Nundah Creek Flood Study

Volume 1 of 2

Flood Study Report

Prepared by Brisbane City Council's, City Projects Office

June 2015

BRISBANE CITY

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

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Executive Summary

Introduction

Brisbane City Council (BCC) is in the process of updating all of its flood studies to reflect the current conditions of the catchment and best practice flood modelling techniques. The most recent flood study for the Nundah Creek catchment was undertaken in 2004 by Brisbane City Council's City Design group (now BCC City Projects Office).

The Nundah Creek catchment is located within the northern suburbs of the Brisbane City Council (BCC) local government area.

The total area of the catchment is approximately 35 km^2. The catchment comprises Downfall Creek (17.7 km^2), Zillman Waterholes (8.3 km^2) and Nundah Creek (9.0 km^2). The catchment is bounded by the Cabbage Tree Creek catchment (north / west), Kedron Brook catchment (south / west) and Nudgee Creek catchment (east), and outlets into Moreton Bay to the east.

The majority of the catchment is a mixture of residential and industrial urbanisation, with a designated conservation area downstream of the Shorncliffe Railway line to the outlet.

Project Objectives

The primary objectives of the project were as follows:

- Update the XP-RAFTS hydrologic model and develop a new TUFLOW hydraulic model to represent the current Nundah Creek catchment conditions using best practice flood modelling techniques;
- Adequately calibrate and verify the flood models to historical storm events to confirm that the models are suitable for the purposes of simulating design flood events.
- Estimate design and extreme flood magnitudes;
- Determine design flood levels for the full range of design and extreme events up to the Probable Maximum Flood (PMF);
- Quantify the impacts of Minimum Riparian Corridor (MRC) and filling / development outside the Modelled Flood Corridor;
- Produce flood extent mapping for the selected range of design and extreme events up to the 2000yr ARI event (as applicable); and,
- Quantify the impacts of climate variability on flooding within the catchment.

Project Elements

The flood study consists of two main components, as follows:

Calibration Modelling

Hydrologic and hydraulic models of the Nundah Creek Catchment have been developed using the XP-RAFTS and TUFLOW modelling software, respectively.

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

Calibration is the process of refining the model parameters to achieve a good agreement between the modelled results and the historical / observed data. Model calibration is achieved when the model simulates the historical event to within specified tolerances.

Calibration of the XP-RAFTS and TUFLOW models was undertaken utilising four historical storms; namely January 2013, October 2010, May 2009 and March 2001.

An acceptable correlation was achieved between the simulated and historical records for all four calibration events. At the Maximum Height Gauges (MHGs), the simulated peak levels were generally within the specified tolerance of ± 0.3 m.

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

Design and Extreme Event Modelling

The calibrated hydrologic and hydraulic models were then used to simulate a range of synthetic design flood events. Design and extreme flood magnitudes were estimated for the full range of events from 2yr ARI to PMF. These analyses assumed ultimate catchment hydrological conditions.

Three waterway scenarios were considered, as follows:

- Scenario 1 – Existing Waterway Conditions: Based on the current waterway and floodplain conditions. Some minor modifications were made to the TUFLOW model developed as part of the calibration phase to represent the latest catchment condition.

- Scenario 2 – Minimum Riparian Corridor (MRC): Includes an allowance for a riparian corridor along the edge of the channel.
- Scenario 3 – Ultimate Conditions: Includes an allowance for the minimum riparian corridor (as per Scenario 2) and also assumes development infill to the boundary of the Modelled Flood Corridor in order to simulate potential development. The Modelled Flood Corridor consists of the larger extent (envelope) of the Flood Planning Area (FPA) 3 boundary and the Waterway Corridor (WC).

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

- Peak flood discharges
- Critical storm durations at selected locations
- Peak flood levels at 100 m intervals along the AMTD line
- Peak flood extent mapping
- Hydraulic structure flood immunity

A sensitivity analysis was also undertaken to understand the impacts of climate variability for two planning horizons; namely 2050 and 2100.

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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. (see ARI/AEP conversion table)
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.
Brisbane Bar	Location at the mouth of the Brisbane River.
Catchment	The area of land draining through the main stream (as well as tributary streams) to a particular site. It always relates to an area above a specific location.
Digital Elevation Model (DEM)	A three-dimensional model of the ground surface elevation.
Design Event, Design Storm	A hypothetical flood/storm representing a specific likelihood of occurrence (for example the 100 year ARI).
Floodplain	Area of land subject to inundation by floods up to and including the Probable Maximum Flood (PMF) event
Flood Frequency Analysis (FFA)	Method of predicting flood flows at a particular location by fitting observed values at the location to a standard statistical distribution.
FPA3	Flood Planning Area 3
HEC-RAS	One-dimensional 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.
Hydstra	File-based time-series data management system
Manning's 'n'	The Gauckler–Manning coefficient, used to represent roughness in 1D/2D flow equations.
Maximum Height Gauge (MHG)	An instrument for measuring a peak water level of a water body at a specific location during a specified time period.
MIKE11	One-dimensional hydrodynamic modelling software package.
Minimum Riparian Corridor (MRC)	An area of (minimum) 15m width either side of the main flow channel, where future revegetation has been assumed for modelling purposes.
Modelled Flood Corridor	Planning Line - The Modelled Flood Corridor consists of the larger extent (envelope) of the Flood Planning Area (FPA) 3 boundary and the Waterway Corridor (WC).
Probable Maximum Flood (PMF)	An extreme flood 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.
Stream(flow) Gauge	An instrument for measuring the water level in a water body, with the ability to register the data in real time.
Thiessen Polygon method	A method of determining spatial rainfall distribution over a catchment
TUFLOW	Hydrodynamic modelling software package.
URBS	Hydrologic modelling software package.
Waterway Corridor (WC)	Planning line used to denote extent of a waterway.
XP-RAFTS	Hydrologic modelling software package.

ADOPTED ARI TO AEP CONVERSION

ARI (years)	Actual AEP (%)	Nominal AEP (%)
2	39	50
5	18	20
10	10	10
20	5	5
50	2	2
100	1	1
200	0.5	0.5
500	0.2	0.2
2000	0.05	0.05

1.0 Introduction

1.1 Catchment Overview

The Nundah Creek catchment is located within the northern suburbs of the Brisbane City Council (BCC) local government area.

The total area of the catchment is approximately 35 km^2. The catchment comprises Downfall Creek (17.7 km^2), Zillman Waterholes (8.3 km^2) and Nundah Creek (9.0 km^2). The catchment is bounded by the Cabbage Tree Creek catchment (north / west), Kedron Brook catchment (south / west) and Nudgee Creek catchment (east), and outlets into Moreton Bay to the east.

Figure 1.1 indicates the locality of the Nundah Creek catchment, and Figure 1.2 presents a general catchment layout.

The majority of the catchment is a mixture of residential and industrial urbanisation, with a designated conservation area downstream of the Shorncliffe Railway line to the outlet.

1.2 Study Background

The most recent flood study for the catchment was undertaken in 2004 by Brisbane City Council and WBM Oceanics Australia (now BMTWBM). This study is documented in the report titled *Nundah Creek Flood Study (Including Zillman Waterholes Flood Mitigation Options) (BCC, WBM Oceanics Australia, September 2004)*. This study only examined the main branches of Downfall Creek, Nundah Creek and Zillman Waterholes, and did not assess any tributaries along these main waterways.

A separate study of a section of Downfall Creek Tributary A was carried out in 2003. This study was undertaken to assess the impacts of a proposed bikeway for the 50yr and 100yr Average Recurrence Interval (ARI) events only.

Since the completion of these studies, numerous changes have occurred within the catchment, including catchment development, changes to the watercourse, and construction of new road crossings.

1.3 Study Objectives

The primary objectives for this study are as follows:

- To ensure Nundah Creek has been assessed using best practice modelling techniques;
- Update the Nundah Creek catchment hydrologic and hydraulic models (as required) to represent the current catchment conditions and best practice flood modelling techniques;

- Adequately calibrate and verify the models to historical storm events;
- Confirm that the hydrologic and hydraulic models are suitable to utilise for the purposes of design event modelling;
- Estimate design and extreme flood magnitudes;
- Determine design flood levels for the full range of design and extreme events up to the PMF;
- Quantify the impacts of Minimum Riparian Corridor (MRC) and filling the floodplain outside the Modelled Flood Corridor;
- Produce flood extent mapping for the selected range of design and extreme events up to the 2000yr ARI event; and,
- Quantify the impacts of climate variability on flooding within the catchment.

1.4 Report Scope and Limitations

As part of this study, the XP-RAFTS hydrologic model developed as part of the 2004 Nundah Creek Flood Study was revised and updated to reflect current conditions of the Nundah Creek catchment. The MIKE11 model developed as part of the 2004 study was used as the basis of a TUFLOW hydraulic model of the catchment developed for this study. The TUFLOW hydraulic model utilises a combination of one-dimensional and two-dimensional modelling.

The scope of work comprised two main stages:

- Stage 1 – Model Calibration; and,
- Stage 2 - Design and Extreme Event Modelling

Calibration was undertaken to four recorded historical storm events to ensure the model was sufficiently reliable and robust to utilise for design and extreme event modelling.

The calibration stage consisted of the following:

- Review and update the current XP-RAFTS hydrologic model of the catchment to include the March 2001, May 2009, October 2010 and January 2013 historical flood events;
- Develop a linked 1D / 2D TUFLOW model of the creek system to replace the existing 1D MIKE11 hydraulic model;
- Calibrate the TUFLOW model to the March 2001, May 2009, October 2010 and January 2013 historical flood events. Verify the XP-RAFTS model outputs against outputs from the TUFLOW model at key locations; and,

The verified hydrologic and calibrated hydraulic models were then used to determine anticipated flood profiles based on Australian Rainfall and Runoff (AR&R) rainfall patterns for the 2, 5, 10, 20, 50 and 100yr Average Recurrence Interval (ARI) events, along with extreme rainfall events including the 200yr ARI, 500yr ARI, 2000yr ARI and the Probable Maximum Flood (PMF). The hydraulic modelling includes consideration of the Minimum (Vegetated)

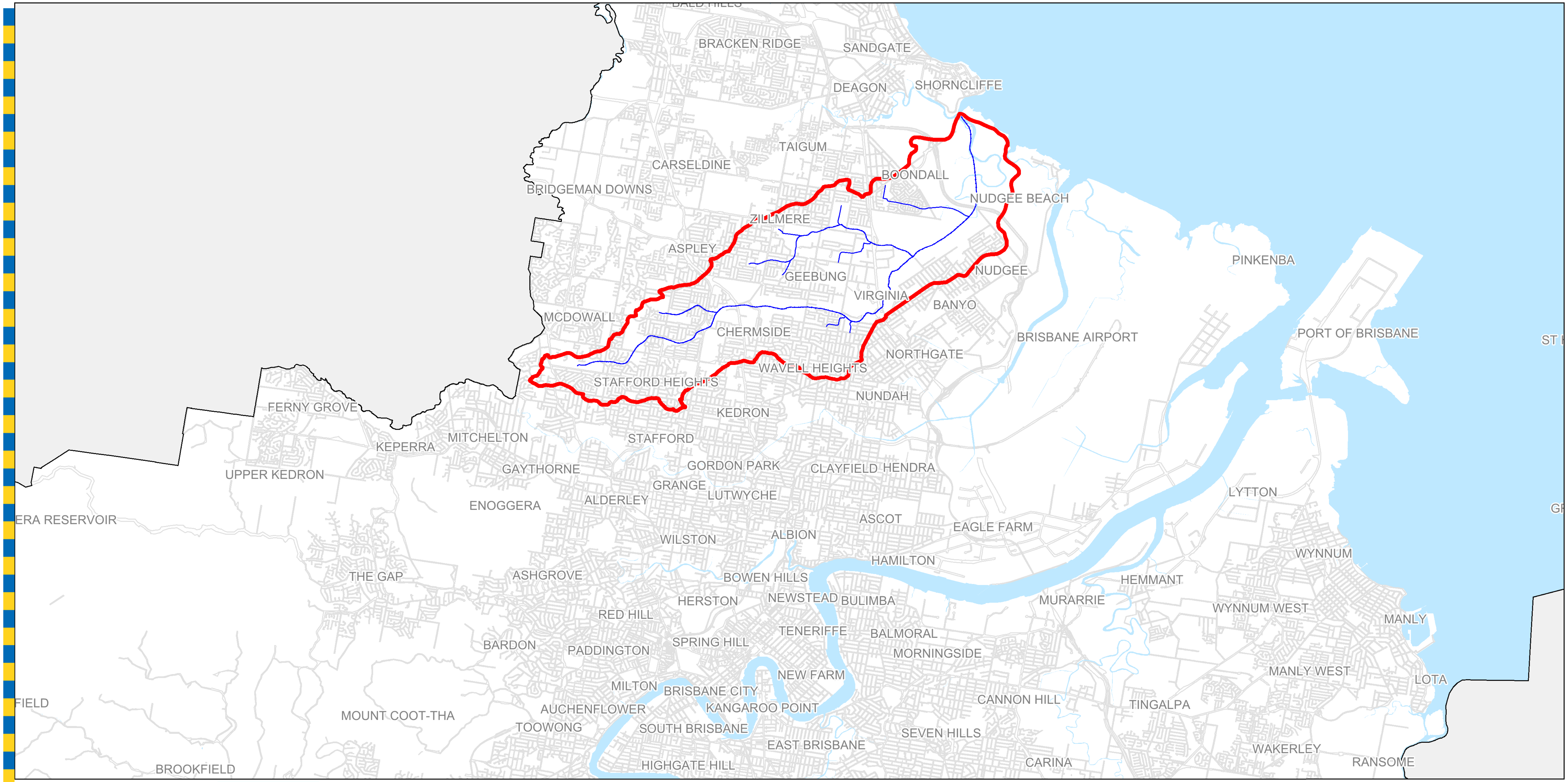
Riparian Corridor (MRC) and the Modelled Flood Corridor (a combination extent of the Waterway Corridor (WC) and Flood Planning Area (FPA) 3). The MRC is modelled in recognition that at some unspecified time in the future, revegetation may occur, either through natural regeneration or as a result of community planting programs. Similarly, the WC assumes that development and filling may occur up to the corridor boundary.

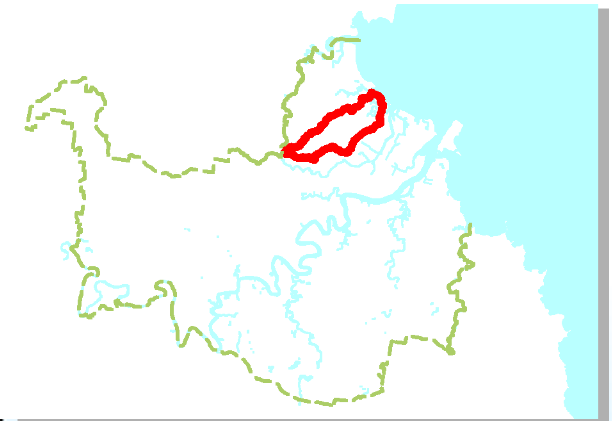
The design and extreme event modelling consisted of the following:

- Estimating design and extreme flood magnitudes for the full range of events from 2yr ARI to PMF;
- Simulating synthetic Australian Rainfall and Runoff (AR&R) design storms for multiple durations to determine the critical duration at various locations within the catchment;
- Utilising the verified XP-RAFTS and calibrated TUFLOW models to determine peak design flood levels for the full range of design and extreme events up to the PMF.
- Adjusting the model to simulate the impacts of MRC and filling outside the Modelled Flood Corridor;
- Combining the modelling results for the various storm durations to produce peak results throughout the catchment for each ARI;
- Producing peak flood extent mapping for the selected range of design and extreme events up to the 2000yr ARI event; and,
- Undertaking climate variability modelling for the 100yr, 200yr and 500yr ARI events to determine the impacts.

The limitations present in this study include the following:

- The accuracy of the calculated results is limited by the accuracy of the survey data used in the development of the hydrologic and hydraulic models;
- The calibration of the hydrologic and hydraulic models is limited by the accuracy and prevalence of the recorded historic stream gauge and MHG data, and the rating curves generated from the calibrated hydraulic model. This should be taken into account when considering the accuracy of results outside the influence of the gauge locations;
- These models are catchment scale and have been developed to simulate the flooding characteristics at a broad scale. As a result, smaller more localised flooding characteristics may not be apparent in the results;
- The XP-RAFTS and TUFLOW models must be used together to produce flooding results, as the XP-RAFTS model has not been developed as a "standalone" model; and,
- BCC 2009 ALS data has been used as the basis for the TUFLOW model topography, with some minor modifications undertaken in places, and more detailed survey used where available. Detailed checks have not been undertaken to determine the accuracy of the ALS data, and it is assumed that the data is representative of the topography and "fit for purpose."





Legend

- AMTD
- Catchment Boundary
- Street
- BCC Boundary

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Nundah Creek Flood Study 2014

Figure 1.1: Locality Plan

N W E S
1000 0 1000 2000
Metres

Prepared :MK
Checked :MK
Revision :0
Publication Date :June 2015
Project Number : 140591

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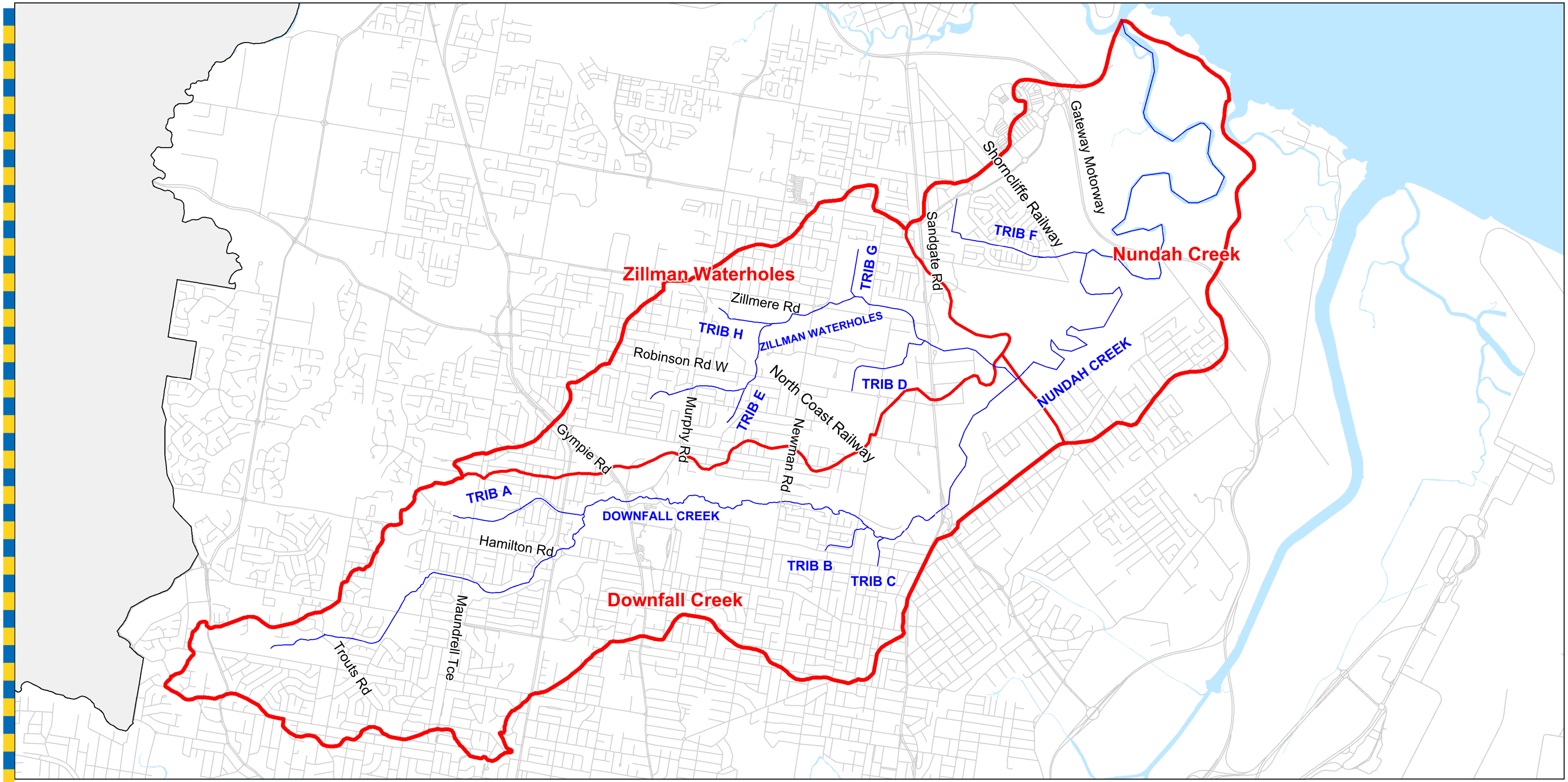

Legend

- BCC Boundary
- Cadastre
- Waterway Centreline
- Subcatchment Boundary

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Nundah Creek Flood Study 2014

N W E S

400 0 400 800

Metres

Prepared :MK
Checked :MK
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Figure 1.2: Catchment Layout

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2.0 Catchment Description

2.1 Catchment and Waterway Features and Characteristics

The Nundah Creek catchment hosts three main waterways and numerous major and minor tributaries, as shown in Figure 1.1. The main waterways of the catchment run west to east, and include Nundah Creek, Downfall Creek, and, Zillman Waterholes.

Downfall Creek traverses numerous suburbs including Everton Park, McDowall, Stafford Heights, Chermside, Chermside West, Geebung and Virginia, before joining Nundah Creek at the junction of Boondall and Banyo.

Zillman Waterholes originates in Aspley and drains the northern areas of the catchment from west to east, including Zillmere, Geebung and Boondall, before draining into Nundah Creek at the junction with Downfall Creek.

The Downfall Creek and Zillman Waterholes catchments are largely urbanised with some Conservation and Emerging Community areas (currently bushland).

Both of these creeks are steeper in their upper sections, and then flatten out with increasing floodplain areas in the lower sections. Both creeks (including their tributaries) have sections of concrete and grass-lined channels. Downfall Creek has approximately 1.1 kilometres of concrete lined channels situated in the upper reaches of the main branch, plus a 0.8km long low-flow concrete channel along Tributary A. Zillman Waterholes has around 0.5 kilometres of concrete lined channels situated in the upper reaches of the main branch and as part of Tributary D, which is located in an industrial zone. There are few sections which have not been modified from their natural condition in either creek. Hydraulic structures are frequent, primarily the many road crossings. Including roads, rail, footbridges and causeways the total number of hydraulic structures along the main braches of Downfall Creek and Zillman Waterholes is 31 and 15 respectively. Much of the floodplain of both of these creeks has either been filled and urbanised or used for public open space.

Nundah Creek begins at the junction of Downfall Creek and Zillman Waterholes and traverses the suburbs of Boondall, Banyo, Nudgee and Nudgee Beach, before discharging into Moreton Bay. The creek is largely tidal and supports mangrove and wetland swamps, of which some are located in the Boondall Wetlands Reserve. The creek has large areas of floodplain encompassing mangroves, wetlands, bushlands and cleared land. There is little urban or other development within these floodplains, the major exceptions being the Gateway Arterial and the Shorncliffe suburban railway line. Nundah Creek has 3 separate crossings; the Shorncliffe railway line, the Gateway Arterial and the footbridge downstream of the Gateway Arterial. Both the Shorncliffe railway line and the Gateway Arterial crossings contain several hydraulic structures along their lengths.

A minor tributary of Nundah Creek also exists in the north-west corner of the subcatchment. This grass-lined channel services a low-density residential area and includes one road crossing, before draining underneath the Shorncliffe railway line and into the main Nundah Creek branch.

Recent and near-future infrastructure development of note within the catchment in the vicinity of the waterway includes:

- Gateway Motorway Upgrade North - Nudgee to Bracken Ridge (TMR – Works to be completed from 2014-2018). Works are in the Nundah Creek subcatchment and include the widening of the Gateway Motorway with some drainage upgrades/modifications along this route;
- Robinson Road West road and crossing upgrade (BCC - Completed 2014). Works are located within Zillman Waterholes upstream of the North Coast railway line;
- Kittyhawk Drive bridge crossing and pedestrian crossing adjacent Chermside Shopping Centre (completed 2007). Works are within Downfall Creek just downstream of Gympie Rd. Natural channel design works has also been completed in the vicinity of these works around the same time; and,
- Viridian Retirement Village – 2141 Sandgate Rd, Boondall (completed 2012). Works included development and filling on the left bank of Zillman Waterholes immediately downstream of Sandgate Road.

2.2 Land Use

The upper reaches of the Downfall Creek and Zillman Waterholes subcatchments contain mainly low-density residential development, with some designated Conservation and Sport and Recreation areas, amongst other uses. The middle and lower reaches of the two subcatchments contain a more varied mix of land use. The main land uses in these areas include Low and Medium Density Residential, Sport and Recreation, Community, Education and Mixed Use, and Industrial zones, which are dominant mainly in the reaches downstream of the North Coast railway line.

Nundah Creek predominantly consists of Environmental Management and Conservation areas, particularly downstream of the Shorncliffe Railway line. Part of this area is designated as the Boondall Wetland Reserve. There are smaller portions of Low-Density Residential area mainly in the north-west and south-west of the catchment, as well as Nudgee College on the western catchment boundary.

2.3 Flood History

There are several continuous stream gauge, rainfall gauge, and Maximum Height Gauge's (MHG's) within the catchment, with a well-established history of flood records. The largest recorded flood event in recent times was the event which occurred in March 2001, which was approximately equivalent to a 20 to 100yr ARI rainfall event in parts of the catchment.

3.0 Available Information

3.1 Previous Studies

3.1.1 Summary

Two other studies have been undertaken previously within the Nundah Creek catchment. A summary of these studies is provided in Table 3.1.

Table 3.1 - Past studies of Nundah Creek and Tributaries

Title	Author	Date	Prepared for
Nundah/Downfall Creek Catchment Management Plan	Chenoweth and Associates	1996	BCC
Nundah Creek Flood Study	City Design and WM Oceanics Australia	2004	BCC

3.1.2 Nundah/Downfall Creek Catchment Management Plan, 1996

This report was prepared by Chenoweth and Associates for Brisbane City Council. The objectives of this study were to;

- Identify and rank the land and water management issues in the catchment
- Describe the guidelines, policies, and action plans recommended to address priority issues;
- Detail the responsibilities, means and implementation targets for achieving projected outcomes;
- Provide suitable mapping components that will support the plan and facilitate further GIS preparation; and,
- Be reflective of the views of the wider community with an interest and a stake in the future protection of the area.

A series of recommendations were also developed for riparian habitat rehabilitation/revegetation. Comparison of this plan with the revegetation plan produced in the Nundah Creek Flood Study (2004, BCC) revealed a number of differences.

3.1.3 Nundah Creek Flood Study, 2004

This flood study was developed by City Design and WBM Oceanics Australia (now BMT WBM). The final report detailed the assessment of the three main project elements, which are summarised as follows:

- Report A: Calibration Report – This report detailed the development and calibration of an XP-RAFTS hydrological model and MIKE11 1D hydraulic model of the main branches of Nundah Creek, Downfall Creek and Zillman Waterholes. The models were calibrated to the January 1992, February 1992, January 1994 and May 1996 events and verified to the January 1974 and March 1992 events;

- Report B: Design Events Report – This report detailed the peak flood levels and discharges obtained from the hydraulic model for the Ultimate Case scenario (Modelled Flood Corridor plus Minimum Riparian Corridor) for the 100, 50, 20, 10, 5 and 2 year ARI events and the Probable Maximum Flood (PMF) event. Inundation mapping was also produced for the 100yr ARI event; and,
- Report C: Zillman Waterholes Flood Mitigation Options Report: This report detailed the assessment of flood mitigation options along the Zillman Waterholes waterway. The report's recommended option for reducing flood levels upstream of Sandgate Road was to replace the northbound culvert beneath Sandgate Road with a bridge configuration of similar dimensions to the newer southbound lanes.

3.2 Topographic Survey Data

3.2.1 Aerial Photography

The following sources of aerial imagery taken during different points in time were available to be used in this study:

- BCC aerial photography – 1997, 1999, 2001, 2005, 2007, 2009, 2011, 2012 and 2013
- NearMap® aerial imagery – 2009 to 2014

3.2.2 Bathymetric/Field Survey

The following is a summary of the sourced survey information used in this study:

- BCC 2009 Airborne Laser Scanning (ALS) survey data was used as the basis of the two-dimensional model DEM. For the March 2001 calibration event, 2002 ALS data was also used in the development of the DEM;
- BCC 2014 ALS survey data (draft format - not adopted by Council at the time of the study) was used in the 2013 calibration event, and all design events, to represent the development at 2141 Sandgate Rd, Boondall, which was completed in 2012;
- Cross-sectional survey data undertaken between February and November 1996, covering the main branches of Downfall Creek, Zillman Waterholes and Nundah Creek;
- Cross-sectional survey data undertaken in 2013 for the purposes of this study. This survey covered parts of Downfall Creek (including Tributaries A and B), Zillman Waterholes (including Tributaries A, B and D), and Nundah Creek (including Tributary A);
- Detailed as-constructed survey of the Robinson Road upgrade works, including bikeway upstream of the works (2014); and,
- Gateway Motorway Upgrade North (GUN) Reference Design TIN (2011) – A design tin of the proposed upgrade of the Gateway Motorway provided by Transport and Main Roads (Qld Government). At the time of this study, this design is considered as a base design and may be subject to change.

3.2.3 Site Visits

Inspections of the catchment were carried out during March and October 2014, and during January and February 2015. The inspections provided information on structures, hydraulic roughness, ground levels and overland flow paths, and confirmed the overall proposed modelling schematisation.

3.3 Hydrometric Data and Analysis

3.3.1 Recorded Rainfall

Rainfall data was obtained from a number of continuous rainfall gauges located in or near the catchment for the following flood events;

- March 2001;
- May 2009;
- October 2010; and,
- January 2013.

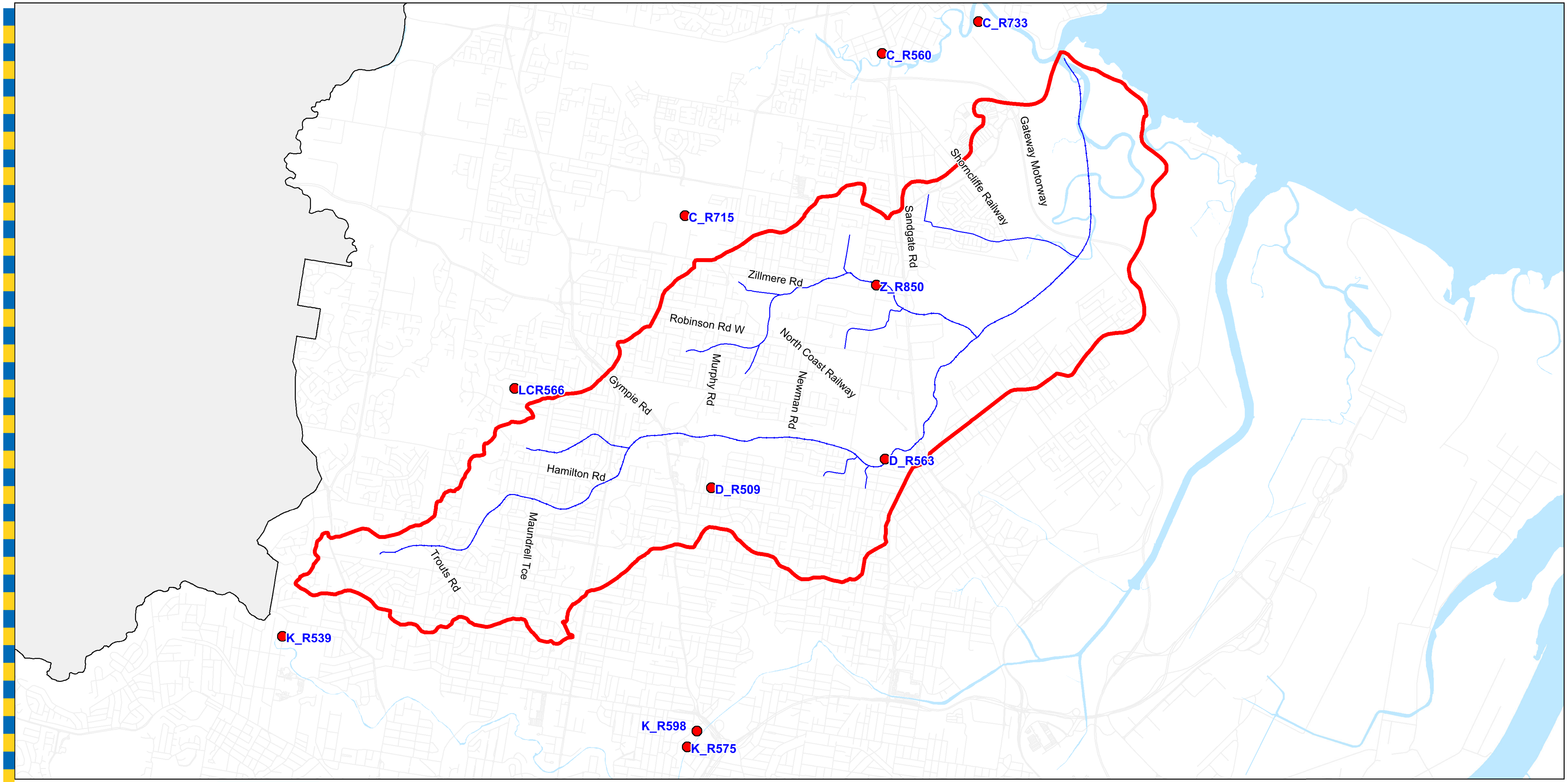
The continuous gauges are shown in Figure 3.1. Only three of the 13 gauges are located within the Nundah Creek catchment, with two located in Downfall Creek and one in Zillman Waterholes. The remaining gauges used in this study are located in the nearby Cabbage Tree Creek and Kedron Brook catchments.

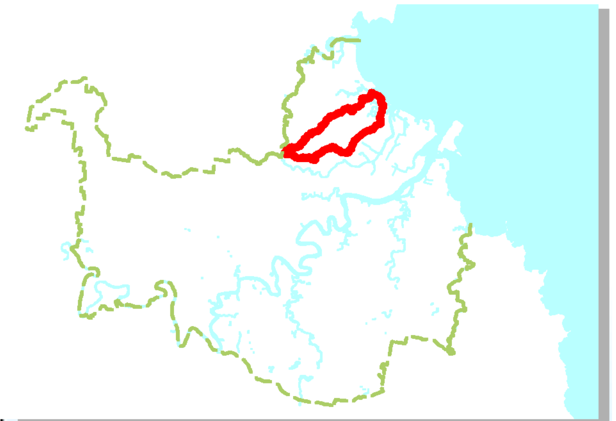
The available rainfall data used for the calibration of the hydrological and hydraulic models is summarised in Table 3.2.

The four calibration events chosen have received widespread recording coverage from gauges outside of the Nundah Creek catchment. Only one gauge within the catchment (D_R563) provides a record of rainfall for all four events.

Table 3.2 - Available and Adopted Rainfall Data

Gauge	Location	Operation Period	Calibration Events			
			March 2001	**May 2009**	**October 2010**	**January 2013**
D_R509	Chermside Pool, Hamilton Road	1994 - 2002	Y	Y	-	-
D_R563	End of Brickyard Rd, Geebung	1994 -	Y	Y	Y	Y
Z_R850	Frank Sleeman Park, Boondall	2009 -	-	Y	Y	Y
K_R539	Osborne Rd, Everton Park	1994 -	Y	Y	Y	Y
K_R542	Hayward St, Stafford	1994 - 2004	Y	-	-	-
K_R598	Suez St, Gordon Park	2000 - 2012	Y	Y	Y	-
C_R733	Sandgate State Primary School, Boondall	1997 - 2003	Y	-	-	-
C_R572	U/S Old Northern Rd, Everton Hills	1994 -	Y	Y	Y	Y
C_R715	Pineapple St, Carseldine	1994 - 2001	Y	-	-	-
C_R560	U/S of Braun St, Deagon	1994 -	Y	Y	Y	Y
LCR566	Aspley Reservoir, Aspley	1994 -	Y	Y	Y	Y
PDR844	Hendra Pony Club, D/S Nudgee Rd	2006 -	-	Y	Y	Y
K_R575	McCord St, Gordon Park	2012 -	-	-	-	Y





Legend

- Rainfall Gauge
- BCC Boundary
- Street
- AMTD
- Catchment Boundary

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Figure 3.1: Location of Continuous Rainfall Gauges

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3.3.2 Stream Gauge Data

Three continuous stream height gauges are located within the Nundah Creek catchment. Firstly, gauge D_A564 is located at the end of Brickyard Road, Geebung on Downfall Creek, and was installed in 1994. Secondly, gauge Z_A851 is located in Frank Sleeman Park, Boondall on Zillman Waterholes, and was installed in 2007. Thirdly, gauge D_A763 is located upstream of Trouts Road in Everton Park and was installed in August 2013. This gauge does not include any recorded data for the selected calibration events.

Data from these two gauges were sourced from Council maintained records to help identify calibration events for this study.

Both gauges were used for the calibration of the hydrologic and hydraulic models and the determination of rating curves.

Continuous height data from both gauges were available for the May 2009, October 2010 and January 2013 calibration events. For the March 2001 calibration event, data was only available for gauge D_A564, as the Z_A851 gauge was installed in 2007.

It should be noted that the readings from gauge Z_A851 during the May 2009 and October 2010 events were considered inconsistent/faulty, and have therefore not been used for calibration purposes.

The peak flood levels recorded for the calibration events are presented in Table 3.3.

Table 3.3 - Peak Water Levels at Continuous Gauges

Gauge	Location	Owner	Period of Operation	Calibration Events (m AHD)			
				March 2001	May 2009	October 2010	January 2013
D_A564	End of Brickyard Rd, Geebung (Downfall Creek)	BCC	1994 - onwards	8.52	7.89	7.84	7.86
D_A763	Upstream of Trouts Road, Everton Park(Downfall Creek)	BCC	2013 - onwards	-	-	-	-
Z_A851	Frank Sleeman Park, Boondall (Zillman Waterholes)	BCC	2007 - onwards	-	3.75*	3.71*	4.53

*Inconsistent/Faulty Reading

3.3.3 MHG Data

There are thirty four Maximum Height Gauge's (MHG's) within the Nundah Creek catchment for which records are available from 1992 onwards. Of those 34 gauges, 6 gauges are situated on Nundah Creek, 18 are on Downfall Creek and 10 are on Zillman Waterholes. As of the date of this study, 5 of those gauges have now closed, including 4 on Nundah Creek and 1 on Zillman Waterholes. Of the closed gauges, only the Zillman Waterholes gauge has recorded information from at least 1 of the chosen calibration events.

A description of the location of each of the MHG's as well as their assigned TUFLOW chainage is given in Table 3.4. Figure 3.2 illustrates the locations of the MHG's and stream gauges and Table 3.5 presents the peak flood levels recorded for the four calibration events.

It was also noted that;

- Gauges D140, D180 and D190 for the May 2009 event, and gauges D190 and D200 for the October 2010 event were debris level readings as the water level did not reach the minimum recording level at each of the gauges.
- No readings for gauges D208 and Z150 were recorded for the January 2013 event as both gauges were destroyed.

Table 3.4 - MHG Locations

Branch	Gauge Name	Approx. AMTD (m)	Location Description
Nundah Creek	N95	2608	D/S Gateway Motorway, Nudgee Beach
	N110	3650	U/S Shorncliffe Railway, Boondall (northern crossing near Tributary A)
	N120	3475	D/S Shorncliffe Railway, Nudgee
Downfall Creek	D100	5288	Virginia Golf Course, Banyo
	D110	6267	D/S Sandgate Rd, Virginia
	D120	6566	D/S North Coast Railway, Virginia
	D130	6721	U/S North Coast Railway, Virginia
	D140	7955	Between Newman Rd and Bilsen Rd, Geebung
	D150	8380	D/S Newman Rd, Wavell Heights
	D160	8436	U/S Newman Rd, Chermside
	D170	9220	Between Kittyhawk Dr and Newman Rd, Chermside
	D180	10017	D/S Gympie Rd, Chermside
	D190	10106	U/S Gympie Rd, Chermside
	D200	10539	Between Hamilton Rd roundabout and Gympie Rd, Chermside
	D208	11012	Downstream Hamilton Rd roundabout, Chermside
	D210	11103	Within Hamilton Rd roundabout, Chermside
	D212	11227	U/S Hamilton Rd roundabout, Chermside West
	D220	12085	D/S Maundrell Tce, Chermside
	D230	13198	U/S Rode Rd, Stafford Heights
	D235	13889	U/S Parton St, Stafford Heights
	D240	14156	U/S Trouts Rd, Everton Park
Zillman Waterholes	Z100	0	D/S side of Virginia Golf Course, Banyo
	Z110	874	D/S Sandgate Rd footbridge, Boondall
	Z120	988	D/S Sandgate Rd, Boondall
	Z130	1088	U/S Sandgate Rd, Boondall
	Z140	1382	U/S Zillmere Rd, Boondall
	Z150	1819	D/S Groth Rd, Boondall
	Z160	2295	D/S Zillmere Rd footbridge, Boondall
	Z170	2531	U/S Newman Rd, Zillmere
	Z180	4200	Between Murphy Rd and Robinson Rd, Geebung

Table 3.5 - Maximum Flood Height Recordings from MHG's

Branch	Gauge Name	Peak Flood Level (m AHD)			
		Event Date			
		March 2001	May 2009	October 2010	January 2013
Nundah Creek	N95	**Gauge not installed**	**Gauge not installed**	1.77	1.88
	N110	2.23	2.53	2.56	2.60
	N120	2.09	2.36	2.35	2.24
Downfall Creek	D100	4.61	4.64	4.53	4.55
	D110	5.39	5.30	5.29	5.70
	D120	7.14	6.59	6.61	6.60
	D130	7.70	**5.27^**	7.08	6.99
	D140	10.31	**9.26***	9.81	9.82
	D150	11.33	10.46	11.00	11.05
	D160	11.55	**---**	**---**	11.04
	D170	14.74	**---**	**---**	**---**
	D180	17.74	**16.53***	**---**	17.12
	D190	18.81	**16.28^**	**17.43***	**---**
	D200	19.89	**---**	**18.92***	19.45
	D208	**Gauge not installed**	21.32	21.52	**DEST**
	D210	22.16	21.46	21.74	21.65
	D212	**Gauge not installed**	22.12	22.26	22.34
	D220	27.29	**---**	**---**	26.65
	D230	32.17	**---**	**---**	31.41
	D235	**Gauge not installed**	**NA**	**---**	**---**
	D240	39.46	39.54	39.48	39.35
Zillman Waterholes	Z014	4.94	**Gauge Closed**		
	Z100	3.42	3.13	3.53	3.54
	Z110	3.92	4.05	4.31	4.10
	Z120	4.06	4.29	4.50	4.21
	Z130	4.23	4.39	4.55	4.28
	Z140	4.62	4.47	4.78	4.54
	Z150	4.67	4.53	4.88	**DEST**
	Z160	**Gauge not installed**	5.77	5.92	5.74
	Z170	6.77	6.66	7.15	6.58
	Z180	15.09	14.98	15.22	14.87

Key: **NA = No data available**
DEST = gauge destroyed – no level recorded
*** Level from nearby debris height**
--- Level did not reach bottom of inner gauge
^ Faulty reading

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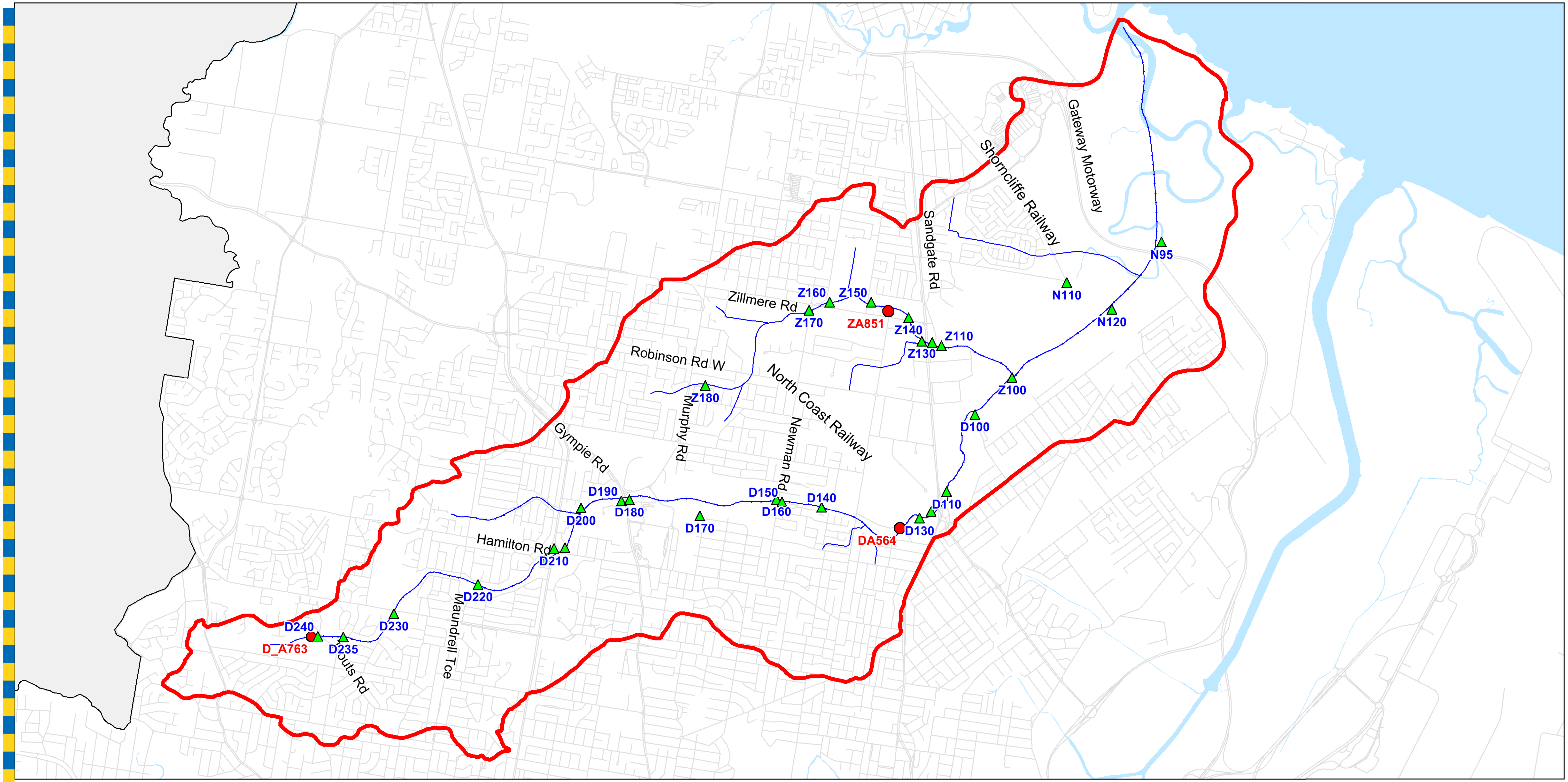

Legend

- Maximum Height Gauge
- Stream Gauge
- BCC Boundary
- Streets
- AMTD
- Catchment Boundary

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Figure 3.2: Location of Maximum Height and Stream Gauges

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3.3.4 Tidal Information

Tidal information recorded at the Brisbane Bar gauge was used for the calibration events.

A tidal level and time shift of 1 minute and -0.07m was applied to the tidal readings for each event to better replicate the tidal condition at the downstream boundary of Nundah Creek.

3.4 Hydraulic Structure Data

Structure information from the existing MIKE11 model developed as part of the Nundah Creek Flood Study (BCC, 2004) was used as the basis for the structure data in this study.

Design drawings and as-constructed plans were sourced for the significant hydraulic structures and channels within the catchment and compared against the MIKE11 data and revised where necessary.

Four site visits were also undertaken, whereby dimensions for several structures were obtained and verified against existing information, if available.

Structure information for all structures included in the TUFLOW model is summarised in the hydraulic structure reference sheets (HSRS) provided in Appendix E.

3.5 Selection of Calibration Events

Calibration events were selected by considering the relative size of the event and the availability of data for each event, with more recent events generally taking precedence. Events prior to 1996 were discarded as comprehensive survey data for the creek was collected during this year. Many topographic and developmental changes have also occurred within the catchment since this time.

The selected events are summarised below.

Calibration Events

- March 2001
- May 2009
- October 2010
- January 2013

Intensity-Frequency-Duration (IFD) charts for each calibration event are shown in Appendix B.

4.0 Hydrologic Model Development and Calibration

4.1 Overview

Hydrologic modelling of the runoff in the Nundah Creek catchment was carried out using XP-RAFTS (2009). XP-RAFTS is an urban and rural runoff routing model used to calculate flood hydrographs from rainfall, catchment and channel inputs.

The XP-RAFTS model for the Nundah Creek catchment was initially developed as part of the 1996 Nundah Creek Flood Study. For the 1996 study, the model was jointly calibrated with the hydraulic model for a number of historical events from January 1974 up until May 1996.

Preliminary assessment of the 1996 XP-RAFTS model indicated that the general subcatchment routing and layout would be suitable for use in this study, although with some modification required.

The changes made to the 1996 XP-RAFTS model to bring it up to date with current catchment conditions are summarised below:

- Revision of subcatchment delineation based on 2009 ALS data, up-to-date aerial imagery and drainage networks, and with consideration to TUFLOW hydraulic model proposed inflow locations;
- Revision of existing subcatchment land use based on 2001 to 2013 aerial imagery and Nearmap ® aerial imagery;
- Revision of link routing properties;
- Revision of storage node characteristics based on 2009 ALS data;
- The hydrology model was simulated using the latest version of XP-RAFTS (Version 2009);
- Verification of existing subcatchment slopes and revision where necessary;
- Using a one-subcatchment approach (combination of impervious and pervious subareas) for the purpose of a better calibration; and,
- Update of all subcatchment PERN values.

Once these modifications were made, the hydrology model was deemed fit-for-purpose for use in this study.

4.2 Model Set Up and Schematisation

Subcatchments are represented as nodes within XP-RAFTS to provide points within the model where total and localised flow hydrograph information can be extracted. For the hydrologic model, the Nundah Creek catchment was subdivided into 78 subcatchments. Of these 78 subcatchments, 47 are located in the Downfall Creek catchment, 24 in Zillman Waterholes, and 7 in Nundah Creek.

Catchment area, land use (impervious and pervious), slope and roughness (PERN) values were used to define the subcatchments. Figure 4.1 illustrates the model layout including subcatchment delineation. Dummy nodes were incorporated into the model to allow flow hydrographs to be derived for tributaries upstream of junctions.

The determination of land use throughout the catchment for the calibration scenario modelling was made with consideration to existing land use at the time of each event. Existing land use for each event was derived through the use of available aerial imagery in combination with the ultimate land use conditions as detailed within Brisbane City Council's CityPlan 2014.

Fraction impervious values adopted within the hydrology model for different land use types are summarised in Table 4.1. These values 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. The CityPlan land use type for the Existing and Calibration event scenarios are shown in Figure 4.2.

The hydrologic roughness parameter (PERN) is input as a Manning's 'n' representation of the average sub-catchment roughness. A value of n = 0.05 was used for all subcatchments.

The average catchment slope (based on the equal area method) for each subcatchment was derived from available topographic data, based on an analysis of typical flow paths in the catchment.

The drainage paths of the Nundah Creek catchment are represented in the XP-RAFTS model by a number of links, including channel routing links, lagging links and dummy lag links with zero lag time.

Creek cross sections are a requirement for, and were applied to, the routing links in the hydrologic model. The cross sections were sourced from ALS 2009 and ground survey along Downfall Creek, Zillman Waterholes and Nundah Creek. In each case, the cross section considered to be the most representative of the reach was input to the XP-RAFTS model.

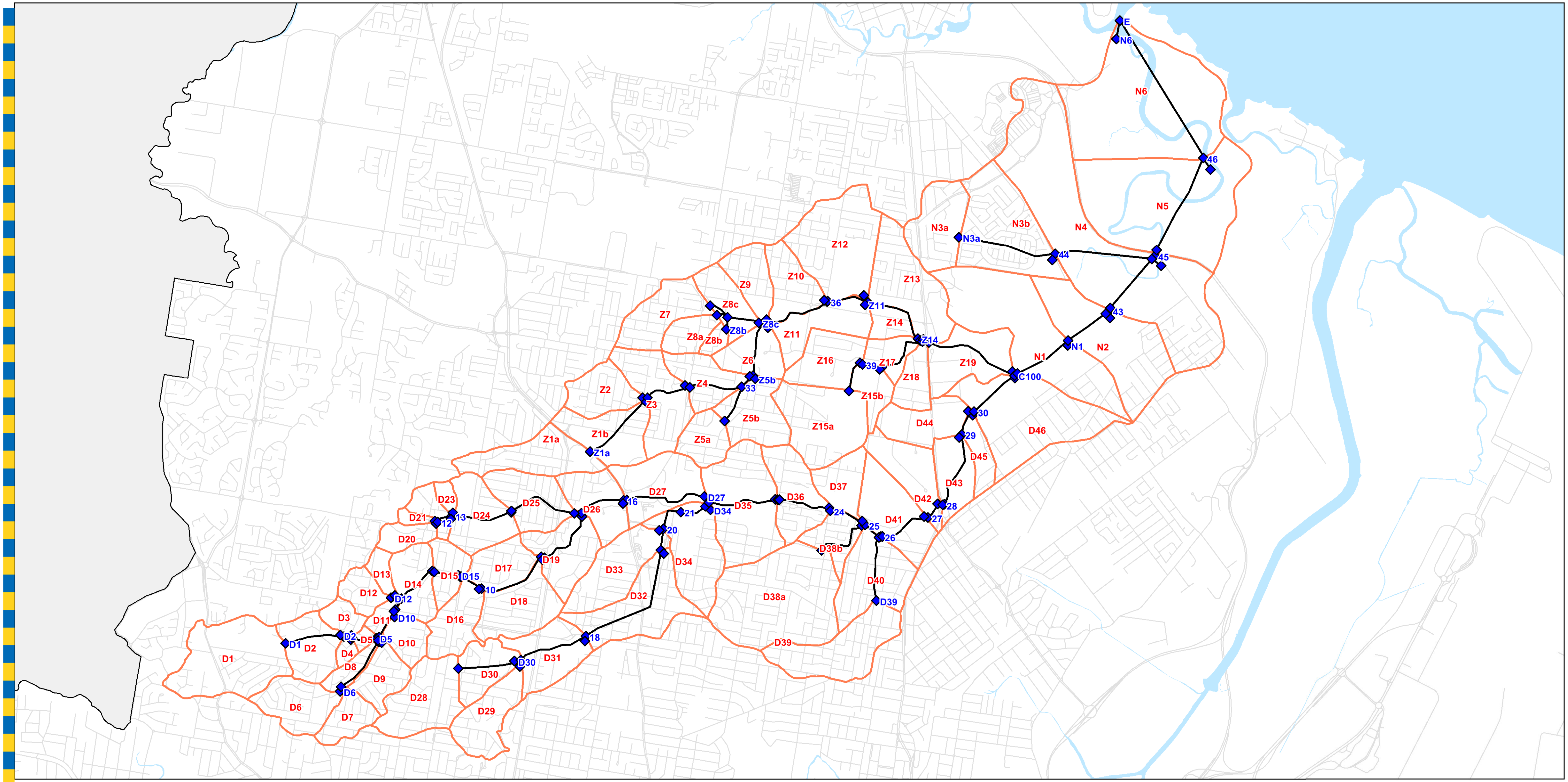
Manning's 'n' values for each cross section in the routing links were derived based on available aerial photography and were again selected to represent the average Manning's 'n' value along the channel within each subcatchment.

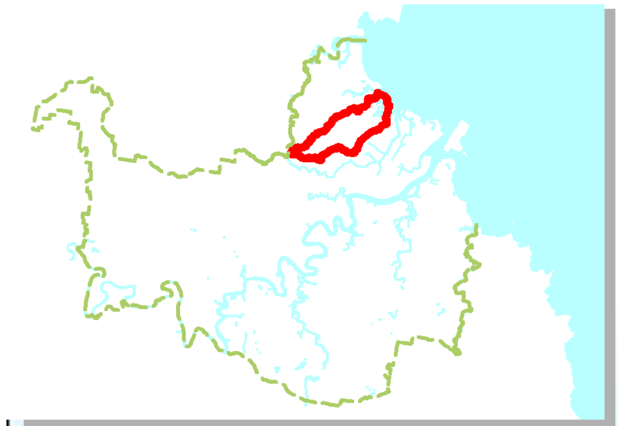
Two storage basins also exist in the 1996 XP-RAFTS model and were updated as part of this study. The basins simulate the detention of flood waters at the downstream end of the model within the Nundah Creek subcatchment. One basin is located upstream of the Shorncliffe Railway, whilst the second basin is located upstream of the Gateway Motorway. Level-storage relationships for the two basins were updated based on available ALS 2009 data, whilst the basin outlet dimensions and outflow information were revised based on structural drawings and the Nundah Creek Flood Study (1996) MIKE11 hydraulic model results.

The XP-RAFTS subcatchment parameters adopted in the calibration models are shown in Appendix C.

Table 4.1 - Land Use Fraction Impervious values

Land Use Type	Fraction Impervious
Community Use Area Cemetery	0.5
Community Use Area Community Facilities	0.7
Community Use Area Education Purposes	0.7
Community Use Area Emergency Services	0.7
Community Use Area Health Care Purposes	0.7
Community Use Area Railway	0.75
Community Use Area Utility Services	0.75
Conservation	0
Emerging Communities	0.7
Environmental Protection	0
Future Industry	0.9
General Industry	0.9
High Density Residential	0.9
Investigation Area	0.7
Light Industry	0.9
Low Density Residential	0.6
Low-Medium Density Residential	0.7
Medium Density Residential	0.8
Multi-Purpose Centre Convenience Centre	0.9
Multi-Purpose Centre Major Centre	0.9
Multi-Purpose Centre Suburban Centre	0.9
Park Land	0.05
Roads	0.9
Rural	0.2
Special Purpose Centre Entertainment Centre	0.8
Special Purpose Centre Major Hospital And Medical Facility	0.8
Special Purpose Centre Major Residential Institution	0.8
Special Purpose Centre Marina	0.8
Sport And Recreation	0.2





Legend

- RAFTS Node
- RAFTS Link
- RAFTS Subcatchment Boundary
- D1 RAFTS Node Name
- D1 RAFTS Subcatchment Name
- BCC Boundary
- Streets
- AMTD

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Figure 4.1: Hydrologic Model Layout

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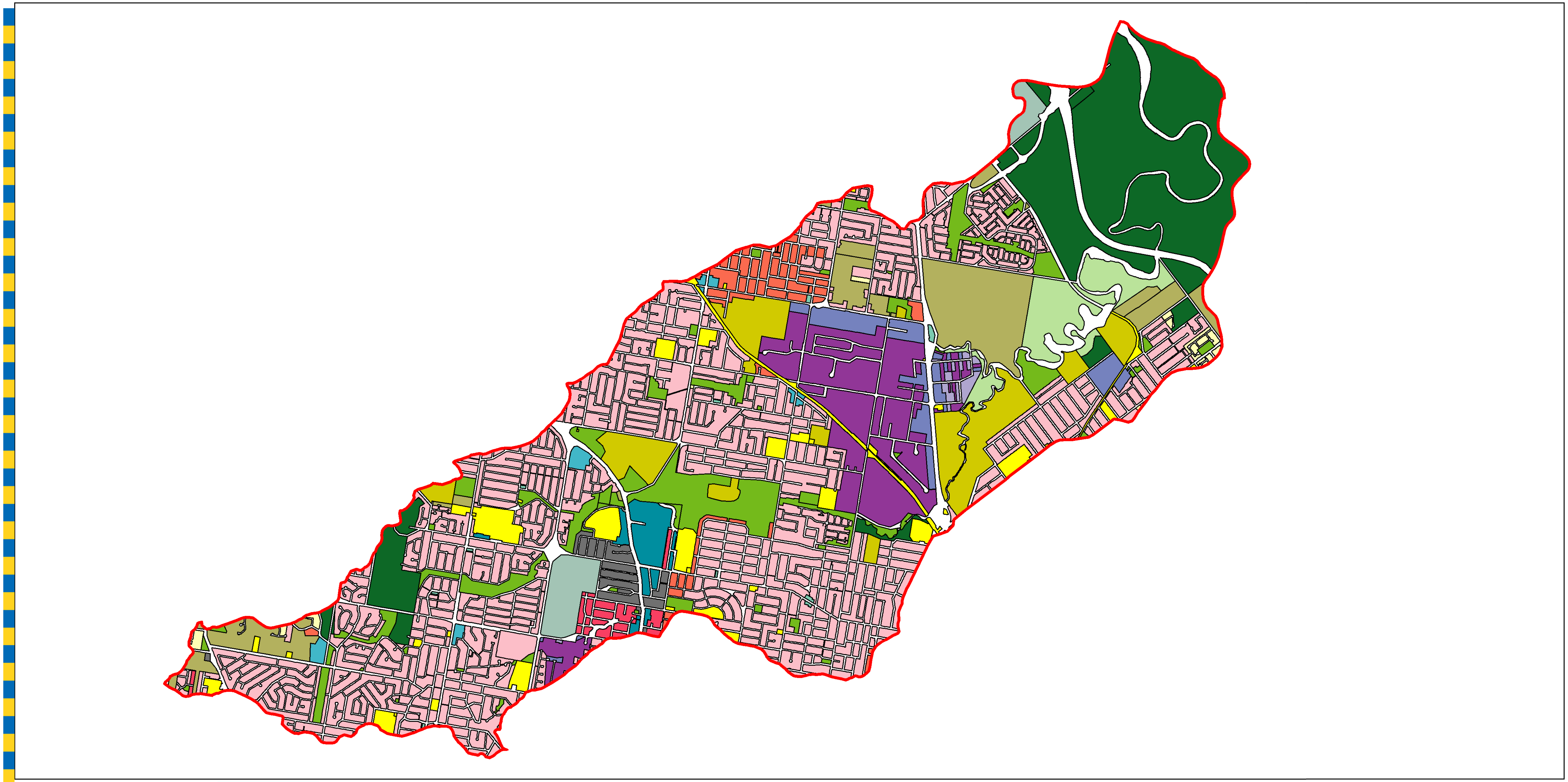

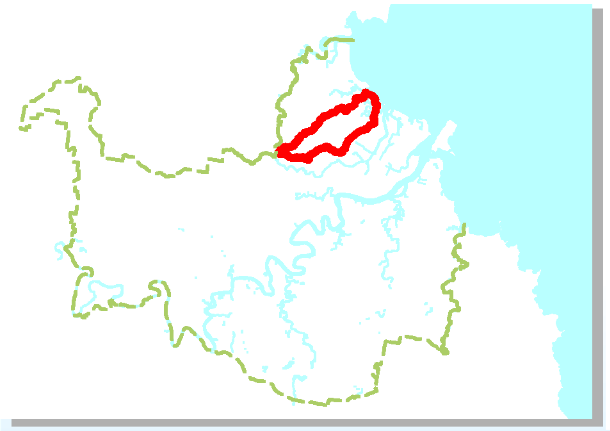

Legend

- Community Use Area
- Conservation
- Emerging Communities
- Environmental Protection
- Future Industry
- General Industry
- Light Industry
- Investigation Area
- Low Density Residential
- Low-Medium Density Resident
- Medium Density Residential
- High Density Residential
- Multi-Purpose Centre
- Special Purpose Centre
- Park Land
- Roads
- Rural
- Sport and Recreation

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Figure 4.2: Existing Scenario Catchment Land Use

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4.3 Calibration Procedure

Hydrologic model calibration was undertaken by comparing XP-RAFTS generated flows against TUFLOW generated flows and recorded event flows (calculated using rating curves developed from this study's hydraulic model) at the two stream gauges within the catchment. The results of the hydrologic calibration are discussed in Section 4.4.

The XP-RAFTS model parameter BX was varied to improve the match of modelled flows to recorded events at both gauges. The BX parameter is a multiplication factor for the B parameter, where B = storage delay time coefficient. A final BX factor of 0.7 was used for all calibration events.

Initial and continuous losses were adopted for each calibration event. These losses are summarised in Table 4.2.

Table 4.2 – Adopted XP-RAFTS Initial and Continuing Losses

Calibration Event	Initial Loss (mm)	Continuing Loss (mm/hr)
March 2001	40	0
May 2009	0	0
October 2010	0	0
January 2013	0	0

Due to antecedent rainfall over the catchment prior to the May 2009, October 2010 and January 2013 events, the adopted initial loss and continuous loss for these events were set to 0 mm and 0 mm/hr, respectively, to represent full catchment saturation. Refer to Section 5.4 for further information on the antecedent rainfall characteristics for each calibration event.

4.4 Hydrologic Model Calibration Results

For each calibration event, the XP-RAFTS hydrologic model was checked against the hydraulic model and historic data at the two stream gauges within the catchment.

The checks included a comparison of the discharge hydrographs from the hydrologic and hydraulic models at the stream gauges, against a historic event discharge hydrograph. The historic stream gauge water level data was converted to a discharge hydrograph via a Q-H rating curve that was developed from the hydraulic model results.

The comparison graphs are detailed in Sections 4.4.1 to 4.4.4. Also, peak discharge comparisons are shown in Table 4.3 and Table 4.4.

Generally, for all events, a very good match between the hydraulic model hydrographs and historic hydrographs is achieved. The historic hydrographs show a good correlation with the hydraulic model hydrographs for the rising limb and the peak. The peaks of the XP-RAFTS hydrographs for each calibration event are also generally in good agreement with the peaks from the hydraulic model and historic event hydrographs. An exception to this however, is at gauge Z_A851 for the January 2013 event; where there is up to a 29% difference in peak discharges between the hydrographs. This may be caused by a difference in the timing of the inflows contributing to the peak as evidenced in the double-peaked nature of the hydrograph in the hydrology result. By contrast, the hydraulic model produces a single peak.

Table 4.3 - Peak Discharge Comparison – D_A564 Gauge

Event	Peak Discharge (m^3/s)		
	XP-RAFTS	TUFLOW	Historic
March 2001	233	211	212
May 2009	135	134	150
October 2010	137	139	146
January 2013	151	151	148

Table 4.4 - Peak Discharge Comparison – Z_A851 Gauge

Event	Peak Discharge (m^3/s)		
	XP-RAFTS	TUFLOW	Historic
January 2013	56	72	69

4.4.1 March 2001 event

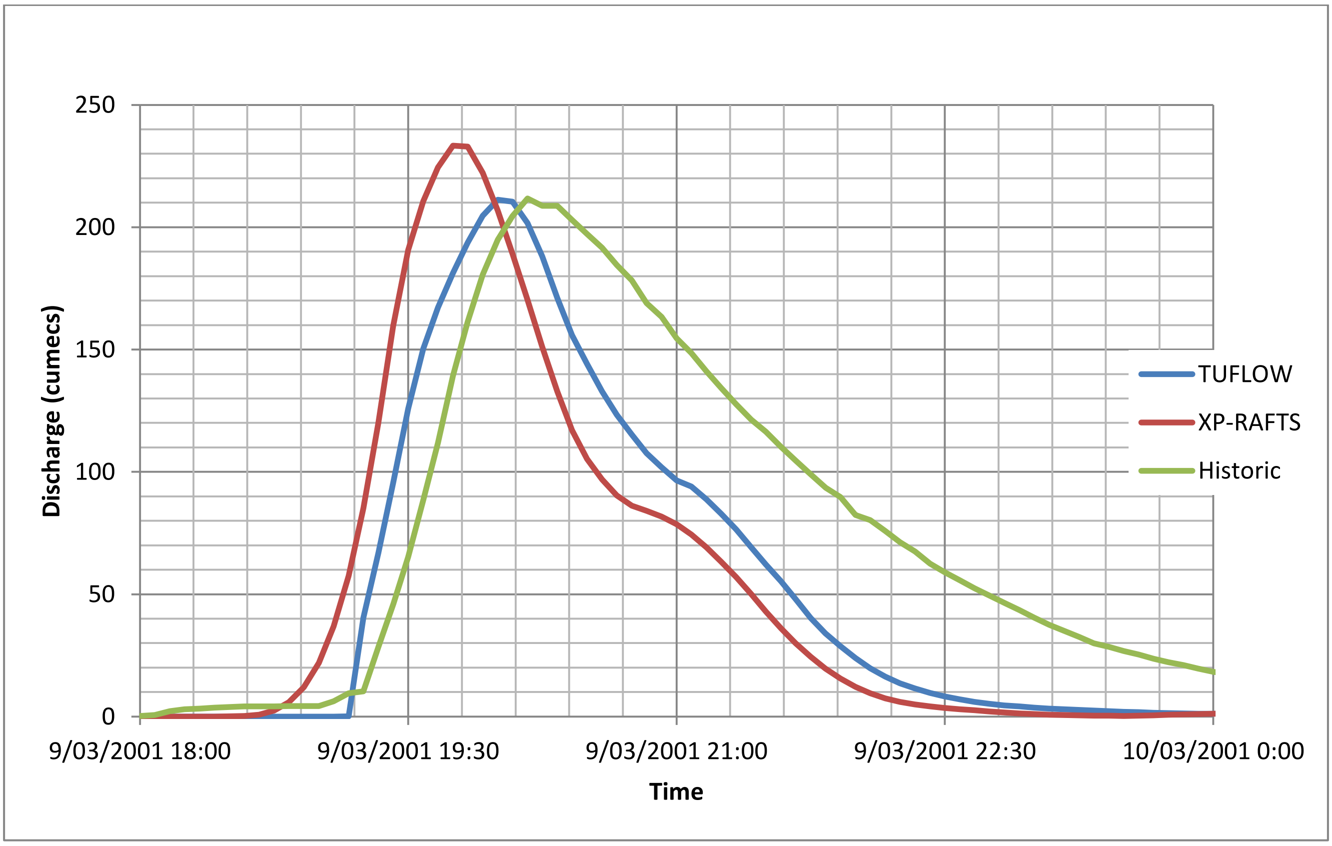


Figure 4.3 – Downfall Creek Stream Gauge D_A564 Hydrograph Comparison – March 2001 Event

4.4.2 May 2009 event

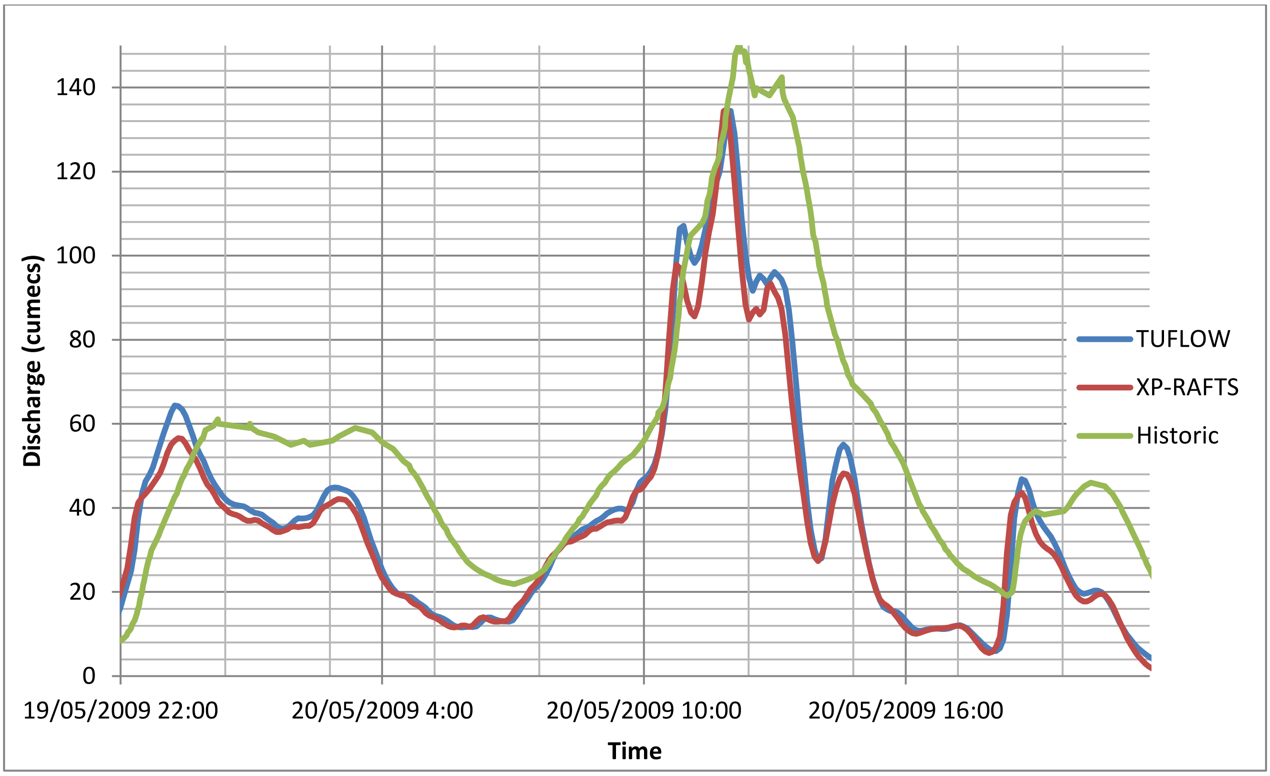


Figure 4.4 – Downfall Creek Stream Gauge D_A564 Hydrograph Comparison – May 2009 Event

4.4.3 October 2010 event

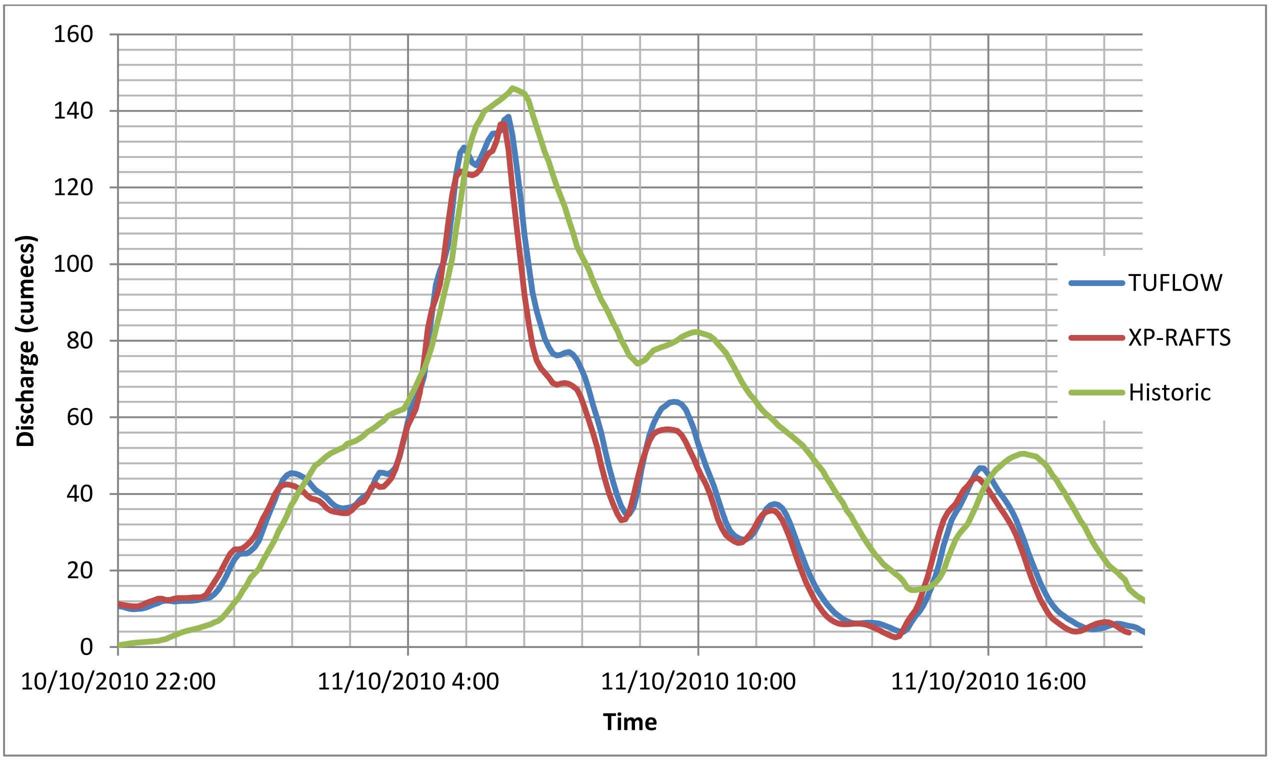


Figure 4.5 – Downfall Creek Stream Gauge D_A564 Comparison – October 2010 Event

4.4.4 January 2013 event

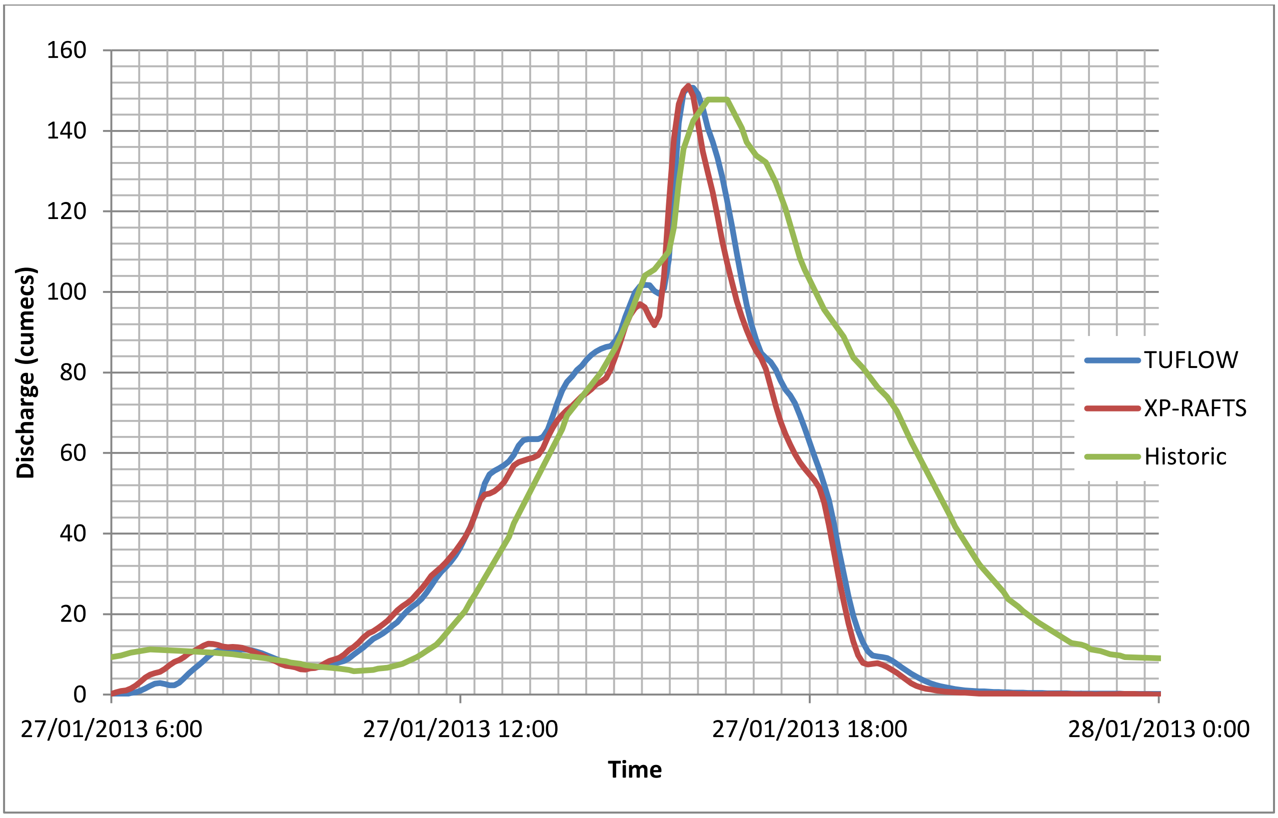


Figure 4.6 – Downfall Creek Stream Gauge D_A564 Comparison – January 2013 Event

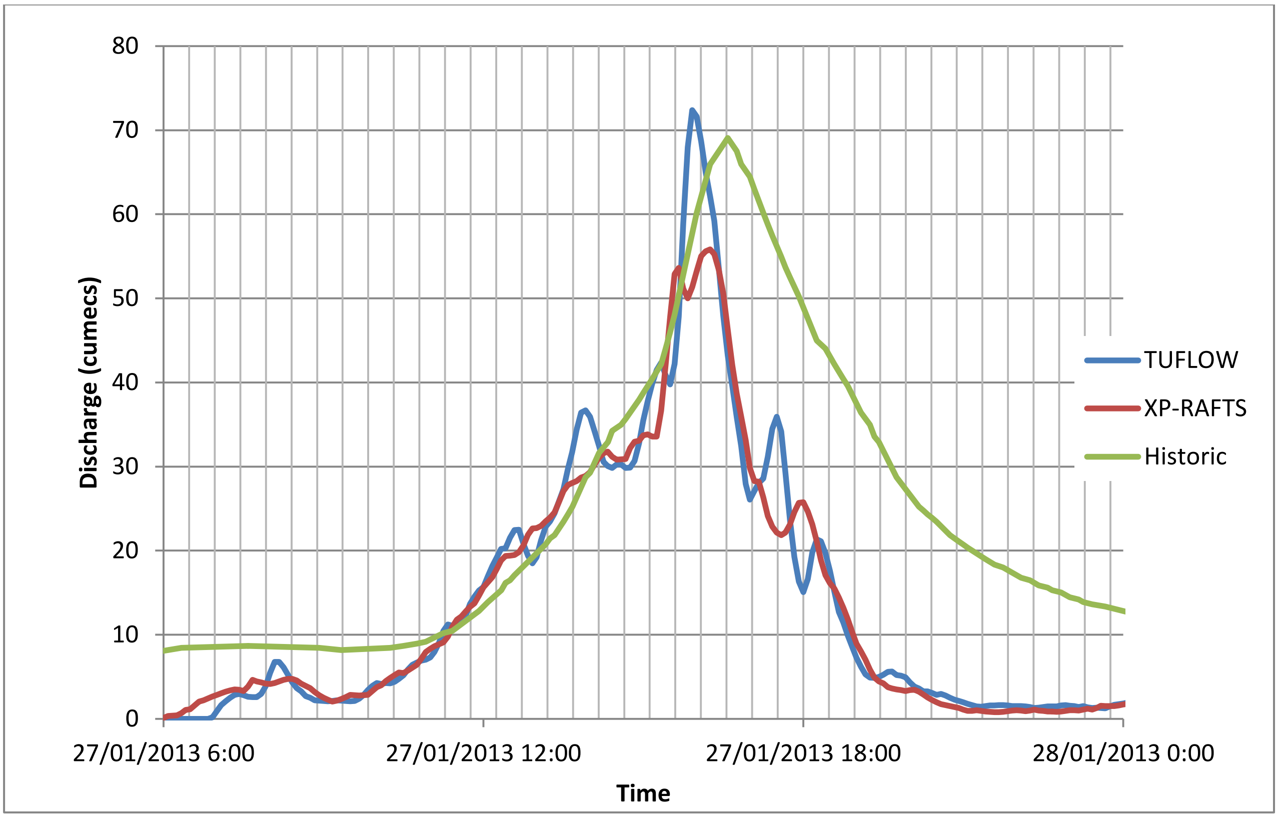


Figure 4.7 – Zillman Waterholes Stream Gauge Z_A851 Comparison – January 2013 Event

5.0 Hydraulic Model Development and Calibration

5.1 Overview

The hydraulic modelling of the Nundah Creek catchment was undertaken using TUFLOW (Build 2012-05-AE-iSP).

TUFLOW is a combined 1-dimensional/2-dimensional (1D/2D) unsteady flow hydraulic model, which can model free-surface flows in one-dimensional links (such as open channels, pipes and culverts, bridges, etc.) and two-dimensional domains.

Unsteady models simulate the progression of a flood wave down the creek over time and therefore have the ability to simulate:

- the rise and fall of the flood;
- variations in downstream tidal effect;
- storage effects of floodplains; and,
- overland flow paths.

5.2 Model Development

5.2.1 Model Schematisation

The characteristics of the Nundah Creek catchment resulted in a requirement for a combined 1D/2D hydraulic model being developed to represent the catchment.

Characteristics influencing the need for a 1D model component include:

- Well defined channelisation of flow paths;
- Significantly more in-bank flow compared to overbank/floodplain flow; and,
- Minor channels where better in-channel definition of topography is required.

Characteristics influencing the need for a 2D model component include:

- Very flat and wide floodplain areas;
- Large meander bends with short-circuiting of flow;
- Significantly more overbank flow compared with in-channel flow; and,
- Poorly defined break-out flow paths.

As such, a fully 2D model was used for the section of the hydraulic model downstream of Sandgate Road on both Zillman Waterholes and Downfall Creek branches, to the Nundah Creek outlet into Moreton Bay.

In all other areas of the catchment, a combined 1D/2D model was utilised whereby the main in-bank areas of the channels and tributaries were represented as one-dimensional and the overbank/storage areas were represented as two-dimensional.
The schematisation of the hydraulic model, including model area, inflow locations, boundaries and structure locations is shown in Figure 5.1.

A grid size of 5 m was used to define the flow in the 2-dimensional domain of the TUFLOW model. A timestep of 1 second was used during the simulation for the 1-D areas, whilst a timestep of 2 seconds was used for the 2-D areas.

5.2.2 Topography

Topographic data was sourced from new and existing survey and the existing MIKE11 hydraulic model.

The topographic information for the TUFLOW hydraulic model was obtained from the following sources:

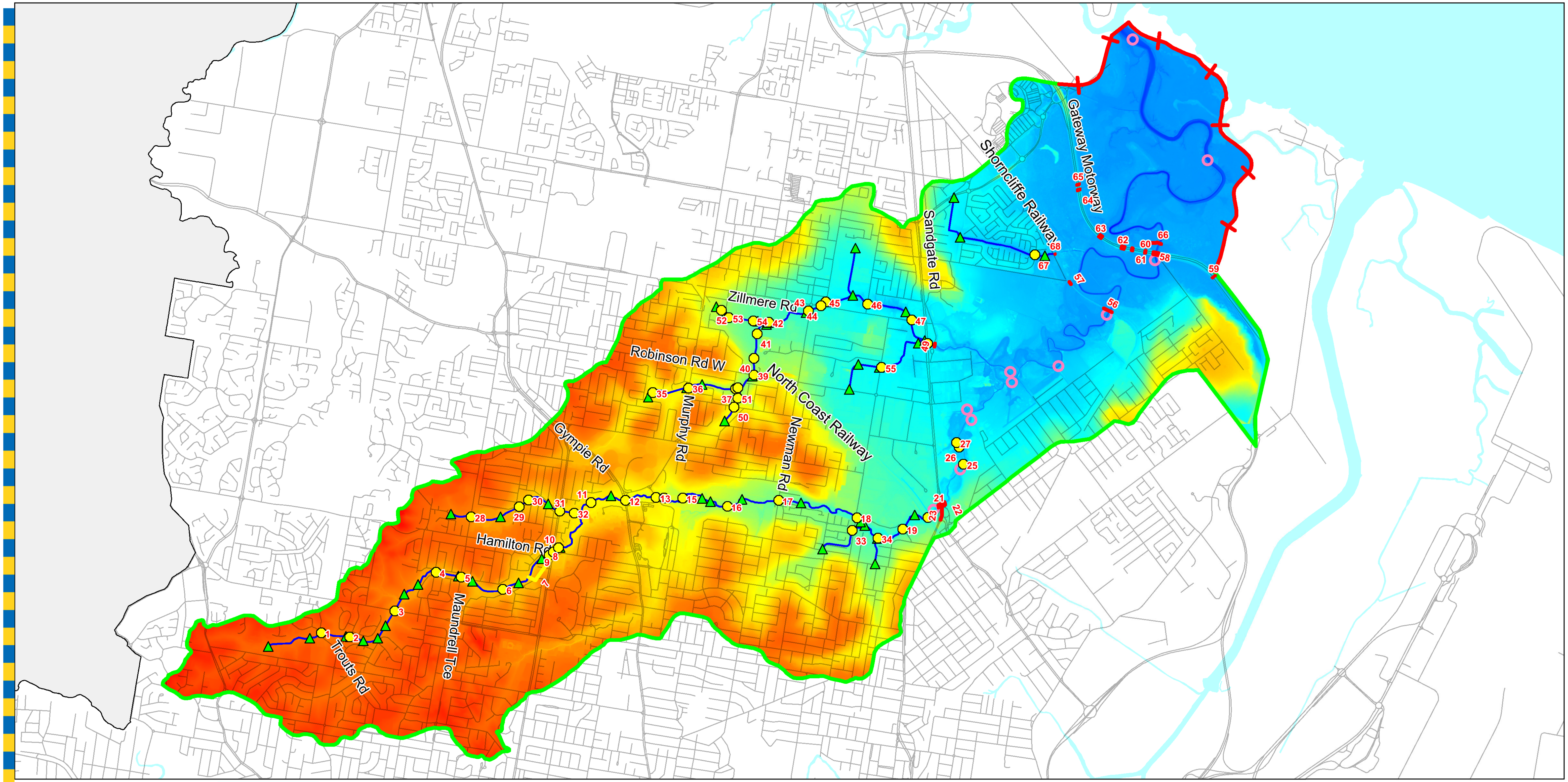
- BCC 2009 Airborne Laser Scanning (ALS) survey data: Used as the basis of the two-dimensional model DEM. For the March 2001 calibration event, 2002 ALS data was also used in the development of the DEM where appropriate;
- BCC 2014 ALS survey - used in the 2013 calibration event to represent the development at 2141 Sandgate Rd, Boondall, which was completed in 2012;
- Cross-sectional survey undertaken between February and November 1996, covering the main branches of Downfall Creek, Zillman Waterholes and Nundah Creek; and,
- Cross-sectional survey undertaken in 2013 for use in this study. This survey covered parts of Downfall Creek (including Tributaries A and B), Zillman Waterholes (including Tributaries A, B and D), and Nundah Creek (including Tributary A);

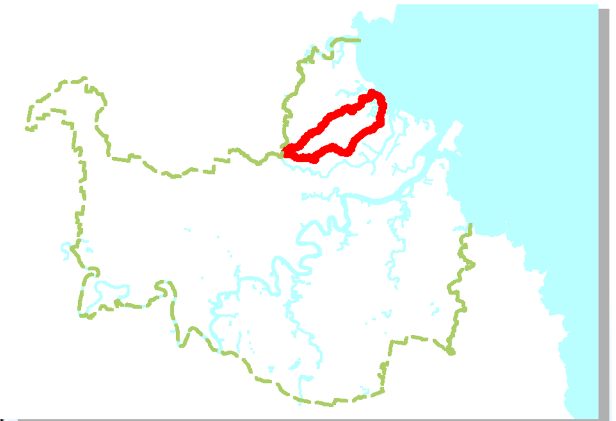
In some areas of the model, modification of the topography was necessary for model stability purposes and to better represent specific areas of the channels/catchment. Modifications included:

- Lowering or raising of cross-section inverts immediately upstream and downstream of structures to match structure inverts for model stability;
- Lowering of cross-section inverts (extracted from the 2009 ALS DEM) along Zillman Waterholes Tributary G; and,
- Modification of cross-section overbanks to simulate blockage from adjacent objects, i.e. fences.

5.2.3 Land Use

The land uses in the catchment for the calibration scenarios were determined from site inspections and review of aerial photography. The Manning’s ‘n’ roughness values used in the TUFLOW model are listed in Table 5.1.





Legend

- 1D Inflow
- 2D Inflow
- 1D Structure
- 2D Structure
- Structure ID
- Downstream Boundary
- BCC Boundary
- 1D Channel
- 2D Domain

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Figure 5.1: Hydraulic Model Layout

FLM - 140591

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Table 5.1 - TUFLOW Model Roughness Parameters

Land Use	Manning's 'n' Value
Urban/Residential Areas	0.12 - 0.2
Streets/Roadways	0.02
Concrete (i.e. - Culverts)	0.015
Heavy Vegetation/Mangroves	0.09 - 0.12
Medium Vegetation	0.05 - 0.07
Light Vegetation	0.04 - 0.05
Open Waterways	0.03
Grassland/Park Land	0.045

5.2.4 Hydraulic Structures

Each of the 68 simulated crossings, roads and footbridges are modelled with a combination of culverts or bridge openings and weirs.

A summary of hydraulic structures that are included in the calibration and/or design model, along with their chainage and a description is provided in Table 5.2.

Table 5.2 - Nundah Creek Catchment Structure Details

Map No.	TUFLOW ID	Location	Branch	Approx. AMTD	Details[1]
1	DC_2040	Trouts Rd	Downfall Creek	14125	2 x 1.2m Circular
2	DC_2326	Parton St	Downfall Creek	13855	1 x 1.82x1.78m RCBC and 2 x 1.84x1.58m RCBC
3	DS_3014	Rode Rd	Downfall Creek	13180	4 x 2.74x1.8m RCBC
4	DC_3635	Footbridge adj. Ennerdale St	Downfall Creek	12550	2 Span - 1 x 7.9m/1 x 8.7m Bridge
5	DC_3907	Maundrell Tce	Downfall Creek	12285	6 x 1.825m Circular
6	DC_4380	Huxtable Park Pedestrian Bridge	Downfall Creek	11805	Single 9.8m span bridge
7	Drainage Pipes	Pipe Network U/S Hamilton Rd Roundabout	Downfall Creek	11500	1 x 1.8m Circular x 310m length
8	DC_5009	Hamilton Rd Roundabout (U/S)	Downfall Creek	11185	5 x 3.04x2.75m RCBC
9	DC_5130	Hamilton Rd Roundabout (within)	Downfall Creek	11115	2 x 7.66x3.54m RCBC
10	DC_5182	Hamilton Rd Roundabout (D/S)	Downfall Creek	11075	5 x 3.04x2.75m RCBC
11	DC_SI_03	Footbridge adj. Brentwick St	Downfall Creek	10425	2 x 2.4x1.2m RCBC
12	DC_6218	Gympie Rd	Downfall Creek	10090	4 x 2.8x2.8m RCBC

Map No.	TUFLOW ID	Location	Branch	Approx. AMTD	Details[1]
13	DC_B9860	Kittyhawk Dr	Downfall Creek	9732	3 span bridge (2 x 15.9m and 1 x 16.1m)
14	DC_B9861_SI_10	Footbridge 1 Seventh Brigade Park	Downfall Creek	9632	Single 20.0 m span bridge
15	DC_SI_08	Footbridge 2 Seventh Brigade Park	Downfall Creek	9443	Single 20.0 m span bridge
16	DC_7466	Footbridge 3 Seventh Brigade Park	Downfall Creek	8960	3 Span - 2 x 9.0m/1 x 11.6m Bridge
17	DC_8050	Newman Rd	Downfall Creek	8425	2 x 16m span bridge
18	DC_9010	Footbridge adj. Bilsen Rd	Downfall Creek	7570	Single 15.4m span bridge
19	DC_9619	Footbridge adj. end of Brickyard Rd	Downfall Creek	6980	1 x 7.35x2.4m RCBC and 1 x 6.43x2.4m RCBC
20	DC_9997	North Coast Railway	Downfall Creek	6640	2 x 13.2m span bridge
21	DC_10147	Sandgate Rd Northbound	Downfall Creek	6490	3 spans (1 x 9.4m,1 x 9.5m,1 x 9.7m)
22	Sandgate Road Bridge	Sandgate Rd Overpass	Downfall Creek	6450	2 spans (2 x 26.9m)
23	DC_10200	Sandgate Rd Southbound	Downfall Creek	6425	3 spans (2 x 9.3m, 1 x 9.7m)
24	DC_10232	Sandgate Rd Southbound Off-ramp	Downfall Creek	6405	6 Span Bridge (average span of 4.1m)
25	DC_10704	Footbridge No. 3 in Golf Course	Downfall Creek	5920	Single 12m span bridge
26	DC_10953	Footbridge No. 4 in Golf Course	Downfall Creek	5730	Single 6m span bridge
27[3,4]	DC_10995	Footbridge No. 5 in Golf Course	Downfall Creek	NA	Single 13m span bridge
28	TA_W3320	Maundrell Tce	Downfall Ck Trib A	1276	1 x 1.8m Circular
29	TA_W5409	Marban St	Downfall Ck Trib A	722	3 x 1.525m Circular
30	TA_SI_01	Footbridge in Frederick Annand Park	Downfall Ck Trib A	593	2 span bridge (25m total length)
31	TA_W4286	Webster Rd	Downfall Ck Trib A	227	2 x 2.64x1.22m RCBC
32	TA_SI_02	Footbridge D/S Webster Rd	Downfall Ck Trib A	59	Single 21.5m span bridge
33	TB_SI_04	Footbridge at end of Bilsen Rd	Downfall Ck Trib B	155	Single 16m span bridge
34	TG_SI_05	Footbridge adj. end of Borrows St	Downfall Ck Trib C	28	Single 8.2m span bridge

Map No.	TUFLOW ID	Location	Branch	Approx. AMTD	Details[1]
35	ZC_7260	Rainbow Park Footbridge	Zillman Waterholes	4688	Single 11.8m span bridge
36	ZC_7617	Murphy Rd	Zillman Waterholes	4340	5 x 1.675m Circular
37	ZC_SI_06	Footbridge adj. Roland St	Zillman Waterholes	3825	Single 8.5m span bridge
38	ZC_30031198	Bikeway U/S Robinson Rd West	Zillman Waterholes	3794	3 x 1.2mx1.2m RCBC
39	ZC_8351 – Calibration	Robinson Rd West	Zillman Waterholes	3610	4 x 2.13m x 2.15m RCBC
	ZC_140904 – Design				6 x 3.3m x 2.7m RCBC
40	ZC_8521	North Coast Railway	Zillman Waterholes	3440	5 x 1.8m Circular
41	ZC_8801	Causeway O'Callaghan's Park	Zillman Waterholes	3170	2 x 0.375m Circular
42	ZC_8942	Causeway Park	Zillman Waterholes	2990	4 x 0.3m Circular
43	ZC_9426	Newman Rd	Zillman Waterholes	2511	8 x 1.82m Circular
44	ZC_9580	Zillmere Rd (Pipe Culverts)	Zillman Waterholes	2415	6 x 1.82m Circular
45	ZC_9633	Footbridge D/S Zillmere Rd	Zillman Waterholes	2346	Single 14.7m Span bridge
46	ZC_10121	Groth Rd	Zillman Waterholes	1865	1 x 3.05x1.685m RCBC and 6 x 3.05x1.535m RCBC
47	ZC_10648	Zillmere Rd (Box Culverts)	Zillman Waterholes	1350	1 x 2.45x2.35m RCBC and 6 x 2.45x2.13m RCBC
48	ZC_10945	Sandgate Rd	Zillman Waterholes	1050	10 x 2.45x2.14m RCBC and 2 x 16m span bridge
49	ZC11038	Bridge D/S Sandgate Rd	Zillman Waterholes	950	4 x 5.8m span bridge
50	TE_DEM	Copperfield St	Zillman Trib E	247	6 x 0.75m Circular
51	TE_SI_07	Footbridge D/S Copperfield St	Zillman Trib E	137	Single 6.5m span bridge
52	TH_C5612P_01	Access Rd 1 – 39 Jenning's St	Zillman Trib C	537	1 x 1.8m Circular
53	TH_SI_01	Access Rd 2 – 39 Jenning's St	Zillman Trib C	449	2 x 1.8m Circular
54	TH_DEM_03	Footbridge O'Callaghan's Park	Zillman Trib C	191	Single 14m span bridge
55	TD_DEM	Bilsen Rd	Zillman Trib D	624	4 x 1.2m Circular

Map No.	TUFLOW ID	Location	Branch	Approx. AMTD	Details[1]
56	NC_14445	Shorncliffe Railway 1	Nundah Creek	3510	3 x (1x5.9m), 4 x (5.8x1.2m), 2 x (5.4x1.5m), 1 x (4x3.8m), 2 x (5.7x3.6m)
57	NC_LB_968	Shorncliffe Railway 2	Nundah Creek	3510	2 x 4.7x1.3m RCBC and 3 x 6.1x1.3m RCBC
58[2]	NC_16738 - Calibration	Gateway Motorway Bridge	Nundah Creek	2750	2 x 20.5m span bridge
	NC_16738 - Design				2 x 23.8m span bridge
59[2]	No ID - Calibration	Gateway Motorway Culvert 1	Nundah Creek	2750	2 x 1.2x0.75m RCBC
	No ID - Design				3 x 1.8x0.9m RCBC
60[2,4]	33075	Gateway Motorway Culvert 2	Nundah Creek	2750	4 x 2.13x0.875m and 1 x 2.13x1.05m SLBC
61[2]	33076	Gateway Motorway Culvert 3	Nundah Creek	2750	4 x 2.1x0.8m and 2 x 2.1x1.05m SLBC
62[2]	Gate_Central_115	Gateway Motorway Culvert 4	Nundah Creek	2750	9 x 2.13x0.875m and 7 x 2.13x1.05m RCBC
63[2]	N_LB_1560	Gateway Motorway Culvert 5	Nundah Creek	2750	8 x 2.13x0.86m and 7 x 2.13x1.07m SLBC
64[4]	No ID – Design	Gateway Motorway Culvert 6	Nundah Creek	2750	1 x 1.5x1.5m RCBC
65[2,4]	33079	Gateway Motorway Culvert 7	Nundah Creek	2750	2 x 1.16x1.25m and 1 x 1.32x1.21m RCBC
66	NC_16863	Footbridge D/S Gateway Mwy	Nundah Creek	2625	2 Spans – 1 x 10m and 1 x 20m
67	TF_DEM	College Way	Nundah Trib A	552	4 x 3x1.5m RCBC
68	TF_SI_11	Shorncliffe Railway	Nundah Trib A	335	2 x 5.2x1.05m RCBC

[1] Some dimensions have been measured off structural drawings, ALS 2009 survey data and aerial photography and are therefore approximate only.
[2] Proposed Gateway Motorway upgrade works
[3] Removed from final design model simulations
[4] Not included in Hydraulic Structure Reference Sheets

5.2.5 Boundary Conditions

A total of 55 inflows were defined and applied to the TUFLOW hydraulic model to reflect the hydrologic behaviour of the creek. Inflows were obtained directly from the XP-RAFTS model outputs. In most locations, local inflows were applied to the hydraulic model, so as to allow flood routing to occur in all areas of the hydraulic model where possible.
The location of each inflow is shown in Figure 5.1.

A dynamic tailwater boundary along Moreton Bay was used in the hydraulic model. The location of the boundary is shown in Figure 5.1.

The adopted tailwater levels are discussed in Section 3.3.4.

5.3 Calibration Procedure

For each calibration event, the peak flood levels calculated by the hydraulic model were compared to the recorded MHG readings. Flood level hydrographs were also compared to the recorded gauge readings where available.

Manning's 'n' values were varied to improve the correlation of the modelled discharge and peak levels with recorded data. Adopted Manning's 'n' values were generally not varied across calibration events for the same land use types and the values were chosen to represent the best calibration outcome with all events taken into consideration.

The results of the hydraulic model calibration are discussed in the following sections. The error tolerances are generally considered to be +/- 300mm for MHG readings and +/-150mm for stream gauge readings. The calibration of the hydraulic model is therefore considered acceptable if the model results lie within these tolerances, and also show a good correlation to the shape of the stream gauge hydrographs.

5.4 Hydraulic Model Calibration Results

5.4.1 March 2001

The 9th March 2001 event was one of the largest recently recorded rainfall events within the Nundah Creek catchment, and the largest recorded event in surrounding catchments. The event was characterised as a relatively short event of 1-3 hours duration of high intensity rainfall across Brisbane. An assessment of the available stream gauge and MHG recordings within the catchment indicate that it was the largest flood event recorded in the Downfall Creek subcatchment during the period of operation of the stream gauge and therefore the largest event modelled in the Downfall Creek subcatchment as part of the calibration process.

Rainfall records from two stations within the Nundah Creek catchment and 6 stations in surrounding catchments are available for this event. The surrounding catchments include Kedron Brook and Cabbage Tree Creek. The recorded data has been plotted on an Intensity-Frequency-Duration (IFD) curve as shown in Appendix B. The gauges recorded varying intensities during this event with AEP's of approximately 1 to 20% for durations between 1 and 3 hours with the exception of the Nundah Creek gauge (D_R509) which was approximately 10 to 50% AEP.

Table 5.3 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the pluviographs with available information. Further information on cumulative rainfall distribution is provided in Appendix A.

Table 5.3 - Rainfall characteristics (9^{th} March 2001 event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)
		14-day	**4-day**	**9^{th} March 2001**
C_R560	U/S of Braun St, Deagon	12	8	129
C_R715	Pineapple St, Carseldine	3	3	172
C_R733	Sandgate State Primary School, Boondall	10	8	96
C_R509	Chermside Pool, Hamilton Road	5	5	106
D_R563	End of Brickyard Rd, Geebung	8	8	102
D_R539	Osborne Rd, Everton Park	2	1	124
K_R598	Suez St, Gordon Park	3	3	146
LCR566	Aspley Reservoir, Aspley	3	3	183

The simulated spatial distribution of rainfall gauge information for the March 2001 event is shown in Appendix D. The spatial distribution is based on the Thiessen polygon method.

Almost no rainfall was recorded for the four days prior to the March 2001 rainfall event. Therefore it was assumed that the antecedent conditions were a relatively dry catchment and low creek water levels and an initial loss of 40 mm was adopted in the hydrologic model.

In the hydraulic model, there is a satisfactory match between historic and calibrated levels at the MHG locations for the 2001 event, with modelled levels within +/-300mm of recorded levels at 17 of the 25 MHG's. The modelled levels at the remaining 8 MHG's are within 550mm of recorded levels, with the maximum difference occurring at MHG D170 in the park along Downfall Creek downstream of Gympie Road. The full comparison of modelled and recorded levels at the MHG's and stream gauges are detailed in Table 5.4 and Table 5.5.

Table 5.4 - Comparison of MHG modelled and recorded levels – March 2001 Event

Branch	Gauge Name	March 01 Recorded Level (m AHD)	March 01 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
Nundah Creek	N95	**Gauge not installed**		
	N110	2.23	2.59	0.36
	N120	2.09	2.39	0.30
Downfall Creek	D100	4.61	4.58	-0.03
	D110	5.39	5.87	0.48
	D120	7.14	7.66	0.52
	D130	7.70	7.91	0.21
	D140	10.31	10.13	-0.18
	D150	11.33	11.43	0.10
	D160	11.55	11.53	-0.02
	D170	14.74	14.19	-0.55
	D180	17.74	17.47	-0.27
	D190	18.81	18.80	-0.01
	D200	19.89	19.78	-0.11
	D208	**Gauge not installed**		
	D210	22.16	22.56	0.40
	D212	**Gauge not installed**		
	D220	27.29	27.35	0.06
	D230	32.17	31.88	-0.29
	D235	**Gauge not installed**		
	D240	39.46	39.57	0.11
Zillman Waterholes	Z100	3.42	3.64	0.22
	Z110	3.92	4.16	0.24
	Z120	4.06	4.43	0.37
	Z130	4.23	4.75	0.52
	Z140	4.62	4.90	0.28
	Z150	4.67	4.93	0.26
	Z160	**Gauge not installed**		
	Z170	6.77	7.23	0.46
	Z180	15.09	15.32	0.23

Table 5.5 - Comparison of Stream Gauge modelled and recorded levels –March 2001 Event

Gauge	Location	March 01 Recorded Level (m AHD)	March 01 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
D_A564	End of Brickyard Rd, Geebung (Downfall Creek)	8.52	8.53	0.01

A comparison of the modelled and recorded hydrographs at stream gauge D_A564 is detailed in Figure 5.2. The comparison shows a very good match of the rising limb of the hydrographs, along with the timing and magnitude of the flood peak. The peak difference between modelled and recorded levels is 10mm. A poor match is observed on the downward limb of the hydrograph, although this is generally given lower importance during calibration. The falling limb cannot be simulated well within the hydraulic model due to the complexity of catchment soil conditions and catchment storage characteristics when flood levels are receding.

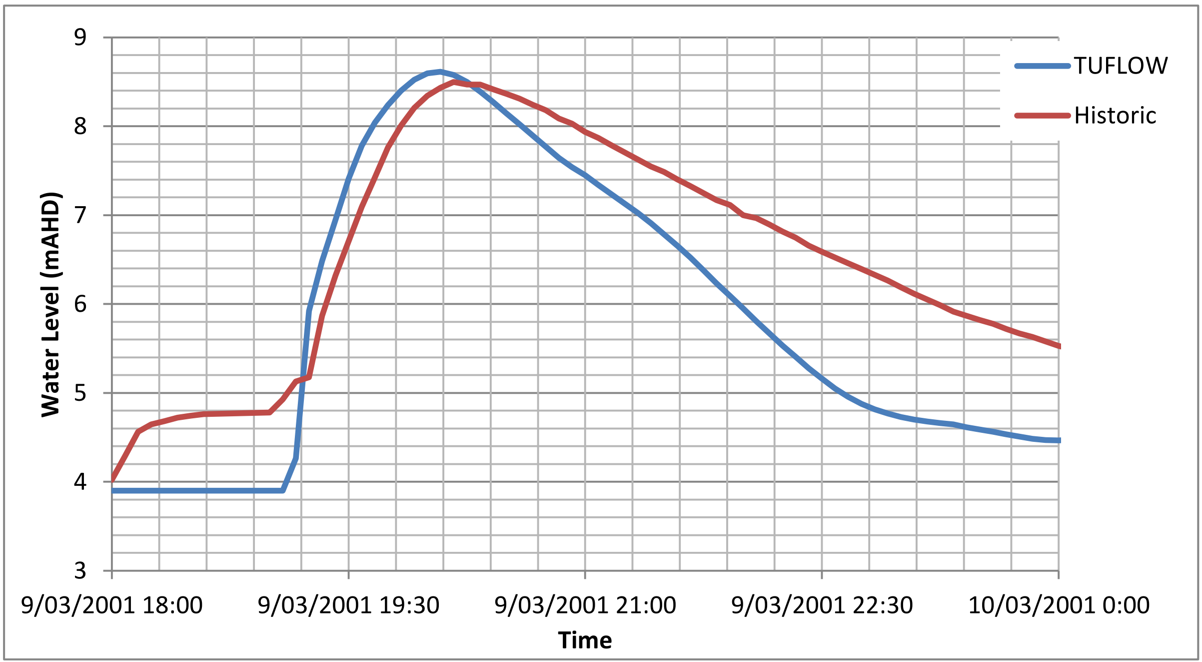

Figure 5.2 – Gauge D_A564 – Comparison of modelled vs. Historic Levels – March 2001 Event

5.4.2 May 2009

The 20th May 2009 event took place over a period of 12-16 hours on the evening of May 19 through to around midday on May 20. Rainfall during this period was relatively steady, with peak rainfall occurring around 10-12pm on May 20.

An assessment of the available stream gauge and MHG recordings within the catchment indicate that it was one of the smallest modelled calibration events in the catchment along with the January 2013 event. This is mainly due to the long duration of the rainfall event compared to the critical duration of the catchment, despite the event producing large rainfall totals across Brisbane.

Rainfall records from two stations within the Nundah Creek catchment and 4 stations in surrounding catchments are available for this event. The surrounding catchments include Kedron Brook and Cabbage Tree Creek. The recorded data has been plotted on an Intensity-Frequency-Duration (IFD) curve as shown in Appendix B. The gauges recorded varying intensities during this event with AEP's of approximately 10 to 100% for durations between 1 and 3 hours.

Table 5.6 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the pluviographs with available information. Further information on cumulative rainfall distribution is provided in Appendix A.

Table 5.6 - Rainfall characteristics (20th May 2009 event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	19th – 20th May 2009	20th May 2009
C_R560	U/S of Braun St, Deagon	124	122	305	196
D_R563	End of Brickyard Rd, Geebung	122	122	306	195
K_R539	Osborne Rd, Everton Park	120	120	323	213
K_R598	Suez St, Gordon Park	143	142	308	192
LCR566	Aspley Reservoir, Aspley	117	117	285	180
Z_R850	Frank Sleeman Park, Boondall	124	123	301	189

The simulated spatial distribution of rainfall gauge information for the May 2009 event is shown in Appendix D. The spatial distribution is based on the Thiessen polygon method.

A moderate amount of rainfall was recorded for the four days prior to the May 2009 rainfall event, with almost all antecedent rainfall occurring within 24 hours of event commencement. This has resulted in a second, smaller flood peak which is noticeable in the stream gauge hydrographs for the event. Therefore it can be assumed that the antecedent conditions were a relatively wet catchment and low to medium creek water levels. An initial loss of 0 mm was adopted in the hydrologic model.

In the hydraulic model, there is a very good match between historic and calibrated levels at the MHG locations for the 2009 event, with modelled levels within +/-300mm of recorded levels at 20 of the 21 MHG's. The maximum difference of 380mm occurs at MHG Z100 which is located in the park downstream of Sandgate Rd along Zillman Waterholes. The full comparison of modelled and recorded levels at the MHG's and stream gauges are detailed in Table 5.7 and 5.8.

Table 5.7 - Comparison of MHG modelled and recorded levels – May 2009 Event

Branch	Gauge Name	May 09 Recorded Level (m AHD)	May 09 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
Nundah Creek	N95	**Gauge not installed**		
	N110	2.53	2.59	0.06
	N120	2.36	2.43	0.07
Downfall Creek	D100	4.64	4.43	-0.21
	D110	5.30	5.52	0.22
	D120	6.59	6.72	0.13
	D130	**5.27^**		
	D140	**9.26***	9.52	0.26
	D150	10.46	10.63	0.17
	D160	**---**		
	D170	**---**		
	D180	**16.53***	16.63	0.10
	D190	**16.28^**		
	D200	**---**		
	D208	21.32	21.04	-0.28
	D210	21.46	21.44	-0.02
	D212	22.12	22.40	0.28
	D220	**---**		
	D230	**---**		
	D235	**NA**		
	D240	39.54	39.31	-0.23
Zillman Waterholes	Z100	3.13	3.51	0.38
	Z110	4.05	4.00	-0.05
	Z120	4.29	4.19	-0.10
	Z130	4.39	4.36	-0.03
	Z140	4.47	4.48	0.01
	Z150	4.53	4.52	-0.01
	Z160	5.77	5.70	-0.07
	Z170	6.66	6.76	0.10
	Z180	14.98	14.98	0.00

Key: **NA = No data available**
*** Level from nearby debris height**
--- Level did not reach bottom of inner gauge
^ Faulty reading

Table 5.8 - Comparison of Stream Gauge modelled and recorded levels – May 2009 Event

Gauge	Location	May 09 Recorded Level (m AHD)	May 09 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
D_A564	End of Brickyard Rd, Geebung (Downfall Creek)	7.89	7.62	-0.27

A comparison of the modelled and recorded hydrographs at stream gauge D_A564 is detailed in Figure 5.3. The comparison shows a good match of the hydrographs, along with a very good timing match of the flood peak. The peak difference between modelled and recorded levels is 270 mm.

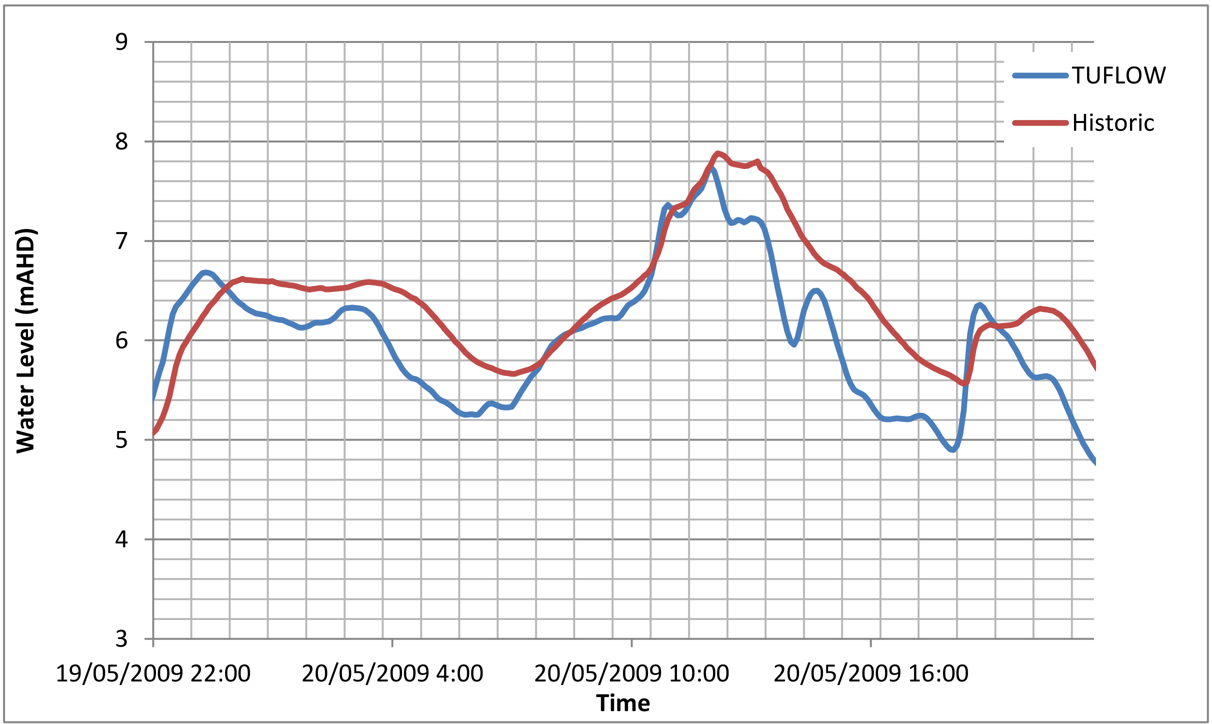

Figure 5.3 – Gauge D_A564 – Comparison of modelled vs. Historic Levels – May 2009 Event

5.4.3 October 2010

The 11th October 2010 event took place over a period of 10-12 hours on the morning of October 11, with rainfall peaking around 4-5am. An assessment of the available stream gauge and MHG recordings within the catchment indicate that it was the largest flood event modelled in the Zillman Waterholes subcatchment as part of the calibration process.

Rainfall records from two stations within the Nundah Creek catchment and 4 stations in surrounding catchments are available for this event. The surrounding catchments include Kedron Brook and Cabbage Tree Creek. The recorded data has been plotted on an Intensity-Frequency-Duration (IFD) curve as shown in Appendix B. The gauges recorded varying intensities during this event with AEP's of approximately 10 to 50% for durations between 1 and 3 hours.

Table 5.9 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the pluviographs with available information. Further information on cumulative rainfall distribution is provided in Appendix A.

Table 5.9 - Rainfall characteristics (11th October 2010 event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	8th – 11th October 2010	11th October 2010
C_R560	U/S of Braun St, Deagon	220	173	387	219
D_R563	End of Brickyard Rd, Geebung	177	143	320	177
K_R539	Osborne Rd, Everton Park	117	73	274	201
K_R598	Suez St, Gordon Park	171	123	298	175
LCR566	Aspley Reservoir, Aspley	154	110	331	221
Z_R850	Frank Sleeman Park, Boondall	209	163	385	225

The simulated spatial distribution of rainfall gauge information for the October 2010 event is shown in Appendix D. The spatial distribution is based on the Thiessen polygon method.

A moderate amount of rainfall was recorded for the four days prior to the October 2010 rainfall event, with almost all antecedent rainfall occurring within 72 hours of event commencement. A short burst of high intensity rainfall on the 8th October has resulted in a second, smaller flood peak which is noticeable in the stream gauge hydrographs within the catchment for the event. Therefore it can be assumed that the antecedent conditions were a relatively wet catchment and low to medium creek water levels and an initial loss of 0 mm was adopted in the hydrologic model.

In the hydraulic model, there is a very good match between historic and calibrated levels at the MHG locations for the 2010 event, with modelled levels within +/-300mm of recorded levels at 22 of the 23 MHG's. The maximum difference of 420mm occurs at MHG D212 which is located upstream of the Hamilton Road roundabout along Downfall Creek. The full comparison of modelled and recorded levels at the MHG's and stream gauges are detailed in Table 5.10 and Table 5.11.

Table 5.10 - Comparison of MHG modelled and recorded levels – October 2010 Event

Branch	Gauge Name	Oct 10 Recorded Level (m AHD)	Oct 10 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
Nundah Creek	N95	1.77	2.04	0.27
	N110	2.56	2.68	0.12
	N120	2.35	2.50	0.15
Downfall Creek	D100	4.53	4.44	-0.09
	D110	5.29	5.54	0.25
	D120	6.61	6.73	0.12
	D130	7.08	6.92	-0.16
	D140	9.81	9.83	0.02

Branch	Gauge Name	Oct 10 Recorded Level (m AHD)	Oct 10 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
	D150	11.00	11.03	0.03
	D160	---		
	D170	---		
	D180	---		
	D190	**17.43***	17.59	0.16
	D200	**18.92***	19.16	0.24
	D208	21.52	21.29	-0.23
	D210	21.74	21.74	0.00
	D212	22.26	22.68	0.42
	D220	**---**		
	D230	**---**		
	D235	**---**		
	D240	39.48	39.30	-0.18
Zillman Waterholes	Z100	3.53	3.56	0.03
	Z110	4.31	4.16	-0.15
	Z120	4.50	4.42	-0.08
	Z130	4.55	4.72	0.17
	Z140	4.78	4.88	0.10
	Z150	4.88	4.91	0.03
	Z160	5.92	5.91	-0.01
	Z170	7.15	7.15	0.00
	Z180	15.22	15.18	-0.04

Key: * Level from nearby debris height
--- Level did not reach bottom of inner gauge

Table 5.11 - Comparison of Stream Gauge modelled and recorded levels – October 2010 Event

Gauge	Location	Oct 10 Recorded Level (m AHD)	Oct 10 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
D_A564	End of Brickyard Rd, Geebung (Downfall Creek)	7.84	7.66	-0.18

A comparison of the modelled and recorded hydrographs at stream gauge D_A564 is detailed in Figure 5.4. The comparison shows a very good match of the rising limb of the hydrograph, along with the timing of the flood peak. The peak difference between modelled and recorded levels is 180mm.

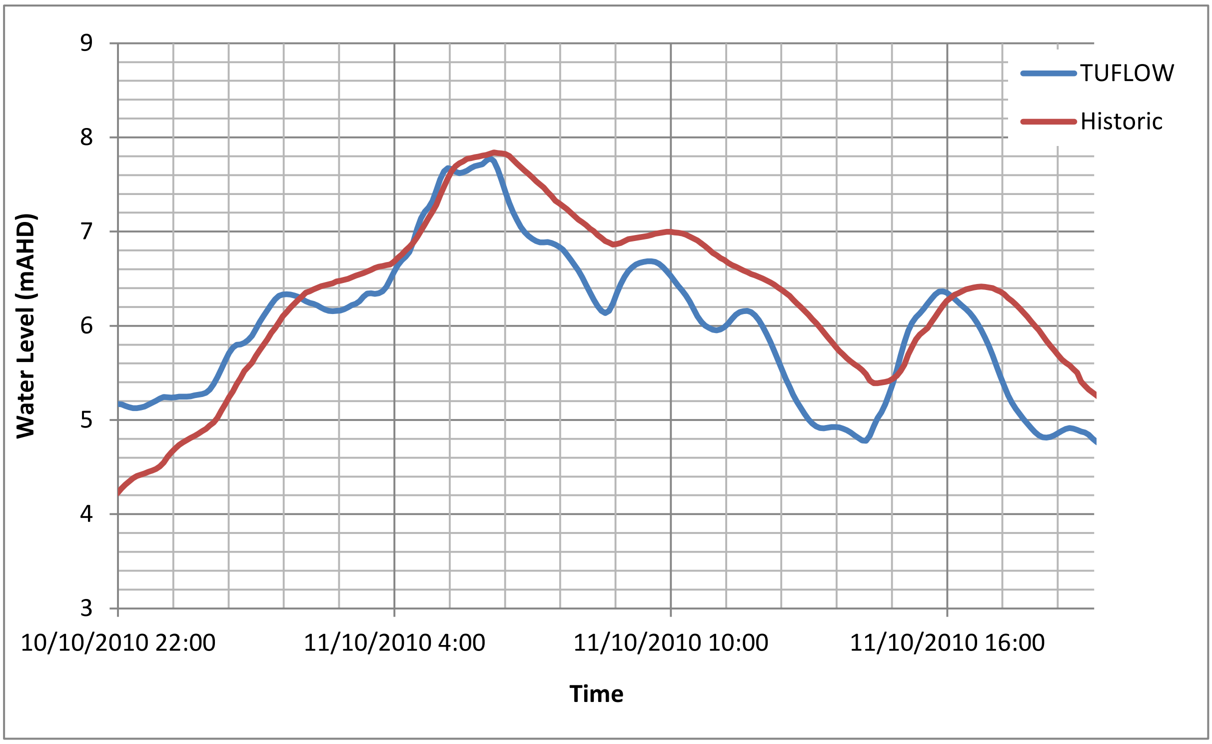

Figure 5.4 – Gauge D_A564 – Comparison of modelled vs. Historic Levels – October 2010 Event

5.4.4 January 2013

The 27th 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, the catchment was considered to be fully saturated prior to the peak of the storm moving through.

An assessment of the available stream gauge and MHG recordings within the catchment indicate that it was one of the smallest modelled calibration events in the catchment along with the May 2009 event. This is mainly due to the long duration of the rainfall event compared to the critical duration of the catchment, despite the event producing large rainfall totals across Brisbane.

Rainfall records from two stations within the Nundah Creek catchment and 4 stations in surrounding catchments are available for this event. The surrounding catchments include Kedron Brook and Cabbage Tree Creek. The recorded data has been plotted on an Intensity-Frequency-Duration (IFD) curve as shown in Appendix B. The gauges recorded varying intensities during this event with AEP’s of approximately 10 to 100% for durations between 1 and 3 hours.

Table 5.12 indicates the 4-day and 14-day antecedent rainfall as well as the total event rainfall at the pluviographs with available information. Further information on cumulative rainfall distribution is provided in Appendix A.

Table 5.12 - Rainfall characteristics (27th January 2013 event)

Gauge ID	Location	Antecedent Rainfall (mm)		Event Rainfall (mm)	
		14-day	4-day	25th – 28th January 2013	27th January 2013
C_R560	U/S of Braun St, Deagon	108	99	277	166
D_R563	End of Brickyard Rd, Geebung	148	139	344	189
K_R575	McCord St, Gordon Park	136	121	322	188
K_R539	Osborne Rd, Everton Park	166	151	431	238
LCR566	Aspley Reservoir, Aspley	159	149	368	194
Z_R850	Frank Sleeman Park, Boondall	124	115	304	177

The simulated spatial distribution of rainfall gauge information for the January 2013 event is shown in Appendix D. The spatial distribution is based on the Thiessen polygon method.

A moderate amount of rainfall was recorded for the four days prior to the January 2013 rainfall event, with almost all antecedent rainfall occurring within 48 hours of the peak rainfall event. Therefore it can be assumed that the antecedent conditions were a wet catchment and low to medium creek water levels. An initial loss of 0 mm was adopted in the hydrologic model.

In the hydraulic model, there is a very good match between historic and calibrated levels at the MHG locations for the 2013 event, with modelled levels within +/-300mm of recorded levels at 24 of the 25 MHG's. The maximum difference of 410mm occurs at MHG D180 which is located downstream of Gympie Rd along Downfall Creek. The full comparison of modelled and recorded levels at the MHG's and stream gauges are detailed in Table 5.13 and Table 5.14.

Table 5.13 - Comparison of MHG modelled and recorded levels – January 2013 Event

Branch	Gauge Name	January 13 Recorded Level (m AHD)	January 13 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
Nundah Creek	N95	1.88	2.05	0.17
	N110	2.60	2.68	0.08
	N120	2.24	2.50	0.26
Downfall Creek	D100	4.55	4.49	-0.06
	D110	5.70	5.62	-0.08
	D120	6.60	6.88	0.28
	D130	6.99	7.10	0.11
	D140	9.82	9.75	-0.07
	D150	11.05	10.92	-0.13
	D160	11.04	11.00	-0.04
	D170	---		
	D180	17.12	16.71	-0.41
	D190	---		
	D200	19.45	19.16	-0.29
	D208	**DEST**		
	D210	21.65	21.54	-0.11
	D212	22.34	22.47	0.13
	D220	26.65	26.75	0.10
	D230	31.41	31.13	-0.28
	D235	---		
	D240	39.35	39.41	0.06
Zillman Waterholes	Z100	3.54	3.59	0.05
	Z110	4.10	4.07	-0.03
	Z120	4.21	4.26	0.05
	Z130	4.28	4.47	0.19
	Z140	4.54	4.59	0.05
	Z150	**DEST**		
	Z160	5.74	5.78	0.04
	Z170	6.58	6.90	0.30
	Z180	14.87	15.00	0.13

Key: DEST = gauge destroyed – no level recorded
--- Level did not reach bottom of inner gauge

Table 5.14 - Comparison of Stream Gauge modelled and recorded levels – January 2013 Event

Gauge	Location	January 13 Recorded Level (m AHD)	January 13 Modelled Level (m AHD)	Difference (Modelled minus Recorded) (m)
D_A564	End of Brickyard Rd, Geebung (Downfall Creek)	7.86	7.84	-0.02
Z_A851	Frank Sleeman Park, Boondall (Zillman Waterholes)	4.53	4.60	0.07

A comparison of the modelled and recorded hydrographs at stream gauges D_A564 and Z_A851 is detailed in Figure 5.5 and Figure 5.6. The comparison for both gauges shows a good match of the rising limb of the hydrographs, along with the timing of the flood peak. The peak difference between modelled and recorded levels is 20mm for Gauge D_A564 and 70mm for Gauge Z_A851.

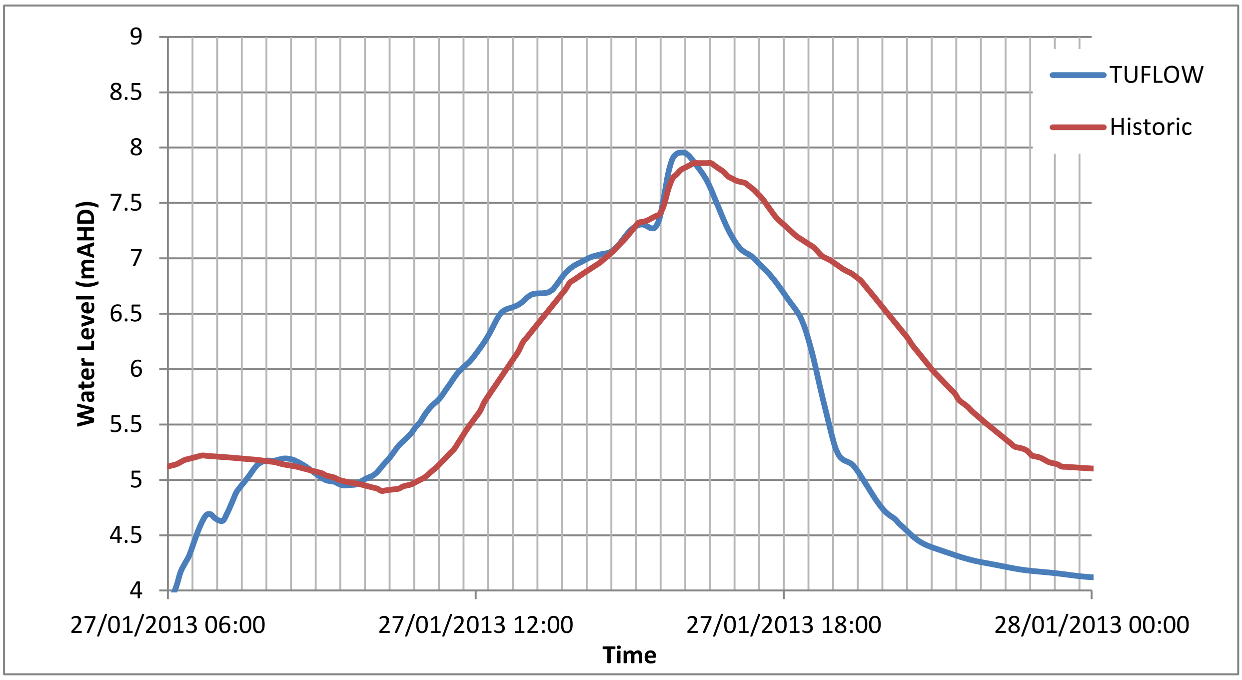

Figure 5.5 – Gauge D_A564 – Comparison of modelled vs. Historic Levels – January 2013 Event

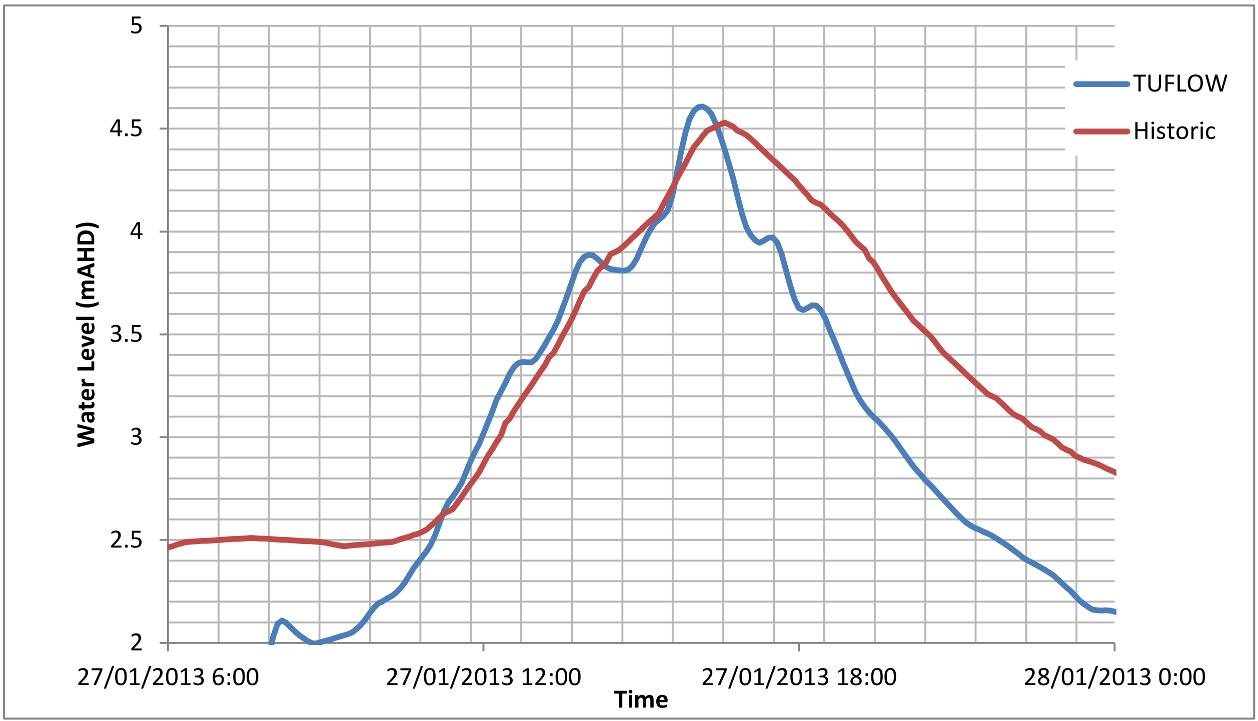

Figure 5.6 – Gauge Z_A851 – Comparison of modelled vs. Historic Levels – January 2013 Event

5.5 Hydraulic Structure Verification

The structure losses at major bridge and culvert crossings, as calculated by the TUFLOW model, were verified by checking against the structure losses as modelled by HEC-RAS (Version 4.1.0).

The calculated head loss comparisons for each structure between TUFLOW and HEC-RAS, for each calibration event, are shown in Table 5.15. It is recommended to verify bridge head-losses against losses calculated in HEC-RAS. However, the comparison for some of the major culverts in the catchment has also been included in the table.

Table 5.15 - Comparison of Hydraulic Model Structure Head Loss

Structure	Calibration Event	Flow (m^3/s)	TUFLOW Head Loss (m)	HEC-RAS Head Loss (m)	Head Loss Difference (HEC – TUFLOW) (m)
Gympie Rd, Downfall Ck (Culvert)	March 01	166.0	1.05	1.23	0.18
	May 09	62.1	0.25	0.23	-0.02
	October 10	85.6	0.37	0.55	0.18
	January 13	65.8	0.25	0.26	0.01
Kittyhawk Drive, Downfall Ck (Bridge)	May 09	61.4	0.03	0.09	0.06
	October 10	84.9	0.03	0.09	0.06
	January 13	65.5	0.03	0.09	0.06
Newman Rd, Downfall Ck (Bridge)	March 01	156.5	0.03	0.12	0.09
	May 09	91.0	0.01	0.02	0.01
	October 10	121.6	0.01	0.05	0.04
	January 13	105.9	0.01	0.03	0.02
North Coast Railway, Downfall Ck (Bridge)	March 01	194.8	0.18	0.12	-0.06
	May 09	131.8	0.04	0.05	0.01
	October 10	134.5	0.04	0.05	0.01
	January 13	145.3	0.05	0.05	0.00
Maundrell Tce, Downfall Ck (Culvert)	March 01	87.9	0.79	0.96	0.17
	May 09	36.3	0.20	0.35	0.15
	October 10	44.7	0.34	0.58	0.24
	January 13	43.9	0.30	0.56	0.26
Marban St, Downfall Ck Trib A (Culvert)	March 01	23.3	0.76	0.96	0.20
	May 09	12.7	0.40	0.56	0.16
	October 10	14.3	0.49	0.44	-0.05
	January 13	12.2	0.37	0.52	0.15
Murphy Rd, Zillman Waterholes (Culvert)	March 01	37.2	1.05	0.88	-0.17
	May 09	22.1	0.63	0.32	-0.31
	October 10	29.0	0.73	0.56	-0.17
	January 13	21.1	0.61	0.32	-0.29
Bilsen Rd, Zillman Trib D (Culvert)	March 01	17.5	1.06	1.28	0.22
	May 09	17.3	1.02	1.38	0.36
	October 10	19.2	1.18	1.41	0.23
	January 13	17.7	1.00	1.43	0.43
College Way,	March 01	6.6	0.01	0.01	0.00

Structure	Calibration Event	Flow (m^3/s)	TUFLOW Head Loss (m)	HEC-RAS Head Loss (m)	Head Loss Difference (HEC – TUFLOW) (m)
Nundah Ck Trib F (Culvert)	May 09	5.8	0.01	0.01	0.00
	October 10	9.2	0.01	0.02	0.01
	January 13	6.3	0.01	0.01	0.00

5.6 Hydrologic-Hydraulic Model Consistency Check

Consistency checks between the calibrated hydrology and hydraulic models were carried out by comparing discharge hydrographs from the two models at each stream gauge location. The results of the consistency checks are documented in Section 4.4.

6.0 Design Event Analysis

6.1 Design Event Scenarios

For the purpose of this report, the term "design events" refers to selected events with an Average Recurrence Interval (ARI) ranging from 2 to 100 years, or AEP ranging from 50% to 1%. The term "extreme events" refers to those events with an ARI larger than 100 years.

The XP-RAFTS and TUFLOW models were used to determine both discharges and flood levels for the 2yr, 5yr, 10yr, 20yr, 50yr and 100yr ARI (50%, 20%, 10%, 5%, 2%, 1% AEP) events. These events were simulated for durations ranging from 30 minutes to 12 hours.

The following scenarios were simulated in the hydraulic model:

Scenario 1: Existing Waterway Conditions
Topography is as defined from the latest available survey and land use is for the Ultimate Catchment land use scenario as per BCC City Plan 2014.

Scenario 2: Minimum Riparian Corridor (MRC)
As for the Scenario 1 model, but with an allowance for a riparian corridor along the edge of the waterway. This is simulated as dense vegetation (i.e. Manning's 'n' value of 0.15) extending from the top of the low flow channel for a minimum width of 15 m on both sides of the creek, or until the Modelled Flood Corridor boundary is reached. Where there is no obvious low flow channel, the vegetation is applied at the anticipated 50% AEP flood level. Depending on design channel condition, some exceptions were applied. This exception was applied in areas of the catchment where obvious grass and/or concrete lined channels and design channels were in existence, and where a maintenance plan is in place. For these areas, a Manning's 'n' value of 0.08 was applied instead.

Figure 6.2 shows the adopted Minimum Riparian Corridor within the Nundah Creek catchment.

Scenario 3: Ultimate Waterway Conditions
As for the 'MRC' model but full development (in accordance with the CityPlan) is assumed outside of the 'Modelled Flood Corridor'. The Modelled Flood Corridor consists of the larger extent (envelope) of the FPA3 boundary and the Waterway Corridor (WC).

The 'ultimate case' (Scenario 3) is used to guide the setting of development levels throughout the BCC area for planning purposes. It represents the ultimate catchment land use scenario, assuming with floodplain filling associated with development up to the 'Modelled Flood Corridor' and is used to assess filling in the floodplain. This has traditionally been modelled as infinite left and right bank height markers along the boundaries of the WC and was focused primarily on the 1% AEP event.

However, the CityPlan 2014 has introduced Flood Planning Areas (FPA) which define the extent of development filling together with the Waterway Corridor (WC).

The 'Modelled Flood Corridor' can be developed by undertaking the following steps:

- Create the FPA1 to FPA3 boundaries using the Scenario 1 hydraulic model results;
- Combine the FPA1 to FPA3 boundaries into one polygon; and,
- Generate the Modelled Flood Corridor by adopting the larger extent of the combined FPA1, 2 and 3 boundary and the Waterway Corridor.

The 'Modelled Flood Corridor' should then be modelled as a vertical wall in the hydraulic model in conjunction with the MRC for design events up to 1% AEP event.

For events greater than the 1% AEP event, it is inappropriate to restrict flood waters in this way as it is not a realistic representation of what would reasonably be expected to occur during a flood event. As such, the following method for simulating Scenario 3 should be adopted:

- Ensure topography is extended sufficiently to contain anticipated PMF extents;
- Simulate the 1% AEP flood levels using vertical walls;
- Add a 300mm development freeboard (to derive the 'development level'); and,
- In areas outside the 'Modelled Flood Corridor', fill the floodplain to the development level and re-simulate the events greater than 1% AEP.

Figure 6.1 shows the Modelled Flood Corridor within the Nundah Creek catchment.

Table 6.1 indicates the three hydraulic scenarios simulated in the design modelling, noting that all design event scenarios were modelled using ultimate hydrological conditions. The following describes the hydraulic scenarios which were modelled.

Table 6.1 – Design Event Scenarios

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

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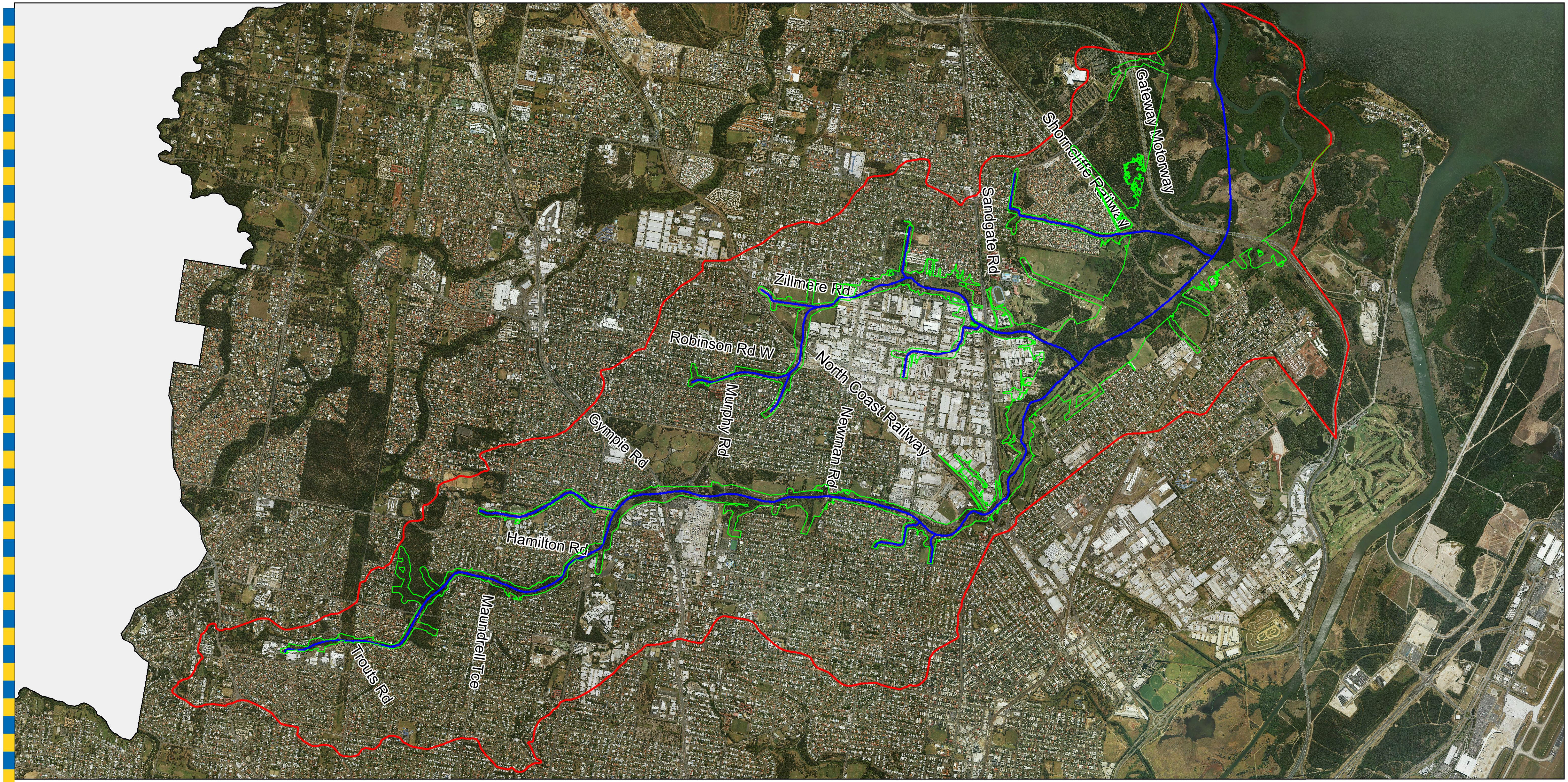

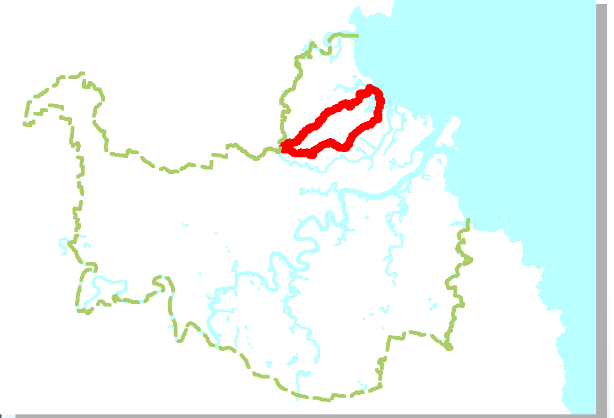

Legend

- Hydraulic Model Boundary
- Flood Corridor
- AMTD
- BCC Boundary

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Metres

Prepared :MK
Checked :MK
Revision :0
Publication Date :June 2015
Project Number : 140591

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Figure 6.1: Ultimate Scenario Modelled Flood Corridor

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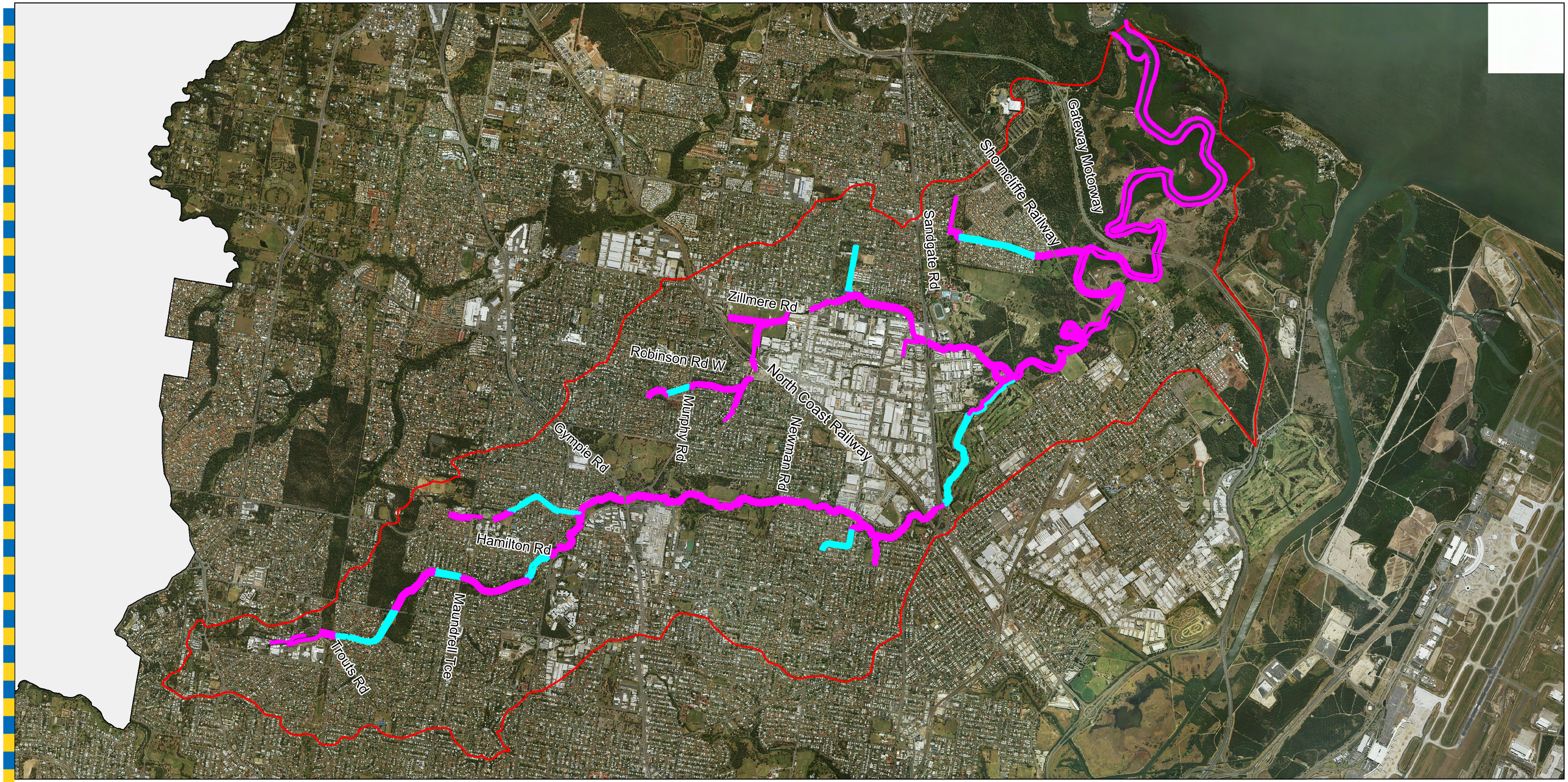

Legend

- Hydraulic Model Boundary
- MRC Manning's n = 0.15
- MRC Manning's n = 0.08
- BCC Boundary

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

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Figure 6.2: Minimum Riparian Corridor

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6.2 Design Hydrology

6.2.1 General

This section details the derivation of the design flood hydrology for the design events.

6.2.2 Available Data

The following data was available for use in the determination of the design flood hydrology:

- Calibrated 2014 XP-RAFTS and TUFLOW models;
- Australian Rainfall and Runoff (1987);
- 2004 Nundah Creek Flood Study (BCC);
- BCC aerial photography;
- NearMap aerial photography;
- Current version of BCC CityPlan (2014); and,
- BCC Cadastre and GIS databases.
- Latest BCC waterway corridor mapping (2014 CityPlan)

6.2.3 Methodology

This study utilises the synthetic design storm concept from AR&R (1987) to estimate the design ARI flood in Nundah Creek. This methodology used was as follows:

- Design Intensity Frequency Duration (IFD) estimates are determined from AR&R for the full range of storm ARIs (2yr to 100yr) and durations (30 minute to 12 hours);
- Design temporal patterns are determined and design hyetographs produced for the full range of ARIs and durations;
- Appropriate design rainfall loss parameters are adopted;
- Update the calibrated hydrology model to be suitable for simulating design flood events; and,
- Using the updated calibrated models, design storms are simulated and the peak discharges and critical durations established within the model domain.

6.2.4 XP-RAFTS Model Set-up

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

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

Appendix C indicates the XP-RAFTS catchment parameters that were adopted for the design event modelling scenarios. The current adopted version of BCC CityPlan was used to establish the ultimate catchment hydrological conditions. The adopted land-use for the ultimate catchment development is shown in Figure 6.3.

Rainfall Losses
The Initial Loss (IL) and Continuing Loss (CL) approach was used to simulate the rainfall losses in order to determine the rainfall excess. The IL is known to be the amount of rainfall that occurs before the start of surface runoff, while the CL is assumed to be the average loss rate throughout the remainder of the rainfall event.

An IL of 0 mm was adopted in the design event hydrology model, in recognition that design event rainfall is derived from the rain burst and not lead-up rainfall. This value is typically used in Brisbane City Council flood studies and is a conservative approach for initial rainfall loss estimation. A CL of 0 mm/hr was also adopted, which was determined from the results of the calibration hydrology modelling.

Considering the land use within the Nundah Creek catchment includes a significant amount of development, an IL of 0 mm and a CL of 0 mm/hr were considered appropriate for use in the design hydrology model.

Design hyetographs
Design hyetographs were derived from the techniques in AR&R. Hyetographs were created for the 2yr, 5yr, 10yr, 20yr, 50yr and 100yr ARI events. Durations of 30 minute, 45 minute, 1 hour, 1.5 hours, 2 hours, 3 hours, 4.5 hours, 6 hours, 9 hours and 12 hours were analysed.

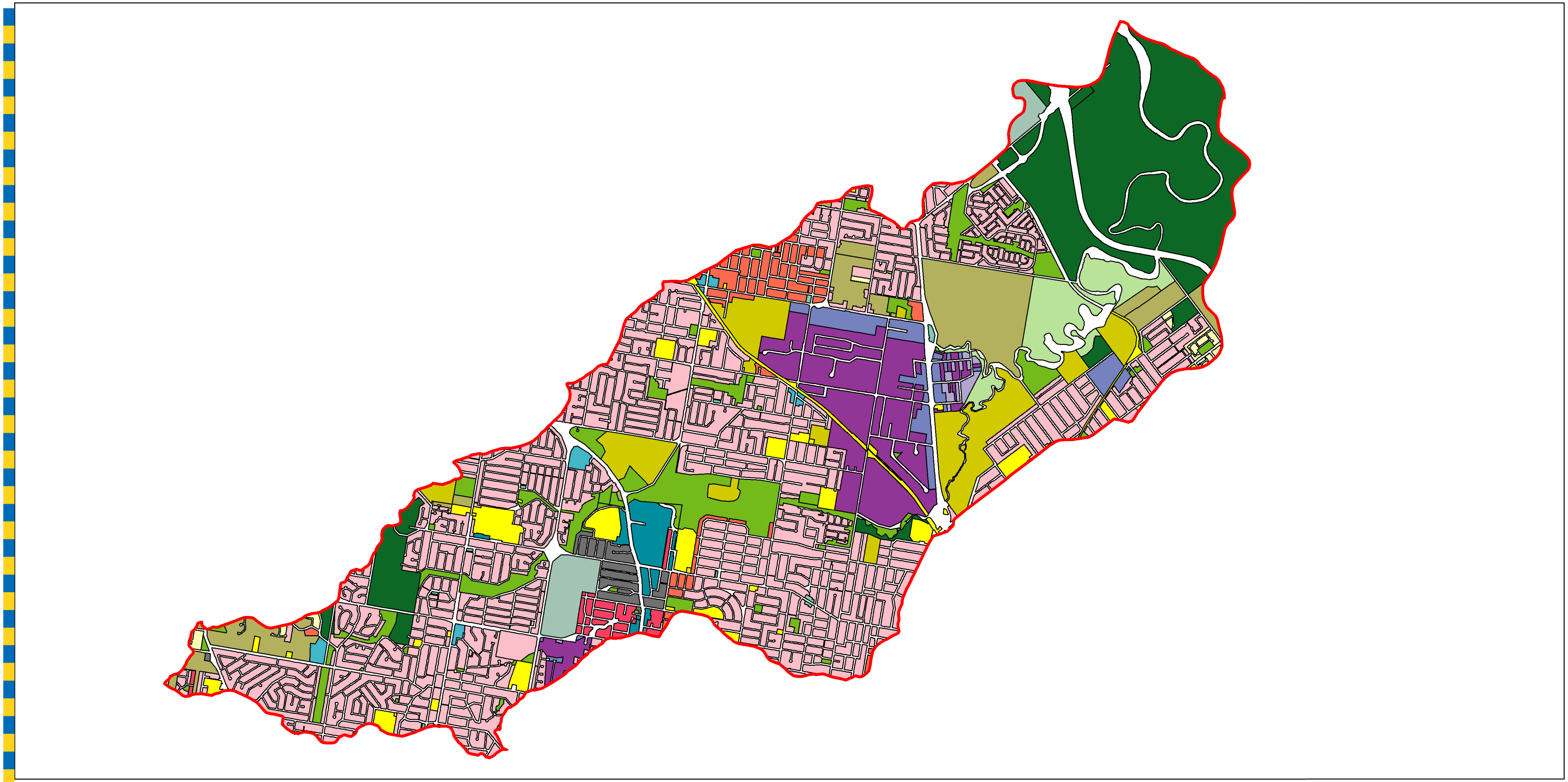
6.3 Design Hydraulics

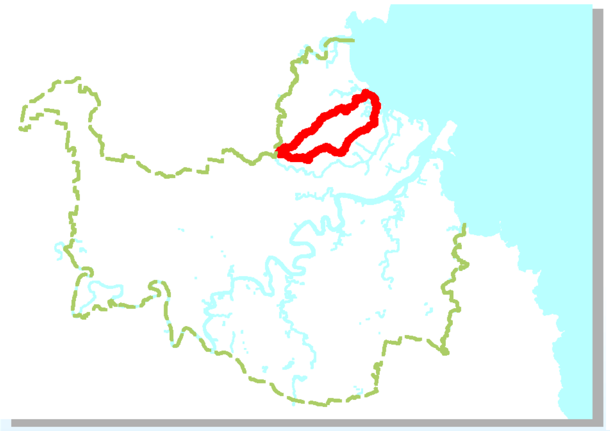
6.3.1 General

This section details the changes made to the calibrated TUFLOW model as part of the development of the hydraulic model for the design flood events.

6.3.2 TUFLOW model roughness

The hydraulic roughness in the calibrated TUFLOW model was updated as required to represent the ultimate catchment conditions as per the City Plan 2014.





Legend

Community Use Area	Low-Medium Density Resident
Conservation	Medium Density Residential
Emerging Communities	High Density Residential
Environmental Protection	Multi-Purpose Centre
Future Industry	Special Purpose Centre
General Industry	Park Land
Light Industry	Roads
Investigation Area	Rural
Low Density Residential	Sport and Recreation

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Figure 6.3: Ultimate Scenario Catchment Land Use

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6.3.3 TUFLOW model boundaries

The design inflow boundaries to the TUFLOW model were taken from the results of the XP-RAFTS model for each ARI and duration. The inflow locations did not change from the calibrated TUFLOW model.

The TUFLOW model utilised a fixed water level (H-T) boundary at its downstream extent (i.e. Moreton Bay). A Mean High Water Springs (MHWS) value of 0.77 m AHD was adopted for all design events.

It should be noted that the joint probability of fluvial and tidal events has not been considered in the modelling.

6.3.4 TUFLOW model topography

The TUFLOW model was updated for the design event modelling by including the most up-to-date catchment topography and structure details. The following topographic changes were included in the model:

- Gateway Motorway Upgrade North - Nudgee to Bracken Ridge (TMR – Works to be completed from 2014-2018). Works are in the Nundah Creek subcatchment and include the widening of the Gateway Motorway with some drainage upgrades/modifications along this route; and,
- Robinson Road West road and crossing upgrade (BCC - Completed 2014). Works are located within Zillman Waterholes upstream of the North Coast railway line.

6.4 Design Event Results

6.4.1 Design Flows and Levels

The flood levels results for the 2yr-100yr ARI (Scenario 1 and 3) events are tabulated in Appendix F and Appendix G.

The peak discharges for all modelled structures are detailed in the Hydraulic Structure Reference Sheets in Appendix E.

Longitudinal profiles for the 2-100yr ARI Scenario 1 design event flood levels are shown in Figure 6.4 to Figure 6.6.

Table 6.2 provides peak flows at selected major hydraulic structures for the Scenario 1 conditions.

Results for scenarios not detailed in this report are available in electronic format.

Table 6.2 – Design Event Peak Discharge at Selected Major Structures (Scenario 1)

Location[1]	Reach	Peak Discharge (m^3/s)					
		2yr ARI	5yr ARI	10yr ARI	20yr ARI	50yr ARI	100yr ARI
Trouts Road	Downfall Creek	28	38	44	52	60	68
Gympie Road	Downfall Creek	83	106	113	127	158	185
Newman Road	Downfall Creek	130	172	190	216	257	292
Robinson Road West	Zillman Waterholes	46	61	68	78	86	98
Gateway Mwy Bridge[2]	Nundah Creek	92	118	130	145	164	181

[1] Some major structures have not been included in the table above. This is due to the extensive weir and floodplain flow across the structure and the difficulty of accurately defining the peak discharge at the structure location

[2] Peak discharge is the peak through the structure and across the weir directly above the structure only.

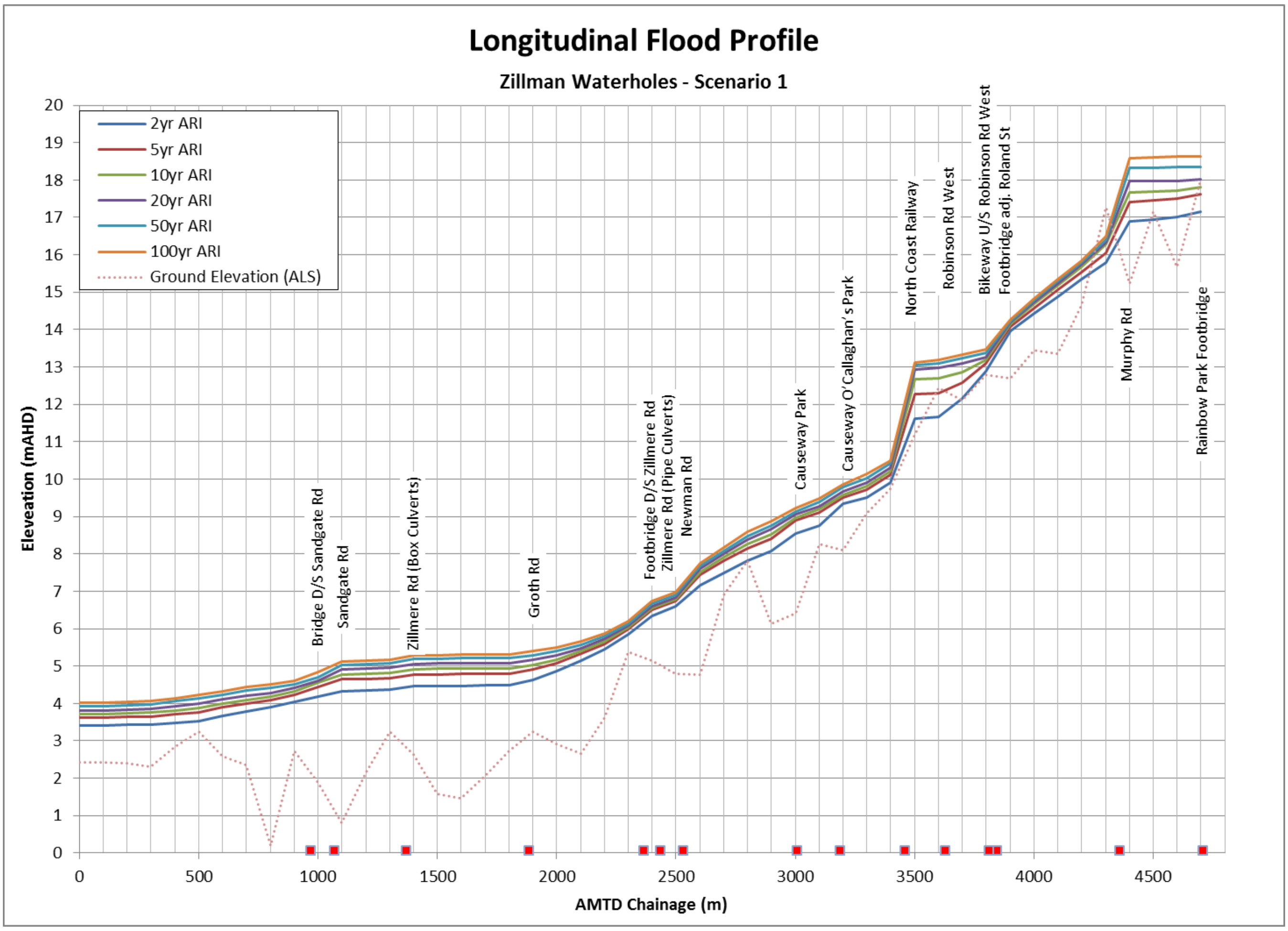

Figure 6.4 – Design Event Profile Plot – Zillman Waterholes

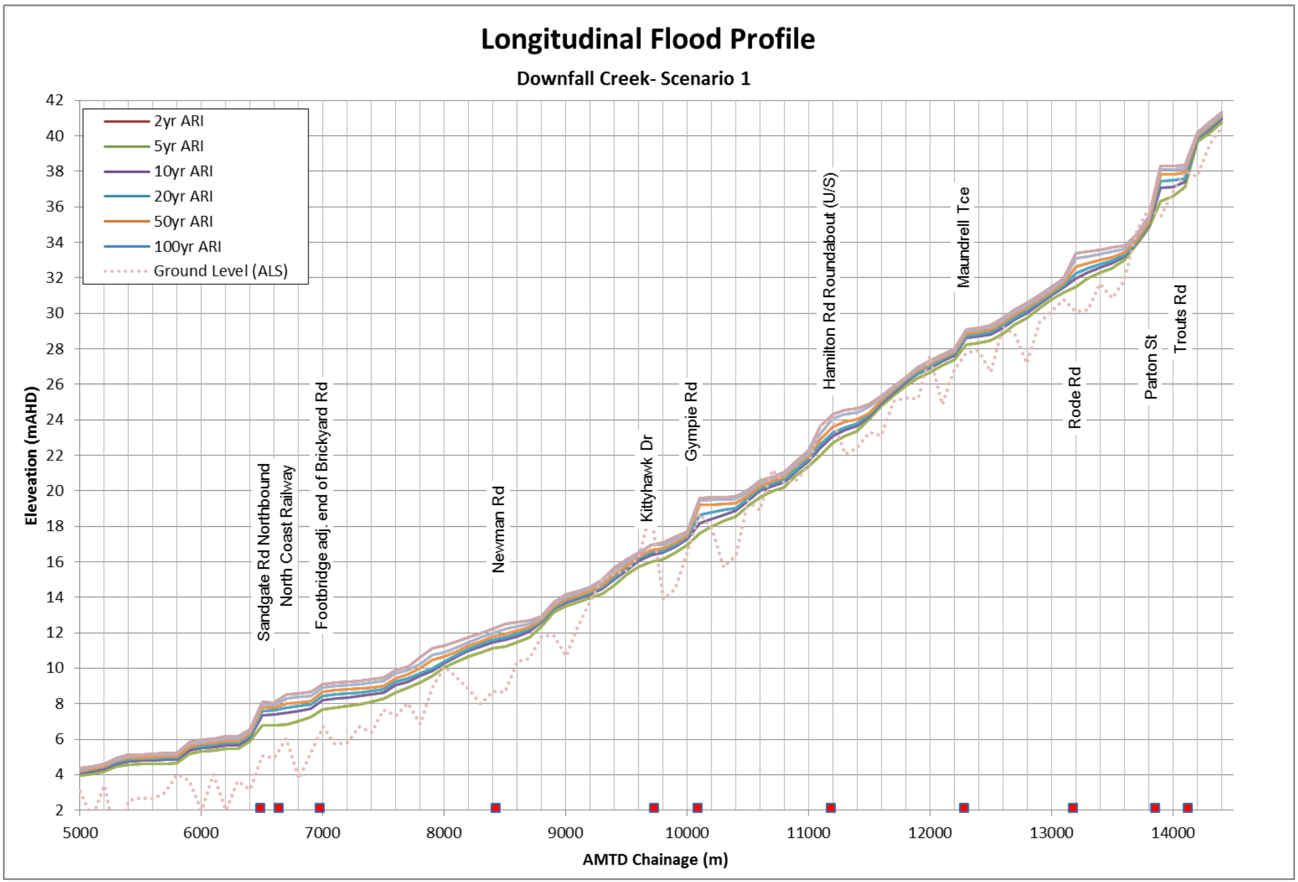

Figure 6.5 – Design Event Profile Plot – Downfall Creek

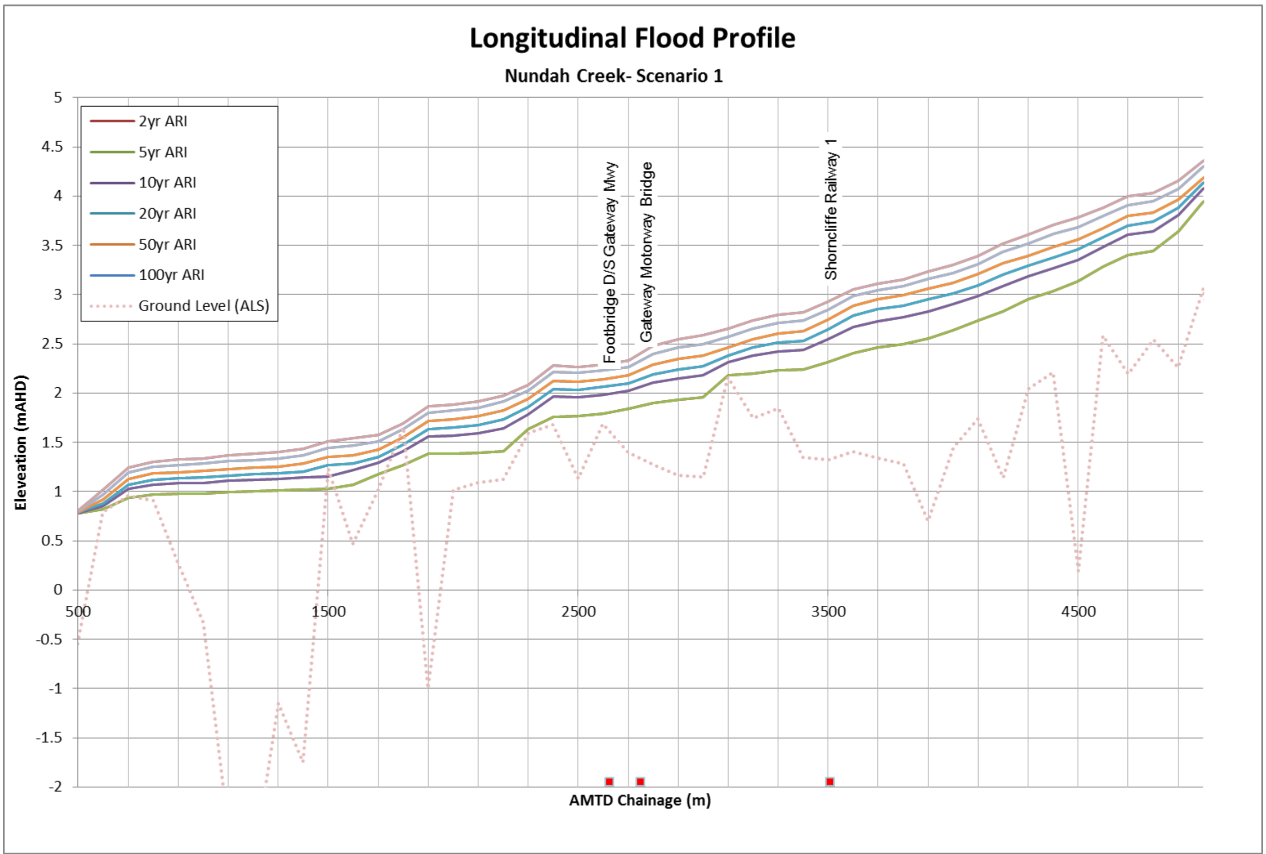

Figure 6.6 – Design Event Profile Plot – Nundah Creek

6.4.2 Critical Durations

The critical durations at key locations within the catchment for the 2-100yr ARI Scenario 1 design events are provided in Table 6.3. The critical duration is defined as the storm duration which produces the peak discharge at a specified location. The critical durations listed in the table are specified at the upstream face of the structure.

Table 6.3 – Critical Durations at Key Locations

Creek / Channel	Key Location	Critical Duration (minutes)					
		2yr ARI	5yr ARI	10yr ARI	20yr ARI	50yr ARI	100yr ARI
Downfall Creek	Trouts Rd	60	60	60	60	60	60
	Parton St	60	60	60	60	60	60
	Rode Rd	60	60	60	60	60	60
	Maundrell Tce	60	60	60	60	60	60
	Hamilton Rd Roundabout (U/S)	60	60	60	60	60	60
	Gympie Rd	60	60	60	60	60	60
	Kittyhawk Dr	60	60	60	60	60	60
	Newman Rd	60	60	60	60	60	60
	Footbridge adj. end of Brickyard Rd	90	90	90	90	90	90
	North Coast Railway	90	90	120	120	90	90
	Sandgate Rd Northbound	90	90	120	120	90	90
Zillman Waterholes	Murphy Rd	60	60	60	60	60	60
	Robinson Rd West	60	60	60	60	60	60
	North Coast Railway	60	60	60	60	60	60
	Newman Rd	60	60	60	60	60	60
	Zillmere Rd (Pipe Culverts)	60	60	60	60	60	60
	Groth Rd	60	60	60	60	60	60
	Zillmere Rd (Box Culverts)	60	60	60	60	60	60
	Sandgate Rd	60	90	90	90	90	60
Nundah Creek	Shorncliffe Railway 1	180	180	180	180	120	120
	Gateway Motorway Bridge	180	180	180	180	180	180

6.4.3 Rating Curves

Rating curves (H-Q) have been derived at the two stream gauge locations along Downfall Creek and Zillman Waterholes. The Downfall Creek (D_A564) gauge is located at the end of Brickyard Road in Geebung, whilst the Zillman Waterholes (Z_A851) gauge is located in Frank Sleeman Park in Boondall. The rating curves are shown in Figure 6.7 and Figure 6.8.

The rating curves have been averaged from a selection of Scenario 1 design event H-Q curves and are an estimate of the flooding regime at each stream gauge location.

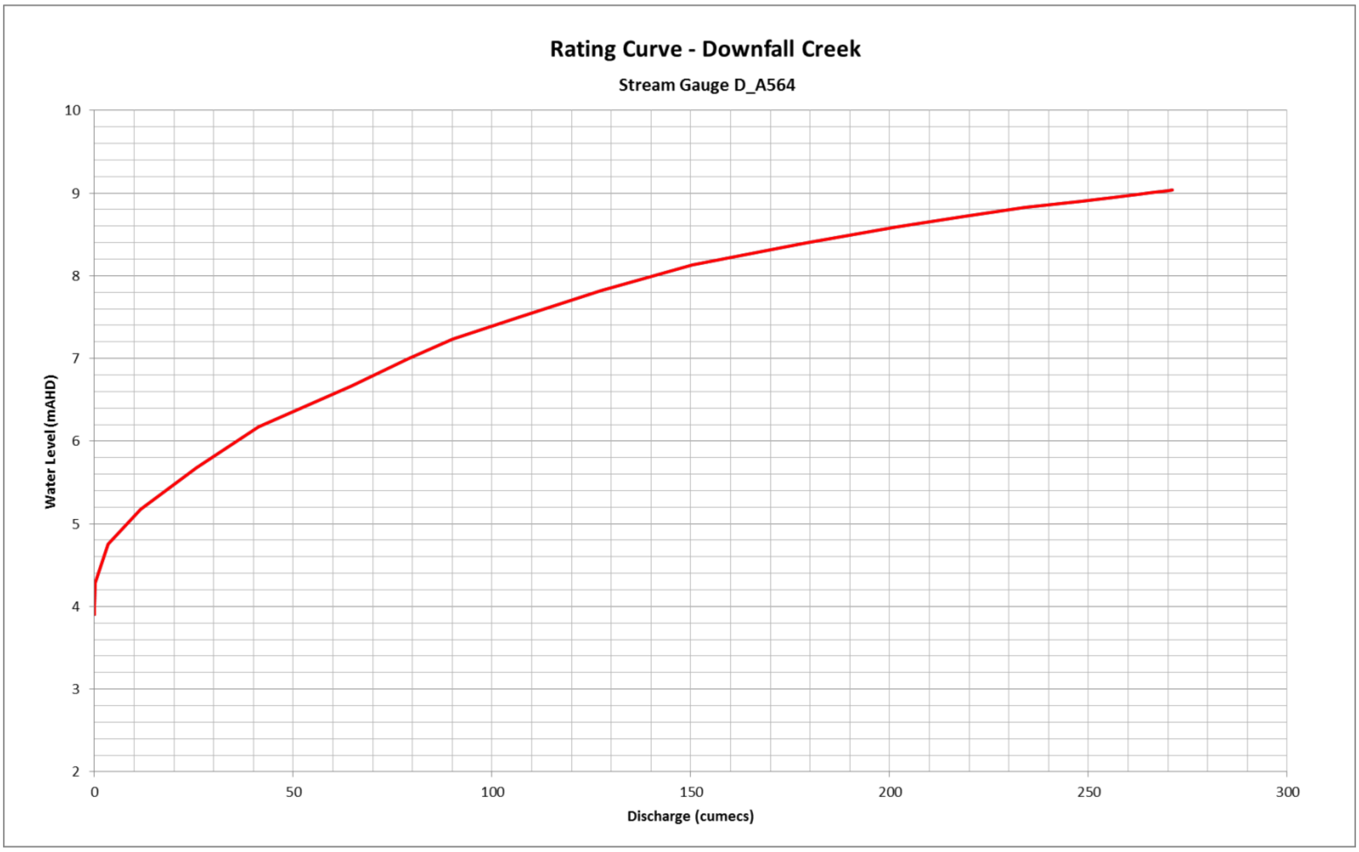

Figure 6.7 – Rating Curve (H-Q) at Stream Gauge D_A564

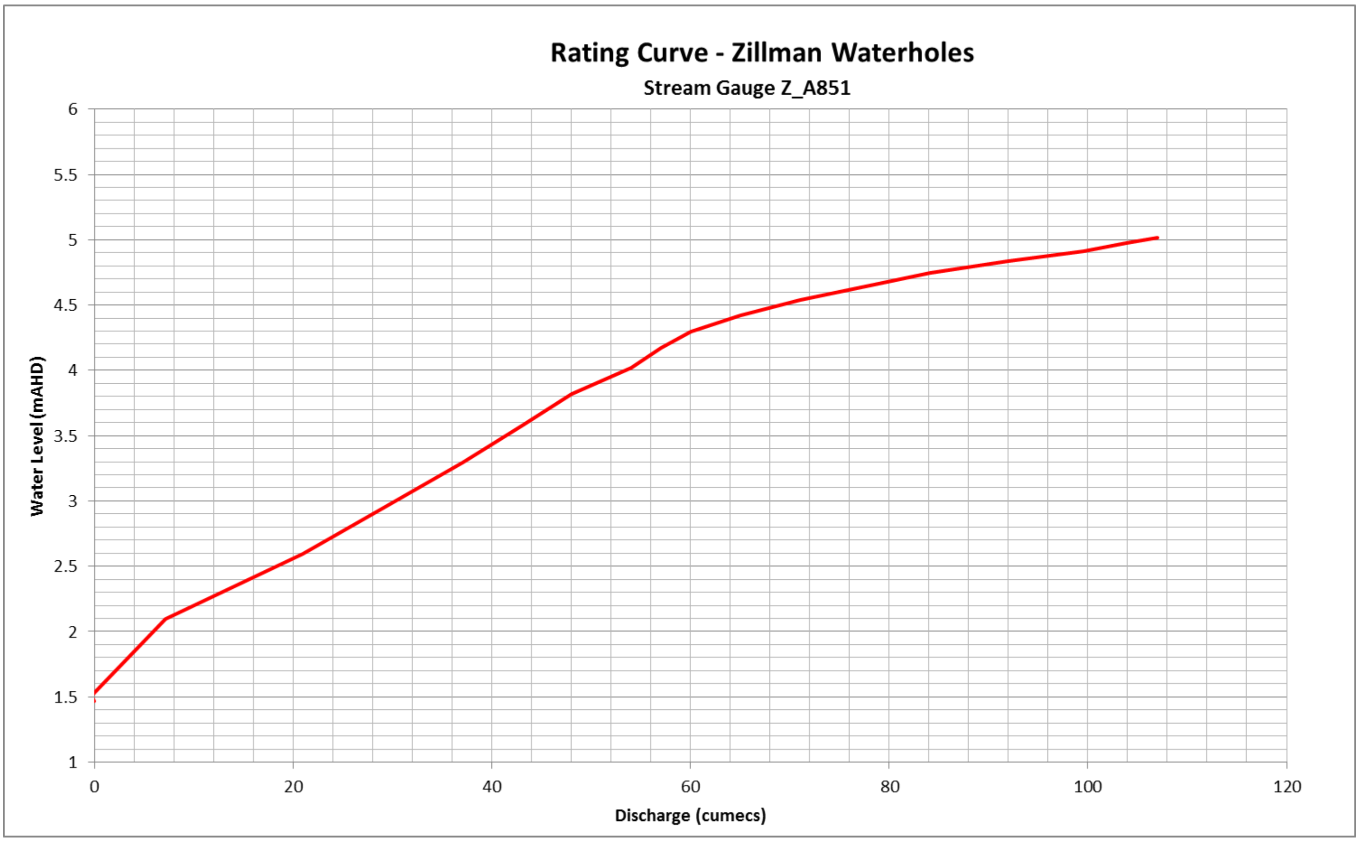

Figure 6.8 – Rating Curve (H-Q) at Stream Gauge Z_A851

6.4.4 Return Periods of Historic Events

In order to estimate the return periods of historical events modelled, the Scenario 1 flood levels results at selected locations were compared against the historical event flood levels for the calibration events.

Table 6.4 indicates the return period of the historical events at the selected locations.

Table 6.4 – Return periods of historic events

Creek / Channel	Location	Return Period (ARI years)			
		March 2001	May 2009	October 2010	January 2013
Downfall Creek	Stream Gauge DA564 - End of Brickyard Rd, Geebung	10-20yr	2-5yr	2-5yr	2-5yr
	MHG D240 - U/S Trouts Rd, Everton Park	< 2yr	< 2yr	< 2yr	< 2yr
	MHG D220 - D/S Maundrell Tce, Chermside	10-20yr	-	-	< 2yr
	MHG D230 - U/S Rode Rd, Stafford Heights	5-10yr	-	-	< 2yr
Zillman Waterholes	Stream Gauge ZA851 – Frank Sleeman Park, Boondall	-	-	-	2-5yr
	MHG Z180 - Between Murphy Rd and Robinson Rd, Geebung	< 2yr	< 2yr	2-5yr	< 2yr

Creek / Channel	Location	Return Period (ARI years)			
		March 2001	May 2009	October 2010	January 2013
	MHG Z130 - U/S Sandgate Rd, Boondall	< 2yr	2yr-5yr	2yr-5yr	< 2yr
Nundah Creek	MHG N110 (U/S Shorncliffe Railway)	< 2yr	2-5yr	2-5yr	2-5yr

6.4.5 Flood Immunity of Existing Crossings

The flood immunity of the existing waterway crossings under Scenario 1 conditions is presented in Table 6.5. The value indicated is the ARI of the largest flood which does not fully overtop the road / structure, when considering the 2-yr ARI (50% AEP) to 100-yr ARI (1% AEP) events. Interpolation between ARIs to ascertain an intermediate ARI value has not been undertaken.

Table 6.5 – Flood Immunity at Major Structures

Creek / Channel	Structure Location	Minimum Deck Level (m AHD)	Flood Immunity (ARI years) Existing
Downfall Creek	Trouts Rd	38.2	< 2yr
	Parton St	37.0	2yr
	Rode Rd	32.7	20yr
	Maundrell Tce	27.7	< 2yr
	Hamilton Rd Roundabout (U/S)	24.28	50yr
	Hamilton Rd Roundabout (D/S)	24.4	200yr
	Gympie Rd	18.61	10yr
	Kittyhawk Dr	19.2	> 2000yr
	Newman Rd	11.98	20yr
	Footbridge adj. end of Brickyard Rd	7.5	< 2yr
	North Coast Railway	8.4	50yr
	Sandgate Rd Northbound	7.24	5yr
	Sandgate Rd Southbound	8.2	> 2000yr
	Sandgate Rd Southbound Off-ramp	5.68	< 2yr
Downfall Creek Tributary A	Marban St	24.2	2yr
	Webster Rd	21.4	2yr
Zillman Waterholes	Murphy Rd	17.7	10yr
	Robinson Rd West	13.4	100yr
	North Coast Railway	12.9	10yr

Creek / Channel	Structure Location	Minimum Deck Level (m AHD)	Flood Immunity (ARI years) Existing
	Newman Rd	6.1	< 2yr
	Zillmere Rd (Pipe Culverts)	5.8	< 2yr
	Groth Rd	4.0	< 2yr
	Zillmere Rd (Box Culverts)	3.8	< 2yr
	Sandgate Rd (Northbound)	4.5	2yr
Zillman Waterholes Tributary E	Copperfield St	15.3	2yr
Zillman Waterholes Tributary D	Bilsen Rd	5.57	< 2yr
Nundah Creek	Shorncliffe Railway 1	2.9	50yr
	Gateway Motorway Bridge	4.41	> 2000yr
Nundah Creek Tributary A	College Way	2.9	50yr
	Shorncliffe Railway	2.9	50yr

6.4.6 Flood Mapping

The flood mapping products are provided in Volume 2 and include flood extent mapping for the Scenario 1 design events.

6.4.7 Hydraulic Structure Reference Sheets

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

7.0 Rare and Extreme Event Analysis

7.1 Overview

This section details the derivation of the design flood hydrology for the following extreme events:

(i) 200yr and 500yr ARI (0.5% and 0.2% AEP) events
(ii) 2000yr ARI (0.05% AEP) event, and
(iii) Probable Maximum Precipitation (PMP)

7.2 Hydrologic Modelling

The XP-RAFTS model developed as part of the design event analysis has been adopted in its unchanged form for assessing the extreme event scenarios.

All rare and extreme event modelling was undertaken using ultimate hydrological conditions, and in accordance with City Project Office's adopted methodology. The Technical Memorandum for Adopted Methodology – Extreme Events Modelling is shown in Appendix J.

7.2.1 200yr and 500yr ARI Events

The IFD rainfall data for the 200yr and 500yr ARI events was obtained using the CRC-Forge method. During this process it was found that the 200yr ARI CRC-Forge rainfall intensities were lower than the 100yr ARI AR&R rainfall intensities. Therefore, adjustments were made to the 200yr ARI rainfall intensity as follows:

$$\text{200yr ARI intensity (I)} = (\text{500yr } I_{\text{CRC-Forge}} - \text{100yr } I_{\text{AR\&R}}) \times \{(\text{200yr } I_{\text{CRC-Forge}} - \text{100yr } I_{\text{CRC-Forge}}) / (\text{500yr } I_{\text{CRC-Forge}} - \text{100yr } I_{\text{CRC-Forge}})\} + \text{100yr } I_{\text{AR\&R}}$$

Table 7.1 indicates the adopted 200yr and 500yr ARI design rainfall intensities and total depths with comparison to the adopted 100yr ARI.

Table 7.1 – Adopted IFD (200yr and 500yr ARI)

Duration (hr)	Rainfall Intensity (mm/hr)			Total Rainfall Depth (mm)		
	100yr ARI	200yr ARI	500yr ARI	100yr ARI	200yr ARI	500yr ARI
0.5	152.3	171.9	200.0	76.2	86.0	100.0
0.75	129.5	146.2	170.1	97.1	109.7	127.6
1	106.7	120.4	140.1	106.7	120.4	140.1

Duration (hr)	Rainfall Intensity (mm/hr)			Total Rainfall Depth (mm)		
	100yr ARI	200yr ARI	500yr ARI	100yr ARI	200yr ARI	500yr ARI
1.5	93.0	104.9	122.1	139.5	157.4	183.2
2	79.2	89.4	104.0	158.4	178.8	208.0
3	51.8	58.4	68.0	155.4	175.2	204.0
4.5	42.1	47.6	55.3	189.5	214.2	248.9
6	32.5	36.7	42.7	195.0	220.2	256.2
9	26.5	29.9	34.8	238.5	269.1	313.2
12	20.5	23.1	26.9	246.0	277.2	322.8

The AR&R 100yr ARI design temporal pattern was adopted for both the 200yr and 500yr ARI events.

7.2.2 2000yr ARI

The 2000yr ARI IFD rainfall was determined using the CRC-Forge method. To avoid the need to simulate all of the different storm durations, a simplified super-storm method was used. This same methodology has also been used on other BCC flood studies currently being undertaken.

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

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 the 30 minute, 1 hour, 1.5 hours, 2 hours, and 3 hours storm bursts. Durations less than 30 minutes were not considered. The total rainfall depth of the super-storm was set equal to the 6 hour 2000yr ARI CRC-Forge rainfall depth (representative across the Brisbane region), which was determined as 340 mm.

7.2.3 PMP

For the PMP scenario, the 6 hour super-storm approach was also undertaken using the same temporal pattern as the 2000yr ARI.

The total PMP depth was derived from the 6 hour storm duration using the Generalised Short Duration Method (GSDM). For the tropical and sub-tropical coastal areas it is recommended that this method is to be used to estimate the PMP over areas up to 520 km^2 and for durations up to 6 hours. To apply a consistent methodology across the majority of

BCC an average catchment size of 60 km^2 and moisture adjustment factor of 0.85 were adopted.

The total rainfall depth of the super-storm was set equal to the 6 hour GSDM PMP rainfall depth (representative across the Brisbane region), which was determined as 816 mm.

Table 7.2 indicates the adopted super-storm temporal pattern and hyetographs for the 2000yr ARI and the PMP.

Table 7.2 – Adopted Super-storm Hyetographs

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

7.3 Hydraulic Modelling

7.3.1 General

This section details the changes made to the design TUFLOW model as part of the development of the hydraulic model for the extreme flood events.

7.3.2 Modelled Scenarios

The TUFLOW model was used to determine both discharges and flood levels for the 200yr ARI, 500yr ARI, 2000yr ARI and the PMF (Probable Maximum Flood).

Table 7.3 indicates the hydraulic scenarios considered in the extreme event modelling, noting that all extreme event scenarios were modelled using ultimate hydrological conditions.

Table 7.3 – Extreme Event Scenarios

ARI (year)	Scenario 1	Scenario 2	Scenario 3
200	✓	✗	✓
500	✓	✗	✓
2000	✓	✗	✗
PMF	✓	✗	✗

7.3.3 TUFLOW model roughness

Generally, no changes were made from the design event TUFLOW model(s). Some very minor changes were made to the roughness layer in the TUFLOW model around Gympie Road for model stability.

7.3.4 TUFLOW model topography

Some very minor changes were made to the topographic layer in the TUFLOW model around Gympie Road and the Sandgate Road Overpass (Downfall Creek) for model stability. In addition, for modelling extreme events – scenario 3 for events greater than the 1% AEP event, it is inappropriate to restrict flood waters in this way as it is not a realistic representation of what would reasonably be expected to occur during a flood event. As such, the following method for simulating Scenario 3 should be adopted:

- Ensure topography is extended sufficiently to contain anticipated PMF extents;
- Simulate the 1% AEP flood levels using vertical walls;
- Add a 300mm development freeboard (to derive the ‘development level’); and,
- In areas outside the ‘Modelled Flood Corridor’, fill the floodplain to the development level and re-simulate the events greater than 1% AEP.

7.3.4.1 Stretching

In order to create the “Stretched Scenario 3” flood surfaces, the Scenario 3 “ultimate” flood level surfaces were firstly required to be generated. As previously discussed in Section 6.1, the ultimate scenario involves modifying the flood model topography to represent a fully developed (filled) floodplain in accordance with City Plan and in most instances making further allowances for a riparian corridor. This process generally results in design flood levels being increased, when compared with Scenario 1 "existing" flood levels. Council requires these increased levels to then be mapped against the current floodplain topography thus providing a flood extent that is conservative; in most cases extends beyond the "existing" flood extent and 'flags' the additional properties that could potentially be at flood risk in the future and should have development controls (planning levels) applied. WaterRIDE was utilised for the purpose of stretching the Scenario 3 "ultimate" case results and producing the "Stretched Scenario 3" flood levels and surfaces. The WaterRIDE 'buffer width' tool was used, whereby the surface is extended by an equal number of grid cells (or TIN triangles) as a buffer around the current wet cells. A minimum depth threshold is used to determine what surrounding cells (within the buffer width) are considered 'available' for stretching. For this purpose, a value of 200 was used for the buffer width and -5 for the minimum depth threshold. Using these high values / tolerances ensured the flood surface was initially stretched far beyond the realistic limit of stretching.

From experience to date, it is known that there are inherent anomalies with the stretching process and some degree of manual intervention is typically required by an experienced / skilled practitioner to produce a more realistic stretched flood surface.

7.3.5 TUFLOW model boundaries

The extreme event inflow boundaries to the TUFLOW model were taken from the results of the XP-RAFTS model for each ARI and duration. The inflow locations did not change from the design event TUFLOW model.

The TUFLOW model utilised a fixed water level (H-T) boundary at its downstream extent (i.e. Moreton Bay). A Highest Astronomical Tide (HAT) value of 1.31 m AHD was adopted for all extreme events.

7.3.6 Hydraulic Structures

All extreme event TUFLOW models incorporated the same hydraulic structures as the design event TUFLOW models, with the exception of the following structures, which were removed due to their negligible flood impact and/or for model stability;

2000yr ARI Event

- Sandgate Rd Northbound – Downfall Creek
- Causeway in O'Callaghan's Park – Zillman Waterholes

PMF Event

- Sandgate Rd Northbound – Downfall Creek
- Sandgate Rd Overpass – Downfall Creek
- Maundrell Terrace – Downfall Creek Tributary A
- Causeway in O'Callaghan's Park – Zillman Waterholes
- Causeway in Park – Zillman Waterholes
- Sandgate Road Northbound – Zillman Waterholes

7.4 Results and Mapping

7.4.1 Peak Flood Levels

Tabulated peak flood levels for the rare and extreme events are provided at the following locations:

- Scenario 1: 200yr ARI to 2000yr ARI events – Appendix F
- Scenario 3: 200yr and 500yr ARI events – Appendix G

Longitudinal profiles for the 200, 500 and 2000yr ARI and PMF Scenario 1 design event flood levels are shown in
Figure 7.1 to Figure 7.3.

Results for scenarios not detailed in this report are available in electronic format.

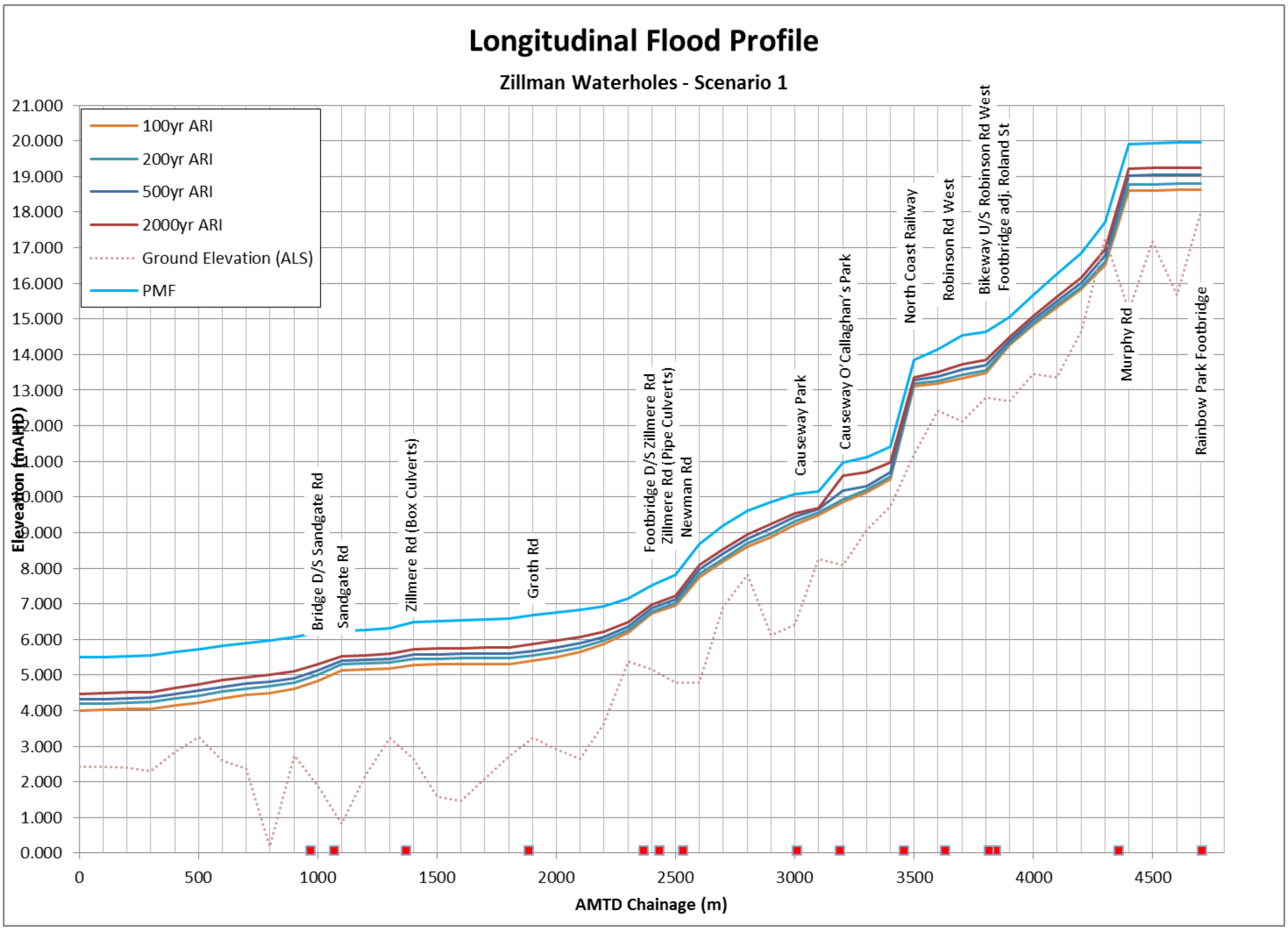

Figure 7.1 – Extreme Event Profile Plot – Zillman Waterholes

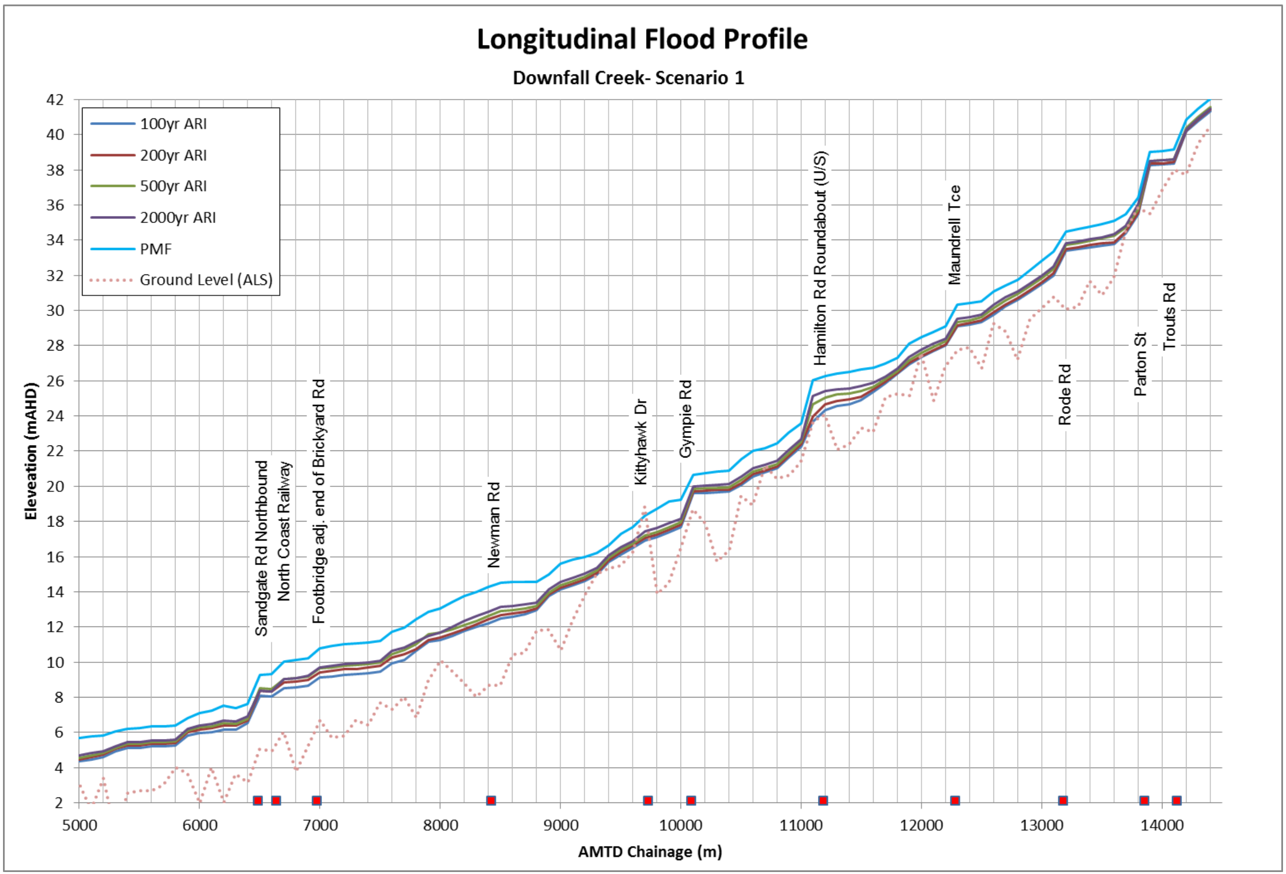

Figure 7.2 – Extreme Event Profile Plot – Downfall Creek

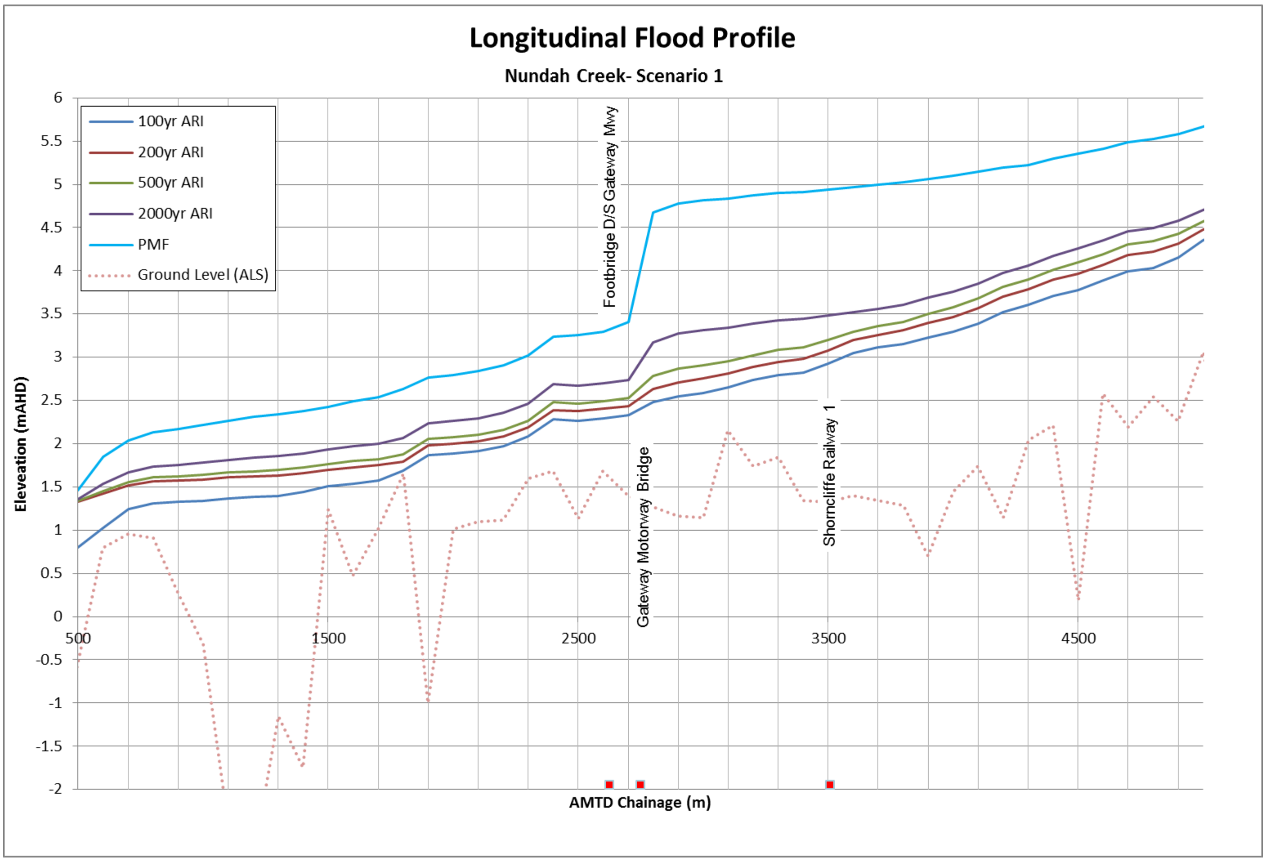

Figure 7.3 – Extreme Event Profile Plot – Nundah Creek

7.4.2 Flood Mapping

The flood mapping products are provided in Volume 2 and include flood extent mapping for the Scenario 1 extreme events.

8.0 Sensitivity Analysis

8.1 Overview

This section details the sensitivity analysis undertaken in the design and extreme event TUFLOW hydraulic models, in particular assessing the effects of climate variability.

8.2 Climate Variability

Council's Natural Environment, Water and Sustainability (NEWS) Branch required longer term planning horizons to be considered in their program of flood studies by considering extreme flood events and potential climate variability impacts. At this time, State Planning Policy 3/11 (now superseded by the Coastal Protection State Planning Regulatory Provision) and the Inland Flood Study (DERM, 2010) had provided guidance on assessing the potential impacts on communities and development of projected climate variability effects, including sea level rise and increased rainfall intensities.

The SPP 3/11 outlined the following factors to be used by local government to determine planning levels for appropriate planning horizons (2050, 2070 and 2100):

- A sea-level rise factor of 0.8 metres;
- An increase in the maximum cyclone intensity by 10 per cent; and
- Where a relevant storm-tide inundation assessment has not been completed in relation to a proposed development, the coastal hazard area is taken to be all land between high water mark and a minimum default 100-year Design Storm Tide Event level of 1.5 metres above the level of Highest Astronomical Tide for all developments in SEQ.

The Inland Flooding Study outlines the rationale for adopting an interim methodology for assessing flooding risk in Queensland:

1. The proposed methodology is to factor a 5 per cent increase in rainfall intensity at Annual Exceedance Probabilities (AEP) of 1% (100yr ARI), 0.5% (200yr ARI) and 0.2% (500yr ARI) per degree of global temperature increase for all rainfall events recommended in SPP 1/03 for the location and design of new development.
2. The following temperatures and timeframes should be used for the purposes of applying the climate variability factor in Recommendation 1:

    a) 2C by 2050
    b) 3C by 2070
    c) 4C by 2100

To enable BCC to understand and plan for the impacts of climate variability on flooding in the Nundah Creek Catchment, an analysis was undertaken, which can be summarised as follows:

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

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

8.2.1 Modelled Scenarios

The TUFLOW model was used to determine climate variability impacts for the 100yr, 200yr and 500yr ARI events. Table 8.1 indicates the events modelled and the respective climate variability modifications undertaken.

Table 8.1 – Climate Variability Modelling Scenarios

Event	Scenario	Rainfall Condition	Adopted Tailwater	
			Condition	Level (m AHD)
100-yr ARI (2050)	1 and 3	+ 10%	MHWS + 0.3 m	1.07
100-yr ARI (2100)	1 and 3	+ 20%	MHWS + 0.8 m	1.57
200-yr ARI (2050)	1	+ 10%	HAT + 0.3 m	1.61
200-yr ARI (2100)	1	+ 20%	HAT + 0.8 m	2.11
500-yr ARI (2100)	1	+ 20%	HAT + 0.8 m	2.11

The rainfall intensity in the XP-RAFTS model was increased by 10% (or 20%) and simulations undertaken to determine the climate variability hydrographs. These hydrographs were then input into the Scenario 1 and 3 TUFLOW models and simulations undertaken for all climate variability scenarios.

8.2.2 TUFLOW model topography

Generally, no changes were made from the design event TUFLOW model(s). Some very minor changes were made (for model stability) to the topographic layer in the TUFLOW model around Gympie Road and the Sandgate Road Overpass (Downfall Creek) for the 500yr ARI CC2100 events.

8.2.3 Hydraulic Structures

All Climate Variability event TUFLOW models incorporated the same hydraulic structures as the design event TUFLOW models, with the exception of the two causeway structures along Zillman Waterholes, which were removed for the 500yr ARI CC2100 event.

8.2.4 Tabulated Results

Results for the climate variability events are available in electronic format.

Longitudinal profiles for the 100-500yr ARI Scenario 1 design event flood levels are shown in Figure 8.1 to Figure 8.3.

Results for scenarios not detailed in this report are available in electronic format.

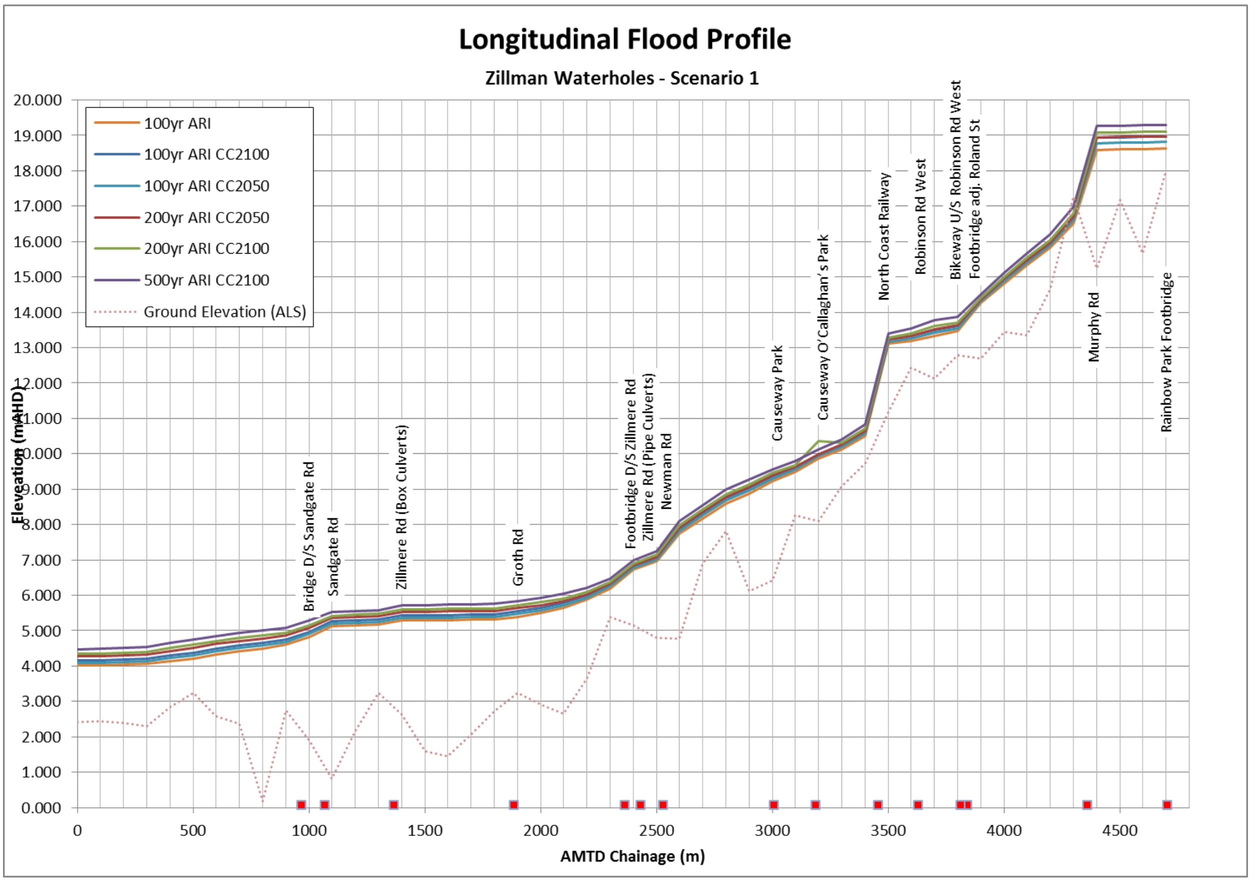

Figure 8.1 – Climate Variability Event Profile Plot – Zillman Waterholes

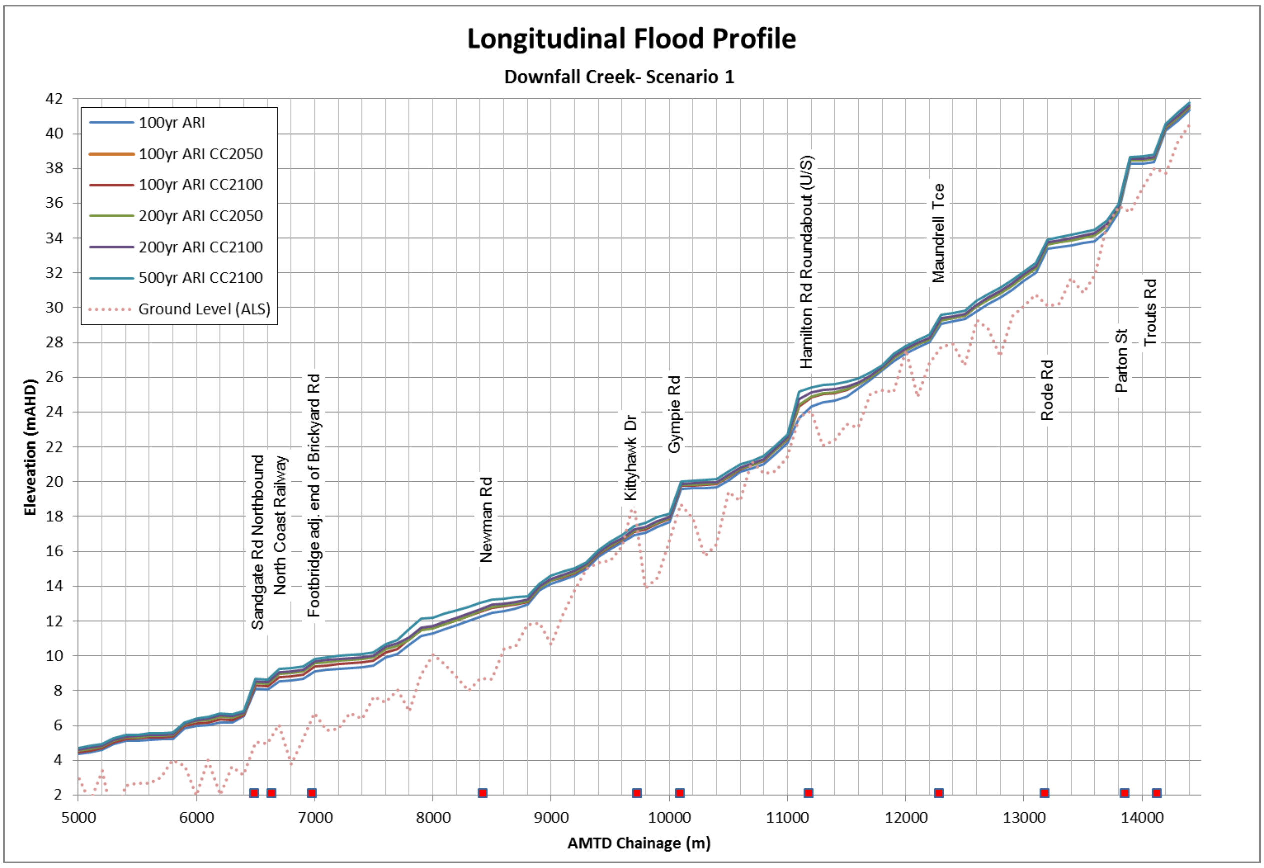

Figure 8.2 – Climate Variability Event Profile Plot – Downfall Creek

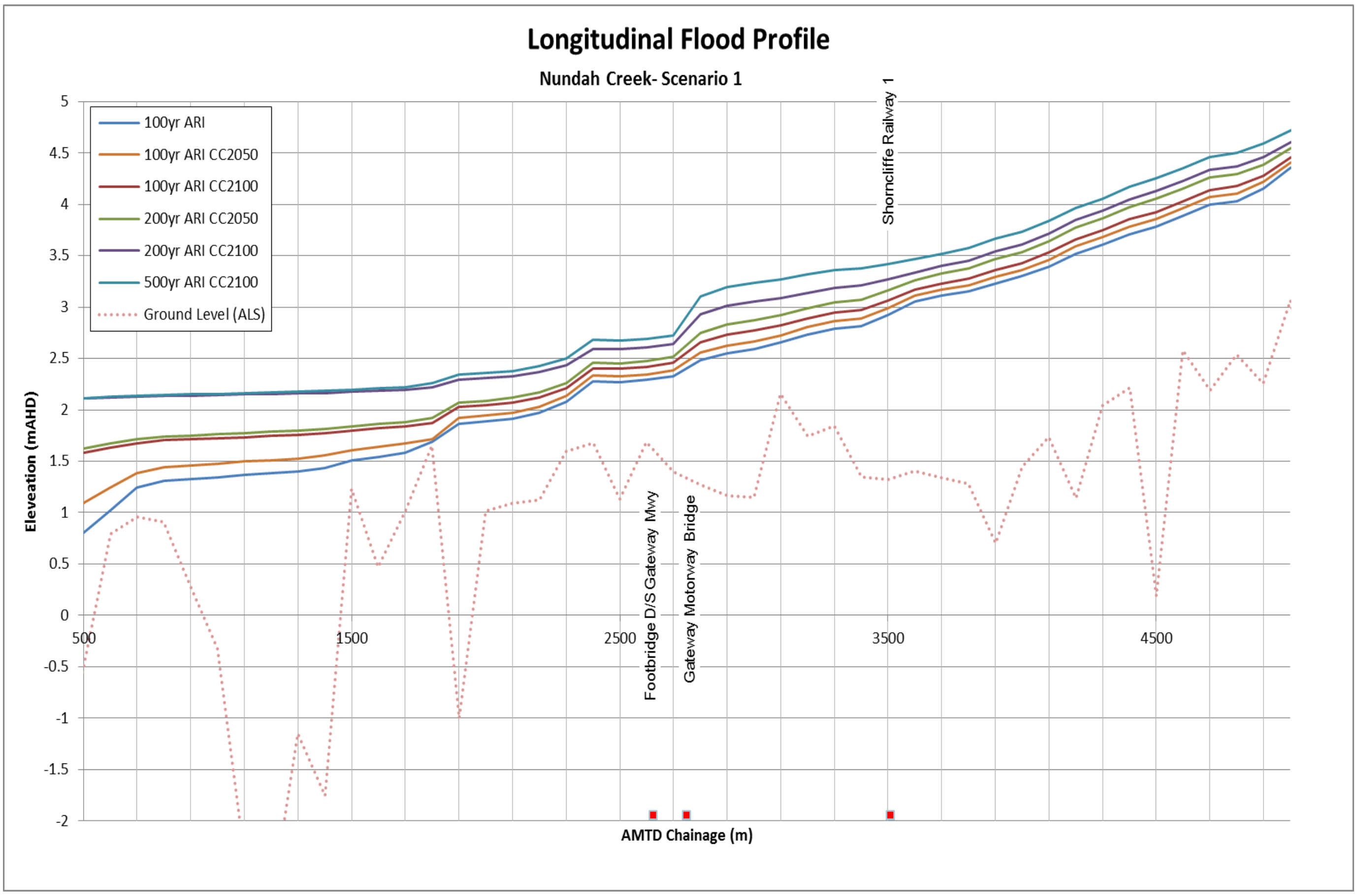

Figure 8.3 – Climate Variability Event Profile Plot – Nundah Creek

9.0 Summary of Findings

This flood study report details the calibration, design events, extreme events and sensitivity modelling for Nundah Creek. An updated hydrologic model and a new hydraulic model have been developed for the study using the XP-RAFTS and TUFLOW modelling software respectively.

Hydrometric data was sourced from the available recorded rainfall data. Numerous MHG's are present within the catchment, however only two continuous stream gauges exist. Calibration of the XP-RAFTS and TUFLOW models was undertaken for the January 2013, October 2010, May 2009 and March 2001 events.

The results of the hydraulic calibration indicated that, in general, the XP-RAFTS and TUFLOW models were able to satisfactorily replicate the historical flooding events to within the specified tolerances. On this basis, it was concluded that the XP-RAFTS and TUFLOW models were sufficiently robust to be used to accurately simulate design flood events.

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

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

Three waterway scenarios were considered as follows:

- Scenario 1 is based on the current waterway conditions and ultimate land use as per City Plan 2014. Some topographical changes were made to the TUFLOW model developed as part of the calibration phase, including the Robinson Road upgrade and the Gateway Motorway upgrade design;
- Scenario 2 includes an allowance for a riparian corridor along the edge of the channel; and,
- Scenario 3 includes an allowance for the riparian corridor (as per Scenario 2) and also assumes filling to the Modelled Flood Corridor boundary to simulate potential development.

The results from the TUFLOW modelling were used to produce the following:

- Peak flood discharges at selected locations;
- Critical storm durations at selected locations;
- Peak flood levels at 100 m intervals along the AMTD line ;
- Peak flood extent mapping; and,
- Hydraulic structure flood immunity data

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

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

Appendix A: Cumulative Rainfall Distribution for Calibration Events

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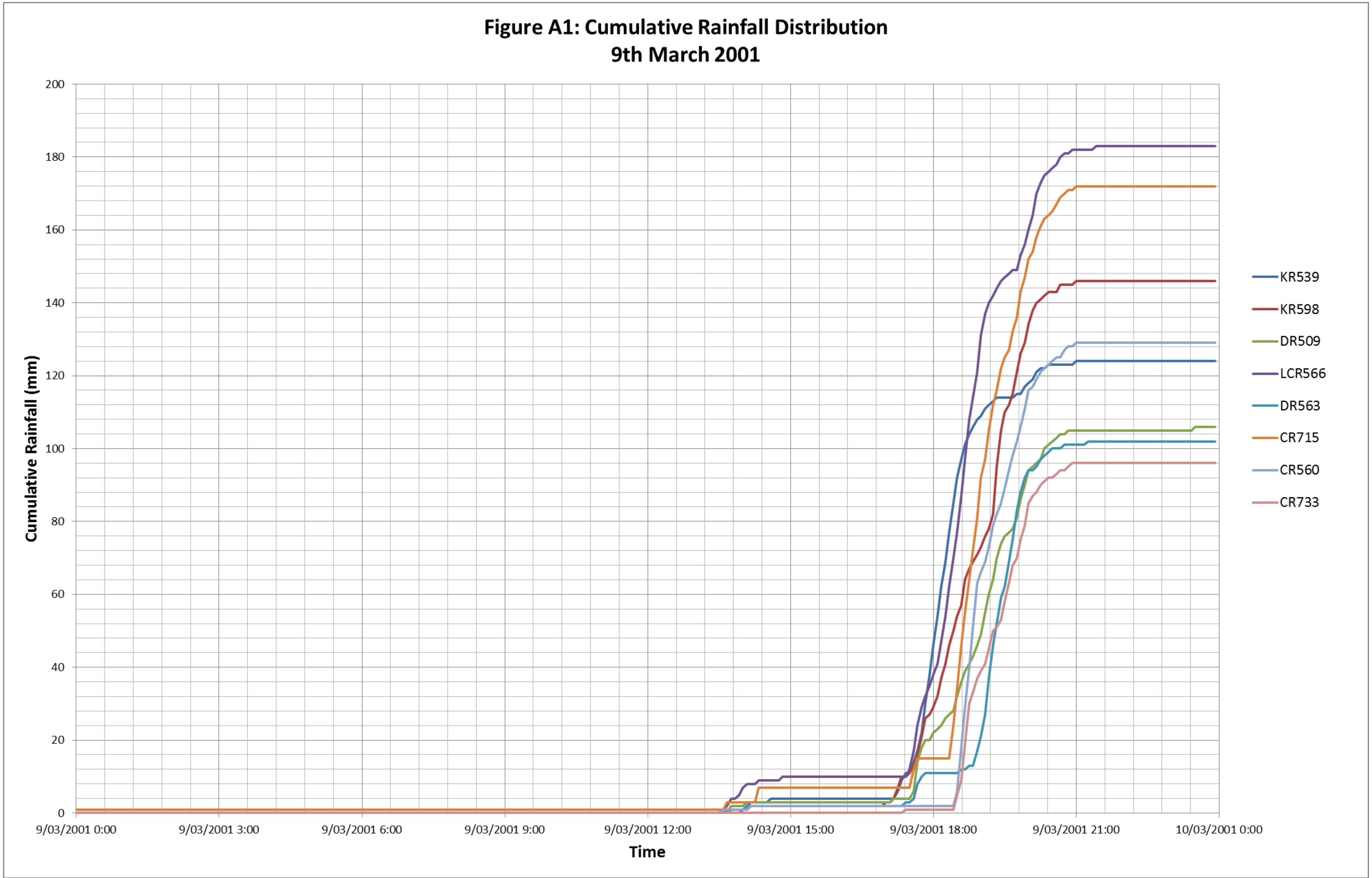
Figure A1: Cumulative Rainfall Distribution
9th March 2001
Cumulative Rainfall (mm)
200
180
160
140
120
100
80
60
40
20
0
9/03/2001 0:00
9/03/2001 3:00
9/03/2001 6:00
9/03/2001 9:00
9/03/2001 12:00
9/03/2001 15:00
9/03/2001 18:00
9/03/2001 21:00
10/03/2001 0:00
Time
KR539
KR598
DR509
LCR566
DR563
CR715
CR560
CR733

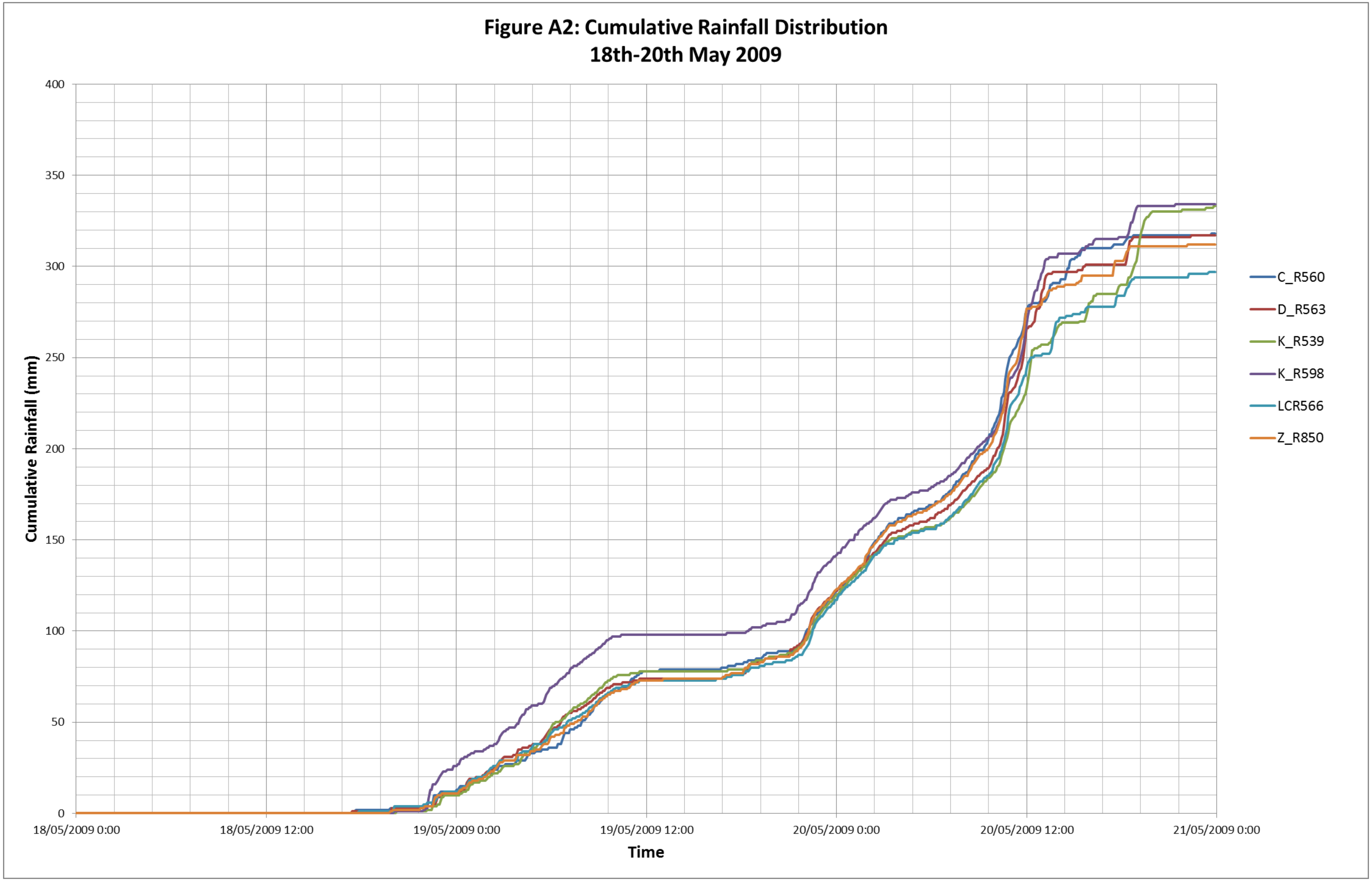

Figure A2: Cumulative Rainfall Distribution
18th-20th May 2009
Cumulative Rainfall (mm)
400
350
300
250
200
150
100
50
0
18/05/2009 0:00
18/05/2009 12:00
19/05/2009 0:00
19/05/2009 12:00
20/05/2009 0:00
20/05/2009 12:00
21/05/2009 0:00
Time
C_R560
D_R563
K_R539
K_R598
LCR566
Z_R850

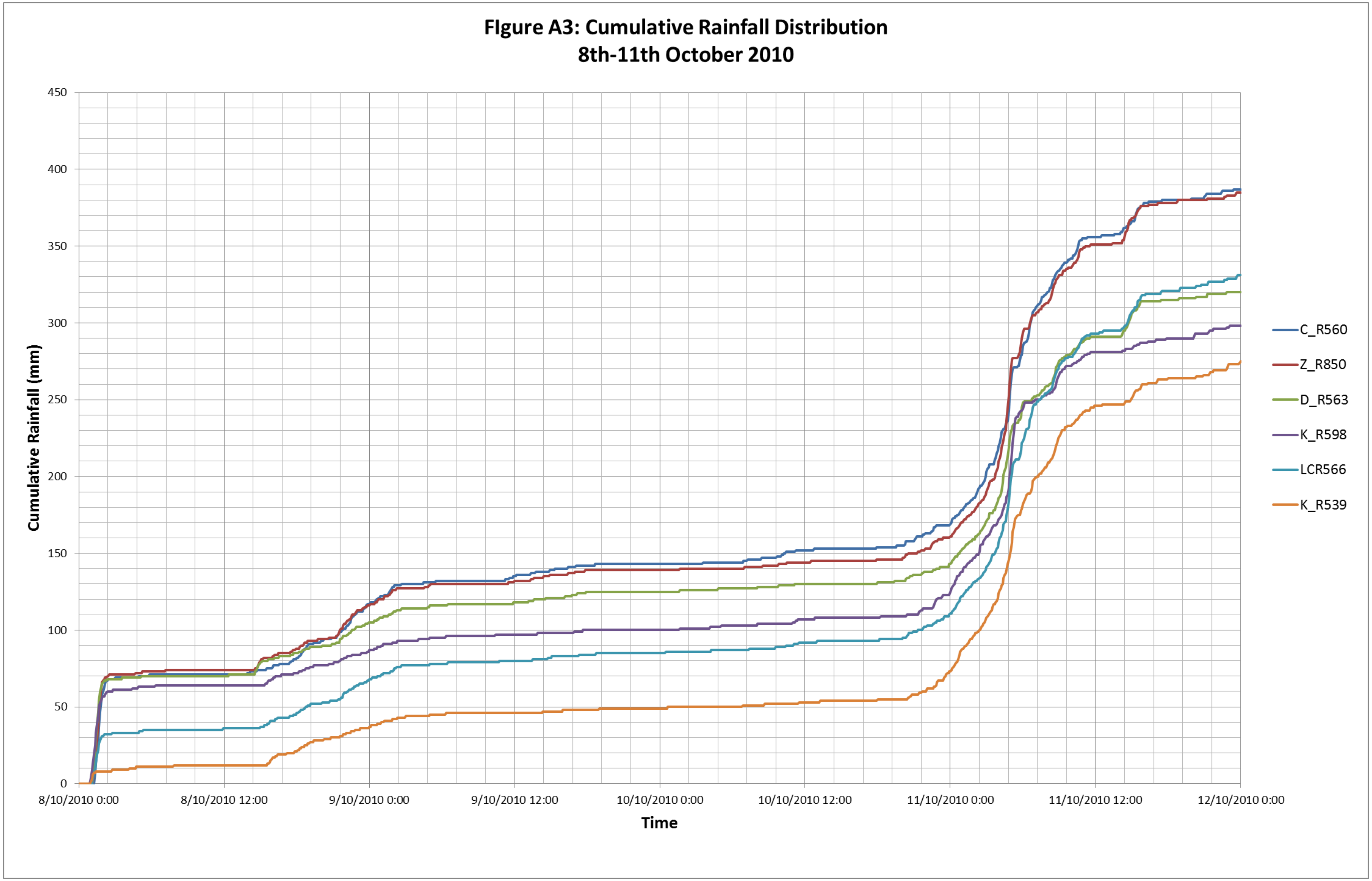
FIgure A3: Cumulative Rainfall Distribution
8th-11th October 2010
Cumulative Rainfall (mm)
450
400
350
300
250
200
150
100
50
0
8/10/2010 0:00
8/10/2010 12:00
9/10/2010 0:00
9/10/2010 12:00
10/10/2010 0:00
10/10/2010 12:00
11/10/2010 0:00
11/10/2010 12:00
12/10/2010 0:00
Time
C_R560
Z_R850
D_R563
K_R598
LCR566
K_R539

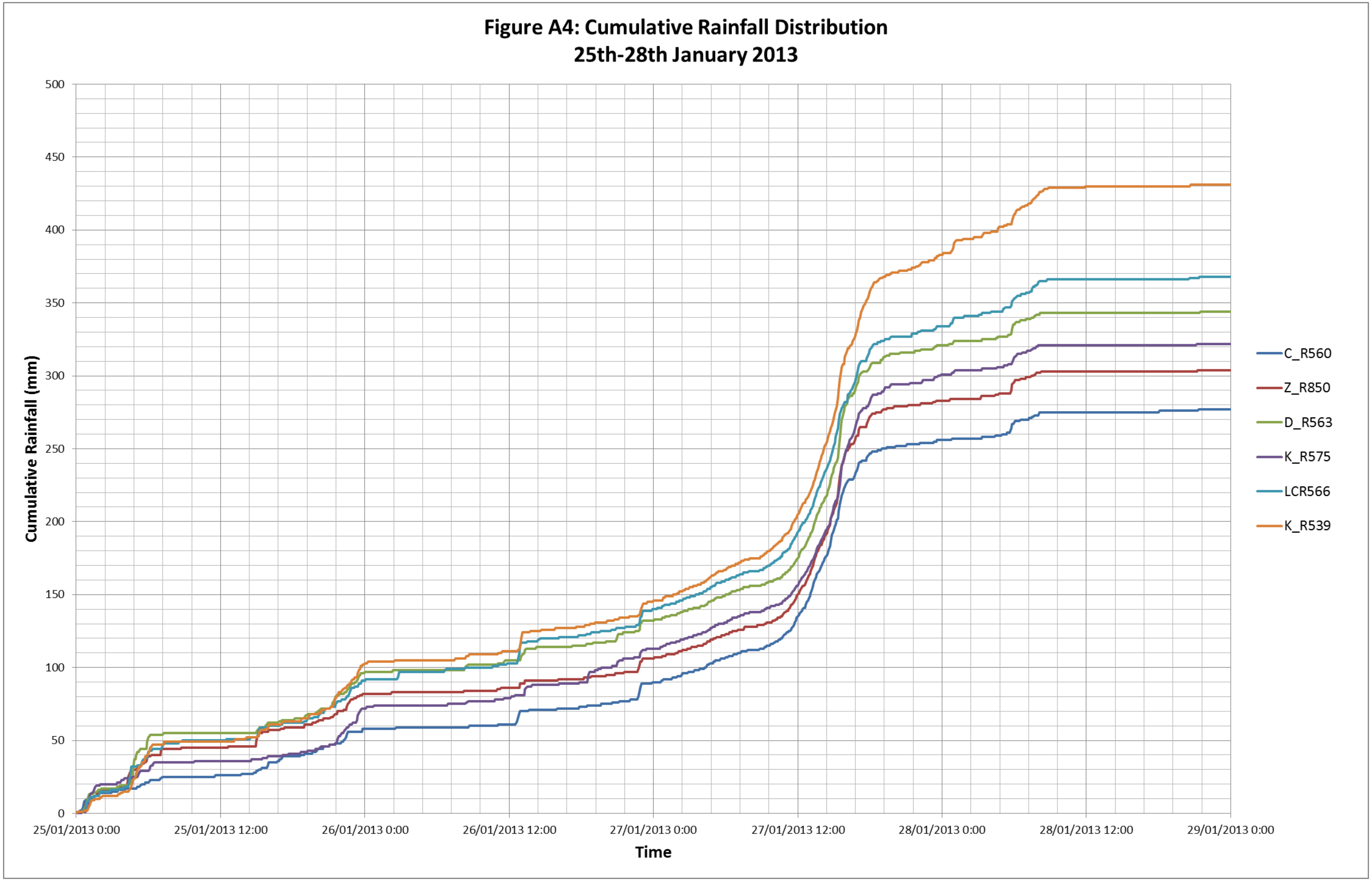
Figure A4: Cumulative Rainfall Distribution
25th-28th January 2013
Cumulative Rainfall (mm)
500
450
400
350
300
250
200
150
100
50
0
25/01/2013 0:00
25/01/2013 12:00
26/01/2013 0:00
26/01/2013 12:00
27/01/2013 0:00
27/01/2013 12:00
28/01/2013 0:00
28/01/2013 12:00
29/01/2013 0:00
Time
C_R560
Z_R850
D_R563
K_R575
LCR566
K_R539

Appendix B: Intensity-Frequency-Duration Plots for Calibration Events

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Figure B1: IFD Curve- March 2001 Event

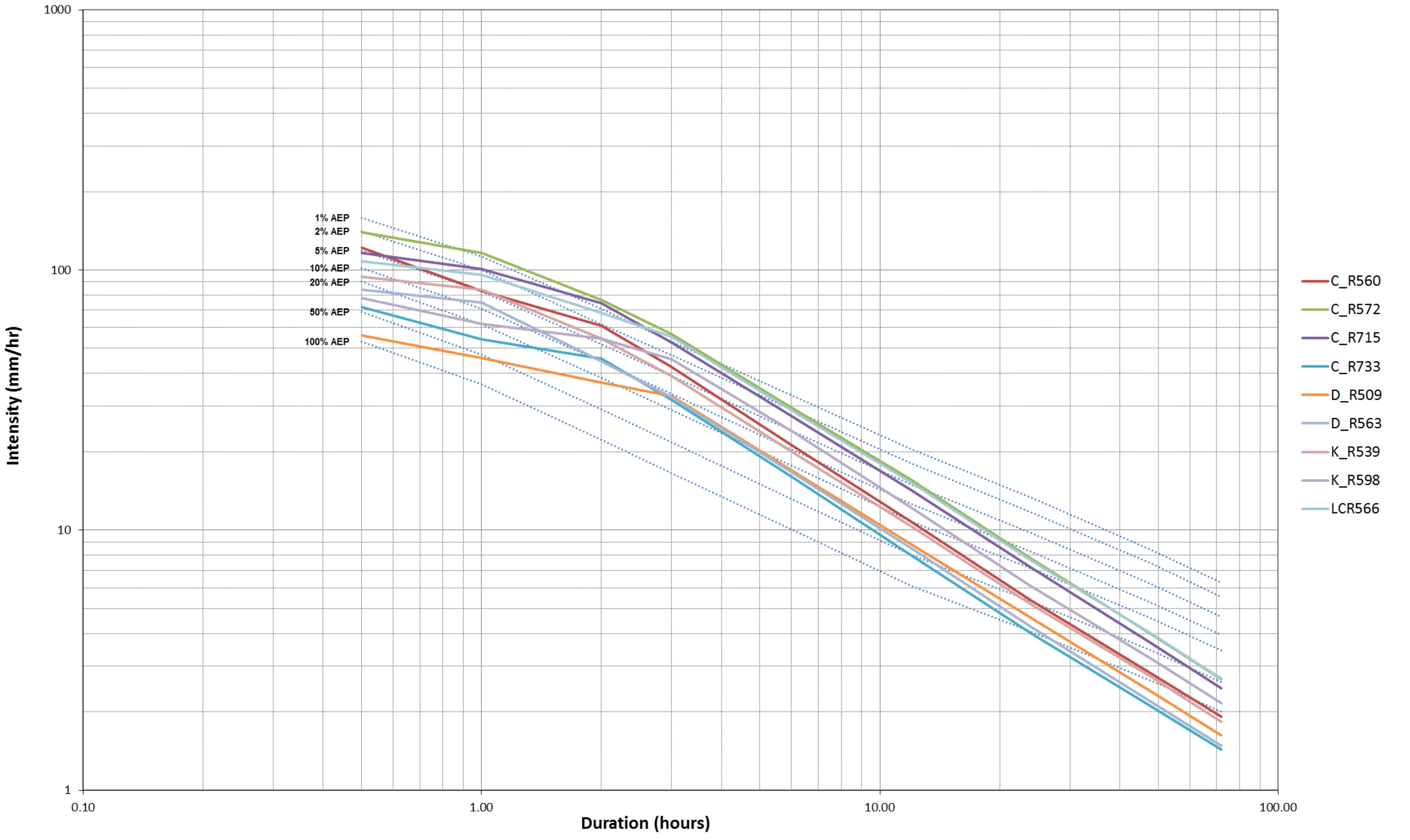


Figure B2: IFD Curve- May 2009 Event

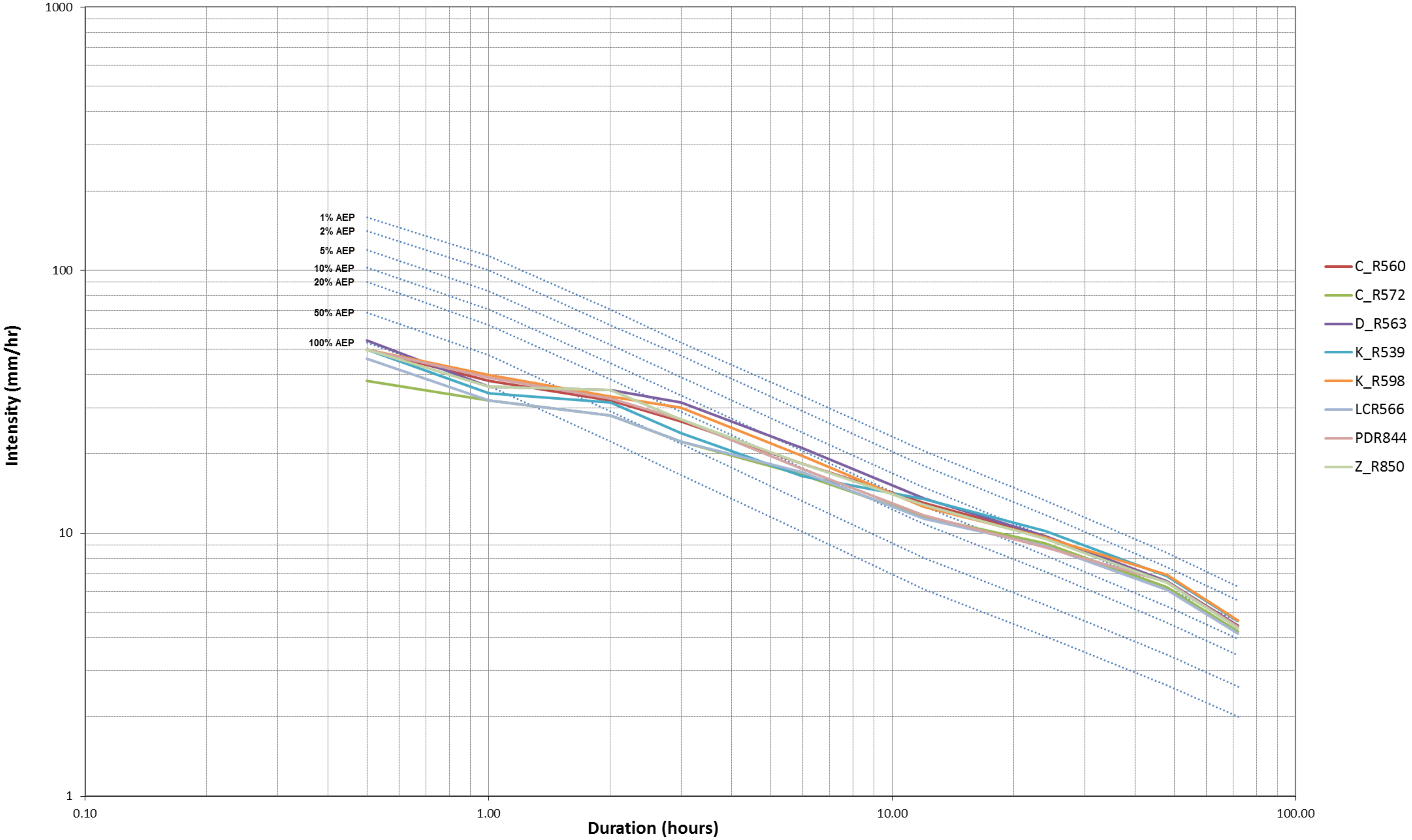
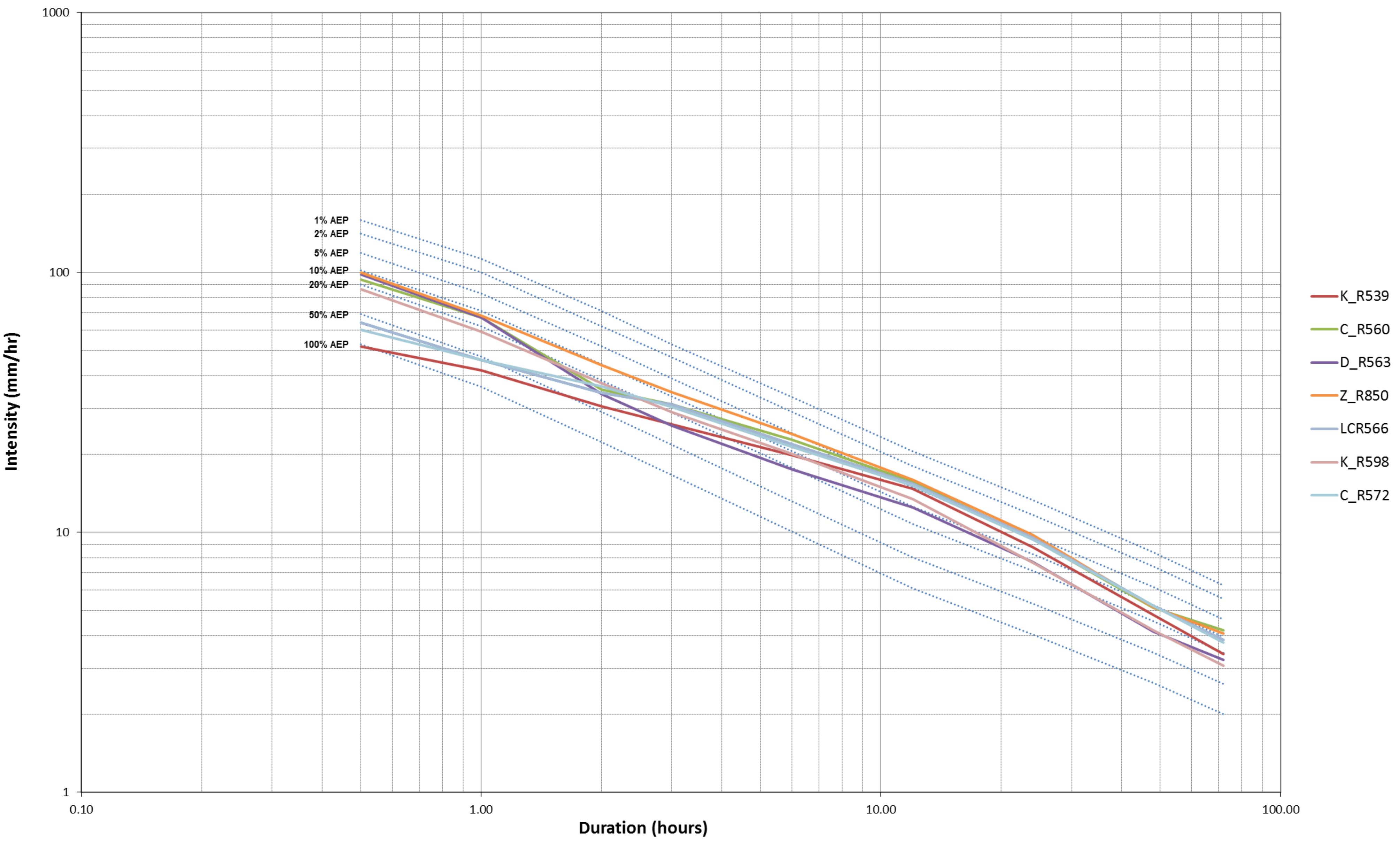


Figure B3: IFD Curve- October 2010 Event



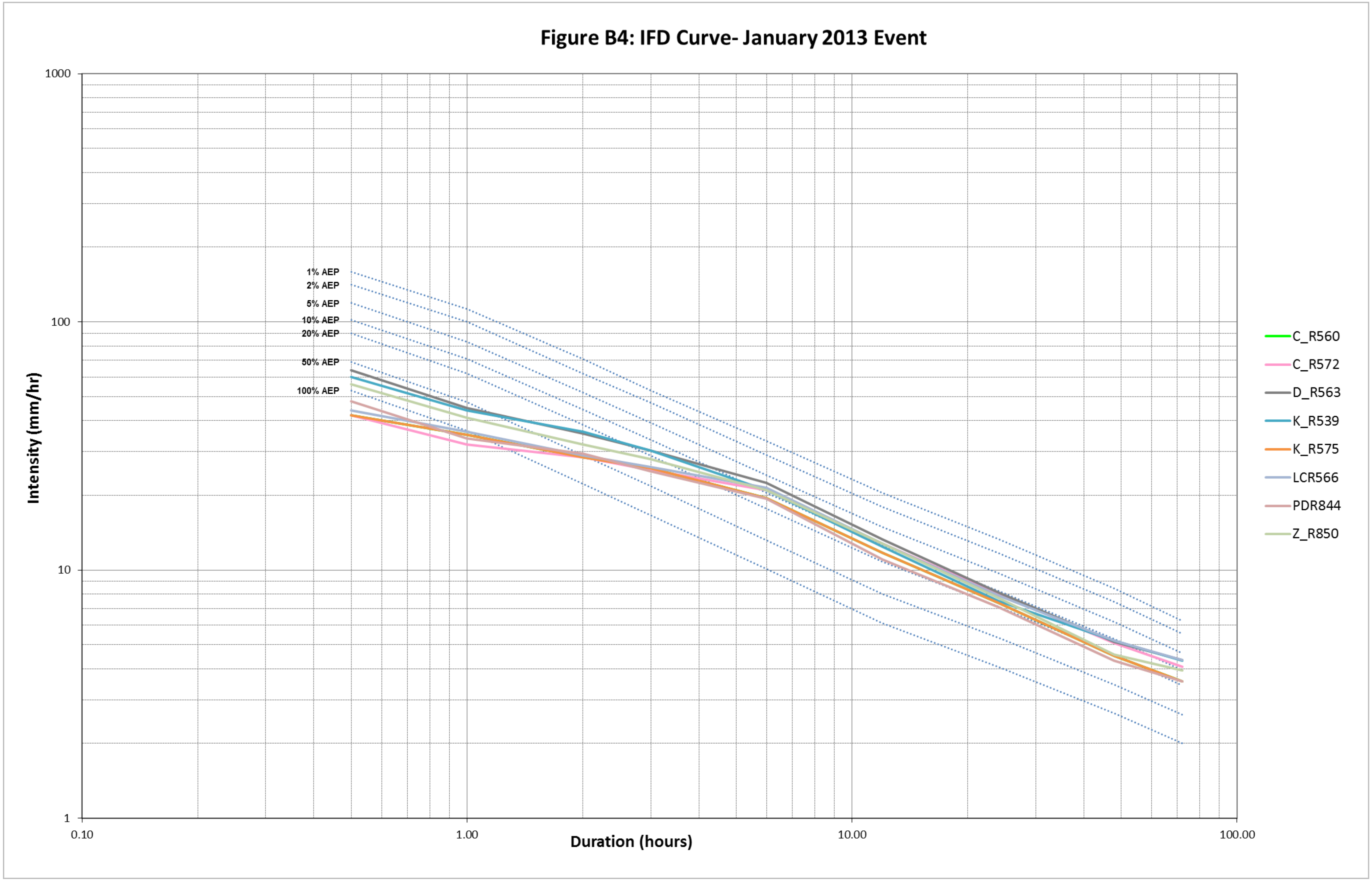


Figure B4: IFD Curve- January 2013 Event
Intensity (mm/hr)
Duration (hours)
1000
100
10
1
0.10
1.00
10.00
100.00
1% AEP
2% AEP
5% AEP
10% AEP
20% AEP
50% AEP
100% AEP
C_R560
C_R572
D_R563
K_R539
K_R575
LCR566
PDR844
Z_R850

Appendix C: XP-RAFTS Hydrologic Model Inputs

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XP-RAFTS Sub-catchment Parameters for Calibration Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
D1	80.8	0.05	51.21	2.3
D10	18.5	0.05	41.92	3.8
D11	7.5	0.05	36.80	2.6
D12	17.3	0.05	51.40	3.2
D13	9.5	0.05	9.62	3.3
D14	32.1	0.05	37.25	3.0
D15	20.9	0.05	62.67	3.2
D16	32.3	0.05	64.37	2.7
D17	29.2	0.05	57.04	1.2
D18	45.0	0.05	65.22	1.8
D19	42.1	0.05	70.03	1.1
D2	35.1	0.05	52.23	2.6
D20	14.6	0.05	29.73	2.4
D21	4.5	0.05	23.17	6.2
D22	13.4	0.05	47.79	3.8
D23	5.7	0.05	25.91	5.6
D24	41.6	0.05	61.25	2.6
D25	41.5	0.05	62.46	1.5
D26	36.4	0.05	58.40	1.8
D27	50.1	0.05	30.85	0.8
D28	52.2	0.05	68.20	2.2
D29	38.8	0.05	66.56	1.8
D3	12.6	0.05	55.46	4.9
D30	29.4	0.05	65.79	1.8
D31	42.8	0.05	77.61	1.1
D32	62.8	0.05	80.04	1.4
D33	50.0	0.05	86.81	1.2
D34	55.1	0.05	61.93	1.4
D35	78.1	0.05	41.24	1.3
D36	42.6	0.05	58.97	1.2
D37	26.3	0.05	79.22	1.7
D38a	118.5	0.05	67.10	1.1
D38b	22.7	0.05	55.08	1.1
D39	59.3	0.05	67.89	1.2
D4	5.0	0.05	66.59	5.9
D40	54.0	0.05	63.23	1.6
D41	50.5	0.05	73.03	1.5
D42	38.4	0.05	87.50	0.3
D43	30.3	0.05	33.56	0.4
D44	35.4	0.05	72.76	0.4

XP-RAFTS Sub-catchment Parameters for Calibration Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
D45	16.2	0.05	38.71	0.8
D46	99.4	0.05	52.10	0.6
D5	4.2	0.05	48.16	3.8
D6	37.6	0.05	62.25	1.8
D7	21.4	0.05	68.12	3.2
D8	12.0	0.05	63.67	1.4
D9	25.5	0.05	67.15	2.0
N1	123.1	0.05	29.85	0.7
N2	91.9	0.05	42.81	0.7
N3a	45.5	0.05	52.47	2.1
N3b	84.8	0.05	56.85	2.1
N4	234.1	0.05	29.28	0.8
N5	164.3	0.05	8.90	0.1
N6	178.9	0.05	10.21	0.1
Z10	32.4	0.05	70.04	1.3
Z11	36.9	0.05	78.74	0.6
Z12	82.1	0.05	53.32	0.9
Z13	62.9	0.05	55.75	1.2
Z14	13.8	0.05	69.63	1.0
Z15a	65.2	0.05	75.62	1.7
Z15b	17.7	0.05	90.00	1.7
Z16	37.8	0.05	89.87	0.8
Z17	17.6	0.05	90.00	0.7
Z18	20.8	0.05	89.96	0.2
Z19	46.7	0.05	53.86	0.3
Z1a	46.7	0.05	71.37	0.3
Z1b	43.8	0.05	44.05	0.3
Z2	31.6	0.05	66.32	2.5
Z3	52.3	0.05	58.67	2.6
Z4	31.2	0.05	57.01	1.6
Z5a	24.2	0.05	66.75	1.9
Z5b	39.9	0.05	63.86	1.9
Z6	28.7	0.05	59.69	1.9
Z7	41.0	0.05	68.19	2.0
Z8a	17.7	0.05	65.42	3.0
Z8b	6.3	0.05	68.68	3.0
Z8c	27.9	0.05	52.20	3.0
Z9	27.6	0.05	63.64	1.9

XP-RAFTS Sub-catchment Parameters for Design and Extreme Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
D1	80.8	0.05	70.21	2.3
D10	18.5	0.05	62.16	3.8
D11	7.5	0.05	37.14	2.6
D12	17.3	0.05	51.40	3.2
D13	9.5	0.05	11.15	3.3
D14	32.1	0.05	38.69	3.0
D15	20.9	0.05	62.67	3.2
D16	32.3	0.05	64.37	2.7
D17	29.2	0.05	57.04	1.2
D18	45.0	0.05	65.54	1.8
D19	42.1	0.05	70.75	1.1
D2	35.1	0.05	72.42	2.6
D20	14.6	0.05	29.73	2.4
D21	4.5	0.05	23.21	6.2
D22	13.4	0.05	49.03	3.8
D23	5.7	0.05	33.69	5.6
D24	41.6	0.05	62.89	2.6
D25	41.5	0.05	62.49	1.5
D26	36.4	0.05	60.35	1.8
D27	50.1	0.05	31.37	0.8
D28	52.2	0.05	68.22	2.2
D29	38.8	0.05	66.56	1.8
D3	12.6	0.05	67.91	4.9
D30	29.4	0.05	66.79	1.8
D31	42.8	0.05	79.05	1.1
D32	62.8	0.05	79.92	1.4
D33	50.0	0.05	86.91	1.2
D34	55.1	0.05	56.45	1.4
D35	78.1	0.05	41.24	1.3
D36	42.6	0.05	62.54	1.2
D37	26.3	0.05	79.22	1.7
D38a	118.5	0.05	67.10	1.1
D38b	22.7	0.05	55.08	1.1
D39	59.3	0.05	67.89	1.2
D4	5.0	0.05	66.63	5.9
D40	54.0	0.05	63.24	1.6
D41	50.5	0.05	73.04	1.5
D42	38.4	0.05	87.50	0.3
D43	30.3	0.05	33.56	0.4
D44	35.4	0.05	72.76	0.4

XP-RAFTS Sub-catchment Parameters for Design and Extreme Events				
Catchment Name	Area (ha)	PERN	Percentage Impervious	Catchment Slope (%)
D45	16.2	0.05	38.71	0.8
D46	99.4	0.05	52.14	0.6
D5	4.2	0.05	48.16	3.8
D6	37.6	0.05	67.99	1.8
D7	21.4	0.05	68.12	3.2
D8	12.0	0.05	66.98	1.4
D9	25.5	0.05	67.15	2.0
N1	123.1	0.05	54.72	0.7
N2	91.9	0.05	46.05	0.7
N3a	45.5	0.05	56.03	2.1
N3b	84.8	0.05	59.64	2.1
N4	234.1	0.05	37.15	0.8
N5	164.3	0.05	8.90	0.1
N6	178.9	0.05	11.73	0.1
Z10	32.4	0.05	70.07	1.3
Z11	36.9	0.05	77.35	0.6
Z12	82.1	0.05	54.24	0.9
Z13	62.9	0.05	65.82	1.2
Z14	13.8	0.05	66.77	1.0
Z15a	65.2	0.05	75.62	1.7
Z15b	17.7	0.05	90.00	1.7
Z16	37.8	0.05	89.87	0.8
Z17	17.6	0.05	90.00	0.7
Z18	20.8	0.05	89.96	0.2
Z19	46.7	0.05	73.49	0.3
Z1a	46.7	0.05	71.37	0.3
Z1b	43.8	0.05	44.05	0.3
Z2	31.6	0.05	66.32	2.5
Z3	52.3	0.05	58.67	2.6
Z4	31.2	0.05	57.66	1.6
Z5a	24.2	0.05	66.75	1.9
Z5b	39.9	0.05	64.40	1.9
Z6	28.7	0.05	59.69	1.9
Z7	41.0	0.05	68.19	2.0
Z8a	17.7	0.05	65.43	3.0
Z8b	6.3	0.05	68.72	3.0
Z8c	27.9	0.05	52.18	3.0
Z9	27.6	0.05	63.64	1.9

Appendix D: Thiessen Polygon Rainfall Distribution for Calibration Events

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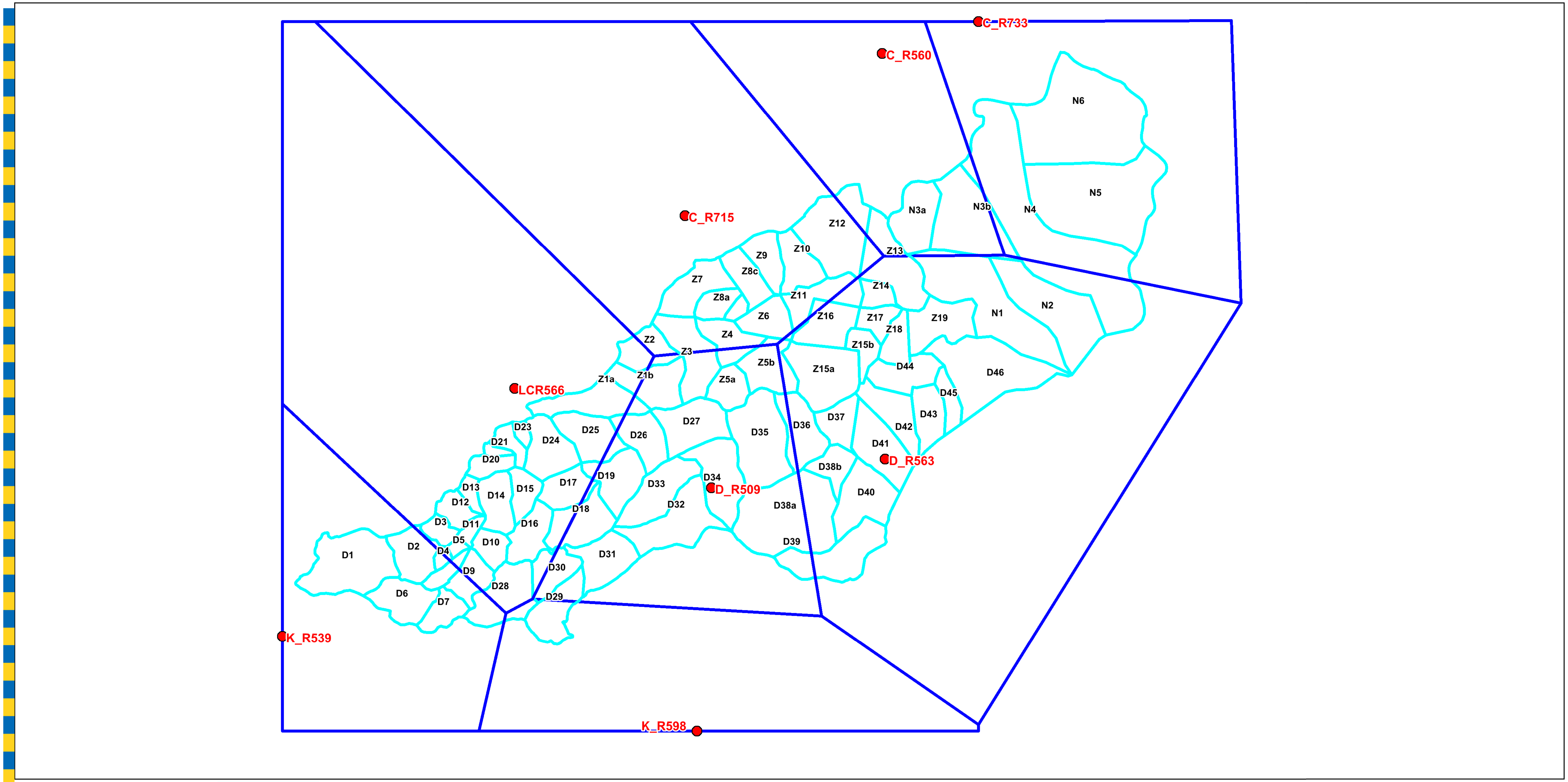

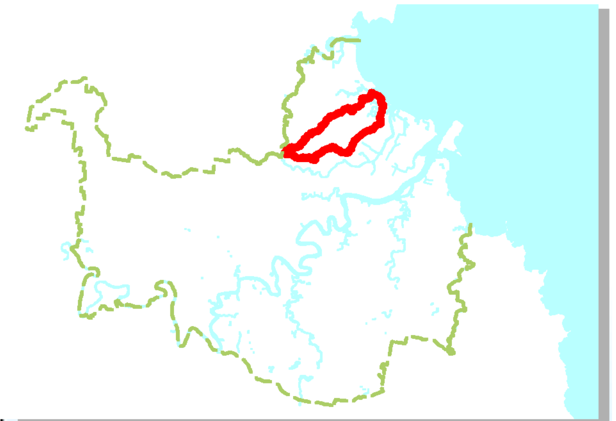

Legend

Rainfall Gauge

Thiessen Polygon

Subcatchment Boundary

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

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Nundah Creek Flood Study 2014

N W E S

500 0 500 1000

Metres

Prepared :MK
Checked :MK
Revision :0
Publication Date :June 2015
Project Number : 140591

Brisbane City Council
City Projects Office
GPO Box 1434
Brisbane Qld 4001

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Figure D1: Thiessen Distribution March 2001 Event

FLM - 140591

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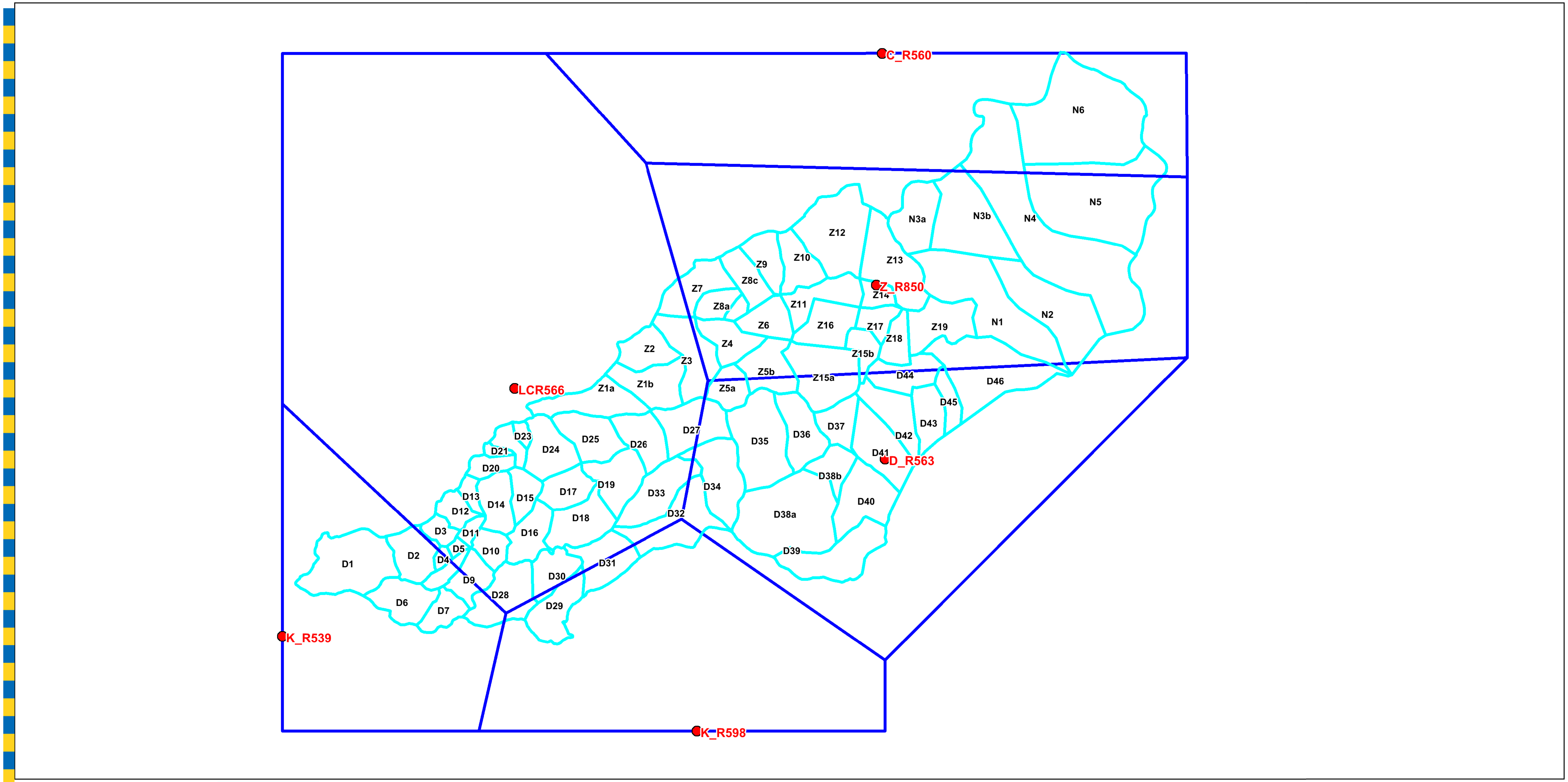

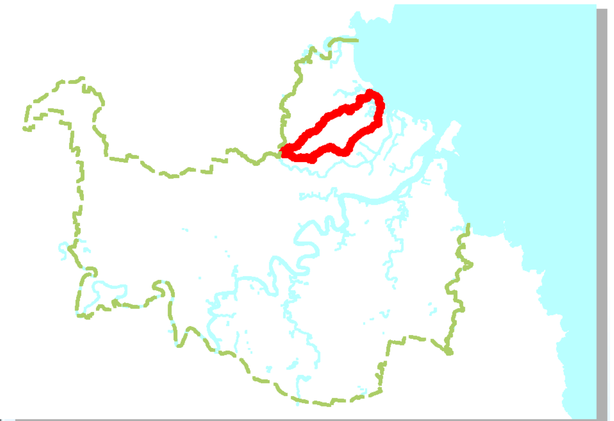

Legend

- Rainfall Gauge
- Thiessen Polygon
- Subcatchment Boundary

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Metres

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Figure D2: Thiessen Distribution May 2009 Event

FLM - 140591

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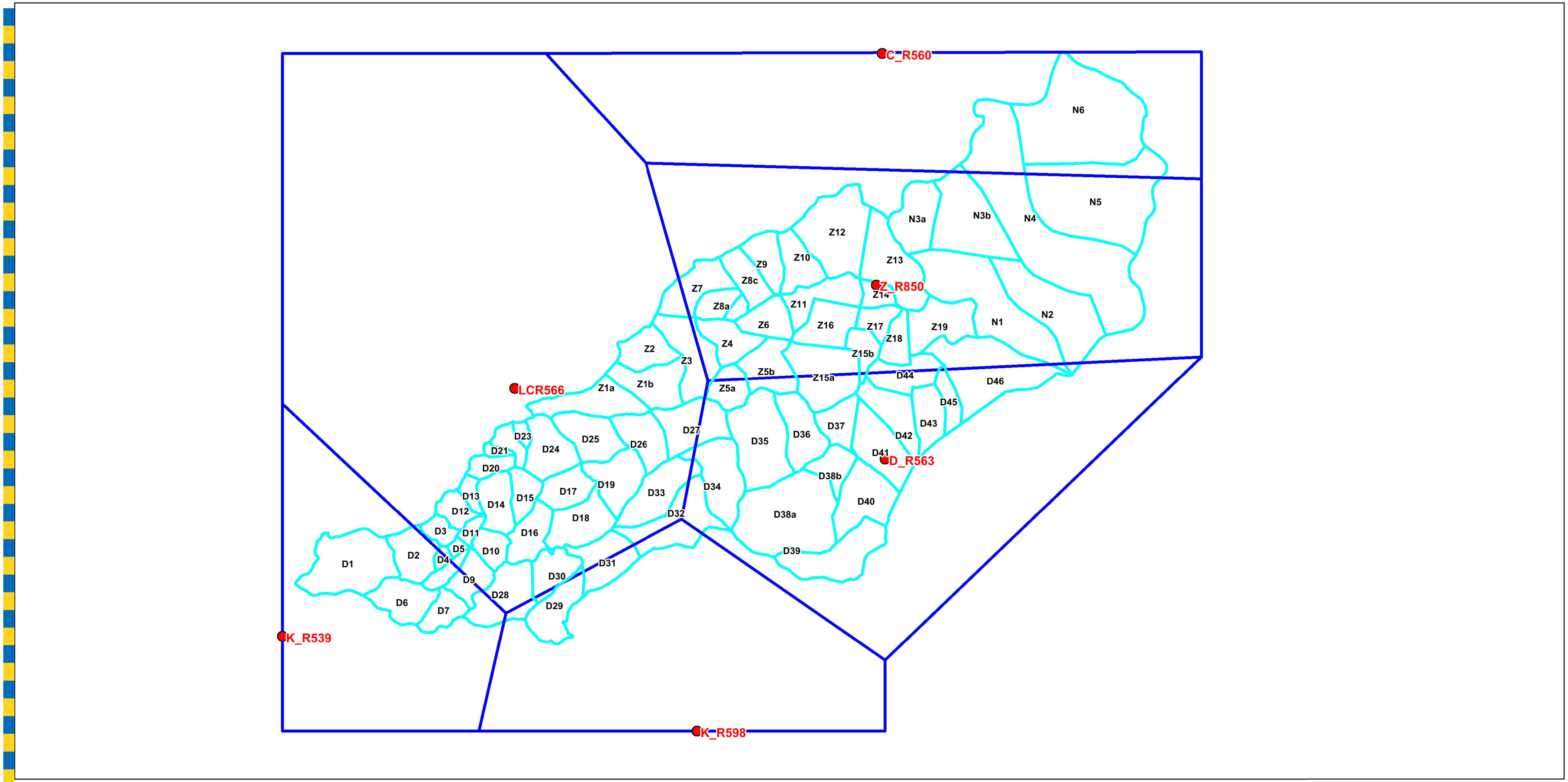

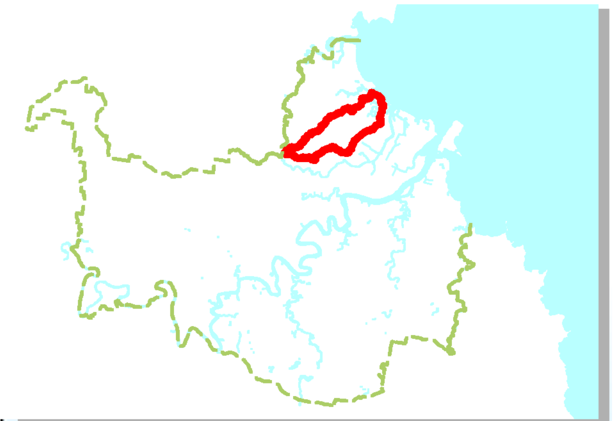

Legend

Rainfall Gauge

Thiessen Polygon

Subcatchment Boundary

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500 0 500 1000

Metres

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Figure D3: Thiessen Distribution October 2010 Event

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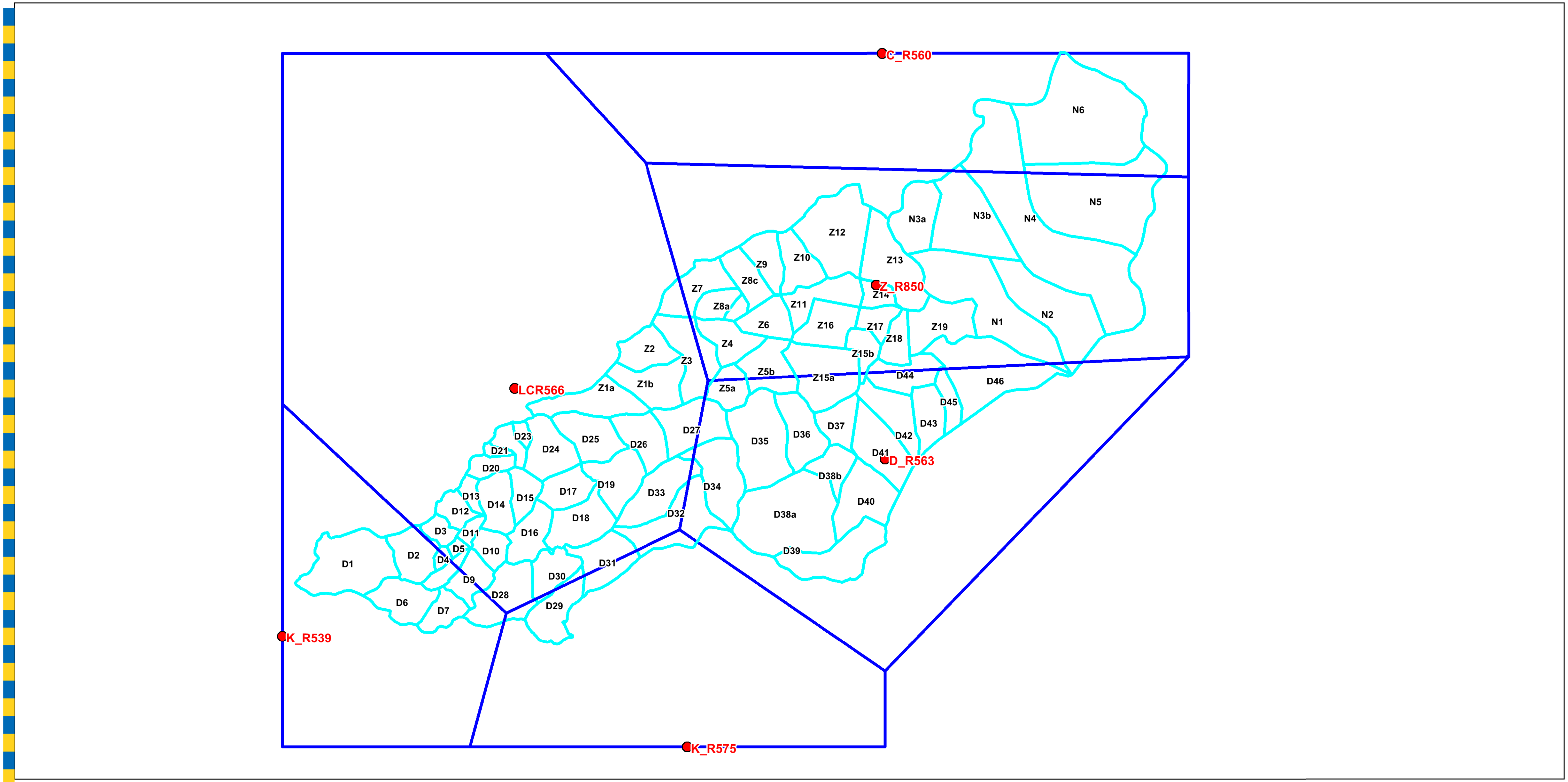

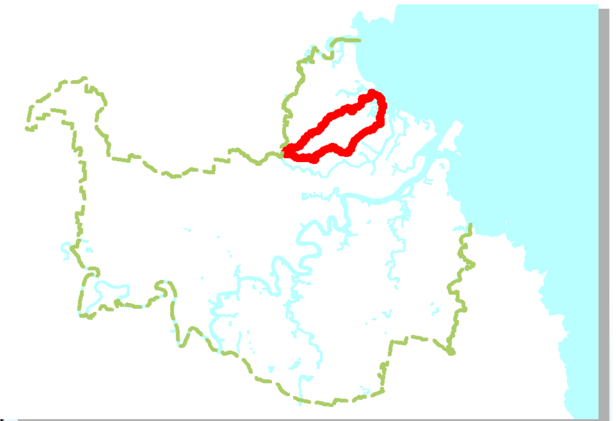

Legend

- Rainfall Gauge
- Thiessen Polygon
- Subcatchment Boundary

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N W E S

500 0 500 1000
Metres

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Figure D4: Thiessen Distribution January 2013 Event

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FLM - 140591

Appendix E: Hydraulic Structure Reference Sheets

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Creek	**Downfall Creek**
Location	**Trouts Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 C17
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	DC_2040	AMTD (m)	14125

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 2 x 1.2m RCPC

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

UPSTREAM INVERT LEVEL (m): 36.495 UPSTREAM OBVERT LEVEL: 37.695

DOWNSTREAM INVERT LEVEL (m): 36.257 DOWNSTREAM OBVERT LEVEL: 37.457

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 19.3

LENGTH OF CULVERT BARREL AT OBVERT (m): 19.3

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D1030 FB no. 8566/6

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 19.3 LOWEST POINT OF WEIR (m AHD): 38.2

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

PIER WIDTH: 0.5

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Trouts Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	81.2	40.02	38.76	1.26	148	1.82	0.3	5.1
500yr (0.2%)	87.1	40.09	38.76	1.33	150	1.89	0.4	5.1
100yr (1%)	68.2	39.92	38.52	1.39	146	1.72	0.3	5.0
50yr (2%)	59.7	39.85	38.36	1.49	145	1.65	0.3	4.9
20yr (5%)	52.2	39.78	38.14	1.64	143	1.58	0.2	4.9
10yr (10%)	44.0	39.72	37.83	1.89	140	1.52	0.2	4.8
5yr (20%)	38.4	39.66	37.69	1.96	137	1.46	0.2	4.8
2yr (50%)	28.3	39.53	37.46	2.07	134	1.33	0.1	4.7

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Trouts Rd**

Trouts Road configuration

Trouts Road

Creek	**Downfall Creek**
Location	**Parton St**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 D17
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	DC_2326	AMTD (m)	13855

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 1 x 1.82x1.78m RCBC and 2 x 1.84x1.58m RCBC

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

UPSTREAM INVERT LEVEL (m):	33.719	UPSTREAM OBVERT LEVEL:	35.5
DOWNSTREAM INVERT LEVEL (m):	33.59	DOWNSTREAM OBVERT LEVEL:	35.37

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 36.75

LENGTH OF CULVERT BARREL AT OBVERT (m): 36.75

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D980 FB no. 8566/6

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 36.75 LOWEST POINT OF WEIR (m AHD): 37

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

PIER WIDTH: 0.08

HEIGHT OF HAND/GUARDRAIL: 1.22

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Parton St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	89.1	38.49	36.00	2.49	125	1.49	0.2	8.7
500yr (0.2%)	85.7	38.49	35.97	2.51	124	1.49	0.2	8.7
100yr (1%)	64.5	38.26	35.67	2.59	115	1.26	0.1	8.4
50yr (2%)	55.4	38.07	35.51	2.56	105	1.07	0.1	8.2
20yr (5%)	47.7	37.80	35.35	2.45	91	0.80	0.1	7.9
10yr (10%)	39.6	37.41	35.19	2.22	73	0.41	0.0	7.4
5yr (20%)	36.5	37.02	35.12	1.89	35	0.02	0.0	6.8
2yr (50%)	29.6	36.25	34.97	1.28	0	0.00	0.0	5.6

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Parton St**

Parton Street

Creek	**Downfall Creek**
Location	**Rode Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 F16
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	DC_3014	AMTD (m)	13180

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 4 x 2.74mx1.8m RCBC

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

UPSTREAM INVERT LEVEL (m):	29.23	UPSTREAM OBVERT LEVEL:	31.03
DOWNSTREAM INVERT LEVEL (m):	29.25	DOWNSTREAM OBVERT LEVEL:	

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 25.8

LENGTH OF CULVERT BARREL AT OBVERT (m): 25.8

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D920 FB no. 8566/6

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 25.8 LOWEST POINT OF WEIR (m AHD): 32.7

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

PIER WIDTH: 0.4

HEIGHT OF HAND/GUARDRAIL: 1.0

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	**Downfall Creek**
Location	**Rode Rd**

ARI (AEP %)	**Peak Discharge (m3/s)**	**Peak U/S Water Level (m AHD)**	**Peak D/S Water Level (m AHD)**	**Afflux (m)**	**Max Width of Weir Flow (m)**	**Max Depth of Weir Flow (m)**	**Velocity (m/s)**	
							Weir	**Structure**
2000yr (0.05%)	171.5	33.79	32.61	1.18	87	1.09	0.6	5.2
500yr (0.2%)	156.0	33.69	32.48	1.21	85	0.99	0.5	5.3
100yr (1%)	114.0	33.35	32.11	1.24	75	0.65	0.2	5.1
50yr (2%)	98.2	33.06	31.94	1.12	62	0.36	0.1	4.9
20yr (5%)	85.3	32.61	31.79	0.82	0	0.00	0.0	4.3
10yr (10%)	74.9	32.22	31.66	0.56	0	0.00	0.0	3.8
5yr (20%)	67.7	31.96	31.55	0.41	0	0.00	0.0	3.5
2yr (50%)	52.9	31.47	31.29	0.18	0	0.00	0.0	3.3

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Rode Rd**

Rode Road looking downstream

Creek	**Downfall Creek**
Location	**Footbridge adjacent Ennerdale St**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 H14
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	DC_3635	AMTD (m)	12550

STRUCTURE DESCRIPTION: Wooden Footbdidge

STRUCTURE SIZE: 2 spans (1x7.9m, 1x8.7m)

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

UPSTREAM INVERT LEVEL (m): 26.2 UPSTREAM OBVERT LEVEL: 29.24

DOWNSTREAM INVERT LEVEL (m): 26.14 DOWNSTREAM OBVERT LEVEL: 29.24

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D870 FB no. 8566/6

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 1.5 LOWEST POINT OF WEIR (m AHD): 29.81

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

PIER WIDTH: 0.35

HEIGHT OF HAND/GUARDRAIL: 0.79

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Footbridge adjacent Ennerdale St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	206.7	30.17	30.01	0.15	NA	0.36	NA	4.2
500yr (0.2%)	176.6	29.95	29.82	0.13	NA	0.14	NA	4.1
100yr (1%)	132.2	29.57	29.49	0.08	NA	0.00	NA	3.6
50yr (2%)	114.1	29.38	29.33	0.05	NA	0.00	NA	3.3
20yr (5%)	101.0	29.22	29.19	0.03	NA	0.00	NA	3.1
10yr (10%)	88.6	29.07	29.05	0.02	NA	0.00	NA	3.1
5yr (20%)	79.4	28.95	28.93	0.02	NA	0.00	NA	3.0
2yr (50%)	60.9	28.62	28.60	0.02	NA	0.00	NA	2.9

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Footbridge adjacent Ennerdale St

Footbridge looking downstream

Footbridge looking downstream

Creek	**Downfall Creek**
Location	**Maundrell Tce**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 J14
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_3907	AMTD (m)	12285

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 6 x 1.825m diameter RCPC

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

UPSTREAM INVERT LEVEL (m):	25.11	UPSTREAM OBVERT LEVEL:	26.93
DOWNSTREAM INVERT LEVEL (m):	24.9	DOWNSTREAM OBVERT LEVEL:	26.72

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 17.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 17.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D830 FB no. 8566/5

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 17.6 LOWEST POINT OF WEIR (m AHD): 27.7

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

PIER WIDTH: 0.3

HEIGHT OF HAND/GUARDRAIL: 1.0

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Maundrell Tce

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	217.0	29.50	28.64	0.85	82	1.80	1.4	4.7
500yr (0.2%)	182.0	29.32	28.48	0.84	77	1.62	1.3	4.6
100yr (1%)	135.9	29.06	28.26	0.80	71	1.36	1.0	4.4
50yr (2%)	118.2	28.95	28.17	0.78	68	1.25	0.9	4.2
20yr (5%)	103.6	28.84	28.06	0.78	65	1.14	0.8	4.2
10yr (10%)	90.1	28.71	27.94	0.76	60	1.01	0.6	4.1
5yr (20%)	80.4	28.58	27.83	0.74	58	0.88	0.5	4.0
2yr (50%)	61.1	28.20	27.56	0.63	44	0.50	0.2	3.7

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Maundrell Tce**

Maundrell Terrace looking downstream

Creek	**Downfall Creek**
Location	**Huxtable Park Pedestrian Bridge**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 L15
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_4380	AMTD (m)	11805

STRUCTURE DESCRIPTION: Steel and timber pedestrian bridge

STRUCTURE SIZE: Single 9.8m span

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

UPSTREAM INVERT LEVEL (m): 23.61 UPSTREAM OBVERT LEVEL: 25.33

DOWNSTREAM INVERT LEVEL (m): 23.59 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D760 FB no. 8566/5

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.62 LOWEST POINT OF WEIR (m AHD): 25.4

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.09

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Huxtable Park Pedestrian Bridge

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	229.4	26.86	26.69	0.16	NA	1.46	NA	3.8
500yr (0.2%)	189.7	26.71	26.57	0.14	NA	1.31	NA	3.6
100yr (1%)	143.0	26.51	26.40	0.12	NA	1.11	NA	3.2
50yr (2%)	124.7	26.43	26.33	0.10	NA	1.03	NA	3.0
20yr (5%)	108.0	26.35	26.26	0.09	NA	0.95	NA	2.9
10yr (10%)	91.9	26.27	26.17	0.10	NA	0.87	NA	2.7
5yr (20%)	82.1	26.19	26.09	0.10	NA	0.79	NA	2.6
2yr (50%)	62.7	25.99	25.90	0.09	NA	0.59	NA	2.6

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Huxtable Park Pedestrian Bridge

Huxtable Park footbridge

Huxtable Park footbridge looking upstream

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (Upstream)

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 N13
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_5009	AMTD (m)	11185

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 5 x 3.04mx2.75m RCBC

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

UPSTREAM INVERT LEVEL (m): 20.77   UPSTREAM OBVERT LEVEL: 23.53

DOWNSTREAM INVERT LEVEL (m): 20.74   DOWNSTREAM OBVERT LEVEL: 23.49

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 22.3

LENGTH OF CULVERT BARREL AT OBVERT (m): 22.3

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D690 FB no. 8566/5

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 22.3   LOWEST POINT OF WEIR (m AHD): 24.28

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

PIER WIDTH: 0.4

HEIGHT OF HAND/GUARDRAIL: 0.53

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (Upstream)

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	243.9	25.44	25.12	0.33	180	1.16	0.7	6.3
500yr (0.2%)	198.2	25.12	24.63	0.50	103	0.84	0.6	6.3
100yr (1%)	151.1	24.42	23.73	0.68	40	0.14	0.0	6.2
50yr (2%)	133.4	24.14	23.30	0.84	0	0.00	0.0	4.6
20yr (5%)	116.7	23.68	22.99	0.69	0	0.00	0.0	4.3
10yr (10%)	99.9	23.35	22.70	0.64	0	0.00	0.0	4.2
5yr (20%)	88.7	23.14	22.50	0.64	0	0.00	0.0	4.0
2yr (50%)	67.2	22.76	22.09	0.67	0	0.00	0.0	3.5

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (Upstream)

Culverts looking upstream

Culverts looking downstream

Creek	**Downfall Creek**
Location	**Hamilton Rd Roundabout (within)**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 N13
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_5130	AMTD (m)	11115

STRUCTURE DESCRIPTION: 2 span concrete bridge

STRUCTURE SIZE: 2 x 7.66mx3.54m RCBC

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

UPSTREAM INVERT LEVEL (m):	18.87	UPSTREAM OBVERT LEVEL:	22.41
DOWNSTREAM INVERT LEVEL (m):	19.23	DOWNSTREAM OBVERT LEVEL:	22.41

For culverts give floor level | For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 9.86

LENGTH OF CULVERT BARREL AT OBVERT (m): 9.86

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D650 FB no. 8566/5

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 9.86 LOWEST POINT OF WEIR (m AHD): 22.9

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

PIER WIDTH: 0.3

HEIGHT OF HAND/GUARDRAIL: 1.06

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (within)

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	227.9	25.09	25.04	0.05	170	2.19	0.3	2.5
500yr (0.2%)	195.4	24.59	24.53	0.06	115	1.69	0.3	2.5
100yr (1%)	151.0	23.67	23.59	0.08	75	0.77	0.1	3.4
50yr (2%)	133.2	23.21	23.15	0.07	50	0.31	2.4	2.5
20yr (5%)	116.7	22.91	22.86	0.05	0	0.01	0.0	2.2
10yr (10%)	99.9	22.62	22.59	0.03	0	0.00	0.0	7.7
5yr (20%)	88.7	22.42	22.39	0.03	0	0.00	0.0	9.3
2yr (50%)	67.1	22.01	21.98	0.02	0	0.00	0.0	2.0

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (within)

Bridge looking upstream

Bridge looking downstream

Creek	Downfall Creek
Location	**Hamilton Rd Roundabout (Downstream)**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 N13
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_5182	AMTD (m)	11075

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 5 x 3.04mx2.75m RCBC

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

UPSTREAM INVERT LEVEL (m): 19.87 UPSTREAM OBVERT LEVEL: 22.62

DOWNSTREAM INVERT LEVEL (m): 19.78 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 35.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 35.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D620 FB no. 8566/5

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 35.6 LOWEST POINT OF WEIR (m AHD): 24.4

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

PIER WIDTH: 0.4

HEIGHT OF HAND/GUARDRAIL: 0.5

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (Downstream)

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	239.9	24.98	22.83	2.16	120	0.58	0.6	8.3
500yr (0.2%)	195.4	24.46	22.65	1.81	58	0.06	1.3	7.6
100yr (1%)	150.9	23.51	22.33	1.18	0	0.00	0.0	4.7
50yr (2%)	132.7	23.05	22.16	0.90	0	0.00	0.0	4.6
20yr (5%)	116.6	22.77	21.99	0.78	0	0.00	0.0	4.4
10yr (10%)	99.8	22.50	21.85	0.65	0	0.00	0.0	4.2
5yr (20%)	88.6	22.30	21.69	0.61	0	0.00	0.0	4.0
2yr (50%)	67.2	21.90	21.41	0.48	0	0.00	0.0	3.7

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Hamilton Rd Roundabout (Downstream)

Culverts looking downstream

Culverts looking upstream

Creek	Downfall Creek
Location	**Footbridge adjacent Brentwick St**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	119 P11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_SI_03	AMTD (m)	10425

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 2 x 2.4mx1.2m RCBC

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

UPSTREAM INVERT LEVEL (m):	15.4	UPSTREAM OBVERT LEVEL:	16.6
DOWNSTREAM INVERT LEVEL (m):	15.038	DOWNSTREAM OBVERT LEVEL:	16.238

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 4

LENGTH OF CULVERT BARREL AT OBVERT (m): 4

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 4 LOWEST POINT OF WEIR (m AHD): 17.1

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure details are based on 2014 site measurements and ALS 2009 data

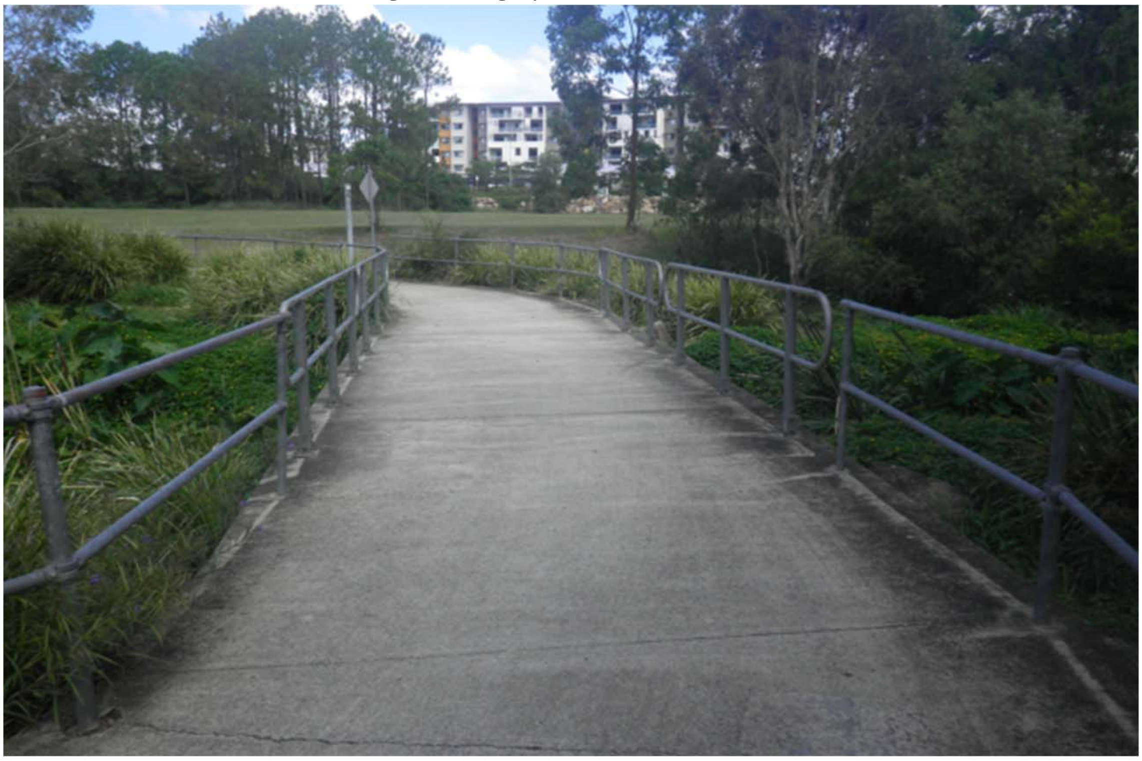
Creek	**Downfall Creek**
Location	**Footbridge adjacent Brentwick St**

ARI (AEP %)	**Peak Discharge (m3/s)**	**Peak U/S Water Level (m AHD)**	**Peak D/S Water Level (m AHD)**	**Afflux (m)**	**Max Width of Weir Flow (m)**	**Max Depth of Weir Flow (m)**	**Velocity (m/s)**	
							Weir	**Structure**
2000yr (0.05%)	320.4	20.38	20.13	0.25	NA	3.28	NA	6.6
500yr (0.2%)	263.3	20.18	19.96	0.22	NA	3.08	NA	7.1
100yr (1%)	203.3	19.90	19.69	0.21	NA	2.80	NA	7.1
50yr (2%)	180.0	19.75	19.55	0.21	NA	2.65	NA	7.1
20yr (5%)	156.4	19.54	19.32	0.22	NA	2.44	NA	7.1
10yr (10%)	132.7	19.33	19.02	0.31	NA	2.23	NA	7.0
5yr (20%)	116.8	19.21	18.88	0.33	NA	2.11	NA	7.0
2yr (50%)	83.6	18.93	18.57	0.36	NA	1.83	NA	6.9

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Footbridge adjacent Brentwick St

Footbridge looking upstream



Footbridge configuration

Creek	**Downfall Creek**
Location	**Gympie Rd**

INFO SOURCE:	Site Inpsection (2014) and design drawing	UBD REF:	119 R11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_6218	AMTD (m)	10090

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 4 x 2.8mx2.8m RCBC

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

UPSTREAM INVERT LEVEL (m):	14.2	UPSTREAM OBVERT LEVEL:	17
DOWNSTREAM INVERT LEVEL (m):	14.2	DOWNSTREAM OBVERT LEVEL:	17

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 42

LENGTH OF CULVERT BARREL AT OBVERT (m): 42

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 42 — LOWEST POINT OF WEIR (m AHD): 18.61

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.2

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: CP-1-03 (MPN Consulting) Job 4634 - As part of the Westfield Works

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

The Gympie Road bridge and culvert have been combined into a culvert structure. In the absence of any other information, the upstream invert level is assumed to be the same as the downstream invert level. Guardrail measured on site. Structure upgraded, date unknown.

Creek	Downfall Creek
Location	Gympie Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	310.5	19.94	18.45	1.49	204	1.33	0.5	5.5
500yr (0.2%)	251.2	19.78	18.27	1.51	182	1.17	0.5	8.3
100yr (1%)	184.8	19.52	18.04	1.48	158	0.91	0.5	8.0
50yr (2%)	157.5	19.38	17.94	1.44	140	0.77	0.4	8.0
20yr (5%)	127.2	19.12	17.81	1.31	100	0.51	0.3	8.0
10yr (10%)	113.4	18.56	17.65	0.91	0	0.00	0.0	8.1
5yr (20%)	105.7	18.09	17.50	0.60	0	0.00	0.0	8.8
2yr (50%)	82.8	17.55	17.19	0.35	0	0.00	0.0	4.6

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Gympie Rd

Gympie Road looking upstream

Gympie Road looking downstream

Creek	**Downfall Creek**
Location	**Kittyhawk Dr**

INFO SOURCE:	Site Inpsection (2014) and design drawing	UBD REF:	120 A11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_B9860	AMTD (m)	9732

STRUCTURE DESCRIPTION: 3 span concrete bridge

STRUCTURE SIZE: 3 spans (2 x 15.9m and 1 x 16.1m)

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

UPSTREAM INVERT LEVEL (m): 13.14

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 36

LENGTH OF CULVERT BARREL AT OBVERT (m): 36

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 36

LOWEST POINT OF WEIR (m AHD): 19.2

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

PIER WIDTH: 4 x 850mm circular

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: BR-00 to BR-22 (MPN Consulting) - WP53440

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Bridge invert levels based on ALS 2009 data and available survey information for creek. Weir width based on measurements from aerial photography.

Creek	Downfall Creek
Location	Kittyhawk Dr

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	308.7	17.50	17.41	0.09	0	0.00	0.0	2.5
500yr (0.2%)	252.8	17.28	17.20	0.08	0	0.00	0.0	2.2
100yr (1%)	190.1	16.99	16.93	0.06	0	0.00	0.0	2.0
50yr (2%)	162.8	16.85	16.81	0.05	0	0.00	0.0	2.0
20yr (5%)	134.3	16.67	16.63	0.04	0	0.00	0.0	1.9
10yr (10%)	118.7	16.52	16.49	0.03	0	0.00	0.0	1.9
5yr (20%)	108.3	16.41	16.37	0.03	0	0.00	0.0	1.9
2yr (50%)	83.7	16.01	15.97	0.03	0	0.00	0.0	1.8

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Kittyhawk Dr**

Kittyhawk Drive looking downstream

Creek	**Downfall Creek**
Location	**Footbridge 1 Seventh Brigade Park**

INFO SOURCE:	Site Inpsection (2014)	UBD REF:	120 A11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_B9861_SI_10	AMTD (m)	9632

STRUCTURE DESCRIPTION: Steel and Timber Bridge

STRUCTURE SIZE: Single 20.0m span bridge

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

UPSTREAM INVERT LEVEL (m): 13

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 3.5

LENGTH OF CULVERT BARREL AT OBVERT (m): 3.5

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 3.5

LOWEST POINT OF WEIR (m AHD): 15.94

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.4

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Bridge invert levels based on ALS 2009 data and available survey information for creek. Weir width based on measurements from aerial photography.

Creek	Downfall Creek
Location	Footbridge 1 Seventh Brigade Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	301.3	17.22	17.10	0.12	NA	1.28	NA	4.2
500yr (0.2%)	247.6	17.05	16.94	0.11	NA	1.11	NA	4.0
100yr (1%)	187.8	16.80	16.71	0.09	NA	0.86	NA	3.7
50yr (2%)	163.9	16.68	16.60	0.08	NA	0.74	NA	3.5
20yr (5%)	135.3	16.52	16.45	0.07	NA	0.58	NA	3.2
10yr (10%)	119.8	16.40	16.32	0.08	NA	0.46	NA	3.1
5yr (20%)	109.0	16.28	16.20	0.08	NA	0.34	NA	3.0
2yr (50%)	83.5	15.89	15.85	0.04	NA	0.00	NA	3.0

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Footbridge 1 Seventh Brigade Park**

Footbridge looking upstream

Creek	**Downfall Creek**
Location	**Footbridge 2 Seventh Brigade Park**

INFO SOURCE:	Site Inpsection (2014)	UBD REF:	120 B11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_SI_08	AMTD (m)	9443

STRUCTURE DESCRIPTION: Steel and Timber Bridge

STRUCTURE SIZE: Single 20.0m span bridge

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

UPSTREAM INVERT LEVEL (m): 11.9 UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m): DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 2.3

LENGTH OF CULVERT BARREL AT OBVERT (m): 2.3

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.3 LOWEST POINT OF WEIR (m AHD): 15.97

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.2

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Bridge invert levels based on ALS 2009 data and available survey information for creek. Weir width based on measurements from aerial photography.

Creek	Downfall Creek
Location	Footbridge 2 Seventh Brigade Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	301.3	16.37	16.28	0.08	NA	0.40	NA	4.1
500yr (0.2%)	247.6	16.20	16.13	0.07	NA	0.23	NA	4.0
100yr (1%)	187.8	15.90	15.85	0.05	NA	0.00	NA	4.1
50yr (2%)	163.9	15.72	15.68	0.04	NA	0.00	NA	4.1
20yr (5%)	135.3	15.45	15.42	0.03	NA	0.00	NA	4.1
10yr (10%)	119.8	15.29	15.26	0.03	NA	0.00	NA	4.1
5yr (20%)	109.0	15.17	15.14	0.03	NA	0.00	NA	4.0
2yr (50%)	83.5	14.84	14.82	0.03	NA	0.00	NA	4.1

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Footbridge 2 Seventh Brigade Park**

Footbridge looking downstream

Creek	**Downfall Creek**
Location	**Footbridge 3 Seventh Brigade Park**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 D11
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	DC_7466	AMTD (m)	8960

STRUCTURE DESCRIPTION: Steel and Timber Bridge

STRUCTURE SIZE: 3 Span - 2 x 9.0m/1 x 11.6m Bridge

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

UPSTREAM INVERT LEVEL (m):	10.66	UPSTREAM OBVERT LEVEL:	14.175
DOWNSTREAM INVERT LEVEL (m):	9.845	DOWNSTREAM OBVERT LEVEL:	14.175
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D460 FB no. 8566/4

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.66 LOWEST POINT OF WEIR (m AHD): 12.5

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

PIER WIDTH: 0.6

HEIGHT OF HAND/GUARDRAIL: 1.27

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

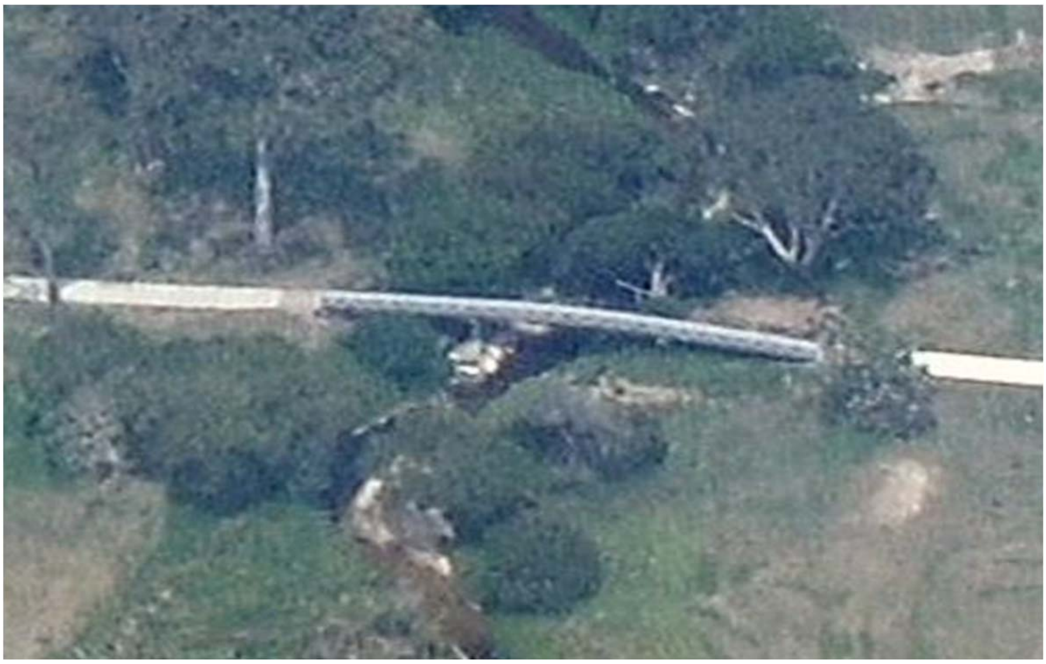
ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Footbridge 3 Seventh Brigade Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	353.1	14.47	14.41	0.06	NA	1.97	NA	4.6
500yr (0.2%)	299.9	14.29	14.25	0.04	NA	1.79	NA	4.9
100yr (1%)	234.1	14.05	14.02	0.03	NA	1.55	NA	4.8
50yr (2%)	207.7	13.93	13.91	0.03	NA	1.43	NA	4.8
20yr (5%)	177.0	13.78	13.76	0.02	NA	1.28	NA	4.7
10yr (10%)	157.7	13.69	13.66	0.03	NA	1.19	NA	4.7
5yr (20%)	144.5	13.62	13.59	0.02	NA	1.12	NA	4.7
2yr (50%)	114.0	13.41	13.40	0.02	NA	0.91	NA	4.7

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek
Location	Footbridge 3 Seventh Brigade Park



Footbridge looking downstream

Creek	**Downfall Creek**
Location	**Newman Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 F11
DATE OF SURVEY:	September-1996	ASSET ID:	
TUFLOW ID:	DC_8050	AMTD (m)	8425

STRUCTURE DESCRIPTION: 2 span concrete bridge

STRUCTURE SIZE: 2 span x 16m

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

UPSTREAM INVERT LEVEL (m): 8.16 UPSTREAM OBVERT LEVEL: 10.97

DOWNSTREAM INVERT LEVEL (m): 8.04 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes S1799 YF .002 Sheet 10 of 20D400 FB no. 856

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 17.6 LOWEST POINT OF WEIR (m AHD): 11.975

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

PIER WIDTH: 0.3

HEIGHT OF HAND/GUARDRAIL: 1.215

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: May-1996

HAS THE STRUCTURE BEEN UPGRADED?

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

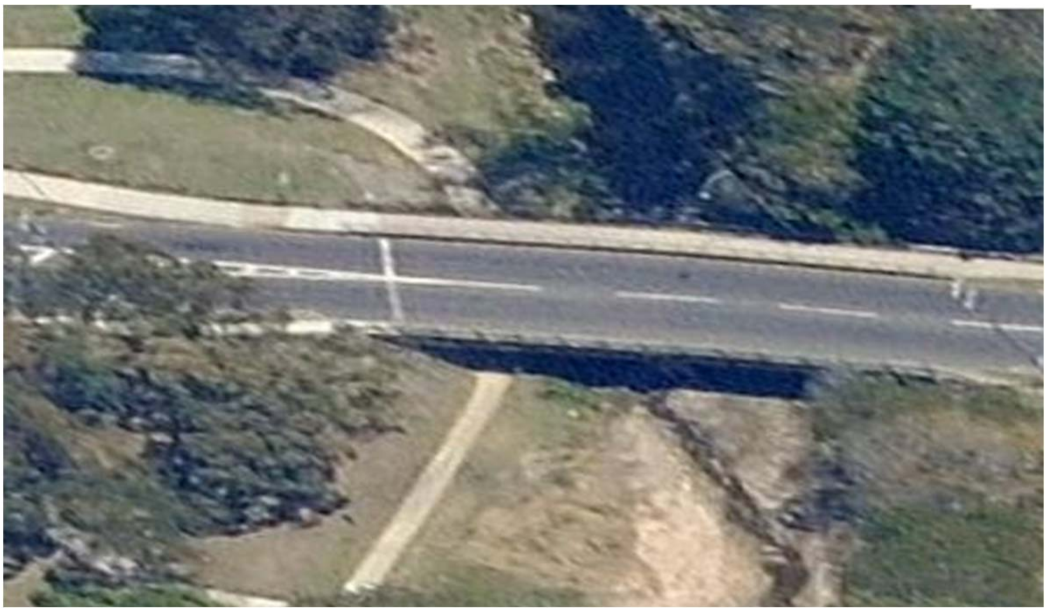
ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Newman Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	482.5	13.09	12.89	0.20	305	1.12	0.5	3.5
500yr (0.2%)	406.0	12.85	12.65	0.20	295	0.87	0.4	3.5
100yr (1%)	291.9	12.43	12.24	0.19	260	0.45	0.1	3.2
50yr (2%)	256.6	12.16	12.02	0.14	230	0.18	0.0	3.0
20yr (5%)	216.3	11.87	11.79	0.07	0	0.00	0.0	2.5
10yr (10%)	189.5	11.66	11.62	0.04	0	0.00	0.0	2.2
5yr (20%)	171.9	11.52	11.49	0.03	0	0.00	0.0	2.2
2yr (50%)	130.1	11.15	11.13	0.02	0	0.00	0.0	2.2

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Newman Rd**



Creek	**Downfall Creek**
Location	**Footbridge adjacent Bilsen Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 K12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	DC_9010	AMTD (m)	7570

STRUCTURE DESCRIPTION: Footbridge

STRUCTURE SIZE: Single 15.4m span

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

UPSTREAM INVERT LEVEL (m): 4.25 UPSTREAM OBVERT LEVEL: 7.2

DOWNSTREAM INVERT LEVEL (m): 4.25 DOWNSTREAM OBVERT LEVEL: 7.2

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 3.6 LOWEST POINT OF WEIR (m AHD): 7.5

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.68

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Footbridge adjacent Bilsen Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	421.8	10.50	10.28	0.22	NA	3.00	NA	5.6
500yr (0.2%)	372.9	10.36	10.16	0.21	NA	2.86	NA	5.4
100yr (1%)	268.4	9.81	9.64	0.18	NA	2.31	NA	5.1
50yr (2%)	239.5	9.62	9.46	0.16	NA	2.12	NA	5.0
20yr (5%)	203.5	9.35	9.20	0.15	NA	1.85	NA	4.8
10yr (10%)	182.1	9.14	8.99	0.14	NA	1.64	NA	4.7
5yr (20%)	166.7	8.94	8.82	0.13	NA	1.44	NA	4.5
2yr (50%)	129.0	8.56	8.48	0.09	NA	1.06	NA	4.0

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek**
Location	**Footbridge adjacent Bilsen Rd**

Footbridge looking upstream

Creek	Downfall Creek
Location	**Footbridge adjacent end of Brickyard Rd**

INFO SOURCE: Nundah Creek Flood Study (2004, BCC)

UBD REF: 120 L12

DATE OF SURVEY:

ASSET ID:

TUFLOW ID: DC_9619

AMTD (m) 6980

STRUCTURE DESCRIPTION: Pedestrian Bridge

STRUCTURE SIZE: 1 x 7.35x2.4m and 1 x 6.43x2.4m RCBC

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

UPSTREAM INVERT LEVEL (m): 3.87 UPSTREAM OBVERT LEVEL: 6.27

DOWNSTREAM INVERT LEVEL (m): 3.87 DOWNSTREAM OBVERT LEVEL: 6.27

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 5.375

LENGTH OF CULVERT BARREL AT OBVERT (m): 5.375

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D300 FB no. 8566/4

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 5.375 LOWEST POINT OF WEIR (m AHD): 6.3

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

PIER WIDTH: 0.46

HEIGHT OF HAND/GUARDRAIL: 1.04

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

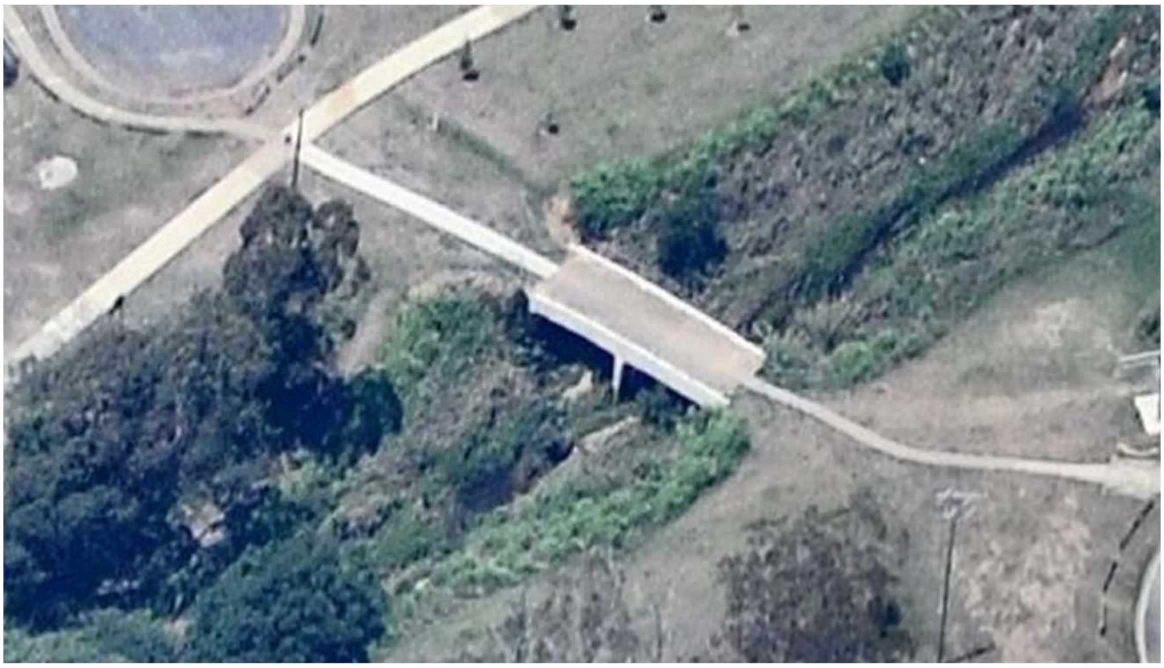
Culvert barrel data based on 2004 NCFS MIKE11 model.

Creek	Downfall Creek
Location	Footbridge adjacent end of Brickyard Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	267.0	9.70	9.44	0.26	17	3.40	2.1	5.0
500yr (0.2%)	247.5	9.62	9.39	0.23	17	3.32	1.8	4.8
100yr (1%)	215.4	9.11	8.87	0.24	17	2.81	1.5	4.7
50yr (2%)	207.1	8.92	8.68	0.24	17	2.62	1.5	4.6
20yr (5%)	194.0	8.65	8.40	0.25	17	2.35	1.3	4.5
10yr (10%)	181.9	8.44	8.17	0.26	17	2.14	1.2	4.5
5yr (20%)	171.3	8.19	7.94	0.25	17	1.89	1.1	4.4
2yr (50%)	135.5	7.65	7.48	0.17	17	1.35	0.6	3.8

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Downfall Creek**
Location	**Footbridge adjacent end of Brickyard Rd**



Footbridge looking upstream

Footbridge configuration

Creek	Downfall Creek
Location	North Coast Railway

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 N12
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_9997	AMTD (m)	6640

STRUCTURE DESCRIPTION: Steel and concrete railbridge

STRUCTURE SIZE: 2 span x 13.2m

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

UPSTREAM INVERT LEVEL (m): 2.4 UPSTREAM OBVERT LEVEL: 7.33

DOWNSTREAM INVERT LEVEL (m): 2.4 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D260 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 6 LOWEST POINT OF WEIR (m AHD): 8.4

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

PIER WIDTH: 1.2

HEIGHT OF HAND/GUARDRAIL: Nil

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	North Coast Railway

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	413.8	8.99	8.40	0.60	30	0.59	1.9	4.6
500yr (0.2%)	371.7	9.00	8.50	0.50	30	0.60	1.8	4.1
100yr (1%)	300.4	8.50	8.10	0.40	30	0.10	0.1	3.7
50yr (2%)	274.2	8.29	7.96	0.33	0	0.00	0.0	3.4
20yr (5%)	231.3	7.98	7.78	0.20	0	0.00	0.0	2.8
10yr (10%)	200.1	7.76	7.62	0.14	0	0.00	0.0	2.5
5yr (20%)	175.2	7.47	7.39	0.08	0	0.00	0.0	2.4
2yr (50%)	136.4	6.82	6.78	0.03	0	0.00	0.0	2.3

Notes:

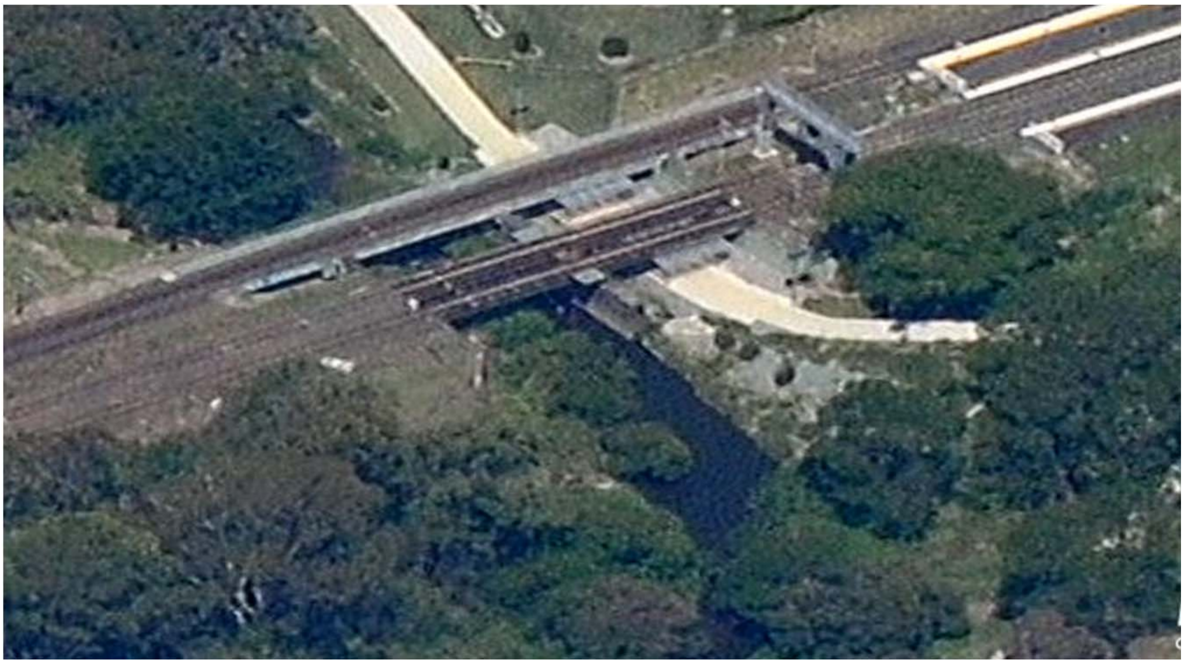
Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Downfall Creek**
Location	**North Coast Railway**



Railway looking downstream

Creek	**Downfall Creek**
Location	**Sandgate Rd Northbound**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 N12
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_10147	AMTD (m)	6490

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: 3 span (1x9.4m, 1x9.5m, 1x9.7m)

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

UPSTREAM INVERT LEVEL (m): 2.474   UPSTREAM OBVERT LEVEL: 6.66

DOWNSTREAM INVERT LEVEL (m): 2.426   DOWNSTREAM OBVERT LEVEL:

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?   Yes D225 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 24.22   LOWEST POINT OF WEIR (m AHD): 7.236

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

PIER WIDTH: 0.25

HEIGHT OF HAND/GUARDRAIL: 1.267

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Sandgate Rd Northbound

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	312.1	8.13	7.87	0.26	NA	0.89	NA	NA
500yr (0.2%)	228.1	8.22	7.51	0.71	NA	0.99	NA	5.6
100yr (1%)	204.8	7.82	7.22	0.60	NA	0.58	NA	5.2
50yr (2%)	196.2	7.68	7.07	0.62	NA	0.45	NA	5.1
20yr (5%)	187.0	7.51	6.90	0.61	NA	0.27	NA	5.1
10yr (10%)	177.0	7.34	6.70	0.64	NA	0.10	NA	4.9
5yr (20%)	167.1	7.11	6.53	0.59	NA	0.00	NA	4.9
2yr (50%)	136.4	6.58	6.17	0.41	NA	0.00	NA	4.8

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Downfall Creek
Location	Sandgate Rd Northbound

Sandgate Road looking downstream

Creek	**Downfall Creek**
Location	**Sandgate Road Overpass**

INFO SOURCE:	NearMap Aerial Photography (2014)	UBD REF:	120 N12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	Sandgate Road Bridge	AMTD (m)	6450

STRUCTURE DESCRIPTION: Concrete bridge overpass

STRUCTURE SIZE: 2 spans (2 x 26.9m) - main opening

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

UPSTREAM INVERT LEVEL (m):

UPSTREAM OBVERT LEVEL: 9.15

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 10

LOWEST POINT OF WEIR (m AHD): 10.68

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Department of Transport and Main Roads - Job No. 140/U99/AB50

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure details based on Department of Transport and Main Roads drawings. Weir width based on aerial photography measurements.

Creek	Downfall Creek
Location	Sandgate Road Overpass

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	382.7	7.94	7.64	0.30	0	0.00	0.0	4.6
500yr (0.2%)	325.8	7.68	7.48	0.20	0	0.00	0.0	4.2
100yr (1%)	254.1	7.29	7.15	0.14	0	0.00	0.0	4.2
50yr (2%)	231.6	7.12	7.00	0.11	0	0.00	0.0	4.2
20yr (5%)	204.7	6.87	6.79	0.09	0	0.00	0.0	4.2
10yr (10%)	182.7	6.66	6.53	0.13	0	0.00	0.0	4.2
5yr (20%)	168.7	6.49	6.41	0.09	0	0.00	0.0	4.0
2yr (50%)	136.7	6.17	6.10	0.07	0	0.00	0.0	2.9

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Downfall Creek
Location	Sandgate Road Overpass

Sandgate Rd Southbound looking downstream

Creek	**Downfall Creek**
Location	**Sandgate Rd Southbound**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 N12
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_10200	AMTD (m)	6425

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: 3 span (2x9.3m and 1x9.7m)

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

UPSTREAM INVERT LEVEL (m): 1.172 UPSTREAM OBVERT LEVEL: 7.57

DOWNSTREAM INVERT LEVEL (m): 1.38 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D213 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 10.55 LOWEST POINT OF WEIR (m AHD): 8.197

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

PIER WIDTH: 0.25

HEIGHT OF HAND/GUARDRAIL: 1.503

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Sandgate Rd Southbound

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	349.8	7.63	7.46	0.17	0	0.00	0.0	3.5
500yr (0.2%)	306.3	7.47	7.24	0.22	0	0.00	0.0	4.0
100yr (1%)	242.0	7.13	6.88	0.26	0	0.00	0.0	3.5
50yr (2%)	220.6	6.98	6.74	0.24	0	0.00	0.0	3.5
20yr (5%)	199.7	6.76	6.57	0.19	0	0.00	0.0	3.5
10yr (10%)	182.2	6.51	6.40	0.11	0	0.00	0.0	3.3
5yr (20%)	169.7	6.41	6.30	0.11	0	0.00	0.0	3.1
2yr (50%)	137.6	6.11	6.01	0.09	0	0.00	0.0	2.9

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Downfall Creek**
Location	**Sandgate Rd Southbound**

Sandgate Road looking downstream

Creek	**Downfall Creek**
Location	**Sandgate Rd Southbound Off-ramp**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 N12
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_10232	AMTD (m)	6405

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: 6 span (average span of 4.1m)

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

UPSTREAM INVERT LEVEL (m):	1.38	UPSTREAM OBVERT LEVEL:	5.1
DOWNSTREAM INVERT LEVEL (m):	1.284	DOWNSTREAM OBVERT LEVEL:	

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D205 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 6.755 LOWEST POINT OF WEIR (m AHD): 5.675

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

PIER WIDTH: 0.35

HEIGHT OF HAND/GUARDRAIL: 1.406

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

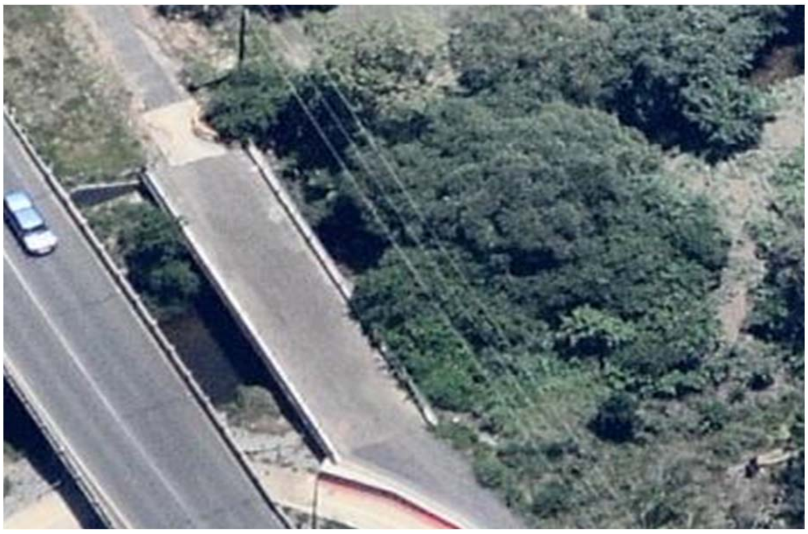
ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Sandgate Rd Southbound Off-ramp

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	302.1	7.37	6.58	0.79	NA	1.70	NA	7.0
500yr (0.2%)	271.2	7.16	6.47	0.69	NA	1.48	NA	6.5
100yr (1%)	222.9	6.81	6.31	0.50	NA	1.13	NA	5.5
50yr (2%)	205.7	6.68	6.25	0.43	NA	1.01	NA	4.8
20yr (5%)	187.6	6.52	6.15	0.37	NA	0.84	NA	4.4
10yr (10%)	174.2	6.33	6.09	0.25	NA	0.66	NA	4.1
5yr (20%)	163.4	6.23	5.97	0.26	NA	0.55	NA	3.6
2yr (50%)	133.1	5.97	5.82	0.16	NA	0.30	NA	3.3

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Downfall Creek**
Location	**Sandgate Rd Southbound Off-ramp**



Creek	**Downfall Creek**
Location	**Footbridge No. 3 in Golf Course**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 P10
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_10704	AMTD (m)	5920

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: Single 12m span

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

UPSTREAM INVERT LEVEL (m): 1.69 UPSTREAM OBVERT LEVEL: 3.6

DOWNSTREAM INVERT LEVEL (m): 0.99 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes D156 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 5.0 LOWEST POINT OF WEIR (m AHD): 3.2

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Footbridge No. 3 in Golf Course

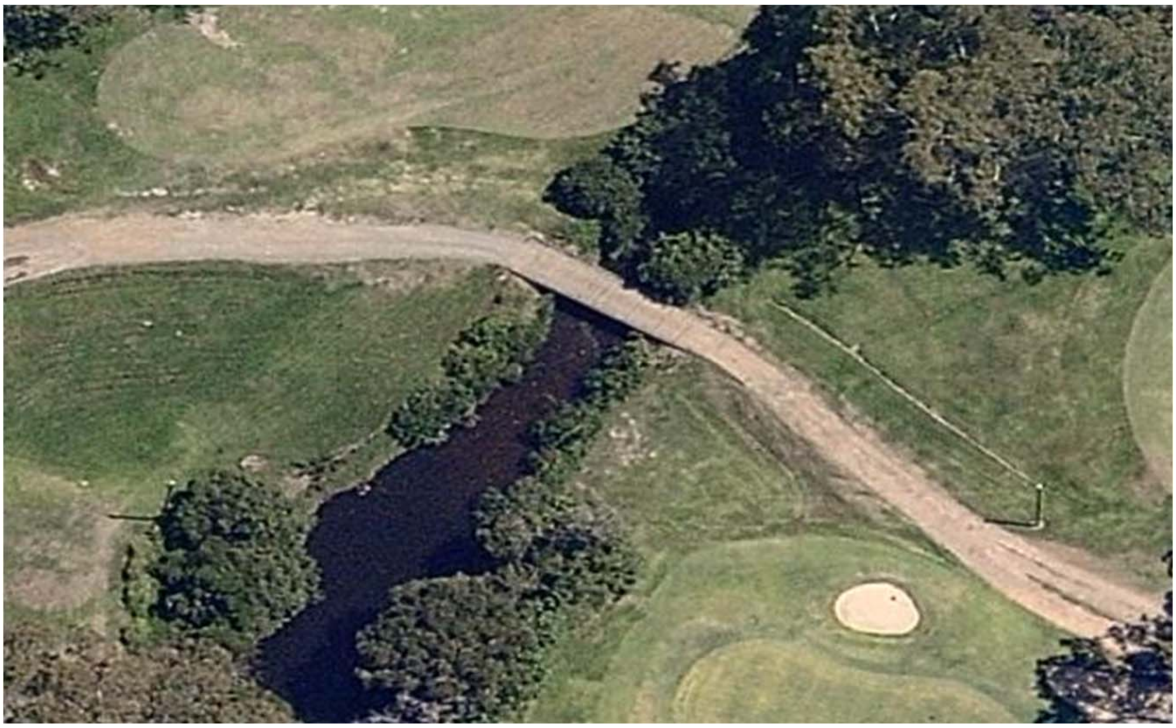
ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	66.6	6.31	6.29	0.02	NA	3.11	NA	6.3
500yr (0.2%)	61.9	6.21	6.20	0.02	NA	3.01	NA	6.9
100yr (1%)	50.6	5.95	5.94	0.01	NA	2.75	NA	6.9
50yr (2%)	46.0	5.86	5.84	0.01	NA	2.66	NA	6.9
20yr (5%)	40.0	5.67	5.65	0.01	NA	2.47	NA	6.9
10yr (10%)	38.8	5.64	5.63	0.01	NA	2.44	NA	6.9
5yr (20%)	34.3	5.52	5.50	0.02	NA	2.32	NA	6.9
2yr (50%)	28.6	5.33	5.31	0.02	NA	2.13	NA	6.9

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Downfall Creek
Location	Footbridge No. 3 in Golf Course



Footbridge looking upstream

Creek	**Downfall Creek**
Location	**Footbridge No. 4 in Golf Course**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 P9
DATE OF SURVEY:	February to April 1996	ASSET ID:	
TUFLOW ID:	DC_10953	AMTD (m)	5730

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: Single 6m span

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

UPSTREAM INVERT LEVEL (m): 1.238   UPSTREAM OBVERT LEVEL: 2.4

DOWNSTREAM INVERT LEVEL (m): 0.827   DOWNSTREAM OBVERT LEVEL:

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE?   Yes D148 FB no. 8566/3

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.45   LOWEST POINT OF WEIR (m AHD): 2.4

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek
Location	Footbridge No. 4 in Golf Course

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	35.4	5.55	5.54	0.02	NA	3.15	NA	4.5
500yr (0.2%)	33.2	5.46	5.45	0.01	NA	3.06	NA	5.2
100yr (1%)	26.4	5.21	5.20	0.02	NA	2.81	NA	5.3
50yr (2%)	26.2	5.13	5.11	0.02	NA	2.73	NA	5.3
20yr (5%)	24.3	5.02	5.01	0.01	NA	2.62	NA	5.5
10yr (10%)	22.5	4.92	4.91	0.01	NA	2.52	NA	5.3
5yr (20%)	21.5	4.82	4.81	0.01	NA	2.42	NA	5.3
2yr (50%)	16.6	4.61	4.60	0.01	NA	2.21	NA	5.2

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Downfall Creek
Location	Footbridge No. 4 in Golf Course

Footbridge looking upstream

Creek	**Downfall Creek Tributary A**
Location	**Maundrell Tce**

INFO SOURCE:	Gecko BCC database	UBD REF:	119 J12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TA_W3320	AMTD (m)	1276

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 1 x 1.8m RCPC

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

UPSTREAM INVERT LEVEL (m):	30.83	UPSTREAM OBVERT LEVEL:	32.63
DOWNSTREAM INVERT LEVEL (m):	29.12	DOWNSTREAM OBVERT LEVEL:	30.92

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 14 LOWEST POINT OF WEIR (m AHD): 32.62

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: W3320

BRIDGE OR CULVERT DETAILS: 2 x 1.2x0.8m box culvert transitioning to a 1 x 1.8m circular culvert (control structure)

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

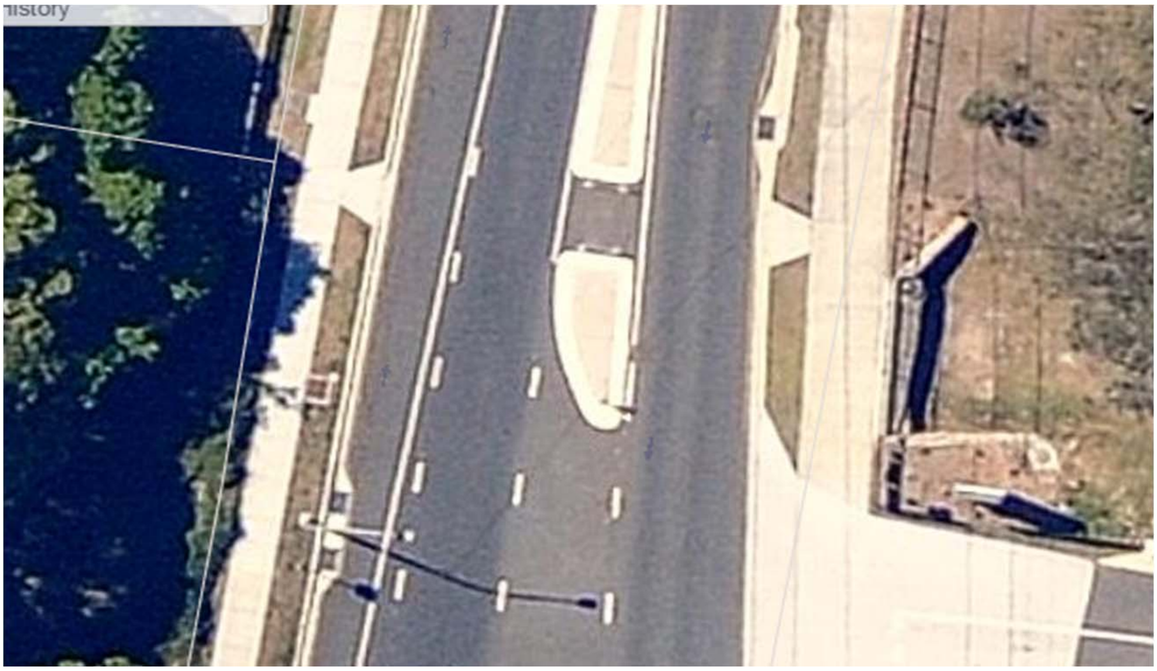
Structure size and invert data based on Gecko BCC database plan no. W3320. Weir width based on measurements taken from aerial photography

Creek	Downfall Creek Tributary A
Location	Maundrell Tce

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	26.7	5.58	5.56	0.02	80	0.00	0.4	3.4
500yr (0.2%)	27.7	5.49	5.48	0.02	80	0.00	0.4	3.4
100yr (1%)	21.9	5.25	5.23	0.02	78	0.00	0.4	3.3
50yr (2%)	19.3	5.16	5.15	0.02	78	0.00	0.3	3.2
20yr (5%)	16.6	5.06	5.04	0.02	75	0.00	0.3	3.2
10yr (10%)	13.6	4.96	4.94	0.01	72	0.00	0.3	3.1
5yr (20%)	11.4	4.86	4.85	0.01	62	0.00	0.3	3.0
2yr (50%)	7.4	4.67	4.65	0.02	35	0.00	0.3	2.8

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek Tributary A**
Location	**Maundrell Tce**



Creek	**Downfall Creek Tributary A**
Location	**Marban St**

INFO SOURCE:	Gecko BCC database	UBD REF:	119 L11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TA_W5409	AMTD (m)	722

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 3 x 1.525m RCPC

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

UPSTREAM INVERT LEVEL (m):	21.94	UPSTREAM OBVERT LEVEL:	23.465
DOWNSTREAM INVERT LEVEL (m):	21.82	DOWNSTREAM OBVERT LEVEL:	23.345
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 14.1

LENGTH OF CULVERT BARREL AT OBVERT (m): 14.1

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 14.1 LOWEST POINT OF WEIR (m AHD): 24.2

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 0.5

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: W5409

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure size and invert data based on Plan no. W5409.

Creek	Downfall Creek Tributary A
Location	Marban St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	52.8	24.78	23.73	1.05	47	0.58	1.4	4.6
500yr (0.2%)	49.3	24.77	23.74	1.03	47	0.57	1.2	4.6
100yr (1%)	39.3	24.63	23.50	1.13	43	0.43	1.1	4.5
50yr (2%)	34.6	24.57	23.41	1.15	38	0.37	0.9	4.4
20yr (5%)	29.5	24.52	23.31	1.20	37	0.32	0.7	4.1
10yr (10%)	24.9	24.44	23.20	1.24	33	0.24	0.6	3.9
5yr (20%)	20.6	24.29	23.09	1.20	20	0.09	0.4	3.7
2yr (50%)	15.0	23.75	22.92	0.82	0	0.00	0.0	2.7

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek Tributary A
Location	Marban St

Marban Street looking upstream

Marban Street looking downstream

Creek	**Downfall Creek Tributary A**
Location	**Footbridge in Frederick Annand Park**

INFO SOURCE:	Site inspection (2014)	UBD REF:	119 M11
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TA_SI_01	AMTD (m)	593

STRUCTURE DESCRIPTION: 2 span bridge (25m total)

STRUCTURE SIZE: 2 span bridge (25m total)

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

UPSTREAM INVERT LEVEL (m): 21.24

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 1.5

LOWEST POINT OF WEIR (m AHD): 23.5

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure invert and weir levels based on 2009 ALS data. Other data based on site measurements.

Creek	**Downfall Creek Tributary A**
Location	**Footbridge in Frederick Annand Park**

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	52.6	23.36	23.27	0.10	0	0.00	0.0	6.6
500yr (0.2%)	49.5	23.41	23.30	0.11	0	0.00	0.0	6.6
100yr (1%)	39.5	22.90	22.84	0.06	0	0.00	0.0	5.8
50yr (2%)	34.8	22.61	22.56	0.05	0	0.00	0.0	3.3
20yr (5%)	29.7	22.53	22.47	0.06	0	0.00	0.0	3.1
10yr (10%)	25.0	22.43	22.37	0.06	0	0.00	0.0	3.0
5yr (20%)	20.5	22.34	22.27	0.07	0	0.00	0.0	2.9
2yr (50%)	14.9	22.20	22.11	0.09	0	0.00	0.0	2.7

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Downfall Creek Tributary A**
Location	**Footbridge in Frederick Annand Park**

Footbridge looking upstream

Footbridge configuration

Creek	Downfall Creek Tributary A
Location	Webster Rd

INFO SOURCE:	Design Drawing	UBD REF:	119 N12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TA_W4286	AMTD (m)	24.38

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 2 x 2.64mx1.22m RCBC

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

UPSTREAM INVERT LEVEL (m):	18.38	UPSTREAM OBVERT LEVEL:	19.6
DOWNSTREAM INVERT LEVEL (m):	18.3	DOWNSTREAM OBVERT LEVEL:	19.52

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): LOWEST POINT OF WEIR (m AHD): 21.4

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: W4286

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Downfall Creek Tributary A
Location	Webster Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	78.8	22.81	21.19	1.63	130	1.41	0.4	8.5
500yr (0.2%)	72.3	22.75	20.99	1.75	127	1.35	0.4	8.5
100yr (1%)	54.8	22.50	20.72	1.78	110	1.10	0.3	8.2
50yr (2%)	46.9	22.35	20.60	1.75	100	0.95	0.3	8.0
20yr (5%)	39.3	22.14	20.43	1.71	85	0.74	0.3	7.7
10yr (10%)	32.9	21.89	20.29	1.60	60	0.49	0.3	7.4
5yr (20%)	27.5	21.61	20.17	1.44	30	0.21	0.2	7.0
2yr (50%)	22.3	21.06	19.87	1.19	0	0.00	0.0	6.2

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek Tributary A
Location	Webster Rd

Webster Road looking downstream

Creek	**Downfall Creek Tributary A**
Location	**Footbridge Downstream of Webster Rd**

INFO SOURCE:	Site inspection (2014)	UBD REF:	119 P12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TA_SI_02	AMTD (m)	59

STRUCTURE DESCRIPTION: Steel and timber footbridge

STRUCTURE SIZE: Single 21.5m span

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

UPSTREAM INVERT LEVEL (m): 17.77

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 3.2

LOWEST POINT OF WEIR (m AHD): 20.75

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure data based on 2009 ALS, site measurements, and aerial photography.

Creek	Downfall Creek Tributary A
Location	Footbridge Downstream of Webster Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	69.0	21.08	21.07	0.01	NA	0.33	NA	1.9
500yr (0.2%)	63.5	20.88	20.87	0.01	NA	0.13	NA	2.4
100yr (1%)	49.5	20.60	20.60	0.01	NA	0.00	NA	2.2
50yr (2%)	43.5	20.46	20.45	0.01	NA	0.00	NA	2.2
20yr (5%)	37.8	20.30	20.30	0.01	NA	0.00	NA	2.2
10yr (10%)	32.3	20.14	20.13	0.01	NA	0.00	NA	2.2
5yr (20%)	27.2	20.01	20.00	0.01	NA	0.00	NA	2.1
2yr (50%)	22.1	19.67	19.67	0.01	NA	0.00	NA	2.1

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek Tributary A
Location	Footbridge Downstream of Webster Rd

Footbridge looking downstream

Footbridge looking upstream

Creek	**Downfall Creek Tributary B**
Location	**Footbridge at end of Bilsen Rd**

INFO SOURCE:	Site inspection (2014)	UBD REF:	120 J12
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TB_SI_04	AMTD (m)	155

STRUCTURE DESCRIPTION: Concrete and steel footbridge

STRUCTURE SIZE: Single 16m span bridge

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

UPSTREAM INVERT LEVEL (m): 6.42 UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m): DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.6 LOWEST POINT OF WEIR (m AHD):

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure data based on 2009 ALS, site measurements, and aerial photography.

Creek	Downfall Creek Tributary B
Location	Footbridge at end of Bilsen Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	78.2	10.04	10.04	0.00	NA	NA	NA	3.5
500yr (0.2%)	87.2	9.94	9.93	0.00	NA	NA	NA	4.5
100yr (1%)	68.2	9.41	9.41	0.00	NA	NA	NA	4.4
50yr (2%)	60.1	9.22	9.22	0.00	NA	NA	NA	4.4
20yr (5%)	52.2	8.97	8.97	0.00	NA	NA	NA	4.4
10yr (10%)	44.4	8.78	8.77	0.00	NA	NA	NA	4.3
5yr (20%)	38.8	8.58	8.57	0.00	NA	NA	NA	4.3
2yr (50%)	29.4	8.22	8.22	0.00	NA	NA	NA	4.3

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak across the entire flooded width

Creek	Downfall Creek Tributary B
Location	Footbridge at end of Bilsen Rd

Footbridge looking downstream

Footbridge looking upstream

Creek	**Downfall Creek Tributary C**
Location	**Footbridge adjacent end of Borrows St**

INFO SOURCE:	Site inspection (2014)	UBD REF:	120 K13
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TG_SI_05	AMTD (m)	28

STRUCTURE DESCRIPTION: Concrete footbridge

STRUCTURE SIZE: Single 8.2m span bridge

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

UPSTREAM INVERT LEVEL (m): 4.52 UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m): DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.3 LOWEST POINT OF WEIR (m AHD): 6.71

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure data based on 2009 ALS, site measurements, and aerial photography.

Creek	Downfall Creek Tributary C
Location	Footbridge adjacent end of Borrows St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	51.9	9.91	9.89	0.02	NA	3.20	NA	2.3
500yr (0.2%)	73.2	9.82	9.80	0.02	NA	3.11	NA	4.5
100yr (1%)	64.5	9.29	9.28	0.01	NA	2.58	NA	4.0
50yr (2%)	59.7	9.10	9.09	0.01	NA	2.39	NA	3.7
20yr (5%)	56.5	8.84	8.83	0.01	NA	2.13	NA	3.4
10yr (10%)	47.4	8.63	8.62	0.01	NA	1.92	NA	3.0
5yr (20%)	40.9	8.40	8.38	0.01	NA	1.69	NA	2.7
2yr (50%)	30.7	7.93	7.91	0.02	NA	1.22	NA	2.8

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Downfall Creek Tributary C**
Location	**Footbridge adjacent end of Borrows St**

Footbridge configuration

Footbridge looking upstream

Creek	Zillman Waterholes
Location	**Rainbow Park Footbridge**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 A7
DATE OF SURVEY:	March/April 1996	ASSET ID:	
TUFLOW ID:	ZC_7620	AMTD (m)	4688

STRUCTURE DESCRIPTION: Pedestrian Bridge

STRUCTURE SIZE: Single 11.8m span bridge

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

UPSTREAM INVERT LEVEL (m): 15.71   UPSTREAM OBVERT LEVEL: 17.53

DOWNSTREAM INVERT LEVEL (m): 15.71   DOWNSTREAM OBVERT LEVEL:

For culverts give floor level   For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 3.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 3.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes 346-0a FB no. 8566/8

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 3.6   LOWEST POINT OF WEIR (m AHD): 17.93

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

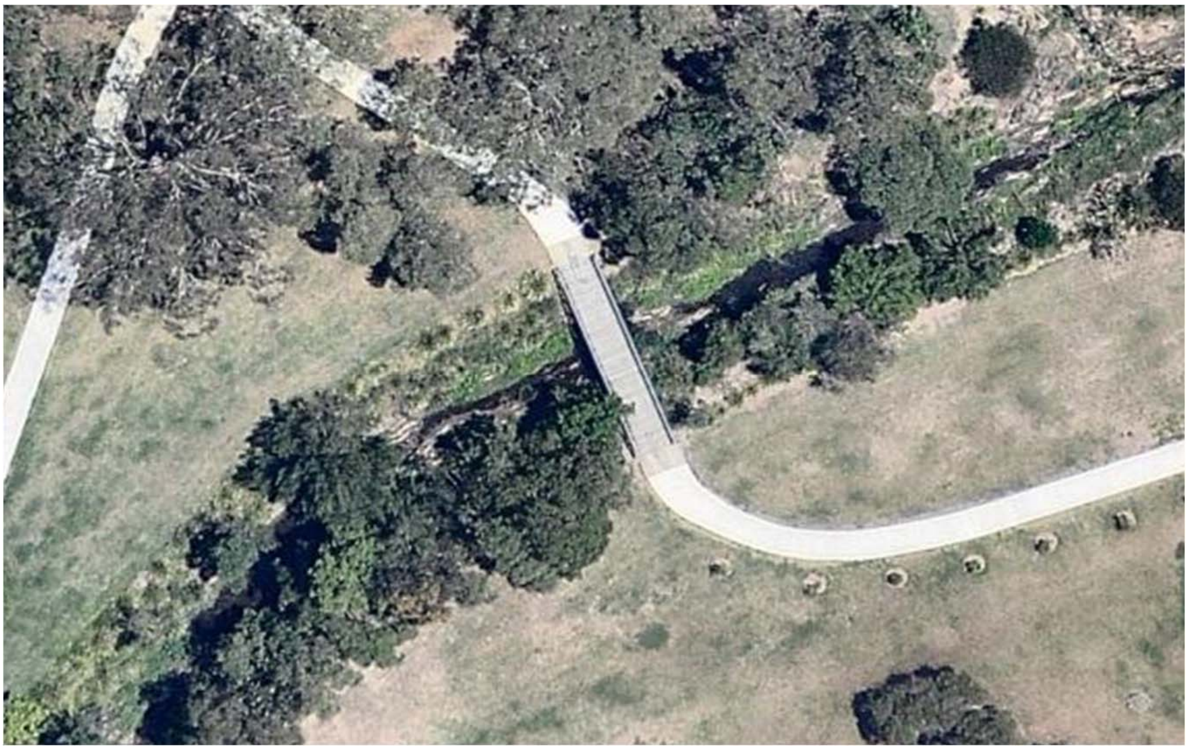
Plans for this footbridge were not located - Bilsen Rd footbridge plans have been used to provide standard dimensions.

Creek	Zillman Waterholes
Location	Rainbow Park Footbridge

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	87.7	19.27	19.25	0.02	NA	1.34	NA	3.7
500yr (0.2%)	76.2	19.08	19.06	0.02	NA	1.15	NA	3.9
100yr (1%)	57.6	18.68	18.64	0.05	NA	0.75	NA	3.5
50yr (2%)	48.8	18.44	18.37	0.07	NA	0.51	NA	3.4
20yr (5%)	41.7	18.11	18.04	0.06	NA	0.18	NA	3.3
10yr (10%)	34.5	17.87	17.84	0.04	NA	0.00	NA	3.2
5yr (20%)	29.5	17.67	17.64	0.03	NA	0.00	NA	3.1
2yr (50%)	20.9	17.24	17.21	0.03	NA	0.00	NA	3.1

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes**
Location	**Rainbow Park Footbridge**



Rainbow Park footbridge aerial view

Creek	**Zillman Waterholes**
Location	**Murphy Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 B6
DATE OF SURVEY:	April-1996	ASSET ID:	
TUFLOW ID:	ZC_7617	AMTD (m)	4340

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 5 x 1.675m diameter pipes

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

UPSTREAM INVERT LEVEL (m):	14.675	UPSTREAM OBVERT LEVEL:	16.35
DOWNSTREAM INVERT LEVEL (m):	14.6	DOWNSTREAM OBVERT LEVEL:	16.27
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 21.4

LENGTH OF CULVERT BARREL AT OBVERT (m): 21.4

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z650 FB no. 8566/8

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 21.4 LOWEST POINT OF WEIR (m AHD): 17.7

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

PIER WIDTH: 0.15

HEIGHT OF HAND/GUARDRAIL: 0.83

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Murphy Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	99.1	19.21	17.19	2.02	180	1.51	0.2	5.7
500yr (0.2%)	83.1	19.01	16.99	2.02	170	1.31	0.1	5.6
100yr (1%)	63.9	18.57	16.70	1.87	145	0.87	0.1	5.3
50yr (2%)	57.0	18.30	16.68	1.62	120	0.60	0.0	5.1
20yr (5%)	53.8	17.97	16.60	1.37	80	0.27	0.0	4.9
10yr (10%)	50.9	17.67	16.51	1.16	0	0.00	0.0	4.7
5yr (20%)	39.8	17.40	16.26	1.14	0	0.00	0.0	3.6
2yr (50%)	29.7	16.89	15.96	0.92	0	0.00	0.0	3.2

Notes:
Weir velocity is the average across the entire flooded width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes**
Location	**Murphy Rd**

Murphy Road looking downstream

Murphy Road aerial view

Creek	**Zillman Waterholes**
Location	**Footbridge adjacent Roland St**

INFO SOURCE:	Site inspection (2014)	UBD REF:	120 D6
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	ZC_SI_06	AMTD (m)	3825

STRUCTURE DESCRIPTION: Timber footbridge

STRUCTURE SIZE: Single 8.5m span bridge

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

UPSTREAM INVERT LEVEL (m): 11.98

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 1.6

LOWEST POINT OF WEIR (m AHD): 13.44

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure data based on 2009 ALS, site measurements, and aerial photography.

Creek	Zillman Waterholes
Location	Footbridge adjacent Roland St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	145.0	14.12	14.11	0.01	NA	0.68	NA	3.8
500yr (0.2%)	123.2	14.04	14.03	0.01	NA	0.60	NA	4.3
100yr (1%)	96.5	13.92	13.91	0.01	NA	0.48	NA	4.3
50yr (2%)	89.0	13.89	13.88	0.01	NA	0.45	NA	4.3
20yr (5%)	83.4	13.86	13.86	0.01	NA	0.42	NA	4.3
10yr (10%)	75.0	13.83	13.82	0.01	NA	0.39	NA	4.3
5yr (20%)	62.2	13.77	13.75	0.01	NA	0.33	NA	4.3
2yr (50%)	45.9	13.68	13.66	0.01	NA	0.24	NA	4.2

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes**
Location	**Footbridge adjacent Roland St**

Footbridge looking downstream

Footbridge configuration

Creek	**Zillman Waterholes**
Location	**Bikeway Upstream of Robinson Rd West**

INFO SOURCE:	2014 Design HEC-RAS model	UBD REF:	120 E6
DATE OF SURVEY:	2014	ASSET ID:	
TUFLOW ID:	ZC_30031198	AMTD (m)	3794

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 3 x 1.2mx1.2m RCBC

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

UPSTREAM INVERT LEVEL (m):	11.47	UPSTREAM OBVERT LEVEL:	12.67
DOWNSTREAM INVERT LEVEL (m):	11.44	DOWNSTREAM OBVERT LEVEL:	12.44

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 6

LENGTH OF CULVERT BARREL AT OBVERT (m): 6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes140206 ZILLMAN BIKEWAY SURFACE TIN

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 6 LOWEST POINT OF WEIR (m AHD): 13.25

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: July-1905

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

Structure data baed on the following sources:

1. 30031198 - ZILLMANBIKEWAY - SMEC HECRAS Project BCC Bikeway - Feb 2014

2. 140206 ZILLMAN BIKEWAY SURFACE TIN

Creek	Zillman Waterholes
Location	Bikeway Upstream of Robinson Rd West

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	116.1	14.10	13.90	0.20	NA	0.85	NA	5.7
500yr (0.2%)	97.2	14.01	13.76	0.25	NA	0.76	NA	5.7
100yr (1%)	75.4	13.89	13.54	0.34	NA	0.64	NA	5.7
50yr (2%)	69.5	13.86	13.46	0.40	NA	0.61	NA	5.7
20yr (5%)	65.0	13.83	13.37	0.46	NA	0.58	NA	5.7
10yr (10%)	57.5	13.76	13.22	0.53	NA	0.51	NA	5.6
5yr (20%)	47.7	13.69	13.12	0.57	NA	0.44	NA	5.5
2yr (50%)	35.4	13.59	12.97	0.62	NA	0.34	NA	5.3

Notes:
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak across the entire flooded width

Creek	Zillman Waterholes
Location	Bikeway Upstream of Robinson Rd West

Bikeway looking downstream

Aerial view of bikeway

Creek	**Zillman Waterholes**
Location	**Robinson Rd West**

INFO SOURCE:	2014 Site Survey	UBD REF:	120 E6
DATE OF SURVEY:	2014	ASSET ID:	
TUFLOW ID:	ZC_140904	AMTD (m)	3610

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 6 x 3.3m x 2.7m RCBC

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

UPSTREAM INVERT LEVEL (m):	9.83	UPSTREAM OBVERT LEVEL:	12.53
DOWNSTREAM INVERT LEVEL (m):	9.72	DOWNSTREAM OBVERT LEVEL:	12.42

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 36

LENGTH OF CULVERT BARREL AT OBVERT (m): 36

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Refer BCC Project 140904

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 36 LOWEST POINT OF WEIR (m AHD): 13.4

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: 3003981-DD1102/DD3101/DD3102

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: July-1905

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Robinson Rd West

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	151.4	13.62	13.41	0.21	60	0.22	1.1	2.6
500yr (0.2%)	129.6	13.47	13.31	0.16	37	0.07	1.0	2.9
100yr (1%)	97.9	13.23	13.14	0.09	0	0.00	0.0	2.9
50yr (2%)	85.7	13.13	13.06	0.07	0	0.00	0.0	2.8
20yr (5%)	77.9	12.99	12.95	0.04	0	0.00	0.0	2.8
10yr (10%)	68.0	12.71	12.68	0.02	0	0.00	0.0	2.8
5yr (20%)	60.9	12.31	12.30	0.01	0	0.00	0.0	2.8
2yr (50%)	45.8	11.67	11.66	0.02	0	0.00	0.0	2.7

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes**
Location	**Robinson Rd West**

Robinson Road West aerial view

Robinson Road West looking downstream

Creek	**Zillman Waterholes**
Location	**North Coast Railway**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 E5
DATE OF SURVEY:	April-1996	ASSET ID:	
TUFLOW ID:	ZC_8521	AMTD (m)	3440

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 5 x 1.8m RCPC

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

UPSTREAM INVERT LEVEL (m): 8.85 UPSTREAM OBVERT LEVEL: 10.65

DOWNSTREAM INVERT LEVEL (m): 8.82 DOWNSTREAM OBVERT LEVEL: 10.62

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 12.73

LENGTH OF CULVERT BARREL AT OBVERT (m): 12.73

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z540 FB no. 8566/8

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 12.73 LOWEST POINT OF WEIR (m AHD): 12.9

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

PIER WIDTH: 2x0.45m,2x2.25m

HEIGHT OF HAND/GUARDRAIL: 1.9

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	North Coast Railway

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	151.9	13.33	11.08	2.25	400	0.43	0.4	5.7
500yr (0.2%)	127.4	13.25	10.84	2.41	380	0.35	0.4	5.6
100yr (1%)	96.8	13.10	10.63	2.46	360	0.20	0.3	5.5
50yr (2%)	83.7	13.03	10.54	2.49	350	0.13	0.2	5.5
20yr (5%)	71.0	12.92	10.44	2.48	0	0.02	0.0	5.3
10yr (10%)	63.7	12.62	10.34	2.27	0	0.00	0.0	5.0
5yr (20%)	57.3	12.23	10.24	1.99	0	0.00	0.0	4.5
2yr (50%)	44.5	11.58	10.01	1.56	0	0.00	0.0	3.5

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	Zillman Waterholes
Location	North Coast Railway

Railway aerial view

Creek	**Zillman Waterholes**
Location	**Causeway in O'Callaghan's Park**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 E4
DATE OF SURVEY:	April-1996	ASSET ID:	
TUFLOW ID:	ZC_8801	AMTD (m)	3170

STRUCTURE DESCRIPTION: Concrete causeway

STRUCTURE SIZE: 2 x 0.375m diameter

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

UPSTREAM INVERT LEVEL (m):	6.825	UPSTREAM OBVERT LEVEL:	7.2
DOWNSTREAM INVERT LEVEL (m):	6.775	DOWNSTREAM OBVERT LEVEL:	7.15

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 4.8

LENGTH OF CULVERT BARREL AT OBVERT (m): 4.8

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z483 FB no. 8566/8

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 4.8 LOWEST POINT OF WEIR (m AHD): 7.4

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: Nil

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Causeway in O'Callaghan's Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	NA	10.58	9.73	0.85	27	3.18	NA	NA
500yr (0.2%)	107.4	10.72	9.96	0.76	27	3.32	1.2	4.8
100yr (1%)	88.4	9.82	9.64	0.18	27	2.42	1.3	3.7
50yr (2%)	79.4	9.74	9.54	0.20	27	2.34	1.2	3.7
20yr (5%)	70.3	9.65	9.43	0.22	27	2.25	1.1	3.7
10yr (10%)	63.8	9.54	9.36	0.18	27	2.14	1.1	3.7
5yr (20%)	57.2	9.47	9.27	0.19	27	2.07	1.0	3.7
2yr (50%)	44.1	9.30	8.96	0.35	27	1.90	0.9	3.7

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Zillman Waterholes
Location	Causeway in O'Callaghan's Park

Causeway aerial view

Creek	**Zillman Waterholes**
Location	**Causeway in Park**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 F4
DATE OF SURVEY:	April-1996	ASSET ID:	
TUFLOW ID:	ZC_8942	AMTD (m)	2990

STRUCTURE DESCRIPTION: Concrete causeway

STRUCTURE SIZE: 4 x 0.3m diameter

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

UPSTREAM INVERT LEVEL (m):	6.055	UPSTREAM OBVERT LEVEL:	6.355
DOWNSTREAM INVERT LEVEL (m):	5.99	DOWNSTREAM OBVERT LEVEL:	6.29

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 3.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 3.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z450 FB no. 8566/8

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 3.6 LOWEST POINT OF WEIR (m AHD): 6.5

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: Nil

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

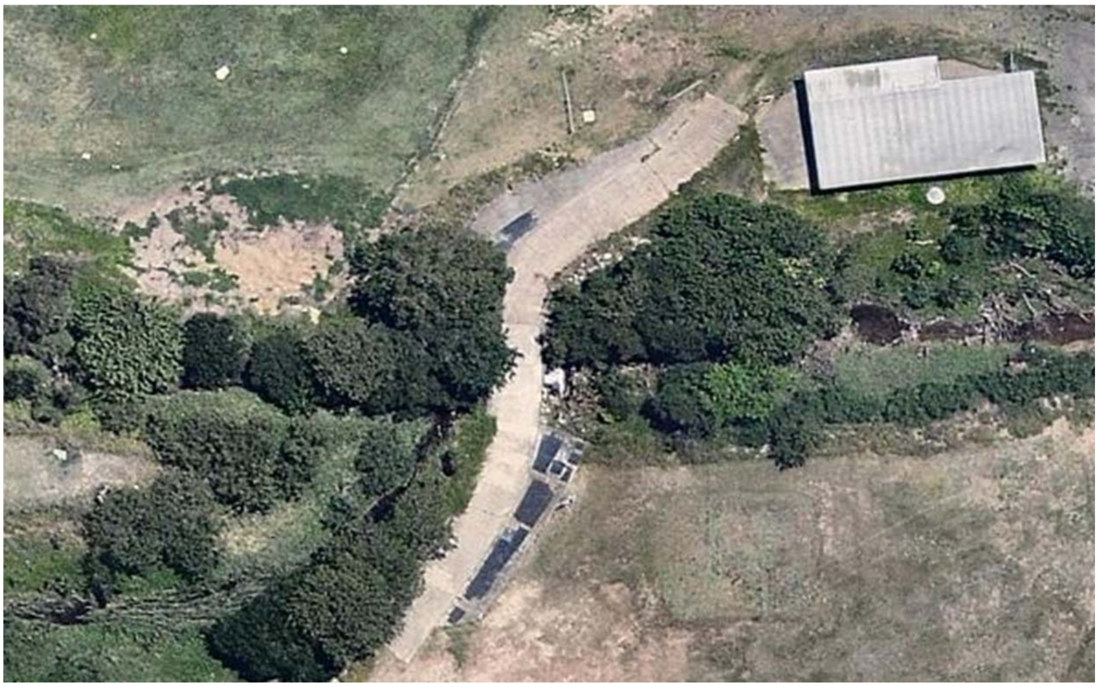
ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Causeway in Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	162.9	9.52	9.49	0.03	22	3.02	2.4	3.8
500yr (0.2%)	153.0	9.42	9.38	0.04	22	2.92	2.4	4.1
100yr (1%)	124.7	9.22	9.14	0.08	22	2.72	2.1	4.1
50yr (2%)	115.3	9.13	9.02	0.10	22	2.63	2.0	4.1
20yr (5%)	106.1	9.05	8.91	0.14	22	2.55	1.9	4.0
10yr (10%)	97.8	8.95	8.79	0.16	22	2.45	1.8	4.0
5yr (20%)	90.2	8.87	8.66	0.21	22	2.37	1.7	4.0
2yr (50%)	72.1	8.52	8.30	0.22	22	2.02	1.6	3.9

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Causeway in Park**



Causeway aerial view

Creek	Zillman Waterholes
Location	**Newman Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 H3
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_9426	AMTD (m)	2511

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 8 x 1.82m diameter

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

UPSTREAM INVERT LEVEL (m):	3.672	UPSTREAM OBVERT LEVEL:	5.495
DOWNSTREAM INVERT LEVEL (m):	3.64	DOWNSTREAM OBVERT LEVEL:	5.46

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 17.28

LENGTH OF CULVERT BARREL AT OBVERT (m): 17.28

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z380 FB no. 8566/7

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 17.28 LOWEST POINT OF WEIR (m AHD): 6.1

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.17

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Newman Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	97.0	7.85	7.28	0.57	28	1.75	0.3	4.0
500yr (0.2%)	92.7	7.73	7.18	0.56	28	1.63	0.2	4.0
100yr (1%)	87.4	7.55	7.01	0.53	28	1.45	0.2	3.8
50yr (2%)	85.7	7.48	6.95	0.53	28	1.38	0.2	3.8
20yr (5%)	82.9	7.42	6.89	0.52	28	1.32	0.2	3.7
10yr (10%)	80.2	7.34	6.83	0.52	28	1.24	0.2	3.6
5yr (20%)	76.3	7.26	6.77	0.49	28	1.16	0.1	3.5
2yr (50%)	66.4	7.03	6.63	0.40	28	0.93	0.1	3.1

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Newman Rd**

Newman Road aerial view

Creek	**Zillman Waterholes**
Location	**Zillmere Rd (Pipe Culverts)**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 H3
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_9580	AMTD (m)	2415

STRUCTURE DESCRIPTION: Reinforced concrete pipe culverts

STRUCTURE SIZE: 6 x 1.82m diameter

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

UPSTREAM INVERT LEVEL (m):	3.59	UPSTREAM OBVERT LEVEL:	5.41
DOWNSTREAM INVERT LEVEL (m):	3.479	DOWNSTREAM OBVERT LEVEL:	

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 13

LENGTH OF CULVERT BARREL AT OBVERT (m): 13

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z357 FB no. 8566/7

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 13 LOWEST POINT OF WEIR (m AHD): 5.8

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 0.96 for steel/0.75 for ARMCO

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Zillmere Rd (Pipe Culverts)

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	67.0	7.08	6.88	0.20	28	1.28	0.6	3.0
500yr (0.2%)	62.1	6.98	6.78	0.20	28	1.18	0.4	3.2
100yr (1%)	54.9	6.84	6.63	0.21	28	1.04	0.2	3.2
50yr (2%)	53.9	6.78	6.57	0.21	28	0.98	0.2	3.5
20yr (5%)	53.5	6.72	6.51	0.21	28	0.92	0.2	3.5
10yr (10%)	53.1	6.68	6.46	0.22	28	0.88	0.2	3.5
5yr (20%)	53.5	6.63	6.40	0.23	28	0.83	0.2	3.2
2yr (50%)	51.9	6.51	6.25	0.26	28	0.71	0.2	3.1

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Zillmere Rd (Pipe Culverts)**

Zillmere Road aerial view

Creek	Zillman Waterholes
Location	**Footbridge Downstream of Zillmere Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 H3
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_9633	AMTD (m)	2346

STRUCTURE DESCRIPTION: Arched steel pedestrian bridge

STRUCTURE SIZE: Single 14.7m span

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

UPSTREAM INVERT LEVEL (m):	2.912	UPSTREAM OBVERT LEVEL:	6.053
DOWNSTREAM INVERT LEVEL (m):	2.982	DOWNSTREAM OBVERT LEVEL:	6.053

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z352 FB no. 8586/7

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.62 LOWEST POINT OF WEIR (m AHD): 5.5

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.33

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Zillman Waterholes
Location	Footbridge Downstream of Zillmere Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	75.0	6.84	6.54	0.30	21	1.34	0.5	3.3
500yr (0.2%)	74.2	6.74	6.44	0.30	21	1.24	0.5	3.4
100yr (1%)	70.4	6.59	6.30	0.29	21	1.09	0.4	3.3
50yr (2%)	68.5	6.53	6.25	0.27	21	1.03	0.4	3.3
20yr (5%)	67.1	6.47	6.21	0.26	21	0.97	0.3	3.3
10yr (10%)	65.4	6.39	6.19	0.20	21	0.89	0.3	3.2
5yr (20%)	63.7	6.34	6.14	0.19	21	0.84	0.3	3.2
2yr (50%)	58.6	6.18	6.02	0.17	21	0.68	0.2	3.0

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Footbridge Downstream of Zillmere Rd**

Creek	**Zillman Waterholes**
Location	**Groth Rd**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 K3
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_10121	AMTD (m)	1865

STRUCTURE DESCRIPTION: Reinforced concrete box culvert bridge

STRUCTURE SIZE: 1 x 3.05x1.685m RCBC and 6 x 3.05x1.535m RCBC

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

UPSTREAM INVERT LEVEL (m): 1.98 UPSTREAM OBVERT LEVEL: 3.658

DOWNSTREAM INVERT LEVEL (m): 1.946 DOWNSTREAM OBVERT LEVEL: 3.658

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 18.38

LENGTH OF CULVERT BARREL AT OBVERT (m): 18.38

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z290 FB no. 8566/7

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 18.38 LOWEST POINT OF WEIR (m AHD): 4.0

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

PIER WIDTH: 0.32

HEIGHT OF HAND/GUARDRAIL: 1.08

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Weir length - 30.68m

Creek	Zillman Waterholes
Location	Groth Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	66.5	5.85	5.79	0.06	33	1.85	0.2	1.7
500yr (0.2%)	99.1	5.67	5.61	0.06	33	1.67	0.1	3.4
100yr (1%)	98.1	5.37	5.32	0.05	33	1.37	0.1	3.6
50yr (2%)	95.0	5.28	5.23	0.05	33	1.28	0.1	3.6
20yr (5%)	93.4	5.14	5.09	0.05	33	1.14	0.1	3.6
10yr (10%)	91.0	5.00	4.95	0.05	33	1.00	0.1	3.5
5yr (20%)	87.3	4.87	4.80	0.07	33	0.87	0.1	3.4
2yr (50%)	77.0	4.57	4.50	0.07	33	0.57	0.1	2.8

Notes:

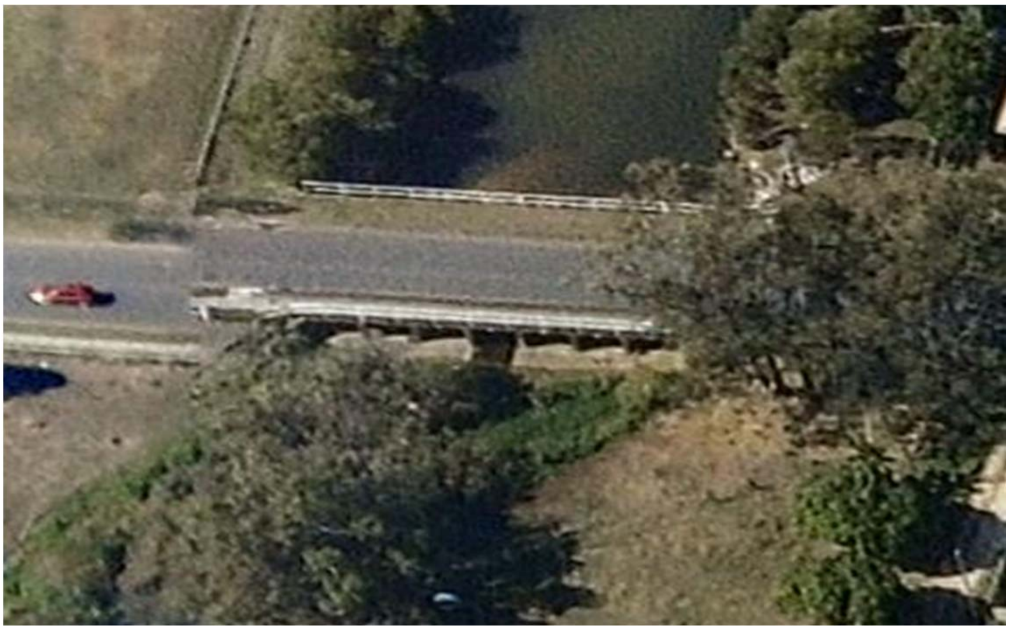
Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Zillman Waterholes
Location	Groth Rd



Groth Road looking downstream

Groth Road looking upstream

Creek	**Zillman Waterholes**
Location	**Zillmere Rd (Box Culverts)**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 M4
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_10648	AMTD (m)	1350

STRUCTURE DESCRIPTION: Concrete box culverts

STRUCTURE SIZE: 1 x 2.45x2.35m RCBC and 6 x 2.45x2.13m RCBC

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

UPSTREAM INVERT LEVEL (m): 1.043 UPSTREAM OBVERT LEVEL: 3.403

DOWNSTREAM INVERT LEVEL (m): 1.089 DOWNSTREAM OBVERT LEVEL: 3.45

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 16.7

LENGTH OF CULVERT BARREL AT OBVERT (m): 16.7

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z230 FB no. 8566/87

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 18 LOWEST POINT OF WEIR (m AHD): 3.8

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

PIER WIDTH: 0.24

HEIGHT OF HAND/GUARDRAIL: 1.065

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Weir length - 25.7m

Creek	Zillman Waterholes
Location	Zillmere Rd (Box Culverts)

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	99.9	5.71	5.64	0.07	31	1.91	0.4	2.1
500yr (0.2%)	97.9	5.55	5.49	0.06	31	1.75	0.3	2.2
100yr (1%)	84.4	5.27	5.21	0.06	31	1.47	0.2	2.0
50yr (2%)	79.5	5.18	5.12	0.06	31	1.38	0.2	2.0
20yr (5%)	77.0	5.05	4.99	0.05	31	1.25	0.2	1.9
10yr (10%)	73.6	4.91	4.85	0.06	31	1.11	0.2	1.8
5yr (20%)	69.4	4.76	4.71	0.05	31	0.96	0.2	1.7
2yr (50%)	60.3	4.45	4.41	0.04	31	0.65	0.2	1.6

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Zillmere Rd (Box Culverts)**

Zillmere Road aerial view

Creek	**Zillman Waterholes**
Location	**Sandgate Rd Northbound**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 M4
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_10945	AMTD (m)	1050

STRUCTURE DESCRIPTION: Reinforced concrete box culverts

STRUCTURE SIZE: 10 x 2.45x2.14m RCBC

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

UPSTREAM INVERT LEVEL (m):	0.82	UPSTREAM OBVERT LEVEL:	2.99
DOWNSTREAM INVERT LEVEL (m):	0.89	DOWNSTREAM OBVERT LEVEL:	3.06

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 18.05

LENGTH OF CULVERT BARREL AT OBVERT (m): 18.05

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes Z180 FB no. 8566/87

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 18.05 LOWEST POINT OF WEIR (m AHD): 4.5

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

PIER WIDTH: 0.35

HEIGHT OF HAND/GUARDRAIL: 1.05

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Sandgate Rd northbound and southbound have been combined as one structure in the TUFLOW model-utilising details from the northbound culverts

Creek	Zillman Waterholes
Location	Sandgate Rd Northbound

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	124.5	5.51	5.30	0.21	45	1.01	0.2	2.2
500yr (0.2%)	124.6	5.38	5.14	0.24	45	0.88	0.2	2.7
100yr (1%)	112.7	5.11	4.83	0.28	45	0.61	0.2	2.2
50yr (2%)	107.4	5.01	4.71	0.30	45	0.51	0.1	2.3
20yr (5%)	100.6	4.89	4.62	0.27	45	0.39	0.1	2.3
10yr (10%)	93.1	4.76	4.52	0.24	45	0.26	0.0	2.3
5yr (20%)	85.5	4.63	4.43	0.19	45	0.13	0.0	2.3
2yr (50%)	73.1	4.32	4.19	0.13	0	0.00	0.0	2.2

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes**
Location	**Sandgate Rd Northbound**

Sandgate Road looking downstream

Creek	**Zillman Waterholes**
Location	**Sandgate Rd Southbound**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	120 M4
DATE OF SURVEY:	February-1996	ASSET ID:	
TUFLOW ID:	ZC_10945	AMTD (m)	1050

STRUCTURE DESCRIPTION: Concrete bridge

STRUCTURE SIZE: 2 span x 16m

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

UPSTREAM INVERT LEVEL (m): 0.85 UPSTREAM OBVERT LEVEL: 4.5

DOWNSTREAM INVERT LEVEL (m): 0.85 DOWNSTREAM OBVERT LEVEL: 4.5

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 20

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 20 LOWEST POINT OF WEIR (m AHD): 5.3

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

PIER WIDTH: 0.55

HEIGHT OF HAND/GUARDRAIL: 0.9

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: 292104

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 1998/99

HAS THE STRUCTURE BEEN UPGRADED?

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

ADDITIONAL COMMENTS:

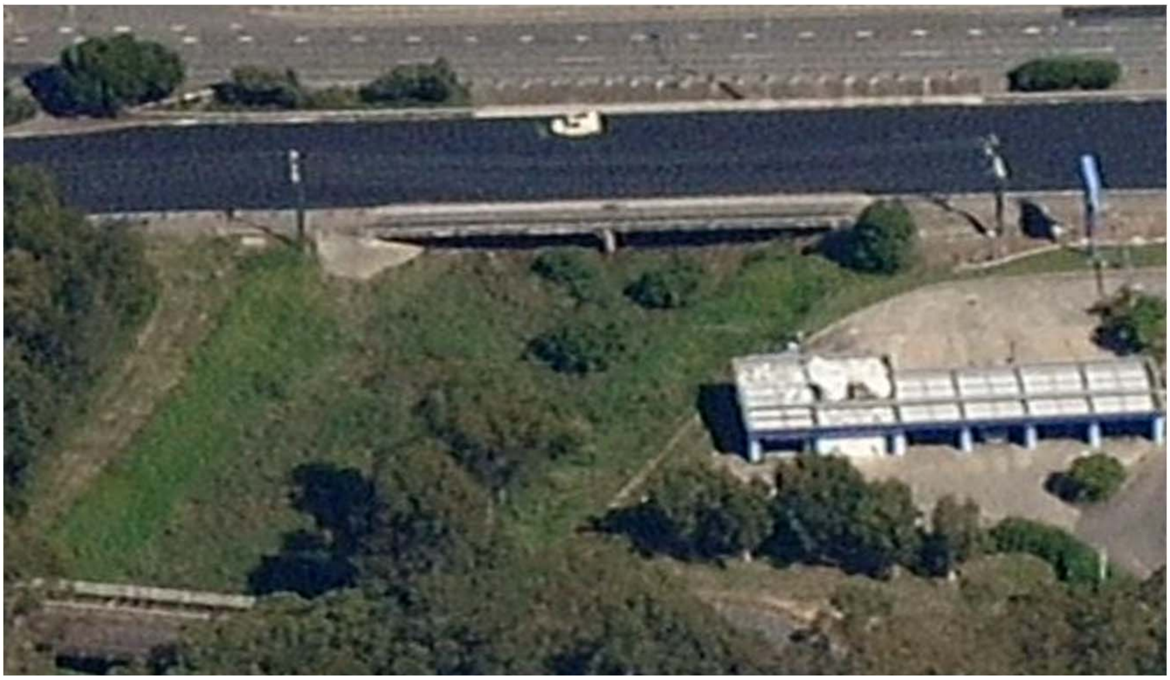
Sandgate Rd northbound and southbound have been combined as one structure in the TUFLOW model- utilising details from the northbound culverts

Creek	Zillman Waterholes
Location	Sandgate Rd Southbound

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	124.5	5.51	5.30	0.23	45	1.00	0.2	2.2
500yr (0.2%)	124.6	5.38	5.14	0.25	45	0.87	0.2	2.7
100yr (1%)	112.7	5.11	4.83	0.29	45	0.60	0.2	2.2
50yr (2%)	107.4	5.01	4.71	0.30	45	0.50	0.1	2.3
20yr (5%)	100.6	4.89	4.62	0.27	45	0.38	0.1	2.3
10yr (10%)	93.1	4.76	4.52	0.24	45	0.25	0.0	2.3
5yr (20%)	85.5	4.63	4.43	0.21	45	0.12	0.0	2.3
2yr (50%)	73.1	4.32	4.19	0.15	0	0.00	0.0	2.2

Notes:
Hydraulic data in the table above is a copy of the data for 'Sandgate Rd Northbound

Creek	Zillman Waterholes
Location	Sandgate Rd Southbound



Sandgate Road looking upstream

Creek	**Zillman Waterholes**
Location	**Bridge Downstream of Sandgate Rd**

INFO SOURCE:	Site Inspection (2015)	UBD REF:	120 N5
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	Sandgate Footbridge ZC11038	AMTD (m)	950

STRUCTURE DESCRIPTION: 4 span bridge

STRUCTURE SIZE: 4 span x 5.8m

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

UPSTREAM INVERT LEVEL (m): UPSTREAM OBVERT LEVEL: 4.5

DOWNSTREAM INVERT LEVEL (m): DOWNSTREAM OBVERT LEVEL: 4.5

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 6.8

LENGTH OF CULVERT BARREL AT OBVERT (m): 6.8

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 6.8 LOWEST POINT OF WEIR (m AHD): 5

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure details based on aerial photography and site measurements

Creek	Zillman Waterholes
Location	Bridge Downstream of Sandgate Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	133.9	5.23	5.15	0.08	NA	0.23	NA	2.2
500yr (0.2%)	130.0	5.06	4.97	0.09	NA	0.06	NA	2.6
100yr (1%)	112.1	4.76	4.67	0.09	NA	0.00	NA	2.4
50yr (2%)	107.0	4.63	4.56	0.08	NA	0.00	NA	2.2
20yr (5%)	100.4	4.54	4.45	0.08	NA	0.00	NA	2.0
10yr (10%)	93.0	4.44	4.36	0.08	NA	0.00	NA	1.6
5yr (20%)	85.4	4.36	4.28	0.07	NA	0.00	NA	1.6
2yr (50%)	72.9	4.12	4.07	0.05	NA	0.00	NA	1.4

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Zillman Waterholes
Location	Bridge Downstream of Sandgate Rd

Bridge looking downstream

Creek	**Zillman Waterholes Tributary C**
Location	**Access Road 1 - 39 Jenning's St**

INFO SOURCE:	Site Inspection (2015)	UBD REF:	120 D3
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TH_C5612P_01	AMTD (m)	537

STRUCTURE DESCRIPTION: Concrete pipe culverts

STRUCTURE SIZE: 1 x 1.8m diameter

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

UPSTREAM INVERT LEVEL (m):	10.3	UPSTREAM OBVERT LEVEL:	12.1
DOWNSTREAM INVERT LEVEL (m):	10.2	DOWNSTREAM OBVERT LEVEL:	12
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 9.2

LENGTH OF CULVERT BARREL AT OBVERT (m): 9.2

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 9.2   LOWEST POINT OF WEIR (m AHD): 13.24

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure size is a copy of structure TH_SI_01. Structure inverts based on creek cross-sectional survey data in vicinity of structure. Weir data based on 2009 ALS and aerial photography

Creek	Zillman Waterholes Tributary C
Location	Access Road 1 - 39 Jenning's St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	29.8	14.08	13.28	0.81	NA	0.84	NA	5.0
500yr (0.2%)	37.7	14.23	13.39	0.84	NA	0.99	NA	5.1
100yr (1%)	29.4	14.08	13.26	0.81	NA	0.84	NA	5.1
50yr (2%)	25.9	13.99	13.19	0.80	NA	0.75	NA	5.1
20yr (5%)	22.9	13.90	13.11	0.79	NA	0.66	NA	5.1
10yr (10%)	19.5	13.77	12.92	0.85	NA	0.53	NA	5.0
5yr (20%)	16.9	13.68	12.78	0.90	NA	0.44	NA	5.0
2yr (50%)	11.8	13.47	12.47	1.01	NA	0.23	NA	4.4

Notes:

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes Tributary C**
Location	**Access Road 1 - 39 Jenning's St**

Culvert aerial view

Creek	**Zillman Waterholes Tributary C**
Location	**Access Road 2- 39 Jenning's St**

INFO SOURCE:	Site Inspection (2015) and Gecko BCC database	UBD REF:	120 D3
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TH_SI_01	AMTD (m)	449

STRUCTURE DESCRIPTION: Concrete pipe culverts

STRUCTURE SIZE: 2 x 1.8m diameter

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

UPSTREAM INVERT LEVEL (m):	9	UPSTREAM OBVERT LEVEL:	10.8
DOWNSTREAM INVERT LEVEL (m):	8.8	DOWNSTREAM OBVERT LEVEL:	10.6

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 7.5

LENGTH OF CULVERT BARREL AT OBVERT (m): 7.5

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 7.5 LOWEST POINT OF WEIR (m AHD): 11.9

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Structure inverts based on creek cross-sectional survey data in vicinity of structure. Weir data based on 2009 ALS and aerial photography

Creek	Zillman Waterholes Tributary C
Location	Access Road 2- 39 Jenning's St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	25.8	12.56	10.82	1.74	NA	0.66	NA	5.1
500yr (0.2%)	26.0	12.64	10.93	1.71	NA	0.74	NA	5.1
100yr (1%)	25.7	12.55	10.79	1.76	NA	0.65	NA	5.1
50yr (2%)	25.5	12.49	10.72	1.78	NA	0.59	NA	5.0
20yr (5%)	25.1	12.42	10.64	1.78	NA	0.52	NA	5.0
10yr (10%)	23.7	12.24	10.51	1.73	NA	0.34	NA	4.7
5yr (20%)	22.3	12.03	10.42	1.61	NA	0.13	NA	4.4
2yr (50%)	17.6	11.50	10.24	1.26	NA	0.00	NA	3.6

Notes:

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes Tributary C**
Location	**Access Road 2- 39 Jenning's St**

Culvert looking upstream

Culvert looking downstream

Creek	**Zillman Waterholes Tributary C**
Location	**Footbridge in O'Callaghan's Park**

INFO SOURCE:		UBD REF:	120 E4
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TH_DEM_03	AMTD (m)	191

STRUCTURE DESCRIPTION: Timber footbridge

STRUCTURE SIZE: Single 14m span bridge

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

UPSTREAM INVERT LEVEL (m): 7.57

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 1.6

LOWEST POINT OF WEIR (m AHD): 9.7

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

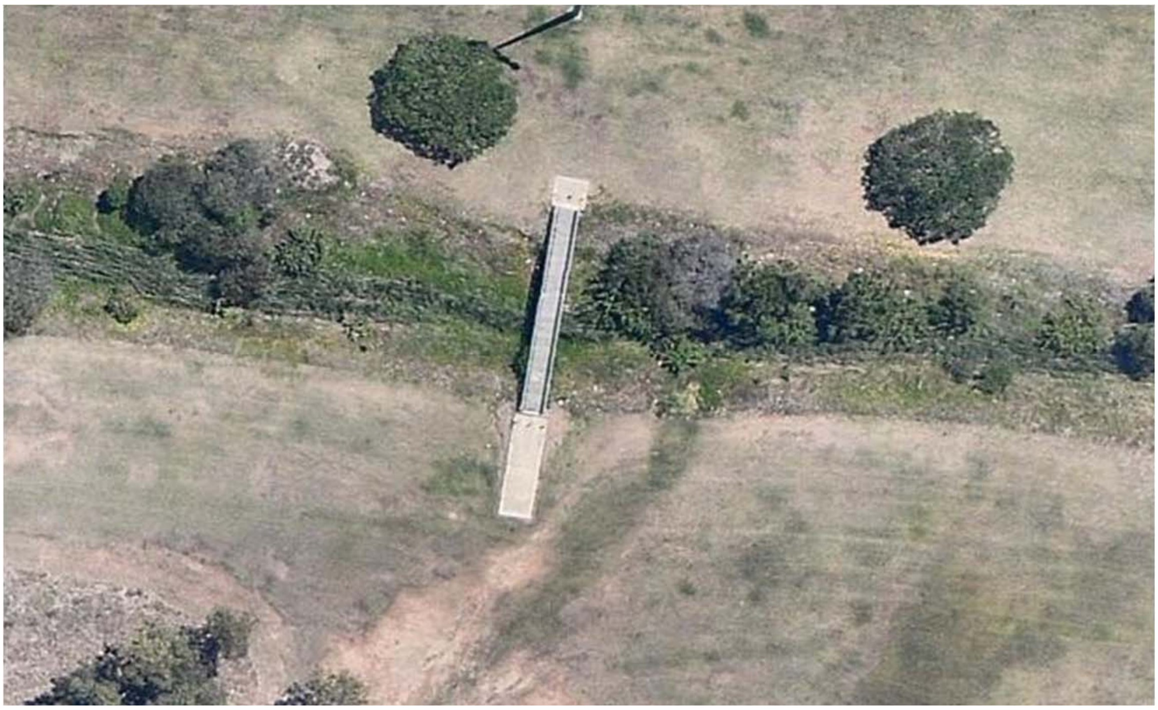
Bridge levels based on ALS 2009 data and available survey information for creek. Weir width based on measurements from aerial photography.

Creek	Zillman Waterholes Tributary C
Location	Footbridge in O'Callaghan's Park

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	40.0	9.78	9.75	0.03	NA	0.08	NA	3.7
500yr (0.2%)	38.8	9.65	9.63	0.02	NA	0.00	NA	4.5
100yr (1%)	32.2	9.44	9.43	0.02	NA	0.00	NA	4.5
50yr (2%)	29.5	9.37	9.35	0.02	NA	0.00	NA	4.5
20yr (5%)	27.4	9.29	9.27	0.01	NA	0.00	NA	4.4
10yr (10%)	24.2	9.19	9.18	0.01	NA	0.00	NA	4.4
5yr (20%)	21.7	9.08	9.08	0.01	NA	0.00	NA	4.4
2yr (50%)	17.5	8.76	8.75	0.01	NA	0.00	NA	4.3

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Zillman Waterholes Tributary C**
Location	**Footbridge in O'Callaghan's Park**



Footbridge aerial view

Creek	**Zillman Waterholes Tributary D**
Location	**Bilsen Rd**

INFO SOURCE:	Gecko BCC database	UBD REF:	120 L6
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TD_DEM	AMTD (m)	624

STRUCTURE DESCRIPTION: Concrete pipe culverts

STRUCTURE SIZE: 4 x 1.2m diameter

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

UPSTREAM INVERT LEVEL (m):	3.08	UPSTREAM OBVERT LEVEL:	4.28
DOWNSTREAM INVERT LEVEL (m):	2.69	DOWNSTREAM OBVERT LEVEL:	3.89
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 19.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 19.6

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 19.6 LOWEST POINT OF WEIR (m AHD): 5.57

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 0.5

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Inverts, weir data and structure length based on 2009 ALS data and aerial photography

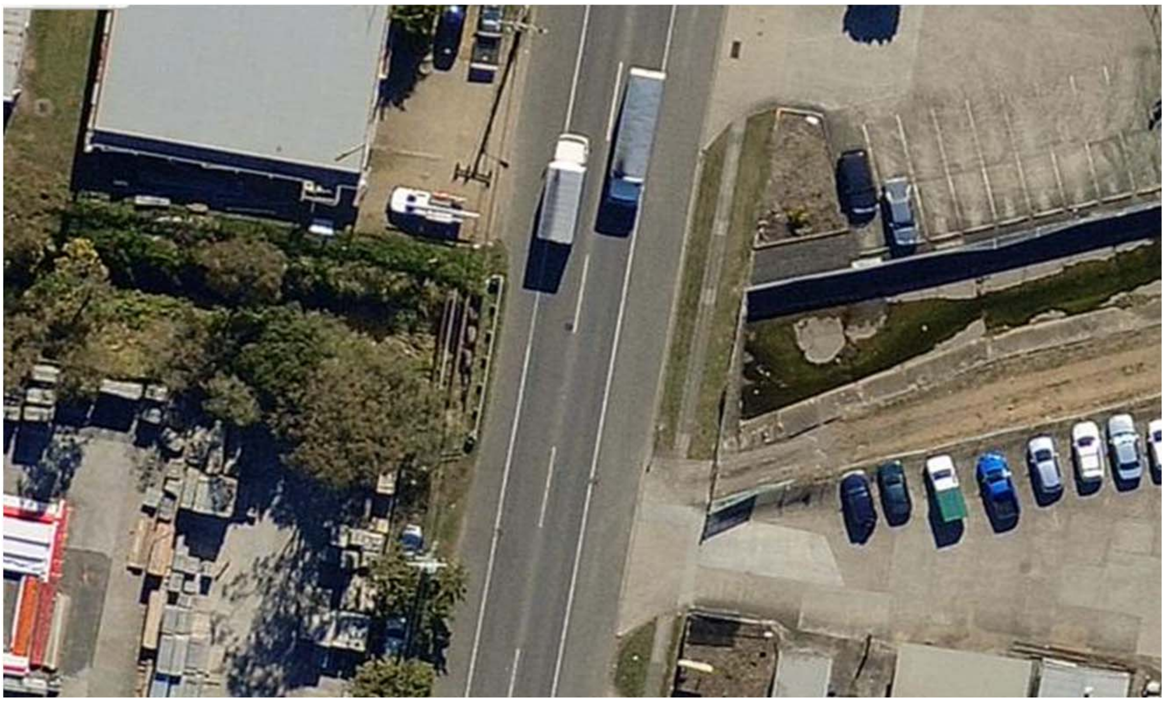
Creek	Zillman Waterholes Tributary D
Location	Bilsen Rd

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	22.1	6.34	5.53	0.81	22	0.77	0.2	4.1
500yr (0.2%)	24.9	6.29	5.42	0.87	22	0.72	0.2	4.8
100yr (1%)	23.1	6.21	5.17	1.04	22	0.64	0.1	4.8
50yr (2%)	22.3	6.16	5.07	1.09	22	0.59	0.1	4.7
20yr (5%)	21.5	6.11	4.95	1.16	22	0.54	0.0	4.7
10yr (10%)	21.0	6.05	4.84	1.21	22	0.48	0.0	4.6
5yr (20%)	20.8	5.98	4.70	1.28	22	0.41	0.0	4.6
2yr (50%)	20.1	5.81	4.45	1.36	22	0.24	0.0	4.5

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Zillman Waterholes Tributary D
Location	Bilsen Rd

Bilsen Road looking upstream



Bilsen Road aerial view

Creek	**Zillman Waterholes Tributary E**
Location	**Copperfield St**

INFO SOURCE:	Gecko BCC database	UBD REF:	120 D7
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TE_DEM	AMTD (m)	247

STRUCTURE DESCRIPTION: Concrete pipe culverts

STRUCTURE SIZE: 6 x 0.75m diameter

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

UPSTREAM INVERT LEVEL (m): 14.19 UPSTREAM OBVERT LEVEL: 14.94

DOWNSTREAM INVERT LEVEL (m): 13.15 DOWNSTREAM OBVERT LEVEL: 13.9

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 20.22

LENGTH OF CULVERT BARREL AT OBVERT (m): 20.22

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 20.22 LOWEST POINT OF WEIR (m AHD): 15.3

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Inverts, weir data and structure length based on 2009 ALS data and aerial photography

Creek	Zillman Waterholes Tributary E
Location	Copperfield St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	17.5	15.65	14.83	0.82	45	0.35	0.0	3.5
500yr (0.2%)	21.7	15.76	14.98	0.78	50	0.46	0.0	3.6
100yr (1%)	16.6	15.65	14.82	0.82	44	0.35	0.0	3.5
50yr (2%)	14.5	15.60	14.75	0.85	43	0.30	0.0	3.4
20yr (5%)	12.5	15.54	14.66	0.88	38	0.24	0.0	3.4
10yr (10%)	10.2	15.44	14.57	0.87	35	0.14	0.3	3.3
5yr (20%)	9.1	15.35	14.49	0.86	25	0.05	0.0	3.2
2yr (50%)	7.0	15.10	14.34	0.76	0	0.00	0.0	2.7

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	Zillman Waterholes Tributary E
Location	Copperfield St

Copperfield Street aerial view

Copperfield Street alignment

Creek	**Zillman Waterholes Tributary E**
Location	**Footbridge Downstream of Copperfield St**

INFO SOURCE:	Site Inspection (2014)	UBD REF:	120 E7
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TE_SI_07	AMTD (m)	137

STRUCTURE DESCRIPTION:

STRUCTURE SIZE: Single 6.5m span bridge

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

UPSTREAM INVERT LEVEL (m): 12.39

UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m):

DOWNSTREAM OBVERT LEVEL:

For culverts give floor level

For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 1.5

LENGTH OF CULVERT BARREL AT OBVERT (m): 1.5

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? No

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 1.5

LOWEST POINT OF WEIR (m AHD): 13.77

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Inverts, weir data and structure length based on 2009 ALS data and aerial photography

Creek	Zillman Waterholes Tributary E
Location	Footbridge Downstream of Copperfield St

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	20.6	14.13	14.09	0.04	NA	0.36	NA	3.8
500yr (0.2%)	23.1	14.03	13.98	0.05	NA	0.26	NA	4.6
100yr (1%)	16.1	13.91	13.85	0.06	NA	0.14	NA	4.5
50yr (2%)	13.7	13.85	13.80	0.05	NA	0.08	NA	4.5
20yr (5%)	12.1	13.75	13.72	0.03	NA	0.00	NA	4.5
10yr (10%)	10.4	13.58	13.56	0.01	NA	0.00	NA	4.4
5yr (20%)	9.1	13.44	13.43	0.01	NA	0.00	NA	4.3
2yr (50%)	7.1	13.32	13.26	0.06	NA	0.00	NA	4.3

Notes:
Structure velocity is the peak across the bridge opening
Peak Discharge is the peak across the entire flooded width

Creek	**Zillman Waterholes Tributary E**
Location	**Footbridge Downstream of Copperfield St**

Footbridge looking downstream

Footbridge configuration

Creek	**Nundah Creek**
Location	**Shorncliffe Railway 1**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	121 D3
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	NC_14445	AMTD (m)	3510

STRUCTURE DESCRIPTION: Main channel rail crossing

STRUCTURE SIZE: 3 x (1x5.9m), 4 x (5.8x1.2m), 2 x (5.4x1.5m), 1 x (4x3.8m), 2 x (5.7x3.6m)

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

UPSTREAM INVERT LEVEL (m):	1.355, 1.355, 1, -1.39, -1.1	UPSTREAM OBVERT LEVEL:	2.44
DOWNSTREAM INVERT LEVEL (m):	1.355, 1.355, 1, -1.42, -1.1	DOWNSTREAM OBVERT LEVEL:	

For culverts give floor level — For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 6.2

LENGTH OF CULVERT BARREL AT OBVERT (m): 6.2

TYPE OF LINING: Concrete

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

IS THERE A SURVEYED WEIR PROFILE? Yes N230 FB no. 8566/2

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 6.2 LOWEST POINT OF WEIR (m AHD): 2.9

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

PIER WIDTH: 1.03

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Nundah Creek
Location	Shorncliffe Railway 1

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	224.7	3.50	3.47	0.02	NA	0.60	NA	2.0
500yr (0.2%)	236.8	3.23	3.18	0.06	NA	0.33	NA	2.3
100yr (1%)	216.6	2.97	2.90	0.07	NA	0.07	NA	2.3
50yr (2%)	209.9	2.90	2.83	0.07	NA	0.00	NA	2.3
20yr (5%)	197.4	2.79	2.72	0.07	NA	0.00	NA	2.3
10yr (10%)	179.5	2.69	2.63	0.06	NA	0.00	NA	2.1
5yr (20%)	159.1	2.58	2.53	0.05	NA	0.00	NA	2.0
2yr (50%)	115.3	2.34	2.31	0.03	NA	0.00	NA	1.6

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Nundah Creek
Location	Shorncliffe Railway 1

Railway looking downstream

Creek	**Nundah Creek**
Location	**Shorncliffe Railway 2**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	121 C2
DATE OF SURVEY:	March-1996	ASSET ID:	
TUFLOW ID:	NC_LB_968	AMTD (m)	3600

STRUCTURE DESCRIPTION: Culverts to north of main channel rail crossing

STRUCTURE SIZE: 2 x 4.7x1.3m RCBC and 3 x 6.1x1.3m RCBC

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

UPSTREAM INVERT LEVEL (m):	1.12	UPSTREAM OBVERT LEVEL:	2,44
DOWNSTREAM INVERT LEVEL (m):	0.875	DOWNSTREAM OBVERT LEVEL:	

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes N230 FB no. 8566/2

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 5.7 LOWEST POINT OF WEIR (m AHD): 2.9

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

PIER WIDTH: 1

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Nundah Creek
Location	Shorncliffe Railway 2

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	46.7	3.48	3.47	0.01	NA	0.58	NA	1.9
500yr (0.2%)	48.7	3.21	3.18	0.03	NA	0.31	NA	2.0
100yr (1%)	46.0	2.99	2.92	0.07	NA	0.09	NA	2.3
50yr (2%)	44.6	2.93	2.85	0.09	NA	0.03	NA	1.9
20yr (5%)	42.5	2.86	2.75	0.11	NA	0.00	NA	2.3
10yr (10%)	41.3	2.78	2.67	0.11	NA	0.00	NA	2.4
5yr (20%)	34.2	2.67	2.56	0.11	NA	0.00	NA	2.2
2yr (50%)	20.2	2.41	2.36	0.05	NA	0.00	NA	1.0

Notes:
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Shorncliffe Railway 2**

Creek	**Nundah Creek**
Location	**Gateway Motorway Bridge**

INFO SOURCE:	KBR/DTMR Gateway Mwy Upgrade Report (2012)	UBD REF:	121 F1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	NC_16738	AMTD (m)	2570

STRUCTURE DESCRIPTION: Arterial Bridge

STRUCTURE SIZE: 2 x 23.8m span bridge

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

UPSTREAM INVERT LEVEL (m): -2.1 UPSTREAM OBVERT LEVEL: 3.047

DOWNSTREAM INVERT LEVEL (m): -2.2 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 20.24, 15.74

LENGTH OF CULVERT BARREL AT OBVERT (m): 20.24, 15.74

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 20.24, 15.74 LOWEST POINT OF WEIR (m AHD): 4.405

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

PIER WIDTH: 0.55

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Refer KBR/DTMR Gateway Mwy Upgrade Report (2012)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2015 onwards

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Gateway Motorway beginning to be upgraded from early 2015. Structure size remains the same, with changes to length and invert levels only

Creek	Nundah Creek
Location	Gateway Motorway Bridge

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	363.6	2.99	2.75	0.24	0	0.00	0.0	2.2
500yr (0.2%)	253.9	2.65	2.54	0.11	0	0.00	0.0	1.9
100yr (1%)	180.7	2.39	2.34	0.06	0	0.00	0.0	1.5
50yr (2%)	164.2	2.32	2.28	0.04	0	0.00	0.0	1.4
20yr (5%)	144.8	2.23	2.19	0.04	0	0.00	0.0	1.3
10yr (10%)	130.0	2.13	2.11	0.02	0	0.00	0.0	1.3
5yr (20%)	117.6	2.05	2.03	0.02	0	0.00	0.0	1.2
2yr (50%)	92.4	1.85	1.84	0.01	0	0.00	0.0	1.0

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Gateway Motorway Culvert 2**

INFO SOURCE:	KBR/DTMR Gateway Mwy Upgrade Report (2012)	UBD REF:	121 F1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	Gate_East_150	AMTD (m)	

STRUCTURE DESCRIPTION: Reinforced concrete box culvert

STRUCTURE SIZE: 4 x 2.13x0.875m and 1 x 2.13x1.05m SLBC

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

UPSTREAM INVERT LEVEL (m):	1.37	UPSTREAM OBVERT LEVEL:	2.245,2.42
DOWNSTREAM INVERT LEVEL (m):	1.37	DOWNSTREAM OBVERT LEVEL:	2.245,2.42

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 59.7

LENGTH OF CULVERT BARREL AT OBVERT (m): 59.7

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 59.7 LOWEST POINT OF WEIR (m AHD):

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Refer KBR/DTMR Gateway Mwy Upgrade Report (2012)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2015 onwards

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Gateway Motorway beginning to be upgraded from early 2015. Structure size remains the same, with changes to length and invert levels only

Creek	Nundah Creek
Location	Gateway Motorway Culvert 2

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	20.7	3.24	2.72	0.52	0	0.00	0.0	2.3
500yr (0.2%)	17.7	2.84	2.51	0.33	0	0.00	0.0	1.9
100yr (1%)	12.8	2.52	2.32	0.20	0	0.00	0.0	1.4
50yr (2%)	11.4	2.44	2.26	0.17	0	0.00	0.0	1.2
20yr (5%)	9.3	2.32	2.18	0.14	0	0.00	0.0	1.2
10yr (10%)	7.1	2.22	2.10	0.12	0	0.00	0.0	1.0
5yr (20%)	5.1	2.13	2.03	0.11	0	0.00	0.0	0.8
2yr (50%)	2.3	1.92	1.86	0.06	0	0.00	0.0	0.5

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Gateway Motorway Culvert 3**

INFO SOURCE:	KBR/DTMR Gateway Mwy Upgrade Report (2012)	UBD REF:	121 E1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	33076 Gecko	AMTD (m)	

STRUCTURE DESCRIPTION: Reinforced concrete box culvert

STRUCTURE SIZE: 4 x 2.1x0.8m and 2 x 2.1x1.05m SLBC

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

UPSTREAM INVERT LEVEL (m):	1.31	UPSTREAM OBVERT LEVEL:	2.11,2.36
DOWNSTREAM INVERT LEVEL (m):	1.28	DOWNSTREAM OBVERT LEVEL:	2.08,2.33
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 58.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 58.6

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 58.6 LOWEST POINT OF WEIR (m AHD):

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Refer KBR/DTMR Gateway Mwy Upgrade Report (2012)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2015 onwards

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Gateway Motorway beginning to be upgraded from early 2015. Structure size remains the same, with changes to length and invert levels only

Creek	Nundah Creek
Location	Gateway Motorway Culvert 3

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	27.6	3.32	2.73	0.58	0	0.00	0.0	3.0
500yr (0.2%)	24.1	2.91	2.52	0.39	0	0.00	0.0	2.7
100yr (1%)	20.0	2.59	2.33	0.26	0	0.00	0.0	2.2
50yr (2%)	18.3	2.50	2.27	0.23	0	0.00	0.0	2.0
20yr (5%)	15.7	2.38	2.19	0.19	0	0.00	0.0	1.7
10yr (10%)	13.0	2.28	2.11	0.17	0	0.00	0.0	1.5
5yr (20%)	10.9	2.19	2.04	0.15	0	0.00	0.0	1.3
2yr (50%)	5.0	1.98	1.87	0.11	0	0.00	0.0	1.0

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Gateway Motorway Culvert 4**

INFO SOURCE:	KBR/DTMR Gateway Mwy Upgrade Report (2012)	UBD REF:	121 E1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	Gate_Central_115	AMTD (m)	

STRUCTURE DESCRIPTION: Reinforced concrete box culvert

STRUCTURE SIZE: 9 x 2.13x0.875m and 7 x 2.13x1.05m RCBC

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

UPSTREAM INVERT LEVEL (m):	1.5	UPSTREAM OBVERT LEVEL:	2.375,2.55
DOWNSTREAM INVERT LEVEL (m):	1.5	DOWNSTREAM OBVERT LEVEL:	2.375,2.55

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 53.8

LENGTH OF CULVERT BARREL AT OBVERT (m): 53.8

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 53.8 LOWEST POINT OF WEIR (m AHD):

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Refer KBR/DTMR Gateway Mwy Upgrade Report (2012)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2015 onwards

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Gateway Motorway beginning to be upgraded from early 2015. Structure size remains the same, with changes to length and invert levels only

Creek	Nundah Creek
Location	Gateway Motorway Culvert 4

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	67.4	3.29	2.87	0.42	0	0.00	0.0	2.8
500yr (0.2%)	42.9	2.90	2.75	0.15	0	0.00	0.0	1.9
100yr (1%)	22.7	2.61	2.56	0.05	0	0.00	0.0	1.1
50yr (2%)	17.7	2.53	2.50	0.03	0	0.00	0.0	0.9
20yr (5%)	11.8	2.42	2.40	0.02	0	0.00	0.0	0.7
10yr (10%)	7.7	2.32	2.31	0.01	0	0.00	0.0	0.6
5yr (20%)	5.1	2.23	2.22	0.01	0	0.00	0.0	0.5
2yr (50%)	1.3	2.02	2.02	0.00	0	0.00	0.0	0.4

Notes:

Maximum width of weir flow is the flow across the weir directly above the structure only

Weir velocity is the average across the structure width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Gateway Motorway Culvert 5**

INFO SOURCE:	KBR/DTMR Gateway Mwy Upgrade Report (2012)	UBD REF:	111 D20
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	N_LB_1560	AMTD (m)	

STRUCTURE DESCRIPTION: Reinforced concrete box culvert

STRUCTURE SIZE: 8 x 2.13x0.86m and 7 x 2.13x1.07m SLBC

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

UPSTREAM INVERT LEVEL (m):	1.5	UPSTREAM OBVERT LEVEL:	2.36,2.57
DOWNSTREAM INVERT LEVEL (m):	1.5	DOWNSTREAM OBVERT LEVEL:	2.36,2.57
For culverts give floor level		For bridges give bed level	

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 46.5

LENGTH OF CULVERT BARREL AT OBVERT (m): 46.5

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 46.5 LOWEST POINT OF WEIR (m AHD):

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER: Refer KBR/DTMR Gateway Mwy Upgrade Report (2012)

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE: 2015 onwards

HAS THE STRUCTURE BEEN UPGRADED? Yes

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

ADDITIONAL COMMENTS:

Gateway Motorway beginning to be upgraded from early 2015. Structure size remains the same, with changes to length and invert levels only

Creek	Nundah Creek
Location	Gateway Motorway Culvert 5

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	86.8	3.35	2.78	0.57	0	0.00	0.0	3.0
500yr (0.2%)	65.0	2.92	2.60	0.32	0	0.00	0.0	2.5
100yr (1%)	44.0	2.60	2.42	0.17	0	0.00	0.0	2.1
50yr (2%)	37.4	2.51	2.37	0.14	0	0.00	0.0	1.8
20yr (5%)	28.5	2.40	2.28	0.12	0	0.00	0.0	1.5
10yr (10%)	20.8	2.30	2.21	0.09	0	0.00	0.0	1.2
5yr (20%)	15.5	2.22	2.15	0.08	0	0.00	0.0	1.0
2yr (50%)	6.1	2.04	1.99	0.05	0	0.00	0.0	0.5

Notes:
Maximum width of weir flow is the flow across the weir directly above the structure only
Weir velocity is the average across the structure width at time of peak discharge
Structure velocity is the peak within the culvert barrel
Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek**
Location	**Footbridge Downstream of Gateway Motorway**

INFO SOURCE:	Nundah Creek Flood Study (2004, BCC)	UBD REF:	111 F20
DATE OF SURVEY:	April-1996	ASSET ID:	
TUFLOW ID:	NC_16863	AMTD (m)	2625

STRUCTURE DESCRIPTION:

STRUCTURE SIZE: 2 Spans – 1 x 10m and 1 x 20m

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

UPSTREAM INVERT LEVEL (m): -2.533 UPSTREAM OBVERT LEVEL: 2.87

DOWNSTREAM INVERT LEVEL (m): -2.131 DOWNSTREAM OBVERT LEVEL: 2.87

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

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

IS THERE A SURVEYED WEIR PROFILE? Yes N150 FB no. 8566/2

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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 2.65 LOWEST POINT OF WEIR (m AHD): 1

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

PIER WIDTH: 0.6

HEIGHT OF HAND/GUARDRAIL: 1.4

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Creek	Nundah Creek
Location	Footbridge Downstream of Gateway Motorway

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	303.6	2.73	2.71	0.01	NA	1.73	NA	2.5
500yr (0.2%)	214.0	2.51	2.50	0.01	NA	1.51	NA	1.9
100yr (1%)	156.0	2.31	2.31	0.01	NA	1.31	NA	1.6
50yr (2%)	143.9	2.25	2.24	0.01	NA	1.25	NA	1.5
20yr (5%)	129.2	2.16	2.15	0.01	NA	1.16	NA	1.4
10yr (10%)	119.2	2.08	2.07	0.01	NA	1.08	NA	1.3
5yr (20%)	109.7	2.00	2.00	0.01	NA	1.00	NA	1.3
2yr (50%)	90.0	1.81	1.80	0.01	NA	0.81	NA	1.2

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	Nundah Creek
Location	Footbridge Downstream of Gateway Motorway

Footbridge looking upstream

Creek	**Nundah Creek Tributary A**
Location	**College Way**

INFO SOURCE:	Site Inspection (2015)	UBD REF:	121 A1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TF_DEM	AMTD (m)	552

STRUCTURE DESCRIPTION: Concrete box culverts

STRUCTURE SIZE: 4 x 3.1x1.5m and 3 x3.1x1.7m

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

UPSTREAM INVERT LEVEL (m): 0.63 UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m): 0.58 DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m): 23.6

LENGTH OF CULVERT BARREL AT OBVERT (m): 23.6

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 23.6 LOWEST POINT OF WEIR (m AHD): 2.9

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL: 1.1

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify Survey Book No.

CONSTRUCTION DATE OF CURRENT STRUCTURE:

HAS THE STRUCTURE BEEN UPGRADED? Yes - date unknown

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

ADDITIONAL COMMENTS:

Lowest point of weir based on ALS 2009 data

Creek	Nundah Creek Tributary A
Location	College Way

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	24.5	3.47	3.47	0.00	90	0.57	0.3	1.4
500yr (0.2%)	19.5	3.13	3.13	0.00	60	0.23	0.2	1.2
100yr (1%)	13.7	2.95	2.94	0.00	40	0.05	0.0	0.9
50yr (2%)	12.8	2.87	2.86	0.00	0	0.00	0.0	0.8
20yr (5%)	11.7	2.75	2.74	0.01	0	0.00	0.0	0.8
10yr (10%)	10.4	2.64	2.63	0.01	0	0.00	0.0	0.7
5yr (20%)	9.7	2.52	2.51	0.01	0	0.00	0.0	0.7
2yr (50%)	8.0	2.28	2.27	0.01	0	0.00	0.0	0.6

Notes:

Weir velocity is the average across the entire flooded width at time of peak discharge

Structure velocity is the peak within the culvert barrel

Peak Discharge is the peak across the entire flooded width

Creek	Nundah Creek Tributary A
Location	College Way

College Way looking downstream

College Way looking upstream

Creek	**Nundah Creek Tributary A**
Location	**Shorncliffe Railway**

INFO SOURCE:	Site Inspection (2015)	UBD REF:	121 B1
DATE OF SURVEY:		ASSET ID:	
TUFLOW ID:	TF_SI_11	AMTD (m)	335

STRUCTURE DESCRIPTION: Concrete box culverts

STRUCTURE SIZE: 2 x 5.2x1.05m

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

UPSTREAM INVERT LEVEL (m): -0.017 UPSTREAM OBVERT LEVEL:

DOWNSTREAM INVERT LEVEL (m): DOWNSTREAM OBVERT LEVEL:

For culverts give floor level For bridges give bed level

For culverts:

LENGTH OF CULVERT BARREL AT INVERT (m):

LENGTH OF CULVERT BARREL AT OBVERT (m):

TYPE OF LINING:

(e.g. concrete, stones, 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 eg crown, kerb, hand rails whichever is higher.

WEIR WIDTH (m): 16.9 LOWEST POINT OF WEIR (m AHD): 2.9

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

PIER WIDTH:

HEIGHT OF HAND/GUARDRAIL:

Description of all hand and guardrails and height to top and underside of guardrails

PLAN NUMBER:

BRIDGE OR CULVERT DETAILS:

Wingwall/Headwall details eg. 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. Specify 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 loaction if applicable.

ADDITIONAL COMMENTS:

Lowest point of weir based on ALS 2009 data. Invert based on U/S cross-section surveyed invert

Creek	Nundah Creek Tributary A
Location	Shorncliffe Railway

ARI (AEP %)	Peak Discharge (m3/s)	Peak U/S Water Level (m AHD)	Peak D/S Water Level (m AHD)	Afflux (m)	Max Width of Weir Flow (m)	Max Depth of Weir Flow (m)	Velocity (m/s)	
							Weir	Structure
2000yr (0.05%)	21.4	3.46	3.46	0.00	NA	0.56	NA	1.3
500yr (0.2%)	21.5	3.12	3.10	0.02	NA	0.22	NA	1.3
100yr (1%)	19.3	2.94	2.90	0.04	NA	0.04	NA	1.2
50yr (2%)	17.7	2.86	2.83	0.03	NA	0.00	NA	1.2
20yr (5%)	16.9	2.72	2.69	0.04	NA	0.00	NA	1.1
10yr (10%)	14.2	2.61	2.58	0.03	NA	0.00	NA	1.1
5yr (20%)	12.8	2.50	2.47	0.03	NA	0.00	NA	1.1
2yr (50%)	10.2	2.24	2.23	0.02	NA	0.00	NA	1.0

Notes:

Structure velocity is the peak across the bridge opening

Peak Discharge is the peak through the structure and across the weir directly above the structure only

Creek	**Nundah Creek Tributary A**
Location	**Shorncliffe Railway**

Railway looking downstream

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Appendix F: Design Events (Scenario 1) – 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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AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)	0.05% AEP (2000yr ARI)
NUNDAH CREEK									
N 0	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31	1.31
N 100	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31	1.31
N 200	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31	1.31
N 300	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31	1.31
N 400	0.77	0.77	0.77	0.77	0.78	0.78	1.32	1.32	1.32
N 500	0.78	0.78	0.78	0.79	0.80	0.80	1.33	1.34	1.35
N 600	0.82	0.85	0.88	0.92	0.97	1.02	1.42	1.45	1.54
N 700	0.94	1.03	1.07	1.13	1.19	1.24	1.52	1.56	1.67
N 800	0.97	1.07	1.12	1.18	1.25	1.31	1.56	1.61	1.73
N 900	0.98	1.08	1.13	1.20	1.27	1.33	1.58	1.63	1.76
N 1000	0.98	1.09	1.14	1.21	1.28	1.34	1.59	1.64	1.78
N 1100	0.99	1.11	1.16	1.23	1.31	1.37	1.61	1.66	1.81
N 1200	1.00	1.12	1.17	1.24	1.32	1.38	1.62	1.68	1.84
N 1300	1.01	1.13	1.18	1.26	1.33	1.40	1.63	1.70	1.86
N 1400	1.02	1.14	1.20	1.28	1.37	1.44	1.66	1.73	1.89
N 1500	1.03	1.15	1.27	1.35	1.44	1.51	1.70	1.77	1.93
N 1600	1.07	1.22	1.28	1.37	1.47	1.54	1.73	1.80	1.97
N 1700	1.17	1.29	1.35	1.42	1.51	1.58	1.75	1.82	2.00
N 1800	1.27	1.41	1.48	1.55	1.63	1.69	1.79	1.87	2.07
N 1900	1.38	1.56	1.63	1.72	1.80	1.86	1.98	2.05	2.24
N 2000	1.38	1.57	1.65	1.74	1.82	1.89	2.00	2.07	2.26
N 2100	1.39	1.59	1.68	1.76	1.85	1.92	2.03	2.10	2.30
N 2200	1.41	1.64	1.73	1.82	1.91	1.97	2.09	2.16	2.36
N 2300	1.63	1.78	1.86	1.94	2.02	2.08	2.19	2.27	2.47
N 2400	1.76	1.96	2.04	2.12	2.22	2.28	2.39	2.48	2.69
N 2500	1.76	1.96	2.04	2.12	2.21	2.27	2.38	2.46	2.67
N 2600	1.79	1.99	2.06	2.14	2.23	2.29	2.40	2.49	2.70
N 2700	1.84	2.03	2.10	2.18	2.27	2.33	2.43	2.53	2.73
GATEWAY MOTORWAY									
N 2800	1.90	2.10	2.19	2.29	2.40	2.48	2.64	2.78	3.17
N 2900	1.94	2.15	2.24	2.35	2.46	2.55	2.71	2.87	3.27
N 3000	1.96	2.18	2.27	2.38	2.50	2.59	2.75	2.91	3.31
N 3100	2.18	2.31	2.38	2.47	2.57	2.65	2.81	2.96	3.34
N 3200	2.20	2.38	2.46	2.55	2.65	2.73	2.89	3.02	3.39
N 3300	2.23	2.42	2.51	2.60	2.71	2.79	2.95	3.08	3.42
N 3400	2.24	2.44	2.53	2.63	2.73	2.82	2.98	3.11	3.45
N 3500	2.32	2.54	2.64	2.75	2.85	2.92	3.08	3.20	3.48
RAILWAY									
N 3600	2.40	2.67	2.79	2.89	2.99	3.05	3.20	3.29	3.52
N 3700	2.46	2.73	2.85	2.96	3.05	3.11	3.26	3.36	3.56

AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)	0.05% AEP (2000yr ARI)
N 3800	2.50	2.77	2.89	2.99	3.09	3.15	3.31	3.41	3.61
N 3900	2.56	2.83	2.95	3.06	3.16	3.23	3.40	3.50	3.69
N 4000	2.64	2.90	3.01	3.12	3.22	3.30	3.46	3.57	3.75
N 4100	2.73	2.98	3.09	3.21	3.31	3.39	3.57	3.68	3.86
N 4200	2.83	3.09	3.20	3.32	3.43	3.52	3.70	3.81	3.98
N 4300	2.95	3.19	3.29	3.40	3.52	3.61	3.79	3.90	4.06
N 4400	3.04	3.27	3.38	3.49	3.61	3.71	3.89	4.01	4.17
N 4500	3.14	3.36	3.46	3.56	3.68	3.78	3.97	4.10	4.25
N 4600	3.28	3.48	3.58	3.68	3.80	3.89	4.07	4.19	4.35
N 4700	3.40	3.61	3.70	3.80	3.91	4.00	4.18	4.30	4.45
DOWNFALL CREEK									
D 4800	3.44	3.64	3.74	3.84	3.95	4.03	4.22	4.34	4.50
D 4900	3.64	3.81	3.88	3.97	4.08	4.15	4.32	4.43	4.58
D 5000	3.94	4.07	4.13	4.18	4.30	4.35	4.48	4.57	4.70
D 5100	4.06	4.19	4.25	4.32	4.41	4.47	4.60	4.70	4.82
D 5200	4.20	4.33	4.40	4.48	4.55	4.61	4.74	4.83	4.94
D 5300	4.45	4.61	4.69	4.78	4.86	4.92	5.05	5.13	5.22
D 5400	4.58	4.77	4.86	4.95	5.04	5.12	5.26	5.34	5.43
D 5500	4.59	4.78	4.87	4.96	5.06	5.14	5.28	5.37	5.46
D 5600	4.62	4.81	4.91	5.01	5.11	5.19	5.34	5.44	5.52
D 5700	4.63	4.83	4.92	5.02	5.13	5.21	5.36	5.45	5.54
D 5800	4.65	4.86	4.95	5.04	5.16	5.24	5.41	5.50	5.59
D 5900	5.19	5.38	5.50	5.56	5.72	5.82	6.01	6.10	6.20
D 6000	5.32	5.52	5.62	5.73	5.86	5.96	6.16	6.28	6.39
D 6100	5.36	5.56	5.67	5.78	5.92	6.03	6.24	6.37	6.48
D 6200	5.45	5.66	5.78	5.91	6.04	6.16	6.41	6.55	6.69
D 6300	5.45	5.65	5.77	5.87	6.03	6.15	6.37	6.51	6.63
D 6400	5.87	6.08	6.18	6.29	6.45	6.53	6.68	6.78	6.93
SANDGATE ROAD									
D 6500	6.76	7.36	7.60	7.76	7.95	8.09	8.35	8.51	8.54
D 6600	6.77	7.38	7.61	7.76	7.93	8.06	8.31	8.46	8.49
RAILWAY									
D 6700	6.85	7.49	7.78	8.01	8.31	8.52	8.85	9.03	9.03
D 6800	7.04	7.57	7.84	8.07	8.37	8.58	8.91	9.09	9.10
D 6900	7.24	7.71	7.95	8.16	8.46	8.66	8.99	9.18	9.20
D 7000	7.66	8.20	8.45	8.66	8.92	9.11	9.44	9.63	9.70
D 7100	7.77	8.29	8.53	8.74	9.01	9.20	9.52	9.72	9.80
D 7200	7.87	8.36	8.59	8.81	9.07	9.26	9.58	9.78	9.87
D 7300	7.97	8.42	8.64	8.85	9.11	9.30	9.63	9.82	9.92
D 7400	8.12	8.51	8.72	8.92	9.18	9.36	9.69	9.89	9.99
D 7500	8.30	8.64	8.82	9.02	9.27	9.45	9.77	9.97	10.08

AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)	0.05% AEP (2000yr ARI)
D 7600	8.65	9.04	9.23	9.45	9.71	9.91	10.25	10.47	10.62
D 7700	8.89	9.26	9.44	9.65	9.91	10.10	10.44	10.67	10.84
D 7800	9.20	9.55	9.70	9.99	10.25	10.63	10.75	11.01	11.18
D 7900	9.55	9.87	10.00	10.48	10.74	11.15	11.28	11.57	11.67
D 8000	10.02	10.26	10.35	10.65	10.89	11.27	11.39	11.67	11.67
D 8100	10.37	10.65	10.74	10.94	11.16	11.51	11.62	11.89	12.02
D 8200	10.68	10.99	11.10	11.25	11.45	11.76	11.88	12.12	12.35
D 8300	10.90	11.23	11.35	11.51	11.72	11.99	12.15	12.36	12.61
D 8400	11.12	11.47	11.60	11.78	12.00	12.22	12.41	12.62	12.87
NEWMAN ROAD									
D 8500	11.23	11.60	11.74	11.94	12.23	12.49	12.69	12.90	13.14
D 8600	11.44	11.81	11.94	12.10	12.35	12.58	12.78	12.97	13.20
D 8700	11.75	12.09	12.21	12.32	12.51	12.70	12.88	13.06	13.27
D 8800	12.37	12.58	12.66	12.74	12.84	12.94	13.07	13.21	13.38
D 8900	13.14	13.34	13.41	13.49	13.63	13.74	13.84	13.96	14.12
D 9000	13.50	13.70	13.77	13.87	14.02	14.14	14.25	14.39	14.58
D 9100	13.73	13.93	14.00	14.09	14.25	14.36	14.48	14.62	14.81
D 9200	13.95	14.16	14.24	14.35	14.49	14.60	14.71	14.85	15.03
D 9300	14.21	14.47	14.57	14.69	14.86	14.99	15.09	15.22	15.37
D 9400	14.69	15.00	15.12	15.27	15.54	15.69	15.80	15.92	16.05
D 9500	15.30	15.53	15.64	15.78	15.97	16.12	16.25	16.38	16.55
D 9600	15.72	16.06	16.17	16.29	16.41	16.51	16.62	16.74	16.89
D 9700	15.98	16.38	16.50	16.64	16.92	16.94	17.07	17.21	17.42
KITTYHAWK DRIVE									
D 9800	16.12	16.50	16.62	16.76	16.95	17.09	17.23	17.39	17.61
D 9900	16.51	16.85	16.96	17.09	17.26	17.40	17.53	17.70	17.92
D 10000	16.96	17.26	17.36	17.46	17.58	17.69	17.81	17.95	18.14
GYMPIE ROAD									
D 10100	17.60	18.16	18.64	19.19	19.45	19.59	19.72	19.85	20.01
D 10200	18.00	18.42	18.79	19.22	19.47	19.62	19.74	19.88	20.04
D 10300	18.29	18.65	18.90	19.27	19.51	19.65	19.78	19.92	20.08
D 10400	18.54	18.86	19.01	19.31	19.54	19.68	19.81	19.95	20.12
D 10500	19.16	19.45	19.57	19.74	19.94	20.08	20.20	20.35	20.55
D 10600	19.63	19.99	20.12	20.24	20.43	20.57	20.69	20.82	21.03
D 10700	19.95	20.25	20.37	20.53	20.66	20.78	20.89	21.03	21.20
D 10800	20.21	20.49	20.61	20.77	20.91	21.03	21.14	21.29	21.47
D 10900	20.88	21.09	21.21	21.44	21.51	21.64	21.76	21.88	22.05
D 11000	21.37	21.66	21.80	21.96	22.11	22.26	22.39	22.52	22.68
HAMILTON ROAD									
D 11100	22.01	22.42	22.62	22.91	23.22	23.67	23.96	24.65	25.14

AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)	0.05% AEP (2000yr ARI)
HAMILTON ROAD									
D 11200	22.70	23.09	23.29	23.61	24.06	24.33	24.64	25.06	25.40
D 11300	23.08	23.40	23.57	23.87	24.31	24.56	24.86	25.22	25.52
D 11400	23.37	23.65	23.79	24.03	24.42	24.66	24.94	25.28	25.58
D 11500	24.03	24.17	24.25	24.38	24.72	24.89	25.11	25.42	25.71
D 11600	24.78	24.95	25.02	25.11	25.25	25.37	25.50	25.68	25.90
D 11700	25.34	25.51	25.58	25.67	25.76	25.85	25.93	26.06	26.23
D 11800	25.93	26.10	26.18	26.28	26.33	26.40	26.44	26.57	26.69
D 11900	26.36	26.56	26.65	26.76	26.85	26.95	27.01	27.18	27.35
D 12000	26.69	26.93	27.02	27.14	27.25	27.35	27.42	27.59	27.76
D 12100	27.07	27.29	27.38	27.49	27.59	27.69	27.75	27.92	28.10
D 12200	27.37	27.62	27.71	27.81	27.92	28.01	28.08	28.24	28.41
MAUNDRELL TERRACE									
D 12300	28.21	28.60	28.73	28.86	28.97	29.09	29.17	29.35	29.53
D 12400	28.33	28.69	28.81	28.95	29.07	29.19	29.27	29.45	29.63
D 12500	28.48	28.82	28.95	29.08	29.20	29.33	29.42	29.61	29.78
D 12600	28.86	29.19	29.31	29.46	29.61	29.77	29.90	30.13	30.34
D 12700	29.35	29.64	29.77	29.92	30.07	30.22	30.33	30.55	30.74
D 12800	29.76	30.03	30.15	30.30	30.47	30.61	30.70	30.92	31.09
D 12900	30.26	30.51	30.62	30.75	30.89	31.04	31.13	31.36	31.52
D 13000	30.76	31.00	31.10	31.23	31.36	31.51	31.62	31.85	32.00
D 13100	31.18	31.44	31.55	31.67	31.82	31.99	32.10	32.36	32.49
RODE ROAD									
D 13200	31.49	31.99	32.25	32.63	33.09	33.38	33.49	33.72	33.82
D 13300	31.96	32.32	32.51	32.82	33.21	33.48	33.60	33.84	33.93
D 13400	32.31	32.60	32.76	33.01	33.34	33.59	33.71	33.97	34.05
D 13500	32.55	32.82	32.96	33.17	33.46	33.70	33.82	34.11	34.17
D 13600	33.01	33.18	33.27	33.42	33.62	33.79	33.89	34.24	34.33
D 13700	33.86	33.97	34.02	34.11	34.28	34.41	34.50	34.73	34.82
D 13800	34.82	34.96	35.03	35.14	35.30	35.46	35.55	35.76	36.05
PARTON STREET									
D 13900	36.33	37.06	37.44	37.82	38.09	38.28	38.36	38.51	38.51
D 14000	36.59	37.13	37.49	37.84	38.10	38.29	38.37	38.52	38.53
D 14100	37.11	37.41	37.59	37.93	38.17	38.35	38.44	38.60	38.60
TROUTS ROAD									
D 14200	39.68	39.84	39.91	40.01	40.10	40.18	40.27	40.40	40.31
D 14300	40.14	40.31	40.41	40.54	40.63	40.74	40.84	41.00	40.88
D 14400	40.78	40.94	41.03	41.15	41.24	41.34	41.44	41.59	41.46

AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)	0.05% AEP (2000yr ARI)
ZILLMAN WATERHOLES									
Z 0	3.41	3.62	3.71	3.81	3.92	4.01	4.20	4.31	4.47
Z 100	3.41	3.62	3.72	3.81	3.93	4.02	4.20	4.33	4.48
Z 200	3.43	3.64	3.73	3.83	3.95	4.04	4.23	4.35	4.51
Z 300	3.44	3.65	3.75	3.85	3.97	4.06	4.25	4.37	4.53
Z 400	3.48	3.71	3.81	3.94	4.06	4.15	4.34	4.48	4.64
Z 500	3.54	3.77	3.88	4.00	4.13	4.22	4.43	4.57	4.74
Z 600	3.67	3.89	3.99	4.11	4.24	4.34	4.54	4.68	4.85
Z 700	3.78	4.01	4.09	4.21	4.34	4.43	4.63	4.76	4.94
Z 800	3.89	4.10	4.18	4.29	4.41	4.50	4.69	4.82	5.00
Z 900	4.04	4.24	4.32	4.41	4.52	4.61	4.79	4.92	5.10
Z 1000	4.18	4.43	4.56	4.61	4.71	4.83	5.01	5.14	5.30
SANDGATE ROAD									
Z 1100	4.33	4.64	4.78	4.90	5.02	5.13	5.30	5.40	5.53
Z 1200	4.35	4.66	4.80	4.93	5.05	5.15	5.32	5.42	5.56
Z 1300	4.38	4.68	4.82	4.95	5.08	5.17	5.34	5.45	5.60
ZILLMERE ROAD									
Z 1400	4.46	4.77	4.92	5.06	5.19	5.28	5.45	5.57	5.73
Z 1500	4.47	4.78	4.93	5.07	5.20	5.29	5.46	5.58	5.75
Z 1600	4.48	4.79	4.93	5.08	5.21	5.30	5.47	5.59	5.76
Z 1700	4.48	4.79	4.93	5.08	5.21	5.31	5.47	5.60	5.77
Z 1800	4.49	4.80	4.94	5.09	5.22	5.31	5.48	5.61	5.78
GROTH ROAD									
Z 1900	4.62	4.91	5.03	5.17	5.30	5.39	5.56	5.68	5.87
Z 2000	4.85	5.08	5.18	5.29	5.41	5.50	5.65	5.77	5.96
Z 2100	5.16	5.32	5.40	5.48	5.57	5.65	5.77	5.89	6.06
Z 2200	5.44	5.60	5.66	5.72	5.81	5.88	5.96	6.07	6.21
Z 2300	5.85	5.98	6.03	6.08	6.14	6.20	6.26	6.36	6.48
Z 2400	6.35	6.51	6.56	6.60	6.67	6.73	6.79	6.88	6.98
ZILLMERE ROAD									
Z 2500	6.60	6.74	6.79	6.84	6.90	6.97	7.03	7.13	7.23
NEWMAN ROAD									
Z 2600	7.17	7.43	7.52	7.61	7.67	7.75	7.83	7.96	8.08
Z 2700	7.50	7.81	7.91	8.00	8.08	8.18	8.26	8.39	8.52
Z 2800	7.82	8.16	8.27	8.38	8.47	8.59	8.69	8.83	8.95
Z 2900	8.07	8.40	8.53	8.65	8.75	8.87	8.98	9.12	9.24
Z 3000	8.55	8.89	8.97	9.06	9.14	9.23	9.32	9.43	9.53
Z 3100	8.77	9.11	9.20	9.28	9.39	9.48	9.56	9.67	9.68
Z 3200	9.33	9.51	9.58	9.68	9.78	9.87	9.94	10.17	10.59

AMTD (m)	Design Events – Scenario 1 (Existing Waterway Conditions) Peak Water Levels (m AHD)								
	50% AEP (2yr ARI)	**20% AEP (5yr ARI)**	**10% AEP (10yr ARI)**	**5% AEP (20yr ARI)**	**2% AEP (50yr ARI)**	**1% AEP (100yr ARI)**	**0.5% AEP (200yr ARI)**	**0.2% AEP (500yr ARI)**	**0.05% AEP (2000yr ARI)**
Z 3300	9.52	9.72	9.81	9.91	10.03	10.13	10.20	10.30	10.69
Z 3400	9.90	10.12	10.22	10.31	10.41	10.50	10.58	10.70	10.97
RAILWAY									
Z 3500	11.62	12.28	12.67	12.93	13.04	13.11	13.18	13.27	13.37
Z 3600	11.66	12.30	12.69	12.97	13.09	13.18	13.27	13.39	13.51
ROBINSON ROAD									
Z 3700	12.15	12.59	12.87	13.10	13.22	13.33	13.43	13.58	13.73
Z 3800	12.88	13.09	13.19	13.26	13.38	13.47	13.56	13.70	13.85
Z 3900	13.95	14.07	14.15	14.19	14.23	14.26	14.31	14.39	14.48
Z 4000	14.42	14.57	14.68	14.74	14.78	14.82	14.88	14.98	15.09
Z 4100	14.88	15.05	15.18	15.24	15.29	15.34	15.40	15.51	15.63
Z 4200	15.34	15.53	15.67	15.74	15.78	15.83	15.90	16.02	16.15
Z 4300	15.79	16.05	16.28	16.34	16.40	16.50	16.60	16.77	16.95
MURPHY ROAD									
Z 4400	16.91	17.42	17.66	17.96	18.31	18.59	18.77	19.03	19.22
Z 4500	16.95	17.45	17.68	17.96	18.33	18.61	18.78	19.04	19.24
Z 4600	17.02	17.49	17.72	17.98	18.34	18.62	18.80	19.05	19.25
Z 4700	17.16	17.61	17.81	18.02	18.36	18.63	18.80	19.06	19.25

Appendix G: Design Events (Scenario 3) – 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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AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
NUNDAH CREEK								
N 0	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31
N 100	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31
N 200	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31
N 300	0.77	0.77	0.77	0.77	0.77	0.77	1.31	1.31
N 400	0.77	0.77	0.77	0.78	0.78	0.78	1.32	1.32
N 500	0.78	0.78	0.79	0.79	0.80	0.81	1.34	1.35
N 600	0.82	0.85	0.87	0.92	0.97	1.03	1.44	1.48
N 700	0.93	1.02	1.06	1.12	1.20	1.27	1.57	1.62
N 800	0.96	1.06	1.11	1.18	1.26	1.33	1.62	1.68
N 900	0.97	1.07	1.13	1.20	1.29	1.36	1.64	1.70
N 1000	0.97	1.08	1.13	1.21	1.30	1.37	1.65	1.72
N 1100	0.98	1.10	1.16	1.23	1.33	1.40	1.68	1.75
N 1200	0.99	1.11	1.17	1.25	1.34	1.42	1.70	1.77
N 1300	1.00	1.12	1.18	1.26	1.35	1.44	1.71	1.79
N 1400	1.01	1.13	1.20	1.29	1.39	1.48	1.74	1.82
N 1500	1.02	1.14	1.27	1.36	1.47	1.55	1.79	1.87
N 1600	1.07	1.22	1.29	1.39	1.50	1.59	1.82	1.90
N 1700	1.16	1.28	1.34	1.43	1.54	1.62	1.84	1.92
N 1800	1.25	1.39	1.46	1.55	1.64	1.71	1.88	1.97
N 1900	1.38	1.56	1.65	1.75	1.85	1.92	2.08	2.17
N 2000	1.38	1.57	1.66	1.77	1.87	1.94	2.10	2.19
N 2100	1.39	1.59	1.69	1.79	1.90	1.97	2.13	2.21
N 2200	1.41	1.63	1.74	1.84	1.95	2.02	2.18	2.26
N 2300	1.62	1.76	1.84	1.94	2.04	2.11	2.26	2.33
N 2400	1.74	1.95	2.04	2.14	2.25	2.33	2.49	2.55
N 2500	1.75	1.95	2.04	2.14	2.25	2.33	2.48	2.54
N 2600	1.77	1.97	2.06	2.16	2.27	2.34	2.49	2.56
N 2700	1.82	2.02	2.10	2.20	2.31	2.39	2.54	2.61
GATEWAY MOTORWAY								
N 2800	1.90	2.11	2.21	2.33	2.48	2.60	2.84	2.94
N 2900	1.93	2.15	2.24	2.37	2.53	2.65	2.90	3.00
N 3000	1.95	2.17	2.27	2.40	2.56	2.68	2.94	3.04
N 3100	2.18	2.33	2.40	2.51	2.65	2.76	3.01	3.10
N 3200	2.19	2.39	2.47	2.59	2.72	2.83	3.08	3.15
N 3300	2.24	2.45	2.54	2.66	2.79	2.90	3.14	3.21
N 3400	2.26	2.47	2.57	2.69	2.83	2.94	3.18	3.23
N 3500	2.33	2.56	2.67	2.79	2.92	3.02	3.24	3.28
RAILWAY								
N 3600	2.43	2.70	2.83	2.95	3.05	3.14	3.32	3.34
N 3700	2.48	2.76	2.89	3.00	3.11	3.19	3.38	3.39

AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
N 3800	2.52	2.80	2.92	3.04	3.15	3.24	3.44	3.45
N 3900	2.58	2.86	2.99	3.11	3.23	3.32	3.54	3.54
N 4000	2.70	2.96	3.08	3.21	3.34	3.44	3.67	3.67
N 4100	2.78	3.04	3.16	3.28	3.42	3.52	3.77	3.77
N 4200	2.87	3.13	3.25	3.38	3.52	3.63	3.89	3.89
N 4300	2.99	3.22	3.33	3.46	3.60	3.72	3.97	3.97
N 4400	3.06	3.29	3.40	3.54	3.69	3.81	4.07	4.08
N 4500	3.17	3.38	3.49	3.61	3.77	3.89	4.16	4.17
N 4600	3.31	3.51	3.61	3.72	3.87	3.99	4.25	4.27
N 4700	3.42	3.62	3.72	3.83	3.97	4.08	4.34	4.36
DOWNFALL CREEK								
D 4800	3.47	3.67	3.77	3.88	4.02	4.13	4.38	4.40
D 4900	3.67	3.84	3.93	4.03	4.16	4.27	4.50	4.52
D 5000	3.96	4.12	4.19	4.30	4.41	4.50	4.72	4.73
D 5100	4.07	4.24	4.33	4.43	4.56	4.66	4.90	4.92
D 5200	4.23	4.40	4.50	4.60	4.74	4.84	5.10	5.14
D 5300	4.53	4.71	4.81	4.91	5.05	5.16	5.41	5.48
D 5400	4.66	4.85	4.95	5.07	5.21	5.33	5.59	5.67
D 5500	4.67	4.86	4.97	5.08	5.23	5.35	5.63	5.71
D 5600	4.70	4.90	5.01	5.13	5.28	5.41	5.70	5.79
D 5700	4.71	4.92	5.02	5.15	5.30	5.43	5.72	5.80
D 5800	4.77	4.98	5.09	5.22	5.38	5.50	5.81	5.90
D 5900	5.24	5.45	5.53	5.67	5.83	5.97	6.31	6.38
D 6000	5.38	5.58	5.68	5.82	5.98	6.12	6.49	6.56
D 6100	5.42	5.63	5.75	5.89	6.06	6.21	6.59	6.67
D 6200	5.53	5.74	5.86	6.01	6.18	6.34	6.73	6.82
D 6300	5.59	5.80	5.91	6.05	6.21	6.37	6.74	6.84
D 6400	5.95	6.15	6.26	6.44	6.63	6.84	7.22	7.29
SANDGATE ROAD								
D 6500	6.86	7.46	7.70	7.94	8.20	8.38	8.91	9.05
D 6600	7.06	7.61	7.84	8.07	8.33	8.52	9.02	9.16
RAILWAY								
D 6700	7.13	7.70	7.97	8.27	8.61	8.84	9.35	9.49
D 6800	7.23	7.75	8.01	8.30	8.64	8.87	9.38	9.52
D 6900	7.39	7.84	8.09	8.37	8.70	8.92	9.43	9.57
D 7000	7.72	8.25	8.51	8.76	9.07	9.29	9.78	9.95
D 7100	7.84	8.34	8.59	8.84	9.14	9.36	9.84	10.01
D 7200	7.93	8.41	8.65	8.90	9.19	9.40	9.89	10.06
D 7300	8.02	8.47	8.69	8.94	9.22	9.44	9.91	10.09
D 7400	8.16	8.55	8.76	9.00	9.28	9.49	9.96	10.13
D 7500	8.34	8.67	8.86	9.08	9.36	9.57	10.02	10.20

AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
D 7600	8.69	9.10	9.30	9.55	9.83	10.04	10.48	10.67
D 7700	8.93	9.32	9.52	9.75	10.03	10.24	10.67	10.87
D 7800	9.21	9.60	9.78	10.11	10.39	10.84	11.03	11.31
D 7900	9.57	9.91	10.07	10.64	10.94	11.45	11.67	11.99
D 8000	10.07	10.29	10.41	10.76	11.04	11.52	11.73	12.05
D 8100	10.46	10.72	10.82	11.04	11.28	11.72	11.92	12.22
D 8200	10.78	11.08	11.19	11.34	11.54	11.95	12.14	12.43
D 8300	10.96	11.30	11.43	11.61	11.85	12.23	12.46	12.74
D 8400	11.15	11.53	11.68	11.88	12.16	12.52	12.82	13.10
NEWMAN ROAD								
D 8500	11.27	11.68	11.86	12.11	12.46	12.78	13.14	13.39
D 8600	11.48	11.88	12.03	12.24	12.54	12.84	13.19	13.43
D 8700	11.77	12.16	12.28	12.42	12.66	12.91	13.25	13.47
D 8800	12.31	12.65	12.73	12.81	12.94	13.10	13.38	13.58
D 8900	13.18	13.38	13.46	13.57	13.72	13.85	14.04	14.23
D 9000	13.51	13.73	13.83	13.95	14.10	14.23	14.40	14.59
D 9100	13.86	14.01	14.06	14.17	14.32	14.44	14.60	14.78
D 9200	14.13	14.28	14.33	14.43	14.56	14.67	14.82	14.97
D 9300	14.37	14.59	14.68	14.80	14.96	15.09	15.23	15.36
D 9400	14.81	15.11	15.25	15.40	15.63	15.79	15.94	16.04
D 9500	15.41	15.60	15.73	15.85	16.04	16.19	16.36	16.48
D 9600	15.83	16.19	16.30	16.38	16.49	16.60	16.73	16.85
D 9700	16.07	16.48	16.62	16.74	16.91	17.07	17.25	17.40
KITTYHAWK DRIVE								
D 9800	16.20	16.60	16.74	16.87	17.05	17.21	17.41	17.58
D 9900	16.55	16.94	17.08	17.19	17.35	17.51	17.70	17.87
D 10000	16.95	17.31	17.43	17.50	17.64	17.77	17.93	18.08
GYMPIE ROAD								
D 10100	17.50	18.06	18.67	19.16	19.44	19.62	19.79	19.94
D 10200	17.96	18.38	18.76	19.20	19.47	19.65	19.83	19.98
D 10300	18.32	18.68	18.91	19.24	19.51	19.68	19.86	20.01
D 10400	18.64	18.96	19.04	19.29	19.54	19.71	19.88	20.03
D 10500	19.23	19.55	19.65	19.81	19.97	20.12	20.27	20.42
D 10600	19.71	20.07	20.22	20.39	20.55	20.67	20.79	20.90
D 10700	20.00	20.33	20.47	20.64	20.78	20.91	21.01	21.12
D 10800	20.26	20.57	20.71	20.88	21.03	21.17	21.28	21.38
D 10900	20.86	21.16	21.30	21.48	21.64	21.80	21.89	21.99
D 11000	21.35	21.74	21.89	22.02	22.20	22.46	22.47	22.55
HAMILTON ROAD								
D 11100	21.97	22.38	22.60	22.89	23.20	23.81	24.10	24.67

AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
HAMILTON ROAD								
D 11200	22.64	23.03	23.26	23.56	23.90	24.47	24.81	25.13
D 11300	23.14	23.45	23.64	23.90	24.20	24.72	25.08	25.33
D 11400	23.50	23.76	23.92	24.14	24.42	24.87	25.20	25.44
D 11500	24.06	24.23	24.32	24.44	24.78	25.17	25.38	25.61
D 11600	24.80	24.97	25.05	25.15	25.29	25.60	25.65	25.83
D 11700	25.35	25.54	25.62	25.70	25.79	25.98	26.00	26.15
D 11800	25.93	26.13	26.21	26.27	26.32	26.42	26.45	26.58
D 11900	26.36	26.59	26.69	26.79	26.89	27.06	27.12	27.31
D 12000	26.71	26.96	27.07	27.20	27.32	27.50	27.59	27.78
D 12100	27.10	27.34	27.45	27.57	27.70	27.86	27.97	28.18
D 12200	27.40	27.66	27.76	27.87	27.98	28.14	28.21	28.41
MAUNDRELL TERRACE								
D 12300	28.20	28.58	28.71	28.85	28.97	29.10	29.19	29.39
D 12400	28.31	28.68	28.81	28.95	29.08	29.22	29.31	29.51
D 12500	28.47	28.82	28.95	29.09	29.23	29.38	29.48	29.69
D 12600	28.84	29.18	29.31	29.46	29.63	29.83	29.94	30.26
D 12700	29.33	29.65	29.79	29.95	30.13	30.31	30.41	30.69
D 12800	29.76	30.07	30.21	30.37	30.55	30.72	30.83	31.08
D 12900	30.30	30.58	30.71	30.86	31.04	31.23	31.36	31.62
D 13000	30.84	31.11	31.22	31.37	31.55	31.76	31.90	32.16
D 13100	31.27	31.55	31.67	31.82	32.01	32.24	32.39	32.64
RODE ROAD								
D 13200	31.58	32.08	32.34	32.74	33.18	33.46	33.59	33.82
D 13300	32.01	32.39	32.60	32.92	33.31	33.58	33.72	33.94
D 13400	32.41	32.71	32.87	33.13	33.46	33.73	33.87	34.10
D 13500	32.65	32.93	33.08	33.30	33.60	33.88	34.02	34.26
D 13600	33.05	33.24	33.33	33.50	33.70	34.01	34.15	34.41
D 13700	33.88	33.99	34.05	34.19	34.33	34.56	34.68	34.93
D 13800	34.83	34.96	35.03	35.17	35.32	35.48	35.60	35.81
PARTON STREET								
D 13900	36.32	37.06	37.46	37.86	38.13	38.33	38.42	38.57
D 14000	36.60	37.16	37.51	37.87	38.15	38.34	38.43	38.58
D 14100	37.14	37.46	37.63	37.99	38.25	38.44	38.53	38.70
TROUTS ROAD								
D 14200	39.68	39.84	39.93	40.03	40.12	40.22	40.30	40.42
D 14300	40.13	40.32	40.42	40.55	40.66	40.78	40.88	41.03
D 14400	40.77	40.95	41.04	41.17	41.27	41.37	41.46	41.60

AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	20% AEP (5yr ARI)	10% AEP (10yr ARI)	5% AEP (20yr ARI)	2% AEP (50yr ARI)	1% AEP (100yr ARI)	0.5% AEP (200yr ARI)	0.2% AEP (500yr ARI)
ZILLMAN WATERHOLES								
Z 0	3.43	3.64	3.74	3.85	3.99	4.10	4.35	4.37
Z 100	3.43	3.64	3.74	3.85	3.99	4.11	4.36	4.38
Z 200	3.44	3.65	3.75	3.87	4.01	4.13	4.38	4.41
Z 300	3.46	3.67	3.78	3.89	4.04	4.15	4.41	4.43
Z 400	3.51	3.73	3.85	3.97	4.11	4.23	4.48	4.51
Z 500	3.58	3.81	3.92	4.05	4.20	4.32	4.58	4.66
Z 600	3.73	3.96	4.07	4.21	4.36	4.48	4.74	4.86
Z 700	3.85	4.09	4.21	4.34	4.50	4.62	4.90	5.03
Z 800	3.98	4.22	4.34	4.47	4.64	4.77	5.05	5.18
Z 900	4.16	4.38	4.51	4.65	4.82	4.95	5.23	5.36
Z 1000	4.33	4.58	4.73	4.91	5.12	5.27	5.62	5.75
SANDGATE ROAD								
Z 1100	4.42	4.75	4.93	5.15	5.40	5.58	5.98	6.11
Z 1200	4.46	4.79	4.97	5.19	5.45	5.63	6.03	6.16
Z 1300	4.50	4.83	5.01	5.24	5.50	5.68	6.08	6.21
ZILLMERE ROAD								
Z 1400	4.59	4.93	5.12	5.35	5.61	5.80	6.22	6.35
Z 1500	4.61	4.95	5.14	5.37	5.63	5.82	6.24	6.37
Z 1600	4.61	4.95	5.14	5.37	5.64	5.83	6.24	6.38
Z 1700	4.62	4.96	5.15	5.37	5.64	5.83	6.25	6.38
Z 1800	4.62	4.96	5.15	5.37	5.64	5.83	6.25	6.38
GROTH ROAD								
Z 1900	4.71	5.02	5.20	5.42	5.68	5.86	6.28	6.41
Z 2000	4.89	5.16	5.29	5.48	5.73	5.91	6.32	6.46
Z 2100	5.17	5.38	5.48	5.60	5.79	5.96	6.37	6.51
Z 2200	5.47	5.67	5.74	5.83	5.94	6.06	6.42	6.56
Z 2300	5.88	6.04	6.11	6.19	6.28	6.37	6.59	6.74
Z 2400	6.44	6.64	6.72	6.81	6.90	6.99	7.15	7.27
ZILLMERE ROAD								
Z 2500	6.79	6.98	7.06	7.15	7.24	7.34	7.50	7.62
NEWMAN ROAD								
Z 2600	7.28	7.55	7.67	7.80	7.93	8.07	8.27	8.41
Z 2700	7.55	7.88	8.02	8.17	8.32	8.48	8.72	8.88
Z 2800	7.84	8.19	8.34	8.50	8.65	8.81	9.04	9.21
Z 2900	8.07	8.41	8.57	8.73	8.89	9.06	9.29	9.48
Z 3000	8.53	8.90	9.02	9.14	9.28	9.43	9.65	9.84
Z 3100	8.75	9.11	9.23	9.35	9.50	9.65	9.83	10.06
Z 3200	9.30	9.52	9.61	9.73	9.86	9.97	10.03	10.23

AMTD (m)	Design Events – Scenario 3 (Ultimate Conditions) Peak Water Levels (m AHD)							
	50% AEP (2yr ARI)	**20% AEP (5yr ARI)**	**10% AEP (10yr ARI)**	**5% AEP (20yr ARI)**	**2% AEP (50yr ARI)**	**1% AEP (100yr ARI)**	**0.5% AEP (200yr ARI)**	**0.2% AEP (500yr ARI)**
Z 3300	9.49	9.72	9.83	9.95	10.08	10.19	10.26	10.46
Z 3400	9.88	10.11	10.22	10.32	10.43	10.53	10.62	10.82
RAILWAY								
Z 3500	11.59	12.24	12.66	12.97	13.11	13.21	13.32	13.46
Z 3600	11.65	12.29	12.70	13.02	13.17	13.29	13.43	13.60
ROBINSON ROAD								
Z 3700	12.13	12.58	12.89	13.15	13.30	13.44	13.60	13.79
Z 3800	13.10	13.23	13.32	13.42	13.52	13.62	13.76	13.94
Z 3900	14.13	14.28	14.39	14.45	14.49	14.55	14.65	14.79
Z 4000	14.50	14.69	14.83	14.91	14.96	15.03	15.15	15.30
Z 4100	14.93	15.13	15.29	15.36	15.42	15.48	15.59	15.75
Z 4200	15.37	15.59	15.75	15.82	15.87	15.93	16.03	16.17
Z 4300	15.80	16.07	16.30	16.49	16.54	16.60	16.70	16.85
MURPHY ROAD								
Z 4400	16.89	17.40	17.63	17.96	18.32	18.62	18.84	19.11
Z 4500	16.96	17.45	17.66	17.96	18.33	18.64	18.86	19.13
Z 4600	17.03	17.50	17.71	17.99	18.36	18.66	18.88	19.14
Z 4700	17.17	17.62	17.80	18.02	18.37	18.67	18.89	19.15

Appendix H: Model Handover Information

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Model Handover Information

The Nundah Creek TUFLOW model was run using the 2012-05-AE-iSP-w64 version of the TUFLOW executable. To run the model from the TUFLOW control file a batch file is required. The lines of code required for the batch file are as follows:

Set TUFLOWEXE=<insert path to TUFLOW executable here>\TUFLOW_iSP_w64.exe

Set RUN=start "TUFLOW" /wait/low "%TUFLOWEXE%" –nwk –b
–S <insert scenario number> -e1<insert ARI> -e2<insert duration> <insert .TCF file name>.TCF

All text in red must be replaced with the relevant code. Codes for ARIs are shown in Table1, codes for durations are shown in Table2 and scenario numbers are shown in Table 3.

Table1: Code for ARIs

ARI	Event Code
2	002y
5	005y
10	010y
20	020y
50	050y
100	100y
200	200y
500	500y
2000	2000y
PMF	PMF

Table2: Code for Durations

Duration	Event Code
30 Minutes	030m
45 Minutes	045m
1 Hour	060m
1.5 Hours	090m
2 Hours	120m
3 Hours	180m
4.5 Hours	270m
6 Hours	360m
9 Hours	540m
12 Hours	720m
Extreme Events Super Storm	EE

Table3: Code for Durations

Scenario Number	Description
S1	Existing Waterway Condition
S2	Existing Waterway Condition+ Minimum Riparian Corridor
S3	Ultimate Waterway Condition+ Minimum Riparian Corridor

The following revisions have been used for the following modelling scenarios:

Model Scenario	TCF File Name
Design Events (Ultimate/Existing) up to 1% AEP (100 yr ARI)	NCFS_Des_~S~_~e1~_~e2~_032.tcf
Extreme Events for 0.5%	NCFS_EE_~S~_~e1~_~e2~_032.tcf
Extreme Events for 0.2% AEP	NCFS_EE_~S~_~e1~_~e2~_041.tcf
0.05% AEP	NCFS_EE_~S~_~e1~_~e2~_033.tcf
PMF	NCFS_EE_~S~_~e1~_~e2~_034.tcf
Climate Change Scenario for 1% and 0.5% AEP	NCFS_Des_~S~_~e1~_~e2~_035.tcf to NCFS_Des_~S~_~e1~_~e2~_038.tcf
Climate Change Scenario for 0.2%	NCFS_Des_~S~_~e1~_~e2~_040.tcf

All model results including flood level, depth, velocity and depth-velocity surfaces/grids are available in electronic format.

The DEM is read in ASCII text format and all other files are in MID/MIF MapInfo format.

TUFLOW directory structure is shown below:

TUFLOW

- Bc_dbase
- Check
  - Calibration
    - 1D
    - 2D
  - Design
    - 1D
    - 2D
  - Climate_Change
    - 1D
    - 2D
  - Extreme
    - 1D
    - 2D
- Model
  - xs
  - mi
    - DEM
    - 1D

            - 2D
- Results
    - Calibration
        - 1D
        - 2D
    - Design
        - 1D
        - 2D
    - Climate_Change
        - 1D
        - 2D
    - Extreme
        - 1D
        - 2D
    - Final ASC FILES
        - Calibration
        - Climate Change
            - Existing
            - Ultimate
        - Design
            - Existing
            - Ultimate
        - Extreme
            - Existing
            - Ultimate
- Runs_Calibration
    - Log
    - Batch files
- Runs_Climate_Change
    - Log
    - Batch files
- Runs_Design
    - Log
    - Batch files
- Runs_Extreme
    - Log
    - Batch files

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Appendix I: External Peer Review Documentation

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Our Ref: L.B20679.004.NFS.docx

17 June 2015

Brisbane City Council
City Projects Office
Green Square, Level 1
505 St Pauls Terrace
Fortitude Valley
Qld 4006

Attention: Hanieh Zolfaghari

Dear Hanieh

RE: NUNDAH CREEK FLOOD MODELLING PEER REVIEW

Background

BMT WBM was commissioned by Council to undertake a peer review of the Nundah Creek flood modelling prepared as part of the Nundah Creek Flood Study. This letter documents the outcomes of BMT WBM's review.

At the commencement of the review process, Council submitted the following data to BMT WBM:

- Hydrological models;
- Hydraulic models including all model output files; and
- GIS data.

These data were reviewed and initial feedback on the calibration modelling was provided to Council by email (dated 9th October 2014). Follow up reviews of the calibration model were undertaken and lastly the design event model for which feedback was provided to Council by email (dated 5th May 2015).

Some issues in the modelling were identified and rectified following feedback provided to Council – these are not discussed in this letter as they have been since been resolved.

Overview of the Modelling Approach

Hydrological models were developed using XP-RAFTS. The structure of the XP-RAFTS models and the associated sub-catchment parameters have been reviewed. Hydraulic models of the Nundah Creek system were developed using TUFLOW. A 5m computational grid cell size was used. The upper and middle reaches of the creeks were modelled in 1D (i.e. upstream of Sandgate Road) and linked to the 2D model domain of the floodplain. The lower reach of the creek system from Sandgate Road to the outfall at Moreton Bay was modelled in 2D.

Model Performance

The model performance has been checked in relation to: mass balance error, negative depth warnings, and instability. The model performance is considered acceptable to meet the objectives of Council's flood study. It is noted that Council has also assessed the model performance in relation to replication of historical events (calibration and verification) and bridge structures have been compared to equivalent HEC-RAS models. Council's acceptable tolerance for calibration is 0.15m variance for peak flood levels at stream gauges and 0.3m variance for peak flood levels at maximum height gauges. This correlates with standard industry practice. Note that the review did not include the calibration – discussed further below.

Limitations of the Review

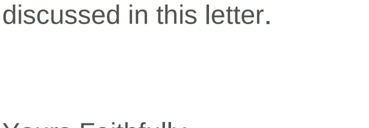
This review has focussed on scrutinising the design and performance of the models developed by Council. The scope of the review does not include the underlying data used to develop the model or the broader flood study methodology and procedure. For example, the accuracy of the topographic data, land use mapping (based on Brisbane City Council's City Plan and refined using aerial imagery), structure details and historic flood data has not been explicitly checked. If supplied information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions may change. As a consequence, BMT WBM provides no liability to the accuracy or the precision of the supplied data. All liability to do with the assumptions that rely on the accuracy or the precision of the supplied data rest with Brisbane City Council.

While the design and performance of the models used for calibration has been reviewed, the calibration and verification exercise has not been reviewed (for example, BMT WBM has not inspected modelled water levels at Maximum Height Gauge locations or reviewed comparisons of observed data versus modelled results).

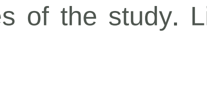
Conclusion

The flood modelling undertaken as part of the Nundah Creek Flood Study complies with current industry practice, and is considered suitable for the purposes of the study. Limitations to this endorsement are discussed in this letter.

Yours Faithfully
BMT WBM



Richard Sharpe
Senior Flood Engineer



Ben Caddis RPEQ (9234)
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Our Ref: L.B20679.006.NFS.docx

25 November 2015

Brisbane City Council
City Projects Office
Green Square, Level 1
505 St Pauls Terrace
Fortitude Valley
Qld 4006

Attention: Hanieh Zolfaghari

Dear Hanieh

RE: NUNDAH CREEK FLOOD MODELLING PEER REVIEW – ADDENDUM

Background

BMT WBM was commissioned by Council to undertake a peer review of the Nundah Creek flood modelling prepared as part of the Nundah Creek Flood Study. BMT WBM's review was documented in a letter report (letter reference: L.B20679.006.NFS 17th June 2015). This letter forms an addendum to the previous review.

The Nundah Creek model has since been revised by Council as follows:

- SA polygons for inflows in the 2D domain had been digitised using MapInfo ellipse objects. TUFLOW does not recognise ellipse objects, and, therefore, they were ignored in the model. This resulted in insufficient flow being inserted in the model. Council has converted the ellipse objects to MapInfo region objects, which TUFLOW does recognise. Given TUFLOW's error reporting process, this error was not obvious in the version of TUFLOW current at the time of the project.
- A small change was made to the land use for all historical events in the vicinity of the Gateway Motorway to improve the calibration. This change only affects historical events – the design events land use is based on City Plan.

BMT WBM has reviewed:

- The corrected SA polygon MapInfo layer;
- The revised MapInfo materials layers;
- The revised 100 year Scenario 1 100 year ARI flood level surface; and
- A TUFLOW log file and 1D result file for the scenario 1 100 year ARI 2 hour storm duration design event.

BMT WBM's assessment of the supplied information is that the corrections have been implemented correctly and the model performance is similar to that in the previous review. The increased flow in the catchment has resulted in higher flood levels and a greater extent of flood inundation, particularly in the lower catchment.

The Gateway Motorway forms a major control in the catchment. East of the Motorway, Nundah Creek flows through the low lying Boondall Wetlands, which form a coastal marsh adjacent to Moreton Bay. Since this area is flat and low lying, without any discernible water shed between neighbouring catchments, the model extent cuts through the wetlands. In this area, the 100 year ARI flood extent reaches much of the eastern model extent (more so than in the previous model revision). Here, the downstream boundary has been extended up through the Boondall Wetlands to the Gateway Motorway to enable water to drain away. This arrangement may limit the ability for the model to estimate flood levels east of the Gateway Motorway. However, we understand that the flood risk in this area will be defined by coastal flood hazards.

In conclusion, the flood modelling undertaken as part of the Nundah Creek Flood Study complies with current industry practice, and is considered suitable for the purposes of the study. Limitations to this endorsement that were discussed in this and our previous review letter apply.

Yours Faithfully
BMT WBM

Richard Sharpe
Senior Flood Engineer

Ben Caddis RPEQ (9234)
Supervising Engineer

Appendix J: Technical Memorandum for Adopted Methodology – Extreme Events Modelling

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Dedicated to a better Brisbane

MEMORANDUM

Brisbane City Council

To:	**Natural Environment Water and Sustainability Branch (NEWS)**	Date:	**15/03/2013**
Attn:	**Suba Subasing Gamachchige -** Project Owner, NEWS		
CC:	**Ellen Davidge -** Principal Engineering Officer, NEWS **Evan Caswell** - Principal Engineer, Flood Management		
From:	**Allan Herring -** Design Manager, Flood Management **Hanieh Zolfaghari –** Engineer, Flood Management		
Re:	**Technical Memorandum for Adopted Methodology - Extreme Events Modelling**		

Planning & Design Branch
Flood Management

Green Square South Tower
505 St Pauls Tce
Fortitude Valley Qld 4006
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Brisbane Qld 4001

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1.0 Introduction

The Flood Management team, within the Planning and Design Branch of the City Projects Office, has been asked to provide a technical memorandum for the adopted methodology for the extreme events hydrologic modelling which has been undertaken with the intention to update Council's creek flood studies.

2.0 Background

The additional scenarios to be modelled as part of the flood studies include the 200, 500 and 2000 year average recurrence interval (ARI) events and the Probable Maximum Precipitation (PMP) event. This memorandum documents the methodology adopted as well as the limitations of the methodology.

3.0 Methodology

Events Up to 100 year ARI

The events up to the 100 year ARI are developed using the AR&R temporal pattern which involves running multiple model runs to simulate the various standard storm durations.

200 and 500 year ARI Events

For the 200 and 500 Year ARI events, the CRC-Forge rainfall data were derived and used for each catchment. The CRC-Forge method adopts the AR&R temporal pattern to simulate rainfall within the catchment, and also requires multiple model runs to simulate the various standard storm durations.

The durations modelled were 30min. 1hr, 3 hrs and 6 hrs.

A 9hr rainfall depth was interpolated for Kedron Brook and Bulimba Creek.

2000 year ARI Event

To analyse the 2000 Year ARI flood event, the CRC-Forge rainfall depths were adopted. However, to simplify the analysis over a large number of similarly sized catchments, (based on the average size of catchments in the Brisbane area) the adopted rainfall data was extracted for a catchment size of 60 km^2 located at the north-west part of Brisbane. Note that rainfall depth varies by less than 10% across the entire area.

To avoid running multiple storm patterns for different storm durations, a super-storm approach was adopted. This is a common practice adopted overseas for broad scale planning scenario flood mapping with the temporal pattern built up to reflect the extreme rainfall depths published by the BoM. The rationale for adopting this approach is that world-wide research shows that as storm rainfall depths increase for short duration storms, the rainfall intensity becomes more uniform. For this reason, the multi peaked temporal patterns for the 100 year from AR&R were not considered suitable for the analysis of the more extreme events.

For this analysis, a 6 hour super storm was developed in 30 min blocks to represent a number of shorter extreme events. Shorter durations than 30 minutes were not considered. The pattern developed is representative of the 30, 60, 90, 120, and 180 minute storm burst. The total rainfall depth and duration of the storm was set equal to 6 hours for all catchments except Kedron Brook and Bulimba Creek.

For these two catchments only, a nine hour pattern was developed and applied, with the central part of the storm replicating the six hour pattern. This was considered necessary to ensure that all catchment routing was complete by the end of the model run.

Reference: *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM), BoM, June 2003.*

PMP

For the PMP scenario, the rainfall depth was derived from the 6 hour temporal pattern using the Generalised Short Duration Method (GSDM). For the tropical and subtropical coastal areas it is recommended that this method is to be used to estimate the PMP over areas up to 520km^2 and for durations up to 6 hours.

For the purpose of PMP estimation for the creeks and to be consistent across the Brisbane area, an average catchment size of 60 km^2 and moisture adjustment factor of 0.85 were adopted. This method is adopted for most of the creeks within the Brisbane area; however, exception is made to Oxley Creek due to the longer response time of the catchment. The adopted PMP temporal Pattern is shown in ***Appendix A***.

Other Durations and ARI's

No methodology or guidance is provided by the BoM or by AR&R for the estimation of PMP rainfall depths for durations longer than 6 hours or ARI's between 2000 years and PMP. One common method used by practitioners makes use of Log-Log interpolation. The challenge with this methodology is to provide an ARI for the PMP event and then to interpolate between the 2000 year ARI rainfall depths and the PMP rainfall depths. The method is approximate only but is considered reasonable considering the paucity of observed extreme rainfall observations in Australia and overseas. It is generally accepted that the probability of the PMP is in the order of 1 in 10^6 to 1 in 10^7.

All rainfall depths derived by the methods described were rounded to the nearest 10mm and they are shown in ***Appendix B***.

3.1 Verification

The storm pattern derived using methodology mentioned above was compared against 2 extreme storm events, which were the Carrara event and the Maroochydore event. The Maroochydore was in the order of 2000 year ARI and the Carrara event between 500 and 2000 year ARI respectively.

The comparison shows a good correlation and certified the adopted methodology.

3.2 Limitations

The assumptions and limitations of the adopted methodology to model extreme events include:

- The GSDM method is only valid for catchments with areas up to 520km^2; however, the majority of the catchments in Brisbane are smaller than 100 km^2 in size, with an average size of 60 km^2.
- Derived rainfall depths vary by less than 10% within the different catchments in the Brisbane area; however, the adoption of an average catchment size of 60km^2 is considered a reasonable approach considering the significant amount of rainfall during an extreme event.
- The adopted PMP pattern is well suited for catchments with a response time of half an hour up to 6 hours. This is the response time for the majority of the creeks in Brisbane with the exception of Oxley Creek.

For a better understanding of the limitations of this method, *The Estimation of Probable Maximum Precipitation in Australia: GSDM, June 2003* paper is attached to this memorandum (***Appendix C***).

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Appendix A

Adopted Temporal Pattern

Duration (%)	0	3	6	8	11	14	17	19	22	25
Rainfall (%)	0	1	2	4	5	6	7	9	11	12
Duration (%)	28	31	33	36	39	42	44	47	50	53
Rainfall (%)	14	17	19	22	26	29	34	39	48	57
Duration (%)	56	58	61	64	67	69	72	75	78	81
Rainfall (%)	66	71	74	78	81	83	86	88	89	91
Duration (%)	83	86	89	92	94	97	100			
Rainfall (%)	93	94	95	96	98	99	100			

Appendix B

200 and 500 Year ARI Event Rainfall Depth (mm)

Creek Name	Storm Events									
	200 Year ARI					500 Year ARI				
	30 min	1 Hour	3 Hour	6 Hour	9 Hour	30 min	1 Hour	3 Hour	6 Hour	9 Hour
Bulimba Creek	80	110	160	200	252	90	120	180	230	294
Kedron Creek	90	120	170	220	271	100	140	200	250	315
Lota Creek	80	110	160	210		90	130	190	240	
Norman Creek	80	120	170	210		100	130	190	240	
Breakfast Creek	90	130	180	230		100	150	210	260	
Perrin Creek	80	110	170	210		100	130	200	250	
Pine River Creek	90	120	180	220		100	140	200	260	
Albany Creek	90	130	180	230		110	150	210	270	
Cabbage Tree Creek	90	120	180	220		100	140	210	260	
Nundah Creek	90	120	180	220		100	140	200	260	

2000 Year ARI, PMP, Carrara and Maroochydore Events Rainfall Depth (mm)

Event	Storm Duration									
	0.5 hour	1 hour	1.5 hour	2 hour	2.5 hour	3 hour	4 hour	4.5 hour	5 hour	6 hour
2000 year ARI	120	170	190	220	240	260	290	300	310	340
PMP	230	340	440	510	570	620	700	730	770	820
Carrara	80	150	190	230	260	280	340	360	380	440
Maroochydore	60	120	160	200	220	260	310	330	350	350

Appendix C

The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method

HYDROMETEOROLOGICAL ADVISORY SERVICE
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JUNE 2003

The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method

DISCLAIMER

The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method (GSDM) offers guidance to those engaged in estimating the probable maximum precipitation for durations up to three or six hours in Australia. Despite careful preparation, it may contain typographical or other errors that affect use of the procedures and/or the numerical values obtained. Readers are encouraged to report suspected errors to the Hydrology Unit of the Bureau of Meteorology. Once confirmed, errors will be noted and, where circumstances allow, corrected. The Bureau will maintain a list of GSDM errata/corrigenda accessible via the World Wide Web. The location of the list will be advised through the Hydrometeorological Advisory Service section of the Bureau's web site: http://www.bom.gov.au/hydro/has. The Bureau of Meteorology does not give any commitment to communicate errors, whether suspected or confirmed. Nor is liability accepted from losses arising from use of the GSDM, its procedures, howsoever caused. The Bureau of Meteorology has not approved any instruction that use of the GSDM procedures be made mandatory for particular applications.

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1. INTRODUCTION

Probable Maximum Precipitation (PMP) is defined by the World Meteorological Organization (1986) as '*the greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year*'.

Hydrologists use a PMP magnitude, together with its spatial and temporal distributions, for the catchment of a dam to calculate the probable maximum flood (PMF). The PMF is one of a range of conceptual flood events used in the design of hydrological structures. In the main, it is used to design a spillway that will minimise the risk of overtopping of the dam. Overtopping of a dam structure can result in damage to the dam wall or abutments through breaching. The risk of loss of life, cost of rebuilding the dam, cost of the additional flood damage downstream and cost to the community due to the loss of a water supply can thus be minimised.

The purpose of this publication is to provide a method that can be used to make consistent and timely estimates of probable maximum precipitation for catchment areas up to 1000 km^2. Estimates are limited to a duration of six hours along the tropical and subtropical coastal areas and three hours in inland and southern Australia. The method allows for two classes of terrain and takes into account the local moisture availability and the mean elevation of the catchment.

The low density of the raingauge networks, particularly the pluviograph network, has resulted in few severe short-duration rainstorms having been recorded or documented in Australia. This is particularly the case in the sparsely populated part of the continent away from the coastal fringe and is a severe limitation on the estimation of short duration probable maximum precipitation in Australia. For this reason, United States data and Australian data have been used in the development of the Generalised Short Duration Method for use in Australia. Areal rainfall data are provided for some major Australian rainstorms in Appendix 3 to support the PMP magnitudes derived.

Design temporal and spatial distributions of PMP based on average storm characteristics are also given. These facilitate the distribution of the PMP depth when used in hydrological models.

This document replaces 'Bulletin 53: The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method' (Bureau of Meteorology, December 1994), and should be used instead. It was considered that a new version was required as, since 1994, a revised method of spatial distribution has been introduced and the moisture factors updated.

2. HISTORY OF THE DEVELOPMENT OF PMP METHODOLOGY IN AUSTRALIA

The early methods used to estimate extreme floods, other than reliance on local knowledge, were statistical. Frequency analysis has been used in most parts of Europe where it is relatively effective due to the homogeneity of the storm population, the long length of records and the availability of historical flood marks. The original spillway designs of some Australian dams, such as the Warragamba Dam, were based on this method. In the tropics and subtropics (e.g. Australia), the lack of homogeneity in the storm population and relatively short length of records cause significant deficiencies in the severe storm rainfall sample available for frequency analysis. This led to the need to develop deterministic methods, which used the sample outliers to estimate the rainfall from the optimum storm mechanism and a maximisation factor to adjust the storm rainfall to that possible with the potential extreme moisture inflow.

The deterministic methods of estimating PMP have developed from '*in situ* maximisation' through 'storm transposition' to the current 'generalised' methods.

2.1 *In Situ* Storm Maximisation Method

Early estimates of PMP in Australia (1950s to 1970s) were based on *in situ* maximisation. Only storms that had occurred over the catchment were considered for maximisation. The rainfall depths from storms covering a range of durations were maximised for moisture and the maximum depth at a specified duration was taken as the PMP for that duration. The maximisation procedure consisted of the adjustment of the rainfall depth measured in a storm by the ratio of the highest observed atmospheric moisture content in the area of the catchment to that observed in the storm. In some cases, the rainfall was also maximised for potential wind speed and direction accompanying the rainfall, but in general there was insufficient information available to make this practical. Wind speed and direction are now considered to be part of the overall storm mechanism. Recorded temporal and spatial distributions of the individual storms were used as design patterns.

The occurrence or lack of occurrence of an outlier in the storm sample, within the length of rainfall records available for different catchments, led to inconsistencies between PMP estimates for catchments in the same general area.

2.2 Storm Transposition Method

During the late 1960s and early 1970s storm transposition was gradually introduced. This procedure increased the size of the sample of significant storms that could be maximised for a catchment. The larger sample improved the consistency of PMP estimates within regions of similar topography, and generally led to higher PMP estimates than those produced using *in situ* maximisation.

The method was limited to the transposition of storms that had occurred near the catchment in regions with similar topographic features to those of the catchment. No guidance was available on how to adjust storm depths for the response of rainfall to differing topography. Consequently, storms that occurred near the subject catchment could not be transposed if they had occurred over a region with different topography. In addition, the individual storm spatial patterns of the transposed storms reflected the topography of the storm area and were not always appropriate for use in the target catchment. The choice of storms for transposition introduced a significant level of subjectivity to the methodology.

A storm transposition method is used for catchments in southwestern Tasmania, as described in 'Development of the Method of Storm Transposition and Maximisation for the West Coast of Tasmania - HRS 7' (Xuereb et al., 2001); the extreme lack of data making it impractical to develop a generalised method for this region.

2.3 Generalised Methods

Generalised methods of estimating PMP have gradually been developed for various parts of Australia and were introduced from the mid-1970s onward. This follows the trend in the United States where they were gradually introduced from the early 1960s. Generalised methods differ from the *in situ* and transposition methods in that they use all available data over a large region and include adjustments for moisture availability and differing topographic effects on rainfall depth. These storm data are enveloped by smoothing over a range of areas and durations. Generalised methods also provide design spatial and temporal patterns of PMP for the catchment. These methods require a considerable investment of time to develop, but when completed, estimates for individual catchments can be made more easily and objectively.

The United States generalised methods for areas with minimal topographic enhancement were developed first as an extension of the limited transposition methods. This type of method was suitable for most of the United States east of the Rocky Mountains (United States National Weather Service, 1978). Variations on the basic method were then gradually developed for areas with significant topographic enhancement of the rainfall. The method of dealing with topographic effects varies considerably, reflecting the specific problems posed by the prevailing meteorological regime and the availability of meteorological information (World Meteorological Organization, 1986; United States Weather Bureau, 1961, 1965, 1969; United States National Weather Service 1977, 1984, 1988; Wang, 1986).

The use of generalised methods has tended to increase the PMP estimates for a given catchment, compared with those obtained using the '*in situ* maximisation' and 'storm transposition' methods due to the increased chance of the larger sample containing an outlier. This is discussed with respect to the Warragamba Dam Catchment in Pearce (1993). Generalised method estimates have a lower notional Annual Exceedance Probability (AEP). They also have the advantage of providing regionally consistent estimates, although the notional AEP may vary slowly across a large zone or differ between zones. In assessment of both comparative risk and cost-benefit analyses between dams within a region, generalised methods set a more uniform standard than *in situ* or limited transposition methods (where topographic effects made transposition subjective).

The generalised methods currently available in Australia are:

i) The Generalised Short Duration Method (GSDM) described in chapters 3 and 4.

(ii) The Generalised Southeast Australia Method (GSAM), which was finalised in 1992. This method is for use in catchments in southeast Australia and is described by Kennedy et al. (1988), Pearce and Kennedy (1993, 1994) and Minty et al. (1996). Figure 1 shows the two zones for application of the GSAM: inland and coastal. The maximum duration covered by this method ranges from 3 to 5 days

(iii) The revised version of the Generalised Tropical Storm Method (GTSMR), which was finalised in 2003. This method is applicable to those parts of Australia affected by tropical storms and divides the region into 3 parts: the coastal application zone (CAZ), the inland application zone (IAZ) and the southwest Western Australia application zone (SWAZ). Figure 1 shows these zones. The maximum duration covered by this method is 5 days in the coastal zone in summer and 4 days for all other zones and seasons. The method is described in Walland et al. (2003).

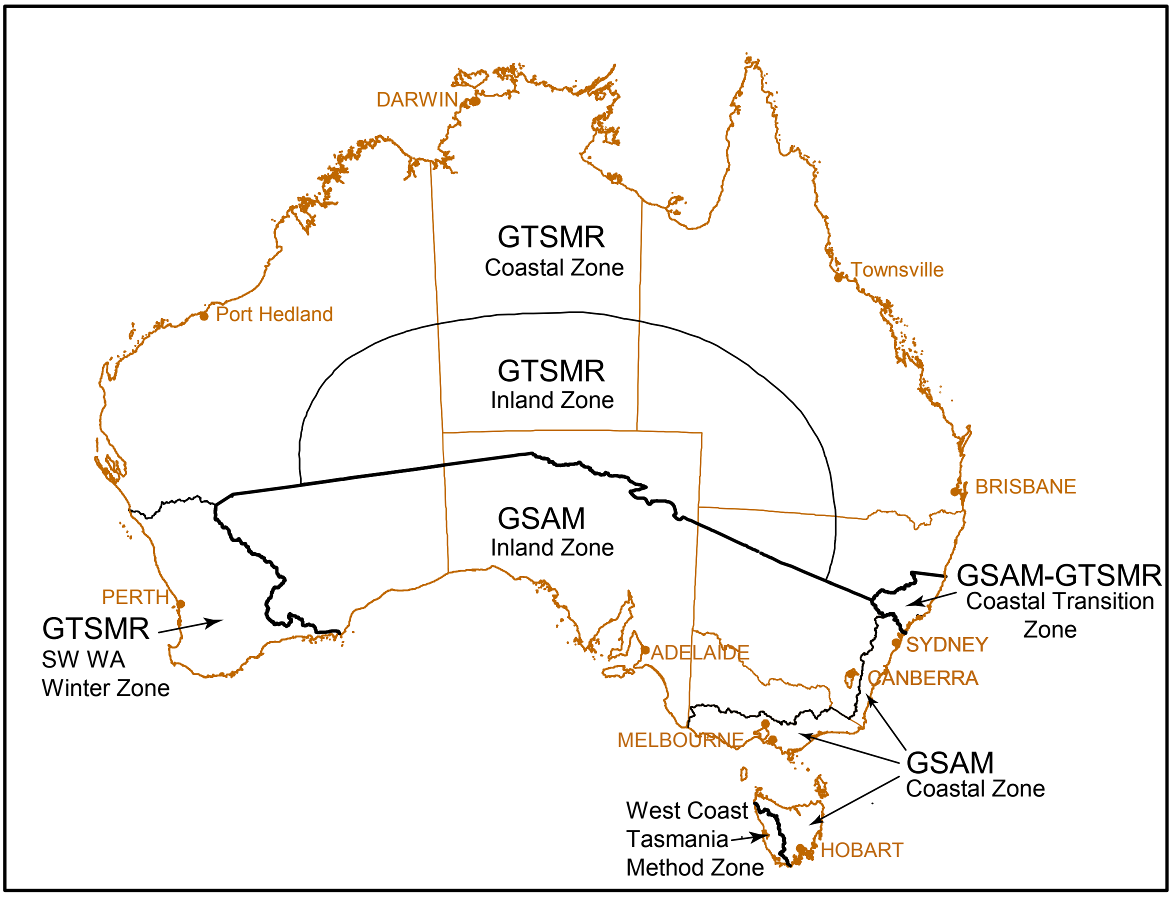

Figure 1: Generalised Tropical Storm Method and Generalised Southeast Australia Method Zones

2.4 Limitations and Restrictions on Generalised PMP Estimation Methods used in Australia

The accuracy and reliability of an estimate depends on the amount and quality of the data available for use in the estimating procedure and the maintenance of a balance in the degree of maximisation used in order to obtain realistic estimates. The transposition method was limited to the use of storms that occurred near the catchment in areas with similar topographic features. The generalised methods use a deterministic approach to adjust for topographic and moisture effects and thus increase the usable transposition area. However, even with these adjustments there are meteorological limitations on the transposability of some types of storms. The selection of meteorologically compatible zones in generalised PMP methodology requires that an equivalent optimum storm mechanism could occur anywhere in the transposition area; the frequency of occurrence is not important. The GTSMR, for example, is only applicable to those parts of Australia affected by tropical storms. The frequency of occurrence of the storm mechanisms varies considerably across the zones, but this does not necessarily affect the magnitude of the estimated PMP.

The restrictions on the GSAM and GTSMR PMP estimation methods for short durations are due to the limitations on availability and quality of short duration storm data. The development of these methods relied significantly on daily data in order to make the most effective use of record length and network density for the storm search procedures. These methods therefore need to be used in conjunction with the GSDM where appropriate (i.e. over small catchments where the critical duration is between that covered by the GSDM and the GSAM or GTSMR).

All three of the generalised methods are based on single storm events only, including single storms with multiple peaked temporal distributions. This means that the methods have an upper limit to the effective duration for which they can be applied to the catchment. The joint probability of a design sequence of two or more extreme rainfall events would be much lower than the probability of the generalised PMP event by itself.

None of the methods incorporates long-term climate change, other than climatic variability implicitly contained within the available years of records. However, climatic trends progress slowly so their influence on PMP is small compared to other uncertainties in estimating extreme values. This is consistent with the current practice described in World Meteorological Organization (1986).

3. BACKGROUND TO PMP ESTIMATION FOR SHORT DURATIONS

Methods for estimating PMP for small areas and short durations have been used by the Bureau of Meteorology since 1960. The first depth-duration-area (DDA) values used in Australia were those published by the United States Weather Bureau in 1945 (United States Weather Bureau, 1945).

The original method was known as the 'Thunderstorm Model' method because extreme rainfall totals for short durations and small areas are most likely to be produced by large, efficient convective cells. These cells may be either isolated thunderstorms or form part of a mesoscale or synoptic scale storm system. Later, the method became known as the 'method of adjusted United States data' (Kennedy, 1982). PMP estimation for short durations and small areas in Australia was based on the maximisation of United States thunderstorm depth-duration-area (DDA) data because of an inadequate supply of Australian short duration rainfall data. The Australian network of daily rainfall gauges has a far greater density and more effective years of record than the pluviograph network.

Initially it was recommended that the method be used to estimate PMP over areas up to 200 mi^2 (520 km^2) and for durations up to 6 hours for catchments in the tropical and subtropical coastal strips of the continent. The method was later extended to cover inland and southern Australia where the limit to the duration was 3 hours. The maximum area for application was also increased to 1000 km^2 for all areas.

In 1978 the DDA curves used by the Bureau of Meteorology were updated using information given in later hydrometeorological reports (United States Weather Bureau, 1960, 1969; United States National Weather Service, 1977, 1978) and by Wiesner (1970). At this time, terrain classifications of 'rough' and 'smooth' were introduced, with separate sets of DDA curves being provided for each category.

In 1984 a phenomenal storm occurred near Dapto in New South Wales (Shepherd and Colquhoun, 1985). For some areas and durations, the maximised rainfall from this storm exceeded the adjusted United States values. Areal rainfall depths recorded in this storm were added to the United States data when the method was published in 1985 as 'Bulletin 51: The Estimation of Probable Maximum Precipitation in Australia for Short Durations and Small Areas' (Bureau of Meteorology, 1985).

With the publication of *Bulletin 51,* the six-hour zone was broadened, especially in northern Australia, and an intermediate zone was introduced between the three and six hour zones. Subsequently, the definitions of 'rough' and 'smooth' terrain were altered, as described in 'Australian Rainfall and Runoff' (The Institution of Engineers, Australia, 1987). This and other adjustments were included in the next edition, published as *Bulletin 53* in 1994. Since then, the method has been referred to as the 'Generalised Short Duration Method' (GSDM), in line with the terms used to describe other generalised methods.

The GSDM is suitable for application to small catchments such as those of tailings dams and small reservoirs anywhere in Australia. Chapter 4 explains the GSDM procedure in detail and a worked example is found in Appendix 2. Additionally areal rainfall depths recorded in a number of severe Australian storms are given in Appendix 3.

4. GSDM PROCEDURE

This section describes in detail the steps to be followed in determining GSDM PMP estimates for a catchment. A sample calculation sheet to use with this procedure is given in Appendix 1 and an example covering all the steps is provided in Appendix 2.

4.1 Selection of Duration Limits

The first step is to establish the maximum duration for which the method is applicable to the catchment. Figure 2 shows the areas of Australia subject to the duration limits of three and six hours. There is also an intermediate zone where the maximum duration can be determined by using linear interpolation, setting the boundary values to three and six hours.

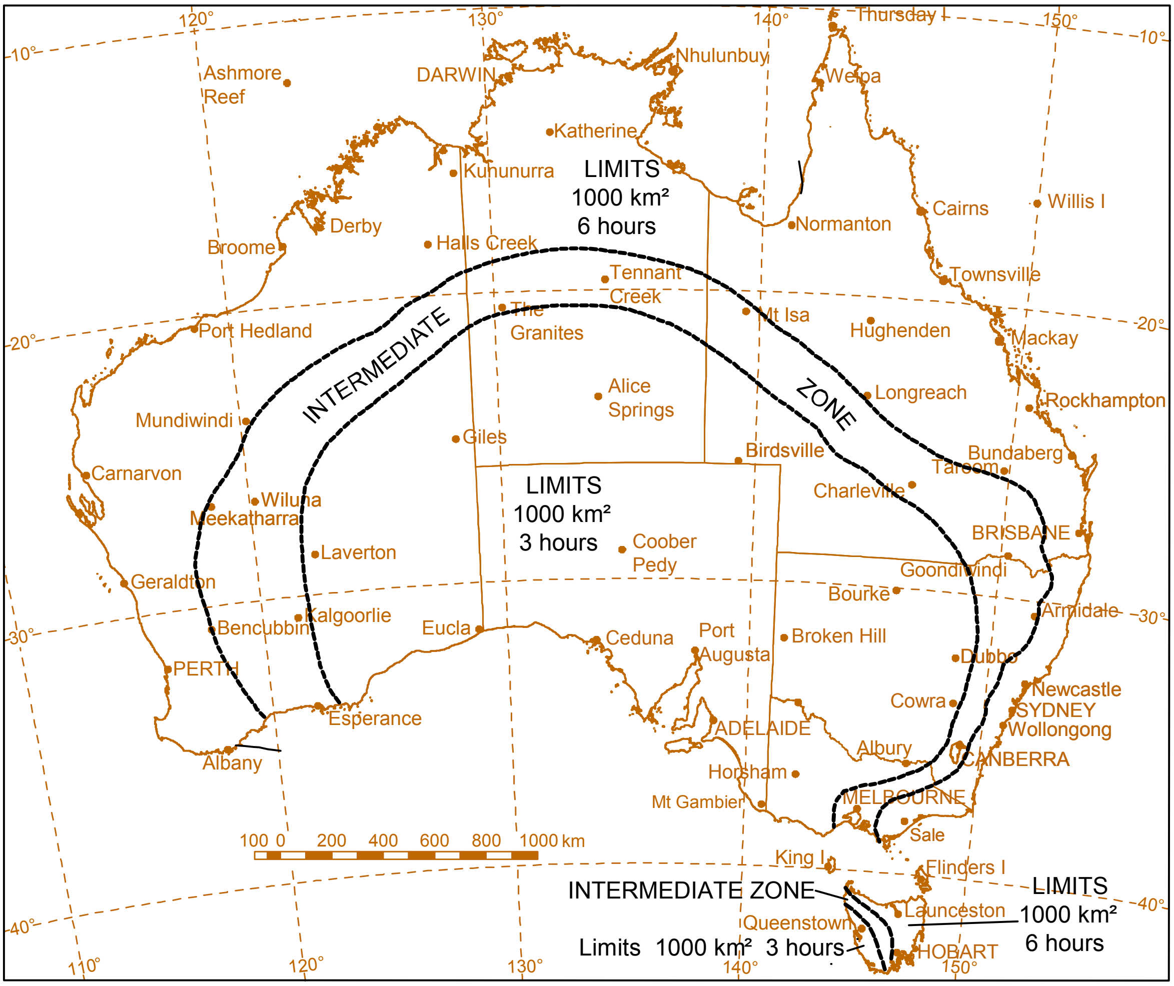

Figure 2: Generalised Short-Duration Method zones.

4.2 Selection of Terrain Category

Rainfall from single, short duration thunderstorm events is not significantly affected by the terrain. Therefore, it is not necessary to classify the terrain of the catchment for durations of an hour or less.

If durations longer than one hour are required, the next step is to establish the terrain category of the catchment and to calculate the percentages of the catchment that are 'rough' and 'smooth'. 'Rough' terrain is classified as that in which elevation changes of 50 m or more within horizontal distances of 400 m are common. 'Rough' terrain induces areas of low level convergence which can contribute to the development and redevelopment of storms, thereby increasing rainfall in the area over longer durations.

Terrain that is within 20 km of generally 'rough' terrain should also be classified as 'rough'. If there is 'smooth' terrain within the catchment that is further than 20 km from generally 'rough' terrain, an areally weighted factor of 'rough' (**R**) and 'smooth' (**S**) terrain should be calculated such that **R** plus **S** equals one. If a catchment proves difficult to classify under these guidelines then the whole catchment should be classified as 'rough'.

4.3 Adjustment for Catchment Elevation

The next step is calculation of the Elevation Adjustment Factor (**EAF**). The mean elevation of the catchment should be estimated from a topographic map. If this value is less than or equal to 1500 m the EAF is equal to one. For elevations exceeding 1500 m the EAF should be reduced by 0.05 for every 300 m by which the mean catchment elevation exceeds 1500 m. For most catchments in Australia the EAF will be equal to one.

4.4 Adjustment for Moisture

The moisture index used in PMP work is the precipitable water value corresponding to the 24-hour persisting dewpoint. By assuming a saturated atmosphere with a pseudo-adiabatic lapse rate during storm conditions, the precipitable water value can be estimated from the surface dew point temperature, a commonly measured quantity. The ratio of the extreme moisture index for a storm location to the moisture index at the time of the storm was used in the maximisation process.

The rainfall Depth-Duration-Area (DDA) curves in Figure 4 have been standardised to a moisture index equivalent to a surface dew point temperature of 28EC. An adjustment is required to allow for the potential moisture availability at the catchment. A map has been constructed based on the percentage adjustment for any locality and is given in Figure 3. The Moisture Adjustment Factor (**MAF**) for a catchment can be read from this map.

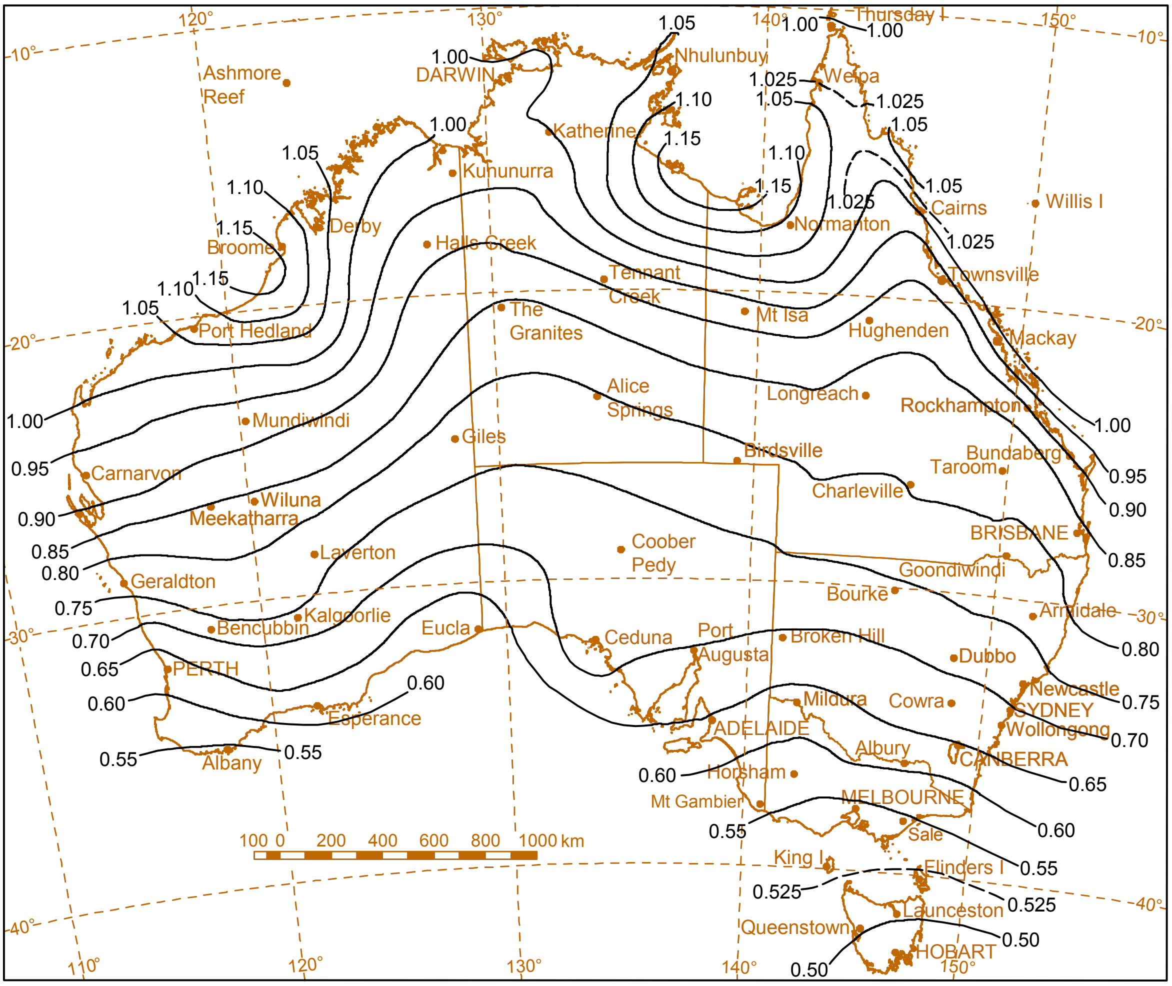

Figure 3: Moisture Adjustment Factor

4.5 Calculation of PMP Estimates

The DDA curves, given in Figure 4, were produced by drawing enveloping curves to the highest recorded United States and Australian rainfall depths, which had been adjusted to correspond to a common moisture index.

Also given in Figure 4 are PMP values applicable to a point, based on those given by Wiesner (1970). If a PMP value is required for an area smaller than 1 km^2 the value can be estimated by using linear interpolation between the 1 km^2 and the point values.

The initial rainfall depth for the 'smooth' ($\mathbf{D_S}$) and/or 'rough' ($\mathbf{D_R}$) terrain categories are read from the DDA curves for the required catchment area and storm duration. To obtain rainfall values for intermediate durations a plot of rainfall (log) versus duration (linear) can be used. The value for the specified duration can then be interpolated.

The PMP estimates for the catchment are calculated from:

PMP Value = (S H D_S + R H D_R) H MAF H EAF

This value should then be rounded to the nearest 10 mm.

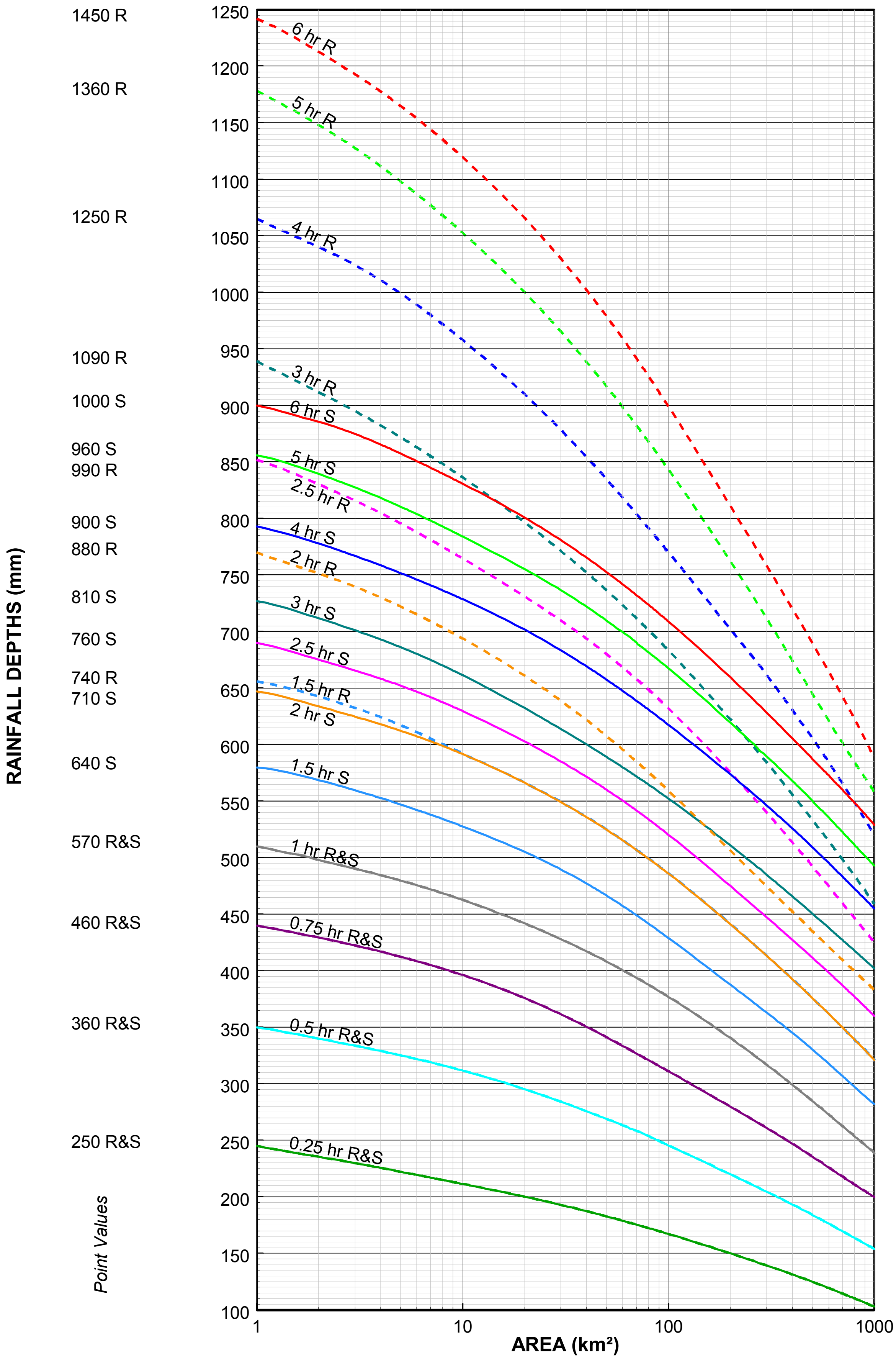

Figure 4: Depth-Duration-Area Curves of Short Duration Rainfall

5. DESIGN TEMPORAL DISTRIBUTION OF PMP

A design temporal distribution was derived using pluviograph traces recorded in major Australian storms. This pattern is shown in Table 1 with figures rounded to 1% and presented as a mass curve in Figure 9.

Table 1: Design Temporal Distribution of Short Duration PMP

% of time	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
% of PMP	0	4	10	18	25	32	39	46	52	59	64	70	75	80	85	89	92	95	97	99	100

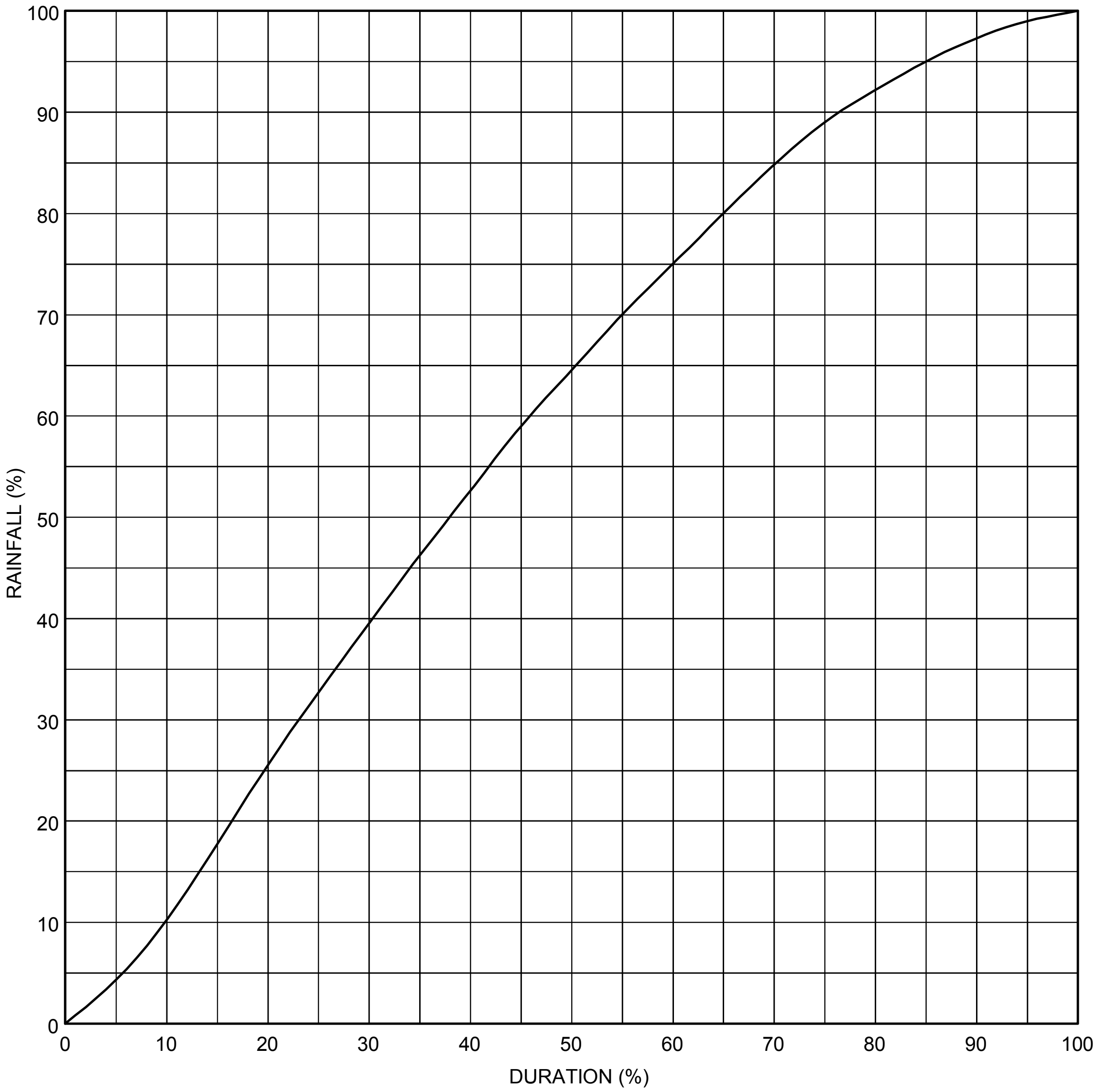

Figure 5: Generalised Short Duration Method Temporal Distribution

6. DESIGN SPATIAL DISTRIBUTION OF PMP

The design spatial distribution for convective storm PMP is given in Figure 6. It is based on the distribution provided by the United States Weather Bureau (1966) and the World Meteorological Organization (1986) but has been modified in light of Australian experience. It assumes a virtually stationary storm and can be oriented in any direction with respect to the catchment. Instructions for the application of the spatial distribution are given below and an example is given in Appendix 2.2.

For simplicity and consistency of application, it is recommended that PMP depth be distributed using a step-function approach. This means having a constant value at all points in the interval between consecutive ellipses (or within the central ellipse), and stepping to a new constant value at each new ellipse. This constant value between ellipses is the mean rainfall depth for that interval and is derived by the procedure described below. Further information on the rationale behind this method may be found in Taylor et al. (1998).

Instructions for the use of the spatial distribution diagram

Step 1 Positioning the spatial distribution diagram

Enlarge or reduce the size of the spatial distribution diagram (Figure 6) to match the scale of the catchment outline map. Overlay the spatial distribution diagram on the catchment outline and move it to obtain the best fit by the smallest possible ellipse. This ellipse is now the outermost ellipse of the distribution.

Step 2 Areas of catchment between successive ellipses

Determine the area of the catchment lying *between* successive ellipses ($CBtn_i$, where the i^{th} ellipse is one of the ellipses A to J).

Where the catchment completely fills both ellipses, this is just the difference between the areas enclosed by each ellipse as given in Table 2.3:

$$CBtn_i = Area_i - Area_{i-1}$$

Where the catchment only partially fills the interval between ellipses, use planimetering or a similar method to determine this area.

Step 3 Area of catchment enclosed by each ellipse

Determine the area of the catchment *enclosed by* each ellipse ($CEnc_i$):

$$CEnc_i = \sum_{k=A}^{i} CBtn_k$$

The area of the catchment enclosed by the outermost ellipse will be equal to the total area of the catchment.

Step 4 Initial mean rainfall depth enclosed by each ellipse

Obtain the x-hour initial mean rainfall depths ($IMRD_i$) for each of the areas enclosed by successive ellipses ($CEnc_i$) (Step 3).

Where the catchment completely fills an ellipse ($CEnc_i = Area_i$), determine the x-hour initial mean rainfall depth for this area from Table 2.3. Where the catchment only partially fills an ellipse ($CEnc_i < Area_i$), determine the x-hour initial mean rainfall depth for that area from the appropriate Depth-Duration-Area (DDA) curves (Figure 4).

Table 2: Initial Mean Rainfall Depths Enclosed by Ellipses A-H in Figure 6

Ellipse label	*Area Enclosed ((km²)*	*Area between (km²)*	*Initial Mean Rainfall Depth (mm)*										
			Duration (hours)										
			0.25	*0.5*	*0.75*	*1*	*1.5*	*2*	*2.5*	*3*	*4*	*5*	*6*
SMOOTH													
A	2.6	2.6	232	336	425	493	563	628	669	705	771	832	879
B	16	13.4	204	301	383	449	513	575	612	642	711	765	811
C	65	49	177	260	330	397	453	511	546	576	643	695	737
D	153	88	157	230	292	355	404	459	493	527	591	639	679
E	280	127	141	207	264	321	367	418	452	490	551	594	634
F	433	153	129	190	243	294	340	387	422	460	520	562	599
G	635	202	118	174	223	269	314	357	394	434	491	531	568
H	847	212	108	161	208	250	293	335	373	414	468	506	544
ROUGH													
A	2.6	2.6	232	336	425	493	636	744	821	901	1030	1135	1200
B	16	13.4	204	301	383	449	575	672	742	810	926	1018	1084
C	65	49	177	260	330	397	511	590	663	717	811	890	950
D	153	88	157	230	292	355	459	527	598	647	728	794	845
E	280	127	141	207	264	321	418	480	546	590	669	720	767
F	433	153	129	190	243	294	387	446	506	548	621	664	709
G	635	202	118	174	223	269	357	417	469	509	578	613	656
H	847	212	108	161	208	250	335	395	441	477	541	578	614

Note that no initial mean rainfall depths are required for ellipses I and J because the areas of these ellipses are greater than 1,000 km² which is the areal limit of the DDA curves.

Step 5 Adjusted mean rainfall depth enclosed by each ellipse

Adjust the initial mean rainfall depths for moisture and elevation using the adjustment factors and procedure described in Section 4:

$$AMRD_i = IMRD_i \times MAF \times EAF$$

The adjusted mean rainfall depth (AMRD) for the area enclosed by the outermost ellipse will be equal to the (unrounded) PMP for the whole catchment (Section 4.5).

Step 6 Volume of rain enclosed by each oval

Multiply the area of the catchment enclosed by each ellipse ($CEnc_i$) (Step 3) by the corresponding adjusted mean rainfall depth for that area ($AMRD_i$) (Step 5) to obtain the volume of rainfall over the catchment and within each ellipse ($VEnc_i$):

$$VEnc_i = AMRD_i \times CEnc_i$$

Step 7 Volume of rainfall between successive ellipses

Obtain the volume of rainfall over the catchment and between successive ellipses ($VBtn_i$) by subtracting the consecutive enclosed volumes ($VEnc_i$) (Step 6):

$$VBtn_i = VEnc_i - VEnc_{i-1}$$

The volume of rainfall within the central ellipse has already been obtained in Step 6.

Step 8 Mean rainfall depth between successive ellipses

Obtain the mean rainfall depth over the catchment and between successive ellipses (MRD_i) by dividing the volume of rainfall between the ellipses ($VBtn_i$) (Step 7) by the catchment area between them ($CBtn_i$) (Step 2):

$$MRD_i = \frac{VBtn_i(Step7)}{CBtn_i(Step2)}$$

Step 9 Other PMP Durations

Repeat steps 1 to 8 for other durations.

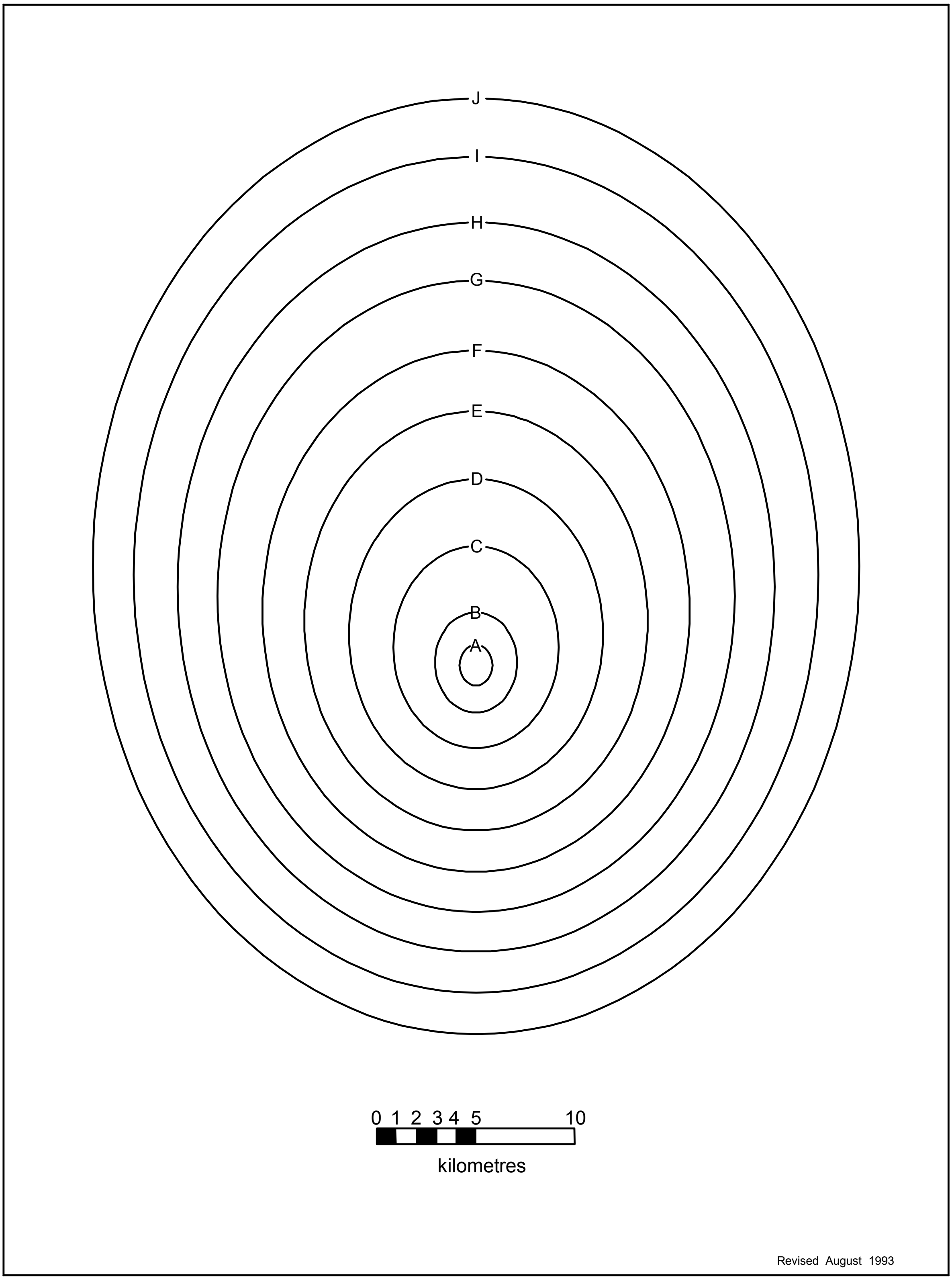

Figure 6: Generalised Short Duration Method Spatial Distribution

7. SEASONAL VARIATION OF PMP

The meteorological events associated with short duration, limited area PMP are most likely to be summer or early autumn convective storms. They may be isolated ‘supercells’, or they may consist of numerous convective cells embedded in a larger storm system. However, other seasonal factors, such as high antecedent rainfall, may cause greater floods to occur at other times of the year.

In some regions summers are mostly dry so very large catchment loss rates may be assumed in the calculation of the probable maximum summer flood. If the winters are wet, winter PMP values with low losses may produce a higher flood. This is sometimes the case in southwestern Australia.

The areal limit for short duration winter PMP estimates is taken as 500 km^2. It is reasonable to transpose smaller scale convective storms between seasons, as their basic structure is not considered to vary significantly with season. However, seasonal transposition of synoptic-scale storms to estimate PMP over large areas is not considered realistic.

For Australian catchments south of 30ES, Figure 7 can be used to convert the annual PMP to the PMP for a specific month. The monthly percentage moisture adjustment has been derived for a number of locations in southern Australia by calculating the extreme moisture index for each month as a percentage of the extreme annual moisture index. The highest monthly values are given in Figure 7. It is a straightforward procedure to calculate the annual PMP and convert it to a monthly PMP by multiplying by the appropriate percentage given in Figure 7.

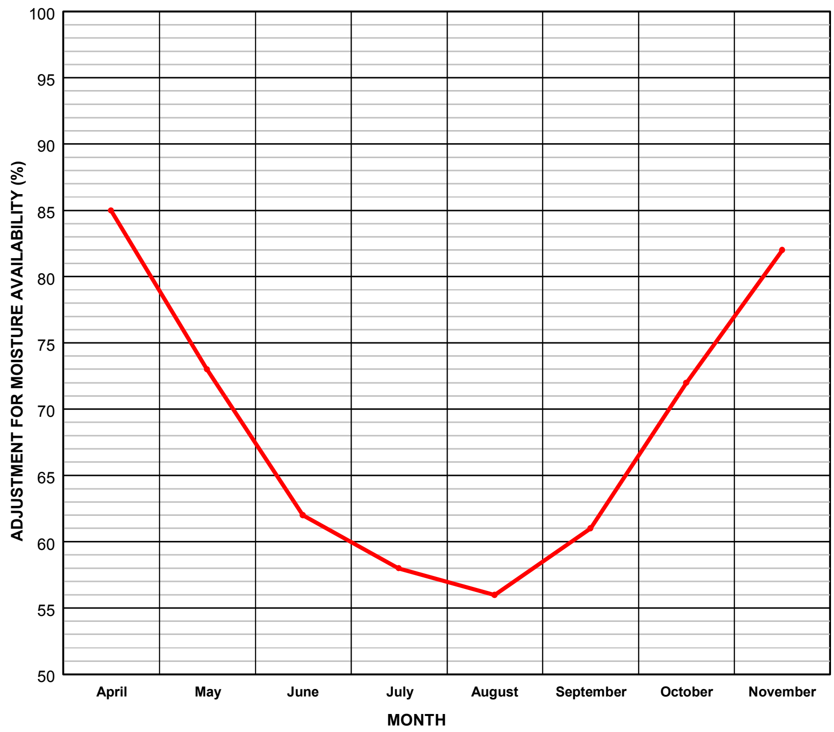

Figure 7: Monthly Percentage Moisture Adjustment for Southern Australia (south of 30ES) Note: The areal limit for winter is 500km^2

8. NOTIONAL AEP OF PMP DEPTHS DERIVED USING THE GSDM

In theory, the PMP concept, as defined in section 2, implies zero probability of exceedance. However, the estimates made by the various PMP methods have a non-zero probability of exceedance. For example, the '*in situ* maximisation' method PMP estimates for the Fortescue River catchment in Western Australia were exceeded by rainfall from Tropical Cyclone Joan in 1975 (Kennedy, 1982). The maximised storm depths from the Dapto 1984 storm (Shepherd and Colquhoun, 1985) near Wollongong in NSW exceeded the 'method of adjusted United States data' PMP estimates used at the time. Notional probabilities of exceedance can therefore be associated with the application of the method (i.e. the methodology plus the limitations of available data) used to estimate the PMP, but not with the concept of PMP itself.

Using deterministic methods of estimating PMP rather than statistical methods, means that the assignment of Annual Exceedance Probabilities (AEPs) to the PMP estimates is not straightforward. The uncertainties associated with any estimate of the exceedance probability of a PMP depth are very large. However, by using the same assumptions to estimate AEPs for each of the PMP methods, the results can provide useful guidance in a comparative sense (Pearce, 1994).

Estimates of PMP depth have been made using a variety of methods for some catchments (e.g. *in situ*, limited transposition, generalised), but the associated notional probabilities vary considerably. Generalised methods of PMP estimation, applicable to different meteorological regions, can also have different exceedance probabilities. Probabilities of variables such as temporal patterns, spatial patterns, antecedent rainfall, losses, reservoir levels, flood model assumptions etc. assumed in converting rainfall to floods will also affect the notional exceedance probability of the PMF with respect to that of the PMP estimates. However, as discussed above for the PMP, if similar assumptions and flood models are used in transforming the PMP to PMF, the resultant design flood can provide useful guidance in comparing safety between various dams.

Kennedy and Hart (1984) used notional AEPs for various PMP methods as a means of indicating the different security levels provided by the different methods. Laurenson and Kuczera (1999) issued interim estimates of the AEP which included a modification of Kennedy and Hart's (1984) figures. They recommended an AEP of 10^{-7} for areas of 100 km^2 and below, rising to 10^{-6} for an area of 1000 km^2. On the subject of confidence limits, they added:

- Recommended AEP values plus or minus two orders of magnitude of AEP be regarded as notional upper and lower limits for true AEPs;
- Recommended AEP values plus or minus one order of magnitude of AEP be regarded as confidence limits with about 75% subjective probability that the true AEP lies within the limits; and
- The recommended AEP values be regarded as the current best estimates of the AEPs.

9. CONCLUSION

The Generalised Short Duration Method of estimating Probable Maximum Precipitation described here enables design engineers to make estimates of PMP for small areas and short durations for any site in Australia. The method is based partly on United States data as only a few severe short duration rainstorms have been adequately documented in Australia. It should be noted, however, that the highest rainfall depths at some durations for the ‘rough’ terrain category were derived from depths recorded in a storm that occurred near Dapto, New South Wales in 1984.

This document included both the revised method of spatial distribution of GSDM depth estimates introduced in 1996 and the updated moisture data used by the Hydrometeorology Section of the Bureau of Meteorology since 2001. It supersedes ‘Bulletin 53: The Estimation of Probable Maximum Precipitation in Australia: Generalised Short Duration Method’ (Bureau of Meteorology, 1994), and should be used instead.

The notional AEP of the GSDM estimates is approximately 10^{-7} for an area of 100 km^2 rising to 10^{-6} for an area of 1000 km^2 for all durations covered by the method (Laurenson and Kuczera, 1999). The uncertainty attached to these estimates is discussed in Section 8.

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Appendix 1

GSDM CALCULATION SHEET

LOCATION INFORMATION

Catchment .... Area .... km²

State .... Duration Limit .... hrs

Latitude ....E..............' S Longitude.....................E...............' E

Portion of Area Considered:

Smooth , **S** = ... (0.0 - 1.0) Rough , **R** = ... (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)

Mean Elevation ....m

Adjustment for Elevation (-0.05 per 300m above 1500m) ....

EAF = ... (0.85 - 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)

MAF = ... (0.40 - 1.00)

PMP VALUES (mm)

Duration (hours)	**Initial Depth - Smooth (D_S)**	**Initial Depth - Rough (D_R)**	**PMP Estimate = (D_SHS + D_RHR) H MAF H EAF**	**Rounded PMP Estimate (nearest 10 mm)**
0.25				
0.50				
0.75				
1.0				
1.5				
2.0				
2.5				
3.0				
4.0				
5.0				
6.0				

Prepared by .... Date........../.........../..........

Checked by .... Date........../.........../..........

Appendix 2

EXAMPLE OF THE APPLICATION OF THE GSDM

A2.1 PMP Estimates for the Example Catchment

All calculations and relevant information are recorded on the GSDM Calculation Sheet, Table A2.1.

(i) Estimates of short duration PMP are required for a hypothetical catchment in New South Wales, centred around the coordinates 36E25' S 148E15' E. The catchment area is 110 km².

(ii) From Figure 2 it is determined that the catchment lies within the intermediate zone. Linear interpolation across the zone indicated a maximum duration of 5 hours.

(iii) From a suitably contoured map of the area, it was found that 10% of the catchment was considered 'smooth' and the remaining 90% 'rough'. 'Rough' terrain is that in which elevation changes of 50 m or more within horizontal distances of 400 m are common. Terrain that was within 20 km of 'rough' terrain was classified as 'rough'. 'Smooth' terrain within the catchment but further than 20 km from 'rough' terrain was classified as 'smooth'.

S = 0.1 and R = 0.9

(iv) From Figure 4, the initial depths for both the 'smooth', D_S, and 'rough', D_R, categories were read, for a catchment area of 110 km^2 for each duration up to 5 hours.

(v) The average elevation of the catchment was found to be 1750 m.

Adjustment for Elevation	=	- 0.05 per 300 m above 1500m
	=	- ((1750-1500)/300) H (0.05)
	=	- 0.04

EAF = 1.0 - 0.04 = 0.96

(vi) From Figure 3, the moisture adjustment factor was found to be 0.60.

MAF = 0.60

(vii) PMP depth = (S H D_S + R H D_R) H EAF H MAF
= (0.1 H D_S + 0.9 H D_R)H 0.96 H 0.60

The estimates were then rounded to the nearest 10 mm.

Table A2.1: Example GSDM Calculation Sheet

LOCATION INFORMATION	
Catchment ..... EXAMPLE	Area ..... 110 ..... km²
State ..... N.S.W.	Duration Limit ..... 5 ..... hrs
Latitude ..... 36..E ..... 25..' S	Longitude ..... 148..E..... 15..' E
Portion of Area Considered:	
Smooth , **S** = ... 0.1 ..... (0.0 - 1.0)	Rough , **R** = ... 0.9 ..... (0.0 - 1.0)

ELEVATION ADJUSTMENT FACTOR (EAF)
Mean Elevation ..... 1750 ..... m
Adjustment for Elevation (-0.05 per 300m above 1500m) ....-0.04 .....
EAF = ... 0.96 ..... (0.85 - 1.00)

MOISTURE ADJUSTMENT FACTOR (MAF)
MAF = ... 0.60 ..... (0.40 - 1.00)

PMP VALUES (mm)

Duration (hours)	Initial Depth - Smooth (D_S)	Initial Depth - Rough (D_R)	PMP Estimate = (D_SHS + D_RHR) H MAF H EAF	Rounded PMP Estimate (nearest 10 mm)
0.25	164	164	94	90
0.50	242	242	139	140
0.75	306	306	176	180
1.0	372	372	214	210
1.5	423	480	273	270
2.0	480	552	314	310
2.5	514	624	353	350
3.0	546	675	381	380
4.0	611	760	429	430
5.0	661	832	469	470
6.0	-	-	-	-

Prepared by ....N. Smith....................................... Date ..../1...../....06....../...03.......

Checked by ....P. Citizen..................................... Date ....3..../.....06....../.....03.......

A2.2 Spatial distribution over the example catchment

In this example, the distribution of only the three-hour PMP will be derived. Results are given in columns a-h of Table A2.2.

Step 1 Positioning the spatial distribution diagram

The scale of the spatial distribution diagram was altered to match that of the catchment outline map. The spatial distribution diagram was placed over the catchment outline to obtain the best fit by the smallest possible ellipse. Ellipse E encloses the catchment as shown in Figure A2.1.

Step 2 Areas of catchment between successive ellipses

The catchment areas *between* successive ellipses ($CBtn_i$) were determined. The results are listed in column b.

e.g. between ellipses A and B, $CBtn_B = 13.4\ km^2$ (from Table 2)
between ellipses B and C, $CBtn_C = 37.7\ km^2$ (by planimetering)

Step 3 Area of catchment enclosed by each ellipse

The catchment area *enclosed by* each ellipse ($CEnc_i$) (column c) was calculated by progressively accumulating the catchment areas between ellipses (column b).

e.g. for ellipse C, $CEnc_C = 2.6 + 13.4 + 37.7 = 53.7\ km^2$

As a check, the area enclosed by the outermost ellipse, ellipse E, which is 110 km^2, should equal the area of the catchment.

Step 4 Initial mean rainfall depth enclosed by each ellipse

Since the catchment completely fills ellipses A and B, the 3-hour initial mean rainfall depths ($IMRD_i$) at these areas may be determined from Table 2, weighting and summing the 'smooth' and 'rough' depths according to the proportions of 'smooth' and 'rough' terrain (Section A2.1).

i.e., 3 hr, ellipse A, 'smooth' = 705 mm
3 hr, ellipse A, 'rough' = 901 mm
$IMRD_A = (0.1 \times 705 + 0.9 \times 901) = 881$ mm

For ellipses C, D and E, the initial mean rainfall depths were determined from the 3-hour DDA curves in Figure 4.

e.g. for ellipse C, 3 hr, 53.7 km^2, 'smooth' = 585 mm
3 hr, 53.7 km^2, 'rough' = 731 mm
$IMRD_C = (0.1 \times 585 + 0.9 \times 731) = 716$ mm

The initial mean rainfall depths are listed in column d.

Step 5 Adjusted mean rainfall depth enclosed by each ellipse

The initial mean rainfall depths (column d) were adjusted for moisture and elevation (column e) by multiplying by the moisture and elevation adjustment factors (Section A2.1).

e.g. for ellipse C, $AMRD_C = 716 \times 0.60 \times 0.96 = 412$ mm

As a check, the adjusted mean rainfall depth for the area enclosed by the outermost ellipse, ellipse E, which is 382 mm, should approximately equal the 3-hour (unrounded) PMP for the catchment (Section A2.1).

Step 6 Volume of rainfall enclosed by each ellipse

The adjusted mean rainfall depths (column e) were multiplied by the areas of the catchment enclosed by each ellipse (column c) to give values for the volume of rainfall enclosed by each ellipse ($VEnc_i$) (column f).

e.g. for ellipse C, $VEnc_C = 412 \times 53.7 = 22{,}124$ mm.km^2

Step 7 Volume of rainfall between successive ellipses

Consecutive enclosed rainfall volumes (column f) were subtracted to obtain the rainfall volume between ellipses ($VBtn_i$) (column g).

e.g. between ellipses B and C, $VBtn_C = 22{,}124 - 7{,}312 = 14{,}812$ mm.km^2

Step 8 Mean rainfall depth between successive ellipses

The mean rainfall depths between successive ellipses (MRD_i) (column h) were obtained by dividing the rainfall volume between ellipses (column g) by the area between ellipses (column b).

e.g. between ellipses B and C, $MRD_C = 14{,}812 / 37.7 = 393$ mm

Step 9 Other PMP Durations

Repeat the above steps for other durations for which the spatial distribution of PMP is required.

Table A2.2: Calculation of the Spatial Distribution of 3-hour PMP over the Example Catchment

a Ellipse	b Step 2 Catchment area between ellipses (km^2)	c Step 3 Catchment area enclosed by ellipse (km^2)	d Step 4 Initial mean rainfall depth (mm)	e Step 5 Adjusted mean rainfall depth (mm)	f Step 6 Rainfall volume enclosed by ellipse (mm.km^2)	g Step 7 Rainfall volume between ellipses (mm.km^2)	h Step 8 Mean rainfall depth between ellipses (mm)
A	2.6	2.6	881	507	1,318	1,318	507
B	13.4	16	793	457	7,312	5,994	447
C	37.7	53.7	716	412	22,124	14,812	393
D	42.6	96.3	673	388	37,364	15,240	358
E	13.7	**110**	663	**382**	42,020	4,656	340

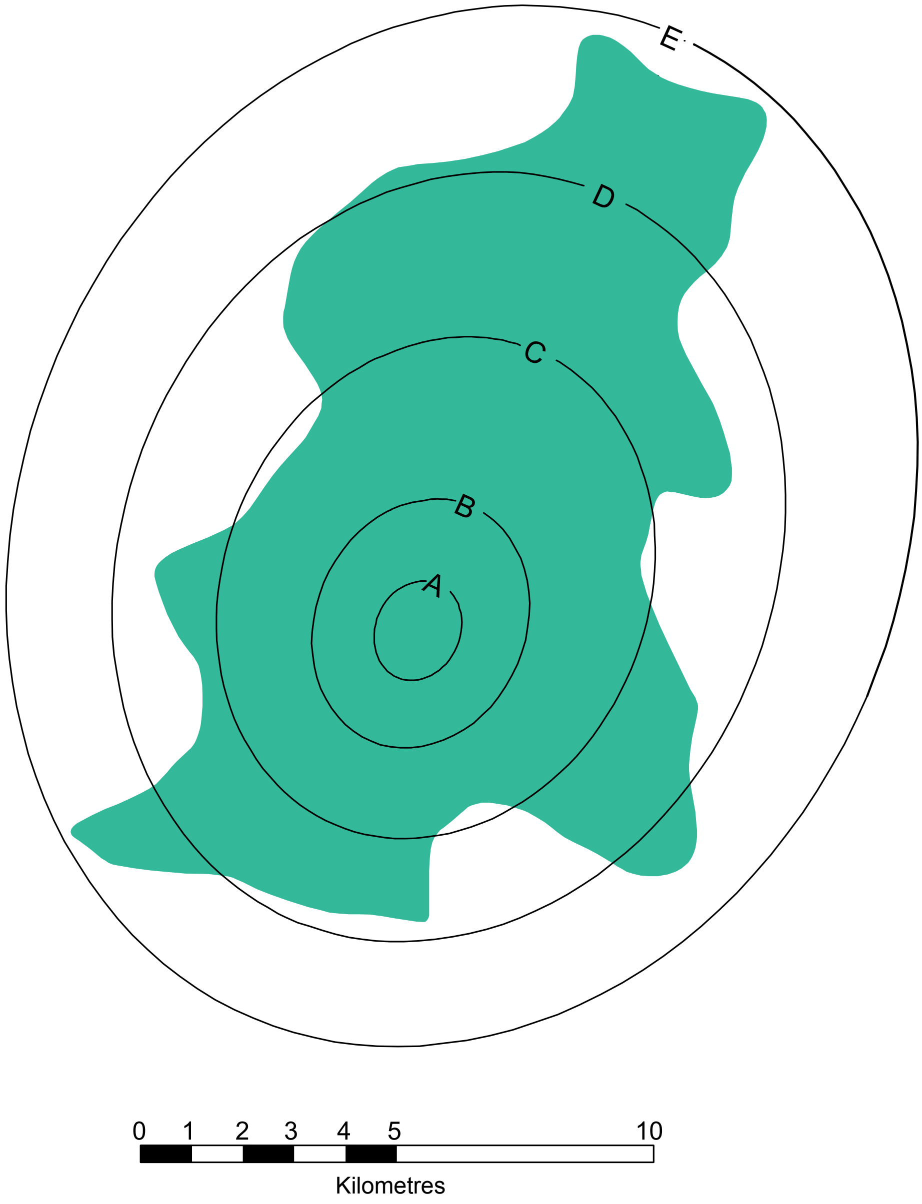

Figure A2.1: Spatial Distribution over Example Catchment

Appendix 3

NOTABLE SHORT DURATION AREAL RAINFALL EVENTS RECORDED IN INLAND AND SOUTHERN AUSTRALIA

A3.1 The Molong Storm of 20 March 1900

On 20 March 1900 a series of thunderstorms formed over a strip of country about 75 km wide extending from near Hungerford to the southeast near Moss Vale in New South Wales. The heaviest rainfall occurred in the Orange-Molong area. The information given by Russell (1901) indicates that the storm lasted for about three hours. The storm dew point temperature was estimated as 19EC. The recorded storm rainfall and the rainfall normalised for the moisture content corresponding to an extreme dew point temperature of 23.5EC are compared with the PMP estimates in Table A4.1.

Table A3.1: Depth-Area Data for the Molong Storm

Area (km²)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 23.5EC (mm)	3-hour PMP Estimate (mm)
10	205	300	450
50	195	290	400
100	190	280	380
500	180	260	310
1000	170	250	270

A3.2 The St Albans Storm of 8 January 1970

On 8 January 1970 between 1400 and 1730 EST an intense thunderstorm was located in the St Albans area about 15 km west-northwest of Melbourne. Near the centre of the storm rainfall totals exceeding 120 mm were recorded. The storm was studied by Finocchiaro (1970). Radar observations and information obtained from private raingauge readers indicate that about 90 per cent of the total rainfall fell within a period of 1.5 hours. The storm dew point was assessed to have been 13EC and the extreme dew point for the storm area for January is 20.4EC. The storm data are compared with the PMP estimates in Table A3.2.

Table A3.2: Depth-Area Data for the St Albans Storm

Area (km²)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 20.4EC (mm)	1.5-hour PMP Estimate (mm)
1	111	210	300
10	88	170	280
20	80	150	260
30	72	140	260
50	63	120	240

A3.3 The Woden Valley Storm of 26 January 1971

During the evening of 26 January 1971 extremely heavy rainfall associated with an almost stationary thunderstorm complex fell over the Canberra suburbs of Farrer and Torrens for about 90 minutes (Bureau of Meteorology, 1972). The resulting flood in the Woden Valley claimed several lives. The storm dew point temperature was assessed as 14EC and the extreme dew point is 22.8EC. The storm data are compared with the PMP estimates in Table A3.3.

Table A3.3: Depth-Area Data for the Woden Valley Storm

Area (km^2)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 22.8EC (mm)	1.5-hour PMP Estimate (mm)
1	102	220	370
10	99	210	340
50	87	190	300
100	78	170	270
250	62	130	240

A3.4 The Melbourne Storm of 17 February 1972

On the afternoon of 17 February 1972 an intense thunderstorm developed over the city of Melbourne and the suburbs immediately north of the city. The storm was observed by radar and three pluviograph traces were obtained from sites near the centre of the storm. This storm lasted for about 60 minutes and produced severe local flooding. Rainfall depths for this storm are given by Pierrehumbert and Kennedy (1982). The storm dew point was estimated as 12EC and the extreme dew point is 20.9EC. The storm depth-area values are compared with the PMP estimates in Table A3.4.

Table A3.4: Depth-Area Data for the Melbourne Storm

Area (km^2)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 20.9EC (mm)	1-hour PMP Estimate (mm)
2	83	180	270
20	73	160	240
50	68	150	220
100	60	130	200
250	49	110	180

A3.5 The Laverton Storm of 7 April 1977

A storm lasting for about 12 hours brought exceptionally heavy rain to areas to the west and north of Melbourne on 7 April 1977. The heaviest burst in the storm lasted for about 3 hours and affected areas from Laverton to Sunbury. The Melbourne and Metropolitan Board of Works (1979) gives details of the rainfall recorded over the entire storm area. The representative storm dew point temperature was 10EC and the extreme dew point is 20.1EC. The recorded and maximised storm depth-area data are compared with the PMP estimates in Table A3.5.

Table A3.5: Depth-Area Data for the Laverton Storm

Area (km^2)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 20.1EC (mm)	3-hour PMP Estimate (mm)
10	121	310	340
100	96	240	280
400	73	180	240
600	60	150	220
800	53	130	210
1000	51	130	200

A3.6 The Buckleboo Storm of 26 January 1981

On the afternoon of 26 January 1981 an intense and almost stationary thunderstorm produced some of the highest short-duration rainfalls ever recorded in South Australia. While the only quantitative data are daily totals, it is reliably reported that virtually all the rain fell in a period of about three hours. The representative storm dew point was estimated to have been 19EC. The recorded values were adjusted for a moisture content corresponding to a surface dew point temperature of 23.5EC for comparison with the PMP estimates in Table A3.6.

Table A3.6: Depth-Area Data for the Buckleboo Storm

Area (km^2)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 23.5EC (mm)	3-hour PMP Estimate (mm)
10	187	270	450
50	169	250	400
100	154	230	380
500	106	160	310
1000	77	110	270

A3.7 The Barossa Valley Storm of 2 March 1983

During the evening of 2 March 1983 numerous thunderstorm cells produced very heavy rainfall over the Adelaide Plains and the eastern part of the Mt Lofty Ranges. Nearly all the rain fell in a period of about three hours. The thunderstorms occurred in a moist airmass of tropical origin which was fed into the area from the northeast. The storm is described by Burrows (1983).

The rainfall produced severe flash flooding and extensive property damage, particularly in the Barossa Valley and around Dutton. An unofficial gauge on a farm 1 km north of Dutton recorded 330 mm during the storm. Several unofficial gauges recorded totals in excess of 200 mm, whereas the highest value recorded by an official gauge was 103 mm at Angaston. This illustrates the problem of detecting severe local storms with the sparse network of official gauges.

The representative storm dew point temperature was estimated as 20EC and the extreme dew point is 22.2EC. The storm rainfalls are compared with the PMP estimates for a duration of three hours in Table A3.7.

Table A3.7: Depth-Area Data for the Barossa Valley Storm

Area (km^2)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 22.2EC (mm)	3-hour PMP Estimate (mm)
1	300	360	440
10	222	270	400
50	190	230	350
100	173	210	340
500	129	150	270
1000	110	130	240

A3.8 The Dapto Storm of 18 February 1984

An extraordinary heavy rainfall event occurred near Dapto in New South Wales on 18 February 1984, as described by Shepherd and Colquhoun (1985). The rainfall was particularly heavy on and near the Illawarra escarpment. While rain fell for more than 24 hours most of the rain fell in a period of about 6 hours. For durations of around 6 hours and areas up to about 200 km^2 the normalised rainfall values exceed the adjusted United States data. The maximised rainfall values from the Dapto storm were used in deriving the `rough' terrain category DDA curves in Figure 2 in the first edition of *Bulletin 51* by the Bureau of Meteorology (1985). The storm dew point temperature was estimated to be 19EC. The extreme dew point temperature for February is 23.3EC. The 6-hour rainfall values for this storm are given in Table A3.8 where they are compared with the PMP estimates.

Table A3.8: Depth-Area Data for the Dapto Storm

Area (km²)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 23.3EC (mm)	6-hour PMP Estimate (mm)
10	520	750	750
50	450	650	650
100	410	590	600
500	250	360	460
1000	160	230	390

A3.9 The Sydney Storm of 4-7 August 1986

A low pressure centre which moved southwards close to the coast brought very heavy rainfall to the Sydney metropolitan area, the Blue Mountains and the Illawarra region, causing extensive local flooding. Six fatalities resulted from the storm. The Sydney rainfall for the 24 hours to 9 am on 6 August 1986 was a record 328 mm. There was a particularly heavy period of rain on the afternoon of 5 August 1986. Pluviograph data have been used to extract maximum 6 hour depths for that part of the storm which occurred over the metropolitan area. The storm dew point was 10EC and the extreme dew point is 16.7EC. The storm is described by the Bureau of Meteorology (1987). The depth-area rainfall values for the storm are compared with the PMP estimates in Table A3.9.

Table A3.9: Depth-Area Data for the Sydney Storm

Area (km²)	Recorded Storm Rainfall (mm)	Storm Rainfall Adjusted to 16.6EC (mm)	6-hour PMP Estimate (mm)
50	133	250	320
200	124	230	270
500	112	210	240
1000	103	190	200

A3.10 The St Kilda Storm of 7 February 1989

On the afternoon of 7 February 1989, a severe thunderstorm brought torrential rainfall to the inner southern and southeastern suburbs of Melbourne (Board of Works, 1989). The storm was centred over the St Kilda area and caused flash flooding. The heavy rainfall part of the storm lasted for about one hour. The representative storm dew point temperature was estimated to have been 14EC and the extreme dew point for February is 20.9EC. The depth-area rainfall values for the storm are compared with PMP estimates in Table A3.10.