along a predictable set of routes.

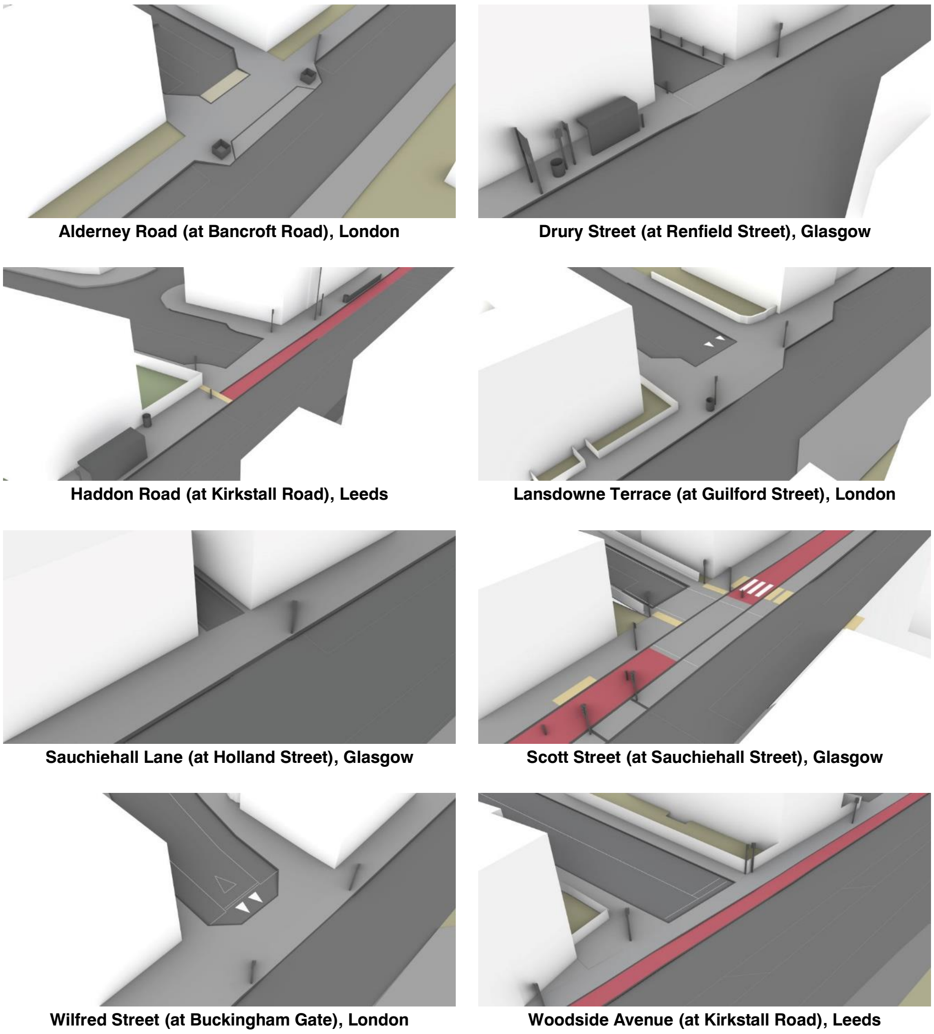
Our chosen detailed-study sites were as shown in Table 2. Full details, including illustrations, plans and photographs can be found in Appendix 2:

Table 2: Detailed-study site list

Unique ref	City	Name	Google Streetview and Openstreetmap.org links
CF-487	Cardiff	Glamorgan St at Cowbridge Rd East	https://goo.gl/maps/MsY2gf6zUc55JGWa8 Openstreetmap.org link
CF-72	Edinburgh	Simpson Loan at Chalmers Street	https://goo.gl/maps/Kvtyvniyke3PPzhz7 Openstreetmap.org link
CF-93	Glasgow	Sauchiehall Lane east of Holland St	https://goo.gl/maps/152diyU2SdCm1nB9A Openstreetmap.org link
CF-102	Glasgow	Scott Street at Sauchiehall Street	https://goo.gl/maps/nZTTvG18V8g3K1xL6 Openstreetmap.org link
CF-85	Glasgow	Drury Street at Renfield Street	https://goo.gl/maps/KmHduiH4echaqUzR7 Openstreetmap.org link
CF-2	Leeds	Kirkstall Road Haddon Road	https://goo.gl/maps/9a1LiDPNe4CmXFjz5 Openstreetmap.org link
CF-366	Leeds	Kirkstall Road Woodside Avenue	https://goo.gl/maps/ipPznRtuYhqYcLAx6 Openstreetmap.org link
CF-1	London	Lansdowne Terrace at Guilford Street	https://goo.gl/maps/ZwasTTsK4hu4gUp87 Openstreetmap.org link
CF-228	London	Wilfred Street at Buckingham Gate	https://goo.gl/maps/XWWDUPAH7LRvvA748 Openstreetmap.org link
CF-394	London	Alderney Road at Bancroft Road	https://goo.gl/maps/cPkqNenXXLQfyPaYA Openstreetmap.org link

To demonstrate the variety of designs involved, Figure 9 shows images from simplified 3D models of eight of the ten sites.

Figure 9: 3D model images of eight detailed-study sites



(3D model includes data © Crown copyright 2023, OS 100046668)

IN-PERSON STUDY

A number of repeat visits were made to some of these sites, enabling us to see them at different times of day and at different times of year.

Our in-person study (as distinct from the fixed camera analysis) of these sites included:

- Careful evaluation of the context of each location
- Recording the dimensions and features at each site, and producing simplified site plans

- Taking a structured set of photographs for reference
- Recording longer videos (up to around an hour in total) using hand-held cameras and temporarily-fixed wide-angle cameras
- Recording our experiences walking and (sometimes) cycling through these sites
- Taking structured and semi-structured observations and counts of vehicles and behaviour.

We carried out a count of different road users, with the aim of providing a general guide as to the level of use we were observing, rather than a detailed analysis.

Our approach was standardised, recording counts for ten minutes at a time. It was judged that these counts give a guide as to the level of use, and that this period was practical for in-person observation. At busier sites it was not possible for one researcher to record all traffic movement simultaneously. Instead, they recorded different aspects of use over two sequential 10-minute periods. This was a practical method to collect data from a 20-minute period (short enough so changes in level of use were small) but covering all users. At the busiest sites multiple observers were used to make this practical.

Where we saw more unusual behaviours, this on-site study also allowed us to take a record of how significant these were – for example at the Alderney Road site an unexpectedly high proportion of pedestrians were crossing the carriageway of Bancroft Road at the junction, and routes in and out of Alderney Road (the side road) appeared more important to drivers than routes along the “main” Bancroft Road.

Having this information meant that we were able to predict roughly what behaviours might be seen on the fixed-camera footage, and this also assisted in identifying the best locations for these cameras.

FIXED CAMERA SITING AND QUALITY

We used fixed cameras to provide footage of behaviours over a much longer period, using the services of the company Streets Systems. These were attached to a telescopic mast, which was held upright by attaching it to appropriate existing sign posts or lamp posts (i.e. lighting columns).

For most sites the cameras used provided four views, making it possible to cover multiple angles. Only one mast was used at each site.

Footage was recorded over at least two days, and often three days.

The footage allowed us (usually) to observe:

- Whether pedestrians turned their heads in looking for vehicles
- Whether pedestrians changed their walking or wheeling speed or rhythm
- The routes pedestrians took through the site.

The limitations of the footage included:

- At some sites we could not locate the cameras to see properly into the side road
- We could not judge facial expressions or other similar details
- We could not see the behaviours of drivers through the windows of their vehicles.

The main limitations in using camera footage are the same limitations that exist while observing behaviours in person.

STRUCTURED AND UNSTRUCTURED ANALYSIS

Our analysis of fixed-camera footage included both informal and structured elements, both being important.

Supporting both elements, Streets Systems were able to use artificial intelligence to extract clips of video which show situations where pedestrians and vehicles cross the same area within a short time of one another. For all but the busiest sites, this made it more efficient to analyse interactions, meaning we did not need to watch the full length of the video footage.

Streets Systems also used artificial intelligence to provide:

- Images onto which the paths of street users are traced, according to whether they belonged to certain categories (e.g. pedestrian, cyclist, car, van), combined into hourly and multi-day images
- Heatmaps (repeating the above, but with brighter colours showing areas of high usage)
- Counts of street users passing specific points (strictly speaking these were lines, not points), allocated to the above categories, and presented as graphs showing usage hour by hour.

7.2 Structured analysis of footage

We devised a structured process to allow an objective comparison of different sites.

Appendix 4 provides an explanation of the options considered for alternative analytical processes, and of the limits on structured analysis of behaviours at a side road junction.

SUMMARY OF STRUCTURED ANALYSIS PROCESS

In summary, the process involved:

- Analysis of the experiences of pedestrians, counting each "pedestrian experience" where something notable happened (ignoring the others) rather than counting each interaction
- Recording when we observed situations where we considered that what actually happened to pedestrians was unsatisfactory – assessed as a "Risk Level Actual" (RLA) measure
- Using a measure based on simplified predictions of what a blind or partially sighted pedestrian might have experienced from an interaction – assessed as a "Predicted Vulnerability Indicator" (PVI) measure
- Recorded indicators of "Observable Polite Driving" (OPD).

ANALYSING PEDESTRIAN EXPERIENCES RATHER THAN INTERACTIONS

Our decision to focus on pedestrian experiences rather than interactions between pedestrians and vehicles was a practical one. The need for this arises for a wide range of reasons, which we describe in detail in Appendix 4.

The most important reason is because one pedestrian can interact with multiple vehicles, and one driver can interact with multiple pedestrians.

At busier sites such multi-pedestrian/multi-vehicle interactions were common. For example we repeatedly saw situations with:

- Drivers giving way to pedestrians already crossing (because the alternative was to collide with them), with a number of pedestrians then feeling confident to cross in front of the stationary vehicle, partly because it was not moving and partly because other pedestrians had already halted its progress
- Pedestrians crossing in front of a vehicle because the vehicle was stationary in a queue of traffic waiting to exit the side road
- Pedestrians having an exiting driver give way to them, but with an entering driver continuing.

The character of these interactions cannot adequately be captured by a simplistic record of separate vehicle-pedestrian interactions (recording who gave way to who in each case). A balance was struck between over simplifying categorisation and creating an impractically high number of interaction categories.

For any study evaluating the effects of infrastructure design – overly-simplified approaches would provide misleading results, for example because:

- Vehicle drivers are recorded as giving way to pedestrians while they wait in a line of traffic queuing to exit (perhaps because they don't narrow the gap to a vehicle ahead), making a junction that is relatively difficult to cross appear to be prioritising pedestrians
- Sites with very high numbers of pedestrians will show high levels of vehicle give-way behaviour (almost) irrespective of the design of the infrastructure (these sites changing character when there are fewer pedestrians)
- Any count of the total number of interactions must either be highly subjective or limited in accuracy because many interactions can occur at a distance, with only subtle changes in driver behaviour (for example with a driver slowing slightly sooner so as not to intimidate a crossing pedestrian).

The last point is crucial. A well-designed junction might be one in which approach speeds are very low, and here there may be a much smaller number of interactions where pedestrians come close to vehicles – and a much larger number of distant interactions, where a driver makes only subtle changes in behaviour (avoiding a closer interaction). To be able to compare the performance of such a junction to one with a poor design both close and distant interactions must be counted.

In practical terms our process meant one record (in an analysis database) for every pedestrian or associated group of pedestrians (e.g. friends together) crossing, with a note made of the number of pedestrians in each group (with such a group sharing one common experience, but with this counted separately for each group member). For each experience, we recorded, where relevant, three key measures (RLA, PVI, OPD) as described below.

RLA MEASURE

The "risk level actual" (RLA) measure records actual problematic or unsatisfactory events, at two levels. The lower category (nominally recorded as "probably risky or worrying" or "prA") includes situations where we felt that a pedestrian was probably at some risk and situations where we thought the pedestrian was probably worried by what happened or by the conditions they experienced. The higher category (nominally recorded as "definitely risky or scary" or "drA") includes situations where we felt that a pedestrian was more at risk or was definitely alarmed or scared by the situation.

There is the potential for a high level of subjectivity in this measure. To ensure that we were working as objectively as possible we recorded a table indicating what events should be classified within this measure, and what events fitted within the lower or higher category. This is shown below as Table 3.

Note that this RLA measure is designed to be sensitive to problematic issues that might exclude some pedestrians, rather than being a way of evaluating actual risk as "moderate" or "high". Many pedestrians can be seen in our footage to be dealing well with what we classified as more risky or difficult situations.

Table 3: RLA measure details

Code	Risk level actual measure categories (RLA)
sA	**Situations not to be classified as risky or worrying/scary:** • Pedestrian: - continues without changing speed or direction - has to walk around a stationary car which is in the way - walks between queuing cars if there is no vehicle movement - walks in front of a waiting vehicle, or between waiting vehicles, using the drivable space (i.e. the space intended both for driving and pedestrians) without leaving the drivable space, if there is no vehicle movement - diverts off drivable space behind waiting vehicle if this is stationary or almost stationary - runs (rather than walks) out of politeness (not out of fear).
prA	**"Moderate" problems** **Situations to be classified as "probably risky or worrying", but which are not sufficiently so to be classified as "definitely risky or worrying/scary".** • Pedestrian: - steps into the main carriageway or associated ramp to pass in front of a waiting vehicle - appears to nearly walk into the side of a slow moving car but notices the risk at the last moment - walks in front of a waiting vehicle, or between waiting vehicles, using the drivable space (i.e. the space intended both for driving and pedestrians), without leaving the drivable space, if there is minor vehicle movement - probably could have crossed in time, but unusually high vehicle speed, large vehicle size, or other similar factors meant they chose not to try

	- show any signs of fear, or more raised concern for the welfare of small children, than is typical on crossing a road - alters direction, even a little, as a result of concerns about a vehicle pointing toward them - stops abruptly, but it looks like they were actively aware they might need to (e.g. walking quickly and looking actively up the side road as visibility becomes possible) - stops short of what is intended to be the drivable space because a vehicle entering or leaving the side road is driven outside that area (if they need to step back, this is recorded as drA). • Driver: - commits to a manoeuvre that they need to complete for their own safety, while pedestrians are very close to the drivable space (but there is no actual risk of a collision) - commits to entering the side road thinking they are clear to do so, but then has to hold, blocking traffic on the main road - holds short of hitting someone, is clearly aware they are there well before any risk of actually hitting them, but is assertive in driving as if the person is inconveniencing them.
drA	**"Higher" risk problems** **Situations to be classified as definitely risky or scary/worrying.** • Actual collision (none seen) • Pedestrian: - acts in alarm - takes a step back, or they stop abruptly if it seems they did not expect to need to do so - has to move back or sideways because a vehicle is encroaching in their space - uses the main carriageway to cross in front of a vehicle - runs, out of fear or worry - would have been stuck in a space one driver was expecting to travel through, had a driver travelling in the opposite direction not stopped their vehicle to allow progress - walks in front of or between waiting exiting vehicles if there is at the same time a risk from vehicles entering, including if a driver is waiting for a gap in traffic on the main road which will allow them to enter. • Driver: - commits to a manoeuvre they will be forced to carry out for their safety (because of another moving vehicle), and had the pedestrian not stopped, collision with one or the other seemed possible

	- commits to a manoeuvre to enter the side road, which they will be forced to carry out for their own safety, while a pedestrian is dealing with or emerging from negotiating exiting vehicles into the space the entering driver is needing to use. • A second driver does not hold clear despite the pedestrian dealing with negotiating a waiting exiting vehicle.

PVI MEASURE

The PVI measure seeks to provide a guide to the kinds of problem that might be faced by pedestrians who are blind, partially sighted, or who are less able to negotiate more complex and risky interactions with vehicles. This is not a measure of what happened, but a greatly simplified prediction of what might have happened had each pedestrian been blind or partially sighted.

Clearly any actual attempt to predict people's experiences would be entirely subjective, and likely inaccurate, so it is important to emphasise that **this measure is not an actual prediction of what experiences blind or partially sighted people would have at these locations**. Instead, the PVI measure used a set of more objectively observable factors to provide a broad numerical indication informing us about how well a junction was prioritising pedestrians. It does this by asking whether a pedestrian who assumed they were on a footway, and who continued without taking notice of any threat from vehicles, would encounter problems.

Specifically, the PVI measure asks what would have happened had the pedestrian we observed in the footage been blind or partially sighted, had they continued ahead at the junction without changes to speed or direction of travel. It makes the assumption that the pedestrian has no awareness of a potential collision with a vehicle, and that they take no avoiding action. It also assumes that the drivers of the vehicles involved behave exactly as captured in our footage, and that they do not take any additional action (over and above the way they were observed behaving in reality) to avoid a problem or collision – even as the potential for one became obvious.

Table 4 shows the indicators that could be selected for the PVI measure. More than one indicator could be chosen for recording each pedestrian experience.

Table 4: PVI measure details

Code	Predicted Vulnerability Indicators (PVI) summary	Explanation *(NB this is not a prediction of actual experiences - indicators are based on assumptions to provide an objective numerical measure of junction performance)*
HbC	“hit by car”	Pedestrian would have walked in front of a moving car sized vehicle
HbL	“hit by larger”	Pedestrian would have walked in front of a moving larger vehicle
HBl	“hit by bicycle likely”	Pedestrian would probably have been hit by a bicycle
HBr	“hit by bicycle risk”	There would have been some risk of a collision with a bicycle
TdMB	“touching distance moving bicycle”	Pedestrian would have walked within touching distance of a moving bicycle, but there would have been no collision
TdMC	“touching distance moving car”	Pedestrian would have walked within touching distance of a moving car sized vehicle, but there would have been no collision
TdML	“touching distance moving larger”	Pedestrian would have walked within touching distance of a larger moving vehicle, but there would have been no collision
WiMC	“walk into moving car”	Pedestrian would have walked into the side of a moving car sized vehicle (any movement)
WiML	“walk into moving larger”	Pedestrian would have walked into the side of a moving larger vehicle (any movement)
WiSC	“walk into stationary car”	Pedestrian would have walked into the side of a stationary car
WiSL	“walk into stationary larger”	Pedestrian would have walked into the side of a stationary larger vehicle

OPD MEASURE

The “observable polite driving” (OPD) measure is a way to record when we could see that drivers behaved politely. This tries to distinguish between drivers giving way because they are effectively forced to do so, from situations where they had chosen to give way (i.e. explicitly acknowledging the priority of the crossing pedestrians). It also allows a record of situations where drivers were effectively forced to give way, but where they did so with apparent politeness.

Table 5 shows the indicators that could be selected for the OPD measure. More than one indicator could be selected for one pedestrian experience.

Table 5: OPD measure details

Code	Observable polite driving indicators (OPD) summary	Explanation
Hg	“holds leaving gap”	Driver holds (stationary), leaving a gap in front of them on the drivable space (i.e. the area intended both for driving on and for pedestrians) which the pedestrian uses
Hm	“holds moving”	Driver holds clear of the drivable space while continuing to move, but moves in a way that appears to be intended to allow a pedestrian to cross at their established speed
HJc	“holds just clear”	Driver holds (stationary) just clear of the drivable space (with the vehicle partly on this, or otherwise dominating the space because it is close to the pedestrian)
HVc	“holds very clear”	Driver holds (stationary) very clear of the drivable space (or at the edge of this space where the result is that they are sufficiently distant from the pedestrian not to dominate the space)

7.3 Analysis results summary

Details of our analysis for each detailed-study site are in Appendix 2. This section presents four key graphs summarising observations and problems.

Figure 10 compares the numbers of pedestrians and vehicles crossing the drivable space, broken down to show the maximum and minimum numbers observed in any hourly period (in our study period of 7am to 7pm). (Note that vehicles at Lansdowne Terrace were mostly bicycles.)

The balance between vehicle and pedestrian numbers helped to determine the character of the environment at each site, but note that peak/minimum pedestrian/vehicle numbers did not necessarily occur during the same study hour.

Figure 10: Maximum and minimum pedestrian/vehicle numbers

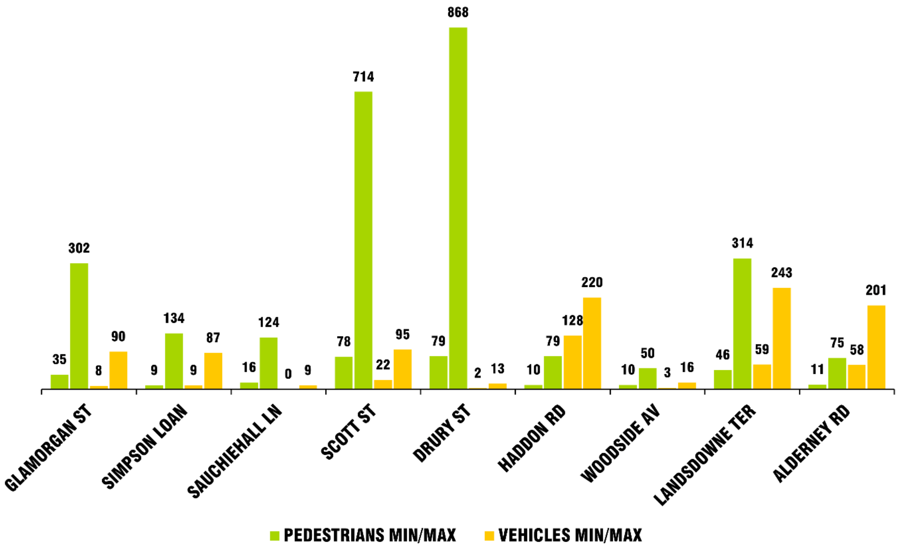


Figure 11 shows a graph on which actual problematic pedestrian experiences – flagged as including moderate or higher level problems according to the RLA measure – are plotted against the number of vehicles crossing the drivable space.

Figure 11: RLA plotted against number of vehicles crossing

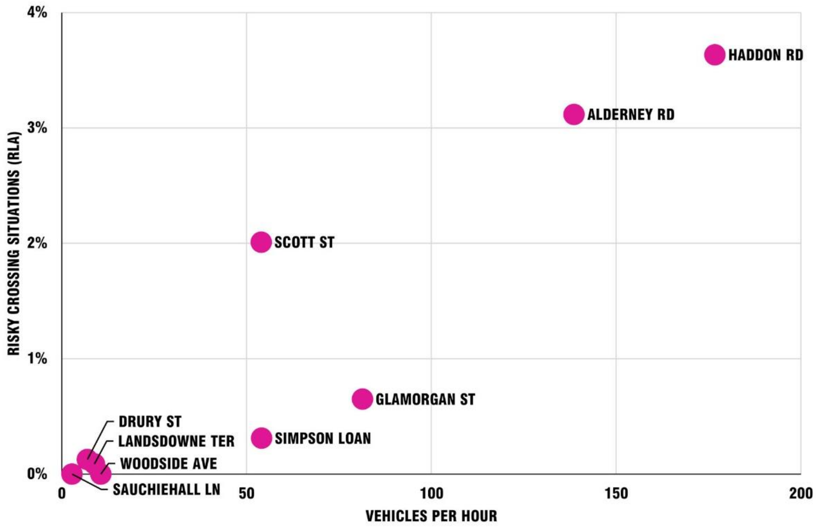


Figure 12 shows a graph recording situations for a pedestrian that we classified as problematic according to the PVI measure, plotted against the number of vehicles crossing the drivable space.

Figure 12: PVI plotted against number of vehicles crossing

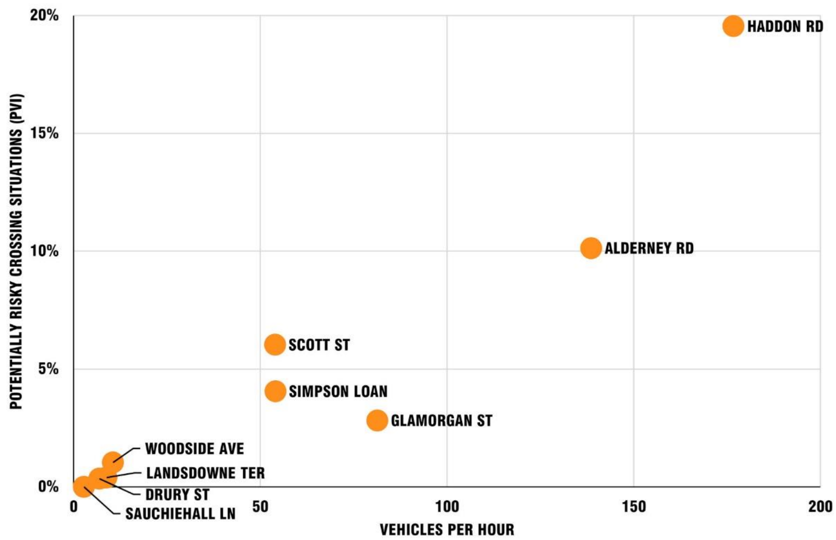
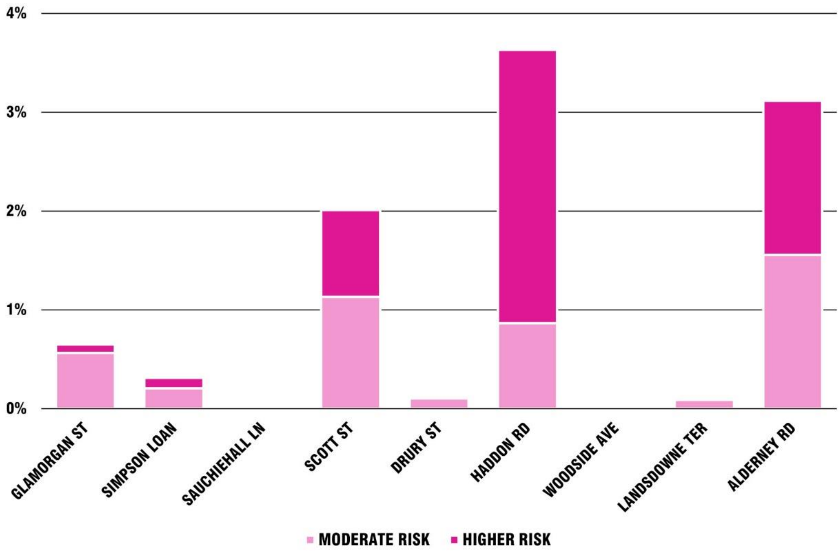


Figure 13 shows a histogram illustrating the percentage of pedestrian experiences that we flagged for each site as including moderate (pale pink) or higher level (dark pink) problems, according to the RLA measure, broken down to show the balance between these two categories.

Figure 13: RLA experiences by site



7.4 Learning

A BROAD FAILURE TO PRIORITISE PEDESTRIANS

It was established that problems existed at almost all our study sites. We did not speak to those involved in designing our detailed-study sites, but the evidence shows almost all fail to establish the degree of pedestrian priority which we consider designers were aiming for.

There is no doubt that at most of our study sites the design completely fails to create a situation where pedestrians "don't even have to look up" – which was clearly stated as an aim by one of our key designer informants. This is consistent with previous studies, which show a wide range of conditions at different locations, with at some sites a high number of situations where drivers forced pedestrians to yield (see the literature review for details).

Our conclusion is that critical factors in these designs not achieving priority for pedestrians include:

- The failure to force very slow vehicle speeds
- The provision of these designs in locations where drivers are approaching too fast

- The provision of these designs in locations where drivers do not feel able to comfortably slow down or stop
- The failure, in some locations, to convince drivers, via visual clues, that they are mounting / crossing a footway
- The provision of these designs in locations where there is too high a level of traffic movement.

Figure 11 and Figure 12 in the sub-section above show that the number of actual riskier experiences for pedestrians (RLA) that we observed, and indeed the number of experiences we predicted would theoretically have caused problems for some disabled pedestrians (according to our PVI measure), were *on* the whole just *products of the number of vehicles entering or exiting the side road*.

It can be seen from Figure 13 that at some of the sites at which higher numbers of vehicles were crossing between 2% and 3.5% of pedestrian experiences were flagged as problematic according to our RLA measure.

In some cases it was quite common to observe pedestrians who looked like they were struggling or who appeared concerned or frightened by the conditions they were facing. We could not capture objective data about fear, but as observers saw situations at some of the busier locations which alarmed us.

SUCCESS AT QUIETER LOCATIONS

Unsurprisingly, at quieter locations there were fewer problems for pedestrians. For example, we recorded:

- No interactions between pedestrians and vehicles in three days of video at the crossing of Sauchiehall Lane (at Holland Street)
- No difficult interactions (RLA) at the crossing of Woodside Avenue (at Kirkstall Road).

ADAPTABILITY OF MOST PEDESTRIANS

Pedestrians made adaptations to their behaviour at locations where this was necessary to stay safe, for example:

- At some sites, at times, pedestrians could be seen behaving with particular caution, looking carefully for oncoming vehicles before crossing – and at busier sites lining up in groups, waiting to cross
- At sites where there were vehicles queuing to exit, pedestrians usually moved slightly into the side road, leaving the area intended for their use (the drivable space), in order to cross behind or between vehicles
- At busier sites, pedestrians could sometimes be seen crossing slightly into the side road, distancing themselves a little from entering vehicles.

Pedestrians could also be seen taking decisions based on only the very briefest of glances, and we suspect that on many occasions people were utilising additional information, such as from the sound of traffic. They also sometimes seemed to be making complex calculations, for example by judging that an exiting queue of traffic was about to move.

On many occasions pedestrians were observed making sudden judgements about how to stay safe, for example:

- Suddenly stopping when a vehicle passed close in front of them
- Stepping backwards to keep clear of an entering vehicle which had encroached onto the space they had been standing on.

This adaptability of most pedestrians can create a misleading situation where infrastructure looks to be well-designed because most cope with using it, and injury rates are low. However, the specific impairments of some disabled people mean they do not have the same information available to them, or power to act as easily to stay safe. Some others have impairments to their mobility which limit their options physically. And a third group, which includes younger (non-disabled) children and some neurodiverse people, are less able to make the more advanced judgements needed to stay safe or to make progress in these more complex situations.

ADAPTABILITY OF DRIVERS

We saw many interactions between drivers and pedestrians in which it was evident that the driver was responding on the fly to the situation that had emerged ahead of them. In such circumstances it was obvious that the driver was giving way, sometimes by reacting very quickly, in order to avoid hitting a pedestrian who had walked into their path.

Such interactions are of a different character to those in which a driver gives way *in anticipation* of a pedestrian:

- Arriving and wishing to cross
- Intentionally walking into their path (perhaps asserting their presence to force the driver to give way)
- Walking into their path accidentally (having not noticed either the drivable space or the presence of the oncoming vehicle).

While the differences between these interactions were sometimes obvious (subjectively), there were also many interactions that could not easily be categorised – there being no objective method for an observer to determine whether a driver was anticipating a need to give way, giving way voluntarily, or giving way because the alternative was to run into the pedestrian.

SOME CONTINUOUS FOOTWAYS SUCCEED

There *are* locations where pedestrians are, at least commonly, being prioritised, and where the level access provided by continuing the footway has advantages for all users. The situation at Sauchiehall Lane was a good example, as was that at Drury Street (also in Glasgow).

At Sauchiehall Lane, the low levels of vehicle use mean that it is very unlikely that a pedestrian and vehicle will meet, while the ramp and constrictions of the lane force vehicles to be driven very slowly.

For the purposes of general navigation, it is important for the presence of side roads to be detectable by blind and partially sighted pedestrians. However where very minor entrances, like to Sauchiehall Lane, exist in an otherwise complex and compact streetscape it seems unlikely that the loss of the detectability of this lane will lead to problems.

Our data shows where traffic is very low and the time traversing a continuous footway across a minor entrance/exit like this is short, the risks of negative experience are minimal. Meanwhile, the level surface and the ability to proceed without any pause or worry are an advantage.

At Drury Street, the high levels of pedestrian traffic, low level of use by vehicles, and constraints provided by the narrow lane, effectively create pedestrian priority. However, there were some unsatisfactory interactions observed here, and the success of this particular continuous footway is qualified. The absence of a steep ramp, and the width of Renfield Street at this point, mean that vehicles could take a relatively fast and/or sweeping path on entering, or could cross the drivable space at odd angles (i.e. more parallel to the footway rather than pointing their vehicle more obviously along the line of the lane).

EFFECTS OF PEDESTRIAN NUMBERS

At junctions where there are a large number of pedestrians present, particular behaviours emerged. Based on an informal analysis, we concluded that these included the following:

- Drivers were more likely to be more cautious when they could see lots of pedestrians ahead of them. We suspect that the presence of a number of pedestrians becomes much more obvious than the presence of a single pedestrian; also that it becomes much more difficult for an approaching driver to interpret and predict behaviours as the number of pedestrians increases.
- Where there were more pedestrians, there was a much greater chance that a driver arrives when pedestrians are crossing the space they wish to drive over. In these circumstances almost every driver held back, and where necessary to

avoid causing injury, stopped to wait. This created a situation where following pedestrians were confident to cross, meaning the driver waited for them too.

- Individual pedestrians in larger crowds may be taking less notice of a junction, relying on the responses of people around them rather than carefully checking for themselves for oncoming vehicles.

LIMITED EFFECTS OF FOOTWAY APPEARANCE

We saw no evidence that the presence of structures that appear to continue the footway, but which don't also restrain vehicle speed and path, automatically lead to good driver behaviour.

Examples include the performance of the structures at the end of Alderney Road (with Bancroft Road) in London and at the end of Haddon Road (junction with Kirkstall Road) in Leeds. The Alderney Road structure is of a different colour to the carriageway, matches the footway, and is raised to footway level. In contrast, the Haddon Road structure is visually insignificant, as both footway and carriageway are asphalt, and this is flush with the carriageway. Yet we recorded a rate of problematic situations which was roughly comparable at both sites once the higher levels of traffic at Haddon Road were considered.

ADDITIONAL PROBLEMS WITH ENTERING VEHICLES

Conditions observed in this study were consistent with observations from previous studies about the higher number of problematic situations caused by vehicles entering the side road (in comparison to those exiting). In observing behaviours, we concluded the following:

- Entering drivers might not be anticipating a need to stop, so they maintained a higher speed if they could. Exiting drivers were already anticipating a possible need to stop at the main road, if only for their own safety, and this seemed to make them more inclined to stop.
- Some entering vehicles could only be seen by pedestrians looking behind (i.e. over their shoulder), whereas exiting vehicles could be seen by looking to the side.
- It seemed to be difficult for pedestrians to separate out which drivers were intending to turn, within a stream of approaching vehicles. Not all drivers indicated, and even if they did it takes longer for a pedestrian to look for this than to spot a vehicle leaving the side road.
- Vehicles on the main carriageway were likely to be approaching faster, meaning that predictions about the intention of their drivers needed to be made at a greater distance.

Conditions on the main carriageway made a difference to how drivers behaved on turning right into a side road. In busier traffic, most obviously at Haddon Road, these drivers faced a choice between waiting a longer time and taking a greater risk. We could see drivers sometimes made a turn judging that they would be able to clear the main carriageway before a collision occurred (notably sometimes in front of large, fast-moving vehicles). It seemed unlikely that those drivers, under considerable pressure to make that one judgement accurately, had accounted for pedestrians crossing.

We observed pedestrians taking account of such a situation by waiting to cross.

EFFECTS OF EXIT QUEUING

Situations where there is traffic queuing to exit the side road produced quite a different environment for pedestrians, in comparison to those where exiting vehicles were rarer.

The environment created by queuing exiting vehicles could be difficult and problematic, for example:

- Vehicles were physically in the way
- Pedestrians had to account for the risk that vehicles move unpredictably, for example rolling backwards or forwards (with a risk of being crushed between vehicles)
- The presence of queuing vehicles visibly dominated the junction
- Pedestrians needed to deal with both queuing and entering vehicles simultaneously.

Figure 14 illustrates conditions created when four vehicles were queuing to exit Haddon Road in Leeds. The driver of the blue car has been waved into the road by the driver of a small white lorry, and the driver of a black car (nearer to the camera) has stopped in response. Typically pedestrians here could be seen, in such circumstances, to move into the side road, passing between vehicles further back from the intended crossing point at the end of the side road while at the same time taking care to watch for vehicles turning in.

Figure 14: Queuing exiting vehicles (Haddon Rd, Leeds)

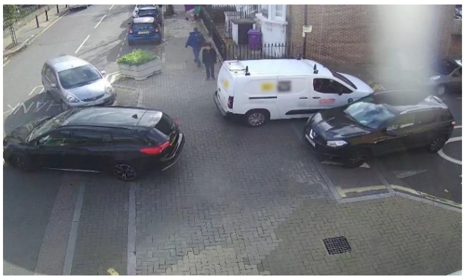
EFFECTS OF TWO-WAY MOVEMENT

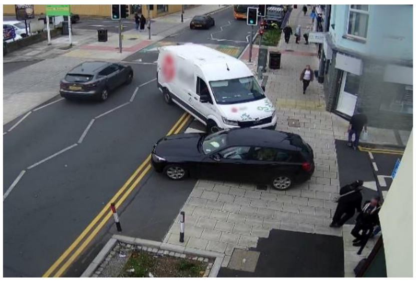
Situations where pedestrians were simultaneously negotiating entering and exiting vehicles were of a very different character to those where they were only dealing with a threat from one direction. The problems included:

- The need to watch for traffic from multiple directions
- The need to judge the behaviour of more than one driver at one time
- The reduced availability of options when making a mistake
- Crossing pedestrians could be hidden from entering vehicles by the presence of exiting vehicles
- The view of entering vehicles was blocked for pedestrians by exiting vehicles.

Figure 15 shows images extracted from video footage of two-way traffic movement at Alderney Street (London) and Glamorgan Street (Cardiff). In both cases pedestrians are faced with complex vehicle movements, and drivers are negotiating conditions in which they are focused on avoiding damage to their vehicles.

Figure 15: Video captures showing complex vehicle movements





EFFECTS OF APPROACH SPEEDS ON THE SIDE ROAD AND THE MAIN ROAD

Researchers judged that vehicle approach speed from the side road had an effect on pedestrian behaviour. We did not attempt to assess vehicle speed objectively because of the prohibitively difficult technical challenges involved in doing so. Effects were observable by noting the differences in the behaviour of different drivers at an individual site – with vehicles approaching faster or more slowly.

When vehicles were approaching faster, pedestrians were more cautious. We theorise that this added caution arises because people wanted to be confident about having sufficient time to cross safely, and because they may have considered that drivers of faster vehicles would be less likely to stop.

A vehicle approaching faster seems sometimes to cause pedestrians to hold back for a disproportionate length of time, giving way before this is strictly necessary. Pedestrians need to respond to these faster moving vehicles while the vehicles are much further away from the junction, making judgements more difficult. Adding a margin for error in such circumstances has a bigger effect than when a vehicle is approaching more slowly.

Our observations on the effect of approach speed on the main carriageway are more limited. Determining whether pedestrians were responding to subtle signs that a driver was intending to turn into the side road was challenging. However, it seems self-evident that approach speed has an effect. We theorise some drivers may assume speed (and momentum) gives them priority over crossing pedestrians.

For pedestrians it can be difficult to judge which vehicles are turning into a side road given:

- Any increase in traffic levels, because there are more vehicles to look at
- Even small increases in approach speed, as these mean that judgements need to be recalibrated, especially if a vehicle is accelerating or decelerating
- Drivers considering giving way to a pedestrian may be less comfortable in holding up others when in heavy traffic
- Drivers considering giving way may feel less safe doing so if in faster moving traffic
- Drivers turning right across traffic are under greater pressure when approach speeds and levels of traffic are higher.

Our literature review noted that previous studies provide evidence that the most problematic pedestrian-vehicle interactions occur when drivers are turning right from the main road into the side road. At our detailed-study sites the problems with “right turn in” movements included:

- Drivers taking a relatively fast, sweeping turn, maintaining speed
- Drivers choosing to take the right turn in front of larger or faster oncoming vehicles, relying for their safety on their judgement that they would be clear of the main road before there was any collision
- Some of the drivers we saw turning right seemed to be preoccupied with looking for a suitable gap in traffic, consequently paying little attention to crossing pedestrians.

EFFECTS OF GIVE-WAY LINES

Informal observation of whether drivers gave way at the position officially marked with white dashed give-way line markings, suggested that, in the absence of pedestrians:

- Many drivers did not actually stop their vehicles at all, even when giving way to other traffic – continuing to move slowly, judging when they could continue, and only stopping when there was no other option
- Those drivers who did stop their vehicles to give way, did so at the point when they could not keep moving without inconveniencing or alarming drivers in oncoming traffic.

EFFECTS OF PERMANENT BARRIERS TO VISIBILITY

At some of our study sites exiting drivers had very little time to respond to pedestrians intending to cross, as these pedestrians emerged from behind walls, or parked vehicles. This influences whether drivers give way, as many did not have the opportunity to do so. This problem was, of course, worse in the case of higher approach speeds.

Figure 16 illustrates the difference between two designs (showing a raised side road entry treatment rather than a continuous footway). The first creates a situation where a pedestrian can step onto the raised section of carriageway having taken only one or two steps after becoming visible to a driver. In the second image the pedestrian is visible to a driver for three or four times as long before they step onto the carriageway.

Figure 16: Pedestrian visibility - difference in time available for driver to respond

We chose one study site, at the junction of Simpson Loan with Chalmers Street in Edinburgh, to study this effect (Figure 16 is roughly modelled on conditions here).

Pedestrians crossing Simpson Loan while walking north (in a situation as shown in the left image above), typically take only around two steps between them becoming visible to an exiting driver, and them stepping onto the space used by vehicles. A wall blocks visibility of pedestrians, and their views of approaching vehicles. Southbound pedestrians are visible for very much longer (being in a situation roughly equivalent of that shown in the right image – although the build-out section of footway here is even longer than that illustrated).

There were many situations in which exiting drivers had insufficient time to respond to northbound pedestrians, however we recorded few situations where pedestrians were at risk because they stopped and looked as at any other junction (this site having been chosen as an example of a side road entry treatment rather than as an example of a continuous footway).

On the other hand, southbound pedestrians are visible for a protracted period before arriving at the crossing point. However, we saw little evidence that increased visibility of southbound pedestrians on its own led drivers to give way more often. There were some occasions when drivers appeared to behave in a way which allowed southbound pedestrians to cross by driving more slowly toward the junction – but such effects are very difficult to quantify.

EFFECTS OF RAMPS ON SPEED

Appendix 2 provides an additional commentary on the ramp designs (or lack of ramps) at our detailed study sites, the gradients and heights of these, information about Dutch entrance kerbs and their use in exit constructions, and the availability of different entrance kerb units in the UK.

Subjectively, it appeared that at most of our detailed-study sites vehicles could be driven at a problematically high speed over the crossing point (drivable space).

Speeds were not measured because of the level of technical challenge involved. This difficulty relates to the need to gauge the changing profile of vehicle speed over the infrastructure rather than the speed at any one easily identified point.

Figure 17 shows ramp design, or the lack of a ramp, at Sauchiehall Lane, Wilfred Street, and Scott Street. More images are provided in Appendix 1 and 2.

Figure 17: Differing ramp designs (and lack of ramp)

Self-evidently, sufficiently steep and high ramps, bringing the carriageway to footway height, force drivers to moderate their speed to avoid discomfort or even minor damage to the vehicle.

In some locations there were no ramps provided or these were in an unhelpful location. At the junction of Scott Street and Sauchiehall Street in Glasgow (the third image in Figure 17) there is a ramp on the main carriageway (raising the main carriageway to the level of the surrounding footway, leaving no difference in height at the location where ramps were used at those other sites where they were included). This ramp was of a gently sloping design, and some vehicles here did not slow at all. The raised carriageway allowed problematically fast, sweeping turns into the side road. The design at Drury Street in Glasgow also has no ramps. In Walthamstow the standard designs lack ramps.

Where ramps were present we looked to see if drivers noticeably slowed down, for example to a walking pace, but did not see any evidence of this being a consistent and predictable effect – other than at Sauchiehall Lane. We thus judge that the ramps elsewhere were not steep or high enough.

In Section 8, *Discussion of core findings*, we suggest that good continuous footway designs will always include ramps which are sufficient to slow vehicles to around walking pace.

EFFECTS OF A LACK OF CONSTRAINT ON VEHICLE PATH

Problematic situations were seen to arise at sites where drivers were able to negotiate the turn into or from the side road in a sweeping curve.

Figure 18 illustrates the effects on vehicle path of tighter corner radii at a standard side-road junction. A slight tightening of corners, as shown in the second image, might mean a driver having to slow their vehicle before entering the side road. The third image shows that a more severe tightening of corners might make it necessary to slow a vehicle considerably just to negotiate the junction without risk of damaging the vehicle. A positive side effect of this layout is that tactile paving and kerbs, and the slope on any dropped kerb arrangement, define a clear direction for crossing (rather than pedestrians crossing at a point where these are at an angle to their direction of travel).

Figure 18: Differences arising from tighter corners (standard junction design)

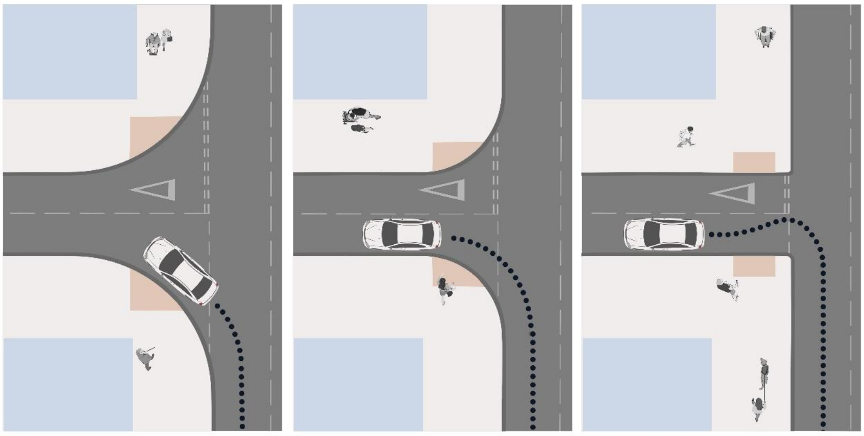


Figure 19 illustrates the problems seen at the Scott Street junction (with Sauchiehall Street). The left image is taken from the fixed camera, and beside this the right image shows traces, superimposed on that image, indicating the paths taken by cars entering the side street here (the numbered arrows indicate points used to analyse vehicle and pedestrian numbers). It can be seen that vehicle drivers are free here to follow a sweeping curve as they cross the drivable space.

Figure 19: Problems with lack of constraint on vehicle path, Scott Street (Glasgow)

Figure 20 shows images from the fixed camera used to study the site at Glamorgan Street (at Cowbridge Road East) in Cardiff. Problematic conditions were sometimes seen here – particularly when vehicles were both entering and exiting simultaneously. However, some constraints to vehicle path – not least caused by the width of Glamorgan Street when vehicles are travelling in both directions – are evident.

Figure 20: Constraints to vehicle path, Glamorgan Street (Cardiff)

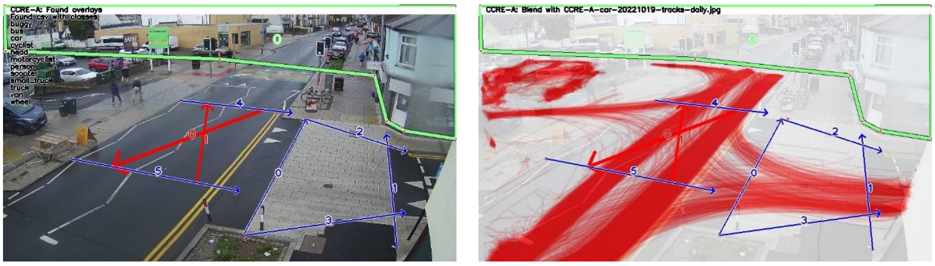


Figure 21 shows a sequence of images from the fixed camera at Haddon Road, Leeds. In these it can be seen that

- The car entering the side road is in heavy flowing traffic
- The vehicle path is a sweeping curve, encountering the area the pedestrians are walking well before this is lined up for travelling along the side road
- The vehicle effectively arrives from behind the pedestrians
- Because there are no exiting vehicles the driver is able to use part of the "wrong" side of Haddon Road as part of the sweeping curve.

Figure 21: Sequence of images captured at Haddon Road (Leeds)

8 Discussion of core findings

8.1 Introduction

This project has yielded evidence that structures being called "continuous footways", on wider busier public side road ends, are failing to provide a high degree of priority for pedestrians.

The project team spent many months observing the behaviours of both pedestrians and drivers, investigating how different infrastructure hindered or benefitted pedestrian movement and safety. There were times when we saw positive driving behaviour, which matched design aspirations, only for us to then witness the power of an individual impatient driver to undermine any sense of pedestrian safety and comfort. It is apparent that the fine details of design can have a crucial impact on whether designs prioritise pedestrians, but it is also evident that wider street and traffic conditions have an effect too.

In reporting on this study there is a fine line between describing the problems observed with new infrastructure, and the risk that such criticisms will be taken as a defence of the *status quo.* There are important lessons to be learned, but it is equally crucial to acknowledge that existing streets (without continuous footways) exclude or intimidate a wide range of pedestrians, and consider pedestrian priority as, at best, an afterthought.

If what has been tried isn't working well then this raises important questions about alternatives. There are some obvious simple changes that might help to improve matters a little. These include the addition of dropped kerbs, tactile paving, signalised crossings (i.e. with traffic lights), and additional maintenance. However, it seems highly unlikely that traffic signals can be added at every busy side road junction, and while adding dropped kerbs and tactile paving is essential it does nothing for the overall priority of pedestrians. This research highlights the need for much wider changes to our streetscapes, including at side road junctions and entrances. We have considered where the idea of a continuous footway fits (and doesn't fit) with this, and what design details are important.

With a view to drawing together the many threads of a complex project, this section is framed as a discussion, organised in themes. This includes both conclusions and recommendations. Many of these are high-level, but some provide important supporting findings of detail.

The main conclusions and recommendations are listed separately in the final section, "Summary of main conclusions and recommendations".

8.2 Core findings

CONFUSION OVER WHAT A CONTINUOUS FOOTWAY IS

The literature review determined that there is a high degree of confusion over what is, and what is not, a continuous footway. This was confirmed in conversations with designers, and from evidence throughout the rest of the project work.

This complicates any discussion over the effectiveness of continuous footways, and about how they should be designed. The resulting lack of design standardisation also has real-world effects.

However named, there are a growing number of side-road junction treatments where new designs – often with some similarity to continuous footways – have decreased or removed the distinction between carriageway and footway.

For more details about the level of confusion over terminology and the lack of standardisation, please refer to information in the accompanying literature review, and on conversations with designers (Sections 3 and 5.3).

DESIGN INTENTIONS DO NOT NECESSARILY RESULT IN THE DESIRED OUTCOMES

Based on consultation interviews, work with disabled people, and the detailed-study site work, it can be concluded that

(i) different designers of continuous footways – or designs being called continuous footways – may have had quite different objectives

(ii) outcomes for users are not necessarily in line with designer expectations.

There appear to be three principal strands in terms of designer intention. These are that behaviour would be changed by:

- *creating ambiguity between what is footway and what is carriageway* (leading to everyone being careful and looking out for one another)
- *creating an unambiguous continuation of the footway* (leading drivers to behave carefully simply because they feel they are driving over footway)
- creating an *unambiguous continuation of the footway, but with behaviours determined as much by strong constraints on vehicle speed, path, and movement complexity* (i.e. both forcing vehicles to slow and using appearance to encourage cautious driving).

Designs can be seen to fail in different ways when compared to the designer's intentions. Problems may arise because:

- The theory was wrong or incomplete. For example, some designs fail despite creating ambiguity and others fail even when they appear to have created unambiguous continuations of the footway.
- A design is intended to create one effect but creates another. For example, some designs intended to create unambiguous continuations of the footway in reality create an ambiguous drivable space, or simply something that to drivers seems to be part of the carriageway.
- The physical constraints on driver behaviour are insufficient. Some designs can be seen to have ramps that fail to slow vehicle speeds, or a design allowing drivers to enter the side road driving at speed in a wide sweeping curve.
- The volume or speed of traffic using the streets is too high. We saw similar designs used on different streets performing very differently, because of the number of vehicles using them or their speeds.

The last point is a particularly important one. Our study showed that different behaviours arose at sites that appeared similar, but where overall traffic conditions were different – or at single sites as traffic conditions changed during the day. This points to questions that are wider than about design principles.

BOTH SUCCESS AND FAILURE WERE OBSERVED

This study observed failures to prioritise pedestrians but also found evidence that continuous footway designs may be useful in some places. Some lessons can also be applied to the design of footway crossovers. Our broad observations are:

- Most of the infrastructure currently being called a continuous footway, or which attempts to continue the footway over the end of wider side roads in Britain, does not successfully prioritise pedestrians over vehicles. This has implications for inclusion.
- Pedestrians are disadvantaged where the footway appears to continue, but drivers still assume priority crossing the drivable space.
- Pedestrian priority is reduced where traffic volumes and speeds are higher
- While some continuous footway designs clearly fail to prioritise pedestrians, there are locations where there are more benefits than disadvantages arising from the use of 'real' continuous footway designs (which create unambiguous continuations of the footway).

- Features of good quality 'real' continuous footway designs at the end of *public* side roads would also have value if used to improve footway crossovers to/from a *private* area or access.

The clearest examples of positive effects were on Sauchiehall Lane in Glasgow – a location with low vehicle use and strong constraints on vehicle speed and movement.

For more information, please refer to sections reporting on work with disabled people and on our detailed-study sites (Sections 6 and 7).

ADDING TACTILE PAVING TO FAILING DESIGNS

The study raises questions about how to improve those locations where infrastructure can currently be seen to be less inclusive than desired.

A key question investigated was in relation to the use of tactile paving at continuous footways. Guidance is currently contradictory, and many of the concerns raised with us were about the absence of tactile paving at continuous footways in Britain.

As noted throughout this report, at most of the detailed-study sites pedestrians were not being provided with unambiguous priority. There were also regular situations where they needed to respond to risks from vehicles to maintain their safety. In such circumstances, as a minimum alteration, a standard arrangement of blister-style tactile paving should be retro-fitted to the kerb free edge of the area so that blind and partially sighted people can know to stop before crossing the path of vehicles. Mapping the problem, and developing local retrofit programmes is a matter of urgency in terms of inclusion and safety.

This conclusion applies equally to sites with footway crossovers (providing vehicle access over the footway to private sites) where high numbers of vehicles cross the footway (for example at entrances to petrol stations and car parks), especially where crossover design allows for faster vehicle speeds.

This is an important conclusion, but it does not imply that standard tactile paving arrangements should necessarily be used where it is possible to create more effective continuous footway designs nor at all footway crossovers.

From our observations, we concluded that tactile paving would not deliver benefits at the quietest of our study sites, where pedestrians were crossing very narrow lanes. Nor is there evidence that using tactile paving at most smaller footway crossovers (such as private driveways) is likely to have benefits. Unintended consequences include costs, maintenance issues, and the introduction of significant problems for users who find tactile paving difficult to negotiate. Indeed, the provision of tactile paving at every small lane entrance and every private access, even if such a programme was realistic would, for blind and partially sighted pedestrians, undermine the significance of the tactile paving at major entrances or side roads.

FUTURE USE OF 'REAL' CONTINUOUS FOOTWAYS ON SIDE STREETS

The evidence we have collected suggests that 'real' continuous footways, which are well designed and standardised and installed in appropriate locations, could prioritise pedestrian movement. This could apply on side road junctions not just like those at Sauchiehall Lane or Drury Street, but also on what are currently wider entrances/exits. However, the determining factor is likely to be the creation of conditions more like those we saw at these sites – with only very slow vehicle speeds possible, very low vehicle numbers, and very simple vehicle movements.

Such conditions do already exist in some locations in British towns and cities, but this raises questions about how such conditions could be created more widely. This would require greater reform – but greater reform seems essential if pedestrians are to be prioritised by any means.

8.3 The need for standardisation and clarification

FUTURE USE OF THE TERM CONTINUOUS FOOTWAY

To make this report consistent and understandable we have had to invent new terms. For example, we refer to 'real' continuous footways to distinguish designs that unambiguously continue the footway, compared to approaches where the intention is less clear. Similarly, for the space that can be driven over in more ambiguous designs we refer to the "drivable space" – as in such situations it is not obvious whether this area is functioning primarily as a footway or carriageway.

This is just one of many issues that illustrate the high degree of confusion that currently exists around the use of the title continuous footway, and about what designs are covered by it.

The clearest response to this confusion would be to standardise the use of the term – applying it only to those 'real' continuous footways where an unambiguous continuation of the footway exists. This is to be recommended.

An alternative might be to adopt the Dutch use of the title "exit construction" for a more carefully defined feature, with reference to the Dutch designs. However, this is probably unhelpful given the current proliferation of alternative terminology.

If use of the term continuous footway is standardised as referring to 'real' continuous footways then this raises questions about what to call the many ambiguous arrangements that already exist, which it wouldn't cover.

There are two existing terms in common use, which might apply to such arrangements: "side road entry treatment" and "raised side road entry treatment". These terms are used to refer to a broad range of designs under each heading, rather than any one recognisable design. It is recommended that in future these terms are used to refer to any arrangement that fails to provide an unambiguous continuation of the footway. There may be other alternative catch-all descriptions, such as "traffic-calmed junction".

For more information about the problems with terminology, please refer to Sections 3 and 4, describing the literature review and the mapping work respectively.

DESIGN STANDARDISATION

In other areas of road design, standardisation is used to ensure that infrastructure has recognisable meanings to drivers. It seems likely that standardisation of continuous footways is necessary to create predictable driver and pedestrian behaviours. If continuous footways become a recognisable well-defined element of infrastructure this will help drivers understand how to deal with them. Where necessary rules could be created to apply to these situations (in the Highway Code), something that would be difficult as things stand.

Piloting 'real' continuous footways should be the first stage in a national programme seeking this standardisation. The use of standard design elements is critical. This should start with the use of a recognisable entrance kerb, of appropriate gradient, materials and colour.

For more information about standardisation of equivalent designs elsewhere, please refer to the summary of the literature review (Section 3).

CLARIFYING CLOSE CONNECTIONS WITH FOOTWAY CROSSOVERS

It seems unhelpful to continue to provide designers with guidance which implies that continuous footways and footway crossovers are entirely different pieces of infrastructure. There is no practical difference between a footway continuing across a small public lane and a footway continuing over an equivalently sized private access road.

Figure 22 shows images illustrating the connections.

Figure 22: Images of footway crossovers

Footway crossover to private driveway
(problematic crossfall/slope over whole footway width)

Footway crossovers along a longer stretch of footway
(problematic crossfall/slope throughout)

Exit construction (using entrance kerbs)
at a Dutch petrol station – part of creating a level footway

Dutch-style entrance kerbs (by Charcon) being added at a footway crossover (to a private driveway) in a new residential development, to create a level footway
(photo © courtesy of Aberdeenshire Council)

It seems essential to support designers by clarifying the legal differences between the provision of access across a footway to a public street, versus that across a footway to a private area or access. Specifically, questions about the legality of providing vehicle access over a footway to a public street must be answered. For more information about these issues, please refer to the summary of the literature review in Section 3.

There are also related issues in regard to how legally drivable areas, and non-drivable footways, are described in traffic orders – with these being clearly specified (without ambiguity).

Clarifying the close connections between continuous footways and footway crossovers is important. This will help to link discussions over the conditions and design features needed to ensure that the infrastructure functions well and is inclusive – whatever more theoretical differences there might be between these.

In the long-term drivers may be encouraged to adopt more careful behaviour at continuous footways through the consistent use of the same ramps at footway crossovers as at 'real' continuous footways, and in particular the adoption of appropriately steep, high, and recognisable entrance kerb style ramps. For more information about ramp design, please refer to Appendix 2.

8.4 Building understanding between designers and users

THE PERCEPTIONS OF DESIGNERS AND USERS ARE OFTEN VERY DIFFERENT

When discussing questions of safety from traffic, most of the user-orientated organisational representatives we interviewed believed that continuous footways created situations *where pedestrians needed to stay alert, choosing a safe time to cross the side road by observing traffic, or negotiating visually with drivers*. This contrasted with designers and others involved in providing continuous footways, who told us the objective was to create situations *where pedestrians did not need to do this at all*.

While we saw evidence that some designers lacked detailed knowledge, and that supporting guidance was limited or flawed, we found no evidence to back up the strong (negative) views of some disabled people on designers' capabilities and motivations. In contrast, we heard from a range of designers, and from associated professionals, about their passionate wish for streets to be improved for all pedestrians, including disabled people.

In contrast some designers explained that problematic designs were arising because those wanting to do really good work were being forced to compromise, by people they described as "highway engineers", those involved in road safety audits, or by others focused on improving or maintaining capacity and flow (traffic speed and volume) entering and leaving junctions.

It was notable that none of the people interviewed as representatives of user-orientated organisations (which were focused on disability and inclusion) spoke about continuous footways being introduced as part of more comprehensive efforts to improve streets for pedestrians. This contrasted strongly with responses from those involved in designing and providing continuous footways, who tended to present their use as just one element in a much bigger potential programme of change.

Our observations do not necessarily imply that design-orientated informants were right and user-orientated organisations wrong. For example it might be argued that while designers were reporting an idealised vision of long-term change, user-orientated organisations, and disabled people, were reporting their real-life experience of those changes.

To some extent we could see that these designers and organisations representing disabled people might share overall objectives, while being divided into two different camps, with a lack of connection or knowledge-sharing being a significant problem.

Worryingly, it was evident that there is a real risk that opposition to more radical change, from those who are – not unreasonably – afraid that their needs are being ignored, may help entrench the *status quo* of traffic dominance and low pedestrian priority. This can make good quality changes less likely. A divide and rule situation makes desirable outcomes for pedestrians less likely.

Work is needed to lessen the divide between these two camps. The aim should be to build allegiances, connections and real in-depth knowledge around what seems to be a strong shared desire for streets that prioritise pedestrian movement. This requires time and effort. Designers, and others promoting changes to streets, must devote more resources to working in depth with disabled people – and the time of disabled people must be valued properly. Consultations and engagement work should not be limited to a set of pre-determined options, instead offering scope and openness for real learning. Some of the organisational representatives we worked with highlighted recent lost opportunities to involve them, at an early stage, in work that supports the use of continuous footways. Unfortunately, the kind of more comprehensive work which we carried out as part of this project, with disabled people and relevant organisations, remains rare.

BETTER UNDERSTANDING OF VISUAL IMPAIRMENT AND NAVIGATION

It is important that designers understand how changes made to streets can profoundly affect disabled people, and others on the edge of being excluded. Designers involved in providing changes to side road layouts (including with the use of continuous footways) should know the key factors making navigation safe or dangerous, or easy or difficult, for blind and partially sighted people. These do not necessarily preclude the use of new designs, but a lack of an understanding means that new designs may exclude people.

Most significantly, it is a problem for blind and partially sighted people that there has been a rise in the number of locations where the distinction between footway and carriageway is blurred, or where the transition from one to the other is indistinct. This has the potential to increase fear, not only at these locations but much more widely – as the sense that footways are (relatively) safe spaces is eroded.

It may not be fully appreciated that blind and partially sighted pedestrians also face conditions where they may be frightened of becoming lost, of walking unknowingly into danger, or that they need to apply a significant effort to avoid these situations.

It is important for designers to understand that current streets provide a level of exclusion meaning that an individual blind or partially sighted pedestrian may not be able to predict whether a particular journey can be accomplished on a particular day.

Designers need to fully understand the importance of the following if they are to meet the needs of blind and partially sighted people:

- The need for simplicity and predictability, and in particular standardised indications of the presence of side roads – providing both a navigational feature and an indication of the transition between footway space and areas where pedestrians are at raised risk from vehicles. The simplicity and effectiveness of kerbs in producing this effect.
- The effects of raised areas of carriageway, and kerb-free transition points, whether at continuous footways or elsewhere, in regard to the above point.
- The difficulties in traversing a larger open area in a straight line, and the need to have clear physical features that enable them to orientate themselves – both in terms of direction and so that they can recognise beginning and end points (and preferably also physical features that indicate when a mistake is made, and which allow for this to be corrected)
- The limited ability of many blind and partially sighted pedestrians to use the alignment of blisters on tactile paving for correctly orientating themselves before crossing, and the consequent importance of kerbs
- The difference between the easy interpretation of a slope at a dropped kerb with blister tactile paving on entering and exiting an area of carriageway, compared to the difficulties interpreting level area of tactile paving
- The way in which many blind and partially sighted people navigate by seeking particular familiar features, or by counting the occurrence of certain obvious features, and the role of side roads in this regard
- The basic challenge of keeping track of movement and progress on a journey while navigating with limited sight – with a long cane / by using a guide dog / by feeling for features with hands and feet.

For more information, including on tactile paving, please refer to our work with disabled people as described in Section 6.

8.5 Future continuous footway design

This sub-section sets out key conclusions and recommendations related to the future use of continuous footway designs. In summary, it proposes that:

'Real' continuous footways – which provide an unambiguous sense that the footway continues (as viewed from the perspective of *both* pedestrians and those driving across them) – do have value. However, these will only work well, and can only be inclusive:

- If there is an *unambiguous* sense that the footway continues
- with the inclusion of features that strongly limit vehicle speed (e.g. to a walking pace)
- with the inclusion of features that limit the complexity of possible vehicle movement (e.g. so that simultaneous two-way vehicle movement is prevented) or if used where such conditions exist anyway
- if used in locations where traffic volumes and speeds are appropriately low
- if used in locations where wider traffic speed (on approach to the location) is appropriate.

Alternative designs, which do not attempt to visually continue the footway, and which maintain a clear distinction between footway and carriageway for blind and partially sighted pedestrians, should be used in locations where such conditions do not exist or cannot be created.

An obvious alternative is the use of more traditional raised side road entry treatments – which raise the carriageway to footway level but in which there is no attempt to create an impression that the footway continues. Traffic speeds and paths at such a design can be restricted using many of the same design elements discussed in this report.

It seems likely that in situations where speeds and volumes cannot be *sufficiently* reduced then a good quality raised side road entry treatment may be more inclusive than a compromised continuous footway. Standard blister-style tactile paving, in a standard layout, should be used in such locations (see Section 6.2). Other research might evidence whether zebra crossing markings could be added to further improve priority.

LIMITING LOCAL SPEED WITH RAMPS

It is difficult to determine exactly how low vehicle speeds should be to properly prioritise pedestrians on suitably designed continuous footways or footway crossovers. We conclude that the necessary speed is *very* low. Only if trials prove that 'real' continuous footways can successfully and inclusively prioritise pedestrians, in very low-speed environments, should trials be considered where slightly faster speeds are possible.

A useful rule of thumb – unless it is proven that higher speeds are appropriate – will be that it is necessary to bring vehicles to a *walking speed*, using physical design features, *before* they cross the continuous footway structure. In addition to increasing the prioritisation of pedestrians, such conditions will also substantially reduce the risks arising for them when things don't work as planned.

It is self-evident that sufficiently steep high ramps can slow vehicle speeds. We tried to evaluate how steep and high a ramp needs to be to ensure that a continuous footway properly prioritises pedestrians. A comprehensive discussion is provided in Appendix 2, and this also highlights the recent increased availability of Dutch entrance kerb style units in the UK. Key details are summarised below.

At most continuous footways in Britain the ramps used, if any, provide much less of a constraint on speeds than those used as standard at Dutch exit constructions or with the equivalent infrastructure in some other countries.

The height of the ramp is as important as its gradient (based on basic geometry and physics), but we found little mention of ramp height in literature discussing continuous footways. The inclusion of this detail in guidance is crucial.

The use of much steeper ramps at a small number of junctions in Glasgow (around 15-25) was notable. These are not all necessarily continuous footway designs (many have a non-footway like surface on the drivable space), but they seemed nonetheless to be relevant to this study. We chose one such site at the junction of Sauchiehall Lane and Holland Street as a detailed-study site. We considered this to be a location where the continuation of the footway was unambiguous. It was obvious that vehicles had to be driven more slowly here when mounting or descending these ramps. Such sites provide an initial model for an appropriately steep and high ramp design, not least because of their Dutch-style entrance-kerb design (see Figure 23 and Appendix 2 for details).

Figure 23: Dutch (style) entrance kerbs/ramps

Sauchiehall Lane ramp/kerb (Glasgow)

Standard Dutch entrance kerb (Amsterdam)

One of our key informants, who was directly involved in the design of some continuous footways, was questioned about the use of more gentle ramps in their projects. They indicated a personal preference for steeper and higher ramps, but that the local authority employing them was concerned about the risks of being sued for damage to vehicles. The designer explained that the authority believed that it had to provide conditions that could be negotiated in any road-legal vehicle (for example including sports cars, and long limousines) without damage. We note that such vehicles will be used on Dutch streets, and assume that the City of Glasgow assessed such risks in regard to the ramps at Sauchiehall Lane (and elsewhere).

Clearly, the legal risks local authorities will face in using sufficiently steep ramps must be clarified and resolved if 'real' continuous footways are to be part of British streets in future. Otherwise styles of ramp that are standard infrastructure in other countries, and that are designed for this specific purpose, may not be included in designs used here.

(The issues introduced by positioning of the ramp – across the main road rather than alongside it – at the junction of Scott Street (with Sauchiehall Street[16]), seem sufficient evidence that these unusual arrangements are to be avoided.)

It should be noted that the requirement for a suitably high ramp has consequences for situations where, alongside the footway, there is a wish to continue a stepped cycle track across a side road end. Stepped cycle tracks sit between footway and carriageway, at a height lower than the footway with their outside edge marked by a drop to carriageway level at a second kerb. If such a design was continued across a side road end then a suitably high ramp could not be provided between either carriageway and cycle track, or cycle track and footway.

The use of a steeper ramp gradient (with sufficient height) has other advantages in terms of inclusion. From informal subjective observation, alongside two experts in mobility training, we concluded that the ramp at the junction of Sauchiehall Lane (with Holland Street) would probably be detectable with a long cane, and under a pedestrian's feet. Such an arrangement might be sufficiently steep for a guide dog to interpret as marking a kerb line and footway edge. If this is the case, the position of these ramps may define routes for blind or partially sighted pedestrians, helping to reduce risks of disorientation and of drifting into the carriageway.

[16] Noting that the sites at Scott Street (junction with Sauchiehall Street) and Sauchiehall Lane (junction with Holland Street) are different places

Further research to confirm this observation would be required, and this could be conducted by bringing together a larger number of long-cane and guide dog users.

One concern raised with us is that some adapted vehicles used by (or for) wheelchair users have attachments beneath the vehicle, with a relatively low clearance to the ground. Steeper/higher ramps might cause damage to such vehicles. This risk should be investigated further, and the disadvantage it may cause should be treated seriously. However, in the long-term vehicle designs tend to adapt to suit road conditions.

A second concern raised was that people using adapted cycles may find steeper/higher ramps create a barrier for them. This is an important consideration, and further research may help to clarify how much this is an issue – and what options exist to mitigate any disadvantage. It seems relevant to note that Dutch guidance[17] advises against the use of exit constructions if a main cycle route is along the side road but that their use to support a main cycle route to cross a side road is common.

LIMITING LOCAL SPEEDS WITH PATH CONSTRAINTS

It is highly probable that the increasing use of larger off-road style vehicles like SUVs, designed to minimise discomfort from bumps, is reducing the effectiveness of ramps to control speeds. However, vehicle speeds can also be limited by constraining vehicle paths - ensuring tighter turns and sufficiently narrow spaces for vehicle use.

Figure 24 shows two images of Dutch exit constructions, and a number of features that create a constraint on vehicle paths.

Figure 24: Constrains to vehicle path at Dutch exit constructions (Amsterdam)

[17] ASVV Recommendations for traffic provisions in built-up areas, Ede: CROW, 1998 (English edition) (For details see literature review document)

Such constraints include:

- Sufficient height on the kerbs to either side of the ramps (meaning that drivers of car-sized vehicles are careful to use the ramps, without clipping corners – marked A in the images)
- The extent (length) of the ramps (marked B in the images), and particularly of the ramp alongside the main carriageway
- Strategic positioning of features like bollards, signposts, cycle racks, and other street furniture (marked C in the images). The positioning of these features can ensure that a vehicle must navigate not just one but several pinch points – which has a greater overall effect.

A challenge for designers will be to balance a desire to allow larger vehicles to turn (such as delivery lorries), whilst also constraining the speed of smaller vehicles. Elsewhere we have recommended that continuous footways should only be used where conditions allow drivers to stop on the main carriageway. Such conditions should also allow the drivers of occasional larger vehicles to use the whole carriageway space for manoeuvres.

As well as speed-reducing impacts, there are other less obvious advantages in constraining the path of vehicles. At some of our detailed-study sites, vehicles were occasionally driven wide of the space intended, with drivers using areas intended only for pedestrian use. Such locations included Alderney Road in London, and Glamorgan Street in Cardiff. There, an entering vehicle sometimes met an exiting vehicle, significantly narrowing the space available for manoeuvring. We saw entering drivers steering off the intended path, particularly with their front wheels. This could be seen to sometimes force pedestrians to step backwards.

Similarly, some of the disabled participants in the study spoke about problems with the parking of vehicles. They had observed situations in which ramps to footway height had encouraged the parking of vehicles on wider areas of footway. At some of our detailed-study sites the distinction between areas for parking and areas for pedestrians had also been muddied.

Constraints on vehicle path can also help to make approaching vehicles more visible to pedestrians. At a number of our detailed-study sites entering drivers sometimes approached pedestrians from behind, rather than from their side. This could be seen for example at both Scott Street (junction with Sauchiehall Street) and Drury Street (junction with Renfield Street) in Glasgow. At these sites there is no entrance ramp, meaning that vehicles turning from the main carriageway can pass across the footway with a wide sweeping turn.

In our study we found no sites in Britain where the path available for right-turn-in movements had been constrained, but we consider that such restrictions might be made with appropriate central features on the main carriageway.

LIMITING THE COMPLEXITY OF VEHICLE MOVEMENTS

From observations it is obvious (and unsurprising) that pedestrians can more easily deal with vehicles arriving from one direction than they can simultaneous two-way movement of vehicles. Two-way movement creates a substantial step up in difficulty and risk for all pedestrians.

Two-way traffic also produces situations where some pedestrians are hidden from entering drivers by exiting vehicles (most obviously those whose head height is below the vehicle height). This greatly increases risks to those pedestrians.

Until the effectiveness of continuous footways, in creating unambiguous pedestrian priority, can be proven for one-way vehicle movement, designs that permit simultaneous two-way movement should not be used.

We use the phrase “simultaneous two-way movement” to allow for situations like those that exist at cul-de-sacs. Cul-de-sacs can be extremely quiet side streets on which a narrowed entrance functions without any problems, but – simply due to being cul-de-sacs – they cannot be one-way streets.

Narrowing the space available for driving restricts the path of vehicles and hence reduces speeds. It also ensures simultaneous vehicle movements are not possible. When combined these factors transform the safety and comfort of pedestrians.

Our design-focused informants told us about resistance to the use of one-vehicle-wide two-way entrances to side roads. They talked about the pressure to maintain traffic flow and speed on the main carriageway. However almost any solution that prioritises pedestrian movement across any side road entrance will rely on entering drivers being able to stop safely and comfortably on the main carriageway. The idea that traffic flow should be maintained at the cost of pedestrian priority over a side road also contradicts recent changes to the Highway Code, which instruct drivers to give way to crossing pedestrians.

In Edinburgh a set of road design features (to prioritise walking and cycling) are being built on West Coates and other sections of the A8 west of Haymarket Station. Some of these allow space for one small vehicle to sit between the carriageway and a cycle track, either just after leaving the main carriageway, or while waiting to enter this. This may permit entering vehicles to leave the main road without immediately needing to cross the spaces used by pedestrians and by cyclists. The performance of these designs may provide valuable information about this approach, and the City of Edinburgh Council is studying their effects.

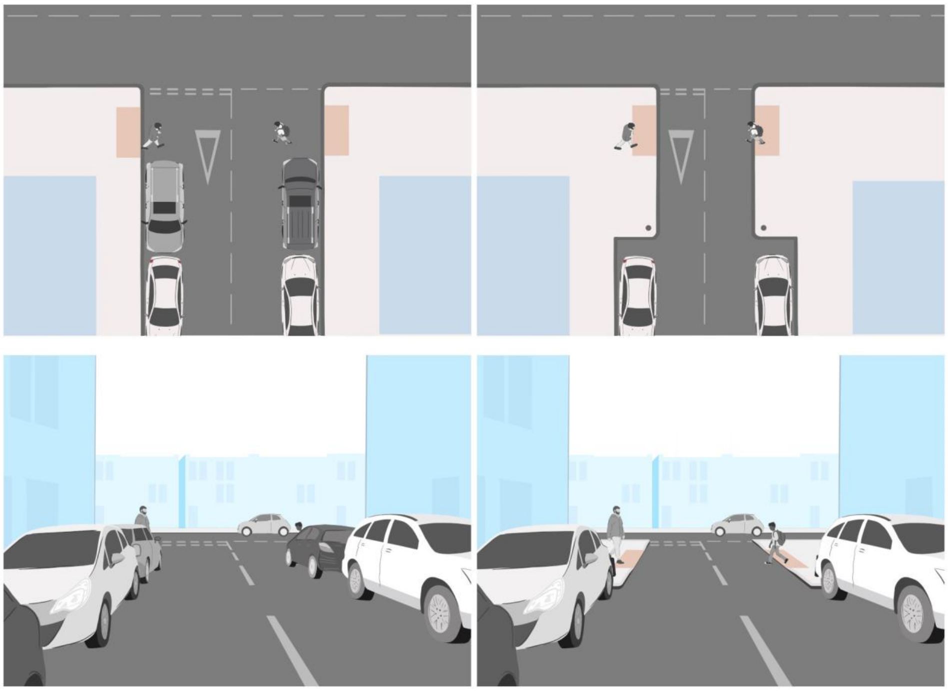
PEDESTRIAN VISIBILITY

There are other important advantages in narrowing the space that can be driven over. These include:

- Pedestrians are vulnerable to vehicle movement while on a much smaller space
- Blind and partially sighted people only need to maintain a straight path for a short distance (assuming that they are provided with features by which they can orientate themselves to cross the space)
- Pedestrians are visible to drivers (and vice versa) before stepping onto the drivable space.

Figure 25 illustrates the way in which, for a standard side road junction, build-out areas make pedestrians visible to a driver (and the driver's vehicle visible to pedestrians) while they remain on the footway. In the case of a continuous footway, the equivalent change is to narrow the space available for driving over.

Figure 25: Effects of build-outs at standard junction



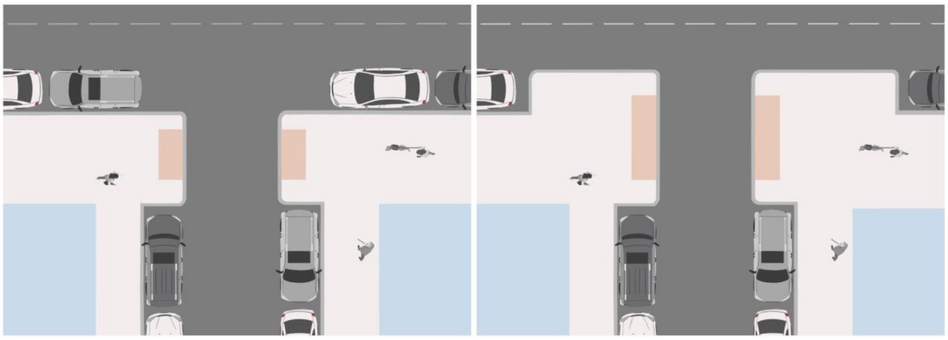
Very few continuous footways in Britain include features to achieve this narrowing effect. However, they are a relatively standard feature on Dutch exit constructions (as defined by the extent of the ramp on the side road, and other limits to the area that can be driven on).

On many streets such “build-out” areas (and their equivalent on continuous footway structures) might make a substantial difference to the length of time that a pedestrian is visible before any potential interaction with a vehicle. In many cases these build-out areas more than double the time before the crossing point (or drivable space) is reached. Crucially, pedestrians also have more time to observe approaching vehicles.

However, it is important to note that some of our detailed-study sites included build-outs or an equivalent narrowing of the drivable space, yet still failed to properly prioritise pedestrians. Therefore, we conclude that this feature is helpful, but that on its own it is not sufficient to ensure priority.

Dutch exit constructions typically also have a build-out area to account for situations where parking is allowed along the side of the carriageway of the main road. Figure 26 shows a simplified illustration of how such a feature would change the design of an ordinary British side road junction.

Figure 26: Build-outs into main carriageway (standard junction)

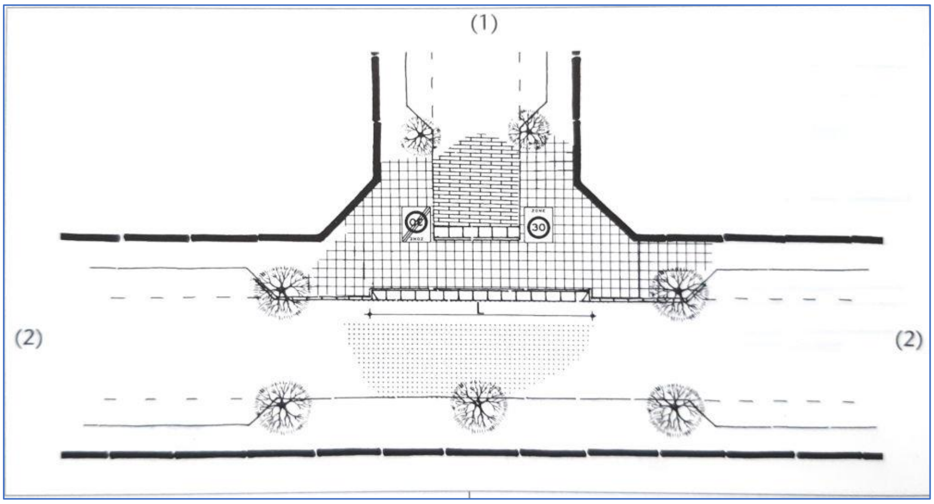


This second build-out area moves the end of the side road into the main carriageway. In the case of a continuous footway the position of the ramped transition to the main carriageway would be moved, tightening the turn required by entering vehicles.

Figure 27 shows the standard image of an exit construction included in the Dutch ASVV urban street design guide[18], which can be seen to have both features. More details of this document are described in the literature review (see Section 3).

[18], ASVV Recommendations for traffic provisions in built-up areas, Ede: CROW, 1998 (English edition) (For details see literature review document)

Figure 27: Exit construction design from Dutch ASVV manual (© CROW)



RESTRICTED VISIBILITY AND PAINT MARKINGS

In our study of the effects of restricted visibility on driver behaviour we noted that these are complex. On the one hand, drivers may be more careful if it is obvious that they are emerging into a space where they cannot see oncoming pedestrians or vehicles, but on the other hand they may be *less* careful for the same reason.

This is a complex scenario to analyse, but in our observations we saw many situations in which individual drivers appeared to take little care in emerging into a space where they might have put pedestrians at risk. We also observed that drivers could often be seen to respond quickly when a potential collision arose. With these observations in mind, it can be argued that what matters is that drivers have as much opportunity as possible to see conflicting pedestrian movements. The section above recommended design options to improve visibility.

Some previous discussion around restricted visibility has focused on whether give-way markings should be placed further from the main carriageway, even if this means that drivers who stop at these markings cannot see oncoming vehicles. However, as noted in Section 7.4, in practice drivers rarely stopped at such markings – and they could often be seen to ignore their exact location.

The literature review established that Dutch exit constructions do not include any markings of priority. It also found that there is little certainty among experts that these markings, in Britain, provide any legal priority for pedestrians.

Minor changes in continuous footway design could be seen to substantially change whether or not a design produced an unambiguous continuation of the footway. It appears that the addition of only minor features, such as paint markings, can create an ambiguous effect – making it unclear what is footway and what is carriageway. Examples of such markings included triangular ramp markings, lines indicating parking restrictions, and give way markings.

It seems reasonable to conclude that a 'real' continuous footway effect will be weakened if paint markings associated with the carriageway are marked on the footway area.

It was clear from the study that drivers interpret such markings as only one of many indications of a need to give way. It seems reasonable to conclude that the provision of any such markings will have an insignificant effect on driver behaviour in any situation where it is already obvious that they are driving over a section of footway (although this should be kept under review where 'real' continuous footways are introduced). Therefore, any need to provide such markings may indicate the failure of a design to create an unambiguous continuation of the footway (with the consequent pedestrian priority).

This study does not have good evidence as to whether give-way markings provided *on the carriageway*, and encountered *before* a driver mounts a ramp onto a 'real' continuous footway, will have a substantial effect – although it indicates doubt that such markings provide legal priority to pedestrians. The inclination to give way to pedestrians should therefore be researched if examples of 'real' continuous footways are built.

It seems likely that there are many other factors, aside from the positioning of the lines themselves, which will be more important in determining where drivers stop their vehicles to await a gap in traffic (see Section 7.4).

RESTRICTING USE OF CONTINUOUS FOOTWAYS TO SITES WITH WIDER CONSTRAINTS ON SPEED

Earlier we noted that the performance of continuous footways is likely to depend, at least in part, on low enough vehicle approach speeds.

This relates both to vehicles approaching from the side road and vehicles approaching on the main carriageway.

In practice, the physical constraints on speed in the side road need to be determined not only by the presence of more common speed-calming features (i.e. humps or an equivalent using vertical deflection), but also by the width of the carriageway. Appropriate design should imply to drivers that slow speeds are natural on the side road, and should make faster speeds physically difficult or impossible. It should be noted that Dutch exit constructions (where used over public streets) are only used at the transition between slow speed local access streets and urban through streets (see Section 8.6) – and that the local access streets are designed to be "self-explaining" to emphasise their low-speed function.

These conditions should also have an effect not just on drivers exiting the side road, but also on those entering, who may be much more likely to give way to pedestrians if they know that they are entering a low-speed environment than if they consider this an interruption to an ongoing faster journey.

Speeds on the main road also matter. For a continuous footway to work properly (in allowing drivers to give way to pedestrians) drivers must feel safe and comfortable slowing to a walking speed, or in stopping, as their vehicle approaches on the main carriageway.

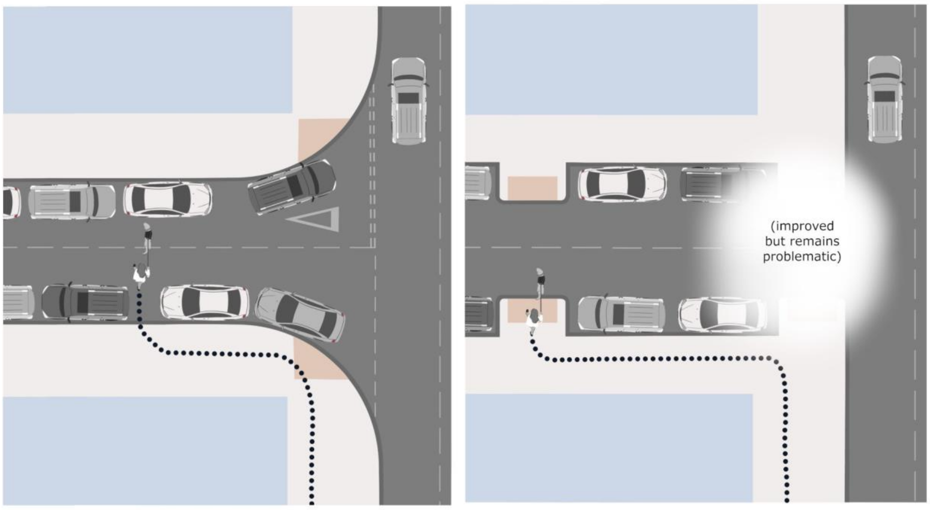
PROVIDING BACK-UP OPTIONS FOR CROSSING

The study noted that at many of the detailed-study sites there were few back-up options available for pedestrians crossing.

Blind and partially sighted people may sometimes choose to walk into a side road so that they can cross it at a safer or simpler point. In some situations, such an indent may be of only of a metre or two, but in other cases people walk much further into a side road. On some side streets the presence of parked vehicles makes it difficult or impossible for a blind or partially sighted pedestrian to cross in this way.

An inclusive approach (illustrated in Figure 28) would provide a backup option, allowing a pedestrian to cross within the side road if conditions at the junction are not adequate (noting that the ideal option *would* allow all pedestrians to cross at the junction).

Figure 28: Backup crossing option provided with build-outs



Such a crossing point should be built so that parked vehicles cannot block it or obstruct the visibility or passage of those crossing, crossing distances are minimised, and kerbs on either side of the crossing are parallel. The design process should also consider how a blind or partially sighted pedestrian will find such a crossing point (for example, with an appropriate tactile feature).

TESTING ALTERNATIVE TACTILE PAVING ARRANGEMENTS

Although unproven, arguments against using standard tactile paving styles and arrangements at continuous footways *which provide unambiguous pedestrian priority*, might be reasonable. This is based on the idea that the visual effect of standard tactile paving risks weakening the impression drivers are given that they are driving over an uninterrupted footway. However, that argument is only reasonable where pedestrian priority is unambiguous, vehicle speeds are extremely low, and most pedestrians cross without any interaction with a vehicle. Such conditions were not provided at any of the wider or busier side roads we studied. Therefore, we conclude that at these locations standard tactile paving in a standard layout should be provided.

Alternative arrangements for tactile paving were considered in the course of the project. These included situations where blister-style paving was used, but at some distance from the area that could be driven on. We also tried to understand whether an alternative style of paving (for example, of a corduroy type) might be used. It is possible that some of these options might have value, but novel arrangements could very easily be confusing or misleading. Alternatives to standard arrangements of blister-style paving could be trialled at sites providing unambiguous pedestrian priority (once these exist) – as part of work to determine how this affects their functioning. However, this should only happen as part of an organised research programme which seeks a nationally standardised approach (rather than by individual designers working separately).

For many blind and partially sighted people tactile paving only remains useful if it is used consistently on the streets and if it conveys very simple messages. Areas that lack kerbs can be particularly difficult to navigate (as noted elsewhere), meaning that tactile features become important for reasons other than safety. The increasing use of non-standard tactile paving arrangements, installed as part of efforts to provide continuous footways but differing from site to site, has the potential to create confusing conditions for blind and partially sighted pedestrians.

One important option, which should be researched further for use in these circumstances, would involve the provision of “guide line” tactile paving that long cane users, or those using the feeling in their feet, can follow over any larger open area (see Section 5.4). Specifications for this style of paving are provided in Chapter 6 of the Department for Transport’s “Guidance on the Use of Tactile Paving Surfaces”.[19]

Typical tactile paving materials may not be strong enough to withstand use in places that are driven over regularly. Current unavailability of suitably load bearing materials is not an appropriate reason to ignore the potential value of new arrangements.

We noted that some blind and partially sighted participants in this study commented on how difficult it was to access mobility training and that changes to streets could create what one called “a guessing game”. We understood that these problems had threatened them with complete exclusion from some streets. Clearly new layouts, however well intentioned, must not exclude anyone simply because unfamiliarity and the absence of any support to deal with changes. Designers must not assume that mobility training will be available locally or that it will be tailored to their design choices. Proactively addressing these issues is critical in terms of local authorities making “reasonable adjustments” under equality laws. Research on the level of local and national provision is needed.

[19] Department for Transport, Guidance on the Use of Tactile Paving Surfaces, Department for Transport, London, 2021

8.6 Wider reform of streets

While there are equivalents in places elsewhere, we have only found one country – the Netherlands – where an equivalent of a 'real' continuous footway can be seen as a standard and common feature, to be driven over when entering or exiting a public side street. The research evidences that these have been in use for decades.

We found good evidence of debates, in older informal Dutch literature, around how to make the priority of one driver over another as clear as possible on their range of junction designs. We found no accompanying debate about any problems for pedestrians.

In our literature review we established that it is Dutch national policy to ensure that local access streets and urban through streets[20] are recognisable and that they are clearly distinguishable from each other. A range of features are used to create this effect, like changes in surfacing materials or the absence of any priority markings at junctions in the local access streets. The same national policy – on "Sustainable Safety" – rejects the use of designs which promote traffic flow on local access streets, and it is standard practice to discourage or prevent through traffic on these.

Exit constructions are used, within this system, as a standardised and recognisable gateway marking the transition point between one category of street and the other.

One key piece of Dutch research, looking at the safety of exit constructions, concluded that this gateway function and its role in area-wide safety – rather than conditions at the actual exit – were the most important reasons for the use of exit constructions in the Netherlands (see the literature review for details).

The effectiveness and safety of Dutch exit constructions is likely linked to their standardised design, and their use in these specific well-defined well-recognised locations.

Whilst street hierarchies do exist in the Britain, distinctions are very much more blurred than in this Dutch system.

Current British attempts to use continuous footways also appear to be being compromised by a wish to accommodate high levels of vehicle use and traffic flow, yet the need to change conditions to improve the priority of pedestrians is accepted.

[20] In Dutch these categories of road which are known as 'erftoegangswegen' and 'gebiedsontsluitingswegen'. The translation of the first term, as 'local access streets' is easy and self-explanatory. The direct translation of 'gebiedsontsluitingswegen' is 'distributor roads', but this phrase has different connotations in Britain, implying a much larger road or one designed primarily to move vehicles. We use the title 'urban through streets' here instead.

Here there is no nationally agreed (and effectively used) set of design principles, nor any equivalently comprehensive programme, for reforming streets to this effect.

It has been suggested that the use of side-road zebra crossings may provide an alternative tool for prioritising pedestrian passage across the end of side roads. However we heard that zebra crossings do not work well for blind and partially sighted pedestrians. A recent small scale on street trial of these, at two low-risk sites, recorded improved priority for pedestrians but also significant levels of non-compliance[21]. In any case it seems likely that their success or failure would depend on many of the same factors we report as significant for 'real' continuous footways.

Although a significant task, there could be major benefits in a refocusing of the overall philosophy of transport planning in Britain. This could make the application of 'real' continuous footways, and other pedestrian focused changes, much more straightforward. While a national approach might be most powerful it may also be possible to start this work with a focus on smaller areas – such as on a single city.

The Dutch Sustainable Safety system would be one obvious source of inspiration for this – even if their designs were found to include some failings in terms of inclusion, which is something worthy of further research – but there may be others.

[21] Jones M, Matyas M and Jenkins D, "Non-prescribed zebra crossings at side Roads", TRL 2021

9 Summary of main conclusions and recommendations

Following on from the previous section's discussion on the complex themes and findings arising, the project's main conclusions and recommendations are summarised, in brief, below.

9.1 Conclusions

1. There is a high degree of confusion over what is and what is not a continuous footway. This complicates any discussion over the effectiveness of continuous footways, and the resulting lack of design standardisation has real-world effects.

2. Most of the infrastructure currently being called a "continuous footway", or which attempts to continue the footway over the end of wider side roads in Britain, does not successfully prioritise pedestrians over vehicles. This has implications for inclusion.

3. To some extent we could see that designers and organisations representing disabled people might share overall objectives, while being divided into two different camps, with a lack of connection or knowledge-sharing being a significant problem. It was evident that there is a real risk that opposition to more radical change, from those who are – not unreasonably – afraid that their needs are being ignored, may help entrench the *status quo* of traffic dominance and low pedestrian priority. This can make good quality changes less likely.

4. It is a problem for blind and partially sighted people that there has been a rise in the number of locations where the distinction between footway and carriageway is blurred, or where the transition from one to the other is indistinct. This has the potential to increase fear, not only at these locations but much more widely – as the sense that footways are (relatively) safe spaces is eroded. The lack of tactile paving, to warn of a kerb-free transition into a space which drivers may be treating as part of the carriageway, is a problem with many of the designs that are currently being called continuous footways in Britain.

5. At most continuous footways in Britain the ramps used, if any, provide much less of a constraint on speeds than those used as standard at Dutch "exit

constructions". The height of the ramp is as important as its gradient, but there is little mention of ramp height in literature discussing continuous footway design.

6. At continuous footways simultaneous two-way vehicle movement creates significant additional challenges and risks to pedestrians.

7. Narrowing the space available for driving over the footway helps to transform safety, comfort and convenience for pedestrians. In contrast to arrangements seen in other countries, few continuous footways in Britain include features to do this.

8. The traffic volumes and vehicle speeds on the carriageways approaching a continuous footway – on both the main road and the side road – affect the degree to which they are likely to prioritise pedestrians.

9. The increasing use of non-standard tactile paving arrangements, installed as part of efforts to provide continuous footways but differing from site to site, is likely to create confusing conditions for blind and partially sighted pedestrians.

10. While this work points to problems with some new infrastructure it also highlights that more typical streets exclude people. It points to a lack of evidence about the success of 'real' continuous footways, but suggests these should be tested (provided they are designed so as to provide an unambiguous continuation of the footway, with additional features to limit vehicle speeds and paths, and which have an appropriately low level of vehicle use).

9.2 Recommendations

EARLY ACTION

1. As a minimum alteration, a standard arrangement of blister-style tactile paving should be retro-fitted at sites where it appears to pedestrians as if the footway continues while at the same time it is predictable that they could meet a driver who is behaving as if on a carriageway.

STANDARDISATION

2. The clearest response to the current confusion about the term continuous footways would be to standardise this – applying it only to those 'real' continuous footways where an unambiguous continuation of the footway exists.

3. In the longer term, it seems likely that the standardisation of continuous footways is necessary to create predictable driver and pedestrian behaviours, and work to achieve this should be undertaken, with proper trials of 'real' continuous footways. The use of recognisable, standardised (and effectively steep and high) ramps should be a key part of this.

COLLABORATION

4. Those interested in progress and on improving conditions for pedestrians, should build allegiances, connections, and real in-depth knowledge, lessening the divide between designers focused on implementing changes and organisations representing disabled people concerned about them.

5. It is essential that designers involved in providing changes to side road layouts should understand the key factors making navigation safe or dangerous, or easy or difficult, for blind and partially sighted people.

GETTING CONTINUOUS FOOTWAYS RIGHT

6. Where vehicle speeds and volumes cannot be sufficiently reduced to make a continuous footway suitable, then a good quality "raised side road entry treatment" may be more inclusive than a compromised continuous footway.

7. Continuous footways should only be used where wider conditions make them suitable, and specifically where wider design creates traffic volumes and speeds on the carriageways approaching the structure which are low enough.

8. A useful rule of thumb will be that it is necessary to bring vehicles to a walking speed, using physical design features, before they cross a continuous footway structure, whether or not pedestrians are present.

9. The inclusion in design guidance of details about ramp design, including ramp height, will be important. If 'real' continuous footways are to be constructed, and are to successfully prioritise pedestrians, it is likely that these should include an appropriately steep and high ramp, of a standardised and recognisable design.

10. Questions relating to the use of appropriately high and steep ramps, and the potential that councils are sued for damage to vehicles if they use these, should be resolved.

11. In designing future continuous footways (and footway crossovers) constraints on vehicle path, ensuring tight turns and sufficiently narrow spaces, should be used to slow any vehicles which are able to negotiate ramps without needing to slow to walking speed.

12. Physical constraints should be used to prevent simultaneous two-way vehicle movement. These should also narrow the area of footway available for driving over, creating situations in which pedestrians can be seen for as long as possible before they reach this area.

13. Alternative tactile paving arrangements – for use at those 'real' continuous footways and wider/equivalent footway crossovers which can be shown to provide unambiguous pedestrian priority – should be trialled, to research whether they have any value, as part of an organised programme which seeks a nationally standardised approach (rather than by individual designers working separately).

THE NEED FOR WIDER REFORM OF OUR STREETS

14. Given that…

    a. Most attempts to use continuous footways in Britain are compromised by a wish to accommodate high levels of vehicle use and traffic flow

    b. The need to change conditions to improve the priority of pedestrians is accepted (irrespective of the use of continuous footways)

    c. There is no nationally agreed set of design principles or programme for reforming streets being effectively implemented in a way that points to a future in which pedestrians are prioritised

    d. 'Real' continuous footways (as exit constructions) are long-established and very common feature on Dutch streets, but not elsewhere, with these used as an integral part of a national programme reforming how streets work

    …then this research suggests that the future use of continuous footways – other than on small lanes and accesses – may need to take place as part of an equivalently radical plan for the reform of how streets work more generally.