Tingalpa Channel Flood Study
Volume 1 of 2

Flood Study Report

Prepared by Brisbane City Council's, City Projects Office

June 2015

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Note: *The Tingalpa Channel Flood Study is a joint initiative of Brisbane City Council and the Queensland Government.*

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Executive Summary

Introduction

Brisbane City Council (BCC) is in the process of updating its flood studies to reflect the current conditions of the respective catchments and best practice flood modelling techniques. The current flood information for the Tingalpa Channel catchment is sourced from the Stormwater Management Plan (SMP) undertaken by Sinclair Knights Merz (now Jacobs Engineering Group Inc) in 1998 on behalf of BCC.

Tingalpa Channel is a relatively small catchment, and a sub-catchment of Bulimba Creek. It is located approximately 10 km south-east of the Brisbane CBD. The catchment has an area of 1,380 hectares and lies within the suburbs of Carindale, Chandler, Belmont, Gumdale, Wakerley, Manly West and Tingalpa. The entire catchment is situated within the Brisbane City Council (BCC) jurisdiction. The main land uses within the catchment include environmental protection, conservation, open space, sport and recreation, low density residential and general industry.

Project Objectives

The primary objectives of the project were as follows:

- Update/develop the Tingalpa Channel Catchment flood models (hydrologic and hydraulic) to represent the current catchment conditions and best practice flood modelling techniques;
- Develop a two dimensional (2D or 1D/2D) hydraulic model using the best practice flood modelling techniques to derive reliable flood information for the catchment;
- Calibrate and verify the hydrologic and hydraulic models to historical storm events to confirm that the models are fit for the purposes of design flood event estimation and flood forecasting;
- Estimate flood magnitudes for design, rare and extreme events;
- Determine design flood levels for the full range of design flood events including rare and extreme events;
- Produce flood inundation mapping for the selected range of design flood events including rare and extreme events (as applicable);
- Quantify the potential impacts of climate variability on flooding within the catchment in the 2050 and 2100 planning horizons.

Project Elements

The Tingalpa Channel Flood Study comprises two main components, as follows:

Model Development and Calibration

Hydrologic and hydraulic models of the Tingalpa Channel catchment have been developed using the XP-RAFTS and MIKE FLOOD modelling software, respectively.

The hydrologic model simulates the catchment rainfall-runoff estimation and runoff-routing processes. The hydrologic model also utilises high-level routing methodology to simulate the flow of floodwater in the major waterways within the catchment. The hydraulic model uses more sophisticated routing to simulate the movement of this floodwater through these waterways in order to predict flood levels, flood discharges and velocities. The hydraulic model takes into account the effects of the channel/floodplain topography; downstream tail water conditions and hydraulic structures.

Calibration is the process of refining the model parameters to achieve a good agreement between the modelled results and the historical / observed data for the catchment. Model calibration is achieved when the model simulates the historical event to within specified tolerances. Verification is then undertaken on additional historical flood events to confirm the calibrated model is suitable for use in simulating intended design storm events.

Calibration of the XP-RAFTS and MIKE FLOOD models was undertaken utilising two historical storms, namely the 11th October 2010 and 25th January 2012 events. Verification of the XP-RAFTS and MIKE FLOOD models utilised the 20th May 2009 and 26th December 2010 historical storm events. Flood levels recorded at three Maximum Height Gauges (MHGs) were used in the calibration and verification processes as no continuous stream height gauges exist within the catchment.

A reasonable agreement was achieved between the simulated and historical flood level records for both of the calibration events. Utilising the adopted parameters from the calibration process, the verification was undertaken. Similarly the verification achieved reasonable results between the simulated and historical records for both of the events.

Given the results of the calibration and verification process were quite reasonable, the XP-RAFTS and MIKE FLOOD models were considered acceptable for use in the second part of the flood study, in which design flood levels were estimated.

Design, Rare and Extreme Event Modelling

The calibrated hydrologic and hydraulic models were used to simulate a range of design flood events, namely the 2, 5, 10, 20, 50 and 100 year ARI events. Flood magnitudes of rare and extreme events were also estimated for the 200, 500 and 2000 year ARI and PMF events. These analyses assumed ultimate catchment development conditions. The MIKE FLOOD hydraulic model was run using the flood discharges estimated from the XP-RAFTS hydrology model for the above events to estimate peak flood levels and flood inundation extents.

Three waterway scenarios were considered, as follows:

- Scenario 1 – Existing Waterway Conditions: Based on the current waterway conditions;
- Scenario 2 – Minimum Riparian Corridor (MRC): As for Scenario 1, but includes an allowance for a riparian corridor along the edge of the channel;
- Scenario 3 – Ultimate Conditions: Includes an allowance for the minimum riparian corridor (as per Scenario 2) and also assumes development infill to the boundary of the Modelled Flood Corridor in order to simulate potential development.

The results from the MIKE FLOOD modelling were used to determine / produce the following:

- Peak flood discharges
- Critical storm durations at selected locations
- Peak flood levels
- Peak flood extent mapping
- Hydraulic structure flood immunity and hydraulic structure reference sheets.

A sensitivity analysis was undertaken to identify the impacts for two future planning horizons; namely 2050 and 2100. This included making allowances for increased rainfall intensity and increased mean sea level rise. This climate variability analysis was undertaken for the 100, 200 and 500 year ARI events.

Blockage analysis was also conducted for twelve structure crossings in accordance with Queensland Urban Drainage Manual (QUDM) recommendations to determine the impacts on flooding. Inlet and sediment blockage were represented for independent model simulations. Results from the MIKE FLOOD model simulations were used to quantify the impacts on peak flood levels upstream of these structures.

Mapping has been produced for Scenario 1 and includes the 2, 5, 10, 20, 50, 100, 200, 500 and 2000 year ARI events.

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Glossary of Terms

Term	Definition
Annual Exceedance Probability(AEP)	The probability that a given rainfall total or flood flow will be exceeded in any one year.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20 year ARI design flood will occur on average once every 20 years.
Australian Height Datum (AHD)	Australian Height Datum (AHD) is the reference level for defining reduced ground levels adopted by the National Mapping Council of Australia. The level of 0.0 m AHD is approximately mean sea level.
Brisbane Bar	Location at the mouth of the Brisbane River
Catchment	The area of land draining through the main stream (as well as tributary streams) to a particular site. It always relates to an area above a specific location.
Digital Elevation Model (DEM)	A three-dimensional model of the ground surface elevation.
Design Event, Design Storm	A hypothetical flood/storm representing a specific likelihood of occurrence (for example the 100 year ARI).
Floodplain	Area of land subject to inundation by floods up to and including the probable maximum flood (PMF) event
Flood Frequency Analysis (FFA)	Method of predicting flood flows at a particular location by fitting observed values at the location to a standard statistical distribution.
Flood Planning Area (FPA)	Council has developed five Flood Planning Areas (FPAs) for Brisbane River and creek flooding to guide future building and development in flood prone areas. There is one FPA for local overland flow flooding.
HEC-RAS	Hydrodynamic modelling software package.
Hydrograph	A graph showing how the discharge or stage/flood level at any particular location varies with time during a flood.
Manning's 'n'	The Gauckler–Manning coefficient, used to represent roughness in 1D/2D flow equations.
MIKE11 / MIKE21 MIKE FLOOD	Hydrodynamic modelling software package.
Minimum Riparian Corridor (MRC)	A zone of dense vegetation located either side of the main waterway channel assumed for modelling purposes.
Probable Maximum Flood (PMF)	An extreme flood associated with a PMP deemed to be the largest flood that could conceivably occur at a specific location.
Probably Maximum Precipitation (PMP)	The maximum precipitation (rainfall) that is reasonably estimated to not be exceeded.
RAFTS	Hydrologic modelling software package.

List of Abbreviations

Abbreviation	Definition
1D	One dimensional, in the context of hydraulic modelling
2D	Two dimensional, in the context of hydraulic modelling
AMTD	Adopted Middle Thread Distance
ALS	Airborne Laser Scanning
AR&R	Australian Rainfall and Runoff
BCC	Brisbane City Council
CBD	Central Business District
CL	Continuing rainfall loss (mm/hr)
FPA	Flood Planning Area
IFD	Intensity Frequency Duration
IL	Initial rainfall loss (mm)
m AHD	metres above Australian Height Datum
MFC	Modelled Flood Corridor
MHG	Maximum Height Gauge
MRC	Minimum Riparian Corridor
MSQ	Maritime Safety Queensland
POT	Peak Over Threshold
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
QUDM	Queensland Urban Drainage Manual
WC	Waterway Corridor
WQA	Water Quantity Assessment

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1.0 **Introduction**

1.1 Catchment Overview

Tingalpa Channel, a tributary of Bulimba Creek, is located 15 km south-east of Brisbane CBD. It originates in the foothills of Mt Petrie in the south, and flows in a northerly direction before merging with Bulimba Creek at Carmichael Park, Tingalpa. It receives flow from three main tributaries named West, North and East Channels, which join Tingalpa Channel between Manly and Wynnum Roads.

The catchment is elongated in shape with an approximate length of 7 km, and covers an area of 1,380 hectares. It lies within the suburbs of Belmont, Gumdale, Carindale, Chandler, Manly-West, Wakerley and Tingalpa. Wynnum Road, Manly Road and Old Cleveland Road are three major roads which cross the catchment. The Gateway Motorway intersects the catchment in its south-west corner for a short stretch. The entire catchment lies within the Brisbane City Council jurisdiction. A locality map of the catchment is given in Figure 1.1.

The upper catchment topography is generally steep whilst moderately sloping in the middle and lower reaches with some ponding areas adjacent to the waterway. Lower parts of the catchment also contain wetlands and detention basins and some flood prone land that remains undeveloped. The Tingalpa Channel waterway is subject to tidal intrusion from Bulimba Creek up to Manly Road.

In terms of land use, more than half of the catchment is zoned as environmental protection, conservation, open space and sport and recreation uses. Low and medium residential, industrial and rural land uses also feature within the catchment.

1.2 Study Background

BCC is in the process of updating its flood studies to reflect the current conditions of the catchment and best practice flood modelling techniques.

A Stormwater Management Plan (SMP) for the Tingalpa Channel catchment was carried out by consulting engineers Sinclair Knight Merz (now Jacobs) for BCC in 1998. The aim of that study was to develop a stormwater strategy, estimate design flood levels for the catchment, delineate Flood Regulation Lines (FRL), and to identify waterway rehabilitation measures.

As part of the study a hydrological model was developed using XP-RAFTS Version 5.1 software and a hydraulic model developed using 1D MIKE11 (Version 3.2) software. The catchment was analysed for design floods ranging from 2 to 100 year ARI. Two methods were used for the determination of design flows, namely: the Duration Independent Storms (DIS) and standard Australian Rainfall & Runoff storms (ARR 1987). FRL’s were introduced as a means of demarcating the desired extents for development. Presently these models are not in working condition.

1.3 Study Objectives

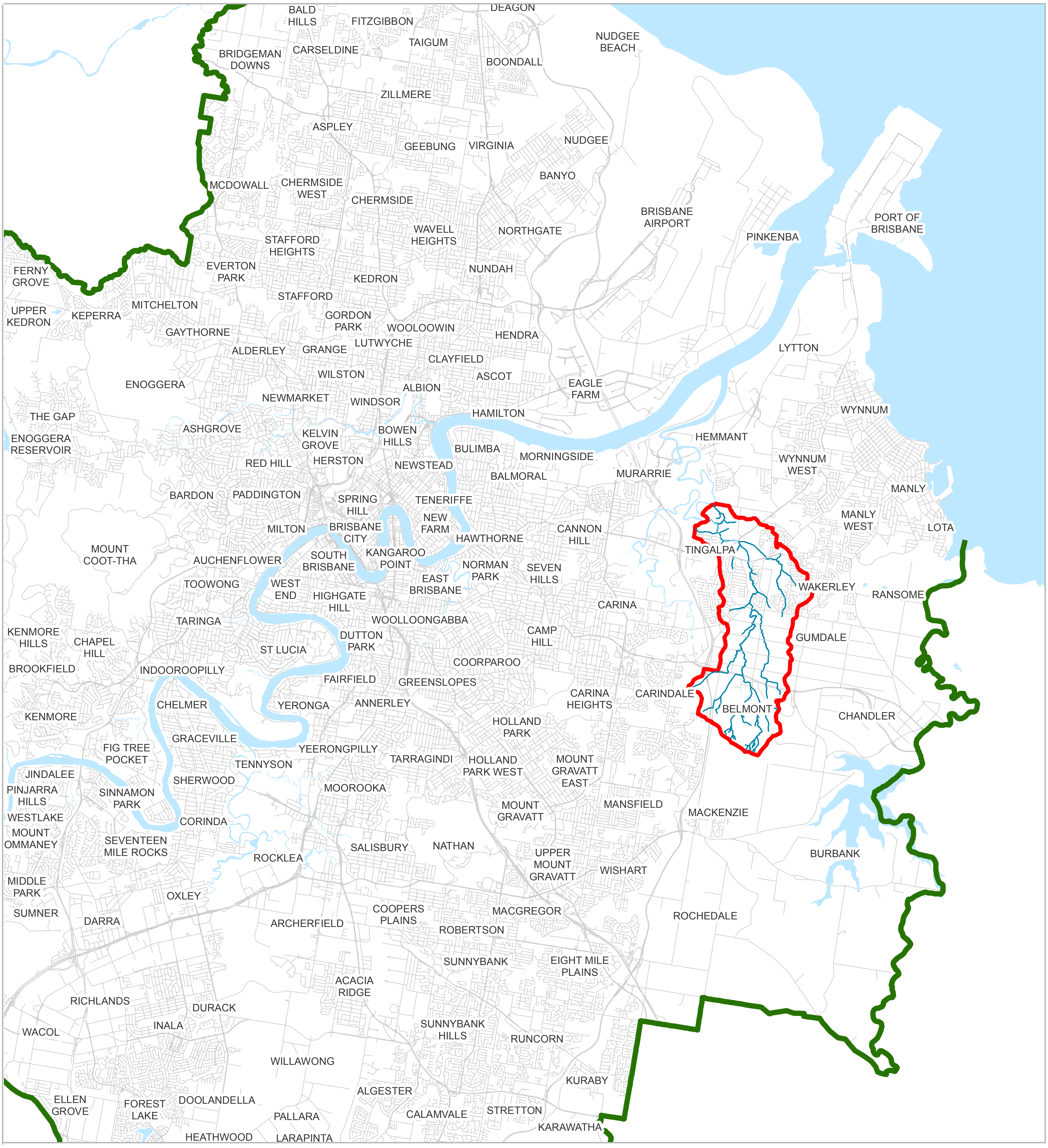
The primary objectives of the Tingalpa Channel Flood Study are:

- Review and update the hydrology modelling of Tingalpa Channel catchment to represent BCC City Plan, 2014 development conditions and to a current version of modelling software;
- Develop a two dimensional (2D or 1D/2D) hydraulic model using the best practice flood modelling techniques to derive reliable flood information for the catchment;
- Adequately calibrate and verify the hydrologic and hydraulic models to historical storm events to confirm that the models are fit for the purposes of design flood event estimation;
- Estimate flood information for the selected range of design flood events including large and extreme events considering planning requirements; and
- Quantify the effects of climate variability on flooding in the catchment.

1.4 Scope of the Study

The following tasks were undertaken to achieve the project objectives that are outlined in Section 1.3:

- Collating and reviewing previous flood studies and models, topographic information and where available recorded flood information;
- Upgrading the existing XP-RAFTS hydrologic model developed as a part of the Tingalpa Channel catchment in the SMP, 1998;
- Development of a 2D hydraulic model using MIKE FLOOD software for the Tingalpa Channel catchment to replace the existing 1D hydraulic model MIKE11 ;
- Calibration and verification of the XP-RAFTS and MIKE FLOOD models using available recorded flood information (since 2009). Verification of model results with reference to the SMP, 1998 results in case of non-availability of historical data;
- Use of calibrated flood models to simulate the design flood events for 2, 5, 10, 20, 50 and 100 year ARI events using AR&R, 1987 storms and representing ultimate catchment development conditions;
- Estimation of flood information for rare to extreme flood events, which include 200 year, 500 year, 2000 year ARI and PMF events;
- Undertake climate variability modelling for the 100 year, 200 year and 500 year ARI events to determine the impacts in 2050 and 2100 planning horizons; and
- Develop peak flood level inundation extents maps of the catchment for a selected range of large and extreme events up to PMF.



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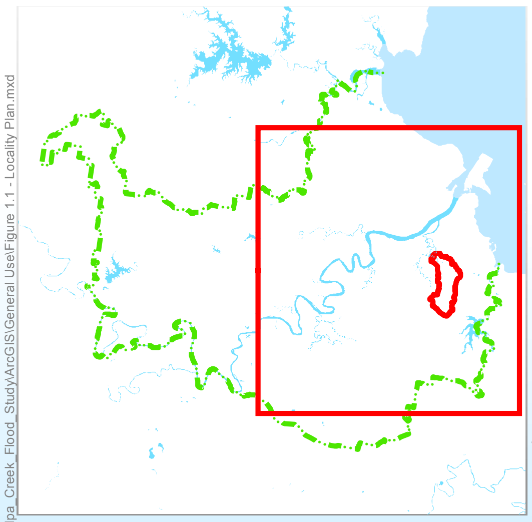

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Revision : 0
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File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 1.1 - Locality Plan.mxd

Legend

- Brisbane City Boundary
- Tingalpa Drain Catchment
- Channel Centreline

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Tingalpa Channel Flood Study 2015

Figure 1.1 - Locality Plan

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1.5 Study Limitations

In utilising the flood models it is important to be aware of their limitations which can be summarised as follows:

- In the development of the 2D hydraulic model, Airborne Laser Scanning (ALS) data, 2009 has been used to represent catchment topography. Detailed checks have only been carried at the locations where surveyed cross section information is available to confirm the validity of this data. It is assumed that the ALS data represents the catchment topography to an accuracy of ±150mm and is “fit for purpose”
- The model results have only been calibrated / verified against readings of recorded flood heights at the locations of MHG’s. Therefore, other suitable measures to validate model results were adopted. This has included comparison of results with the existing flood level information for the catchment and comparison of discharge hydrographs between the hydrologic and hydraulic models at selected locations. These facts need to be taken into account when considering the accuracy of results outside the influence of the gauge locations
- The models described and used for the study are meant to be used at the catchment scale and have been developed to estimate the flooding characteristics at a broad scale. As a result, smaller or more localised flooding characteristics may not be represented in the model output.

2.0 **Catchment Description**

2.1 Catchment, Waterway Features and Characteristics

The Tingalpa Channel catchment begins in the steep ridgelines of Mount Petrie in the south and extends to Bulimba Creek in the north. The catchment may be divided into three distinct topographical areas namely the upper, middle and lower reaches as adopted in the previous SMP study.

Upper reach: the area to the south of Ermelo Road is generally steep when compared to the middle and lower reaches. The highest elevation of the catchment is approximately 160 m AHD, and is located to the south of Old Cleveland Road in the suburb of Belmont. Ground levels across the catchment immediately to the north of Old Cleveland Road in the suburb of Gumdale vary from around 20 to 35m AHD. It appears that modifications were made to the natural channel to the north of Old Cleveland Road by landscaping the overbank extents and creating water ponding areas. However, some parts of the upper reaches still remain in a natural form.

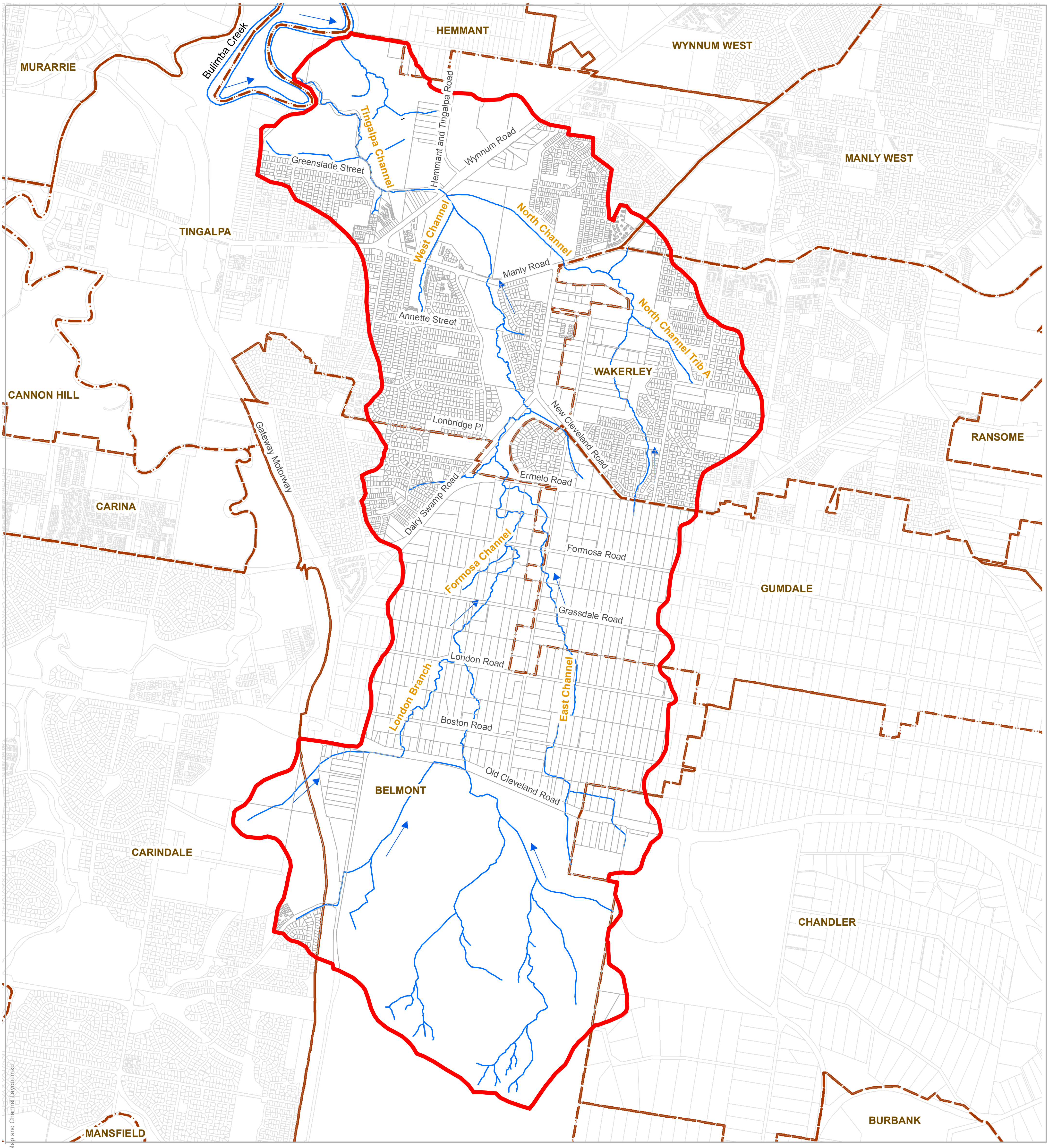
Middle reach: the area between Manly Road and Ermelo Road is moderately sloping and confined to large parcels of conservation areas and low density residential development. The highest elevation of the middle reach is about 35m AHD and reduces to about 15m AHD. Ponding and low-lying wetland areas of approximately 50 to 200m wide are visible at several locations while a detention basin is also located towards the eastern side of the middle reach. An accurate water depth through these ponded areas is difficult to determine.

Lower reach: the area from Manly Road to Bulimba Creek consists of a narrow low flow channel with a flat gradient which is exposed to back water and tidal effects from Bulimba Creek. Most of the low-lying areas are subject to frequent inundation. As a result these areas exist as parklands and open space with predominant vegetation. It is anticipated that the lower reach is subjected to the accumulation of sediments. Pockets of low-medium density urban development exist in the eastern and western parts of the lower reaches together with rural areas.

2.2 Tingalpa Channel and Tributaries

Tingalpa Channel is fed by three main tributaries, named: East Channel, West Channel and North Channel. East Channel joins Tingalpa Channel downstream of Formosa Road, while West and North Channel join Tingalpa Channel between Manly and Wynnum Roads. Another small tributary exists in the upper reaches, named London Branch as shown in Figure 2.1.

Tingalpa Channel traverses the catchment in a northerly direction having originated from the foothills of Mt Petrie approximately 1.3 km before crossing Old Cleveland Road. The London Road Branch merges with Tingalpa Channel from the west, immediately after crossing London Road. East Channel joins from the east before passing Ermelo Road. Tingalpa Channel enters into a man-made detention basin located upstream of Manly Road. West Channel merges from the west while the North Channel merges into the Tingalpa Channel from the east immediately before Wynnum Road footbridge. Tingalpa Channel flows approximately another 1200 m through a wide floodplain before discharging into Bulimba Creek at Carmichael Park located to the east of the Gateway Motorway.



Legend

- Tingalpa Drain Catchment
- Flow Direction
- Channel Centreline
- Bulimba Creek
- Cadastre
- Suburb Boundaries

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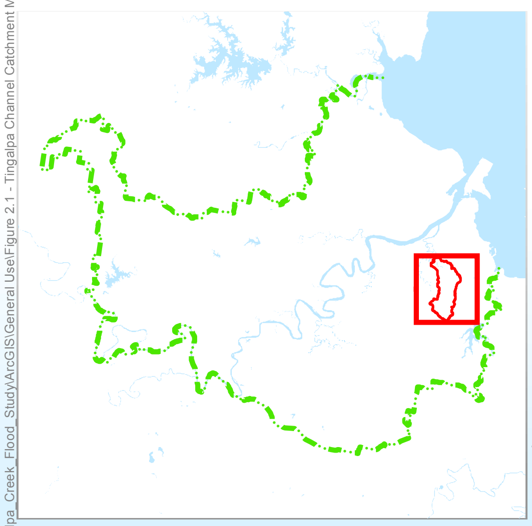

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Figure 2.1: Tingalpa Channel Catchment Map and Channel Layout

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File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 2.1 - Tingalpa Channel Catchment Map and Channel Layout.mxd

North Channel contains a smaller tributary that runs adjacent to residential development located on the eastern part of the catchment. A detention basin is sited on this tributary (North Tributary A) which acts as a control device used to lower peak flood discharge.

It was reported in the SMP study, 1998 that the channels upstream of Wynnum Road including the reaches of West, North and Tingalpa Channels up to Manly Road were excavated, unlined channels. Generally the channel sections are 1 to 2 m deep with a trapezoidal configuration.

2.3 Land Use

The current land use within the Tingalpa catchment study area is a mixture of rural, low density residential, industrial, sporting fields, open space and environmental protection.

The catchment area to the south of Old Cleveland Road consists mainly of native bushland and is classified as conservation, environmental protection or sport and recreation in the City Plan (2014). Therefore, undeveloped areas in the southern end of the catchment in Belmont are unlikely to be developed significantly in the near future.

The upper catchment north of Old Cleveland Road in the Gumdale area comprises environmental protection areas. Rural residential development is expected to be confined to existing areas and new developments of this type may be limited in the future.

Land uses in the lower catchments to the north of Dairy Swamp Road, contain pockets of low-medium density residential developments outside the waterway corridor. The area surrounding the waterway is expected to develop further if flooding constraints can be overcome. Low density residential development with some minor industrial areas exists in the eastern part adjacent to the North Channel and its tributary.

The lower part of the catchment area mainly consists of land zoned for conservation and open space with low density residential development occupying the higher grounds. Taking into account the location and the risk of flooding on some of the low lying floodplain areas it is likely that these areas will remain in an undeveloped state in the future. For a current land use map please refer to Appendix C.

3.0 **Available Information**

3.1 Previous Studies

As described in the Section 1.2, a SMP was undertaken in 1998 for the Tingalpa Channel catchment which provided the current design flood level information. The SMP estimated design flood levels for the 2, 5, 10, 20, 50 and 100 year ARI events.

3.2 Topographic Data

Cross section survey was conducted by Brisbane City Council in 1997 prior to the preparation of the SMP, (1998) and these details are available for use. New cross section survey at a few selected locations was also undertaken in 2014 as a part of this flood study. The locations of surveyed cross sections in 2014 are given in Figure A-1 in Appendix A. There was no separate bathymetric survey undertaken in the wetland areas of the catchment and it was anticipated that available cross section survey data would provide sufficient information on the bathymetry for this study.

3.2.1 Aerial Survey and Photography

Aerial images are available for the catchment from 1995 to 2012 within Council's GIS system. Existing ALS data of 2002 and 2009 were used to obtain topographic information for the catchment. Contour maps developed in 2002 and 2009 are also available and were used for demarcating catchment boundaries, sub-catchment layout for the hydrology model and storage characteristics of detention areas. Aerial map for Tingalpa Catchment is given in Figure A-2 in Appendix A.

3.2.2 Site Visits

Site visits were undertaken to identify the existing conditions of the waterway, the characteristics of storage areas provided by the detention basins and wetlands, and hydraulic structures. These visits were made at high and low tide to inspect the hydraulic behaviour during fluctuating tail water conditions.

3.3 Hydrometric Data

3.3.1 Rainfall Recording Stations

Hydrometric data availability for the Tingalpa Channel catchment is limited. There are no rainfall stations located within the catchment. However five rainfall recording stations are available nearby within the Bulimba, Lota and Hemmant Creek catchments. Details of these stations and availability of information are listed in Table 3-1 and their locations are given in Figure 3.1.

Rain gauge PP.E1840@540370 (LTR 840) in the Lota Creek catchment is located almost on the eastern boundary of the Tingalpa Channel catchment while PP.E2141@540279 (LTR 141) is located to the west of the catchment as shown in Figure 3.1. Gauges PP.E1527@540129 (BMR527), PP.E1706@540128 (BMR 706) and PP.E1830@541026 (BMR830) are within the Bulimba Creek catchment and are located to the north, west and south of the Tingalpa Channel catchment, respectively.

Table 3-1: Availability of rainfall gauge data for the Tingalpa Channel Catchment

Rain Gauge ID	Location / Catchment	Operating period	Storm event				
			20/05/09	07/02/10	10/10/10	24/12/10	24/01/12
PP.E1527 @540129 (BMR527)	Doughboy Parade, Hemmant / Bulimba Creek	January 1994 to date	✓	✓	✓	✓	✓
PP.E1706 @540128 (BMR706)	Old Cleveland Rd, Carindale / Bulimba Creek	January 1994 to date	✓	✓	✓	✓	✓
PP.E1830 @540126 (BMR830)	Edwards Park (Merion Place), Carindale / Bulimba	February 1994 to date	✓	✓	✓	✓	✓
PP.E1840 @540370 (LTR840)	Sleeman Centre, Chandler / Lota Creek	February 2005 to date	✓	✓	✓	✓	✓
PP.E2141 @540279 (LTR141)	Rickertt Road, Ransome / Lota Creek	June 1999 to date	✓	✓	✓	✓	✓

Table 3-2: Storm events and available recorded rainfall information

Storm Event Date	Period	Highest Rainfall			Approximate ARI of the rainfall event
		Rainfall total(mm)	Gauge ID	Ranking	
20th May 2009	18/05/2009 to 21/05/2009	244	PP.E1527 540129 (BMR527)	2	6 -10 hr: 1 - 2 year ARI > 10 hr: 2 - 5 year ARI
07th February 2010	06/02/2010 to 08/02/2010	125	PP.E1830 540126 (BMR830)	5	Less than 1 year ARI
10th October 2010	08/10/2010 to 12/10/2010	180	PP.E1527 540129 (BMR527)	3	6 -10 hr: 1 - 2 year ARI
24th December 2010	24/12/2010 t0 27/12/2010	133	PP.E1706 540128 (BMR706)	4	2 - 6 hr: 1 year ARI or lower
24th January 2012	23/01/2012 to 26/01/2012	255	PP.E2141 540279 (LTR141)	1	6 -10 hr: 1 - 2 year ARI > 10 hr: 2 - 5 year ARI

3.3.2 Stream Height / Maximum Height Gauging Stations

There is no continuous stream height gauge located in the Tingalpa catchment. However three Maximum Height gauges, which record the maximum flooded height during a flood event, are located in the middle and lower reaches. One gauge has been operational since 2009 and the earliest available information record is in that year. The other two were installed in August 2010 and have been operational since then.

Table 3-3 indicates MHG location details and the recorded flood height of all significant events since the establishment of these gauges. Locations of the MHGs are shown in Figure 3.1. MHG readings are also available for the 27th January 2013 event; however, these resulted from the Brisbane River flooding and were not suitable for this study. There were no flood heights recorded for events prior to 2009.

Table 3-3: Maximum Height Gauge details and data availability

MHG ID	Location	MHG Flood Level Data Availability (mAHD)				
		20 May 2009	07 Feb 2010	11 Oct 2010	24 Dec 2010	25 Jan 2012
TD120	East of Greenslade Street	NA	NA	2.06	2.25	2.36
BM1030	Upstream of Wynnum Road Bridge	2.84	2.38	2.46	2.57	-
TD150	Downstream of Formosa Road, East Branch	NA	NA	4.78	5.09	4.88
	Ranking[1]	**4**	**5**	**1**	**2**	**3**

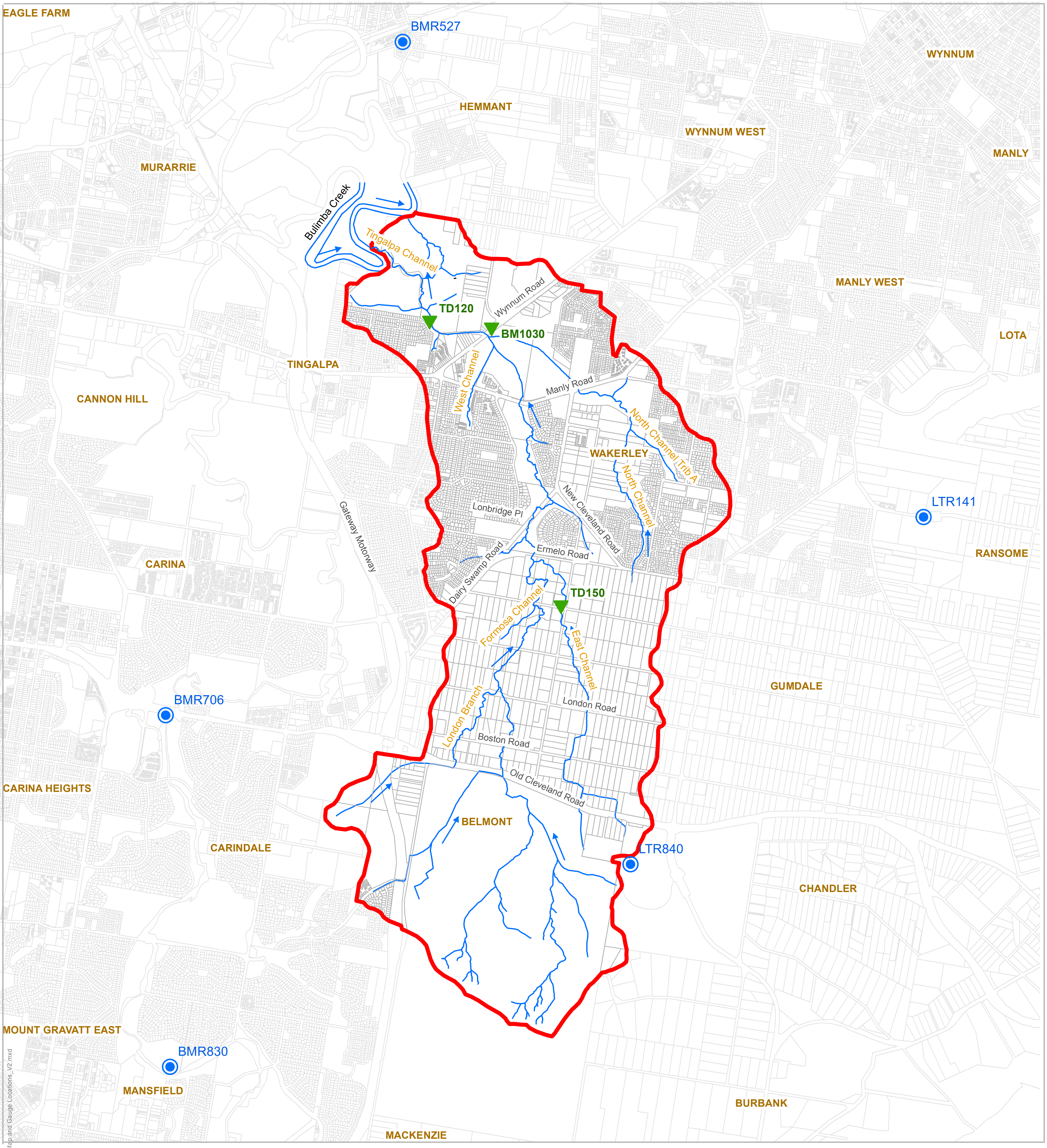
[1]Ranking of rainfall events was conducted based on the availability of MHG readings per storm event, the intensity/magnitude of the rainfall and flood height and also completeness of the data

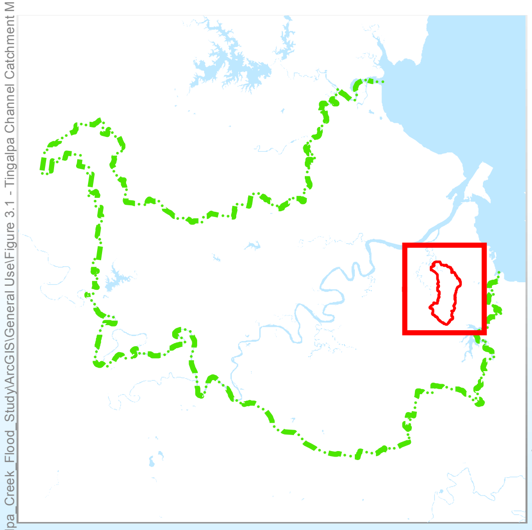
3.3.3 Tidal Information

Tingalpa Channel is subjected to tidal impacts from the Bulimba Creek estuary. To determine the tidal boundary at the confluence of Tingalpa Channel, the Bulimba Creek hydraulic model (MIKE11, 2010) was run with the recorded stream height data of Doughboy Parade stream gauge (HG.E1528@540129 - BMA528), which is located in Bulimba Creek catchment further downstream of the Tingalpa Channel confluence. Stream height data from HG.E1528@540129 (BMA528), which was used in the Bulimba Creek MIKE11 model for each of the calibration and verification events in deriving downstream boundary conditions, are included in Appendix A (Figures A3-A6).

3.4 Hydraulic Structure Data

There are 18 culvert crossings and two bridge crossings located within the modelled area of the Tingalpa Channel catchment. The bridge structures are located at Wynnum Road: a 4 span bridge and Grassdale Road; a single span bridge. Data for these structures were sourced mainly from ‘as constructed’ drawings and more information is included in Section 5 of this report and in the Hydraulic Structure Reference Sheets given in Appendix E.





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Project Number : 130115

Legend

- Rainfall Stations
- Flow Direction
- Maximum Height Gauge
- Channel Centreline
- Tingalpa Drain Catchment
- Cadastre

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Figure 3.1: Tingalpa Channel Catchment Hydrometric Gauge Locations

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3.5 Characteristics of Recorded Storm Events

The available flood level information for the five recent events recorded in the catchment is listed in Table 3-3. The events are:

- May 2009
- February 2010
- October 2010
- December 2010
- January 2012.

3.5.1 20th May 2009 Storm Event

This event produced the highest flood level reading recorded by MHG-BM1030 since installation of the gauge in 2009. The gauge recorded a maximum flood level of 2.84m AHD.

The storm event lasted nearly three days with rainfall commencing on 18th May 2009 and continuing until 21st May 2009. The heaviest bursts occurred in the evening of 19th May 2009 and rain continued until the morning hours of the following day. Rainfall records are available from the five rain gauge stations listed in Table 3-1. The highest cumulative rainfall of 244 mm was recorded at PP.E1527@540129 (BMR527) rain gauge. Cumulative plots of rainfall for the event are given in Figure A-7 in Appendix A. Table 3-4 lists the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the five rain gauge stations.

IFD curves for the recorded rainfall for the event are plotted for each rainfall station and included in Figure 3.2.

Table 3-4: Recorded Rainfall Data for May 2009 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	(6 pm on 19th to 6pm 20th May)	18th to 21st May
PP.E1527@540129 (BMR527)	Doughboy Parade, Hemmant	78	78	162	244
PP.E1706@540128 (BMR706)	Old Cleveland Rd, Carindale	65	62	148	219
PP.E1830@540126 (BMR830)	Edwards Park, Carindale	65	63	148	221
PP.E1840@540370 (LTR840)	Sleeman Centre, Chandler	63	60	130	194
PP.E2141@540279 (LTR141)	Rickertt Road, Ransome	73	68	154	226

[1] 4 days and 14 days prior to 6pm on the 19th May 2009

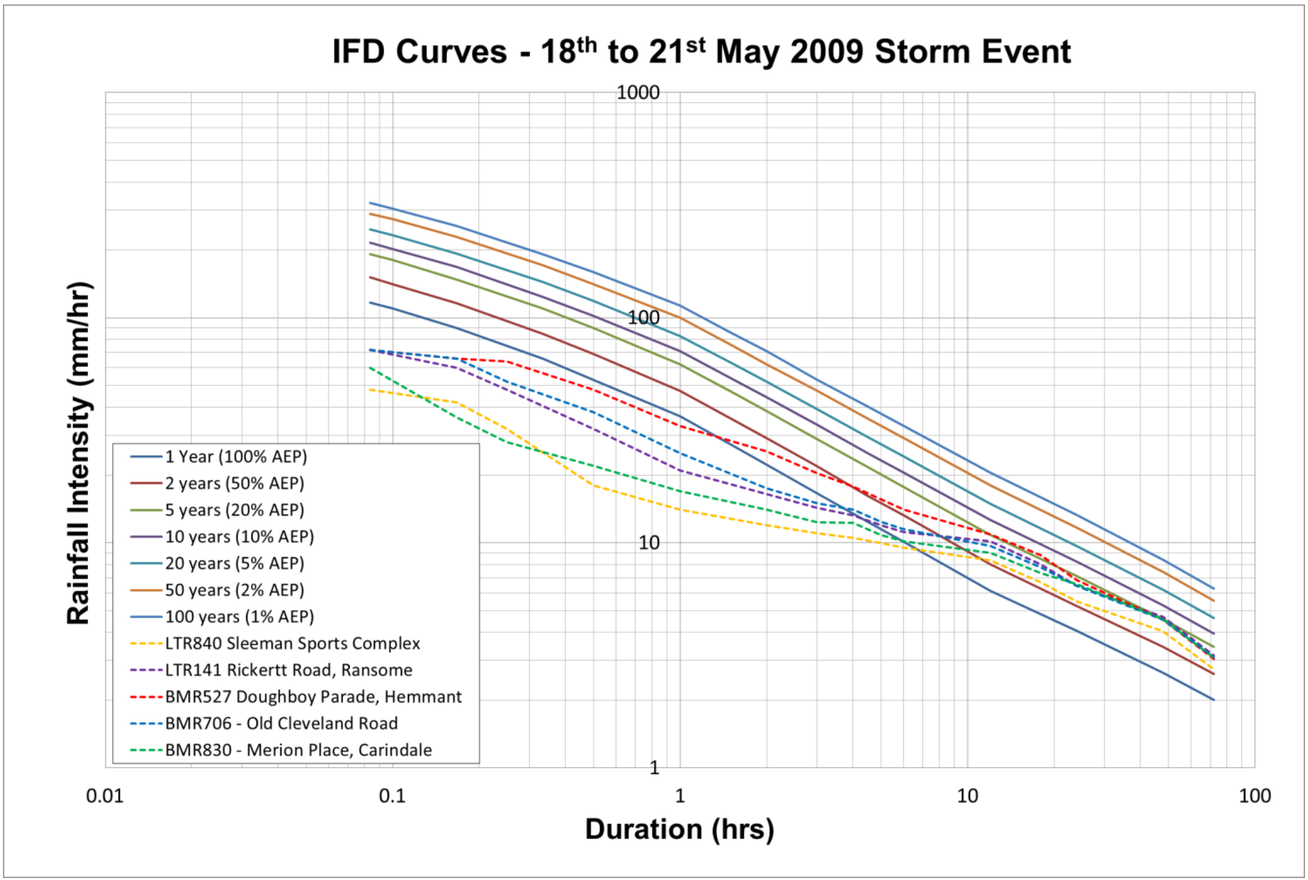


Figure 3.2: IFD Plots for the 18th to 21st May 2009 Storm Event

3.5.2 10th October 2010 Storm Event

This storm occurred after installation of two other MHGs - TD120 and TD150 - in the Tingalpa Channel catchment in early October 2010 and therefore, flood level data exists for all three gauges. The MHG at Wynnum Road recorded a flood level of 2.46m AHD for this event (see Table 3-3).

The storm event started on the 8th October with heavy rain bursts resulting in an early flood peak followed by small bursts until the evening of 10th October 2010. Heavy bursts occurred again in the late hours of the 10th and continued to the following day. Peak flood levels were recorded in the early hours of the morning of the 11th October.

The highest cumulative rainfall of approximately 180mm was recorded in the rain gauge station PP.E1527@540129 (BMR527). Rainfall details for the rainfall stations are reported in Table 3-5 with IFD plots for the event in Figure 3-3. Cumulative plots of rainfall are given in Figure A-8 of Appendix A.

Table 3-5: Recorded Rainfall Data for October 2010 Storm Event.

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	(6 pm on 10th to 6pm 11th Oct)	08th to 11th October
PP.E1527@540129 (BMR527)	Doughboy Parade, Hemmant	130	84	94	178
PP.E1706@540128 (BMR706)	Old Cleveland Rd, Carindale	135	88	85	173
PP.E1830@540126 (BMR830)	Edwards Park, Carindale	122	83	88	171
PP.E1840@540370 (LTR840)	Sleeman Centre, Chandler	95	56	71	120
PP.E2141@540279 (LTR141)	Rickertt Road, Ransome	125	74	64	145

[1] 4 days and 14 days prior to 6pm on the 10th October 2010

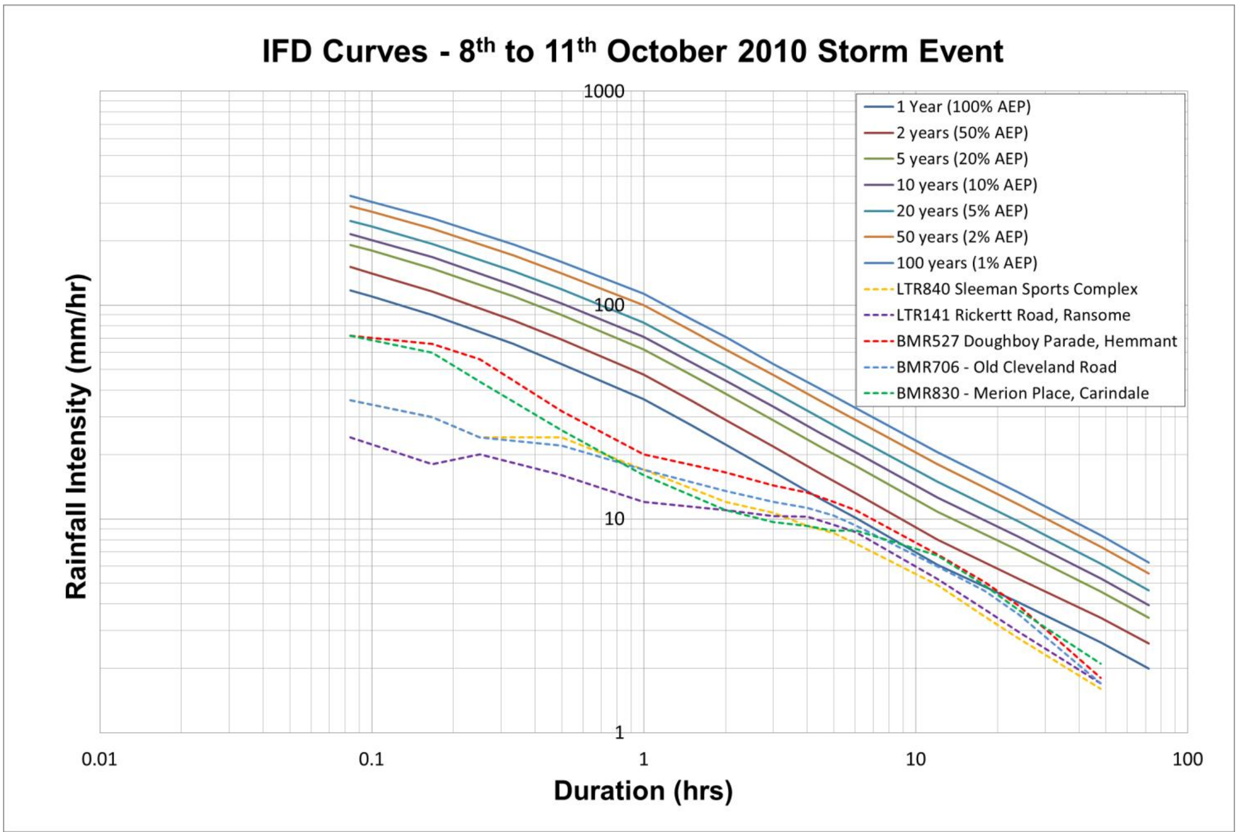


Figure 3.3: IFD Plots for the 8th to 11th October 2010 Storm Event.

3.5.3 24th to 27th December 2010 Storm Event

This event started on the evening of 24th December 2010 with heavy rain bursts and resulted in a flood peak in the early hours of the 25th. Small bursts of rain continued until the evening of the 26th followed by further heavy bursts untill the morning of the 27th. The recorded flood level at Wynnum Road MHG was 2.57m AHD. Flood levels for the other two MHG's are listed in Table 3-3. Rainfall details for the rainfall stations are reported in Table 3-5 with IFD plots for the event in Figure 3.4. Cumulative plots of rainfall are given in Figure A-9 of Appendix A.

The highest cumulative rainfall of 133 mm was recorded in the station PP.E1527@540129 (BMR527) in the three day period. From inspections of various rainfall stations it appears that the rainfall pattern is not uniform across the upper and lower parts of the catchment .

Table 3-6: Recorded Rainfall Data for December 2010 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	(4 pm on 24th to 4pm on 25th Dec)	24th to 27th October
PP.E1527@540129 (BMR527)	Doughboy Parade, Hemmant	189	22	31	67
PP.E1706@540128 (BMR706)	Old Cleveland Rd, Carindale	182	11	79	133
PP.E1830@540126 (BMR830)	Edwards Park, Carindale	166	13	48	78
PP.E1840@540370 (LTR840)	Sleeman Centre, Chandler	192	12	42	73
PP.E2141@540279 (LTR141)	Rickertt Road, Ransome	185	20	47	108

[1] Data 4 days and 14 days prior to 4pm on the 24th December

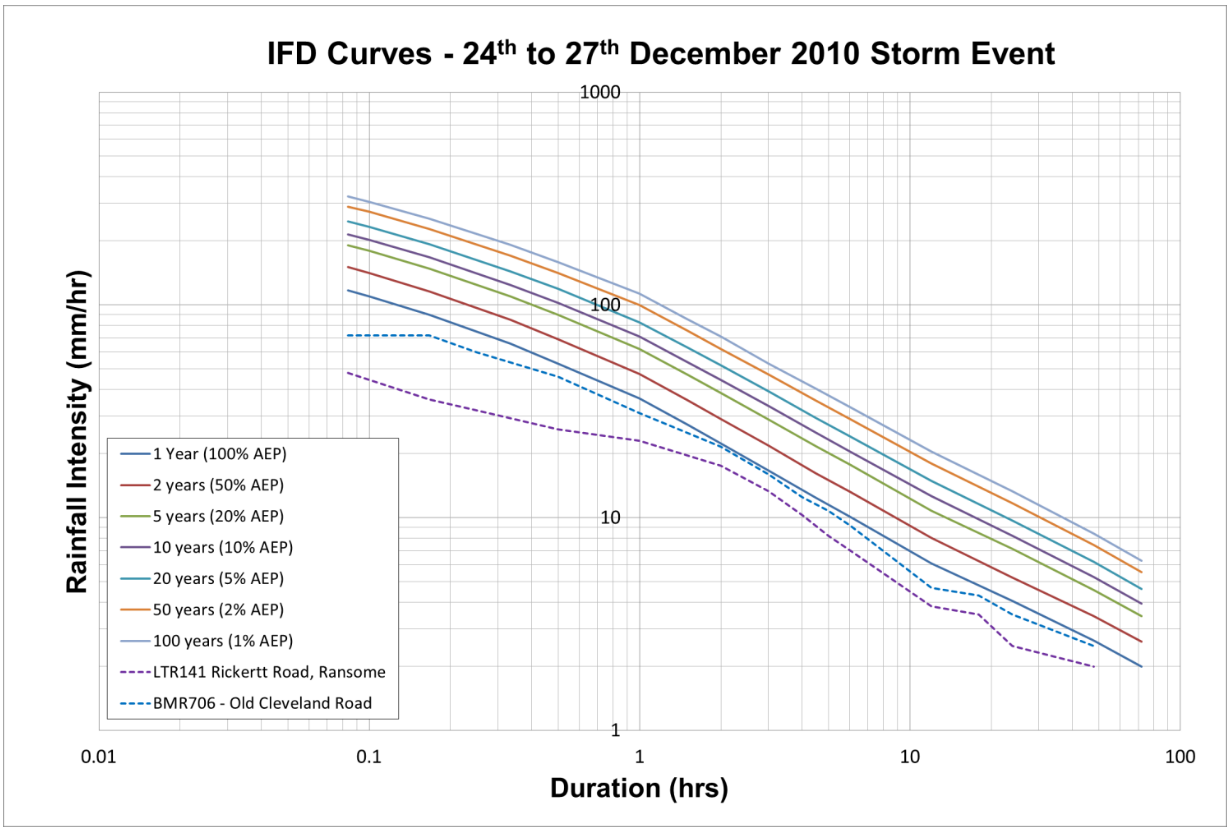


Figure 3.4: IFD Plots for the 24th to 27th December 2010 Storm Event.

3.5.4 24th to 26th January 2012 Storm Event

The January 2012 storm event commenced with heavy storm bursts in the afternoon of the 24th January. Rainfall continued until midday on the 25th. Cumulative rainfall of 253mm was recorded at rainfall station PP.E2141@540279 (LTR141) in Lota Creek. The Bulimba Creek rainfall station recorded 201mm of total rainfall for the same period.

There was no flood level reading available at the MHG located at Wynnum Road, however records are available for the other two MHGs for the flood peak in the afternoon of the 25th. Cumulative rainfall for the storm event is given in Table 3-7 and the IFD plots for the event are given in Figure 3.5. Cumulative rainfall plots for the storm event are given in Figure A-10 in Appendix A.

Table 3-7: Recorded Rainfall Data for January 2012 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	(Noon on 24th to noon on 26th Jan)	24th to 26th January 2012
PP.E1527@540129 (BMR527)	Doughboy Parade, Hemmant	164	85	200	201
PP.E1706@540128 (BMR706)	Old Cleveland Rd, Carindale	182	75	199	201
PP.E1830@540126 (BMR830)	Edwards Park, Carindale	149	62	200	203
PP.E1840@540370 (LTR840)	Sleeman Centre, Chandler	141	61	189	192
PP.E2141@540279 (LTR141)	Rickertt Road, Ransome	200	106	253	255

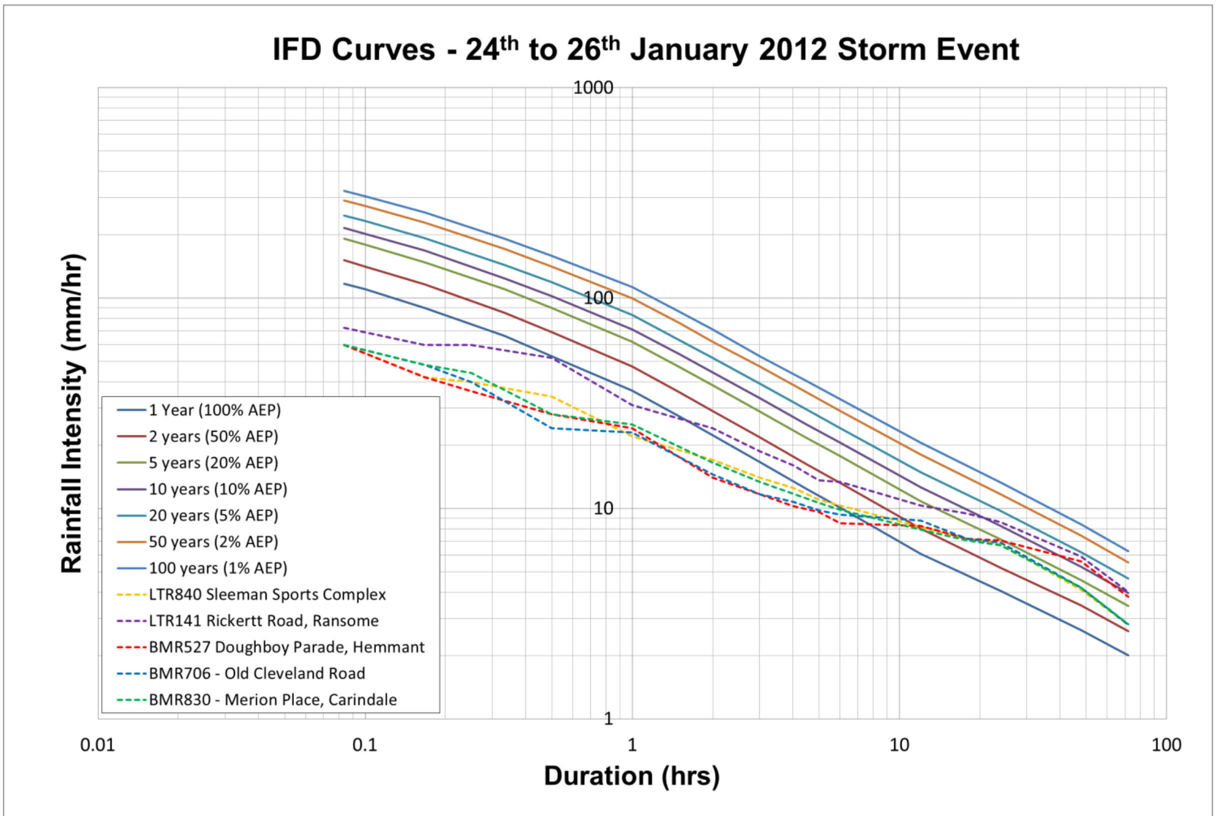


Figure 3.5: IFD Plots for the 24th to 26th January 2012 Storm Event

4.0 **Hydrologic Model Development and Calibration**

4.1 Overview

The hydrologic model simulates the rainfall-runoff process within the catchment and calculates the flow hydrograph at the outlet of each sub-catchment. The XP-RAFTS model for Tingalpa Channel catchment was initially developed as part of the Gumdale to Tingalpa Stormwater Management Plan (SKM, 1998). However, due to the non-availability of recorded data prior to 1998, calibration of the model to recorded levels was not possible. The installation of three MHG's in recent years has allowed Council to obtain flood height records which could assist in model calibration.

Preliminary assessment of the XP-RAFTS, (1998) model indicated that the model was required to be modified to address the following:

- Update the model to the latest version of the software (i.e. XP-RAFTS 2009)
- Update of sub-catchment delineation to produce better definition in the hydraulic model
- Update the impervious fractions with reference to the City Plan (2014) and QUDM (2007)
- Update the link between catchments (node) according to their routing sequence
- Estimate and update catchment slopes based on the equal area method
- Apply storage discharge characteristics where detention basins/storage areas are required to be introduced.

4.2 Hydrological Model Set Up and Schematisation

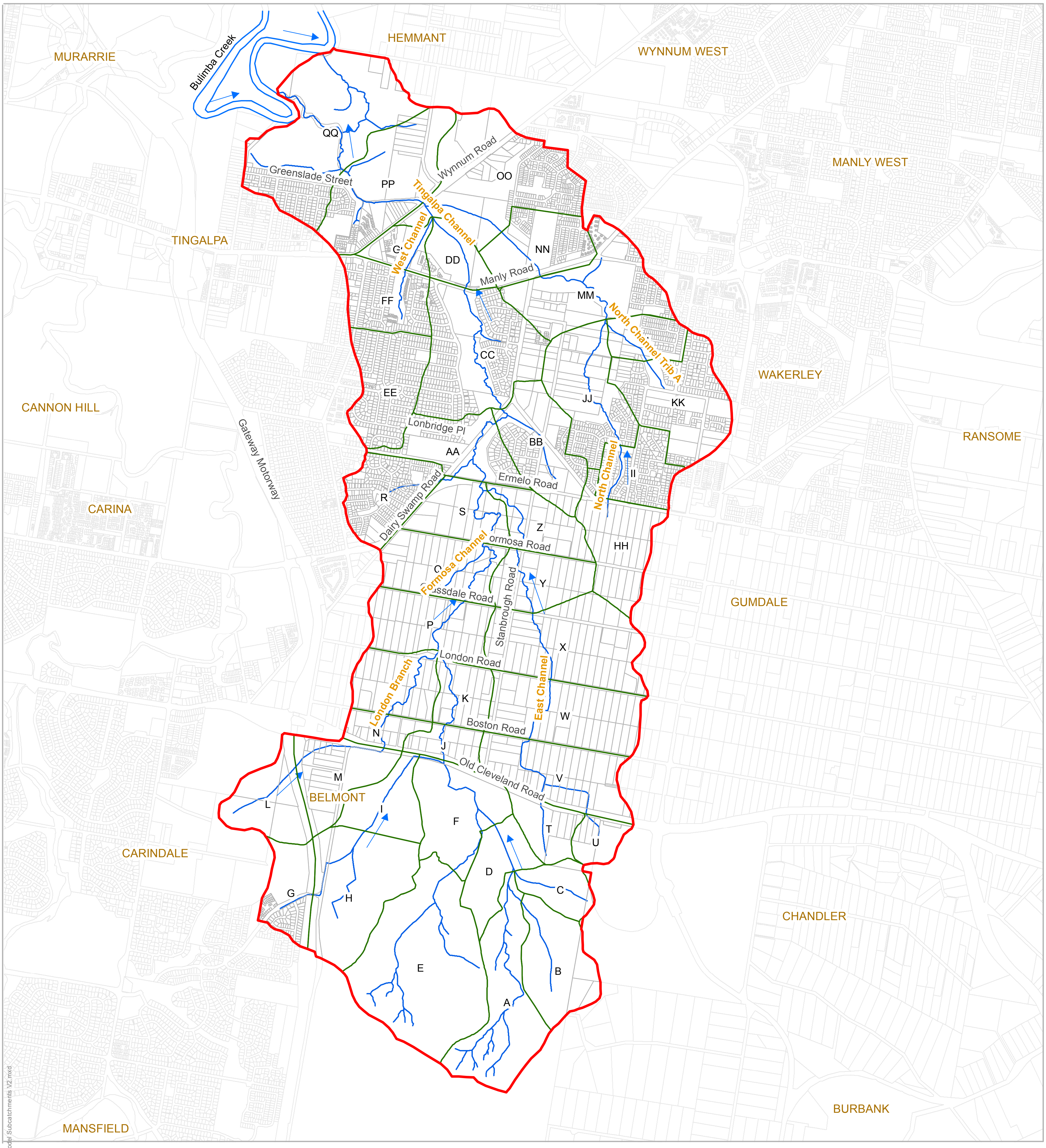
4.2.1 General

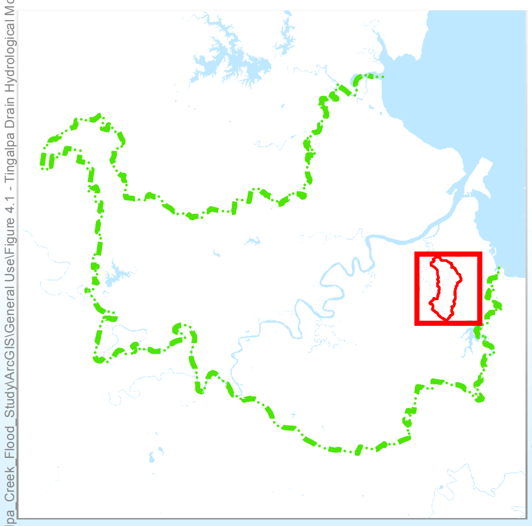
This section describes the sub-catchment parameters used in the XP-RAFTS model. The adopted sub-catchment parameters for the calibration and verification events are presented in Table 4-1. The same sub-catchment parameters have been used for all events due to the relatively recent age of the calibration and verification events and the minimal changes in catchment / channel topography and development during this period.

4.2.2 Sub-catchment Delineation

The XP-RAFTS hydrology model developed in 1998 for Tingalpa Channel catchment comprised of 35 sub-catchments. Sub-catchment delineation defined in the model was reviewed and updated to better represent the current catchment conditions. This included further sub-dividing eight of the larger sub-catchments into finer areas to suitably represent the stormwater discharge locations and inflows into the MIKE FLOOD hydraulic model. The updated sub-catchment layout is indicated in Figure 4.1 and catchment XP-RAFTS model nodes in Figure 4.2.

Each sub-catchment in XP-RAFTS model was simulated using a two catchment methodology to reflect the pervious and impervious conditions. A summary of the adopted sub-catchment parameters for the calibration and verification events is presented in Table 4-1.





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Prepared : 077900
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Project Number : 130115

File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 4.1 - Tingalpa Drain Hydrological Model Subcatchments V2.mxd

Legend

- Tingalpa Drain Catchment
- Tingalpa Drain Sub-Catchments
- Channel Centreline
- Flow Direction

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Figure 4.1: Tingalpa Channel Sub-Catchment Layout

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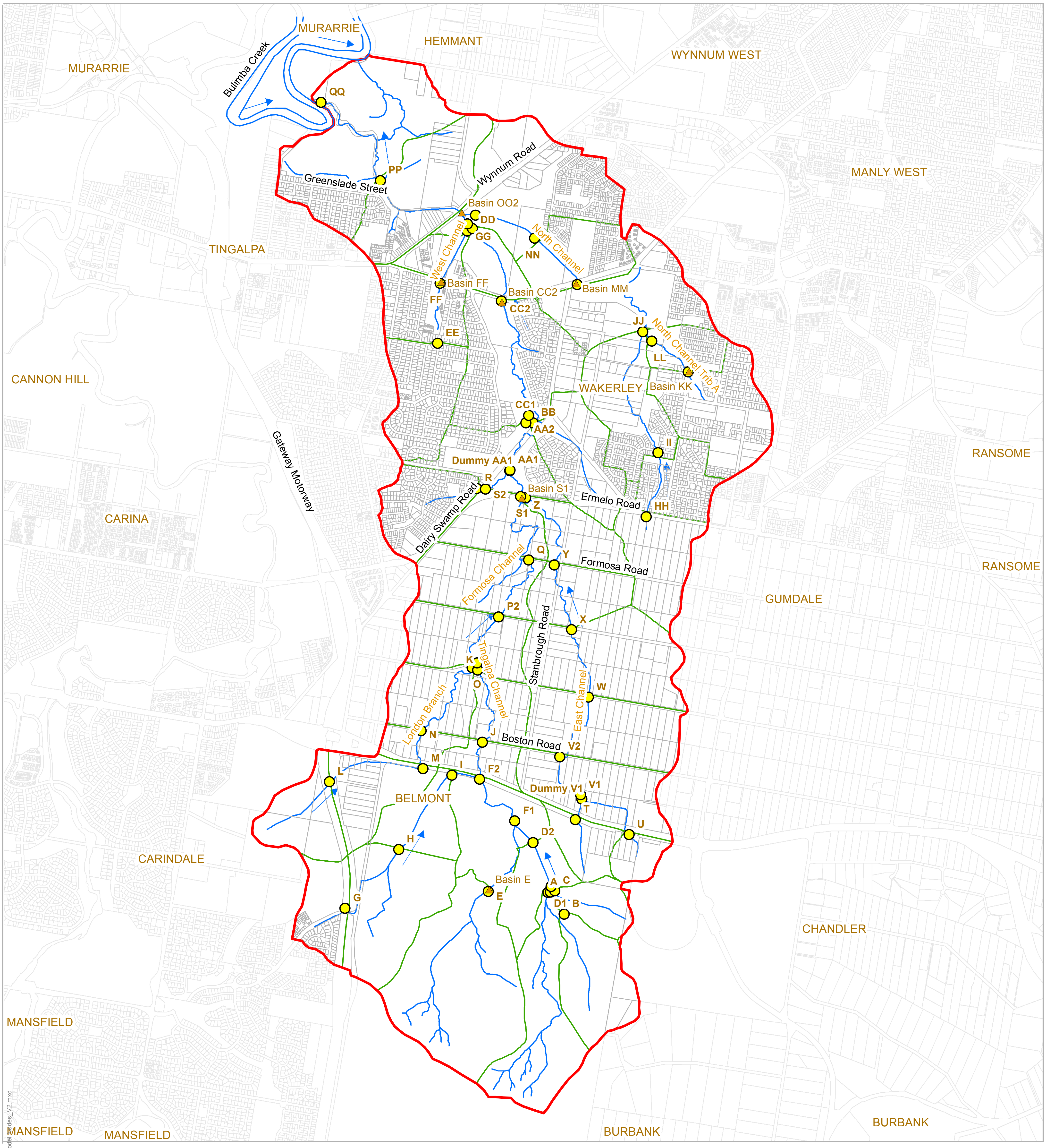
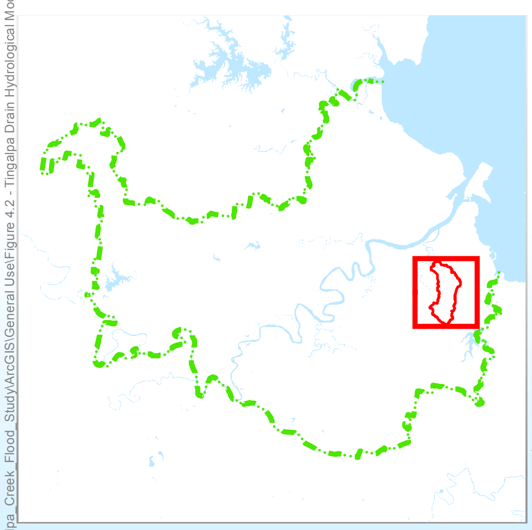


Legend

- RAFTS Basin
- RAFTS Nodes
- Tingalpa Drain Catchment
- Tingalpa Drain Sub-Catchments
- Flow Direction
- Channel Centreline



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Tingalpa Channel Flood Study 2015

Figure 4.2: Tingalpa Channel Catchment XP-RAFTS Model Nodes

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File : G:\BICD\Proj\15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 4.2 - Tingalpa Drain Hydrological Model Nodes_V2.mxd

Table 4-1: Sub-catchment parameters adopted in XP-RAFTS model

Sub-Catchment	Area (ha)	Impervious (%)	Impervious Area (ha)	Pervious Area (ha)	Catchment Slope
A	46.1	0.2	0.1	45.9	3.4%
B	32.0	1.9	0.6	31.4	1.5%
C	14.2	2.1	0.3	13.9	3.2%
D	20.1	1.5	0.3	19.9	2.1%
E	84.2	0.6	0.5	83.7	4.2%
F	34.8	4.9	1.7	33.1	1.9%
G	19.7	28.4	5.6	14.1	12.3%
H	48.9	9.6	4.7	44.2	3.5%
I	21.0	5.2	1.1	19.8	2.0%
J	11.4	21.9	2.5	8.9	2.3%
K	16.1	17.3	2.8	13.3	1.3%
L	25.5	10.2	2.6	22.9	6.5%
M	27.2	20.2	5.5	21.6	2.2%
N	10.6	22.7	2.4	8.1	1.7%
O	24.3	17.7	4.3	20	1.4%
P	32.5	16.6	5.4	27	1.1%
Q	31.4	17.2	5.4	26	1.8%
R	27.8	51.1	14.2	13.6	3.1%
S	22.6	19.4	4.4	18.2	1.4%
T	15.0	12.0	1.8	13.1	3.8%
U	9.7	33.0	3.2	6.4	3.8%
V	38.6	21.0	8.1	30.4	1.2%
W	43.3	17.8	7.7	35.6	1.2%
X	52.8	17.6	9.3	43.5	2.4%
Y	23.1	17.8	4.1	18.9	3.0%
Z	20.4	18.1	3.7	16.7	1.4%
AA	28.9	30.8	8.9	20	1.9%
BB	33.3	54.6	18.2	15.1	1.5%
CC	58.5	42.2	24.7	33.8	0.5%
DD	14.9	6.0	0.9	14	0.1%
EE	33.3	52.3	17.4	15.9	2.8%
FF	25.3	58.9	14.9	10.4	1.1%
GG	10.9	19.3	2.1	8.8	0.4%
HH	30.0	17.0	5.1	24.9	2.1%
II	28.3	52.6	14.9	6.1	2.3%
JJ	40.6	68.4	27.8	8.8	0.8%
KK	43.1	50.8	21.9	21.2	2.2%
LL	14.7	50.4	7.4	7.3	2.5%
MM	50.2	46.2	23.2	19.9	1.3%
NN	28.5	43.9	12.5	16	1.7%
OO	62.5	24.8	15.5	47	0.6%
PP	49.1	25.0	12.3	36.8	0.7%
QQ	76.0	36.6	27.8	48.2	0.2%
Total	**1363**	**-**	**358**	**1004**	**-**

4.2.3 Percentage Impervious

The land-use and impervious areas have been identified using BCC aerial photography and BCC City Plan 2014. The adopted land-use for the calibration and verification events is shown in Appendix C-1. Table 4-2 indicates the percentage impervious values adopted for the various land-use types. Where XP-RAFTS sub-catchments contained more than one type of land-use, weighted averages of the percentage imperviousness were applied for each sub-catchment.

Table 4-2: Sub-catchment parameter by land-use

Land-use Type	% Impervious
Cemetery	15
Community purposes	25
Conservation	0
Education purposes	40
Emergency services	55
Emerging community	70
Environmental management	15
Industry	90
Low-medium density residential	65
Low density residential	55
Major sports venue	50
Neighbourhood centre	95
Open space	0
Road Reserve	55
Rural*	20
Special purpose (Utility services)	50
Sport and recreation	5-10

*Rural areas would usually have a lower impervious percentage; however aerial photography shows that some of these areas have already been developed

4.2.4 Sub-catchment Slope

Sub-catchment slopes have been estimated with the most recent topographical data and determined using the equal area method calculation. This analysis reveals that the sub-catchments located upstream of Old Cleveland Road and on the catchment boundary have a relatively higher slope compared to other sub-catchments within the catchment.

4.2.5 Detention Basin

Existing storage areas and detention basins provide considerable flood storage within the Tingalpa catchment. Review of the XP-RAFTS, (1998) model indicated the need to update/re-calculate the stage/storage and discharge data used in the stage-storage relationship for the detention areas, as the hydrology model results are to be verified against the hydraulic model results.

There are six storage and detention areas incorporated in the updated XP-RAFTS model including a detention basin constructed on the North Tributary in conjunction with land development activities. The location details of these basins/areas are given in Table 4-3. Stage/discharge and stage/storage details derived for these areas are given in Appendix B (Tables B-1 to B-6).

Table 4-3: Location of storage/detention basins in XPRAFTS model

Item	Channel	Storage node	Location Details
1	Tingalpa Channel	S1	Detention area to the north of Formosa Road up to Ermelo Road (UBD Map 182/J2-4)
2	Tingalpa Channel	CC2	Detention area to the North of Ermelo Road up to the Manly Road (UBD Map 182/K14-20)
3	Tingalpa Channel	OO2	Detention area to the north of Manly Road up to Wynnum Road (UBD Map 162/J11-14)
4	West Channel	FF	Detention area to the south of Manly Road (UBD Map 162/H14-15)
5	North Channel	MM	Detention area to the north of Taylor Place up to Manly Road (UBD Map 162/N14-P14)
6	North Channel	KK	Detention Basin located to the north of Basella Street (UBD Map 162/Q16-17)

4.2.6 Hydrologic Model Roughness (PERN)

The hydrologic roughness parameter (PERN) is input as a Manning's 'n' representation of the average sub-catchment roughness. It is an empirical parameter that takes into account pervious sub-catchment roughness. For impervious areas an "n" value of 0.03 was used for most sub-catchments, while for pervious areas the values ranged from 0.05 to 0.09.

4.2.7 Link and Routing Parameters

Routing of the channel links was undertaken using the Muskingum-Cunge methodology. The program calculates the Muskingum K and X values based on the channel cross-sectional and longitudinal characteristics. The cross-sectional shape was reviewed and modified accordingly to represent current conditions.

Links representing below ground stormwater drainage conduits (where appropriate and applicable) were modelled using the link-lag approach. This approach translates the base of the hydrograph (without attenuation) based on the input lag time. The lag time was initially calculated assuming an average travel time of 2 m/s.

4.2.8 Rainfall

Recorded data from each calibration and verification event was incorporated into the XP-RAFTS model using a standard HYDSYS database format. The HYDSYS rainfall data, which was derived for use in the hydrological modelling, comprised recorded rainfall at five minute intervals.

For the January 2012 event, Thiessen Polygons were used to enable the gauged rainfall to be apportioned to each of the sub-catchments in the XP-RAFTS model. Sub-catchments which fell totally within a polygon were fully assigned to the respective rain gauge. Those sub-catchments which overlapped across two of more polygons were proportioned to the respective rain gauge based on the proportion of area within each polygon. Thiessen polygon map used for the rainfall distribution are included in Figure C-6 in Appendix C.

The May 2009 event also utilised the Thiessen Polygon approach, however each sub-catchment was assigned a single rain gauge station based on the dominant proportion within the sub-catchment. Thiessen polygon map used for the May 2009 event rainfall distribution are given in Figure C-7 in Appendix C.

The above-mentioned events experienced consistent rainfall across the entire catchment; however, the December 2010 and October 2010 event had significant spatial variation. During the calibration process, it was observed from simulation results that the Thiessen Polygon distribution did not represent the rainfall within areas of the catchment; therefore adjustments to the rainfall weightings were undertaken. It was determined that each model would be best suited with a single rainfall distribution. This resulted in better calibration and verification for both October 2010 and December 2010 events respectively.

4.2.9 Rainfall Losses

The Initial Loss (IL) and Continuing Loss (CL) methodology was used to simulate the rainfall losses. An IL of between 5 and 20mm and a CL rate of 0 mm/hr were adopted while simulating the calibration and verification storm events.

The IL is known to be the amount of rainfall loss that occurs before the start of surface runoff. The initial loss comprises factors such as interception storage (e.g. tree leaves); depression storage (e.g. ditches, surface puddles, etc.) and the initial infiltration capacity of the soil, whereby a dry soil has a larger capacity than a saturated soil.

The CL is assumed to be the average loss rate throughout the remainder of the rainfall event and is predominantly dependant on the underlying soil type and porosity.

4.3 Selection of Storm Events for Calibration and Verification

Four storm events were selected for calibration and verification purposes and are listed in Table 4.4. Ranking of rainfall events was conducted based on the availability of MHG readings per storm event and flood height, the intensity/magnitude of the rainfall (Table 3-2) and also completeness of the data.

Table 4-4: Calibration and verification storm events

Calibration event	Verification events
11th October 2010	20th May 2009
25th January 2012	24th December 2010

The available flood level information for the five recent events recorded in the catchment is listed in Table 3-3. Maximum flood heights at all three MHG locations were reported for only the 11th October 2010 and 24th December 2010 storm events. One of each from these two events was allocated for model calibration and verification.

The 20th May 2009 and 24th January 2012 events were identified as having the highest rainfall intensity having a 1 to 2 year ARI (50% AEP) for 6 -10 hour storm durations and 2-5 year (50% AEP) ARI for durations in 10 hour or longer. The ARI for October 2010 was up to 2 year (50% AEP), while for December 2010 less than a 2 year ARI (50% AEP) event. Based on these facts a higher and a lower intensity rainfall event each were assigned to both the calibration and verification phases.

4.4 Calibration and Verification Process

The updated XP-RAFTS model was used to simulate the selected rainfall events. Rainfall data was available from five rain gauge stations in nearby catchments. Recorded rainfall data for each calibration and verification event was obtained at 5 minutes intervals and applied to the XP-RAFTS model. Thiessen polygons methodology as discussed in 4.2.8 was adopted to allocate rain gauge data to each sub-catchment in the model.

As no continuous stream height gauges are located within the Tingalpa Channel catchment, direct calibration of the hydrologic model to recorded stream flows was not possible. Instead, calibration was conducted by attempting to match the hydraulic model results to MHG recorded data. Additionally, at selected locations, discharge hydrograph comparison between the hydrologic and hydraulic models was undertaken to verify the hydrology model, the same procedure adopted in the previous Gumdale to Tingalpa Stormwater Management Plan (1998). The comparison of discharge profiles obtained from the two models at their respective locations also assisted in identifying the consistency between model discharges. Results of the hydrology model calibration are summarised in Section-5: Hydraulic Model Development and Calibration.

Defalt parameters adopted in the XP-RAFTS model are given in Table 4-5. The simulation files used for each calibration event are shown in Appendix K.

Table 4-5: XP-RAFTS Model Parameters

Description	Notation	Value Adopted
Storage non-linearity exponent	N	-0.285
Storage delay time coefficient multiplier	Bx	1.0
Continuing Loss	CL	0mm/hr

5.0 **Hydraulic Model Development and Calibration**

5.1 Overview

The original hydraulic model for the Tingalpa Channel catchment is a 1D MIKE11 model developed in conjunction with the previous SMP (1998), and was not functioning at the time of this study.

Topographic characteristics of the Tingalpa Channel catchment together with flood prone land in the middle and lower reaches best suites the adoption of a 2D flood modelling approach to assess the flooding characteristics. This is justified by the presence of:

- A flat and wide flood plain with narrow and shallow low flow channels mostly in the middle and lower reaches;
- Low lying vegetated lands that provide significant flood storage;
- Ponding areas in environmental protection allotments and absence of efficient stormwater drainage system, resulting in braided overland flow;
- Tidal intrusion from the Bulimba Creek and Brisbane River in the lower part of the catchment;
- Culvert crossings with low discharge capacity and large, broad weir flows and local road network with low flood immunity and wide overflow lengths.

A 2D flood model with a fine grid was built to assess the hydraulic behaviour and flooding impacts of Tingalpa Channel. Adoption of a 4m grid resolution, with an embedded low flow channel was deemed appropriately accurate to represent the waterway configuration within the model extents. The bathymetry data of the waterway channel was derived from new surveyed sections, 2014 and the sections that were obtained from the MIKE 11 model, SMP (1998).

Although not a requirement of this flood study, the standalone MIKE11 model, used in the SMP (1998) was reviewed and updated using both the new surveyed cross sections of 2014 and sections derived from ALS data of 2009. This MIKE11 model was also verified against recorded flood level information so that validation of the MIKE FLOOD model results could be undertaken in the upper reaches of the catchment; where no recorded flood information was available.

5.2 Model Selection

Hydraulic modelling of the Tingalpa Channel catchment was carried out using the flood modelling software: MIKE FLOOD Release 2014 (sp1), which is a combination of 1D-MIKE11 and 2D-MIKE21. MIKE FLOOD model allows the representation of topographic characteristics of the catchment and hydrologic input data in 2D-MIKE21 and, hydraulic structure modelling in 1D-MIKE11. These two models are then dynamically linked through couple file in MIKE FLOOD. The coupled MIKE FLOOD model provides the facility to assess the hydraulic and flooding characteristics of Tingalpa channel and its tributaries together with catchment’s flood plain.

5.3 Model Development

5.3.1 Available Data for MIKE FLOOD Model

A number of datasets have been used in the development of the MIKE FLOOD model. These include:

- MIKE11 model developed in SMP (1998)
- Cross section survey undertaken by BCC in 1997 and 2014
- Airborne Laser Scanning (ALS) data of 2009
- Contour Maps and GIS data from BCC
- City Plan 2014
- Bulimba Creek MIKE11 model, 2010
- Bulimba Creek design event runs (with AR&R, 1987 rainfall) done by WBM in 2014 for Hemmant-Lytton Flood study
- Design drawings for hydraulic structures
- Recorded flood information - BCC Hydrometric Data Base
- Hydrologic model output from XP-RAFTS model developed in the study.

5.3.2 Model Schematisation

The MIKE FLOOD model for the Tingalpa Channel catchment was built by coupling 1D-MIKE11 and 2D-MIKE21 models. Tingalpa catchment was modelled in the 2D-MIKE21 domain including the waterway channels, floodplain and weir structures with a fine grid. The culverts and bridge crossings were represented as 1D-structures in MIKE11 branches. Standard coupling was introduced in MIKE FLOOD Couple file at the structure locations and linked the end points of MIKE11 branches and MIKE21 grid cells. The resulting MIKE FLOOD model provides the ability to estimate flooding characteristics of the Tingalpa catchment.

5.3.3 Development of MIKE 21 model

The extent of the2D- MIKE21 domain of the MIKE FLOOD model was selected to cover the full extent of the Tingalpa Channel catchment. Tingalpa waterway channels were introduced only to the north of Old Cleveland Road up to its confluence with Bulimba Creek as shown in Figure 5.1: MIKE FLOOD Model Layout and Structure Locations. A 4m x 4m grid resolution was used to define the catchment in the model, which covers an area approximately 3.2 km x 7.2 km. Coordinates of the lower left and upper right corners of the MIKE21 grid and the number of grid cells in the direction of both X and Y directions are listed in Table 5-1 below.

Table 5-1: Grid Setup

Location	X- Coordinate (GDA94)	Y- Coordinate (GDA94)	J-Grid cells in X-direction	K- Grid cells in Y-direction
Lower Left	511740.4	6955230	0	0
Upper Right	515352.4	6962422	903	1798

The following waterway channels were included in the MIKE21 model and embedded into the channel bathymetry:

- Tingalpa Channel: From north of Old Cleveland Road down to its confluence with Bulimba Creek;
- West Channel: Downstream of Annette Street to the Tingalpa Channel confluence;
- East Channel: From north of Old Cleveland Road to its confluence with Tingalpa Channel immediately north of Ermelo Road;
- North Channel: North of New Cleveland Road to its confluence with Tingalpa Channel;
- North Channel Tributary A: North of Bassella Street to the North Channel confluence;
- London Branch: From Old Cleveland Road to its confluence with Tingalpa Channel located to the north of London Road.

5.3.3.1 MIKE21 Model Topography

As the channel conveyance comprises a very small part of the total channel and floodplain conveyance, the 2D representation with a 4m x 4m grid, and embedded channel with updated bathymetry was considered as adequate to represent channel geometry. This means that the narrow creek channels in the upper part of the catchment are mostly represented by one to two grid cells within the adopted 4m grid.

Council's ALS data of 2009 was used to derive the 4m Digital Elevation Model (DEM) grid required for the 2D-MIKE21 model extent. The channel bathymetry was created using MIKE11, SMP (1998) model topographic data, surveyed cross section information of 2014 and 1997, and invert levels at the crossings obtained from design drawings. The bathymetry of the detention basin located at the top end of North Channel tributary was also included using information available in design drawings. The channel bathymetry was then stamped into the DEM grid to form the final topography for the hydraulic model.

Detailed checks on the accuracy of the 2009 ALS data outside the channels have not been undertaken. It is assumed that the data is representative of the actual topography and 'fit for purpose'.

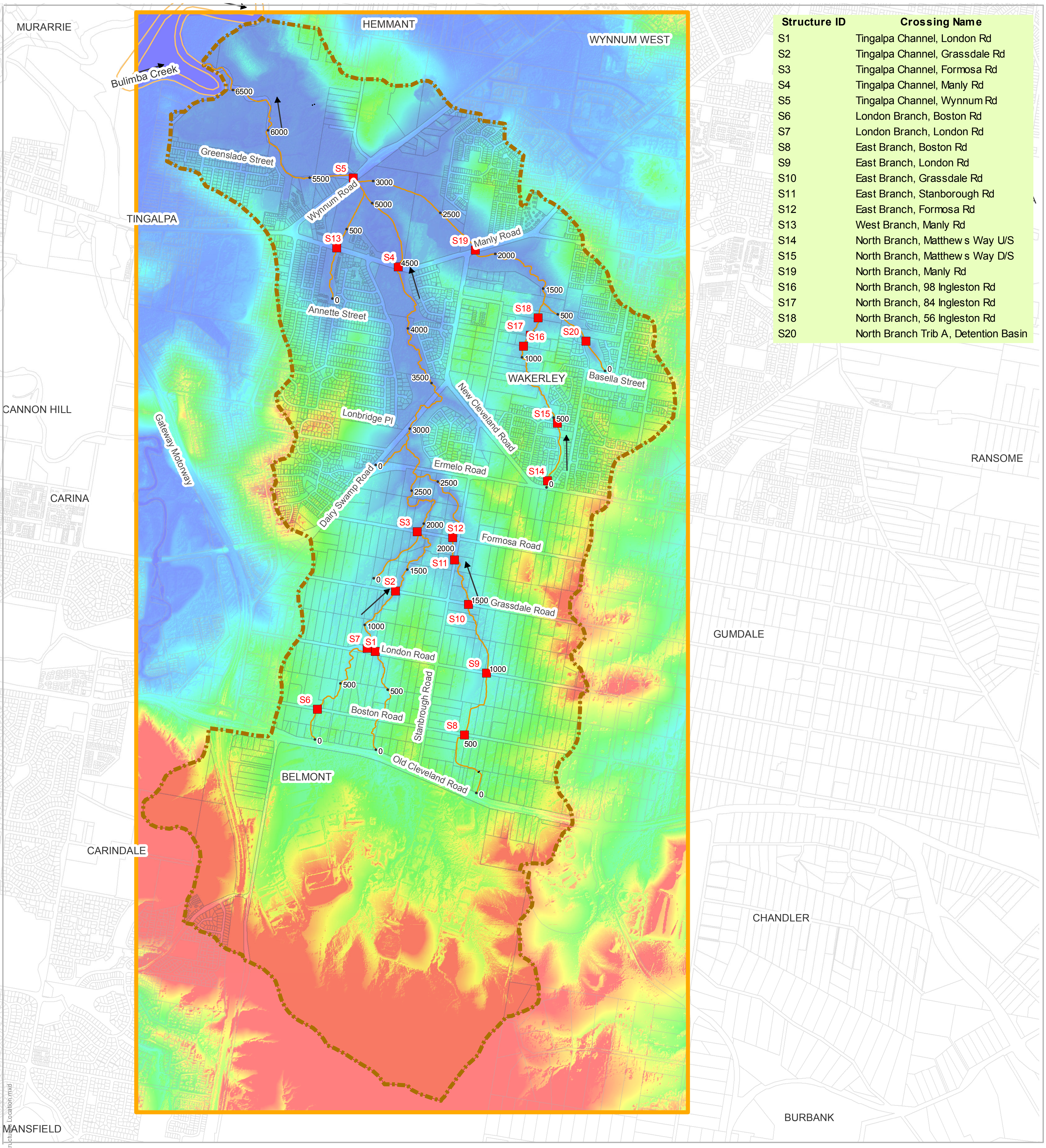
5.3.3.2 MIKE21 Model Resistance File - Model Roughness

The Model Resistance file that contains the Manning's roughness values for the MIKE21 model was developed using the land use in City Plan (2014), aerial photography (2012) and information collected from field visits. Each land use category in City Plan was assigned a Manning's 'n' value based on QUDM, input from recently completed flood studies and experience from similar projects. The adopted roughness values corresponding to a various land-use types are shown in Table 5-2.

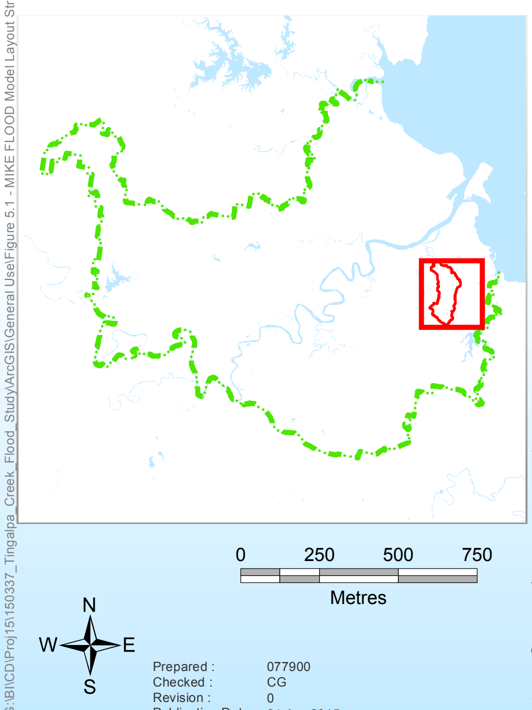
5.3.3.3 Eddy Viscosity

The Eddy Viscosity parameter is used in the 2D-MIKE21 model to simulate large-scale transfer of momentum caused by small-scale turbulent eddy flow across the model bathymetry. The eddy viscosity value can also be used to dampen the effect of model instabilities.

A velocity based eddy viscosity of 0.8 m^2/s has been applied globally within the model with the exception of areas at the 1D/2D structure links. This value is within the guidelines recommended by the software developer, DHI for a grid size between 1 to 10 m. At coupled cells the eddy viscosity was set to 4 m^2/s to enhance model stability.



Structure ID	Crossing Name
S1	Tingalpa Channel, London Rd
S2	Tingalpa Channel, Grassdale Rd
S3	Tingalpa Channel, Formosa Rd
S4	Tingalpa Channel, Manly Rd
S5	Tingalpa Channel, Wynnum Rd
S6	London Branch, Boston Rd
S7	London Branch, London Rd
S8	East Branch, Boston Rd
S9	East Branch, London Rd
S10	East Branch, Grassdale Rd
S11	East Branch, Stanborough Rd
S12	East Branch, Formosa Rd
S13	West Branch, Manly Rd
S14	North Branch, Matthews Way U/S
S15	North Branch, Matthews Way D/S
S19	North Branch, Manly Rd
S16	North Branch, 98 Ingleston Rd
S17	North Branch, 84 Ingleston Rd
S18	North Branch, 56 Ingleston Rd
S20	North Branch Trib A, Detention Basin



Legend

- Structure Locations
- MIKE FLOOD Channel Centreline
- Tingalpa Drain Catchment
- DEM Extent
- Flow Direction
- Bulimba Creek

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Figure 5.1: MIKE FLOOD Model Layout & Structure Locations

DATA INFORMATION

Prepared : 077900
Checked : CG
Revision : 0
Publication Date : 24 Jun 2015
Project Number : 130115

File : G:\BICD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 5.1 - MIKE FLOOD Model Layout Structure Location.mxd

FLM - 130115 - 001

Table 5-2: Roughness parameters adopted in MIKE FLOOD Model

Topographical feature / Land-use	Manning's 'n'	Manning's 'M'
Cemetery	0.06	17
Community Purposes	0.04 - 0.12	25 - 8
Conservation	0.04	25
Education Purposes	0.1	10
Emergency Services	0.1	10
Emerging Community	0.12	8
Environmental Management	0.07	14
Industry	0.15	7
Low - Medium Density Residential	0.15	7
Low Density Residential	0.12	8
Major Sports Venue	0.05	20
Neighbourhood Centre	0.15	7
Open Space	0.04	25
Rural	0.04 -0.12	25 - 8
Special Purposes Utility Services	0.05	20
Specialised Centre	0.15	7
Sports and Recreation	0.04	25
Roads	0.02	50
Channel - medium	0.035	29
Channel – medium to rough	0.05	20
Minimum Riparian Corridor	0.15	7

5.3.3.4 Boundary Conditions

Two downstream boundaries are specified in the MIKE 21 model setup and bathymetry file in the bottom left corner of the 2D-model domain. These are specified as tidal water level boundaries.

All the inflows to the MIKE FLOOD model from the catchment were introduced into the MIKE21 model domain as 36 source points and applied into a single grid cell or multiple grid cells depending on the magnitude of the discharge. They were placed at the lowest section of the channel and at the centre of each sub-catchment or at the start of a channel. Inflow point locations in the MIKE21 model are shown in Figure 5.2: MIKE FLOOD Model Inflow Locations Layout.

The inflow hydrographs were derived from the XP-RAFTS model for each sub-catchment and applied to MIKE21 grid cells as source points. When the flow was applied to multiple cells, (if required) it was divided equally across the number of grid cells based on the magnitude.

Downstream boundary water level profiles for Tingalpa Channel at the Bulimba Creek confluence were derived by simulating the existing Bulimba Creek model MIKE11, (2010) for each calibration and verification event. Appropriate inflows were obtained by simulating the Bulimba Creek hydrology model: WBNM with recorded rainfall data for the recorded events. Downstream tidal boundary applied to the Bulimba Creek MIKE11 model in simulating each of the recorded rainfall events was derived from the stream gauge at Doughboy Parade and included in Figures A-3 to A-6 of Appendix A. These boundary conditions derived are given in Figures C-2 to C-5 of Appendix C.

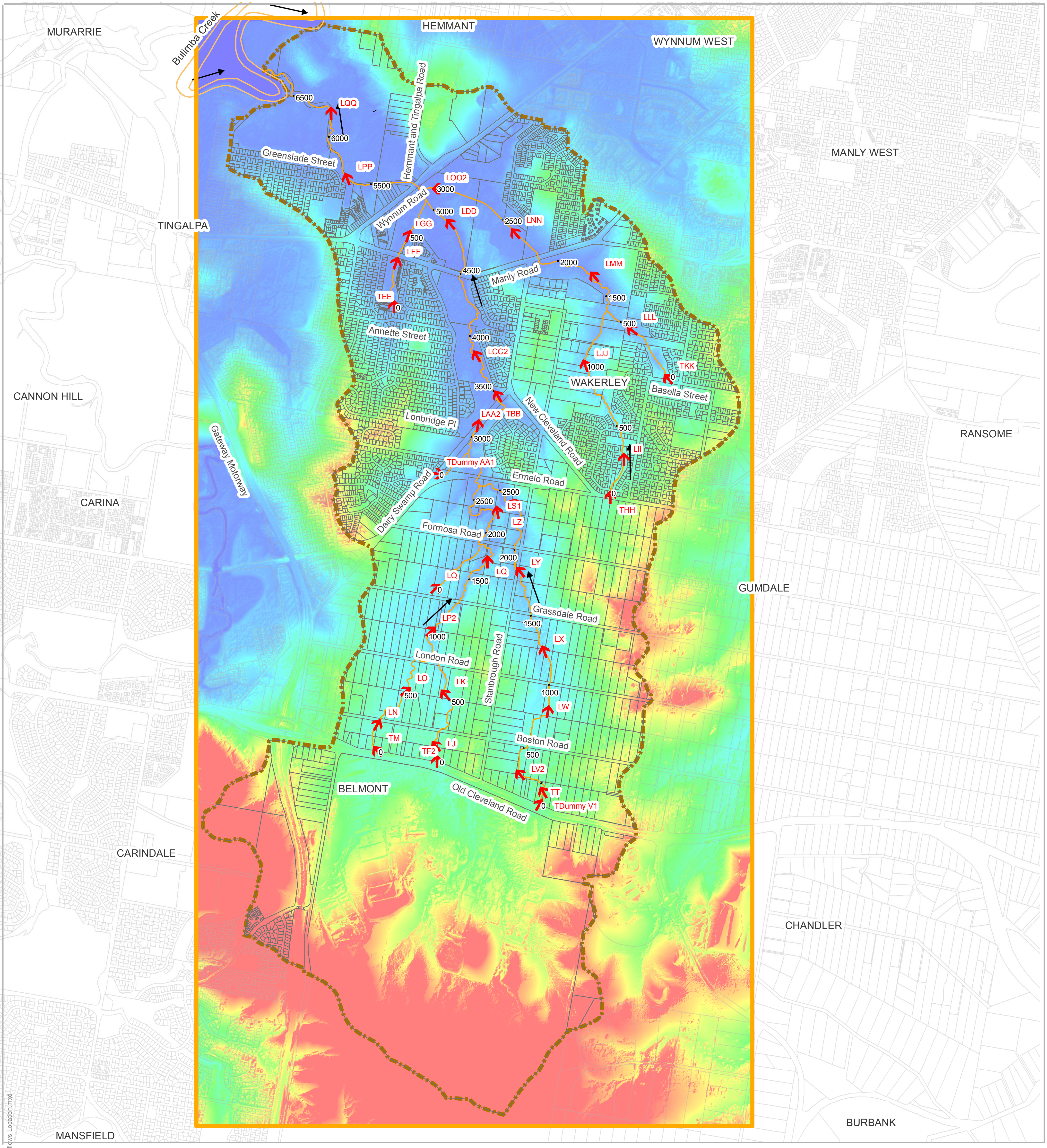
5.3.3.5 Flooding and Drying Depths

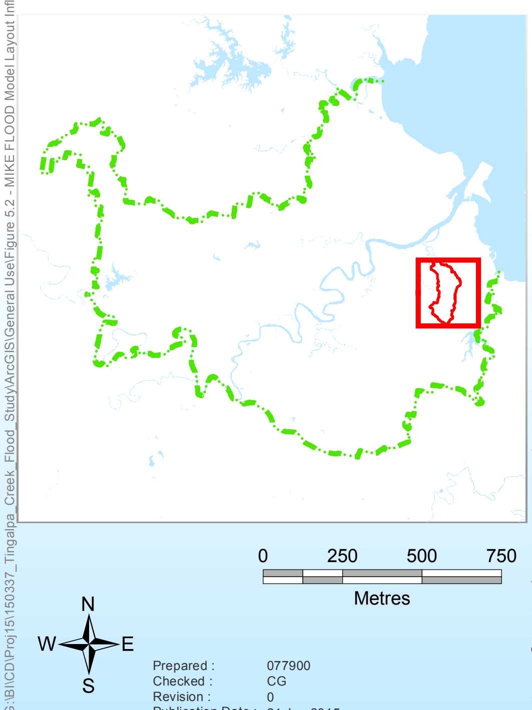
Flooding and drying depths are enabled as it was for inland flooding applications. A flooding depth of 0.05m and a drying depth of 0.02m were applied. These values were within the range of recommended values by DHI.

5.3.3.6 Run Parameters

In MIKE FLOOD applications, DHI recommends using a time step such that the Courant number is maintained to a value less than 1.0. In order to achieve this condition time step of 0.4 of a second was used in MIKE21 model with a Courant number of 0.54.

After setting up the MIKE21 model it was run with a time step 0.4 second to ensure model stability and it runs with no errors and the results were reasonable. This MIKE21model was coupled in the MIKE FLOOD with MIKE11 model, once developed.





Legend

- Inflow Locations
- MIKE FLOOD Channel Centreline
- DEM Extent
- Flow Direction
- Bulimba Creek
- Tingalpa Drain Catchment

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Figure 5.2: MIKE FLOOD Model Inflow Locations Layout

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FLM - 130115 - 001

File: G:\BICD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 5.2 - MIKE FLOOD Model Layout Inflows Location.mxd

5.3.4 MIKE 11 Model Development

5.3.4.1 MIKE 11 Model Files

A standard 1D-MIKE11 model was developed to include the culverts and two bridge structures in the Tingalpa Channel catchment. This was then coupled with the MIKE21 model developed using MIKE FLOOD couple.

The MIKE11 network file consists of short (15 to 50m long) network branches and the configuration details of the culverts and bridges located in the catchment. The waterway lengths of all structures modelled exceeded at least two MIKE21 grid cells. In the cross section data file for the location of each structure crossing, one upstream and one downstream cross section were introduced. In the HD parameters file global roughness value 0.035 was adopted for all cross sections. A roughness value of 0.02 was applied to all culverts in the network file.

The model inflows in the MIKE11 boundary file consisted of open boundaries with dummy flow as the catchment inflows were introduced within the MIKE21 domain.

5.3.4.2 Hydraulic Structures

There are 18 culverts and two bridges modelled within the Tingalpa Channel catchment. These structures were introduced as1D elements in the MIKE11 model network file using the culvert modelling approach. Standalone MIKE11 model was run with a 0.4 second time step to ensure that it runs with no errors.

Structure details were obtained from the design drawings held by Council. In-situ measurements were made for a few culverts to verify the dimensions. Hydraulic structures that were included in the MIKE11 model are given in Table 5-3 and their locations indicated in Figure 5.1 with the MIKE FLOOD model layout.

Wynnum Road Bridge and Grassdale Road Bridge were also modelled as regular culverts. The Wynnum Road Bridge consists of a two lane structure comprising a bridge and culvert combination in the inbound lane, and four span bridge structures in the outbound lane. Grassdale Road Bridge was single span. The overflow on culverts and bridges were modelled in the 2D-MIKE21 domain.

Hydraulic Structure Reference Sheets are provided in Appendix E and contain the structure geometry details as extracted from design drawings.

Table 5-3: Hydraulic Structures Modelled

Channel	Structure Location	Model ID	Structure Detail	Structures linked Cells MIKE21 (j, k) cell coordinates
Tingalpa	London Rd	S1	6/1200 x 900mm RCBC	U/S 2 cells (391,750 and 392,750) D/S 2 cells (390,755 and 391,755)
Tingalpa	Grassdale Rd	S2	Single Span Bridge (10m)	U/S 8 cells (419,848 to 426, 848) D/S 8 cells (425,854 to 432,854)
Tingalpa	Formosa Rd	S3	2/1200 x 375mm RCBC	U/S 2 cells (458,948 and 459,948) D/S 2 cells (459,951 and 460,951)
Tingalpa	Manly Rd	S4	4/2400 x 700mm RCBC 8/2100 x 1200mm RCBC 2/2400 x 1000mm RCBC	U/S 9 cells (425,1380 to 433,1378) D/S 9 cells (427,1386 to 435,1385)
Tingalpa	Wynnum Rd	S5	Inbound – 4 span and 2/3000x2700mm RCBC, Outbound – 4 span	U/S 9 cells (354,1523 to 361,1527) D/S 9 cells (349,1527 to 356,1531)
London	Boston Rd	S6	2/600mm RCP	U/S 2 cells (298,657 and 299,657) D/S 2 cells (299,660 and 300,660)
London	London Rd	S7	4/1200x900mm RCBC	U/S 2 cells (376,756 and 377,756) D/S 2 cells (379,760 and 380,760)
East	Boston Rd	S8	2/1200x600mm RCBC	U/S 2 cells (536,614 and 537,614) D/S 2 cells (537,619 and 538,619)
East	London Rd	S9	2/300mm RCP	U/S 1 cell (527,716) D/S 1 cell (573,720)
East	Grassdale Rd	S10	3/3300x1800mm RCBC	U/S 3 cells (542,828 to 544,828) D/S 3 cells (542,832 to 544,832)
East	Stanbrough Rd	S11	3/3300x1200mm RCBC	U/S 3 cells (523,899 to 523,901) D/S 3 cells (519,901 to 519,903)
East	Formosa Rd	S12	3/3300x1200mm RCBC	U/S 3 cells (515,937 to 517,937) D/S 3 cells (515,941 to 517,941)
West	Manly Rd	S13	1/3700x1500mm RCBC[1]	U/S 2 cells (326,1409 and 327,1409) D/S 2 cells (329,1416 and 330,1416)
North	Matthews Way U/S	S14	5/1500x600mm RCBC	U/S 2 cells (671,1029 and 672,1029) D/S 2 cells (672,1034 and 673,1034)
North	Matthews Way D/S	S15	3/2700x750mm RCBC 2700x1000mm RCBC	U/S 3 cells (688,1123 to 690,1123) D/S 3 cells (686,1129 to 688,1129)
North	98 Ingleston Rd	S16	5/2100x1000mm RCBC[1]	U/S 3 cells (631,1250 to 633,1250) D/S 3 cells (632,1253 to 634,1253)
North	84 Ingleston Rd	S17	5/2400x1280mm RCBC[1]	U/S 3 cells (642,1269 to 644,1269) D/S 3 cells (642,1271 to 644,1271)
North	56 Ingleston Rd	S18	5/2100x1800mm RCBC	U/S 3 cells (656,1297 to 658,1297) D/S 3 cells (657,1301 to 659,1301)
North	Manly Rd	S19	4/3000x1800mm RCBC[1]	U/S 5 cells (553,1404 to 557,1404) D/S 5 cells (552,1411 to 556,1411)
North Tributary	Off-Williams Street	S20	3/600mm RCP	U/S 2 cells (737,1255 and 738,1255) D/S 2 cells (734,1261 and 735,1261)

[1] Modelling adopted averaged values. Please refer to Hydraulic Structure Reference Sheet for more information.

5.3.5 MIKE FLOOD Couple

Having developed the 1D-MIKE11 and 2D-MIKE21 models, they were coupled in the MIKE FLOOD couple file. The MIKE11 network branches with each structure were coupled into the MIKE21 grid cells using standard links.

MIKE FLOOD couple was simulated using a 0.4 second time step in both the MIKE21 and MIKE11 models. This MIKE FLOOD model was then simulated with selected calibration and verification events. The simulation files used in each calibration event are shown in Appendix K.

5.4 MIKE FLOOD Model Calibration and Verification Procedure

5.4.1 General

As described in section 3.3.2, there are no continuous stream height gauges in the Tingalpa Channel catchment. Three MHGs located in the middle and lower reaches have recorded flood height readings since 2009. Two of these MHGs are located in the lower reaches adjacent to Tingalpa channel and the other is in the middle reach adjacent to East channel.

Historical storm events selected for model calibration were the 25th January 2012 and 11th October 2010 events. Recorded flood level readings were available for two and three MHGs, respectively, for these two calibration events. Model verification was undertaken with the 24th December 2010 and 20th May 2009 events where flood level readings from three and one MHGs, respectively were available.

The recorded MHG levels are generally considered to have an accuracy of ± 300mm. If the modelled flood levels are within the 300mm tolerance of the recorded MHG levels they are generally considered as acceptable.

5.4.2 Methodology

The following procedure was adopted in calibrating and verifying the MIKE FLOOD and XP-RAFTS model results.

1. Using the inflow hydrographs derived from the XP-RAFTS model for the two calibration events (i.e. 24th January 2012 and 11th October 2010) run the MIKE FLOOD model and compare the computed flood levels against the observed flood levels at MHG locations. Determine if the levels are within the ± 300mm tolerance limits;
2. Compare the discharge hydrographs between the XP-RAFTS and MIKE FLOOD model at selected locations in the catchment with reference to flood peak, timing and shape to estimate the reliability of discharge characteristics between the hydrology and hydraulic models;
3. If the results are not satisfactory, iteratively adjust the model parameters that include roughness values adopted in the MIKE21 model, rainfall loss parameters and lag time adopted in the XP-RAFTS model and repeat step-1. Model results are satisfactory when acceptable tolerance with the observed MHG data and a good match of the discharge hydrographs is achieved;
4. Adopt model parameters based on the calibration results;
5. The model verification phase provides a means of checking the calibrated model parameters. Run the selected verification events (i.e. 24th December 2010 and 20th May 2009) using the inflow hydrographs derived from the XP-RAFTS model, through the calibrated MIKE FLOOD model. Compare the estimated flood level results against the levels observed in MHGs to check if the desired tolerance exists. Also compare the discharge hydrographs between the XP-RAFTS and MIKE FLOOD model at the same locations as in step-2 above. If the results are acceptable calibration and verification procedure is complete. If the results are considerably different review hydrology input data and repeat steps 1 to 5 by slight adjustment of model parameters;

6. As the availability of recorded MHG flood levels are limited, the updated standalone MIKE11 model, (SMP 1998) is run with the above calibration and verification events. Peak flood levels computed from the MIKE11 model is then used to spot check the MIKE FLOOD model levels specifically in the upper reaches of Tingalpa Channel catchment.

5.5 Results of the Hydraulic Model Calibration and Verification

5.5.1 Calibration Events: 24th January 2012 and 10th October 2010

Peak flood levels obtained for both calibration events from the MIKE FLOOD model simulations were compared with recorded MHG levels and are tabulated in Table 5-4. Comparison plots of discharge hydrographs between XP-RAFTS and MIKE FLOOD model for the two events are also included as listed in Section 5.5.3.

January 2012 event: This was a multiple peak flood event with the recorded maximum flood height likely occurring in the early morning of the 25th January as shown in discharge hydrograph comparison plots. IFD plots given in Figure 3.5 indicate that the intense storm bursts of 6 to 10 hour in duration are approximately 1 to 2 year ARI, while storm bursts greater than 10 hours in duration range from 2 to 5 year ARI.

October 2010 event: Peak flood levels most likely occurred in the morning of the 11th October 2010 as indicated in discharge hydrograph comparison figures. IFD plots given in Figure 3.3 indicate that intense storm bursts of 6 to 10 hour are less than 2 year ARI.

Table 5-4: Calibration Events - Comparison of recorded and modelled flood levels

MHG	Channel	24th January 2012 event			10th October 2010 event		
		Recorded (mAHD)	Modelled (mAHD)	Difference (m)	Recorded (mAHD)	Modelled (mAHD)	Difference (m)
TD120	Tingalpa	2.36	2.42	-0.06	2.06	2.31	-0.25
BM1030	Tingalpa	N/A	2.63	-	2.46	2.59	-0.13
TD150	East	4.88	4.52	0.36	4.78	4.57	0.21

5.5.2 Verification Events: 24th December 2010 and 20th May 2009

Peak flood levels derived from the MIKE FLOOD model for both verification events simulations compared against recorded MHG levels are tabulated in Table 5-5. Comparison plots of discharge hydrographs between the XP-RAFTS and MIKE FLOOD model at selected locations for the May 2009 event are also included as described in Section 5.5.3.

May 2009 event: Modelled discharge profiles indicate that this event produced dual peaking with the highest peak occurring in the morning of 20th May 2009. IFD plots for the May 2009 event given in Figure 3.2 indicate that intense storm bursts of 6 to 10 hours in duration are approximately 1 to 2 year ARI, while bursts greater than 10hr hour duration are 2-5 year ARI.

December 2010 event: IFD plots for the December 2010 event given in Figure 3.4 indicate that the intensity of rainfall was less than 1 year ARI.

Table 5-5: Verification Events- Comparison of recorded and estimated flood levels

MHG	Channel	24th December 2010 event			20th May 2009 event		
		Recorded (mAHD)	Modelled (mAHD)	Difference (m)	Recorded (mAHD)	Modelled (mAHD)	Difference (m)
TD120	Tingalpa	2.25	2.12	0.13	N/A	2.44	-
BM1030	Tingalpa	2.57	2.45	0.12	2.84	2.65	0.19
TD150	East	5.09	4.66	0.43	N/A	4.58	-

5.5.3 Flood Discharge Profiles Comparison: MIKEFLOOD and XP-RAFTS Models

The discharge profiles from the hydrologic and hydraulic models were compared as stated above in order to provide credibility to the model calibration outcomes. This also demonstrated the consistency between the XP-RAFTS hydrology and MIKE FLOOD hydraulic models developed in the study. These comparisons were undertaken after extracting MIKE FLOOD model discharge profiles at the following selected locations (Figure D-1 to D-4 in Appendix-D) and corresponding XP-RAFTS model runoff for the calibration and verification events.

- Tingalpa Channel
  - Discharge profile north of Boston Road and XPRAFTS model flow at sub-catchment K
  - Discharge profile north of Ermelo Road and XPRAFTS model flow at sub-catchment AA
- East Channel
  - Discharge profile north of Formosa Road and XPRAFTS model flow at sub-catchment Y
- North Channel
  - Discharge profile north of Bassella Road and XPRAFTS model flow at sub-catchment MM

Comparison plots for the January 2012 calibration event and May 2009 verification event are included in Figures 5.3 to 5.10, while plots for the October and December 2010 events are in Appendix C: Figures C-8 to C-15. The inundation extent for both calibration and verification events are included in Appendix- D, Figures D-1 to D-4.

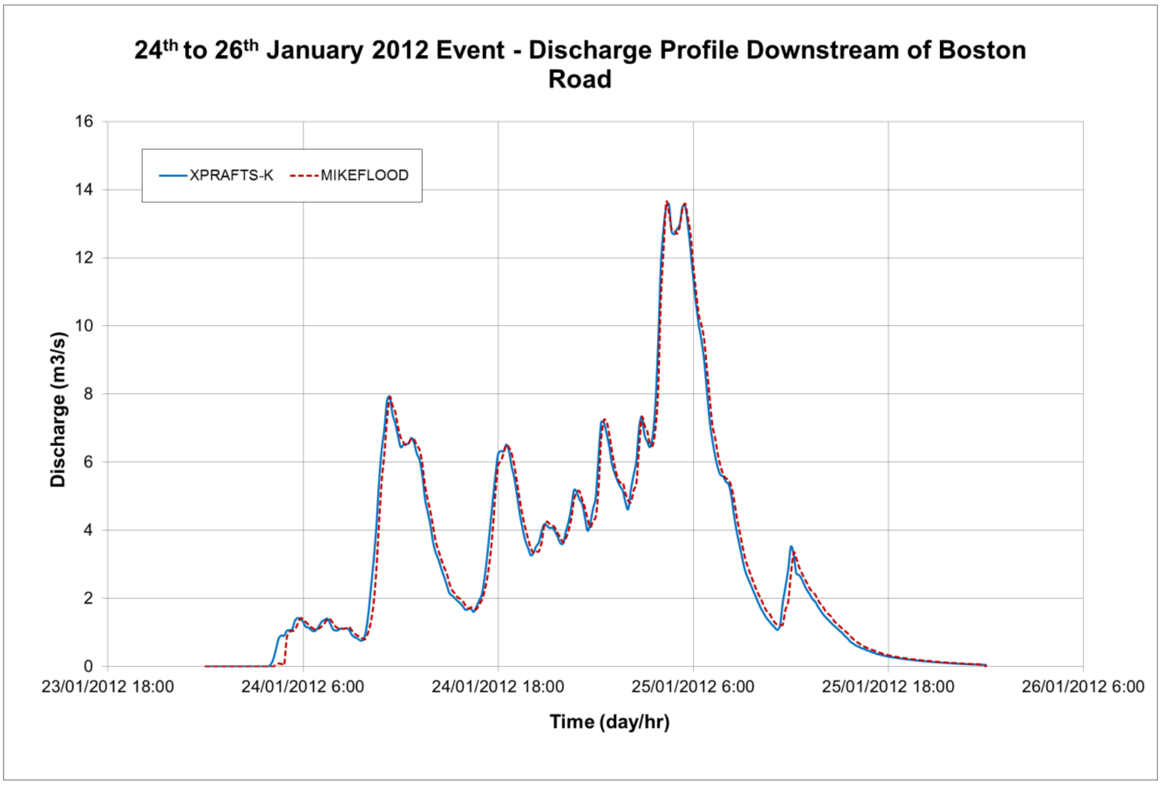


Figure 5.3: January 2012 calibration - discharge profiles downstream of Boston Road

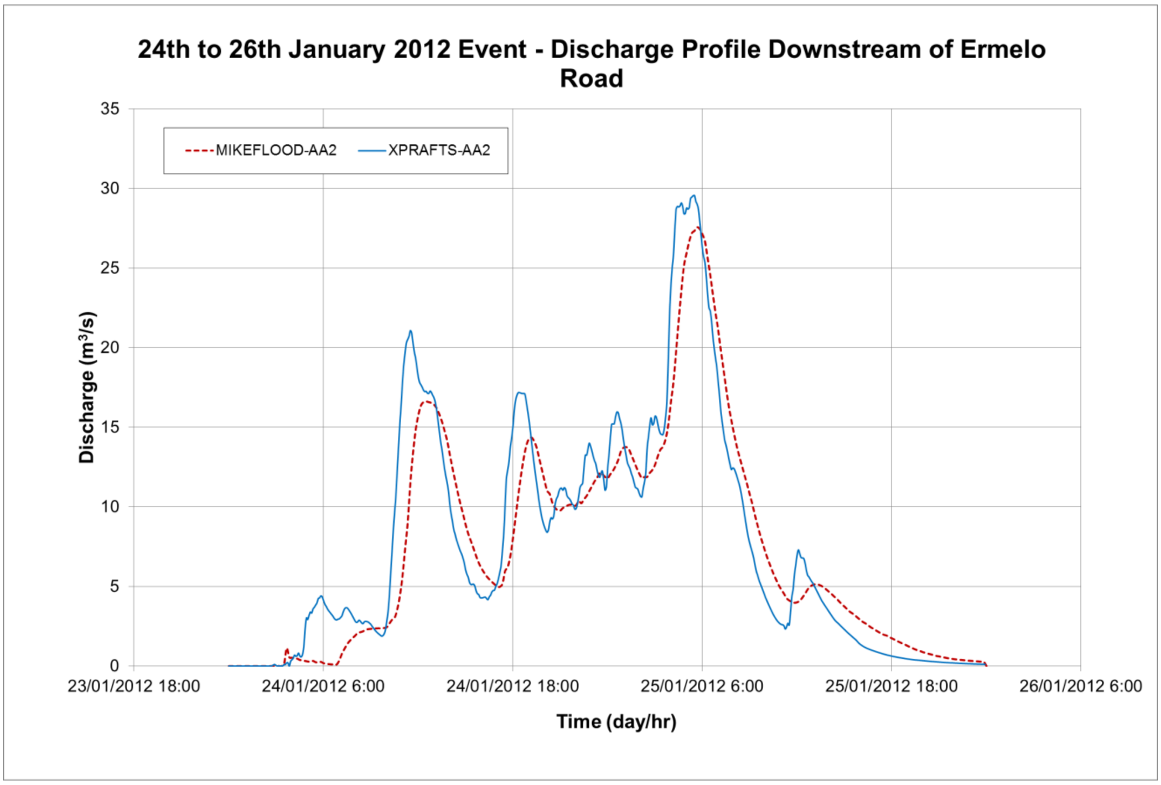


Figure 5.4: January 2012 calibration - discharge profiles downstream of Ermelo Road

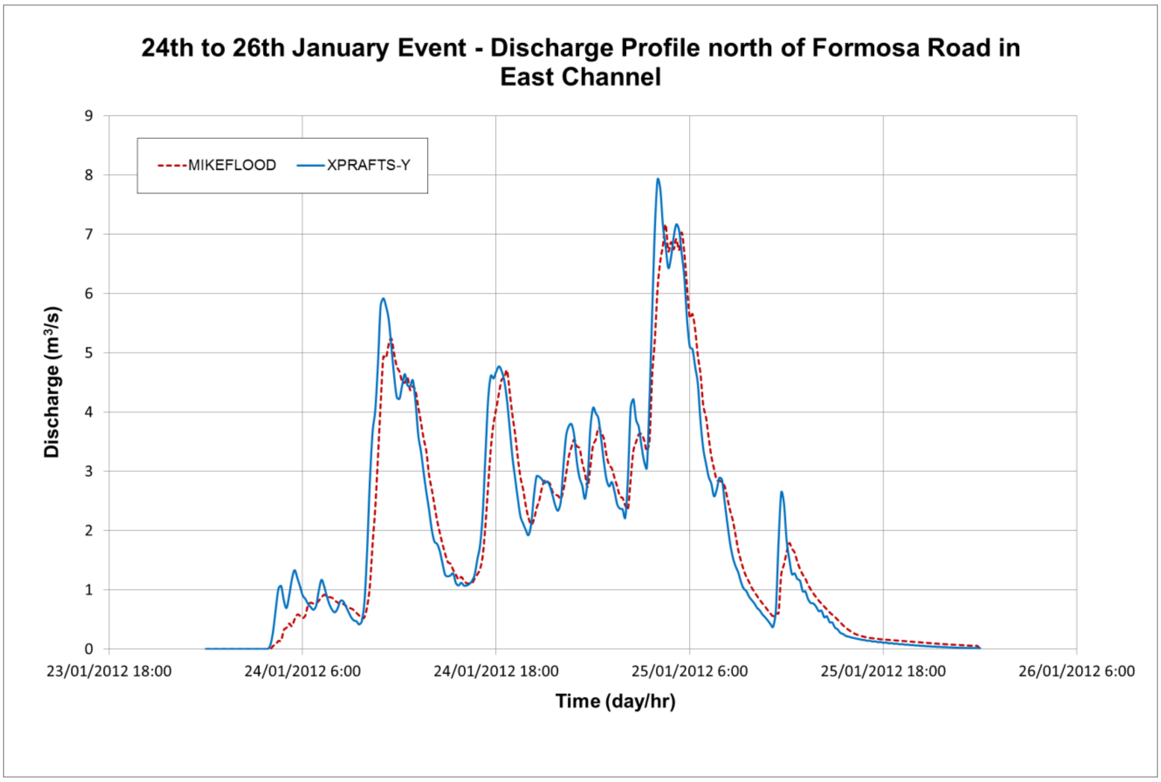


Figure 5.5: January 2012 calibration - discharge profiles north of Formosa Road in East Channel

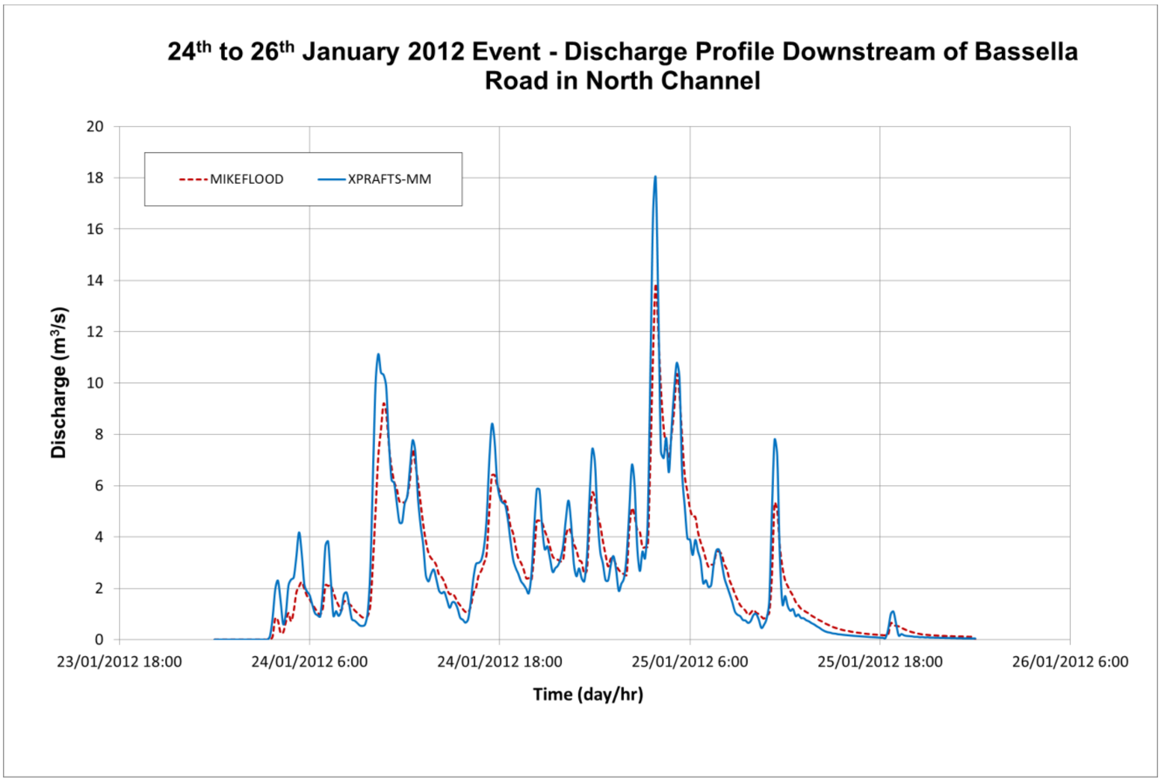


Figure 5.6: January 2012 calibration - discharge profiles downstream of Bassella Road

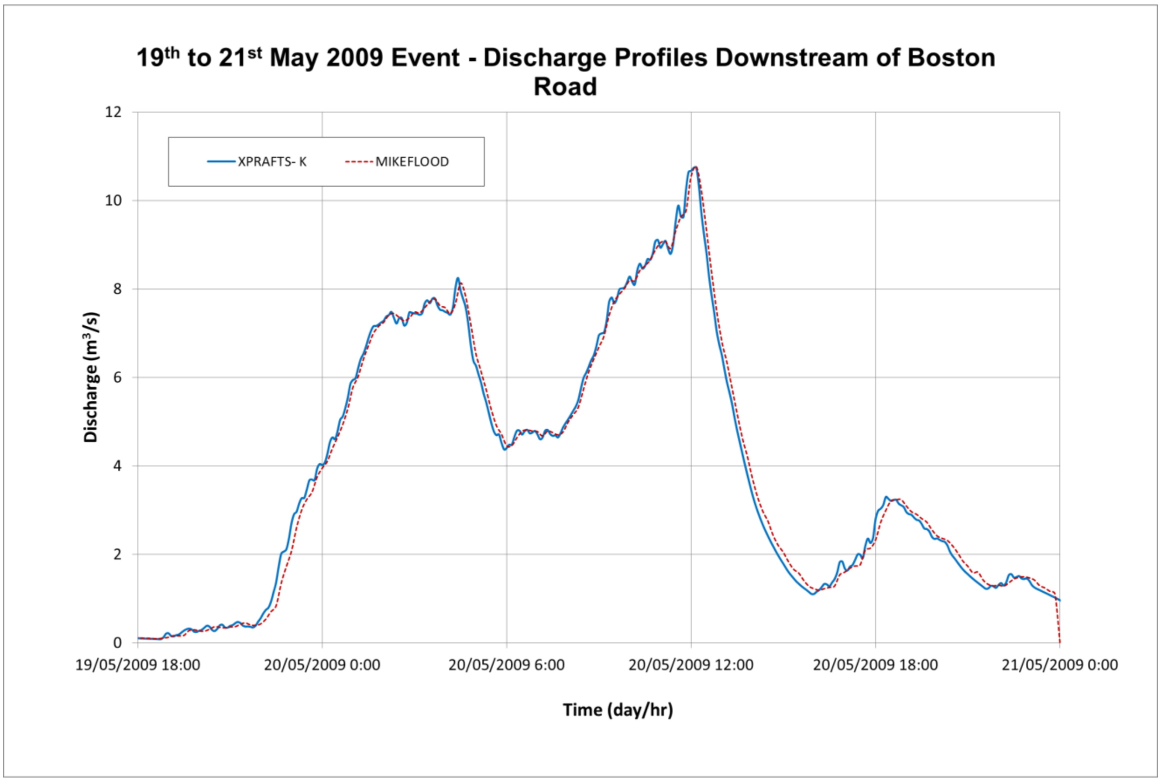


Figure 5.7: May 2009 verification - discharge profiles downstream of Boston Road.

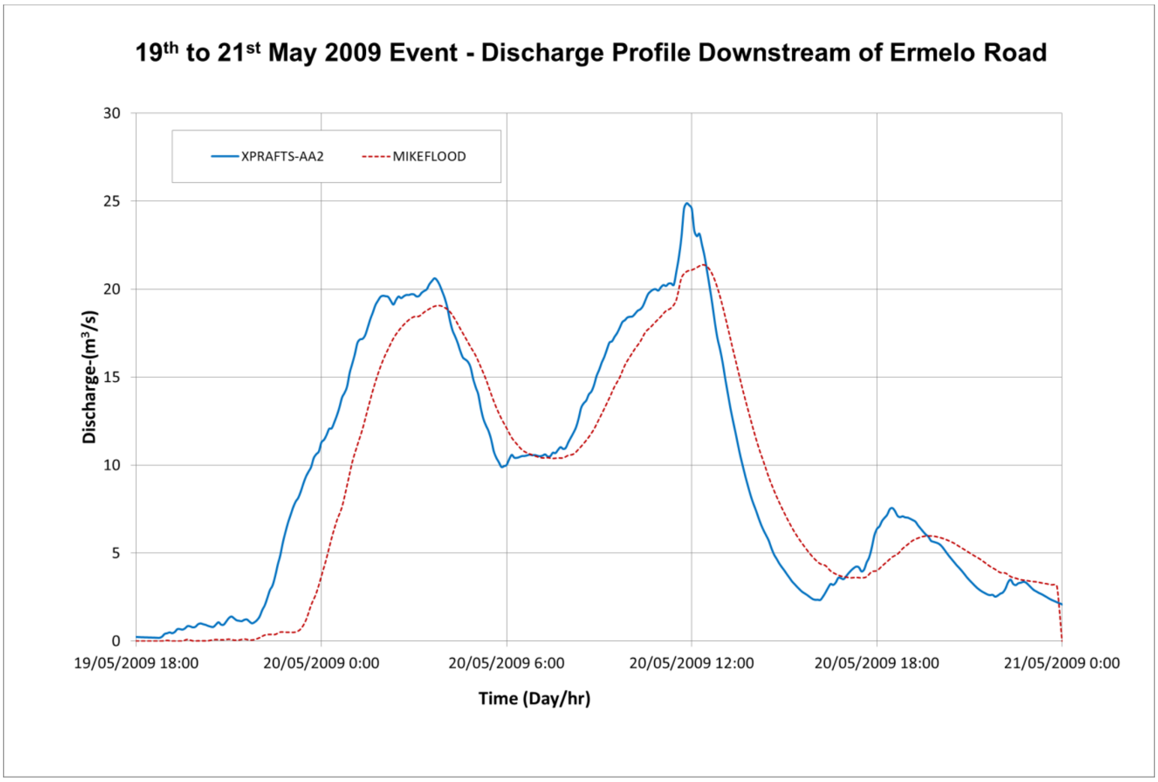


Figure 5.8: May 2009 verification - discharge profiles downstream of Ermelo Road

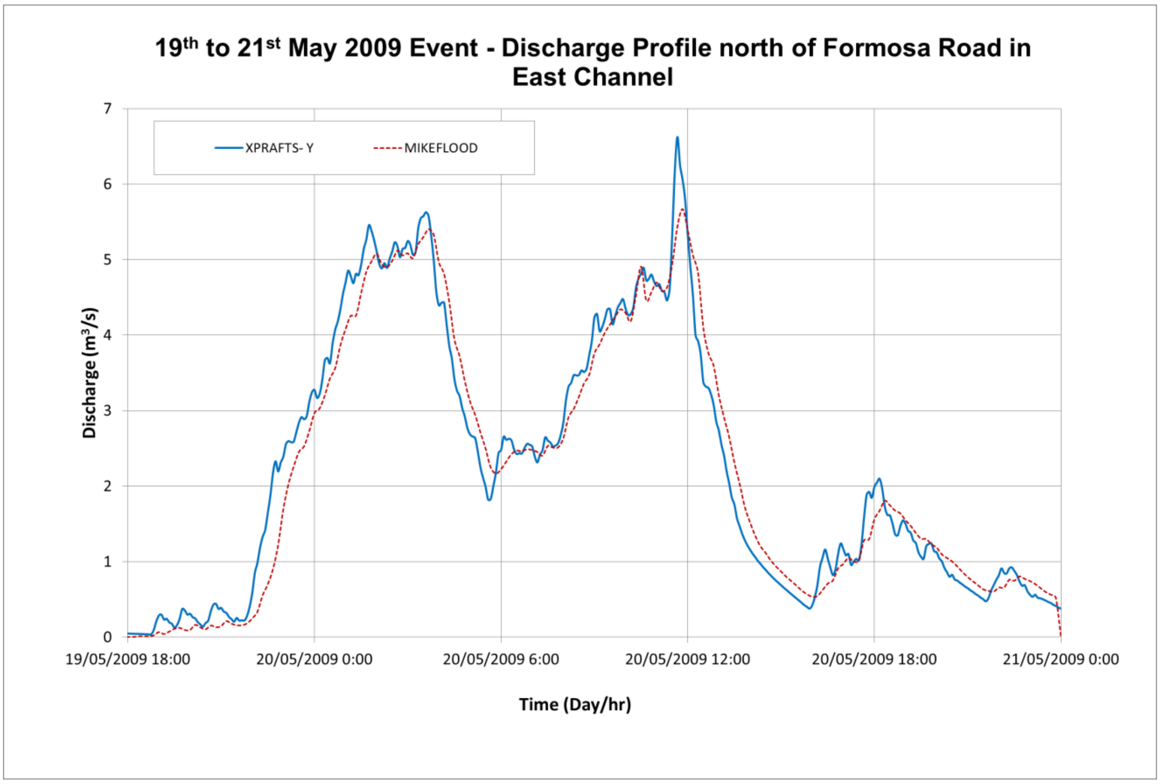


Figure 5.9: May 2009 verification - discharge profiles north of Formosa Road in East Channel

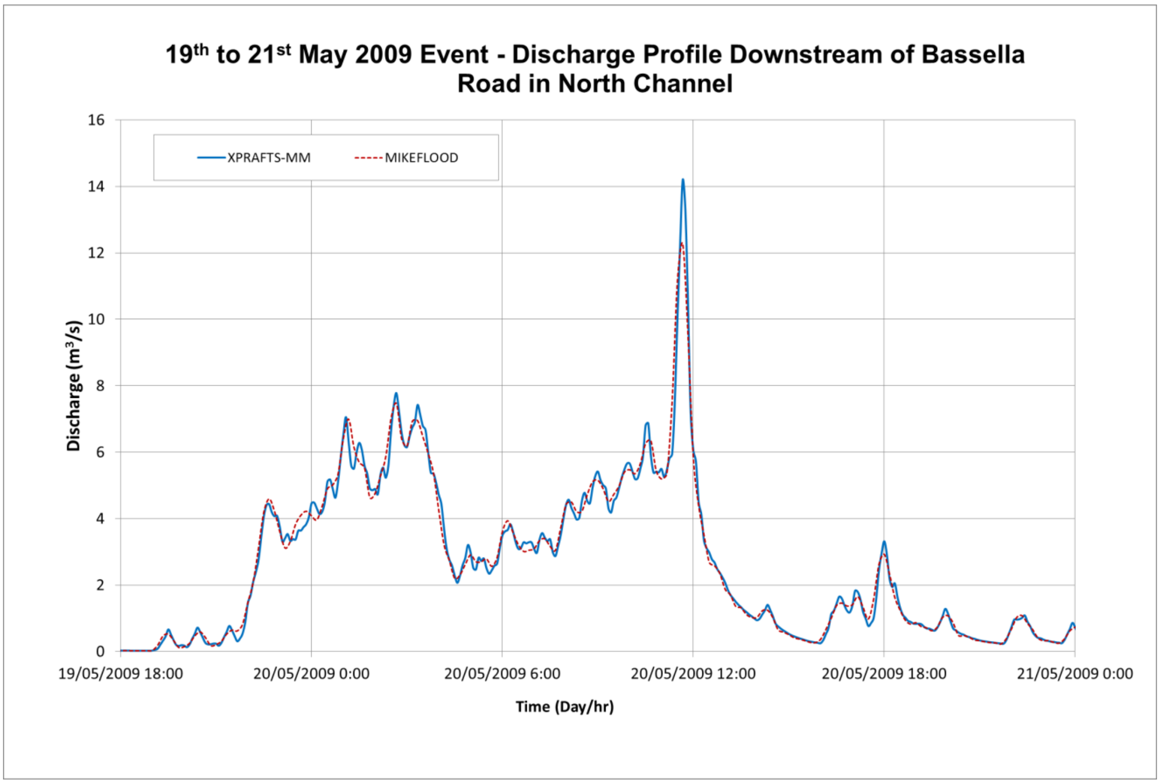


Figure 5.10: May 2009 verification - discharge profiles downstream of Bassella Road

5.6 Discussion of Results

Calibration of XP-RAFTS and MIKE FLOOD models was undertaken with data from the January 2012 and October 2010 events. Verification of the XP-RAFTS and MIKE FLOOD utilised storm events from May 2009 and December 2010.

Apart from the January 2012 calibration and December 2010 verification events at MHG TD150, results within the desired tolerance of ±300mm were achieved for all recorded flood levels at MHGs referenced in this study. For January 2012 calibration event, a number of simulations were conducted by changing the roughness values; however the model only showed a slight improvement in the calibration results at the MHG-150. The estimated flood level for January 2012 event at this gauge was 360mm lower than recorded flood levels.

Similarly the verification events showed that for the MHGs located in lower reaches, the computed flood level results were within the required tolerance. .A consistent lower flood level result was also observed for the MHG-150 located in East Channel.

As there were no continuous stream height gauges located in the catchment the discharge hydrographs from the hydrologic and hydraulic models were compared in order to provide credibility to the model calibration outcomes. The discharge hydrographs derived from the hydrologic and hydraulic models at selected locations were compared with reference to the timing of peaks, discharge magnitudes and shape of the plot. This also helps verify the consistency between the hydrology and hydraulic models. Examination of the preceding plots shows both timing and magnitude of the peak discharges well matched for the locations analysed. Some lagging and attenuation of the peaks from the hydraulic model outputs are seen for the lower reaches, where a number of storage areas exist. This may be due to the anomalies of the flood storage characteristics in the respective models.

Generally, 2D hydraulic models are known to simulate storages reasonably well; however, hydrologic models lack the ability to model storages adequately. Further analysis could be done to improve the results. This requires the existence of good calibration data as well.

The results of the hydraulic calibration and verification indicated that the MIKE FLOOD model was able to simulate the historical flooding events reasonably well with the exception of the slightly lower calibration (January 2012) and verification (December 2010) event at MHG TD150, which is located in a tributary (East Channel) of Tingalpa Channel. The model simulated the lower reaches, where other two gauges are located within the specified tolerance. Comparison of discharge hydrographs on the upper reach showed a good correlation between the hydrologic and hydraulic model. On this basis, it was concluded that the XP-RAFTS and MIKE FLOOD models were sufficiently robust to be used together to simulate design flood events.

6.0 **Design Event Analysis**

6.1 Design Event Terminology

The preferred terminology for design flood events in the draft AR&R is as follows:

- Annual Exceedance Probability (AEP) is to be used (in lieu of ARI) when an annual maximum frequency series has been utilised to derive the data being used.
- Average Recurrence Interval (ARI) is to be used (in lieu of AEP) when a peak over threshold (POT) frequency series has been utilised to derive the data being used.

The design rainfall data provided in AR&R effectively represents the results of a frequency analysis of the POT series rainfall data. As the design flood estimation used in this study is to be based entirely on the design rainfall data provided in AR&R (1987), the correct terminology is to use ARI rather than AEP.

In this study the term ARI is used predominantly, however, the equivalent AEP definitions are also included for completeness. The respective AEPs adopted for each of the design events are given in Table 6-1.

Table 6-1: ARI versus AEP

ARI (year)	AEP (%)
2	50
5	20
10	10
20	5
50	2
100	1

It is noted that the AEP values presented in Table 6-1 are based on the simplistic relationship AEP = 1/ARI when the relationship between ARI and AEP is expressed more fully by the equation AEP = 1 – exp (-1 / ARI). For this study the former relationship is used for convenience.

6.2 Design Event Scenarios

Table 6-2 indicates the three scenarios utilised in the modelling of the design events, noting that all design event scenarios were modelled using ultimate (i.e. fully developed) catchment hydrological conditions.

For the purpose of this report, the term "design events" refers to those events from 2-year ARI (50 % AEP) to 100-year ARI (1 % AEP).

Table 6-2: Design Event Scenarios Modelled

ARI (year)	AEP (%)	Scenario 1	Scenario 2	Scenario 3
2	50	✓	✗	✓
5	20	✓	✗	✓
10	10	✓	✗	✓
20	5	✓	✗	✓
50	2	✓	✗	✓
100	1	✓	✓	✓

The following describes the design event scenarios:

Scenario 1: Existing Waterway Conditions

Scenario 1 is based on the current waterway conditions. Some minor modifications were made to the MIKE FLOOD model developed as part of the calibration / verification; refer to Section 6.4 for further details.

Scenario 2: Minimum Riparian Corridor (MRC)

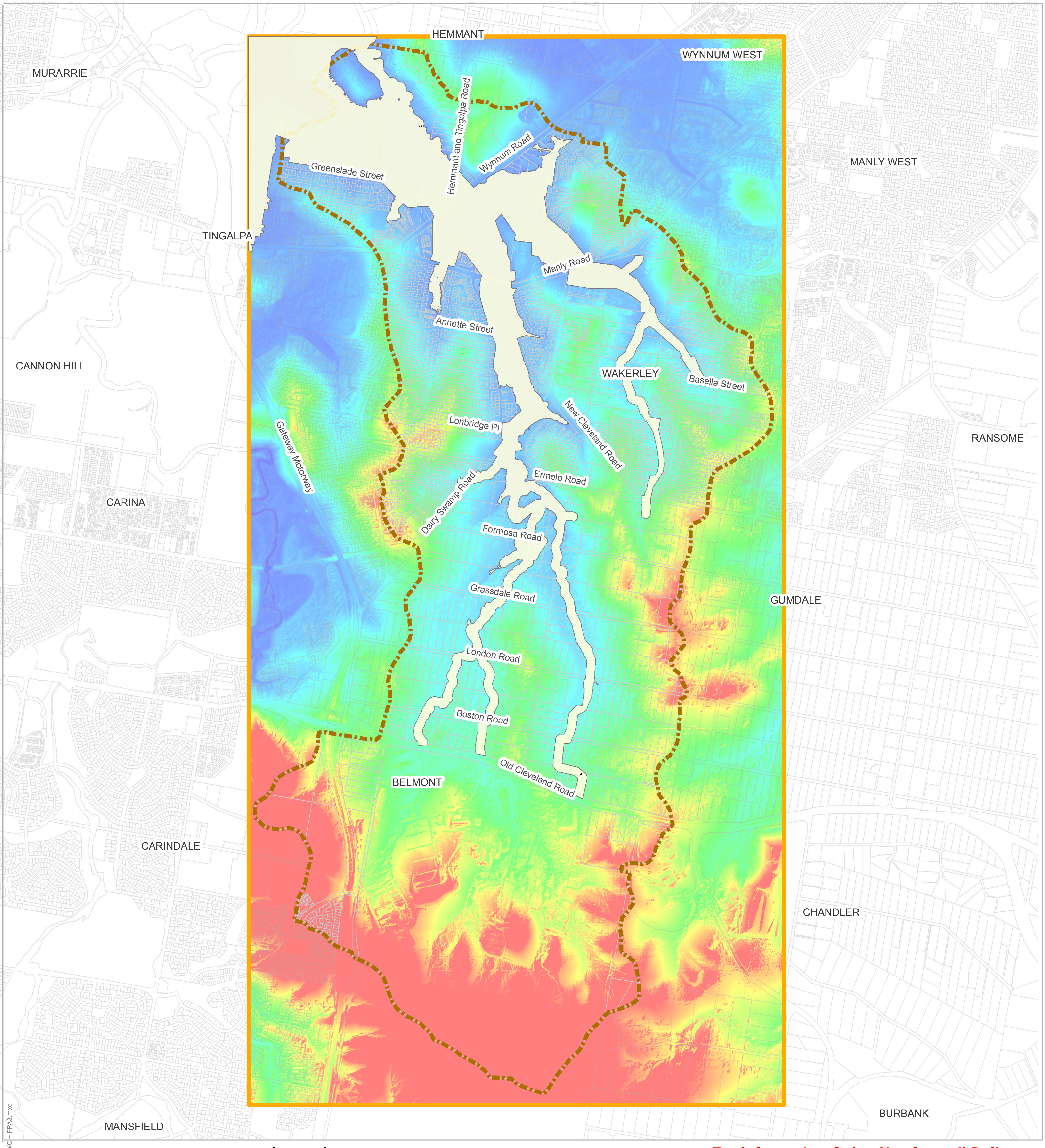
Scenario 2 is based on Scenario 1 but includes an allowance for a 15m riparian corridor along each side of the creek beginning at the top of the low flow channel bank. A default value of n = 0.15 was used in most locations along the waterway. However, where changes were not considered appropriate (adjacent to buildings, driveways, easements etc.) the Manning's 'n' was left unchanged.

Scenario 3: Filling to the Modelled Flood Corridor + Minimum Riparian Corridor (MRC)

The modelled flood corridor is the envelope of the waterway corridor and the shared boundary between Flood Planning Area 3 (FPA3) and FPA4. The FPA3-4 boundary can be defined as the greater extent of not less than 0.6 m depth in the 100-year ARI (1 % AEP) event and a hazard (i.e. DxV) value of not less than 0.6 m^2/s in the 100-year ARI (1 % AEP) event. Figure 6.1 indicates the modelled flood corridor for the creek.

Scenario 3 assumes filling to the modelled flood corridor boundary to represent potential future development. In the design events, 2-year ARI (50 % AEP) to 100-year ARI (1 % AEP), the filling acts as a barrier and the corridor can be modelled as a glass-wall of infinite height. This is a simple and conservative assumption used to develop design planning levels. It does not necessarily reflect allowable development assumptions under City Plan.

For the modelling of events greater than 100-year ARI (1 % AEP), the fill height outside of the modelled flood corridor is set to 0.3m above the calculated Scenario 3 100-year ARI (1 % AEP) flood level.

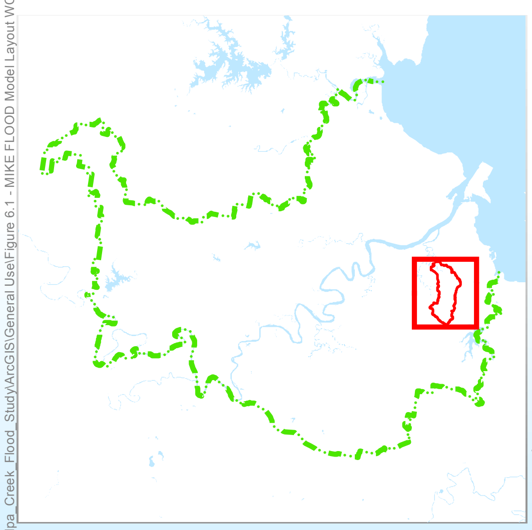


Legend

For Information Only - Not Council Policy

- Conveyance Corridor - Greater extent of FPA3 and the Waterway Corridor
- Tingalpa Drain Catchment
- DEM Extent
- Cadastre

Brisbane City Council
City Projects Office
GPO Box 1434
Brisbane Qld 4001
For more information
visit www.brisbane.qld.gov.au
or call (07) 3403 8888



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Prepared : 077900
Checked : CG
Revision : 0
Publication Date : 24 Jun 2015
Project Number : 130115

File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Figure 6.1 - MIKE FLOOD Model Layout WC + FPA3.mxd

DATA INFORMATION

The flood maps must be read in conjunction with the flood study report and interpretedby a qualified professional engineer. The flood maps are based on the best data available to Brisbane City Council ("Council") at the time the maps were developed. Council, and the copyright owners listed below, give no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) presented in these maps and the user uses and relies upon the data in the maps at its own sole risk and liability. Council is not liable for errors or omissions in the flood maps. To the full extent that it is able to do so in law, the Council disclaims all liability (including without limitation, liability in negligence) for any loss, damage or costs (including indirect and consequential loss and damage), caused by or arising from anyone using or relying on the data contained in the flood maps for any purpose whatsoever.

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Figure 6.1: MIKE FLOOD Model Layout
Flood Corridor for Scenario 3

FLM - 130115 - 001

6.3 Design Event Hydrology

Design flood estimation can be undertaken using flood frequency analysis (FFA) of annual maximum flows or peak over threshold series if observed stream flow records are available for the site. FFA enables estimating the magnitude of floods of selected probability of exceedance by undertaking statistical analysis of annual peak flows of recorded floods over a number of years. However, there are no stream gauges located in the Tingalpa Channel catchment and therefore FFA is not possible to be undertaken for this catchment.

6.3.1 Investigation Methodology

The design flood analysis undertaken for the catchment in this study is based on the text Australia Rainfall & Runoff (AR&R) 1987, which was developed using industry accepted methodology. The methodology is as follows:

- IFD curves for Brisbane (AR&R, 1987) developed by the BoM, were used to estimate the intensity for design rainfall events of ARI 2, 5, 10, 20, 50 and 100 years with 30, 60, 90, 120, 180, 270 and 360 minute durations;
- Design temporal patterns provided by AR&R (1987) are used to distribute design rainfall over the duration of the storm;
- Design events are simulated through the calibrated hydrology model (XP-RAFTS) after adopting rainfall loss parameters dependant on catchment conditions;
- Hydraulic model (MIKE FLOOD) simulations are undertaken for the proposed scenarios using the design event discharges derived from the hydrology model to estimate flood levels.

6.3.2 XP-RAFTS Model Set-up

The calibrated XP-RAFTS model was used to simulate the design storm rainfall-runoff and sub-catchment routing process. The following describes the adjustments made to the model in order to simulate the design events.

Catchment Development

The design events were modelled using ultimate catchment hydrological conditions. These conditions assume that the state of development within the catchment is at its ultimate condition, with reference to the current adopted planning scheme. Increasing development within the catchment will generally increase the percentage impervious and lower the PERN hydrologic roughness values.

The BCC City Plan (2014) was used to establish the ultimate catchment hydrological conditions. The adopted land-use for the ultimate catchment development is shown in Figure C-1 in Appendix C. An aerial image of the catchment is shown in Figure C-2 in Appendix C.

Rainfall Losses

Rainfall losses were introduced as Initial Loss (IL) and Continuing Loss (CL) parameters in order to determine the rainfall excess.

An IL of 0 mm was adopted for design event modelling. This value was adopted in recognition that the design storms created through the AR&R methodology represent critical storm burst information and may not account for lead-up rainfall which might otherwise satisfy any IL demands within the catchment.

A CL of 0 mm/hr was adopted for design event modelling, as identified through calibration of the hydrologic and hydraulic models.

6.4 Design Event Hydraulic Modelling

The MIKE FLOOD model was used to determine design flood levels for the scenarios detailed in Table 6-2 for the 2-year ARI (50 % AEP) to the 100-year ARI (1 % AEP) events. These events were simulated for durations ranging from 30 minutes to 6 hours.

6.4.1 MIKE FLOOD model extents and grid

For scenarios 1, 2 and 3, the MIKE FLOOD model utilised the same model extents as the MIKE FLOOD model developed for the calibration and verification events. For information on the grid used refer to Section 5.3.5

6.4.2 MIKE FLOOD model roughness

The hydraulic roughness in the calibrated MIKE FLOOD model was updated as required to represent ultimate catchment conditions. The main changes in roughness values were made to the industrial land-use area located within the North Channel sub-catchments. Refer to Table 5-2 and Appendix C-1 for more information on the roughness values adopted for each land use.

6.4.3 MIKE FLOOD model boundaries

Design Inflows

The design inflow (Q-T) boundaries to the MIKE FLOOD model were taken from the XP-RAFTS model for each ARI and duration. For Scenarios 1 and 2 the model utilised the same inflow locations as the MIKE FLOOD model developed for the calibration and verification events. For Scenario 3, a change to the inflow location occurred on the single inflow to the tributary (Formosa Channel) that joins Tingalpa Channel near Formosa Road. This area does not have a waterway corridor, nor does it meet the criteria for the creation of a notional flood corridor based on the Flood Planning Area 3-4 boundary. Consequently, as the original inflow location falls within the assumed filled (developed) zone outside the modelled flood corridor, the inflow location was required to be shifted slightly downstream.

Design Tailwater Boundary

The Tingalpa Channel MIKE FLOOD model utilises a variable water level (H-T) boundary at its downstream extent at Bulimba Creek. The flood study procedure required that Mean High Water Springs (MHWS) conditions be utilised for all design events. However, review of the Bulimba Creek Flood Study indicated that a MHWS level of 0.95 m AHD would be exceeded at the mouth of Tingalpa Channel due to the magnitude of the fluvial discharge in Bulimba Creek.

The Bulimba Creek Flood Study MIKE11 model was used to generate H-T boundaries for all events and durations modelled. Simulations were undertaken with this model utilising a fixed MHWS (0.95 m AHD) boundary at the Bulimba / Brisbane River confluence. From the results of each simulation, a water level hydrograph was extracted at the Tingalpa Channel - Bulimba Creek confluence. This methodology creates a more realistic downstream boundary, rather than using a fixed MHWS boundary at Tingalpa Channel.

6.4.4 MIKE FLOOD model parameters

The following modelling parameters were adopted in the design event model. The simulation files used for each design event are shown in Appendix K.

Table 6-3: MIKE21 Hydraulic Parameters

Parameter	Parameter Value
Drying Depth	0.02 m
Flooding Depth	0.05 m
Simulation Timestep	0.4 second
Eddy Viscosity	Constant: 0.8; Near Structures: 4.0

6.5 Results and Mapping

6.5.1 Peak Flood Discharge Results

Peak flood discharges estimated from the MIKE FLOOD model simulations were extracted at structure crossing locations. These discharges are presented in Table 6-4 and correspond to the total flow, typically taken immediately upstream of the crossing. Corresponding peak flood levels at these locations are included in Table 6-5.

In the vicinity of a number of crossings, the flood extents are quite wide (or they interact with different branches) for some or all of the flood events. At these locations, it is difficult to determine an appropriate single discharge value representative at the structure. Engineering judgement was applied to estimate the discharge values at these locations which include:

- Formosa Road,
- Manly Road (West Channel, Tingalpa Channel and East Channel), and
- Wynnum Road.

Table 6-4: Design Event Peak Discharge at Major Structures (Scenario 1)

Structure Location	Peak Discharge (m^3/s)					
	2-yr ARI (50 % AEP)	5-yr ARI (20 % AEP)	10-yr ARI (10% AEP)	20-yr ARI (5 % AEP)	50-yr ARI (2 % AEP)	100-yr ARI (1 % AEP)
Tingalpa Channel						
London Road	17.4	24.7	29.4	35.8	48.0	54.6
Grassdale Road	25.6	37.4	44.6	53.3	66.1	76.7
Manly Road	29.0	42.3	55.5	65.7	81.6	99.3
Wynnum Road	28.4	38.5	40.4	63.3	71.1	93.4
London Channel						
London Road	6.8	10.1	12.8	13.6	18.0	20.3
East Channel						
Grassdale Road	10.3	15.4	18.6	21.7	26.9	32.6
Stanbrough Road	11.2	15.6	18.4	22.7	27.1	31.5
Formosa Road	12.0	17.8	21.2	25.5	31.4	37.4
West Channel						
Manly Road	4.0	5.2	5.9	6.7	7.6	8.2
North Channel						
Matthews Way u/s	2.2	3.0	3.6	4.6	5.5	7.2
Matthews Way d/s	5.8	8.0	9.1	10.9	12.6	14.6
Manly Road	10.1	11.5	15.3	17.7	23.3	26.3

Table 6-5: Design Event Peak Water Level at Major Structures (Scenario 1)

Structure Location	Peak Water Level (m AHD)					
	2-yr ARI (50 % AEP)	5-yr ARI (20 % AEP)	10-yr ARI (10% AEP)	20-yr ARI (5 % AEP)	50-yr ARI (2 % AEP)	100-yr ARI (1 % AEP)
Tingalpa Channel						
London Road	9.21	9.41	9.51	9.63	9.78	9.89
Grassdale Road	6.45	6.84	7.05	7.31	7.69	7.89
Manly Road	2.70	2.93	3.09	3.32	3.56	3.67
Wynnum Road	2.59	2.74	2.82	2.94	3.07	3.18
London Channel						
London Road	9.04	9.21	9.30	9.42	9.57	9.70
East Channel						

Structure Location	Peak Water Level (m AHD)					
	2-yr ARI (50 % AEP)	5-yr ARI (20 % AEP)	10-yr ARI (10% AEP)	20-yr ARI (5 % AEP)	50-yr ARI (2 % AEP)	100-yr ARI (1 % AEP)
Grassdale Road	6.77	7.00	7.08	7.19	7.34	7.44
Stanbrough Road	5.37	5.69	5.80	6.00	6.18	6.29
Formosa Road	4.84	5.10	5.26	5.58	5.76	5.88
West Channel						
Manly Road	2.64	2.81	2.90	3.03	3.18	3.31
North Channel						
Matthews Way u/s	14.23	14.31	14.36	14.43	14.51	14.57
Matthews Way d/s	9.64	9.72	9.78	9.85	9.93	10.1
Manly Road	2.66	2.85	2.93	3.04	3.18	3.26

6.5.2 Critical Durations

A full range of event durations (30 minutes, 1 hour, 1.5 hour, 2 hour, 3 hour, 4.5 hour and 6 hour) were simulated. From the results, the critical duration for the 2-year ARI (50 % AEP) to 100-year ARI (1 % AEP) events at key locations within the catchment were determined. These are summarised in Table 6-7. For the purpose of this analysis, the critical duration is taken as the storm duration which produces the peak flood level.

Table 6-6: Critical Durations at Key Locations

Structure Location	Critical Duration (minutes)					
	2-yr ARI (50 % AEP)	5-yr ARI (20 % AEP)	10-yr ARI (10% AEP)	20-yr ARI (5 % AEP)	50-yr ARI (2 % AEP)	100-yr ARI (1 % AEP)
Tingalpa Channel						
London Road	90	90	90	90	90	90
Grassdale Road	90	90	90	90	90	90
Formosa Road	120	120	120	120	120	90
Manly Road	360	270	180	180	180	180
Wynnum Road	360	360	360	360	270	270
East Channel						
Boston Road	60	60	60	60	60	60
London Road	90	90	90	90	60	60
Grassdale Road	120	90	90	90	90	90
Stanbrough Road	90	90	90	90	90	90
Formosa Road	120	90	90	90	90	90
London Channel						

Structure Location	Critical Duration (minutes)					
	2-yr ARI (50 % AEP)	5-yr ARI (20 % AEP)	10-yr ARI (10% AEP)	20-yr ARI (5 % AEP)	50-yr ARI (2 % AEP)	100-yr ARI (1 % AEP)
Boston Road	90	90	90	60	60	60
London Road	90	90	90	90	90	60
West Channel						
Manly Road	360	360	360	360	360	360
North Channel						
Matthews Way u/s	30	90	90	90	90	90
Matthews Way d/s	60	60	90	90	60	60
98 Ingleston Road	60	60	60	60	60	60
84 Ingleston Road	60	60	60	60	60	60
56 Ingleston Road	60	60	60	60	60	60
Manly Road	360	360	360	360	360	360

6.5.3 Peak Flood Levels

Tabulated peak flood level results for the design events are provided in the Appendices for the following scenarios:

- Scenario 1, 2-year ARI (39 % AEP) to 100-year ARI (1 % AEP) events – Appendix F
- Scenario 3, 2-year ARI (39 % AEP) to 100-year ARI (1 % AEP) events – Appendix G

The peak flood levels are the maximum flood level when considering the full range of durations from 30 minutes to 6 hours. The peak flood levels are extracted along the new creek adopted middle thread distance (AMTD) line for Tingalpa Channel and its tributaries.

6.5.4 Flood Immunity of Existing Crossings

The flood immunity of the structures under Scenario 3 was determined for each crossing by comparing peak flood levels upstream of the crossing with the minimum overtopping levels. Scenario 3 results are reported since it represents future planning conditions. The estimated structure immunities are presented in Table 6-8, where the minimum event considered was the 2-year ARI (50% AEP) and the maximum was the 100-year ARI (1% AEP).

Table 6-7: Flood Immunity at Major Structures

Structure Location	Flood Immunity (ARI)
Tingalpa Channel	
London Road	< 2-year ARI (< 50% AEP)
Grassdale Road	20-year ARI (5% AEP)
Formosa Road	< 2-year ARI (< 50% AEP)
Manly Road	10-year ARI (10% AEP)
Wynnum Road	Outbound 100-year ARI (1% AEP)
	Inbound 5-year ARI (20% AEP)
East Channel	
Boston Road	< 2-year (50% AEP)
London Road	< 2-year (50% AEP)
Grassdale Road	100-year ARI (1% AEP)
Stanbrough Road	< 2-year ARI (50% AEP)
Formosa Road	5-year ARI (20% AEP)
West Channel	
Manly Road	100-year ARI (1% AEP)
North Channel	
Matthews Way U/S	100-year ARI (>1% AEP)
Matthews Way D/S	100-year ARI (>1% AEP)
98 Ingleston Road	< 2-year ARI (<50% AEP)
84 Ingleston Road	100-year ARI (1% AEP)
56 Ingleston Road	100-year ARI (1% AEP)
Manly Road	50-year ARI (2% AEP)
London Channel	
Boston Road	< 2-year ARI (<50% AEP)
London Road	< 2-year ARI (<50% AEP)

Details of flood level and flow data derived for the hydraulic structure crossings modelled are summarised in the Hydraulic Structure Reference Sheets and included in Appendix E.

6.5.5 Flood Mapping

The flood mapping products are provided in Appendix L (Volume 2) and include the following:

- Flood Level Mapping
    - Scenario 1: 2-year ARI (50 % AEP) to 2000-year ARI (0.05 % AEP)

With the move to 'two-dimensional' flood models, the production of flood levels and extents is inherent in simulating a model, i.e. a flood map is a direct output from a model simulation removing the requirement to apply a separate process. For the Scenario 1 "existing" simulations, the model is run and the direct output is usually able to be mapped or referenced in a GIS environment. For Tingalpa Channel, some minor adjustments were made to the direct output before mapping could take place. These minor adjustments took place near the detention basin (North Tributary A), near the crossing at 84 Ingleston Road (North Tributary), and on the tributary that joins Tingalpa Channel near Formosa Road. A similar adjustment was done for Scenario 3 results. These changes accounted for minor instabilities found at these locations.

6.6 Hydraulic Structure Verification

It is common practice in BCC flood studies to cross-check structure head-losses against results from the HEC-RAS hydraulic modelling software. The HEC-RAS V4.1 model was used to assess the head losses of the following hydraulic structures:

- Grassdale Road – Tingalpa Channel;
- Wynnum Road – Tingalpa Channel

Results of the analysis are shown in Table 6-8.

Generally, the MIKE FLOOD head-losses for the hydraulic structures were within ±0.2 m of the HEC-RAS values for the full range of design flows at which checks were undertaken. This is considered reasonable and gives credence to the MIKE FLOOD results.

The simulation files used for each HEC-RAS structure verification are shown in Appendix K.

Table 6-8: Verification of Structure Head Losses using HEC-RAS model.

	Discharge (m^3/s)	MIKE FLOOD Head-loss (m)	HEC-RAS Head-loss (m)	Difference (m)
Grassdale Road – Tingalpa Channel				
2-yr ARI (50% AEP)	21.8	0.32	0.32	0
5-yr ARI (20% AEP)	31.3	0.44	0.44	0
10-yr ARI (10% AEP)	37.1	0.52	0.50	0.02
20-yr ARI (5% AEP)	43.7	0.64	0.58	0.06
50-yr ARI (2% AEP)	55	0.82	0.87	-0.05
100-yr ARI (1% AEP)	64.5	0.90	1.04	-0.14
Wynnum Road – Tingalpa Channel[1]				
2-yr ARI (50% AEP)	29.5	0.04	0.01	0.03
5-yr ARI (20% AEP)	44.5	0.08	0.03	0.05
10-yr ARI (10% AEP)	53.5	0.09	0.03	0.06
20-yr ARI (5% AEP)	62.9	0.14	0.03	0.11
50-yr ARI (2% AEP)	79.6	0.18	0.03	0.15
100-yr ARI (1% AEP)	95.1	0.22	0.02	0.20

[1] In MIKE FLOOD, Wynnum Road was modelled as one structure (both lanes). In HEC-RAS the inbound and outbound lanes were modelled separately (two structures). This may be one reason on the variation of head-loss through Wynnum Road.

7.0 **Rare and Extreme Event Analysis**

7.1 Rare and Extreme Event Scenarios

Table 7-1 indicates the events and scenarios modelled as part of the extreme event analysis. These scenarios have been previously described in Section 6.2. All rare and extreme event modelling was undertaken using ultimate hydrological conditions.

Table 7-1: Extreme Event Scenarios

ARI (year)	AEP (%)	Scenario 1	Scenario 2	Scenario 3
200	0.5	✓	✗	✓
500	0.2	✓	✗	✓
2000	0.05	✓	✗	✗
PMF		✓	✗	✗

For the modelling of the Scenario 3 events, the fill height outside of the “Modelled Flood Corridor” is set to the Scenario 3 100-yr ARI (1 % AEP) flood level plus an additional height allowance of 0.3 m. The “100-yr ARI (1 % AEP) plus 0.3 m flood surface” is then required to be stretched onto the floodplain. The methodology for this stretching is detailed below.

7.2 Flood Extent Stretching Process

In order to simulate the “ultimate” scenario, the model topography must be modified to represent filling associated with development. This in turn affects the resulting flood mapping with the flood extent limited to the edge of the filled floodplain. Post processing of the model output is required to represent the modelled flood levels against the current floodplain conditions.

WaterRIDE was utilised for the purpose of stretching the Scenario 3 “ultimate” case results and producing the “stretched” flood surface(s). Before the surface could be stretched, minor adjustment were made to the direct grid output (refer Section 6.5.5). The unstretched surface was then mapped onto the existing conditions model (without the hand/guardrail) ground surface terrain grid. This grid is used as the ground level terrain in which WaterRide will use to stretch the surface.

To enable the surface to be stretched, the WaterRIDE ‘buffer width’ tool was used, whereby the surface is extended by an equal number of grid cells (or TIN triangles) as a buffer around the current wet cells. A minimum depth threshold is used to determine what surrounding cells (within the buffer width) are considered ‘available’ for stretching. For this purpose, a value of 100 was used for the buffer width and -5 for the minimum depth threshold. Using these high values / tolerances ensured the flood surface was initially stretched far beyond the realistic limit of stretching.

From experience to date, it is known that there are inherent anomalies with the automated stretching process and some degree of manual intervention is typically required by an experienced / skilled practitioner to produce a more realistic stretched flood surface. To facilitate this process, a comparison of the mapped extent against the “existing” flooding extents (including larger events) was undertaken. In areas where there were obvious anomalies, some minor adjustments were made to the mapped extents of the stretched flood surface.

In general, the modified areas are mostly observed around tight bends; at structures with high head losses; steep areas where the water can leak; stream junctions where cross-flow is likely; parallel channels; secondary paths and breakout areas. Despite the review of the stretched surfaces and the inclusion of break lines to manipulate the stretching process, the process and outputs are still subject to limitations as follows:

- The application of break lines will result in significant steps in the generated surface in some locations.
- The application of break lines is highly subjective in some locations.
- The stretching process may not be readily repeatable (i.e. the output has not come directly from a model simulation and if model outputs change, it cannot be guaranteed that the process will not need further refinement to produce acceptable results).

7.3 Rare and Extreme Event Hydrology

7.3.1 Overview

Extreme event flood hydrology was determined for the following events, which are detailed further in Sections 7.2.2 to 7.2.4.

(i) 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) events

(ii) 2000-year ARI (0.05 % AEP) event, and

(iii) Probable Maximum Precipitation (PMP)

7.3.2 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) Events

The 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) design IFD rainfall data was obtained using the CRC-Forge method for the events. The 200-year (0.5 % AEP) design IFD was slightly modified to take into account the differences between the two different methodologies adopted, the AR&R and CRC-Forge. CRC-Forge applies Aerial Reduction Factors (ARF), which results in lower intensities compared to AR&R.

Proportions of 100-year ARI (1% AEP), 200-year ARI (0.5% AEP) and 500-year ARI (0.2 % AEP) derived from CRC-Forge, together with the AR&R 100-year (1% AEP) IFD for Brisbane were used to estimate the rainfall intensity values for 200-year (0.5 % AEP).

Table 7-2 indicates the adopted 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) design rainfall intensities with comparison to the adopted 100-year ARI (1 % AEP). The 1.5 hour, 2-hour and 4.5-hour values were interpolated as CRC-Forge does not produce results for these intermediate values. The interpolation was based on a process of plotting a duration versus intensity graph (i.e. for 200-year and 500-year ARI) and estimating the values at the time of interest.

Table 7-2: Adopted IFD (200-year ARI and 500-year ARI)

Duration (hr)	Rainfall Intensity (mm/hr)		
	100-yr ARI (1 % AEP)	200-yr ARI (0.5 % AEP)	500-yr ARI (0.2 % AEP)
0.5	159	169	184
1	113	119	128
1.5	86	92(1)	99(1)
2	71	76(1)	82(1)
3	53	57	64
4.5	40	44(1)	49(1)
6	33	36	41

Note (1) - Interpolated value

7.3.3 2000-year ARI (0.05 % AEP)

The 2000-year ARI (0.05 % AEP) IFD rainfall was determined using the CRC-Forge method. To avoid the need to simulate all of the different storm durations, a simplified super-storm method was used. This methodology was derived by BCC and has been used on other BCC flood studies concluded recently.

The rationale for adopting this approach is that research indicates that as storm rainfall depths increase during short duration storms, the rainfall intensity becomes more uniform. For this reason, the multi-peaked AR&R temporal pattern (as used for the 200-year ARI and 500-year ARI) was not considered suitable for the analysis of this more extreme event.

A 6-hr super-storm was developed to represent all storm durations up to 6 hours. The super-storm was developed in 30 minutes blocks and incorporates the 0.5-hr, 1-hr, 1.5-hr, 2-hr and 3-hr storm bursts. Durations less than 30 minutes were not considered. The total rainfall depth of the super-storm was set equal to the 6-hr 2000-year ARI (0.05 % AEP) CRC-Forge rainfall depth (representative across the Brisbane Region) which was determined as 340 mm.

7.3.4 Probable Maximum Precipitation

For the PMP scenario, the 6-hr super-storm approach was also undertaken using the same temporal pattern as the 2000-year ARI (0.05 % AEP) event.

The total PMP depth was derived from the 6-hr storm duration using the Generalised Short Duration Method (GSDM). For the tropical and sub-tropical coastal areas it is recommended that this method is to be used to estimate the PMP over areas up to 520 km^2 and for durations up to 6 hours. To apply a consistent methodology across the majority of BCC an average catchment size of 60 km^2 and moisture adjustment factor of 0.85 were adopted.

The total rainfall depth of the super-storm was set equal to the 6-hr GSDM PMP rainfall depth, which was determined as 816 mm. Table 7-3 indicates the adopted super-storm temporal pattern and hyetographs for the 2000-year ARI (0.05 % AEP) and the PMP.

Table 7-3: Adopted Super-storm Hyetographs

Time (hr)	Rainfall (%)	Rainfall (mm)		Time (hr)	Rainfall (%)	Rainfall (mm)	
		2000-yr ARI (0.05 % AEP)	PMP			2000-yr ARI (0.05 % AEP)	PMP
0.00	0	0.00	0.00	3.17	58	41.00	75.08
0.17	1	4.33	9.92	3.33	70	41.00	75.08
0.33	3	4.33	9.92	3.50	75	16.00	38.25
0.50	4	4.33	9.92	3.67	77	7.58	27.63
0.67	5	4.33	9.92	3.83	80	7.58	27.63
0.83	6	4.33	9.92	4.00	82	7.58	27.63
1.00	8	4.33	9.92	4.17	84	7.58	18.42
1.17	9	4.33	13.46	4.33	86	7.58	18.42
1.33	10	4.33	13.46	4.50	89	7.58	18.42
1.50	11	4.33	13.46	4.67	90	4.33	13.46
1.67	14	7.58	18.42	4.83	91	4.33	13.46
1.83	16	7.58	18.42	5.00	92	4.33	13.46
2.00	18	7.58	18.42	5.17	94	4.33	9.92
2.17	20	7.58	27.63	5.33	95	4.33	9.92
2.33	23	7.58	27.63	5.50	96	4.33	9.92
2.50	25	7.58	27.63	5.67	97	4.33	9.92
2.67	30	16.00	38.25	5.83	99	4.33	9.92
2.83	34	16.00	38.25	6.00	100	4.33	9.92
3.00	46	41.00	75.08				

7.4 Rare and Extreme Event Hydraulic Modelling

7.4.1 Overview

The MIKE FLOOD model was used to simulate the scenarios as detailed in Section 7.1 to enable design flood levels and flood mapping products to be determined / produced.

7.4.2 MIKE FLOOD model grid

Minor changes were made to the grid from the design event MIKE FLOOD model. Simulation of the extreme events, in particularly 2000-year ARI (0.05% AEP) and PMF suggested that flow from Tingalpa Channel would enter the neighbouring Hemmant-Lytton catchment. To enable model stability, a boundary which allows water to drain was established in the Hemmant-Lytton catchment. Similarly, to the west of the Tingalpa Channel catchment, near the confluence of Bulimba Creek, an opening has been introduced.

7.4.3 MIKE FLOOD model roughness

No changes to model roughness were made from the design event MIKE FLOOD model.

7.4.4 MIKE FLOOD model boundaries

Design Inflows

The extreme event inflow (Q-T) boundaries to the MIKE FLOOD model were taken from the results of the XP-RAFTS model for each ARI and duration. The inflow locations did not change from the design event MIKE FLOOD model.

Design Tailwater Boundary

The rare and extreme event MIKE FLOOD model utilised a water level (H-T) boundary at its downstream extent at Bulimba Creek

Simulations were undertaken with the Bulimba Creek model utilising a fixed MHWS (0.95 m AHD) boundary at the Bulimba Creek / Brisbane River confluence. From the results of each simulation, a hydrograph was extracted at the Tingalpa Channel / Bulimba Creek confluence. It was considered that this methodology would create a more realistic downstream boundary, as Tingalpa Channel joins Bulimba Creek more than 4.5 km upstream of the Brisbane River.

7.4.5 MIKE FLOOD model parameters

No changes to modelling parameters were made from the design event MIKE FLOOD model(s).

7.4.6 Hydraulic Structures

All extreme event MIKE FLOOD models incorporated the same hydraulic structures as the design event MIKE FLOOD models.

7.5 Results and Mapping

7.5.1 Peak Flood Levels

Tabulated peak flood level results are provided in the Appendices for Tingalpa Channel and its tributaries. The tabulated flood levels are provided for the following events and scenarios:

- Scenario 1, 200-year ARI (0.5 % AEP), 500-year ARI (0.2 % AEP) and 2000-year ARI (0.05 % AEP) events – Appendix H
- Scenario 3, 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) events – Appendix I

7.5.2 Flood Mapping

Flood mapping products for the extreme events are provided in Volume 2 of the report (A3 Booklet) and include the following mapping products:

- Scenario 1: Water Level Surface Mapping: 200-year ARI (0.5 % AEP) , 500-year ARI (0.2 % AEP) and 2000-year ARI (0.05% AEP)

Refer to Section 6.5.8 Flood Mapping for discussion of the mapping process.

7.5.3 Discussion of Results

Longitudinal plots of the Scenario-1 100-yr ARI (1% AEP) to PMF profiles for Tingalpa Channel, London Branch, East Channel, West Channel, North Channel and North Channel Tributary A are provided through Figures 7.1 to 7.6 respectively. The average increase in flood depth for the main Tingalpa Channel and East Channel when compared to the 100-year ARI (0.1% AEP) (Scenario 1) flood profile are shown in Table 7-4. The results indicate the average increase in flood level is consistent for both channels.

Table 7-4: Average increase in flood level

Event	Average Increase in Flood Level (m) with reference to the 100-yr ARI (1 % AEP) flood level	
	Tingalpa Channel	East Channel
200-yr ARI (0.5 % AEP)	0.10	0.07
500-yr ARI (0.2 % AEP)	0.23	0.16
2000-yr ARI (0.05 % AEP)	0.88	0.62
PMF	2.74	2.31

The flood profiles for the 200-year ARI (0.5% AEP), 500-year ARI (0.2% AEP) and 2000-year ARI (0.05% AEP) are observed to follow a very similar trend to the 100-year ARI (1% AEP) flood profile along Tingalpa Channel and other branches within the catchment (refer to Figures 7.1 to 7.6).

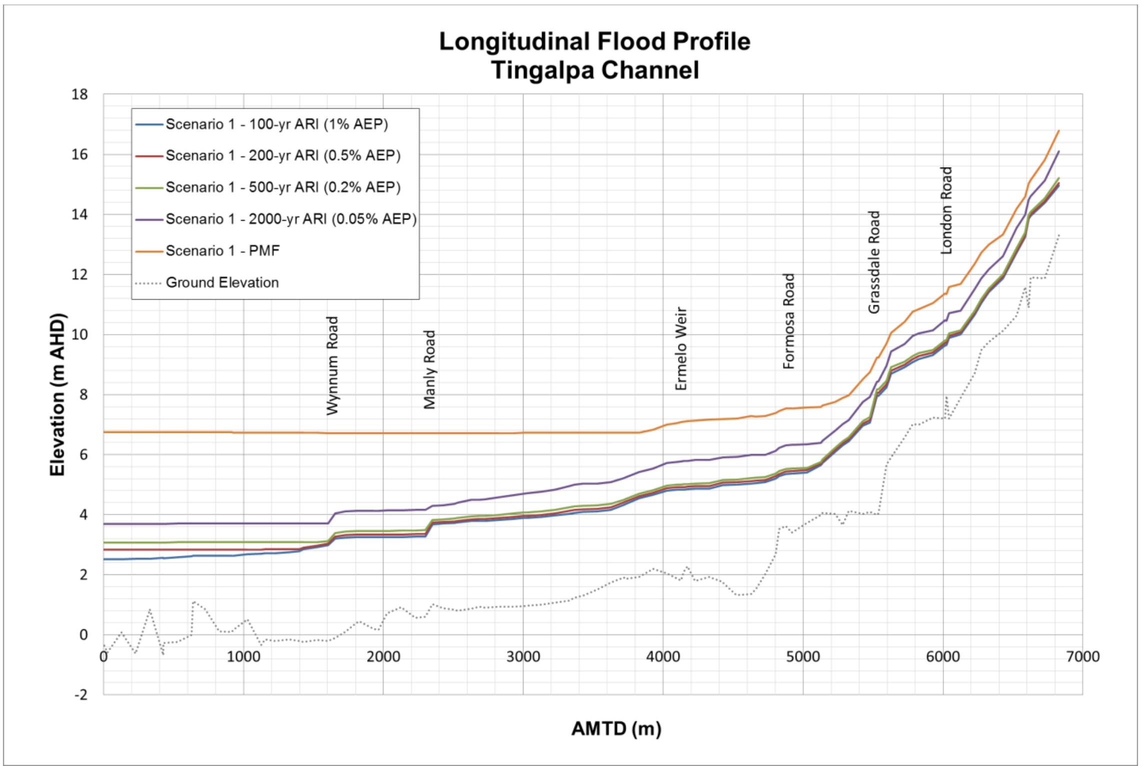

Figure 7.1: Longitudinal Profile 100-year (1% AEP), 200-yr (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – Tingalpa Channel (Scenario 1)

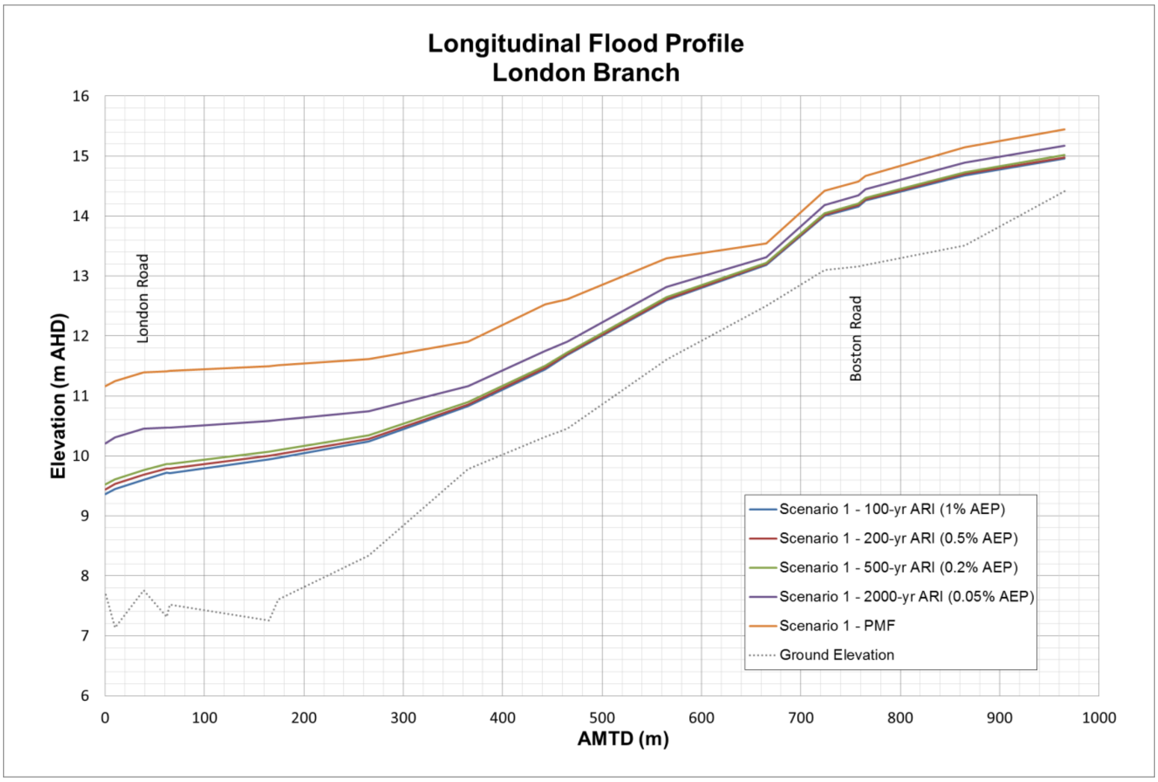

Figure 7.2: Longitudinal Profile 100-year (1% AEP), 200-year (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – London Channel (Scenario 1)

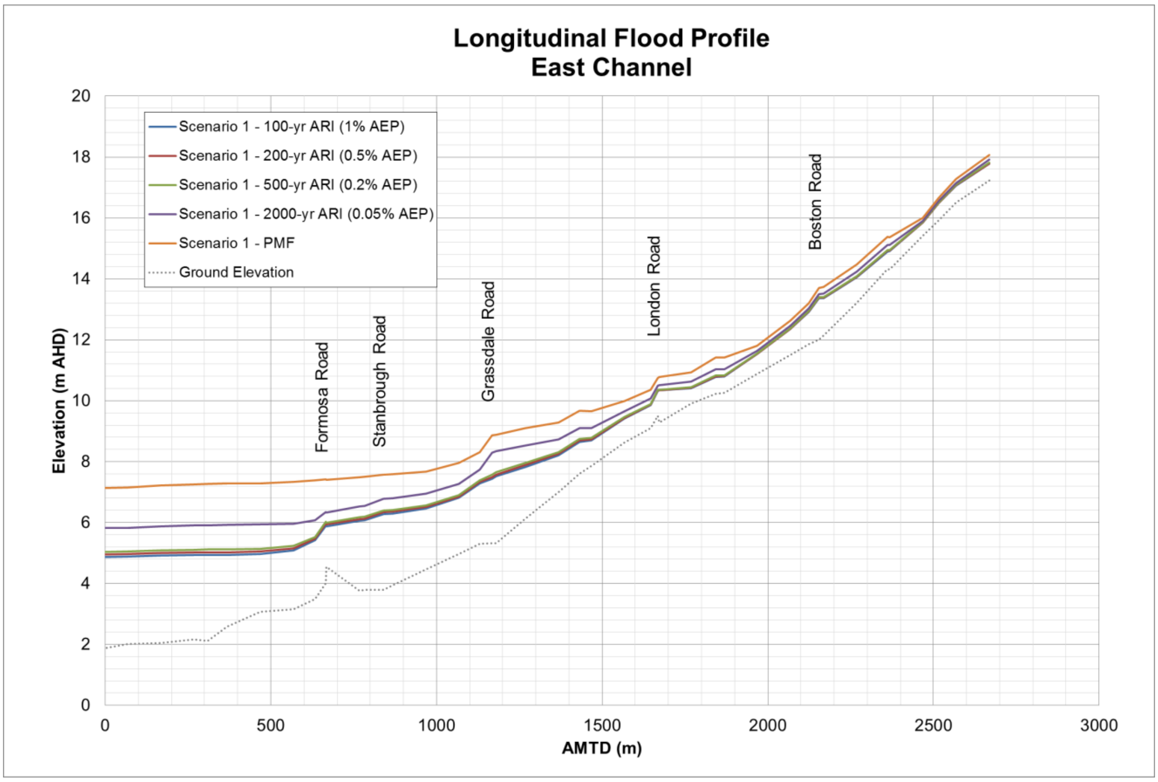

Figure 7.3: Longitudinal Profile 100-year (1% AEP), 200-year (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – East Channel (Scenario 1)

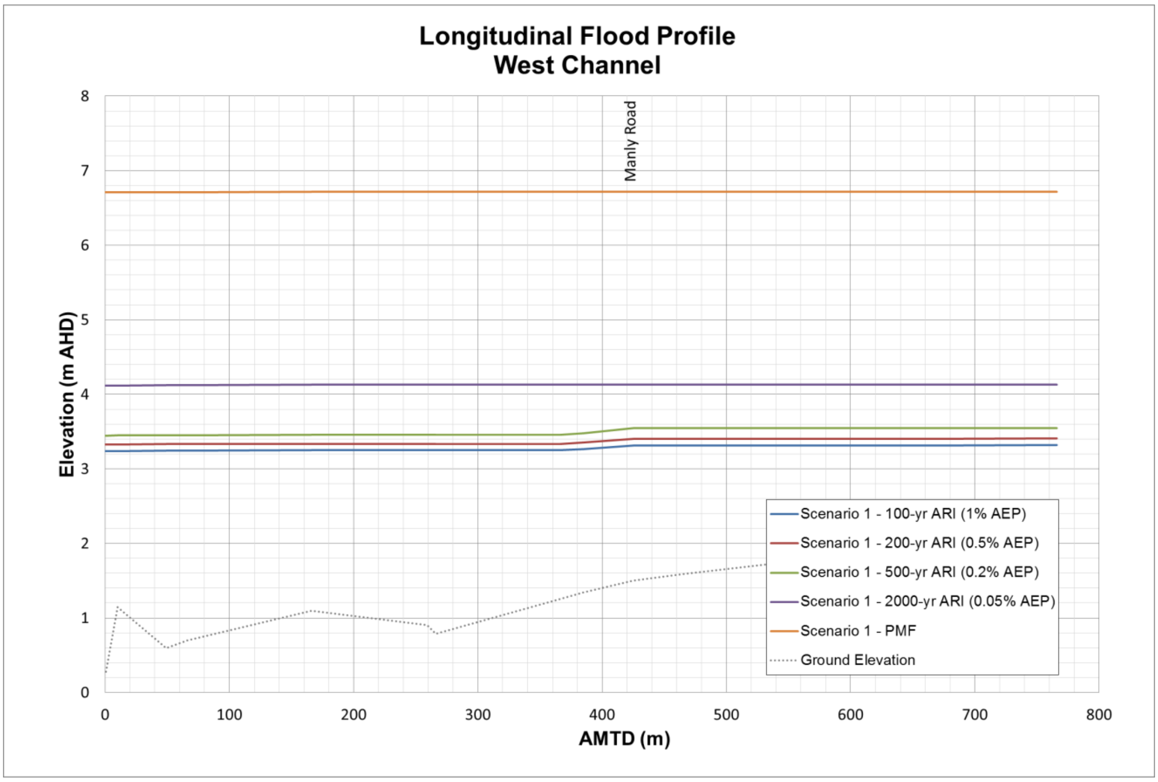

Figure 7.4: Longitudinal Profile 100-year (1% AEP), 200-year (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – West Channel (Scenario 1)

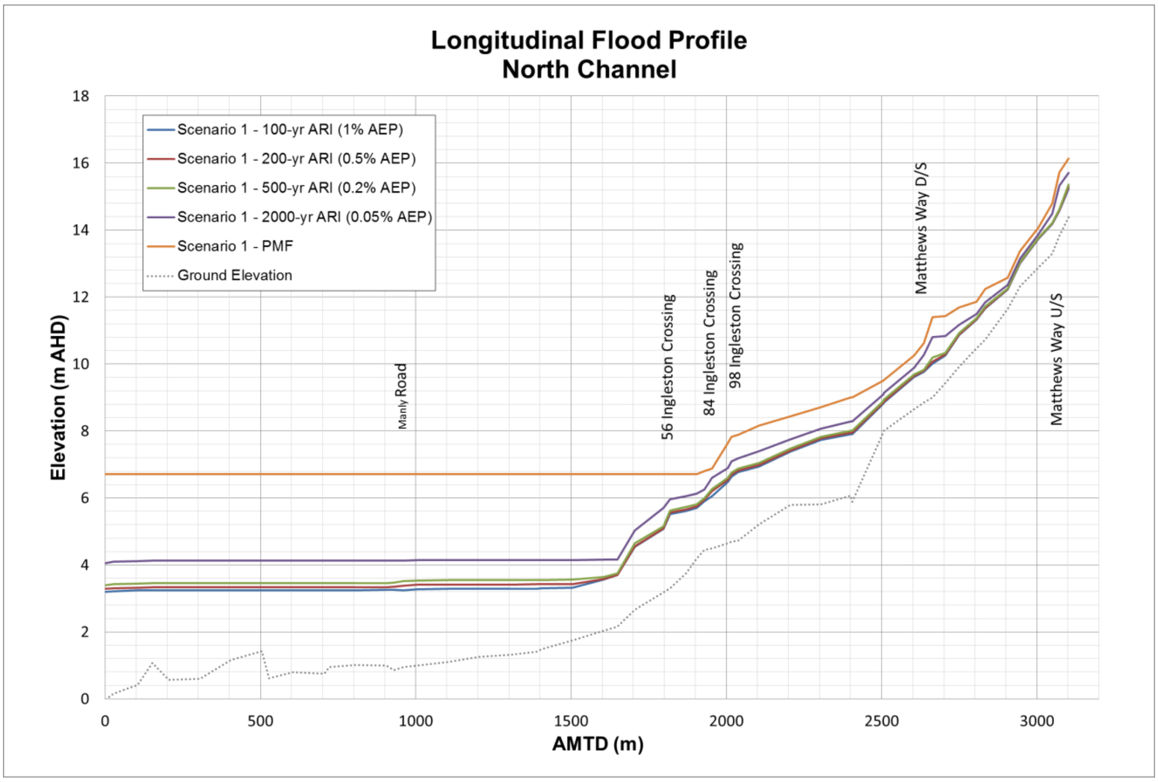

Figure 7.5: Longitudinal Profile 100-year (1% AEP), 200-year (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – North Channel (Scenario 1)

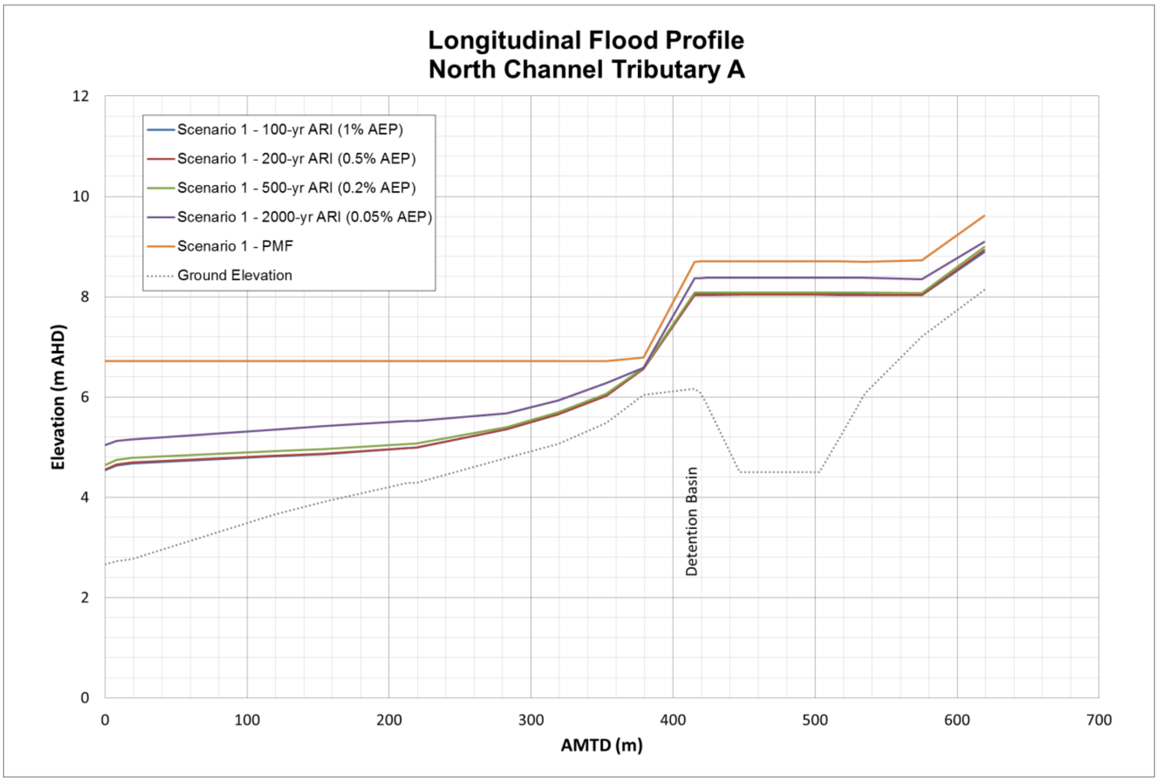

Figure 7.6: Longitudinal Profile 100-year (1% AEP), 200-year (0.5% AEP), 500-year (0.2% AEP), 2000-year (0.05% AEP) and PMF – North Channel Tributary A (Scenario 1).

8.0 **Climate Variability and Structure Blockage**

8.1 Overview

To enable comprehensive planning to be undertaken, BCC flood studies are required to undertake a sensitivity analysis to address the following:

- Climate variability
- Hydraulic structure blockage

The following sections provide the details of these analyses.

8.2 Climate Variability

8.2.1 Overview

To allow BCC to undertake future land-use planning, there is a requirement to understand the impacts of climate variability on flooding. BCC flood studies are therefore required to utilise the latest statutory guidelines in order to assess these impacts.

To understand and plan for the effects of climate variability on flooding in the Tingalpa Channel catchment, two scenarios were modelled, as outlined below. These scenarios are consistent with those undertaken in other recently completed BCC flood studies and the latest statutory guidelines.

- 2050 Planning Horizon
    - 10 % increase in rainfall intensity
    - 0.3 m increase in mean sea level

- 2100 Planning Horizon
    - 20 % increase in rainfall intensity
    - 0.8 m increase in mean sea level

8.2.2 Modelled Scenarios

Modelling was used to determine the climate variability impacts for the 100-year ARI (1 % AEP), 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) events. Table 8-1 indicates the events modelled and the respective modifications undertaken.

The rainfall intensity in the XP-RAFTS model was increased by 10 % and 20 % and simulations undertaken to determine the climate variability hydrographs. These hydrographs were then input into the MIKE FLOOD model and simulations undertaken for both climate variability scenarios.

Table 8-1: Climate Variability Modelling Scenarios

ARI (year)	AEP (%)	Planning horizon	Rainfall Condition	Tailwater Condition	Scenario 1	Scenario 3
100	1	2050	+ 10 %	MHWS(1) + 0.3 m	✓	✓
		2100	+ 20 %	MHWS(1) + 0.8 m	✓	✓
200	0.5	2050	+ 10 %	MHWS(1) + 0.3 m	✓	✗
		2100	+ 20 %	MHWS(1) + 0.8 m	✓	✗
500	0.2	2100	+ 20 %	MHWS(1) + 0.8 m	✓	✗

(1) The Bulimba Creek model was run with a fixed MHWS (0.95 m AHD) boundary at the Bulimba Creek / Brisbane River confluence. A hydrograph was extracted at the Tingalpa Channel / Bulimba Creek confluence and used as input into the Tingalpa Channel Flood Study

8.2.3 Hydraulic Modelling

The climate variability MIKE FLOOD model(s) incorporated the same model set-up as the design event MIKE FLOOD model(s), apart from the boundary conditions.

The XP-RAFTS model was utilised to derive the inflow boundary conditions for the +10 % rainfall intensity and +20 % rainfall intensity scenarios. The inflow boundary locations did not change from the design event modelling.

Simulations were undertaken with the Bulimba Creek MIKE11 climate variability existing condition model, and utilised a fixed boundary at the Bulimba Creek / Brisbane River confluence. The fixed boundary condition used at the confluence with the Brisbane River corresponded to that indicated in Table 8-1. It is considered that this methodology would create a more realistic downstream boundary, rather than using a fixed MHWS boundary at Bulimba Creek. Both climate variability scenarios (Scenario 1 and 3) used the same downstream boundary condition hydrographs extracted from the Bulimba Creek model at the confluence of Tingalpa Channel.

8.2.4 Impacts of Climate Variability

Tables 8-2 to 8-4 indicate the peak flood level climate variability comparison for Scenario 1. The flood level results are provided at selected locations along the creek for the 100-year ARI (1 % AEP), 200-year ARI (0.5 % AEP) and 500-year ARI (0.2 % AEP) events.

Table 8-2: 100-year ARI (1% AEP) Climate Varaibility Impacts at Selected Locations (Scenario 1)

Location	100-yr ARI (1% AEP) Flood Level (m AHD)		
	Existing	2050 (CC1)	2100 (CC2)
Tingalpa Channel			
London Road	9.89	9.98	10.09
Grassdale Road	7.89	8.04	8.21
Formosa Road	5.37	5.48	5.58
Manly Road	3.67	3.75	3.82
Wynnum Road	3.20	3.29	3.39
London Rd Channel			
Boston Road	14.10	14.12	14.15
London Road	9.70	9.81	9.91
East Channel			
Boston Road	13.31	13.34	13.36
London Road	10.33	10.35	10.37
Grassdale Road	7.44	7.54	7.64
Stanbrough Road	6.29	6.38	6.45
Formosa Road	5.88	5.96	6.03
West Channel			
Manly Road	3.31	3.42	3.53
North Channel			
Matthews Way u/s	14.57	14.61	14.65
Matthews Way d/s	10.0	10.14	10.27
98 Ingleston Road	6.77	6.86	6.92
84 Ingleston Road	6.04	6.24	6.29
56 Ingleston Road	5.52	5.6	5.68
Manly Road	3.26	3.42	3.51

Table 8-3: 200-year ARI (0.5% AEP) Climate Variability Impacts at Selected Locations (Scenario 1)

Location	200-yr ARI (0.5% AEP) Flood Level (m AHD)		
	Existing	2050 (CC1)	2100 (CC2)
Tingalpa Channel			
London Road	9.96	10.05	10.17
Grassdale Road	8.0	8.16	8.31
Formosa Road	5.45	5.56	5.66
Manly Road	3.73	3.81	3.88
Wynnum Road	3.28	3.37	3.49
London Rd Channel			
Boston Road	14.11	14.14	14.16
London Road	9.77	9.87	9.97
East Channel			
Boston Road	13.32	13.35	13.37
London Road	10.34	10.36	10.38
Grassdale Road	7.49	7.60	7.70
Stanbrough Road	6.35	6.43	6.50
Formosa Road	5.94	6.01	6.07
West Channel			
Manly Road	3.4	3.53	3.61
North Channel			
Matthews Way u/s	14.6	14.64	14.73
Matthews Way d/s	10.08	10.22	10.36
98 Ingleston Road	6.82	6.89	6.96
84 Ingleston Road	6.2	6.28	6.29
56 Ingleston Road	5.56	5.65	5.75
Manly Road	3.4	3.51	3.62

Table 8-4: 500-year ARI (0.2% AEP) Climate Variability Impacts at Selected Locations (Scenario 1)

Location	500-yr ARI (0.5% AEP) Flood Level (m AHD)	
	Existing	2100
Tingalpa Channel		
London Road	10.03	10.28
Grassdale Road	8.12	8.42
Formosa Road	5.53	5.78
Manly Road	3.82	3.97
Wynnum Road	3.39	3.61
London Rd Channel		
Boston Road	14.13	14.19
London Road	9.85	10.06
East Channel		
Boston Road	13.34	13.39
London Road	10.36	10.40
Grassdale Road	7.57	7.99
Stanbrough Road	6.41	6.54
Formosa Road	5.99	6.12
West Channel		
Manly Road	3.54	3.71
North Channel		
Matthews Way u/s	14.63	14.83
Matthews Way d/s	10.19	10.59
98 Ingleston Road	6.88	7.02
84 Ingleston Road	6.26	6.36
56 Ingleston Road	5.63	5.86
Manly Road	3.53	3.74

8.3 Hydraulic Structure Blockage

8.3.1 Overview

Blockage of hydraulic structures is a common cause of increasing flood risk over and above the risk due to the intensity and duration of the rainfall. Current guidance recommends that designers of hydraulic structures should make allowances for the risk of blockage in the design. However, current guidance does not stipulate that blockage is required to be included as part of the determination of the overall design flood level.

BCC has taken the approach to include the blockage of selected hydraulic structures as part of a sensitivity analysis. This approach will allow BCC to understand the potential impacts should the selected hydraulic structures become blocked during an event.

8.3.2 Selection of Hydraulic Structures

The following hydraulic structures were selected for the blockage analysis:

- Tingalpa Channel - Manly Road
- Tingalpa Channel - Wynnum Road
- East Channel – Grassdale Rd
- East Channel – Stanbrough Road
- East Channel – Formosa Road
- North Channel – Matthews Way Upstream
- North Channel – Matthews Way Downstream
- North Channel – 98 Ingleston Road Crossing
- North Channel – 84 Ingleston Road Crossing
- North Channel – 56 Ingleston Road Crossing
- North Channel – Manly Road
- West Channel – Manly Road

These structures were selected based primarily on the limiting size of the bridge or culvert dimensions in QUDM. However, other factors were considered including the following:

- the predominant upstream catchment use;
- availability of woody debris;
- existing submergence of the inlet;
- flood risk of upstream properties; and
- flooding characteristics of the reach

8.3.3 Blockage Scenarios

The blockage analysis has been carried out with the existing case scenario (Scenario 1) for the 100-yr ARI (1% AEP) design event only. Individual structures were blocked and modelled into six different simulations (A to E) to ensure that the blockage impacts would not be masked by the effect of blocking other crossings.

The Queensland Urban Drainage Manual (QUDM) was used as guidance for the degree of blockage for each structure. QUDM recommends that culverts of the size found in Tingalpa Channel adopt 25% sediment blockage for the culvert barrel and 20% blockage for the culvert inlet.

For the modelling of box culvert blockages, this has been achieved by raising the invert level to account for a sediment blockage of 25% and further reducing the culvert width to account for an additional 20 % of inlet blockage. This approach is considered to be conservative and assumes both inlet blockage and culvert barrel blockage are incremental and occur together. The same approach has been applied to bridges.

8.3.4 Impacts of Structure Blockage

Table 8-5 indicates the flood level differences immediately upstream of the hydraulic structure for each of the 13 crossings.

Table 8-5: Impact of Structure Blockages (100-yr ARI – 1% AEP)

Blockage Simulation	Structure Location	Maximum Span of the Bridge/Culvert[1] (m)	Flood Level (m AHD)		Difference in Flood Level (m)
			Existing	Blockage Analysis	
B	Manly Road, Tingalpa Channel	2.4m	3.67	3.79	0.12
A	Wynnum Road, Tingalpa Channel	~4.6m	3.20	3.34	0.14
C	Grassdale Road, East Channel	3.3m	7.44	7.91	0.47
E	Stanbrough Road, East Channel	3.3m	6.29	6.37	0.08
D	Formosa Road, East Channel	3.3m	5.88	6.04	0.16
A	Matthews Way U/S, North Channel	1.5m	14.57	15.07	0.5
B	Matthews Way D/S, North	2.7m	10.00	10.69	0.69
C	98 Ingleston - North	2.1m	6.77	6.81	0.04
D	84 Ingleston - North	2.4m	6.04	6.44	0.4
E	56 Ingleston - North	2.1m	5.52	5.98	0.46
F	Manly Rd – North	3.0m	3.26	3.33	0.07
C	Manly Rd - West	3.7m (in model)	3.31	3.48	0.17

[1] Consists of the maximum span of the bridge or culvert modelled. For information on the actual culvert/bridge sizes refer to the hydraulic structure reference sheet.

9.0 **Summary of Study Findings**

9.1 Summary and Conclusions

Hydrologic and hydraulic models of the Tingalpa Channel catchment have been developed using the XP-RAFTS (2009) and MIKE FLOOD (2014) modelling software respectively. This report details the calibration and verification of both models design events, rare and extreme events modelling and sensitivity analysis undertaken for the Tingalpa Channel catchment.

Hydrometric data was sourced from the available recorded rainfall data. There are no continuous stream gauges within the Tingalpa Channel catchment. Three MHGs are available within the catchment in the lower and upper reaches which assisted in the model calibration and verification process.

Calibration of XP-RAFTS and MIKE FLOOD models was undertaken with data from the January 2012 and October 2010 rainfall events. Verification of the XP-RAFTS and MIKE FLOOD utilised May 2009 and December 2010 events.

Consistency checking of the models has also been undertaken at a number of locations along the middle/upper reaches in the catchment by comparing discharge hydrographs between hydrologic and hydraulic models. Both timing and peak discharge showed a good correlation for calibration and verification events. The discharge profile comparison also helped to identify the reliability of results between two models in the upper reaches where recorded flood level information is not available.

Acceptable results within the tolerance of ±300mm for MHGs were achieved with the October 2010 calibration event. A good correlation was observed between modelled and recorded events for the gauges located in the lower reaches (MHG TD120 and MHG BM1030) for both calibration events. The difference between calibration and recorded levels at MHG TD150 (at the bottom of the upper reach of the model) for January 2012 was slightly outside the adopted tolerance. Attempts were made to improve the calibration through modifying the roughness values; however the model results only showed a slight improvement. The verification events showed that for the MHGs located in the lower reaches the modelled results were within the tolerance of ±300mm.

The results of the hydraulic calibration and verification indicated that the MIKE FLOOD model was able to simulate the historical flooding events reasonably well, with the exception of the slight lower calibration (January 2012) and verification (December 2010) event for MHG TD150 located in East Branch. The model simulated the lower reaches within the specified tolerance. Comparison of discharge hydrographs in the upper reach showed a good correlation between the hydrologic and hydraulic models. On this basis, it was concluded that the XP-RAFTS and MIKE FLOOD models were sufficiently robust to be used together to simulate design flood events.

Cross-checks of the MIKE FLOOD structure head-losses were undertaken at selected structures using the HEC-RAS software, from which it was confirmed that the model was representing the structures adequately.

Design and extreme flood magnitudes were estimated for the full range of events from 2-yr ARI (50% AEP) to PMF. These analyses assumed hydrologic ultimate catchment development conditions in accordance with BCC City Plan (2014).

Three waterway scenarios were considered as follows:

- Scenario 1 is based on the current waterway conditions. No further modifications were made to the MIKE FLOOD model developed as part of the calibration / verification phase.
- Scenario 2 includes an allowance for a riparian corridor along both sides of the channel.
- Scenario 3 includes an allowance for the riparian corridor (as per Scenario 2) and also assumes filling to the modelled flood corridor to simulate potential development.

The results from the MIKE FLOOD modelling were used to produce the following:

- Peak flood discharges at selected locations
- Critical storm durations at selected locations
- Peak flood levels at cross section reporting points
- Peak flood extent mapping
- Peak flood depth mapping
- Hydraulic structure flood immunity data

As part of the required sensitivity analysis a climate variability analysis was then undertaken to determine the impacts for two planning horizons; namely 2050 (CC1) and 2100 (CC2). This included making allowances for increased rainfall intensity and increased mean sea level rise. This analysis was undertaken for the 100-year ARI (1% AEP), 200-year ARI (0.5% AEP) and 500-year ARI (0.2% AEP) events.

The sensitivity analysis also included analyses of blockages on significant hydraulic structures. Twelve structures in the Tingalpa Channel Catchment were blocked as per the recommendations in QUDM. Each structure was analysed in such a manner that it would not interfere with other structures.

Hydraulic Structure Reference Sheets (HSRS) for all major crossings within the MIKE FLOOD model area were also prepared. The HSRS provide data for each hydraulic structure and include data relating to the structure description, location, hydraulic performance and history.

9.2 Model Limitations

In utilising the models developed for this study it is important to be aware of their limitations which can be summarised as follows:

- The models have only been calibrated / verified at locations where MHG records exist. This should be taken into account when considering the accuracy of results outside the influence of these locations.
- The storm events considered for calibration and verification are relatively small (e.g. 2-year ARI). The calibrated parameters adopted from XP-RAFTS are warranted for small events, and may not necessarily be valid for larger and extreme events.
- The new AR&R update is due to be released in the near future and design flow estimation technique and design storm intensity estimation may alter slightly with the new release. The modelling of Tingalpa Channel adopted the storm intensity associated with AR&R (1987).
- There is no continuous recording stream gauge located within the Tingalpa Channel catchment and therefore calibration to a continuous recording stream gauge could not be undertaken. This may limit the validity of the calibration achieved.
- These models are catchment scale and have been developed to simulate the flooding characteristics at a broad scale. As a result, smaller more localised flooding characteristics may not be apparent in the results.
- BCC 2009 ALS data has been used as the basis for the MIKE FLOOD model topography, together with limited surveyed sections and with minor modifications. Detailed checks have not been undertaken on the accuracy of the ALS data, it is assumed that the data is representative of the topography and “fit for purpose.”
- Future changes to catchment conditions that have not been specifically reflected in the modelling scenarios may impact the validity of the study.
- The accuracy of the model results is directly linked to the following:
    - The accuracy limits of the data used to develop the model (e.g. ALS, survey information, bridge data, etc.);
    - The accuracy and quality of the hydrometric data used to verify the models;
    - The number of historical stream gauge / MHG reporting locations throughout the catchment;
    - The purpose of the study (i.e. catchment / broad-scale or detailed).

10.0 **References**

Brisbane City Council (2011) *Bulimba Creek Flood Study*, CPO, Brisbane City Council, QLD.

Brisbane City Council (2014) *Brisbane City Plan*, Brisbane City Council, accessed January 2015 [http://www.brisbane.qld.gov.au/planning-building/planning-guidelines-tools/brisbane-city-plan-2014]

Department of Energy and Water Supply (2013) *Queensland Urban Drainage Manual, 3rd Edition 2013 – Provisional*, Department of Energy and Water Supply, Brisbane, QLD, accessed March 2015, [https://www.dews.qld.gov.au/__data/assets/pdf_file/0008/78128/qudm2013-provisional.pdf]

Sinclair Knight Merz (1998) *Gumdale to Tingalpa Stormwater Management Plan*, Brisbane City Council, Brisbane, QLD

Appendix A – Available Data / Information

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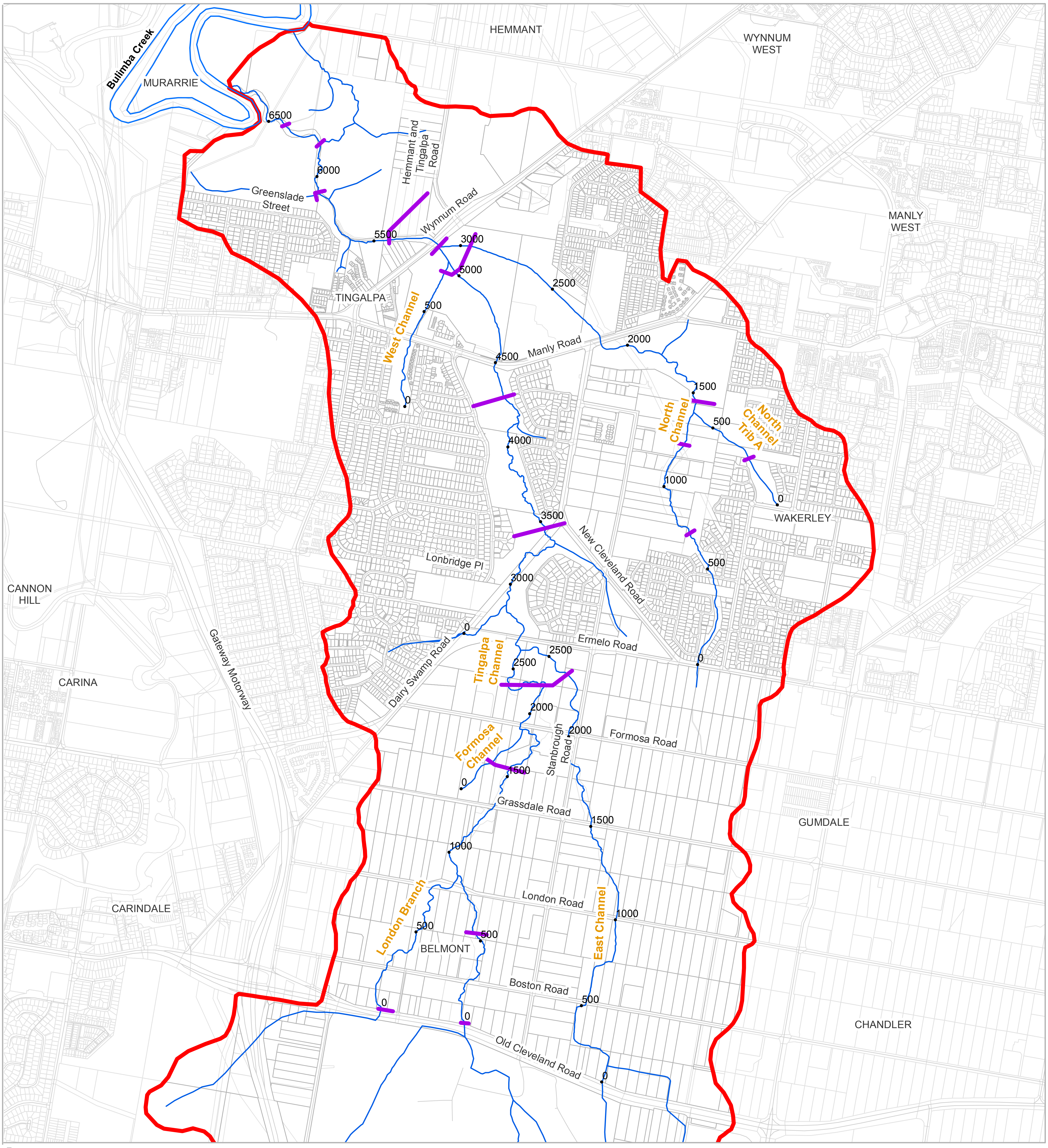

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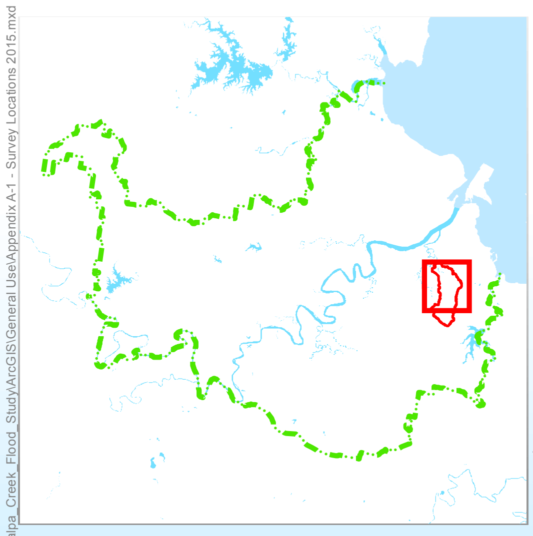

Legend

- Survey Locations 2014
- Bulimba Creek
- Tingalpa Drain Catchment
- Channel Centreline
- Cadastre

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Revision : 0
Publication Date : 23 Jun 2015
Project Number : 150337

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Tingalpa Channel Flood Study 2015

Appendix A1
Survey Locations

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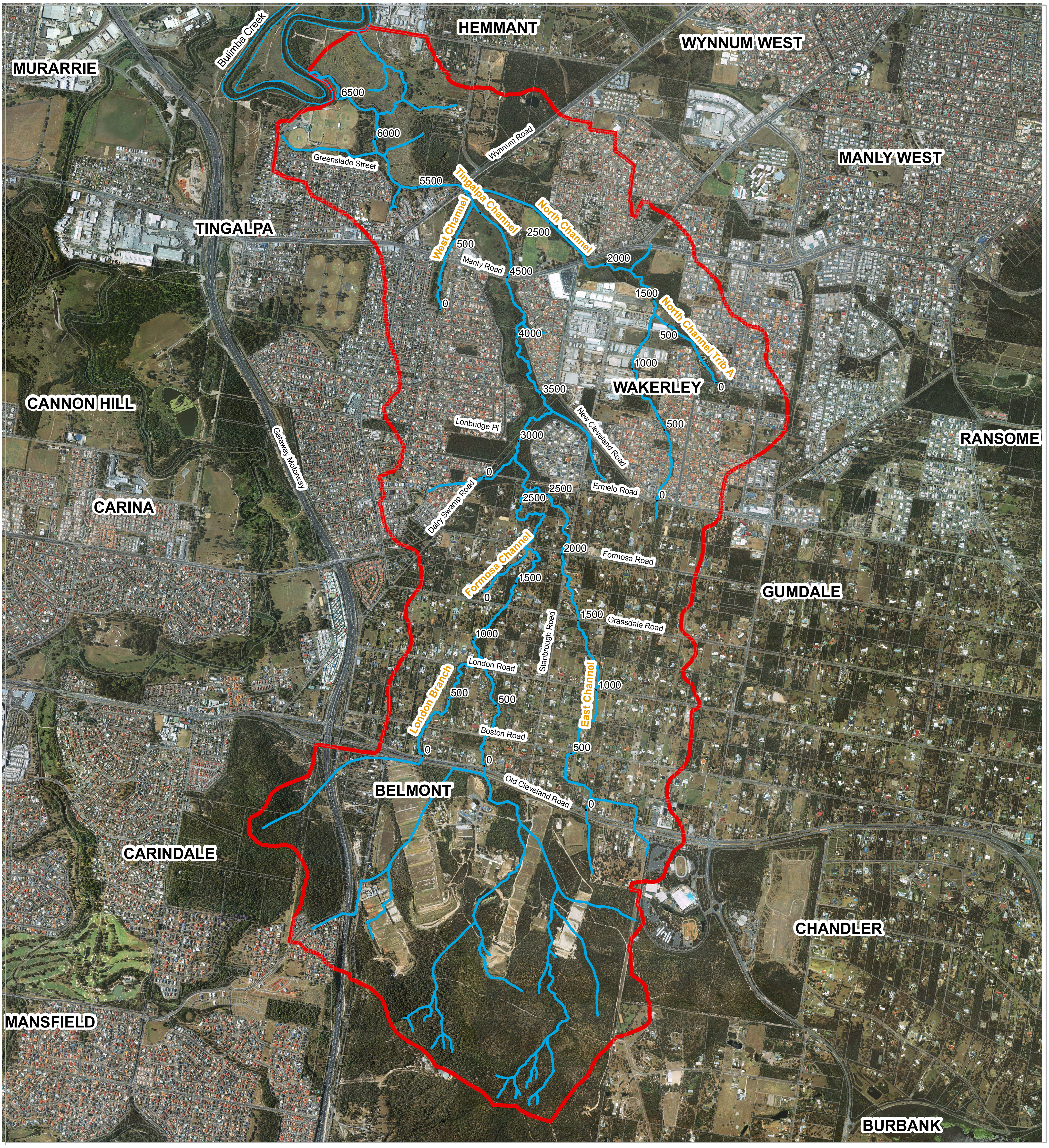

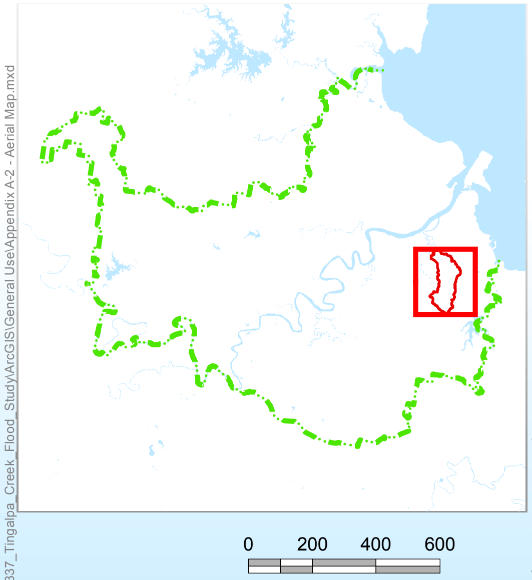

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- Channel Centreline
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- Tingalpa Drain Catchment

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Appendix A-2: Tingalpa Channel Catchment Aerial Image

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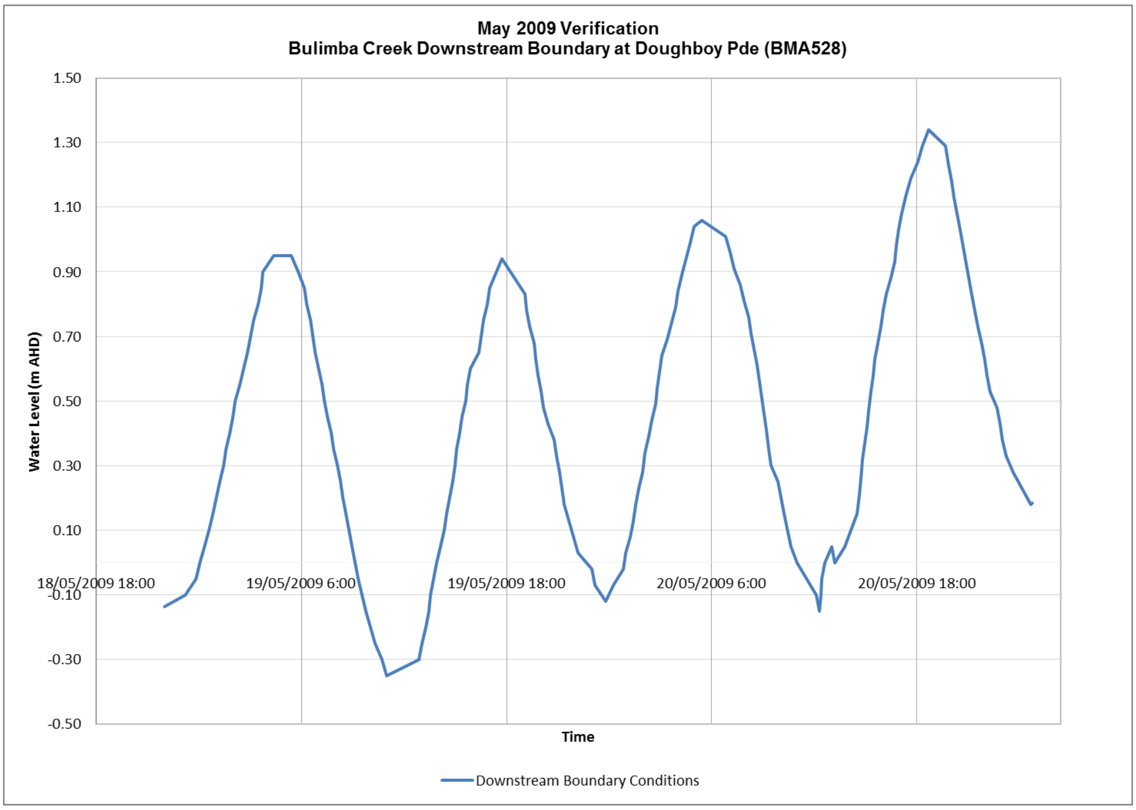

Figure A-3: Downstream Tidal Boundary for May 2009 event at Doughboy Pde Stream Gauge

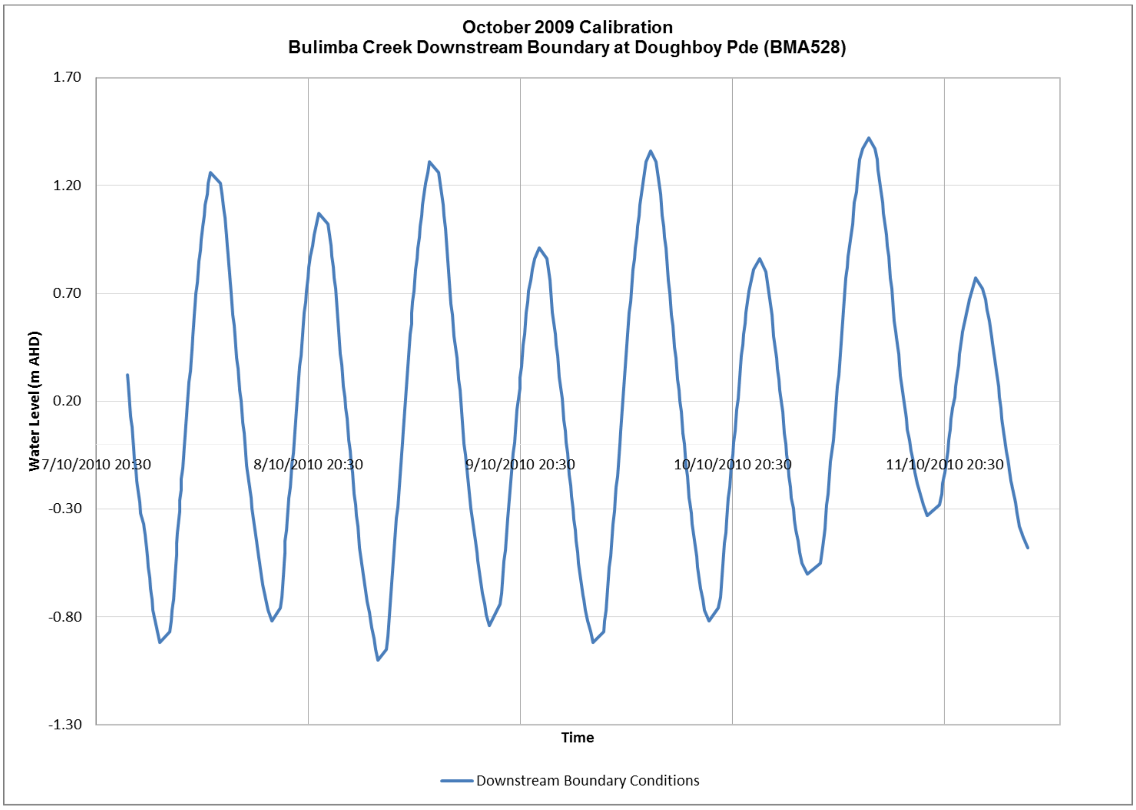

Figure A-4: Downstream Tidal Boundary for October 2010 event at Doughboy Pde Stream Gauge

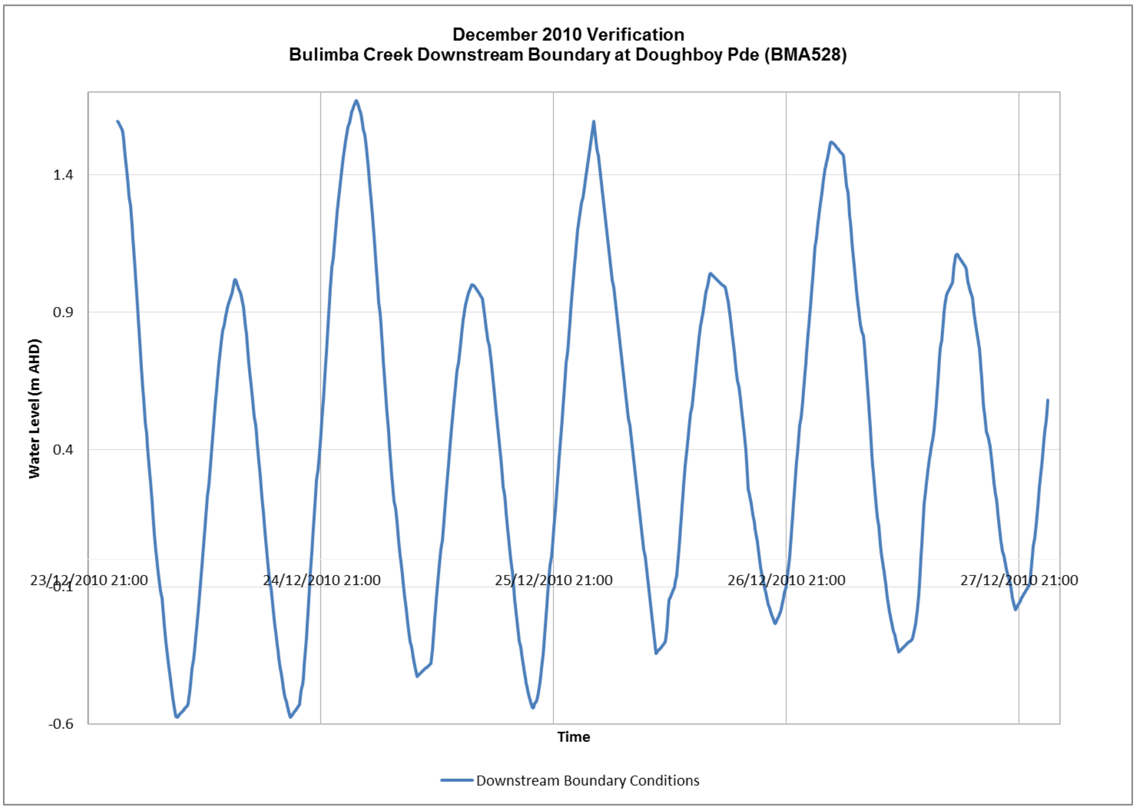

Figure A-5: Downstream Tidal Boundary for December 2010 event at Doughboy Pde Stream Gauge

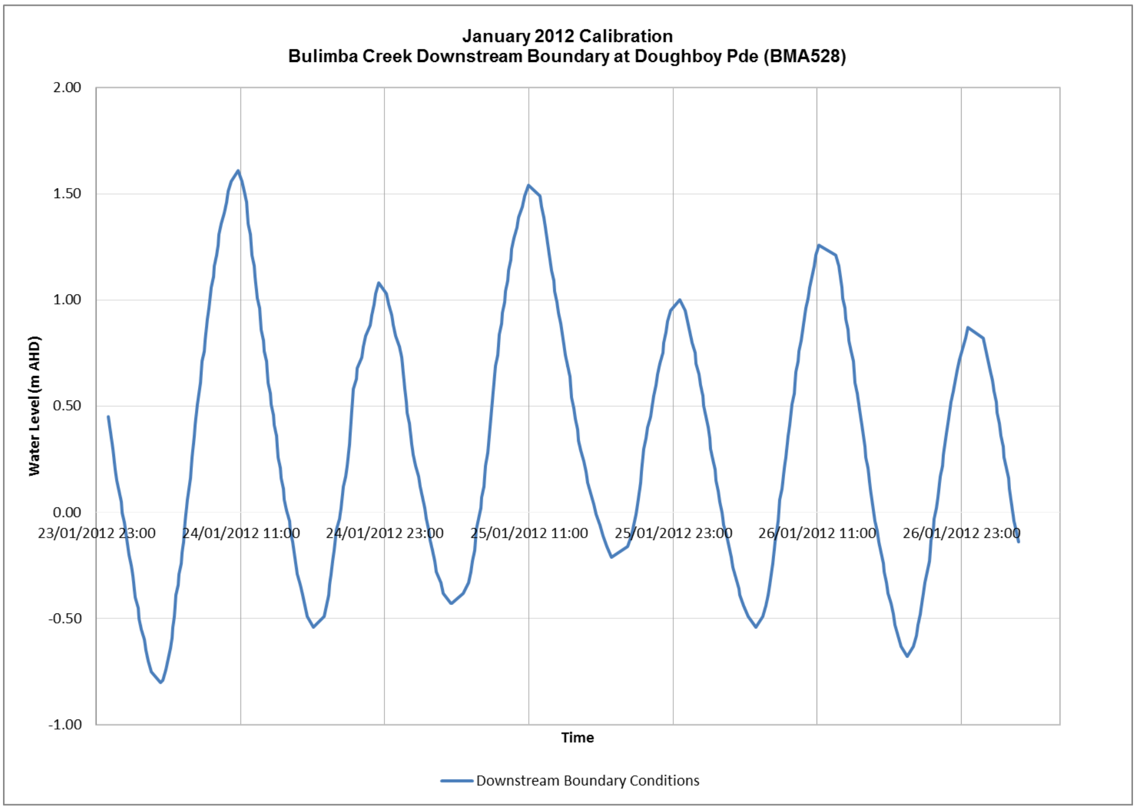

Figure A-6: Downstream Tidal Boundary for January 2012 event at Doughboy Pde Stream Gauge

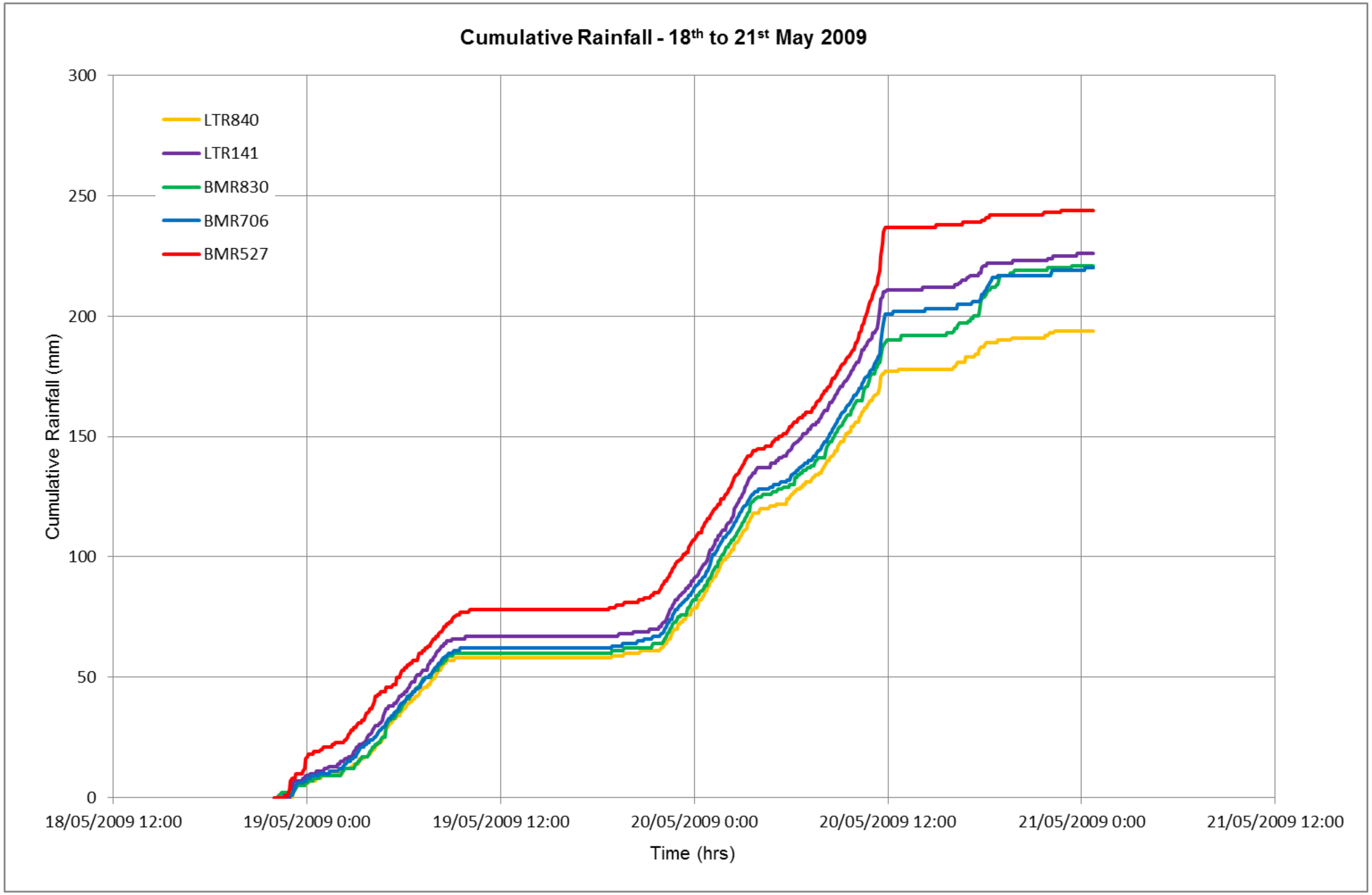

Figure A-7: Cumulative Rainfall Plots for May 2009 Event

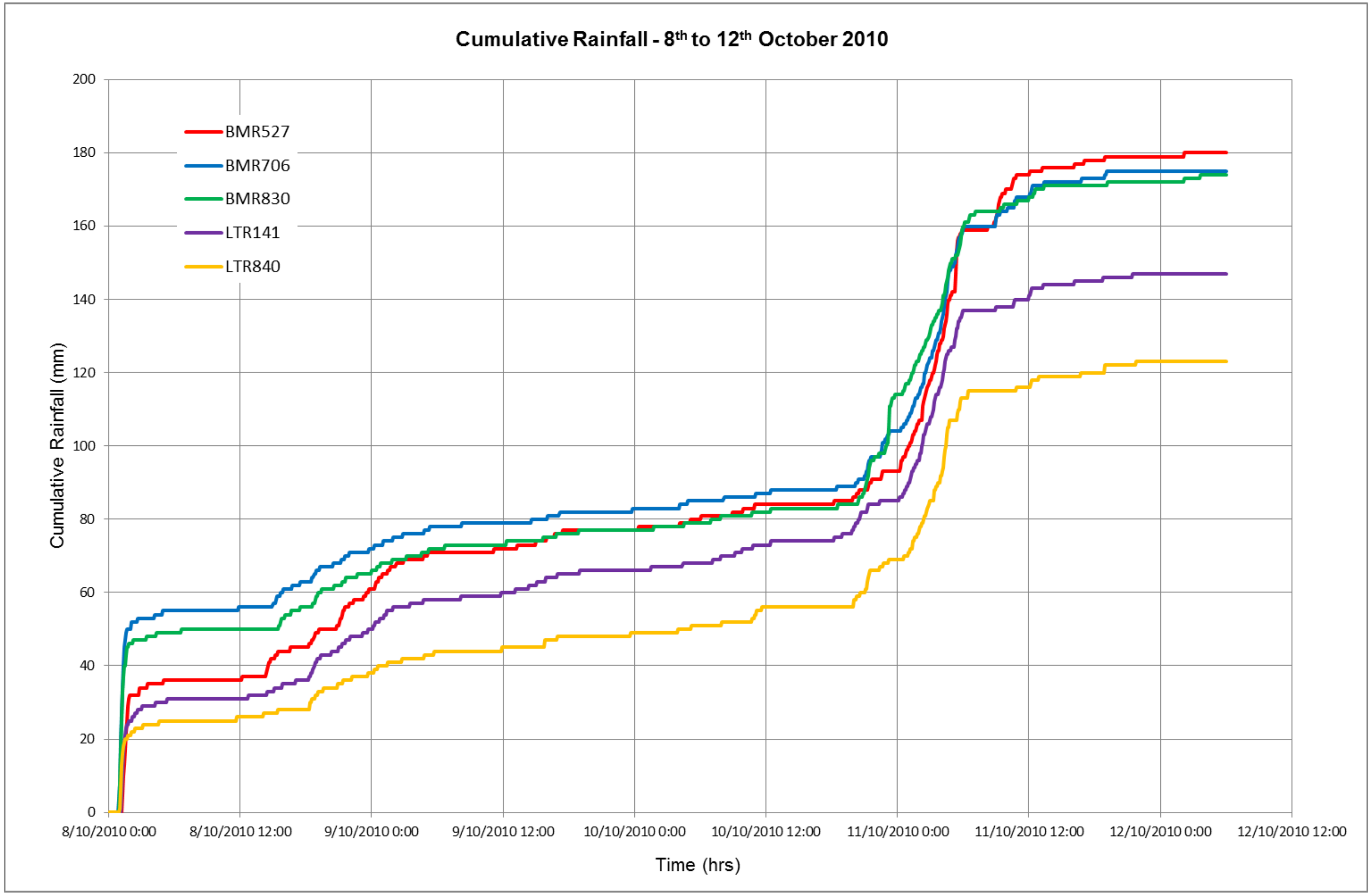

Figure A-8: Cumulative plots of rainfall for October 2010 event

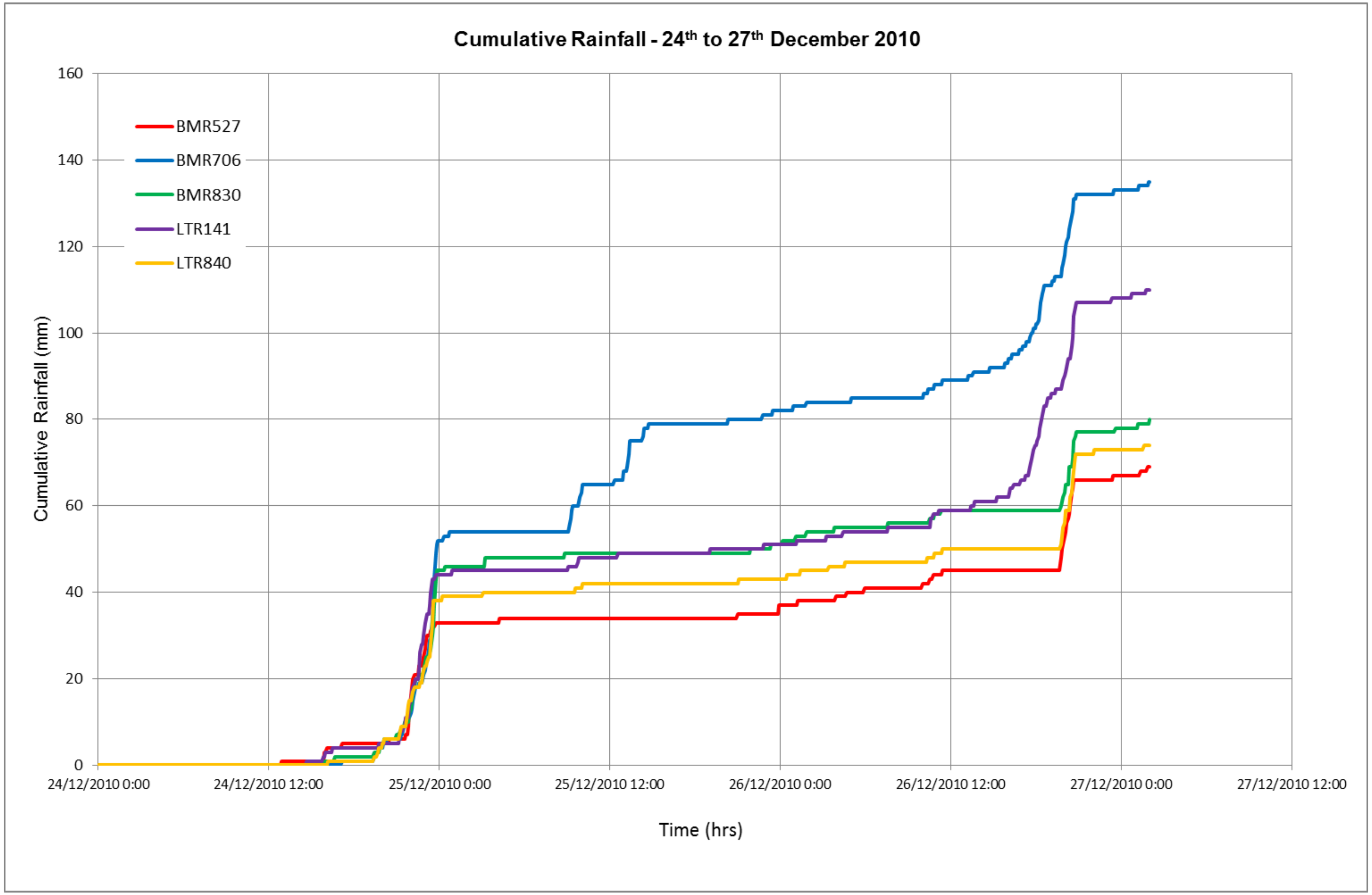

Figure A-9: Cumulative plots of rainfall for December 2010 event

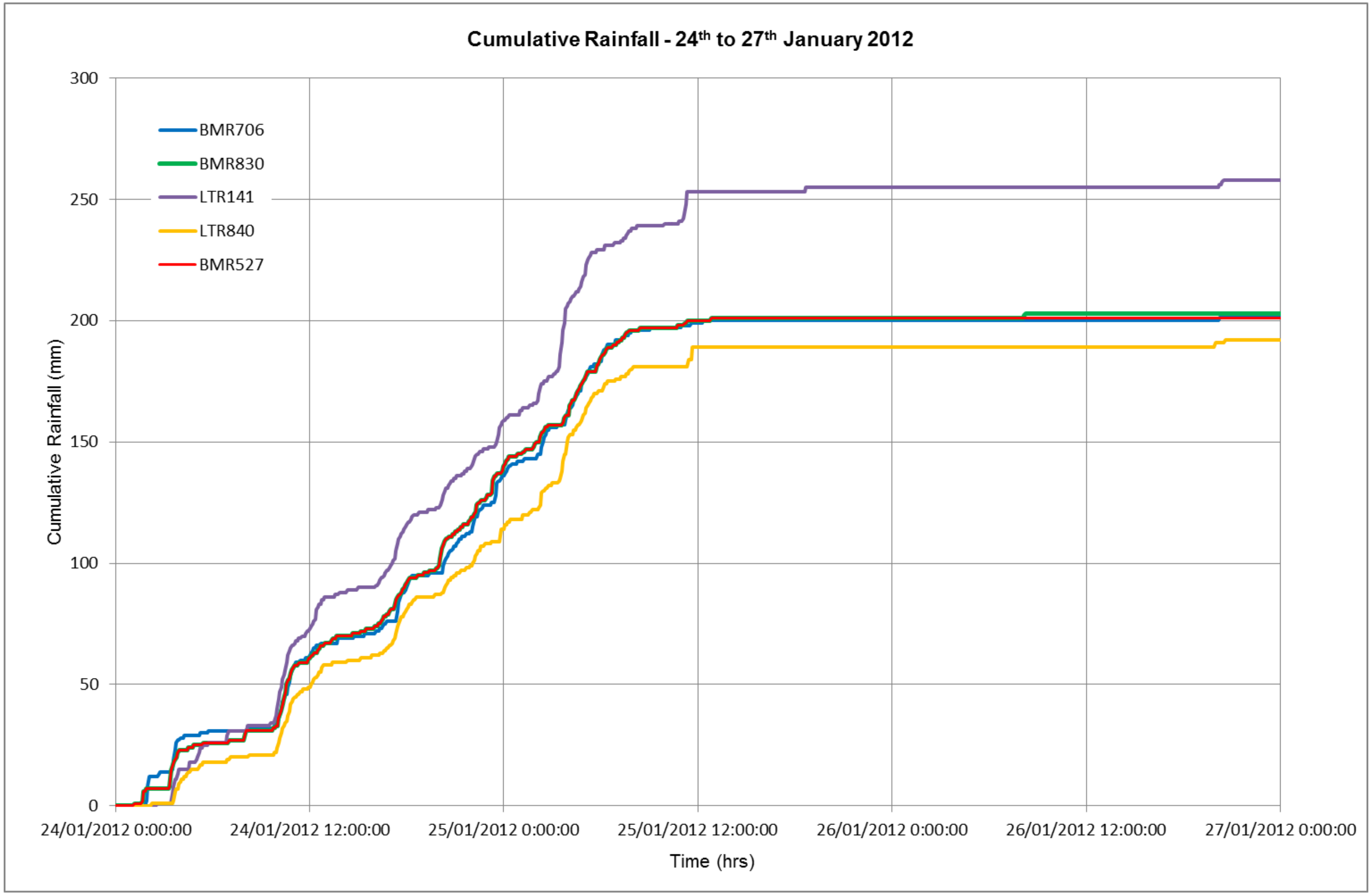

Figure A-10: Cumulative plots of rainfall for January 2012 event

Appendix B – Detention Basin Stage-Storage and Stage-Discharge Data for Hydrology Model

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XPRAFTS Model-Stage Discharge data for detention basins

Table B-1: Detention area to the north of Formosa Road up to Ermelo Road

Sub catchment	H-Stage (m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
S	2.25	0	2.95	0
	2.5	562	3	0.5
	3	4986	3.25	9.1
	3.5	13878	3.5	29.1
	4	24785	3.75	59.1
	4.5	34932	4	99.1
	5	48070	4.25	148.6
			4.5	207.0
			4.75	274.8
			5	313.9

Table B-2: Detention area to the North of Ermelo Road up to the Manly Road

Sub catchment	H-Stage (m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
CC	1	0	1.1	0.0
	1.5	2301	1.25	3.8
	2	40652	1.5	12.6
	2.5	123877	1.75	24.1
	3	224902	2	38.4
	3.5	336102	2.25	54.8
	4	453802	2.5	72.6
			2.75	86.3
			3	97.8
			3.25	107.6
			3.5	116.1

Table B-3: Detention area to the north of Manly Road up to Wynnum Road

Sub catchment	H-Stage (m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
OO	0	0	0	0
	1	1000	0.1	2.1
	1.5	28190	1	40.2
	2	118780	1.25	54.2
	2.5	271005	1.5	68.7
	3	484930	1.75	87.6
			2	110.5
			2.25	134.2
			2.5	158.1
			2.75	182.2
			2.9	195.9

Table B-4: Detention area to the south of Manly Road

Sub catchment	H-Stage (m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
FF	1.5	0	1.3	0
	1.75	98	1.46	0.1
	2	710	1.74	1.9
	2.25	1975	1.99	4.1
	2.5	3651	2.23	6.8
	2.75	5275	2.5	10.2
	3	6730	2.72	13.4
	3.25	8237	2.82	14.9

Table B-5: Detention area to the north of Taylor Place up to Manly Road

Sub catchment	H -Stage(m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
MM	1.04	0	0	0
	1.50	2	1	17.7
	1.75	14	1.17	21.9
	2.00	45	1.26	24.2
	2.25	898	1.56	32.8
	2.50	4039	1.86	42.1
	2.75	7915	2.07	49.2
	3.00	11330	2.18	53.4
	3.25	14918	2.47	64
	3.50	18032	2.72	73.5
	3.75	20660	2.88	79.7
	4.00	22811	3	83.3
			3.5	98.1

Table B-6: Detention Basin located to the north of Basella Road

Sub catchment	H-Stage (m AHD)	S-Storage (m^3)	H-Stage (m AHD)	Q-Discharge (m^3/s)
KK	6.45	0	6.2	0.0
	6.5	259	6.45	0.2
	6.75	1416	6.7	0.7
	7	1628	6.95	1.3
	7.25	1845	7.2	1.9
	7.5	2053	7.45	2.3
	7.75	2268	7.7	2.6
	8	2483	7.95	2.9
	8.25	2766	8.2	3.2
	8.5	3296	8.45	3.4
			8.7	3.6
			8.95	3.9
			9.2	4.1

Appendix C – Hydrologic and Hydraulic Model Input Data

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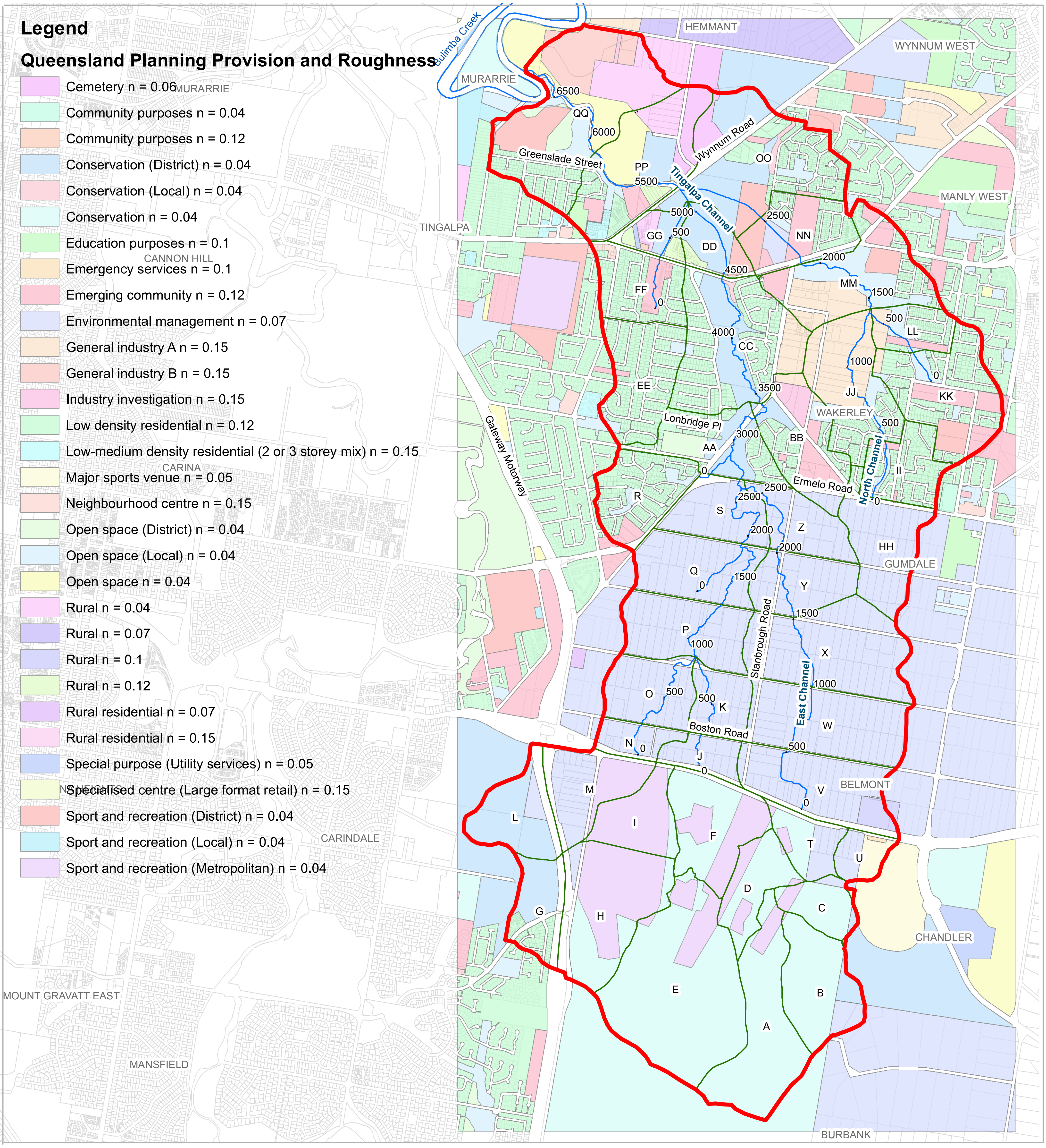

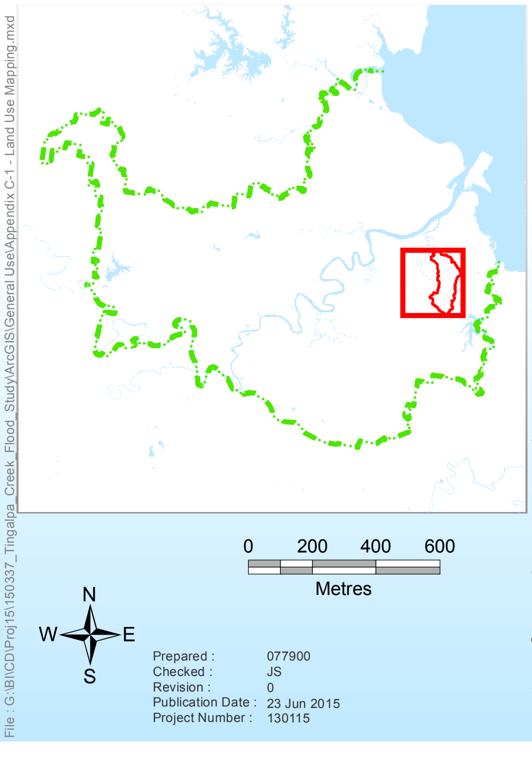

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Legend

- Tingalpa Drain Catchment
- Tingalpa Drain Sub-Catchments
- Channel Centreline
- Bulimba Creek

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Appendix C-1: Tingalpa Channel Catchment Land Use Mapping

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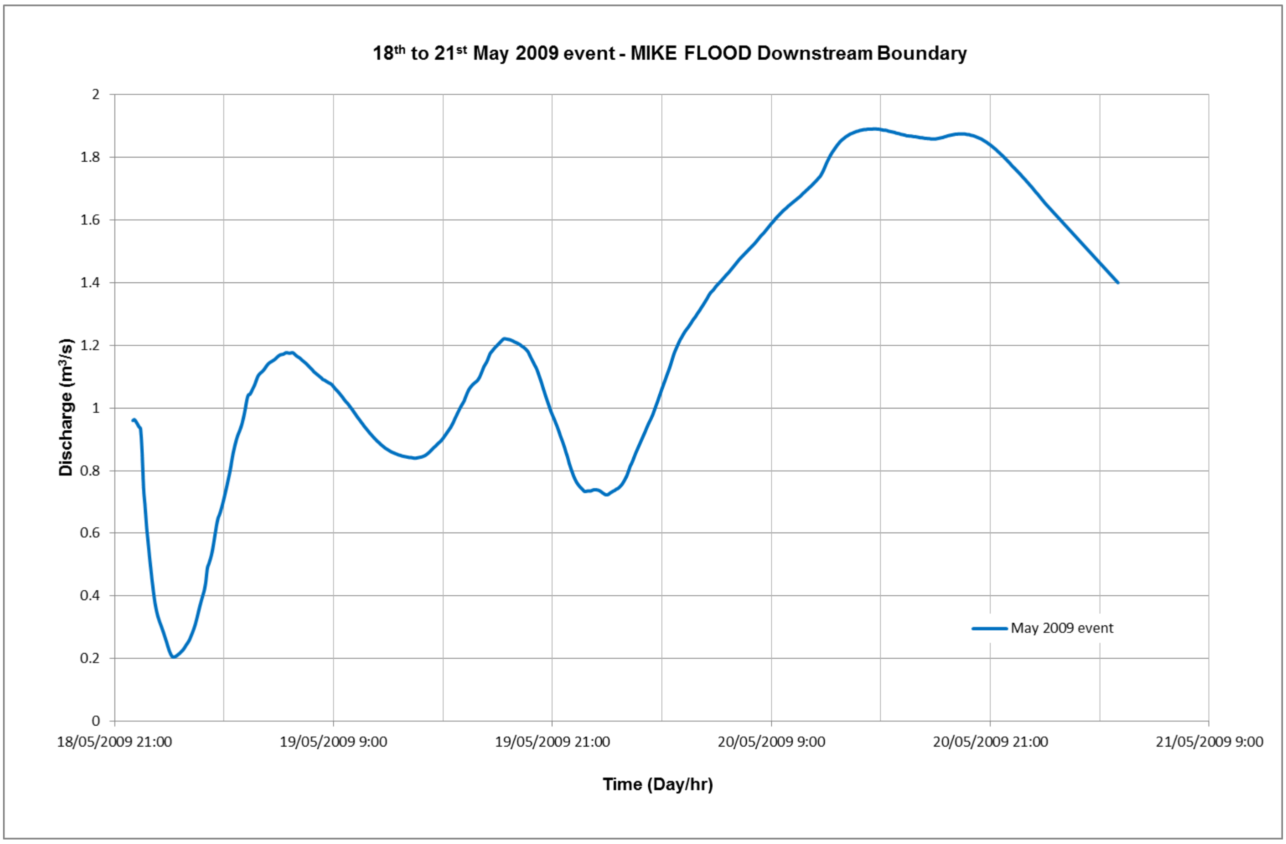


Figure C2 - Downstream boundary for Tingalpa Channel for May 2009 event

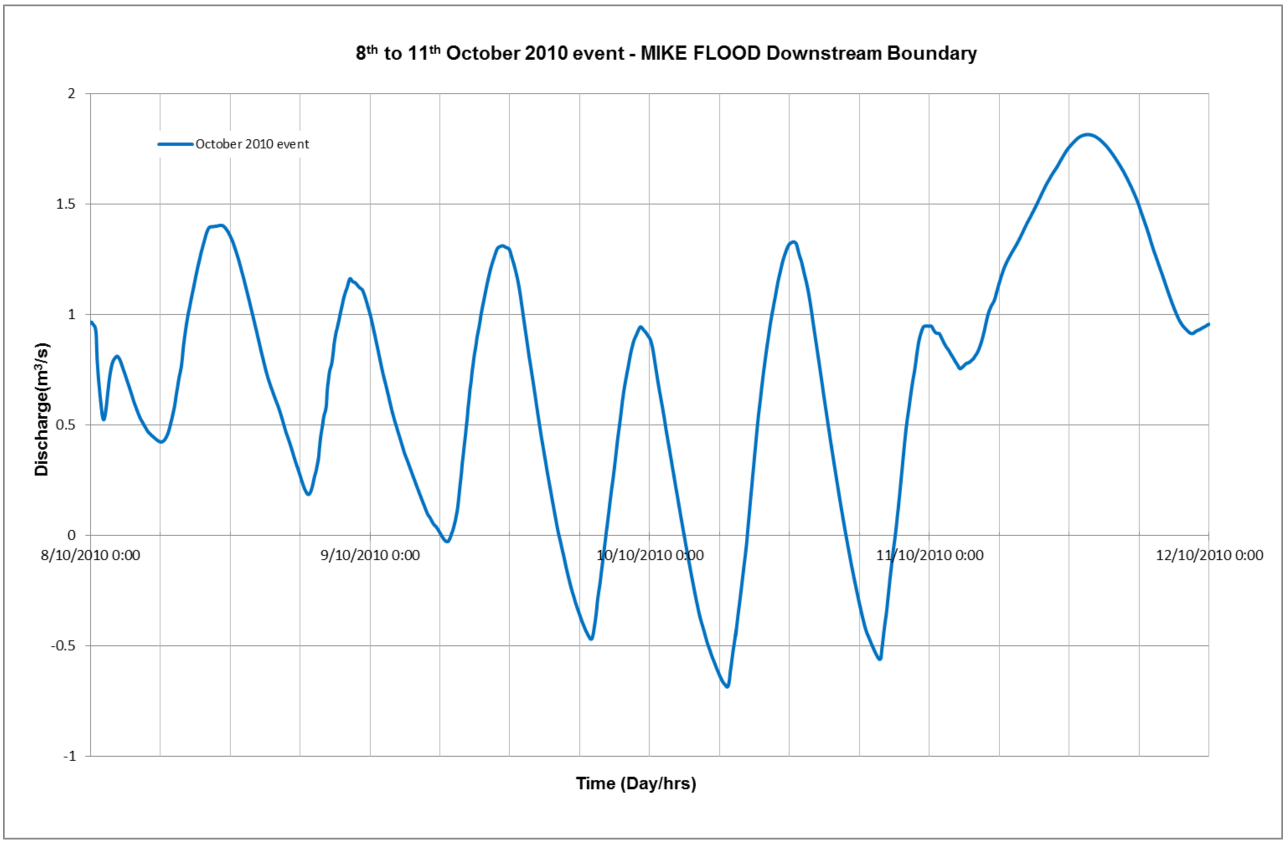


Figure C3 - Downstream boundary for Tingalpa Channel for October 2010 event

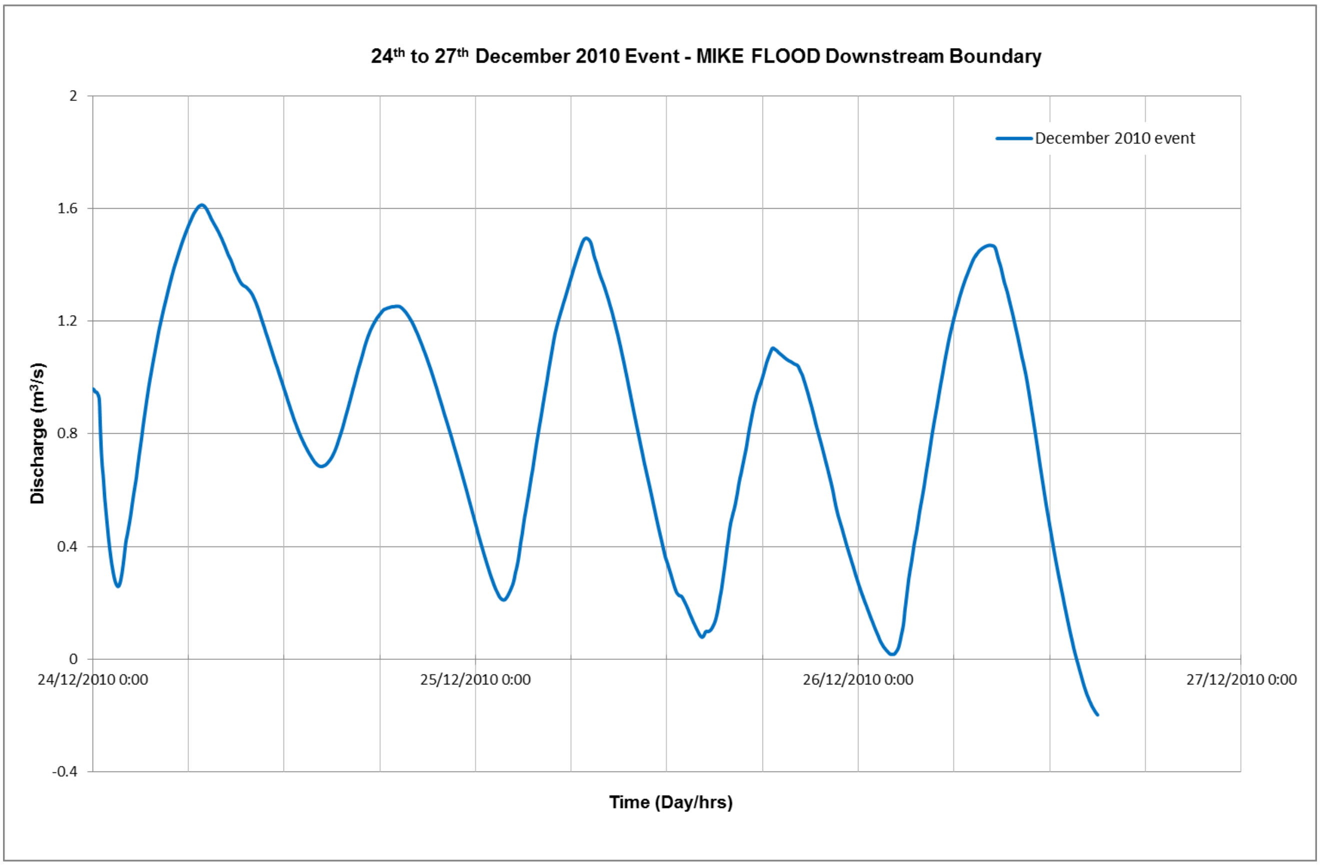


Figure C4 – Downstream boundary for Tingalpa Channel for December 2010 event

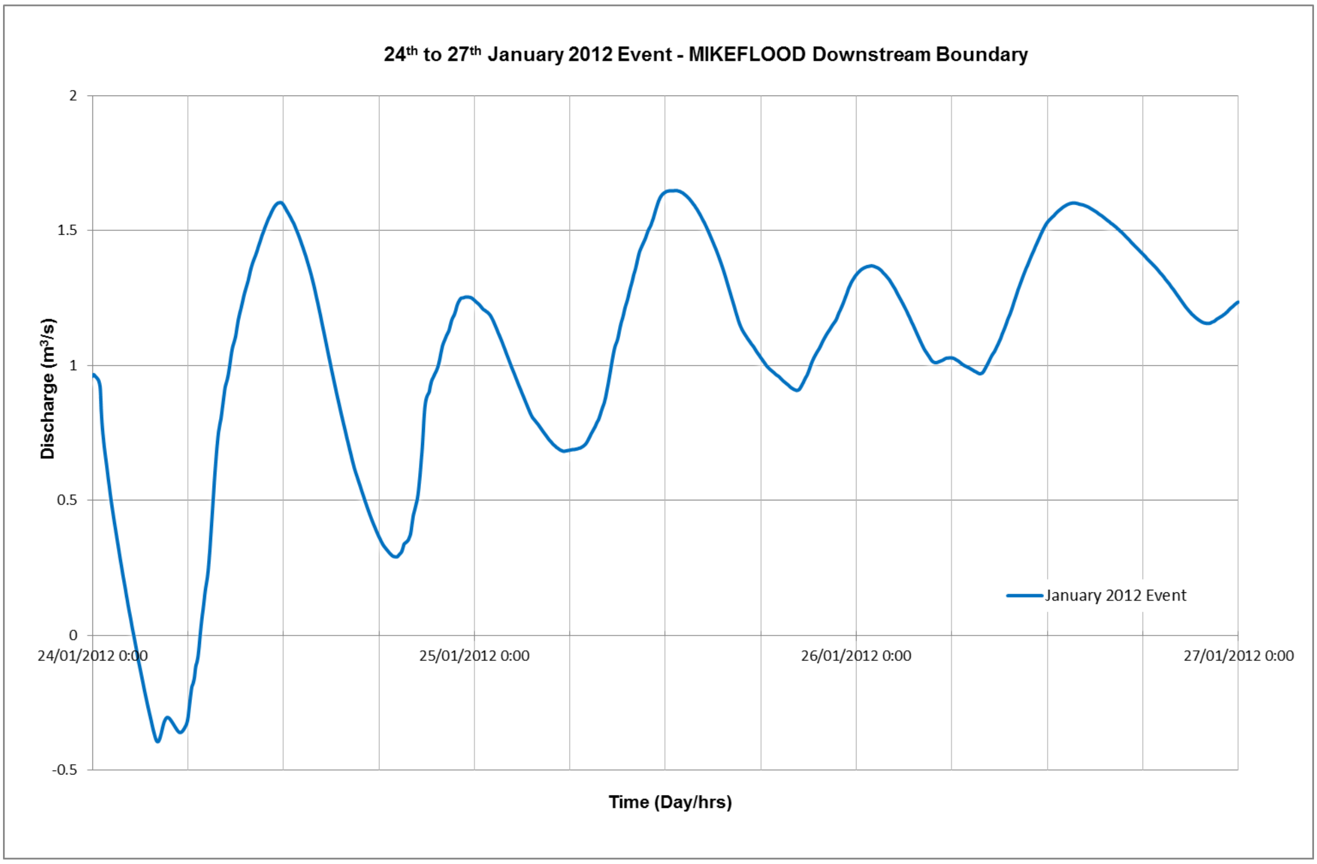
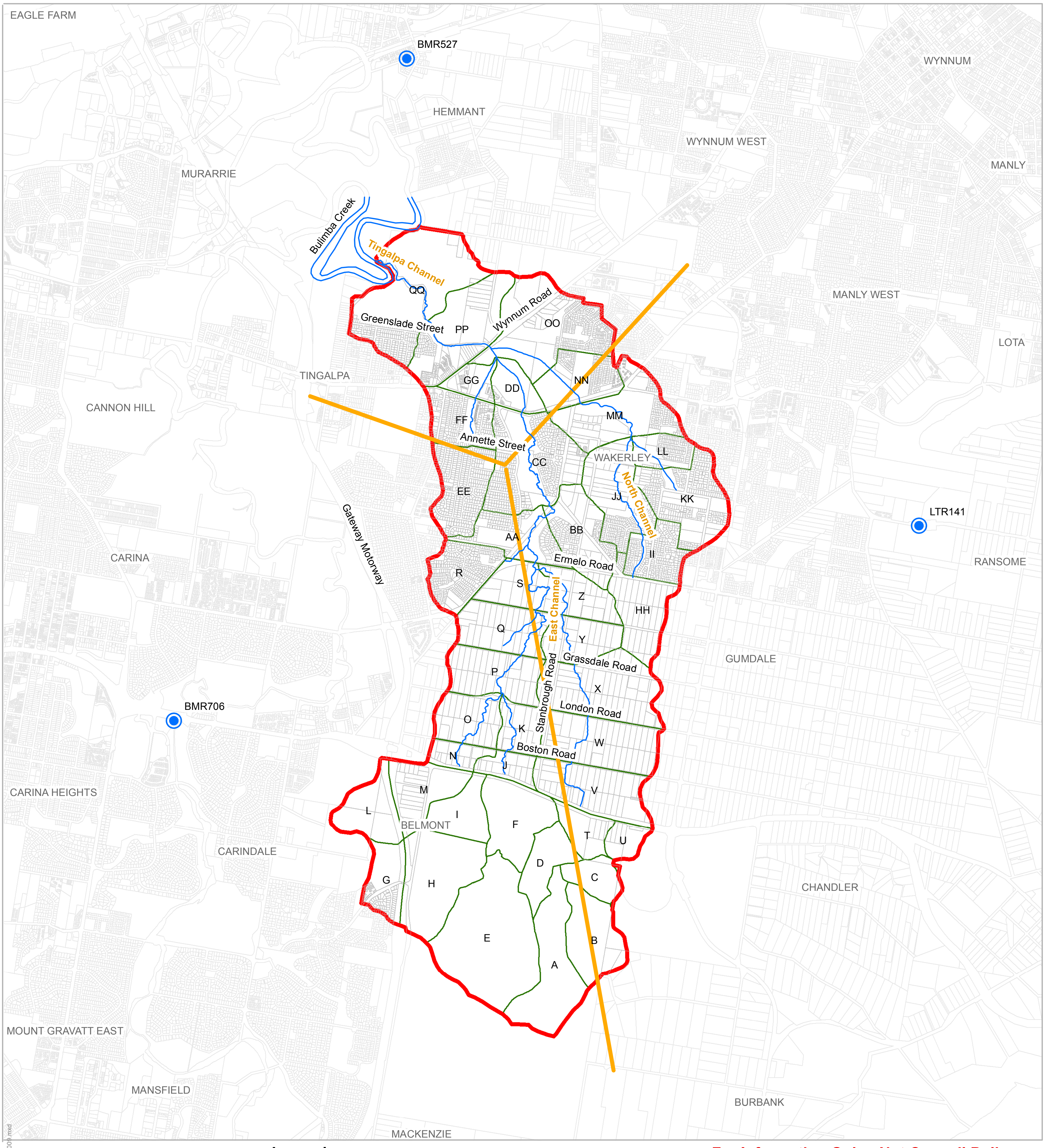
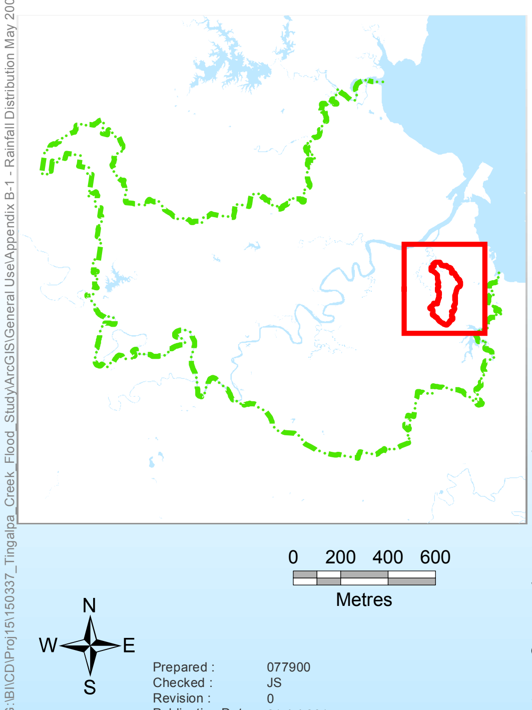


Figure C5: Downstream boundary for Tingalpa Channel for January 2012 event





Legend

- Rainfall Gauges May 2009 Event
- Thiessen Polygon Boundary
- Tingalpa Drain Catchment
- Tingalpa Drain Sub-Catchments
- Cadastre

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Appendix C-6: Rainfall Distribution May 2009

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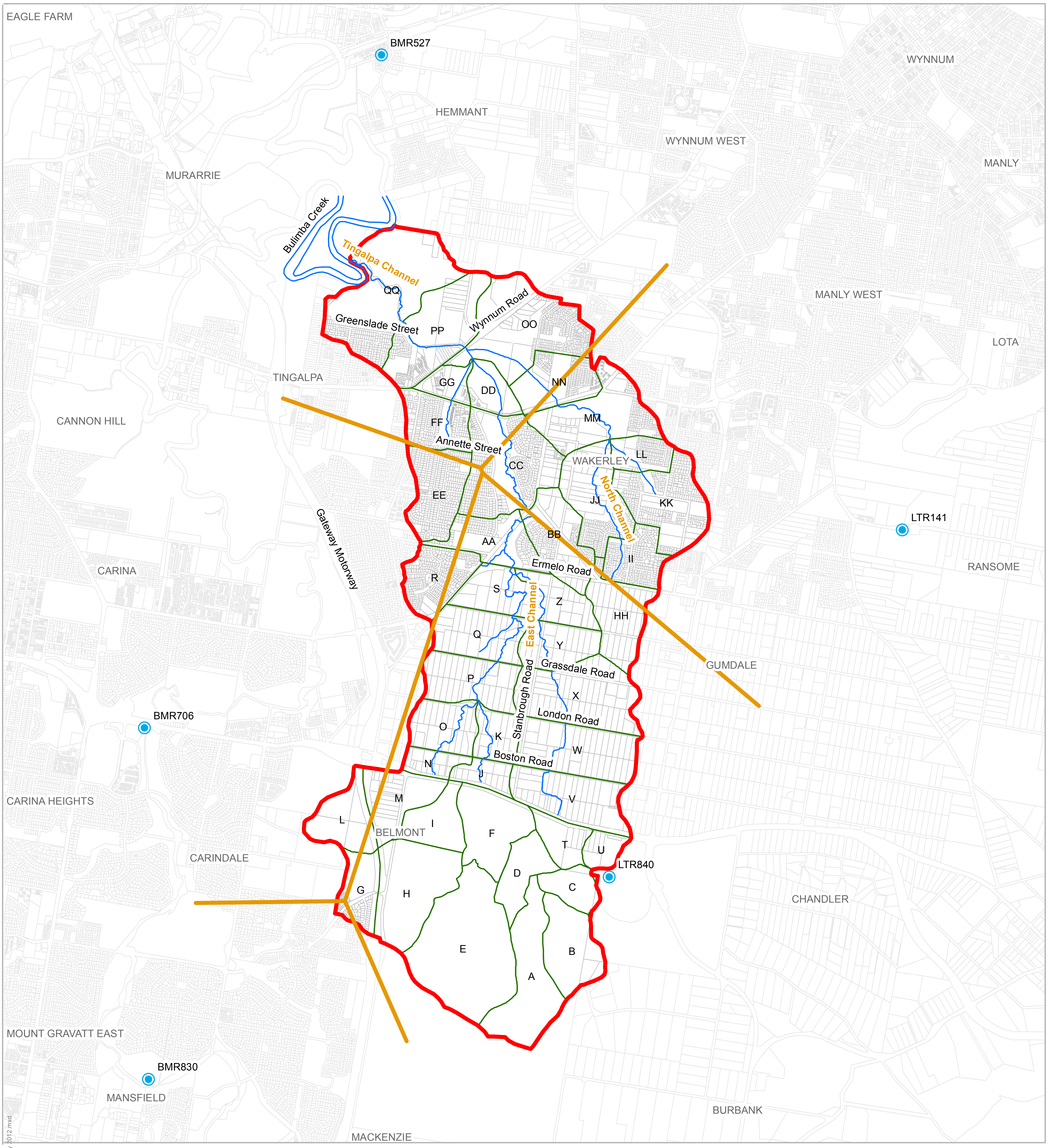

Legend

- Rainfall Gauges January 2012 Event
- Thiessen Polygon Boundary
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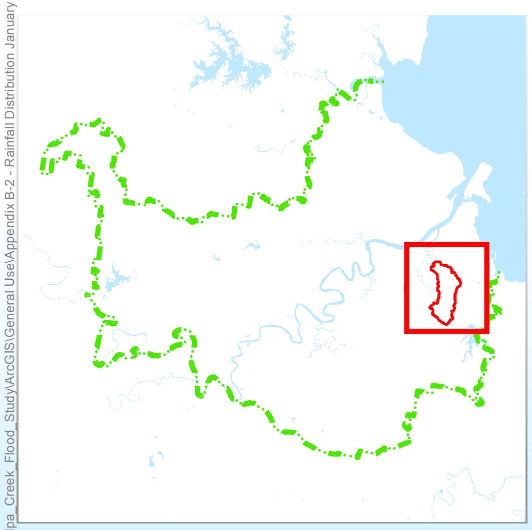

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Appendix C-7: Rainfall Distribution January 2012

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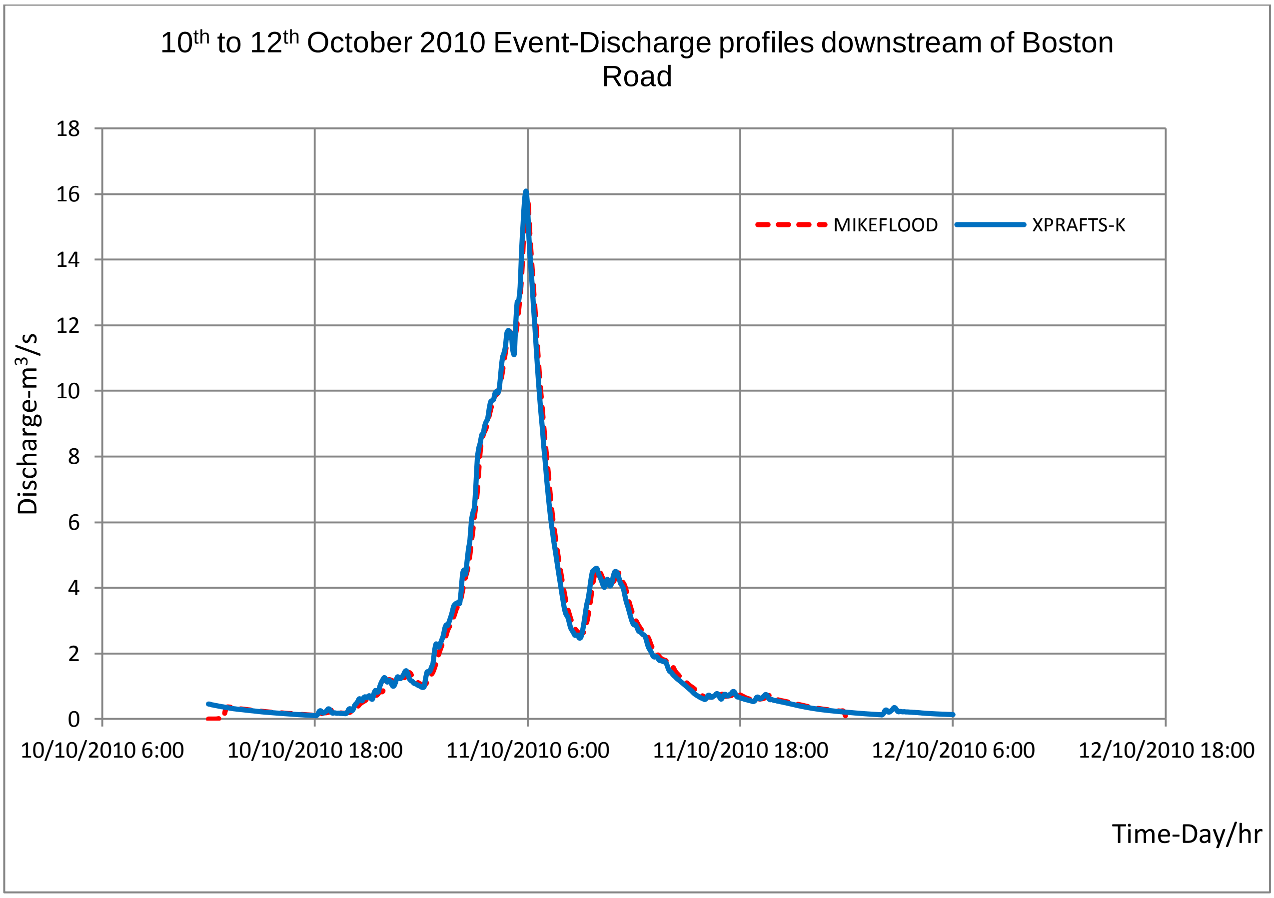

Figure C-8: October 2010 Calibration Event-Discharge profiles downstream of Boston Road

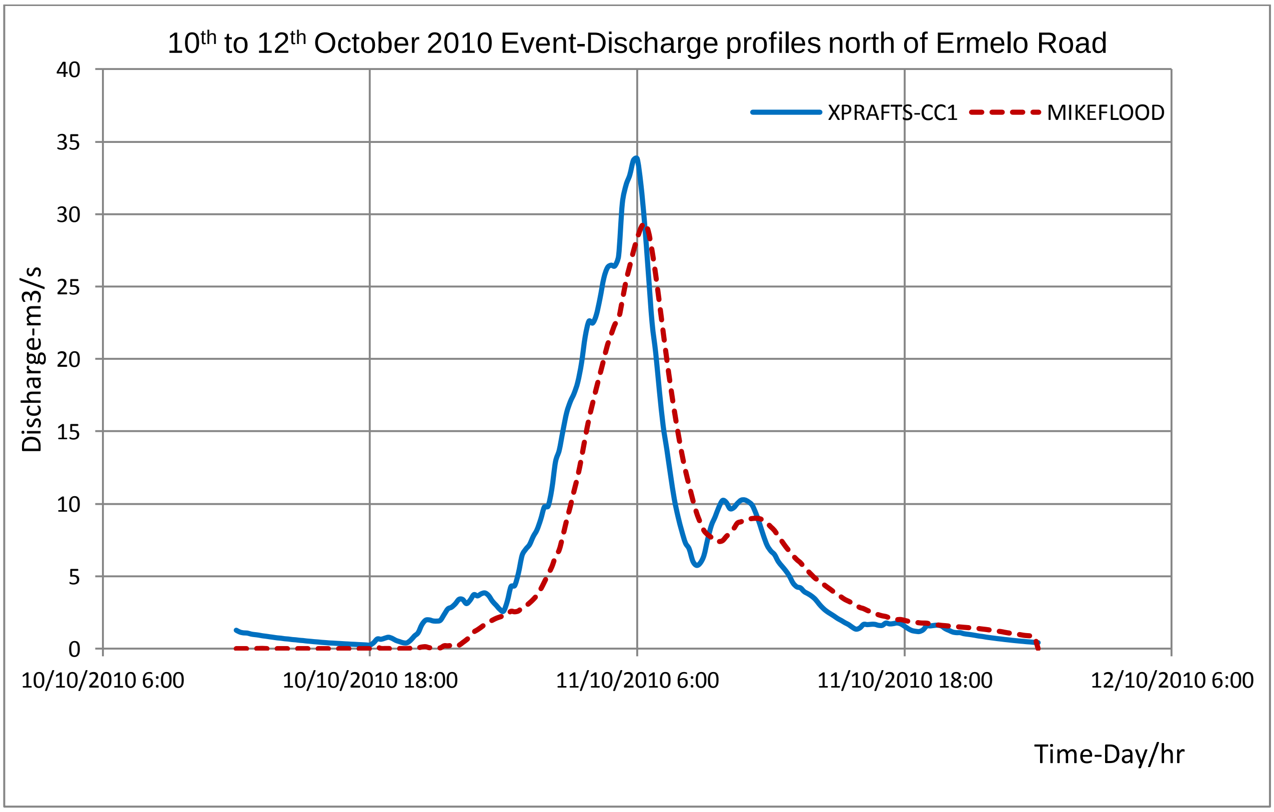

Figure C-9: October 2010 Calibration Event-Discharge Profiles north of Boston Road

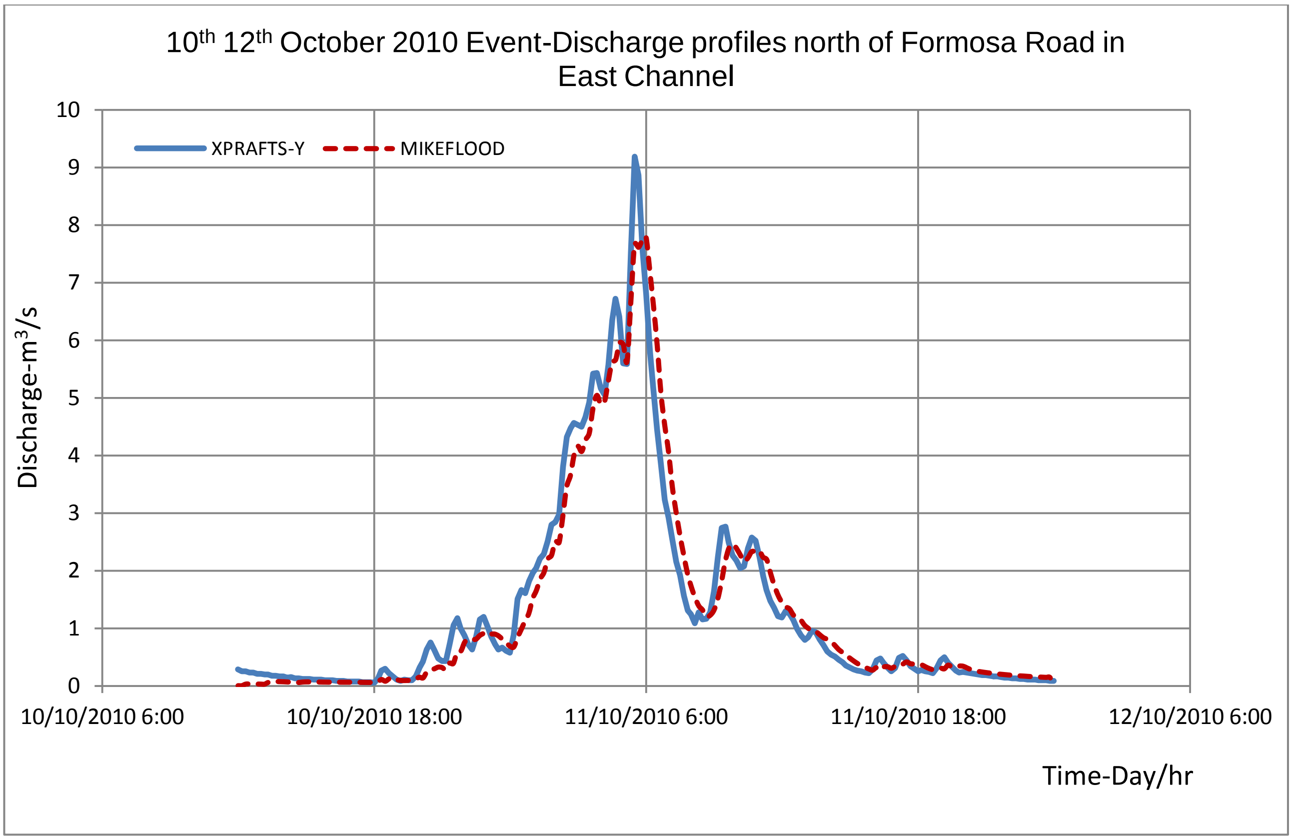

Figure C-10: October 2010 Calibration Event-Discharge profile north of Formosa Road in East Channel

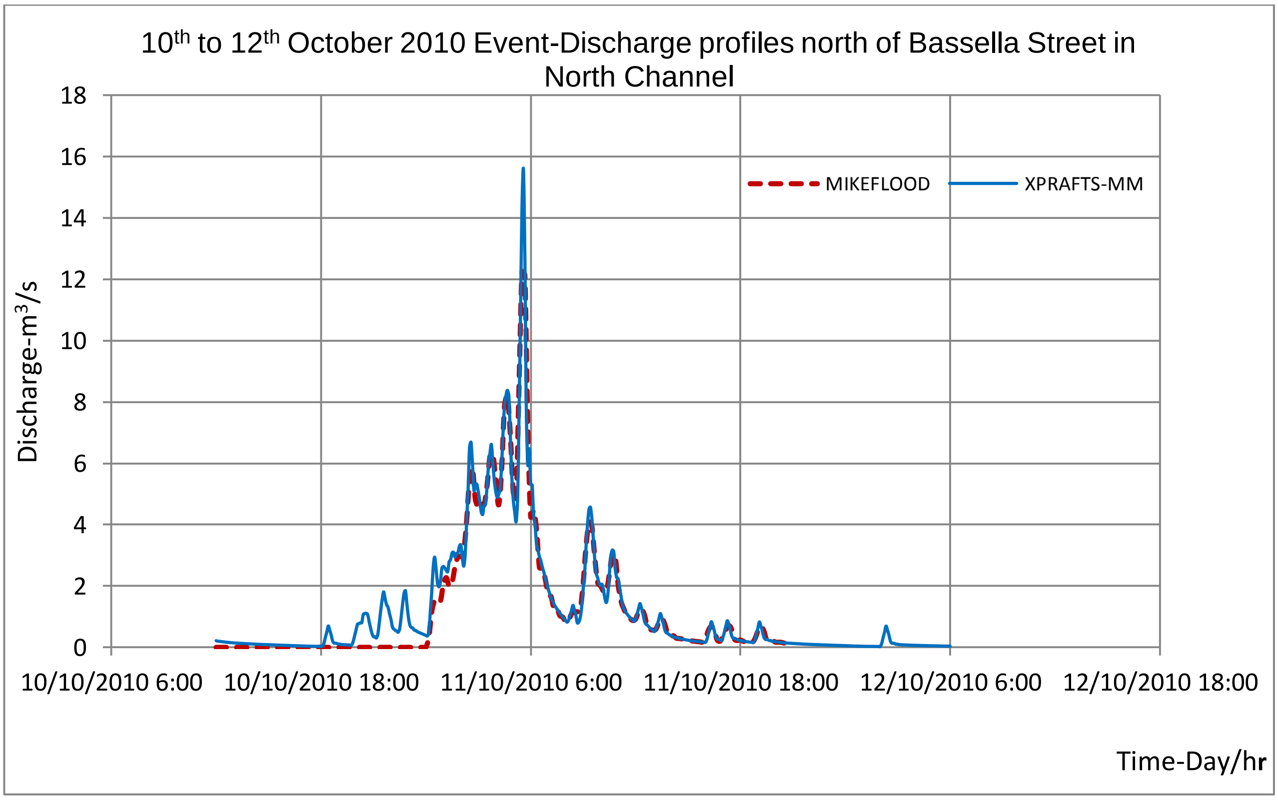

Figure C-11: October 2010Event-Discharge profiles north of Bassella Street in North Channel

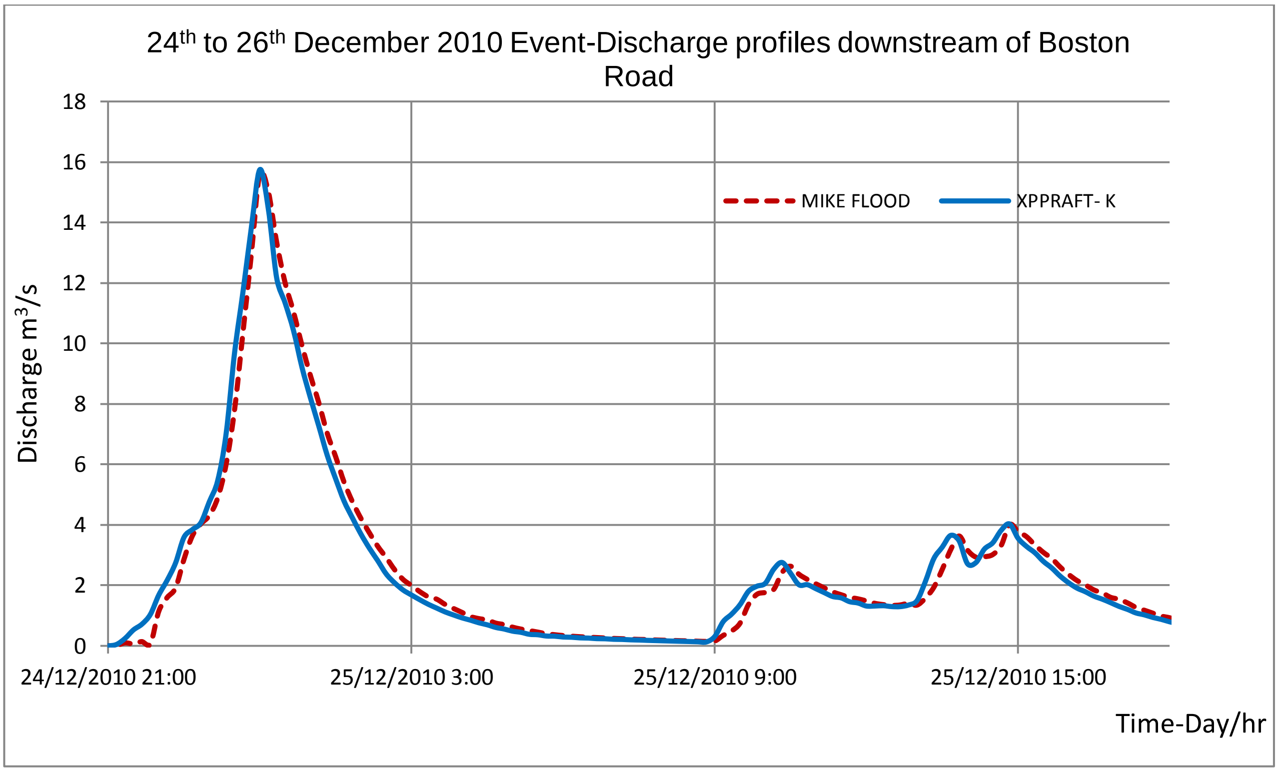

Figure C-12: December 2010 Verification event –Discharge profiles downstream of Boston Road

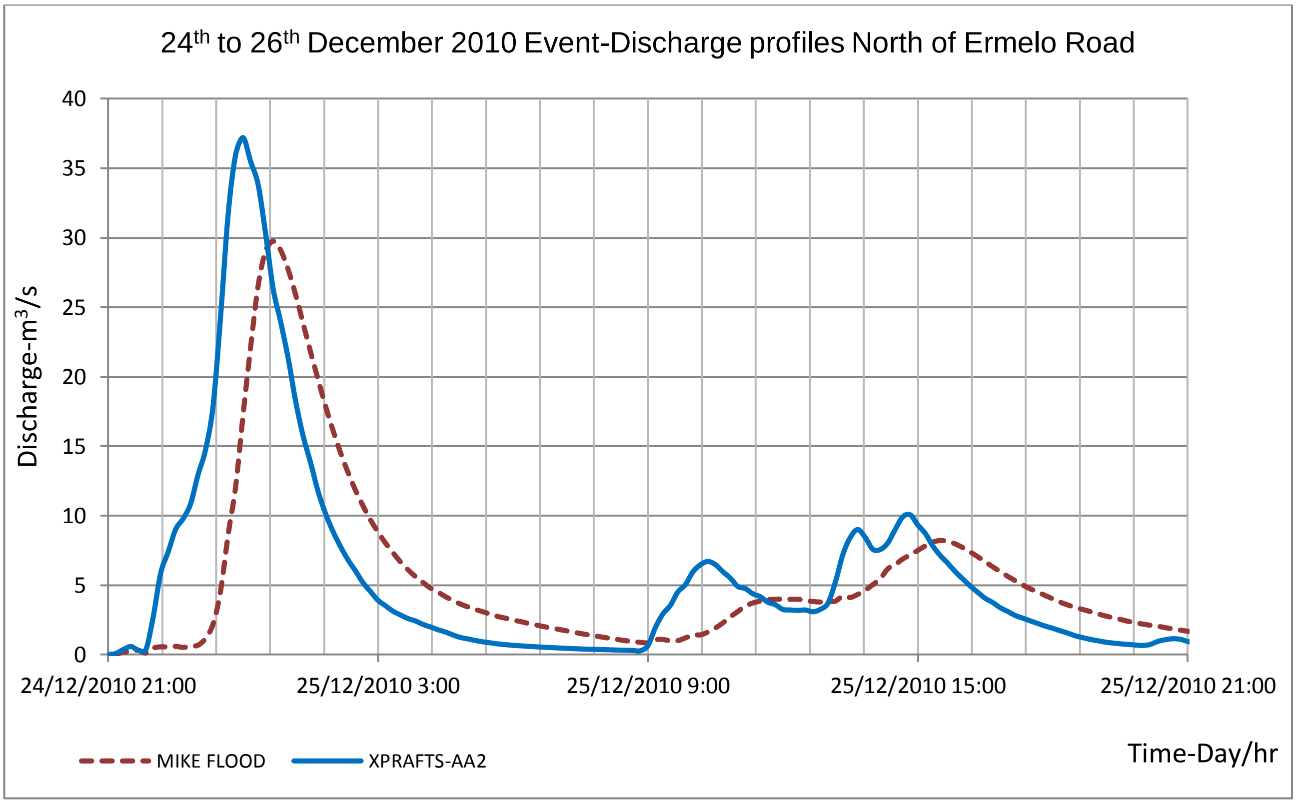

Figure C-13: December 2010 Verification event-Discharge profiles downstream of Ermelo Road

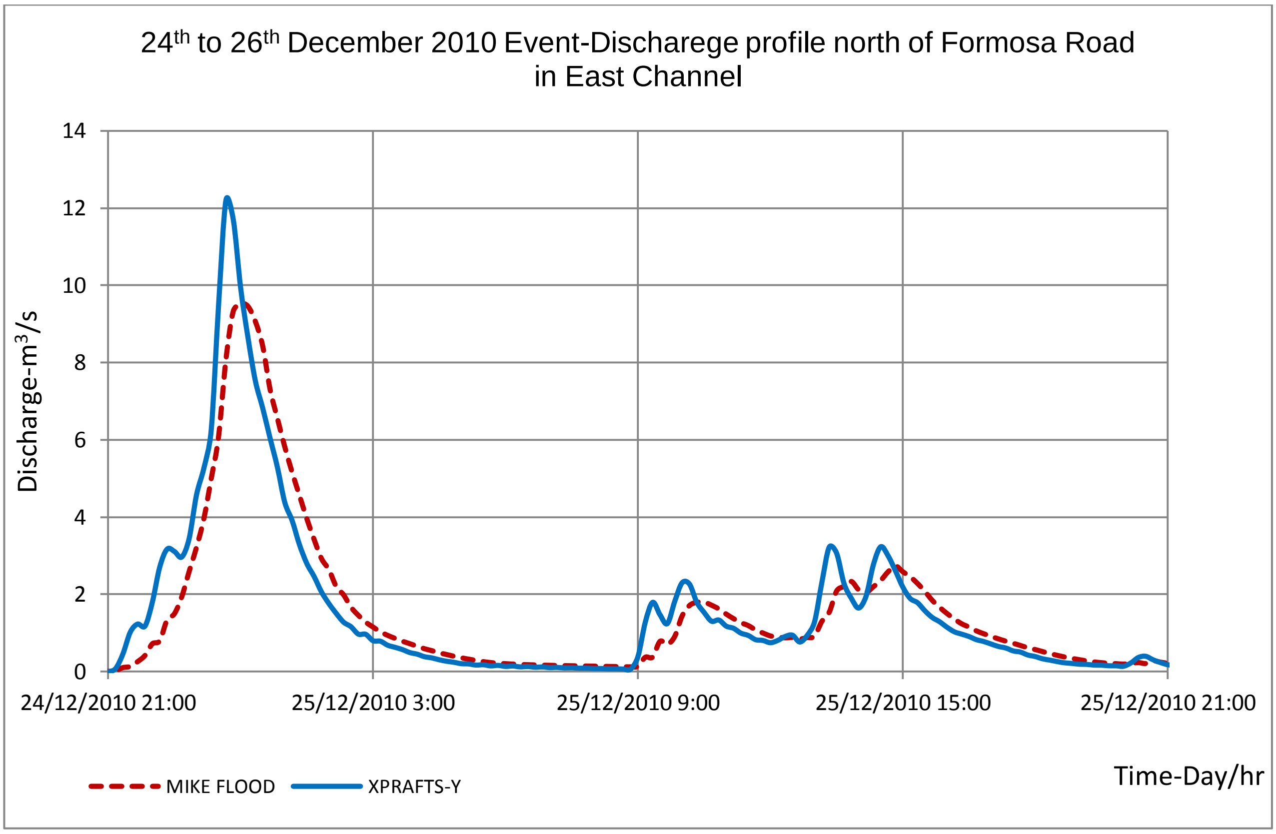

Figure C-14: December 2010 Valibration event-Discharge profiles north of Formosa Road

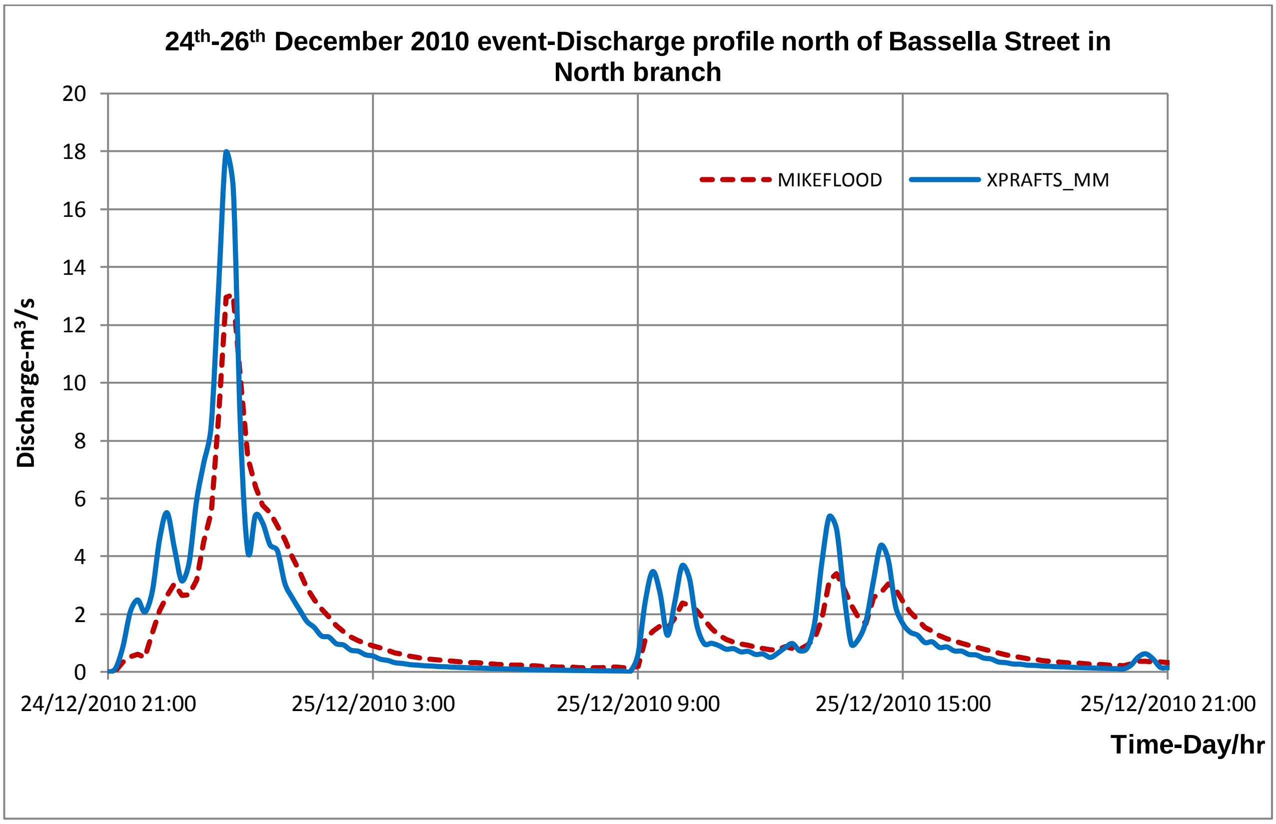

Figure C-15: December 2010 Valibration event-Discharge profiles north of Bassela Street.

Appendix D – Inundation Extents for Calibration and Verification Events and Discharge Comparison Locations

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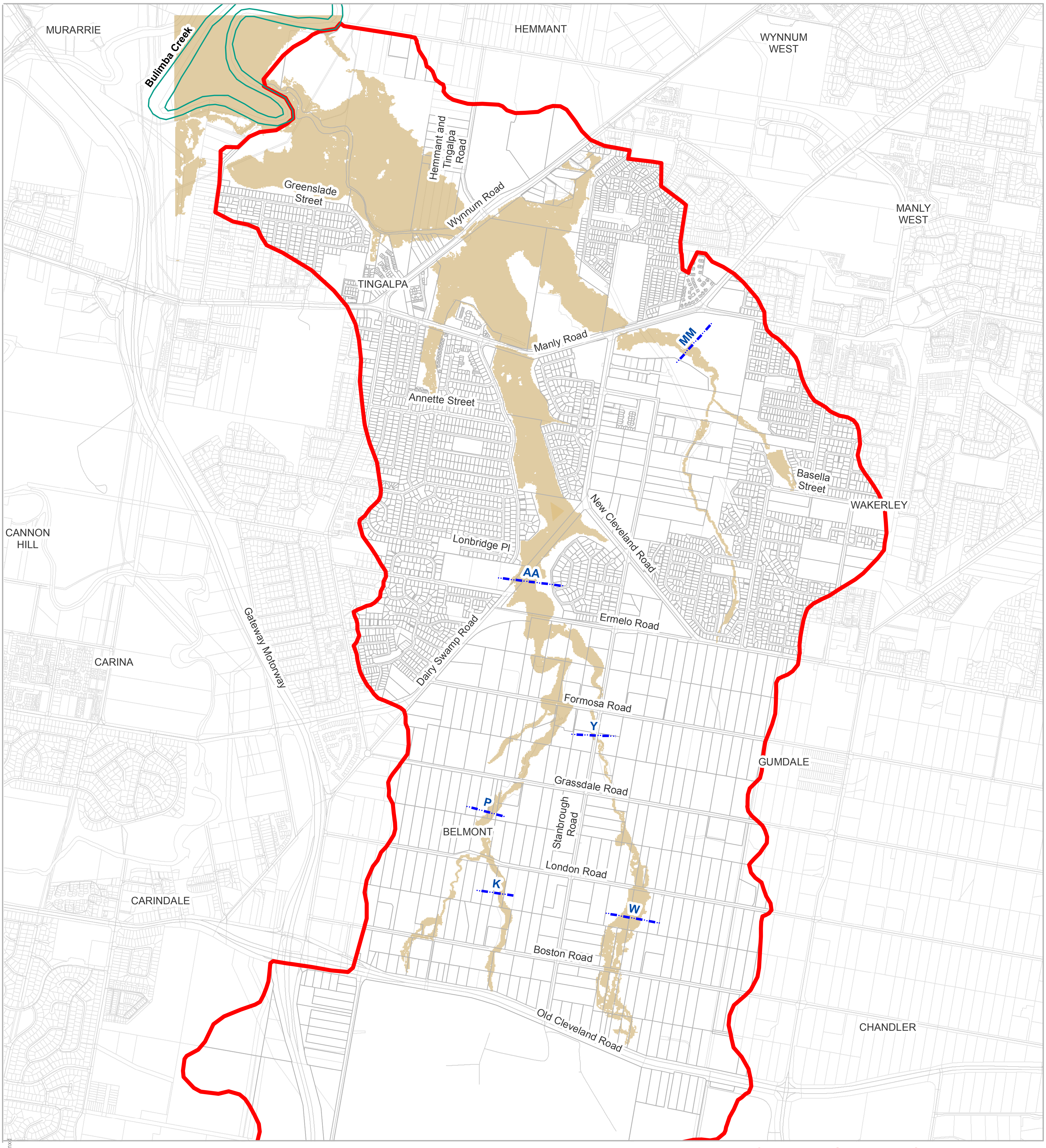

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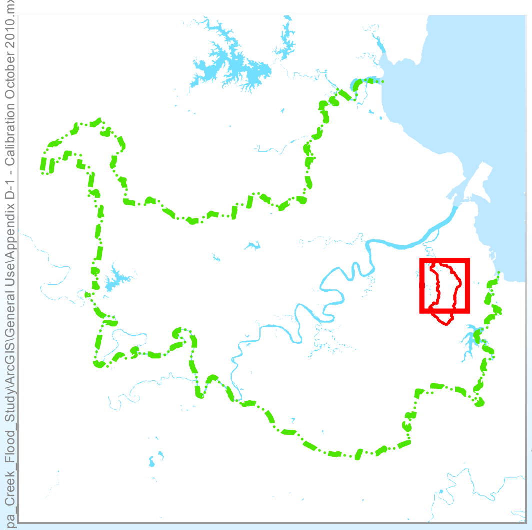

Legend

- Discharge Extraction Locations
- Bulimba Creek
- Tingalpa Drain Catchment
- Modelled Inundation Extent
- Cadastre

0 250 500
Metres

N W E S

Prepared : 077900
Checked : CG
Revision : 0
Publication Date : 22 Jul 2015
Project Number : 150337

File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Appendix D-1 - Calibration October 2010.mxd

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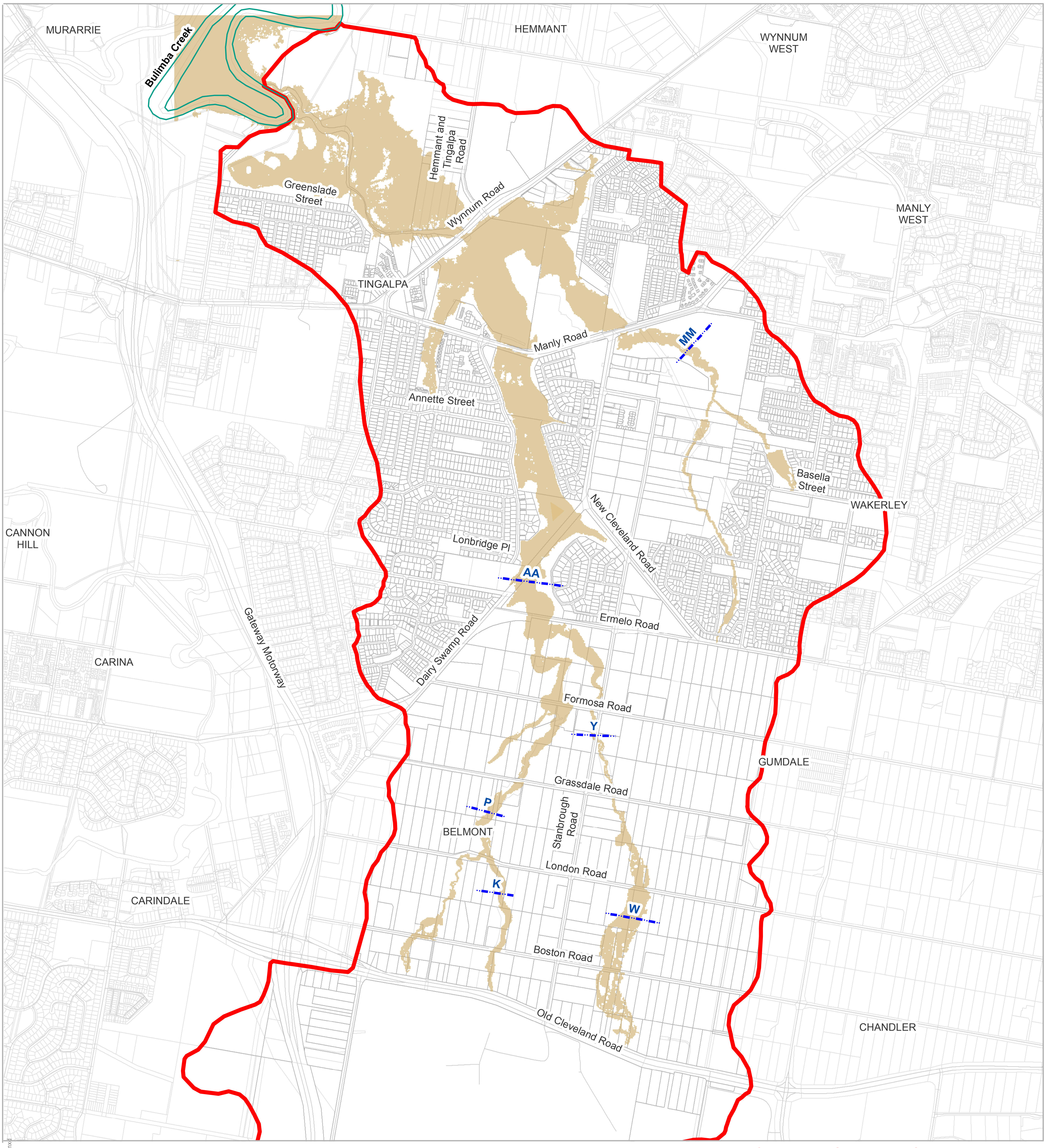
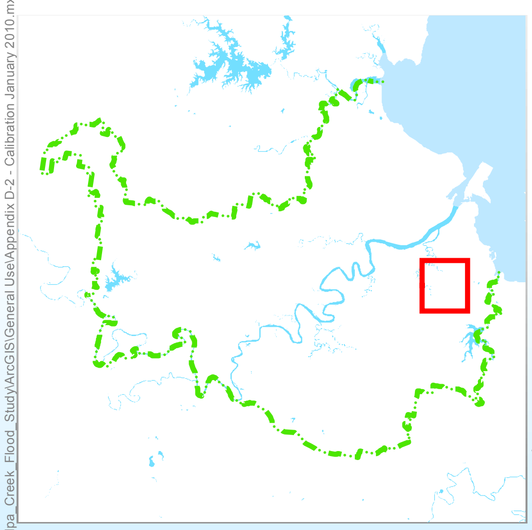
Appendix D1 - October 2010 Calibration Event Inundation Extent

FLM - 150337 - 001



For Information Only - Not Council Policy



0 250 500
Metres

N W E S

Prepared : 077900
Checked : CG
Revision : 0
Publication Date : 22 Jul 2015
Project Number : 150337

File : G:\BI\CD\Proj15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Appendix D-2 - Calibration January 2010.mxd

Legend

- Discharge Extraction Locations
- Bulimba Creek
- Tingalpa Drain Catchment
- Modelled Inundation Extent
- Cadastre

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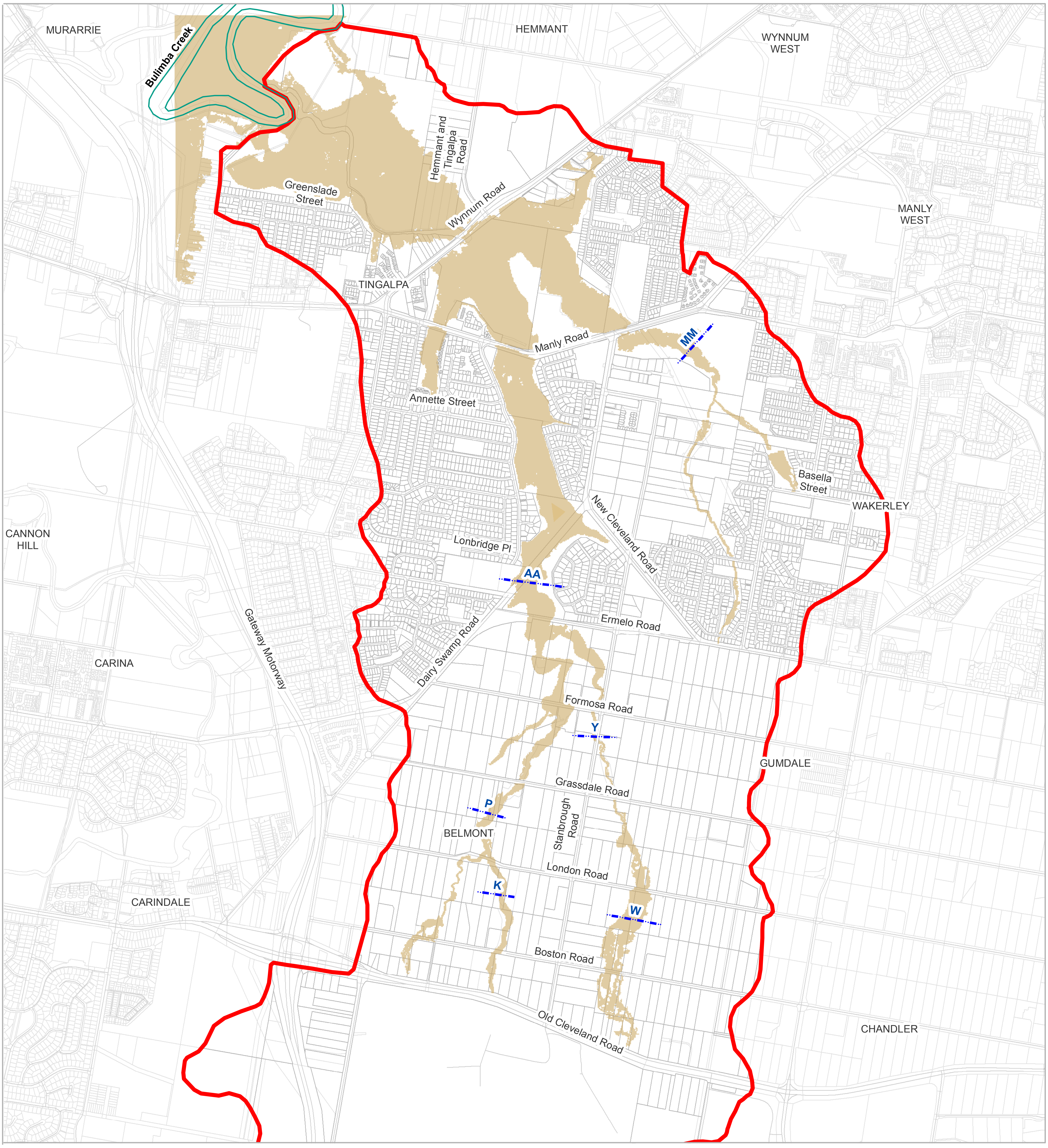
Appendix D2 - January 2012 Calibration Event Inundation Extent

FLM - 150337 - 001



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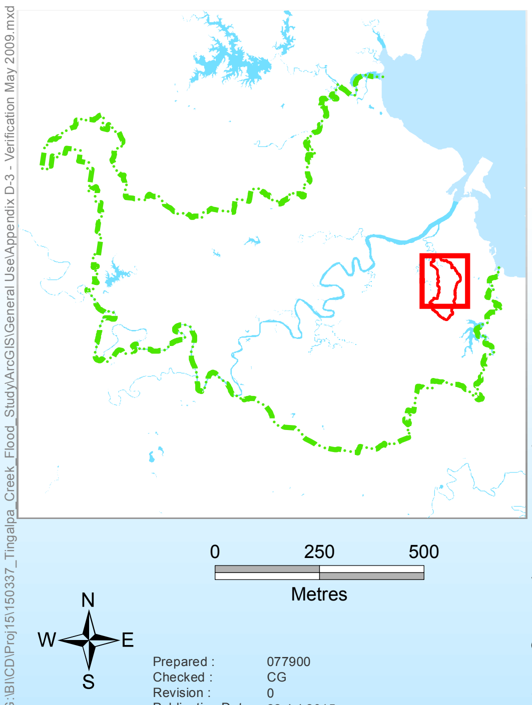

Legend

- Discharge Extraction Locations
- Bulimba Creek
- Tingalpa Drain Catchment
- Modelled Inundation Extent
- Cadastre

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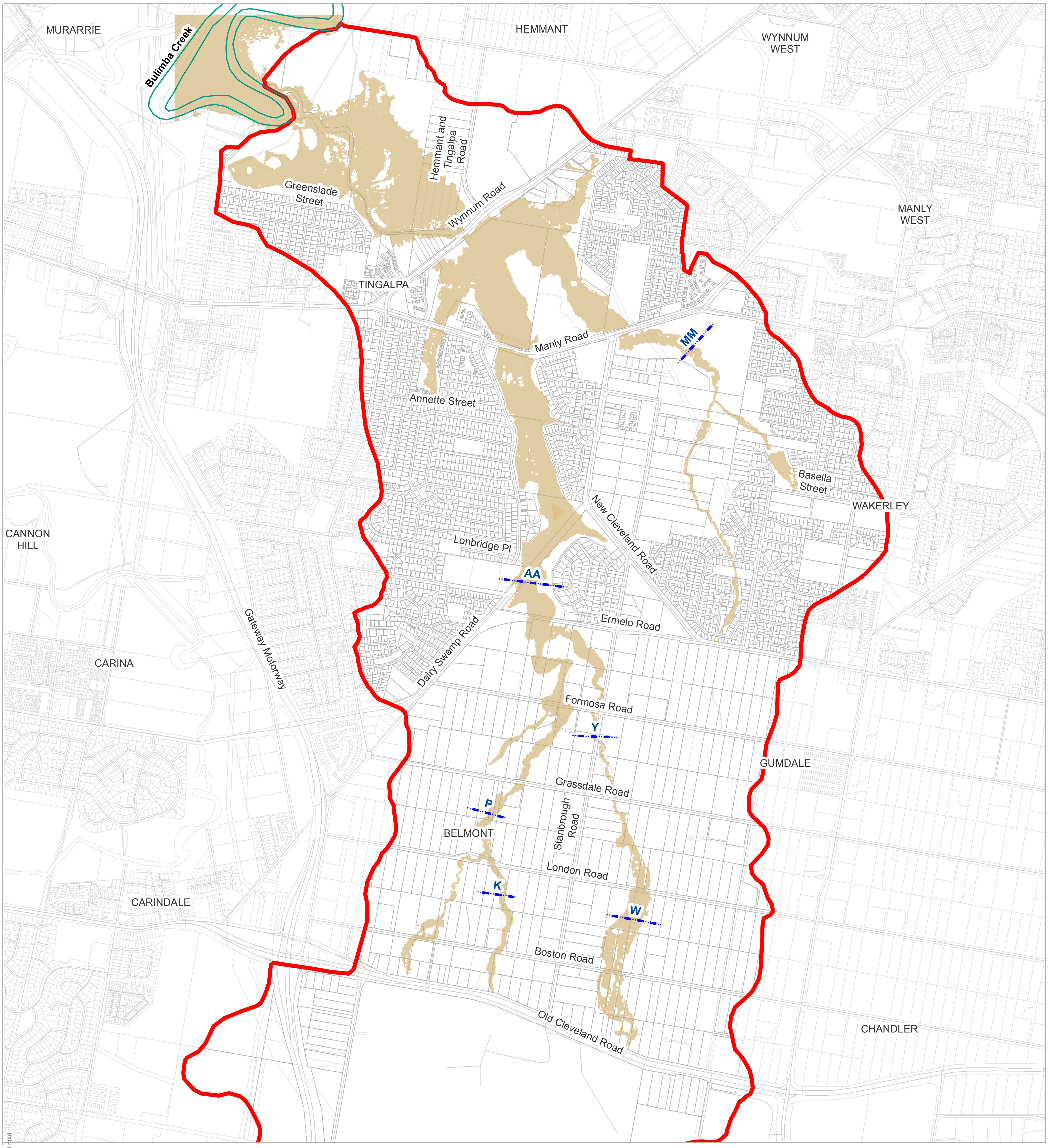
File : G:\BICD\Proj\15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Appendix D-3 - Verification May 2009.mxd

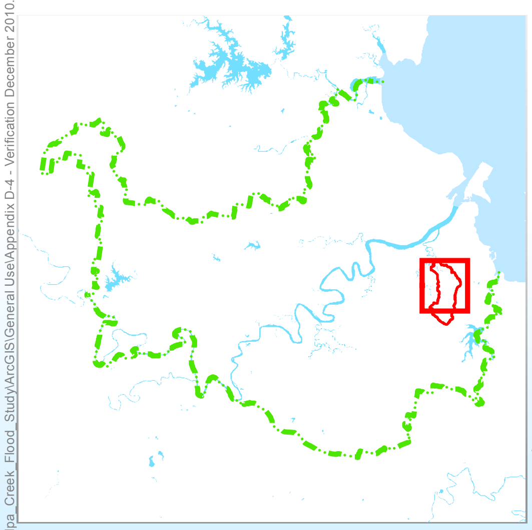
Tingalpa Channel Flood Study 2015

Appendix D3 - May 2009 Verification Event Inundation Extent

FLM - 150337 - 001



For Information Only - Not Council Policy



0 250 500

Metres

N W E S

Legend

- Discharge Extraction Locations
- Bulimba Creek
- Tingalpa Drain Catchment
- Modelled Inundation Extent
- Cadastre

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Tingalpa Channel Flood Study 2015

Appendix D4 - December 2010 Verification Event Inundation Extent

FLM - 150337 - 001

File : G:\BICD\Proj\15\150337_Tingalpa_Creek_Flood_Study\ArcGIS\General Use\Appendix D-4 - Verification December 2010.mxd

Appendix E – Hydraulic Structure Reference Sheets

The modelling results presented in the Hydraulic Structure Reference Sheets are based on the Existing conditions modelling scenario outputs.

The following briefly describes the methodology used to extract/estimate values used in the HSRS results tables. Refer to every second page of each structure.

1. Discharge represents the combined channel and floodplain flow as measured between two grid points typically located at the edges of the PMF inundation extent upstream of the crossing.
2. Water level values are extracted on the channel centreline upstream and downstream of the structure.
3. Peak flow depth has been estimated at the lowest point of the weir.
4. Peak velocity has been extracted at peak water level from the critical duration event for the structure.

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Creek:	Tingalpa Channel	**Immunity Rating (S1):**	<50% AEP
Location:	London Road		<2-yr ARI

DATE OF SURVEY:	N/A	UBD REF:	182 J4
SURVEYED CROSS SECTION ID:	TD280 (Gumdale to Tingalpa SMP 1998)	BCC ASSET ID (Gecko):	C0245B
MODEL ID:	S1	New AMTD (m):	6034

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 6 / 1200 x 900 mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m)	7.3m	U/S OBVERT LEVEL (m)	8.2m
D/S INVERT LEVEL (m)	7.2m	D/S OBVERT LEVEL (m)	8.1m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 15m

LENGTH OF CULVERT AT OBVERT (m): 15m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 15 PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~8.8m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.05m and Guardrail 0.7m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: Concrete barrier with handrail on top

PLAN NUMBER: W10022

BRIDGE OR CULVERT DETAILS:

Culvert is skewed

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1996

HAS THE STRUCTURE BEEN UPGRADED? No Not since 1996

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	Tingalpa Channel
Location:	London Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	133.0	10.71	10.47	0.2	185	1.9	1.7	1.7
500-yr (0.2%)	61.5	10.03	9.82	0.2	130	1.2	1.5	1.7
100-yr (1%)	54.6	9.89	9.66	0.2	125	1.1	1.5	1.7
50-yr (2%)	48.0	9.78	9.53	0.3	125	1.0	1.5	1.7
20-yr (5%)	35.8	9.63	9.36	0.3	110	0.8	1.4	1.7
10-yr (10%)	29.4	9.51	9.23	0.3	105	0.7	1.4	1.6
5-yr (20%)	24.7	9.41	9.12	0.3	100	0.6	1.4	1.6
2-yr (50%)	17.4	9.21	8.93	0.3	90	0.4	1.2	1.6

Creek:	Tingalpa Channel
Location:	London Road

Inlet of London Road culverts (Tingalpa Channel)

Outlet of London Road culverts (Tingalpa Channel)

Creek:	Tingalpa Channel	**Immunity Rating:**	2% AEP
Location:	Grassdale Road		50-yr ARI

DATE OF SURVEY: N/A	UBD REF: 182 K3
SURVEYED CROSS SECTION ID: TD200 (Gecko)	BCC ASSET ID (Gecko): B9813
MODEL ID: S2	New AMTD (m): 5501

STRUCTURE DESCRIPTION: Bridge

STRUCTURE SIZE: One span

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 4.03m U/S OBVERT LEVEL (m) ~7.2m

D/S INVERT LEVEL (m) 3.94m D/S OBVERT LEVEL (m) ~7.1m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): N/A

LENGTH OF CULVERT AT OBVERT (m): N/A

TYPE OF LINING: N/A

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): ~19.0m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): 7.8m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail ~1.4m and Guardrail 0.85m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: N/A

PLAN NUMBER: B9813

BRIDGE OR CULVERT DETAILS:

Bridge is slightly skewed

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2006

HAS THE STRUCTURE BEEN UPGRADED? No Not since 2006

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

New bridge has replaced an older timber bridge

Creek:	Tingalpa Channel
Location:	Grassdale Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	187.0	8.39	8.18	0.2	215	0.6	1.6	2.1
500-yr (0.2%)	91.1	8.12	7.45	0.7	105	0.3	0.7	3.6
100-yr (1%)	76.7	7.89	7.27	0.6	65	0.1	0.6	3.4
50-yr (2%)	66.1	7.69	6.95	0.7	0	-	-	3.6
20-yr (5%)	53.3	7.31	6.77	0.5	0	-	-	3.1
10-yr (10%)	44.6	7.05	6.62	0.4	0	-	-	2.8
5-yr (20%)	37.4	6.84	6.48	0.4	0	-	-	2.5
2-yr (50%)	25.6	6.45	6.21	0.2	0	-	-	2.0

Creek:	Tingalpa Channel
Location:	Grassdale Road

Inlet of Grassdale Road Bridge

Outlet of Grassdale Road Bridge

Creek:	Tingalpa Channel	**Immunity Rating:**	<50% AEP
Location:	Formosa Road		<2-yr ARI

DATE OF SURVEY: N/A | UBD REF: 182 K1

SURVEYED CROSS SECTION ID: TD170 (Gecko) | BCC ASSET ID (Gecko): C5472B

MODEL ID: S3 | New AMTD (m): 4897

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 2 / 1200 x 375mm

For Culverts: Number of cells/pipes & sizes — For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 3.55m — U/S OBVERT LEVEL (m) 3.93m

D/S INVERT LEVEL (m) 3.53m — D/S OBVERT LEVEL (m) 3.91m

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 3.55m

LENGTH OF CULVERT AT OBVERT (m): 3.53m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 10.8m — PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~4.3m

HEIGHT OF GUARDRAIL/HANDRAIL: No handrail or guardrail present

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS:

PLAN NUMBER: CD090048

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2010

HAS THE STRUCTURE BEEN UPGRADED? No — Not since 2010

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	Tingalpa Channel
Location:	Formosa Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	190.9	6.32	6.31	0.0	220	2.0	0.7	1.2
500-yr (0.2%)	96.8	5.53	5.52	0.0	200	1.2	0.8	1.3
100-yr (1%)	81.3	5.37	5.37	0.0	190	1.1	0.7	1.3
50-yr (2%)	67.9	5.23	5.23	0.0	190	0.9	0.7	1.3
20-yr (5%)	56.1	5.05	5.05	0.0	190	0.8	0.7	1.3
10-yr (10%)	46.6	4.92	4.91	0.0	180	0.6	0.7	1.3
5-yr (20%)	39.3	4.82	4.81	0.0	180	0.5	0.7	1.3
2-yr (50%)	27.4	4.70	4.65	0.0	170	0.4	0.7	1.3

Creek:	Tingalpa Channel
Location:	Formosa Road

Inlet of Formosa Road culverts (Left culverts)

Outlet of Formosa Road culverts (Left culverts)

Creek:	Tingalpa Channel	**Immunity Rating:**	10% AEP
Location:	Manly Road		10-yr ARI

DATE OF SURVEY: N/A	UBD REF: 162 K14
SURVEYED CROSS SECTION ID: TD100 (Gecko)	BCC ASSET ID (Gecko): C4598P
MODEL ID: S4	New AMTD (m): 2327

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 6/2400x1200mm and 8/2100x1200mm

For Culverts: Number of cells/pipes & sizes — For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~1.1m — U/S OBVERT LEVEL (m) ~2.3m

D/S INVERT LEVEL (m) ~1.1m — D/S OBVERT LEVEL (m) ~2.3m

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 27m

LENGTH OF CULVERT AT OBVERT (m): 27m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 27m — PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~3.2m (West of structure)

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail ~1.1m and Guardrail 0.75m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 38m and the guardrail 91m.

PLAN NUMBER: W8414

BRIDGE OR CULVERT DETAILS:

The invert of the culverts between the inbound and outbound lanes are different for part of this structure. See drawing below for more details.

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1990

HAS THE STRUCTURE BEEN UPGRADED? No — Not since 1990

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Lowest point of weir uses the lowest point of the highest structure (Outbound Lane). Three sets of culverts modelled. Height of culverts was based on average height.

Creek:	Tingalpa Channel
Location:	Manly Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3^]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	263.7	4.29	4.18	0.1	300	1.1	2.3	2.2
500-yr (0.2%)	128.1	3.82	3.55	0.3	250	0.6	1.9	2.4
100-yr (1%)	99.3	3.67	3.37	0.3	185	0.5	1.7	2.3
50-yr (2%)	81.6	3.56	3.27	0.3	135	0.4	1.4	2.3
20-yr (5%)	65.7	3.32	3.02	0.3	50	0.1	0.5	2.1
10-yr (10%)	55.5	3.09	2.87	0.2	0	-	-	1.7
5-yr (20%)	42.3	2.93	2.78	0.2	0	-	-	1.4
2-yr (50%)	29.0	2.70	2.62	0.1	0	-	-	0.9

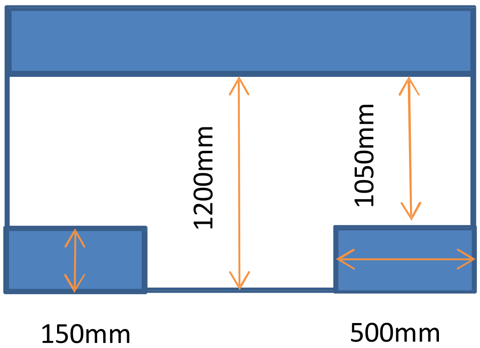
^ inbound outbound lanes with different levels. Flow breakout seems to occur firstly through west of structure

Inlet of Manly Road culverts (Tingalpa Channel)

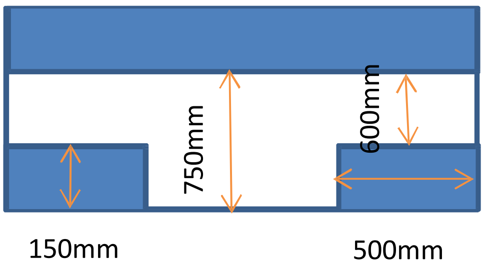
Creek:	Tingalpa Channel
Location:	Manly Road

Outlet of Manly Road culverts (Tingalpa Channel)

Looking from the exit of the 5th and 6th west most culverts



Looking from the exit of the 4 west most culverts



Outlet of Manly Road culverts (Tingalpa Channel)

Creek:	Tingalpa Channel	**Immunity Rating:**	> 1% AEP (Out) 10% AEP (In)
Location:	Wynnum Road		>100-yr ARI (Out) 10-yr ARI (In)

DATE OF SURVEY: N/A

UBD REF: 162 J12

SURVEYED CROSS SECTION ID: TD50 (Gecko)

BCC ASSET ID (Gecko): B2250/B2260

MODEL ID: S5

New AMTD (m): 1623

STRUCTURE DESCRIPTION: Bridge/Culvert (Inbound) and Bridge (Outbound)

STRUCTURE SIZE: Inbound (4 span and 2/3000 x 2700mm), Outbound (4 Span)

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~-0.49m U/S OBVERT LEVEL (m) 2.51m

D/S INVERT LEVEL (m) ~-0.49m D/S OBVERT LEVEL (m) 2.51m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 10m (Inbound culvert only)

LENGTH OF CULVERT AT OBVERT (m): 10m (Inbound culvert only)

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 25m (both structures) PIER WIDTH (m): 0.45m

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~2.9m (Inbound) to ~4.1m (Outbound)

HEIGHT OF GUARDRAIL/HANDRAIL: 1.27m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 40m

PLAN NUMBER: B2250/B2260

BRIDGE OR CULVERT DETAILS:

The inbound lane consists of a 4 span bridge and 2 culverts, while the outbound lane consists of a 4 span bridge. The outbound lane has a higher capacity (larger cross sectional area and is elevated) than the inbound lane.

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Inbound 1964; Outbound 1974

HAS THE STRUCTURE BEEN UPGRADED? Yes Extra drawings exists for 1983

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	Tingalpa Channel
Location:	Wynnum Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX FLOW WIDTH ACROSS ROAD (m) Inbound (Outbound)	APPROX. FLOW DEPTH ABOVE STRUCT. (m)[4]^ Inbound (Outbound)	PEAK VELOCITY (m/s)[5]	
		(m AHD)					Weir (Outb.)	Structure
2000-yr (0.05%)	262.7	4.05	3.70	0.4	560	0.3 (1.2)	1.2	2.2
500-yr (0.2%)	118.0	3.39	3.12	0.3	0	0 (0.5)	-	1.7
100-yr (1%)	93.4	3.20	2.98	0.2	0	0 (0.3)	-	1.4
50-yr (2%)	71.1	3.08	2.90	0.2	0	0 (0.2)	-	1.2
20-yr (5%)	63.3	2.94	2.80	0.1	0	0 (0.1)	-	1.0
10-yr (10%)	40.4	2.83	2.73	0.1	0	-	-	1"
5-yr (20%)	38.5	2.74	2.67	0.1	0	-	-	1.5"
2-yr (50%)	28.4	2.59	2.55	0.0	0	-	-	1.5"

^ inbound outbound lanes with different level

" estimated values due to model uncertainty at this location for this event

Creek:	Tingalpa Channel
Location:	Wynnum Road

Inlet of Wynnum Road bridge/culverts

Outlet of Wynnum Road bridge/culverts

Creek:	London Branch	**Immunity Rating:**	<50% AEP
Location:	Boston Road		<2-yr ARI

DATE OF SURVEY: N/A	UBD REF: 182 H6
SURVEYED CROSS SECTION ID: TD334 (ALS 2009)	BCC ASSET ID (Gecko): C2357P
MODEL ID: S6	New AMTD (m): 737

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 2 / 600mm dia RCP

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~13.16m U/S OBVERT LEVEL (m) ~13.76m

D/S INVERT LEVEL (m) ~13.15m D/S OBVERT LEVEL (m) ~13.75m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 10m

LENGTH OF CULVERT AT OBVERT (m): 10m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 10m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~13.7m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.1m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 5m.

PLAN NUMBER: W13079 (not available)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

W13079 - Drawing not available from plan custodian

Creek:	London Branch
Location:	Boston Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	33.8	14.25	14.17	0.1	220	0.6	1.4	1.7
500-yr (0.2%)	19.6	14.13	14.04	0.1	200	0.4	1.2	1.7
100-yr (1%)	16.2	14.10	14.00	0.1	175	0.4	1.1	1.7
50-yr (2%)	14.4	14.06	13.96	0.1	175	0.4	1.1	1.7
20-yr (5%)	11.0	14.03	13.91	0.1	175	0.3	1.0	1.7
10-yr (10%)	9.4	13.99	13.86	0.1	125	0.3	0.9	1.7
5-yr (20%)	8.0	13.96	13.82	0.1	110	0.3	0.9	1.7
2-yr (50%)	5.6	13.90	13.75	0.2	110	0.2	0.8	1.7

Creek:	London Branch
Location:	Boston Road

Inlet of Boston Road culverts (London Branch)

Outlet of Boston Road culverts (London Branch)

Creek:	London Branch
Location:	London Road

Immunity Rating:	<50% AEP
	<2-yr ARI

DATE OF SURVEY: N/A

UBD REF: 182 G4

SURVEYED CROSS SECTION ID: TD280 (Gecko)

BCC ASSET ID (Gecko): C0244B

MODEL ID: S7

New AMTD (m): 48

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 4 / 1200 x 900mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 7.4m U/S OBVERT LEVEL (m) 8.3m

D/S INVERT LEVEL (m) 7.3m D/S OBVERT LEVEL (m) 8.2m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): ~13.5m

LENGTH OF CULVERT AT OBVERT (m): ~13.5m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 13.2m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~8.8m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.05m and Guardrail 0.7m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is 6.65m and guardrail approximately 9m.

PLAN NUMBER: W10022

BRIDGE OR CULVERT DETAILS:

Crossing is located immediately downstream of a private crossing

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1996

HAS THE STRUCTURE BEEN UPGRADED? No Not since 1996

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Immediately upstream of London Road Branch, London Road crossing there are two smaller private crossings. One crossing with 2 / 830mm RCP and the furthest upstream with a diameter of 900mm

Creek:	London Branch
Location:	London Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	43.4	10.49	10.45	0.0	185	1.7	0.9	1.2
500-yr (0.2%)	22.7	9.85	9.77	0.1	130	1.1	1.1	1.5
100-yr (1%)	20.3	9.70	9.60	0.1	125	0.9	1.1	1.5
50-yr (2%)	18.0	9.57	9.47	0.1	125	0.8	1.0	1.4
20-yr (5%)	13.6	9.42	9.31	0.1	110	0.6	1.0	1.4
10-yr (10%)	12.8	9.30	9.18	0.1	105	0.5	1.0	1.4
5-yr (20%)	10.1	9.21	9.08	0.1	100	0.4	0.9	1.4
2-yr (50%)	6.8	9.04	8.90	0.1	90	0.2	0.6	1.3

Creek:	London Branch
Location:	London Road

Inlet of London Road culverts (London Branch)

Outlet of London Road culverts (London Branch)

Creek:	East Channel	**Immunity Rating:**	<50% AEP
Location:	Boston Road		<2-yr ARI

DATE OF SURVEY: N/A	UBD REF: 182 M7
SURVEYED CROSS SECTION ID: TD320 (Gecko)	BCC ASSET ID (Gecko): C1847B
MODEL ID: S8	New AMTD (m): 2138

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 2 / 1200 x 600mm

For Culverts: Number of cells/pipes & sizes — For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m)	12.03m	U/S OBVERT LEVEL (m)	12.63m
D/S INVERT LEVEL (m)	~11.85m	D/S OBVERT LEVEL (m)	12.45m

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 15.5m

LENGTH OF CULVERT AT OBVERT (m): 15.5m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 15.5m — PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~13.1m

HEIGHT OF GUARDRAIL/HANDRAIL: Guardrail 0.6m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the guardrail is approximately 5m.

PLAN NUMBER: G-11-75 (not available)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

G-11-75 - Drawing not available from plan custodian

Creek:	East Channel
Location:	Boston Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	31.1	13.45	13.01	0.4	150	0.4	1.5	2.1
500-yr (0.2%)	19.2	13.34	12.94	0.4	135	0.2	1.2	2.0
100-yr (1%)	14.4	13.31	12.92	0.4	135	0.2	1.1	2.0
50-yr (2%)	13.0	13.28	12.90	0.4	120	0.2	1.0	1.9
20-yr (5%)	11.2	13.25	12.88	0.4	115	0.2	0.9	1.9
10-yr (10%)	9.0	13.22	12.85	0.4	110	0.1	0.8	1.9
5-yr (20%)	8.1	13.19	12.84	0.4	100	0.1	0.7	1.9
2-yr (50%)	4.9	13.14	12.81	0.3	95	0.04	0.6	1.8

Creek:	East Channel
Location:	Boston Road

Inlet of Boston Road culverts (East Branch)

Outlet of Boston Road culverts (East Branch)

Creek:	East Channel	**Immunity Rating:**	<50% AEP
Location:	London Road		<2-yr ARI

DATE OF SURVEY: N/A	UBD REF: 182 M5
SURVEYED CROSS SECTION ID: TD300 (Gumdale to Tingalpa SMP 1998)	BCC ASSET ID (Gecko): C1844P
MODEL ID: S9	New AMTD (m): 1660

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 2 / 300mm dia RCP

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~9.6m U/S OBVERT LEVEL (m) ~9.9m

D/S INVERT LEVEL (m) ~9.2m D/S OBVERT LEVEL (m) ~9.5m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 11m

LENGTH OF CULVERT AT OBVERT (m): 11m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 11m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~9.9m

HEIGHT OF GUARDRAIL/HANDRAIL: No handrail or guardrail present

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: N/A

PLAN NUMBER: W13079 (not available)

BRIDGE OR CULVERT DETAILS:

Woody debris found blocking part of the entrance of the culvert during inspection.

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

W13079 - Drawing not available from plan custodian

Creek:	East Channel
Location:	London Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	47.9	13.45	13.01	0.4	115	3.6	1.5	1.8
500-yr (0.2%)	25.9	13.34	12.94	0.4	95	3.4	1.3	1.8
100-yr (1%)	22.2	10.33	10.03	0.3	95	0.4	1.2	1.8
50-yr (2%)	18.9	10.30	10.01	0.3	85	0.4	1.2	1.8
20-yr (5%)	15.1	10.26	9.99	0.3	75	0.4	1.1	1.8
10-yr (10%)	12.3	10.23	9.98	0.3	75	0.3	1.0	1.8
5-yr (20%)	10.5	10.20	9.97	0.2	75	0.3	0.9	1.8
2-yr (50%)	7.4	10.16	9.95	0.2	65	0.3	0.8	1.8

Creek:	East Channel
Location:	London Road

Inlet of Boston Road culverts (East Branch)

Outlet of Boston Road culverts (East Branch)

Creek:	East Channel
Location:	Grassdale Road

Immunity Rating:	> 1% AEP
	> 100-yr ARI

DATE OF SURVEY:	N/A	UBD REF:	182 M3
SURVEYED CROSS SECTION ID:	TD230 (Gecko)	BCC ASSET ID (Gecko):	C0145B
MODEL ID:	S10	New AMTD (m):	1156

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3 / 3300 x 1800mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m)	5.42m	U/S OBVERT LEVEL (m)	7.22m
D/S INVERT LEVEL (m)	5.34m	D/S OBVERT LEVEL (m)	7.14m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 12m

LENGTH OF CULVERT AT OBVERT (m): 12m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 12m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~7.8m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.0m and Guardrail 0.7m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 11.5m and the guardrail 37m

PLAN NUMBER: W9919

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1996

HAS THE STRUCTURE BEEN UPGRADED? No Not since 1996

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Culverts have replaced timber bridge

Creek:	East Channel
Location:	Grassdale Road

ARI (AEP %)	**DISCHARGE (m3/s)[1]**	**U/S Water Level[2]**	**D/S Water Level[2]**	**AFFLUX (m)**	**APPROX. FLOW WIDTH ACROSS ROAD (m)**	**APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]**	**PEAK VELOCITY (m/s)[4]**	
		(m AHD)					**Weir**	**Structure**
2000-yr (0.05%)	69.7	8.30	8.05	0.3	140	0.5	1.6	2.4
500-yr (0.2%)	38.9	7.57	7.44	0.1	0	-	-	2.2
100-yr (1%)	32.6	7.44	7.34	0.1	0	-	-	1.9
50-yr (2%)	26.9	7.34	7.26	0.1	0	-	-	1.6
20-yr (5%)	21.7	7.19	7.14	0.1	0	-	-	1.4
10-yr (10%)	18.6	7.08	7.04	0.0	0	-	-	1.2
5-yr (20%)	15.4	7.00	6.98	0.0	0	-	-	1.0
2-yr (50%)	10.3	6.77	6.71	0.1	0	-	-	0.9

Creek:	East Channel
Location:	Grassdale Road

Inlet of Grassdale Road culverts (East Branch)

Outlet of Grassdale Road culverts (East Branch)

Creek:	East Channel
Location:	Stanbrough Road

Immunity Rating:	50% AEP
	2-yr ARI

DATE OF SURVEY:	N/A	UBD REF:	182 L2
SURVEYED CROSS SECTION ID:	TD175 (Gumdale to Tingalpa SMP 1998)	BCC ASSET ID (Gecko):	C4697B
MODEL ID:	S11	New AMTD (m):	816

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3/ 3300 x 1200mm

For Culverts: Number of cells/pipes & sizes   For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 3.81m   U/S OBVERT LEVEL (m) 5.01m

D/S INVERT LEVEL (m) 3.81m   D/S OBVERT LEVEL (m) 5.01m

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): ~14m

LENGTH OF CULVERT AT OBVERT (m): ~14m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 14.4m   PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~5.5m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.2m and Guardrail 0.8m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail 22m and Guardrail 41m

PLAN NUMBER: W11528

BRIDGE OR CULVERT DETAILS:

Culverts are slightly skewed

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2000

HAS THE STRUCTURE BEEN UPGRADED? No   Not since 2000

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Skewed culvert. Upstream from the crossing, a number of smaller culverts join the pond (private property) with the channel.

Creek:	East Channel
Location:	Stanbrough Road

ARI (AEP %)	**DISCHARGE (m3/s)[1]**	**U/S Water Level[2]**	**D/S Water Level[2]**	**AFFLUX (m)**	**APPROX. FLOW WIDTH ACROSS ROAD (m)**	**APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]**	**PEAK VELOCITY (m/s)[4]**	
		(m AHD)					**Weir**	**Structure**
2000-yr (0.05%)	65.9	6.73	6.58	0.2	375	1.2	1.1	2.2"
500-yr (0.2%)	37.0	6.41	6.21	0.2	340	0.9	1.2	2"
100-yr (1%)	31.5	6.29	6.10	0.2	200	0.8	1.2	1.8"
50-yr (2%)	27.1	6.18	5.99	0.2	181	0.7	1.2	1.8"
20-yr (5%)	22.7	6.00	5.82	0.2	145	0.5	1.2	1.8"
10-yr (10%)	18.4	5.80	5.60	0.2	130	0.3	1.1	1.4"
5-yr (20%)	15.6	5.69	5.50	0.2	100	0.2	1.0	1.8"
2-yr (50%)	11.2	5.37	5.28	0.1	0	-	-	2.1"

" estimated values due to model uncertainty at this location for this event

Creek:	East Channel
Location:	Stanbrough Road

Inlet of Stanbrough Road culverts (East Branch)

Outlet of Stanbrough Road culverts (East Branch)

Creek:	East Channel
Location:	Formosa Road

Immunity Rating:	10% AEP
	10-yr ARI

DATE OF SURVEY: N/A

UBD REF: 182 L1

SURVEYED CROSS SECTION ID: TD170 (Gecko)

BCC ASSET ID (Gecko): C2365B

MODEL ID: S12

New AMTD (m): 648

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3 / 3300 x 1200mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 3.32m U/S OBVERT LEVEL (m) 4.52m

D/S INVERT LEVEL (m) 3.27m D/S OBVERT LEVEL (m) 4.47m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 11m

LENGTH OF CULVERT AT OBVERT (m): 11m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 11m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~5.4m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.0m and Guardrail 0.7m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the guardrail is approximately 29m

PLAN NUMBER: W11766

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2001

HAS THE STRUCTURE BEEN UPGRADED? No Not since 2001

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Culverts have replaced narrower culverts in 2001. Weir (pond) exists upstream of Formosa Road crossing.

Creek:	East Channel
Location:	Formosa Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	77.7	6.34	6.17	0.2	85	0.9	2.2	2.4
500-yr (0.2%)	44.3	5.99	5.71	0.3	75	0.6	1.9	2.3
100-yr (1%)	37.4	5.88	5.59	0.3	60	0.5	1.6	2.3
50-yr (2%)	31.4	5.76	5.52	0.2	50	0.4	1.3	2.2
20-yr (5%)	25.5	5.58	5.39	0.2	35	0.2	0.9	2.0
10-yr (10%)	21.2	5.26	5.11	0.1	0	-	-	1.8
5-yr (20%)	17.8	5.10	5.01	0.1	0	-	-	1.5
2-yr (50%)	12.0	4.84	4.79	0.0	0	-	-	1.1

Creek:	East Channel
Location:	Formosa Road

Inlet of Formosa Road culverts (East Branch)

Outlet of Formosa Road culverts (East Branch)

Creek:	West Channel		**Immunity Rating:**	1% AEP
Location:	Manly Road			100-yr ARI

DATE OF SURVEY:	N/A	UBD REF:	162 H14
SURVEYED CROSS SECTION ID:	TD600 (Gecko)	BCC ASSET ID (Gecko):	C0049B, B9758
MODEL ID:	S13	New AMTD (m):	405

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: Pedestrian (5 x 1200mm dia); Inbound (Single span 6000x770mm); Outbound (2/3700x1500mm)

For Culverts: Number of cells/pipes & sizes — For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m)	1.5m	U/S OBVERT LEVEL (m)	2.7m; 2.3m; 3m
D/S INVERT LEVEL (m)	~1.5m	D/S OBVERT LEVEL (m)	2.7m; 2.3m; 3m

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 24m (all 3 structures)

LENGTH OF CULVERT AT OBVERT (m): 24m (all 3 structures)

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 24m (all 3 structures) PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~2.6m (Inbound) to ~3.5m (Outbound)

HEIGHT OF GUARDRAIL/HANDRAIL: 0.7m (guardrail of outbound lane)

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the guardrail on the outbound lane is approximately 22m

PLAN NUMBER: W8414/B1340

BRIDGE OR CULVERT DETAILS:

A number of structures exist for Manly Road crossing. A pedestrian crossing comprising of 5/1200mm, followed by a single span 6000x770mm (inbound lane) and 2/3700 x 1500mm (outbound lane)

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Pedestrian Bridge 1993, Outbound lane 1973

HAS THE STRUCTURE BEEN UPGRADED? No — Not since 1993

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	West Channel
Location:	Manly Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	24.4	4.13	4.13	0.0	300	0.6	0.9	3.4
500-yr (0.2%)	9.8	3.54	3.48	0.1	40	0.04	0.2	3.0
100-yr (1%)	8.2	3.31	3.27	0.0	0	-	-	2.8
50-yr (2%)	7.6	3.18	3.14	0.0	0	-	-	2.7
20-yr (5%)	6.7	3.03	2.99	0.0	0	-	-	2.6
10-yr (10%)	5.9	2.9	2.87	0.0	0	-	-	2.5
5-yr (20%)	5.2	2.81	2.78	0.0	0	-	-	2.4
2-yr (50%)	4.0	2.64	2.61	0.0	0	-	-	1.5

^ inbound outbound lanes with different levels (values based on outbound lane)

Creek:	West Channel
Location:	Manly Road

Inlet of Wynnum Road culverts (West Branch)

Outlet of Wynnum Road culverts (West Branch)

Creek:	North Channel		**Immunity Rating:**	> 1% AEP
Location:	Matthews Way Upstream			> 100-yr ARI

DATE OF SURVEY: N/A

UBD REF: 162 P20

SURVEYED CROSS SECTION ID: TD570 (ALS 2009)

BCC ASSET ID (Gecko): C4711B

MODEL ID: S14

New AMTD (m): 3061

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 5 / 1500 x 600mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 13.81m U/S OBVERT LEVEL (m) 14.41m

D/S INVERT LEVEL (m) 13.33m D/S OBVERT LEVEL (m) 13.93m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 20m

LENGTH OF CULVERT AT OBVERT (m): 20m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 20m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~15.0m

HEIGHT OF GUARDRAIL/HANDRAIL: Guardrail 0.7m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the guardrail is approximately 18m

PLAN NUMBER: WP4967

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2003

HAS THE STRUCTURE BEEN UPGRADED? No Not since 2003

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	North Channel
Location:	Matthews Way Upstream

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	15.1	15.33	14.49	0.8	55	0.3	1.2	2.9
500-yr (0.2%)	8.5	14.63	14.22	0.4	0	-	-	2.2
100-yr (1%)	7.2	14.57	14.20	0.4	0	-	-	2.1
50-yr (2%)	5.5	14.51	14.10	0.4	0	-	-	2.0
20-yr (5%)	4.6	14.43	14.10	0.3	0	-	-	1.8
10-yr (10%)	3.6	14.36	14.10	0.3	0	-	-	1.7
5-yr (20%)	3.0	14.31	14.00	0.3	0	-	-	1.6
2-yr (50%)	2.2	14.23	13.90	0.3	0	-	-	1.5

Creek:	North Channel
Location:	Matthews Way Upstream

Inlet of Matthews Way culvert (1st Crossing)

Outlet of Matthews Way culvert (1st Crossing)

Creek:	North Channel
Location:	Matthews Way Downstream

Immunity Rating:	> 1% AEP
	> 100-yr ARI

DATE OF SURVEY: N/A

UBD REF: 162 P18

SURVEYED CROSS SECTION ID: TD566 (ALS 2009)

BCC ASSET ID (Gecko): C0285B

MODEL ID: S15

New AMTD (m): 2950

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3 / 2700 x 750mm and 2700 x 1000mm

For Culverts: Number of cells/pipes & sizes   For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 9.05m   U/S OBVERT LEVEL (m) 9.8m and 10.05m

D/S INVERT LEVEL (m) 9.0m   D/S OBVERT LEVEL (m) 9.75m and 10.0m

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 20m

LENGTH OF CULVERT AT OBVERT (m): 20m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 20m   PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~10.5m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail ~1.2m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 15m

PLAN NUMBER: WP827

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1998

HAS THE STRUCTURE BEEN UPGRADED? No   Not since 1998

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	North Channel
Location:	Matthews Way Downstream

ARI (AEP %)	**DISCHARGE (m3/s)[1]**	**U/S Water Level[2]**	**D/S Water Level[2]**	**AFFLUX (m)**	**APPROX. FLOW WIDTH ACROSS ROAD (m)**	**APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]**	**PEAK VELOCITY (m/s)[4]**	
		(m AHD)					**Weir**	**Structure**
2000-yr (0.05%)	27.3	10.81	10.27	0.5	60	0.3	1.0	2.8
500-yr (0.2%)	17.4	10.19	9.83	0.4	0	-	-	2.6
100-yr (1%)	14.6	10.00	9.77	0.2	0	-	-	2.5
50-yr (2%)	12.6	9.90	9.72	0.2	0	-	-	2.4
20-yr (5%)	10.9	9.90	9.67	0.2	0	-	-	2.2
10-yr (10%)	9.1	9.80	9.63	0.2	0	-	-	2.0
5-yr (20%)	8.0	9.70	9.59	0.1	0	-	-	2.0
2-yr (50%)	5.8	9.60	9.53	0.1	0	-	-	1.3

Creek:	North Channel
Location:	Matthews Way Downstream

Inlet of Matthews Way culvert (2nd Crossing)

Outlet of Matthews Way culvert (2nd crossing)

Creek:	North Channel	**Immunity Rating:**	<50% AEP
Location:	98 Ingleston Rd		<2-yr ARI

DATE OF SURVEY: N/A

UBD REF: 162 N16

SURVEYED CROSS SECTION ID: TD556 (ALS 2009)

BCC ASSET ID (Gecko): N/A

MODEL ID: S16

New AMTD (m): 2031

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3 / 2100 x 850mm and 2 / 2100 X1100mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~4.8m U/S OBVERT LEVEL (m) ~5.65m and ~5.9m

D/S INVERT LEVEL (m) ~4.79m D/S OBVERT LEVEL (m) ~5.64m and ~5.89m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 6m

LENGTH OF CULVERT AT OBVERT (m): 6m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 6m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~6.1m

HEIGHT OF GUARDRAIL/HANDRAIL: Guardrail 0.55m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of guardrail is approximately 14m

PLAN NUMBER: Not available

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Drawing not available from plan custodian. Measurements taken from on-site visit. Lowest point of the weir calculated based on LAS information and on-site measurements.

Creek:	North Channel
Location:	98 Ingleston Rd

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	45.3	7.19	7.05	0.1	55	1.1	1.0	1.3
500-yr (0.2%)	32.3	6.88	6.70	0.2	40	0.8	1.0	1.2
100-yr (1%)	29.4	6.77	6.57	0.2	35	0.7	0.9	1.1
50-yr (2%)	25.4	6.68	6.46	0.2	35	0.6	0.9	1.4
20-yr (5%)	21.8	6.60	6.35	0.3	35	0.5	0.8	1.3
10-yr (10%)	18.9	6.51	6.24	0.3	35	0.4	0.7	1.1
5-yr (20%)	16.1	6.45	6.18	0.3	30	0.4	0.6	1.2
2-yr (50%)	10.7	6.25	6.08	0.2	25	0.2	0.4	1.5

Creek:	North Channel
Location:	98 Ingleston Rd

Inlet of culverts at 98 Ingleston Road

Outlet of culverts at 98 Ingleston Road

Creek:	North Channel		**Immunity Rating:**	1% AEP
Location:	84 Ingleston Rd			100-yr ARI

DATE OF SURVEY: N/A	UBD REF: 162 N16
SURVEYED CROSS SECTION ID: TD554 (ALS 2009)	BCC ASSET ID (Gecko): N/A
MODEL ID: S17	New AMTD (m): 1944

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 3/2400 x 1200mm and 2/2400 x 1400mm

For Culverts: Number of cells/pipes & sizes　　For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~4.62m　　U/S OBVERT LEVEL (m) ~5.82m and ~6.02m

D/S INVERT LEVEL (m) ~4.61m　　D/S OBVERT LEVEL (m) ~5.81m and ~6.01m

For culverts give floor level　　For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 5m

LENGTH OF CULVERT AT OBVERT (m): 5m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 5m　　PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~6.2m

HEIGHT OF GUARDRAIL/HANDRAIL: Guardrail 0.55m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the guardrail is approximately 15m

PLAN NUMBER: Not available

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown　　Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Drawing not available from plan custodian. Measurements taken from on-site visit. Lowest point of the weir calculated based on LAS information and on-site measurements.

Creek:	North Channel
Location:	84 Ingleston Rd

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	46.1	6.60	6.47	0.1	55	0.4		2.5"
500-yr (0.2%)	34.6	6.26	6.14	0.1	50	0.1		2"
100-yr (1%)	29.9	6.04	6.02	0.0	0"	-	-	1.8"
50-yr (2%)	25.7	5.96	5.96	0.0	0"	-	-	1.6"
20-yr (5%)	20.4	5.89	5.90	0.0	0"	-	-	1.4"
10-yr (10%)	17.7	5.81	5.84	0.0	0"	-	-	1.3"
5-yr (20%)	15.6	5.77	5.79	0.0	0	-	-	1.5"
2-yr (50%)	10.8	5.65	5.67	0.0	0	-	-	1.1"

" estimated values due to model uncertainty at this location for this event

Creek:	North Channel
Location:	84 Ingleston Rd

Inlet of culverts at 84 Ingleston Road

Outlet of culverts at 84 Ingleston Road

Creek:	North Channel	**Immunity Rating:**	> 1% AEP
Location:	56 Ingleston Rd		> 100-yr ARI

DATE OF SURVEY: N/A	UBD REF: 162 N16
SURVEYED CROSS SECTION ID: TD548 (ALS 2009)	BCC ASSET ID (Gecko): N/A
MODEL ID: S18	New AMTD (m): 1808

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 5/2100 x 1800mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~4.0m U/S OBVERT LEVEL (m) ~5.8m

D/S INVERT LEVEL (m) ~3.91m D/S OBVERT LEVEL (m) ~5.71m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 12m

LENGTH OF CULVERT AT OBVERT (m): 12m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 12m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~5.8m

HEIGHT OF GUARDRAIL/HANDRAIL: No handrail or guardrail

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS:

PLAN NUMBER: Not available

BRIDGE OR CULVERT DETAILS:

High fence above structure

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: Unknown

HAS THE STRUCTURE BEEN UPGRADED? Unknown Unknown

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Drawing not available from plan custodian. Measurements taken from on-site visit. Lowest point of the weir calculated based on LAS information and on-site measurements.

Creek:	North Channel
Location:	56 Ingleston Rd

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	45.5	5.97	5.70	0.3	30	0.2	1.3	3.1
500-yr (0.2%)	32.9	5.63	5.15	0.5	0	-	-	3.1
100-yr (1%)	28.7	5.52	5.07	0.4	0	-	-	3.0
50-yr (2%)	25.2	5.41	4.98	0.4	0	-	-	2.9
20-yr (5%)	21.7	5.29	4.90	0.4	0	-	-	2.7
10-yr (10%)	18.1	5.15	4.80	0.4	0	-	-	2.6
5-yr (20%)	15.2	5.04	4.70	0.3	0	-	-	2.4
2-yr (50%)	10.0	4.81	4.52	0.3	0	-	-	2.2

Creek:	North Channel
Location:	56 Ingleston Rd

Inlet of culverts at 56 Ingleston Road

Creek:	North Channel	**Immunity Rating:**	1% AEP
Location:	Manly Road		100-yr ARI

DATE OF SURVEY: N/A	UBD REF: 162 M14
SURVEYED CROSS SECTION ID: TD520 (Gecko)	BCC ASSET ID (Gecko): C4600B
MODEL ID: S19	New AMTD (m): 947

STRUCTURE DESCRIPTION: Culvert

STRUCTURE SIZE: 4/3000 x 1800mm

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) ~1.02m U/S OBVERT LEVEL (m) ~2.82m

D/S INVERT LEVEL (m) ~0.97m D/S OBVERT LEVEL (m) ~2.77m

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 25m

LENGTH OF CULVERT AT OBVERT (m): 25m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

WEIR WIDTH (m): 25m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): ~3.4m

HEIGHT OF GUARDRAIL/HANDRAIL: Handrail 1.06m and Guardrail 0.6m

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS: The length of the handrail is approximately 37m and the guardrail 63m

PLAN NUMBER: W11709

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2001

HAS THE STRUCTURE BEEN UPGRADED? Yes Extension to include footway in 2001

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

None

Creek:	North Channel
Location:	Manly Road

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2] (m AHD)	D/S Water Level[2] (m AHD)	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS ROAD (m)	APPROX. FLOW DEPTH ABOVE STRUCTURE (m)[3]	PEAK VELOCITY (m/s)[4]	
							Weir	Structure
2000-yr (0.05%)	80.3	4.13	4.13	0.0	300	0.7	1.4	2.6
500-yr (0.2%)	31.9	3.51	3.47	0.0	95	0.1	0.6	1.6"
100-yr (1%)	26.3	3.26	3.26	0.0	0	-	-	1.6"
50-yr (2%)	23.3	3.18	3.15	0.0	0	-	-	1.7"
20-yr (5%)	17.7	3.04	3.01	0.0	0	-	-	1.8"
10-yr (10%)	15.3	2.93	2.90	0.0	0	-	-	1.7"
5-yr (20%)	11.5	2.85	2.81	0.0	0	-	-	1.4"
2-yr (50%)	10.1	2.66	2.64	0.0	0	-	-	1"

"estimated values due to model uncertainty at this location for this event

Creek:	North Channel
Location:	Manly Road

Inlet of culverts at Manly Road

Creek:	North Channel Tributary A	**Immunity Rating:**	> 1% AEP
Location:	Detention Basin		> 100-yr ARI

DATE OF SURVEY: N/A

UBD REF: 162 Q16

SURVEYED CROSS SECTION ID:

BCC ASSET ID (Gecko): B9929

MODEL ID: S20

New AMTD (m): 397

STRUCTURE DESCRIPTION: Culvert, Spillway and Pedestrian Bridge

STRUCTURE SIZE: 3/600mm RCP

For Culverts: Number of cells/pipes & sizes For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 6.45 U/S OBVERT LEVEL (m) 7.05

D/S INVERT LEVEL (m) 6.05 D/S OBVERT LEVEL (m) 6.65

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 19.2m

LENGTH OF CULVERT AT OBVERT (m): 19.2m

TYPE OF LINING: Precast concrete

(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE? No survey conducted for this study

If yes give details i.e. plan number and/or survey book number. Note: this section should be at the highest part of the road e.g. Crown, kerb, hand rails whichever is higher

SPILLWAY WIDTH (m): ~20m PIER WIDTH (m): N/A

In direction of flow, i.e. distance from u/s face to d/s face

LOWEST POINT OF WEIR (m AHD): 7.65m (Spillway level)

HEIGHT OF GUARDRAIL/HANDRAIL:

DESCRIPTION OF HAND AND GUARD RAILS AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS:

PLAN NUMBER: WP3704

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details e.g. Pipe flusk with embankment or projecting, socket or square end, entrance rounding, levels. For bridges, details of piers and section under bridge including abutment details. Specific survey book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2002

HAS THE STRUCTURE BEEN UPGRADED? No

If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek:	North Channel Tributary A
Location:	Detention Basin

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS SPILLWAY (m)	APPROX. FLOW DEPTH ABOVE SPILLWAY (m)[3^]	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	25.1	8.37	6.59	1.8	20	0.7	2.4	3.2
500-yr (0.2%)	11.0	8.08	6.59	1.5	20	0.4	1.9	2.9
100-yr (1%)	8.1	8.04	6.56	1.5	20	0.4	1.8	2.9
50-yr (2%)	7.4	7.97	6.53	1.4	20	0.3	1.6	2.8
20-yr (5%)	5.7	7.89	6.50	1.4	20	0.2	1.3	2.8
10-yr (10%)	5.7	7.83	6.47	1.4	20	0.2	1.1	2.8
5-yr (20%)	3.6	7.78	6.46	1.3	20	0.1	0.9	2.7
2-yr (50%)	1.7	7.55	6.41	1.1	0	-	-	2.5

^ the level of the basin wall is approximate 8.5m AHD

Creek:	North Channel Tributary A
Location:	Detention Basin

Spillway at detention basin (culvert inlet not visible in photo)

Outlet of culverts and spillway from detention basin

Appendix F – Design Events – Existing Scenario (S1) Peak Water Levels

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Tingalpa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	6827	TD1000_Su2015	14.13	14.38	14.50	14.66	14.83	14.96
100	6727		13.83	13.99	14.08	14.18	14.29	14.39
200	6627		13.32	13.52	13.61	13.72	13.85	13.95
216	6611	Copy_LS8	13.25	13.44	13.54	13.64	13.76	13.85
239	6588	LS8	12.69	12.84	12.93	13.02	13.14	13.24
300	6527		12.12	12.29	12.38	12.48	12.61	12.72
400	6427		11.33	11.48	11.56	11.66	11.78	11.87
500	6327		10.88	11.03	11.11	11.20	11.32	11.41
553	6274	TD270_Su2015	10.42	10.61	10.71	10.81	10.95	11.05
600	6227		10.05	10.22	10.31	10.42	10.55	10.66
700	6127		9.33	9.52	9.63	9.75	9.90	10.00
784	6043	TD279 ALS2009	9.21	9.41	9.51	9.63	9.78	9.89
London Road								
802	6025		8.93	9.12	9.23	9.36	9.53	9.66
812	6015	TD270 TD260	8.89	9.10	9.21	9.34	9.51	9.64
900	5927		8.56	8.78	8.89	9.02	9.18	9.32
1000	5827		8.36	8.59	8.70	8.85	9.03	9.19
1042	5785	TD198_ALS	8.23	8.45	8.57	8.72	8.92	9.08
1100	5727		8.07	8.29	8.41	8.56	8.76	8.91
1200	5627		7.65	7.93	8.08	8.26	8.51	8.69
1230	5597	TD199FM	7.15	7.42	7.58	7.77	8.05	8.24
1290	5537	TD200	6.51	6.91	7.12	7.38	7.75	7.96
1300	5527		6.49	6.89	7.10	7.36	7.74	7.95
1312	5515		6.45	6.84	7.05	7.31	7.69	7.89
Grassdale Road								
1340	5487		6.21	6.48	6.62	6.77	6.95	7.27
1349	5478	TD180	6.19	6.46	6.60	6.75	6.93	7.07
1400	5427		6.13	6.38	6.51	6.65	6.83	6.96
1500	5327		5.80	5.98	6.08	6.19	6.33	6.45
1546	5281	TD175_Su2015	5.66	5.83	5.93	6.04	6.19	6.31
1600	5227		5.42	5.62	5.72	5.84	5.98	6.10
1687	5140	TD172_ALS	5.16	5.32	5.41	5.50	5.62	5.72
1700	5127		5.13	5.28	5.35	5.44	5.56	5.65
1800	5027		4.85	4.95	5.02	5.12	5.28	5.40
1900	4927		4.70	4.83	4.92	5.06	5.23	5.37
1910	4917	TD170	4.70	4.83	4.92	5.06	5.23	5.37
1920	4907		4.70	4.82	4.92	5.05	5.23	5.37
Formosa Road								
1940	4887		4.65	4.81	4.91	5.05	5.23	5.37
1950	4877	TD150	4.61	4.79	4.90	5.04	5.22	5.36
2000	4827		4.45	4.68	4.80	4.95	5.14	5.28

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2025	4802	TD140ALS	4.36	4.60	4.73	4.88	5.07	5.21
2100	4727		4.23	4.48	4.61	4.76	4.94	5.08
2163	4664	TD145_Su2015A	4.18	4.44	4.57	4.73	4.92	5.06
2200	4627		4.17	4.42	4.55	4.71	4.90	5.04
2300	4527		4.15	4.40	4.52	4.68	4.87	5.00
2307	4520	TD145_Su2015B	4.15	4.40	4.52	4.68	4.86	5.00
2400	4427		4.13	4.38	4.51	4.67	4.85	4.99
2403	4424	TD145_Su 2015C	4.13	4.38	4.50	4.66	4.85	4.98
2500	4327		4.07	4.29	4.41	4.56	4.74	4.87
2600	4227		4.05	4.28	4.40	4.55	4.73	4.87
2654	4173	TD140_US-ALS	4.04	4.26	4.38	4.53	4.71	4.85
Ermelo Weir								
2680	4147	TD140	4.03	4.25	4.37	4.52	4.70	4.84
2700	4127		4.03	4.25	4.37	4.52	4.70	4.83
2729	4098	TD135	4.02	4.25	4.36	4.51	4.69	4.83
2800	4027		4.00	4.22	4.34	4.49	4.66	4.80
2900	3927		3.92	4.12	4.23	4.37	4.53	4.66
3000	3827		3.82	4.01	4.12	4.25	4.41	4.54
3100	3727		3.62	3.81	3.92	4.05	4.21	4.34
3107	3720	TD128 LS1	3.61	3.80	3.90	4.04	4.20	4.33
3200	3627		3.37	3.56	3.67	3.81	4.00	4.16
3300	3527		3.25	3.46	3.58	3.74	3.95	4.10
3400	3427		3.21	3.43	3.56	3.72	3.93	4.09
3461	3366	TD125_Su2015	3.16	3.40	3.52	3.69	3.91	4.06
3500	3327		3.13	3.37	3.49	3.66	3.89	4.03
3600	3227		3.04	3.28	3.41	3.59	3.82	3.97
3700	3127		2.98	3.23	3.36	3.55	3.78	3.92
3800	3027		2.95	3.19	3.33	3.52	3.76	3.89
3824	3003	TD120	2.94	3.18	3.32	3.51	3.75	3.89
3900	2927		2.91	3.16	3.30	3.49	3.73	3.86
4000	2827		2.88	3.12	3.26	3.46	3.70	3.83
4100	2727		2.85	3.09	3.23	3.44	3.67	3.80
4142	2685	TD110	2.84	3.08	3.23	3.43	3.67	3.79
4200	2627		2.83	3.07	3.22	3.43	3.66	3.78
4300	2527		2.77	3.02	3.17	3.39	3.62	3.74
4320	2507	TD105_Su2015	2.75	2.99	3.15	3.38	3.61	3.73
4400	2427		2.72	2.96	3.12	3.35	3.59	3.70
4478	2349	TD100	2.71	2.94	3.10	3.33	3.57	3.68
4484	2343		2.70	2.93	3.09	3.32	3.56	3.67
Manly Road								
4516	2311		2.62	2.78	2.87	3.02	3.27	3.37
4529	2298	TD70	2.62	2.78	2.87	2.99	3.14	3.27
4600	2227		2.62	2.78	2.87	2.99	3.14	3.27

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
4700	2127		2.61	2.78	2.86	2.99	3.13	3.26
4800	2027		2.61	2.77	2.86	2.98	3.13	3.26
4861	1966	TD60	2.61	2.77	2.86	2.98	3.13	3.25
4900	1927		2.61	2.77	2.86	2.98	3.13	3.25
5000	1827		2.61	2.77	2.85	2.98	3.12	3.25
5024	1803	TD55_Sur2015	2.60	2.77	2.85	2.98	3.12	3.25
5100	1727		2.60	2.76	2.85	2.97	3.11	3.24
5185	1642	TD50	2.59	2.74	2.82	2.94	3.07	3.18
Wynnum Road								
5224	1603	TD30	2.55	2.67	2.73	2.80	2.90	2.98
5300	1527		2.53	2.64	2.70	2.76	2.85	2.92
5400	1427		2.49	2.59	2.65	2.71	2.79	2.85
5429	1398	TD25_Su2015	2.43	2.53	2.59	2.65	2.72	2.79
5500	1327		2.38	2.49	2.55	2.61	2.68	2.74
5600	1227		2.34	2.46	2.52	2.58	2.66	2.72
5673	1154	TD20	2.32	2.45	2.51	2.57	2.65	2.71
5700	1127		2.32	2.44	2.50	2.56	2.64	2.70
5800	1027		2.31	2.43	2.49	2.55	2.62	2.68
5900	927		2.28	2.40	2.46	2.51	2.58	2.64
5912	915	TD17_Su2015	2.28	2.40	2.45	2.51	2.58	2.63
6000	827		2.28	2.39	2.45	2.51	2.57	2.63
6100	727		2.28	2.39	2.45	2.51	2.58	2.63
6187	640	TD15_Su2015	2.27	2.39	2.45	2.51	2.58	2.63
6200	627		2.27	2.38	2.44	2.50	2.57	2.62
6300	527		2.25	2.36	2.42	2.47	2.54	2.59
6399	428	TD12_Su2015	2.17	2.28	2.34	2.39	2.45	2.56
6400	427		2.17	2.28	2.34	2.39	2.45	2.56
6497	330	TD10	1.97	2.07	2.12	2.22	2.38	2.53
6500	327		1.96	2.06	2.11	2.21	2.38	2.53
6600	227		1.84	1.95	2.04	2.18	2.37	2.52
6700	127		1.73	1.90	2.02	2.17	2.36	2.52
6800	27		1.66	1.88	2.01	2.16	2.36	2.52
6827	0		1.66	1.88	2.01	2.16	2.36	2.52

London Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	965	TD336_Su2015	N/A	N/A	14.61	14.84	14.91	14.96
100	865		14.42	14.49	14.52	14.58	14.64	14.68

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
200	765		14.02	14.08	14.12	14.16	14.22	14.26
207	758	TD334 ALS2009	13.95	14.00	14.04	14.08	14.12	14.16
220	745		13.90	13.96	13.99	14.03	14.06	14.10
Boston Road								
236	729		13.75	13.82	13.86	13.91	13.96	14.00
241	724	TD332 ALS2009	13.73	13.81	13.86	13.90	13.96	14.00
300	665		13.04	13.08	13.10	13.13	13.16	13.19
400	565		12.24	12.36	12.41	12.47	12.55	12.60
500	465		11.32	11.43	11.49	11.56	11.64	11.68
522	443	TD330	11.10	11.20	11.25	11.30	11.37	11.44
600	365		10.43	10.56	10.62	10.69	10.77	10.83
700	265		9.66	9.89	9.97	10.06	10.16	10.25
791	174	TD280_US	9.27	9.48	9.58	9.71	9.85	9.97
800	165		9.25	9.46	9.55	9.69	9.83	9.94
900	65		9.09	9.25	9.34	9.45	9.59	9.71
903	62	TD279 ALS2009	9.08	9.25	9.34	9.45	9.60	9.72
908	57		9.04	9.21	9.30	9.42	9.57	9.70
London Road								
926	39	TD270 TD260	8.90	9.08	9.18	9.31	9.47	9.60
955	10		8.73	8.93	9.03	9.16	9.32	9.45
965	0		8.66	8.86	8.96	9.09	9.24	9.37

East Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	2668	TD325 ALS2009	17.61	17.66	17.69	17.71	17.75	17.78
100	2568		16.88	16.94	16.97	17.00	17.04	17.07
153	2515	TD323_ALS	16.36	16.40	16.42	16.44	16.46	16.48
200	2468		15.76	15.79	15.80	15.82	15.84	15.85
300	2368		14.78	14.79	14.82	14.85	14.88	14.91
307	2361	TD321_ALS	14.74	14.77	14.80	14.84	14.87	14.90
400	2268		13.86	13.92	13.95	13.98	14.01	14.05
500	2168		13.20	13.25	13.28	13.31	13.34	13.37
513	2155	TD320 ALS2009	13.20	13.25	13.27	13.30	13.34	13.36
520	2148		13.14	13.19	13.22	13.25	13.28	13.31
Boston Road								
540	2128		12.81	12.84	12.85	12.88	12.90	12.92

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
545	2123	TD310 ALS2009	12.76	12.80	12.83	12.85	12.89	12.91
600	2068		12.20	12.25	12.28	12.31	12.33	12.35
700	1968		11.42	11.45	11.46	11.48	11.51	11.53
800	1868		10.61	10.66	10.68	10.72	10.76	10.79
826	1842	TD305_ALS	10.58	10.63	10.66	10.70	10.75	10.78
900	1768		10.21	10.26	10.29	10.33	10.38	10.41
995	1673	TD300 ALS2009	10.16	10.21	10.23	10.26	10.30	10.33
1000	1668		10.16	10.20	10.23	10.26	10.30	10.33
London Road								
1016	1652		9.95	9.97	9.98	9.99	10.01	10.03
1022	1646	TD290 ALS2009	9.66	9.71	9.74	9.78	9.82	9.86
1100	1568		9.18	9.25	9.29	9.33	9.38	9.42
1200	1468		8.34	8.42	8.47	8.53	8.62	8.69
1236	1432	TD240 ALS	8.19	8.33	8.39	8.47	8.57	8.65
1300	1368		7.71	7.86	7.93	8.02	8.12	8.21
1400	1268		7.16	7.40	7.49	7.60	7.73	7.83
1488	1180	TD230 ALS	6.88	7.09	7.17	7.28	7.42	7.51
1500	1168		6.85	7.06	7.13	7.23	7.35	7.44
1504	1164		6.77	7.00	7.08	7.19	7.34	7.44
Grassdale Road								
1520	1148		6.71	6.98	7.04	7.14	7.26	7.34
1537	1131	TD210 ALS	6.65	6.91	6.99	7.09	7.21	7.29
1600	1068		6.31	6.52	6.59	6.66	6.75	6.82
1700	968		5.78	6.02	6.10	6.22	6.36	6.46
1800	868		5.45	5.72	5.83	6.02	6.19	6.30
1828	840	TD175 ALS	5.35	5.67	5.79	5.99	6.16	6.28
1840	828		5.37	5.69	5.80	6.00	6.18	6.29
Stanbrough Road								
1864	804		5.28	5.50	5.60	5.82	5.99	6.10
1885	783	Copy_TD175	5.23	5.44	5.56	5.79	5.96	6.07
1900	768		5.20	5.41	5.53	5.77	5.94	6.05
2000	668		4.90	5.10	5.25	5.59	5.76	5.88
2002	666	TD170	4.90	5.12	5.27	5.60	5.78	5.90
2012	656		4.84	5.10	5.26	5.58	5.76	5.88
Formosa Road								
2028	640		4.79	5.01	5.11	5.39	5.52	5.59
2035	633	TD150	4.78	4.99	5.09	5.21	5.33	5.42
2100	568		4.41	4.61	4.69	4.83	4.97	5.09
2200	468		4.13	4.36	4.48	4.64	4.82	4.96
2300	368		4.10	4.33	4.45	4.61	4.79	4.94
2359	309	TD145_Su2015	4.10	4.33	4.45	4.61	4.79	4.93
2400	268		4.10	4.33	4.44	4.60	4.79	4.93
2500	168		4.09	4.32	4.44	4.59	4.78	4.91

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2600	68		4.07	4.30	4.42	4.57	4.75	4.89
2668	0		4.05	4.28	4.40	4.55	4.73	4.87

West Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	766	TD610	3.11	3.18	3.21	3.25	3.28	3.32
100	666		2.64	2.81	2.90	3.03	3.18	3.32
200	566		2.64	2.81	2.90	3.03	3.18	3.32
300	466		2.64	2.81	2.90	3.03	3.18	3.31
341	425	TD600	2.64	2.81	2.90	3.03	3.18	3.31
Manly Road								
381	385	TD70	2.61	2.78	2.87	2.99	3.14	3.27
400	366		2.61	2.77	2.86	2.98	3.12	3.25
500	266		2.61	2.77	2.86	2.98	3.12	3.25
507	259	TD60	2.61	2.77	2.86	2.98	3.13	3.25
600	166		2.61	2.77	2.86	2.98	3.12	3.25
700	66		2.60	2.77	2.85	2.98	3.12	3.25
717	49	TD55_Su2015A	2.60	2.77	2.85	2.97	3.12	3.25
756	10		2.60	2.76	2.85	2.97	3.12	3.24
766	0		2.60	2.76	2.85	2.97	3.12	3.24

North Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
4	3101	TD570 ALS2009	14.71	14.84	14.92	15.03	15.15	15.24
33	3072	TD569 ALS2009	14.23	14.31	14.36	14.43	14.51	14.57
Matthews Way Upstream								
56	3049	TD568 ALS2009	13.94	14.02	14.05	14.10	14.14	14.18
100	3005		13.56	13.61	13.64	13.69	13.71	13.74
159	2946	TD568DS_ALS	12.90	12.92	12.94	12.96	12.99	13.01
200	2905		12.07	12.12	12.14	12.16	12.20	12.23
271	2834	TD568DS2_ALS	11.38	11.48	11.52	11.58	11.61	11.65
300	2805		11.10	11.17	11.20	11.25	11.28	11.32

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
355	2750	TD568DS3_ALS	10.50	10.63	10.68	10.75	10.81	10.86
400	2705		9.97	10.05	10.08	10.13	10.18	10.25
442	2663	TD567 ALS2009	9.64	9.72	9.78	9.85	9.93	10.01
Matthews Way Downstream								
469	2636	TD566 ALS 2009	9.53	9.59	9.63	9.67	9.72	9.77
500	2605		9.28	9.38	9.42	9.49	9.55	9.61
598	2507	TD565 ALS2009	8.57	8.64	8.67	8.73	8.79	8.85
600	2505		8.55	8.60	8.64	8.69	8.75	8.81
700	2405		7.36	7.52	7.61	7.71	7.82	7.91
705	2400	TD560_Su2015	7.36	7.52	7.61	7.71	7.82	7.91
800	2305		7.25	7.39	7.47	7.56	7.65	7.74
900	2205	TD559 ALS2009	6.94	7.06	7.12	7.21	7.29	7.38
1000	2105	TD558 ALS2009	6.38	6.58	6.66	6.75	6.85	6.94
1068	2037	TD557 ALS2009	6.25	6.45	6.51	6.60	6.68	6.77
98 Ingleston Crossing								
1080	2025		6.08	6.18	6.24	6.35	6.46	6.57
1088	2017	TD556 ALS2009	6.02	6.23	6.31	6.42	6.52	6.63
1100	2005		5.92	6.11	6.18	6.28	6.38	6.48
1151	1954	TD555 ALS2009	5.66	5.78	5.82	5.90	5.97	6.05
1155	1950		5.65	5.77	5.81	5.89	5.96	6.04
84 Ingleston Crossing								
1168	1937		5.67	5.79	5.84	5.90	5.96	6.02
1176	1929	TD554 ALS2009	5.50	5.64	5.70	5.77	5.85	5.91
1200	1905		5.10	5.29	5.38	5.50	5.61	5.70
1235	1870	TD550_Su2015	4.91	5.15	5.26	5.39	5.51	5.61
1286	1819	TD548 ALS2009	4.81	5.04	5.15	5.29	5.41	5.52
56 Ingleston Crossing								
1308	1797	TD545 ALS2009	4.52	4.70	4.80	4.90	4.98	5.07
1400	1705	TD578A_ALS	3.72	3.92	4.00	4.20	4.40	4.54
1456	1649	TD540_Su2015	3.21	3.34	3.40	3.52	3.62	3.69
1500	1605		2.97	3.13	3.21	3.34	3.46	3.56
1600	1505		2.75	2.93	3.01	3.11	3.23	3.33
1700	1405		2.71	2.88	2.97	3.06	3.18	3.30
1716	1389	TD530_ALS	2.70	2.88	2.96	3.05	3.17	3.30
1800	1305		2.68	2.85	2.93	3.03	3.16	3.29
1900	1205		2.66	2.83	2.90	3.02	3.16	3.29
2000	1105		2.65	2.81	2.89	3.01	3.15	3.28
2100	1005		2.65	2.80	2.89	3.01	3.15	3.28
2142	963	TD520	2.66	2.85	2.93	3.04	3.18	3.26
Manly Road								
2175	930	TD510	2.64	2.81	2.90	3.01	3.15	3.26
2200	905		2.63	2.79	2.87	2.98	3.13	3.25
2300	805		2.62	2.78	2.87	2.98	3.13	3.25

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2383	722	TD505 ALS2009	2.62	2.78	2.86	2.98	3.13	3.25
2400	705		2.62	2.78	2.86	2.98	3.12	3.25
2500	605		2.61	2.77	2.86	2.98	3.12	3.25
2578	527	TD60	2.61	2.77	2.85	2.98	3.12	3.25
2600	505		2.60	2.77	2.85	2.98	3.12	3.25
2700	405		2.60	2.77	2.85	2.97	3.12	3.25
2800	305		2.60	2.77	2.85	2.97	3.12	3.24
2900	205		2.60	2.77	2.85	2.97	3.12	3.24
2953	152	TD55 Su2015	2.60	2.77	2.85	2.97	3.12	3.24
3000	105		2.60	2.76	2.85	2.97	3.12	3.24
3078	27		2.59	2.75	2.84	2.96	3.10	3.22
3105	0		2.59	2.74	2.83	2.94	3.08	3.20

North Channel Trib A

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	619	TD585A-ALS2009	8.45	8.58	8.66	8.75	8.81	8.89
44	575	TD585B-ALS2009	7.63	7.79	7.84	7.89	7.97	8.03
84	535	TD584A_ALS	7.55	7.78	7.83	7.89	7.97	8.04
100	519		7.55	7.78	7.83	7.89	7.97	8.04
116	503	TD584B_ALS	7.55	7.78	7.83	7.89	7.97	8.04
172	447	TD583A_ALS	7.55	7.78	7.83	7.89	7.97	8.04
196	423	TD583B_ALS	7.55	7.78	7.83	7.89	7.97	8.04
200	419		7.55	7.78	7.83	7.89	7.97	8.04
204	415	TD_582_ALS	7.55	7.78	7.83	7.89	7.97	8.04
Detention Basin Culverts								
240	379	TD581_ALS	6.41	6.46	6.47	6.50	6.53	6.56
266	353	TD2000_Su2015	5.74	5.83	5.87	5.92	5.97	6.03
300	319		5.38	5.46	5.50	5.54	5.60	5.66
336	283	TD580US-ALS	5.04	5.14	5.18	5.23	5.30	5.36
400	219		4.62	4.70	4.74	4.79	4.89	4.99
406	213	TD580_ALS	4.59	4.67	4.71	4.77	4.87	4.98
465	154	TD579_ALS	4.19	4.30	4.37	4.52	4.72	4.86
500	119		4.06	4.20	4.29	4.46	4.68	4.82
600	19		3.83	4.02	4.11	4.31	4.54	4.68
611	8		3.81	3.99	4.09	4.28	4.50	4.64
619	0		3.72	3.92	4.00	4.20	4.40	4.54

Formosa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	428	ALS_Ch0	7.55	7.78	7.83	7.89	7.97	8.04
83	345	ALS_Ch83	5.66	5.74	5.77	5.82	5.88	5.93
100	328		5.48	5.57	5.60	5.64	5.70	5.74
200	228	TD_185	4.71	4.78	4.81	4.85	4.93	5.01
300	128		4.09	4.22	4.31	4.48	4.69	4.83
338	90	TD172_Su_2015	3.97	4.14	4.22	4.42	4.64	4.78
400	28		3.85	4.03	4.12	4.32	4.55	4.69
410	18	ALS_Ch410	3.83	4.01	4.11	4.31	4.54	4.68
428	0		3.72	3.92	4.00	4.20	4.40	4.54

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Appendix G – Design Events – Ultimate Scenario (S3) Peak Water Levels

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Tingalpa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	6827	TD1000_Su2015	14.32	14.61	14.73	14.89	15.08	15.23
100	6727		13.96	14.14	14.24	14.35	14.48	14.58
200	6627		13.45	13.65	13.75	13.87	14.00	14.09
216	6611	Copy_LS8	13.37	13.57	13.67	13.78	13.90	14.00
239	6588	LS8	12.82	13.02	13.13	13.25	13.40	13.52
300	6527		12.36	12.58	12.70	12.84	13.00	13.13
400	6427		11.58	11.78	11.89	12.01	12.15	12.27
500	6327		11.05	11.24	11.34	11.45	11.59	11.70
553	6274	TD270_Su2015	10.63	10.84	10.95	11.08	11.23	11.35
600	6227		10.20	10.41	10.53	10.67	10.84	10.97
700	6127		9.42	9.65	9.78	9.94	10.11	10.26
784	6043	TD279 ALS2009	9.31	9.53	9.65	9.81	9.99	10.13
London Road								
802	6025		9.11	9.36	9.50	9.66	9.86	10.02
812	6015	TD270 TD260	9.09	9.34	9.48	9.65	9.85	10.01
900	5927		8.83	9.07	9.20	9.36	9.57	9.74
1000	5827		8.59	8.84	8.98	9.15	9.37	9.54
1042	5785	TD198_ALS	8.47	8.73	8.87	9.05	9.28	9.46
1100	5727		8.23	8.47	8.61	8.79	9.01	9.20
1200	5627		7.72	8.02	8.19	8.40	8.67	8.88
1230	5597	TD199FM	7.23	7.52	7.69	7.91	8.23	8.47
1290	5537	TD200	6.70	7.08	7.28	7.54	7.95	8.19
1300	5527		6.68	7.06	7.27	7.52	7.94	8.18
1312	5515		6.63	7.01	7.21	7.47	7.88	8.13
Grassdale Road								
1340	5487		6.48	6.78	6.94	7.12	7.50	7.65
1349	5478	TD180	6.46	6.76	6.92	7.10	7.32	7.50
1400	5427		6.37	6.65	6.80	6.97	7.18	7.34
1500	5327		6.07	6.30	6.44	6.59	6.78	6.93
1546	5281	TD175_Su2015	5.93	6.16	6.29	6.44	6.63	6.77
1600	5227		5.75	5.98	6.10	6.24	6.41	6.55
1687	5140	TD172_ALS	5.39	5.57	5.67	5.79	5.94	6.07
1700	5127		5.35	5.52	5.62	5.74	5.88	6.01
1800	5027		4.98	5.18	5.31	5.47	5.67	5.82
1900	4927		4.87	5.11	5.26	5.44	5.64	5.80
1910	4917	TD170	4.87	5.11	5.26	5.44	5.64	5.80
Formosa Road								
1950	4877	TD150	4.86	5.11	5.25	5.43	5.64	5.80
2000	4827		4.78	5.05	5.19	5.37	5.58	5.74
2025	4802	TD140ALS	4.68	4.96	5.11	5.30	5.50	5.66
2100	4727		4.44	4.72	4.86	5.04	5.24	5.40

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2163	4664	TD145_Su2015A	4.36	4.64	4.78	4.95	5.15	5.30
2200	4627		4.34	4.62	4.76	4.94	5.13	5.28
2300	4527		4.30	4.57	4.71	4.88	5.07	5.21
2307	4520	TD145_Su2015B	4.30	4.57	4.71	4.88	5.07	5.21
2400	4427		4.28	4.55	4.68	4.86	5.05	5.20
2403	4424	TD145_Su 2015C	4.28	4.55	4.68	4.85	5.05	5.19
2500	4327		4.17	4.42	4.54	4.71	4.91	5.06
2600	4227		4.13	4.37	4.50	4.66	4.86	5.01
2654	4173	TD140_US-ALS	4.11	4.34	4.47	4.63	4.83	4.98
Ermelo Weir								
2680	4147	TD140	4.09	4.33	4.46	4.62	4.81	4.97
2700	4127		4.09	4.33	4.45	4.62	4.81	4.96
2729	4098	TD135	4.09	4.32	4.45	4.61	4.80	4.95
2800	4027		4.07	4.30	4.42	4.58	4.78	4.93
2900	3927		3.98	4.19	4.31	4.45	4.63	4.78
3000	3827		3.87	4.07	4.18	4.33	4.50	4.64
3100	3727		3.69	3.88	3.98	4.12	4.30	4.44
3107	3720	TD128 LS1	3.68	3.87	3.97	4.11	4.29	4.43
3200	3627		3.44	3.63	3.75	3.89	4.08	4.24
3300	3527		3.28	3.51	3.64	3.80	4.01	4.17
3400	3427		3.25	3.49	3.61	3.78	4.00	4.16
3461	3366	TD125_Su2015	3.21	3.46	3.59	3.76	3.98	4.14
3500	3327		3.18	3.43	3.56	3.74	3.96	4.11
3600	3227		3.10	3.35	3.48	3.66	3.89	4.04
3700	3127		3.04	3.29	3.42	3.61	3.84	3.99
3800	3027		3.01	3.25	3.39	3.59	3.82	3.96
3824	3003	TD120	3.00	3.24	3.38	3.58	3.81	3.95
3900	2927		2.97	3.22	3.36	3.56	3.79	3.93
4000	2827		2.93	3.18	3.32	3.53	3.75	3.88
4100	2727		2.90	3.14	3.28	3.50	3.71	3.84
4142	2685	TD110	2.89	3.13	3.28	3.49	3.71	3.83
4200	2627		2.88	3.12	3.27	3.48	3.70	3.82
4300	2527		2.84	3.09	3.23	3.45	3.66	3.78
4320	2507	TD105_Su2015	2.83	3.07	3.22	3.44	3.65	3.77
4400	2427		2.78	3.03	3.18	3.41	3.62	3.73
4478	2349	TD100	2.77	3.01	3.16	3.38	3.59	3.70
4484	2343		2.77	3.01	3.16	3.38	3.59	3.70
Manly Road								
4516	2311		2.69	2.88	2.98	3.20	3.37	3.49
4529	2298	TD70	2.69	2.88	2.98	3.11	3.29	3.43
4600	2227		2.69	2.88	2.98	3.11	3.28	3.42
4700	2127		2.68	2.87	2.98	3.10	3.27	3.41
4800	2027		2.68	2.87	2.97	3.10	3.27	3.41

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
4861	1966	TD60	2.68	2.87	2.97	3.10	3.27	3.40
4900	1927		2.68	2.87	2.97	3.10	3.27	3.40
5000	1827		2.68	2.86	2.97	3.09	3.27	3.40
5024	1803	TD55_Sur2015	2.68	2.86	2.97	3.09	3.26	3.40
5100	1727		2.67	2.86	2.96	3.09	3.26	3.39
5185	1642	TD50	2.66	2.83	2.93	3.04	3.20	3.32
Wynnum Road								
5224	1603	TD30	2.62	2.75	2.82	2.91	3.04	3.13
5300	1527		2.58	2.70	2.75	2.83	2.93	3.00
5400	1427		2.52	2.63	2.68	2.74	2.83	2.89
5429	1398	TD25_Su2015	2.47	2.57	2.62	2.69	2.77	2.83
5500	1327		2.40	2.50	2.55	2.62	2.70	2.76
5600	1227		2.34	2.45	2.51	2.58	2.67	2.73
5673	1154	TD20	2.32	2.44	2.49	2.57	2.66	2.72
5700	1127		2.31	2.43	2.49	2.56	2.65	2.71
5800	1027		2.29	2.41	2.47	2.54	2.63	2.69
5900	927		2.27	2.38	2.44	2.51	2.59	2.65
5912	915	TD17_Su2015	2.26	2.38	2.43	2.50	2.58	2.64
6000	827		2.26	2.38	2.43	2.50	2.58	2.64
6100	727		2.26	2.38	2.44	2.51	2.59	2.64
6187	640	TD15_Su2015	2.26	2.38	2.43	2.51	2.59	2.65
6200	627		2.25	2.37	2.43	2.50	2.58	2.64
6300	527		2.23	2.35	2.41	2.47	2.55	2.63
6399	428	TD12_Su2015	2.16	2.27	2.33	2.40	2.49	2.61
6400	427		2.16	2.28	2.33	2.40	2.49	2.61
6497	330	TD10	2.01	2.12	2.18	2.28	2.44	2.59
6500	327		2.01	2.11	2.17	2.27	2.43	2.59
6600	227		1.88	2.01	2.09	2.23	2.41	2.58
6700	127		1.77	1.95	2.06	2.21	2.41	2.58
6800	27		1.71	1.92	2.05	2.21	2.40	2.58
6827	0		1.70	1.92	2.05	2.21	2.40	2.58

London Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	965	TD336_Su2015	N/A	14.87	14.92	14.99	15.07	15.13
100	865		14.57	14.68	14.74	14.81	14.90	14.96
200	765		14.08	14.16	14.20	14.25	14.32	14.37

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
207	758	TD334 ALS2009	13.98	14.06	14.10	14.14	14.21	14.26
220	745		13.95	14.03	14.07	14.11	14.18	14.23
Boston Road								
236	729		13.88	13.97	14.01	14.07	14.14	14.19
241	724	TD332 ALS2009	13.87	13.96	14.01	14.06	14.14	14.19
300	665		13.14	13.20	13.24	13.29	13.35	13.40
400	565		12.36	12.47	12.52	12.59	12.66	12.72
500	465		11.46	11.59	11.64	11.71	11.77	11.82
522	443	TD330	11.20	11.32	11.37	11.45	11.55	11.62
600	365		10.57	10.72	10.79	10.88	10.98	11.07
700	265		9.76	9.99	10.09	10.20	10.33	10.43
791	174	TD280_US	9.40	9.64	9.77	9.92	10.09	10.21
800	165		9.38	9.61	9.74	9.90	10.06	10.19
900	65		9.20	9.42	9.54	9.70	9.89	10.03
903	62	TD279 ALS2009	9.20	9.42	9.54	9.70	9.90	10.03
908	57		9.16	9.39	9.52	9.68	9.88	10.03
London Road								
926	39	TD270 TD260	9.08	9.33	9.46	9.63	9.83	9.99
955	10		8.96	9.20	9.33	9.50	9.70	9.86
965	0		8.91	9.15	9.28	9.44	9.64	9.80

East Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	2668	TD325 ALS2009	17.69	17.75	17.78	17.82	17.86	17.89
100	2568		16.95	17.02	17.05	17.08	17.13	17.16
153	2515	TD323_ALS	16.44	16.51	16.54	16.58	16.61	16.64
200	2468		15.80	15.85	15.87	15.89	15.91	15.93
300	2368		15.01	15.11	15.15	15.21	15.28	15.35
307	2361	TD321_ALS	14.96	15.05	15.10	15.16	15.24	15.31
400	2268		14.12	14.21	14.25	14.32	14.38	14.43
500	2168		13.27	13.32	13.35	13.38	13.42	13.46
513	2155	TD320 ALS2009	13.23	13.28	13.31	13.34	13.38	13.41
520	2148		13.16	13.21	13.23	13.26	13.30	13.34
Boston Road								
540	2128		12.90	12.95	12.98	13.02	13.07	13.11

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
545	2123	TD310 ALS2009	12.86	12.92	12.96	13.00	13.06	13.10
600	2068		12.34	12.40	12.43	12.47	12.52	12.56
700	1968		11.59	11.66	11.70	11.75	11.82	11.87
800	1868		10.83	10.93	10.99	11.07	11.17	11.25
826	1842	TD305_ALS	10.79	10.88	10.93	11.00	11.09	11.16
900	1768		10.34	10.42	10.47	10.53	10.61	10.67
995	1673	TD300 ALS2009	10.17	10.22	10.24	10.28	10.33	10.37
1000	1668		10.16	10.21	10.24	10.27	10.32	10.36
London Road								
1016	1652		9.96	9.98	9.99	10.01	10.04	10.08
1022	1646	TD290 ALS2009	9.80	9.89	9.93	9.99	10.06	10.12
1100	1568		9.28	9.38	9.43	9.50	9.58	9.65
1200	1468		8.45	8.57	8.64	8.72	8.82	8.90
1236	1432	TD240 ALS	8.32	8.47	8.54	8.63	8.75	8.83
1300	1368		7.76	7.94	8.03	8.15	8.30	8.41
1400	1268		7.19	7.46	7.58	7.73	7.90	8.03
1488	1180	TD230 ALS	6.95	7.19	7.31	7.47	7.65	7.79
1500	1168		6.91	7.16	7.27	7.43	7.60	7.74
1504	1164		6.85	7.10	7.22	7.38	7.57	7.71
Grassdale Road								
1520	1148		6.80	7.07	7.18	7.32	7.48	7.60
1537	1131	TD210 ALS	6.73	7.01	7.12	7.26	7.42	7.53
1600	1068		6.43	6.63	6.70	6.81	6.96	7.07
1700	968		5.90	6.11	6.23	6.37	6.55	6.66
1800	868		5.60	5.85	6.00	6.17	6.34	6.46
1828	840	TD175 ALS	5.55	5.82	5.97	6.14	6.32	6.43
1840	828		5.55	5.82	5.97	6.14	6.32	6.44
Stanbrough Road								
1864	804		5.42	5.66	5.82	5.98	6.15	6.27
1885	783	Copy_TD175	5.37	5.62	5.80	5.96	6.13	6.25
1900	768		5.34	5.60	5.78	5.94	6.11	6.23
2000	668		4.99	5.26	5.54	5.71	5.89	6.01
2002	666	TD170	4.99	5.28	5.55	5.72	5.91	6.03
2012	656		4.96	5.26	5.52	5.69	5.87	5.99
Formosa Road								
2028	640		4.92	5.15	5.39	5.52	5.69	5.81
2035	633	TD150	4.91	5.13	5.23	5.37	5.54	5.67
2100	568		4.67	4.89	4.99	5.14	5.32	5.46
2200	468		4.28	4.52	4.66	4.83	5.04	5.21
2300	368		4.20	4.45	4.58	4.76	4.98	5.14
2359	309	TD145_Su2015	4.20	4.44	4.57	4.75	4.97	5.13
2400	268		4.19	4.44	4.57	4.75	4.96	5.13

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2500	168		4.18	4.42	4.55	4.73	4.94	5.10
2600	68		4.16	4.39	4.52	4.69	4.89	5.04
2668	0		4.13	4.37	4.50	4.66	4.86	5.01

West Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	766	TD610	3.21	3.30	3.35	3.42	3.46	3.52
100	666		2.72	2.90	3.01	3.14	3.32	3.46
200	566		2.69	2.90	3.00	3.14	3.32	3.46
300	466		2.69	2.90	3.00	3.14	3.32	3.46
341	425	TD600	2.69	2.90	3.00	3.14	3.32	3.46
Manly Road								
381	385	TD70	2.68	2.88	2.98	3.11	3.28	3.42
400	366		2.68	2.87	2.97	3.10	3.27	3.40
500	266		2.68	2.87	2.97	3.10	3.27	3.40
507	259	TD60	2.68	2.87	2.97	3.10	3.27	3.40
600	166		2.68	2.87	2.97	3.10	3.27	3.40
700	66		2.68	2.86	2.97	3.09	3.26	3.40
717	49	TD55_Su2015A	2.68	2.86	2.97	3.09	3.26	3.40
756	10		2.67	2.86	2.96	3.09	3.26	3.39
766	0		2.67	2.86	2.96	3.09	3.26	3.39

North Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
4	3101	TD570 ALS2009	14.71	14.84	14.92	15.03	15.16	15.25
33	3072	TD569 ALS2009	14.24	14.32	14.36	14.44	14.52	14.60
Matthews Way Upstream								
56	3049	TD568 ALS2009	14.00	14.10	14.14	14.19	14.26	14.30
100	3005		13.66	13.73	13.76	13.80	13.85	13.89
159	2946	TD568DS_ALS	12.91	12.96	12.98	13.02	13.05	13.09
200	2905		12.11	12.18	12.21	12.26	12.30	12.33
271	2834	TD568DS2_ALS	11.43	11.54	11.60	11.67	11.74	11.80

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
300	2805		11.15	11.25	11.30	11.36	11.42	11.47
355	2750	TD568DS3_ALS	10.52	10.62	10.68	10.75	10.82	10.88
400	2705		10.01	10.12	10.17	10.27	10.37	10.47
442	2663	TD567 ALS2009	9.76	9.88	9.95	10.05	10.19	10.32
Matthews Way Downstream								
469	2636	TD566 ALS 2009	9.67	9.78	9.84	9.92	10.01	10.08
500	2605		9.44	9.57	9.64	9.73	9.82	9.90
598	2507	TD565 ALS2009	8.60	8.68	8.73	8.80	8.86	8.94
600	2505		8.55	8.63	8.67	8.74	8.81	8.88
700	2405		7.35	7.53	7.63	7.76	7.87	7.98
705	2400	TD560_Su2015	7.35	7.53	7.63	7.76	7.87	7.98
800	2305		7.24	7.40	7.50	7.61	7.72	7.82
900	2205	TD559 ALS2009	6.91	7.05	7.13	7.23	7.34	7.44
1000	2105	TD558 ALS2009	6.34	6.63	6.72	6.83	6.95	7.05
1068	2037	TD557 ALS2009	6.21	6.47	6.54	6.64	6.74	6.83
98 Ingleston Crossing								
1080	2025		6.08	6.21	6.31	6.43	6.56	6.66
1088	2017	TD556 ALS2009	6.01	6.25	6.35	6.47	6.58	6.68
1100	2005		5.92	6.14	6.22	6.33	6.44	6.53
1151	1954	TD555 ALS2009	5.61	5.75	5.78	5.83	5.91	5.98
1156	1949		5.61	5.74	5.77	5.82	5.90	5.97
84 Ingleston Crossing								
1168	1937		5.59	5.74	5.79	5.86	5.92	5.97
1176	1929	TD554 ALS2009	5.46	5.59	5.65	5.72	5.79	5.86
1200	1905		5.06	5.21	5.30	5.41	5.52	5.61
1235	1870	TD550_Su2015	4.88	5.05	5.15	5.28	5.40	5.51
1286	1819	TD548 ALS2009	4.78	4.95	5.04	5.18	5.31	5.42
56 Ingleston Crossing								
1308	1797	TD545 ALS2009	4.51	4.66	4.74	4.85	4.96	5.07
1400	1705	TD578A_ALS	3.71	3.93	4.03	4.22	4.44	4.61
1456	1649	TD540_Su2015	3.28	3.47	3.56	3.70	3.83	3.93
1500	1605		3.14	3.33	3.42	3.56	3.71	3.82
1600	1505		2.91	3.11	3.21	3.33	3.48	3.59
1700	1405		2.84	3.04	3.14	3.25	3.39	3.49
1716	1389	TD530_ALS	2.83	3.03	3.12	3.24	3.37	3.49
1800	1305		2.79	2.99	3.08	3.19	3.32	3.48
1900	1205		2.76	2.94	3.03	3.14	3.31	3.48
2000	1105		2.72	2.90	3.00	3.13	3.30	3.47
2100	1005		2.70	2.89	3.00	3.13	3.30	3.47
2142	963	TD520	2.71	2.94	3.03	3.14	3.32	3.47
Manly Road								
2175	930	TD510	2.69	2.90	2.99	3.11	3.27	3.42

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
2200	905		2.69	2.87	2.97	3.10	3.27	3.40
2300	805		2.68	2.87	2.97	3.10	3.27	3.40
2383	722	TD505 ALS2009	2.68	2.87	2.97	3.10	3.27	3.40
2400	705		2.68	2.87	2.97	3.10	3.27	3.40
2500	605		2.68	2.86	2.97	3.09	3.26	3.40
2578	527	TD60	2.68	2.86	2.97	3.09	3.26	3.40
2600	505		2.68	2.86	2.97	3.09	3.26	3.40
2700	405		2.67	2.86	2.97	3.09	3.26	3.40
2800	305		2.67	2.86	2.96	3.09	3.26	3.40
2900	205		2.67	2.86	2.96	3.09	3.26	3.40
2953	152	TD55 Su2015	2.67	2.86	2.96	3.09	3.26	3.40
3000	105		2.67	2.86	2.96	3.09	3.26	3.39
3078	27		2.66	2.84	2.94	3.06	3.23	3.36
3105	0		2.65	2.83	2.93	3.05	3.21	3.34

North Channel Trib A

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	619	TD585A-ALS2009	8.45	8.60	8.67	8.77	8.84	8.92
44	575	TD585B-ALS2009	7.70	7.81	7.86	7.92	8.01	8.09
84	535	TD584A_ALS	7.55	7.79	7.84	7.89	7.98	8.05
100	519		7.55	7.79	7.84	7.89	7.98	8.05
116	503	TD584B_ALS	7.55	7.79	7.84	7.89	7.98	8.05
172	447	TD583A_ALS	7.55	7.79	7.84	7.89	7.98	8.05
196	423	TD583B_ALS	7.55	7.79	7.83	7.89	7.98	8.05
200	419		7.55	7.79	7.83	7.89	7.97	8.05
204	415	TD_582_ALS	7.54	7.78	7.83	7.89	7.97	8.05
Detention Basin Culverts								
240	379	TD581_ALS	6.42	6.46	6.48	6.51	6.55	6.58
266	353	TD2000_Su2015	5.74	5.85	5.89	5.94	6.02	6.08
300	319		5.39	5.51	5.56	5.62	5.71	5.78
336	283	TD580US-ALS	5.07	5.19	5.23	5.30	5.39	5.48
400	219		4.70	4.80	4.86	4.94	5.07	5.20
406	213	TD580_ALS	4.66	4.76	4.83	4.91	5.05	5.19
465	154	TD579_ALS	4.23	4.36	4.46	4.61	4.83	5.00
500	119		4.07	4.22	4.34	4.52	4.75	4.93
600	19		3.83	4.02	4.12	4.31	4.56	4.73
611	8		3.81	3.99	4.10	4.29	4.52	4.69

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
619	0		3.71	3.93	4.03	4.22	4.44	4.61

Formosa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)					
			2-yr ARI (50% AEP)	5-yr ARI (20% AEP)	10-yr ARI (10% AEP)	20-yr ARI (5% AEP)	50-yr ARI (2% AEP)	100-yr ARI (1% AEP)
0	428	ALS_Ch0	7.55	7.79	7.83	7.89	7.98	8.05
83	345	ALS_Ch83	5.67	5.78	5.83	5.89	5.97	6.04
100	328		5.49	5.60	5.65	5.71	5.79	5.86
200	228	TD_185	4.77	4.86	4.91	4.98	5.10	5.23
300	128		4.12	4.26	4.38	4.55	4.78	4.96
338	90	TD172_Su_2015	3.96	4.15	4.27	4.46	4.70	4.87
400	28		3.84	4.03	4.13	4.33	4.57	4.74
410	18	ALS_Ch410	3.83	4.01	4.12	4.31	4.55	4.73
428	0		3.71	3.93	4.03	4.22	4.44	4.61

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Appendix H – Rare and Extreme Events – Existing Scenario (S1)

Peak Water Levels

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Tingalpa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	6827	TD1000_Su2015	15.05	15.21	16.11
100	6727		14.44	14.53	15.13
200	6627		14.00	14.09	14.60
216	6611	Copy_LS8	13.90	13.99	14.49
239	6588	LS8	13.30	13.39	13.98
300	6527		12.78	12.88	13.55
400	6427		11.93	12.00	12.61
500	6327		11.46	11.53	12.16
553	6274	TD270_Su2015	11.12	11.18	11.87
600	6227		10.73	10.80	11.51
700	6127		10.07	10.14	10.80
784	6043	TD279 ALS2009	9.96	10.03	10.71
London Road					
802	6025		9.74	9.82	10.47
812	6015	TD270 TD260	9.72	9.80	10.47
900	5927		9.41	9.49	10.14
1000	5827		9.28	9.38	10.04
1042	5785	TD198_ALS	9.18	9.28	9.95
1100	5727		9.00	9.10	9.69
1200	5627		8.80	8.91	9.44
1230	5597	TD199FM	8.35	8.46	8.96
1290	5537	TD200	8.06	8.18	8.44
1300	5527		8.05	8.17	8.43
1312	5515		8.00	8.12	8.39
London Road					
1340	5487		7.35	7.45	8.18
1349	5478	TD180	7.15	7.24	7.92
1400	5427		7.03	7.11	7.75
1500	5327		6.51	6.58	7.15
1546	5281	TD175_Su2015	6.38	6.45	7.02
1600	5227		6.16	6.23	6.79
1687	5140	TD172_ALS	5.78	5.84	6.46
1700	5127		5.70	5.76	6.40
1800	5027		5.48	5.56	6.34
1900	4927		5.45	5.53	6.32
1910	4917	TD170	5.45	5.53	6.32
Formosa Road					
1950	4877	TD150	5.44	5.52	6.31
2000	4827		5.36	5.45	6.22
2025	4802	TD140ALS	5.29	5.37	6.12
2100	4727		5.16	5.24	5.98
2163	4664	TD145_Su2015A	5.14	5.23	5.99

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
2200	4627		5.12	5.22	5.99
2300	4527		5.08	5.17	5.92
2307	4520	TD145_Su2015B	5.08	5.17	5.92
2400	4427		5.07	5.16	5.91
2403	4424	TD145_Su 2015C	5.06	5.16	5.91
2500	4327		4.95	5.04	5.83
2600	4227		4.95	5.04	5.82
2654	4173	TD140_US-ALS	4.93	5.02	5.79
Ermelo Weir					
2680	4147	TD140	4.92	5.01	5.78
2700	4127		4.91	5.00	5.77
2729	4098	TD135	4.91	5.00	5.76
2800	4027		4.88	4.97	5.72
2900	3927		4.73	4.82	5.55
3000	3827		4.62	4.70	5.42
3100	3727		4.42	4.52	5.23
3107	3720	TD128 LS1	4.41	4.50	5.22
3200	3627		4.24	4.36	5.08
3300	3527		4.19	4.31	5.04
3400	3427		4.18	4.30	5.03
3461	3366	TD125_Su2015	4.15	4.27	4.99
3500	3327		4.12	4.25	4.95
3600	3227		4.04	4.17	4.83
3700	3127		3.99	4.12	4.77
3800	3027		3.96	4.08	4.71
3824	3003	TD120	3.96	4.07	4.70
3900	2927		3.93	4.04	4.65
4000	2827		3.89	4.00	4.57
4100	2727		3.86	3.96	4.51
4142	2685	TD110	3.85	3.96	4.50
4200	2627		3.84	3.95	4.49
4300	2527		3.80	3.89	4.40
4320	2507	TD105_Su2015	3.78	3.88	4.37
4400	2427		3.75	3.84	4.32
4478	2349	TD100	3.73	3.82	4.30
4484	2343		3.73	3.82	4.29
Manly Road					
4516	2311		3.44	3.55	4.18
4529	2298	TD70	3.36	3.48	4.15
4600	2227		3.35	3.47	4.15
4700	2127		3.34	3.47	4.14
4800	2027		3.34	3.46	4.14
4861	1966	TD60	3.34	3.46	4.13

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
4900	1927		3.34	3.46	4.13
5000	1827		3.33	3.45	4.13
5024	1803	TD55_Sur2015	3.33	3.45	4.12
5100	1727		3.32	3.44	4.12
5185	1642	TD50	3.26	3.36	3.99
Wynnum Road					
5224	1603	TD30	3.03	3.12	3.70
5300	1527		2.96	3.09	3.70
5400	1427		2.89	3.09	3.70
5429	1398	TD25_Su2015	2.85	3.08	3.70
5500	1327		2.85	3.08	3.70
5600	1227		2.84	3.08	3.70
5673	1154	TD20	2.84	3.08	3.70
5700	1127		2.84	3.08	3.70
5800	1027		2.84	3.08	3.70
5900	927		2.84	3.08	3.70
5912	915	TD17_Su2015	2.83	3.08	3.70
6000	827		2.83	3.08	3.70
6100	727		2.83	3.08	3.70
6187	640	TD15_Su2015	2.84	3.08	3.70
6200	627		2.83	3.08	3.70
6300	527		2.83	3.08	3.70
6399	428	TD12_Su2015	2.83	3.08	3.70
6400	427		2.83	3.08	3.70
6497	330	TD10	2.83	3.08	3.70
6500	327		2.83	3.08	3.70
6600	227		2.83	3.08	3.70
6700	127		2.83	3.08	3.70
6800	27		2.83	3.08	3.70
6827	0		2.83	3.08	3.70

London Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	965	TD336_Su2015	14.98	15.01	15.17
100	865		14.70	14.73	14.89
200	765		14.28	14.31	14.45
207	758	TD334 ALS2009	14.18	14.20	14.34
220	745		14.11	14.13	14.25
Boston Road					

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
236	729		14.02	14.04	14.17
241	724	TD332 ALS2009	14.02	14.05	14.18
300	665		13.20	13.22	13.31
400	565		12.62	12.64	12.82
500	465		11.70	11.73	11.91
522	443	TD330	11.47	11.50	11.75
600	365		10.86	10.90	11.16
700	265		10.29	10.35	10.74
791	174	TD280_US	10.02	10.10	10.60
800	165		10.00	10.07	10.58
900	65		9.79	9.86	10.47
903	62	TD279 ALS2009	9.79	9.86	10.47
908	57		9.77	9.85	10.49
London Road					
926	39	TD270 TD260	9.68	9.77	10.45
955	10		9.53	9.61	10.31
965	0		9.44	9.52	10.21

East Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	2668	TD325 ALS2009	17.79	17.81	17.91
100	2568		17.08	17.10	17.15
153	2515	TD323_ALS	16.49	16.50	16.56
200	2468		15.85	15.86	15.90
300	2368		14.93	14.95	15.11
307	2361	TD321_ALS	14.92	14.94	15.12
400	2268		14.06	14.08	14.23
500	2168		13.38	13.40	13.52
513	2155	TD320 ALS2009	13.38	13.40	13.50
520	2148		13.32	13.34	13.45
Boston Road					
540	2128		12.93	12.94	13.01
545	2123	TD310 ALS2009	12.92	12.94	13.03
600	2068		12.36	12.38	12.46
700	1968		11.54	11.55	11.63
800	1868		10.81	10.84	11.03
826	1842	TD305_ALS	10.80	10.83	11.04
900	1768		10.43	10.45	10.62
995	1673	TD300 ALS2009	10.35	10.37	10.52

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
1000	1668		10.34	10.36	10.50
London Road					
1016	1652		10.03	10.04	10.14
1022	1646	TD290 ALS2009	9.87	9.89	10.07
1100	1568		9.44	9.46	9.65
1200	1468		8.73	8.77	9.10
1236	1432	TD240 ALS	8.69	8.74	9.10
1300	1368		8.25	8.31	8.73
1400	1268		7.88	7.95	8.52
1488	1180	TD230 ALS	7.57	7.65	8.34
1500	1168		7.49	7.57	8.30
1504	1164		7.49	7.57	8.30
Grassdale Road					
1520	1148		7.39	7.44	8.05
1537	1131	TD210 ALS	7.34	7.39	7.75
1600	1068		6.86	6.90	7.28
1700	968		6.51	6.57	6.94
1800	868		6.36	6.42	6.80
1828	840	TD175 ALS	6.34	6.40	6.79
1840	828		6.35	6.41	6.73
Stanbrough Road					
1864	804		6.15	6.21	6.58
1885	783	Copy_TD175	6.13	6.19	6.54
1900	768		6.11	6.17	6.52
2000	668		5.94	6.00	6.32
2002	666	TD170	5.96	6.02	6.34
2012	656		5.94	5.99	6.34
Formosa Road					
2028	640		5.66	5.71	6.17
2035	633	TD150	5.47	5.53	6.08
2100	568		5.16	5.24	5.97
2200	468		5.05	5.14	5.94
2300	368		5.02	5.12	5.92
2359	309	TD145_Su2015	5.02	5.11	5.91
2400	268		5.01	5.11	5.91
2500	168		5.00	5.09	5.88
2600	68		4.97	5.06	5.83
2668	0		4.95	5.04	5.82

West Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	766	TD610	3.41	3.55	4.13
100	666		3.40	3.55	4.13
200	566		3.40	3.55	4.13
300	466		3.40	3.55	4.13
341	425	TD600	3.40	3.54	4.13
Manly Road					
381	385	TD70	3.35	3.48	4.13
400	366		3.33	3.46	4.13
500	266		3.33	3.46	4.13
507	259	TD60	3.34	3.46	4.13
600	166		3.33	3.46	4.13
700	66		3.33	3.45	4.13
717	49	TD55_Su2015A	3.33	3.45	4.13
756	10		3.33	3.45	4.12
766	0		3.32	3.45	4.12

North Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
4	3101	TD570 ALS2009	15.29	15.36	15.71
33	3072	TD569 ALS2009	14.60	14.63	15.33
Matthews Way Upstream					
56	3049	TD568 ALS2009	14.20	14.22	14.49
100	3005		13.75	13.77	13.88
159	2946	TD568DS_ALS	13.02	13.04	13.14
200	2905		12.24	12.26	12.36
271	2834	TD568DS2_ALS	11.68	11.72	11.85
300	2805		11.34	11.37	11.49
355	2750	TD568DS3_ALS	10.89	10.93	11.17
400	2705		10.28	10.34	10.84
442	2663	TD567 ALS2009	10.08	10.19	10.81
Matthews Way Downstream					
469	2636	TD566 ALS 2009	9.80	9.83	10.27
500	2605		9.65	9.69	9.88
598	2507	TD565 ALS2009	8.89	8.94	9.13
600	2505		8.86	8.90	9.10
700	2405		7.94	8.00	8.28

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
705	2400	TD560_Su2015	7.95	8.00	8.28
800	2305		7.77	7.83	8.07
900	2205	TD559 ALS2009	7.42	7.47	7.75
1000	2105	TD558 ALS2009	6.99	7.05	7.40
1068	2037	TD557 ALS2009	6.82	6.88	7.19
98 Ingleston Crossing					
1080	2025		6.63	6.70	7.05
1088	2017	TD556 ALS2009	6.69	6.75	7.09
1100	2005		6.54	6.60	6.89
1151	1954	TD555 ALS2009	6.21	6.27	6.61
1156	1949		6.20	6.26	6.60
84 Ingleston Crossing					
1168	1937		6.09	6.14	6.47
1176	1929	TD554 ALS2009	5.94	5.99	6.25
1200	1905		5.75	5.81	6.13
1235	1870	TD550_Su2015	5.65	5.73	6.06
1286	1819	TD548 ALS2009	5.56	5.63	5.97
56 Ingleston Crossing					
1308	1797	TD545 ALS2009	5.10	5.15	5.70
1400	1705	TD578A_ALS	4.56	4.64	5.04
1456	1649	TD540_Su2015	3.70	3.75	4.15
1500	1605		3.57	3.64	4.15
1600	1505		3.42	3.56	4.15
1700	1405		3.42	3.55	4.14
1716	1389	TD530_ALS	3.42	3.55	4.14
1800	1305		3.42	3.55	4.14
1900	1205		3.41	3.54	4.14
2000	1105		3.41	3.54	4.14
2100	1005		3.41	3.54	4.14
2142	963	TD520	3.40	3.53	4.14
Manly Road					
2175	930	TD510	3.35	3.47	4.13
2200	905		3.34	3.46	4.13
2300	805		3.34	3.46	4.13
2383	722	TD505 ALS2009	3.34	3.46	4.13
2400	705		3.33	3.46	4.13
2500	605		3.33	3.46	4.13
2578	527	TD60	3.33	3.45	4.13
2600	505		3.33	3.45	4.13
2700	405		3.33	3.45	4.13
2800	305		3.33	3.45	4.13
2900	205		3.33	3.45	4.12
2953	152	TD55 Su2015	3.33	3.45	4.12
3000	105		3.33	3.45	4.12

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
3078	27		3.30	3.42	4.10
3105	0		3.28	3.40	4.06

North Channel Trib A

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	619	TD585A-ALS2009	8.93	8.99	9.09
44	575	TD585B-ALS2009	8.03	8.07	8.35
84	535	TD584A_ALS	8.04	8.08	8.37
100	519		8.04	8.08	8.38
116	503	TD584B_ALS	8.04	8.08	8.38
172	447	TD583A_ALS	8.04	8.08	8.38
196	423	TD583B_ALS	8.04	8.08	8.38
200	419		8.03	8.08	8.37
204	415	TD_582_ALS	8.03	8.08	8.37
Detention Basin Culverts					
240	379	TD581_ALS	6.56	6.59	6.59
266	353	TD2000_Su2015	6.02	6.06	6.28
300	319		5.66	5.69	5.93
336	283	TD580US-ALS	5.36	5.40	5.68
400	219		4.99	5.07	5.52
406	213	TD580_ALS	4.98	5.06	5.52
465	154	TD579_ALS	4.87	4.96	5.42
500	119		4.83	4.92	5.34
600	19		4.70	4.79	5.15
611	8		4.66	4.75	5.13
619	0		4.56	4.64	5.04

Formosa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
0	428	ALS_Ch0	8.04	8.08	8.38
83	345	ALS_Ch83	5.93	5.97	6.21
100	328		5.74	5.78	5.99
200	228	TD_185	5.02	5.08	5.53
300	128		4.84	4.93	5.37

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Extreme Event - Scenario 1 Existing Case - Peak Water Levels (m AHD)		
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)	2000-yr ARI (0.05% AEP)
338	90	TD172_Su_2015	4.79	4.88	5.27
400	28		4.70	4.79	5.15
410	18	ALS_Ch410	4.70	4.79	5.15
428	0		4.56	4.64	5.04

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Appendix I – Rare and Extreme Events – Ultimate Scenario (S3) Peak Water Levels

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Tingalpa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	6827	TD1000_Su2015	15.23	15.52
100	6727		14.58	14.74
200	6627		14.09	14.24
216	6611	Copy_LS8	14.00	14.14
239	6588	LS8	13.52	13.68
300	6527		13.13	13.30
400	6427		12.27	12.42
500	6327		11.70	11.85
553	6274	TD270_Su2015	11.35	11.50
600	6227		10.97	11.14
700	6127		10.26	10.44
784	6043	TD279 ALS2009	10.13	10.31
London Road				
802	6025		10.02	10.21
812	6015	TD270 TD260	10.01	10.20
900	5927		9.74	9.94
1000	5827		9.54	9.75
1042	5785	TD198_ALS	9.46	9.67
1100	5727		9.20	9.41
1200	5627		8.89	9.11
1230	5597	TD199FM	8.47	8.71
1290	5537	TD200	8.20	8.43
1300	5527		8.19	8.42
1312	5515		8.14	8.38
Grassdale Road				
1340	5487		7.65	7.86
1349	5478	TD180	7.50	7.71
1400	5427		7.35	7.55
1500	5327		6.93	7.12
1546	5281	TD175_Su2015	6.77	6.96
1600	5227		6.55	6.71
1687	5140	TD172_ALS	6.07	6.23
1700	5127		6.02	6.18
1800	5027		5.84	6.02
1900	4927		5.82	6.01
1910	4917	TD170	5.82	6.01
Formosa Road				
1950	4877	TD150	5.82	6.00
2000	4827		5.76	5.94
2025	4802	TD140ALS	5.68	5.86
2100	4727		5.42	5.59

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
2163	4664	TD145_Su2015A	5.32	5.49
2200	4627		5.31	5.47
2300	4527		5.24	5.41
2307	4520	TD145_Su2015B	5.24	5.41
2400	4427		5.22	5.39
2403	4424	TD145_Su 2015C	5.22	5.39
2500	4327		5.08	5.25
2600	4227		5.04	5.21
2654	4173	TD140_US-ALS	5.01	5.18
Ermelo Weir				
2680	4147	TD140	4.99	5.16
2700	4127		4.99	5.15
2729	4098	TD135	4.98	5.15
2800	4027		4.95	5.12
2900	3927		4.80	4.96
3000	3827		4.67	4.83
3100	3727		4.46	4.65
3107	3720	TD128 LS1	4.45	4.64
3200	3627		4.26	4.47
3300	3527		4.20	4.40
3400	3427		4.18	4.39
3461	3366	TD125_Su2015	4.16	4.37
3500	3327		4.14	4.34
3600	3227		4.07	4.26
3700	3127		4.02	4.20
3800	3027		3.98	4.16
3824	3003	TD120	3.98	4.15
3900	2927		3.95	4.12
4000	2827		3.90	4.06
4100	2727		3.86	4.02
4142	2685	TD110	3.85	4.01
4200	2627		3.84	4.00
4300	2527		3.80	3.95
4320	2507	TD105_Su2015	3.79	3.93
4400	2427		3.75	3.88
4478	2349	TD100	3.72	3.86
4484	2343		3.72	3.85
Manly Road				
4516	2311		3.54	3.71
4529	2298	TD70	3.48	3.68
4600	2227		3.47	3.66
4700	2127		3.46	3.65
4800	2027		3.46	3.65

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
4861	1966	TD60	3.46	3.65
4900	1927		3.46	3.65
5000	1827		3.45	3.64
5024	1803	TD55_Sur2015	3.45	3.64
5100	1727		3.44	3.63
5185	1642	TD50	3.37	3.53
Wynnum Road				
5224	1603	TD30	3.17	3.30
5300	1527		3.03	3.13
5400	1427		2.92	3.07
5429	1398	TD25_Su2015	2.86	3.07
5500	1327		2.82	3.06
5600	1227		2.80	3.06
5673	1154	TD20	2.80	3.06
5700	1127		2.80	3.05
5800	1027		2.80	3.05
5900	927		2.79	3.05
5912	915	TD17_Su2015	2.79	3.05
6000	827		2.78	3.05
6100	727		2.79	3.05
6187	640	TD15_Su2015	2.79	3.05
6200	627		2.79	3.05
6300	527		2.78	3.05
6399	428	TD12_Su2015	2.78	3.05
6400	427		2.78	3.05
6497	330	TD10	2.77	3.04
6500	327		2.77	3.04
6600	227		2.77	3.04
6700	127		2.77	3.04
6800	27		2.77	3.04
6827	0		2.77	3.04

London Road

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	965	TD336_Su2015	15.12	15.21
100	865		14.95	15.03
200	765		14.36	14.43
207	758	TD334 ALS2009	14.25	14.32

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
220	745		14.22	14.28
Boston Road				
236	729		14.18	14.25
241	724	TD332 ALS2009	14.18	14.25
300	665		13.39	13.45
400	565		12.71	12.78
500	465		11.82	11.89
522	443	TD330	11.62	11.72
600	365		11.06	11.17
700	265		10.43	10.56
791	174	TD280_US	10.21	10.37
800	165		10.19	10.35
900	65		10.03	10.21
903	62	TD279 ALS2009	10.03	10.21
908	57		10.03	10.22
London Road				
926	39	TD270 TD260	9.99	10.19
955	10		9.86	10.06
965	0		9.80	10.00

East Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	2668	TD325 ALS2009	17.88	17.92
100	2568		17.16	17.20
153	2515	TD323_ALS	16.63	16.68
200	2468		15.93	15.96
300	2368		15.33	15.42
307	2361	TD321_ALS	15.29	15.38
400	2268		14.42	14.49
500	2168		13.45	13.50
513	2155	TD320 ALS2009	13.40	13.44
520	2148		13.33	13.37
Boston Road				
540	2128		13.10	13.16
545	2123	TD310 ALS2009	13.09	13.16
600	2068		12.55	12.61
700	1968		11.86	11.93

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
800	1868		11.23	11.33
826	1842	TD305_ALS	11.15	11.24
900	1768		10.66	10.74
995	1673	TD300 ALS2009	10.36	10.42
1000	1668		10.35	10.40
London Road				
1016	1652		10.07	10.12
1022	1646	TD290 ALS2009	10.11	10.19
1100	1568		9.64	9.72
1200	1468		8.90	9.00
1236	1432	TD240 ALS	8.83	8.94
1300	1368		8.41	8.58
1400	1268		8.03	8.28
1488	1180	TD230 ALS	7.79	8.11
1500	1168		7.74	8.07
1504	1164		7.71	8.03
Grassdale Road				
1520	1148		7.60	7.92
1537	1131	TD210 ALS	7.53	7.66
1600	1068		7.07	7.20
1700	968		6.66	6.79
1800	868		6.46	6.58
1828	840	TD175 ALS	6.44	6.56
1840	828		6.44	6.57
Stanbrough Road				
1864	804		6.27	6.41
1885	783	Copy_TD175	6.25	6.38
1900	768		6.23	6.37
2000	668		6.01	6.15
2002	666	TD170	6.03	6.17
2012	656		5.99	6.13
Formosa Road				
2028	640		5.82	5.97
2035	633	TD150	5.68	5.84
2100	568		5.48	5.65
2200	468		5.24	5.43
2300	368		5.17	5.37
2359	309	TD145_Su2015	5.16	5.36
2400	268		5.16	5.35
2500	168		5.12	5.31
2600	68		5.07	5.25
2668	0		5.04	5.21

West Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	766	TD610	3.53	3.68
100	666		3.52	3.67
200	566		3.52	3.67
300	466		3.52	3.67
341	425	TD600	3.52	3.67
Manly Road				
381	385	TD70	3.47	3.65
400	366		3.46	3.65
500	266		3.46	3.65
507	259	TD60	3.46	3.65
600	166		3.46	3.65
700	66		3.45	3.64
717	49	TD55_Su2015A	3.45	3.64
756	10		3.45	3.64
766	0		3.45	3.64

North Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
4	3101	TD570 ALS2009	15.25	15.37
33	3072	TD569 ALS2009	14.60	14.73
Matthews Way Upstream				
56	3049	TD568 ALS2009	14.31	14.36
100	3005		13.89	13.93
159	2946	TD568DS_ALS	13.09	13.13
200	2905		12.33	12.39
271	2834	TD568DS2_ALS	11.79	11.88
300	2805		11.47	11.53
355	2750	TD568DS3_ALS	10.87	10.97
400	2705		10.45	10.61
442	2663	TD567 ALS2009	10.29	10.48
Matthews Way Downstream				
469	2636	TD566 ALS 2009	10.06	10.16
500	2605		9.88	9.98
598	2507	TD565 ALS2009	8.93	9.02
600	2505		8.87	8.96
700	2405		7.96	8.10

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
705	2400	TD560_Su2015	7.96	8.10
800	2305		7.80	7.93
900	2205	TD559 ALS2009	7.42	7.56
1000	2105	TD558 ALS2009	7.03	7.17
1068	2037	TD557 ALS2009	6.81	6.94
98 Ingleston Crossing				
1080	2025		6.64	6.79
1088	2017	TD556 ALS2009	6.66	6.80
1100	2005		6.51	6.64
1151	1954	TD555 ALS2009	5.96	6.14
1156	1949		5.95	6.14
84 Ingleston Crossing				
1168	1937		5.96	6.06
1176	1929	TD554 ALS2009	5.84	5.92
1200	1905		5.59	5.72
1235	1870	TD550_Su2015	5.49	5.63
1286	1819	TD548 ALS2009	5.39	5.54
56 Ingleston Crossing				
1308	1797	TD545 ALS2009	5.05	5.20
1400	1705	TD578A_ALS	4.57	4.79
1456	1649	TD540_Su2015	3.91	4.04
1500	1605		3.80	3.95
1600	1505		3.58	3.72
1700	1405		3.54	3.71
1716	1389	TD530_ALS	3.54	3.71
1800	1305		3.53	3.71
1900	1205		3.53	3.70
2000	1105		3.52	3.70
2100	1005		3.52	3.69
2142	963	TD520	3.52	3.69
Manly Road				
2175	930	TD510	3.47	3.65
2200	905		3.46	3.65
2300	805		3.46	3.65
2383	722	TD505 ALS2009	3.46	3.65
2400	705		3.45	3.65
2500	605		3.45	3.64
2578	527	TD60	3.45	3.64
2600	505		3.45	3.64
2700	405		3.45	3.64
2800	305		3.45	3.64
2900	205		3.45	3.64
2953	152	TD55 Su2015	3.45	3.64

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
3000	105		3.45	3.64
3078	27		3.41	3.60
3105	0		3.39	3.57

North Channel Trib A

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	619	TD585A-ALS2009	8.91	9.04
44	575	TD585B-ALS2009	8.09	8.19
84	535	TD584A_ALS	8.06	8.16
100	519		8.05	8.15
116	503	TD584B_ALS	8.05	8.16
172	447	TD583A_ALS	8.05	8.16
196	423	TD583B_ALS	8.05	8.15
200	419		8.05	8.15
204	415	TD_582_ALS	8.05	8.15
Detention Basin Culverts				
240	379	TD581_ALS	6.58	6.61
266	353	TD2000_Su2015	6.08	6.20
300	319		5.77	5.89
336	283	TD580US-ALS	5.47	5.58
400	219		5.19	5.35
406	213	TD580_ALS	5.17	5.34
465	154	TD579_ALS	4.98	5.19
500	119		4.90	5.11
600	19		4.69	4.90
611	8		4.65	4.87
619	0		4.57	4.79

Formosa Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Rare and Extreme Event - Scenario 3 Ultimate Case - Peak Water Levels (m AHD)	
			200-yr ARI (0.5% AEP)	500-yr ARI (0.2% AEP)
0	428	ALS_Ch0	8.05	8.15
83	345	ALS_Ch83	6.04	6.16
100	328		5.85	5.97
200	228	TD_185	5.21	5.37
300	128		4.93	5.14
338	90	TD172_Su_2015	4.84	5.05
400	28		4.70	4.91
410	18	ALS_Ch410	4.69	4.90
428	0		4.57	4.79

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Appendix J – External Peer Review Documentation

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Ref:	Init:	Date:
43801730	MOBA	23 March 2015

Review of MIKE FLOOD Model – Tingalpa Creek Catchment

Dear Chandra,

In accordance with your request we have reviewed the MIKE FLOOD model developed by Brisbane City Council (BCC) for the purpose of assessing whether the model is technically sound, physically realistic and appropriate for determining the potential for flooding in the Tingalpa Creek catchment. This letter report summarises our findings of the model build with brief recommendations where appropriate.

General Overview

BCC has recently developed a coupled 1D/2D MIKE FLOOD model of the Tingalpa Creek catchment located approximately 12km south-east of the Brisbane CBD. Tingalpa Creek discharges into the Bulimba Creek downstream of Wynnum Road, which subsequently flows into the Brisbane River. The developed MIKE FLOOD model covers an area of approximately 14 km^2 with inflows applied downstream of Old Cleveland Road in Belmont. A 2D MIKE 21 model (4 m grid size) is used to model the floodplain. Structures such as culverts, weirs and bridges are represented in a 1D MIKE 11 model. The two models are coupled via MIKE FLOOD. For this review, model setups for the May 2009, October 2010, December 2010 and January 2012 flood events and the corresponding results were assessed. All four flood events were used for model calibration.

MIKE 21 Model

Bathymetry & Boundaries

The extent of the model area is sufficient as the flood surface does not back up against 'dry land' cells on the model boundary at any location. No obvious interpolation errors or rapidly changing/erroneous bed levels were observed in the grid data. The selection of a 4 m grid resolution is appropriate, considering the resulting 2D grid size of approximately 1.1 million active cells and the hydraulic features being resolved in the floodplain.

The Tingalpa Creek and its tributaries are not represented in the MIKE 11 model. This means that the narrow creek channels in the upstream part of the catchment are only represented by one to two grid cells. However, the waterways in this part of the catchment are shallow and not well-defined. This means that the channel conveyance is not significantly underestimated by the lack of modelling the channels in 1D. This is further confirmed by a comparison of elevation transects extracted from the

4 m model grid and the previously built MIKE 11 model based on bathymetric survey, which shows there is not a significant difference between the creek geometry in the two datasets. As the channel conveyance comprises a very small part of the total channel and floodplain conveyance, the 2D representation of the channel is sufficient and the channel conveyance and geometry deemed adequately represented by the 2D grid spacing used.

Two downstream boundaries are specified in the MIKE 21 setup file and bathymetry, in the upper left corner of the model domain and specified as tide water level boundaries. The setup of all boundaries is deemed appropriate.

Time Step & Courant Number

For MIKE FLOOD applications DHI recommends that a Courant number of less than 1 is maintained. For example, with an approximate maximum flood depth of 5 m, an approximate maximum current speed of 2.5 m/s, a grid size 4 m and a time step of 0.4 seconds, the Courant number is 0.95 and within the recommended guideline.

Coriolis Forcing

Coriolis forcing is applied (a box ticked in Bathymetry in the MIKE 21 setup). Whilst this will not adversely affect model results, it is not relevant for floodplain modelling at this scale.

Flooding & Drying Depths

Flooding and drying are enabled, as they must be for a river flow event inundating a floodplain. A flooding depth of 0.05 m and a drying depth of 0.02 m have been applied. These values are at the upper end of the range of values generally recommended by DHI for a grid size of 4m, but considered valid for this application.

Initial Surface Elevation

The water levels at the downstream boundaries in the initial surface elevation files do not match the water levels at the first time step in the tide water level time series. This should be corrected to avoid a surge of water in or out of the model. A storage basin downstream of Basella Street has been filled in the initial condition map, reducing the volume of floodplain storage available at the start of the simulation.

Eddy Viscosity

Various empirical relationships exist for estimating appropriate values of eddy viscosity in the absence of observed eddy behaviour. High eddy values will normally smooth out the flow variability by transferring the high energy flow from one grid cell to the neighbouring cells with lower energies. A velocity based eddy viscosity of 0.8 m^2/s has been applied globally within the model. This value is within the guidelines recommended by DHI for a grid size between 1 to 10 m. At coupled cells the eddy viscosity has been set to 4 m^2/s to enhance model stability.

Resistance

Seventeen different zones of resistance have been defined in the model. However, the seventeen different Manning's M values used can be grouped into seven main land use types. These represent road pavement, waterways, residential areas (low and high density) and open pervious areas with minimal, moderate and dense vegetation. Based on visual inspection of aerial imagery the Manning's M values defined for these regions are generally appropriate. The number of regions could be reduced without adversely affecting model results as some of the Manning's M values only differ slightly.

Source Points

Flows from sub-catchments within the model domain have been incorporated as source points and their locations are deemed appropriate. A total of 36 source points have been applied in the MIKE 21 model. Most of the source point inflows have been applied to two or more grid cells; this is the correct approach to avoid excessive velocities or 'jetting' to occur at source point locations.

MIKE 11 Model

Network

The MIKE 11 network consists of short (15-50 m) branches used to model structures at 20 locations in the model. The waterway length of all structures exceeds two MIKE 21 model grid cells. Therefore, all structures have been modelled using a culvert only and coupled explicitly in the MIKE FLOOD model (the overland flow on top of the culvert or bridge is modelled in the 2D domain). This is the correct approach to avoid duplication of flow capacity. The roughness for culverts has been set to Manning's n of 0.02 and is considered appropriate.

Cross Sections

Some cross sections upstream and downstream of structures have a natural shape and some have a simplified rectangular or trapezoidal geometry. Using a simplified cross section is justified when modelling small structures. The width of the cross-sections has been reduced to the approximate width of the structure. All cross sections in the model have monotonically increasing conveyance curves.

The invert levels of most cross-sections match the level ("z") values in the MIKE 21 bathymetry to which the cross sections are coupled, which improves stability and is considered good modelling practise. There is a mismatch between the invert levels and the MIKE 21 bathymetry levels at six cross sections: 56 Ingleston Crossing (upstream and downstream), Basin North Trib upstream, Boston Road East upstream and Formosa Road Tingalpa (upstream and downstream). The differences in levels at the mentioned locations are within 5 cm, with the exception of Formosa Road where the difference exceeds 60 cm. It is recommended to adjust the cross section invert levels or the MIKE 21 bathymetry at these couples to ensure the levels are more similar.

A relative resistance factor of one has been applied to each cross section, meaning that the roughness value defined in the hydrodynamic parameter (*.HD11) file is being used. The bed resistance implementation is considered appropriate.

Boundary Conditions

Forty boundary conditions have been assigned in the boundary file at both ends of all branches. All boundaries are defined as water level boundaries. This is the necessary and accepted approach when coupling the branches to a MIKE 21 grid.

Hydrodynamic Parameters

The Delta value on the Default Parameters tab of the HD11 is used to control the time cantering of the solution scheme. The default value is 0.5 which is centred in time and values greater than default can be used to dissipate the wave front to produce a more stable model. A value of 0.6 was found to have been applied, which is acceptable for MIKE FLOOD applications where time steps are small. A global Manning's n value of 0.035 has been applied and is considered appropriate.

MIKE FLOOD Model

Standard Links

The standard links in the MIKE FLOOD models have been defined with a momentum factor of one and an exponential smoothing factor of 0.2. Depth adjustment has also been activated. The definition of the standard links is appropriate.

Results

The MIKE 21 models have a 10 minute save interval and produce result files of between 3.4 and 5.4 GB. Both the save interval and the model result file size are appropriate. The MIKE 11 models also have a 10 minute save interval, which could be reduced to e.g. two or five minutes.

No instabilities were found in the MIKE 21 result file. An animation of the overland water movement did not show water experiencing sharp changes in flow direction at any locations. The overland flow velocity is low in most areas with an average maximum current velocity of between 0.15 and 0.2 m/s in the four calibration events. The longitudinal profiles of the modelled peak flood surfaces along the waterways in the Tingalpa Creek catchment do not show any rapid changes in peak water levels or peak surface slopes.

Some instabilities in discharges were found in the MIKE 11 result files. However, the instabilities in discharges do not cause major instabilities in water levels. Common instabilities found in all four MIKE 11 result files are at the ‘Wynnum Rd’, ‘Manly Rd North’ and ‘Stanbrough Rd East’ structures, see Figure 1, Figure 2 and Figure 3 showing the modelled water levels upstream and downstream of the structures and the discharges at the structures for the May 2009 flood event. The head losses at ‘Manly Rd North’ and ‘Stanbrough Rd East’ are minimal, less than 3 cm on average for all calibration events. Structures with very small head losses can cause model instabilities and should be considered removed from the model.

The head loss at the ‘Wynnum Rd’ structure is significant, but the structure is positioned diagonally to the model grid, which can also result in instabilities. It is recommended to review the modelled discharges in the MIKE 11 result files and assess the context of the structures’ hydraulic impact on the results. A trial run could also be set up with the exponential smoothing factor in the couple file reduced to 0.1 for the problematic structures and the time step reduced to 0.3 seconds to assess if these changes improve the stability of the MIKE 11 discharge hydrographs. Further investigation is warranted of the couple definition to assess if localised smoothing of the bathymetry can also improve the structure stability, by simplifying the pathways for flow into and out of the coupled cells.

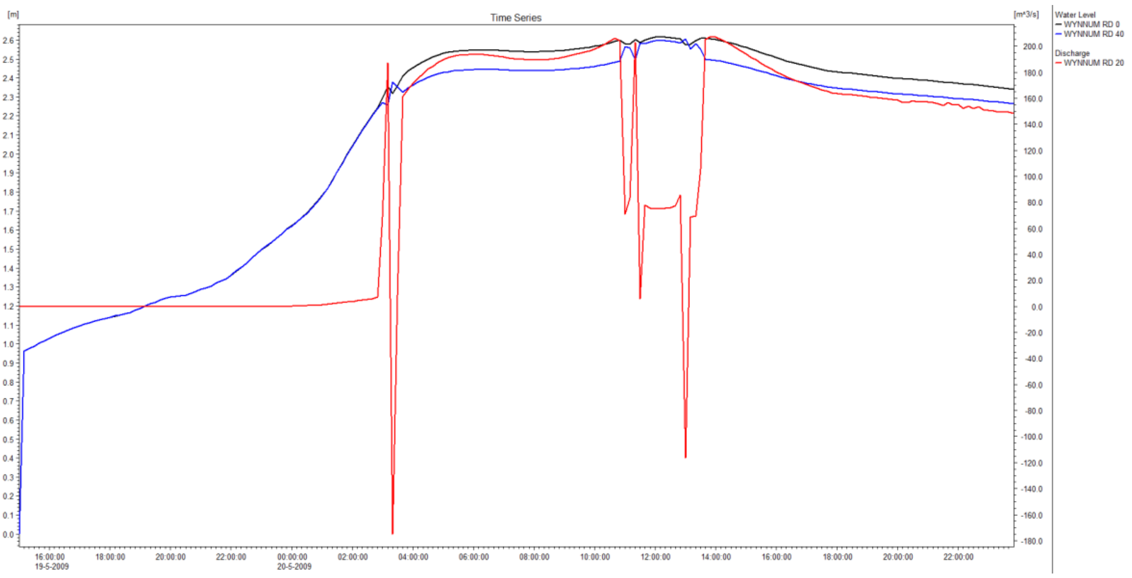

Figure 1 Modelled water levels and discharges at the Wynnum Rd structure – May 2009 flood event

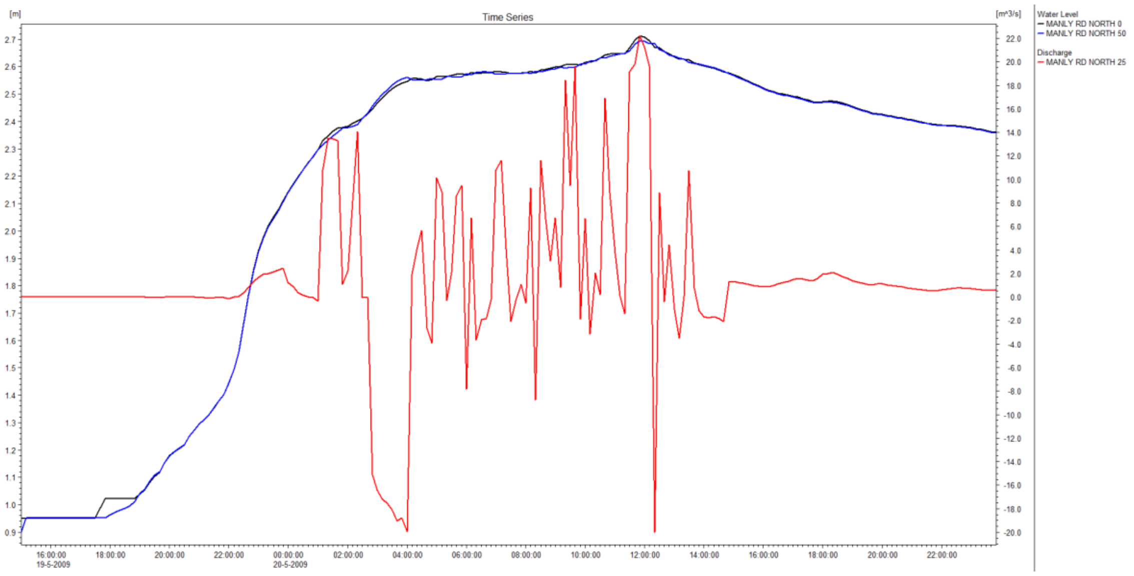

Figure 2 Modelled water levels and discharges at the Manly Rd North structure – May 2009 flood event

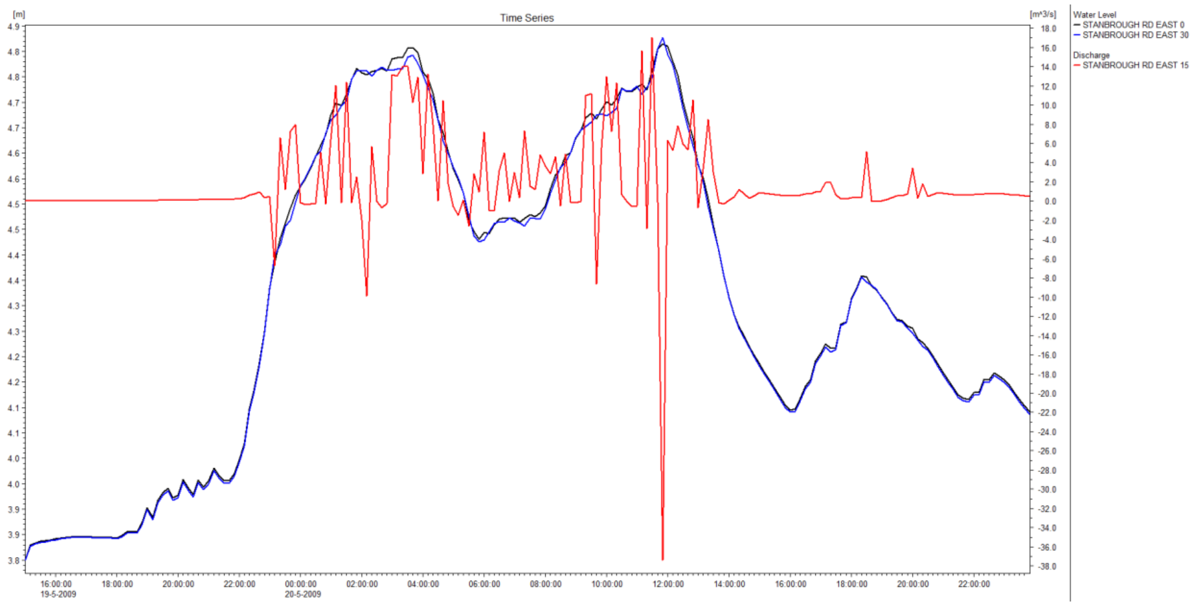

Figure 3 Modelled water levels and discharges at the Stanbrough Rd structure – May 2009 flood event

Summary

Overall the MIKE FLOOD models have been built within the generally accepted guidelines. With the following recommendations the model will be suitable for assessing the potential for flooding and flood hazard within the Tingalpa Creek catchment.

Key recommendations:

- Adjust the initial condition files to ensure the water level applied at the downstream boundaries matches the water level at the first time step in the tide water level time series;
- Adjust the MIKE 11 cross section invert levels or the MIKE 21 bathymetry to ensure the levels at the coupled cells are identical; and
- Review each coupled structure discharge plot in the MIKE 11 result file for instabilities and assessment in context of the structure's hydraulic impact on the results.

Optional:
- Reduce the MIKE 11 save interval from 10 minutes to e.g. 2 or 5 minutes.

Please do not hesitate to contact me if you require further clarifications.

Yours sincerely,
DHI

Monika Balicki
Senior Engineer

Reviewed by

Mark Britton
Global Corporate Relationship Manager (RPEQ No. 06815)

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Ref:	Init:	Date:
43801730	knc	18 June 2015

Review of MIKE Flood Model Results and Study report

Dear Chandra,

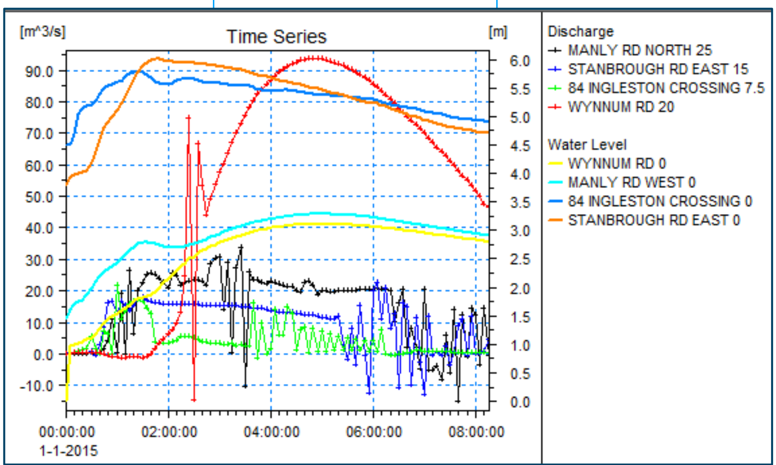
In accordance with your request we have reviewed the Tingalpa Channel Flood Study report and results. In March 2015 a peer review of model build and calibration was carried out by DHI and a review certification document was issued confirming that the MIKE FLOOD model was satisfactory.

Our final review focuses on whether the flood model will meet industry standards and is fit for the purpose. The following table summarises items checked during the review process explaining inputs, description of the present state and a brief recommendation where appropriate. Once all aspects of the review process have been addressed the final report will be signed by an RPEQ certified engineer.

1. Tingalpa Channel Flood Study

The following table provides a description of the items reviewed and describes the inputs/reference; description of the situation and recommendations for improvement or change:

Topic	Item/Reference	Description	Recommendations
1: MIKE21 Model Setup	Model extent, Aerials, Hydraulic Structures, Bathymetry, Initial Conditions, Boundary Conditions,	Model was built to represent floodplain conveyance characteristics appropriately. Model captures hydraulic conveyance losses and storage effects. Design flood extents were checked against glass walling effects and we found the flood envelope contained within model extent	Most of these items were reviewed during model build and calibration phase except model setups associated with design events. Consistency was maintained between calibrated/validated models and design models so that newly setup models meet the same standards.

Topic	Item/Reference	Description	Recommendations
2: Model Input Parameters	Courant Number; Coriolis Forcing; Flooding and Drying Depths; Initial Surface Elevation; Eddy Viscosity	Values from previous model maintained except Initial Water Level where changes were made to match firstly the time step of the model. This was recommended in the previous model review.	Modelling could be simplified by applying some of the previous review comments e.g., Manning's roughness values. Adopting previous recommendations was not mandatory since they will not significantly change the modelling outcome/
3: Mike FLOOD Model	Network; Cross Sections; Boundary Conditions; Hydrodynamic Parameters; Standard Links	MIKE 11 model schematisation and input parameters are appropriate for the flood modelling task. Structure modifications suggested in previous review successfully implemented in the model.	There are still some minor differences between MIKE21 grid elevations and invert levels of MIKE11 cross sections. Discharge fluctuations at the following locations may further reduce by closing the gap between those levels. (see list below) However, these discharge fluctuations did not have any impact on downstream or upstream water levels at affected structures. Further stability checks are not warranted at this stage.
4: Model Results 	TDFS_2015_100y270min & TDFS_2015_100y360min	Model results checked using 100yr 270min and 100yr 360min simulations	There are some discharge fluctuations at Manly Rd, Wynnum Rd, Stanbrough Rd East and the Ingleston Crossing structure locations. As seen in the plot, there is no adverse impact on water levels due to those fluctuations. Most of the discharge anomalies occurred due to local eddies forming upstream of the structure. These eddies may have formed due to various reasons. One common reason being terrain variations or localised low spots adjacent to the structure. No additional suggestions to improve stability at this stage but it is recommended to inspect each hydrograph for the peak rather than simply adopting tabulated values of peak from MIKE View.

Topic	Item/Reference	Description	Recommendations
5: Modelling Report	Table 3.2 Storm events and available recorded rainfall events Table 3.3 Maximum Height Gauge Details and data availability	Reporting storm recurrence interval and time of concentration. Correlation between recurrence interval and reported maximum gauge height.	Approximate ARI value estimated for calibration and validation using different storm durations. The reader might confuse which duration is relevant to local catchment conditions. For example, using any storm duration greater than 6 hours to report ARI of the storm event has reduced relevance if the critical duration of the catchment is less than 6 hours. This has further implications when interpreting MHG readings against recurrence interval. It is recommended to use consistent (for example 0-6hr) time durations to report ARI for all the storm events and use a consistent approach across the whole modelling report.
6: Modelling report	Section 4.2.1 General	Sub Catchment parameters	The same calibrated sub catchment parameters were used for design flood forecasting. All calibrated events lie below the 2yr recurrence interval and so the suitability of some of catchment parameters could be questioned for rare event floods. Recommended to include a limitation statement about the limited number of storm events available for calibration and validation of the model.
7: Modelling Report	Table 4.1 Sub Catchment Parameter adopted in XP-Rafts model	Previous and impervious factions of sub catchments – Existing Conditions utilising BCC aerial photography and BCC City Plan	Similar information for ultimate catchment conditions not presented in the report. Suggest presenting only changed values if most parameters unchanged except for a few catchments.
8: Modelling Report	Section 4.2.6 Hydrologic Roughness (PERN)	Averaged Manning's n Values used and ranged from n=0.03 to n=0.009	Recommend to include average roughness values into same Table 4.1 to have better understanding of the nature of subcatchments.
9: Modelling Report	Table 5.2 Model Setup	Model parameters used in calibration model	Include drying depth to be consistent with Table 7.4. Check Courant number reported in MIKE21 model.

Topic	Item/Reference	Description	Recommendations
10: Modelling Report	Table 5.3 Roughness parameters adopted in Mike Flood Model	Weighted average roughness values per sub catchment	Recommend reporting weighted average roughness value used per catchment. Is it similar to Rafts PERN value? See above (comment 8.)
11: Modelling Report	Section 5.3.7 Boundary Conditions	Catchment inflow locations	Include a sentence about how inflow locations were selected relative to sub catchment i.e., top/bottom or centroid of sub catchment
12: Modelling Report	Table 5.5 Calibration events –Comparison of recorded and estimated flood levels	Difference in flood levels – recorded vs, Modelled	State effort made to get a balanced calibration. For example Upstream – overestimate; Downstream – underestimate. Do changes upstream worsen downstream conditions?
13: Modelling Report	Table 5.6 Validation events Comparison of recorded and estimated flood levels	Difference in flood levels – recorded vs, Modelled	All gauging points show model over estimates flood levels compared to observed levels. Is there room to bring down flood levels slightly in calibration runs and then revalidate? Explain possible reasons behind this. Is this conservative approach desired due to modelling assumptions and input data accuracy?
14 Modelling Report	Calibration Plot	Long section plot for gauge values and profiles of standard design events (2yr ARI to 100yr ARI)	Plotting reported gauge values as points in long section profile plot (with design storm profile) would provide a clear idea of calibration and validation events flood recurrence interval relative to hydraulic model. This will enable user to compare relevance of hydrological recurrence interval estimated in IFD plot and draw conclusion regarding event magnitude and impact on catchment.

Topic	Item/Reference	Description	Recommendations
15 Modelling Report	Section 6.1 Design Event Terminology	AR&R Update	New AR&R update is due for release by end of 2015 or early 2016 and design flow estimation technique and design storm intensity estimation may differ slightly with the new release. Recommended to include statement to revisit model when new design parameters are available and to carry out sensitivity testing to make sure flood estimates will not change by a significant amount.
16: Modelling Report	Section 6.3.2 Hydrologic Roughness (PERN)	PERN hydrologic roughness values for ultimate catchment conditions	Use a similar approach to existing condition. Append these values to % impervious table for ultimate catchment conditions.
17: Modelling Report	Table 6.5 Design event peak discharge at major structures	Source for reported values	Check if peak discharges occurred at discharge spike or natural highest point in the flow hydrograph.
18 Modelling Report	Section 6.5.4 Flood immunity of Existing Crossings	Scenario used to report flood immunity	Explain reason behind using most constrained model scenario to report flood immunity of existing structures.
19: Modelling Report	Flood Maps	Scenario 3 Flood Mapping	Flood maps were not available at the time of model review. Therefore we suggest including a disclaimer for Scenario 3 flood maps stating accuracy and limitations of producing them using a stretching tool and recommending to use them only for planning purposes.
20: Modelling Report	Section 7.22: 200yr and 500yr events	Comparison of AR&R and CRC-Forge design IFD Data	Explain reason for slight change in design IFD values. CRC-Forge applies Aerial Reduction Factors and AR&R method has a separate formula to apply them to estimated IFD values. There is no mention about ARF's in the report.
21: Modelling Report	Section 8.3 Hydraulic Structure Blockage	No. of model scenarios	Not sure how many models were run for hydraulic structure blockage assessment – values of 6, 12 & 13 are mentioned in this section. Also Table 8.5 need to reflect correct blockage simulation name

Topic	Item/Reference	Description	Recommendations
			(A,B,C…L?)
22: Modelling Report	Summary of Study Findings	Model calibration Cross checks of the MIKE FLOOD Structure head loss values Model Accuracy	State model calibration challenges and slightly above reported values at Gauge TD150. This is not presented anywhere else in the report. Include paragraph in the report with table comparing head loss values otherwise remove from summary of study findings. State model accuracy associated with data source and expected tolerance i.e. ± 150mm / ± 300mm

Overall the MIKE FLOOD models have been built to industry accepted standards as fit for the purpose. The draft modelling report needs some further improvements to enhance transparency and highlight modelling assumptions. The report needs further proofreading and alterations to improve clarity and overall readability.

Best regards

DHI

18/06/2015

X

Nilantha Karunarathna
Senior Engineer
Signed by: Kanaththege Nilantha Chaminda Karunarathna

Cc: *Chandra Gunaratne*
Encls: *43801730_Peer_June 15_Invoice.pdf*

Appendix K – Model Files

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Hydrology – XP RAFTS

Folder Structure

- 150337 Tingalpa Channel Flood Study
  - Calculation
    - Flood Management
      - XP-RAFTS
        - TDFS_2015
          - Calibration
            - December_2010
            - January_2012
            - May_2009
            - October_2010
          - Design

File Names

	Event	Run
Calibration / Verification	October 2010	TDFS_2015_October_2010_BMR527.XP
	January 2012	TDFS_2015_January_2012.xp
	May 2009	TDFS_2015_May_2009.xp
	December 2010	TDFS_2015_December_2010_BMR706.xp
Design\ Extreme	Design Events (IFD1987) 2-yr ARI (50% AEP) to 100-yr (1% AEP)	TDFS_2015.xp
	Rare and Extreme Events (CRC Forge) 200-yr ARI (0.5% AEP) 500-yr ARI (0.2% AEP)	
	2000-yr (0.05% AEP) and PMF	
Climate Change	Climate Variability 2050 – CC1 Climate Variability 2100 – CC2	TDFS_2015_Climate_Change.xp

Hydraulics - MIKE FLOOD

Folder Structure

150337 Tingalpa Channel Flood Study

- Calculation
  - Flood Management
    - MIKE FLOOD
      - Calibration
      - Design
        - Existing
        - MRC
        - Ultimate
      - Extreme
        - Existing
        - Ultimate
      - Sensitivity
        - Blockage
        - Climate Change
          - Existing
          - Ultimate

File Names

	Scenarios	Events	Couple File	Tailwater Levels
Calibration / Verification	Scenario 1 Existing	October 2010	TDFS_2015_October_2010.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with the Doughboy Pde stream gauge data as downstream boundary)
		January 2012	TDFS_2015_January_2012.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with the Doughboy Pde stream gauge data as downstream boundary)
		May 2009	TDFS_2015_May_2009.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with the Doughboy Pde stream gauge data as downstream boundary)
		December 2010	TDFS_2015_December_2010.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with the Doughboy Pde stream gauge data as downstream boundary)
Design Events	Scenario 1 Existing	2-yr ARI (50% AEP) to 100-yr ARI (1% AEP)	TDFS_2015_###y###min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
	Scenario 2 MRC	100-yr ARI (1% AEP)	TDFS_2015_###y###min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
	Scenario 3 Ultimate	2-yr ARI (50% AEP) to 100-yr ARI (1% AEP)	TDFS_2015_###y###min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Hemmant Creek Flood Study re-run of Bulimba Creek model with a MHWS of 0.95m AHD at Brisbane River confluence)
Extreme Events	Scenario 1 Existing	200-yr ARI (0.5% AEP) 500-yr ARI (0.2% AEP)	TDFS_2015_###y###min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
		2000-yr ARI (0.05% AEP) and PMF	TDFS_2015_###y360min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)

	Scenarios	Events	Couple File	Tailwater Levels
	Scenario 3 Ultimate	200-yr ARI (0.5% AEP) 500-yr ARI (0.2% AEP)	TDFS_2015_###y###min.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Hemmant Creek Flood Study re-run of Bulimba Creek model with a MHWS of 0.95m AHD at Brisbane River confluence)
Climate Change Scenario	Scenario 1 Existing	100-yr ARI (1% AEP) 2050 (CC1) and 2100 (CC2)	TDFS_2015_100y###minCC1.couple TDFS_2015_100y###minCC2.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
		200-yr ARI (0.5% AEP) 2050 (CC1) and 2100 (CC2)	TDFS_2015_200y###minCC1.couple TDFS_2015_200y###minCC2.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
		500-yr ARI (0.2% AEP) 2100 (CC2)	TDFS_2015_500y###minCC2.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary)
	Scenario 3 Ultimate	100-yr ARI (1% AEP) 2050 (CC1) and 2100 (CC2)	TDFS_2015_100y###minCC1.couple TDFS_2015_100y###minCC2.couple	TWL = Hydrograph at Tingalpa/Bulimba Creek Confluence (Bulimba Creek Flood Study model re-run with a MHWS of 0.95m AHD used as downstream boundary) – Existing Condition

Hydraulics – HEC-RAS

Folder Structure

150337 Tingalpa Channel Flood Study

Calculation

→ Flood Management

→ HecRas

File Names

Structure	Plan Number
Grassdale Road	GrassdaleRoad_A (TIngalpaChannel.p03)
Wynnum Road	WynnumRoad (TingalpaChannel.p02)