BORNHORST + WARD PTY. LTD.
A.B.N. 78 010 151 354
Consulting Civil and Structural Engineers

Level 4
67 Astor Terrace
Spring Hill Qld 4000
Australia
mail@bornhorstward.com.au
P +61 7 3013 4699

BORNHORST + WARD
CONSULTING ENGINEERS
CIVIL AND STRUCTURAL

2 December 2015
Ref. No. 12191Y

Economic Development Queensland
Email: wendy.brewster@dilgp.qld.gov.au

ATTENTION: WENDY BREWSTER

Dear Wendy,

Re: SERVICING ENGINEERING REPORT
117 CURTAIN AVENUE WEST, HAMILTON, LOT 14 SP195300

DEVELOPMENT PROPOSAL

The proposed development application is for a Material Change of Use – for temporary activities within the site. The temporary activities are to include use of the existing site as a car parking and storage facility.

It is noted that no civil works are proposed as a result of this proposal. The site will be used for temporary activities in its current partially developed state.

SITE CHARACTERISTICS

The proposed site is bound between Curtain Ave West to the north and Barcham Street to the east. The boundary to the west and south are private property Lot 1194 SP156342. Please refer to Figure 1 below.

Figure 1: Orientation Plan (Retrieved from Google Maps 30/11/2015)

The existing site is fully developed with asphalt pavement. The site is can be accessed via a driveway directly off Barcham St or Curtain Ave West. Current uses of the site include the temporary storage of vehicles and equipment, which is similar to the proposed use.

TOPOGRAPHY AND SITE DRAINAGE

The site is relatively flat and has levels ranging between RL2.0 – 2.75m AHD. The existing asphalt parking area and buildings discharge either directly into the channel in the north east or flow into the adjoining road reserves.

Major flows from the site are expected to discharge north east into the channel either side of Barcham St or north onto Curtain Ave West.

FLOODING

A BCC Floodwise Property report has been obtained for the site. The BCC Defined Flood Level for the site is RL2.5m AHD as a result of Storm Tide from the Brisbane River. A hydraulic analysis report completed by Aurecon in March 2015 has also been obtained. The report investigates the filling of the existing channel adjacent to the sites north, and replacing it with culverts to create developable space. Chainage -385 in Appendix A relates to the bushland basin in the north eastern corner of the site. Appendix B shows the existing flood level at this location to be RL 3.080m AHD.

As indicated above there are discrepancies above between the two flood reports. As the Aurecon report was prepared for an internal investigation, the levels shown are for information only. The approved reference document for the site is therefore the Brisbane City Council Floodwise Report which indicates a flood level of RL 2.50m AHD. Our advice however is for any demountable structure that is to be located on site be raised on posts or similar so as the floor level is at or above RL 3.10m.

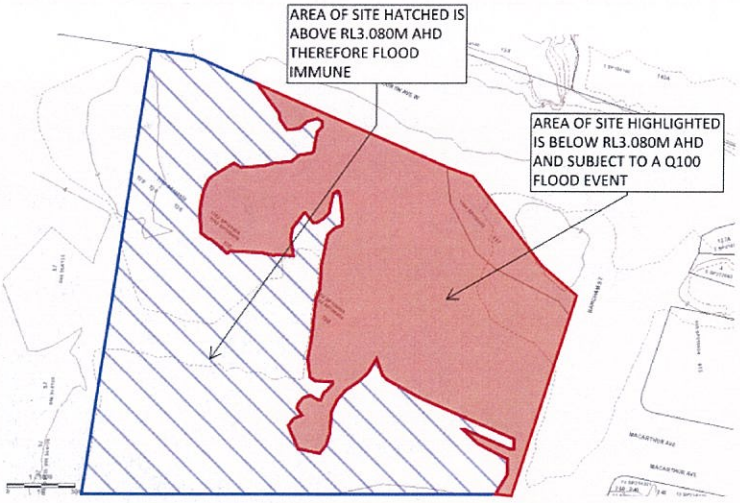


Figure 2: Flood affected area (Retrieved from BCC City Plan 2014 1/12/2015)

As the entire site is below the RL3.080m AHD flood level, Bornhorst & Ward recommend a management plan to be implemented for a flood event where the vehicles are moved to a flood immune area. The expected time of concentration for the Q_{100} flood event is in the hours, therefore there will be sufficient time for vehicles to be relocated. Refer to SKC-001 attached in Appendix C for further information.

The BCC Floodwise report is attached in Appendix A. The Aurecon Hydraulic Analysis Report is attached in Appendix B.

EXISTING & PROPOSED STORMWATER INFRASTRUCTURE

The only stormwater infrastructure near the site is on the fronting road reserves.

- There is a channel at the corner of Barcham Street and Curtain Avenue West which connects to cross road culverts draining beneath both adjoining streets. These culverts are tidally drained and ultimately discharge into the Brisbane River to the south.

Based on a review of the size of the site and the neighbouring channel and culvert systems, it is deemed the site will drain sufficiently. Further investigations need to be undertaken should there be any extensions to the area, with provisions for new drainage being reviewed at this time.

Further to this, as the site is located within the lower 1/3 of the greater catchment area and within close proximity to the Brisbane River, stormwater detention will not be required as per BCC City Plan 2014.

EXISTING & PROPOSED SEWERAGE AND WATER INFRASTRUCTURE

There is existing sewer and water infrastructure within the fronting road reserves. This is summarised as follows and indicated on drawing SKC001 attached:

- There is an existing sewer within Curtain Avenue West, on the northern side of the site. This drains west until connection to the existing Northshore Hamilton Trunk Sewer constructed in 2011.
- There is an existing water main within Curtain Ave West, on the northern side of the site. This runs around the site and down Barcham Street.

It is noted that the existing Northshore Hamilton Trunk Sewer and water main system are sized for future development of the area. Further to this the prior industrial developments serviced by the Macarthur Avenue sewer have since ceased, alleviating capacity within this infrastructure.

It is considered that the proposed temporary site uses will produce negligible sewer and water flows. Based on this there is sufficient sewer and water capacity within the existing infrastructure to service the temporary uses of the site. Should an additional water connection be required for the temporary land uses, permission from QUU will be sought. The existing sewer pipe from Curtain Avenue will be used as the primary connection while the water main can be taken from Curtain Avenue or Barcham Street.

SUMMARY

This desktop serviceability report has demonstrated that the existing infrastructure surrounding the site is suitable for the proposed temporary site uses. The following points summarise the findings and recommendations:

- The site is able to service both its water and sewer needs.
- The BCC Floodwise Report indicates a flood level of RL2.50m

- The Aurecon Hydraulic Analysis Report indicates a flood level of 3.08m for the site. As this document is for information only and was not passed on to BCC, the official flood level for the site is based on the BCC Report.
- Bornhorst & Ward advise that any demountable structure on the site have it's floor level raised above the Q_{100} flood level by Aurecon.
- Bornhorst & Ward advise that a management plan be implemented for flood events where vehicles parked on the site are moved to a flood immune area.

If you have any queries please contact the undersigned.

Yours faithfully,
BORNHORST & WARD PTY LTD

Per: NICHOLAS ROZIS
DIRECTOR

Encl. Appendix A – BCC Floodwise Report
Appendix B – Aurecon Hydraulic Analysis Report
Appendix C – Development Drawing and Figures

APPENDIX A

BCC FLOODWISE REPORT

Brisbane City Council

FloodWise Property Report

Report Reference
1449034743514
02/12/2015 15:39:03

Dedicated to a better Brisbane

THIS REPORT IS FOR BUILDING AND DEVELOPMENT PURPOSES ONLY

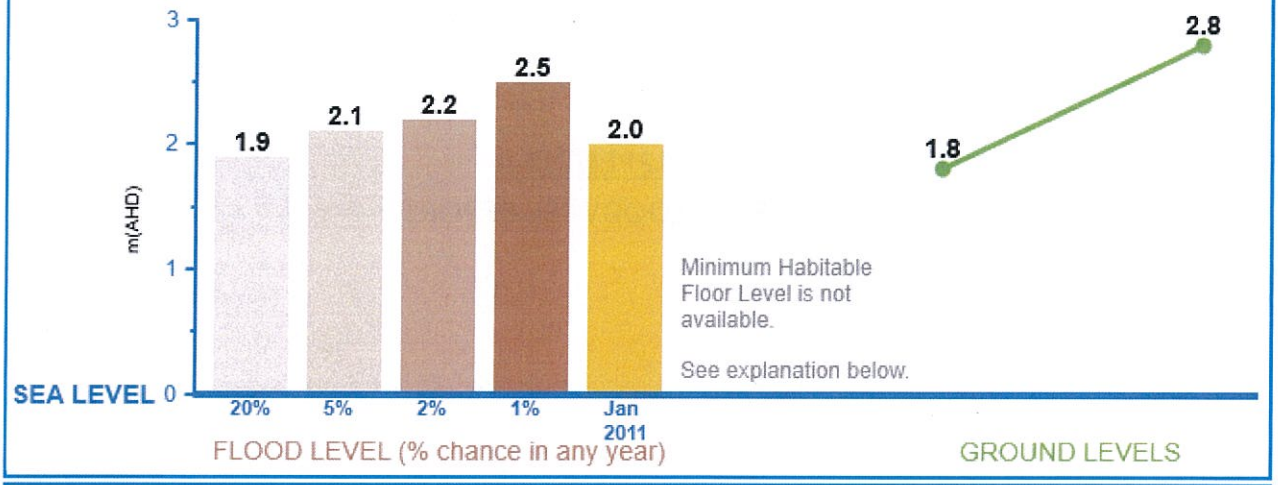
The FloodWise Property Report provides property or lot-based flood information for building and development requirements. This report provides information on estimated flood levels, habitable floor level requirements and more technical information on the four sources of flooding: river, creek / waterway, storm tide and overland flow. Refer to the Useful Definitions section for a glossary of terms.

To find out more about how the contents of this report may affect building or development on this property, please visit www.brisbane.qld.gov.au/planning-building.For more general information about understanding your flood risk and how to prepare your property, family or business for potential flooding visit www.brisbane.qld.gov.au/beprepared

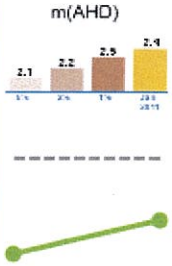
THIS IS A REPORT FOR:

Rateable Address: 117 CURTIN AVE, HAMILTON QLD 4007
Lot Details: L.1194 SP.156342

FLOOD LEVEL INFORMATION



EXPLANATION



m(AHD) - Metres Australia Height Datum. The level of 0.0m AHD is approximately mean sea level.

Flood Levels - The Flood level bar chart above shows the possible flooding level and percentage chance of that level being reached or exceeded in any year. If an orange bar shows, it is the calculated January 2011 flood level at this address or lot.

Minimum Habitable Floor Level - Applies to residential development only. Please refer to Council's planning scheme to learn how this may affect you. If a property is in an overland flow path, or a large allotment, a minimum habitable floor level cannot be provided. Refer flood and planning development flags below.

Ground Levels- The green line above shows this property's approximate lowest and highest ground levels based on latest available information (2009 airborne laser survey) to Council. If you are building, please confirm with a surveyor.

For further information and definitions please refer to the Useful Definitions page

FLOOD AND PLANNING DEVELOPMENT FLAGS

DEVELOPMENT FLAG(S)

This property may also be affected by one or more flood or property development overlays or flags. These include: OVERLAND FLOW PATH,LARGE ALLOTMENT,WATERWAY CORRIDOR

Please review the technical summary over page and refer to Council's planning scheme for further information.

Brisbane City Council

FloodWise Property Report

Report Reference
1449034743514
02/12/2015 15:39:03

Dedicated to a better Brisbane

TECHNICAL SUMMARY

This section of the FloodWise Property Report contains more detailed flood information for this property so surveyors, builders, certifiers, architects and engineers can plan and build in accordance with Council's planning scheme. For more information about building and development in Brisbane please visit www.brisbane.qld.gov.au/planning-building or talk to a Development Assessment Planning Information Officer via Council's Contact Centre on (07) 3403 8888.

THIS IS A REPORT FOR:

Rateable Address: 117 CURTIN AVE, HAMILTON QLD 4007

Lot Details: L.1194 SP.156342

PROPERTY INFORMATION (Summary)

The following table provides a summary of flood information for this property. More detailed flood level information is provided in the following sections of this report.

PROPERTY SUMMARY	LEVEL (mAHD)
Minimum Ground Level	1.8
Maximum Ground Level	2.8
Min Habitable Floor Level	Contact Council
Defined Flood Level (DFL)	2.5
Defined Flood Level Source	STORMTIDE
Flooding may also occur from	STORMTIDE,RIVER,OVERLAND FLOW

ESTIMATED PEAK FLOODING LEVELS

The table below displays the peak estimated flood levels by probability for this property. Estimated flood level data should be used in conjunction with applicable planning scheme requirements - Refer to Flood Planning Development Information.

Note that the overland flow flooding level maybe higher than the levels below from other sources.

DESCRIPTION	LEVEL (mAHD)	SOURCE
20% AEP	1.9	STORMTIDE
5% AEP	2.1	STORMTIDE
2% AEP	2.2	STORMTIDE
1% AEP	2.5	STORMTIDE
January 2011	2.0	RIVER
DFL	2.5	STORMTIDE

FLOOD PLANNING DEVELOPMENT INFORMATION

This section of the FloodWise Property Report contains information about Council's planning scheme overlays. Overlays identify areas within the planning scheme that reflect distinct themes that may include constrained land and/or areas sensitive to the effects of development.

FLOOD OVERLAY CODE

The Flood overlay code of Council's planning scheme uses the following information to provide guidelines when developing properties. The table below summarises the Flood Planning Areas (FPAs) that apply to this property. Development guidelines for the FPAs are explained in Council's planning scheme, which is available from www.brisbane.qld.gov.au/planning-building.

FLOOD PLANNING AREAS (FPA)		
RIVER	CREEK/WATERWAY	OVERLAND FLOW
FPA4		Applicable
FPA5		

COASTAL HAZARD OVERLAY CODE

The coastal hazard overlay code of Council's planning scheme uses the following information to provide guidelines when conducting new development. The table below summarises the coastal hazard categories that apply to this property. Development guidelines for the following coastal hazard overlay sub-categories are explained in the planning scheme, which is available from www.brisbane.qld.gov.au/planning-building.

COASTAL HAZARD OVERLAY SUB-CATEGORIES
Medium Storm Tide Inundation Area
Erosion Prone Area - permanent inundation by 2100

NOTE: Where land is identified within one or more flood planning area on the Flood Overlay, or is identified within a Storm Tide Inundation area on the Coastal Hazard Overlay, the assessment criteria that provide the highest level of protection from any source of flooding applies.

PROPERTY DEVELOPMENT FLAGS

Overland Flow Path - Mapping indicates this property may be located within an overland flow path. Overland flow flooding usually occurs when the capacity of the underground piped drainage system is exceeded and/or when the overland flow path is blocked. It is recommended you consult a Registered Professional Engineer of Queensland to determine this property's habitable floor level and flooding depth. Please refer to Council's planning scheme for further information.

Waterway Corridor - This property may also be located within a mapped waterway corridor as identified in the waterway corridors overlay map of Council's planning scheme. Please consider this in conjunction with Council's planning scheme requirements.

Large Allotment - This property is either a Large Allotment of over 1000 square metres or is located within a Large Allotment. Flood levels may vary significantly across allotments of this size. Further investigations may be warranted in determining the variation in flood levels and the minimum habitable floor level across the site. For more information or advice, it is recommended you engage a Registered Professional Engineer of Queensland.

Brisbane City Council

FloodWise Property Report

Report Reference
1449034743514
02/12/2015 15:39:03

Dedicated to a better Brisbane

Useful Definitions

Australian Height Datum (AHD) - The reference level for defining ground levels in Australia. The level of 0.0m AHD is approximately mean sea level.

Annual Exceedance Probability (AEP) – The probability of a flood event of a given size occurring in any one year, usually expressed as a percentage annual chance.

Defined Flood Level (DFL) - The DFL for Brisbane River flooding is a level of 3.7m AHD at the Brisbane City Gauge based on a flow of 6,800 m^3/s.

Maximum and Minimum Ground Level – Highest and lowest ground levels on the property based on available ground level information. A Registered Surveyor can confirm exact ground levels.

Minimum Habitable Floor Level – The minimum level in metres AHD at which habitable areas of development (generally including bedrooms, living rooms, kitchen, study, family and rumpus rooms) must be constructed.

Council's Planning Scheme - The City Plan (planning scheme) has been prepared in accordance with the Sustainable Planning Act as a framework for managing development in a way that advances the purpose of the Act. In seeking to achieve this purpose, the planning scheme sets out the Council's intention for future development in the planning scheme area, over the next 20 years.

Residential Flood Level (RFL) – Residential flood level (RFL) for Brisbane River flooding equates to the flood level applicable to the extent of January 2011 floods as depicted by mapping on the Queensland Reconstruction Authority website or the Council's defined flood level (DFL) for the Brisbane River, whichever is higher.

Rateable Address - A Lot or Property may have more than one street address. The address shown on this report is the address used by Council for the Lot or property selected.

Property - A property will contain 1 or more lots. The *Multiple Lot Warning* is shown if you have selected a property that contains multiple lots.

Brisbane City Council's Online Flood Tools

Council provides a number of online flood tools:

- to guide planning and development
- to help residents and businesses understand their flood risk and prepare for flooding.

Planning and Development Online Flood Tools

Council's online flood tools for planning and development purposes include:

- FloodWise Property Report
- Flood Overlay Code

For more information on Council's planning scheme and online flood tools for planning and development:

- phone 07 3403 8888 to talk to a Development Assessment Customer Liaison Officer
- visit www.brisbane.qld.gov.au/planning-building
- visit a Regional Business Centre.

Helping residents and businesses be prepared for flooding

Council has a range of free tools and information to help residents and businesses understand potential flood risks and how to be prepared. This includes:

- Flood Awareness Maps
- Flooding in Brisbane – A Guide for Residents
- Flooding in Brisbane – A Guide for Business
- Early Warning Alert Service. Visit www.brisbane.qld.gov.au/earlywarning to register for email, home phone or SMS severe weather alert updates.

Note: The Flood Awareness Maps show four levels of flood risk from high risk (flooding is very likely to occur) through to very low risk (very rare and extreme flood events). Flooding in the low and very low risk areas has no planning and development requirements and is therefore not reflected in the FloodWise Property Report.

For more information on Council's online flood tools for residents and business:

- Visit www.brisbane.qld.gov.au/beprepared
- Phone (07) 3403 8888.

Brisbane City Council

FloodWise Property Report

Report Reference
1449034743514
02/12/2015 15:39:03

Dedicated to a better Brisbane

Disclaimer

1. Defined Flood Levels and Residential Flood Levels, and the Minimum Habitable Floor Levels are determined from the best available information to Council at the date of issue. These flood levels, for a particular property, may change if more detailed information becomes available or changes are made in the method of calculating flood levels.
2. Council makes no warranty or representation regarding the accuracy or completeness of a FloodWise Property report. Council disclaims any responsibility or liability in relation to the use or reliance by any person on a FloodWise Property Report.

Planning to build or renovate?

For information, guidelines, tools and resources to help you track, plan or apply for your development visit **www.brisbane.qld.gov.au/planning-building**

You can also find the Brisbane City Plan 2014 and Neighbourhood Plans as well as other information and training videos to help with your building and development plans.

APPENDIX B

AURECON HYDRAULIC ANALYSIS REPORT

aurecon

Hamilton Northshore Development

Hydraulic Analysis

Economic Development Queensland

9 March 2015
Revision: 0
Reference: 245069

Leading. Vibrant. Global.
www.aurecongroup.com

Document control record

Document prepared by:

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 14, 32 Turbot Street
Brisbane QLD 4000
Locked Bag 331
Brisbane QLD 4001
Australia

T +61 7 3173 8000
F +61 7 3173 8001
E brisbane@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Hydraulic Analysis				
Document ID			**Project number**		245069	
File path		**245069 - Hamilton Northshore Development - Hydraulic Analysis Report - R0.docx**				
Client		Economic Development Queensland	**Client contact**		Archie Venitis	
Rev	**Date**	**Revision details/status**	**Prepared by**	**Author**	**Verifier**	**Approver**
0	6 March 20159 March 20156 March 20159 March 20159 March 2015	Draft for Client Review	C Smyth	B Sexton	T Graham	T Graham
Current revision		**0**				

Approval			
Author signature		Approver signature	
Name	Brian Sexton	Name	Trinity Graham
Title	Senior Engineer	Title	Technical Director

Hamilton Northshore Development

Date 9 March 2015
Reference 245069
Revision 0

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 14, 32 Turbot Street
Brisbane QLD 4000
Locked Bag 331
Brisbane QLD 4001
Australia
T +61 7 3173 8000
F +61 7 3173 8001
E brisbane@aurecongroup.com
Waurecongroup.com

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Project background

The proposed continued redevelopment of Hamilton Northshore will convert what is currently industrial land into a high quality residential area. The site is bounded by the Brisbane River to the south, Kingsford Smith Drive to the north, and The Royal Queensland Golf Club to the east (refer to Figure 1). A flowpath exists which conveys runoff from the upstream catchment via an open drain which runs through the site before discharging into the Brisbane River. The catchment primarily contains urbanised land and produces high runoff rates and a relatively quick response time.

The masterplanning for the development requires that consideration is given to flood conveyance and that adequate drainage infrastructure and easements are inherent to the overall design.

Aurecon have been commissioned by Economic Development Queensland (EDQ) to undertake a hydraulic assessment of the site. Aurecon has previous experience at this location having carried out the Northern Australia Trade Coast Drainage and Fill Study (2006/7). As part of this study Aurecon developed a hydrologic and hydraulic model which is still currently available and useable.

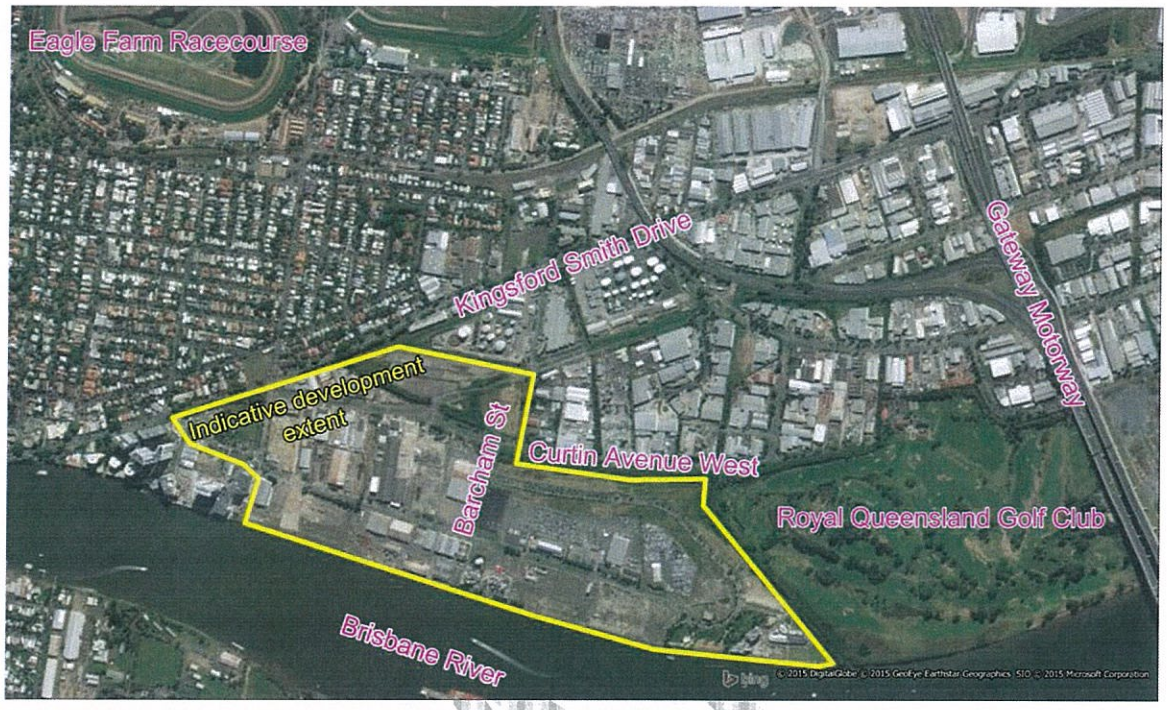


Figure 1 Locality plan

1.2 Previous studies

The Northern Australia Trade Coast Drainage and Fill Study (2006/7) involved the development of a RAFTS hydrologic model and a one-dimensional MIKE11 hydraulic model for drainage system that runs through the Hamilton Northshore site.

This study provided predicted design event flood information for a range of events as well as looking at various development scenarios. For further information on the particulars of this study please refer to the referenced documentation.

It was noted that the extent of the NATC hydraulic model did not cover the extent of open channel up to Kingsford Smith Drive and consequently it needed to be extended. This is further discussed in Section 3.3.1.

It was also noted that no calibration was previously undertaken as part of the 2006/7 study.

1.3 Objectives and design criteria

Meetings (and further discussion via telephone and email) were held with both EDQ and Bornhorst and Ward (B&W – another sub-consultant to EDQ working on the project). Over the course of the early stages of the project the objectives of the study were defined. They were split into two main categories as follows:

- Analysis of the section of channel between Barcham St and Kingsford Smith Drive to determine the effects of filling the channel to maximise development potential. Ideally this will seek to determine:
  - 10 year ARI sub-surface capacity with excess overland flow capacity
  - 100 year ARI sub-surface capacity (ie complete capture of flow within the underground network)

- Analysis of the pedestrian crossing of the channel near the boundary of the Royal Queensland Golf Club to optimise the design (ie bridge options versus culvert options)
  - The design would seek to minimise afflux (any increase in upstream flood levels) and maintain manageable velocities at the structure (typically <1.0 m/s for a channel of this nature)

1.4 Data sourcing and checking

Aurecon met and communicated with B&W to obtain relevant data which was subsequently used in the checking and modifying the hydraulic model.

This included:

- Site survey information (in AutoCad '.dwg' format)
- Masterplanning sketches
- Preliminary general arrangement drawing sets for development areas within the site
- As-Constructed drawings for new developments in the area
- Details of the existing culvert beneath Kingsford Smith Drive (ie at the upstream extent of the site)

This data was collated and reviewed by Aurecon to establish its use in the study and, where necessary, to confirm accuracy. For example, the survey data was cross-checked against the MIKE 11 cross-sectional data at the bank-full level for consistency. It was found that generally speaking both sets of topographic data agreed quite well – discrepancies were typically in the order of 0.1 m to 0.2 m.

At this early stage of the project this was seen as a satisfactory comparison. It is recommended that at detailed design additional cross-sectional data be obtained to ensure it is current, and that geo-morphological changes in the channel (or changes to the bank levels) are taken into account. However, seeing as the development is only at masterplanning phase, it does not warrant the expenditure on obtaining updated survey data at this stage in the project.

2 Hydrology

2.1 General

The RAFTS model that was developed as part of the Northern Australia Trade Coast Drainage and Fill Study (2006/7) was retrieved from Aurecon's archives for use in this project. The existing scenario model has been adopted for this investigation noting that as the catchment is fully developed, future increases in runoff is not expected to be significant.

Due to the age of the model it first had to be updated to run on the most current RAFTS software version. Once this had been achieved the model was reviewed in terms of its setup and parameterisation. This review process found that the approach and selection of parameters/coefficients in the model were satisfactory and in line with current industry guidelines (ie Australian Rainfall and Runoff, 1997).

For information regarding the parametrisation of the model please refer to the Northern Australia Trade Coast Drainage and Fill Study (2006/7). Figure 7 shows the subcatchment discretisation (also reproduced at larger scale in Appendix A).

The model was then rerun for a range of events and durations, and the necessary results extracted for use in the MIKE 11 hydraulic model. This is further discussed in Section 3.

2.2 Software

RAFTS (developed by XP solutions) is a non-linear runoff routing model used extensively throughout Australia and South East Asia. It has been shown to work well on catchments ranging in size from a few square metres to thousands of square kilometres of both urban and rural nature, and is therefore suitable for use in assessing the hydrologic behaviour of the Hamilton Northshore catchment.

The software uses the Laurensen non-linear runoff routing procedure to develop a stormwater runoff hydrograph from either an actual event (recorded rainfall time series) or a design storm, utilising Intensity-Frequency-Duration data together with dimensionless storm temporal patterns and standard Australian Rainfall and Run-off (AR&R) data. This is in line with current industry practices for determining design discharge information.

2.3 Hydrologic analysis

The RAFTS hydrologic model was run for the following three design event magnitudes:

- 10 year Average Recurrence Interval (ARI)
- 50 year Average Recurrence Interval (ARI)
- 100 year Average Recurrence Interval (ARI)

Note that for each design event magnitude the full range of standard event durations were simulated (ie from the 15 minute storm through to the 6 hour storm).

Analysis of the discharge characteristics within the drainage channel was then undertaken to establish which event durations for each of the event magnitudes, were critical.

It was found that in the case of the 50 year and 100 year ARI events the 60 minute storm generated the peak (critical) discharges, while it was the 90 minute storm that generated the peak (critical) discharge for the 10 year ARI event (refer to Figure 2 which shows the locations of interest being considered).

This is demonstrated in Figure 3 and Figure 4 which shows the design discharge hydrographs for Kingsford Smith Drive and the proposed pedestrian crossing.

Figure 2 Design hydrograph location of interest

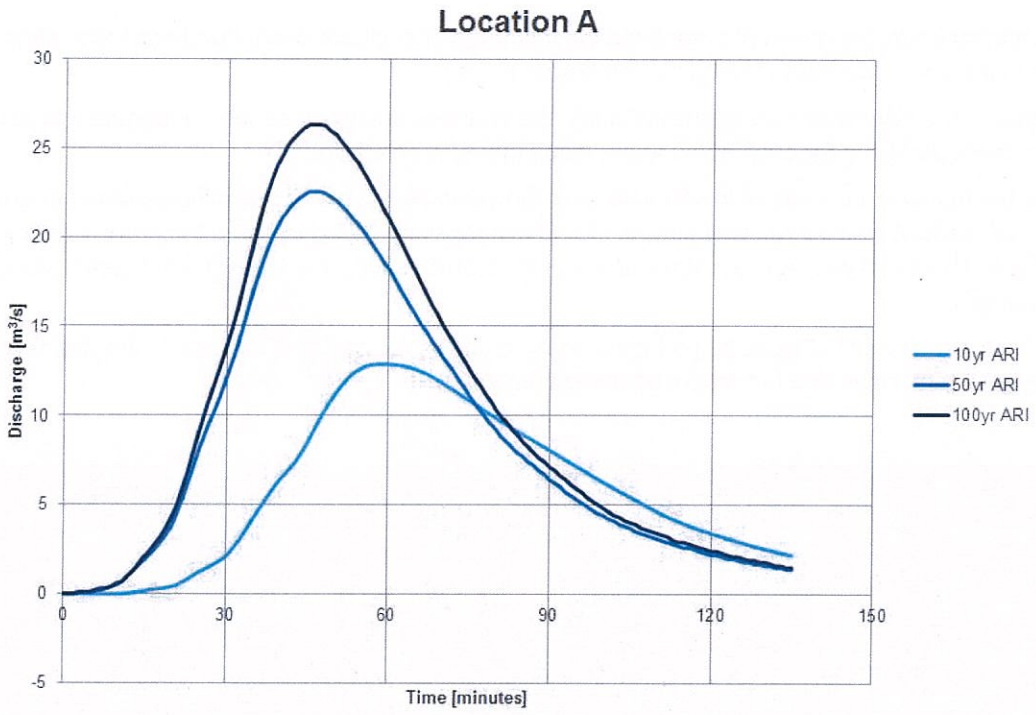


Figure 3 Location A design event hydrographs

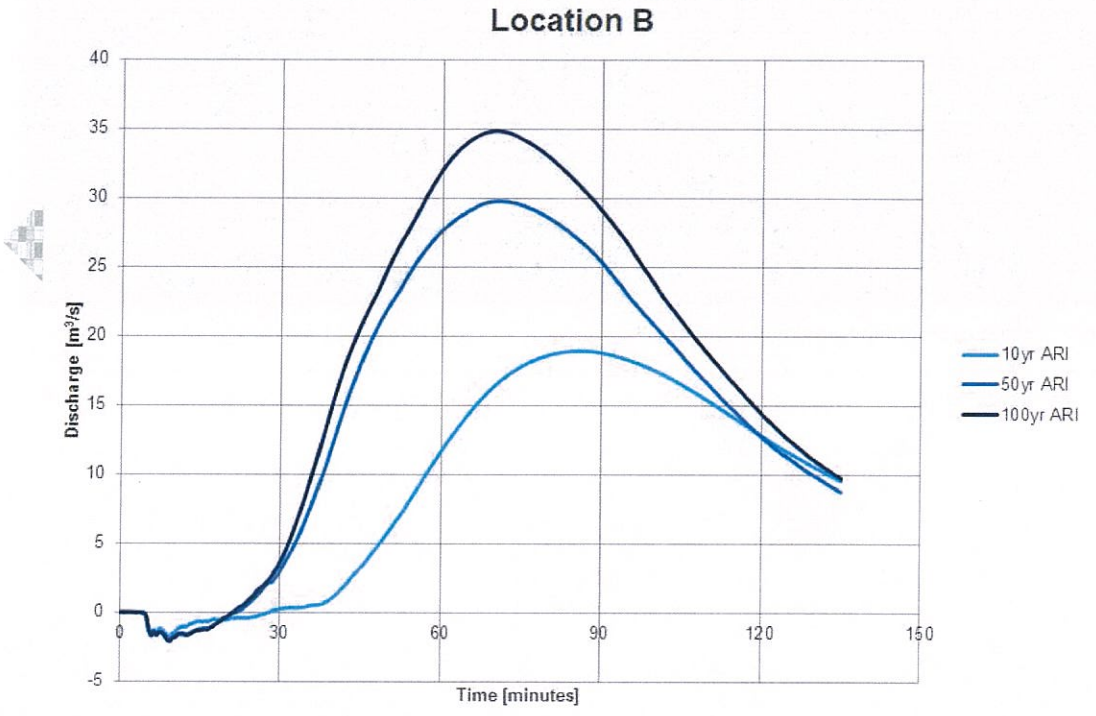


Figure 4 Location B design event hydrographs

Table 1 also presents the exact peak discharges corresponding to the graphical data.

Table 1 Design peak discharge data

Return period (years)	Location A Peak Discharge (m^3/s)	Location B Peak Discharge (m^3/s)
10	12.9	18.9
50	22.5	29.8
100	26.3	34.8

2.4 Sensitivity analysis

A sensitivity analysis was carried out to test the effect of increased peak discharge. This was undertaken for the 100 year ARI event whereby a 20% increase in the peak discharge was applied to the hydrograph. This simulates the effect of increased rainfall intensity which is expected to occur as a result of climate change.

The hydrographs generated for this scenario are provided in Figure 5, while the peak discharge data corresponding to the graphical data is shown in Table 2. The results of this exercise are discussed in Section 4.3.

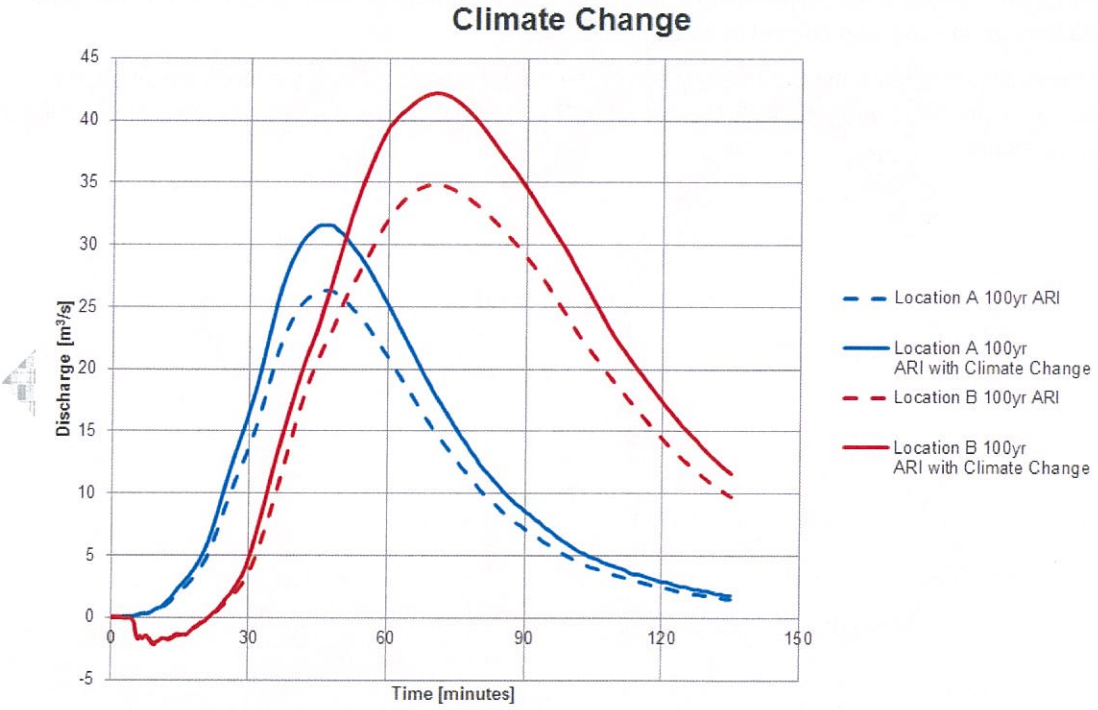


Figure 5 Sensitivity analysis 100 year ARI design hydrographs

Table 2 Sensitivity testing peak discharge data

Scenario	Location A Peak Discharge (m^3/s)	Location B Peak Discharge (m^3/s)
100 year ARI	26.3	34.8
100 year ARI with climate change	31.6	42.2

3 Hydraulic analysis

3.1 Background

The hydraulic analysis for this project was based on the use of the existing model that was developed as part of the Northern Australia Trade Coast Drainage and Fill Study (2006/7).

The 2006/7 MIKE11 model was retrieved from Aurecon's archives for use in this project. Due to the age of the model it first had to be updated to run on the most current MIKE11 software version. Once this had been achieved the model was reviewed in terms of its set-up and parameterisation. This review process found that the approach and selection of parameters/coefficients in the model were satisfactory and in line with current industry practices.

For information regarding the parametrisation of the model please refer to the Northern Australia Trade Coast Drainage and Fill Study Report (2006/7). Figure 6 shows the network view of the 2006/7 MIKE 11 model.

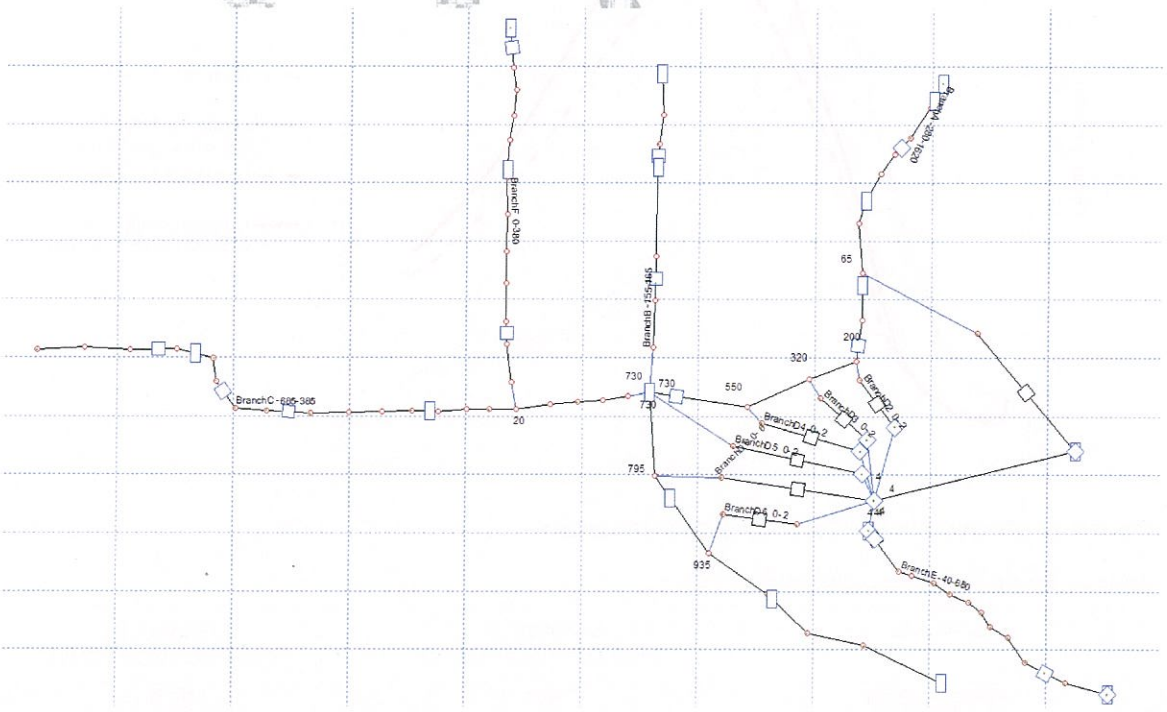


Figure 6 Network view of the 2006/7 MIKE 11 model

3.2 Software

MIKE 11 is robust and reputable one-dimensional hydraulic modelling package developed by the Danish Hydraulic Institute (DHI). It allows creek channel and floodplains to be represented by one cross-section over a creek reach. The difference in roughness across the section can be represented in detail, however water levels and velocities are averaged over the entire section.

For unsteady flow – as is the case in the Hamilton Northshore project – MIKE11 solves the full, dynamic, Saint-Venant equation using an implicit, finite difference method. It is also capable of modelling various flow regimes along with the effects of bridges, culverts, weirs, and structures. It is therefore suited for use in the hydraulic assessment of the Hamilton Northshore development.

3.3 Methodology and approach

In order to test the various scenarios as outlined in Section 1.3 it was necessary to undertake some significant modification of the model. These modifications are explained in the following sections to provide background on the methodology/approach taken. The model was consistently reviewed to ensure that the modifications were functioning in a hydraulically sensible and correct manner, and that no instabilities were present.

3.3.1 Model extension

A review of the model extent as developed for the 2006/7 study showed that it did not extend all the way to Kingsford Smith Drive – the most upstream model cross-section was located 220 m downstream of the Kingsford Smith Drive property boundary.

Three additional cross-sections were added to the model to extend it as far as the KSD property boundary. These cross-sections were interpolated based on the existing model data, aerial imagery and a review of survey/culvert details. As the project is at a masterplanning phase it does not warrant the acquisition of detailed survey for this section of channel but it is recommended that this be obtained for any future detailed design in this location.

Figure 7 shows the existing cross-sections as well as the newly incorporated interpolated sections. Note that this figure is also reproduced in larger scale in Appendix A.

Also included is the proposed location of the pedestrian cross-drainage structure.

Key locations of interest include:

- Pre-existing (2006/7 study) model upstream extent: ch -685
- Modified model upstream extent: ch -900
- Barcham Street: ch -685
- Pedestrian pathway proposed location: ch 350

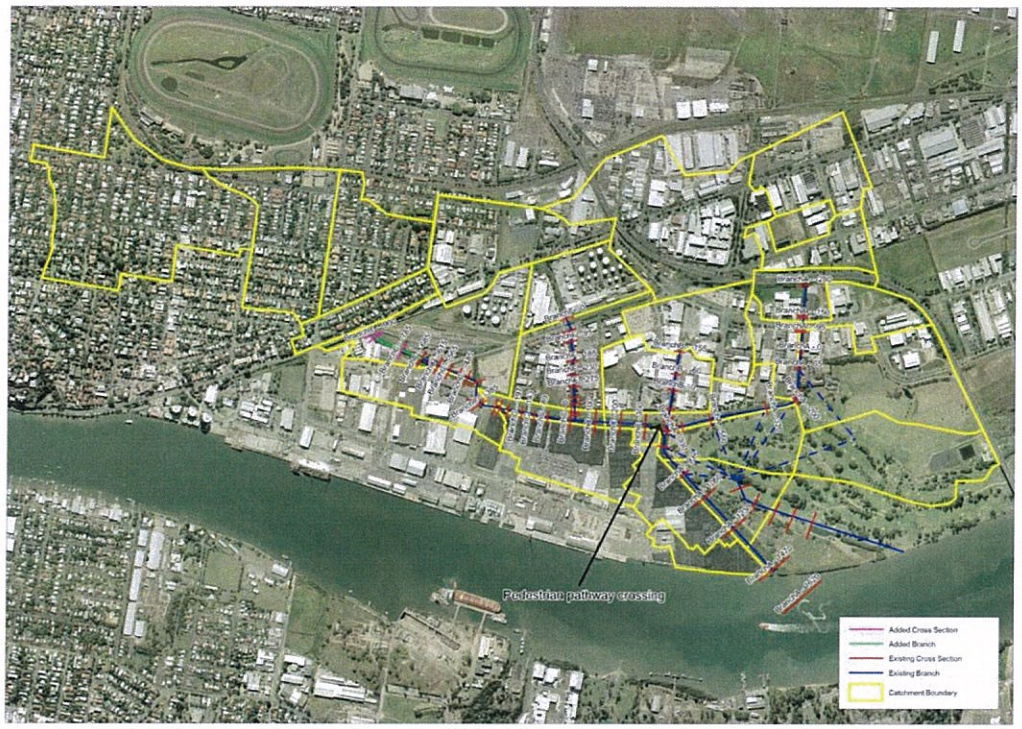


Figure 7 Updated model layout

3.3.2 Incorporation of cross-drainage at pedestrian pathway

In order to test the effect of cross-drainage being put in place at the pedestrian pathway (refer to Figure 7 where this is identified), culverts and bridges were tested within the hydraulic model. MIKE11 has the capability to accurately compute the effect of these structures on flow in terms of variations in water level and velocity profile.

This was carried out in an iterative manner such that optimisation of the crossing design could be evaluated and refined against the design objectives.

3.4 Design testing

The following tests were conducted within the model:

- Filling of existing drainage channel and provision of alternate underground capacity with options investigated including:
  - 3/1.8 m Reinforced Concrete Pipes (RCP) – equivalent capacity to Kingsford Smith Drive culverts
  - 6/1.8 m RCP – double the capacity of the Kingsford Smith Drive culverts
- Assessment of cross-drainage at pedestrian pathway with a range of options assessed including:
  - 7/2.4 m x 2.4 m Reinforced Concrete Box Culvert units (RCBC)
  - 6/2.4 m x 2.4 m RCBC units
  - 5/2.4 m x 2.4 m RCBC units
  - 4/2.4 m x 2.4 m RCBC units
  - 3/2.4 m x 2.4 m RCBC units
  - Clear spanning bridge (estimated to be approximately 30 m in length)
  - Double spanning bridge (ie 2/15 m spans)

3.5 Sensitivity analysis

As described in Section 2.4 a sensitivity test was carried out replicating the effect of increased rainfall intensity which is expected to occur as a result of climate change. This was simulated for the 100 year ARI event with the discharge being scaled up by 20%.

A further sensitivity test was completed assuming increased tailwater levels in the Brisbane River. This represents the effect of long term sea level rise associated with climate change. An increase in tailwater level of 0.3 m was applied to the MHWS level of 1.01 mAHD – this corresponds to a future timeframe of around 2060. This is consistent with current guidelines and leads to a predicted peak tailwater level of 1.31 mAHD. The increased tailwater level was applied as a fixed water surface boundary condition.

The results of the sensitivity analysis are outlined in Section 4.3 of the report.

4 Results

This section of the report outlines the key findings of the hydraulic analysis. They are divided into three sections:

- The filling of the drain in its upstream reaches of the site
- The pedestrian pathway cross-drainage structure
- The sensitivity analysis

4.1 Filling of drain

Section 1.3 states one of the objectives of the study as being to assess the provision of underground drainage capacity for the 10 and 100 year ARI events between Kingsford Smith Drive and Barcham Street.

This was represented within the hydraulic model by an underground pipe section running in parallel to an above ground flow path. The flow path was digitised assuming a 20 m road corridor that was assumed to contain:

- Grass verges
- Shoulder/parking
- Vehicular carriageway
- Median strip (eg vegetated)

This was deemed a sensible assumption for this early stage of the project and would serve to give results which would inform the overall feasibility of the objective. The 20 m wide roadway flow path was digitised using trapezoidal sections with a 20 m base-width, 1:4 side slopes and a Manning's *n* roughness coefficient of 0.02.

In testing the filling of the channel between Kingsford Smith Drive and Barcham Street (see Figure 8) it became evident that it is not possible to control the flow in a feasible/cost effective/safe manner.

Figure 8 Section of drain tested as being replaced with underground capacity

In providing the equivalent area of the existing KSD culverts (3/1.8 m RCP = approximately 7.6 m^2) to run between the property boundary at KSD and Barcham Street, combined with the roadway corridor* to take overland flow the results are as follows**:

- 10 year ARI: up to 0.6 m depth of overland flow within the road corridor
- 100 year ARI: up to 1.1 m depth of overland flow along road corridor (refer to Figure 9 where a longitudinal section of the road profile is shown with corresponding inundation depths)

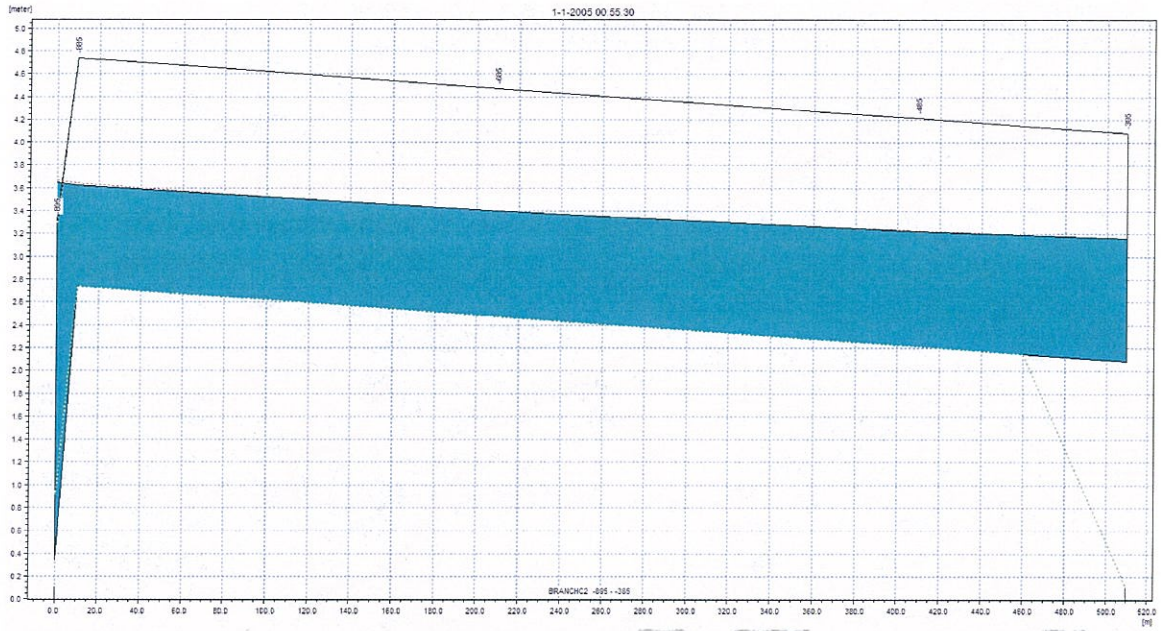


Figure 9 Longitudinal profile showing 100 year ARI inundation along proposed drainage roadway easement (approximately 1m depth of inundation)

** As discussed in Section 3.3.2 the road corridor easement we have assumed is approximately 20m wide which would account for roadway, median and shoulder capacity – this was based on a review of masterplanning sketches received*
*** Note that the total flows for the 10 year and 100 year ARI events are approximately 26m^3/s and 13 m^3/s respectively along this section of channel*

Due to the flat nature of the terrain and the high tailwater levels within the sections of the channel downstream of Barcham Street, the velocities within the underground network and channel are relatively low (<1 m/s).

A test was also undertaken which involved doubling the underground cross-sectional area to approximately 15 m^2 but it only serves to reduce overland flood levels by approximately 100/150 mm.

Having approximately 1 m deep roadway flow in a 100 year ARI event also presents a 'high to extreme' hazard in what will be a residential area (as per the SCARM guidelines). This is obviously not desirable for safety reasons, and even in much more minor events (eg a 2 year ARI) it is likely to give rise to regular nuisance flooding.

It is therefore apparent that this section of channel should in fact be maintained with a view to potentially maximising its capacity to reduce flood risk (eg clearing of vegetation, etc). This section of channel is approximately 20 m wide and 3 m deep so it is significant in area/capacity and cannot be practicably provided as underground capacity.

4.2 Pedestrian pathway cross-drainage structure

A high number of iterations were conducted in assessing the pedestrian pathway cross-drainage design as outlined in Section 3.5.

Note that the initial sizing was based on a review of the existing channel dimensions such that a feasible RCBC configuration could be implemented (ie taking into account cover requirements, available channel capacity, etc). RCBC units were selected as they provide more efficient flow area characteristics when compared to RCP units.

The outcomes of the analysis are described in the following sections.

4.2.1 Culvert testing

Table 3 shows the afflux and peak culvert velocity associated with the model testing for the various 2.4 m high RCBC configurations.

Note that the 100 year ARI flood profile does exceed bankfull level upstream of the proposed crossing and therefore inundates what could be considered as developable land.

Table 3 Summary of culvert testing results for 100 year ARI event (2.4m x 2.4m RCBC configuration)

Number of cells (2.4m x 2.4m RCBC)	Afflux (m)	Velocity (m/s)
3	0.08	2.08
4	0.03	1.53
5	0.02	1.47
6	0.01	1.13
7	0.00	0.88

It was observed that the 2.4 m high RCBC units are either barely submerged or have a free surface within the culvert cells (ie the invert of the culvert is set to that of the channel at 0.0 mAHD and flood levels are approximately 2.4 mAHD).

Testing was also undertaken for 1.8 m high RCBC units – the results are not shown as they were found to be significantly submerged thus limiting their flow efficiency (ie increased afflux and higher velocities). In addition, because of the submergence they are at increased risk of blockage.

It is therefore recommended that a 2.4 m high cell configuration is most suited to the channel topography and potential flood conditions/depths. The results of this set of tests have been provided in Appendix B.

Of the various 2.4 m high RCBC configurations tested, the option of 6/2.4 m x 2.4 m is deemed the most suitable because:

- Afflux is maintained at or below 0.01 m (this is typically considered an acceptable modelling tolerance and has been assumed as a suitable threshold for this stage of the project) and does not impact on developable land
- Peak velocities are maintained at approximately 1 m/s. This is not overly different from the existing channel characteristics when in flood (approximately <1 m/s in this reach) and will not generate significant scour risk

Based on the outcomes of the 100 year ARI event, the number of runs that were completed for the 50 year and 10 year ARI's were refined to include 6/2.4 m x 2.4 m RCBCs and, purely for comparative purposes, 4/2.4 m x 2.4 m RCBCs. The results show that due to the lower flows and greater containment within the channel afflux is not an issue in any of these modelled scenarios – peak increases are in the order of 0.01 m. These results are also presented in Appendix B and summarised in Table 4 and Table 5.

Table 4 Summary of culvert testing results for 50 year ARI event

Number of cells	Afflux (m)	Velocity (m/s)
4	0.01	1.38
6	0.01	1.02

Table 5 Summary of culvert testing results for 10 year ARI event

Number of cells	Afflux (m)	Velocity (m/s)
4	0.01	1.03
6	0.01	0.67

A single run was then completed whereby an equivalent area was provided using RCP's to achieve the capacity of the 6/2.4 m x 2.4 m RCBCs (total area = 34.5 m^2).

This equates to approximately 7/2.4 m RCPs.

The results of the analysis showed that this configuration generates the following results:

- Afflux: 0.01 m
- Velocity: 1.1 m/s

Accordingly, it could be further assessed at detailed design phase as to which culvert configuration was preferred, ie RCBC construction or RCP construction.

Afflux criteria could also be investigated and negotiated with key stakeholders (eg land-owners, local authorities, etc) at detailed design phase which may enable a further reduction in culvert capacity to be attained.

4.2.2 Bridge testing

Based on a review of the existing channel profile it is estimated that a single span bridge in the order of 30 m can traverse the channel. In assessing this within the hydraulic model the flow can occur in an uninterrupted fashion (ie without causing afflux). Further evaluation of the construction of a pier will not generate afflux greater than the recommended 6/2.4 m x 2.4 m RCBC configuration (ie in the order of a few millimetres). Consequently the implementation of a bridge design can be shown to meet the design objectives of minimising afflux and not generating excessive flow velocities.

However it is acknowledged that bridge construction is likely to be significantly more expensive than culvert construction, hence making a culvert design solution preferable.

4.3 Sensitivity analysis

The results of the two sensitivity tests that were undertaken for the 100 year ARI event are discussed in this section of the report. The focus of the sensitivity analysis focuses on the pedestrian pathway design as it is clear that the filling of the channel upstream of Barcham Street is not a feasible/cost effective option.

In relation to the culvert design, the sensitivity testing assumed the recommended culvert configuration of 6/2.4 m x 2.4 m RCBCs.

The testing of a 20% increase in discharge showed flood levels to increase typically in the order of 0.15 m. Afflux however still remained at 0.01 m implying that this culvert design should not exacerbate flood risk or afflux in the event of increased rainfall intensities in the vicinity of the pedestrian pathway .

The testing of increased tailwater conditions (ie by 0.3 m) to replicate greenhouse related sea level rise showed that in the vicinity of the culvert peak flood levels rose by 0.02 m. Afflux however still remained at 0.01 m implying that this culvert design should not exacerbate flood risk or afflux in the event of projected 50 year sea level rise.

5 Conclusions and recommendations

Aurecon were commissioned by Economic Development Queensland (EDQ) to undertake a hydraulic assessment of the Hamilton Northshore Development site. The focus of the assessment was against pre-defined objectives as outlined in Section 1.3. Hydrologic and hydraulic modelling was carried out based on modified model data taken from the Northern Australia Trade Coast Drainage and Fill Study (2006/7).

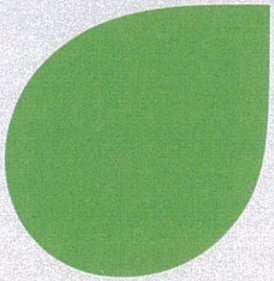
The key findings and recommendations of this study are summarised below:

- In testing the filling of the channel between Kingsford Smith Drive and Barcham Street (see Figure 8) it became evident that it is not possible to control the flow in a feasible/safe manner. As opposed to filling in this section of channel, it is clear that it should in fact be maintained as an open channel with a view to potentially maximising its capacity to reduce flood risk (eg clearing of vegetation, etc)
- A culvert design solution for the pedestrian pathway is feasible and can be shown to meet the project objectives. The recommended design configuration is 6/2.4 m x 2.4 m RCBCs because:
  - Maximum afflux is maintained at or below 0.01 m (this is typically considered an acceptable impact)
  - Peak velocities are maintained at approximately 1 m/s. This is not overly different from the existing channel characteristics when in flood (approximately <1 m/s in this reach) and will not generate significant scour risk
- Providing and an equivalent area using RCP's (ie 7/2.4 m RCPs) was also shown to meet the project objectives/design criteria. Accordingly, it could be further assessed at detailed design phase as to which culvert configuration was preferred ie RCBC construction or RCP construction
- The implementation of a bridge design can also be shown to meet the design objectives – however it is acknowledged that bridge construction is likely to be significantly more expensive than culvert construction, hence making a culvert design solution preferable
- Sensitivity testing of increased rainfall intensity and sea-level rise shows that the recommended design configuration will not exacerbate flood risk or afflux (ie compared to a pre-design condition) in both of these scenarios

  It is recommended that at further stages of design (eg detailed design), additional modelling be undertaken to take into account any new data pertaining to the proposed development/site. Consideration should also be given as to whether new survey would be of benefit. Similarly, with the advance in hydraulic modelling technology and techniques, the option of developing a more comprehensive/accurate model could be explored (eg a combined 1D/2D hydrodynamic simulation). The updated hydrologic and hydraulic models can be used to assist with determining appropriate minimum development levels required to achieve the desired level of flood immunity and integration with the surrounding built environment.


DRAFT

Appendices



Appendix A
Model layout


Modelled bridge location
Added Cross Section
Added Branch
Existing Cross Section
Existing Branch
Catchment Boundary

Appendix B
Tabulated results data

Hamilton Northshore Development Hydraulic Analysis
Project No. 245069
Date: 6/03/2015

100 Year ARI- flood levels, depths and afflux for 2400mm*2400mm RCBCs												
		Exg (mAHD)	Dev (mAHD)		Dev (mAHD)		Dev (mAHD)		Dev (mAHD)		Dev (mAHD)	
X-Section Chainage (m)	Minimum Invert (mAHD)		3 cells	Afflux (m)	4 cells	Afflux (m)	5 cells	Afflux (m)	6 cells	Afflux (m)	7 cells	Afflux (m)
-900	0.35	3.590	3.590	0.000	3.590	0.000	3.590	0.000	3.590	0.000	3.590	0.000
-895	0.34	3.590	3.590	0.000	3.590	0.000	3.590	0.000	3.590	0.000	3.590	0.000
-785	0.30	3.580	3.580	0.000	3.580	0.000	3.580	0.000	3.580	0.000	3.580	0.000
-685	0.26	3.560	3.560	0.000	3.560	0.000	3.560	0.000	3.560	0.000	3.560	0.000
-615	0.12	3.550	3.550	0.000	3.550	0.000	3.550	0.000	3.550	0.000	3.550	0.000
-565	0.14	3.360	3.360	0.000	3.360	0.000	3.360	0.000	3.360	0.000	3.360	0.000
-520	0.26	3.350	3.360	0.010	3.350	0.000	3.350	0.000	3.350	0.000	3.350	0.000
-485	0.11	3.350	3.350	0.000	3.350	0.000	3.350	0.000	3.350	0.000	3.350	0.000
-455	0.00	3.350	3.350	0.000	3.350	0.000	3.350	0.000	3.350	0.000	3.350	0.000
-400	-0.06	3.080	3.080	0.000	3.080	0.000	3.080	0.000	3.080	0.000	3.080	0.000
-385	-0.25	3.080	3.090	0.010	3.080	0.000	3.080	0.000	3.080	0.000	3.080	0.000
-325	-0.40	3.050	3.050	0.000	3.050	0.000	3.050	0.000	3.050	0.000	3.050	0.000
-305	0.21	3.040	3.050	0.010	3.040	0.000	3.040	0.000	3.040	0.000	3.040	0.000
-245	0.21	2.920	2.940	0.020	2.930	0.010	2.930	0.010	2.930	0.010	2.920	0.000
-197	0.20	2.810	2.830	0.020	2.810	0.000	2.810	0.000	2.810	0.000	2.810	0.000
-143	0.20	2.790	2.810	0.020	2.790	0.000	2.790	0.000	2.790	0.000	2.790	0.000
-89	0.19	2.760	2.780	0.020	2.760	0.000	2.760	0.000	2.760	0.000	2.760	0.000
0	0.00	2.710	2.750	0.040	2.720	0.010	2.720	0.010	2.720	0.010	2.710	0.000
100	0.00	2.570	2.620	0.050	2.580	0.010	2.570	0.000	2.570	0.000	2.570	0.000
200	0.00	2.490	2.550	0.060	2.500	0.010	2.500	0.010	2.490	0.000	2.490	0.000
300	0.00	2.400	2.480	0.080	2.430	0.030	2.420	0.020	2.410	0.010	2.400	0.000
340	0.00	2.390	2.470	0.080	2.420	0.030	2.410	0.020	2.400	0.010	2.390	0.000
350	Culvert											
360	0.00	2.350	2.330	-0.020	2.34	-0.010	2.340	-0.010	2.35	0.000	2.350	0.000
385	0.20	2.250	2.240	-0.010	2.24	-0.010	2.240	-0.010	2.250	0.000	2.250	0.000
		Peak Afflux:		0.080		0.030		0.020		0.010		0.000

50 Year ARI- flood levels, depths and afflux for 2400mm*2400mm RCBCs

X-Section Chainage (m)	Minimum Invert (mAHD)	Exg (mAHD)	Dev (mAHD) 3 cells	Afflux (m)	Dev (mAHD) 4 cells	Afflux (m)	Dev (mAHD) 5 cells	Afflux (m)	Dev (mAHD) 6 cells	Afflux (m)	Dev (mAHD) 7 cells	Afflux (m)
-900	0.35	3.450			3.450	0.000			3.450	0.000		
-895	0.34	3.450			3.450	0.000			3.450	0.000		
-785	0.30	3.440			3.440	0.000			3.440	0.000		
-685	0.26	3.420			3.420	0.000			3.420	0.000		
-615	0.12	3.410			3.410	0.000			3.410	0.000		
-565	0.14	3.190			3.190	0.000			3.190	0.000		
-520	0.26	3.180			3.180	0.000			3.180	0.000		
-485	0.11	3.180			3.180	0.000			3.180	0.000		
-455	0.00	3.180			3.180	0.000			3.180	0.000		
-400	-0.06	2.970			2.970	0.000			2.970	0.000		
-385	-0.25	2.970			2.970	0.000			2.970	0.000		
-325	-0.40	2.940			2.940	0.000			2.940	0.000		
-305	0.21	2.940			2.940	0.000			2.940	0.000		
-245	0.21	2.820			2.820	0.000			2.820	0.000		
-197	0.20	2.650			2.660	0.010			2.650	0.000		
-143	0.20	2.630			2.640	0.010			2.640	0.010		
-89	0.19	2.610			2.610	0.000			2.610	0.000		
0	0.00	2.560			2.570	0.010			2.560	0.000		
100	0.00	2.430			2.440	0.010			2.430	0.000		
200	0.00	2.350			2.360	0.010			2.360	0.010		
300	0.00	2.280			2.290	0.010			2.280	0.000		
340	0.00	2.270			2.280	0.010			2.270	0.000		
350	Culvert											
360	0.00	2.23			2.23	0.000			2.23	0.000		
385	0.20	2.140			2.14	0.000			2.140	0.000		
		Peak Afflux:				0.010				0.010		

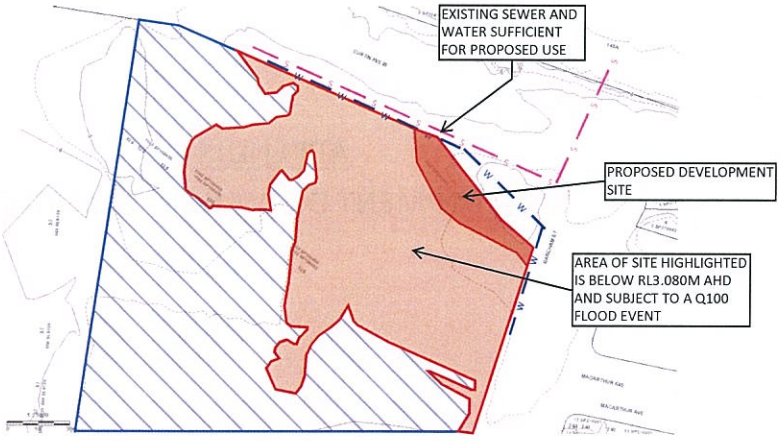
10 Year ARI- flood levels, depths and afflux for 2400mm*2400mm RCBCs												
		Exg (mAHD)	Dev (mAHD)		Dev (mAHD)		Dev (mAHD)		Dev (mAHD)		Dev (mAHD)	
X-Section Chainage (m)	Minimum Invert (mAHD)		3 cells	Afflux (m)	4 cells	Afflux (m)	5 cells	Afflux (m)	6 cells	Afflux (m)	7 cells	Afflux (m)
-900	0.35	2.820			2.820	0.000			2.820	0.000		
-895	0.34	2.820			2.820	0.000			2.820	0.000		
-785	0.30	2.810			2.810	0.000			2.810	0.000		
-685	0.26	2.790			2.790	0.000			2.790	0.000		
-615	0.12	2.780			2.780	0.000			2.780	0.000		
-565	0.14	2.690			2.690	0.000			2.690	0.000		
-520	0.26	2.680			2.680	0.000			2.680	0.000		
-485	0.11	2.680			2.680	0.000			2.680	0.000		
-455	0.00	2.680			2.680	0.000			2.680	0.000		
-400	-0.06	2.600			2.600	0.000			2.600	0.000		
-385	-0.25	2.600			2.610	0.010			2.610	0.010		
-325	-0.40	2.580			2.580	0.000			2.580	0.000		
-305	0.21	2.580			2.580	0.000			2.580	0.000		
-245	0.21	2.440			2.440	0.000			2.440	0.000		
-197	0.20	2.230			2.230	0.000			2.230	0.000		
-143	0.20	2.210			2.220	0.010			2.220	0.010		
-89	0.19	2.190			2.190	0.000			2.190	0.000		
0	0.00	2.140			2.150	0.010			2.150	0.010		
100	0.00	2.040			2.040	0.000			2.040	0.000		
200	0.00	1.960			1.960	0.000			1.960	0.000		
300	0.00	1.900			1.910	0.010			1.910	0.010		
340	0.00	1.890			1.900	0.010			1.900	0.010		
350	Culvert											
360	0.00	1.860			1.86	0.000			1.860	0.000		
385	0.20	1.780			1.780	0.000			1.780	0.000		
		Peak Afflux:				0.010				0.010		

aurecon

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 14, 32 Turbot Street
Brisbane QLD 4000
Locked Bag 331
Brisbane QLD 4001
Australia
T +61 7 3173 8000
F +61 7 3173 8001
E brisbane@aurecongroup.com
W aurecongroup.com

APPENDIX C

DEVELOPMENT DRAWINGS AND FIGURES



BORNHORST + WARD
CONSULTING ENGINEERS
CIVIL AND STRUCTURAL

Level 4, 67 Astor Terrace
Spring Hill, QLD 4000, Australia
P. +61 (7) 3013 4699
mail@bornhorstward.com.au
www.bornhorstward.com.au

PROJECT
NORTHSHORE HAMILTON
117 CURTAIN AVE W

SUBJECT
FLOOD MAPPING

PROJECT No.
151202al

DRAWING No.
SKC001

REVISION
-

0 10 20 30 40 50

ORIGINAL SIZE A3

Date : Sep 14, 2015
User : shgroup#997492

Scale = 1:500

Metres 10 20

Location :

6,964,947

507,532 N 507,758

6,964,823

Disclaimer :