Stormwater Drainage Assessment Report

Preston Market

V180123

Prepared for
Victorian Planning Authority

3 September 2019

Cardno

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Table of Contents

Tables

Figures

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) has engaged Cardno to prepare a Stormwater Drainage Assessment to assist in the preparation of a Structure Plan for the Preston Market (PM) redevelopment site located along Mary Street (City of Darebin).

1.1 Purpose of this Document

The purpose of this document is to provide a drainage assessment of the existing drainage conditions and a developed case scenario at the site, as relevant to the Preston Market. This includes consideration of the regional flood behaviour associated with Melbourne Water's drainage network and the local drainage network at the market. The previous Situational Analysis Report (18/05/2019) provided an understanding of the key stormwater issues for the PM site, enabling the development of a stormwater management strategy.

1.2 Study Area

The Preston Market site is located 9km from Melbourne's CBD between Cramer Street and Murray Road in Darebin. The original site area of 4.6 ha was extended to include the additional parcel areas to the west of the train line for the developed scenario referred to as "North" and "South" development areas (Figure 1-1).

The PM site is also located downstream of a wider catchment (i.e. Preston Main Drain catchment) that eventually drains to Mayers Park and into the Merri Creek. This catchment includes a drainage investigation area of about 70 hectares and is shown in Figure 1-2. The Preston Main Drain Catchment is shown in Figure 1-3 and the setup of the hydraulic model has been illustrated in Figure 1-4.

Figure 1-1 Preston Market Development Site (Nearmap, 2019)

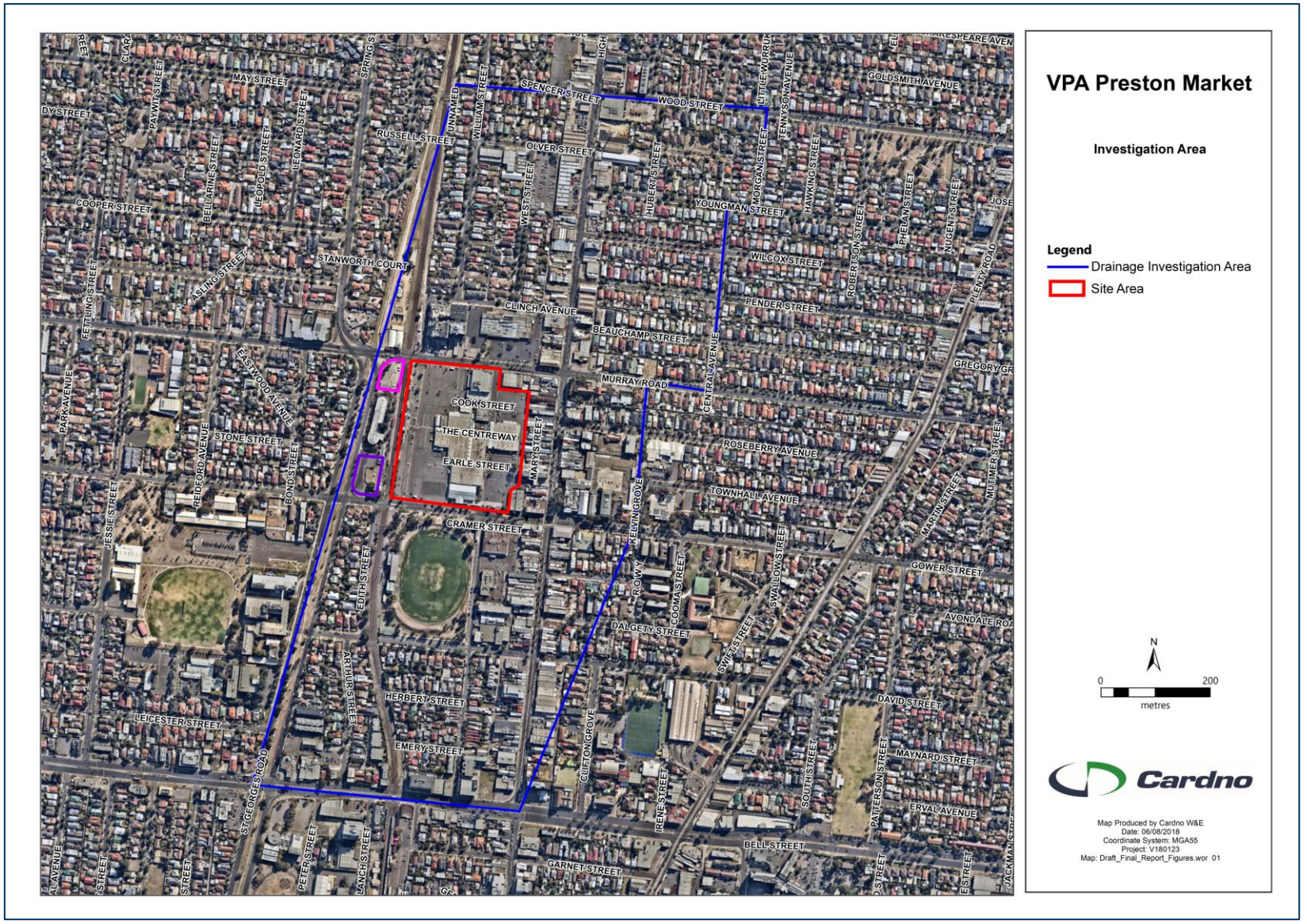

Figure 1-2 Preston Market Site and Drainage Investigation Area

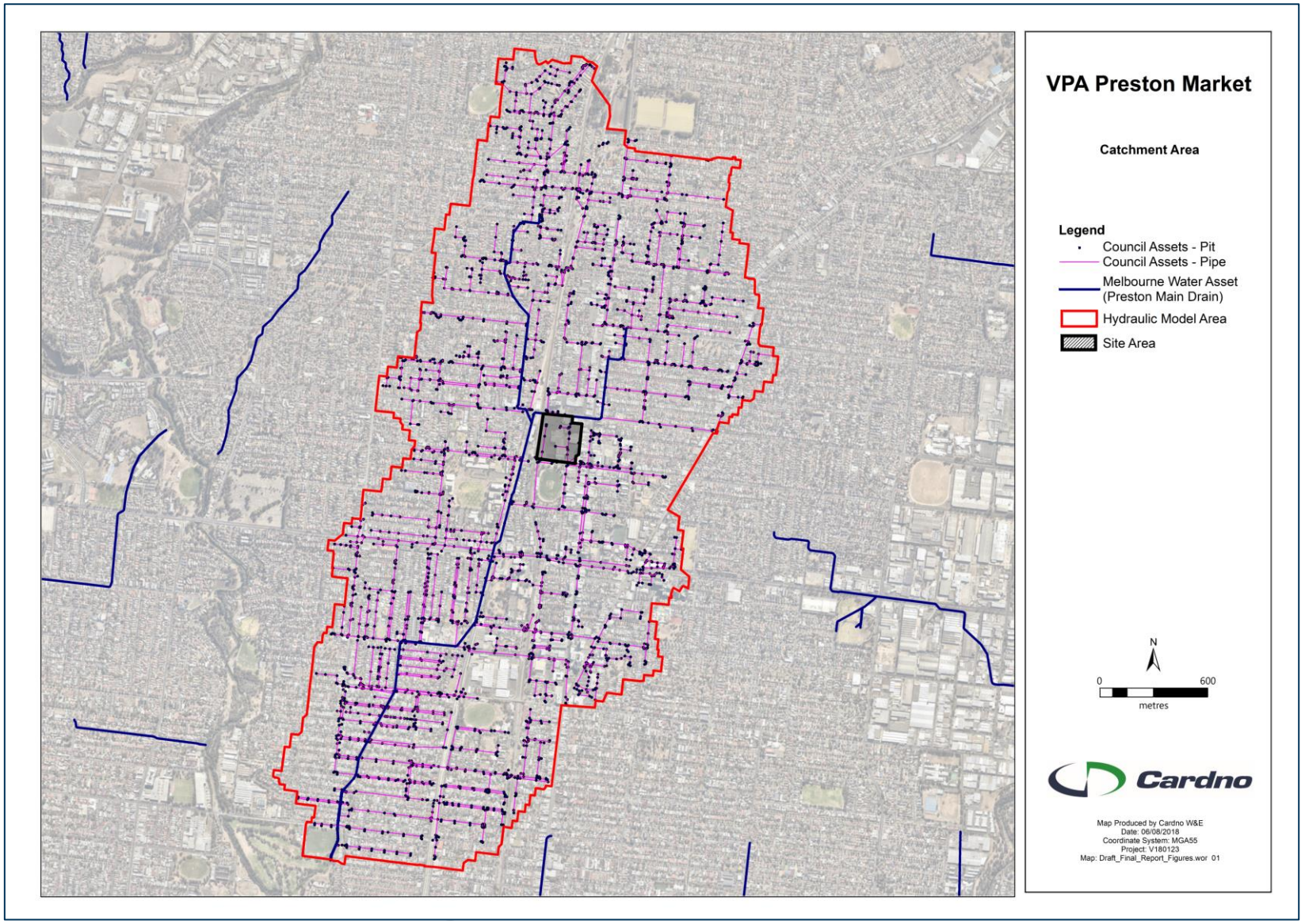

Figure 1-3 Preston Main Drain Catchment

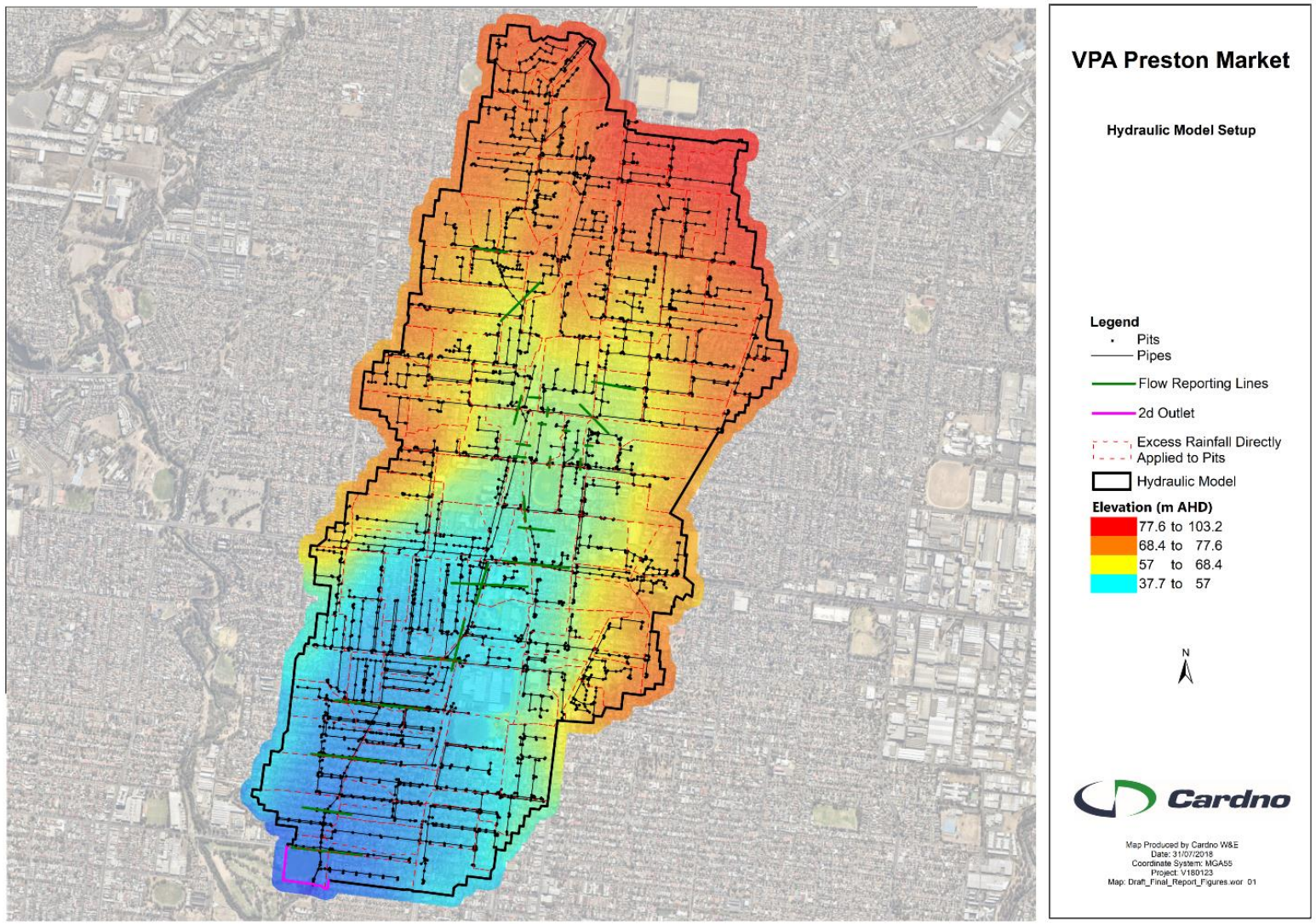

Figure 1-4 Preston Main Hydraulic Model Setup

2 Stormwater Network Assessment

There are two components to the stormwater network at the PM site and 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 southern 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 the 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, 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 above ground component of the drainage system and occur when underground drainage pipes reach their capacity and 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.

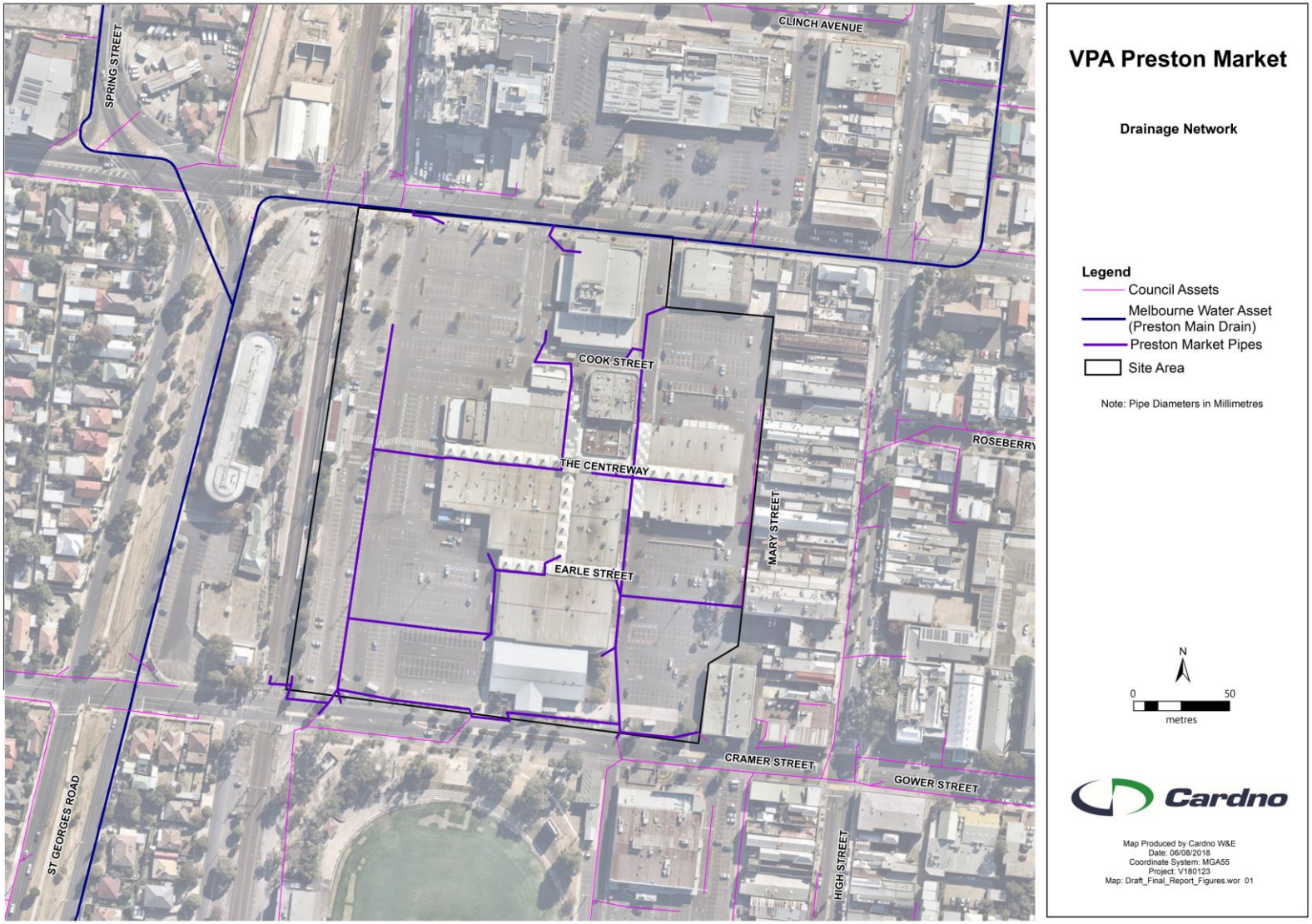

Figure 2-1 Existing stormwater drainage infrastructure within Preston Market

3 Planning Controls

3.1 Darebin Planning Scheme (Special Building Overlay)

Figure 3-1 shows the Special Building Overlay 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 there has been substantial development since the underground infrastructure was constructed. It is important to note that the overlay extent was developed from earlier flood mapping completed by Melbourne Water (around 1996).

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 area)

Figure 3-2 below shows the 1%AEP flood extent developed by Melbourne Water using modelling results from Cardno in 2012. It is important to note that the flood extents shown in this figure are based on a methodology that is no longer used by Melbourne Water. The method used to generate the flood extent has been superseded by Melbourne Water from 2016. Cardno considers that the flood extent shown is not an accurate description of the expected extent of flooding at Preston Market. The flood extent does cover flooding from both the council and Melbourne Water drainage networks

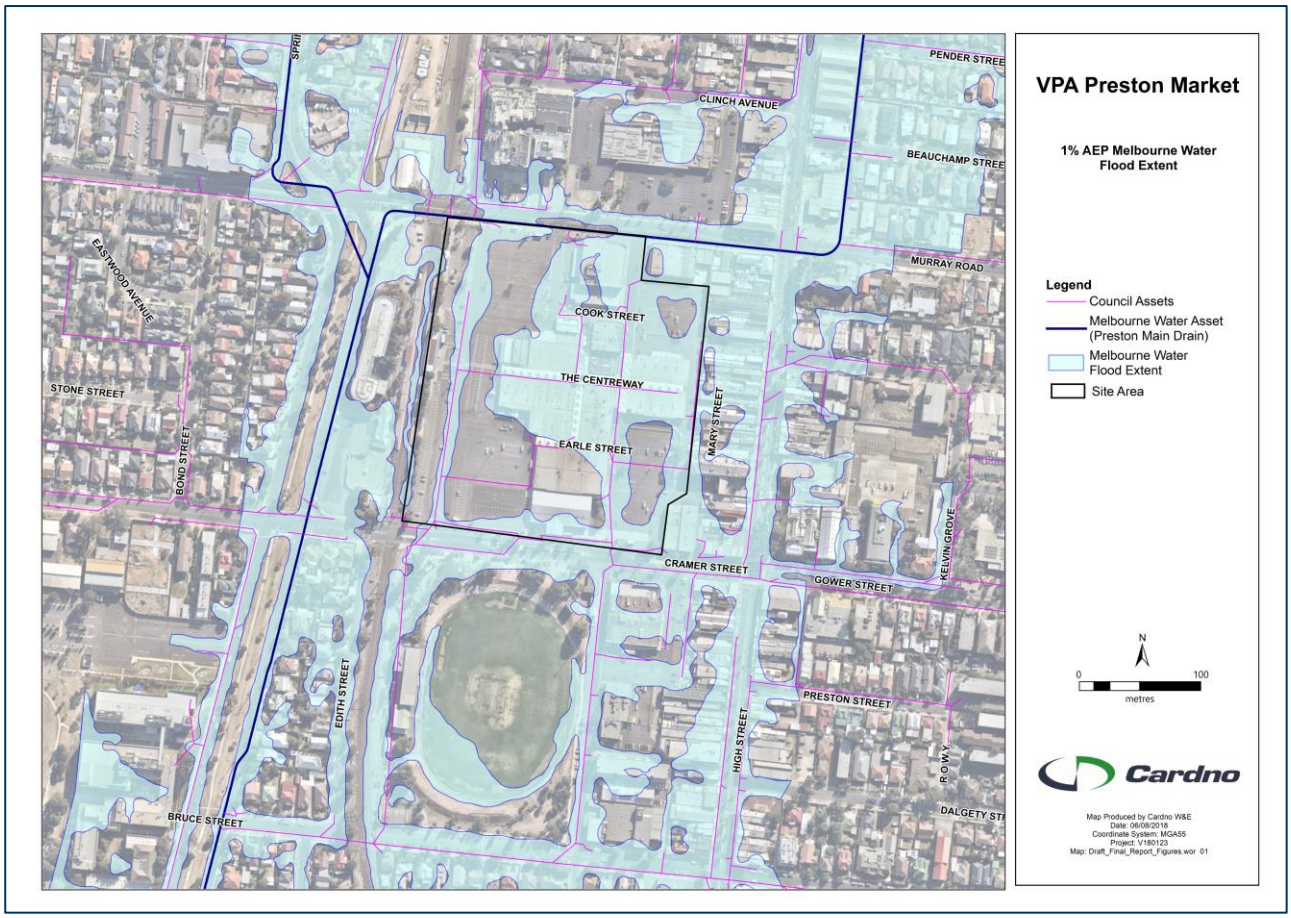

Figure 3-2 1% AEP flood extent for the Preston Market Site (Melbourne Water, Deprecated)

4 Existing Flooding Behaviour

The existing flooding behaviour of the Preston Market site was thus assessed by considering the local and Regional Flood Behaviour. The project brief requires analysis of existing flooding behaviour for the existing 100 year (1% AEP) and 10 year (10% AEP) storm event.

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

- Amendments to the block outs of the existing railway station buildings
- Run files were adjusted to utilise latest version of TUFLOW (2018-03-AC\TUFLOW_iDP_w64)

Flood extent filtering was conducted as per Melbourne Water's Technical Specifications (November 2018).

4.1 Flood Analysis

Cardno amended the flood model generated in 2012 for the Preston Main Drain Flood Study

The data was processed to apply Melbourne Water current filtering criteria to define the expected flood extent and depth across the catchment for the following flood events:

- 10% AEP flood event, current climate conditions
- 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 4-1 and Figure 4-2 show the 1% AEP current climate conditions for flood depth and flood hazard. Figure 4-3 and Figure 4-4 show the 10% AEP current climate conditions for flood depth and flood hazard.

Figure 4-1 shows that the maximum flood depths in the Preston Market site are generally less than 20 cm, however, there are significant overland flow paths adjacent to the development area that need to be considered when developing a design response. These include Cramer Street and the western boundary of the site with the railway carpark, which both act as floodways. High Street carries a significant flood flow and care would need to be taken with any connection into this area to ensue flood waters are not redirected onto the Preston Market site.

Flooding is shown on the site and is primarily due to the capacity of the internal drainage network being overwhelmed by the very high rainfall intensities. From a design perspective, the future drainage of the market should be designed to ensure that this flood behaviour is managed to ensure public safety and maintain or reduce the overall flood risk.

4.1.1 Hazard Categories

The hazard categories shown in Figure 4-2 and Figure 4-4 have been defined according to the best practice specification outlined in Australian Rainfall and Runoff 2016 (Figure 4-5). According to these definitions, anything that is 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 considered to be generally safe for most uses. These categories align with Melbourne Water's safe access guidelines.

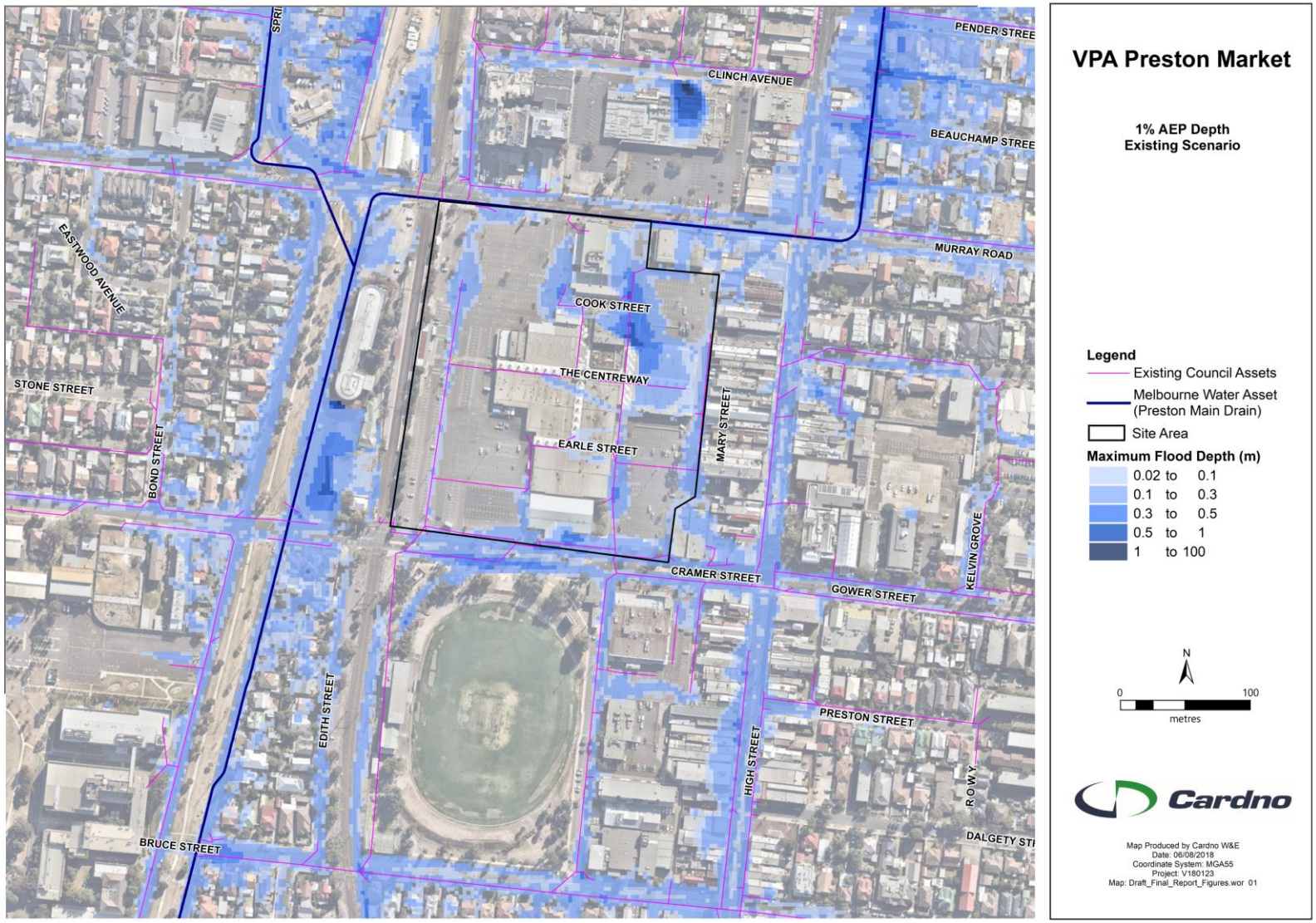

Figure 4-1 1% AEP Existing Flood Depths

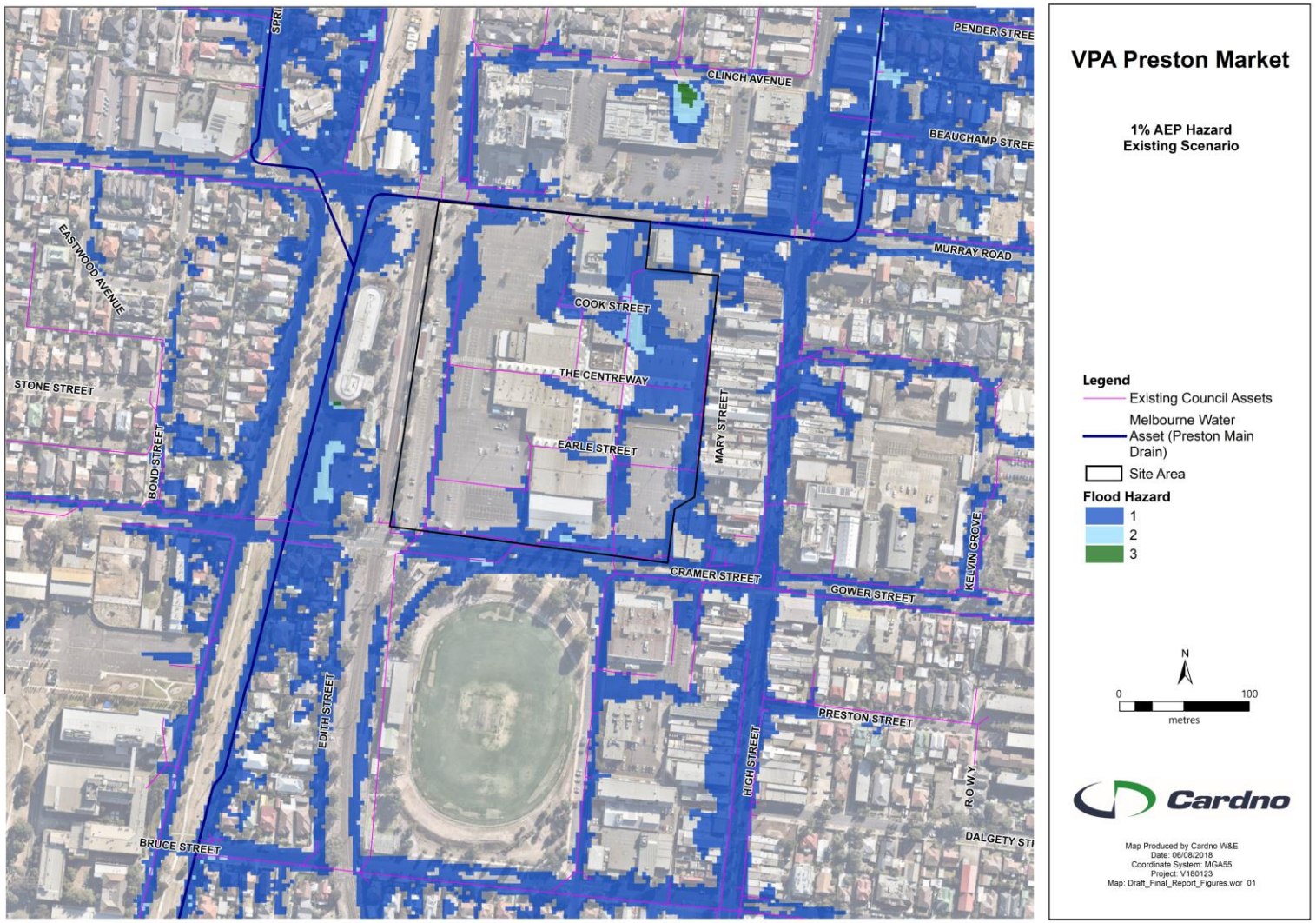

Figure 4-2 1% AEP Existing Flood Hazards

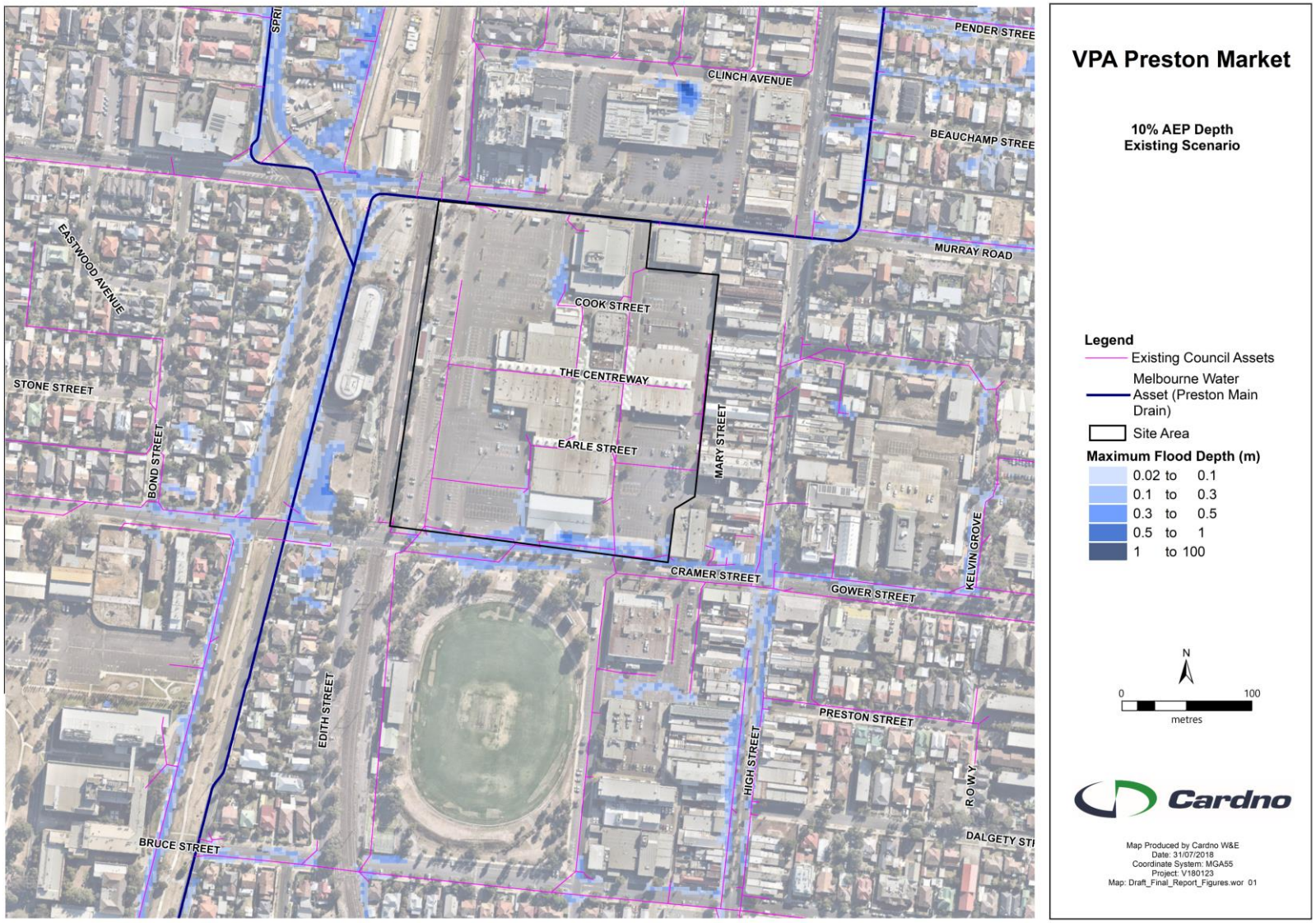

Figure 4-3 10% AEP Existing Flood Depths

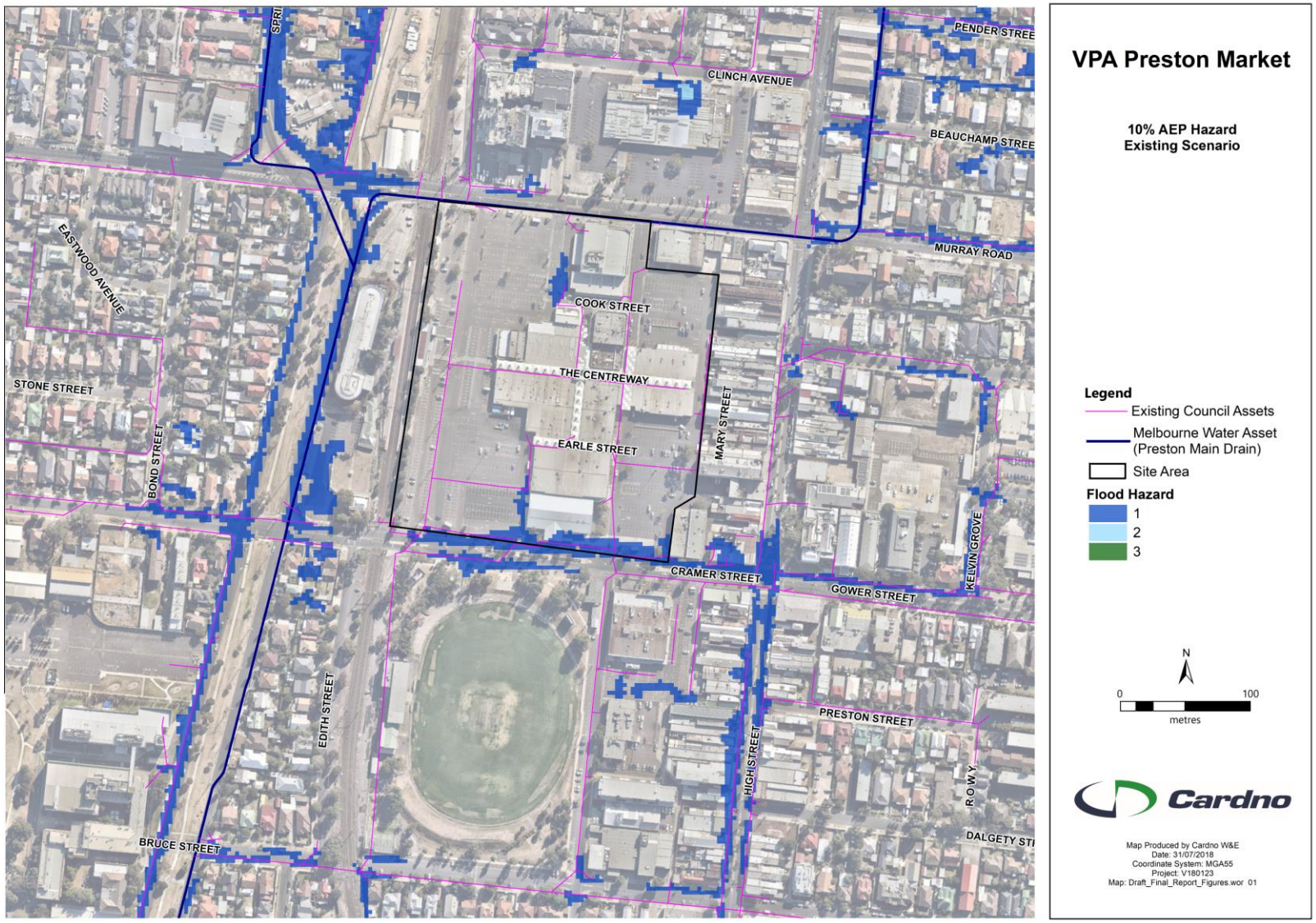

Figure 4-4 10% AEP Existing Flood Hazard

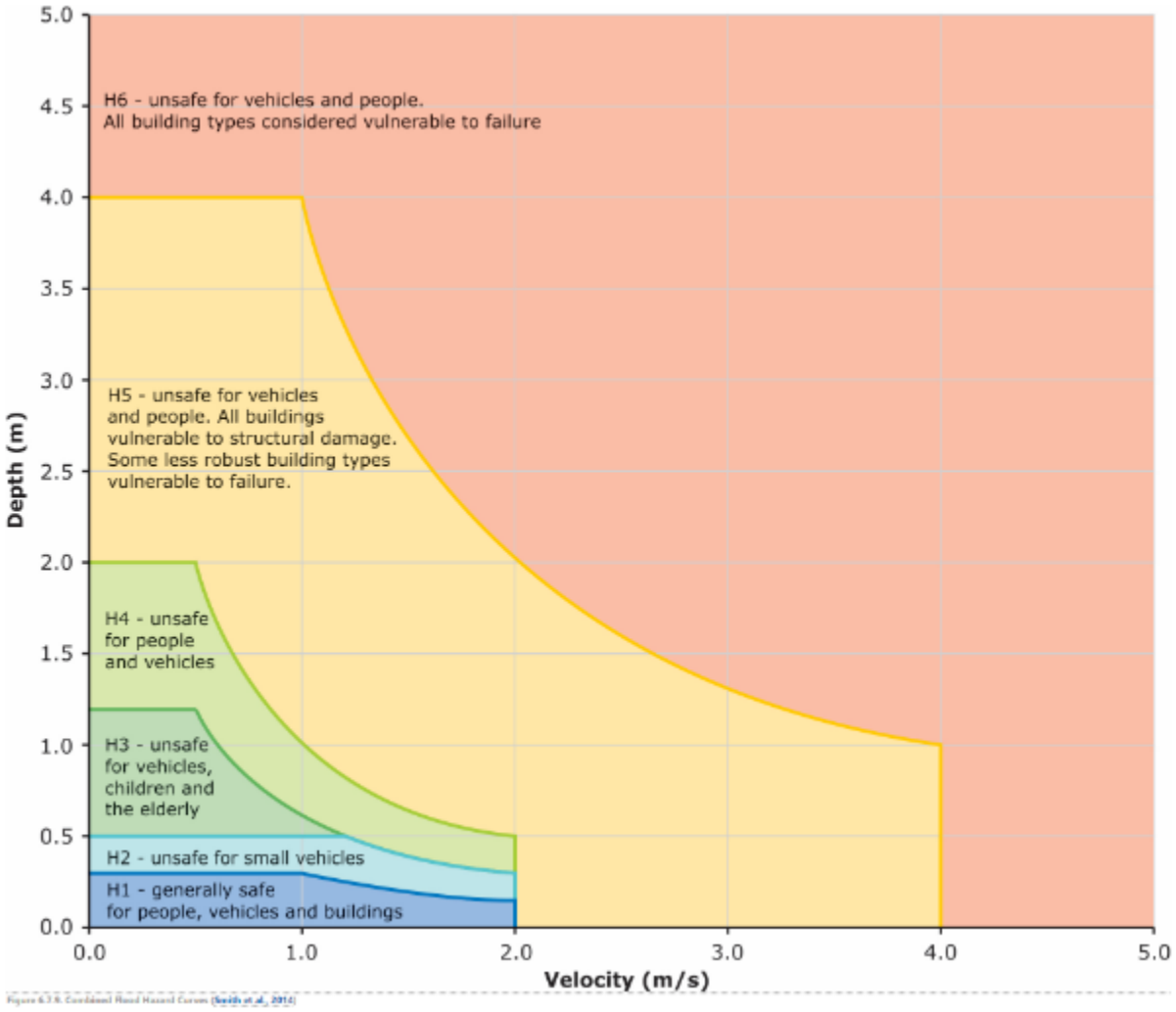

Figure 4-5 Hazard Categories (ARR2016)

5 Draft Framework Plan

Figure 5-1 illustrates the draft Framework plan for Preston Market, including a combination of residential and commercial activity. The site will also provide recreational infrastructure, pedestrian thoroughfares and open space allocations. An internal road network has also been proposed to allow vehicular movement between Murray Road and Cramer Street.

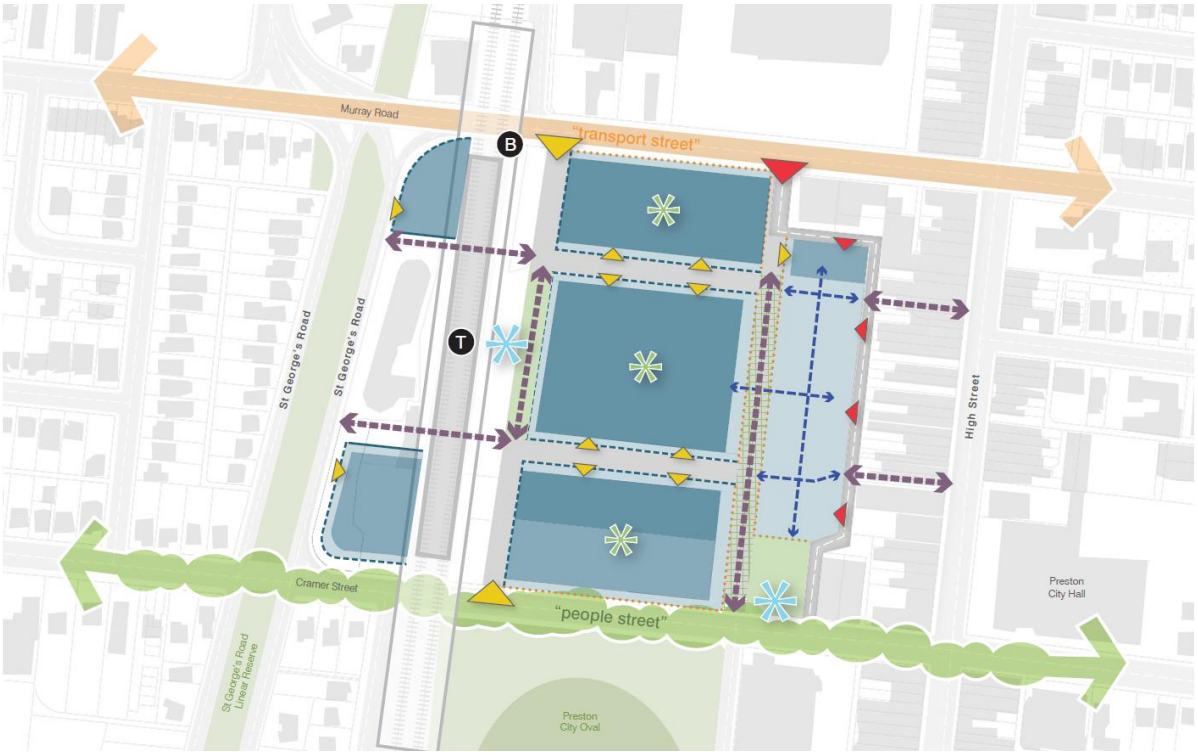

Figure 5-1 Proposed Preston Market Precinct Development Plan (architectus, 2019)

This layout plan is indicative only and was provide by the VPA for flood analysis purposes. The plan indicates the potential 'superblocks' expected as part of the redevelopment. The redevelopment layout has not yet been to public consultation and is subject to change.

6 Future Development Flooding and Modelling Criteria

6.1 Flood Criteria

The future development flood criteria have been based upon the project brief requirements. The Preston Market site requirements are:

- Any 1% AEP overland paths in road reserves must meet Melbourne Water's floodway safety criteria for depth of flow and flow velocity
- Any 1% AEP overland flow must be fully contained with reserves (roads, open space)
- Flooding cannot be increased either upstream or downstream of the Preston Market site or for existing landholders
- The internal drainage network of the PM site should have capacity for the 10% AEP (1 in 10 year ARI) flood event.

6.2 Climate Change

Climate change will be computed for the following scenario:

- Developed Case: 1% AEP storm event within the drainage investigation area for the proposed development of the PM and associated development areas east and west of the railway

ARR 2016 provides guidance on the estimation of the effects of climate change on rainfall intensity. It recommends the use of a 5% increase in rainfall intensity per °C. The percentage increase in rainfall intensity at a time period can be derived from the equation:

$$P = 100(1.05^{\Delta T} - 1)\%$$

Where:

P is the percentage increase in rainfall intensity at 2100 (compared to the baseline conditions); and

ΔT is the expected temperature increase at 2100.

Melbourne Water's technical specification adopts the Representative Concentration Pathway (RCP) 8.5 future emissions scenario. For the Melbourne region, the expected temperature increase in 2100 under this pathway is 3.644 degrees. This value is entered into the equation above to determine the percentage increase in intensity at 2100 for all design storms.

The increase in rainfall intensity for 2100 was determined to be 19.5%. All developed scenarios were modelled for climate change assuming a 19.5% increase in rainfall intensity.

6.3 Modelling Inputs

The existing conditions drainage model was modified to include elements of the Draft Framework Plan for the Preston Market site, discussed in Section 5. In accordance with the design requirements, the modifications included:

- Raising any proposed buildings to be above the expected flood levels
    - Developed Scenario: Proposed development east of the railway and north and south development areas, west of the railway, as well as removing existing building block outs, where these intersect proposed building footprints
- Road cross sections have been adopted that allow for a depth of flooding of up to 20 cm across the road reserve. These sections assume:
- Roads grade generally from north to south, and west to east.

- The road transitions immediately from the property edge to a 20 cm deep channel adopting a 50% sloping batter. See Figure 6-1.
- Some minor reconfiguration and increased sizing of local drainage as highlighted in to cater for the 10% AEP storm event.

A typical road section such as those summarised above, is outlined in Figure 6-1. Note that road widths have been nominated as per the indicative Draft Framework Plan and vary across the site.

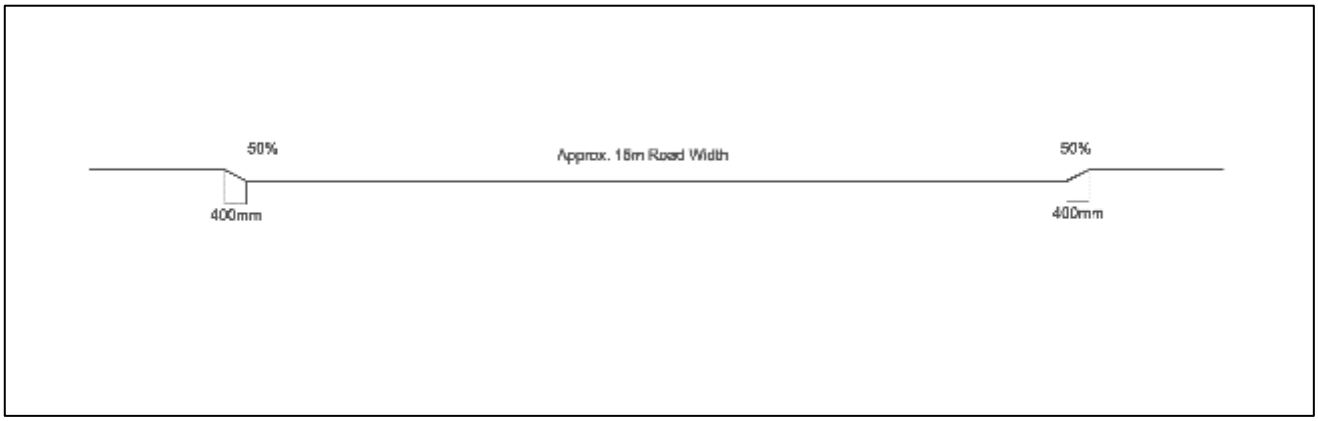

Figure 6-1 Typical Road Cross Section (20cm depth)

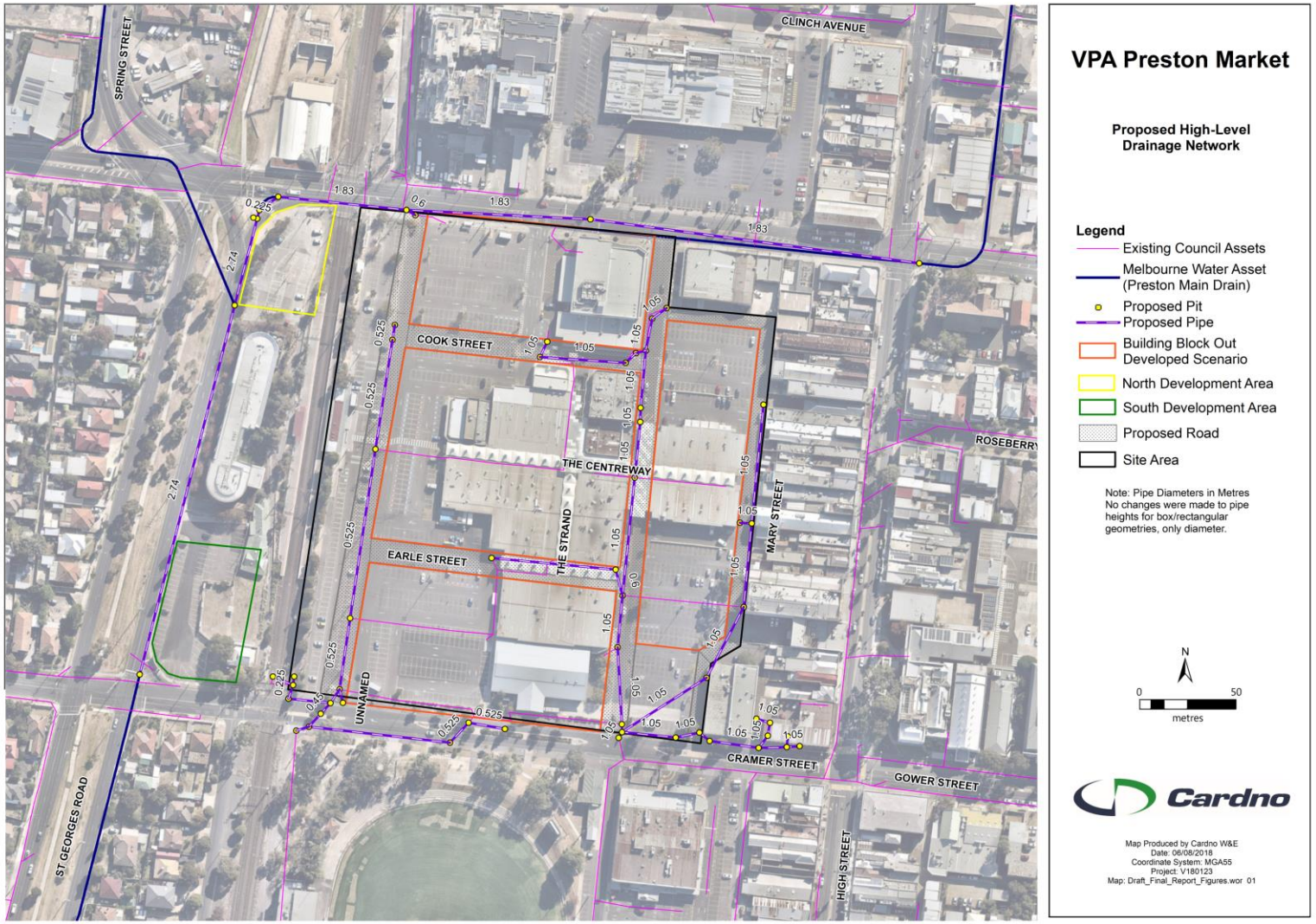

Figure 6-2 Proposed High-Level Drainage Network

7 Flood Mitigation

Flood mitigations options to alleviate flooding in and around the Preston Market site and meet the flood criteria set above, were identified and discussed with VPA before being taken to further modelling. All options include storage and conveyance of overland flows in a safe manner and consist of the safe conveyance of 1% AEP Overland Flow Paths using the proposed internal road network and the storage of 10% AEP flows in the upgraded local drainage system.

7.1 Flood Modelling Results

Figures 7-1 to 7-4 show depth and hazard plots for the developed scenario and Figure 7-5 shows the change in water surface elevation between the developed scenario and existing situation. The results show:

- There are decreases in flooding throughout the PM site primarily due to modifications to the capacity of the existing drainage to service the proposed development. The initial development pipe sizes are shown in Figure 6-2. Excess overland flows are now allowed for in roadways through the site. All buildings will be raised above any adjacent flood level.
- For roads within the PM site, flood hazard is generally low (Class H1)
- There is a small increase in offsite flooding on Murray Road adjacent to Clinch Avenue of up to 80mm. This is being caused by the proposed building blockout on the PM site causing water to pond on Murray Road. This is considered to be a minor increase that can be mitigated in detailed design by:
    - Slightly offsetting the proposed PM building on Murray Road
    - Minor re-shaping of the entrance to the western PM roadway and area in front of the proposed PM building on Murray Road to allow water to more easily enter the roadway and travel through the PM site as it does under existing conditions
- There is small increase in flooding to the south of the PM site on Cramer and Mary Streets of up to 70mm. This is being caused by the proposed building blockout on the PM site causing water to flow south onto Mary Street instead of west on Cramer Street. This is considered to be a minor increase that can be mitigated in detailed design by:
    - Slightly offsetting the proposed PM building on Cramer Street
    - Minor re-shaping of the entrance to the eastern PM roadway and area in front of the proposed PM building on Cramer Street to allow water to more easily exist the roadway and travel west along Cramer Street as it currently does under existing conditions
- There is an increase in flooding between St Georges Road and the train line of up to 170mm. This is being caused by the proposed buildings west of the railway removing an existing flooded area, resulting in water being displaced onto adjacent areas. This would likely need to be offset with the introduction of compensation flood storage in southern development area. Based on the results of the flood modelling, this would likely need to be in the order of 200m^3 of storage.

It is understood that the railway in the vicinity of the station will be elevated in the future as it is subject to a level crossing removal. Further modelling should be undertaken at that stage once the level crossing removal is established to better define the flood impacts and clearly define the flood storage compensation volume required.

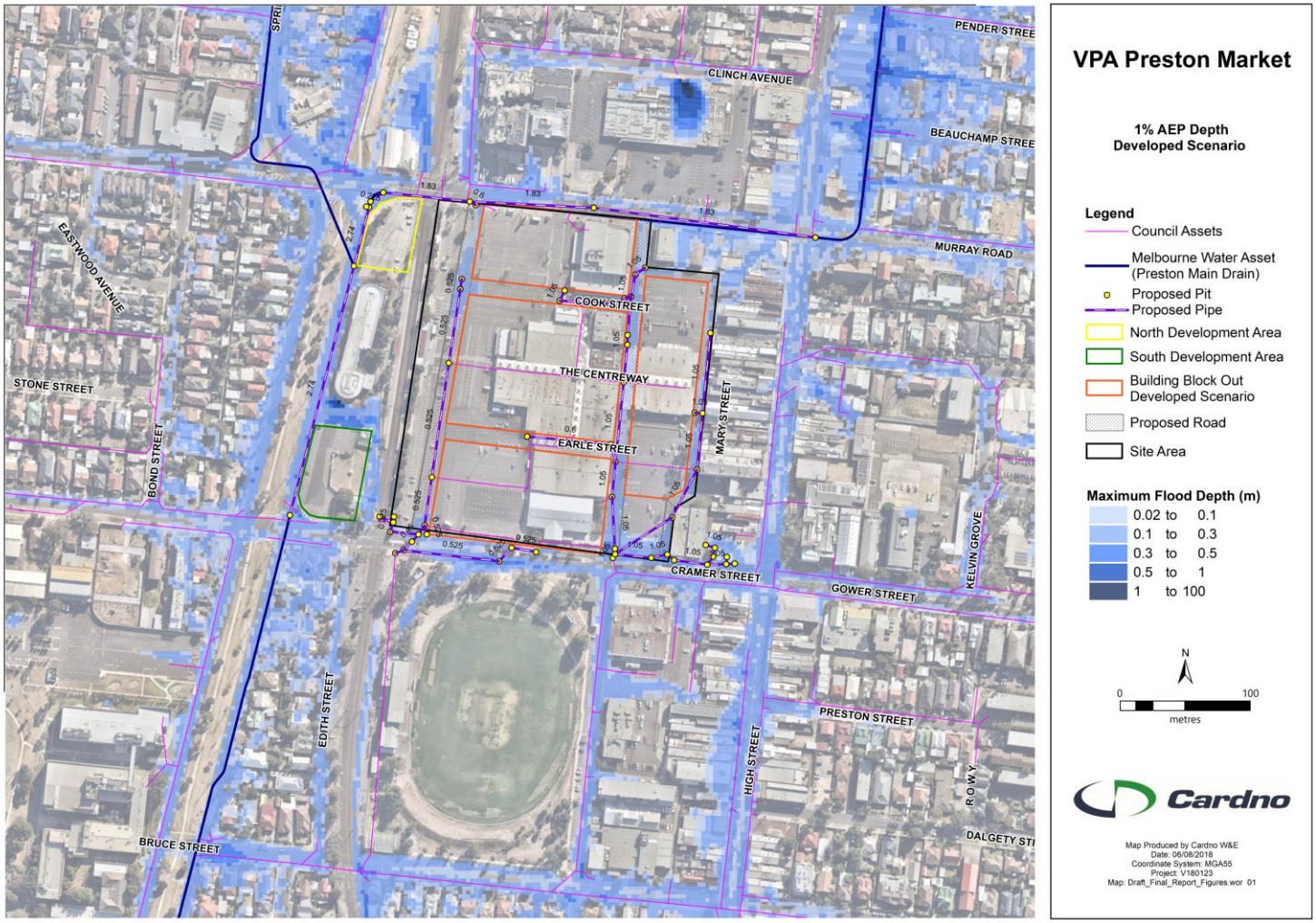

Figure 7-1 1% AEP Developed Scenario Flood Depth

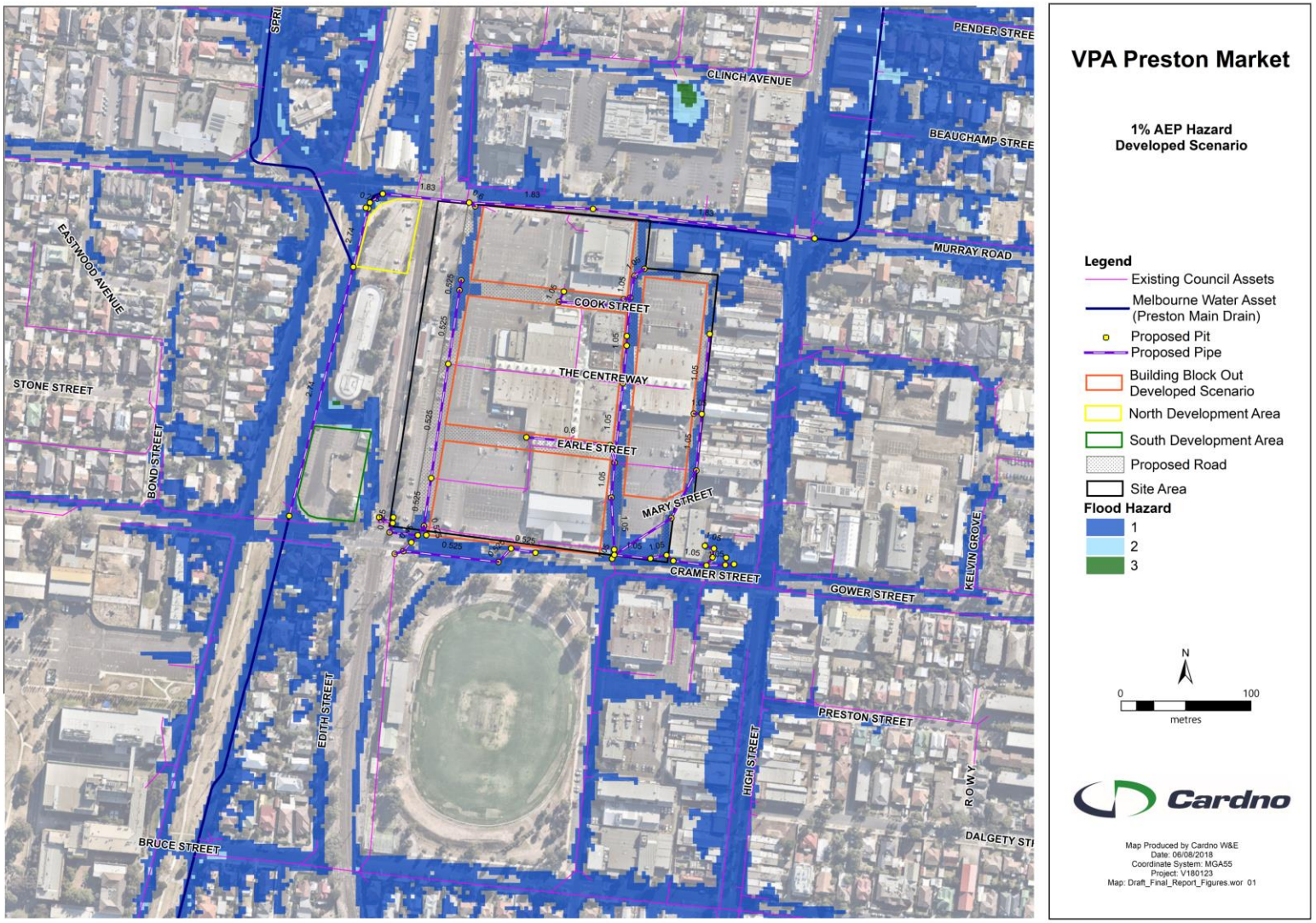

Figure 7-2 1% AEP Developed Scenario Flood Hazard

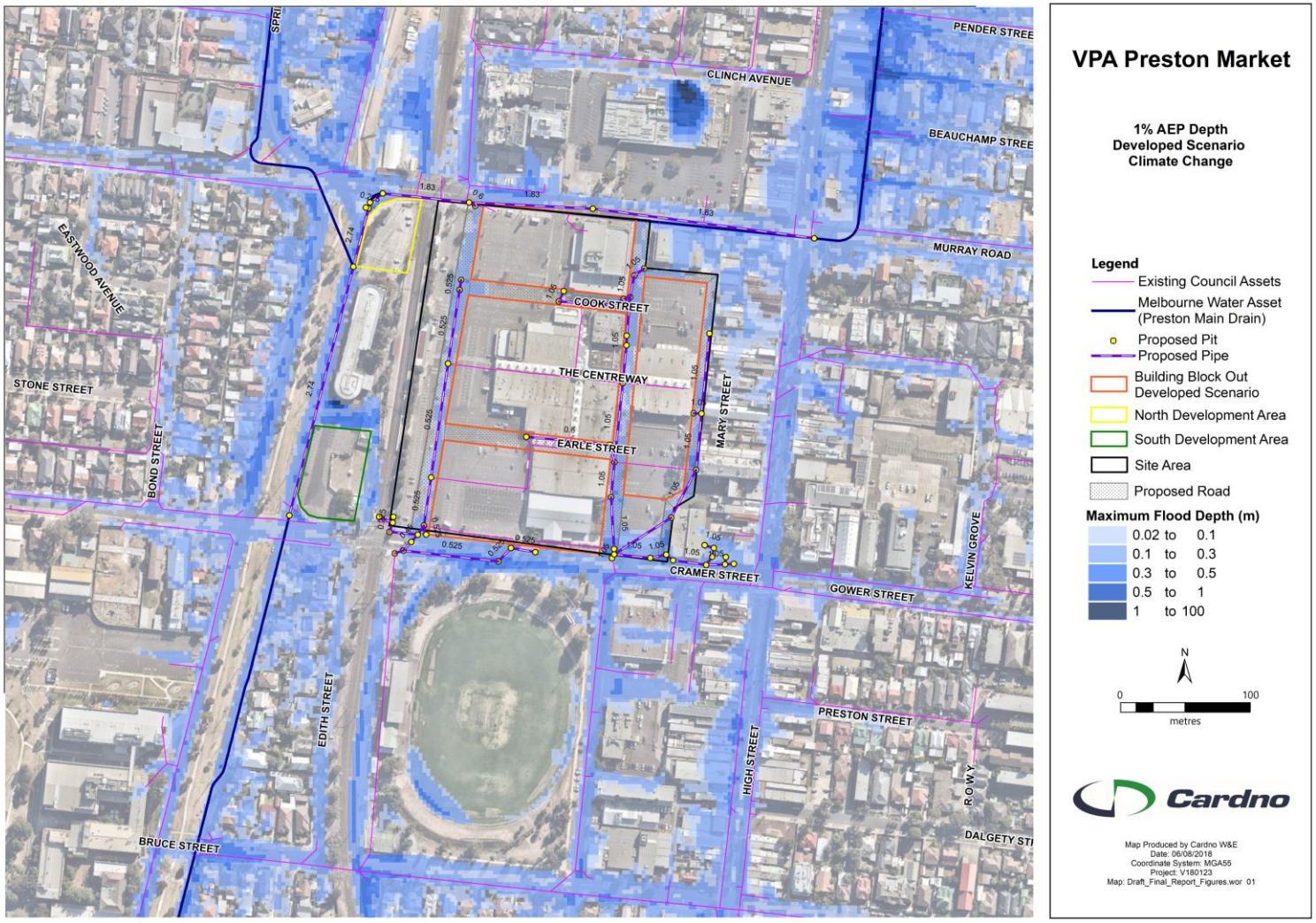

Figure 7-3 1% AEP Developed Scenario Climate Change Flood Depth

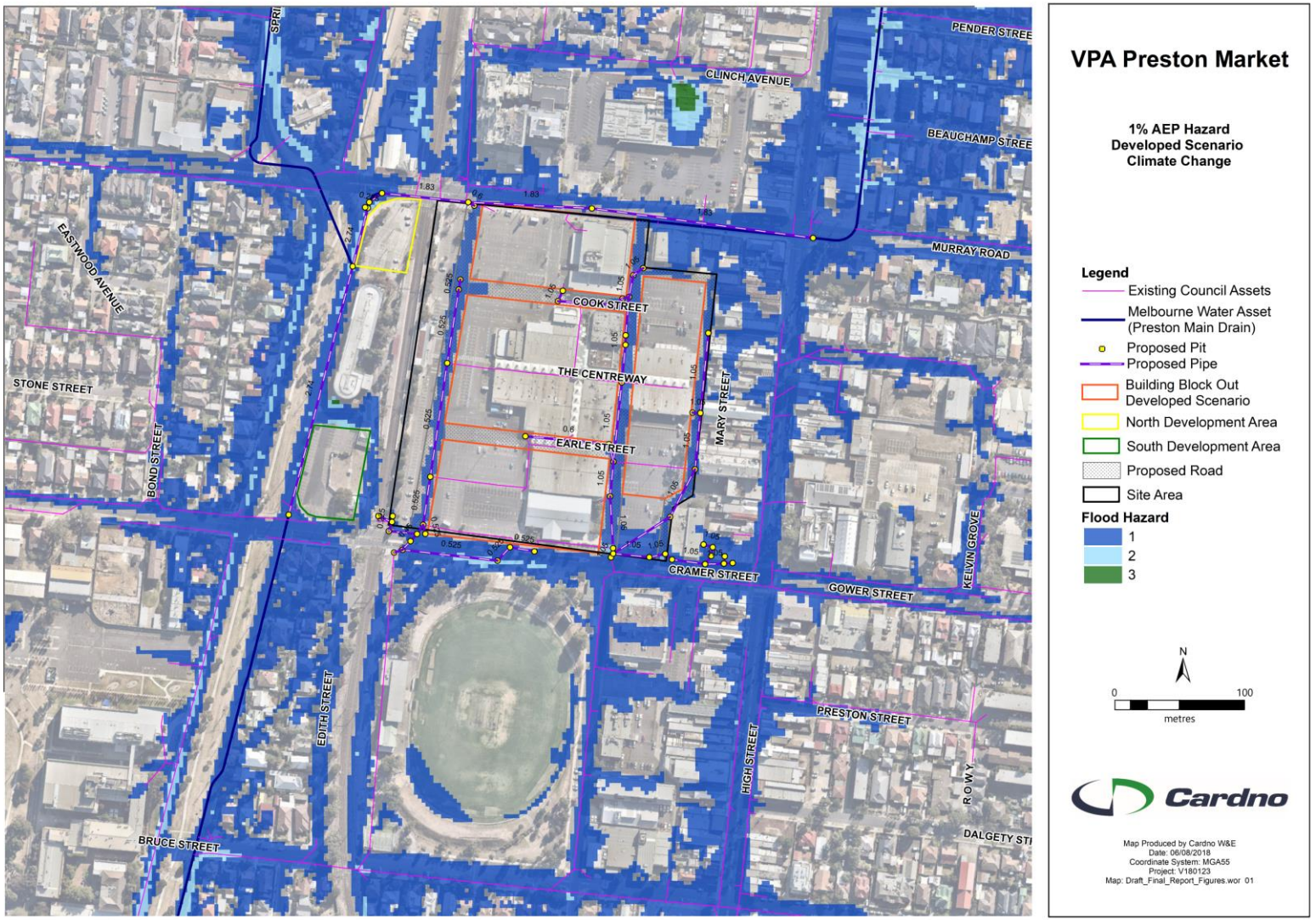

Figure 7-4 1% AEP Developed Scenario Climate Change Flood Hazard

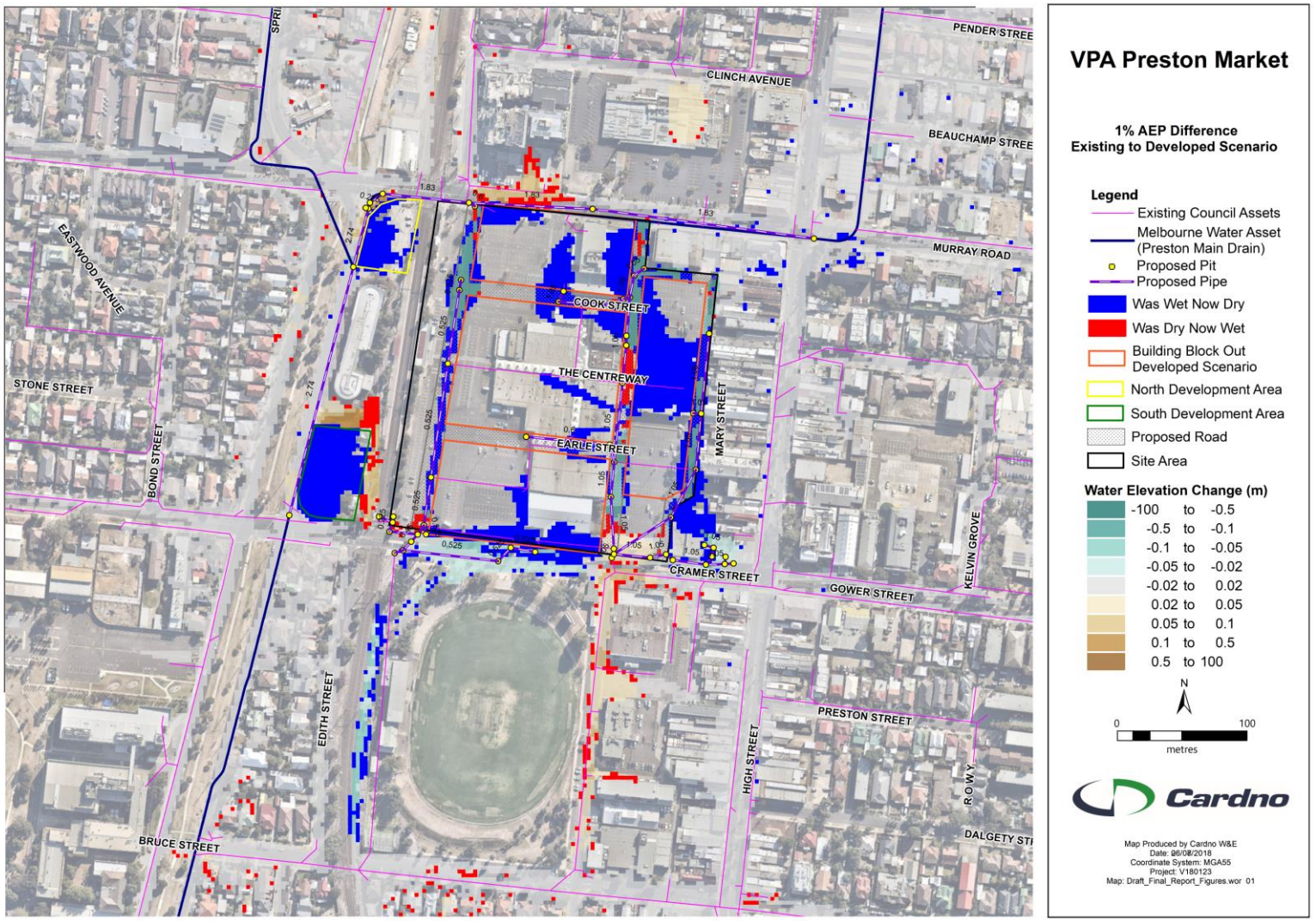

Figure 7-5 1% AEP Water Surface Elevation Difference Plot – Developed Scenario

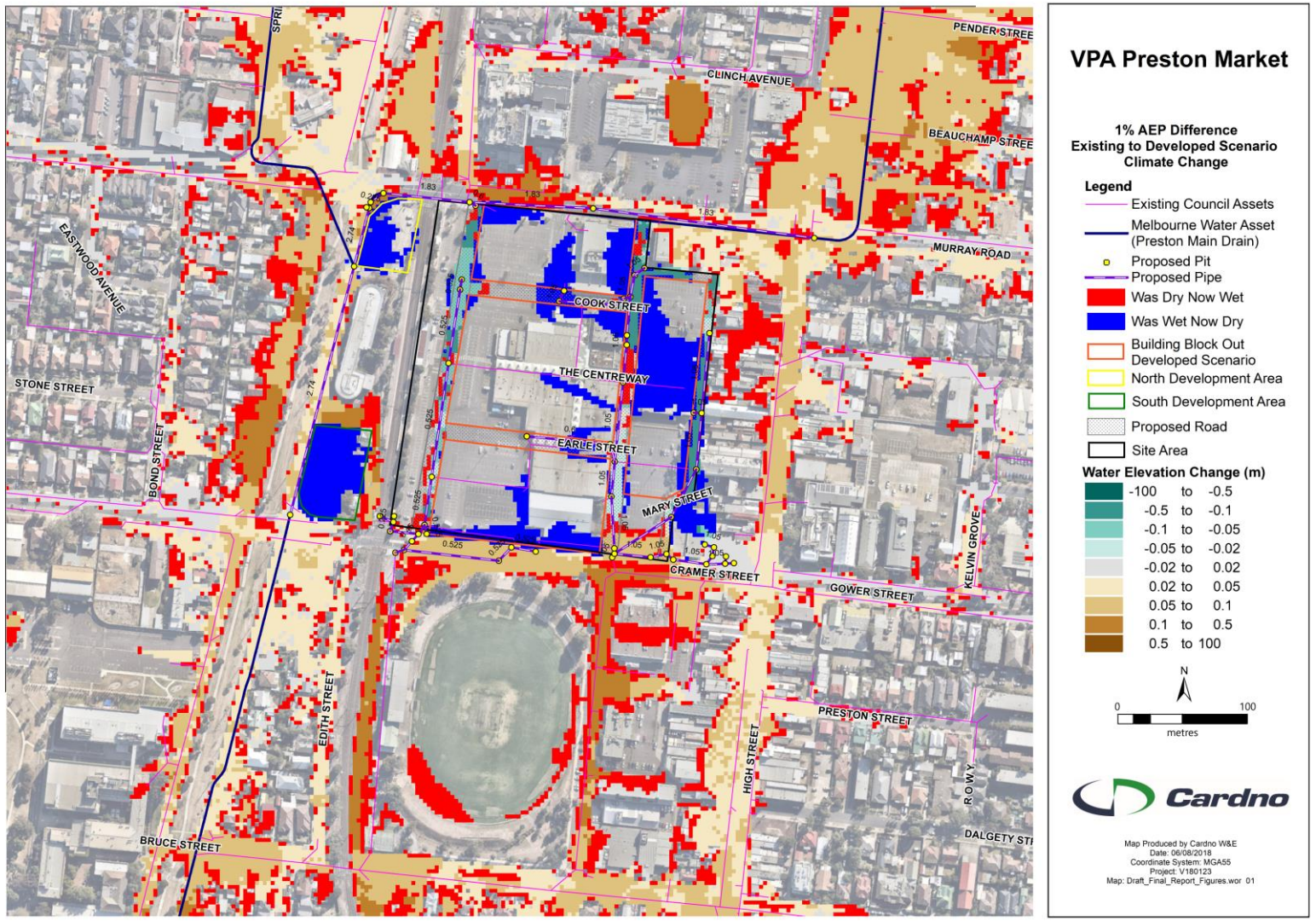

Figure 7-6 1% AEP Water Surface Elevation Difference Plot – Developed Scenario Climate Change

8 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) asset,
- 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.

8.1 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 8-1.

Table 8-1 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.

8.2 Water Sensitive Urban Design

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

Music Modelling of the site has determined that a bioretention system (Raingarden) with a footprint of **150m²** 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 150 m² bioretention asset or a combination of assets with a total area of 150m² distributed throughout the site (e.g tree pits, raingardens, etc...)

Figure 8-1 Option A MUSIC schematic

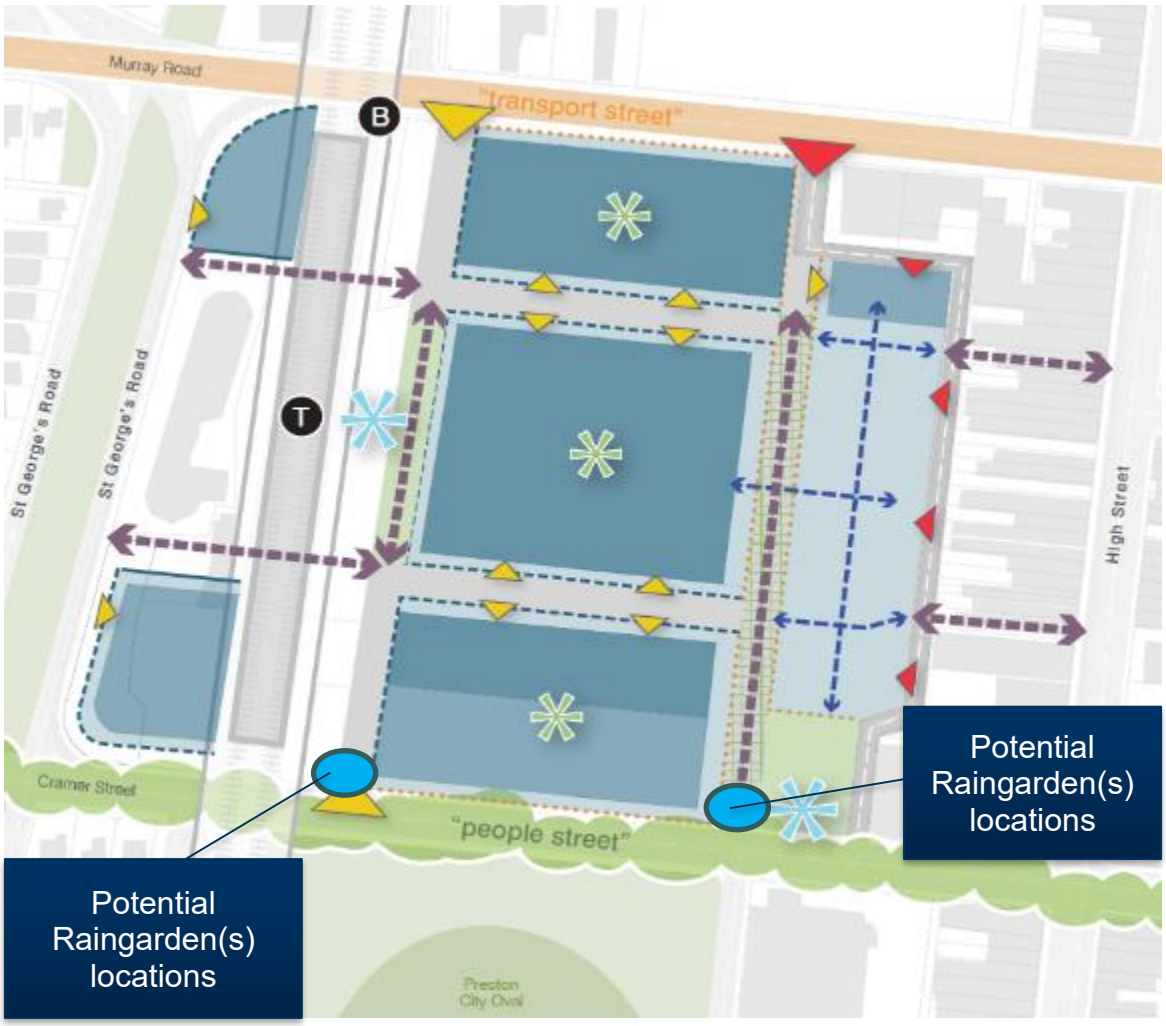

Figure 8-2 Option A potential location of WSUD assets.

	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	

Table 8-2 Option A: Advantages, drawbacks and Cost estimate (CAPEX only)

8.2.2 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 managing the stormwater treatment of the Preston Market site consists in treating and reusing stormwater runoffs from the site. The proximity of the site to the Preston City Oval offers an opportunity to reuse stormwater runoffs to irrigate the oval which annual irrigation demand has been estimated to be around **7ML/yr.**

Figure 1-1 Preston City Oval

The following infrastructure or similar will generally be required for 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

Modelling of the system for the Preston Market shows that a 100 m^3 buffer tank, a 100m^2 bioretention system (raingarden) and a 5000 m^3 stormwater reuse tank will provide for about 75% of the annual irrigation demand of the Preston City Oval.

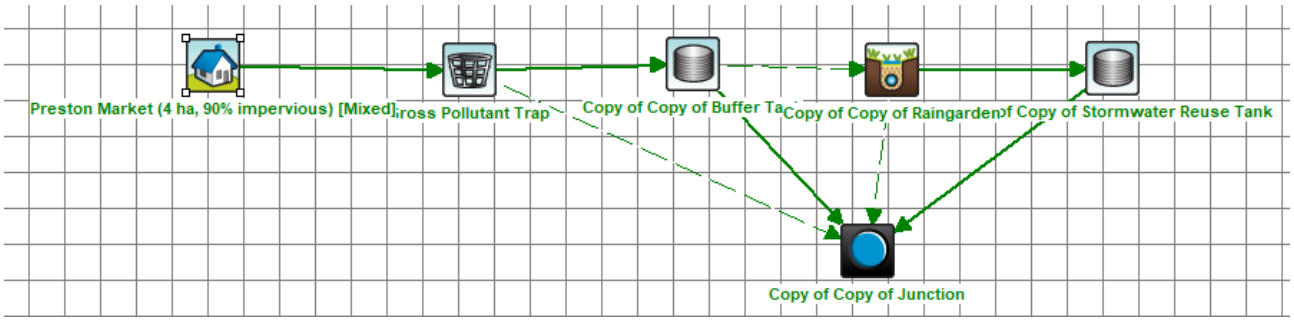

Figure 8-3 Option B MUSIC Schematic

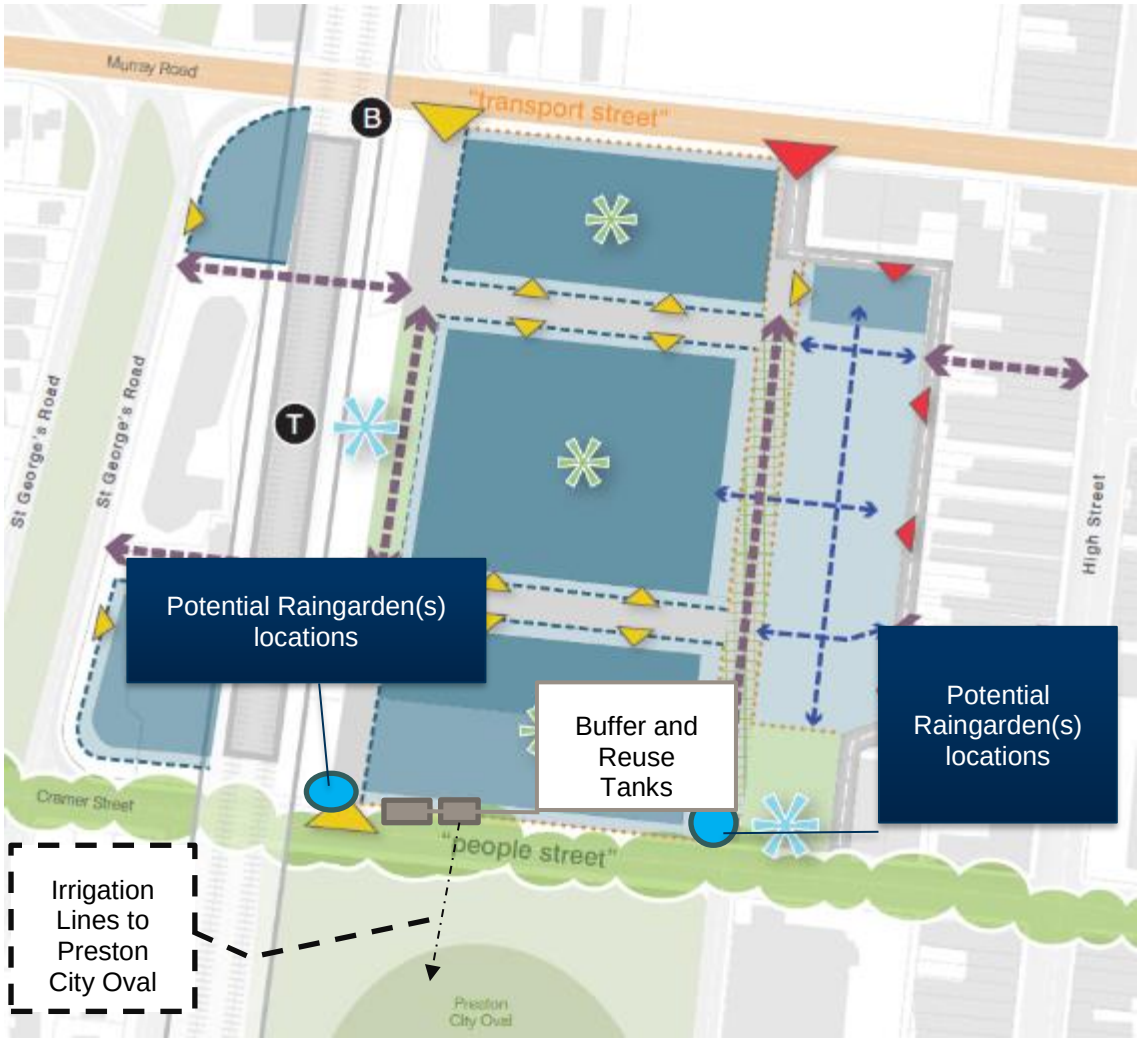

Figure 8-4 Option B Stormwater harvesting and reuse Scheme location

	Advantages	Drawbacks
Option B	Improves stormwater quality and achieves required treatment objectives	Cost, ongoing maintenance and operation requirements
	Increase native vegetation cover for biodiversity, soil moisture for human comfort and health, improve the quality of recreation spaces, amenity and liveability value	
	Smaller WSUD asset required (100m^2 instead of 150m^2)	
	Diversification of water supply and provision of alternative supplies for resilience and Integrated Water Management aspects.	

Table 8-3 Option B Advantages, drawbacks and Cost estimate (CAPEX only)

9 Conclusion

This report presents a stormwater drainage assessment for the Preston Market and associated development areas north and south of the Preston Railway station.

The report has identified that the Preston Market (PM) site is subject to overland flows from the Preston Main drain in the 1% AEP flood event and subject to a Special Building Overlay (SBO). As the flood extent delineated by the SBO is based on a methodology that is no longer used by Melbourne Water and has been superseded from 2016, Cardno considers that this original flood extent is not an accurate representation of the expected extent of flooding at Preston Market.

The existing flooding behaviour of the Preston Market site was therefore re-assessed using the current methodology, as per Melbourne Water guidelines and results confirm that the existing maximum flood depths within the Preston Market site are generally less than 20 cm and are a low safety hazard. Flood depths in the development areas west of the railway track and south of the Preston Railway Station, between Cramer St and the station, however, have a maximum flood depth in excess of 50 cm.

A draft future urban structure plan was provided and flood modelling of the future development scenario was undertaken. Overall, the assessment has found that:

- There are decreases in flooding throughout the PM site primarily due to modifications to the capacity of the existing drainage to service the proposed development. Excess overland flows are now allowed for in roadways through the site and the flood hazard is generally low (Class H1)
- There is an increase in flooding in the development areas between St Georges Road and the train line of up to 170mm. This is being caused by the proposed buildings west of the railway blocking an existing flow path, resulting in water being displaced onto adjacent areas. This would likely need to be offset with the introduction of compensation flood storage in southern development area that would need to be in the order of 200m^3 of storage.
- There are minor offsite increases in flooding at Murray Road, adjacent to Clinch Avenue. These are caused by the proposed buildings at the market site. These can be mitigated in the detailed design phase of the project by setting back the building farther from Murray Road or reshaping the roadway entry to the site.
- There are minor offsite increases in flooding at Cramer and Mary Streets, south of the site. These are caused by the redirection of flows from Cramer Street to Mary Street. These can be mitigated in the detailed design phase of the project by setting back the building farther from Cramer Street and reshaping the roadway entry to the site to direct water along Cramer Street.
- There is a significant overland flow path along High Street. Although this flowpath is not directly connected to the Preston Market, care should be taken in developing any pedestrian linkages to High Street, to ensure that overland flows are not redirected towards the site

Integrated Stormwater Management Opportunities such as treatment and reuse of stormwater on site or for irrigation purposes (e.g. Preston City Oval) which aim to satisfy clauses 56.07, 53.18 and 19.03 of the Victoria Planning Provisions regarding integrated water management and urban run-off management were investigated.

Water quality and reuse modelling of the system for the Preston Market shows that a 100 m^3 buffer tank, a 100m^2 Bioretention system (raingarden) and a 500 m^3 stormwater reuse tank will provide for about 75% of the annual irrigation demand of the Preston City Oval. All future options should be developed as part of an integrated solution to managing stormwater at this site in collaboration with relevant Stakeholders such as Melbourne Water, Yarra Valley Water and Darebin City Council.