Townsville City Council
27 July 2011
Document No. 60212663

Upper Bohle Plains Flood Study

Base-line Flooding Assessment

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Prepared for

Townsville City Council

Prepared by

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Quality Information

Document Upper Bohle Plains Flood Study

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Date 27 July 2011

Prepared by Vadivu Verakumaran / Wen Han Ooi

Reviewed by Paul Glenn

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	27-Jul-2011	Final Copy	Stephen Downes Technical Director - Water	

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Executive Summary

AECOM Australia Pty Ltd (AECOM) was engaged by Townsville City Council (TCC) to develop refined base-case and future urbanisation hydrologic and hydraulic flood models for the Upper Bohle Plains area based on previously developed and calibrated models as part of the *City Wide Flood Constraints Project*. The purpose of the *City Wide Flood Constraints Project* is to:

- identify flood constraints for new planning development projects;
- develop concepts for trunk stormwater and flood mitigation infrastructure for future capital investment; and
- assess escape routes and flooding along major arterials.

Study Area

The study area (Figure 1-1) intersects catchments of the Bohle River, Saunders Creek, Stony Creek and the Black River and is bounded by the Alice River in the west and the Bohle River in the east. Major road features passing through the study area include Hervey Range Road and the Ring Road (northern part named Shaw Road) near the southern and eastern extents, respectively and existing residential developments within the study area include Kalynda Chase, Rangewood and the north eastern portion of Rupertswood.

Scope of Works

The scope of works for the *Upper Bohle Plains Flood Study* includes:

- collation and review of available data and previous models relevant to the study;
- site assessment of the Rangewood and Kalynda Chase developments as well as Shaw Road to identify any additional hydraulic constraints and verify available as-built plans;
- update of existing XP-RAFTS hydrologic models within the study area to determine:
    - base-case runoff for the 2, 5, 10, 20, 50 and 100-year annual recurrence interval (ARI) storm events and the Probable Maximum Precipitation (PMP) event;
    - runoff for the 50 and 100 year ARI storm events with future catchment urbanisation;
- develop a MIKE FLOOD hydraulic model within the study area to determine:
    - base-case flood extents, velocity and depth of flow for the 2, 5, 10, 20, 50 and 100-year ARI storm events and PMP event;
    - peak flood envelopes for the 50 and 100 year ARI events for base-case and future catchment urbanisation scenarios.

Study Approach

The assessment builds on a number of previous flood assessments in the vicinity of the study area. Where possible, existing hydrologic and hydraulic models have been updated and refined to provide sufficient resolution according to the *Preparation of Flood Studies and Reports - Guidelines* (2010) developed by TCC.

Existing XP-RAFTS hydrologic models developed for the *Bohle Plains Flood Planning Study (BPFPS)* and *Lower Bohle River Flood Study – Base-line Flooding Assessment (LBRFS)* were updated to include more recent Light Detection and Ranging (LiDAR) topographic data. The catchment delineation was refined within the Rangewood and Kalynda Chase development to better understand flow through existing open channel drain infrastructure and flooding of properties within the developments.

A dynamically coupled 1D / 2D MIKE FLOOD hydraulic model was developed to assess base-line flooding conditions within the study area for the range of storm events and for the 50 and 100-year ARI future catchment urbanisation storm events. Additional culverts along Shaw Road were incorporated into the hydraulic model based on as-built plans and open channel drains within the Kalynda Chase development from the LiDAR topography.

Summary, Conclusions and Recommendations

Model results include the 2, 5, 10, 20, 50, 100 year and PMP critical duration events, water surface elevations, depth of flow and velocity for base-case and future urbanisation scenarios. Maximum flood envelopes have been

developed for the 50 and 100 year ARI events for the same range of parameters and scenarios. All results are presented in Appendix B.

The base-case and urbanised case scenario results indicate that rural areas, existing and proposed development and existing and proposed arterial roads may be impacted due to the 50-year Annual Recurrence Interval (ARI) or lesser storm event including:

- approximately 22 rural lots may be impacted by flooding along Saunders and Stony Creeks;
- approximately 29 lots may be impacted along the Rangewood development open channel drains;
- approximately 4 local roadways may be impacted along the Kalynda Chase development open channel drains (further refinement of the model with respect to local drainage and storage may provide different results);
- Shaw Road may need to be closed at the intersection with a Bohle River tributary in the northeast corner of the model during a 10-year or greater ARI storm event;
- Tomkins Road may need to be closed along most of its entirety during a 2-year or greater ARI storm event.
- Proposed industrial areas around Tompkins Road may be inundated during a 2-year or great ARI storm event and access to facilities may be limited due to flooding on Tompkins Road

In all cases, mitigations options would include:

- upstream detention basins on the west side of the proposed Ring Road alignment that detain flows from Saunders Creek and tributaries of the Bohle River may relieve flooding of Shaw Road, Tomkins Road and reduce the required culvert sizes along the proposed Ring Road alignment;
- raising roads and adding larger culverts;
- realignment of roads to higher ground;
- diversion of flows around major development areas.

The primary recommendations for model and analysis refinements include:

- alternative analysis for the placement of detention facilities to reduce downstream flooding impacts;
- evaluation of raising or realigning roadways;
- analysis of regional diversions to reduce impacts to developed areas.

1.0 Introduction

1.1 Overview

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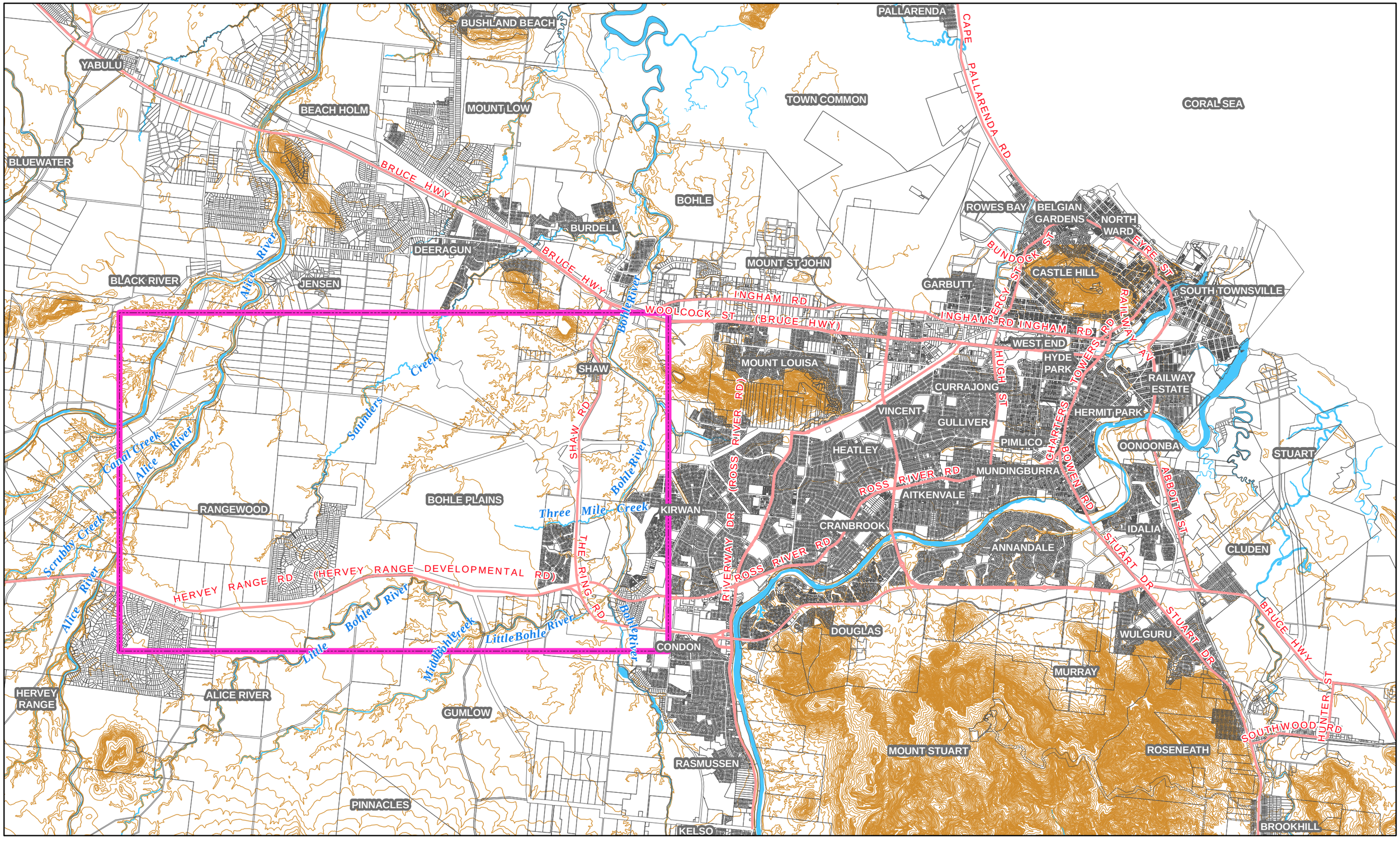

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Scale: 1:75,000
(when printed at A3)

0 500 1,000 2,000 Metres

Legend

- Model Extent
- Contours (5m Intervals)

UPPER BOHLE PLAINS FLOOD STUDY
Location Map

Figure 1-1

2.0 Available Data

2.1 Spatial Data

TCC provided the following data for the study:

- topography data from in the form of contours and XYZ tiles at 1 meter (m) spacing based on 2009 LiDAR survey;
- aerial photography flown between 19 and 29 June 2009 with pixel sizes of 0.125 m;
- digital cadastral database containing property boundaries (TCC, 18/3/2011).

2.2 Previous Reports

This study was developed based on a number of relevant previous flood studies that were completed by AECOM including.

2.2.1 Bohle River Floodplain Management Study, April 2001

The *Bohle River Floodplain Management Study (BRFMS)* project assessed the hydraulics and mapped the extents of the of the Bohle River floodplain from Kelso Drive to its outlet at Halifax Bay. RORB hydrologic and 1-dimensional (1D) MIKE 11 hydraulic models were developed to complete the flood extents analysis.

2.2.2 Ring Road Stages 2 & 3 – Bohle River Flooding, September 2006

The *Ring Road Stages 2 & 3 – Bohle River Flooding* project assessed flood levels adjacent to Ring Road, determined approximate bridges sizes and assessed flood mitigation options. The *BRFMS* MIKE 11 model was updated to a MIKE FLOOD model to more accurately represent the two-dimensional (2D) floodplain hydraulics from Gollogly Lane in the south to Mount Louisa in the north. Details of recently constructed developments were incorporated into the RORB hydrologic model for the analysis.

2.2.3 Liberty Rise Development Flooding Assessment, September 2008

The *Liberty Rise Development Assessment* project analysed flooding for the Liberty Rise development project. The MIKE FLOOD model developed for the Ring Road project (September 2006) was used as the basis for the assessment and base-case model updated to include the Liberty Rise development information.

2.2.4 Kern Drain Trunk Drainage Assessment, January 2008

The *Kern Drain Trunk Drainage Assessment* project established 50 year ARI hydraulic grade lines for Kern Drain based on as-built plans. The RORB model used for the BRFMS was converted to an XP-RAFTS hydrologic model, which was refined to include all new developments since the 2001 study.

2.2.5 Kalynda Chase Flood Modelling, February 2008

The *Kalynda Chase Flood Modelling* project assessed flooding upstream and downstream due to the development and mitigation measures to ensure “no worsening”. Large open channel drains were preliminarily designed based on the analysis.

2.2.6 Bohle Plains Flood Planning Report, April 2010

The *Bohle Plains Flood Planning Report (BPFPR)* consolidated all modelling studies completed in the Bohle Plains area since the *BRFMS.* The assessment included hydrological and hydraulic modelling of the Bohle River, Saunders Creek, Stony Creek and Black River catchments for the 50 year ARI storm event.

2.2.7 Little Bohle Flood Plain Study, June 2011

The *Little Bohle River Flood Study (LBRFS)* assessed base-case flooding for the Little Bohle River. Hydrologic and hydraulic models for the Black River, Saunders and Stony Creek catchments were updated using TCC LiDAR topography flown in 2009 within the project area.

3.0 Hydrology Assessment

3.1 Overview

XP-RAFTS was used to model existing and future hydrology for the portions of the Black River, Saunders Creek, Stony Creek and the Bohle River catchments flowing into the study area. Existing XP-RAFTS models were updated to include:

- detailed contours from 2009 LiDAR generated topography;
- land use changes;
- refinement of sub-catchment boundaries to produce inflow hydrographs at key locations within the Rangewood and Kalynda Chase developments for input into the hydraulic model.

3.2 XP-RAFTS

XP-RAFTS is a rainfall-runoff routing model that predicts flow versus time hydrographs at discrete locations based on Laurenson's non-linear routing method. Catchments are represented by nodes that are inter-connected by links. Each node in the model represents the characteristics of a sub-catchment and each link represents the flow path length and slope. The factors that affect the volume and peak flow generated within a catchment include:

- area;
- flow path length;
- slope;
- land use;
- rainfall intensity and temporal pattern;
- soils;
- initial abstraction and storage.

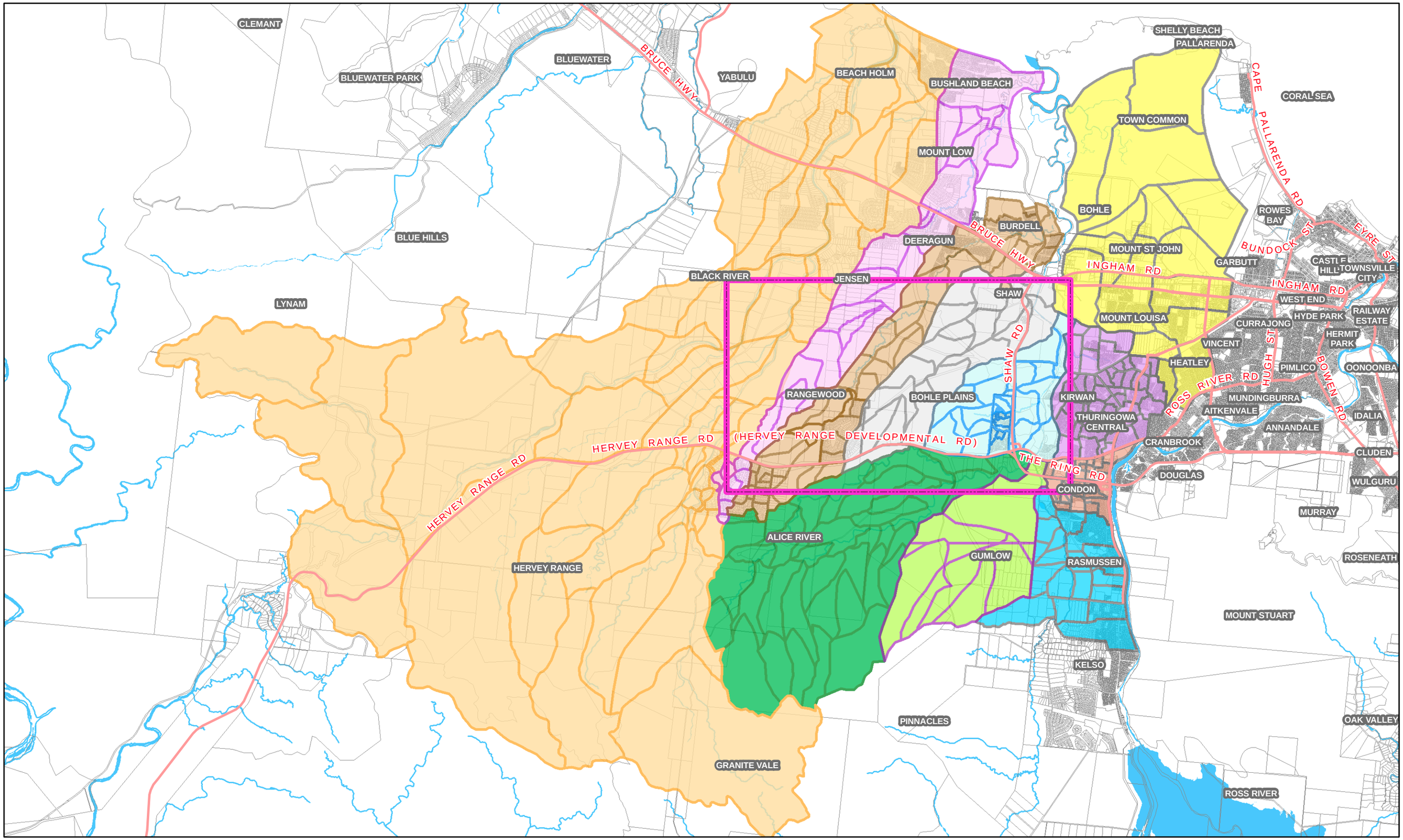
Hydrological models are calibrated to stream gauge data with input from rain gauge data by adjusting parameters such the roughness coefficient (Manning's 'n') and the initial and continuing losses until a close comparison between historical and modelled flow rates and volumes are observed. Models are typically verified with an independent data set to evaluate the calibration.

3.3 Base-case Hydrology

3.3.1 Catchment

Figure 3-1 shows the location and extent of catchments within the study area. Details of Black River, Saunders Creek, Stony Creek, Bohle River 1 and Bohle River 2 sub-catchments are shown in Figures 3-2 to 3-6 and parameter details are presented in Appendix A. Note that percent impervious is considered as the portion of the area that is 100-percent impervious. Changes from previous models included:

- redirecting 180 hectares (ha) from the Stony Creek catchment to Black River based on the refined 2009 LiDAR existing topography;
- revising impervious fraction and roughness from more recent aerial photography (TCC, 29/06/2009);
- refining catchments within the Rangewood and Kaylnda Chase developments.



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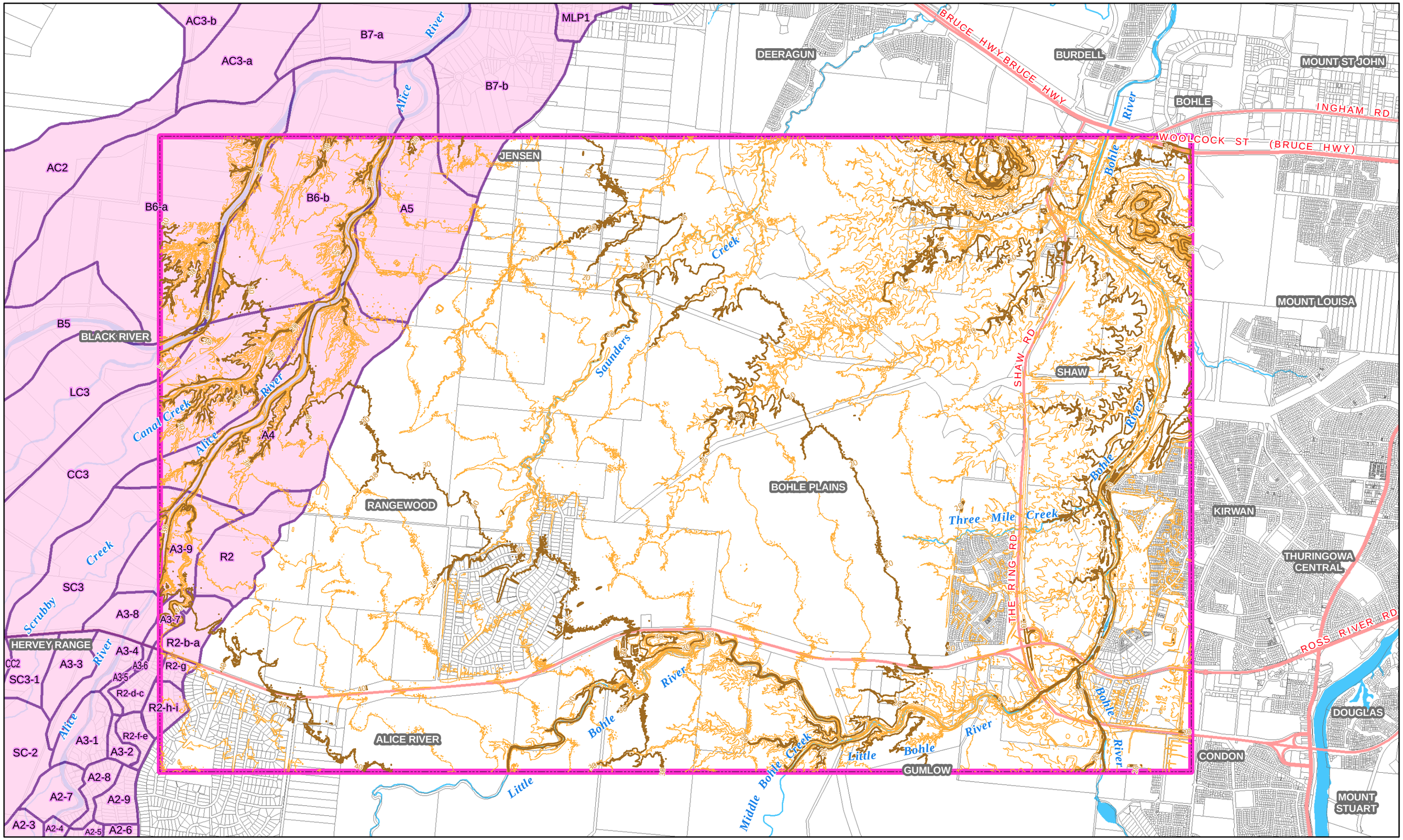
Legend

- Model Extent
- Black River Catchment
- Little Bohle Catchment
- Bohle River 2 Catchment
- Middle Bohle Catchment
- Middle Bohle Catchment
- Kirwan Catchment
- Louisa Creek
- Condon Catchment
- Stony Creek Catchment
- Saunders Creek Catchment
- Bohle River 1 Catchment

UPPER BOHLE PLAINS FLOOD STUDY
Extent of Model Catchments

Figure 3-1



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0 500 1,000 2,000 Metres

Legend

- Model Extent
- Black River Catchment
- Index Contours (10m)
- Contours (2m)

UPPER BOHLE PLAINS FLOOD STUDY
Black River Catchment

Figure 3-2