52-54 Pemberton Street Botany

Masterplan Stormwater Management Report

November 2014

Australand Residential Botany Pty Ltd

Mott MacDonald

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Contents

Executive Summary

Australand Residential Botany Pty Ltd proposes to redevelop the existing site bounded by Pemberton, Wilson, Warrana and adjacent future development into a multi-unit residential development. Mott MacDonald has been commissioned to undertake an assessment of the water management issues as part of a Masterplan Stage 1 DA submission.

Hughes Trueman/Mott MacDonald has previously undertaken 2D flood modelling in the site catchment and it is understood that Council has not completed any major catchment modelling investigations since this time. This existing flood modelling has been used to assist in the stormwater management assessment. A copy of the previous 2D flood modelling is attached to this report.

The key issues associated with the proposed development with respect to stormwater management are summarised below.

Flooding

Pemberton and Wilson Streets, downstream of the site, are significantly prone to flooding due to a constriction (building over) in the trunk stormwater channel/overland flowpath easement over 21 Pemberton Street. The level of ponding in Pemberton Street is controlled by the level and width of the downstream overland flowpath running through 21 Pemberton Street. The resulting ponding level in Pemberton Street is below the level of the subject site.

Pemberton and Wilson Streets operate as overland flowpaths. The previous flood studies for the precinct indicate flood inundation into the site from Pemberton Street, however, this is as a result of the existing building in this location not being included in the flood modelling. There is a constant line of buildings within the site along Pemberton Street, therefore there is no flood inundation into the site along this frontage. A small area of flood storage exists off Wilson Street at the south of the site. An equivalent volume of flood storage will be provided within the proposed development. The previous flood modelling indicates that in the 1 in in 100 year recurrence interval the overland flow depth in Pemberton Street adjacent to the site shall be up to 600mm and the flow depth in Wilson Street adjacent to the site shall be up to 200 mm.

A 500mm freeboard will be provided above the flood level in Pemberton Street to the proposed development floor levels in accordance with Botany Council's requirements.

A freeboard of 300mm shall be provided at all basement entry ramps.

Minimum Flood Planning Levels have been determined based on the 1 in 100 recurrence interval flood levels determined from the previous 2D flood modelling for the area undertaken by Hughes Trueman/ Mott MacDonald. The post development flows from the site shall be less than the current flows from the site and shall not impact on the regional flows/depth of flow in Wilson and Pemberton Street. These proposed minimum flood planning levels are shown on Figure 3.5 in this report.

Water Quantity Management

Detention for the development shall be provided within the proposed development to constrain outflows to 'state of nature' volumes. Detention shall be considered on a catchment by catchment basis to maintain the existing flow regime and to ensure that no adverse impacts are introduced to third parties.

Botany Council's stormwater guidelines require absorption to be considered as part of the stormwater design. It is considered that, due to the groundwater levels at the site, absorption is not appropriate in this instance.

There is a stormwater drainage line crossing the site. This pipe currently drains a small upstream catchment in Kurnell Street (approximately 3000sqm) and also collects stormwater from within the site. This pipeline discharges into the main stormwater main that runs between Wilson Street and Permberton Street. The pipe size ranges from 375mm increasing to 525mm at its discharge point into the main channel. This stormwater line is old and will conflict with the proposed development basements. It is proposed to remove this existing stormwater pipe and replace it with a new pipe running around the basement envelope and connect into the trunk stormwater channel. The proposed pipe shall have a reduced contributing catchment area as all site flows shall be directed through separate connections via detention systems. The pipe shall provide for the upstream Kurnell Street flow only. Overland flow from this minor upstream catchment shall be accommodated in a proposed overland flowpath across the site.

Easements

There are a number of existing drainage easements on the existing site. A drainage easement running north-south through the site caters for the upstream Kurnell Street catchment. This easement will be removed and the drainage (piped and overland) will be diverted around the proposed development as discussed above.

A second easement covering a significant portion of the site is understood to remain from the early land uses (market gardens) on site to permit surface drainage from areas within the site. This easement was subsequently built over and its function (to provide surface drainage to the market gardens) was no longer required. This easement is not required as part of the proposed development and can be removed.

Development Impacts

The total impervious area of the site will be reduced post-development. This will result in reduced levels of discharge. With the addition of detention, discharge volumes will be significantly reduced.

The proposed development floor levels and carpark entry crest levels will be located above the flood levels with appropriate freeboard provision to protect the development from flooding.

The proposed development will not result in any adverse impacts to any third party.

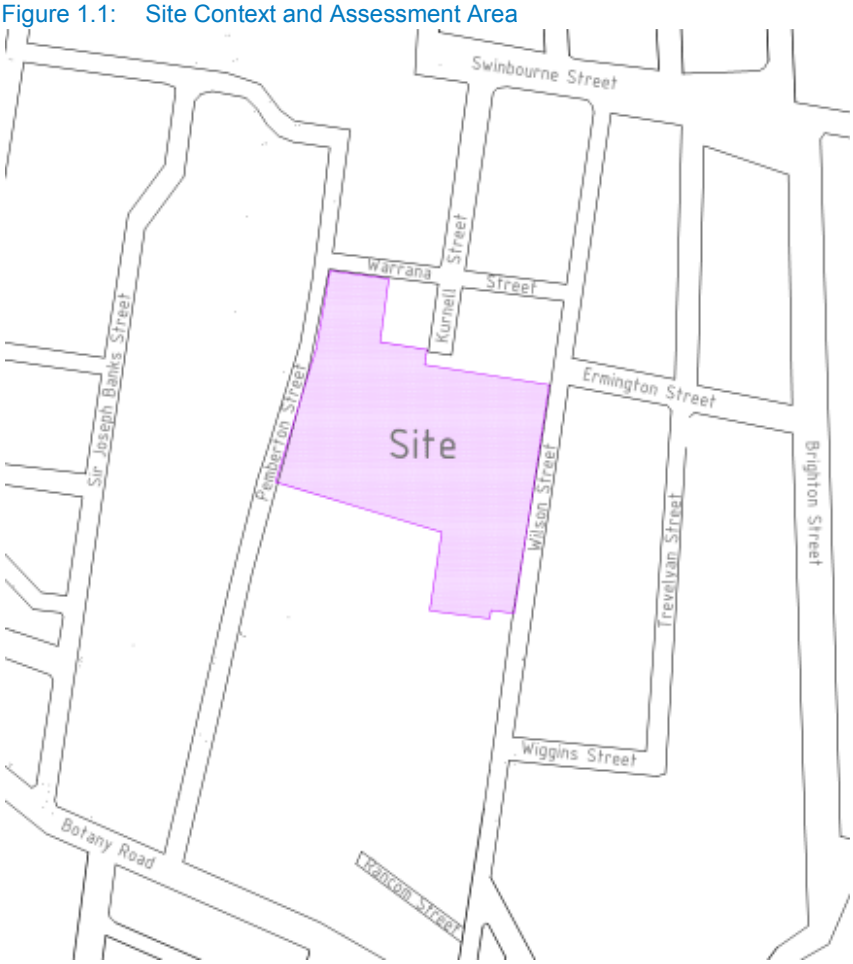
1. Introduction

1.1 Background

Mott MacDonald has been commissioned by Australand Residential Botany Pty Ltd to prepare a masterplan stormwater management report for the proposed redevelopment of 52-54 Pemberton Street, Botany as part of the Stage 1 Masterplan DA for the development.

The site is indicated in Figure 1.1 below.

Figure 1.1: Site Context and Assessment Area



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1.2 Purpose of Assessment

The main aims of this masterplan stormwater management report are:

- To consider the flooding issues (local and regional) relevant to the site planning
- To assess and recommend appropriate floor levels controls for the proposed development
- To identify requirements with respect to maintaining existing flood storage within the site
- To consider and incorporate detention requirements
- To address water quality management issues

1.3 Scope of Assessment

This study investigates the following:

- The infrastructure site constraints,
- Topographical constraints – slope, drainage corridors;
- Appreciation of hydrological issues by desktop review of previous studies;
- Identification of Stormwater Quantity Management issues - detention requirements;
- Identification of likely Stormwater Quality Management obligations; and
- Integration issues with adjacent properties and proposed development

The study addresses all the items raised by Botany Bay Council at the meeting of 25/11/14 including:

- Proposed floor levels and basement ramp crest levels for the proposed development;
- Incorporation of on-site detention;
- Maintenance of existing flood storage on site;
- Existing easements;
- External site catchment from Kurnell Street.

1.4 Base Data

The base data used as a part of this assessment includes:

- Survey by Crux Surveying (30/01/2013)
- Survey by Dunlop Thorpe & Co. (15/10/2014)
- Architectural Drawings by Group GSA. Note: Proposed building footprints and other landuses shown in this report and drawings are indicative only. Refer to the architectural drawings for further details.
- Previous regional flood modelling undertaken in the area by Mott MacDonald – Parkgrove, Botany Flood and Stormwater Management Report, Mott MacDonald. (2011)

The report prepared by KFW and provided by Botany Bay Council for the adjacent 42-44 Pemberton site has also been reviewed as a part of this assessment.

1.5 Regional Context

The subject site comprises a parcel of land bounded by Pemberton Street to the west, Warrana Street to the north, Wilson Street to the east and future residential development to the south (currently industrial lots). The southern boundary of the site is approximately 260m to the north of Botany Road. More broadly, the site is located within the Botany Bay Local Government Area (LGA).

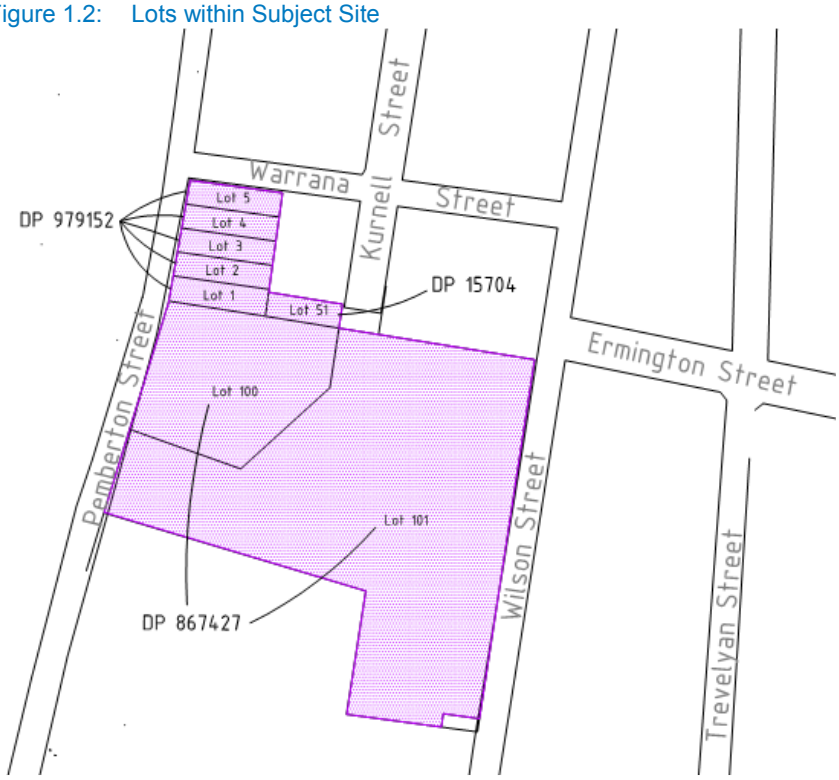
1.6 Lots and Site Areas

The site encompasses a number of lots, as indicated in Figure 1.2 below. Approximate areas of the respective lots are included in Table 1.1.

Table 1.1: Lot Areas

DP	Lot	Approximate Area (sqm)
979152	1	645
979152	2	589
979152	3	583
979152	4	578
979152	5	572
15704	51	456
867427	100	5,894
867427	101	21,760
	Total	***31,077***

Figure 1.2: Lots within Subject Site



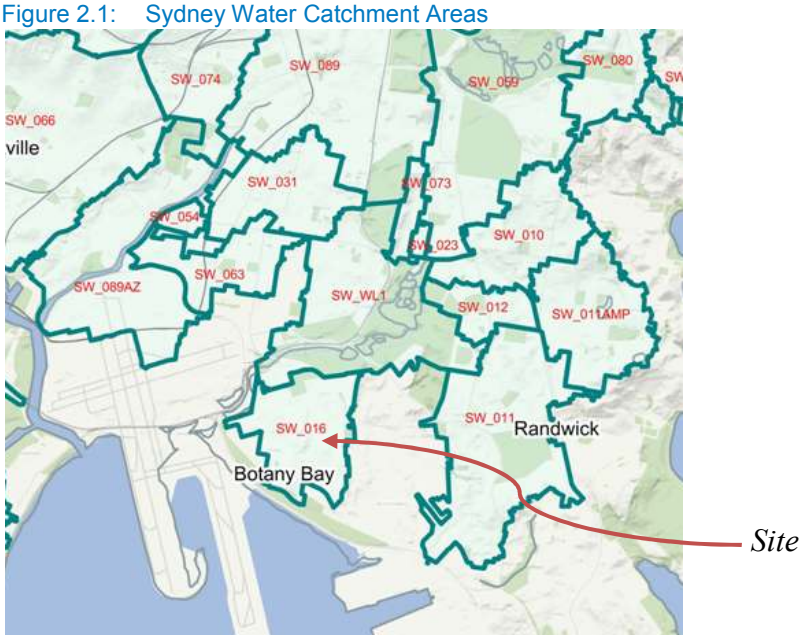
2. Existing Site Conditions & Constraints

2.1 Catchments & Hydrology

2.1.1 Regional

The site sits wholly within the Foreshore Beach subcatchment draining to Botany Bay and is within Sydney Water catchment SW_016 (refer to Figure 2.1 below). Sydney Water maintains the trunk drainage system within the catchment.

Figure 2.1: Sydney Water Catchment Areas



Source: Sydney Water Stormwater Drainage Areas, Sydney Water Asset Data Information. 2012

All site areas ultimately drain to the west to Pemberton Street. A catchment boundary divides the site into eastern and western sub-catchments. The western subcatchment drains directly to Pemberton Street, while the eastern subcatchment drains to the southeast to Wilson Street and the new street to the south of the site. The flows in Wilson Street drain along a drainage easement to the south of the site to Pemberton Street.

A 900mm diameter pipe runs along an easement beyond the site's southern boundary. The pipe continues across Pemberton Street and through the property on its western side (continuing through an easement). Midway between Pemberton Street and Sir Joseph Banks Street, the 900mm pipe joins an open channel which subsequently joins a Box culvert in Sir Joseph Banks Street. The trunk stormwater system runs southerly along Sir Joseph Banks Street and Livingstone Avenue

prior to crossing Sir Joseph Banks Park and discharging into the bay via 3 No. 1650mm dia pipes. The existing stormwater from Sir Joseph Banks Street to the ultimate discharge point varies in cross section between multiple piped systems and multiple box culverts.

The existing regional stormwater is shown schematically on Figure 2.2 below. The local stormwater infrastructure and constraints are shown in more detail on Figure 2.3.

Figure 2.2: Regional Stormwater

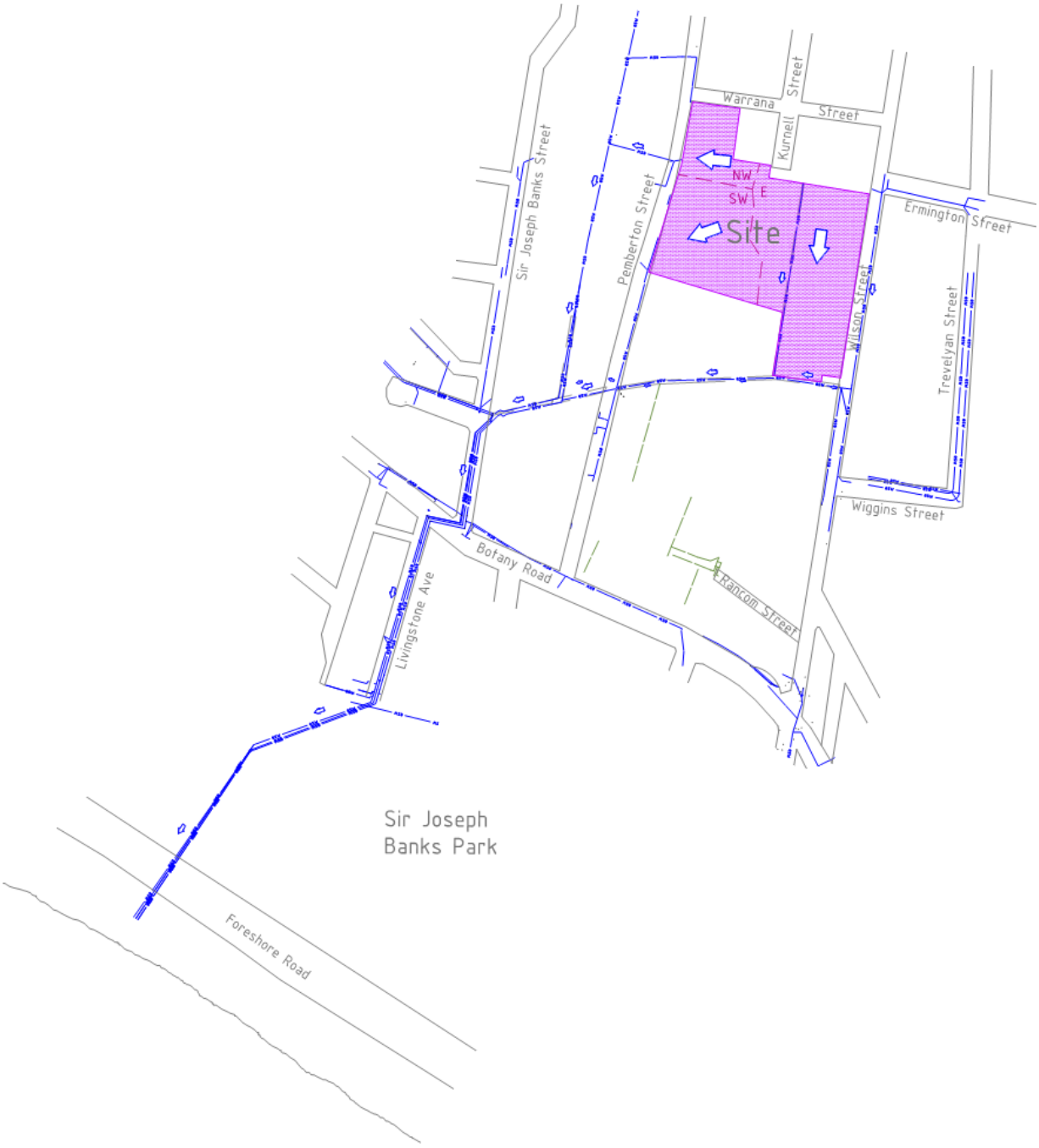
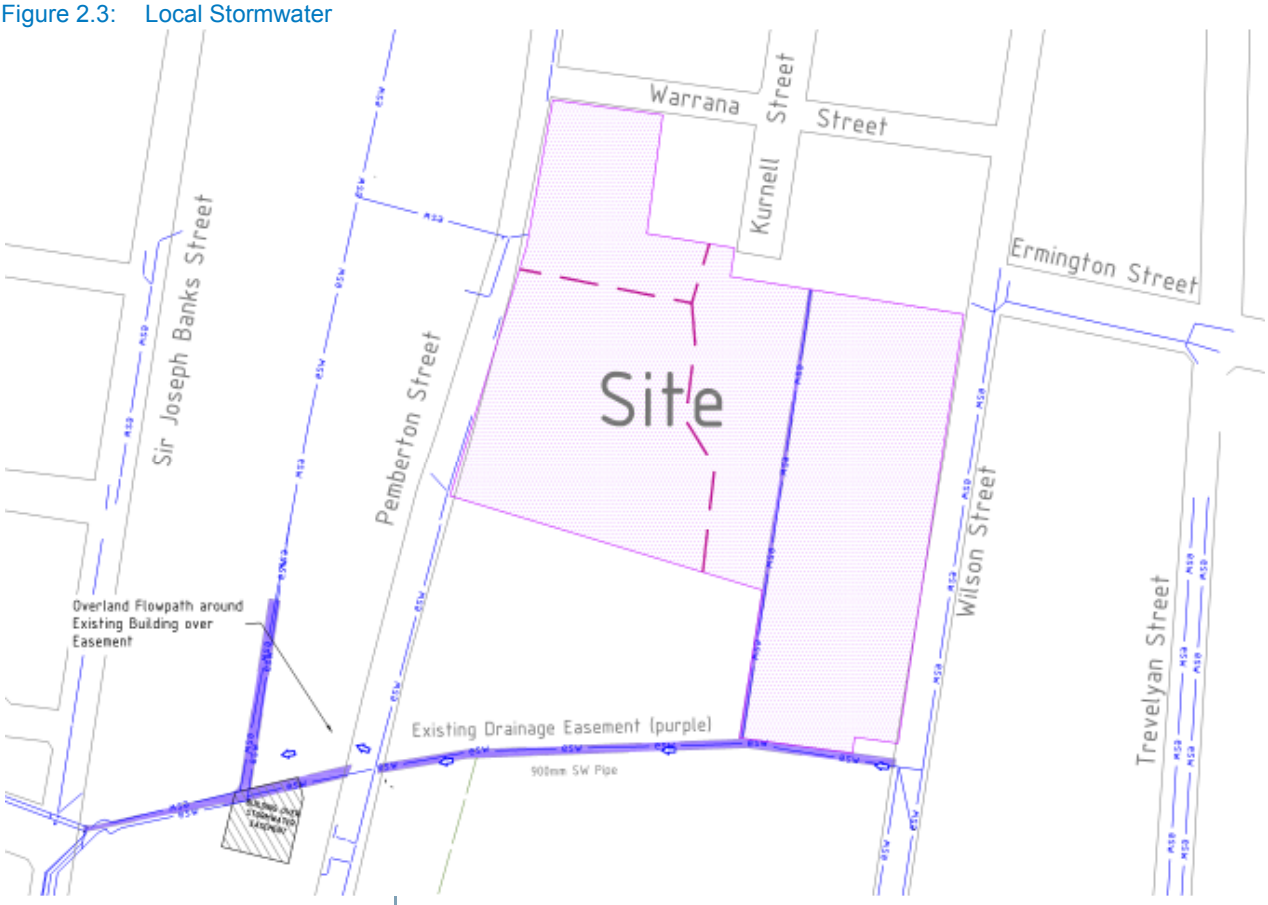


Figure 2.3: Local Stormwater



2.1.2 Site Drainage

The existing site drains principally to the existing piped systems in Pemberton and Wilson Streets based on the catchment boundary indicated in Figure 2.3 above. Portion of the site drains into the cross site pipeline running from Kurnell Street

2.1.2.1 Stormwater Easement through Site

A stormwater line runs along an easement through the site in a southerly direction. The pipe increases in size from 375mm at the site's northern boundary to 525mm at its connection to the 900mm main running westerly adjacent to the site's southern boundary, as described in Section 2.1.1 above. This stormwater line currently conveys flows from the southern end of Kurnell Street bounded to the north by Warrana Street.

2.1.3 External Catchments

The only external catchment draining through the site is that comprising the southern end of Kurnell Street and adjacent properties, which drains along the existing stormwater easement described in Section 2.1.2 above.

The broader sub-catchment within which the site is situated, extends approximately 1.2km upstream (north) of the northern boundary of the site. This catchment drains generally in a south-westerly direction along Pemberton and Sir Joseph Banks Streets and does not flow through the subject site.

2.1.4 Existing Flooding and Flood Controls

The area bounded by Botany Road, Wilson Street, Pemberton Street and the south of the subject site is potentially prone to flooding due to downstream topographic constraints. Minor flows from this area drain through the existing 900mm diameter pipe described in Section 2.1.1 above while major flows, up to the 100 year rainfall event drain overland between Pemberton Street and Sir Joseph Banks Street. The drainage easement along this route is currently obstructed by a building over the top, meaning that the overland flow in major storm events flows through private land to the north of the easement, through an open carport area between existing buildings. The level over and width through which the floodwaters must flow to pass from Pemberton Street to Sir Joseph Banks Street is the downstream flood control. The weir level along this path is approximately RL4.10. In extreme storm events water ponds in Pemberton Street and into adjacent sites, to a level of approximately RL4.55[1] as it discharges over this weir. The southern boundary of the subject site is above this level. Were the flood path between Pemberton Street and Sir Joseph Banks Street to become completely blocked, water would pond further until overtopping into Botany Road at a level of approximately RL5.15. This would have significant implications for many properties in Pemberton Street, particularly those downstream of the subject site.

Flooding also currently occurs in Wilson Street. At present, flood waters pond to a depth of approximately 300mm prior to flowing overland across downstream sites (Ref 2D flood modelling output attached). It is understood that council proposes to manage this flow along the

[1] Parkgrove, Botany Flood and Stormwater Management Report. Mott MacDonald (2011)

proposed new street to the south of the subject site, which will connect Wilson Street to Pemberton Street. An existing drainage easement containing the 900mm diameter pipe runs within this corridor.

The existing ponding in Wilson Street extends partially onto the south-east corner of the subject site. Post development flood modelling for the adjacent sites indicates that the ponding will be between 0 and 0.2m over a small area of the site. The resultant volume of flood storage will be included within detention storage within the site.

2.2 Existing Site Characteristics

2.2.1 Land Use & Topography

The entire western site catchment houses large buildings and otherwise impervious hard surfaces. The catchment is characterised by flat grades, generally less than 1%, sloping in a south-westerly direction. The north-western corner of the site, adjacent to Warrana Street, grades more steeply (approximately 4-5%) in a westerly direction.

The eastern catchment has a grassed area at its south; the remainder is characterised similarly to the western catchment – of buildings and hard surfaces. The catchment drains generally to the south-east at very flat grades (less than 1% on average).

The existing site has an impervious area of 82.5%.

2.2.2 Stormwater Quality

Stormwater quality management facilities within the existing site are not apparent.

2.2.3 Flooding

It is understood that council is currently preparing (or has commissioned the preparation of) a regional flood study for this catchment. Council has not previously identified the site as being flood affected. There are, however, a number of factors that need to be considered carefully in the future design of the site, with respect to flood management.

2.2.3.1 Flow along Wilson and Pemberton Streets

Wilson and Pemberton Streets both act as floodways during major storm events, transferring flood waters from the upstream catchment to

the downstream drainage system. A freeboard will need to be applied to proposed buildings and car park accesses off these streets and the proposed new street to the south of the development.

2.2.3.2 Drainage Easement through 17-19 Pemberton Street

As discussed in Section 2.1.4, it is imperative that the existing overland flow corridor through 17-19 Pemberton Street is maintained. Ultimately, any future development of the site should ensure that there is no building over the drainage easement.

The ponding effects in Pemberton and Wilson Streets associated with this flood control impose a regional flooding issue on this and adjacent developments. A freeboard will need to be provided above this flood level to building floor levels and carpark entries in the proposed development.

2.2.3.3 Local Flooding

The site may be subject to local flooding, however, strategies such as the provision of clear overland flowpaths and the application of freeboard to proposed floor levels will be implemented to mitigate this risk.

3. Development & Future Infrastructure Requirements

3.1 Proposed Development

It is proposed to redevelop the site as a multi-unit residential development interspersed with open space. A basement is proposed under the majority of the site. Refer to the architectural drawings and masterplan report for further details of the development proposal.

Figure 3.1: Proposed Development

3.1.1 Relevant Policies & Guidelines

A number of policies and guidelines are relevant to the water management and preliminary services assessment for this development. These include:

- Stormwater Management Technical Guidelines, City of Botany Bay. (2013)
- Development Control Plan Part 9C Pemberton-Wilson Street Precinct, City of Botany Bay. (2013)

The requirements of these policies will be incorporated in the proposed development planning and future design and have been discussed in the relevant sections of this report.

3.2 Site Grading

The site will be graded based on a number of factors, including:

- Integration with the surrounding, existing and proposed development;
- Integration with the adjacent roads;
- Provision of appropriate freeboard controls to buildings; and
- Provision of overland flowpaths where required and of sufficient grade.

3.3 Stormwater Management

3.3.1 Water Quantity Management Objectives

3.3.1.1 Detention

Botany Council's stormwater drainage guidelines outline the water quantity management requirements for the proposed development.

The guideline states that Onsite Detention System (OSD) shall be designed to detain the stormwater runoff generated by the development for all storm durations up to and including the 1 in 100 year on site. The permissible site discharge from the site shall be designed to restrict the discharge to 1 in 5 year event peak flow under the "state of nature" condition of the site.

An assessment of the detention requirements for the proposed development has been undertaken.

Table 3.1: Detention Requirements

Catchment	5yr ARI (State of Nature)	100yr ARI (with Detention)	Detention Volume Required
Western	0.23 cu.m/s	0.23 cu.m/s	546 cu.m
Eastern	0.321 cu.m/s	0.321 cu.m/s	673 cu.m

It is necessary that the proposed detention facilities are located above the 100 year flood level at their point of discharge such that they are not inundated during flood events and can discharge freely.

In addition to the above detention requirements for the development, we have undertaken an assessment of the existing and proposed conditions and summarise these below:

Table 3.2: Existing and Proposed Conditions

Catchment	100yr ARI (existing conditions)	100yr ARI (proposed Conditions)	100yr ARI (proposed conditions) – with detention
Western	1.00 cu.m/s	0.98 cu.m/s	0.23 cu.m/s
Eastern	1.36 cu.m/s	1.35 cu.m/s	0.321 cu.m/s

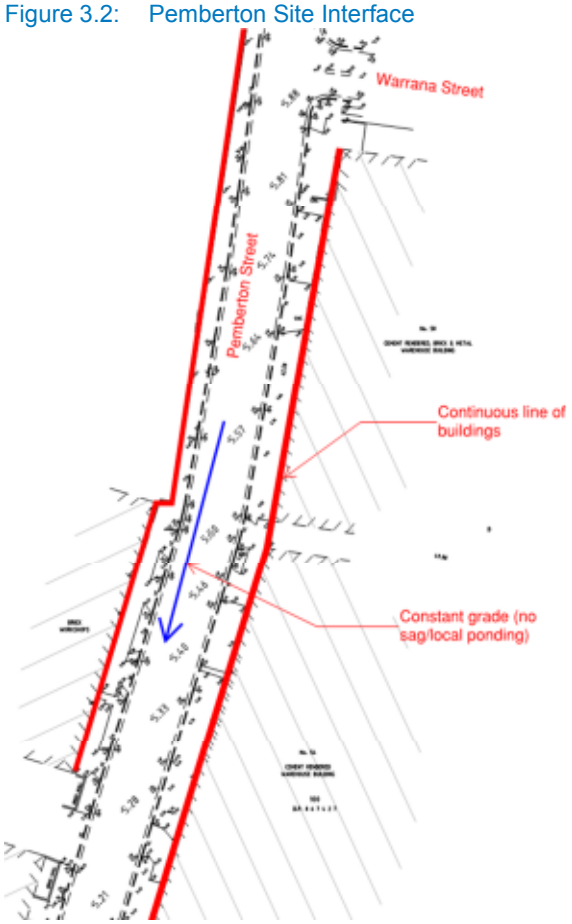
As indicated in the above table, the proposed development, largely resulting from the existing building coverage across the site and impervious area, will not adversely impact any third parties. The inclusion of on-site detention will significantly reduce site discharge.

3.3.1.2 Compensatory Flood Storage

There is a limited amount of flood storage at the south-eastern corner of the site (approximately 300 cu.m). An equivalent volume will be stored in the proposed detention tanks on site, offsetting the potential removal of this storage as part of the proposed development. There is no other significant existing flood storage within the site.

We have reviewed the existing flood study for the adjacent 42-44 Pemberton Street development, provided by council which indicates inundation into the 52-54 Pemberton Street site towards the north of the site. This is an aberration in the flood modelling as the existing building in this location was not included in the flood modelling. Therefore, there is no existing flood storage in this location. Equally, we have reviewed the survey information for Pemberton Street and confirm that there is no low point or change in cross section at this location. It can therefore be considered that the flow depth along the site frontage remains relatively constant without localised areas of ponding. This is illustrated in Figure 3.2 below showing the existing site survey, the constant line of buildings and constant road grade.

Figure 3.2: Pemberton Site Interface



3.3.1.3 Site Stormwater Drainage

Botany Bay Council requires all stormwater to be designed for the 20 year ARI rainfall event.

3.3.1.4 Absorption

Botany Council's stormwater drainage guidelines require the on-site absorption system to detain and absorb all storm events up to and including the 1 in 100 year for all durations from 6 minutes to 72 hour storm inclusive on site. The guideline states that absorption will not be permitted if groundwater levels are within 2.5m of the existing surface levels. Investigations have been undertaken in this regard and it is understood that ground water levels may be in the order of 2-3m below

existing surface levels in areas of the site. As such, it is not considered that the use of absorption for stormwater discharge is appropriate for this site. As a result, the Onsite Detention System (OSD) shall be designed to detain the stormwater runoff generated by the development for all storm durations up to and including the 1 in 100 year for all durations from 6 minutes to 72 hour storm inclusive on site. The permissible site discharge from the site shall be designed to restrict the discharge to 1 in 5 year event peak flow under the “state of nature” condition of the site. Maximum discharge permitted to Council’s kerb and gutter is 10L/s. Higher rates of discharge are only permitted by directly connecting to Council’s Pit and Pipe System.

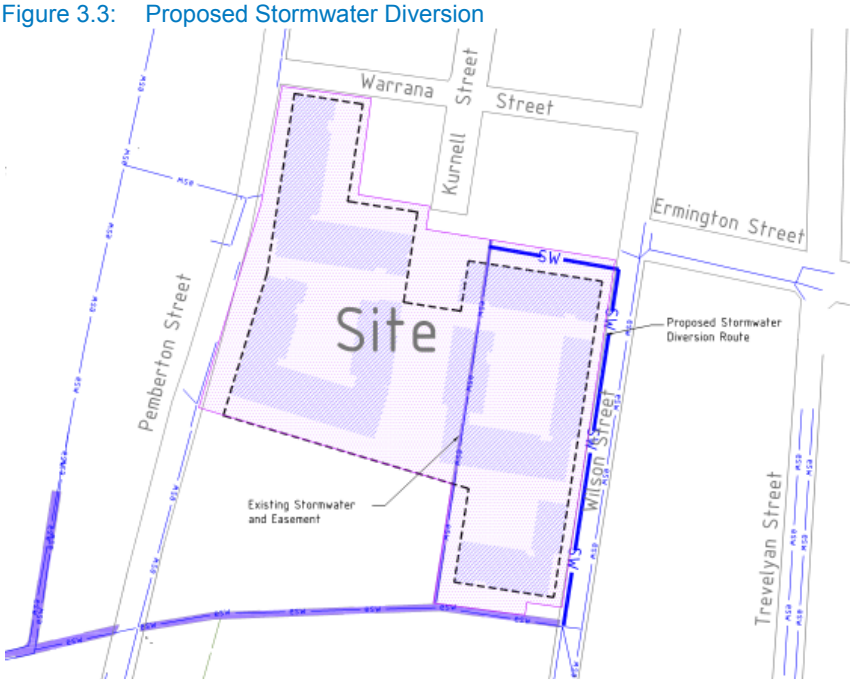
3.3.1.5 Diversion of Stormwater from Kurnell Street

The existing stormwater main and easement described in Section 2.1.2 will require relocation as there will be insufficient clearance above the proposed basement to retain the stormwater in this location. The pipe will be diverted to the east and along Wilson Street as shown in Figure 3.3 below. The existing pipe connects flows from the external Kurnell Street catchment in addition to a significant portion of the site.

The proposed diversion pipe will convey the upstream Kurnell Street catchment (bounded by Warrana Street to the north); the site catchment flows shall be managed through a new pipe and detention system.

An overland flowpath to convey flows in excess of the piped capacity will be provided from Kurnell Street to Wilson Street.

Figure 3.3: Proposed Stormwater Diversion

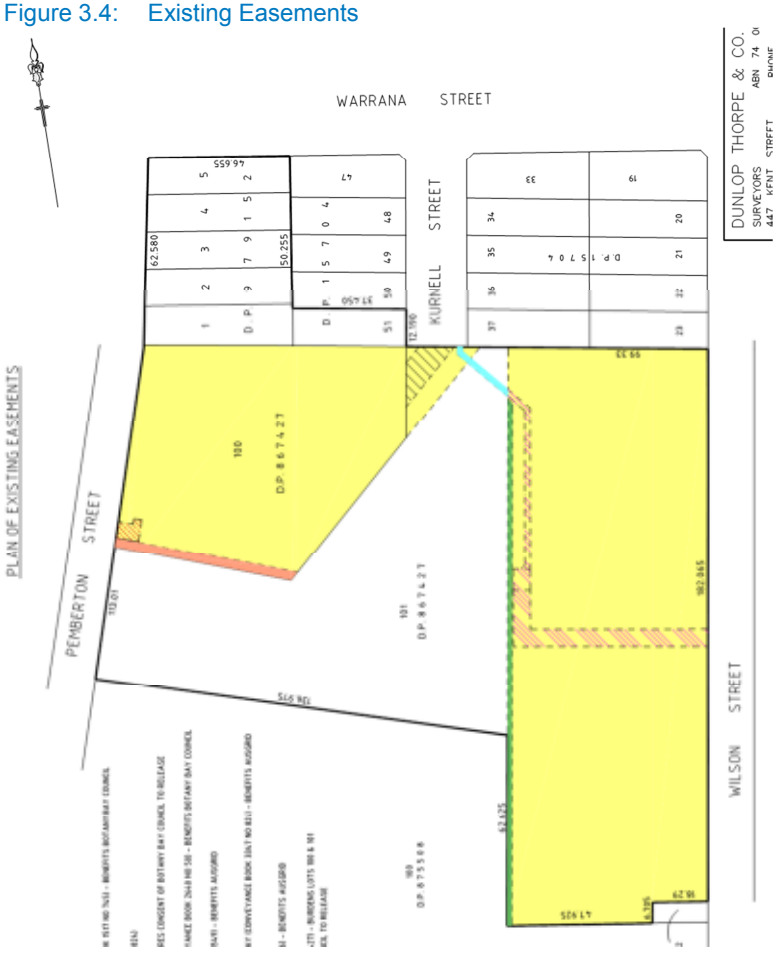


3.3.2 Existing Easements

There are a number of existing drainage easements in favour of council on the existing site. These are shown in Figure 3.4 below. The easement shown in green on the figure running north-south through the site is the drainage easement catering for the upstream Kurnell Street catchment. Details of this easement and the proposed stormwater diversion have been addressed above in sections 2.1.2.1 and 3.3.1.5.

The large easements shown in yellow on the figure covering large areas of the site are understood to be extant easements from previous land uses (market gardens) on site to permit surface drainage from areas within the site and do not and were not intended to serve any function with respect to flooding or detention. Subsequently (from the 1950s onwards), buildings were placed on site over the top of the drainage easements. It appears that the drainage easements were not extinguished at this time despite serving no ongoing purpose. The easements continue to serve no purpose as part of the proposed development and can be removed.

Figure 3.4: Existing Easements



Note: drainage easements shown in yellow and green

3.3.3 Freeboard

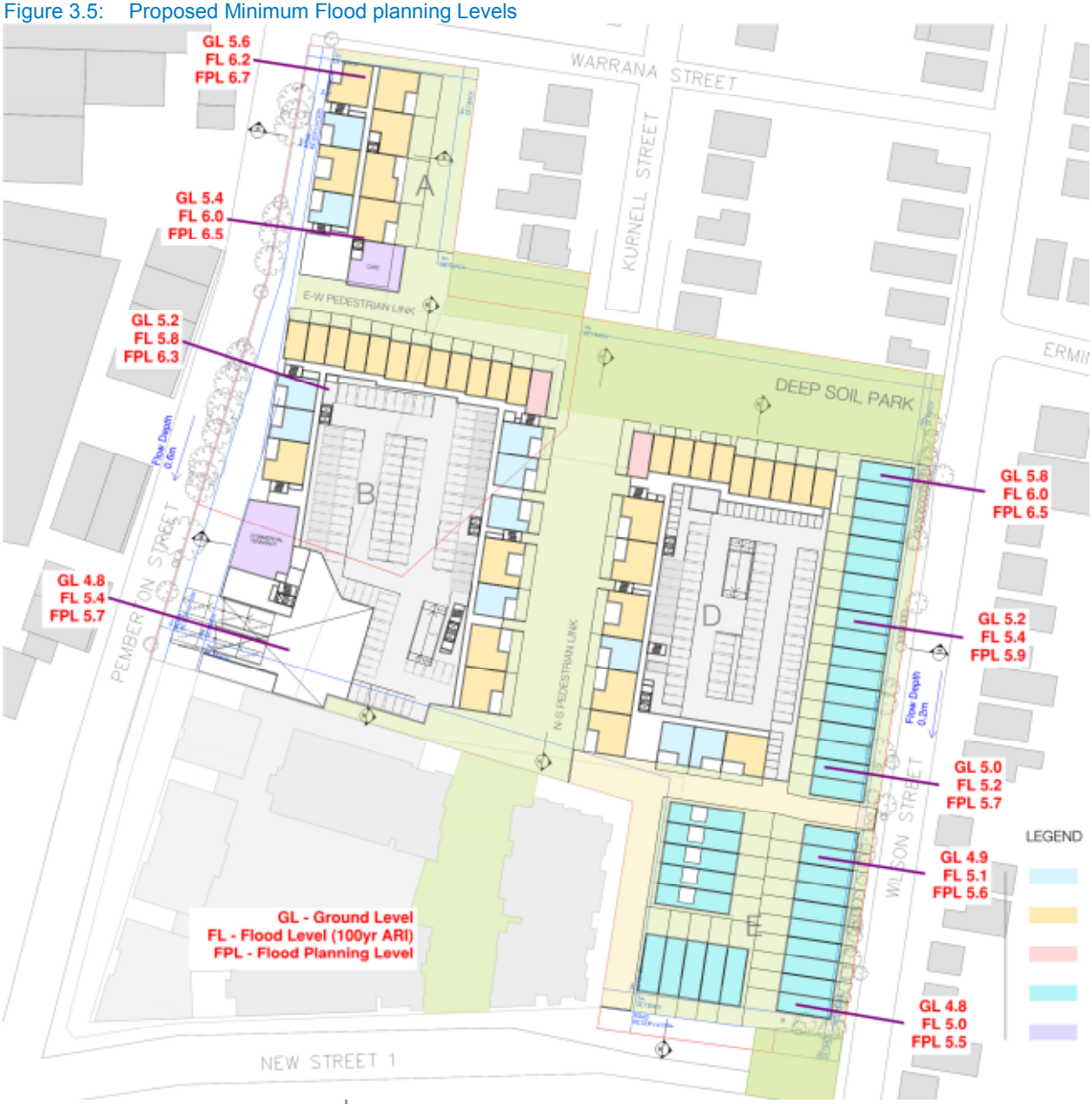
Freeboard is a factor of safety above a given flood level (usually 100 year Average Recurrence Interval (ARI)) above which building floor levels and basement entries must be situated.

Minimum Food Planning Floorlevels have been based on the provision of a freeboard above the 100yr ARI flood level. The freeboard to be applied to this development adjacent to the roadway (overland flowpath), in accordance with Botany Council DCP shall be 500mm for

habitable areas and 300mm for non-habitable areas, including basement carpark entries.

These flood planning level requirements will be incorporated in the proposed design. The relevant minimum flood planning levels are shown on Figure 3.5 below:

Figure 3.5: Proposed Minimum Flood planning Levels



4. References

- Stormwater Management Technical Guidelines, City of Botany Bay. (2013)
- Development Control Plan Part 9C Pemberton-Wilson Street Precinct, City of Botany Bay. (2013)
- Parkgrove, Botany Flood and Stormwater Management Report, Mott MacDonald. (2011)

Appendices

Appendix A. 2011 Flood Report

Mott MacDonald
Hughes Trueman

AUSTCORP

PARKGROVE, BOTANY
FLOOD AND
STORMWATER
MANAGEMENT REPORT

NOVEMBER 2011

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COMMERCIAL IN CONFIDENCE

1.0 INTRODUCTION

The Parkgrove Trust plans to develop a parcel of land bounded by Pemberton, Wilson and Rancom Streets at Botany. A Flood and Stormwater Management Report was completed and submitted to Council in December 2007. The purpose of the study was to assist with the site masterplanning, provide an estimate of flood levels for the site, identify flood risk and to provide recommended floor levels for future development. To address an extended review process of the December 2007 report the following HT documents have been completed and should be read in conjunction with this current study.

- Parkgrove, Botany, Flood and Stormwater Management Report (December 2007)
- Parkgrove, Botany, Flood and Stormwater Management Report Addendum 1 (April 2008)
- Parkgrove, Botany, Flood and Stormwater Management Report Addendum 2 (January 2010)
- Parkgrove, Botany, Flood and Stormwater Management Report Addendum 2 (March 2010)
- Parkgrove, Botany, Flood and Stormwater Management Report Addendum 3 (June 2010)

1.1 BACKGROUND

The June 2010 report was a response to further comments from Botany Bay Council (email correspondence 23rd April 2010 and meeting on 29th April 2010). Botany Bay Council provided comment to the June 2010 report in correspondence dated 19th August 2010 (copy attached at the appendix). This report comprises part of a detailed response to the latest round of Council comments.

This report revisits the assessment of the existing and proposed flood envelope across the site and in the vicinity of the proposed development using two-dimensional modelling. The purpose of this current study is to confirm the observations and recommendations discussed in the previous stormwater management study and subsequent addendum documents.

2.0 FLOOD STUDY REVIEW

The key aims, objectives and outcomes of each report indicated at section 1.0 is provided at the Appendix

2.1 PRE DEVELOPMENT FLOODING MECHANISMS

The Parkgrove site is bound east by Wilson Street, west by Pemberton Street and south by Rancom Street. It is located between sag points on Wilson Street and Pemberton Street respectively.

Overland flow from the upstream catchment flows from west to east across the site while minor flow is conveyed via a 900mm diameter pipe which discharges to an open channel to the west of Pemberton Street.

Overland flow from Pemberton Street is impeded by existing development over the stormwater channel easement. The December 2007 report indicated that surface flow building up at the Pemberton Street sag can only flow downstream via a 'gap' through a driveway corridor at 21 Pemberton Street. Once the flood level in Pemberton Street reaches a critical level of approximately RL4.1mAHD, flow continues downstream. The building facade line at Pemberton Street generally forms a continuous barrier to overland flow. Therefore the overriding control impacting the flood level at Pemberton Street is the 'gap' at 21 Pemberton Street. Therefore, if the gap through 21 Pemberton Street is blocked, surface flow may pond in Pemberton Street and back up to a level of 5.15mAHD before overtopping occurs at Botany Road.

Flooding at Wilson Street is determined by a 14ha upstream catchment. Runoff exceeding pipe capacity ponds in Wilson Street to a depth of 0.3m before overland flow occurs across the site towards Pemberton Street

The pre development flood mechanisms described above are shown at Figure 3-1.

2.2 POST DEVELOPMENT FLOODING MECHANISMS

The proposed development footprint is indicated at HT Dwg 06s221C 08. The site shall be raised to elevate buildings to above 1 in 100 Year ARI flood level. The proposal of a park is central to the development (Central Basin) providing compensatory flood storage and detention for areas of the site draining to the central basin. The park will also serve as a bio-retention facility to manage the quality of stormwater discharging from the site.

The overland flow path from Wilson Street to Pemberton Street is maintained by allowing through flow within New Street 1. This is critical to managing flood related issues at the site.

A summary of peak 1 in 100 Year ARI flood levels from the June 2010 addendum is included in Table 2-1 below. A summary of results from all previous assessments is provided at the Appendix.

Table 2-1 Summary of Flood Levels from June 2010 assessment

Location	Peak 100 Year ARI Flood Level (mAHD)	
	Pre Development	Post Development
Pemberton Street Sag	4.47	4.50
Wilson Street Sag	5.10	5.07

3.0 RE-ASSESSMENT OF FLOOD MECHANISMS

3.1 TWO-DIMENSIONAL FLOOD MODELLING

A two-dimensional flood modelling exercise is required to support this current flood study report as a requirement by the Botany Council. TUFLOW was chosen as the appropriate computer software for two-dimensional flood modelling for the following reasons:

- TUFLOW simulates flooding through two-dimensional overland flows and one-dimensional piped urban flows
- Storage areas and flood attenuation are considered given that topography within floodplain are correctly represented
- TUFLOW generates GIS-based graphical results which are great for presentation and easy to understand

The initial TUFLOW study has been undertaken by an independent consultant, BMT WBM. A review of this model is provided in the paragraphs below.

3.1.1 Review of BMT WBM TUFLOW Model

A report which describes in details the TUFLOW model developed by BMT WBM for the purpose of supporting this current report is attached in Appendix A. The TUFLOW model setup and input parameters have been reviewed and summarised below.

3.1.1.1 Model Topography

A 2m model grid was selected for the study. It was considered as appropriate for representing local flow paths that are of interest in the study.

A Digital Elevation Model (DEM) representing the existing topography provided by MMHT was used for the model (12 outputs are provided at Appendix A). The DEM was developed base on data which consists of photogrammetry spot levels on 15m grid, breaklines representing kerbs and embankments as well as detailed ground survey of the site and adjacent road reserves.

A DEM representing the post development topography was also provided by MMHT for TUFLOW modelling. The post-development DEM is based MMHT's design and includes key ground level changes such as raising much of the site above the 1 in 100 year flood level, the construction of a detention basin (Central Basin) and the construction of a new road (New Road No.1) between Wilson and Pemberton streets.

The detailed ground survey used for developing the DEM gives a good representation of topography within and in the immediate surroundings of the site. Although the use of photogrammetrical information alone (with 15m resolution) to the north of the site reduces model results accuracy, it is still considered as adequate because any potential flood impact from the proposed development is unlikely to extend to areas which is remote from the site.

Buildings were modelled as raised land. It is considered as an appropriate approach because it underestimates additional flood storage within buildings and gives conservative estimate of flood levels. It is also consistent with the approach adopted in the previous flood study undertaken for the site (MMHT December 2007).

3.1.1.2 Model Drainage Network

A summary of the pipe network included in the TUFLOW model is shown below in Table 3-1. The pipe network details were provided by MMHT to BMT WBM.

Table 3-1 Pipe Network Details

Name	From	To	Length (m)	U/S Invert (mAHD)	D/S Invert (mAHD)	Pipe Diameter (mm)
P B12	B12	B11	9.35	13	12.28	300
P B11	B11	B10	36.39	11.08	8.19	375
P B11	B10	B9	22.79	7.55	6.22	375
P B9	B9	B8	18.30	5.68	5.53	375
P B8	B8	B7	5.62	5.45	5.35	375
P B7	B7	B5	193.0	4.85	3.56	525
P B5	B5	B4	65.1	3.46	3.162	900
P B4	B4	B3	118.3	3.162	2.62	900
P B3	B3	B2	39.3	2.62	2.44	900
P B2	Pit1	B1	53.1	2.44	2.2	900
P BA3	BA3	BA2	16.5	12.96	12.41	225
P BA2	BA2	BA1	8.49	12.15	11.94	375
P BA1	BA1	B11	1.5	11.78	11.7	375
P BE	BE	BA1	14.02	13.45	12.41	0.51W x 0.15H
P BB	BB	B8	10.14	5.95	5.77	375
P BD	BD	B7	10.06	5.64	5.51	300
P BC	BC	B7	18.65	5.26	4.86	300
P Z	Z	N115	27	4.8	4.65	300
P BZ	BZ	B3	24.6	2.8	2.65	600
P AA	AA	B5	127.7	6.1	3.75	525
P C3	C3	B5	5	4.18	4.15	375
Pipe Park	Park	B2	100	3.7	2.5	525
RaftsToN115	Rafts	N115	176	4.8	4.65	1.4W x 0.8H
N115toB1	N115	B1	250	4.6	2.4	1.4W x 0.8H
DS Drain	Drain	DS	300	1.5	0.5	1.5W x 1.2H

3.1.1.3 Model Hydrology

Hydrology was provided by MMHT. Methodology and approach adopted was discussed in details in MMHT Flood Report December 2007. Hydrology for the Wilson and Pemberton Street catchments was based on DRAINS result outputs and hydrology for the northern catchment was based on RAFTS result outputs.

The 1-hour duration storm generates the peak flood level on Pemberton Street in a 1 in 100-Year ARI event for both existing and post-development scenario.

3.1.1.4 Model Roughness and Other Assumptions

The site mainly consists of industrialised areas and road reserves. A Mannings n value of 0.015 was selected for road reserves. All remaining area was modelled to have Mannings n value of 0.05, which is typical for highly industrialised areas. Pipe roughness was defined with a Mannings n value of 0.015.

Other key assumptions mainly relate to downstream boundary conditions. It was assumed that surface overland flows drain freely towards Hannon and Margate Streets. A 'normal depth' downstream boundary condition was selected. A fixed tailwater level of 2.1mAHD was applied to the pipe DS Drain as downstream boundary. It was considered as a conservative assumption and appropriate because it is unlikely to have impact on flood levels on Pemberton Street.

3.1.2 Development of MMHT TUFLOW Model

3.1.2.1 Model Topography

The approach and assumptions adopted by BMT WBM is considered to be appropriate. However, a review of the ground model was undertaken at critical locations. The ground model was adjusted based on site observations (north of the site on Pemberton Street) and detailed ground survey.

Detailed ground survey indicates that flood water in 19-21 Wilson Street can escape through an approximately 2m gap between buildings to the site. However, from aerial photographs and also site observations, the flow path is likely be blocked by stacked containers and is not available for active flow. The ground model has been adjusted to block the minor flow path at 19-21 Wilson Street.

3.1.2.2 Model Drainage Network

The pipe network details included in BMT WBM TUFLOW model are consistent with the information provided by MMHT. However, some minor adjustments to model set-up are as follows:

- The capacity of pipe DS Drain has been doubled based on detailed ground survey which indicates that it is a twin box culvert (Table 3.2). The invert levels of the pipe have been raised as shown below in Table 3-2 according to the detailed ground survey.
- A blockage factor of 20% has been applied to the pipe DS Drain. This is considered as reasonable because the drainage culvert is located downstream of the open drainage

ditch west of Pemberton Street and is more prone to blockage during major storm events. The assumption is likely produce a conservative estimate of flood levels at Pemberton Street. However, a number of sensitivity analyses have been carried out and confirmed that the assumptions made to this drainage culvert do not impact on the peak flood level at Pemberton Street. The sensitivity analyses carried out are discussed in details in Section 3.5.1 this flood report.

Table 3-2 Modified Pipe Details

Name	From	To	Length (m)	U/S Invert (mAHD)	D/S Invert (mAHD)	Pipe Diameter (mm)
DS Drain	Drain	DS	300	1.95	0.95	Twin 1.5W x 1.2H

3.1.2.3 Model Hydrology

The model hydrology inputs have been reviewed and found to be consistent with the previous flood report (MMHT December 2007). It has also been confirmed that the 1-hour duration storm generates peak flood level in a 1 in 100-Year ARI event for both existing and post-development scenario.

3.1.2.4 Model Roughness and Other Assumptions

The model roughness parameters adopted by BMT WBM are considered as appropriate. Although most of the industrial properties in the vicinity of the proposed development are concrete or asphalt lined and are less resistant to flows, a Mannings n value of 0.05 is reasonable as it represents the fences and other obstructions to flow within the industrialised area.

The 'normal depth' downstream boundary condition is considered as reasonable. The boundary condition is located some distance downstream of the area of interest.. The fixed tailwater level of 2.1mAHD as downstream boundary to pipe DS Drain is also considered appropriate. A number of sensitivity analyses have been carried out to confirm a varying downstream boundary does not impact on the peak flood level at Pemberton Street and these are discussed in Section 3.5.1 of this report.

4.0 RESULTS

A discussion of MMHT Tuflow modelling results are provided in the following sections.

4.1 Pre Development Flood Mechanisms

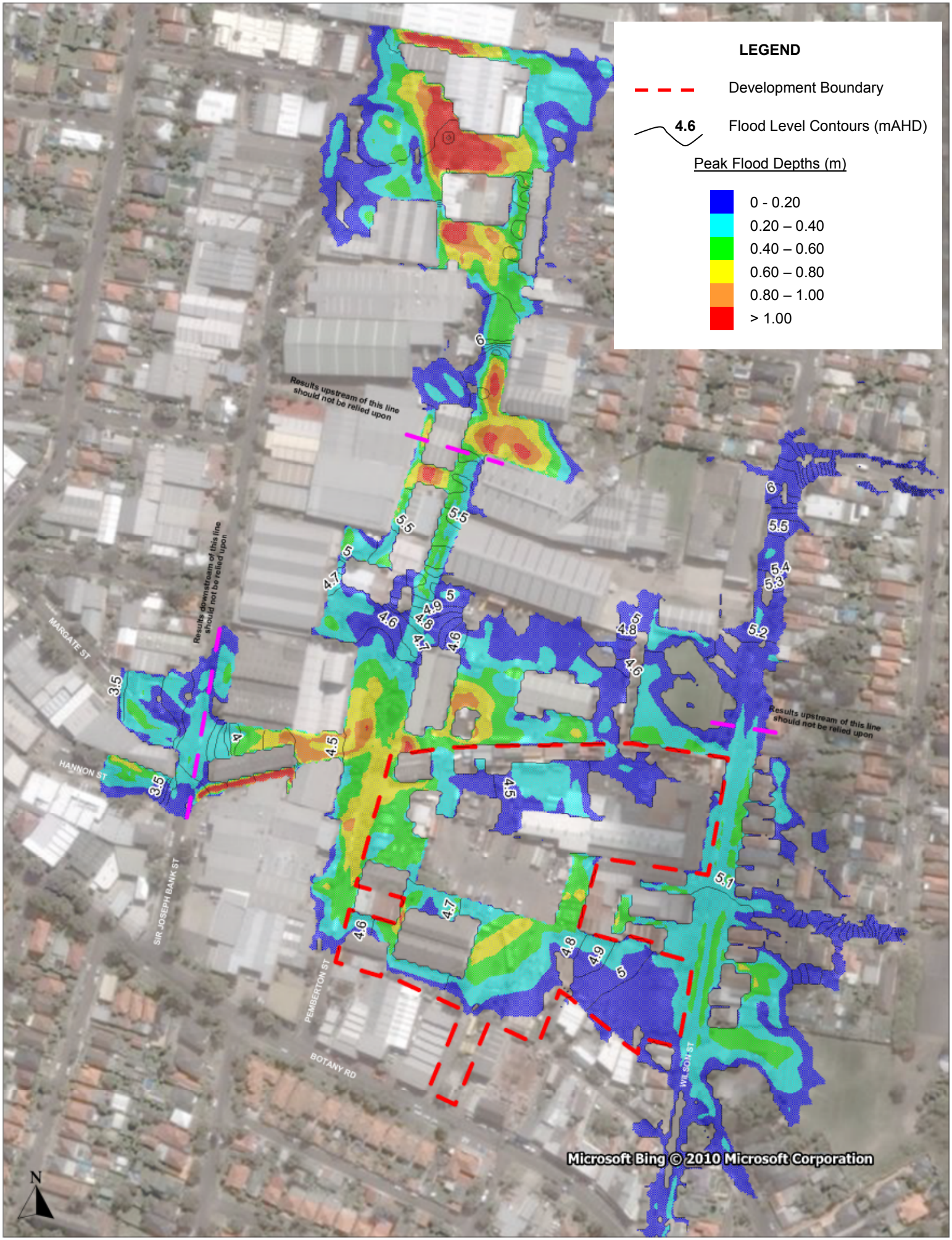
TUFLOW result for the 1 in 100 Year ARI 1 hour storm under existing conditions is shown in Figure 3-1. Result indicates that runoff from Wilson Street catchment ponds at Wilson Street sag and then flows westward to Pemberton Street through the site. The peak 1 in a 100 Year ARI flood level at Wilson Street sag is approximately 5.10mAHD.

Runoff from the northern catchment flows southward to the sag located adjacent to 21 Pemberton Street mainly along the road reserve and partly through buildings. This runoff joins Pemberton Street local catchment runoff with flow from Wilson Street and ponds up to a level of about 4.05mAHD before it can escape through the gap between buildings at 21 Pemberton Street. The peak 1 in a 100 Year ARI flood level at Pemberton Street sag is approximately 4.55mAHD.

A summary of TUFLOW model results is shown in Table 3-3 below. Although estimated peak 1 in 100 Year ARI flood level at Pemberton Street sag is slightly higher than the previous assessment, TUFLOW modelling results generally agree with DRAINS model results as documented in MMHT's flood report of June 2010. TUFLOW estimated flood level at Pemberton Street is slightly higher as a higher Mannings n value of 0.05 has been adopted for the overland flow path through gap between buildings at 21 Pemberton Street. The DRAINS model had utilised a Mannings n value of 0.014 for the flow path and therefore is more effective in conveying flows. Mannings n value of 0.05 is considered as adequate for reason discussed in Section 3.1.2.4. The flood level difference is minimal.

Table 3-3 Summary of Results (Pre Development Conditions)

Location	Peak 100-Year ARI Flood Level (mAHD)	Maximum Flood Depth (m)
Wilson Street Sag	5.10	0.5
Pemberton Street Sag	4.55	0.8



Scale: 1:3,000

50 0 50 100 150

Meters

Figure 3-1 Peak 1 in 100 Year ARI Flood Level Contours and Flood Depths Existing Conditions

4.3 POST-DEVELOPMENT FLOOD MECHANISMS

TUFLOW results for the 1 in 100 Year ARI 1 hour storm under post-development conditions are shown in Figure 3-2. Flooding characteristics are generally similar to those under existing conditions. Overland flow from the Wilson Street catchment ponds at Wilson Street sag and escapes westward to Pemberton Street through the proposed New Road No.1 located north of the site. The peak 1 in a 100 Year ARI flood level at Wilson Street sag is approximately 5.07mAHD.

Compensatory storage is provided by the Central Basin within the proposed development. During a 100 year ARI storm event TUFLOW model results indicate that peak 1 in 100 Year ARI flood level in the basin is approximately 4.68mAHD. This is less than the peak level at the Wilson Street Sag.

Flooding characteristics along Pemberton Street are very similar to those under existing conditions on the basis that current flow path through 21 Pemberton Street remains unchanged. The peak 1 in a 100 Year ARI flood level at Pemberton Street sag has increased slightly to approximately 4.59mAHD representing an overall increase of 0.04m. This is consistent with the results indicated by the MMHT June 2010 Addendum. The proposed New Road No.1 maintains connection between the sags on Wilson and Pemberton streets and may facilitate the reduction of the flood level at Wilson Street.

A summary of TUFLOW model results is shown in Table 3-4 below.

Table 3-4 Summary of Results (Post-Development Conditions)

Location	Peak 100-Year ARI Flood Level (mAHD)	Maximum Flood Depth (m)
Central Basin	4.68	1.2
Wilson Street Sag	5.07	0.5
Pemberton Street Sag	4.59	0.9

4.4 Peak Flood Level Comparison (MMHT TUFLOW study)

Figure 3-3 indicates differences in peak 1 in 100 Year ARI flood level in the vicinity of the proposed development. TUFLOW model result shows that there is no change (within 10mm difference) in peak flood level as a result of the proposed development to the north of the site (green hatch). The peak flood level has decreased in the order of 50mm in the Wilson Street area (light blue hatch). There is a marginal increase in peak flood level (less than 50mm) in the proximity of Pemberton Street sag (yellow hatch)..

The above findings also agree with the DRAINS model results as documented in MMHT's flood report December 2007. Comparisons of TUFLOW results and afflux are shown in Table 3-5 below.

Table 3-5 Comparisons of Results (MMHT TUFLOW)

Location	Peak 100 Year ARI Flood Level (mAHD)		Afflux (m)
	Existing	Post	(Post – Existing)
Pemberton Street Sag	4.55	4.59	0.04
Wilson Street Sag	5.10	5.07	-0.03

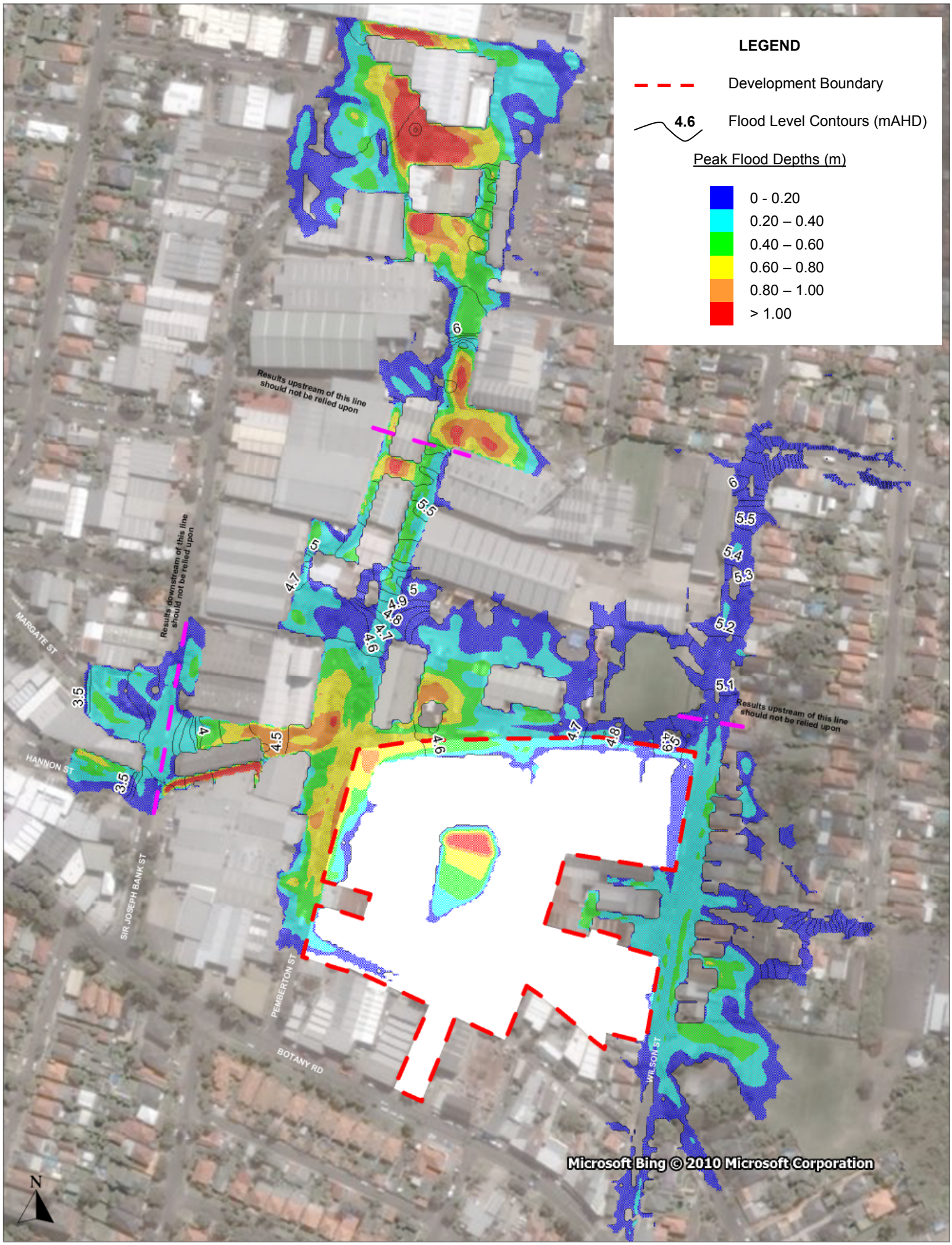
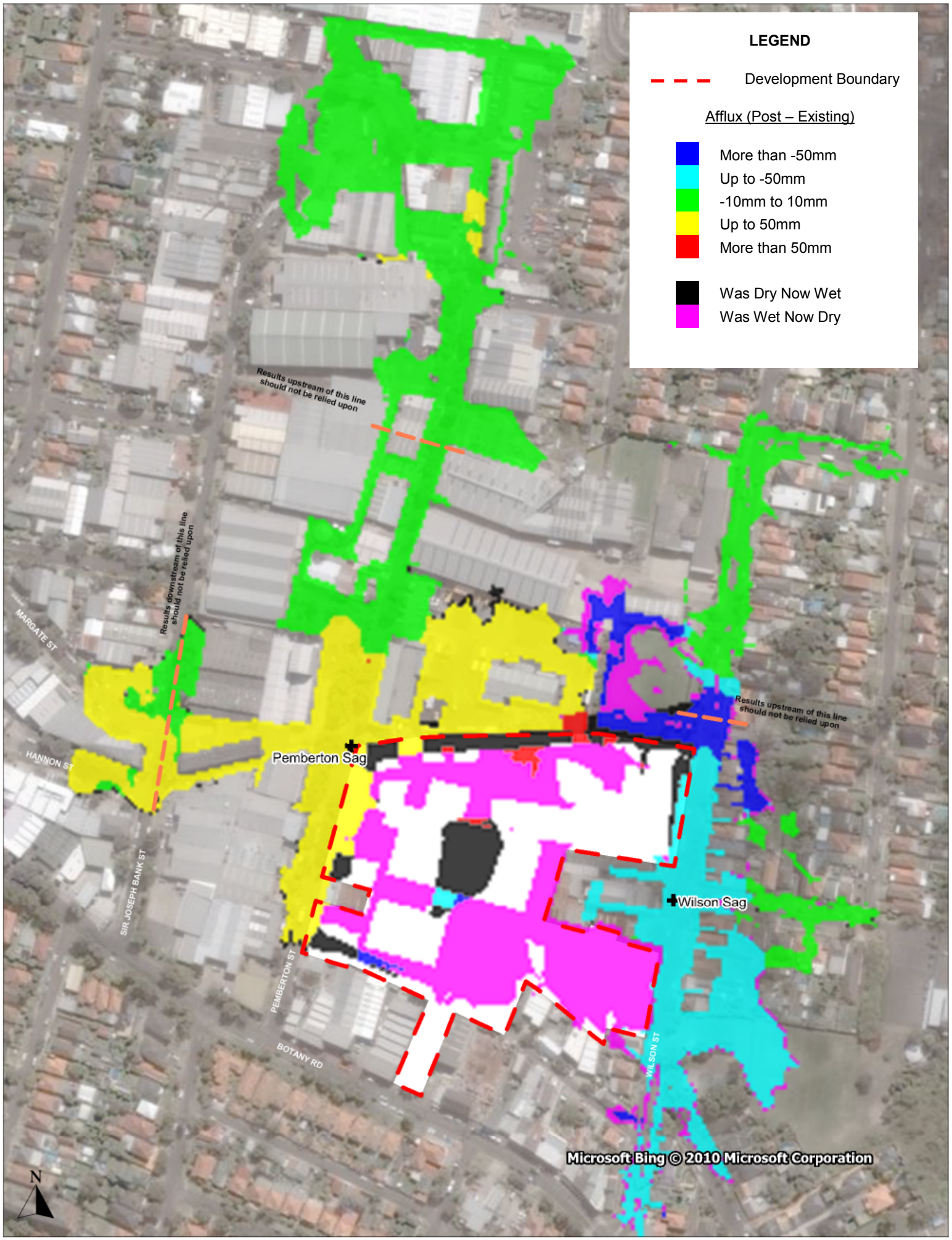


Figure 3-2 Peak 1 in 100 Year ARI Flood Level Contours and Flood Depths
Post-Development Conditions



Scale: 1:3,000

50 0 50 100 150

Meters

Figure 3-3 Difference in Peak 1 in 100 Year ARI Flood Level Post-Development Conditions – Existing Conditions

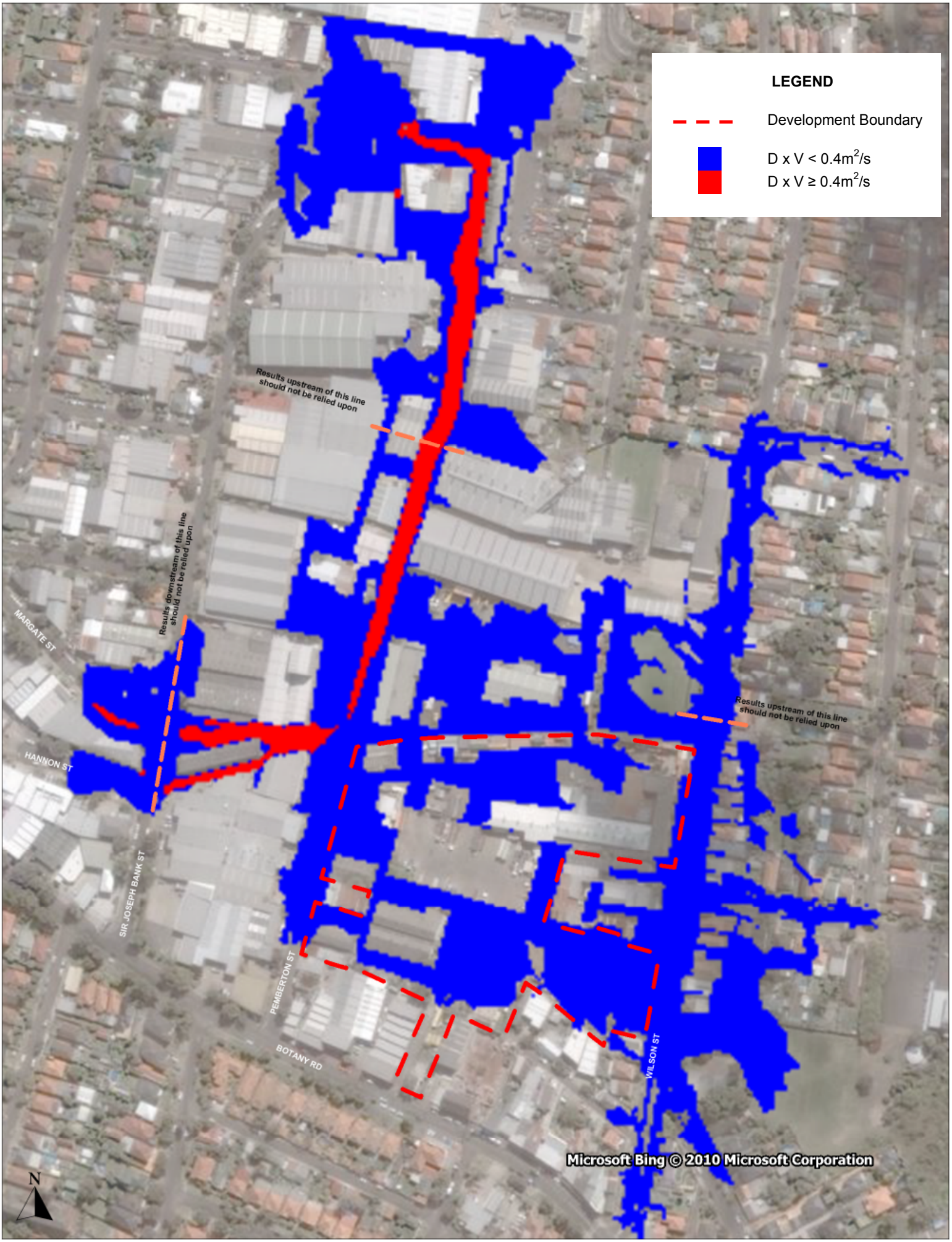
4.4 FLOOD HAZARD

Figure 3-4 and Figure 3-5 indicate the DxV relationship in the vicinity of the proposed development under existing conditions and post-development conditions respectively. The products of depths and velocities can be used as a measure of degree of hydraulic hazard. It is recommended in Australian Rainfall & Runoff (1986) that the value should not exceed 0.4m^2/s for pedestrian safety. The limit is based on experimental studies of stability of children in flowing water by Foster and Cox (1973). A higher value of 0.6-0.7m^2/s is appropriate for indication of hazardous conditions to vehicles.

Figure 3-4 indicates that road corridor along Pemberton Street upstream of the sag adjacent to 17-19 Pemberton has a DxV value greater than 0.4m^2/s for the existing predevelopment scenario. This area shown in red would become hazardous particularly to pedestrians during major storm events. The overland flow path between buildings at 21 Pemberton Street and the open drain ditch located west of Pemberton Street is also indicated as hazardous mainly because the high velocities of flood water. Section 4.3 notes existing predevelopment ponding depths at Wilson Street and Pemberton Street reach a maximum of 0.5m and 0.8m respectively in a 1 in 100 Year ARI event. The NSW floodplain development manual notes that flood depths greater than 0.3m may give rise to some instability.

Figure 3-5 shows that flood hazard conditions in the vicinity of the proposed development under post-development conditions are very similar to those under existing conditions. This finding again supports that the proposed development does not impose a negative impact on the adjacent properties. Further, motor vehicles can safely access the site from Botany Road via Rancom Street under severe weather conditions. Flood depths are 0.5 and 0.9m for Wilson Street and Pemberton Street respectively

Depth of water in the proposed Central Basin can reach a maximum of 1.2m in major storm events and safety measures such as signage should be considered.



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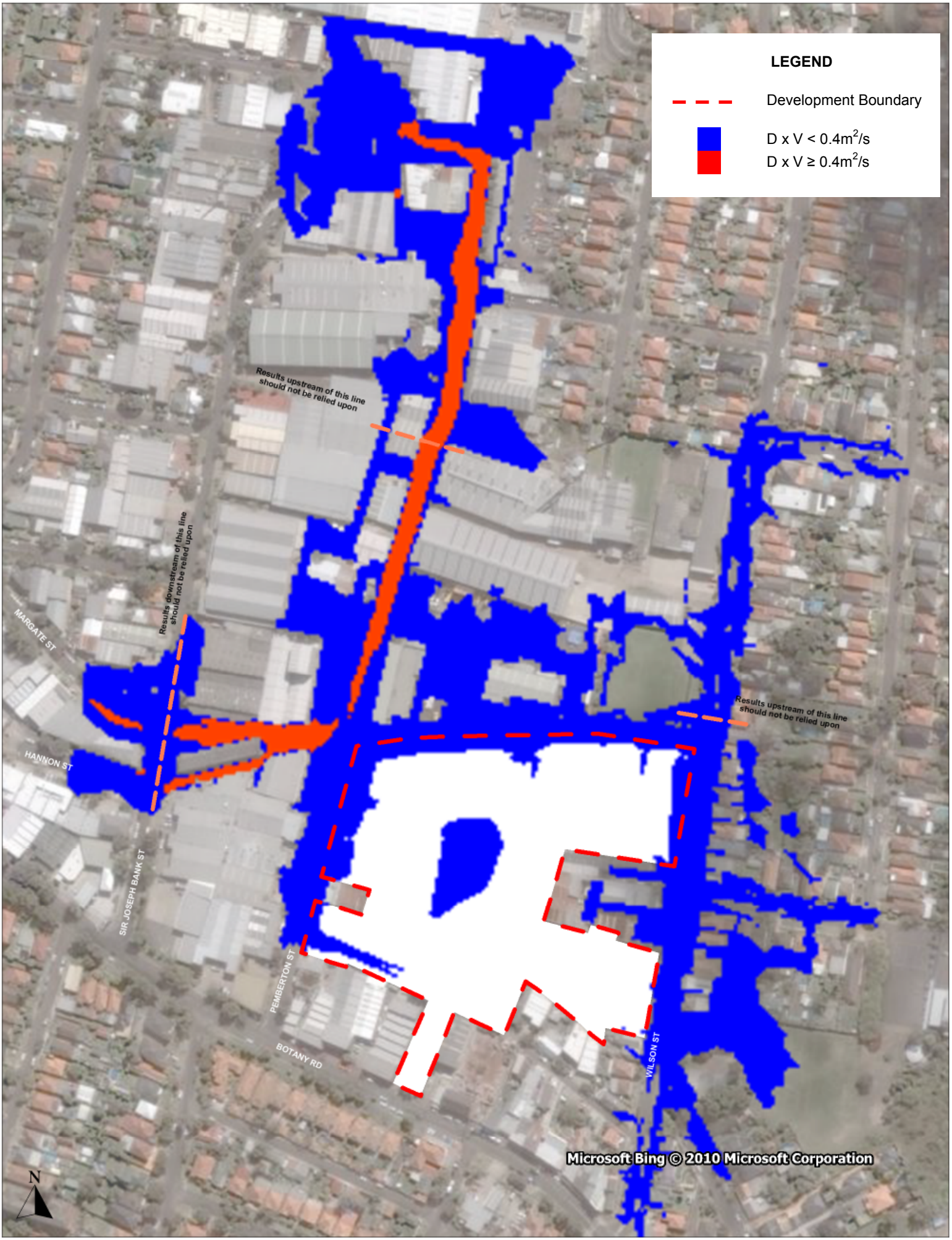
Meters

Figure 3-4 Pedestrian Hazard Zone Existing Conditions



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Meters

Figure 3-5 Pedestrian Hazard Zone
Post-Development Conditions

4.5 SENSITIVITY ANALYSIS

4.5.1 Downstream Boundary Conditions

A number of sensitivity analyses have been carried out to confirm assumed downstream boundary conditions are appropriate and any changes to the assumed downstream boundary conditions do not impact on estimated flood levels at Pemberton Street. Table 3-6 shows comparison of peak 1 in 100 Year ARI flood level at key locations for the adopted assumptions and three different downstream boundary conditions as sensitivity analyses.

The comparison shows that varying downstream conditions do not have an impact on the estimated flood levels on Pemberton Street during a 1 in 100 Year ARI event. The finding confirms that flood behaviours on Pemberton Street are dependent on the characteristics of the overland flow path between buildings at 21 Pemberton Street. The downstream boundary conditions are located some distance downstream of this hydraulic control.

Table 3-6 Comparison of Results (Downstream Boundary Conditions)

Downstream Boundary Conditions	Peak 100 Year ARI Flood Level (mAHD)					
	Open Drains Downstream		Open Drains Upstream		Pemberton Street Sag	
	Existing	Post	Existing	Post	Existing	Post
2.1mAHD Fixed Tailwater Level and 20% blockage on DS_Drain	3.65	3.67	3.98	4.01	4.55	4.59
2.1mAHD Fixed Tailwater Level and 0% blockage on DS_Drain	3.19	3.22	3.95	3.98	4.55	4.59
0.95mAHD Fixed Tailwater Level and 20% blockage on DS_Drain	3.65	3.67	3.98	4.01	4.55	4.59
2.5mAHD Fixed Tailwater Level and 20% blockage on DS_Drain	3.69	3.70	3.99	4.02	4.55	4.59

4.5.2 Blockage

The Pemberton Street sag is drained by the 900mm diameter trunk drainage (P B2). However, this trunk drainage has very limited capacity. It is found to have less than 5 Year ARI capacity in MMHT December 2007 flood report. It is expected that it conveys only a small portion of flows during a major storm event while a major portion of flows is conveyed through the overland flow path between buildings at 21 Pemberton Street. The sensitivity analysis carried out investigates the impact on peak flood levels if the trunk drainage is 100% blocked. Table 3-7 below summarises the differences in peak flood level under unblocked and 100% blocked scenario.

Sensitivity analysis result indicates that blockage on the 900mm diameter pipe only has minor impact on peak flood level on Pemberton Street. Peak 1 in 100 Year ARI flood level is expected to increase by approximately 40mm if the 900mm diameter pipe become 100% blocked. The result confirms the observation that the trunk drainage has only very limited capacity. It conveys only a small portion of flows even under unblocked scenario and makes little difference to flood level on Pemberton Street if the pipe capacity is further reduced. Peak flood level in the proposed Central Basin is expected to increase marginally by approximately 70mm under blocked scenario.

Table 3-7 Comparison of Results (Blockage Sensitivity Analysis)

Location	Peak 100 Year ARI Flood Level (mAHD)			
	Unblocked		100% Blocked	
	Existing	Proposed	Existing	Proposed
Central Basin	-	4.68	-	4.75
Pemberton Street Sag	4.55	4.59	4.59	4.63
Wilson Street Sag	5.13	5.07	5.13	5.07

The previous assessment (June 2010) of blockage on the 900mm diameter trunk drainage was conservative. The sensitivity analysis the drainage has limited capacity and indicates blockage has minimal impact on flood level.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The current flood study report and two-dimensional flood modelling exercise addresses comment raised by Botany Bay Council. TUFLOW model results generally agree with those from the previous assessments. In conclusion, the current study confirms that:

- The proposed Central Basin offsets loss of flood storage due to raising of site levels and provides compensatory flood storage.
- Flow path through 'gap' between buildings at 21 Pemberton Street exists under present day conditions. Maintaining the flow path is critical in preserving current flood behaviour in post development conditions.
- The proposed development does not cause adverse flood impact on the adjacent properties.
- Flood depths and velocities in the vicinity of the proposed development are not hazardous to pedestrian and motor vehicles.
- Blockage or reduction in capacity of the 900mm diameter trunk drainage has minimal impact on flood level on Pemberton Street.