

Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment



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Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

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Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

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Acronyms / Abbreviations

AEP	Annual Exceedance Probability
AFAC	Australasian Fire and Emergency Service Authorities Council
AHD	Australian Height Datum
ARF	Areal Reduction Factor
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
BoM	Australian Bureau of Meteorology
DCP	Development Control Plan
DEM	Digital Elevation Model
DfE	Defined Flood Event
DPHI	NSW Department of Planning and Infrastructure
FDM	Floodplain Development Manual
FRMS&P	Floodplain Risk Management Study and Plan
FRM	Flood Risk Management
FPL	Flood Planning Level
FPA	Flood Planning Area
FSR	Floor Space Ratio
HOB	Height of Building
IFD	Intensity-Frequency-Duration
LEP	Local Environment Plan
LGA	Local Government Area
LIDAR	Light Detection and Ranging
PMF	Probable Maximum Flood
SEPP	State Environmental Planning Policy
SES	NSW State Emergency Service
SFC	Special Flood Consideration



Glossary

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.

Annual Exceedance
Probability (AEP)

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

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.
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.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

Glossary

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. Floodplain 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	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 consider 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.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

Glossary

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 PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions.
Probable maximum precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.
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 has been engaged by NSW Department of Planning Housing and Infrastructure (NSW DPHI), to prepare a Flood Impact and Risk Assessment (FIRA) to support the Campsie Town Centre Planning Proposal.

The key stages of the Campsie Town Centre rezoning to date, and accompanying flood risk assessments have been as follows:

- The draft Campsie Town Centre Master Plan was initially exhibited publicly by Council from March to June 2021, with an updated Master Plan prepared by September 2021 in response to public submissions – Stantec was engaged by Council to prepare supporting desktop flood risk assessments for the master plan, finalised on 3 May 2022.
- Council prepared a pre-Gateway Planning Proposal submission in late 2024 – Stantec prepared an updated, high-level Flood Risk Assessment to support the pre-Gateway submission dated 5 September 2024.
- The Department of Planning Housing and Infrastructure issued a Gateway Determination for Campsie Town Centre on 17 January 2025 allowing it to proceed subject to conditions. Although Campsie Town Centre is a Council-led Planning Proposal, NSW DPHI recognizes its State Significance given the potential significant contribution and is assisting with funding for technical studies – the current engagement by NSW DPHI for Stantec to prepare a more detailed Flood Impact and Risk Assessment to support the post-Gateway planning proposal.

This report summarises the outcomes of the FIRA for the post-gateway Campsie Town Centre planning proposal, including summarising the hydrology and hydraulic modelling for both existing and post-development conditions, and a review of flood risk for the study area.

1.1 Background for Flood Assessment Update

Stantec was engaged by Council to prepare the pre-Gateway Campsie Town Centre Flood Planning Report which was finalised and submitted to Council on 5 September 2024. This assessment was based on the adoption of flood model results from the combined mainstream and overland flow TUFLOW model for the Cooks River prepared by Stantec on behalf of Canterbury Bankstown Council (Stantec, 2024). This updated flood data superseded the original Flood Assessment based on the Flood Study data for Cooks River Mainstream (2009) and Overland Flow (2016) Studies.

Gateway conditions were released by NSW DPHI in January 2025 including the following flood-related conditions:

1.19 Address the findings and recommendations of the Flood Risk Assessment, including:

- *explain how the recommendations are addressed within the planning proposal package*
- *address the development within and in proximity to the floodway and flood storage, including the duration of inundation and the potential impacts of potential filling and raising of development sites on flood behaviour*
- *address consistency against all requirements with the 9.1 Direction 4.1 Flooding, including but not limited to addressing the proposed intensification on land identified as high hazard*



- *update mapping within the planning proposal package*
- *address consistency with the DPHI Shelter in Place Guideline published 9 January 2025.*

In addition to these flood-related Gateway conditions, the requirements for this post-gateway FIRA have been guided by previous discussions and comments provided by NSW DCCEEW representatives in May 2024 and NSW DPHI technical experts in March 2025. Key updates in this revised Assessment include:

- Updates to the combined mainstream and overland flow TUFLOW model for the Cooks River (Stantec). Updates to the TUFLOW model include:
 1. Refinement of hydraulic modelling with updated hydraulic roughness mapping based on Sydney Water Cooks River naturalization works;
 2. Development and validation of a new WBNM hydrologic model to generate upstream boundary hydrographs for Cooks River, ensuring consistency across all events and durations;
 3. Alteration of downstream boundary conditions to ensure suitability for a range of design events and durations;
 4. Expanded modelling of design flood events across a full suite of AEPs and durations (including 5%, 1%, 0.2%, 0.05%, and PMF), consistent with latest Planning Circular guidance;
 5. High level modelling of post-development conditions for the precinct to inform a precinct-wide flood impact assessment. Assessment of existing and future (post-development) flood risk is required to inform strategic planning;
- Consideration of climate change impacts using higher return period events (0.2% and 0.05% AEP) as a conservative proxy, consistent with NSW Flood Inquiry recommendations, rather than separate climate-adjusted design events;
- Clarification of development feasibility in high flood hazard areas, integration of emergency response and resilience considerations, and review of flood-related development controls.

1.2 Study Objective and Scope

This FIRA has been prepared to support the post-Gateway Campsie Town Centre Planning Proposal and respond to flood-related Gateway conditions issued by the NSW Department of Planning, Housing and Infrastructure (DPHI) in January 2025. The objective is to assess potential flood impacts of proposed land use changes and evaluate the compatibility of intensified development with current flood risk planning policies and technical guidelines.

The scope of the assessment has been guided by:

- Gateway Determination Condition 1.19, which requires addressing flood hazard, inundation duration, development feasibility in flood-affected areas (including floodway and flood storage), consistency with Ministerial Direction 4.1, and application of the Shelter-in-Place Guideline (2025);
- Comments from NSW DPHI technical experts (March 2025) and prior input from NSW DCCEEW representatives (May 2024);



- Relevant recent policy and technical guidance, including:
 - The 2023 NSW Flood Risk Management Manual and Emergency Management Guide (EM01),
 - Planning Circular PS 24-001 (March 2024),
 - Shelter-in-Place Guideline for Flash Flooding (January 2025), and
 - NSW Flood Inquiry recommendations on climate adaptation.

To align with the above, the assessment includes:

- Updated evaluation of existing flood risk using refined hydrologic and hydraulic modelling for the combined mainstream and overland floodplain;
- Strategic-level flood impact modelling of post-development conditions to inform rezoning feasibility and support land use planning;
- Consideration of high hazard areas and their development potential, including requirements for structural stability, access, and emergency response;
- Assessment of evacuation and shelter-in-place feasibility in accordance with the 2025 Shelter-in-Place Guideline;
- Analysis of climate change sensitivity using 0.2% and 0.05% AEP events as a conservative proxy for future conditions;
- Summary responses to flood-related Gateway conditions and alignment with contemporary policy.

This targeted and updated approach ensures the Campsie Town Centre Planning Proposal is informed by the best available flood data and meets the expectations of State Government agencies for strategic growth in flood-affected areas.



1.3 Study Area

Campsie is a cultural, retail and local employment hub in the CBD City's east that provides cross-regional links to metropolitan centres to the North, East, South and West. The Campsie Precinct study area is bounded by Cooks River along its north and east, properties fronting Canterbury Rd to the south, and Tudor St, Loch St, Bruce Ave, Omaha St, Varidel Ave and Clarence St from the west. The study area for Campsie Precinct is shown in **Figure 1-1**.

Campsie Precinct study area is located approximately 12km from the Sydney Business District, situated at the junction of Inner and Western Sydney. Campsie's neighbouring suburbs are Croydon Park to the north, Ashbury and Canterbury to the east, Clemton Park to the south and Belmore and Belfield to the west. Campsie is centred around a retail and commercial strip running north-south along Beamish Street. The study area is centred around a retail and commercial strip running north-south along Beamish Street. Beamish Street. This strip is bisected by the T3 Bankstown train line, which will be upgraded to a Metro line in 2025. While the train line enables public transport access, it limits North-South connectivity within the study area. The commercial strip contains fine-grain built form with one to two storey buildings together with recent four to six storey shop top housing developments.

Campsie is estimated to have a current population (from 2021 census data) of 26,132 people, with currently 22% of dwellings being detached houses and 78% being apartments / units.

Campsie Town Centre is located along a ridge line largely with north-south orientation, following Beamish Street. The crest line is pronounced between contour level 42m AHD, along Canterbury Road, near the Canterbury Hospital, following north along Beamish Street, and reaching contour level 15m AHD near Eight Avenue intersection with Beamish Street. From here, the topography drops evenly due north to the Cooks River. A second crest line is identified in the topography, running parallel to the main crest line with a north-south orientation. This crest line also originates in the hilltop near Canterbury Hospital extending north along Loch Street, Carrington Street, cut by the train line and extending to Eight Avenue.



2 Available Data

The data summarised and reviewed in the following sections has been compiled by Stantec over the past Flood Risk Assessment projects with Council including the Master Plan in 2021-2022 and Pre-Gateway Planning Proposal assessment in 2024. Stantec has been confirmed with Council that the data is still relevant and that Stantec has approval to utilise the data on behalf of NSW DPHI and Council.

2.1 Campsie Town Centre Master Plan and Planning Proposal

As briefed in **Section 1**, the draft Campsie Town Centre Master Plan was initially exhibited publicly from March to June 2021, with an updated Master Plan prepared by September 2021 in response to public submissions. Following the Local Planning Panel's recommendations, Council has undertaken further engagement with the community in early 2022.

2.1.1 Framework

The proposed framework layout is shown in **Figure 2-1**. One of the key drivers for Campsie Town Centre will be growth over the next 20 years (to the year 2036), in population (an additional 14,800 residents), housing (additional 6,360 homes), and employment (an additional 2,700 jobs). This growth has been addressed through opportunities for additional height and density (Floor Space Ratio, or FSR), ensuring more people are living and working near sustainable transport, jobs and services.

A significant portion of the area is proposed for intensification, particularly in the following:

- The town centre around Beamish Street, extending to the west until Carrington Square;
- The southern area bounded by Claremont St to the north, properties fronting Canterbury Rd to the south and Thorncraft Parade to the west.
- Northern area bounded by Cooks River to the north, Clissold Pde to the south, and Beamish St west.

Generally, the height and density are proposed to be highest in these three main areas. As most of the town is developed already (brownfield), the intensification will most likely be vertical aside from some infill development opportunities.

2.1.2 Proposed Zoning

The existing land use zoning and the proposed land use zoning is shown in **Figure 2-3** and **Figure 2-4**, respectively. As can be seen in the figure, the centre is currently zoned mixed use (B4), with the surrounding areas predominantly high density residential, with the exception of the western area which will remain medium density residential and two low-density residential 'special character' areas.

The Canterbury Road frontage is proposed to mostly remain as commercial land use, with some high-density residential zoning added.



While the majority of the land use zoning for the area remains unchanged, several key land use changes are proposed. The areas of change are dash-lined areas such as:

- The centre of the Precinct has been defined as B4 mixed use which will enable the co-location of residential and commercial development and support the viability of the commercial retail space and generate employment growth.
- Most of the northern area, referred to as 'Cooks River foreshore' has changed to high density residential from medium-density residential;
- The two special character areas; west of Carrington Square and between Redman St and Canterbury Rd, have been changed to low density residential, with changes to high density residential in adjacent areas.

2.1.3 Character Areas

The Precinct has also been divided into 12 character areas to represent the predominant proposed future development types that are shown in **Figure 2-4**. Some of the key spatial move goals include:

- Define and celebrate unique character areas such as the Beamish St high street (Area 01 in **Figure 2-4**);
- Celebrate and connect to the river through foreshore restoration and development in the area (Area 07);
- More people living and working near the station which is to be replaced by the Campsie Metro Station (Area 01-04, and 08); and,
- Create a health precinct anchored by two hospitals. Leverage the area around Canterbury Hospital (Area 5) to attract and establish health and lifestyle related uses and activities that become unique to Campsie, including investment in allied and private health.

2.1.4 Proposed Changes in Density and Building

The growth of Campsie Town Centre has been addressed in the Campsie Precinct Rezoning Proposal through opportunities for additional height (Height of Building or HOB) and density (Floor Space Ratio, or FSR), ensuring more people are living and working near sustainable transport, jobs and services.

Generally the height and density are proposed to be highest in the heart of the city centre and decrease further away from this central location. As most of the city is developed already (brownfield), the intensification will most likely be vertical aside from some infill development opportunities.

The proposed FSR and HOB for the proposed Campsie Precinct are shown in **Figure 2-5** and **Figure 2-6** respectively. In **Figure 2-5**, red and dark pink colours show the highest level of proposed FSR, while cyan and light yellow colours show the lowest level FSR. In **Figure 2-6**, pale violet and violet colours show the highest level of proposed HOB, while tea green and cyan colours show the lowest level of proposed HOB. In the south-east of the precinct, the block shown in **Figure 2-6** (in green), bounded to the south by Canterbury Rd, Clunes Ln to the north and Phillips Ln to the west has been removed from planned intensification and is not proposed for HOB change as shown in the figure.

It is noted that intensification is not proposed for large portions of the study area, particularly the north-western and eastern parts, which are proposed to remain largely unchanged.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

2 Available Data

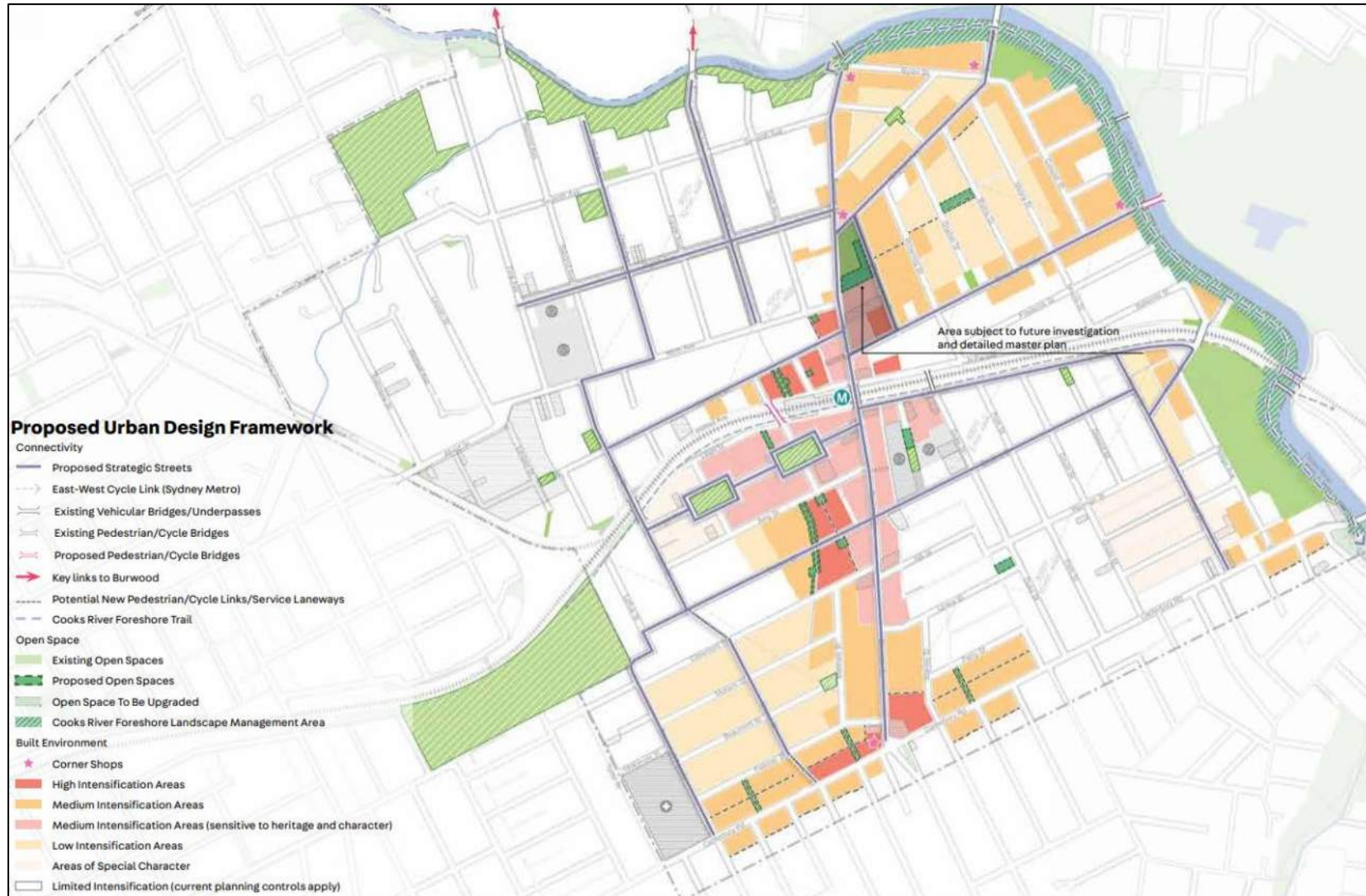


Figure 2-1 Campsie Precinct – Framework Map Showing the Proposed Future Town Layout (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024)



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment 2 Available Data

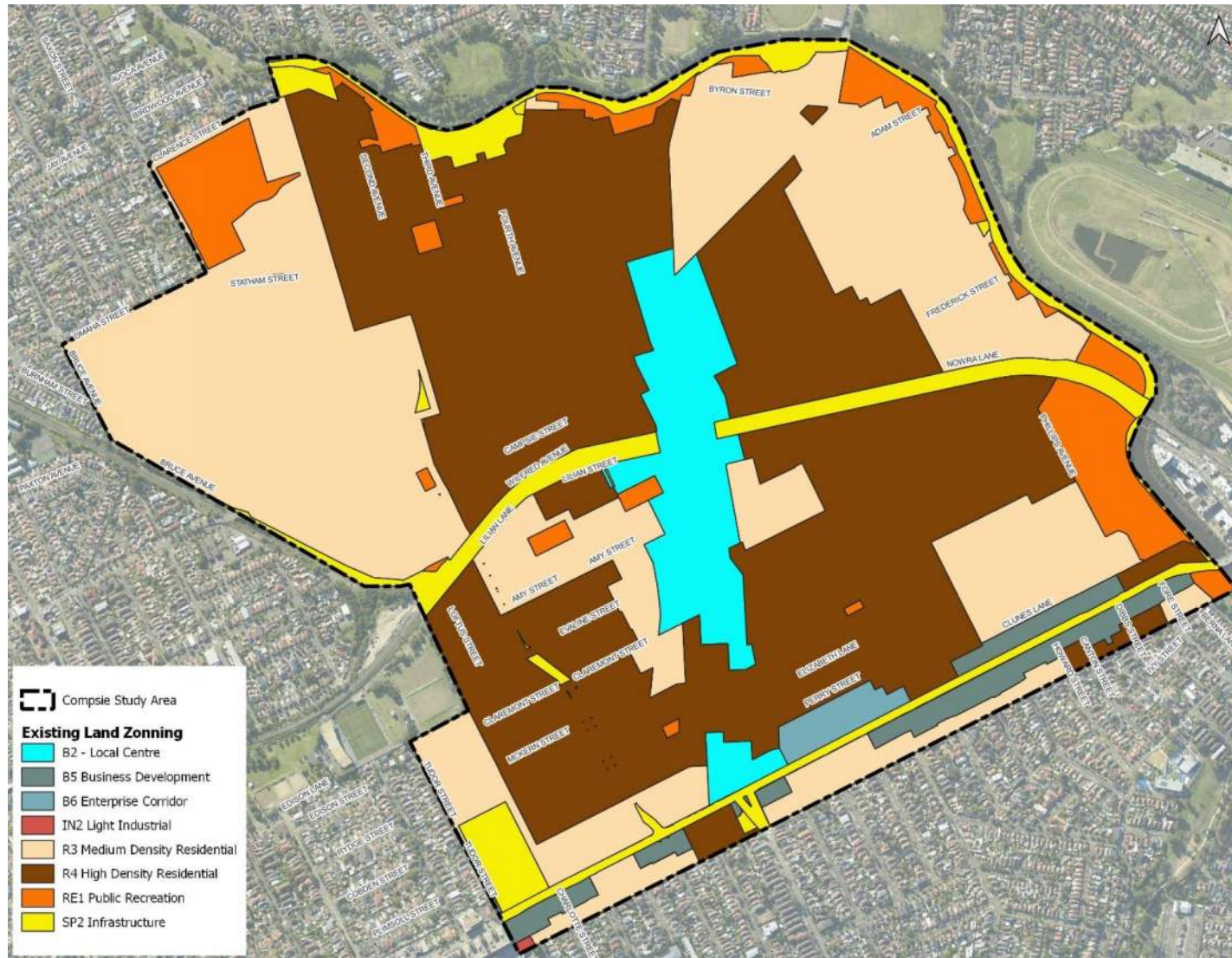


Figure 2-2 Campsie Precinct – Existing Land Use (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024)



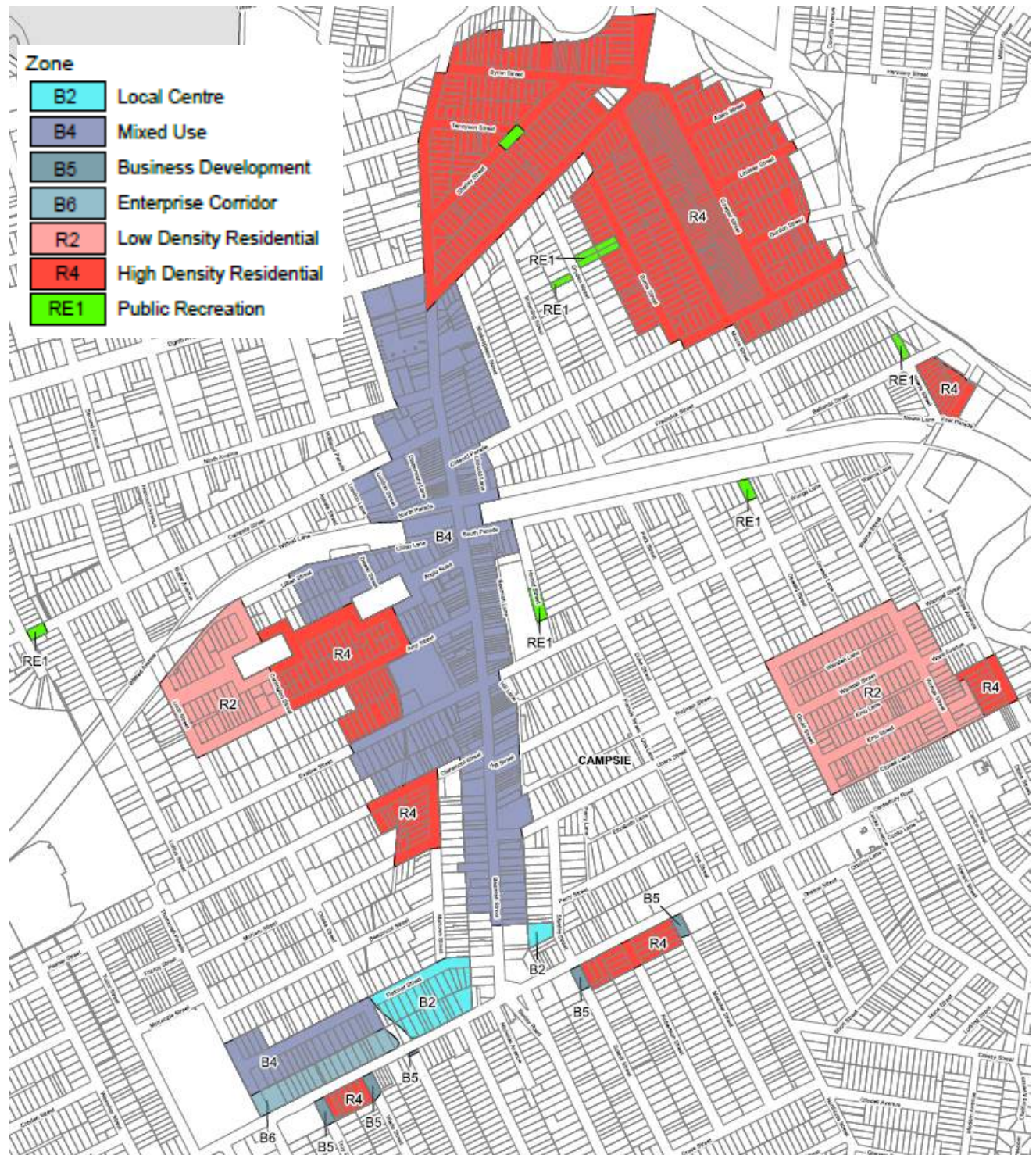


Figure 2-3 Campsie Precinct Master Plan – Proposed Land Zoning Map (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024), Note: Under the Standard Instrument LEP updates, the B2 Local Centre zone has been renamed E1 Local Centre, the B4 Mixed Use zone is now MU1 Mixed Use, and the B5 and B6 Business zones are now consolidated into the E3 Productivity Support zone.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

2 Available Data

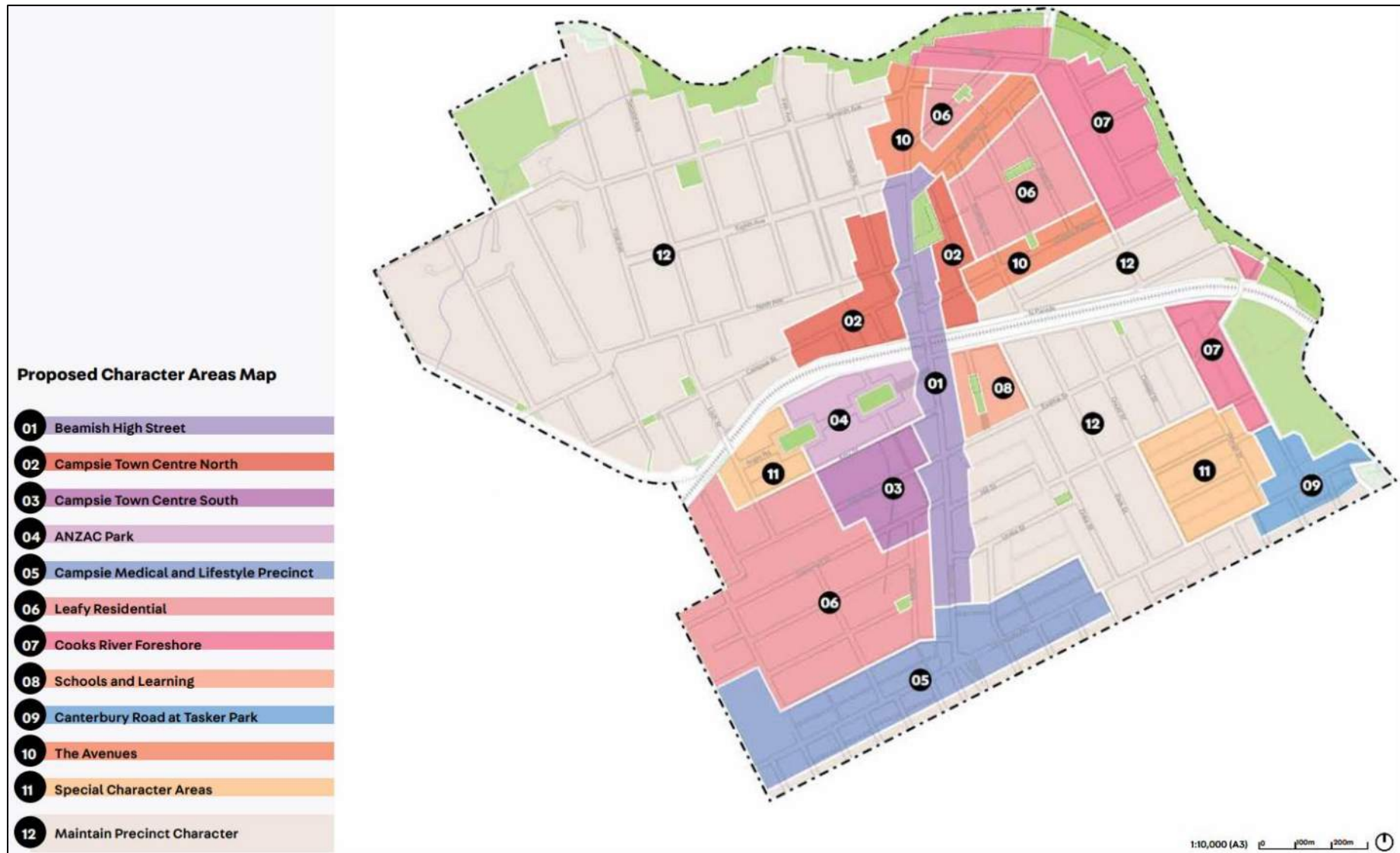


Figure 2-4 Campsie Precinct – Proposed Character Areas (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024)



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment 2 Available Data

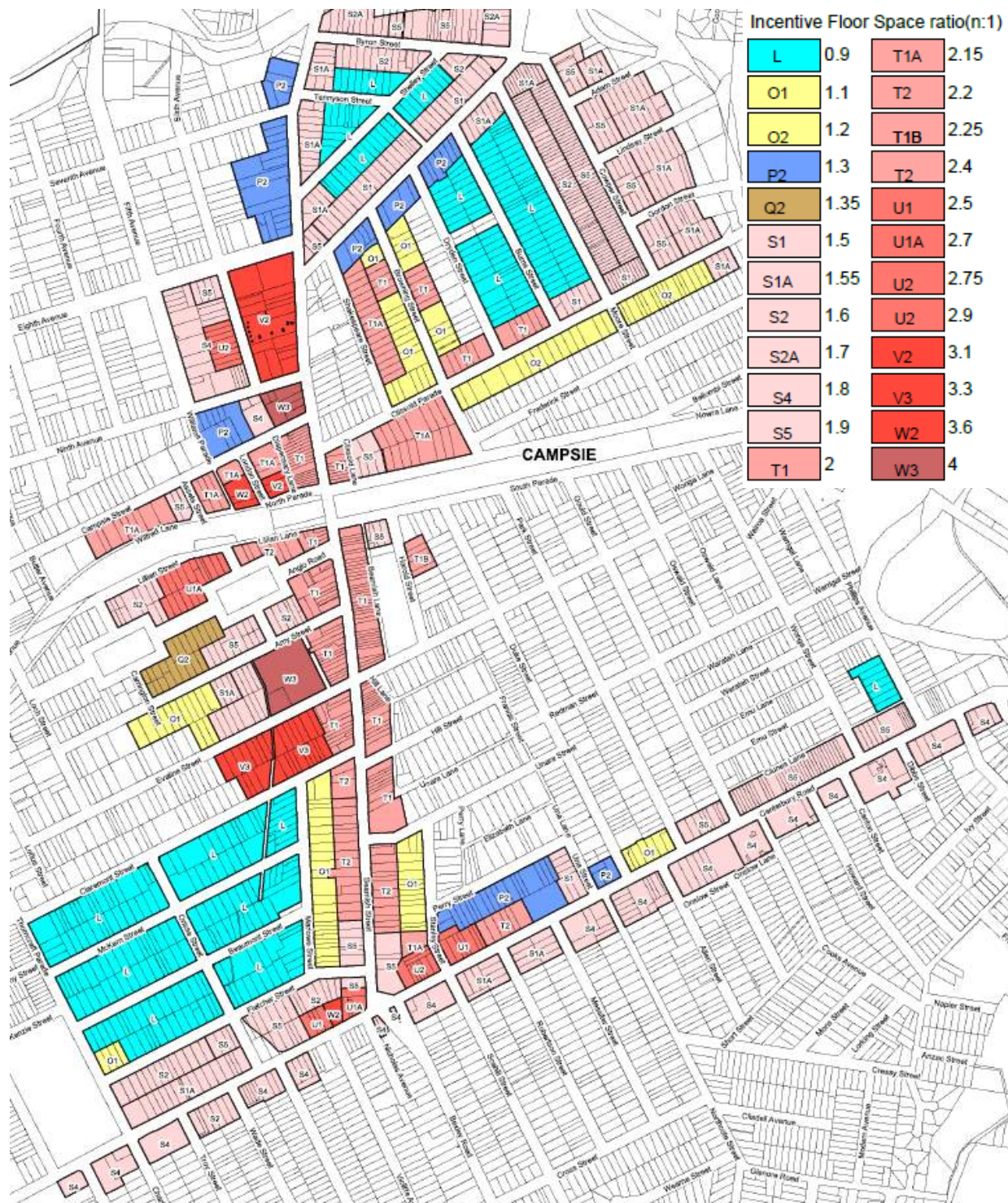


Figure 2-5 Campsie Precinct Rezoning – Proposed Incentive Floor Space Ratio (FSR) Map (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024) Note: This map reflects the current proposed incentive FSR framework. Council has advised that a further update to this map is anticipated following input from its economic consultant. Revised mapping will be incorporated once available.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment



Figure 2-6 Campsie Precinct Rezoning – Proposed Height of Buildings (HOB) (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024)

2.2 Previous Flood Studies

The following regional flood studies have been prepared for the Campsie study area:

- Cooks River Flood Study (MWH+PB, 2009)
- Cooks River Final Overland Flow Study (Cardno, 2016)

A brief summary of these studies is included in the following sub-sections.

2.2.1 2009 Cooks River Flood Study

The study prepared by MWH+PB on behalf of Sydney Water investigates flood behaviour throughout the Cooks River catchment. The report and modelling were completed in 2009. The Cooks River Catchment discharges to Botany Bay at Tempe, adjacent to and immediately south of Sydney Airport. The catchment area is approximately 102 km² and covers portions of 13 local government areas. The catchment has been extensively developed, with many reaches severely altered by developments, and the channel has been constrained or diverted from its original alignment. Much of the main channel of the Cooks River is concrete lined, as is Alexandra Canal and many of the Cooks River's tributaries. Wolli Creek and Bardwell Creek are largely natural waterways.

The study provides information on flood conditions throughout the catchment for a range of design floods, including the 2-year, 20-year, and 100-year Average Recurrence Intervals (ARI's) and the PMF.

This study included the analysis of surface runoff across the catchment, flooding within the underground stormwater drainage network, and flood behaviour through the drains and other watercourses towards the lower end of the catchment. A 1D/2D TUFLOW hydraulic model was established with a 7m grid cell size based on available LIDAR data. Variable hydraulic roughness was applied with buildings not digitised in the 2D but a composite roughness being adopted for residential and commercial uses. The downstream boundary water levels were derived from tidal and flood conditions within Botany Bay.

With regard to the 1D drainage network, aside from culverts and bridges, the open channels were modelled in the 1D using cross sections spaced roughly every 100 metres.

Information on the extent of flood inundation, and peak water levels was provided for the 2-year, 20-year, 100-year ARI and PMF event. Peak depth of flooding, and velocity of floodwater was provided for the 100-year ARI event only. As it defines existing flood conditions, this study is the equivalent of a Flood Study in accordance with the Flood Risk Management Process.

The hydrologic model was developed using the Watershed Bounded Network Model (WBNM) software program and was used to estimate flood flows within the Cooks River and its tributaries. Design rainfall was assessed using ARR87 design rainfall depths and patterns, with 2 hour duration assumed critical for all design events. Initial and continuing losses were variable based on pervious (10mm and 2.5mm/hr) and impervious (1.5mm and 0mm/hr) surfaces.



2.2.2 2016 Cooks River Final Overland Flow Study

The study prepared by Stantec (formerly Cardno) on behalf of Canterbury-Bankstown Council (formerly Canterbury Council) investigates overland flow flooding behaviour throughout the Cooks River catchment in the former Canterbury LGA. The report and modelling were completed in 2016.

The study provides information on flood conditions throughout the catchment for a range of design floods, including the 2-year, 5-year, 10 year, 20-year, 50 year and 100-year ARI's and the PMF. Flood behaviour was modelled in a 1D/2D SOBEK hydraulic model for all design flood events. Model runs were carried out for the rainfall event durations of 15 minutes, 20 minutes, 25 minutes, 30 minutes, 45 minutes, 60 minutes, 90 minutes, 2 hours, 3 hours, 4.5 hours and 6 hours for all AEP events. The PMF event was run for storm durations between 15 minutes and 2 hours.

The model was calibrated to the flood event that occurred on the 14 October 2014. Hydrology for the model was applied as direct rainfall or rainfall-on-grid in the SOBEK model. Design rainfall was assessed using ARR87 design rainfall depths and patterns. Initial and continuing losses were variable based on pervious (10mm and 2.5mm/hr) and impervious (1mm and 0mm/hr) surfaces.

Peak water level, depth, and velocity in the study area were determined based on the peak value for each grid cell from all durations modelled in a particular event. As the direct rainfall approach is used, every 2D cell is inundated with some flood depth. A 0.15m depth filter was applied to highlight primary flow paths excluding locations of minor localised runoff depths. As it defines existing flood conditions, this study is the equivalent of a Flood Study in accordance with the Flood Risk Management Process.

2.2.3 2025 Cooks River Updated Overland Flood Study

Canterbury-Bankstown Council has recently engaged a consultant to prepare an updated Flood Study for Overland Flooding for part of the Cooks River catchment. The project, when finalised and adopted will supersede the previous 2016 Overland Flood Study. Unlike the previous study, which was based on SOBEK modelling, the updated study will be based on a TUFLOW hydraulic model. In discussions with Council at the start of this project, Council noted that the Flood Study is still in the process of preparing design flood models for the study area, with flood results not available at this time.

2.3 GIS Information

To assist this assessment, Canterbury-Bankstown Council provided GIS information including an updated cadastral layer, existing and proposed land use zoning layers, and combined flood extent mapping for the 1% AEP, 1% AEP + Climate Changes, and PMF events for the entire Local Government Area (LGA). Also, Council provided further GIS information (Source: Canterbury Bankstown Local Environment Plan 2024, dated 20/08/2024) including:

- Land Reservation Acquisition (LRA) proposed for the Precinct;
- Base Height of Building (HOB) which is the proposed HOB base for the Precinct;
- Incentive HOB which is an incentive HOB proposed for the Precinct;
- Base Floor Space Ratio (FSR) which is the proposed FSR base for the Precinct; and
- Incentive FSR which is an incentive FSR proposed for the Precinct.



2.3.1 Current Land Use Zoning

Canterbury-Bankstown Council provided Stantec with the current land use zoning layers in GIS to assist with the flood planning review.

2.3.2 LiDAR Topography

The ELVIS - Elevation and Depth - Foundation Spatial Data website was accessed with two datasets available from the website. This data was originally accessed by Stantec for the 2024 Cooks River modelling project. The files appear to have been recorded on the following dates:

- April 2013; and,
- May 2020.

Both files appear to be 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. Review of the two LiDAR datasets showed that the May 2020 LiDAR data provided the most comprehensive and latest available dataset that covered the entire study area.

2.3.3 Building Footprints

Canterbury-Bankstown Council provided Stantec access to a geoscape building footprint layer recorded in September 2020. The building footprint database has been prepared on behalf of the NSW Department of Planning and Infrastructure (DPHI). This layer covered the entire Cooks River catchment. The level of detail in the DPHI layer was assessed to be of good quality, relating to recent enhanced sampling techniques. This data was originally accessed by Stantec for the 2024 Cooks River modelling project.

The building footprint layer was provided to Stantec to be adopted in the hydraulic modelling of the area so that the hydraulic obstructions that buildings present in an urban catchment can be accounted for accurately within the model. To represent the high blockage that is caused by buildings, a roughness value of 0.5 was applied to all building footprints.

2.3.4 Pit and Pipe Database

Stormwater pit and pipe data for the catchment provided by Council on 21 June 2022 was used for this assessment. This data was originally accessed by Stantec for the 2024 Cooks River modelling project. From discussions with Canterbury-Bankstown Council representatives it is understood that the pit and pipe data has been recently surveyed as part of an update in Council's information therefore the data is up to date. It is also understood that Council's surveyors were unable to access the rail line corridors therefore details in the database for culverts and pipes within the rail corridor are understood to be unreliable.

- The details provided within the pit and pipe database included:
- For stormwater pits the details included: pit dimensions, if the pit was an inlet type in terms of kerb, inlet or manhole, and on-grade or sag pit, and invert and depth of the pit.
- For pipes / culverts details included dimensions (diameter for pipes and width and height for culverts), and inverts.



2.4 Channel Naturalisation Design Plans

Stantec were provided by Council copies of design plans for channel naturalisation works from 2014 prepared by Sydney Water. Design plans were provided for three sites near the study area along Cooks River:

- Site 1- Heynes Reserve near the confluence of Cooks River and Cup and Saucer Creek
- Site 2- Flockhart Park located Burwood Road bridge.
- Site 3- Whiddon Reserve located near Second Ave / Lees Ave bridge.

The location of the three naturalisation sites are shown in **Figure 2-7**. Stantec were also provided flood impact assessment reports prepared in support of the naturalisation works. Details from these 2014 design plans were incorporated into the updated hydraulic model as discussed in **Section 3.4.1**.

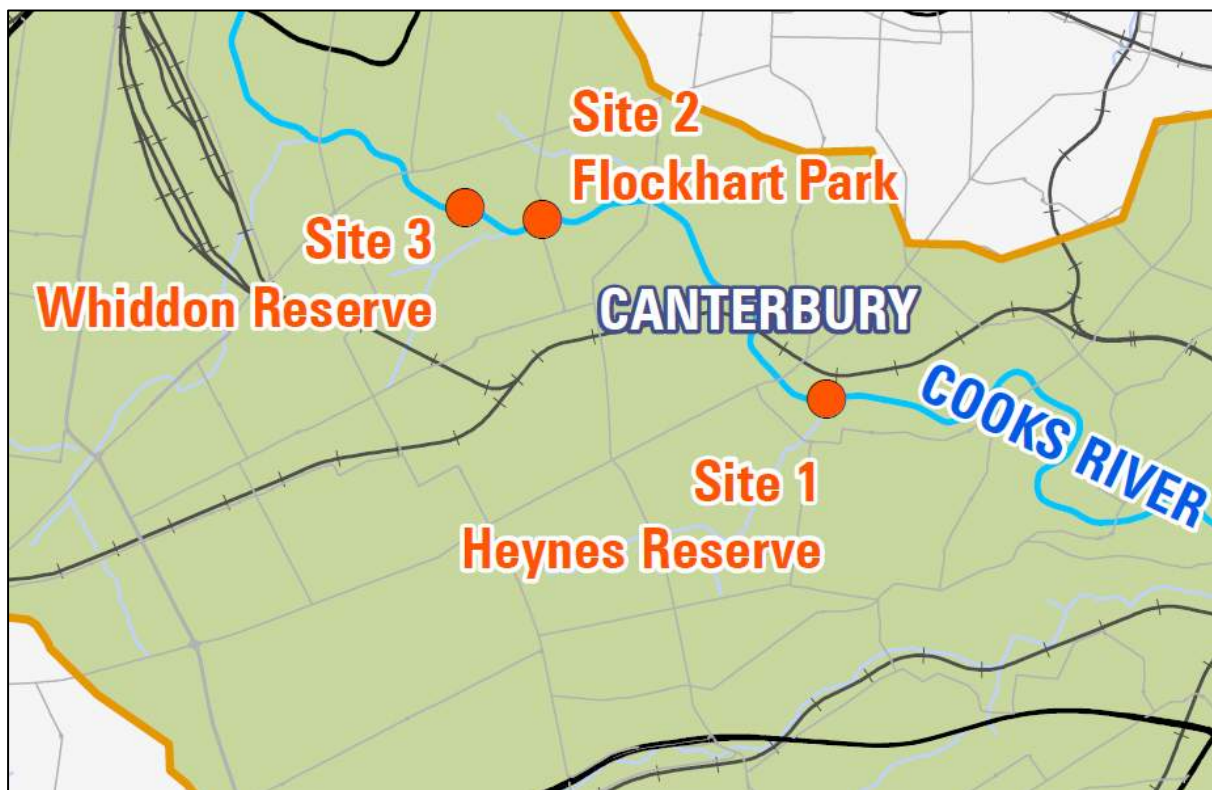


Figure 2-7 Location of Channel Naturalisation Sites along Cooks River (Source: Sydney Water Naturalisation Design Plans, 2014)

3 Flood Modelling

Within the scope for this project was an update of design flood model results for the study area. Stantec reviewed all available data including the models from the two previous Flood Studies. A brief overview of these models is included in **Section 2.2**. While the flood modelling conducted in these two previous studies was in accordance with best practice at the time, there have been developments and improvements in hydrology and hydraulic modelling since these studies were completed. Furthermore, as the study area is affected by both Cooks River mainstream and overland flooding, a consolidated flood model that considered both flooding types was considered necessary.

The adopted methodology for the updated flood model is outlined in **Section 3.1** to **Section 3.7**.

This new TUFLOW model of Cooks River was originally prepared as part of the *Flood Planning Assessment for Belmore, Lakemba and Canterbury Local Centre Master Plans and Belfield Small Village Centre Master Plan* (Stantec, 2024) and encompasses the Campsie study area as shown in **Figure 3-1**. This updated TUFLOW hydraulic model has been adopted and updated in this revised assessment for Campsie (where the previous 2022 Campsie flood assessment adopted the previous 2009 and 2016 study results). A number of minor updates have been made to date to the TUFLOW model as part of the Campsie project. From past reviews by Council and NSW DCCEE technical staff, the model was found suitably detailed for the purposes of this assessment for Campsie.

The updated flood model has been validated compared to the two previous flood studies as summarised in **Section 3.7**. The updated flood model utilises more contemporary modelling techniques in keeping with current industry best practice. However, the two previous flood studies are relevant as they are still the adopted flood study models for the area, and as they both went through a more rigorous validation and calibration process than was possible for the updated flood model scope. Therefore, a detailed model validation has been conducted to ensure that the updated flood models are suitable in reference to the calibrated and currently adopted flood study models for the catchment.

In addition, in the model methodology section (**Section 3.1**) frequent reference is made to the model set-up relative to these previous flood study models. In these following sections, references to these studies are either ‘2009 Mainstream Study’ referring to the *Cooks River Mainstream Flood Study* (MWH+PB, 2009), or ‘2016 OLF Study’ refers to the *Cooks River Final Overland Flow Study* (Stantec, 2016).

Finally, a summary of the updated design flood model results has been provided in **Section 3.8**.

As discussed in **Section 2.2.3**, Council is currently preparing an updated Overland Flood Study of part of the Cooks River catchment using a TUFLOW hydraulic model to supersede the 2016 Study. However in discussions with Council at the start of this project, Council noted that model outputs from this current study will not be available in time for this FIRA. Therefore no validation of the adopted TUFLOW model to these latest Council study results was possible.



3.1 Model Methodology

3.1.1 Adopted Model Platform

A TUFLOW 1D/2D hydrology and hydraulic model was established for the catchment as part of the updated flood modelling. TUFLOW is currently the industry standard platform in NSW. It is the same platform used in the 2009 Mainstream Study, while the 2016 OLF Study adopted a similar 1D/2D model using SOBEK.

Hydrology was applied using a rainfall-on-grid approach, meaning the flow routing was conducted within the 2D domain of the TUFLOW model. This is a commonly adopted approach for local overland flooding catchments as occurs in this area. For context, the 2016 OLF Study also adopted rainfall-on-grid approach to hydrology, while the 2009 Mainstream Study adopted a conventional hydrology model which then fed into the TUFLOW model.

The updated flood model utilised the Heavily Parallelised Computing (HPC) approach within TUFLOW (also referred to as TUFLOW GPU). This TUFLOW approach uses different computer hardware to TUFLOW classic (also called TUFLOW CPU) which was adopted within the 2009 Mainstream Study model.

The main advantage of TUFLOW HPC is that it provides significantly quicker model run times. HPC provides the ability to run models on Graphics Cards, to achieve significantly shorter model run times, increasing modelling capabilities to be able to run hydraulic models with higher cell resolution, and across larger extents. Whereas TUFLOW Classic is limited to running a simulation on a single CPU core, HPC provides parallelisation of the TUFLOW model allowing modellers to run a single TUFLOW model across multiple CPU cores or GPU graphics cards (which utilise thousands of smaller CUDA cores).

Given the large catchment area of the Cooks River, and the need for high resolution grid cells as discussed in the sub-sections below, the adoption of TUFLOW HPC was seen as appropriate for this updated flood model. This change in processing platform will lead to differences in model results when compared with the 2009 model, which used TUFLOW Classic.



3.1.2 TUFLOW Engine Version

There are relatively frequent updates to the TUFLOW engine versions that help progressively improve modelling in line with improved practices and processing capabilities. The adopted model engine for the updated flood model is 2020-10-AD, which was a recent version when this model was first created. There have been a lot of changes in the TUFLOW engines compared to the superseded version from the 2009 Mainstream Study, 2007-07-BF. These version changes mean that it is not possible to replicate previous TUFLOW engine results, and some model result impacts are attributable to the change in model engine. However, as newer engine versions incorporate performance and accuracy improvements, their use is considered appropriate for this updated modelling exercise.

3.1.3 Model Details

The total two-dimensional (2D) model area for the updated flood model is 2,727.2 ha (27.27 sq. km), with the model boundary layout shown in **Figure 3-1**. The model area has been delineated as follows:

- On the upstream side of Cooks River, the model has been started from near Gregory Street and Cleveland Street in the suburb of Strathfield South.
- On the downstream side of the Cooks River the model has been extended to near the pedestrian bridge for Foord Ave in Hurlstone Park and Waterside Crescent in Earlwood.
- The entire Cooks River catchment between this upstream and downstream end of the model have been included in the model area. This includes the Coxs Creek catchment, and the entire Cup and Saucer Creek catchment which are both major tributaries of the Cooks River. In addition, the catchments of several smaller overland flowpaths have been included in the model area including a flowpath on the north bank of the river in Croydon Park.

The study area is located in the central part of the model area. The model area has been extended far beyond the study areas to include the full catchment flowing to this length of the river.

A grid size of 2m x 2m was adopted for the updated flood model, with a grid cell count of approximately 6.8 million cells. For a TUFLOW classic model this grid cell count would not be functional, however with the adopted TUFLOW HPC the model run times were roughly a day. Therefore, this grid cell size provided a balance between achieving an adequate degree of accuracy in the representation of topographic features and providing acceptable run times. Furthermore, this grid size allowed for roadways to be represented by at least two cells.

A time step of 1 second was applied to the 2D component of the model and a time step of 0.5 second for the 1D component. This is within the recommended ranges for 2D for 1D outlined in TUFLOW guidelines.



3.1.4 Topography

The majority of the model 2D grid was based on LiDAR sourced from the ELVIS portal and recorded in May 2020 as discussed further in **Section 2.3.2**. The topography of the TUFLOW model is shown in **Figure 3-2**. LiDAR data can have limitations, particularly in areas with:

- Permanent waterbodies, where water surfaces obscure terrain,
- Dense vegetation, or
- Building footprints, where point returns are sparse or inaccurate.

In this model, Cooks River, as a permanent waterbody, lacked valid LiDAR surface data. Since no bathymetric or hydrographic survey data were available, the riverbed within the banks was represented as follows:

- The 2009 Mainstream Study model included river bathymetry data, which, after consultation with Council, was deemed the best available representation.
- The bathymetric data from the 2009 model was extracted and incorporated into the current model, replacing the LiDAR-derived river surface. **Figure 3-2** shows the extent of this substitution.

Additional review of the LiDAR data identified anomalously deep holes, some corresponding to basement car park entries, and others to construction excavation pits. The model treated these features as follows:

- Basement entries were assumed to be permanent features and were retained as-is.
- Construction pits, likely temporary, were filled in the model surface to reflect expected long-term conditions.



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment 3 Flood Modelling

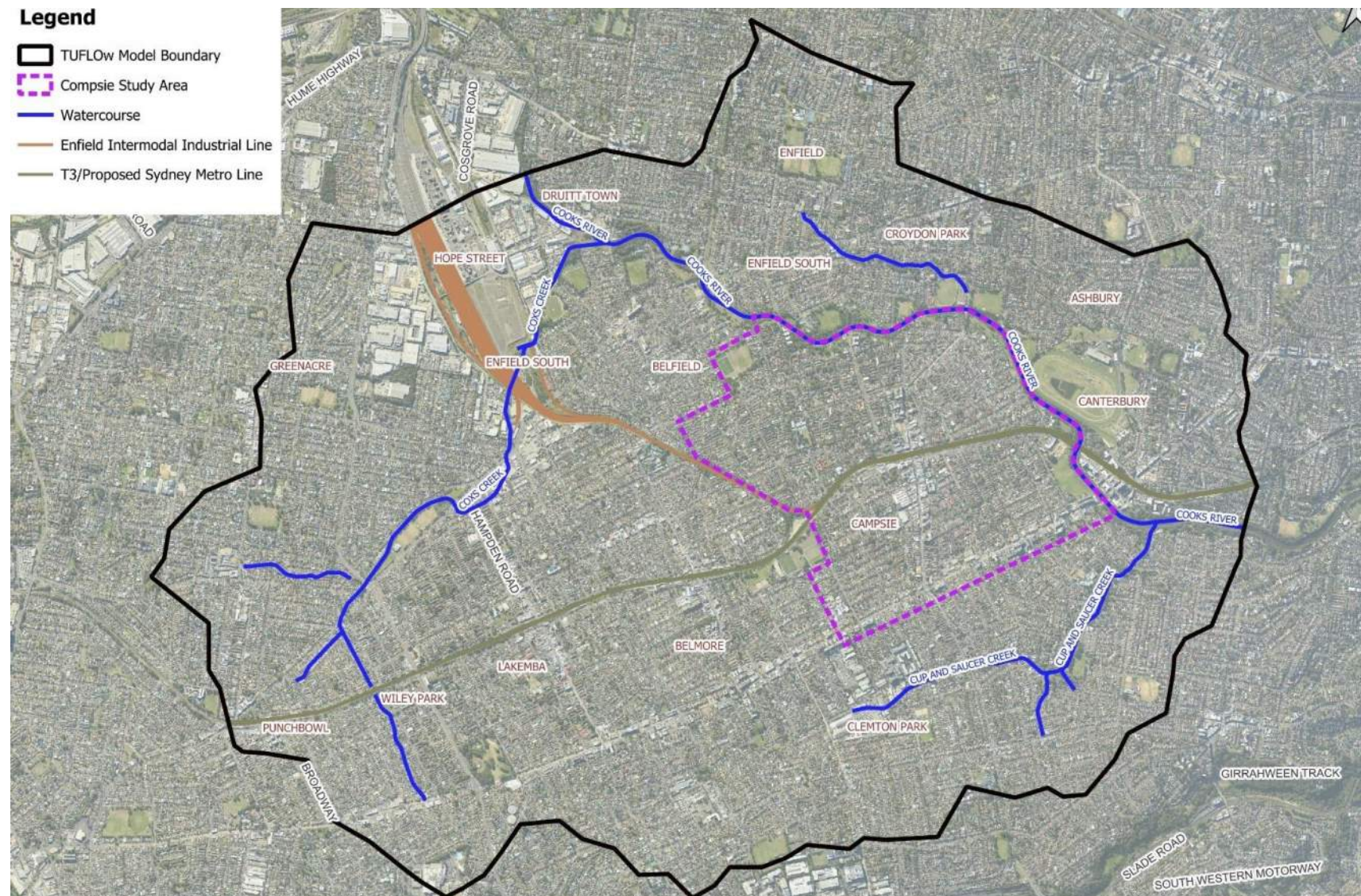


Figure 3-1 TUFLOW Hydraulic Model Boundary



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment
3 Flood Modelling

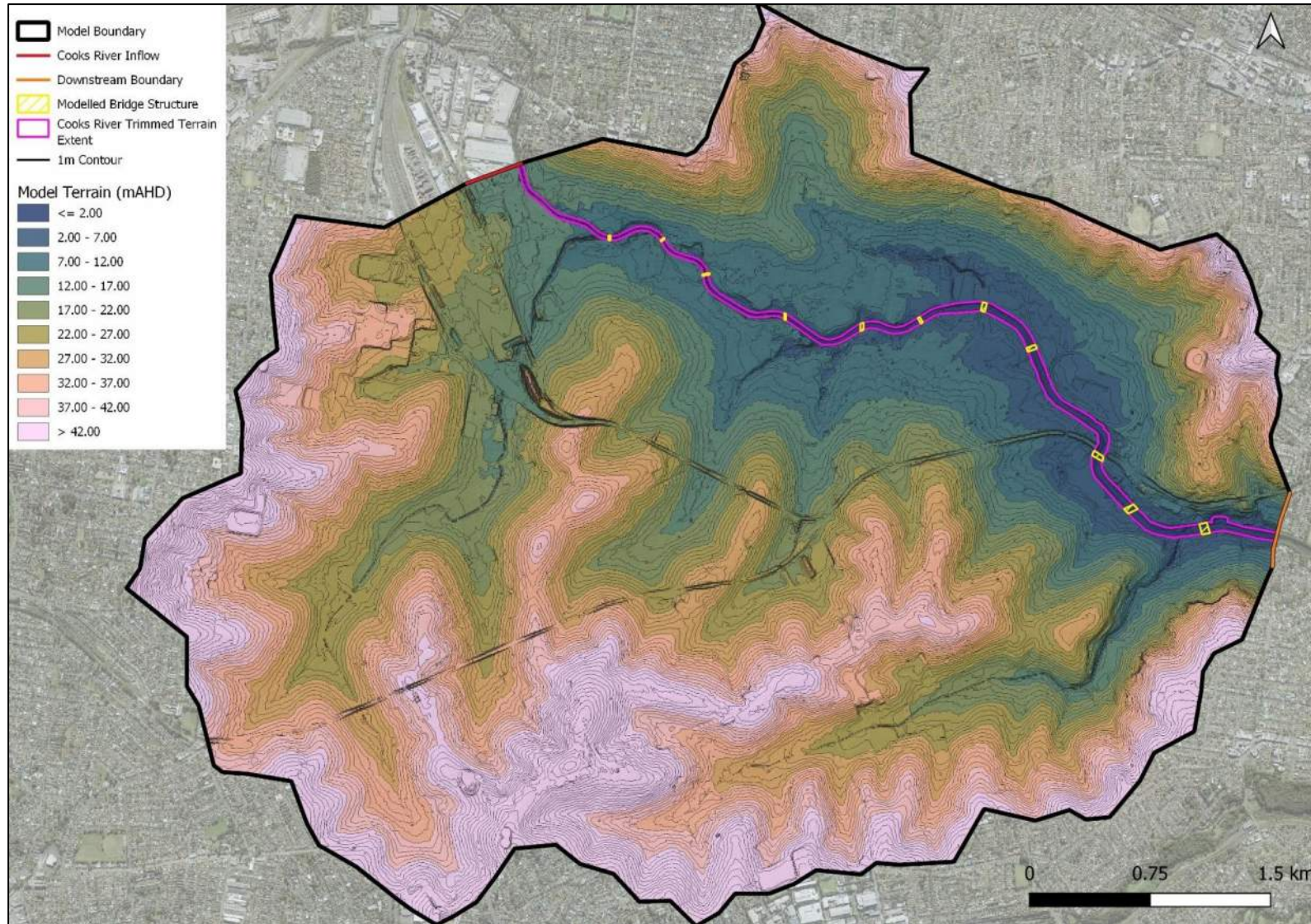


Figure 3-2 Model Topography, River Trimmed Bathymetry Extent, Upstream and Downstream Model Boundaries and Modelled Bridge Structures



3.2 TUFLOW Direct Rainfall Hydrology Component

3.2.1 Design Flood Event

A range of design flood events were simulated in this study to support FIRA and future development planning. These events were selected in consultation with Council and reflect both common and rare flooding scenarios. The modelled events include:

- 5% AEP event (1 in 20 year), with durations of 60, 90, 120 and 180 minutes
- 1% AEP event (1 in 100 year), using a critical duration of 120 minutes, as confirmed through sensitivity testing during the 2024 flood modelling study
- 0.2% AEP event (1 in 500 year), with durations of 60, 90, 120 and 180 minutes
- 0.05% AEP event (1 in 2000 year), with durations of 30, 45, 60, 90, 120 and 180 minutes
- Probable Maximum Flood (PMF), with durations of 30, 60, 90, 120, 180, 240, 360, 720 and 1440 minutes

Durations were selected for each AEP to assess the range of potential critical durations, based on 1% AEP modelling from past Council studies short duration events (1hr to 3hr) are assumed critical for both overland and mainstream sections of the study area. The exception is the PMF event, where not only the critical duration event is important, but the duration of flooding is also important for the flood risk assessment. Therefore for the PMF event long duration events, 4.5hr, 6hr, 12hr and 24hr were also modelled.

Consistent with the *NSW Flood Inquiry*, extreme flood events such as the 0.2% and 0.05% AEP have been used in this study to inform flood planning and support land use planning. Rather than undertaking separate climate change modelling, these higher-end events have been adopted as practical proxies to account for the potential effects of climate change. This approach aligns with the recommendation that events such as the 0.05% or 0.02% AEP should be considered, particularly for higher-risk proposals. It also ensures that the increased flood frequency and levels associated with climate change are reflected in planning decisions without requiring duplicate modelling efforts.

Design rainfall depths were based on the methodologies outlined in ARR87, as previously adopted by Council. These values were calculated at the catchment centroid using Bureau of Meteorology (BoM) IFD data (coordinates: -33.9128, 151.0901). Standard ARR87 temporal patterns were applied using hyetographs with 5-minute intervals for the 5%, 1% and 0.2% AEP events. The 0.05% AEP, being closer to an extreme PMF event, adopted the GSDM temporal pattern (see below for PMF summary).

The 0.2% AEP and 0.05% AEP event rainfall depths were generated using the interpolation function in XP-RAFTS hydrologic model, with rainfall depths for these two events interpolated from the 1% AEP and PMF events. A summary of the adopted design rainfall depth (mm) for the updated flood model are included in **Table 3-1**.



Table 3-1 Adopted Design Rainfall Depths for the Updated TUFLOW Model

Duration (minutes)	5% AEP (mm)	1% AEP (mm)	0.2% AEP (mm)	0.05% AEP (mm)
30	—	—	—	90.74
45	—	—	—	112.73
60	66.2	88	105.3	130.5
90	82.2	109.2	124.0	154.6
120	86.8	115.2	138.8	173.7
180	99.9	132.6	161.8	202.7

3.2.2 Design Rainfall – PMF Event

The Probable Maximum Precipitation (PMP) values were derived using the Generalised Short Duration Method (GSDM) for event durations between 15 minutes and 6 hours. For longer durations (12 hour and 24 hour), the Generalised Southeast Australia Method (GSAM) was applied, in accordance with current ARR2019 recommendations.

Unlike the previous 2024 Model prepared by Stantec for the pre-gateway submission, which applied PMP ellipses (A, B, and C), the updated assessment adopts a single set of PMP values across the study area, removing the need for spatially variable rainfall input. This single rainfall pattern approach for PMF is consistent with the 2016 Overland Flow (OLF) Study and 2009 Mainstream Flood Study.

The PMP rainfall depths presented in **Table 3-2** were generated using the GDSM and GSAM calculations in the XP-RAFTS hydrologic model software. These depths were applied to simulate the full range of PMF event durations used in the overland flow modelling. For the short duration, 30 min and 60 min events, the rainfall totals are slightly lower relative to the 2016 OLF Study rainfall totals.

Table 3-2 Calculated PMF Rainfall Depths (mm) Compared to Previous Study

Event Duration (minutes)	Updated Model PMF (mm)	2016 OLF Study (mm)
30	216.7	230.0
60	321.9	330.0
90	394.9	379.5
120	454.3	430.0
180	533.7	N/A
270	616.3	N/A
360	699.0	N/A
720	803.4	N/A
1440	948.7	N/A



3.2.3 Rainfall Losses

As the model is a rainfall-on-grid model, initial and continuing rainfall losses were applied to the hydrology component of the TUFLOW 2D model based on pervious and impervious surface types. The pervious and impervious rainfall losses applied to the model are presented in **Table 3-3**. These loss values are consistent with those adopted within the previous flood study models.

Table 3-3 Initial and Continuing Rainfall Losses Adopted in the Updated Flood Model

Surface Type	Initial Loss (mm)	Continuing Loss (mm/hr)
Pervious	10.0	1.5
Impervious	1.0	0.0

These losses were applied through surface material mapping for the TUFLOW 2D model. Eleven different surface materials were mapped in the model area, with a summary of the adopted impervious percentage for each included in **Table 3-4**. The layout of surface material mapping for the model is shown in **Figure 3-3**.

For the extreme events, 0.05% AEP and PMF, conservatively it has been assumed that the catchment was saturated prior to these extreme events. Therefore for the entire study area initial and continuing losses of 0mm and 0mm/hr have been adopted for these two events.

Table 3-4 Surface Types and Assumed Impervious Percentages, Rainfall Losses and Hydraulic Roughness Values

Surface Type	Impervious Percentage	Initial Loss (mm)	Cont. Loss (mm/hr)	Hydraulic Roughness
Residential	35%	6.85	1.625	0.05
Roads	70%	3.7	0.75	0.02
Maintained Grass	0%	10	2.5	0.03
Buildings	100%	1	0	0.5
Commercial	90%	1.9	0.25	0.1
Industrial	100%	1	0	0.03
Park	25%	8.65	2.125	0.03
Waterway	0%	0	0	0.015, 0.02, 0.03
Dense Vegetation	0%	10	2.5	0.06
Open Channel	100%	1	0	0.015
Railway	80%	5.5	1.25	0.02



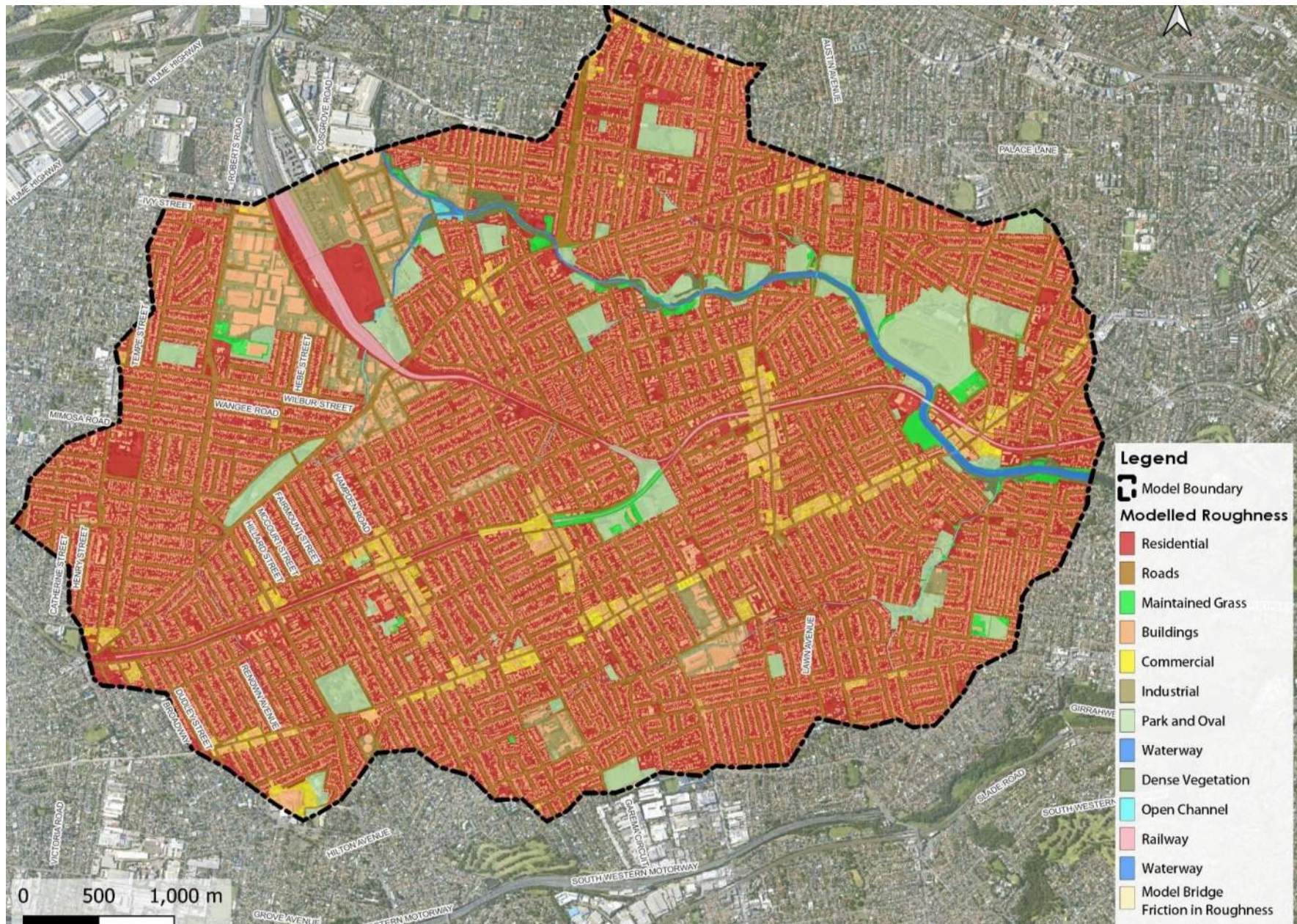


Figure 3-3 Updated Flood Model – Surface Material Types



3.3 Upstream WBNM Hydrology Model

The TUFLOW direct rainfall model extent covers a large portion, but not all, of the catchment of the upper Cooks River. From the upstream model boundary, there is a hydrology catchment to the north-west that drains to the Cooks River channel. The delineation of this upstream catchment is shown in **Figure 3-4**. Reporting from the 2009 Mainstream Study showed that this upstream hydrology catchment was modelled in WBNM software, using seven sub-catchments (CR1 to CR7) with areas and impervious percentages for these sub-catchments included in mapping from the 2009 report as shown in the background of **Figure 3-4**.

To simulate inflows from the upstream Cooks River catchment, a hydrologic model was required. The 2009 Mainstream Study provided data included results only for the 2-hour 1% AEP and PMF events, no other durations or AEPs. However, this study considers a broader range of durations and design events (as described in **Section 3.2**), and therefore required more comprehensive upstream hydrologic inputs.

Although the original WBNM model used in the 2009 Mainstream Study was not available, a new WBNM hydrologic model was developed specifically for this study. The model configuration was based on the 2009 report's documented catchment boundaries and land use assumptions to ensure consistency with the previous approach, while expanding coverage to all relevant event durations.

To confirm the reliability of the updated model, the WBNM-derived 1% AEP and PMF 2-hour hydrographs were compared against corresponding hydrographs from the 2019 Cooks River model. Pervious initial and continuing losses (10mm and 2.5mm/hr) and impervious initial and continuing losses (1.5mm and 0mm/hr) were adopted consistent with the 2009 WBNM model.

As the exact model inflow location for the current TUFLOW model lay downstream of the 2009 TUFLOW model upstream boundary, composite link lag factors were required to replicate a combination of WBNM and TUFLOW lags from the 2009 modelling. The adopted lag factors in the updated WBNM model were:

- C lag = 2.18
- Imp C lag = 0.1
- Flowpaths – R type and 0.33

As shown in **Figure 3-5**, the results demonstrated close agreement to the 2009 hydrographs in terms of peak flow, timing, and hydrograph shape—validating the updated WBNM model for use in this study.

The same set-up was adopted for design flood modelling for all listed durations for the 5%, 1%, 0.2% and PMF events. For the 0.05% AEP (1hr, 1.5hr, 2hr and 3hr) and PMF long duration (12hr and 24hr) events, where design IFD were not loaded into WBNM, hydrograph scaling has been prepared based on relative rainfall depth ratios and timing from available short duration PMF events.

The final hydrographs generated by the WBNM model were adopted as flow-time series inputs at the upstream boundary for each design event. These are presented in **Figure 3-5** and **Figure 3-6**. Results show close agreement in peak flow, timing, and shape for the two available events, confirming the reliability of the updated WBNM model for upstream boundary inflows.



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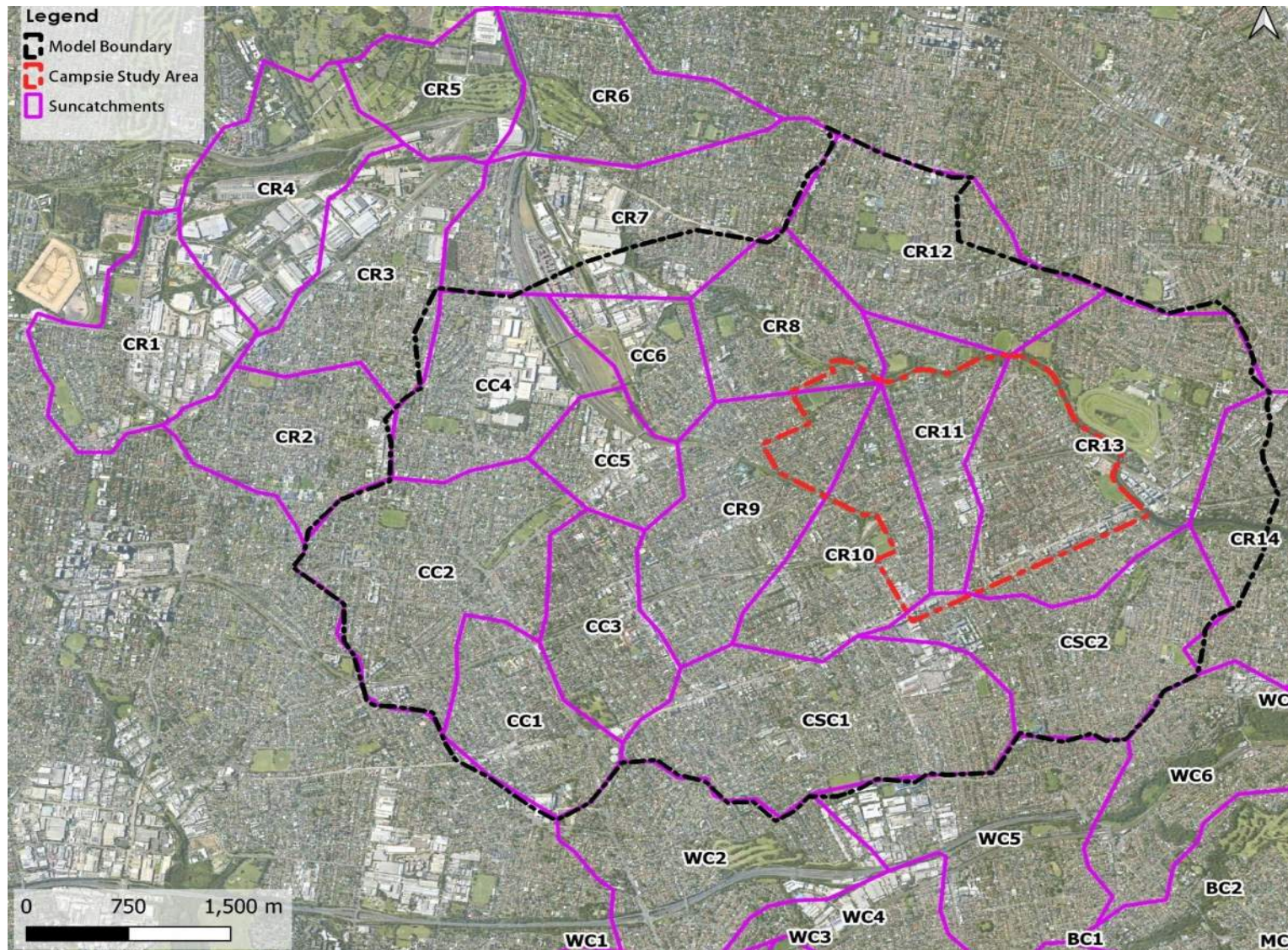


Figure 3-4 Catchment Delineation for 2009 Mainstream Study WBNM Model Relative to TUFLOW Model Boundary for Current Study



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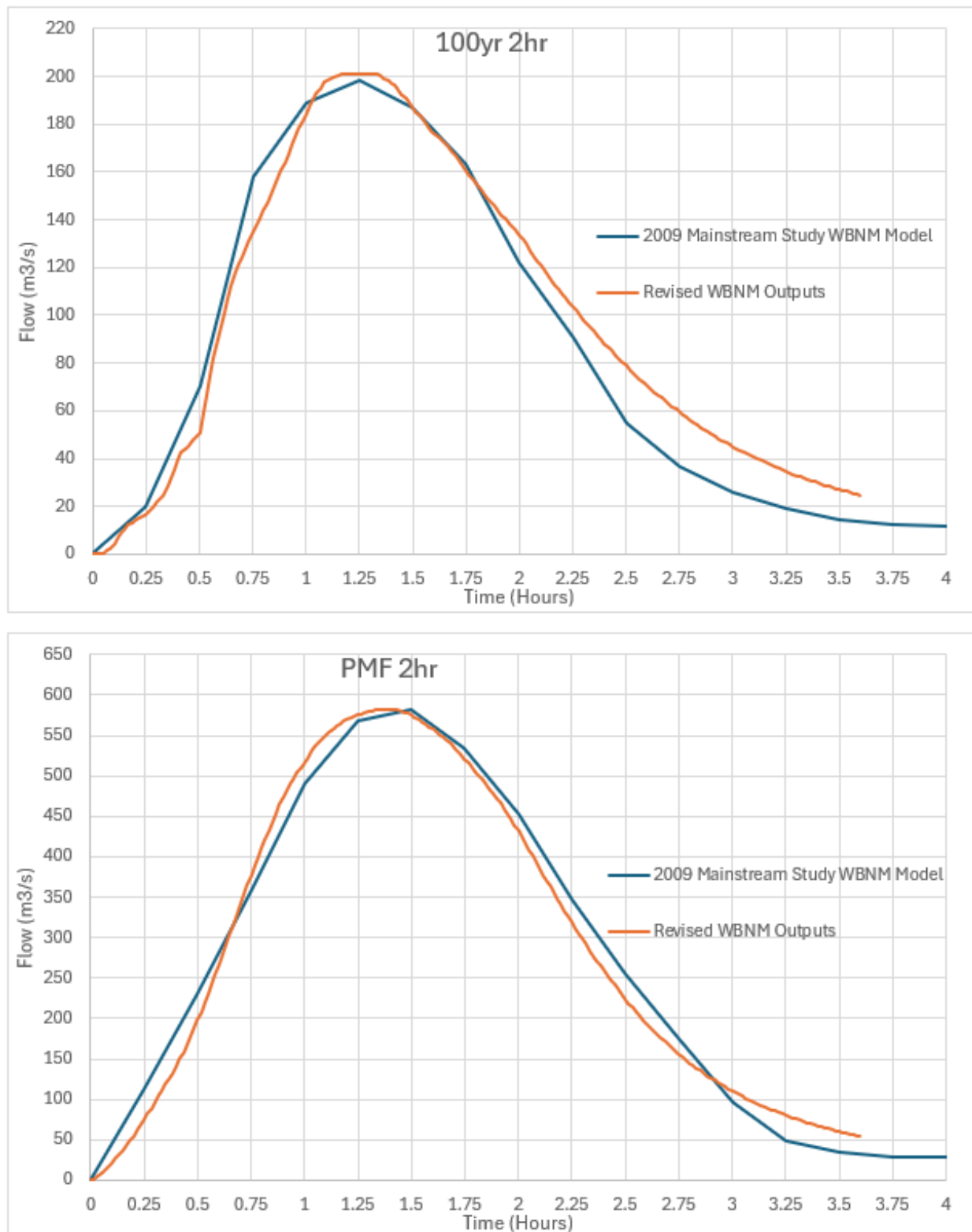


Figure 3-5 Upstream Boundary – Comparison of inflow hydrographs from the updated WBNM model and the 2009 Mainstream Study model for validation purposes. The figure compares hydrographs for the 2-hour duration of the 1% AEP (top) and PMF (bottom) design events.



3.4 TUFLOW 2D Hydraulic Component

3.4.1 Hydraulic Roughness

Hydraulic roughness was simulated in the 2D domain of the TUFLOW model using variable Manning's n roughness based on surface types. Using the same surface type mapping from hydrology impervious percentage, roughness values for the surfaces are summarised in Table 3-4. Surface types were mapped using a combination of cadastre for land use types, aerial imagery and site observations. The layout of the surface types is shown in **Figure 3-3**.

For the Cooks River waterway, the roughness values of 0.015 – 0.02 were adopted in accordance with the set-up of the 2009 Mainstream Study model. The difference is that in the 2009 Mainstream Study model, the area of low roughness 0.015 was applied beyond the concrete lined channel, and also applied to the overbank areas which are often heavily vegetated. Given this heavy vegetation, the previously adopted roughness was too low for the observed conditions, as a result revised mapping was applied in the updated model for the Cooks River waterway.

Generally, roughness values have been reviewed and found to be consistent with the 2016 OLF Study model. However, there is one key distinction in surface type mapping, the 2016 OLF Study adopted a composite residential surface type that combined buildings and non-building areas in one layer, with a roughness of 0.3. As detailed building footprint information was available for this updated flood model (see **Section 2.3.3**), buildings were separated in the surface types mapping of the model. To represent the high blockage that is caused by buildings, a roughness value of 0.5 was applied to all building footprints, with the non-building portion of residential areas with a roughness value of 0.05 for the existing scenario model.

As part of this revised assessment, updates have been made to hydraulic roughness in several sections of floodplain around Cooks River. This is following the supply of Sydney Water channel naturalisation design plans from 2014 provided by Council (refer to **Section 2.4**). With these design plans available, it was possible to refine the roughness mapping to reflect the density and extent of vegetation presented in the naturalisation works. Review of latest available aerial imagery confirmed these channel naturalisation works from 2014 were essentially implemented as per the design plans. Comparison to results from the 2024 study model showed these roughness changes only had minor impact on water level results along the Cooks River.

3.4.2 Cooks River Bridge Structures

Along the Cooks River waterway, a total of 11 bridge structures were identified that required inclusion within the hydraulic model. Due to the large-scale size of the bridge structures, and as the river has now been modelled within the 2D domain, the bridge structures were also incorporated into the 2D domain. The adopted model approach for bridge structures involved applying a layered polygon that allows for depth varying flow obstructions to be applied to 2D flows. The bridges in the model area were modelled as follows:

- Bridges with multiple cells and piers were modelled with partial blockage and form losses to represent the flow obstructions these structures present. For clear span bridges where there is no potential obstruction in the waterway no blockage or form loss was applied to this lowest layer;



- The second layer set above the first, represents the bridge deck and was blocked 100%. The obvert and surface level of the bridges (applied as top and bottom layer elevations in the polygon) were determined through review of the bridge details modelled in the 2009 Mainstream Study.
- The third layer represents the bridge surface, with no blockage applied to this layer. While some bridges with railings may present some form of blockage in this layer, the effects were assumed to be negligible.

The bridge structure modelling approach is very different to that applied in the 2009 Mainstream Study model, as that was done in the 1D domain while this updated flood model uses the 2D domain. This change in model approach, combined with improvements in TUFLOW versions from 2007 to 2020 has caused differing model outcomes for the bridge structure modelling. As discussed further in **Section 3.7.2**, the 2009 Mainstream Study model appears to apply very high and unrealistic form losses on the bridge structures. This results in pronounced stepped water level results in the previous model. Comparatively, the updated flood model results show a more gradual water level gradient along the river between bridges which is seen as more representative of likely bridge structure influence.

3.4.3 Boundary Condition – Cooks River Flows and Levels

The updated hydraulic model incorporates a section of the Cooks River extending from South Strathfield (upstream) to Earlwood (downstream), including the Cup and Saucer Creek confluence. To represent the broader hydraulic influence of the Cooks River beyond this modelled reach, two boundary conditions were applied: an upstream flow boundary and a downstream water level boundary. The locations of these boundaries are shown in **Figure 3-2**.

Downstream Boundary

Within the TUFLOW model, the downstream boundary has been located downstream of the Cup and Saucer Creek confluence to reflect the tailwater influence from the lower Cooks River system. This location was chosen to ensure downstream conditions were realistically captured without introducing instability near the modelled area of interest.

In previous versions of the TUFLOW model, stage-time (water level) boundary condition was applied using extracted water level time series results from the 2009 Mainstream Study TUFLOW model for the 1% AEP and PMF 2-hour events. However with updated modelling considering a range of events and AEPs, the downstream boundary condition needed to be updated.

Water levels at this boundary were derived using an H-Q (stage–discharge) relationship based on regional slope estimates and previous modelling experience. This also required iterative modelling to confirm the most suitable gradients to appropriately reflect tailwater effects from the lower Cooks River floodplain and sea level conditions further downstream.

For PMF and 0.05% AEP events, a tailwater slope of 0.0015 was applied, while a slope of 0.0012 was used for all other events. These values were validated against the 2009 Cooks River model, showing consistent peak water level profiles in the lower reaches of the model for the available 1% AEP and PMF events. This suitable matching of 2009 water levels is shown in the downstream sections of the water level longitudinal section for these two events shown in **Figure 3-13**.



Upstream Boundary

As noted in **Section 3.3**, the inflow hydrographs at the upstream Cooks River boundary for each design event have been extracted from a local WBNM hydrology model set-up for this project. These hydrographs have been applied to the TUFLOW model at the upstream boundary near South Strathfield. The extracted results from WBNM modelling adopted as inflow hydrographs for the TUFLOW model events are shown in **Figure 3-6** and **Figure 3-7**.

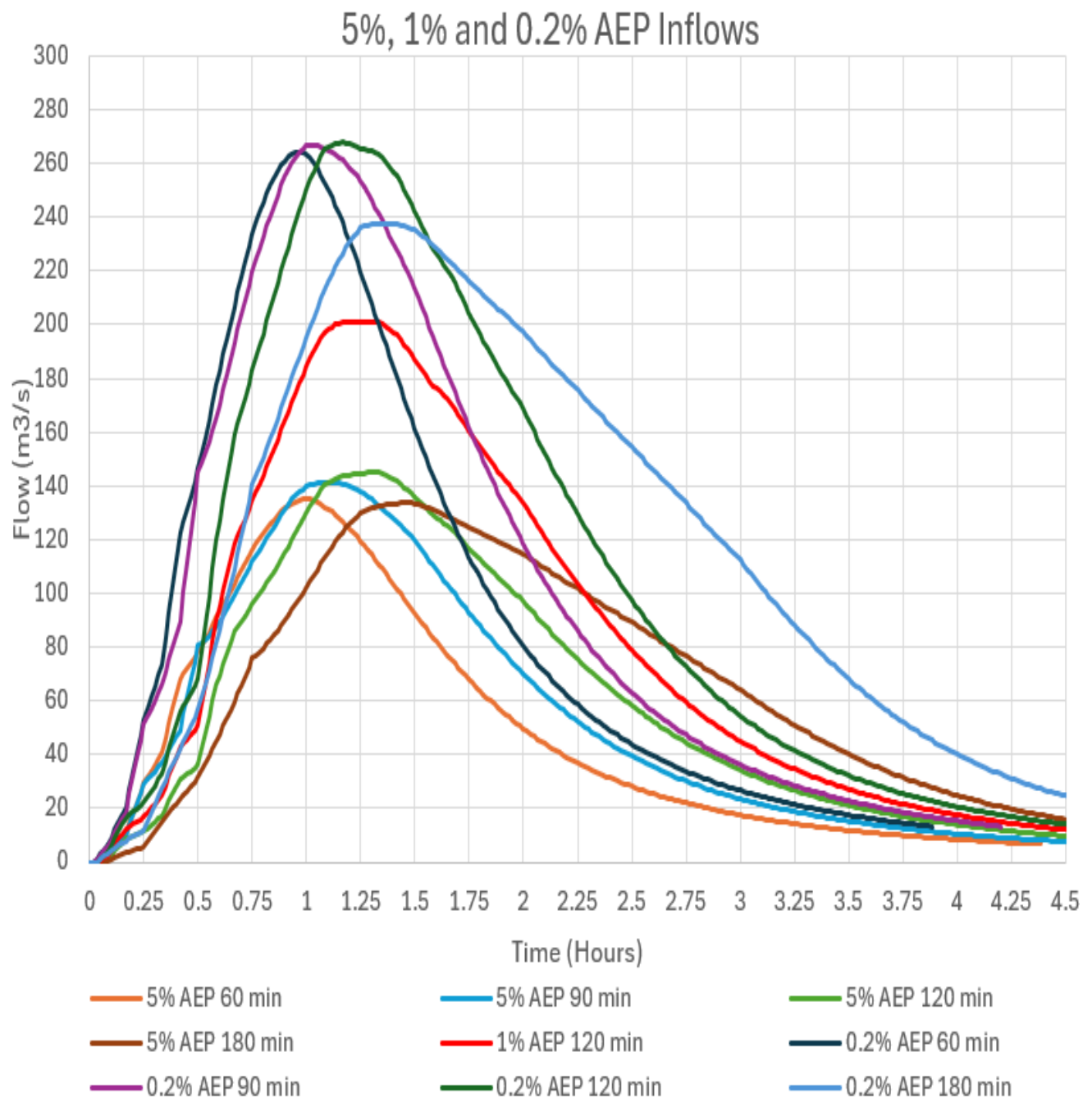


Figure 3-6 TUFLOW Upstream Boundary Condition – Inflow Hydrographs from the Updated WBNM Model for 5%, 1% and 0.2% AEP Events for Modelled Durations



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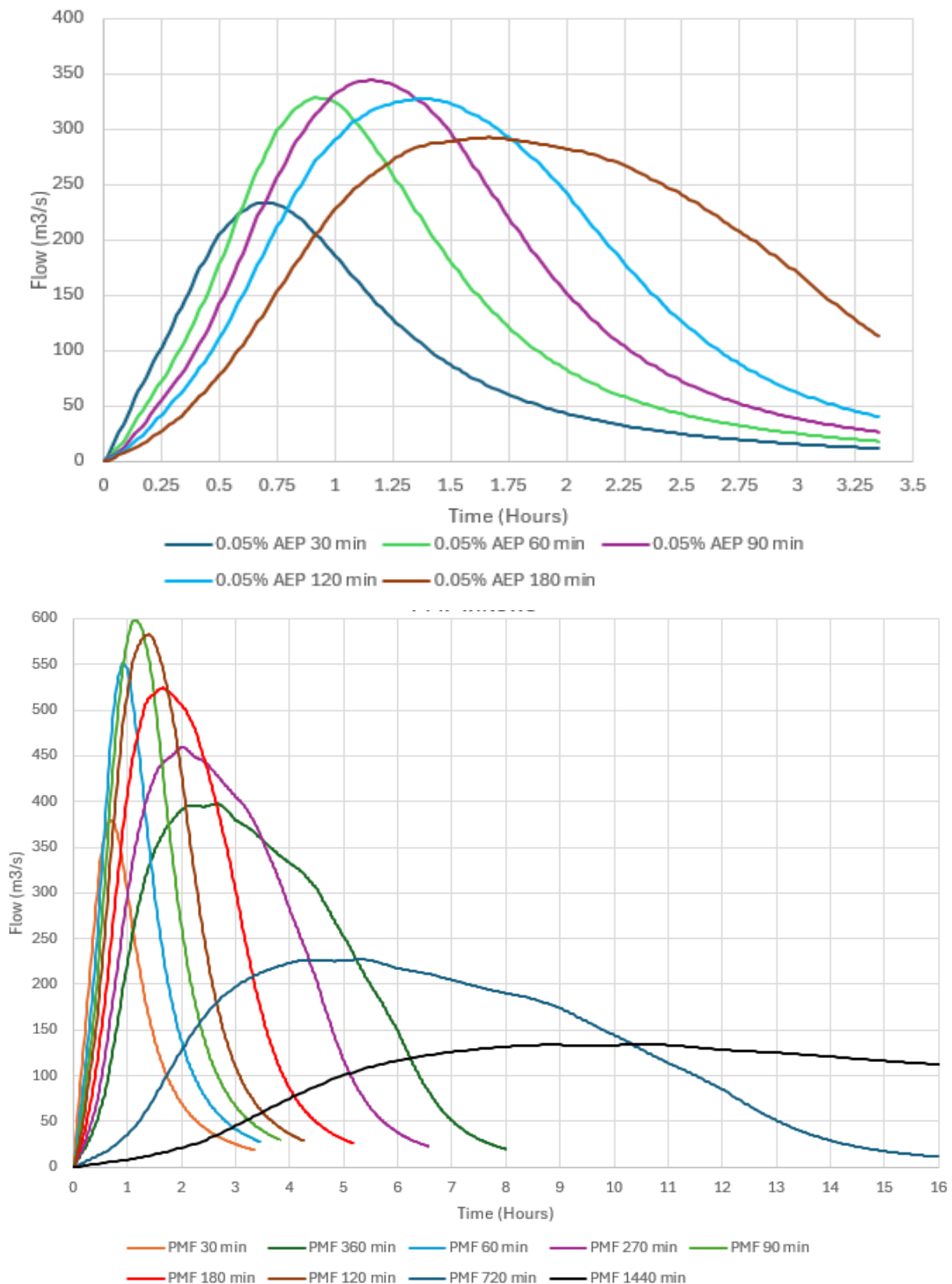


Figure 3-7 TUFLOW Upstream Boundary Condition – Inflow Hydrographs from the Updated WBNM Model for 0.05% AEP (Top) and PMF (Bottom) for Modelled Durations



3.5 1D Hydraulic Component

Within the TUFLOW model, all surface flows have been modelled within the two-dimensional (2D) domain. The one-dimensional (1D) component of the TUFLOW model has been used to model culvert and pipe structures. Council provided GIS layers of the stormwater pit and pipe network as outlined in **Section 2.3.4**.

A detailed review of the provided pit and pipe database was conducted and it was found that the surveyed details generally matched observed conditions from Streetview and the previous OLF Study model. The exception was within the rail corridors, where the observed conditions and the 2016 OLF Study model details in the corridor did not match the database details. In discussion with Council staff, it was confirmed that Council's surveyors were likely not granted access to rail corridors to survey pipes and culverts. Therefore for these corridors it was assumed that the details modelled in the 2016 OLF Study model are the most appropriate representation of these structures, and these details were applied in the updated flood model. The modelling approach for all pipes / culverts was as follows:

- Pipe sizes were applied as per the Council database except for rail corridor pipes where the 2016 OLF Study modelled pipe details were adopted. The modelled pipe / culvert sizes are shown in **Figure 3-8**.
- Entrance and exit loss coefficients of 0.5 and 1.0 were added to all pipes / culverts.
- A height contraction coefficient of 0.6 and width contraction coefficient of 0.9 were also applied; and,
- A Manning's n value of 0.015 was used for all pipes and culverts.

Pit inlet capacity has been accounted for within the hydraulic model through sizing pits individually and assigning flow rating curves for each pit. The pit rating curves were obtained using the generic rating curve set provided by TUFLOW. These generic rating curves were agreed upon in discussions with Council staff. For stormwater inlet pits, a range of different pit details were available from Council's database including width, length, type (grated inlet, kerb inlet or manhole), kerb length, and configuration (sag or on-grade). The number of potential combinations for all of these different pit details meant that there were too many unique combinations to reasonably establish rating curves for each. Therefore the following standard pit details were adopted in the model, resulting in 37 unique pit types each of which has its own generic rating curve. The various pit sizes from the database were scaled to the nearest standard dimension:

- Three standard pit lengths and widths – 0.45m, 0.9m and 1.8m;
- Five lintel lengths – 1.2m, 1.8m, 2.4m, 3.0m, and 4.2m; and,
- Two entry pit configurations – Sag and on-grade.

Over 3,700 pits were included in the updated model. All pits named 'nodes' in the database with no surveyed details were assumed to be closed manholes and were not modelled as inlet pits in the updated flood model. As shown in **Figure 3-9**, testing of model results found that the sizing of pits, compared to adopting unlimited pit capacity had relative minor impacts on flood behaviour. The reason for the minimal impacts is that pipe capacity is not significantly greater than pit capacity, so with or without pit sizing the system capacity is still low. Within the model all stormwater structures are connected to the 2D grid via SX points or lines which allow flow to transfer between the 1D and 2D domains based on the hydraulic capacity of the pipe.



3.5.1 1D Blockage Factor

All pipes less than 375mm in diameter were assumed to be 100% blocked and were not included in the model. For pipes 375mm diameter and greater, no blockage factor was applied to stormwater pipes / culverts within the model. For the stormwater pit network blockage, factors of 50% for all sag pits and 20% for all on-grade pits in accordance with Council policies. As shown in **Figure 3-9**, testing found that the pit blockage factors had relatively minor impacts on flood results compared to unlimited pit modelling across most flowpaths, as pipe capacity is not significantly greater than pit capacity, so with or without blockage the capacity is low. However there are some specific locations of more significant impacts, near rail and road crossings and other constraint areas.

3.6 Critical Duration

Both the 2009 Mainstream and 2016 Overland Flow Path (OLF) Study identified the 2-hour event as critical for the 1% AEP. In line with this, the updated 2024 modelling confirmed that the 2-hour duration remains critical for the 1% AEP event across the study area, as validated through sensitivity testing and adopted.

For the additional design events included in this study (5%, 0.2%, 0.05% AEP, and PMF), multiple storm durations were modelled, as outlined in **Sections 3.2.1 and 3.2.2**. For existing flood mapping, the maximum results from all modelled durations was adopted.

The representative critical duration for each event, for post-development modelling, was determined through comparative analysis of modelled flood behaviour, with the selected duration representing the event that produced the maximum (or close to maximum in some locations) flood level or hazard for the study area. This assessment focused on the urbanised sub-catchments of the study area—where overland flow impact risks are pronounced—rather than the mainstream Cooks River corridor. The adopted critical durations for each event are summarised in **Table 3-5** below.

Figure 3-10 presents the Critical Duration Mapping for the PMF event. Critical duration mapping for the remaining design events is provided in the TUFLOW model output maps in **Appendix A**.

Table 3-5: Adopted Critical Durations for Post-Development Modelling by Design Event for Campsie Town Centre

Design Event	Critical Duration
5% AEP	90 minutes (1.5 hr)
1% AEP	120 minutes (2 hr)
0.2% AEP	120 minutes (2 hr)
0.05% AEP	120 minutes (2 hr)
PMF	30min and 180 minutes (0.5 and 3 hr)



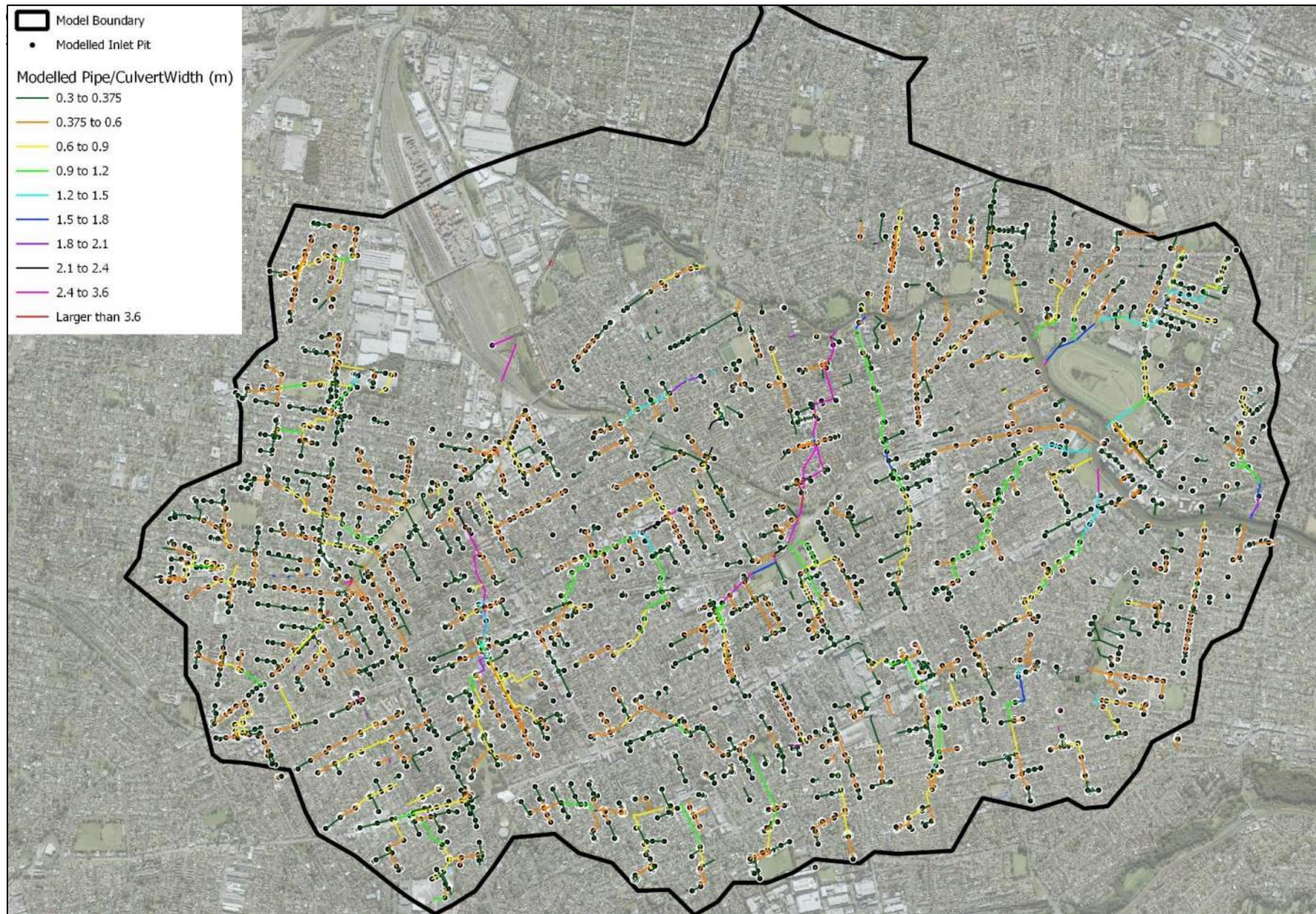


Figure 3-8 Updated Flood Model – 1D Modelled Pit and Pipe Data



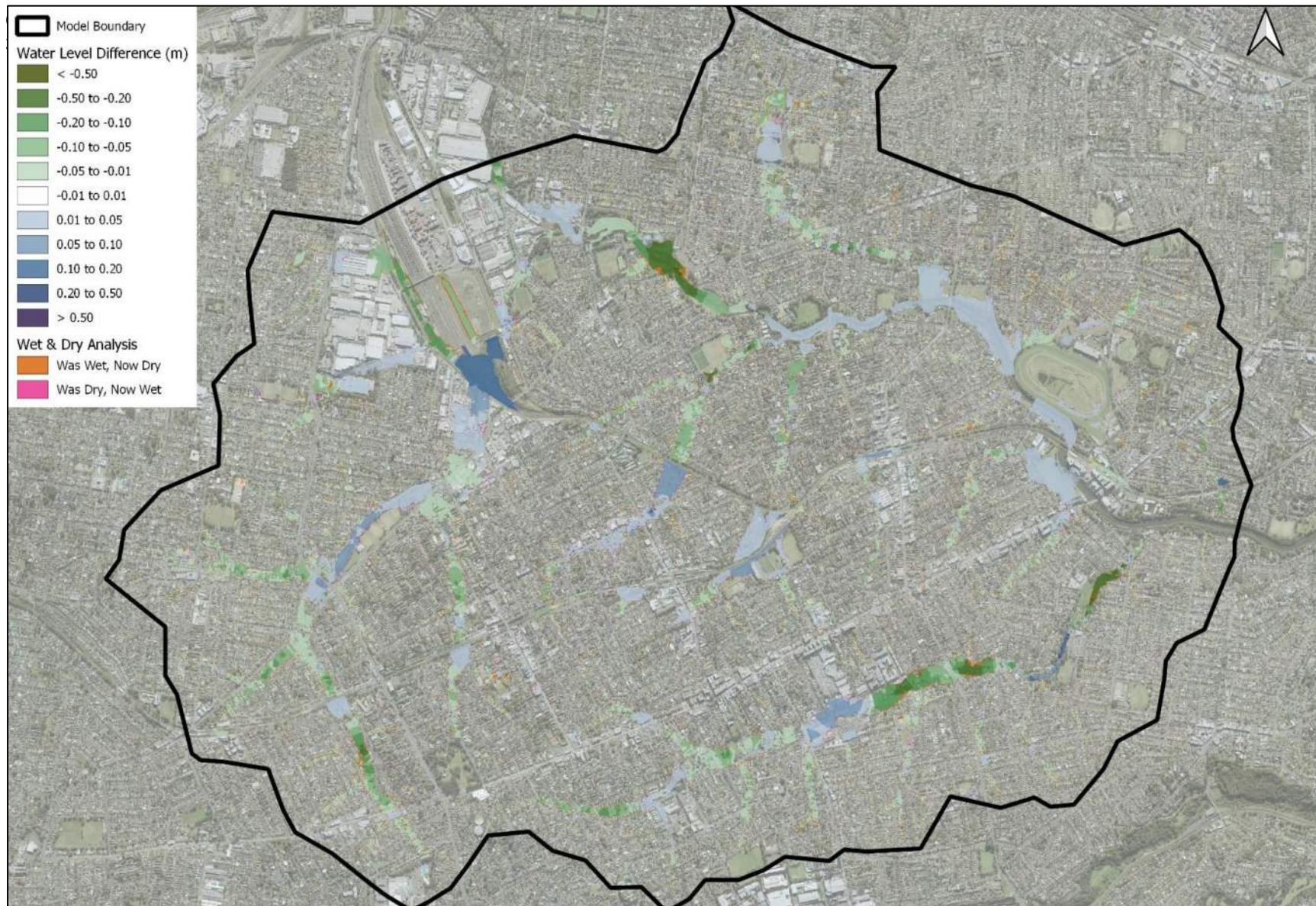


Figure 3-9 Updated Flood Modelling – Sensitivity Testing – 1% AEP 2 hour Water Level Differences (in metres) – Sized and Blocked Pits Less Unlimited Pit Model



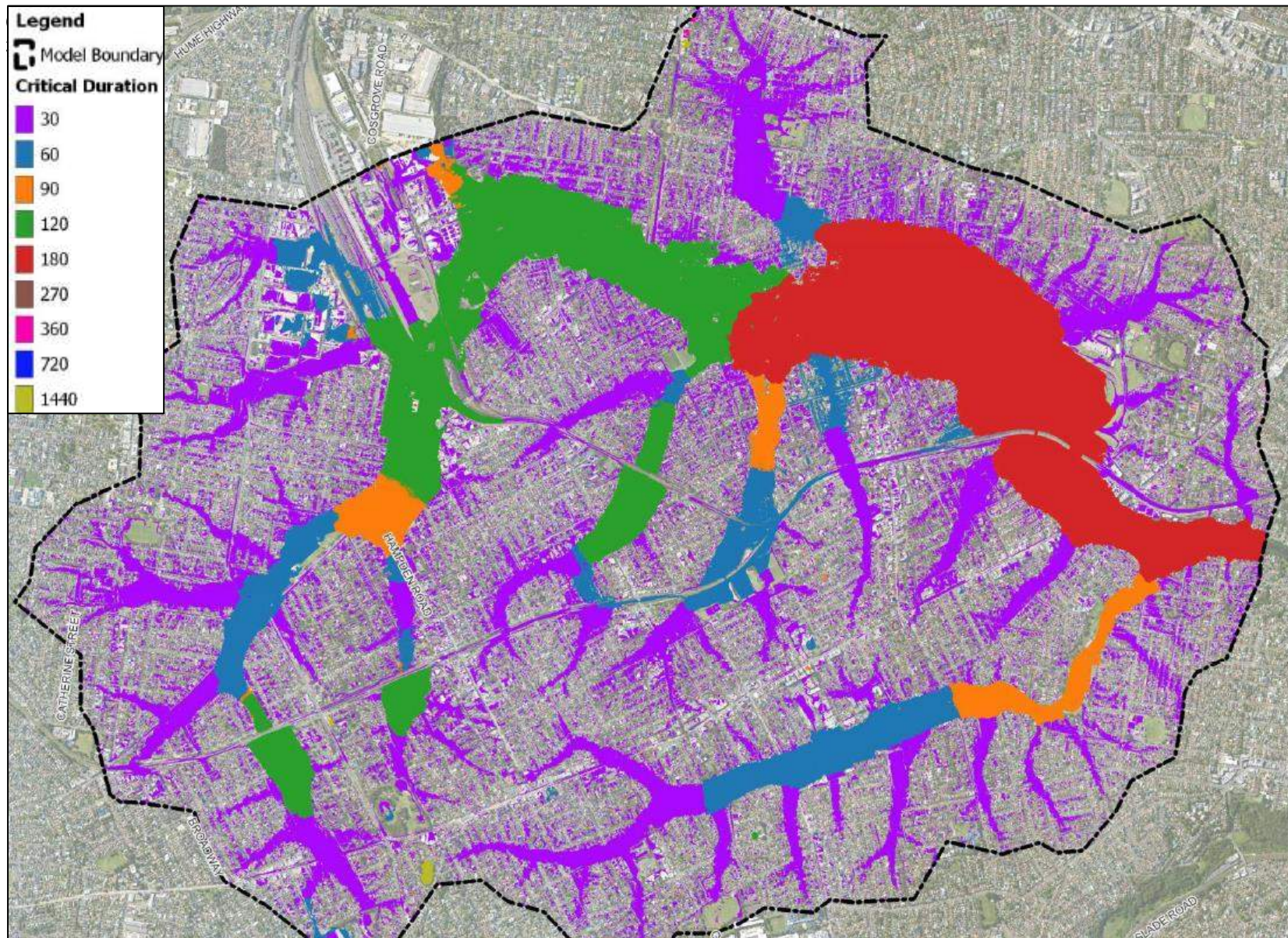


Figure 3-10 Updated Flood Model – PMF Critical Duration Mapping showing all tested durations, with the 30 and 180 minutes events identified as the adopted critical durations for Campsie Town Centre



3.7 Model Validation

3.7.1 Changes to Model Approach

As discussed in earlier sections, the updated flood model had a number of differentiations from the 2009 Mainstream Study model and 2016 OLF Study model. The main differences in model results are attributable to the following reasons:

- The TUFLOW version was updated (2020-10-AD from 2007-07-BF in 2009 Mainstream Study) and the model processor type was updated from TUFLOW HPC from TUFLOW classic. These model changes will in turn have impacts on model results, however as these are the more up to date model versions the updates are considered appropriate to be in accordance with latest available practice.
- Compared to the 2016 OLF Study the modelling software was changed from SOBEK to TUFLOW, which is the current industry standard modelling platform in NSW. The change in model software changes computation processes and will influence model results.
- The model terrain was updated from older LiDAR in the two previous models to LiDAR from May 2020, with resulting impacts on hydraulic model behaviour. The more recent LiDAR data was assumed to be more appropriate for adoption in the updated model. For the Cooks River the bathymetry from the 2009 Mainstream Study was retained therefore changes in topography should be minor within the riverbanks.
- In terms of floodplain representation, the 2009 Mainstream Study adopted a 1D approach for the Cooks River channel and bridge structures. The updated model simulated both within the 2D domain, using the same bathymetry and bridge structure data but changing the hydraulic approach. This results in different form loss behaviour and internal energy distribution.
- Hydraulic roughness model changes included applying a very high roughness value to building footprints for overland areas, and for the Cooks River floodplain roughness areas were altered to account for banks with heavy vegetation areas more accurately than was done in the previous model.
- The pit and pipe data in the updated flood model is based on recent Council survey database which differs from the previously modelled 2016 OLF Study. The exception is the rail corridors where SOBEK pipe / culvert details from the 2016 OLF Study model have been retained in this model. However, the changes in structure details upstream and downstream of the rail corridors appears to have a significant impact on modelled ponding severity upstream of the rail corridors.
- Design rainfall depths differ slightly from those adopted in the 2009 Mainstream Study and 2016 OLF Study.

Generally, it is considered that the updated flood model provides a more detailed analysis that is more in keeping with present-day industry best practice for modelling. Therefore the above changes to the model methodology are considered appropriate, and the following model result comparison discussions should be reviewed in light of this conclusion.

A comparison of peak flow results to 2009 Mainstream Study results has been conducted at three locations: A, B and C, with the locations of these flow review lines shown in **Figure 3-12**. The summary of peak flow results for the two studies is included in **Table 3-6**. Overall, the comparison shows a reasonable agreement between the two models. For the 1% AEP 2-hour event, the updated model results range from a 5.7% increase to an 11.0% decrease across the three locations. For the



PMF 90-minute event, differences range from a 6.5% increase to a 14.6% decrease. These variations are considered acceptable and reflect the combined effects of updates to modelling software, terrain representation, hydraulic structure detail, and hydrologic boundary inputs applied in the revised model.

Table 3-6 Comparison of Peak Flow Results (in m³/s) for Updated Flood Model and 2009 Mainstream Study

ID	Description	1% AEP 2hour			PMF 90 min		
		2009 Mainstream	Updated Model	Difference (%)	2009 Mainstream	Updated Model	Difference (%)
A	Upper - 480m Upstream of Cox Creek Confluence	190.5	201.4	5.7%	572.3	40.1	6.5%
B	Mid - 337m Downstream of Brighton Ave Bridge	366.4	330.9	-9.7%	1168.2	-148.7	-14.6%
C	Lower - 125m Downstream of Canterbury Rd Bridge	383.1	340.9	-11.0%	985.2	1019.1	-3.3%

A comparison of flow hydrograph results for the 1% AEP 2 hour event between the two studies is shown in **Figure 3-11**. The results show the updated model results are slightly more delayed than the 2009 Mainstream Study with peaks at all three locations being between 10-30 minutes later. The likely reason for this change is the additional lag time in rainfall-on-grid routing compared to traditional hydrology.

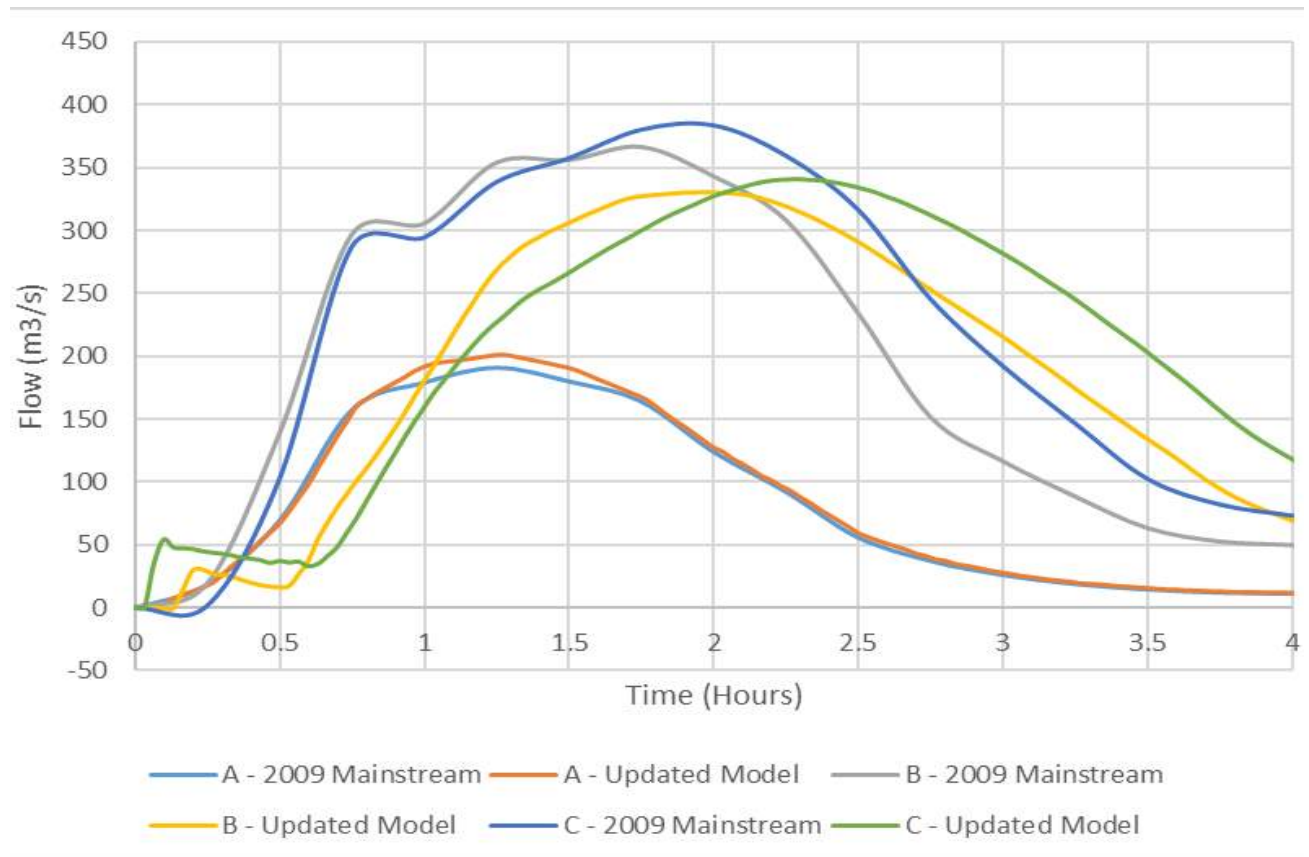


Figure 3-11 Flow Hydrograph Results Comparison (1% AEP 2 hour event)– Updated Flood Model and 2009 Mainstream Study



With respect to water level differences between the updated flood model and 2009 Mainstream Study, the following results are presented below:

- An elevation section along the Cooks River centreline has been prepared to compare study model results. The location of the centreline is shown in **Figure 3-12**, while the elevation section plot is shown in **Figure 3-13**. The elevation section results show that the 2009 Mainstream results has stepped level results along the length of the river, due to large form losses on the eleven bridge structures along the river. Conversely the updated flood model shows a more gradual water level gradient along the river length. Upon review of bridge details, it is expected that most bridges should not present the significant flow obstruction that is suggested in the 2009 Mainstream Study results. With the modelling of the bridges in the 2D of the updated model, it is assumed that less stepped water level gradient is a more realistic model result than the previous 2009 Mainstream results.
- A water level difference plot for updated model less 2009 Mainstream Study model has been presented in **Figure 3-14 and Figure 3-15** for the 1% AEP and PMF events respectively. The 1% AEP results show:
 - The upper portion of the model area has water level increases compared to the 2009 Mainstream Study. This is likely due to a more confined channel section in these upper reaches in the 2020 LiDAR, combined with higher roughness values, and different timing of flows arriving from the rainfall-on-grid portion of the Cocks Creek catchment that has a confluence with Cooks River in this upper portion.
 - The middle portion of the model area has water level decreases compared to the 2009 Mainstream Study. This is likely due to the reduced impacts of form losses in the various bridge structures along this section of river, with the largest decreases localised upstream of these various bridge structures.
 - The lower portion has minor water level increases downstream of the rail bridge compared to the 2009 Mainstream Study. This is likely due to changes in flow timing and changes in hydraulic roughness in overbank areas and changes in overbank terrain.

Overall based on the above review, it is concluded that the updated flood model generally shows reasonable agreement with the 2009 Mainstream Flood Study model. The comparison on peak flows, flow hydrographs, and peak water level results shows that the models have relatively modest differences in most instances. In any case, model result differences can be attributed to updates in the modelling approach which are justifiable and that typically provide more detailed modelling techniques in keeping with current best practice.



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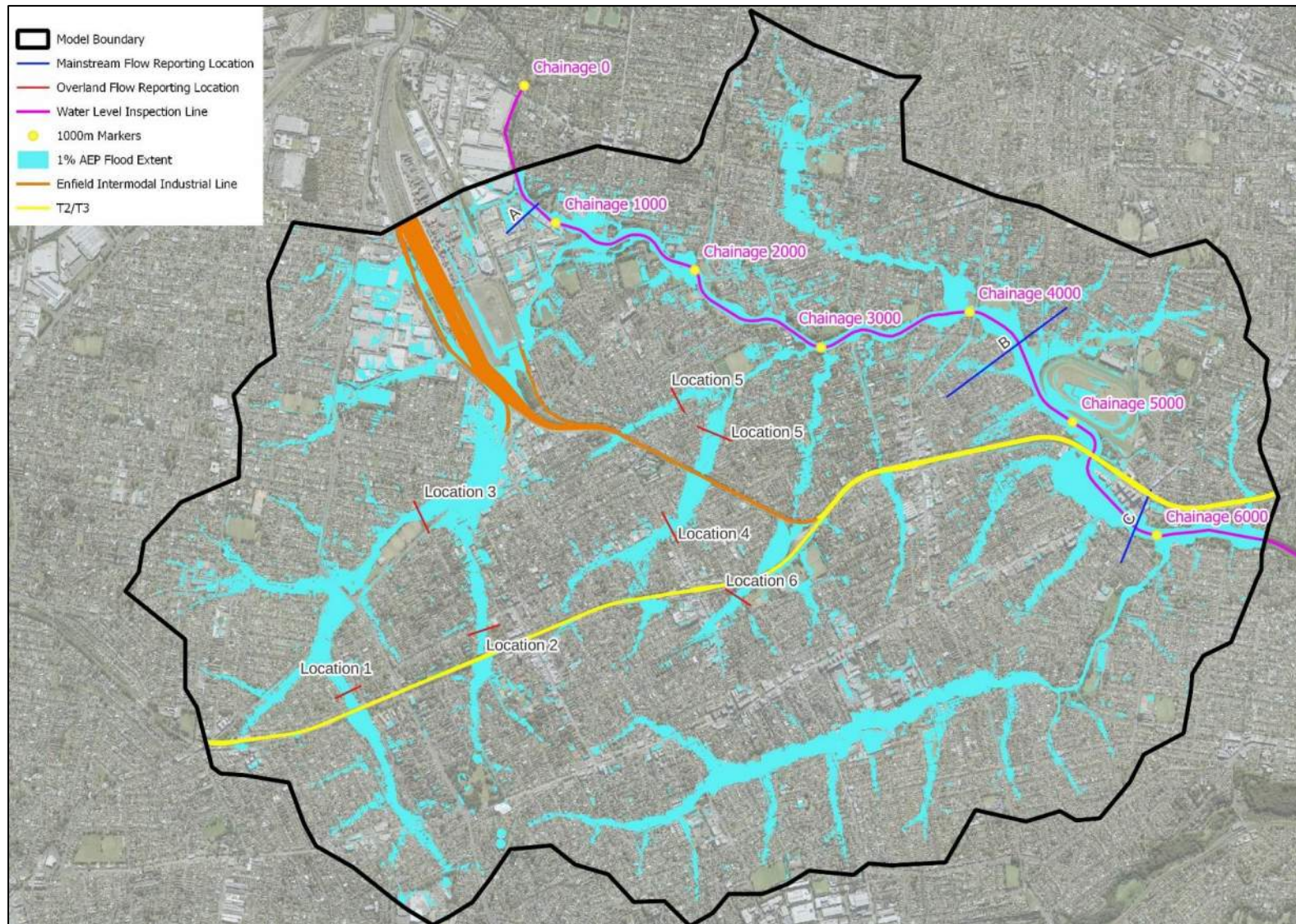


Figure 3-12 Layout of Flow Measurement Lines and Cooks River Long Section Line and Markers



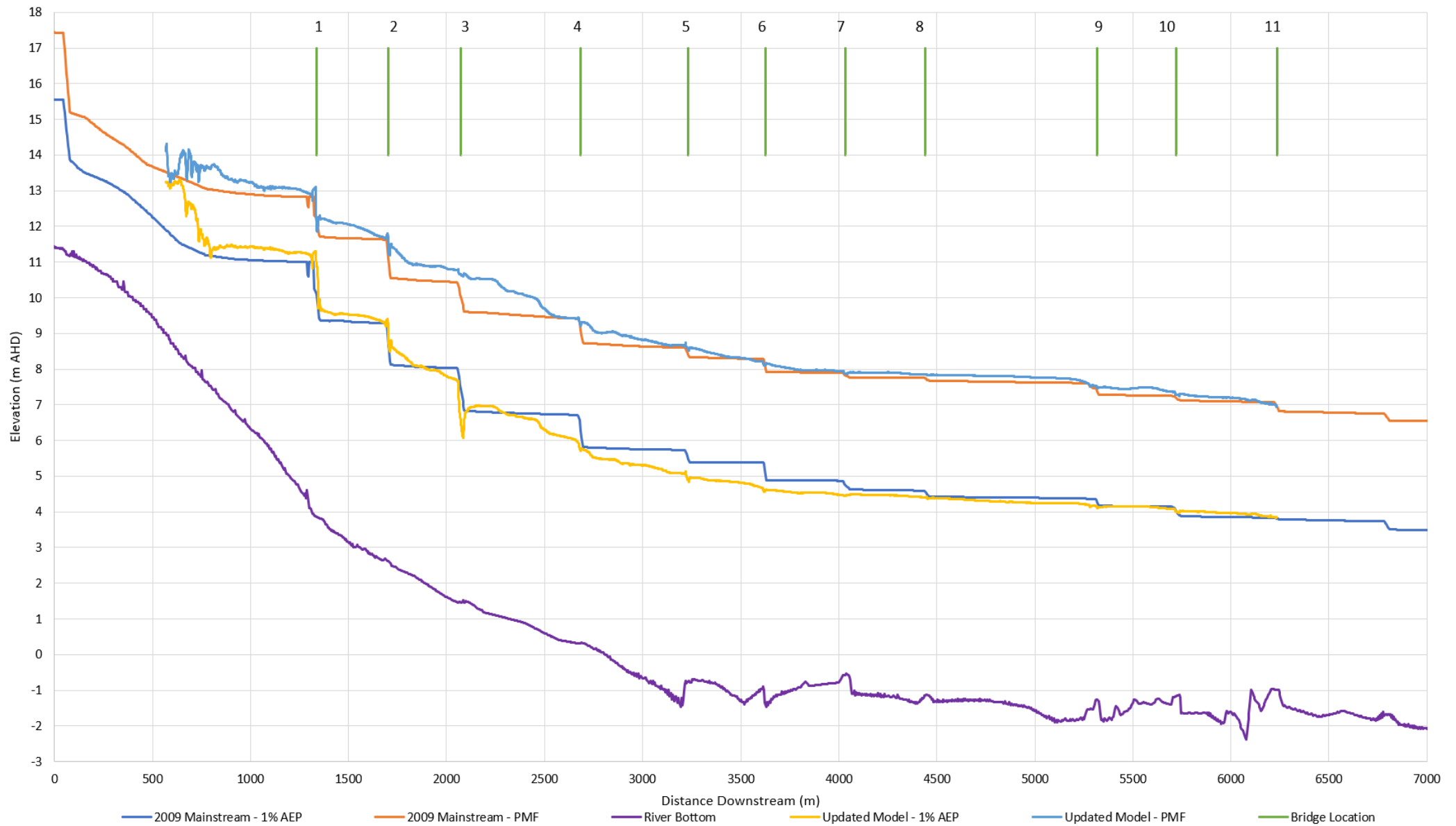


Figure 3-13 Elevation Section for Cooks River from Upstream to Downstream – Peak Water Level Results – Updated Flood Model and 2009 Mainstream Study



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Figure 3-14 Peak Water Level Result Differences (in metres) – 1% AEP Event - Updated Flood Model Less 2009 Mainstream Study Model



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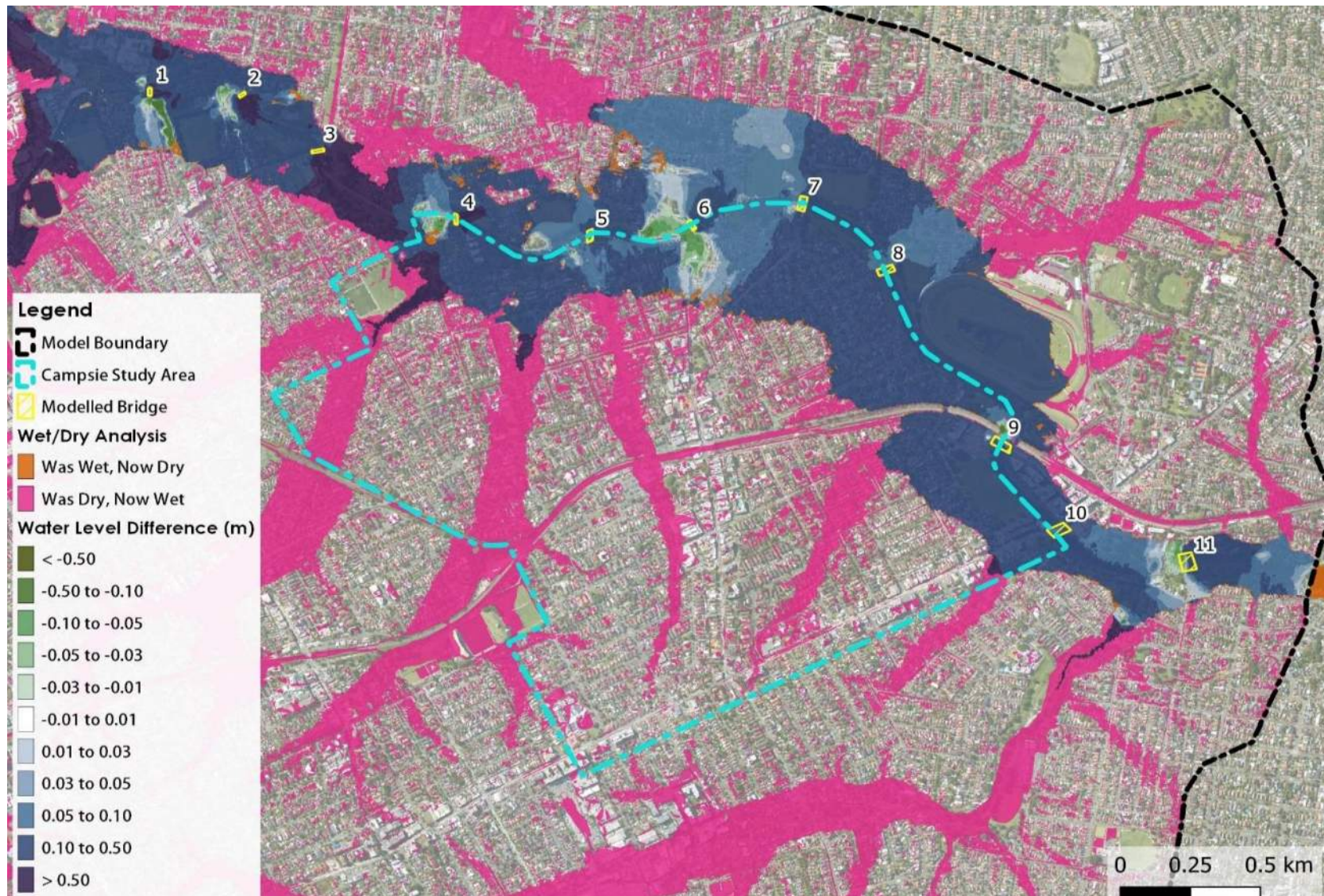


Figure 3-15 Peak Water Level Result Differences (in metres) – PMF Event - Updated Flood Model Less 2009 Mainstream Study Model



3.7.2 Comparison to 2016 OLF Study Results

A comparison of peak flow results to the updated flood model and 2016 OLF Study results has been conducted at six locations: 1-6 with the locations of these flow review lines shown in **Figure 3-12**. The summary of peak flow results for the two studies is included in **Table 3-7**. The results show that the peak flow results diverge significantly from the 2016 OLF Study results at most locations for both 1% AEP and PMF events.

Table 3-7 Comparison of Peak Flow Results (in m³/s) for Updated Flood Model and 2016 OLF Study

ID	Description	2016 ID	1% AEP 2hour			PMF		
			2016 OLF	Updated Model	Diff (%)	2016 OLF	Updated Model	Diff (%)
1	Urunga Pde	2	36.4	23.9	-34%	51.8	49	-5%
2	Lakemba St	4	10.1	7.0	-30%	77.4	23.4	-70%
3	Macdonald St	5	37.4	71.6	91%	252.4	293.8	16%
4	Burwood Rd	7	16.8	20.2	20%	288.5	89.9	-69%
5	Baltimore St	8	35.2	13.6	-61%	363.0	78.9	-78%
6	Myall St	9	20.8	6.8	-67%	114.5	58.9	-49%

With respect to peak depth result differences between the updated flood model and 2016 OLF Study, the depth difference plots have been presented in **Figure 3-16** and **Figure 3-17** for the 1% AEP and PMF events respectively. Caution should be used when comparing model results for all mainstream Cooks River areas, as the 2016 OLF model did not include mainstream inflows (outside its study area), whereas the current model includes the full Cooks River catchment. This explains higher mainstream flood levels in the updated model. The main reasons for differences in the 1% AEP results include:

- The most significant depth differences are upstream of rail line culvert crossings. At almost all of these locations, the updated flood model has significantly more ponding upstream of the rail corridor, often within residential neighbourhoods. There are also often significant water level decreases downstream of the crossings. This behaviour clearly shows the flow capacity of the rail line crossings is less in the updated flood model compared to the 2016 OLF Study model. This conclusion is further supported by review of the peak flow results in **Table 3-7**, where locations downstream of rail crossings (locations 1, 2 and 5) all result in significant flow reductions compared to the previous study. It is not clear if the reduced culvert capacity is a result of the modelling platform change, changes in pit and pipe data upstream and downstream, application of pit sizing and blockage, or changes in roughness values. However, these results suggest that the 2016 OLF Study may have underestimated the amount of ponding upstream of almost all rail crossings and how much the rail crossings act as a flow obstruction in the catchment.
- There are other areas of impacts, both increases and decreases which are not near rail corridors and are likely attributable to a range of other model changes discussed in **Section 3.7.1**:
 - Changes in model terrain and as a result flow depths in the 2D domain of the model
 - Change in roughness approach to adopt a high roughness specifically for building footprints
 - Changes in pit and pipe details to reflect those in Councils latest database.
 - Change from SOBEK to TUFLOW modelling platform.



As the depth differences are generally distributed across the modelled area, with both increases and decreases in water level, this indicates that the updates did not systematically increase or decrease flood volumes. This interpretation is further supported by the mixed peak flow changes in **Table 3-7**.

For the PMF event, **Table 3-7** shows the peak flows for the updated model are significantly smaller at all locations but one. Downstream the same rail culvert reduced capacities observed in the 1% AEP are also observed in the PMF event with significant increases in ponding depth upstream of all rail crossings.

Overall, the updated model demonstrates improved hydraulic representation and terrain accuracy, but with significant local variation when compared with the 2016 OLF Study. These differences are attributed to model refinements, particularly reduced rail crossing capacity, improved terrain, and revised drainage infrastructure inputs. The comparison confirms that while overall flood volumes remain broadly consistent, flood behaviour varies significantly at local scale—highlighting the importance of using current data and updated modelling practices.



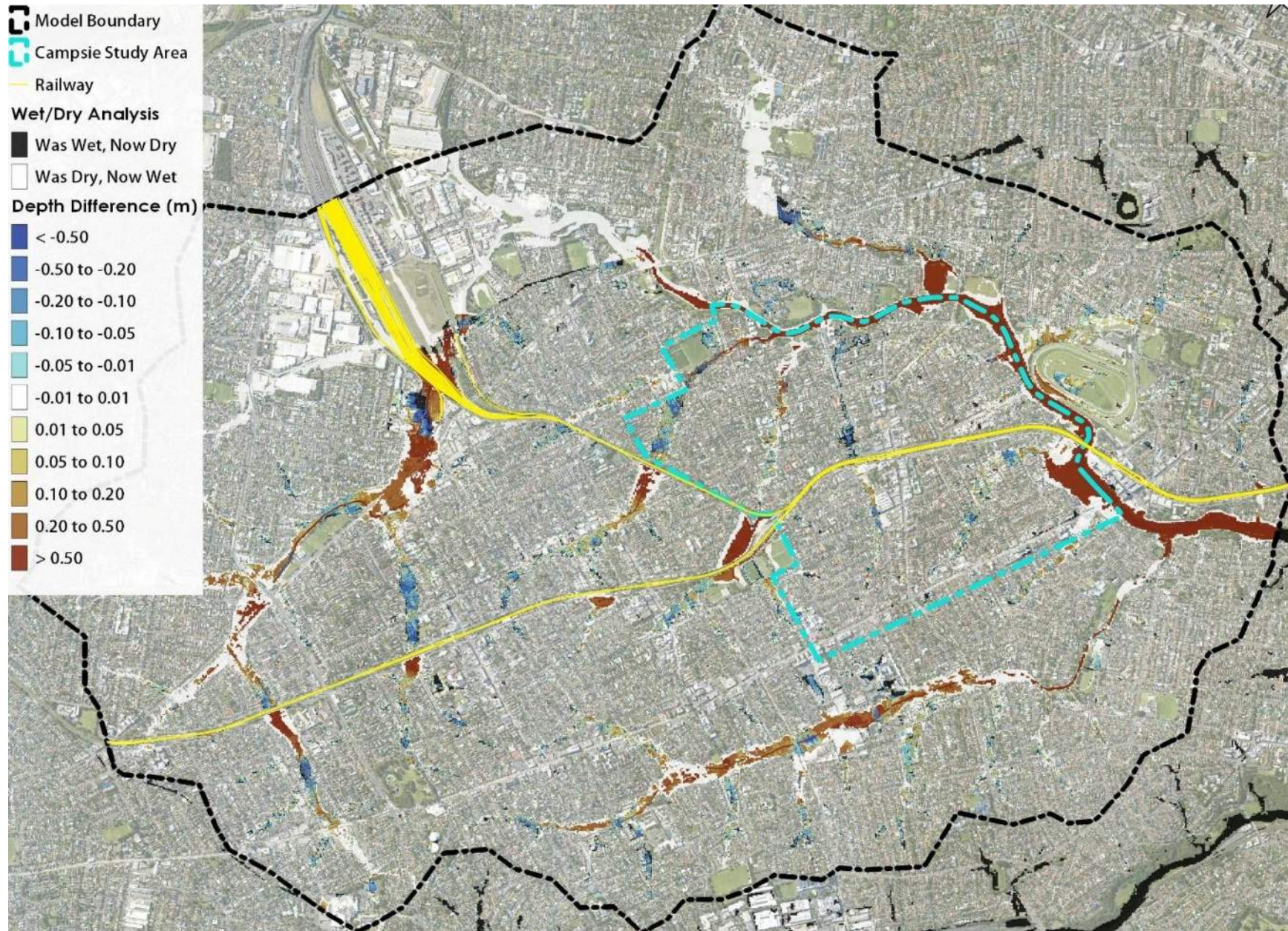


Figure 3-16 Peak Depth Result Differences – 1% AEP Event - Updated Flood Model Less 2016 OLF Study Model



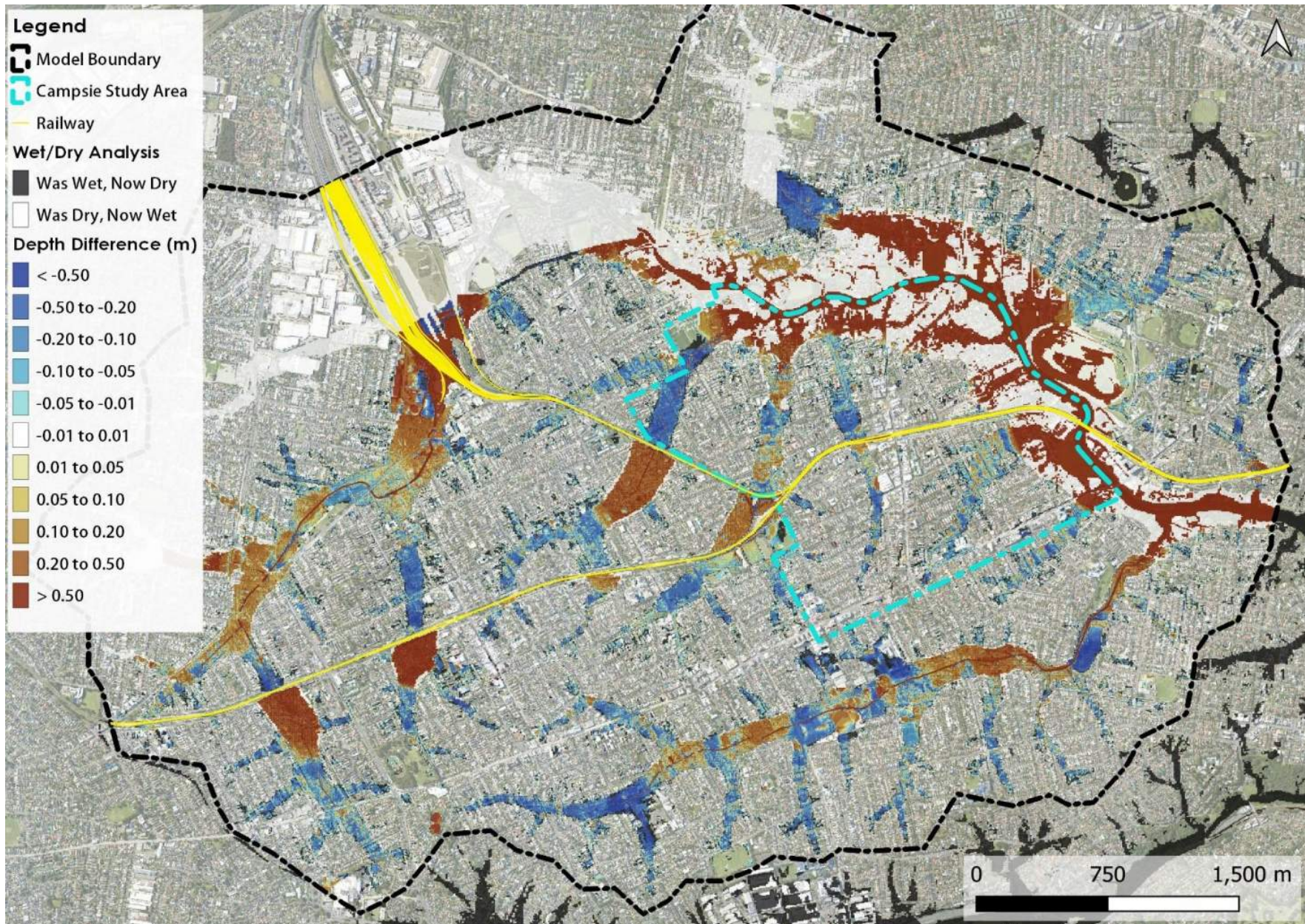


Figure 3-17 Peak Depth Result Differences – PMF Event (Maximum Water Levels across All Durations) - Updated Flood Model Less 2016 OLF Study



3.8 Flood Model Results for Existing Condition

A full set of flood maps has been prepared for the existing conditions flood model for all design events, including 5% AEP, 1% AEP, 0.2% AEP, 0.05% AEP, and the PMF. This complete map set is provided in **Appendix A**. The following flood result maps were prepared based on TUFLOW model results and are presented based on the critical duration for each event as summarised in **Section 3.5**:

- Figure C1–C4: Mapping of the entire model extent for critical duration mapping for the 5%, 0.2% and 0.05% AEP and PMF events (1% AEP 2 hour was confirmed critical in previous studies)
- Figure A1–A5: Peak flood depth for 5%, 1%, 0.2%, 0.05% AEP and PMF (metres)
- Figure A6–A10: Peak flood velocity for 5%, 1%, 0.2%, 0.05% AEP and PMF (m/s)
- Figure A11–A15: Hydraulic category maps (floodway, flood storage, flood fringe) for 5%, 1%, 0.2%, 0.05% AEP and PMF
- Figure A16–A20: Provisional hazard mapping (high, transitional, low) for 5%, 1%, 0.2%, 0.05% AEP and PMF
- Figure A21–A25: H1–H6 hazard category mapping for 5%, 1%, 0.2%, 0.05% AEP and PMF
- Figure A26–A29: Water level difference mapping for 5%, 0.2%, 0.05%, and PMF AEP events minus 1% AEP to show the incremental increase in flood levels as events became rarer (relevance discussed further under the climate change section).
- Figure A30: 1% AEP Flood Planning Area with 0.5 m freeboard applied

These model results have been utilised in understanding the existing flood behaviour of the study area. The definitions of provisional hazard, H1-H6 hazard and flood function are provided in the following sections.

The flood depth and velocity maps demonstrate that the highest depths and velocities generally align with the Cooks River channel and key overland flow paths traversing the study area. In the PMF event, inundation is widespread, with depths in excess of 4 m along the main channel and select low-lying roads.

3.8.1 Provisional Hazard

Provisional flood hazard is determined through a relationship developed between the depth and velocity of floodwaters and is based strictly on hydraulic considerations.

Historically, the criteria for these relationships have been taken from the NSW FDM (Appendix L; NSW Government, 2005). The Manual defines two major categories for provisional hazard – high and low. A third minor transitional category is also included that requires further investigation of the site in question to define the hazard category. The provisional hazard curves are shown in **Figure 3-18**.



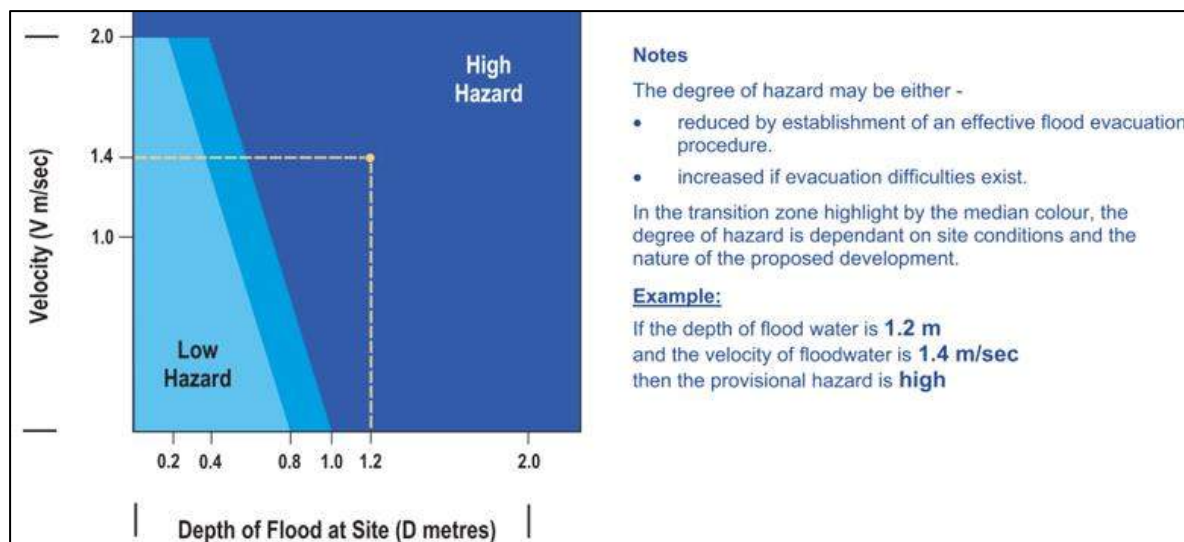


Figure 3-18 Provisional Hazard Curves from Appendix L of the Floodplain Development Manual

3.8.2 H1-H6 Hazard Category

A new method of hazard categorisation has been developed and is included in the 2019 edition of Australian Rainfall & Runoff (Book 6: Flood Hydraulics, Section 7.2.7). The classification is still based on depth and velocity but utilises six categories based on the stability of children, adults, the elderly and vehicles in flood waters. The ARR hazard category curves are shown in **Figure 3-19**.

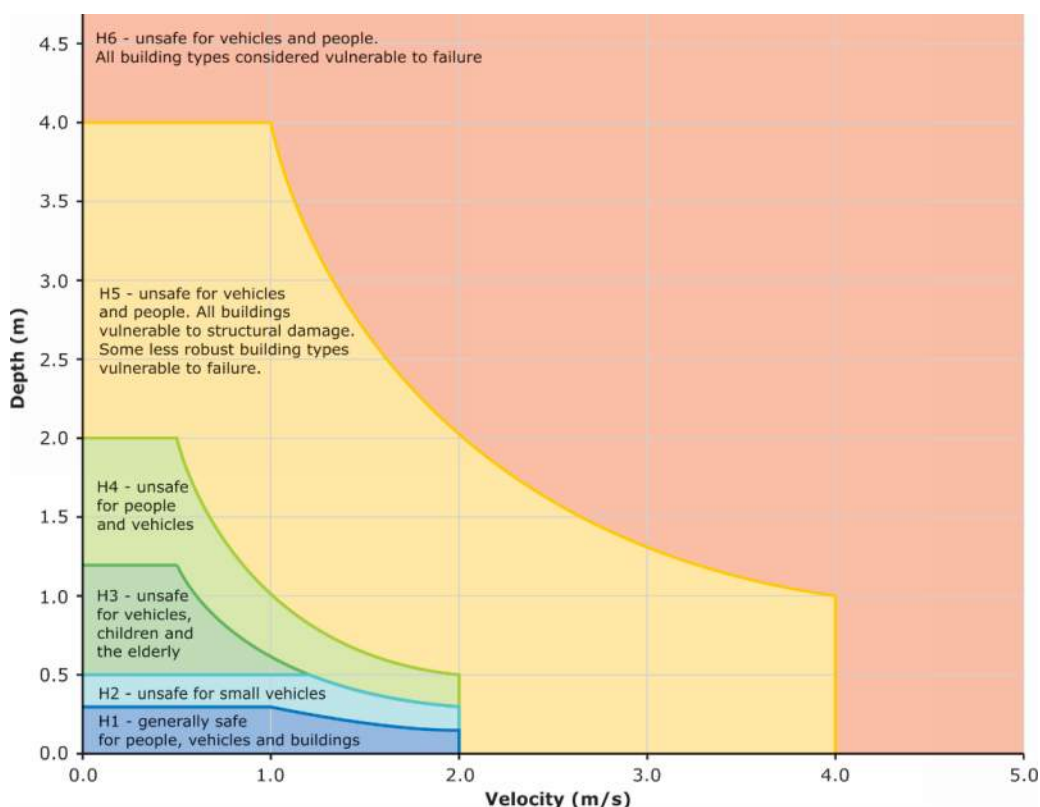


Figure 3-19 H1-H6 Hazard Categories (Source: Section 7.2.7, Book 6, ARR, 2019)



3.8.3 Hydraulic Categories

The 2023 Flood Risk Management Manual identifies three primary hydraulic categories to describe flood-prone land: floodway, flood storage, and flood fringe. These categories support flood planning by differentiating between areas that convey floodwater, store it temporarily, or pose minimal impact if developed.

In this study, hydraulic categories were determined using indicator thresholds based on velocity, depth, and velocity–depth product, in line with threshold values provided by Canterbury-Bankstown Council during prior studies and correspondence. These thresholds are summarised below:

- **Floodway:** Floodways are areas that convey a significant portion of the flood flow. If obstructed, these areas would cause unacceptable increases in flood levels or flow redirection that could adversely affect other areas. They are typically high-energy zones and should be protected from development.

Council-adopted indicator thresholds used to define floodways:

- Velocity ≥ 1.00 m/s, or
 - Velocity–depth product ≥ 0.30 m²/s
- **Flood Storage Areas:** Flood storage areas act as temporary holding zones for floodwaters during the passage of a flood. Blocking or filling these areas can lead to significant increases in flood levels and discharges elsewhere in the catchment.

Council-adopted threshold:

- Areas outside of the floodway where depths ≥ 0.20 m

These zones play an important role in reducing downstream flood peaks and attenuating flows and are often targeted for preservation in floodplain planning.

- **Flood Fringe Areas:** Flood fringe areas represent the remainder of the flood-prone land—those areas that are outside the floodway and flood storage zones and do not contribute significantly to flow conveyance or flood storage. These areas are typically subject to lower flow velocities and depths and may be suitable for more flexible development options (subject to flood compatibility).

Council-adopted threshold:

- Areas outside of the floodway where depths < 0.20 m

Note: These indicator-based categories are considered provisional. They are commonly used at the planning stage to identify strategic flood risk areas, but may be refined during future floodplain risk management studies, detailed modelling, or site-specific development applications.



3.8.4 Flood Planning Area

As part of this project a preliminary Flood Planning Area (FPA) exercise was conducted where a 0.5 metre freeboard was added to 1% AEP flood levels to determine the Flood Planning Level (FPL) and the mapped area lower than this FPL was approximated. The following trimming process was applied to the FPA extents:

- Trimmed to the PMF extents, as the PMF theoretically represents the maximum extent of flood risk;
- Trimmed to remove all FPA extents that are not in contact with a 1% AEP flood extent and minor manual edits to some areas where the FPA was an unreasonable extension beyond the 1% AEP extent.

The resultant FPA mapping for the four study areas has been presented in figures in later chapters. It is noted that the FPA mapping was prepared based on the 2024 version of the updated TUFLOW model. The updates made as part of this post-gateway assessment have resulted in only minor alterations to 1% AEP flood levels for existing conditions. Therefore retention of the previous FPA mapping was considered appropriate for the purposes of this FIRA.

3.8.5 Review of Flood Severity Across Range of Events

Beyond the 1% AEP planning event, the 5%, 0.2%, 0.05% AEP and PMF events have been modelled in line with the NSW Flood Inquiry and the PS24-001 Planning Circular (refer to **Section 4.1** for further details). The extent and severity of flooding in these events provide a more complete picture of future flood risks—particularly for evacuation and land use planning.

A comparison of peak flood levels from the existing 1% AEP relative to the existing 5% AEP, 0.2% AEP and 0.05% AEP and PMF are included in Figures A26 to A29 in **Appendix A**. These figures show the change in flood levels for more frequent (5% AEP) and rarer flood events (0.2% and 0.05% AEP and PMF), and the change in flood extents between these events (pink and orange for increased and reduced flood extents respectively). The results show:

- Figure A26: The 5% AEP has slightly reduced flood extents (orange areas) relative to the 1% AEP, with only slightly lower flood levels (0.05 – 0.10 metres) along all overland flowpaths in the study area. For Cooks River mainstream floodplain 5% AEP levels are approximately 0.75 metres lower than 1% AEP.
- Figure A27 and A28: The 0.2% AEP and 0.05% AEP flood extents are slightly wider than the 1% AEP (pink areas). The flood levels along overland flowpaths are on average only 0.10 metres and 0.2 metres above the 1% AEP levels for the 0.2% and 0.05% AEP events respectively. Cooks River mainstream flood level differences to 1% AEP are more pronounced at 0.6 metres and 1.0 metres for the 0.2% and 0.05% AEP respectively.
- Figure A29: PMF levels are between 0.2 – 0.7 metres higher than 1% AEP levels along the overland flowpaths. The Cooks River mainstream floodplain for the study area has differences between the 1% AEP and PMF events of 4 metres. In addition, the flood extents of the PMF are significantly wider than the 1% AEP (pink areas) covering large parts of the Campsie Town Centre residential areas near the river foreshore.

Further discussion of these outcomes relative to climate change, FPL selection, and implications of development controls are included in sub-sections of **Chapter 5**.



4 Relevant Flood Planning Guidance

Reference is made to several relevant sources for guidance on assessing the flood risk of the proposal:

- The recent Planning Circular PS24-001, released in March 2024 outlines existing flood-related planning policies and provides further information and advice on their application in planning. The circular also provides updates on flood-related policy initiatives underway, including action taken in response to the *2022 NSW Flood Inquiry*.
- The 2021 Flood Prone Land Package included a range of guidance and documents, with two considered relevant to this assessment:
 1. Considering flooding in land use planning guideline
 2. Ministerial Direction 4.1 applies to all relevant planning authorities that are responsible for flood prone land when preparing a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.
- The 2023 Flood Risk Management (FRM) Manual and Toolkits supersedes the 2005 Floodplain Development Manual (FDM). Of the eight supporting FRM Guides within the toolkit, two are considered relevant to this assessment:
 1. Flood Impact and Risk Assessment – Flood Risk Management Guide LU01
 2. Support for Emergency Management Planning - Flood Risk Management Guide EM01
- The Shelter-in-Place (SiP) for Flash Flooding Guideline was released in 2024 by NSW DPHI providing useful information in the assessment of shelter-in-place as a potential emergency response for the proposed development.
- Australian Rainfall and Runoff (AR&R) released in 2024 version 4.2 of the Guide to Flood Estimation. This update in Book 1 Chapter 6 included new guidance on the application of increases to design rainfall related to climate change impacts.

Further discussion of each of these documents and related requirements, noting the relevance to this assessment is included in the following sections.

4.1 Planning Circular PS24-001

The recent Planning Circular PS24-001, released in March 2024 outlines existing flood-related planning policies and provides further information and advice on their application in planning. The circular also provides updates on flood-related policy initiatives underway, including action taken in response to the *2022 NSW Flood Inquiry*.

As noted within Attachment A of Planning Circular PS 24-001, DPHI recommends planning authorities adopt a risk-based approach to the assessment of planning proposals, local and regional Development Applications (DAs), and State Significant Development (SSD) and State Significant Infrastructure (SSI) applications. This should include taking into account the flood risk profile of each proposal. Matters to consider include:



- Whether the proposal is in a high-risk catchment (which are Northern Rivers, Hawkesbury–Nepean, Georges, Wilsons, Tweed, Macleay, Richmond, Hunter, Clarence and Shoalhaven Rivers)
- The location of the proposal in relation to flood behaviour and constraints including:
 - Floodway, flood storage area or flood fringe area
 - The hazard vulnerability classification of the land
- Frequency of inundation
- Whether the proposal provides for safe occupation and efficient and effective evacuation in flood events and how it is to be achieved
- Any known evacuation constraints such as the flood emergency response classification for the area and available warning times (including rate of rise and when the evacuation route is cut by floodwater)
- Whether the proposal is for a sensitive or hazardous land use, or other higher risk uses and what controls (if any) are proposed to reduce any identified risks
- Whether there may be adverse flooding impacts on surrounding properties
- Potential impacts of cut and fill and other building works on flood behaviour
- Ability of proposed development to withstand flood impacts.

These recommendations broadly reflect the flood assessment requirements of the Ministerial Direction 4.1 for planning proposals. The planning circular PS 24-001 also notes:

The above matters should be considered across a range of flood scenarios for high risk proposals. The typical events examined may include the 10% Annual Exceedance Probability (AEP), 5% AEP, 1% AEP, 0.5% or 0.2% AEP, the PMF event, and in relation to the flood planning level (if available).

Consistent with the NSW Flood Inquiry, extreme flood events such as the 0.05% or 0.02% AEP should also be considered, particularly for higher risk proposals and when setting flood planning levels to support land use planning. The impacts of climate change on future flood frequency and levels should also be considered.

4.2 2021 Flood Prone Land Policy

The 2021 Flood Prone Land Package was released in July 2021, includes the following key documents:

- A revised s9.1 local planning direction on flooding (Local Planning Direction, or “the Act”);
- A new planning circular: Considering flooding in land use planning: guidance and statutory requirements (Planning Circular);
- A new guideline: Considering Flooding in Land Use Planning (Guideline);
- Standard Instrument (Local Environmental Plans) Amendment (Flood Planning) Order 2021: two local environmental plan (LEP) clauses which introduces flood related development controls;
- An amendment to clause 7A of Schedule 4 to the Environmental Planning and Assessment Regulation 2000 (the Regulation);
- State Environmental Planning Policy Amendment (Flood Planning) 2021; and,



- Revocation of the Guideline on Development Controls on Low Flood Risk Areas (2007).

The revised flood-prone land package allows a more contemporary approach to better manage flood risk beyond the 1% AEP, including building greater resilience. The package reverses the effects of the 2007 Planning Circular and Guideline on Development Controls on Low Flood Risk Areas, Ministerial Direction No. 4.3 which has restricted Councils in NSW from applying residential development controls on land between the 1% AEP flood extent and the PMF extent.

The update package addresses the key concerns over the safety of people, the management of potential damage to property and infrastructure, and the management of the cumulative impacts of development, particularly on evacuation capacity. A summary of the key outcomes from the package is summarised in the following sub-sections.

4.2.1 Updated Standard LEP Clauses

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).

4.2.1.1 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 2005 FDM 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.

4.2.1.2 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 generally relate to include:

- Sensitive uses that require ongoing functionality during and after a flood event such as hospitals with emergency facilities and emergency services facilities;
- Sensitive uses that require high levels of assistance with evacuation, such as seniors housing, group homes, boarding houses, hostels, caravan parks, educational establishments, centre-based childcare facilities and hospitals;
- Hazardous industries or hazardous storage establishments that require containment of materials in the event of a flood;
- Development that requires risk to life or other safety consideration such as (these examples are listed in the guideline Considering Flooding in Land Use Planning):
 - areas of low probability flood events that have the potential for high consequences (for example, where new floodways develop in low probability floods);
 - where development controls are needed to address risk to life or other safety considerations identified in studies under the FRM process or through the emergency management planning process;
 - areas with evacuation limitations;
 - where increases in dwelling densities would have a significant impact on the ability of the existing community to evacuate using existing evacuation routes within the available warning time;
 - where vertical evacuation for short duration flooding is required such as where the rate of rise of floodwater prohibits safe evacuation from the land;
 - behind flood levees which may have warning and/or evacuation limitations;
 - impacted by either high hazard or/and H4 to H6 hazard vulnerability thresholds in the PMF as defined in the manual or its supporting guides, and unable to safely evacuate;
 - areas indirectly affected by flooding where development may have for example outages of utilities; and
 - areas isolated by floodwaters and/or terrain (such as high flood island or trapped perimeter).

The requirements for development consent for this clause are similar but more limited than the mandatory clause considering safe occupation and efficient evacuation of people in the event of a flood, appropriate measures to manage risk to life, and effects on the environment.

4.2.2 Council Consideration of Optional LEP Clause

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.

In discussions with Canterbury-Bankstown Council's catchment management planning team and stormwater asset planning team it is understood that it is Council's intention not to adopt the optional LEP clause 5.22 for land between the FPA and the PMF. Therefore only the mandatory LEP clause 5.21 for the FPA will be applicable.

Although the optional SFC clause is unlikely to be adopted by Council, it is still considered relevant as it is generally in accordance with similar provisions for the SFC are applicable to planning proposals in accordance with the s9.1 Local Planning Direction.

4.2.3 Requirements for Planning Proposals under Ministerial Direction 4.1

The s9.1 Local Planning Direction (now referred to as Ministerial Direction 4.1) applies when an authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land. The key requirements of the local planning direction for planning proposals include:

1. A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy (2021), the 2023 Flood Risk Management (FRM) Manual, the 2021 Guideline on Considering Flooding in Land Use Planning, and any relevant flood study and/or floodplain risk management plan adopted by council.
1. No rezoning of flood-prone land from open space/environment zones to residential/business/industrial..
2. A planning proposal must not contain provisions that apply to the flood planning area which:
 - a. permit development in floodway areas,
 - b. permit development that will result in significant flood impacts to other properties,
 - c. permit development for the purposes of residential accommodation in high hazard areas,
 - d. permit a significant increase in the development and/or dwelling density of that land,
 - e. permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate,
 - f. permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require consent,
 - g. are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or
 - h. permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.



3. 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 a), b), d), e), f) from item 3 above. An additional requirement for this area is if a planning proposal is likely to affect the safe occupation of and efficient evacuation of the lot. This includes considering shelter-in-place feasibility only where horizontal evacuation is not achievable, and all ten SiP assessment criteria (refer Section 4.1.7) must be addressed.
4. For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 ([now superseded by the 2023 FRM Manual](#)) or as otherwise determined by a Floodplain Risk Management Study or Plan adopted by the relevant council.

A final section of the direction notes that a planning proposal may be inconsistent with the above terms of the direction only if the planning proposal authority can satisfy the Secretary of the Department of Planning and Environment (or their nominee) that:

- (a) the planning proposal is in accordance with a floodplain risk management study or plan adopted by the relevant Council in accordance with the principles and guidelines of the FDM 2005 (now superseded by the 2023 FRM Manual), or
- (b) where there is no council adopted floodplain risk management study or plan, the planning proposal is consistent with the flood study adopted by the council prepared in accordance with the principles of the FDM 2005 (now superseded by the 2023 FRM Manual) or
- (c) the planning proposal is supported by a flood and risk impact assessment accepted by the relevant planning authority and is prepared in accordance with the principles of FDM 2005 (now superseded by the 2023 FRM Manual) and consistent with the relevant planning authorities' requirements, or
- (d) the provisions of the planning proposal that are inconsistent are of minor significance as determined by the relevant planning authority.

It is noted that subsequent to the July 2021 release of the package, the ministerial direction has since been included within the Local Planning Directions set and has been renamed Section 4.1 Flooding. It is included in Focus Area 4 – Resilience and Hazards. The text of the flooding direction is unchanged from that included in Section 9.1 direction of the July 2021 package.

Local planning direction 9.1 (now Ministerial Direction 4.1) applies when an authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land. Upon the future finalisation of the Campsie Town Centre Master Plan, the last stage is the preparation of a planning proposal submission, therefore the planning proposal requirements are particularly relevant to this review. These requirements provide clear, enforceable criteria for planning proposals on flood-prone land. Proposals must demonstrate consistency with current flood planning policy, including how emergency response (evacuation or shelter-in-place) will be safely managed, and whether any intensification of development is appropriate based on local flood behaviour.

This list forms the basis for the flood risk review of the Campsie Precinct included in this assessment. Furthermore, the requirements generally address the same objectives as those in the LEP amended clause 5.21.



4.3 2023 Flood Risk Management Manual and Toolkit

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 technical 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. Of the eight FRM Guidelines, two provide particularly relevant guidance for this assessment as discussed in the following sub-sections.

4.3.1 FRM Guide LU01 – Flood Impact and Risk Assessment

The LU01 guideline provides advice on the preparation of a Flood Impact and Risk Assessment (FIRA). The aim of a FIRA is to support a development proposal which may alter flood behaviour to identify and analyse the impacts of the proposed development on the flood risk to the existing community, the impacts and risks of flooding on the development and its users, and how these impacts can be managed to minimise the growth in risk to the community due to the development.

This guideline summarises requirements for assessment of flood impacts from proposed developments. The guideline outlines a two-stage concept of a 'simple' and 'detailed' FIRA. As noted in Section 2.9 of the Guide, a detailed FIRA may be required when:

- no or insufficient flood information for the proposed site exists in an existing study and the proposed development is of a large scale or involves rezoning
- there are known deficiencies in broad-scale flood modelling
- the proposed development is of significant scale that would likely impact catchment hydrology and/or flood behaviour
- a simple assessment shows a potentially significant impact on flood behaviour or to the development
- a proposed development will significantly increase the population on flood prone land or will significantly impact flood evacuation of the existing community.

Table 3 of the Guide lists impact considerations including flood level change, change in duration of flooding, velocity change, change in warning and evacuation time, change in frequency of inundation, flood function change, and hazard category change.

Table 4 of the Guide lists flood risk considerations for multi-lot, large-scale development including:

- 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

The guide for considerations of both impacts and risks for proposed development have been taken into account for this assessment. Due to the high-level nature of the rezoning, with only indicative footprints available at this time, the scope of the FIRA has been adjusted to account for this limited development information. The risk considerations generally reflect the planning proposal requirements and therefore are addressed within the flood risk review in **Section 5**.

4.3.2 FRM Guide EM01 – Support for Emergency Management Planning

Section D4 of the FRM Guide EM01 outlines two decision-making frameworks for proposed development:

1. Future community growth directions – This includes identifying areas where new development does not adversely impact on existing development and where flood risks to the new development and its users can be effectively managed. This may inform the making of an LEP by rezoning areas to support greenfield development or redevelopment and the inclusion of development controls required to manage the flood and EM risk to development within these zonings in a DCP.
2. Development consistent with current zonings – This relates to the strategic application of development controls in the DCP in existing zoned and developed areas. For example, controls may be tailored to minimise risk to infill development and ‘one off’ single dwelling redevelopment and their occupants within an area.

Essentially the decision-making framework for type 1 (Figure 20 of the Guide), notes that for any greenfield site or strategic rezoning, shelter-in-place is not preferred and evacuation is the preferred form of emergency response, otherwise ‘reconsider development in this area’. However, the framework for type 2 (Figure 21 of the Guide), notes that any infill development ‘consistent with current zoning’ shelter-in-place may be suitable if ‘consider restricting development types and apply controls’.

In this instance it is assumed that the suitability for this study area be guided by the flood risks associated with shelter-in-place given local conditions.

4.4 Shelter-in-Place for Flash Flooding Guideline

The Shelter-in-Place (SiP) for Flash Flooding Guideline was prepared by the NSW Department of Planning, Housing and Infrastructure (DPHI) in 2024 and finalised in January 2025. Evacuation constraints are a critical issue when consent authorities consider development applications, planning proposals, and rezonings in flood-prone areas. The guideline aims to assist consent authorities in undertaking site-specific, risk-based assessments to determine if shelter-in-place is a suitable emergency management strategy for developments proposed in flash flood environments. This involves balancing the merits, risks, and impacts of the proposal to ensure safety and resilience.

Shelter-in-place refers to the internal movement of a building’s occupants to an area within the building located above the Probable Maximum Flood (PMF) level before the property becomes inundated by floodwaters. Evacuation off-site remains the primary emergency management strategy



for flooding in NSW. This involves moving people threatened by flood to safer locations outside the flood impact zone, typically ensuring their safe and timely return. Generally, self-evacuation to an area not affected by flooding is the most appropriate strategy, as outlined in the NSW State Flood Plan and Local Flood Plans. However, in flash flood situations—where flood onset occurs rapidly with little warning—evacuation may be unachievable, and shelter-in-place may be the only viable alternative.

The guideline identifies ten key considerations that must be addressed for shelter-in-place to be considered an appropriate emergency management strategy:

1. **Alignment with existing emergency management strategies:** Shelter-in-place must align with local flood risk management processes and be supported by the NSW State Emergency Service (SES) and other relevant authorities.
2. **Evacuation feasibility:** Off-site evacuation, the preferred primary emergency management strategy, must have been thoroughly investigated and determined to be unachievable due to constraints such as short warning times or physical barriers.
3. **Development type suitability:** Shelter-in-place is generally unsuitable for developments such as medical centres, emergency service facilities, community centres, and sensitive or hazardous land uses, where evacuation or other strategies may be necessary.
4. **Exclusion of greenfield development:** The guideline does not support shelter-in-place as an emergency management strategy for greenfield developments due to higher associated risks and lack of established infrastructure.
5. **Flood warning systems:** Existing government-developed flood warning systems that provide advanced, detailed forecasts of flash flooding must be in place to allow sufficient time to evacuate occupants to refuge locations or prepare for sheltering.
6. **Community awareness:** Effective communication strategies must be in place to ensure the community and building occupants are informed of the risks associated with the chosen emergency management strategy, including shelter-in-place procedures.
7. **Detailed evacuation assessment:** A comprehensive assessment confirming that off-site evacuation is not achievable must be conducted and documented as part of the risk evaluation.
8. **Flood behaviour and hazard assessment:** Flood behaviour at the site must be assessed with consideration of climate change and the potential maximum duration of isolation, up to and including the PMF, to confirm that:
 - a) Flash flooding is the sole flood risk at the site, whether from overland flow, local creeks, or riverine sources.
 - b) Flooding initiates within six hours from the commencement of causative rainfall, and the expected duration of shelter-in-place isolation by floodwaters is less than 12 hours.
 - c) The development is not located in areas subject to high hazard flooding, such as floodways or H5/H6 hazard zones, nor are surrounding roadways subject to such hazards.
9. **Emergency management response and communication:** The guideline requires clear documentation of how shelter-in-place will be integrated into the site's emergency management response, detailing actions before, during, and after the sheltering event. Additionally, how these procedures will be communicated and maintained for occupants and visitors throughout the life of the development must be specified.



10. **Secondary risk identification and management:** Secondary risks arising from shelter-in-place must be thoroughly understood and managed. These risks include medical emergencies, building fires, and occupant health and wellbeing during isolation. The Flood Impact Risk Assessment (FIRA) must outline how these risks will be addressed, with reference to relevant tools such as Table 12 of EM01, to ensure effective mitigation measures are in place.

This comprehensive guideline supersedes previous drafts and is an important reference when assessing shelter-in-place as an emergency management strategy for flash flood-prone developments in NSW. It ensures that shelter-in-place is only applied where evacuation is impractical, and where appropriate safety, communication, and risk management measures are fully integrated into development planning and operation.

As per industry briefings by NSW DPHI upon the final guidelines release, while the above 10 referenced requirements are important considerations, for any proposed SiP not meeting all of these requirements a merit based review of the flood risk implications is recommended. NSW DPHI also noted this is just a guideline and each consent authority can assess the flood risk of SiP in their own way.

4.5 ARR Version 4.2 Climate Change Guidance

In late 2022, the Australian Government Department of Climate Change, Energy, the Environment and Water in partnership with Engineers Australia commenced an 18-month project to update the climate change considerations chapter of the Australian Rainfall and Runoff guidelines (Chapter 6, Book 1) to incorporate the most recent and relevant climate science and projections.

The project involved the undertaking of a rigorous literature review of hydroclimatology under climate change relevant to design flood estimation, which was peer reviewed and published in a leading international journal. The findings were used to draft practical flood guidance which was finalised after an extensive process of review and feedback by industry. Funding for this project was received from National Emergency Management Agency under the Disaster Risk Reduction Package. The project report was adapted to replace Book 1 Chapter 6 of *ARR A Guide to Flood Estimation within the revised Version 4.2*.

The latest guidance provides a rainfall increase percentage accounting for the impacts of climate change above the 1960-1990 baseline conditions from ARR2019. It is expected that storm bursts will become more intense as a result of climate change influences. The calculation of rainfall increase percentages is based on several factors:

- Storm event duration – The largest rainfall increases are expected for the shorter duration events, with a 15% increase in rainfall per degree of warming for rainfall durations of 1 hour or less. For longer duration rainfall events, 24-hour and longer rainfall events, rainfall increases are relatively lower at 8% increase per degree of warming.
- Planning horizon – The impacts of climate change are expected to increase over time. Therefore rainfall increase estimates have been provided for a range of short term (year 2021 – 2040), medium term (2041 – 2060) and long term (year 2081 – 2100).
- Shared Social Pathway (SSP) – The latest IPCC guidance assigns four climate change pathways based on expected performance; SSP1, SSP2, SSP3, and SSP5.



5 Flood Risk Review for Campsie

In accordance with Planning Circular PS 24-001 and other relevant guidelines summarised in **Section 4**, it is recommended that planning authorities adopt a risk-based approach to the flood assessment of land use planning applications. This should include taking into account the flood risk profile of the proposal.

Based on advice in the various flood planning guidance including two planning circulars, Ministerial Direction 4.1 and FRM Guides, a planning proposal should consider the following issues in reviewing flood risk:

- A brief summary of existing flood behaviour;
- Consideration of climate change in flood risk;
- A review of flood planning levels and flood planning area;
- Change in land use zoning, or rezoning within the FPA;
- Assessing flood impacts of proposed development of the study area;
- Precluding development within high flood risk areas such as floodways or high hazard areas;
- Intensification of residential development within the FPA;
- Flood emergency response, and review of the potential for flood evacuation or shelter-in-place;
- Special flood considerations and additional flood risk for vulnerable developments; and

A review of these flood risk factors for Campsie Town Centre are discussed in the following sections.

5.1 Existing Flood Behaviour Summary

Utilising the updated design flood model results, a range of study area focussed flood maps have been provided for this flood risk review in the following sub-sections. More detailed flood mapping (**Appendix A**) includes peak depth, velocity, hazard categories, flood function and FPA mapping.

The Campsie precinct flood behaviour is summarised below:

- **Mainstream flooding** occurs along the Cooks River foreshore area. With several exceptions, generally the 1% AEP flood extents do not affect residential development areas within Campsie. The rarer flood events, particularly the PMF, affect parts of Campsie northern and eastern sides.
- **Five Overland Flow Paths (OLFPs)** traverse the study area from the southwest to the northeast, ultimately discharging into the Cooks River. These OLFPs are illustrated in **Figure 5-1** and described as follows:
 1. **Bruce Avenue to Rudd Park OLFP**
A formalised drainage channel enters the precinct at Bruce Avenue, flows adjacent to Rudd Park, and discharges to the Cooks River between Third Avenue and Fourth Avenue. The channel is partially culverted upstream and appears daylighted through the park corridor.
 2. **Alma Avenue to Harcourt Reserve OLFP**
This overland flow path enters the precinct at the intersection of Alma Avenue and



Campsie Street, flows through the grounds of Harcourt Public School and Harcourt Reserve, and drains to the Cooks River downstream of Fourth Avenue.

3. **Orissa Street to Fifth Avenue OLFP**

Originating near the intersection of Orissa Street and Fletcher Street, this OLFP follows the western boundary of the Campsie Shopping Centre, passes beneath the railway near Lilian Street, continues through Fifth Avenue, and discharges into the Cooks River. Surface flow in this corridor is constrained by built infrastructure and involves culverted segments.

4. **Perry Street to Tasker Park OLFP**

This OLFP begins in the vicinity of Perry Street and Wairoa Street, flows northeast through Phillips Avenue and Tasker Park, and approaches the Cooks River adjacent to the riverbank. While the railway corridor interrupts the natural surface flow, the flow path resumes downstream of the railway and discharges to the river via Frederick Street.

5. **Cressy Street to Tasker Park OLFP (Minor Tributary)**

A short overland flow path originates outside the study area near the intersection of Cressy Street and Northcote Street, enters the precinct at Canterbury Road, and merges with the fourth OLFP at Tasker Park before reaching the Cooks River.

5.2 Review of Climate Change Impacts

5.2.1 Background

As outlined within the Planning Circular PS24-001 and as discussed with DCCEEW, this assessment considers the potential impacts of climate change. Climate change impacts on flooding are typically accounted for in two forms:

- Sea Level Rise and the impacts on tailwater conditions; and
- Rainfall increase, which affects design rainfall inputs and flood magnitude.

The background for these two climate change impacts and how they have been accounted for within flood modelling for this FIRA is discussed below.

Sea Level Rise

Sea level rise was not explicitly modelled in this study. However, its potential impact on downstream tailwater conditions is expected to be minor due to the inland location and dominance of local rainfall-driven flooding. This was confirmed through previous testing of the climate change scenario from the 2009 Mainstream Study (1% AEP with 20% rainfall and 0.45m sea level rise).

Rainfall Increase

As mentioned in **Section 4.5**, guidance released by ARR in 2023 (referred to as ARR4.2) introduces a new approach for estimating future rainfall changes, based on event duration, design year, and Shared Socioeconomic Pathways (SSPs). ARR4.2 rainfall increases are referenced to ARR2019 baselines, whereas this study adopts ARR87 design rainfall for consistency with Council modelling practices.

A comparison of rainfall total depths for the following have been tabulated in **Table 5-1**:



- ARR87 for 1% AEP, 0.2% AEP and 0.05% AEP – Adopted Design Rainfall in Modelling for this FIRA
- ARR2019 for 1% AEP – Design Rainfall Used as the Basis for Climate Change Scaling in ARR4.2 (based on pre-1990 baseline conditions)
- ARR4.2 for 1% AEP – Short-Term (Year 2021 - 2040), Medium-Term (Year 2041 – 2060) and Long-Term (Year 2081 – 2100) for Shared Socioeconomic Pathways (SSPs) Medium (SSP2-4.5) and High (SSP3-7.0). These four conditions correspond to temperature increases (above 1990 temperatures) of 1.7 °C, 1.8 °C, 2.4 °C and 3.3 °C.

The analysis in this instance has focussed on the intermediate pathways SSP2 and SSP3 rather than the lowest, SSP1, and highest pathway, SSP5. It appears current consensus is coalescing around SSP2 and SSP3 being the most likely future outcome based on current projections. This assumption reflects informal guidance provided to the industry by the authors of ARR4.2 and NSW DCCEEW representatives.

Table 5-1 Total Rainfall Depths in mm for Design Rainfall from ARR87 (1%, 0.2% and 0.05% AEP), ARR2019 (1% AEP) and ARR4.2 (1% AEP) for Short-Term, Medium-Term and Long-Term Conditions for SSP2 and SSP3 Scenarios

Duration	ARR87 5% AEP	ARR87 1% AEP	ARR87 0.2% AEP	ARR4.2 Climate Change Scenarios					
				Base	Short term (1.2 °C)	SSP2 Med (1.7 °C)	SSP3 Med (1.8 °C)	SSP2 Long (2.4 °C)	SSP3 Long (3.3 °C)
60 m	66.2	88.0	105.3	61.6	72.8	78.1	79.2	86.2	97.7
90 m	82.2	109.2	124.0	71	82.8	88.3	89.5	96.6	108.5
120 m	86.8	115.2	138.8	79.1	91.4	97.1	98.3	105.6	117.7
180 m	99.9	132.6	161.8	93.4	106.8	112.9	114.2	122.1	135.0

For 2-hour duration storms, the adopted 1% AEP rainfall depth (115.2mm) is greater than a SSP2 long-term rainfall depth (105.6mm) and slightly smaller than the SSP3 long-term rainfall total (117.7mm). The ARR87 0.2% AEP (138.8mm) is significantly higher than the SSP3 long-term estimated rainfall total.

The ARR87 5% AEP 90-minute event (which in this AEP is critical for overland flow portions of the study area as shown in Figure A1 of Appendix A) (82.2mm) is equivalent to a 1% AEP short-term rainfall total (82.8mm) in ARR4.2.

This rainfall total analysis does not account for the added conservatism of the ARR87 temporal pattern relative to the ARR2019 temporal pattern methodology (where the median rather than maximum temporal pattern is selected from a set of 10). Therefore, even when using the same rainfall totals, from past testing by Stantec in other areas in Sydney, ARR87 peak flows are expected to exceed ARR2019 based peak flows.

Based on recent ARR4.2 guidance to review adopted design rainfall totals, the apparent conservatism of retaining ARR87 rainfall means that the design modelling adopted in this FIRA already reasonably account for a long-term estimate for climate change rainfall increases. As a proxy, the assessment of 0.2% AEP modelling as a representation of climate changes conditions may be conservative as it corresponds to greater rainfall totals than SSP3 long-term estimates.



Conversely, review of 5% AEP results from the current assessment appears to be a suitable proxy to potential short-term impacts of climate change, roughly equivalent to estimated impacts to the present-day.

Therefore discussion in the following sub-section and in the flood risk review chapter examines the use of the 0.2% AEP event as a conservative estimate for future climate change 1% AEP conditions. Otherwise it should be assumed that the 1% AEP results in this assessment already account for future climate change rainfall increases based on a comparison to ARR4.2 latest design rainfall guidance.

5.2.2 Model Results

The water level increases when comparing the climate change (0.2% AEP) and current climate 1% AEP are shown in Figure A26 of **Appendix A**. The results show that all of the overland flowpaths have water level increases between 0.06 – 0.12 metres. Mainstream Cooks River floodplain has more significant water level increases of 0.6 metres.

The potential increase in flood risk for this severe climate change (0.2% AEP) scenario can be seen in comparing the following figures in **Appendix A**:

- Comparing flood function for the 1% AEP (Figure A12) and 0.2% AEP (Figure A13). It shows that both floodway and flood storage are marginally more extensive in the climate change scenario, however floodway is generally still confined to road reserves and drainage and open space corridors.
- Comparing provisional flood hazard for the 1% AEP (Figure A17) and 0.2% AEP (Figure A18). It shows that high hazard is marginally more extensive in the climate change scenario, however is generally still confined to road reserves and drainage and open space corridors.
- Comparing H1-H6 hazard for the 1% AEP (Figure A22) and 0.2% AEP (Figure A23). It shows that all hazard categories are only marginally more extensive in the climate change scenario.

Overall it is considered that climate change impacts will only result in a marginal increase in flood risk for the overland flow portions of the study area based on these model results. The foreshore areas of the Cooks River mainstream floodplain will potentially have increased flood risk due to climate change, however the incremental increases in flood risk are typically contained in areas not proposed for intensification of development.

5.3 Flood Planning Level and Risk Assessment

As noted within the Mandatory LEP Clause of the standard LEP clause (see **Section 4.2.1.1**) the Flood Planning Level (FPL) in accordance with the 2005 FDM 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 current Canterbury-Bankstown LEP adopts the 1% AEP level with a 0.5m freeboard for the entire LGA. A recent change within Council procedure is consideration of climate change impacts within the 1% AEP event. This decision, endorsed by the local Flood Risk Management Committee (FRMC) is in



response to the recent release of ARR version 4.2 which outlined a methodology to increase ARR2019 design rainfall depths (derived from records pre-1990) to account for the impacts of climate change.

As part of the 2022 Flood Inquiry released by the State Government, 'finding O' of the inquiry notes a risk based approach should be used to consider flood planning level, particularly for high risk catchments.

Review of the flooding conditions of the study area suggest that this not significantly high-risk catchment relative to other catchments. The flood affectation is in keeping with many other urban overland flow affected catchments in Sydney. The floodplain of the Cooks River does not have as significant riverine flooding severity as other major rivers in the Sydney basin.

A review of the model results for different AEPs relative to the 1% AEP (summarised in **Section 3.8.5**) show that:

- For overland flowpaths within Campsie, the flood levels of the 0.2% and 0.05% AEP and PMF events are approximately 0.1m, 0.2m, and 0.5m higher than the 1% AEP level. There are some minor sections of overland flowpath where PMF levels are up to 0.7 metres higher than the 1% AEP. This small flood range shows that a 0.5 metre freeboard would essentially encompass overland flooding risk up to at least the 0.05% AEP (1 in 2,000 year) event, but for most of the study area even up to the PMF event.
- For mainstream Cooks River floodplain:
 1. The 0.2% AEP flood level is 0.6 metres higher than the 1% AEP, suggesting this event would only cause minor flooding above an FPL with 0.5m freeboard. The flood extents for the 0.2% AEP are slightly wider than the 1% AEP though still contained within foreshore sites and open space areas.
 2. The 0.05% AEP flood level is 1 metre higher than the 1% AEP, with flood extents wider still, however still affecting only properties closest to the river corridor.
 3. The PMF level is 4 metres higher than the 1% AEP with much more widespread flooding extending several blocks away from the river corridor. The mainstream flood risk in a PMF event extends significantly beyond the FPL and associated FPA.

This high level risk review supports the Council adoption of a standard 1% AEP plus 0.5m freeboard for FPL across the entire LGA including the study area. The Flood Planning Area (FPA) for the study area corresponding to this 1% AEP plus 0.5m freeboard have been prepared as discussed in **Section 3.8.4** and shown in **Figure 5-1**. As per Council's DCP requirements, the higher risk development types of vulnerable developments are required to consider flood risk up to the PMF level, which in principle is in accordance with the risk-based consideration for these types of developments.

The 1% AEP with 0.5m freeboard addresses overland flooding risk within the study area up to at least the 0.05% AEP, and for large extents of the flowpaths would also elevate floor levels above even the PMF level. For mainstream flooding the 0.5m freeboard would nearly elevate floor levels to the 0.2% AEP level, with significant residual flood risk in the extreme PMF event.

NSW DPHI has responded to the recommendations of the inquiry by fully supporting six recommendations and giving in-principle support to the remaining 22, with additional work required for their implementation.



5.4 Land Use Zoning Changes

Ministerial Direction 4.1 under Section 2 notes that 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. These land use changes represent an intensification in zoning from a non-urban or low-intensity use, which could potentially increase flood risk.

The FPA extents and the proposed land use zoning of the Precinct are shown in **Figure 5-1**. As can be seen in **Figure 5-1**, the FPA includes several locations proposed for land use change under the planning proposal.

A summary of the land use change areas proposed in the Proposal with location numbering is shown in **Figure 5-1**. The land use changes for the numbered areas, and whether or not they are flood affected and therefore not in accordance with this provision of the Policy is summarised in **Table 5-2**. All land use changes are not in the categories listed in the NSW Flood Prone Land 2021 package, therefore are eligible changes even if they are flood affected.

All identified zoning changes involve intensification within existing urban or residential zones (e.g., medium to high density residential or mixed use) and do not involve rezoning land from the categories restricted under Direction 4.1. Therefore, the changes are considered eligible even if the sites are flood affected.

Table 5-2 Review of Proposed Land Use Change Areas

Location	Existing Land Use	Proposed Land Use	Flood Affection	Consistent with Ministerial Direction 4.1 Provisions
1	Medium Density Residential	High Density Residential	Yes	Yes – Eligible Change
2	Medium Density Residential	High Density Residential	Yes	Yes – Eligible Change
3	Medium Density Residential	High Density Residential	No	Yes – Eligible Change
4	Medium Density Residential	Low Density Residential	No	Yes – Eligible Change
5	Mixed Use	Mixed Use	Yes	Yes – Eligible Change
6	Medium Density Residential	High Density Residential	Yes	Yes – Eligible Change
7	Medium Density Residential	Low Density Residential	No	Yes – Eligible Change
8	Mixed Use	High Density Residential	Yes	Yes – Eligible Change
9	Medium Density Residential	High Density Residential	No	Yes – Eligible Change
10	Medium Density Residential	Local Centre	No	Yes – Eligible Change
11	Medium Density Residential	Mixed Use	No	Yes – Eligible Change

5.4.1 Outcome

None of the proposed land use changes involve rezoning from non-developable to developable zones, such as from Recreation, Rural, Environmental Protection, or Special Purpose Zones. As such, the proposed changes do not trigger restrictions under Clause 2 of Ministerial Direction 4.1 and are deemed consistent, even where some of the land is flood affected.



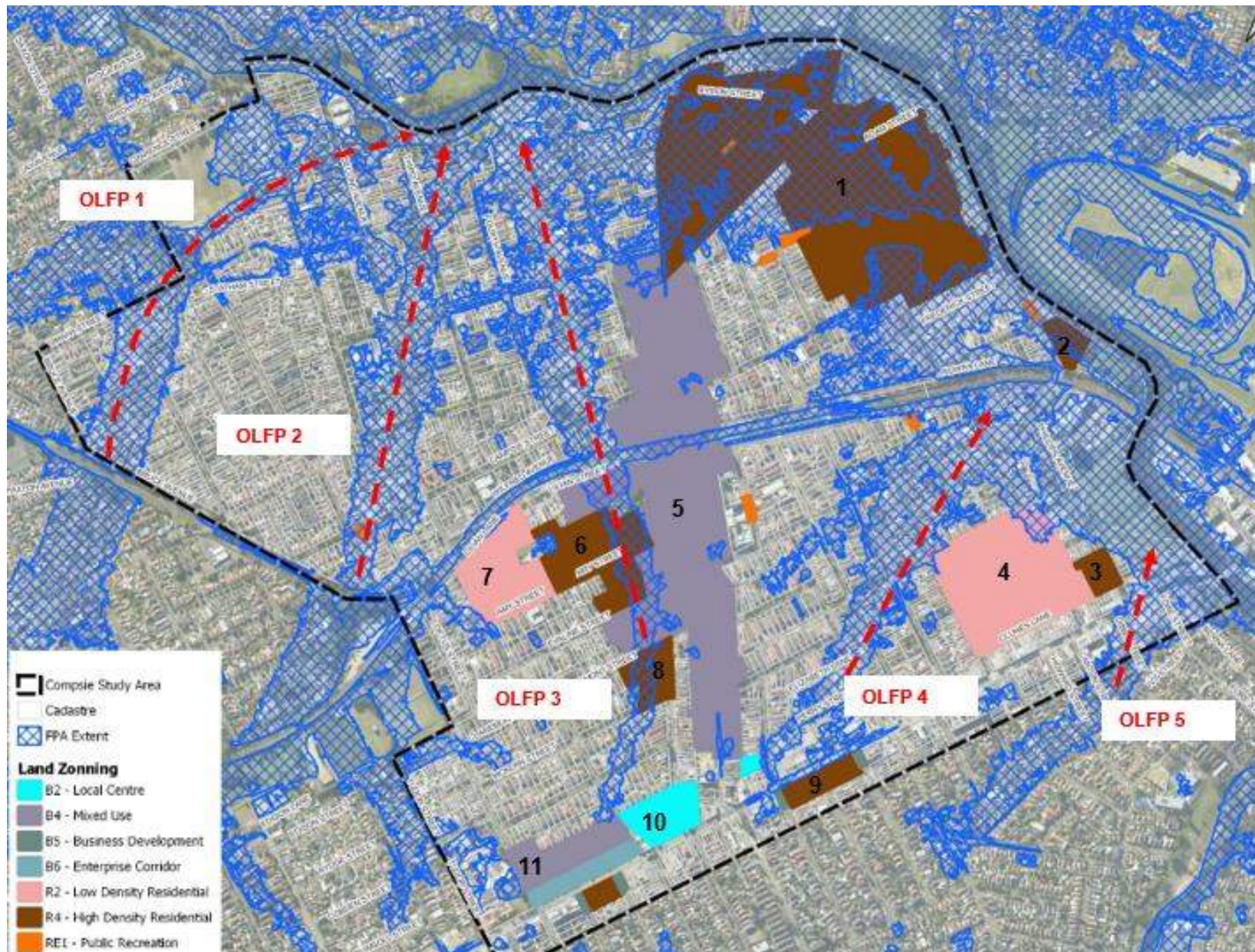


Figure 5-1 Numbered Locations of Developable Land Use Changes from the Planning Proposal and FPA Extent



5.5 Impact Assessment for Future Development

This high-level FIRA has been prepared to support the Campsie Town Centre Planning Proposal. It provides a strategic evaluation of potential flood risks impacts under future development conditions, particularly in areas subject to land use change or intensification. The assessment aims to inform precinct-scale planning decisions, while recognising that detailed, site-specific assessments will be required at the development application (DA) stage.

All future development proposals must be supported by detailed, site-specific flood impact assessments that demonstrate consistency with planning controls, manage local flood risks, and maintain floodplain function.

5.5.1 Post-Development Modelling Assumptions

To simulate post-development flood behaviour, adjustments were made to the existing flood model to represent likely development impacts. These assumptions reflect a planning-phase understanding of future built form and are summarised as follows:

- **Digital Elevation Model (DEM):**
No changes were made to the base terrain model, as detailed post-development ground levels and site designs were not available at the rezoning stage.
- **Buildings and Flow Obstruction:**
A dual treatment approach was adopted depending on whether proposed buildings intersect flood-sensitive areas:
 - **Yellow hatched areas (Figure 5-2):**
Proposed development sites located outside mapped flood-sensitive areas were modelled as blocked footprints (2d_code in TUFLOW) —fully obstructing flow. These structures were removed from the 2D domain (voided), meaning floodwaters cannot flow through them and must be routed around. Conservatively, the entire extent of the developments sites were blocked from the model to assess impacts if they offer no flood storage in the future. The only exclusions made to the development sites were floodway and significant flood storage portions of sites on the Cooks River foreshore. An example is the group of properties east of Nowra Street where the eastern floodway and flood storage portion of the sites has been excluded from the modelled development extent as shown in **Figure 5-2**.
 - **Green hatched areas (Figure 5-2):**
Proposed buildings intersecting OLFPs or other flood-sensitive areas were modelled as conveyance-preserving building zones, retained in the 2D domain with a Manning's n value of 0.1. This simulates partial obstruction due to features such as subfloor construction, fencing, landscaping, or residual infrastructure. This conservative approach reflects the expectation that any future development in these locations must preserve flood conveyance and/or storage capacity.
- **Hydrology:**
Two changes have been applied to TUFLOW model hydrology:



- Blocked development sites (yellow hatching) have had cumulative flows from these footprints inserted into the TUFLOW model at the low point in the perimeter around the site (2d_sa_rf layers). This has contributed to more consolidated local flows at some locations.
- All development sites (both yellow and green hatched) have been altered in the post-development modelling to adopt initial and continuing losses of 1mm and 0mm/hr respectively. Conservatively it has been assumed that due to expanded roof areas and hardstand driveways of post-developed sites, that rainfall losses will reduce. Review of TUFLOW check files shows that an additional 3,141 m³ of total rainfall volume was added to the post-development model compared to the existing model. Across the blocked development footprints this equates to 4mm of additional rainfall excess as a result of the reduced rainfall losses in the post-development model.

In reality, redevelopment is not anticipated to significantly increase impervious surface coverage, and Council's On-Site Detention (OSD) policy will ensure that post-development peak flows are consistent with existing conditions. Therefore the above post-development model assumption is considered conservative.

Similarly, the complete hydraulic blockage of entire development sites in the post-development scenario is considered particularly conservative given that existing buildings were all modelled with only the high roughness approach

5.5.2 Flood-Impact-Sensitive Sites

Areas including floodways, flood storage areas, and overland flow paths (OLFPs) have been considered flood-sensitive for this assessment. Any future development within these areas has the potential to alter flood conveyance or reduce available flood storage. For the purposes of this high-level flood modelling, a simplified classification of proposed buildings was adopted based on the mapped constraints in **Figure 5-2**.

In this modelling, buildings located within high hazard or flood-sensitive areas were treated to allow partial conveyance of floodwaters through them. This approach was applied solely for hydraulic modelling purposes to test the broader effects of development, and should not be interpreted as an assessment of development feasibility.

Importantly, the classification of buildings as "flood impact sensitive" within these areas is not a conclusion regarding development potential. Any future proposal within these locations must be supported by a site-specific flood impact assessment to demonstrate that floodplain function is preserved and that adverse off-site impacts are avoided. Final development outcomes must be determined through the development application process in consultation with Council.



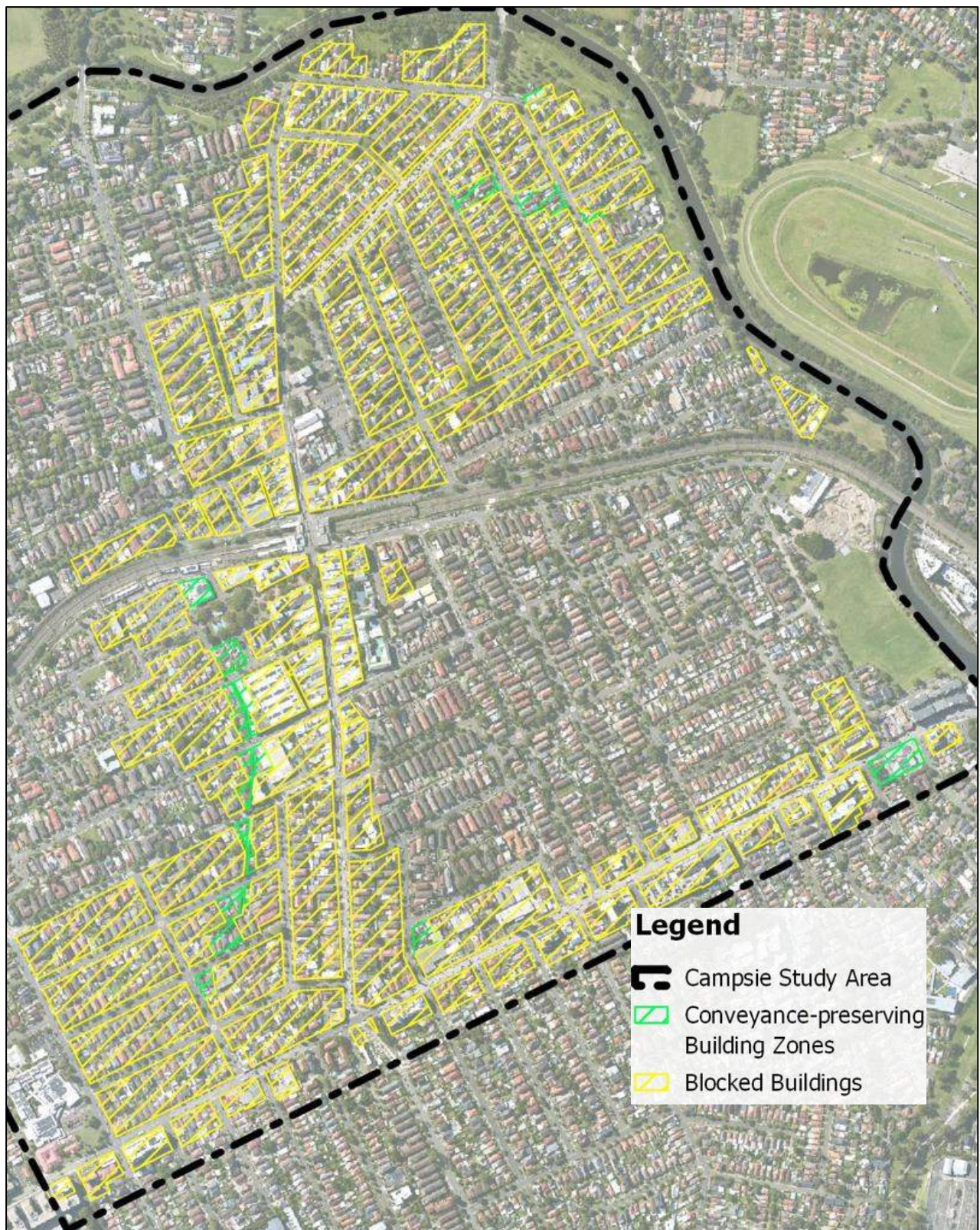


Figure 5-2 Post-Development Scenario Model Set-up. Yellow hatch areas represent fully blocked development sites removed from the 2D domain. Green hatch areas denote OLFP or flood-sensitive sites retained with Manning's $n = 0.1$.

5.5.3 Post-Development Model Results

Water level difference results comparing post-development to existing conditions were generated for the 5%, 1%, 0.2%, 0.05% AEP, and PMF events using critical storm durations tailored to each design scenario. This section focuses on outcomes from the 1% AEP event with a 120-minute critical duration, which provides a representative snapshot of post-development flood behaviour across the Campsie Town Centre precinct. The complete set of flood mapping is provided in **Appendix B**.

The post-development flood modelling indicates that changes in water levels across most of the precinct are negligible to minor, typically within ± 0.05 m (refer to Figure 5-3). Localised reductions in flood levels are observed, particularly where development avoids flow corridors or adopts conveyance-preserving zoning. In contrast, small increases in water levels (generally between 0.05 m and 0.1 m) are noted in a few infill areas constrained by topography or existing structures. These changes are consistent with expectations for an urban intensification scenario and do not suggest widespread adverse hydraulic impacts.

There are minor water level increases downstream of the western flowpath OLFP3, which continue to the convergence with Cooks River. These downstream impacts are likely a result of a change in flow behaviour through the impact sensitive development sites, and the increased runoff from the reduction in rainfall losses for development sites. These minor impacts are assumed to be able to be resolved on a site-by-site basis through proper conveyance design and through appropriate OSD design to ensure no increases in existing runoff.

There are minor water level increases along Brighton Ave and Shelley St to the north as a result of local stormwater being consolidated from development sites into the road reserve (by complete blockage of the surrounding development sites). These impacts are considered stormwater drainage issues rather than overland flooding impacts, and should be able to be resolved through appropriate site discharge design to ensure stormwater runoff enters the local stormwater drainage network.

Another example of a local stormwater issue coming to light through the blockage of development sites from the model is on Beamish St on the southern side of the precinct. In the existing case, what is a small area of ponding on the road has been modelled to a more significant ponding area of Beamish Street as development sites both to the east and west have been fully blocked in the post-development scenario. Similar to the above examples this is considered a local stormwater issue as appropriate discharge into local stormwater network should resolve this issue. Further review of the stormwater network capacity in this area, and potential for developer stormwater network upgrades is included in **Section 6.3**.

The hydraulic function of the floodplain—defined by floodway, flood storage, and flood fringe categories—remains largely unchanged under the post-development case. **Figure 5-4** illustrates that most intensified areas continue to function as flood fringe zones, with core conveyance areas preserved. This outcome confirms that development has been appropriately directed away from critical flow paths, maintaining the hydraulic integrity of the floodplain. Comparison with existing conditions supports this conclusion, showing minimal encroachment into storage or floodway zones.



Hazard categorisation mapping under the 1% AEP post-development scenario (**Figure 5-5**) shows that the majority of developed areas fall within low to moderate hazard bands (H1–H3). Higher hazard classifications (H4–H6) remain concentrated within open channels and designated overland flow corridors, away from proposed development zones. This distribution aligns with planning intentions to avoid placing intensified residential development in hazardous locations and supports the feasibility of effective emergency response strategies, including vertical evacuation where applicable. Comparison with the existing hazard map reveals no significant expansion of extreme hazard areas, indicating that post-development conditions do not exacerbate flood risk across the precinct.

Water level differences for other AEPs, 5%, 0.2% and 0.05% AEP are similarly localised and minor to the 1% AEP event. PMF impacts for the mainstream Cooks River are more widespread as shown in **Figure 5-6** (also Figure B30 of **Appendix B**). The impacts are caused by the complete blockage of development sites, which in the PMF event represents a significant blockage of mainstream floodplain conveyance, as shown by the orange areas in the figure. While widespread in both upstream and downstream directions, the impacts are minor (for the most part less than 0.1 metres) relative to the significant depth of flooding in the PMF event. This is further shown in H1-H6 hazard difference figure for the PMF event in Figure B35 of **Appendix B**, the results show negligible increase in hazard category throughout the study area and Cooks River floodplain as a result of these impacts.

In light of the conservative change in model methodology to block buildings in the post-development model but not the existing model, these impacts in the PMF event do not necessarily reflect potential development impacts in this rare event. Overall, these PMF impacts are not considered a significant concern given the limitations of this high-level model methodology and the minor nature of the impacts relative to the over 4 metres depth of flooding in Cooks River in this extreme event.

5.5.4 Limitations of Impact Assessment

The post-development flood modelling for this study was undertaken at a high level to support the rezoning stage. The modelling approach applied simplified assumptions about building footprints and future development form based on available master plan data.

In particular, a dual treatment was used for proposed buildings depending on their location within or outside mapped flood-sensitive areas (as shown in **Figure 5-9**). For buildings in flood-sensitive areas, a high Manning's roughness ($n = 0.1$) was used to represent partial obstruction (e.g., due to elevated subfloor structures), while buildings outside these areas were voided from the 2D domain to simulate full obstruction. These assumptions are suitable for strategic modelling but are not intended to represent final built form or development feasibility.

Building footprints were adopted as block-wide envelopes and may not reflect final building designs, levels, or layouts. No changes were made to terrain in this assessment, and detailed civil or drainage design inputs are not available at this stage. Consequently, this modelling does not assess all potential impacts of redevelopment in detail. Due to these simplifications, the outcomes of the modelling should be considered indicative only. They serve to test the cumulative and precinct-scale flood behaviour under assumed development and identify sites that may require more careful assessment.

It is also worth noting that this is a risk assessment specifically for the rezoning works, not for the complete development of the sites. The sites have significant existing development potential based on



current zoning of an existing urban area largely zoned R3 Medium Density Residential or R4 High Density Residential. Therefore the focus of this risk assessment has to be on the incremental change from existing capacity to proposed capacity, because that is what the rezoning project is. The proposed building footprints modelled in the post-development condition would likely be very similar to the building footprints that would be possible under the 'existing capacity' scenario. Realistically, when comparing to existing capacity, the flood impacts of the proposed rezoning would be negligible as it would only relate to the marginal increased building footprints that the rezoning would facilitate.

Ultimately, flood impact assessments will need to be completed on a site-by-site basis at the DA stage, supported by detailed hydraulic modelling, development design, and consideration of floor levels, flood mitigation measures, and emergency response.

This approach is consistent with the intent of Ministerial Direction 4.1, which permits strategic assessment at the rezoning phase without requiring full post-development modelling. A similar approach was adopted for the Bankstown Town Centre TOD flood assessment in 2024, providing precedent within CBC LGA for using indicative modelling to inform precinct-scale planning proposals.

5.5.5 Outcome

The conclusions from this exercise are:

- The modelling approach conservatively assumed all proposed buildings as either fully blocked or partially obstructing flood flows, based on mapped flood sensitivity. In addition development site runoff has been modelled to increase by reducing the rainfall losses for development sites to be the equivalent of 100% impervious;
- For most of the study area, predicted flood level impacts under post-development conditions are minor and likely manageable through appropriate site design and mitigation. While there are regional impacts for the PMF mainstream Cooks River floodplain, these impacts are not seen as overly concerning given the limitations of this high-level model methodology and the minor nature of the impacts relative to the flooding in this extreme event ;
- A number of sites were identified as flood impact sensitive where future development will need to demonstrate that conveyance or storage is not adversely affected. These are the sites where existing scenario modelling shows flowpaths through the sites;
- These sensitive sites have been flagged, but this does not imply that other sites do not require assessment—all flood affected development must demonstrate flood compatibility at the DA stage.

Overall, this strategic modelling indicates that the precinct-wide development proposed under the Campsie Town Centre Planning Proposal can likely be accommodated without significant adverse cumulative flood impacts, provided that detailed assessments are carried out during the subsequent planning stages on a site-by-site basis.



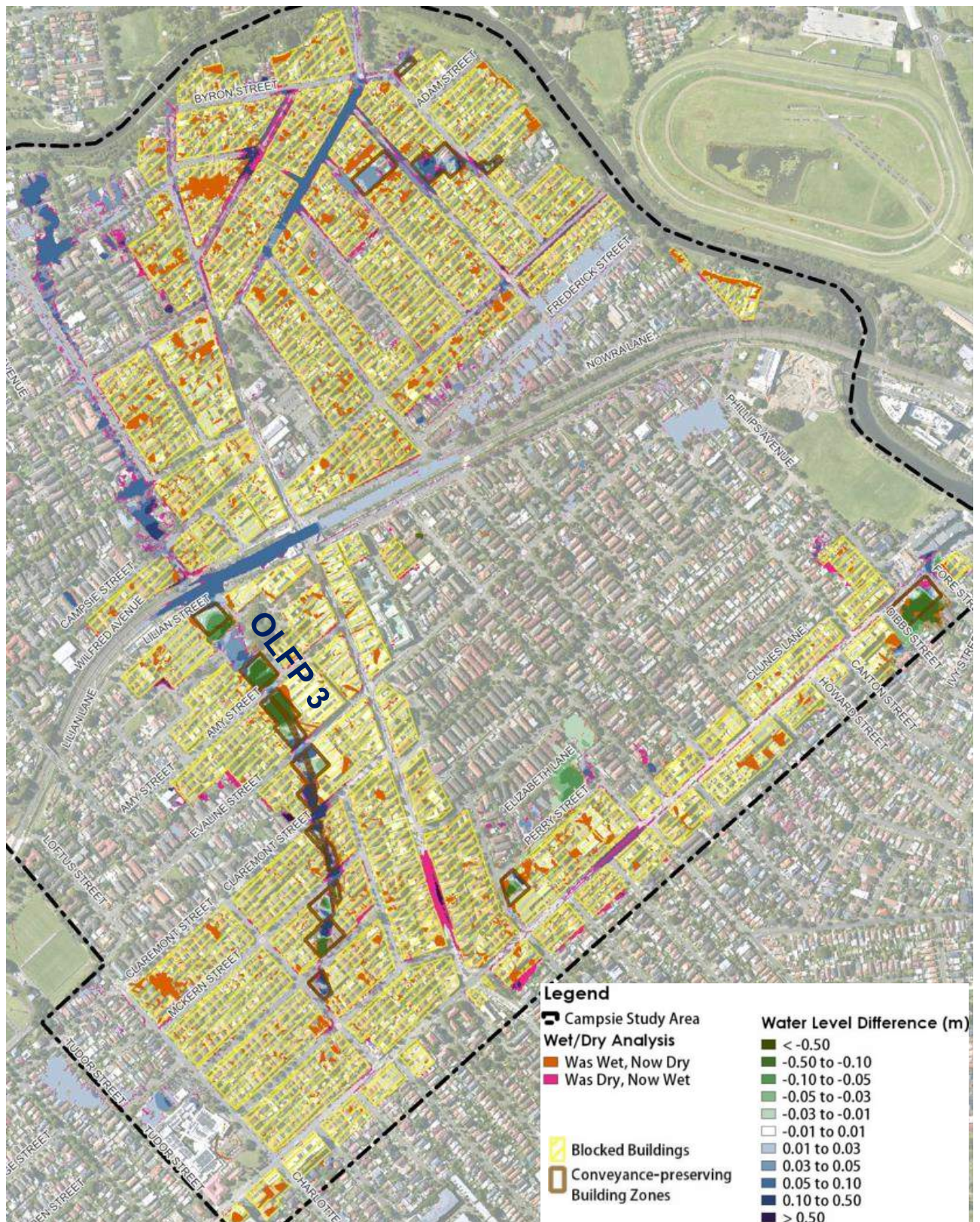


Figure 5-3: Water Level Difference (Post-Development minus Existing) – 1% AEP, 120 min - Most differences are within ± 0.05 m, consistent with localised infill impacts



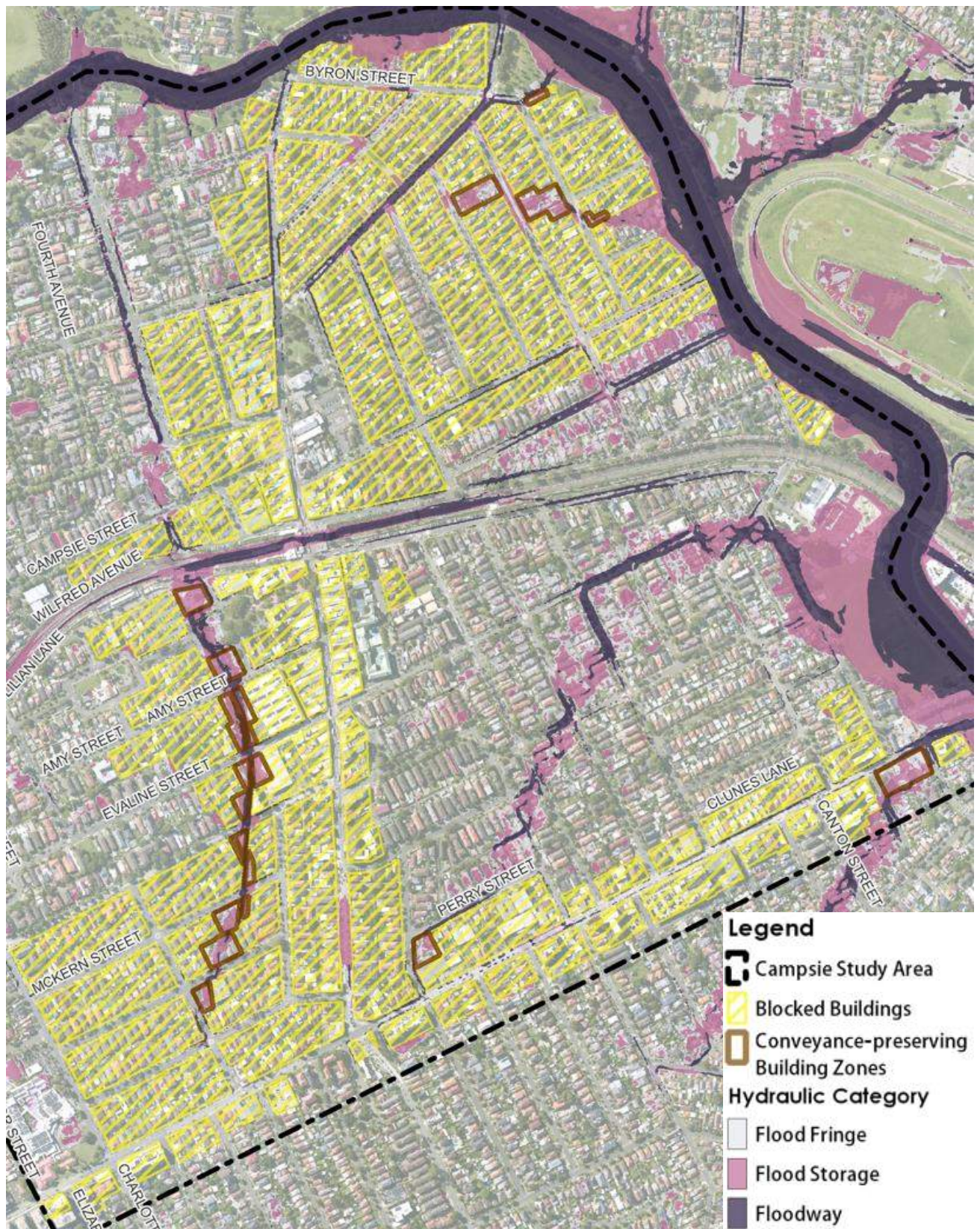


Figure 5-4: Flood Function Category – Post-Development, 1% AEP, 120 min. Floodway is contained within portions of 'Impact Sensitive Sites' for some OLFPs



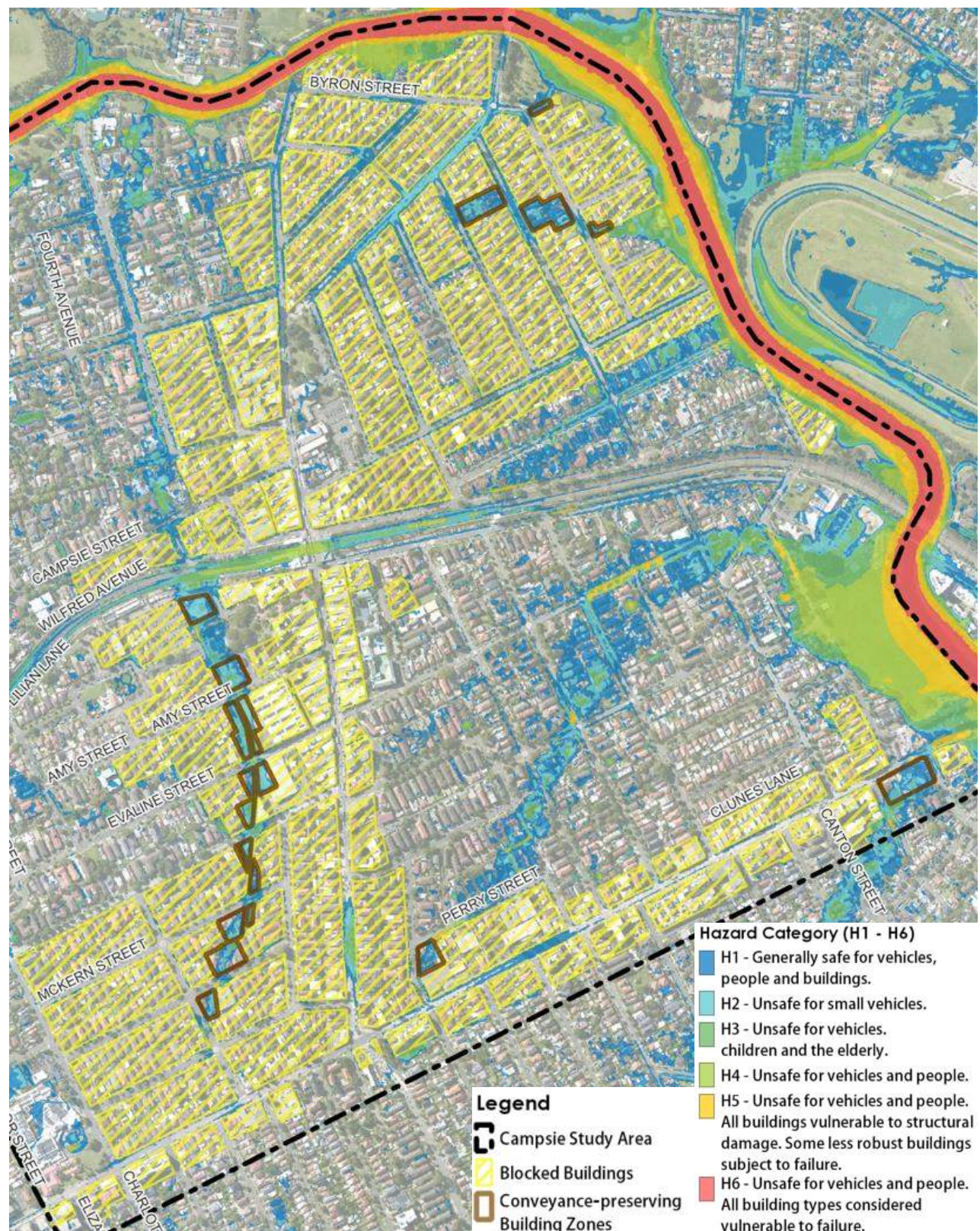


Figure 5-5: H1-H6 Hazard Category Mapping – Post-Development, 1% AEP, 120 min - Hazardous zones remain concentrated in open spaces and watercourses.



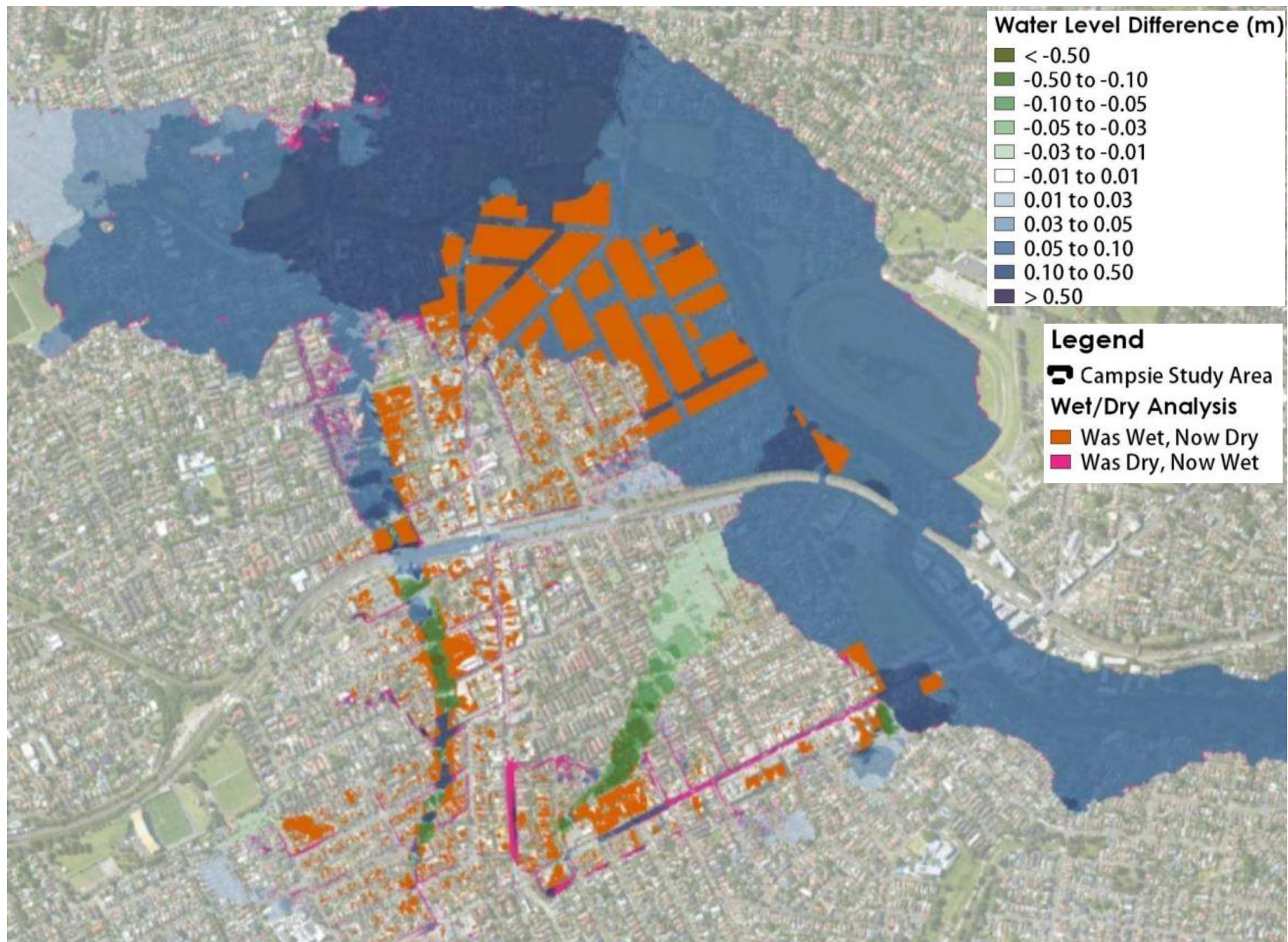


Figure 5-6: Water Level Difference (Post-Development minus Existing) – PMF Event. More widespread impacts on Cooks River



5.6 Development in High Flood Risk Areas

5.6.1 Floodway

Ministerial Direction 4.1 and the NSW *Flood Prone Land Policy (2021)* specify that planning proposals must not permit development within floodway areas. For the purpose of this review, floodways are defined as areas of the floodplain that convey significant flows during a 1% AEP event and where obstruction would cause unacceptable increases in flood levels or hazard elsewhere, consistent with the Flood Risk Management Manual 2023.

The mapped 1% AEP floodway extent for the Campsie Precinct is shown in **Figure 5-7** (also Figure A16 in **Appendix A**). The results indicate that floodway is primarily confined to the Cooks River channel and riparian corridor, which functions as the main flood conveyance corridor. Only limited and isolated segments of overland flow paths (OLFPs) within the study area meet the hydraulic thresholds to be classified as floodways, typically where local flow depth and velocity are elevated.

For the three OLFPs that interact with the intensification areas (OLFP3, 4 and 5 shown in **Figure 5-7**), the majority of these flowpaths do not satisfy the criteria for floodway designation. Where floodway conditions do occur along OLFPs, they are restricted to small, non-developable portions of the corridor. For OLFP3 there is marginal interaction with floodway and some of the developments sites, however generally the floodway is contained in the existing narrow drainage easement corridor along the centre of the flowpath. The two main development blocks that interact with OLFP4 (corner of Perry St and Stanley St) and OLFP5 (south of Canterbury Rd bounded by Dibbs St and Fore St) both show as flood storage and not floodway affected.

For the mainstream Cooks River floodplain, four 'spots' have been identified in **Figure 5-7**. Spots 1, 2 and 4 have significant flood affectation in a 1% AEP event, however all are classed as flood storage and not floodway. For Spot 3, the extent of intensification in **Figure 5-7** for this group of Nowra Street properties extends from flood free on the western frontage to flood storage in the centre and floodway on the eastern side closest to the Cooks River. Therefore, only the western portion of these sites are considered 'developable', excluding all of the floodway affected portions of the site. This was reflected in post-development modelling (refer to modelled development extent shown in **Figure 5-2**), where only the western portion of the site was modelled as 'blocked'. The flood impact results from this post-development modelling (**Figure 5-3**) showed that impacts in the 1% AEP for this site were negligible.

The areas identified for rezoning or increased density (shown as yellow hatching in **Figure 5-7**) are located outside of floodway extents. The only exception is Spot 3 near Nowra Street, with only the western part of this site considered developable as a result of floodway portions being excluded. Accordingly, the Planning Proposal does not propose any development within mapped floodway areas, and is therefore considered consistent with Ministerial Direction 4.1 and current flood policy.

As shown in **Figure 5-7** there are development sites affected by flood storage within overland flowpaths, though it is assumed that flood storage is less of a concern than conveyance for overland flowpaths. For mainstream Cooks River flooding, where preservation of flood storage is more critical, development sites (shown in yellow) only marginally extend into the mainstream flood storage. Spot 1, 2 and 4 in **Figure 5-7** are all significant mainstream flood storage areas, however all three areas have



been excluded from proposed intensification therefore this flood storage has been maintained in post-development modelling.

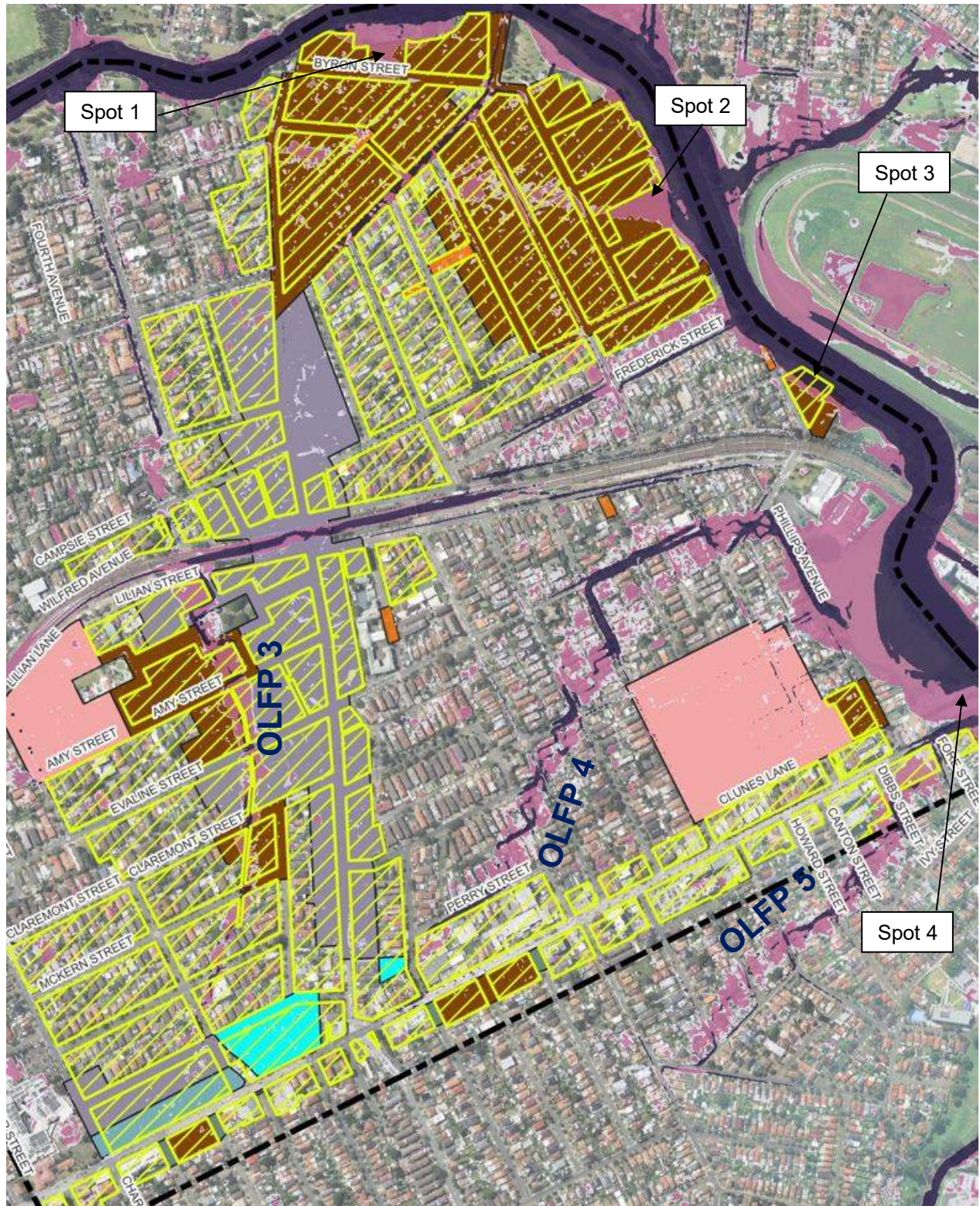


Figure 5-7 1% AEP Flood Function (Floodway, Flood Storage and Flood Fringe) – Campsie Precinct



5.6.2 High Hazard

The Ministerial Direction 4.1 states that planning proposals should not permit development for the purpose of residential accommodation within high hazard areas. These areas are defined as locations where conditions during a 1% AEP flood pose an unacceptable risk to life and property, and where safe occupation or evacuation cannot be reasonably ensured.

Figure 5-8 (also shown as Figure A21 in **Appendix A**) illustrates the extent of the mapped 1% AEP high hazard zone in relation to the Planning Proposal's land use zoning. The mapping indicates that high hazard areas are predominantly confined to the Cooks River corridor and public road reserves.

For all overland flowpaths (OLFP3, 4 and 5) that interact with intensification sites there is negligible high hazard (or transitional hazard) affectation within any development sites as shown in **Figure 5-8**.

For the four mainstream 'spots' shown in **Figure 5-8**, all have at least partial interaction with high hazard flooding in the 1% AEP event. However for spots 1, 2 and 4 the extent of intensification has been set avoiding these high hazard areas. For spot 3, similar to the floodway discussion of the previous sub-section, the eastern portion of the site is high hazard affected and therefore not eligible for residential development. However the adopted developable portion of these Nowra Street sites avoids high hazard areas and therefore would be eligible for development.

5.6.3 Outcome

The Planning Proposal avoids development within floodway and high hazard areas and is therefore considered consistent with Ministerial Direction 4.1 and the NSW Flood Prone Land Policy (2021) in that regard. The only development site showing significant interaction with both floodway and high hazard is Spot 3, the properties east of Nowra Street. For these sites only the western portions that are not floodway or high hazard affected in the 1% AEP should be considered for future development.

There is marginal floodway affectation of some sites along OLFP3, 4 and 5. This designation reflects the conclusion of the post-development modelling identifying these sites as 'flood-impact sensitive sites'. This reinforces that any potential redevelopment of these sites will need to ensure continued conveyance through appropriate site design.



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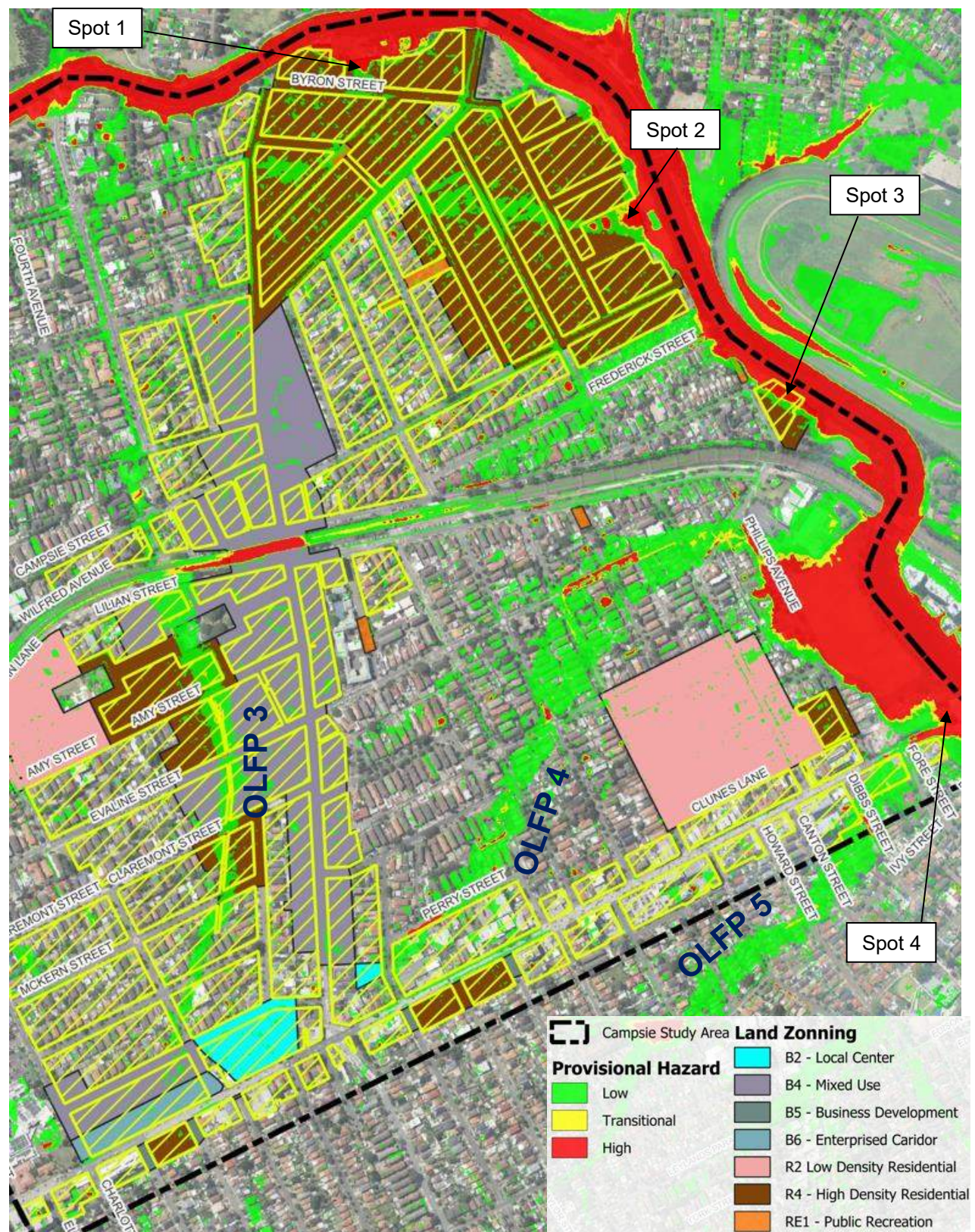


Figure 5-8 1% AEP Provisional Flood Hazard (High, Transitional and Low Hazard) – Campsie Precinct



5.7 Intensification of Development and Cumulative Development

The Ministerial Direction 4.1 notes a planning proposal must not permit a significant increase in the development and/or dwelling density within the FPA. Similarly, the standard LEP clause notes that Councils should consider the impacts of cumulative development on the floodplain. The FPA extent (along with 1% AEP and PMF extents) is overlaid on 'intensification' sites (yellow hatched areas) in **Figure 5-9**. In several ways the proposal involves a potential intensification of occupation:

- The change of use locations in **Section 5.4** mostly involve an increased residential zoning from medium density to high density residential.
- As discussed in **Section 2.1.4**, the proposal involves an uplift in Floor Space Ratio (FSR) for parts of the study area.
- As discussed in **Section 2.1.4**, the proposal involves an uplift in Height of Building (HOB) for large parts of the study area.

In most instances, the proposed intensification will be in the form of vertical development with HOB and FSR increases to accommodate the growing population.

To assess the potential intensification of occupation of these sites, three potential occupation scenarios should be considered:

- **Existing site** – Estimated occupation of the existing site with current use
- **Existing capacity** – The maximum potential occupation of the site under current LEP zoning, FSR and HOB not considering other site constraints;
- **Proposed capacity** – The maximum potential occupation of the site under proposed rezoning, FSR and HOB, not considering other site constraints.

As this is a planning-stage assessment, the focus is on comparing existing capacity and proposed capacity. These sites already have development potential under current controls, and this review addresses the incremental increase in flood exposure from that baseline.

It is assumed that the developable portions of these sites will be flood-free under post-development conditions. This is based on adherence to CBC's current Flood Planning Level (FPL) requirements, which mandate that all habitable floor levels be constructed at or above the 1% AEP flood level plus 0.5m freeboard.

In greenfield precincts, this is typically achieved through bulk filling. In this case (infill redevelopment), it is expected that appropriate fill, site design and elevated building footprints will raise habitable areas above the FPL—effectively removing them from the FPA.

Through compliance with Council's flood-related development controls and confirmation of post-development conditions via modelling during DA stage, most development sites in the study area may be considered suitable for intensification under Ministerial Direction 4.1.

No changes to the Planning Proposal are currently recommended under this Policy provision; however, zoning refinements or localised controls may be required to reflect site-specific flood constraints.



5.7.1 Flood Risk Implications of Intensification

Considering the flood risk implications of intensification and the associated filling or raising of portions of these sites to facilitate the development:

- The potential filling or raising of development sites would involve consideration of potential flood impacts.
- Based on the proposed FSR and HOB, much of the intensification in the Planning Proposal will occur vertically in multi-storey residential buildings compared to existing capacity for current zoning which in most cases has significant redevelopment. This means that any additional occupants due to rezoning would typically reside above both the FPL and the PMF, effectively being elevated above the entire floodplain.
- It is expected that new multi-storey buildings could be designed to be stable during flooding up to the PMF and that all non-ground floor residents in multi-storey residential development would be only exposed to an indirect flood risk in all events. PMF hazard mapping of the study area shows several sites are affected by up to H5 hazard which would require structural design for flood forces. No areas are subject to H6 hazard, where structural failure risks may be significant.
- Implementation of site-specific flood emergency response plans for new multi-storey development could potentially reduce the flood risk faced directly and indirectly by future residents in contrast to the flood risks faced by existing residents or potential residents under the existing capacity of development sites.
- This assessment applies to sites where post-development conditions ensure compliance with Council's FPL and where no severe hazard constraints (e.g. high hazard or floodway areas) preclude development.
- Assumptions regarding structural stability and flood-free development must be confirmed through detailed flood impact assessments at later planning stages.

To support these above referenced flood risk considerations for potential development in the floodplain, a literature review has been conducted of relevant guidelines, research papers and other materials as summarised in **Appendix C**. The flood risk reasoning for vertical intensification is particularly addressed in the references in Section C.5 from the Hawkesbury Nepean Floodplain Management Steering Committee (HNFMSC) guidelines from 2006.

5.7.2 Outcome

Regarding intensification in the FPA, there is a proposed intensification compared to existing capacity as a result of the Planning Proposal. To ensure no significant increase in flood risk, the intensification of these development sites would be contingent on the following at DA stage:

- Raising of the developable portions of the site above the FPL in accordance with Council's flood-related development controls, associated with this would be consideration of flood impacts on a site-by-site basis resulting from this raising.
- Intensification for multi-storey residential buildings would be vertical, meaning additional occupants from the rezoning would likely reside above both the PMF and FPL levels.
- Building stability would need to be assured up to the PMF event
- Appropriate implementation of flood emergency response provisions for development sites to reduce the risk to life for all occupants.



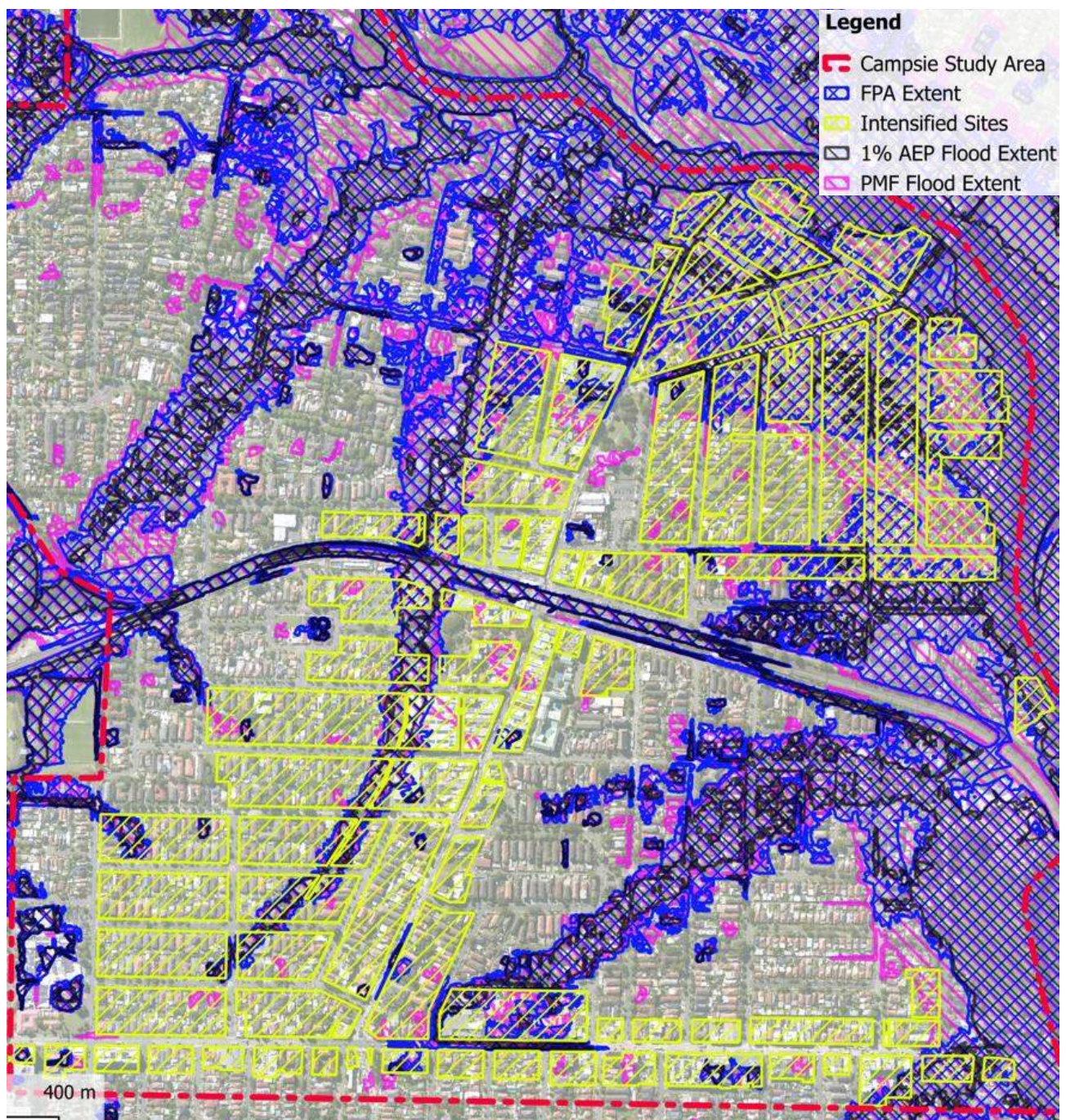


Figure 5-9 1% AEP and PMF Flood Extents and Flood Planning Area (FPA) and Proposed Intensified Sites – Campsie Precinct

5.8 Flood Emergency Response

Flood emergency response assessments must consider flood behaviour across a full range of events, including up to the PMF. Unlike planning controls focused on the 1% AEP flood, emergency response must address rare, extreme events where evacuation, shelter-in-place, and structural resilience become critical.

When determining the flood risk to life, the flood hazard in an area does not directly equate to the danger posed to persons on the floodplain. This is due to the capacity for people to respond and react to flooding and to avoid entering floodwaters. This concept is referred to as flood emergency response.

To help minimise the flood risk to future occupants, it is important that developments consider flood emergency response. There are two main forms of evacuation that may be adopted:

- Evacuation: The horizontal evacuation of occupants from the floodplain before the properties and/or evacuation routes becomes flooded;
- Shelter-in-place: The vertical evacuation of occupants in a building to a level higher than the PMF level who then shelter from the flood until it is safe to return to the ground floor and external areas.

Within the NSW Flood Prone Land 2021 package, flood emergency response requirements are included in both the standard LEP clauses (both mandatory and optional) and the planning proposal requirements. It is also discussed in the guideline and other documents in the package. Its significance is that if a suitable flood emergency response is implemented that removes occupants from any flooding, then the residual flood risk of a site can be reduced, even potentially for intensified development on the floodplain.

Effective flood emergency response is developed on a site-by-site basis; therefore it is difficult to assess its feasibility for a high-level planning proposal review such as this. However general commentary on the planning proposal and the opportunities for flood evacuation or shelter-in-place are discussed as follows.

5.8.1 Flood Behaviour

The PMF event is typically adopted as the design event for flood emergency response as it represents the estimated upper limit of flooding albeit extremely rare flooding. The typical AEP of the PMF in urban areas like the study area is 1 in 1 million AEP to 1 in 10 million AEP.

This discussion of flood emergency response in this assessment focusses on the PMF, particularly H1-H6 hazard in this event as these hazard categories relate to vulnerable occupants in the floodplain. As a result, PMF H1-H6 hazard mapping has been prepared for the study area included in the next sub-sections.

Based on NSW SES advice, horizontal evacuation is typically the primary recommended flood emergency response for all new developments on flood prone land. However if horizontal evacuation is not feasible due to flash flooding and the very short warning times then shelter-in-place is a feasible alternative. Particularly if the period of isolation is a matter of hours.



5.8.2 Evacuation Timeline

The Australasian Fire and Emergency Service Authorities Council (AFAC) defines flash flooding as:

Flash flooding may be defined as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment. Flash flood environments are characterized 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 flooding affectation of the Cooks River where the Campsie Precinct is located would be defined as 'flash flooding' based on the above definition. The NSW SES evacuation timeline assesses the suitability of evacuation based on two considerations:

- **Available time:** For flood evacuation to be effective, a warning system and procedure needs to be prepared that ensures all occupants can be evacuated prior to flooding occurring. For flash flooding environments such as the Cooks River and overland flooding areas, the amount of time from the onset of rainfall to flooding occurring is typically sub-hourly, which does not provide a sufficient time for horizontal flood evacuation except on the fringes of the floodplain. Also for flash flooding there are not typically stream gauges installed within trunk drainage systems, unlike in large riverine catchments where streamflow gauges can detect flooding in the upper catchment and provide an additional warning time. The only opportunity for advanced warning times would be to implement a system like FloodSmart Parramatta which relies on continuous real-time modelling of forecast rainfall to provide flood warnings. Even then, horizontal evacuation within the study area may be vulnerable to any incidents on evacuation routes which trap drivers and passengers on flooded roads.
- **Required time:** The time needed to evacuate all occupants considering time for acceptance of occupants of the need to evacuate, travel time, and traffic and other delays. In this instance, as shown in the flood maps in **Appendix A**, the Cooks River floodplain for the foreshore area and overland flow areas, even in the PMF event is relatively narrow. This is advantageous for evacuation as it means that the distance to land higher than the PMF is short and travel time is also likely to be short, even if pedestrian evacuation is required instead of vehicular evacuation. Review of flood extent mapping suggests most flooded areas can access land above the PMF within several hundred metres of the site along public roads. This is in contrast to large riverine floodplains where land higher than the PMF may be several kilometres away and along heavily used regional evacuation routes which would significantly increase the required time.

For shelter-in-place, the same flash flooding conditions apply as discussed above for horizontal evacuation. However, under shelter-in-place the time required to evacuate vertically within a building to a level higher than the PMF could be several minutes only.

5.8.3 Evacuation Routes and Flood Timing Review

As part of this assessment, evacuation routes have been mapped for the study area in **Figure 5-11** to **Figure 5-14**. As discussed above, a review of PMF extents shows that in most instances land higher than the PMF is typically within several hundred metres of most development sites. Furthermore, it appears that for most of the floodplain, the evacuation routes would be defined as rising road access meaning that evacuation would be along a route where the flood depth progressively decreases as one travels along the evacuation route. This is viewed as a lower flood risk than flood islands where



evacuation routes are cut before flooding of the site occurs. In these instances, horizontal flood evacuation is more difficult.

In addition, a flood timing review has been conducted based on available existing scenario results from the TUFLOW hydraulic modelling. The assessment considered all key road locations within the study area, with local low points in the roads selected conservatively along potential evacuation routes from the development sites. The locations of the flood timing review points are shown in **Figure 5-11 to Figure 5-14**.

For each point, flood timing review focussed on two components using all PMF duration events from 30 minute up to 24 hour:

- Rate of rise – Determines the time available from onset of rainfall for emergency response to be coordinated. At all locations the time to peak of flooding is less than 1 hour in the PMF event.
- Duration of flooding – Determines the period of isolation for sheltering residents. For this assessment it has been assumed that flooding depths less than 0.3 metres are negligible flood risk and are trafficable, guided by the H1 hazard threshold depth (refer to **Section 3.8.2**), a hazard which is safe for all vehicles (even small vehicles), pedestrians and buildings. The maximum period of flooding for each road crossing is labelled with the colour coded inspection points shown in **Figure 5-11 to Figure 5-14**. The methodology to determine the maximum flooding duration has been calculated as follows:
 1. From the start of the model event, using PO csv results, the time to flooding receding to less than 0.3 metres depth has been calculated for each PMF duration event.
 2. For each inspection point, these have been located in the low point in the road corridor, often near the edges of the road. For critical locations, review of the road cross section has been conducted and the representative road level has been guided by the crest of the road, with the 0.3 metre depth and duration recalculated from this level. This more detailed analysis has only been conducted within the evacuation routes of the intensified sites, therefore road flooding durations for other areas in the precinct may be overestimated based on values shown in the current figures.

Examples of PMF time series results in the Cooks River waterway are shown in and for the upper (north of Byron St) and lower sections (east of Gordon Street) of the Cooks River respectively. The durations of flooding for these Cooks River waterway locations is significantly longer, with deeper depths than experienced at any of the road crossing locations assessed. As an example, the road crest level at the Byron Street lowpoint is 6.0m AHD, which has been marked up on the adjacent river time series below to illustrate how Byron Street flooding at that location has been estimated to be 10.5 hours for the PMF 12 hour event.



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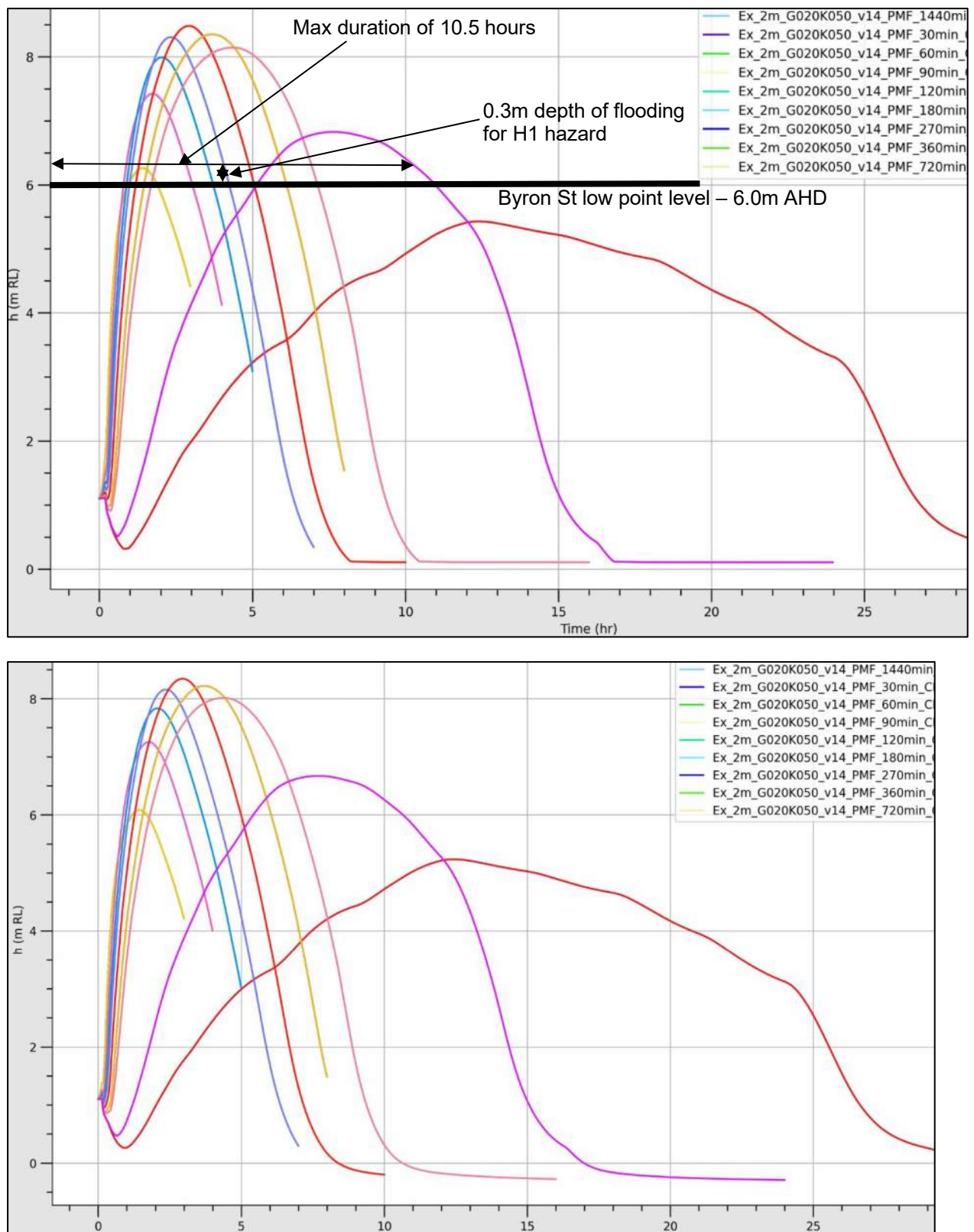


Figure 5-10 PMF Water Level Time Series for All Durations (30m, 60m, 90m, 120m, 180m, 270m, 360m, 720m and 1440m) at Cooks River Upstream near Byron St (Top) and Downstream near Gordon St)



5.8.4 Evacuation Feasibility

Evacuation feasibility has been assessed based on two criteria:

- Whether there is a continuous rising evacuation route from the site to flood-free land;
- Whether that route remains below H2 hazard category in the PMF event.

As shown in **Figure 5-11** to **Figure 5-14**, most parts of the precinct proposed for intensification or land use change have access to flood-free evacuation routes. These are mapped as pink arrows in the figures. However, certain sites do not meet this requirement and are identified as Emergency Response Key Areas. None of these sites are proposed for intensification or change under this planning proposal.

For some of the sites which would be evacuation constrained due to flooding of the access roadway, it is recommended that an alternate site access point be considered if the frontage road is not a suitable flood evacuation route due to significant flooding of the road. In these instances where rear site access will produce improved evacuation routes for any future development, potential site amalgamation could provide improved flood risk outcomes and should be encouraged where feasible.

5.8.5 Shelter-in-Place Background

Shelter-in-Place is considered a feasible emergency response, particularly for multi-storey residential developments in flash flooding areas such as those proposed within the Precinct. This type of development can elevate the majority of the higher-risk residential use above the PMF level and can make allowance for shelter-in-place refuge and vertical evacuation for ground floor occupants. In this way, intensified development offers more shelter-in-place opportunities as it will likely provide more floor space for refuge above the PMF level compared to an existing single-storey residential dwelling.

Aside from the timeline considerations discussed above, there are two other key concerns for shelter-in-place – flood isolation period and structural stability of the building.

The period of isolation refers to the amount of time a site would be flooded, restricting occupants in refuge from leaving the property or accessing emergency services in the event of a medical emergency. As the Cooks River mainstream and overland flow floodplains are flash flooding environments, flooding often subsides quickly. Therefore, most flooding within the precinct is expected to be of short duration.

In accordance with the 2025 Shelter-in-Place Guidelines, PMF isolation periods of up to 12 hours from the onset of rainfall are generally considered appropriate for shelter-in-place, while durations exceeding 12 hours would be considered higher risk. In a change from the draft guideline, duration of isolation in the final guideline is calculated from the start of the onset of the PMF rainfall event. The likely assumption in this revised criteria is that it would be unsafe to travel during a PMF rainfall event, therefore residents would be 'isolated' from the start of the rainfall event rather than when the flooding of any specified evacuation route commences.

The H1–H6 hazard category curves presented in **Figure 3-19** include two hazards (H5 and H6) that relate to potential structural instability. Development in areas subject to H5 or H6 hazard must consider specific structural design to withstand PMF forces, in accordance with the Shelter-in-Place



Guidelines and engineering best practice. For areas outside H5–H6, structural stability can generally be assured with standard design.

For the above considerations, the following sub-sections assesses the flood behaviour of the study area to confirm at a high-level the feasibility of SiP in accordance with the requirements of the 2025 SiP Guideline.

5.8.6 Shelter-in-Place (SiP) Feasibility

Where flood-free evacuation cannot be reliably achieved in flash flooding environments, the feasibility of shelter-in-place has been assessed in accordance with the final Shelter-in-Place Guidelines for Flash Flooding (2025) published by the Department of Planning, Housing and Infrastructure (DPHI). These guidelines establish a structured 10-point framework for assessing whether shelter-in-place is an acceptable emergency management strategy, especially in highly urbanised flash-flood environments such as Campsie.

To respond to recent commentary, this section now adopts a structured format that aligns directly with the ten SiP criteria, addressing each within the context of this study. Responses to the ten requirements of the SiP guideline for the Campsie Town Centre are included in **Table 5-3**.

Table 5-3 Review of Study Area Suitability for Shelter-in-Place Based on 2025 Guideline Requirements

Criteria (Shelter-in-Place Guidelines 2025)	Campsie Precinct Response
1. Alignment with existing emergency management strategies (NSW SES/local plans)	The precinct currently lacks a dedicated SES shelter-in-place designation. However, the FIRA provides precinct-level guidance to inform future strategic planning and integration into emergency response frameworks.
2. Evacuation feasibility assessed and determined unachievable	Evacuation is constrained at several locations due to PMF road inundation. Critical access routes including Canterbury Road and Fifth Avenue are affected in PMF scenarios, limiting off-site evacuation options. The flash flooding nature of the study area for both overland flow and mainstream flooding, means that there is less than 1 hour from onset of rainfall till significant flooding of all assessed road locations in PMF short duration events. Therefore, there is insufficient time available for evacuation, meaning it is not feasible and unachievable.
3. Presence of sensitive, hazardous, or critical land uses	The study area includes residential intensification zones but does not involve new medical, emergency services, or other highly vulnerable uses that would preclude shelter-in-place.
4. Greenfield development exclusion	Not applicable – the Campsie precinct is an established urban area undergoing brownfield redevelopment.
5. Flash flood warning systems in place	At present, no formal flash flood early warning system exists for this area. This limits early mobilisation. Shelter-in-place is considered cautiously for short-duration, high-density urban flooding contexts. Flood warning systems should be designed on a site-by-site basis until a regional warning system is implemented for the area.
6. Community risk communication	Further community awareness and SES-endorsed emergency communication strategies are recommended. Through development controls at DA stage, there is an opportunity for future developments to be required to develop site-specific Flood Emergency Response Plan that is released to residents with



Criteria (Shelter-in-Place Guidelines 2025)	Campsie Precinct Response
	ongoing training and information sharing. Cannot be assessed in further detail at planning proposal stage.
7. FIRA includes evacuation feasibility testing	Completed – the current FIRA identifies key road sections inundated under PMF conditions and notes the limited viability of area-wide evacuation. PMF short duration events flood all roads in less than 1 hour confirming flash flooding and evacuation not being possible.
8. Flood behaviour, isolation and hazard analysis (with PMF and CC): a. flash flooding is the only flood risk present at the site, whether it be from overland flooding, local creek or riverine flooding b. the flooding occurs within less than 6 hours from the commencement of causative rain and the duration of shelter in place due to isolation by floodwaters is less than 12 hours from the commencement of rainfall c. the development is not subject to high hazard flooding (e.g. floodways, high hazard H5 or H6 areas) or surrounding roadways are not subject to high hazard flooding	(a) Flash flooding is the only risk, including overland flow and local catchment surcharge. Review of timing for Cooks River mainstream flooding confirms that it is also flash flooding in nature in these upper reaches of the river, with minimal time available to evacuate, and a relatively fast falling limb as well. (b) Detailed review of road flooding timing shows flooding in the PMF occurs within 1 hour of rainfall onset and lasts < 12 hours from the onset of rainfall at most locations. The duration of flooding at each key road location (in hours) is labelled in Figure 5-11 to Figure 5-14. It shows that at all key road locations for evacuation routes flooding is less than 12 hours. The one exception is the evacuation route on the corner of Nowra Street which has a maximum flooding duration of 12.2 hours. Given the approximate nature of the analysis and being within 12 minutes of the stated threshold from the guideline, it is at Council's determination to confirm if this is a suitable duration of flooding. There are also two locations on Canterbury Road that exceed 12 hours as well, however the development sites to the south would utilise Fore St and Dibbs St and therefore are not reliant on these locations on Canterbury Rd. All other locations with durations in excess of 12 hours are not required evacuation routes for the area of proposed intensification in this planning proposal. (c) It is not clear from this requirement the design event these requirements are in reference to. For flood affectation for development sites: • All development sites are negligibly by floodway up to at least the 1% AEP. There is only minor floodway affectation of development sites in the 0.05% AEP event (refer to Figure A18 of Appendix A). • All development sites are affected by H4 or less hazard up to and including the 0.05% AEP event. • Only in the PMF event are sites affected by H5 hazard. H6 hazard does not significantly affect proposed development sites even in a PMF event. For flood affectation of access roads to development sites: • All access roads for development sites are at most marginally affected by high hazard in all events up to and including the 0.05% AEP (refer to Figure A23 of Appendix A); • There is high hazard affectation of access roads in the PMF event particularly for the Cooks River mainstream affected portion of the study area in a PMF event. Overall, it is considered that the conditions of item 8.c are generally satisfied, further discussion is included below.
9. Integration into emergency plans and site communication strategy	To be developed at DA stage. At this planning level, only indicative guidance can be offered. Site-based Emergency Response Plans will be necessary for implementation. Council can specify these requirements through DCP controls.
10. Secondary risks addressed (medical, fire, well-being)	These are discussed briefly under Section 5.8.9 . These should be evaluated in further detail at DA stage. It is expected that buildings proposing shelter-in-place must consider elevated refuge design, power continuity, emergency supplies, and access to medical/emergency support.



In conclusion, the results of this SiP review, in light of a full PMF event suite and hazard mapping, suggest that shelter-in-place is a broadly feasible emergency strategy across much of the Campsie Town Centre precinct. The proposed areas of intensification for the most part avoid the Emergency Response Key Areas outlined in the following section. Final suitability should be confirmed at the DA stage, based on site-specific duration, hazard, and structural assessments.

5.8.7 Emergency Response Key Areas

Emergency Response Key Areas are locations where development may be significantly constrained due to:

- Lack of viable evacuation routes, areas that can be classed as a flood island under the provisions of the Flood Emergency Response Classification of Communities (FERCC);
- Long-duration flooding of road evacuation route (>12 hours);
- High PMF hazard (H6 hazard affected sites).

As shown in **Figure 5-11** to **Figure 5-14**, most Emergency Response Key Areas fall outside the proposed intensification or rezoning areas. However, some of the key locations for the planning proposal are discussed further below:

- Spot 1: The low point on Byron Street that fronts these properties has a duration of flooding of 10.5 hours, getting close to but not exceeding the 12-hour limit of the SiP Guideline. However a significant portion of these sites is affected by H6 hazard, meaning that Shelter-in-Place refuges would be difficult to confirm structural stability in a PMF flood event.
- Spot 2: The evacuation route for these properties has a duration of flooding of less than 7 hours. However a significant portion of these sites is affected by H6 hazard, meaning that Shelter-in-Place refuges would be difficult to confirm structural stability in a PMF flood event. Also these sites are affected by both the local OLFP and Cooks River mainstream flooding, with flooding of these sites in event frequent (5% AEP) events.
- Spot 3: This site overlaps with both land use change and intensification. As noted in previous sections, the eastern portion of the site is not proposed for redevelopment. It would also not be eligible for redevelopment as it is H6 hazard affected and not suitable for SiP. The western portion is H5 hazard affected meaning that structural design could facilitate SiP refuge, however the duration of flooding of the main evacuation route is 12.2 hours, 12 minutes longer than the threshold of the SiP guideline. Regarding both duration and hazard in a PMF event, this site is near the limit of acceptable thresholds for SiP eligibility. Proceeding with this site for intensification should be determined by Council's decision making on flood risk for SiP in its role as consent authority.
- Spot 4 has H6 hazard affectation and durations of flooding on Canterbury Road in excess of the 12 hour limit, therefore would not be considered eligible for SiP. This site is not proposed for intensification in the current planning proposal and based on this conclusion would not be eligible.

Most other areas of the precinct proposed for development fall well within the short-duration (<12hr) PMF exposure category and are not impacted by H6 hazard (nor H5 hazard in a lot of cases). Therefore, shelter-in-place may be conditionally supported at the strategic level, subject to DA-level assessment, robust design measures, and integration with emergency response planning.



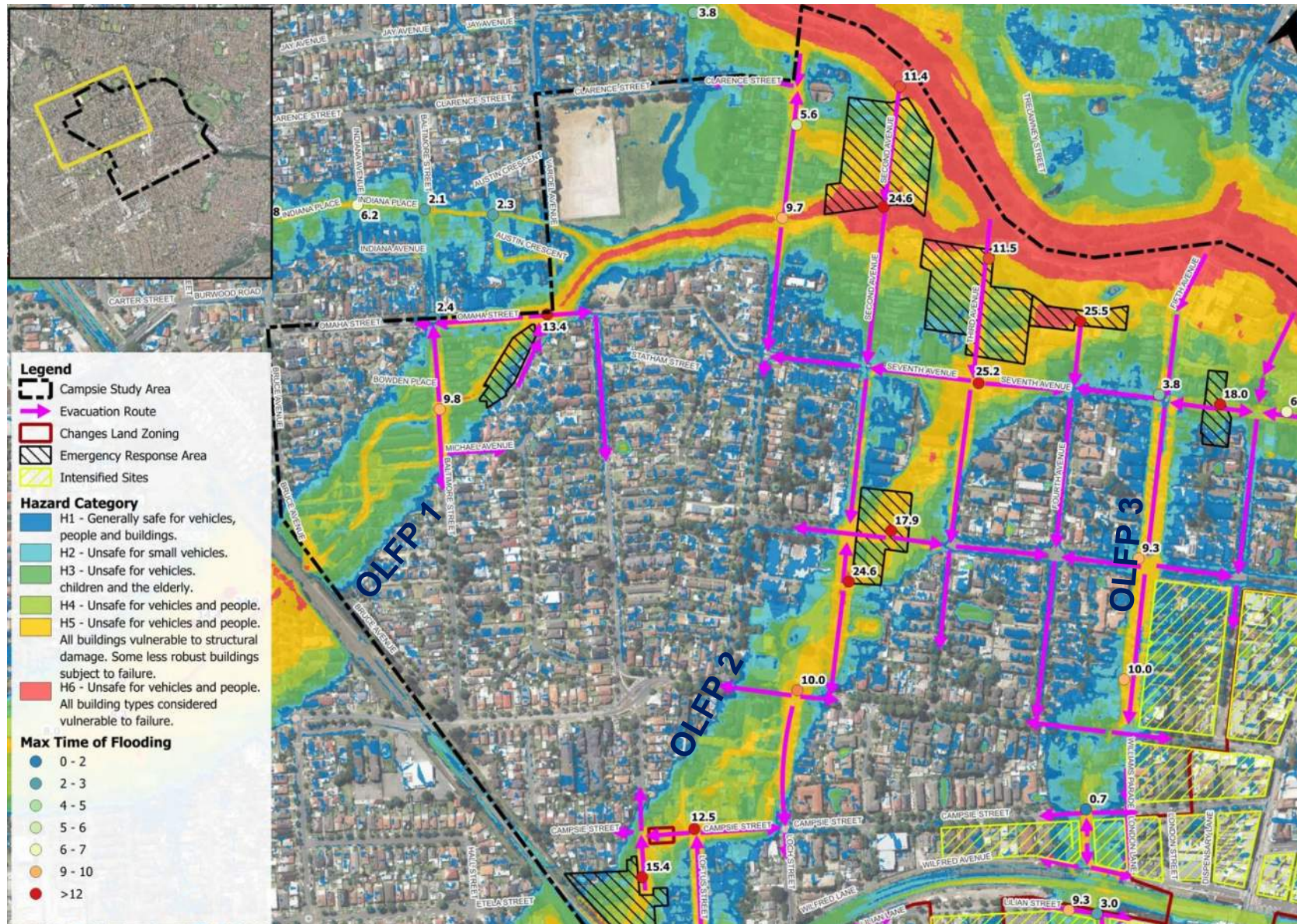


Figure 5-11 PMF H1-H6 Hazard Categories with Evacuation Route Mapping, Flood Duration Inspection Points and Potential Flood Emergency Response Areas – Campsie Precinct (Northwest Part)



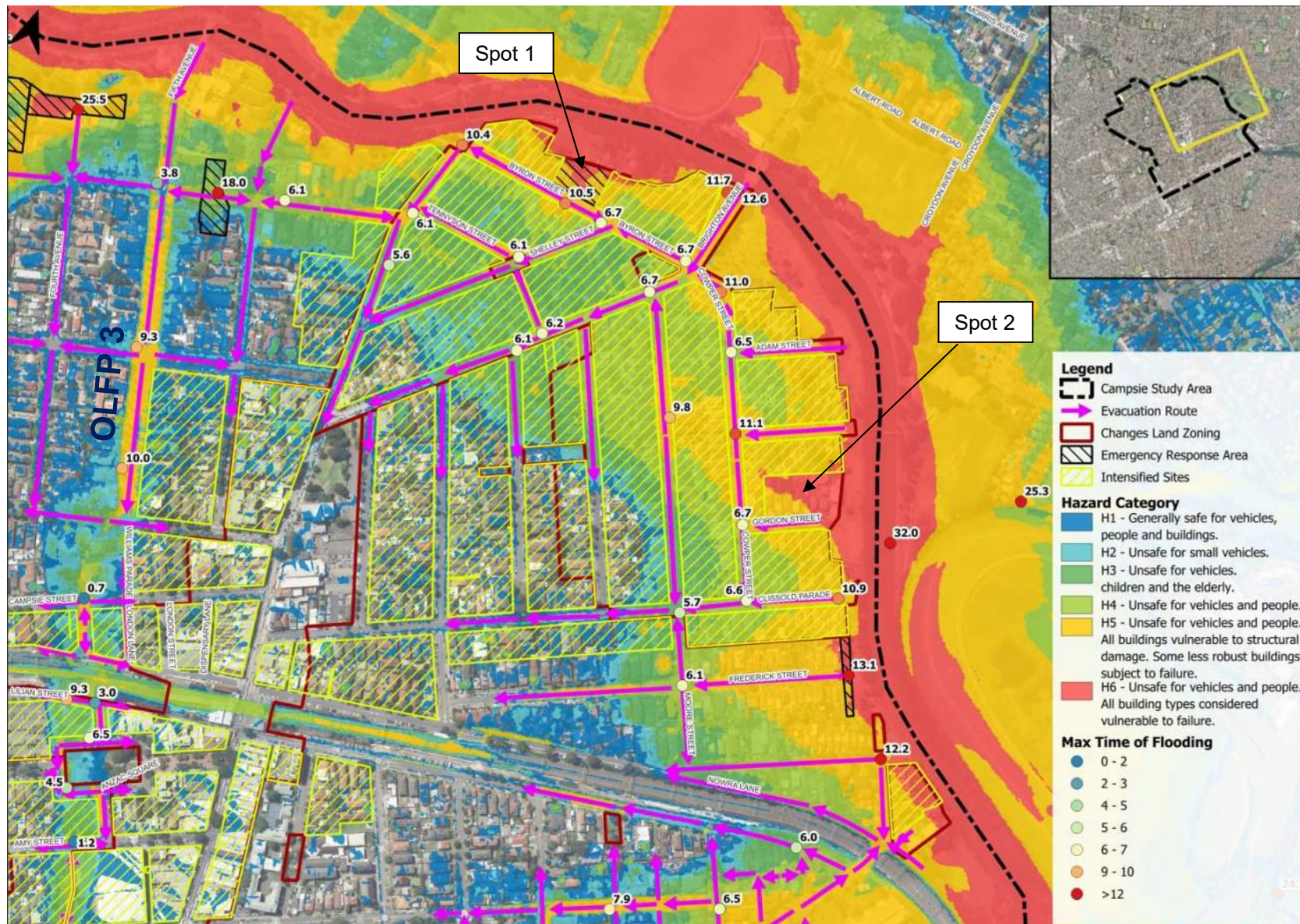


Figure 5-12 PMF H1-H6 Hazard Categories with Evacuation Route Mapping, Flood Duration Inspection Points and Potential Flood Emergency Response Areas – Campsie Precinct (Northeast Part)



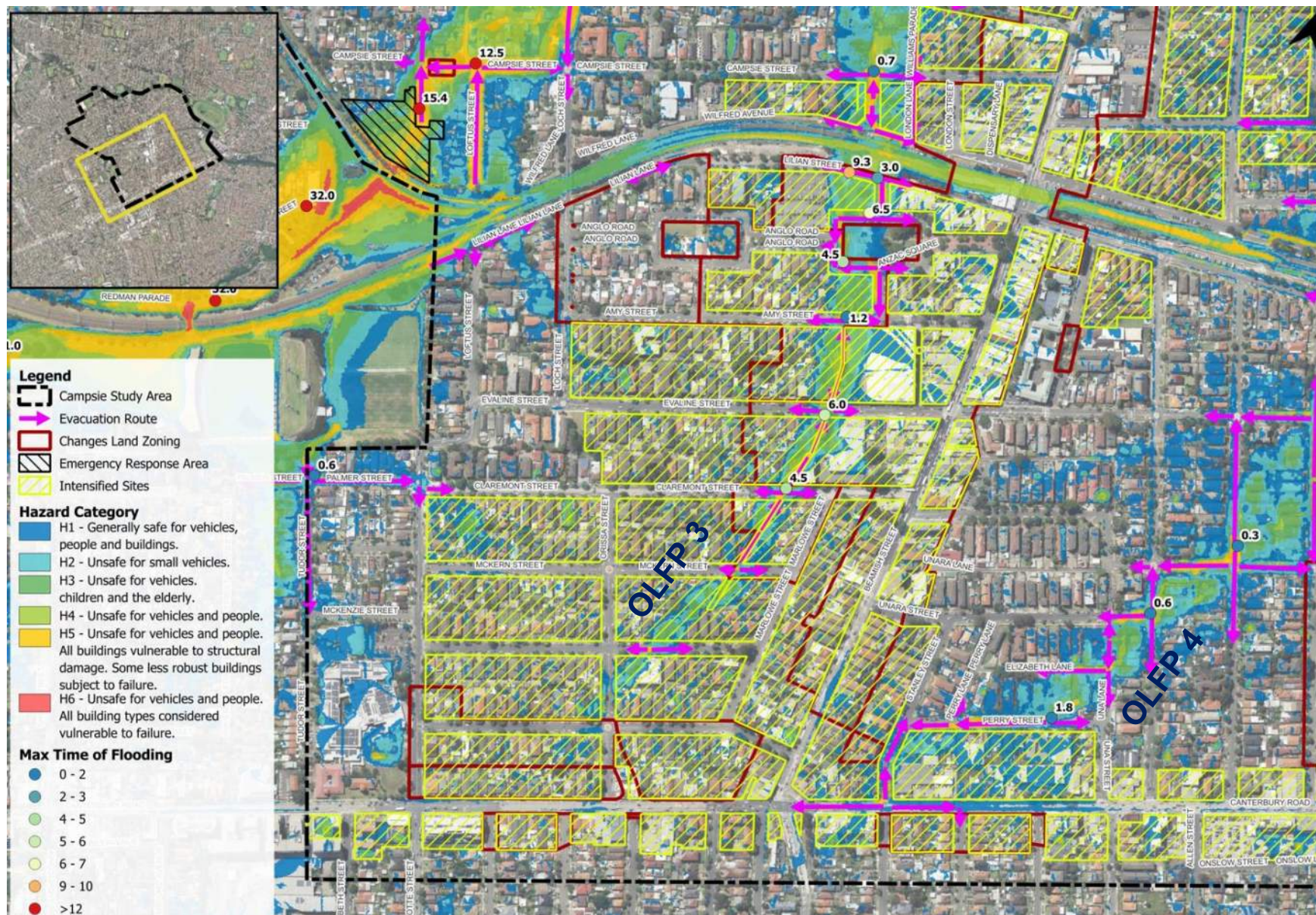


Figure 5-13 PMF H1-H6 Hazard Categories with Evacuation Route Mapping, Flood Duration Inspection Points and Potential Flood Emergency Response Areas – Campsie Precinct (Southwest Part)



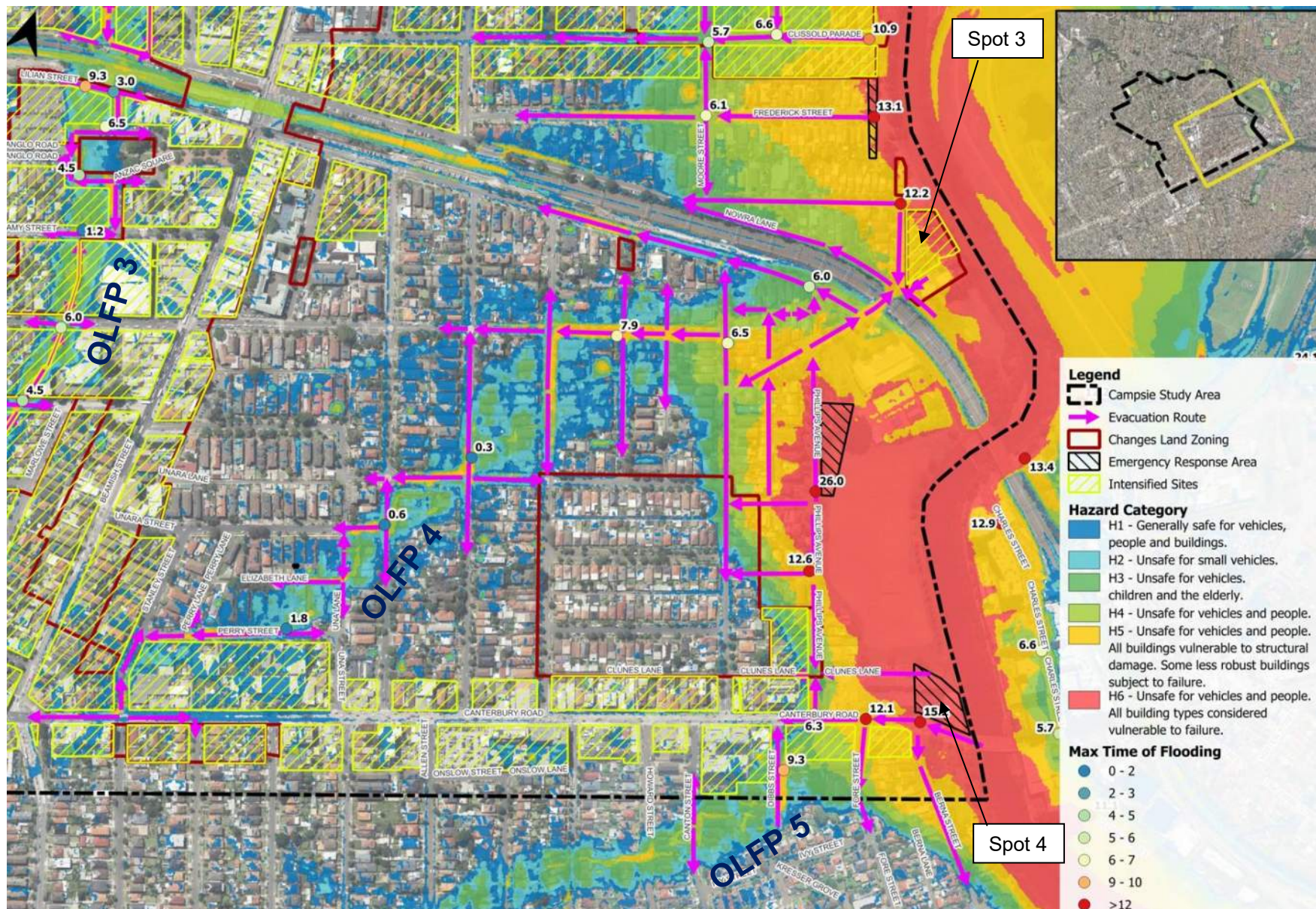


Figure 5-14 PMF H1-H6 Hazard Categories with Evacuation Route Mapping, Flood Duration Inspection Points and Potential Flood Emergency Response Areas – Campsie Precinct (Southeast Part)



5.8.8 Flood Emergency Response in Land Use Planning

Section D4 of the FRM Guide EM01 outlines two decision-making frameworks for development:

1. Future community growth directions – This includes identifying areas where new development does not adversely impact on existing development and where flood risks to the new development and its users can be effectively managed. This may inform the making of an LEP by rezoning areas to support greenfield development or redevelopment and the inclusion of development controls required to manage the flood and EM risk to development within these zonings in a DCP. This forms the basis of Figure 20 of the Guide.
2. Development consistent with current zonings – This relates to the strategic application of development controls in the DCP in existing zoned and developed areas. For example, controls may be tailored to minimise risk to infill development and ‘one off’ single dwelling redevelopment and their occupants within an area. This is the basis of Figure 21 of the Guide.

The decision-making framework for type 1 (Figure 20 of the Guide), notes that for any greenfield site or strategic rezoning, shelter-in-place is not viable and evacuation is the only form of emergency response, otherwise ‘reconsider development in this area’. However, the framework for type 2 (Figure 21 of the Guide), notes that any infill development ‘consistent with current zoning’ shelter-in-place may be suitable if ‘consider restricting development types and apply controls’.

Based on this framework, and given that due to the flash flooding nature of the study area meaning that evacuation may not be relied upon exclusively, this would mean that any development sites without flood free access from the floodplain may not be eligible for rezoning.

However, development type whether that be within current zoning or rezoned infill development, is not a considered determinant of the flood risk associated with shelter-in-place. Therefore for infill rezoning similar to that proposed for Campsie, a broader consideration of flood risk is recommended. This approach is consistent with flood risk based assessment is recommended within Planning Circular PS24-001 and other relevant guidance.

To confirm potential impacts on the proposal of assessing the suitability of shelter-in-place, a review of development sites with direct access to PMF flood free land has been conducted. Conservatively, if evacuation is not possible in flash flooding areas, and shelter-in-place were not considered feasible based on EM01, then any development site without direct access out of the PMF extent would not be eligible for rezoning. The development sites this would apply to are shown as Brown hatched in **Figure 5-15** across the entire study area noting that not all of them are included in the area of intensification for this Planning Proposal. In **Figure 5-16**, only affected sites within intensification areas of the planning proposal are shown:

- **Yellow hatching** – both land use change and intensification;
- **Red hatching** – land use change only;
- **Pink hatching** – intensification only.

As shown, given the number of sites potentially affected, this would have an impact on the proposal. As a result, if shelter-in-place is not deemed possible and these affected sites would not be able to rely on evacuation, then a conservative interpretation of the flood risk may limit the development potential of the sites shown in **Figure 5-15**. This is considered a conservative assessment of the flood risk, and is not supported by Stantec at this time, however this review is included as a potential worst-case assessment of the potential limitations flooding may place on the proposed development.



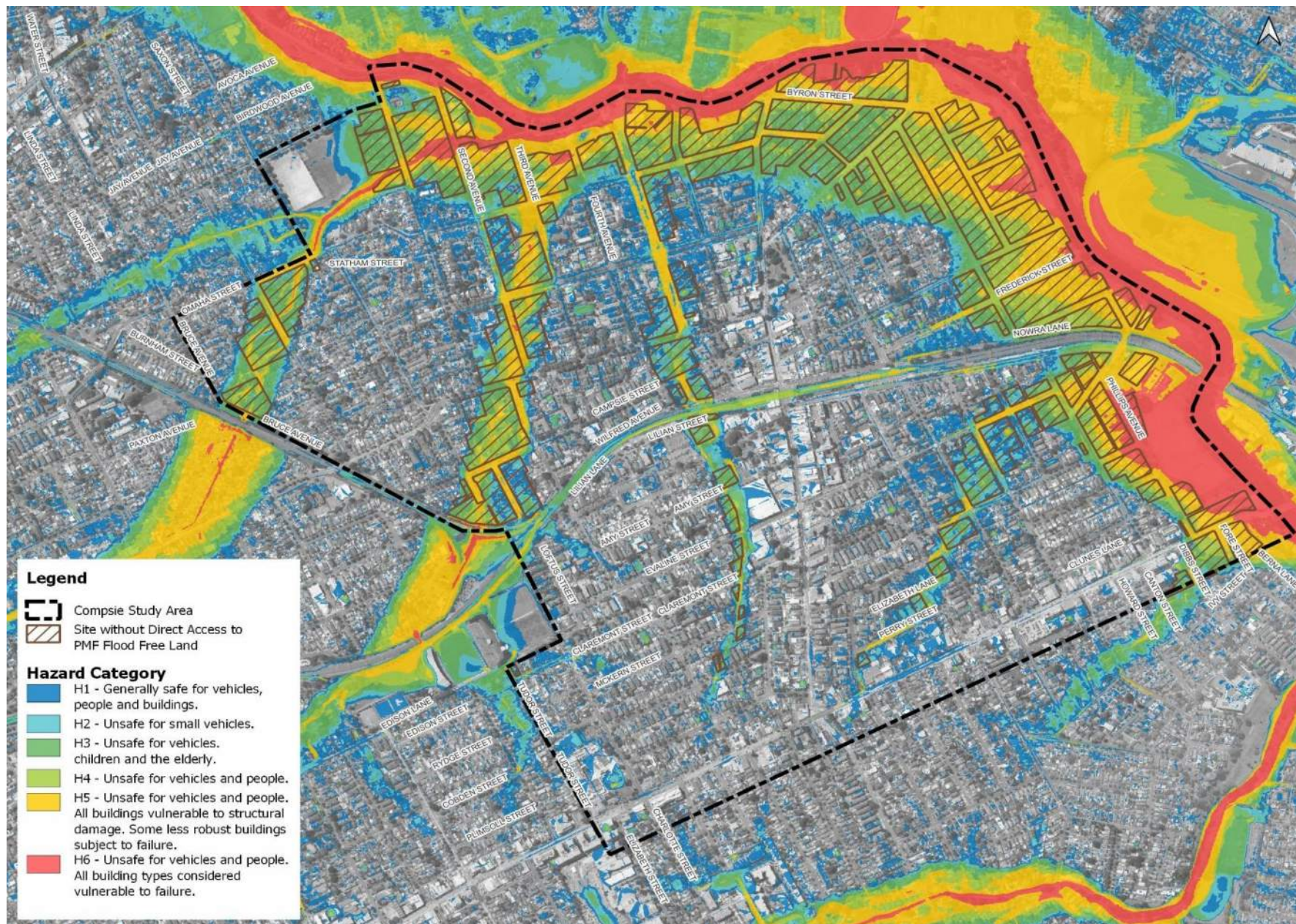


Figure 5-15 Sites Without Direct Access to PMF Flood Free Land – with PMF H1-H6 Hazard

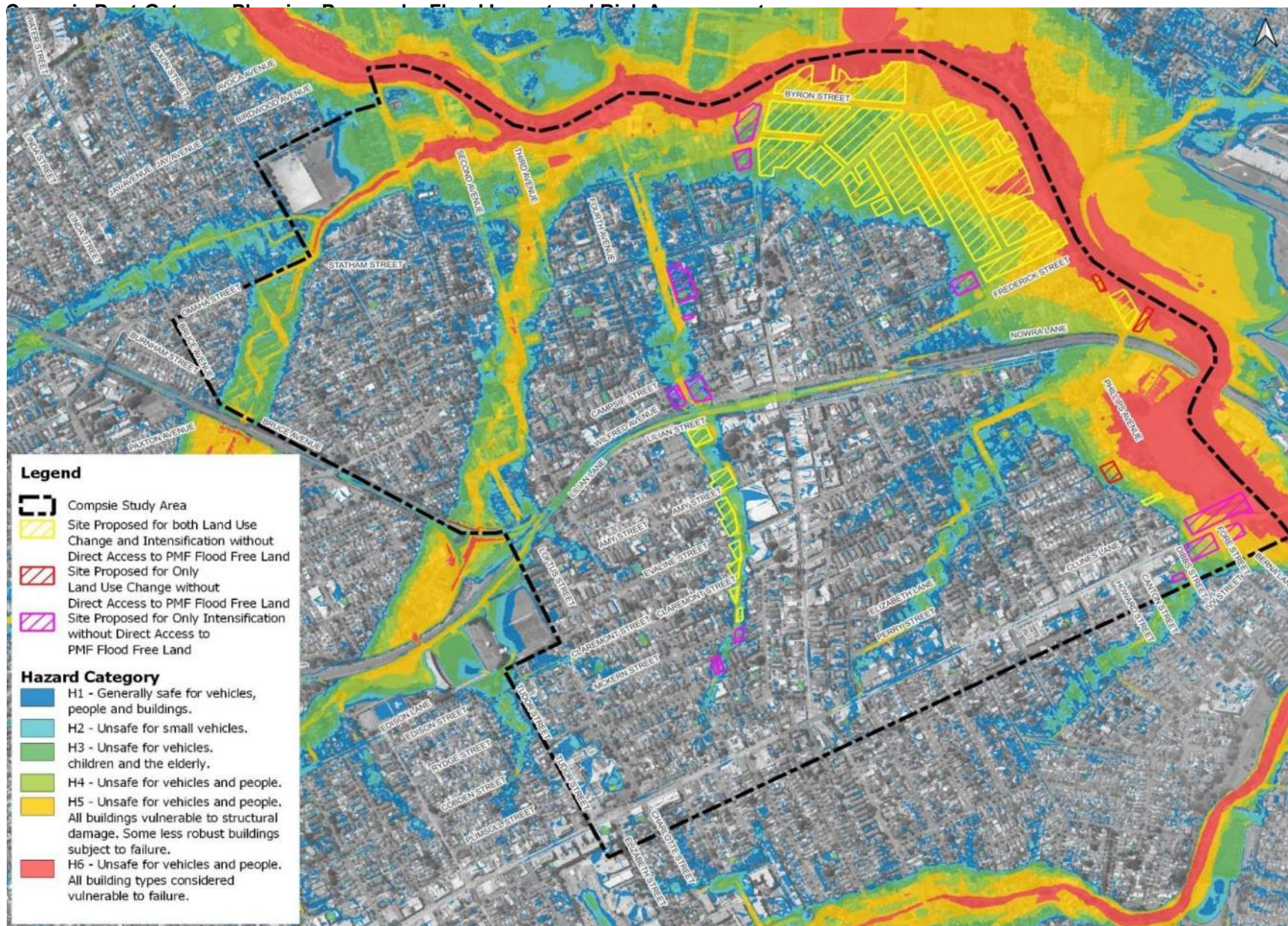


Figure 5-16 Sites Proposed for Changes to Land Use or Intensification Without Direct Access to PMF Flood Free Land – with PMF H1-H6 Hazard



5.8.9 Flood Risk Implications of Shelter-in-Place and Secondary Risks

One of the requirements for planning proposals within Ministerial Direction 4.1 is that:

... not 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.

Evacuation for most sites is a short distance away, with limited sites able to access any one of the evacuation routes. However, a consideration is whether it is safer for occupants on levels higher than the PMF to remain safely within a building than to add to the number of persons attempting to evacuate by road. It is possible that the number of vehicles queued on multi-storey basement driveways waiting to exit on to possibly crowded local roads exposes the occupants to greater flood risk than if they remained in place.

Another advantage of multi-storey residential buildings is that a flood emergency response plan is routinely developed for such developments and that the bodies corporate provide a means to implement and maintain the plans. However it is noted that both NSW SES and NSW DCCEEW have previously provided comments noting that site-based FERPs are not supported by either organisation as a primary emergency response mechanism. Under these circumstances, it is possible that intensified development may not cause a significant additional strain on emergency services.

As noted in the SiP Guideline, secondary risks of shelter-in-place, such as occupants entering floodwaters or experiencing medical emergencies, must also be considered. However, when comparing the relative risks for PMF flash flood scenarios, shelter-in-place is often a lower-risk option than attempting vehicular evacuation during hazardous conditions. Specifically (with supporting literature review included in **Appendix C**):

- For short duration isolation, the direct flood risks to residents on flood free land, or in a multi-storey building above the floodplain are in essence the same, assuming that structural stability can be assured. As noted in various sources cited in **Appendix C**, the vast majority of flood fatalities are a result of drowning with only a minority a result of secondary risks. There was no data cited in these sources as to the number of fatalities from secondary risks for properties elevated above the PMF, for short durations and for appropriately designed and resourced shelters. As stated within DEFRA and Environmental Agency (2009) a survey of 1,123 found that “22 per cent of people that failed to reach a concrete or brick structure died whilst everyone who sought refuge in such structures survived (Bern et al., 1993)”.
- As noted above, due to lack of available time, it is likely emergency services will be unable to mobilise and coordinate any response until PMF flash flooding has passed. Furthermore, self evacuation to medical services will not be possible as the risks of driving in PMF rainfall, and the widespread nature of PMF flash flooding ensures almost all evacuation routes in the LGA will be flooded. Therefore the temporary isolation of residents from emergency and medical services would apply to both flood affected shelter-in-place residents and flood free properties throughout the LGA. As noted in **Appendix C**, DEFRA and Environmental Agency (2009) notes that as a simple rule, if emergency services do not have time to coordinate then shelter-in-place is the ‘safer’ approach. Though not stated in the cited reference, this would be particularly true for dwellings elevated above the PMF level.



- The risk of some residents entering floodwaters will remain whether residing on flood free land or in a flooded multi-storey development. The flood affectation of the site, the inability to leave the driveway, the ability to establish a site-specific flood emergency response plan, and targeted community education program for residents of flood affected buildings means that it is possible this risk is equal or lessened in buildings surrounded by floodplain. As noted in DEFRA and Environmental Agency (2009), human behaviour in evacuation procedures also results in risky decision-making and people not following instruction. Risks of people entering floodwaters exists for flood evacuated residents, sheltered flood affected residents and even residents in flood free lands.

Regarding the requirements of item 8.c of the SiP Guideline relative to this study area:

- As noted in **Table 5-3**, it is not clear from the SiP Guideline which design event the hazard requirements for development sites relate to. In this study area, the development sites are affected by less than H5 hazard in all events up to and including the 0.05% AEP event (1 in 2,000 year event). Being suitably low hazard up to and including this rare event is expected to suitably address this concern.
- It is only in the PMF event that development sites are H5 hazard affected. By definition, structural stability in H5 hazard areas can be addressed through suitable structural design. Therefore precluding development sites because they are H5 hazard mapped area in a PMF event at this planning proposal phase is not considered suitable. Rather at the DA stage or as conditions of consent, the structural stability of SiP refuge structures can be assessed in better detail by Council as consent authority, reviewing structural stability under PMF flood and debris loading.
- The requirement for low hazard affected access roads has been considered addressed for all events up to and including the 0.05% AEP event. It is only in the PMF event that significant lengths of access roads are affected by high hazard flooding.



5.8.10 Outcome

This high-level review of flood emergency response considerations suggests that shelter-in-place should be feasible for development sites of the rezoning. The flash flooding regime means that evacuation may not be a reliable emergency response as there is insufficient time to coordinate evacuation of all residents. With an inability for emergency services to assist during a flash flood, shelter-in-place provisions should be feasible without a need to increase the burden on emergency services or any regional evacuation routes. The duration of isolation of less than 12 hours from the onset of rainfall, and through suitable design for structural stability the risks for shelter-in-place should be feasible.

For context, this means that flooding isolation throughout the study area will be less than 12 hours in all events up to and including the PMF which for a catchment of this size has a probability of 1 in 10,000,000. This short maximum duration of flood isolation and the associated secondary risks should be considered suitable in the most rare of flood events (for a catchment of this size a PMF is 1,000 times less likely than a PMF for the largest riverine catchments, refer to **Appendix C** under C.1). In a suitably flood protected, stable and well-resourced shelter, the coincident probabilities of a medical emergency or other kind of emergency in this small window of time during such a rare flood event is incredibly unlikely.

Therefore, the rezoning is compatible with the flood emergency response guidance provided in the Ministerial Direction 4.1. This is a broadscale review of potential for the study area. The identification of appropriate flood emergency responses needs to be undertaken on a site-by-site basis and should be applied through Council's role as a consent authority.

Based on the framework within FRM Guide EM01, shelter-in-place may not be possible for an infill rezoning. However, it is considered that potential intensification be assessed on its merit as is encouraged in the 2023 FRM Manual (and previously the 2005 FDM). This flood risk-based review reflects the advice from the latest Planning Circular PS24-001. This analysis highlights a key point, there is existing capacity and flood risk in infill development sites, unlike greenfield development. Furthermore, consideration of non-direct risks suggests flood risk should be in-line with flood free developments due to the PMF flash flooding nature of the study area.



5.9 Special Flood Consideration and Vulnerable Developments

5.9.1 Planning Policy Context

Under Ministerial Direction 4.1 and the optional LEP Clause 5.22, Special Flood Consideration (SFC) areas refer to land between the FPA and the PMF extent. These areas require additional planning scrutiny due to elevated flood risk in rare events.

In these areas, vulnerable development should only be permitted where emergency response (evacuation or shelter-in-place) is demonstrated to be safe and feasible.

5.9.2 Vulnerable Uses Affected

The following vulnerable land uses should not be permitted in areas without reliable flood response:

- Childcare centres
- Hospitals and medical facilities
- Seniors housing and aged care
- Boarding houses and hostels
- Residential care, respite, or group homes

The Planning Proposal includes one vulnerable development — a medical precinct near Canterbury Hospital. This site is outside mapped flood hazard areas and Emergency Response Key Areas and is therefore considered suitable for its proposed use.

5.9.3 Site-Specific Considerations

Based on the emergency response mapping and duration analysis:

- **Spot 3:** Not suitable for vulnerable development due to high hazard (H5–H6), long PMF flood duration, and lack of evacuation. Rezoning should be reconsidered or additional controls applied.
- **Spot 4:** Not suitable for vulnerable development due to high hazard (H5–H6), long PMF flood duration, and lack of evacuation.

5.9.4 Planning Recommendations

To ensure alignment with Ministerial Direction 4.1 and flood risk management guidance:

- Avoid permitting vulnerable development in Emergency Response Key Areas;
- Apply site-specific development controls in the LEP or DCP (e.g. minimum floor levels, refuge design, emergency plans);
- Continue monitoring and updating PMF hazard and duration mapping;
- Confirm emergency response feasibility before rezoning any site affected by Spot 3 or Spot 4 constraints;
- Apply a risk-based approach, consistent with Planning Circular PS24-001, EM01, and the Shelter-in-Place Guidelines.



6 Recommendations for Future Development Controls

To support the Planning Proposal and appropriately manage future development within the Campsie Precinct, it is recommended that Canterbury-Bankstown Council consider a suite of tailored flood-related development controls. These should be implemented through a precinct-specific Development Control Plan (DCP) and applied at the development application stage. The intent is to ensure flood risk is managed effectively, particularly in areas subject to high hazard, flood emergency response limitations, or development intensification.

These recommendations reflect the likely form of future development (including multi-storey buildings), site constraints, and current best practice in floodplain risk management.

6.1 Potential Flood-Related Development Controls

The following themes are recommended for inclusion in the future Development Control Plan (DCP), particularly where land is subject to flooding or may be exposed to emergency response constraints.

The strategic-level flood planning outcomes of this assessment may be referenced in future development controls such as the Campsie Development Control Plan (DCP), to guide applicants during early-stage planning and ensure consistency with this precinct-wide assessment. However, the outputs of this study are not intended for detailed design or site-specific flood assessment purposes, which must be addressed through separate modelling and analysis at the development application stage.

6.1.1 Shelter-in-Place and Emergency Response Design

Where evacuation may not be reliably achieved due to flash flooding characteristics, development should include provisions for safe shelter-in-place. As concluded in **Section 5.8**, due to the flash flooding nature of the Campsie floodplain it is assumed evacuation will not be feasible in all flood events and Shelter-in-Place will be required. It is recommended that DCP controls should clarify thresholds for shelter duration, access isolation, and hazard exposure. Facilities for water, power, sanitation, and emergency supplies should be provided where relevant to support safe isolation.

To ensure SiP are designed appropriately, the 2025 Shelter-in-Place Guideline sets out 10 design criteria for conditions of consent, grouped into mandatory and optional criteria as listed in **Table 6-1**. DCP controls related to SiP could utilise some or all of the same requirements as listed below at the DA stage.

Further to these SiP related development controls, it is recommended that Canterbury-Bankstown Council considers the establishment of a register of developments approved with shelter-in-place as an emergency strategy, as encouraged under the SiP Guidelines (2025, p. 5). Site-specific Emergency Flood Plans should accompany each DA where SiP is proposed.



Table 6-1 Recommended Design Criteria for Conditions of Consent from 2025 SiP Guideline

ID	Type	Requirement
i.	Mandatory	The floor level of the shelter in place part of the development be above the PMF
ii.		Structural soundness for conditions in a PMF event, considering flood and debris forces, be verified by a suitably qualified structural engineer
iii.		Area and access to the area does not rely on access to electricity, is self-directing, and have clearly marked internal access for all people on site, including consideration of access for potential occupants and/or visitors.
iv.	Optional	Protection from weather and appropriate heating and cooling.
v.		Access to personal hygiene facilities such as a toilet.
vi.		A minimum floor space of 2 m ² per person.
vii.		Items for self-sufficiency that are stored, maintained and are regularly updated in an accessible location above the PMF, including sufficient drinking water and food for occupants, fire extinguishers, radios and torches with spare batteries, and a first aid kit with an automated external defibrillator (AED).
viii.		Centralised communal shelters may be considered but must be freely accessible internally at all times and externally accessible during events.
ix.		Access is provided to onsite systems that generate power of the shelter in place location during and after the event for a full range of flood events up to the PMF.
x.		Includes signage, communication, or design elements to support sheltering.

6.1.2 Basement Flood Risk Management

The current 2022 CBC DCP under Chapter 2.2 item 9.9 requires all garages or parking areas to be elevated above the 1% AEP plus 0.15m freeboard.

Multi-storey development is expected to incorporate basement parking. Given the rapid onset of floodwaters throughout the study area and due to the high flood risk nature of basements, basement entries should be protected to either the Flood Planning Level (1% AEP + 500 mm) or the PMF level, whichever is greater. This will ensure that the risk of flooding for basement areas is addressed. Given the PMF levels are up to 4 metres higher than the 1% AEP levels for Cooks River floodplain, this requirement may be onerous for properties in these areas.

The DCP should require hydraulic analysis and/or water surface level checks for all proposed basement entries in flood-affected areas. Design measures may include elevated driveways, or overland flow redirection.

6.1.3 Overland Flood Conveyance and Impacts

This high-level review confirms that the Planning Proposal mostly avoids development within mapped floodways at the strategic level. However, any future development proposed within or adjacent to floodways or overland flow paths (OLFPs) must be subject to detailed hydraulic assessment and design. It must be demonstrated that such development:

- Maintains sufficient conveyance space for floodwaters;
- Avoids obstruction of the waterway;
- Does not result in adverse impacts on neighboring properties or flood flowpaths;
- Where appropriate, incorporates design responses such as OLFP redirection or site-specific flow management strategies.



These considerations will need to be addressed during subsequent development stages and in the preparation of supporting flood impact assessments. It is noted that the current 2022 CBC DCP under Chapter 2.2 Section 9 does have existing controls that extensively cover overland flowpath and conveyance considerations:

9.1: Do not obstruct any overland flow path. Council will enforce the removal of any obstruction to overland flow within private properties and recover from the owners the cost of carrying out such work.

9.2: Do not obstruct existing runoff, entering the site from upstream properties or sub-catchments, from flowing into the subject site, or redirect it to increase the quantity or concentration of surface runoff entering adjoining properties.

Note: During periods of heavy rainfall, it is anticipated that there will be potential runoff, across boundaries of some properties, which will enter downstream sites from upstream properties due to the local contours of the area.

9.3 Consider potential runoff at the design stage and design so it will not have any adverse impact on adjoining properties. Overland flow should not be obstructed from flowing naturally and is not to pond or concentrate along boundaries of adjoining properties. Suitable channels, open dish drains, walls or any other measures may be necessary to accommodate the existing and potential overland flow paths throughout the subject site.

9.4 Care must be exercised to ensure that provision of any of the above remedial measures will not result in diverting runoff into the OSD system, if this is unattainable, then the OSD system must be designed to cater for the additional stormwater runoff anticipated from upstream catchment area(s)

9.5 Council may require that the design specify the extent of the overland flow path through the site, and that the development be located/modified clear of the overland flow path or set at an appropriate freeboard

Unlike the above overland flowpath requirements in the current DCP that are extensive, requirements for mainstream flooding and impacts in flood storage area are less clearly stated.

6.1.4 Reference to Latest Flood Risk Guidance

All future DCP controls should incorporate reference to the most current technical and policy documents, including those outlined in Section 3 of this report. At the time of preparing site-specific assessments, the most up-to-date guidance must be applied to ensure consistency with State Government expectations. Key references currently include:

- *FRM Manual and Associated Toolkit* (NSW Government, 2023). Specifically, the relevant guides would be *FRM Guide LU01 – Flood Impact and Risk Assessment* outlining requirements for FIRA submissions
- *Planning Circular PS24-001* (2024), and
- *Shelter-in-Place for Flash Flooding Guideline* (NSW Government, 2025).



6.1.5 Land to which Flood-Related Controls Apply

The current 2022 CBC DCP includes flooding controls in Chapter 2.2. In this chapter, controls for all former Canterbury LGA (including the Campsie Town Centre study area) are outlined in Sections 9 for overland flooding areas and Section 10 for mainstream flooding areas of Cooks River. The previous flood tagged FPA properties for mainstream Cooks River, extracted from the DCP under Figure 10C are shown in **Figure 6-1**.



Figure 6-1 Mainstream Flood Planning Area for Campsie in 2022 DCP Chapter 2.2 Figure 10C

It is noted that the previous FPA maps do not include PMF affected properties for Cooks River and do not include overland flood affected properties. However the 2022 DCP does not specify that controls only apply to the above FPA extent only, with controls specifically for overland flooded sites.

Given the controls for basement entries and Shelter-in-Place referenced in the prior sub-sections both require consideration up to the PMF event (not just the 1% AEP), it is recommended that relevant controls be applied to all properties within the PMF extent, not only to the FPA.

The existing scenario modelling results from this study for 1% AEP and PMF flood extents, and the updated FPA mapping (prepared as outlined in Section 3.8.4) are shown in **Figure 6-2**. This mapping combined overland flooding and mainstream Cooks River flooding into a single set of extents. This mapping (not formally adopted by Council) shows that generally the FPA aligns with the PMF extent for most of the Campsie study area, though there are some PMF mainstream affected areas not included in the FPA.

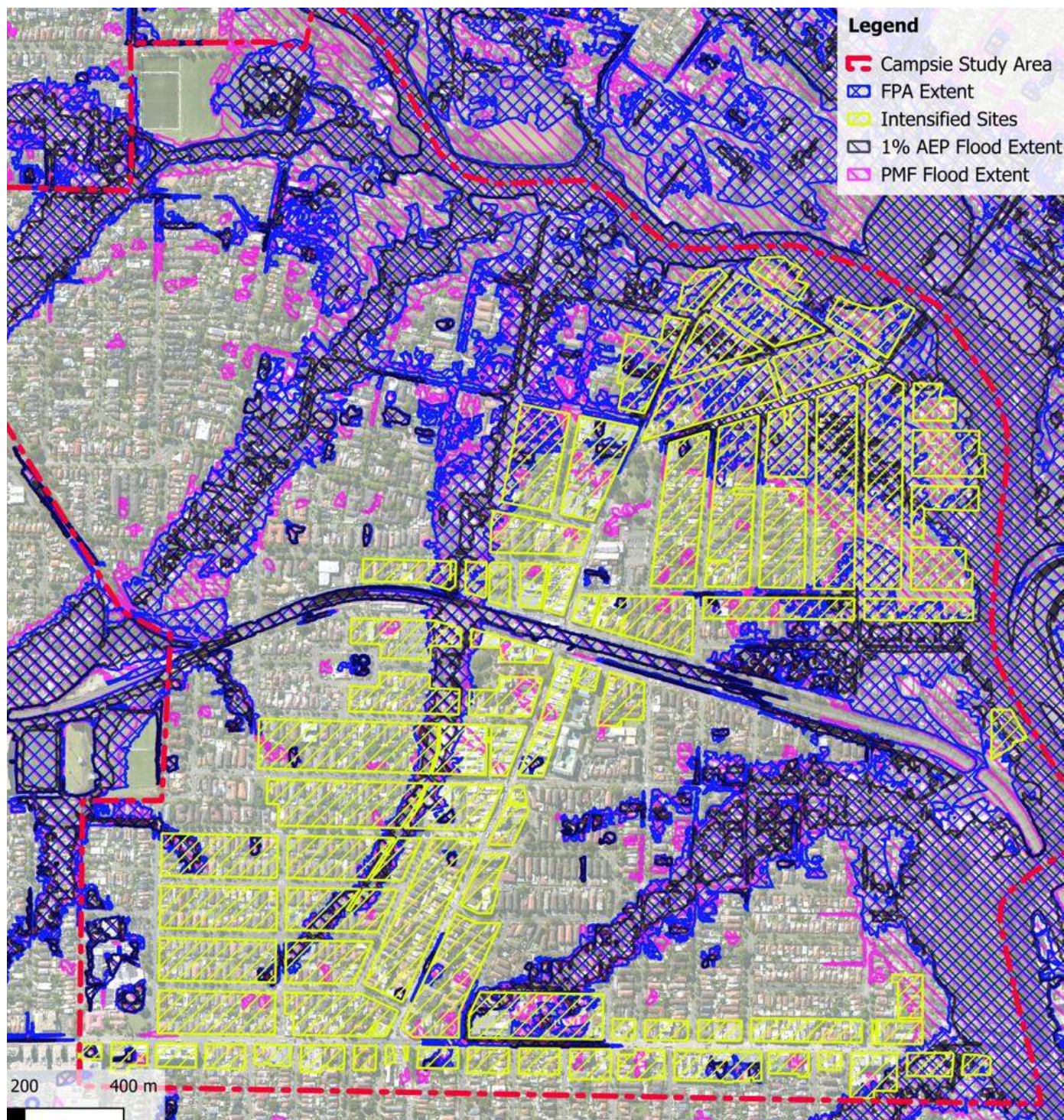


Figure 6-2 1% AEP and PMF Flood Extents and Flood Planning Area (FPA) – Campsie Precinct

Many Council's in NSW apply a flood control matrix that applies different controls based on proposed land use of a DA, and the flood affectation of the site. The flood affectation of the site is normally classed into three Flood Risk Precincts (FRPs); High (1% AEP high hazard), Medium (1% AEP or FPA) and Low (PMF). By applying relevant controls (basement entry requirements, SiP requirements etc) to Low FRP properties, this is a way to ensure these controls are applied for all PMF affected properties. Its noted that Council already adopts a flood control matrix approach for properties in the former Bankstown LGA under Schedules 3 and 5, including some controls applied to Low FRP sites.



6.2 Fill Design Considerations and Compliance with Council Policy

In accordance with flood risk management principles, land filling should be limited to areas outside mapped floodways and significant flood storage areas. Within these areas, fill can reduce storage capacity, obstruct flood flows, and increase flood risk to adjacent properties. Such outcomes would be inconsistent with floodplain management objectives.

In particular, filling should not occur within overland flow paths (OLFPs). Built form in these areas should be designed to either maintain open flow corridors or incorporate suspended structures that allow floodwaters to pass beneath the development footprint. This approach is consistent with practices already applied elsewhere in the Canterbury-Bankstown LGA.

6.3 Stormwater Pipe Drainage Network Upgrade Opportunities

The 5% AEP 1D stormwater pipe results from modelling in this assessment provide insight into the stormwater network performance across the Campsie Town Centre precinct and help identify preliminary opportunities for targeted drainage upgrades.

Figure 6-3 presents a colour-coded map of the modelled stormwater pipe network under the future-development scenario, with flood extents shown to distinguish segments running at or near capacity from those operating below capacity during the 5% AEP design event (90 min duration). These results help highlight areas where surface ponding is influenced by hydraulic limitations, suggesting where network improvements may reduce local flood risk.

One notable opportunity is along Beamish Street, where modelled results indicate persistent surface ponding in a topographic low point. GIS asset data confirms this area is currently serviced by a 450 mm diameter stormwater pipe, which is shown to be surcharged or near full capacity during the 5% AEP event (refer to **Figure 6-3**). Post-development model results for this section of Beamish St show additional ponding compared to existing conditions as the minor flowpaths through development sites both to the east and west have been completely blocked in modelling. These local road impacts are not considered realistic as it is assumed site design at DA stage will allow flows to be conveyed suitably. One of the opportunities in this regard is a pipe upgrade for the 450mm pipe through the site east of Beamish Street. While the pipe appears to function as designed, it is likely undersized for managing larger or more frequent storm events, and an upgrade should be considered by developers in this area to enhance flood resilience along this high-traffic commercial corridor. This is seen as an opportunity as this small section of pipe is flowing full, but there is available capacity within the trunk drainage line downstream suggesting the network could accept additional flow from this pipe.

Beyond Beamish Street, the model identifies additional locations where flow transitions from surcharged upstream pipes into downstream segments operating below capacity, often coinciding with observed surface ponding. These locations suggest the presence of hydraulic bottlenecks, which may benefit from further investigation, and potentially from pipe replacement, network realignment, or capacity augmentation. Strategic upgrades in these locations could help reduce the extent of mapped



Campsie Post-Gateway Planning Proposal – Flood Impact and Risk Assessment

6 Recommendations for Future Development Controls

flood hazard, particularly within high hazard zones where flood depth and velocity are amplified by insufficient drainage performance.

It is noted that this study did not include a detailed stormwater drainage design or pipe capacity verification, nor were individual pipes assessed for adequacy against Council design standards.

It is also noted that in discussions with Council, it is understood that significant drainage upgrades are not currently planned within this study area. These potential opportunities for drainage improvements could be investigated by developers to more efficiently facilitate development of some sites.

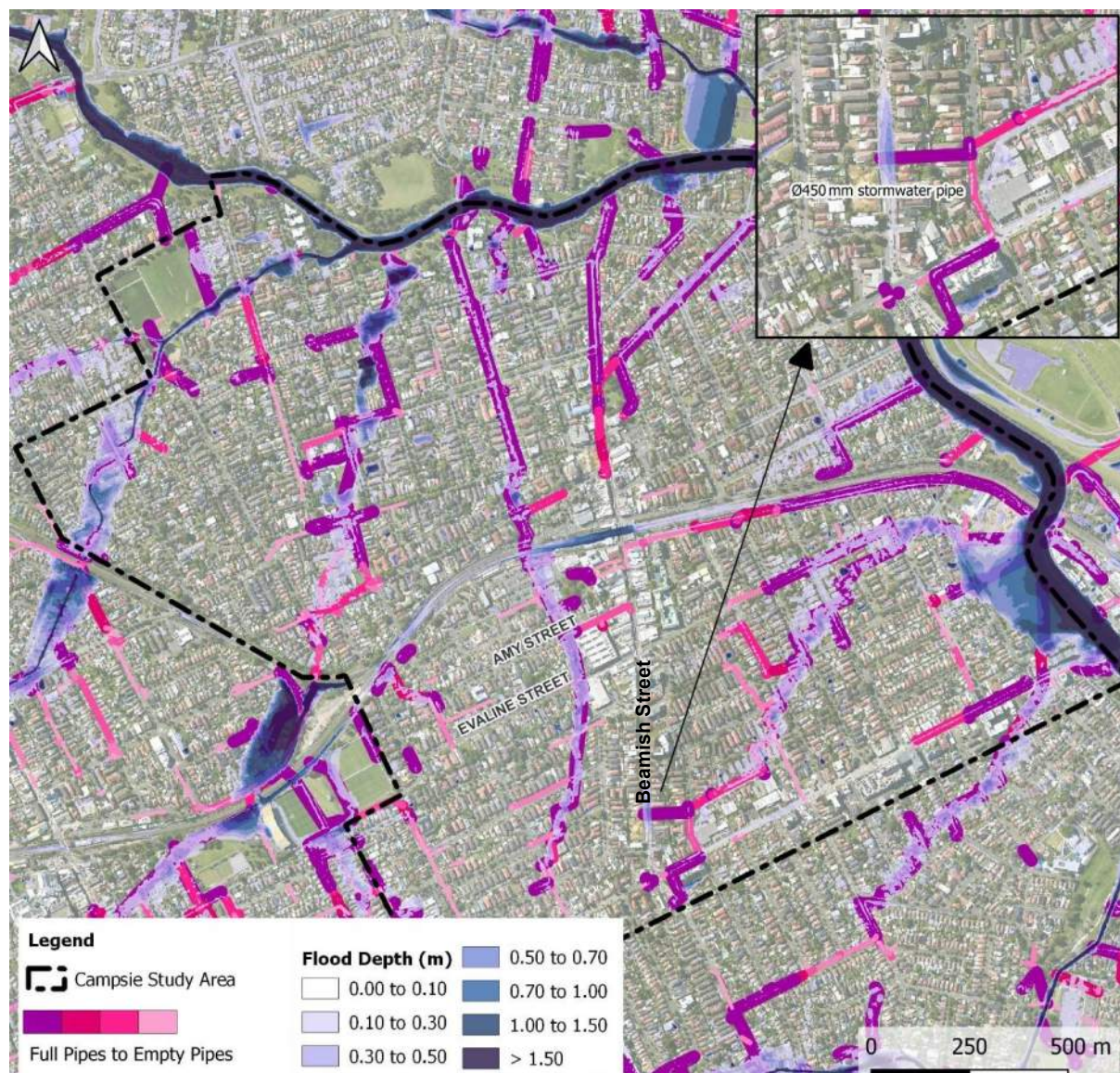


Figure 6-3: Stormwater Network Performance and Flood Depth – 5% AEP Event, 90min duration (Future Development Scenario)



7 Conclusion

7.1 Potential Flood Constraint Areas

Through this assessment, several flood constraint areas have been identified for further review during the next phase of the Planning Proposal process. These include four sites requiring risk management or further investigation, and two sites where no development is considered feasible, as summarised in **Table 7-1**. The locations of these constraint sites are mapped in **Figure 7-1**, with 1% AEP hydraulic categories shown for reference.

Upon review of the post-gateway planning proposal details, it appears that all three of the four flood constraint areas are excluded from proposed change of use or intensification. Spot 3 has currently been proposed for land use change and intensification, proceeding with this site for intensification should be determined by Council's decision making on flood risk for SiP in its role as consent authority.

Table 7-1 Summary of Flood Constraint Areas

Location	Description	Recommendation
Spot 1 Byron Street	Minor flooding in 5% AEP event 1% AEP flood storage area 1% AEP partial high hazard area PMF partial H6 hazard area PMF duration of 10.5 hours	<u>No zoning change or intensification is currently proposed.</u> Due to frequency of flooding, 1% AEP flood affectation and PMF H6 hazard affectation site is not recommended for inclusion in the planning proposal.
Spot 2 Gordon Street	Significant flooding in 5% AEP event 1% AEP flood storage area 1% AEP partial high hazard area PMF H6 hazard area PMF duration of 7 hours	<u>No zoning change or intensification is currently proposed.</u> Due to frequency of flooding, 1% AEP flood affectation and PMF H6 hazard affectation site is not recommended for inclusion in the planning proposal.
Spot 3 Nowra Street (Western Portion of Site Only)*	Partial flooding in 1% AEP event 1% AEP partial flood storage area 1% AEP partial high hazard area PMF H5 hazard area PMF duration of 12.2 hours	<u>Both zoning change and intensification are currently proposed.</u> Based on 1% AEP flooding site is appropriate for redevelopment. Regarding both duration and hazard in a PMF event, this site is near the limit of acceptable thresholds for SiP eligibility. Proceeding with this site for intensification should be determined by Council's decision making on flood risk for SiP in its role as consent authority.
Spot 4 Canterbury Road	Partial flooding in 5% AEP event 1% AEP flood storage area 1% AEP high hazard area PMF H6 hazard area PMF duration > 12 hours	<u>No zoning change or intensification is currently proposed.</u> Due to frequency of flooding, 1% AEP flood affectation and PMF H6 hazard and duration, the site is not recommended for inclusion in the planning proposal.

*The eastern portion of the Nowra Street sites are not eligible for development as significantly affected in both 1% AEP and PMF events.



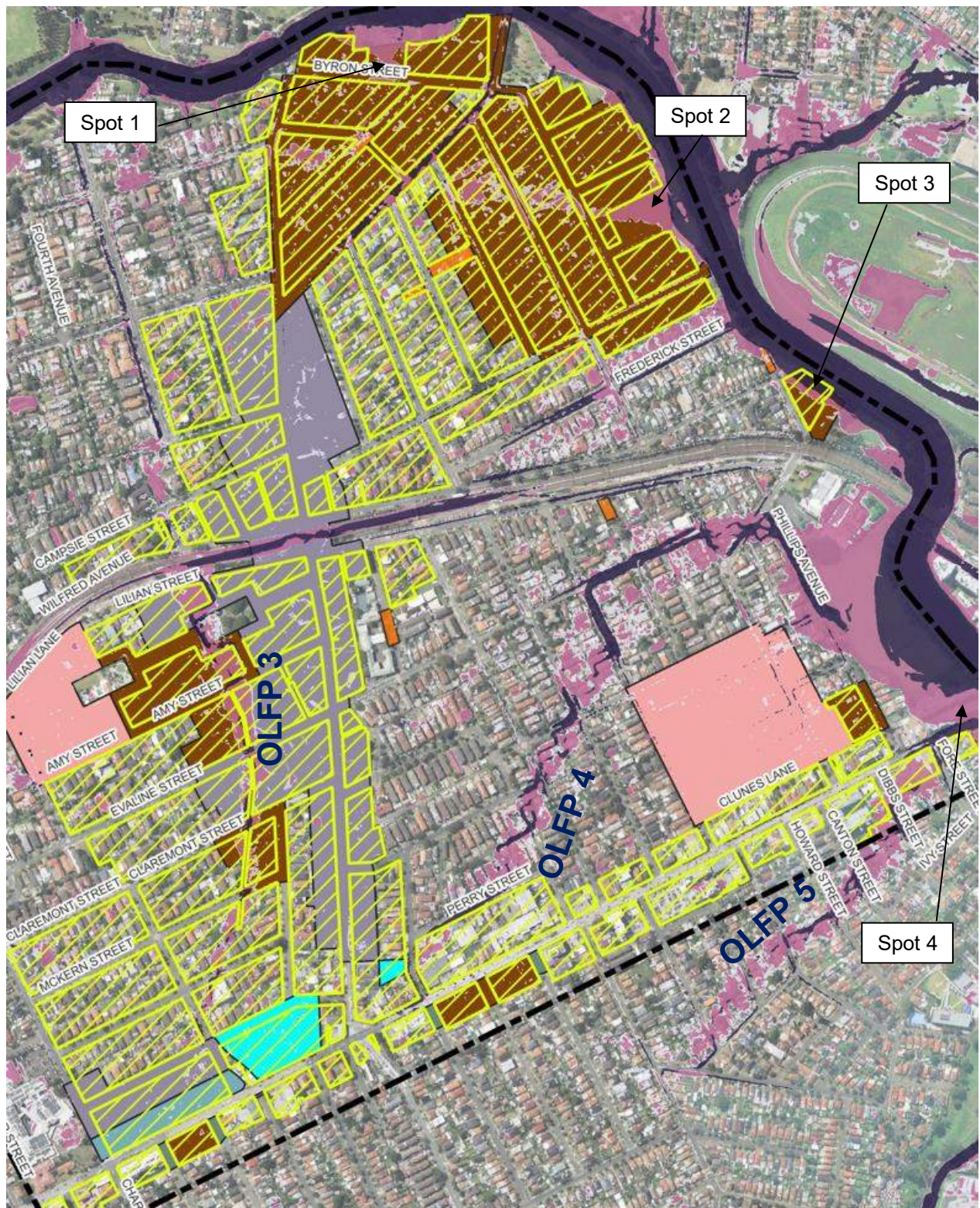


Figure 7-1 Campsie Precinct Flood Constraint Sites – with 1% AEP Floodway Mapping

7.2 Review of Ministerial Direction 4.1 Flooding Requirements

The Campsie Precinct Rezoning Proposal has been reviewed against the Ministerial Directions 4.1 as discussed in Section 5. A summary of each of the planning proposal requirements is included in **Table 7-2** below.

Table 7-2 Review of Study Area Flood Affection Compared to Ministerial Direction Planning Proposal Requirements

Direction Provision	Comment
A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy, the principles of the Floodplain Development Manual 2005, the Considering flooding in land use planning guideline 2021, and any adopted flood study and/or floodplain risk management plan adopted by the relevant council	Yes, upon review it appears that the Planning Proposal adheres to the principles of all of these documents.
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	Yes, all proposed rezoning does not fit within these categories and therefore are eligible changes.
A planning proposal must not contain provisions that apply to the flood planning area which: a) permit development in floodway areas, b) permit development that will result in significant flood impacts to other properties, c) permit development for the purposes of residential accommodation in high hazard areas,	All of these conditions may reasonably be satisfied as follows: a) Floodway is generally confined to Cooks River channel and in very isolated locations in overland flow areas. It has very limited overlay on developable land, with negligible interaction with proposed intensification areas of the planning proposal. In accordance with these provisions, Figure 5-7 shows that these floodway areas have not been considered as part of the Planning Proposal, b) Post-development modelling shows that impacts in the 1% AEP event are localised and should be able to resolved on a site-by-site basis at later DA stage. PMF impacts on Cooks River mainstream floodplain are wider ranging, however are relatively minor (<0.1 metres) and do not result in a change in hazard affection. Therefore impacts for a high-level precinct-wide scale are considered suitable. c) The 1% AEP high hazard is mapped against the land use zoning of the Planning Proposal in Figure 5-8. It shows that the high hazard is generally confined to Cooks River channel and public road reserves in most locations. However it marginally covers some portions of areas proposed for intensification without any proposed changes to existing land use on the Cooks River foreshore, including a small area between Lindsay Street and Gordon Street and another area on the southern part of Tasker Park. These two small areas have been shown as Spot 1 and Spot 2, respectively, in Figure 5-8. In accordance with these provisions, these high hazard areas have not been proposed for intensification or residential uses in the planning proposal. Consideration could be given to re-aligning the high hazard flowpaths to consolidate the developable portion of a site or consideration could



Direction Provision	Comment
d) permit a significant increase in the development and/or dwelling density of that land, e) permit development for the purpose of centre-based childcare facilities, hostels, boarding houses, group homes, hospitals, residential care facilities, respite day care centres and seniors housing in areas where the occupants of the development cannot effectively evacuate, f) permit development to be carried out without development consent except for the purposes of exempt development or agriculture. Dams, drainage canals, levees, still require consent, g) are likely to result in a significantly increased requirement for government spending on emergency management services, flood mitigation and emergency response measures, which can include but are not limited to the provision of road infrastructure, flood mitigation infrastructure and utilities, or h) permit hazardous industries or hazardous storage establishments where hazardous materials cannot be effectively contained during the occurrence of a flood event.	be given to elevating structures one level above the high hazard flowpath to maintain the flood conveyance up to the PMF and to allow for maintenance. d) It is assumed that the developable portions of these sites will be flood-free in the post-development condition. This assumption is based on adherence to CBC current Flood Planning Level (FPL) requirements for all proposed residential buildings to have all habitable floor levels suspended above the 1% AEP plus 0.5m freeboard (FPL). Through appropriate site design, and adherence to Council's flood-related development controls it is therefore assumed the relevant areas of the development sites will be elevated above the FPL and therefore intensification would be suitable in accordance with this provision. e) A high-level review of flood emergency response suggests that evacuation may be feasible for most of the Planning Proposal study area as most areas have rising road access to flood free land in the PMF event. Also within the Proposed Rezoning, there is no vulnerable development has been proposed. f) It is not possible to assess this at this post-gateway Planning Proposal stage. g) A high-level review of flood emergency response suggests that shelter-in-place may be feasible for most of the Planning Proposal study area as durations and hazard of flooding meets the requirements of the SiP Guideline 2025. This should be possible through site specific emergency response plans that do not increase the burden on emergency services or require significant road upgrades to enable evacuation post-flood. Flood emergency response key issue areas have been shown as black hatched areas in Figure 5-11 to Figure 5-14. Among the flood emergency response areas there is no overlap with areas proposed for change to land use along with intensification. The proposed sites at Spot 3 on Nowra Street are near the limit of acceptable duration of flooding for SiP eligibility based on the 2025 SiP Guideline. h) It is not possible to assess this at this post-gateway Planning Proposal stage, the current DCP has specific requirements that do not permit hazardous material storage below a certain level which should address this concern for future development associated with the Master Plan. Appropriate DCP controls can be developed to address storage. Also, within the Proposed Rezoning, there is no hazardous material storage has been proposed.
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 a), b), d), e), f) from item 3 above. An additional requirement for this area is if a planning proposal is likely to affect the safe occupation of and efficient evacuation of the lot	The same responses as noted in the relevant items above apply to Special Flood Considerations. The medical precinct proposed near Canterbury Hospital. This area is one of the highest elevated areas of the study area, and would generally be considered suitable based on the flood risk in this area.



Direction Provision	Comment
For the purposes of preparing a planning proposal, the flood planning area must be consistent with the principles of the Floodplain Development Manual 2005 or as otherwise determined by a FRMS&P	In accordance with this provision, the 1% AEP plus 500mm freeboard should be used when assessing the planning proposal associated with the Master Plan. This requirement is also in accordance with Part 2.2 of the draft Consolidated Canterbury-Bankstown DCP.

Overall, this flood planning review concludes that generally the proposed intensification of development and changes in zoning in the floodplain in this Planning Proposal are in accordance with the provisions of the NSW Flood Prone Land 2021 as discussed above.

It is noted that this is a high-level review of the flood conditions of the study area. These requirements should be reviewed in further detail and more formally during the development stage. Included within this may be further identification and development of potential flood mitigation measures to facilitate any potential development.

7.3 Gateway Flood-Related Comments

For the Campsie Town Centre planning proposal, Gateway conditions were released by NSW DPHI in January 2025 including flood-related conditions under Item 1.19. These requirements are listed in *italics* below, with Stantec's response based on the above FIRA outcomes.

1.19 Address the findings and recommendations of the Flood Risk Assessment, including:

- explain how the recommendations are addressed within the planning proposal package*

Response: Comprehensive post-gateway FIRA summarised in the above report

- address the development within and in proximity to the floodway and flood storage, including the duration of inundation and the potential impacts of potential filling and raising of development sites on flood behaviour*

Response: As summarised in Section 5.6, proposed development sites are negligibly affected by floodway, with only minor flood storage interaction. Modelling shows that proposed site filling does not result in significant regional flood impacts in the 1% AEP event. OLFP affected sites have been nominated as 'flood-impact-sensitive' and modelled as allowing conveyance post-development.

- address consistency against all requirements with the 9.1 Direction 4.1 Flooding, including but not limited to addressing the proposed intensification on land identified as high hazard*

Response: As discussed in the above section, review against Ministerial Direction 4.1 requirements shows the planning proposal is consistent with flooding requirements.

- update mapping within the planning proposal package*

Response: Updated existing flood mapping for 5%, 1%, 0.2% and 0.05% AEP and PMF events is included in **Appendix A**. Post-development mapping is also included in **Appendix B**.

- address consistency with the DPHI Shelter in Place Guideline published 9 January 2025.*

Response: Review against SiP guideline requirements in **Section 5.8.6** has found that all key requirements are met for development sites included in the planning proposal.



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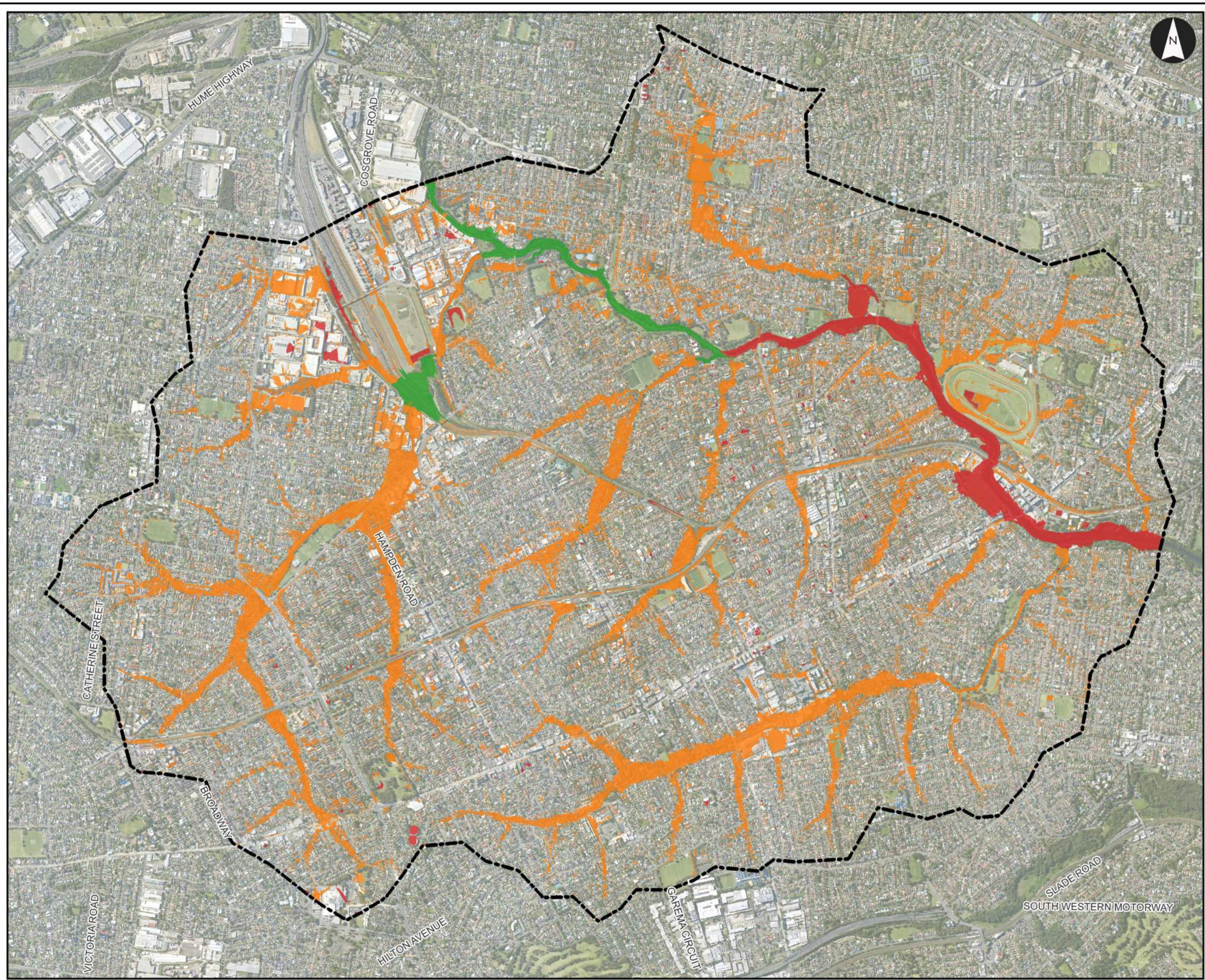


Appendices



Appendix A Flood Mapping (Existing Scenario) Figures





**5% AEP Existing Condition
Critical Duration**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A1

Legend

Model Boundary

Critical Duration

- 60
- 90
- 120
- 180

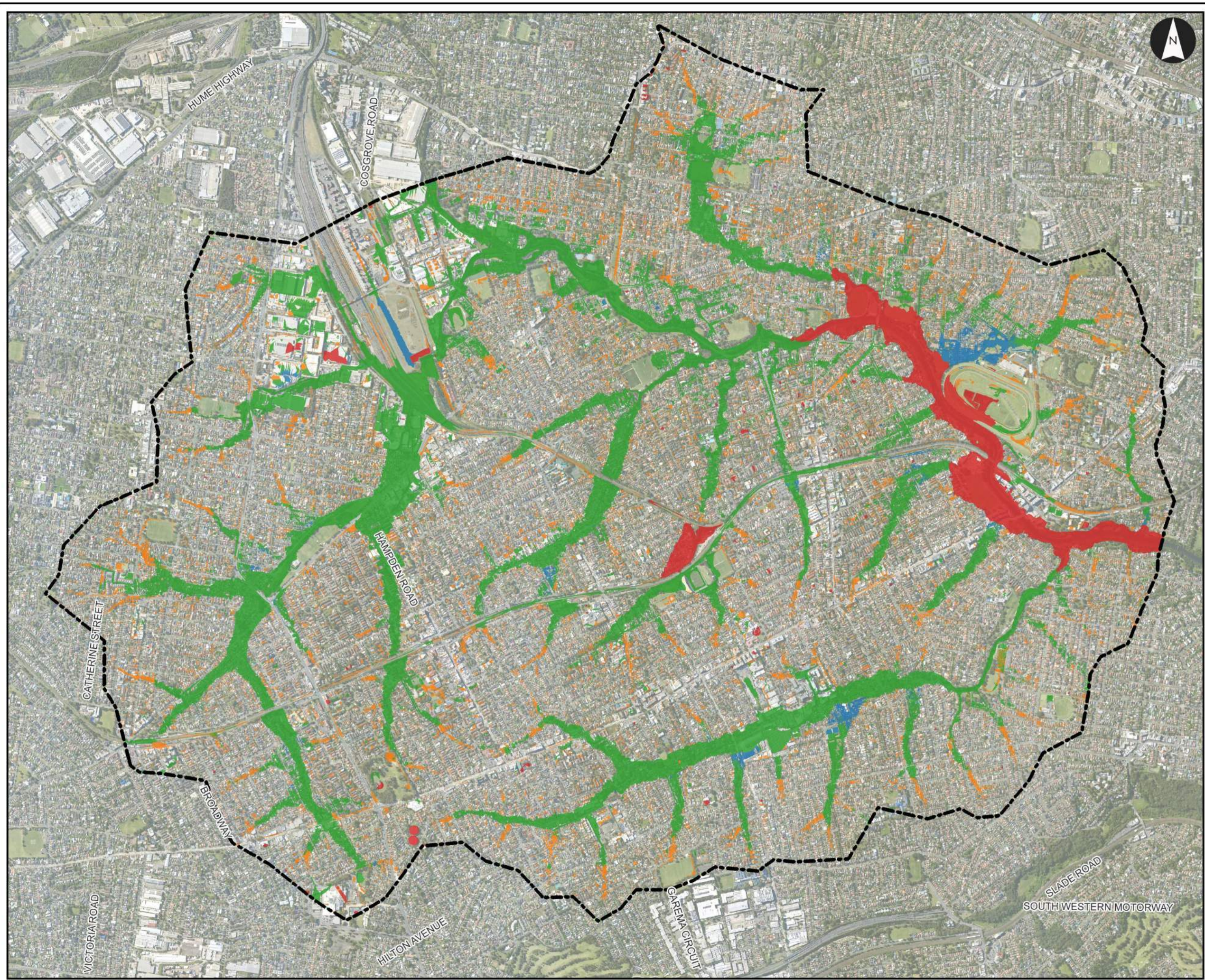
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:23000





**0.2% AEP Existing Condition
Critical Duration**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A2

Legend

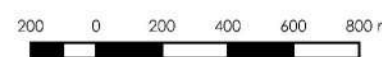
Model Boundary

Critical Duration

- 60
- 90
- 120
- 180

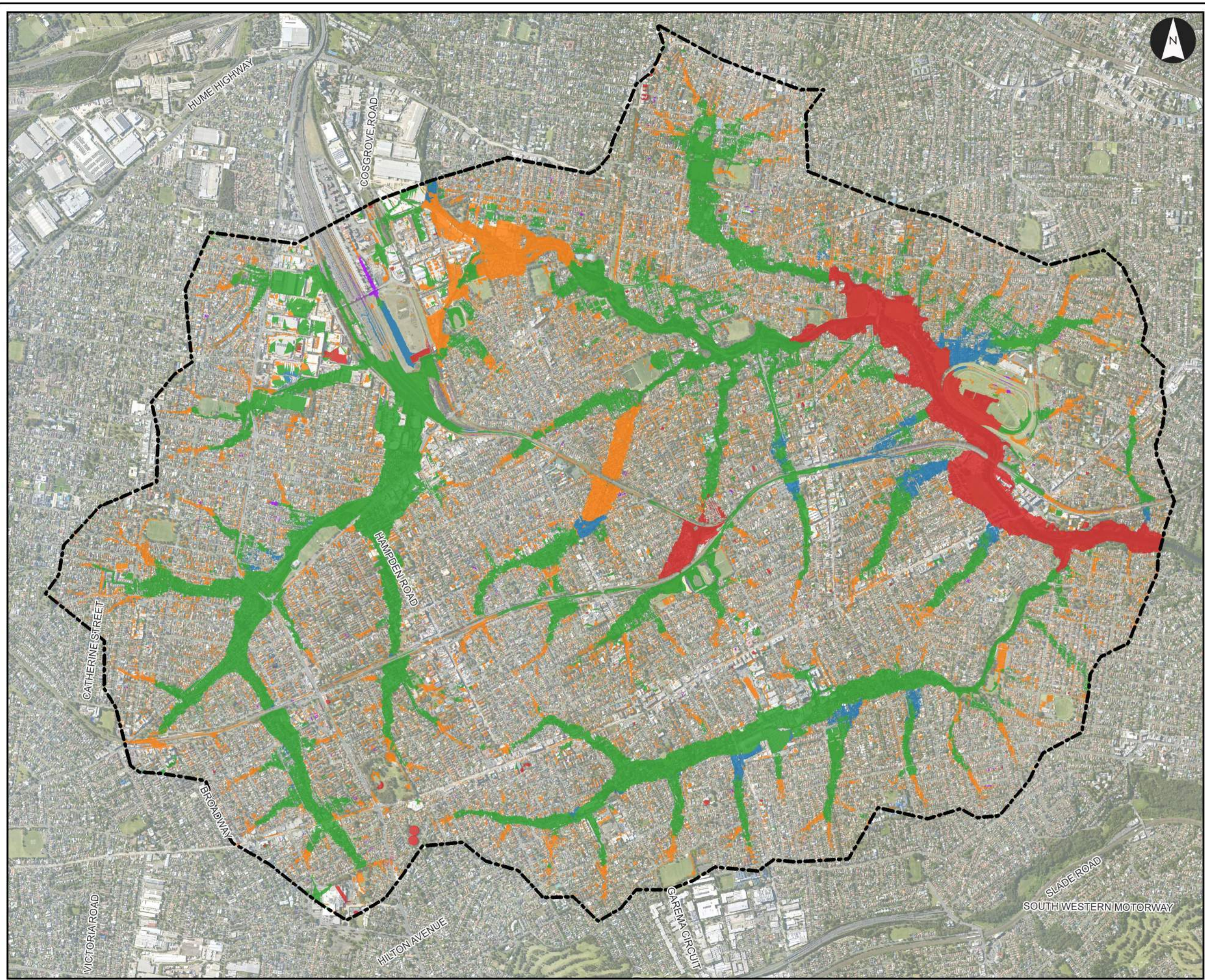
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:23000





**0.05% AEP Existing Condition
Critical Duration**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A3

Legend

Model Boundary

Critical Duration

- 30
- 60
- 90
- 120
- 180

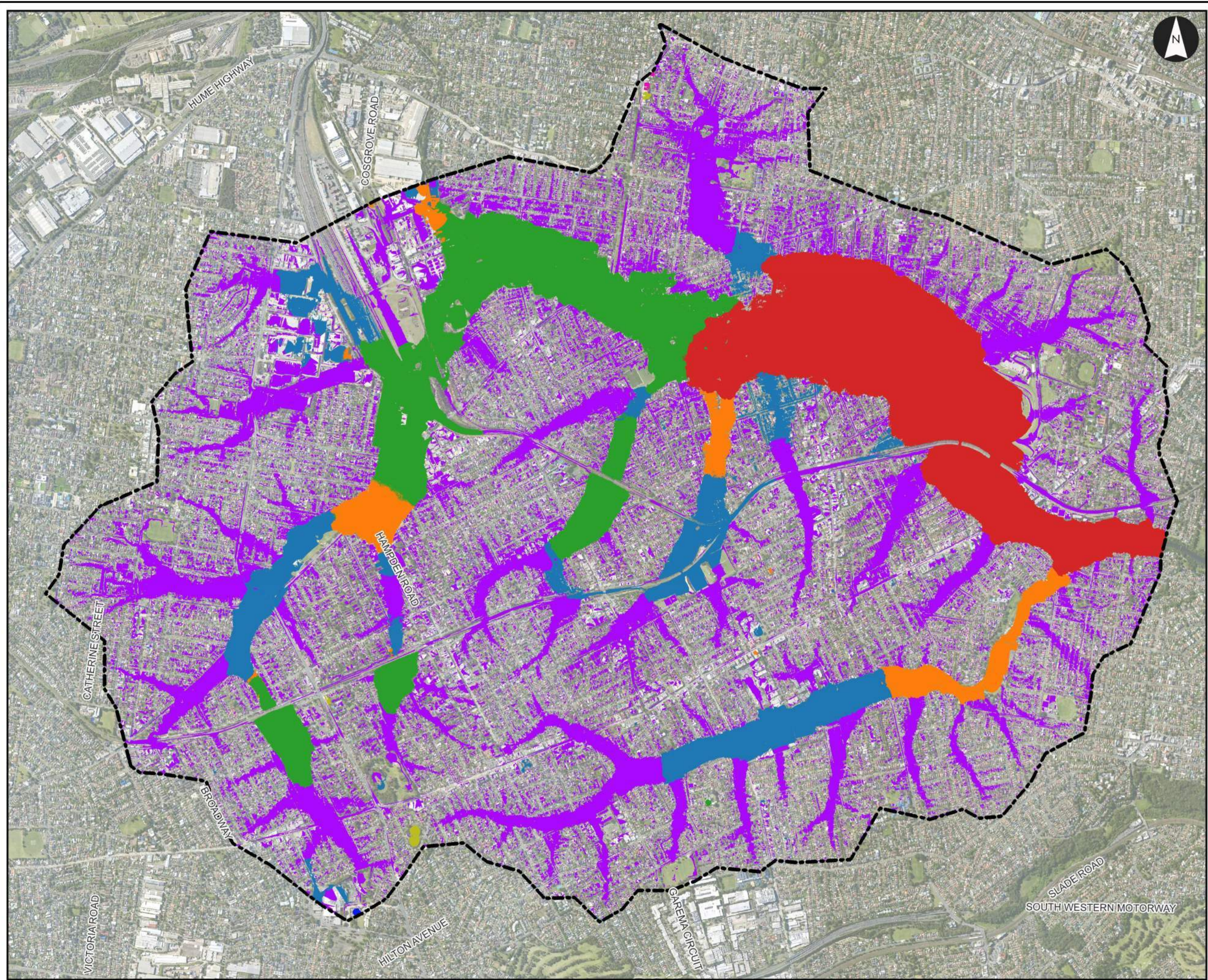
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:23000





**PMF Existing Condition
Critical Duration**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A4

Legend

Model Boundary

Critical Duration

- 30
- 60
- 90
- 120
- 180
- 270
- 360
- 720
- 1440

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



200 0 200 400 600 800 m

Scale at A3: 1:23000





**5% AEP Existing Condition
Flood Depth**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A5

Legend

Campsie Study Area

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:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**1% AEP Existing Condition
Flood Depth**

Project: Campsie Rezoning - Updated Flood Risk
Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A6

Legend

Campsie Study Area

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:7856

References:
1. Metromap
2. Road NSW

Stantec

90 0 90 180 270 360 m

Scale at A3: 1:9000





**0.2% AEP Existing Condition
Flood Depth**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A7

Legend

Campsie Study Area

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

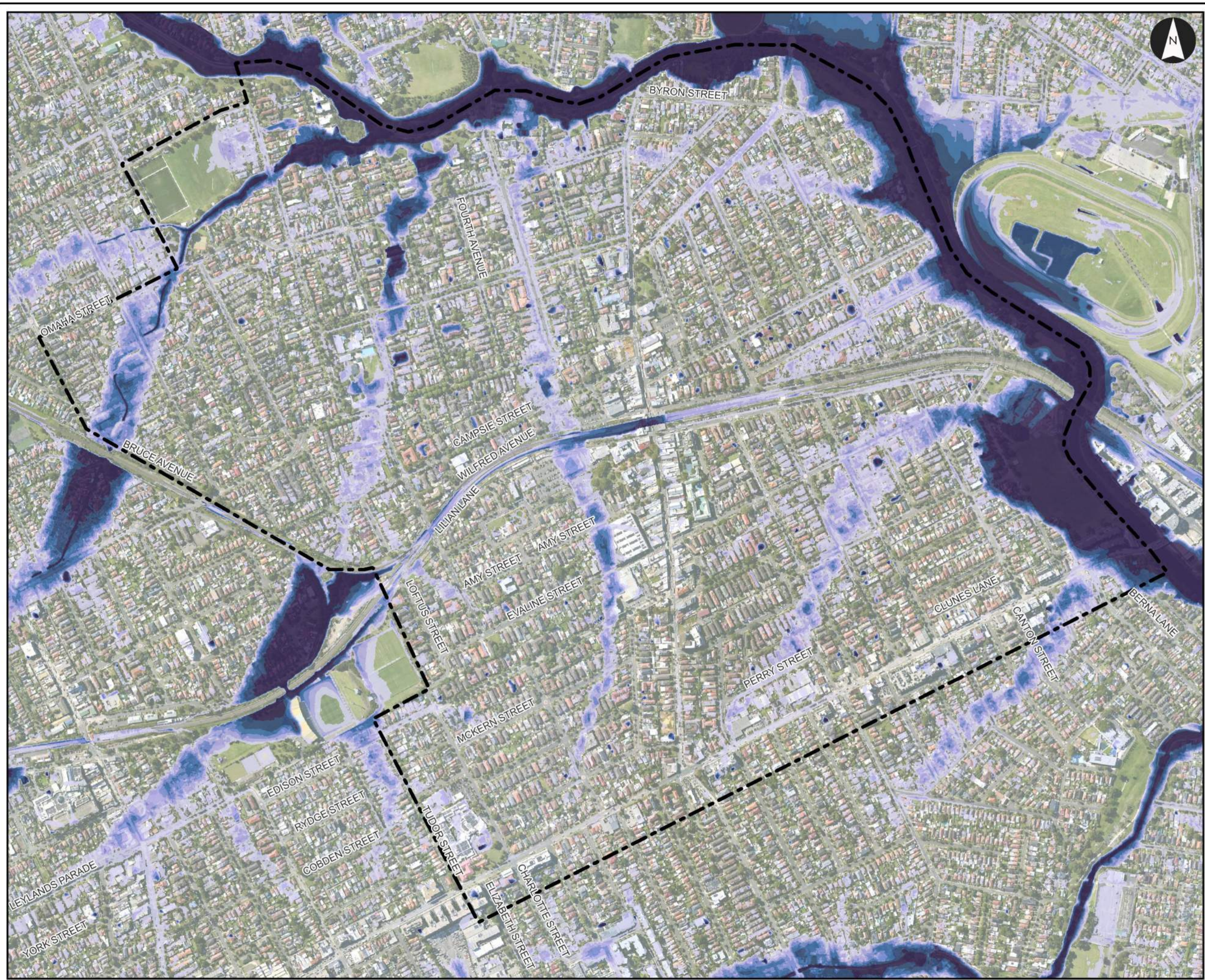
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2. Road NSW



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**0.05% AEP Existing Condition
Flood Depth**

Project: Campsie Rezoning - Updated Flood Risk
Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A8

Legend

 Campsie Study Area

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:7856

References:
1. Metromap
2. Road NSW

 **Stantec**

90 0 90 180 270 360 m

Scale at A3: 1:9000





**PMF Existing Condition
Flood Depth**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A9

Legend

 Campsie Study Area

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:
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References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





5% AEP Existing Condition Flood Velocity

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A10

Legend

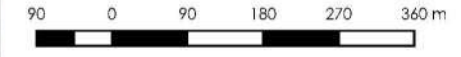
 Campsie Study Area

Flood Velocity (m/s)

-  0.00 to 0.50
-  0.50 to 1.00
-  1.00 to 1.50
-  1.50 to 2.00
-  2.00 to 3.00
-  > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**1% AEP Existing Condition
Flood Velocity**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A11

Legend

Campsie Study Area

Flood Velocity (m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW

Stantec

90 0 90 180 270 360 m

Scale at A3: 1:9000





**0.2% AEP Existing Condition
Flood Velocity**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A12

Legend

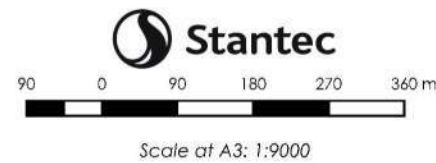
 Campsie Study Area

Flood Velocity (m/s)

-  0.00 to 0.50
-  0.50 to 1.00
-  1.00 to 1.50
-  1.50 to 2.00
-  2.00 to 3.00
-  > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.05% AEP Existing Condition
Flood Velocity**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A13

Legend

 Campsie Study Area

Flood Velocity (m/s)

-  0.00 to 0.50
-  0.50 to 1.00
-  1.00 to 1.50
-  1.50 to 2.00
-  2.00 to 3.00
-  > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW

 **Stantec**

90 0 90 180 270 360 m

Scale at A3: 1:9000





**PMF Existing Condition
Flood Velocity**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A14

Legend

 Campsie Study Area

Flood Velocity (m/s)

-  0.00 to 0.50
-  0.50 to 1.00
-  1.00 to 1.50
-  1.50 to 2.00
-  2.00 to 3.00
-  > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW

 **Stantec**

90 0 90 180 270 360 m

Scale at A3: 1:9000





**5% AEP Existing Condition
Hydraulic Category**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A15

Legend

Campsie Study Area

Hydraulic Categories

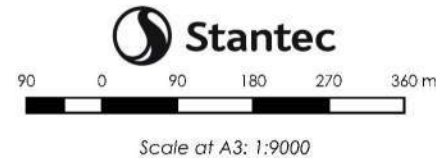
Flood Fringe

Flood Storage

Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**1% AEP Existing Condition
Hydraulic Category**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A16

Legend

Campsie Study Area

Hydraulic Categories

Flood Fringe

Flood Storage

Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW

Stantec

90 0 90 180 270 360 m

Scale at A3: 1:9000





**0.2% AEP Existing Condition
Hydraulic Category**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A17

Legend

Campsie Study Area

Hydraulic Categories

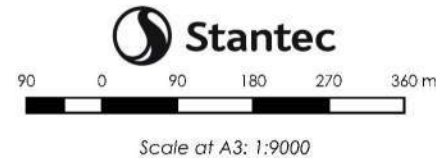
Flood Fringe

Flood Storage

Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.05% AEP Existing Condition
Hydraulic Category**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A18

Legend

-  Campsie Study Area
- Hydraulic Categories**
-  Flood Fringe
 -  Flood Storage
 -  Floodway

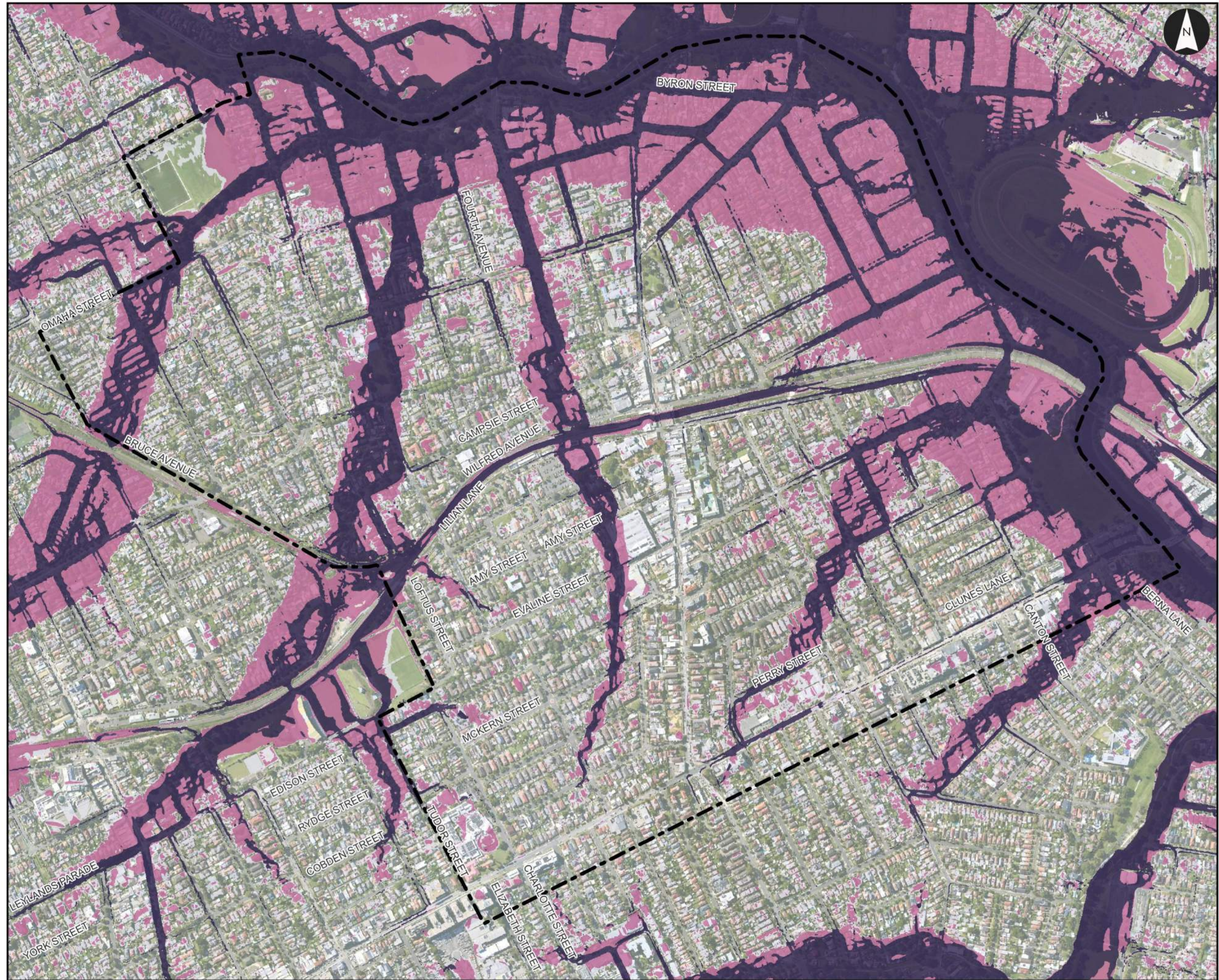
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





PMF Existing Condition Hydraulic Category

Project: Campsie Rezoning - Updated Flood Risk
Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A19

Legend

Campsie Study Area

Hydraulic Categories

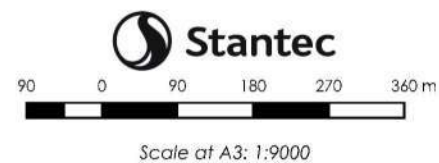
Flood Fringe

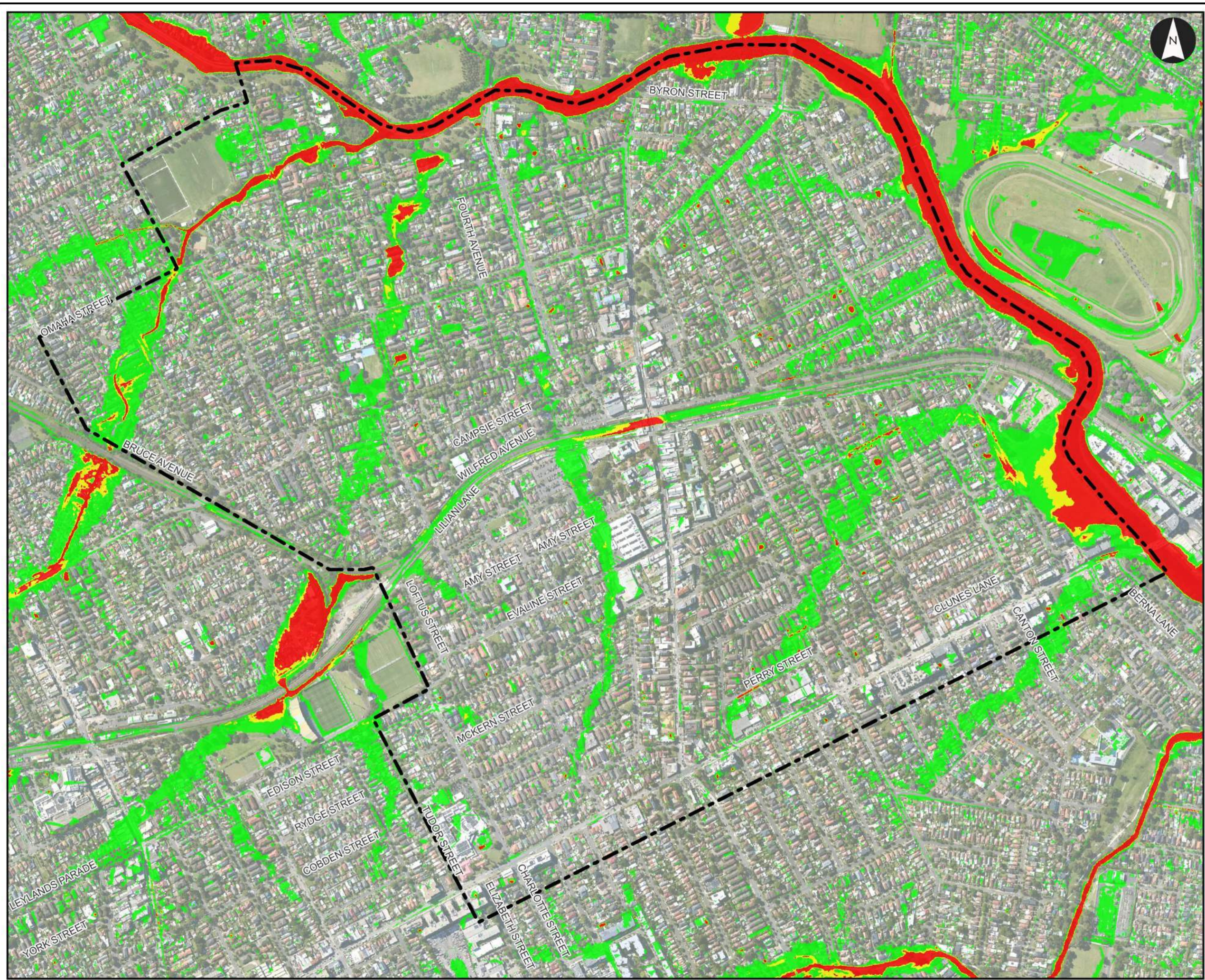
Flood Storage

Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**5% AEP Existing Condition
Provisional Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A20

Legend

Campsie Study Area

Provisional Hazard

- Low
- Transitional
- High

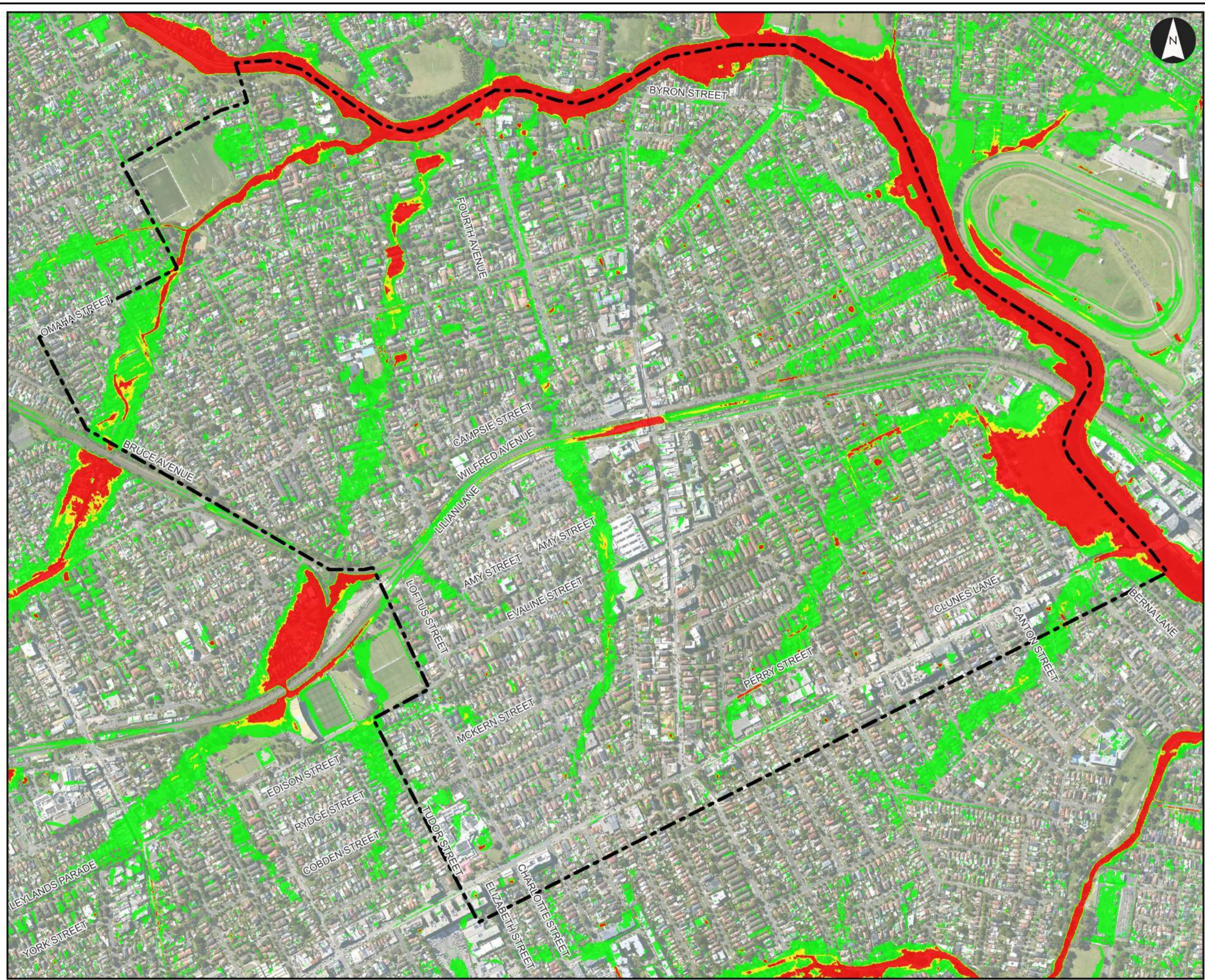
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**1% AEP Existing Condition
Provisional Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A21

Legend

 Campsie Study Area

Provisional Hazard

 Low

 Transitional

 High

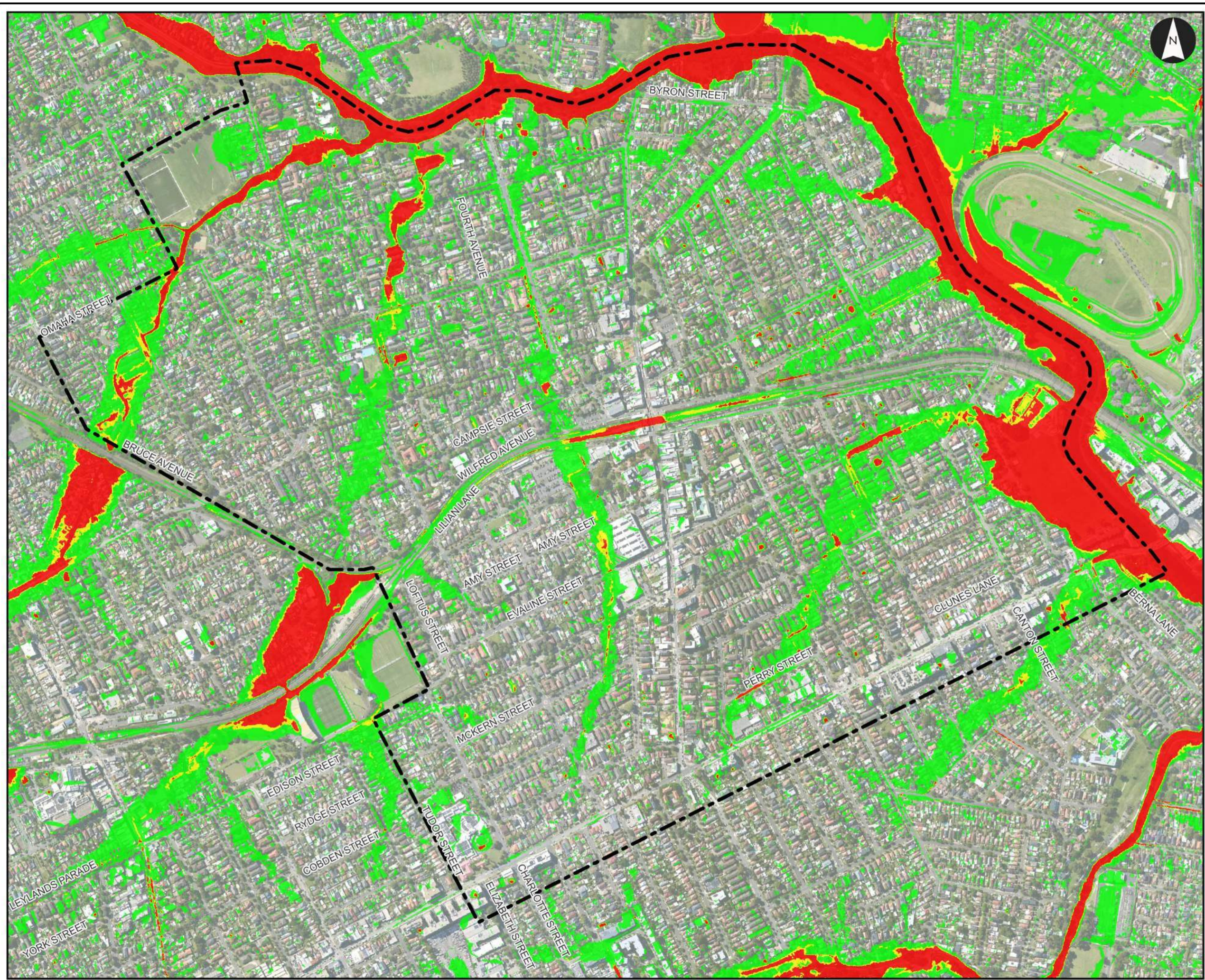
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.2% AEP Existing Condition
Provisional Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A22

Legend

 Campsie Study Area

Provisional Hazard

-  Low
-  Transitional
-  High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.05% AEP Existing Condition
Provisional Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A23

Legend

 Campsie Study Area

Provisional Hazard

-  Low
-  Transitional
-  High

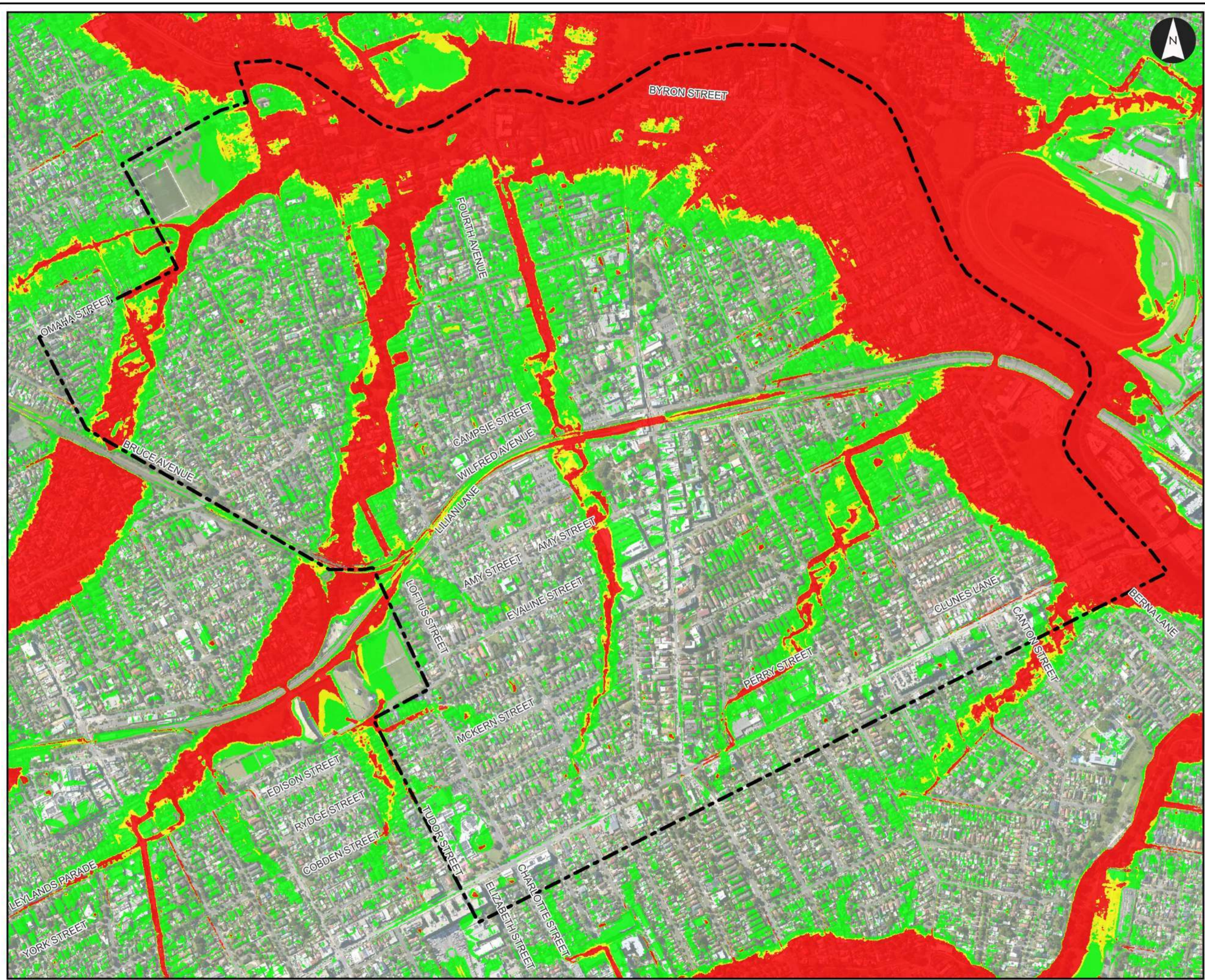
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**PMF Existing Condition
Provisional Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A24

Legend

 Campsie Study Area

Provisional Hazard

-  Low
-  Transitional
-  High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



90 0 90 180 270 360 m

Scale at A3: 1:9000





**5% AEP Existing Condition
Flood Hazard**

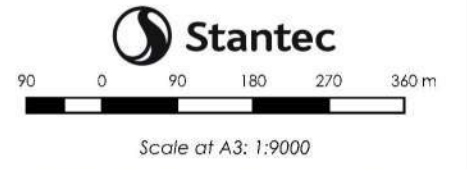
Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A25

- Legend**
- Campsie Study Area
- Hazard Category (H1 - H6)**
- 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:7856

References:
1. Metromap
2. Road NSW



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1% AEP Existing Condition Flood Hazard

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A26

Legend

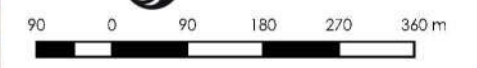
Campsie Study Area

Hazard Category (H1 - H6)

- 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.

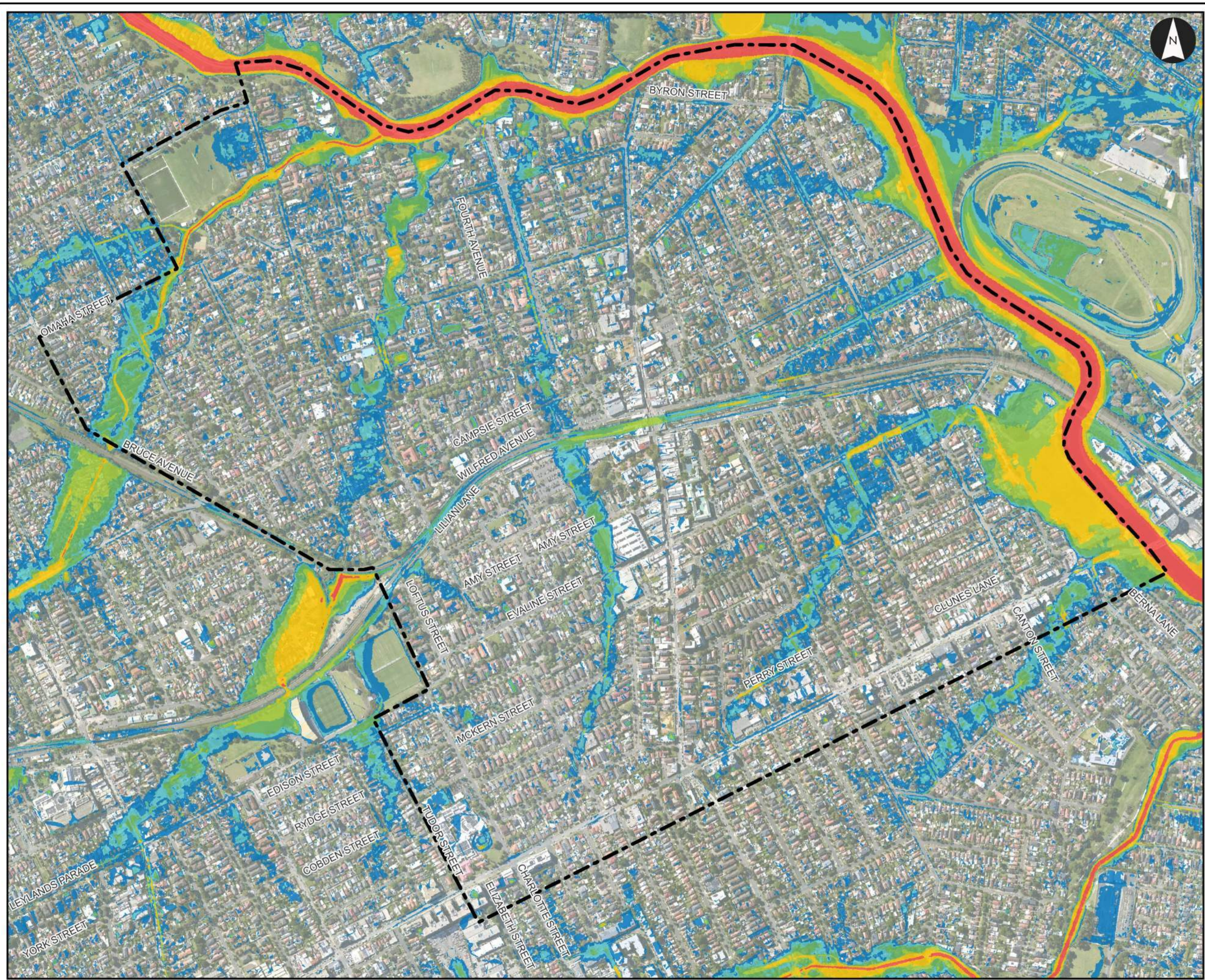
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.2% AEP Existing Condition
Flood Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A27

Legend

Campsie Study Area

Hazard Category (H1 - H6)

- 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.

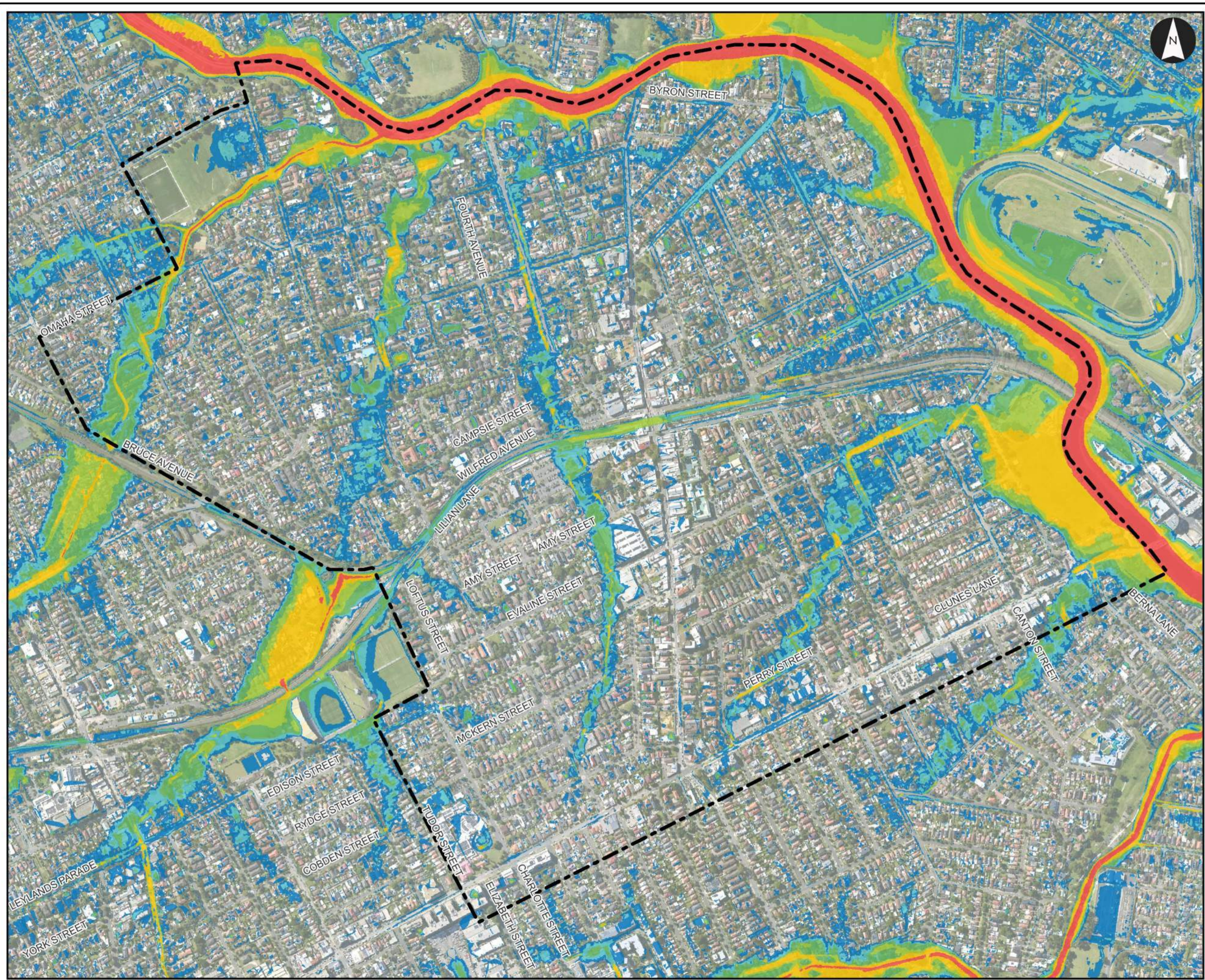
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.05% AEP Existing Condition
Flood Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A28

Legend

Campsie Study Area

Hazard Category (H1 - H6)

- 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:7856

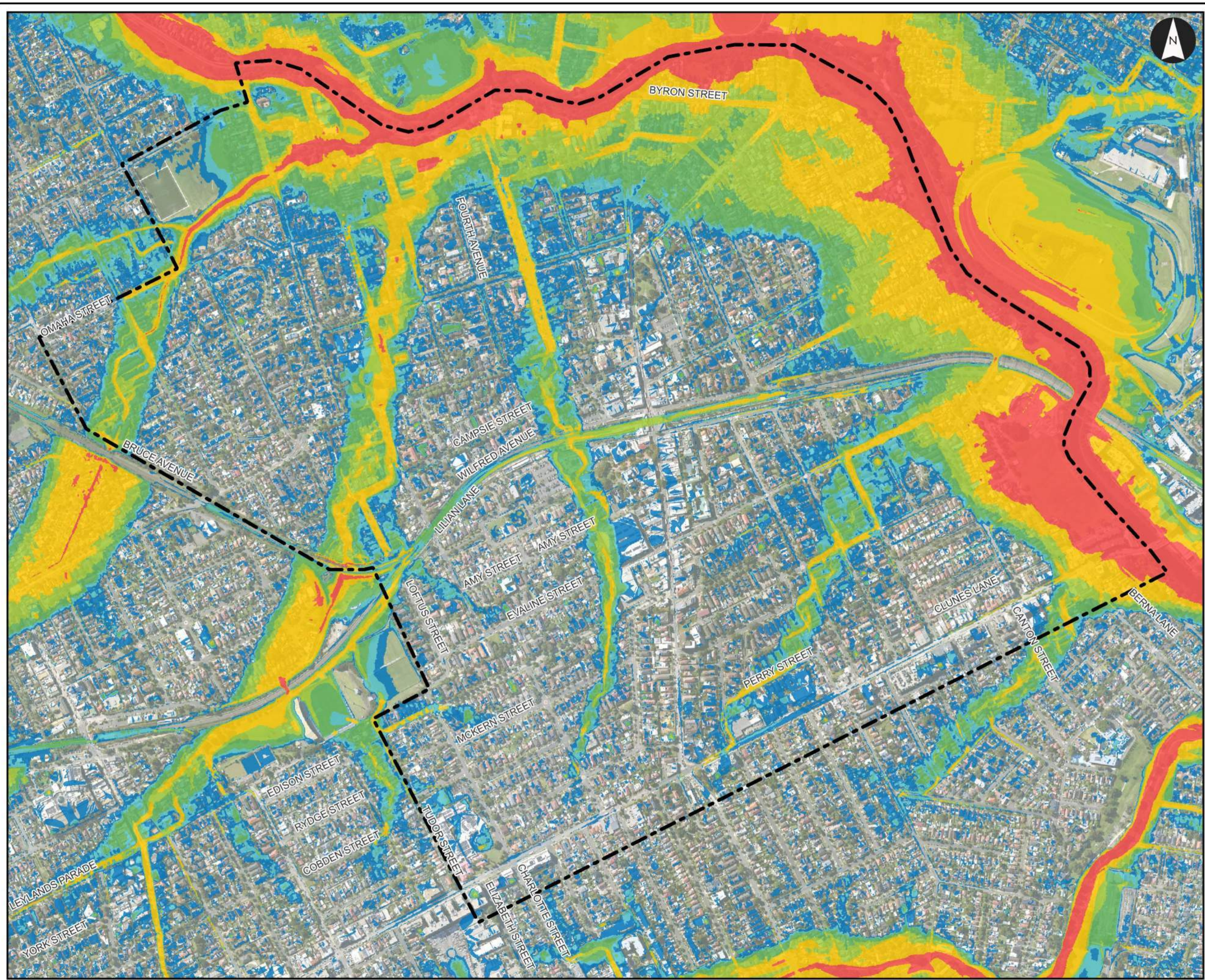
References:
1. Metromap
2. Road NSW

Stantec

90 0 90 180 270 360 m

Scale at A3: 1:9000





**PMF Existing Condition
Flood Hazard**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-21)
Figure No: A29

Legend

Campsie Study Area

Hazard Category (H1 - H6)

- 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:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





5% AEP Less 1% AEP Existing Condition Water Level Difference

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A30

Legend

 Campsie Study Area

Wet/Dry Analysis

-  Was Wet, Now Dry
-  Was Dry, Now Wet

Water Level Difference (m)

-  < -1.00
-  -1.00 to -0.50
-  -0.50 to -0.20
-  -0.20 to -0.10
-  -0.10 to -0.01
-  -0.01 to 0.01
-  0.01 to 0.10
-  0.10 to 0.20
-  0.20 to 0.50
-  0.50 to 1.00
-  > 1.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.2% AEP Less 1% AEP Existing
Condition
Water Level Difference**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A31

Legend

Campsie Study Area

Wet/Dry Analysis

- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -1.00
- 1.00 to -0.50
- 0.50 to -0.20
- 0.20 to -0.10
- 0.10 to -0.01
- 0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- 0.50 to 1.00
- > 1.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000



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**0.05% AEP Less 1% AEP Existing
Condition
Water Level Difference**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A32

Legend

Campsie Study Area

Wet/Dry Analysis

- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -1.00
- 1.00 to -0.50
- 0.50 to -0.20
- 0.20 to -0.10
- 0.10 to -0.01
- 0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- 0.50 to 1.00
- > 1.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000



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.



**PMF Less 1% AEP Existing Condition
Water Level Difference**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A33

Legend

Campsie Study Area

Wet/Dry Analysis

- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -1.00
- 1.00 to -0.50
- 0.50 to -0.20
- 0.20 to -0.10
- 0.10 to -0.01
- 0.01 to 0.01
- 0.01 to 0.10
- 0.10 to 0.20
- 0.20 to 0.50
- 0.50 to 1.00
- > 1.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**1% AEP Existing Condition
Flood Planning Area with 0.5m
freeboard applied**

Project: Campsie Rezoning - Updated Flood Risk
Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: SHP, Checked By: MG
Date: (2025-07-22)
Figure No: A34

Legend

-  Campsie Study Area
-  Flood Planning Area Extent

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW

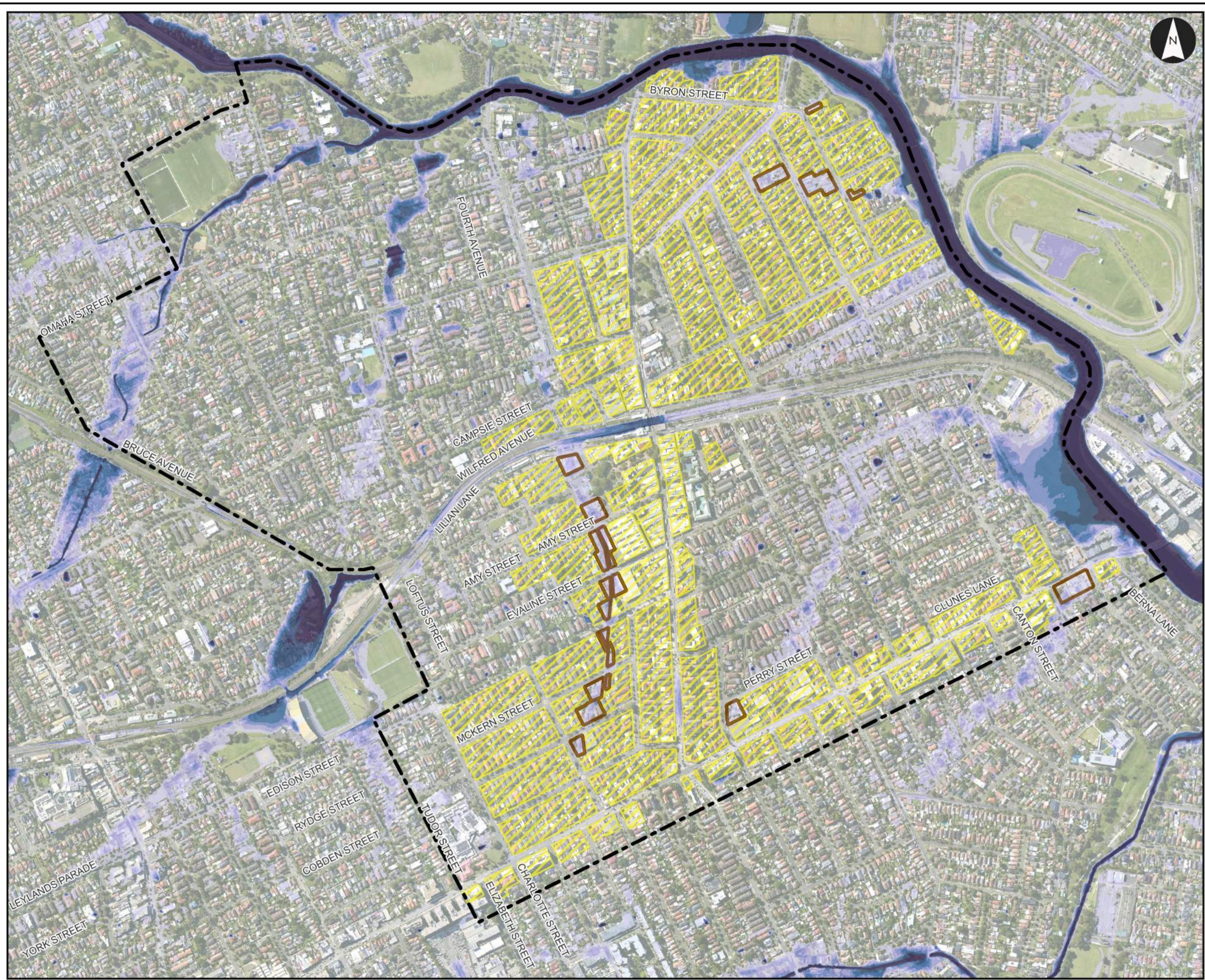


Scale at A3: 1:9000



Appendix B Flood Mapping (Post-Development Scenario) Figures





**5% AEP Flood Depth
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B1

Legend

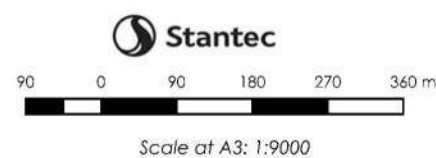
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

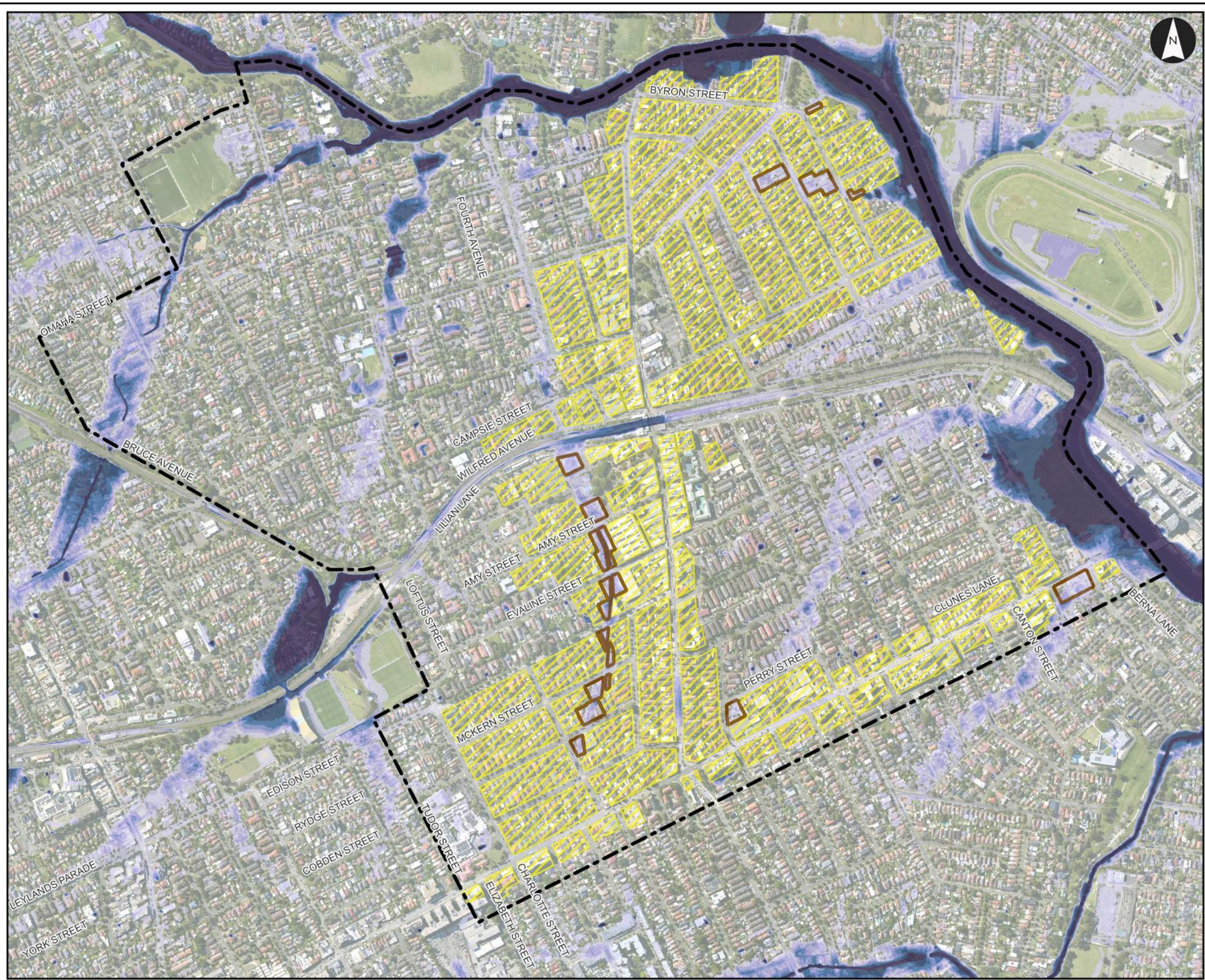
Flood Depth (m)

- 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:7856

References:
1. Metromap
2. Road NSW





**1% AEP Flood Depth
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B2

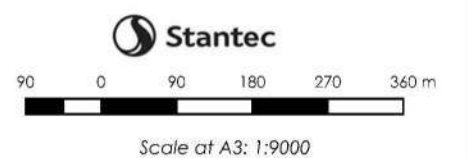
Legend

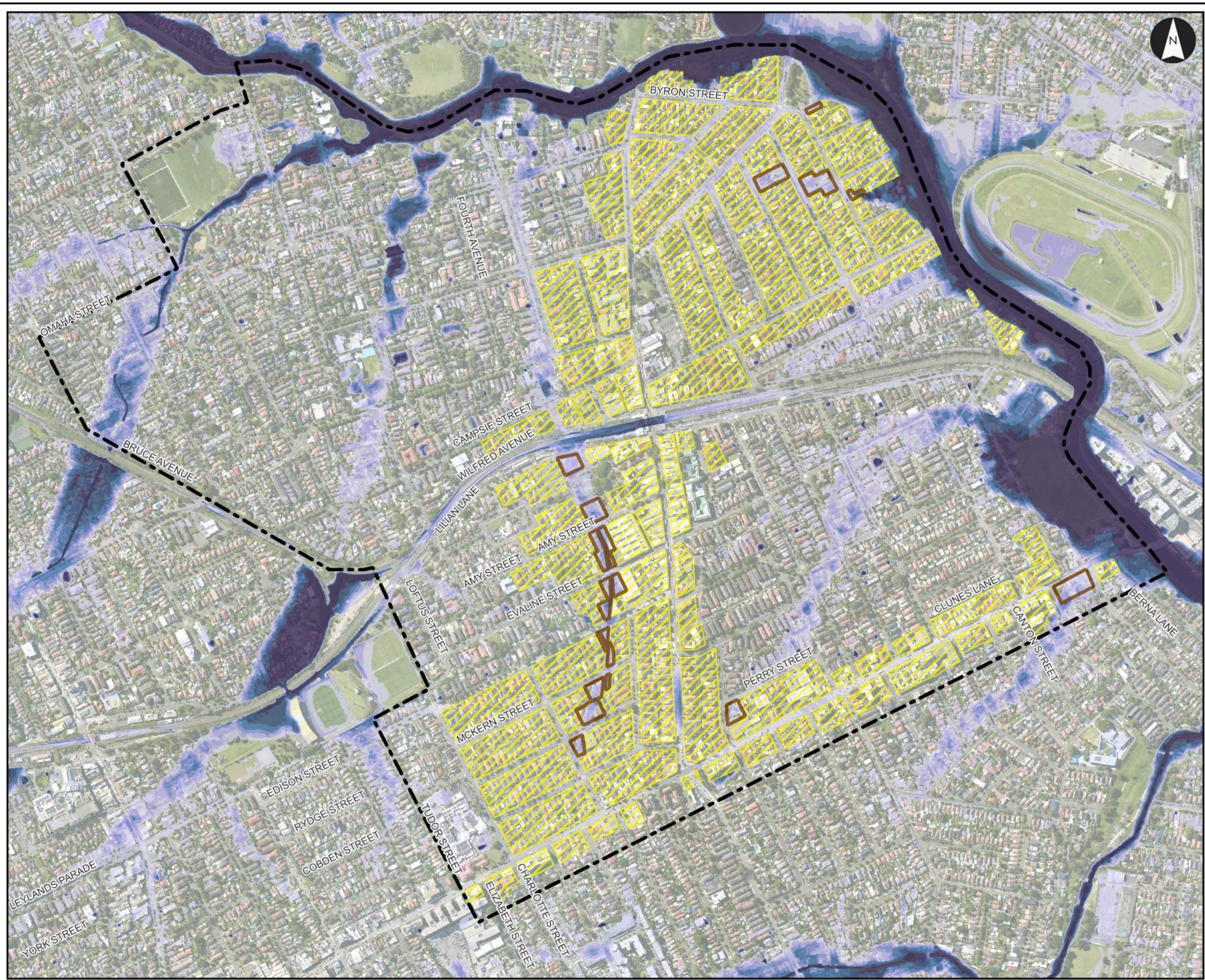
- Campsie Study Area
 - Blocked Buildings
 - Conveyance-preserving Building Zones
- Flood Depth (m)**

- 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:7856

References:
1. Metromap
2. Road NSW





**0.2% AEP Flood Depth
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B3

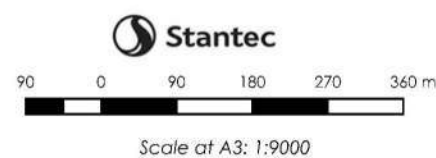
Legend

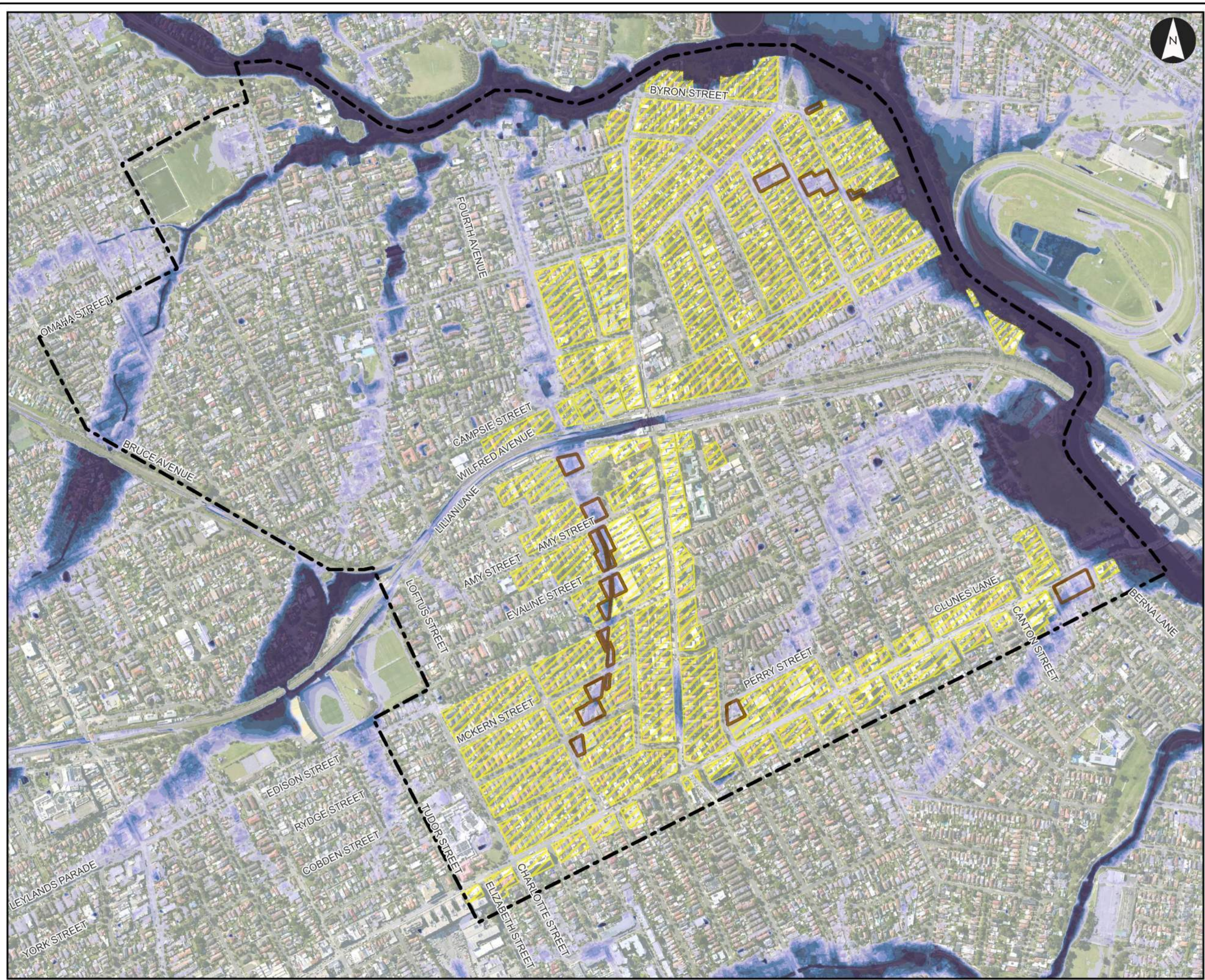
- Campsie Study Area
 - Blocked Buildings
 - Conveyance-preserving Building Zones
- Flood Depth (m)**

- 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:7856

References:
1. Metromap
2. Road NSW





**0.05% AEP Flood Depth
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B4

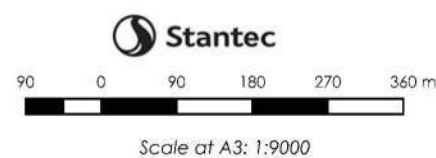
Legend

- Campsie Study Area
 - Blocked Buildings
 - Conveyance-preserving Building Zones
- 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:7856

References:
1. Metromap
2. Road NSW





**PMF Flood Depth
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B5

Legend

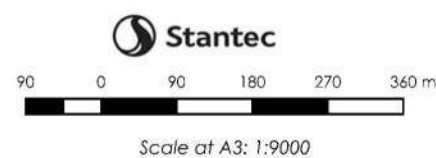
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

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:7856

References:
1. Metromap
2. Road NSW





**5% AEP Flood Velocity
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B6

Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

Flood Velocity (m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**1% AEP Flood Velocity
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B7

Legend

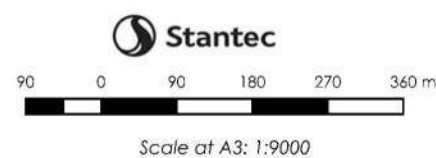
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

Flood Velocity (m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.2% AEP Flood Velocity
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B8

Legend

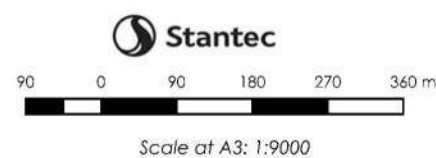
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

Flood Velocity (m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.05% AEP Flood Velocity
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B9

Legend

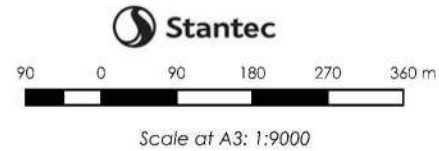
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones

Flood Velocity (m/s)

- 0.00 to 0.50
- 0.50 to 1.00
- 1.00 to 1.50
- 1.50 to 2.00
- 2.00 to 3.00
- > 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





PMF Flood Velocity Post Development Condition

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B10

Legend

Campsie Study Area

Blocked Buildings

Conveyance-preserving
Building Zones

Flood Velocity (m/s)

0.00 to 0.50

0.50 to 1.00

1.00 to 1.50

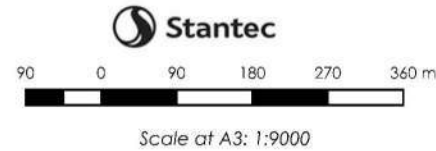
1.50 to 2.00

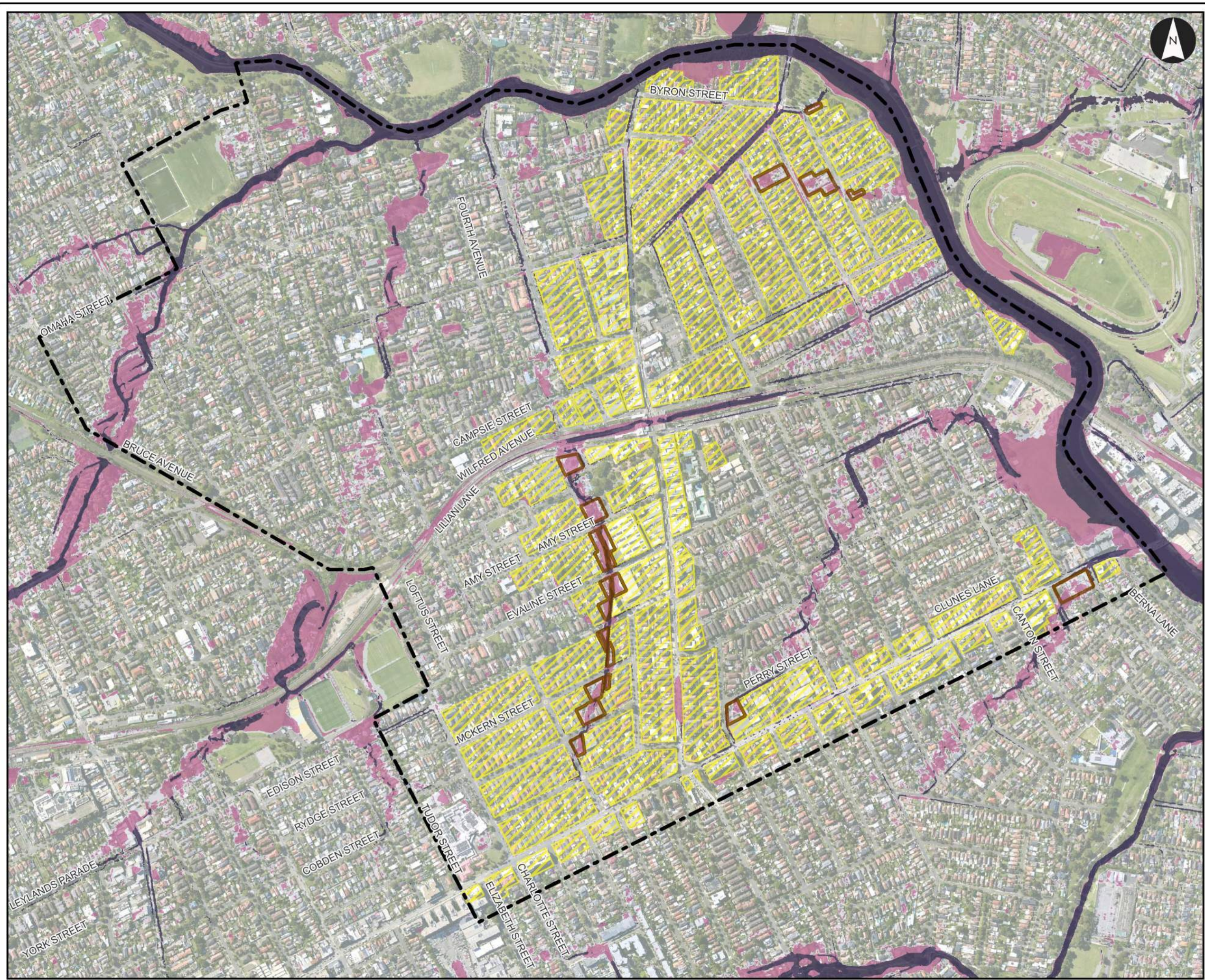
2.00 to 3.00

> 3.00

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**5% AEP Hydraulic Category
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

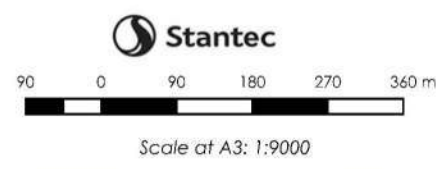
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B11

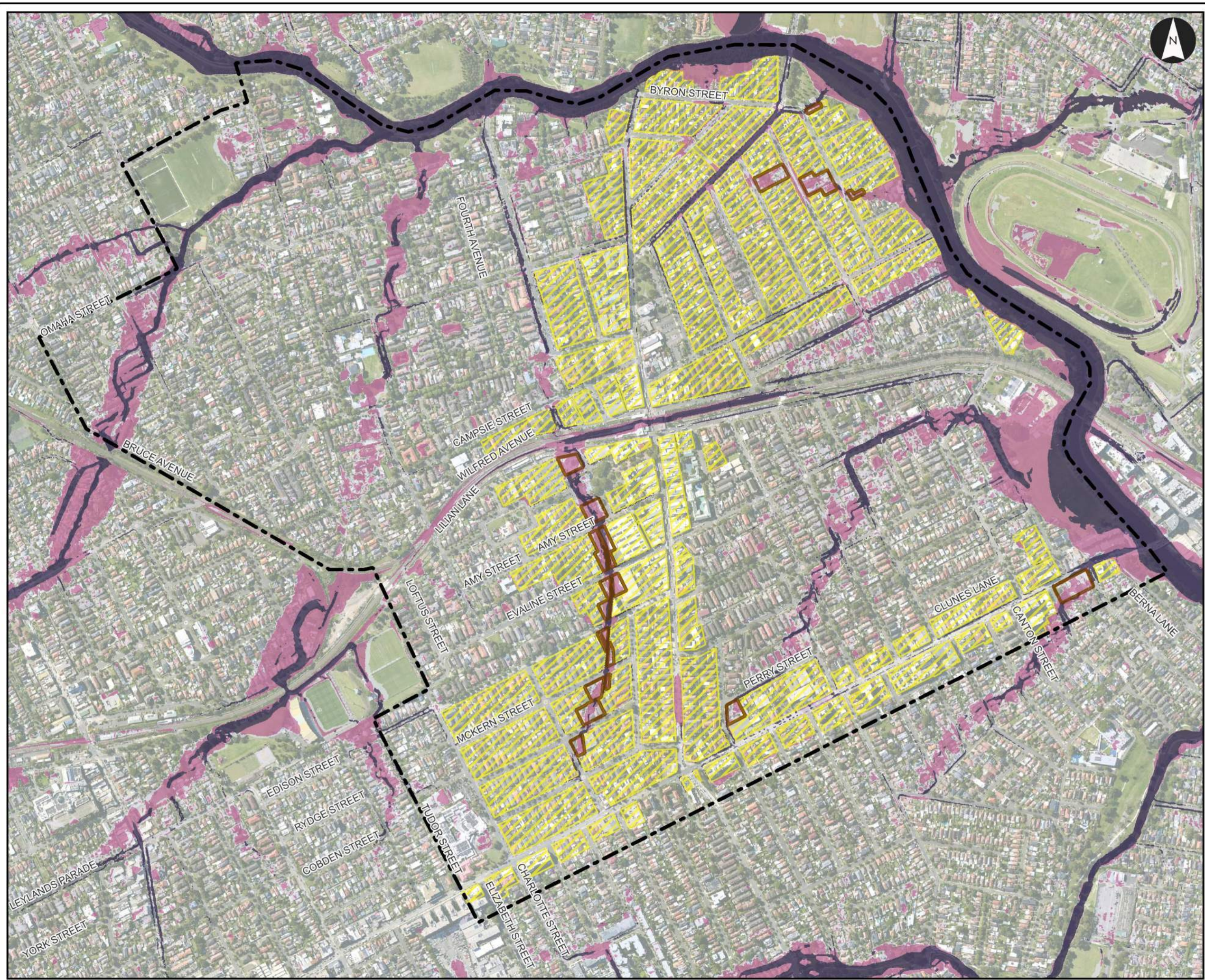
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hydraulic Category**
 - Flood Fringe
 - Flood Storage
 - Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**1% AEP Hydraulic Category
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

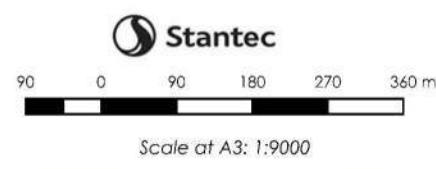
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B12

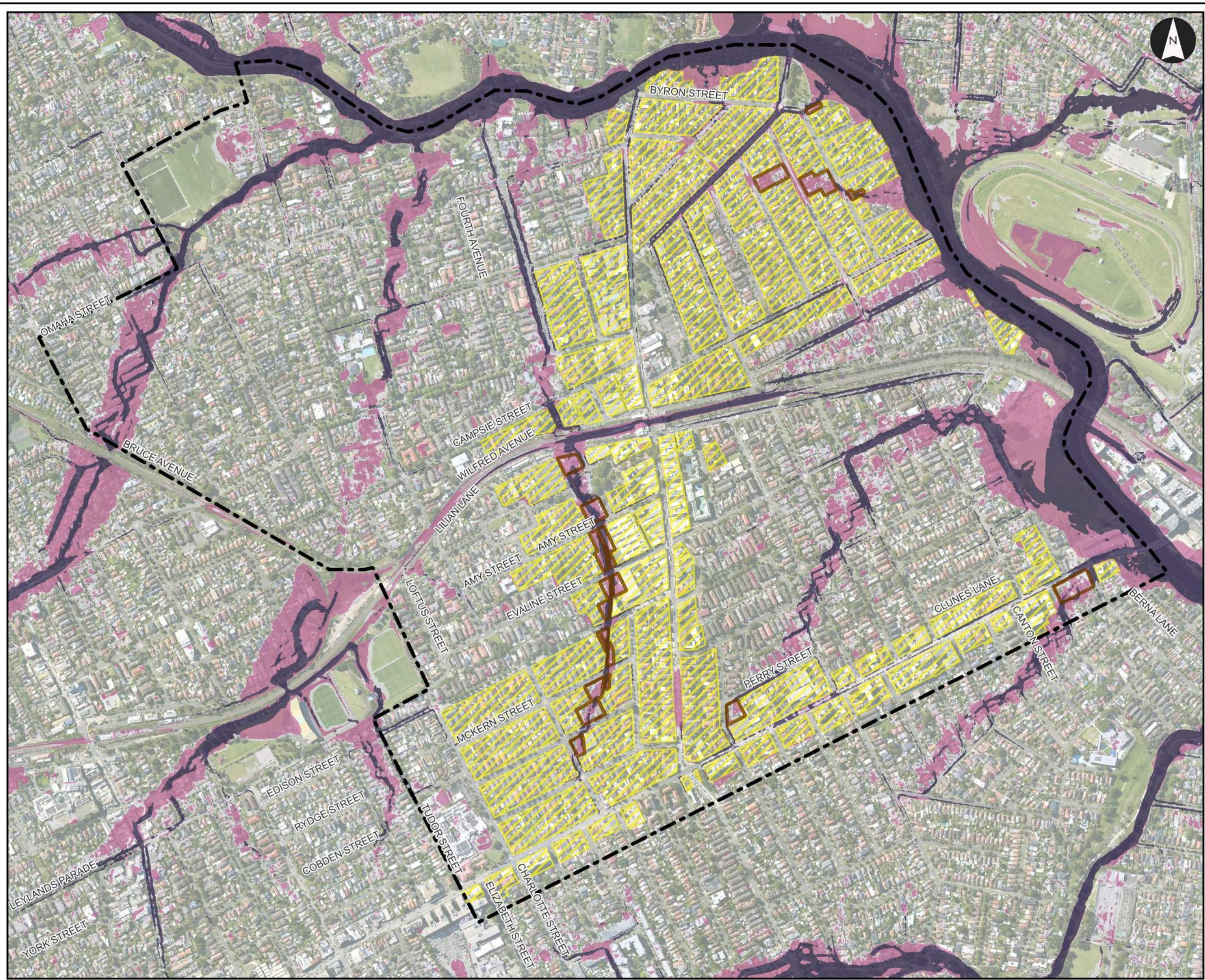
Legend

-  Campsie Study Area
-  Blocked Buildings
-  Conveyance-preserving Building Zones
- Hydraulic Category**
 -  Flood Fringe
 -  Flood Storage
 -  Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.2% AEP Hydraulic Category
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

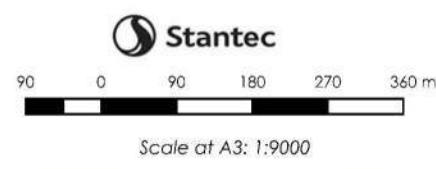
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B13

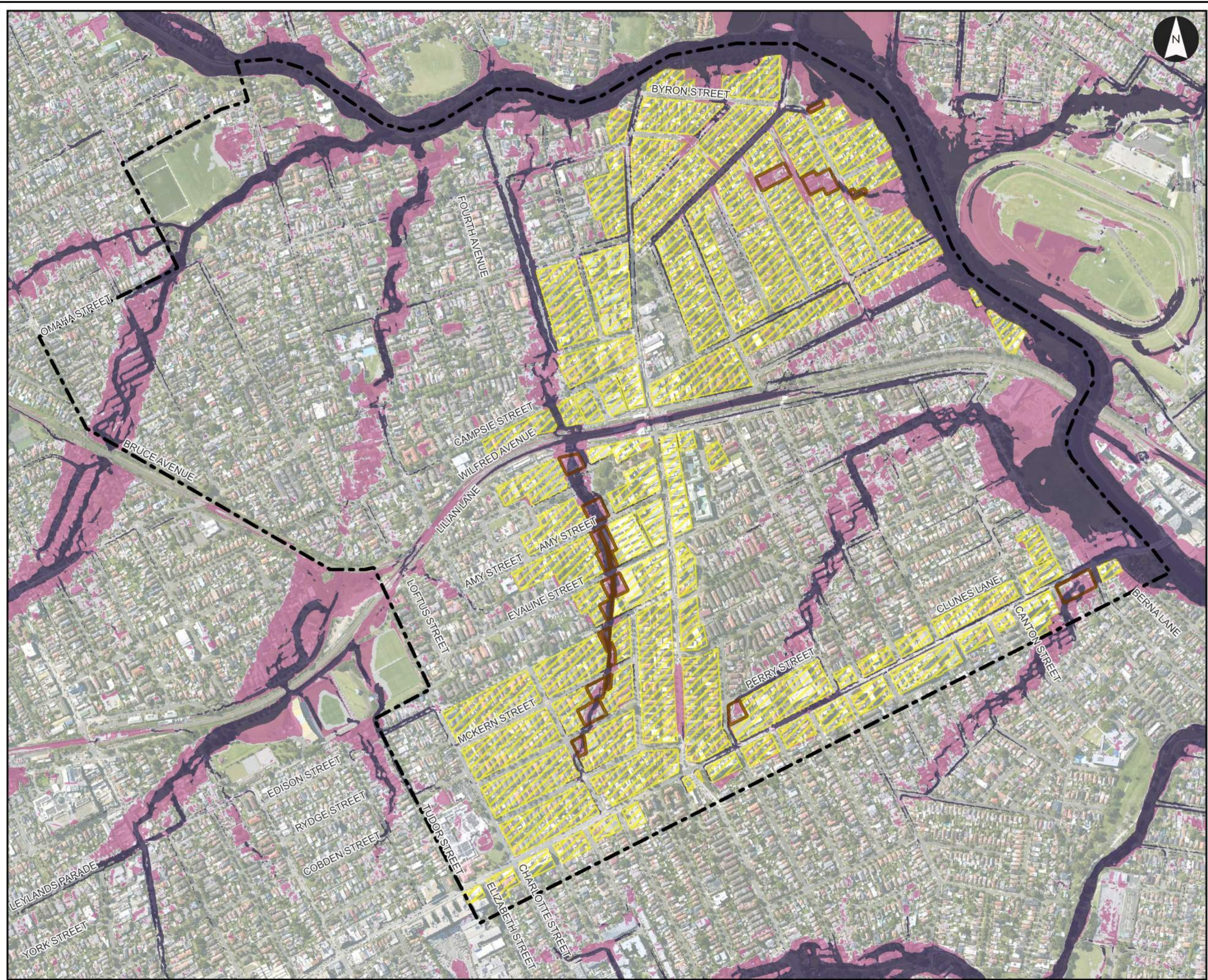
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hydraulic Category**
 - Flood Fringe
 - Flood Storage
 - Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





0.05% AEP Hydraulic Category Post Development Condition

Project: Campsie Rezoning - Updated Flood Risk Assessment

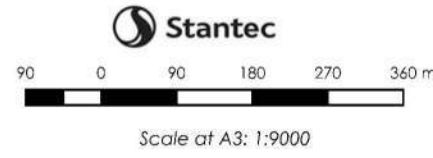
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B14

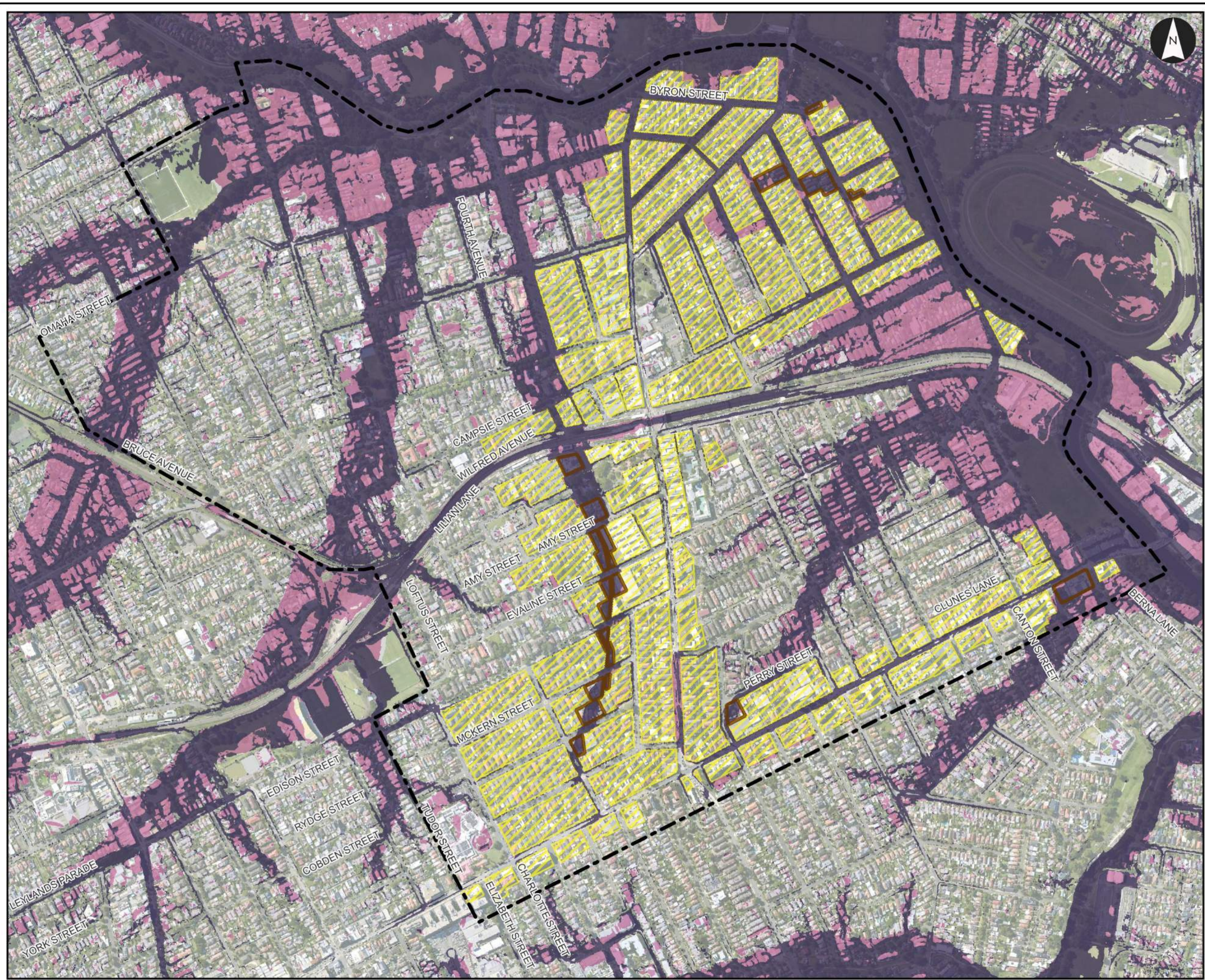
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hydraulic Category**
 - Flood Fringe
 - Flood Storage
 - Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**PMF Hydraulic Category
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

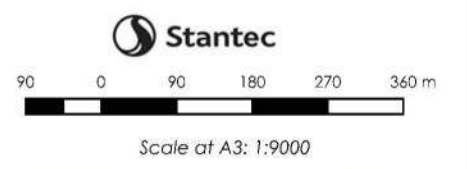
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B15

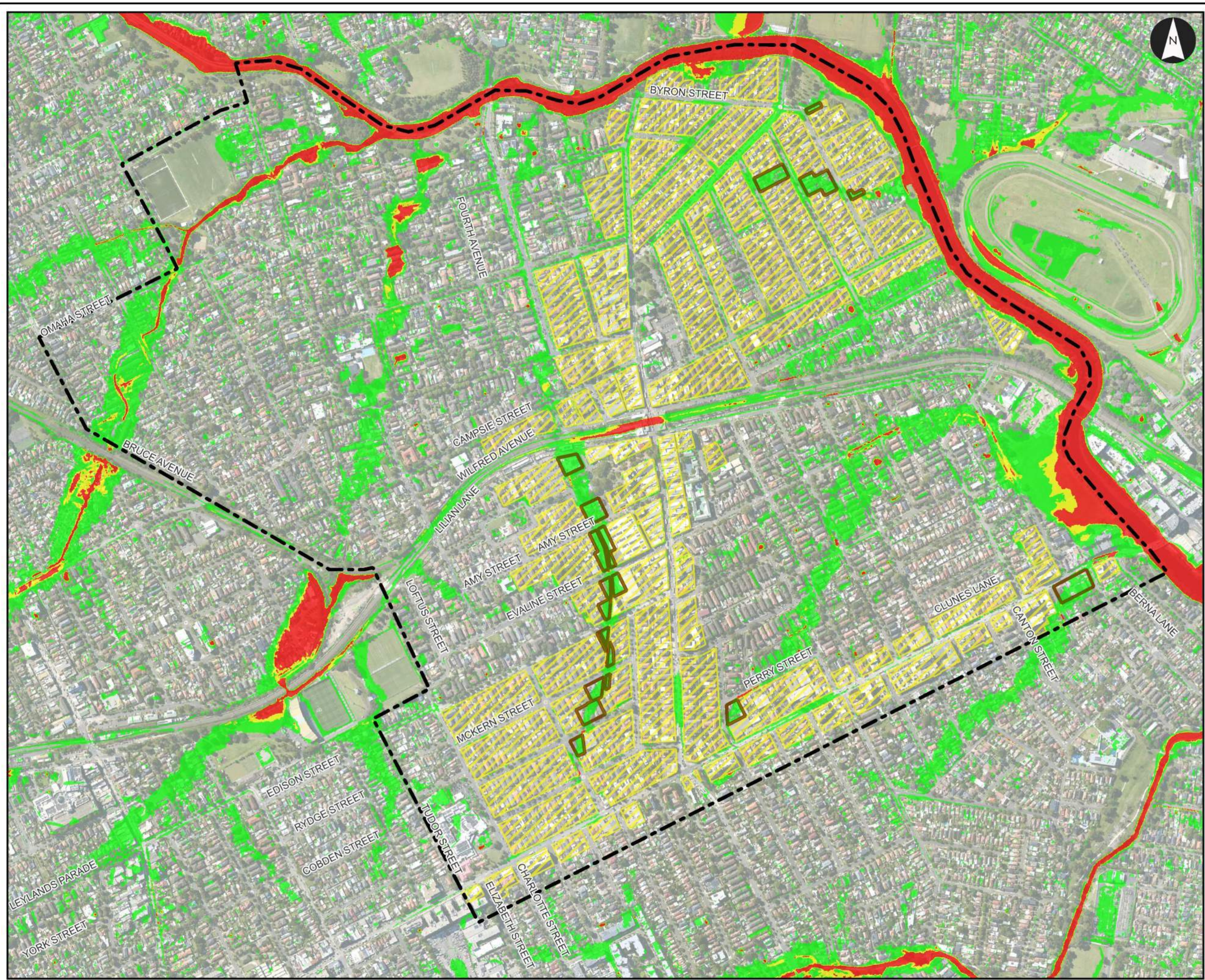
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hydraulic Category**
 - Flood Fringe
 - Flood Storage
 - Floodway

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**5% AEP Provisional Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

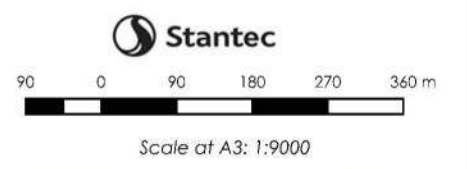
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B16

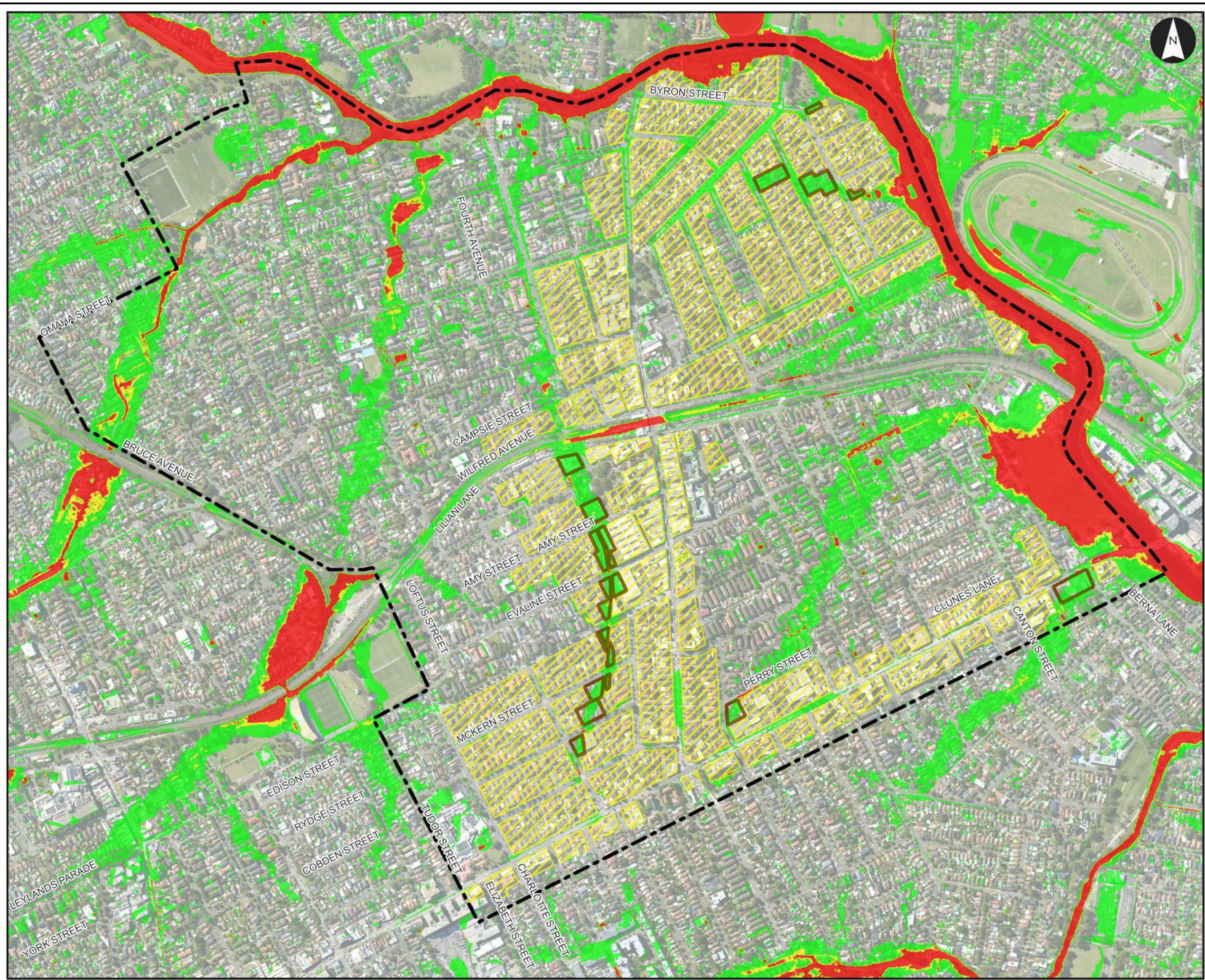
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Provisional Hazard**
 - Low
 - Transitional
 - High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**1% AEP Provisional Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

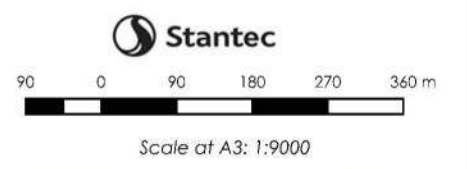
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B17

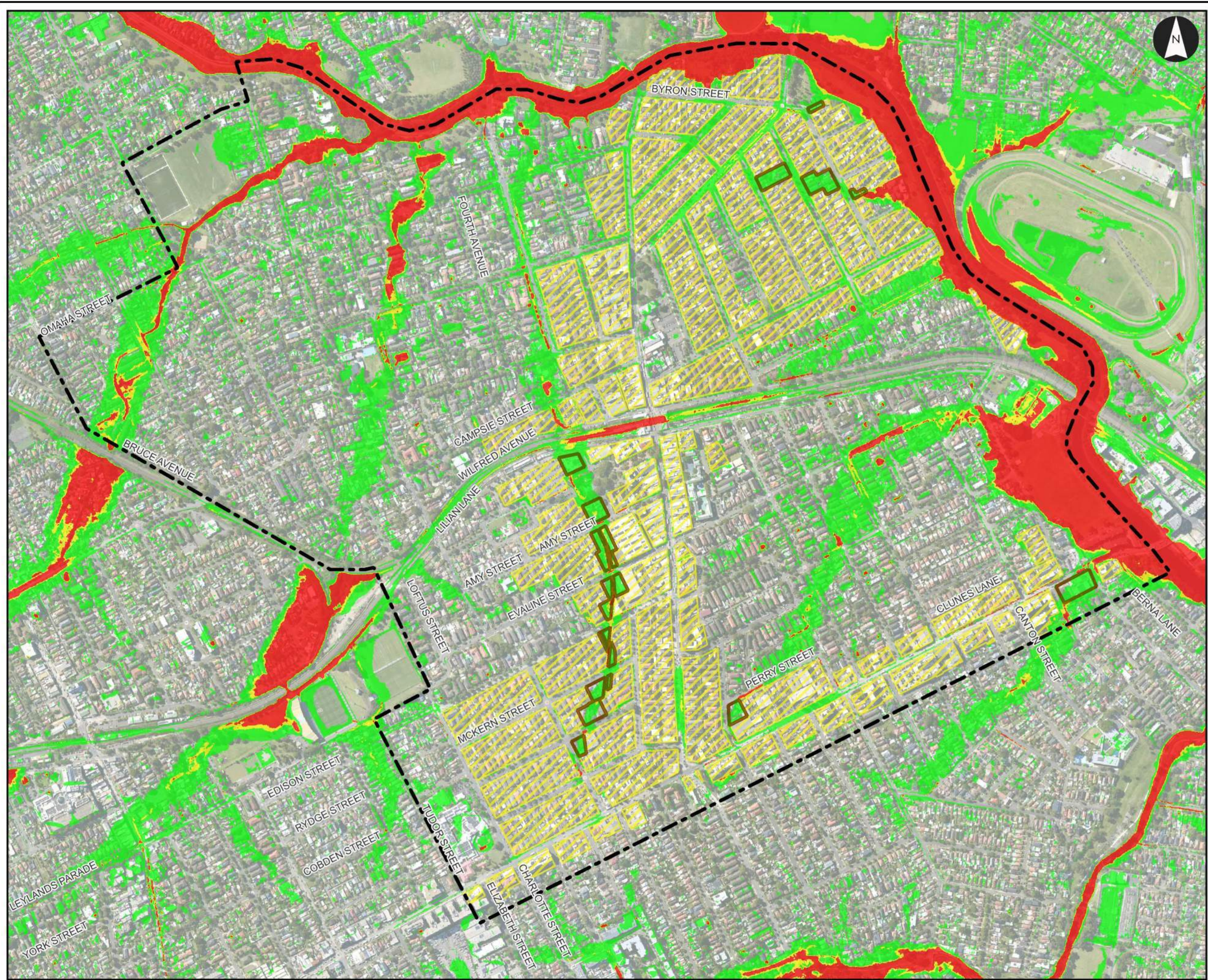
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Provisional Hazard**
 - Low
 - Transitional
 - High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





**0.2% AEP Provisional Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk
Assessment

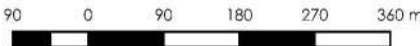
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B18

Legend

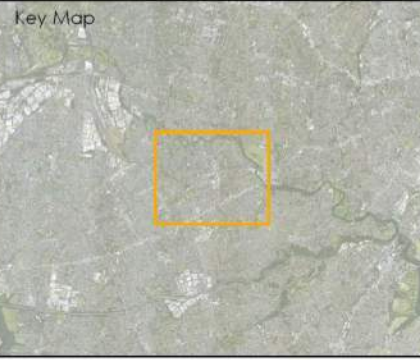
- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving
Building Zones
- Provisional Hazard**
 - Low
 - Transitional
 - High

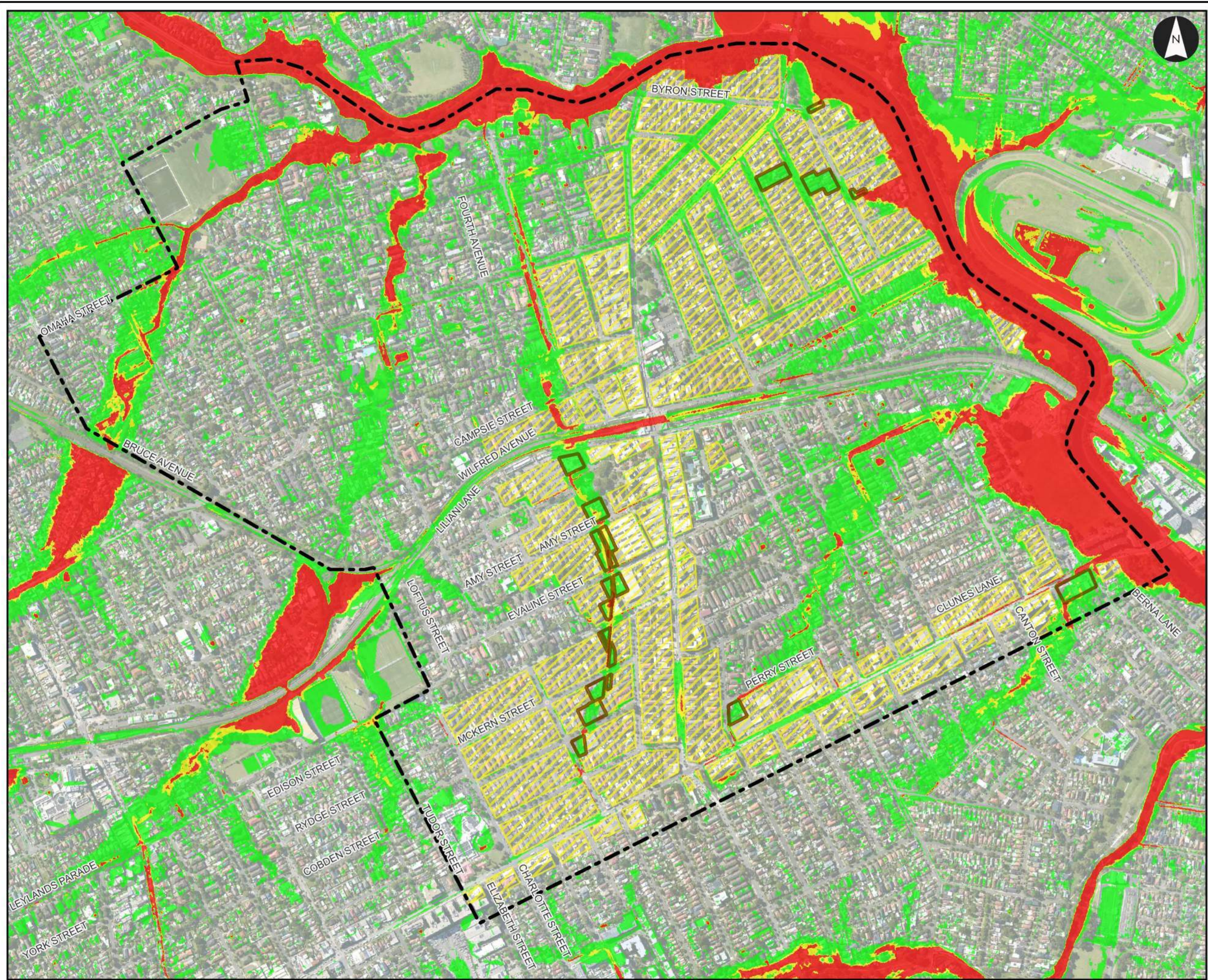
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





0.05% AEP Provisional Hazard Post Development Condition

Project: Campsie Rezoning - Updated Flood Risk Assessment

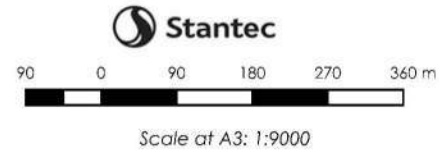
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B19

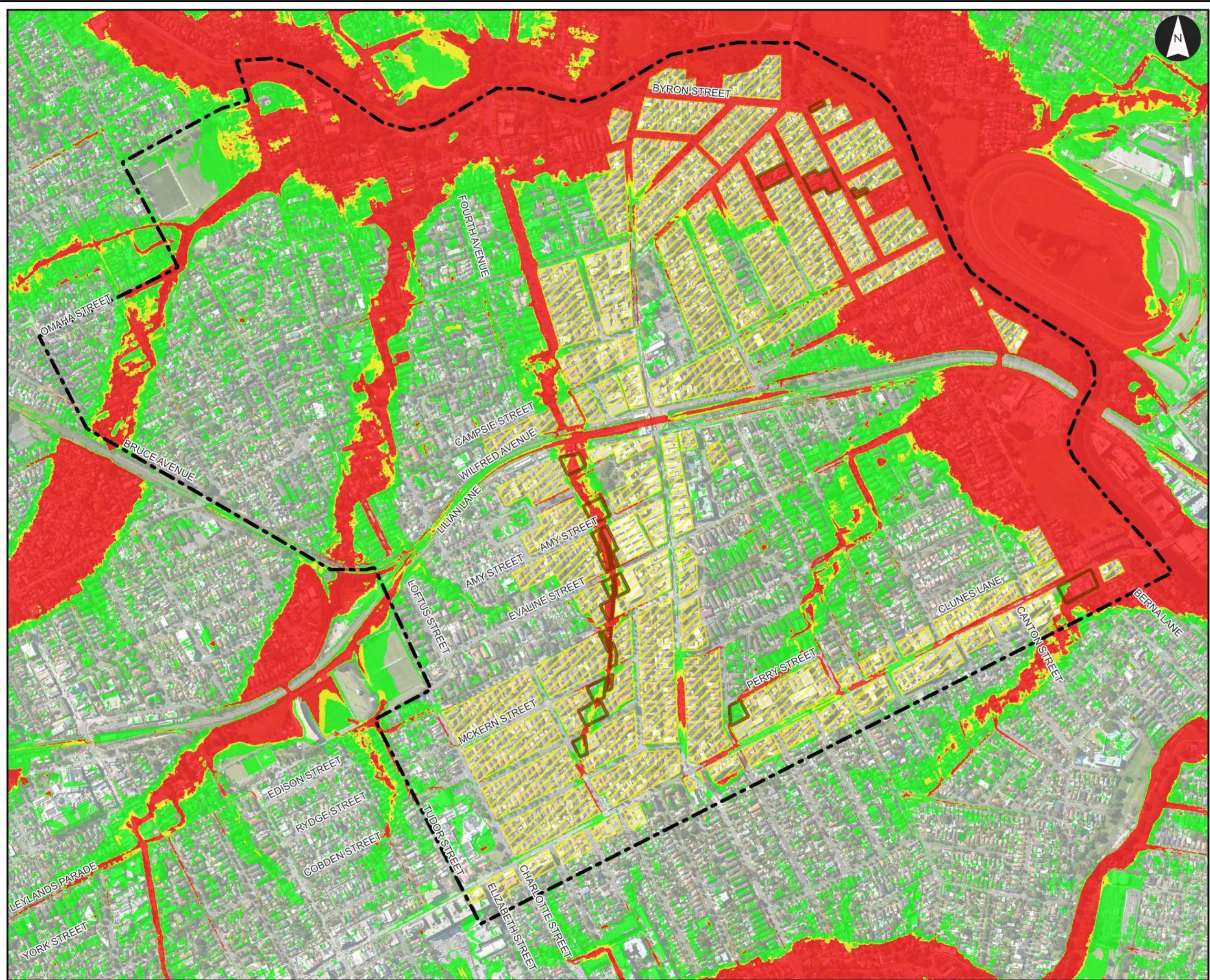
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Provisional Hazard**
 - Low
 - Transitional
 - High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





PMF Provisional Hazard Post Development Condition

Project: Campsie Rezoning - Updated Flood Risk Assessment

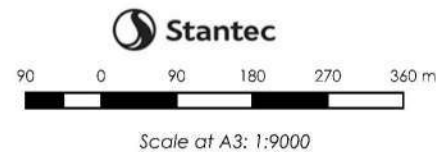
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B20

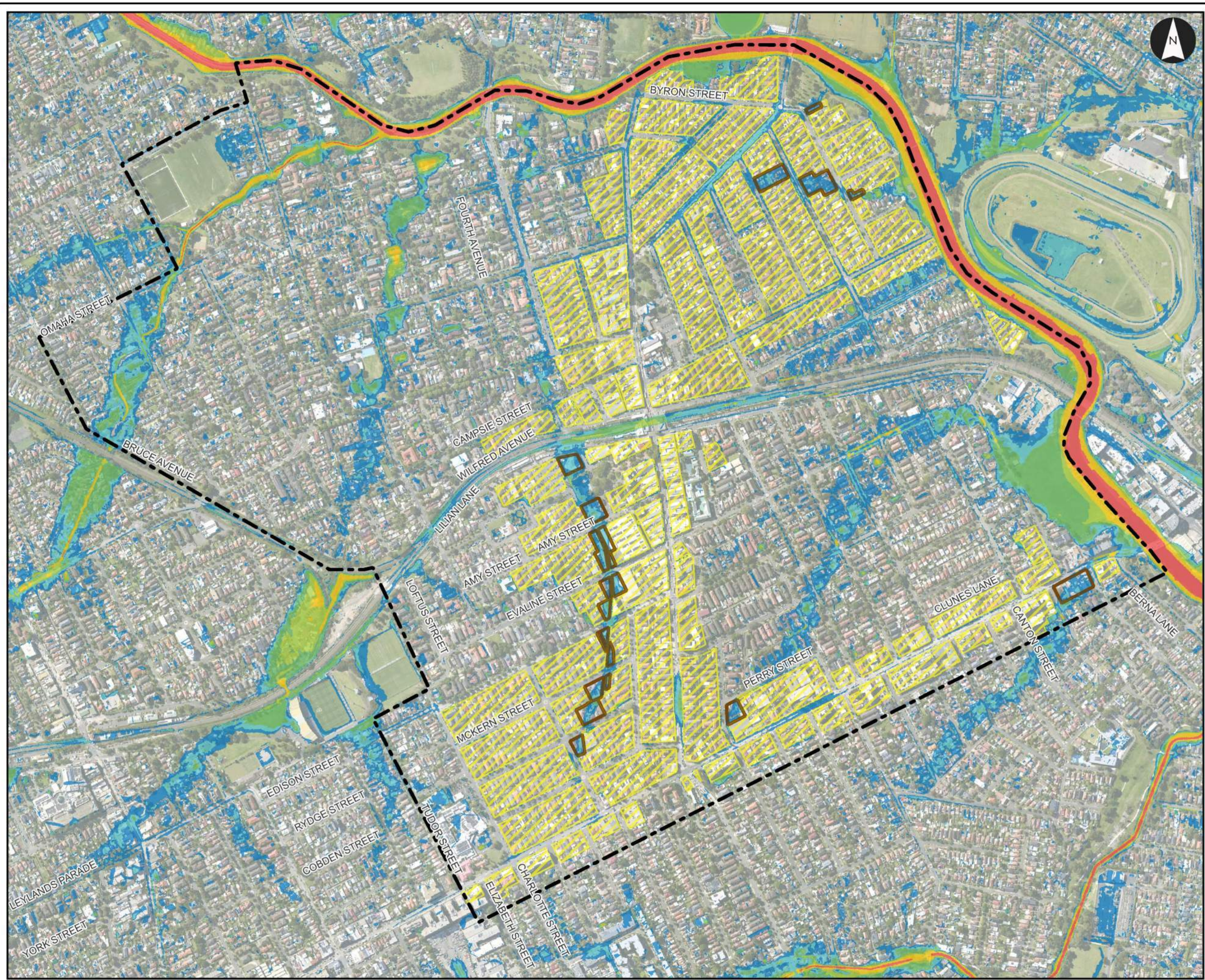
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Provisional Hazard**
 - Low
 - Transitional
 - High

Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW





5% AEP Flood Hazard Post Development Condition

Project: Campsie Rezoning - Updated Flood Risk Assessment

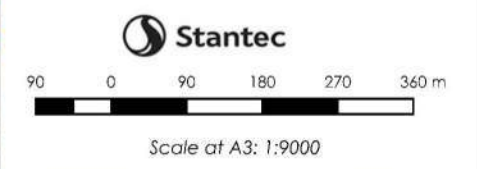
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B21

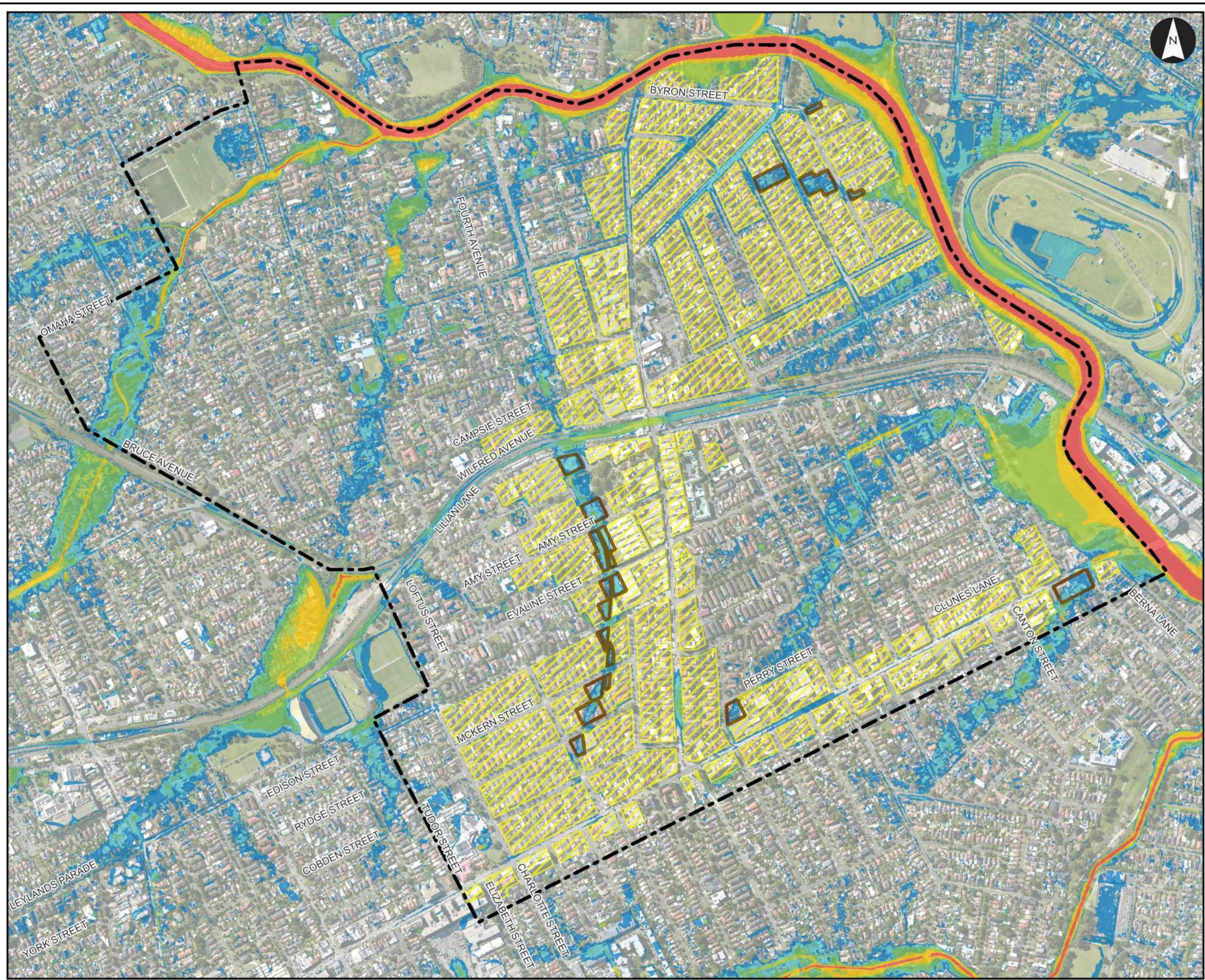
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hazard Category (H1 - H6)**
 - 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:7856

References:
1. Metromap
2. Road NSW





**1% AEP Flood Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

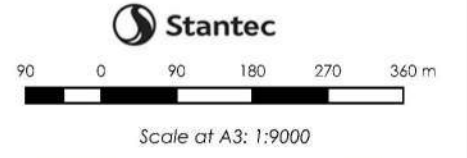
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B22

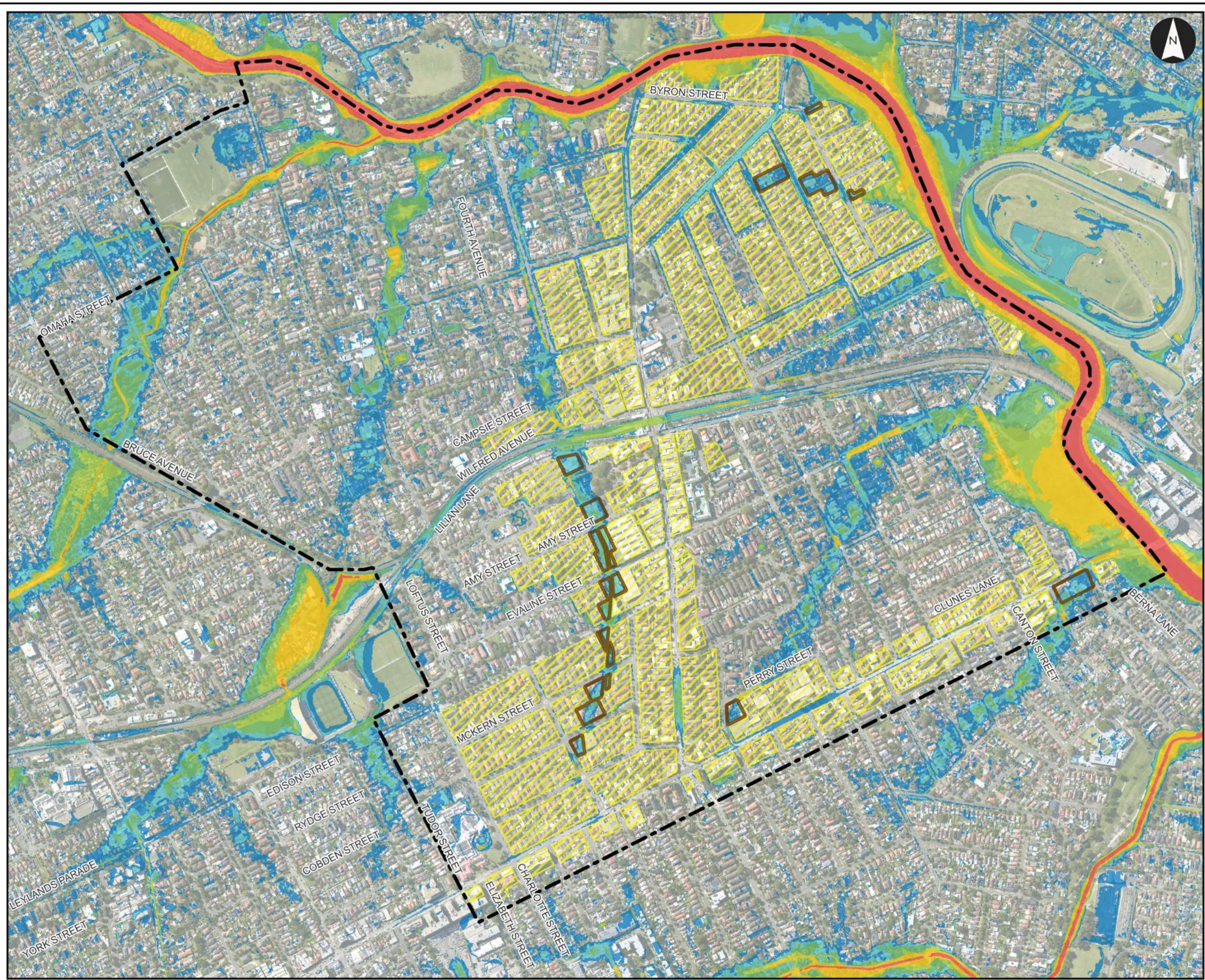
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hazard Category (H1 - H6)**
 - 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:7856

References:
1. Metromap
2. Road NSW





**0.2% AEP Flood Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B23

Legend

Campsie Study Area

Blocked Buildings

Conveyance-preserving Building Zones

Hazard Category (H1 - H6)

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.

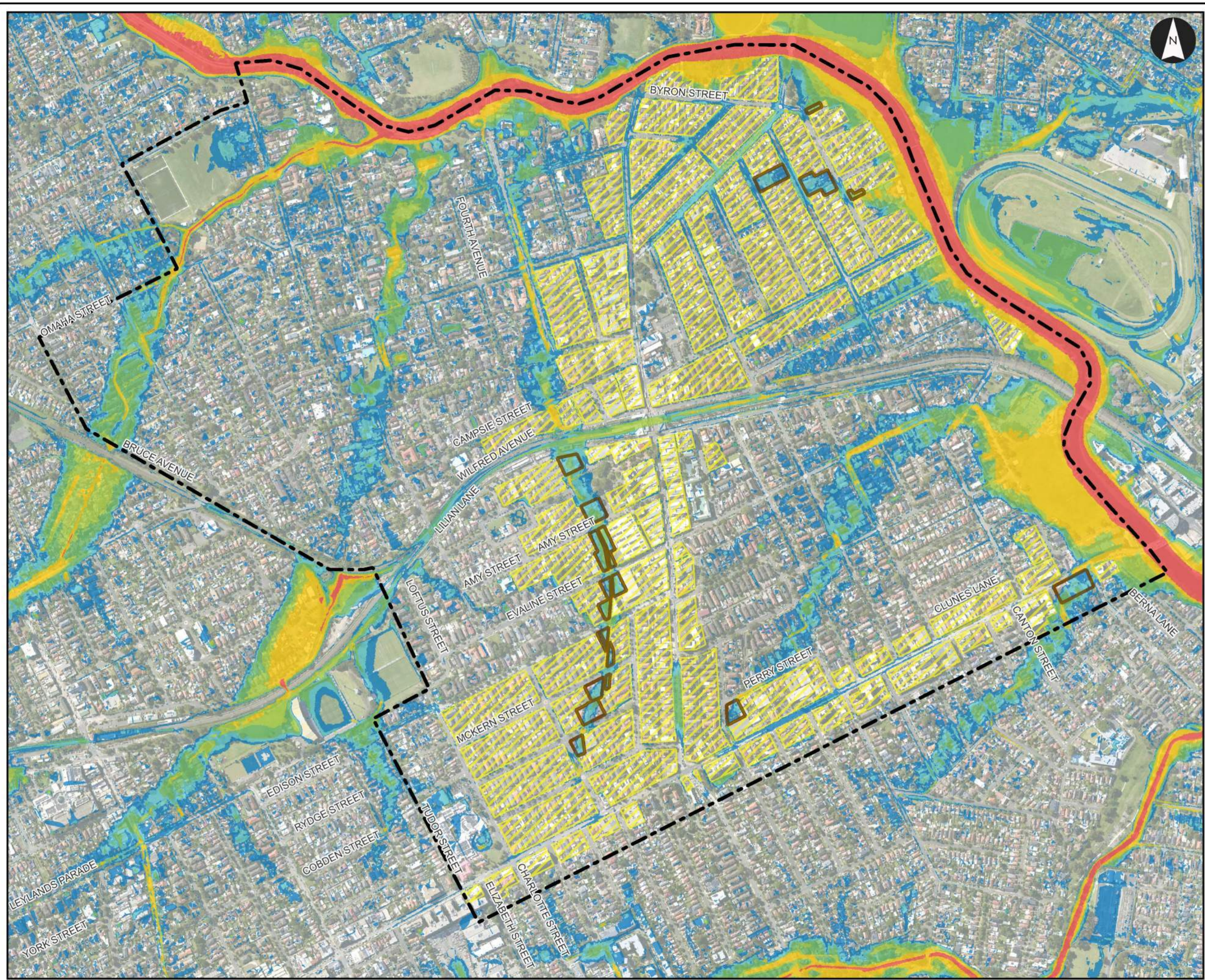
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**0.05% AEP Flood Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

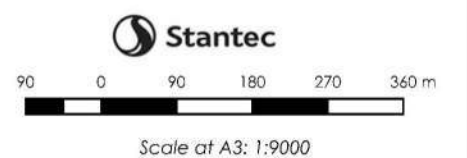
Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B24

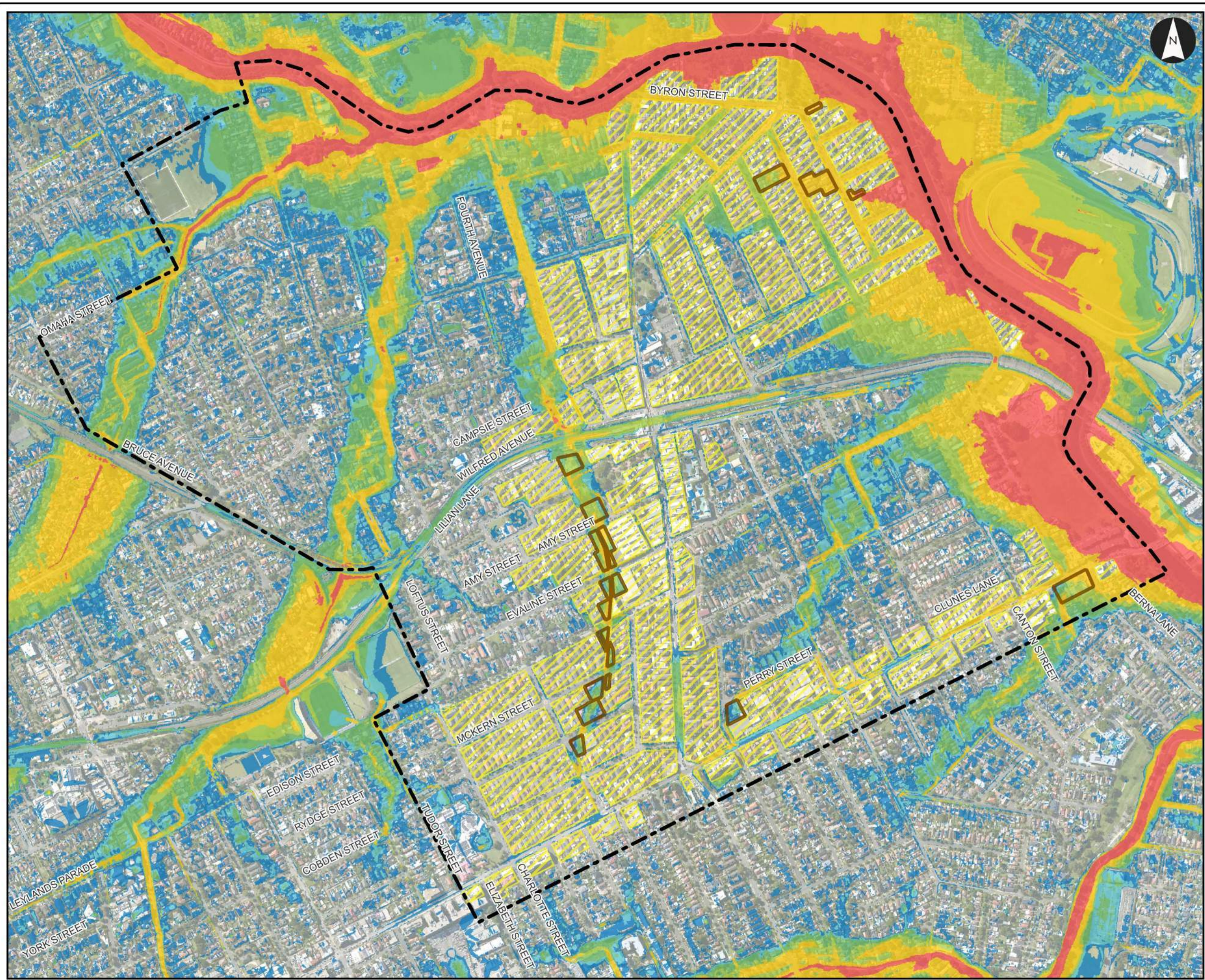
Legend

- Campsie Study Area
- Blocked Buildings
- Conveyance-preserving Building Zones
- Hazard Category (H1 - H6)**
 - 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:7856

References:
1. Metromap
2. Road NSW





**PMF Flood Hazard
Post Development Condition**

Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204303
Drawn By: HR, Checked By: MG
Date: (2025-07-21)
Figure No: B25

Legend

Campsie Study Area

Blocked Buildings

Conveyance-preserving Building Zones

Hazard Category (H1 - H6)

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.

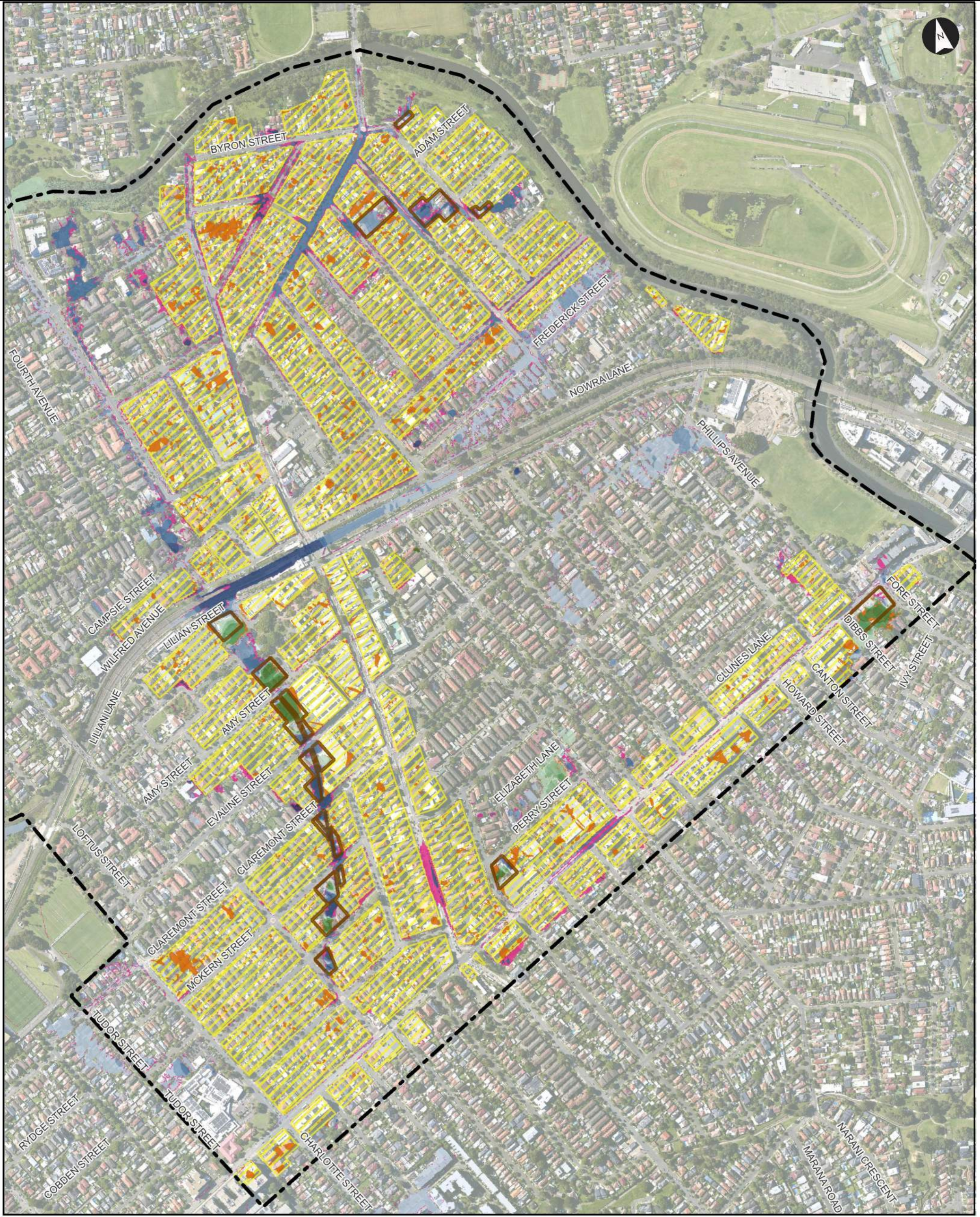
Notes:
1. Map displayed in EPSG:7856

References:
1. Metromap
2. Road NSW



Scale at A3: 1:9000





**5% AEP Water Level Difference
Post Development Condition**

Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304

Drawn By: HR, Checked By: MG
Date: (2025-07-22)

Figure No: B26



Legend

Campsie Study Area

Wet/Dry Analysis

Was Wet, Now Dry

Was Dry, Now Wet

Water Level Difference (m)

- < -0.50
- 0.50 to -0.10
- 0.10 to -0.05
- 0.05 to -0.03
- 0.03 to -0.01
- 0.01 to 0.01
- 0.01 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- > 0.50

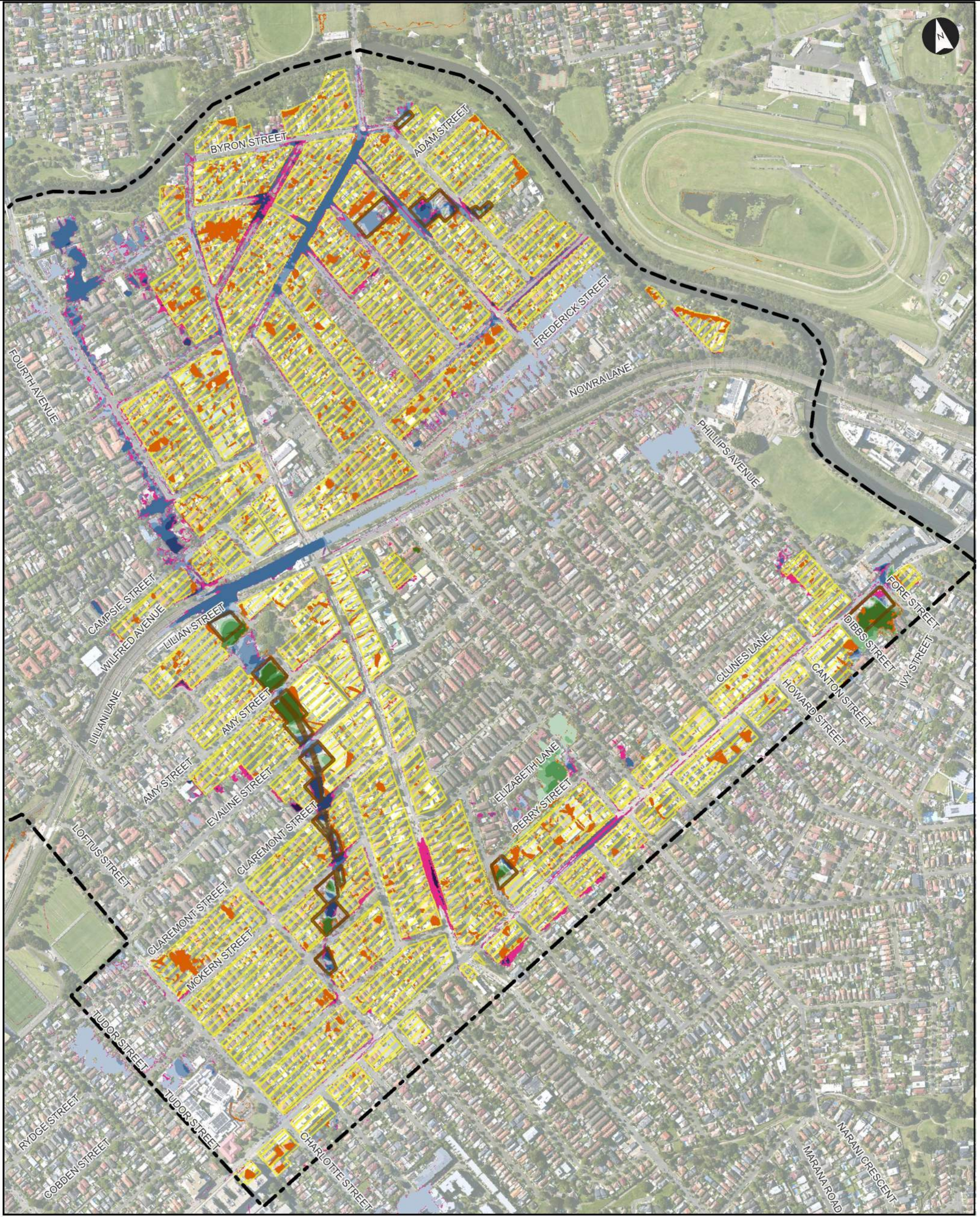
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





**1% AEP Water Level Difference
Post Development Condition Less
Existing Condition**
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B27



Legend

- Campsie Study Area
- Wet/Dry Analysis**
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -0.50
- 0.50 to -0.10
- 0.10 to -0.05
- 0.05 to -0.03
- 0.03 to -0.01
- 0.01 to 0.01
- 0.01 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- > 0.50

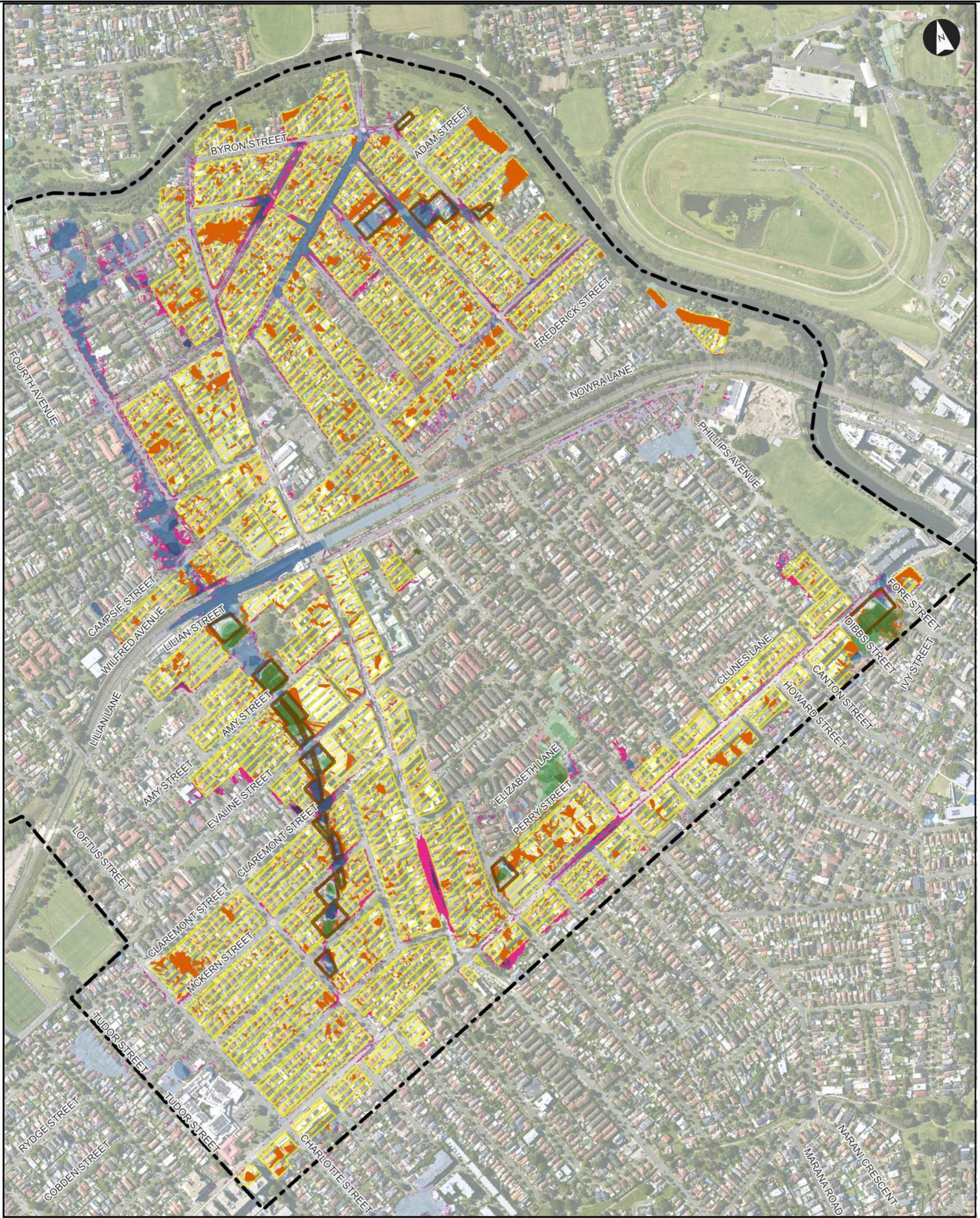
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





**0.2% AEP Water Level Difference
Post Development Condition Less
Existing Condition**

Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council

Project Code: 300204304

Drawn By: HR, Checked By: MG

Date: (2025-07-22)

Figure No: B28



Legend

Campsie Study Area

Wet/Dry Analysis

Was Wet, Now Dry

Was Dry, Now Wet

Water Level Difference (m)

- < -0.50
- 0.50 to -0.10
- 0.10 to -0.05
- 0.05 to -0.03
- 0.03 to -0.01
- 0.01 to 0.01
- 0.01 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- > 0.50

Notes:

1. Map displayed in EPSG:7856

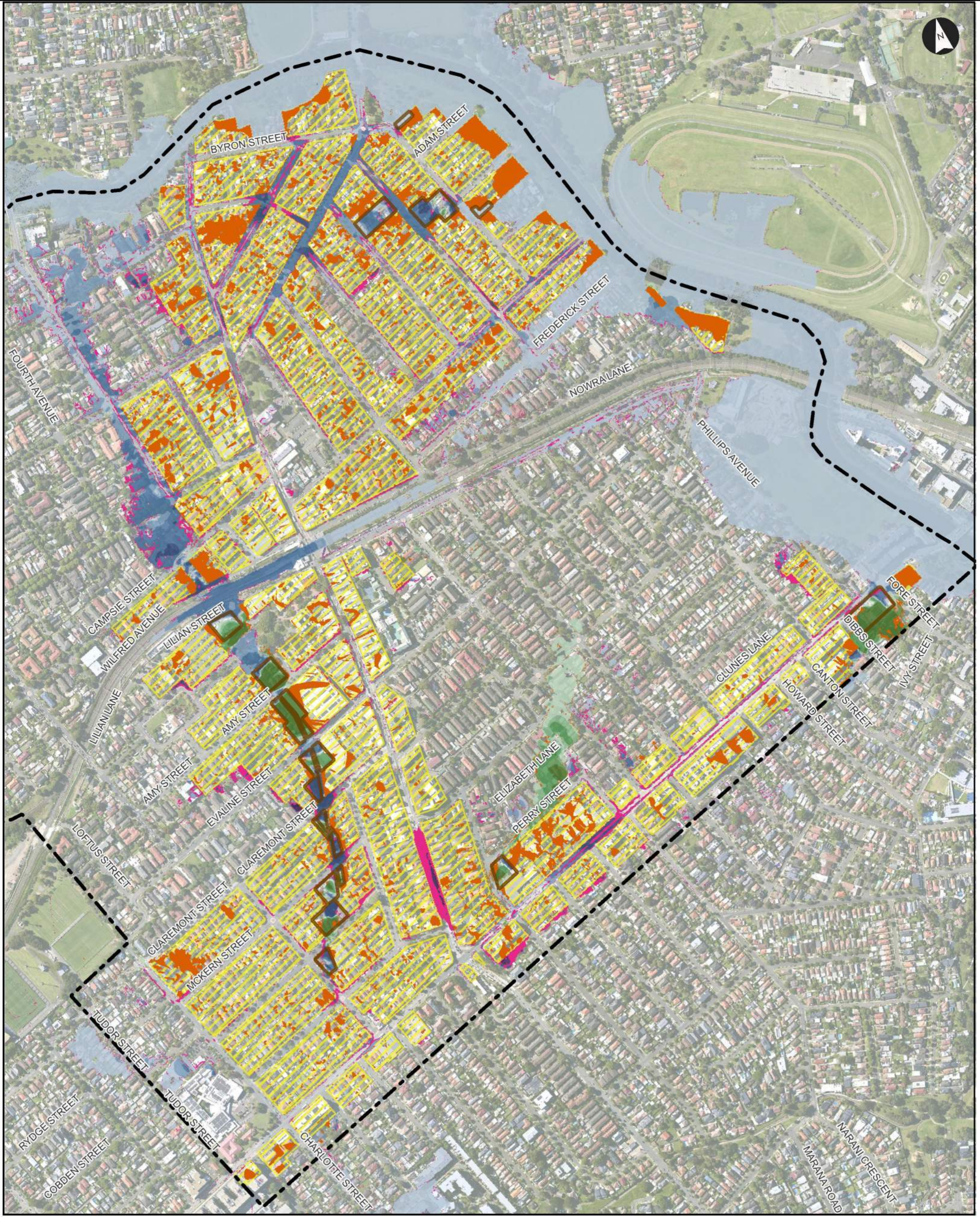
References:

1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





**0.05% AEP Water Level Difference
Post Development Condition Less
Existing Condition**
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B29



Legend

- Campsie Study Area
- Wet/Dry Analysis**
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -0.50
- 0.50 to -0.10
- 0.10 to -0.05
- 0.05 to -0.03
- 0.03 to -0.01
- 0.01 to 0.01
- 0.01 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- > 0.50

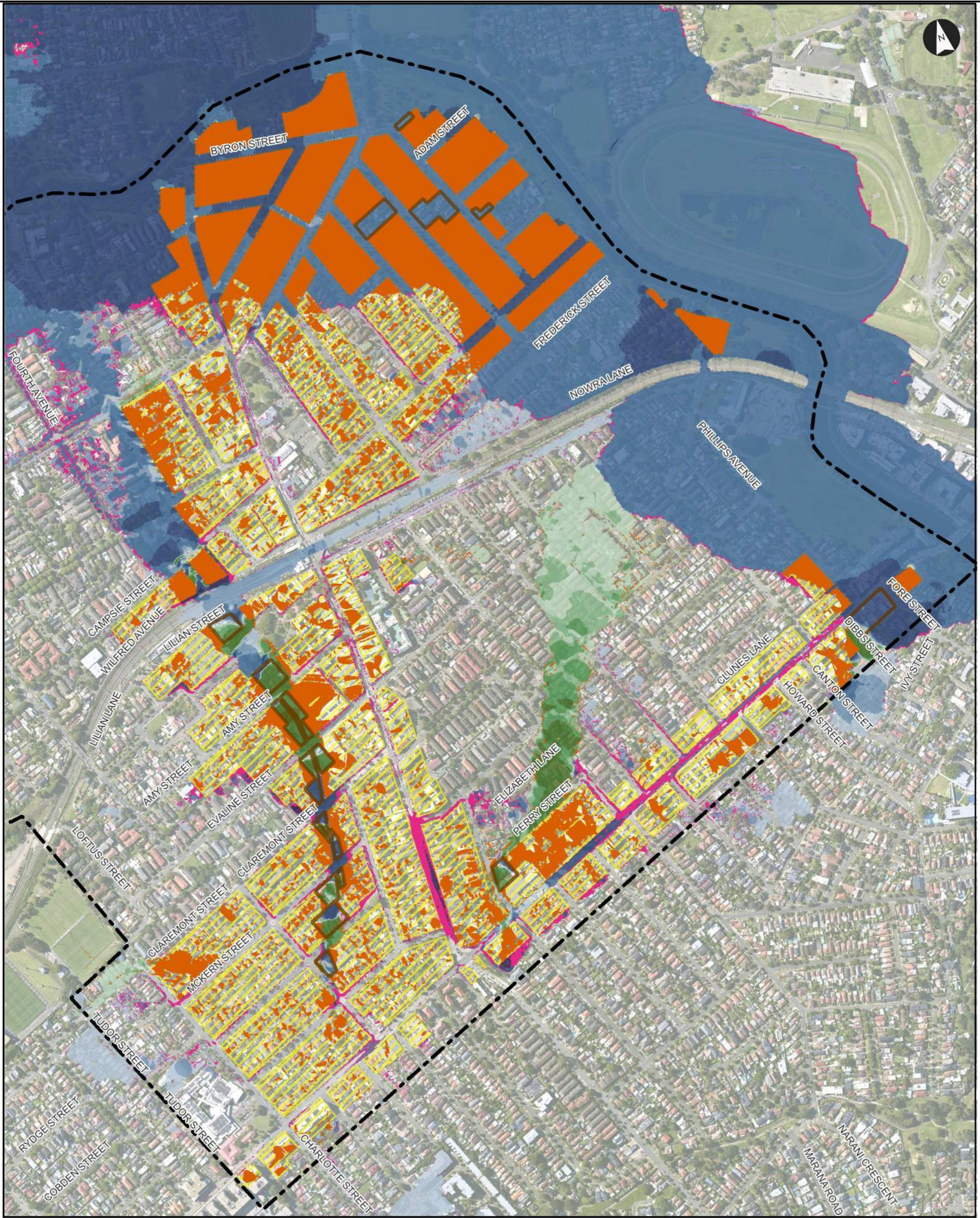
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





PMF Water Level Difference
Post Development Condition Less
Existing Condition
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B30



Legend

- Campsie Study Area
- Wet/Dry Analysis**
- Was Wet, Now Dry
- Was Dry, Now Wet

Water Level Difference (m)

- < -0.50
- 0.50 to -0.10
- 0.10 to -0.05
- 0.05 to -0.03
- 0.03 to -0.01
- 0.01 to 0.01
- 0.01 to 0.03
- 0.03 to 0.05
- 0.05 to 0.10
- 0.10 to 0.50
- > 0.50

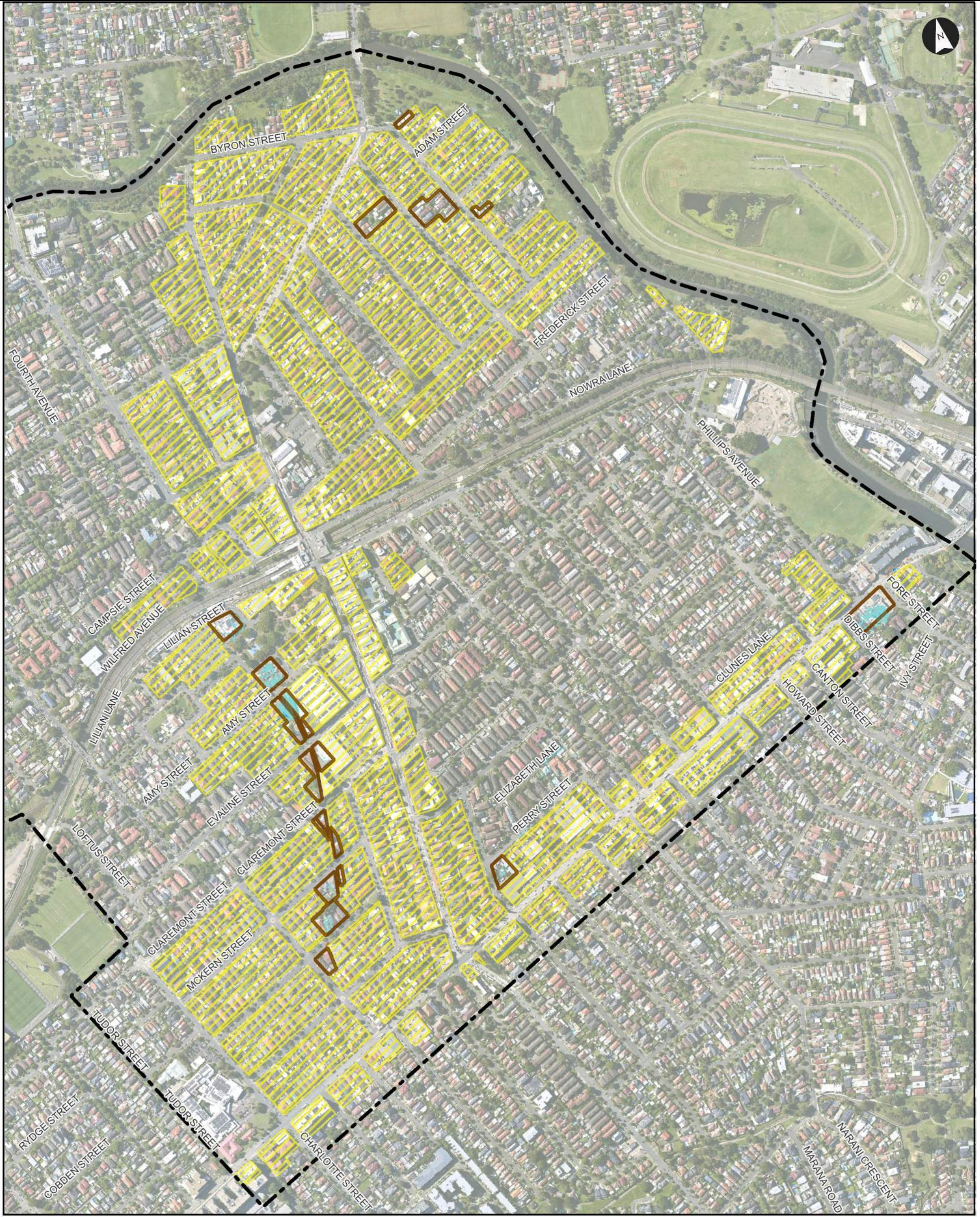
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





5% AEP Hazard Difference
Post Development Condition Less
Existing Condition
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B31

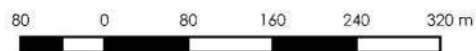


Legend
 Campsie Study Area
Hazard Difference

- 5
- 4
- 3
- 2
- 1
- 1
- 2
- 3
- 4
- 5

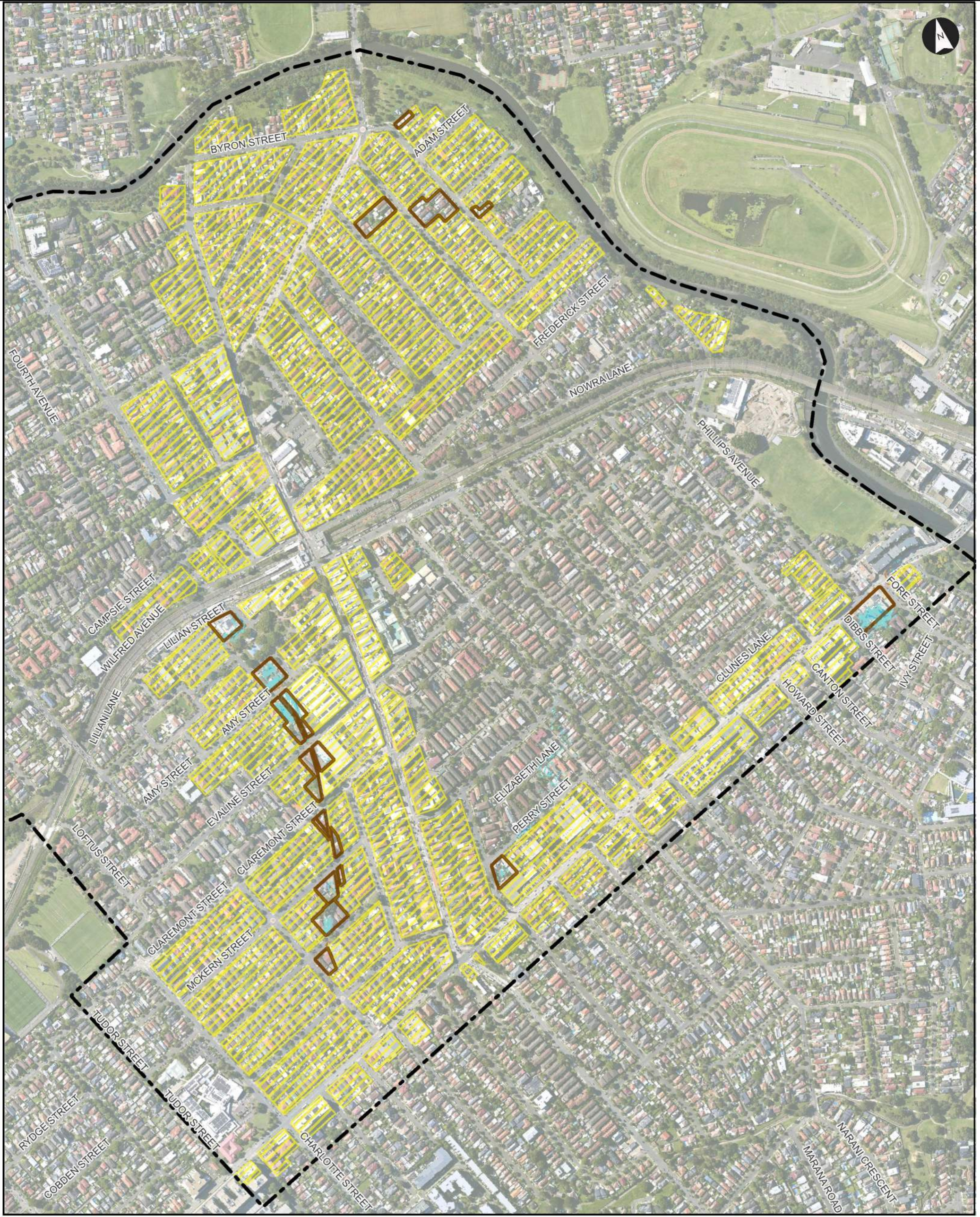
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap



Scale at A3: 1:7200





**1% AEP Hazard Difference
Post Development Condition Less
Existing Condition**
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B32

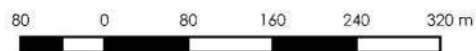


Legend
Campsie Study Area
Hazard Difference

- 5
- 4
- 3
- 2
- 1
- 1
- 2
- 3
- 4
- 5

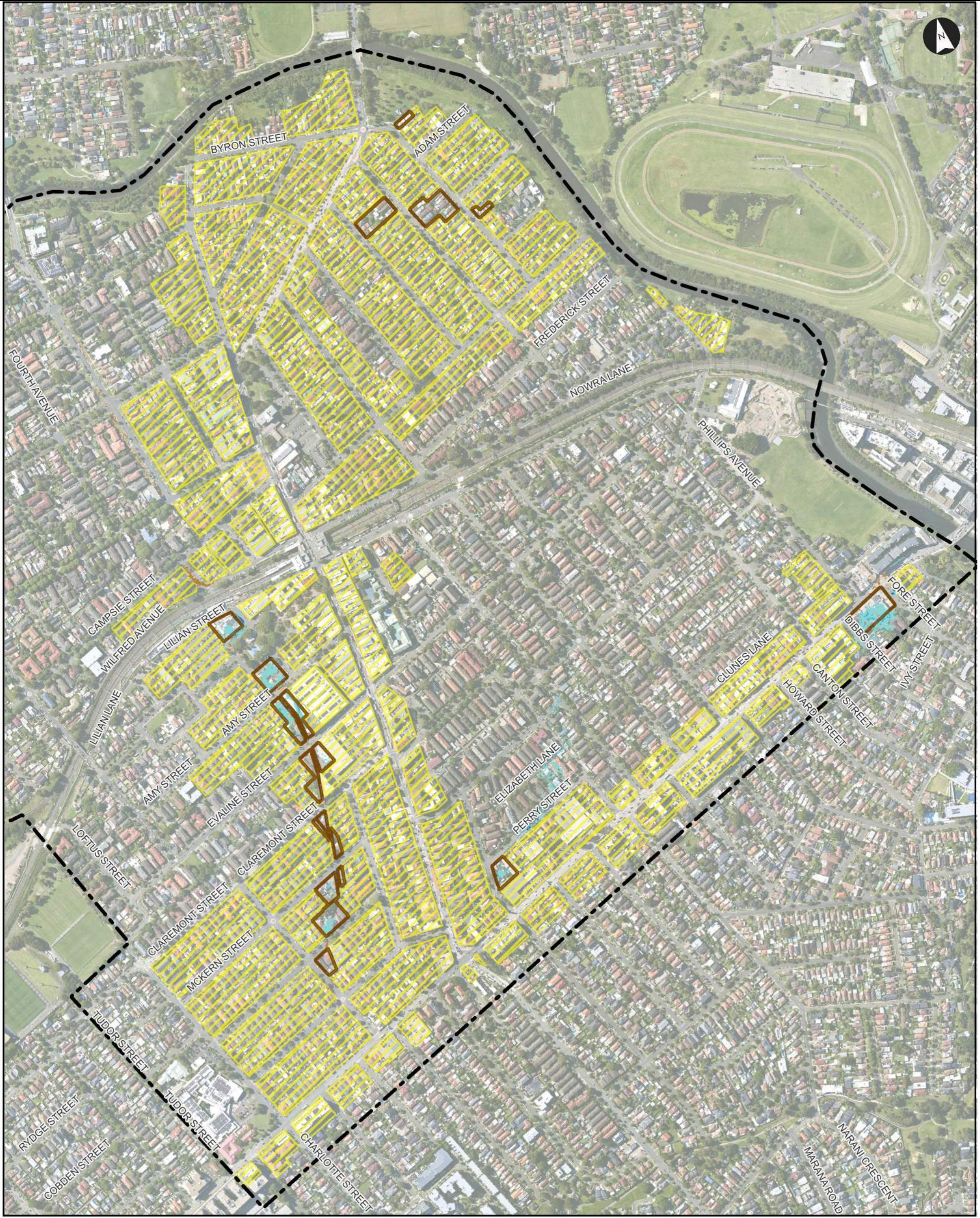
Notes:
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References:
1. Base Map: Metromap



Scale at A3: 1:7200





0.2% AEP Hazard Difference
Post Development Condition Less
Existing Condition
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B33



Legend

 Campsie Study Area
Hazard Difference

-  -5
-  -4
-  -3
-  -2
-  -1
-  1
-  2
-  3
-  4
- 5

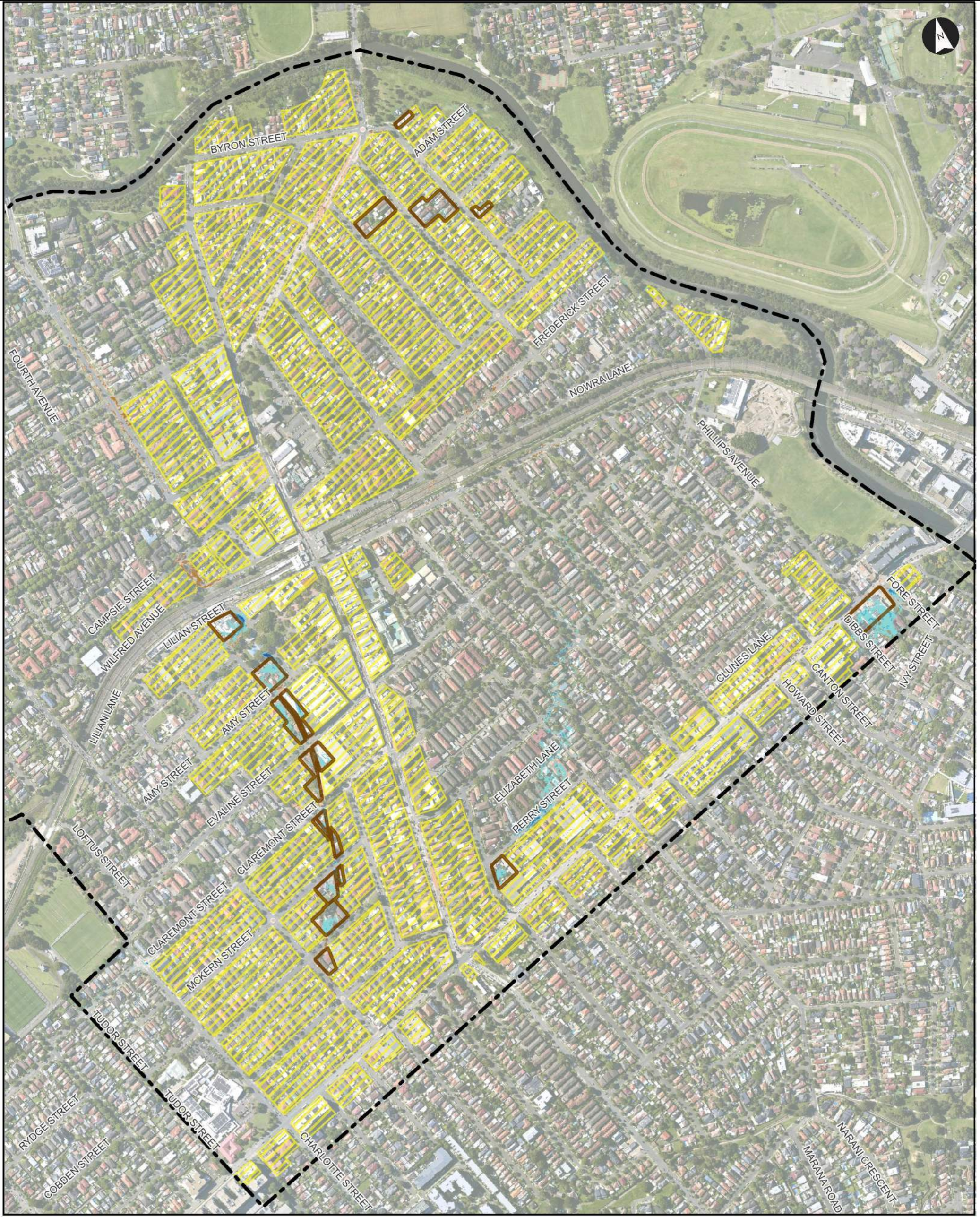
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap

80 0 80 160 240 320 m

Scale at A3: 1:7200





0.05% AEP Hazard Difference
Post Development Condition Less
Existing Condition
Project: Campsie Rezoning - Updated Flood
Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B34

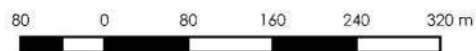


Legend
 Campsie Study Area
Hazard Difference

- 5
- 4
- 3
- 2
- 1
- 1
- 2
- 3
- 4
- 5

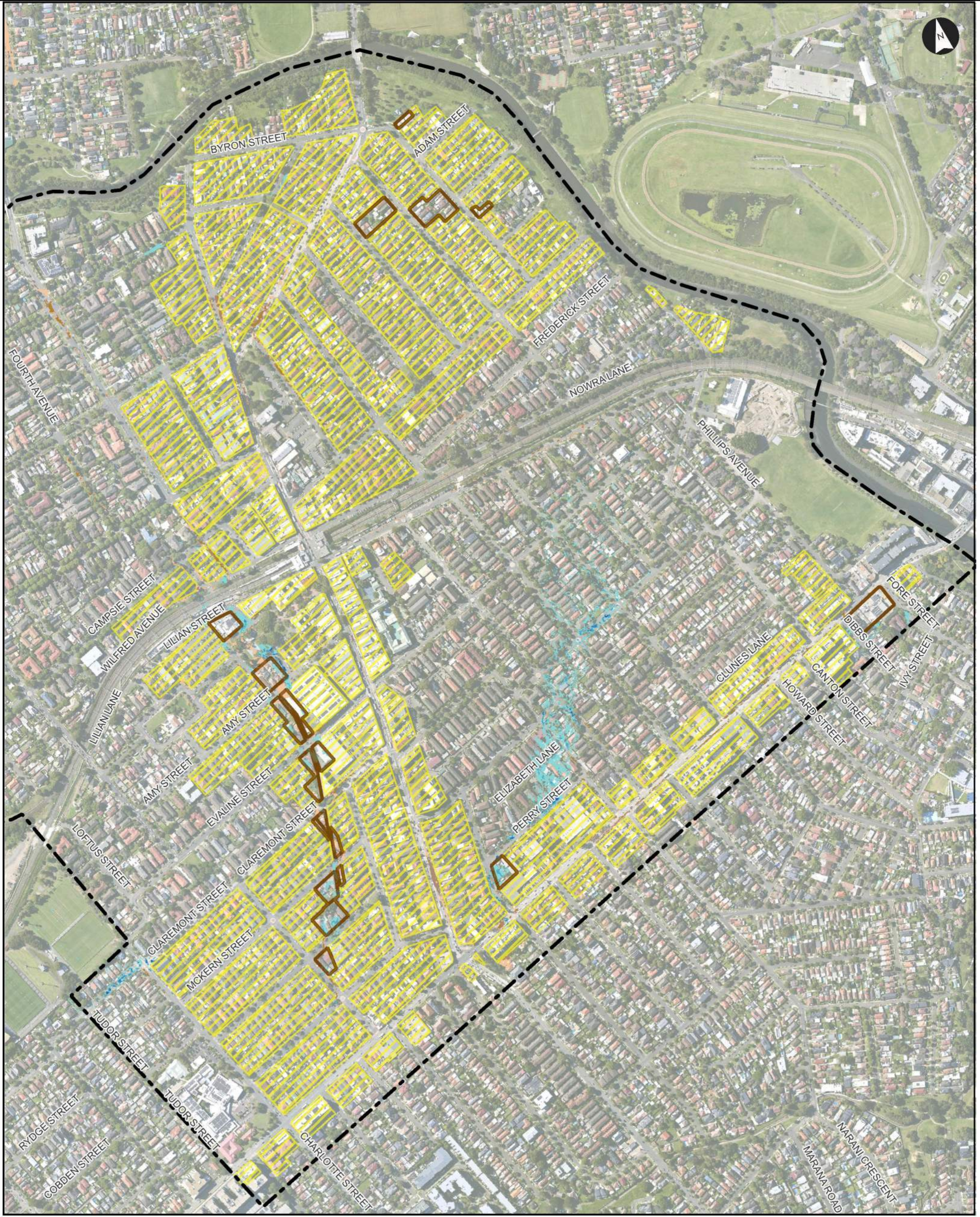
Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap



Scale at A3: 1:7200





PMF Hazard Difference
Post Development Condition Less
Existing Condition
Project: Campsie Rezoning - Updated Flood Risk Assessment

Client: Canterbury Bankstown Council
Project Code: 300204304
Drawn By: HR, Checked By: MG
Date: (2025-07-22)
Figure No: B35

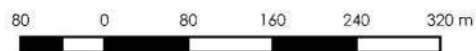


Legend
 Campsie Study Area
Hazard Difference

- 5
- 4
- 3
- 2
- 1
- 1
- 2
- 3
- 4
- 5

Notes:
1. Map displayed in EPSG:7856

References:
1. Base Map: Metromap



Scale at A3: 1:7200



Appendix C Literature Review of Flood Risk Considerations

Based on comments received during preliminary discussion of the FIRA, there was a need for additional supporting documentation in reporting for the flood risk implications of redevelopment. This literature review summary has been prepared in relation to a range of flood risk topics relevant to this FIRA.

C.1 Probability of a Probable Maximum Flood

As shown in **Figure C-1**, extracted from Figure 8.3.2 of Book 8, Chapter 3 of ARR4.2, the equivalent AEP of a PMF causing rainfall event increases relative to reduced catchment area. This means that the smaller the catchment, the rarer the PMF event is. For overland flooding and smaller mainstream river catchments such as this (catchment area less than 100 km²), the PMF is equivalent to a 1 in 10,000,000 AEP event. For large riverine catchments (100,000 km²) this reduces to a 1 in 10,000 AEP, or 1,000 times more likely than small catchment PMF.

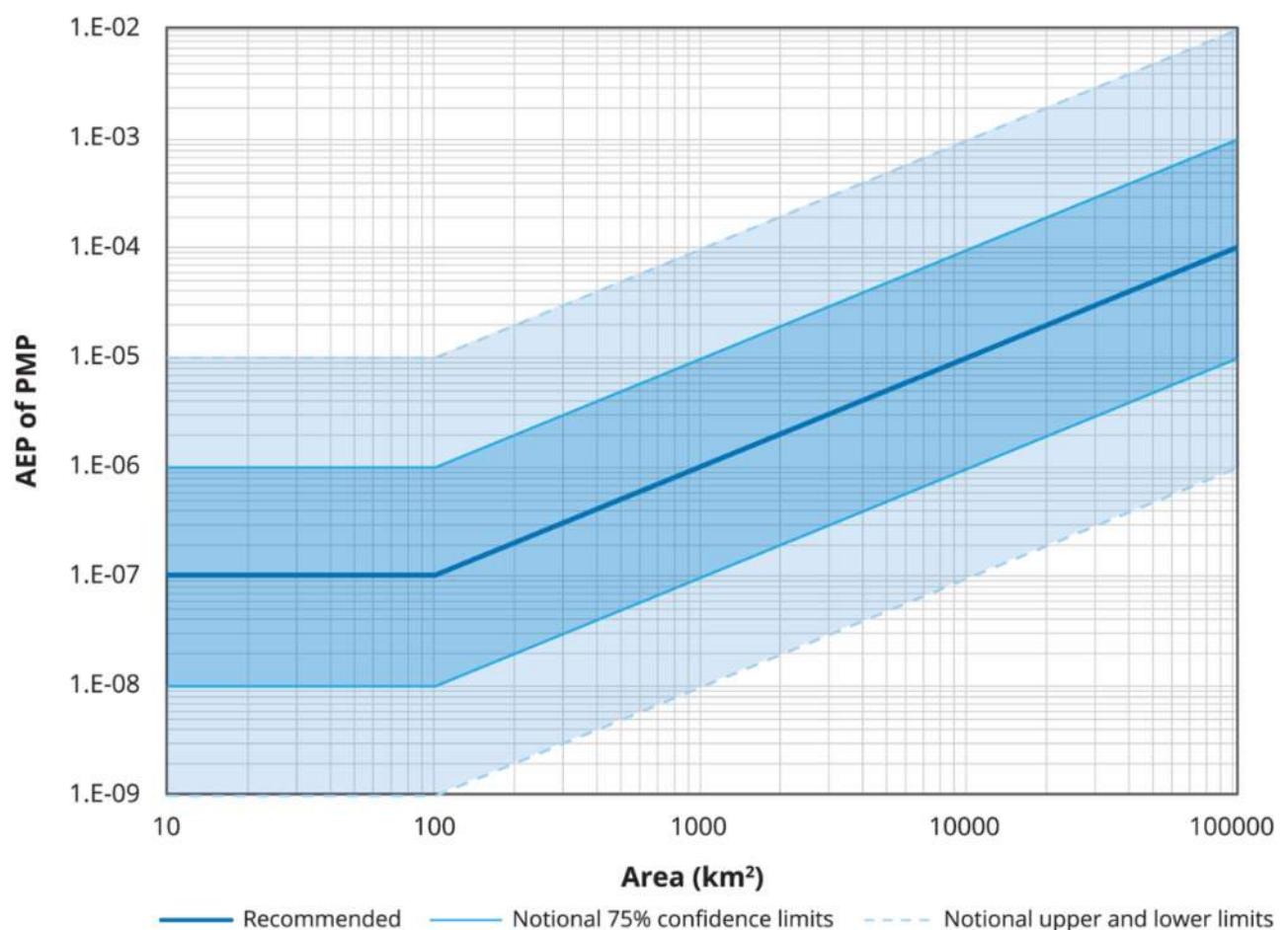


Figure C-1 Recommended Regional Estimates for the AEP of Probable Maximum Precipitation (PMP)
(Source: ARR, 2024)



C.2 Relative Flood Risk of Shelter-in-Place

Regarding the relative merits of shelter-in-place in flash flooding environments, as stated within DEFRA and Environment Agency (2009, 19): *“A simple rule of thumb was that if the emergency services are able to knock on doors to advise people to leave, it was safe to evacuate. However, if the flooding was already too severe for the emergency services to reach people, it would be safer to go upstairs.”*

The same resource also cites: *Significant loss of life can also occur in floods where people cannot find refuge inside. A survey of 45 housing clusters comprising 1,123 people showed that nearly 22 per cent of people that failed to reach a concrete or brick structure died whilst everyone who sought refuge in such structures survived (Bern et al., 1993)”*(DEFRA and Environment Agency, 2009, 18).

As stated within Rogencamp and Barton (2012, 7): *“For the Lockyer Valley floods of 2011, a very high proportion of 70% of the people killed were in their homes at the time of the flood. Based on the data supplied in Fitzgerald et al (2010) (assessing recorded flood deaths in Australia over the 12 year period from 1997 to 2008), not one of the 73 people killed by floods between 1997 and 2008 was in their home at the time of the flood.”*

As stated within UNSW WRL (2014, 16): *Jonkman and Kelman (2005) highlighted that in most floods, people are more likely to be killed or injured if they are outside of their home or in their cars during the flood. Subsequently, undertaking evacuation at inappropriate times, such as when the floodwaters have risen in depth and velocity, is likely to increase chance of death (Cave et al., 2009).*

A commonly referenced resource for dam consequence category assessments, Graham 1999, calculates low flood severity as depths less than 3 metres and Velocity x Depth product (VxD) less than 4.6 m²/s. For this category with no warning time, the estimated fatality rate was 0.01 or 1% of all people in the floodplain.

C.3 Secondary Flood Risks

The relative risk to life for secondary risks such as flood isolation, or other hazards is relatively low compared to the primary flood risk of direct exposure to flood hazard. As stated within UNSW WRL (2014, 16): *Two hundred and six (206) flash flood fatalities occurred in Australia between 1950 and March 2008 (Coates and Haynes, 2008). The cause of death for the majority of these cases was drowning. Other fatalities were a result of heart attacks or overexertion, or indirect causes such as electrocution or fallen trees (Coates and Haynes, 2008). Similarities have been observed in the United States, where 93 % of flash flood deaths can be attributed to drowning (French et al., 1983).*

Rogencamp and Barton (2012) as one of its key outcomes recommends flood risk assessments be consistent with the risk management approach for dam safety. Reviewing the principles of the ANCOLD Guidelines on the Consequence Categories for Dams (October 2012), it is noted that:

- Calculation of dam consequence is based on the incremental difference from non-dam-break flood event to the dam break event. In essence this FIRA proposes a similar approach in only assessing the incremental difference in flood risk from the existing capacity to the proposed capacity of the area.



- Calculation of Population at Risk (PAR) for Non-Itinerant population is guided by VxD for overfloor flooding depth. Therefore if dwelling floor levels are above the flood level then there is no PAR. In essence this means there is no consideration of secondary risk for non-itinerant population for dam consequence category assessments, a well-established risk assessment.

C.4 Human Behaviour in Flooding

With respect to human behaviour, it is noted that these secondary risks are not only relevant to shelter-in-place but also evacuation as well. DEFRA and Environment Agency (2009, 20) notes that: *In discussing the effectiveness of evacuation, it is also important to consider that people may not evacuate, even if instructed to do so. Professional partners involved in flood evacuations interviewed as part of this research stated the police cannot order people to evacuate, only advise them to do so. People often refuse, preferring to wait and see what happens.*

The following excerpt relating to flood fatalities in Australia is from Rogencamp and Barton (2012, 7): *Fitzgerald et al (2010) assessed the 73 recorded flood deaths in Australia over the 12 year period from 1997 to 2008. This assessment indicated that approximately 50% of deaths related to motor vehicle use (e.g. crossing a flooded road). A further 25% of deaths were attributable to “inappropriate or high-risk behaviour during floods” (e.g. children playing in a flooded creek) and another 16% were associated with attempts to swim or wade across flooded waterways. The study concluded that “the vast majority of deaths in Australia (>90%) that occur as a result of floods occur because of the choices made by the individual; choices to engage in inappropriate risk-taking behaviour or to enter flooded waterways either by foot or in a vehicle.*

C.5 Flood Risk for Medium and High Density Residential

As outlined by the Hawkesbury Nepean Floodplain Management Steering Committee (HNFMSC) in their 2006 guideline *Designing Safer Subdivisions: Guidance On Subdivision Design In Flood Prone Areas*, flood damages can actually be reduced if high rise or multi-storey unit development is adopted rather than single or two-storey dwelling houses, villas and townhouses. As stated in the guideline in many cases multi-storey units or high rise units could *“Provide a refuge for occupiers in short duration flooding. Although occupiers would normally be asked to evacuate if the predicted flood level was above the critical level for that area, in an emergency any people remaining in the building would not necessarily be risking life and limb by remaining in the building until the flood recedes. In such short duration floods, emergency workers would not necessarily need to put themselves at increased risk to rescue trapped residents”*.

Other flood risk benefits of multi-storey developments are outlined in the same guideline:

Additional benefits can be delivered through multistorey high-rise units. By achieving the same yield in a vertical plane rather than by increasing the overall footprint of the buildings, the potential for flow obstruction is reduced. This gives more opportunities to maintain lower velocities between the buildings on the site thereby reducing the potential for damage due to flowing water. As the forces are proportional to the square of the velocity any reduction in velocity produces significant advantages.

There are also more opportunities for buildings to be orientated and positioned to minimise concentration of floodwaters and improve flow through the development when subdivision and building design are integrated.





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