Flood Impact Assessment for Lot 9, 28 McPherson Street Banksmeadow

Reference: R.S20352.001.docx
Date: January 2019
FINAL Report
Confidential

Document Control Sheet

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Document:	R.S20352.001.docx
Title:	Flood Impact Assessment for Lot 9, 28 McPherson Street Banksmeadow
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Synopsis: **Flood Impact Statement for Lot 9 McPherson Street prepared to satisfy the Environmental Impact Statement (EIS) conditions of the Secretary's environmental assessment requirements (SEARs)**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
000	17/01/2019	JDE		SF	
001	29/01/2019	SF		SF	

DISTRIBUTION

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1 Introduction

This flood impact assessment supports a Development Application (DA) and Environmental Impact Statement (EIS) for a warehouse and distribution facility located at 28 McPherson Street, Banksmeadow in the Bayside Local Government Area. The proposed development is a State Significant Development (SSD) submitted to the Department of Planning and Environment (DPE) pursuant to Section 4.12(8) of the Environmental Planning and Assessment Act 1979 (EP&A Act). It has been prepared for Orica Australia Pty Ltd (Orica).

1.1 Background

The subject site was formerly part of a wider property owned by Orica known as Southlands. In 2012 (with later modifications) the Southlands Remediation and Redevelopment project was approved by the NSW Minister for Planning. The subject site was identified in that approval as a portion of a compensatory flood basin across the site and is defined as Lot 9 DP 1205673.

Lot 9 has therefore not been developed other than for landscaping works and is the subject of restrictions on title allowing future development subject to the flood storage being maintained.

Orica are therefore seeking to develop the site using a suspended concrete platform in order to maintain the existing flood storage volume.

1.1.1 Overview of the Proposed Development

The proposed DA seeks approval for the following:

- site preparation works, including vegetation removal, proof rolling and capping across the site;
- the construction of a suspended concrete platform to support the warehouse buildings and hardstand/ car parking areas above the natural ground surface, including a crossover over easement to McPherson Street; and
- the construction and use of Building 1 and Building 2 comprising warehouse (industrial) and ancillary office/commercial spaces

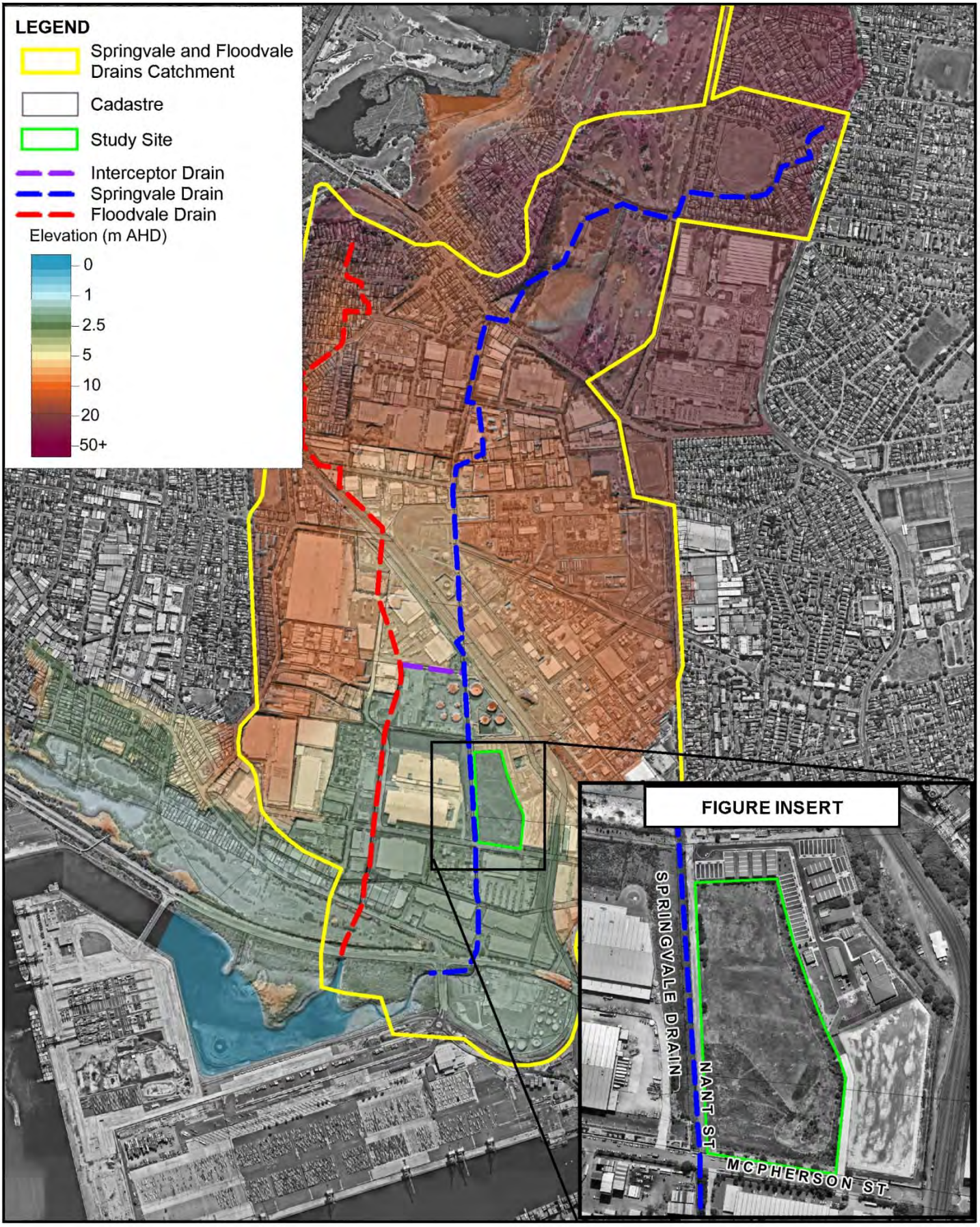
An extract of the site plan, identifying Buildings 1 and 2 and illustrating the proposed site layout, is provided in Appendix A.

1.2 Study Area

The study site comprises industrial zoned land at the lower end of the Springvale and Floodvale Drains catchment. The Springvale Drain and Floodvale Drain catchment is some 380 ha in size and consists predominantly of industrial land use.

The site is located in the suburb of Banksmeadow and is subject to the planning controls outlined in the NSW Governments Environmental Planning Policy (Three Ports) 2013 (Three Ports SEPP).

The locality and topography of the study catchment is shown in Figure 1-1.



Title:

Study Site
LOT 9, 28 McPherson Street, Banksmeadow

Figure: 1-1

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N

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The site is bound by Nant Street on its western boundary, McPherson Street on its southern boundary, and a dog housing/training facility and a new 8 unit industrial development site (currently under construction) on its northern and eastern boundaries. 'Springvale Drain' runs along the western side of Nant Street, adjacent to the western lot boundary.

As shown in Figure 1-1, the catchment headwaters have an elevation of approximately 30 m AHD around the suburbs of Pagewood and Daceyville. The topography descends from the catchment headwaters to the relatively flat and broad floodplain level of 2-5 m AHD where the main tributaries of Floodvale Drain and Springvale Drain outlet to Port Botany. The study site elevations range from 3 m AHD to 4 m AHD.

1.3 Report Purpose

This report outlines the detailed hydrological and hydraulic assessment undertaken for the proposed warehouse and distribution facility at Lot 9, DP 1205673, 28 McPherson Street, Banksmeadow. The assessment includes the following:

- a comprehensive assessment of the impact of flooding on the development for the full range of flood events up to the probable maximum flood (PMF)
- an assessment of the impacts of the development on flood behaviour (i.e. levels, velocities and duration of flooding) and on adjacent, downstream and upstream areas
- details of proposed floor levels for all proposed habitable structures on the site having considered the full range of flood events up to the PMF
- a flood emergency response plan for the site, which includes consideration of site accessibility, flood-free access to and from the development site, and evacuation measures in extreme flood events up to the PMF

2 Existing Information

2.1 Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014)

BMT previously developed the Springvale Drain and Floodvale Drain Flood Study on behalf of Botany Bay Council (now Bayside Council) in 2014. The flood study is the current hydraulic model of the Springvale Drain and Floodvale Drain catchment and provides comprehensive flood risk information for mainstream and overland flow sources.

This flood assessment has been undertaken using the TUFLOW hydraulic model developed as part of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014), provided by Bayside Council.

2.2 Additional Survey and Ground Elevation Data

Several sources of ground elevation data have been sought for the study site for inclusion into the TUFLOW hydraulic model. Data was inclusive of surveyed ground elevations, and as-built ground levels for the study site and adjacent lots.

The ground elevation data utilised in this study are listed below:

- 10240B FINISHED SURFACE LEVELS REV 2.dwg
- 150608 TRIANGLE FILE-ModelACAD2K.dwg
- Design-3D-934906.dwg
- YN210094_Soutlands_Supertin ascon survey rev02_20150506.12da
- 10240 stage 2 levels 2.dwg

Section 3 discusses the use of the ground elevation data in the hydraulic flood model.

3 Flood Model Development

This section provides information on the development of hydraulic and hydrological models which have been used to assess the impact of the proposed development on existing flood conditions.

A summary of both the hydrological and hydraulic model is provided in this section.

3.1 Hydrologic Model

The hydrologic model predicts the amount of runoff from rainfall and the attenuation of the flood wave as it travels down the catchment. This process is dependent on catchment area, slope and vegetation; variation in distribution, intensity and amount of rainfall; and antecedent conditions of the catchment.

Consistent with previous investigations, a critical storm duration of 2 hour and 9 hour for the 5% AEP and 1% AEP events was maintained for this study, as well as a 3 hour critical storm duration for the PMF event.

3.2 Hydraulic Model

TUFLOW, a fully 2D hydraulic modelling software package, was utilised for Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014) and has been used to undertake this flood assessment.

In order to assess the design flood conditions and potential flood impacts, the following TUFLOW models have been utilised and developed:

- Current scenario model. This scenario utilises the TUFLOW model developed as part of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014); and
- Proposed scenario model. This scenario revises the land uses and topography within the TUFLOW model at the proposed development site to replicate the proposed development.

3.2.1 Current Scenario (Baseline Conditions)

A review and update of the model was undertaken to include recent survey information. The following sections document the updates to the Springvale Drain and Floodvale Drain TUFLOW model as part of the ‘current scenario’ model.

3.2.1.1 Ground Surface Elevation Grid

The ground surface elevation grid is used to represent the topography of the channels and floodplain in the TUFLOW model. The ability of the hydraulic model to provide an accurate representation of the flow distribution on the floodplain ultimately depends upon the quality of the underlying topographic data.

3.2.1.1.1 Elevation Data – Lot 102, 26 McPherson Street Banksmeadow

Elevation data for the adjacent lot, Lot 102, 26 McPherson Street Banksmeadow, were included into the TUFLOW model. Elevation data was inclusive of ground level survey and as-built ground levels following construction of the Southlands Industrial Estate. These sources of data provided a change

in finished floor levels (FFLs), revised platform levels and revised drainage areas in the northern and western portion of the site. Details of the ground surface elevation have been provided by Aurecon and incorporated into the TUFLOW model with the following file references:

- 10240B FINISHED SURFACE LEVELS REV 2.dwg
- 150608 TRIANGLE FILE-ModelACAD2K.dwg
- Design-3D-934906.dwg

3.2.1.1.2 Elevation Data – Lot 9, 28 McPherson Street Banksmeadow, Lot 100 28A McPherson Street Banksmeadow and Lot 101 28B McPherson Street Banksmeadow

Ground elevation data for 28, 28A and 28B McPherson Street were included in the TUFLOW model. Details of the ground surface elevation have been provided by DBL Property Pty Limited with the following file references:

- YN210094_Soutlands_Supertin ascon survey rev02_20150506.12da
- 10240 stage 2 levels 2.dwg

3.2.1.2 Buildings

The influence of buildings and other obstacles to the passage of flow in urban floodplains is an important issue in the context of urban floodplain management (Engineers Australia, 2012). In a typical urban floodplain, some buildings will be elevated on fill and totally obstruct the passage of floodwater, others may be inundated with floodwater ponding inside the building, whilst others may be elevated on piers allowing flow under the building.

For this assessment, the buildings in the adjacent lots were modelled as impermeable structures 0.2 m above the surveyed floor levels. They were assigned a high Manning's 'n' value (refer to Section 3.2.1.3) above their FFL to represent the energy dissipation of water flowing through and around the buildings. This approach was favoured over blocking out buildings as it includes the storage effects of the building being inundated.

3.2.1.3 Hydraulic Roughness (Manning's n)

As part of the current scenario model, the surface roughness zones (Manning's "n") have been updated to reflect the building layout as discussed in Section 3.2.1.2. The value of the roughness coefficient for buildings (n = 1.0), is based on industry standards (e.g. Chow, 1959).

The Manning's "n" values from the Springvale Drain and Floodvale Drain Flood Study are listed in Table 1-1.

Table 1-1 Adopted Manning's "n" values

Surface	Manning's "n"
Urban block	0.070
Grass (maintained)	0.030
Parkland	0.040
Dense vegetation	0.090

Surface	Manning's "n"
Railway corridor	0.080
Roads / Concrete	0.020
Buildings	1.000
Industrial	0.050
Harbour, dams, waterbodies etc	0.022
Tidal / Estuary	0.031

Figure 3-1 illustrates the updates to the existing flood model documented above to establish the 'current scenario' flood conditions.

3.2.2 Proposed Scenario

The following changes were made to the current scenario TUFLOW model to reflect the initial site concept, referred to herein as the 'proposed scenario'. Plans of the initial site concept are shown in Appendix A.

Figure 3-1 illustrates the changes to the hydraulic model to represent the 'proposed scenario' model.

3.2.2.1 Suspended Slab

The proposed development constitutes an elevated ground floor slab, supported by timber/concrete piers. Details of the timber piling grid was provided by Costin Roe Consulting Pty Ltd (drawing reference: CO9349.11-S01-P-3.pdf). The elevated slab has been represented in the model using a layered flow constriction layer and a storage reduction layer to model the hydraulic losses associated with flow around the building piers, in addition to modelling the impacts of the piers in relation to reduced storage. Blockage between the building piers has not been considered for this assessment.

To account for the proposed piers, the layered flow constriction layer representative of the opening between the ground elevation and the underside of the elevated slab was modelled with a blockage of 0.5% in accordance with relevant design drawings, and using the following assumptions regarding pier size and spacing:

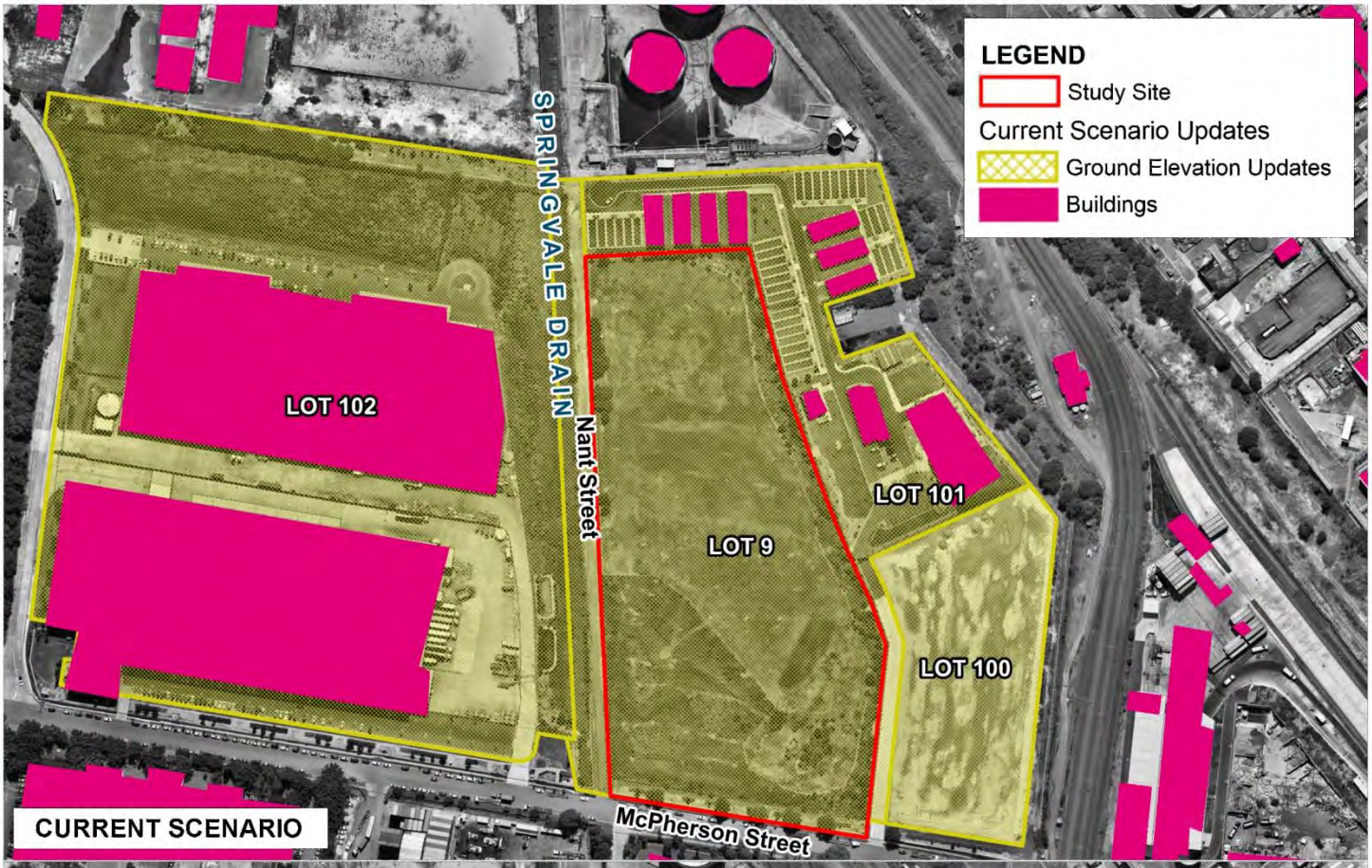
(1) 800 mm diameter pier columns; and

(2) 10 m pier centres.

The underside of the building slab (i.e. soffit) has been modelled at 6.4 m AHD. The slab deck has been modelled at a thickness of 0.3 m. No obstructions have been modelled above the deck height of 6.7 m AHD (as it is well above the PMF flood level, refer Section 5).

3.2.2.2 Topographic modifications

Consideration was given to structures which may become an impediment to flood flows or have the potential to remove flood storage from the floodplain. A layer of capping was modelled over the extent of the raised platform (refer Figure 3-1) to provide structural integrity to the subgrade and piers. In the hydraulic model, the capping layer was modelled as 0.1 m in height, as confirmed by Civil Engineers Costin Roe.



Title:
2D Flood Model Updates

Figure: 3-1

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4 Design Flood Conditions

4.1 Introduction

Design storm events are hypothetical events that are used to estimate design flood conditions. They are based on a probability of occurrence, usually specified as an Average Recurrence Interval (ARI) or as an Annual Exceedance Probability (AEP). Section 6 of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014) describes the design storm conditions which have been utilised in this study. The 5% AEP, 1% AEP and PMF events have been assessed as part of this study. Table 4-1 lists the variables assessed for each design event. Further discussion on each of these variables is presented in the following report sections.

Table 4-1 Design Flood Combinations

Design Flood Condition	Design Rainfall	Blockage Scenario
5% AEP	5% AEP, 2 Hour Storm, 9 Hour Storm	Unblocked
		Blocked
1% AEP	1% AEP, 2 Hour Storm, 9 Hour Storm	Unblocked
		Blocked
Probable Maximum Flood (PMF)	PMF, 3 Hour Storm	Unblocked

4.2 Design Rainfall

Since the completion of the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014), the Australian Rainfall & Runoff (ARR) 2016 guideline was released that revised the recommended application of temporal patterns for use in design flood estimation. For simplicity, this study has adopted the temporal patterns and initial and continuing loss guidance in accordance with ARR (2001) to ensure consistency with the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014). The Bureau of Meteorology's Generalised Short-Duration Method has been used to estimate the PMF event.

A critical duration of 2 hours and 9 hours for the 5% AEP and 1% AEP design storm events, and 3 hours for the PMF was utilised for this assessment based on the modelling previously undertaken for the Springvale Drain and Floodvale Drain catchment.

4.3 Drainage Blockage

The blockage of drainage conduits for this study utilises the same methodology documented in the Springvale Drain and Floodvale Drain Flood Study (BMT WBM, 2014). The blockage factors applied for the blocked design condition in both the current and proposed scenario models is given below:

- Applying a 0% and 50% blockage factor to all drainage structures (pit inlets, pipes, culverts and bridges).

Design flood conditions have been determined from the combined 'maximum envelope' of both the blocked and unblocked conditions.

5 Model Results

5.1 Introduction

Design model results are presented for the current scenario and proposed scenario model. The following results are presented in this section:

- Design flood conditions (peak flood levels and peak flood velocities); and
- Provisional Hazard Classification (H1 to H6 categories).

5.2 Design Flood Results

Design flood simulations were undertaken for the 5% AEP, 1% AEP and PMF design events. Peak flood conditions have been mapped and are presented in Appendix B (Figures B-1 to B-6).

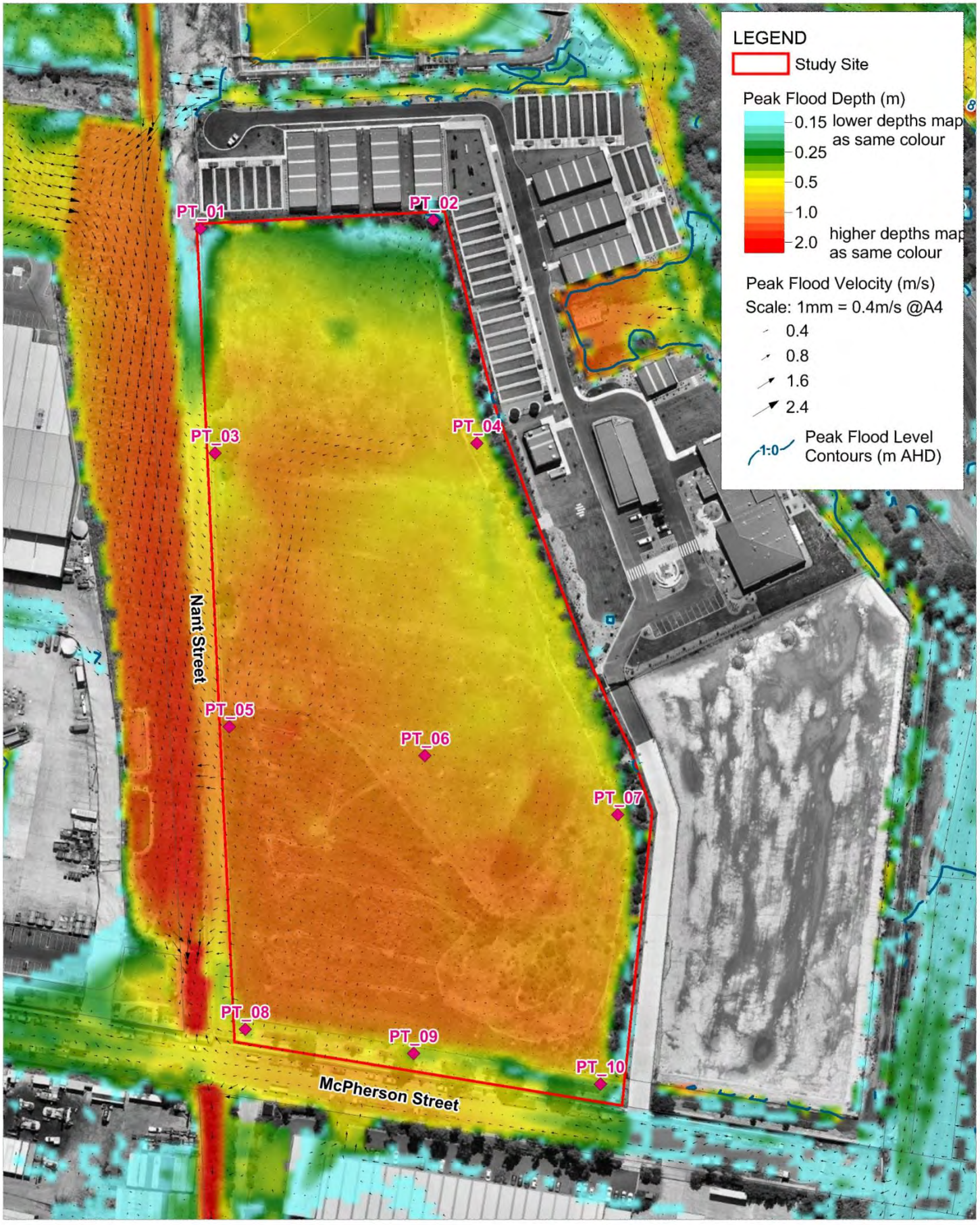
Figure 5-1 shows the peak flood condition for the current scenario 1% AEP design event. Selected locations labelled P01 to P10 on Figure 5-1 show the peak water level and velocity for the current and proposed scenarios, as listed in Table 1-1 and Table 1-2 respectively.

Table 1-1 Peak Water Levels at Selected Locations for 5% AEP, 1% AEP and PMF Events

Location (Refer to Figure 5-1)	Current Scenario			Proposed Scenario		
	5% AEP Event (m AHD)	1% AEP Event (m AHD)	PMF Event (m AHD)	5% AEP Event (m AHD)	1% AEP Event (m AHD)	PMF Event (m AHD)
PT_01	n/a	n/a	4.9	n/a	n/a	4.9
PT_02	n/a	n/a	5.0	n/a	n/a	5.0
PT_03	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_04	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_05	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_06	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_07	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_08	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_09	3.9	4.1	4.9	4.0[1]	4.1	4.9
PT_10	3.9	4.1	4.9	4.0[1]	4.1	4.9

n/a: no flooding indicated

[1] rounding occurs to 4.0, however difference in flood levels is less than the suggested 0.1 m (refer to impact mapping in Appendix C).



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Peak Flood Results - Current Scenario 1% AEP

Figure: 5-1

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Table 1-2 Peak Velocities at Selected Locations for 5% AEP, 1% AEP and PMF Events

Location (Refer to Figure 5-1)	Current Scenario			Proposed Scenario		
	5% AEP Event (m/s)	1% AEP Event (m/s)	PMF Event (m/s)	5% AEP Event (m/s)	1% AEP Event (m/s)	PMF Event (m/s)
PT_01	n/a	n/a	0.8	n/a	n/a	0.7
PT_02	n/a	n/a	0.2	n/a	n/a	0.3
PT_03	0.2	0.3	0.9	0.2	0.3	0.9
PT_04	0.0	0.0	0.1	0.1	0.1	0.2
PT_05	0.2	0.3	0.6	0.2	0.3	0.6
PT_06	0.0	0.0	0.2	0.1	0.1	0.2
PT_07	0.0	0.1	0.2	0.0	0.1	0.2
PT_08	0.2	0.2	0.5	0.2	0.2	0.4
PT_09	0.0	0.0	0.2	0.0	0.1	0.2
PT_10	0.0	0.0	0.3	0.0	0.0	0.3

n/a: no flooding indicated

Refer to Section 7.3 for a detailed description of the existing flood behaviour.

5.3 Provisional Hazard Classification

The Updating National Guidance on Best Practice Flood Risk Management (NFRAG, 2014) considers a holistic approach to consider flood hazards to people, vehicles and structures. It recommends a composite six-tiered hazard classification, reproduced in Figure 5-2. The six hazard classifications are summarised in Table 5-3.

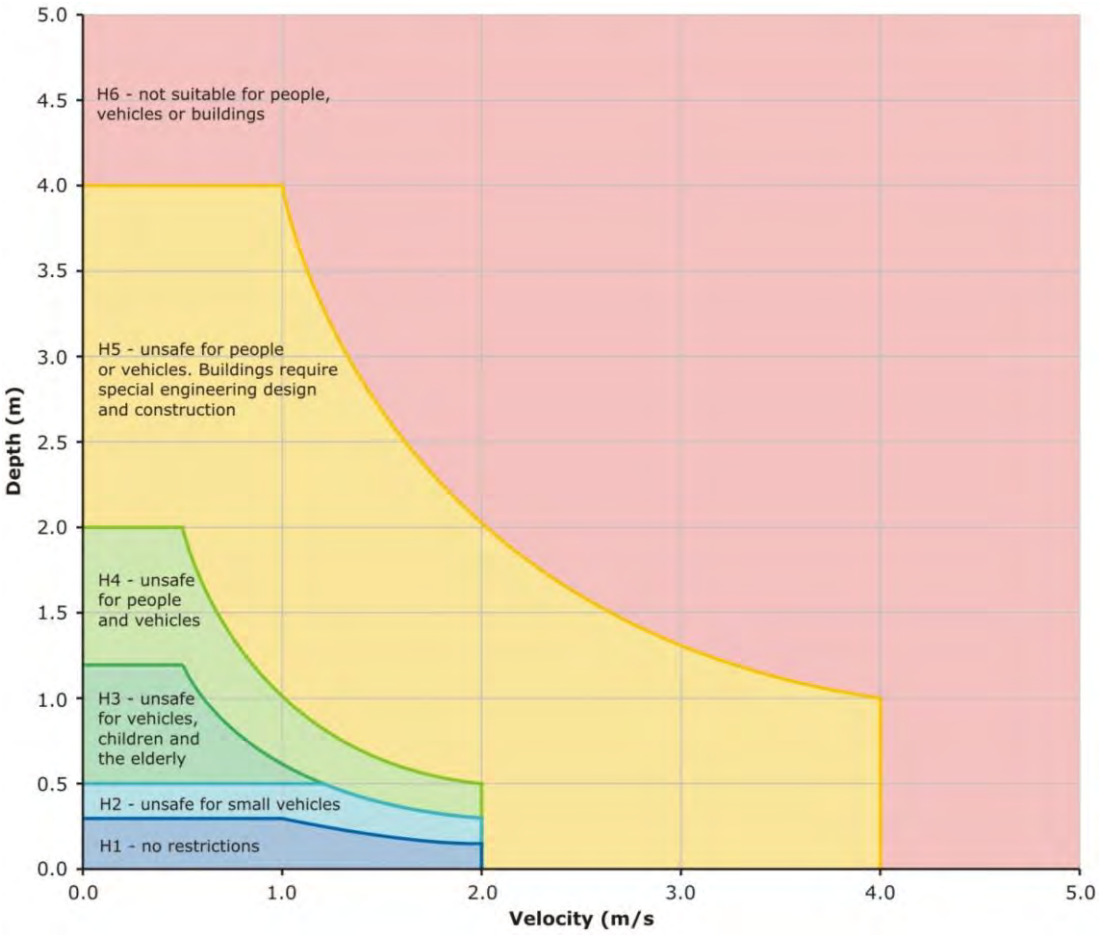


Figure 5-2 Combined Flood Hazard Curves

Table 5-3 Combined Flood Hazard Curves – Vulnerability Thresholds

Hazard Classification	Description
H1	Relatively benign flow conditions. No vulnerability constraints.
H2	Unsafe for small vehicles.
H3	Unsafe for all vehicles, children and the elderly.
H4	Unsafe for all people and vehicles.
H5	Unsafe for all people and all vehicles. Buildings require special engineering design and construction.
H6	Unconditionally dangerous. Not suitable for any type of development or evacuation access. All building types considered vulnerable to failure.

The key factors influencing flood hazard or risk are:

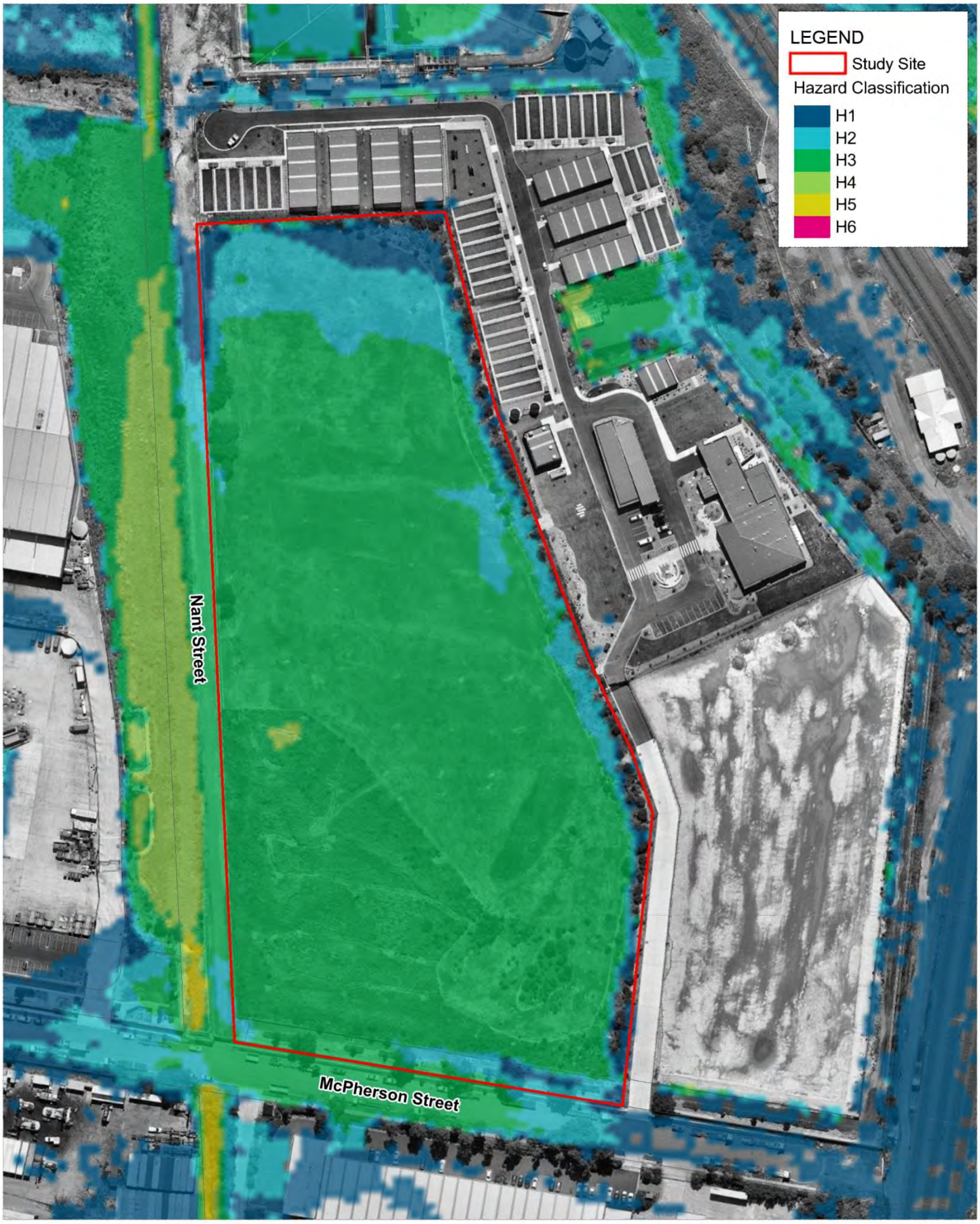
- Size of the Flood
- Rate of Rise - Effective Warning Time
- Community Awareness

- Flood Depth and Velocity
- Duration of Inundation
- Obstructions to Flow
- Access and Evacuation

The provisional flood hazard level is often determined on the basis of the predicted flood depth and velocity. This is conveniently done through the analysis of flood model results. A high flood depth will cause a hazardous situation while a low depth may only cause an inconvenience. High flood velocities are dangerous and may cause structural damage while low velocities generally do not.

Preliminary hazard category mapping for the current scenario and proposed scenario is included in Figure 5-3 and Figure 5-4 respectively, for the 1% AEP events. Appendix B contains preliminary hazard mapping for the PMF event.

Refer to Section 7.3 for a detailed description of the existing flood behaviour.



Title:

Preliminary Hazard - Current Scenario 1% AEP

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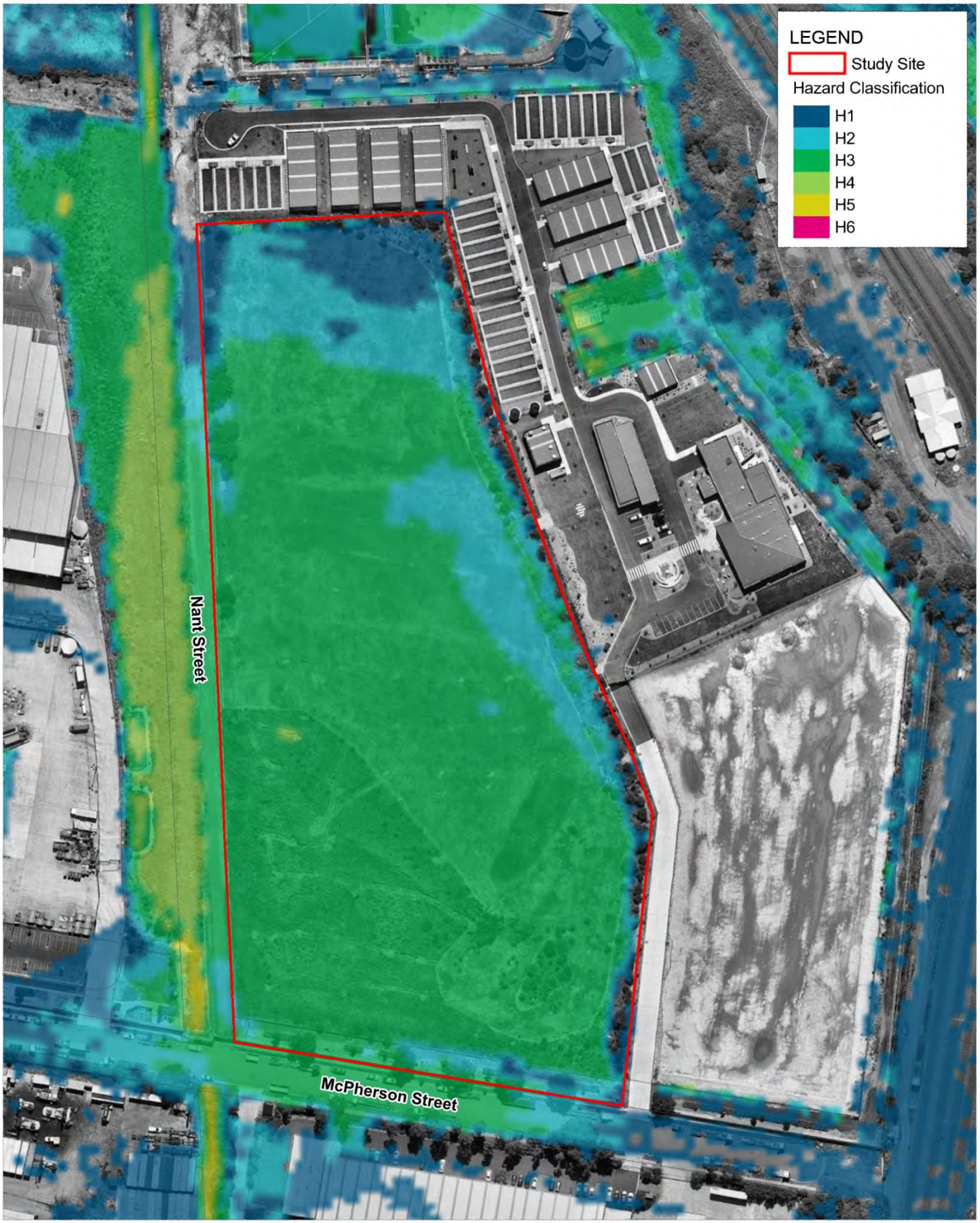

Title:

Preliminary Hazard - Proposed Scenario 1% AEP

Figure: **5-4**

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6 Flood Impact Assessment

6.1 Introduction

In order to assess the proposed development, modelling was undertaken to represent the site layout as discussed in Section 3.2.2 and presented in Section 5.

The resultant change in flood conditions have been assessed against the current scenario model (refer Section 5) and are presented in the following section.

6.2 Flood Impacts

Peak flood impacts for the proposed development have been mapped and are presented in Appendix C (Figures C-1 to C-3).

Figure 6-1 shows a flood afflux map comparing the peak water levels for the proposed scenario against the current scenario peak water levels for the 1% AEP. The maps identify areas where:

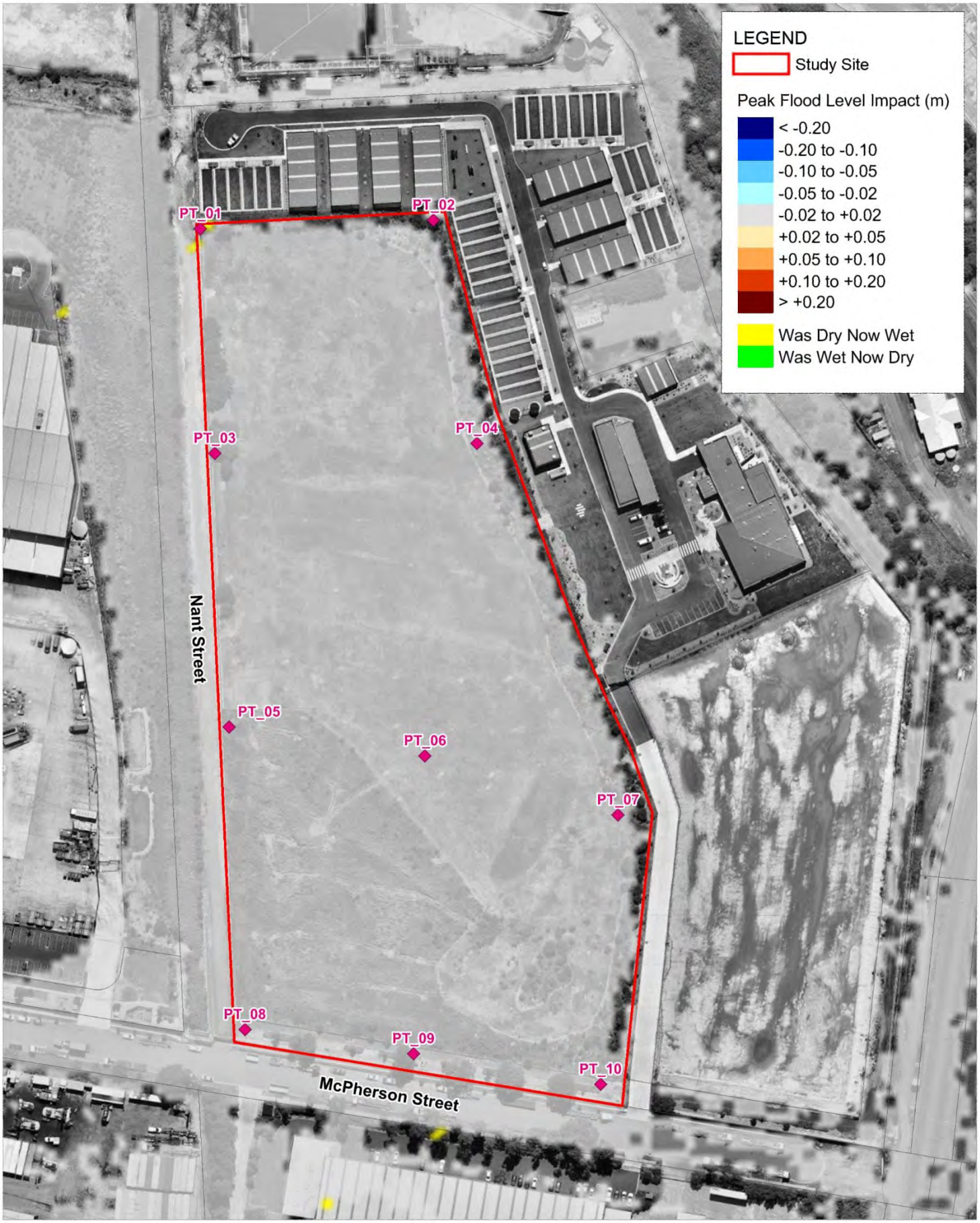
- Flooding previously occurred in the current scenario model but no longer occurs in the proposed scenario model (referenced “was wet now dry”);
- Flooding now occurs in the proposed scenario model which was previously not flooded in the current scenario model (referenced “was dry now wet”); and
- Extent and degree of change in the peak water levels.

The degree of change in peak flood levels has been identified at a number of locations within the vicinity of the proposed development site. The points are labelled Pt01 to Pt10 on Figure 6-1 and correspond with the locations listed in Table 6-1.

Table 6-1 Comparison of peak water levels at selected locations between the proposed scenario and current scenario for 1% AEP Events

Location (Refer to Figure 6-1)	Peak water levels (m AHD)		Difference in levels (m) between proposed scenario and current scenario
	Current Scenario	Proposed Scenario	
PT_01	n/a	n/a	n/a
PT_02	n/a	n/a	n/a
PT_03	4.1	4.1	0.0
PT_04	4.1	4.1	0.0
PT_05	4.1	4.1	0.0
PT_06	4.1	4.1	0.0
PT_07	4.1	4.1	0.0
PT_08	4.1	4.1	0.0
PT_09	4.1	4.1	0.0
PT_10	4.1	4.1	0.0

n/a: no flooding indicated



Title:

Peak Flood Level Impacts
1% AEP

Figure: 6-1

Rev: -

N

0 37.5 75m

Approx. Scale

BMT

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Filepath : S:WATERPROJECTSS20352_Lot_9_McPherson_Street_Banksmeadow_FIAMIWorkspacesBAFigure_C02_100YR_Afflux_01.wor

Table 6-1 shows that in the 1% AEP, the proposed scenario causes no discernible changes to peak flood level.

In addition to the 1% AEP, there are no modelled off-site impacts in the 5% AEP or PMF event (refer Appendix C). This is due to the underside of the proposed development deck (6.7 m AHD) being elevated well above the PMF flood levels (5.0 m AHD).

7 Flood Emergency Response Plan

7.1 Introduction

It is important to be prepared in the event of a flood. A Flood Emergency Response Plan (FERP) is required to ensure the occupants of the proposed warehouse distribution development are suitably informed of the property specific flood risk, what to do to prepare for a flood, what to do during a flood, and what to do following a flood.

The NSW SES has developed an interactive online tool that business owners/operators can use to prepare site specific Emergency Business Continuity Plans. Information on the interactive online tool can be found at the following web address:

http://www.sesemergencyplan.com.au/business/

The interactive online tool asks a series of questions. Based on the responses to the questions, a series of actions are listed for what to do before, during and after a flood event. Once the series of questions have been answered, the online tool produces an editable version of the Emergency Business Continuity Plan that can then be edited/completed by the business owner/operator.

The contents of the SES Emergency Business Continuity Plan specific to flood risk include the following:

- Description of local flood behaviour specific to the site;
- Description of triggers and actions to take in the event of a flood;
- Evacuation plan to be followed in the event of a flood (if required) (including evacuation point, triggers for evacuation and how to manage particular evacuees);
- List of actions to be completed to prepare your business for a flood event (including who is responsible for actioning each item and how often each action should be reviewed);
- List of actions to be followed when a flood event is imminent/occurring;
- List of emergency contacts in case of a flood emergency; and
- List of actions to be followed during the recovery phase of a flood event.

A significant amount of the above information can be readily entered by the business owner/operator, or is automatically generated as part of the SES interactive online tool. However, some of the above information is not readily available. This document aims to provide the information that is not readily available, to be built in to the SES Emergency Business Continuity Plan. The information contained in this document includes:

- Description of local flood behaviour, including design flood event mapping provided in Appendix B (to be used to complete the “Know Your Risk” section of the SES Emergency Business Continuity Plan);
- Evacuation considerations (to be used to complete the “Evacuation Plan” section of the SES Emergency Business Continuity Plan); and

- List of key flood safety measures (to aid in the completion of the "Triggers and Actions to Take" section of the SES Emergency Business Continuity Plan).

7.1.1 Glossary of Terms

Terms and expressions often referred to when discussing flooding behaviour, flood risk or floodplain management at a site are provided below.

Australia Height Datum (AHD)	National survey datum corresponding approximately to mean sea level.
annual exceedance probability (AEP)	The chance of a flood of a given size (or larger) occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (i.e. a 1 in 20 chance) of a peak discharge of 500 m^3/s (or larger) occurring in any one year. (see also average recurrence interval)
average recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20yr ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (see also annual exceedance probability).
catchment	The catchment at a particular location is the area of land that drains to that point.
design flood event	A hypothetical flood representing a specific likelihood of occurrence (for example the 100yr ARI or 1% AEP flood).
development	Existing or proposed works that may or may not impact upon flooding. Typical works are filling of land, and the construction of roads, floodways and buildings.
flood	Relatively high river or creek flows, which overtop the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and inundate floodplains and/or local overland flooding associated with major drainage before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
flood hazard	The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods.
flood level	The height or elevation of floodwaters relative to a datum (typically the Australian Height Datum). Also referred to as "stage".
floodplain	Land adjacent to a river or creek that is periodically inundated due to floods. The floodplain includes all land that is susceptible to inundation by the probable maximum flood (PMF) event.
flood planning level (FPLs)	Flood Planning Levels selected for planning purposes are derived from a combination of the adopted flood level plus freeboard, as determined in floodplain management studies and incorporated in floodplain risk 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 plans. The concept of FPLs supersedes the "standard flood event". As FPLs do not necessarily extend to the limits of flood prone land, floodplain risk management plans may apply to flood prone land beyond that defined by the FPLs.
flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event. Under the merit policy, the flood prone definition should not be seen as necessarily precluding development.
floodplain management	The co-ordinated management of activities that occur on the floodplain.
floodplain risk management	A document outlining a range of actions aimed at improving floodplain management. The plan is the principal means of managing the risks associated with the use of the floodplain. A floodplain risk management plan needs to be developed in accordance with the principles and guidelines contained in the NSW Floodplain Management Manual. The plan usually contains both written and diagrammatic information describing how particular areas of the floodplain are to be used and managed to achieve defined objectives.
flood storage	Floodplain areas where floodwaters accumulate before being conveyed downstream. These areas are important for detention and attenuation of flood peaks.
floodway	Areas and flowpaths where a significant proportion of floodwaters are conveyed during a flood (including all bank-to-bank creek sections).
freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determining the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
overland flow	Overland flow is surface run off before it enters a waterway. It is caused by rainfall which flows downhill along low points concentrating in gullies, channels, surface depressions and stormwater systems.
peak flood level, flow or velocity	The maximum flood level, flow or velocity that occurs during a flood event.
probable maximum flood (PMF)	An extreme flood deemed to be the maximum flood likely to occur.
runoff	The amount of rainfall from a catchment that ends up as flowing water in the river or creek.
velocity	The speed at which the floodwaters are moving. A flood velocity predicted by a 2D computer flood model is quoted as the depth averaged velocity, i.e. the average velocity throughout the depth of the water column. A flood velocity predicted by a 1D or quasi-2D computer flood model is quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.
water level	See flood level.

7.2 Development Description

A warehouse distribution development is proposed for the site (refer Appendix A) comprising two large buildings (warehouses), car parking and heavy vehicle loading bays. The hardstand area of the proposed development is to be elevated to 6.7 m AHD utilising a suspended concrete platform to support buildings and hardstand/parking areas above the natural ground surface.

The Three Ports SEPP for which the proposed development falls within does not mandate specific flood planning levels, however Bayside Council provides some guidance in this regard. Chapter 8 of City of Botany Bay's (now Bayside Council) Stormwater Management Technical Guidelines states the following:

"For a site within Council's identified flood area or within the vicinity of Council or Sydney Water drainage easement/reserve or stormwater drainage system (including open/covered channel, watercourse and underground drainage pipes/culverts), the finished floor levels shall be minimum 500mm (habitable buildings/structures) and 300mm (non-habitable buildings/structures, such as garages, ramps to the basement car parking area) above the estimated 1% AEP flood level"

Therefore, the flood planning levels at the site are required to be 4.6 m AHD for habitable buildings/structures and 4.4 m AHD for non-habitable buildings/structures (where the 1% AEP flood level is 4.1 m AHD, refer Section 5).

The development has been designed with the following key floor levels:

- Main suspended concrete podium slab: 6.7 m AHD; and
- southern carpark suspended concrete podium slab: 5.2 m AHD

As per the supplied design plans, both suspended slabs meet the minimum FPL requirement specified in Councils 2013 DCP. Furthermore, both suspended concrete podium slabs are elevated above the PMF peak level (4.9-5.0 m AHD).

7.3 Local Flood Behaviour

During major floods such as the 1% AEP event, the roads immediately adjacent the site (McPherson Street and Nant Street) are subject to significant overland inundation from Springvale Drain. The site itself acts as a large storage basin, typified by low flood velocities but significant flood depths.

The key flood levels at the site include:

- A 1% AEP flood level of 4.1 m AHD; and
- A PMF level of up to 5.0 m AHD.

Based on the above levels, and the floor level of the two suspended concrete podium slabs being set at 5.6 m AHD and 6.7 m AHD, all hardstand areas of the proposed development will be free of inundation during events up to and including the PMF event.

The Best Practice Flood Risk Management approach to flood hazard mapping (NFRAG, 2014) classifies the floodplain into six distinct hazard zones (H1 to H6) as shown previously in Figure 5-2, based on important thresholds of flood depth, velocity and depth-velocity product. The adopted thresholds identify when modelled flood conditions would present a risk to people, vehicles and

building constructions. Figure 5-4 (refer Section 5.3) shows the preliminary flood hazard at the site and surrounding areas.

During the 1% AEP event the flood hazard mapping shows that floodwaters along Nant Street and McPherson Street are categorised as H1, H2 or H3 which cannot be safely navigated by the elderly and children. Additionally, the H3 level of flood hazard is unsafe for vehicles, noting however that this classification refers to cars, and not large road trains (although this may still be the case). The flood hazard within the development site is predominantly H3, principally as a result of the flood depth (noting the low velocities).

During the PMF event, the flood hazard classification on site, along Nant Street and McPherson Street increases to H4. A H4 classification is unsafe for all people and vehicles. Furthermore, minor sections of the site and Nant Street are subject to H5 hazard, meaning any structure located in these areas will require engineering design and construction (to avoid failure).

Figure 7-1 shows the 1% AEP and PMF rate of rise at the proposed development site for the critical duration of 2 hours, 3 hours and 9 hours.

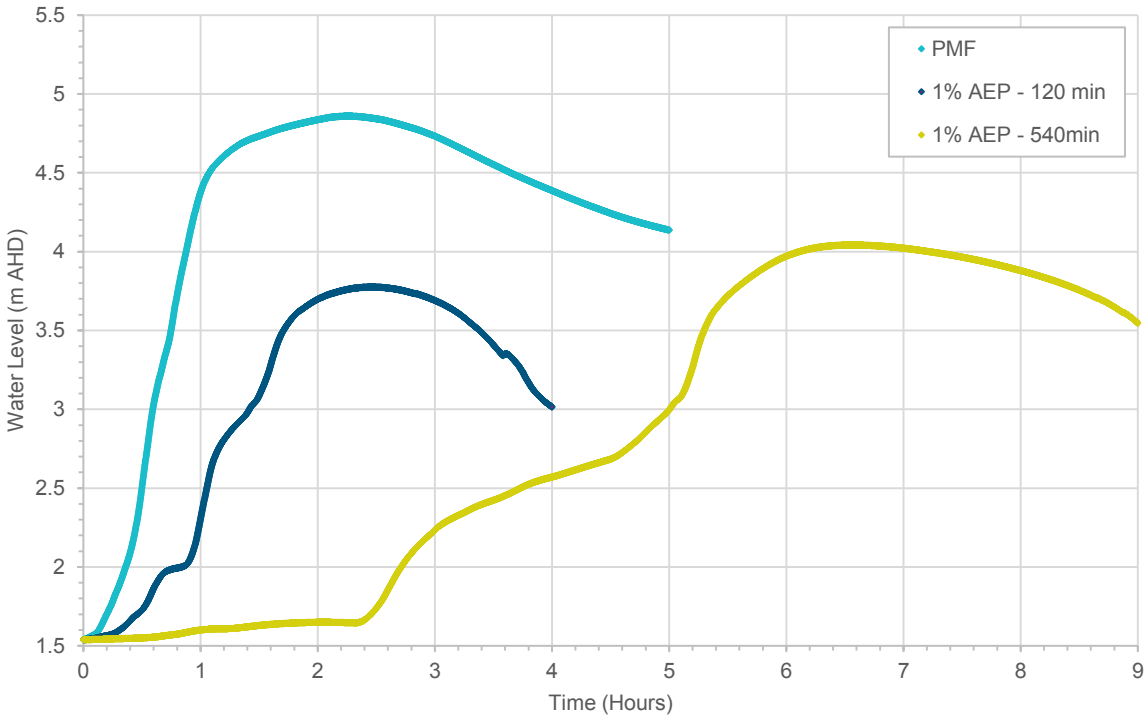


Figure 7-1 1% AEP and PMF Water Level (m AHD) vs. Time (Hours)

Nant Street and McPherson Street have a minimum elevation of approximately 3.0 m AHD and 3.3 m AHD respectively. In general, the approximate warning time from event start to inundation of the Site, Nant Street and McPherson Street ranges from 1.5-5 hours for the 1% AEP event and 35 minutes for the PMF.

In regard to duration of inundation, and as per Figure 7-1, during the 1% AEP 2-hour design event, Nant Street would be cut by floodwaters for approximately 2.5 hours and McPherson Street for 2 hours. During the 1% AEP 9-hour design event and PMF event, Nant Street and McPherson Street would be cut by floodwaters for in excess of 4 hours.

7.4 Evacuation considerations

Based on the local flood behaviour near the site during major flood events (refer Section 5 and Section 7.3), and design of the proposed warehouse distribution development, there will be insufficient warning time to enable a whole of site evacuation during flood events exceeding the 1% AEP. Floodwaters could potentially inundate the surrounding roads (Nant Street and McPherson Street) within the hour of the onset of flood producing rainfall. It must also be noted that given the low-lying nature of the Springvale Drain and Floodvale Drain catchment, that there would be limited opportunity to evacuate to a suitable destination off-site via the primary carriageways of Foreshore Road and Botany Road.

Taking in to account the limited available warning time to safely evacuate, the distribution and hazard classification of floodwaters surrounding the site, and the proposed design providing flood free refuge over the entire development footprint, it is recommended that habitants remain on-site (i.e. sheltering in place) during flood events.

7.4.1 Evacuation Procedure

The emergency evacuation procedure to be followed for all areas on site is to seek refuge inside the habitable areas of Building 1 and Building 2 within the proposed warehouse distribution development.

Once alerted to inundation of McPherson Street, site management should take the following actions:

- Confirm rising water level in Floodvale Drain and McPherson Street; and
- When water inundation is visible on McPherson Street, ensure that habitants remain on-site until flood waters have receded and it is safe to do so.

Given the elevation above the floodplain, it is not recommended to install, maintain or operate a flood warning system, however rely on flood education, awareness and preparedness to mitigate the flood risk. A potential option to notify habitants of water inundation on McPherson Street (particularly in the event of a night time flood event) would be to install an automated flood level alert device which automatically flashes when water level reaches a specified depth on McPherson Street.

7.5 Flood Education, Awareness and Preparedness

In addition to having an emergency evacuation procedure in place, it is recommended that a flood education, awareness and preparedness program is implemented on site. This will ensure that tenants and staff members who are regularly on site are aware of the site flood risk and what they should do and what to direct their customers to do in the case of an emergency. The flood education, awareness and preparedness program should:

- Provide an overview / summary of the level of flood risk on site including inundation rate of rise times;
- Explain and if necessary demonstrate the emergency evacuation procedures;
- Outline that the site should not be exited either by foot or vehicle once there is flooding on McPherson Street.

This program should be implemented when new tenants move into the building or during a training and induction process for new and existing staff members.

Additionally, site management should consider installing signage in appropriate areas of the site which outlines the flood emergency evacuation procedure.

7.6 Before a Flood

Outlined below are several flood safety measures to be followed before a flood. Guidance on how to address each measure is included in the NSW SES interactive online tool, with supporting information provided in this document.

- Using the information contained in this document, in conjunction with property specific information such as resident details and key contact person/s, prepare a NSW SES Emergency Business Continuity Plans (http://www.sesemergencyplan.com.au/business/);
- Prepare an Emergency Flood Kit (i.e. first aid kit, torches, batteries, bottled water, non-perishable food items, important documents, medication; blankets and spare clothes) as detailed in the NSW SES Business Continuity Plans;
- In case of a night time flood event, locate your NSW SES Emergency Flood Kit in an accessible location and utilise torches and other emergency lighting as required;
- Identify the needs of any vulnerable persons likely to be on-site in the event of a flood emergency (i.e. elderly, disabled, young children) and include instructions in the NSW SES Emergency Business Continuity Plan to address these needs (e.g. identify a care support person to provide assistance in the event of a flood etc.);
- Inspect the property for available elevated areas to relocate any hazardous substances, furniture, equipment and belongings to (this only applies to ground and lower ground levels);
- Locate utilities such as gas, water, and electricity and note their elevations in relation to the premises and surroundings in the NSW SES Emergency Business Continuity Plan;
- It is recommended that multiple communication media are maintained on Site (e.g. internet, mobile phone, landline phone, radio, satellite phone etc.) so that if one communication platform fails there is a redundancy in place to maintain effective communication with emergency services during a flood event;
- Communicate to all occupants of the premises the NSW SES Emergency Business Continuity Plan, location of the Emergency Flood Kit, and discuss the risk of flooding to the site, contact/communication methods, and actions to take before, during and after a flood event.

In addition to the above measures, it is recommended that an education program developed and implemented for all staff in the building. It is vital that all occupants of the building are informed of the evacuation procedure during flood events and that they are advised on the best course of action in the instance that a flood event occurs. It is recommended that annual ‘refresher’ training or information is disseminated to all staff to ensure new occupants are educated on flood risk and recommended procedures to follow.

7.7 During a Flood

Outlined below are a few key flood safety measures to be followed during a flood. Guidance on how to address each measure is included in the NSW SES interactive online tool, with supporting information provided in this document.

- Follow the procedures outlined in this document and details contained in the developed NSW SES Emergency Business Continuity Plan and locate the Emergency Flood Kit;
- During storm events monitor the BoM website for warnings, ABC radio broadcasts, local emergency services social media pages, and local news outlets;
- Follow all advice and instructions given to you by emergency services;
- Ensure all occupants on-site are informed and in agreeance on the shelter in place approach, and that the Emergency Flood Kit has been collected; and
- Turn off all utilities possible and relocate belongings to higher ground above the predicted flood level if possible (i.e. ground level and below only).

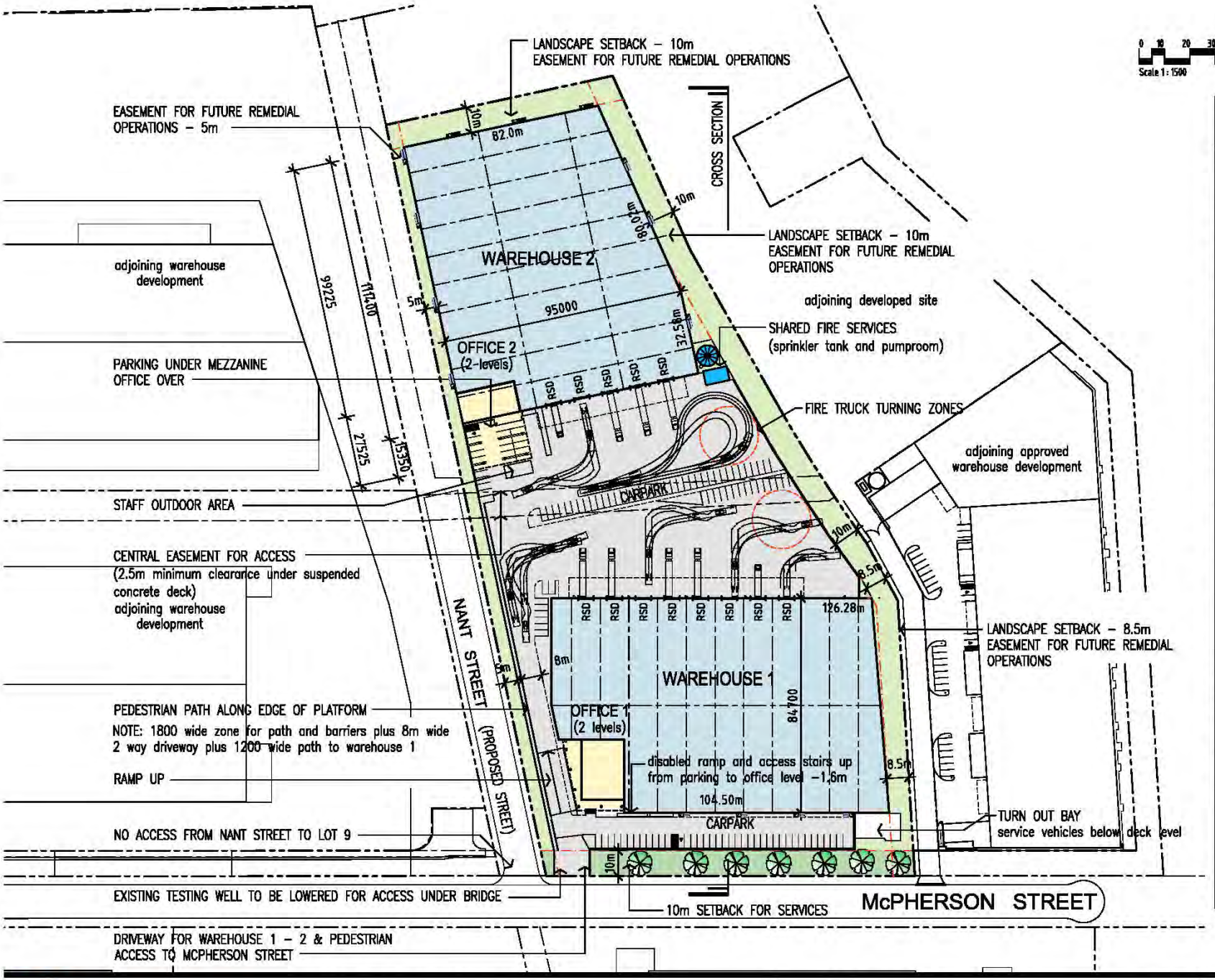
8 Conclusion

The property at Lot 9, 28 McPherson Street, Banksmeadow is affected by flooding. This report has analysed the flood characteristics in design flood events ranging from the 5% AEP to the PMF.

A flood impact assessment was undertaken on the initial site plan to determine impacts associated with the proposed elevated ground slab and piling grid configuration. The results indicate that there are no discernible impacts on existing flood conditions as a result of the proposed warehouse distribution development.

A site FERP was prepared to ensure the occupants of the proposed warehouse distribution development are suitably informed of the property specific flood risk, what to do to prepare for a flood, and what to do during a flood. The FERP was prepared consistent with the NSW SES interactive online tool that business owners/operators can use to prepare site specific Emergency Business Continuity Plans. The primary recommendation of the FERP was to remain on-site (which is flood free in events up to and including the PMF design event).

Appendix A Site Plan



SCHEDULE OF AREAS

SITE AREA	41 290 sqm
SITE AREA - less 1 459 sqm for 10m front setback services zone to McPherson St.	39 831 sqm
CONCRETE PLATFORM suspended concrete platform to support buildings & hardstand / parking areas above basin including crossover over easement to McPherson Street	34 130 sqm
BUILDING 1	
for services)	
WAREHOUSE 1	10 135 sqm
OFFICE 1 - 2 storey	1 000 sqm
405 gnd floor + 595 first floor	
TOTAL BUILDING AREA	11 135 sqm
AWNING 1 - 8m wide	740 sqm
59 carspaces including 1 disabled space provided on site for building 1	
BUILDING 2	
WAREHOUSE 2	9 645 sqm
OFFICE 2 - 2 storey	1 000 sqm
280 gnd floor + 720 first floor	
TOTAL BUILDING AREA	10 645 sqm
AWNING 1 - 8m wide	496 sqm
58 carspaces including 1 disabled space provided on site for building 2	
COUNCIL CARPARK REQUIREMENTS	
WAREHOUSE DISTRIBUTION AREA	1 CAR / 300m2
OFFICE AREA	1 CAR / 40m2

ORICA

PROPOSED WAREHOUSE DISTRIBUTION AND OFFICE DEVELOPMENT

ORICA AUSTRALIA

lot 9 McPherson Street, Banksmedow. NSW

AXIS ARCHITECTURAL
4 / 112 Cronulla Street, Cronulla NSW 2230
p + 02 9523 7858 / m + 0414 954 405
e + david@axisarchitects.com.au
AXIS ARCHITECTURAL Pty Ltd - ABN 18 086 853 376
Nominated Architect - David McDonald NSW ARB No. 7997

Drawing:
SITE PLAN - OPTION 6
NO ACCESS VIA NANT STREET

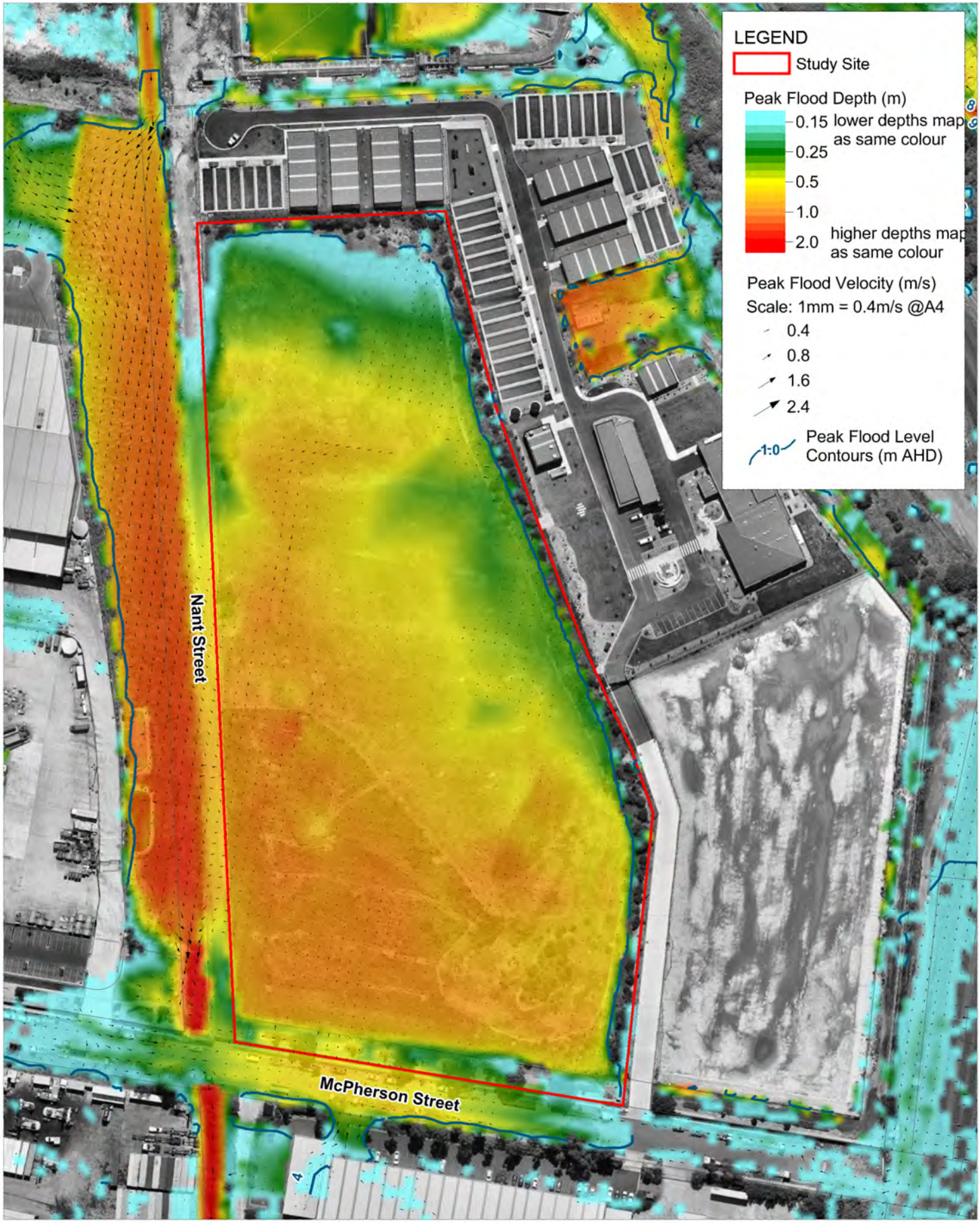
Scale : 1 : 1500 @A3
Drawn : AA
Date : Jan 2018

Project No : 180101

Drawing No : SK - A 106

Issue : P4

Appendix B Design Flood Results



Title:

Peak Flood Results - Current Scenario 5% AEP

Figure: B-1

Rev: -

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Approx. Scale

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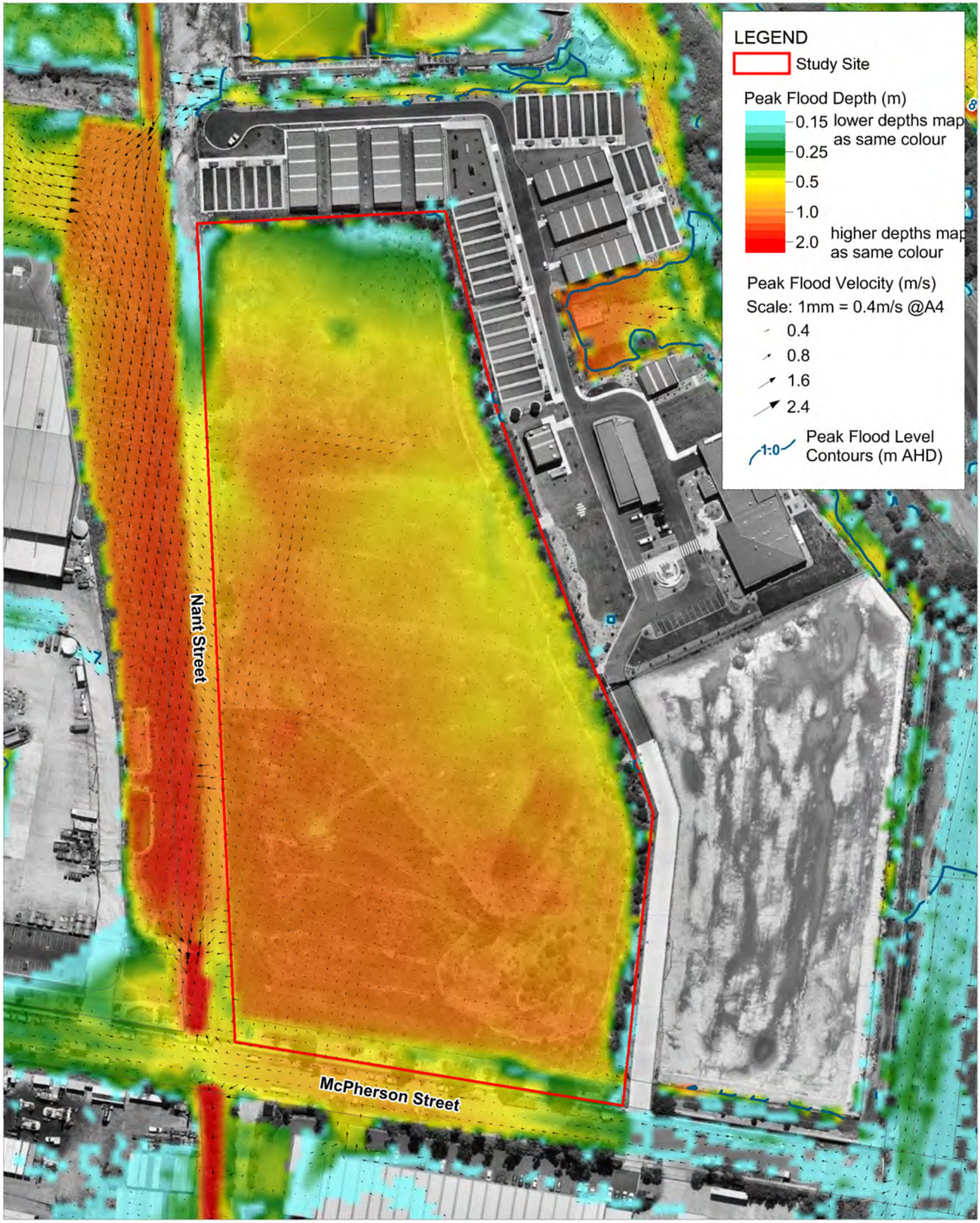

Title:

Peak Flood Results - Current Scenario 1% AEP

Figure: B-2

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Approx. Scale

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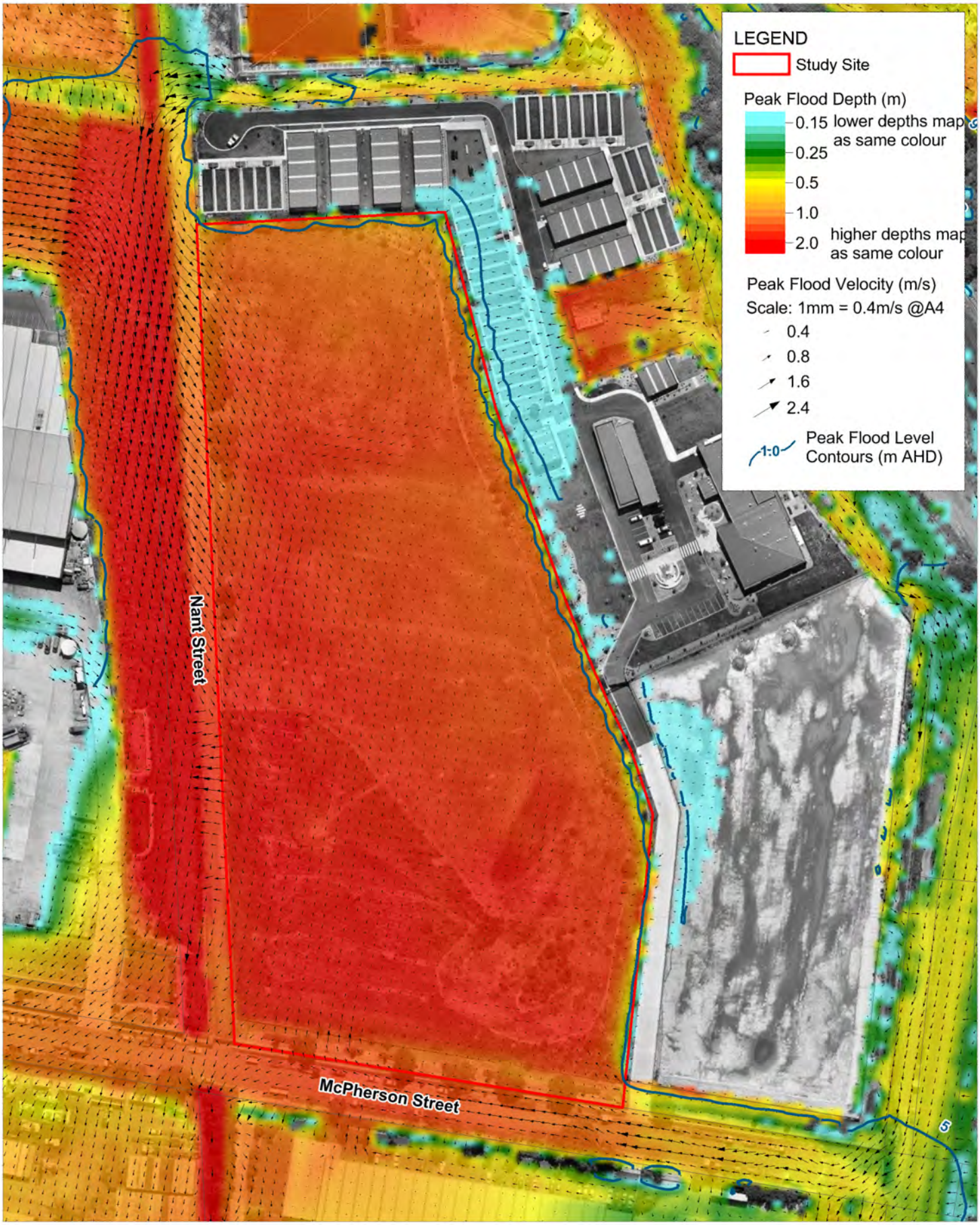

Title:

Peak Flood Results - Current Scenario PMF

Figure: B-3

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0 37.5 75m

Approx. Scale

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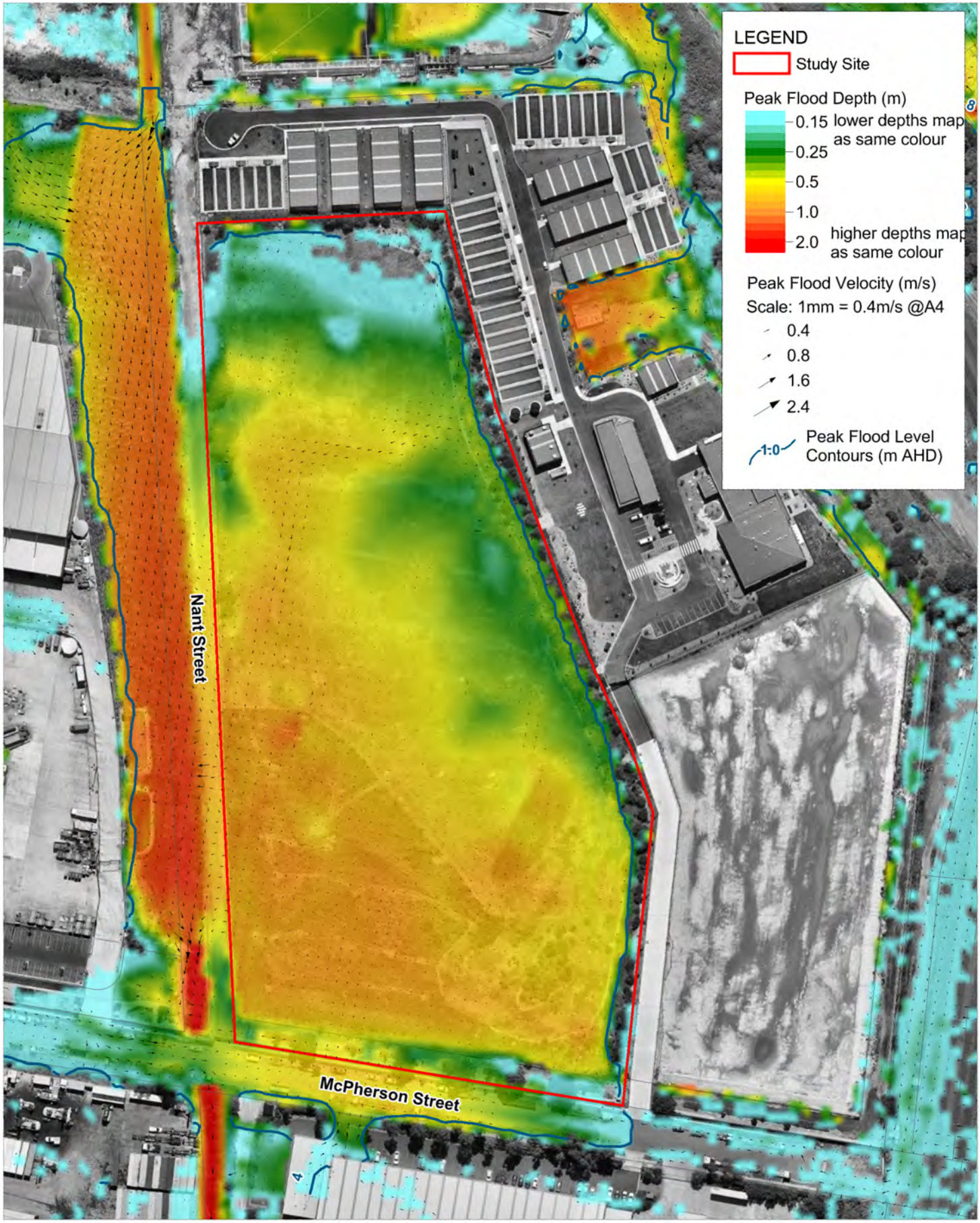

Title:

Peak Flood Results - Proposed Scenario 5% AEP

Figure: **B-4**

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Approx. Scale

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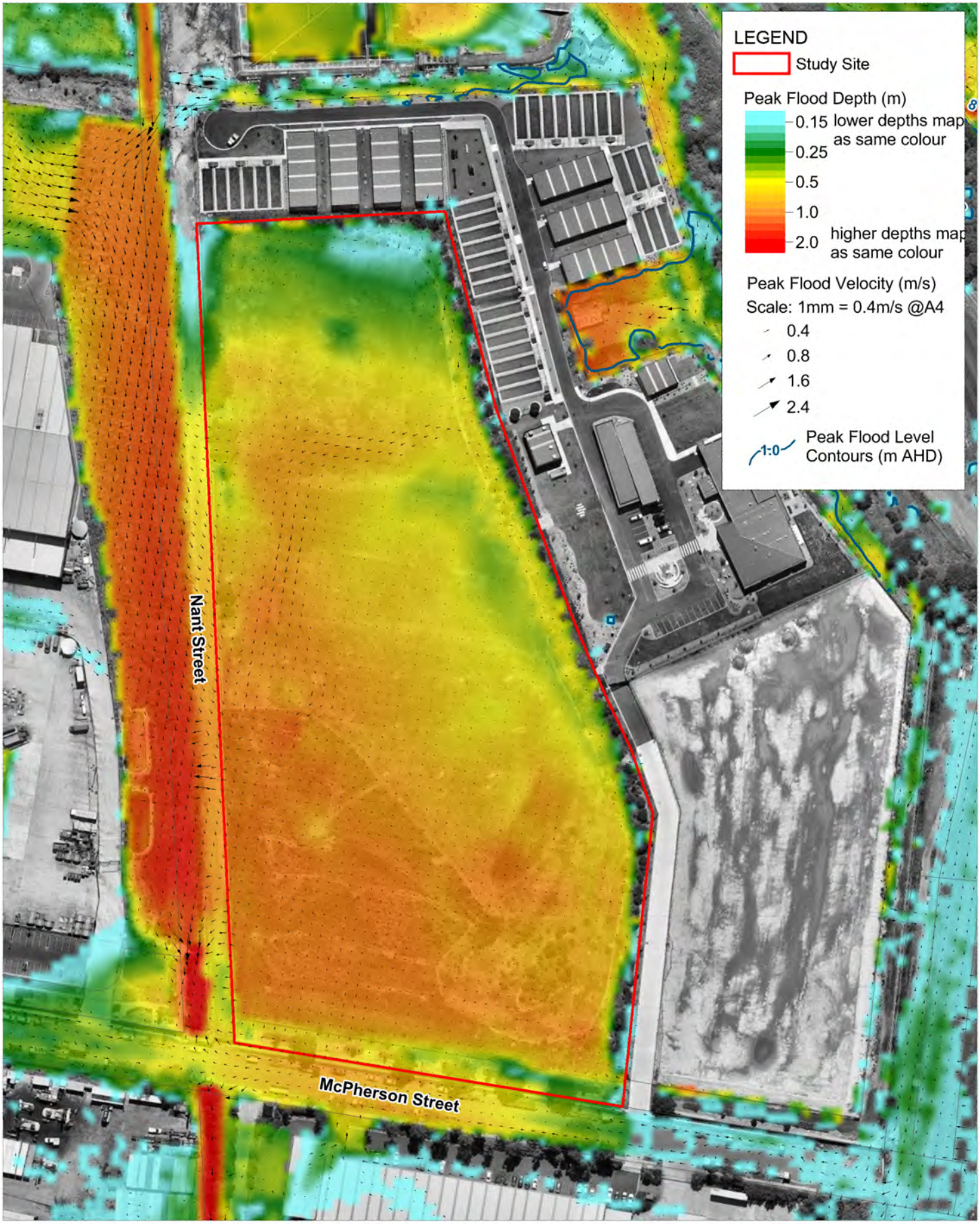

Title:

Peak Flood Results - Proposed Scenario 1% AEP

Figure: **B-5**

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0 37.5 75m

Approx. Scale

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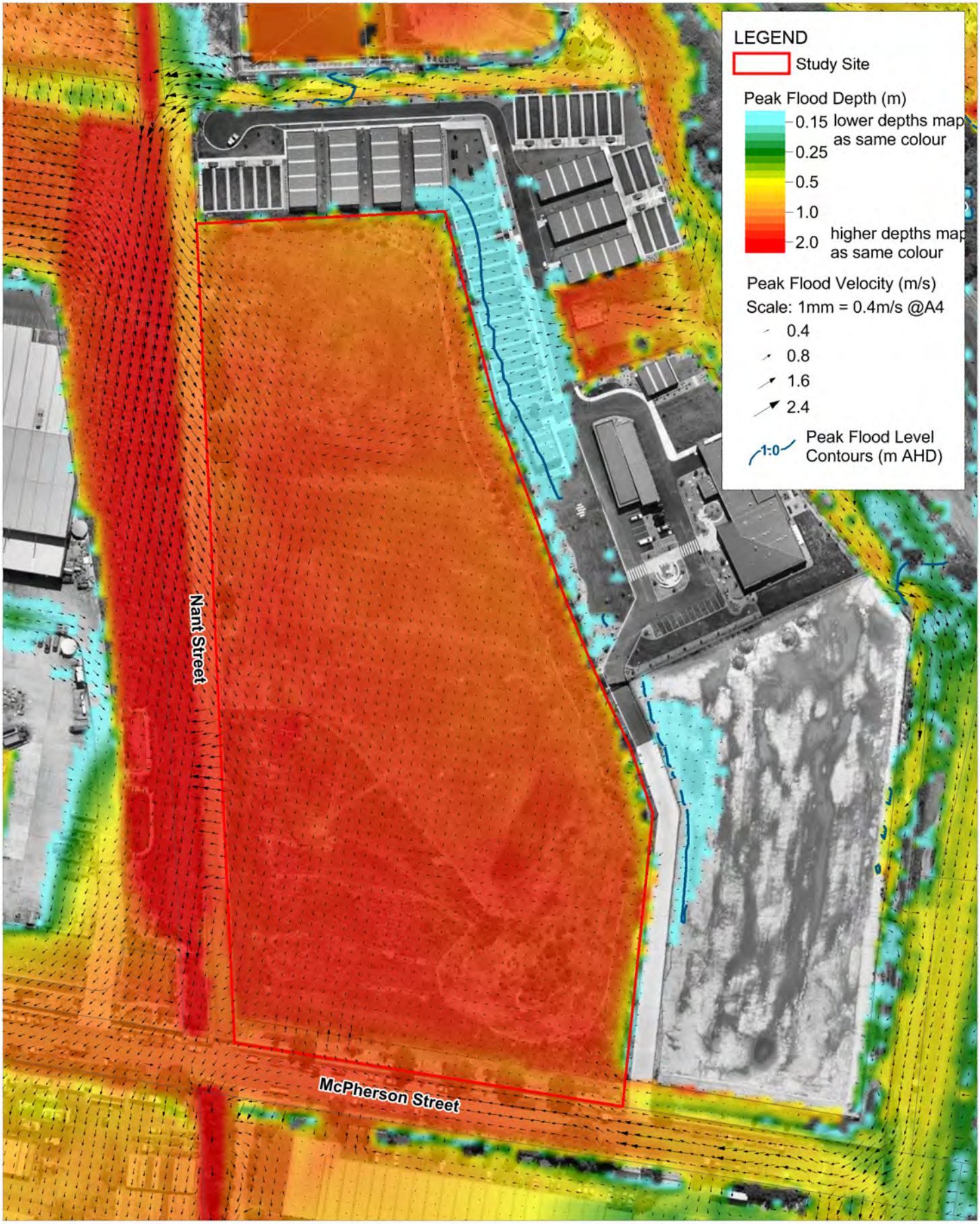

Title:

Peak Flood Results - Proposed Scenario PMF

Figure: **B-6**

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Approx. Scale

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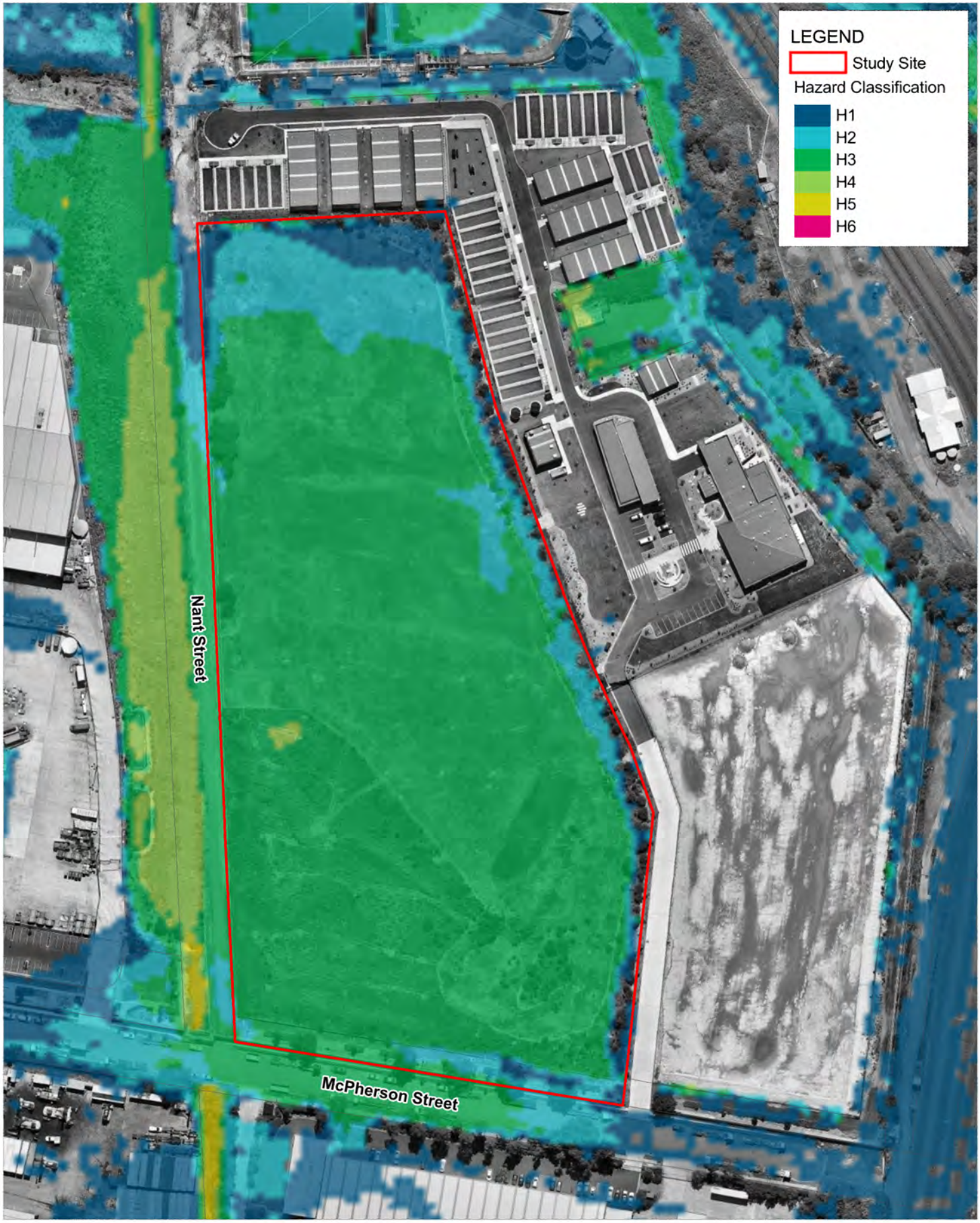

Title:

Preliminary Hazard - Current Scenario 1% AEP

Figure: B-7

Rev: -

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Approx. Scale

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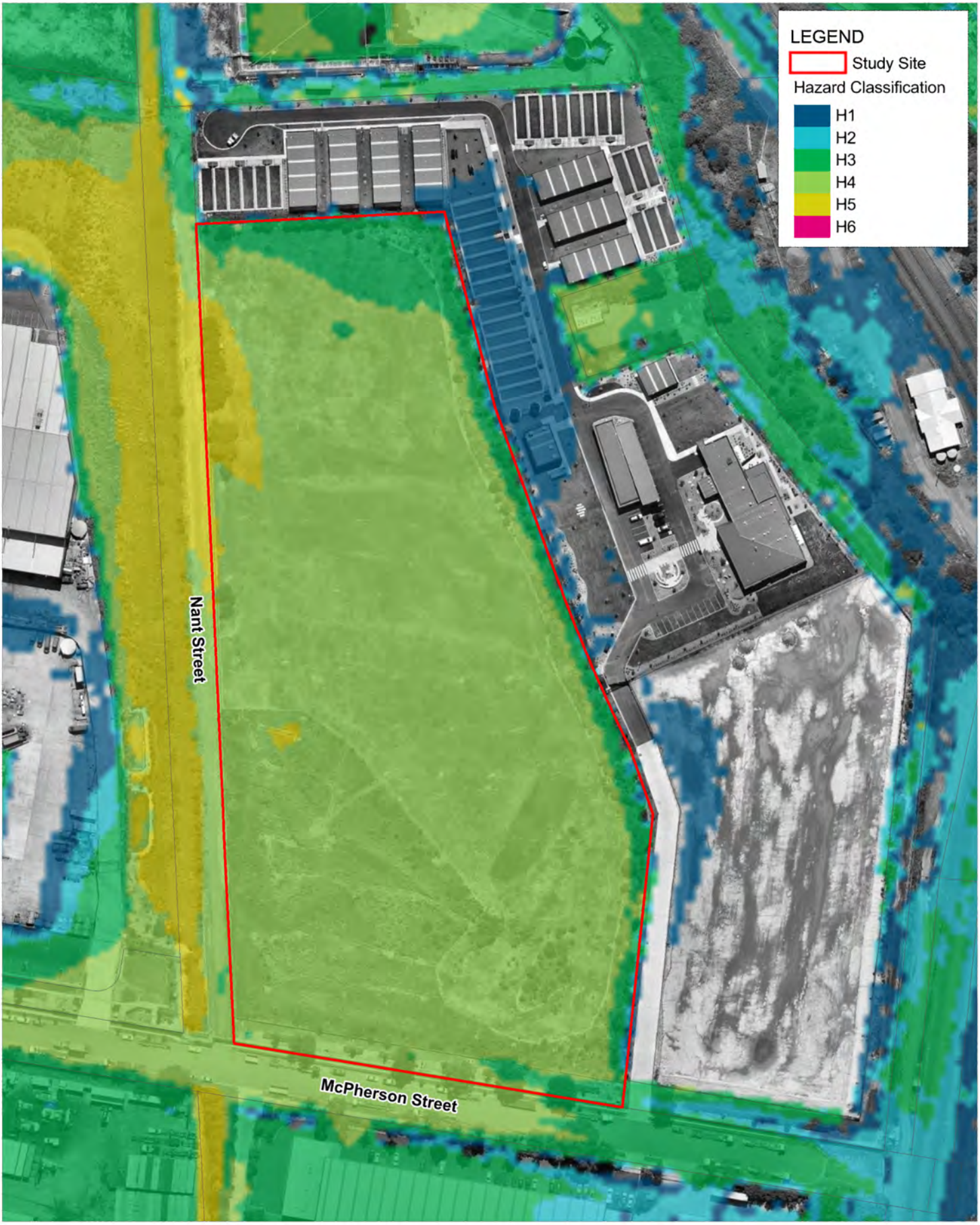

Title:

Preliminary Hazard - Current Scenario PMF

Figure: **B-8**

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Approx. Scale

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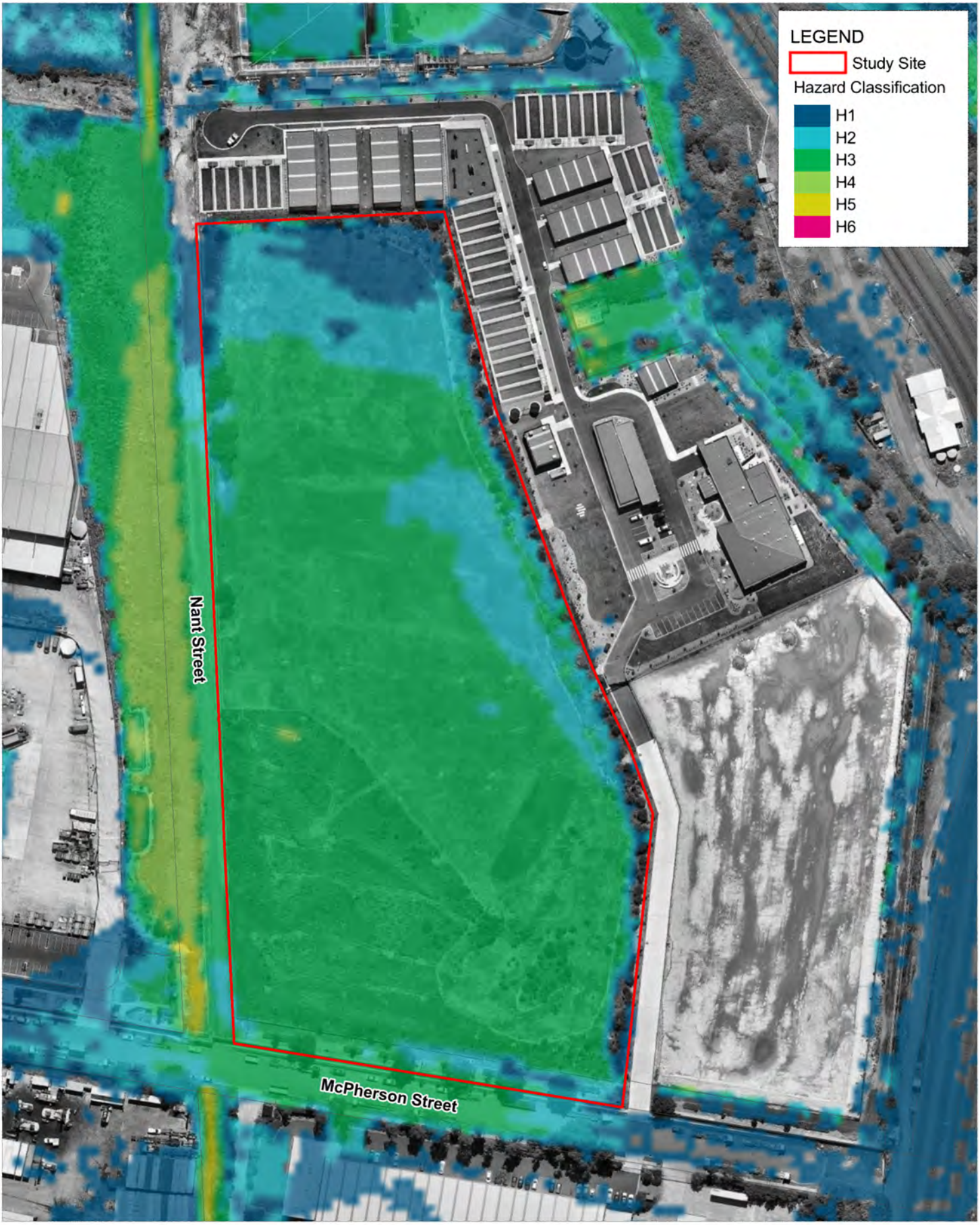

Title:

Preliminary Hazard - Proposed Scenario 1% AEP

Figure: **B-9**

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Approx. Scale

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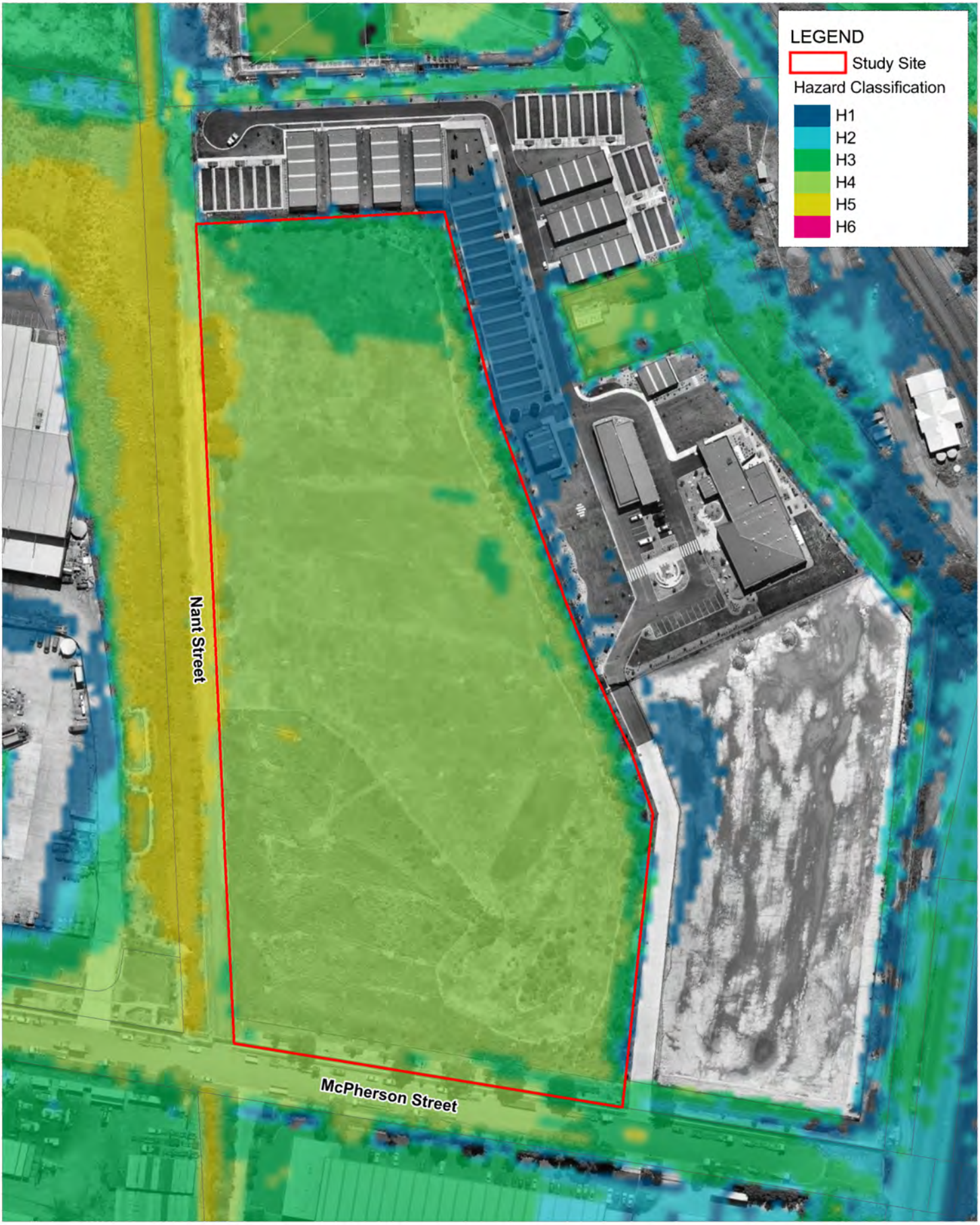

Title:

Preliminary Hazard - Proposed Scenario PMF

Figure: B-10

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N

0 37.5 75m

Approx. Scale

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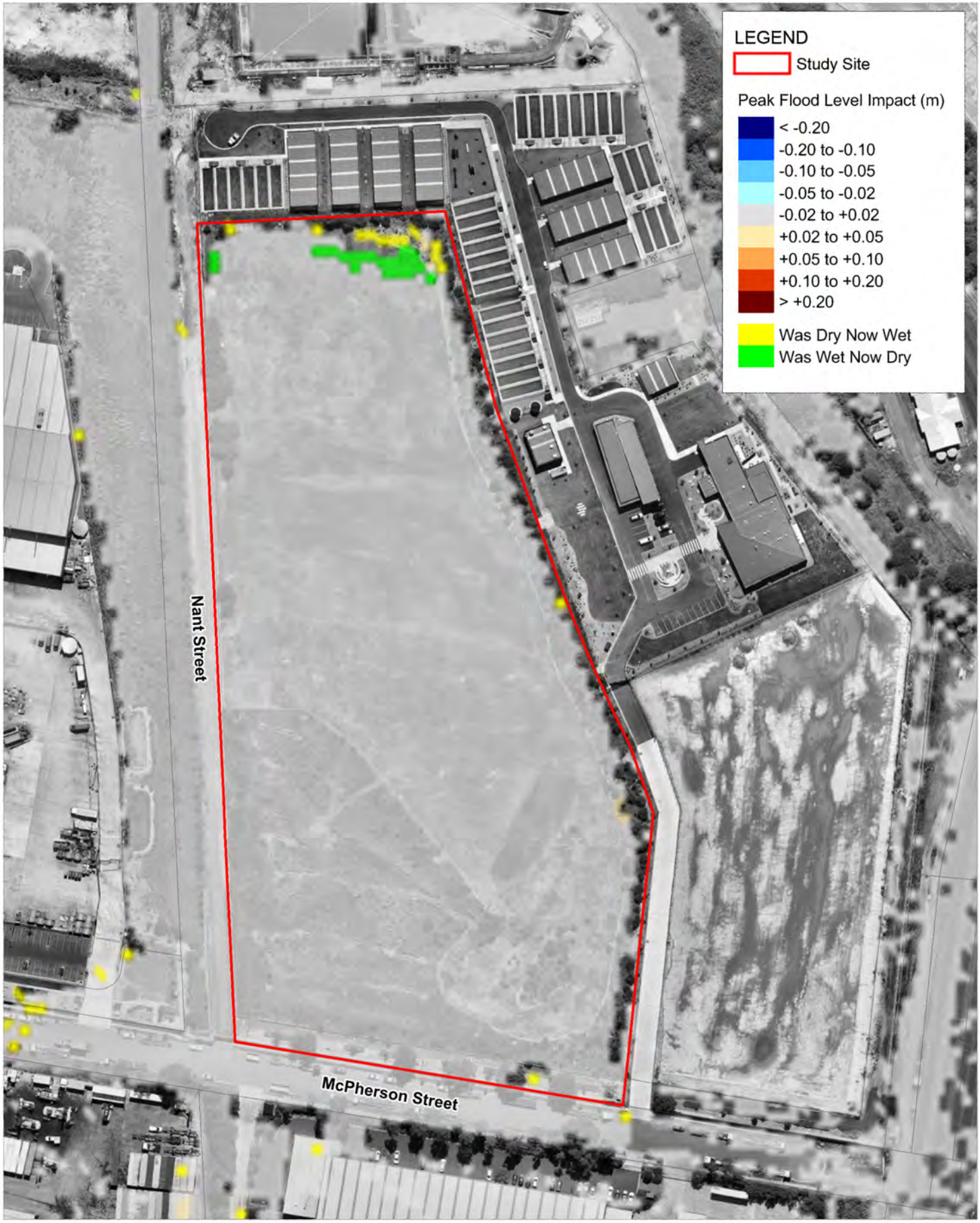
www.bmt.org

Filepath : S:WATERPROJECTSS20352_Lot_9_McPherson_Street_Banksmeadow_FIAMIWorkspacesBAFigure_B10_PMF_BPHazard_DEV.wor

Appendix C Flood Impacts



Title:

Peak Flood Level Impacts
5% AEP

Figure: C-1

Rev: -

N

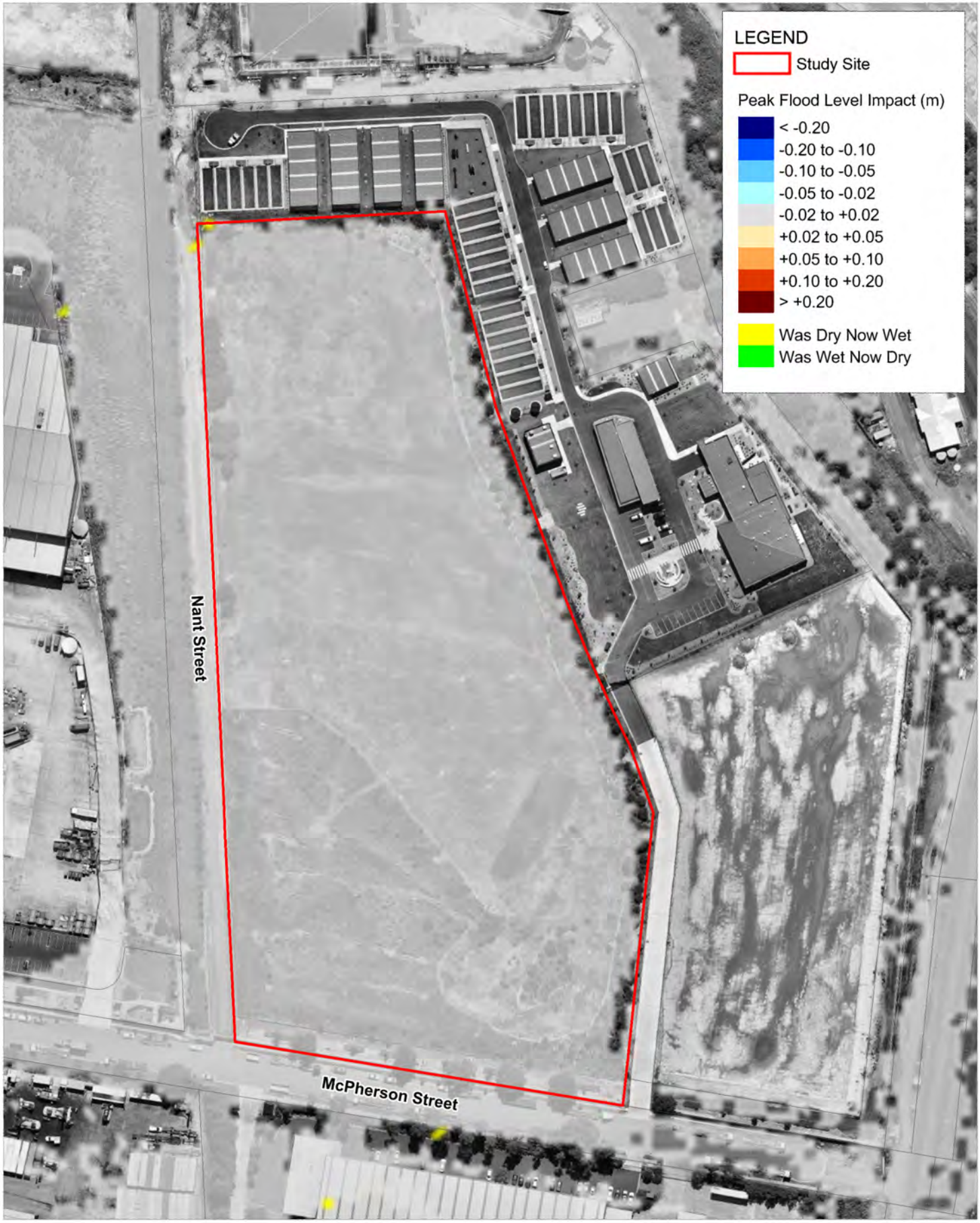
0 37.5 75m

Approx. Scale

BMT

www.bmt.org

Filepath : S:WATERPROJECTSS20352_Lot_9_McPherson_Street_Banksmeadow_FIAMIWorkspacesBAFigure_C01_020YR_Afflux_01.wor



Title:

Peak Flood Level Impacts
1% AEP

Figure: C-2

Rev: -

N

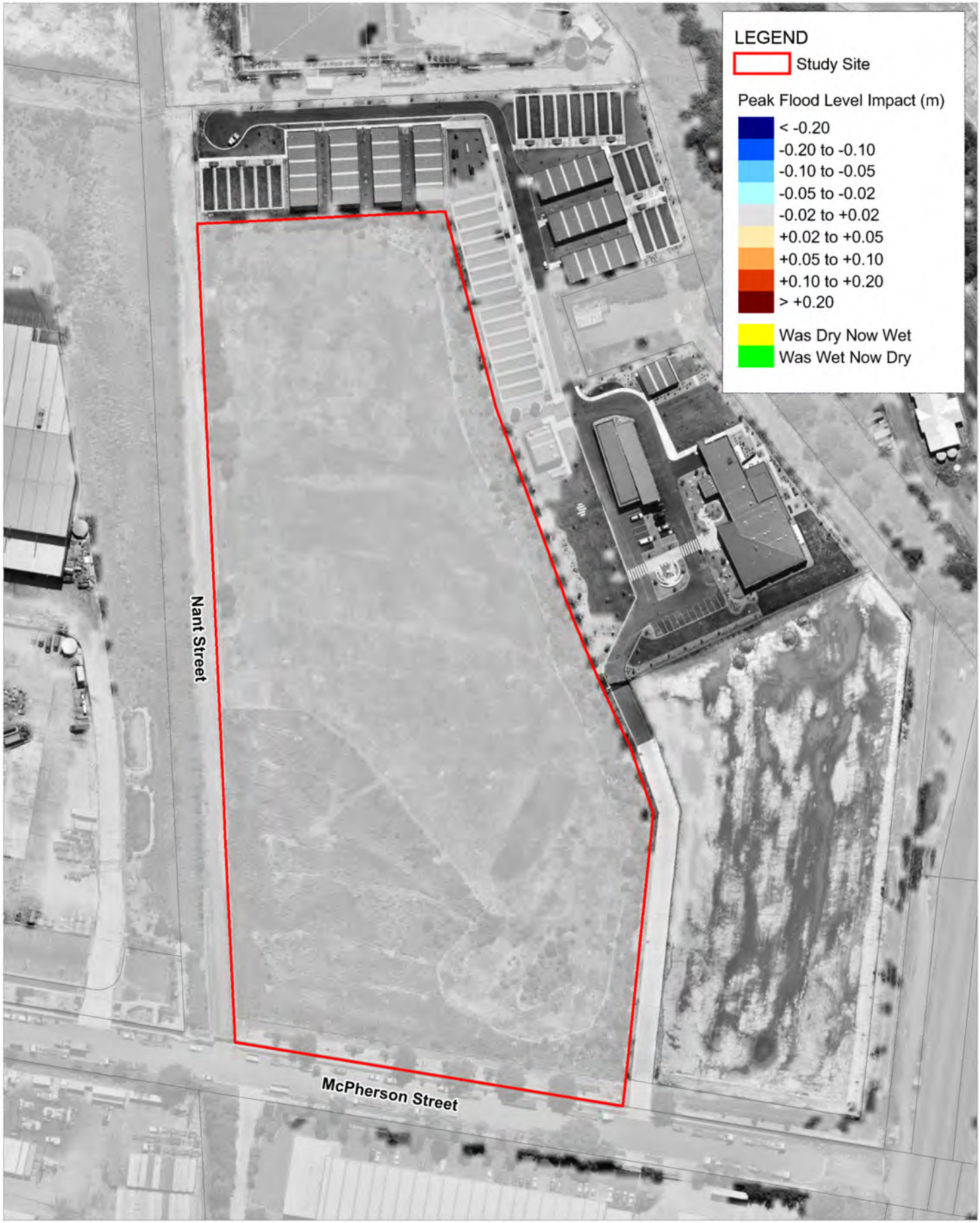
0 37.5 75m

Approx. Scale

BMT

www.bmt.org

Filepath : S:WATERPROJECTSS20352_Lot_9_McPherson_Street_Banksmeadow_FIAMIWorkspacesBAFigure_C02_100YR_Afflux_01.wor



Title:

Peak Flood Level Impacts
PMF

Figure: C-3

Rev: -

N

0 37.5 75m

Approx. Scale

BMT
www.bmt.org

Filepath : S:WATERPROJECTSS20352_Lot_9_McPherson_Street_Banksmeadow_FIAMIWorkspacesBAFigure_C03_PMF_Afflux_01.wor

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