Stormwater Drainage Assessment Report

Preston Market

V180123

Prepared for
Victorian Planning Authority

11 October 2021

Cardno®

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Glossary of Terms

Average Exceedance Probability (AEP)

The chance of a given discharge or level value being exceeded in a given year. A 1% AEP flood event has a 1% chance of occurring in any year (and is equivalent to the 1 in 1% AEP event).

The conversion from ARI to AEP is shown in the table below

ARI (years)	AEP (%)
1	63%
2	39%
5	18% (usually approximated as the 20% AEP)
10	10%
20	5%
50	2%
100	1%

Australian Height Datum (AHD)

A common national surface level datum approximately corresponding to mean sea level.

Australian Rainfall and Runoff (AR&R)

Australian Rainfall and Runoff is the industry standard resources for the estimation of flood flows in Australia.

Average Recurrence Interval (ARI)

The average or expected value of the period between exceedances of a given discharge or event. A 100-year ARI event would occur, on average, once every 100-years. A 10-year ARI event would occur on average, once every 10 years.

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.

Council

The City of Darebin Council

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 in 1 year or 100%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.

Floodplain

Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.

Melbourne Water Corporation (MW)

The regional floodplain management and drainage authority.

Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In this report, 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.
Special Building Overlay (SBO)	This is an overlay that provides for control of the development of land in areas subject to flooding from formal drainage networks, including underground drains
Topography	A surface which defines the ground level of a chosen area.
Water Sensitive Urban Design (WSUD)	Water sensitive urban design (WSUD) is an approach to planning and designing urban areas to make use of stormwater and reduce the environmental degradation it may cause to rivers and creeks.

1 Introduction

The Victorian Planning Authority (VPA) have engaged Cardno to undertake flood mitigation modelling of the updated layout plan for the proposed redevelopment of the Preston Market. This is to assist in the preparation of a Structure Plan for the site.

The scope of this assessment is to ensure that in 1% AEP event, the updated layout plan is able to be implemented without adversely impacting flooding within neighbouring private properties. A further assessment has also been undertaken for the 1% AEP Climate Change Event.

The hydraulic model developed for the Preston Main Drain Flood Study (Cardno, 2012) has been used in this assessment.

1.1 Study Area

The Preston Market site is located 9km north of Melbourne’s CBD, between Cramer Street and Murray Road within the City of Darebin as shown in Figure 1-1. The original site area of 4.6 ha is to be extended to include an additional two parcels to the west of the train line for the developed scenario which are referred to as the “North” and “South” development areas.

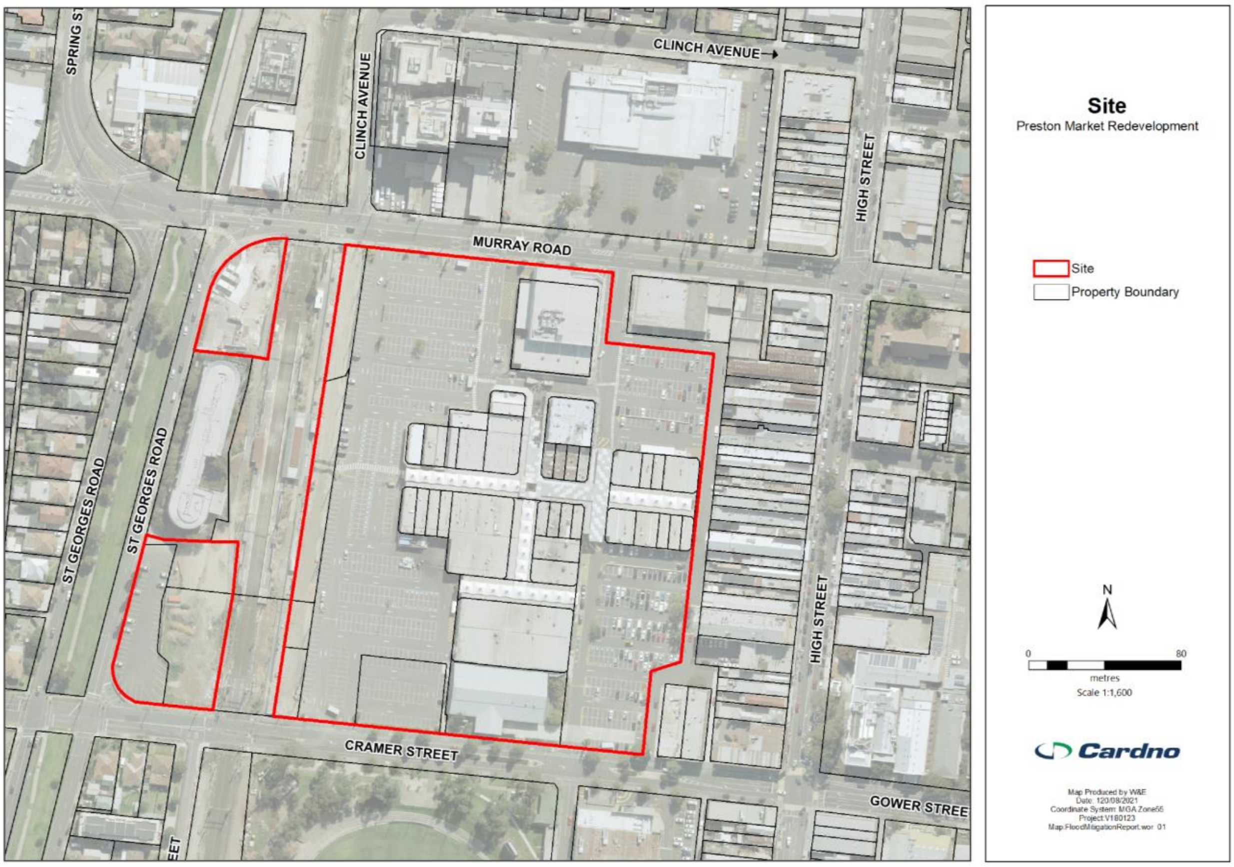

Figure 1-1 Site

The Preston Market site is located within the greater Preston Main Drain catchment, which eventually drains to Mayers Park and into the Merri Creek. The Preston Main Drain Catchment is shown in Figure 1-2 and the setup of the hydraulic model in Figure 1-3.

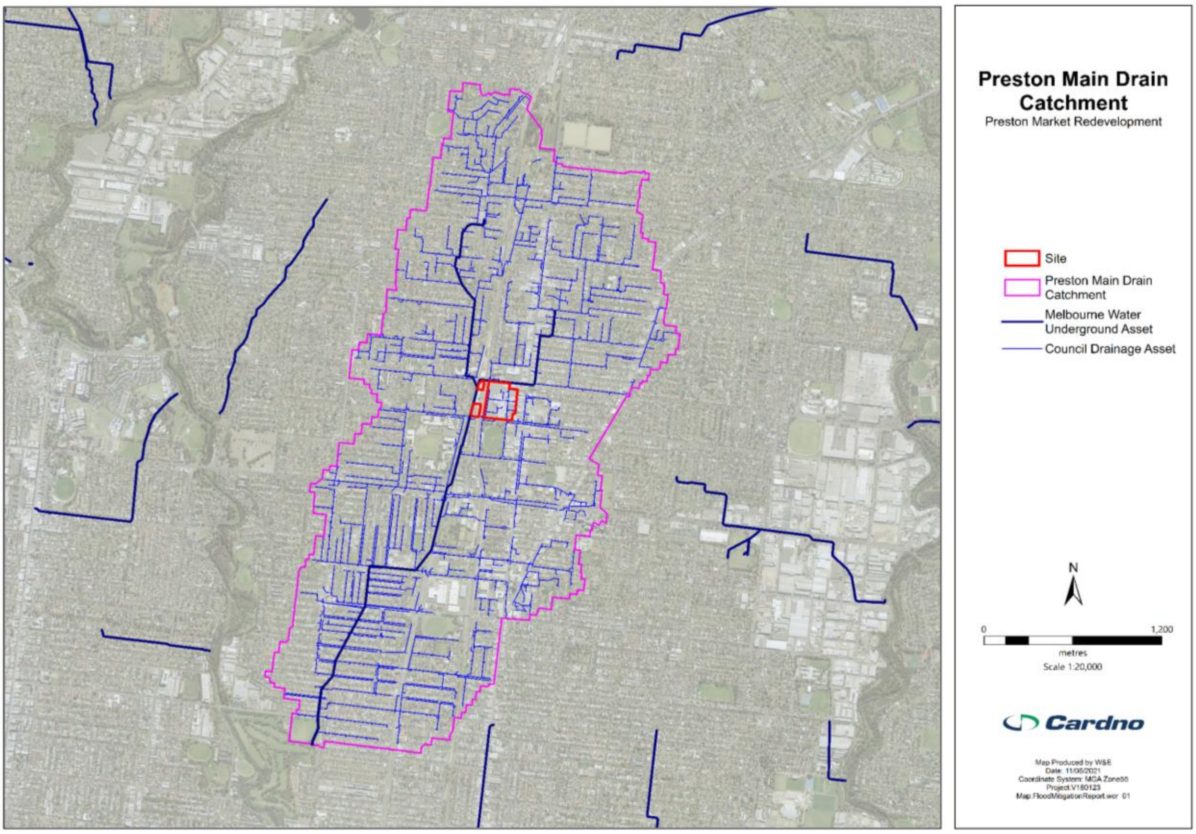

Figure 1-2 Preston Main Drain Catchment

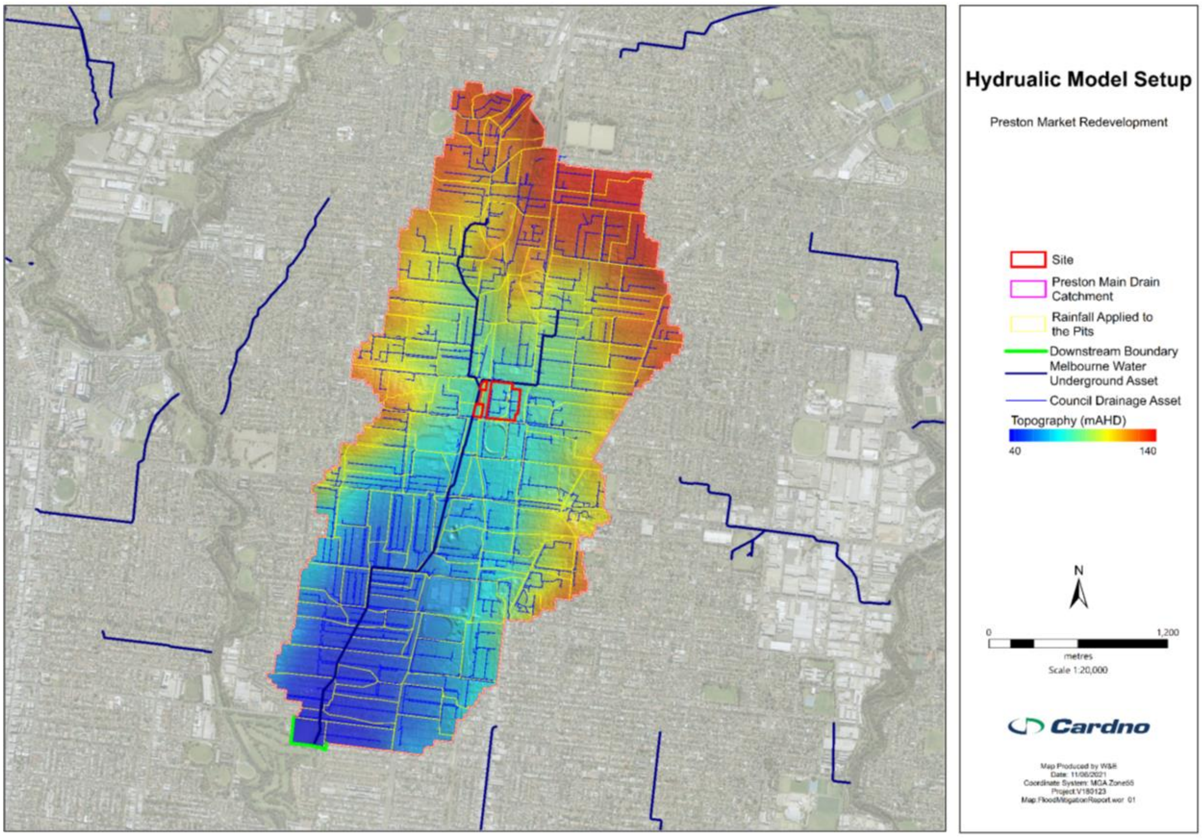

Figure 1-3 Hydraulic Model Setup

2 Stormwater Network Assessment

There are two components to the stormwater network at the site and the associated development areas North and South of the Preston Railway Station consisting of the regional catchment scale flows and the flows generated internally to the market. Regional stormwater infrastructure on the site is owned by Melbourne Water, with the local or internal drainage network consisting of a range of both privately owned and Council assets (Refer to Figure 2-1).

2.1 Regional Drainage

The Preston Market is located along the Preston Main Drain which is a 4.0 km long piped drainage network, running from Wood Street in a southerly direction to its outfall at the southern end of Mayer Park in Northcote. In the vicinity of the site, the Preston Main Drain flows east to west along Murray Road before joining the Spring Street Main Drain at the intersection of Murray Road and St Georges Road. The drain then flows south along St Georges Road.

The drain is sized to cater for the 20% AEP flows, which is standard for residential/mixed used areas at the time at which the drain was constructed. The drain varies in diameter in the vicinity of the site, from 1600 mm along Murray Road before increasing to 2740 mm along St Georges Road.

2.2 Local Drainage

There is an existing piped stormwater system within the Preston Market site, consisting of both private and publically owned infrastructure. All paved roads and car parking areas are drained by grated pits or side entry pits. There are collector drains on Bruce Street which connect into the Preston Main Drain running along St Georges Road.

Overland flows are an aboveground component of the drainage system and occur when the underground drainage pipes reach their capacity and therefore cannot cope with more runoff from heavy rainfall. The excess runoff then travels overland, following low-lying, natural drainage paths. Overland flows are conveyed through the site from north to south.

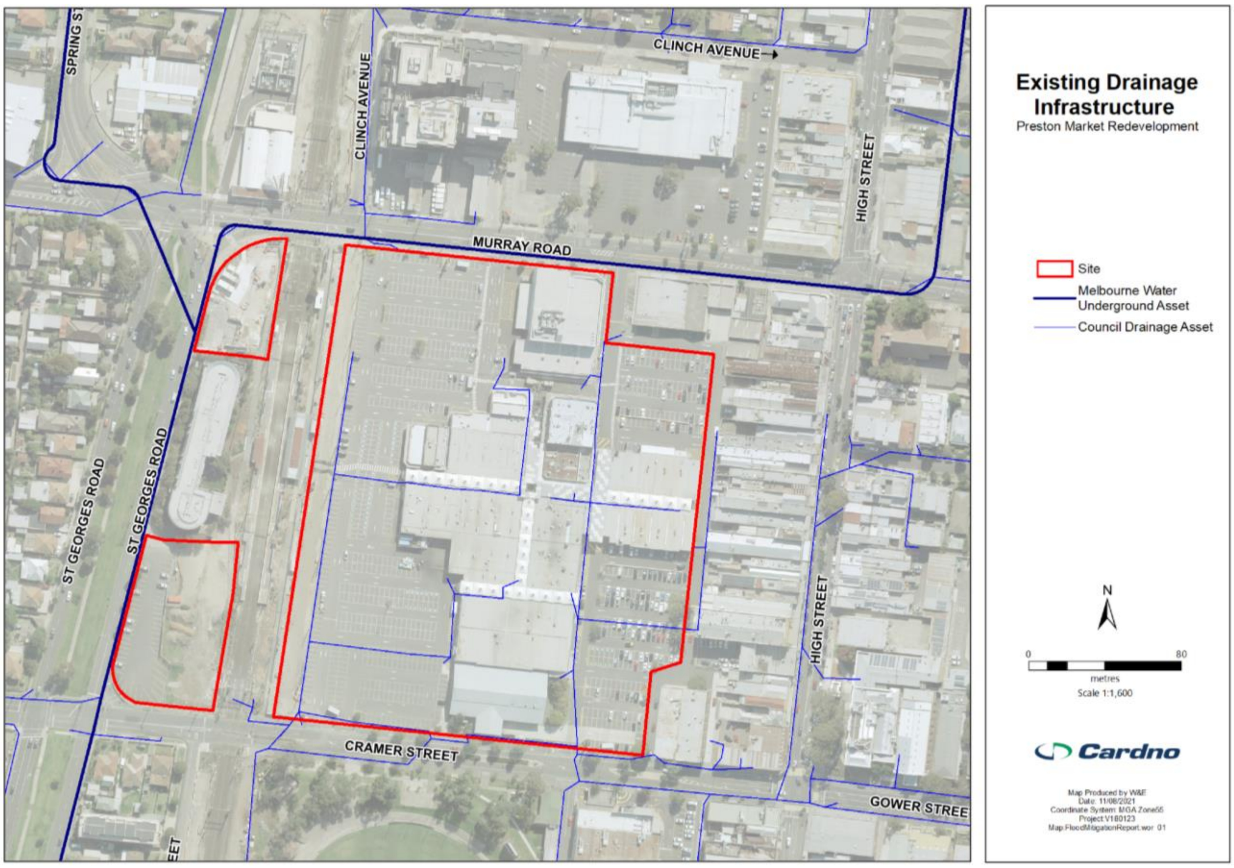

Figure 2-1 Existing Drainage Infrastructure

3 Planning Controls

3.1 Darebin Planning Scheme (Special Building Overlay)

Figure 3-1 below shows the Special Building Overlay (SBO) of the City of Darebin Planning Scheme as it applies to the site. The SBO applies to areas that are subject to stormwater flooding in urban areas. These are generally areas which are inundated due to the inability of the stormwater infrastructure to convey the full flood flows in the 1% AEP flood event (also referred to as the 1 in 100 year ARI event). This overlay is suitable for areas where stormwater systems were implemented prior to current design standards and/or there has been substantial development occulting within the catchment since the underground infrastructure was constructed.

The purpose of the Special Building Overlay is:

> To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.

> To identify land in urban areas liable to inundation by overland flows from the urban drainage system as determined by, or in consultation with, the floodplain management authority.

> To ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity.

> To protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

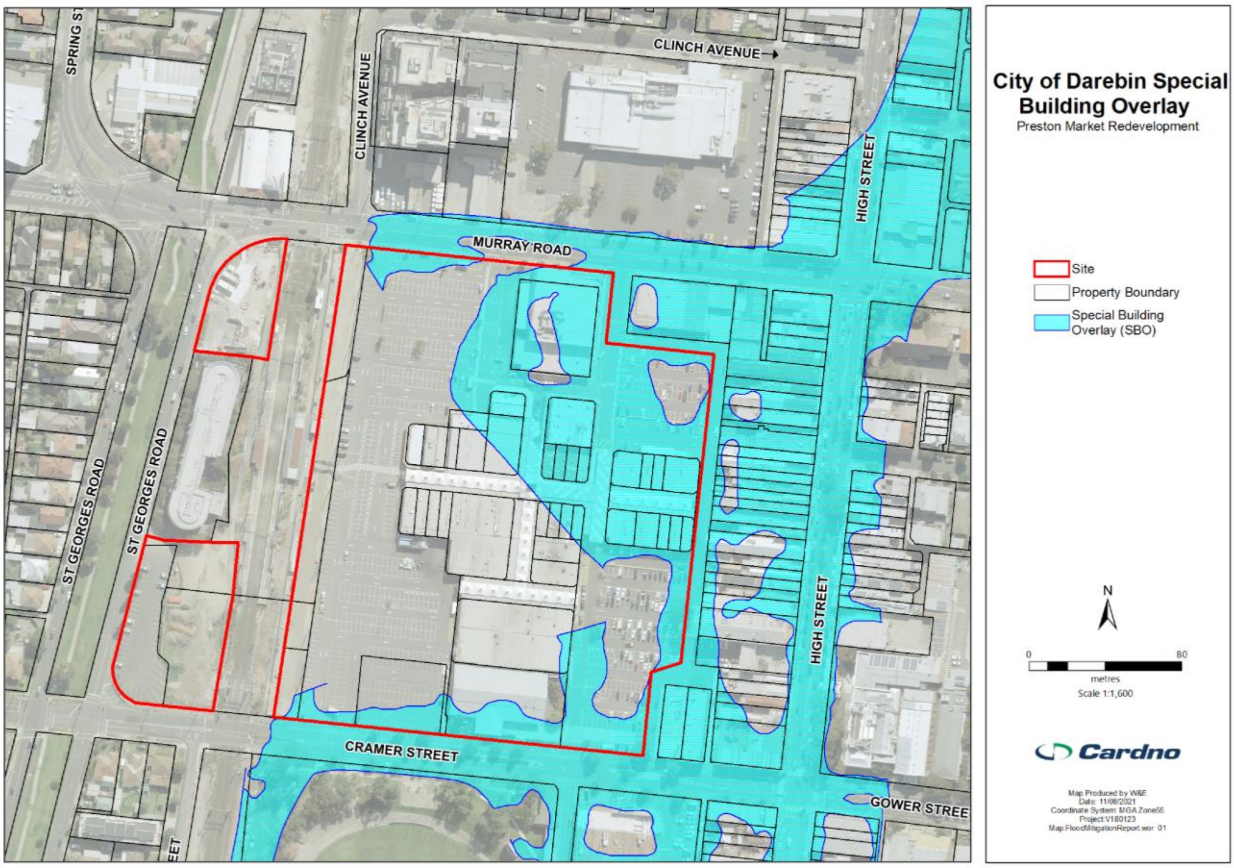

Figure 3-1 City of Darebin Special Building Overlay (Amendment C1)

3.2 Melbourne Water Flood Extent

In 2012, Cardno was commissioned by Melbourne Water and the City of Darebin to undertake flood mapping of the Preston Main Drain catchment area (which includes the Preston Market site). As this site is subject to flooding due to the Melbourne Water Asset, the hydraulic model developed as part of the 2012 assessment has used in this assessment.

4 Existing Flooding Behaviour

The existing flooding behaviour of the Preston Market site has been assessed by considering the local and regional flood behaviours. The project brief requires analysis of existing flooding behaviour for the 1 in 100 year ARI (1% AEP) and 1 in 100 year ARI (1% AEP) Climate Change storm events.

The flood model from Cardno's 2012 study was assessed as being largely fit-for-purpose. However, several minor changes were made, including:

- Amendments to the topography/roughness within the site including:
  - Modelling the floor levels of all buildings located within the site as being located above the 1% AEP + Climate Change flood level as per observed site conditions.
  - It was noticed that there were several issues with how the LiDAR had picked up the surface levels within the site. In particular, a significant section of Mary Street is covered by a roof, which wasn't removed from the LiDAR. This resulted in Mary Street acting as a large blockage to the overland flows. Therefore, a terrain modification has been used to correct the LiDAR, which based on site imagery shows Mary Street will act as an overland flow path and not a blockage to flows.
  - The hydraulic manning's roughness within the site has been updated to account for any overland flow paths through the site which had previously been incorrectly defined, such as the covered section of Mary Street as discussed above.
- Run files were adjusted to utilise the TUFLOW version 2018-03-AC\TUFLOW_iDP_w64, which at the commencement of the earlier stages of this project was the latest release.

Flood extent filtering was conducted as per Melbourne Water's Technical Specifications (July 2020).

4.1 Flood Analysis

As detailed above, Cardno amended the flood model generated in 2012 for the Preston Main Drain Flood Study.

The data was processed to apply Melbourne Water's current filtering criteria to define the expected flood extent and depth across the site and surrounding areas for the following flood events:

- 1% AEP flood event, current climate conditions
- 1% AEP flood event, future climate conditions adopting a 19.5% increase in rainfall intensity across all storm events.

The modelling included consideration of both Melbourne Water and Council owned assets. Figure 4-2 and Figure 4-3 show the 1% AEP current climate conditions for flood depth and flood hazard. Figure 4-4 and Figure 4-5 show the 1% AEP climate change conditions for flood depth and flood hazard.

Figure 4-2 shows that the maximum flood depths in the Preston Market site are generally less than 20 cm, with the major flow path through the site centred directly north of Mary Street.

Both the North and South development areas are located within the St Georges Road 1% AEP overland flowpath.

4.1.1 Hazard Categories

The hazard categories shown in Figure 4-3 and Figure 4-5 have been defined according to the best practice specification outlined in Australian Rainfall and Runoff 2019 (Figure 4-1). According to these definitions, any areas that are designated as above H1 (dark blue) is considered to be at least unsafe for small vehicles to traverse. In practice, flood hazard categories of H1 and H2 are generally considered to be safe for most users. These categories align with Melbourne Water's safe access guidelines.

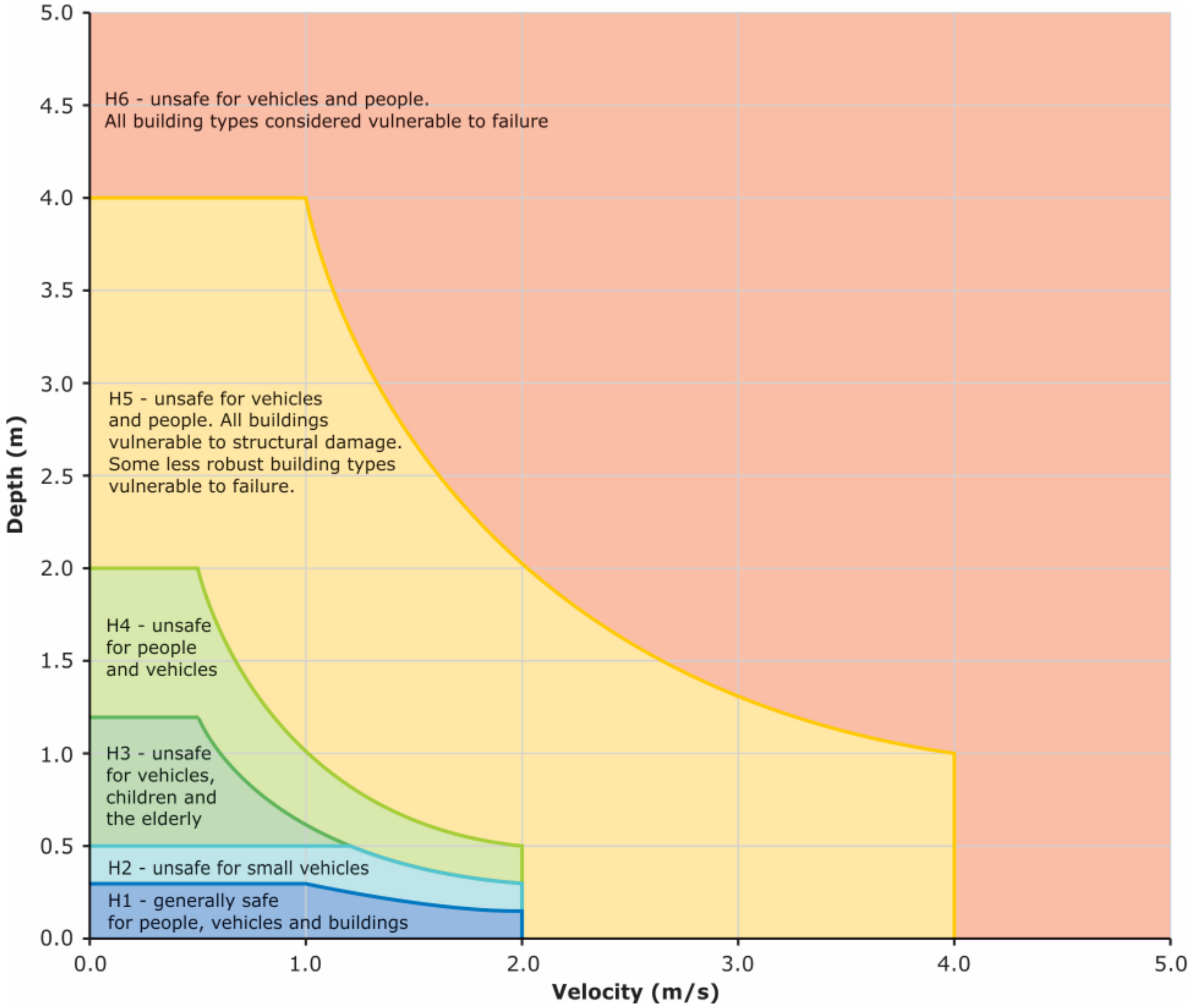

Figure 4-1 ARR2019 Hazard Classes

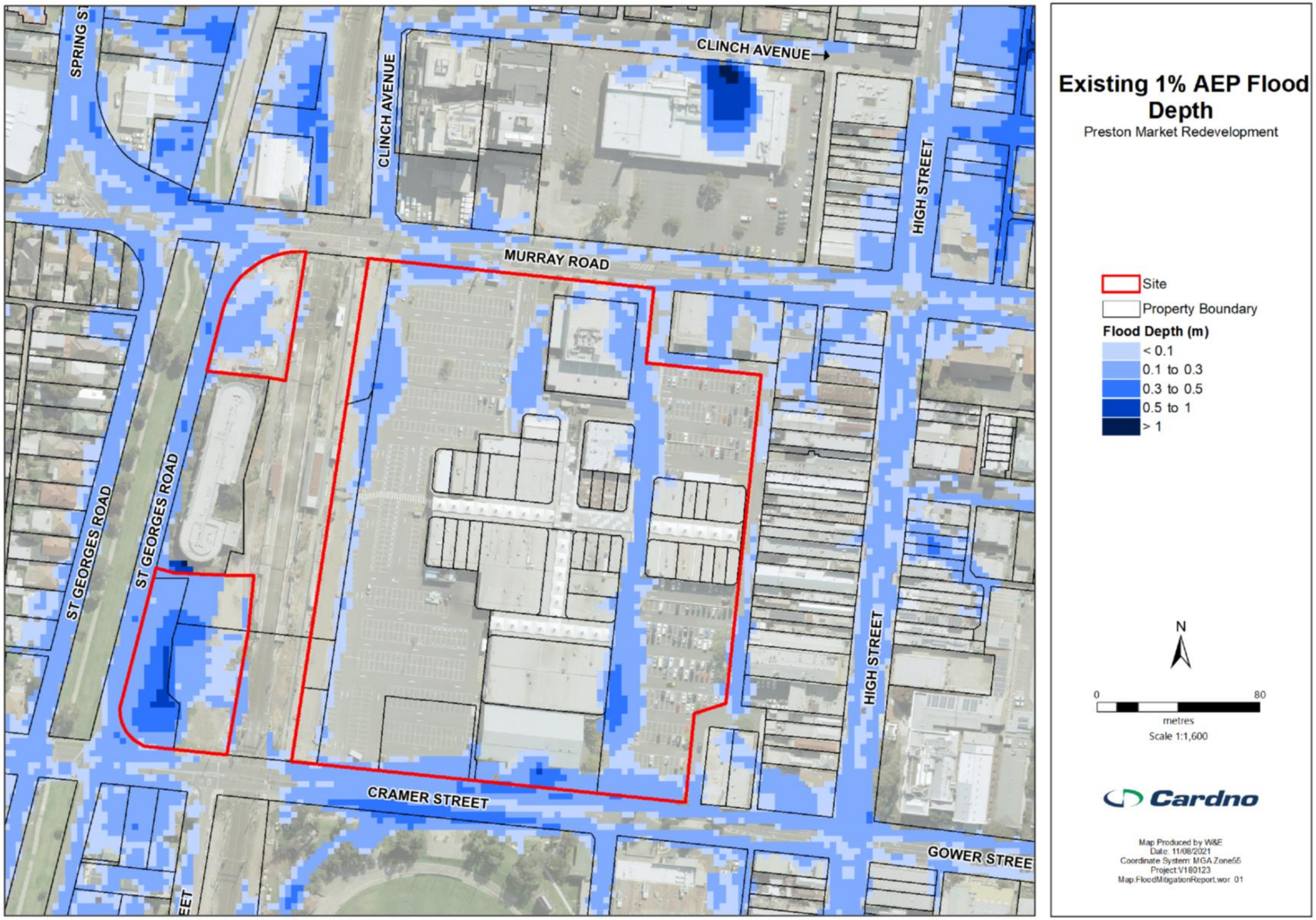

Figure 4-2 Existing 1% AEP Flood Depth

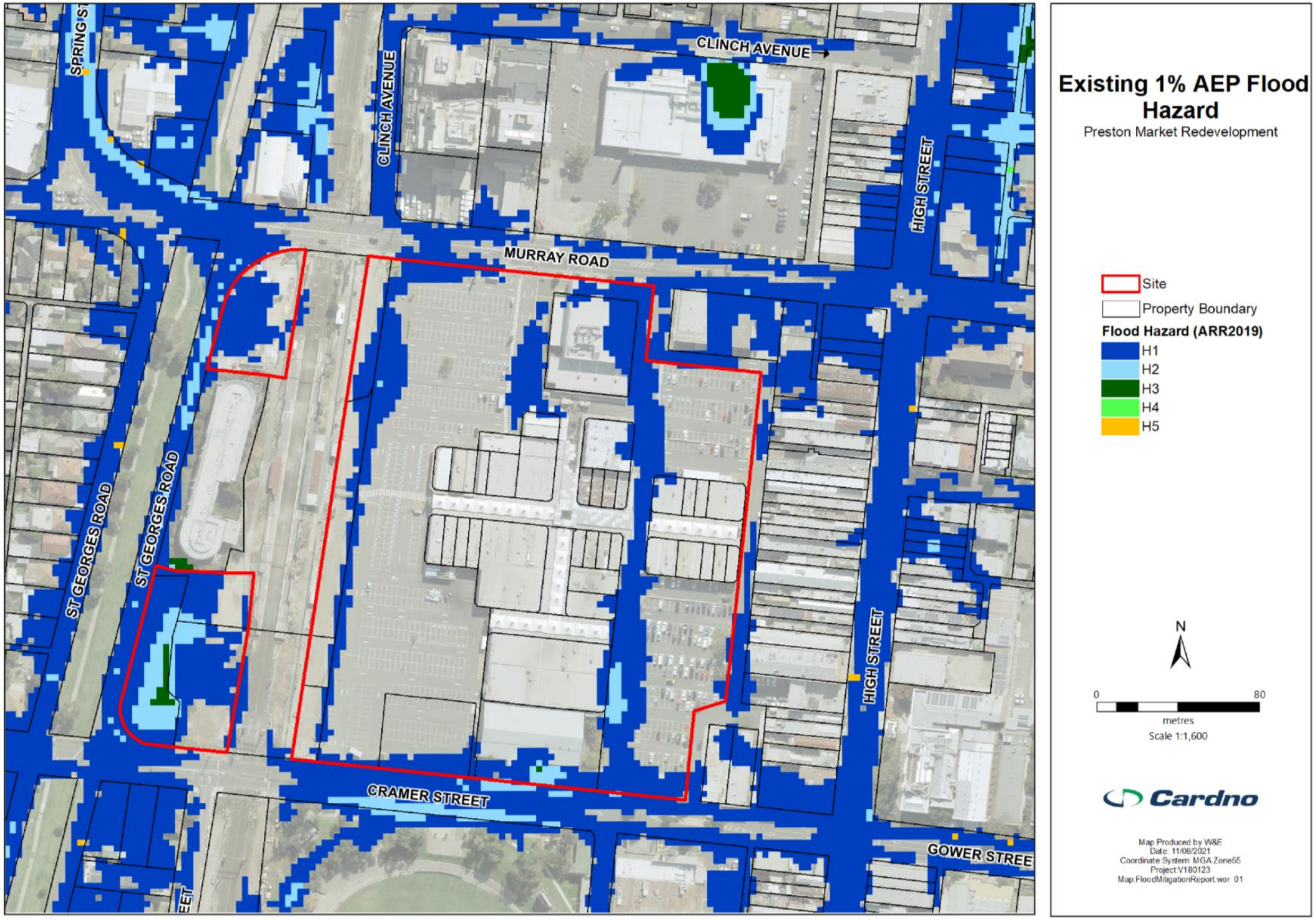

Figure 4-3 Existing 1% AEP Flood Hazard

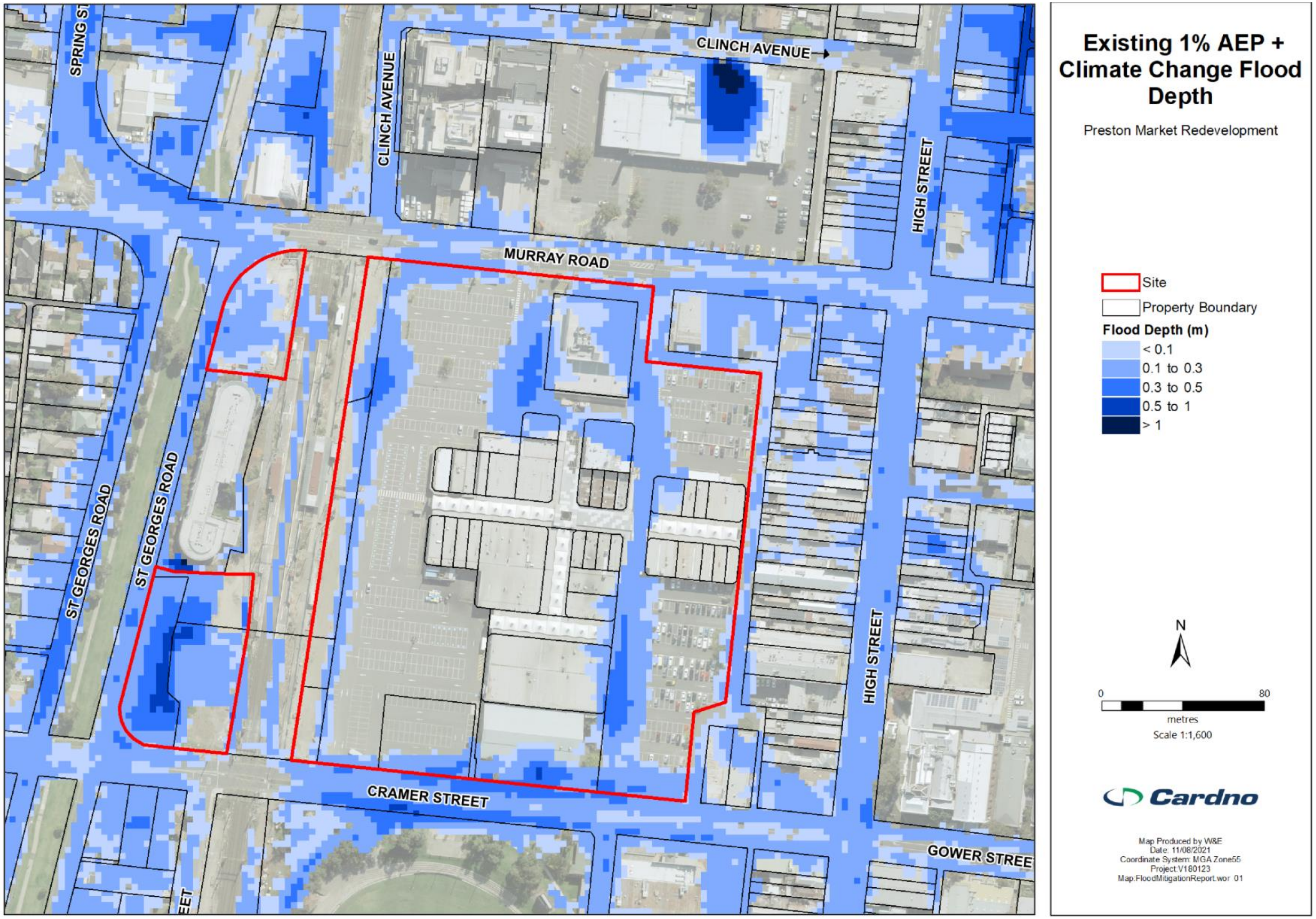

Figure 4-4 Existing 1% AEP + Climate Change Flood Depth

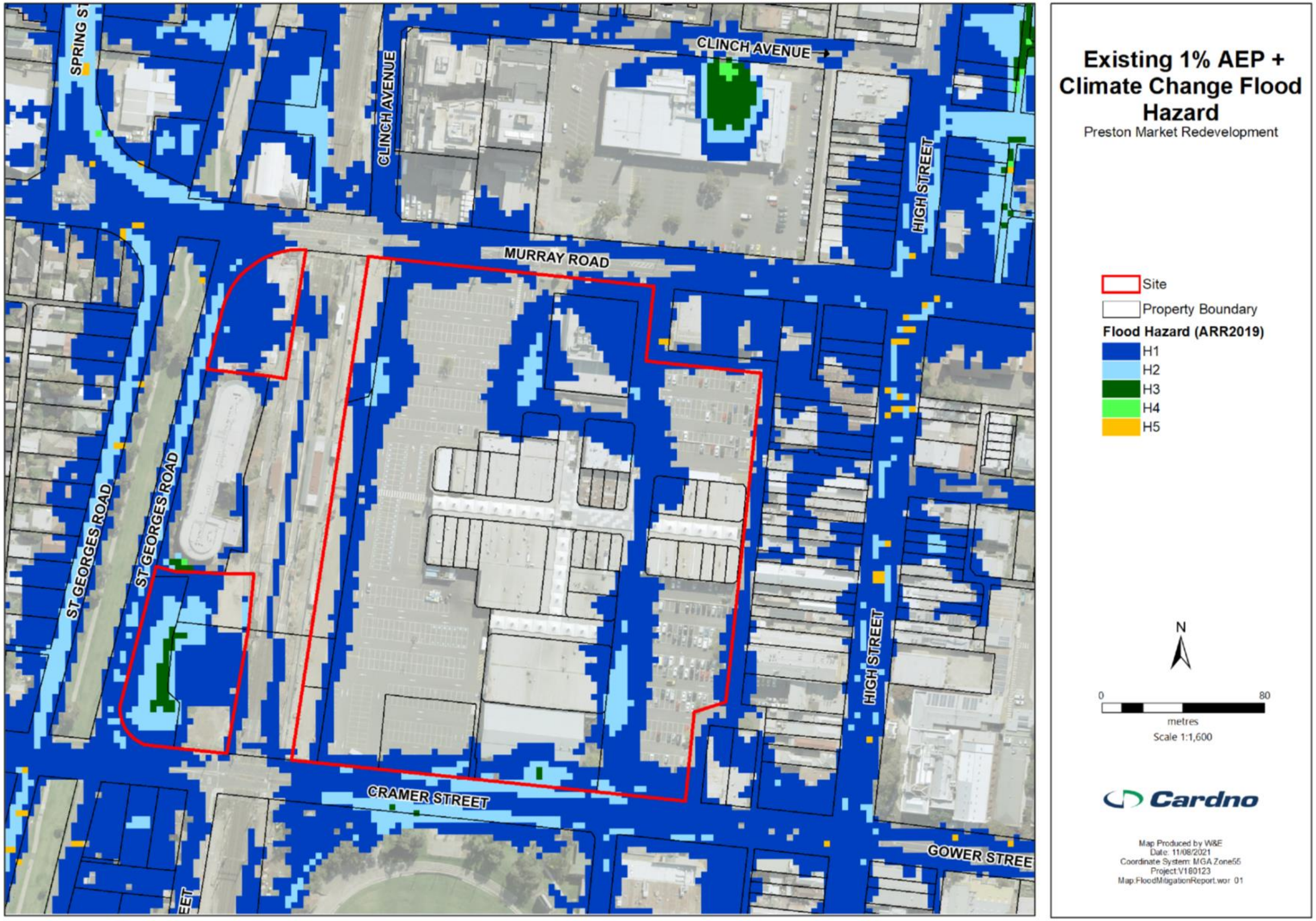

Figure 4-5 Existing 1% AEP + Climate Change Flood Hazard

5 Proposed Site Layout

Figure 5-1 below shows the current site layout plan for the Preston Market redevelopment for which this assessment has been undertaken. The current design for the market consists of 11 separate buildings with space set aside for the overland flow to transverse the site from the north to the south.

All proposed site buildings have been modelled as complete blockages to overland flows.

It should be noted that if this layout is to change in the future, the flood impact assessment will be required to be undertaken again.

Figure 5-1 Proposed Site Layout

In order to create a high level 3D surface for the proposed design, the site has been graded from north to south as shown in Figure 5-2, with 7 strategically placed raised pavements (150mm high) located at key intersections to control and direct the flow of water through the site as required.

Due to the proposed site grading increasing the conveyance of overland flows through the site, raised pavements are required in order to both direct overland flows through the site and to reduce velocities with the aim of reducing the peak flow rate leaving the site.

Futhermore, it is proposed to install pits on the upstream side of each of the raised pavements which connect into the existing drainage network within the site. The modelled drainage network of the proposed conditions is shown in Figure 5-2.

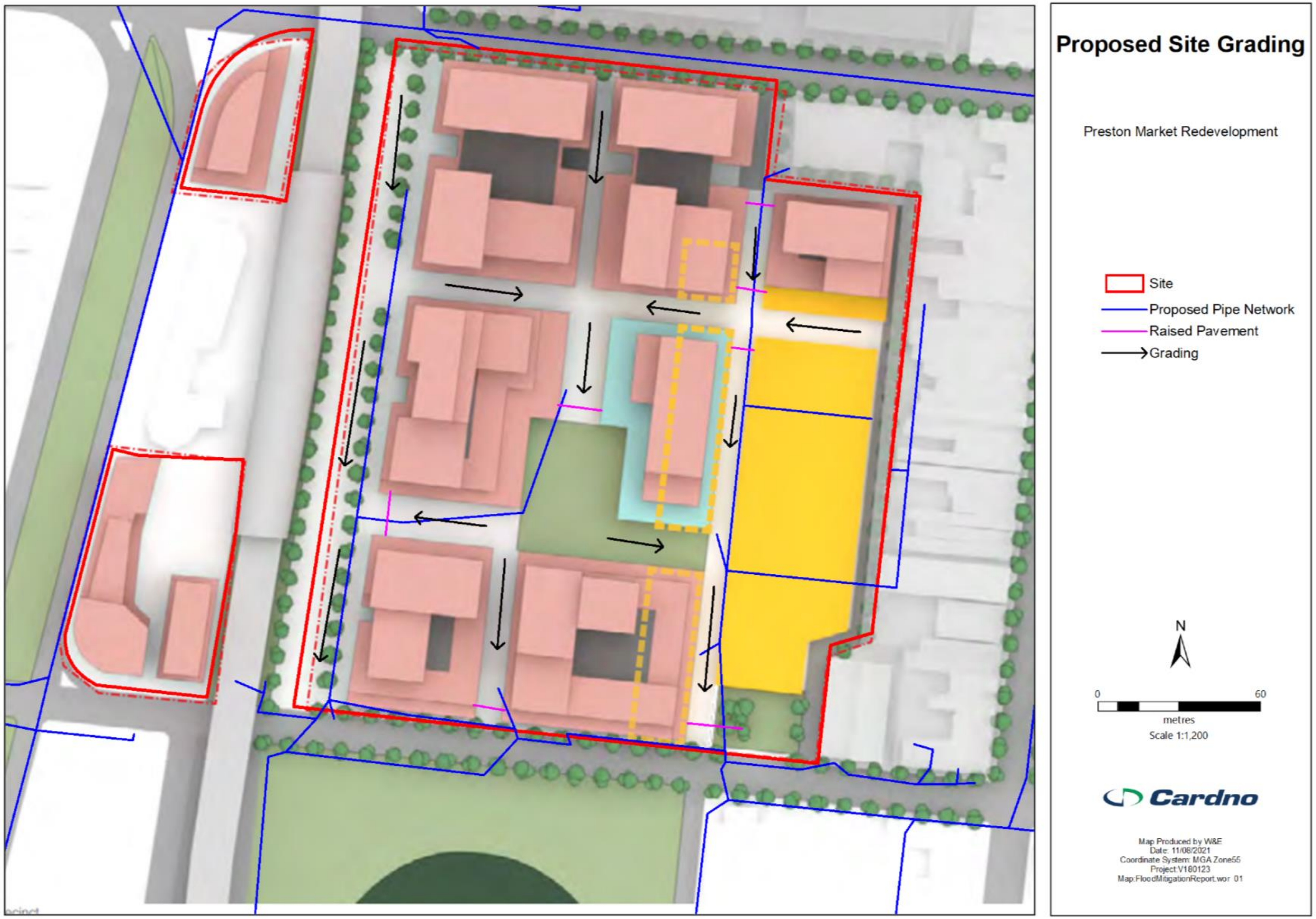

Figure 5-2 Proposed Site Grading

The North and South development areas, located to the west of the rail line, have been modelled with the proposed buildings being complete blockages to overland flows. These areas are located within the 1% AEP flood extent along Murray Road and so the proposed buildings will result in a loss of flood plain storage. As such, compensatory storage will be required to maintain no adverse offiste impacts. For the North development area, the storage volume required is approximately $280m^3$. For the South development area, a volume of approximately 420 m^2. It would be expected that the required storage volumes may be able to be reduced as part of the detailed design stage of the project.

It is acknowldeged that due to the current design for the Murray Road Level Crossing Removal, the final design for both the North and South development areas will need to signficantly change as it is expected that the Level Crossing Removal project will considerly alter the flood behaviour in the vicinity of these two development areas.

6 Flood Modelling Results

Hydraulic modelling of the proposed design outlined in Section 5 does not result in any adverse flood impacts to neighbouring private properties in both the 1% AEP and 1% AEP plus climate change events.

Table 6-1 outlines the peak flow rates at key locations through the site under the proposed conditions, with the locations for each of these flows shown in Figure 6-1 .

Table 6-1 Proposed Site Flow Rates

Location	1% AEP	1%CC AEP
Murray Road	4.8 m^3/s	7.6 m^3/s
Murray Road & High Street	3 m^3/s	6.4 m^3/s
PO_3	0.62 m^3/s	1.13 m^3/s
PO_4	0.04 m^3/s	0.07 m^3/s
PO_5	0.21 m^3/s	0.39 m^3/s
PO_6	0.92 m^3/s	1.55 m^3/s
PO_7	0.06 m^3/s	0.29 m^3/s
PO_8	0.14 m^3/s	0.59 m^3/s
PO_10	0.87 m^3/s	1.58 m^3/s
PO_12	0.72 m^3/s	1.00 m^3/s
PO_13	0.1 m^3/s	0.22 m^3/s
PO_14	0.28 m^3/s	0.47 m^3/s
PO_15	0.48 m^3/s	1.12 m^3/s
PO_24	0.35 m^3/s	0.69 m^3/s

Figure 6-2 shows the proposed 1% AEP flood depths, Figure 6-3 shows the proposed flood hazard and Figure 6-4 the 1% AEP difference plot for the proposed design.

Figure 6-5 shows the proposed 1% AEP + Climate Change flood depths, Figure 6-6 shows the flood hazard and Figure 6-7 the 1% AEP + Climate Change difference plot for the proposed design

As shown in Figure 6-4, there is a minor increase in flood levels (maximum of 2cm) within a small section of Cramer Street in the 1% AEP flood event, these small increases to the flood levels do not result in any increase to the flood hazard category of the roadway and therefore do not affect the flood risk of the road.

Along the south side of Cramer Street there is a very limited number of cells which are classified as “was dry now wet”. These cells are located around the edges of the flood extent, occur along the edge of the roadway and are contained within both carparks and recreation reserves. These cells are located on the edge of the flood extent and usually surrounded by no increases to flood levels, therefore they have been considered minor instabilities within the model (but do not affect overall model health), and would be dealt with at the detailed design stage of the project.

Increases to flood velocities along St Georges Road are associated with flood waters flowing into the proposed swale within the site from the roadway. These increased peak velocities are associated with water more easily flowing out of the roadway during the initial phase of the flood event. As apart the functional design of the development, how flow enters the swale would be more controlled during this initial phase of the flood event (kerb outlets or pit/pipe connections) which would remove this impact from occurring. It should also be noted that even though there are some slight localised increases to the peak velocity, the overall flood hazard category of the roadway remains unchanged with the addition of the proposed works.

Furthermore, as shown in Figure 6-7, there is a minor increase in flood levels (maximum of 2cm) within a small section of Murray Road and St Georges Road in the 1% AEP plus climate change flood event. As above, these increases in flood levels are fully contained within the road reserve and do not result in any increase to the flood hazard category of the roadways.

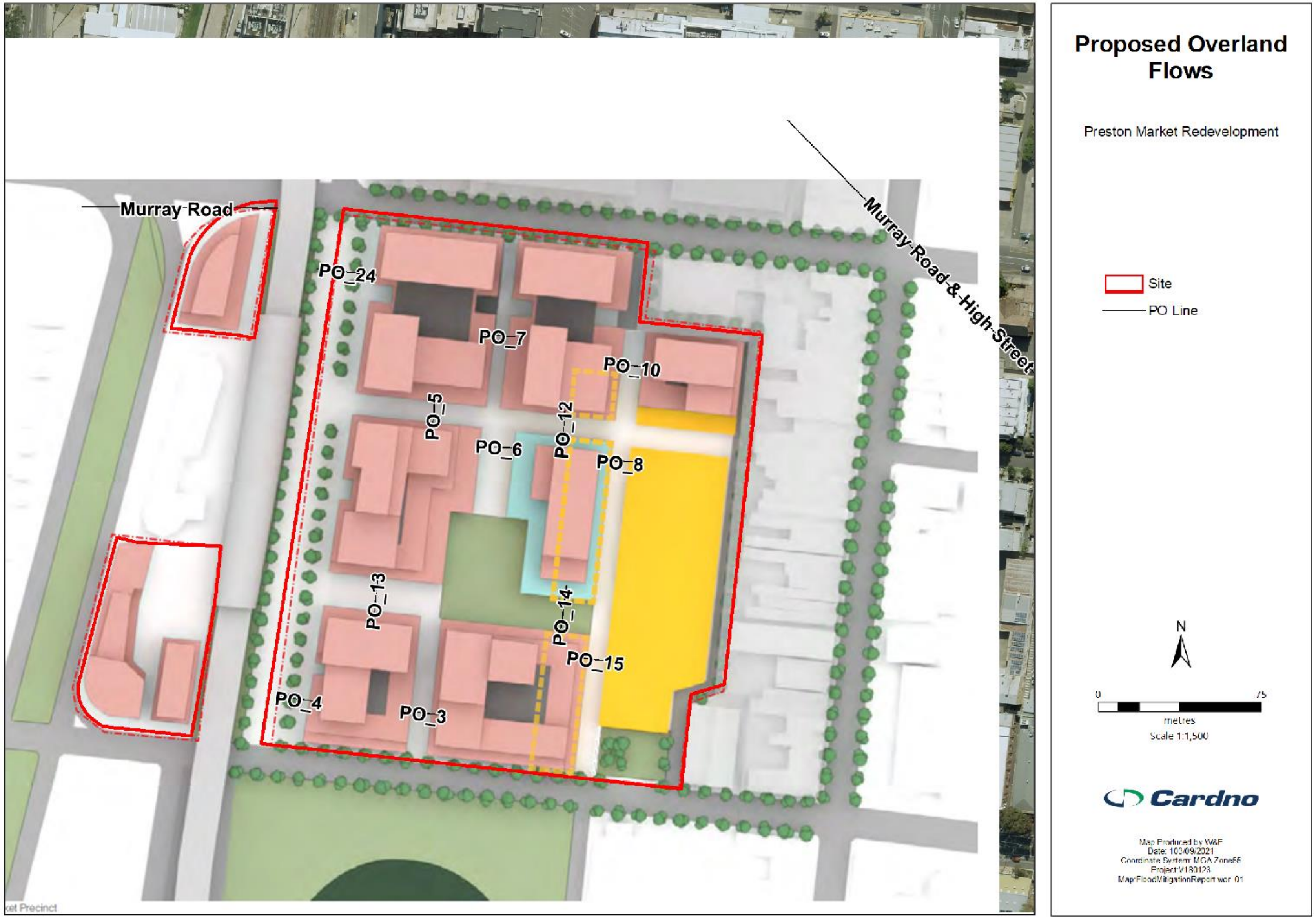

Figure 6-1 Proposed Overland Flows

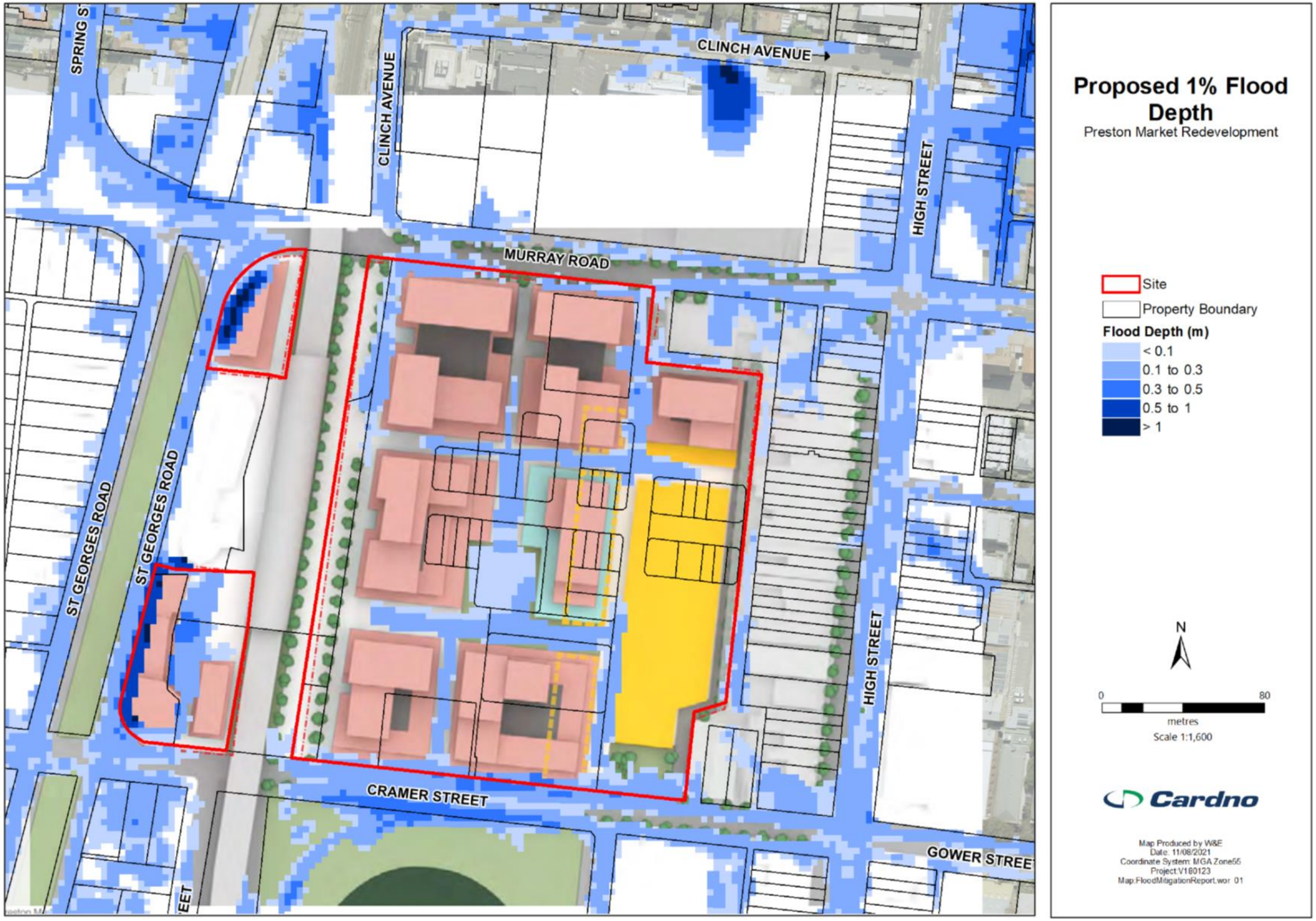

Figure 6-2 Proposed 1% Flood Depth

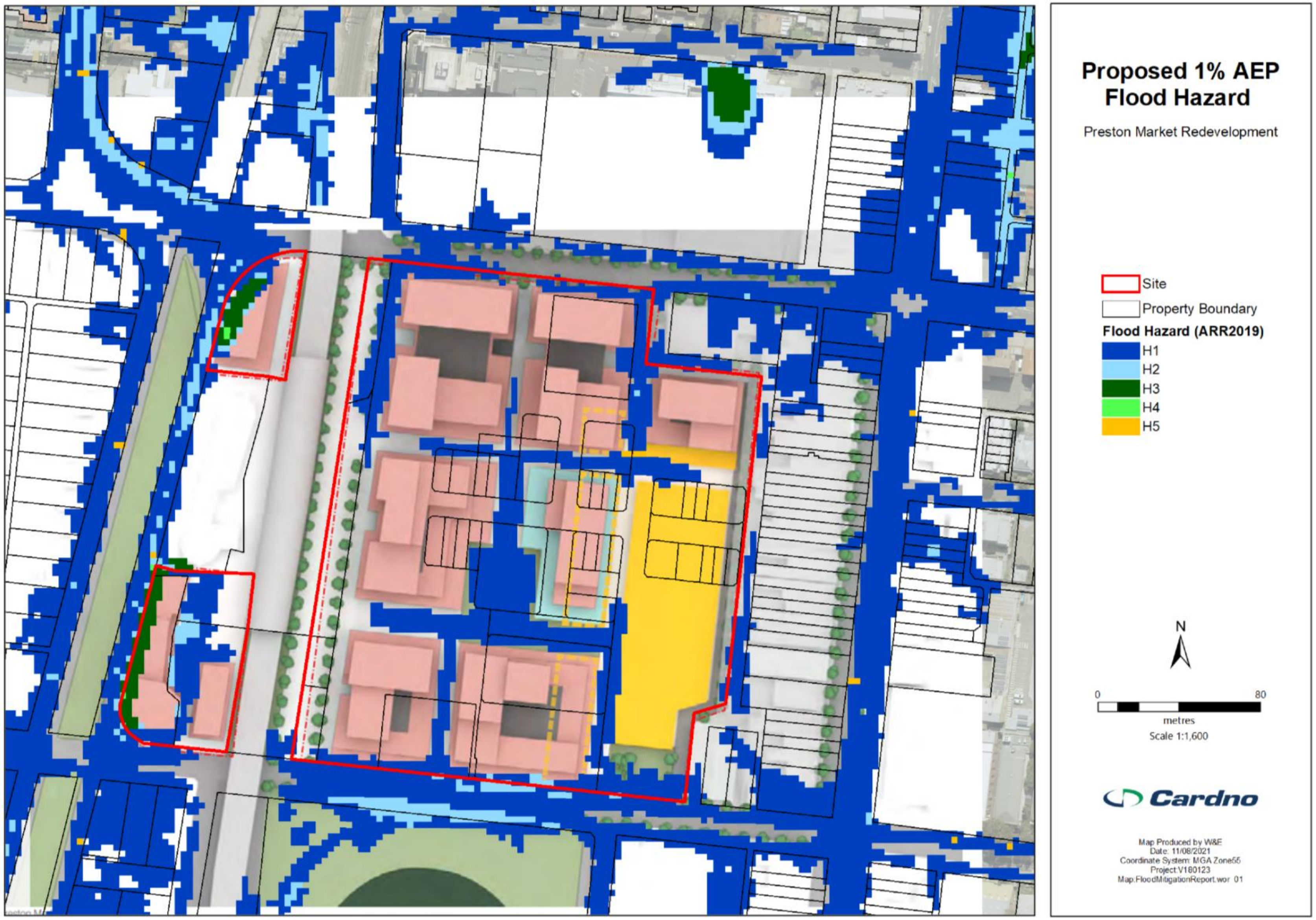

Figure 6-3 Proposed 1% AEP Flood Hazard

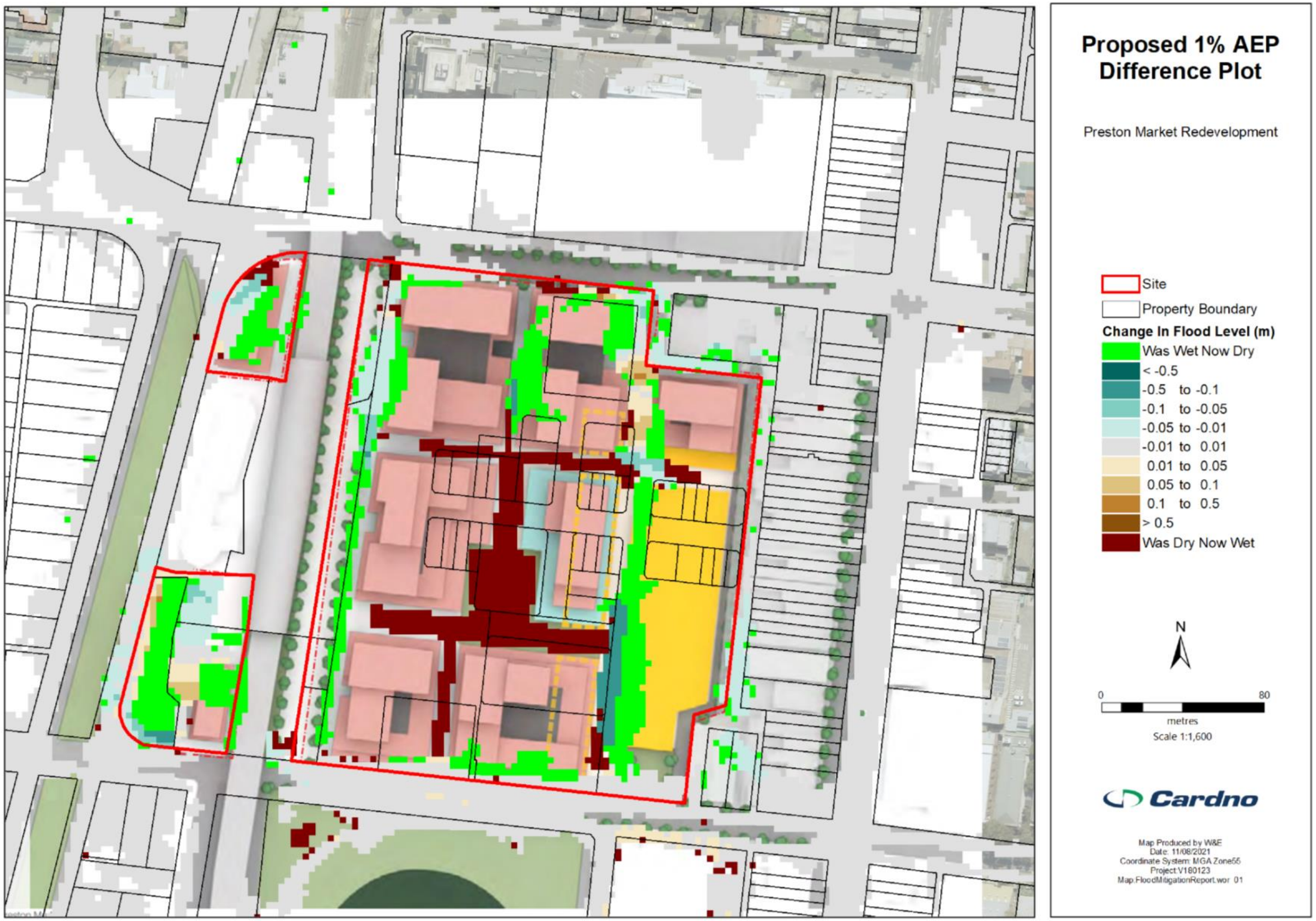

Figure 6-4 Proposed 1% AEP Difference Plot

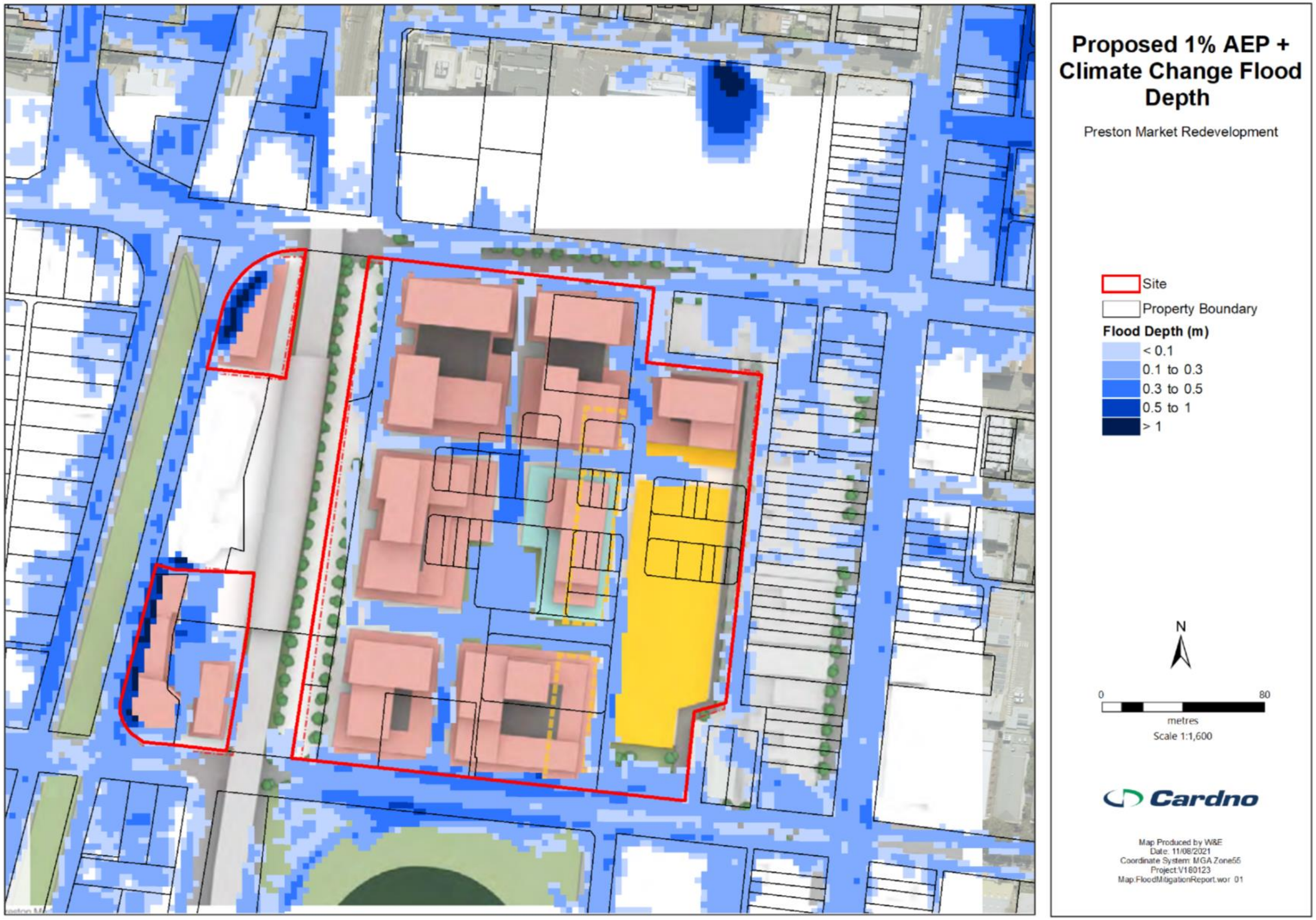

Figure 6-5 Proposed 1% AEP + Climate Change Flood Depth

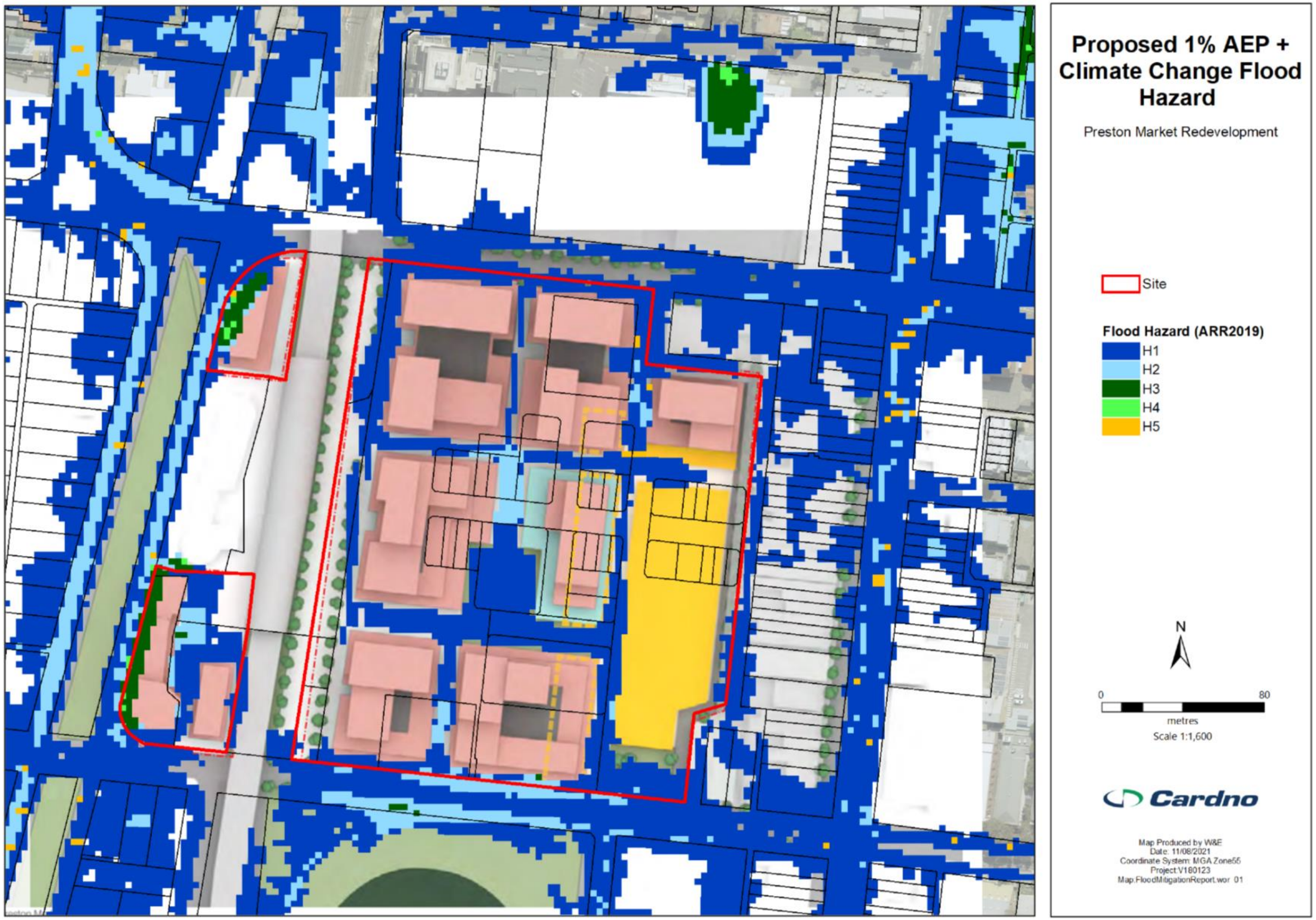

Figure 6-6 Proposed 1% AEP + Climate Change Flood Hazard

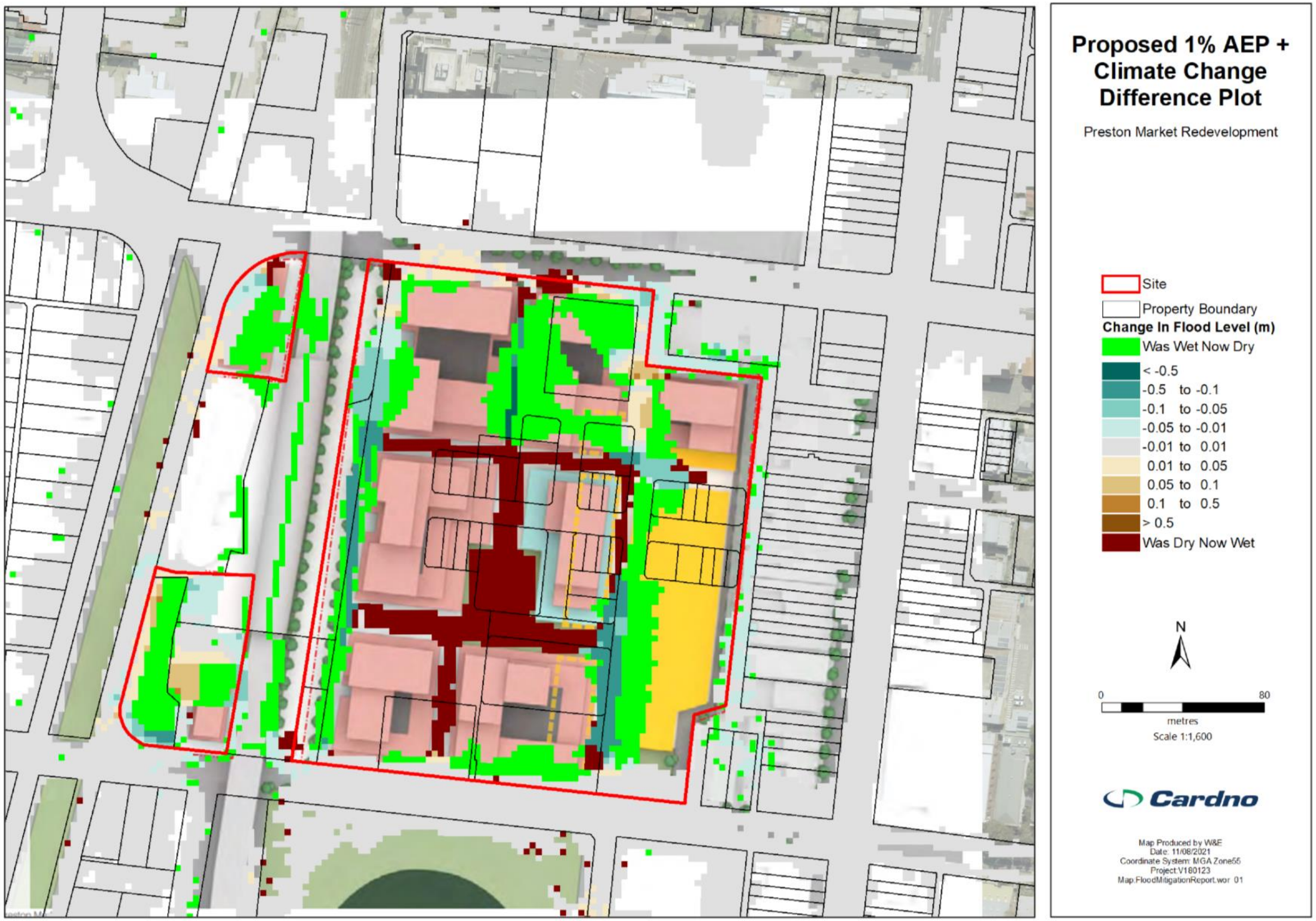

Figure 6-7 Proposed 1% AEP + Climate Change Difference Plot

7 Stormwater Quality

Water quality and integrated water management for the Preston Market development can be managed through a number of different approaches. For the purpose of this report, two main options have been identified:

> A precinct scale treatment of stormwater by a single or multiple Water Sensitive Urban Design (WSUD) assets

> A precinct scale treatment of stormwater with the addition of a stormwater harvesting for non-potable supply (e.g. irrigation of the Preston City Oval)

The main objective of the treatment measures is to meet best practice stormwater quality guidelines and objectives based on the “Best Practice Environmental Management Guidelines” (CSIRO 1999), which will be required for the redevelopment of the Preston Market. It should be noted that this is a high-level assessment and may be subject to change in future stages.

7.1 Water Quality Objectives

In order to achieve the required treatment objectives, water quality treatment measures will be incorporated into the site layout in order to meet the best practice management targets outlined in Table 7-1 below.

Table 7-1 Best Practice Water Quality Targets

Pollutant	Target Reduction
Total Suspended Solids	80%
Total Nitrogen	45%
Total Phosphorus	45%
Gross Pollutants	70%

To determine the effectiveness of the proposed treatment train in meeting the water quality objectives, stormwater quality modelling was performed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 6.3.0.

7.2 Water Sensitive Urban Design

7.2.1 Option A: A precinct scale treatment of stormwater by a single or multiple Water Sensitive Urban Design (WSUD) assets

MUSIC modelling of the site has determined that a bioretention system (i.e. raingarden) with a footprint of 320 m^2 would provide the required water quality treatment for the entire Preston Market site. It should be noted that the treatment train can consist of a single 320 m^2 bioretention asset or a combination of assets with a total area of 320 m^2 distributed throughout the site (e.g. multiple tree pits, raingardens, etc.). In the case of Figure 7-1, the main site area has been over-treated to meet best practice requirements. Figure 7-2 illustrates an example of where the WSUD assets could be situated in regards to the site layout.

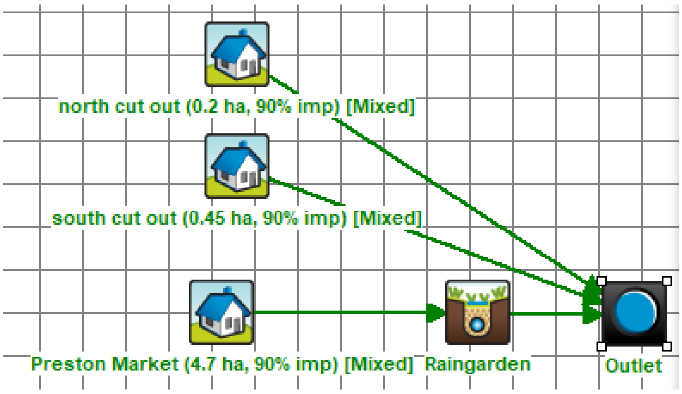

Figure 7-1 Option A MUSIC Schematic

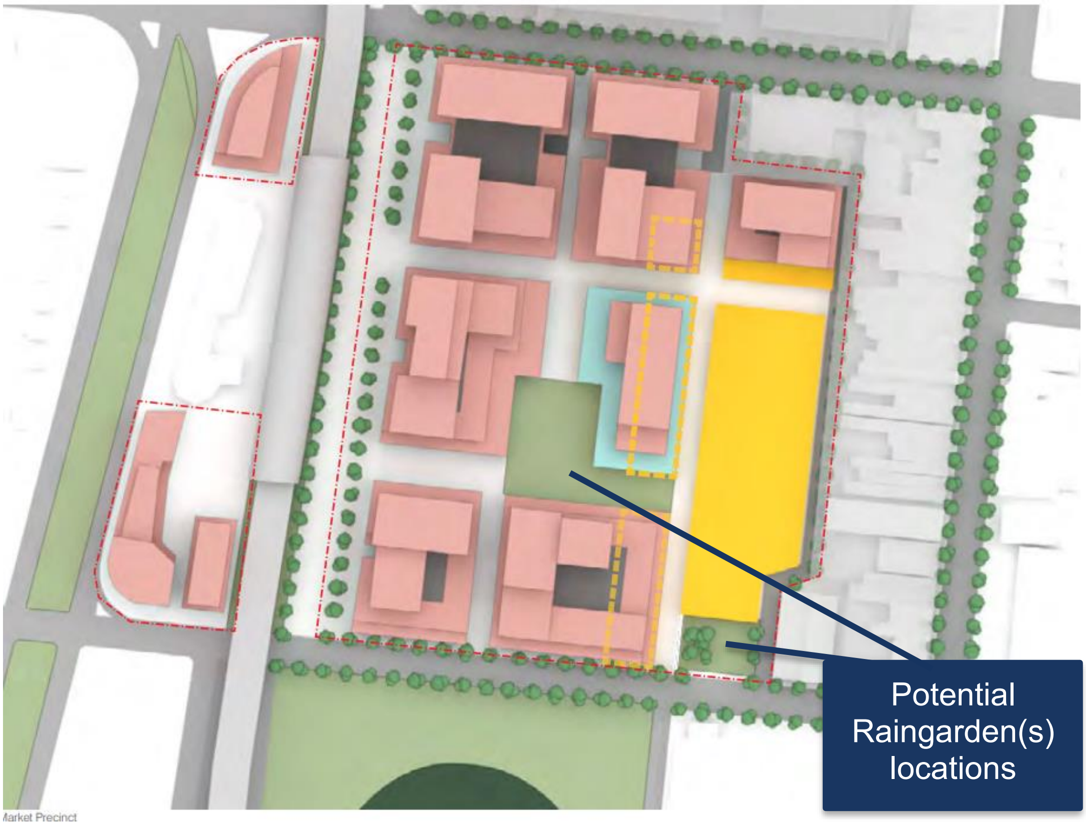

Figure 7-2 Option A potential location of WSUD assets

Table 7-2 below outlines the advantages and drawbacks of Option A.

Table 7-2 Option A: Advantages, drawbacks and Cost estimates (CAPEX only)

	Advantages	Drawbacks
Option A	Improves stormwater quality and achieves required treatment objectives	No diversification of water supply and provision of alternative supplies for resilience and Integrated Water Management aspects
	Increase native vegetation cover for biodiversity, soil moisture for human comfort and health, improve the quality of recreation spaces, amenity and liveability value	

7.2.2 Option B: A precinct scale treatment of stormwater with the addition of a stormwater harvesting for non-potable supply (i.e. irrigation of the Preston City ovals)

Another option to manage the stormwater treatment of the Preston Market site consists of treating and reusing stormwater runoff. The proximity of the site to the Preston City Oval (as shown in Figure 7-3 below) offers an opportunity to reuse stormwater runoff to irrigate the oval which has an estimated annual irrigation demand has of around 7ML/yr.

Figure 7-3 Preston City Oval

The following infrastructure or similar will generally be required for these type of stormwater reuse schemes:

- Diversion
- Pump and transfer main
- Bioretention and/or multi-media filters
- Storage tanks
- Pump and transfer main
- UV disinfection treatment
- Chlorine disinfection treatment

MUSIC modelling of a stormwater harvesting system for the Preston Market development shows that two 100 m^3 buffer tanks, a 200 m^2 bioretention system (i.e. raingarden) and a 500 m^3 stormwater reuse tank should provide for approximately 75% of the annual irrigation demand of the Preston City Oval. Similarly, to Option A, the main site area has been over-treated to meet best practice requirements as shown in Figure 7-4. Figure 7-5 illustrates an example of where the water treatment assets could be situated with regards to the site layout.

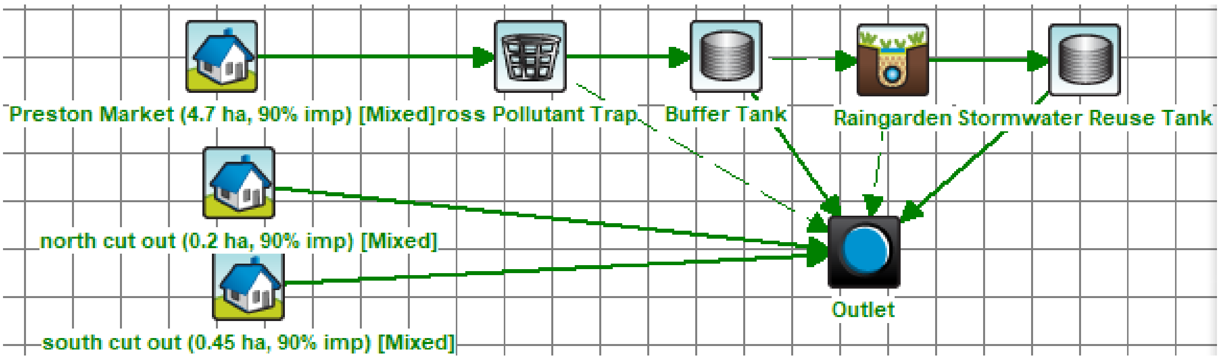

Figure 7-4 Option B MUSIC Schematic

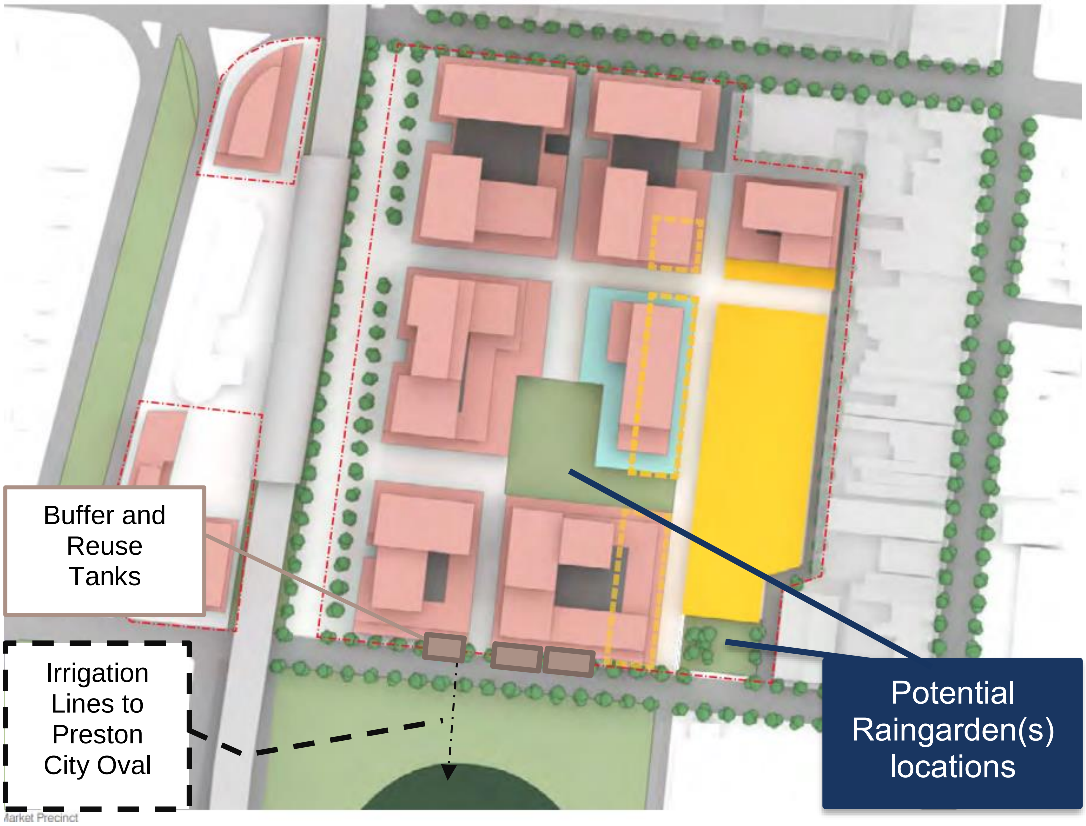

Figure 7-5 Option B Stormwater harvesting and reuse Scheme location

Table 7-3 discusses the advantages and drawbacks of Option A.

Table 7-3 Option B: Advantages, drawbacks and Cost estimate (CAPEX only)

	Advantages	Drawbacks
Option B	Improves stormwater quality and achieves required treatment objectives	Cost, ongoing maintenance and operation requirements

8 Conclusion

Hydraulic modelling of the Preston Market redevelopment has shown for the current proposed layout plan of the site is able to be to implemented without resulting any adverse offsite impacts for the 1% AEP and 1% AEP plus climate change flood events. This outcome is possible by simply controlling and directing flood waters through the site using surface grading and some strategically placed raised pedestrian crossings.

It is acknowledged that the design for the North and South development areas (west of the railway line) will need to change due to the Murray Road Level Crossing removal works. However, the current design in these areas would require onsite storage to account for the loss of flood plain storage due to the proposed buildings with approximately 280 m^3 required for the North development area and approximately 420m^3 for the South development area.