Perrin Creek Flood Study

Volume 1 of 2

Prepared by Brisbane City Council and
DHI Water & Environment Pty Ltd

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Executive Summary

This report details the model development, model calibration and verification, design event modelling, extreme event modelling and sensitivity modelling undertaken for the Perrin Creek Flood Study. This study produces flood data which is used to produce flood information products to support future catchment planning and risk management.

Perrin Creek is located in the southern suburbs of Brisbane, encompassing a catchment area of approximately 8.5 km^2. The catchment lies mainly within the suburbs of Morningside, Cannon Hill and Seven Hills. Landuse in the catchment consists of low-density residential development within the upper and middle reaches, and light industry in the lower reaches. Perrin Creek discharges into the Brisbane River immediately downstream of the Cairncross Dockyards in Morningside.

The Perrin Creek catchment has undergone significant development in the last 25 years. The most recent flood investigation prior to this study was completed in 2012, which upgraded hydrological and hydraulic models originally developed in the early 1990's. However the Perrin Creek 1D model from the 2012 study is not able to produce flood information products consistent with current Council standards. Council has therefore decided to develop a new 1D/2D model that can produce required flood information products.

The most recent hydrological model of the Perrin Creek catchment was developed in XP-RAFTS by Council in 2015. This model was reviewed as part of this flood study and used to generate inflow hydrographs. The hydrology model was jointly calibrated with the hydraulic model and then used to generate the design hydrology inputs for the hydraulic model. In addition, extreme event and climate variability model scenario hydrographs were generated using the same model, in accordance with Council's latest design guidelines.

A new hydraulic model was developed for this study using MIKE FLOOD 2014 SP3. The model includes Perrin Creek from Valaria Avenue down to the confluence with the Brisbane River. The catchment upstream of Colmslie shopping centre was modelled using 1D channels while the downstream and the surrounding floodplains were modelled in 2D. The model contains a total of 14 structures, including two bridges and 12 culverts.

The MIKE FLOOD model was calibrated to three historical flood events: May 2015, January 2013 and May 2009, and the model was validated against the January 2015 flood event. The model agreed closely with historical Maximum Height Gauge (MHG) recordings for all events, as well as flood debris marks taken for the May 2015 event. Given the close agreement with the MHG data for the historical events, the model was considered suitable for design and extreme event modelling.

The hydrologic and hydraulic models were used to determine discharges and flood levels in Perrin Creek and its tributaries for a range of design events between the 50% AEP and 1% AEP, and for the 0.5% AEP, 0.2% AEP, 0.05% AEP and PMF extreme events. Design storm durations between 30 minutes and 270 minutes were simulated to develop peak inundation envelopes for each design event.

Peak flood levels were extracted from the modelling results for the design and extreme event models for the existing case scenarios and the ultimate case scenarios. The existing case scenarios used the same topography and roughness values as the 2015 calibration and validation models, as these models represent the current state of the floodplain. The ultimate case scenarios used a modified roughness map based on the ultimate catchment condition in the City Plan (2014). Cross-sections and the 2D grid for events up to and including the 1% AEP flood used a modified topography based on the current Waterway Corridor and Flood Planning Area. For the extreme events the cross-sections and grid were extended based on the results from the 1% AEP ultimate scenario and the method outlined in the BCC Flood Study Procedure Document Version 7.1 (BCC, 2015).

In general, the longitudinal flood peak water level profile was consistent for all design and extreme events, given the catchment slope in the steeper upstream reaches and flatter downstream reaches. In the upstream parts of the catchment the critical duration was approximately 60 minutes. However, in the downstream parts of the catchment (downstream of the Colmslie Shopping Centre) where the floodplain widens and storage attenuates the hydrograph significantly, the critical duration varied between events, and was up to 180 minutes in larger events.

Sensitivity analysis was undertaken for a range of structure blockage scenarios. This included simulation of partial and full blockage of key structures within the catchment for the 1% AEP event. Partial blockage scenarios generally produced no significant increase in peak flood level. However, in the fully blocked scenarios the increase in the 1% AEP peak water level was significant in most cases, and varies between 0.15m and 0.42m at a number of key structures.

Climate variability scenarios were also modelled. This involved modelling 2050 and 2100 scenarios for increased rainfall intensity and increased mean sea levels. The impact of these changes is summarised in **Section 8.0**.

The flood immunity of most structures within the catchment was assessed to be equivalent to less than a 20% AEP flood event, with pipes and culverts around the Colmslie Shopping Centre having a flood immunity equivalent to less than 50% AEP.

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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.
AHD	Australian Height Datum (AHD) is the reference level for defining reduced 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 up to and including the 1% AEP event in this report.
Extreme Event	A hypothetical flood/storm representing a specific likelihood of occurrence greater than (but not including) the 0.05% AEP event in this report.
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.
Probable Maximum Precipitation (PMP)	The maximum precipitation (rainfall) that is reasonably estimated to not be exceeded.
XP-RAFTS	Hydrologic modelling software package.
Very Rare Event	A hypothetical flood/storm representing a specific likelihood of occurrence between the range of 1% AEP (not including) and 0.05% AEP (including) event in this report.

List of Abbreviations

Abbreviation	Definition
1D	One dimensional, in the context of hydraulic modelling
2D	Two dimensional, in the context of hydraulic modelling
EY	Exceedance per year
AMTD	Adopted Middle Thread Distance
ALS	Airborne Laser Scanning

AR&R	Australian Rainfall and Runoff (1999)
BCC	Brisbane City Council
CBD	Central Business District
CL	Continuing rainfall loss (mm/hr)
ECW	Enhanced Compression Wavelet (optimized image format)
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 (2013)
WC	Waterway Corridor
WQA	Water Quantity Assessment

AEP to ARI Conversion

AEP (%) - Actual	AEP (%) - Nominal	AEP (1 in x) - Nominal	ARI (years)
39.3	50	2	2
18.1	20	5	5
9.5	10	10	10
4.9	5	20	20
2	2	50	50
1	1	100	100
0.5	0.5	200	200
0.2	0.2	500	500
0.05	0.05	2000	2000

1.0 Introduction

Brisbane City Council (BCC) engaged DHI Water and Environment Pty Ltd (DHI) in January 2016 to undertake a flood study for the Perrin Creek catchment. City Projects Office (CPO) managed the delivery of the Perrin Creek Flood Study on behalf of the Natural Environment Water and Sustainability (NEWS) branch.

Recently upgraded hydrology models for the catchment were provided by BCC, and DHI carried out hydraulic model development, calibration and validation, and design model simulation and mapping. The hydraulic model was prepared in line with Council requirements for the production of flood information products.

1.1 Catchment Overview

The Perrin Creek catchment is located 8km south-east of the Brisbane CBD. Perrin Creek extends from the Seven Hills Bushland Reserve to its confluence with the Brisbane River. Stream flows enter Perrin Creek from multiple tributaries as far upstream as the foothills of Seven Hills, and as far east as the Park Hill Village in Murarrie. The Perrin Creek catchment covers an area of approximately 8.5 km^2, and includes the suburbs of Cannon Hill, Morningside, Murarrie and Seven Hills. Major roads within the catchment include Wynnum Road, Junction Road and Lytton Road. The Perrin Creek catchment is shown in **Figure 1-1**.

The Colmslie Shopping Centre is located in the centre of the catchment, and the shopping centre carpark experienced extensive flooding from Perrin Creek overflows during the May 2015 flood event. This location in the catchment is a pinch-point that constrains the flow from the upper parts of the catchment due to the size of the culverts and alignment complexity under the shopping centre, as well as siltation issues that can result in reduced culvert capacity.

1.2 Study Background

Flood investigation for the Perrin Creek catchment was initially carried out in the late 1990's, using an XP-RAFTS catchment hydrology model and a one-dimensional MIKE11 hydraulic model of the creek. There have been several updates to the flood models since the original model was developed.

The most recent flood investigation of Perrin Creek was completed in 2012, and this included changes to the creek and floodplain resulting from the development of the Port of Brisbane land downstream of Lytton Road. The works associated with that investigation were a continuation of the hydrology and hydraulic model upgrade works initiated in 2006-2008. The study produced an updated XP-RAFTS (version v2009) and an updated MIKE11 model (version v2009), and estimated design flood levels for events up to and including the 1% AEP event. In 2013, some additional work was undertaken to model climate variability and extreme event scenarios, and an addendum report was prepared to document this work.

The following hydraulic modelling study reports document these previous investigations into the Perrin Creek catchment:

- Perrin Creek Flood Investigation (BCC 2012)
- Perrin Creek Flood Investigation - Addendum Report – Extreme Event and Climate Variability Analyses (BCC 2013)

1.3 Study Objectives

This flood study supports Council's planning policy and flood risk management. Flood levels, depths, extents and hazard information for a range of design flood events will be used to inform flood information products identified in the Brisbane City Plan 2014, including Flood Wise Property Reports and Flood Overlays.

The main reasons for upgrading the previous Perrin Creek flood investigations are:

- A more detailed model is required to improve schematisation of some structures which are thought to act as significant constraints to creek discharges.
- Council wishes to update the model to take advantage of improvements in flood modelling software and modelling techniques. The most recent hydraulic model is a 1D model, and it is expected that two dimensional (2D) modelling will better represent the topography of the floodplain and flow paths of the creek, in particular within the Colmslie Shopping Centre area.
- The existing 1D hydraulic model cannot produce reliable hazard/velocity information within the floodplain, which is required to produce Flood Planning Areas (FPA) in accordance with the City Plan (2014).
- Council wishes to ensure that flood models and reports are consistent across all Council's creek catchments.

1.4 Scope of the Study

This flood study provides a new hydraulic model (MIKE FLOOD) and an updated hydrologic model (XP-RAFTS). The models were calibrated and validated to four recent historical events, including an iterative joint calibration exercise during which both sets of model parameters were simultaneously evaluated against recorded flood level data. The following primary tasks were carried out during the flood study:

- Data review and field inspection reporting.
- Development of the hydraulic model using MIKE FLOOD Version 2014 SP3.
- Update of the hydrology model in XP-RAFTS 2013 SP1.
- Structure loss comparison and reporting.
- Joint model calibration and validation.
- Preparation and simulation of the Base Case, Minimum Riparian Corridor (MRC) and Flood Corridor (FPA3/4+WC+MRC) scenarios for a range of probabilities between 50% AEP and Probable Maximum Flood (PMF).
- Structure blockage and climate variability modelling.
- Production of flood extent maps.

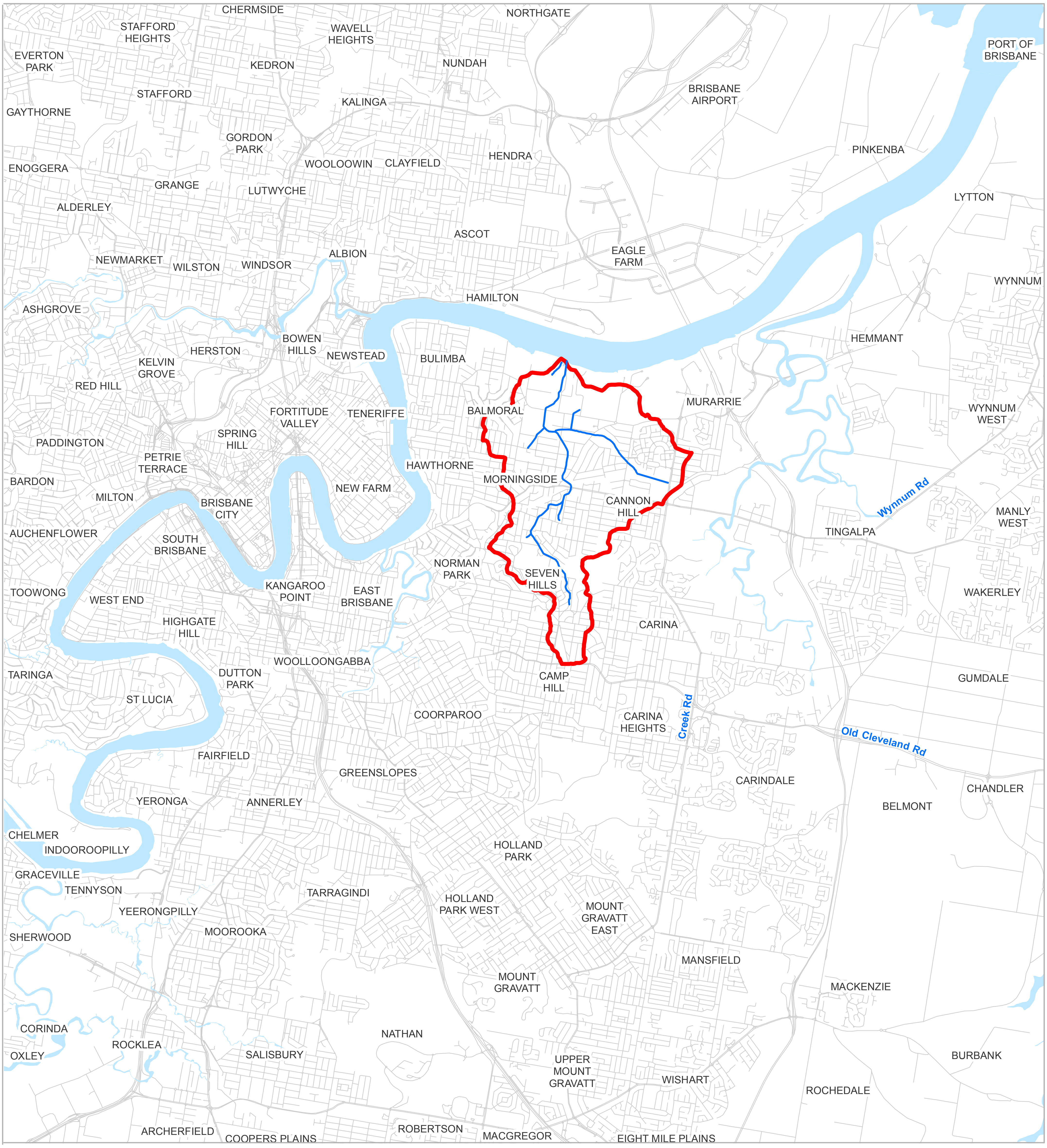
1.5 Study Limitations

Flood records within the catchment for the selected calibration and validation events were limited to Maximum Height Gauge records at discrete locations and some surveyed debris levels. No continuous gauging records of level or flow in Perrin Creek or its tributaries exists. Whilst the calibration and validation results indicate that Council can have strong confidence in the models' predictive capability, the lack of any information on timing to peak and catchment response is a recognised limitation.

Hydraulic structure data used in the model has been sourced from design drawings, as-constructed survey, previous model inputs and measurements taken during site inspection, as described in **Section 3.4**. The model results are reliant on the accuracy of these hydraulic structure inputs.

Key limitations on the study are identified as:

- Calibration was limited to Maximum Height Gauge records
- When structure information was not available or discrepancies were observed between different sources of structure data, the information was verified via site observation
- Some structures were omitted where these were considered to have minimal impact on flood levels and flow paths, in particular footbridges where the deck level was elevated above the floodplain
- There was limited information available about the state of the creek channel downstream of Lytton Road during the 2009 May flood event, and no measured water level data was available for the 2009 calibration event



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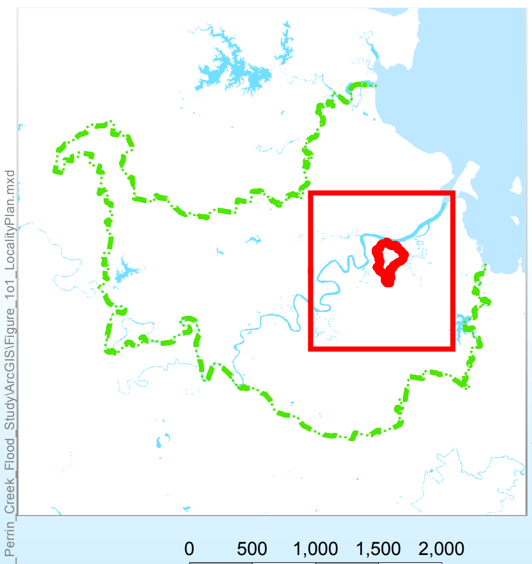

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Legend

- Perrin Creek Waterway
- Perrin Creek Catchment
- Brisbane City Boundary

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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.

Perrin Creek Flood Study 2016

Figure 1.1: Perrin Creek Catchment - Locality Plan

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Checked : CG
Revision : 0
Publication Date : 31 May 2016
Project Number : 150851

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2.0 **Catchment Description**

2.1 Catchment, Waterway Features and Characteristics

Perrin Creek is located in the southern suburbs of Brisbane, lying within the suburbs of Morningside, Cannon Hill and Seven Hills. The creek discharges into the Brisbane River immediately downstream of the Cairncross Dockyards, Morningside as shown in **Figure 1-1**.

Catchment landuse currently includes low-density residential development in the upper and middle reaches, and light industry in the lower reaches. Some significant features in the catchment are shown in **Figure 2-1**. The catchment is almost entirely urbanised, with only isolated pockets of potential new future urban development situated within the region bounded by Lytton Road and Beelarong Street, Morningside.

Perrin Creek is predominantly an open channel system. Flow is conveyed underground for an isolated reach between Wynnum Road and Baringa Street. Upstream of Wynnum Road up to Elwell Street, the open channel is largely concreted and heavily constrained by residential development on both sides of the creek. From downstream of Algoori Street to Lytton Road (Riverside Channel), the creek flows through a constructed channel, and mangroves line the banks of the Creek in this reach. An open channel downstream of Lytton Road (Riverside Channel) conveys the flow to the Brisbane River. A portion of this reach was excavated and lined with concrete-filled mattresses in 1990. Recent works have been undertaken by the Port of Brisbane Corporation to divert the natural flow into the constructed section, with the natural creek channel being filled.

2.2 Perrin Creek and Tributaries

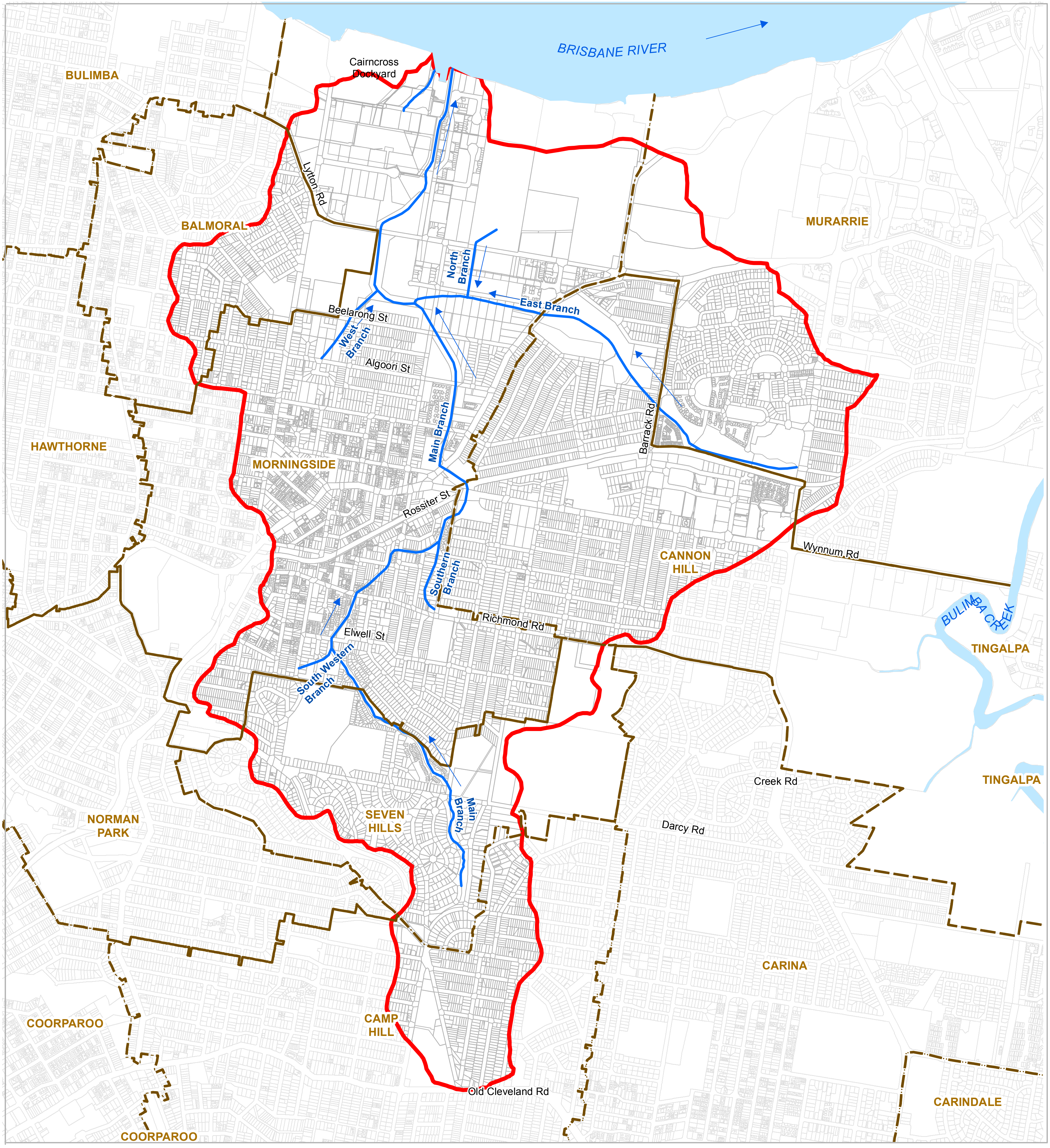
There are four major tributaries feeding into the main branch of the Creek. These are East Branch (Branch 2), West Branch (Branch 3), South-Western Branch (Branch 6) and Southern Branch (Branch 7) as shown in **Figure 2-1**. Another branch, named North Branch (Branch 4) feeds into East Branch in between Riverside Place and Col Gardner Drive. A section of creek upstream of Elwell Street to Valaria Avenue (Branch 5) is a natural channel with some modified channel sections.

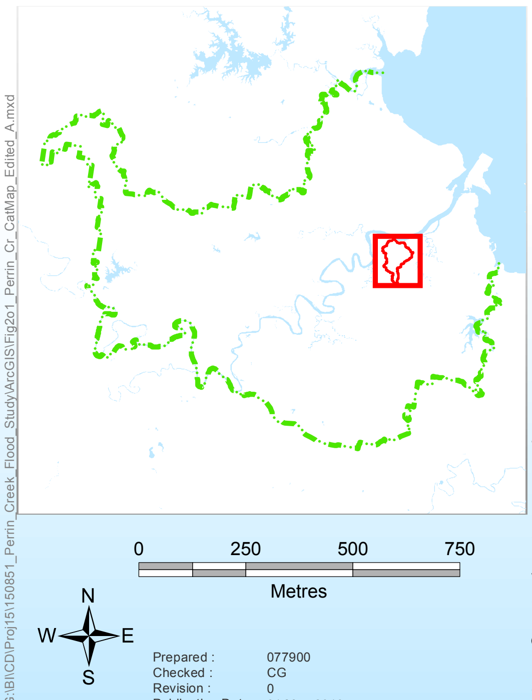
The Branch 3 and Branch 4 tributary floodplains are mainly low lying and grassy. The degree of urban development on Branch 2 varies along its length. Low lying grassy floodplains exist in the upper reaches, followed by light residential development and heavily vegetated sections adjacent to the Cannon Hill Anglican College. Branch 6 contains heavily vegetated banks and joins Perrin Creek to the north of Elwell Street. Branch 7 is a concrete lined channel that starts to the south of Richmond Road.

2.3 Catchment History

Perrin Creek has undergone significant development in the last 25 years. Key changes in the creek waterway include:

- Concrete lining of the sections between Richmond Road and Lang Street in the 1950s and 1960s
- Construction of the Colmslie Hotel and Colmslie Shopping Centre were completed in the mid-1980s, and the associated piping of the creek between Wynnum Road and Baringa Street. Further extensions of the Colmslie Shopping Centre completed in 2002–04.
- The creek between Baringa Street and Lytton Road was further modified by the construction of a wider open channel in the late 1990s as part of residential development near Baringa Street, and industrial development on the eastern bank near Lytton Road. A tidal barrage was also completed just downstream of Algoori Street as part of this development. The State Hockey Centre (located in Colmslie Reserve east of the Riverside Channel – see **Figure 2-1**) was built in the early 1990s over a breakout path to the Brisbane River, requiring redirection of flows to the south.
- The Riverside Channel was built as part of Riverside Place, an industrial area constructed adjacent to Perrin Creek downstream of Lytton Road. This channel was not connected to the Creek prior to 2009 due to environmental reasons, however it was able to act as an overflow path in times of flooding.
- Following investigations by Council in 2001, an additional span was added to the Lytton Road crossing to provide a wider waterway area.
- Following changes to the lower reaches of Perrin Creek by Port of Brisbane in 2009, part of the Perrin Creek main branch was filled downstream of Lytton Road and the flow is now directed to the Brisbane River through a recent connection to the Riverside Channel.





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Legend

- Flow Direction
- Perrin Creek Waterway
- Perrin Creek Catchment
- Cadastre
- Suburb Boundaries

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Figure 2.1: Perrin Creek Catchment Map and Creek Layout

DATA INFORMATION

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3.0 **Available Information**

3.1 Previous Studies

The previous reports listed below were reviewed for relevance to the current investigations in terms of providing background information and data for modelling purposes and understanding staging of upgrades and works within the catchment:

- Perrin Creek Flood Investigation Addendum – Extreme Event and Climate Variability Analyses (BCC, 2013)
- Perrin Creek Flood Investigation (BCC,2012)
- Colmslie Industrial Land – Hydraulic Analysis (2005)
- Perrin Creek Development and Model Review (2004)
- Upgrade Lytton Road (Perrin Creek) Flood Mitigation Investigation (BCC, 2001)
- Lytton Road (Perrin Creek) Flood Mitigation Investigation (BCC, 1999)
- Perrin Creek Master Drainage Plan (GHD, 1992)

3.2 Topographic Data

The following sections list the various sources of topographic data used during development of the MIKE FLOOD hydraulic model.

3.2.1 Existing and New Survey Information

- 2015 cross-section survey
- 2009 & 2012 MIKE11 models (cross-sections)
- Balmoral Pool survey data
- Perrin Creek survey data
- Lytton Road Cycleway design drawings
- Perrin Creek Bikeway Morningside design elevation data
- Cannon Hill Bikeway design data
- Lytton Road Bridge Extension design data
- Colmslie Shopping Centre as-constructed stormwater drawings
- Concrete Channel (Elwell Street – Richmond Road) design drawings

3.2.2 Aerial Imagery and Airborne Laser Scanning (ALS) Data

- 2014 ALS (1m grid)
- 2009 ALS (2m grid)
- 2012 Aerial Images
- 2009 Aerial Images
- 2001 Aerial Images
- 1997 Aerial Images

3.2.3 Field Inspection Data

A field inspection was undertaken on 28th January 2016 and attended by project staff from both BCC and DHI. The field inspection had the following objectives:

- to allow the project team to obtain a general understanding of likely flood risk within the catchment;
- to familiarise the project team with the study area and with the major structures, roads and other key features;
- to understand recent changes to the catchment that are not reflected in the existing model; and
- to take on-ground measurements of structures where these were needed.

The Field Inspection Report summarises information gathered during the field inspection. It was submitted to Council as a separate deliverable and is referenced in **Section 10** of this report.

3.3 Hydrometric Data

3.3.1 Recorded Rainfall

Pluviograph data availability for the Perrin Creek catchment is limited. One rainfall station (P_R029) existed within the catchment at Morningside until the mid-2000's but is now closed. However, there are rainfall recording stations located nearby within the Pashen Creek and Norman Creek catchments.

Station details and the availability of data for the selected calibration and validation events are listed in **Table 3-2**. Cumulative rainfall plots for selected historical rainfall events are included in **Appendix A** for both the Pashen Creek and Norman Creek pluviographs.

3.3.2 Recorded Flood Levels

3.3.2.1 Stream Height / Maximum Height Recording Stations

There is no continuous stream height gauge located within the Perrin Creek catchment. However, there are several Maximum Height Gauges (MHG) located in the middle and lower reaches of the catchment. **Table 3-1** below indicates the availability of MHG data, and **Table 3-3** gives MHG location details and their recorded flood heights for the selected calibration and validation events. Locations of the MHGs are shown in **Figure 3-1**.

Table 3-1 Availability of MHG Data within the Perrin Creek Catchment

MHG ID		P003	P005	P100	P110	P115	P120	P130	P230
Location		Baringa St DS	Jersey St US	Lytton Rd US	Beeralong St US	Baringa St DS	Railway line US	Jersey St US	Rosewood Pl
MHG Flood Level Data Availability	20-Nov-79	✗	✗	✗	✗	✗	✓	✗	✗
	05-May-80	✗	✗	✓	✓	✗	✓	✗	✗
	31-Dec-80	✗	✗	✗	✓	✗	✗	✗	✗
	22-Jun-83	✗	✗	✓	✓	✗	✓	✗	✗
	08-Apr-84	✗	✗	✓	✓	✗	✓	✗	✗
	04-Apr-88	✗	✓	✓	✓	✗	✓	✗	✗
	06-Jul-88	✗	✓	✓	✓	✗	✓	✗	✗
	06-Apr-90	✗	✓	✓	✓	✗	✓	✗	✗
	12-Dec-91	✗	✗	✗	✓	✗	✗	✗	✗
	09-Feb-92	✓	✓	✓	✓	✗	✓	✗	✗
	21-Feb-92	✗	✓	✓	✓	✗	✗	✗	✗
	03-May-96	✗	✓	✓	✓	✗	✓	✗	✗
	04-Dec-96	✗	✓	✗	✗	✗	✓	✗	✗
	09-Mar-01	✗	✓	✗	✓	✗	✓	✗	✗
	10-Mar-01	✗	✗	✗	✗	✗	✗	✗	✗
	20-May-09	✗	✗	✓	✓	✗	✓	✗	✗
	27-Jan-13	✗	✗	✓	✗	✓	✗	✗	✓
	23-Jan-15	✗	✗	✗	✗	✓	✗	✗	✓
	20-Feb-15	✗	✗	✓	✗	✓	✗	✗	✗
	01-May-15	✗	✗	✓	✓	✓	✓	✗	✓

The following flood events were selected for the calibration and validation of the Perrin Creek hydrology/hydraulic flood models:

- May 2009;
- January 2013;
- January 2015; and
- May 2015.

Section 4.3 discusses how these calibration and verification events were selected.

3.3.2.2 Debris Marks

Post flood event survey of debris marks exist for the May 2015 flood event. The location and surveyed levels of the debris marks are detailed in **Table 3-4**.

Table 3-2 Rainfall Gauge Details and Data Availability for Calibration/Verification Events

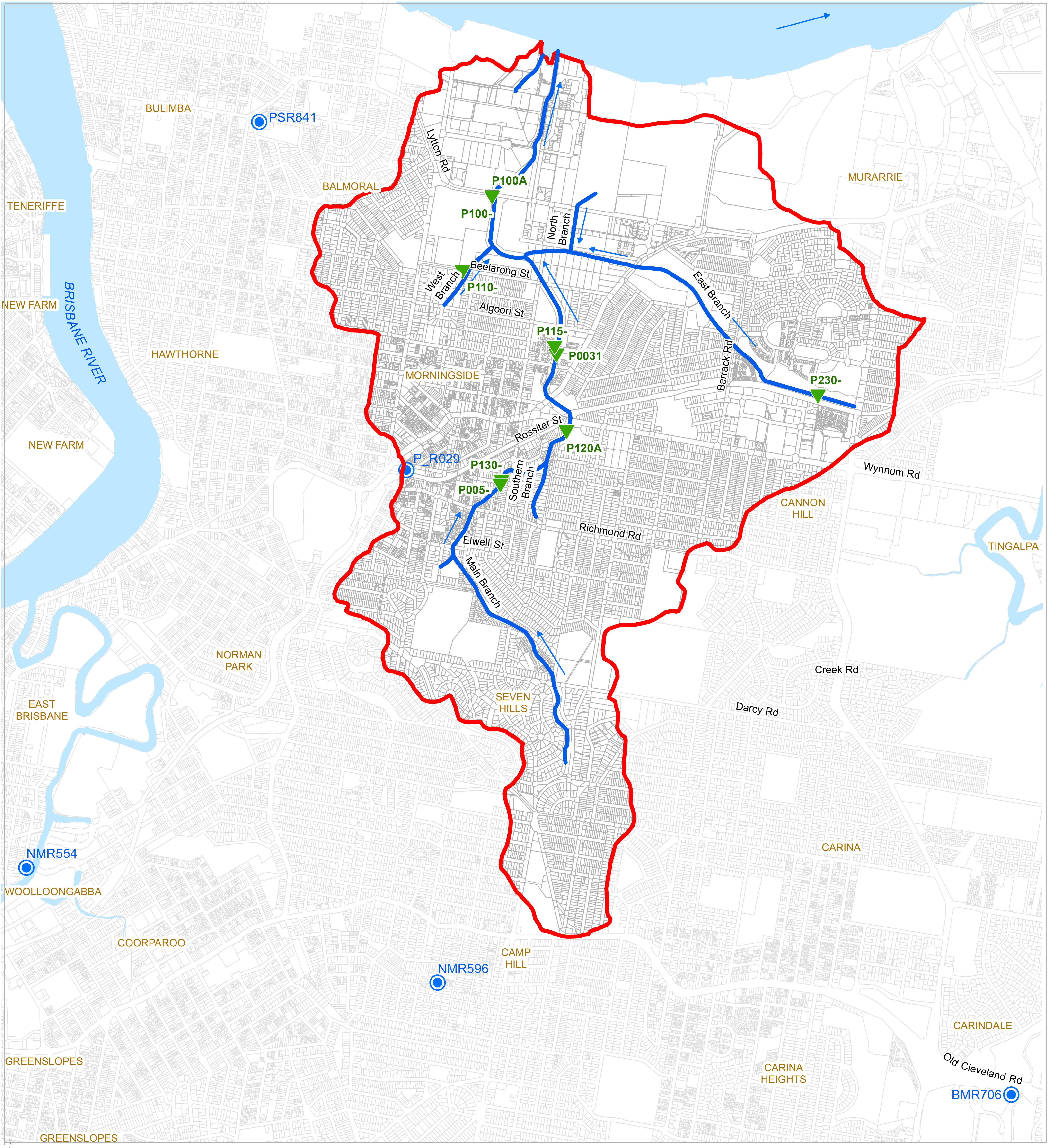
Rain Gauge ID	Location / Catchment	Operating period	Storm event			
			20/05/2009	27/01/2013	23/01/2015	01/05/2015
NMR596 (PP.E1596 @540240)	Norman Creek Tarana Street, Camp Hill	March 1998 to date	✓	✓	✓	✓
PSR841 (PP.E1841 @540369)	Pashen Creek Bulimba Library – Oxford Street	February 2005 to date	✓	✓	✓	✓

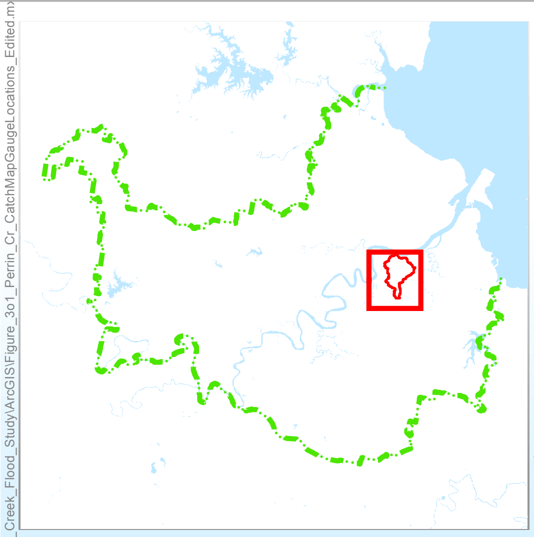
Table 3-3 MHG Details and Data Availability for Calibration/Validation Events

MHG ID	Location	MHG Flood Level Data (mAHD)			
		20/05/2009	27/01/2013	23/01/2015	01/05/2015
P005	Jersey St US	-	-	-	-
P100	Lytton Rd US	2.68	2.00	-	2.44
P110	Beeralong St US	2.69	-	-	2.53
P115	Baringa St DS	-	2.42	2.46	2.82
P120	Railway line US	4.04	-	-	4.67
P230	Rosewood Pl	-	6.84	6.33	7.27

Table 3-4 May 2015 Flood Event Debris Mark Survey

Site Ref.	Survey Point X Coordinate (GDA96)	Survey Point Y Coordinate (GDA96)	Surveyed Peak Flood Level (mAHD)	Site Location
A	507934.13	6962354.38	2.66	2 Brenda Street, Morningside.
B	507935.31	6961865.79	4.81	25 Junction Road Morningside.
C	507871.52	6961730.61	4.98	8 Rossiter Street Morningside.





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Legend

- Maximum Height Gauge
- Perrin Creek Waterway
- Perrin Creek Catchment
- Rainfall Gauges
- Flow Direction

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Perrin Creek Flood Study 2016

Figure 3.1: Perrin Creek Catchment Hydrometric Gauge Locations

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3.3.3 Tidal Information

Water levels in the downstream reaches of Perrin Creek are subject to tidal influence from the Brisbane River. Furthermore, for flood events in Perrin Creek where local catchment flooding is coincident with flooding in the Brisbane River, the flood-generated additional water depth above the tidal water level needed to be estimated at the confluence.

The Port of Brisbane Corporation provided historical tide measurement data at Sugar Berth. This measurement station is located only 1.5km downstream from the confluence of Brisbane River and Perrin Creek, and four years of measured data from June 2010 to December 2015 was available for this study. The measured data period included two of the calibration events of which one validation event was selected for this study, and for these events the Sugar Berth recorded water level was directly applied as the downstream water level, with no adjustment.

The May 2009 calibration event was not included in the recorded data set at Sugar Berth, so downstream boundary conditions for the MIKE FLOOD model were estimated for this event. The comparison between observed and predicted (generated in the MIKE21 Toolbox using tidal constituents for the Brisbane Bar Gauge) shows the extent and magnitude of the 2009 flood event at the Brisbane Bar location (refer to **Figure 3-2**). However, the additional water depth above the expected tidally generated water level (in this case ~0.5m) is not only event specific, but is also expected to vary with location due to flood water slope and tidal interaction influence.

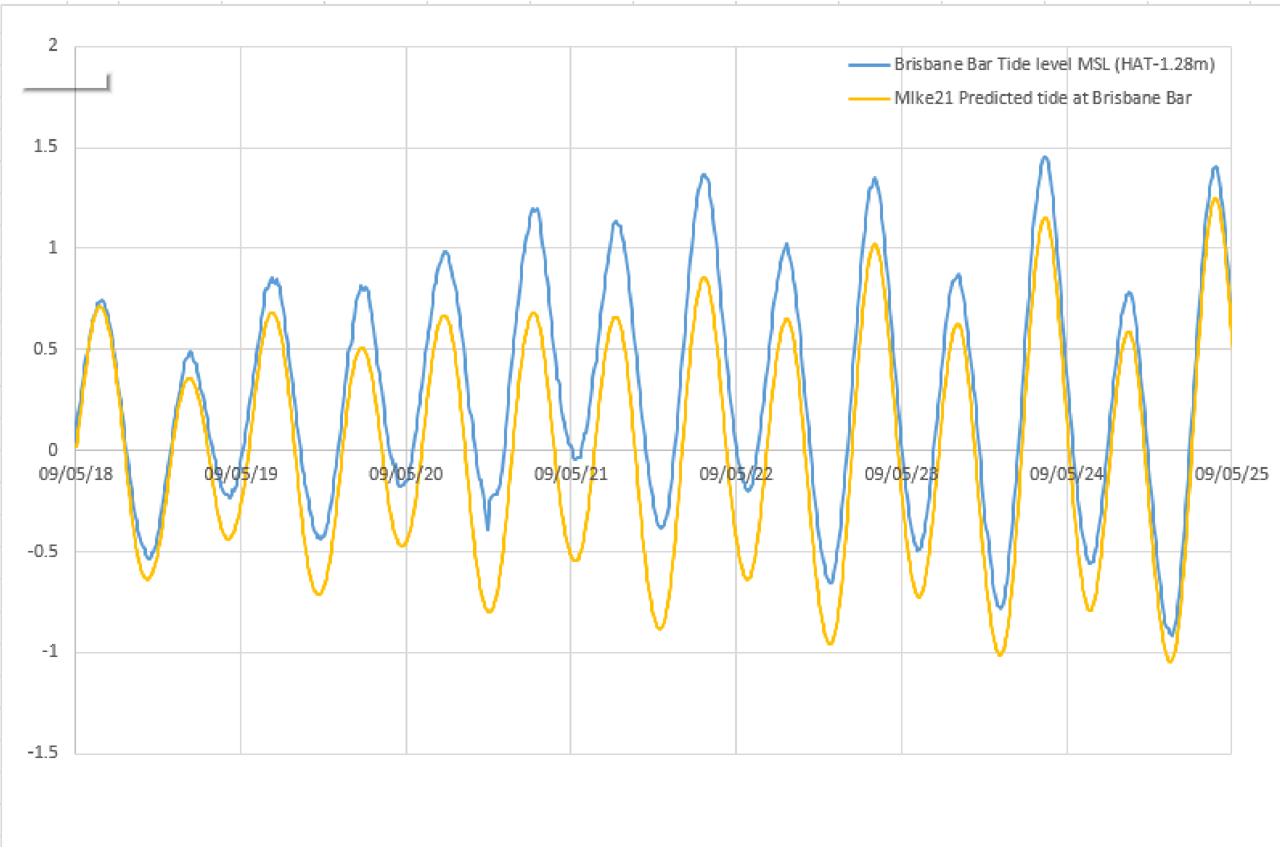


Figure 3-2 Brisbane Bar observed water levels and predicted tide levels (May 2009)

The differences between water levels at Brisbane Bar and Sugar Berth (including additional flood component and tidal phase and amplitude) were examined using available observed flood water levels during the January 2013 flood event. **Figure 3-3** shows a good match in recorded level for this particular flood event, with only minor phase and magnitude differences on high tides. On neap tides it was observed that the level at Sugar Berth the level was 0.22m higher than at the Brisbane Bar.

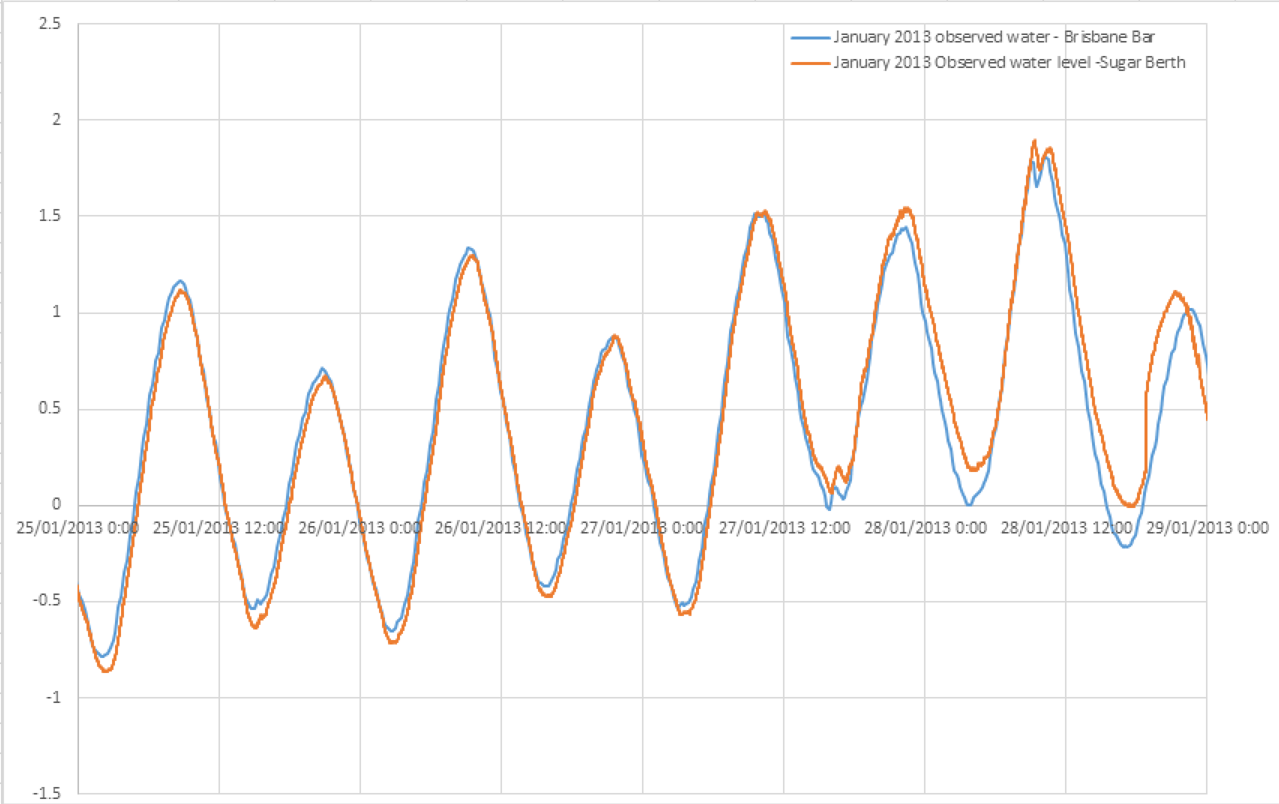


Figure 3-3 Observed water levels at Brisbane Bar and Sugar Berth (January 2013)

Allowing for the average difference in tide level between the Brisbane Bar and Sugar Berth, and adding 0.22m (the Perrin Creek May 2009 flood peak coincides with a neap tide in the Brisbane River), the observed tide levels at Brisbane Bar were adjusted to create a time series of water level that could be used as a downstream boundary condition for Perrin Creek in the May 2009 calibration event.

3.4 Hydraulic Structure Data

Hydraulic structure data gathered during the data review and the field inspection was compiled into the Field Inspection report as a separate document and is referenced in **Section 10** of this report.

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 the Perrin Creek catchment was initially developed as part of the Perrin Creek Flood Investigation (BCC, 2012). Preliminary assessment of the XP-RAFTS (2012) model indicated that the model required modification as follows:

- Update of sub-catchment delineation to produce better definition in the hydraulic model.
- Update of the impervious fractions with reference to the City Plan (2014) and QUDM (2008, 2013).
- Update of the channel routing and lag links between catchments (nodes).
- Estimation and update of the sub-catchment slopes based on the equal area method.
- Update of the sub-catchment PERN values.
- Update of the storage discharge characteristics for the detention basins/storage areas.

The hydrologic model developed for this study was simulated using XP-RAFTS Version 2013.

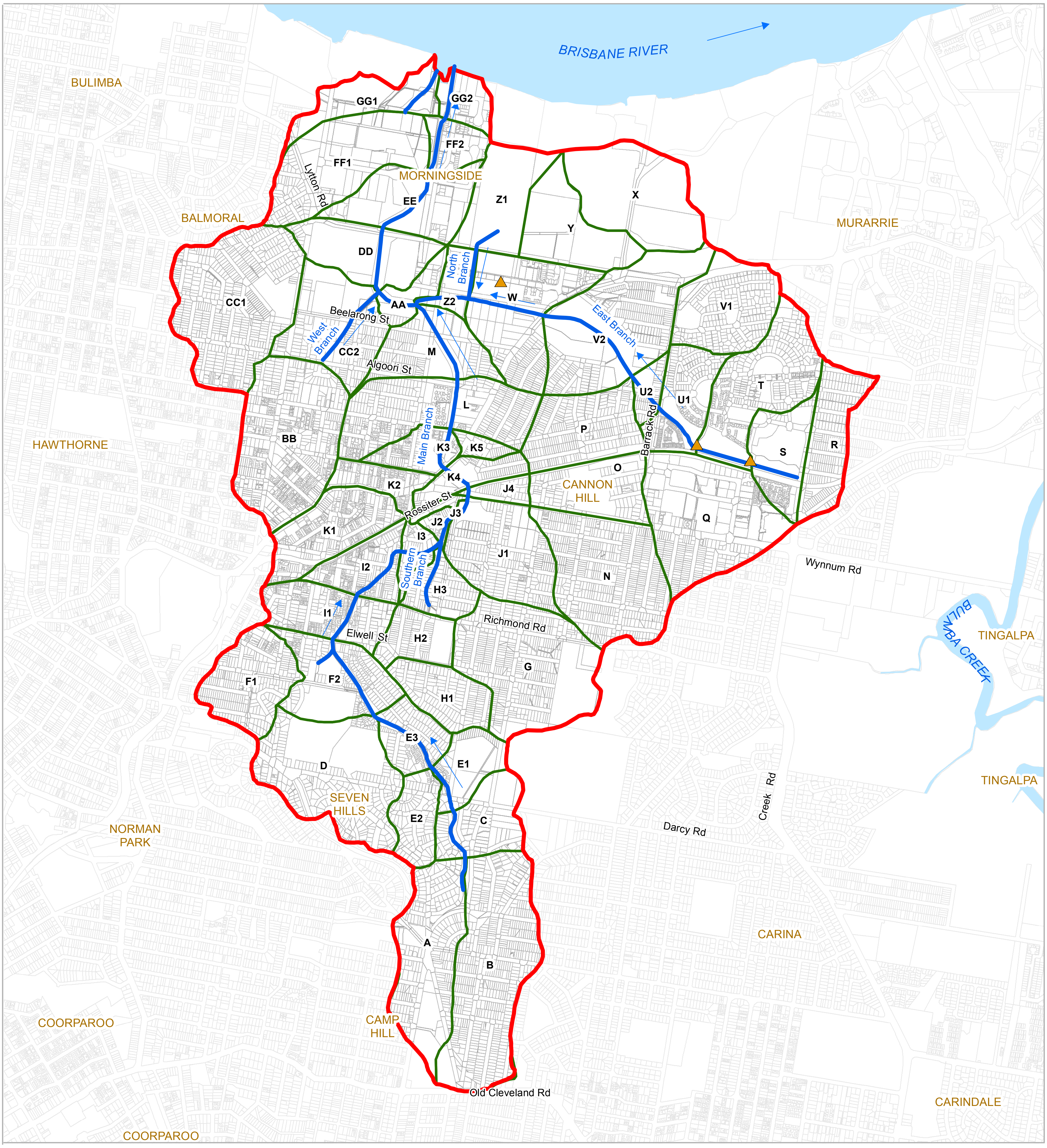
4.2 Hydrological Model Set Up and Schematisation

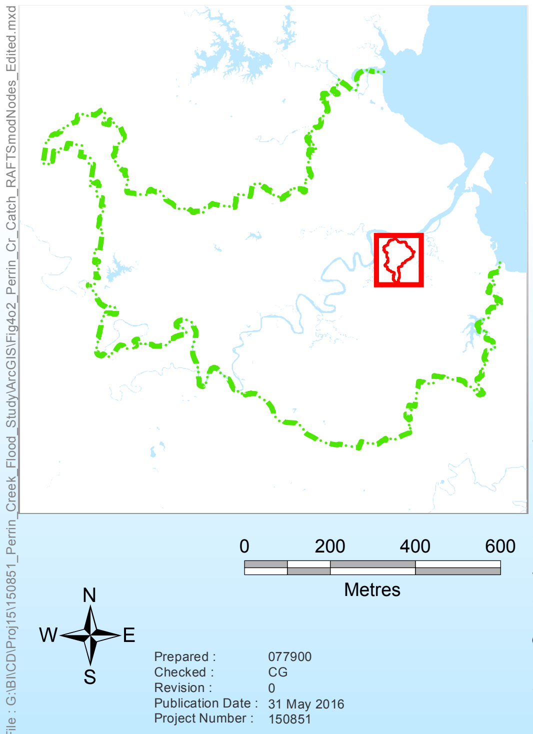
4.2.1 General

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 **Appendix B**. 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 Perrin Creek XP-RAFTS model comprises 53 sub-catchments, the layout of which is shown in **Figure 4-1** and **Figure 4-2**. Total catchment and sub-catchment delineation was adjusted from the 2012 model to better represent current catchment conditions. This included sub-dividing several sub-catchments into smaller sub-catchment regions to better represent the stormwater discharge locations and inflows into the MIKE FLOOD hydraulic model. Each sub-catchment in XP-RAFTS 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 **Appendix B**.





Legend

- RAFTS Basin
- Perrin Creek Waterway
- Perrin Creek Catchment
- Sub-Catchments
- Flow Direction

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Perrin Creek Flood Study 2016

Figure 4.1: Perrin Creek Sub-Catchment Layout

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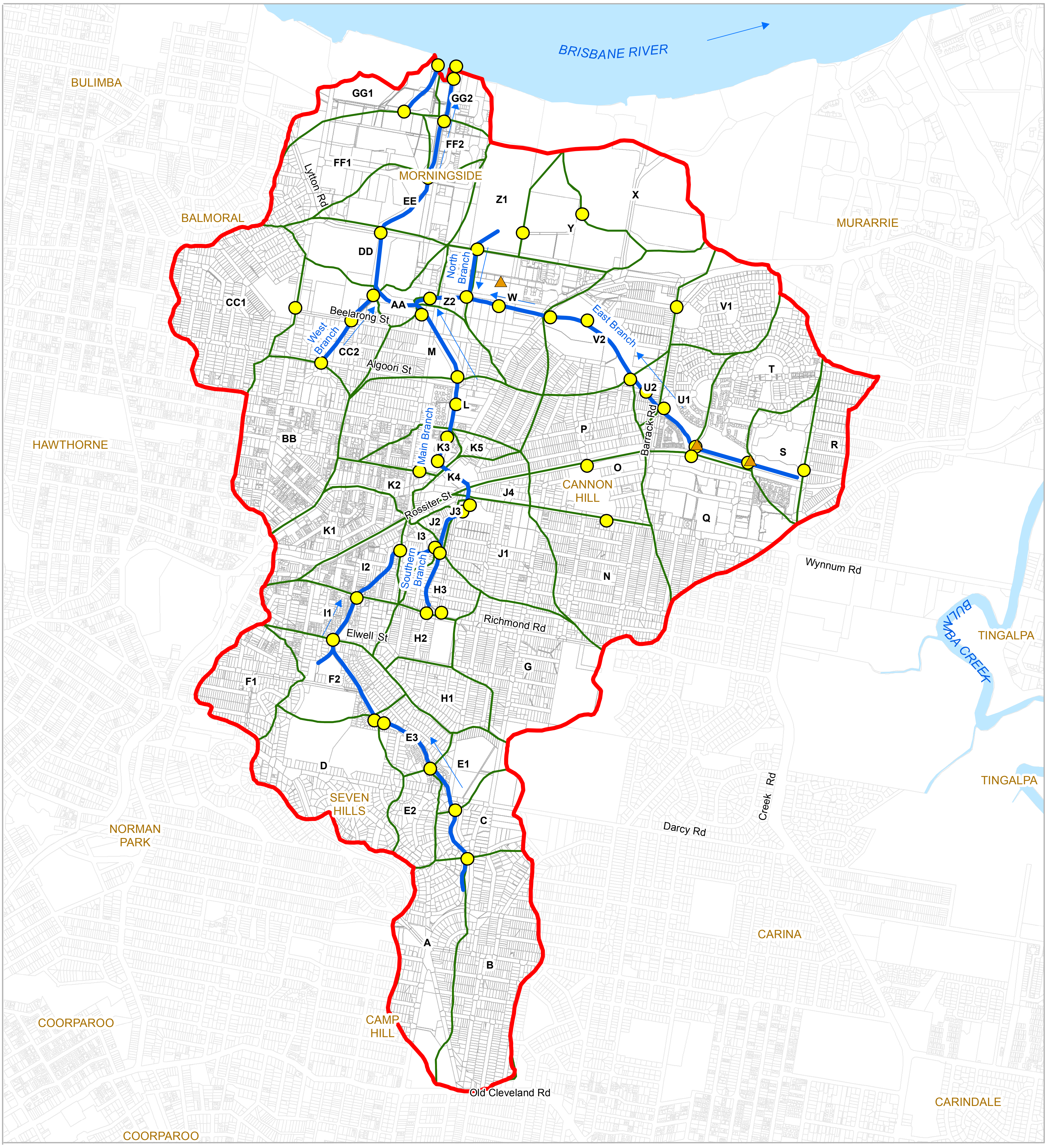

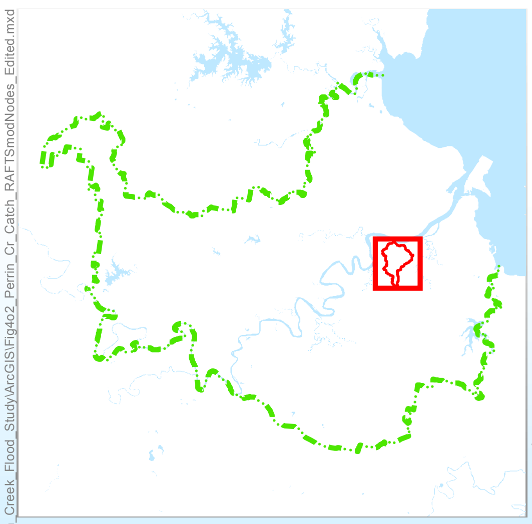

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Legend

- RAFTS Basin
- RAFTS Nodes
- Perrin Creek Waterway
- Perrin Creek Catchment
- Sub-Catchments
- Flow Direction

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Figure 4.2: Perrin Creek Catchment XP-RAFTS Model Nodes

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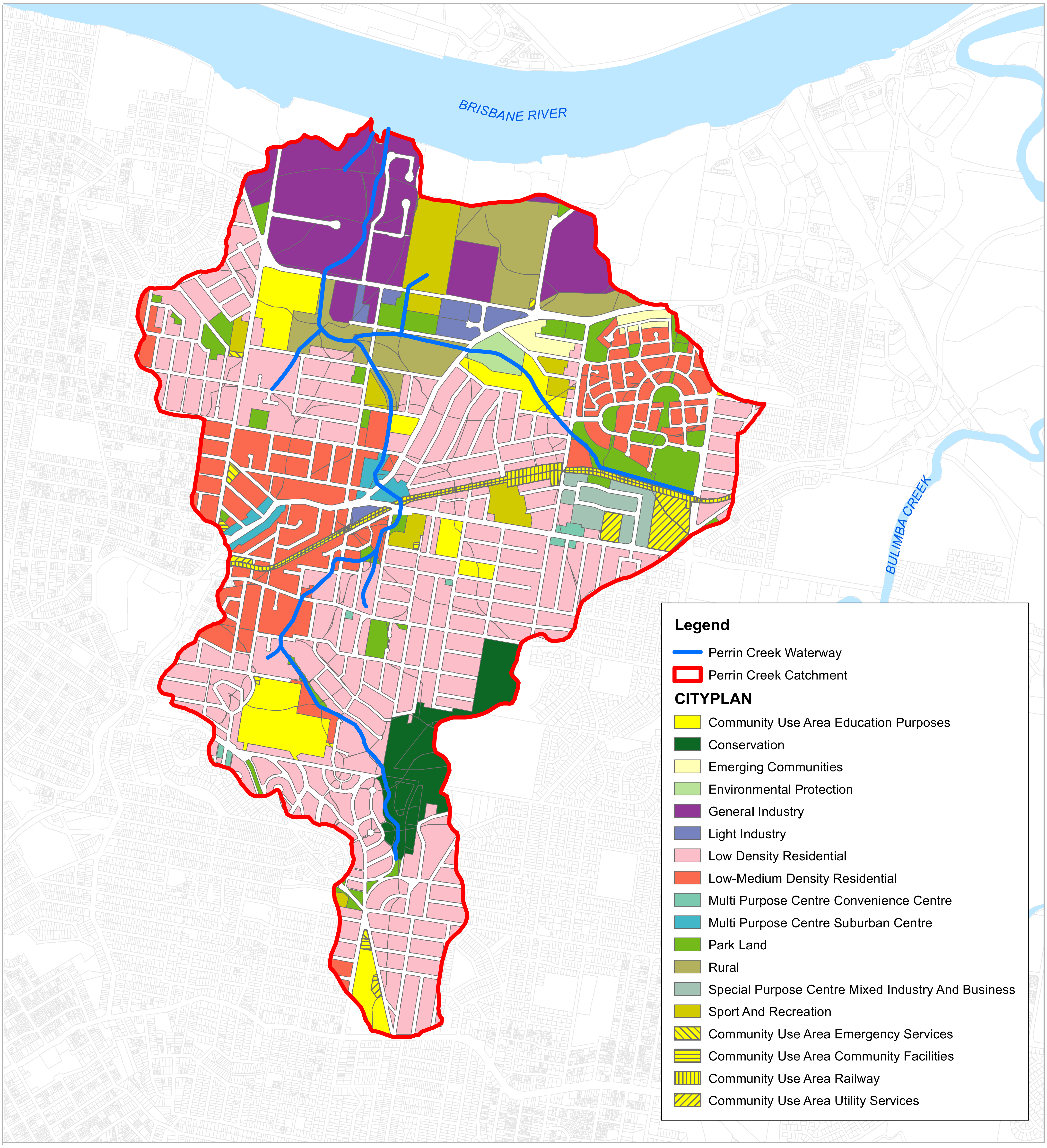
4.2.3 Percentage Impervious

The fraction/percentage impervious values adopted within the hydrology model for the different land-use types were determined in accordance with the Queensland Urban Drainage Manual (Queensland Government, 2008, and 2013 provisional) Table 4.05.1, aerial photography and site inspections. **Table 4-1** details the percentage impervious values adopted for the various land-use types in the catchment. The adopted land-use types for the calibration and verification events are shown in **Figure 4-3**.

Table 4-1 Land Use Fraction Impervious values

Land-use Type	% Impervious
Community Use Area Community Facilities	70
Community Use Area Education Purposes	70
Community Use Area Emergency Services	70
Community Use Area Railway	75
Community Use Area Utility Services	75
Conservation	0
Emerging Communities	70
Environmental Protection	0
General Industry	90
Light Industry	90
Low Density Residential	60
Low-Medium Density Residential	70
Medium Density Residential	80
Multi-Purpose Centre Convenience Centre	90
Multi-Purpose Centre Suburban Centre	90
Park Land	5
Roads	90
Rural	20
Special Purpose Centre Major Hospital And Medical	80
Sport And Recreation	20



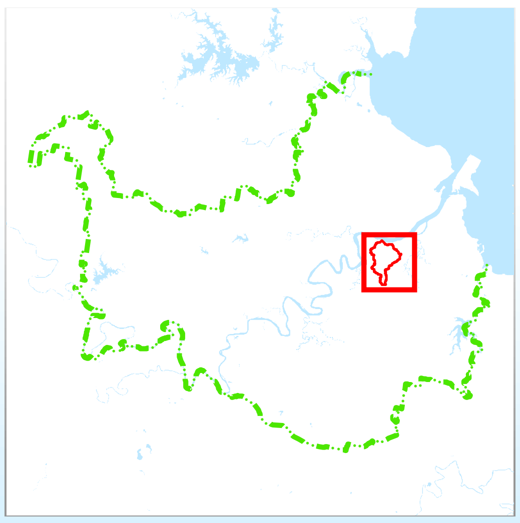


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Figure 4.3: Perrin Creek Catchment Existing Landuse

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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 catchment. Review of the XP-RAFTS (2012) model indicated the need to update/re-calculate the storage values used in the stage-storage relationship for the detention basins, as the hydrology model results are to be verified against the hydraulic model results.

There are two storage and detention areas incorporated in the XP-RAFTS model. Stage-storage relationships have been derived for the basins. The location details of these basins are given in **Table 4-2** and the storage details in **Table B2** of **Appendix B.**

Table 4-2 Location of storage/detention basins in XP-RAFTS model

Item	Channel	Storage node	Location Details
1	East Branch	Basin 1A	Detention area downstream of Basin 1B, bounded by Cleveland Railway, end of Rosewood Place, and 15 Wyandra Crescent, Murarrie
2	East Branch	Basin 1B	Detention area bounded by Creek Road, Cleveland Railway and end of Rosewood Place, Murarrie

4.2.6 Hydrologic 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 a value of n=0.015 was used for most sub-catchments, while for pervious areas the values ranged from n=0.04 to n=0.08.

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 database, which was used in the hydrological modelling, comprises recorded rainfall at five minute intervals, noting that the rain gauge only records information when 1mm or more of rain has fallen.

For all calibration and verification events, Thiessen Polygons were used to enable the gauged rainfall to be apportioned to each of the sub-catchments in the XP-RAFTS model. Each sub-catchment was assigned a single rain gauge station based on the dominant proportion within the sub-catchment.

The calibration and verification events experienced were generally consistent rainfalls across the entire catchment, based on an assessment of the rainfall totals at each rain gauge used in the Thiessen Polygon distribution.

Thiessen Polygon distributions for each calibration and verification event are presented in **Appendix A** (**Figure A5** – **Figure A8**).

4.2.9 Rainfall Losses

The Initial Loss (IL) and Continuing Loss (CL) methodology was used to simulate the rainfall losses. The following IL and CL values (**Table 4-3**) were adopted while simulating the calibration and verification storm events.

Table 4-3 Rainfall loss values used in calibration and verification runs

Calibration/ Verification Event	Rainfall losses - permeable catchments		Rainfall losses - impermeable catchments	
	Initial loss (mm)	Continuing losses (mm/hr)	Initial loss (mm)	Continuing losses (mm/hr)
2015 May	150	2.5	0	2.5
2015 January	50	2.5	0	2.5
2013 January	25	2.5	0	2.5
2009 May	25	2.5	0	2.5

The IL is 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.

A large IL was adopted in the May 2015 calibration event. This event occurred at a seasonally dry time of year, and followed a two month period of negligible rainfall, producing very dry antecedent conditions relative to the other calibration events. It is also noted that the catchment model has a relatively high percentage of impervious area, making it more insensitive to the IL parameter.

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

4.3 Calibration and Validation Process

4.3.1 Selection of Calibration and Validation Events

Four storm events were selected for calibration and validation purposes and are listed in **Table 4-4**. The available historical ranking of rainfall events was conducted based on the availability of MHG readings for each storm event, the intensity/magnitude of the rainfall and flood height, and the currency and completeness of the data. It was also decided to calibrate and validate the hydrology/hydraulic models to more recent flood events due to changes within the catchment, in particular the lower section of Perrin Creek where significant channel works were undertaken in 2009.

Table 4-4 Calibration and Validation Storm Events

Calibration events	Validation event
1st May 2015	23rd January 2015
27th January 2013	
20th May 2009	

The available flood level information for the four recent events recorded in the catchment is listed in **Table 3-3** and **Table 3-4**. The May 2015 event has the most comprehensive record of MHG data from the chosen calibration and validation events, with flood height recordings available at 5 different gauges, and surveyed debris marks at three locations. The magnitude of the flood event was also the highest of all chosen events at three of the gauge locations. The two other calibration events each have three MHG recordings available, whilst the January 2015 validation event has two MHG recordings available.

4.3.2 Characteristics of Selected Recorded Storm Events

4.3.2.1 20th May 2009 Storm Event

From all the selected calibration events, the May 2009 event produced the highest flood level reading recorded at downstream MHG's P100 and P110.

The storm event lasted nearly three days with rainfall commencing on 18th May 2009 and continuing until the late evening of 20th May 2009. Two heavy bursts occurred in the evenings of both the 18th and 19th May 2009, with heavy rain continuing until the morning of 20th May. Rainfall records are available from the two rain gauge stations listed in **Table 3-2**. The highest cumulative rainfall of 267mm for the event was recorded at rain gauge PSR841. **Table 4-5** lists the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the two rain gauge stations. Further information on cumulative rainfall is provided in **Appendix A (Figure A1 – Figure A4)**.

Table 4-5 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 20th May
PP.E1841@540369 (PSR841)	Bulimba Library - Oxford Street	83	80	186	267
PP.E1596@540240 (NMR596)	Tarana Street - Camp Hill	69	67	158	226

[1] 4 days and 14 days prior to 7pm on the 19th May

IFD curves for the recorded rainfall for the event are plotted for each rainfall station and included in **Figure 4-4**. The plot for this event indicates a magnitude of less than 1EY to 50% AEP at the two gauges for durations between 1 and 3 hours.

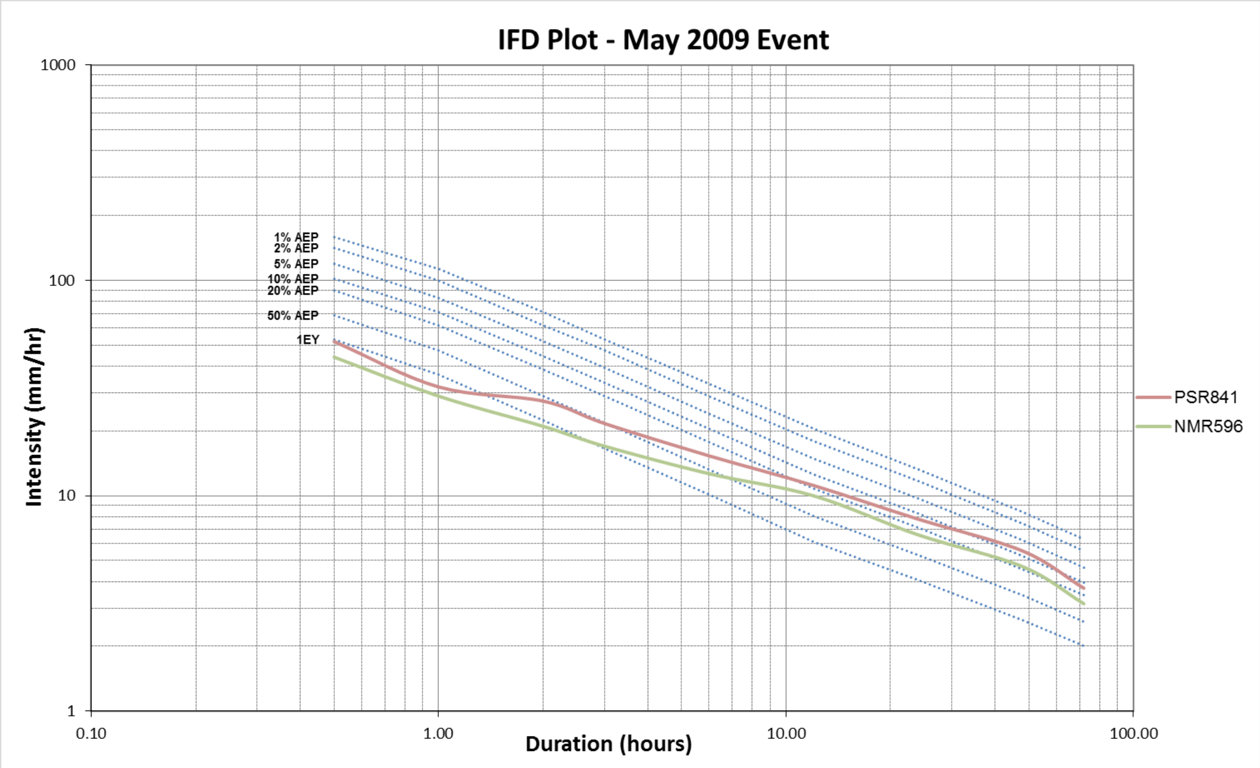


Figure 4-4 IFD Plot for the May 2009 Storm Event

4.3.2.2 *27th January 2013 Storm Event*

The January 2013 event (ex-Tropical Cyclone Oswald) was a long duration event beginning on the 25th January and continuing until the 28th January with rainfall peaking on the afternoon of the 27th January. Due to the long slow-moving nature of the storm, there was moderate antecedent rainfall within the catchment in the 2 days prior to the peak of the event.

Rainfall records are available from the two rain gauge stations listed in **Table 3-2**. The highest cumulative rainfall of 276mm for the event was recorded at rain gauge PSR841. **Table 4-6** lists the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the two rain gauge stations. Further information on cumulative rainfall is provided in **Appendix A**.

IFD curves for the recorded rainfall for the event are plotted for each rainfall station and included in **Figure 4-5**. The plot for this event indicates magnitudes of between 1EY and 20% AEP at the two gauges for durations between 1 and 3 hours.

Table 4-6 Recorded Rainfall Data for January 2013 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	25th – 27th January	27th January
PP.E1841@540369 (PSR841)	Bulimba Library - Oxford Street	15	12	276	168
PP.E1596@540240 (NMR596)	Tarana Street - Camp Hill	7	6	254	161

[1] 4 days and 14 days prior to 25th January

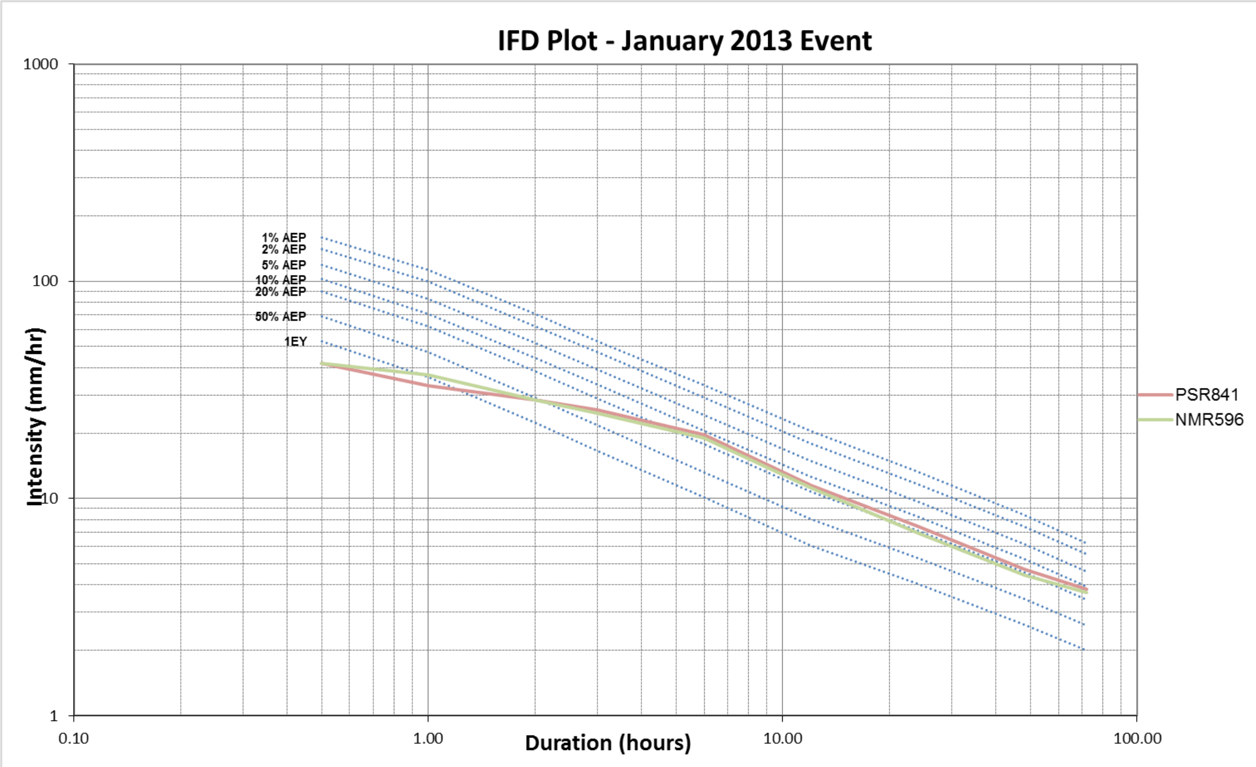


Figure 4-5 IFD Plot for the January 2013 Storm Event

4.3.2.3 *23rd January 2015 Storm Event*

The January 2015 event was a short duration event with widespread moderate rainfall across Brisbane during the mid-morning with a secondary burst in some areas (including the Perrin Creek catchment) in the mid-afternoon.

Rainfall records are available from the two rain gauge stations listed in **Table 3-2**. The highest cumulative rainfall of 161mm for the event was recorded at rain gauge PSR841. **Table 4-7** lists the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the two rain gauge stations. Further information on cumulative rainfall distribution is provided in **Appendix A**.

IFD curves for the recorded rainfall for the event are plotted for each rainfall station and included in **Figure 4-6**. The plot for this event indicates magnitudes of between 1EY and 20% AEP at the two gauges for durations between 1 and 3 hours.

Table 4-7 Recorded Rainfall Data for January 2015 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)
		14-day[1]	4-day[1]	23rd January
PP.E1841@540369 (PSR841)	Bulimba Library - Oxford Street	56	13	161
PP.E1596@540240 (NMR596)	Tarana Street - Camp Hill	46	13	149

[1] 4 days and 14 days prior to 23rd January

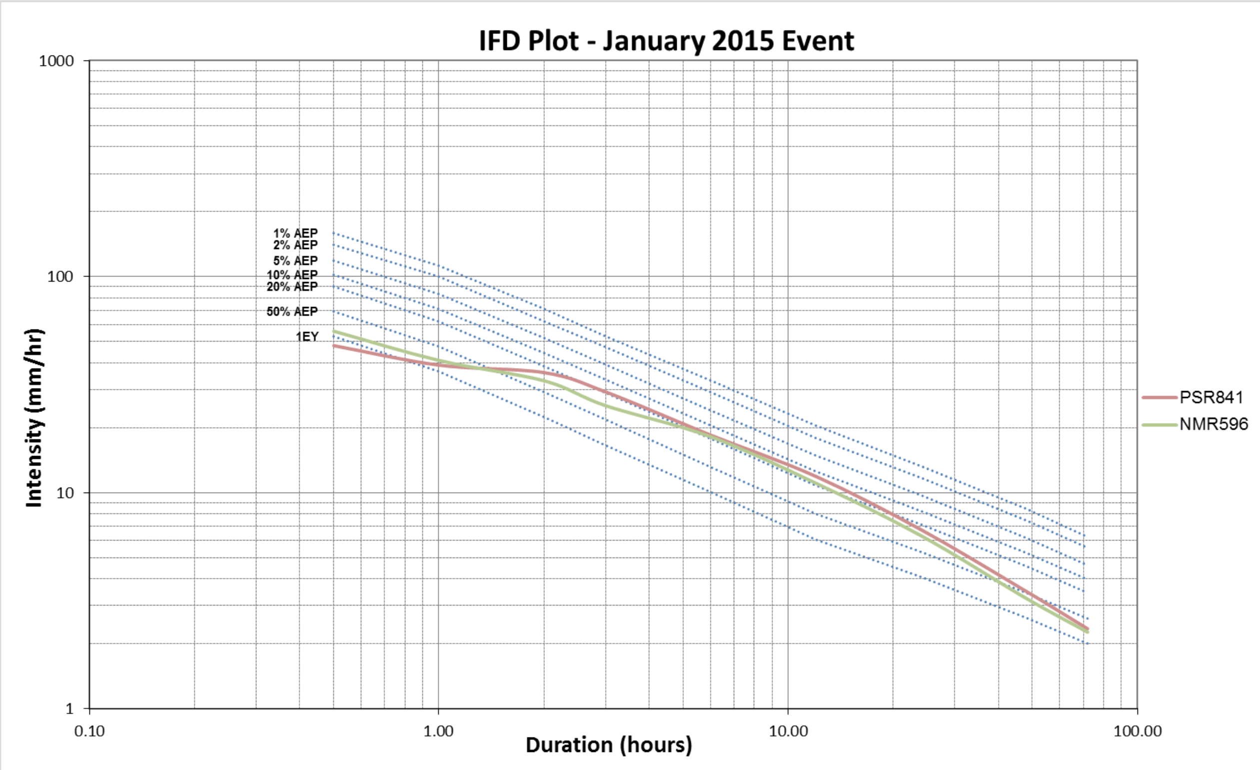


Figure 4-6 IFD Plot for the January 2015 Storm Event

4.3.2.4 1st May 2015 Storm Event

On Friday 1st May 2015, an East Coast Low developed within a trough bringing heavy rainfall to the South East Queensland coast area, including Brisbane. Heavy rain associated with an East Coast Low pressure system began falling in the Perrin Creek catchment from late morning, with the heaviest burst occurring after 3pm, before easing off around 7pm. The May 2015 event produced the highest flood level reading recorded at MHG's P115, P120 and P230 from the selected calibration events.

Rainfall records are available from the two rain gauge stations listed in **Table 3-2**. The highest cumulative rainfall of 262mm for the event was recorded at rain gauge PSR841. **Table 4-8** lists the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the two rain gauge stations.

IFD curves for the recorded rainfall for the event are plotted for each rainfall station and included in **Figure 4-7**. The plot for this event indicates AEP's of between 50% and 2% at the two gauges for durations between 1 and 3 hours. Further information on cumulative rainfall distribution is provided in **Appendix A**.

Table 4-8 Recorded Rainfall Data for May 2015 Storm Event

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day[1]	4-day[1]	(7:30 pm on 30th Apr to 7:30pm on 1st May)	30th Apr – 1st May
PP.E1841@540369 (PSR841)	Bulimba Library - Oxford Street	68	36	226	262
PP.E1596@540240 (NMR596)	Tarana Street - Camp Hill	50	34	213	249

[1] Data 4 days and 14 days prior to 7:30pm on the 30th April

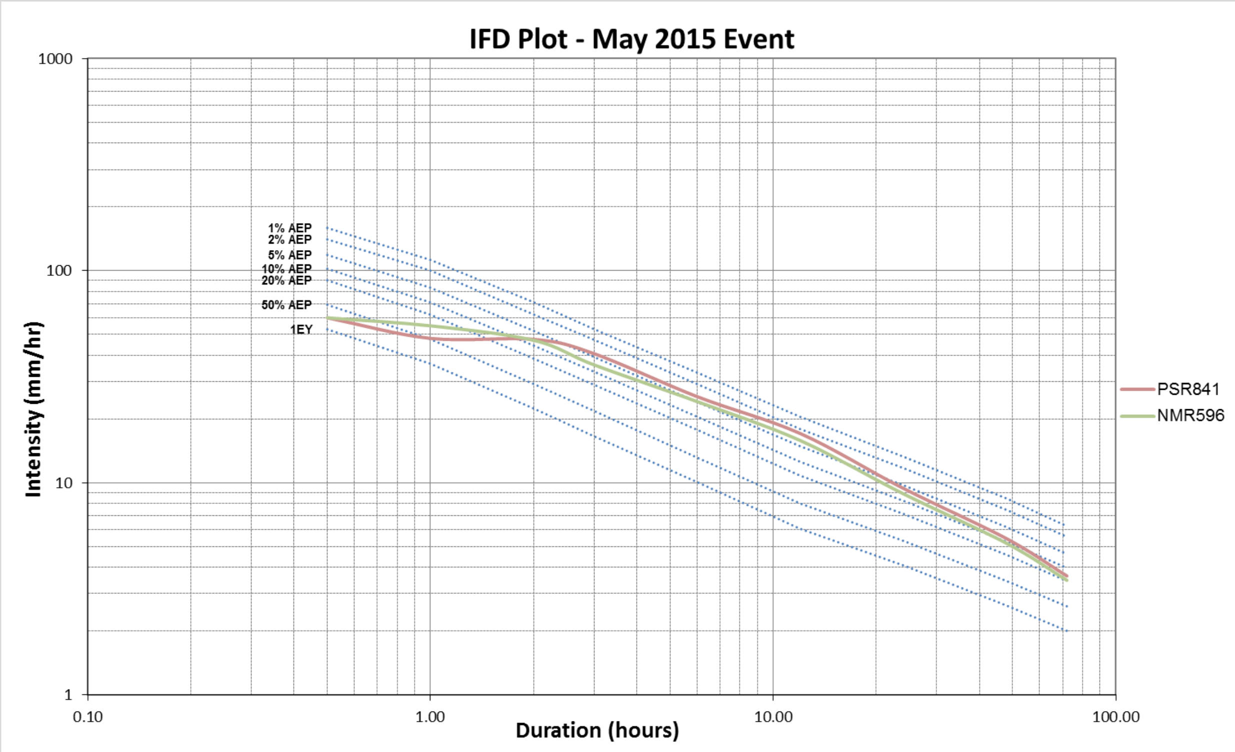


Figure 4-7 IFD Plot for the May 2015 Storm Event

5.0 **Hydraulic Model Development and Calibration**

5.1 Overview

Prior to this study, the most recent hydraulic model for the Perrin Creek catchment was a 1D MIKE11 model developed in the late 1990's. This model has gone through several updates and reviews, the most recent of which was completed in 2012 and included changes made to the catchment as part of the Port of Brisbane development downstream of Lytton Road.

For this study a 1D-2D coupled MIKE FLOOD model of the catchment was developed in order to better represent a range of floodplain and waterway features. The major catchment features and the modelling approach used to represent these features are outlined in **Table 5-1**.

The waterways in the upper reaches of the catchment are generally narrow natural or constructed channels. To ensure accurate representation of the conveyance of these channels, a 1D model was used for the low flow channel. In the downstream section of the catchment where the channel widens out, a fully 2D model was used since the channel conveyance can be adequately represented in the grid. Topographic features of the upper catchment and lower floodplain, including the critical flood prone area around the Colmslie Shopping Centre, were represented within a new 2D grid.

Table 5-1 Catchment characteristics and modelling approach

Catchment Characteristics	Modelling approach
Narrow channels less than 5m wide upstream of Elwell Street	1D channel laterally coupled to 2D grid at channel centre – this method is well-suited for narrow channels with less than two cells width.
6~8m wide concrete lined channels between Lang Street and Elwell Street	1D channel laterally coupled to 2D grid on both sides (L/R) – these channels are wide enough to require separate lateral couples. Duplication of flow conveyance in the 2D grid between L/R couple lines was minimised using higher roughness values on the 2D domain in areas overlapping with the 1D model.
Floodplain storage in Regent Park and areas downstream of Algoori Street, as well as the two large detention basins at Park Hill Village	These wide channels and the floodplain are modelled in 2D only. Detention basin storage and an overflow weir are modelled in 2D domain while the low flow pipe outlet is modelled in 1D.
Low lying open floodplain that provides significant storage	Floodplain storage and conveyance is represented in the 2D domain.
Tidal intrusion from the Brisbane River in the lower reaches of the catchment	A time varying water level is applied at the downstream boundary of the 2D grid to simulate river flooding and tidal variation.

5.2 Model Selection

Hydraulic modelling was carried out using the 1D/2D flood modelling software MIKE FLOOD Release 2014 (SP3). MIKE FLOOD dynamically couples the 1D (MIKE11) and 2D (MIKE21) models with water level and discharge data transferred at each model time step.

5.3 MIKE21 Model Development

5.3.1 Available Data

A number of datasets have been used to develop the MIKE21 model. The datasets used in this flood study include:

- The 2012 MIKE11 model of Perrin Creek supplied by BCC;
- Cross-section survey undertaken by BCC in 2015;
- A 1m DEM based on Airborne Laser Scanning (ALS) data of 2014;
- A 2m DEM based on ALS data of 2009;
- Various other survey data within the catchment (Balmoral Pool, Perrin Creek, Lytton Road Cycleway, Perrin Creek Bikeway Morningside, Cannon Hill Bikeway and Lytton Road Bridge Extension);
- GIS data from BCC (City plan 2014, cadastre, waterway corridors, etc.);
- As constructed drawings from BCC for hydraulic structures; and
- Recorded flood information, BCC's Maximum Height Gauge (MHG) data and debris levels.

5.3.2 Model Schematisation

A 3m grid resolution was selected to represent the catchment, lower floodplain and channel in the MIKE21 2D model. The selection of grid size takes into account the overland flow features that need to be resolved (like road and rail embankments), whilst achieving a reasonable simulation time and providing adequate resolution in channels. A preliminary assessment of run time indicated that a 2m grid would result in unacceptable simulation times, whilst a 4m grid would be too coarse to accurately model channel conveyance in the lower reaches. Where channels are less than 3-4 grid cells wide (9-12m), these are represented in 1D and coupled to the 2D model, rather than being represented in 2D only.

The MIKE21 model covers the full extent of the Perrin Creek floodplain, as shown in **Figure 5-1**. Coordinates of the lower left and upper right corners of the MIKE21 grid are listed in **Table 5-2** below. The model parameters used in the MIKE21 model are listed below in **Table 5-3**. The layout of the 1D components of the model are shown in **Figure 5-2**, along with the catchment outline and the 2D model domain extent.

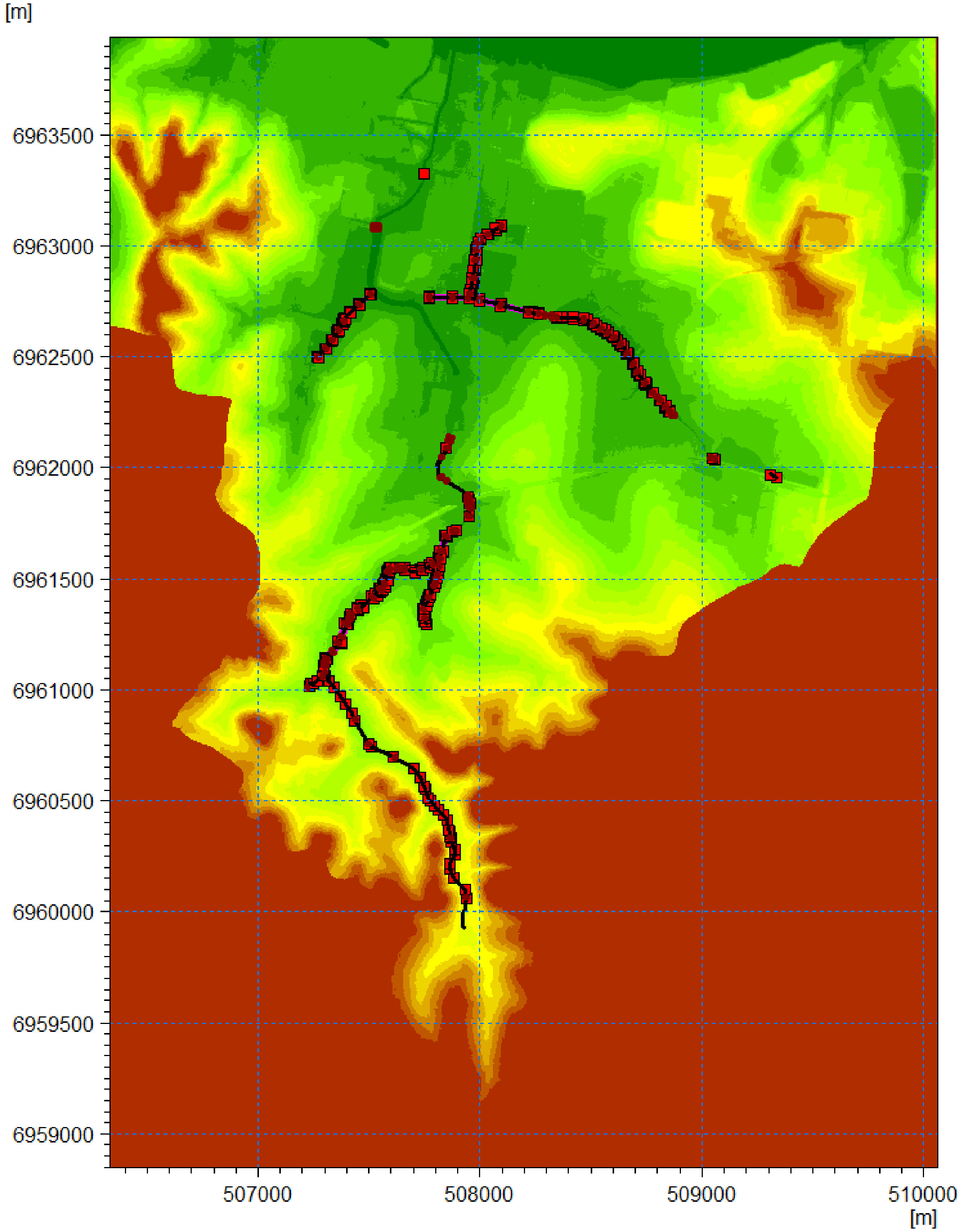


Figure 5-1 MIKE21 model domain

Table 5-2 2D model domain extent

Location	X-Coordinate (GDA 96)	Y-Coordinate (GDA 96)	J-Grid cells in X-direction	K-Grid cells in Y-direction
Lower Left	506334	6958848	0	0
Upper Right	510060	6963942	1242	1697

Table 5-3 2D model paramenters

Parameters	Values
Time Step	0.2 seconds
Drying Depth	0.02m
Flooding Depth	0.05m
Eddy Viscosity	1 m²/s (Global)

The following waterway channels were represented in the 1D model and excluded from the MIKE21 bathymetry:

- Concrete lined channel between Bridgewater Street and Lang Street;
- Concrete lined channel between Richmond Road and Bridgewater Street;
- Concrete lined channel between Elwell Street and Richmond Road;
- Natural channel and tributary upstream of Elwell Street;
- Natural channel between Barrack Road and Ivy Street;
- Natural channel between Ivy Street and Junction Road;
- Natural channel from Junction Road to the confluence at Perrin Creek;
- Channel upstream of Lytton Road culverts at Colmslie Recreation Reserve;
- Channel downstream from the Lytton Road culverts to Barwon Street;
- Concrete lined channel between Avon Street and Lang Street; and
- Channel downstream of Algoori Street down to the confluence at Perrin Creek.

5.3.3 Topography

A 1m Digital Elevation Model (DEM) based on 2014 ALS was used to create the majority of the 3m grid required for the MIKE21 model. Additional survey data was available for Balmoral Pool, small sections of Perrin Creek, Lytton Road Cycleway, Perrin Creek Bikeway Morningside, Cannon Hill Bikeway and Lytton Road Bridge Extension. The ALS data was removed where this survey data overlapped with it, and a single 3m DEM using the merged data was created.

The 2015 surveyed cross-section data was also compared with the merged 3m DEM to ensure consistency. In areas where the DEM and survey data differed, manual edits to the grid were carried out to better represent the channel conveyance. Reaches where the grid was modified from the DEM include Perrin Creek channel between Baringa Street and the Gabion Weir, some parts of Perrin Creek downstream of the Gabion Weir, the engineered channel downstream of Lytton Road to the confluence with the Brisbane River, and the channel between Lang Street and Rossiter Street.

The 2014 ALS data was captured as part of the SEQ 2014 LiDAR Capture Project, undertaken by Fugro Spatial Solutions Pty. Ltd. on behalf of the Queensland Government. The ALS data was acquired from a fixed wing aircraft over Brisbane City Council area on the 28th October 2014. The SEQ 2014 LiDAR Capture Project's technical processes and specifications were designed to achieve the following data accuracies:

- Vertical data: 0.3 m @ 95 % threshold accuracy
- Horizontal data: 0.8 m @ 95 % threshold accuracy

As part of this flood study, detailed validation checks have not been undertaken on the accuracy of the 2014 ALS data. It is assumed that the data is representative of the topography and "fit for purpose".

It is believed that the May 2009 flood event occurred prior to the completion of the engineered channel downstream of Lytton Road. For the calibration of the May 2009 flood event a version of the model was produced that incorporated the original channel based on the 2009 ALS data, This issue is discussed further in **Section 5.9**.

5.3.4 Model Roughness

The Manning's roughness input data for the MIKE21 model was initially developed by adopting the roughness values corresponding to City Plan development categories, as listed in **Table 5-4**. Aerial photography, site visit information and roughness values from previous studies were used to further develop the roughness map. The adopted roughness map, showing spatial variability of adopted roughness values across the Perrin Creek catchment, is shown in **Figure 5-3**.

5.3.5 Eddy Viscosity

Eddy viscosity is used to represent sub-grid scale turbulence. Adjustment of eddy viscosity parameters alters the enhancement or retardation of flow eddy generation in the solution scheme. A velocity based eddy viscosity map was applied in the MIKE21 model, with a value of $1m^2/s$ applied globally except at 1D/2D standard coupled locations. A higher value of $5m^2/s$ was applied at these locations to enhance model stability around structures (this method is considered by DHI to be standard modelling practice for MIKE FLOOD). The eddy viscosity values selected are consistent with the model resolution and based on previous experience with similar flood modelling cases.

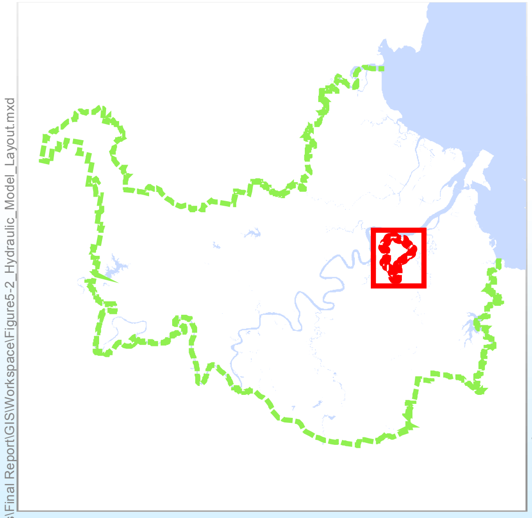
5.3.6 Boundary Conditions

The only downstream boundary specified in the MIKE21 model setup and bathymetry file is the Brisbane River tidal water level boundary.

The XP-RAFTS hydrological model inflows were applied directly into the MIKE21 domain as source points for the specified sub-catchments, at locations consistent with the downstream extent of each sub-catchment or sub-catchment grouping. A total of 17 source points were applied in the MIKE21 model, with these being applied either to a single grid cell or split across multiple cells depending on the magnitude of flow. The source point locations in the MIKE21 model are shown in **Figure 5-4**.

Table 5-4 Roughness parameters adopted in MIKE21

Topographical feature/Land-use	Manning's 'n'	Manning's 'M'
City Plan Land-use		
Roads	0.02	50
Railway		
Shopping Centre carparks		
Concrete lined channels		
Channel – Mudflat/tidal influenced	0.025	40
Channel – Medium	0.033	33.33
Conservation	0.04	25
Open Space		
Community Purpose		
Sport and recreation		
Rural		
Cemetery	0.06	16.67
District	0.07	14.29
Environmental Management		
Emergency services	0.1	10
Education purpose		
Low density residential	0.12	8.33
Emerging community		
Low Impact industry	0.15	6.67
Low-Medium density residential		
District		
Medium density residential		
Specialised centre (Mixed Industry and business)		
General industry A		
General industry B		
General industry C		
Neighbourhood centre		
Corridor		
Special purpose (Utility services),		
High density residential		



0 125 250 375

Metres

N W E S

Legend

- Perrin Creek 1D section
- Perrin Creek Catchment
- DEM Extent

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Figure 5-2: Hydraulic Model Layout

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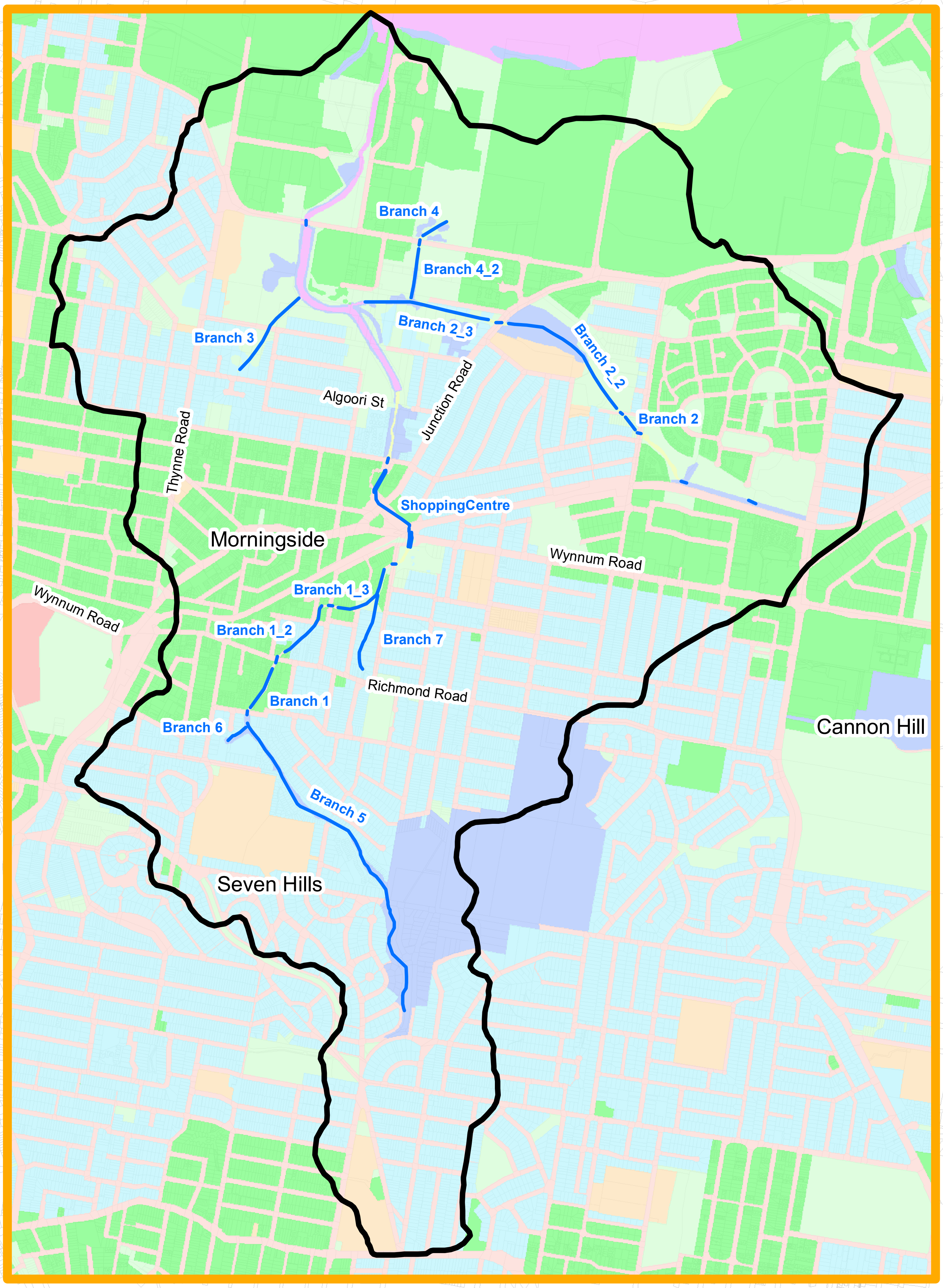
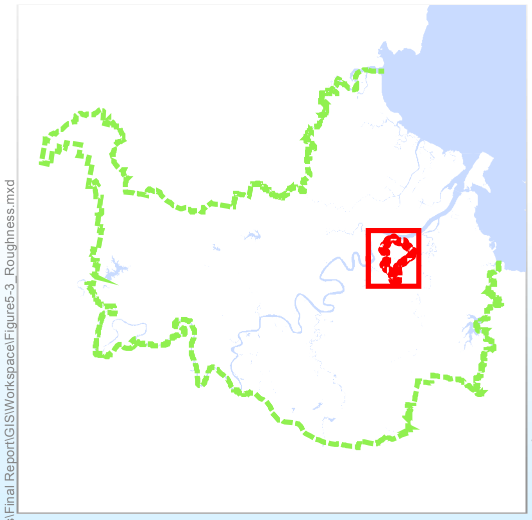
Legend

Queensland Planning Provision and Roughness

- Mannings n = 0.2
- Mannings n = 0.15
- Mannings n = 0.12
- Mannings n = 0.10
- Mannings n = 0.07
- Mannings n = 0.06
- Mannings n = 0.04
- Mannings n = 0.033
- Mannings n = 0.025
- Mannings n = 0.02





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- DEM Extent
- Perrin Creek 1D section
- Perrin Creek Catchment

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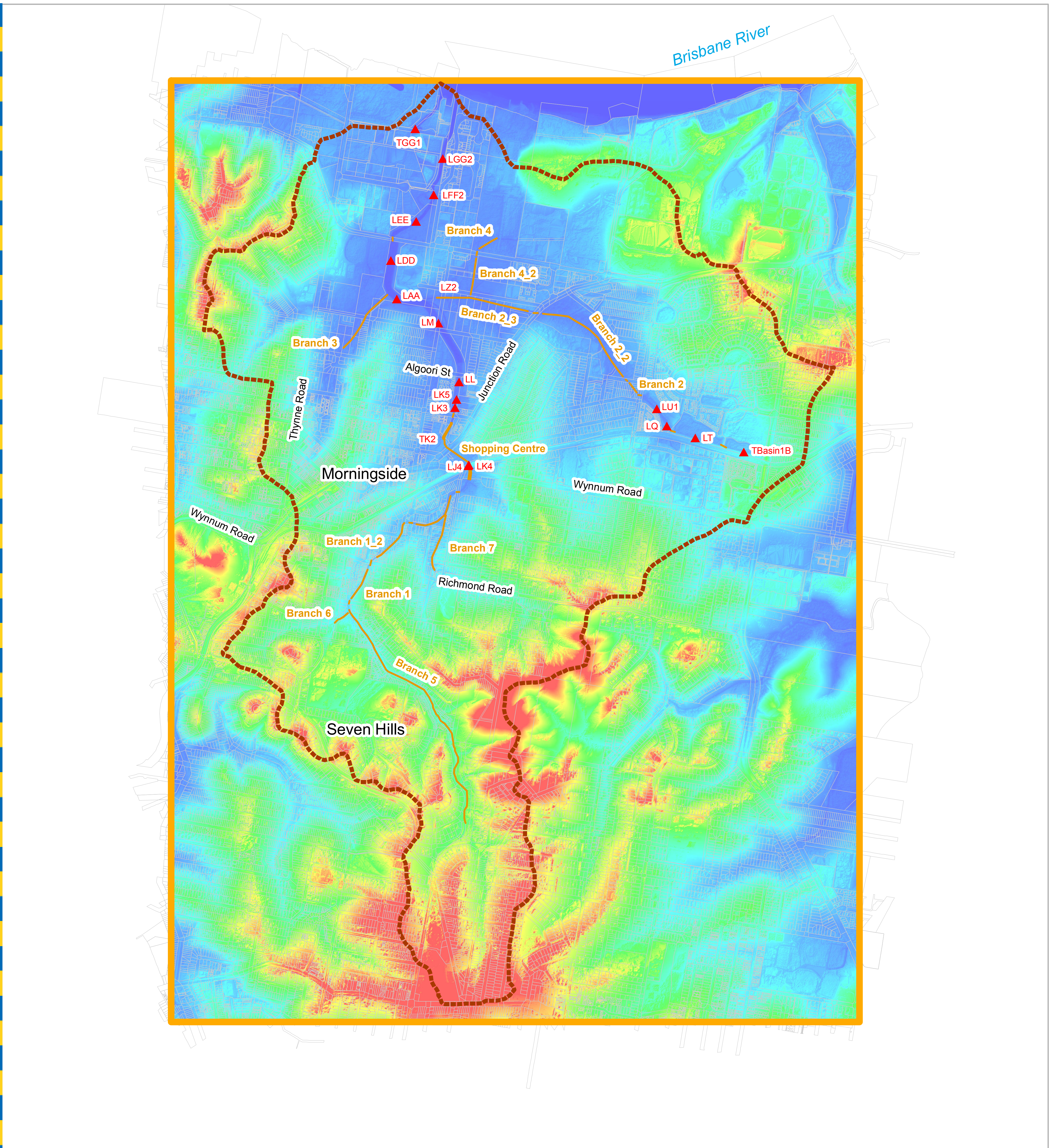
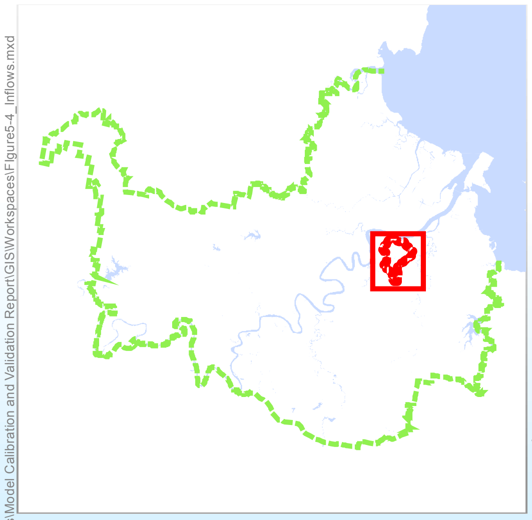
Figure 5-3: Hydraulic Model Roughness Map





Legend

- ▲ Inflow Locations
- DEM Extent
- Perrin Creek
- Perrin Creek Catchment

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Figure 5-4: MIKE21 source point inflow locations

5.4 MIKE11 Model Development

5.4.1 Development of the MIKE11 Model

The 2012 MIKE11 model developed by Council was used as the basis of the MIKE11 model components of the MIKE FLOOD model developed in this study. All existing cross-sections in the 2012 model were checked against the available survey data. The existing structures within the 2012 model were reviewed against structure design drawings and/or dimensions measured during the site visit. Eighteen waterway structures were modelled in the MIKE FLOOD model, including six additional structures that were not modelled in the 2012 MIKE11 model.

The 2012 MIKE11 model was altered to represent only incised channels and structures, and to exclude floodplain areas now represented in the MIKE21 model. The MIKE11 model was also extended upstream of Elwell Street to capture the channel in the upper parts of the catchment, as well as the channel between Avon Street and Lang Street. The 2015 surveyed cross-sections were used as the basis for the three new additional branches, and to confirm the accuracy of existing cross-sections in the 2012 model. Negligible differences were observed, and the 2012 model cross-sections were used to define geometry across the majority of the MIKE11 network. The layout of the updated MIKE11 model is shown in **Figure 5-2**.

The branches in MIKE11 corresponding to channels with road crossing culverts (for example between Elwell Street and Richmond Road) were reconfigured to ensure the best transition of flow between the 1D channel and the 2D floodplain, and transition of flow between the 2D floodplain and culvert flow. This MIKE11 channel shortening and separation at structures resulted in alternating sections of:

- 1D low-flow channel with lateral couples to 2D floodplain, and
- short “structure” branches with standard couples (at each end) to 2D channel.

Once the branches had been altered and the structures were modelled as separate branches, the cross-section widths were restricted to exclude the floodplain from MIKE11. A total of 29 branches were included in the new MIKE11 model (see **Table 5-5)**.

5.4.2 Model Roughness

A global Manning’s ‘*n’* of 0.033 was applied in the MIKE11 model; however, local roughness factors have been applied within the cross-sections based on the previous MIKE11 model. As much as practically possible, MIKE11 roughness values are consistent with MIKE21 roughness values, although it is noted that the MIKE21 roughness implementation has by far the larger influence on floodplain levels and velocities.

5.4.3 Boundary Conditions

A total of 76 boundary conditions were specified in MIKE11, of which 49 are open water level boundaries which exist solely for the purpose of transferring level data (and flow based on solution of the energy equation) between MIKE11 and MIKE21. The remaining 27 boundaries were inflow boundaries where the XP-RAFTS sub-catchment hydrographs were applied directly to the MIKE11 channel (refer to **Table 5-6**).

Table 5-5 MIKE11 Branches

Channel	Channel Location	Upstream Chainage(m)	Downstream Chainage (m)
BaringaSt	Baringa St culvert	0	20
BarrackRd	Barrack Rd culvert	0	18
BRANCH1	Elwell St to Richmond Rd	0	180
BRANCH1_2	Richmond Rd to Bridgewater St	1735	1983
BRANCH1_3	Bridgewater St to Lang St	2050	2324
BRANCH2	Barrack Rd to Ivy St	425	489
BRANCH2_2	Ivy St to Junction Rd	554	1116
BRANCH2_3	Junction Rd to Perrin Creek main channel	1205	1706
BRANCH3	Algoori St to Perrin Creek main channel	38	411
BRANCH4	Col Garden Dr to Lytton Rd	1000	1100
Branch4_2	Lytton Rd to Branch2_3	1160	1360
BRANCH5	Seven Hills Bushland reserve to Elwell St.	0	1425
BRANCH6	Ramsay Ln to Elwell St.	0	85
BRANCH7	Richmond Rd to Mornington Cres	0	310
BridgewaterSt	Bridgewater St	0	20
Drainage1	Wyandra Cres Detention Basin	0	30
Drainage2	Rosewood Pl Detention Basin	0	30
Elwell_St	Elwell St culvert	0	20
IvySt	Ivy St culvert	0	9
JunctionRd	Junction Rd culvert	0	35
LangSt	Lang St culvert	0	25
LyttonRd1_new	Lytton road culvert	0	15
LyttonRd2	Lytton road bridge	1122	1142
Railway	Railway culvert	0	15
RichmondSt	Richmond St culvert	0	30
ShoppingCentre	Shopping Centre	2552	2852
ShoppingCentreTrib	Shopping Centre	2730	2827
WynnumRd1	Rossiter St to Wynnum Rd	0	50
WynnumRd2	Rossiter St to Wynnum Rd	0	56

Table 5-6 MIKE11 Boundaries (sub-catchment inflow locations only)

Channel	Chainage (m)	XP-RAFTS Sub-catchment (Local/Total)
BRANCH1	120	LI1
BRANCH1_2	1913	LI2
BRANCH1_3	2120	LI3
BRANCH1_3	2260	LJ3
BRANCH1_3	2275	LJ2
BRANCH1_3	2300	LJ1
BRANCH2_2	575	TP
BRANCH2_2	590	LU2
BRANCH2_2	900	TDummy4a
BRANCH2_2	1000	LV2
BRANCH2_3	1425	LW
BRANCH2_3	1640	LZ2
BRANCH3	38	LBB
BRANCH3	200	LCC1
BRANCH3	311	LCC2
BRANCH4	1000	TZ1
BRANCH5	0	TDummy1a
BRANCH5	332	LC
BRANCH5	595	LE1
BRANCH5	645	LE2
BRANCH5	895	LE3
BRANCH5	945	LD
BRANCH5	1370	LF2
BRANCH6	0	TF1
BRANCH7	0	TH2
BRANCH7	160	LH3
ShoppingCentreTrib	2730	TK2

5.4.4 Hydraulic Structures

The updated MIKE11 model included two bridges and twelve culverts. Of these, seven of the culverts and Lytton Road Bridge were represented in the 2012 MIKE11 model, with the remainder being added based on design or as constructed drawings and observations made during the field visit. Hydraulic structures that were included in the MIKE11 model are given in **Table 5-7**. **Figure 5-5** shows the locations of these MIKE11 structures within the catchment.

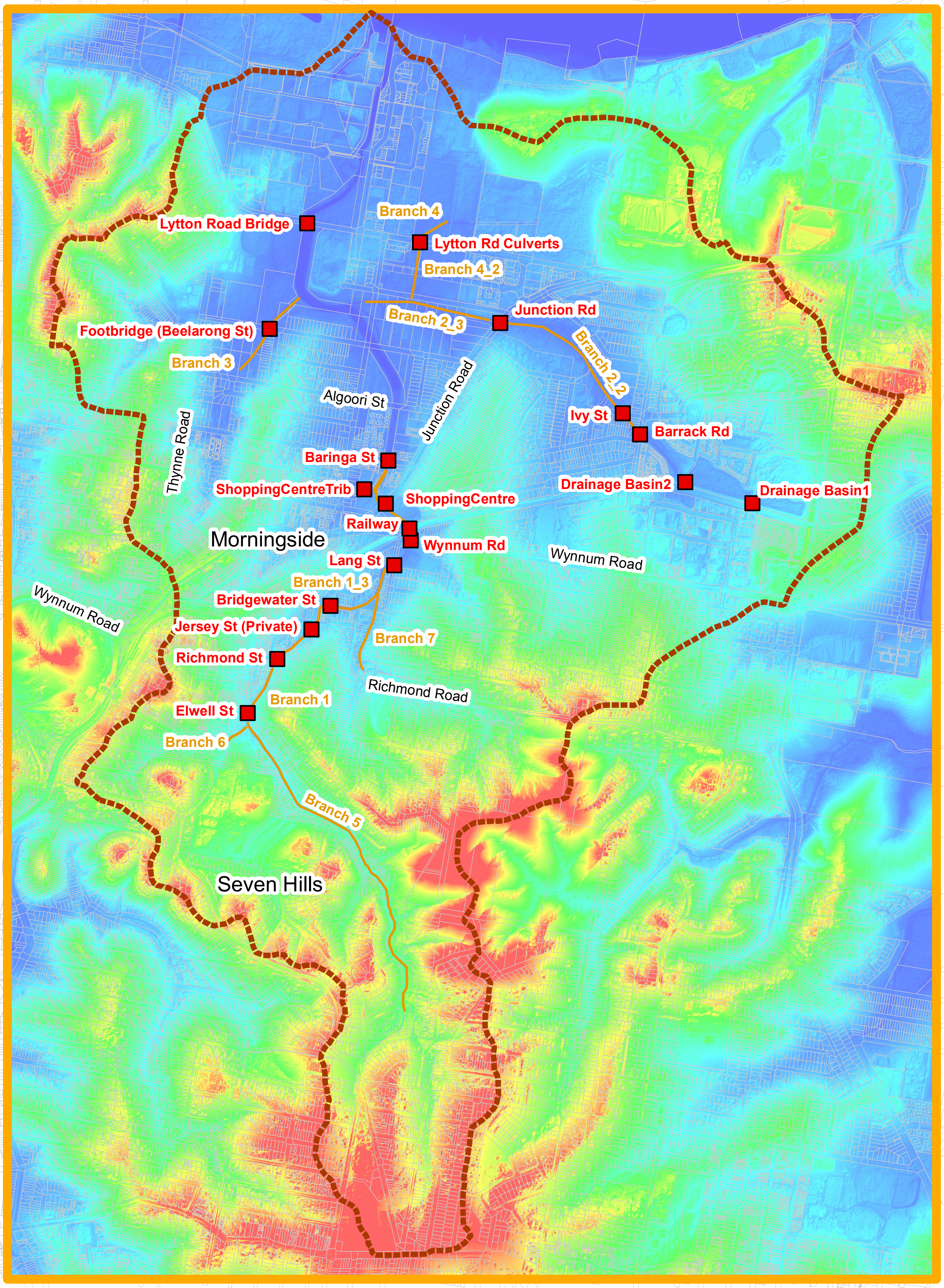
The culverts under Wynnum Road, the Railway, and under the Shopping Centre at the corner of Wynnum Road and Junction Road, were all modelled as closed cross-sections. The structure details from the existing MIKE11 model were utilised and cross-checked against structure detail drawings as well as measurements obtained during the site inspection. Modelling culverts using closed cross-sections was considered an appropriate methodology when the length of the culvert relative to the diameter was long (behaviour was friction dominated) and when constrained geometry dictates the use of a simpler and more stable coupling (as in the case of the Railway culverts).

For structures where the waterway length (in the direction of flow) was greater than 6m the structure was modelled in MIKE11 as a culvert only (not including a MIKE11 weir), with overtopping simulated in the 2D domain. For shorter structures (mostly foot bridges) a coincident 1D overflow structure was included in the MIKE11 model.

Structure losses in MIKE11 at key drainage crossings were compared against losses estimated for the same structure geometry using HEC-RAS. A short report explaining the HEC-RAS model setups and energy loss results comparison was submitted to Council as a separate deliverable and is attached in **Appendix D** of this report.

Table 5-7 Hydraulic structure details in MIKE11

Channel	Structure Location	Structure Detail	Structures linked Cells MIKE21 (j, k) cell coordinates
JunctionRd	Junction Road	6/1800mm RCP	U/S 4 cells (661,1276 to 663,1279) D/S 4 cells (652,1278 to 654,1281)
BarrackRd	Barrack Road	4/2400 x 1200mm RCBC	U/S 4 cells (848,1130 to 848,1127) D/S 4 cells (842,1134 to 842,1131)
BaringaSt	Baringa Street	6/1650mm RCP	U/S 6 cells (506,1091 to 511,1090) D/S 6 cells (508,1098 to 513,1097)
BridgewaterSt	Bridgewater Street	3/3000 x 1500mm RCBC	U/S 3 cells (429,901 to 429,899) D/S 3 cells (435,900 to 435,898)
RichmondRd	Richmond Road	3/1675mm RCP	U/S 4 cells (356,823 to 359,823) D/S 4 cells (362,832 to 365,832)
LangSt	Lang Street	3/3000 x 1800mm RCBC	U/S 3 cells (514,955 to 514,953) D/S 3 cells (520,957 to 520,955)
IvySt	Ivy Street	2/600mm RCP	U/S 1 cell (823,1156) D/S 1 cell (820,1158)
Elwell_St	Elwell Street	3/2400 x 2100mm RCBC	U/S 4 cells (319,754 to 322,754) D/S 4 cells (321,760 to 324,760)
Drainage2	Wyandra Cres Detention Basin	1/600mmRCP	U/S 1 cell (909,1064) D/S 1 cell (901,1066)
Drainage1	Rosewood Pl Detention Basin	2/525mm RCP	U/S 1 cell (1001,1036) D/S 1 cell (992,1041)
LyttonRd2	Lytton Road (Colmslie Recreation Reserve)	4/1372mm RCP	U/S 3 cells (553,1389 to 551,1389) D/S 3 cells (552,1382 to 550,1382)
LyttonRd1_new	Lytton Road (Perrin Creek crossing)	Cross-Section Database	U/S 9 cells (394,1410 to 402,1408) D/S 9 cells (394,1415, to 402,1413)
BRANCH1_2	Old footbridge between Jersey St and Bridgewater St	Bridge	No coupled waterway length less than 6m (included in lateral couple)
BRANCH3	Footbridge crossing at Beelarong Street	Bridge	No coupled waterway length less than 6m (included in lateral couple)
WynnumRd1	Wynnum Road	3/3000 x 1800mm RCBC	U/S 3 cells (535,978 to 537,978) D/S 3 cells (536,997 to 538,997)
WynnumRd2	Wynnum Road	2/3000 x 1800mm RCBC 2/3350 x 2200mm RCBC 4/1800 RCP	U/S 2 cells (538,978 to 539,978) D/S 2 cells (539,998 to 540,998)
Rail Culvert	Cleveland Rail Line	8/1800 x 1800mm RCBC	U/S 5 cells (536,978 to 540,1001) D/S 5 cells (536,1002 to 540,1003)
ShoppingCentre	Shopping Centre downstream of Railway	2/3900 x 1650mm RCBC 4/1800mm RCP 6/1800mm RCP 4/1800mm RCP + 1/5200x2400 RCBC	U/S 3 cells (537,1007 to 539,1007) D/S 4 cells (505,1081 to 508,1081)
ShoppingCentre2	Shopping Centre outlet from western sub catchment	1/1620mm RCP	D/S 1 cell (504,1081)



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Legend

- Structure Locations
- DEM Extent
- Perrin Creek
- Perrin Creek Catchment

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Figure 5-5: MIKE FLOOD Structure Locations

5.5 MIKE FLOOD Model Development

The term MIKE FLOOD is used in this report to describe a 1D-2D dynamically coupled model. However, the model setup includes independent 1D (MIKE11) and 2D (MIKE21) models, with MIKE FLOOD simply a text file prepared through a graphical user interface that manages the connection of the two models. In the Perrin Creek model, both “Lateral” and “Standard” couple types were used to link the 1D and 2D models.

5.5.1 Lateral Couples

The location (in j,k cell coordinates) of MIKE21 grid points connected to MIKE11 low flow channel branches via lateral couples are shown below in **Table 5-8**. In MIKE FLOOD the Lateral Link Options page is used to select parameters that control the flow across the internal weir between the MIKE11 bank overflow or spilling level and the MIKE21 floodplain. The relevant lateral link model parameters selected in this study are presented in **Table 5-9**.

Table 5-8 Lateral couple definitions for each MIKE11 branch

Channel	Laterally linked Cells MIKE21 (j, k) cell coordinates
BRANCH5	Centre couple - 620 cells (531,358 to 321,741)
BRANCH6	Centre couple - 46 cells (295, 720 to 319,739)
BRANCH1	Left bank – 81 cells (323,765 to 352,816) Right bank – 81 cells (327,764 to 356,815)
BRANCH1_2	Left bank – 112 cells (370,840 to 420,901) Right bank – 111 cells (373,836 to 422,897)
BRANCH1_3	Left bank – 113 cells (443,900 to 503,947) Right bank – 120 cells (442,896 to 506,947)
BRANCH7	Left bank – 125 cells (474,814 to 494,910) Right bank – 126 cells (476,815 to 496,912)
BRANCH2	Left bank – 29 cells (838,1134 to 826,1150) Right bank – 29 cells (840,1137 to 828,1153)
BRANCH2_2	Left bank – 256 cells (813,1163 to 670,1275) Right bank – 258 cells (815,1165 to 671,1278)
BRANCH2_3	Left bank – 190 cells (643,1281 to 479,1307) Right bank – 189 cells (643,1281 to 479,1305)
BRANCH3	Left bank – 174 cells (311,1216 to 388,1312) Right bank – 173 cells (313,1215 to 391,1309)
BRANCH4	Left bank – 50 cells (588,1412 to 557,1394) Right bank – 51 cells (587,1415 to 556,1396)
BRANCH4_2	Left bank – 79 cells (551,1377 to 542,1308) Right bank – 79 cells (548,1377 to 539,1308)

Table 5-9 Lateral Link model parameters

Attribute	Value
Type	Weir 1
Source	HGH
Depth Tolerance	0.1
Weir	1.838
Friction(n)	0.05
Exponential smoothing factor	1

5.5.2 Standard/Structure Link Couples

The end chainage (both ends) of each branch in MIKE11, whether it is a low-flow channel or a short structure branch, is coupled to MIKE21 grid points to allow flow to enter or exit the 2D model domain. In MIKE FLOOD the Standard/Structure Link Options page is used to select parameters that control the transfer of flow into and out of MIKE11 branch endpoints. The Standard Link model parameters selected (in this study there are no Structure couples specified) are presented in **Table 5-10**.

Table 5-10 Standard/Structure Link model parameters

Attribute	Value
Momentum Factor	1
Extrapolation Factor	0
Depth Adjustment	Yes
Exponential smoothing factor	0.1-0.2

5.5.3 Run Parameters

The MIKE FLOOD model utilises the 0.2 second time step applied in the MIKE21 model. The MIKE11 model time step was also set to 0.2 seconds, however MIKE FLOOD replaces the nominated MIKE11 time step with the MIKE21 time step automatically. Results from the models are saved every simulated five minutes.

5.6 MIKE FLOOD Model Calibration and Validation

5.6.1 Procedure

Five Maximum Height Gauges are located in the upper, middle and lower reaches of the catchment. Four historical storm events were selected for calibration and validation of the model on the basis of there being suitable recorded data, and the catchment conditions being similar to that represented by the model.

The most recent May 2015 event was selected as the primary calibration event, with this event having recorded MHG data at all five gauge locations, as well as three surveyed debris flood levels within the catchment. The January 2013 and May 2009 events were also used for model calibration, with both events have recordings at three MHG locations. The January 2015 event was used as the validation event as this event only had records at two MHG locations. The recorded MHG levels were generally considered to have an accuracy of ±300mm. On this basis if the calibration modelled flood levels were within 300mm of the recorded MHG levels they were considered as acceptable.

For each calibration and validation event, the catchment runoff hydrographs were obtained from the XP-RAFTS model and applied to the MIKE11 and MIKE21 models as boundary conditions or source points. The downstream boundary of the model is the recorded event water level of the Brisbane River at the Sugar Berth Terminal (located near the confluence of Perrin Creek and Brisbane River), except for the May 2009 events (refer to **Section 3.3.3** for detailed discussion).

Calibration of the MIKE FLOOD model was carried out by comparing the estimated flood levels at the MHG locations for the specified flood events to see if the ±300mm tolerance limit could be achieved. The model was iteratively improved to achieve the calibration tolerance by altering:

- the MIKE11 and MIKE21 model Manning's roughness values within a reasonable range;
- the XP-RAFTS catchment storage, catchment roughness, lag time and initial losses, and
- the model geometry (including structures in places) if erroneous water levels were indicative of errors in schematisation or input data sufficient to warrant additional inspection or discussion with Council officers.

Flood discharge profiles obtained from MIKE FLOOD and XP-RAFTS models were also compared at selected locations. This was done to identify differences between the two models in flood peak timing and magnitude.

5.6.2 Limitations of calibration and validation

The calibration and validation is potentially limited by local hydraulic effects that may not be known or documented, but which could affect recordings at MHG locations. These may include:

- proximity of the MHG to hydraulic structures;
- proximity of the MHG to the primary channel or flow path; and
- the potential for debris blockage to affect MHG recordings and flood behaviour upstream of culverts or bridges.

Issues that were identified at some MHG locations potentially affecting the calibration are discussed in more detail in **Section 5.9**.

5.7 Results of the Hydraulic Model Calibration and Validation

5.7.1 May 2015 Calibration Event

This storm event was estimated to range between a 10% and 2% AEP event across the catchment (see **Section 4**). MHG data was available at five locations within the catchment: the upstream gauges (P230 and P120), the centre of the catchment (P115), and the downstream gauges (P100 and P110). Debris flood marks were also recorded upstream and downstream of the Colmslie Shopping Centre. **Table 5-11** below compares the model calibration results against recorded MHG levels and **Table 5-12** compares the recorded flood debris marks against the modelled levels. The results are discussed in **Section 5.9**.

Table 5-11 May 2015 MHG comparison

MHG	Location	Modelled (mAHD)	Recorded (mAHD)	Difference (m)
P120	Approx. 25m upstream of the culverts under Rossiter Street/Wynnum Road. Left Bank.	4.87	4.67	0.20
P115	Approx. 90m downstream of culverts under Baringa Street. Left Bank.	2.81	2.82	-0.01
P110	Adjacent upstream to footbridge at Beelarong Street. Left Bank.	2.72	2.53	0.19
P100	Immediately upstream of Lytton Road Bridge on Perrin Creek. Left Bank.	2.69	2.44	0.25
P230	Adjacent to the upstream culvert inlet at the most eastern Drainage Basin in Park Hill Village	7.19	7.27	-0.08

Table 5-12 May 2015 flood debris comparison

Location	Modelled (mAHD)	Recorded (mAHD)	Difference (m)
2 Brenda Street, Morningside	2.73	2.66	0.07
25 Junction Road, Morningside	4.43	4.81	-0.38
8 Rossiter Street, Morningside	5.01	4.98	0.03

5.7.2 January 2013 Calibration Event

The January 2013 event was a three day rainfall event and is estimated to range between a 1EY and a 20% AEP event. Three MHG recordings were available during this event: the most downstream gauge (P100), the central gauge (P115) and the upstream gauge on the eastern side of the catchment (P230). **Table 5-13** compares the model calibration results against recorded MHG levels, with the results discussed in **Section 5.9**.

Table 5-13 January 2013 MHG comparison

MHG	Location	Modelled (mAHD)	Recorded (mAHD)	Difference (m)
P120	Approx. 25m upstream of the culverts under Rossiter Street/Wynnum Road. Left Bank.	4.11	-	-
P115	Approx. 90m downstream of culverts under Baringa Street. Left Bank.	2.51	2.42	0.09
P110	Adjacent upstream to footbridge at Beelarong Street. Left Bank.	2.32	-	-
P100	Immediately upstream of Lytton Road Bridge on Perrin Creek. Left Bank.	2.26	2.00	0.26
P230	Adjacent to the upstream culvert inlet at the most eastern Drainage Basin in Park Hill Village	6.43	6.84	-0.41

5.7.3 May 2009 Calibration Event

The 2009 event lasted almost three days and consisted of two heavy bursts of rainfall, with the estimated magnitude of the event being between a 1EY and a 50% AEP event. Three MHG recordings are available for this event, two downstream (P100 and P110) and the upstream gauge near the Colmslie Shopping Centre (P120). **Table 5-14** compares the model calibration results against recorded MHG levels, and the results are discussed in **Section 5.9**.

Table 5-14 May 2009 MHG comparison

MHG	Location	Modelled (mAHD)	Recorded (mAHD)	Difference (m)
P120	Approx. 25m upstream of the culverts under Rossiter Street/Wynnum Road. Left Bank.	4.22	4.04	0.18
P115	Approx. 90m downstream of culverts under Baringa Street. Left Bank.	2.59	-	-
P110	Adjacent upstream to footbridge at Beelarong Street. Left Bank.	2.50	2.69	-0.19
P100	Immediately upstream of Lytton Road Bridge on Perrin Creek. Left Bank.	2.46	2.68	-0.22
P230	Adjacent to the upstream culvert inlet at the most eastern Drainage Basin in Park Hill Village	6.13	-	-

5.7.4 January 2015 Validation Event

The January 2015 event lasted less than a day, with the magnitude of the event estimated to be between a 1EY and a 20% AEP event. Only two maximum height gauges were available for this event, these being the upstream gauge on the eastern side of the catchment (P230) and the gauge in the centre of the catchment (P115). **Table 5-15** compares the model calibration results against recorded MHG levels, and the results are discussed in **Section 5.9**.

Table 5-15 January 2015 MHG comparison

MHG	Location	Modelled (mAHD)	Recorded (mAHD)	Difference (m)
P120	Approx. 25m upstream of the culverts under Rossiter Street/Wynnum Road. Left Bank.	4.07	-	-
P115	Approx. 90m downstream of culverts under Baringa Street. Left Bank.	2.45	2.46	-0.01
P110	Adjacent upstream to footbridge at Beelarong Street. Left Bank.	2.22	-	-
P100	Immediately upstream of Lytton Road Bridge on Perrin Creek. Left Bank.	2.16	-	-
P230	Adjacent to the upstream culvert inlet at the most eastern Drainage Basin in Park Hill Village	6.33	6.33	0.00

5.8 Flood Discharge Profiles Comparison

Discharge hydrographs from the hydraulic and hydrology model results were compared for the four calibration and validation events, at the following locations:

1. XP-RAFTS Node LF2 (Upper Catchment)
2. XP-RAFTS Node TJ1 (Upstream of Colmslie Shopping Centre, near MHG P120)
3. XP-RAFTS Node TDD (Upstream of Lytton Road Bridge, near MHG P100)
4. XP-RAFTS Node TStorage1 (Immediately downstream of Drainage Basin2 outlet/Node LQ)
5. XP-RAFTS Node TV2 (Downstream of Junction Road Bridge)

Figures comparing the May 2015 calibration event are presented in this section (refer to **Figure 5-6** to **Figure 5-10**), with other calibration events and the January 2015 validation event shown in **Figure C1** to **Figure C15** in **Appendix C**.

In general, the MIKE FLOOD model and the XP-RAFTS model exhibit similar behaviour (peakiness), with the magnitude of the peaks attenuated and delayed slightly in the MIKE11 model as might be expected due to channel routing and response differences between the models. At locations upstream of Lytton Road and Junction Road the significant floodplain storage effects can be clearly seen in the MIKE FLOOD discharge curves.

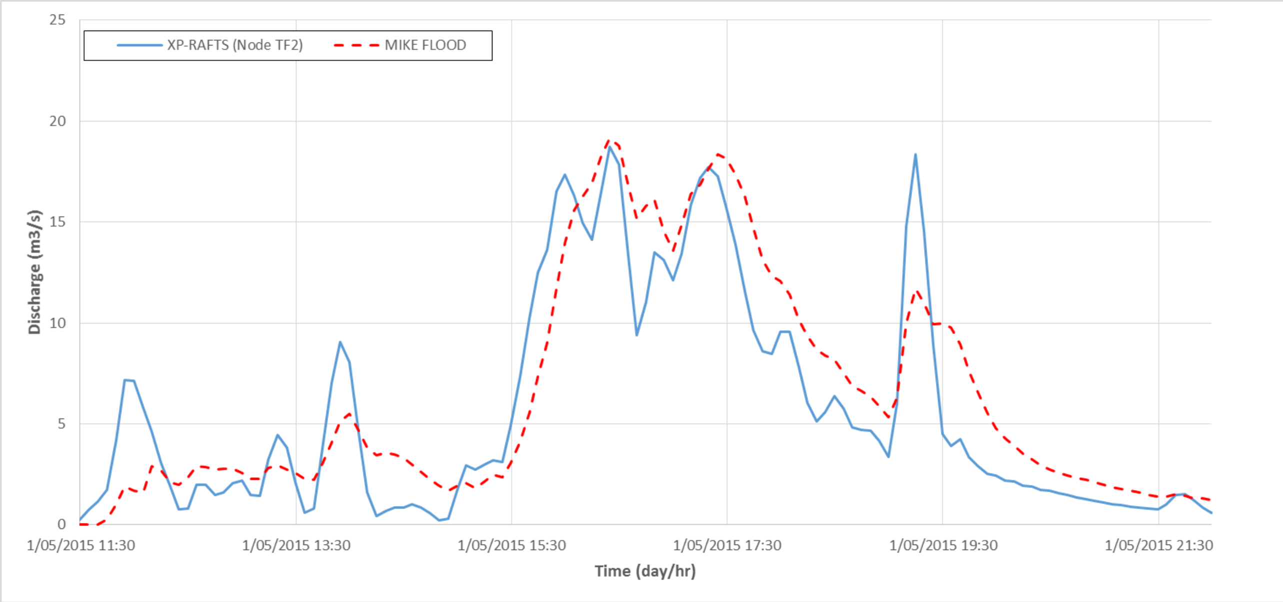


Figure 5-6 May 2015 calibration event – discharge profiles upstream of Elwell Street

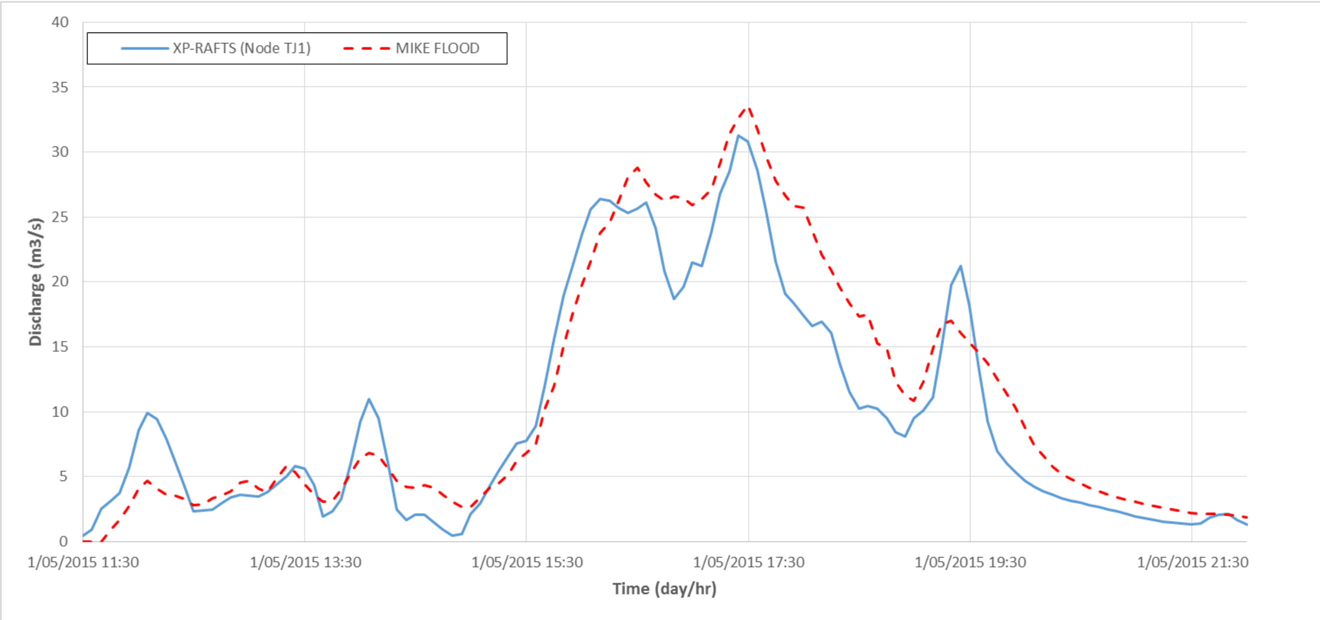


Figure 5-7 May 2015 calibration event – discharge profiles upstream of Shopping Centre

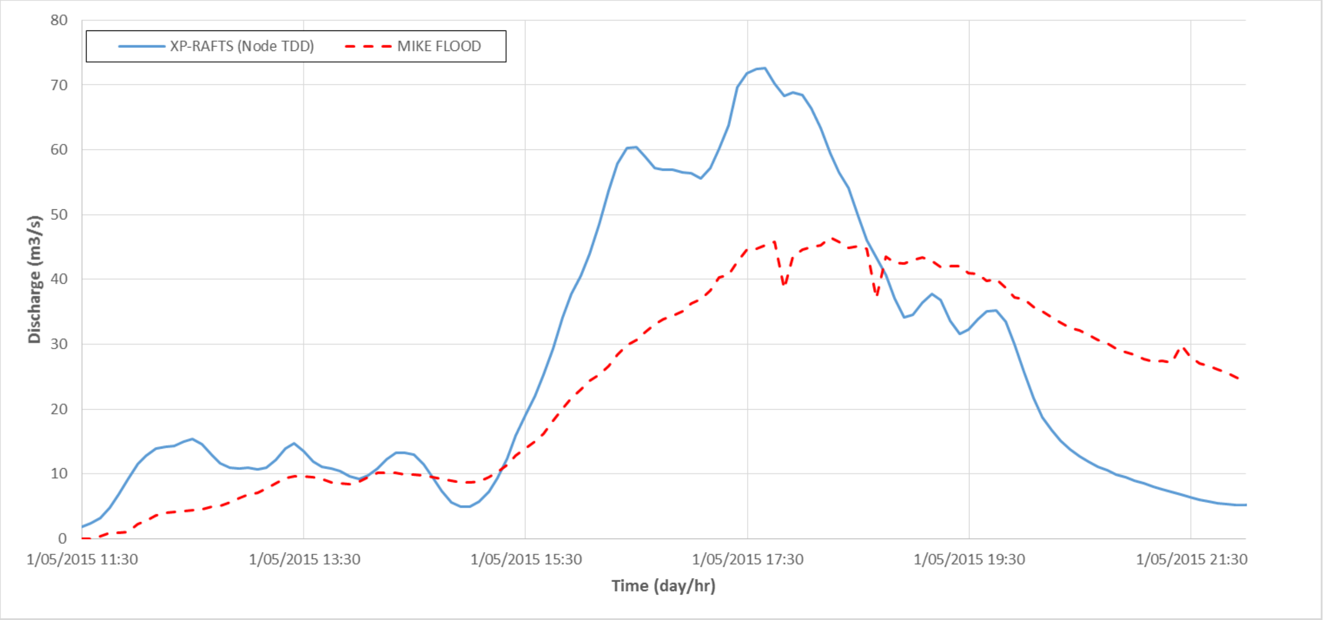


Figure 5-8 May 2015 calibration event – discharge profiles upstream of Lytton Road

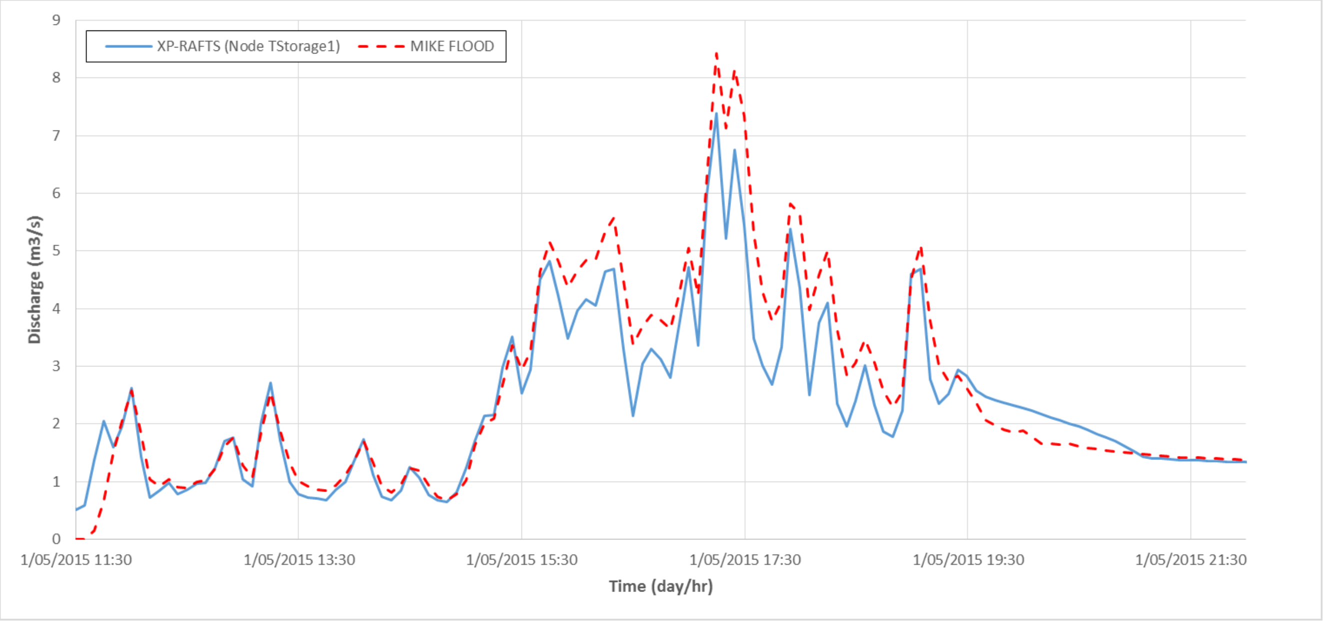


Figure 5-9 May 2015 calibration event – discharge profiles upstream of Barrack Road

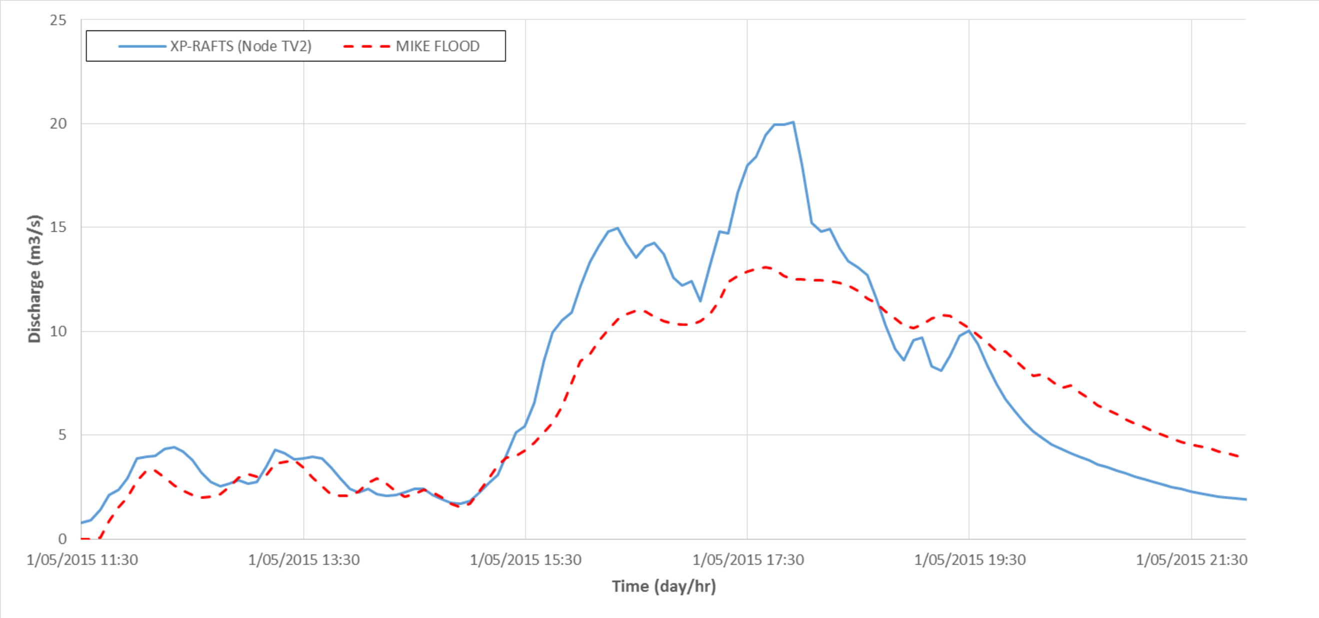


Figure 5-10 May 2015 calibration event – discharge profiles d/s of Junction Road

5.9 Discussion of Results

5.9.1 May 2015

The May 2015 event calibration results indicate good agreement between the modelled and recorded MHG levels. Modelled levels at all comparison locations are within the calibration target of ±0.3m. At the two downstream gauges (P110 and P100) the model overestimates the recorded flood level by 0.19m and 0.25m respectively. At the most upstream gauge P120, upstream of the Colmslie Shopping Centre, the modelled level is 0.20m higher than the recorded flood level.

Additionally, three flood debris marks were surveyed during the May 2015 event, and excellent agreement is achieved at two out of the three locations. The location at which poor agreement was achieved is across from Wynnum Road in the Colmslie Shopping Centre carpark. The recorded flood debris level of 4.81m is underestimated by the model by 0.38m. The underestimation could be attributed to partial blockage of the floodway caused by cars in the carpark at the time of the flood and the partial obstruction caused by fences and walls of large commercial buildings, which has not been accounted for in the model.

5.9.2 January 2013

MHG levels were recorded for the January 2013 event at the gauges P230, P115 and P100. At the downstream MHG P100 the model overestimates the peak flood level by 0.26m which is within the calibration tolerance. At MHG P230 the model underestimates the peak flood level by 0.41m. At MHG P115 the model overestimates the peak flood level by 0.09m.

P230 is located upstream of the culvert at Drainage Basin 1, with heavy vegetation located near the inlet of the culvert. It is possible that some culvert blockage from debris occurred during the January 2013 flood event, so several scenarios were run to assess the sensitivity of this localised water level to debris blockage of the Drainage Basin 1 outlet culvert. A blockage ratio of 45% produced levels consistent with the MHG record and within the calibration tolerance of ±0.3m, without an adverse impact on the calibration results in other parts of the model.

Furthermore, the recorded level at this location is not consistent with MHG records and predicted levels from the May 2015 and January 2015, adding further weight to the possibility that the recorded level might be debris-affected.

5.9.3 May 2009

Three recorded MHG levels were also available for the May 2009 calibration event. This included the two downstream gauges (P100 and P110) and the gauge upstream of Colmslie Shopping Centre (P120). At the upstream gauge the model overestimates the peak flood level by 0.18m. At the downstream gauges the model underestimates the recorded flood level at P110 by 0.19m and at P100 by 0.22m.

During this period the creek downstream of Lytton Road Bridge was being realigned. This calibration result (within the calibration tolerance of ±0.3m) was only achievable after the 2m ALS data from 2009 and the 2009 MIKE11 cross-sections geometry were implemented locally to represent the pre-realignment channel downstream of Lytton Road Bridge.

5.9.4 January 2015

Two MHG levels were recorded for the January 2015 validation event, at gauge P230 and at gauge P115. There was excellent agreement between the model and the observed levels at gauge P115 where the level was underestimated by 0.01m, and at the P230 gauge where the modelled level is exactly the same as the recorded level.

and **Figure 5-12** show the longitudinal profile of the peak water level along both the primary channels within the model extent.

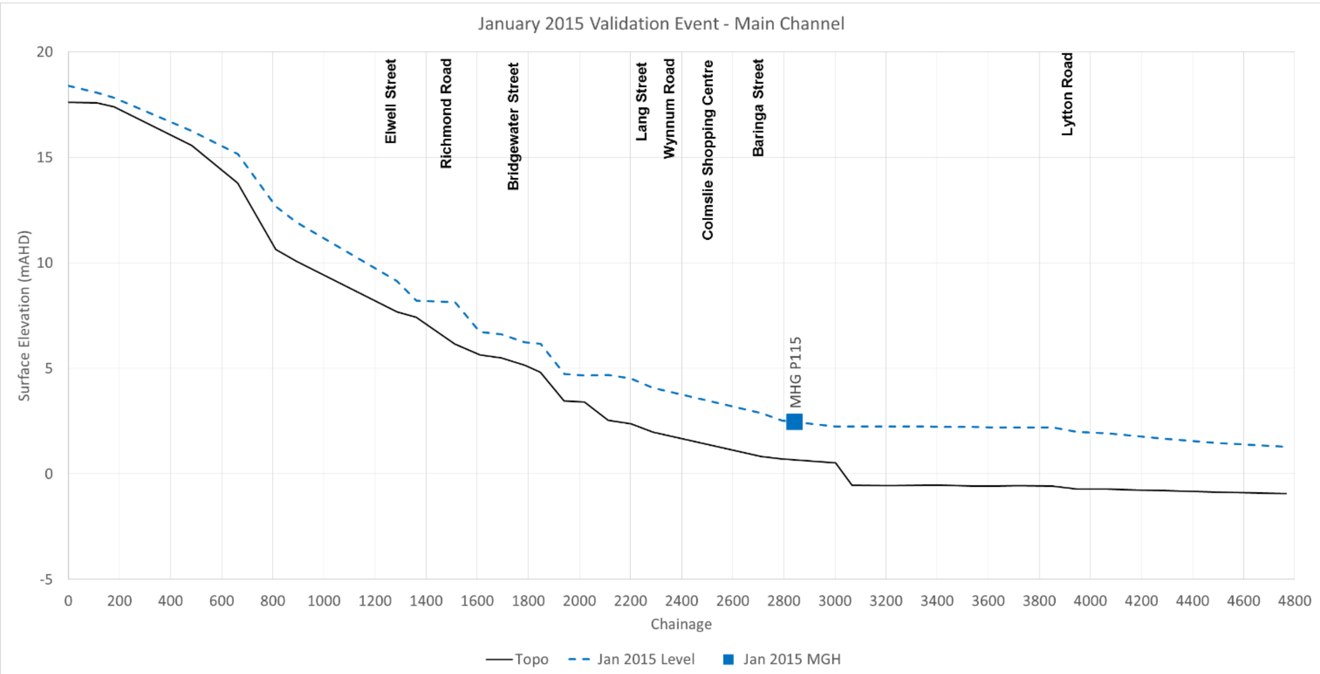


Figure 5-11 January 2015 validation event longitudinal section, Main Channel

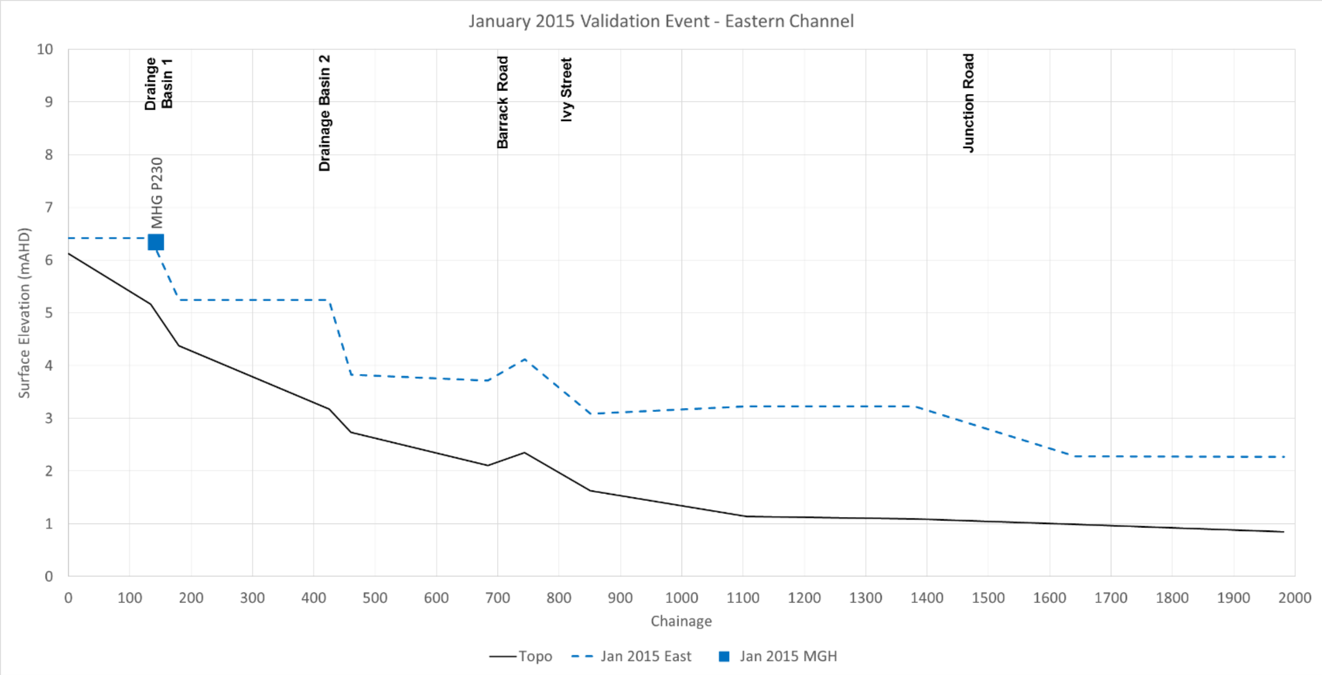


Figure 5-12 January 2015 validation event longitudinal section, Eastern Channel

5.9.5 Overall calibration performance and comparison of calibration events

The model achieves acceptable results for all calibration and validation events, with only one MHG record outside the calibration target (possibly debris affected) and a further surveyed debris mark also outside the ±0.3m calibration target. At both of these locations there is sufficient evidence presented to suggest these are outliers, based on the potential for debris blockage, and model consistency trends between events and adjacent recorded levels. The model is therefore considered fit for purpose and suitable for carrying out design event runs for the current catchment conditions and future scenarios.

The longitudinal profiles of peak flood level are presented in **Figure 5-13** and **Figure 5-14** for the three calibration events. They all display similar trends in both primary channels within the model extent, except in the lower reaches of the Main Channel for the May 2009 event. In the 2009 event a lower level upstream (MHG P120) corresponds to a higher level downstream (MHG P100), due to the change in channel geometry after 2009 (the impact of pre-realignment channel geometry has been discussed in previous sections).

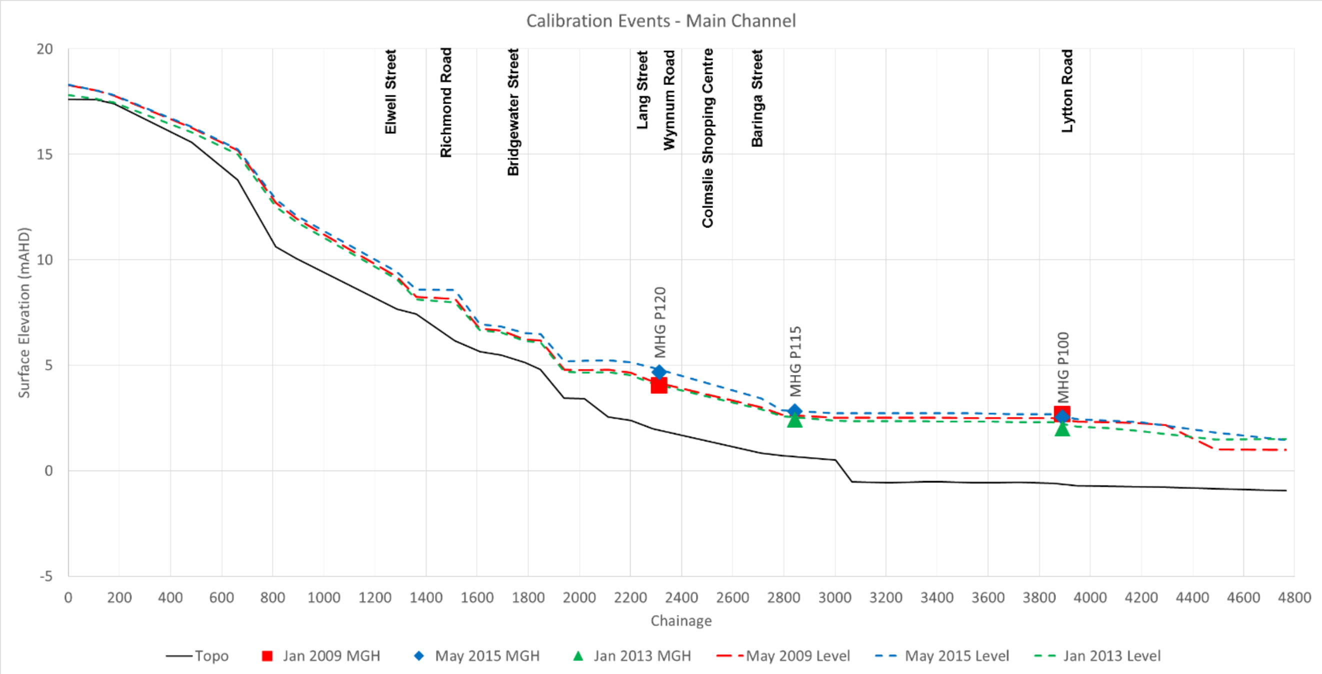


Figure 5-13 Calibration events longitudinal profile, Main Channel

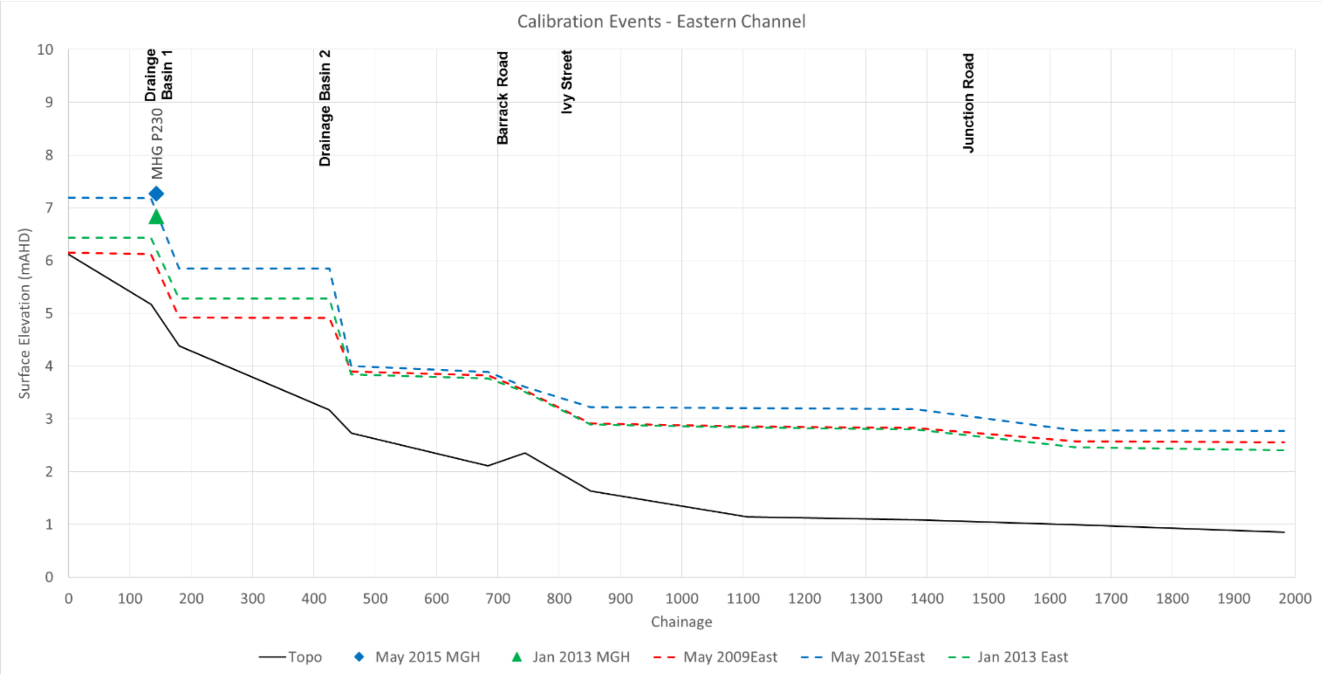


Figure 5-14 Calibration events longitudinal profile, Eastern Channel

6.0 **Design Event Analysis**

6.1 Design Event Terminology

The use of the terms "recurrence interval" and "return period" has been criticised as leading to confusion in the minds of some decision-makers and members of the public. Therefore, the current update of AR&R will utilise different terminology. The updated AR&R guidelines indicate that for larger flood magnitudes the term AEP (%) should be used instead of ARI (years).

Table 6-1 indicates the equivalent AEP value (rounded to a whole number) with respect to ARI. The relationship can be expressed by the following equation:

AEP = 1 – exp (-1 / ARI)

Table 6-1 ARI vs AEP

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

In this study, events having an 50%, 20%, 10%, 5%, 2% and 1% AEP are referred to as design events, and these are discussed in this section. Events having an AEP of 0.5%, 0.2% and 0.05% years are referred to as rare events, and these events are discussed in **Section 7**.

6.2 Design Event Scenarios

Three scenarios are included in the design event modelling:

Scenario 1 - Existing Waterway conditions: Scenario 1 is based on the current waterway conditions applied in the model calibration/verification model.

Scenario 2 - Minimum Riparian Corridor (MRC): Scenario 2 includes the allowance for a 15m riparian corridor on each side of the low flow channel of the creek. A default value of Manning's 'n' of 0.15 (Manning's 'M' of 6.667) was applied within this corridor, however where a changed value was not considered appropriate (adjacent to buildings, driveways, easements etc.) the calibration model Manning's 'n' was left unchanged.

Scenario 3 - Ultimate Waterway conditions: Scenario 3 assumes filling to the flood corridor boundary to represent ultimate catchment development. In the design events (i.e. up to the 1% AEP), the filling acts as a barrier and the flood 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 the City Plan.

The flood corridor is the greater extent of the combined Flood Planning Areas 1, 2 and 3 and waterway corridor including drainage easements, roads and local open spaces. **Table 6-2** displays the Flood Planning Area specifications. **Figure 6-1** displays the flood corridor which was used to model the ultimate scenario. For the extreme events the fill height outside of the flood corridor is set to the Scenario 3 1% AEP flood level plus an additional height allowance of 0.3m.

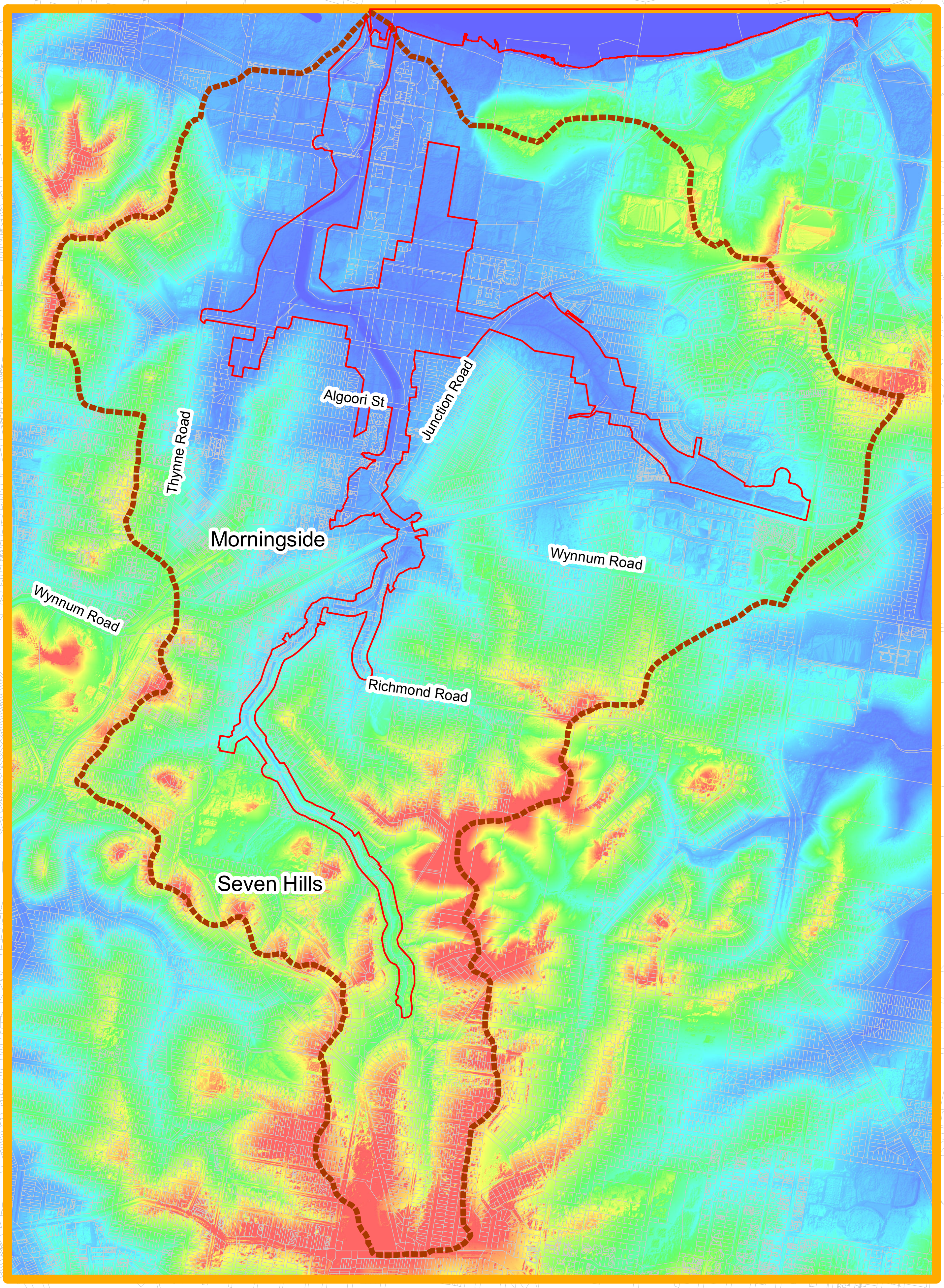
The design events (50%, 20%, 10%, 5%, 2% and 1% AEP) simulated for each scenario are summarised in **Table 6-3**. Note that the hydrology applied to all scenarios utilised the ultimate catchment land use conditions.

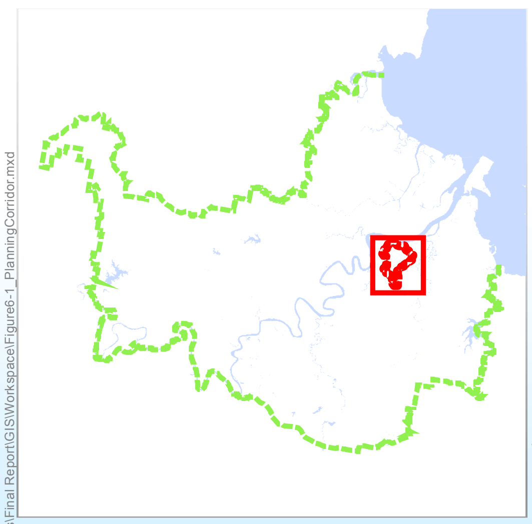
Table 6-2 Flood Plannning Area Specifications

Planning Area	Specifications
FPA1	Using Existing Model Scenario – Within the 10% AEP flood extent; and the Depth x Velocity Product > 1.2m²/s in the 1% AEP flood
FPA2	Using Existing Model Scenario – Greater extent of depth > 1.2m in 1% AEP flood; and the Depth x Velocity product > 1.2m²/s in the 1% AEP flood
FPA3	Using Existing Model Scenario – Greater extent of depth > 0.6m in 1% AEP flood; and the Depth x Velocity product > 0.6m²/s in the 1% AEP flood
FPA4	Greater Extent of 1% AEP stretched ultimate surface and 1% AEP Existing Surface
FPA5	Greater Extent of 0.2% AEP stretched ultimate surface and 0.2% AEP Existing Surface

Table 6-3 Design Event Scenarios

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





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Publication Date : 08 Jul 2016
Project Number : 100001

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Legend

- DEM Extent
- Flood Planning Corridor
- Perrin Creek Catchment

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DATA INFORMATION

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Perrin Creek Flood Study 2016

Figure 6-1: Flood Corridor

6.3 Design Event Hydrology

Design flood estimation can be undertaken using flood frequency analysis if observed stream flow records are available for gauging stations within the catchment. However there are no stations in the Perrin Creek catchment, and therefore this approach is not possible for this catchment. Instead design rainfall events are applied to the calibrated catchment rainfall-runoff model to calculate design hydrograph inflow boundaries for the hydraulic model.

6.3.1 Investigation Methodology

The design flood analysis undertaken for the catchment in this study is based on Australian Rainfall & Runoff (AR&R 1987). The methodology applied is as follows:

- IFD curves for Brisbane based on AR&R (1987) are used to derive event rainfall depths for 50%, 20%, 10%, 5%, 2% and 1% year AEP design events, with 30, 45, 60, 90, 120, 180, and 270 minute durations.
- Design temporal patterns from AR&R (1987) are used to distribute the design rainfall depth over the assumed duration of the storm.
- Design rainfalls are applied to the hydrology model (XP-RAFTS) to calculate design hydrographs for each design event AEP and storm duration.
- Hydraulic model simulations are undertaken for the proposed scenarios using the design event hydrographs to simulate the design event flooding.

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. This section describes the adjustments made to the model in order to simulate the design events.

Catchment Development

The design events were modelled using ultimate catchment conditions. These conditions assume that the state of development within the catchment is at its ultimate condition as specified in the City Plan 2014. Depending on the developed state of the catchment, an increase in development will generally affect the percentage impervious and the PERN hydrologic roughness values. The adopted hydraulic model roughness map for the ultimate catchment condition is shown in **Figure 5-3**.

Rainfall Losses

Rainfall losses are represented using Initial Loss (IL) and Continuing Loss (CL) parameters in order to determine the rainfall excess. An IL of 0 mm and a CL of 2.5 mm/hr was adopted for the design event modelling, consistent with other Brisbane-based studies.

Design hyetographs

Design hyetographs were derived from the techniques in AR&R (1987). Hyetographs were created for events between 50% AEP and 0.2% AEP, for durations between 30 minutes and 4.5 hours. Council’s 6 hour super-storm hyetograph based on the GSDM estimation technique was utilised for the 0.05% AEP and PMF events.

6.4 Design Event Hydraulic Modelling

The MIKE FLOOD model was used to determine design flood levels for those scenarios described in **Table 6-3** for events between the 50% AEP and the 1% AEP. These events were simulated for storm durations of between 30 minutes and 4.50 hours.

6.4.1 MIKE FLOOD model extents

The Scenario 1, 2 and 3 MIKE FLOOD models utilised the same model extent as the MIKE FLOOD model developed for the calibration and validation events.

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 as per City Plan 2014.

6.4.3 MIKE FLOOD model boundaries

Design Inflows

The design inflow boundaries to the MIKE FLOOD model were taken from the XP-RAFTS model for each AEP and duration. For all scenarios the model applied the same inflow locations as the MIKE FLOOD model developed for the calibration and validation events.

Design Tailwater Boundary

The Perrin Creek MIKE FLOOD model applied a fixed water level boundary at the Brisbane River confluence, with a Mean High Water Springs (MHWS) level of 1.06 mAHD used for all design events.

6.4.4 MIKE FLOOD model parameters

The wetting and drying depths, eddy viscosity and time step parameters that were used in the calibration and validation models were applied to all design event models as given in **Table 5-3**.

6.5 Results and Mapping

6.5.1 Peak Discharge Results

Peak flood discharges estimated from the MIKE FLOOD model simulations were extracted upstream of key structure crossing locations. The peak discharges for all design events as well as corresponding peak flood levels are given in the **Table 6-4**.

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

Structure Location	Peak Discharge (m³/s)					
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)
Main Channel						
Elwell Street	21	30	34	36	36	36
Richmond Road	22	28	28	29	29	29
Rossiter Street/Wynnum Road	29	38	39	39	39	39
Baringa Street	30	34	34	34	34	34
Gabion Weir	31	38	43	61	80	96
Lytton Road Bridge	31	40	64	65	77	76
Eastern Channel						
Barrack Road	10	11	10	11	10	12
Junction Road	11	15	16	18	20	21

6.5.2 Critical Durations

A range of event between 30 minutes and 270 minutes (30 minutes, 45 minutes, 1 hour, 1.5 hour, 2 hours, 3 hours, and 4.5 hours) were simulated from which the critical duration for the design events is determined at key locations within the catchment. **Table 6-5** displays the critical duration at these locations.

Table 6-5 Critical Durations at Key Structure Locations (Scenario 1)

Structure Location	Critical Duration (minutes)					
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)
Main Channel						
Elwell Street	60 mins	60 mins	60 mins	60 mins	60 mins	60 mins
Richmond Road	60 mins	60 mins	60 mins	60 mins	60 mins	60 mins
Rossiter Street/Wynnum Road	60 mins	60 mins	60 mins	60 mins	60 mins	60 mins
Baringa Street	60 mins	60 mins	90 mins	60 mins	60 mins	60 mins
Gabion Weir	90 mins	120 mins	120 mins	120 mins	120 mins	120 mins
Lytton Road Bridge	120 mins	120 mins	120 mins	180 mins	120 mins	120 mins
Eastern Channel						
Barrack Road	60 mins	60 mins	60 mins	60 mins	60 mins	60 mins

Structure Location	Critical Duration (minutes)					
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)
Junction Road	60 mins	60 mins	90 mins	120 mins	120 mins	120 mins

6.5.3 Peak Flood Levels

Tabulated peak flood level results are provided for Scenario 1 upstream of major structures in **Table 6-6,** and in **Appendix E** for Scenario 1 and Scenario 3 at 100 metre chainage intervals along the AMTD lines. The peak flood levels are the maximum flood level at the specified location for all storm durations.

Table 6-6 Design Event Peak Water Level upstream of Major Structures (Scenario 1)

Structure Location	Peak Water Level (mAHD)					
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)
Main Channel						
Elwell Street	9.20	10.05	10.54	10.79	10.99	11.13
Richmond Road	8.35	9.28	9.47	9.74	9.95	10.10
Rossiter Street/Wynnum Road	4.55	5.17	5.27	5.41	5.55	5.66
Baringa Street	3.09	3.47	3.52	3.69	3.86	3.97
Gabion Weir	2.30	2.53	2.67	2.84	3.01	3.13
Lytton Road Bridge	2.20	2.43	2.61	2.77	2.94	3.06
Eastern Channel						
Barrack Road	3.85	3.94	3.98	4.03	4.07	4.11
Junction Road	2.67	2.89	3.03	3.22	3.41	3.50

6.5.4 Flood Immunity of Existing Crossings

The flood immunity of the structures for Scenario 1 was determined by comparing peak flood levels upstream of the crossing with the minimum overtopping levels. The estimated structure immunities are presented in **Table 6-7**, where the minimum event considered was the 50% AEP and the maximum event was the 1% AEP.

The majority of the structures within the catchment have a flood immunity equivalent to a 20% AEP design event or less. One of the areas of particular interest in the study is the Colmslie Shopping Centre. The structures located upstream of the shopping centre have a flood immunity equivalent to a 50% AEP design event or less.

Table 6-7 Flood Immunity at Major Structures

Structure Location	Flood Immunity AEP (%)
Main Channel	
Elwell Street	20%
Richmond Road	50%
Jersey Street (Private)	20%
Bridgewater Street	50%
Lang Street	<50%
Wynnum Road/Rossiter Street	<50%
Railway	>PMF
Shopping Centre Inlet (upstream)	50%
Baringa Street	50%
Lytton Road	20%
Eastern Channel	
Drainage 1 (Detention Basin 1)	2%
Drainage 2 (Detention Basin 2)	2%
Barrack Road	<50%
Ivy Street	<50%
Junction Road	10%
Other Tributaries/Channels	
Lytton Road (Joins Eastern Channel)	5%
Footbridge (Joins Main Channel)	<50%

6.5.5 Flood Mapping

The study flood mapping products are provided in Volume 2. The maps include design floods between the 50% AEP and 1% AEP events for Scenario 1.

7.0 **Rare and Extreme Event Analysis**

7.1 Extreme Event Scenarios

Table 7-1 shows the events and scenarios modelled for the extreme event analysis. Scenario descriptions are as described in **Section 6.2**.

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		✓	×	×

7.2 Extreme Event Hydrology

7.2.1 Overview

Extreme event rainfalls were determined for the 0.5% AEP, 0.2% AEP, 0.05% AEP and PMP events. XP-RAFTS simulations with these rainfalls were then carried out to produce inflow hydrograph boundaries for the extreme event flood modelling.

7.2.2 0.5% AEP and 0.2% AEP Events

The 0.5% AEP and 0.2% AEP design IFD rainfall data was obtained using the CRC-Forge method for the events. The 0.5% AEP design IFD was slightly modified to take into account the differences between the AR&R and CRC-Forge methodologies. The 1% AEP, 0.5% AEP and 0.2% AEP events derived from CRC-Forge, together with the AR&R 1% AEP for Brisbane, were used to estimate the rainfall intensity values adopted for the 0.5% AEP event.

Table 7-2 shows the adopted 0.5% AEP and 0.2% AEP design rainfall intensities, and compares these against the adopted 1% AEP intensity. The 1.5 hour, 2 hour and 4.5 hour values were interpolated as the CRC-Forge methodology does not produce results for these intermediate values.

Table 7-2 Adopted IFD for 1% AEP, 0.5% AEP and 0.2% AEP

Duration (hr)	Rainfall Intensity (mm/hr)		
	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
0.5	159	163.8	190.9
0.75	130	135.3	157.7
1	113	116.8	133.5
1.5	86	92.8	108
2	71	75.6	88
3	53	55.8	65
4.5	40.4	43.2	50.2

7.2.3 0.05% AEP Event

The 0.05% AEP IFD rainfall was also determined using the CRC-Forge method, however, to avoid the need to simulate all different storm durations, a simplified super-storm method was used. This same methodology has also recently been applied to other BCC flood studies. This approach is consistent with research indicating 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 0.5% AEP and 0.2% AEP) was not applied for the analysis of the more extreme events.

A 6 hour super-storm was developed to represent all storm durations up to 6 hours. The super-storm was developed in 30 minute blocks, and incorporates storm bursts of 30 minutes up to 3 hours. Durations less than 30 minutes were not considered. The total rainfall depth of the super-storm was set equal to the 6 hour 0.05% AEP CRC-Forge rainfall depth (representative across the Brisbane Region) which was estimated to be 340mm.

7.2.4 PMP

For the PMP scenario, the 6 hour super-storm approach was also used, with the same temporal pattern developed for the 0.05% AEP event. The total PMP depth was derived from the Generalised Short Duration Method (GSDM) for a 6 hour storm duration. This method is considered appropriate for tropical and sub-tropical coastal areas of up to 520 km^2, and for storm durations up to 6 hours. To apply a methodology that is consistent 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 hour GSDM PMP rainfall depth, which was calculated to be 816mm. **Figure 7-1** and **Table 7-3** show the adopted super-storm temporal pattern and hyetographs for the 0.05% AEP and the PMP.

Table 7-3 Adopted Super Storm Hyetographs

Time (hr)	Rainfall (%)	Rainfall (mm)		Time (hr)	Rainfall (%)	Rainfall (mm)	
		0.05% AEP	PMP			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	27.62
0.67	5	4.33	9.92	3.83	80	7.58	27.62
0.83	6	4.33	9.92	4.00	82	7.58	27.62
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	27.62	5.33	95	4.33	9.92
2.33	23	7.58	27.62	5.50	96	4.33	9.92
2.50	25	7.58	27.62	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				

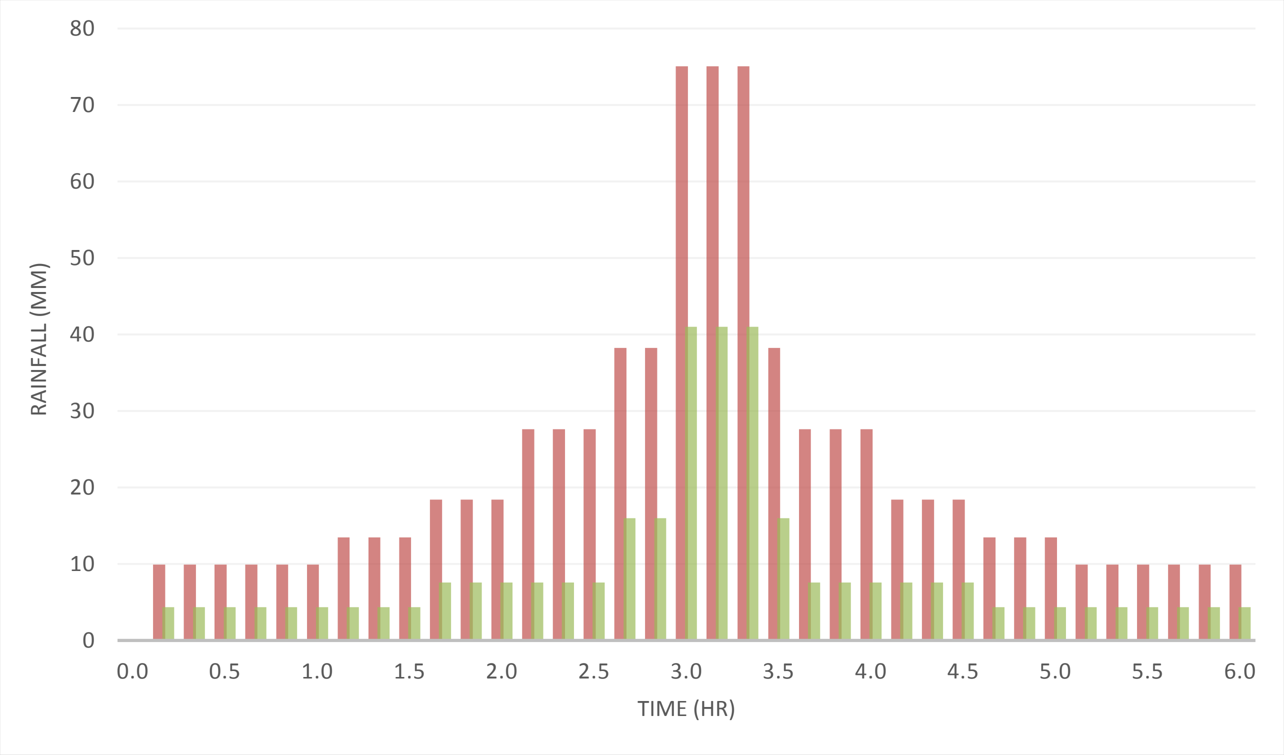

Figure 7-1 Super-storm temporal pattern - 0.05% AEP & PMP

7.3 Hydraulic Modelling

7.3.1 Overview

The MIKE FLOOD model was used to simulate the scenarios outlined in **Section 7.1**, to produce design flood levels and flood mapping products.

7.3.2 MIKE FLOOD model grid

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

7.3.3 MIKE FLOOD Topography

For the ultimate catchment extreme event scenarios, the topography was modified based on the 1% AEP ultimate catchment scenario results by restricting the floodplain. A depth of 300mm was added to the 1% AEP water levels to derive the ‘development level’. In areas outside the defined Flood Corridor (see **Section 6.2**) the floodplain was filled to the derived development level.

7.3.4 MIKE FLOOD model roughness

No changes were made from the design event MIKE FLOOD models.

7.3.5 MIKE FLOOD model boundaries

Extreme Event Flows

The extreme event inflow boundaries to the MIKE FLOOD model were taken from the results of the XP-RAFTS model for each ARI and duration. For all scenarios the model utilised the same inflow locations as the MIKE FLOOD model developed for the calibration and validation events.

Extreme Event Tailwater Boundary

A fixed water level boundary was applied at the Brisbane River confluence. The Highest Astronomical Tide (HAT) level of 1.65 mAHD was used for all extreme events.

7.3.6 MIKE FLOOD model parameters

No changes were made from the design event MIKE FLOOD models.

7.3.7 Hydraulic Structures

No changes were made from the design event MIKE FLOOD models.

7.4 Results and Mapping

7.4.1 Peak Flood Levels

Tabulated peak flood levels for extreme events are provided in **Appendix F**. Levels are provided for the following events and scenarios:

- Scenario 1: 0.5% AEP, 0.2% AEP and 0.05% AEP events
- Scenario 3: 0.5% AEP and 0.2% AEP events

7.4.2 Flood Mapping

Flood mapping products for the extreme events are provided in **Volume 2**. Water level surface mapping is included for the 0.5% AEP, 0.2% AEP and 0.05% AEP events for Scenario 1.

7.4.3 Discussion of Results

Longitudinal water level plots of Scenario 1 results for events between the 1% AEP and PMF are displayed in the **Figure 7-2** and **Figure 7-3**. The plots includes the Main Channel in Perrin Creek and the Eastern Channel. All events equal to or greater than the 100 year ARI event have similar hydraulic profiles along both the Main and Eastern channels.

The average incremental peak flood depth of each extreme event relative to the 1% AEP event level is in shown in **Table 7-4**.

Table 7-4 Average increase in flood level relative to 1% AEP event

Event	Average increase in flood level (m) compared against 1% AEP level	
	Main Channel	Eastern Channel
0.5% AEP	0.10	0.05
0.2% AEP	0.27	0.14
0.05% AEP	0.68	0.48
PMF	1.62	1.17

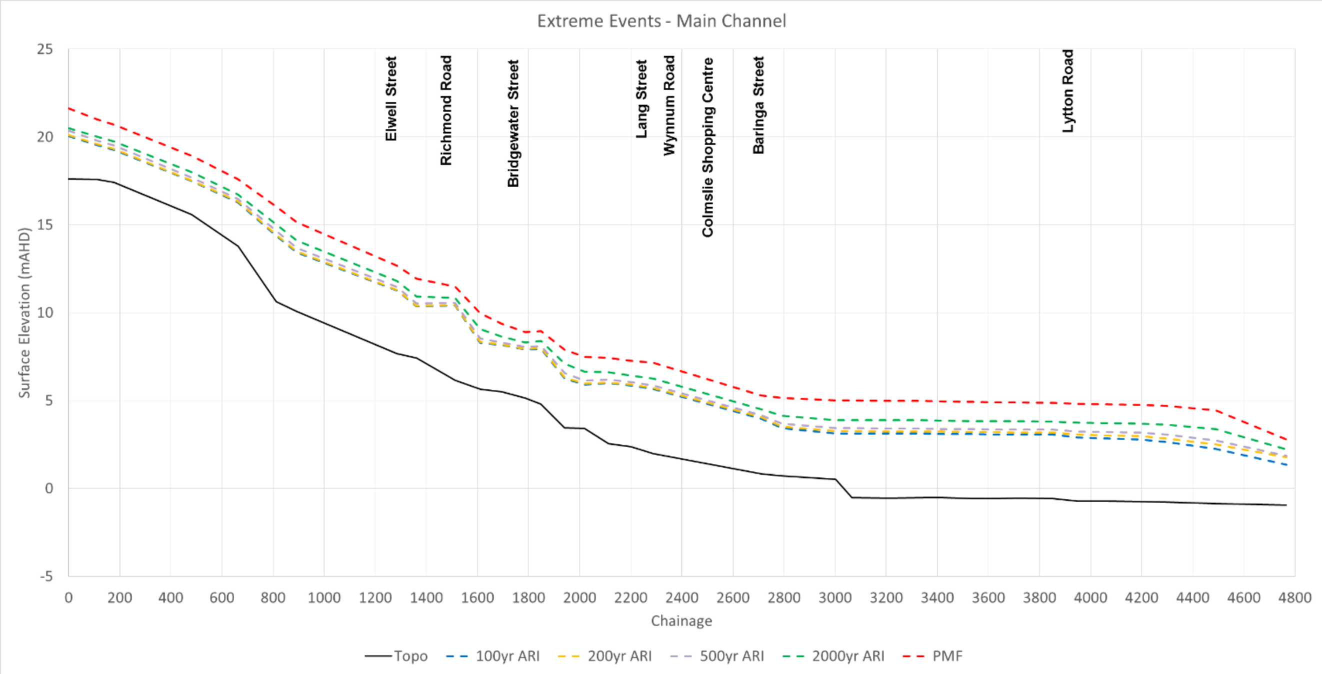

Figure 7-2 Longitudinal profile 1% AEP to PMF (Main Channel)

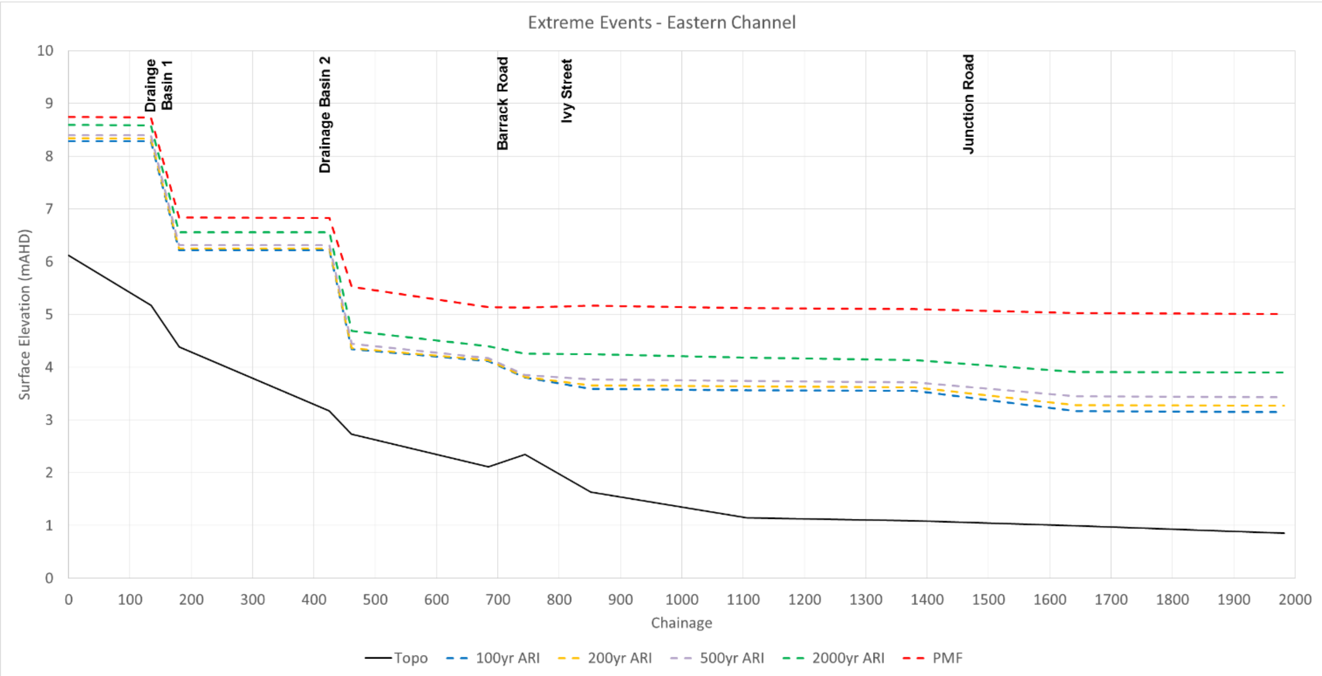

Figure 7-3 Longitudinal profile 1% AEP to PMF (Eastern Channel)

8.0 **Climate Variability and Structure Blockage**

8.1 Overview

To provide further information to support catchment and development planning, BCC flood studies include sensitivity analyses to factors which may affect the future behaviour of the catchment and waterway system. This includes considering the impact of climate variability on the catchment hydrology, and the impact of hydraulic structure blockages on peak flood levels.

8.2 Climate Variability

8.2.1 Overview

To allow BCC to undertake future land-use planning, the potential impacts of climate variability on flooding must be assessed. BCC flood studies are therefore required to apply the latest statutory guidelines regarding climate variability provision.

Climate variability scenarios undertaken in this study are outlined below. These scenarios are consistent with the most recently completed BCC flood studies and the latest statutory guidelines.

- Sensitivity test CC1: 2050 Planning Horizon
  - 10% increase in rainfall intensity
  - 0.3m increase in mean sea level

- Sensitivity test CC2: 2100 Planning Horizon
  - 20% increase in rainfall intensity
  - 0.8m increase in mean sea level

8.2.2 Modelled Scenarios

Climate variability impacts were estimated for the 1% AEP, 0.5% AEP and 0.2% AEP events. **Table 8-1** summarises the events modelled and the respective modifications to the model boundary conditions.

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 + 0.3 m	✓	✓
		2100	+20%	MHWS + 0.8m	✓	✓
200	0.5	2050	+10%	HAT + 0.3m	✓	×
		2100	+20%	HAT + 0.8m	✓	×
500	0.2	2050	+10%	HAT + 0.3m	✓	×
		2100	+20%	HAT + 0.8m	✓	×

8.2.3 Hydraulic Modelling

The climate variability MIKE FLOOD models apply the same model setups as the design event MIKE FLOOD models, apart from the modified boundary conditions specific to the climate variability scenario.

The XP-RAFTS model was utilised to derived the inflow boundary conditions for the +10% and +20% rainfall intensity scenarios. The inflow boundary locations did not change from the design event modelling, and the same design and extreme event hyetographs were applied.

Simulations applied the increased tailwater condition as a fixed downstream boundary, as listed in **Table 8-1**.

8.2.4 Tabulated Results

Peak flood levels from the climate variability scenarios were compared against design and extreme event modelling results at key structure locations. The climate variability scenarios considered include:

- Scenario 1 CC1 (2050): 1% AEP and 0.5% AEP events under existing catchment conditions
- Scenario 1 CC2 (2100): 1% AEP, 0.5% AEP and 0.2% AEP events under existing catchment conditions
- Scenario 3 CC1 (2050): the 1% AEP event under ultimate development catchment conditions
- Scenario 3 CC2 (2100): the 1% AEP event under ultimate development catchment conditions

8.2.5 Impacts of Climate Variability

Table 8-2, **Table 8-3** and **Table 8-4** compare the peak flood levels at key structures for the Scenario 1 climate variability models, for the 1% AEP, 0.5% AEP and 0.2% AEP events respectively.

As expected the 2100 planning horizon scenario produces the largest increase in water levels due to the increased rainfall intensity and sea level rise. The smallest increase for all three events is at Barrack Road. This location is downstream of the two storage basins located within the model.

Table 8-2 1% AEP Climate Variability Impacts at Selected Locations (Scenario 1)

Location	1% AEP Flood Level (mAHD)		
	Existing	2050 (CC1)	2100 (CC2)
Main Channel			
Elwell Street	11.13	11.23	11.34
Richmond Road	10.10	10.21	10.30
Rossiter Street/Wynnum Road	5.66	5.75	5.83
Baringa Street	3.97	4.06	4.14
Gabion Weir	3.13	3.26	3.40
Lytton Road Bridge	3.06	3.18	3.32
Eastern Channel			
Barrack Road	4.11	4.14	4.17
Junction Road	3.50	3.58	3.65

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

Location	0.5% AEP Flood Level (mAHD)		
	Existing	2050 (CC1)	2100 (CC2)
Main Channel			
Elwell Street	11.17	11.28	11.39
Richmond Road	10.14	10.25	10.33
Rossiter Street/Wynnum Road	5.70	5.79	5.87
Baringa Street	4.04	4.13	4.22
Gabion Weir	3.25	3.40	3.59
Lytton Road Bridge	3.17	3.31	3.52
Eastern Channel			
Barrack Road	4.12	4.15	4.19
Junction Road	3.57	3.64	3.76

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

Location	0.2% AEP Flood Level (mAHD)	
	Existing	2100 (CC2)
Main Channel		
Elwell Street	11.32	11.56
Richmond Road	10.29	10.48
Rossiter Street/Wynnum Road	5.84	6.02
Baringa Street	4.17	4.34
Gabion Weir	3.42	3.74
Lytton Road Bridge	3.26	3.66
Eastern Channel		
Barrack Road	4.16	4.23
Junction Road	3.67	3.89

8.3 Hydraulic Structure Blockage

8.3.1 Overview

Blockage of hydraulic structures can increase flood risk beyond that estimated from modelling with full structure openings. Current guidance recommends that designers of hydraulic structures should make allowances for the risk of blockage in the design. However, current guidance does not specify that blockage is required to be included as part of the determination of the overall design flood level.

For this study the blockage of selected hydraulic structures was evaluated as part of the sensitivity analysis to determine the incremental effect. This approach will allow BCC to understand the potential additional 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:

- Main Channel – Elwell Street
- Main Channel – Richmond Road
- Main Channel – Bridgewater Street
- Main Channel – Shopping Centre inlet
- Main Channel – Baringa Street
- Eastern Channel – Barrack Road
- Eastern Channel – Junction Road

8.3.3 Blockage Scenarios

The blockage analysis has been carried out for the existing case (Scenario 1) for the 1% AEP design event, only for the critical duration at each structure. The critical duration for almost all structures is the 60 minute storm duration, with the exception of the Junction Road culverts which have a 120 minute critical duration. For the Elwell Street and Junction Road blockage scenario both the 60 minute and 120 minute storm durations were modelled.

Individual structures were blocked and modelled under 10 different scenarios, to ensure that the blockage impacts would not be masked by the effect of blockages at other structures. The 10 different scenarios include five partially blocked simulations and five fully blocked simulations.

The Queensland Urban Drainage Manual (QUDM) was used as guidance in determining the degree of blockage for each structure. QUDM recommends a 25% sediment blockage for the culvert barrel, and 20% blockage for the culvert inlet, is adopted for culverts of the size found in the Perrin Creek catchment.

For box culverts a sediment blockage of 25% has been represented by raising the invert level, and an inlet blockage of 20% has been represented by reducing the culvert width. This approach is considered to be conservative and assumes both inlet blockage and culvert barrel blockage are incremental and occur simultaneously.

8.3.4 Impacts of Structure Blockage

Table 8-5 gives the 1% AEP flood level differences immediately upstream of the hydraulic structures for each of the 10 blockage simulations. In the partially blocked scenarios small increases of less than or equal to 0.10 metres were seen at most structures. However at Elwell Street and Bridgewater Street the partial blockages produced increases of 0.15 metres and 0.25 metres respectively, indicating the sensitivity of upstream flooding to blockage at these locations.

Table 8-5 1% AEP Peak Water Levels for Blockage Scenarios (Scenario 1)

Scenario	Structure Location	Existing Scenario (mAHD)	Partially Blocked Analysis (mAHD)	Difference (m)	Fully Blocked Analysis (mAHD)	Difference (m)
Elwell Street and Junction Road Blockage	Elwell Street	11.13	11.28	0.15	11.74	0.61
	Junction Road	3.50	3.54	0.04	3.78	0.24
Richmond Road and Barrack Road Blockage	Richmond Road	10.10	10.20	0.10	10.57	0.47
	Barrack Road	4.11	4.12	0.01	4.24	0.13
Baringa Street Blockage	Baringa Street	3.97	4.02	0.05	4.23	0.25
Bridgewater Street Blockage	Bridgewater Street	7.29	7.54	0.25	8.10	0.81
Shopping Centre inlet blockage	Shopping Centre Inlet	5.24	5.27	0.03	5.55	0.31

9.0 **Summary of Study Findings**

9.1 Summary and Conclusions

This report details the calibration and verification, design event modelling, extreme event modelling and sensitivity modelling undertaken for the Perrin Creek Flood Study.

The XP-RAFTS hydrological model and MIKE FLOOD hydrodynamic model were calibrated using the May 2015, January 2013 and May 2009 flood events. The models were then validated against the January 2015 flood event. There are no continuous stream gauges within the Perrin Creek Catchment, however five Maximum Height Gauges are available in the catchment, and these were used during the calibration and verification process.

The combined XP-RAFTS - MIKE FLOOD models were able to be calibrated against the selected historical events to within the required peak water level tolerance of ±300mm. This tolerance was exceeded at one location for one event, and the reason for this discrepancy is discussed in detail in **Section 5.6**. Furthermore, the simulated validation event model peak water levels also agreed with observed levels to within the nominated tolerance. On this basis it was concluded that the both models were sufficiently accurate to simulate design and extreme flood events.

XP-RAFTS and MIKE FLOOD model hydrographs were compared at a number of locations in the catchment. At most locations there was reasonable agreement between the models. Where there were significant differences, this was due to floodplain storage attenuation in the MIKE FLOOD model that could not be adequately represented in the XP-RAFTS model.

Cross-checks of MIKE FLOOD structure head losses were undertaken at selected structures using HEC-RAS. This analysis confirmed that the losses in MIKE11 were being calculated as expected, and that the estimated losses in the flood study model are realistic.

Design and extreme flood magnitudes were estimated for a range of design events between the 50% AEP and the 1%AEP, and for the 0.5% AEP, 0.2% AEP, 0.05% AEP and PMF extreme events. These analyses assumed ultimate catchment development conditions in accordance with the BCC City Plan (2014).

Three waterway scenarios were considered, with these being:

- Scenario 1: This is based on the current waterway conditions. No further modifications were made to the MIKE FLOOD model developed as part of the calibration/validation process.
- Scenario 2: This includes an allowance for a riparian corridor along the edge of the channel.
- Scenario 3: This includes an allowance for the riparian corridor (as per Scenario 2), and also assumes filling to the flood corridor to represent 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 locations;
- Peak flood extent mapping;
- Peak flood depth mapping; and
- Hydraulic structure flood immunity data.

The flood immunity of most structures within the catchment was assessed to be less than a 20% AEP flood event, with pipes and culverts around the Colmslie Shopping Centre having flood immunity of less than 50% AEP.

As part of the study sensitivity analysis, simulations were carried out to determine the impacts of climate variability for two planning horizons: 2050 (Climate Variability Scenario 1), and 2100 (Climate Variability Scenario 2). These scenarios included allowances for increased rainfall intensity and increased sea level rise. The analysis was undertaken for the 1% AEP, 0.5% AEP and 0.2% AEP events.

The sensitivity analysis also included estimation of incremental increases in peak water levels due to blockages at key hydraulic structures. Seven structures within the catchment were blocked in accordance with recommendations in the QUDM. A total of 10 scenarios were undertaken that included simulating a combination of partially and fully blocked structures.

9.2 Model Limitations

This study has been carried out under a number of assumptions, and there are some specific limitations on the models and results.

- The models have only been calibrated/validated at locations where the MHG records and debris marks exist. This should be taken into account when considering the accuracy of results outside the influence of these locations.
- There are no gauging stations located within the catchment and consequently the model is only validated against peak water levels.
- The models have been developed to simulate flooding characteristics at a broad scale, and as a result flooding due to smaller scale features may not be apparent in the results.
- The XP-RAFTS and MIKE FLOOD models must be utilised together to produce flooding results, as the XP-RAFTS model has not been developed as a “standalone” model.
- The topography data provided for this study is assumed to be representative of the catchment topography and waterways.
- Future changes to the catchment conditions that are not reflected in the modelling will affect the relevance of the study results.
- 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. bathymetric data, survey information, structure drawings etc.);
    - the accuracy and quality of the hydrometric data used to verify the models;
    - the number of historical stream gauges/MHG locations throughout the catchment; and
    - the purpose of the study (i.e. broad-scale or detailed).

10.0 **References**

Brisbane City Council (BCC) 2012, *0389634 Perrin Creek Flood Investigation - Draft Report*, Brisbane.

Brisbane City Council (BCC) 2013, *Perrin Creek Flood Investigation -Addendum Report –Extreme Event and Climate Variability analysis - Draft Final Report*, Brisbane.

Brisbane City Council (BCC) 2014 - *BCC City Plan 2014*, Brisbane

Brisbane City Council (BCC) 2015, *Flood Study Procedure Document Version 7.1,* City Projects Office, Brisbane Infrastructure, Brisbane

Mcilwain Civil, 2016, *Colmslie Stage 4 -Perrin Creek Realignment,* Available from: http://www.mcilwaincivil.com/project-Perrin-Creek-Realignment

DHI Water & Environment (DHI) 2016(1), *Perrin Creek Flood Study - Field Inspection Report*, Brisbane.

DHI Water & Environment (DHI) 2016(2)*, Perrin Creek Flood Study – Structure Loss Comparison Report,* Brisbane.

Department of Energy and Water Supply (DEWS) 2013, *Queensland Urban Drainage Manual, 3rd edition* Brisbane.

Pilgrim, DH, (ed) 1987, *Australian Rainfall & Runoff - A Guide to Flood Estimation*, Institution of Engineers, Australia, Barton, ACT.

Appendix A – Rainfall Distribution

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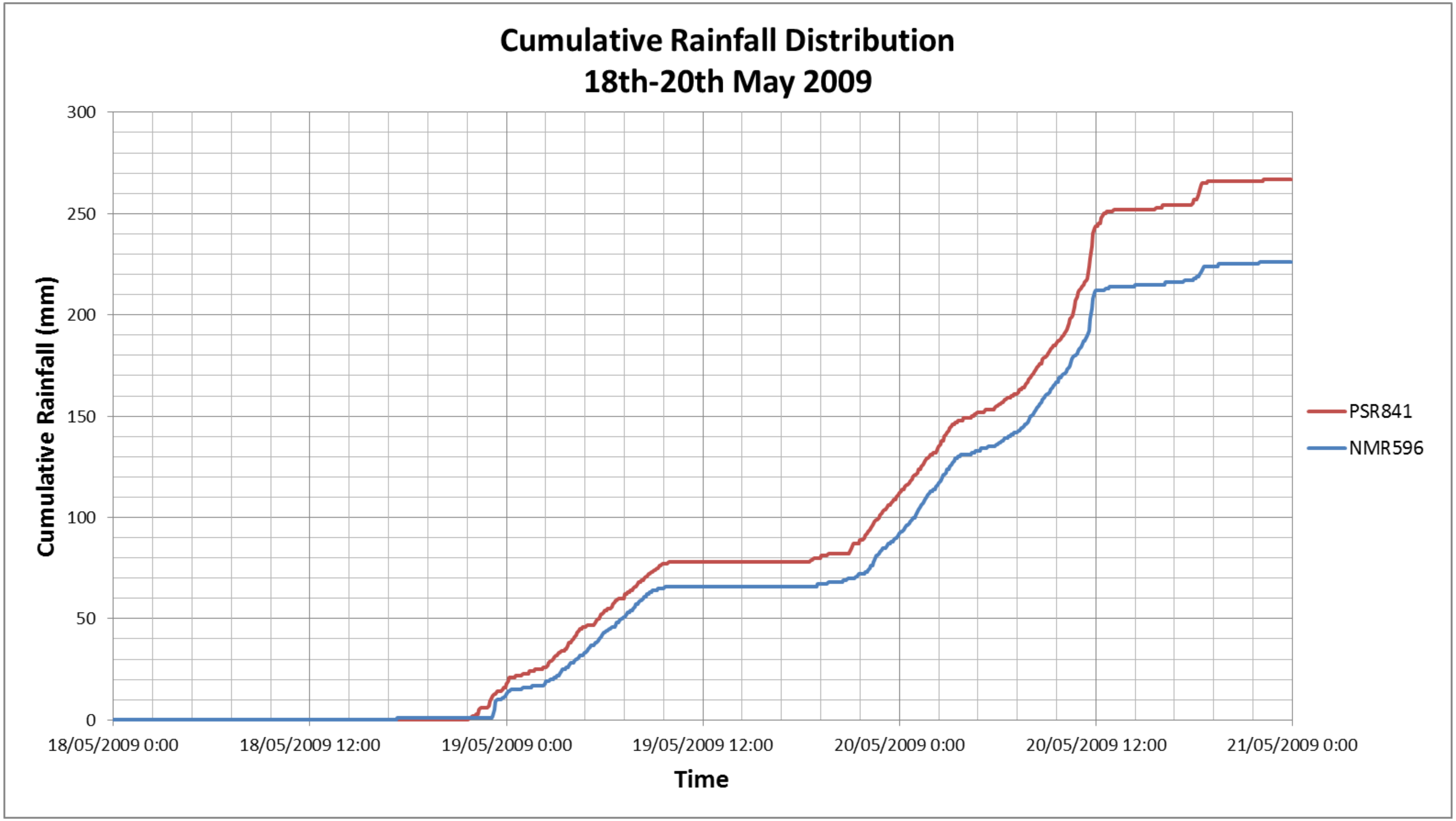
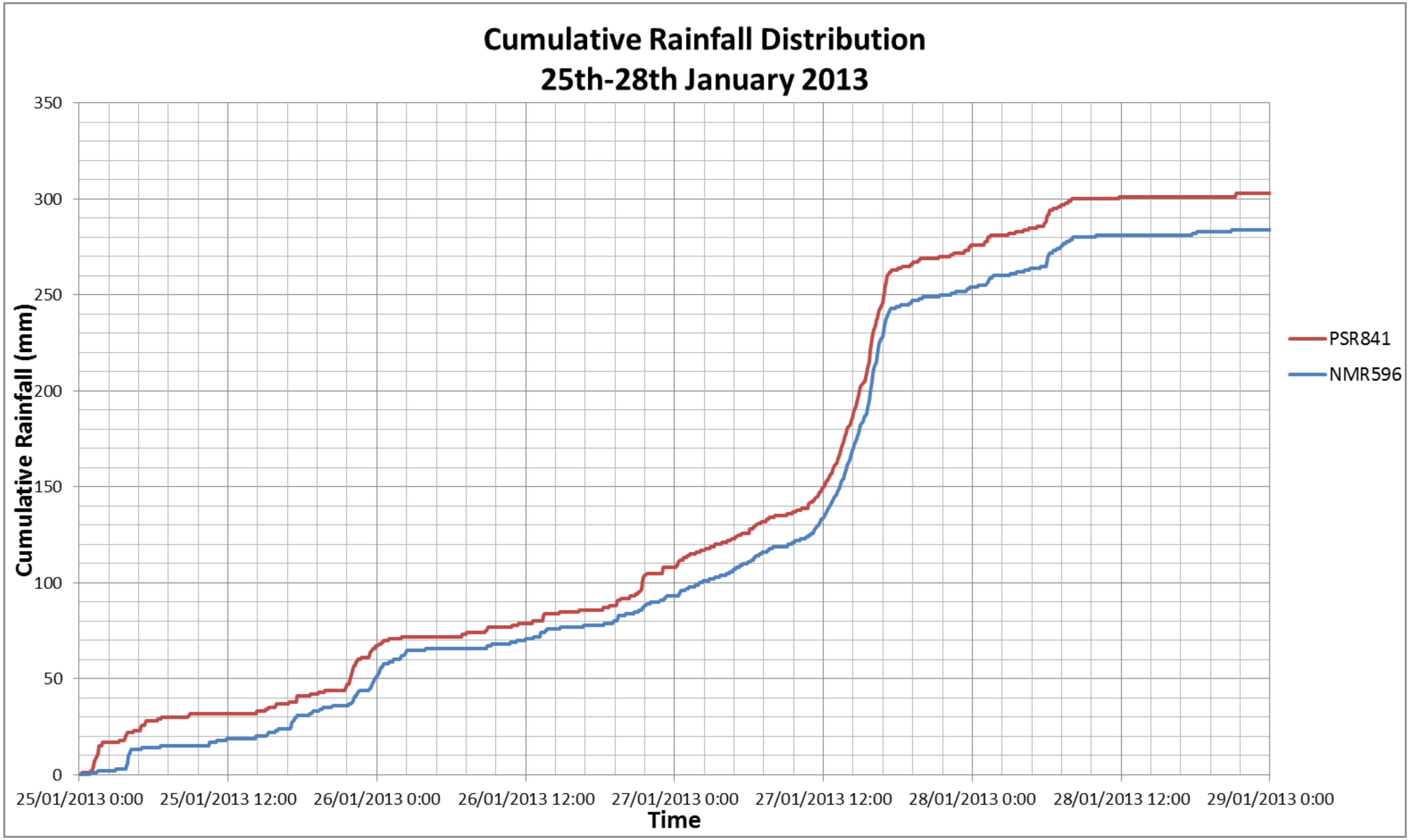


Figure A1: Cumulative Rainfall Plots for May 2009 event



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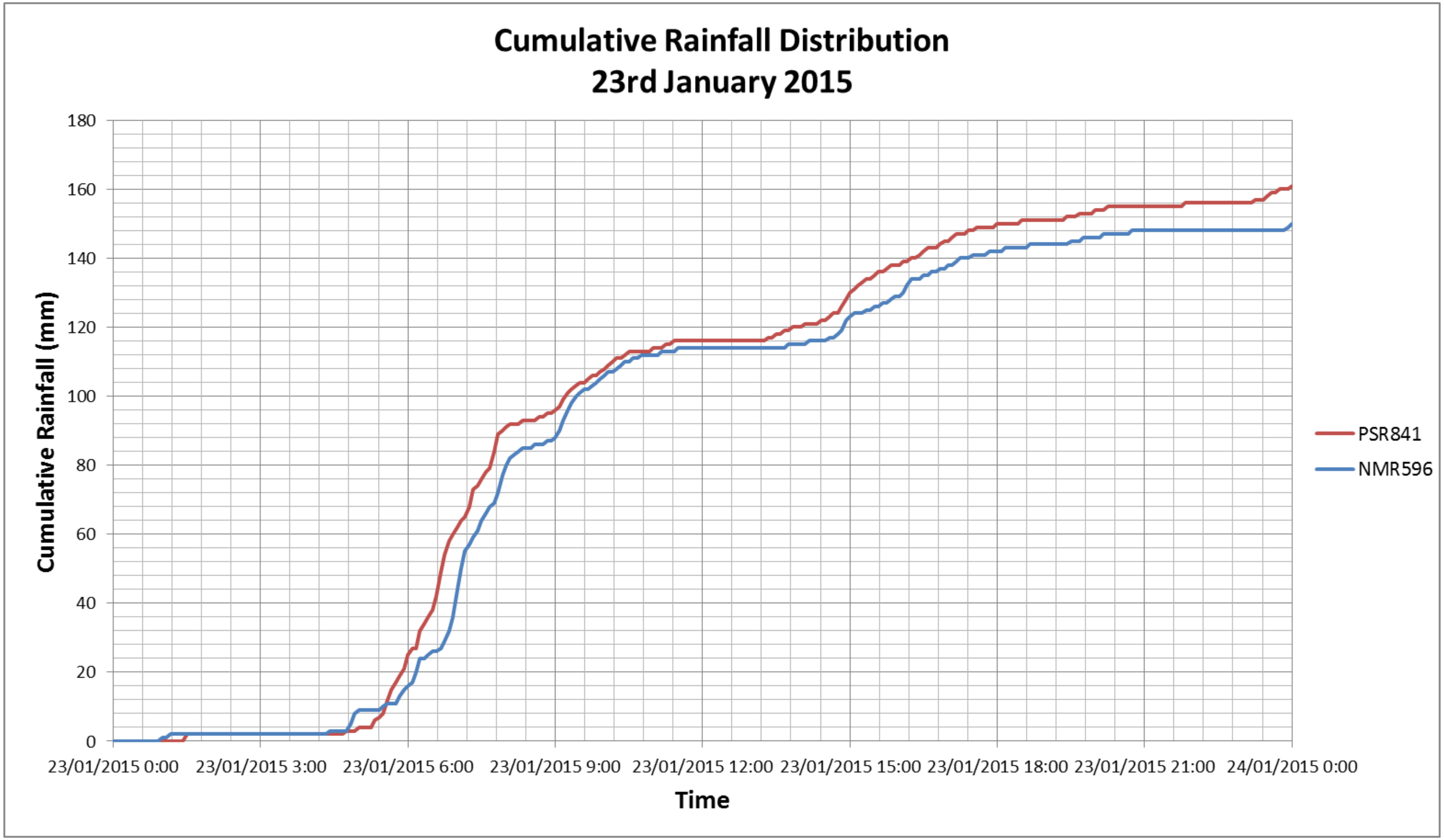

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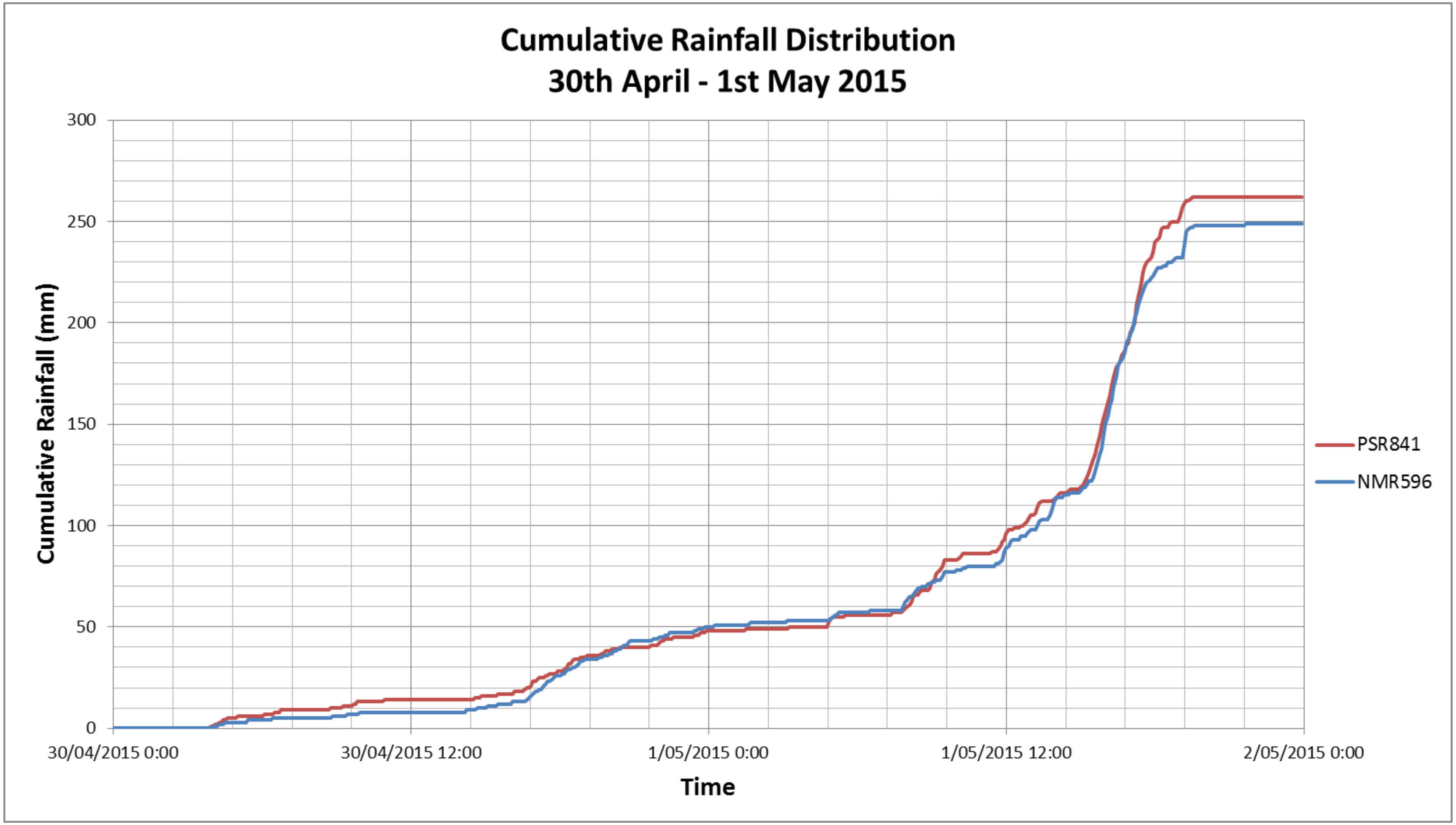
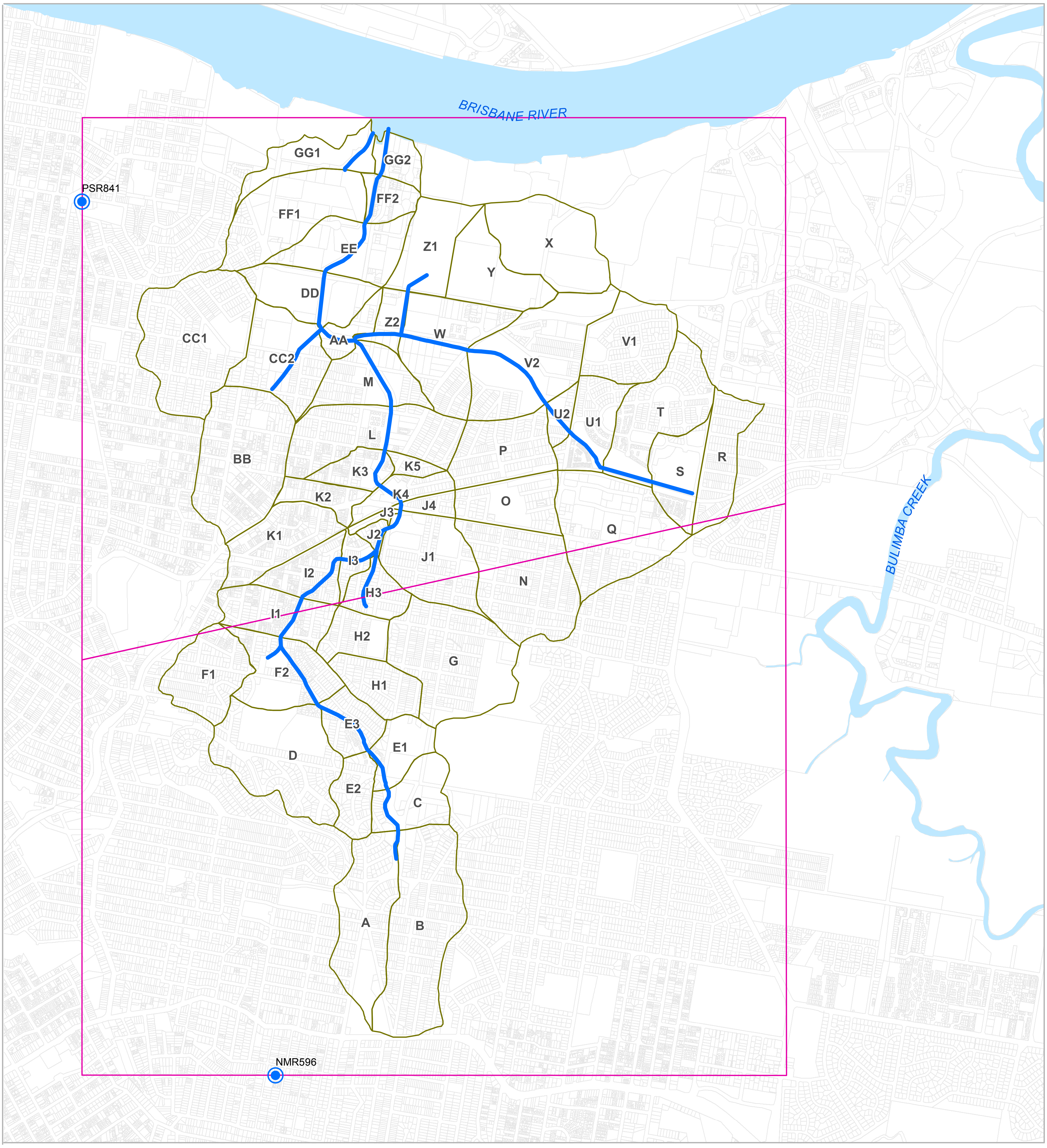
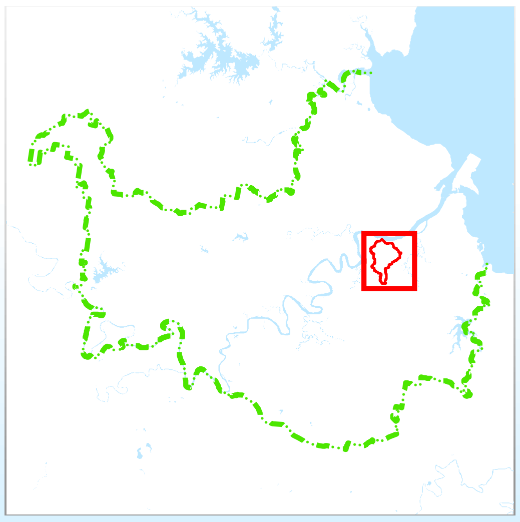


Figure A4: Cumulative Rainfall Plots for May 2015 event





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Legend

- Pluviograph Stations
- Thiessen Polygon
- Perrin Creek Waterway
- Sub-Catchments

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Figure A5: Perrin Creek Thiessen Distribution May 2009 Event

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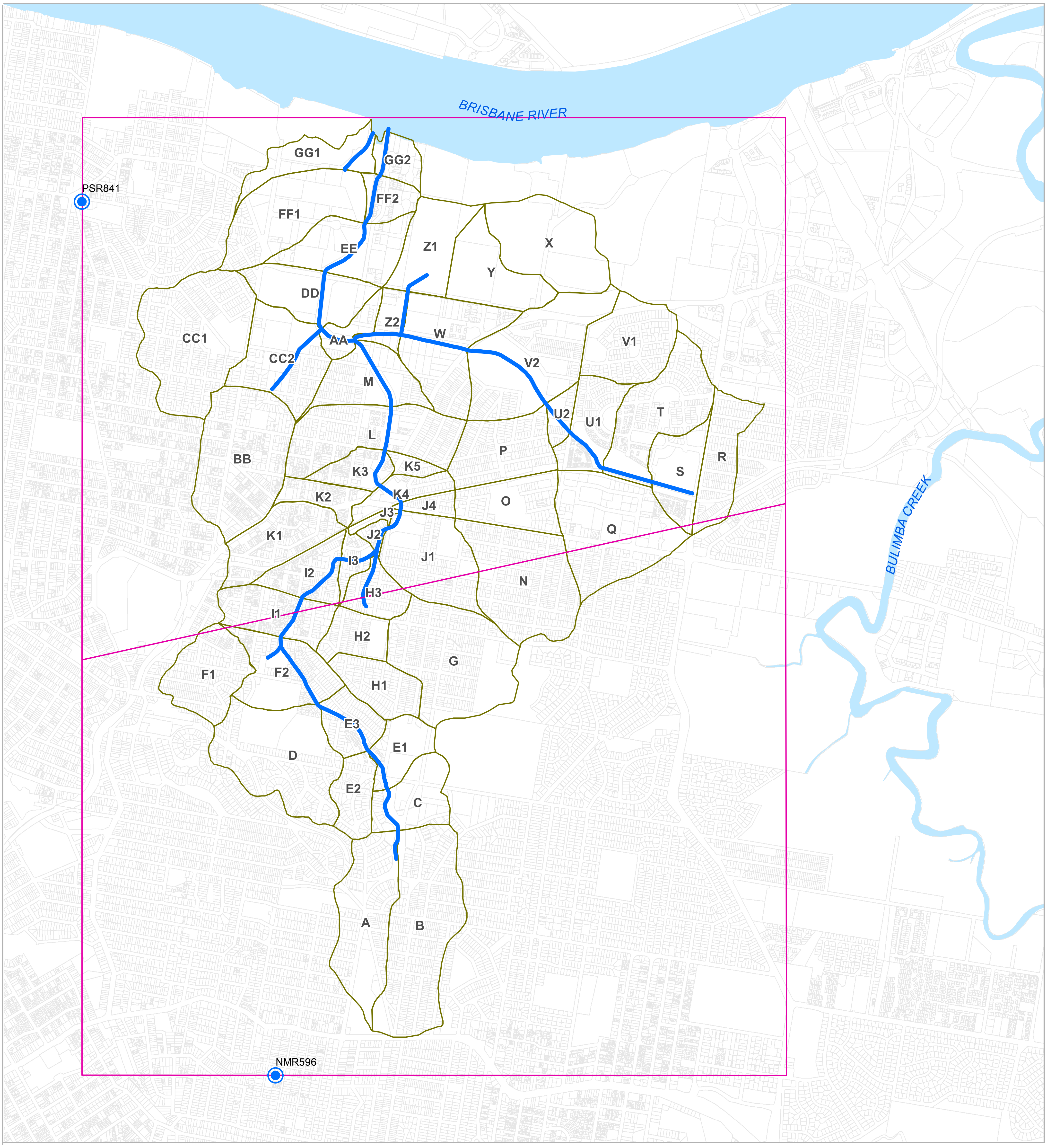

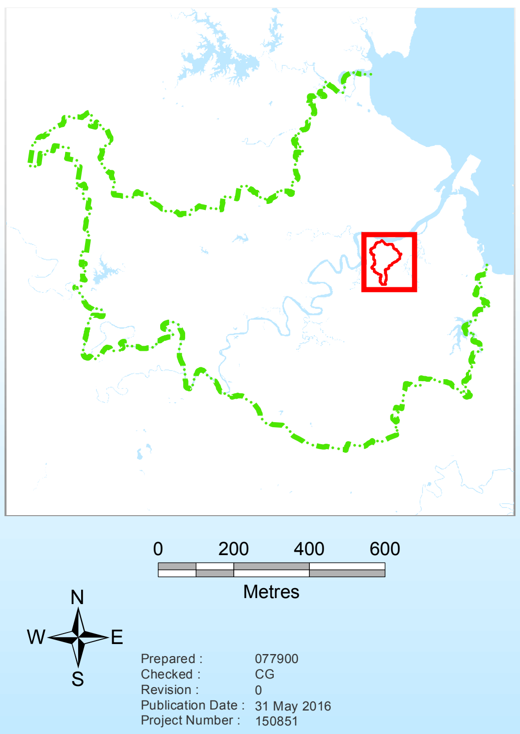

Legend

- Pluviograph Stations
- Thiessen Polygon
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Figure A6: Perrin Creek Thiessen Distribution January 2013 Event

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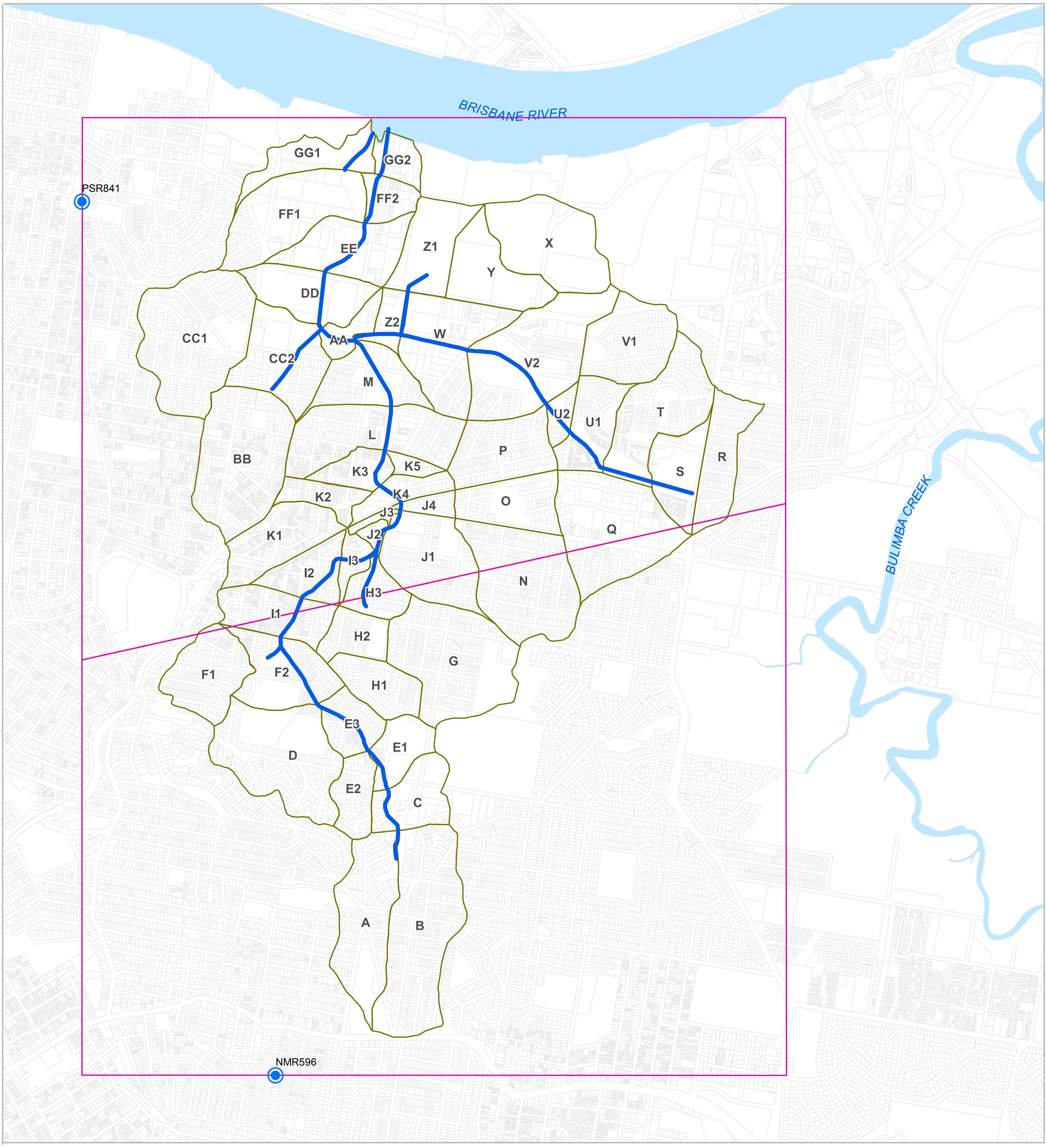

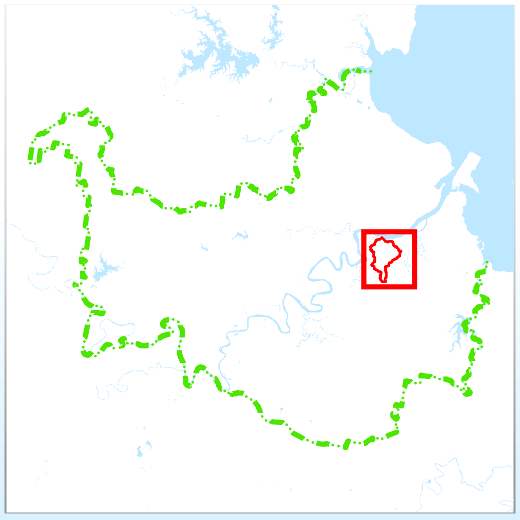

Legend

- Pluviograph Stations
- Thiessen Polygon
- Perrin Creek Waterway
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Figure A7: Perrin Creek Thiessen Distribution January 2015 Event

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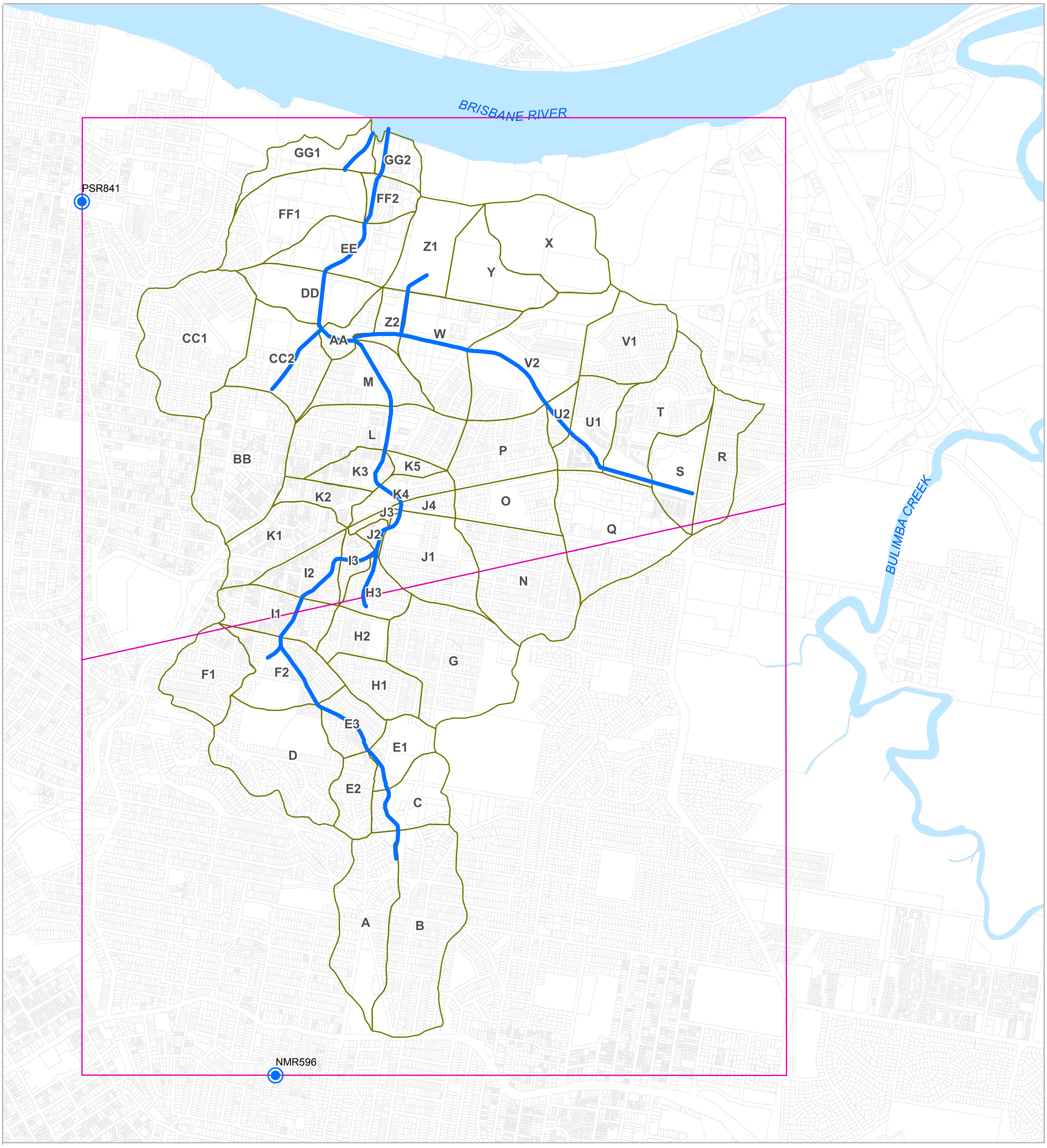

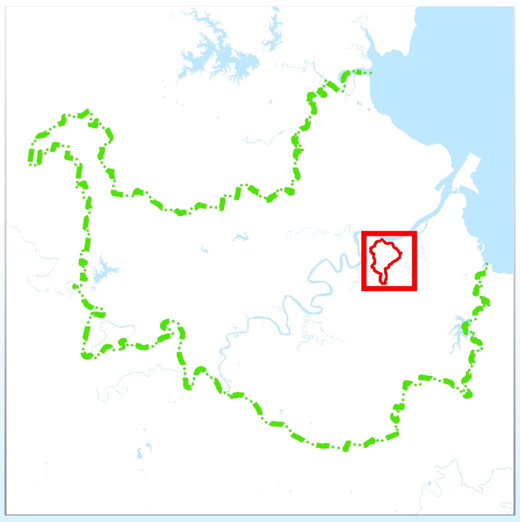

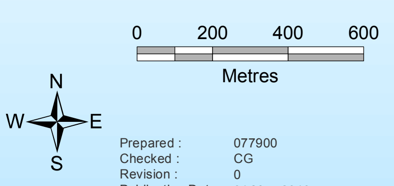

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Project Number : 150851

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Figure A8: Perrin Creek Thiessen Distribution May 2015 Event

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Appendix B – Hydrologic Model Input Data

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Table B1: XP-RAFTS model subcatchment parameters

Catchment	Area (ha)	Impervious (%)	Impervious Area (ha)	Pervious Area (ha)	Catchment Slope (%)
A	25.5	65.1	16.6	8.9	2.16
AA	5.2	49.2	2.6	2.7	1.48
B	38.4	65.8	25.2	13.1	1.92
BB	33.9	71.4	24.2	9.7	1.73
C	13.0	14.5	1.9	11.1	7.22
CC1	37.7	62.8	23.7	14.0	2.00
CC2	20.6	61.8	12.7	7.9	1.28
D	32.2	69.8	22.5	9.7	2.25
DD	16.3	68.8	11.2	5.1	2.57
E1	9.1	12.8	1.2	8.0	6.72
E2	8.7	68.4	5.9	2.7	4.18
E3	9.0	64.4	5.8	3.2	3.24
EE	18.2	90.0	16.3	1.8	0.98
F1	16.7	69.1	11.5	5.2	2.90
F2	17.9	65.2	11.7	6.2	3.09
FF1	25.7	82.2	21.1	4.6	1.65
FF2	6.2	89.2	5.6	0.7	1.05
G	34.6	49.3	17.1	17.6	2.51
GG1	11.7	89.7	10.5	1.2	0.92
GG2	5.9	90.0	5.3	0.6	1.26
H1	11.2	65.6	7.3	3.9	4.91
H2	8.3	53.4	4.4	3.9	3.60
H3	7.8	65.6	5.1	2.7	2.01
I1	14.3	72.7	10.4	3.9	5.34
I2	10.4	72.6	7.6	2.9	1.68
I3	3.9	65.3	2.6	1.4	2.09
J1	21.6	62.5	13.5	8.1	2.74
J2	1.7	71.5	1.2	0.5	2.40
J3	1.3	83.2	1.0	0.2	1.35
J4	3.2	72.7	2.3	0.9	3.78
K1	16.4	77.8	12.8	3.7	2.47
K2	6.5	76.9	5.0	1.5	2.22
K3	6.9	80.3	5.6	1.4	1.29
K4	6.9	79.5	5.5	1.4	2.13
K5	2.5	72.1	1.8	0.7	4.14
L	26.4	68.7	18.1	8.3	2.43
M	15.4	46.9	7.2	8.2	1.05
N	30.9	68.4	21.1	9.8	3.27
O	14.3	56.4	8.1	6.2	2.52
P	17.9	68.3	12.2	5.7	1.61
Q	32.4	75.0	24.3	8.1	2.67
R	14.3	69.1	9.9	4.4	4.82
S	12.6	40.6	5.1	7.5	3.41
T	24.1	58.2	14.0	10.1	2.42
U1	13.1	59.6	7.8	5.3	2.41
U2	3.7	67.2	2.5	1.2	1.93
V1	19.1	63.4	12.1	7.0	4.00
V2	34.3	50.4	17.3	17.0	1.27
W	24.6	56.2	13.8	10.8	1.01
X	25.4	57.9	14.7	10.7	5.08
Y	16.7	59.0	9.8	6.8	2.49
Z1	15.4	29.4	4.5	10.9	1.10
Z2	5.1	31.3	1.6	3.5	0.96

Table B2: Detention Basin Details for Basin 1A

Sub catchment	Outlet Entrance	Minimum Spillway Level	H (m AHD)	S (m^3)
T	3.15	6.2	3.14	0
			3.5	17
			4	1236
			4.5	6768
			5	16330
			5.5	26530
			6	37263
			6.3	44068

Table B3: Detention Basin Details for Basin 1B

Sub catchment	Outlet Entrance	Minimum Spillway Level	H (m AHD)	S (m^3)
S	4.65	8.40	4.92	0
			5	0.01
			5.5	286
			6	1765
			6.5	4475
			7	8522
			7.5	13271
			8	18530
			8.5	26880
			9	40214
			9.2	46730

Appendix C – XP-RAFTS and MIKE FLOOD Discharge Comparison Calibration Events

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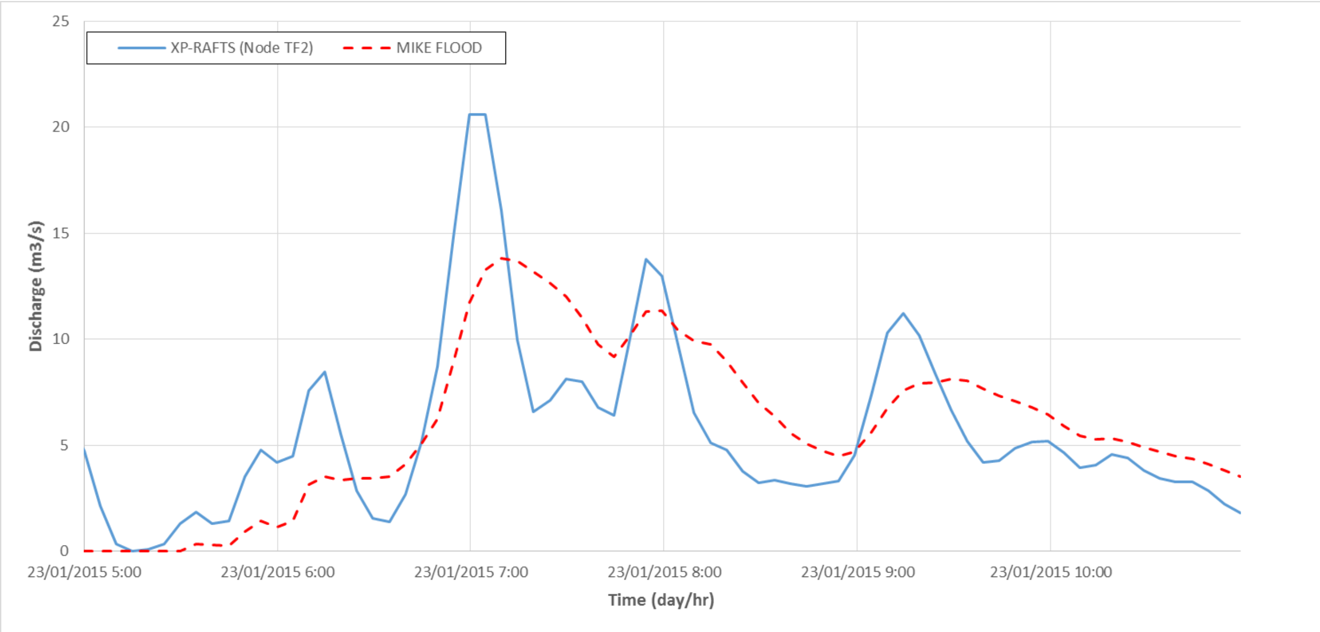

Figure C1: Jan 2015 validation event – discharge profiles upstream of Elwell Street

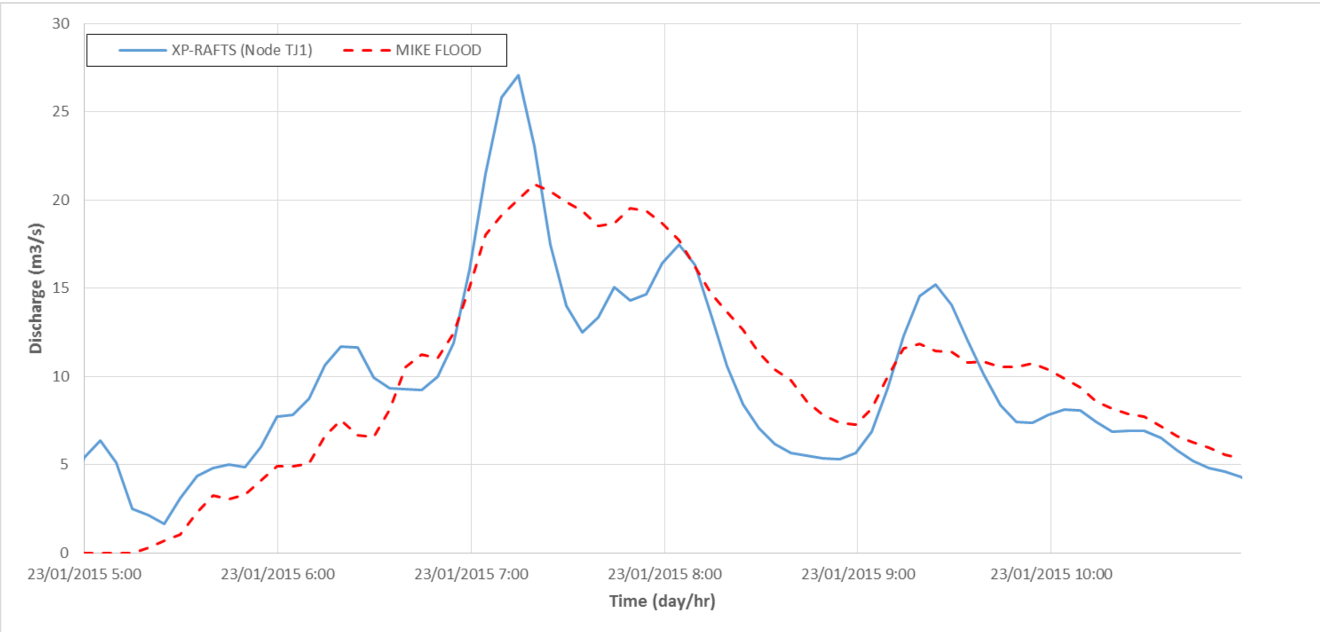

Figure C2: January 2015 validation event – discharge profiles upstream of Shopping Centre

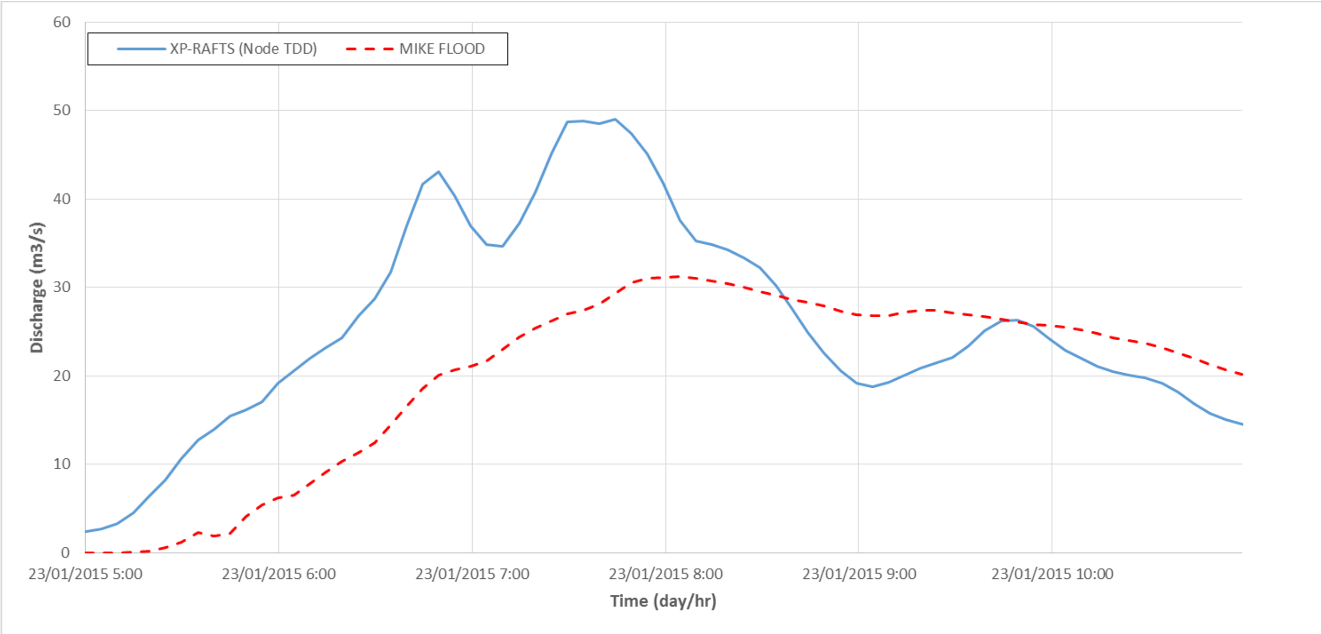

Figure C3: January 2015 validation event – discharge profiles upstream of Lytton Road

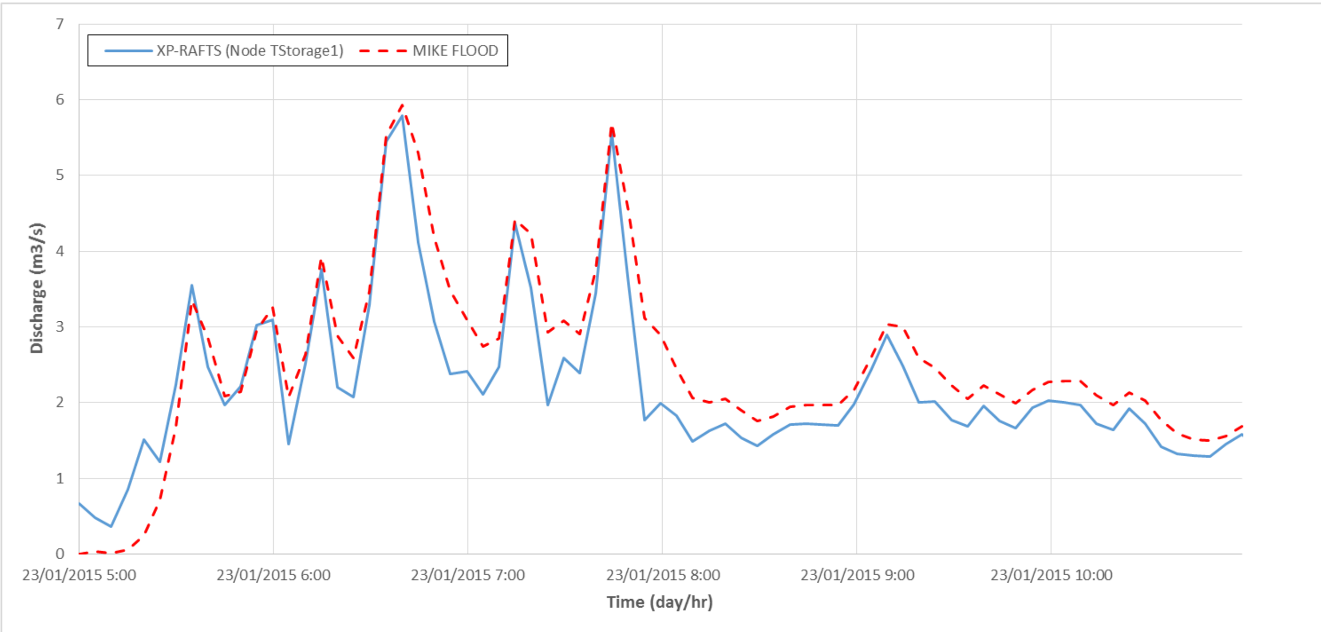

Figure C4: Jan 2015 validation event – discharge profiles upstream of Barrack Road

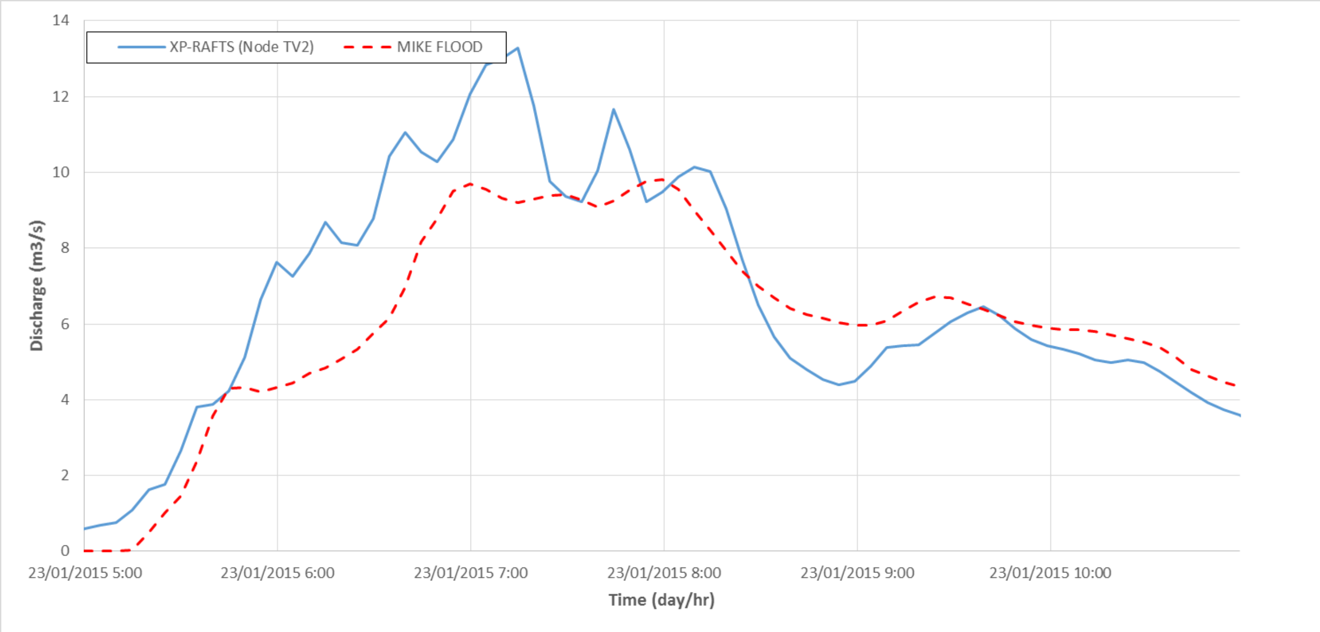

Figure C5: January 2015 validation event – discharge profiles d/s of Junction Road

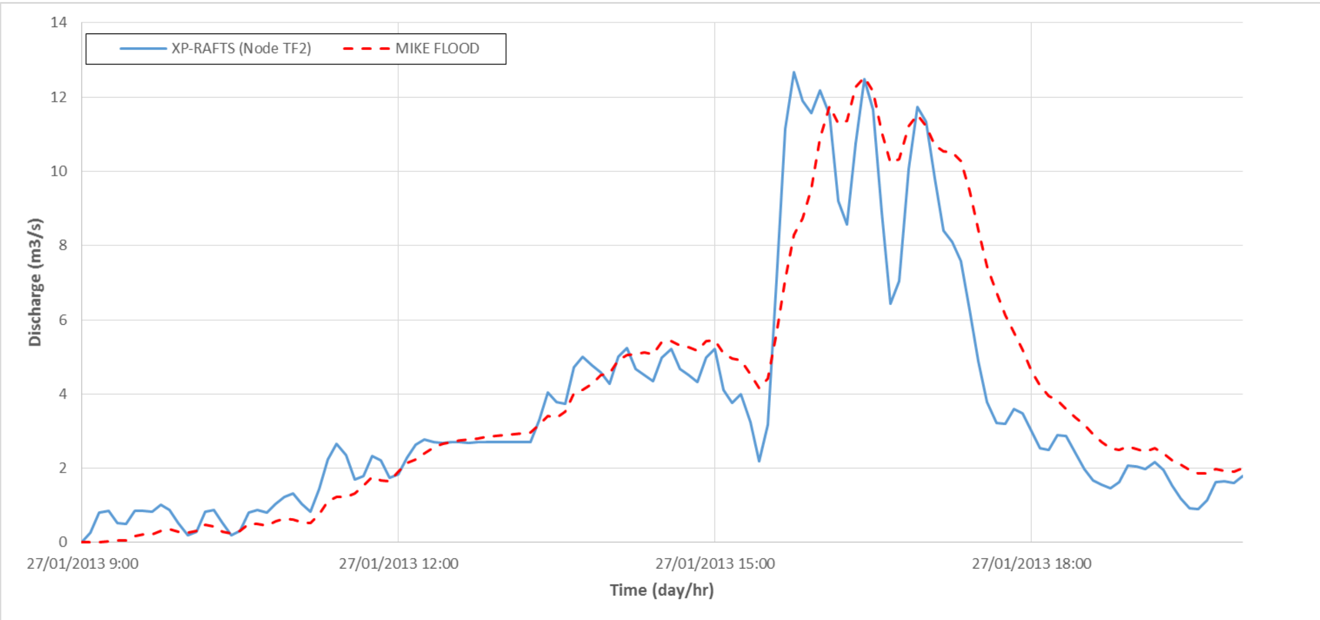

Figure C6: Jan 2013 calibration event – discharge profiles upstream of Elwell Street

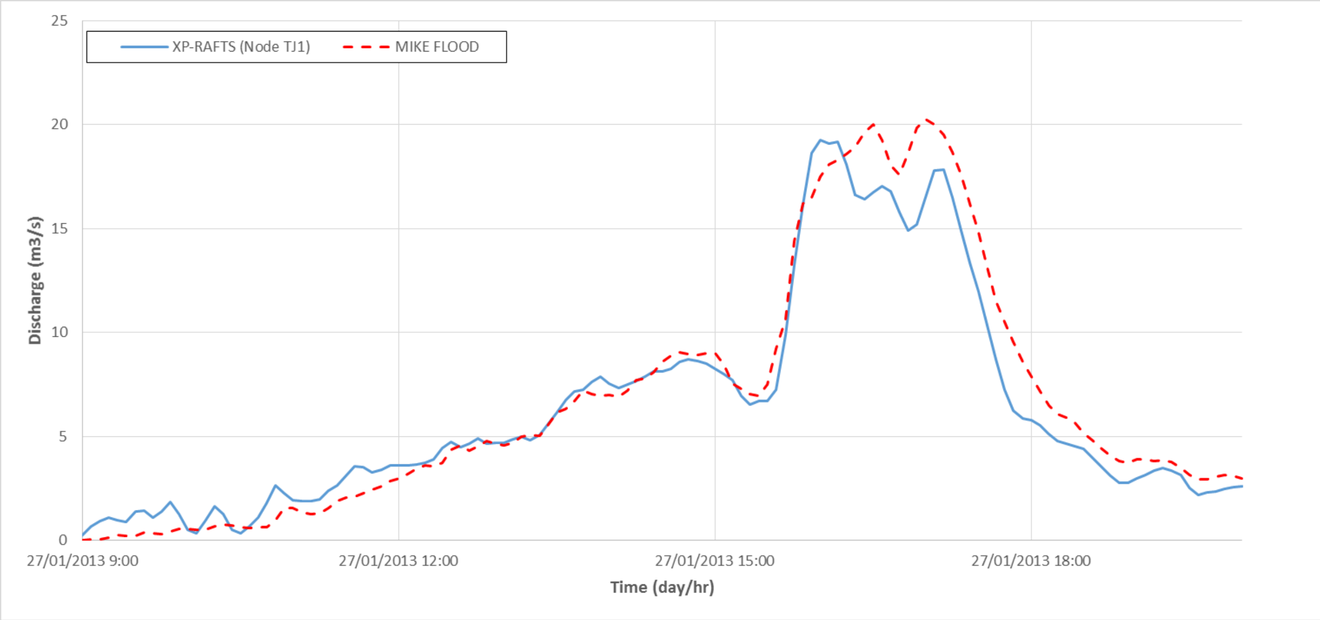

Figure C7: Jan 2013 calibration event – discharge profiles upstream of Colmslie Shopping Centre

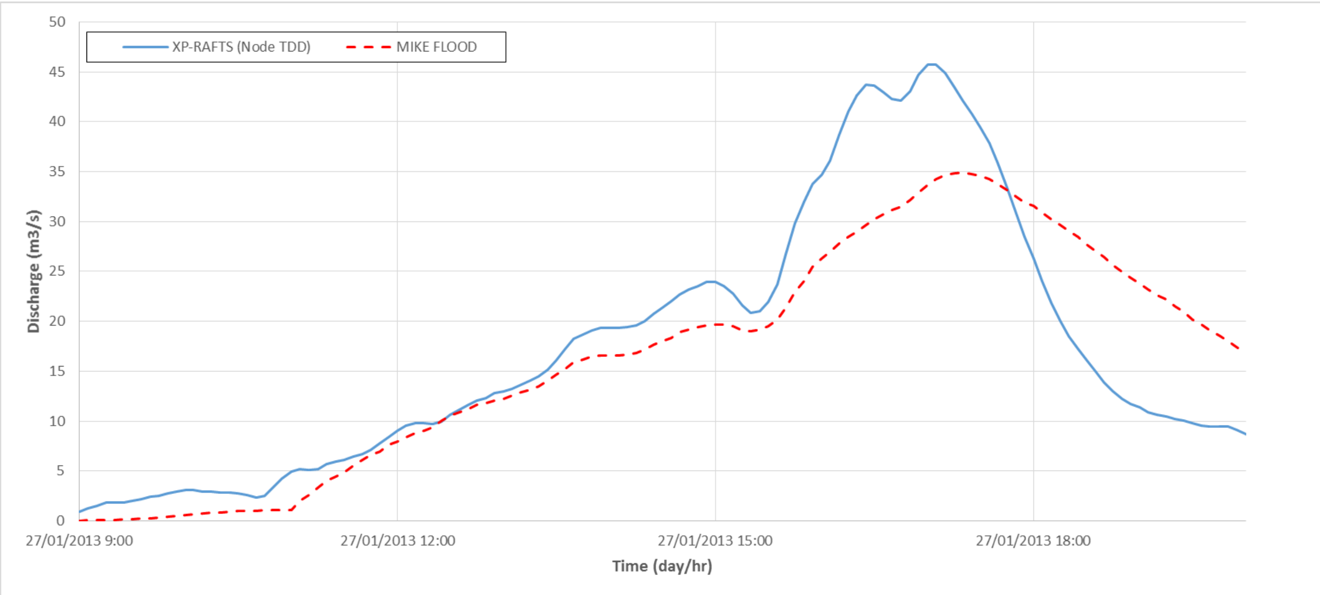

Figure C8: Jan 2013 calibration event – discharge profiles upstream of Lytton Road Bridge

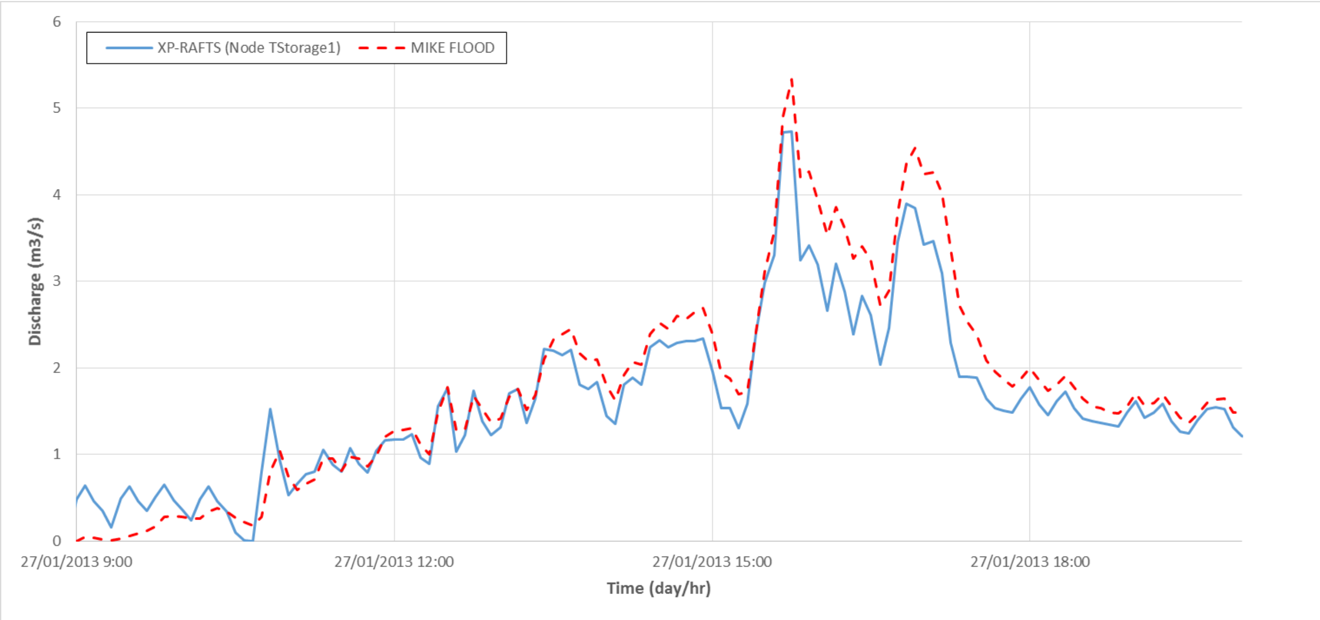

Figure C9: Jan 2013 calibration event – discharge profiles upstream of Barrack Road

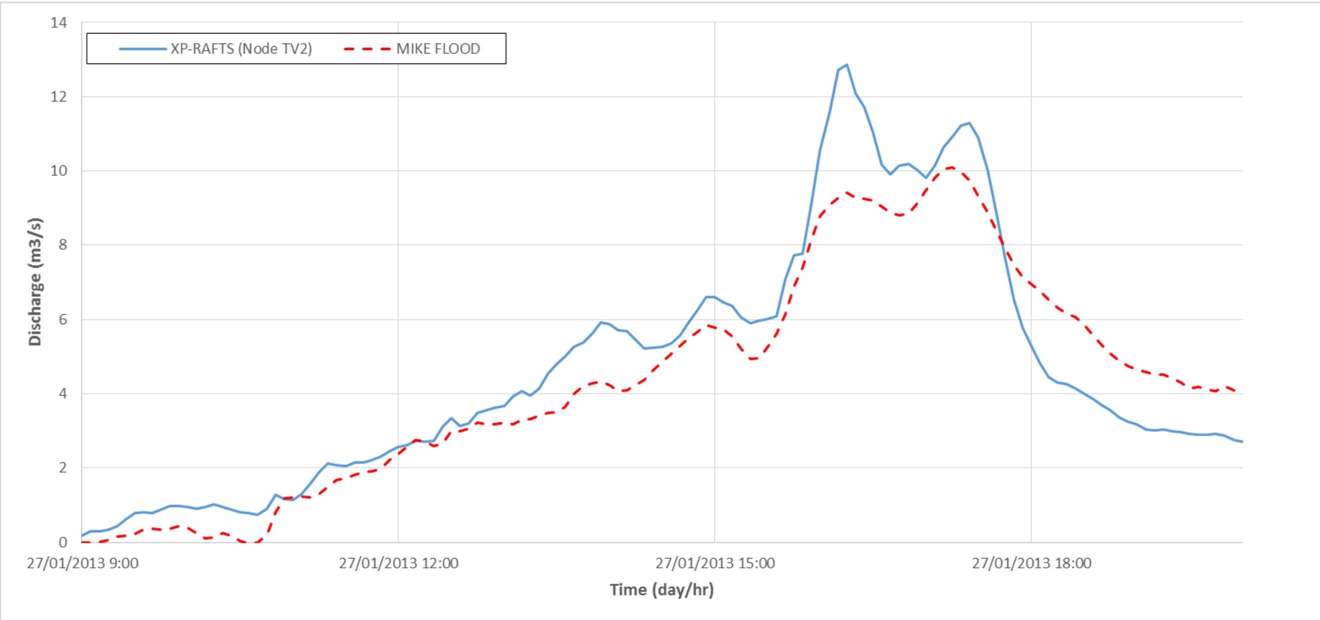

Figure C10: Jan 2013 calibration event – discharge profiles downstream of Junction Road

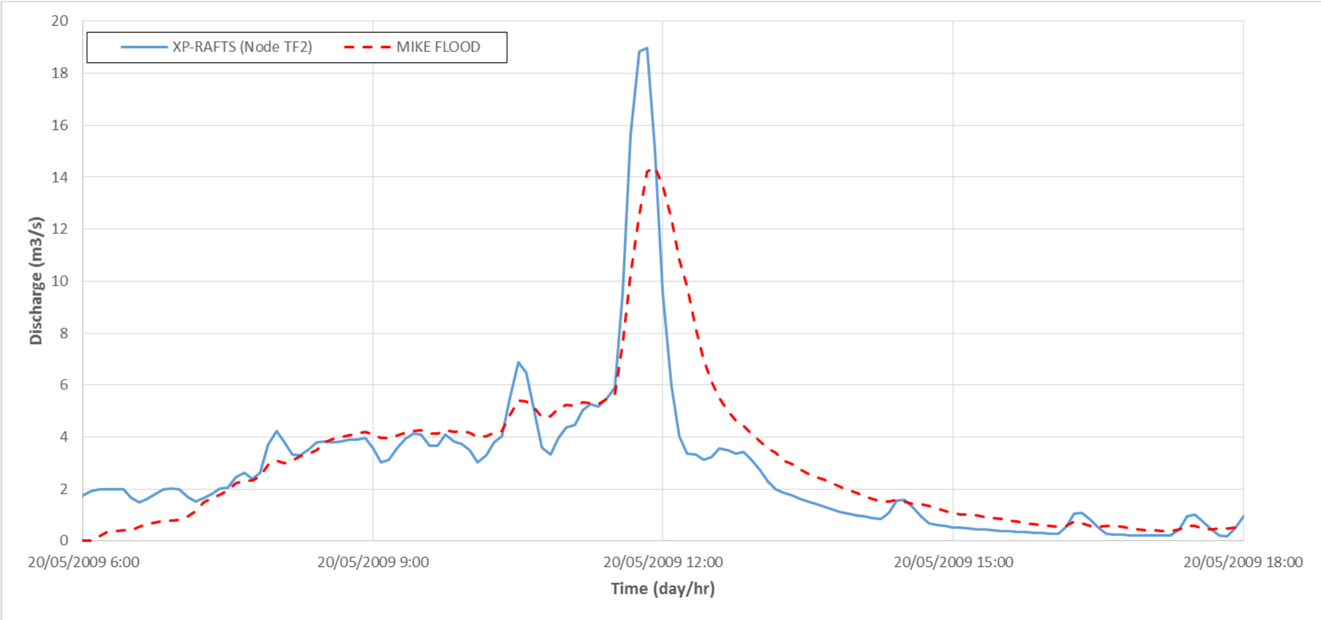

Figure C11: May 2009 verification event – discharge profiles upstream of Elwell Street

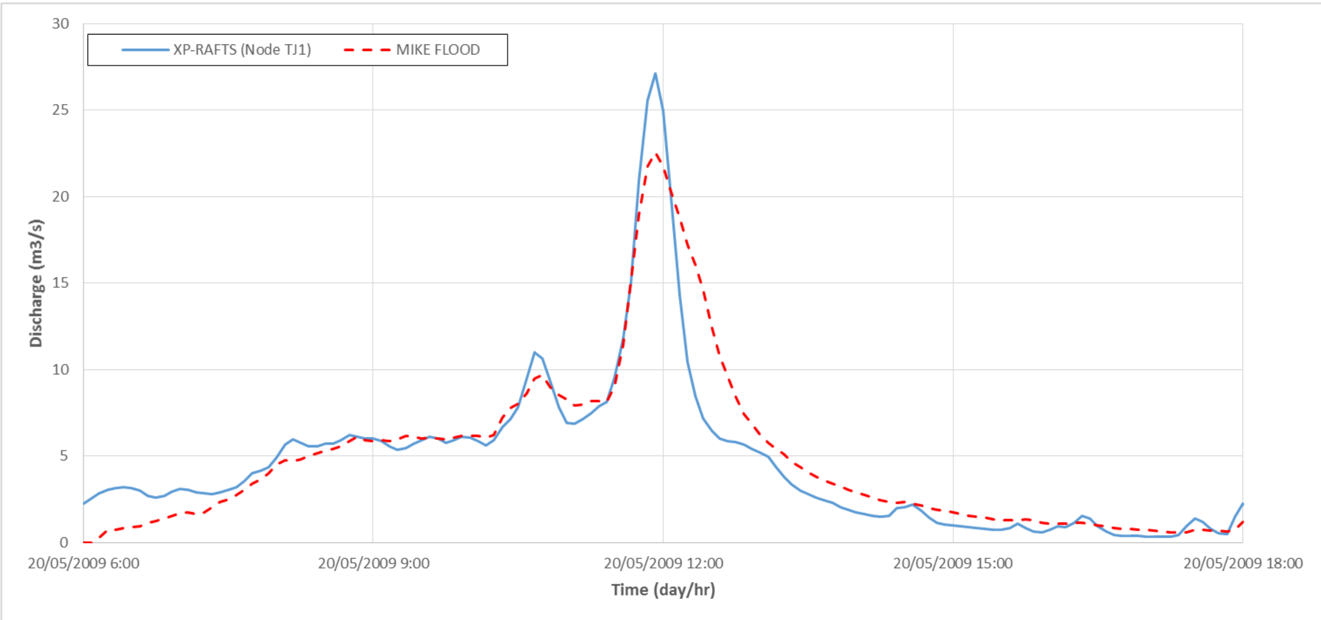

Figure C12: May 2009 verification event – discharge profiles upstream of Colmslie Shopping Centre

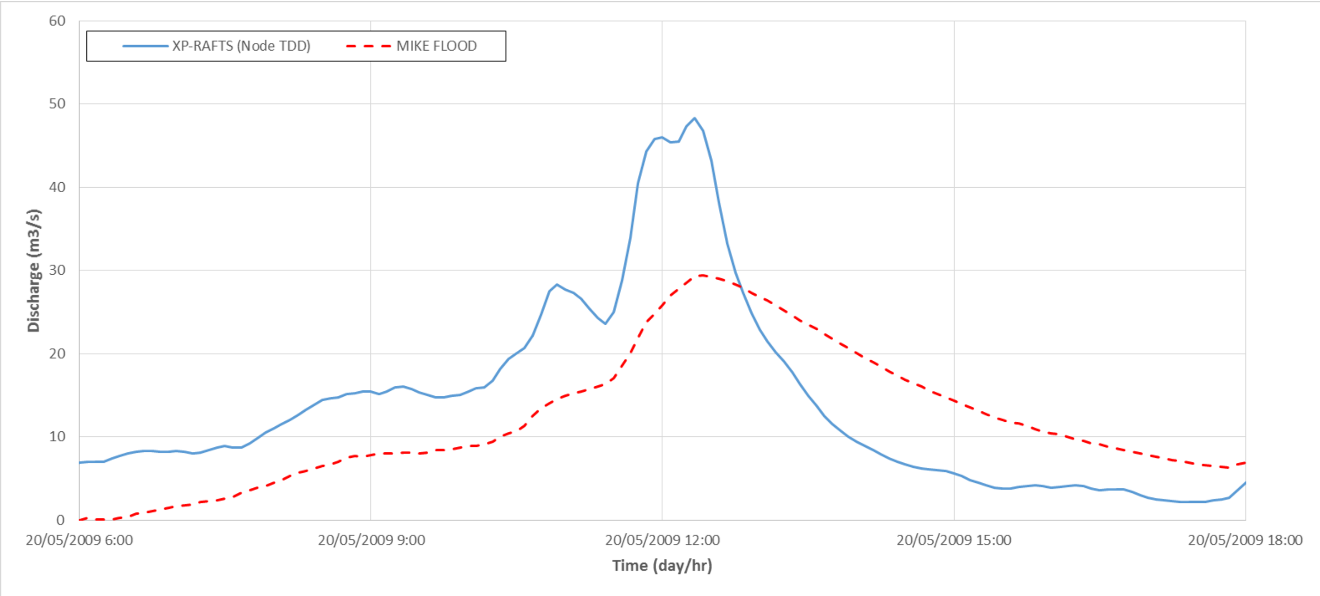

Figure C13: May 2009 verification event – discharge profiles upstream of Lytton Road Bridge

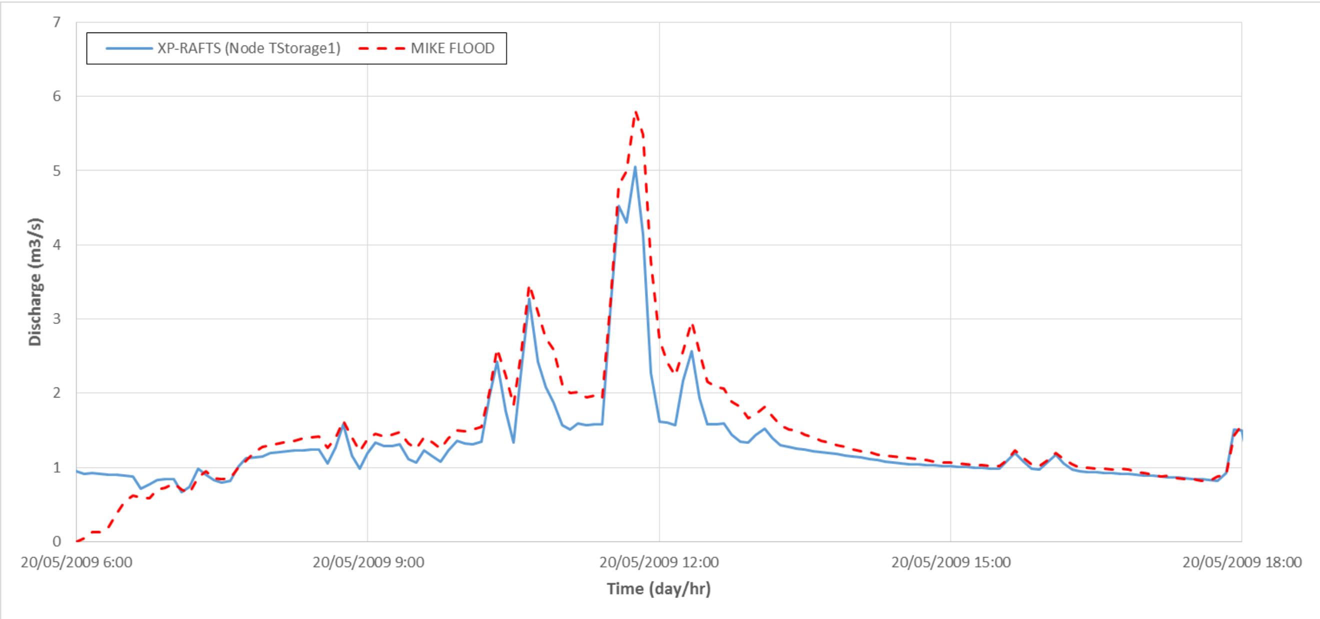

Figure C14: May 2009 verification event – discharge profiles upstream of Barrack Road

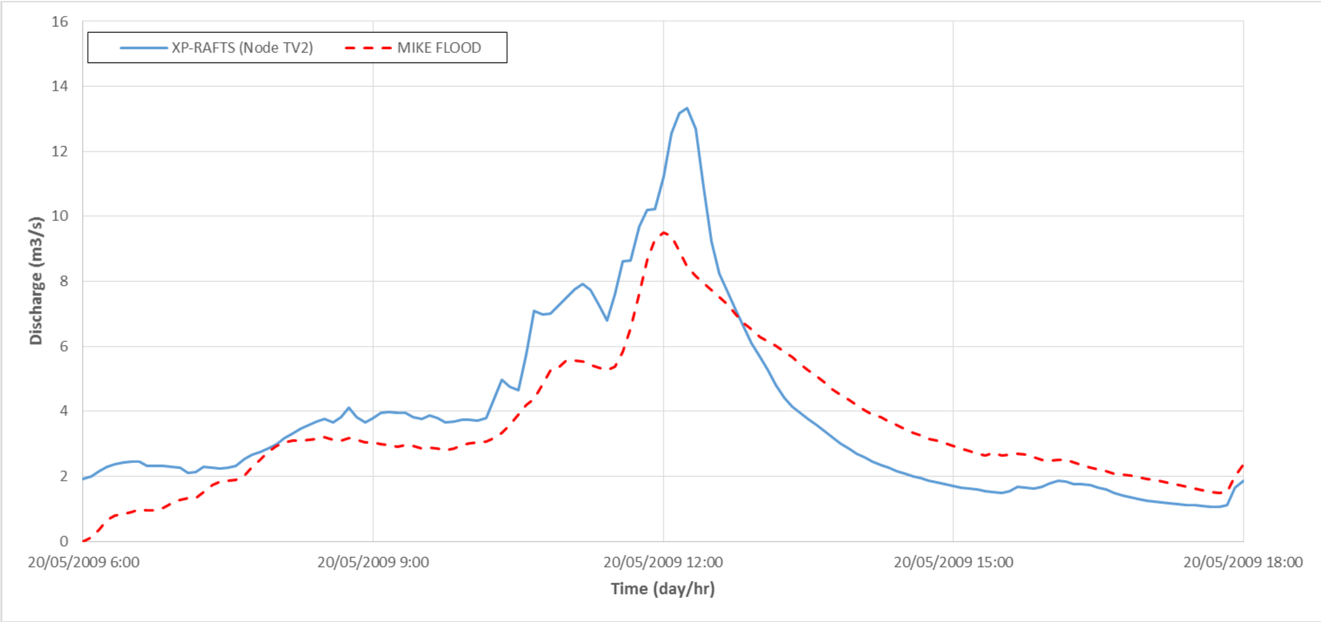

Figure C15: May 2009 verification event – discharge profiles downstream of Junction Road

Appendix D – Structure Head Loss Comparisons

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Perrin Creek Flood Study

Structure Loss Comparison Report

MIKE FLOOD and HEC-RAS

Structure Loss Comparison Report

March 2015

The expert in **WATER ENVIRONMENTS**

Perrin Creek Flood Study

Structure Loss Comparison Report

MIKE FLOOD and HEC-RAS

Prepared for Brisbane City Council

Represented by Nilantha Karunarathna

Perrin Creek Flood Study –Field Inspection Report

Project manager	Kanaththege Nilantha Chaminda Karunarathna
Quality supervisor	Craig Mackay

Project number	43802186
Approval date	6 April 2016
Revision	Final
Classification	Open

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CONTENTS

APPENDICES

1 Introduction

This report provides details of the hydraulic structure loss comparison completed during the model calibration and validation phases of the Perrin Creek Flood Study. Structure loss comparison can provide a better understanding of structure losses occurring at complex crossings. It can also highlight modelling issues associated with structure representation.

The structure loss comparison was carried out using the HEC-RAS modelling program, with the aim of validating the losses calculated by MIKE FLOOD. HEC-RAS is a widely used water modelling package for cross drainage design studies and commonly applied in the water engineering industry for this type of analysis.

2 Background

Following the field investigations and review of the structural drawings, seven structures (Table 2.1) were identified for energy loss comparison. These structures were chosen as they are indicative of different structure types in the study area, and provide indicative estimates of site specific energy losses for other structures. Table 2.1 shows the structures selected for loss comparison.

Table 2.1 Structures identified for analysis

ID	Structure Name	Description
1	Lytton Rd Bridge	Typical Bridge Structure
2	Brenda St. Rock Gabion Weir	Typical Weir Structure
3	Barringa St. Culvert	Typical Culvert Structure
4	Elwell St Culvert	These culverts have a natural channel at the inlet and a concrete channel at the outlet. A pipe crossing is located adjacent to the culvert inlet, and this culvert has a high risk of blockage.
5	Jersey Street foot bridge (Old)	This structure has a low level deck, and has a high probability of blockage.
6	Wynnum Road Culverts, Rail Culverts and pipeline under Colmslie Shopping Centre	Complex storm water drainage network under the shopping centre requires cross validation to check energy losses.
7	Barrack Rd Culverts	This structure has a local weir pool upstream of the culvert, and experiences changing channel conditions.

3 HEC-RAS model development

This section summarises the development of the new HEC-RAS models for those structures where an existing model was unavailable, and the revision of parameters and inputs for the update of the existing models.

Council has provided following three HEC-RAS models to upgrade and compare structure losses.

- Lytton Rd Bridge;
- Brenda St. Rock Gabion Weir;
- Barringa St. Culvert;

The following updates and checks were made of the HEC-RAS models received from Council:

- Models were trimmed to the area of interest;
- Updates to hydraulic structures were carried out according to the checks and verifications undertaken during the site visit and data review;
- Inflow boundary conditions and downstream water level boundaries were updated to be the same as MIKE FLOOD estimates;
- Normal slope boundary conditions were added for the upstream reach;
- Structure dimensions and parameters were checked against MIKE FLOOD model inputs;
- Cross section extents and roughness's were checked;
- Contraction and expansion loss parameters were checked; and
- River station and reach lengths were checked.

In addition to the three existing models provided by Council, four new HEC-RAS models were developed. Model development included setting up model geometry, building cross section databases, entering structure details as per structure drawings, setting up boundary conditions, and running the model.

All HEC-RAS models were run in a steady state, "mixed flow" computation mode to examine the hydraulic flow regime (subcritical / supercritical) at the structure crossing. A summary comparing the MIKE FLOOD and HEC-RAS results is included in Section 4, and long section plots are included in Appendix B.

3.1 Model geometry

HEC-RAS model geometry was prepared using the HEC-GEORAS extension installed in ARCGIS. The HEC-GEORAS tool was developed by the US Army Corps of Engineers, and is capable of producing geo-referenced model geometry with the following features:

- Cross section information;
- Blockage areas;
- Ineffective areas; and
- Structure location and overflow weir conditions.

Typically a HEC-RAS model extent will include creek and floodplains at the structure crossing, and reach lengths extending up to 100m both upstream and downstream of the structure inlet and outlet. Appendix A shows the geometric plan views of all structure models updated and developed during this study.

3.2 Model boundary conditions

HEC-RAS models were run in a steady state, mixed computation mode with appropriate boundary conditions. Discharge time series upstream of structure locations were extracted from the MIKE FLOOD model results. Peak discharge values from the extracted time series were used as the steady discharge for the HEC-RAS model setups. Table 3.1 shows the inflow values applied as steady discharges to the HEC-RAS models.

The downstream boundary conditions were set up using peak water levels obtained from MIKE FLOOD model results. These peak water levels were extracted either from peak water level maps (2-D results) or MIKE11 model results based on structure locations. Table 3.1 shows downstream water level values applied to the HEC-RAS models.

The upstream end of the reach in the HEC-RAS was set to have normal slope boundary condition, based on the bed slope of the upstream reach. Flow splits between the pipe network and overland flow path at Colmslie Shopping Centre were entered into the model after extracting these values from MIKE FLOOD model results.

Table 3.1 Inflow (peak) values applied to HEC-RAS models – upstream boundary

Description	Peak discharge at upstream river reach (m³/s)			
MIKE FLOOD Version / Flood Event	v11 May 2015	v04 Jan 2015	v02 Jan 2013	v02 May 2009
Lytton Rd Bridge	46.18	34.86	34.20	33.25
Brenda St. Rock Gabion Weir	37.27	29.48	25.29	28.59
Barringa St Culvert	6.04	5.00	4.19	5.42
Elwell St. Culvert	19.08	15.93	12.56	15.30
Jersey St. Foot Bridge	20.52	17.27	13.35	16.02
Colmslie Shopping Centre - U/S Wynnum Rd	33.82	20.90	20.28	22.54
Colmslie Shopping Centre - Underground Pipe Line	32.26	21.08	20.77	22.64
Colmslie Shopping Centre - Overland Flow path (estimated)	1.56	0.00	0.00	0.00
Colmslie Shopping Centre - Downstream reach (estimated)	35.17	23.13	22.65	24.67
Barrack Rd Culvert	6.04	5.00	4.19	5.42

Table 3.2 Water levels (peak) applied to HEC-RAS models – downstream boundary

Description	Peak water level at downstream boundary (m)			
MIKE FLOOD Version / Flood Event	v11 May 2015	v04 Jan 2015	v02 Jan 2013	v02 May 2009
Lytton Rd Bridge	2.32	2.02	2.00	1.98
Brenda St. Rock Gabion Weir	2.70	2.29	2.34	2.31
Barringa St Culvert	2.74	2.39	2.42	2.39
Elwell St. Culvert	8.64	8.33	7.99	8.22
Jersey St. Foot Bridge	6.61	6.13	5.92	6.04
Colmslie Shopping Centre - Downstream reach	3.48	2.93	2.94	3.04
Barrack Rd Culvert	3.52	3.47	3.45	3.49

3.3 Modelling parameters

Hydraulic roughness is an important input into all hydraulic models and is a function of the resistance imposed upon the flow by vegetation and channel materials, and the form of the topography. The roughness coefficient used in HEC-RAS is Manning's *'n'*, and these values were taken from the MIKE FLOOD model and applied to the individual HEC-RAS structure models.

Energy loss parameters, such as contraction and expansion losses and structure entry and exit losses were kept within the range of recommended values specified in the HEC-RAS reference manual. However in some instances, adjustments were made to represent local geometric conditions or specific flow constrictions at structure crossings, such as the presence of water mains crossing the channel near the structure. The bridge modelling method selected in HEC-RAS was chosen to be similar to the energy equation approach selected in MIKE11.

3.4 Structure details

Structure details were obtained from the BCC MIKE11 models and modelling reports for those structures previously modelled. Field inspection measurements and photos were used to validate structure dimensions applied to the models. Details for structures not previously modelled were obtained from structure drawings received from BCC.

3.5 Model runs

The comparison has been carried out using peak water levels and discharges from the calibration and validation events, namely:

- May 2015
- January 2015
- January 2013
- May 2009

3.6 Modelling assumptions

The following modelling assumptions and parameters in the MIKE11 and HEC-RAS were kept as similar as possible, to ensure the models were directly comparable:

- floodplain and channel roughness values;
- water level boundary conditions at the downstream end of the structure model reach;
- peak flow rates across the structure;
- entry and exit losses, except at those structures with upstream pipe crossings;
- structure loss computation method –energy loss equation;
- the flow split between overland flow and the pipe network at Colmslie Shopping Centre; and
- channel slope.

3.7 Structure loss modelling differences

There are differences in how hydraulic structure entrance and exit losses are calculated in MIKE FLOOD and HEC-RAS. Specifically, MIKE11 adjusts the contraction and expansion coefficients based on the upstream and downstream channel flow areas, relative to the structure flow area. The report UK Defra / Environment Agency report *Benchmarking Hydraulic River Modelling Software Packages Results Test K (Culverts)* (Crowder et. al., 2004) provides an overview of the loss estimation methods employed in two programs:

Contraction and expansion loss estimation at culvert structure in MIKE11:

The inflow and outflow loss coefficients are used to calculate contraction and expansion loss coefficients, which are functions of the culvert and channel cross sections immediately upstream and downstream of the culvert respectively. The loss coefficients are then used to calculate an inlet and outlet head loss, which is based on the respective velocity heads.

Contraction and expansion loss estimation at culvert structure in HEC-RAS:

Entrance losses are computed as a [fixed] coefficient times the velocity head in the culvert at the upstream end. Exit losses are computed as a coefficient times the change in velocity head from just inside the culvert (at the downstream end) to outside the culvert

These two methods will produce minimal differences when channel velocities are low compared to the structure velocity. However in instances where channel velocities are relatively high compared to structure velocities, the MIKE11 model will generally produce smaller losses.

4 Model results and comparison

1. Lytton Road Bridge

Lytton Road Bridge influences the flooding downstream of Colmslie Shopping Centre. The channel at the structure has a complicated geometry, making it difficult to produce a computationally stable structure in MIKE FLOOD. The raised bed level under the bridge and the low elevated bridge deck make the bridge an important flow control point.

Both MIKE FLOOD and HEC-RAS models indicate small affluxes of the order of 2-4 cms in all of the events (Table 4.1). Affluxes in the events are generally consistent, with the exception of the May 2015 event where the HEC-RAS model estimates a slightly higher value.

Table 4.1 Afflux comparison - Lytton Bridge

Description	Afflux across the structure (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE afflux	0.02	0.03	0.02	0.02
HECRAS afflux	0.04	0.02	0.02	0.02
Difference in afflux	-0.02	0.00	0.00	0.00

2. Brenda Street Rock Gabion Weir

The submerged Rock Gabion Weir at Brenda Street is estimated to have insignificant energy loss across the structure. The MIKE FLOOD and the HEC-RAS afflux values and water levels show close agreement in all events (see Table 4.2).

Table 4.2 Afflux comparison –Brenda St. Rock Gabion Weir

Description	Afflux across the structure (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE afflux	0.02	0.03	0.02	0.02
HECRAS afflux	0.04	0.02	0.02	0.02
Difference in afflux	-0.03	0.00	0.00	0.00

3. Barringa Street Culvert

The MIKE FLOOD and HEC-RAS modelled afflux and water levels did not agree well at the Barringa Street culvert. Overland flows and pipe networks combine just upstream of the structure, making it difficult to reproduce the hydraulic effects associated at this location in the 1D HEC-RAS model.

Structure dimensions and invert levels of the HEC-RAS model supplied by Council were checked against MIKE FLOOD model inputs and were found to agree with these. Table 4.3 compares the afflux and energy loses across the structure. MIKE FLOOD estimates energy losses of approximately half of those in HEC-RAS.

The difference in energy loss estimates is due to the different contraction and expansion loss calculation methods used in the two programs. Section 3.7 provides a detailed description of the two calculation methods. The MIKE11 inlet contraction loss coefficient is adjusted based on the relative upstream and structure areas, whereas the HEC-RAS contraction loss value is fixed. Furthermore, the HEC-RAS has a slightly higher structure velocity, leading to a greater loss in the HEC-RAS model at Barringa St (see contraction loss rows in Table 4.4 and 4.5).

The expansion loss in MIKE11 is also calculated differently to HEC-RAS. The MIKE11 outlet contraction factor is adjusted based on the square of the relative structure and downstream channel areas, and applies this to the structure velocity head. HEC-RAS instead uses a fixed loss coefficient, but applied to the difference in velocity head between the structure and downstream channel. This, in addition to a slightly higher structure velocity, produces a significantly larger loss in the HEC-RAS model (see the expansion loss rows in Table 4.4 and 4.5).

Table 4.3 Afflux comparison – Barringa St. Culvert

Description	Afflux across the structure (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE afflux	0.19	0.20	0.15	0.19
HECRAS afflux	0.39	0.32	0.24	0.31
Difference in afflux	-0.20	-0.12	-0.09	-0.12
MIKE energy loss	0.19	0.19	0.14	0.19
HECRAS energy loss	0.40	0.32	0.33	0.32
Difference in energy loss	-0.21	-0.13	-0.19	-0.13

Table 4.4 Barringa St. culvert – HEC-RAS energy loss calculation summary

Description	Water level (mAHD) / Water level difference (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
U/S Culv Vel.	2.18	2.01	1.76	1.96
D/S Culv Vel.	2.18	2.01	1.76	1.96
D/S River station Vel.	0.58	0.59	0.51	0.58
Contraction Loss	0.12	0.10	0.08	0.10
Expansion Loss	0.23	0.19	0.14	0.18
Total loss	**0.35**	**0.29**	**0.22**	**0.28**

Table 4.5 Barringa St. culvert –MIKE FLOOD energy loss calculation summary

Description	Water level (mAHD) / Water level difference (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
Inside Culvert	1.97	2.051	1.787	2.033
U/S River station Vel.	0.58	0.799	0.673	0.744
D/S River station Vel.	0.61	0.741	0.709	0.801
Contraction Loss	0.07	0.07	0.05	0.07
Expansion Loss	0.09	0.09	0.06	0.08
Total loss	**0.16**	**0.15**	**0.11**	**0.14**

4. Elwell St Culvert

The structure loss comparison between MIKE FLOOD and HEC-RAS showed HEC-RAS estimates are higher across the structure (See Table 4.6). The HEC-RAS model also indicated a flow regime change from subcritical to supercritical upstream of this structure, making direct comparison of water levels difficult.

The difference in inlet and outlet loss calculation methodology between the two models is also responsible for the difference in losses through this structure. The upstream and downstream channel velocities are relatively high compared to the structure velocity (see Table 4.7 and 4.8). As a result, the MIKE11 inlet contraction and expansion coefficients are significantly reduced compared to the fixed HEC-RAS coefficients. The total energy loss in MIKE FLOOD is typically 3 cm in all events, whereas in HEC-RAS it is between 10 cm and 14 cm.

Table 4.6 Afflux comparison – Elwell St. Culvert

Description	**Water level difference across the structure- afflux(m)**			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE afflux	0.04	0.05	0.03	0.03
HECRAS afflux	0.21	0.18	0.14	0.17
Difference in afflux	-0.16	-0.13	-0.11	-0.14
MIKE energy loss	0.04	0.04	0.04	0.04
HECRAS energy loss	0.16	0.14	0.12	0.13
Difference in energy loss	-0.12	-0.10	-0.08	-0.09

Table 4.7 Elwell St. culvert – HEC-RAS energy loss calculations

Description	Water level (mAHD) / Water level difference (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
U/S Culv Vel.	1.70	1.6	1.45	1.57
D/S Culv Vel.	1.72	1.61	1.47	1.59
D/S River station Vel.	1.27	1.2	1.1	1.19
Contraction Loss	0.07	0.07	0.05	0.06
Expansion Loss	0.07	0.06	0.05	0.06
Total loss	**0.14**	**0.12**	**0.10**	**0.12**

Table 4.8 Elwell St. culvert – MIKE FLOOD energy loss calculation

Description	Water level (mAHD) / Water level difference (m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
Inside Culvert	1.73	1.759	1.683	1.787
U/S River station Vel.	1.28	1.303	1.255	1.32
D/S River station Vel.	1.33	1.354	1.312	1.38
Contraction Loss	0.02	0.02	0.02	0.02
Expansion Loss	0.01	0.01	0.01	0.01
Total loss	**0.03**	**0.03**	**0.03**	**0.03**

5. Jersey Street Footbridge (Old)

The Jersey Street Footbridge has significant energy losses when the water level in Perrin Creek reaches the deck level of the bridge (as occurred in the May 2015 event). The bridge deck is skewed at an angle of nearly 50 degrees to the direction of the flow path, (1D model sections are perpendicular to the flow path). Affluxes and total energy loss across the structure are compared between the two models in Table 4.13.

There is a significant difference in the afflux between the two models. However the total energy loss is closer, with the difference being less than or equal to 8 cm in all events. This is likely to be due to differences in the configuration of the structures upstream and downstream of the bridge, and is not considered significant.

Table 4.9 Afflux comparison – Jersey St. Foot Bridge

Description	**Water level difference across the structure- afflux(m)**			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE afflux	0.12	0.29	0.29	0.31
HECRAS afflux	0.02	0.03	0.02	0.03
Difference in afflux	0.10	0.27	0.27	0.28
MIKE energy loss	0.07	0.11	0.10	0.09
HECRAS energy loss	0.03	0.03	0.02	0.03
Difference in energy loss	0.04	0.08	0.08	0.06

6. Colmslie Shopping Centre

The stormwater drainage network under Colmslie Shopping Centre is an important feature in the Perrin Creek Catchment. Flow interaction between the stormwater drainage network and the overland flow path in this area is complex and difficult to model accurately in 1D. The HEC-RAS 1D model was developed after applying assumptions regarding the overland flow path location and the flow distribution between these networks (as previously discussed in Section 3.6). The model schematisation is more representative in MIKE FLOOD as the culverts are modelled using closed sections with varying dimensions along the culvert, rather than hydraulic structures features with a single fixed set of dimensions and culvert shape, as is used in HEC-RAS.

Comparison of the model results indicates that HEC-RAS and MIKE FLOOD estimate similar afflux values across the culvert for all events except the May 2015 event (Table 4.10). This was expected as there is significant overland flooding in the May 2015 event, and the floodplain conveyance and lateral flow distribution is not able to be accurately represented in the 1D HEC-RAS model.

Wynnum Road and Rail culverts are located in an engineered canal and there are no significant contraction and extraction losses upstream and downstream of these culverts. The schematisation of these culverts in MIKE11 and HEC-RAS is identical, and they produce similar very small energy losses through the structures.

Table 4.10 Afflux comparison – Stormwater drainage under Colmslie shopping Centre

Description	Water level difference across the structure- afflux(m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE21	0.95	0.76	0.75	0.76
HECRAS	1.15	0.84	0.80	0.82
Difference in afflux	-0.20	-0.08	-0.05	-0.06

7. Barrack Road Culverts

Both models indicate only a small afflux through the Barrack Road culverts, of the order of 1-2 cm (Table 4.11). The model agree in all events, with the exception of May 2015.

Table 4.1 Afflux comparison – Barrack Road Culverts

Description	Water level difference across the structure- afflux(m)			
Modelling Event	May-15	Jan 2015	Jan-13	May-09
MIKE21	0.01	0.01	0.01	0.01
HECRAS	0.02	0.01	0.01	0.01
Difference in afflux	-0.01	0.00	0.00	0.00

5 Conclusions

In general, the MIKE-FLOOD and HEC-RAS models estimate similar levels of afflux through the structures reviewed here.

Where larger differences were seen, this generally occurred where either:

- structures and channels had complex geometry, or 2D effects in MIKE FLOOD overland flow paths were unable to be schematised accurately in HEC-RAS; or
- the different structure contraction and expansion loss methods yielded different losses in the two models; this generally occurred where upstream and downstream channel velocities were relatively high compared to the structure velocity, and the coefficient corrections in MIKE11 reduced the loss relative to the HEC-RAS loss.

Appendices showing HEC-RAS model geometry and long section plots at structure crossings are included at the back of this report.

APPENDICES

APPENDIX A–Geometric data

Plan Views

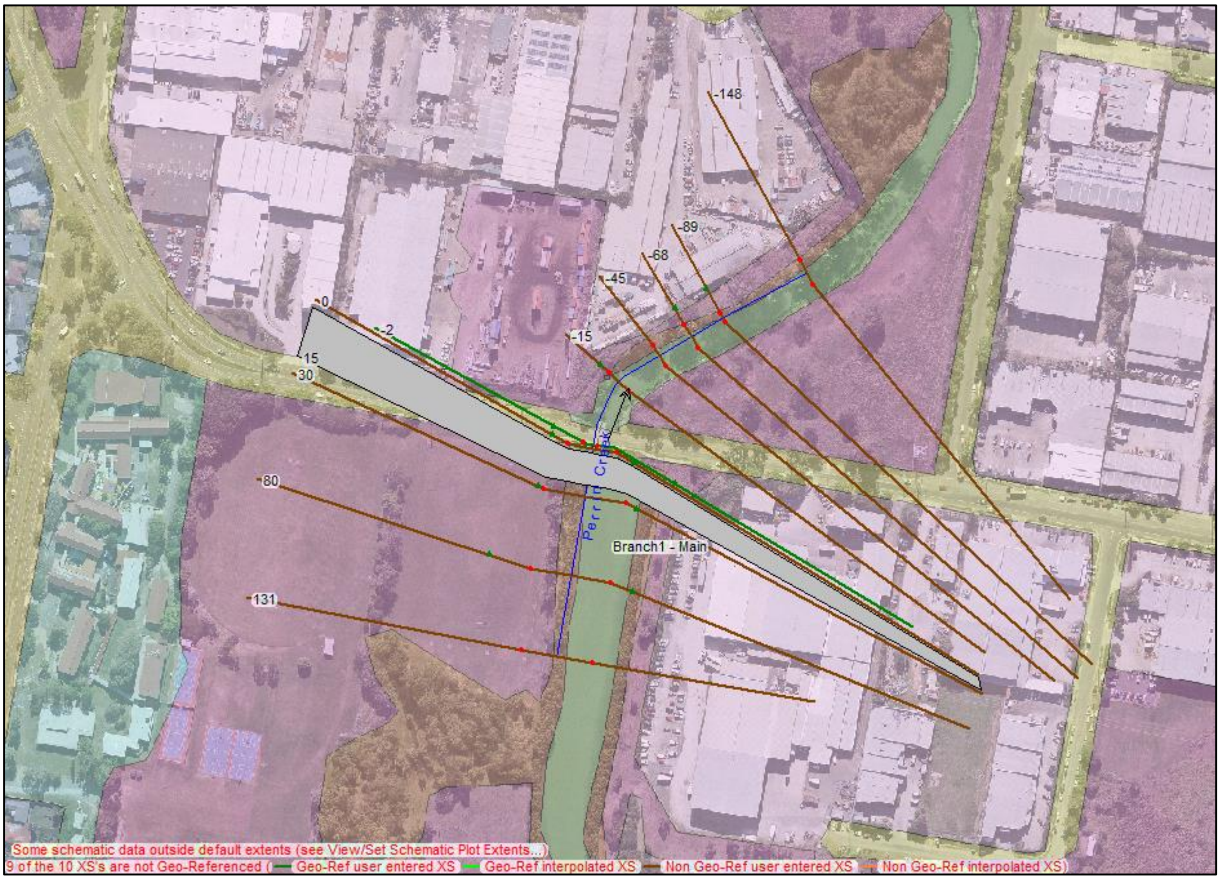

Figure A1: Geometric plan view - Lytton Rd Bridge

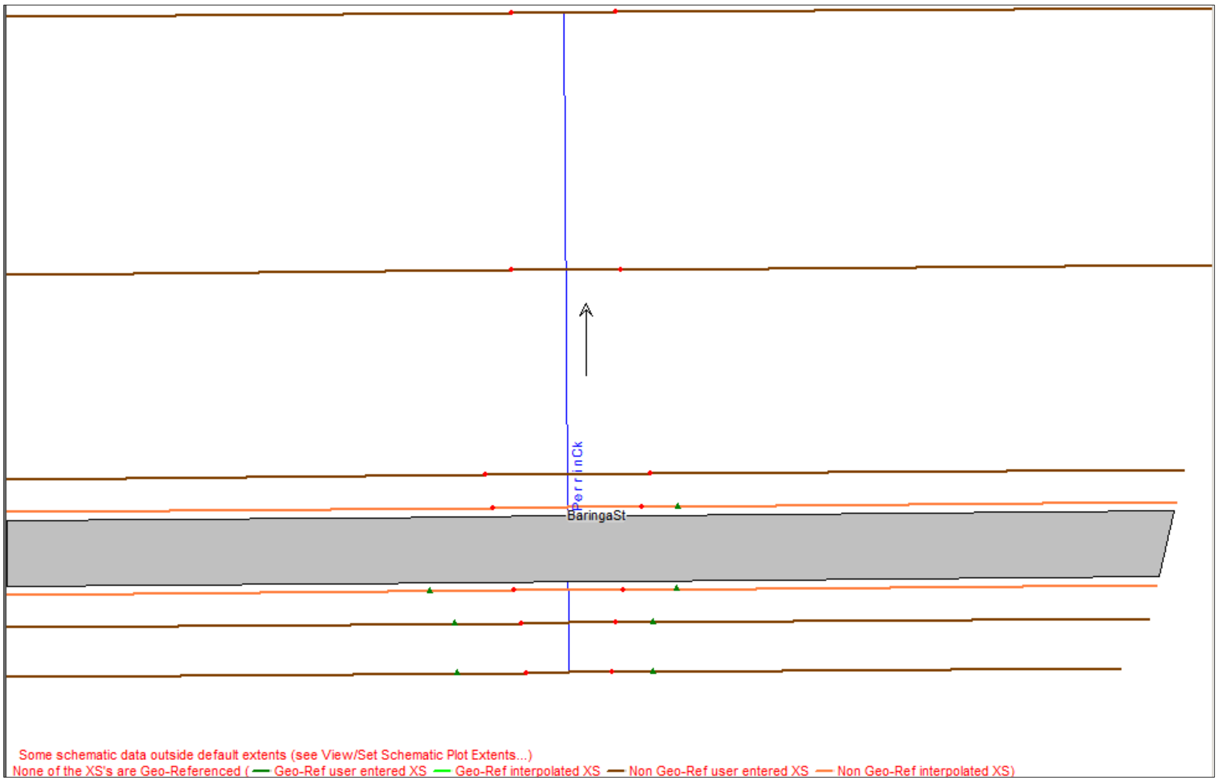

Figure A2: Geometric plan view - Barringa St. Culvert

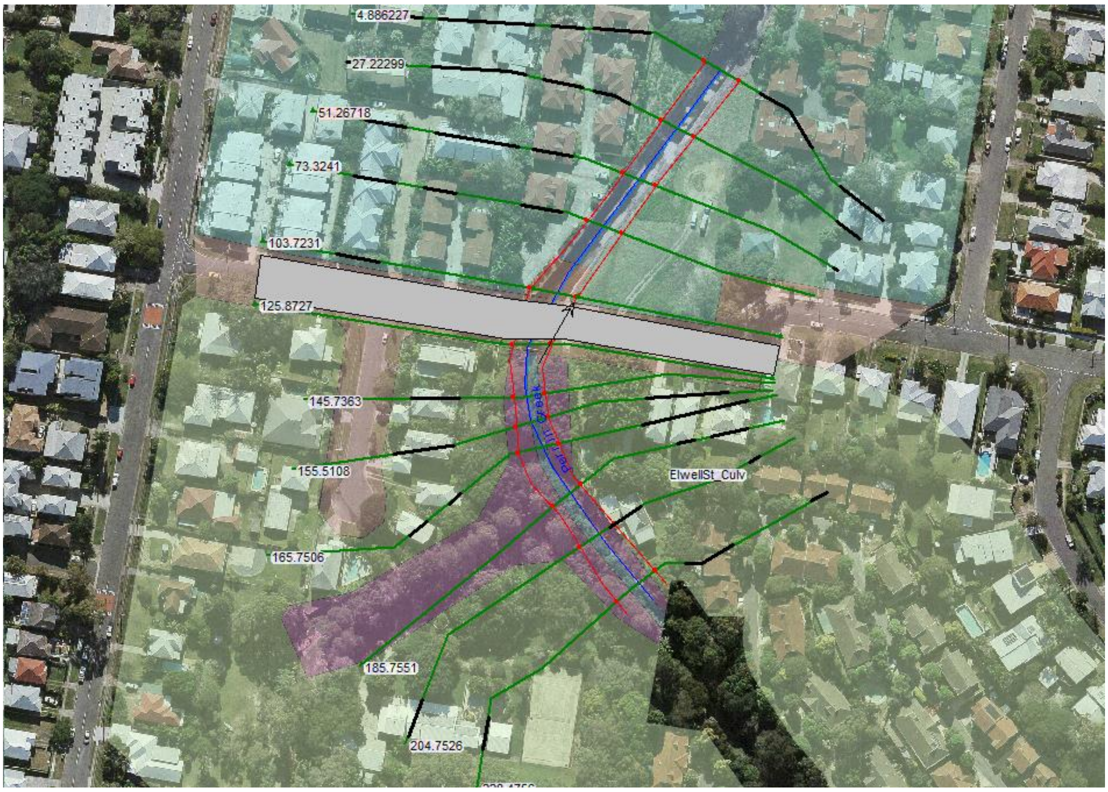

Figure A3: Geometric data - Elwell St Culvert

Figure A4: Geometric plan view - Jersey Street foot bridge (Old)

Figure A5: Geometric Plan View - Brenda St. Rock Gabion Weir

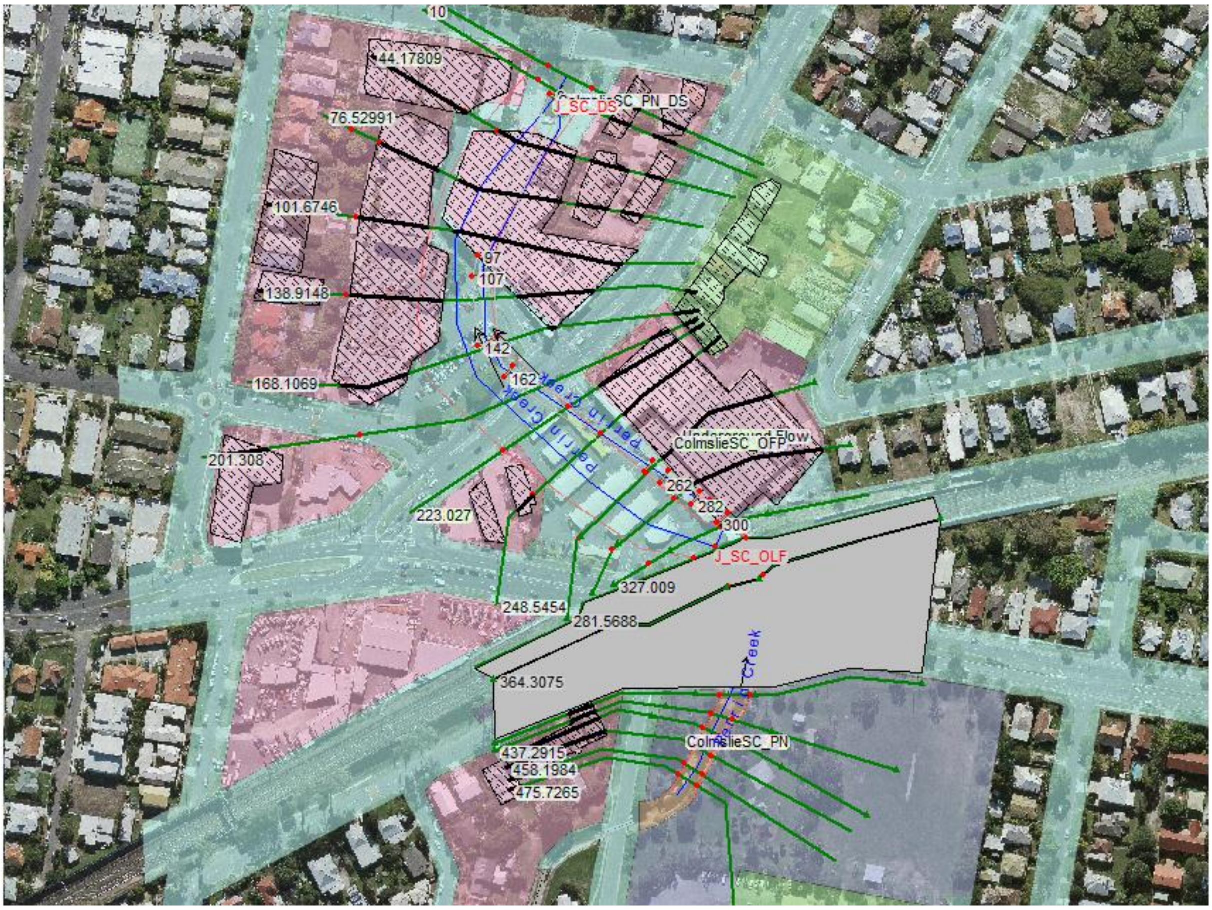

Figure A6: Geometric plan view – Stormwater drainage network at Colmslie shopping Centre

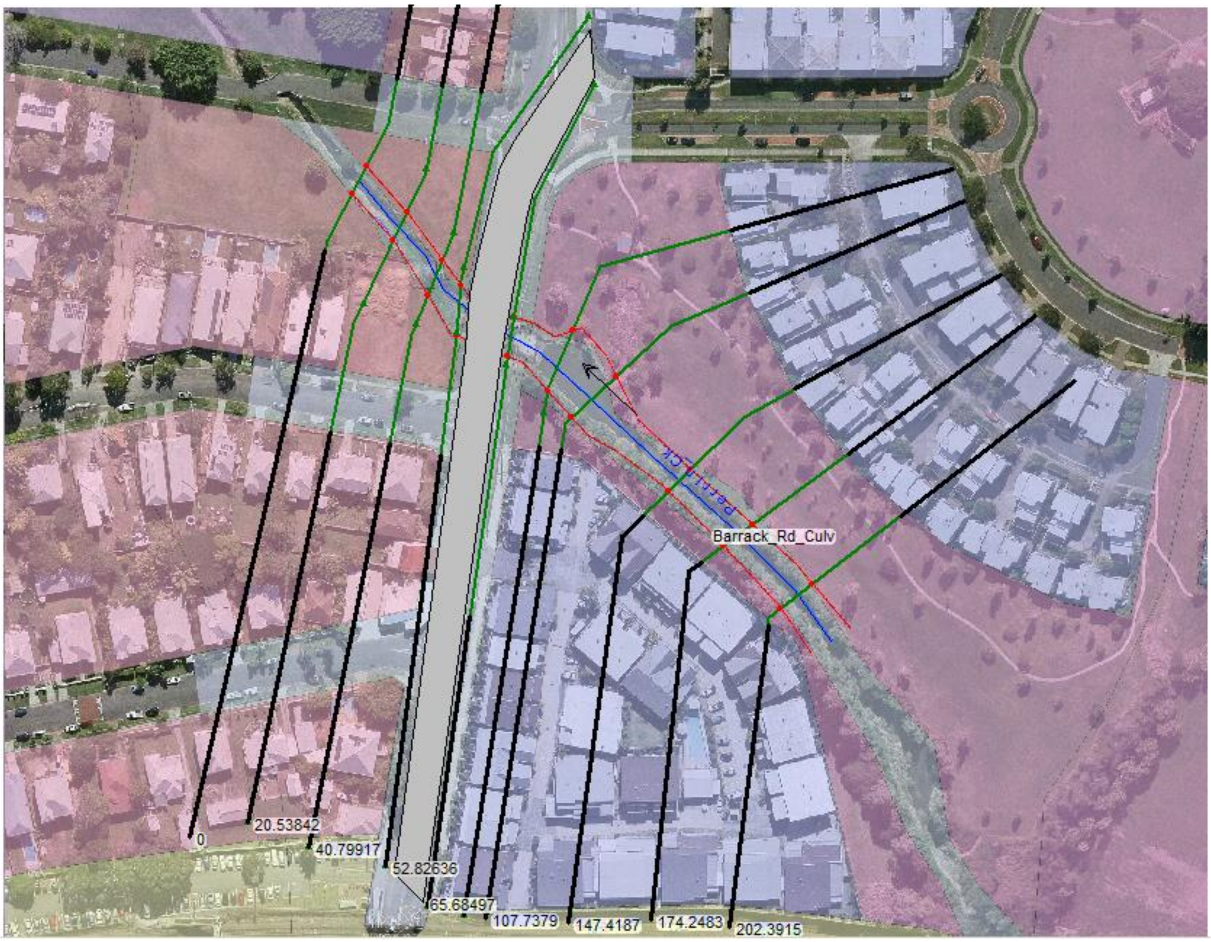

Figure A7: Geometric Plan View - Barrack Rd Culverts

APPENDIX B–Long section Plots

Profiles - May 2015, Jan 2015, Jan2013 & May2009

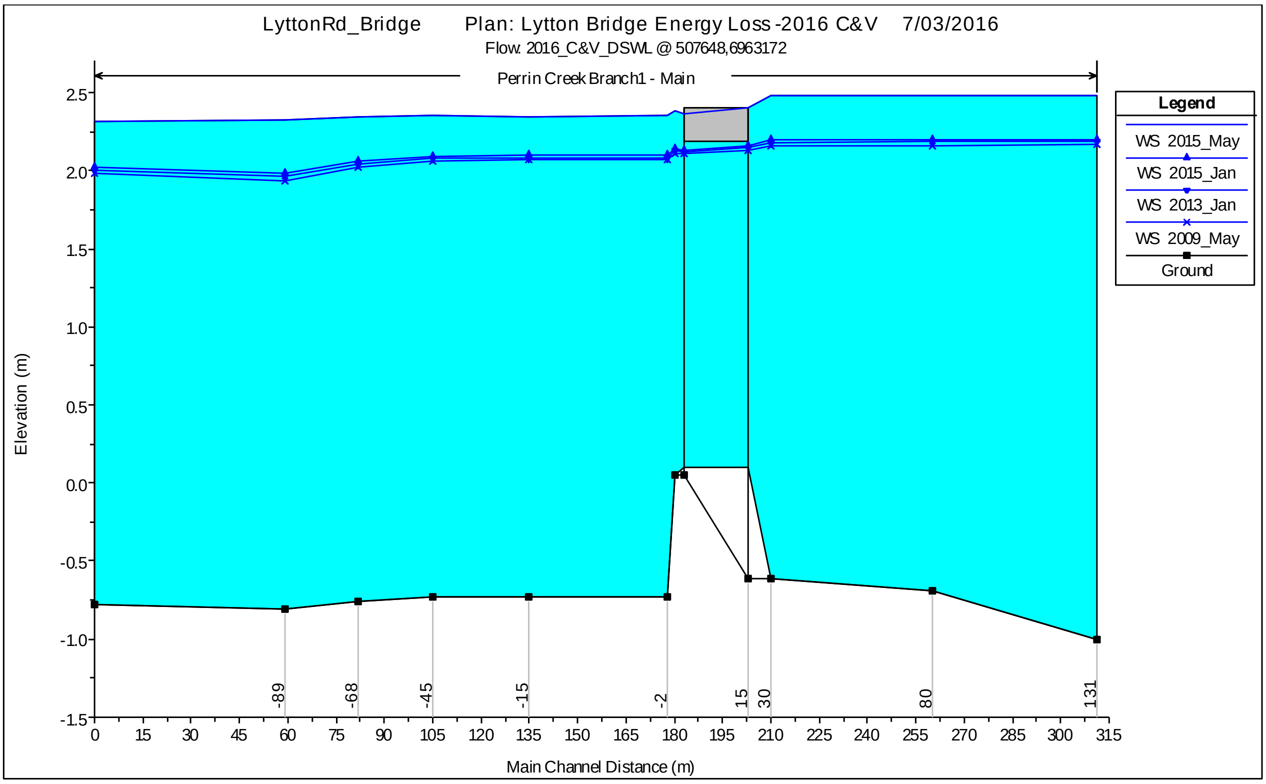

Figure B1: Long Section Plot - Lytton Rd Bridge

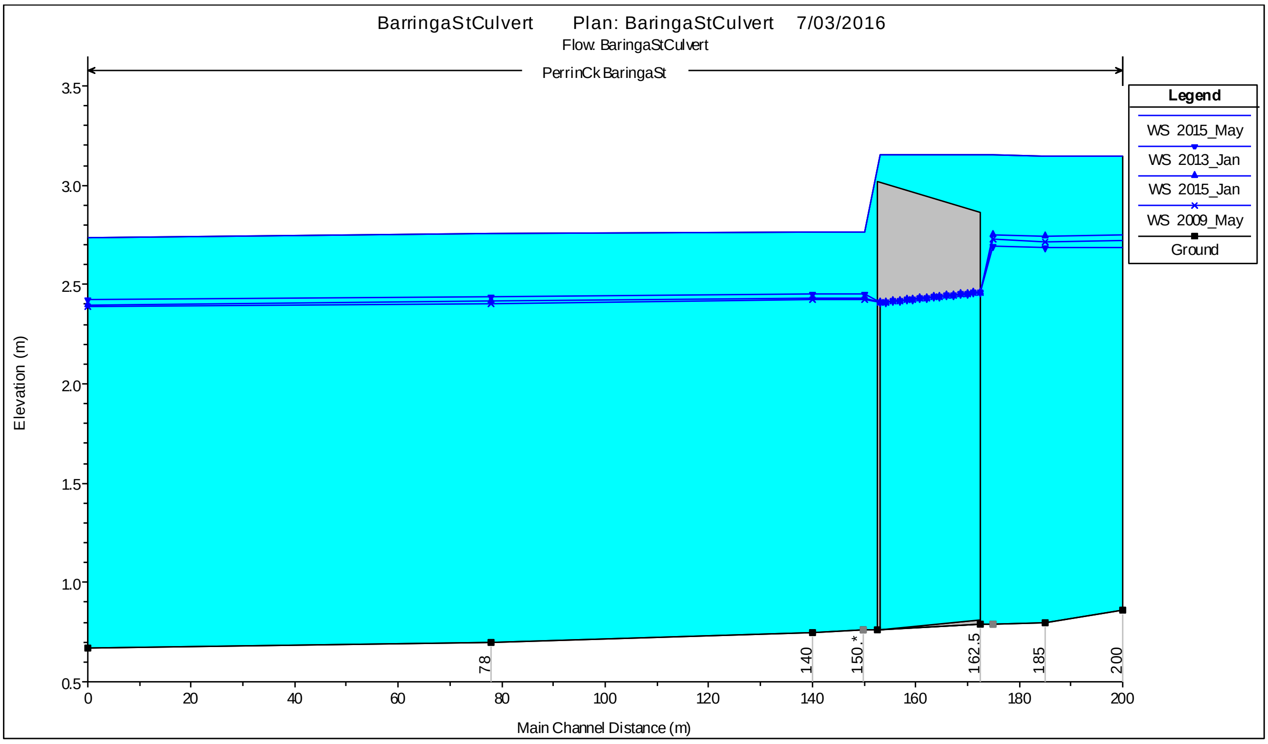

Figure B2: Long Section Plot - Barringa St. Culvert

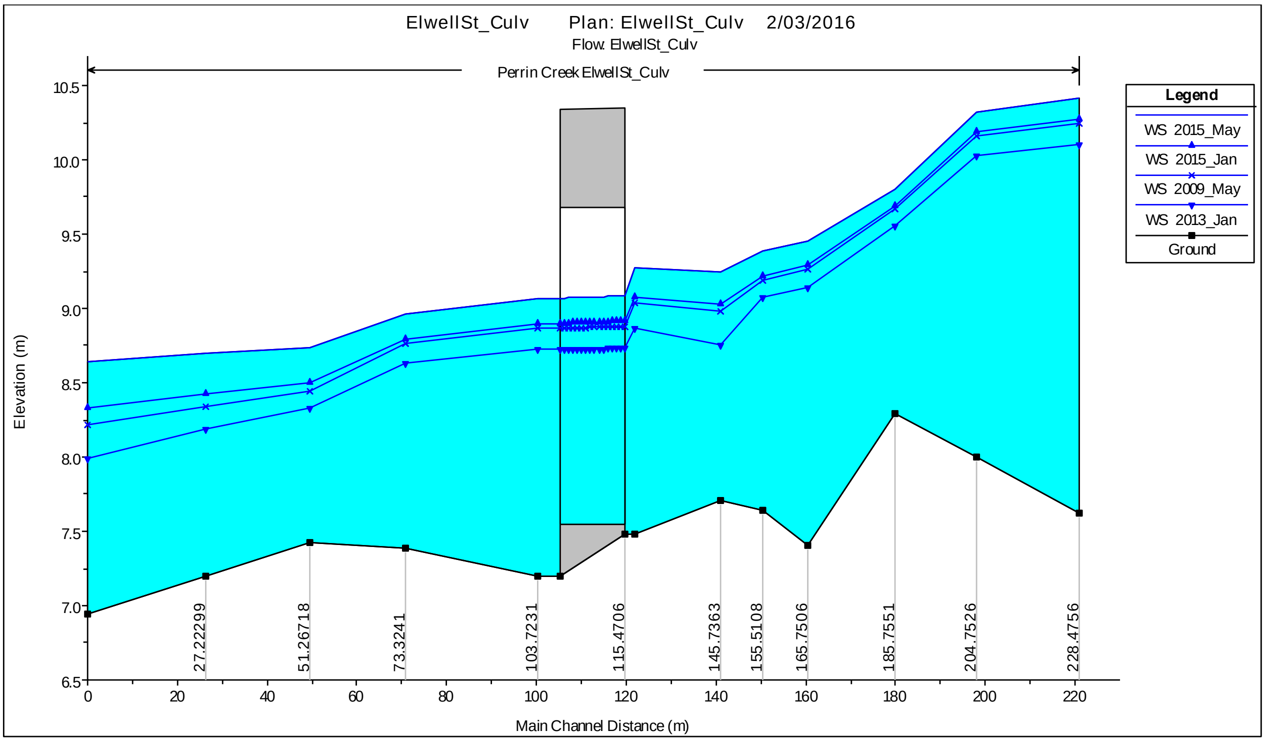

Figure B3: Long Section Plot - Elwell St Culvert

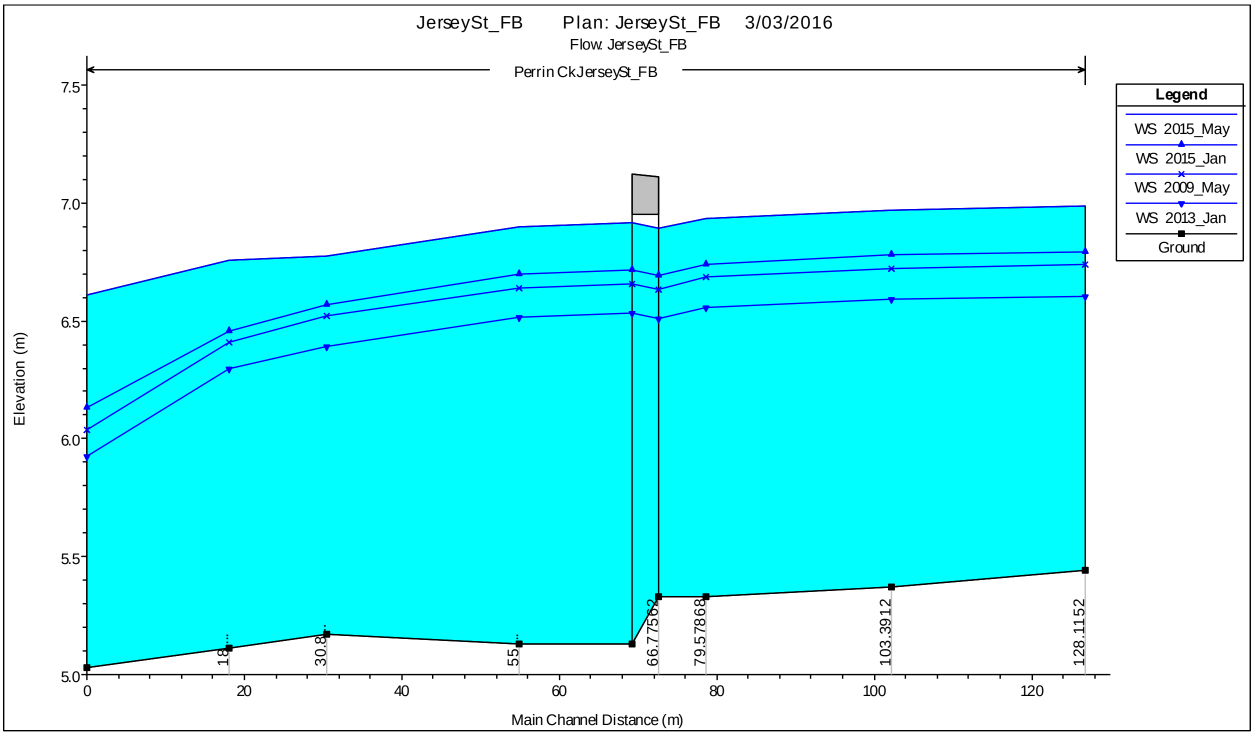

Figure B4: Long Section Plot - Jersey Street foot bridge (Old)

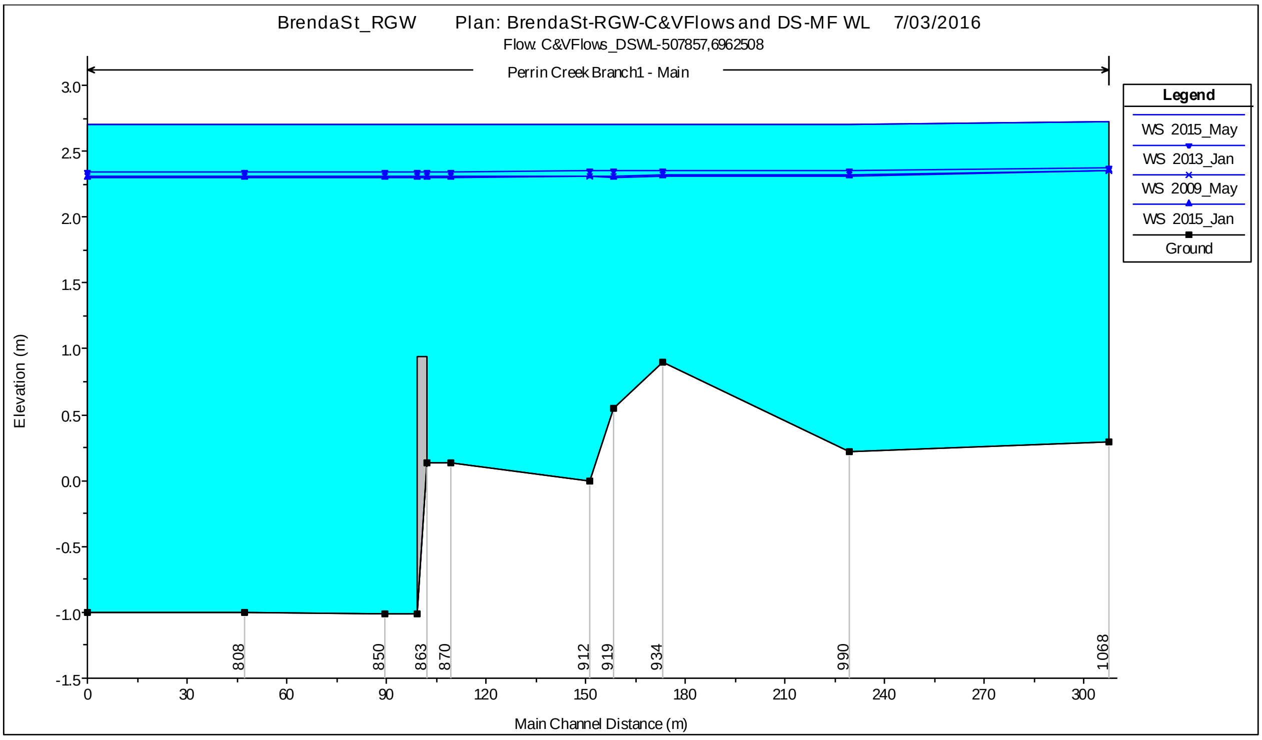

Figure B5: Long Section Plot - Brenda St. Rock Gabion Weir

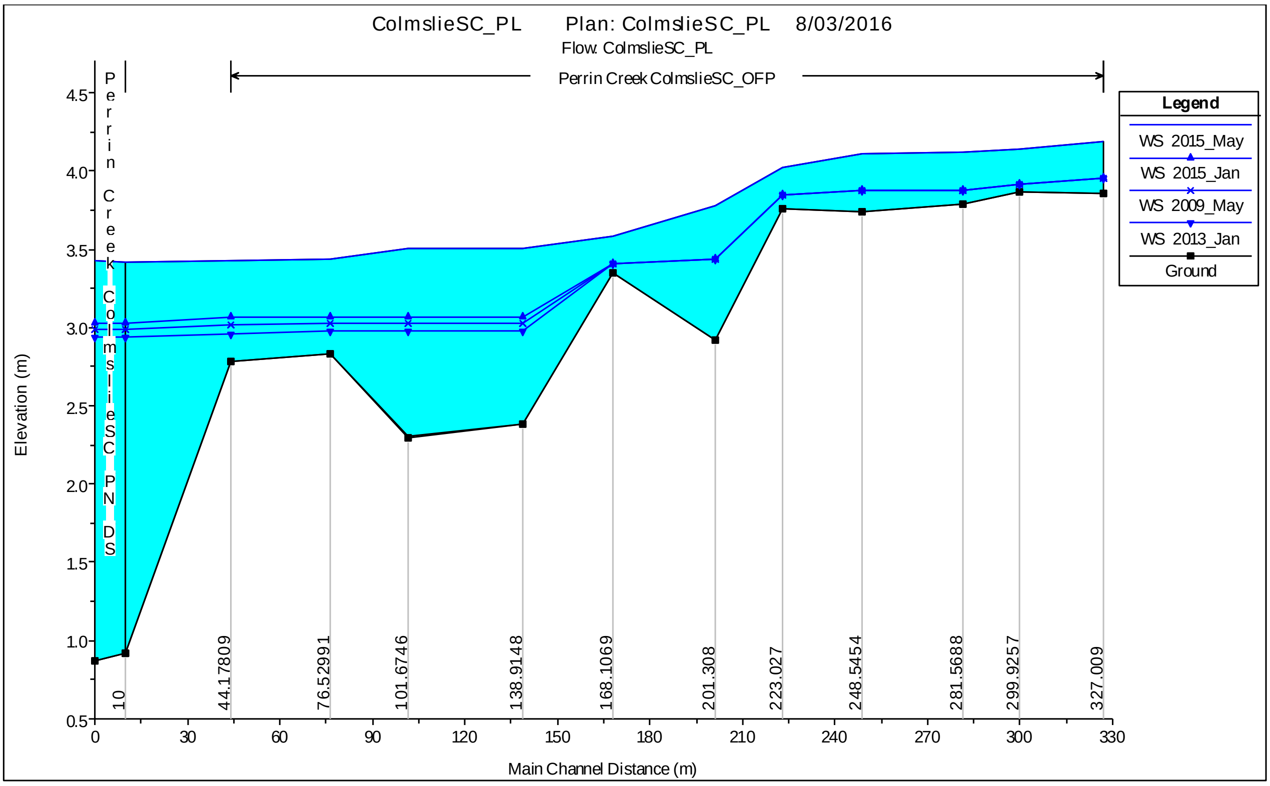

Figure B6: Long Section Plot (Overland Flow Path) - Wynnum Road Culvers, Rail culverts and Pipe line under Colmslie shopping Centre

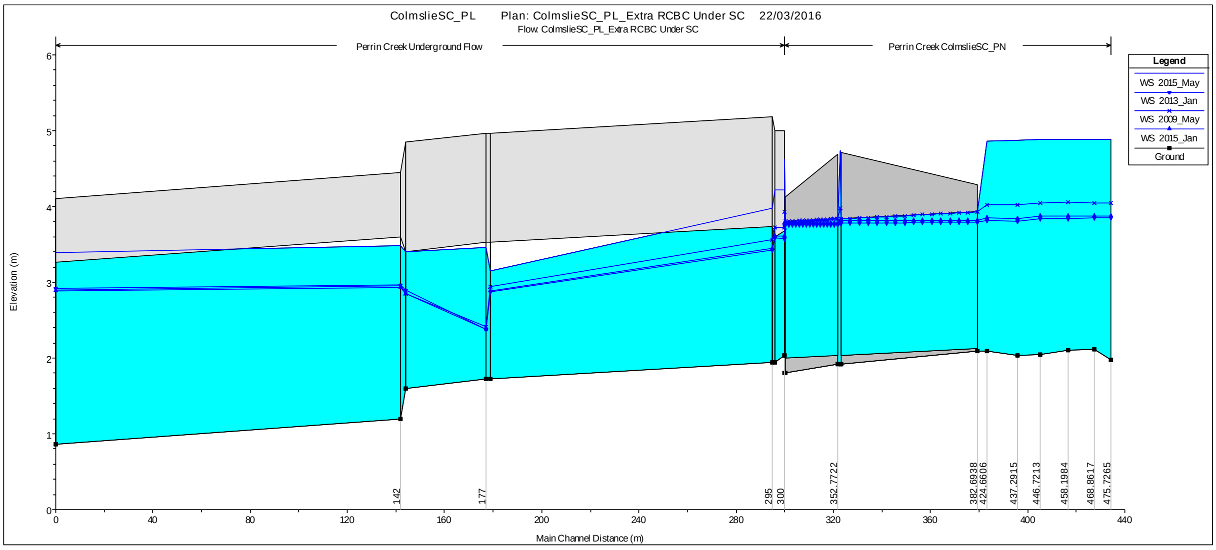

Figure B7: Long Section Plot (channel and pipe network) - Wynnum Road Culvers, Rail culverts and Pipe line under Colmslie shopping Centre

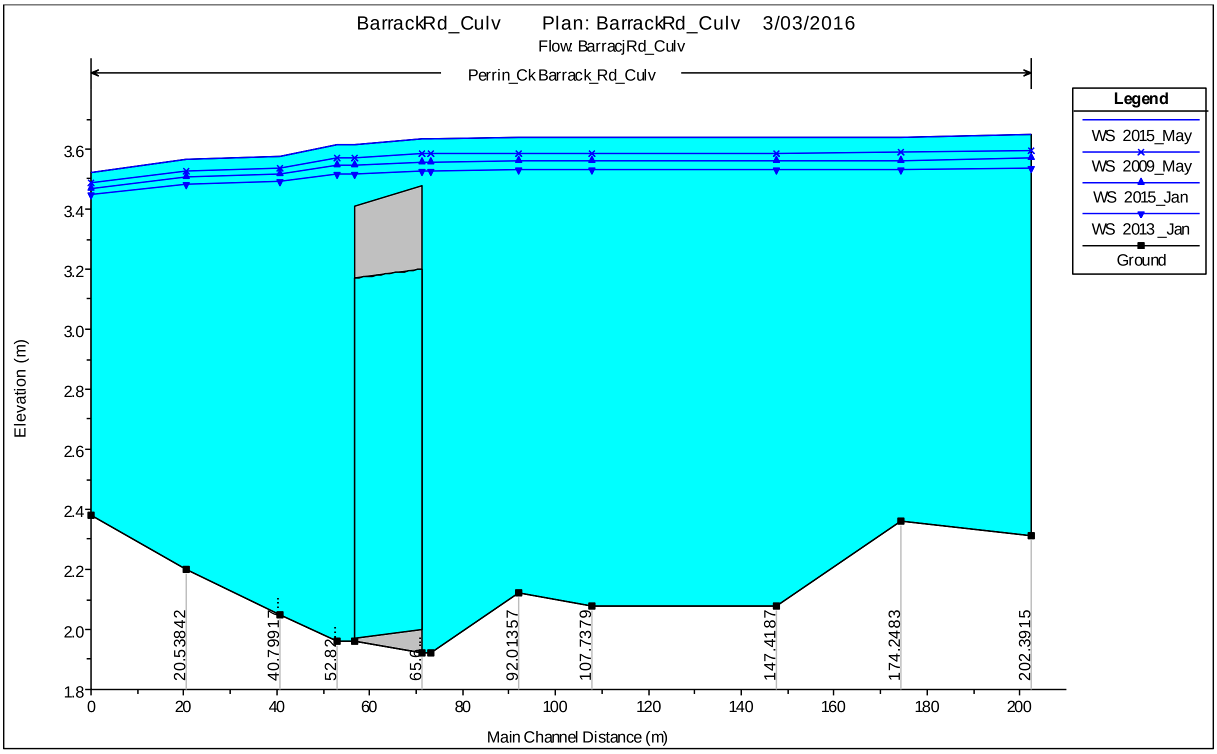

Figure B8: Long Section Plot - Barrack Rd Culverts

Appendix E – Design Event Peak Flood Levels

The flood level data presented in this Appendix has been extracted (in part) from the results of a 2-dimensional flood model. Levels presented have been extracted generally at selected points along the centreline of the waterway with the intent of demonstrating general flood characteristics. The applicability of this data to locations on the floodplains adjacent should be determined by a suitably qualified professional. It is recommended for any detailed assessment of flood risk associated with the waterway that complete flood model results be accessed and interrogated.

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SCENARIO 1 – EXISTING CASE
East Branch

Chainage (m)	New AMTD[1] (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH2_3 1793	0		2.28	2.51	2.66	2.82	2.99	3.11
BRANCH2_3 1693	100		2.29	2.52	2.66	2.83	3.00	3.12
BRANCH2_3 1593	200		2.31	2.54	2.68	2.84	3.01	3.13
BRANCH2_3 1493	300		2.34	2.56	2.69	2.85	3.01	3.13
BRANCH2_3 1393	400		2.35	2.56	2.69	2.85	3.01	3.13
BRANCH2_3 1293	500		2.40	2.57	2.69	2.85	3.02	3.14
	600		2.45	2.63	2.74	2.89	3.06	3.18
JUNCTIONRD 35	617		2.59	2.78	2.88	3.06	3.22	3.31
Junction Road								
JUNCTIONRD 0	645		2.69	2.88	2.99	3.14	3.33	3.43
BRANCH2_2 1088	700		2.69	2.90	3.04	3.23	3.42	3.52
BRANCH2_2 995	800		2.71	2.92	3.05	3.23	3.43	3.53
BRANCH2_2 895	900		2.75	2.95	3.07	3.24	3.43	3.53
BRANCH2_2 795	1000		2.76	2.96	3.08	3.25	3.44	3.54
BRANCH2_2 705	1100		2.77	2.97	3.09	3.25	3.44	3.54
BRANCH2_2 606	1200		2.82	3.00	3.11	3.26	3.45	3.55
IVYST 9	1279		3.05	3.13	3.18	3.29	3.46	3.56
Ivy Street								
IVYST 0	1290		3.49	3.54	3.57	3.60	3.63	3.65
BRANCH2 489	1300		3.51	3.58	3.61	3.65	3.68	3.71
BARRACKRD 18	1372		3.68	3.77	3.81	3.86	3.91	3.95
Barrack Road								
BARRACKRD 0	1400		3.81	3.90	3.95	3.99	4.04	4.07
	1500		3.89	3.98	4.03	4.08	4.12	4.16
	1600		3.95	4.06	4.11	4.17	4.22	4.27
DRAINAGE2 30	1650		4.03	4.14	4.19	4.26	4.31	4.37

[1] AMTD line was updated for use in this study

Chainage (m)	New AMTD[1] (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
Drainage Basin 2								
DRAINAGE2 0	1672		5.04	5.44	5.63	5.88	6.14	6.22
	1700		5.04	5.43	5.63	5.88	6.14	6.22
	1800		5.04	5.43	5.63	5.88	6.14	6.22
	1900		5.04	5.44	5.63	5.88	6.14	6.22
DRAINAGE1 30	1925		5.05	5.43	5.63	5.88	6.14	6.22
Drainage Basin 1								
DRAINAGE1 0	1959		6.66	7.02	7.25	7.57	8.01	8.28
	2000		6.66	7.02	7.25	7.57	8.01	8.28
	2100		6.66	7.02	7.25	7.57	8.01	8.28

Main Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	0		1.06	1.06	1.06	1.06	1.06	1.07
	100		1.13	1.17	1.19	1.24	1.37	1.47
	200		1.24	1.33	1.37	1.47	1.69	1.82
	300		1.40	1.53	1.59	1.72	1.97	2.14
	400		1.51	1.66	1.73	1.88	2.14	2.31
	500		1.65	1.82	1.89	2.05	2.32	2.50
	600		1.81	2.02	2.10	2.29	2.56	2.75
	700		1.94	2.16	2.24	2.41	2.66	2.83
	800		2.00	2.21	2.29	2.45	2.70	2.86
	900		2.06	2.26	2.33	2.50	2.74	2.90
LYTTONRD1_NEW 15	926		2.08	2.27	2.34	2.53	2.77	2.92
Lytton Road Bridge								
LYTTONRD1_NEW 0	940		2.09	2.31	2.45	2.63	2.85	3.01
	1000		2.25	2.48	2.63	2.79	2.94	3.06
	1100		2.25	2.49	2.63	2.80	2.95	3.07
	1200		2.26	2.49	2.64	2.80	2.96	3.07
	1300		2.27	2.50	2.65	2.81	2.97	3.09
	1400		2.27	2.51	2.65	2.82	2.98	3.10
	1500		2.28	2.52	2.66	2.83	2.99	3.12
	1600		2.29	2.52	2.67	2.83	3.00	3.12
	1700		2.29	2.53	2.67	2.84	3.01	3.13
	1800		2.30	2.53	2.67	2.84	3.01	3.14
	1900		2.32	2.56	2.69	2.86	3.03	3.15
	2000		2.53	2.70	2.82	3.00	3.19	3.33
BARINGAST 20	2082		2.66	3.17	3.27	3.44	3.62	3.74
Baringa Street								
	2100		-	3.42	3.44	3.59	3.75	3.85
BARINGAST 0	2103		2.89	3.46	3.52	3.62	3.82	3.95
SHOPPINGCENTRE 2852	2129		3.10	3.47	3.56	3.73	3.89	3.99

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	2200		-	3.89	4.24	4.45	4.65	4.77
	2300		-	4.70	4.81	4.92	5.02	5.10
	2400		-	-	4.94	5.00	5.14	5.24
Shopping Centre Culverts								
SHOPPINGCENTRE 2552	2439		4.03	4.64	4.81	4.97	5.15	5.27
RAILWAY 15	2445		4.11	4.67	4.85	5.04	5.23	5.37
Railway								
	2457		4.29	4.81	5.14	5.17	5.35	5.49
WYNNUMRD2 56	2461		4.33	5.01	5.20	5.31	5.49	5.60
Wynnum Road								
	2500		-	5.19	5.30	5.42	5.56	5.67
WYNNUMRD1 0	2527		4.55	5.17	5.28	5.41	5.56	5.67
LANGST 25	2600		4.56	5.18	5.29	5.42	5.57	5.66
Lang Street								
LANGST 0	2627		4.78	5.26	5.36	5.50	5.65	5.76
BRANCH1_3 2290	2700		5.06	5.39	5.50	5.66	5.83	5.96
BRANCH1_3 2190	2800		5.06	5.39	5.50	5.65	5.82	5.95
BRANCH1_3 2090	2900		5.05	5.39	5.52	5.71	5.96	6.17
BRIDGEWATERST 20	2962		5.48	6.53	6.65	6.84	7.01	7.14
Bridgewater Street								
BRIDGEWATERST 0	2985		6.12	6.58	6.72	6.95	7.15	7.29
BRANCH1_2 1983	3000		6.51	7.10	7.27	7.50	7.67	7.78
BRANCH1_2 1884	3100		6.58	7.13	7.42	7.62	7.80	7.92
BRANCH1_2 1784	3200		6.93	7.44	7.91	8.04	8.15	8.29
RICHMONDST 30	3281		7.75	8.44	8.60	8.84	9.02	9.15
Richmond Road								
	3300		-	9.33	9.40	9.52	9.61	9.68
RICHMONDST 0	3313		8.37	9.32	9.53	9.76	9.94	10.07
BRANCH1 116	3400		8.70	9.69	9.87	10.07	10.22	10.33
BRANCH1 16	3500		8.71	9.74	9.88	10.19	10.39	10.52
ELWELL_ST 20	3532		9.19	10.00	10.46	10.70	10.89	11.02

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
Elwell Street								
ELWELL_ST 0	3551		9.20	10.05	10.54	10.79	10.99	11.13
BRANCH5 1410	3600		9.72	10.37	10.79	11.02	11.21	11.34
BRANCH5 1310	3700		10.45	10.87	11.14	11.38	11.57	11.72
BRANCH5 1210	3800		11.22	11.56	11.73	11.99	12.22	12.37
BRANCH5 1110	3900		11.83	12.20	12.39	12.63	12.85	13.02
BRANCH5 1010	4000		12.81	13.15	13.33	13.55	13.76	13.94
BRANCH5 910	4100		13.80	14.06	14.21	14.41	14.63	14.84
BRANCH5 810	4200		15.62	15.89	16.02	16.18	16.34	16.48
BRANCH5 710	4300		16.18	16.48	16.61	16.78	16.96	17.10
BRANCH5 610	4400		16.96	17.27	17.43	17.64	17.83	18.01
BRANCH5 510	4500		17.53	17.82	17.97	18.14	18.29	18.44
BRANCH5 410	4600		17.92	18.23	18.40	18.60	18.77	18.93
BRANCH5 310	4700		18.33	18.65	18.81	19.02	19.20	19.36
BRANCH5 210	4800		18.69	19.02	19.21	19.43	19.63	19.82
BRANCH5 110	4900		18.93	19.36	19.60	19.83	20.01	20.20
BRANCH5 10	5000		19.27	19.76	19.99	20.26	20.39	20.63

North Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
LYTTONRD2 1360	0		2.33	2.55	2.68	2.85	3.01	3.13
LYTTONRD2 1279	100		2.36	2.56	2.69	2.85	3.01	3.13
LYTTONRD2 1179	200		2.39	2.60	2.70	2.85	3.01	3.13
LYTTONRD2 1142	234		2.40	2.63	2.75	2.89	3.03	3.15
Lytton Road Culverts								
LYTTONRD2 1122	255		2.41	2.64	2.76	2.91	3.05	3.15
BRANCH4 1022	300		2.58	2.69	2.77	2.92	3.06	3.15
	400		2.60	2.74	2.78	2.92	3.06	3.15

South Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH7 310	0		5.06	5.39	5.50	5.66	5.83	5.95
BRANCH7 220	100		5.08	5.41	5.52	5.67	5.82	5.95
BRANCH7 120	200		6.09	6.21	6.28	6.37	6.43	6.50
BRANCH7 20	300		6.62	6.74	6.81	6.89	6.95	7.02

South West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH6 0	0		9.67	10.32	10.76	10.99	11.17	11.29
BRANCH6 85	100		10.67	10.86	10.95	11.10	11.28	11.41

West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	0		2.26	2.49	2.64	2.80	2.96	3.08
BRANCH3 338	100		2.26	2.49	2.64	2.80	2.96	3.08
BRANCH3 238	200		2.26	2.50	2.64	2.81	2.96	3.08
BRANCH3 138	300		2.27	2.50	2.64	2.81	2.96	3.08
BRANCH3 38	400		2.27	2.50	2.64	2.81	2.96	3.08
	428		2.27	2.50	2.64	2.81	2.96	3.08

SCENARIO 3 – ULTIMATE CASE
East Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH2_3 1793	0		2.32	2.58	2.72	2.89	3.08	3.22
BRANCH2_3 1693	100		2.34	2.59	2.73	2.91	3.09	3.24
BRANCH2_3 1593	200		2.35	2.61	2.75	2.92	3.10	3.25
BRANCH2_3 1493	300		2.38	2.62	2.75	2.92	3.11	3.25
BRANCH2_3 1393	400		2.38	2.63	2.76	2.92	3.11	3.25
BRANCH2_3 1293	500		2.43	2.63	2.76	2.93	3.11	3.26
	600		2.48	2.69	2.81	2.97	3.16	3.31
JUNCTIONRD 35	617		2.61	2.82	2.93	3.12	3.28	3.40
Junction Road								
JUNCTIONRD 0	645		2.69	2.92	3.00	3.18	3.37	3.48
BRANCH2_2 1088	700		2.69	2.92	3.08	3.26	3.45	3.55
BRANCH2_2 995	800		2.71	2.93	3.09	3.27	3.46	3.56
BRANCH2_2 895	900		2.75	2.96	3.10	3.28	3.47	3.57
BRANCH2_2 795	1000		2.76	2.97	3.11	3.28	3.47	3.57
BRANCH2_2 705	1100		2.77	2.98	3.11	3.29	3.48	3.58
BRANCH2_2 606	1200		2.81	3.02	3.13	3.30	3.49	3.59
IVYST 9	1279		3.08	3.19	3.26	3.35	3.51	3.61
Ivy Street								
IVYST 0	1290		3.50	3.57	3.60	3.63	3.66	3.70
BRANCH2 489	1300		3.53	3.61	3.64	3.68	3.72	3.76
BARRACKRD 18	1372		3.70	3.80	3.84	3.90	3.95	4.00
Barrack Road								
BARRACKRD 0	1400		3.84	3.91	3.95	4.01	4.07	4.12
	1500		4.01	4.17	4.24	4.33	4.41	4.48
	1600		4.21	4.39	4.47	4.57	4.65	4.74
DRAINAGE2 30	1650		4.28	4.45	4.53	4.63	4.71	4.80
Drainage Basin 2								
DRAINAGE2 0	1672		5.11	5.49	5.69	5.94	6.18	6.24

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	1700		5.11	5.49	5.69	5.93	6.18	6.24
	1800		5.11	5.49	5.69	5.93	6.18	6.24
	1900		5.11	5.49	5.69	5.94	6.18	6.24
DRAINAGE1 30	1925		5.11	5.49	5.69	5.94	6.18	6.24
Drainage Basin 1								
DRAINAGE1 0	1959		6.69	7.04	7.26	7.60	8.04	8.30
	2000		6.69	7.04	7.26	7.60	8.04	8.30
	2100		6.69	7.04	7.27	7.60	8.04	8.30

Main Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	0		1.06	1.06	1.06	1.06	1.06	1.06
	100		1.12	1.15	1.16	1.22	1.32	1.41
	200		1.21	1.29	1.31	1.43	1.61	1.74
	300		1.36	1.48	1.51	1.68	1.91	2.06
	400		1.45	1.61	1.64	1.83	2.08	2.25
	500		1.59	1.77	1.80	2.02	2.27	2.45
	600		1.77	1.99	2.04	2.30	2.59	2.78
	700		1.93	2.17	2.23	2.48	2.75	2.93
	800		2.01	2.24	2.30	2.54	2.81	2.98
	900		2.09	2.32	2.37	2.60	2.86	3.03
LYTTONRD1_NEW 15	926		2.09	2.31	2.42	2.64	2.89	3.05
Lytton Road Bridge								
LYTTONRD1_NEW 0	940		2.10	2.33	2.51	2.71	2.98	3.07
	1000		2.27	2.53	2.67	2.84	3.01	3.14
	1100		2.28	2.54	2.68	2.85	3.02	3.15

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	1200		2.29	2.55	2.69	2.86	3.03	3.17
	1300		2.30	2.56	2.70	2.87	3.05	3.19
	1400		2.32	2.58	2.72	2.89	3.07	3.22
	1500		2.33	2.59	2.73	2.90	3.09	3.24
	1600		2.34	2.60	2.74	2.91	3.10	3.25
	1700		2.35	2.61	2.74	2.92	3.11	3.26
	1800		2.36	2.61	2.75	2.93	3.11	3.27
	1900		2.44	2.67	2.80	2.98	3.17	3.32
	2000		2.75	2.91	3.04	3.26	3.48	3.64
BARINGAST 20	2082		2.90	3.33	3.43	3.64	3.85	4.00
Baringa Street								
	2100		3.03	3.45	3.51	3.70	3.90	4.04
BARINGAST 0	2103		3.13	3.48	3.54	3.76	3.99	4.15
SHOPPINGCENTRE 2852	2129		3.26	3.57	3.66	3.83	4.01	4.15
	2200		-	3.90	4.24	4.47	4.68	4.83
	2300		-	4.71	4.82	4.94	5.06	5.14
	2400		-	-	4.88	5.03	5.19	5.32
Shopping Centre Culverts								
SHOPPINGCENTRE 2552	2439		4.08	4.66	4.82	4.99	5.19	5.34
RAILWAY 15	2445		4.15	4.69	4.88	5.06	5.27	5.43
Railway								
	2457		4.32	4.82	5.00	5.18	5.39	5.54
WYNNUMRD2 56	2461		4.37	5.03	5.16	5.32	5.50	5.64
Wynnum Road								
	2500		-	5.20	5.31	5.44	5.59	5.72
WYNNUMRD1 0	2527		4.58	5.18	5.29	5.43	5.59	5.72
LANGST 25	2600		4.64	5.20	5.31	5.45	5.62	5.75
Lang Street								
LANGST 0	2627		4.85	5.29	5.39	5.54	5.72	5.85
BRANCH1_3 2290	2700		5.11	5.45	5.56	5.73	5.93	6.08
BRANCH1_3 2190	2800		5.12	5.45	5.56	5.73	5.93	6.08

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH1_3 2090	2900		5.11	5.44	5.58	5.78	6.06	6.26
BRIDGEWATERST 20	2962		5.48	5.79	6.62	6.83	7.02	7.17
Bridgewater Street								
BRIDGEWATERST 0	2980		6.09	6.38	6.68	6.94	7.17	7.34
BRANCH1_2 1983	3000		6.46	6.89	7.23	7.50	7.75	7.92
BRANCH1_2 1884	3100		6.58	7.06	7.40	7.67	7.94	8.12
BRANCH1_2 1784	3200		6.90	7.33	7.81	8.00	8.17	8.32
RICHMONDST 30	3281		7.70	8.41	8.59	8.84	9.05	9.22
Richmond Road								
	3300		7.98	9.31	9.40	9.54	9.66	9.75
RICHMONDST 0	3313		8.28	9.41	9.50	9.76	9.97	10.11
BRANCH1 116	3400		8.61	9.61	9.84	10.07	10.26	10.38
BRANCH1 16	3500		8.63	9.62	9.85	10.19	10.41	10.54
ELWELL_ST 20	3532		9.16	9.94	10.41	10.69	10.88	11.03
Elwell Street								
ELWELL_ST 0	3551		9.16	9.97	10.49	10.78	10.97	11.12
BRANCH5 1410	3600		9.99	10.48	10.87	11.11	11.31	11.45
BRANCH5 1310	3700		10.56	10.98	11.24	11.48	11.69	11.84
BRANCH5 1210	3800		11.28	11.67	11.87	12.11	12.35	12.54
BRANCH5 1110	3900		11.88	12.27	12.46	12.72	12.97	13.17
BRANCH5 1010	4000		12.84	13.18	13.38	13.61	13.84	14.06
BRANCH5 910	4100		13.92	14.19	14.35	14.57	14.81	15.02
BRANCH5 810	4200		15.70	15.99	16.13	16.31	16.47	16.62
BRANCH5 710	4300		16.27	16.60	16.74	16.94	17.11	17.25
BRANCH5 610	4400		17.01	17.35	17.51	17.73	17.93	18.11
BRANCH5 510	4500		17.57	17.87	18.02	18.20	18.37	18.53
BRANCH5 410	4600		17.95	18.29	18.47	18.68	18.87	19.05
BRANCH5 310	4700		18.36	18.71	18.88	19.10	19.30	19.49
BRANCH5 210	4800		18.70	19.06	19.25	19.49	19.70	19.91
BRANCH5 110	4900		18.94	19.37	19.60	19.84	20.04	20.24
BRANCH5 10	5000		19.27	19.76	19.99	20.27	20.40	20.65

North Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
LYTTONRD2 1360	0		2.37	2.62	2.75	2.92	3.11	3.25
LYTTONRD2 1279	100		2.39	2.62	2.75	2.92	3.11	3.25
LYTTONRD2 1179	200		2.42	2.65	2.77	2.93	3.11	3.25
LYTTONRD2 1142	234		2.43	2.68	2.80	2.96	3.13	3.26
Lytton Road Culverts								
LYTTONRD2 1122	255		2.44	2.70	2.82	2.97	3.15	3.27
BRANCH4 1022	300		2.60	2.78	2.83	2.97	3.16	3.27
	400		2.63	2.78	2.83	2.97	3.16	3.27

South Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH7 310	0		5.12	5.45	5.56	5.73	5.93	6.08
BRANCH7 220	100		5.14	5.45	5.56	5.73	5.93	6.08
BRANCH7 120	200		6.09	6.21	6.28	6.37	6.43	6.50
BRANCH7 20	300		6.62	6.74	6.81	6.89	6.95	7.02

South West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
BRANCH6 0	0		9.94	10.43	10.83	11.07	11.26	11.40
BRANCH6 85	100		10.67	10.86	10.95	11.17	11.36	11.51

West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)					
			50% AEP (2 yr ARI)	20% AEP (5 yr ARI)	10% AEP (10 yr ARI)	5% AEP (20 yr ARI)	2% AEP (50 yr ARI)	1% AEP (100 yr ARI)
	0		2.29	2.55	2.69	2.86	3.04	3.17
BRANCH3 338	100		2.29	2.55	2.69	2.86	3.04	3.17
BRANCH3 238	200		2.29	2.55	2.69	2.86	3.04	3.17
BRANCH3 138	300		2.29	2.55	2.69	2.86	3.04	3.17
BRANCH3 38	400		2.29	2.55	2.69	2.86	3.04	3.17
	428		2.29	2.55	2.69	2.86	3.04	3.17

Appendix F – Extreme Event Peak Flood Levels

The flood level data presented in this Appendix has been extracted (in part) from the results of a 2-dimensional flood model. Levels presented have been extracted generally at selected points along the centreline of the waterway with the intent of demonstrating general flood characteristics. The applicability of this data to locations on the floodplains adjacent should be determined by a suitably qualified professional. It is recommended for any detailed assessment of flood risk associated with the waterway that complete flood model results be accessed and interrogated.

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SCENARIO 1 – EXISTING CASE
East Branch

Chainage (m)	New AMTD[1] (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
BRANCH2_3 1793	0		3.23	3.39	3.86	4.97
BRANCH2_3 1693	100		3.24	3.40	3.88	4.99
BRANCH2_3 1593	200		3.25	3.41	3.88	4.99
BRANCH2_3 1493	300		3.25	3.42	3.88	4.99
BRANCH2_3 1393	400		3.25	3.42	3.88	4.99
BRANCH2_3 1293	500		3.26	3.42	3.89	5.00
	600		3.30	3.46	3.93	5.01
JUNCTIONRD 35	617		3.40	3.54	3.96	5.02
Junction Road						
JUNCTIONRD 0	645		3.51	3.61	4.04	5.05
BRANCH2_2 1088	700		3.58	3.68	4.10	5.07
BRANCH2_2 995	800		3.59	3.69	4.12	5.08
BRANCH2_2 895	900		3.60	3.70	4.14	5.09
BRANCH2_2 795	1000		3.60	3.71	4.15	5.09
BRANCH2_2 705	1100		3.61	3.71	4.17	5.10
BRANCH2_2 606	1200		3.62	3.72	4.18	5.10
IVYST 9	1279		3.62	3.73	4.18	5.11
Ivy Street						
IVYST 0	1290		3.66	3.75	4.20	5.11
BRANCH2 489	1300		3.72	3.76	4.21	5.12
BARRACKRD 18	1372		3.96	4.01	4.32	5.13
Barrack Road						
BARRACKRD 0	1400		4.09	4.13	4.38	5.15
	1500		4.17	4.22	4.44	5.15
	1600		4.29	4.35	4.61	5.42
DRAINAGE2 30	1650		4.39	4.46	4.71	5.49

[1] AMTD line was updated for use in this study

Chainage (m)	New AMTD[1] (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
Drainage Basin 2						
DRAINAGE2 0	1672		6.24	6.31	6.55	6.81
	1700		6.24	6.31	6.55	6.83
	1800		6.24	6.31	6.55	6.83
	1900		6.24	6.31	6.55	6.84
DRAINAGE1 30	1925		6.24	6.32	6.55	6.84
Drainage Basin 1						
DRAINAGE1 0	1959		8.34	8.40	8.59	8.74
	2000		8.34	8.40	8.59	8.74
	2100		8.34	8.40	8.59	8.74

Main Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
	0		1.66	1.67	1.68	1.68
	100		1.86	1.96	2.41	3.22
	200		2.15	2.35	3.02	3.96
	300		2.41	2.63	3.28	4.32
	400		2.57	2.80	3.46	4.50
	500		2.73	2.97	3.59	4.66
	600		2.94	3.14	3.67	4.74
	700		3.00	3.19	3.70	4.77
	800		3.03	3.22	3.72	4.80
	900		3.06	3.25	3.74	4.82
LYTTONRD1_NEW 15	926		3.08	3.25	3.75	4.83
Lytton Road Bridge						
LYTTONRD1_NEW 0	940		3.12	3.29	3.79	4.89
	1000		3.18	3.34	3.81	4.88

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
	1100		3.19	3.35	3.82	4.90
	1200		3.20	3.36	3.82	4.91
	1300		3.21	3.37	3.84	4.93
	1400		3.22	3.39	3.86	4.96
	1500		3.24	3.40	3.87	4.98
	1600		3.25	3.41	3.88	4.99
	1700		3.25	3.41	3.88	5.00
	1800		3.26	3.42	3.89	5.01
	1900		3.27	3.44	3.90	5.02
	2000		3.44	3.61	4.08	5.11
BARINGAST 20	2082		3.82	3.95	4.32	5.22
Baringa Street						
	2100		3.91	4.02	4.33	5.20
BARINGAST 0	2103		4.03	4.17	4.49	5.30
SHOPPINGCENTRE 2852	2129		4.05	4.17	4.49	5.30
	2200		4.82	4.95	5.28	5.92
	2300		5.13	5.22	5.48	6.07
	2400		5.27	5.40	5.71	6.34
Shopping Centre Culverts						
SHOPPINGCENTRE 2552	2439		5.31	5.45	5.78	6.65
RAILWAY 15	2445		5.41	5.56	5.92	6.75
Railway						
	2457		5.52	5.67	6.02	6.85
WYNNUMRD2 56	2461		5.64	5.79	6.18	7.07
Wynnum Road						
	2500		5.70	5.84	6.23	7.14
WYNNUMRD1 0	2527		5.70	5.84	6.23	7.14
LANGST	2600		5.70	5.84	6.23	7.14
Lang Street						
LANGST 0	2627		5.80	5.95	6.35	7.24

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
BRANCH1_3 2290	2700		6.00	6.16	6.59	7.40
BRANCH1_3 2190	2800		6.00	6.17	6.65	7.50
BRANCH1_3 2090	2900		6.24	6.48	7.03	7.82
BRIDGEWATERST 20	2962		7.17	7.32	7.66	8.15
Bridgewater Street						
BRIDGEWATERST 0	2985		7.33	7.49	7.83	8.46
BRANCH1_2 1983	3000		7.82	7.94	8.21	8.69
BRANCH1_2 1884	3100		7.96	8.08	8.36	8.97
BRANCH1_2 1784	3200		8.32	8.43	8.78	9.57
RICHMONDST 30	3281		9.19	9.35	9.73	10.44
Richmond Road						
	3300		9.71	9.79	10.01	10.56
RICHMONDST 0	3313		10.11	10.25	10.56	11.23
BRANCH1 116	3400		10.36	10.48	10.75	11.45
BRANCH1 16	3500		10.56	10.71	11.11	12.08
ELWELL_ST 20	3532		11.06	11.20	11.56	12.40
Elwell Street						
ELWELL_ST 0	3551		11.17	11.32	11.70	12.61
BRANCH5 1410	3600		11.38	11.53	11.89	12.77
BRANCH5 1310	3700		11.77	11.92	12.25	13.16
BRANCH5 1210	3800		12.42	12.62	12.97	14.03
BRANCH5 1110	3900		13.07	13.29	13.67	14.77
BRANCH5 1010	4000		14.01	14.22	14.59	15.51
BRANCH5 910	4100		14.90	15.10	15.50	16.45
BRANCH5 810	4200		16.53	16.68	16.94	17.82
BRANCH5 710	4300		17.14	17.29	17.56	18.46
BRANCH5 610	4400		18.06	18.27	18.57	19.40
BRANCH5 510	4500		18.49	18.66	18.90	19.75
BRANCH5 410	4600		18.98	19.18	19.40	20.31
BRANCH5 310	4700		19.41	19.62	19.83	20.80

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
BRANCH5 210	4800		19.88	20.11	20.29	21.39
BRANCH5 110	4900		20.25	20.54	20.68	21.87
BRANCH5 10	5000		20.69	20.98	21.04	22.27

North Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
LYTTONRD2 1360	0		3.25	3.41	3.88	4.99
LYTTONRD2 1279	100		3.25	3.41	3.88	4.98
LYTTONRD2 1179	200		3.25	3.41	3.88	4.98
LYTTONRD2 1142	234		3.26	3.41	3.88	4.99
Lytton Road Culverts						
LYTTONRD2 1122	255		3.26	3.41	3.88	4.97
BRANCH4 1022	300		3.26	3.41	3.87	4.96
	400		3.26	3.41	3.87	4.96

South Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
BRANCH7 310	0		6.00	6.17	6.63	7.45
BRANCH7 220	100		6.00	6.18	6.65	7.51
BRANCH7 120	200		6.52	6.62	6.77	7.58
BRANCH7 20	300		7.04	7.14	7.19	7.93

South West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
BRANCH6 0	0		11.33	11.48	11.83	12.69
BRANCH6 85	100		11.45	11.63	12.01	12.89

West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 1 Existing Case – Peak Water Levels (m AHD)			
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)	0.05% AEP (2000 yr ARI)	PMF
	0		3.20	3.36	3.83	4.91
BRANCH3 338	100		3.20	3.37	3.84	4.93
BRANCH3 238	200		3.20	3.37	3.84	4.93
BRANCH3 138	300		3.20	3.37	3.84	4.93
BRANCH3 38	400		3.20	3.37	3.84	4.93
	428		3.20	3.37	3.84	4.93

SCENARIO 3 – ULTIMATE CASE
East Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH2_3 1793	0		3.38	3.59
BRANCH2_3 1693	100		3.40	3.61
BRANCH2_3 1593	200		3.41	3.62
BRANCH2_3 1493	300		3.41	3.62
BRANCH2_3 1393	400		3.41	3.62
BRANCH2_3 1293	500		3.41	3.63
	600		3.45	3.67
JUNCTIONRD 35	617		3.51	3.71
Junction Road				
JUNCTIONRD 0	645		3.56	3.74
BRANCH2_2 1088	700		3.62	3.77
BRANCH2_2 995	800		3.63	3.78
BRANCH2_2 895	900		3.64	3.79
BRANCH2_2 795	1000		3.64	3.79
BRANCH2_2 705	1100		3.65	3.80
BRANCH2_2 606	1200		3.66	3.81
IVYST 9	1279		3.67	3.81
Ivy Street				
IVYST 0	1290		3.71	3.83
BRANCH2 489	1300		3.77	3.85
BARRACKRD 18	1372		4.02	4.08
Barrack Road				
BARRACKRD 0	1400		4.13	4.19
	1500		4.51	4.59
	1600		4.76	4.85
DRAINAGE2 30	1650		4.82	4.92
Drainage Basin 2				
DRAINAGE2 0	1672		6.29	6.35

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
	1700		6.29	6.35
	1800		6.29	6.35
	1900		6.29	6.35
DRAINAGE1 30	1925		6.29	6.36
Drainage Basin 1				
DRAINAGE1 0	1959		8.36	8.46
	2000		8.36	8.46
	2100		8.36	8.46

Main Channel

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
	0		1.65	1.66
	100		1.83	1.89
	200		2.08	2.21
	300		2.34	2.52
	400		2.50	2.72
	500		2.68	2.93
	600		3.01	3.24
	700		3.13	3.35
	800		3.18	3.39
	900		3.22	3.43
LYTTONRD1_NEW 15	926		3.22	3.44
Lytton Road Bridge				
LYTTONRD1_NEW 0	940		3.27	3.49
	1000		3.30	3.50
	1100		3.32	3.52
	1200		3.33	3.53

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
	1300		3.35	3.55
	1400		3.37	3.58
	1500		3.40	3.61
	1600		3.41	3.62
	1700		3.41	3.62
	1800		3.42	3.63
	1900		3.47	3.68
	2000		3.76	3.95
BARINGAST 20	2082		4.11	4.29
Baringa Street				
	2100		4.14	4.30
BARINGAST 0	2103		4.26	4.42
SHOPPINGCENTRE 2852	2129		4.25	4.42
	2200		4.90	5.06
	2300		5.18	5.29
	2400		5.36	5.53
Shopping Centre Culverts				
SHOPPINGCENTRE 2552	2439		5.39	5.56
RAILWAY 15	2445		5.49	5.66
Railway				
	2457		5.61	5.78
WYNNUMRD2 56	2461		5.69	5.87
Wynnum Road				
	2500		5.76	5.92
WYNNUMRD1 0	2527		5.76	5.93
LANGST 25	2600		5.79	5.96
Lang Street				
LANGST 0	2627		5.90	6.07
BRANCH1_3 2290	2700		6.13	6.31
BRANCH1_3 2190	2800		6.13	6.33

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH1_3 2090	2900		6.33	6.57
BRIDGEWATERST 20	2962		7.20	7.35
Bridgewater Street				
BRIDGEWATERST 0	2985		7.38	7.54
BRANCH1_2 1983	3000		7.95	8.12
BRANCH1_2 1884	3100		8.18	8.39
BRANCH1_2 1784	3200		8.38	8.56
RICHMONDST 30	3281		9.27	9.48
Richmond Road				
	3300		9.77	9.88
RICHMONDST 0	3313		10.15	10.31
BRANCH1 116	3400		10.41	10.56
BRANCH1 16	3500		10.59	10.77
ELWELL_ST 20	3532		11.07	11.22
Elwell Street				
ELWELL_ST 0	3551		11.17	11.33
BRANCH5 1410	3600		11.49	11.65
BRANCH5 1310	3700		11.88	12.05
BRANCH5 1210	3800		12.60	12.82
BRANCH5 1110	3900		13.23	13.45
BRANCH5 1010	4000		14.11	14.29
BRANCH5 910	4100		15.07	15.27
BRANCH5 810	4200		16.66	16.82
BRANCH5 710	4300		17.29	17.45
BRANCH5 610	4400		18.17	18.37
BRANCH5 510	4500		18.58	18.76
BRANCH5 410	4600		19.11	19.32
BRANCH5 310	4700		19.55	19.76
BRANCH5 210	4800		19.97	20.20
BRANCH5 110	4900		20.31	20.61

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH5 10	5000		20.71	21.01

North Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
LYTTONRD2 1360	0		3.41	3.62
LYTTONRD2 1279	100		3.41	3.62
LYTTONRD2 1179	200		3.41	3.62
LYTTONRD2 1142	234		3.42	3.63
Lytton Road Culverts				
LYTTONRD2 1122	255		3.42	3.63
BRANCH4 1022	300		3.41	3.62
	400		3.42	3.62

South Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH7 310	0		6.13	6.32
BRANCH7 220	100		6.13	6.32
BRANCH7 120	200		6.52	6.62
BRANCH7 20	300		7.04	7.14

South West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH6 0	0		11.44	11.59
BRANCH6 85	100		11.55	11.71

West Branch

Chainage (m)	New AMTD (m)	Cross Section ID (for reference only)	Design Event – Scenario 3 Ultimate Case – Peak Water Levels (m AHD)	
			0.5% AEP (200 yr ARI)	0.2% AEP (500 yr ARI)
BRANCH3 338	0		3.33	3.53
BRANCH3 238	100		3.33	3.53
BRANCH3 138	200		3.33	3.53
BRANCH3 38	300		3.33	3.53
BRANCH3 338	400		3.33	3.53
	428		3.33	3.53

Appendix G – Hydraulic Structure Reference Sheets

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Creek: Perrin Creek		**Immunity Rating (S1):**	>20% AEP
Location: Elwell Street			>5yr ARI

DATE OF SURVEY:

UBD REF:

SURVEYED CROSS SECTION ID:

BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2015 AMTD (m): PK_3551

STRUCTURE DESCRIPTION: Box Culvert

STRUCTURE SIZE: 3 x 2.4 m x 2.1 m RCBC

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

U/S INVERT LEVEL (m) 7.55 U/S OBVERT LEVEL (m)

D/S INVERT LEVEL (m) 7.55 D/S OBVERT LEVEL (m)

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 14.63

LENGTH OF CULVERT AT OBVERT (m): 14.63

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 14.63 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):

HEIGHT OF GUARDRAIL/HANDRAIL: 1.1

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

PLAN NUMBER: W5438

BRIDGE OR CULVERT DETAILS: Pipe crossing at inlet 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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek: Perrin Creek

Location: Elwell Street

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY $(m/s)^4$ Weir	PEAK VELOCITY $(m/s)^4$ Structure
2000-yr (0.05%)	32.51	11.70	11.56	0.14	63.00	1.26	1.49	2.08
500-yr (-0.2%)	35.40	11.32	11.20	0.12	54.00	0.96	1.34	2.27
200-yr (0.5%)	35.19	11.17	11.06	0.11	51.00	0.83	1.25	2.26
100-yr (1%)	35.68	11.13	11.02	0.11	50.00	0.80	1.23	2.29
50-yr (2%)	36.00	10.99	10.89	0.10	47.00	0.70	1.12	2.31
20-yr (5%)	35.89	10.79	10.70	0.09	42.00	0.57	0.99	2.30
10-yr (10%)	33.76	10.54	10.46	0.08	33.00	0.40	0.83	2.16
5yr (20%)	29.70	10.05	10.00	0.05	NA	Not Overtopped	Not Overtopped	2.10
2yr (50%)	21.38	9.20	9.19	0.01	NA	Not Overtopped	Not Overtopped	1.93

Photo 1 -Structure Detail

Photo 2 - Upstream pipe crossing and debris

Photo 3 - Downstream concrete channel section

Creek:	Perrin Creek	**Immunity Rating (S1):**	>50% AEP
Location:	Richmond Rd		>2yr ARI

DATE OF SURVEY: UBD REF:

SURVEYED CROSS SECTION ID: BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2016 AMTD (m): PK_3300

STRUCTURE DESCRIPTION: Circular Culvert

STRUCTURE SIZE: 3 x 1.675m RCP

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

U/S INVERT LEVEL (m) 6.04 U/S OBVERT LEVEL (m)

D/S INVERT LEVEL (m) 5.86 D/S OBVERT LEVEL (m)

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 25.6

LENGTH OF CULVERT AT OBVERT (m): 25.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 25.6 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):

HEIGHT OF GUARDRAIL/HANDRAIL: N/A

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

PLAN NUMBER: W2984

BRIDGE OR CULVERT DETAILS: Timber fence (2m height) along the road passage

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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek:	Perrin Creek
Location:	Richmond Rd

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	27.68	10.61	9.73	0.88	102.00	0.90	2.28	4.18
500-yr (-0.2%)	28.95	10.29	9.35	0.94	94.00	0.66	2.16	4.59
200-yr (0.5%)	28.90	10.14	9.19	0.95	90.00	0.57	2.08	4.59
100-yr (1%)	28.72	10.10	9.15	0.95	89.00	0.55	2.04	4.57
50-yr (2%)	28.49	9.95	9.02	0.93	84.00	0.47	1.94	4.54
20-yr (5%)	28.75	9.75	8.84	0.91	74.00	0.37	1.76	4.57
10-yr (10%)	28.28	9.47	8.60	0.87	68.00	0.25	1.50	4.52
5yr (20%)	27.65	9.28	8.44	0.84	62.00	0.17	1.25	4.21
2yr (50%)	22.14	8.35	7.75	0.60	NA	Not Overtopped	Not Overtopped	3.83

Photo 1 -Structure Detail

Photo 2 - Noticeable sediment deposits and vegetation built closer to inlet structure

Photo 3 - looking downstream

Creek: Perrin Creek		**Immunity Rating (S1):**	>20% AEP
Location: Jersey St Footbridge			>5yr ARI

DATE OF SURVEY: | UBD REF:

SURVEYED CROSS SECTION ID: | BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2019 AMTD (m): PK_3100

STRUCTURE DESCRIPTION: Old Footbridge -Modelled in

STRUCTURE SIZE: 0

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

U/S INVERT LEVEL (m) U/S OBVERT LEVEL (m) 6.95

D/S INVERT LEVEL (m) D/S OBVERT LEVEL (m) 6.95

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 3.2

LENGTH OF CULVERT AT OBVERT (m): 3.2

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 3.2 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):

HEIGHT OF GUARDRAIL/HANDRAIL: 0.88

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

PLAN NUMBER: N/A

BRIDGE OR CULVERT DETAILS: This bridge has low deck and bridge columns located at the creek bed. P

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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Jersey St Footbridge

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	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	32.54	4.50	4.30	0.16	240.00	1.16	1.37	2.54
500-yr (-0.2%)	33.99	4.15	3.92	0.15	215.00	0.83	1.36	2.65
200-yr (0.5%)	34.01	4.02	3.79	0.14	210.00	0.72	1.32	2.65
100-yr (1%)	33.81	3.94	3.71	0.13	205.00	0.66	1.31	2.64
50-yr (2%)	34.12	3.81	3.58	0.12	195.00	0.55	1.25	2.66
20-yr (5%)	33.93	3.62	3.41	0.11	175.00	0.39	1.09	2.64
10-yr (10%)	34.01	3.42	3.22	0.09	150.00	0.22	0.93	2.65
5yr (20%)	33.72	3.36	3.13	0.07	120.00	0.15	0.95	2.63
2yr (50%)	30.18	2.92	2.66	0.05	NA	NA	NA	2.35

Photo 1 -Structure Detail and captured debris

Photo 2 - Looking upstream

Photo 3 - looking upstream

Creek: Perrin Creek
Location: Bridgewater St.

Immunity Rating (S1): >50% AEP / >2yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2011 AMTD (m): PK_2980
STRUCTURE DESCRIPTION: Box Culvert
STRUCTURE SIZE: 3 x 3.0 m x 1.5 m RCBC
For Culverts: Number of cells/pipes & s For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 4.922 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 4.512 D/S OBVERT LEVEL (m)
For culverts give floor level For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 13.5
LENGTH OF CULVERT AT OBVERT (m): 13.5
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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): 0 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):
HEIGHT OF GUARDRAIL/HANDRAIL: 1.15

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

PLAN NUMBER: W5939
BRIDGE OR CULVERT DETAILS: Reinforced concrete box culvert.
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Bridgewater St.

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	35.00	7.83	7.66	0.17	165.00	0.74	2.60	3.37
500-yr (-0.2%)	31.86	7.49	7.32	0.17	155.00	0.57	2.58	3.26
200-yr (0.5%)	34.86	7.33	7.17	0.16	150.00	0.51	2.48	3.36
100-yr (1%)	34.31	7.29	7.14	0.15	150.00	0.50	2.46	3.35
50-yr (2%)	33.27	7.15	7.01	0.14	145.00	0.44	2.35	3.31
20-yr (5%)	32.63	6.95	6.84	0.11	135.00	0.37	2.14	3.29
10-yr (10%)	34.60	6.72	6.65	0.07	75.00	0.27	1.76	3.36
5yr (20%)	32.88	6.58	6.52	0.06	64.00	0.23	1.61	3.30
2yr (50%)	22.76	6.12	5.48	0.64	NA	Not Overtopped	Not Overtopped	2.92


Photo 1 -Structure Details


Photo 2 - Looking from downstream


Photo 3 - looking upstream

Creek:	Perrin Creek	**Immunity Rating (S1):**	<50% AEP
Location:	Lang St.		<2yr ARI

DATE OF SURVEY: UBD REF:
SURVEYED CROSS SECTION ID: BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2012 AMTD (m): PK_2627
STRUCTURE DESCRIPTION: Box Culvert
STRUCTURE SIZE: 3 x 3.0m x 1.8 m RCBC

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

U/S INVERT LEVEL (m) 2.32 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 2.26 D/S OBVERT LEVEL (m)

For culverts give floor level For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 17.13
LENGTH OF CULVERT AT OBVERT (m): 17.13
TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 11.3 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):
HEIGHT OF GUARDRAIL/HANDRAIL: 1.02

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

PLAN NUMBER: W9382
BRIDGE OR CULVERT DETAILS: Two Box culverts with spanning slab.

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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Lang St.

ARI (AEP %)	DISCHARGE (m^3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	25.19	6.35	6.30	0.05	294.00	1.55	1.47	1.56
500-yr (-0.2%)	37.47	5.95	5.91	0.04	258.00	1.17	1.41	2.55
200-yr (0.5%)	38.74	5.80	5.77	0.03	249.00	1.03	1.34	2.42
100-yr (1%)	38.18	5.76	5.76	0.00	246.00	1.00	1.31	2.36
50-yr (2%)	35.71	5.65	5.63	0.02	244.00	0.89	1.23	2.21
20-yr (5%)	35.60	5.50	5.48	0.02	236.00	0.75	1.23	2.20
10-yr (10%)	33.11	5.36	5.34	0.02	228.00	0.62	1.16	2.04
5yr (20%)	30.72	5.26	5.24	0.02	223.00	0.53	1.10	1.90
2yr (50%)	27.60	4.78	4.73	0.05	196.00	0.23	0.92	1.70

Photo 1 -Structure Details

Photo 2 - Looking Upstream (Inset: Debris at red pointer on map, probably from May 2015 event)

Photo 3 - looking from downstream

Creek: Perrin Creek
Location: Rossiter St/ Wynnum Rd

Immunity Rating (S1):	>50% AEP
	>2yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2013 AMTD (m): PK_2500
STRUCTURE DESCRIPTION: RCBC's and RCP's
STRUCTURE SIZE: 5 x 3.0m x 1.8 m RCBC2 x 3.3
For Culverts: Number of cells/pipes & s For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 2.127 / 2.035 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 2.04 / 1.98 D/S OBVERT LEVEL (m)
For culverts give floor level For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 30.659 / 25.161
LENGTH OF CULVERT AT OBVERT (m): 30.659 / 25.161
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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): 55 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):
HEIGHT OF GUARDRAIL/HANDRAIL: 1

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

PLAN NUMBER: W6047
BRIDGE OR CULVERT DETAILS: Series of culverts that change dimensions under road crossings.
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Rossiter St/ Wynnum Rd

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	19.45	6.23	6.12	0.11	251.00	1.40	1.30	1.20
500-yr (-0.2%)	21.45	5.84	5.80	0.04	185.00	1.00	1.25	1.32
200-yr (0.5%)	21.40	5.70	5.62	0.08	185.00	0.85	1.17	1.32
100-yr (1%)	21.53	5.66	5.57	0.09	174.00	0.82	1.14	1.33
50-yr (2%)	21.43	5.55	5.43	0.12	151.00	0.72	1.06	1.32
20-yr (5%)	23.21	5.41	5.26	0.15	129.00	0.59	0.92	1.43
10-yr (10%)	21.32	5.27	5.17	0.10	115.00	0.49	0.75	1.32
5yr (20%)	21.04	5.17	4.91	0.26	107.00	0.39	0.60	1.30
2yr (50%)	16.69	4.55	4.34	0.21	NA	Not Overtopped	Not Overtopped	1.03

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	15.84	6.23	6.09	0.14	251.00	1.05	1.18	1.47
500-yr (-0.2%)	17.73	5.84	5.72	0.12	185.00	0.65	1.15	1.64
200-yr (0.5%)	17.60	5.69	5.57	0.12	185.00	0.51	1.10	1.63
100-yr (1%)	17.50	5.66	5.53	0.13	174.00	0.48	1.08	1.62
50-yr (2%)	17.95	5.55	5.40	0.15	151.00	0.37	1.02	1.66
20-yr (5%)	18.53	5.40	5.22	0.18	129.00	0.25	0.93	1.71
10-yr (10%)	17.91	5.27	5.11	0.16	115.00	0.17	0.75	1.66
5yr (20%)	17.30	5.16	4.85	0.31	107.00	0.07	0.52	1.60
2yr (50%)	12.19	4.55	4.32	0.23	NA	Not Overtopped	Not Overtopped	1.13


Photo 1 -Structure Details and inlet structure


Photo 2 - Downstream End

Creek: Perrin Creek
Location: Under Wynnum Rail line

Immunity Rating (S1): >1% AEP / >100yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2014
AMTD (m): PK_2452
STRUCTURE DESCRIPTION: Box Culverts
STRUCTURE SIZE: 8 x 1.8m x 1.8m RCBC
For Culverts: Number of cells/pipes & s For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 2.04
U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 2.04
D/S OBVERT LEVEL (m)
For culverts give floor level
For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 15
LENGTH OF CULVERT AT OBVERT (m): 15
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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):

HEIGHT OF GUARDRAIL/HANDRAIL: N/A

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

PLAN NUMBER: N/A
BRIDGE OR CULVERT DETAILS: Site visit photographs used to estimate structure dimensions.
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Under Wynnum Rail line

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	61.23	6.06	5.75	0.31	NA	Not Overtopped	Not Overtopped	2.36
500-yr (-0.2%)	50.46	5.67	5.43	0.24	NA	Not Overtopped	Not Overtopped	1.95
200-yr (0.5%)	44.77	5.51	5.29	0.22	NA	Not Overtopped	Not Overtopped	1.73
100-yr (1%)	43.57	5.47	5.26	0.21	NA	Not Overtopped	Not Overtopped	1.68
50-yr (2%)	39.15	5.33	5.14	0.19	NA	Not Overtopped	Not Overtopped	1.51
20-yr (5%)	35.60	5.14	5.03	0.11	NA	Not Overtopped	Not Overtopped	1.37
10-yr (10%)	34.92	5.11	4.82	0.29	NA	Not Overtopped	Not Overtopped	1.35
5yr (20%)	34.53	4.77	4.66	0.11	NA	Not Overtopped	Not Overtopped	1.33
2yr (50%)	28.69	4.17	4.06	0.11	NA	Not Overtopped	Not Overtopped	1.11


Photo 1 -Inlet Structure


Photo 2 - Looking at rail culvert inlet from Rossiter Road


Photo 3 - Culvert outlet structure

Creek: Perrin Creek
Location: Colmslie Shopping Cntr

Immunity Rating (S1):	>50% AEP
	>2yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2015: AMTD (m): PK2434
STRUCTURE DESCRIPTION: Stormwater drainage pipe
STRUCTURE SIZE: 2 x 3.9m x 1.65m RCBC4 x 1.8
For Culverts: Number of cells/pipes & siz For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 2.04 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 1.1 D/S OBVERT LEVEL (m)
For culverts give floor level For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 290
LENGTH OF CULVERT AT OBVERT (m): 290
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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): 290 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):

HEIGHT OF GUARDRAIL/HANDRAIL: N/A

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

PLAN NUMBER: W3583
BRIDGE OR CULVERT DETAILS: Dimensions changes along pipe network and modelled as closed cross se
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Colmslie Shopping Cntr

ARI (AEP %)	DISCHARGE (m3/s)[1]	U/S Water Level[2]	D/S Water Level[2]	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4]	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	36.79	5.76	4.49	1.27	139.00	0.78	2.52	3.03
500-yr (-0.2%)	38.05	5.42	4.17	1.25	108.00	0.47	2.45	3.13
200-yr (0.5%)	38.20	5.28	4.05	1.23	108.00	0.37	2.33	3.14
100-yr (1%)	37.86	5.24	3.99	1.25	104.00	0.35	2.28	3.11
50-yr (2%)	37.05	5.12	3.89	1.23	102.00	0.29	2.13	3.05
20-yr (5%)	60.40	5.03	3.73	1.30	97.00	0.22	1.85	5.11
10-yr (10%)	35.37	4.77	3.56	1.21	92.00	0.16	1.53	2.91
5yr (20%)	33.87	4.59	3.47	1.12	84.00	0.10	1.18	2.78
2yr (50%)	28.84	3.92	3.10	0.82	NA	Not Overtopped	Not Overtopped	2.45


Photo 1 -Inlet Structure


Photo 2 - Outlet Structure (Right bank culverts)


Photo 3 - Outlet Structure (Left bank culverts)

Creek: Perrin Creek
Location: Barringa St

Immunity Rating (S1): >50% AEP / >2yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2016
AMTD (m): PK_2100
STRUCTURE DESCRIPTION: RCP's
STRUCTURE SIZE: 6 x 1.65m RCP
For Culverts: Number of cells/pipes & : For Bridges: Number of Spans and their lengths
U/S INVERT LEVEL (m) 0.81
U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 0.76
D/S OBVERT LEVEL (m)
For culverts give floor level
For bridges give bed level
For culverts:
LENGTH OF CULVERT AT INVERT (m): 19.5
LENGTH OF CULVERT AT OBVERT (m): 19.5
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)
IS THERE A SURVEYED WEIR PROFILE?
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): 19.5
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):
HEIGHT OF GUARDRAIL/HANDRAIL: 0.8

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

PLAN NUMBER: W3560
BRIDGE OR CULVERT DETAILS: Vegetated natural channel at inlet and outlet structure.
Wingwall/Headwall details e.g. Pipe flush 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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Barringa St

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	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	32.54	4.49	4.22	0.27	240.00	1.16	1.37	2.54
500-yr (-0.2%)	33.99	4.17	3.80	0.37	215.00	0.83	1.36	2.65
200-yr (0.5%)	34.01	4.04	3.65	0.39	210.00	0.72	1.32	2.65
100-yr (1%)	33.81	3.97	3.55	0.42	205.00	0.66	1.31	2.64
50-yr (2%)	34.12	3.86	3.42	0.44	195.00	0.55	1.25	2.66
20-yr (5%)	33.93	3.69	3.21	0.48	175.00	0.39	1.09	2.64
10-yr (10%)	34.01	3.52	3.00	0.52	150.00	0.22	0.93	2.65
5yr (20%)	33.72	3.47	2.86	0.61	120.00	0.15	0.95	2.63
2yr (50%)	30.18	3.09	2.67	0.42	NA	NA	NA	2.35


Photo 1 -Inlet Structure


Photo 2 - Outlet Structure (heavy vegetation)


Photo 3 - Looking at downstream channel from structure

Creek:	Perrin Creek	**Immunity Rating (S1):**	>20% AEP
Location:	Lytton Rd Bridge		>5yr ARI

DATE OF SURVEY: UBD REF:

SURVEYED CROSS SECTION ID: BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2019 AMTD (m): PK_940

STRUCTURE DESCRIPTION: Bridge -Modelled as culvert

STRUCTURE SIZE: 3 spans

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

U/S INVERT LEVEL (m) -0.6 U/S OBVERT LEVEL (m) 2.13

D/S INVERT LEVEL (m) -0.6 D/S OBVERT LEVEL (m) 2.13

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 11

LENGTH OF CULVERT AT OBVERT (m): 11

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 11 PIER WIDTH (m): 0.4m

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

LOWEST POINT OF WEIR (m AHD):

HEIGHT OF GUARDRAIL/HANDRAIL: 1.18

DESCRIPTION OF HAND AND GUARD RAILS

AND HEIGHTS TO TOP AND UNDERISDE OF GUARD RAILS:

PLAN NUMBER: W11233

BRIDGE OR CULVERT DETAILS: 3 span concrete bridge with low elevated bridge deck

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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek: Perrin Creek

Location: Lytton Rd Bridge

ARI (AEP %)	DISCHARGE $(m3/s)^1$	U/S Water $Level^2$	D/S Water $Level^2$	AFFLUX (m)	APPROX. FLOW WIDTH ACROSS	APPROX. FLOW DEPTH ABOVE STRUCTURE $(m)^3$	PEAK VELOCITY $(m/s)^4$	
		(m AHD)					Weir	Structure
2000-yr (0.05%)	48.83	3.80	3.76	0.04	400.00	1.23	0.98	0.91
500-yr (-0.2%)	77.24	3.34	3.26	0.08	368.00	0.75	0.89	1.43
200-yr (0.5%)	78.51	3.17	3.09	0.08	349.00	0.58	0.84	1.46
100-yr (1%)	76.32	3.06	2.94	0.12	335.00	0.47	0.84	1.42
50-yr (2%)	76.86	2.94	2.79	0.15	282.00	0.38	0.78	1.43
20-yr (5%)	64.77	2.77	2.54	0.23	163.00	0.27	0.65	1.20
10-yr (10%)	63.65	2.61	2.38	0.23	50.00	0.19	0.42	1.25
5yr (20%)	39.92	2.43	2.31	0.12	NA	Not Overtopped	Not Overtopped	0.74
2yr (50%)	30.69	2.20	2.10	0.10	NA	Not Overtopped	Not Overtopped	0.57

Photo 1 -Underneath Bridge Deck

Photo 2 - Looking parallel to upstream pipe crossing

Photo 3 - Looking from downstream

Creek: Eastern Branch
Location: Barrack Rd

Immunity Rating (S1): >50% AEP / >2yr ARI

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2022
AMTD (m): EB_1400
STRUCTURE DESCRIPTION: Box culverts
STRUCTURE SIZE: 4 x 2.4m x 1.2m RCBC
For Culverts: Number of cells/pipes & s For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 2
D/S INVERT LEVEL (m) 1.97
U/S OBVERT LEVEL (m)
D/S OBVERT LEVEL (m)
For culverts give floor level — For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 14.6
LENGTH OF CULVERT AT OBVERT (m): 14.6
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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): 14.6
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):
HEIGHT OF GUARDRAIL/HANDRAIL: 0.72

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

PLAN NUMBER: W3779
BRIDGE OR CULVERT DETAILS: Weir pool located at upstream of inlet 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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Barrack Rd

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	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	9.20	4.39	4.34	0.05	131.00	0.70	1.12	0.80
500-yr (-0.2%)	11.23	4.16	4.10	0.06	113.00	0.48	1.06	0.98
200-yr (0.5%)	15.47	4.12	4.06	0.06	112.00	0.44	0.96	1.37
100-yr (1%)	12.43	4.11	4.04	0.07	107.00	0.43	0.94	1.22
50-yr (2%)	10.22	4.07	4.00	0.07	97.00	0.40	0.88	1.23
20-yr (5%)	11.17	4.03	3.96	0.07	88.00	0.37	0.81	1.14
10-yr (10%)	10.40	3.98	3.90	0.08	88.00	0.33	0.72	1.00
5yr (20%)	10.90	3.94	3.86	0.08	86.00	0.30	0.63	1.14
2yr (50%)	9.98	3.85	3.77	0.08	71.00	0.23	0.38	1.01


Photo 1 -Structure Detail (Looking from upstream)


Photo 2 - Upstream weir pool


Photo 3 - Downstream narrow channel

Creek: Eastern Branch		**Immunity Rating (S1):**	>50% AEP
Location: Ivy St			>2yr ARI

DATE OF SURVEY: | UBD REF:

SURVEYED CROSS SECTION ID: | BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2023 | AMTD (m): EB_1290

STRUCTURE DESCRIPTION: Circular culverts

STRUCTURE SIZE: 2 x 0.6m RCP

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

U/S INVERT LEVEL (m) 2 | U/S OBVERT LEVEL (m)

D/S INVERT LEVEL (m) 1.95 | D/S OBVERT LEVEL (m)

For culverts give floor level | For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 8

LENGTH OF CULVERT AT OBVERT (m): 8

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 7 | 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):

HEIGHT OF GUARDRAIL/HANDRAIL: 0.7

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

PLAN NUMBER: W3779

BRIDGE OR CULVERT DETAILS: Low-flow weir located at downstream of the outlet 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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek: Perrin Creek

Location: Ivy St

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	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	1.35	4.20	4.20	0.00	213.00	1.00	1.13	2.38
500-yr (-0.2%)	1.41	3.75	3.74	0.01	196.00	0.55	1.66	2.49
200-yr (0.5%)	1.39	3.67	3.63	0.04	182.00	0.44	1.56	2.46
100-yr (1%)	1.40	3.66	3.56	0.10	177.00	0.38	1.55	2.48
50-yr (2%)	1.40	3.63	3.46	0.17	172.00	0.36	1.49	2.47
20-yr (5%)	1.39	3.60	3.28	0.32	161.00	0.34	1.44	2.45
10-yr (10%)	1.36	3.57	3.20	0.37	99.00	0.32	1.34	2.41
5yr (20%)	1.33	3.54	3.13	0.41	79.00	0.30	1.24	2.35
2yr (50%)	1.34	3.48	3.02	0.46	64.00	0.26	0.99	2.37

Photo 2 - -Structure Detail (inlet blockage)

Photo 1 -Structure Detail (outlet)

Photo 3 - Downstream weir pool

Creek:	Eastern Branch	**Immunity Rating (S1):**	>5% AEP
Location:	Junction Rd		>20yr ARI

DATE OF SURVEY: | UBD REF:
SURVEYED CROSS SECTION ID: | BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2025: AMTD (m): 0
STRUCTURE DESCRIPTION: Circular culvert
STRUCTURE SIZE: 6 x 1.5m RCP
For Culverts: Number of cells/pipes & siz For Bridges: Number of Spans and their lengths
U/S INVERT LEVEL (m) 0.52 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 0.49 D/S OBVERT LEVEL (m)
For culverts give floor level For bridges give bed level
For culverts:
LENGTH OF CULVERT AT INVERT (m): 26.8
LENGTH OF CULVERT AT OBVERT (m): 26.8
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)
IS THERE A SURVEYED WEIR PROFILE?
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): 20 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):
HEIGHT OF GUARDRAIL/HANDRAIL: 0.66

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

PLAN NUMBER: W6211
BRIDGE OR CULVERT DETAILS: Culvert has downstream weir pool. Prone to debris blockage
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: Junction Rd

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	20.38	4.08	3.94	0.14	305.00	0.66	1.60	1.92
500-yr (-0.2%)	21.88	3.67	3.48	0.19	209.00	0.30	1.23	2.06
200-yr (0.5%)	21.15	3.57	3.32	0.25	198.00	0.23	1.01	1.99
100-yr (1%)	21.29	3.50	3.20	0.30	171.00	0.19	0.92	2.01
50-yr (2%)	19.97	3.41	3.09	0.32	135.00	0.12	0.65	1.88
20-yr (5%)	17.66	3.22	2.92	0.30	NA	Not Overtopped	Not Overtopped	1.67
10-yr (10%)	16.21	3.03	2.77	0.26	NA	Not Overtopped	Not Overtopped	1.53
5yr (20%)	14.96	2.89	2.66	0.23	NA	Not Overtopped	Not Overtopped	1.41
2yr (50%)	11.33	2.67	2.48	0.19	NA	Not Overtopped	Not Overtopped	1.07


Photo 1 -Culvert inlet structure -sedimentation and water clogging


Photo 2 - Upstream Channel


Photo 3 - Downstream channel (Weir pool/Local blockage downstream of culvert outlet)

Creek: South West Branch
Location: End of Beelarong St, Morningside

Immunity Rating (S1): N/A | N/A

DATE OF SURVEY:
UBD REF:
SURVEYED CROSS SECTION ID:
BCC ASSET ID [Gecko]:
MODEL ID: Perrin_Creek_v17_May2028
AMTD (m): SWB_180
STRUCTURE DESCRIPTION: Footbridge modelled in 1D
STRUCTURE SIZE: N/A
For Culverts: Number of cells/pipes & s For Bridges: Number of Spans and their lengths

U/S INVERT LEVEL (m) 1.44 U/S OBVERT LEVEL (m)
D/S INVERT LEVEL (m) 0.32 D/S OBVERT LEVEL (m)
For culverts give floor level For bridges give bed level

For culverts:
LENGTH OF CULVERT AT INVERT (m): 1.87
LENGTH OF CULVERT AT OBVERT (m): 1.87
TYPE OF LINING:
(e.g. concrete, stone, brick, corrugated iron)

IS THERE A SURVEYED WEIR PROFILE?
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): 2 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):
HEIGHT OF GUARDRAIL/HANDRAIL: 0.9

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

PLAN NUMBER: 5882-1
BRIDGE OR CULVERT DETAILS: Yes - Footbridge will be included in 1D network.
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:

HAS THE STRUCTURE BEEN UPGRADED?
If, yes, explain type and date of upgrade. Include plan number and location if applicable.

ADDITIONAL COMMENTS:

Creek: Perrin Creek
Location: End of Beelarong St, Morningside

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	APPROX. FLOW DEPTH ABOVE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	5.29	3.88	3.86	0.16				0.97
500-yr (-0.2%)	10.57	3.40	3.39	0.15				1.45
200-yr (0.5%)	9.50	3.24	3.22	0.14				1.41
100-yr (1%)	10.26	3.11	3.10	0.13				1.80
50-yr (2%)	9.74	3.00	2.98	0.12				1.80
20-yr (5%)	9.31	2.84	2.83	0.11				1.78
10-yr (10%)	8.66	2.67	2.66	0.09				1.82
5yr (20%)	8.25	2.53	2.51	0.07				1.79
2yr (50%)	8.00	2.30	2.28	0.05				1.80


Photo 1 -Low flow pipe (0.6m Dia.) from Basin 1A and rail culvert discharging to TStorage1


Photo 2 - General channel characteristics at bridge site

Creek:	Northern Branch	**Immunity Rating (S1):**	>5% AEP
Location:	Lytton Rd Culvert		>20yr ARI

DATE OF SURVEY: | UBD REF:

SURVEYED CROSS SECTION ID: | BCC ASSET ID [Gecko]:

MODEL ID: Perrin_Creek_v17_May2030: AMTD (m): NB_255

STRUCTURE DESCRIPTION: Circular culvert

STRUCTURE SIZE: 4x1.35m RCP

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

U/S INVERT LEVEL (m) 0.53 U/S OBVERT LEVEL (m)

D/S INVERT LEVEL (m) 0.5 D/S OBVERT LEVEL (m)

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT AT INVERT (m): 17.1

LENGTH OF CULVERT AT OBVERT (m): 17.1

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?

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): 17.1 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):

HEIGHT OF GUARDRAIL/HANDRAIL: 0.7

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

PLAN NUMBER: W2985

BRIDGE OR CULVERT DETAILS: Reinforce concrete pipe culvert

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:

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Creek:	Perrin Creek
Location:	Lytton Rd Culvert

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	APPROX. FLOW DEPTH ABOVE STRUCTURE	PEAK VELOCITY (m/s)[4] Weir	PEAK VELOCITY (m/s)[4] Structure
2000-yr (0.05%)	5.00	3.88	3.88	0.00	431.00	0.96	0.71	0.85
500-yr (-0.2%)	14.12	3.42	3.42	0.00	328.00	0.49	0.33	2.39
200-yr (0.5%)	13.52	3.26	3.26	0.00	95.00	0.34	0.24	2.29
100-yr (1%)	14.24	3.16	3.15	0.01	42.00	0.23	0.19	2.41
50-yr (2%)	13.59	3.06	3.03	0.03	NA	0.05	0.01	2.30
20-yr (5%)	12.78	2.91	2.89	0.02	NA	Not Overtopped	Not Overtopped	2.16
10-yr (10%)	11.59	2.76	2.74	0.02	NA	Not Overtopped	Not Overtopped	1.96
5yr (20%)	10.87	2.64	2.63	0.01	NA	Not Overtopped	Not Overtopped	1.84
2yr (50%)	8.14	2.41	2.40	0.01	NA	Not Overtopped	Not Overtopped	1.38

Photo 1 -Structure Inlet detail (Blockage potential)

Photo 2 - Looking upstream from road embankment -heavy vegetation

Photo 3 - Culvert outlet -heavy vegetation

Appendix H – Model Peer Review and Response

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5 February 2016

Review of Perrin Creek hydrologic model and results

Dear Hanieh,

We have reviewed the Perrin Creek hydrologic model developed by Council, and present our review findings in this letter report. Our review has focused on whether the hydrologic model uses standard design parameters, represents typical urban catchment conditions, meets industry standards, and is generally fit for purpose.

Once all items identified in the review have been addressed, a final report will be signed by an RPEQ certified engineer. The hydrologic model will then be able to be used for the joint hydrologic/hydraulic model calibration and validation, and for the design and sensitivity analysis runs.

The following table summarises items checked during the review process. It lists the issues identified in the review, and either requests clarification from Council or makes a recommendation for potential changes or refinements.

Topic	Item/Reference	Description	Recommendations	Brisbane City Council Comments
1: XP-Rafts Model Setup	Catchment setup	There is a discrepancy between the total catchment area modelled (972Ha) and determined from the GIS shapefile (855Ha). The number of catchments (53) in “Perrin_Catchments_v2_Revised_region.shp” file is different to the number modelled (56).	Resolve the discrepancy, and update the model or GIS layer, and reporting, as appropriate	This has been fixed. Total catchment area is 855Ha and the number of subcatchments is 53.
2.XP-Rafts	Catchment	Catchment nodes	Add text to the reporting explaining	Part of this old Perrin Creek channel still carries some

Topic	Item/Reference	Description	Recommendations	Brisbane City Council Comments
Model Setup	setup	FF1 and GG1.	the reason for adding catchment nodes FF1 and GG1 to the model.	runoff in the catchment and overflow from Riverside channel. It needs to be included into the 2D hydraulic model.
3.XP-Rafts Model Setup	Catchment roughness	Uniform but separate roughness values used for pervious and impervious catchments.	We recommend applying weighted average catchment roughness values based on land use types. This will allow changes to catchment roughness values to be calculated in a systematic way, when land use types change in the ultimate land development case.	Use as it is.
4.XP-Rafts Model Setup	Catchment perviousness	Council has made catchment perviousness estimates using BCC land use maps and QUDM recommended percentage perviousness values for each land use category.. Catchments were split in the XP-Rafts model to represent perviousness	XP software recommends a split catchment approach as being more suited for urban catchments It is recommend that landuse maps and perviousness calculations are included in the final hydrology report.	Landuse maps and impervious values will be included in the final report.
5: Model Input Parameters	Catchment storage	Global storage coefficient of 1.5 used in the model.	We expect to modify this parameter during joint calibration, and its value is expected to be in the range of 1.0 to 2.0.	Accepted
6: XP-Rafts Model Setup	Rainfall losses	An initial loss of 15mm is used in the model. The hydrology report	We will modify initial and continuing losses during model calibration.	OK – BCC has not modified any initial/continuing losses since the previous flood study. Selection of appropriate loss parameters

Topic	Item/Reference	Description	Recommendations	Brisbane City Council Comments
		states that a continuing loss approach has been used in the model. However the model has actually been set up using a proportional loss (i.e. a value proportional to rainfall magnitude). The proportional value used in the model is 0.2.	Application of a proportional losses approach for continuing losses is not common, and used mainly in well-gauged catchments where continuous recording of rainfall and discharge measurements are available. We prefer applying absolute continuing loss values (mm/hr) representing median continuing loss values for ungauged catchments such as these.	are part of the calibration process.
7: XP-Rafts Model Setup	Rainfall losses	The same initial and continuing loss values were used for pervious and impervious catchments.	Standard practice is to apply small or no rainfall losses to impervious catchments. We will apply separate rainfall loss values for pervious and impervious catchments in the model calibration.	Accepted
8.XP-Rafts Model Setup	Observed data interval and model running time step	Observed data interval and model running time steps of 5 minutes are the same.	This is recommended and no further action required.	Accepted
9 Model Input Parameters	Flood routing - lag time calculation	Routing of the channel links is done using the Muskingum-Cunge methodology. This is considered a standard industry technique for this type of application. The hydrology report states that cross sections, slope and	We will revisit flood routing during the joint model calibration phase, and adjust model parameters to calibrate flood peak timing.	Accepted

Topic	Item/Reference	Description	Recommendations	Brisbane City Council Comments
		roughness values used in the model were reviewed and modified to represent current conditions.		
10: Model Input Parameters	Flood routing	Flood peak travel time	Did you make any checks to validate the flood peak travel time?	No. That is to be undertaken during calibration process.
11 Model Input Parameters	Flood routing –lateral inflow rainfall losses	Model uses same lateral rainfall losses for natural and engineered creek sections.	We will adjust those losses to reflect channel bed material during model calibration, where there is evidence of significant lateral loss values.	Accepted
12 Model setups	May 2015 event	Council provided a May 2015 event with global database of design storms up to 1% AEP and HydSys storms of May 2009, Jan 2013 and May 2015 events	Council expects DHI to setup calibration runs to May 2009 and the Jan 2013 event. Jan 2015 event requires setting up rainfall HydSys file and Thiessen assignments. DHI could setup design models utilising global design storms and calibrated model parameters up to 1% AEP.	OK – DHI to check global database of design storm values.
13 Design Model Parameters	Aerial Reduction Factors (ARF)	There are no references in the report or rainfall estimates explaining how ARF have been applied.	We won't apply ARF to design rainfalls up to 1% AEP unless Council advises that this is preferred. The Perrin Creek catchment area is less than 10km^2 and application of ARF factors has little benefit for design runs up to 1% AEP.	Accepted
14. Extreme event	Design rainfalls	Comparison of design rainfalls	We recommend comparing design	BCC use ARR design rainfall up to the 1% AEP

Topic	Item/Reference	Description	Recommendations	Brisbane City Council Comments
rainfall estimates	intensities and ARF	between AR&R and CRC Forge and application of ARF	rainfalls derived using AR&R and CRC Forge and applying ARF for extreme event rainfall intensities.	event. The CRC-Forge method is used to derive rainfall inputs for the 0.5%, 0.2%, 0.05% AEP events. However, the ARR 1% AEP intensities and CRC-Forge 1% AEP intensities will be compared to check the validity of use and adjustments made if necessary. BCC will provide rainfall intensities to DHI.
15 Modelling approach	AR&R Update	Perrin Creek hydrology model was setup using AR&R 87 recommendations and design parameters.	Council has indicated in meetings that it prefers that AR&R 1987 is applied for this project, but that outputs will be assessed against the revised AR&R guildelines at a later date. We agree that the hydrology should be reviewed in future once the new guildelines have been finalised. The new AR&R update has been partially released but has not yet been finalised. Design flow estimation techniques and design storm intensity estimations are likely to differ with the new release.	Accepted
16.Hydrology Reporting	Presentation –Maps, tables and graphs	Current hydrology modelling reporting does not include figures showing catchment extent or model schematisation and naming.	Figures showing catchment extent and model schematics with catchment labels should be added into the hydrology section of the report.	Figures are available and will be added to the hydrology report.

Overall the XP-Rafts hydrologic model has been developed to industry accepted standards. As identified in the table, a number of parameters currently in the model will be changed as part of the joint model calibration process, prior to the model being used for flood estimation. The table also identifies several recommended changes or amendments to draft hydrology model reporting, which will enhance help to fully document modelling assumptions and the model setup.

Best regards

DHI

X

Nilantha Karunarathna
Senior Engineer

Cc: *Hanieh Zolfaghari*

BRISBANE CITY

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Brisbane City Council

MEMORANDUM

To:	**Scott Beard** Project Manager, Natural Environment Water and Sustainability Branch	Date : **10/06/2016**
CC:	**Hanieh Zolfaghari** Flood Engineer – Flood Management Team	
From:	**Chandra Gunaratne** Senior Flood Engineer – Flood Management Team	
Re:	**Perrin Creek Flood Study-Peer Review of Hydraulic Model Development, Calibration and Design Event Modelling**	

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1. Introduction

Brisbane City Council (BCC) recently commissioned DHI Water & Environment Pty Ltd (DHI) to undertake the Perrin Creek hydraulic model development and corresponding Flood Study documentation in accordance with the Flood Study Procedure V7.1. Hydrologic model (XP-RAFTS) development for the catchment was carried out by the BCC Flood Management Unit in late 2015.

The Flood Study delivery procedure requires peer review of the model development, its output and supporting documentation. The aim of this review is to ensure that the flood study was undertaken according to Council's guidelines and current standards enabling future adoption of the flood study results. It also assists to identify if the flood models and study documentation are delivered in accordance with appropriate quality systems.

Peer review was undertaken at two stages of the study as listed below:

- Stage-1: Hydraulic Model development and calibration stage with relevant documentation
- Stage-2: At the completion of design event modelling, mapping and draft reporting.

BCC Flood Management Unit undertook the Perrin Creek Flood Study peer review process.

2. Hydraulic Modelling

DHI was appointed to develop a 1D/2D MIKE FLOOD model (Release 14-SP3) for Perrin Creek in early 2016 using the most up to date geographic information, planning documents and recorded flood information available for the catchment. Flood Management supplied the new hydrology model developed for the Perrin Creek catchment with recorded rainfall events and design flood information for 50, 20, 10, 5, 2, 1, 0.5, 0.2 ,0.05 %AEPs and PMF events so that inflow data for the hydraulic model could be obtained.

3. Hydraulic Model - Peer Review

Flood Management Unit carried out the peer review on the Draft calibration report and modelling in March 2016 and Design and Extreme Event Modelling and documentation (draft) in May 2016.

3.1 Stage-1: Model Development and Calibration

The following documents and models were provided for review at Stage-1:

- Calibrated and verified hydraulic model including model files and some results files
- Draft report on model calibration
- HECRAS models used for structure head loss verification
- Flood inundation depth maps

Findings of the model review were documented in CA16/279704 - "FLM-Perrin Creek Flood Study –BCC Review on Model Calibration" and are attached.

DHI has developed a 1D/2D MIKE FLOOD model for the whole Perrin Creek catchment. Creek branches in the upper part of the catchment were modelled as 1D/2D while the lower part of the catchment from Baringa Street to the confluence with Bulimba Creek was modelled as fully 2D. A 3m grid was used for the 2D MIKE21 model and contains 1242 cells (j) in X axis direction and 1697 cells (k) in Y axis direction with zero grid rotation.

Creek crossings were modelled as 1D structure with 2D weirs, with the exception of two foot bridges, which were represented in MIKE11 bridge module. Small network branches were used to introduce each structure in the MIKE11 network file with relevant cross sections.

The following details of the modelling were checked at **Stage-1** review:

3.1.1 MIKE FLOOD model development

MIKE21 Model

- **Validity of the Bathymetry grid used in the model** – The selection of 3m grid for the catchment is considered appropriate based on the catchment size and channel width. The bathymetry data was compared to surveyed cross section levels and ALS data of 2014. Most of the sections compared reasonably well. Identified discrepancies were reported to DHI with Stage-1 comments for correction. Attention was placed on the channel immediately upstream and downstream of each structure, where purely 2D modelling was applied. In these areas, levels from the bathymetry were checked against invert levels from each structure. The comments reported during the Stage-1 review were rectified prior to the design event modelling stage.

- **Inflow data and boundary conditions used and their input locations** - There were 17 source points used to apply inflows to the MIKE21 model starting from Baringa Street. The inflow data was checked with reference to the sub-catchment layout and hydrology model: XP-RAFTS nodes and results, and found to be correct. Exact grid inflow locations and the use of single or multiple cells in distributing flows to the 2D domain were not checked in detail. It is expected that DHI internal QA process would ensure this to be correct.

- **Model resistance used for different land use types** - Manning's M values were used to represent the different land uses within the catchment. The resistance file used represents the roughness of the catchment reasonably well. Values were in the range used by BCC in other flood studies with similar conditions.

- **Eddy viscosity data files:** A velocity based eddy viscosity of $1m^2/s$ has been applied globally within the model. This value is within the MIKE software guidelines recommended figures for a grid between 1 to 10m. At the 1D/2D coupled cells Eddy viscosity is adjusted to 5 m^2/s to enhance model stability, which is acceptable.
- **Flooding and drying depths:** A flooding depth of 0.05m and a drying depth of 0.02m were applied. These values are below the upper limits specified in the MIKE FLOOD guidelines and considered acceptable.
- **Time step and Courant number:** The MIKE21 model time step is set to 0.2 seconds and results saved at every 5 minutes (1500 time step). MIKE software guidelines recommend that a Courant number of less than 1 is to be maintained. With the grid size of 3m and a time step of 0.2 seconds a Courant number of 0.72 is achieved and is within the recommended figures.

MIKE11 Model

Perrin Creek Main channel up to Lang Street and five of its tributaries are modelled as 1D/2D. There are short (9 - 56 m) network branches included in MIKE11 model and coupled in MIKE FLOOD to model 15 structure crossings (culverts and bridges) in the MIKE11. In addition, two long branches have been introduced to model the boxed and piped section underneath the Colmslie shopping centre to the north of Wynnum Road and Junction Road, respectively.

- The network file was assessed for its branch length, structure locations and structure sizes. All the structures were modelled as 1D with a 2D weir with the exception of two structures, which were represented using the 1D bridge module.
- Cross section information used in modelling was based on information provided by BCC. The model incorporated existing cross sectional data with newly surveyed information. The cross section file was checked for its geometry, consistency and included roughness values. Actions had been taken to correct findings from the Stage-1 review.
- Inflows to the MIKE11 model are introduced at 27 locations. Random checks were conducted on inflow files to determine if the output from the XP-RAFTS model has been correctly incorporated into the boundary file in MIKE11. No errors were apparent.
- The HD file was checked for consistencies. The Delta value of 0.7 was used and which is acceptable for MIKE FLOOD applications with small time step (0.2 seconds used). A Global roughness value of 0.033 was used with different roughness values applied for structures modelled as closed sections. A Manning's n value of 0.013 is used for culverts and is appropriate. For the cross sections appropriate Manning's n value is included within the cross section file and appeared acceptable.

Comments noted during the Stage-1 review phase were found to be rectified during the design event review phase.

MIKE FLOOD Couple

MIKE11 model network branches are coupled to corresponding MIKE21 model grid cells within the MIKE FLOOD Couple using standard and lateral links. Standard links are defined with a momentum factor of 1 and a smoothing factor of 0.2 and are considered appropriate.

Model performance was checked with respect to the mass balance, negative depth warnings and instabilities. There were a few anomalies in the model results, which were reported during the initial review stage. However the anomalies do not cause impact on the estimated flood levels.

3.1.2 MIKE FLOOD model calibration and verification

There are no continuous stream height gauges in the Perrin Creek catchment only Maximum Height Gauges (MHG). Model calibration was undertaken using the readings of MHGs available for the first 3 rainfall events listed below while model verification was undertaken with the January 2015 event.

- May 2009
- January 2013
- May 2015
- January 2015

The downstream boundary was taken from the Port of Brisbane Corporation gauge at Sugar Berth except for the May 2009 event which was estimated from recorded and predicted data from Brisbane Bar gauge.

Comparison of recorded MHG readings with modelled flood level results undertaken in the calibration process is within acceptable tolerances.

Consistency checking between hydrology and hydraulic models were undertaken by comparing the discharge hydrographs at selected locations. These graphs show good consistency at most of the locations. When it comes to the areas with flood plain storage some discrepancy is noticed as storage was not incorporated within the XP-RAFTS model.

3.1.3 Outcome of Stage-1 Review

Review of the MIKE FLOOD, MIKE21 and MIKE11 models was conducted and the items in questions were found to be rectified. Therefore the Perrin Creek MIKE FLOOD model built by DHI is considered to meet acceptable industry standards and can be used to assess the flooding characteristics of the Perrin Creek catchment in combination with the XP-RAFTS hydrology model.

3.2 Stage-2: Review of Design events, Extreme events, Climate variability and Blockages modelling and Draft report

DHI used the MIKE FLOOD model developed to run the design, extreme, climate variability and structure blockages scenarios.

DHI submitted design event modelling results and the draft flood study report together with Flood inundation maps to the Flood Management Unit for review in May 2016.

Modelled design flood events include 50, 20, 10, 5, 2, 1% AEP (2, 5, 10, 20, 50 and 100 year ARI) events. Extreme events modelled covers the 0.5, 0.2, 0.05 %AEP (200, 500, 2000 year ARI) and PMF events. Climate Variability modelling was undertaken for 1, 0.5 and 0.2% AEP with 2050 and 2100 planning horizon. Blockages included 7 structures modelled under 10 different scenarios including 5 partially blocked simulations and 5 fully blocked simulations. Blockages scenarios were conducted according to QUDM.

Flood Management reviewed the MIKEFLOOD model input files, flood inundation maps and Draft Flood Study Report and submitted comments to DHI in May 2016. Only minor corrections were identified for the draft and inundation mapping.

Comments regarding the design, extreme, climate variability and blockages scenario event modelling are as follows:

- Adopted tail water levels (MHWS, HAT etc.) for modelling scenarios and Climate Variability were checked. Values used were compared to the tide book levels and are acceptable.
- The modelled flood corridor is the envelope of the waterway corridor and the shared boundary between Flood Planning Area 3 (FPA3) and Area 4 (FPA4). The modelled flood corridor was created by BCC and provided to DHI.
- Randomly selected files were checked for the blockage scenario. Structure size and invert levels seem to correspond to blockages scenario details specified in QUDM.
- A few checks were conducted on the MIKE11 results (.res11 files), which were found to be relatively stable. Lytton Road showed to have some discharge fluctuations (eg. 1% AEP120min); however there seem to be no adverse impact on flood levels.
- The combined 1D/2D flood level results showed anomalies, especially at few 1D/2D coupling locations. To avoid the anomalies, DHI suggested that the 2D only flood levels be used as the final flood level surface. Assessment of the 1% AEP (peak of peak) flood level surface (2D only) was conducted and no major anomalies observed.
- The grid used to model the 0.5% AEP (200yr ARI) and 0.2% AEP (500yr ARI) events was checked. BCC uses waterRIDE to stretch the grid and add the 300mm required. DHI used a different strategy by roughly estimating the extent that the 1% AEP (100yr ARI) +300mm would reach. A comparison was conducted and the grid created showed to be reasonable and acceptable.

3.3 HEC-RAS Modelling Report on Structure Loss Comparison

Separate report was provided to report the comparison of affluxes for seven structures modelled in MIKE FFLOOD model. Affluxes of these structures were also estimated by developing HEC-RAS models and running with the four recorded storm events used for model calibration and verification and compared with that of the MIKE FLOOD.

A detailed check of the HEC-RAS modelling was not undertaken. Review was based mainly on the results and comments provided in the "Perrin Creek Flood Study – Structure Loss Comparison Report". Reported affluxes between MIKE FLOOD and HE-CRAS models appeared reasonable.

4. Recommendation/Conclusion

Hydrology and hydraulic models have been developed using currently available information for the Perrin Creek catchment. The flood modelling undertaken as part of the Perrin Creek Flood Study complies with the current industry accepted practice and fit for the purpose.

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Senior Flood Engineer
Flood Management Unit
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BCC.

Appendix I – Model Handover Information

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The project model setups, inputs and outputs are structured into subfolders in the model archive:

- Final Report
- HEC-RAS
- MF
- XP_RAFTS Historical
- XP-RAFTS Design

Model logs are included in the subfolders.

Final Report
This folder includes this report document, along with copies of the figures and other inputs.

HEC-RAS
The models used for the MIKE FLOOD – HEC-RAS hydraulic structure loss comparison are provided in this folder. The file HecRas Modelling Log.xlsx summarises the comparison runs.

A separate subfolder is provided for each hydraulic structure evaluated in the flood study. This folder includes the HEC-RAS model setup and results.

The subfolder MF Results used for comparison includes the calibration and validation run results used in the comparison.

The subfolder Results includes an Excel file comparing the HEC-RAS and MIKE FLOOD results.

MF
This folder contains all MIKE FLOOD model setups and simulation results. These are structured as follows:

- Blockage Scenarios
- Calibration&Validation
- Climate Change Scenarios
- Existing Scenarios
- Maximum Riparian Corridor Scenarios
- Ultimate Scenarios

The naming convention used is summarised in **Table J1**.

Table J1 Summary of MIKE FLOOD naming convention

Case	**MIKE FLOOD name**	**Name variables**
Blockage Scenarios	Perrin_Creek_v01_XXyr_YYmin_ZZZ	XX = ARI YY = Duration ZZZ = Hydraulic structure blocked

Case	MIKE FLOOD name	Name variables
Calibration&Validation	Perrin_Creek_vRR_Event	RR = calibration model version Event = Calibration or validation event
Climate Change Scenarios	Perrin_Creek_v01_XXyr_YYmin_CCZ_MRC_WC	XX = ARI YY = Duration Z = Climate change scenario 1 or 2
Existing Scenarios	Perrin_Creek_v01_XXyr_YYmin	XX = ARI YY = Duration
Maximum Riparian Corridor Scenarios	Perrin_Creek_v01_100yr_YYmin_MRC	YY = Duration
Ultimate Scenarios	Perrin_Creek_v01_XXyr_YYmin_MRC_WC	XX = ARI YY = Duration

XP_RAFTS Historical

This folder contains the hydrological model simulations of the calibration and validation events. It includes subfolders for each event which contain the XP-RAFTS setup files for that event. Subfolders also include Historical Data, Input data and Output results.

The folder also includes a log file PCFS_2015_RAFTS_ModelLog.xlsx that summarises the different model runs and their settings.

XP_RAFTS Design

This folder contains the hydrological model simulations of the design and extreme events. The contents are stored by event, with these labelled by AEP, Climate Change scenario (CC1 and CC2) and PMP.

Each folder contains XP-RAFTS files with names of the form Des_Perrin_XXyr_YYm, where XX is the ARI and YY is the storm duration.

Climate change models have either CC1 or CC2 appended depending on the scenario.