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Jane Street and Mulgoa Road Infrastructure Upgrade

Review of Environmental Factors

Appendix I – Hydrology and Hydraulic Impact Assessment

October 2016

NSW Roads and Maritime Services

Jane Street and Mulgoa Road Infrastructure Upgrade

Hydrology and Hydraulic Impact Assessment

Final | 7 September 2016

Job number 244597

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Document Verification

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			Prepared by	Checked by	Approved by
		Name	Nathan Cheah	Ivan Varga Sampedro	Kathryn Nation
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		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
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		Signature			

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Contents

Appendices

Tables

Diagram

Figures

1 Introduction

Roads and Maritime Services (Roads and Maritime) propose to upgrade the infrastructure at the Jane Street / Great Western Highway and Mulgoa Road / Castlereagh Road intersection in close proximity to the Penrith Central Business District (CBD). This infrastructure upgrade is necessary to improve traffic flow on this key route and respond to an expected increased travel demand from current and future residential and employment growth in the area.

This report documents the hydrologic and hydraulic impact assessment that has been undertaken to determine the impact of the Jane Street and Mulgoa Road infrastructure upgrade based on the 100% concept design on existing flood behaviour. The location of the proposed works falls within the Peach Tree Creek catchment which discharges into the Nepean River system. A flood study was previously carried out in August 2014 by Lyall and Associates (Lyall & Associates, 2014a) to investigate the feasibility of the different upgrade options and their impacts on the existing flood behaviour. The assessment herein utilised the same flood models and methodology to evaluate the flood impacts of the current 100% design.

1.1 Available Data

The following information was made available by Roads and Maritime for the present assessment:

- *Peach Tree Creek Flood Study*, prepared by Lyall & Macoun Consulting Engineers for Penrith City Council, October 1994 (NSW Public Works Department, 1994)
- *Jane St Extension Flooding Investigation*, Volume 1 and 2, prepared by Lyall & Associates for Roads and Maritime Services, August 2014 (Lyall & Associates, 2014a)
- TUFLOW model builds for the Peach Tree Creek and Penrith CBD catchments and DRAINS model for the Peach Tree Creek local catchments
- Digital elevation models (DEM) developed for the TUFLOW models
- Relevant GIS datasets and aerial photography

2 Flood Mechanism

The Peach Tree Creek catchment is subject to the following flood mechanisms:

- Local catchment flooding as a result of heavy rainfall falling over the Penrith CBD catchment area; and
- Mainstream flooding from the Nepean River.

The 2014 flood study (Lyall & Associates, 2014a) considered the local catchment flooding for the 5, 20 and 100 year Average Recurrence Interval (ARI) events without coincident flooding in the Nepean River, as well as mainstream flooding from the Nepean River of 100 year ARI coincident with a 20 year ARI local catchment flood. The mainstream flooding peak flood levels have been adopted by Penrith City Council for planning purposes. Both the local catchment flooding and mainstream flooding events have been modelled for the assessment herein.

Table 1: Adopted co-incidence of local catchment and mainstream flood events

Flood Event	Local Catchment Event (ARI)	Mainstream River Event (ARI)
5 year ARI local catchment flood	5 year	-
20 year ARI local catchment flood	20 year	-
100 year ARI local catchment flood	100 year	-
100 year ARI mainstream river flood	20 year	100 year

Flood mapping undertaken herein was based on the envelope of the peak flood level grids from both flooding scenarios. The impact on the 100 year ARI peak flood levels was examined for both the local catchment flooding and mainstream flooding from the Nepean River.

3 Flood Model Update

The models developed previously in the 2014 flood study (Lyall & Associates, 2014a) have been obtained and used in this Arup 2016 assessment to model the flood behaviour in the catchment:

- Peach Tree Creek TUFLOW model
    - 2D hydraulic model with 2m grid
    - Model primarily mainstream flooding on Peach Tree Creek
- Penrith CBD TUFLOW model
    - 1D/2D hydraulic model with 2m grid which incorporates the pits/pipes network of the Penrith CBD
    - Model primarily overland flow flooding within the catchment which discharges to Peach Tree Creek downstream

The boundary conditions for these models were extracted from the Peach Tree Creek FPLAIN model (*Peach Tree Creek Flood Study - NSW Public Works Department, 1994*) and the NRGB TUFLOW model (*Nepean River Green Bridge Hydraulic Investigation - Lyall & Associates, 2014b*). Hydrologic inflows were derived from the DRAINS model which was developed for the Peach Tree Creek local sub-catchments.

The following updates have been incorporated into the model as part of the present assessment:

- The extension of the model to include the hydrologic inflows for the catchment north of the railway line
- Updated topographic survey undertaken for the road corridor, i.e. Jane Street / Great Western Highway and Mulgoa Road / Castlereagh Road
- Minor corrections to the hydraulic models to improve stability

All other model assumptions were retained including design rainfall depths and temporal patterns, losses, Manning's *n* roughness for the different land uses, and boundary conditions. An overview of the model setup is provided in Figure 1.

4 Existing Flood Behaviour

The following sections describe the existing flood behaviour affecting the proposed upgrade site under the local catchment flooding and mainstream flooding scenarios. This is the flood behaviour of the area based on the current road layout with no upgrade.

4.1 Local Catchment Flooding

In the local catchment flooding scenario, an existing overland flow path originating from the catchments to the south-east traverses the intersection of Mulgoa Road / Great Western Highway and across the tennis courts before discharging to Peach Tree Creek. At the Castlereagh Road rail underpass, floodwaters up to about 2.5 m deep can be expected in the 100 year ARI event with a 375mm diameter pipe on the northern side of the rail line providing the only discharge point for the trapped water at this sag point. Flood affectation of the properties within the immediate surrounds of the infrastructure upgrade site is mainly found on the western bank of Peach Tree Creek whereby properties along Ladbury Ave are affected by flooding from Peach Tree Creek for events as frequent as the 5 year ARI (refer to Figure 2).

4.2 Mainstream Flooding

In the mainstream flooding scenario, floodwaters can be seen overtopping the eastern banks of Peach Tree Creek in the 100 year ARI event (refer to Figure 5) with the floodwaters from the creek traversing the tennis courts before flowing downstream through the Castlereagh Road rail underpass and entering the commercial/industrial area north of the railway. Flood affection of the properties in this scenario is significantly worse than that of the equivalent recurrence interval of a local catchment flooding. Similarly, properties along Ladbury Ave on the western bank of Peach Tree creek will be severely affected. The distribution of the floodwaters flowing through the creek and the banks upon overtopping is as per Table 2 (compared against the flow distribution of the local catchment flooding scenario).

Table 2: Distribution of peak flows (m^3/s) through the railway bridges under existing conditions

Flood Event	Bruce Neale Dr Underpass (western bank)	Peach Tree Creek	Castlereagh Rd Underpass (eastern bank)
5 year ARI local catchment flood	-	70.7	0.1
20 year ARI local catchment flood	-	74.4	0.1
100 year ARI local catchment flood	-	103.5	0.3
100 year ARI mainstream river flood	8.5	163.1	13.5

5 Proposed Design Flood Behaviour

As part of the 100% concept design, the Castlereagh Road rail underpass will be widened and lowered in addition to the proposed upgrade of the Jane Street / Great Western Highway and Mulgoa Road / Castlereagh Road intersections. The extent of works is as shown in Figure 2 to Figure 5. These changes were incorporated into the hydraulic model as a design TIN layer together with the proposed drainage network and the impact of these proposed works was ascertained without any flood mitigation works. The peak flood level impact map (Figure 6) shows the change in peak flood levels as a result of the proposed works. Strategies to mitigate adverse impacts caused by the proposed works for investigation in subsequent design stages is presented in the following sections.

5.1 Local Catchment Flooding

It can been seen from the peak flood level impact map (refer Figure 6) that in the local catchment flooding scenario, adverse impacts are found immediately upstream of the proposed works south of the Great Western Highway as well as on the south-eastern corner of the intersection of Mulgoa Road / Great Western Highway. This is to be expected as the overland flow path traverses through this intersection under existing conditions and the proposed road upgrade involves regrading of the road which will impede the flows. This can be resolved by providing additional pit inlet capacity and cross drainage underneath the intersection to carry the overland flows through the sub-surface pipes to the downstream floodplain. Another option would be to augment the existing pipes underneath the road to provide additional capacity. Surcharge pits can be provided downstream to allow the flows to be surcharged onto the surface if the drainage upgrade cannot be carried out for the remainder of the pipe system up to the outlet at Peach Tree Creek. Further modelling to investigate the effectiveness of these mitigation works will be undertaken in subsequent design stages.

Due to the lowering of the design road surface level and widening of the rail underpass at Castlereagh Road, it can be seen that there is a decrease in the peak flood levels at this location compared to existing conditions.

Under the local catchment flooding conditions, there is a slight increase in the 100 year ARI flood extent for the NSW Ambulance Service building (south of Great Western Highway) and marginal increase of the 100 year ARI peak flood level of 0.012m for the properties on John Tipping Grove.

5.2 Mainstream Flooding

A slight increase in the peak flood levels with a maximum of 0.035 m was found to occur in the 100 year ARI mainstream flood event as a result of the proposed works, with the banks of the Peach Tree Creek overtopped in this event. It should be noted that under mainstream flooding conditions, significant flood depths are already experienced around the proposed upgrade site even in existing conditions. These impacts spread onto the immediate surrounds as can be seen from Figure 6 and the increase in the 100 year ARI peak flood levels resulted in a marginal increase in flood extents. It is proposed that some minor regrading works to provide additional floodplain storage would help alleviate some of these impacts and this will be investigated in subsequent design stages.

A flood impact table is provided as Table 3 and the distribution of floodwaters flow through the creek and the banks upon overtopping is as per Table 4 for the proposed design scenario.

Table 3: Peak flood level changes for 100% concept design

Location (refer Figure 6)	Local Catchment Flooding			Mainstream Flooding		
	Existing Conditions Peak Flood Levels (mAHD)	Proposed Design Peak Flood Levels (mAHD)	Impact (m)	Existing Conditions Peak Flood Levels (mAHD)	Proposed Design Peak Flood Levels (mAHD)	Impact (m)
1	23.55	23.55	0.00	25.59	25.61	0.03
2	-	-	-	25.59	25.61	0.02
3	24.41	24.06	-0.34	25.60	25.63	0.04
4	25.38	-	-	25.61	25.63	0.02
5	25.64	25.69	0.05	25.65	25.68	0.03
6	24.63	24.63	0.00	25.64	25.67	0.03
7	26.48	26.46	-0.02	26.41	26.40	-0.01
8	24.41	23.95	-0.45	25.60	25.63	0.04

Table 4: Distribution of peak flows (m^3/s) through the railway bridges for 100% concept design scenario

Flood Event	Bruce Neale Dr Underpass (western bank)	Peach Tree Creek	Castlereagh Rd Underpass (eastern bank)
5 year ARI local catchment flood	-	71.0	-
20 year ARI local catchment flood	-	74.5	-
100 year ARI local catchment flood	-	103.5	-
100 year ARI mainstream river flood	8.8	158.2	12.6

Changes to the peak flows are found to be negligible in the local flooding scenario while minor variation of up to about 7% can be expected for the 100 year ARI mainstream flood with slightly increased flows going through the Bruce Neale Drive underpass and reduced flows through Peach Tree Creek at the railway bridge and Castlereagh Road underpass. Therefore it can be concluded that the proposed works do not affect flow distribution in the local catchment scenario whilst widening the railway underpass on Castlereagh Road will not significantly alter flow distribution on the floodplain.

5.3 Castlereagh Street Inundation

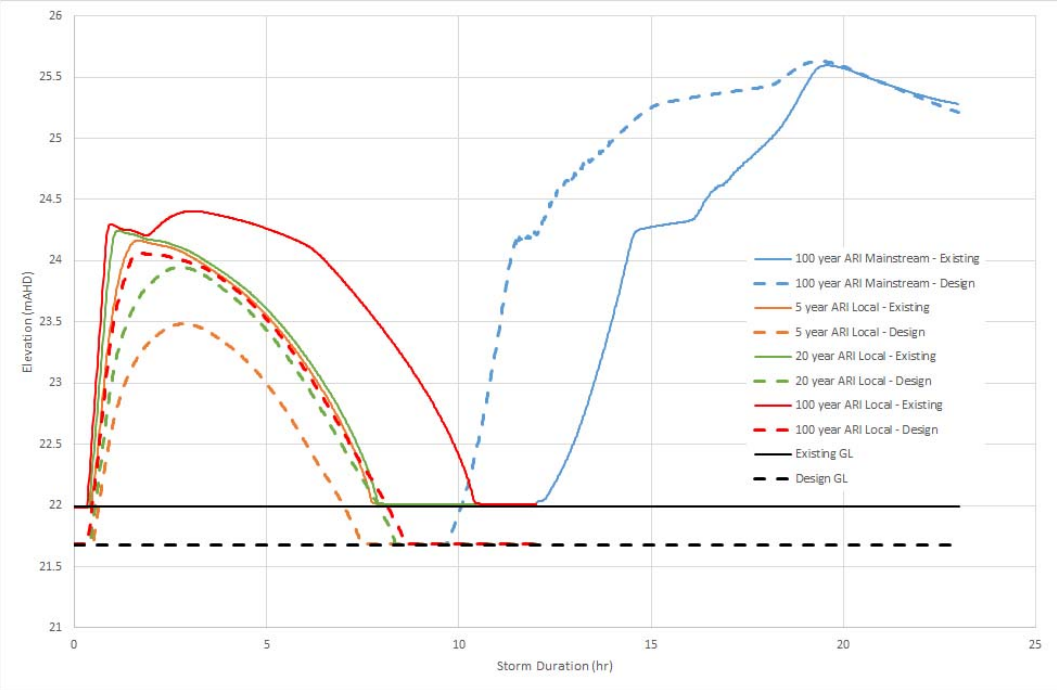
Major flooding was found to occur on the Castlereagh Street sag and despite the changes to the road levels and inclusion of new drainage as part of the 100% concept design, the inundation duration at this sag point remains largely unchanged, with improvement for the 5 year and 100 year ARI local catchment flood and slight worsening for the 20 year ARI local catchment flood (refer Table 5). For the mainstream flood event, the inundation duration exceeds a day, which is an issue in providing flood free egress through this arterial road. For the mainstream flood event, the flood levels peak much later than the local catchment flood. Due to the widening of the Castlereagh Street rail underpass, floodwaters can be seen to fill up the sag about 2.5 hours earlier (refer Diagram 1) compared to existing conditions.

Table 5: Duration of inundation (hours) on Castlereagh Street rail underpass

Flood Event	Existing	100% concept design
5 year ARI local catchment flood*	7.5	7.0
20 year ARI local catchment flood*	7.7	7.9
100 year ARI local catchment flood*	10.3	8.2
100 year ARI mainstream river flood	>24	>24

* Based on 3-hour storm which produced the largest flood volume modelled at the Castlereagh Street sag

Diagram 1: Flood level hydrographs on Castlereagh Street rail underpass



5.4 Drainage Design

The flood modelling results present several implications to the drainage design for the proposed infrastructure upgrade:

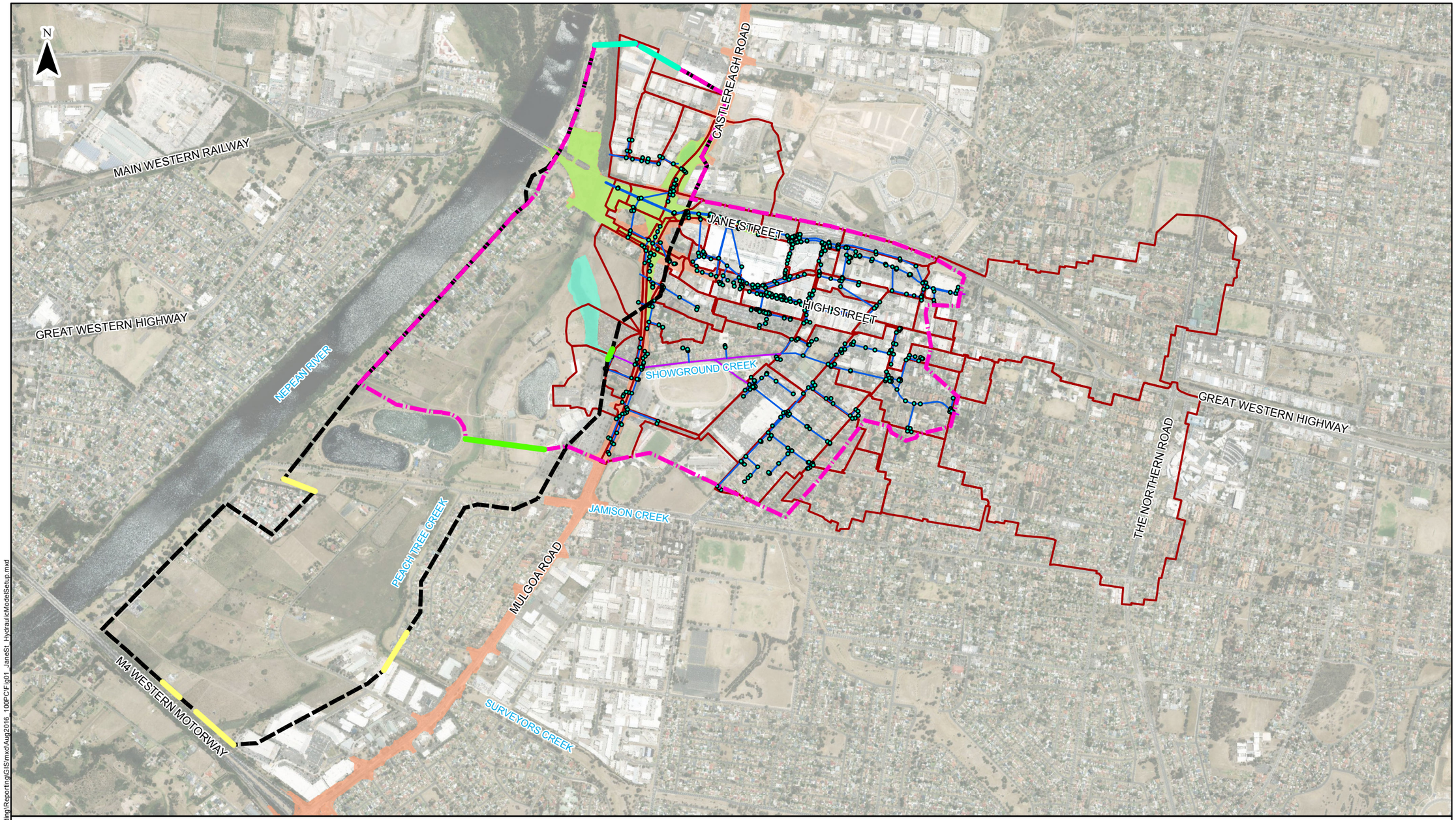
- The 100 year ARI peak flood level at the Peach Tree Creek railway bridge is 23.55 mAHD for the local catchment flood and 25.61 mAHD for the mainstream flood scenario. Backwater is expected to occur for the three 2.1 m diameter trunk drains that are aligned in the east-west direction to the south of the rail line and the 375mm pipe aligned in the east-west direction to the north of the rail line. These drainage pipes all discharge to Peach Tree Creek. The proposed minimum finished level for the Castlereagh Road sag point in the 100% concept design is 21.4 mAHD compared to existing road levels of 22 mAHD. It is not possible to raise the road due to the minimum clearance requirements underneath the railway line. Hence it would be necessary to install one-way valves to prevent backwater flows from the creek into the system which may potentially worsen flood conditions for Castlereagh Road.
- As the proposed infrastructure upgrade involves several major arterial roads which would function as critical evacuation routes during emergency, it would be necessary to provide a certain level of flood immunity to ensure flood free egress could be provided during a flood event.

6 References

1. Lyall and Associates, 2014a, *Jane Street Extension Flooding Investigation*, Volume 1 – Report, Final Report.
2. Lyall and Associates, 2014b, *Nepean River Green Bridge Hydraulic Investigation.*
3. NSW Public Works Department (PWD), 1994, *Peach Tree Creek Flood Study*.

Appendix A

Flood mapping



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Legend

- Penrith CBD and Peach Tree Creek TUFLOW Models - Downstream Boundary
- Penrith CBD TUFLOW Model - Inflow Boundary
- Peach Tree Creek TUFLOW Model - Inflow Boundary
- Penrith CBD TUFLOW Model Extent
- Peach Tree Creek TUFLOW Model Extent
- Pits
- Pipes
- Channels
- DRAINS Sub-Catchments
- Jane Street Survey Extent
- Showground Creek Survey Extent
- Arterial Road Corridor Survey Extent

Issue	Date	By	Chkd	Appd
B	7/09/2016	MWB	NC	LH
A	15/12/2015	MWB	NC	KN

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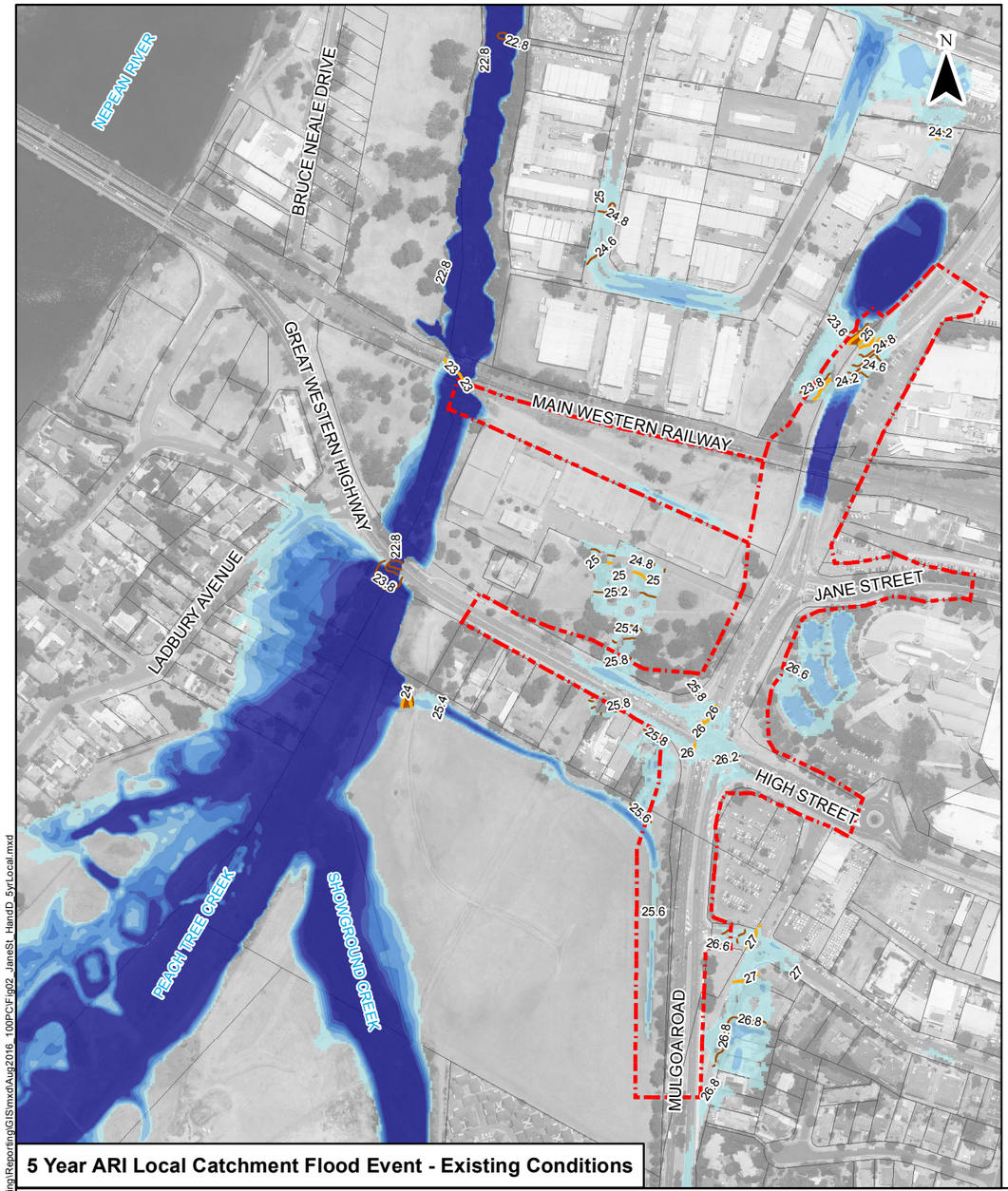
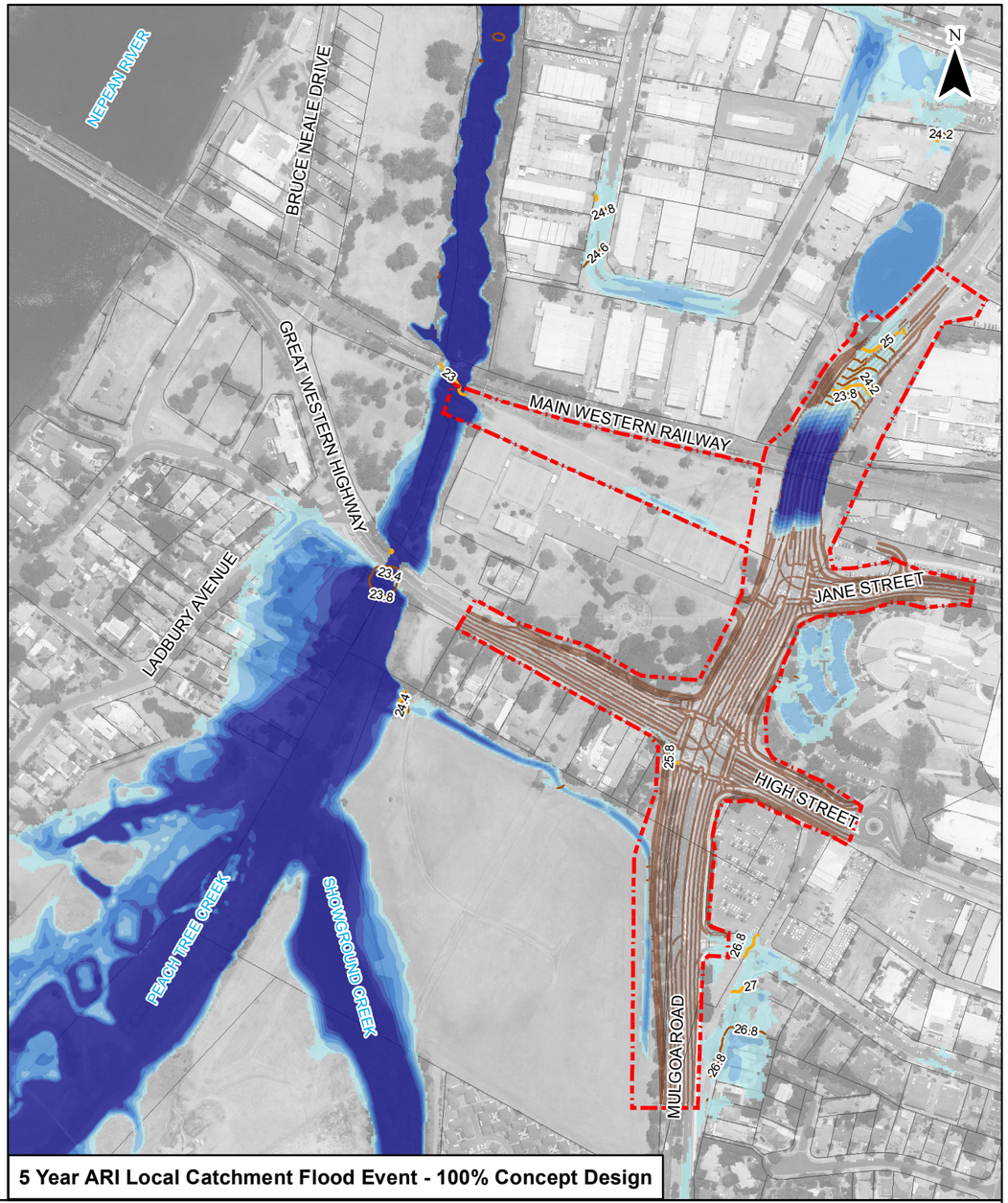
Metres
0 250 500 1,000

Figure 1 - Hydraulic Model Setup

Scale at A3 **1:17,500**	Note: Indicative only. Subject to detailed design.
Job No **244597**	Figure Status **Final**
Figure No **001**	Issue **B**



5 Year ARI Local Catchment Flood Event - Existing Conditions



5 Year ARI Local Catchment Flood Event - 100% Concept Design

Legend

- Project_boundary
- Water Level - Major Contours 1m Interval (m AHD)
- Water Level - Minor Contours 0.2m Interval (m AHD)

5 Year ARI Peak Flood Depth (m)

- 0.0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- > 1.0

Issue	Date	By	Chkd	Appd
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Figure 2 - Peak Flood Levels and Depths
5 Year ARI Local Catchment Flood Event
Existing Conditions and 100% Concept Design

Scale at A3 **1:5,000**	Note: Indicative only. Subject to detailed design.
Job No **244597**	Figure Status **Final**
Figure No **002**	Issue **B**

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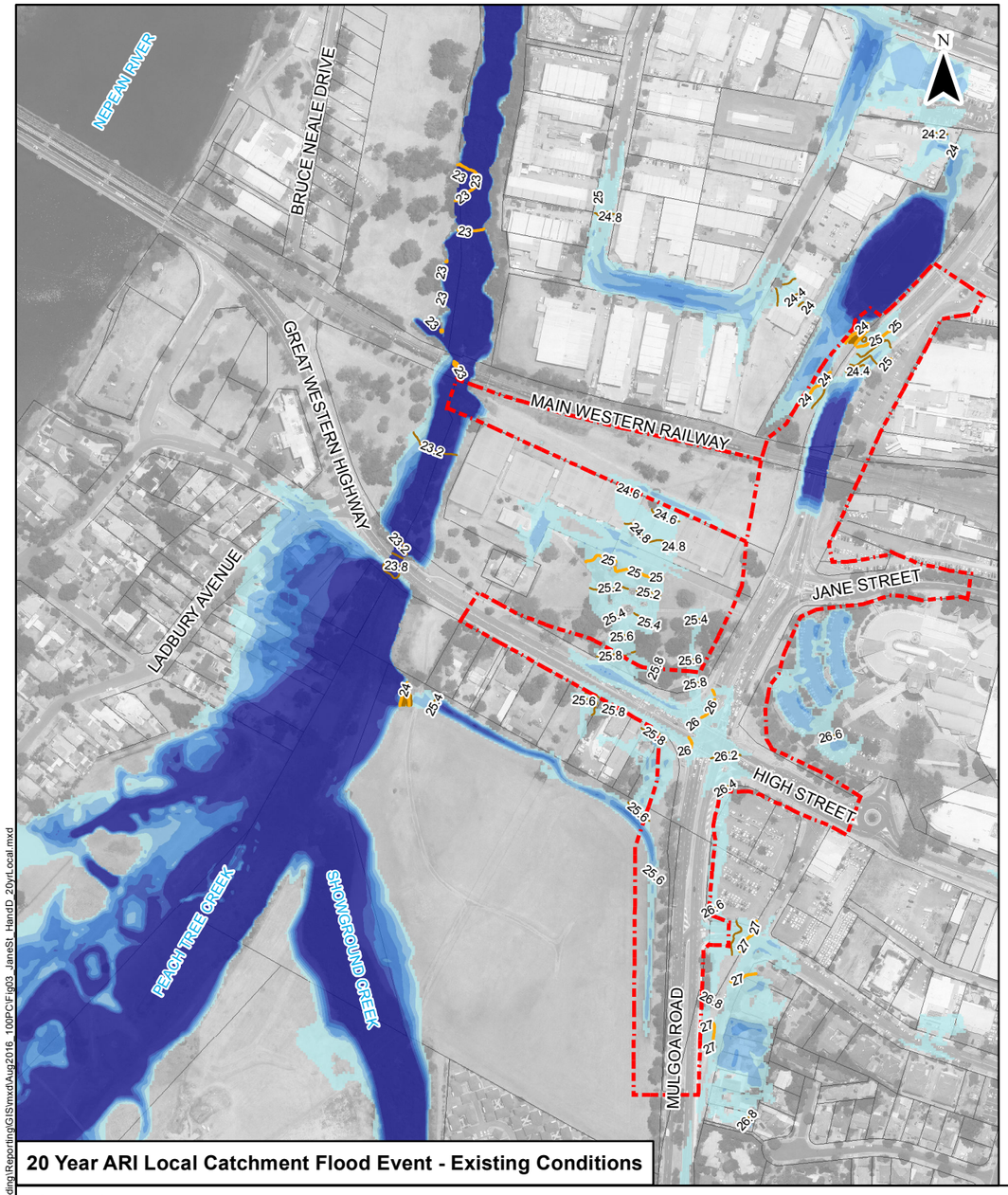
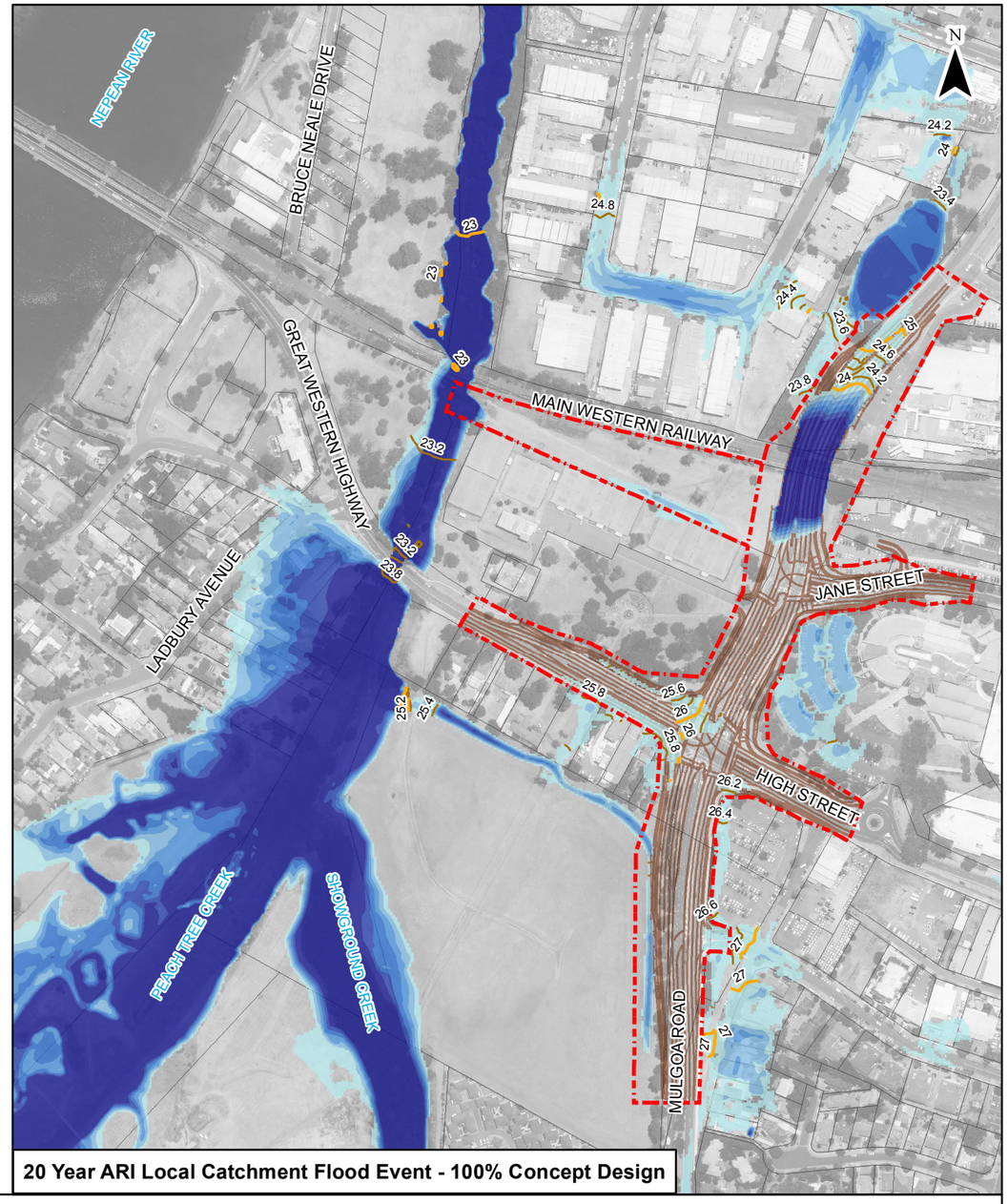


20 Year ARI Local Catchment Flood Event - Existing Conditions



20 Year ARI Local Catchment Flood Event - 100% Concept Design

Legend

- Project_boundary
- Water Level - Major Contours 1m Interval (m AHD)
- Water Level - Minor Contours 0.2m Interval (m AHD)

20 Year ARI Peak Flood Depth (m)

- 0.0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- > 1.0

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Figure 3 - Peak Flood Levels and Depths
20 Year ARI Local Catchment Flood Event
Existing Conditions and 100% Concept Design

Scale at A3 **1:5,000**	Note: Indicative only. Subject to detailed design.
Job No **244597**	Figure Status **Final**
Figure No **003**	Issue **B**

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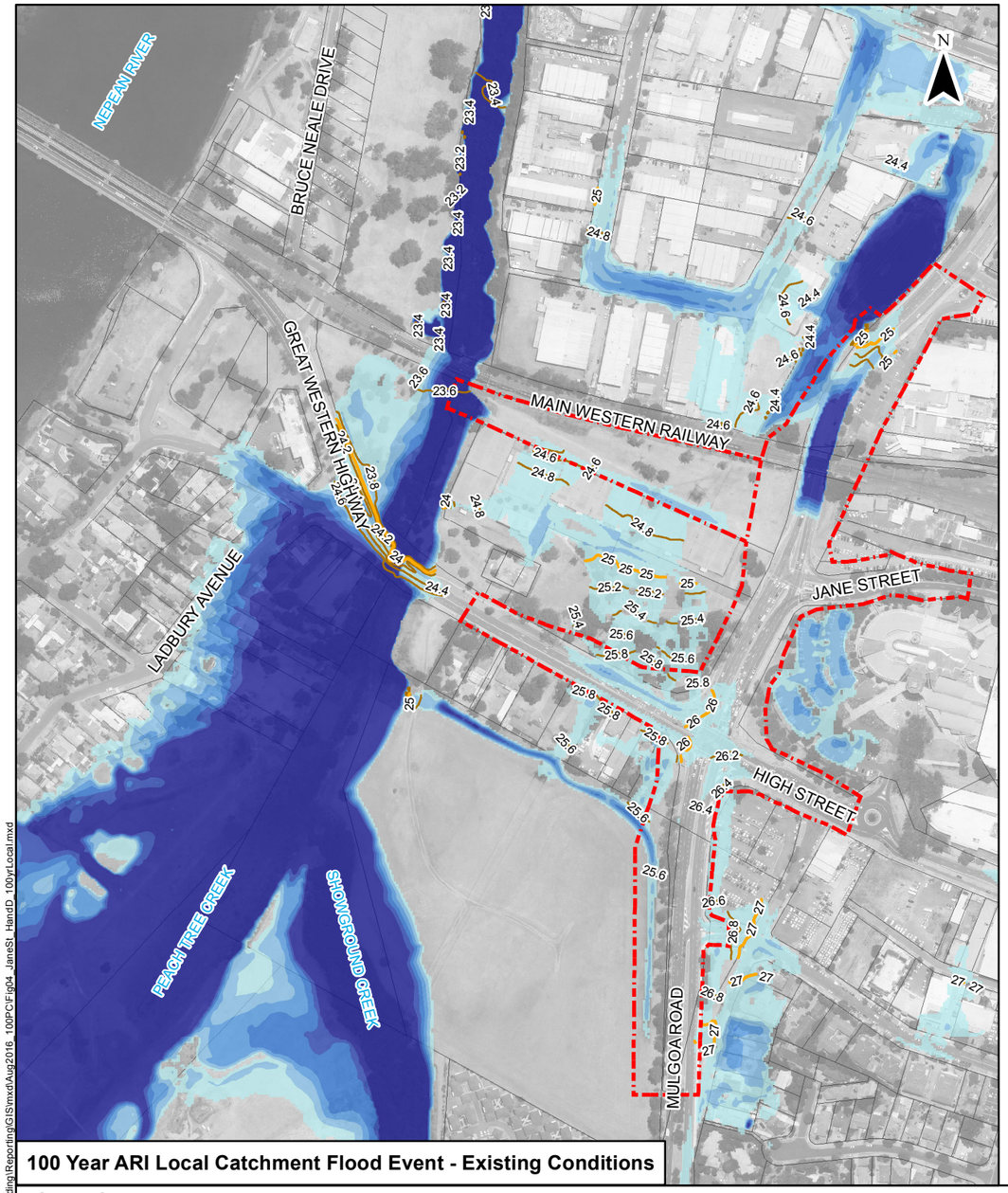
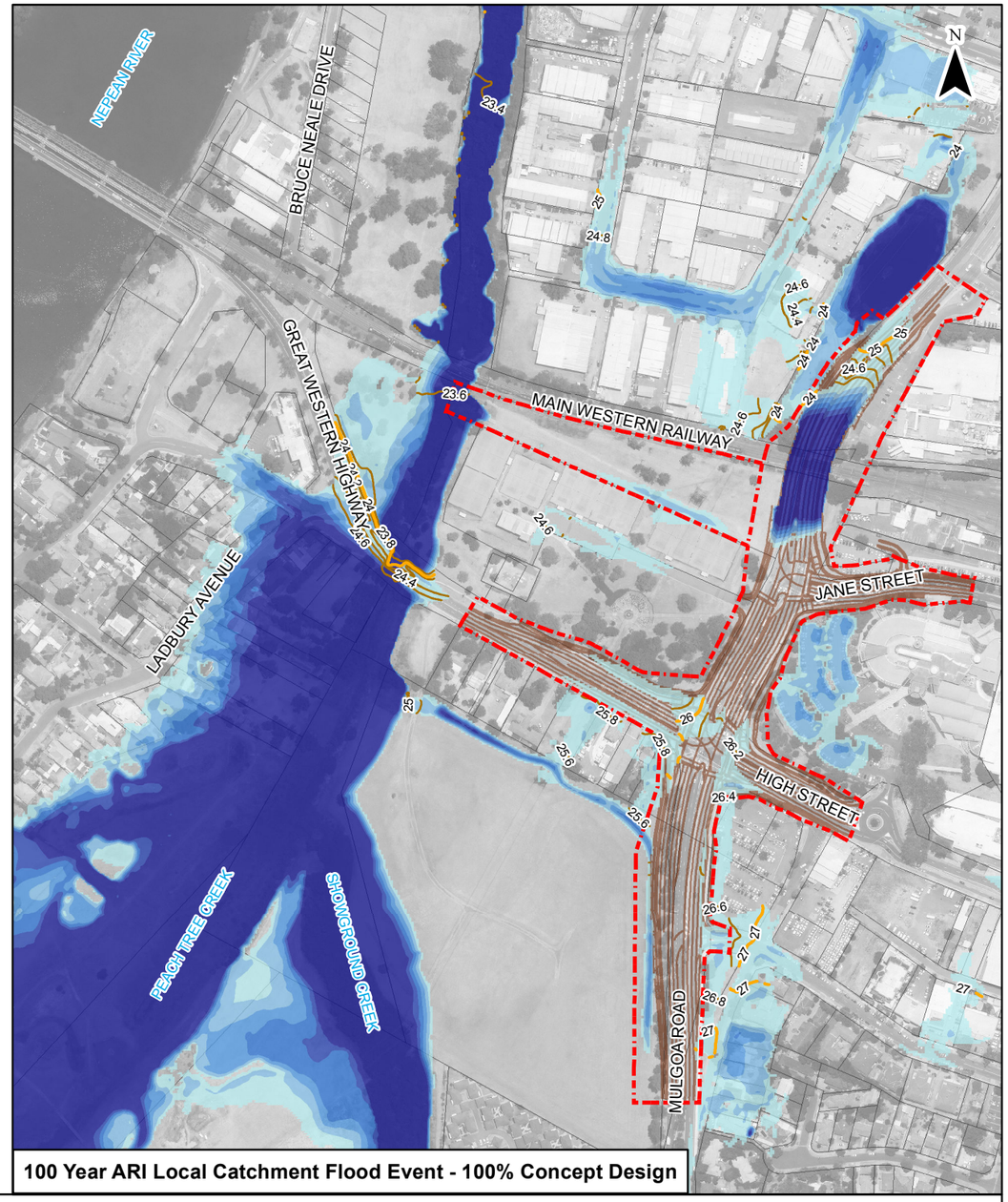


100 Year ARI Local Catchment Flood Event - Existing Conditions



100 Year ARI Local Catchment Flood Event - 100% Concept Design

Legend

- Project_boundary
- Water Level - Major Contours 1m Interval (m AHD)
- Water Level - Minor Contours 0.2m Interval (m AHD)

100 Year ARI Peak Flood Depth (m)

- 0.0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- > 1.0

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Figure 4 - Peak Flood Levels and Depths
100 Year ARI Local Catchment Flood Event
Existing Conditions and 100% Concept Design

Scale at A3 **1:5,000**	Note: Indicative only. Subject to detailed design.
Job No **244597**	Figure Status **Final**
Figure No **004**	Issue **B**

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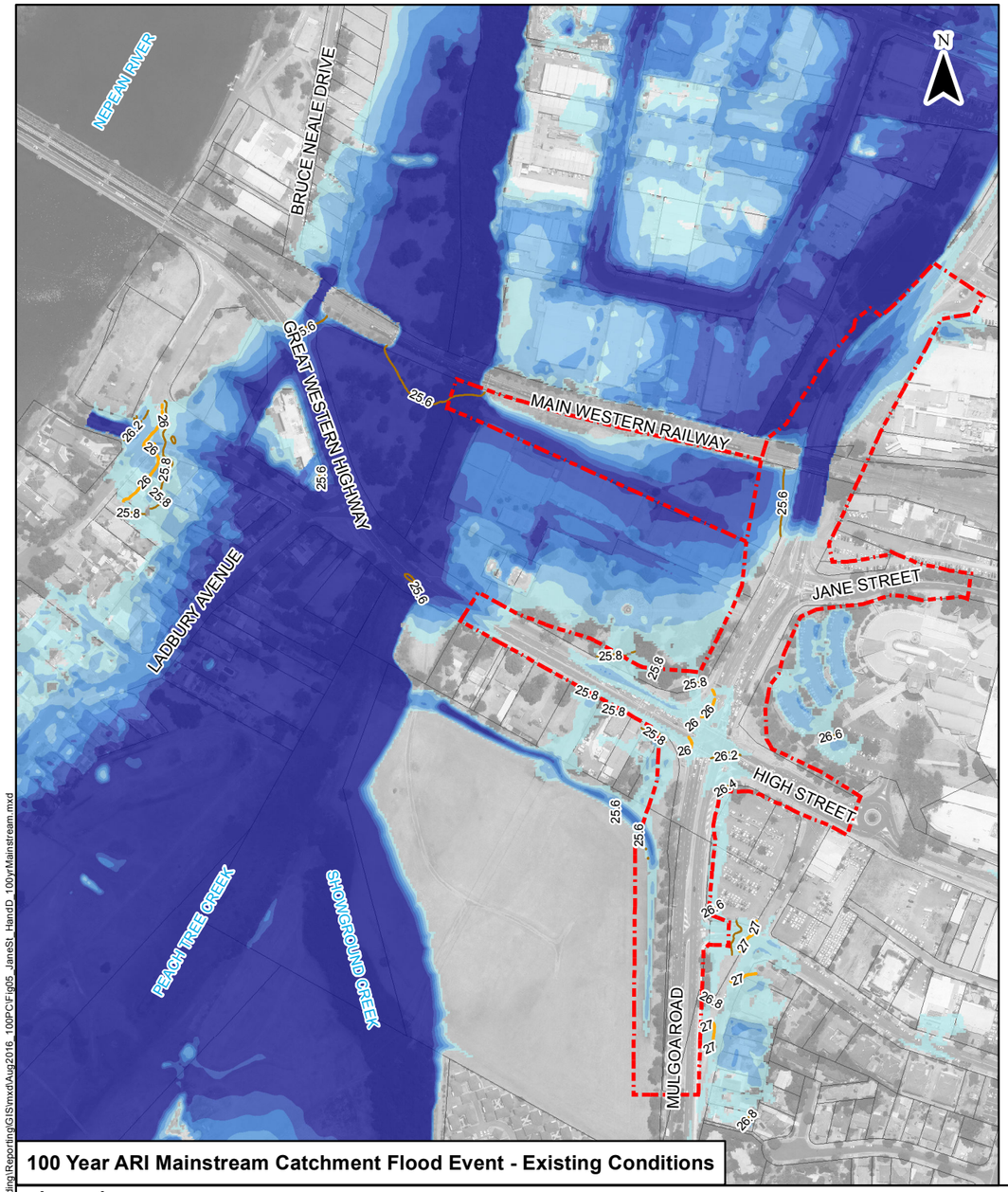
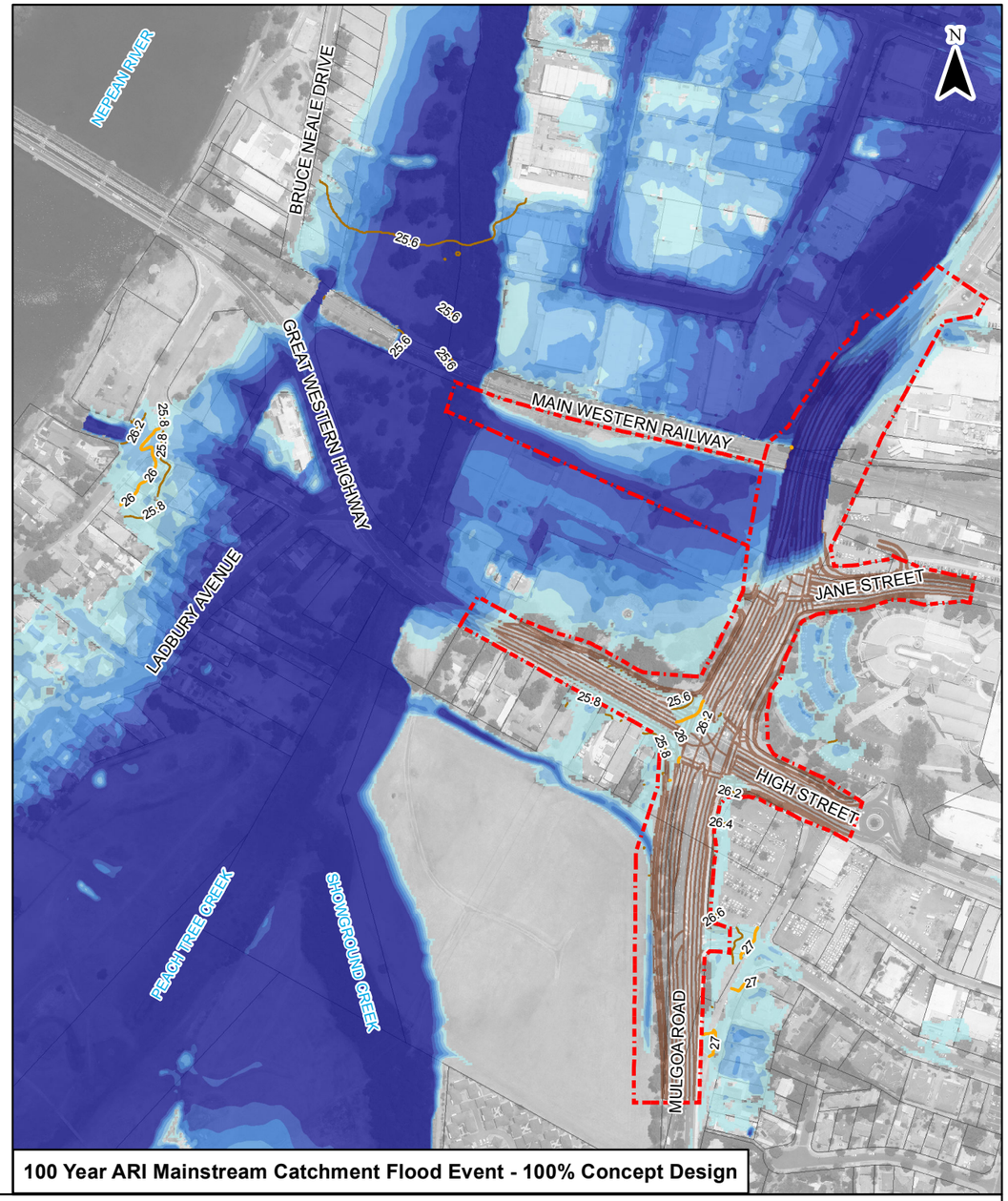


100 Year ARI Mainstream Catchment Flood Event - Existing Conditions



100 Year ARI Mainstream Catchment Flood Event - 100% Concept Design

Legend

- Project_boundary
- Water Level - Major Contours 1m Interval (m AHD)
- Water Level - Minor Contours 0.2m Interval (m AHD)

100 Year ARI Peak Flood Depth (m)

- 0.0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- > 1.0

Issue	Date	By	Chkd	Appd
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Figure 5 - Peak Flood Levels and Depths
100 Year ARI Mainstream Catchment Flood Event
Existing Conditions and 100% Concept Design

Scale at A3 **1:5,000**	Note: Indicative only. Subject to detailed design.
Job No **244597**	Figure Status **Final**
Figure No **005**	Issue **B**

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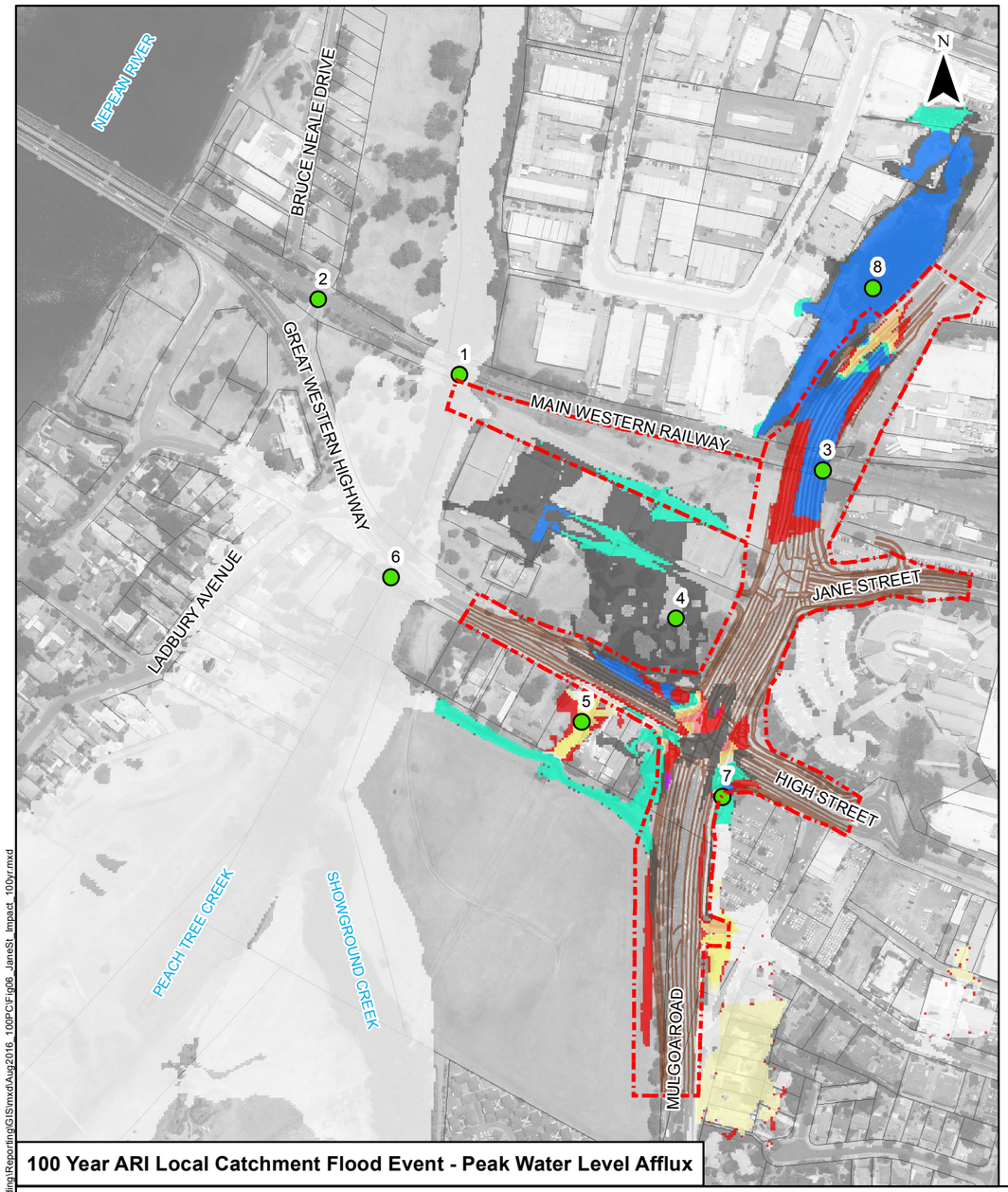
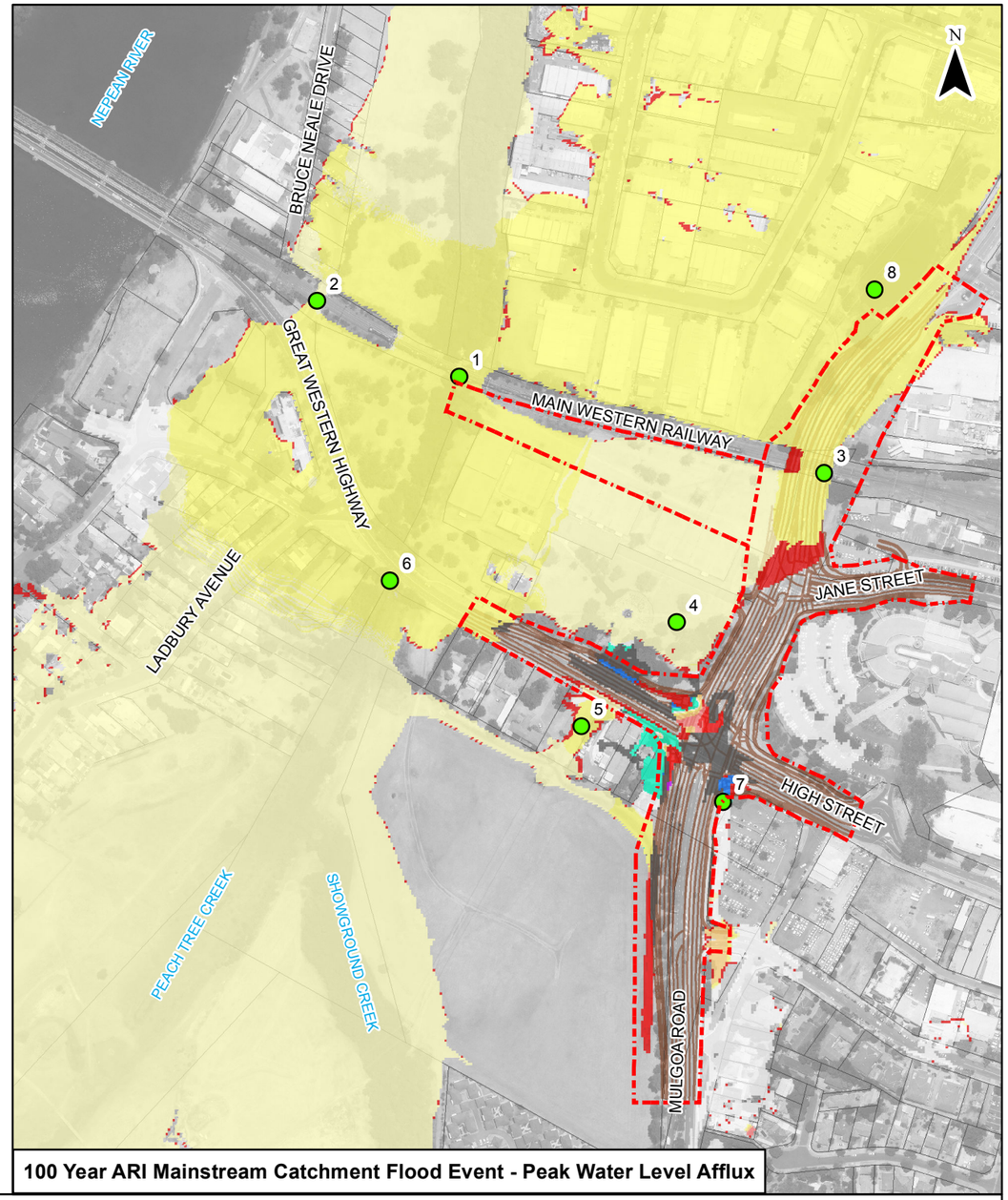


100 Year ARI Local Catchment Flood Event - Peak Water Level Afflux



100 Year ARI Mainstream Catchment Flood Event - Peak Water Level Afflux

Legend

Peak Water Level Afflux (m)

- < -0.100
- -0.100 - -0.010
- -0.010 - +0.010
- +0.010 - +0.025
- +0.025 - +0.050
- +0.050 - +0.100
- +0.100 - +0.200
- +0.200 - +0.300
- > +0.300
- Was Wet Now Dry
- Was Dry Now Wet

- Project_boundary
- Reporting Locations

Issue	Date	By	Chkd	Appd
B	7/09/2016	MWB	NC	LH
A	15/12/2015	MWB	NC	KN

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0 75 150 300

Figure 6 - Peak Flood Level Impact Map 100 Year ARI Local and Mainstream Catchment Flood Events - 100% Concept Design

Scale at A3 **1:5,000**	Note: Indicative only. Subject to detailed design.
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Figure No **006**	Issue **B**

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www.rms.nsw.gov.au/JaneStreetMulgoaRoad

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Jane Street and Mulgoa Road Upgrade
Roads and Maritime Services
PO Box 973
Parramatta CBD NSW 2124

October 2016
RMS 16.529