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Shepparton East Overland Flow Urban Flood Study – Final Report

Reference: R.M8415.003.01.FinalReport.docx
Date: March 2017

Shepparton East Overland Flow Urban Flood Study – Final Report

Prepared for:	Goulburn Broken Catchment Management Authority
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Document:	R.M8415.003.01.FinalReport.docx
Title:	Shepparton East Overland Flow Urban Flood Study – Final Report
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Client Reference:	575

Synopsis: **This report provides the methodology and results from the flood modelling and mapping for the Shepparton East Overland Urban Flood Study project.**

REVISION/CHECKING HISTORY

Revision Number	Date	Checked by		Issued by	
0	08/12/2016	MS		JL	
1	03/03/2017	MS		JL	

DISTRIBUTION

Destination	Revision										
	0	1	2	3	4	5	6	7	8	9	10
Goulburn Broken Catchment Management Authority	PDF	PDF									
BMT WBM File	PDF	PDF									

Executive Summary

This Executive Summary outlines the objectives, methodology and key outcomes of the Shepparton East Overland Flow Urban Flood Study.

Introduction

BMT WBM Pty Ltd (BMT WBM) was commissioned by the Goulburn Broken Catchment Management Authority (GBCMA) to undertake the Shepparton East Overland Urban Flood Study. The study area is located on the eastern fringe of the city of Shepparton. Figure 1-1 shows the general location of the area in relation to its catchment and surrounding features.

The purpose of this report is to document the methodology and results of the hydrological and hydraulic modelling together with the flood mapping and risk outputs.

The study area drains both rural and urban land through a series of man-made drains rather than a natural drainage system. As such the study area's drainage system is similar to an urban system. For this reason the flood modelling, both hydrologic and hydraulic, has been undertaken in accordance with the Melbourne Water (MW) Corporation Flood Mapping Projects Guidelines and Technical Specification.

Study Approach

The study involved the following five key stages:

- data collection;
- hydrological modelling;
- hydraulic modelling;
- flood mapping and deliverables; and
- reporting.

Flood Modelling

This study requires the development of both hydrological and hydraulic models to undertake flood mapping of the study area. Rainfall-runoff (hydrological) modelling of the study area was undertaken with the RORB hydrological modelling package.

The RORB model underwent a joint verification in conjunction with the hydraulic model (TUFLOW) development. Following this verification the design flow outputs from RORB provided inputs into the TUFLOW hydraulic model.

The results from the hydraulic modelling were used to develop flood mapping products, undertake a flood damages assessment, and inform potential flood mitigation strategies.

The flood model provided base case or existing conditions flood information (including flood maps) for the catchment for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% Annual Exceedance Probability (AEP) flood events. The 1% AEP flood extent and depth is shown in Figure 1. In addition to the existing conditions modelling, sensitivity testing of increased urbanisation, climate change and a combination of the two was undertaken.

The modelling showed that the catchment is susceptible to widespread and generally shallow slow moving flooding in even frequent (20% AEP) flood events. Whilst flooding is extensive in many of the developed areas of the catchment, it is generally confined to the road reserves, and where flows pass through residential or commercial properties the peak depths are shallow and with low velocity.

With the exception of the many retarding basins throughout the catchment and at small number of roadways, the flood hazard, as defined by the ARR revision project, shows almost the entire catchment as presenting a low risk to children.

Flood Damages Assessment

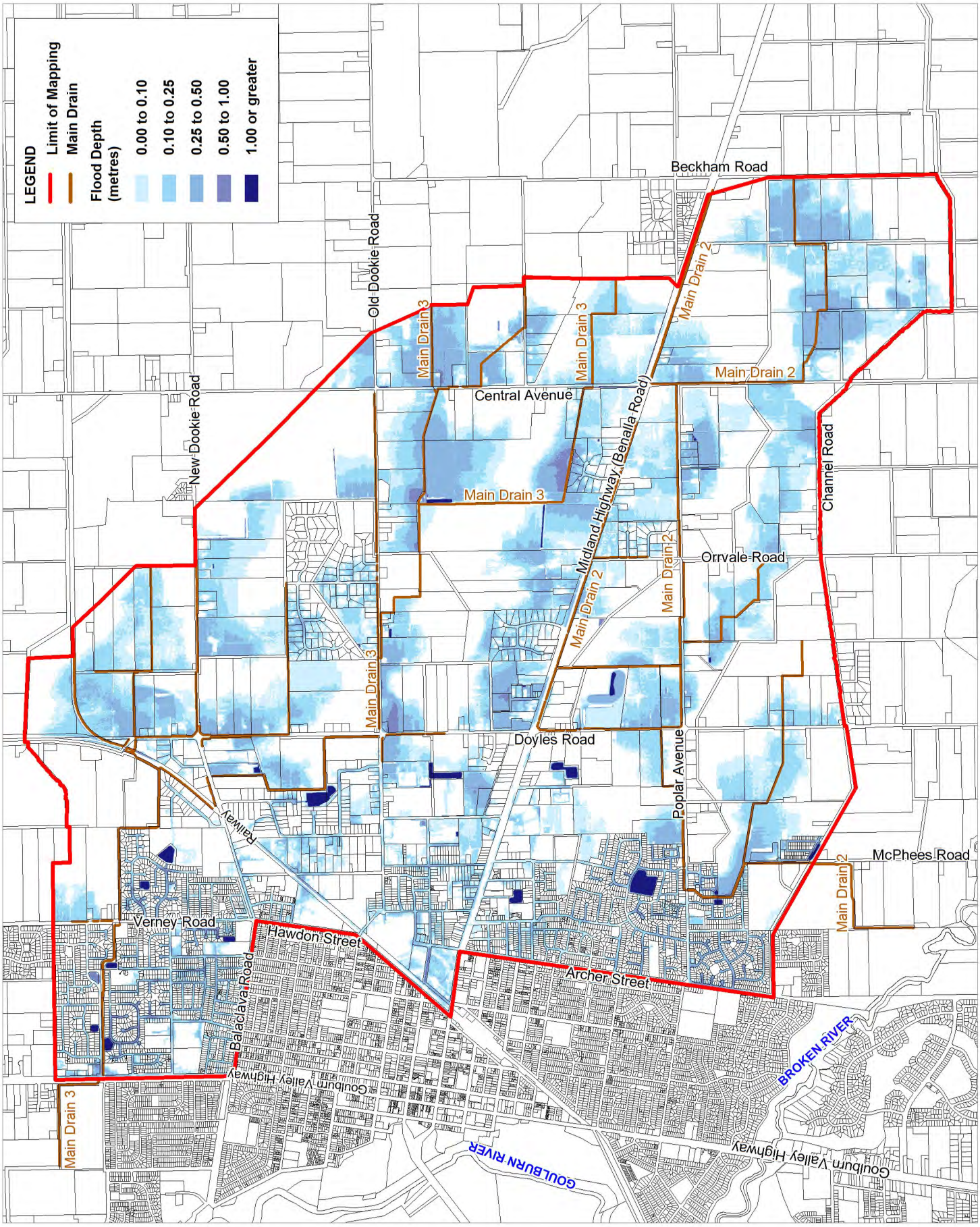
A flood damages assessment was completed for the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP flood events to ascertain the economic damage from flooding to Shepparton East annually. The damages included damage to residential, commercial, agricultural and road infrastructure as well as indirect damages. A loss probability curve was produced to enable the calculation of annual flood damages. Large damages from low probability events are combined with lower damages from more frequent flood events and annual average damage (AAD) is calculated. A summary of the damages is provided in Table 1.

Table 1 Summary of Flood Damages for Shepparton East

Event (ARI)	ANUFLOOD Building Damages	RAM Agricultural Damages	RAM Road Infrastructure Damages	Indirect Damages	Total Damages	Contribution to AAD
PMP	-	-	-	-	$126,006,700	
0.2%	$66,723,800	$12,437,300	$2,449,092	$29,014,400	$110,624,600	$236,631
0.5%	$54,052,600	$10,971,700	$2,322,905	$20,204,200	$87,551,400	$297,264
1%	$45,426,800	$9,788,900	$2,204,335	$17,226,000	$74,646,000	$405,494
2%	$34,676,500	$8,804,400	$2,101,450	$13,674,700	$59,257,000	$669,515
5%	$25,249,700	$7,302,300	$1,905,514	$10,337,300	$44,794,800	$1,560,777
10%	$19,491,500	$6,023,600	$1,721,972	$8,171,100	$35,408,200	$2,005,075
20%	$12,878,600	$5,014,300	$1,535,233	$5,828,400	$25,256,500	$3,033,235
50%	-	-	-	-	-	$3,788,475
					Average Annual Damages	**$11,996,500**

The existing condition AAD for the catchment is $11,996,500.

The damages within the catchment are largely driven by the damage to buildings, particularly commercial and industrial property. This is in part due to the conservative assumption of using the planning scheme rather than individual property assessments but also due to the widespread shallow flooding throughout the catchment which is a limitation of the Rapid Appraisal Method (RAM).



Title:

Shepparton East
Existing Conditions 1% AEP Peak Flood Depth

Figure: 1

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0 0.75 1.5km

Approx. Scale

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1 Introduction

BMT WBM Pty Ltd (BMT WBM) was commissioned by Goulburn Broken Catchment Management Authority (GBCMA) to undertake the Shepparton East Overland Urban Flood Study. The study area is located on the eastern fringe of the city of Shepparton. Figure 1-1 shows the general location of the area in relation to its catchment and surrounding features.

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The RORB model underwent a joint verification in conjunction with the hydraulic model (TUFLOW) development. Following this verification the design flow outputs from RORB provided inputs into the TUFLOW hydraulic model.

The results from the hydraulic modelling were used to develop flood mapping products, undertake a flood damages assessment, and inform potential flood mitigation strategies.

The purpose of this report is to document the development and results of the hydrological and hydraulic modelling together with the flood mapping and risk products.

The study area drains both rural and urban land through a series of man-made drains rather than a natural drainage system. As such the study area's drainage system is similar to an urban system. For this reason the flood modelling, both hydrologic and hydraulic, has been undertaken in accordance with the Melbourne Water (MW) Corporation Flood Mapping Projects Guidelines and Technical Specification (MW Technical Specification, MW 2011).

1.1 Catchment Description

The Shepparton East Overland Urban Flood Study area, together with key drainage features, is shown in Figure 1-2. The study area is located in north-central Victoria approximately 180 km north of Melbourne and covers an area of 49 km^2 to the east of Shepparton township (as shown in Figure 1-1).

There are no significant natural waterways in the study area; however, it is drained by an extensive network of manmade open drains. Goulburn Murray Water Main Drain 2 flows west from the East Goulburn Main Channel, draining agricultural land between the Midland Highway and the Broken River. Its 12.5 km length drains almost 16 km^2 of predominantly agricultural land with some urban areas. The drain discharges to the Broken River between Archer Street and McPhees Road. Goulburn Murray Water Main Drain 3 flows for 20 km north-west from the East Goulburn Main Channel, crossing Central Avenue, Doyles Road and the Goulburn Valley Highway before discharging into Goulburn River at Reedy Swamp. It drains an area of around 20 km^2 to the Goulburn Valley Highway, which forms the downstream extent of the study area. Open drains from agricultural properties combine with Main Drain 2 and Main Drain 3 to form a dense drainage network.

In addition to the Main Drain catchment's there are a number of small urban catchment which drain directly to the Broken and Goulburn Rivers by the urban drainage system. These catchments only partially fall into the area to be flood mapped as discussed in Section 3.3.1.1. The Midland

Highway forms a significant ridge, largely preventing cross-catchment flows between the areas contributing to flow in Main Drain 2 and Main Drain 3. Throughout this study, the hydrological approach has considered the contributing catchments to Main Drain 2 and Main Drain 3 independently of one another as discussed in Section 3.3.1.1. Parameters and results for each of the Main Drain catchments have been reported accordingly. It is of note that any cross-catchment flow will be explicitly modelled in the hydraulic model.

The catchment area is, in general, flat with raised irrigation channels forming barriers to overland flow. For this reason the raised irrigation channels often form the catchment boundaries.

The area to be hydraulically modelled, or the study area, is limited to the extent of the LiDAR data which covers the majority of the catchment. The study area is bordered to the west by Archer Street, Hawdon Street and the Goulburn Valley Highway within Shepparton township. The irrigation channel along Channel Road forms the southern boundary of the study area. The north and east boundary of the flood mapping is limited to the available LiDAR. The flood mapping boundary together with the catchment boundary is shown in Figure 1-2.

Land use within the catchment is mixed. The majority of land use is residential and agricultural (in particular orchards). The orchards have water supplied by an extensive network of irrigation channels which, as noted above, are raised above the surrounding ground levels. Other land use types within the catchment include industrial and commercial.

1.2 Study Objectives

The objective of the study was to create a hydrologic model of the catchment to model the rainfall-runoff process, as well as a 1D/2D dynamically linked TUFLOW hydraulic model to undertake flood mapping of the catchment. The results from the coupled hydrologic and hydraulic model (the flood model) were used to create flood mapping and flood risk products required as well as informing potential flood mitigation strategies. This suite of products was used to improve the understanding of flooding and flood risk in East Shepparton, now and for the future conditions.

The flood model was run for the Scenarios and Events listed under the appropriate heading below.

Specifically, the study aimed to deliver:

- Flood mapping products for the four scenarios and AEP events listed below for the following variables:
  - Peak flood levels
  - Peak flood depths
  - Peak flood velocities; and
  - Flood Hazard.
- The following flood risk products
  - Flood mapping products that are suitable to define planning scheme flood overlays.
  - Recommendations for flood related planning conditions.
  - Tabulated property flood likelihood.

- Flood damages assessment using the Rapid Appraisal Method (RAM).
- Recommendations for structural flood mitigation measures.

1.2.1 Study Scenarios and Events

A number of design events and different scenarios as listed in Table 1-1 and described in more detail below.

- **Base:**
  - Existing rainfall conditions; with
  - Current levels of development.
- **Developed:**
  - Existing rainfall conditions; with
  - Ultimate development conditions – in line with future rezoning and development anticipated around Shepparton East.
- **Climate Change A:**
  - Existing rainfall conditions intensified by 32%; with
  - Current (Base) levels of development.
- **Climate Change B:**
  - Existing rainfall conditions intensified by 32%; with
  - Ultimate (Developed) levels of development.

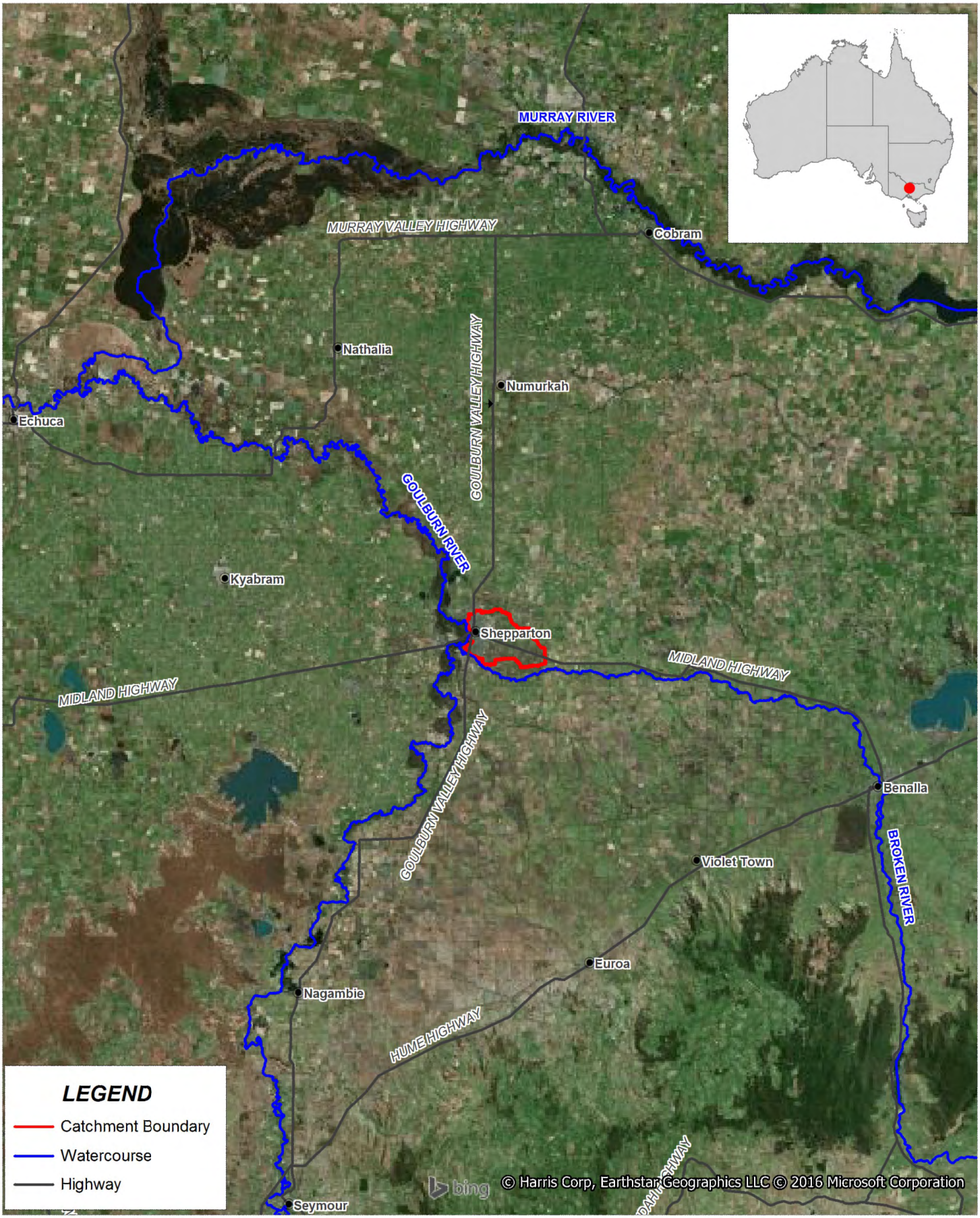
Table 1-1 Required Modelling Scenarios

Scenario	AEP							
	20%	10%	5%	2%	1%	0.5%	0.2%	PMP
Base	✓	✓	✓	✓	✓	✓	✓	✓
Developed	✓	✓	✓	✓	✓	✓	✓	✓
Climate Change A	✓	✓	✓	✓	✓	✓	✓	
Climate Change B	✓	✓	✓	✓	✓	✓	✓	

1.3 Study Approach

The study involved the following five key stages:

- data collection;
- hydrological modelling;
- hydraulic modelling;
- flood mapping and deliverables; and
- reporting.



Title:

Shepparton East Locality Plan

Figure: 1-1

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0 15 30km

Approx. Scale

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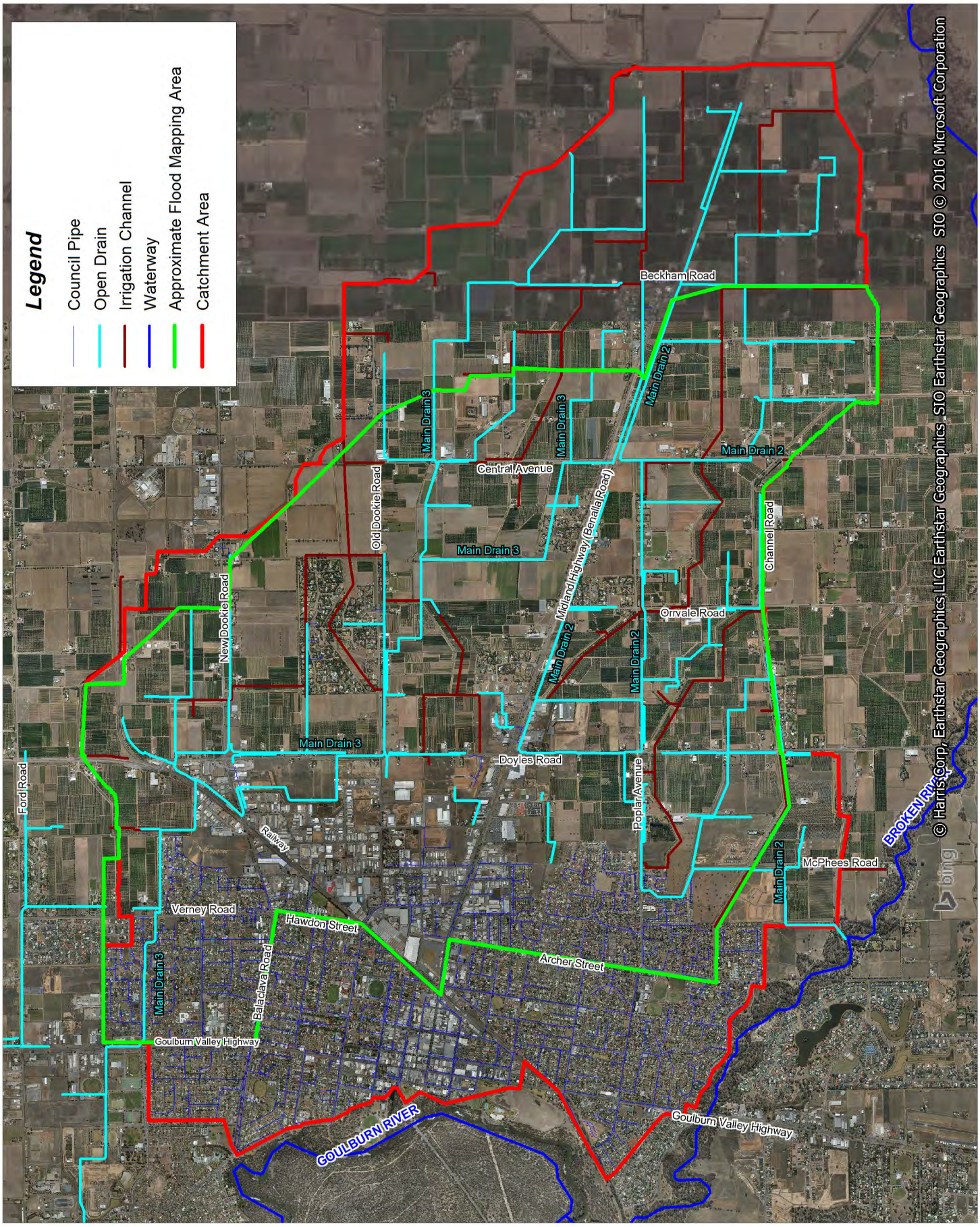

Title:
Shepparton East Catchment Plan

Figure: 1-2

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2 Data Collation

This section documents the data that has been collated by BMT WBM to date for the Study. BMT WBM has obtained information from a number of agencies and sources, including:

- Goulburn Broken Catchment Management Authority (GBCMA);
- Goulburn-Murray Water (GMW);
- Greater Shepparton City Council (GSCC);
- Bureau of Meteorology (BoM); and
- Department of Environment, Land, Water and Planning (DELWP).

2.1 Topographic Data

For the Study 0.5m gridded LiDAR was provided by GBCMA to form the basis of the Digital Elevation Model (DEM) which was used for both the hydrologic and hydraulic modelling components of the Study. The extent of the available LiDAR was less than the hydrologic catchment boundaries and formed the basis of the extent of the hydraulic model. The extent of the available LiDAR is shown in Figure 2-1.

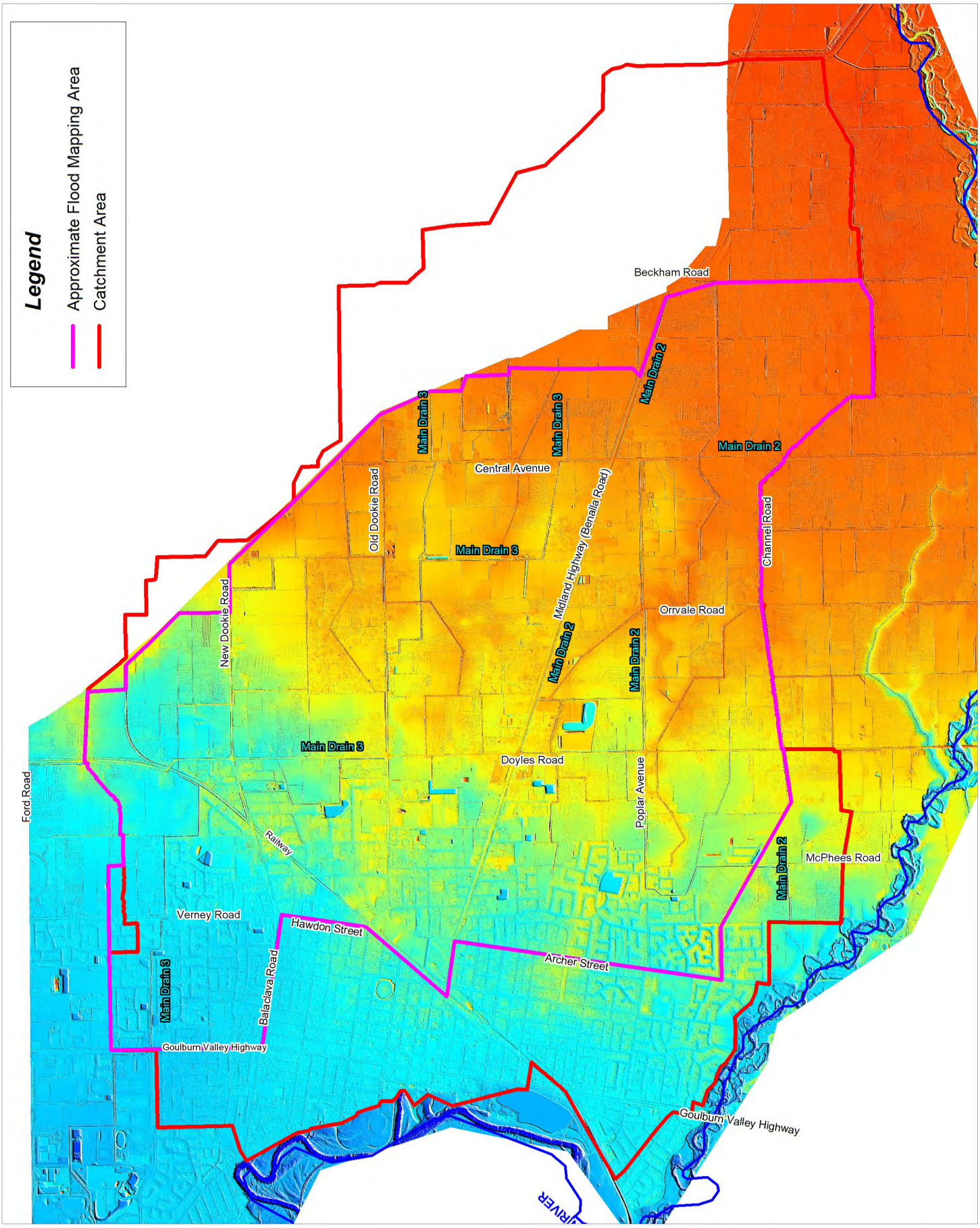
2.2 Aerial Photography

Aerial Photography of the catchment is an important tool for verifying catchment characteristics such as land use, building footprints and other structures. During the hydrologic modelling stage this information was used, along with the planning scheme overlays, to estimate the fraction imperviousness of the catchment. Similarly, when developing the hydraulic model this information was used to assign the Manning's values (roughness) to the catchment and any blockages caused by buildings.

For the Study one geo-referenced tile covering the Shepparton was provided by GBCMA.

2.3 Planning Scheme

The planning scheme layers were used in conjunction with the aerial photography and on-ground photography to define the current land use of the catchment. The planning scheme layers were used in both the hydrologic and hydraulic model to define factors such as fraction impervious and Manning's values (roughness). This was supplied by GBCMA and covers the study area.



Title:

Shepparton East
Digital Elevation Model Extent

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2.4 Drainage Infrastructure

Underground drainage, as well as culvert and open channel information, was used during the hydraulic modelling component of the flood study. It is important to incorporate any assets in the hydraulic model using as accurate information as possible. Locating the asset in the wrong location may disconnect it from the main flow channel. Whilst applying incorrect attributes (width/height/inverts/weirs/drops/etc) may result in incorrect flows passing through the structure. This may result in either elevated or depressed flooding upstream and over the road as well as elevated or depressed water levels downstream depending on which attributes are incorrect.

For the Study two asset collection surveys were undertaken to collate an accurate as possible GIS dataset of the existing drainage network. These were undertaken by Chris Smith Survey and Think Spatial. The survey by Chris Smith Survey captured details of the open channel drainage network whereas the survey by Think Spatial captured details of the underground drainage network.

The provided survey represented a significant improvement on the existing dataset. However many pits could be accessed and as such substantial infilling of the data was required, this is discussed in greater detail in Section 4.4.1.

Within the catchment there are currently 47 retarding basins. The location and details were provided by Greater Shepparton City Council.

2.5 Historic Flooding

Due to the lack of stream or flow gauges within the catchment it was not possible to undertake a traditional model calibration. Fortuitously, a significant flood event occurred during the study. This allowed flood marks to be collected throughout the catchment, together with sub-daily rainfall information.

Immediately following the flood event that occurred on the 27th and 28th of February 2013 BMT WBM and GBCMA undertook a site inspection of the catchment. Soon after a flood level survey was commissioned and undertaken by Spiire. In total 120 flood marks were surveyed and these together with the rainfall information formed the basis of the joint verification of the hydrologic and hydraulic models.

2.6 Streamflow Data

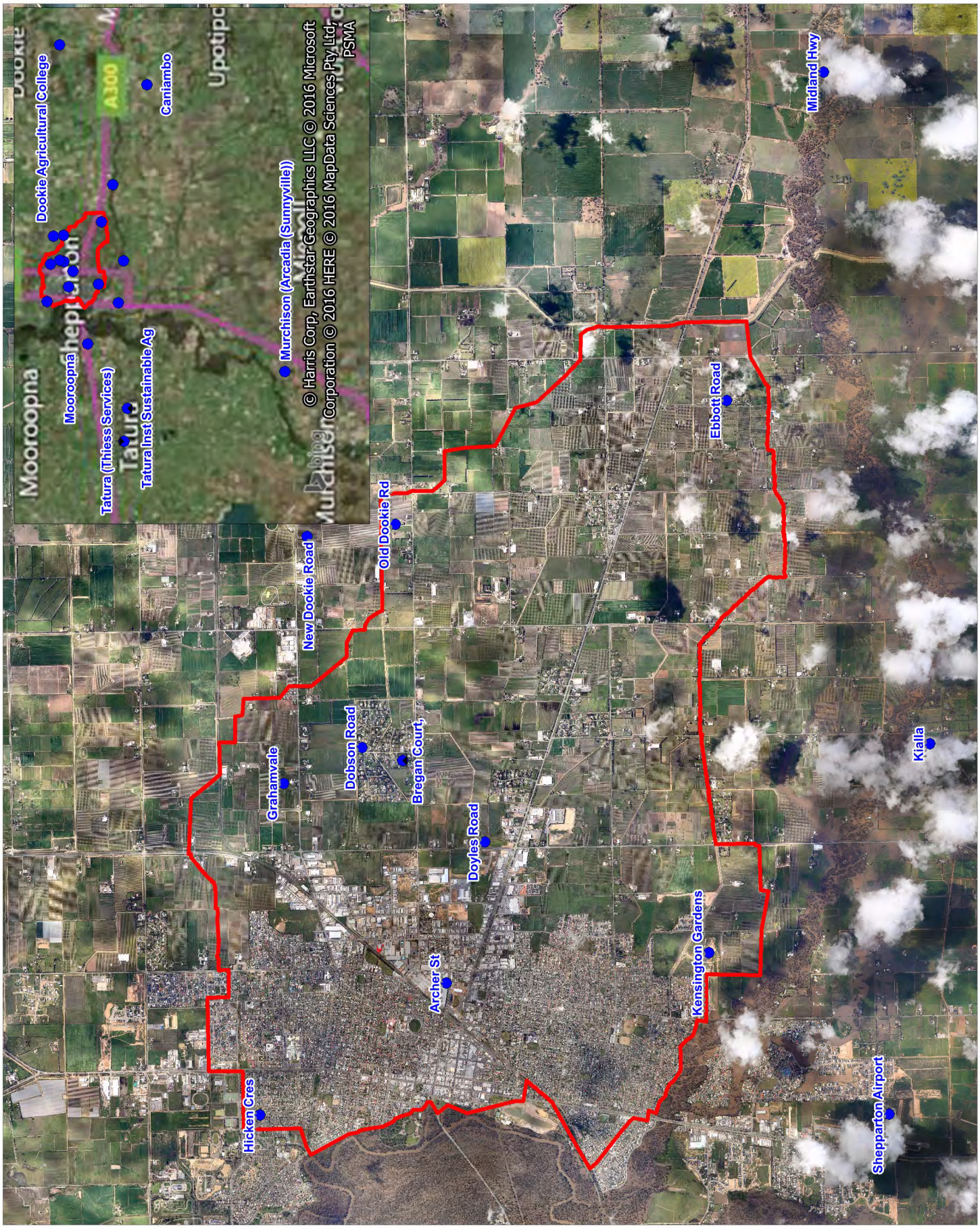
There are no stream flow gauges available within the catchment that could be used to calibrate or verify the hydrologic and hydraulic models.

2.7 Rainfall Data

Rainfall data was used during the verification process whereby the hydrologic and hydraulic models underwent a joint verification of the February 2013 flood event. Both daily and pluviograph rainfall data was obtained from the Bureau of Meteorology as well as a number of privately owned and operated rain gauges within the Study area. The obtained rainfall gauges details are tabulated in Table 2-1 and presented spatially in Figure 2-2.

Table 2-1 Rainfall Data Collected

Station No.	Station Name	Station Type	Provider
81034	Mooroopna	Daily	Bureau of Meteorology
81095	Murchison (Arcadia (Sunnyville))	Daily	Bureau of Meteorology
81013	Dookie Agricultural College	Daily	Bureau of Meteorology
81114	Tatura (Thiess Services)	Daily	Bureau of Meteorology
81007	Caniambo	Daily	Bureau of Meteorology
81125	Shepparton Airport	Daily	Bureau of Meteorology
		Pluviograph	Bureau of Meteorology
81049	Tatura Institute for Sustainable Agriculture	Daily	Bureau of Meteorology
		Pluviograph	Bureau of Meteorology
N/A	Archer St, Shepparton	Daily	Private Individual
N/A	Midland Hwy, East Shepparton	Daily	Private Individual
N/A	Bregan Court, Grahamvale	Daily	Private Individual
N/A	Dobson Road, Grahamvale	Daily	Private Individual
N/A	Hicken Crescent, Shepparton	Daily	Private Individual
N/A	Ebbott Road, East Shepparton	Daily	Private Individual
N/A	Old Dookie Rd, Shepparton East	Daily	Private Individual
N/A	Doyles Road, Shepparton East	Daily	Private Individual
N/A	Kensington Gardens, Channel Road, Shepparton	Daily	Private Individual
N/A	540 New Dookie Road, Lemnos	Daily	Private Individual
N/A	Kialla	Daily	Private Individual
		Pluviograph	
N/A	Grahamvale	Daily	Private Individual
		Pluviograph	



Title:

Shepparton East Rainfall Gauges

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