Scenic Rim Flood Modelling

Canungra Township – Detailed Flood Study

Scenic Rim Regional Council

Reference: 502966-004

Revision: 2

2021-07-16

Document control record

Document prepared by:

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Ground Floor, 25 King Street
Bowen Hills QLD 4006
Locked Bag 331
Brisbane QLD 4001
Australia

T +61 7 3173 8000
F +61 7 3173 8001
E brisbane@aurecongroup.com
W aurecongroup.com

Document control						aurecon
Report title		Canungra Township – Detailed Flood Study				
Document code		502966-0004-REP-HH-0001	**Project number**		502966-004	
File path						
Client		Scenic Rim Regional Council				
Client contact		Heather Nelson	**Client reference**			
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
0	29/01/2021	Draft Issue	S Thielemans	T Graham	-	D Franklin
1	12/02/2021	Final Issue	S Thielemans	T Graham	-	D Franklin
2	16/07/2021	Updated Final Issue	S Thielemans	T Graham	-	D Franklin
Current revision		**2**				

Approval			
Author signature		Approver signature	
Name	S Thielemans	Name	Trinity Graham
Title	Flooding and Drainage Engineer	Title	Technical Director

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Study background

In 2019, Aurecon undertook hydrologic and hydraulic modelling of the Canungra Creek and Biddaddaba Creek catchments. One of the primary objectives of this modelling was to assist Scenic Rim Regional Council (SRRC) with addressing strategic planning objectives and this included modelling of the 1 % AEP event with climate change. Mapping of flood inundation extents was prepared and provided in GIS format for incorporation into the Flood Hazard Overlays of the Planning Scheme.

Since completion of the 2019 assessment, it was determined that some local development within the township of Canungra has occurred and this was not picked up in the LiDAR used in the 2019 catchment wide flood modelling. Therefore, updated modelling focused on the Canungra township area has been undertaken using updated survey data for the area of development.

In addition, the 10m grid spacing used for the catchment wide flood modelling has been reduced to enable a more detailed representation of flood levels within the township area.

This report should be read in conjunction with the Canungra Creek and Biddaddaba Creek Flood Study Report (Aurecon, 2019).

1.2 Study Area

The Albert River is a large tributary of the Logan River which has a confluence with the Logan River some 25 km downstream of the SRRC boundary. Canungra and Biddaddaba Creeks are tributaries of the Albert River catchment and join the Albert River near Mundoolun. As with the upstream areas of Albert River catchment, the Canungra and Biddaddaba Creek catchments are elongated rural catchments that include agricultural land on floodplain areas with forested areas in their upper reaches. Both Canungra Creek and Biddaddaba Creek have several bridges and low-level crossings along their length.

The township of Canungra is situated approximately halfway along the length of Canungra Creek. The creek catchment is completely within the Scenic Rim Local Government boundary and extends as far south as O'Reilly's Rainforest Retreat and Lamington National Park at the upstream end and north to Mundoolun at the confluence with Albert River.

This study focuses on the Canungra Township area, specifically focussing upon the SRRC urban development footprint. The extent of this area is shown on Figure 1.

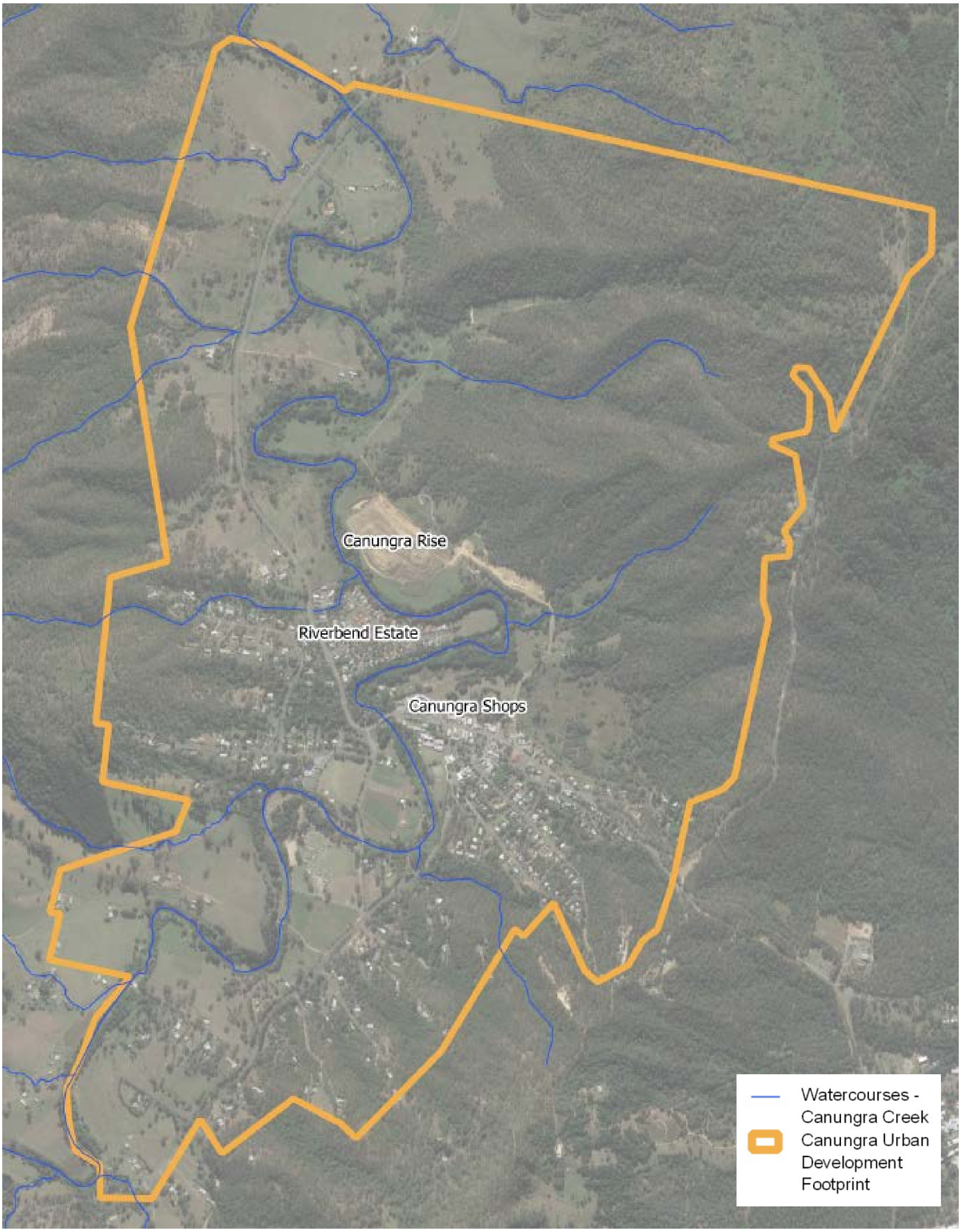


Figure 1 Locality plan

1.3 Study objectives

SRRC has requested an updated detailed flood study for the Canungra township that is compliant with the current State Planning Policy (and associated guidelines) and the relevant requirements of the Building Act 1975 (Act). The flood study is to provide Council with the ability to designate a flood hazard area under Section 13 of the Act.

The following tasks form the scope of this assessment:

- Adoption of hydrologic modelling from the Canungra Creek and Biddaddaba Creek Flood Study.
- Development of a detailed TUFLOW hydraulic model covering urban township area with key parameters:
  - Reduced grid spacing
  - Hydraulic model boundary conditions extracted from the catchment wide hydraulic model
  - Design event modelling of the 1% AEP with Climate Change (RCP 4.5) event
  - Topography in township area updated to include any available data for recent urban developments
- Preparation of 1% AEP with Climate Change flood mapping presenting flood inundation extents, flood depths, flow velocities and hazard rating
- Identification of the minimum and maximum flood levels for each property inundated by the 1% AEP event plus climate change.

The work undertaken to achieve the above objectives is documented in the following report.

2 Study Data

2.1 Previous studies

The Canungra township detailed flood model has been based on two previous flood studies, being:

- Albert River Flood Study (Aurecon, 2017)
  - The Albert River Flood Study was undertaken in 2017 is the most recent study for the Albert River. The 2017 study involved the adoption and refinement of calibrated RAFTS modelling, as well as the development of a TUFLOW hydraulic model. These models were used to determine flooding characteristics in the Albert River for a suite of design events including the 1% AEP plus climate change event. The Albert River RAFTS model was originally developed by Logan City Council (LCC) as part of a detailed Logan River system study. This model was adopted and refined as part of the 2017 Aurecon study for SRRC. The hydrologic modelling for the Albert River Flood Study covers the entire Canungra Creek and Biddaddaba Creek catchment areas and has sub-catchments set up in model schematisation to account for flows from sub-catchments for these watercourses. The Albert River RAFTS hydrologic model was therefore adopted for the provision of inflows for the Canungra Creek and Biddaddaba Creek Flood Study.
- Canungra Creek and Biddaddaba Creek Flood Study (Aurecon, 2019)
  - The 2019 Canungra Creek and Biddaddaba Creek Flood Study adopted the hydrologic modelling from the Albert River Flood Study and developed a new hydraulic model for the two creeks. The development of the detailed Canungra township model has been based on the hydrologic and hydraulic modelling from this study.

2.2 Survey Data

2.2.1 LiDAR

SRRC's 2011 Aerial LiDAR Survey (ALS) data was utilised as the basis for topographic representation within the Albert River catchment for the 2017 and 2019 flood studies. ALS data typically produces levels within an accuracy of ±150 mm and a horizontal accuracy of ±300 mm, which is considered a reasonably accurate representation of the topography.

A review was undertaken to determine whether any additional or more recent LiDAR data is available for the area, however it was concluded that the 2011 LiDAR data is the most up to date data available.

2.2.2 Canungra Rise Development: As-Constructed data

Construction of the Canungra Rise Residential Estate development, located to the north of the Canungra township, was completed after 2011. Therefore, this development is not represented in the 2011 LiDAR data.

In order to assess flood levels accurately in this area, 3D As-Constructed data of the development was sourced by SRRC and this was integrated into the survey data used for the hydraulic model. The extent of this data is shown in Appendix B.

Figure 2 below further illustrates:

- The extent of the As-Constructed data incorporated into the hydraulic model
- The difference between the As-Constructed data and the 2011 LiDAR. Any area in green represents an increase in ground levels; any blue area represents a decrease in ground levels. Figure 2 shows that cut and fill for the development has altered the topography throughout this local area.

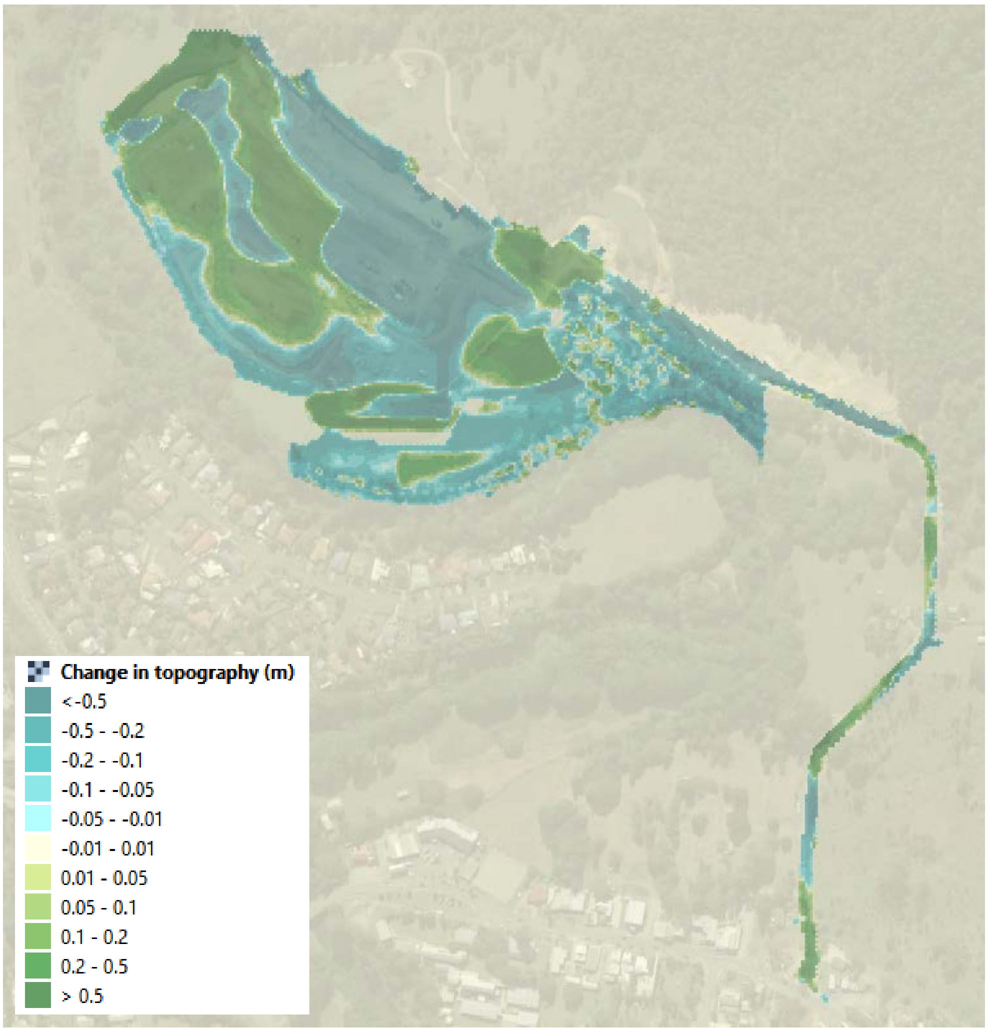


Figure 2 Comparison of 2011 LiDAR data with As-Constructed Canungra Rise topography

2.2.3 Field Survey

As the flood modelling work progressed, it was determined that floor levels of a number of residences were required to confirm freeboard under the 1% AEP event plus climate change. In addition to sourcing this data, the opportunity to survey key parts of the urban development affected by flood inundation was taken.

The scope of the field survey works included:

- Confirm the Australian Height Datum value of the benchmark in the local area (Permanent Survey Mark (PSM) 198610)
- Obtaining floor levels of the houses in the area as indicated in Figure 3 and detailed in Table 1. A number of the properties provided permission for the survey team to enter and obtain floor levels. For those that did not provide permission in the project timeframes, laser survey from the street level was used to determine an approximate floor level.
- Topographic survey spot level checks on the road pavement and kerb areas including the road crown, road edges and kerb profiles.
- Six (6) cross-sections on the finished ground level of the residential estate.

The vertical survey accuracy specifications were:

- +/- 10 mm @95% Confidence Level (House Floor Levels)
- +/- 20 mm @95% Confidence Level (Road profiles)
- +/- 30 mm @95% Confidence Level (Soft surfaces)

Figure 3 Field Survey – Extent of ground survey and floor level survey (imagery: Nearmap 2020)

Table 1 Field Survey – Outcomes

Address	Measurement Location	Floor Level (m AHD)	Instrument Used
8 Beasley Way	Top of step outside	88.53	TPS/Laser
10 Beasley Way	Doorstep	88.39	TPS/Pole
12 Beasley Way	Floor level inside	88.29	TPS/Pole
24 Beasley Way	Floor level inside house	87.36	Level
26 Beasley Way	Doorstep	87.35	TPS/Pole
27 Beasley Way	Floor level inside	87.45	TPS/Pole
31 Beasley Way	Doorstep	87.03	TPS/Pole
40 Roxborough St	Top of step outside	87.39	TPS/Laser
42 Roxborough St	Floor level inside	87.42	TPS/Pole
44 Roxborough St	Floor level inside house	87.38	Level
46 Roxborough St	Floor level inside	87.27	TPS/Pole
50 Roxborough St	Floor level inside house	87.27	Level
52 Roxborough St	Floor level inside house	87.19	Level
54 Roxborough St	Doorstep	87.02	TPS/Pole
56 Roxborough St	Floor level inside house	87.35	Level
58 Roxborough St	Floor level inside house	87.65	Level
60 Roxborough St	Top of step outside	87.80	TPS/Laser
62 Roxborough St	Floor level inside house	87.91	TPS/Pole
64 Roxborough St	Floor level inside house	87.69	Level
68 Roxborough St	Doorstep	88.04	TPS/Pole

Address	Measurement Location	Floor Level (m AHD)	Instrument Used
79 Roxborough St	Doorstep	88.20	TPS/Pole
81 Roxborough St	Top of step outside	88.28	TPS/Laser

2.3 GIS Data

The following GIS datasets were provided by SRRC which were utilised as per the previous studies:

- Aerial imagery – High resolution 2013 aerial imagery
- GIS based hydraulic structures data.
- Updated DCDB (2017)

These datasets have been utilised for the generation of flood mapping and tabulated flood levels.

2.4 Report terminology

This report adopts the latest approach to design flood terminology as detailed in the updated *Australian Rainfall and Runoff – Book 1* (ARR, Commonwealth of Australia 2019). Therefore, all design events are discussed in terms of Annual Exceedance Probability (AEP) using percentage probability (eg 1% AEP design event).

Table 2, an extract of Figure 1.2.1 from Book 1 (ARR 2019), details the relationship between Annual Recurrence Interval (ARI) and AEP for a range of design events.

Table 2 Extract from Figure 1.2.1 AR&R adopted terminology

AEP (%)	AEP (1 in x)	Average recurrence interval (ARI)
10.00	10	9.49
5.00	20	20
2.00	50	50
1.00	100	100
0.50	200	200
0.20	500	500

3 Development of detailed town model

3.1 Hydrologic Modelling

As for the previous projects, the hydrologic modelling software RAFTS has been used in this assessment. RAFTS is a runoff routing model and an industry standard tool commonly used for hydrologic studies.

The existing hydrologic RAFTS model procured from Logan City Council (LCC) for the Albert River catchment, which incorporates the Biddaddaba and Canungra Creek catchments, was adopted. The RAFTS hydrologic model was developed as part of a detailed study of the Logan River system by LCC.

3.1.1 Software platform

The software RAFTS version 2018.1.3 has been used for hydrologic modelling.

3.1.2 Calibration

Details of the calibration of the hydrologic model are included in the Canungra Creek and Biddaddaba Creek Flood Study Report (Aurecon, 2019).

3.1.3 Design event modelling

The 2019 Canungra Creek and Biddaddaba Creek Flood Study were based on rainfall and temporal patterns from the 1987 Australian Rainfall and Runoff (ARR) guidelines which have since been updated.

During the development of the detailed town model, the hydrology has been updated to use the latest ARR 2019 methodology. The main updates are:

- The ARR 2019 methodology adopts an ensemble approach, running 10 temporal patterns per duration, compared with 1 temporal pattern per duration in the ARR 1987 methodology. This allows for sensitivity testing of the catchment to different rainfall distribution storms in order to determine the critical storm.
- Updates to rainfall intensity information as detailed in the IFD (Intensity-Frequency-Duration) curves for the catchment area. This update was undertaken using all the additional rainfall data that has become available since the development of ARR 1987. The differences in rainfall intensity for the 1% AEP event in the Canungra township between 1987 and 2019 are shown in Table 3.

Table 3 Change in Rainfall Intensities

Storm Duration	1987 rainfall intensity (mm/h)	2019 rainfall intensity (mm/h)	Change in rainfall intensity (mm/h)
1h	95.0	88.2	- 6.8
3h	48.8	47.7	- 1.1
6h	31.5	32.8	+ 1.3
12h	20.7	26.4	+ 5.7
24h	14.0	15.2	+ 1.2
48h	9.44	9.75	+ 0.3
72h	7.23	7.24	+ 0.01

The hydrologic modelling was updated to ARR 2019 and used for the detailed town flood modelling. The design event modelling for this study focused on the 1% AEP event plus climate change. Using the calibrated hydrologic model, modelling of the 1% AEP event plus climate change was undertaken. The hydrologic model is shown in Figure A2.

Key modelling parameters for the updated ARR 2019 approach include:

- 2019 rainfall intensities based on IFD extracted from the ARR Data Hub at hydrologic model catchment CAN004 location
- East Coast North temporal patterns adopted with ARR Data Hub recommended losses of 36 mm initial loss and 3.5 mm/hr continuing loss
- Median preburst values were adopted based on ARR Data Hub. Where pre-burst exceeded an initial loss a storm pattern was used to distribute the pre-burst as ARR2019 provides no specific guidance on pre-burst temporal patterns as limited research exists.

3.2 Hydraulic Modelling

3.2.1 Software platform and modelling approach

The detailed town model is a sub-model of the previous Canungra Creek and Biddaddaba Creek Flood Study hydraulic model, for which modelling was undertaken using 2-dimensional (2D) hydraulic modelling software TUFLOW. Note:

- The Canungra Creek and Biddaddaba Creek Flood Study was undertaken using TUFLOW 2018-03-AB (HPC)
- In this study, TUFLOW 2018-03-AB HPC was used to confirm validity of sub-model boundaries by replicating water levels from the regional model using the same TUFLOW computing scheme.
- Sensitivity testing with smaller grid sizes was also undertaken using TUFLOW 2020-01-AB HPC, as this version of TUFLOW uses newer computing techniques in order to run in a stable manner with smaller grid sizes. However, this software version was not adopted due to modelling stability issues.

3.2.2 Modelling extents

The regional Canungra Creek and Biddaddaba Flood Study hydraulic model covered the majority of each catchment from the upper extents to the confluence with the Albert River, covering a total area of approximately 20,000 hectares.

The extent for the detailed town model has been reduced to 1,400 hectares, based largely on the Canungra Urban Development Footprint provided by SRRC, focussing in on the area that is interest to Council.

Both the regional and sub-model extents are shown on Appendix Figure A3.

3.2.3 Topography

The topographic representation in the hydraulic model is based on the survey data detailed in Section 2.2 and includes:

- 2011 LiDAR data
- As-Constructed 3D topography of the Canungra Rise development
- Field survey collected in 2020

Grid spacing

The topography in the regional Canungra Creek and Biddaddaba Flood Study hydraulic model was represented using a 10m grid size. This catchment wide grid size allowed sufficient detail for the channel and floodplain representation in the hydraulic model whilst allowing for reasonable run times.

The purpose of the detailed town model sub-model, however, is to provide flood levels within the Canungra Township. This has been achieved using smaller grid spacing. It should be noted that:

- Sensitivity testing was undertaken using a 2 m grid size. However, due to software constraints leading to instabilities (ie 'standing waves' in the middle of the channel), it was concluded that a 2 m grid size was not suitable for the hydraulic model given the depth of channel being represented (ie the depth cannot be significantly deeper than the grid spacing or instabilities will occur).
- A 5m grid size was adopted in the hydraulic model. This grid size allowed the model to run in a stable manner with reasonable run times, whilst closely replicating previously modelling flood levels from the catchment wide modelling. Further, this allowed for sufficient detail through the township area in order to assess flood levels at houses both in the newly constructed Canungra Rise as well as in other areas of interest such as Picnic Bend and the wider Canungra township area. Note that water levels are slightly (approximately 100mm lower than the regional model) as the smaller grid spacing allows more accurate representation of conveyance.

3.2.4 Roughness assumptions

Surface roughness values used in the hydraulic model are presented in Table 4 and were based on accepted industry values. Land use types were identified for areas using the provided aerial photography. A TUFLOW Roughness map is provided in Appendix Figure A4.

Table 4 Surface Roughness/Manning's n values

Land Use Type	Manning's roughness n
Dense Vegetation	0.09
Medium Vegetation	0.07
Channel	0.05
Logan River and Tributaries	0.07
Floodplains	0.06
High density residential areas	0.10
Low density residential areas	0.08
Roads	0.03

3.2.5 Hydraulic structures

The Christie Street bridge at the Canungra Township has been included in the hydraulic model. Assumptions regarding this bridge structure and its representation in the hydraulic model are as per the regional model, detailed in the Canungra Creek and Biddaddaba Creek Flood Study Report (Aurecon 2019).

There are no other hydraulic structures in the model.

3.2.6 Boundary conditions

Upstream and downstream model boundary conditions have been extracted from the regional hydraulic model at 5-minute intervals, with the RAFTS hydrologic model outputs were applied as local inflows into the TUFLOW hydraulic model where applicable. Table 5 and Appendix Figure A5 detail the sub-model boundary conditions.

Table 5 Boundary Conditions

Boundary	Boundary Information
Upstream	Flow versus time (QT)
Downstream	Water level versus time (HT), taken from PO point in the middle of the channel
Hydrology inputs	Hydrology inputs within the model are represented as Source – Area (2d_SA) boundaries

4 Outcomes

4.1 Mapping

The TUFLOW model results were analysed and a series of maps (refer Appendix A) were developed to present the results for each modelled return period. Four sets of maps were produced to display:

- Inundation extents with peak water surface levels – these maps present depth in 0.5m bands up to a depth of 5m, with 5m contours of the peak water surface levels. For further reference, 0.1m contours are provided in the GIS package.
- Peak velocities – these maps present peak velocity contours in 0.5 m bands up to a velocity of 5 m/s
- Hazard maps – Revised guidelines for presentation of flood mapping are now provided in the Australian Emergency Management Handbook Series (2013) produced by Emergency Management Australia (EMA). This handbook and its supporting flood risk management guidelines are intended to replace the SCARM guidelines under which the previous mapping was prepared. The revised guidelines include a revised categorisation for flood hazard which is shown below in Figure 4. The hazard maps have used a simplified version of this classification, where only 3 levels are outlined (Low, Medium and High Hazard). Each of these simplified bands represent 2 bands within the EMA classification.

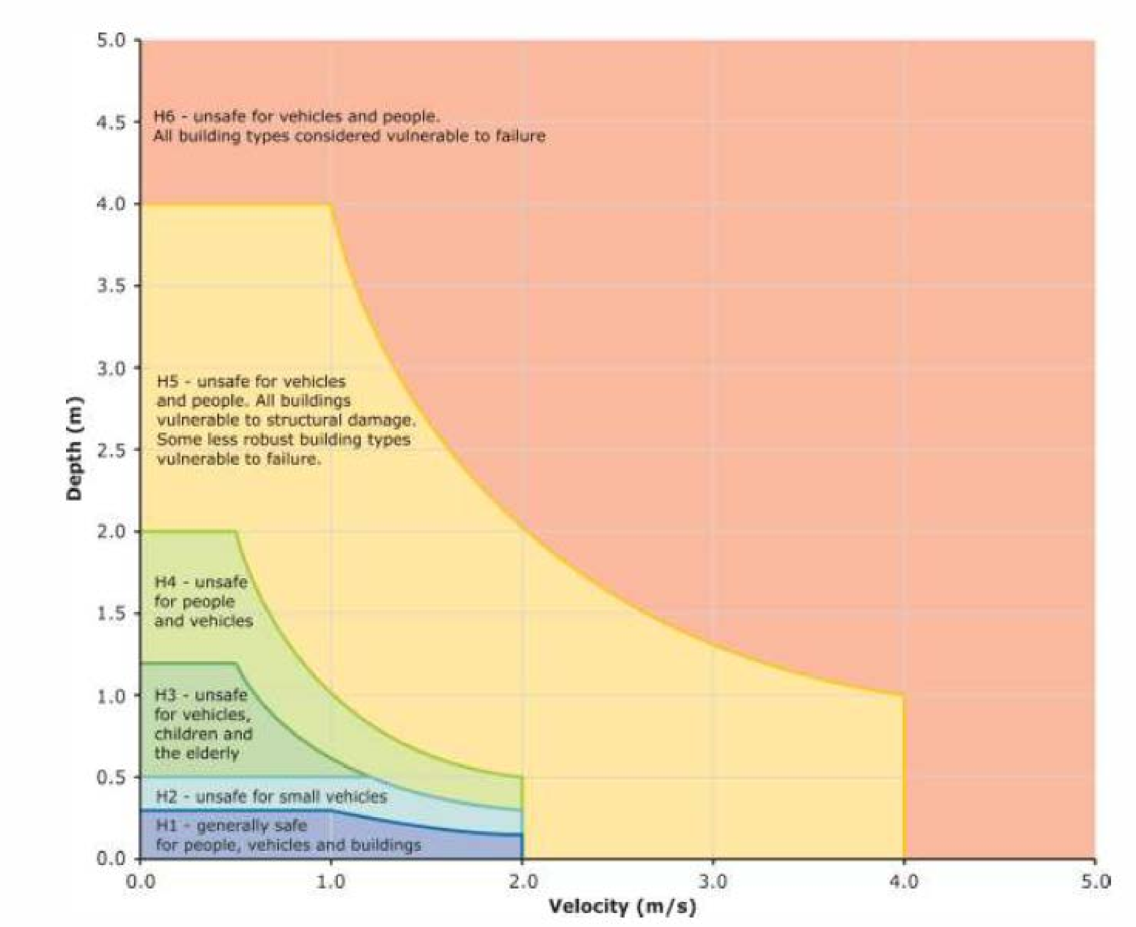


Figure 4 EMA revised flood hazard classification. Source: Australian Emergency Management Handbook Series (2013) – Technical flood risk management guidelines: Flood Hazard

The flood maps accompanying this report provide a regional overview of the modelling results and are supplemented by GIS data to be supplied to SRRC which can be interrogated to provide further detail. A list of the figures and the full set of maps is presented in Appendix A.

4.2 Canungra Rise – Freeboard to Property floor level

The estimated freeboard to property floor levels in the Canungra Rise residential development has been assessed using the updated detailed hydraulic modelling. Table 6 presents a summary of the estimated freeboard for each property for the 1% AEP event plus climate change. For information purposes, the freeboard for the 1% AEP event is also detailed.

The freeboard to floor level for all houses included in the 2020 field survey are shown in Figures A9 and A10 for the 1% AEP plus climate change and the 1% AEP event respectively.

Table 6 Summary of Estimated Freeboard for Canungra Rise properties

House Address	1% AEP + Climate Change Freeboard to floor level (m)	1% AEP Freeboard to floor level (m)
8 Beasley Way	0.61	0.92
10 Beasley Way	0.45	0.80
12 Beasley Way	0.69	1.05
24 Beasley Way	0.34	0.77
26 Beasley Way	0.33	0.76
27 Beasley Way	0.43	0.86
31 Beasley Way	**0.01**	0.44
40 Roxborough St	1.20	1.41
42 Roxborough St	1.23	1.44
44 Roxborough St	1.16	1.33
46 Roxborough St	0.53	0.86
50 Roxborough St	0.39	0.81
52 Roxborough St	**0.17**	0.64
54 Roxborough St	**0.00**	0.43
56 Roxborough St	**0.24**	0.46
58 Roxborough St	0.35	0.62
60 Roxborough St	0.37	0.68
62 Roxborough St	0.39	0.75
64 Roxborough St	**0.09**	0.44
68 Roxborough St	0.44	0.80
79 Roxborough St	0.40	0.96
81 Roxborough St	0.68	1.04

The outcomes of this modelling show that:

- Under the 1% AEP with climate change event there are five properties where the freeboard is below 0.3m (shown in bold). Three of those properties have less than 0.1m freeboard and two with practically no freeboard.
- The surveyed properties all have more than 0.3m freeboard under the 1% AEP event.

4.3 Property flood levels

Peak water levels at properties affected by the 1% AEP plus climate change scenario event were determined from the flood modelling results. The results are tabulated by property and will be provided to Council in spreadsheet format.

5 Conclusions

Scenic Rim Regional Council (SRRC) has recently updated its existing flood modelling across all of its major waterway catchments to gain a better understanding of the Natural Hazard (Flood) characteristics. This study consisted of undertaking detailed modelling of the Canungra township area for the 1% AEP plus RCP 4.5 climate change scenario.

Hydrologic modelling has been adopted and applied form the existing Albert River RAFTS hydrologic model which incorporates the Canungra Creek catchment. Hydraulic modelling of the Canungra township area has been carried out with development of a localised 2D TUFLOW hydraulic model based on the wider regional model of the Canungra Creek catchment.

The wider Canungra Creek modelling was calibrated to key historical events, including the 1974,1990, 2008 and 2013 events, with a focus on the 2008 event as it had the most historical data available.

The 1% AEP plus RCP 4.5 climate change scenario design event (using ARR 2019 guidelines) has been run through the calibrated hydraulic model. The RCP 4.5 climate change scenario was assessed to the 2090 planning horizon. This was allowed for by the application of a 12% increase in rainfall as recommended in ARR (2019).

Mapping of the modelling results has been prepared and includes flood inundation extents, peak water levels, depths, velocities, and hazard zoning in accordance with the EMA guidelines.

6 Assumptions, limitations and recommendations

The following limitations relate to this study:

- No change is proposed to the calibration of the hydrology model as per the 2017 Albert River Flood Study. The limitations associated with model calibration remain as per the original flood modelling.
- The hydrologic model assumes existing development conditions.
- Representation of hydraulic structures through the watercourse are limited to the detail where structure survey has been undertaken at agreed locations.
- The hydraulic modelling presented in this report adopted a 5m grid hydraulic model. This model resolution may not be representative of features such as small local drainage channels.
- Hydraulic models are influenced by the boundary conditions. Areas of flooding in proximity of the downstream boundary condition should be investigated with caution.

The following recommendations are made regarding the future analysis that might be undertaken:

- Information presented in this report is indicative only and may vary, depending upon the level of catchment and floodplain development. Filling of land or excavation and levelling may alter the ground levels locally at any time, whilst errors may occur from place to place in local ground elevation data from which the model has been developed.

7 References

Aurecon 2017, Albert River Flood Study – Final Report

Aurecon 2019, Canungra Creek and Biddaddaba Creek Flood Study

Commonwealth of Australia. (2019). Australian Rainfall and Runoff: A Guide to Flood Estimation. Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors).

BMT WBM, 2010, TUFLOW User Manual

Bureau of Meteorology, 2019, Intensity-Frequency-Duration data

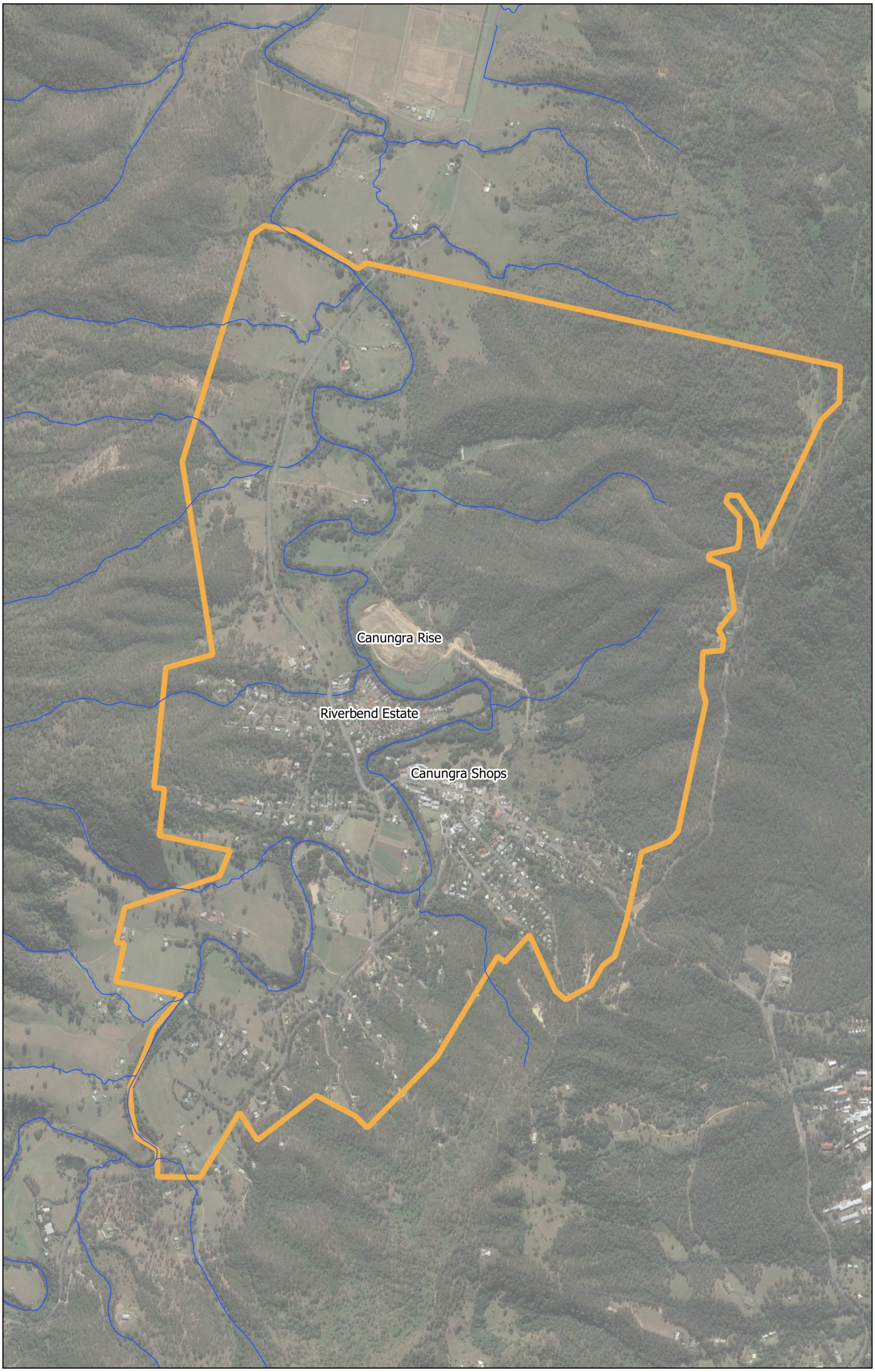
CSIRO, 2000, Floodplain Management in Australia: Best Practice Principles and Guidelines, SCARM Report

Emergency Management Australia, 2013, Managing the floodplain: a guide to best practice in flood risk management in Australia – Handbook 7

Institution of Engineers Australia, 1987, Australian Rainfall & Runoff: A guide to Flood Estimation

Appendix A
Figures

Figure	Description
Figure A1	Locality
Figure A2	Hydrologic Model Layout
Figure A3	TUFLOW Model Extent - Regional vs Sub-model
Figure A4	TUFLOW Roughness
Figure A5	TUFLOW Model Setup
Figure A6	1% AEP with Climate Change - Depth with 5m Water Surface Level Contour
Figure A7	1% AEP with Climate Change - Velocity
Figure A8	1% AEP with Climate Change - Hazard
Figure A9	1% AEP with Climate Change Freeboard to Floor Level - Canungra Rise
Figure A10	1% AEP Freeboard to Floor Level - Canungra Rise



aurecon

Legend

Watercourses - Canungra Creek
Canungra Urban Development Footprint

Notes:

P:\SWM\Work\502966 - Canungra Flood Study\Mapping

Map by: ST

0 600 1200 m

A3 Scale: 1:16000

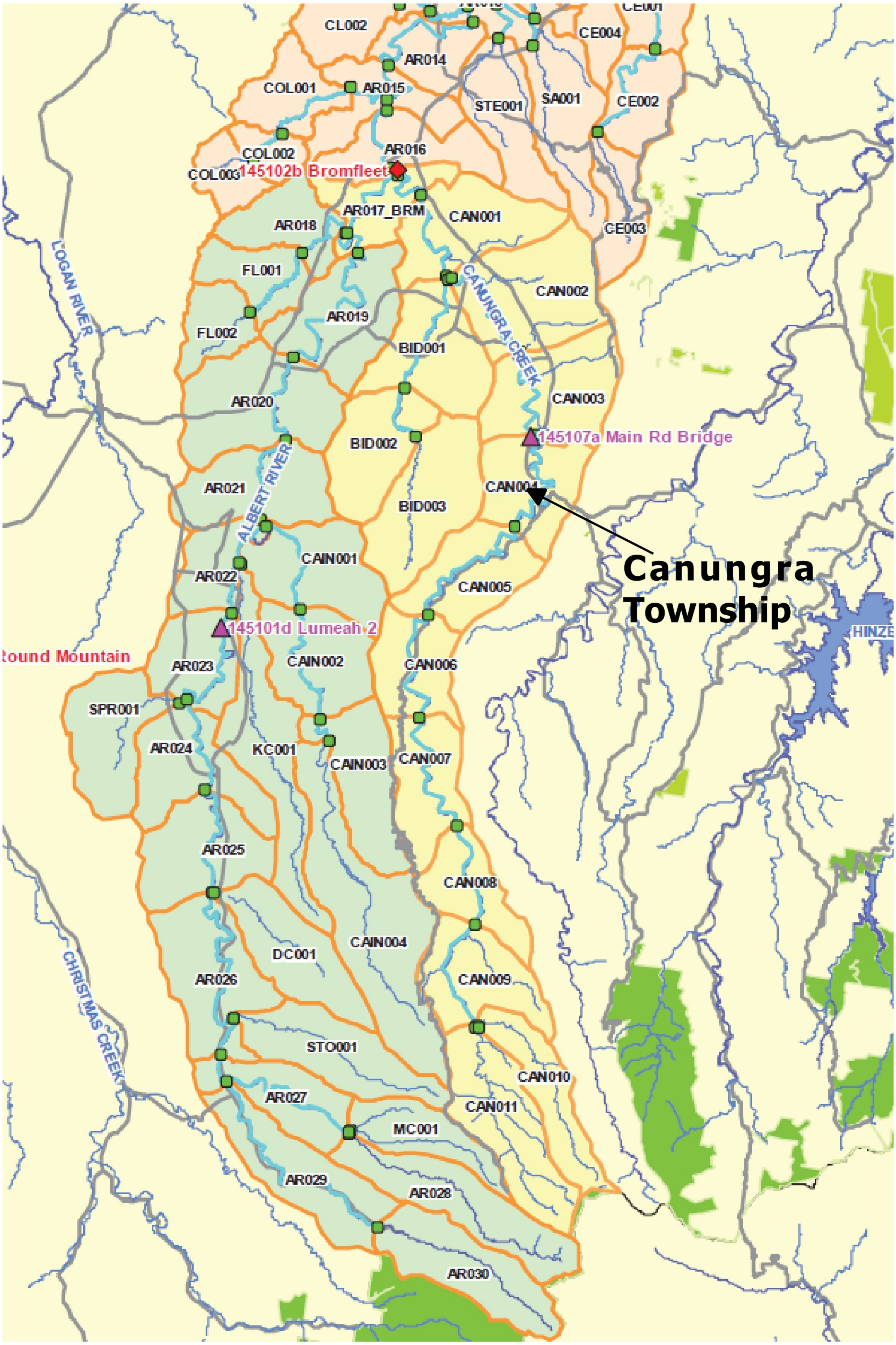
11/2/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A1 - Locality

Document Set ID: 11341510
Version: 1, Version Date: 20/07/2021

aurecon



Legend

- Canungra Creek Catchment
- Biddaddaba Catchment

Notes:

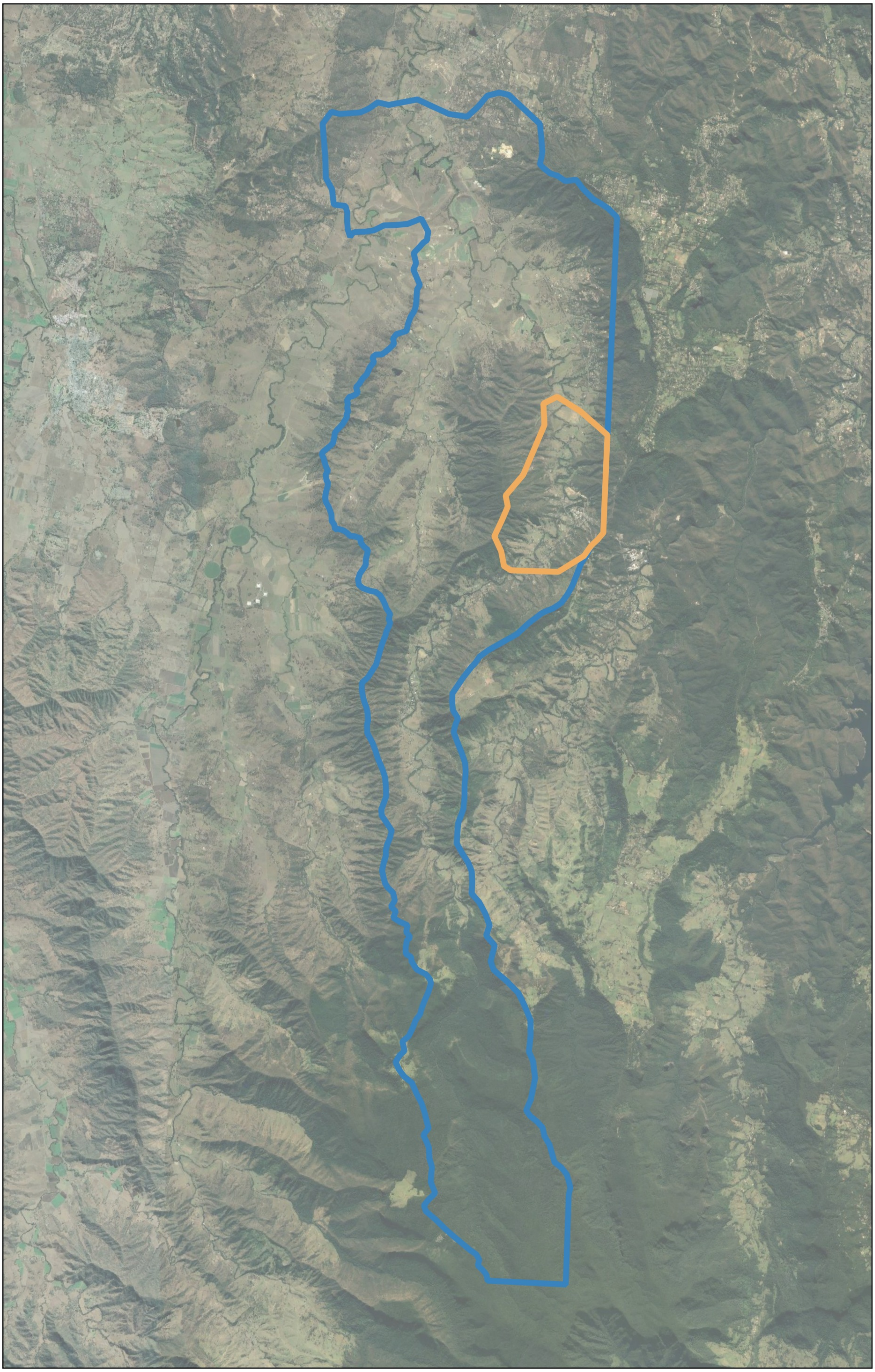
P:\SWM\Work\502966 - Canungra Flood Study\Mapping

Map by: ST

11/2/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A2 - Hydrologic Model Layout



aurecon

Legend

Detailed Town Model Boundary
Regional Model Boundary

Notes:

P:\SWM\Work\502966 - Canungra Flood Study\Mapping

Map by: ST

0 4000 8000 m

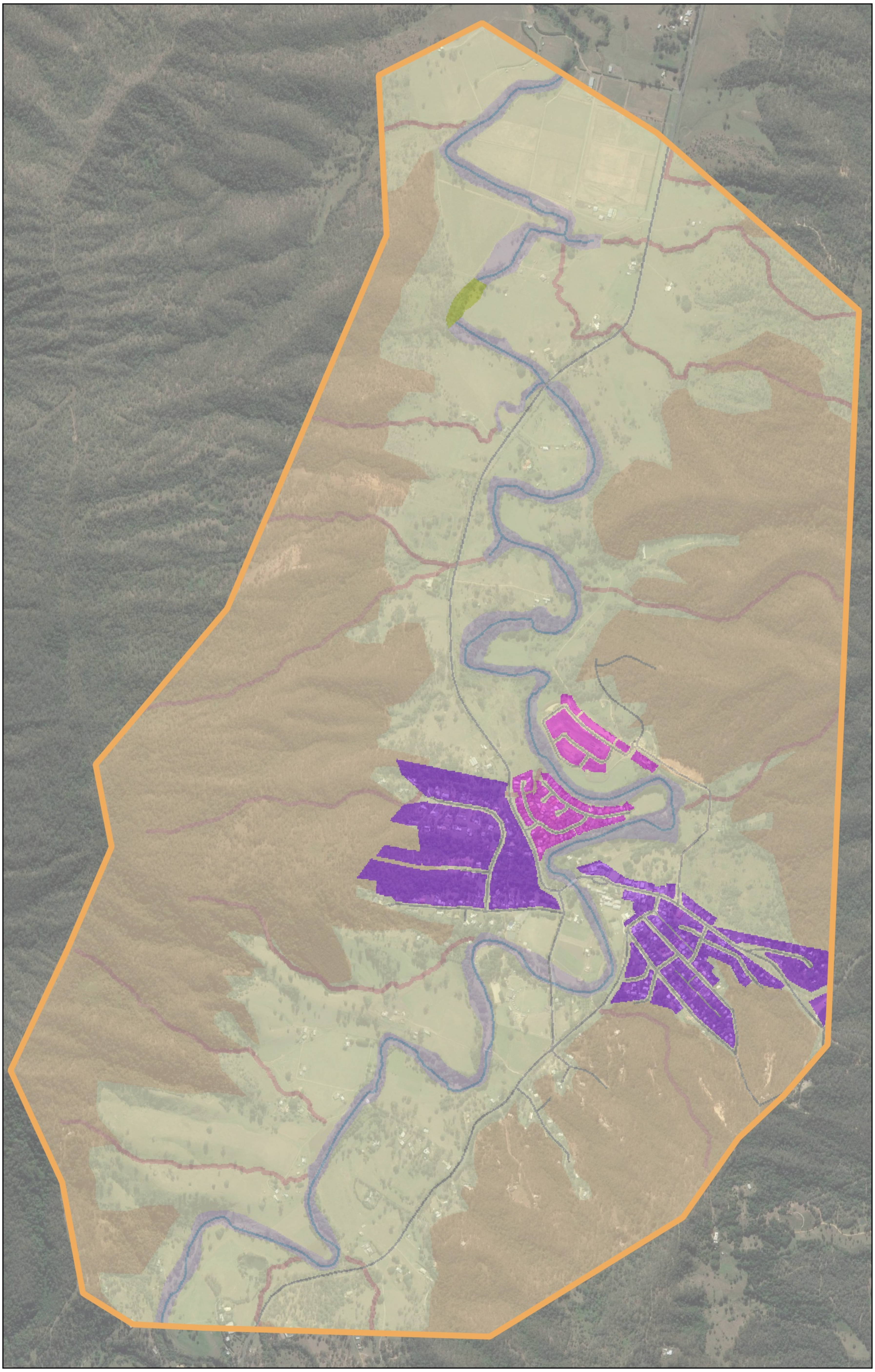
A3 Scale: 1:120000

11/2/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A3 - TUFLOW Model Extent - Regional vs Sub-model

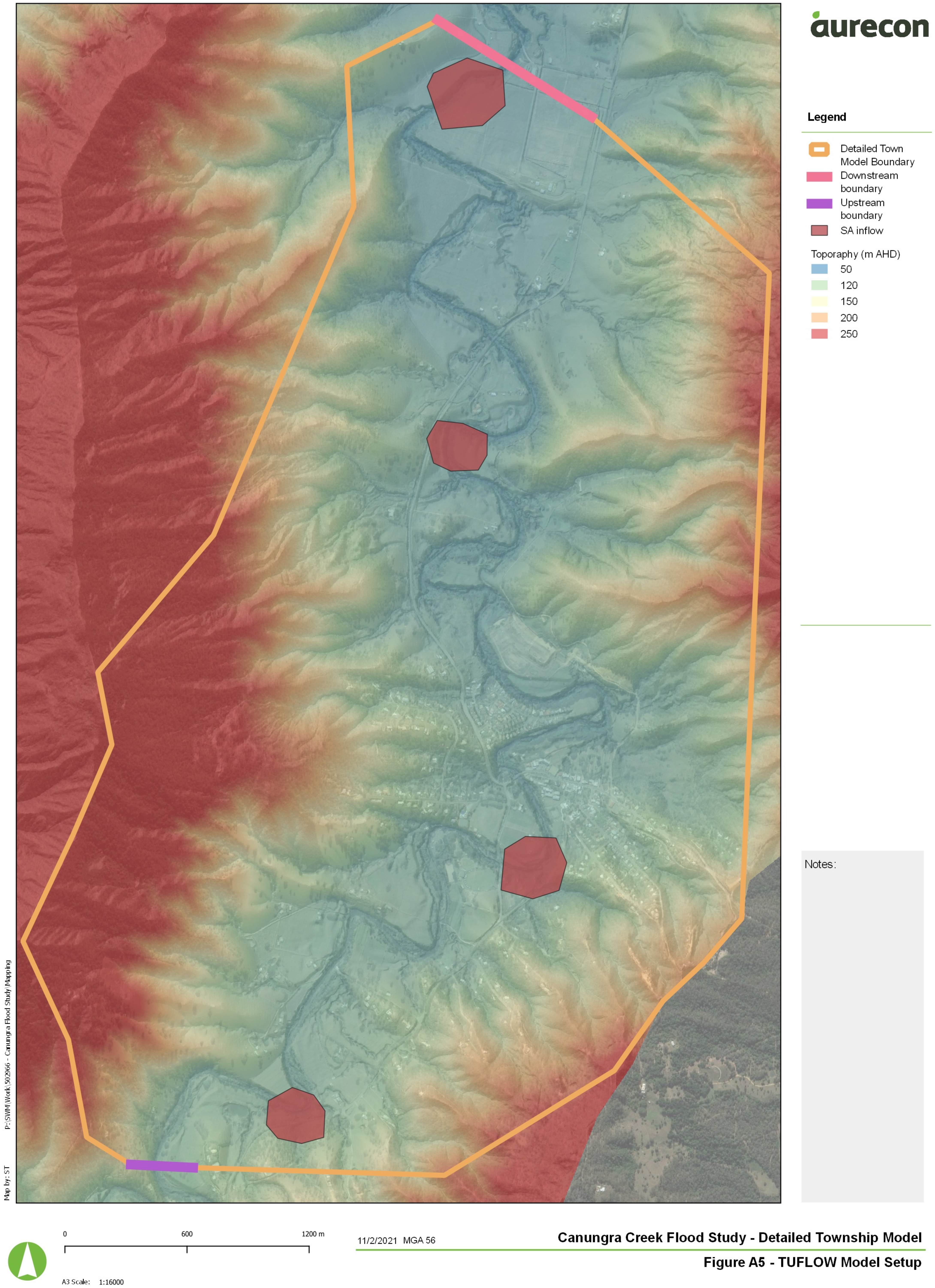
![aurecon]



15/7/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

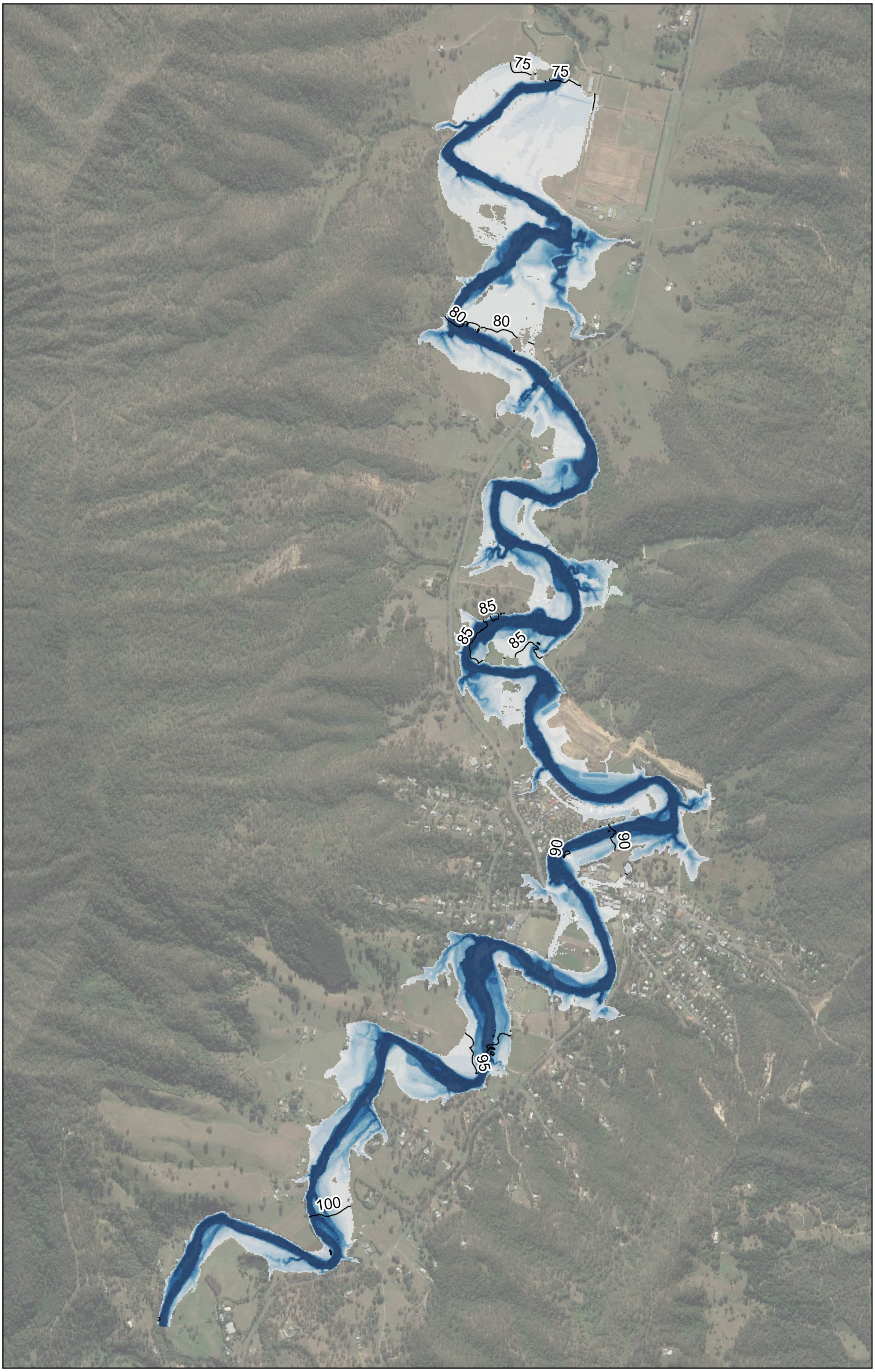
Figure A4 - TUFLOW Roughness



11/2/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A5 - TUFLOW Model Setup



aurecon

Legend

Depth (m)
- 0 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 3.5
- 3.5 - 4
- 4 - 4.5
- 4.5 - 5
- More than 5

Notes:

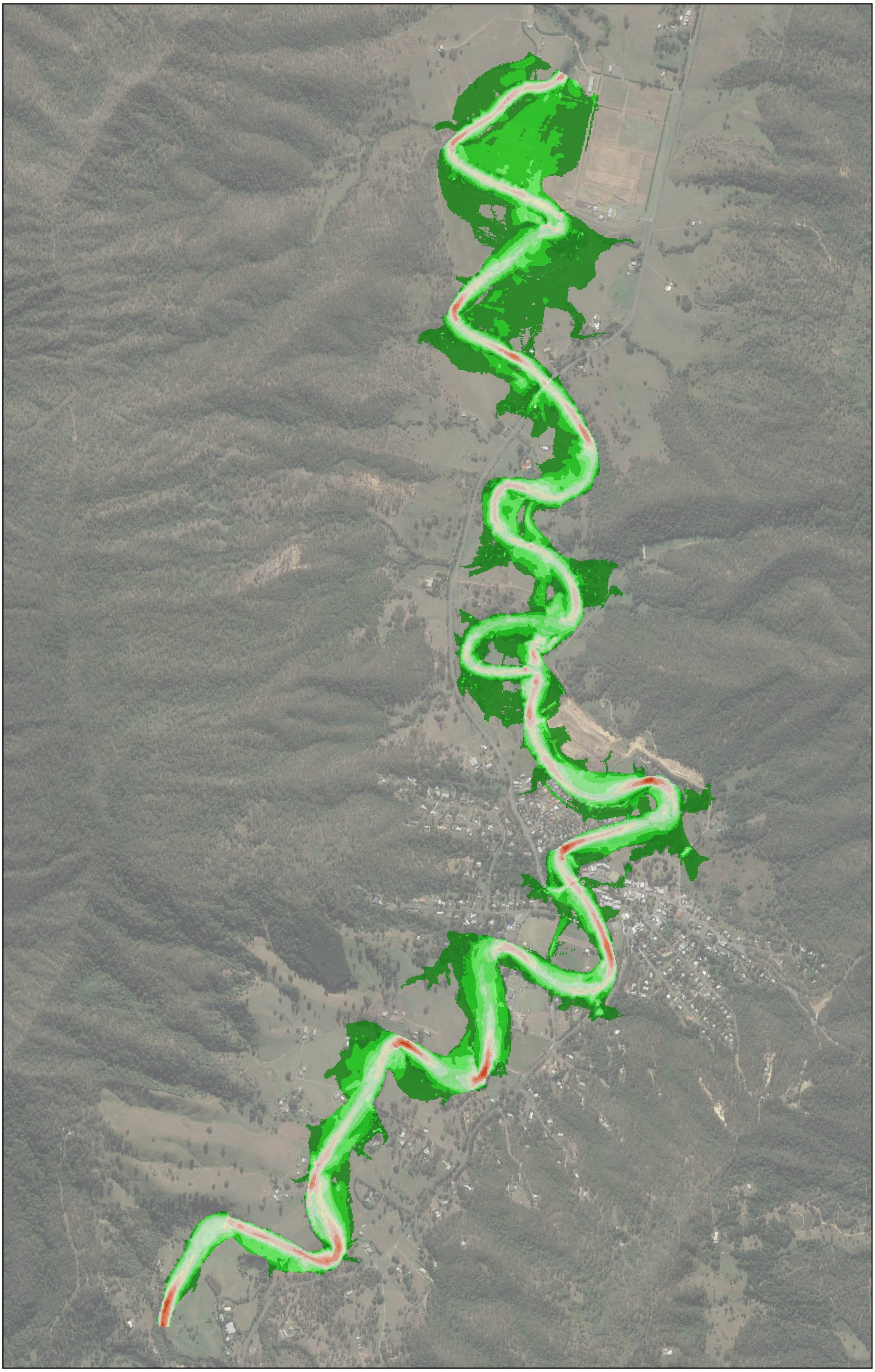
0 600 1,200 m

A3 Scale: 1:16,000

15/7/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A6 - 1% AEP with Climate Change - Depth with 5m Water Surface Level Contours



aurecon

Legend

Velocity (m/s)

- <= 0 - 0.25
- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- > 5.0

Notes:

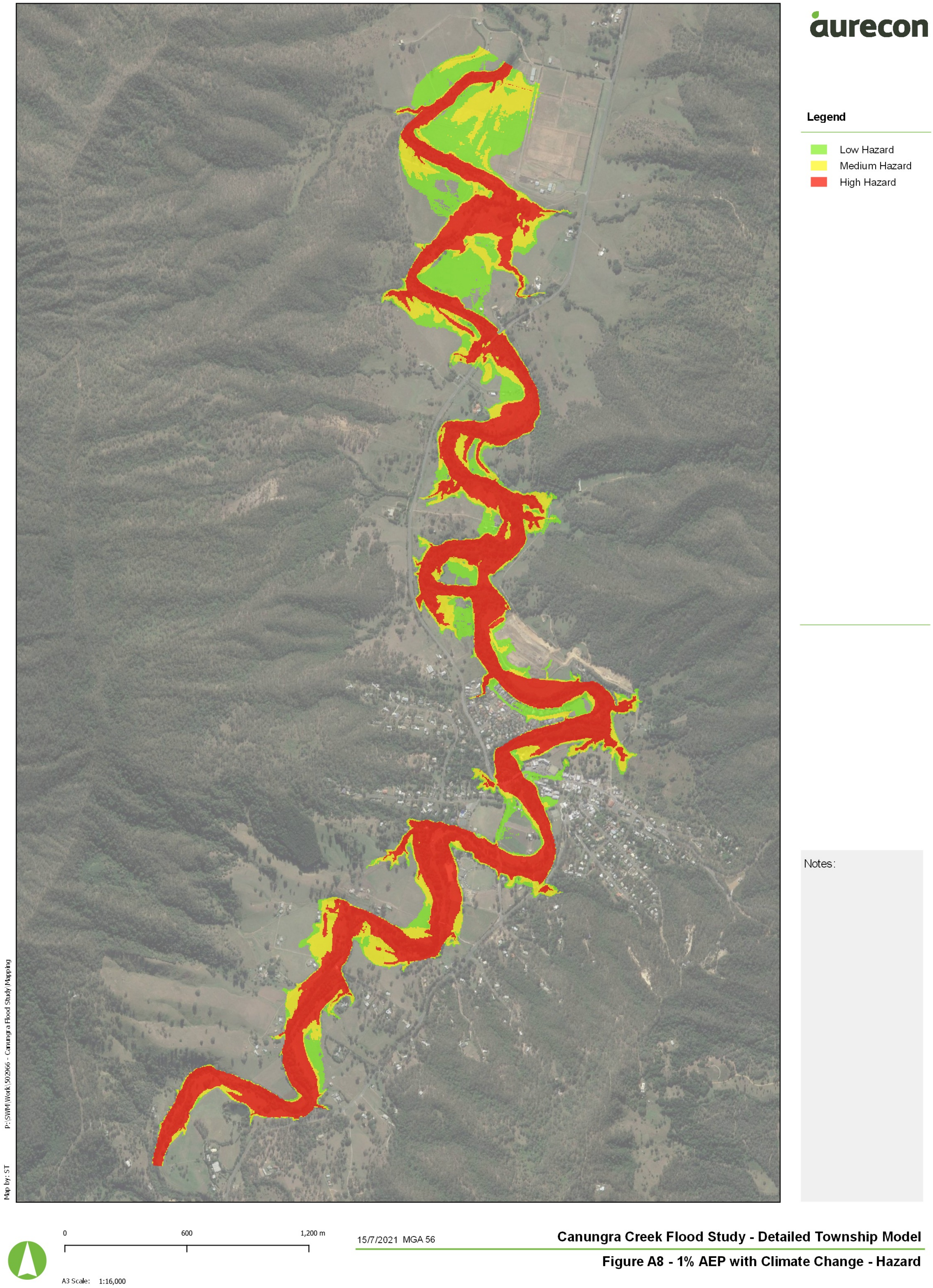
0 600 1,200 m

A3 Scale: 1:16,000

15/7/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

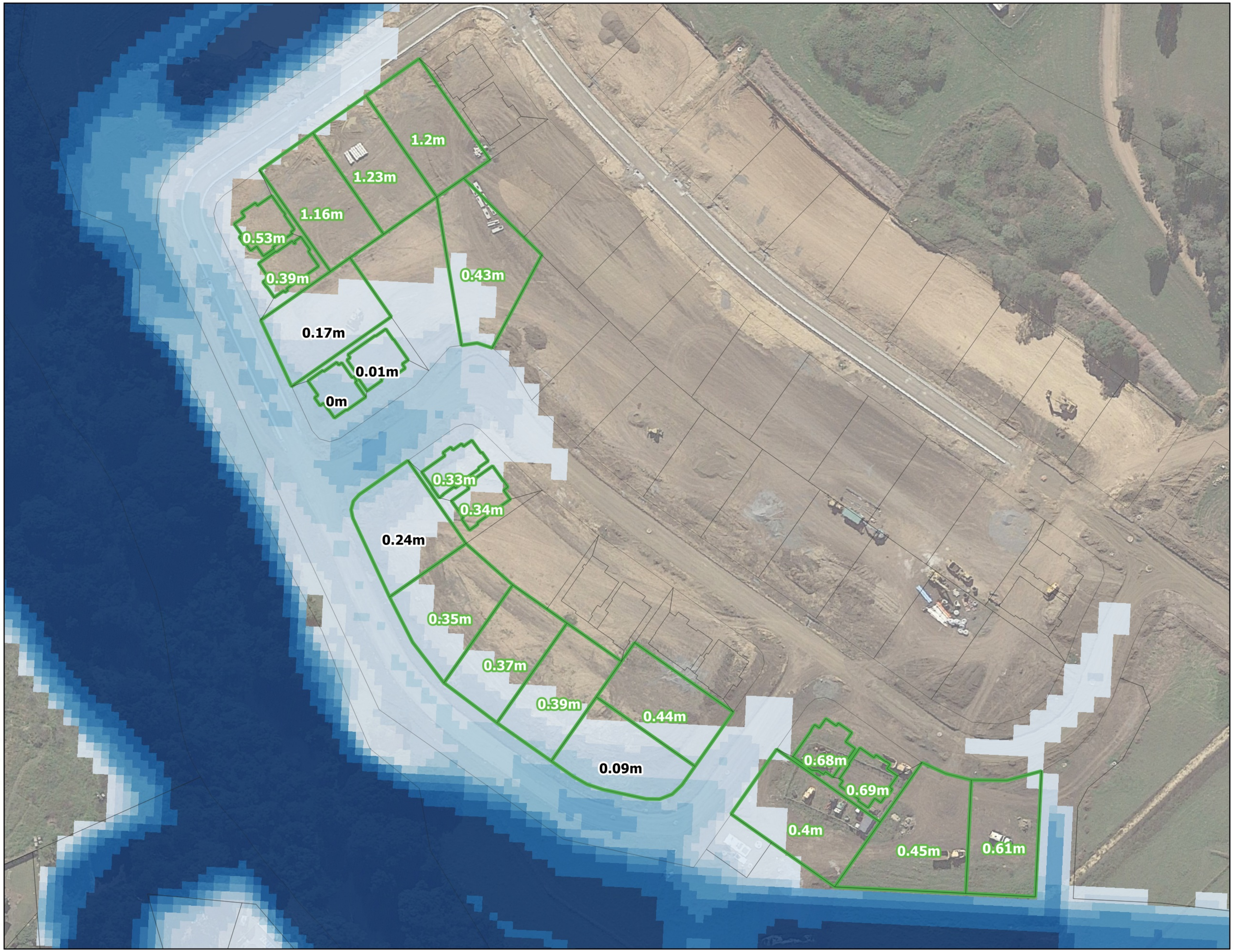
Figure A7 - 1% AEP with Climate Change - Velocity



15/7/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A8 - 1% AEP with Climate Change - Hazard



aurecon

Legend

- Freeboard to floor level
- Cadastre

Depth (m)

- <= 0
- 0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 3
- > 3

Notes:

0 40 80 m

A3 Scale: 1:1200

27/1/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A9 - 1% AEP with Climate Change Freeboard to Floor Level - Canungra Rise

aurecon

Legend

Freeboard to floor level
Cadastre
Depth (m)
<= 0
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
1 - 1.5
1.5 - 2
2 - 3
> 3

Notes:

P:\SWM\Work\502966 - Canungra Flood Study\Mapping

Map by: ST

0 40 80 m
A3 Scale: 1:1200

27/1/2021 MGA 56

Canungra Creek Flood Study - Detailed Township Model

Figure A10 - 1% AEP Freeboard to Floor Level - Canungra Rise

Appendix B
3D Canungra Rise Data Extent

Document prepared by

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Ground Floor, 25 King Street
Bowen Hills QLD 4006
Locked Bag 331
Brisbane QLD 4001
Australia

T +61 7 3173 8000
F +61 7 3173 8001
E brisbane@aurecongroup.com
W aurecongroup.com

Bringing ideas to life