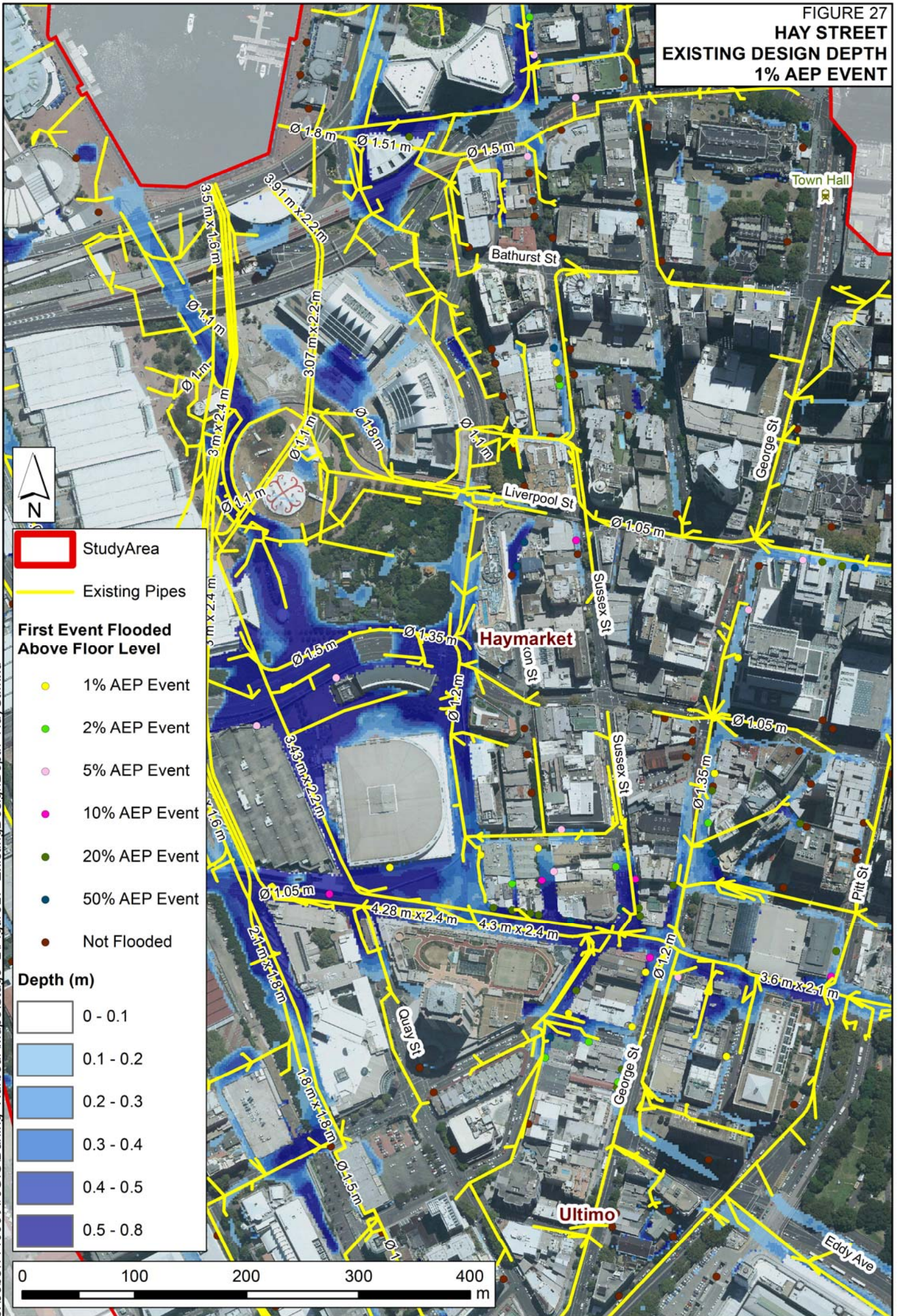


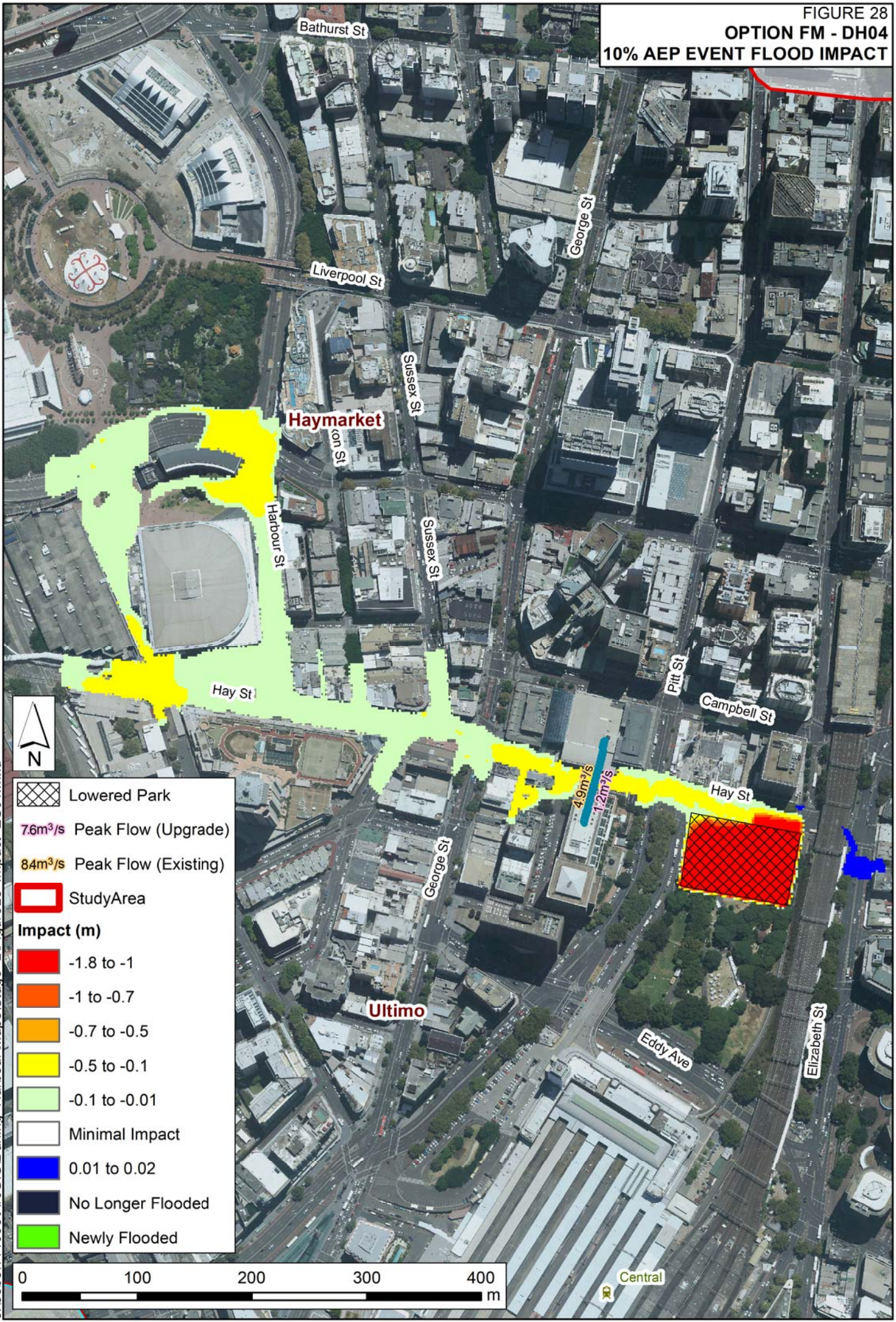
FIGURE 27  
**HAY STREET**  
**EXISTING DESIGN DEPTH**  
**1% AEP EVENT**



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FIGURE 28  
 OPTION FM - DH04  
 10% AEP EVENT FLOOD IMPACT



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











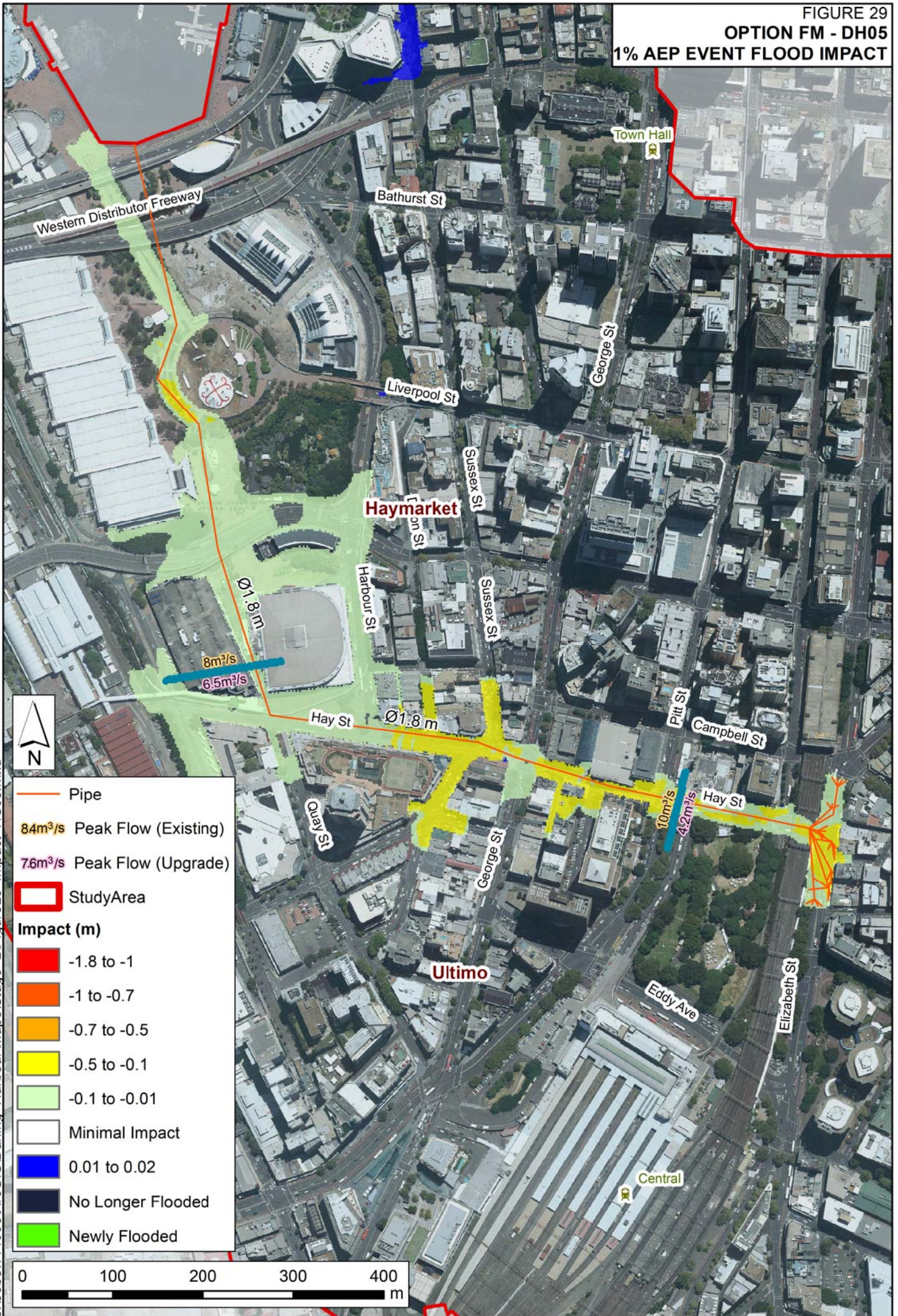
-  Lowered Park
-  76m<sup>3</sup>/s Peak Flow (Upgrade)
-  84m<sup>3</sup>/s Peak Flow (Existing)
-  StudyArea
- Impact (m)**
-  -1.8 to -1
-  -1 to -0.7
-  -0.7 to -0.5
-  -0.5 to -0.1
-  -0.1 to -0.01
-  Minimal Impact
-  0.01 to 0.02
-  No Longer Flooded
-  Newly Flooded





FIGURE 29  
**OPTION FM - DH05**  
**1% AEP EVENT FLOOD IMPACT**



- Pipe
- 84m<sup>3</sup>/s Peak Flow (Existing)
- 76m<sup>3</sup>/s Peak Flow (Upgrade)
- StudyArea
- Impact (m)**
- 1.8 to -1
- 1 to -0.7
- 0.7 to -0.5
- 0.5 to -0.1
- 0.1 to -0.01
- Minimal Impact
- 0.01 to 0.02
- No Longer Flooded
- Newly Flooded



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FIGURE 30  
 OPTION FM - DH05  
 1% AEP EVENT CHANGE IN HAZARD

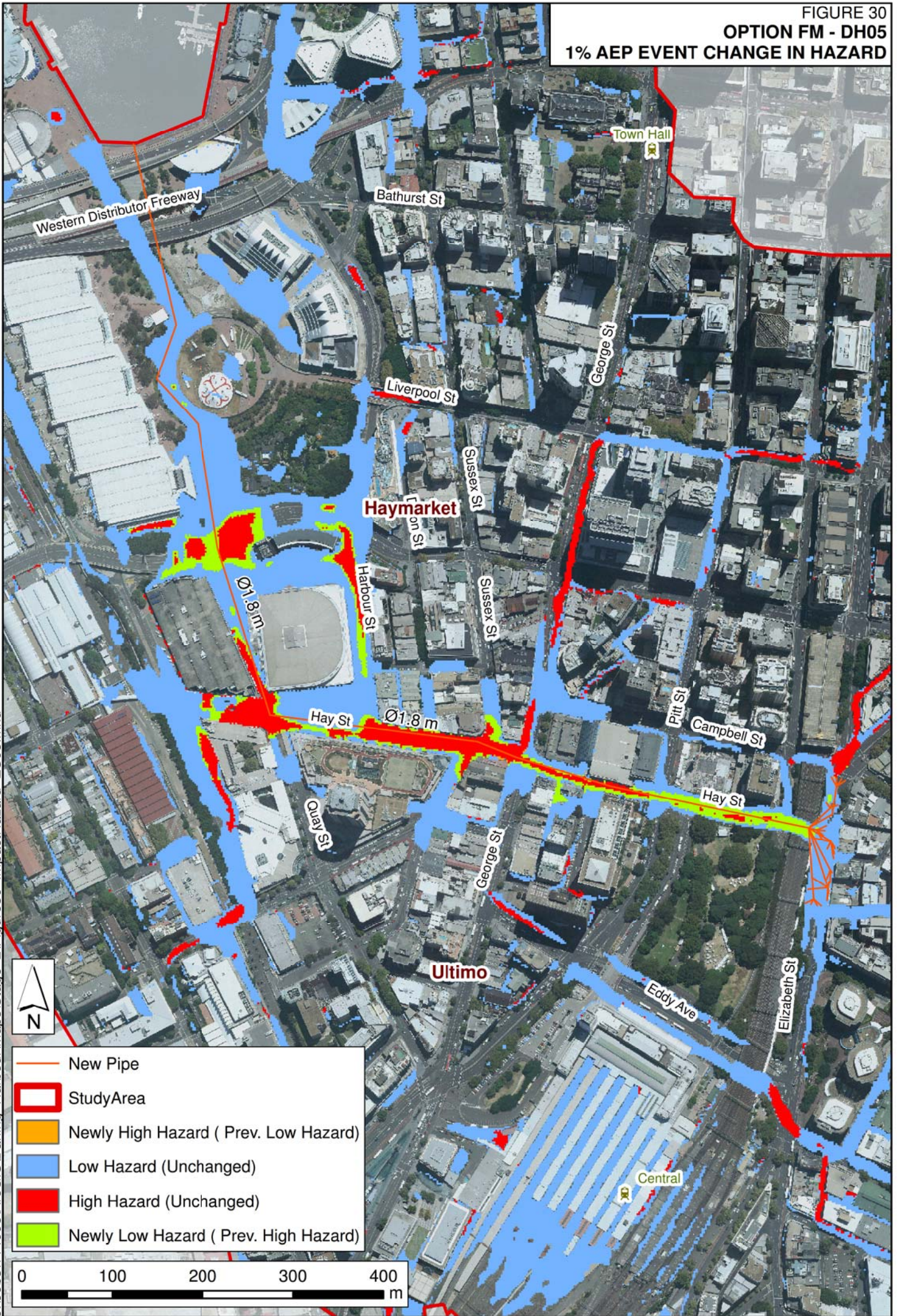




FIGURE 31  
**PYRMONT STREET**  
**EXISTING DESIGN DEPTH**  
**1% AEP EVENT**

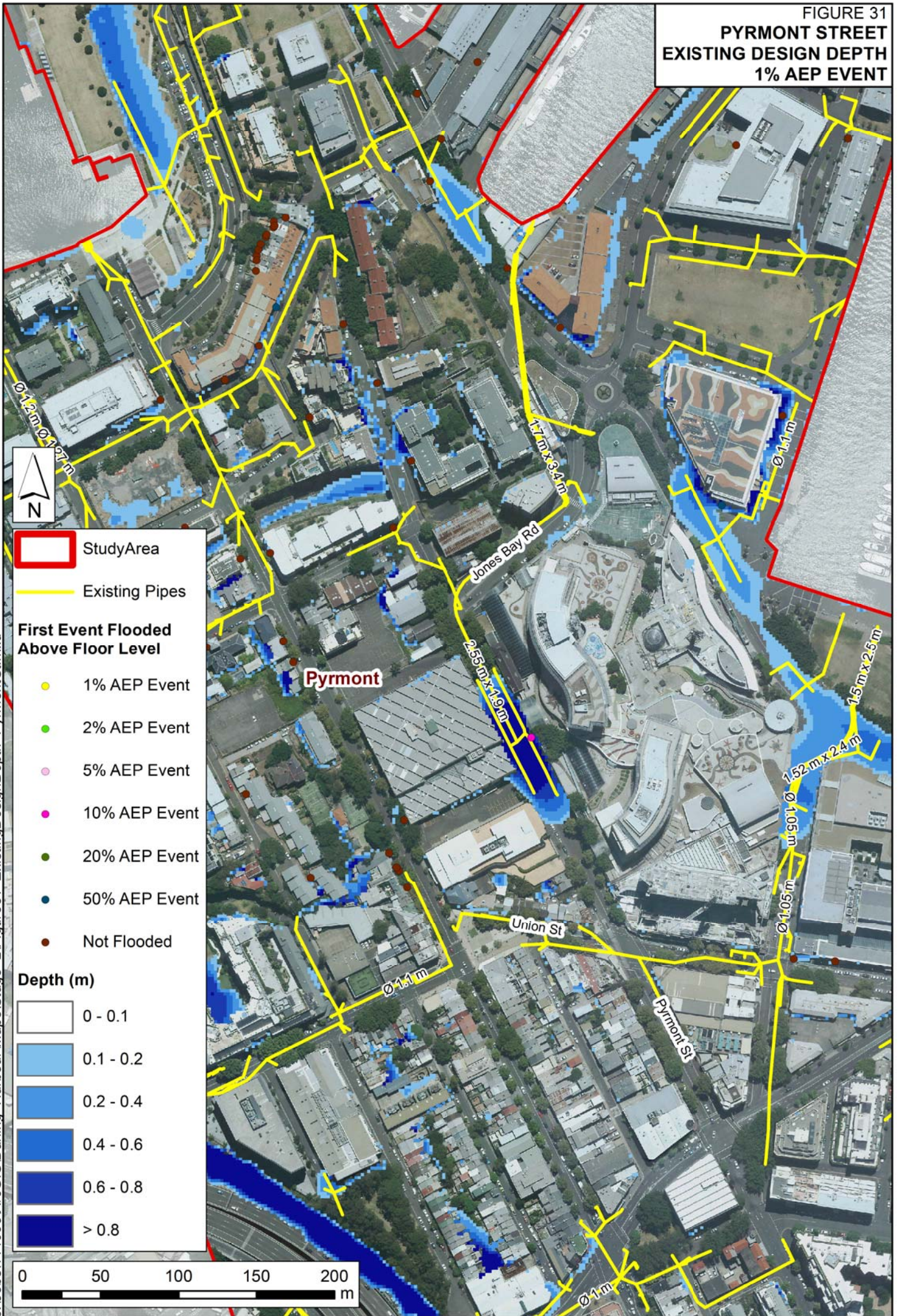
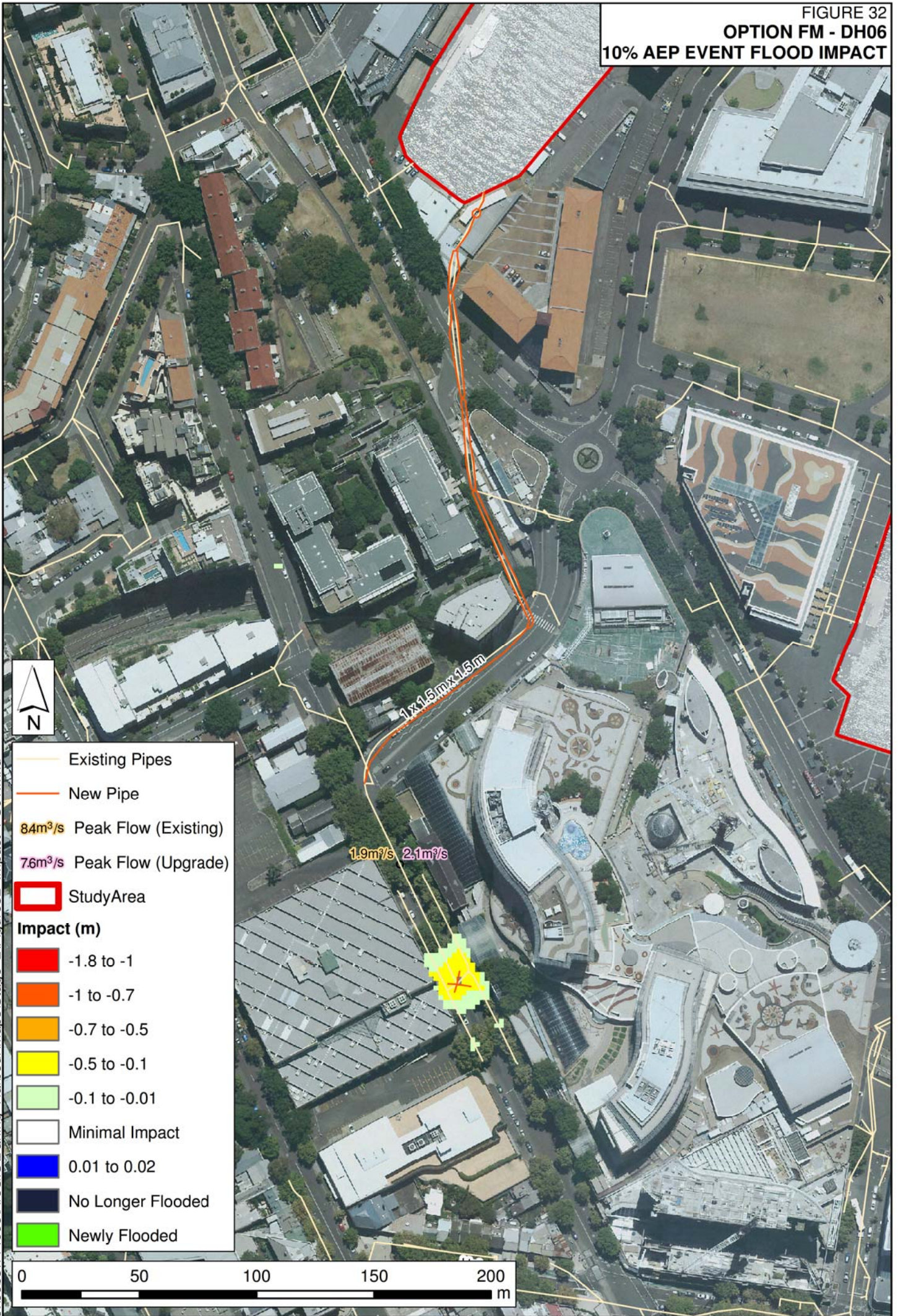




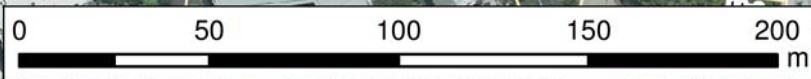
FIGURE 32  
**OPTION FM - DH06**  
**10% AEP EVENT FLOOD IMPACT**



|                   |  |
|-------------------|--|
|                   | Existing Pipes                           |
|                   | New Pipe                                 |
|                   | 84m <sup>3</sup> /s Peak Flow (Existing) |
|                   | 76m <sup>3</sup> /s Peak Flow (Upgrade)  |
|                   | Study Area                               |
| <b>Impact (m)</b> |  |
|                   | -1.8 to -1                               |
|                   | -1 to -0.7                               |
|                   | -0.7 to -0.5                             |
|                   | -0.5 to -0.1                             |
|                   | -0.1 to -0.01                            |
|                   | Minimal Impact                           |
|                   | 0.01 to 0.02                             |
|                   | No Longer Flooded                        |
|                   | Newly Flooded                            |

1 x 1.5m x 1.5m

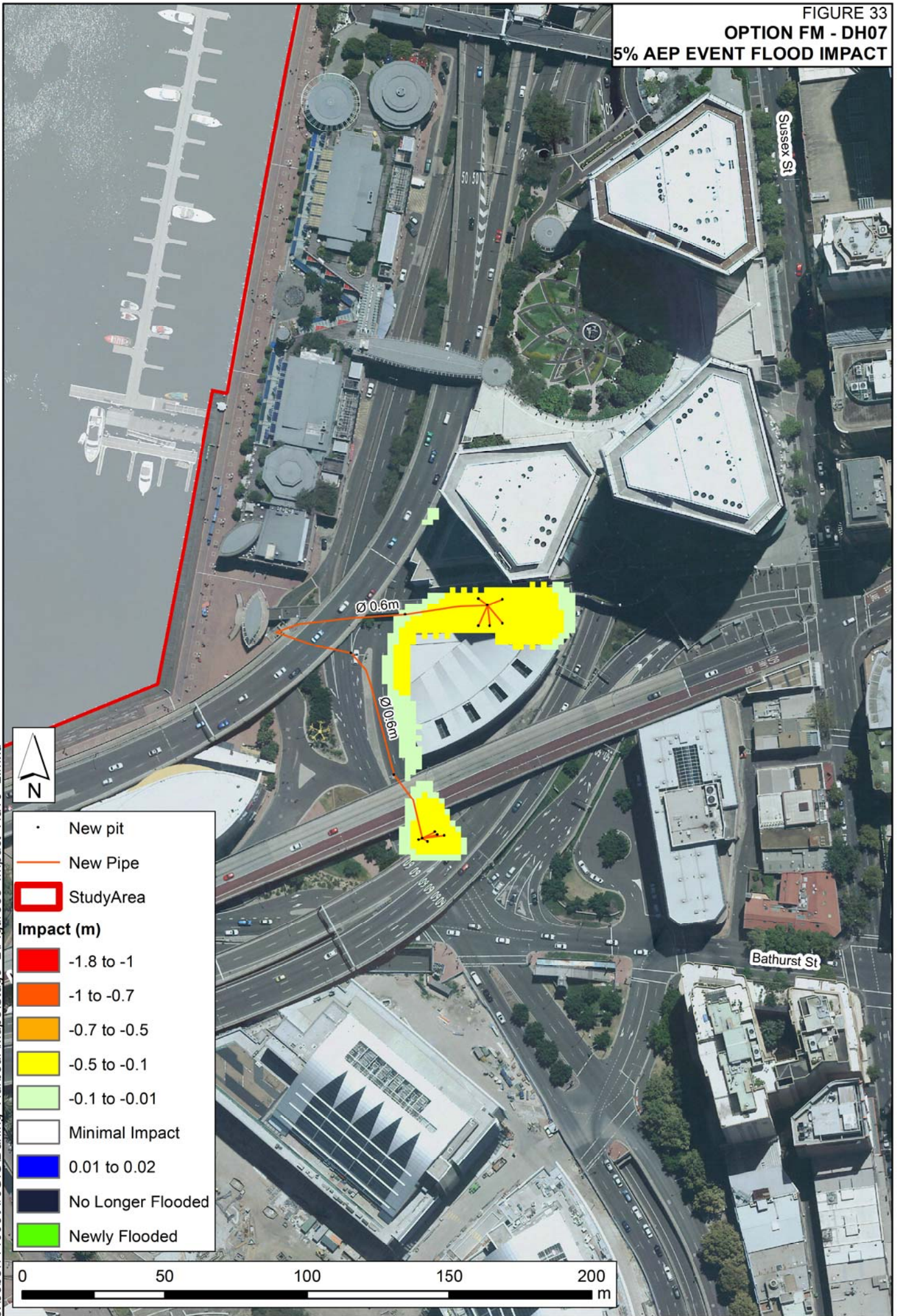
1.9m<sup>3</sup>/s 2.1m<sup>3</sup>/s



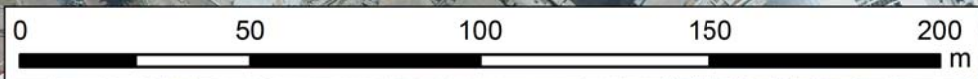
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FIGURE 33  
 OPTION FM - DH07  
 5% AEP EVENT FLOOD IMPACT



- New pit
  - New Pipe
  - ▭ StudyArea
- Impact (m)**
- -1.8 to -1
  - -1 to -0.7
  - -0.7 to -0.5
  - -0.5 to -0.1
  - -0.1 to -0.01
  - Minimal Impact
  - 0.01 to 0.02
  - No Longer Flooded
  - Newly Flooded



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## APPENDIX A: GLOSSARY

Taken from the Floodplain Development Manual (April 2005 edition)

|                                     |  |
|-------------------------------------|--|
| acid sulfate soils                  | Are sediments which contain sulfidic mineral pyrite which may become extremely acid following disturbance or drainage as sulfur compounds react when exposed to oxygen to form sulfuric acid. More detailed explanation and definition can be found in the NSW Government Acid Sulfate Soil Manual published by Acid Sulfate Soil Management Advisory Committee.                       |
| Annual Exceedance Probability (AEP) | The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m <sup>3</sup> /s has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a 500 m <sup>3</sup> /s or larger event occurring in any one year (see ARI).  |
| Australian Height Datum (AHD)       | A common national surface level datum approximately corresponding to mean sea level.   |
| Average Annual Damage (AAD)         | Depending on its size (or severity), each flood will cause a different amount of flood damage to a flood prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.   |
| 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 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event.                                       |
| caravan and moveable home parks     | Caravans and moveable dwellings are being increasingly used for long-term and permanent accommodation purposes. Standards relating to their siting, design, construction and management can be found in the Regulations under the LG Act.  |
| catchment                           | The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.  |
| consent authority                   | The Council, government agency or person having the function to determine a development application for land use under the EP&A Act. The consent authority is most often the Council, however legislation or an EPI may specify a Minister or public authority (other than a Council), or the Director General of DIPNR, as having the function to determine an application.           |
| design flood                        | A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year ARI or 1% AEP flood). It is a probabilistic or statistical estimate, generally being based on some form of probability analysis of flood or rainfall data.   |
| design rainfall                     | Used in the estimation of a flood or the design of a particular component or feature of a hydraulic structure. Design rainfall estimates are based on the intensity, frequency and duration of the storm bursts. The use of a design rainfall in the estimation of a flood does not imply that if such rainfall occurred at a given time, the estimated flood elevations would result. |
| development                         | Is defined in Part 4 of the Environmental Planning and Assessment Act (EP&A Act).  |
|                                     | <b>infill development:</b> refers to the development of vacant blocks of land that are   |



---

generally surrounded by developed properties and is permissible under the current zoning of the land. Conditions such as minimum floor levels may be imposed on infill development.

**new development:** refers to development of a completely different nature to that associated with the former land use. For example, the urban subdivision of an area previously used for rural purposes. New developments involve rezoning and typically require major extensions of existing urban services, such as roads, water supply, sewerage and electric power.

**redevelopment:** refers to rebuilding in an area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.

disaster plan (DISPLAN)

A step by step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations, with the object of ensuring the coordinated response by all agencies having responsibilities and functions in emergencies.

discharge

The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m<sup>3</sup>/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).

ecologically sustainable development (ESD)

Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993. The use of sustainability and sustainable in this manual relate to ESD.

effective warning time

The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

emergency management

A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.

flash flooding

Flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.

flood

Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or 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 excluding tsunami.

flood awareness

Flood awareness is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.

flood education

Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.

flood fringe areas

The remaining area of flood prone land after floodway and flood storage areas have been defined.



|                                    |  |
|------------------------------------|--|
| flood liable land                  | Is synonymous with flood prone land (i.e. land susceptible to flooding by the probable maximum flood (PMF) event). Note that the term flood liable land covers the whole of the floodplain, not just that part below the flood planning level (see flood planning area).   |
| flood mitigation standard          | The average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding.  |
| floodplain                         | Area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land.   |
| floodplain risk management options | The measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options.  |
| floodplain risk management plan    | A management plan developed in accordance with the principles and guidelines in this manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.  |
| flood plan (local)                 | A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service.   |
| flood planning area                | The area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Manual.  |
| Flood Planning Levels (FPLs)       | FPLs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans. FPLs supersede the "standard flood event" in the 1986 manual.   |
| flood proofing                     | A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.   |
| flood prone land                   | Is land susceptible to flooding by the Probable Maximum Flood (PMF) event. Flood prone land is synonymous with flood liable land.  |
| flood readiness                    | Flood readiness is an ability to react within the effective warning time.  |
| flood risk                         | <p>Potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in this manual is divided into 3 types, existing, future and continuing risks. They are described below.</p> <p><b>existing flood risk:</b> the risk a community is exposed to as a result of its location on the floodplain.</p> <p><b>future flood risk:</b> the risk a community may be exposed to as a result of new development on the floodplain.</p> <p><b>continuing flood risk:</b> the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.</p> |
| flood storage areas                | Those parts of the floodplain that are important for the temporary storage of  |



|                         |   |
|-------------------------|---|
|                         | floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.  |
| floodway areas          | Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flows, or a significant increase in flood levels.  |
| freeboard               | Freeboard provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the flood planning level.   |
| habitable room          | <b>in a residential situation:</b> a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.<br><b>in an industrial or commercial situation:</b> an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.  |
| hazard                  | A source of potential harm or a situation with a potential to cause loss. In relation to this manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in the Manual.   |
| hydraulics              | Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.  |
| hydrograph              | A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.  |
| hydrology               | Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.  |
| local overland flooding | Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.   |
| local drainage          | Are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.  |
| mainstream flooding     | Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.  |
| major drainage          | Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purpose of this manual major drainage involves: <ul style="list-style-type: none"> <li>§ the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or</li> <li>§ water depths generally in excess of 0.3 m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or</li> <li>§ major overland flow paths through developed areas outside of defined drainage reserves; and/or</li> <li>§ the potential to affect a number of buildings along the major flow path.</li> </ul> |
| mathematical/computer   | The mathematical representation of the physical processes involved in runoff  |



|                                      |  |
|--------------------------------------|--|
| models                               | generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.   |
| merit approach                       | <p>The merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains.</p> <p>The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into Council plans, policy and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.</p>                 |
| minor, moderate and major flooding   | <p>Both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:</p> <p><b>minor flooding:</b> causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.</p> <p><b>moderate flooding:</b> low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.</p> <p><b>major flooding:</b> appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.</p> |
| modification measures                | Measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 with further discussion in the Manual.  |
| peak discharge                       | The maximum discharge occurring during a flood event.  |
| Probable Maximum Flood (PMF)         | The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with a range of events rarer than the flood used for designing mitigation works and controlling development, up to and including the PMF event should be addressed in a floodplain risk management study.   |
| Probable Maximum Precipitation (PMP) | The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.   |
| probability                          | A statistical measure of the expected chance of flooding (see AEP).  |
| risk                                 | Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment.   |
| runoff                               | The amount of rainfall which actually ends up as streamflow, also known as   |



---

|                       |  |
|-----------------------|--|
|                       | rainfall excess.   |
| stage                 | Equivalent to water level. Both are measured with reference to a specified datum.  |
| stage hydrograph      | A graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum. |
| survey plan           | A plan prepared by a registered surveyor.  |
| water surface profile | A graph showing the flood stage at any given location along a watercourse at a particular time.  |
| wind fetch            | The horizontal distance in the direction of wind over which wind waves are generated.  |

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# Darling Harbour Catchment Floodplain Risk Management Study and Plan

April 2015



**The City of Sydney is preparing a Floodplain Risk Management Study and Plan for the Darling Harbour catchment area and we would like your help.**

**The study will tell us about the type of flood mitigation solutions feasible for the catchment and help us plan for and manage any flood risks.**

**Good management of flood risks can help reduce damage and improve social and economic opportunities.**





The City of Sydney has engaged WMAwater to assist with the preparation of the Darling Harbour Floodplain Risk Management Study and Plan.

The Darling Harbour Flood Study was completed in October 2014, giving the City of Sydney a better understanding of the nature of flooding in your area. A copy of the draft Flood Study is available at [cityofsydney.nsw.gov.au](http://cityofsydney.nsw.gov.au)

The next step in the NSW Government Flood Management Process is the preparation of a Floodplain Risk Management Study and Plan. The purpose of this study and plan is to identify and recommend appropriate actions to manage flood risks in the Darling Harbour area.

This brochure is an introduction to the Floodplain Risk Management Study and Plan and its objectives.

### Stages of the NSW Government Floodplain Management Process

1. Formation of a Committee – complete
2. Data Collection – complete
3. Flood Study – complete
4. **Floodplain Risk Management Study**
5. **Floodplain Risk Management Plan**
6. Implementation of Plan.

### Study area and flooding issues

The Darling Harbour study area includes the inner city suburbs of Haymarket, Surry Hills, and parts of Ultimo, Pyrmont and Sydney. This includes land under the control of the Sydney Harbour Foreshore Authority.

Much of the flooding in this catchment occurs due to natural depressions and low points. In the past, flooding has caused property damage and posed a hazard to people and property located near drainage areas. The Floodplain Risk Management Study and Plan currently being undertaken is to manage these flood risks.

### Have your say

We want your comments about previous flood experiences and potential mitigation options.

The local knowledge of residents and business operators, including your personal experiences of flooding, is a valuable source of information.

The information you provide in the accompanying questionnaire will help the City of Sydney determine how to manage the floods in your area.

For more information about this project, please contact the City of Sydney or WMAwater via the details provided.

### Floodplain risk management options

The following list of floodplain risk management options are examples of the type of strategies that could be considered to minimise risk and reduce the impact of flooding in the catchment. These options will be investigated in more detail during the preparation of the Management Study and Plan. The general categories of these options are:

#### Flood modification options.

Examples include:

- Construction of detention/retarding facilities to reduce the peak flow downstream;
- Upgrading of drainage systems, upgrade of existing pipes or construction of new pipes; and
- Regrading of roads to provide better overland flowpaths.

#### Property modification options and planning control.

Examples include:

- Building and development controls; and
- Flood-proofing measures, such as flood barriers.

#### Response modification options.

Examples include:

- Revision of the Local Disaster Plan;
- Public awareness and education – locality-based flooding information for residents;
- Public awareness and education – flooding information for schools;
- Flood depth markers at major (flood-affected) road crossings;
- Continuation of existing public awareness and education campaigns; and
- Data collection strategies for future floods.

For more information please contact:

WMAwater  
Steve Gray  
Phone 02 9299 2855  
Fax: 02 9262 6208  
[gray@wmawater.com.au](mailto:gray@wmawater.com.au)

City of Sydney  
Sean Howie  
Phone: 02 9246 7349  
[showie@cityofsydney.nsw.gov.au](mailto:showie@cityofsydney.nsw.gov.au)



# Local Resident/Land Owner Survey

The City of Sydney is carrying out a Floodplain Risk Management Study and Plan for the Darling Harbour catchment. Please return your completed questionnaire in the reply-paid envelope by 10 May 2015. Or complete the questionnaire online at [www.cityofsydney.nsw.gov.au/floodplain-management](http://www.cityofsydney.nsw.gov.au/floodplain-management).

## 1

Please provide the following details as we may contact you to discuss some of the information you have provided us. This is optional.

Name: .....

Address: .....

Contact phone number:.....

Email: .....

## 2

What is the best way to contact you?

Letter (post)

Email

Phone

## 3

How many people regularly live/work on this property?

.....  
.....  
.....

## 4

How many of the permanent residents/workers are in age group below:

0-4 years

5-14 years

15-64 years

65+ years

## 5

What is the main language spoken at this address?

English

Other (please specify) .....



6

Is your property (please tick)

- Residential, owner-occupied
- Residential, occupied by a tenant
- Business, owner-occupied
- Business, occupied by a tenant
- Other (please specify).....

7

What type of structure is your property/business? (please tick)

- Freestanding house
- Dual occupancy
- Attached/semi-attached terrace
- Industrial
- Apartment/flat
- Commercial
- Townhouse/unit
- Other (please specify).....

8

How long have you lived, worked at, and/or owned this property?

Years .....

Months .....

9

Have you ever experienced flooding since living and/or working in the Darling Harbour catchment? (please tick relevant boxes)

- Yes, floodwaters entered my house/business
- Yes, floodwaters entered my yard/surrounds of my business
- Yes, the road was flooded and I couldn't get to my car
- Yes, other parts of my neighbourhood were flooded
- No, I haven't experienced flooding

10

Do you have any materials or photos you can provide to evidence the flooding you experienced? If yes, when did this flood occur?

- No
- Yes – the flooding occurred on: .....
- .....



11

Are you aware of the draft Darling Harbour Flood Study?

Yes  No

If yes, was your property identified as being at risk of flooding or near a flood area?

Yes  No  Don't know

12

As a local resident, or business owner, who may have witnessed flooding/drainage problems, you may have your own ideas about how to reduce flood risks. Which of the following do you prefer (1=most preferred, 5=least preferred)?

| Proposed option  | Preference |
|--|------------|
| Retarding or detention facility (these temporarily hold water and reduce peak flood flows) —<br>Suggested location/other comments: | 1 2 3 4 5  |
| Improved flood flow paths —<br>Suggested location/other comments:  | 1 2 3 4 5  |
| Culvert/bridge enlarging —<br>Suggested location/other comments:   | 1 2 3 4 5  |
| Pit and pipe upgrades —<br>Suggested location/other comments:  | 1 2 3 4 5  |
| Flood walls —<br>Suggested location/other comments:  | 1 2 3 4 5  |
| Strategic planning and flood related development controls —<br>Suggested location/other comments:                                  | 1 2 3 4 5  |
| Education of the community, providing greater awareness of potential hazards —<br>Suggested location/other comments:               | 1 2 3 4 5  |
| Flood forecasting, flood warnings, evacuation planning and emergency response measures —<br>Suggested location/other comments:     | 1 2 3 4 5  |

Other (please specify any options you think are suitable): .....

.....

.....

If you have any further comments that relate to the Darling Harbour Floodplain Management Study and Plan, please write them in the space below. Feel free to attach additional pages if necessary.

.....

.....

Glossary

- Culvert** – a piped drain or covered channel that passes under a road or railroad.
- Flood wall** – an embankment or wall, usually constructed from earth or concrete, to help prevent overflow of flood waters.
- Retarding/detention facility** – large storage that captures and holds stormwater runoff allowing it to slowly drain into the adjoining drainage line.

**Privacy notice** The information supplied will be used by the City of Sydney and its consultants to consider flooding matters within the local government area. Personal information will remain confidential, however responses may be accessed by third parties through the Government Information (Public Access) Act 2009.







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| <b>Table C3: Cost Estimate - Option FM-DH01</b> |  |                 |             |             |                     |
|---|--|-----------------|-------------|-------------|---------------------|
| <b>Item No.</b>                                 | <b>Description of work</b>   | <b>Quantity</b> | <b>Unit</b> | <b>Rate</b> | <b>Cost</b>         |
| <b>1</b>  | <b>General Construction Costs</b>  |                 |             |             |                     |
| 1.1   | Site establishment, security fencing, facilities and disestablishment  | 1               | item        | 0           | 0                   |
| 1.2   | Provision of sediment and erosion control  | 1               | item        | 0           | 0                   |
| 1.3   | Construction setout and survey   | 1               | item        | 0           | 0                   |
| 1.4   | Work as executed survey and documentation  | 1               | item        | 0           | 0                   |
| 1.5   | Geotechnical supervision, testing and certification  | 1               | item        | 0           | 0                   |
|   | <b>SUBTOTAL (Assumed as 15% of works cost)</b>   |                 |             |             | <b>\$ 94,858</b>    |
| <b>2</b>  | <b>Demolition and Clearing</b>   |                 |             |             |                     |
| 2.1   | Clearing and grubbing  | 0               | sq. m       | 11          | 0                   |
| 2.2   | Strip topsoil and stockpile for re-use (assuming 150mm depth)  | 0               | cu. m       | 27          | 0                   |
| 2.3   | Dispose of excess topsoil (nominal 10% allowance)  | 0               | cu. m       | 65          | 0                   |
| 2.4   | Pull up and dispose existing road surface  | 303             | sq. m       | 38          | 11,453              |
|   | <b>SUBTOTAL</b>  |                 |             |             | <b>\$ 11,453</b>    |
| <b>4</b>  | <b>Installation of Drainage</b>  |                 |             |             |                     |
| 4.20  | Supply, excavate, bed, lay, joint, backfill and provide connections 1.0m x 1.0m culvert                              | 39              | lin. m      | 2,268       | 88,452              |
| 4.50  | Supply, excavate, bed, lay, joint, backfill and provide connections twin 0.3m dia. Pipe                              | 36              | lin. m      | 1,900       | 68,400              |
| 4.65  | Supply, excavate, bed, lay, joint, backfill and provide connections quadruple 1.5m x 1.5m culvert                    | 26              | lin. m      | 12,096      | 314,496             |
| 4.78  | Install new drainage/junction pit (assumed 1 pit per 5m of pipe)   | 20              | each        | 4,320       | 86,400              |
| 4.87  | Adjustment of existing services (nominal allowance) (assumed 10% of drainage installation cost)                      | 55,775          | item        | 74,547      | 55,775              |
|   | <b>SUBTOTAL</b>  |                 |             |             | <b>\$ 527,123</b>   |
| <b>7</b>  | <b>Footpath and Road Surfaces</b>  |                 |             |             |                     |
| 7.1   | Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing | 303             | sq. m       | 130         | 39,269              |
|   | <b>SUBTOTAL</b>  |                 |             |             | <b>\$ 39,269</b>    |
| <b>9</b>  | <b>Traffic Management</b>  |                 |             |             |                     |
| 9.1   | Control of traffic during works (nominal allowance) (assumed \$500 per lin.m)  | 101             | lin. m      | 540         | 54,540              |
|   | <b>SUBTOTAL</b>  |                 |             |             | <b>\$ 54,540</b>    |
|   | <b>CONSTRUCTION SUBTOTAL</b>   |                 |             |             | <b>\$ 727,243</b>   |
| <b>11</b>                                       | <b>Contingencies</b>   |                 |             |             | <b>\$ -</b>         |
| 11.1  | 50% construction cost  |                 |             |             | <b>\$ 363,621</b>   |
|   | <b>CONSTRUCTION TOTAL, exc. GST</b>  |                 |             |             | <b>\$ 1,090,864</b> |
|   | <b>GST</b>   |                 |             |             | <b>\$ 109,086</b>   |
|   | <b>CONSTRUCTION TOTAL, inc. GST</b>  |                 |             |             | <b>\$ 1,199,951</b> |
|   | <b>CONSTRUCTION TOTAL, rounded</b>   |                 |             |             | <b>\$ 1,200,000</b> |
| <b>11</b>                                       | <b>MAINTENANCE</b>   |                 |             |             |                     |
| 11.1  | Maintenance of mitigation option   |                 |             |             | <b>\$ 1,010</b>     |



| Table C4: Cost Estimate - Option FM-DH02 |  |          |        |        |                     |
|--|--|----------|--------|--------|---------------------|
| Item No.                                 | Description of work  | Quantity | Unit   | Rate   | Cost                |
| 1  | <b>General Construction Costs</b>  |          |        |        |                     |
| 1.1                                      | Site establishment, security fencing, facilities and disestablishment  | 1        | item   | 0      | 0                   |
| 1.2                                      | Provision of sediment and erosion control  | 1        | item   | 0      | 0                   |
| 1.3                                      | Construction setout and survey   | 1        | item   | 0      | 0                   |
| 1.4                                      | Work as executed survey and documentation  | 1        | item   | 0      | 0                   |
| 1.5                                      | Geotechnical supervision, testing and certification  | 1        | item   | 0      | 0                   |
|  | <b>SUBTOTAL (Assumed as 15% of works cost)</b>   |          |        |        | <b>\$ 650,625</b>   |
| 2  | <b>Demolition and Clearing</b>   |          |        |        |                     |
| 2.1                                      | Clearing and grubbing  | 0        | sq. m  | 11     | 0                   |
| 2.2                                      | Strip topsoil and stockpile for re-use (assuming 150mm depth)  | 0        | cu. m  | 27     | 0                   |
| 2.3                                      | Dispose of excess topsoil (nominal 10% allowance)  | 0        | cu. m  | 65     | 0                   |
| 2.4                                      | Pull up and dispose existing road surface  | 2,181    | sq. m  | 38     | 82,442              |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 82,442</b>    |
| 4  | <b>Installation of Drainage</b>  |          |        |        |                     |
| 4.23                                     | Supply, excavate, bed, lay, joint, backfill and provide connections 1.5m x 1.5m culvert                              | 217      | lin. m | 3,024  | 656,208             |
| 4.49                                     | Supply, excavate, bed, lay, joint, backfill and provide connections 0.3m dia. Pipe                                   | 48       | lin. m | 950    | 45,600              |
| 4.53                                     | Supply, excavate, bed, lay, joint, backfill and provide connections 0.375m dia. Pipe                                 | 41       | lin. m | 990    | 40,590              |
| 4.54                                     | Supply, excavate, bed, lay, joint, backfill and provide connections 1.05m dia. Pipe                                  | 161      | lin. m | 1,430  | 230,230             |
| 4.55                                     | Supply, excavate, bed, lay, joint, backfill and provide connections twin 1.5m dia. Pipe                              | 155      | lin. m | 4,860  | 753,300             |
| 4.64                                     | Supply, excavate, bed, lay, joint, backfill and provide connections triple 1.5m x 1.5m culvert                       | 105      | lin. m | 9,072  | 952,560             |
| 4.78                                     | Install new drainage/junction pit (assumed 1 pit per 5m of pipe)   | 145      | each   | 4,320  | 626,400             |
| 4.87                                     | Adjustment of existing services (nominal allowance) (assumed 30% of drainage installation cost)                      | 901,333  | item   | 74,547 | 901,333             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 3,579,821</b> |
| 7  | <b>Footpath and Road Surfaces</b>  |          |        |        |                     |
| 7.1                                      | Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing | 2,181    | sq. m  | 130    | 282,658             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 282,658</b>   |
| 9  | <b>Traffic Management</b>  |          |        |        |                     |
| 9.1                                      | Control of traffic during works (nominal allowance) (assumed \$500 per lin.m)  | 727      | lin. m | 540    | 392,580             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 392,580</b>   |
|  | <b>CONSTRUCTION SUBTOTAL</b>   |          |        |        | <b>\$ 4,988,126</b> |
| 11                                       | <b>Contingencies</b>   |          |        |        | <b>\$ -</b>         |
| 11.1                                     | 50% construction cost  |          |        |        | <b>\$ 2,494,063</b> |
|  | <b>CONSTRUCTION TOTAL, exc. GST</b>  |          |        |        | <b>\$ 7,482,188</b> |
|  | <b>GST</b>   |          |        |        | <b>\$ 748,219</b>   |
|  | <b>CONSTRUCTION TOTAL, inc. GST</b>  |          |        |        | <b>\$ 8,230,407</b> |
|  | <b>CONSTRUCTION TOTAL, rounded</b>   |          |        |        | <b>\$ 8,230,400</b> |
| 11                                       | <b>MAINTENANCE</b>   |          |        |        |                     |
| 11.1                                     | Maintenance of mitigation option   |          | item   |        | <b>\$ 7,270</b>     |



| Table C1: Cost Estimate - Option DH05 |  |          |        |        |                      |
|---------------------------------------|--|----------|--------|--------|----------------------|
| Item No.                              | Description of work  | Quantity | Unit   | Rate   | Cost                 |
| <b>1</b>                              | <b>General Construction Costs</b>  |          |        |        |                      |
| 1.1                                   | Site establishment, security fencing, facilities and disestablishment  | 1        | item   | 0      | 0                    |
| 1.2                                   | Provision of sediment and erosion control  | 1        | item   | 0      | 0                    |
| 1.3                                   | Construction setout and survey   | 1        | item   | 0      | 0                    |
| 1.4                                   | Work as executed survey and documentation  | 1        | item   | 0      | 0                    |
| 1.5                                   | Geotechnical supervision, testing and certification  | 1        | item   | 0      | 0                    |
|                                       | <b>SUBTOTAL (Assumed as 15% of works cost)</b>   |          |        |        | <b>\$ 972,237</b>    |
| <b>2</b>                              | <b>Demolition and Clearing</b>   |          |        |        |                      |
| 2.1                                   | Clearing and grubbing  | 0        | sq. m  | 11     | 0                    |
| 2.2                                   | Strip topsoil and stockpile for re-use (assuming 150mm depth)  | 0        | cu. m  | 27     | 0                    |
| 2.3                                   | Dispose of excess topsoil (nominal 10% allowance)  | 0        | cu. m  | 65     | 0                    |
| 2.4                                   | Pull up and dispose existing road surface  | 1,458    | sq. m  | 38     | 55,112               |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 145,265</b>    |
| <b>4</b>                              | <b>Installation of Drainage</b>  |          |        |        |                      |
| 4.23                                  | Supply, excavate, bed, lay, joint, backfill and provide connections 1.5m x 1.5m culvert                              | 467      | lin. m | 3,024  | 1,412,208            |
| 4.75                                  | Supply, excavate, bed, lay, joint, backfill and provide connections twin 1.5m x 1.2m culvert                         | 0        | lin. m | 5000   | 0                    |
| 4.78                                  | Install new drainage/junction pit (assumed 1 pit per 50m of pipe)  | 10       | each   | 4,320  | 43,200               |
| 4.87                                  | Adjustment of existing services (nominal allowance) (assumed 10% of drainage installation cost)                      | 145,541  | item   | 74,547 | 581,036              |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 5,146,520</b>  |
| <b>7</b>                              | <b>Footpath and Road Surfaces</b>  |          |        |        |                      |
| 7.1                                   | Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing | 1,458    | sq. m  | 130    | 188,957              |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 498,053</b>    |
| <b>9</b>                              | <b>Traffic Management</b>  |          |        |        |                      |
| 9.1                                   | Control of traffic during works (nominal allowance) (assumed \$500 per lin.m)  | 467      | lin. m | 540    | 252,180              |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 691,740</b>    |
|                                       | <b>CONSTRUCTION SUBTOTAL</b>   |          |        |        | <b>\$ 7,453,815</b>  |
| <b>11</b>                             | <b>Contingencies</b>   |          |        |        | <b>\$ -</b>          |
| 11.1                                  | 50% construction cost  |          |        |        | <b>\$ 3,726,907</b>  |
|                                       | <b>CONSTRUCTION TOTAL, exc. GST</b>  |          |        |        | <b>\$ 11,180,722</b> |
|                                       | <b>GST</b>   |          |        |        | <b>\$ 1,118,072</b>  |
|                                       | <b>CONSTRUCTION TOTAL, inc. GST</b>  |          |        |        | <b>\$ 12,298,794</b> |
|                                       | <b>CONSTRUCTION TOTAL, rounded</b>   |          |        |        | <b>\$ 12,298,800</b> |
| <b>11</b>                             | <b>MAINTENANCE</b>   |          |        |        |                      |
| 11.1                                  | Maintenance of mitigation option   |          | item   |        | <b>\$ 12,810</b>     |



| Table C1: Cost Estimate - Option FM-DH06 |  |          |        |        |                     |
|--|--|----------|--------|--------|---------------------|
| Item No.                                 | Description of work  | Quantity | Unit   | Rate   | Cost                |
| <b>1</b>                                 | <b>General Construction Costs</b>  |          |        |        |                     |
| 1.1                                      | Site establishment, security fencing, facilities and disestablishment  | 1        | item   | 0      | 0                   |
| 1.2                                      | Provision of sediment and erosion control  | 1        | item   | 0      | 0                   |
| 1.3                                      | Construction setout and survey   | 1        | item   | 0      | 0                   |
| 1.4                                      | Work as executed survey and documentation  | 1        | item   | 0      | 0                   |
| 1.5                                      | Geotechnical supervision, testing and certification  | 1        | item   | 0      | 0                   |
|  | <b>SUBTOTAL (Assumed as 15% of works cost)</b>   |          |        |        | <b>\$ 310,284</b>   |
| <b>2</b>                                 | <b>Demolition and Clearing</b>   |          |        |        |                     |
| 2.1                                      | Clearing and grubbing  | 0        | sq. m  | 11     | 0                   |
| 2.2                                      | Strip topsoil and stockpile for re-use (assuming 150mm depth)  | 0        | cu. m  | 27     | 0                   |
| 2.3                                      | Dispose of excess topsoil (nominal 10% allowance)  | 0        | cu. m  | 65     | 0                   |
| 2.4                                      | Pull up and dispose existing road surface  | 1,458    | sq. m  | 38     | 55,112              |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 55,112</b>    |
| <b>4</b>                                 | <b>Installation of Drainage</b>  |          |        |        |                     |
| 4.23                                     | Supply, excavate, bed, lay, joint, backfill and provide connections 1.5m x 1.5m culvert                              | 467      | lin. m | 3,024  | 1,412,208           |
| 4.75                                     | Supply, excavate, bed, lay, joint, backfill and provide connections twin 1.5m x 1.2m culvert                         | 0        | lin. m | 5000   | 0                   |
| 4.78                                     | Install new drainage/junction pit (assumed 1 pit per 50m of pipe)  | 10       | each   | 4,320  | 43,200              |
| 4.87                                     | Adjustment of existing services (nominal allowance) (assumed 10% of drainage installation cost)                      | 145,541  | item   | 74,547 | 145,541             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 1,557,749</b> |
| <b>7</b>                                 | <b>Footpath and Road Surfaces</b>  |          |        |        |                     |
| 7.1                                      | Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing | 1,458    | sq. m  | 130    | 188,957             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 188,957</b>   |
| <b>9</b>                                 | <b>Traffic Management</b>  |          |        |        |                     |
| 9.1                                      | Control of traffic during works (nominal allowance) (assumed \$500 per lin.m)  | 467      | lin. m | 540    | 252,180             |
|  | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 252,180</b>   |
|  | <b>CONSTRUCTION SUBTOTAL</b>   |          |        |        | <b>\$ 2,378,846</b> |
| <b>11</b>                                | <b>Contingencies</b>   |          |        |        | <b>\$ -</b>         |
| 11.1                                     | 50% construction cost  |          |        |        | <b>\$ 1,189,423</b> |
|  | <b>CONSTRUCTION TOTAL, exc. GST</b>  |          |        |        | <b>\$ 3,568,269</b> |
|  | <b>GST</b>   |          |        |        | <b>\$ 356,827</b>   |
|  | <b>CONSTRUCTION TOTAL, inc. GST</b>  |          |        |        | <b>\$ 3,925,096</b> |
|  | <b>CONSTRUCTION TOTAL, rounded</b>   |          |        |        | <b>\$ 3,925,100</b> |
| <b>11</b>                                | <b>MAINTENANCE</b>   |          |        |        |                     |
| 11.1                                     | Maintenance of mitigation option   |          | item   |        | <b>\$ 4,860</b>     |



| Table C1: Cost Estimate - Option DH07 |  |          |        |        |                   |
|---------------------------------------|--|----------|--------|--------|-------------------|
| Item No.                              | Description of work  | Quantity | Unit   | Rate   | Cost              |
| <b>1</b>                              | <b>General Construction Costs</b>  |          |        |        |                   |
| 1.1                                   | Site establishment, security fencing, facilities and disestablishment  | 1        | item   | 0      | 0                 |
| 1.2                                   | Provision of sediment and erosion control  | 1        | item   | 0      | 0                 |
| 1.3                                   | Construction setout and survey   | 1        | item   | 0      | 0                 |
| 1.4                                   | Work as executed survey and documentation  | 1        | item   | 0      | 0                 |
| 1.5                                   | Geotechnical supervision, testing and certification  | 1        | item   | 0      | 0                 |
|                                       | <b>SUBTOTAL (Assumed as 15% of works cost)</b>   |          |        |        | <b>\$ 70,712</b>  |
| <b>2</b>                              | <b>Demolition and Clearing</b>   |          |        |        |                   |
| 2.1                                   | Clearing and grubbing  | 0        | sq. m  | 11     | 0                 |
| 2.2                                   | Strip topsoil and stockpile for re-use (assuming 150mm depth)  | 0        | cu. m  | 27     | 0                 |
| 2.3                                   | Dispose of excess topsoil (nominal 10% allowance)  | 0        | cu. m  | 65     | 0                 |
| 2.4                                   | Pull up and dispose existing road surface  | 519      | sq. m  | 38     | 19,618            |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 19,618</b>  |
| <b>4</b>                              | <b>Installation of Drainage</b>  |          |        |        |                   |
| 4.23                                  | Supply, excavate, bed, lay, joint, backfill and provide connections 1.5m x 1.5m culvert                              | 0        | lin. m | 3,024  | 0                 |
| 4.75                                  | Supply, excavate, bed, lay, joint, backfill and provide connections twin 1.5m x 1.2m culvert                         | 0        | lin. m | 5000   | 0                 |
| 4.78                                  | Install new drainage/junction pit (assumed 1 pit per 50m of pipe)  | 9        | each   | 4,320  | 38,880            |
| 4.87                                  | Adjustment of existing services (nominal allowance) (assumed 10% of drainage installation cost)                      | 212,139  | item   | 74,547 | 212,139           |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 291,114</b> |
| <b>7</b>                              | <b>Footpath and Road Surfaces</b>  |          |        |        |                   |
| 7.1                                   | Reinstate disturbed road pavement, including demolition and disposal of additional material to provide good jointing | 519      | sq. m  | 130    | 67,262            |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 67,262</b>  |
| <b>9</b>                              | <b>Traffic Management</b>  |          |        |        |                   |
| 9.1                                   | Control of traffic during works (nominal allowance) (assumed \$500 per lin.m)  | 173      | lin. m | 540    | 93,420            |
|                                       | <b>SUBTOTAL</b>  |          |        |        | <b>\$ 93,420</b>  |
|                                       | <b>CONSTRUCTION SUBTOTAL</b>   |          |        |        | <b>\$ 542,127</b> |
| <b>11</b>                             | <b>Contingencies</b>   |          |        |        | <b>\$ -</b>       |
| 11.1                                  | 50% construction cost  |          |        |        | <b>\$ 271,063</b> |
|                                       | <b>CONSTRUCTION TOTAL, exc. GST</b>  |          |        |        | <b>\$ 813,190</b> |
|                                       | <b>GST</b>   |          |        |        | <b>\$ 81,319</b>  |
|                                       | <b>CONSTRUCTION TOTAL, inc. GST</b>  |          |        |        | <b>\$ 894,509</b> |
|                                       | <b>CONSTRUCTION TOTAL, rounded</b>   |          |        |        | <b>\$ 894,500</b> |
| <b>11</b>                             | <b>MAINTENANCE</b>   |          |        |        |                   |
| 11.1                                  | Maintenance of mitigation option   |          | item   |        | <b>\$ 1,730</b>   |