2007 Flooding Between Urbenville and Woodenbong
Photo Source: NSW SES

URBENVILLE AND WOODENBONG FLOOD STUDY

TENTERFIELD SHIRE COUNCIL
KYOGLE COUNCIL

ISSUE / Final Report
CLIENT / Tenterfield Shire Council & Kyogle Council
DATE / 09/02/2022
BG&E PROJECT NO / S20128

www.bgeeng.com

CONTENTS

APPENDICES

Document *Control*

Revision	Date	Description	Prepared	Reviewed	Approved
A	20/09/2021	Draft	S Mortimer	L Baxter	L Baxter
B	01/11/2021	Public Exhibition Report	S Mortimer	L Baxter	L Baxter
C	09/02/2022	Final report	S Mortimer	L Baxter	L Baxter

GLOSSARY AND ABBREVIATIONS

1d	**1-dimensional – in flood modelling this typically refers to models where flow moves perpendicular to given cross sections. In these study 1d elements have been embedded in the 2d model to represent drainage.**
2d	2-dimensional – in flood modelling this typically refers to the modelling of a gridded elevation surface (DEM) over which runoff can move in all direction on a 2-dimenasional plane eg left, right, backward, forwards.
AEP	Annual Exceedance Probability – the chance of a flood of a given size or larger occurring in any one year, usually expressed as a percentage.
AHD	Australian Height Datum
AIDR	Australian Institute for Disaster Resilience
ARI	Average Recurrence Interval – the long term average number of years between the occurrence of a flood as larger as or larger than the selected event.
ARR2019	Australian Rainfall and Runoff 2019 (Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019). A national guideline used for flood estimation across Australia.
ARR87	Australian Rainfall and Runoff 1987 (Institution of Engineers Australia, 1987). A national guideline to flood estimation now updated with ARR2019.
BoM	Bureau of Meteorology
Catchment	Land area draining to a given point
Cumec	Cubic metre per section also expressed as m^3/s.
DCP	Development Control Plan
DEM	Digital Elevation Model
DFE	The Defined Flood Event (DFE) is selected by council for floodplain risk management purposes for an area/catchment, generally through the FRM process outlined in the Floodplain Development Manual. DFEs form the basis for determining the level of exposure to flooding and associated risks to life and property damage. The manual identifies the 1% AEP flood event, or an equivalent historic flood, as an appropriate starting point for determining the DFE for development controls
Discharge	The rate of flow of water typically measures in volume per unit of time, for example m^3/s
DPIE	Department of Planning, Industry and Environment
Effective warning time	The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

EY	Exceedances per Year
FDM	Floodplain Development Manual 2005
FFA	Flood Frequency Analysis – a statistical means of establish the Annual Exceedance Probability of flood based on gauged data records.
Flash flooding	Flooding which is often sudden and can be unexpected. Usually caused by localised intense rainfall. Often defined as flooding which peaks within six hours of the causative rain (Floodplain Development Manual: the management of flood liable land, April 2005).
Flood fringe	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood prone land	Land subject to flooding up to and including the Probable Maximum Flood (PMF) extent.
Flood storage area	Those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
FPA	Flood Planning Area is land at or below the Flood Planning Level (FPL)
FPL	Flood Planning Level is a combination of the flood level from the defined flood event (DFE) and freeboard selected for flood risk management purposes.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the Flood Planning Level (FPL) is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the Flood Planning Level.
FRM	Flood Risk Management
FRMC	Floodplain Risk Management Committee
FSL	Full Supply Level – refers to the top design water level in a dam.
ha	hectares
Habitable Room	In a residential situation: a living or working area such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Hazard	A source of potential harm or a situation with a potential to cause loss.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.

Hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
ICM	InfoworksICM – a hydrology and hydraulic modelling software. For this study ICM has been used as the rainfall routing model.
LEP	Local Environmental Plan
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. In this study, local overland flooding refers to flooding caused by the local catchments and rainfall within the township areas.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam. In this study mainstream flooding refers to flooding from Tooloom Creek.
ML	megalitre
NSW	New South Wales
PMF	Probable Maximum Flood - the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
PMP	Probable Maximum Precipitation - the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
Rainfall routing model	A hydrology models which converts rainfall depths over time to a flow hydrograph.
RFFE	Regional Flood Frequency Estimation
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood e.g. AEP
Runoff	Rainfall which actually ends up as streamflow.
SES	State Emergency Services
TUFLOW	Hydraulic modelling software for flood, urban drainage, estuarine and coastal assessments.

TERMINOLOGY

Australian Rainfall and Runoff 2019, referred to as ARR2019, describes terminology for describing the frequency of flooding which has been adopted in this Flood Study report.

Frequency Descriptor	EY	AEP (%)	AEP (1 in x)	ARI
Very Frequent	12			
	6	99.75	1.002	0.17
	4	98.17	1.02	0.25
	3	95.02	1.05	0.33
	2	86.47	1.16	0.5
	1	63.21	1.58	1
Frequent	0.69	50	2	1.44
	0.5	39.35	2.54	2
	0.22	20	5	4.48
	0.2	18.13	5.52	5
	0.11	10	10	9.49
Rare	0.05	5	20	19.5
	0.02	2	50	49.5
	0.01	1	100	99.5
Very Rare	0.005	0.5	200	199.5
	0.002	0.2	500	499.5
	0.001	0.1	1000	999.5
	0.0005	0.05	2000	1999.5
Extreme	0.0002	0.02	5000	4999.5
			↓	
			PMP/ PMP Flood	

Preferred terminology indicated in blue. Source ARR2019

Figure T-1-1: ARR2019 Terminology (Preferred terminology indicated in blue)

EXECUTIVE SUMMARY

Purpose of the Urbenville and Woodenbong Flood Study

The Urbenville and Woodenbong Flood Study has been prepared under the Floodplain Risk Management Process to develop a detailed understanding of the flood behaviour at both Urbenville and Woodenbong from both Tooloom Creek (mainstream flooding) and from the local catchment and overland flows through the townships. In addition, Boomi Creek has also been considered.

Detailed hydrologic analysis and hydraulic modelling has been undertaken to map the predicted flood extents, levels, depths, velocities and hazards associated with a range of design flood events; 20% AEP, 5% AEP, 1% AEP, 0.2% AEP and PMF events. Predicted effects of climate change on flood behaviour are also presented.

The information in this Flood Study will be used to inform the subsequent Floodplain Risk Management Study and Plan which will set out flood risk management measures to minimise the risk and consequences of future flooding.

Flooding in the Study Area

Flooding at Woodenbong and Urbenville are subject to two types of flooding; overland flows from local catchments and mainstream from Tooloom Creek and its tributaries.

At Woodenbong, flooding is affected by local overland flows due to the terrain and Woodenbong sitting on a high point in comparison to Tooloom Creek. Overland flows join Black Gully which overtops Roseberry Street and affects properties to the south in severe events. This tributary then drains into Tooloom Creek. The local catchment of Woodenbong is 8.4 km^2 and the catchment area of Tooloom Creek upstream of Woodenbong is 112 km^2.

At Urbenville, flooding is dominated by Tooloom Creek especially in the larger events. There is overland flow flooding throughout the town in smaller events and in the north east of the town in larger events between Beaury Street and Stephen Street. The catchment of Tooloom Creek upstream of Urbenville is 170.9 km^2, the local catchment of Urbenville is 2.6 km^2, and the catchment of Boomi Creek which intersects with Tooloom Creek downstream of the Urbenville is 114.8 km^2.

Community Consultation and Public Exhibition

In preparing the Flood Study information was sought from the community with regard to their experiences of flooding. This was used in validating the findings of the flood modelling against actual event-based data.

A public exhibition has been held prior to Council adopting this final report. The community and key stakeholders were invited to provide further comment on the study findings. Presentations on the study methodology and findings were made to both Tenterfield Shire Councillors and the Urbenville Progress Association and a project website was created including animations of flood behaviour and a summary of the report findings.

1 INTRODUCTION

1.1 The Floodplain Risk Management Framework

The NSW Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources, April 2005) and Australian Institute for Disaster Resilience's Handbook 7 (Managing the Floodplain; A Guide to Best Practice in Flood Risk Management in Australia, 2017), sets out the floodplain risk management process and provides guidance to local councils for the development of flood studies to lead to the development and implementation of floodplain risk management plans.

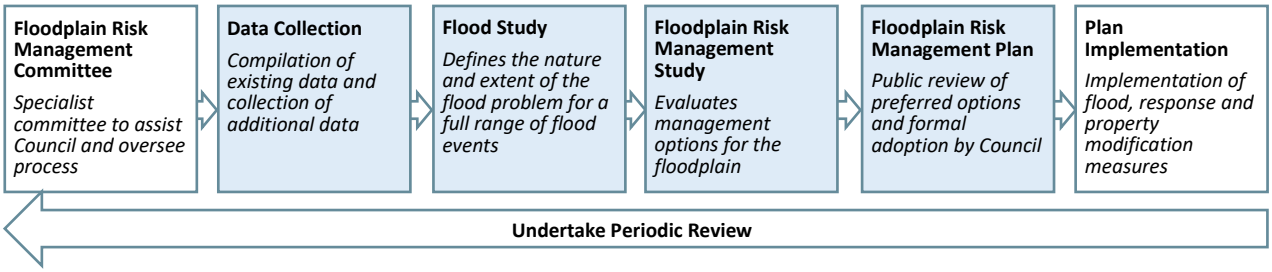


Figure 1-1: Floodplain Risk Management Framework

This is typically overseen by a Floodplain Risk Management Committee (FRMC) comprising representatives from Council and other interested parties including NSW State Emergency Services (NSW SES), Department of Planning, Industry and Environment (DPIE) any other key stakeholders.

For the Urbenville and Woodenbong areas, no detailed studies have been undertaken in the past and planning has been based on previous known flood events. The Urbenville and Woodenbong Flood Study provides opportunity for Council and other interested stakeholders to understand in detail, the flood behaviour in the area and allows, though the later Floodplain Risk Management Study and Plan, to improve safety of the community through flood related development controls and evacuation and warning, provisions of cost-effective flood mitigation measures and improve community awareness.

1.2 Purpose of the Urbenville and Woodenbong Flood Study

The Urbenville and Woodenbong Flood Study has been prepared to provide a detailed understanding of the precited flood behaviour at each town from Tooloom Creek (mainstream flooding) and also from the local catchments comprising both local tributaries to Tooloom creek and local overland flows. The findings of the Flood Study will inform a later Floodplain Risk Management Study and Plan for each town which will investigate options for flood mitigation to minimise future losses due to flooding including flood planning development controls and options such as drainage upgrades, flood protection levees etc. At present, flood planning for both areas is based on anecdotal flood evidence of the highest flooding through the towns. The Flood Study is also important to inform emergency planning and has been prepared to address the Floodplain Risk Management Guideline SES Requirements from the FRM Process (Department of Environment and Climate Change, 2007).

2 BACKGROUND

2.1 The Study Area

The project study area (refer Figure 2-1) includes the townships of Urbenville and Woodenbong as well as Tooloom Creek and Boomi Creeks between the two townships. The study focusses on mainstream flooding from the two creeks and its effect on travel between the two locations as well as local overland flows affecting the each of the towns.

Urbenville, is mostly within the Tenterfield Shire local government area and is situated 13 km south of Woodenbong which is located in the Kyogle local government area. The local government boundary largely follows the line of Tooloom Creek. Although in different local government areas, Urbenville and Woodenbong have close ties, connected by Clarence Way with the local Muli Muli Aboriginal Community located between the two townships. The communities share resources and community facilities such as the high school located in Woodenbong and the hospital located in Urbenville.

2.2 The Catchment Area

To the Toolom Falls the combined catchment area is 312.6 km^2. To their confluence near Urbenville, Tooloom Creek and Boomi Creek have catchment areas of about 170.9 km^2 and about 114.8 km^2 respectively. Smaller sub-catchments drain through the towns (refer Figure 2-2). At Urbenville, an unnamed tributary to Tooloom Creek flows south west of the town draining a catchment area of about 2.3 km^2.

At Woodenbong, a tributary to Tooloom Creek known as Black Gully flows east to west along the north side of the town. A smaller tributary of Black Gully flows through the town east of properties on Richmond Street. A levee was constructed in Richmond Street to provide some protect from flooding during minor flood events. Overland flows also occur within the town from stormwater runoff. To Tooloom Creek the total catchment area is about 8.4 km^2. The catchment of Tooloom Creek upstream of Woodenbong is 112 km^2.

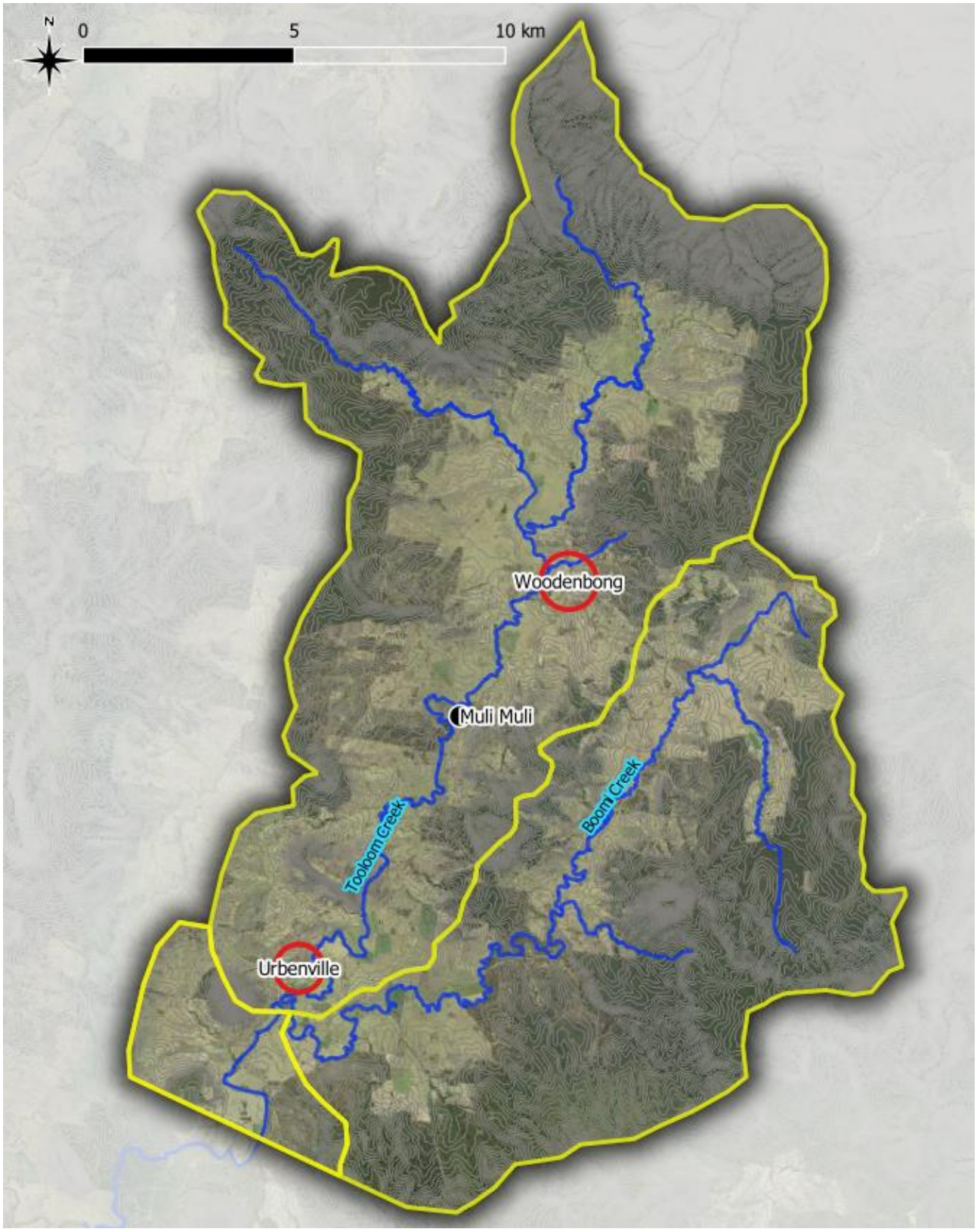


Figure 2-1: The study area and Tooloom and Boomi Creek catchment area

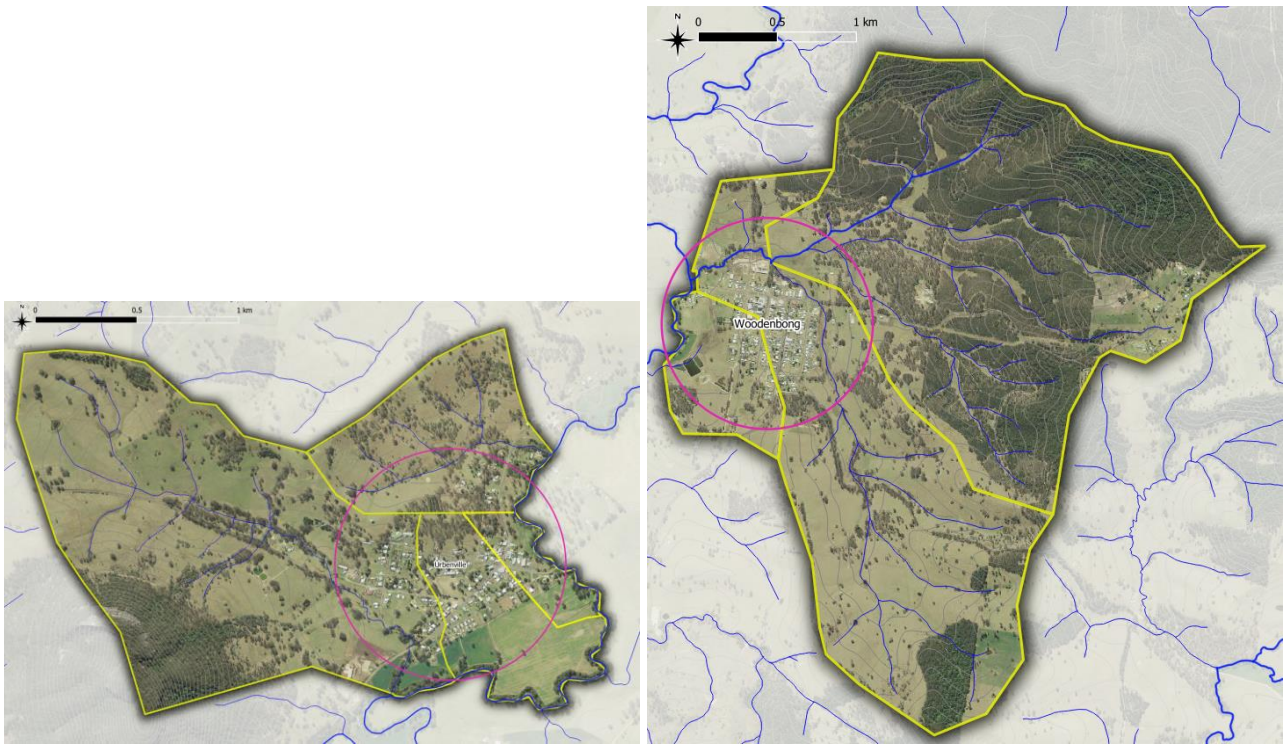


Figure 2-2: Local catchments at Urbenville (left) and Woodenbong (right)

2.3 Historic Flooding

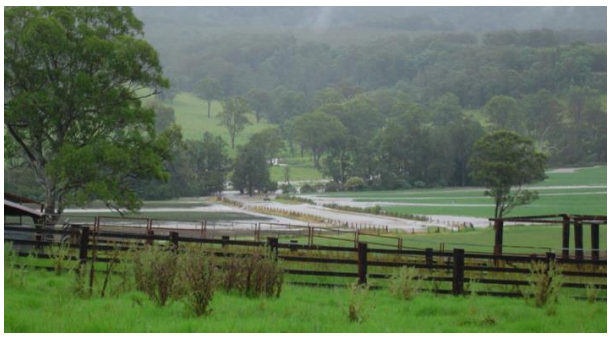
The Tooloom Creek and Boomi Creek valleys that connect Urbenville and Woodenbong are subject to flooding causing inundation of the roads and isolating the community. Flooding also can occur in the towns from the local creeks and overland flows.

In events such as December 2010, January 2011, January 2013, March 2016, March 2017 rising flood waters from Tooloom Creek cut of the road between Urbenville and Woodenbong resulting in isolation of residents.

Damage to the road during flood events prolongs the period of closure. For example following the January 2011 the road about 9 km south of Urbenville was severely damaged meaning the road had to be closed to traffic until it could be repaired.

Recent flooding occurred in 2010, 2011 2013, 2016 and 2017. Although roads were cut and the villages isolated, no floor levels were reported as being inundated. However, elevated homes in the low-lying areas of Urbenville were surrounded by flood waters. These flood events were smaller and more frequent than a 20% AEP event on the Tooloom Creek catchment and larger flood events could occur.

While a number of small floods have occurred in recent years, it has been some time since the Tooloom Creek catchment has suffered from a major flood. Flooding in 1950 and 1954 is thought to be some of the highest on record although there is limited available observed data. From rainfall gauges these events were estimated to be in the order of a 45% to 5% AEP rainfall event.



Looking down from Tooloom Street (Source: Urbenville SES)

Figure 2-3: Photographs of Flooding in the Study Area – December 2010

Tooloom Road (Source: Urbenville SES)

Urbenville Showgrounds (Source: Urbenville SES)

Figure 2-4: Photographs of Flooding in the Study Area – January 2011

Tooloom Road north east of Tooloom Creek Bridge (flooding from overland flows) (Source: Urbenville SES)

Flooding on Urben Street from local catchment (Source: Urbenville SES)

Elevated house Tooloom Street surrounded by waters (Source: Urbenville SES)

Figure 2-5: Photographs of Flooding in the Study Area – January 2013

Urbenville Showgrounds (Source: Urbenville SES)

Clarence Way heading towards Bonalbo (Source: Urbenville SES)

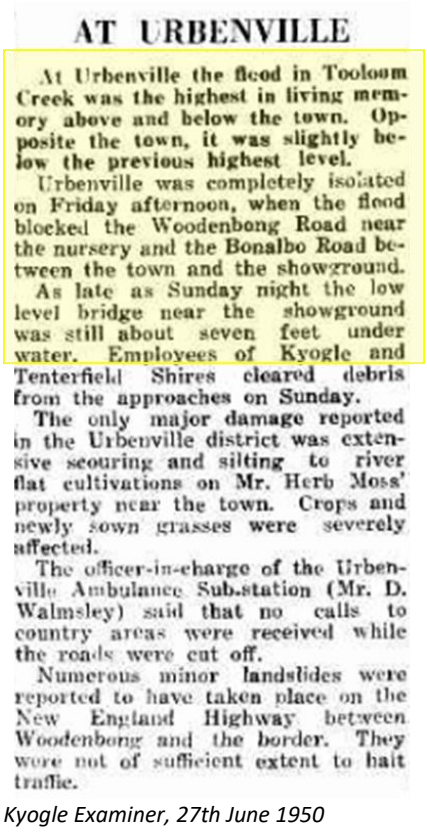
Figure 2-6: Photographs of Flooding in the Study Area – March 2016

On the road between Urbenville and Woodenbong (Source: Urbenville SES)

On the road between Urbenville and Woodenbong (Source: Urbenville SES)

Flooding around elevated homes on Toloom Street (Source: Urbenville SES)

Figure 2-7: Photographs of Flooding in the Study Area – March 2017



AT URBENVILLE

At Urbenville the flood in Tooloom Creek was the highest in living memory above and below the town. Opposite the town, it was slightly below the previous highest level.

Urbenville was completely isolated on Friday afternoon, when the flood blocked the Woodenbong Road near the nursery and the Bonalbo Road between the town and the showground.

As late as Sunday night the low level bridge near the showground was still about seven feet under water. Employees of Kyogle and Tenterfield Shires cleared debris from the approaches on Sunday.

The only major damage reported in the Urbenville district was extensive scouring and silting to river flat cultivations on Mr. Herb Moss' property near the town. Crops and newly sown grasses were severely affected.

The officer-in-charge of the Urbenville Ambulance Sub-station (Mr. D. Walmsley) said that no calls to country areas were received while the roads were cut off.

Numerous minor landslides were reported to have taken place on the New England Highway between Woodenbong and the border. They were not of sufficient extent to halt traffic.

Kyogle Examiner, 27th June 1950

WOODENBONG

Flood Damage

Woodenbong was left high and dry by the recent flood, but was completely isolated from the outside world for a couple of days.

All telephonic communications were cut off also.

Urbenville Road was the first trafficable on the Monday following the flood's climax.

It was not until last Wednesday that traffic was able to get beyond Urbenville.

Traffic, including Watson's truck with clothing for Kyogle from Woodenbong, got through to Kyogle on the next day.

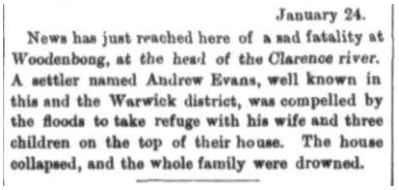
Clothing was also sent on the following Thursday and Friday and Woodenbong schoolchildren sent 100 loaves of bread to Kyogle people.

Many travelers were stranded at the Hotel Woodenbong and a Casino family there were wondering if their home was still safe.

One guest at the hotel, a diabetic, ran out of insulin and was supplied by the Woodenbong Bush Nurse.

Mr. Ernie Martin, a local grazier, had to do a lot of swimming after his cattle and saved all except one cow which was calving.

Kyogle Examiner, 5th March 1954



January 24.

News has just reached here of a sad fatality at Woodenbong, at the head of the Clarence river. A settler named Andrew Evans, well known in this and the Warwick district, was compelled by the floods to take refuge with his wife and three children on the top of their house. The house collapsed, and the whole family were drowned.

Warwick Argus, 25th Jan 1887

Figure 2-8: News articles detailed flooding at Urbenville and Woodenbong

2.4 Flood Behaviour

2.4.1 Urbenville

At Urbenville, flooding from Tooloom Creek is the dominant source of flooding. This is due to the winding nature of the creek creating slowing down the conveyance of floodwaters within the natural creek bed. The intersection of the Boomi and Tooloom Creek occurs just downstream from Urbenville which also contributes to the higher creek levels.

Flooding caused by overland flows affects Welch and Urben Streets. The majority of local overland flooding travels down the natural channel south of Urbenville Road to Tooloom Creek. In the 20% AEP or more frequent events Tooloom Creek spills from the creek channel into the floodplain and affects properties on the south side of Tooloom Street. These floodwaters build up in the larger events to overtop Tooloom Street and affects properties on the northern side of the street in the 1% AEP event. In the PMF event the creek flood extent spreads further into the town and depths of up to 9 m occur on Tooloom Street.

2.4.2 Woodenbong

At Woodenbong floodwaters from Tooloom Creek are predicted to exceed capacity of the creek channel in the 20% AEP or more frequent events. These inundate the floodplain which includes the sporting fields and showground. Floodwaters from the creek do not encroach into the town until the PMF where it affects the northern most lots of Roseberry Lane.

Local catchment flows at Woodenbong affect properties along Richmond Street as flows from the township and the natural channel in this area encroach into backyards of properties in as frequent as the 20% AEP

event. Mount Lindsay Road also becomes inundated to the east of Richmond Street intersection. Within the town there is minimal flooding within properties as local flows are typically contained within the drainage channels alongside the roads.

2.4.3 Toloom Creek

Throughout the Tooloom Creek catchment, the Tooloom Creek expands into the floodplain in the 20% AEP or more frequent event. There are a number of areas where Clarence Way is overtopped in particular near to Muli Muli. Refer to section 9.2 for more details.

2.4.4 Boomi Creek

Boomi Creek runs alongside Boomi Creek Road until it joins Tooloom Creek downstream of Urbenville. In events more frequent that the 20% AEP event, floodwaters spread out of creek channel and into the floodplain. Boomi Creek overtops Boomi Creek Road where the road is in a close vicinity to the creek and where Boomi Creek road crosses the creek. Local tributaries also overtop the road however, these depths typically are less significant than the creek flooding. See section 9.2 for more details.

2.4.5 Muli Muli

Muli Muli is located near to Tooloom Creek on an area of high ground. The town is not affected from flood waters in the 0.5% AEP event but in events greater than this up to the PMF event, Muli Muli Crescent, the street closest to Tooloom Creek, is inundated. Clarence Way to the north and the south is predicted to be flooded events more frequent than the 20% AEP flood event. This road is the only road access way to Muli Muli.

2.5 Relevant Policies, Legislation and Guidance

Flood planning at Urbenville and Woodenbong is governed by local government legislation and policies as well as several NSW and Australia wide Guidance Documents. Development in Urbenville is subject to the flood controls of the Tenterfield Shire Council Local Government Area. Development in Woodenbong is subject to the flood controls of the Kyogle Council Local Government Area.

2.5.1 Local Environmental Plans

The LEP is the principal planning document for the LGA. Flood Planning Areas for Urbenville and Woodenbong are not currently well defined. This Flood Study will provide opportunity to develop suitable Flood Planning Areas for both towns.

With regard to flooding, the LEP applies clauses to areas identified in the Flood Planning Area (FPA). Within areas affected by the FPA, the LEP seeks to ensure that new development is compatible with the flood function and behaviour on the land and does adversely affect flood behaviour in a way that results in detrimental increases in flood affectation and adverse effects on the safe occupation and evacuation of people or environment.

The NSW Flood Prone Land Package replaced previous LEP flood clauses with a new standard clause effective of 14 July 2021. The new clause removes the definition of the Flood Planning Level as the 1% AEP flood level plus 0.5 m freeboard and instead allows Councils to define an appropriate Flood Planning Level through studies such as this one.

2.5.2 Tenterfield Shire Development Control Plan 2014 (amended 2018)

The Tenterfield Shire DCP requires that where there are no available Flood Studies (as currently as is the case for Urbenville) developers may be required to undertake studies including survey and evidence of historic flood levels to show that development will be above designated flood levels.

The DCP defines the Flood Planning Level as the 1% AEP flood level plus 0.5 m freeboard. At present Council use the highest observed flood level plus a freeboard to determine flood levels. At Urbenville this is based on historical flooding at a property on Tooloom Street plus a freeboard. Depths of between 1.0 - 1.2 m were experienced at properties.

2.5.3 Kyogle Development Control Plan 2014

The Kyogle DCP provides controls to manage development within the LGA and is prepared to be consistent with the objectives and provisions of the LEP. With regard to flooding the DCP sets out a number of controls (performance criteria) and acceptable solutions which vary slightly depending on the development type.

Typically development controls require that:

- Buildings, structures and persons on a development site are not exposed to unacceptable risk from flooding including overland flow.
- Rural subdivisions maintain stock access to flood free land and lot layouts maintain access for flood refuge areas.
- Buildings are not located in flood prone land where possible and where a building envelope is proposed on land mapped or known to be flood prone, floor levels of at a least the 1% AEP plus 0.5 m freeboard is achieved.
- Stormwater to be managed so that it does not contribute to flooding or nuisance flooding on adjoining properties.

2.5.4 Guidance Documents

The following key guidance documents are considered in this Flood Study:

- NSW Floodplain Development Manual (2005)
- Australian Rainfall and Runoff 2019 (ARR2019)
- AIDR Handbook Series
- Floodplain Risk Management Guidelines series published by DECC and OEH (now DPIE)

3 REVIEW AND ANALYSIS OF AVAILABLE DATA

3.1 Previous Studies

3.1.1 Kyogle Flood Study (WBM Oceanics Australia, February 2004) and Floodplain Risk Management Plan (BMT WBM, April 2009)

The Kyogle Flood Study and Floodplain Risk Management Plan were adopted in 2009. While the study area does not cover the Urbenville and Woodenbong area, the study and plan provide useful information on the historic rainfall events including the 2008 event.

The study used Australian Rainfall and Runoff 1987 (ARR87) methods and Flood Frequency Analysis (FFA) to determine design event flood behaviour and calibrated the modelling to historic events. The report refers to major flooding around 20 February 1954 as well as smaller flooding in 1974, 1976, 1978, 1980, 1987, 1989,1996, 2001 and 2008. The study found that that the January 2008 event to affect Kyogle was approximately a 2% AEP event.

3.1.2 Tabulam Flood Study (Jacobs, March 2019) and Floodplain Risk Management Study and Plan (Jacobs, December 2019)

Although the study area of the Tabulam Flood Study and Floodplain Risk Management Study and Plan does not cover Urbenville and Woodenbong, the studies provide some insights into historic flooding in the Kyogle LGA noting significant flood events in 1967 and 2011. The study notes that the 1967 event was considerably larger than the 2011 event.

The Tabulam Flood Study undertook FFA (using ARR2016 procedures) to determine design event flood behaviour. The January 2011 event was approximated as a between a 2% AEP and 5% AEP event.

3.2 Historic Data

Historic data was obtained through the community consultation (refer Section 4), data supplied by Tenterfield Shire Council, SES and a search of old media reports. This was used to supplement rainfall gauge data to develop an understanding flood behaviour and also for calibrating and validating the hydrology and hydraulic flood models (refer Section 7).

3.2.1 River Gauges

There are no river gauges within the study area on Tooloom Creek or Boomi Creek.

3.2.2 Rain Gauges

Rainfall data was obtained from Bureau of Metrology (BoM). Within the catchment to the study area there is one rainfall gauge within each town, Urbenville (57020) and Woodenbong (Unumgar Street) (57024). These gauges are daily-read gauges with records back to 1933. Other daily read gauges are sparsely located outside of the catchment area (refer Appendix A). The nearest pluviometry gauges approximately 15 km from the study area. Availability of additional daily-read and sub-daily (pluviograph) gauges are summarised in Table 3-1. Further analysis of the flood events used for calibration is provided in Section 7.

Table 3-1: Rain gauge data availability

Name	BOM Gauge	Year Opened	Year Closed	Gauge Type	Distance to Urbenville (km)	Distance to Woodenbong (km)	Calibration Events Captured
Woodenbong (Unumgar St)	57024	1933	Open	Daily Rainfall	11.2	-	2008, February 2010, December 2010
Urbenville	57020	1935	Open	Daily Rainfall	-	11.2	2008, February 2010, December 2010
Urbenville State Forest	57021	1938	Closed – 1955	Daily Rainfall	0.8	10.4	-
Castille	58010	1933	Closed – 1989	Daily Rainfall	5.9	6.9	-
Killarney Post Office	41056	1972	Closed - 2017	Pluviograph	29.0	31.3	2008, February 2010, December 2010
Rathdowney Post Office	40178	1965	Closed - 2016	Pluviograph	42.7	31.9	2008, February 2010, December 2010
Moogerah Dam	40135	1964	Closed - 2017	Pluviograph	49.1	40.0	2008, February 2010, December 2010
Legume (New Koreelah)	56022	1973	Closed - 2016	Pluviograph	19.2	26.6	2008
Unumgar (Summerland Way)	58016	2000	Open	Pluviograph	21.2	14.9	2008
Maroon Dam	40677	1977	Closed - 2017	Pluviograph	34.7	24.0	2008, February 2010

3.2.3 Anecdotal Flood Information

Anecdotal evidence included responses from the community questionnaire and information provided by Tenterfield Shire Council and Urbenville SES. Community consultation responses are summarised in Appendix D and typically relate to the overland flow flooding within the town asides from properties along Tooloom Street in Urbenville.

3.2.4 Summary of Flood History at Woodenbong and Urbenville

Some of the key flood events affecting the study are summarised in Table 3-2. The AEP has either been estimated from the rainfall data obtained for this study. Residents reported some flooding on other occasions but did not include dates (refer Appendix D).

Table 3-2: Historic Flood Events

Date	Description	AEP estimate (if known)
January 2008	• Approximated as 2% AEP event (Kyogle Council based on Kyogle Flood Study), through data at Urbenville and Woodenbong, this was estimated as an approximate 7% and 25% AEP at each town. • Tooloom Street near the Old Saw Mill flooded at Urbenville • Clarence Way flooded at the bridge in Urbenville heading to Bonalbo • 17752 Clarence Way, flooding breaks banks of creek and 6 inches deep at the back paddock of the property.	7% AEP (Urbenville and Woodenbong daily-read gauge)
February 2010	• Approximated as either a 20 to a 50% AEP event through the daily gauge at Woodenbong • Water lapping at 6 Urben Street, came in through the driveway • Depths of 130 mm in front yard of 6 Urben Street	20% to a 50% AEP event.
December 2010	• Specific AEP is not known, expected to be a short sharp event which would not be captured in the daily readings at Urbenville gauge. • Showground flooded, and water over recreation road and inundated the lower paddock • Flood waters affecting the properties along Richmond Street. • Backyard flooding along in Woodenbong along Richmond Street • SES photos of Beaury Creek Road • Richmond Street 25-33 backyards are flooded, floodwaters have reached back steps of and house footings. • 77 Recreation road water came over the banks of creeks and inundated the lower paddock.	Unknown, ranging from 10% to 47% AEPs in surrounding catchments
January 2011	• SES photos of flooding at Beaury Creek Road, along Tooloom Street Urbenville and the showground	30% AEP at Urbenville
March 2017	• SES photos of flooding along Tooloom Street Urbenville	20% AEP at Urbenville
March 2019	• SES photos of flooding along Tooloom Street Urbenville and on roads heading towards Bonalbo	<63.2 % AEP at Urbenville

3.3 Topographic and Aerial Survey and Imagery

3.3.1 Topographic Data

Aerial imagery was used from Bing Aerial Imagery, SixMaps WMS link, and Google Maps Hybrid. Multiple sources were used as the detail of each was varying in quality.

3.3.2 LiDAR

A 2m resolution LiDAR DEM data is available for the Tooloom Creek and Boomi Creek catchments from elevation.fsdf.org.au (ELVIS, 2020). Data was flow in 2017 and the DEM has a 2m grid resolution. The LiDAR DEM is not hydrologically enforced. The data used to create this DEM has an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal. This is typical of Classification 3 LiDAR obtained in this way and is considered suitable for flood modelling in rural areas (DFSI Spatial, May 2015).

3.3.3 Survey Data – Watercourses

No survey of the watercourse was available and therefore LiDAR data has been adopted. LiDAR does not typically pick up channel dimensions as the LiDAR beam does not typically penetrate water and therefore the cross sections of the channel itself may not be well represented in the flood modelling.

Although this is a limitation of the flood modelling, the effect of this is that peak flood levels may be conservative, particular in the smaller magnitude flood events.

3.3.4 Survey Data – Hydraulic Structures

No survey data was available for the Tooloom Creek or Boomi Creek watercourse crossings. Bridge and culvert length details were provided from Council records. Photos were provided of Mount Lindsay Road Bridge over Tooloom Creek and Woodenbong. A database of the storm water network was provided from each Council however no invert levels were included. The location hydraulic structures such as the levee behind Richmond Street in Woodenbong was provided in this database from Kyogle Council. Other details of these structures was not available.

3.4 GIS data

Tenterfield Shire Council and Kyogle Council provided GIS data including cadastre, land use zoning, and details of the drainage network in the towns and culvert crossing for Clarence Way road and Boomi Creek road. The data did not include invert levels for all culverts and therefore assumptions were made where necessary (refer Table 6-1).

3.5 Data Gap Analysis

A data Gap Analysis reviewed data suitability for use in the study and noted limitations of any assumptions. For some hydraulic structures, such as the Mount Lindsay Road Bridge crossing of Tooloom Creek drawings were available from November 2007, no other survey or work-as-executed drawings or similar was available as assumptions had to be made in the flood modelling.

The data used is considered to be sufficient for the purposes of the Flood Study. Recommendations for additional data to be obtained for the future Floodplain Risk Management Study and Plan are detailed in Table 3-3.

Table 3-3: Data Gap Analysis and Recommendations for Further Data at Later Stages

Issue	Comment	Recommendations to be completed at Floodplain Risk Management Study Stage
Watercourse cross sections	Watercourse has been based on LiDAR as previously surveys sections and models were not available.	Undertake watercourse survey in areas identified for assessment of potential flood mitigation options – to be confirmed at FRMS&P.
Features in the floodplain	Based on LIDAR data.	Obtain survey if in critical flood areas before completing FRMS&P. The levee behind Richmond Street, Woodenbong, and the channel running behind the properties is one such area.
Drainage network	The urban stormwater GIS data was missing invert information for Woodenbong, within Urbenville grate RLs were provided for some areas. Where no invert information was available cross drainage culverts were assumed to have invert levels from the LiDAR. Suitable cover was adopted in areas where LiDAR levels were not appropriate.	For areas where drainage is critical in terms of flood behaviour, or areas where floodplain risk mitigation options are to be considered detailed survey should be obtained.
River Gauge Data	No river gauge is available within the catchment for either town.	The FRMS&P should recommend that a river gauge is installed on Tooloom Creek.
Floor levels	The Flood Study identified properties flooded based on LiDAR DEM ground levels. Over floor flooding will require survey and will be assessed in the next stage; the Floodplain Risk Management Study and Plan.	Obtain floor level survey.
Bridge Crossing of Tooloom Creek near Towns	Road Bridge crossings of Tooloom Creek occur nearby to both Woodenbong and Urbenville on Mount Lindsay Road and Clarence Way. These bridges vicinity to the town have the potential to dictate flood behaviour at the towns. Bridge details were not available for the bridge crossing at Urbenville at Clarence Way, bridge details and photos of the bridge at Woodenbong on Mount Lindsay Road were provided.	Bridge survey.

4 COMMUNITY CONSULTATION

4.1 Community Consultation Program

A community consultation program included newsletters, a questionnaire, and a project website. Community information sessions will be held during the Public Exhibition period.

4.2 Project Website

Project websites are available at:

- www.bgeeng.com/FloodStudies/Urbenville and
- www.bgeeng.com/FloodStudies/Woodenbong.

The websites are being maintained for the duration of the project and provides updates to the community and contact details. The project website is being updated at key milestones throughout the project and includes:

- Summary of study objectives
- Map of the study area
- Link to online questionnaire
- Contact details for residents to obtain further information or provide flood information for use in the study

During the Public Exhibition period the website was updated to include:

- Information about the flood study methodology and its findings
- Copies of draft report for download during Public Exhibition
- Mapping of predicted flood behaviour and flood planning areas
- Feedback form for Public Exhibition submissions and general enquires

4.3 Community Questionnaire and Newsletter

A community newsletter and questionnaire were mailed to 215 Urbenville addresses and 309 Woodenbong addresses in September 2020 and was also made available online. The findings of the questionnaire are useful to understand the community's experiences of past flooding, the level of flood awareness, highlight areas for flood mitigation and allow residents to provide flood information for use in calibration of the flood models. A project email address was also created to allow people to email photographs and addition information.

A detailed analysis of the findings is provided in Appendix D.

4.3.1 Urbenville

Two responses were received online and 20 responses by mail which equates to a 10% response rate. Additional contact was made with two residents who requested it.

The majority of respondents were from residential properties. Half of respondents understood that their property is flood affected, and of these, about half has also experienced flooding at their property. Two had

been evacuated. More people had observed flooding from the local creeks and catchments than they had from Tooloom Creek.

Notably the town of Urbenville has a rather transient population with 23% of people who responded to the questionnaire having moved into the area within the last five years. This means that a significant portion of the population are unlikely to have experienced any major flooding.

Residents were asked to identify areas where they had observed flooding and areas where they thought flood mitigation was required. The responses are mapped in Appendix D and include:

- Tooloom Street – frequent inundation of area
- Area at lower end of Urben and Welch Street and Stephen Street – local catchment flooding
- Forest Park and Urbenville Showground area – one of the first areas to be affected in every flood
- Beaury Street – 2 people mentioned flooding from Tooloom Creek into backyards and paddocks
- General street drainage issues on Urben Street – 3 people mentioned concerns in this area.

Details on historic flooding were requested for use in flood model validation (refer Section 7). Most residents recalled flooding in January 2008 and 2013 including at the locations above.

4.3.2 Woodenbong

Three responses were received online and 23 responses by mail which equates to an 8% response rate. One resident was contracted for further information at their request.

The majority of respondents were from residential properties. More than half respondents do not believe that their property is flood affected.

Like Urbenville, the town of Woodenbong has a reasonable number of new arrivals in the last five years comprising 15% of the population. However nearly 40% of residents have lived in the area for over 40 years.

Residents were asked to identify areas where they had observed flooding and areas where they thought flood mitigation was required. Very few residents had experienced flooding at Tooloom Creek and were not typically concerned with creek flooding however nearly 60% of residents reported having experienced flooding from local creeks.

The responses are mapped in Appendix D and include:

- Paddock areas and Bonalbo Lane/Richmond Street/Dalmorton Street – 4 residents reported inundation of roads leading to isolation
- Lindsay Creek Road creek crossing (Black Gully) and Mount Lindsay Road (east of town) creek crossings (tributary Black Gully) is frequent and a nuisance. One resident suggested flood depth markers.
- Woodenbong Showground and Caravan Park – 6 people highlighted this area

Details on historic flooding were requested for use in flood model validation. Few residents were able to provide information but two provided information in the 2010 event.

4.4 Public Exhibition Period

Due to COVID-19 restrictions no in-person information sessions were held during the Public Exhibition. A series of video presentations of the Flood Study were made and shared on the Flood Study websites. Community members were informed of the public exhibition period via a mailout which was sent to addresses within Urbenville and Woodenbong. The Flood Study report was published online for comment.

A presentation of the Flood Study methodology and findings was made to the Tenterfield Shire Councillors on the 13 October 2021 and the Urbenville Progress Association on the 9 December 2021. A period of time for questions and comments were available in both of these presentations and any questions or comments that residents and councillors had were addressed during this time.

One comment was received from a resident of Woodenbong about the blockage in the drainage channel cause by a build-up of vegetation in local paddocks. They stated this causes the flooding of backyards along Richmond Street. This comment on the need for maintenance has been forwarded onto Kyogle Council and it is recommended that the risk of blockage is considered further within the Floodplain Risk Management Study and Plan.

The comment also suggests the *"Block at the end of the street reclaimed land towards the main road and in doing so reduce the exit point for any water coming down the valley"*. During the Floodplain Risk Management Study and Plan, which is to be prepared following this current Flood Study, detailed survey and a physical site visit will be undertaken to this area to gain further understanding when designing potential mitigation options

The resident states how the levee does not provide protections from flood events, this is in line with BG&E's discussions with Council and the outcomes of the flood modelling.

5 HYDROLOGIC ANALYSIS

5.1 Hydrologic Assessment Approach

The hydrologic assessment considers the Tooloom Creek and Boomi Creek catchments and the local catchments of Urbenville and Woodenbong. Due to no catchments being gauged within the study area, additional methods were required to define flows to input into the hydraulic model.

An approach was adopted which used a rainfall routing model for the entire catchment. Integrated Catchment Modelling (ICM) was adopted for this purpose. ICM is the successor software to XP-RAFTS which has typically been used for similar studies in the past (Kyogle Flood Study) but essentially provides the same functions and calculations.

The purpose of the rainfall routing modelling is to determine the input flows into the hydraulic (TUFLOW) model by converting rainfall depths to hydrographs. Design rainfall data in input from Intensity-Frequency-Duration (IFD) data which has been developed by BoM for the whole of Australia. Parameters such as catchment area, slope, vegetation cover (roughness), initial and continuing losses, lag times and routing parameters are input into the hydrologic model.

5.2 (IFD) Data Review

There is some variation in the IFD across the catchment as shown in refer Figure 5-1. Higher intensity rainfalls are likely in the upper catchment areas where the steeper hillslopes are likely to have orographic effects on rainfall patterns. Rainfall at Urbenville and Woodenbong is likely to be less intense than across other areas of the catchment where the terrain is higher.

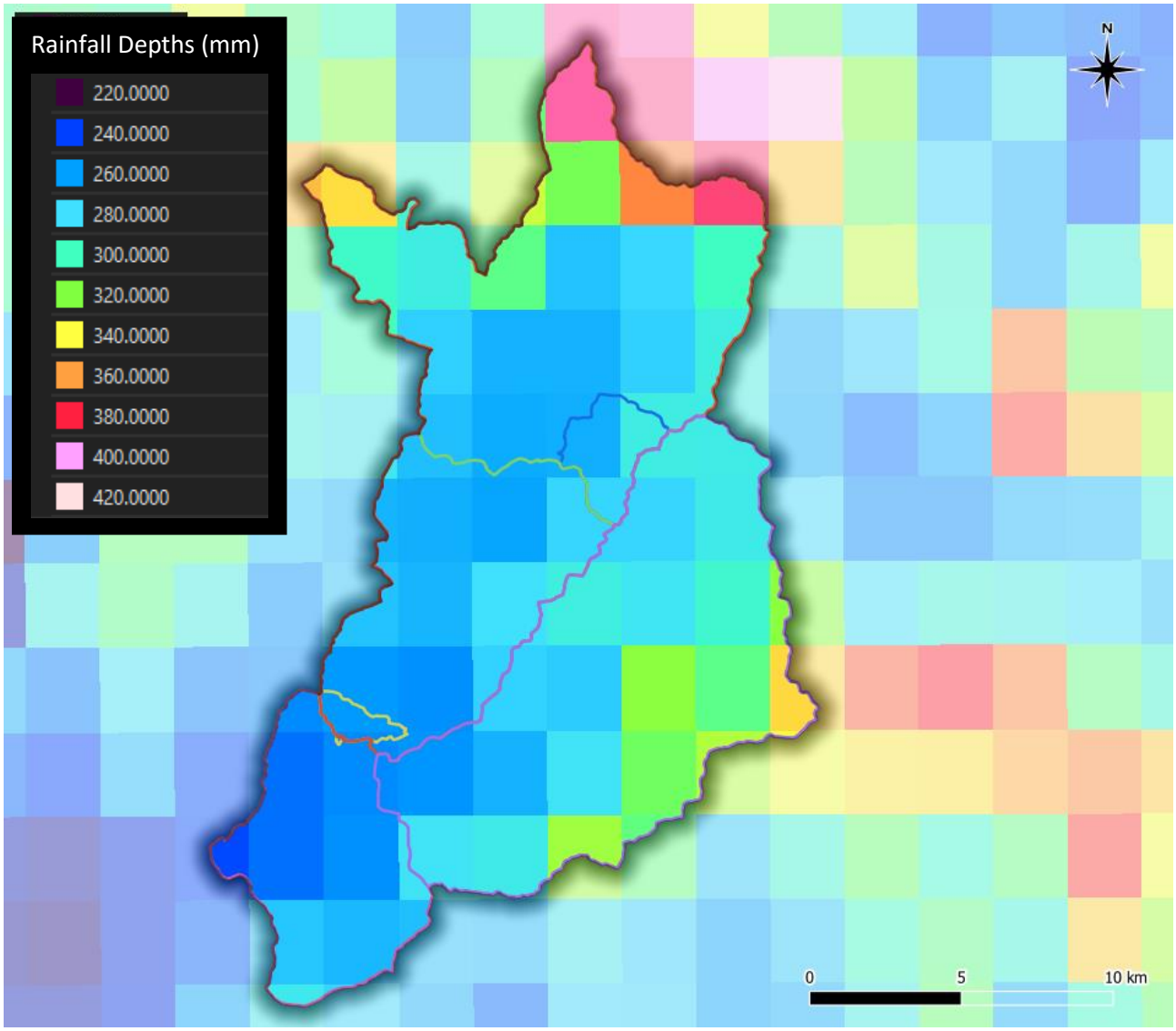


Figure 5-1: Gridded IFD data – Depths – 1% AEP event 24 hours (source: BOM)

A comparison of the IFD data and at-site gauge data is typically desirable for flood studies as a check on the BoM IFD data. However for the Urbenville and Woodenbong Flood Study catchment, there are no sub-daily gauges within the catchment area and only one daily read gauge within each town (refer Section 3.2.2).

At site IFD data was generated based on the daily read gauges at Urbenville (57020) and Woodenbong (57024). The gauges have a record of 88 years at Woodenbong and 86 years at Urbenville, both will therefore give a reasonable IFD estimate of a range of AEP rainfall events. However, this analysis can only be undertaken for durations of 24 hours and longer as the gauge is daily read. Furthermore, it is possible that the daily gauges could underestimate the 24 hour total rainfall as the observed 24 hour rainfall totals are limited to rainfall recorded in the 24 hour period to 0900 hours each day. Should the rainfall event occur either side of this, it would be recorded over a 48 hour period and thus under estimate the 24 hour total.

A comparison of the point IFD data and gauge derived IFD is presented in Figure 5-2 and Figure 5-3, these show the differences between the calculated at site IFD and the BOM IFD for Urbenville and Woodenbong with the points representing observed data and the line representing the BOM IFD.

The BOM IFDs for the shorter durations are consistently higher than the at site IFD, in the frequent events. This would be due, in part, to the reporting durations of the daily gauges being between 9 am each day which may mean that the storm which occurs either side of 9am is recorded as two smaller 24 hour totals. In the intermediate events, the at site IFD and BOM IFD are close to each other. In the rare events there is a

significant difference between the at site, and BOM IFDs. This is due to the gauge at Urbenville not experiencing 1% AEP across all durations, weighting the results down.

The longer duration measurements from the gauge are the most at risk of having reporting errors with multiple days of rainfall being attributed to one day. The cumulation of this could result in overstated longer duration IFDs. This behaviour is also repeated in Figure 5-3 at Woodenbong with the at site IFD and BOM IFD close until the rare events, where the gauge has not experienced storm events of this severity across all durations.

The comparison of the daily gauge data and BOM IFDs show that the BOM IFD is appropriate for use with minimal differences in the less frequent events. In the rare events the comparison is limited by the amount of at site data of this magnitude available.

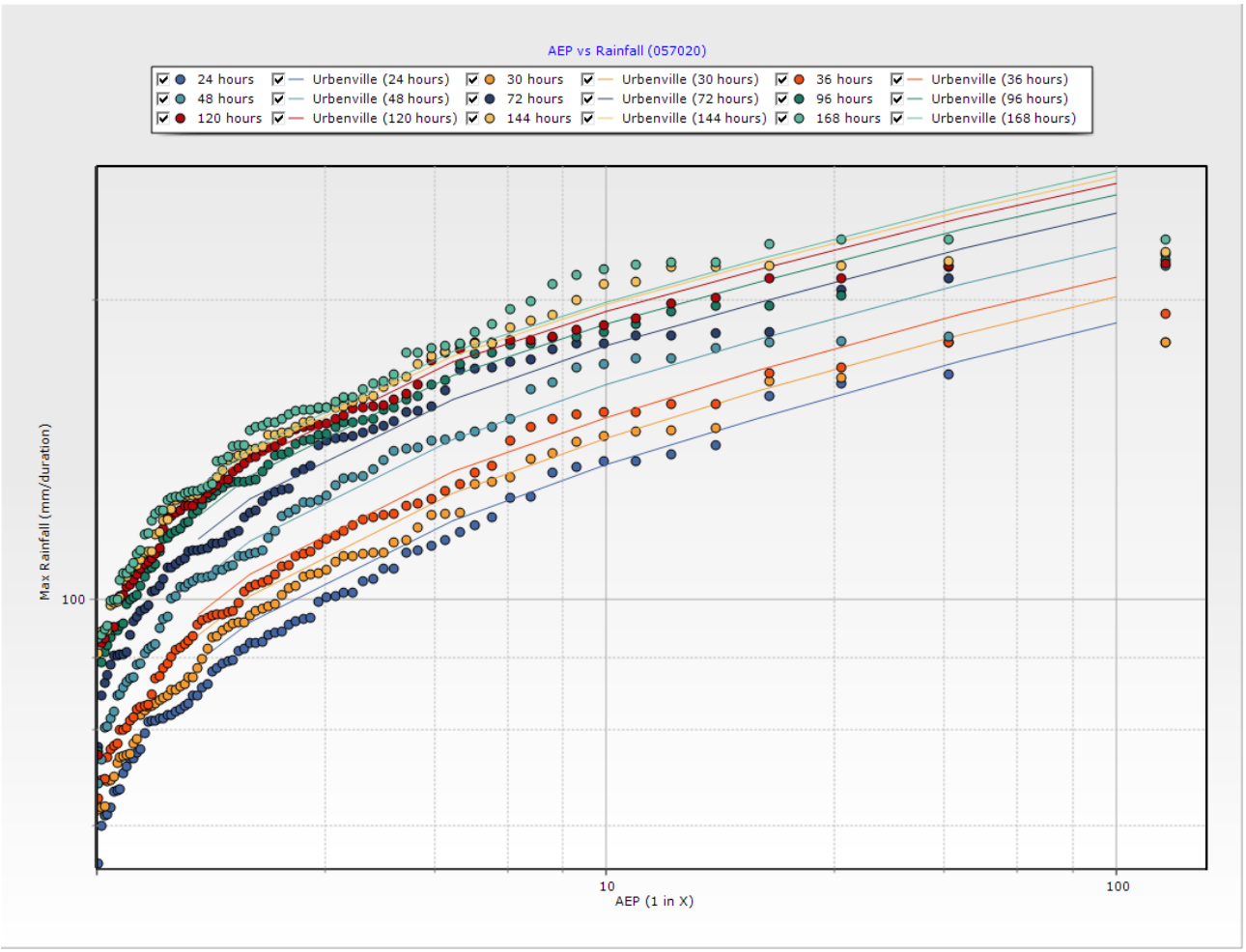


Figure 5-2: Urbenville (57020) and ARR2019 point IFD Comparison

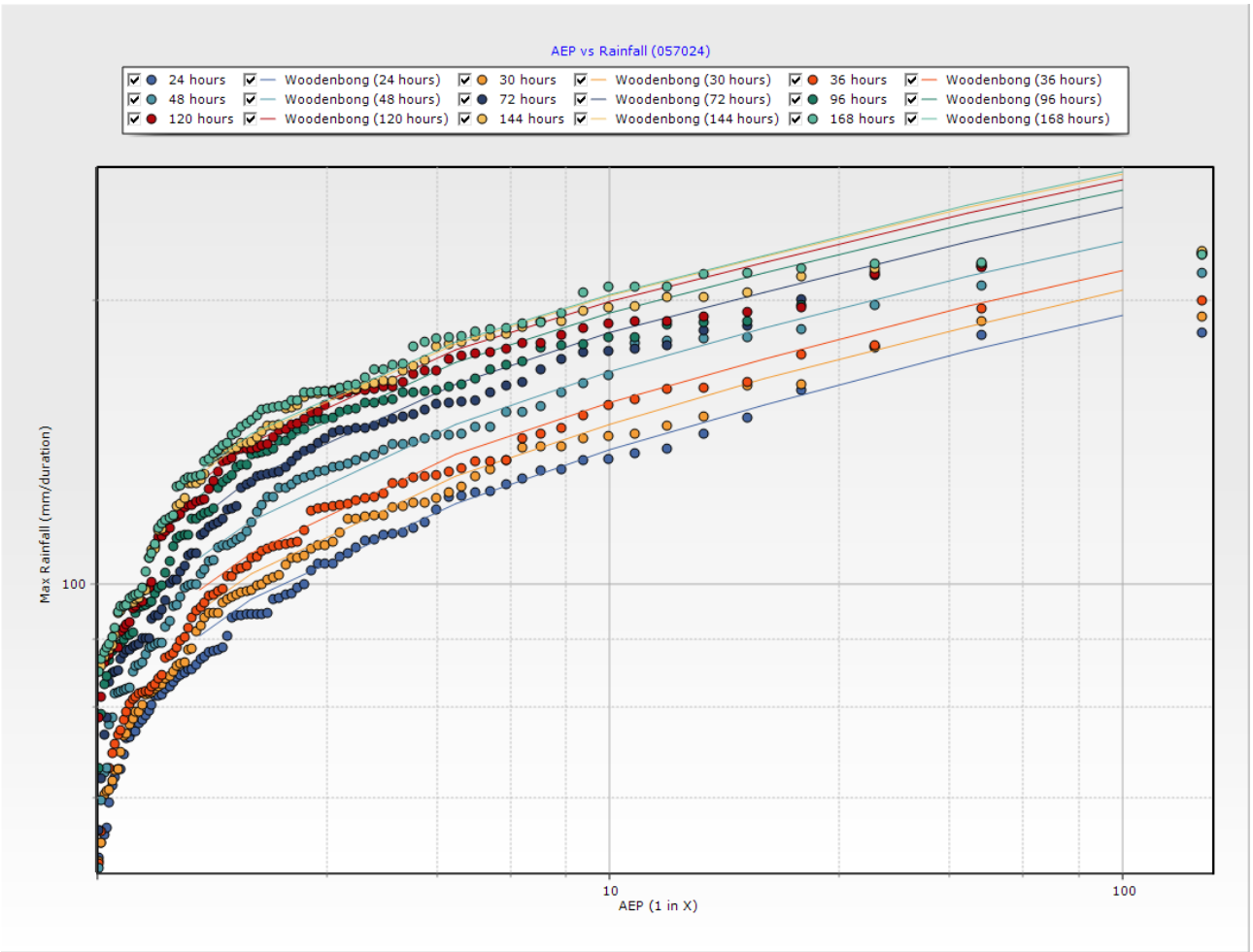


Figure 5-3: Woodenbong (57024) and ARR2019 point IFD Comparison

5.3 Rainfall routing model (ICM)

A rainfall routing model was developed for the catchment to the study area using ICM software.

The rainfall routing model comprised 542 sub-catchments (refer Figure A 4) each with catchment specific parameters applied. Catchment parameters such as percentage impervious and slope were determined using GIS methods, aerial and topographic data and are summarised in Table 5-1.

Hydrological inputs were varied when calculating the flows from flooding from the Tooloom Creek and flows from the local catchments of each town.

5.3.1 Model Parameter Selection

Rainfall routing model parameters are summarised in Table 5-1.

Table 5-1: ICM Model Setup and Adopted Parameters

Parameter	Comment
Catchment delineation	Catchments were delineated in GIS using the 2017 2m LiDAR DEM.
Slope	Catchment equal area slopes were calculated using the 2017 2m LiDAR.

Parameter	Comment
% impervious	Impervious areas of the catchments were estimated using aerial imagery.
Roughness	Manning's n was applied to the catchments based off the impervious, pervious nature of the catchment. A Manning's n of 0.04 was adopted for pervious areas and 0.025 for impervious areas.
Lag time	Lag times were varied depending on the slope and distance of the watercourse between catchments and a typical flow velocity for similar watercourse systems. The velocity within the watercourses were estimated between 1 and 2 m/s dependent on the slope.
Losses	NSW-FFA reconciled losses were adopted from a nearby catchment Peacock Creek. These losses were adopted for the entire study area due to the vicinity of the sub-catchments and similarity of terrain to the rest of the catchment. The losses provided from the NSW-FFA were IL: 49.7 mm and CL 3.26 mm/hr. These losses had been calibrated against the Peacock Creek stream gauge and were given a good quality rating. The ARR19 data hub losses for Urbenville and Woodenbong were IL: 49 mm and CL: 4.6 mm/hr and IL: 51 mm, CL: 4.7 mm/hr. The adoption of NSW-FFA losses provided a more conservative approach with more flow being generated in the hydrology model. Impervious losses were adopted as IL: 1 mm and CL: 0 mm. The initial loss burst adopted was the Probability Neutral Burst Loss from the ARR data hub. This provides the end result of Storm Loss less Pre-burst rainfall for each AEP event and duration.

5.3.2 Spatial Distribution of Rainfall Across Tooloom and Boomi Creeks

The BOM provides gridded IFD data at a resolution of about 6 km^2. The catchment size for the study area is 112.2 km^2 and 170.9 km^2 for Woodenbong and Urbenville town and therefore, spatially variability of the inputs needed to be considered. For the Tooloom Creek catchment to the townships, the average design rainfall depth was calculated for each design event as per ARR2019. This involves calculating the IFD depth at each individual catchment and applying a weighted average as per the sub-catchment area to calculate a spatially distributed catchment average. This was applied for each duration and AEP event within the hydrology model.

A comparison of the total catchment weighted average IFD and the IFD at each town indicated a difference in estimated rainfall depths varying between 1-6%. Using the catchment weighted average method, the rainfall depths were overstated at each township. This is due to the distribution of the IFD across the Tooloom Creek catchment where higher rainfall depths occur due to the natural geography of the upper catchment (refer Figure 5-1). This effect was more dominant in larger magnitude events.

The difference between applying a weighted average IFD for Tooloom Creek upstream of Woodenbong in comparison to the entire catchment including Woodenbong was approximately 1-2%. Therefore the weighted average IFD for the whole creek catchment was applied. The IFDs applied to the catchment can be seen below in Table 5-2.

Table 5-2: IFDs Applied to Tooloom Creek Catchment

Duration	Event rainfall depth (mm)			
	20% AEP	5% AEP	1% AEP	0.2% AEP
15min	24.48	33.25	43.59	55.50
20min	28.28	38.36	50.24	64.00
25min	31.31	42.43	55.53	70.75
30min	33.84	45.78	59.90	76.35
45min	39.54	53.44	69.95	89.22
60min	43.75	59.13	77.54	98.89
90min	49.98	67.83	89.34	113.94
2hr	54.83	74.71	98.90	126.16
3hr	62.59	86.07	114.98	146.51
4.5hr	71.94	100.03	135.14	171.97
6hr	79.92	112.17	152.46	193.96
9hr	93.56	132.78	182.44	231.88
12hr	105.41	150.55	207.63	264.15
18hr	125.39	180.35	249.58	317.63
24hr	142.27	204.76	283.09	360.60
48hr	190.24	270.88	370.22	476.13
72hr	219.73	309.03	418.11	535.88
96hr	238.03	331.91	446.66	570.61
120hr	248.90	345.74	464.57	592.16

The townships of Urbenville and Woodenbong have local catchment areas of 2.3 km^2 and 8.4 km^2 respectively. Therefore, instead of using the catchment average rainfalls, a point IFD was applied for each duration and event within the hydrology model when calculating the flows from the local catchments of each town.

5.3.3 Temporal Patterns

Due to the area of the catchment Tooloom Creek catchment to Urbenville and Woodenbong, areal temporal patterns were applied for the full catchment. Areal temporal patterns are applicable for catchments of 75 km^2.

For the Urbenville and Woodenbong towns where the combined local catchments are smaller than 75 km^2, point temporal patterns were applied for the hydrology models . The joint probability of Tooloom Creek and the local town catchments is addressed in Section 6.2.1.

5.3.4 Hydrology Model Calibration

There are no stream gauges within the study are for flow calibration. The rainfall runoff model outputs were checked against RFFE flows (refer section 5.3.6).

5.3.5 ARRR2019 Ensemble Approach for Design Event Flows

The rainfall runoff routing model was run for the 20% AEP, 5% AEP, 1% AEP, 0.2% AEP events using the ARR2019 ensemble approach. A total of six durations were assessed for the Tooloom Creek and 18 durations were assessed at the townships.

The temporal pattern producing the upper median for each storm duration was identified (rank 5 of 10). For each storm duration assessed, the representative storm for input into the hydraulic TUFLOW model was selected on the following criteria:

- The pattern that provides the upper median flow downstream of the Mount Lindsay Road Bridge at Tooloom Creek at Woodenbong.
- The pattern that provides the upper median flow in Tooloom Creek near Urbenville town.
- The pattern that provides the upper median flows through the Urbenville and Woodenbong townships from local catchments.

Box plots showing the range, median and mean of peak flows for the ensemble are shown in Figure 5-4 and Figure 5-5 for the individual towns catchment flow, the critical durations vary for each design event at each town. For the 1% AEP event at both towns the critical duration is the 1 hour event as shown in the figures.

For Tooloom Creek where the catchment size is larger, the 12 hour event gave the critical duration at Urbenville and Woodenbong as the durations become longer. It is noted that this is the shortest duration assessed. Following ARR2019 guidance for catchments greater than 75 km^2, areal temporal were used for the Tooloom Creek catchment to the towns. The 12 hour storm is the smallest duration pattern available while using areal temporal patterns. Due to the size of the Tooloom Creek catchment and the ARR2019 approach is it assumed smaller durations would not provide the critical duration for this catchment. The box plots for the flows along Tooloom Creek at Urbenville and Woodenbong are shown in Figure 5-6 and Figure 5-7.

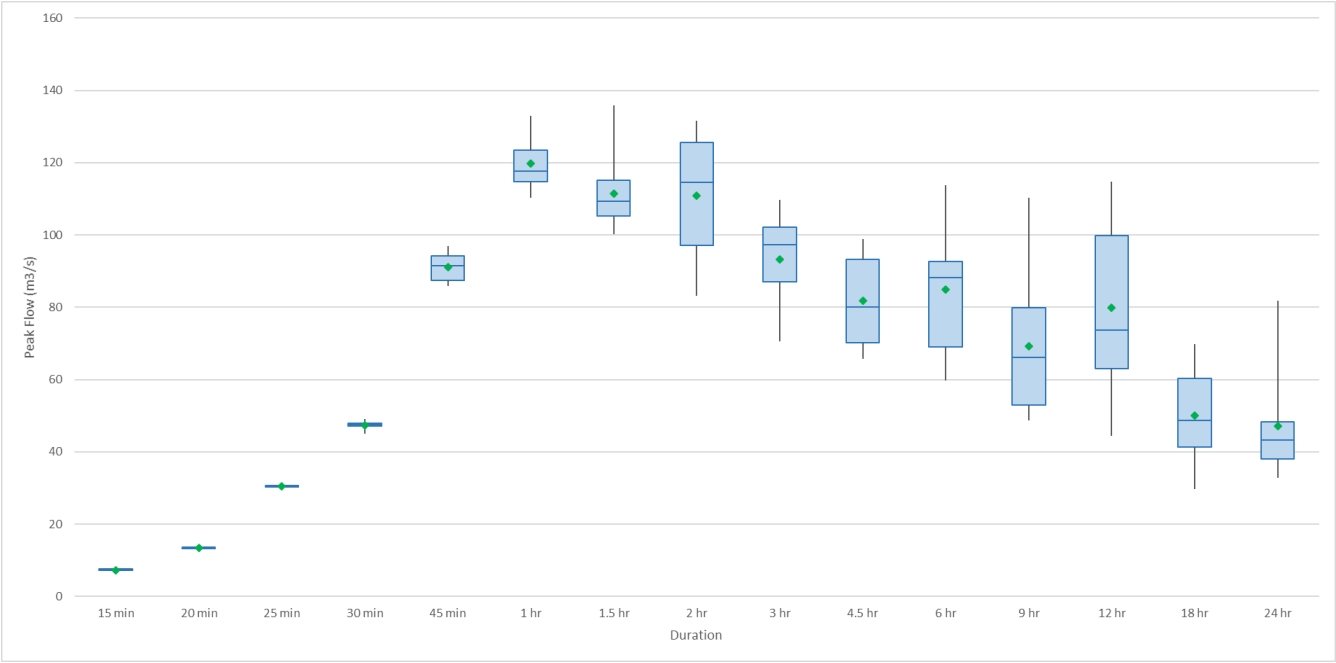


Figure 5-4: Box Plot for 1% AEP at Woodenbong

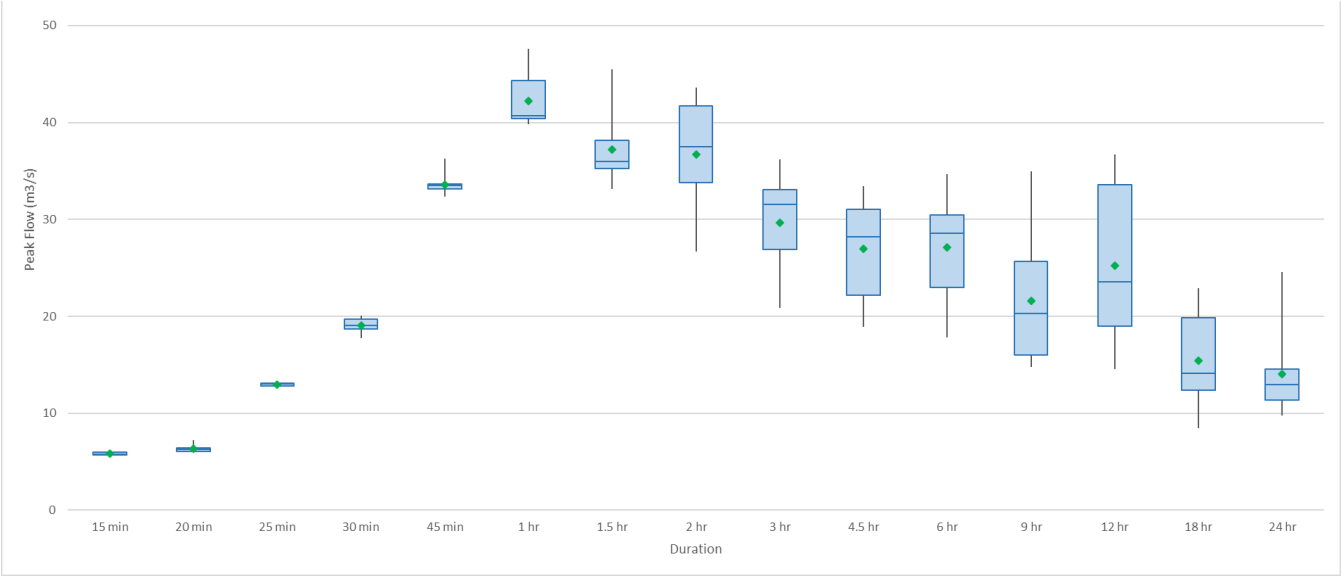


Figure 5-5: Box Plot for 1% AEP at Urbenville

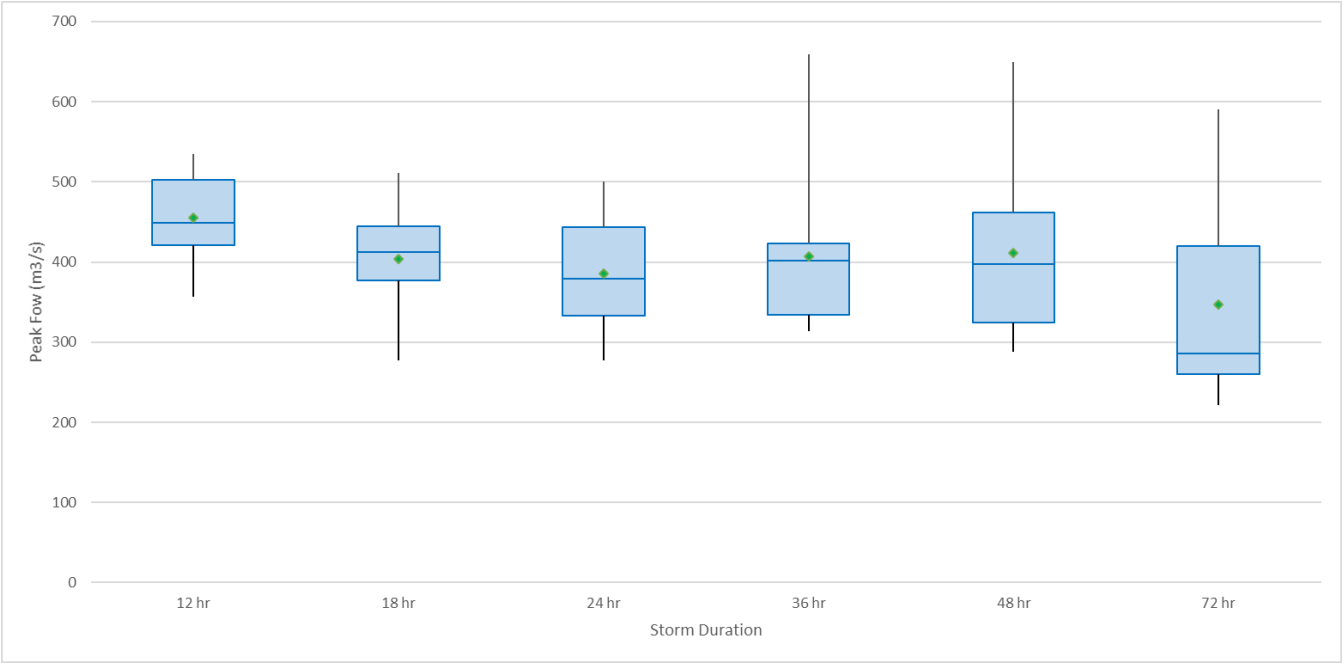


Figure 5-6: Box Plot for the 1% AEP on Tooloom Creek at Woodenbong

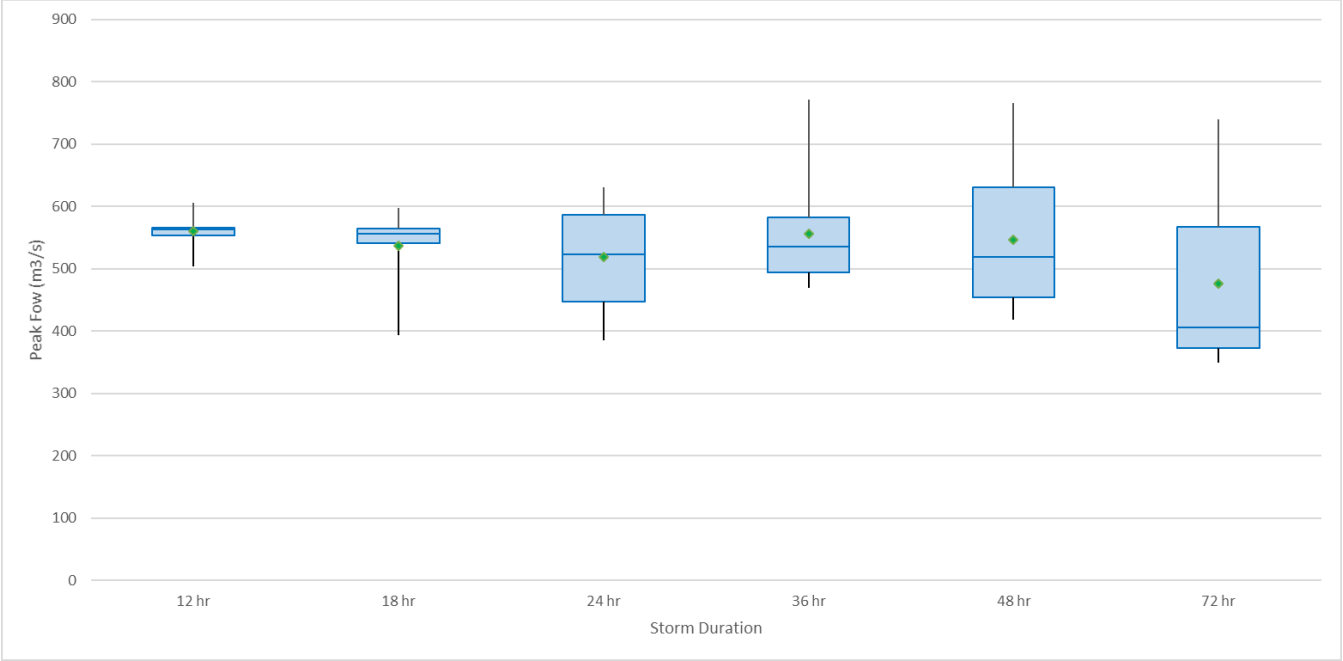


Figure 5-7: Box Plot for the 1% AEP on Tooloom Creek at Urbenville

The critical storms and their corresponding rainfall intensities and totals can be seen below in Table 5-3. The Tooloom Creek has different critical duration in the PMF event at Urbenville and Woodenbong.

Table 5-3: Rainfall Intensities and Totals for Critical Storms

AEP	Catchment	Critical Storm	Rainfall Intensity (mm/hr)	Rainfall Total (mm)
20%	Urbenville	2 hour	26.3	52.6
	Woodenbong	2 hour	26.9	53.8
	Tooloom Creek	12 hour	8.8	105.4
5%	Urbenville	1 hour	56.6	56.6
	Woodenbong	1 hour	58.7	58.7
	Tooloom Creek	12 hour	12.5	150.6
1%	Urbenville	1 hour	73.7	73.7
	Woodenbong	1 hour	77.1	77.1
	Tooloom Creek	12 hour	17.3	207.6
0.2%	Urbenville	1 hour	94.5	94.5
	Woodenbong	1 hour	98.2	98.2
	Tooloom Creek	12 hour	22.0	264.2
PMF	Urbenville	1 hour	400	400
	Woodenbong	1.5 hour	326.7	490
	Tooloom Creek	5 hour for Woodenbong and 12 hour for Urbenville	Woodenbong 136 Urbenville 85.8	Woodenbong 680 Urbenville 1030

5.3.6 Comparison of Rainfall Routing Model to Regional Flood Frequency Estimation (RFFE)

ARR2019 recommend that at least two hydrology methods are used to determine peak flows to assess uncertainties. The RFFE method allows for design flood estimates on ungauged catchments based on data from a number of nearby gauged catchments and/or gauged catchments with similar characteristics. RFFE is an estimation tool and is not appropriate for the detailed assessment of design events but can be used as a check that results from rainfall routing models are within reasonable expected bounds.

A comparison of the rainfall runoff model peak flows and RFFE peak flows is presented in Table 5-4. The results show that the rainfall runoff model outputs is within the confidence bounds of the RFFE.

The RFFE results give a greater flow at Woodenbong than at Urbenville despite a smaller catchment area to Woodenbong. The RFFE estimation for Woodenbong may be unreliable with a shape factor of 0.49. This is outside of the bounds of most catchment used to inform the RFFE model. Less than 10% of all selected gauged catchments used in the RFFE model have catchment shape factors less than 0.51. As an atypical catchment ARR19 guidelines recommend further hydrologic and hydraulic analysis to refine the RFFE model results.

Table 5-4: RFFE Results at Urbenville

AEP (%)	RFFE Discharge (m^3/s)	RFFE Lower Confidence Limit (5%) (m^3/s)	RFFE Upper Confidence Limit (95%) (m^3/s)	ICM Median Temporal Pattern Flow (m^3/s)
20	133	55.7	323	168
5	323	112	933	309
1	703	183	2650	504

Table 5-5: RFFE Results at Woodenbong

AEP (%)	RFFE Discharge (m^3/s)	RFFE Lower Confidence Limit (5%) (m^3/s)	RFFE Upper Confidence Limit (95%) (m^3/s)	ICM Median Temporal Pattern Flow (m^3/s)
20	160	67.1	386	134
5	391	137	1110	235
1	854	229	3140	357

5.4 Probable Maximum Precipitation Flood

Probable Maximum Precipitation (PMP) was calculated for the Urbenville and Woodenbong townships catchment and the upstream catchment. The generalised short-duration method (GSDM) (Bureau of Meteorology, 2003) was applied for the local catchments of each township. Durations between 15 minutes to 6 hours were assessed and the township catchments were found to have a PMP critical storm duration of 1 hour at Urbenville and 1.5 hours at Woodenbong.

The PMP calculation for the catchment for Tooloom Creek to where it passes each town was undertaken using GSDM for critical durations 15 minutes to 6 hours. The found critical duration using the GSDM approach was the 6 hour storm for Urbenville and the 5 hour storm at Woodenbong.

The 5 hour duration was taken as the critical PMP storm duration for Woodenbong. Due to the 6 hour storm being the longest duration of the GSDM, the Generalised Tropical Storm Method (GTSM) (Bureau of Meteorology, 2003) approach was also adopted for Urbenville to assess longer durations. The 24 hours to 72 hour storms were assessed for Tooloom Creek catchment to Urbenville and a 12 hour storm was iterated from between the rainfall depths of the 24 GTSM and 6 hour GDSM. The application of the rainfall within the rainfall routing model found the critical duration was the 12 hour for Tooloom Creek at Urbenville.

5.5 Australian Rainfall and Runoff 1987

5.5.1 Intensity-Frequency-Depth data

A comparison of the ARR87 and 2019 IFD data was undertaken for the point IFD at Urbenville and Woodenbong and for the catchment average IFD. The results are summarised in Figure 5-8, Figure 5-9 and Figure 5-10.

At Woodenbong and Urbenville for shorter duration events (typically less than one hour) the ARR2019 IFD gives higher or similar rainfall depth compared to the ARR87 IFD except for the 20% AEP event. For longer duration events, at Woodenbong the rainfall depth of a given AEP is typically reduced when comparing the 2019 IFD to the ARR87 IFD. At Urbenville it is greater in the 2019 IFD for the 12 and 24 hour events. This indicates that, when compared to the ARR 87 IFD, the revised 2019 IFD may lead lower flood levels for longer duration events.

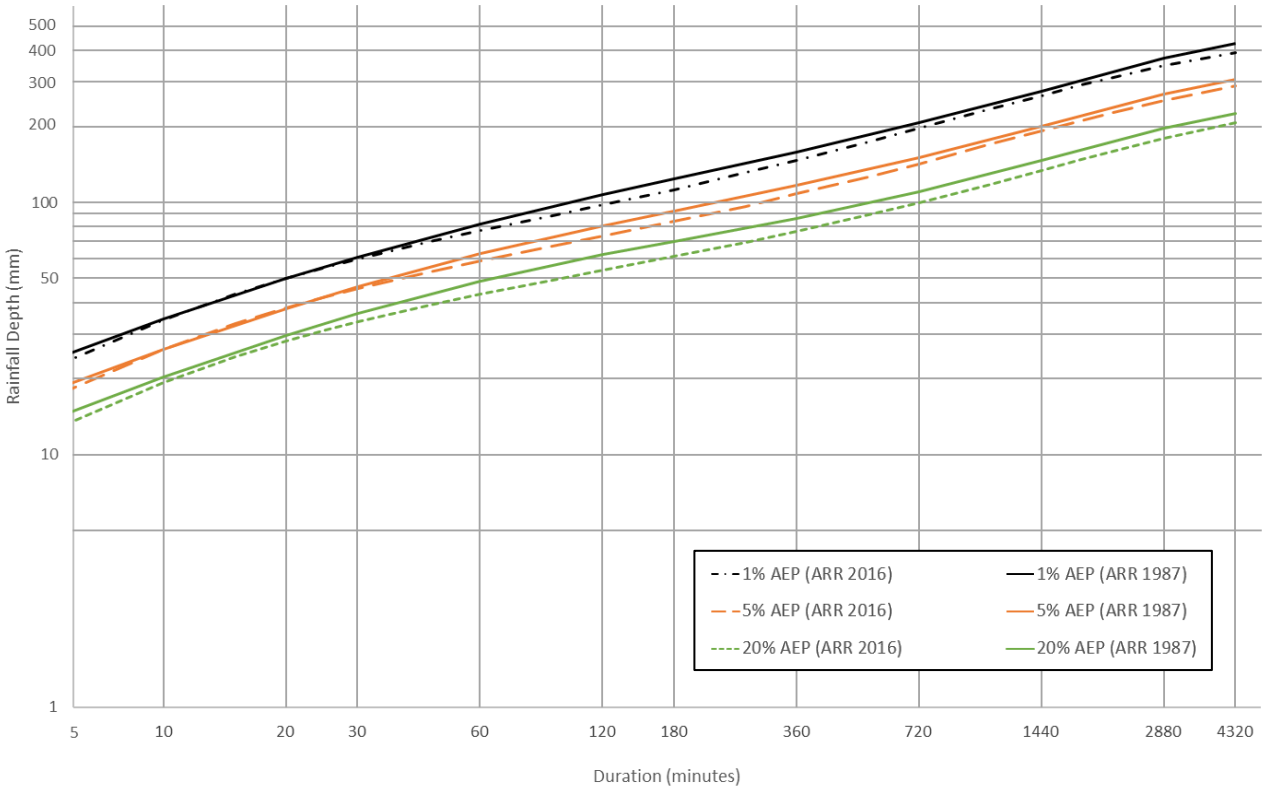


Figure 5-8: ARR87 and ARR2019 Point IFD Comparison – Woodenbong town

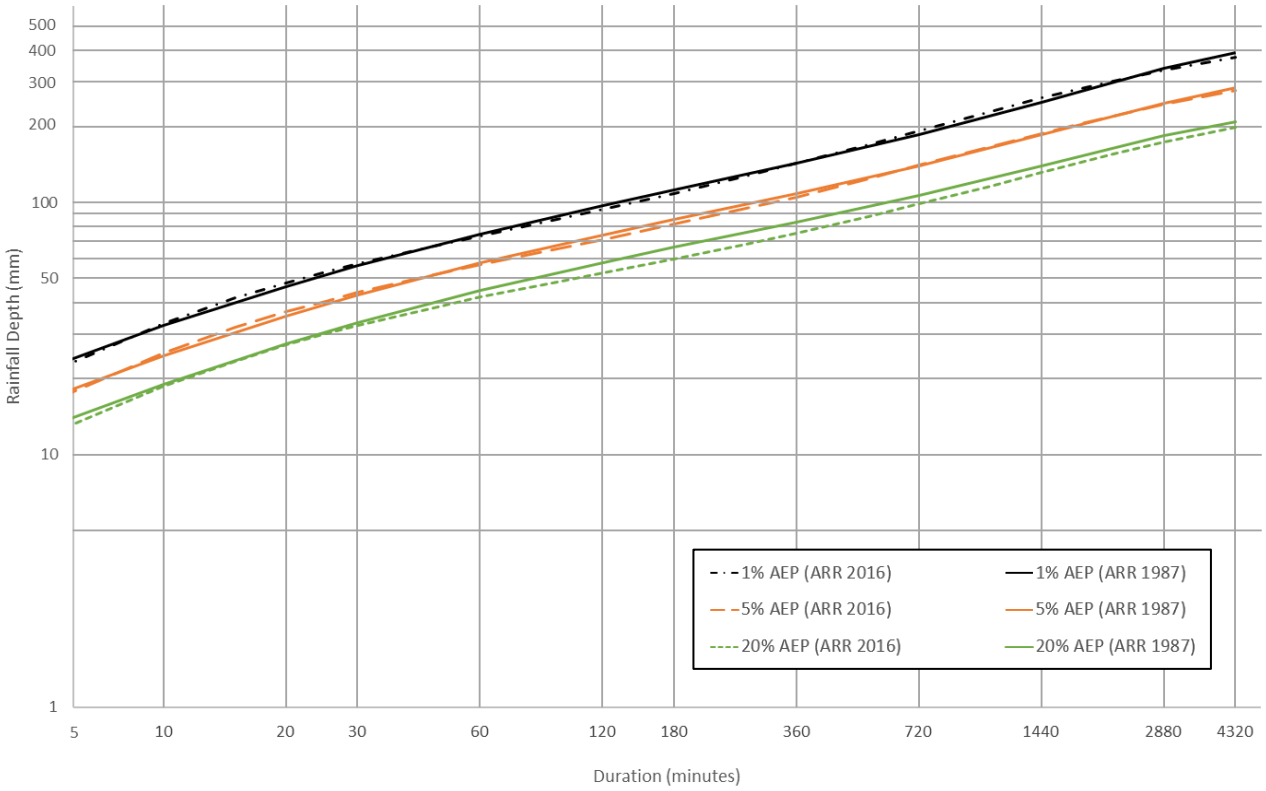


Figure 5-9: ARR87 and ARR2019 Point IFD Comparison – Urbenville town

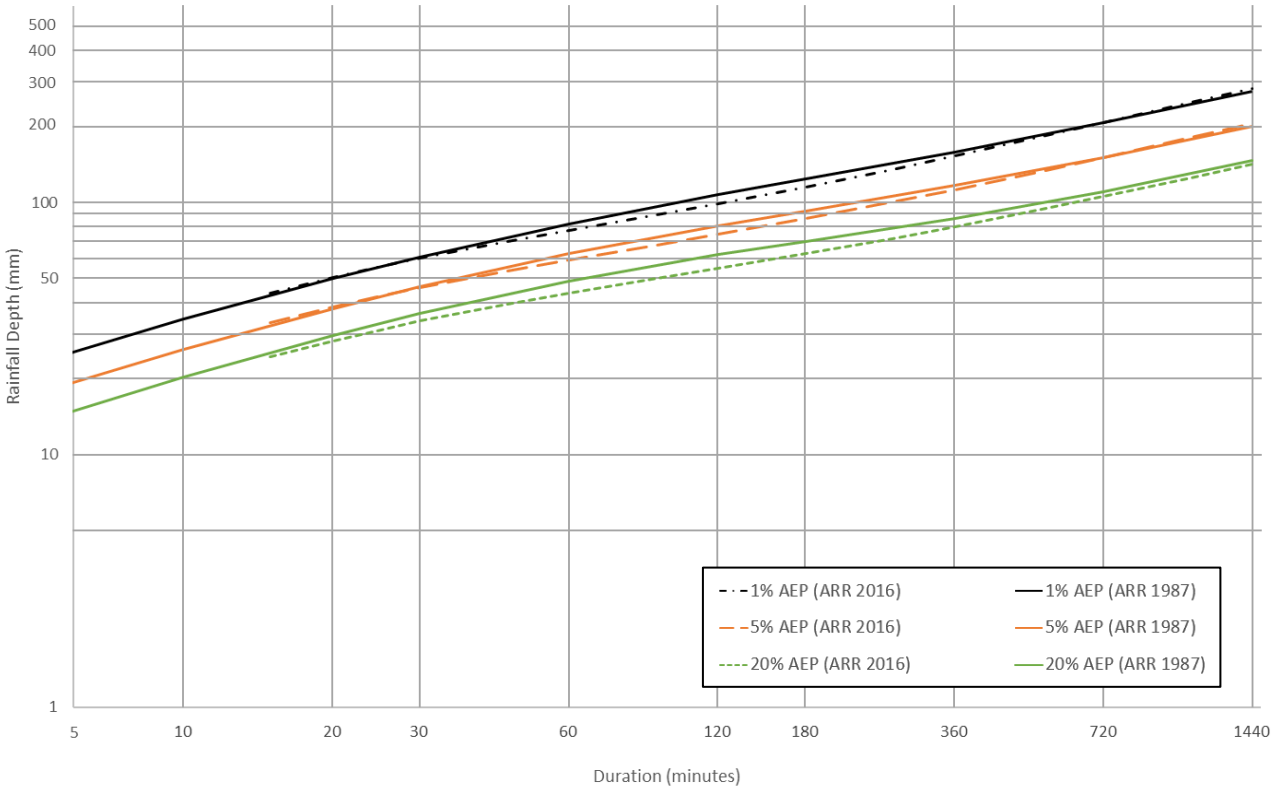


Figure 5-10: ARR87 and ARR2019 Catchment Average Weighted IFD Comparison

5.5.2 ARR87 and ARR2019 Losses

The conversion of rainfall depths to runoff is also affected by other factors such as the application of losses. Losses adopted for this study used the FFA reconciled losses for NSW (refer section 5.3). A comparison of ARR87 and ARR2019 losses is provided in Table 5-6.

On first inspection the ARR87 losses in comparison to the NSW-FFA reconciled losses are significantly different and the ARR2019 losses are much higher than the ARR87 losses. The ARR87 losses are rainfall burst losses however the ARR2019 loss from the ARR data hub is a total storm loss (pre-burst loss plus burst loss). With the application of pre-burst losses which are varied for each event and duration, the loss that is applied in the hydrology model to the rainfall burst is the rainfall burst loss (the initial loss less the pre-burst). An example of this can be seen in the 1% AEP 12 hour storm in Table 5-6.

Table 5-6: Comparison of ARR87 and ARR2019 losses

	Initial loss (mm)	Continuing Loss (mm/hr)
ARR87 (Burst Loss)	10	2.5
ARR2019 (Strom Loss)	49.7	3.26
1% AEP 12 hour Burst Loss	3.6	3.26

5.5.3 Hydrology Assessment

The 5% AEP and 1% AEP events were run through the rainfall routing model using ARR87 procedures. A comparison of the hydrographs for the Tooloom Creek catchment at Woodenbong and Urbenville in Figure 5-11 and Figure 5-12.

For the 5% and 1% AEP events the revised ARR2019 method produces shorter duration critical storms, except for the 1% AEP storm at Woodenbong which is a 6 hour.

For Tooloom Creek, the ARR2019 procedures result in reduced peak flows at both Woodenbong and Urbenville compared to ARR87. The cause of the lower peak flows can also be attributed to a combination of the lower catchment average rainfall depths and greater continuing losses. In addition the varying temporal patterns also has an effect. While ARR87 adopts a single temporal pattern, the introduction of 10 varying temporal patterns in the ARR2019 ensemble approach gives more variation in rainfall distribution and hydrograph shape.

For the 1% AEP event the comparison of ARR87 and ARR2019 methods gives similar results to the 5% AEP event. For the Tooloom Creek catchment at Woodenbong and Urbenville the peak flow is reduced, and the critical duration reduced from 36 to 12 hours at Urbenville and increased from 6 to 12 at Woodenbong. The peak flow for the ARR87 storms occurs in the middle of the storm as opposed later in the ARR19 storms due to the difference in the selected temporal patterns. The 12-hour duration is the smallest duration available using ARR19 guidelines for catchments greater than 75 km^2.

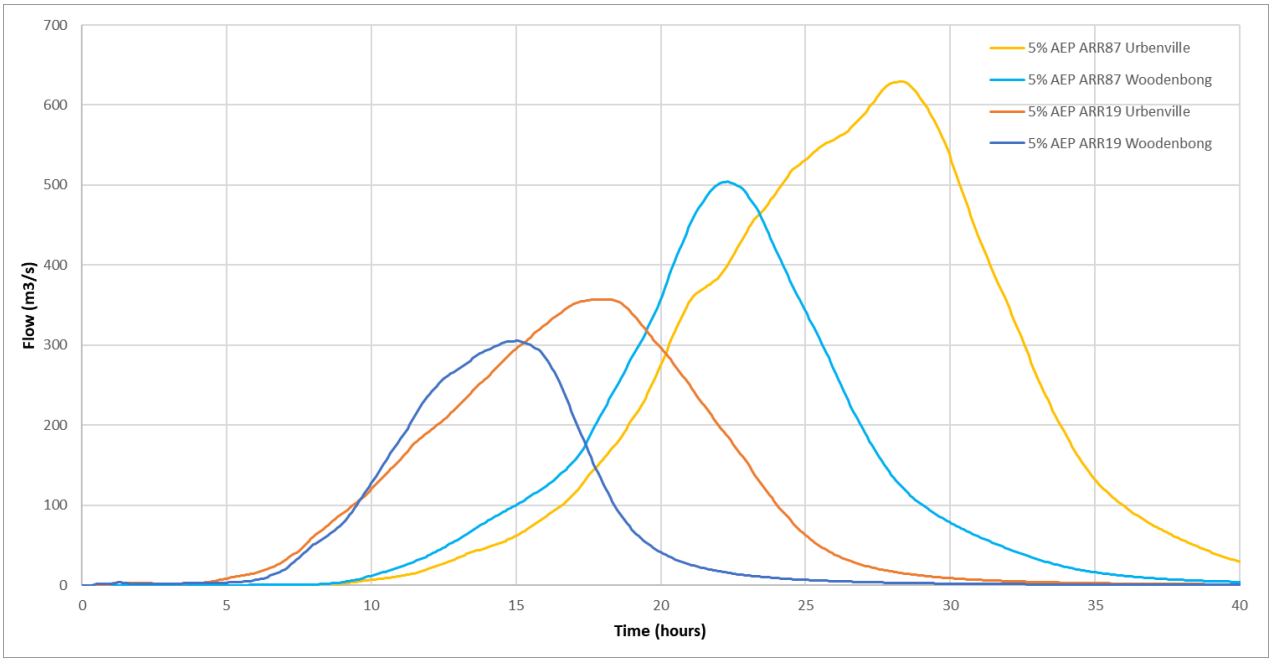


Figure 5-11: 5% AEP ARR87 and ARR19 Flow Comparison – Tooloom Creek

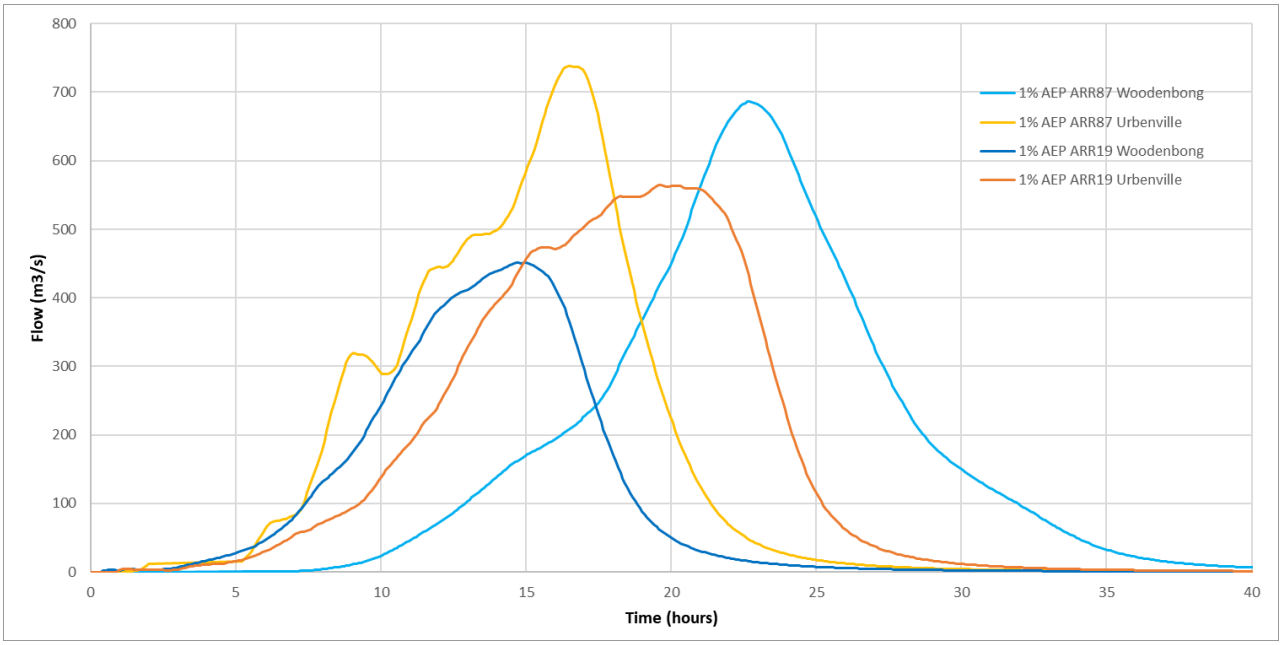


Figure 5-12: 1% AEP ARR87 and ARR19 Flow Comparison – Tooloom Creek

6 HYDRAULIC ANALYSIS

6.1 Hydraulic Modelling

Hydraulic modelling was undertaken using TUFLOW. This modelling package allows effective linking of both 1d and 2d modelling methods. The 2d modelling is grid based, but with the inclusion of 1d elements embedded into the 2d domain, allows for representation of finer details such as narrow waterways, the drainage network, and detailed hydraulic structures.

The model setup is summarised in Table 6-1 and also in Appendix A.

Table 6-1: TUFLOW Model Setup and Adopted Parameters

Parameter	Comment
Model Version	2020-01-AB
Adopted grid cell size	A 2m model grid size was adopted for smaller town models of Woodenbong and Urbenville. For the larger model of Tooloom Creek a 10m grid size was adopted while using 2 m sub-grid-sampling. This gives the model more refined definition within the 10m grid. A larger model size was used for the Tooloom Creek due to the larger model and to reduce model run times. The selected grid size if sufficient for the level of detail required in a largely undeveloped area. A smaller cell size was used for the town models for more refined results.
Model Extent	The Urbenville town model extends approximately 2.5 km upstream and downstream of Tooloom Creek and contains the local catchment to the west. The Woodenbong town model extends 1 km upstream and downstream of Mount Lindesay Road crossing of Tooloom Creek and captures the local catchment to the east. The Tooloom Creek model upstream boundary was set approximately 5 km upstream of Woodenbong and 9 km downstream of Urbenville. It contains the Tooloom Creek between the two towns and captures Mulli Mulli. It also contains Boomi Creek up until Brumby Plains Road. The model extents were set larger than the study area so that any boundary conditions effects have no effect of flood behaviour within the flood study area. Refer to Appendix A for more details.
Digital Elevation Model (DEM)	Developed from 2 m resolution 2017 LiDAR from NSW Spatial Services. LiDAR sourced from NSW Spatial services flown in 2017 has Horizontal Spatial Accuracy: +/-0.80 @95% Confidence Interval and Vertical Spatial Accuracy: +/-0.30 @95% Confidence Interval. Areas in the model terrain which influence hydraulic behaviour such as areas of raised or lowered land, features have been digitised using break lines so that the hydraulic effect of crest levels and depressions is considered.
Manning's roughness values	Based on aerial photography using Manning's 'n' Ranges for Different Land Use Types outlined in ARR2016 ARR Project 15: Two Dimensional Simulations in Rural and Urban Floodplains.
Upstream inflow boundaries	Catchment boundary conditions for the hydraulic model used flow hydrographs established during the hydrologic analysis. The rainfall-runoff routing model (ICM) was used to determine inflows from external catchments. The representative hydrographs

Parameter	Comment
	from the calibrated ICM rainfall runoff routing model was used to input hydrographs into the hydraulic model. For the town models the inflows from Tooloom creek were input from the flows established from the Tooloom Creek hydraulic model.
Internal flow boundaries	For local catchments and catchments internal to the TUFLOW model extent flows have been determined from the rainfall-runoff routing model and input as point inflows at suitable locations.
Downstream boundary	For the Tooloom Creek model an automatically generated HQ (level-flow) boundary based on terrain slope was used. Sensitivity has been undertaken to ensure no boundary effects on the modelled flood behaviour in the study area. For the town models, water levels from the Tooloom Creek model were extracted from the larger Tooloom Creek catchment model and were used to set a HT (water level – time) boundary for each AEP event.
Hydraulic structures – Tooloom Creek and Boomi Creek	Bridge locations were provided from Council. This information did not include pier or deck information, it was assumed that the bridges had a deck thickness of 1m or 0.5m depending on the bridge length and a total blockage from pier obstructions of 5%. The deck levels were set from LiDAR.
Hydraulic Structure – Clarence Valley Way and Boomi Creek Road	Culverts along the roadways within the model such as Clarence Valley Way and Boomi Creek Road were supplied from council. This data included the culvert location and size. Invert levels were taken from LiDAR data.
Stormwater drainage network	Based on Council GIS data and incorporated as 1d elements. Invert levels were not provided for all 1d networks. Pipe inverts were set to ground level using the terrain. Pipes less than 375 mm in diameter were assumed to be blocked providing a conservative approach to overland flow assessment, except for pipes that provided transverse drainage under road crossings to keep connectiveness of flow paths.
Buildings	Buildings within the model extent were digitised from aerial imagery and blocked out of the model extent; it is assumed no flow would pass through buildings. Buildings were digitised to make sure that flow paths were maintained around buildings.
Blockage	All pipes smaller 375 mm were excluded from the model (unless where connecting larger upstream and downstream systems) and effectively assumed as 100% blocked. This provides a conservative of overland flows, particularly in the smaller magnitude events. For other pipes, for the 20%, 5% and 1% AEP a 50% blockage factor was applied to all stormwater networks within the model. For more severe events (0.02% AEP and PMF) a 100% blockage factor was applied to the stormwater networks. This is due to the higher risk of potential blockage in more severe events as per ARR2019. For bridges an extra 10% blockage was applied for the 0.02% AEP and PMF events. For all other events no extra blockage was applied. This is due to the size of the openings of the bridges in comparison to the size of potential debris, as per ARR 2019. Blockage sensitivity was also undertaken (refer section 8.5).
Shallow drains / depressions	Drainage features, or natural depressions which convey flow, were incorporated as a gully (or minimum) line in the flood model. This ensure that flows continue from one cell to the next without artificial obstruction due to grid size.

Parameter	Comment
Roads / Levee	Roads crossing Tooloom Creek and Boomi Creek or running parallel to them such as Clarence Way, Mount Lindsay Road, Tooloom Road and Boomi Creek Road were incorporated as a ridge (or maximum) line in the flood model. This ensured that the rises in topography from the road were captured in the model grid.
Levee at Woodenbong	The levee behind Richmond Street in Woodenbong was input into the model as a ridge line based on LiDAR and with Council's supplied data.

6.2 Modelling Design Events

The flood model was run for the 20% AEP, 5% AEP, 1% AEP, 0.2% AEP and PMF events. In some areas of the study Tooloom Creek is exceeding the creek capacity in the most frequent event modelled the 20% AEP event. The smallest event causing exceeding the creek capacity has not been determined. Results are presented in Appendix B and summarised in Section 8.

6.2.1 Joint Probability Approach

Given the relative catchment sizes between the Tooloom Creek upstream of Urbenville (170.9 km^2) and Woodenbong (112.2 km^2) and the local catchments at Urbenville (2.6 km^2 to Tooloom Creek) and Woodenbong (8.4 km^2 to Tooloom Creek), an event of a given magnitude may not occur on both catchments the same time. In addition, the temporal pattern and storm duration that produces the representative storm for the larger catchment is unlikely to be the same for the local catchments.

Therefore, a joint probability approach was adopted based on the Floodplain Risk Management Guide (OEH, November 2015), as per Table 6-2. For each of the AEP design events at each town the design flood was determined by enveloping two scenarios to extract the maximum values. The critical durations and temporal patterns adopted for the TUFLOW hydraulic model had been determined in the hydrologic modelling (refer section 5).

Table 6-2: Combinations of Catchment Probability for Determining Design Event Flood Behaviour

Design AEP	Town	Scenario	Tooloom Creek catchment	Town catchments
20%	Urbenville	1	12 hour 20% AEP Temporal Pattern ID 17	
		2	Creek full	2 hour 20% AEP Temporal Pattern ID 4643
	Woodenbong	1	12 hour 20% AEP Temporal Pattern ID 17	
		2	Creek full	2 hour 20% AEP Temporal Pattern ID 4641

Design AEP	Town	Scenario	Tooloom Creek catchment	Town catchments
5%	Urbenville	1	12 hour 5% AEP Temporal Pattern ID 15	
		2	Creek full	1 hour 5% AEP Temporal Pattern ID 4567
	Woodenbong	1	12 hour 5% AEP Temporal Pattern ID 17	
		2	Creek full	1 hour 5% AEP Temporal Pattern ID 4565
1%	Urbenville	1	12 hour 1% AEP Temporal Pattern ID 20	1 hour 5% AEP Temporal Pattern ID 4475
		2	12 hour 5% AEP Temporal Pattern ID 15	1 hour 1% AEP Temporal Pattern ID 4405
	Woodenbong	1	12 hour 1% AEP Temporal Pattern ID 17	1 hour 5% AEP Temporal Pattern ID 4565
		2	12 hour 5% AEP Temporal Pattern ID 17	1 hour 1% AEP Temporal Pattern ID 4360
0.2%	Urbenville	1	12 hour 0.2% AEP Temporal Pattern ID 17	1 hour 1% AEP Temporal Pattern ID 4360
		2	12 hour 1% AEP Temporal Pattern ID 20	1 hour 0.2% AEP Temporal Pattern ID 4555
	Woodenbong	1	12 hour 0.2% AEP Temporal Pattern ID 17	1 hour 1% AEP Temporal Pattern ID 4360
		2	12 hour 1% AEP Temporal Pattern ID 17	1 hour 0.2% AEP Temporal Pattern ID 4463
PMF	Urbenville	1	12 hour PMF	
		2	1 hour PMF	
	Woodenbong	1	5 hour PMF	
		2	1.5 hour PMF	

7 MODEL CALIBRATION AND VALIDATION

7.1 Data for Model Calibration and Validation

Within the Urbenville and Woodenbong catchments there are only two active gauges available for model calibration and validation. The Urbenville gauge (Gauge ID: 57020) has daily rainfall readings from 1935 to present day and Woodenbong (Unumgar St) (Gauge ID: 57024) has daily rainfall readings from 1933 to present day. No sub-daily rainfall gauges exist with the Tooloom Creek catchment although in the surrounding catchments there are pluviometer gauges with varying years of record (refer section 3.2). There are no discharge / water level gauges on either Tooloom Creek or Boomi Creek. Figure 7-1 shows the gauge locations within and outside the catchment.

For model calibration, as well as historical rainfall, observed flood marks are useful so that the flood behaviour in the modelling can be calibrated to actual event-based data. Calibration data was collected through the community consultation and SES (refer Appendix D). Little data was available for the 2013 and 2015 events, which are the most recent significant events in both towns. Most residents commented on the flooding in February 2010 in Urbenville and December 2010 in Woodenbong, and 2008 in both. As they had the most available data for model calibration, the 2008 event and the 2010 events were used as the calibration events for the model. SES and council photographs of flooding were also used to visually validate the behaviour of the flood model.

7.2 Rainfall Analysis

7.2.1 Daily Rainfall Gauges

Analysis of the daily gauges within the catchment was undertaken to identify large rainfall events with potential for use in model calibration and validation. Figure 7-1 shows the daily recorded data at Urbenville, Figure 7-2 shows the daily recorded data at Woodenbong. The 1976 and 1954 events are two largest across both locations, the most recent significant events to occur in a single 24 hour period are the March 2017, January 2013 and January 2008 events. The December and February 2010 events are less severe in comparison to these.

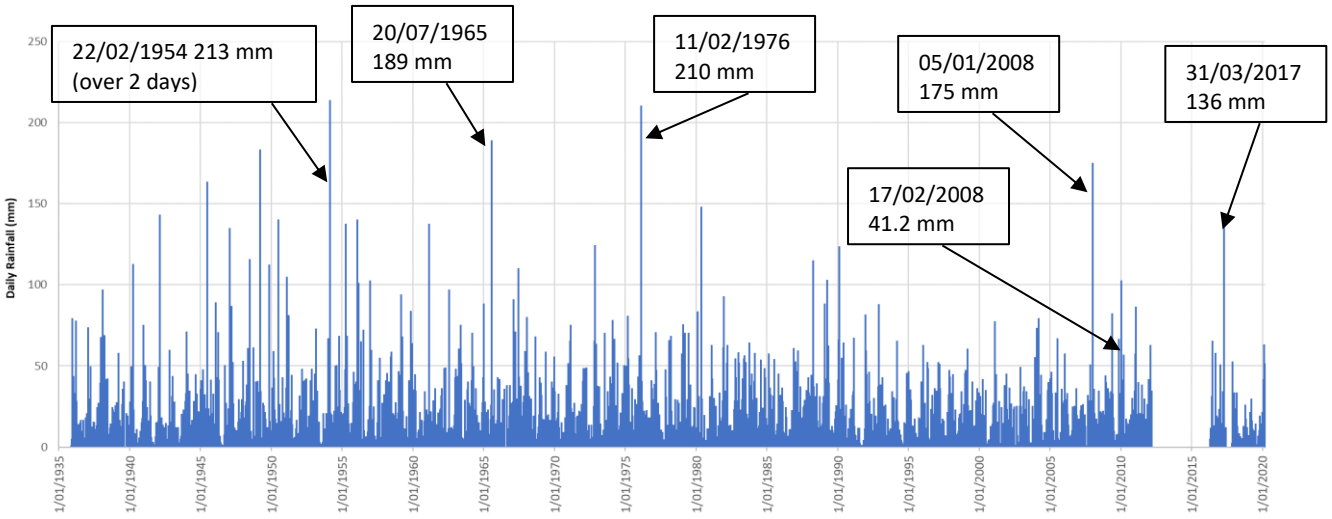


Figure 7-1 Daily Rainfall Data Recorded at Urbenville Gauge (57020) since 1935

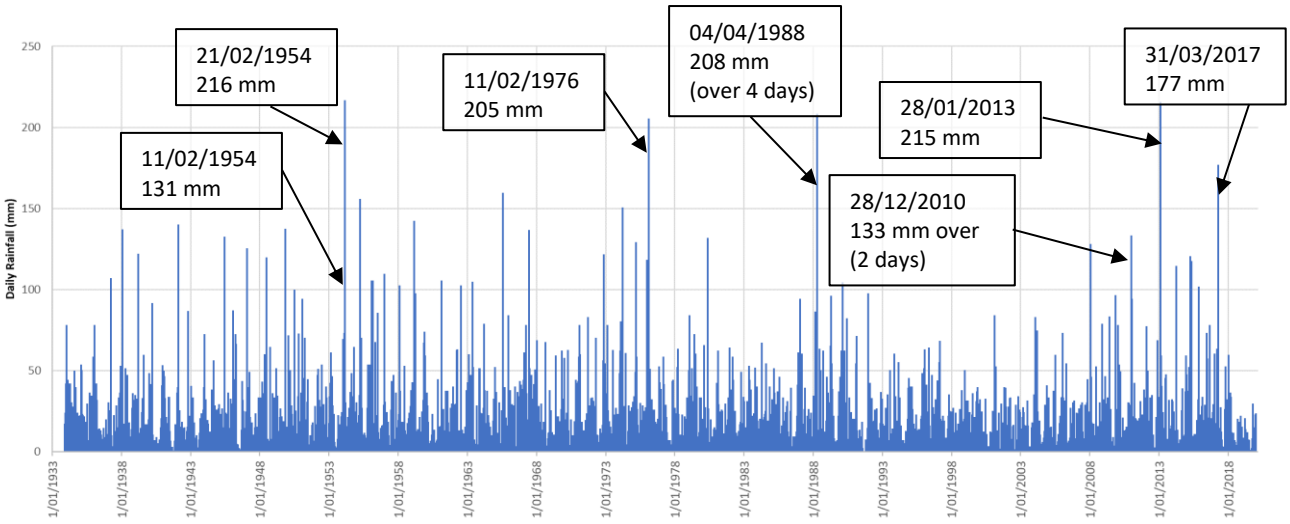


Figure 7-2 Daily Rainfall Data Recorded at Woodenbong Gauge (57024) since 1933

7.2.2 Sub-daily rainfall gauges

There are no sub-daily rainfall gauges (pluviometers) within the catchment and therefore a combination of gauges outside of the catchment was used to establish input rainfall for the calibration events.

For the 2008 event at this time of record there was data available at all pluviographs outside the catchment. For the February 2010 event there was pluviograph data available for Killarney PO, Maroon Dam, Rathdowney PO and Moogerah Dam. For the December 2010 event there was only sub-daily data available for Killarney PO, Rathdowney PO and Moogerah Dam.

7.3 January 2008 Event

The January 2008 event was run as a calibration event for both Urbenville and Woodenbong. An analysis of the available data seen below in Table 7-1, shows the January 2008 rainfall event was approximately a 7% and 25% AEP event at Urbenville and Woodenbong. These are both daily rainfall gauges which will record rainfall in a 24 hour period from 0900 to 0900 and could therefore underestimate the AEP of the storm where the rainfall fell within a different 24 hour period.

The surrounding pluviograph data from outside the catchment varies with the peak AEP and duration ranging from a 3% AEP 9 hour event at Killarney to a 40% AEP 4.5 hour event at Legume. The large differences shows the spatial variability of the storm event over the area. By comparison, the Kyogle Flood Study the 2008 event was found to be a 2% event through FFA of a stream gauge (WBM Oceanics Australia, February 2004).

Table 7-1: Gauges available for the January 2008 Historical event

Gauge	Gauge ID	Gauge Type	AEP for a 24 hour event	Peak AEP and Duration
Urbenville	57020	Daily Rainfall	7%	7% 1 day
Woodenbong	57024	Daily Rainfall	25%	25% 1 day
Legume	56022	Pluviometer Rainfall	56%	39% 4.5 hour Event
Unumgar	58016	Pluviometer Rainfall	19%	9% 7 Day Event
Killarney PO	41056	Pluviometer Rainfall	6%	3% 9 hour
Maroon Dam	40677	Pluviometer Rainfall	40%	17% 15 min
Rathdowney PO	40178	Pluviometer Rainfall	11%	4% 12 hour
Moogerah Dam	40135	Pluviometer Rainfall	37%	19% 4 Day Event

7.4 February 2010 Event

The February 2010 event was run as a calibration event specifically for the town of Urbenville. For the Februrary 2010 event four pluviometer gauges captured data for the storm. From the daily read gauge at Urbenville the AEP for the event is recorded as less than a 63.2% AEP, or less than a 1 in 1 year. The pluviometer gauges in surrounding catchments show the peak AEP ranging from about a 10% AEP in a 1 hour duration at Moogerah Dam and a 50% AEP in a 15 minute storm.

As the Urbenville gauge is a daily gauge read from 0900 to 0900 and the surrounding catchments have critical durations of typically less than 24 hours, it is expected that the storm AEP at Urbenville would be rarer than a 63.2% AEP for a short duration. Table 7-2 shows this in more detail.

Table 7-2 Gauged Data Available for the February 2010 Event at Urbenville

Gauge	Gauge ID	Gauge Type	AEP for a 24 hour event	Peak AEP and Duration
Urbenville	57020	Daily Rainfall	>63.2%	>63.2%
Killarney PO	41056	Pluviometer Rainfall	>63.2%	45% 30 hour
Maroon Dam	40677	Pluviometer Rainfall	>63.2%	46% 15 min
Rathdowney PO	40178	Pluviometer Rainfall	>63.2%	40% 1 hour
Moogerah Dam	40135	Pluviometer Rainfall	17%	10% 1 hour

7.5 December 2010 Event

The December 2010 event was run as a calibration event specifically for the town of Woodenbong. At the Woodenbong daily rainfall gauge the rainfall measured was from a 2 day period. Therefore a range of AEPs were determined for this storm, about 21% AEP if all the rainfall occurred in one day and about 46% AEP if the rainfall occurred over both. Only three pluviometer gauges in surrounding catchments were online during

this event. The range of peak AEPs and durations they experienced were quite similar ranging from a 18% to 30% all over 24 hours. This is seen in more detail in Table 7-3.

Table 7-3 Gauged Data Available for the February 2010 Event at Woodenbong

Gauge	Gauge ID	Gauge Type	AEP for a 24 hour event	Peak AEP and Duration
Woodenbong	57024	Daily Rainfall	21%-46%	21%-46% 1 or 2 days
Killarney PO	41056	Pluviometer Rainfall	30%	30% 24 hour
Rathdowney PO	40178	Pluviometer Rainfall	21%	21% 24 hour
Moogerah Dam	40135	Pluviometer Rainfall	18%	18% 24 hour

From the historical rainfall captured from pluviography data, the historical storms were recreated in ICM to generate flows and then were run in TUFLOW for flood levels and depths. This occurred for each calibration event.

7.6 Model Validation

No detailed flood level markers were available for flood model calibration and therefore a model validation approach has been undertaken against anecdotal evidence provided by the community, and photos provided from SES and council. Some of these photos can be seen in Section 2.3. As many of the comments provided did not include actual dates, times or recorded depths it is difficult to compare directly with the model outputs. A comparison of community comments against the results of the flood modelling has been undertaken to validate that the flood model is reasonably replicating actual flood behaviour.

As shown in Table 7-4 and Table 7-5, generally the model matches well to the anecdotal evidence with key areas replicating similar flood behaviour in the model to what has been reported e.g. inundation in particular areas.

Table 7-4 Comparison of Flood Model Results and Anecdotal Flooding Evidence from the Community Consultation at Urbenville

Location	Date Observed	Observed Flood Behaviour	Model Result
South side of Tooloom Street	2015	Ponding	A reasonable match with observed data. Depths of 700 mm seen ponding in the in 2008 storm event.
6 Urben Street	February 2010	Water in over driveway lapping at house	A reasonable match with observed data 150mm depths seen in the model up the side of the property over the driveway in the February 2010 event
6 Urben street	February 2010	130 mm of water in front yard	A reasonable match with observed data. Depths of 150 mm observed in the front yard of the property in the February 2010 event. Depths may differ from anecdotal advice as the point of observation is unknown.
Tooloom Road (at Old Saw Mill)	2008 and 2013	Water over road	A reasonable match with observed data. The road is flooded at this location with varying depths between 300 mm to 1.5 m over road in the 2008 event.

Location	Date Observed	Observed Flood Behaviour	Model Result
Clarence Way (at bridge heading to Bonalbo	2008 and 2013	Water over road	A reasonable match with observed data. Depths in the model reach up to 400 mm on road in the 2008 event.
6 Welch Street	No Date	Frequent water ponding at corner of street	A reasonable match with observed data. Depths up to 400 mm ponding in the Feb 2010 event which is the smallest calibration event run.

Table 7-5 Comparison of Flood Model Results and Anecdotal Flooding Evidence from the Community Consultation at Woodenbong

Location	Date Observed	Observed Flood Behaviour	Model Result
31 Richmond Street	No Date	500 mm of water in backyard	A reasonable match with observed data. 400 mm depths in calibration events. Depths may differ from anecdotal advice as data of operation is unknown.
Woodenbong Caravan Park / Camping Ground / Baths	No Date	Knee deep slow flowing water	A reasonable match with observed data. Up to 300 mm depths in December 2010 and 600 mm in 2008 events across sporting field, these depths are ponded are have low velocities
Showground	December 2010	Showground flooded	A reasonable match with observed data. Depths of up to 1.2 m in showground in the December 2010 event.
Recreation Road	December 2010	Water over the banks of creeks and inundated lower paddock	A reasonable match with observed data. Depths of 1.2 m in the modelled December 2010 event.
29 Richmond Street	December 2010	Flood waters affecting properties	A reasonable match with observed data. Depths of up to 500 mm on the property in the December 2010 event.
25 and 27 Richmond Street that back onto Bonalbo Lane	December 2010	Backyard flooding	A reasonable match with observed data. Depths up to 200 mm in backyard in the December 2010 event.
Black Gully Culvert on Lindsay Creek Road	No Date	Depths of about 1m over road	A reasonable match with observed data. Depths of 1.2 and 1.7 m over road in 2010 and 2008 event. Depths may differ from anecdotal advice as data of operation is unknown.

8 MODEL RESULTS

8.1 Summary of Flood Behaviour

8.1.1 Urbenville

In Urbenville floodwaters exceed the creek capacity in the 20% AEP event and more frequent events causing inundation of roads into the town such as Clarence Way and Toloom Street. As the magnitude of events becomes larger, the flooding from Tooloom Creek becomes more and more significant. This is due to the natural winding topography of the creek near Urbenville and the junction of Boomi and Tooloom Creek occurring just downstream of Urbenville. These two occurrences slow the floodwaters within the creek and cause backwater up into the town from the Creek. There is also flooding from the local catchments as floodwaters travel between Welch and Urben Street downhill.

8.1.2 Woodenbong

Breakout flows from Tooloom Creek combine with local catchment flows through Black Gully to flood the showground and the sporting fields in events more frequent than the 20% AEP event.

At Woodenbong, properties at Richmond Street experience flooding in their backyards from the channel running behind the properties. There is also flooding in areas near Roseberry Street from Tooloom Creek and Black Gully. This only occurs in severe events. The remainder of the township is affected by minor flow paths along the roads which are typically shallow and contained in the kerb and gutters or drains.

8.1.3 Tooloom and Boomi Creeks

In the Tooloom and Boomi Creek catchment the roads between the two towns are subject to flooding from the creek, and from flow paths coming to the creek. As the events become larger and the flood extent of Tooloom and Boomi Creek grows the amount of flooding of roadways increases. The primary source of flooding on roads along Tooloom and Boomi Creek is from mainstream flooding where this is little elevation change between the road and creek.

8.1.4 Muli Muli

Muli Muli is located next to Tooloom Creek. Clarence Way Road, the only road connecting Muli Muli to the other townships is flooded in events as frequent as the 20% AEP event. Muli Muli is typically not inundated until events greater than the 0.2% AEP event when Muli Muli Crescent can become inundated.

8.1.5 Urbenville Flood Behaviour

8.1.5.1 20% AEP event

At Urbenville floodwaters largely remain within Tooloom Creek in the 20% AEP, although there are breakout flows downstream of Clarence Way road bridge into the open areas behind Tooloom Street. Depths are between 200 to 300 mm and inundate some lots south of Tooloom Street.

Floodwaters also overtop Clarence Way near to the showground with depths of 200 mm over the road. There is no culvert crossing at this location, although drainage channels are evident either side of the road.

The flooding that occurs in the town is dominated by flow from the local catchments. The majority of flooding occurs in the natural flow path as water travels from the hill slopes west of the town. Minor flow paths from between the Welch and Urben Street as overland flows downhill. When the overland flows join the Tooloom

Creek they overtop Tooloom Street with depths up to 400 mm. Flood levels here are dominated by flows from Tooloom Creek.

8.1.5.2 5% AEP Event

At Urbenville in the 5% AEP floodwaters have broken out of the Tooloom Creek, with up to 1 m depths on the floodplain south of Tooloom Street. There are flood water depths of up to 600 mm on the lots on the south side of Tooloom Street. Clarence Way road is overtopped with depths of 400 mm on the road. Tooloom Street is overtopped from tailwaters of Tooloom Creek with depths of 1 m over the road. The flooding in the town is caused from flows in local catchments with floodwaters travelling downhill between Welch and Urben Street.

8.1.5.3 1% AEP Event

At Urbenville in the 1% AEP event, depths of up to 1.6 m is predicted to occur on lots on Tooloom Street. Floodwaters from Toloom Creek cross Tooloom Street to properties on the north side of the street. There are predicted depths of up to 0.8 m on Clarence Way and backwaters from the creek cause depths of 2.6 m on Tooloom Street near the Old Saw Mill, the flooding from Tooloom Creek reaches the south end of Boomi Street. The flooding within the town is from overland flows besides the floodwaters south of Boomi Street.

8.1.5.4 0.2% AEP Event

At Urbenville In the 0.2% AEP even the flood behaviour is similar to the 1% AEP event in terms of areas affected by creek and overland flow flooding asides from the creek floodwaters have crept further into the town crossing further over Tooloom Street and approaching Stephen Street.

8.1.5.5 PMF Event

At Urbenville in the PMF event all the floodwaters are predominantly from Tooloom Creek. Depths become very significant and reach up to 9 m on Tooloom Street. High hazard affects most of the study area.

8.1.6 Woodenbong Flood Behaviour

8.1.6.1 20% AEP event

Breakout flows from Tooloom Creek combine with local catchment flows through Black Gully to flood the showground and the sporting fields in events more frequent than the 20% AEP event . The backwaters from the creek cause and tributary cause flooding on the sporting fields and showground, with the waters extending as far east as Black Gully.

The town flooding is predominantly within the kerb and gutter which is caused by overland flows, with only minor flooding along the streets. There is some inundation of properties and backyards on Richmond Street from the local catchment and the channel running behind these properties to the south. Mount Lindsay Road is flooded in a localised section from the local catchment with depths up to 500 mm.

8.1.6.2 5% AEP Event

In Woodenbong the 5% AEP flooding is very similar except the flood extents caused by the creek backwaters have expanded. The showground and playing fields have larger depths and flood extents. The flooding within the town remains within the drains and gutters alongside the roads except for minor breakout flow. At Richmond Street floodwater from the local catchments travels in the natural channel behind Richmond Street and overtops the levee. The number of properties inundated from remains the same as the 5% AEP, however the flood extent on these properties has increased.

8.1.6.3 1% AEP Event

In Woodenbong in the 1% AEP event, the floodwater behaviour is very similar to the 5% AEP event. There are greater flood depths on the showground, playing fields and Lindsay Creek Road from Tooloom Creek backwaters. The flooding within the town stays confined to minor flow paths alongside the roads with small

depths travelling between properties. The majority of flows from the external catchment travel through the flowpath behind Richmond Street and overtopping the levee into the properties.

8.1.6.4 0.2% AEP Event

In Woodenbong in the 0.2% AEP the floodwater behaviour is very similar to the 1% AEP. There are greater flood depths on the showground, playing fields and Lindsay Creek Road from Tooloom Creek backwaters. The industrial sheds along Roseberry Road are inundated from these floodwaters. There town still remains predominantly flood free with minor flow paths alongside the roads. The majority of flows from the external catchment travel through the flowpath behind Richmond Street and overtopping the levee into the properties, all properties north of Dalmorton Street are inundated in this event with depths up to 1.0 m.

Across the Tooloom and Boomi Creeks between the two towns in the 0.2% AEP event the connecting roads between towns are inundated in multiple areas; see Section 9.2 for more details.

8.1.6.5 PMF Event

In the PMF event at Woodenbong there are greater flood depths on the showground, playing fields and Lindsay Creek Road from Tooloom Creek backwaters. Properties up to Roseberry Lane are inundated by floodwaters. The town still remains predominantly flood free with flow paths alongside the roads and crossing a small amount of properties. The majority of properties behind Richmond Street are now inundated from floodwater in the channel behind the properties.

8.1.7 Tooloom and Boomi Creek

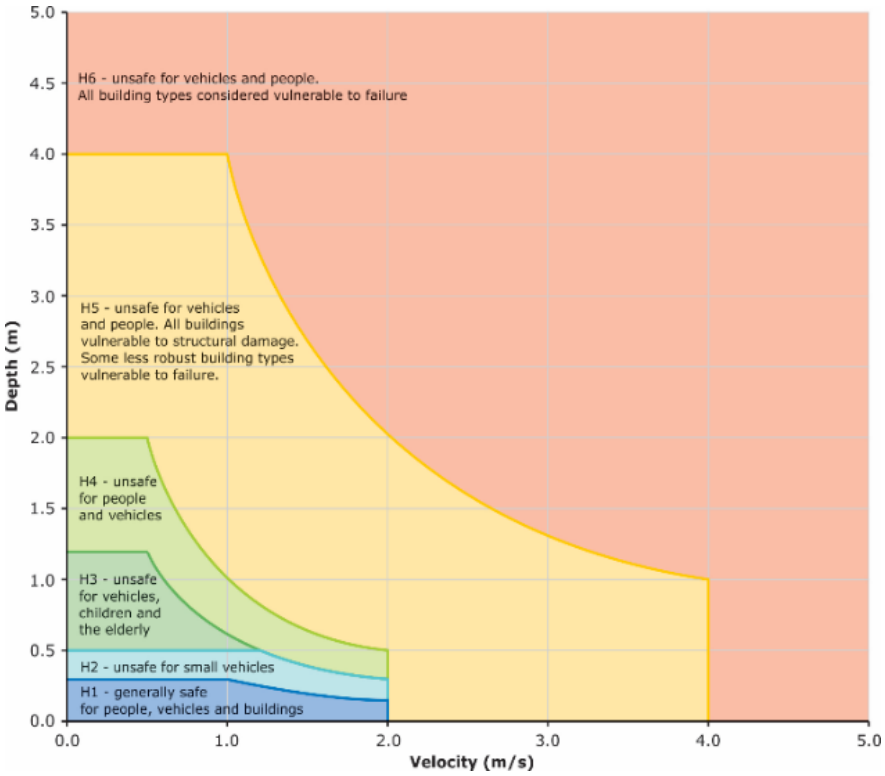
In the 5% AEP for the Tooloom Creek catchment between the towns, the creek remains mainly within its channel with minor locations of breakout flows such as at Woodenbong. There is a small number of locations where the road is are flooded with the major flooding of the roadway occurring near Muli Muli. The town of Muli Muli is above the creek flood level in this flood event. The road is not passable with the path to the north and south with a hazard rating of unsafe for vehicles.

In larger events such as the 20% AEP event Tooloom Creek and Boomi Creek have expanded to fill the floodplain. In the 1% AEP event between the two towns the connecting roads are inundated at multiple locations near Mulli Mulli and Urbenville. Further inundation occurs from mainstream flooding of the creeks and connecting tributaries flooding the roads, more information on this can be seen in Section 9.2.

In Tooloom Creek and Boomi Creek in the PMF event there are greater flood depths than other events, with more floodwater crossing more areas of Clarence Way and Boomi Creek Road.

8.2 Flood Hazard

Mapping of flood hazard for is included in Appendix B. Flood hazard classifications described in ARR 2016 (Book 6, Chapter 7: Safety Design Criteria) have been adopted for the Urbenville and Woodenbong Flood Study as they it provide a greater range of hazard classifications than the provisional hazard categories described in the Floodplain Development Manual 2005. The ARR2019 hazard classifications are in line with AIDR Guideline 7-3 Flood Hazard (Australian Institute for Disaster Resilience (AIDR), 2017).



H1 – Generally safe for vehicles, people and buildings.

H2 – Unsafe for small vehicles.

H3 – Unsafe for vehicles, children and the elderly.

H4 – Unsafe for vehicles and people.

H5 – Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.

H6 – Unsafe for vehicles and people. All building types considered vulnerable to failure.

Figure 8-1: ARR2019 / AIDR General Flood Hazard Curves

8.2.1 Urbenville

At Urbenville in the 20% and 5% events the hazard is quite similar with few areas of high hazard within the town. Areas of high hazard are on the defined flow paths both the overland flow path from the west and Tooloom Creek. There is a high hazard rating at Tooloom Street near the Old Saw Mill, and Clarence Way Road. In the 5% event some properties south of Tooloom Street near the floodplain are classified as H4 due to the flood depths. The 1% and 0.02% AEP event areas of high hazard are present towards the town as the creek flood levels starts to dominate over local catchment flood levels. In the PMF event the whole town is in high hazard H6 due to the depths of floodwater and velocities.

8.2.2 Woodenbong

In Woodenbong in the 20% and 5% there are typically no areas of high hazard with the area being zoned H1 and H2 asides for the defined channels and creeks. As depths increase on the showground and sporting fields their hazard rating increases. In the 1% and 0.2% event the majority of the town is still H1, with flow paths now becoming H5 rating. Some properties on Richmond street are defined as H3 due to flood depths, as does the showground and sporting fields. Mount Lindsay Road is classified as H4 and H5 in certain areas where flooding overtops the road. In the PMF, the properties along Richmond Street and on the northern end of Roseberry Street are classified as H5.

8.2.3 Muli Muli

Muli Muli Crescent is flooded and is classified as H4 in a PMF event. In the 20% AEP event Clarence Way to the north and south of Muli Muli is classified as H4 which is considered unsafe for vehicles and people.

8.3 Flood Function

Hydraulic categories were determined in consideration of with the Floodplain Risk Management Guideline Floodway Definition and the Floodplain Development Manual definitions. Floodways are areas important for conveyance of water flows during floods. These areas are typically naturally defined channels. Flood storage is areas of large depths but slower velocities. These areas are typically overbank flow from the defined channels and creeks and if filled would cause adverse effects on flood behaviour elsewhere. Flood fringe considered as areas of shallow depths and slow velocities.

The following criteria was used to establish the provisional flood function based on Howells et al. (2004) and is mapped in Appendix B:

Floodway:

- Velocity x Depth must be greater than 0.25 m^2/s AND velocity must be greater than 0.25 m/s; OR
- Velocity is greater than 1 m/s

All other areas were determined as Flood Storage except areas where flood depths were less than 200 mm which were classified as Flood Fringe.

At Urbenville in the 20% AEP event, the floodways occur in the main channels such as Tooloom Creek and the channel running south of Urbenville Road. In the 1% AEP event, areas of floodplain in the fields south of Tooloom Street are classified as floodway as the depths and velocities in this area increase. The channel running south of Urbenville Road has a larger area of floodway. In the PMF event the majority of the town is classified as floodway as depths from the creek are significant. The velocities from the overland flows are high reaching greater than 1 m/s classifying the area as floodway .

At Woodenbong, in Tooloom Creek in the 20% AEP event the flow through the creek is classified as floodway due to the high velocities and depths through the natural creek path. In the 20% AEP the floodways occur in the main drainage channels, Tooloom Creek, Black Gully and the channel running behind Richmond Street. There are areas of floodway within the town in the drainage channels along the streets, as the velocities in the drainage channels are high.

In the 1% AEP event the floodways extents increase in all areas of the town. In the PMF event the extent of floodway has expanded to affect a number of properties on Richmond Street and the industrial lots of Roseberry Street.

8.4 Climate Change

Assessment of the potential effects of climate change allows for Council to understand the implications of on flood planning into the future, for example, if the flood planning area need to be extended or flood planning levels increased.

ARR2019 recommends the application of percentage increases in rainfall based on climate scenarios assessed by CSIRO. Through the ARR data hub, Interim Climate Change Factors are provided with percentage increase in rainfall to be applied to a range of future years. ARR2019 recommends the use of RCP4.5 and RCP8.5 values. For Urbenville and Woodenbong this equates to an increase in rainfall of about 9.5% (RCP4.5) and 19.7% (RCP8.5) to 2090.

As per the project brief, a comparison of the 0.2% AEP event to the 1% and AEP event has been used as a proxy to assessment of climate change and also the recommendations of ARR2019. Figure 8-3 and Figure 8-2 shows the difference in peak water levels between the 1% AEP and 0.5% AEP events for Woodenbong and Urbenville. While a percentage increase in rainfall does not directly equate to the same percentage increase in peak flows, adopting 0.5% AEP as a proxy for climate change is considered a suitable estimate.

At Woodenbong there are increases of 15% of flows in Tooloom Creek and water level increases of up to 250 mm. This increase also occurs on Black Gully and the natural channel behind Richmond Street. Within the town of Woodenbong itself there are increases of approximately 3 mm across properties and up to 15 mm in some localised channels.

At Urbenville there is a 36% increase in catchment flows between the 1% and 0.2% AEP events and there are increases in predicted peak water level of up to 900 mm. In areas affected by local catchment flows, there are smaller increases of up to 50 mm on properties within the town, and up to 300 mm on the main flow path from the north west. The Was Dry Now Wet sections of the floodplain show the increase of flood extents between the two events.

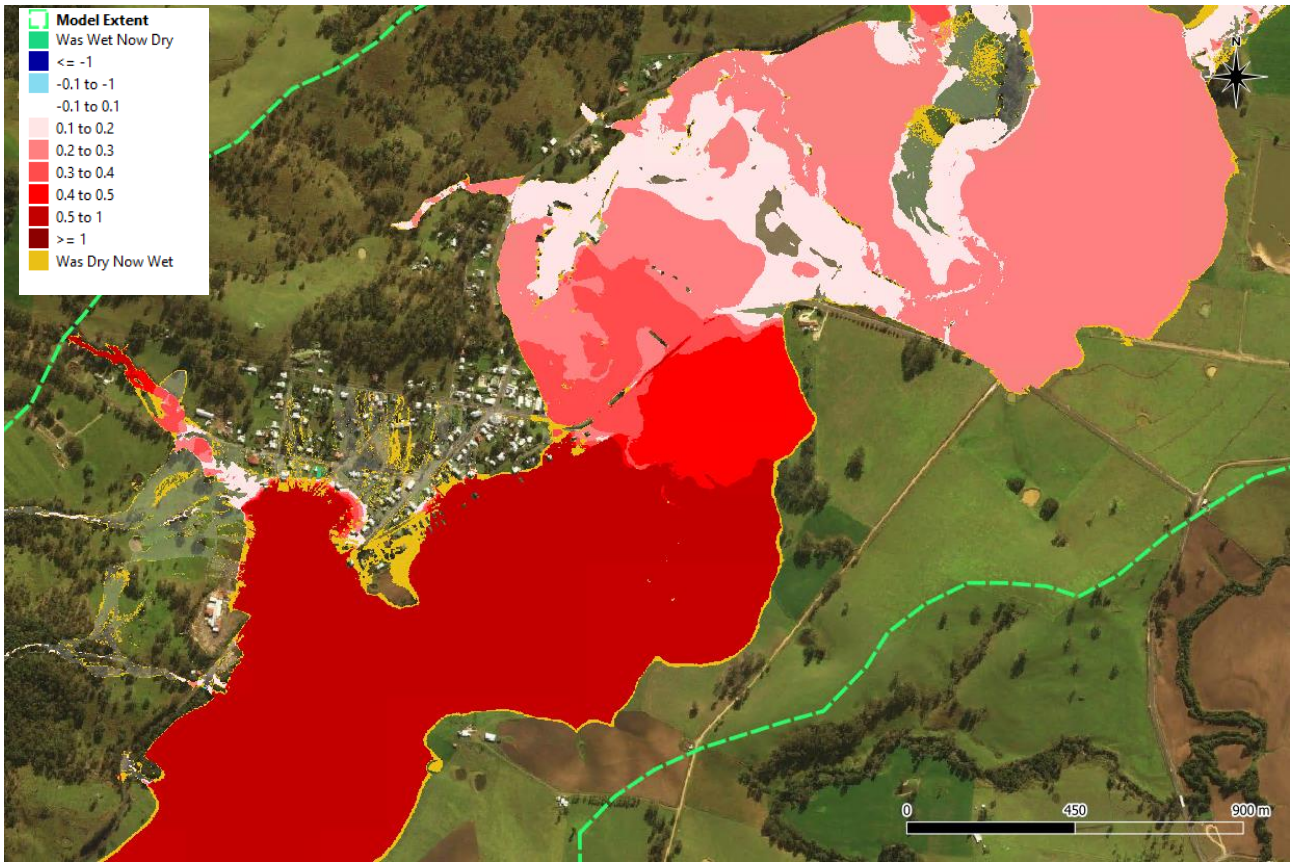


Figure 8-2: Urbenville - Water Level Difference between 0.2% and 1% AEP

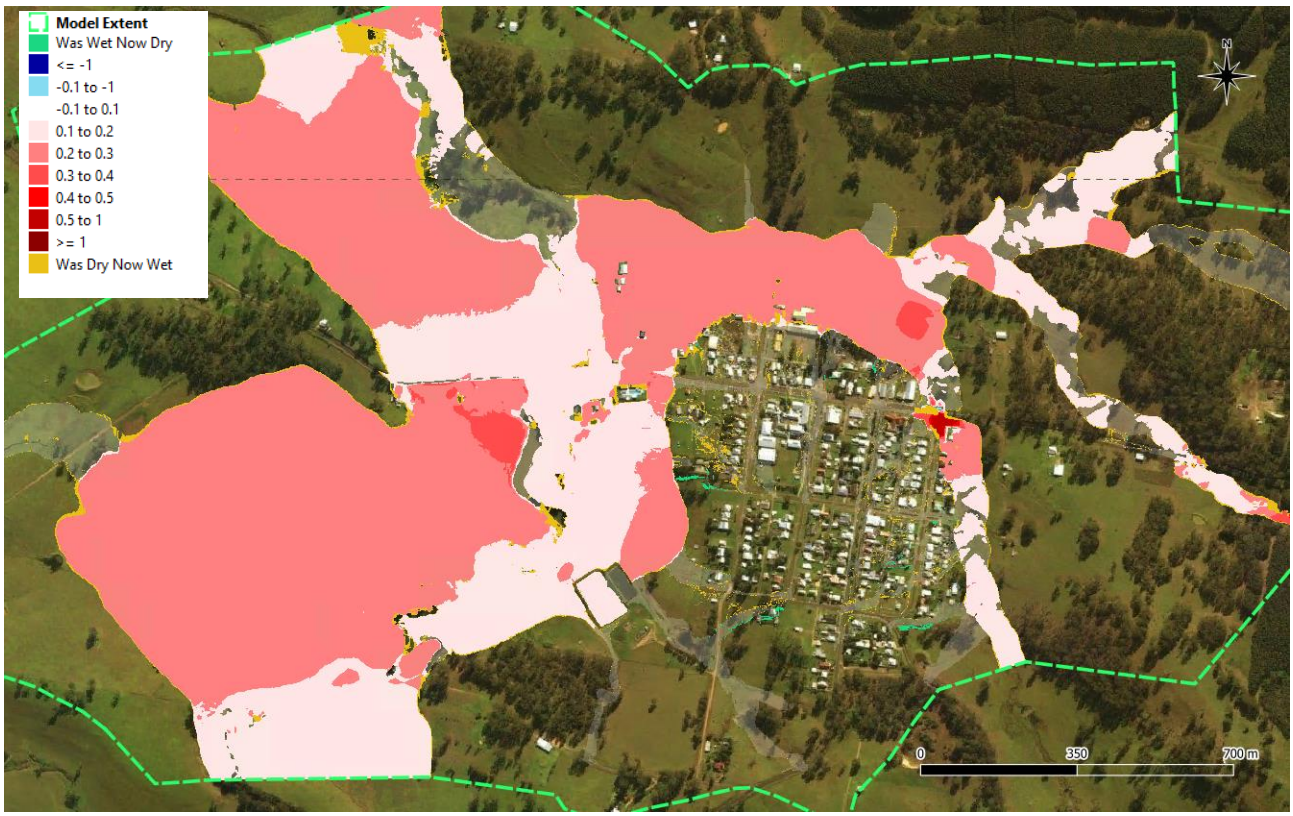


Figure 8-3: Woodenbong - Water Level Difference between 0.2% and 1% AEP

8.5 Blockage Analysis

Sensitivity testing of the model was undertaken with blockage analysis with the blockage increased from 50% to 100% in the stormwater network across all the models, this is increasing the risk factor of blockage from Medium to High in ARR2019. The results from the sensitivity test show no large differences with only localised changes occurring at culvert entry locations.

At Urbenville there are localised increases at the intersection of Beaury Street and Tooloom Street with increases of 200 mm in the 1% AEP due to the blockage of the two 450 mm culverts under Tooloom Street.

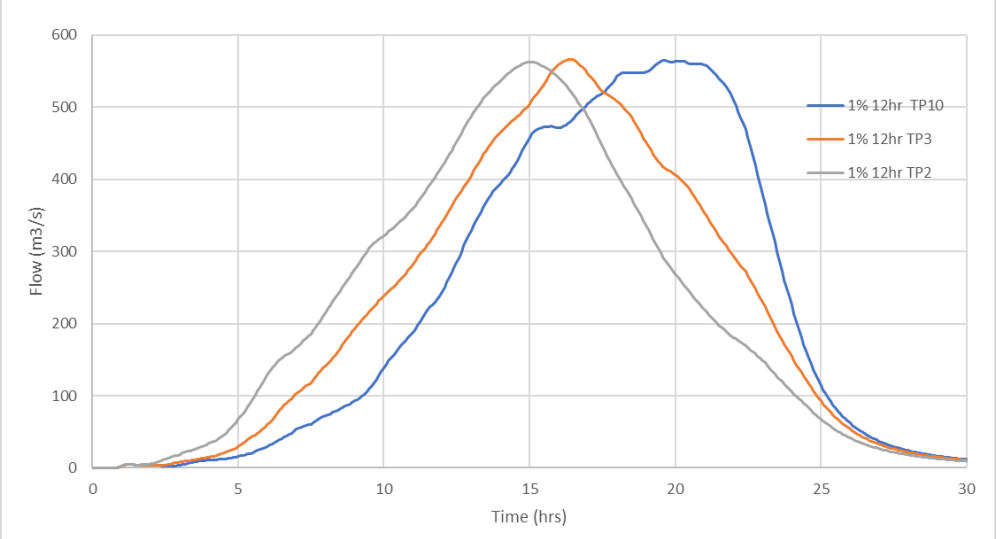
At Woodenbong significant increases in peak flood level occur at the natural overland channel behind Richmond Street crosses Mount Lindsay Road. There are increases in this area of up to 400 mm in the 1% AEP. This is due to the increased blockage at the culvert crossing under Mount Lindesay Road. Although no existing buildings are affected by this increase, this shows the importance of maintenance of the waterways and structures to minimise blockage risk.

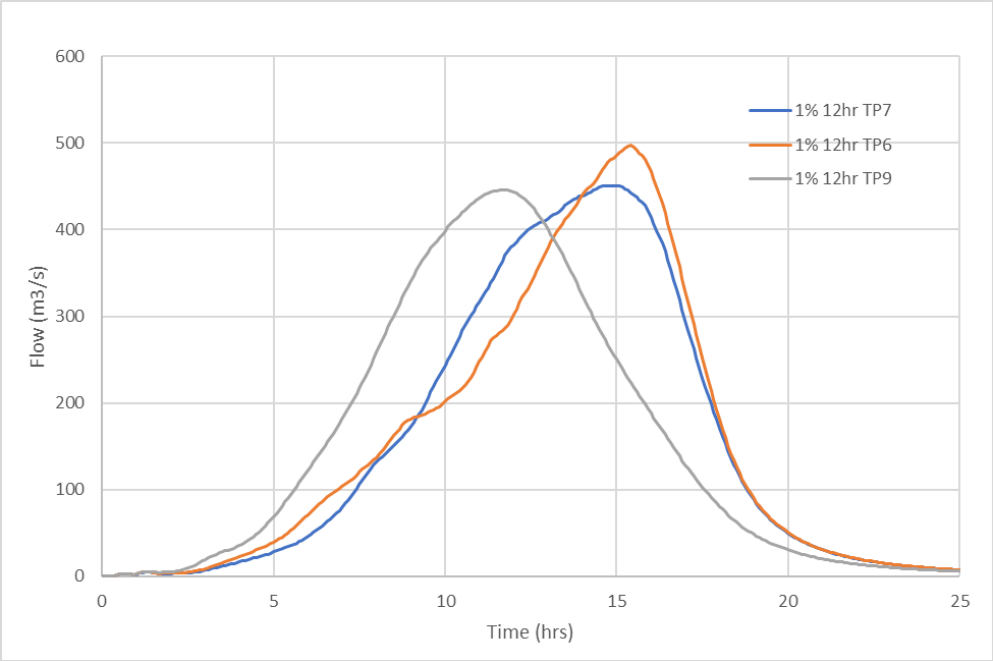
8.6 Sensitivity Analysis

Sensitivity analysis has been undertaken to observe the influence of model parameters on the predicted flood behaviour. Sensitivity was undertaken by adjusting relevant parameters in both the hydrologic rainfall routing model (ICM) and hydraulic (TUFLOW) models and assessed against the 5% AEP and 1% AEP design events.

Table 8-1: Model Sensitivity Assessment

Parameter and Sensitivity Assessment	Outcomes
Initial and Continuing losses a) Adopt ARR19 Losses: IL to 51 mm and CL to 4.7 mm/hr	NSW FFA-reconciled losses applied in the hydrology model are IL 49.7 mm and CL 3.26 mm/hr. As a sensitivity these have been increased to ARR data hub values for the region of IL 51 mm and CL 4.7 mm/hr. At Woodenbong there is a decrease of flows due to the increase of initial and continuing losses. There is a 7% and 11% decrease in flows in the 1% and 5% AEP events respectively. These are decreases from 451 to 418 m^3/s and 305 to 272 m^3/s for each event. For Urbenville the results are very similar with decreases of 8% and 14% in flows in the 1% and 5% AEP events. These are decreases from 564 to 521 m^3/s and 357 to 308 m^3/s. The adopted NSW FFA-reconciled losses are therefore more conservative than the ARR data hub values. The NSW FFA-reconciled losses are considered more appropriate for the Tooloom catchment as they are based on observed data at a nearby similar catchment.
Hydraulic roughness a) Increase of 20% b) Decrease of 20%	Increasing the Mannings n roughness value slows down the floodwater velocities within the model extent and typically causes higher flood depths. By increasing the roughness by 20% within the model there is an increase of flood levels across the model. At properties within Urbenville there is maximum increases of 6 mm and within Tooloom Creek near Urbenville these increases vary between 70 to 100 mm. At Woodenbong there are increases of up to 5 mm within the town. Inside defined channels such as Black Gully and Tooloom Creek these increases are up to 100 mm. Decreasing the roughness by 20% has the opposite effect, increasing flood velocities and lowering flood depths. At Urbenville within well-defined channels there are decreases up to 120 mm. In the township there are decreases up to 10 mm in local overland flows. At Woodenbong within the town flood levels decrease by 5 mm, and within defined channels such as Black Gully and Tooloom Creek levels decrease by up to 50 mm and 100 mm respectively. While the model has some sensitivity to hydraulic roughness, the large differences are seen to occur in the defined waterways and have little impact on properties within either town.
Structure losses at bridges over Tooloom Creek a) Increase by 10% b) Decrease by 10%	Increasing the form losses in the bridges of each model has no significant result in Tooloom Creek in the 5% or 1% AEP events. At Urbenville there are increases of 1 mm upstream of the Clarence Way Bridge. And at Woodenbong there are decreases of 5 mm and decreases of 4 mm either side of Mount Lindsay Road Bridge over the Tooloom Creek. Decreasing the form losses at Urbenville has no significant result in the creek in the 5% AEP event or the 1% AEP event. There are decreases upstream of Clarence Way Ridge of 1 to 3 mm in each event. At Woodenbong there are decreases of 5 mm upstream of Mount Lindsay Road Bridge, and increases of 1 mm downstream as floodwater move more efficiently through the structure. The model has limited sensitivity to structural losses.

Parameter and Sensitivity Assessment	Outcomes
Downstream boundary conditions a) Increase slope by 20% b) Decrease slope by 20%	Downstream boundary sensitivity is undertaken to ensure that the model extends suitably downstream so that boundary affects do not influence the predicted flood behaviour in the study area. By increasing the slope on the downstream boundary the flood levels are reduced by at up to 300 m upstream of the boundary of the creek model. This is still significantly far from Urbenville to have no impact on flood levels within the town. Decreasing the slope by 20% increases flood levels by up to 300mm upstream of the boundary. This is still significantly far from Urbenville to have no impact on flood levels within the town. This has no effect on the flood behaviour at the towns as the boundary is significantly far away from Urbenville.
Temporal Patterns	Sensitivity to temporal patterns assists in understanding flood response times to rainfall and available warning times for flood emergency response and will be considered further in the Floodplain Risk Management Study and Plan. The upper median temporal pattern is the closest highest neighbor to the median has been chosen for each design event from the 10 potential temporal patterns as per ARR2019. For sensitivity testing the temporal pattern which produces the peak flow either side of this has been compared in the rainfall routing model. In Tooloom Creek at Urbenville the upper median temporal pattern (TP10) has a peak flow of 564 m^3/s. The temporal pattern producing the peak above the selected temporal pattern has a peak flow of 566 m^3/s (TP3) and the temporal pattern below has a peak flow of 562 m^3/s (TP2). The peak flows are with 1 % of each other and will have negligible effect on flood levels within the town. The hydrographs for these patterns are seen below. The selected temporal pattern (TP10) has a similar rate of rise than the others, with 5 hours difference between the two peaks.  **Figure 8-4: Urbenville Temporal Patterns** At Woodenbong in Tooloom Creek there is a peak flow of 451 m^3/s in the selected temporal pattern (TP7). The temporal pattern below (TP9) has a peak flow of 446 m^3/s and the temporal pattern above (TP6) has a peak flow of 497 m^3/s. The difference in flows are insignificant to impacts on flood levels within the township. There is a slight difference in

Parameter and Sensitivity Assessment	Outcomes
	timings between the chosen and lower temporal pattern, with approximately 3 hours difference in peaks between the two.  **Figure 8-5: Woodenbong Temporal Patterns**

9 CONSEQUENCES OF FLOODING ON THE COMMUNITY

9.1 Flood Emergency Reponses Classification of Communities

The Flood Emergency Response Classification of Communities (DECC, 2007) is defined to assist in managing flood evacuation and response. Areas are broadly classified based on the flood effect to the area and to the local evacuation routes before the flood peak.

The Flood Emergency Response Classification is mapped in Appendix C.

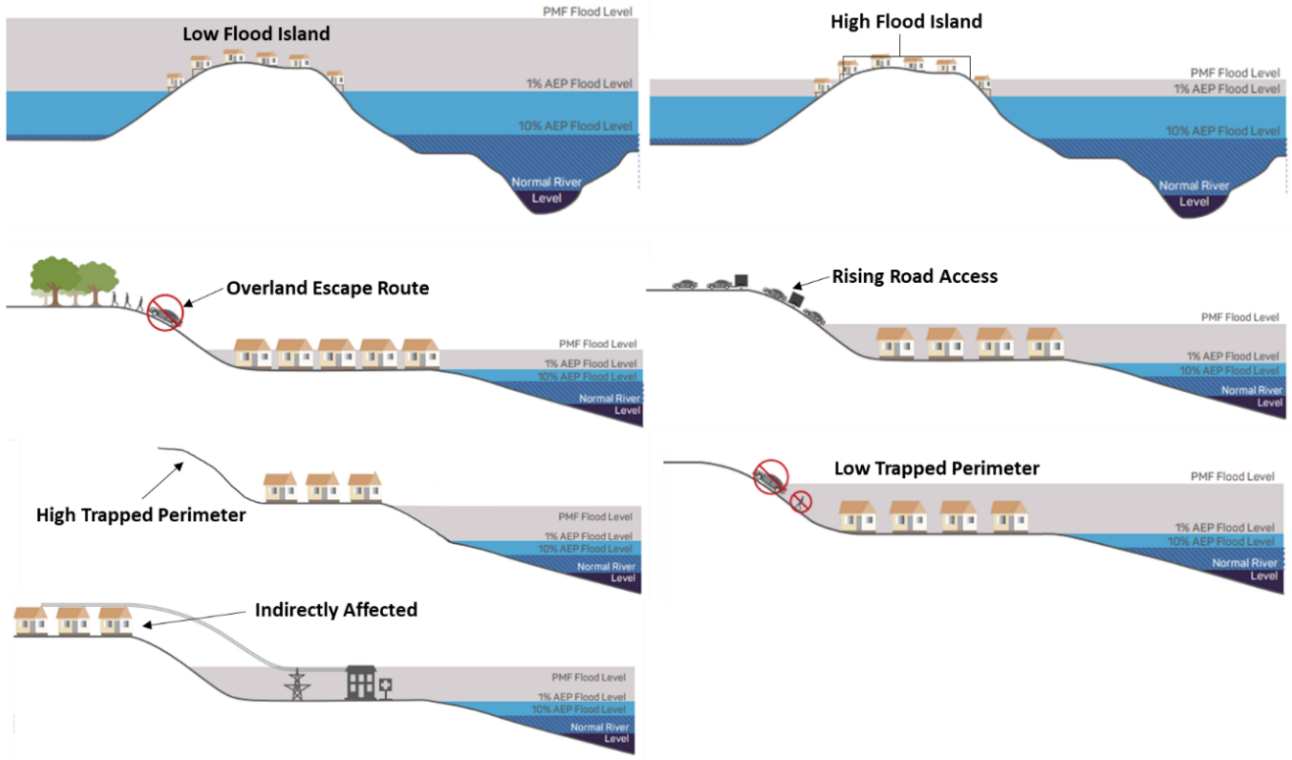


Figure 9-1: Schematic of ERP Classifications (adapted from Guideline 7-2; Flood Emergency Response Classification of the Floodplain (Australian Institute for Disaster Resilience (AIDR), 2017))

9.1.1 Urbenville

The north side of the town within the Tooloom Creek flood extent is classed as Rising Road Access where people can evacuate via vehicle before the peak of the flood (subject to sufficient warning). Outside of the flood extent is typically classed as High Trapped Perimeter. This area is above the PMF extent of the creek but has no route for evacuation. It is expected that Urbenville Road to the west would be cut by flooding from Beaury Creek based on photographs provided of flooding along this road (note the road is outside of the study area and therefore has not been included in the flood modelling).

The Old Saw Mill on Tooloom Road is classified as Area with Overland Escape Route, the roads are cut off from the local catchment overland paths. This area is within the PMF extent and could be subject to inundation. There are overland escape routes via foot, this would be to no habitable areas to evacuate to only the surrounding bushland which is classified as High Trapped Area. Within the floodplain there are areas of Low Flood Islands this includes the Urbenville Showground and Camping Ground.

Table 9-1: Urbenville Township Number of Lots in FERP Category

Classification	Number of Lots
Rising Road Access Area	141
High Trapped Area	129
Area with Overland Escape Route	3
Low Flood Island	7

9.1.2 Woodenbong

At Woodenbong, the majority of the town is classed as Indirectly Affected. There is an escape route from the town through Boomi Creek Road and Old Bruxner Creek Road. This is an unsealed road, which may not be passable to all vehicles in an extreme weather event. This road joins Mount Lindesay Road further east of the town outside of the flooding from Tooloom Creek. Areas within the flood extent are classed as Rising Road Access as they have road access to move to higher ground before being inundated. There are areas of Low Flood Islands within the floodplain near Woodenbong this includes the Woodenbong Campground and swimming pool.

Table 9-2: Woodenbong Township Number of Lots in FERP Category

Classification	Number of Lots
Indirectly Affected	184
Rising Road Access	58
Low Flood Island	3

9.1.3 Tooloom and Boomi Creek

Throughout the Tooloom Creek catchment areas in the floodplain are typically considered as High Trapped Perimeter Areas. Areas outside of the flood extents could be cut from vehicular or overland on foot access to areas of safety. Areas within the PMF flood extent are classified as Areas with Overland Escape Routes, these areas are able to leave before being flooded, however can only travel to the High Trapped Perimeter Areas.

9.1.4 Mulli Mulli

Muli Muli is a High Trapped Perimeter are due to inundation of the Clarence Way to the north and south in the 20% AEP event. The town itself is not flooded until events larger than the 0.05% AEP event however has no means of evacuation or self-resupply.

9.2 Road Inundation

Clarence Way runs between Urbenville and Woodenbong towns. The road is prone to flooding at various locations. Figure 9-4 shows a long section of Clarence Way between the towns.

There are sections of the road where flooding occurs more frequently such as the section south and north of Muli Muli which is more prone to flooding due to the natural topography. In the 20% AEP event the road could be inundated for about 8 hours and in the 1% AEP event for about 15 hours.

In the PMF the road is flooded along most of its length. This flooding is predominantly from Tooloom Creek overtopping the road. This can be seen in the Figure 9-4: Long Section of Clarence Way from Urbenville to .

Figure 9-5 shows a long section of Boomi Creek Road which runs alongside to Boomi Creek. Areas where the road is flooded frequently can be seen. For the majority of areas subject to frequent flooding, inundation occurs where the road crosses the creek or the where it is inundated from mainstream flooding from the rise in water levels in the creek. Road inundation occurs from tributaries of Boomi Creek but not as significant depths. The most significant area of flooding is the Boomi Creek Road crossing of Boomi Creek to the east of the Boomi Creek Road and Clarence Way Road intersection. At this location the road can be submerged for about 15 hours in the 20% AEP event and 20 hours in the 1% AEP event.

Mount Lindesay Road crosses Tooloom Creek at Woodenbong to the west of the town. Figure 9-2 shows the modelled design water levels over the bridge, the bridge is expected to be inundated above deck from the 5% AEP and greater events. Depths of 3 metres over the bridge are expected in the PMF event.

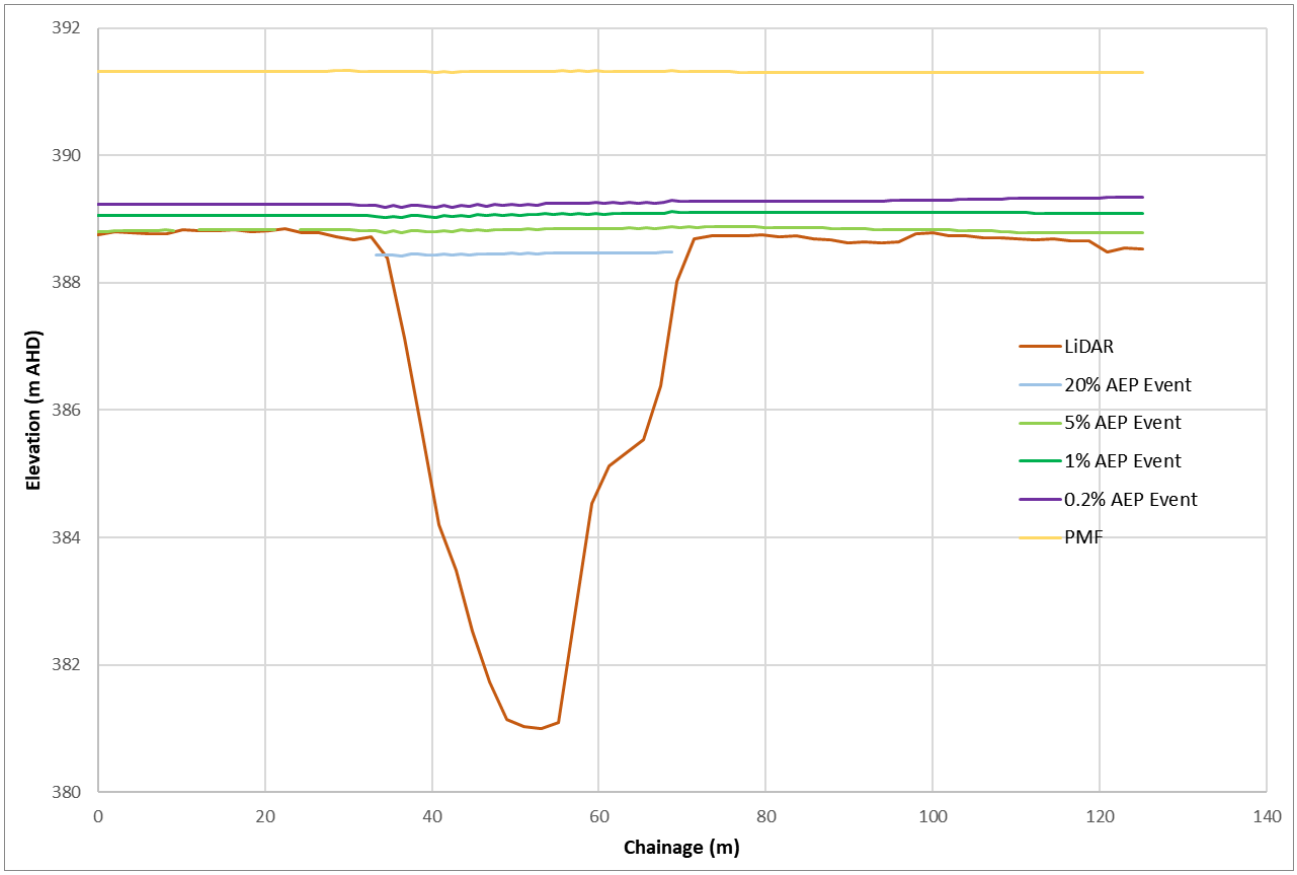


Figure 9-2: Mount Lindesay Road Bridge over Tooloom Creek at Woodenbong

At Urbenville the Clarence Way Road Bridge crosses Tooloom Creek to the north of the town. Figure 9-3 shows the design modelled water levels on the bridge crossing. The bridge is not anticipated to be overtopped above deck level until events greater than the 0.2% AEP event.

Further to the east, Clarence Way Road is flooded in all events as it passes the showground and camping ground. At this location there is no culvert however drainage channels are evident either side of the road. The hazard in the 20% AEP is H1 generally safe for people and vehicles meaning the road is still trafficable in this event however in the 5% AEP is H4 unsafe for vehicles and people. From this event onwards the road is not safe to use.

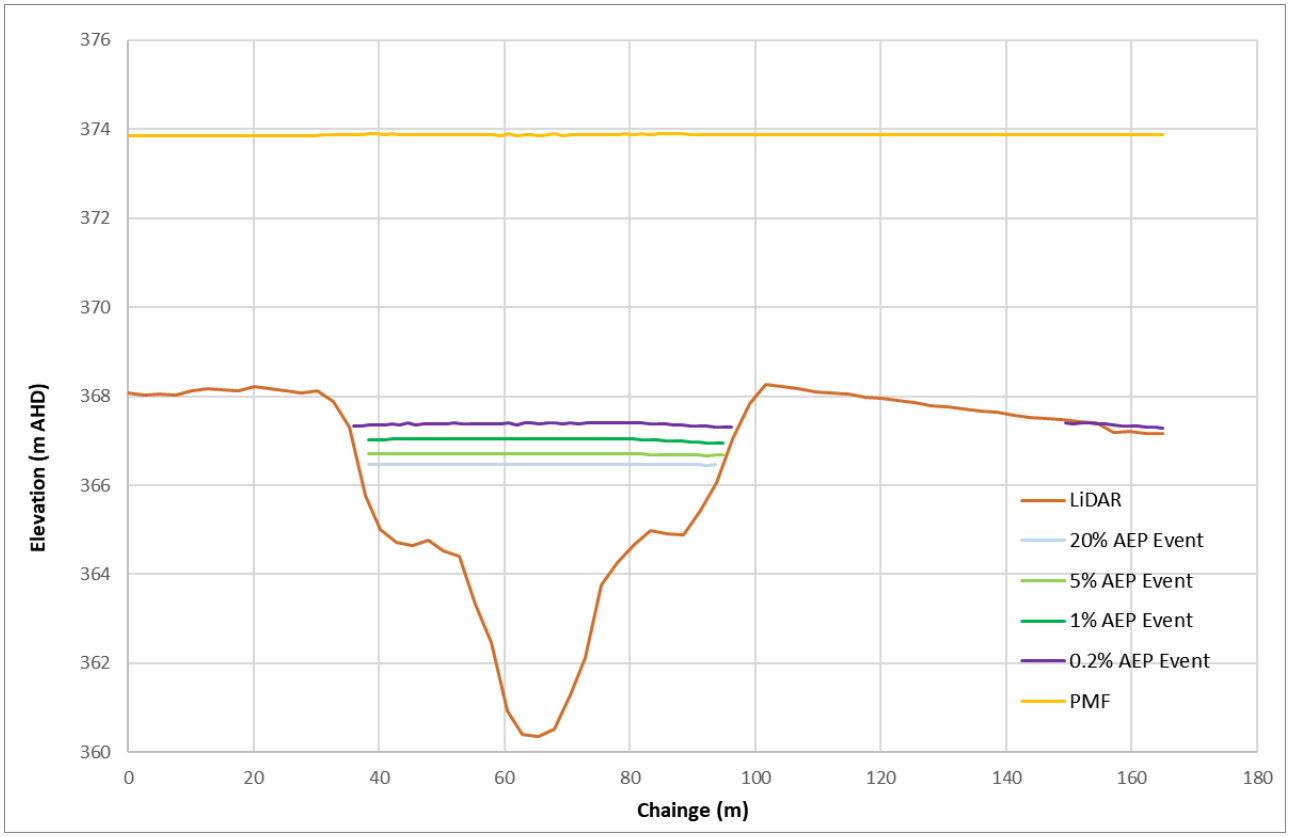


Figure 9-3: Clarence Way Road Bridge over Tooloom Creek at Urbenville

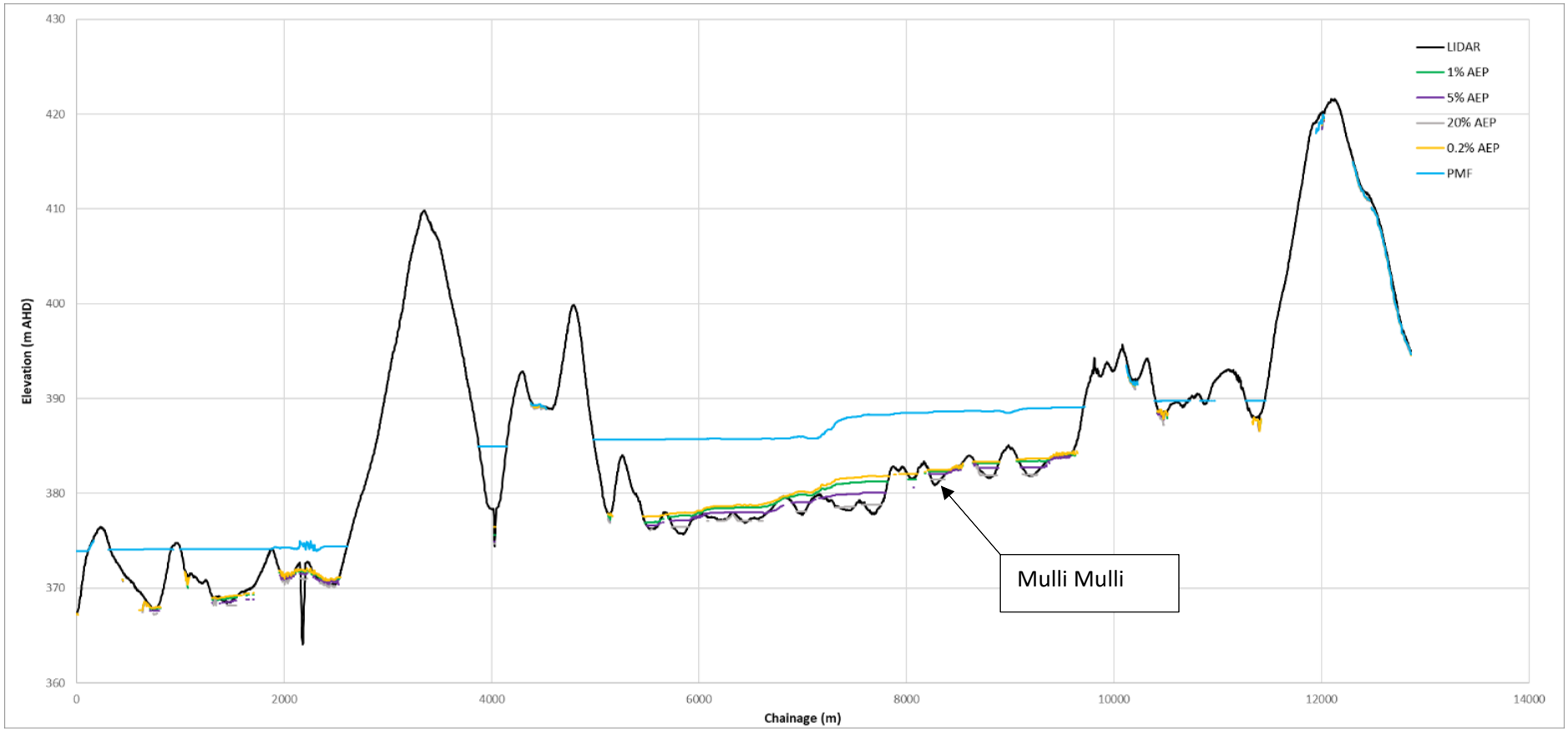


Figure 9-4: Long Section of Clarence Way from Urbenville to Woodenbong

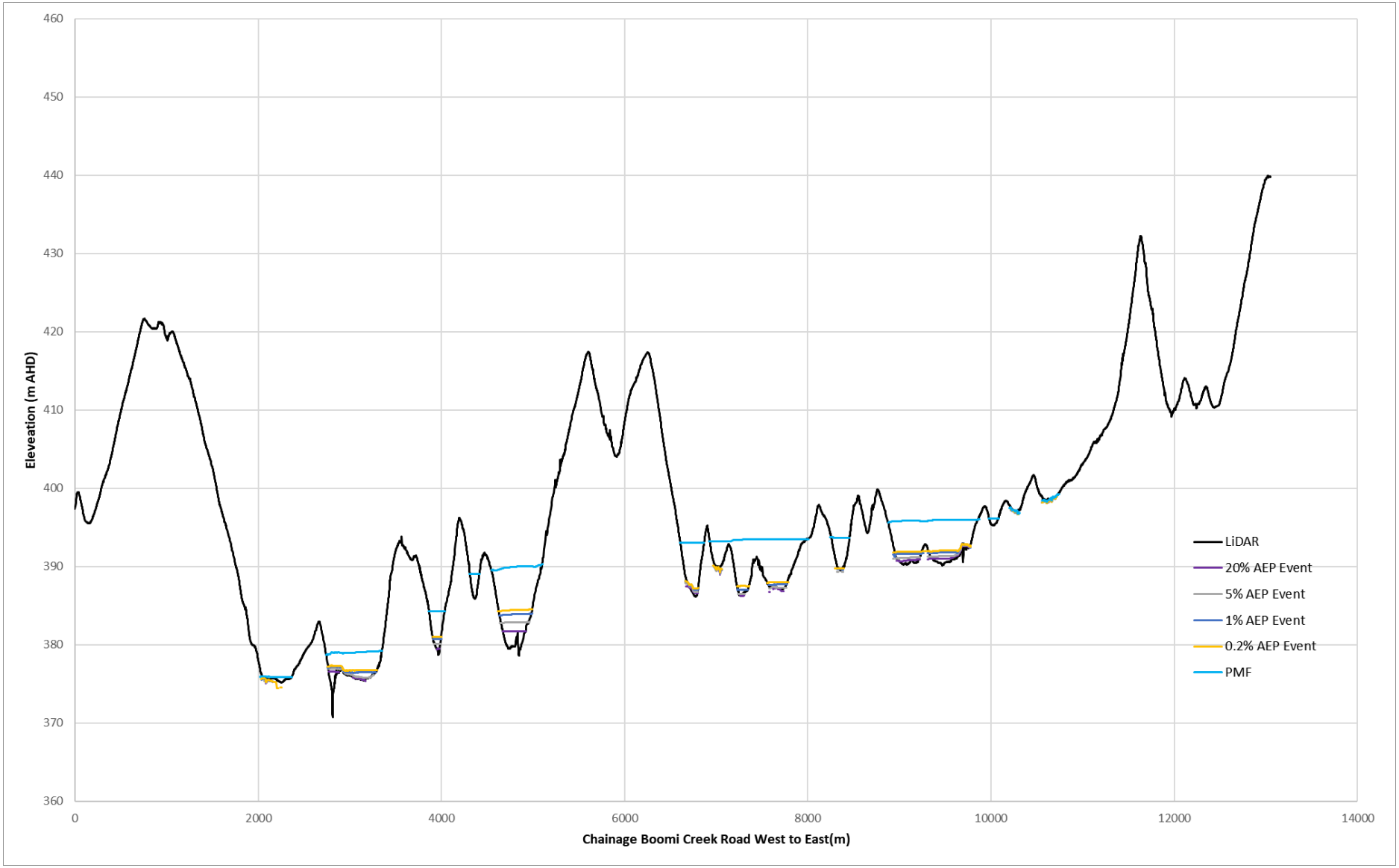


Figure 9-5: Long Section of Boomi Creek Roa

10 MANAGING ACTIVITIES IN THE FLOODPLAIN AND FLOOD RISK

10.1 Land Use Planning

10.1.1 Urbenville

The town of Urbenville is classified as RU5 Village with the surrounding area classified as RU1 Primary Production and areas of national park classified as E1 National Parks and Nature Reserves to the east of the town.

Where Tooloom Creek fills the floodplain in areas south of Tooloom Street it is recommended that the future Floodplain Risk Management Study and Plan consider appropriate land use zoning in this area to restrict further development in the floodway. The showground and campground is flooded frequently in the 5% and 20% event as H4 unsafe for vehicles and people. This area should not be rezoned in the future.

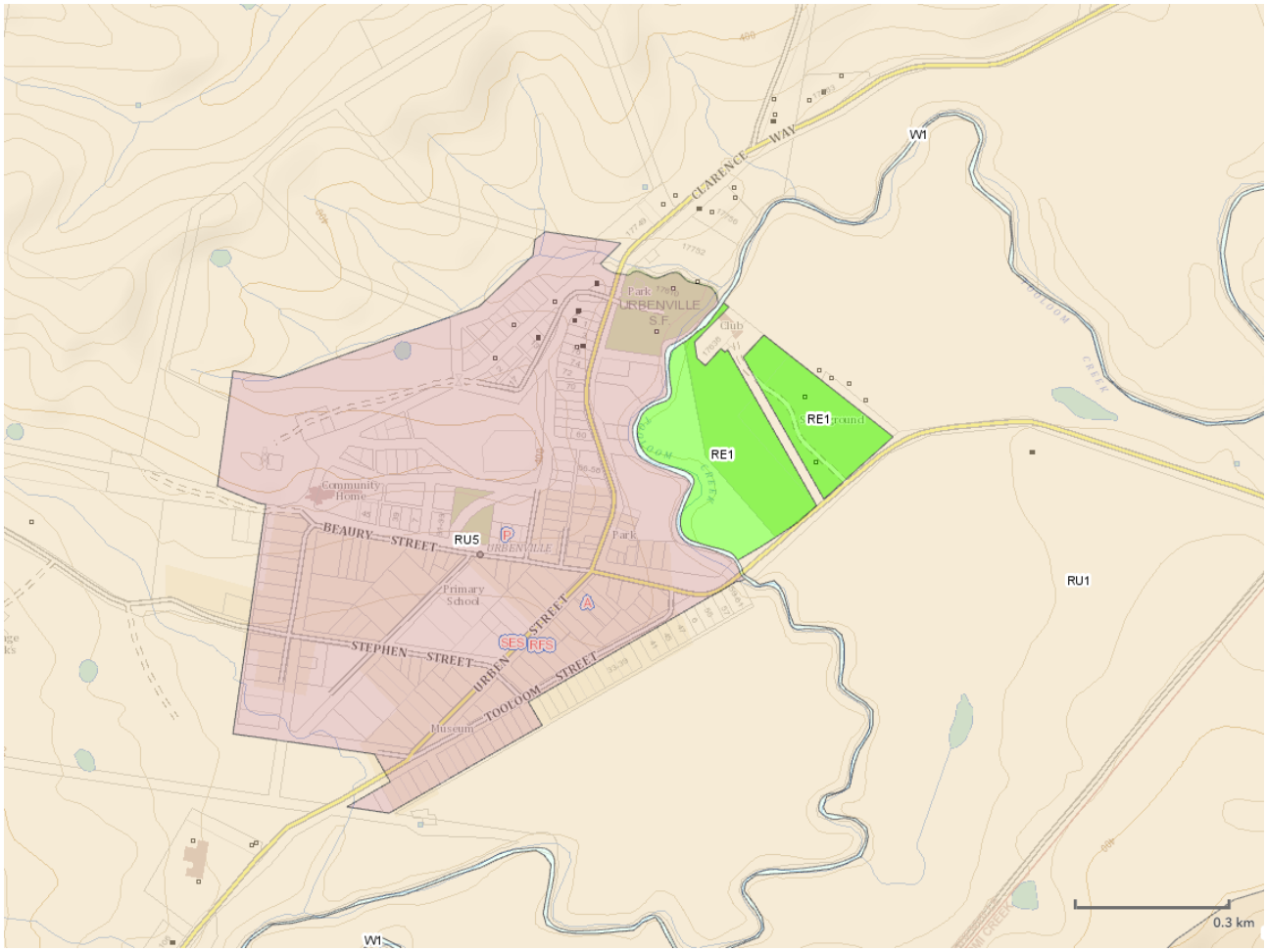


Figure 10-1: Urbenville Land Use Zones

10.1.2 Woodenbong

The town of Woodenbong is typically zoned RU5 Village while the surrounding area is RU1 Primary Production and RE1 Public Recreation. There are areas of R5 Large Lot Residential and RU4 Primary Production Small lots to the south-east of the town. An area of concern is Black Gully as a tributary of Tooloom Creek is more subject to flooding than the rest of the township. Future rezoning of the floodplain surrounding the tributary may be appropriate to prevent further development. The Sewerage System at Woodenbong is surrounded by floodwaters in all events as flows breakout of Tooloom Creek, and is inundated in the 1% AEP events and greater. The hazard of flooding at this area is H1 generally safe for vehicles people and buildings in the 1% and 0.2% AEP events, in the PMF it is H5 unsafe for vehicles and people, all building types vulnerable to structural damage.

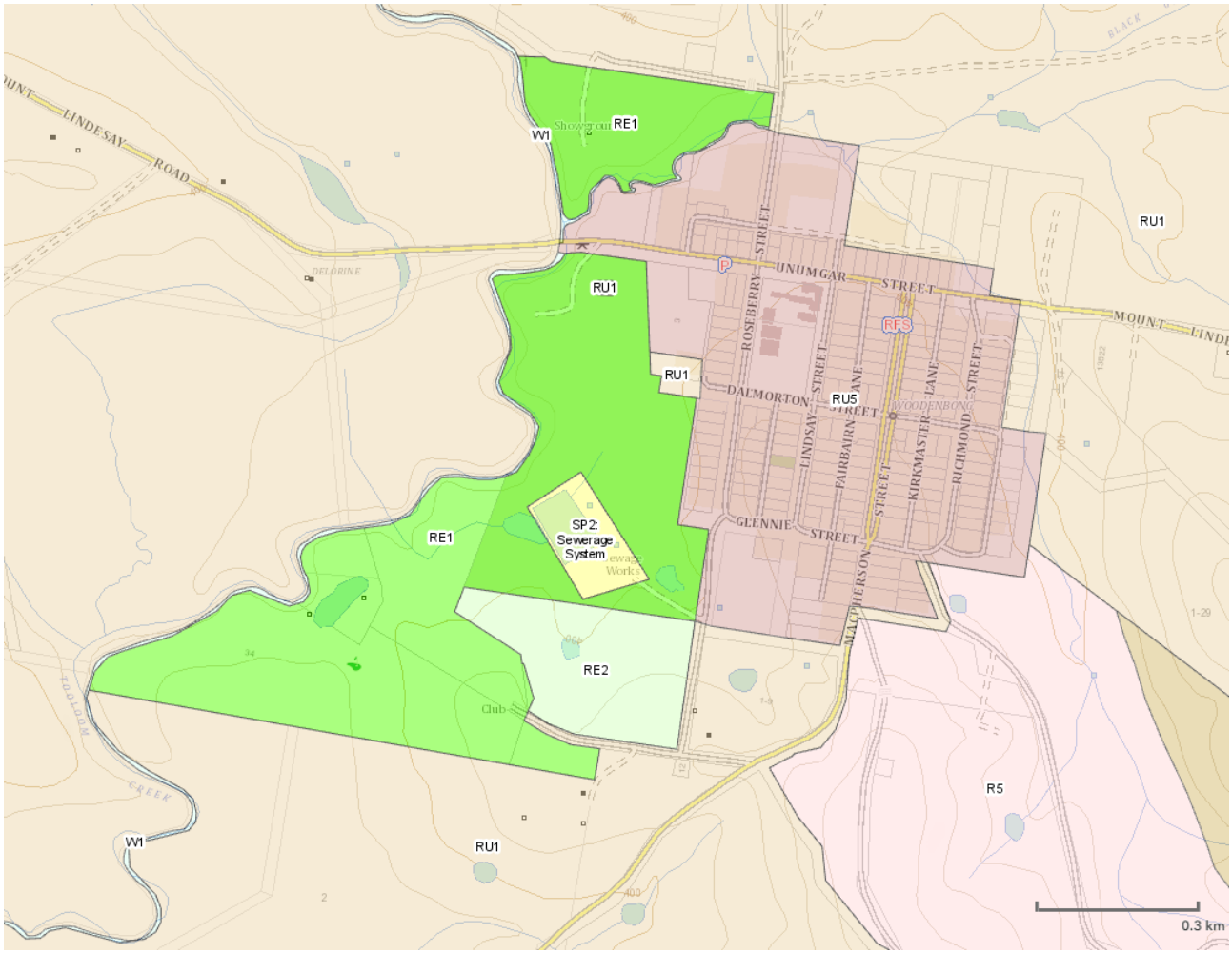


Figure 10-2: Woodenbong Land Use Zones

10.1.3 Muli Muli

The town of Muli Muli is classified as R5 Large Lot Residential. The land use zoning is generally compatible with the flood hazard of the land subject to appropriate development controls.

10.2 Flood Planning Levels (FPL) and Flood Planning Area (FPA)

As summarised in section 2.5 of the Kyogle Council, the DCP typically requires floor levels to be at least 500 mm above the 1% AEP flood level. The Tenterfield Shire Council DCP defines the FPL as the 1% AEP flood

event plus 0.5 metres. Currently the 1% AEP flood level at Woodenbong and Urbenville is based on anecdotal evidence of historic events.

Current guidance makes several recommendations for setting a freeboard for flood planning purposes:

Table 10-1: Guidance (and Legislation) on Determining of Freeboard, FPAs and FPLs

Source	Type	Freeboard / Comment
Tenterfield Council Development Control Plan	Legislation	• The FPL is typically determined as the 1% AEP flood level plus a 0.5 m freeboard. Where the 1% AEP is not known, such as Urbenville historical flood marks are used.
Kyogle Council DCP	Legislation	• The FPL is typically determined as the 1% AEP flood level plus a 0.5 m freeboard.
NSW Floodplain Development Manual (2005)	Legislation / Guidance	• Freeboard to FPL typically 0.5 m applied to the 1% AEP flood for residential property unless benefits of a higher FPL eg vulnerable uses such as aged care facilities, hospitals • Consideration should also be given to using the PMF as the FPL when siting and developing emergency response facilities such as police stations, hospitals, SES headquarters, and critical infrastructure, such as major telephone exchanges, if possible. • Potential for commercial and industrial properties to be based on event more frequent than the 1% AEP flood.
ARR2019	Guidance	• No specific freeboard value stated
AIDR Handbook 7 (2017)	Guidance	• Freeboard range from 300 mm to 600 mm • 300 mm for shallow floodwater • > 600 mm where flood level estimates are uncertain
Queensland Development Code (Queensland Government, 2013)	Interstate	• Minimum floor level for habitable room of 300 mm for all residential building types
Queensland Urban Drainage Manual (IPWEAQ, 2017)	Interstate	• Minimum freeboard of 300 m above the defined flood event (typically the 1% AEP event) for minimum floor levels

10.2.1 Urbenville

The traditional FPA approach of a 0.5 m freeboard to the 1% AEP flood level affects the full town of Urbenville including areas where 1% AEP flood depth are shallow.

In areas north of Beaury Street the PMF flood levels are lower than the 1% AEP plus 0.5 m level in areas where flooding occurs due to local catchment flooding and is not affected by Tooloom Creek in frequent events. In this case application of an FPL of the 1% AEP plus 500 mm level may be over conservative if the extent is larger than the PMF extent.

10.2.2 Woodenbong

For Woodenbong the traditional approach of setting an FPA of a 0.5 m freeboard to the 1% AEP flood level was also applied. The resulting FPA includes the majority of the town, except for southern portions. A lot of these areas are not subject to significant flooding depths within the town drainage along the roads.

The FPA extent for much of the town is caused by flow paths alongside the roads that are contained to the drainage channels. The depths in these channels are less than 100 mm, with some localised low points of 300 mm. Where breakout flow does occur of these channels and travel between buildings the floodwaters sheet flow and have shallow depths that are typically less than 50 mm. The flooding contributing to the FPA in these areas are from local catchments. The PMF level is lower than the FPL level using this application, using this approach may be overly conservative.

10.2.3 Tooloom and Boomi Creek areas

Generally for the Tooloom and Boomi Creek floodplain the PMF extent is larger than the FPA (based on 1% AEP event plus 0.5 m freeboard). A 0.5 m freeboard is likely to be suitable.

10.2.4 Recommended Approach

For the Tooloom Creek flooding the PMF level higher than the Flood Planning level, however within the Woodenbong township and areas of Urbenville the FPL assuming a 500 mm freeboard applied to 1% AEP flood depths is higher than the PMF level. For the township this may be overconservative.

Therefore, the recommended approach is to:

- Adopt a FPA based on all flood levels plus 0.5 m.
- Adopt variable FPLs based on the source and depth of inundation at properties.

This approach means that properties which only subject to shallow depths are not subject to onerous development controls and that new development is not limited by unrealistic development controls.

During the Floodplain Risk Management Study and Plan further analysis on appropriate freeboard should be considered to define the Flood Planning Area for Urbenville and Woodenbong. There are areas of Woodenbong where less strenuous flood controls need to be applied. In overland flow areas an approach where the greater of the PMF or 1% AEP plus a 0.3 m freeboard may be more appropriate.

11 CONCLUSIONS

11.1 Flood Study Summary

The Flood Study has developed robust flood modelling to establish the design flood behaviour for the 20% AEP, 5% AEP, 1% AEP, 0.2% AEP and PMF events. Where possible, the flood modelling has been validated against observed flood marks from the 2008, February 2010 and December 2010 and anecdotal evidence obtained for the community during the community consultation. SES and council photographs of flooding were also used to validate the behaviour of the flood model.

The study has identified the two main sources of flooding for each town; the local catchments that flow through the towns, and flooding from Tooloom Creek.

11.2 Urbenville

At Urbenville, the Tooloom Creek is the dominant source of flooding. In the 5% event the creek flows into floodplain and extends towards the town. In larger events, overland flows travel between Welch and Urben Streets.

The Flood Study has also considered provisional Flood Hazard and Flood Function. Typically, when under overland flow conditions the floodways are limited to the channels and drains with the exception of a few streets. In the larger events and under flooding from Tooloom Creek, areas of floodway affect more properties at Urbenville as the Tooloom Creek flood extent becomes larger in the 1% AEP and PMF events.

At Urbenville the extent of properties within the PMF are classified as Rising Road Access given available evacuation routes via foot to higher ground. These areas of higher ground outside the flood extent are classified as High Trapped Perimeter due to the surrounding roads being cut off.

In the northern area of the town where it is affected by overland and local catchment flows, flood depths are typically less than 0.5 m in the 1% AEP event and therefore adoption of a 0.5 m freeboard above the 1% AEP flood level may be over conservative for flood planning, especially where this causes the FPL to be above the PMF level. A reduced freeboard for these areas is recommended.

11.3 Woodenbong

At Woodenbong the local catchments are the dominant source of flooding as floodwater from Tooloom Creek does not inundate developed areas of the town until greater than a 0.02% AEP event. In the larger events the flows from the channel near Richmond Street and Black Gully exceed the channel capacity and cause areas of high hazard floodway in the 1% AEP and PMF events.

In the 20% AEP the floodways occur in the main drainage channels, Tooloom Creek, Black Gully and the channel running behind Richmond Street. As the magnitude of the flood increases, the floodway extents increase in all areas of the town. In the PMF event the extent of floodway has expanded to affect a number of properties on Richmond Street and the industrial lots of Roseberry Street.

Much of the town is classified as indirectly affected with evacuation routes from the town still accessible. This is subject to the road condition of Old Bruxner Road, an unsealed road connecting Boomi Creek Road Mount Lindesay Road. Areas within the flood extent are classified as Rising Road Access because they have evacuation routes available via foot and road to them before inundation. There are areas of low flood islands within the Tooloom Creek floodplain at Woodenbong.

Within the town, flood depths are typically less than 0.5 m and typically confined to the drainage channels in the roads which is from the local catchments. Due to this the adoption of a 0.5 m freeboard above the 1% AEP flood level may be over conservative for flood planning. A reduced freeboard for these areas is recommended.

11.4 Tooloom and Boomi Creeks

Clarence Way which runs parallel to Tooloom Creek, can remain inundated for about 15 hours in the 1% AEP event. Boomi Creek road which travels next to Boomi Creek remains flooded for about 20 hours in the 1% AEP event.

Around Tooloom Creek and Boomi Creek the majority of area is classed as High Trapped Perimeter where dry and Overland Escape Route where innundated, due to the terrain and scarcity of roads making evacuation via vehicles difficult.

11.5 Next Stage

Following adoption of the Flood Study, Council will move to the Floodplain Risk Management stage which will build upon the findings of this Flood Study to identify options for floodplain risk management.

REFERENCES

Australian Institute for Disaster Resilience (AIDR). (2017). *Guideline 7-2 Flood Emergency Response Classification of the Floodplain.* Commonwealth of Australia.

Australian Institute for Disaster Resilience (AIDR). (2017). *Guideline 7-3 Flood Hazard.* Commonwealth of Australia.

Australian Institute for Disaster Resilience (AIDR). (2017). *Managing the Floodplain; A Guide to Best Practice in Flood Risk Management in Australia.* Commonwealth of Australia.

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

BMT WBM. (April 2009). *Kyogle Floodplain Risk Management Plan.* prepared for Kyogle Council.

Bradley, J. N. (March 1978). *Hydraulic Design Series No.1 Hydraulics of Bridge Waterways.* FHWA.

Bureau of Meteorology. (2003). *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method.*

Bureau of Meteorology. (2003). *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method.*

DECC. (2007). *Flood Emergency Response Classification of Communities.*

Department of Commerce. (July 2015). *Bonalbo Long Term Water Supply and Srought Strategy.*

Department of Environment and Climate Change. (2007). *SES Requirements from the FRM Process.* NSW Government.

Department of Infrastructure, Planning and Natural Resources. (April 2005). *Floodplain Development Manual: the management of flood liable land.* NSW Government.

DFSI Spatial. (May 2015). *Elevation data products specification and description. Source Airbourne Light Detecting and Ranging (LiDAR).* NSW Spatial Services.

ELVIS. (2020, June 25). *Elevation and Depth - Foundation Spatial Data*. Retrieved from https://elevation.fsdf.org.au/

Howells et. al. (2004). *Defining the Floodway - Can One Size Fit All?*

Institution of Engineers Australia. (1987). *Australian Rainfall and Runoff: A Guide to Flood Estimation.* (Editor-in-chief D.H. Pilgrim, Ed.) Barton, ATC.

Jacobs. (December 2019). *Tabulam Floodplain Risk Management Study and Plan, Final FRMS&P.* prepared for Kyogle Council .

Jacobs. (March 2019). *Tabulam Floodplain Risk Management Study and Plan Final Flood Study Report.* prepared for Kyogle Council.

NSW Department of Public Works and Services. (November 2001). *Bonalbo Dam Probable Maximum Flood Study.* prepared for Kyogle Council.

NSW Department of Public Works. (August 2004). *Bonalbo Dam Dambreak Study.* prepared for Kyogle Council.

NSW Public Works. (April 2015). *Bonalbo Dam Addendum to Flood Study.* prepared for Kyogle Council.

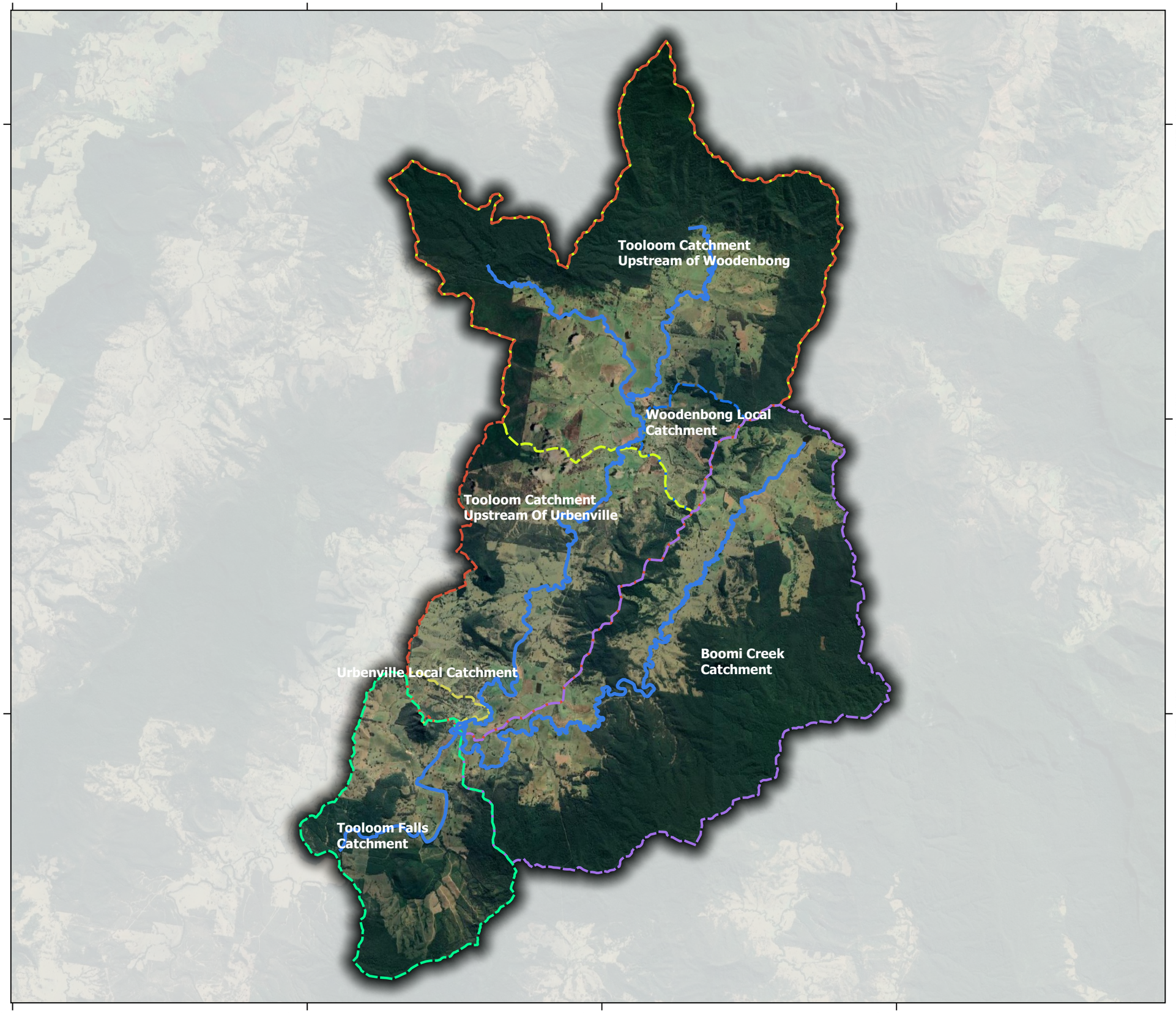
OEH. (November 2015). *Floodplain Risk Management Guide Modelling the Interaction of Catchment Flooding and Oceanic Innundation in Coastal Waterways.* NSW Office of Environment and Heritage.

Public Works Advisory. (July 2017). *Bonalbo Dam 2017 Piping Risk Assessment report number DC17020.* prepared for Kyogle Council.

WBM Oceanics Australia. (February 2004). *Kyogle Flood Study.* prepared for Kyogle Council.

APPENDIX A

FIGURES



Legend

Catchments

- Boomi Creek
- Tooloom Creek Upstream of Woodenbong
- Urbenville local Catchment
- Tooloom Creek Upstream of Urbenville
- Woodenbong Local Catchment
- Tooloom Creek Upstream of Falls

0 2.5 5 km

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

BG&E

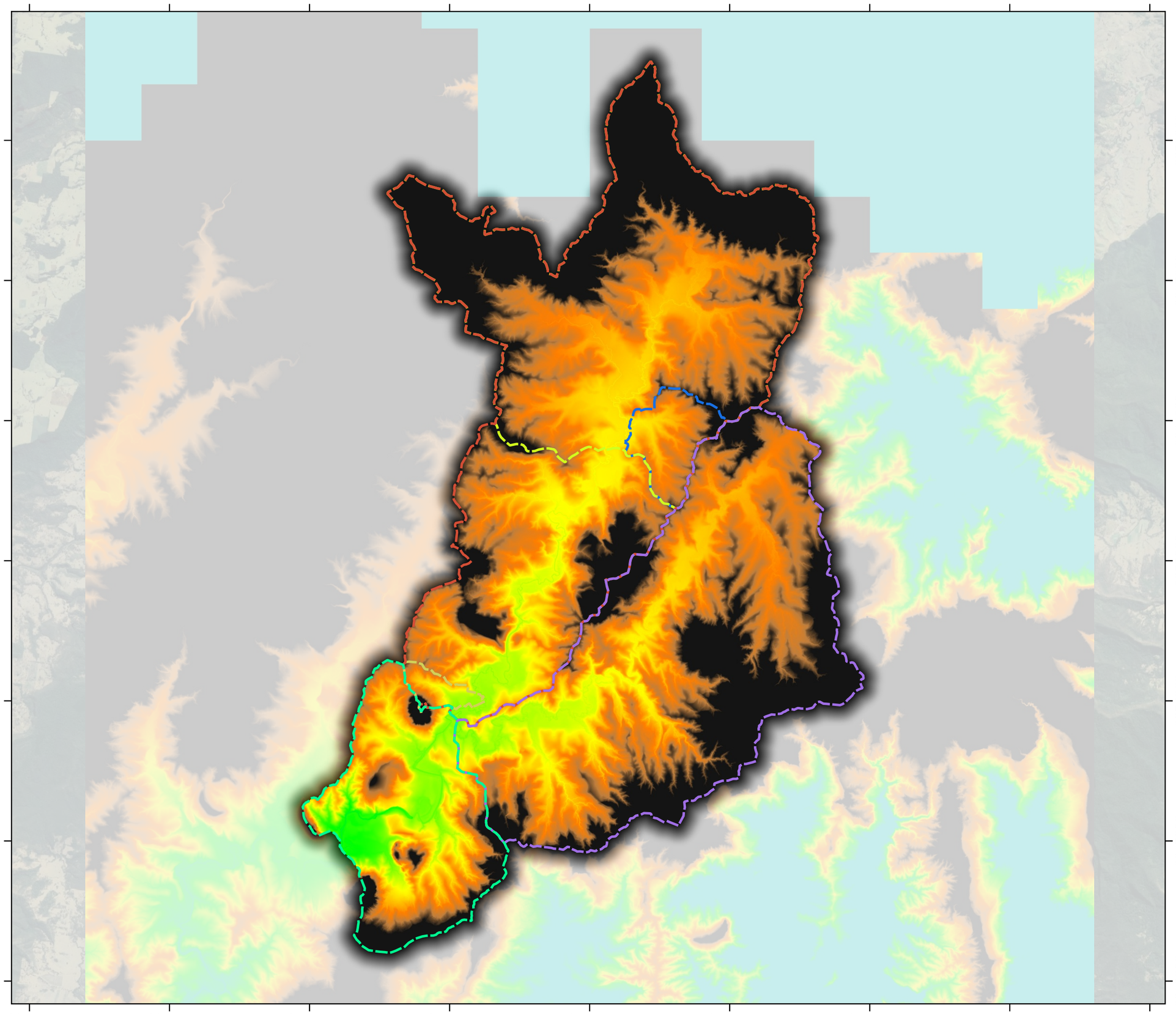
DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 1 – Catchment Plan Tooloom and Boomi Creeks

DATUM GDA2020 / MGA zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ {% "QGISTheme"%}



Legend

CatchmentOutline
- Boomi Creek
- Tooloom Creek Upstream of Woodenbong
- Urbenville local Catchment
- Tooloom Creek Upstream of Urbenville
- Woodenbong Local Catchment
- Tooloom Creek Upstream of Falls

Elevation (m AHD)
- 300
- 340
- 380
- 420
- 460
- 500

0 2.5 5 km

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 13/09/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 2 – Topographic Plan

DATUM GDA2020 / MGA zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Moogerah Dam
Maroon Dam
Rathdowney Post Office
Killarney Post Office
Woodenbong (Unumgar St)
Unumgar (Summerland Way)
Legume (New Koreelah)
Urbenville
Tabulam (Muirne)

6900000
6880000
6860000
6840000
6820000

420000
440000
460000
480000
500000
520000

Legend

Catchments
- Boomi Creek
- Tooloom Creek Upstream of Woodenbong
- Urbenville local Catchment
- Tooloom Creek Upstream of Urbenville
- Woodenbong Local Catchment
- Tooloom Creek Upstream of Falls

Rainfall Gauges
- Pluviograph
- Daily Rainfall

0 10 20 km

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

BG&E

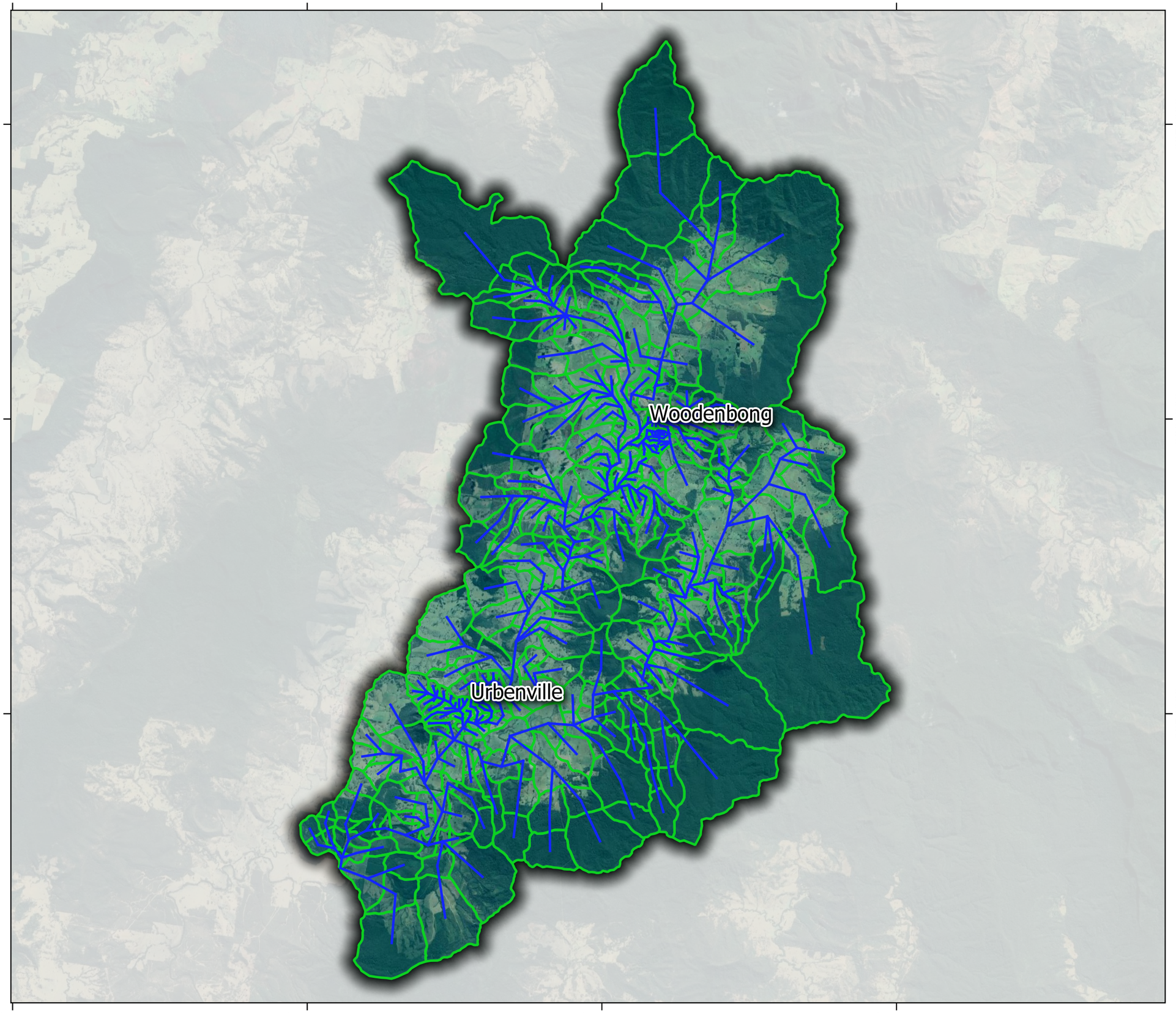
DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 3 – Rainfall Gauges

DATUM GDA2020 / MGA zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]



Legend

- Sub-catchments
- Streampaths

0 2.5 5 km

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

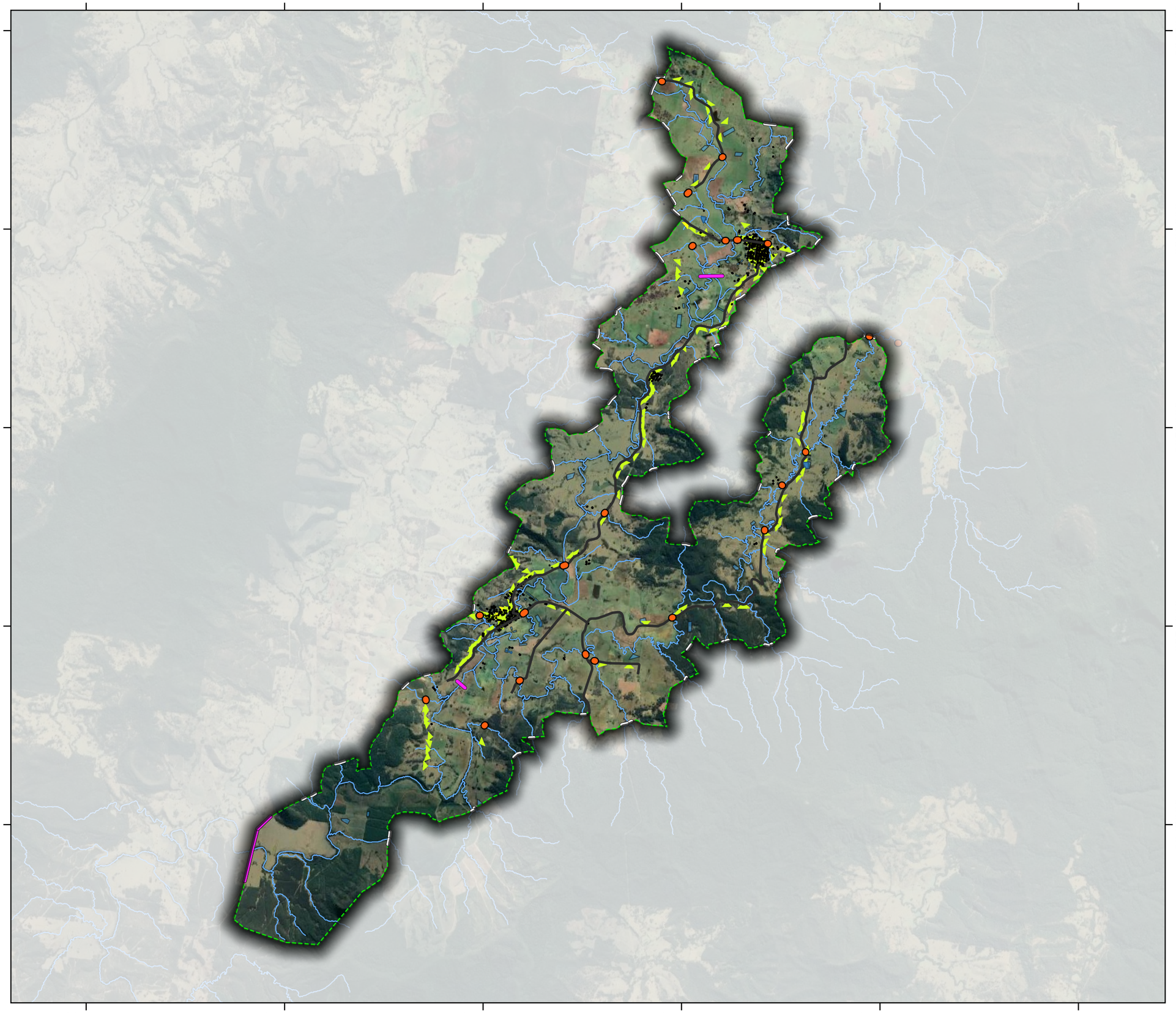
DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 4 – Hydrological Model Layout

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps



Legend

- Buildings
- Model Extent
- Initial Water Level
- Brdiges (2d_lfcsh)
- Local Catchment Flows
- External Flows
- Roads (ridge lines)
- Creeks (gully lines)
- Downstream Boundary

Stormwater Network

- 1d featuers

0 2.5 5 km

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

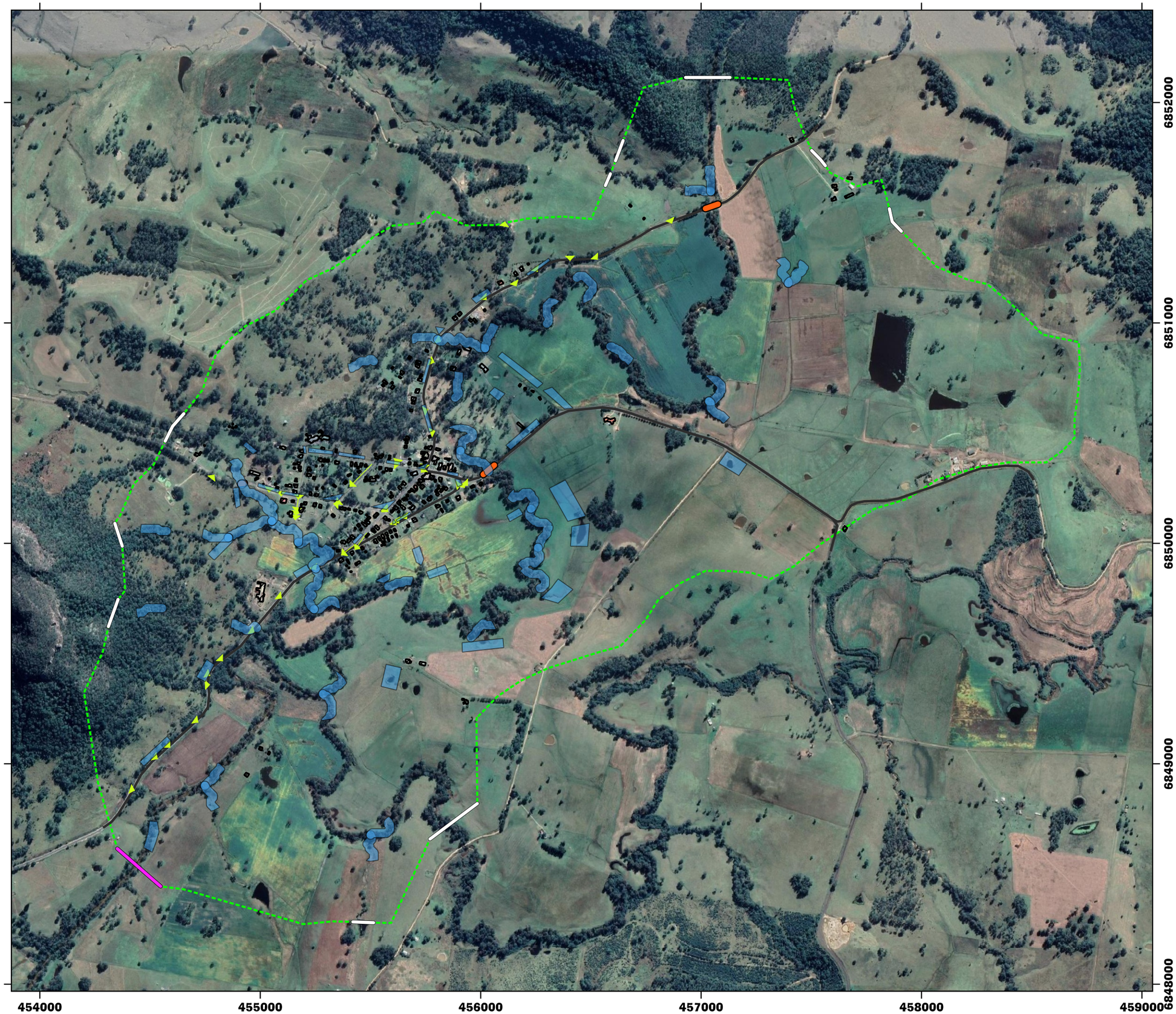
DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 5 – Tooloom Creek Hydraulic Model Layout

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps



Legend

- Buildings
- Model Extent
- Initial Water Level
- Brdiges (2d_lfcsh)
- Local Catchment Flows
- External Flows
- Roads (ridge lines)
- Creeks (gully lines)
- Downstream Boundary

Stormwater Network

- 1d featuers

0 500 1,000 m

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 6 – Urbenville Hydraulic Model Layout

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps

Legend

- Buildings
- Model Extent
- Initial Water Level
- Brdiges (2d_lfcsh)
- Local Catchment Flows
- External Flows
- Roads (ridge lines)
- Creeks (gully lines)
- Downstream Boundary

Stormwater Network

- 1d featuers

0 400 800 m

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 31/08/2021
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure A 7 – Woodenbong Hydraulic Model Layout

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps

APPENDIX B

FLOOD MAPPING

Calibration and Validation Events

Flood Depths

Flood Levels

Flood Velocities

Flood Hazard

Flood Function

Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

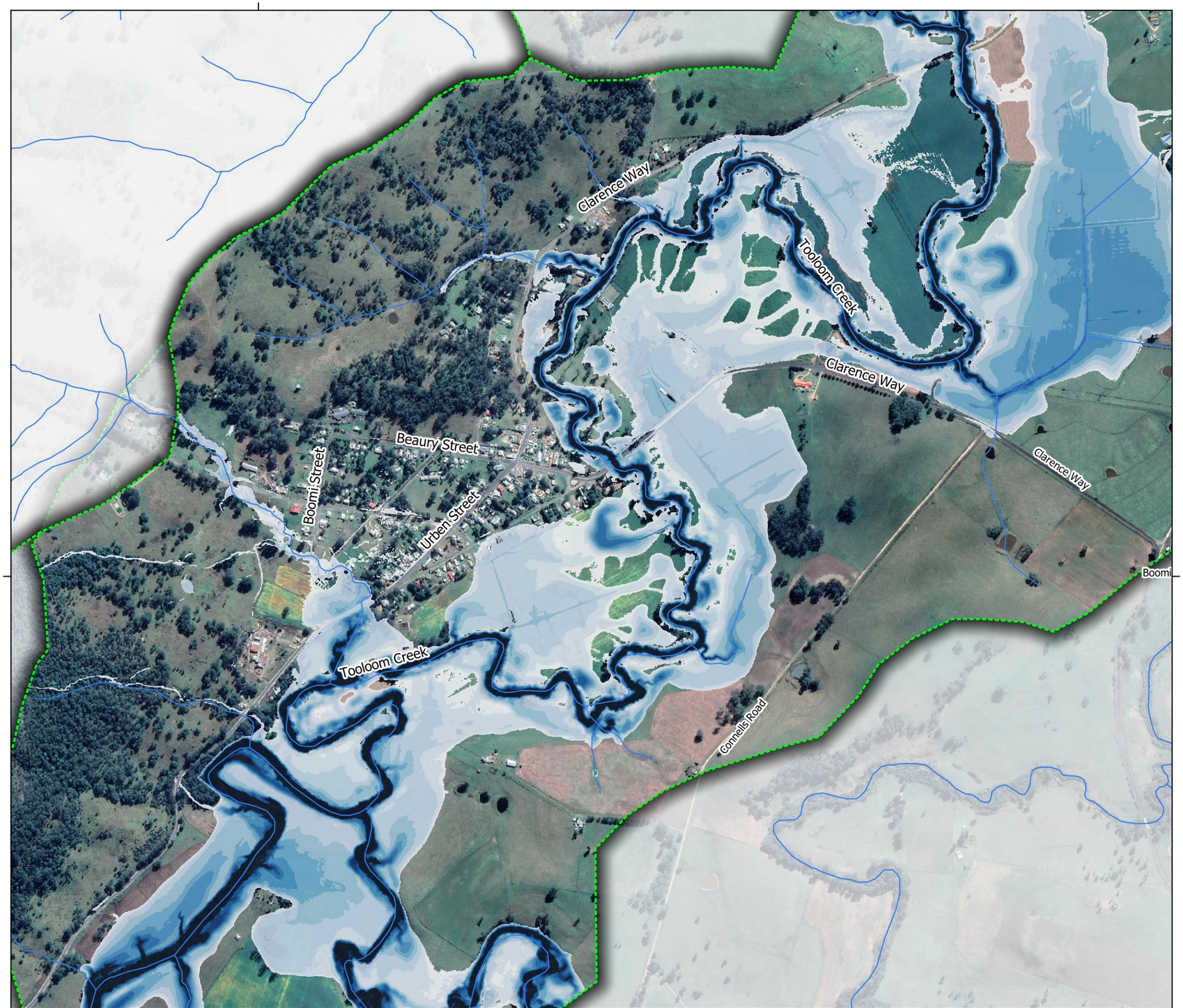
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 1
Woodenbong - Maximum Flood Depths
2008 event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 1: 2008 event - Woodenbong - Maximum Flood Depths



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

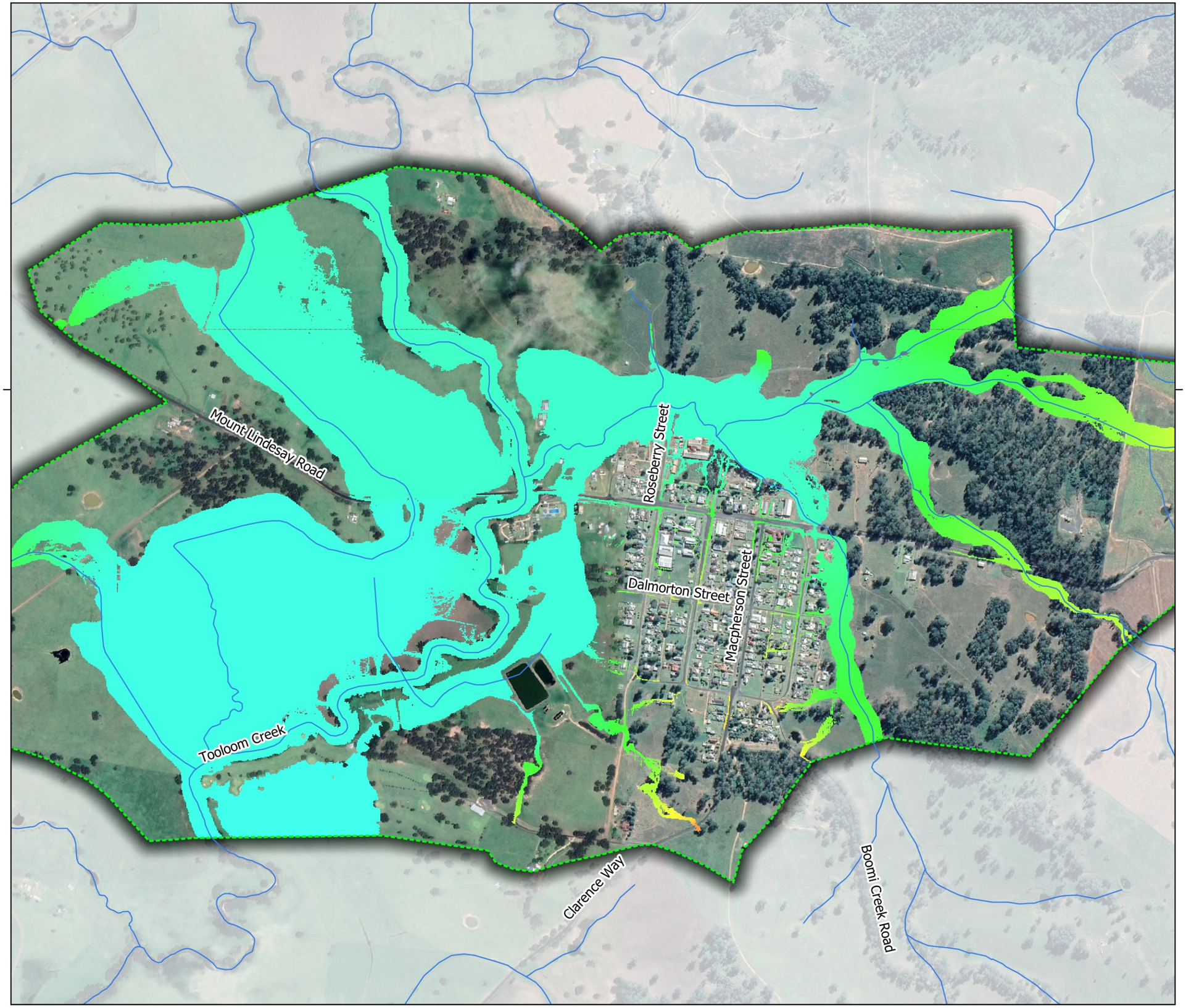
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 2
Urbenville - Maximum Flood Depths
2008 event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 2: 2008 event - Urbenville - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

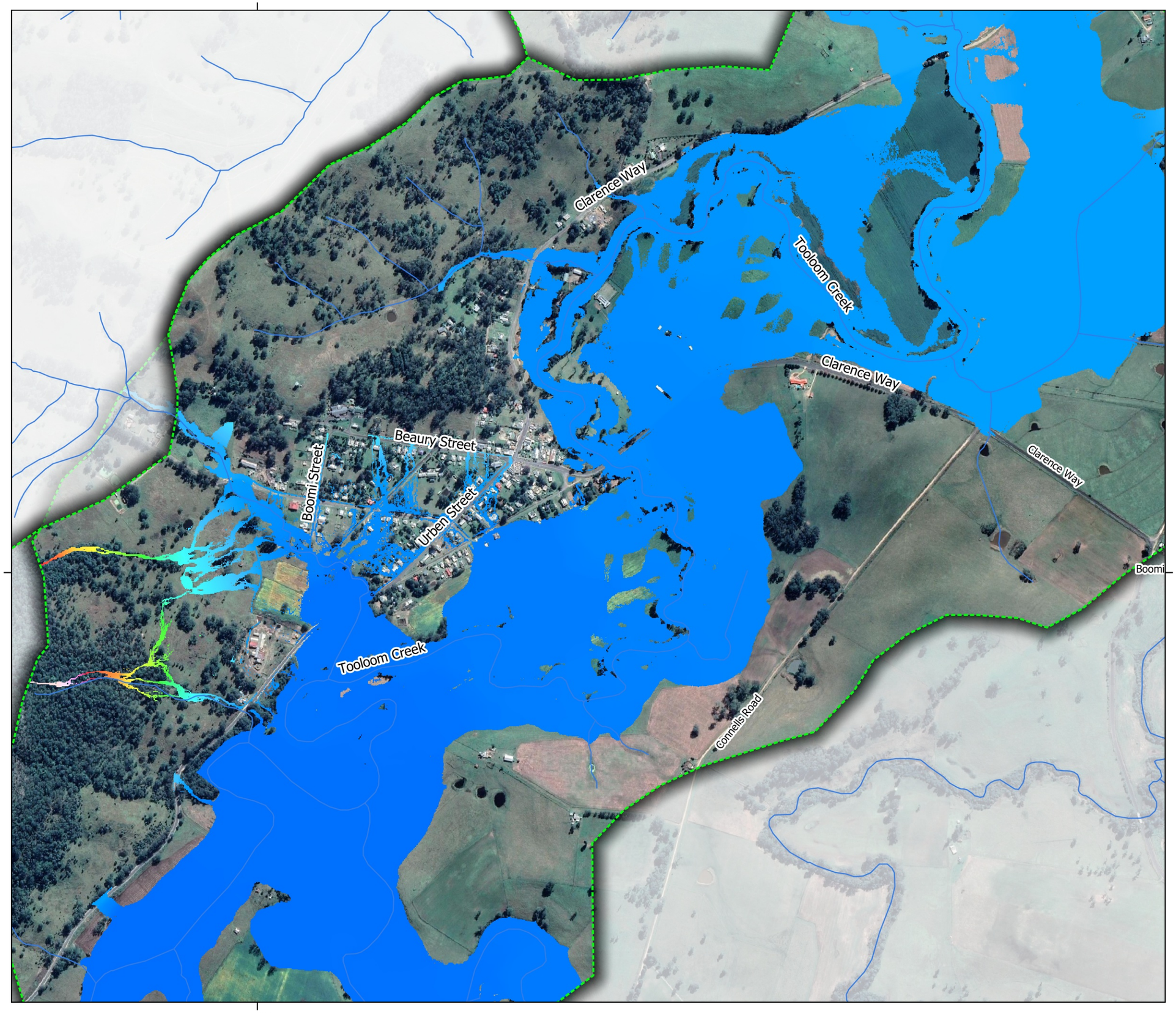
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 3
Woodenbong - Peak Flood Levels
2008 event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 3: 2008 event - Woodenbong - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

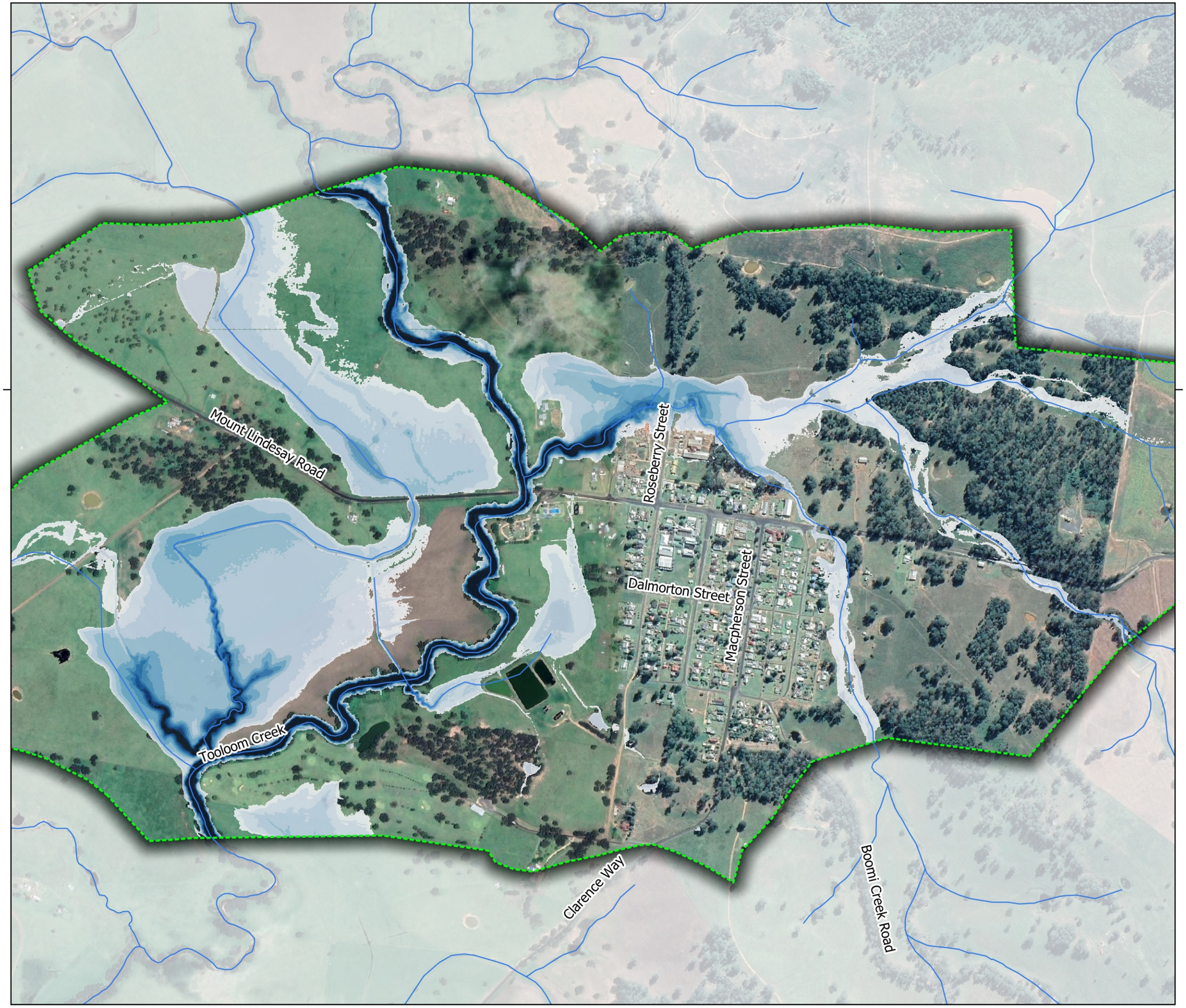
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 4
Urbenville - Peak Flood Levels
2008 event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 4: 2008 event - Urbenville - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

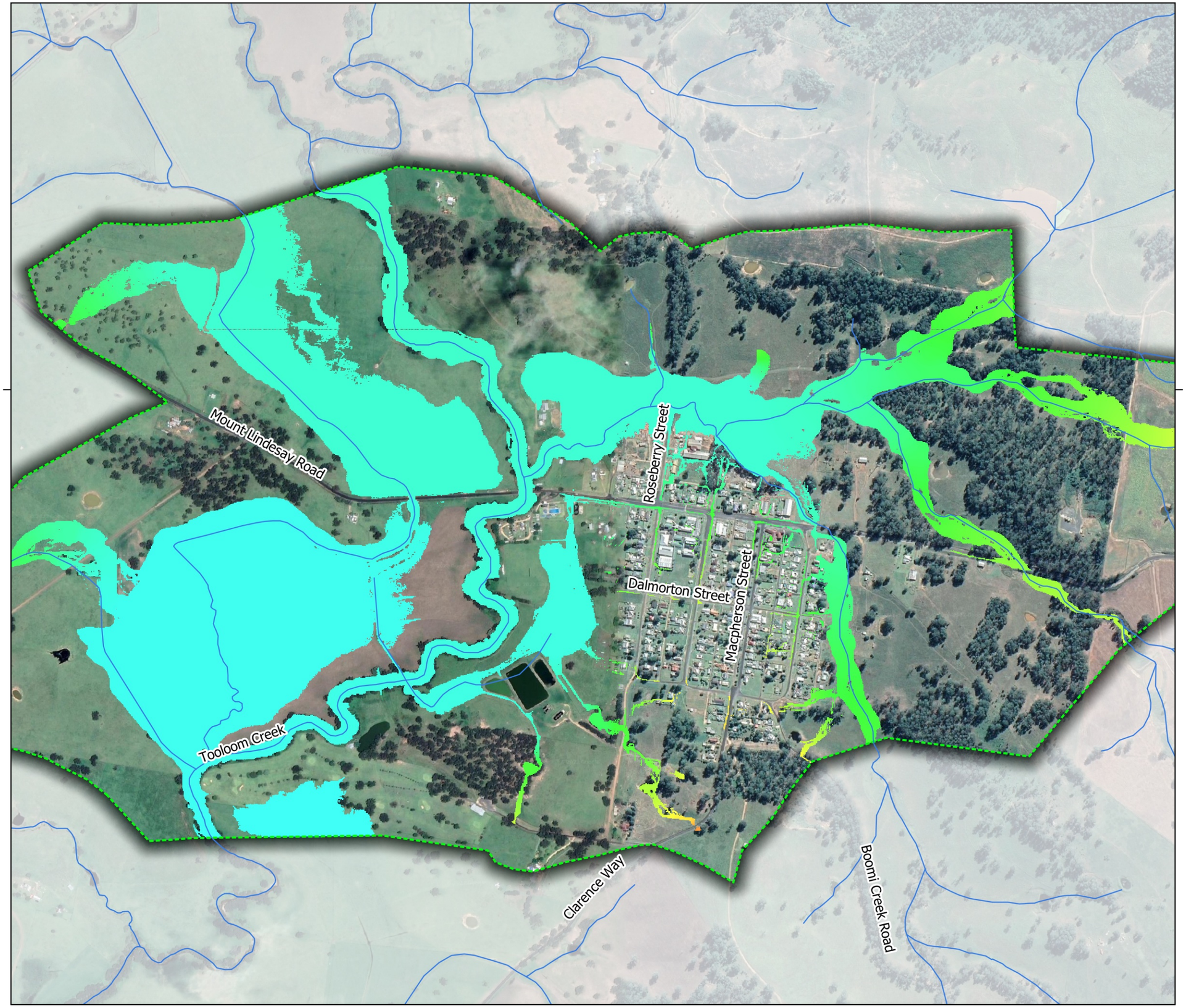
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 5
Woodenbong - Maximum Flood Depths
December 2010 event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 5: December 2010 event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

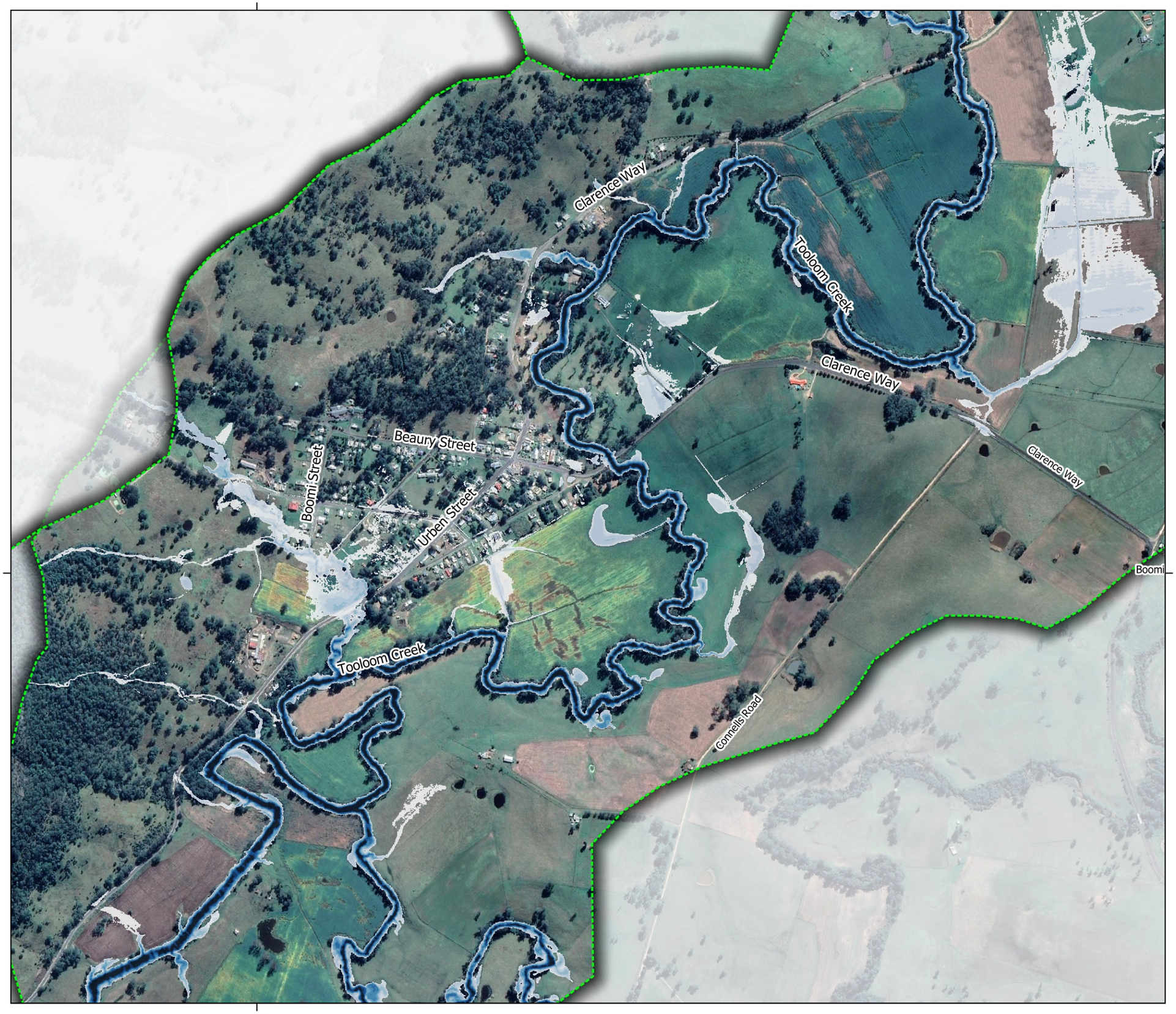
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 6
Woodenbong - Peak Flood Levels
December 2010 event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 6: December 2010 event - Woodenbong - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

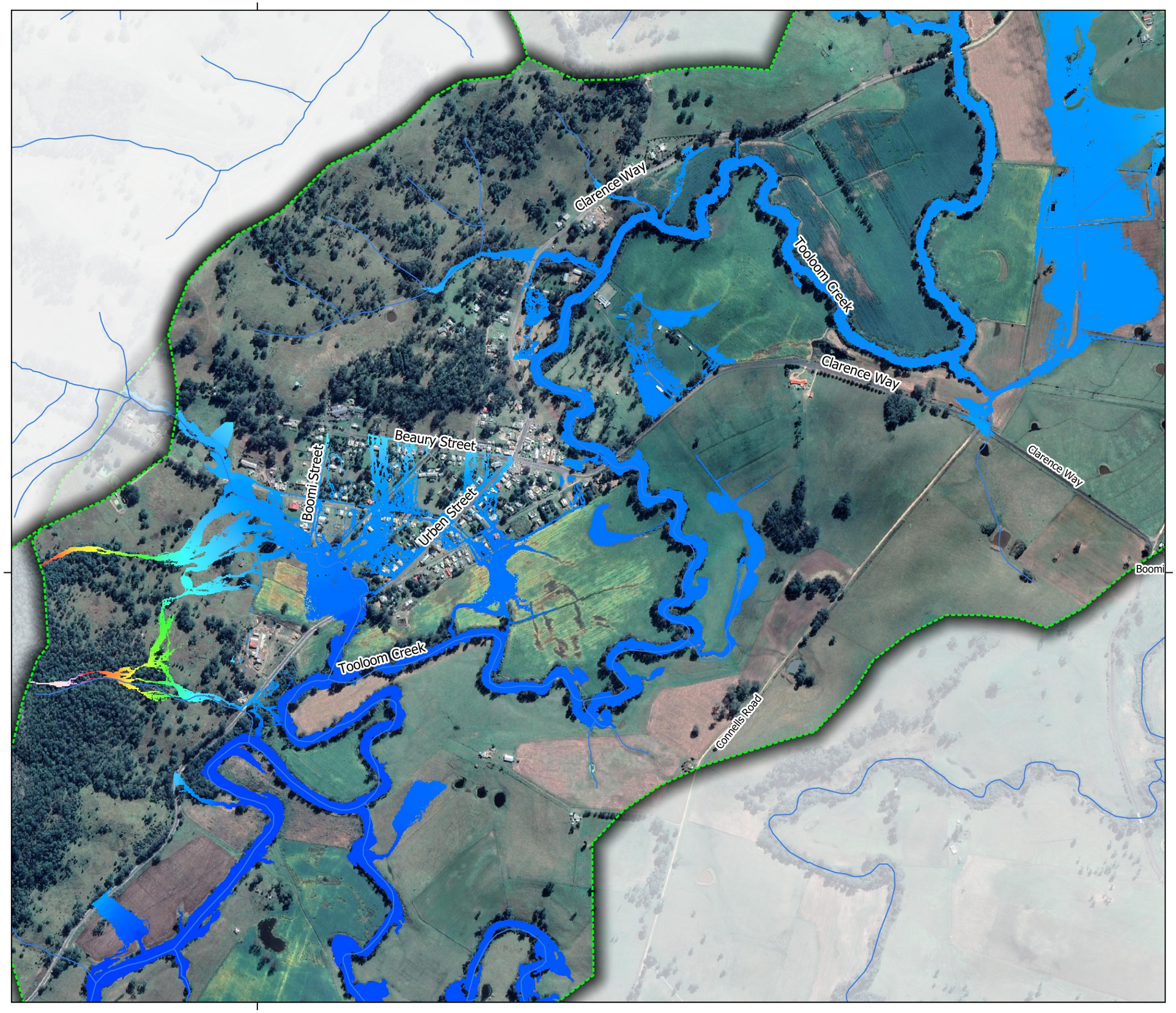
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 7
Urbenville - Maximum Flood Depths
February 2010 event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 7: February 2010 event - Urbenville - Maximum Flood Depths



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

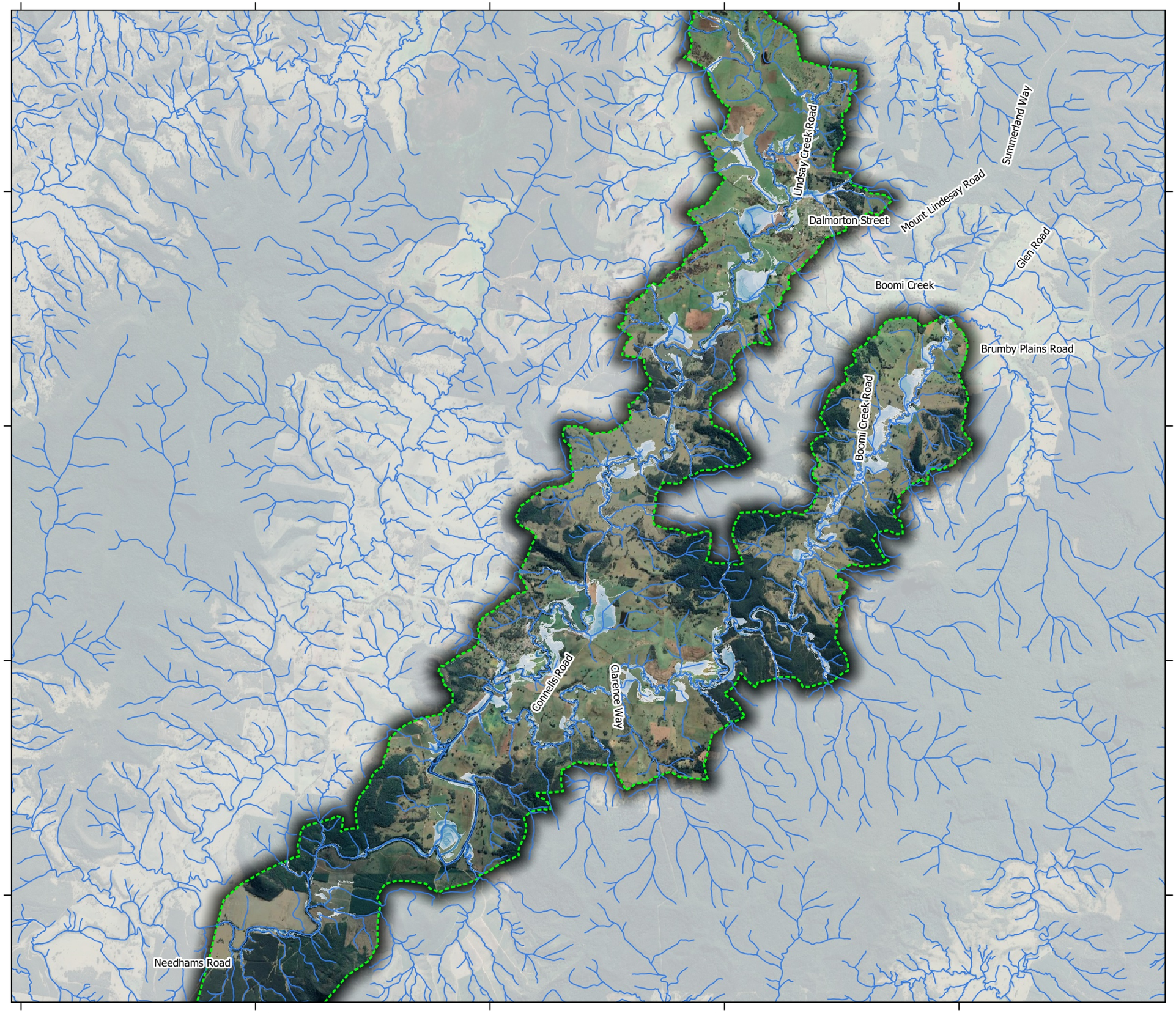
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 8
Urbenville - Peak Flood Levels
February 2010 event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 8: February 2010 event - Urbenville - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 9
Tooloom Creek – Maximum Flood Depths
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 9: 20% AEP event - Tooloom Creek - Maximum Flood Depths

Aerial Imagery Source: SIXmaps

Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

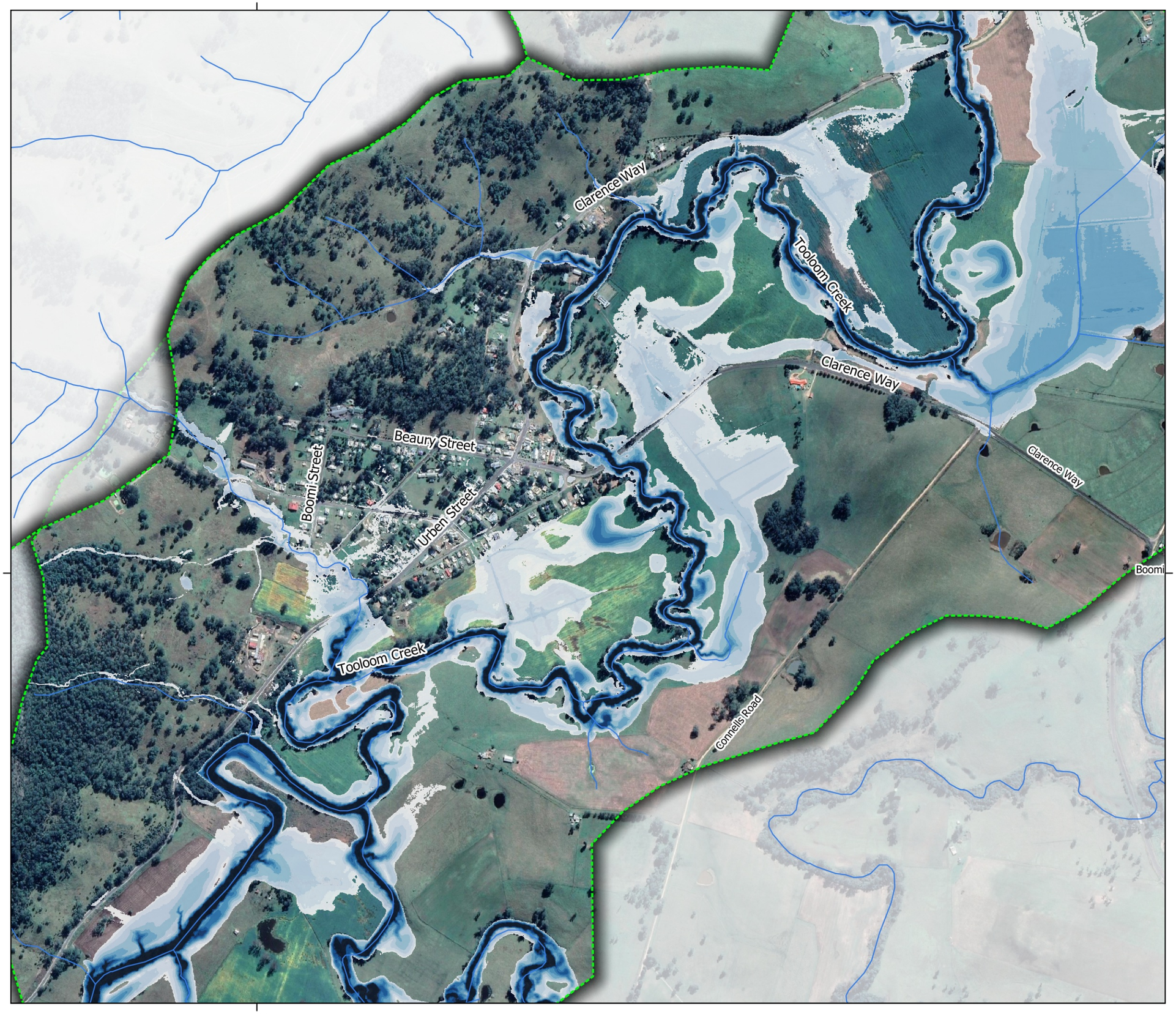
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 10
Woodenbong - Maximum Flood Depths
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 10: 20% AEP event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

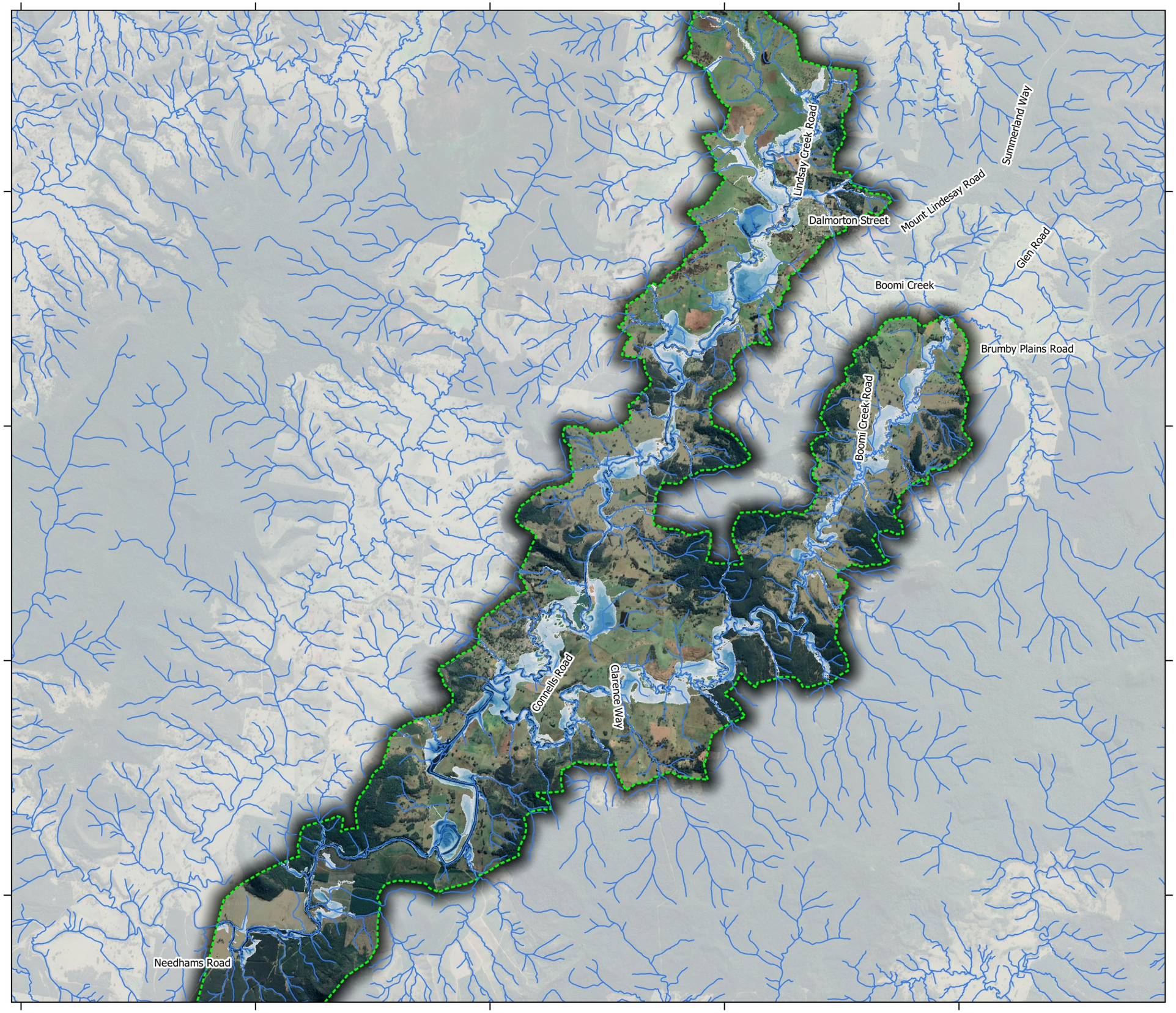
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 11
Urbenville - Maximum Flood Depths
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 11: 20% AEP event - Urbenville - Maximum Flood Depths



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 12
Tooloom Creek - Maximum Flood Depths
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 12: 5% AEP event - Tooloom Creek - Maximum Flood Depths

Aerial Imagery Source: SIXmaps

Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

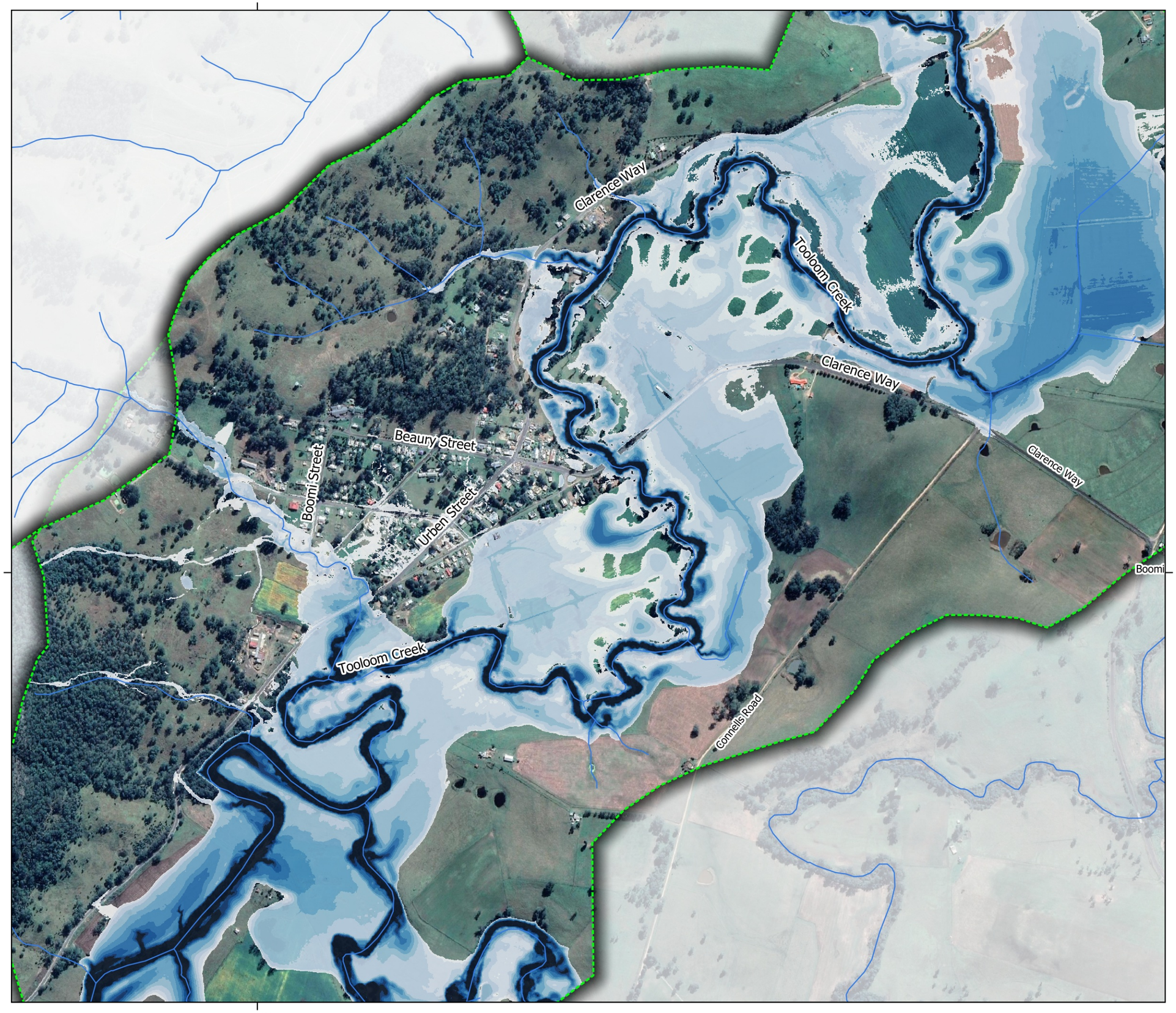
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 13
Woodenbong - Maximum Flood Depths
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 13: 5% AEP event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

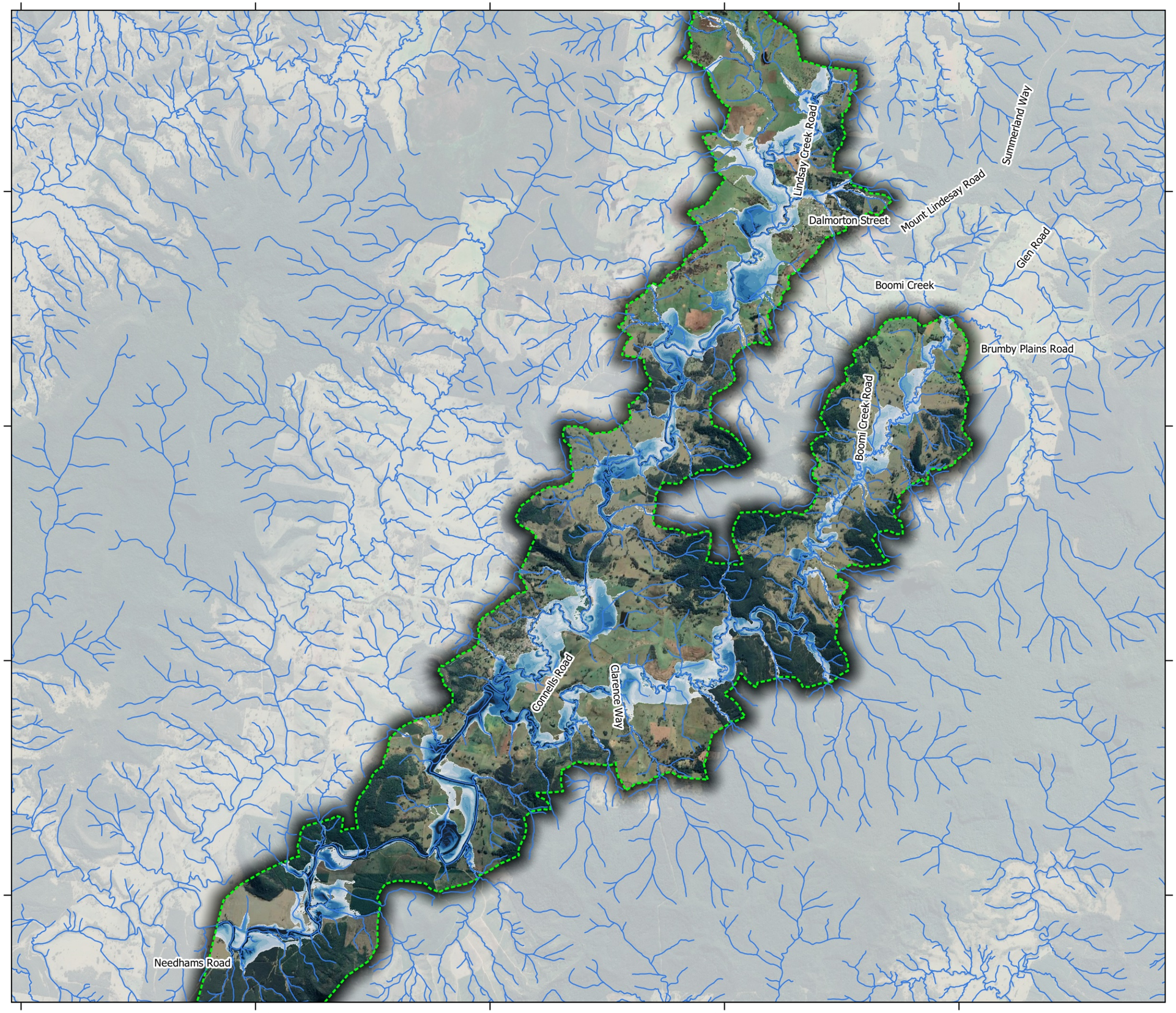
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 14
Urbenville - Maximum Flood Depths
5% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 14: 5% AEP event - Urbenville - Maximum Flood Depths



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 15
Tooloom Creek - Maximum Flood Depths
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 15: 1% AEP event - Tooloom Creek - Maximum Flood Depths

Aerial Imagery Source: SIXmaps

Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

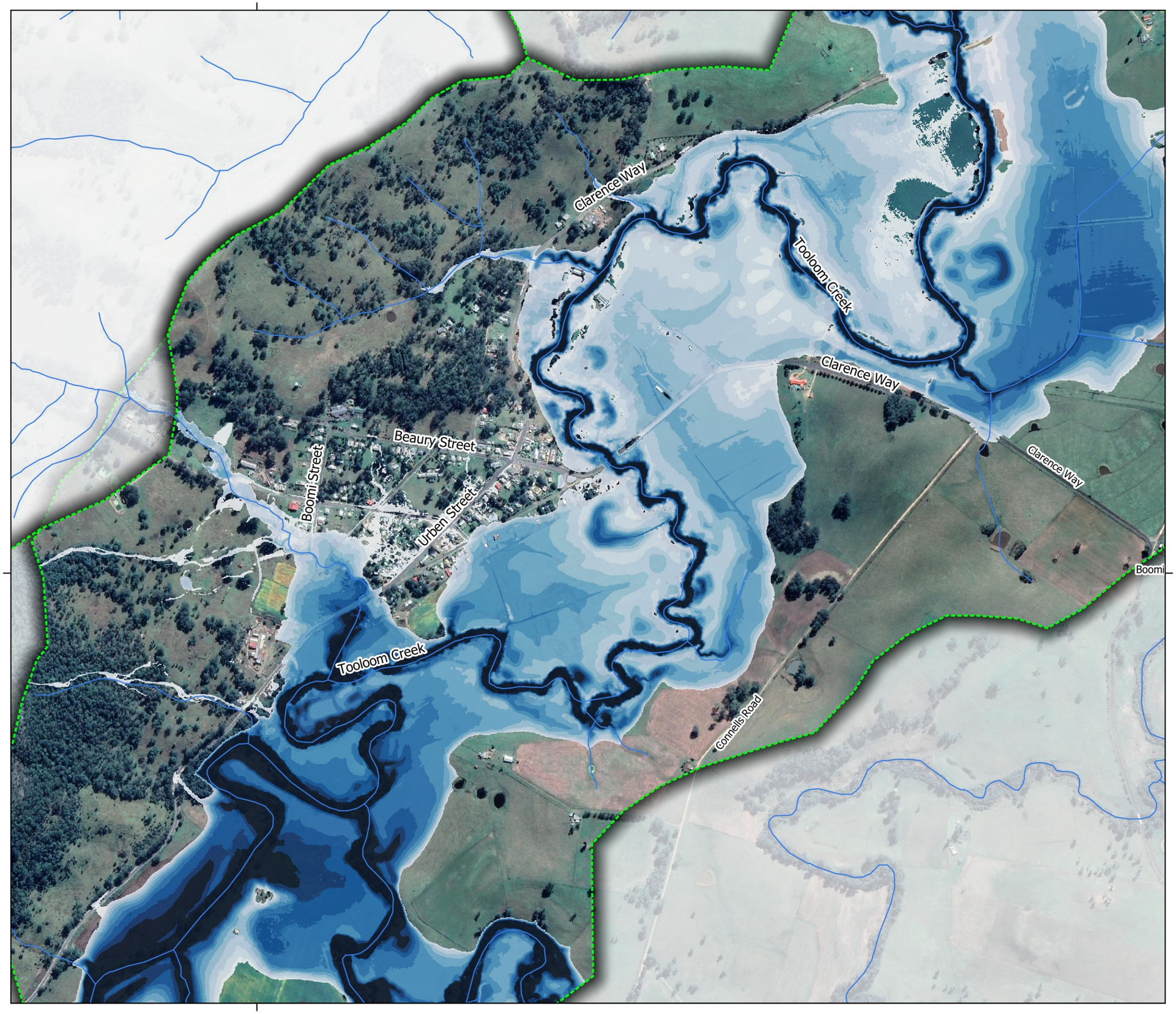
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 16
Woodenbong - Maximum Flood Depths
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 16: 1% AEP event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 17
Urbenville - Maximum Flood Depths
1% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 17: 1% AEP event - Urbenville - Maximum Flood Depths

Dalmorton Street
Lindsay Creek Road
Mount Lindesay Road
Summerland Way
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

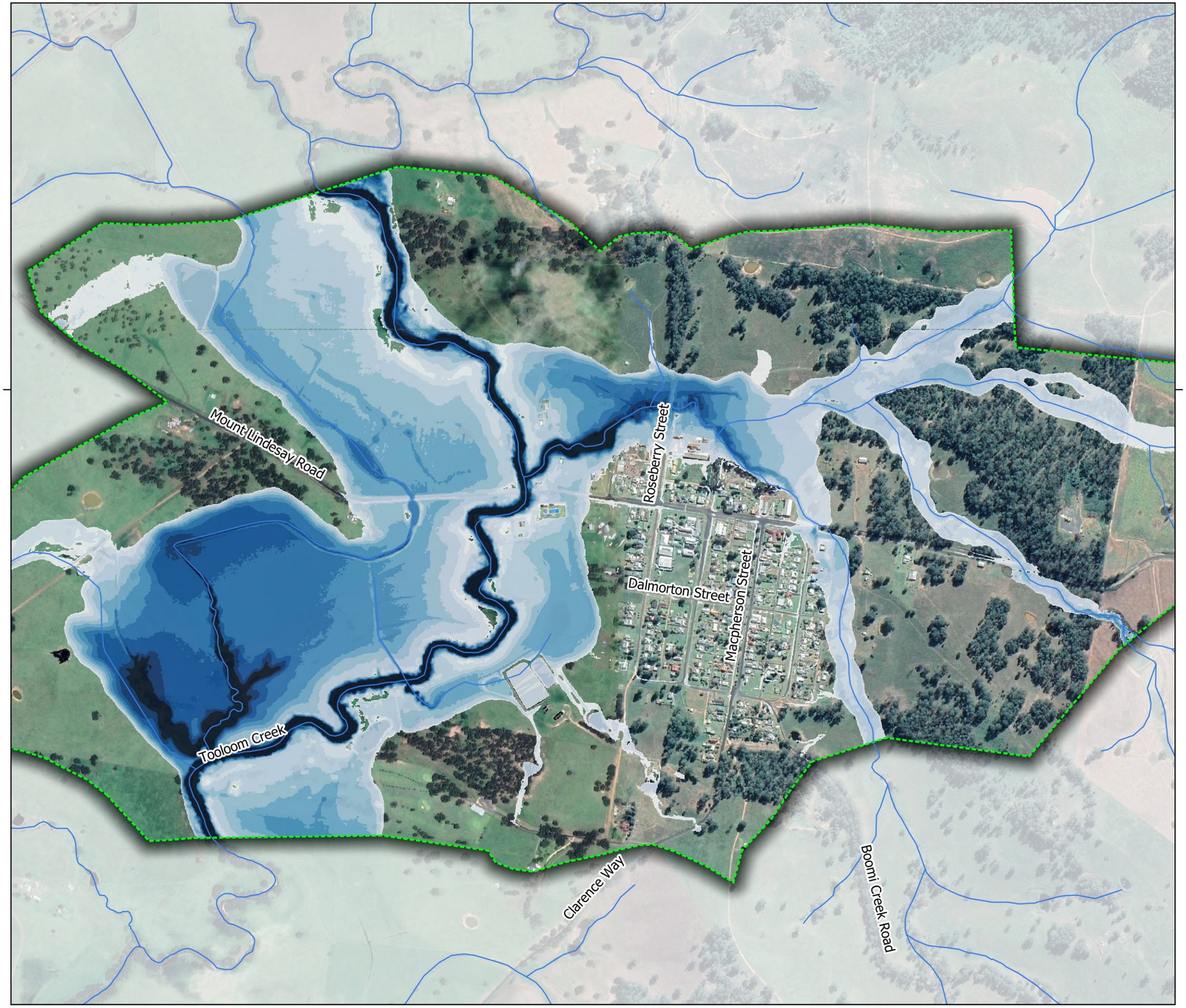
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 18
Tooloom Creek - Maximum Flood Depths
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 18: 0.2% AEP event - Tooloom Creek - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

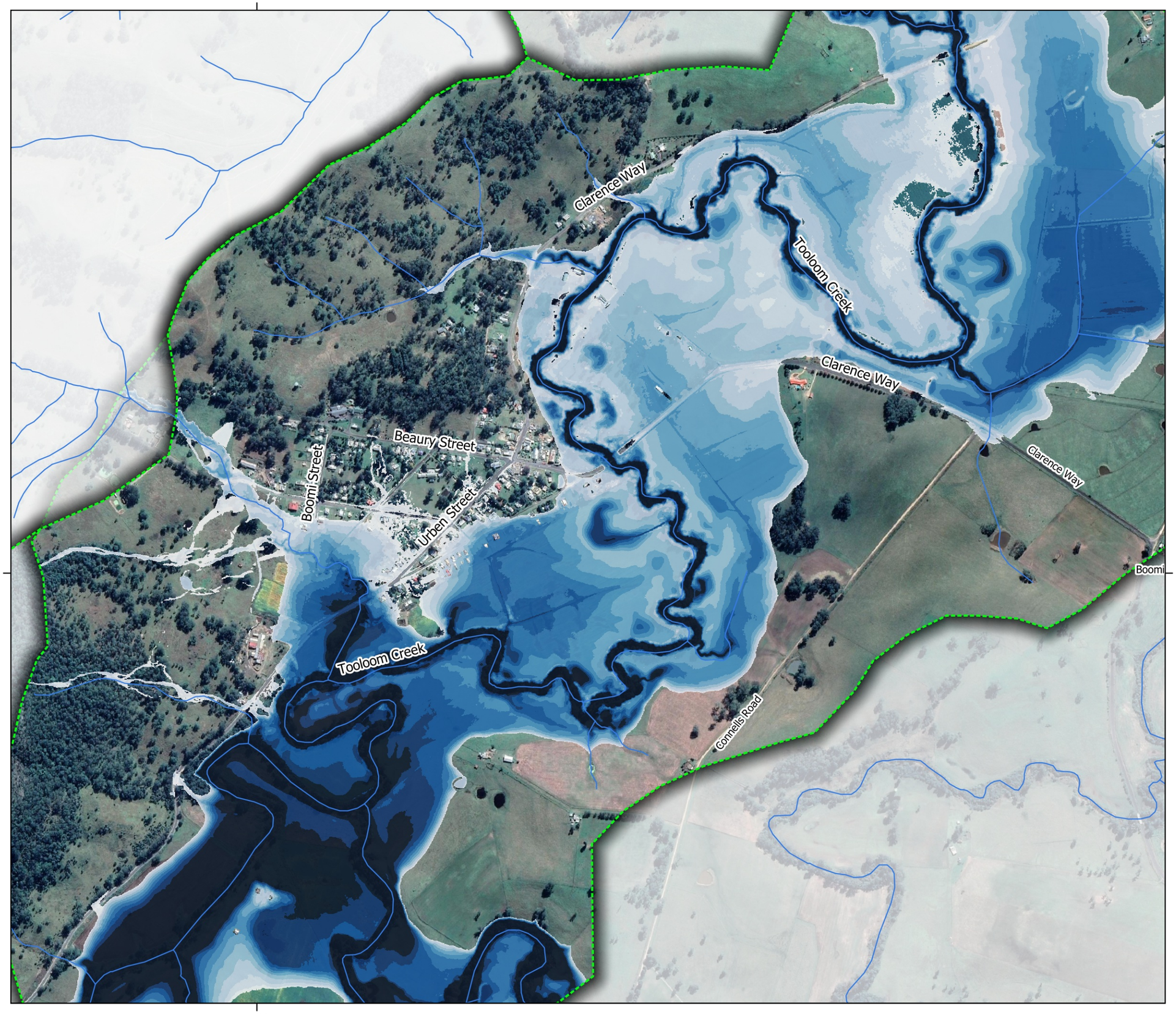
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 19
Woodenbong - Maximum Flood Depths
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 19: 0.2% AEP event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

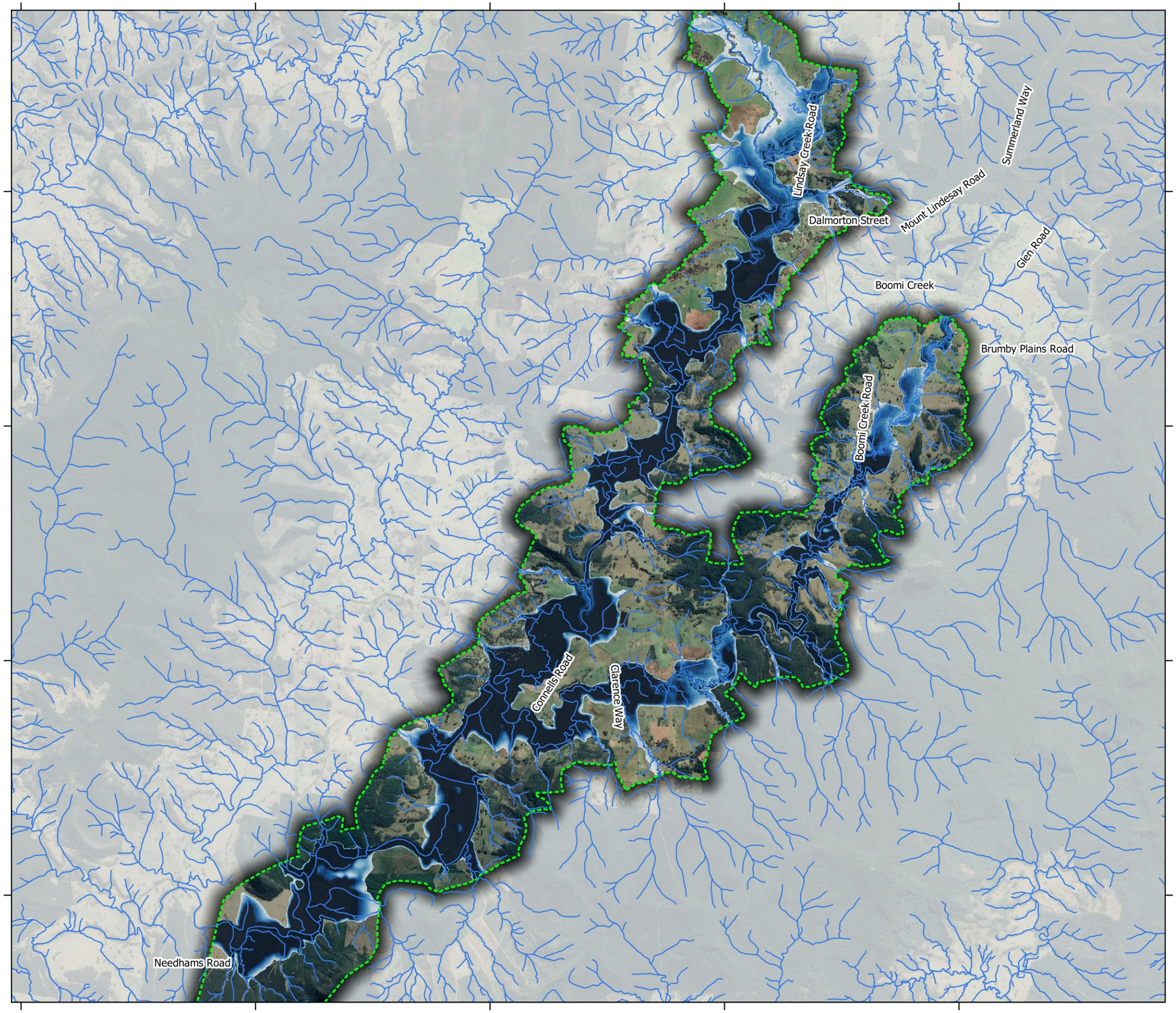
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 20
Urbenville - Maximum Flood Depths
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 20: 0.2% AEP event - Urbenville - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

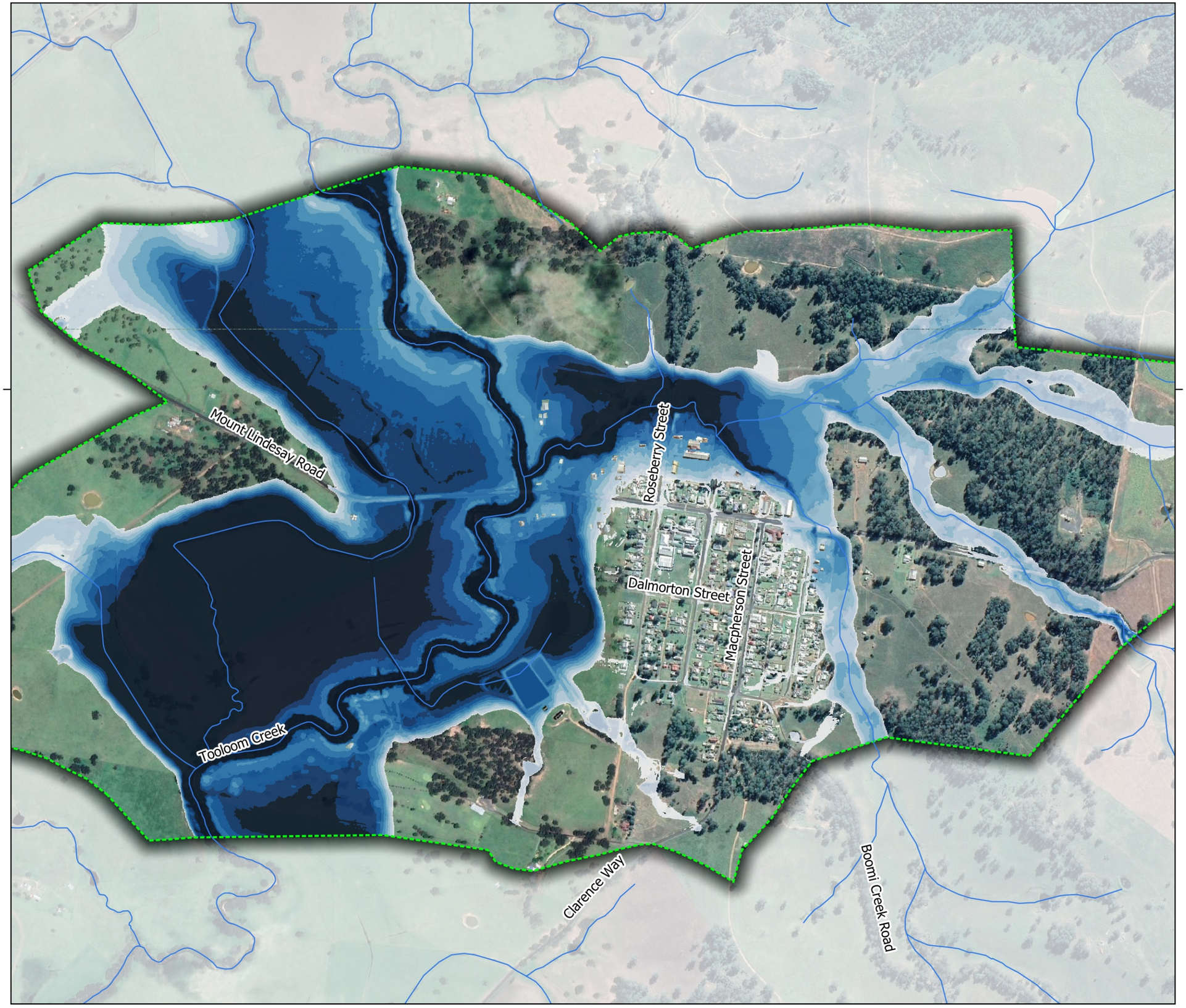
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 21
Tooloom Creek - Maximum Flood Depths
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 21: PMF event - Tooloom Creek - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

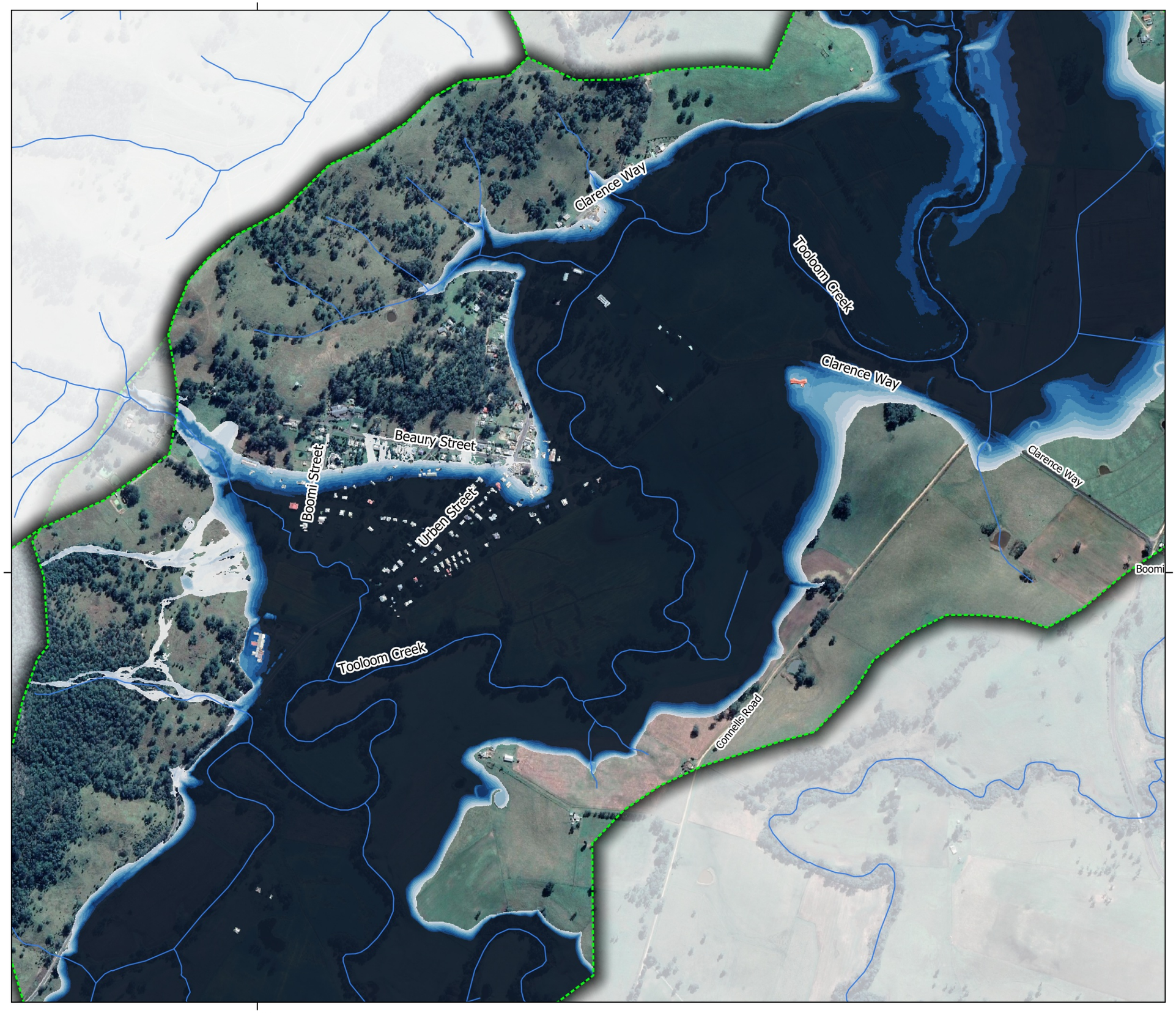
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 22
Woodenbong - Maximum Flood Depths
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 22: PMF event - Woodenbong - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood depth (m)

- <= 0.05 - Not Shown
- 0.05 - 0.1
- 0.1 - 0.2
- 0.2 - 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
- > 4

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

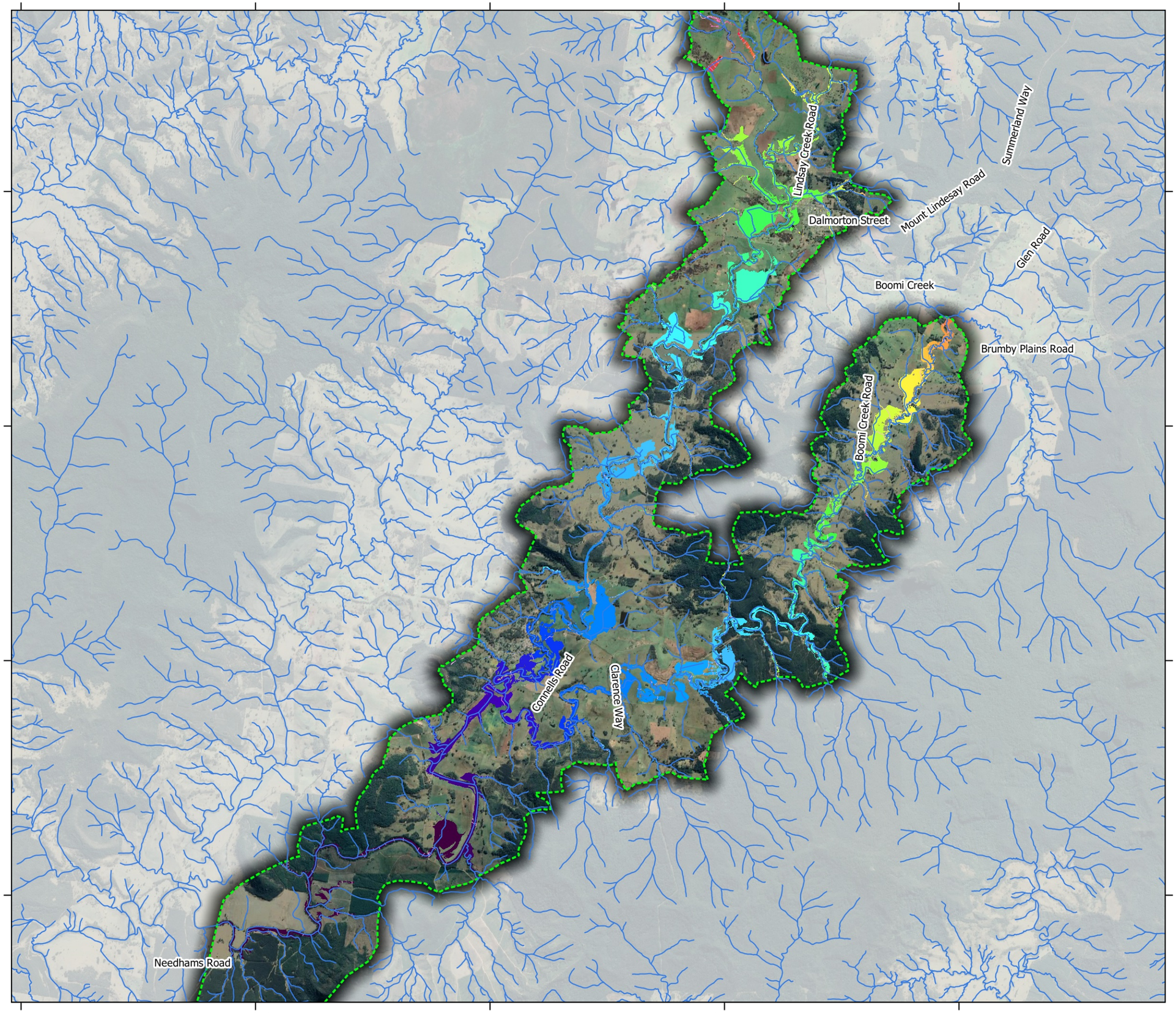
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 23
Urbenville - Maximum Flood Depths
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 23: PMF event - Urbenville - Maximum Flood Depths

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 363
- 366
- 369
- 372
- 375
- 378
- 381
- 384
- 387
- 390
- 393
- 396
- 399
- 402
- 405
- 408
- 411
- 414
- 417
- 420

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

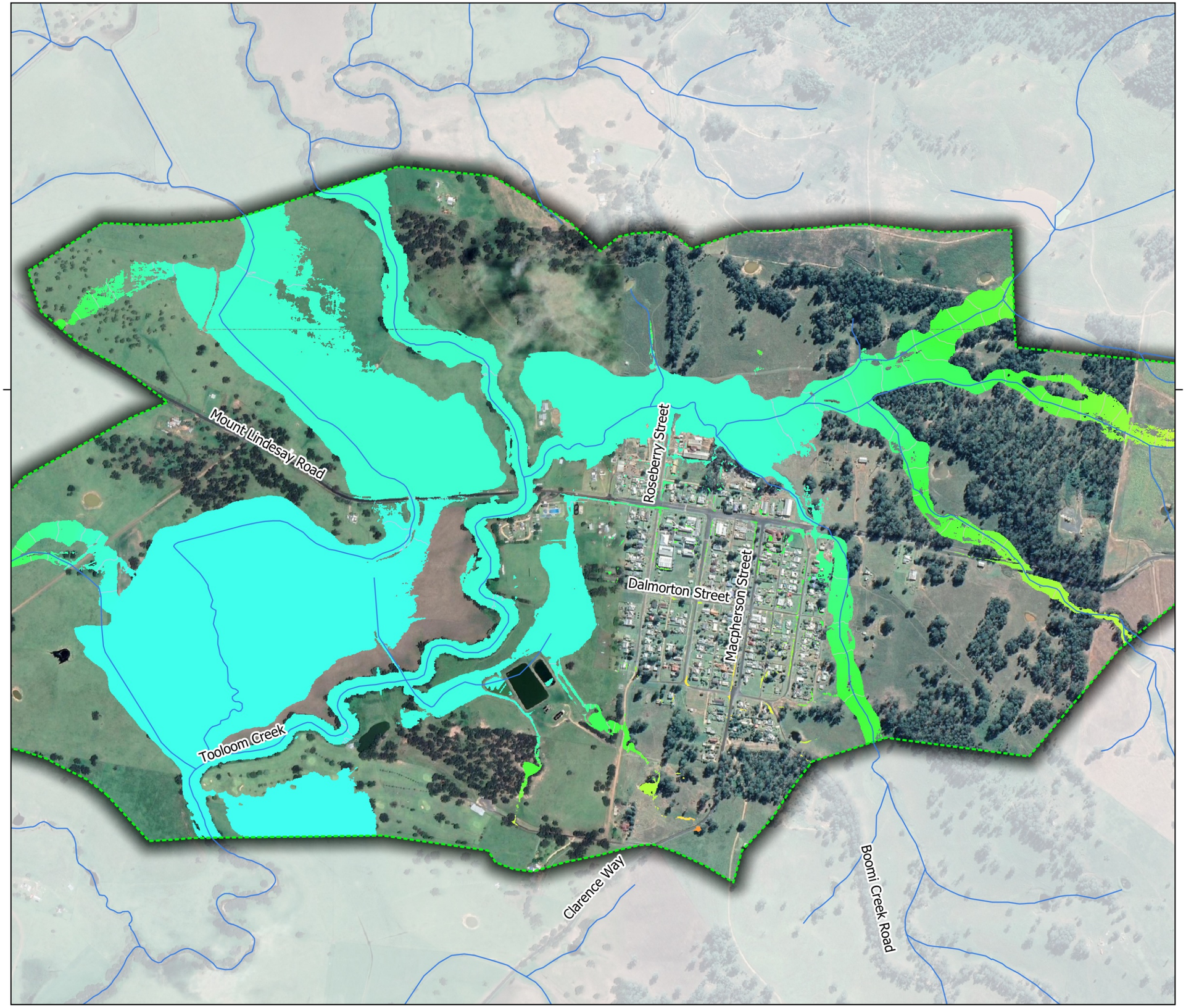
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 24
Tooloom Creek - Peak Flood Levels
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 24: 20% AEP event - Tooloom Creek - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

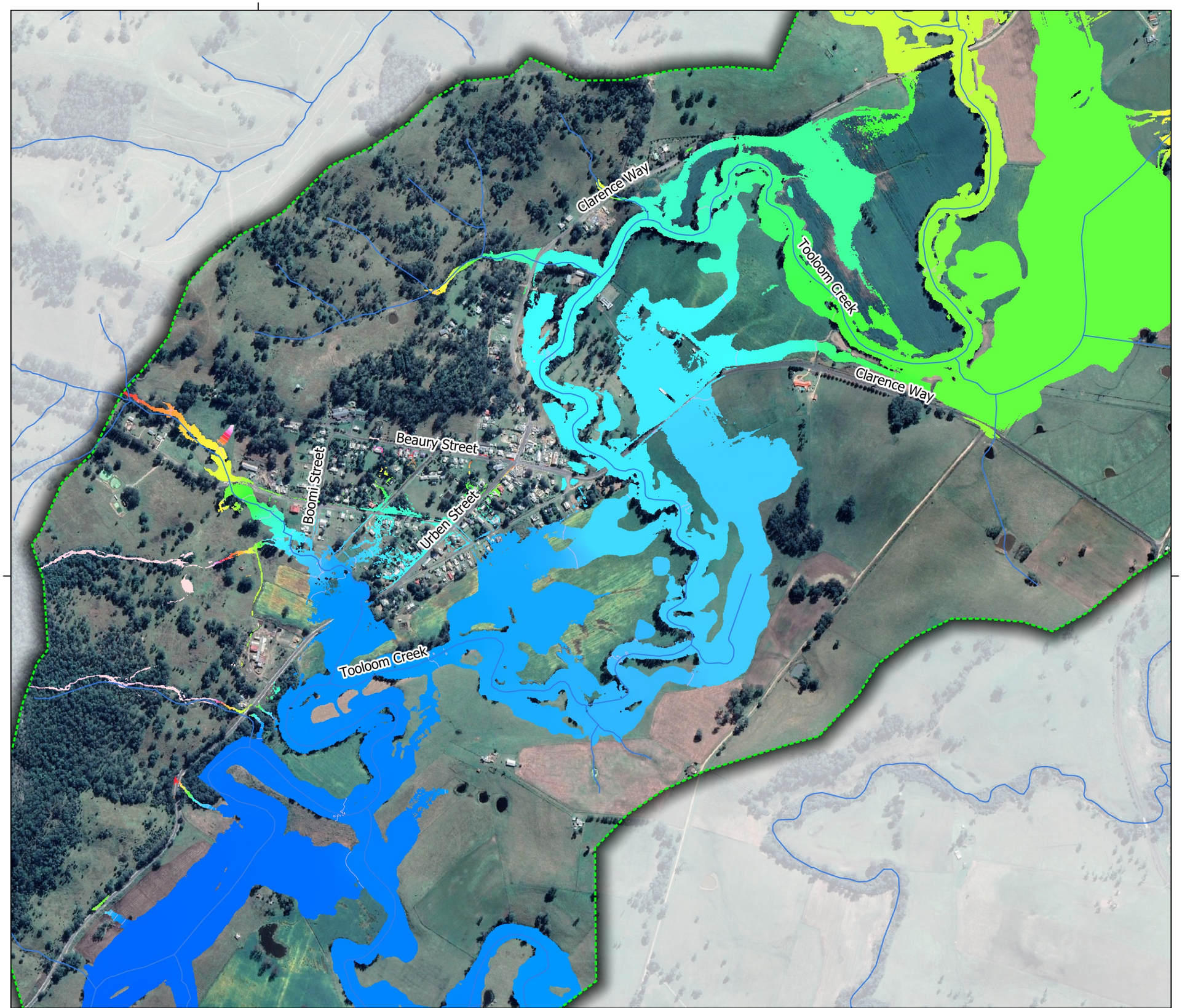
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 25
Woodenbong - Peak Flood Levels
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 25: 20% AEP event - Woodenbong - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

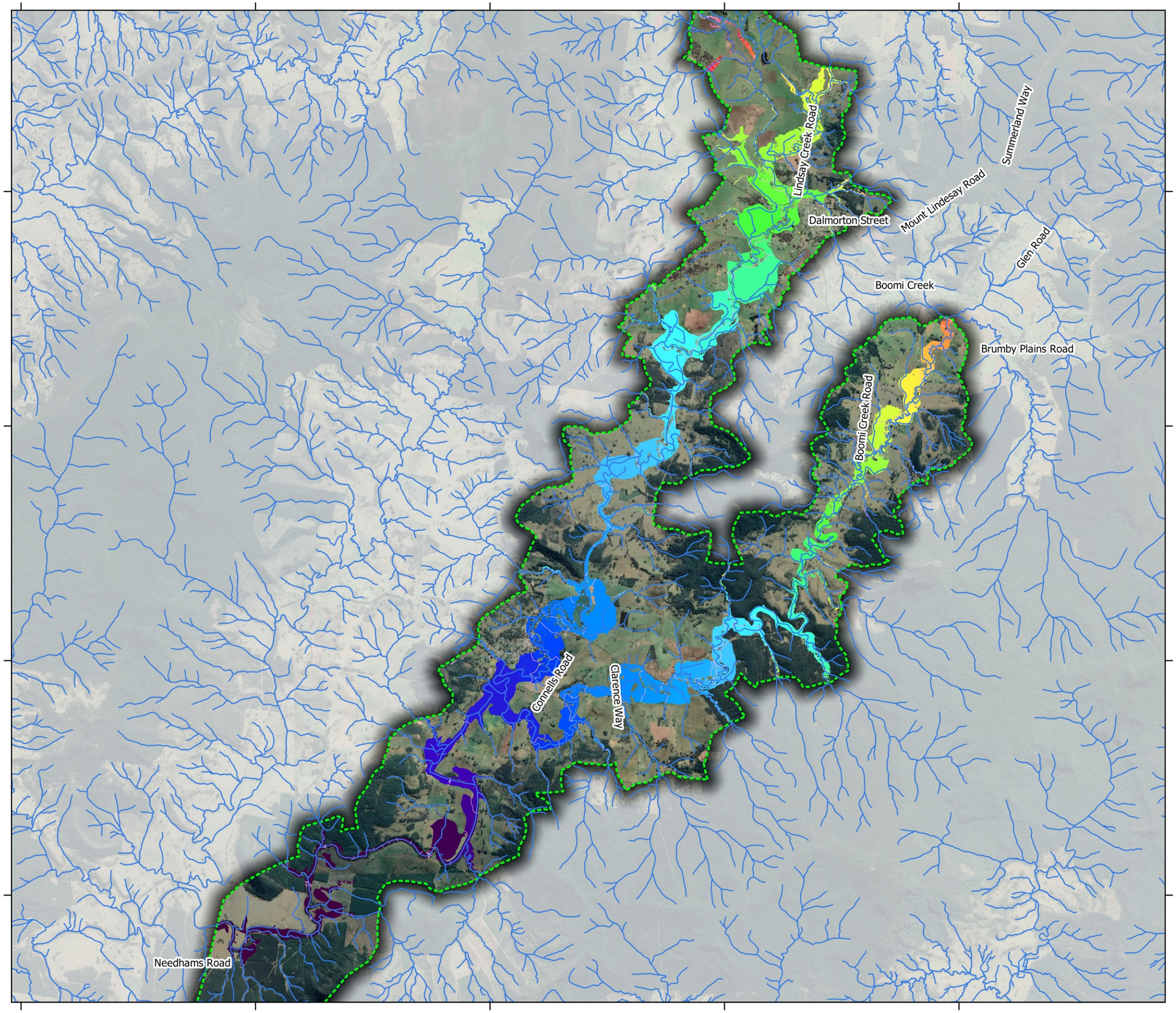
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 26
Urbenville - Peak Flood Levels
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 26: 20% AEP event - Urbenville - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 363
- 366
- 369
- 372
- 375
- 378
- 381
- 384
- 387
- 390
- 393
- 396
- 399
- 402
- 405
- 408
- 411
- 414
- 417
- 420

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

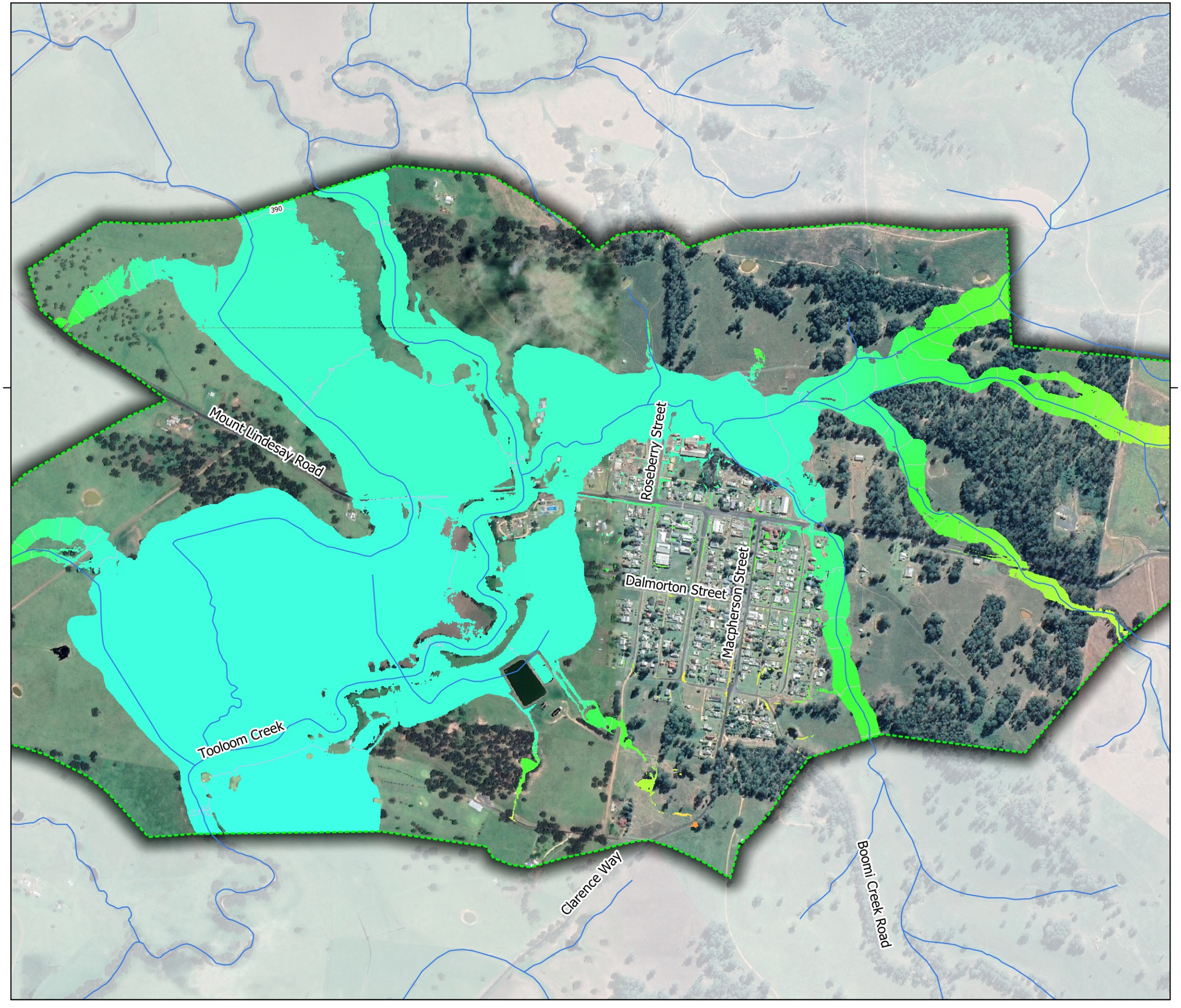
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 27
Tooloom Creek - Peak Flood Levels
5% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 27: 5% AEP event - Tooloom Creek - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

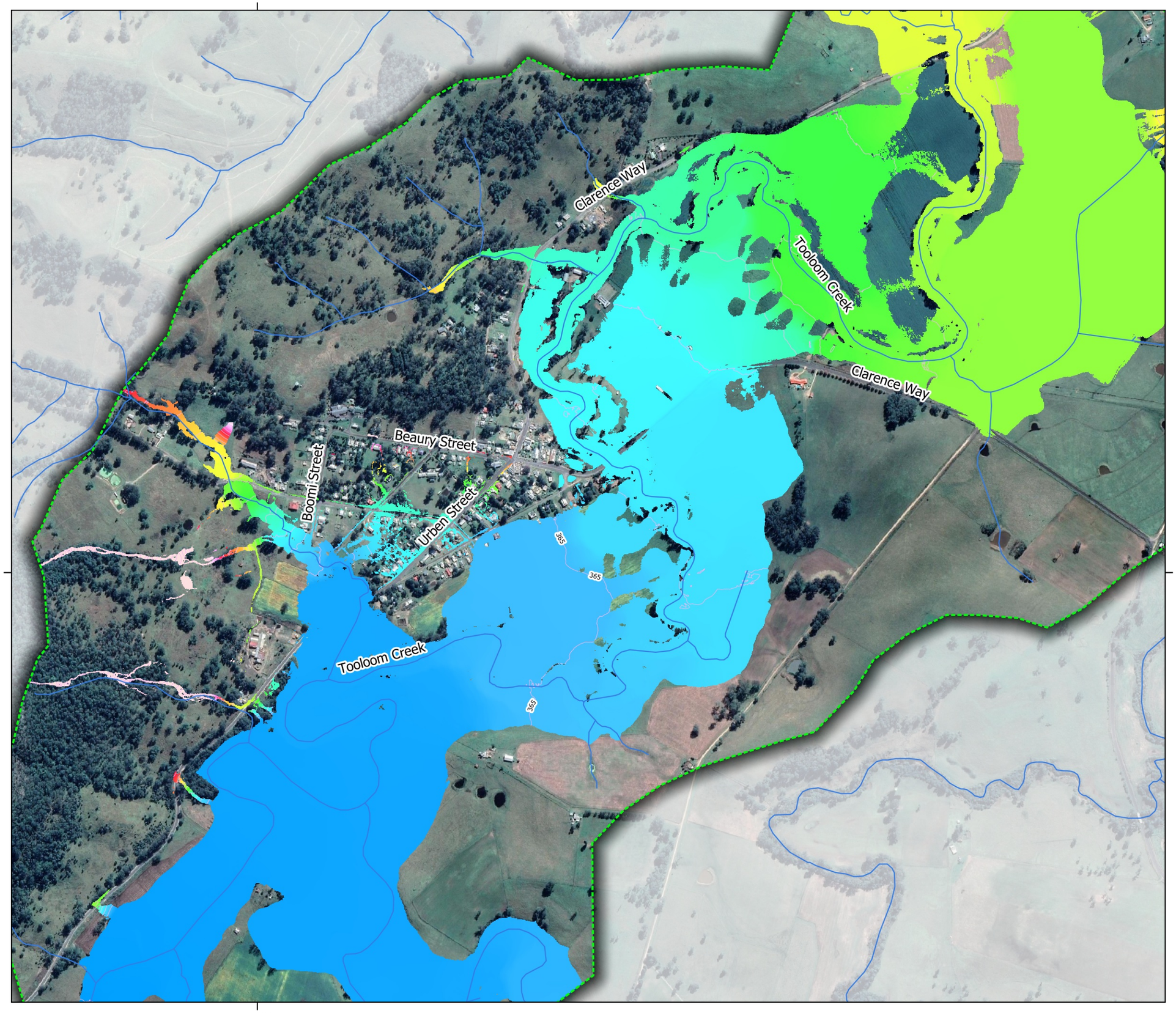
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 28
Woodenbong - Peak Flood Levels
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 28: 5% AEP event - Woodenbong - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

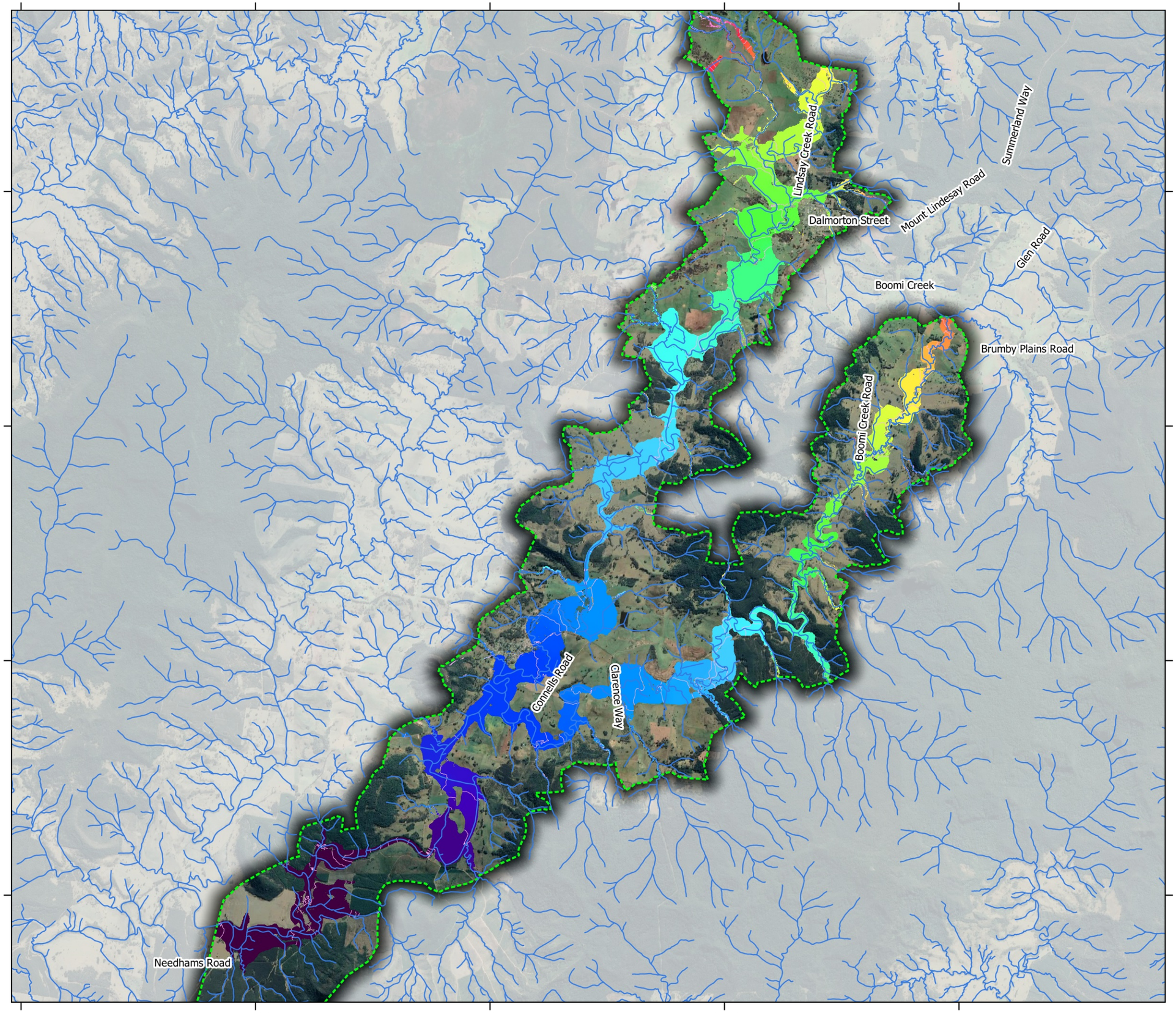
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 29
Urbenville - Peak Flood Levels
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 29: 5% AEP event - Urbenville - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 363
- 366
- 369
- 372
- 375
- 378
- 381
- 384
- 387
- 390
- 393
- 396
- 399
- 402
- 405
- 408
- 411
- 414
- 417
- 420

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

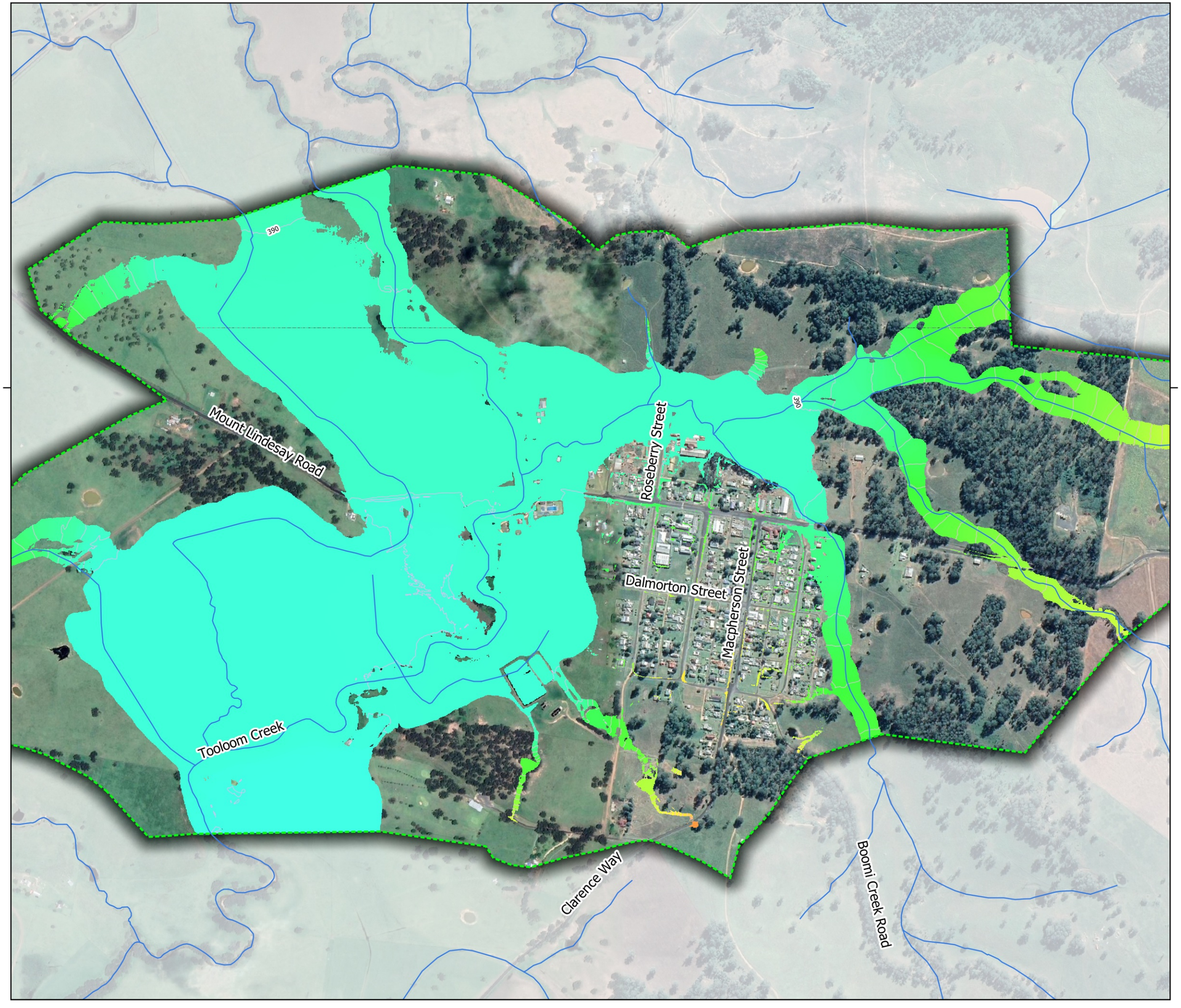
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 30
Tooloom Creek - Peak Flood Levels
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 30: 1% AEP event - Tooloom Creek - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

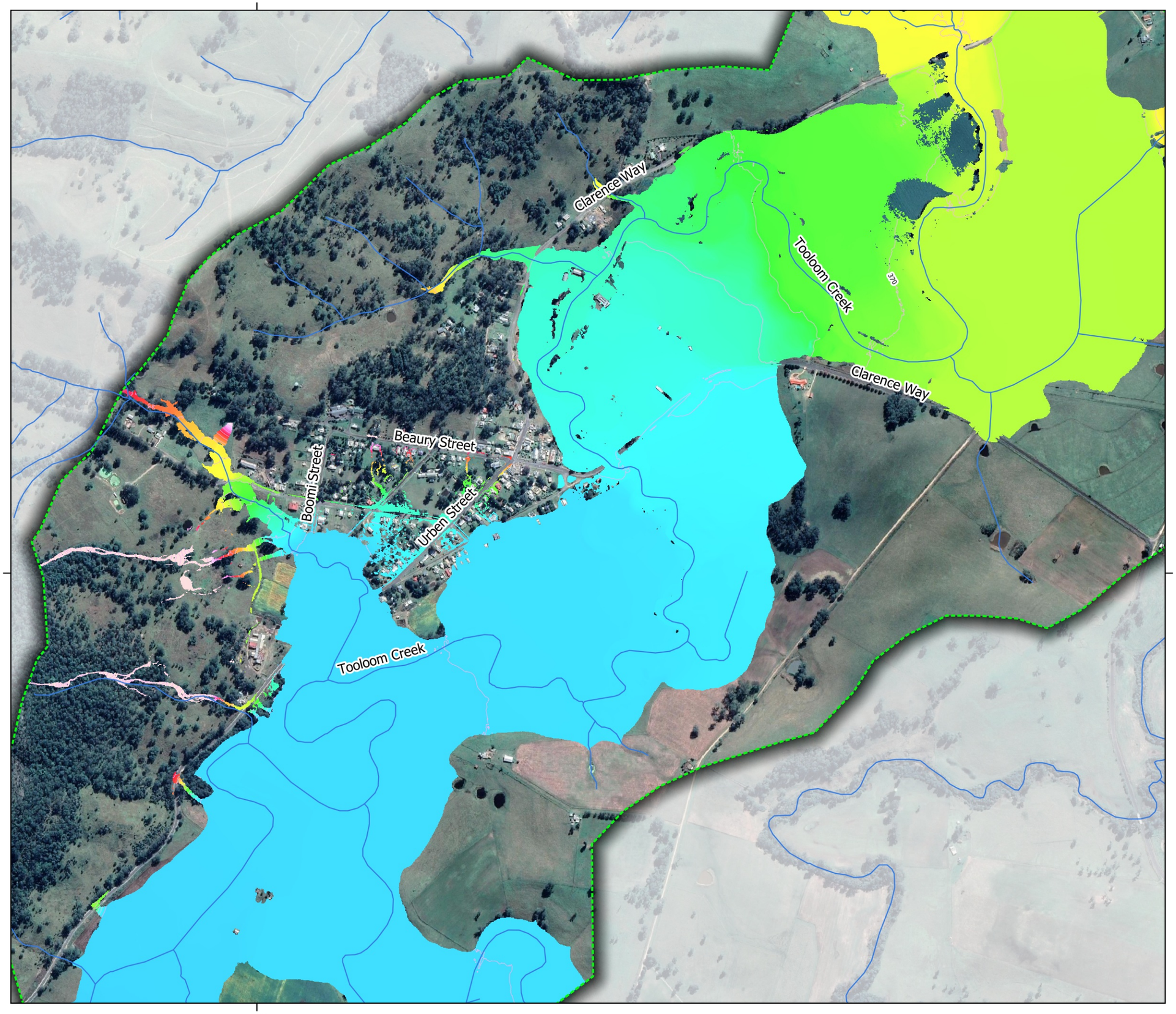
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 31
Woodenbong - Peak Flood Levels
1% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 31: 1% AEP event - Woodenbong - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

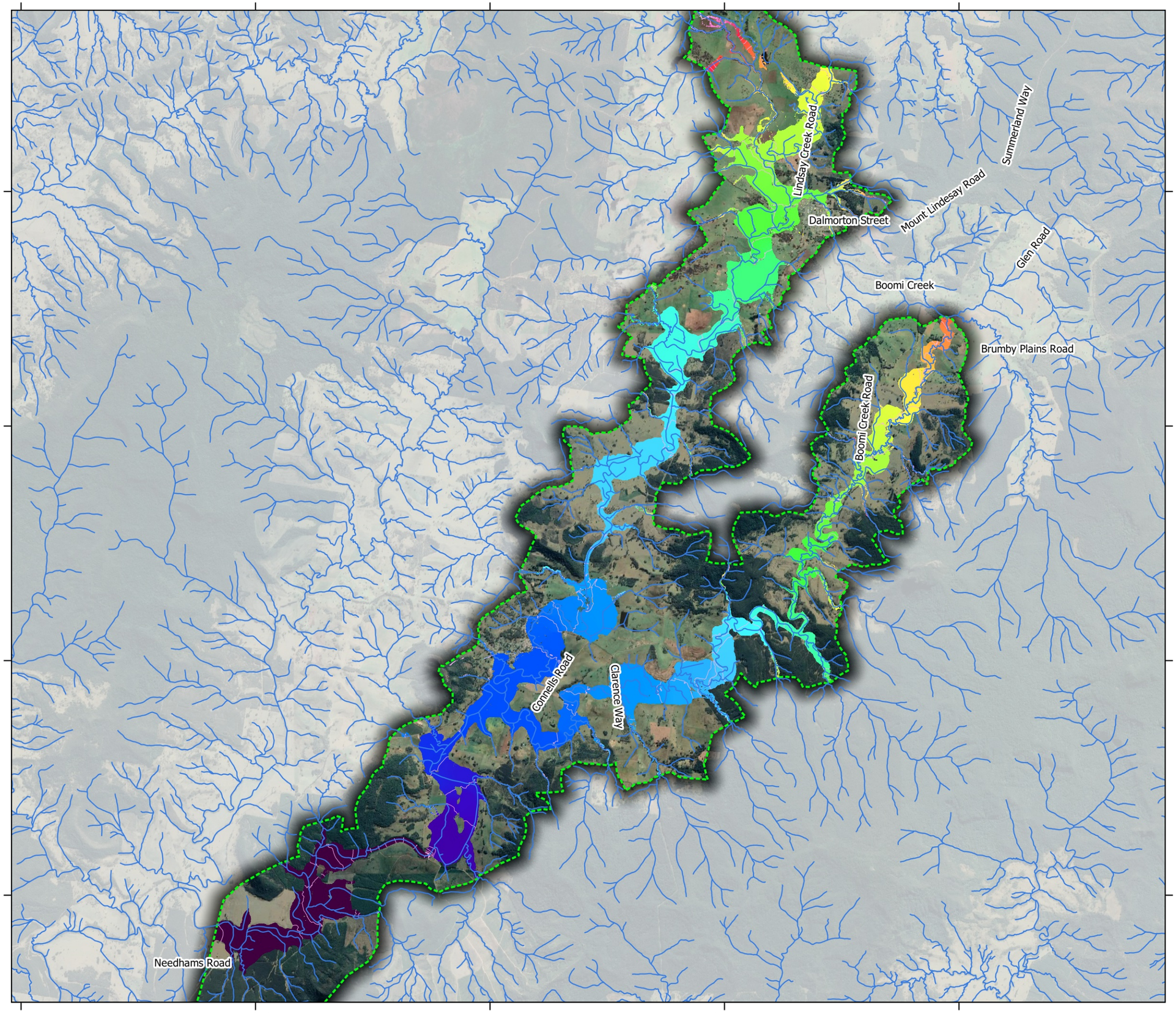
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 32
Urbenville - Peak Flood Levels
1% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 32: 1% AEP event - Urbenville - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 363
- 366
- 369
- 372
- 375
- 378
- 381
- 384
- 387
- 390
- 393
- 396
- 399
- 402
- 405
- 408
- 411
- 414
- 417
- 420

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

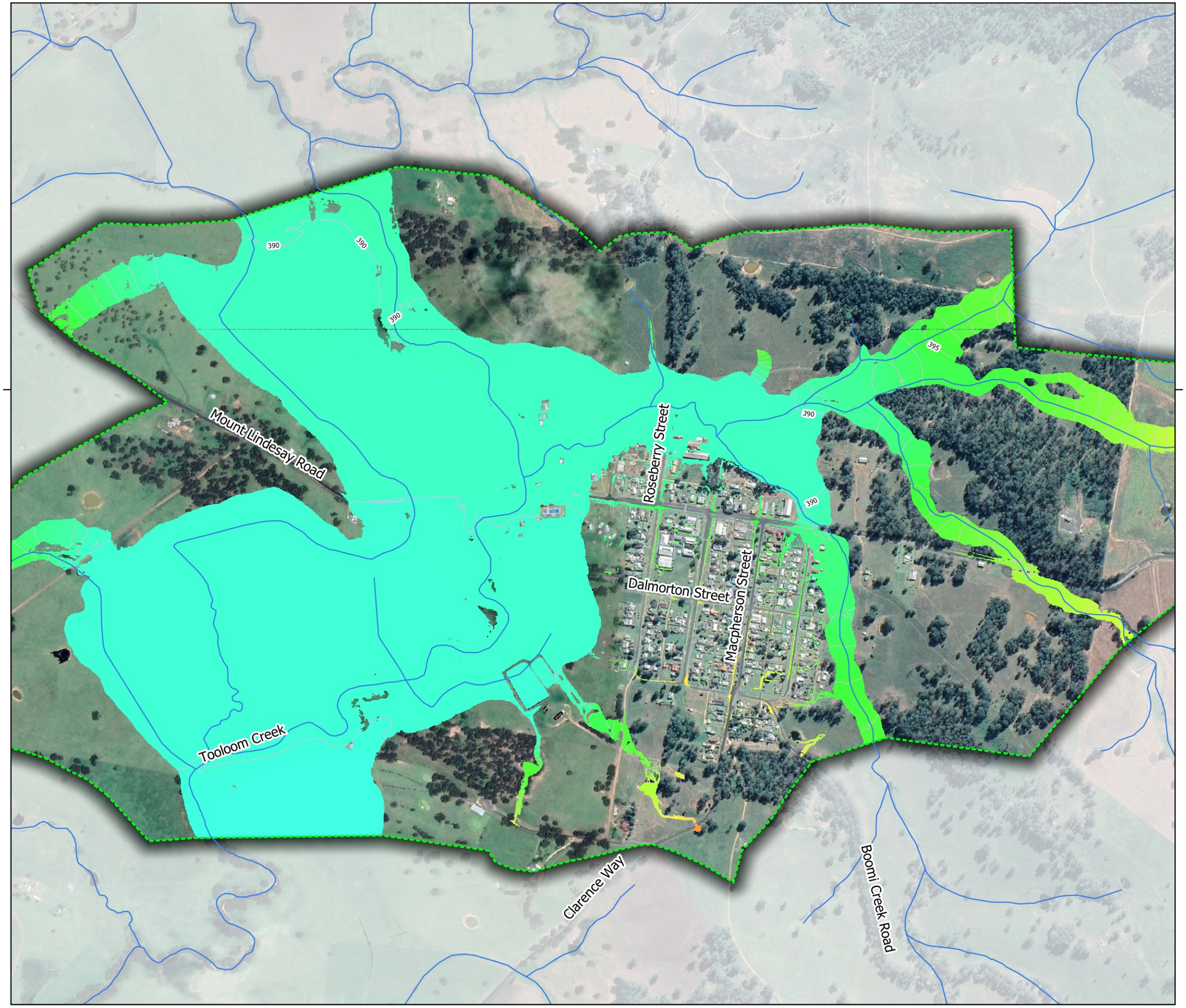
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 33
Tooloom Creek - Peak Flood Levels
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 33: 0.2% AEP event - Tooloom Creek - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

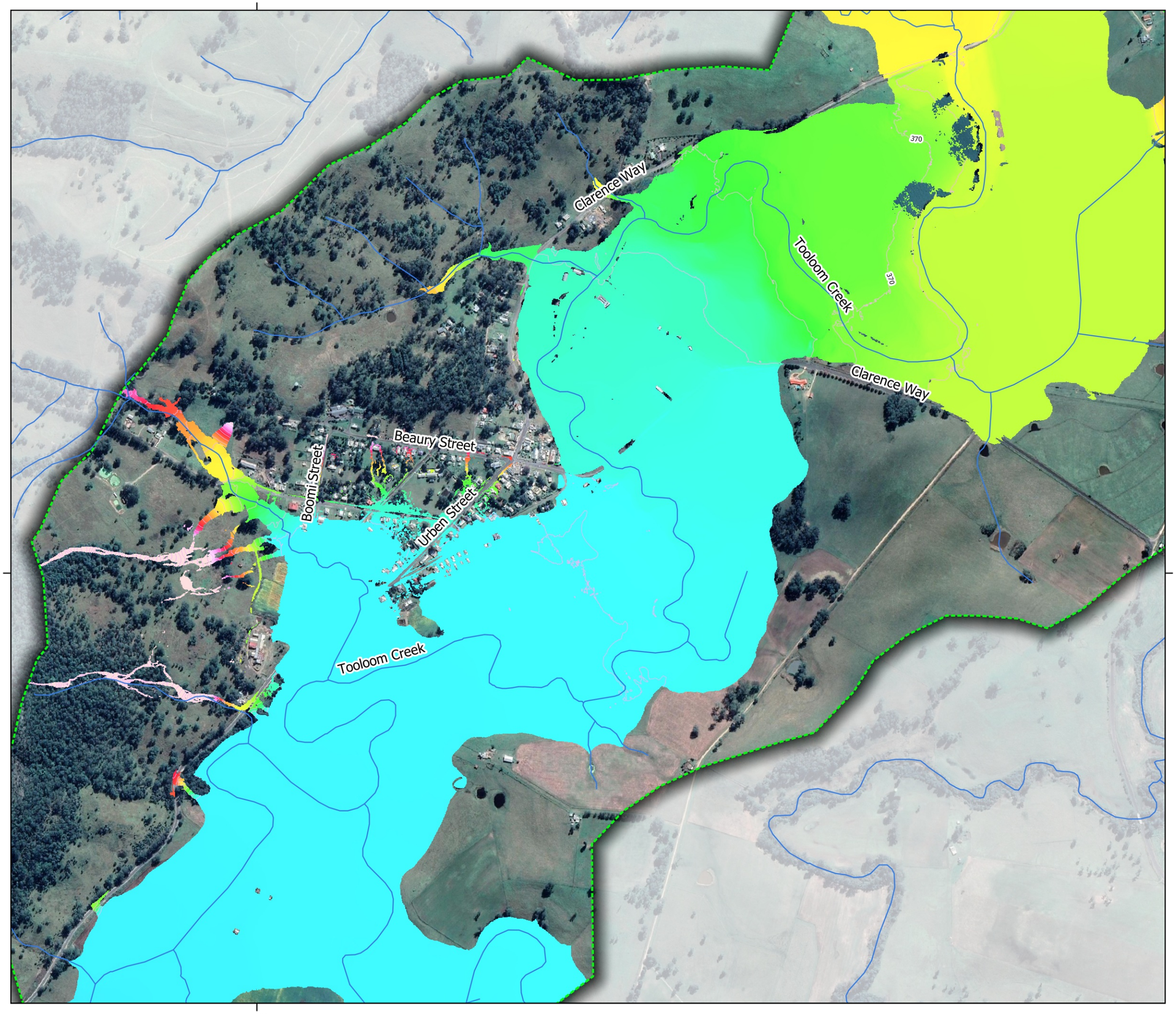
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 34
Woodenbong - Peak Flood Levels
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 34: 0.2% AEP event - Woodenbong - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 362
- 364
- 366
- 368
- 370
- 372
- 374
- 376
- 378
- 380

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 35
Urbenville - Peak Flood Levels
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 35: 0.2% AEP event - Urbenville - Peak Flood Levels

Aerial Imagery Source: SIXmaps

Lindsay Creek Road
Summerland Way
Mount Lindesay Road
Dalmorton Street
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road
B50

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 360
- 363
- 366
- 369
- 372
- 375
- 378
- 381
- 384
- 387
- 390
- 393
- 396
- 399
- 402
- 405
- 408
- 411
- 414
- 417
- 420

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

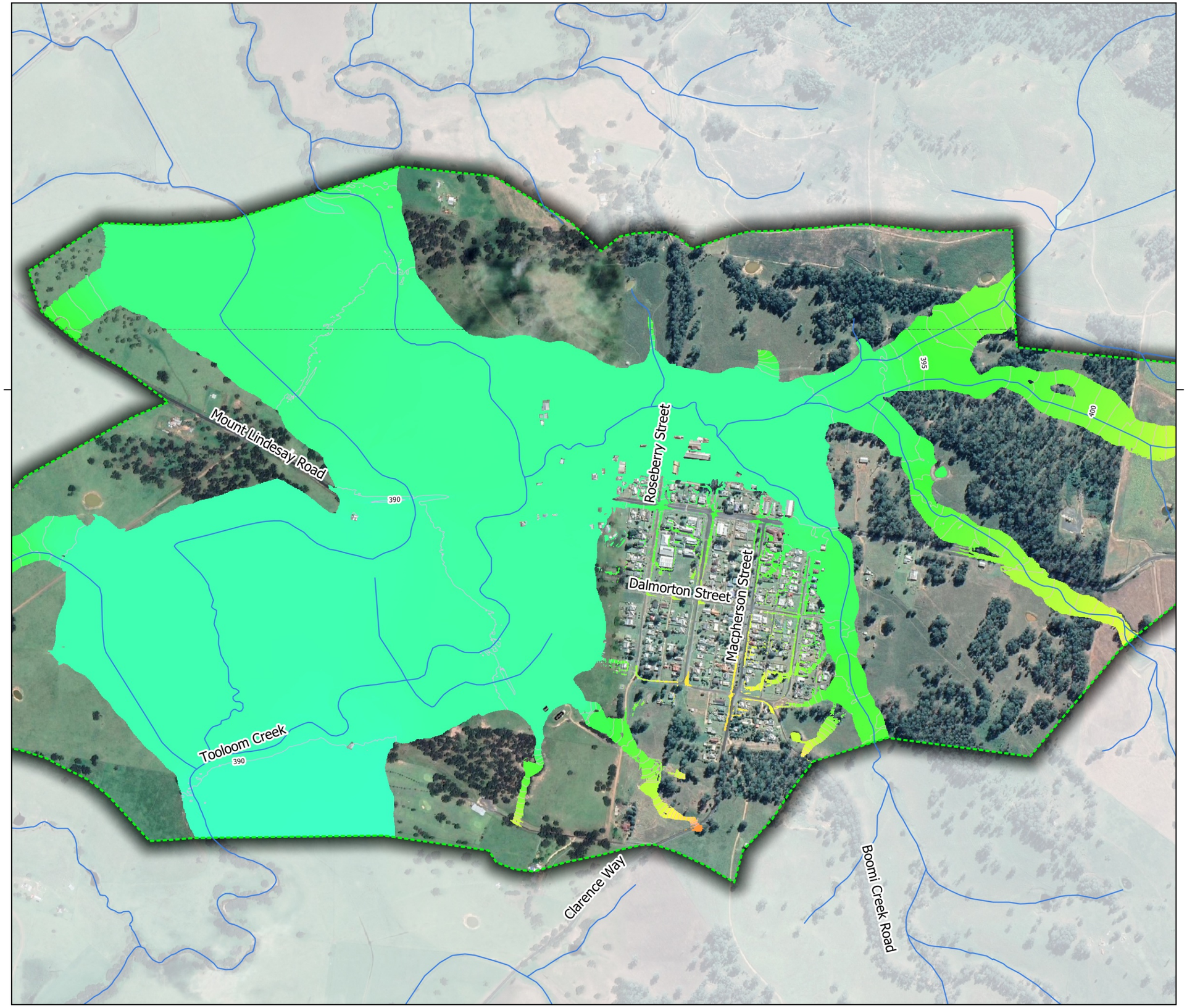
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 36
Tooloom Creek - Peak Flood Levels
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 36: PMF event - Tooloom Creek - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

- 380
- 382
- 383
- 385
- 386
- 388
- 389
- 391
- 392
- 394
- 395
- 397
- 398
- 400
- 401
- 403
- 404
- 406
- 407
- 409
- 410

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

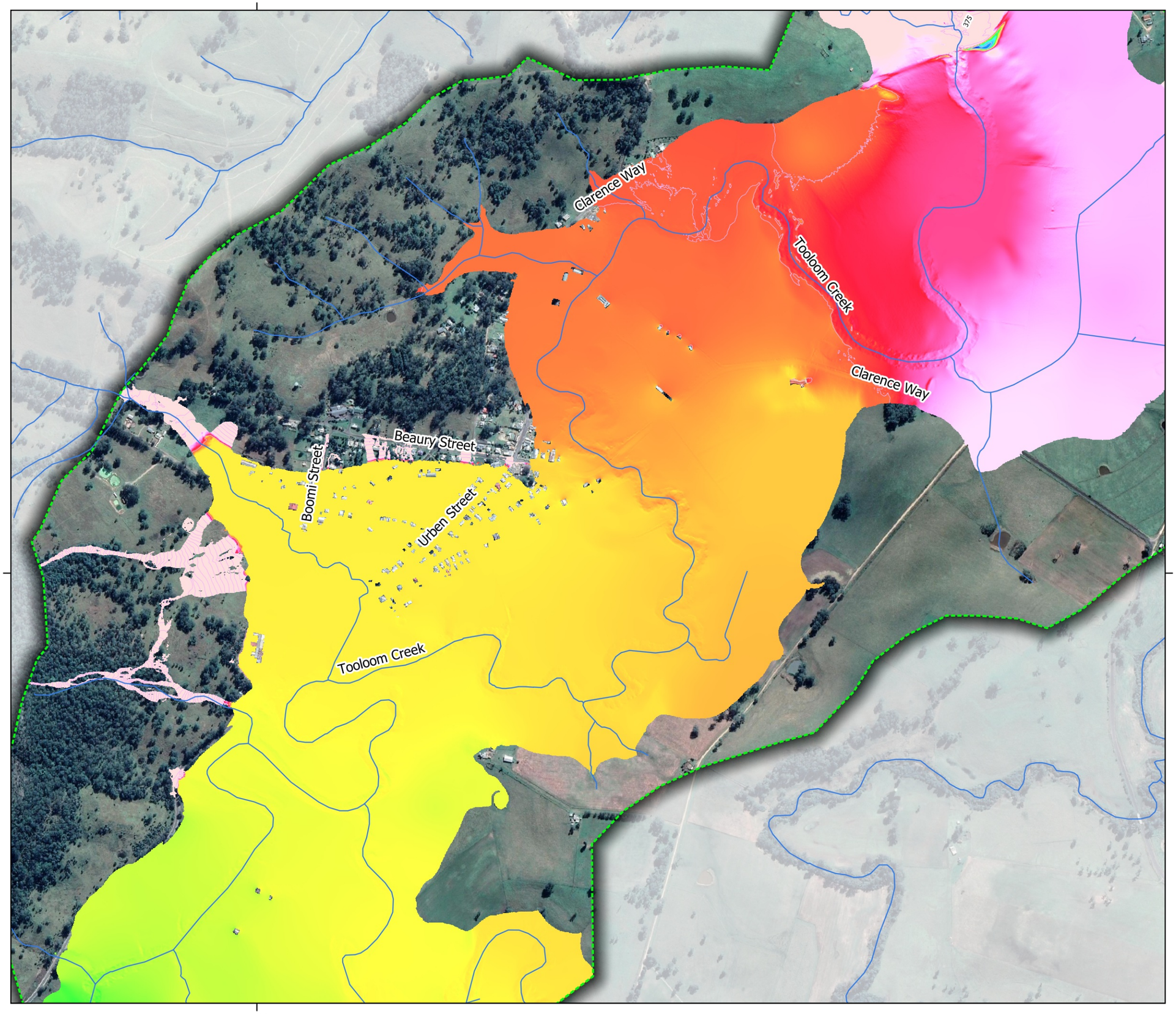
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 37
Woodenbong - Peak Flood Levels
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 37: PMF event - Woodenbong - Peak Flood Levels

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways
- Water Level Contours - 1.0m interval

Peak flood levels (mAHD)

URB_PMF_Enveloped_h_max_filtered0.05

- 372.5
- 372.6
- 372.7
- 372.8
- 372.9
- 373
- 373.1
- 373.2
- 373.3
- 373.4
- 373.5
- 373.6
- 373.7
- 373.8
- 373.9
- 374
- 374.1
- 374.2
- 374.3
- 374.4
- 374.5

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

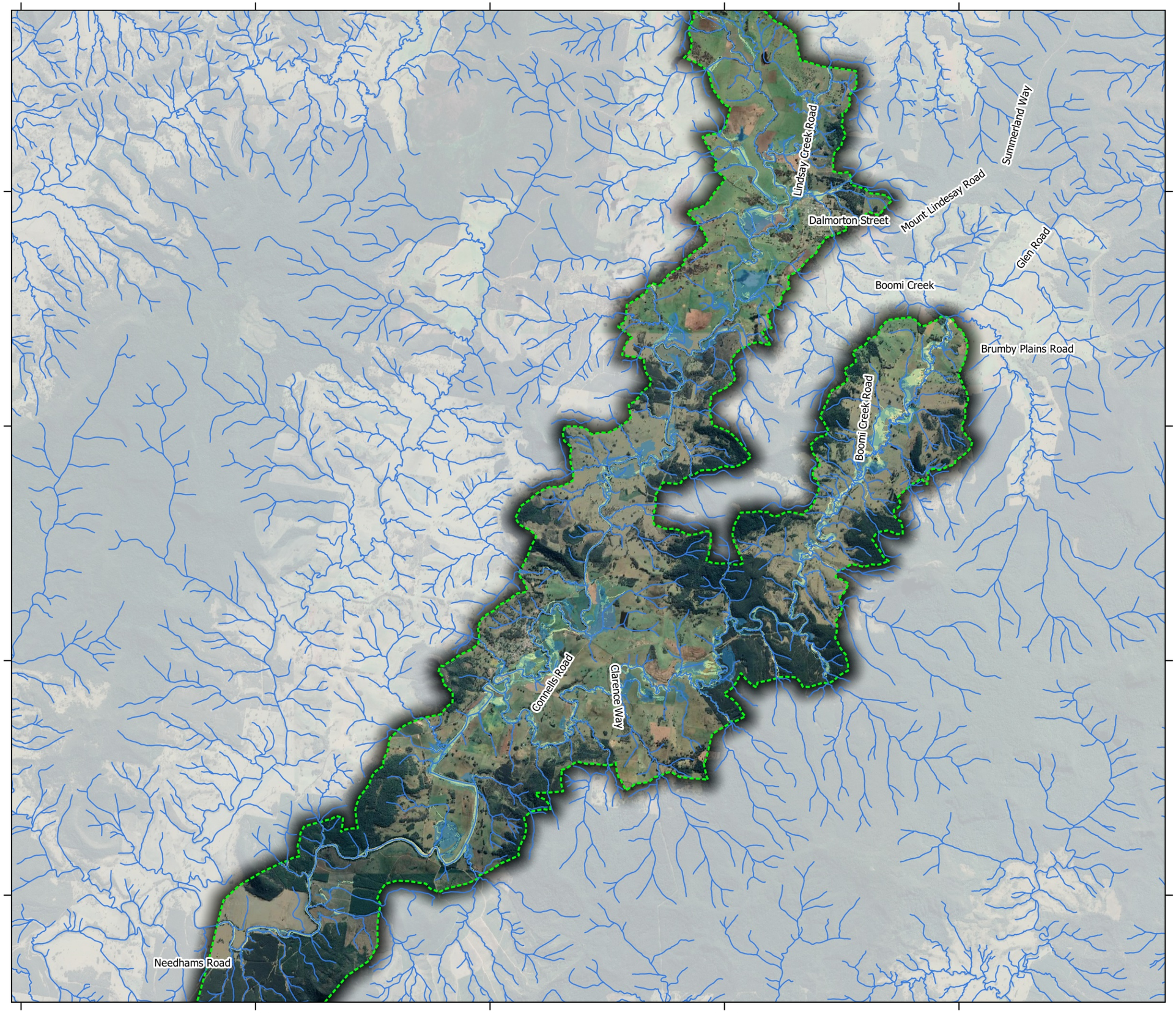
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 38
Urbenville - Peak Flood Levels
PMF event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 38: PMF event - Urbenville - Peak Flood Levels



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

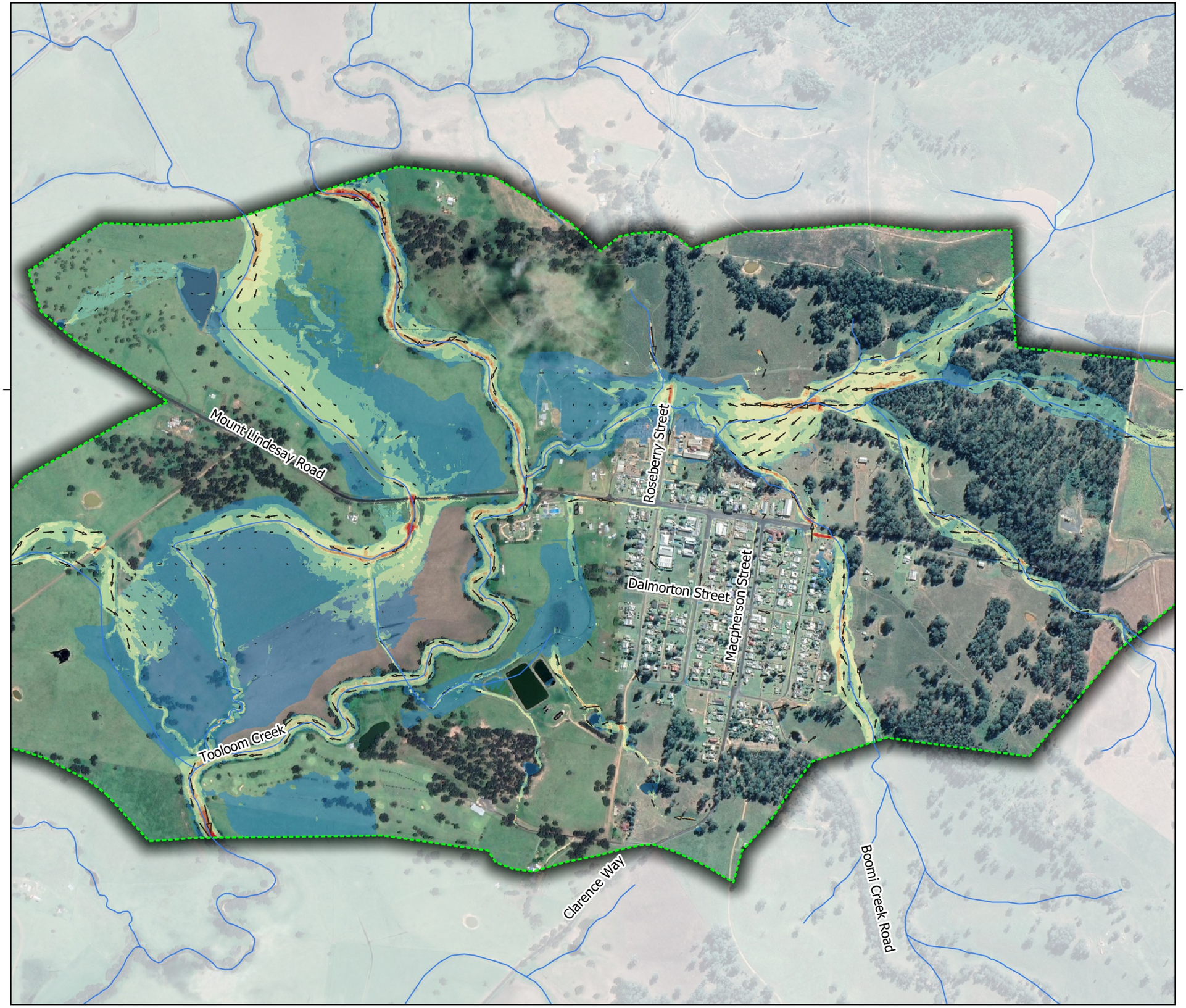
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 39
Tooloom Creek - Maximum Flood Velocities
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 39: 20% AEP event - Tooloom Creek - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

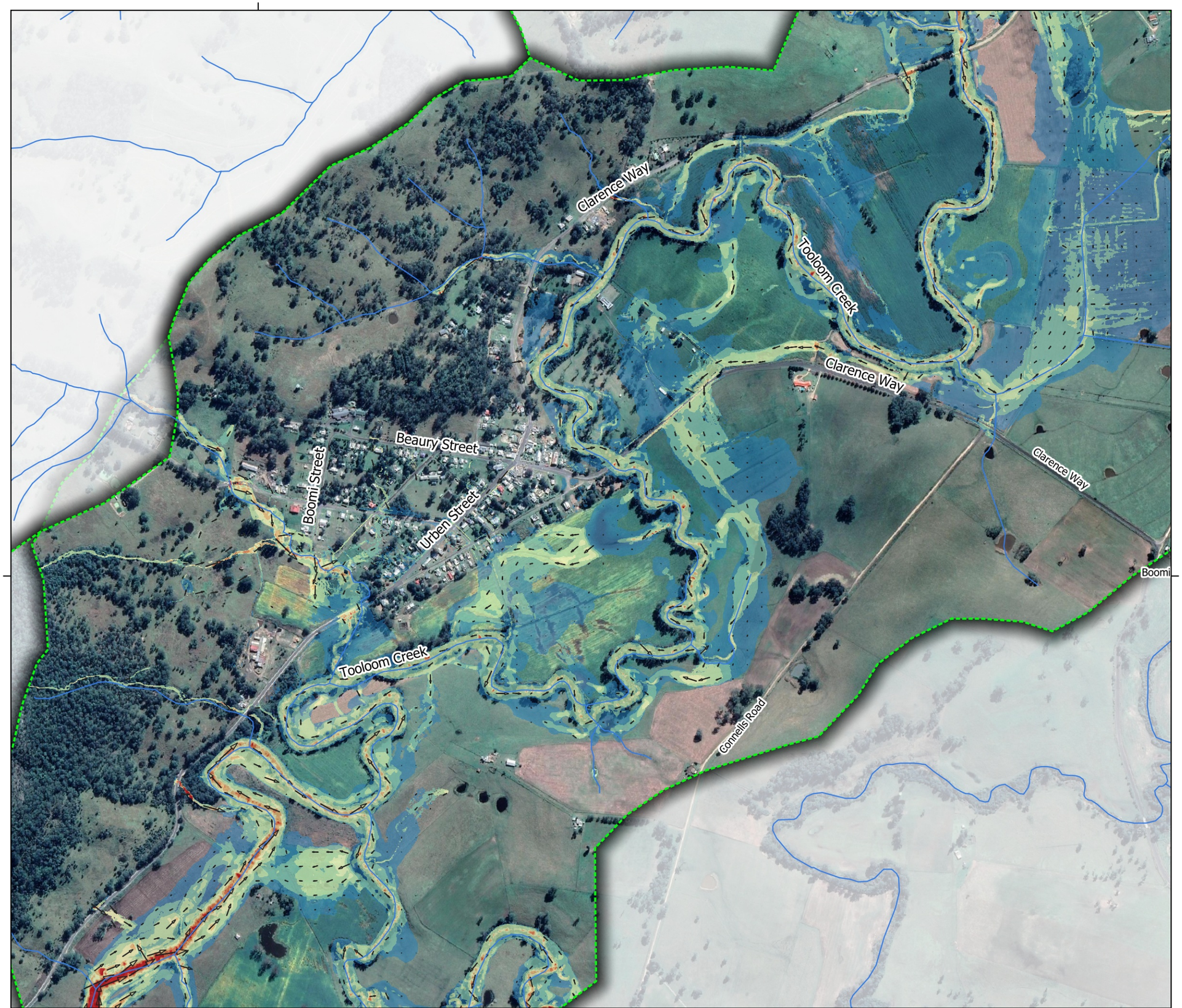
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 40
Woodenbong - Maximum Flood Velocities
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 40: 20% AEP event - Woodenbong - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

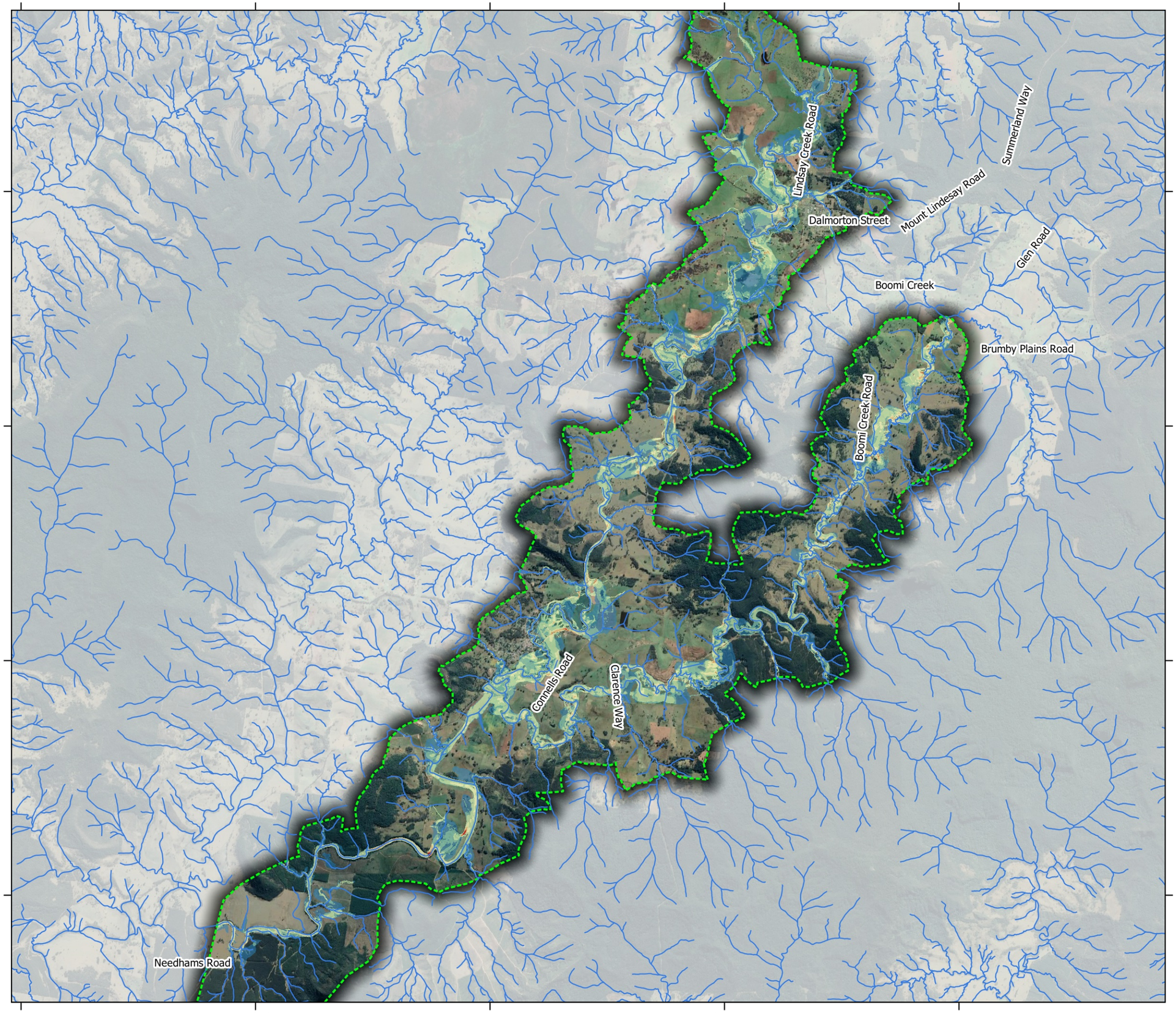
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 41
Urbenville - Maximum Flood Velocities
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 41: 20% AEP event - Urbenville - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

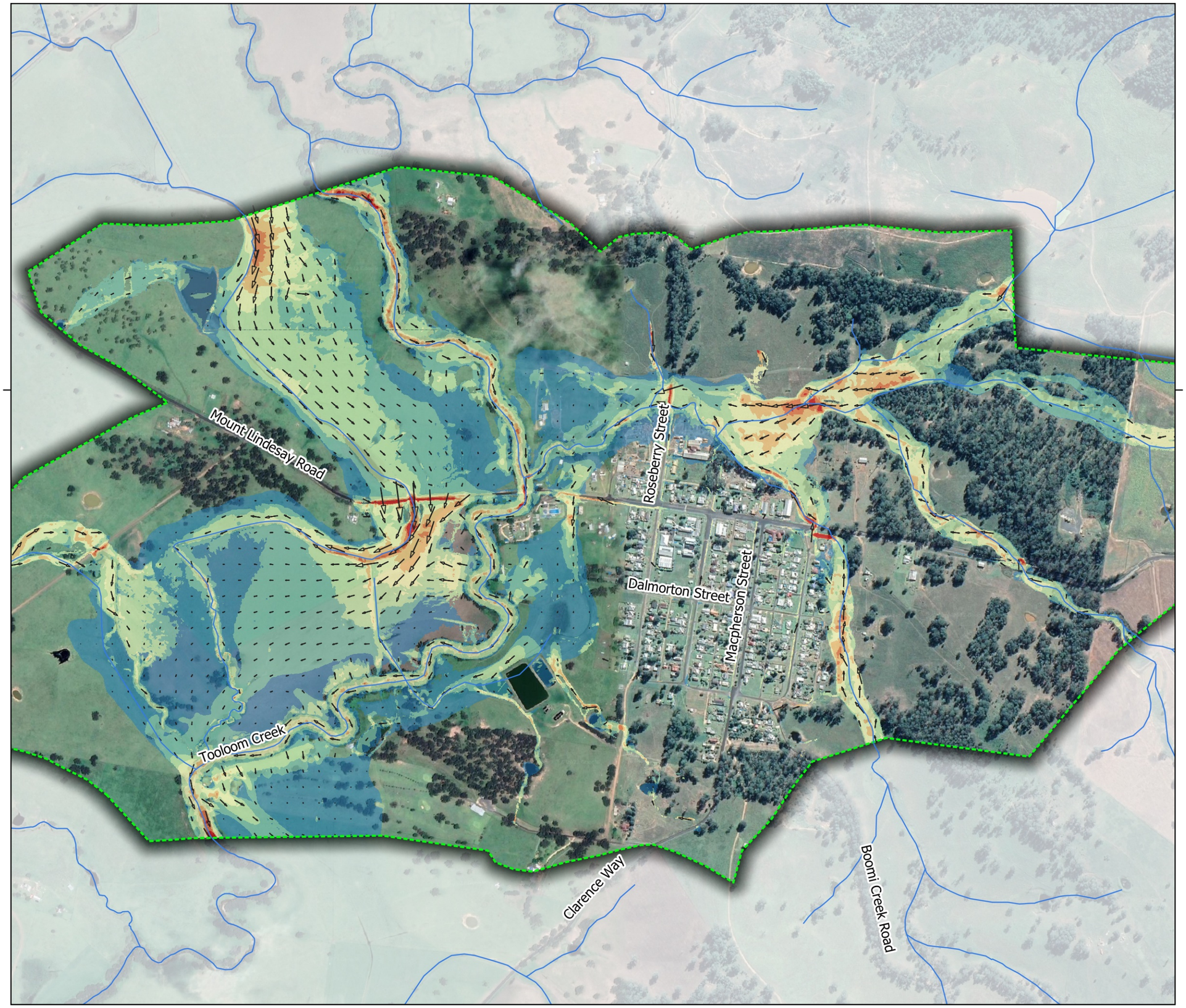
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 42
Tooloom Creek - Maximum Flood Velocities
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 42: 5% AEP event - Tooloom Creek - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

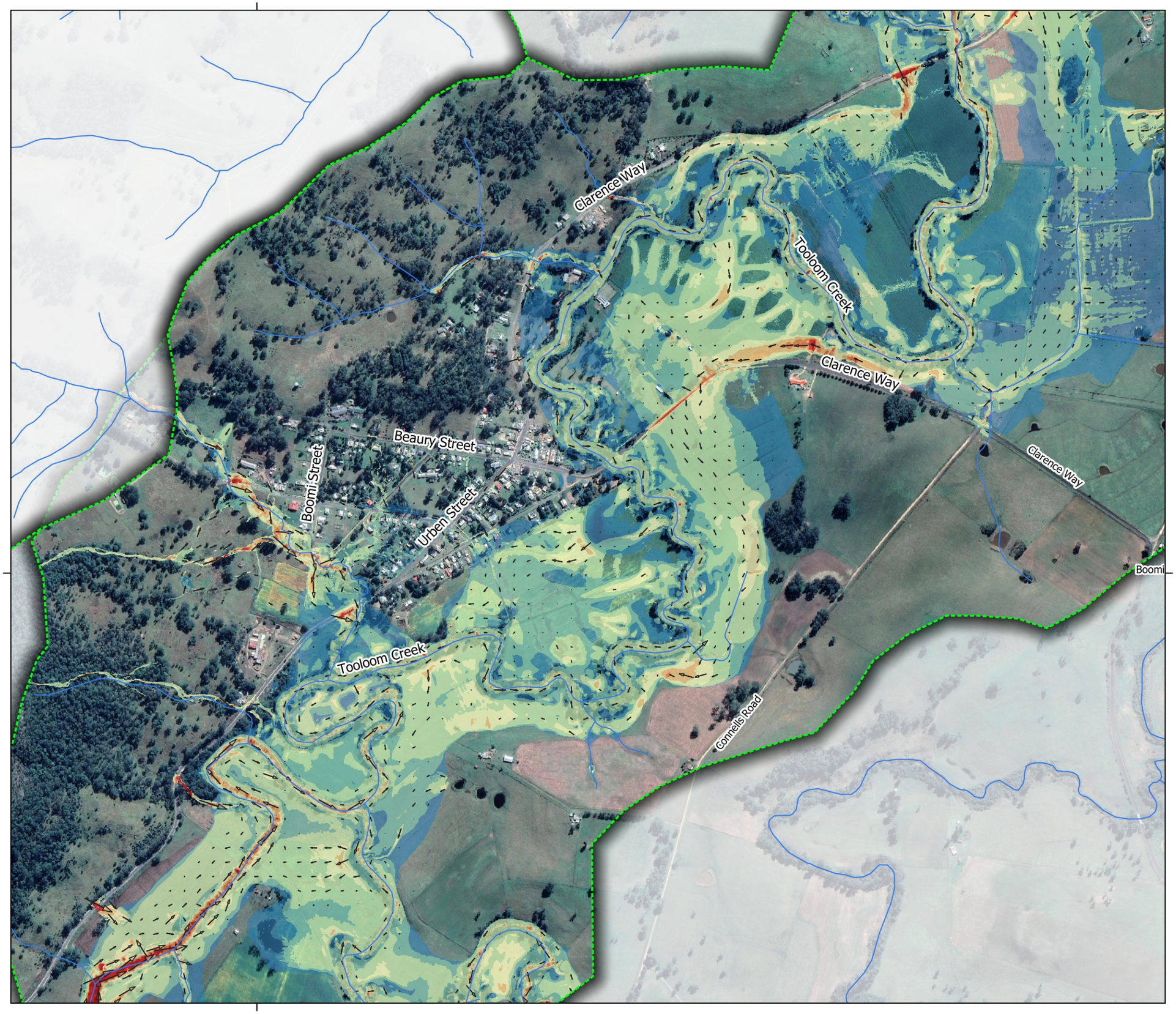
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 43
Woodenbong - Maximum Flood Velocities
5% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 43: 5% AEP event - Woodenbong - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 44
Urbenville - Maximum Flood Velocities
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 44: 5% AEP event - Urbenville - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps

Lindsay Creek Road
Summerland Way
Mount Lindesay Road
Dalmorton Street
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

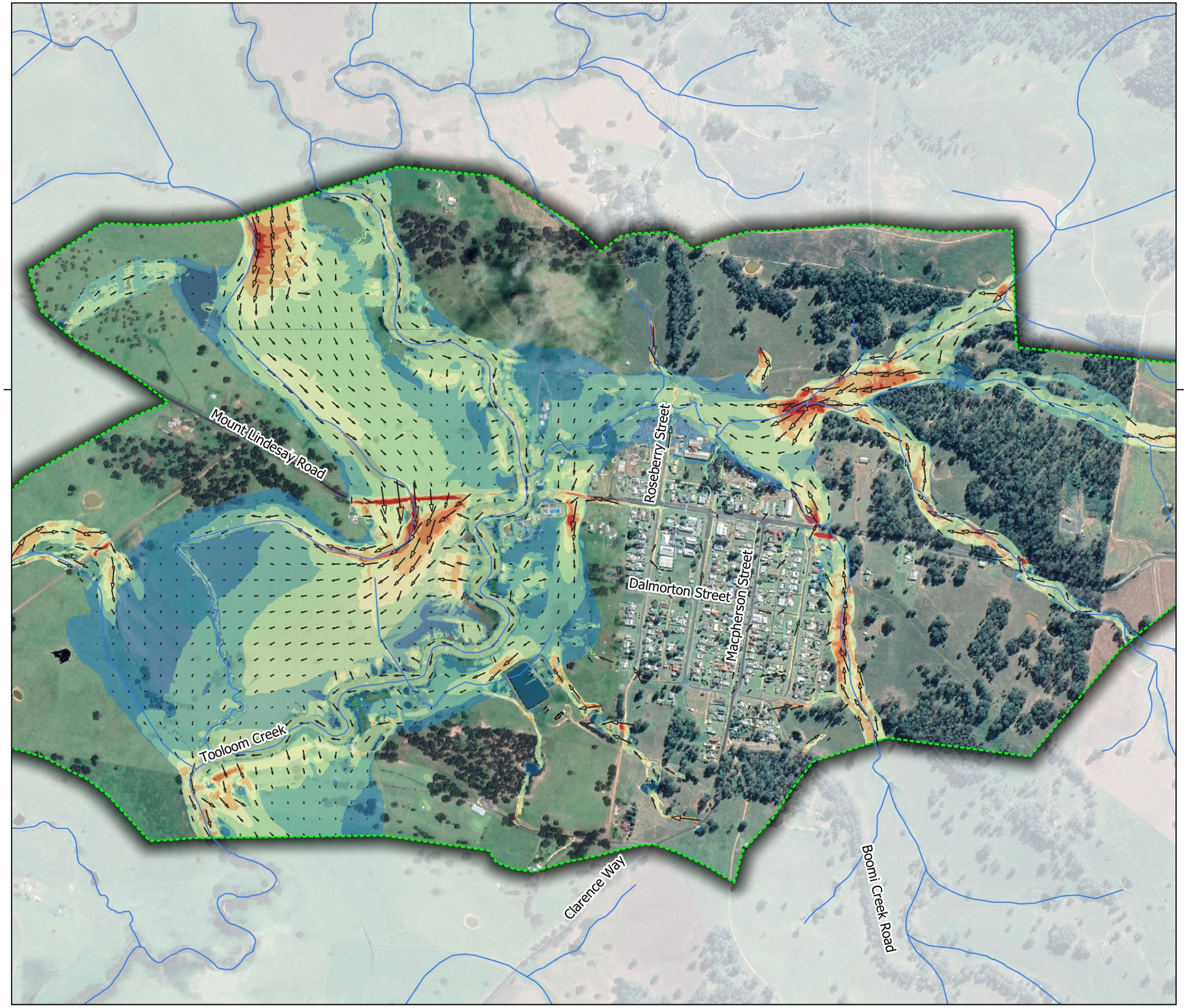
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 45
Tooloom Creek - Maximum Flood Velocities
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 45: 1% AEP event - Tooloom Creek - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

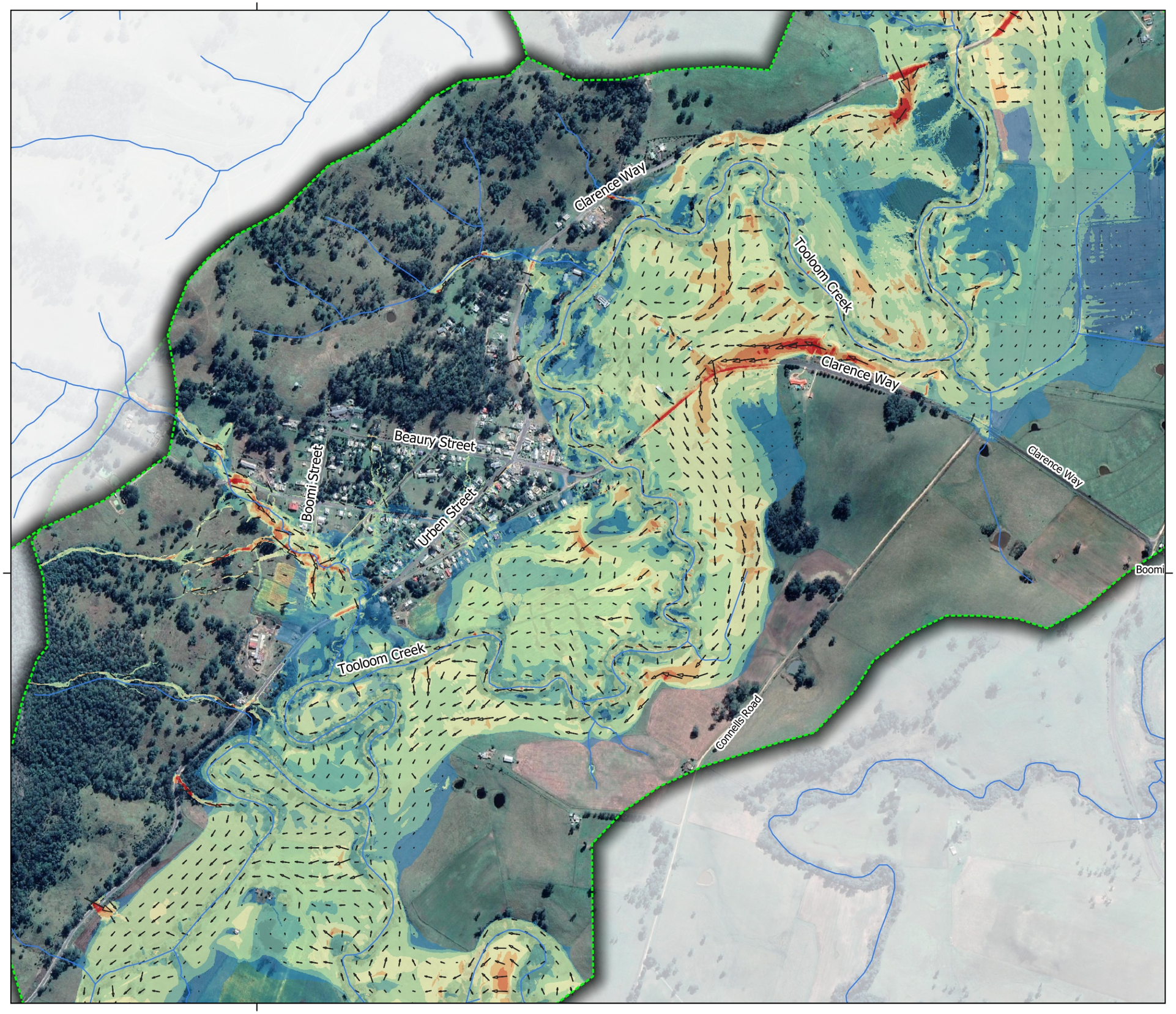
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 46
Woodenbong - Maximum Flood Velocities
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 46: 1% AEP event - Woodenbong - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

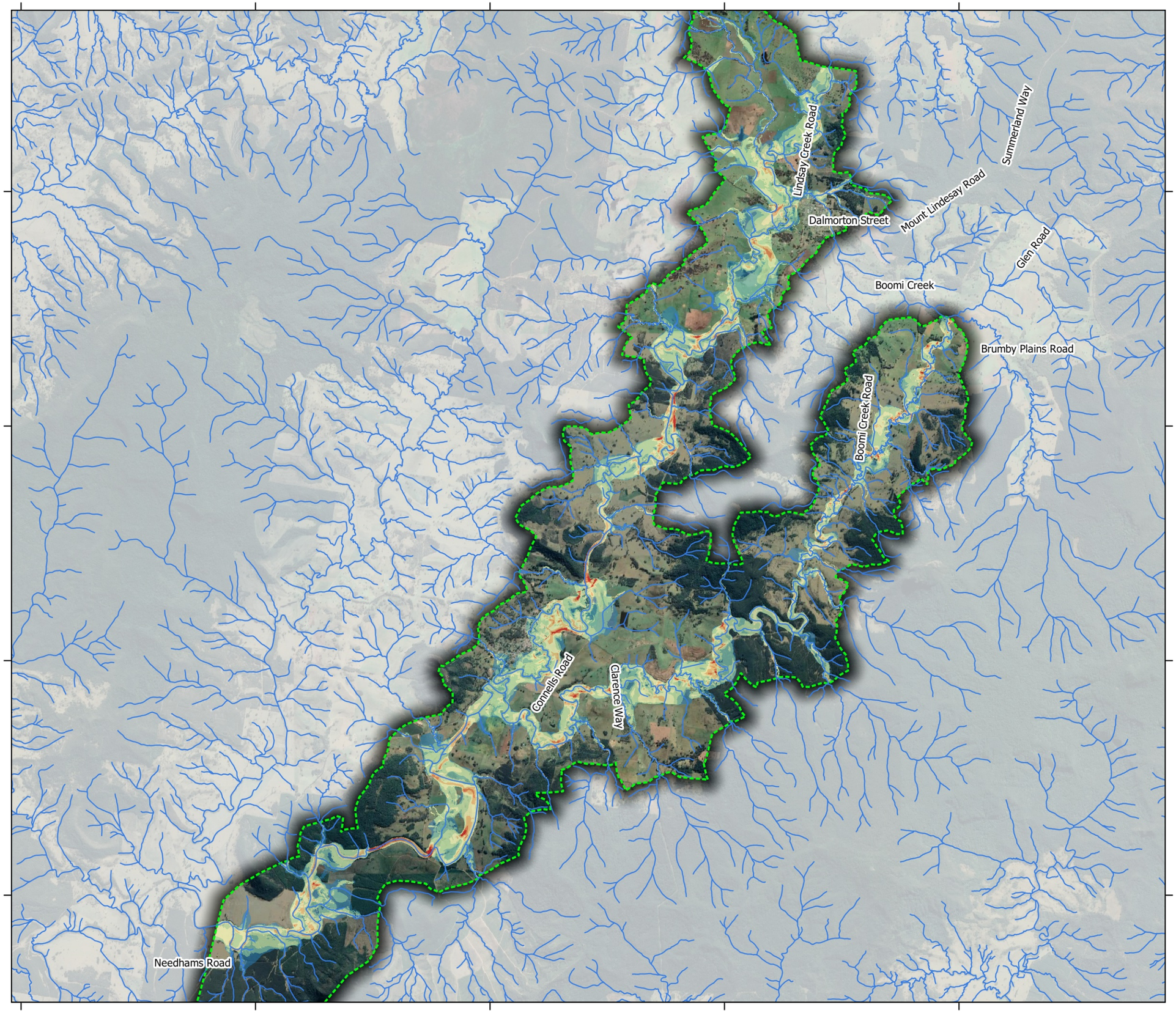
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 47
Urbenville - Maximum Flood Velocities
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 47: 1% AEP event - Urbenville - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

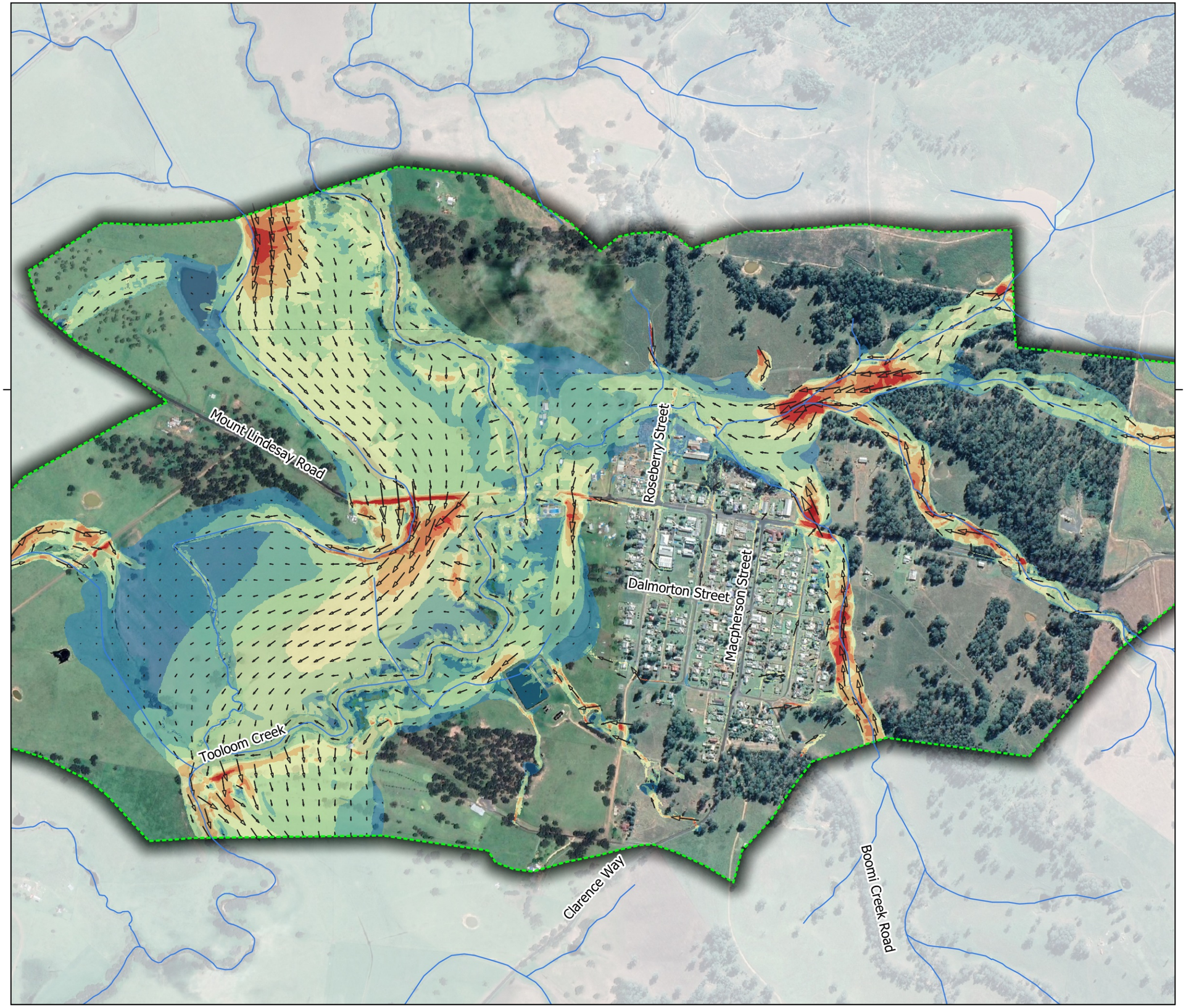
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 48
Tooloom Creek - Maximum Flood Velocities
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 48: 0.2% AEP event - Tooloom Creek - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5-4
- > 4

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

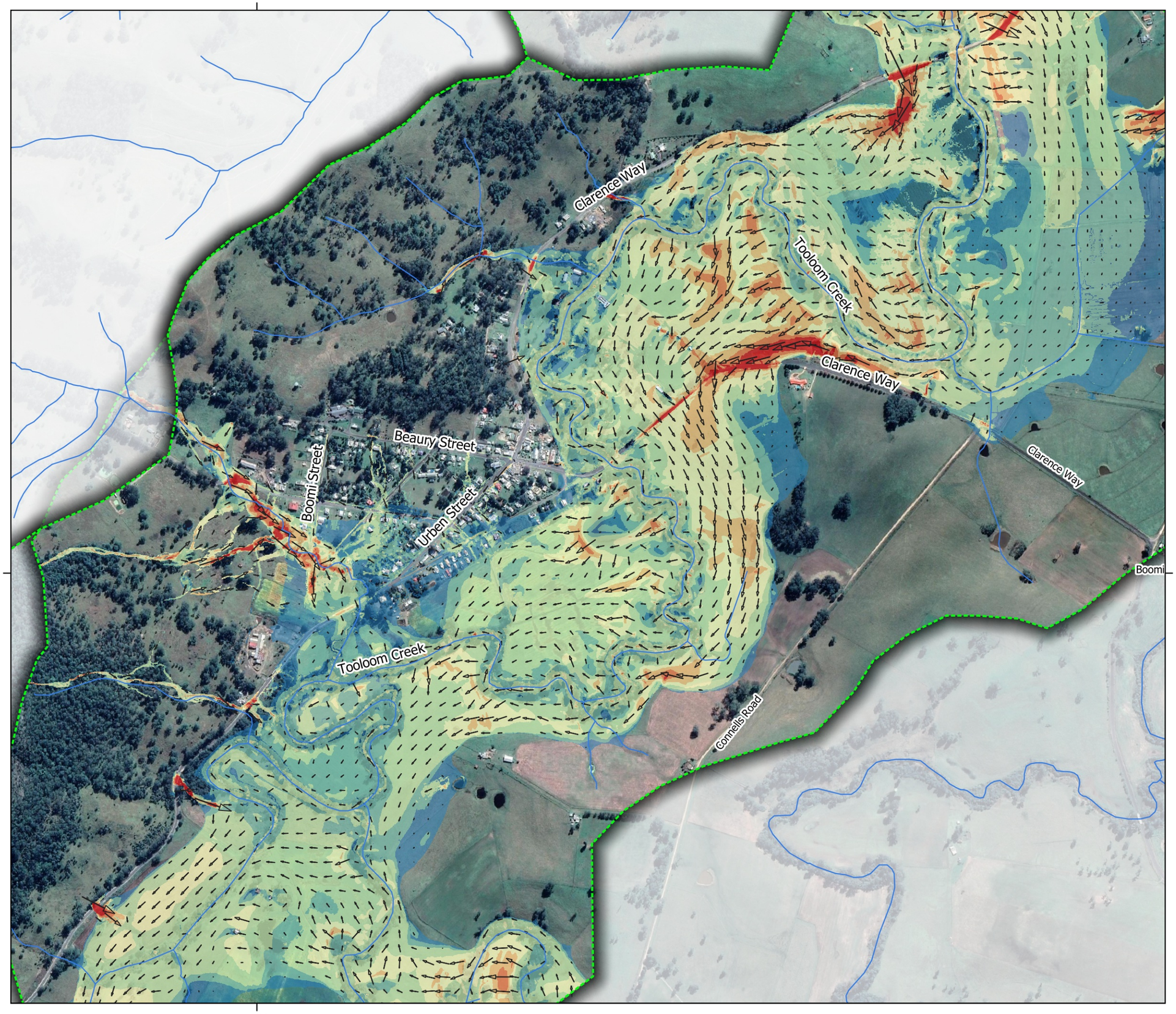
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 49
Woodenbong - Maximum Flood Velocities
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 49: 0.2% AEP event - Woodenbong - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

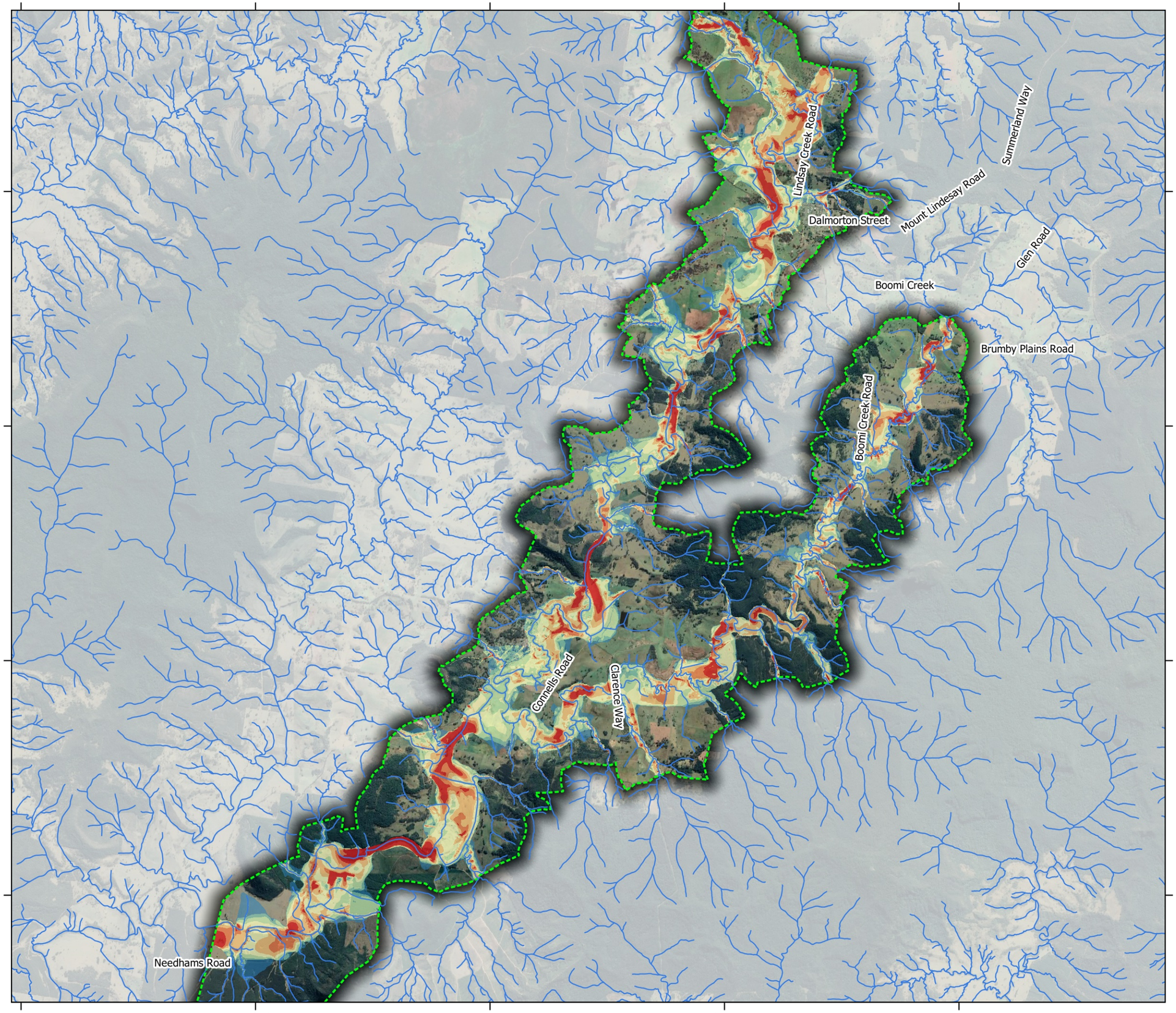
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 50
Urbenville - Maximum Flood Velocities
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 50: 0.2% AEP event - Urbenville - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

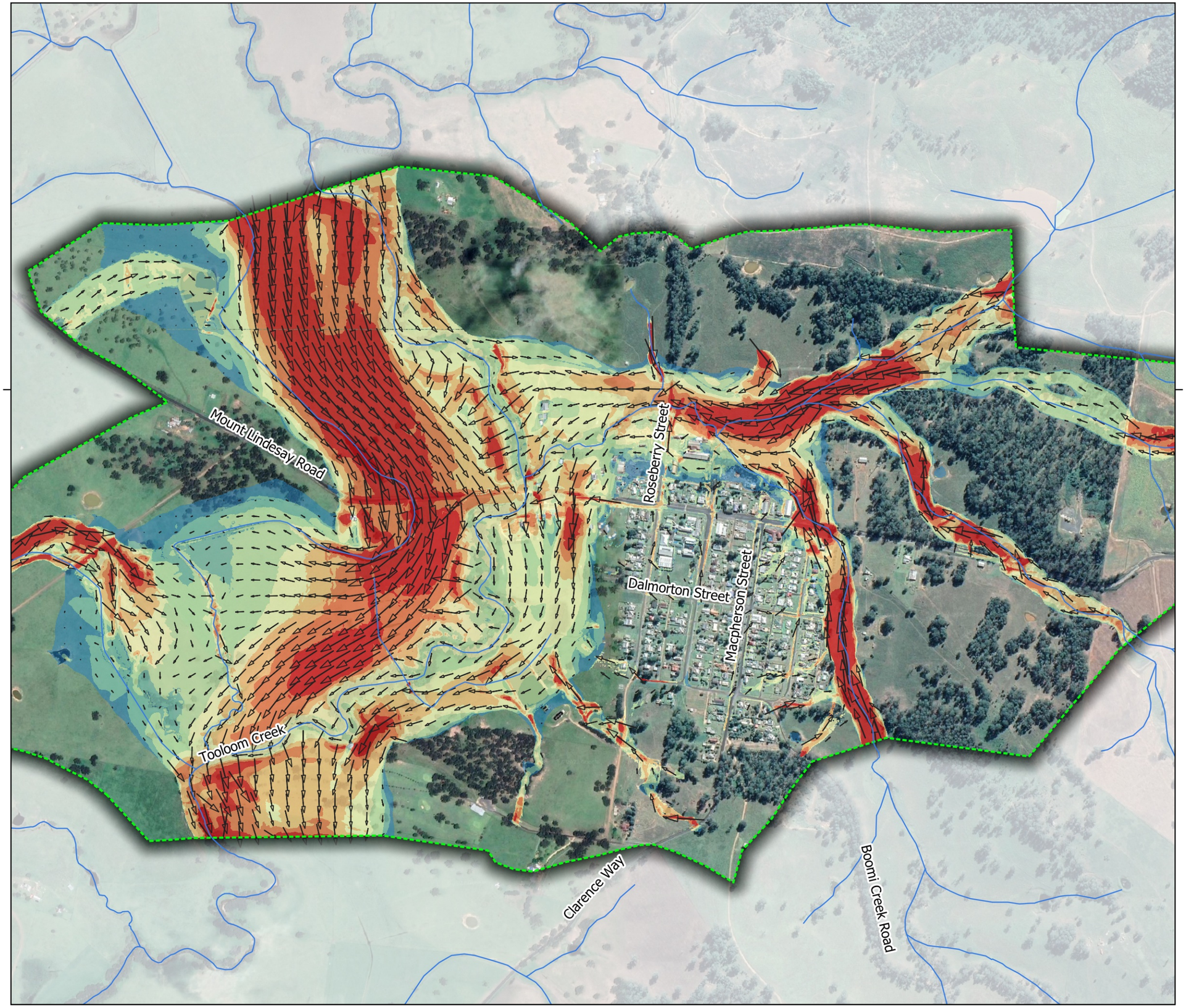
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 51
Tooloom Creek - Maximum Flood Velocities
PMF event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 51: PMF event - Tooloom Creek - Maximum Flood Velocities



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

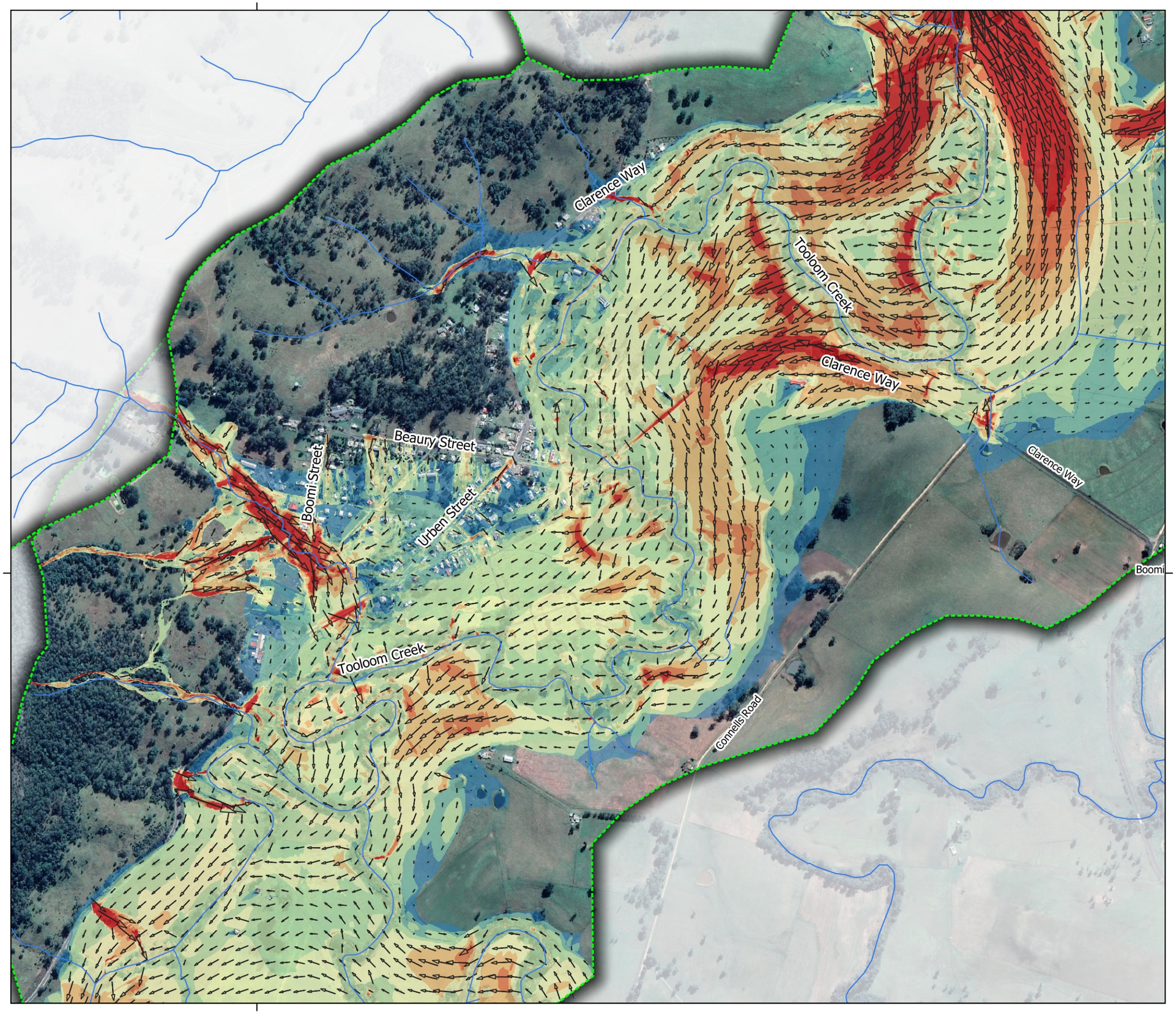
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 52
Woodenbong - Maximum Flood Velocities
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 52: PMF event - Woodenbong - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Peak flood velocity (m/s)

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- > 2.50

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 53
Urbenville - Maximum Flood Velocities
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 53: PMF event - Urbenville - Maximum Flood Velocities

Aerial Imagery Source: SIXmaps

Lindsay Creek Road
Summerland Way
Mount Lindesay Road
Dalmorton Street
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

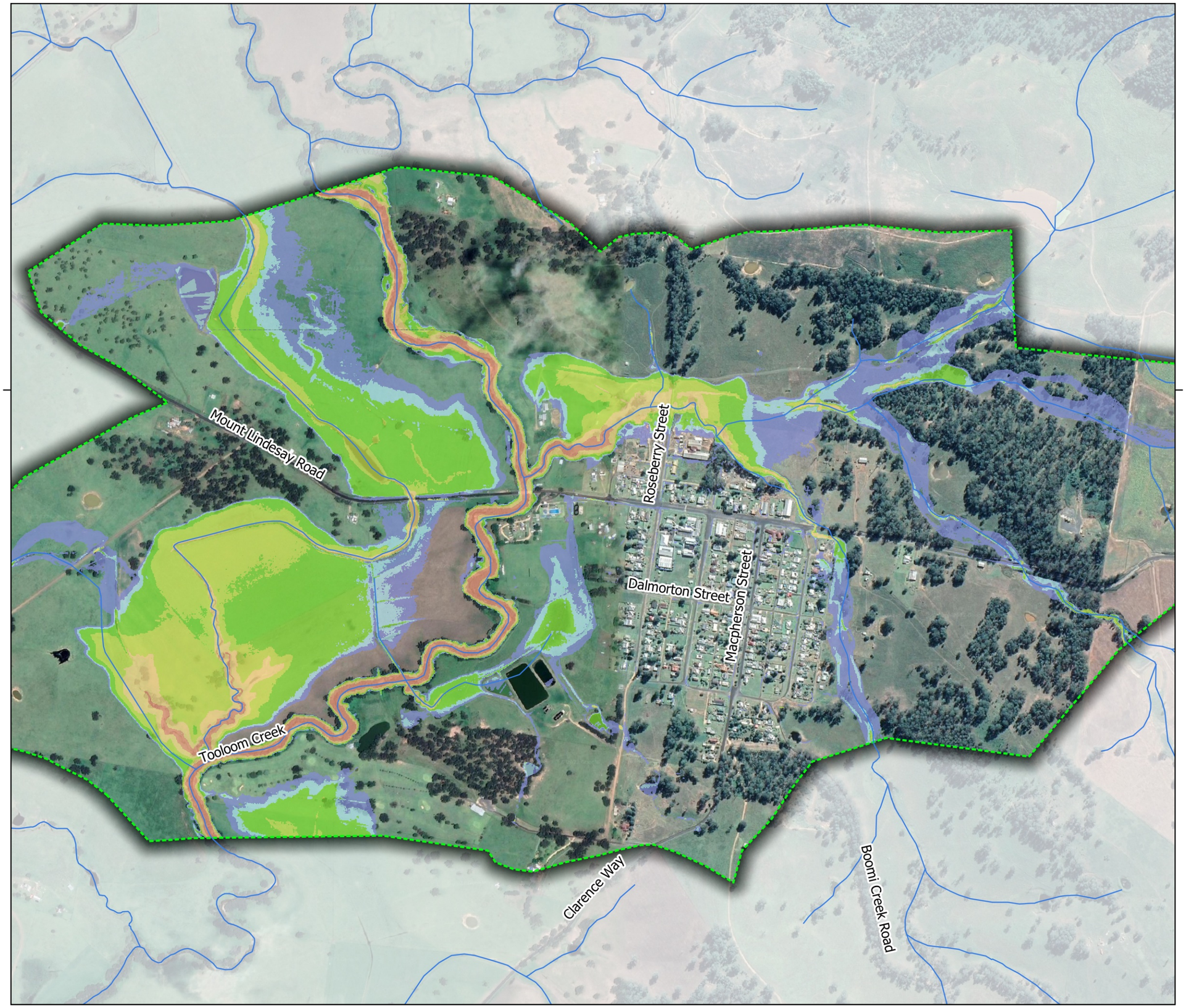
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 54
Tooloom Creek - Maximum Flood Hazard (Provisional)
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 54: 20% AEP event - Tooloom Creek - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

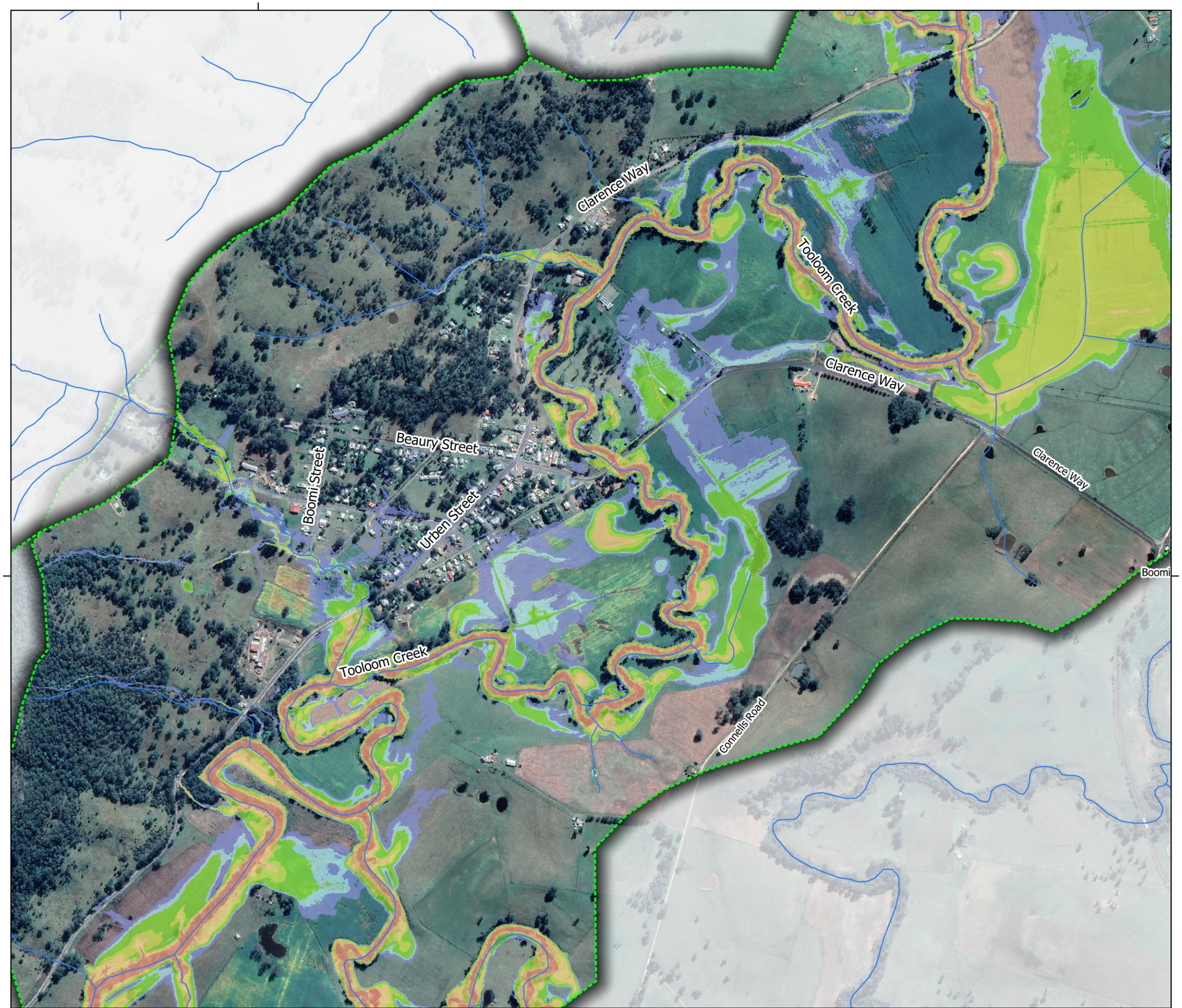
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 55
Woodenbong - Maximum Flood Hazard (Provisional)
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 55: 20% AEP event - Woodenbong - Maximum Flood Hazard (Provisional)



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

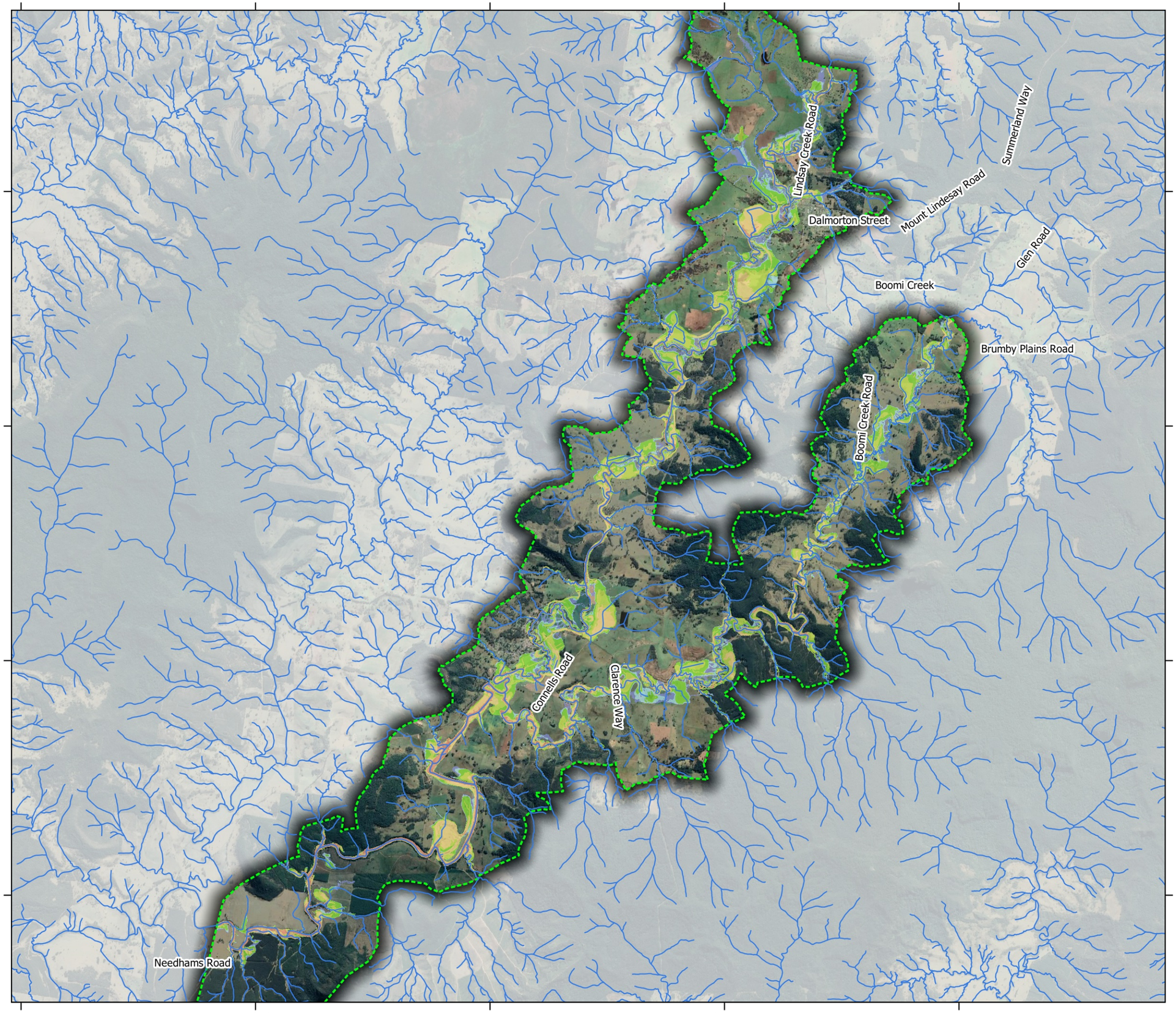
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 56
Urbenville - Maximum Flood Hazard (Provisional)
20% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 56: 20% AEP event - Urbenville - Maximum Flood Hazard (Provisional)



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

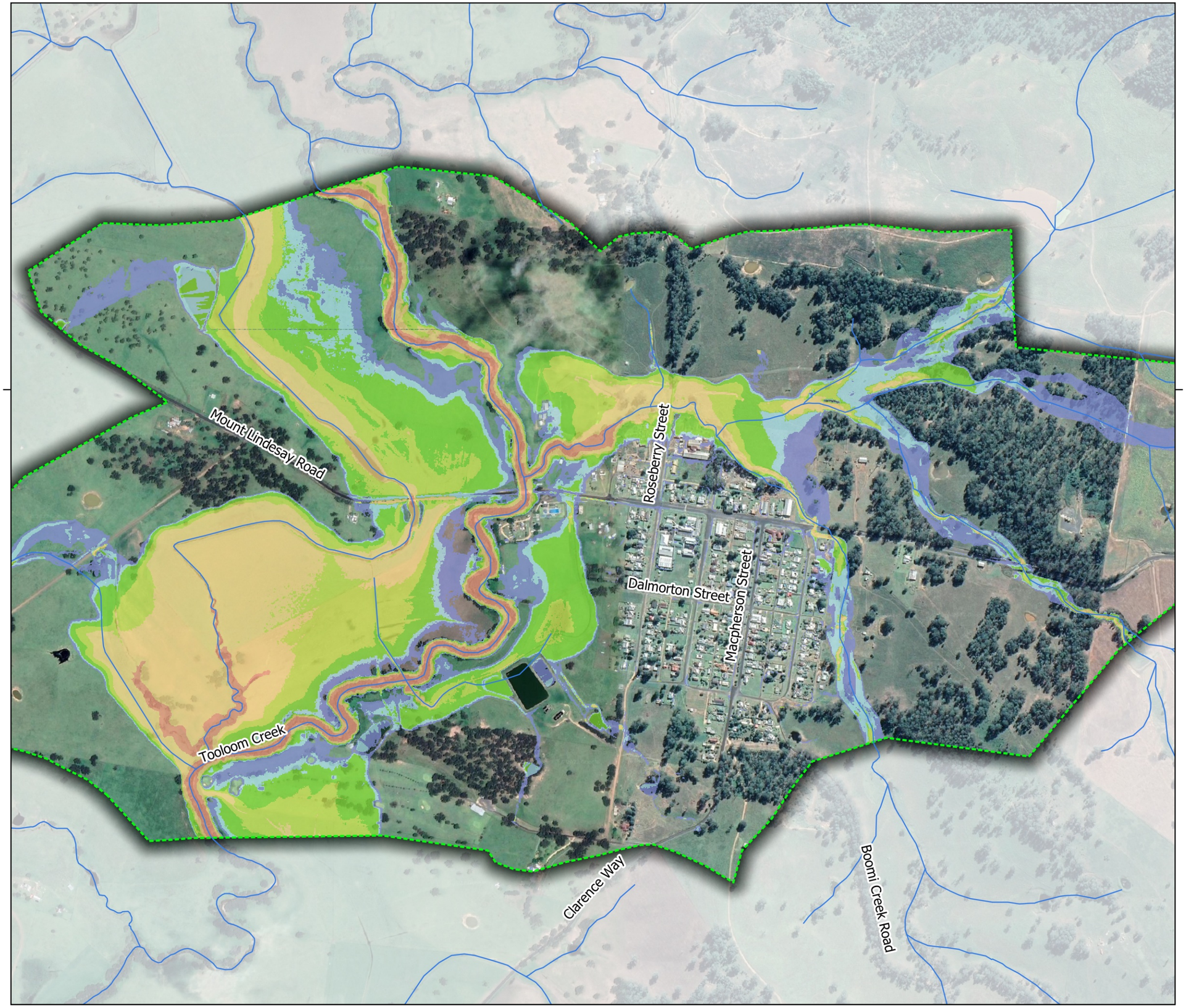
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 57
Tooloom Creek - Maximum Flood Hazard (Provisional)
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 57: 5% AEP event - Tooloom Creek - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

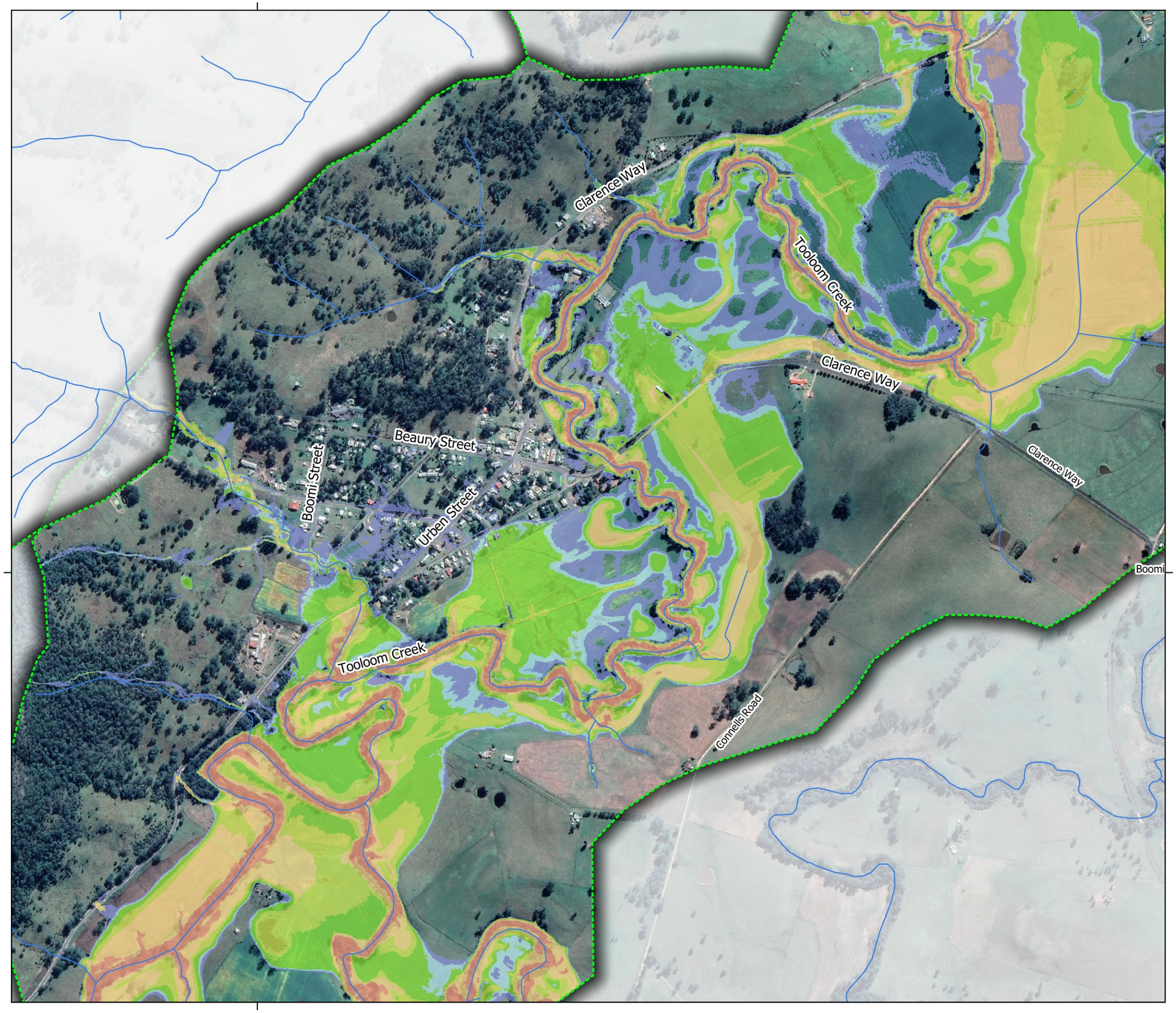
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 58
Woodenbong - Maximum Flood Hazard (Provisional)
5% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 58: 5% AEP event - Woodenbong - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

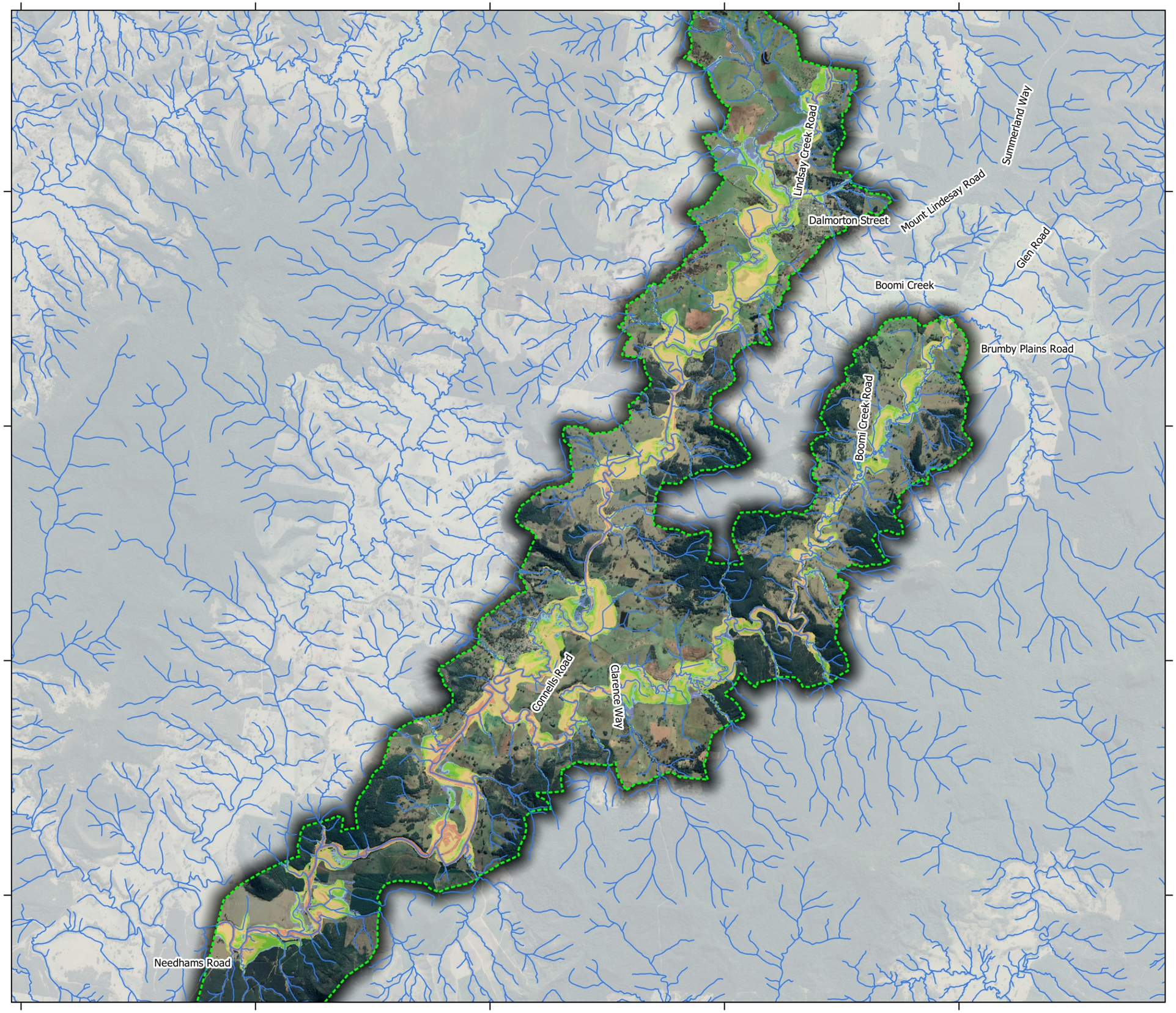
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 59
Urbenville - Maximum Flood Hazard (Provisional)
5% AEP event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 59: 5% AEP event - Urbenville - Maximum Flood Hazard (Provisional)



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

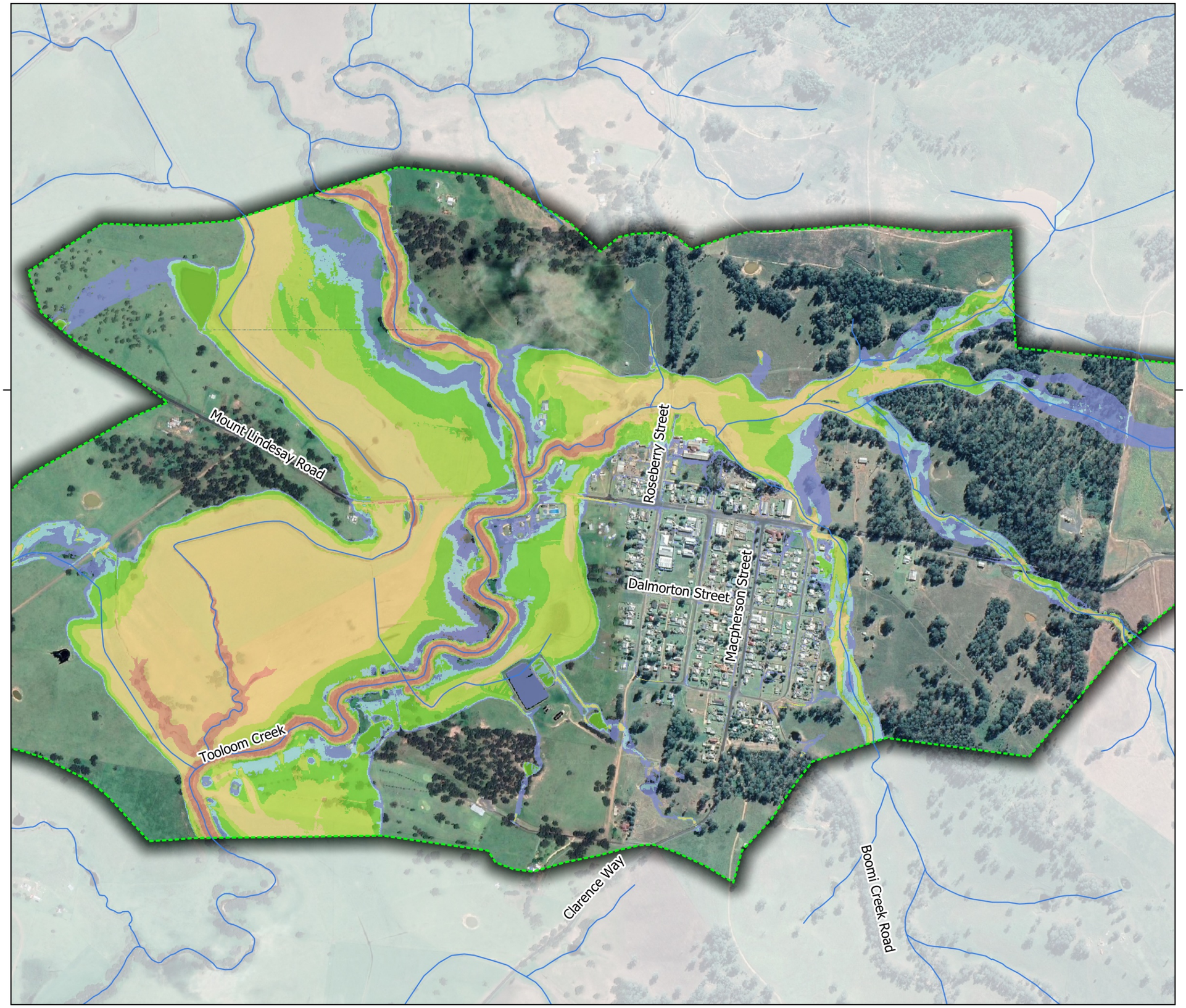
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 60
Tooloom Creek - Maximum Flood Hazard (Provisional)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 60: 1% AEP event - Tooloom Creek - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

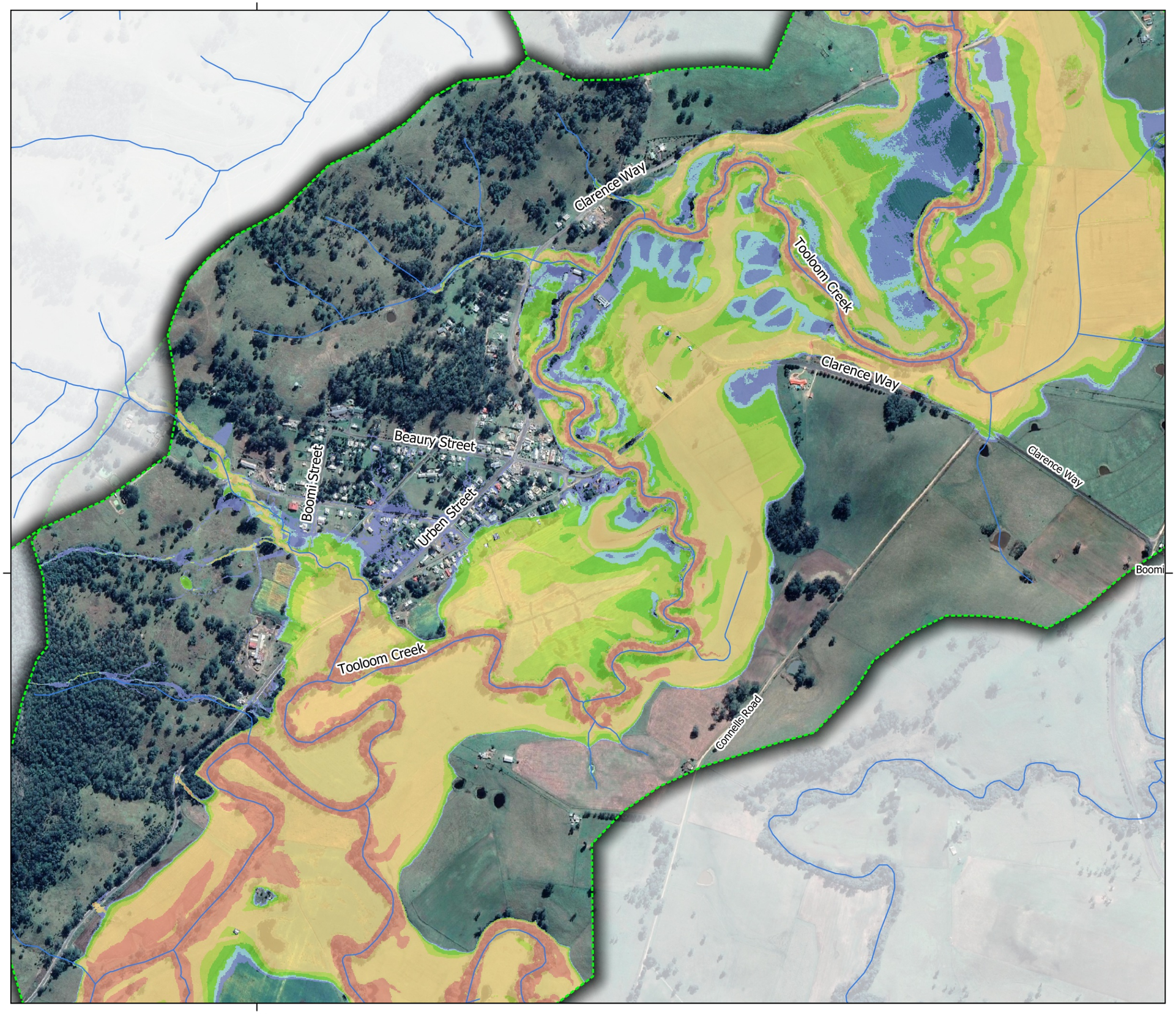
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 61
Woodenbong - Maximum Flood Hazard (Provisional)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 61: 1% AEP event - Woodenbong - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 62
Urbenville - Maximum Flood Hazard (Provisional)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 62: 1% AEP event - Urbenville - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps

Lindsay Creek Road
Summerland Way
Mount Lindesay Road
Dalmorton Street
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

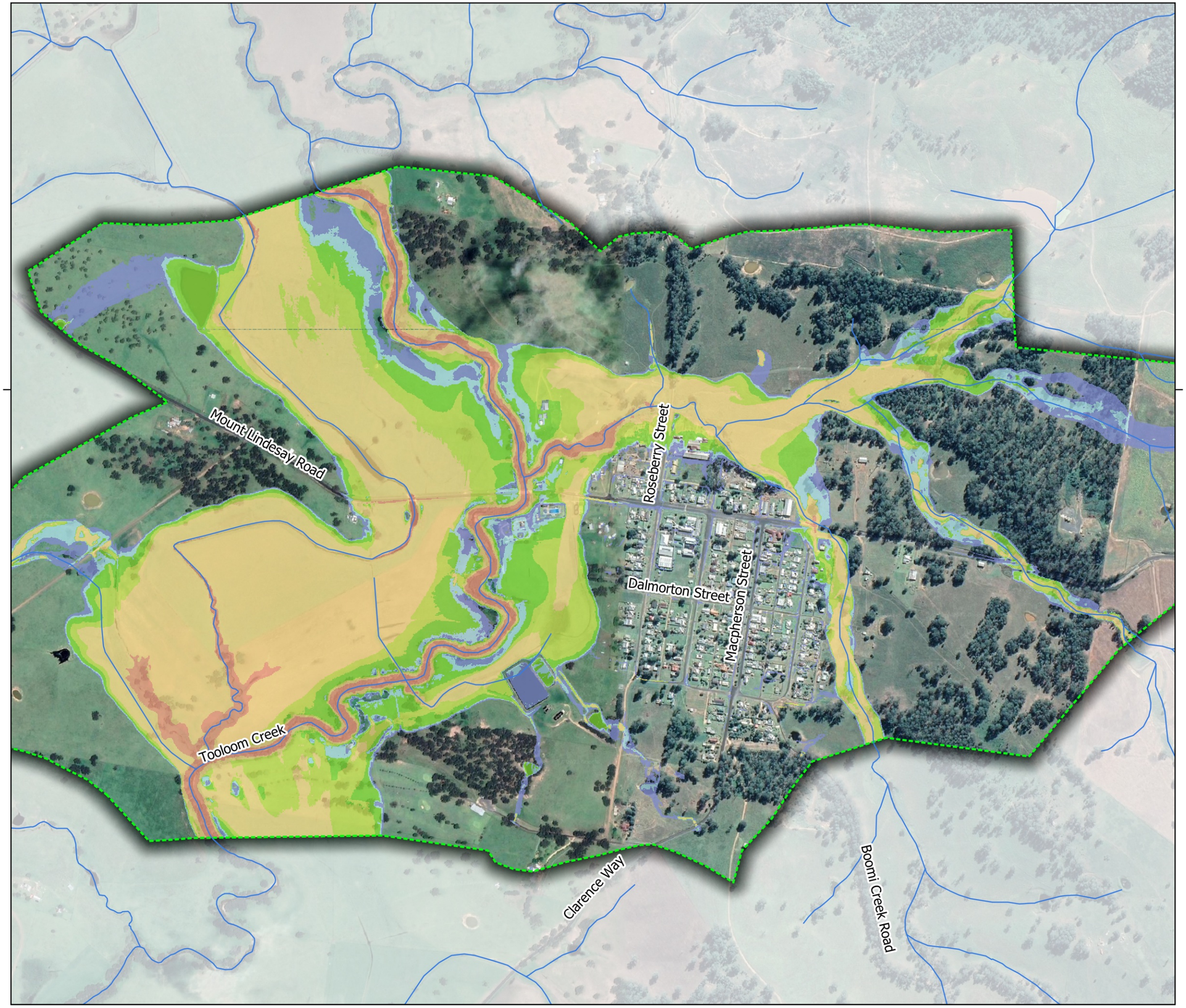
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 63
Tooloom Creek - Maximum Flood Hazard (Provisional)
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 63: 0.2% AEP event - Tooloom Creek - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

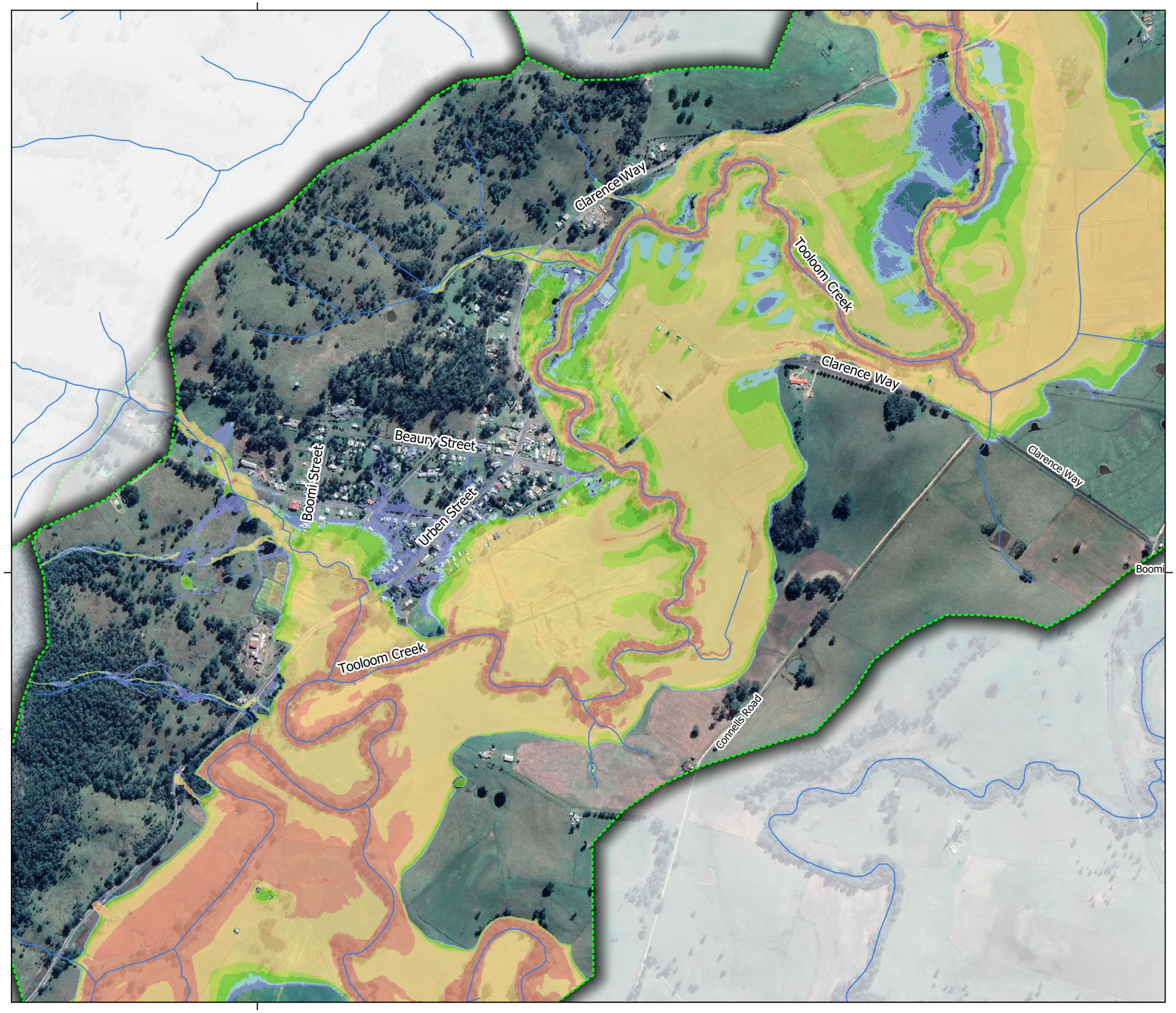
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 64
Woodenbong - Maximum Flood Hazard (Provisional)
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 64: 0.2% AEP event - Woodenbong - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

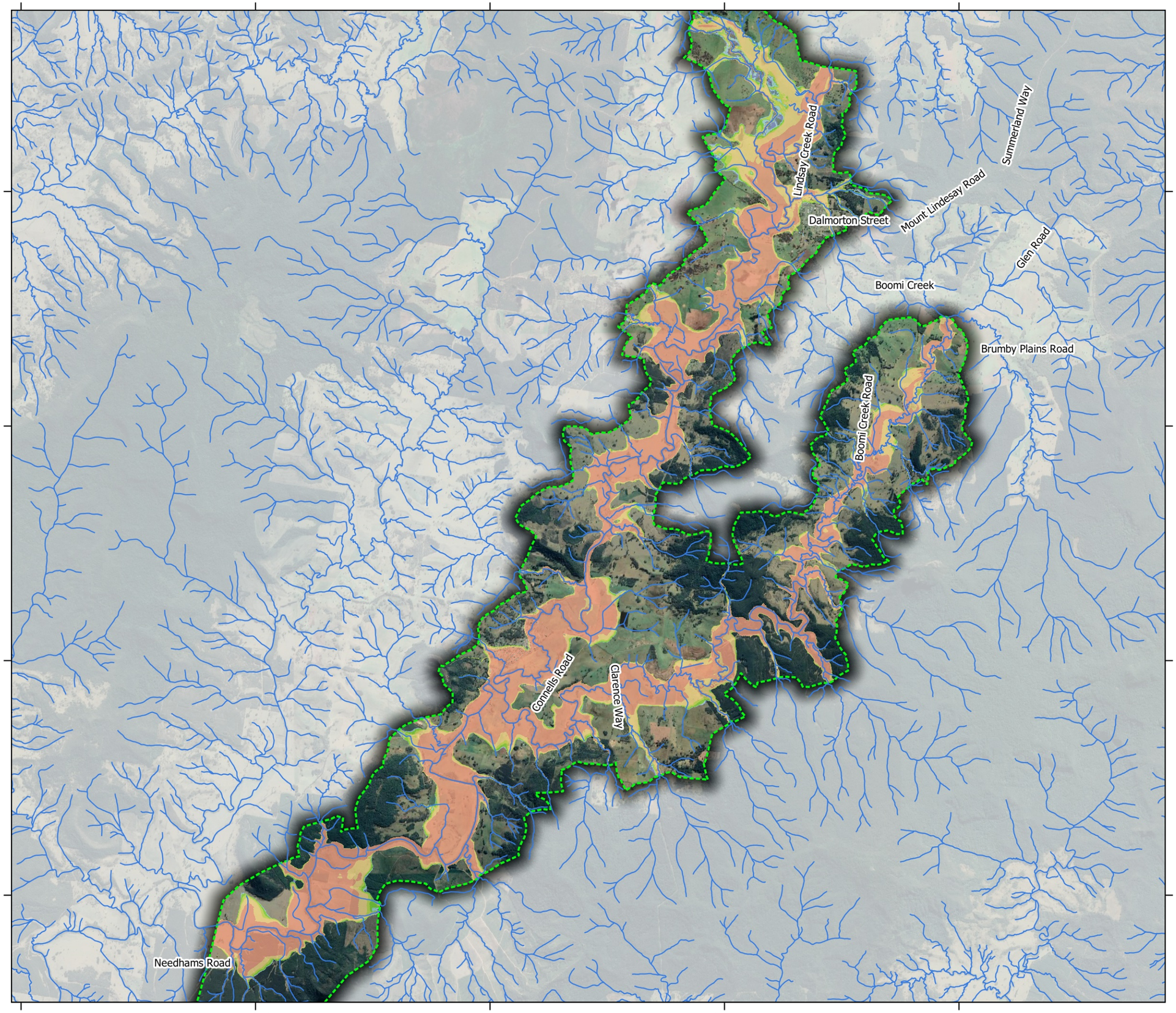
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 65
Urbenville - Maximum Flood Hazard (Provisional)
0.2% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 65: 0.2% AEP event - Urbenville - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

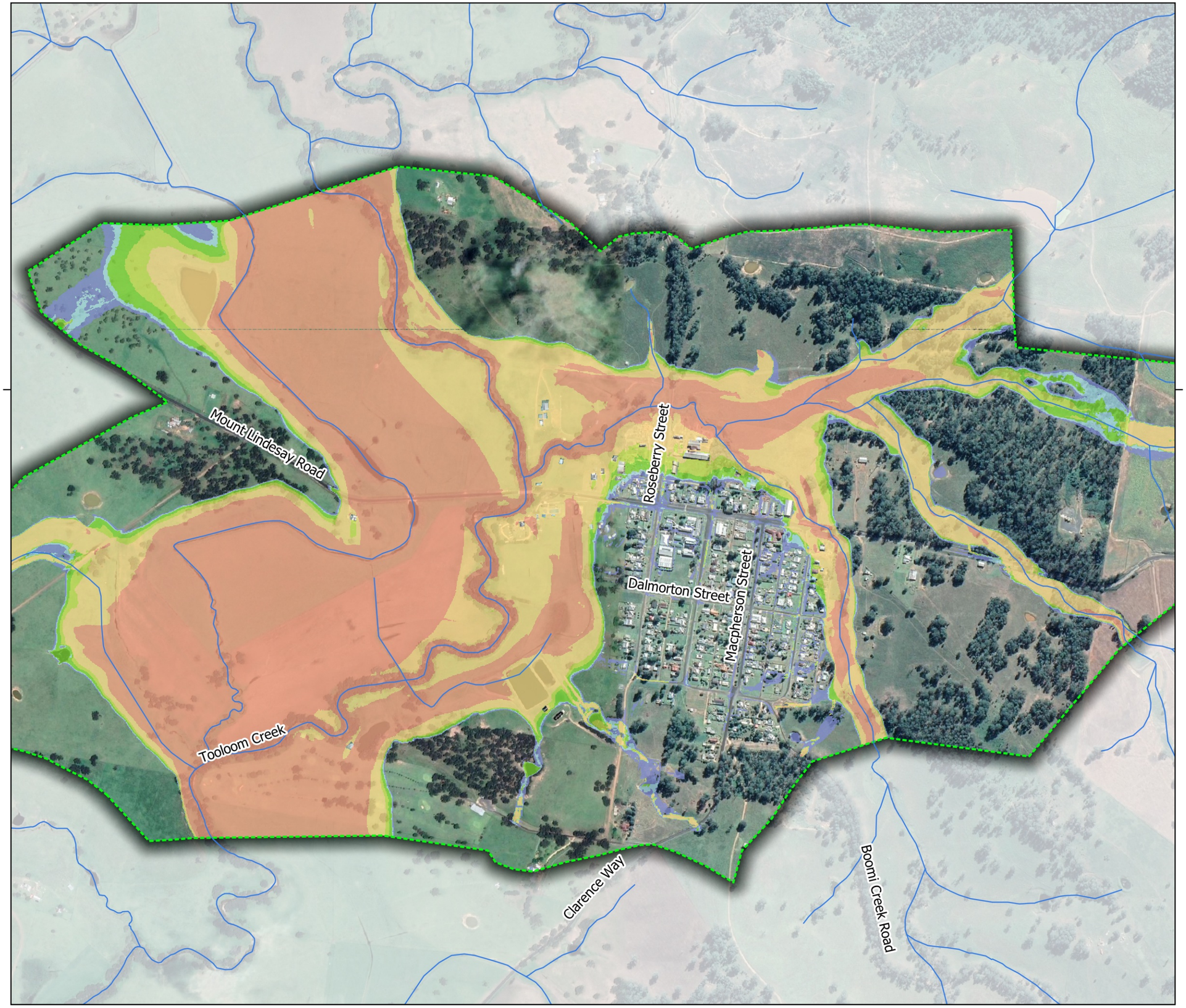
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 66
Tooloom Creek - Maximum Flood Hazard (Provisional)
PMF event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 66: PMF event - Tooloom Creek - Maximum Flood Hazard (Provisional)



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

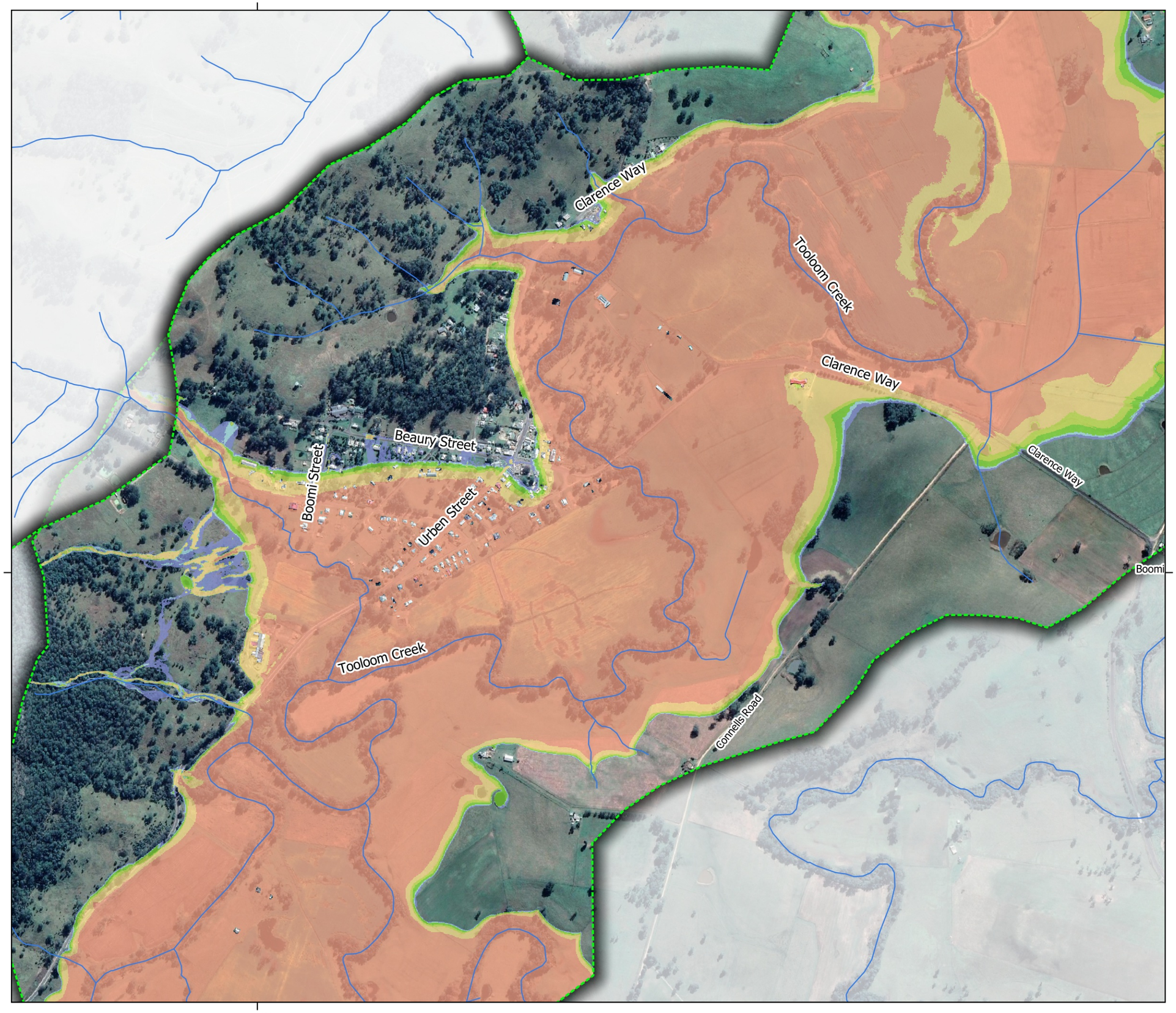
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 67
Woodenbong - Maximum Flood Hazard (Provisional)
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 67: PMF event - Woodenbong - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Hazard classification

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles
- H3: Unsafe for vehicles, children and the elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage.
- H6: Unsafe for vehicles and people.

All building types considered vulnerable to failure

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

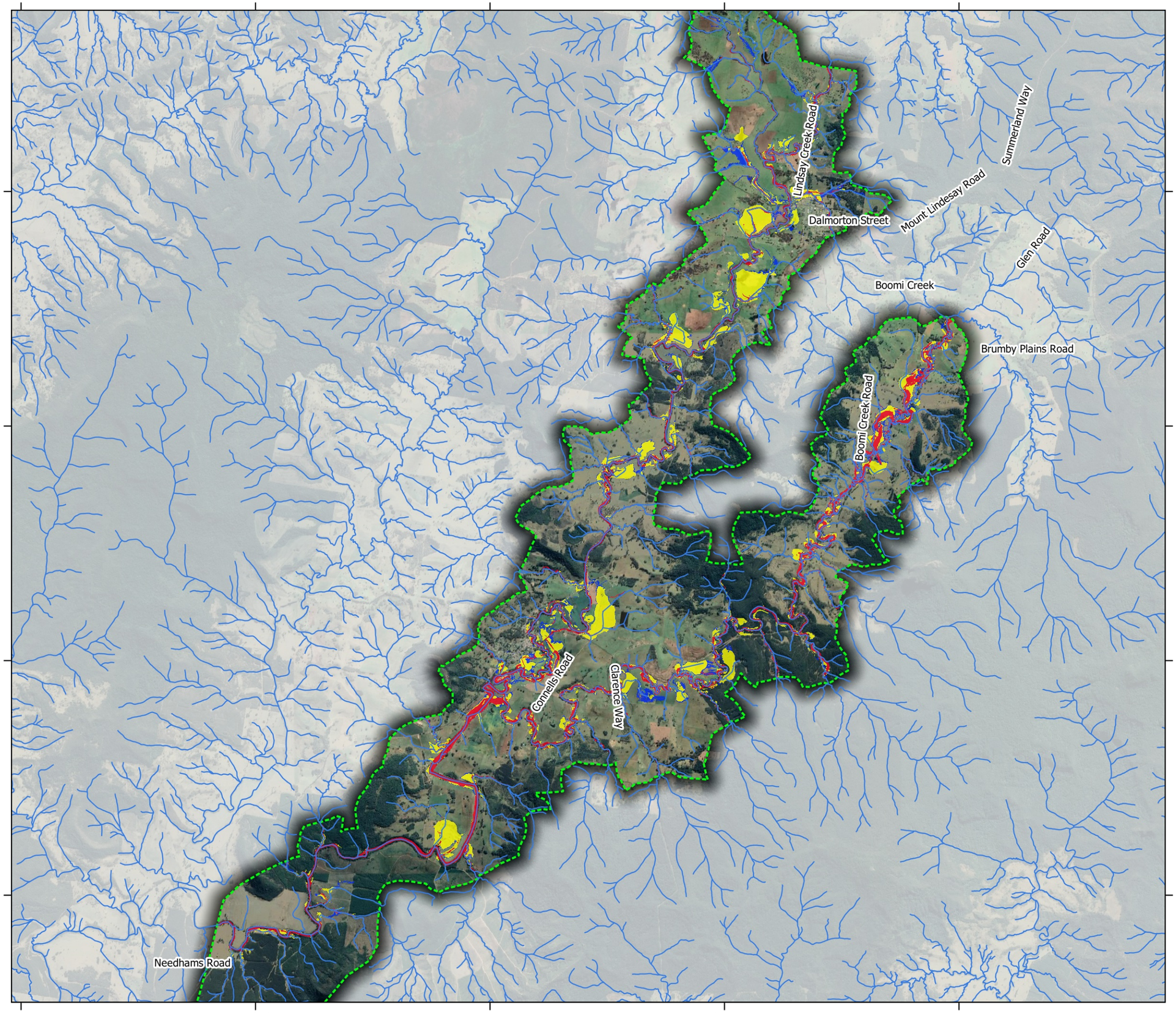
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 68
Urbenville - Maximum Flood Hazard (Provisional)
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 68: PMF event - Urbenville - Maximum Flood Hazard (Provisional)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

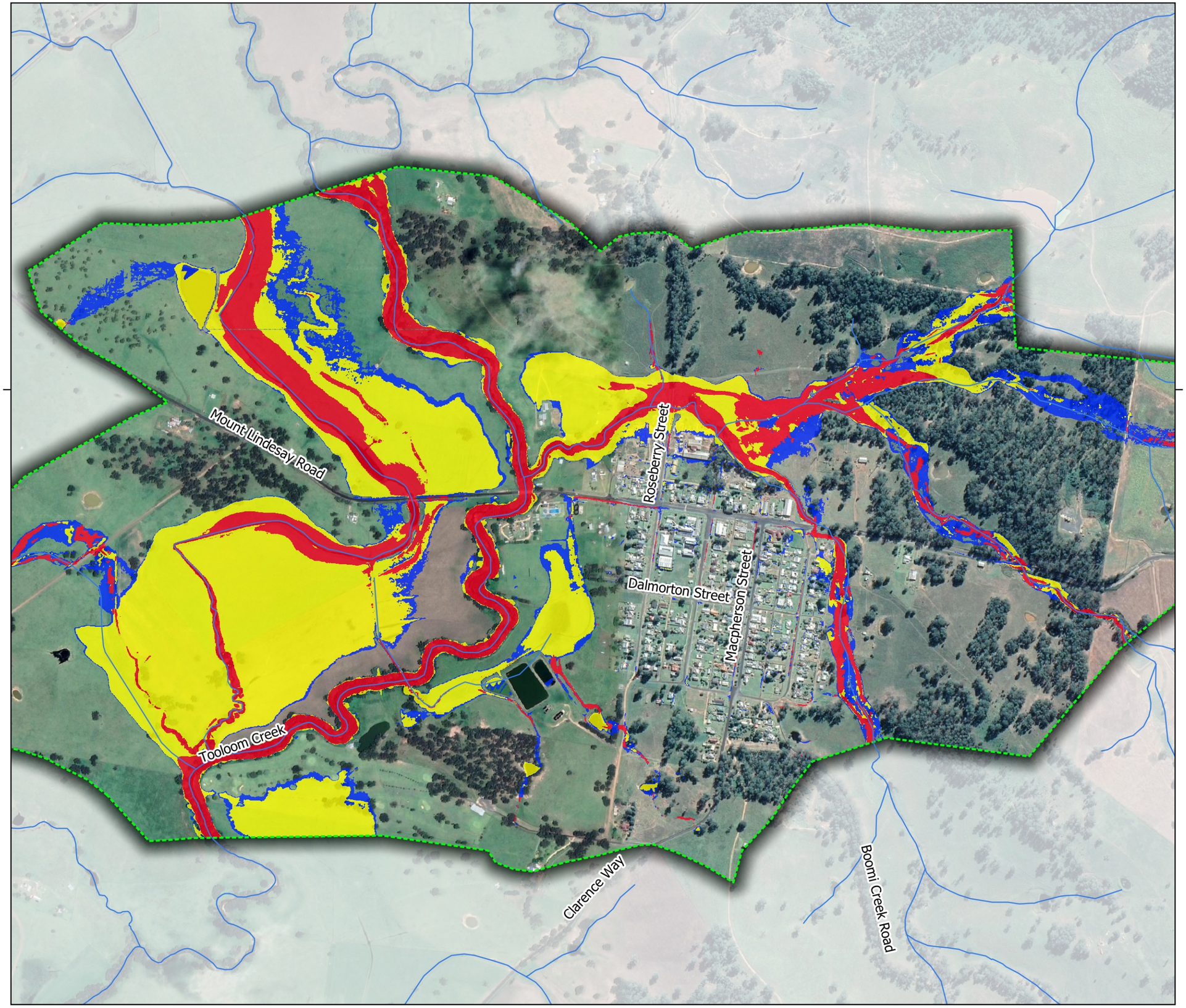
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 69
Tooloom Creek - Flood Function (Preliminary)
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 69: 20% AEP event - Tooloom Creek - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function
- Flood Fringe
- Flood Storage
- Floodway

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

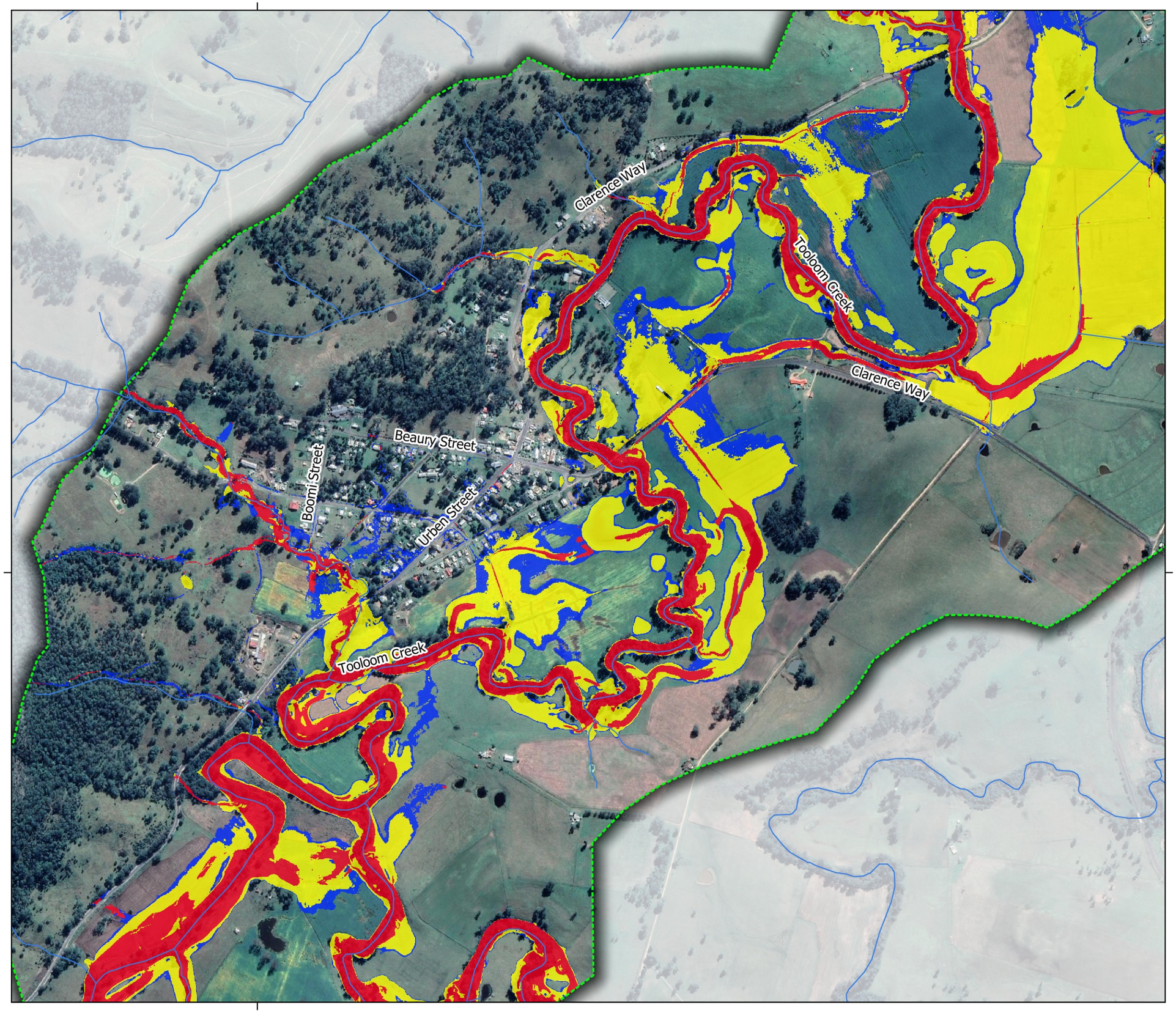
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 70
Woodenbong - Flood Function (Preliminary)
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 70: 20% AEP event - Woodenbong - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 71
Urbenville - Flood Function (Preliminary)
20% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 71: 20% AEP event - Urbenville - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps

Summerland Way
Lindsay Creek Road
Mount Lindesay Road
Dalmorton Street
Glen Road
Boomi Creek
Brumby Plains Road
Boomi Creek Road
Connells Road
Clarence Way
Needhams Road

6860000
6855000
6850000
6845000

445000
450000
455000
460000
465000

Legend

Flood Model Extent
Waterways

Flood function
Flood Fringe
Flood Storage
Floodway

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

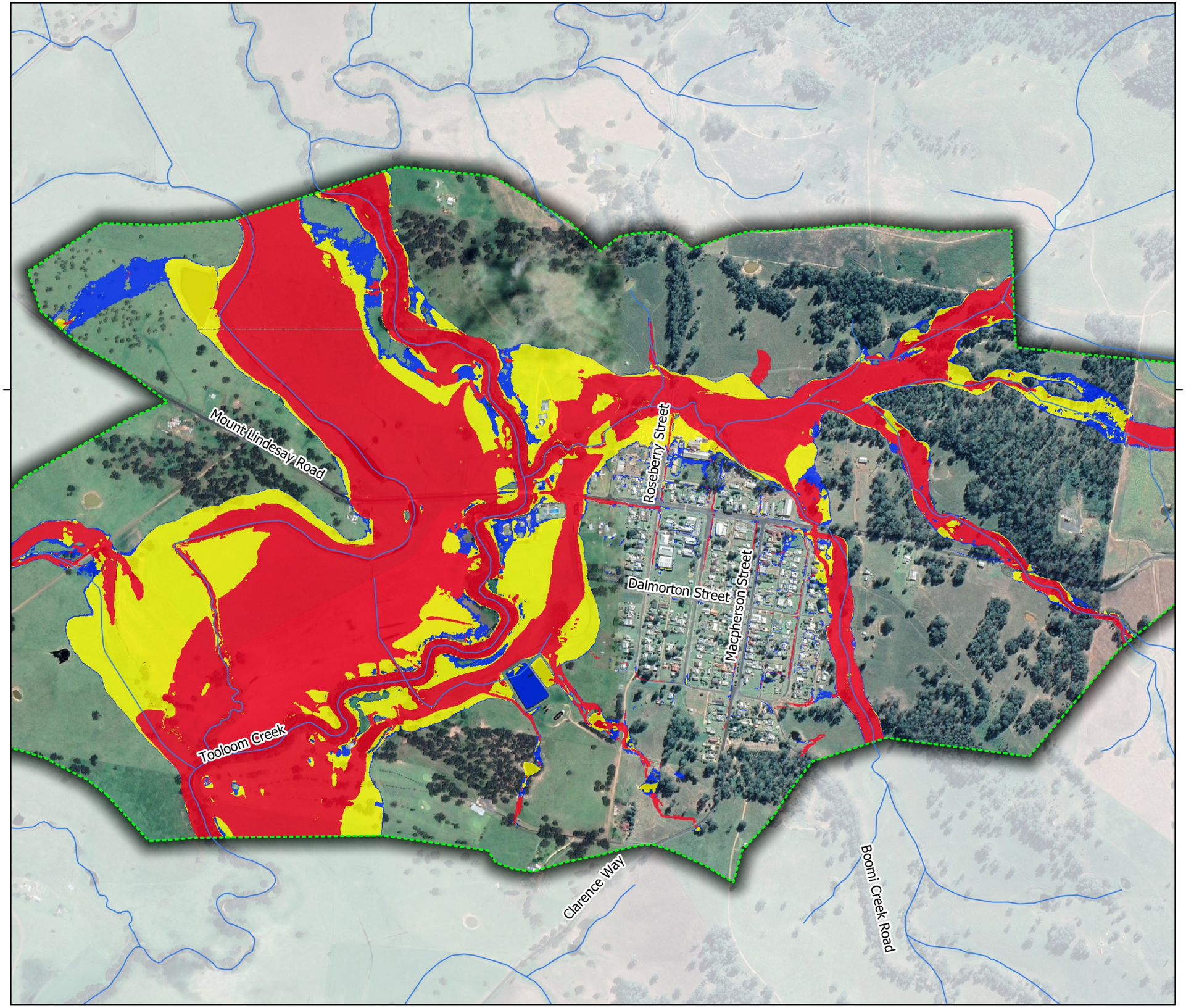
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 72
Tooloom Creek - Flood Function (Preliminary)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 72: 1% AEP event - Tooloom Creek - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

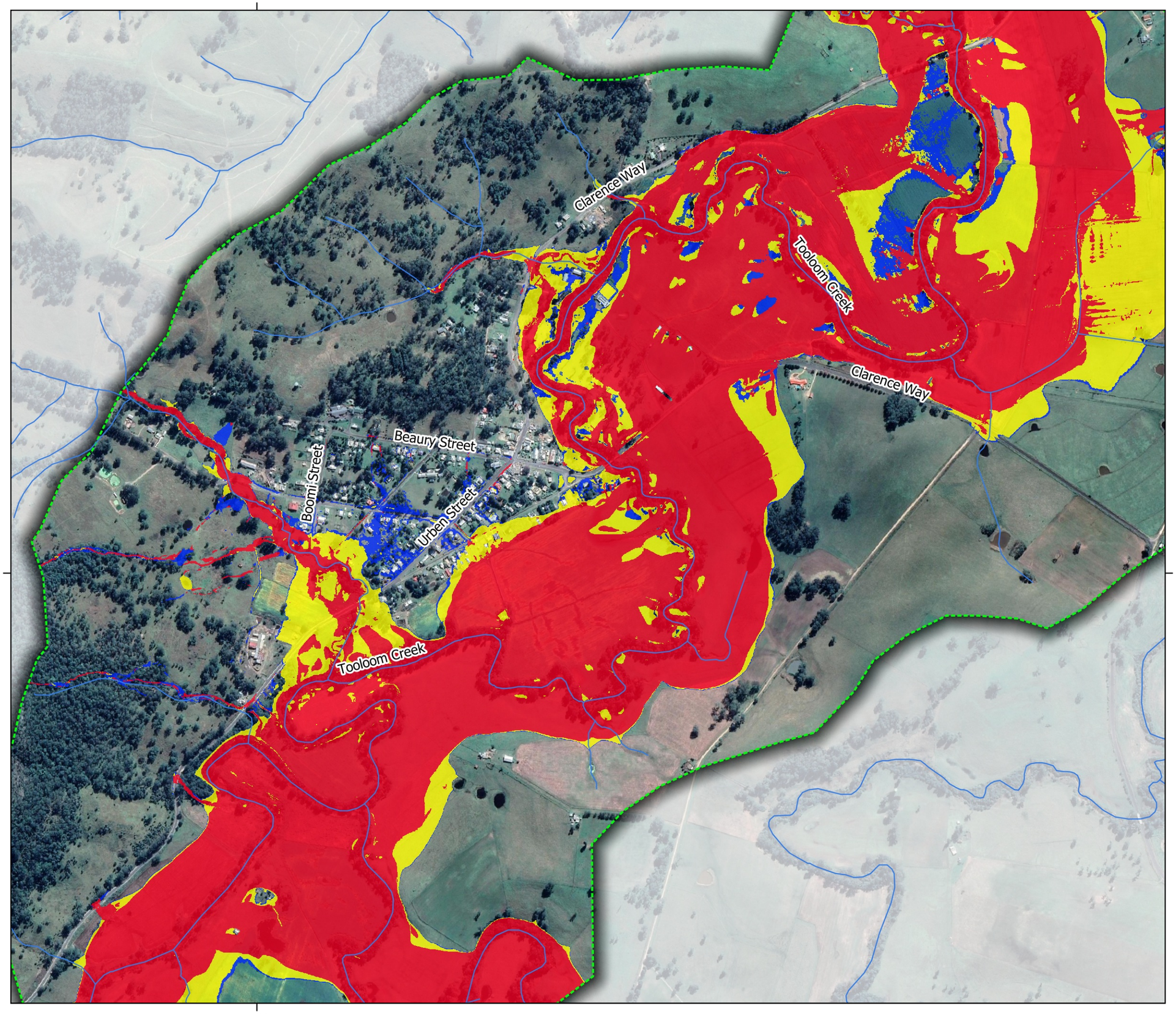
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 73
Woodenbong - Flood Function (Preliminary)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 73: 1% AEP event - Woodenbong - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

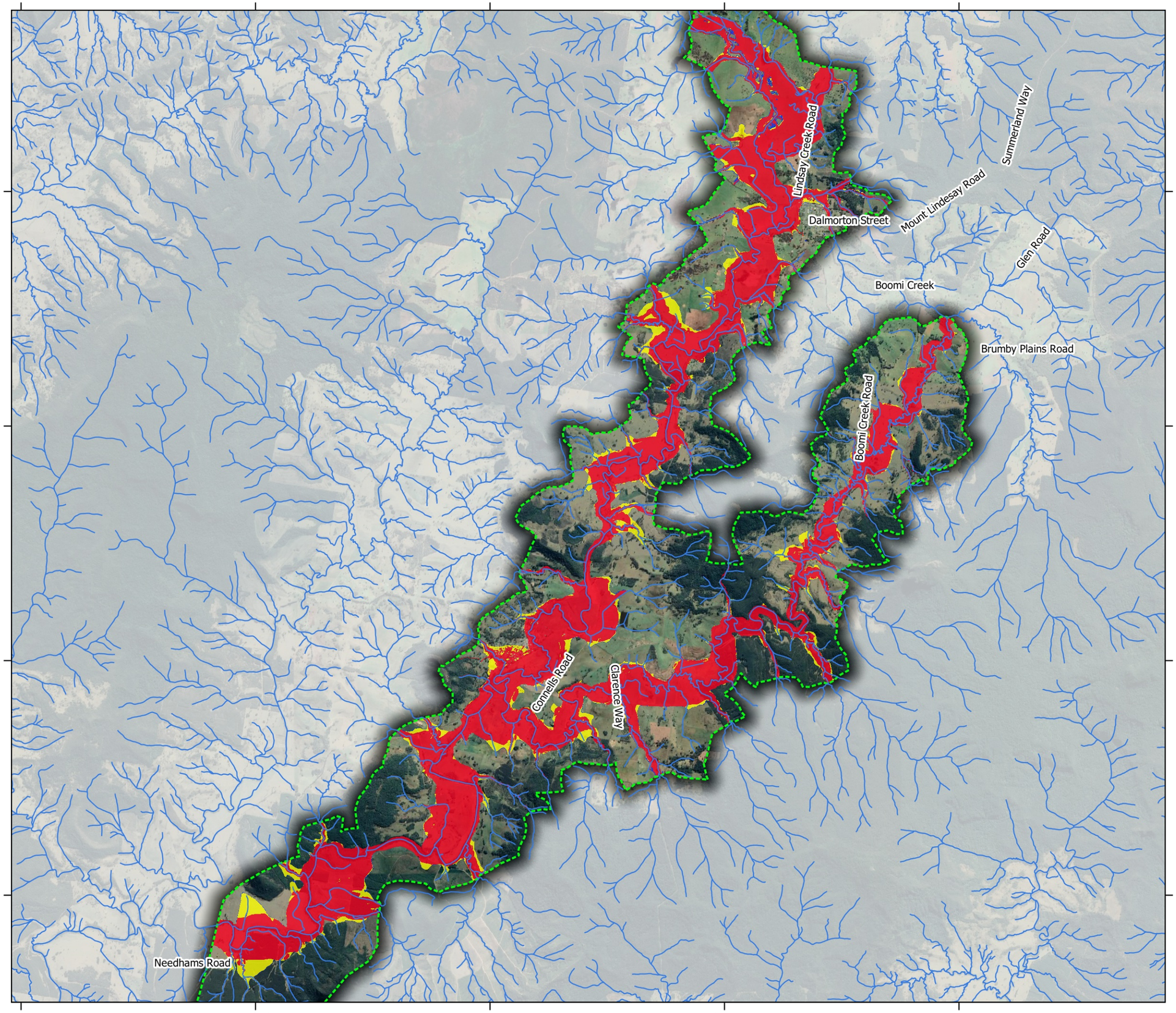
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 74
Urbenville - Flood Function (Preliminary)
1% AEP event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 74: 1% AEP event - Urbenville - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 1 2 3 4 km

SCALE 1:80,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

BG&E

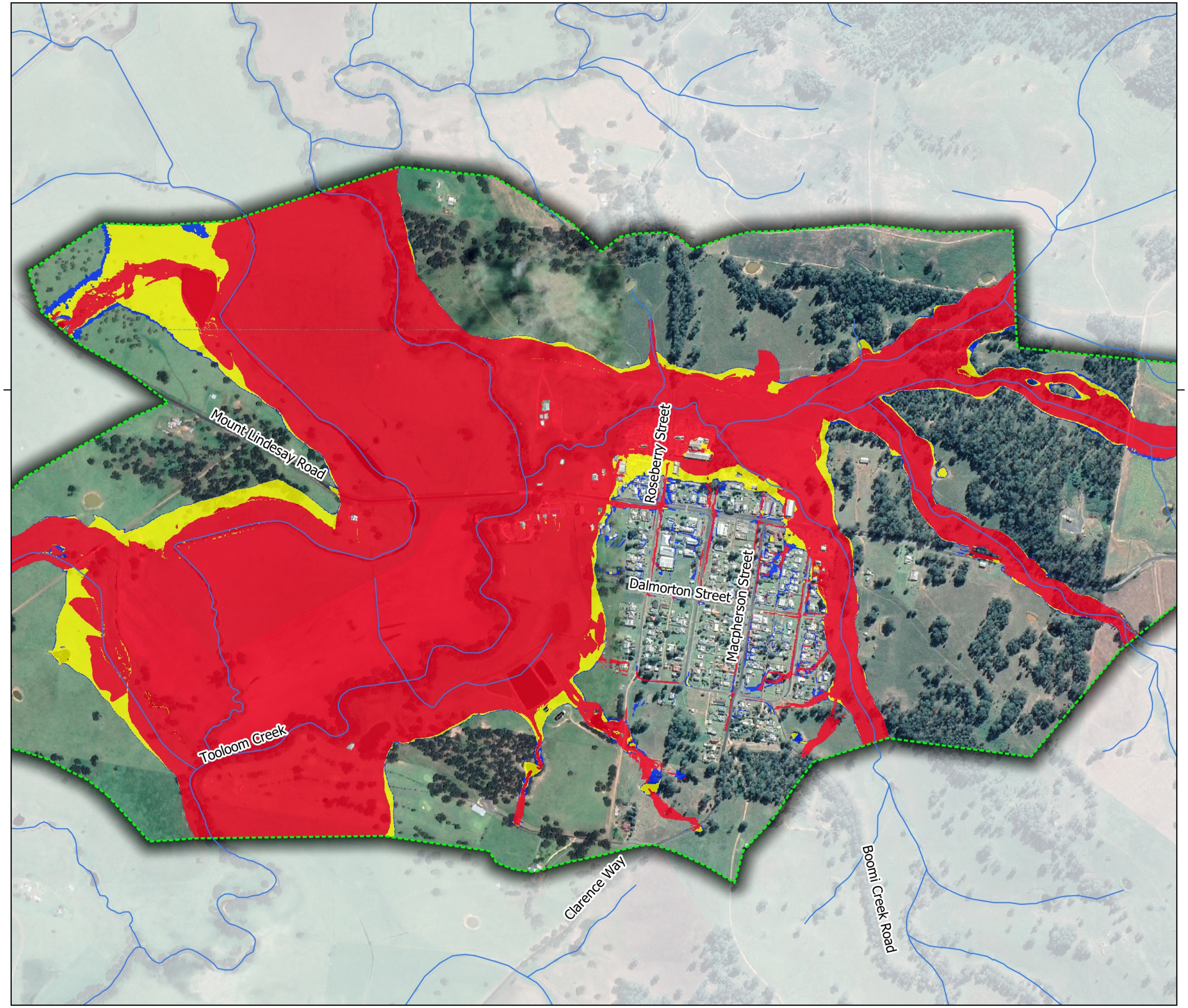
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 75
Tooloom Creek - Flood Function (Preliminary)
PMF event

DATUM GDA2020 / MGA Zone 56

Aerial Imagery Source: SIXmaps

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 75: PMF event - Tooloom Creek - Flood Function (Preliminary)



Legend

Flood Model Extent
Waterways

Flood function
Flood Fringe
Flood Storage
Floodway

0 200 400 600 m

SCALE 1:10,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

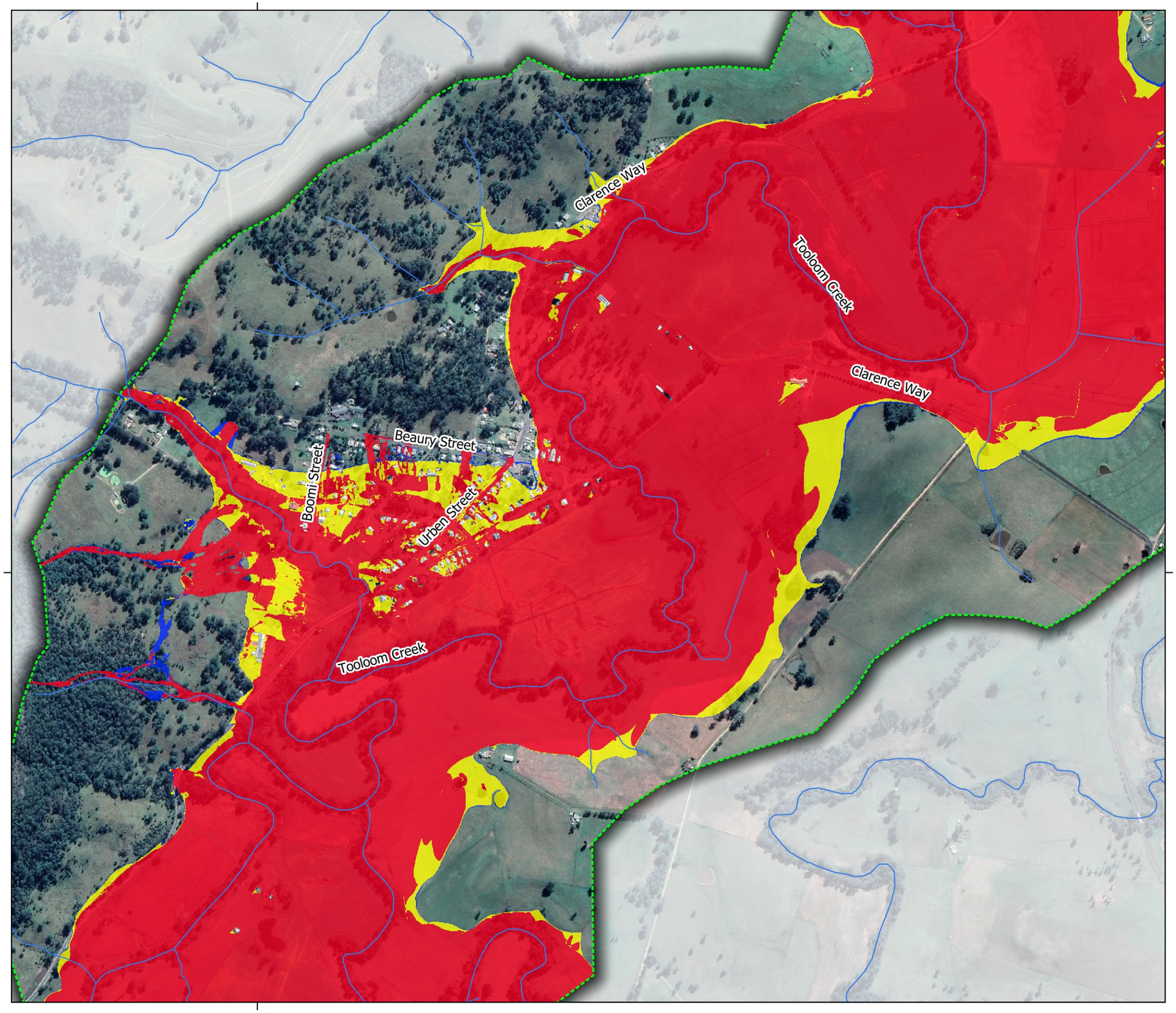
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 76
Woodenbong - Flood Function (Preliminary)
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 76: PMF event - Woodenbong - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- Waterways

Flood function

- Flood Fringe
- Flood Storage
- Floodway

0 200 400 600 m

SCALE 1:11,000

DRAWN: AS
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure B 77
Urbenville - Flood Function (Preliminary)
PMF event

DATUM GDA2020 / MGA Zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_V6.qgz \ Figure B 77: PMF event - Urbenville - Flood Function (Preliminary)

Aerial Imagery Source: SIXmaps

APPENDIX C

ADDITIONAL MAPPING AND OUTPUTS

Legend

- Flood Model Extent
- 5% AEP Event Flood Extent
- PMF Flood Extent

Flood Emergency Response Classification

- Area with Overland Escape Route
- High Flood Island
- High Trapped Perimeter Area
- Low Flood Island
- Rising Road Access Area
- Indirectly Affected Area

0 200 400 600 m

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

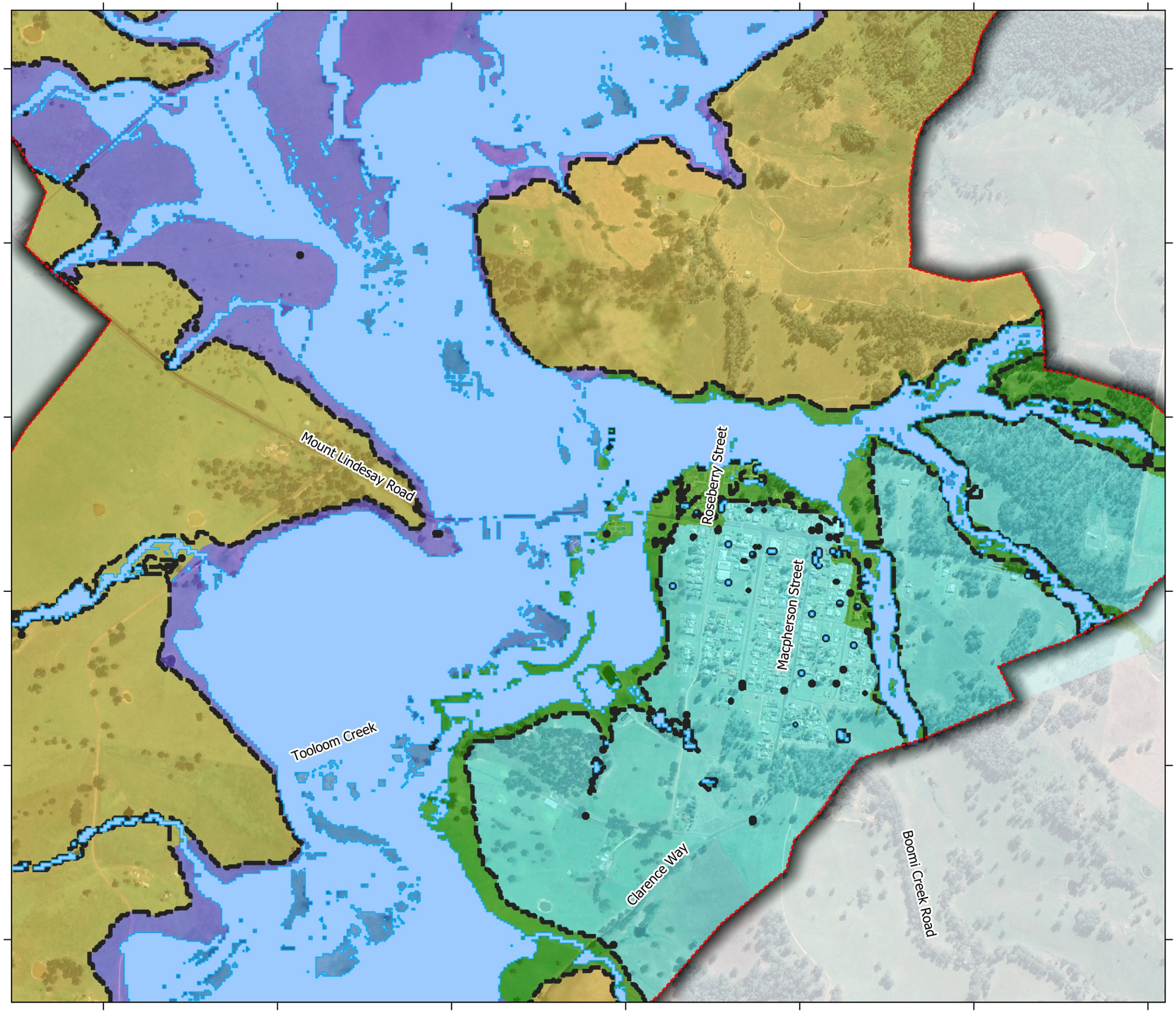
DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure C 1 – Urbenville Flood Emergency Response Classification of Communities

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps



Legend

- Flood Model Extent
- 5% AEP Event Flood Extent
- PMF Flood Extent

Flood Emergency Response Classification

- Area with Overland Escape Route
- High Flood Island
- High Trapped Perimeter Area
- Low Flood Island
- Rising Road Access Area
- Indirectly Affected Area

0 200 400 600 m

DRAWN: SM
REVIEWED: SM
APPROVED: LB

N

DATE: 09/02/2022
PROJECT: Urbenville and Woodenbong Flood Study
CLIENT: Tenterfield and Kyogle Council

Figure C 2 – Woodenbong Flood Emergency Response Classification of Communities

DATUM GDA2020 / MGA zone 56

P:\BGE\SYD\S20128\100 Draw\QGIS\Mapping_Appendix_A_C.qgz \ [% "QGISTheme"%]

Aerial Imagery Source: SIXmaps

APPENDIX D

COMMUNITY CONSULTATION

- Summary of Questionnaire Responses
- Community Newsletter and Questionnaire – October 2020

DISCUSSION PAPER

Community Consultation Summary - Urbenville

Project:	S20128 – Urbenville Flood Study
Prepared for:	Tenterfield Shire Council
Date and Rev:	11/12/2020 – Issue for Information
Prepared by:	Thomas Sigley
Reviewed:	Laura Baxter

1 INTRODUCTION

Effective community consultation and participation, through valuing the experiences and opinions of the community can improve the collaboration between Council and the community enabling the achievement of project outcomes that are satisfactory to all stakeholders.

Community Consultation is ongoing throughout the Flood Study project. The purpose of this Summary Paper is to summarise the consultation undertaken to date and how the findings will be incorporated into the Flood Study. This Summary Paper will be updated at key stages during the project following community consultation phases.

2 COMMUNITY CONSULTATION PROGRAM

The Community Consultation Program involves:

- **Project Website** - A project website is being hosted at https://www.bgeeng.com/floodstudies/urbenville for the duration of the project. This provides the community with updates on the study progress, links to the community questionnaire and contacts to provide information and feedback.
- **Community Newsletter** – a newsletter was mailed to 215 property owners in September 2020. A copy is included as Appendix A. The newsletter informed of the objectives of the Urbenville Flood Study and highlighted the study area. Tenterfield Council also posted notices on their website to link to the community newsletter and project website at https://www.tenterfield.nsw.gov.au/urbenville-and-woodenbong-flood-study
- **Questionnaire** – a questionnaire accompanied the newsletter in September 2020 (copy provided in Appendix A). Residents were given until 31 October 2020 to respond. A copy of the questionnaire was also made available online. The findings of the questionnaire are useful to understand the community's experiences of past flooding, the level of flood awareness, highlight areas for flood mitigation and allow residents to provide flood information for use in calibration of the flood models. A project email address was also created to allow people to email photographs and addition information.

- **Community Information Sessions** – two information sessions are planned. At each session community input will be invited through on the day questions and answers or feedback forms and via the project website.
  - Due to the restrictions of COVID the first will be undertaken online if required. The first session will describe the preliminary findings of and seek feedback on the flood modelling undertaken. It will also present how the results of the community questionnaire and other community feedback are being taken into account in the study.
  - A second community consultation will be undertaken during the public presentation of the Draft Flood Study at start of the Public Exhibition period. This will present further additional information such as flood hazard and emergency classification of communities.
- **Public Exhibition** – the Flood Study will be placed on public exhibition for a period of at least 28 days to invite community feedback before Council adoption.

3 QUESTIONNAIRE FINDINGS

The questionnaire was mailed to property owners in and around the study area. A total number of 215 newsletters and questionnaires were mailed out. The purpose of the community questionnaire was to:

- Understand the level of flood affection and the numbers of people who have experienced flooding;
- Encourage the community to provide information about historic flooding which can be used in flood model calibration and understanding flood behaviour;
- Highlight areas where the community thinks flooding is a concern and requires management;
- Identify the level of flood awareness and the community perceptions on acceptable frequency of flooding.

3.1 Response Rate

A total of 2 responses were received online and 20 by mail. The total number of responses was 22 which equates to a 10.2% response rate. This was considered to be a reasonable response rate, given the size of Urbenville and the number of residents who reside there. Response rates to surveys such as this tend to be more skewed to those who have experienced or are concerned with flooding.

Two respondents requested to be contacted for further information. BG&E spoke to each resident and they provided some information over the telephone. They were also invited to send through additional information by email. At the time of collating community questionnaire findings and compiling this report, additional information from one of respondents had been received in the form of photos. An additional resident, who did not answer the questionnaire, also sent through photos of flooding in Urbenville. Photos can be found in Appendix B.

3.1.1 Who Responded?

Identifying where respondents live can indicate where flooding is of a greater concern to residents. Typically, those in more flood prone areas are more likely to respond and provide feedback. Understanding how long residents have resided in the area can also be beneficial in determining a level of flood awareness in relation to the community i.e. the longer a resident has lived in the area, the more likely they might have experienced flooding.

3.1.2 Property Classification

Figure 1 identifies the residence classification of respondents. 82% of responses received were from residential properties or a residence classified as 'home'. Responses to this question outline that it is home owners or occupiers who may tend to feel more affected by flooding issues than non-residential owners or occupiers. However, results may be skewed, due to a larger tendency for home owners or occupiers to respond to the questionnaire. Of the 3 respondents who indicated 'other', 2 classified the property as both a workplace and home. The remaining response came from Urbenville and District Bowling Club.

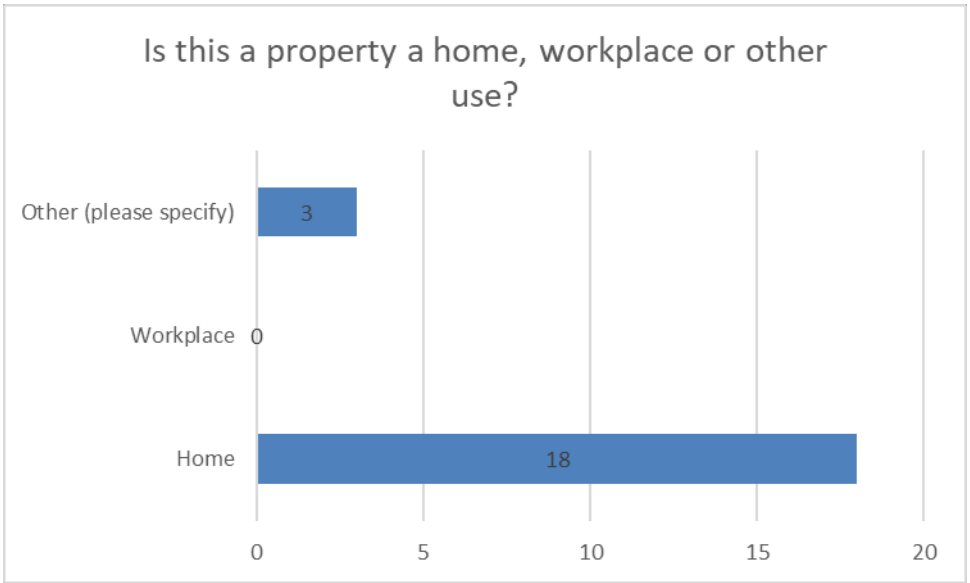


Figure 1: Classification of Residence.

3.1.3 How Long Have Respondents Lived in the Area

Figure 2 presents the period of time during which respondents have lived or worked in the area or at their residence. 23% of respondents had recently moved into the area within the last 5 years, with this group least likely to be aware of the existing flood risks or be aware if their property or workplace could be subject to inundation. 36% of respondents had resided in the area for more than 25 years, with 4 of these residing for longer than 35 years. This group are most likely to have experienced flooding in the area; however the only flood event identified by residents living in the area for over 25 years was the 1990 flood event.

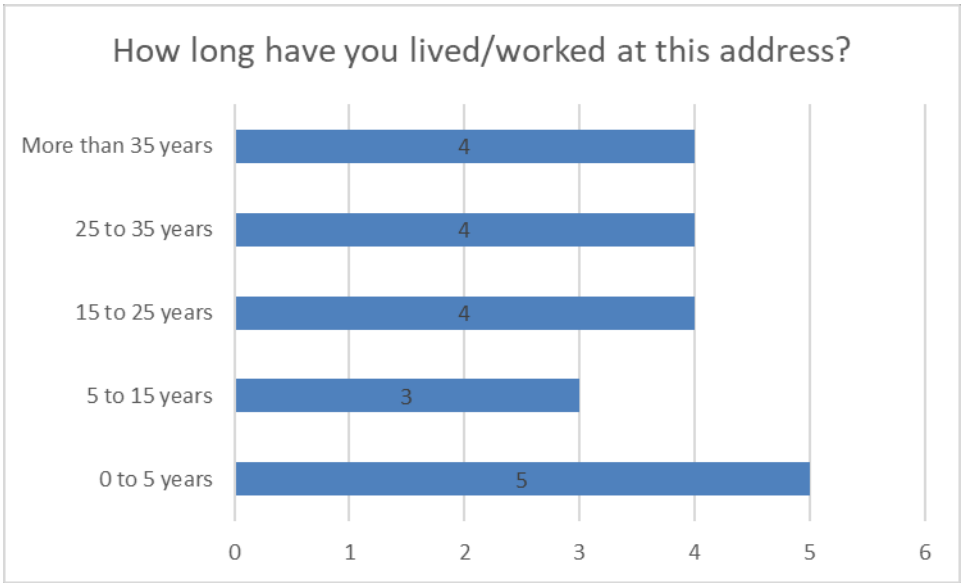


Figure 2: Period of Time Respondents Have Lived in the Area.

3.2 Flood Awareness

Understanding the community's awareness of flood risk and their response allows for targeted flood awareness campaigns and can assist in flood emergency response planning.

3.2.1 Personal Property

The questionnaire asked respondents if they were aware if their property was flood affected and if it had flooded before. This type of question can often be skewed more towards a positive 'yes' response, as respondents who may respond are typically within flood prone areas or have been affected by flooding previously. People who have not experienced flood at their property have a greater tendency to not provide a response, as they feel the issue has not or will not affect them.

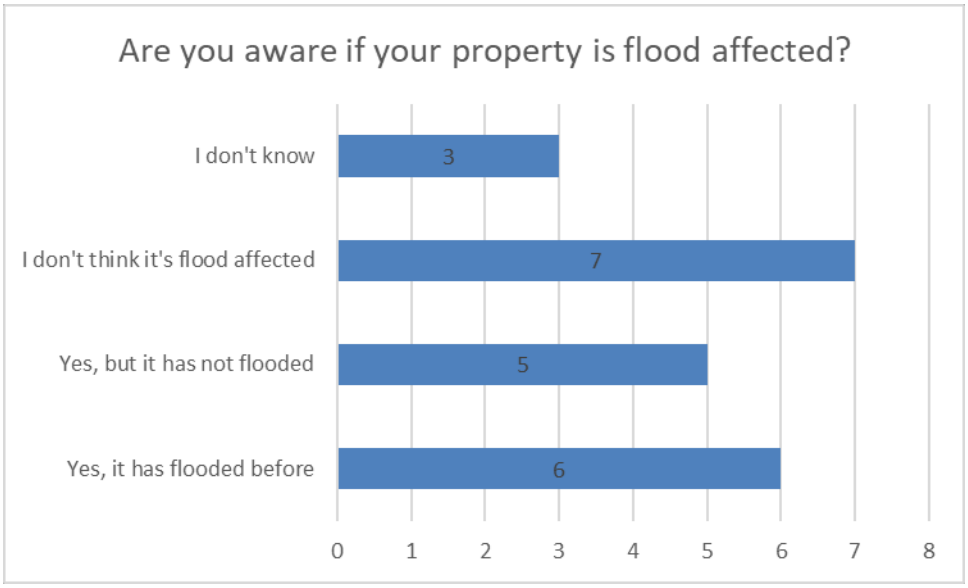


Figure 3: Number of Respondents Affected by Flooding

Figure 3 highlights that almost one third of respondents (32%) did not think their property was flood affected, suggesting that they had not experienced a flood at their residence. 27% of respondents nominated that

their property was flood affected and that it had flooded before, with a further 23% acknowledging that their property was flood affected but had not flooded before.

Of the 6 respondents who elected that their property was flood affected and had flooded before, 5 of these also recalled having to evacuate their residence at some time.

Results relating to flooding experiences, particularly isolation and/or evacuation are presented in Section 3.3.1 below.

3.2.2 Responding to Flooding

Questions asked were aimed to understand the level of flood awareness of the community in terms of emergency response behaviour. Respondents were asked outline if they believed they would know what to do in the event of a flood.

Figure 4 highlights that the majority of people believe they are flood aware. 64% of respondents believed they would know what to do in the event of a flood and a further 27% indicated they 'think' they would know what to do.

Only 1 respondent indicated that they 'would not' know what to do if there was a flood. 1 respondent also did not provide an answer to this question.

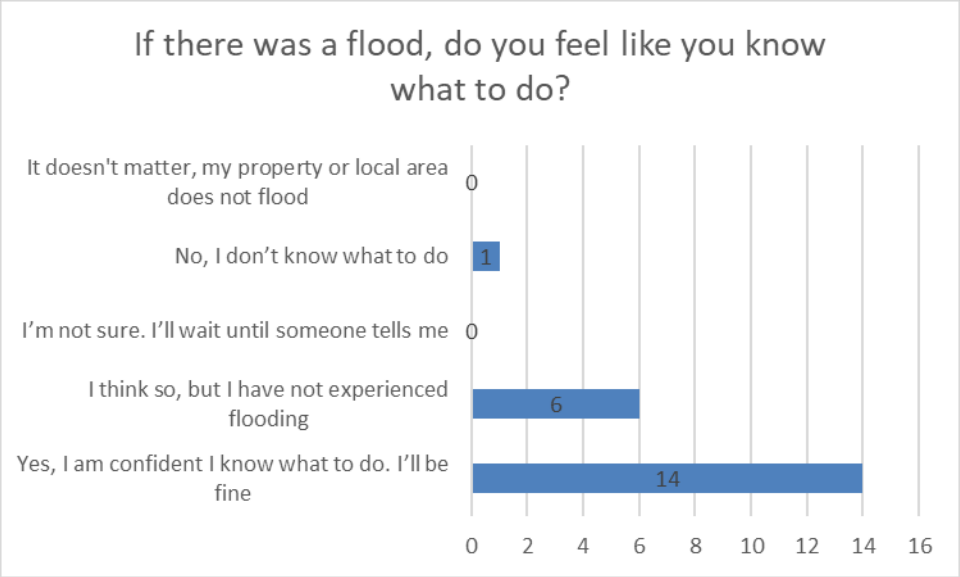


Figure 4: Flood Awareness of Respondents

Although the results indicated a high awareness to act during a flood (91%) this question can be skewed as those who are aware, or are more interested in flooding may be more likely to respond. Similarly of the 14 respondents (64%) who believed they would know what to do in the event of a flood, only 5 had experienced a flood at their property. Additionally, a further 4 respondents (out of the 14) nominated that they did not think' their property was flood affected.

The results may point to a false sense of flood security particularly for those residents who have not experienced flooding but think that they were confident they would know what to do. This highlights the importance of the community consultation through the Flood Study program but also the importance of continued flood awareness and community flood education undertaken by Tenterfield Council and the NSW SES.

While people may believe they know what to do to respond to flooding, based on one or more experiences, the most commonly experienced flood events are typically not considered as rare or extreme events (to be confirmed through the Flood Study). Should a larger flood occur requiring a different response such as evacuation, people may believe that there is no need for evacuation based on their past experiences. This is

a challenge in flood emergency response management and the findings of the Flood Study will be able to assist in planning for and raising awareness of the community emergency response for larger floods.

3.3 Experience of Flooding

3.3.1 Evacuation and Isolation

Respondents were asked to outline if they had been evacuated or isolated during events of flooding. Again, this type of question can often be skewed more towards a positive 'yes' response, as respondents who may respond have typically been affected by flooding in some way.

Figure 5 highlights that half of respondents (50%) nominated that they (or other household members) had never been isolated or evacuated in the past due to flooding. The remaining 50% indicated that they (or other household members) had never experienced isolation or evacuation due to flooding.

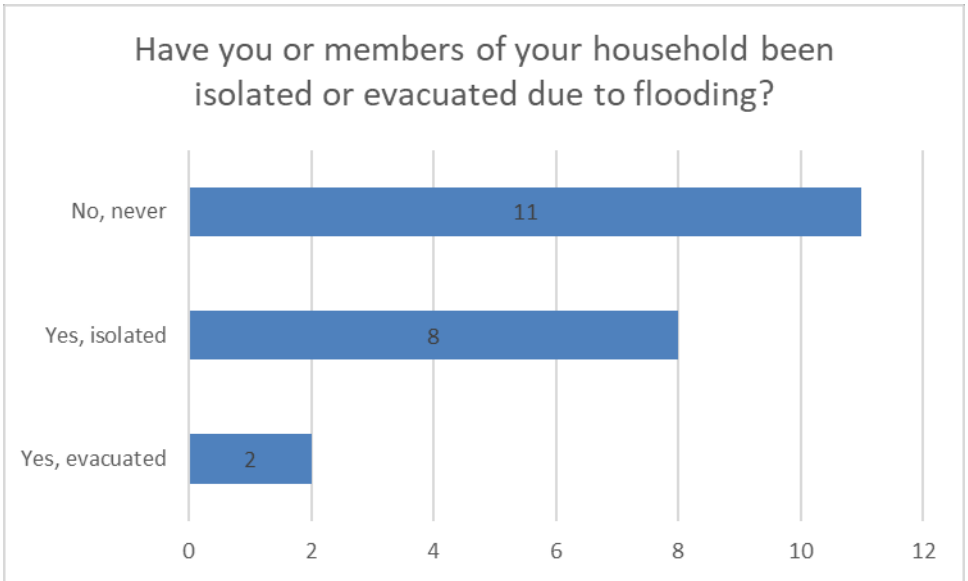


Figure 5: Number of Respondents who have been Isolated or Evacuated from their Household

Of the 8 people who reported having been isolated or evacuated , 4 of those reported believed flooding was caused from local stormwater infrastructure or smaller creeks.

3.3.2 Tooloom Creek

The questionnaire asked respondents to acknowledge if they had ever experienced flooding from Tooloom Creek. This question served to focus on areas subject to mainstream flooding from Tooloom only, rather than localised stormwater flooding and the response of existing council owned pit and pipe infrastructure.

Figure 6 shows that approximately one third of respondents (14) believed they had observed flooding from Tooloom Creek. Of the 14 people reported having observed flooding from Tooloom Creek, 5 people reported flooding from Tooloom Creek had directly affected their property. 2 of these 5 were located in the area around Forest Parkway, just off Clarence Way (heading to Woodenbong).

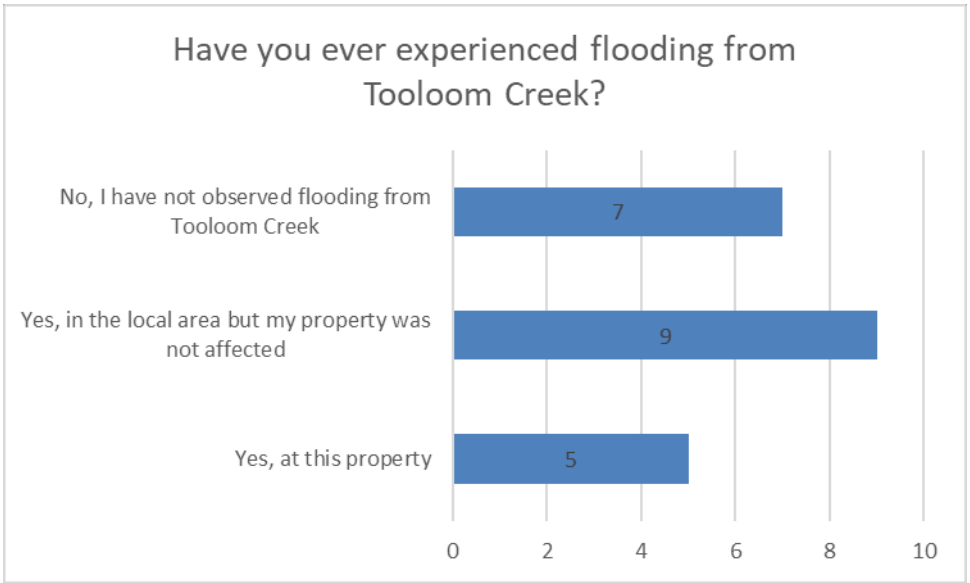


Figure 6: Number of Respondents who have experienced flooding from Tooloom Creek.

A higher proportion of 'Yes' responses relates to the geographic location of Tooloom Creek which flows adjacent to approximately 30 properties, mostly in the northern half of the town. Approximately 10 of these 30 properties back directly onto Tooloom Creek.

3.3.3 Other Sources of flooding

The questionnaire asked respondents to acknowledge if they had ever experienced flooding from stormwater of smaller creeks. This question served to focus on areas subject to localised flooding, unrelated to Tooloom Creek including smaller local creeks and local council-owned stormwater infrastructure such as channels, pits and culverts.

Figure 7 highlights that over half the respondents (12) had experienced flooding at their property from local catchments. The area at the lower end of Urben and Welch Street as well as the area around Forest Park were mentioned on 3 and 2 occasions respectively.

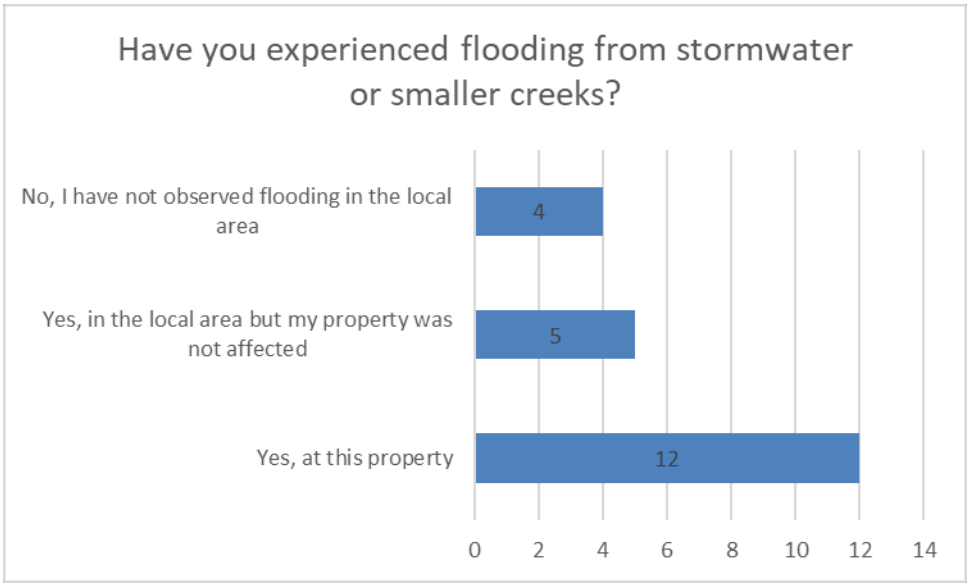


Figure 7: Number of Respondents who have Experienced Flooding from Stormwater or Smaller Creeks

3.3.4 Historic Flooding

Respondents were also asked to provide specific commentary on historic flooding events. Results are summarised in Table 1. These areas are also shown in the mapping in Appendix C.

Repeated flooding (at the same location) was evident for this response. Flooding occurred on separate occasions at the following locations:

- Tooloom Creek (at the back of the shops);
- Forest Park entry (adjacent Tooloom Creek); and
- Flooding of property (17752 Clarence Way) paddocks, just north of Forest Parkway.

All 3 areas, concentrated on an area of Tooloom Creek just upstream of Tooloom Creek Bridge (located on Clarence Way, heading to Bonalbo)

Table 1: Summary of Flood Events where Dates were Provided

Date/Year Observed	Number of Respondents	Comments
1990	1	• Tooloom Creek flooded at back of shops in 1990.
1999	1	• Tooloom Creek flooded at back of shops in 1999. Village cut off from town of Woodenbong
2006	1	• South eastern areas of Urbenville: Areas from bowling club through to lower flats as well as old timber saw mill
2008	1	• Residential Property- 17752 Clarence Way. Flooding breaks banks of creek line. 6 inches deep at the back of paddock in property. Comes about 1/8th of way up the paddock.
6th January 2008	1	• Flooding over the road at Forest Park entry on Clarence Way, adjacent to old sawmill and at bridge on way to Bonalbo.
16th February 2010	1	• Residential Property - 6 Urben Street. Flooding from kerb and gutter, flowing over driveway and running down the back. Depth gets to at least 5 inches. Refer Photograph 1 in Appendix B.
2011/12	1	• Residential Property - 17752 Clarence Way. Flooding breaks banks of creek line. 6 inches deep at the back of paddock in property. Comes about 1/8th of way up the paddock.
6th January 2013	1	• Flooding over the road at Forest Park entry on Clarence Way, adjacent to old sawmill and at bridge on way to Bonalbo.

3.4 Flood Mitigation

3.4.1 Flooding of Other Areas

To understand the local community's priorities for flood mitigation, the questionnaire asked respondents to acknowledge any other areas within the Urbenville Flood Study which they thought flooding should be reduced. This question sought to identify if there were potential priority or 'problem' areas.

Figure 8 highlights that 10 respondents (45%) believed that other areas within the Urbenville Flood Study were problem areas subject to flooding.

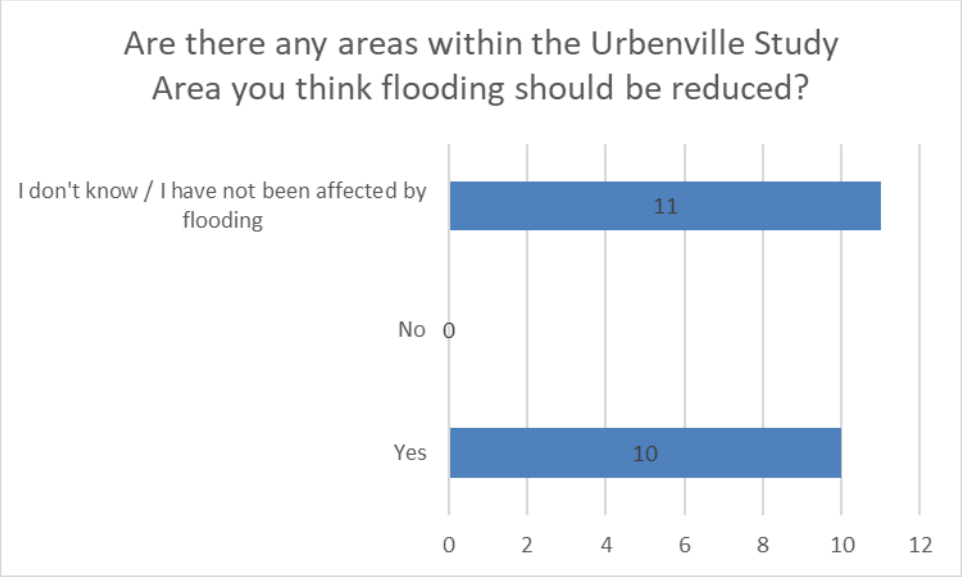


Figure 8: Number of Respondents Who Believed there are Other Problem Areas Where Flooding Should be Reduced

3.4.2 Priority Areas

Respondents identified a number of 'priority areas' where they noted flooding. These are summarised in Table 2. These areas are also mapped in Appendix C.

Table 2: 'Priority' Areas.

Street/Location	Number of Respondents	Comment
Corner of Welch Street and Stephen Street	1	• Residential Property - 6 Welch Street. Access to home is blocked due to flooding, does not need to be flooding rain to do so. • Inadequate/blocked storm water drainage on corner of Welch/Stephen Street and excess runoff down Welch Street.
Tooloom Creek Bridge (Clarence Way on way to Bonalbo)	1	• Tooloom Creek Bridge floods at times (when receiving heavy or flooding rain)
Urbenville Showground/Bowling Club/Forest Park	3	• Showground area becomes isolated during flooding • Water over road at Forest Park turnoff • Road blocked on Clarence Street at Showground • Every flood that affects Urbenville affects the Bowling Club as Tooloom Creek floods and borders the Bowling Club premises and greens.
Clarence Way	5	• Clarence Way (heading to Woodenbong) can get cut off • Gully near Forest park which crosses under Clarence Way

Street/Location	Number of Respondents	Comment
Tooloom Creek	3	• Tooloom Creek flooded at back of shops in 1990 and 1999. Village Cut off from Woodenbong. • Wet seasons will see Tooloom Creek flood and cut off exit roads from Urbenville
Tooloom Street	3	• Residential Property - 25 Tooloom Street. Flood came part-way upstairs, washed away gardens and decking and damaged property under house (didn't reach door level). Occurred twice in 5 to 15 year period. • People owning houses on lower side of Tooloom Street are in flood areas.
Beaury Street	2	• Residential Property - 1 Beaury Street. Tooloom Creek comes up and floods backyard by 12 inches or so. • Town water from Beaury Street is funnelled into backyards/paddocks. Need for pipe, however water will still run into paddocks unless water is directed down to bridge (Tooloom Creek Bridge)
Old Saw Mill (Tooloom Road)	3	• Tooloom Road at Old Saw Mill site gets blocked during floods
Needhams Creek (Tooloom Road)	1	• Needhams Creek came up about 9-10 feet almost to level of new bridge construction. Isolated for 2 weeks in 2020 when new Mulcahy Bridge was being constructed. Floodwater almost came up to level of new bridge.
Urben Street Drainage	3	• Residential Property - 49 Urben Street. Stormwater from roadside gutters seeps into house and floods bedrooms and runs through house. Roadside gutters need to be extended past property. • Residential Property - 29 Urben Street. Drainage needs to be improved at lower end of Tooloom Street and Urben Street. • Residential Property - 6 Urben Street. End of Urben Street has very poor drainage. Water extends over road and cannot drain away. Also comes in from kerbing, flows over driveway and runs down to back of property. Gets to approx. 5 inches deep. Refer Photograph 1 in Appendix B.

3.5 DATA FOR FLOOD MODEL CALIBRATION

Data that will be utilised for flood model calibration is summarised in Table 3. Where no time and dates are provided, the result of the flood modelling can be compared with the anecdotal evidence to validate the model performance.

Table 3: Calibration and Validation Data Summary

Date and Time	Location	Observation	Comment	Approach to flood model calibration
6th January 2008	Tooloom Road (at Old saw mill)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
6th January 2008	Clarence Way (at Forest Park turnoff)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
6th January 2008	Clarence Way (at bridge heading to Bonalbo)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
16th February, 2010	6 Urben Street	5 inches of water in front yard	• Water comes in from kerbing on Urben Street and flows onto driveway before running down to the back. End of Urben Street has very poor drainage, water extends over road and cannot drain away	Consider 2010 event for flood model validation. This can be supplemented by additional data which has been provided by Council.
2013	Tooloom Road (at Old saw mill)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
2013	Clarence Way (at Forest Park turnoff)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
2013	Clarence Way (at bridge heading to Bonalbo)	Water over road (no depth recorded)	• All exits from Urbenville blocked off due to water over road	Review modelled flood behaviour against the anecdotal evidence
No date	1 Beaury Street	12 inches of water in backyard	• Tooloom Creek comes up and floods backyard by 12 inches 'or so'. Creek inundation covers half the height of fenceline.	Review modelled flood behaviour against the anecdotal evidence
No date	Tooloom Road Creek crossing (Needhams Creek)	Water level nearly to level of new bridge construction	• Needhams Creek/Tooloom Creek rose 9-10 feet almost to level of new bridge construction.	Review modelled flood behaviour against the anecdotal evidence

3.6 SUMMARY

- People believe they are generally aware of what they need to do during a flood, with results indicating that 91% of respondents nominating they would either be confident or 'think' they would be confident during a flood event. However, the experience of large and rare floods is limited.
- There is limited data available for calibration of the flood models from the community submissions.
- Key areas identified by the community as requiring flood mitigation or management include:
  - Roads leaving Urbenville:
    - Tooloom Road (at the old saw mill site)
    - Clarence Way (at the bridge heading to Bonalbo)

- Clarence Way (at turnoff to Forest Park)

– General Street drainage in town:
  - Welch Street/Stephen Street
  - Urben Street (particular lower south-western end)
  - Beaury Street (towards Tooloom Street intersection)
– Tooloom Street (properties that back onto Tooloom Creek floodplain)
– Needhams Creek crossing on Tooloom Road

APPENDIX A

Newsletter and Questionnaire – September 2020

URBENVILLE FLOOD STUDY

Tenterfield Shire and Kyogle Councils have engaged engineering consultant BG&E to develop a Flood Study for Urbenville. The study is being undertaken with financial and technical assistance from Council and Department of Planning, Industry and Environment (DPIE) through the NSW Government's Floodplain Management Program.

The Urbenville Flood Study will help us understand the likely flooding scenarios for the town of Urbenville including flooding from Tooloom Creek and from local catchments.

The Urbenville Flood Study will:

- Develop flood models based on historic data and statistical analysis
- Identify the areas of flood prone land to assist with flood planning and risk management
- Establish the likely flood risk and flood hazard for properties in the study area
- Develop flood mapping to assist in future planning and development
- Provide flood intelligence to the NSW SES to assist in flood emergency response

HOW CAN YOU HELP?

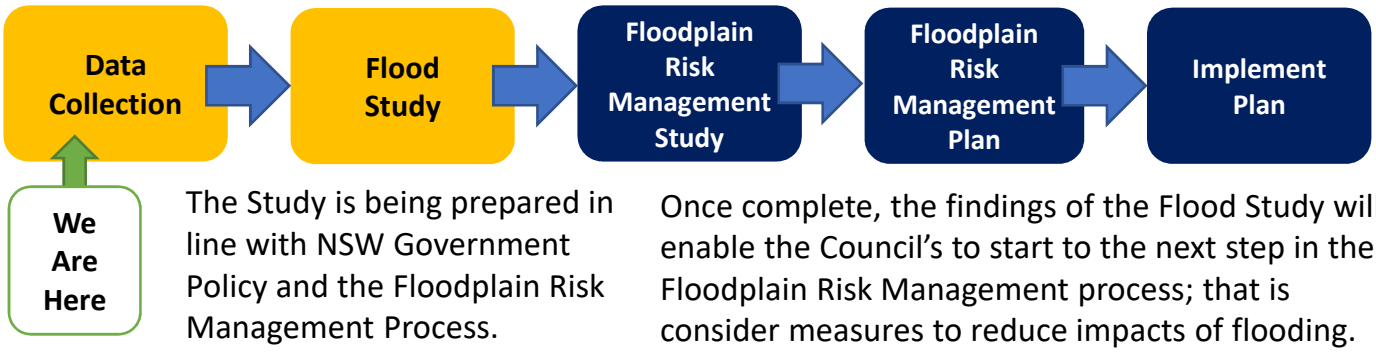
The local community is the best source of information on the flooding issues. We are asking for information such as your experiences, photos and observations of flooding. A Community Information Session will be held at a later date to present the findings of the study.

Please take a few minutes to complete the attached questionnaire and return by reply-paid mail before 30 October 2020.

Alternatively you can complete the questionnaire online using the QR code or by visiting www.surveymonkey.com/r/UrbenvilleFloodStudy

If you have further information such as photographs these can be emailed to: UrbenvilleFloodStudy@bgeeng.com.

THE FLOODPLAIN RISK MANAGEMENT PROCESS

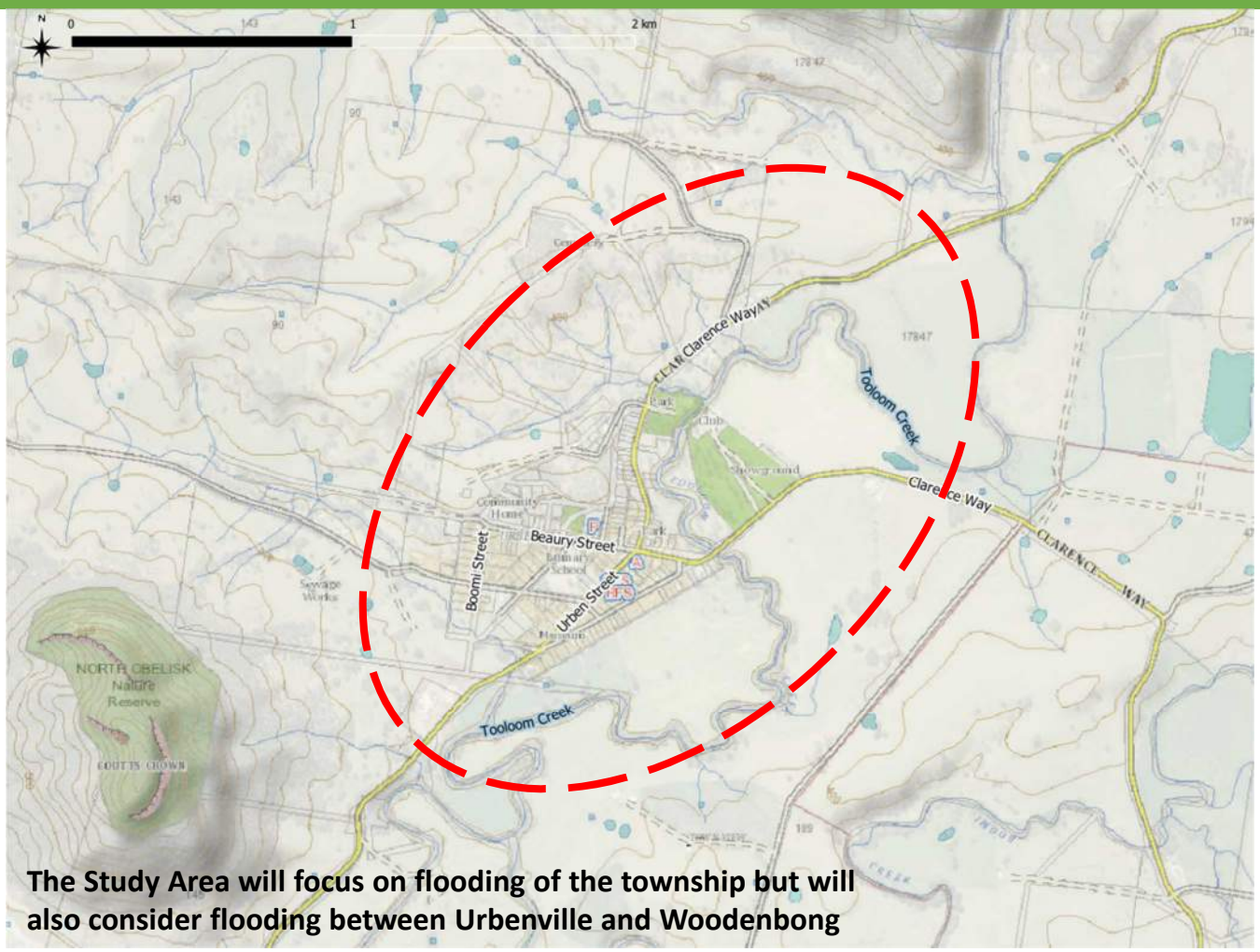


The Study is being prepared in line with NSW Government Policy and the Floodplain Risk Management Process.

Once complete, the findings of the Flood Study will enable the Council's to start to the next step in the Floodplain Risk Management process; that is consider measures to reduce impacts of flooding.

URBENVILLE FLOOD STUDY

STUDY AREA



The Study Area will focus on flooding of the township but will also consider flooding between Urbenville and Woodenbong

CONTACT US

Project Website:
www.bgeeng.com/FloodStudies/Urbenville

Email: UrbenvilleFloodStudy@bgeeng.com

Council: Melissa Blum
m.blum@tenterfield.nsw.gov.au or 0439 118 312

TENTERFIELD SHIRE COUNCIL

KYOGLE COUNCIL
GATEWAY TO THE RAINFORESTS

BG&E

NSW GOVERNMENT
Planning, Industry & Environment

URBENVILLE FLOOD STUDY QUESTIONNAIRE

Thank you for taking the time to answer this questionnaire. Your input provides useful information so that we can calibrate flood models to real-life flood data and helps us focus the study on areas and issues that are a priority to the community. Please return the questionnaire in the pre-paid envelope provided. Alternatively you can complete the questionnaire online: www.surveymonkey.com\r\UrbenvilleFloodStudy

Q1. Your Details

All information provided will remain confidential and will only be used for the purpose of this study. Specific information on the respondents or their responses will not be made available or reported on.

Name _____

Address _____

Email _____

Telephone _____

Please provide you email or telephone number if you agree we can contact you in relation to this study.

Is this a property a home or workplace or other use? _____

Please write, "home", "workplace" or state use if other.

Q2. How long have you lived/worked at this address?

Please tick the box below.

0 to 5 years	5 to 15 years	15 to 25 years	More than 25 years	How Many? (if more than 25)

Q3. How long have you lived/worked in the area?

Please tick the box below.

0 to 5 years	5 to 15 years	15 to 25 years	More than 25 years	How Many? (if more than 25)

Q4. Are you aware if your property is flood affected?

Please tick the box below.

Yes, it has flooded before	Yes, but it has not flooded	I don't think it is flood affected	I don't know

Q5. Have you or members of your household been isolated or evacuated due to flooding?

If you answered yes, you can provide further information at the end of this questionnaire, such as when this happened and for how long.

Yes, Evacuated	Yes, Isolated	No, never

URBENVILLE FLOOD STUDY QUESTIONNAIRE

Q6. Have you ever experienced flooding from Tooloom Creek?

This question relates to flooding from the river only. This information helps us to calibrate the flood models to real-life data and to get more accurate outcomes.

Yes, at this property	Yes, in the local area but my property was not affected	No, I have not observed flooding in the area

If Yes, please provide additional details such as where you observed flooding and the date and time that you experienced flooding. If you can, say how deep the water was or how high did it get? How far did the water go into your property? Was there any damage? Additional space for you response is provided at the end of this questionnaire if you need. If you have photographs these can be emailed to UrbenvilleFloodStudy@bgeeng.com

Q7. Have you experienced flooding from stormwater or smaller creeks?

This question relates to flooding that is not from Tooloom Creek. This may be from the drainage channels in the town, local creeks or after heavy rainfall events.

Yes, at this property	Yes, in the local area but my property was not affected	No, I have not observed flooding in the area

If Yes, please provide additional details such as where you observed flooding and the date and time that you experienced flooding. If you can, say how deep the water was or how high did it get? How far did the water go into your property? Was there any damage? Additional space for you response is provided at the end of this questionnaire if you need. If you have photographs these can be emailed to UrbenvilleFloodStudy@bgeeng.com

Q8. Are there any areas within the Urbenville Study Area you think flooding should be reduced?

This question helps us to identify priority areas. The study area was shown on the second page.

Yes	No	I don't know / I have not been affected by flooding

If Yes, please state where

URBENVILLE FLOOD STUDY QUESTIONNAIRE

Q9. If there was a flood, do you feel like you know what to do?

Yes, I am confident I know what to do. I'll be fine	I think so, but I have not experienced flooding	I'm not sure. I'll wait until someone tells me	No, I don't know what to do	It doesn't matter, my property or local area does not flood

The outcome of the Urbenville Flood Study will assist Tenterfield Shire Council, Kyogle Council, emergency services and the local community in understanding flood behaviour in the area so that flood damages and risk to life can be reduced.

Q10. Do you have any further information you think may help?

Yes, please see below/attached	Yes, I will email some information	Yes, please contact me	No

Photographs and records of previous flooding and rainfall are very useful to help us develop flood models which represent the real-life situations.

If Yes, please attach your feedback to this questionnaire, or email to UrbenvilleFloodStudy@bgeeng.com. If you email, please make sure to include your name and address so we can match your survey results with the information you have provided.

THANK YOU

Thank you for taking the time to answer this questionnaire. Your input is valuable to the outcomes of the Urbenville Flood Study.

Project Website:
www.bgeeng.com/FloodStudies/Urbenville

Email: UrbenvilleFloodStudy@bgeeng.com

Council: Melissa Blum
m.blum@tenterfield.nsw.gov.au or 0439 118 312

Tenterfield Shire Council · Kyogle Council – Gateway to the Rainforests · BG&E · NSW Government – Planning, Industry & Environment

APPENDIX B

Historic Flooding – Photographs

Location: 31 Tooloom Street

Supplied by: Craig Vermeulen

Date and Time Taken: 2nd May, 2015 – 12:08pm

Comments: Shipping container, 31 Tooloom Street.

Photograph 1: 31 Tooloom Street, 2nd May, 2015.

Location: Tooloom Street, property address unknown

Supplied by: Craig Vermeulen

Date and Time Taken: 2nd May, 2015 – 11:42am

Comments: No comment

Photograph 2: 31 Tooloom Street, 2nd May 2015.

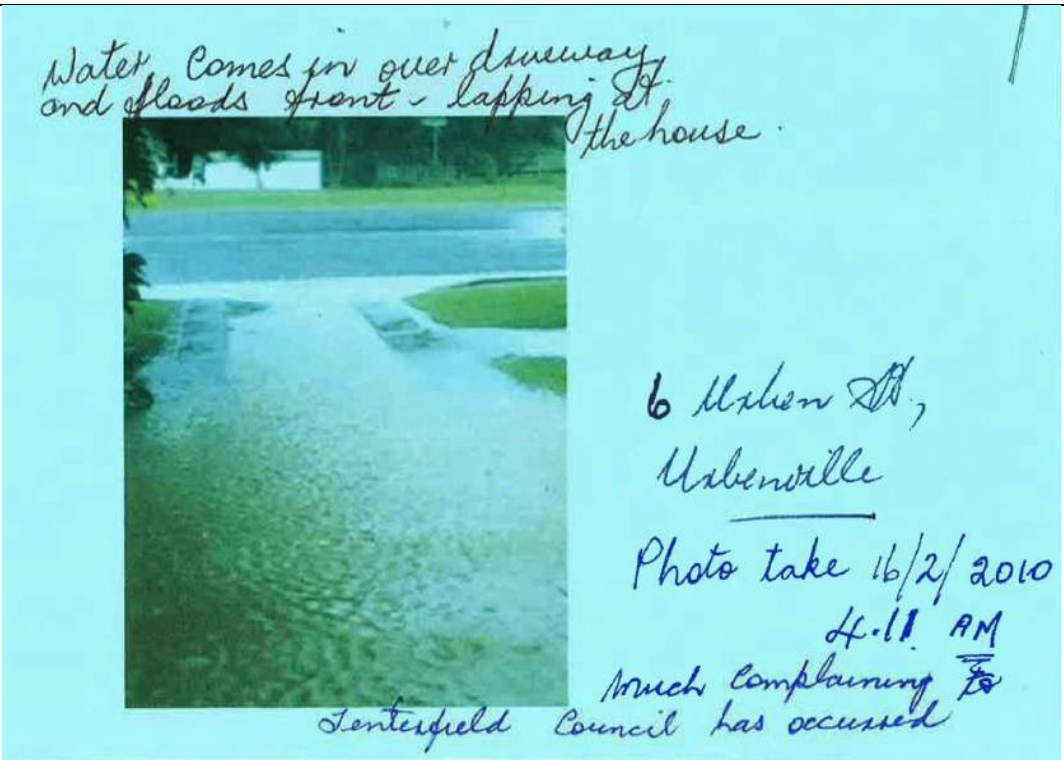
Location: Tooloom Street, looking south

Supplied by: Craig Vermeulen

Date and Time Taken: 31st March, 2017 – 1:04pm

Comments: Tooloom Street, looking south. 25, 29, 31 and 33 Tooloom Street

Photograph 3: Tooloom Street, 31st March 2017.



Location: 6 Urben Street, Urbenville

Supplied by: Jennifer Taylor

Date and Time Taken: 16th February 2010, 4:11AM

Comments: Water comes in over driveway and floods frontyard – lapping at the house.

Photograph 4: Front Yard of 6 Urben Street, 16th February 2020.

Photograph 5: Front yard of 6 Welch Street.

Photograph 6: Front yard of 6 Welch Street.

Photograph 7: Looking north up Welch Street (Urbenville Public School on right)

Location: 6 Welch Street, Urbenville

Supplied by: Marcus McSweeny

Date and Time Taken: No date provided

Comments: Photos were taken (corner of Stephen and Welch Streets) after a thunderstorm. Only about 20mm of rain caused this amount of runoff. Obviously flooding rain creates much more runoff.

Photograph 5 to 7: Front yard of 6 Welch Street.

Photograph 8: Stephen Street, looking North. Urbenville Public School seen in background.

Photograph 9: Downstream culvert headwall passing under Welch Street. Looking North-East towards Urbenville Public School.

Location: Stephen and Welch Street, Urbenville

Supplied by: Marcus McSweeny

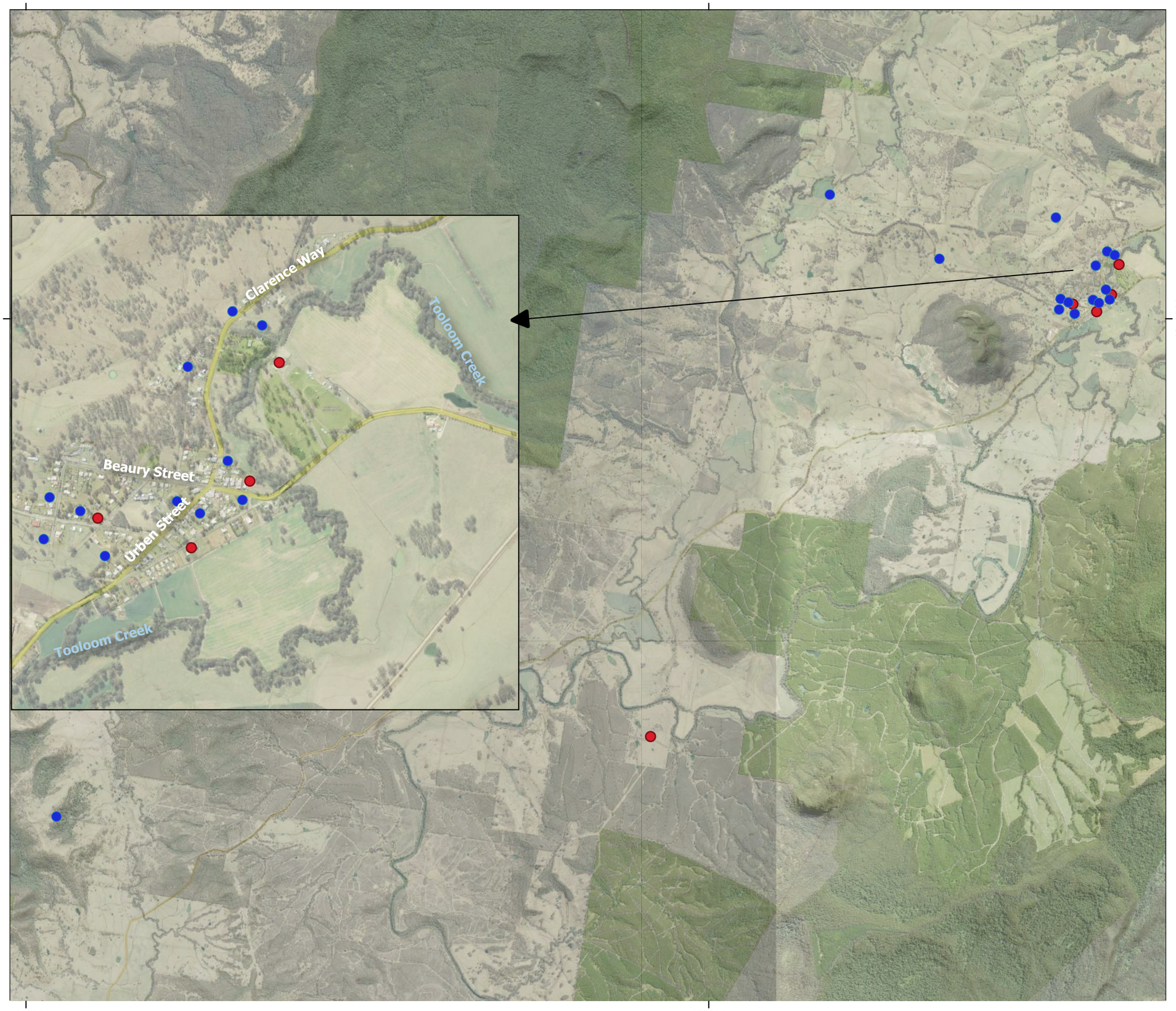
Date and Time Taken: No date provided

Comments: Photos were taken (corner of Stephen and Welch Streets) after a thunderstorm. Only about 20mm of rain caused this amount of runoff. Obviously flooding rain creates much more runoff.

Photograph 8 and 9: Stephen and Welch Street, local stormwater pits and culverts.

APPENDIX C

Mapping



Legend

Urbenville

Location of questionnaire responses

- Has experienced flooding at property
- Has not experienced flooding at property

0 1 2 3 4 km

SCALE 1:55000

N

DRAWN	AS
REVIEWED	LB
APPROVED	LB
DATE	26/11/2020
PROJECT	S20128

Urbenville Flood Study

Figure C1 – Location of Questionnaire Respondents

DATUM GDA 2000 MGA Zone 56

\\bge.int\dfs\Syd\Projects\BGE\SYD\S20128\100 Draw\QGIS\Figures\Urbenville Flood Study.qgz

ACKNOWLEDGEMENT

Legend

Urbenville

- Priority Areas

0 100 200 300 400 500 m

SCALE 1:7500

N

DRAWN	AS
REVIEWED	LB
APPROVED	LB
DATE	26/11/2020
PROJECT	S20128

Urbenville Flood Study

Figure C2 – Location of Priority Areas

DATUM GDA 2000 MGA Zone 56

\\bge.int\dfs\Syd\Projects\BGE\SYD\S20128\100 Draw\QGIS\Figures\Urbenville Flood Study.qgz

ACKNOWLEDGEMENT SI Maps

DISCUSSION PAPER

Community Consultation Summary - Woodenbong

Project:	S20128 – Urbenville and Woodenbong Flood Study
Prepared for:	Tenterfield Shire Council (on behalf of Kyogle Council)
Date and Rev:	11/12/2020 – Issue for Information
Prepared by:	Thomas Sigley
Reviewed:	Laura Baxter

1 INTRODUCTION

Effective community consultation and participation, through valuing the experiences and opinions of the community can improve the collaboration between Council and the community enabling the achievement of project outcomes that are satisfactory to all stakeholders.

Community Consultation is ongoing throughout the Flood Study project. The purpose of this Summary Paper is to summarise the consultation undertaken to date and how the findings will be incorporated into the Flood Study. This Summary Paper will be updated at key stages during the project following community consultation phases.

2 COMMUNITY CONSULTATION PROGRAM

The Community Consultation Program involves:

- **Project Website** - A project website is being hosted for the duration of the project at https://www.bgeeng.com/floodstudies/Woodenbong. This provides the community with updates on the study progress, links to the community questionnaire and contacts to provide information and feedback.

  Community Newsletter – a newsletter was mailed to 309 property owners in September 2020. A copy is included as Appendix A. The newsletter informed of the objectives of the Woodenbong Flood Study and highlighted the study area. Kyogle Council also posted notices on their website to link to the community newsletter and project website at https://www.kyogle.nsw.gov.au/council-engagement/council-business/on-public-exhibition/.
  Tenterfield Shire Council also posted notices on their website to link to the community newsletter and project website at https://www.tenterfield.nsw.gov.au/urbenville-and-woodenbong-flood-study.

- **Questionnaire** – a questionnaire accompanied the newsletter in September 2020 (copy provided in Appendix A). Residents were given until 31 October 2020 to respond. A copy of the questionnaire was also made available online. The findings of the questionnaire are useful to understand the community's experiences of past flooding, the level of flood awareness, highlight areas for flood mitigation and allow residents to provide flood information for use in calibration of the flood models. A project email address was also created to allow people to email photographs and addition information.

- **Community Information Sessions** – two information sessions are planned. At each session community input will be invited through on the day questions and answers or feedback forms and via the project website.
  - Due to the restrictions of COVID the first will be undertaken online if required. The first session will describe the preliminary findings of and seek feedback on the flood modelling undertaken. It will also present how the results of the community questionnaire and other community feedback are being taken into account in the study.
  - A second community consultation will be undertaken during the public presentation of the Draft Flood Study at start of the Public Exhibition period. This will present further additional information such as flood hazard and emergency classification of communities.
- **Public Exhibition** – the Flood Study will be placed on public exhibition for a period of at least 28 days to invite community feedback before Council adoption.

3 QUESTIONNAIRE FINDINGS

The questionnaire was mailed to property owners in and around the study area. A total number of 309 newsletters and questionnaires were mailed out. The purpose of the community questionnaire was to:

- Understand the level of flood affection and the numbers of people who have experienced flooding;
- Encourage the community to provide information about historic flooding which can be used in flood model calibration and understanding flood behaviour;
- Highlight areas where the community thinks flooding is a concern and requires management;
- Identify the level of flood awareness and the community perceptions on acceptable frequency of flooding.

3.1 Response Rate

A total of 3 responses were received online and 23 by mail. The total number of responses was 26 which equates to an 8.4% response rate. This was considered to be a reasonable response rate, given the size of Woodenbong and the number of residents who reside there. Response rates to surveys such as this tend to be more skewed to those who have experienced or are concerned with flooding.

One respondent requested to be contacted for further information. BG&E spoke to each resident and they provided some information over the telephone. They were also invited to send through additional information by email. At the time of collating community questionnaire findings and compiling this report, additional information had not yet been received.

3.1.1 Who Responded?

Identifying where respondents live can indicate where flooding is of a greater concern to residents. Typically, those in more flood prone areas are more likely to respond and provide feedback. Understanding how long residents have resided in the area can also be beneficial in determining a level of flood awareness in relation to the community i.e. the longer a resident has lived in the area, the more likely they might have experienced flooding.

3.1.2 Property Classification

Figure 1 identifies the residence classification of respondents. 85% of responses received were from residential properties or a residence classified as ‘home’. Responses to this question outline that it is home

owners or occupiers who may tend to feel more affected by flooding issues than non-residential owners or occupiers. However, it is worth mentioning that results may be skewed, due to a larger tendency for home owners or occupiers to respond to the questionnaire. All 3 respondents who indicated 'other' classified the property as both a workplace and home.

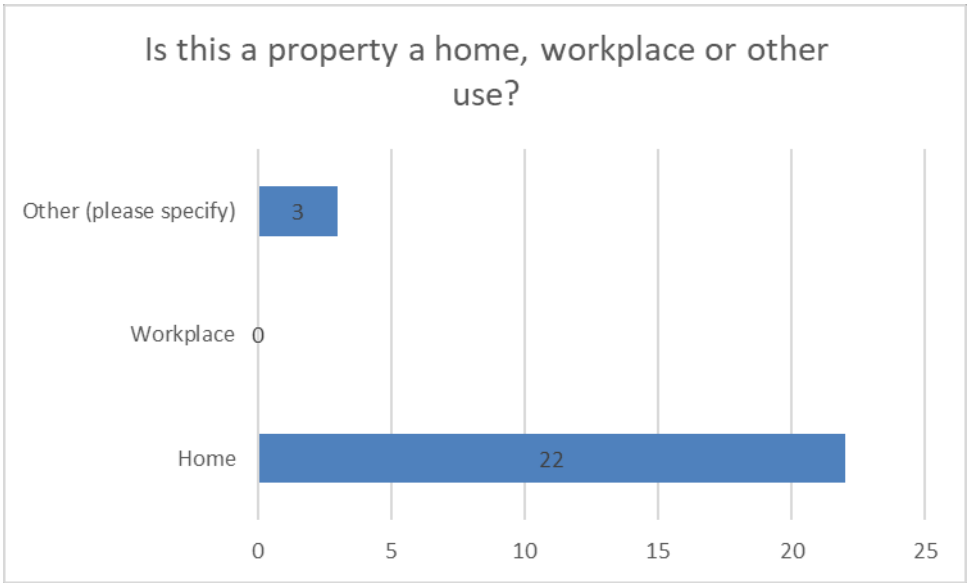


Figure 1: Classification of Residence

3.1.3 How Long Have Respondents Lived in the Area

Figure 2 presents the period of time during which respondents have lived or worked in the area or at their residence. 15% of respondents had recently moved into the area within the last 5 years, with this group least likely to be aware of the existing flood risks or be aware if their property or workplace could be subject to inundation. 38% of respondents had resided in the area for more than 25 years, with 6 of these residing for longer than 35 years. This group are most likely to have experienced flooding in the area. However; flood events noted by the residents were limited to 2010, 2016 or 2017.

Figure 2: Period of Time Respondents Have Lived in the Area

3.2 Flood Awareness

Understanding the community's awareness of flood risk and their response allows for targeted flood awareness campaigns and can assist in flood emergency response planning.

3.2.1 Personal Property

The questionnaire asked respondents if they were aware if their property was flood affected and if it had flooded before. This type of question can often be skewed more towards a positive 'yes' response, as respondents who may respond are typically within flood prone areas or have been affected by flooding previously. People who have not experienced flood at their property have a greater tendency to not provide a response, as they feel the issue has not or will not affect them.

Figure 3 highlights that over half the respondents (54%) did not think their property was flood affected, suggesting that they had not experienced a flood at their residence. 15% of respondents nominated that their property was flood affected and that it had flooded before, with a further 23% acknowledging that their property was flood affected but had not flooded before.

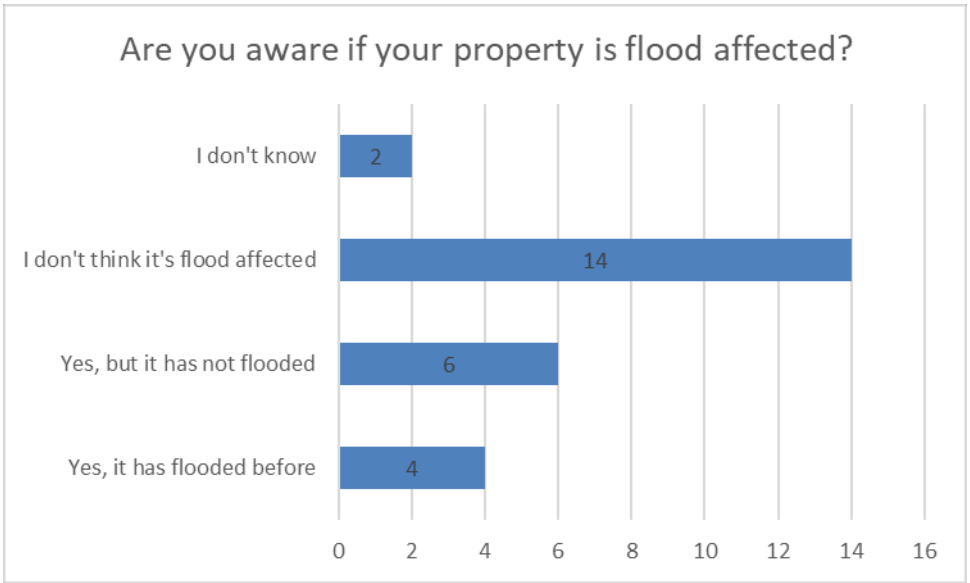


Figure 3: Number of Respondents Affected by Flooding

Of the 4 respondents who elected that the property was flood affected and had flooded before, 3 of these had been isolated due to flooding, whilst the other had been evacuated.

Of the 3 who were isolated, 2 resided on Richmond Street and referenced flooding along Bonalbo Lane and at the back of their property. The 1 respondent who indicated that they were evacuated, resided along Grahams Creek, although a property address was not provided.

Although 5 out of the 14 respondents indicated that they thought their property was not affected by flooding, these residents (or other household members) reported having been isolated due to flooding at some point. This suggests that although their property remained unaffected during flooding events, nearby accessways (roads, paths etc.) could have been obscured from floodwater and blocked, causing them to be 'isolated'.

Results relating to flooding experiences, particularly isolation and/or evacuation are presented in Section 3.3.1 below.

3.2.2 Responding to Flooding

Questions asked within this section of the questionnaire were aimed to understand the level of flood awareness of the community in terms of emergency response behaviour. Respondents were asked outline if they believed they would know what to do in the event of a flood.

Figure 4 highlights that 62% of respondents believed they would know what to do in the event of a flood. A further 12% indicated they 'think' they would know what to do, however had not previously experienced flooding. 23% of respondents indicated that knowing how to respond to flooding "did not matter" as their property or local area did not flood. This group is a particular concern as these may be people who have not yet experienced flooding and are unaware of the actual risk.

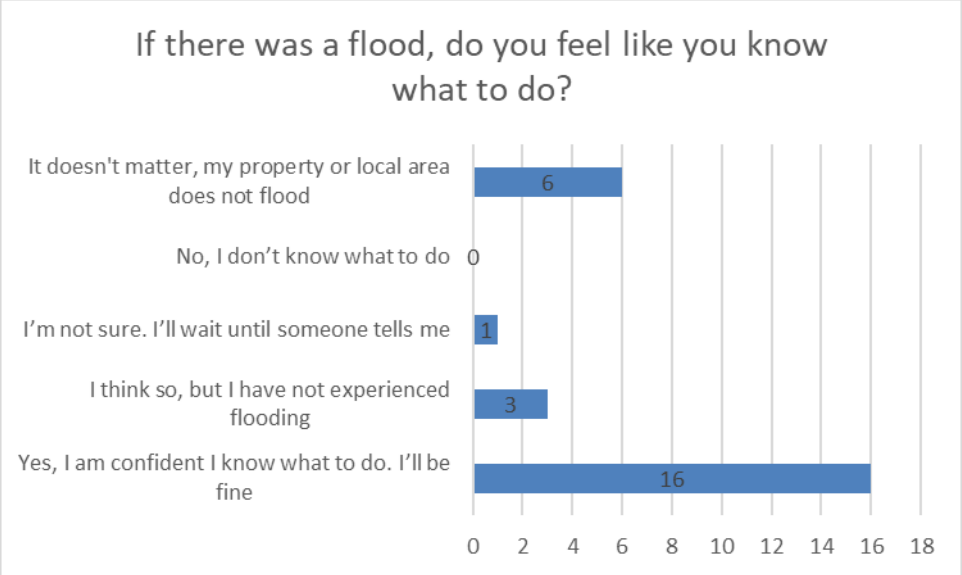


Figure 4: Flood Awareness of Respondents

Although the results indicated a high awareness to act during a flood (74%) this question can be skewed as those who are aware, or are more interested in flooding may be more likely to respond. Of the 16 respondents (62%) who believed they would know what to do in the event of a flood, only 3 had experienced a flood at their property or in the local area.

Of the 6 respondents (23%) who indicated they their flood awareness 'doesn't matter' as their property or local area does not flood, 5 nominated that they 'didn't think' their property was flood affected. What was also surprising was that 4 of these respondents had lived in the area for periods greater than 30 years, whilst the other 2 had only lived there for 0 to 5 years.

The results may point to a false sense of flood security, particularly for those residents who have not experienced flooding but think that they were confident they would know what to do. This highlights the importance of the community consultation through the Flood Study program but also the importance of continued flood awareness and community flood education undertaken by Tenterfield Shire and Kyogle Councils and the NSW SES.

While people may believe they know what to do to respond to flooding, the findings of the questionnaire show that few to no residents have experienced rare to extreme flooding. Should a larger flood occur requiring a different response such as evacuation, people may believe that there is no need for evacuation based on their past experiences. This is a challenge in flood emergency response management and the findings of the Flood Study will be able to assist in planning for and raising awareness of the community emergency response for larger floods.

3.3 Experience of Flooding

3.3.1 Evacuation and Isolation

Respondents were asked to outline if they had been evacuated or isolated during events of flooding. Again, this type of question can often be skewed more towards a positive 'yes' response, as respondents who may respond have typically been affected by flooding in some way.

Figure 5 highlights that 42% of respondents nominated that they (or other household members) had been isolated or evacuated in the past due to flooding. The remaining 58% indicated that they (or other household members) had never experienced isolation or evacuation due to flooding.

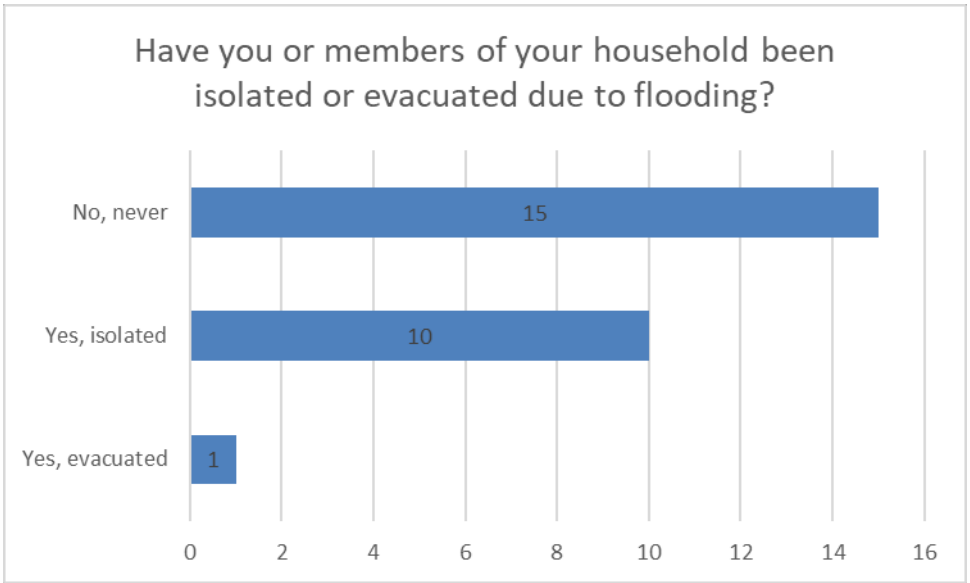


Figure 5: Number of Respondents who have been Isolated or Evacuated from their Household

Of the 10 people who reported having been isolated during flooding the following was found:

- 5 of those reported believed flooding was caused from local stormwater infrastructure or smaller creeks.

3.3.2 Tooloom Creek

The questionnaire asked respondents to acknowledge if they had ever experienced flooding from Tooloom Creek. This question served to focus on areas subject to mainstream flooding from Tooloom Creek only, rather than localised stormwater flooding and the response of existing council owned pit and pipe infrastructure.

Figure 6 highlights that 62% of respondents elected that they had never experienced flooding from Tooloom Creek. Of the 10 people reported having observed flooding from Tooloom Creek, only 1 reported that flooding from Tooloom Creek had directly affected their property, residing at Lot 77 Recreation Road, with photos provided in Appendix B.

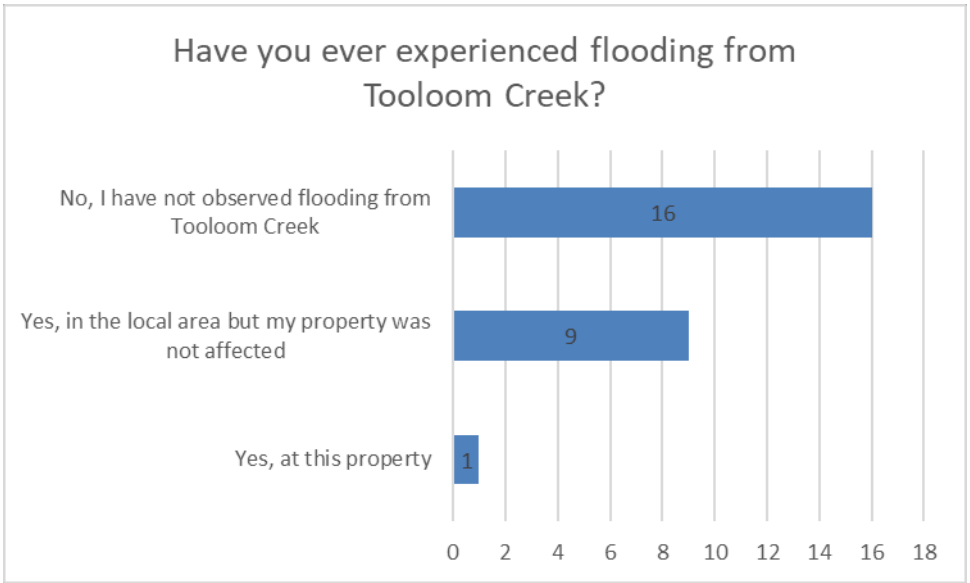


Figure 6: Number of Respondents who have experienced flooding from Tooloom Creek

3.3.3 Other Sources of flooding

The questionnaire asked respondents to acknowledge if they had ever experienced flooding from stormwater of smaller creeks. This question served to focus on areas subject to localised flooding, unrelated to Tooloom Creek including smaller local creeks and local council-owned stormwater infrastructure such as channels, pits and culverts.

Figure 7 highlights that only 5 respondents experienced flooding at their property from local catchments, with a further 10 electing they have experienced flooding in their local area, but not at their property. This equated to approximately 58% of respondents experiencing flooding at their property or in local area.

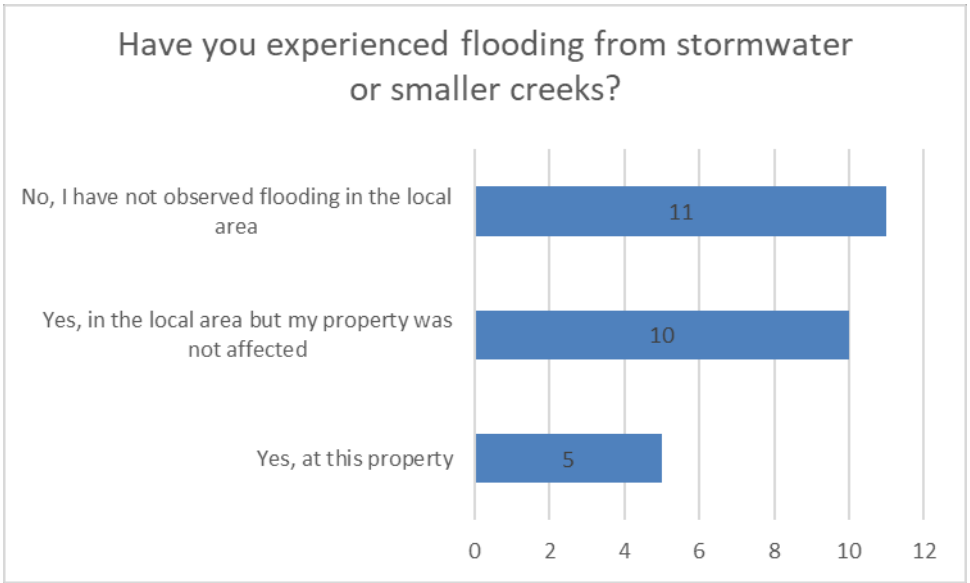


Figure 7: Number of Respondents who have Experienced Flooding from Stormwater or Smaller Creeks

Of the 5 respondents who had experienced flooding at their property, 3 mentioned to the paddock area behind properties along Richmond Street (backing onto Bonalbo Lane).

10 respondents indicated they had experienced flooding in the area (but not at their property). Responses to this question appeared to focus in on 2 main areas:

- Woodenbong Showground, campground/caravan park and swimming pool.

- Lindsay Creek Road creek crossing (Black Gully) and Mount Lindsay Road (east of town) creek crossings (subsidiary Black Gully creek).

3.3.4 Historic Flooding

Respondents were also asked to provide specific commentary on historic flooding events including dates of flooding and flood depths and locations. Results are summarised in Table 1.

Timestamped responses (providing specific dates or times) were limited. 2 respondents made reference to the 2010 storm event and noted to:

- Flooding at residential properties that backed onto Bonalbo Lane (25-33 Richmond Street) and surround paddocks.
- Overtopping of Lindsay and Grahams Creek banks.

A respondent also made mention to a flood event which occurred in April 2016 (or 2017 – cannot recount exact year) involving isolation 'on the other side of town'.

Table 1: Summary of Flood Events where Dates were Provided

Date/Year Observed	Number of Respondents	Comments
2010	2	• 29 Richmond Street (at back of property that fronts Bonalbo Lane) - After heavy rain properties on lower eastern side of 25-33 Richmond Street are substantially flooded. Floodwater levels have reached backsteps and house footings • Floodwater from a substantial rural catchment flows along a natural farmland gully and onto a paddock beside Bonalbo Lane. • Bonalbo Lane - Original watercourse used to be on the far eastern side of the paddocks. However gully has become blocked or filled in, causing the main flood watercourse to flow diagonally across the paddock, then across Bonalbo Lane just below Dalmorton St, and then into backyards at 25, 27, 29, 31 and 33 Richmond Street. • Stormwater runoff from Dalmorton Street joints watercourse draining onto paddock or into Bonalbo Lane. • Residential Property - Lot 77, Recreation Road. Water came over the banks of creeks (Lindsay and Grahams Creek) and inundated lower paddock
April 2016 (or 2017 – cannot remember)	1	• Residential Property - 31 Lindsay Street, Woodenbong. Isolated on other side of town

3.4 Flood Mitigation

3.4.1 Flooding of Other Areas

To understand the local community's priorities for flood mitigation, the questionnaire asked respondents to acknowledge any other areas within the Woodenbong Flood Study which they thought flooding should be reduced. This question sought to identify if there were potential priority or problem areas.

Figure 8 highlights that 11 respondents (42%) believed there are areas within the Woodenbong Flood Study were problem areas subject to flooding.

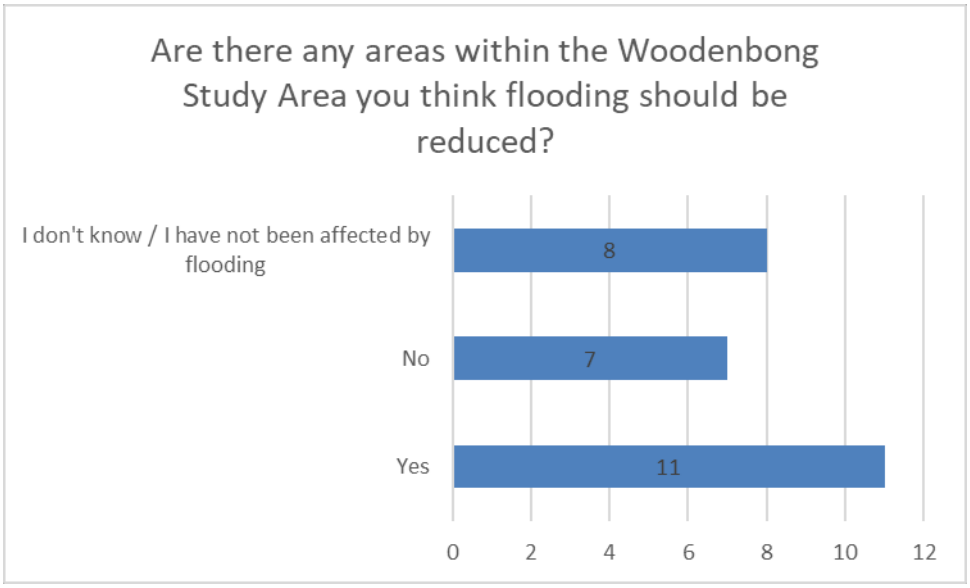


Figure 8: Number of Respondents Who Believed there are Areas Where Flooding Should be Reduced

3.4.2 Priority Areas

Respondents identified a number of 'priority areas' where they noted flooding. These are summarised in Table 2 and on the mapping in Appendix C.

Table 2: 'Priority' Areas.

Street/Location	Number of Respondents	Comment
Woodenbong Caravan Park/Camping ground/Baths	6	• Flooding in Woodenbong Caravan Park • Flooding in Woodenbong Caravan Park and showgrounds • Tooloom Creek overflows in major floods and inundates campground, recreational facilities around the town baths and sports oval. Knee deep, slow flowing and for short periods (approx. 2 hours). • Flooding of Showground during 2010 flood event • Flooding of bridge near Woodenbong Swimming Pool
Richmond Street (properties backing onto Bonalbo Lane)	3	• After heavy rain properties on lower eastern side of 25-33 Richmond Street are substantially flooded. Floodwater levels have reached backsteps and house footings. • Residential Property - 31 Richmond Street. Depth of water in yards up to 500mm during 2010 event. Levee needs to be raised by 1m and made longer to reduce flooding of yards on Richmond Street • Black Gully Culvert on Lindsay Creek Road is sometimes flooded to about 1m over the road (for less than 2 hours). Gully is fed from another gully on Bonalbo Street and one on the eastern side of town. Flood markers required on Mount Lindsay Road and Lindsay Creek Road.
Mount Lindsay Road (Culvert under Mount Lindsay Road/Richmond Street intersection)	2	• Gully Flooded adjacent to transfer facility entrance. Unable to give dates, but occasions have been many. • Flooding is a minor inconvenience to Woodenbong Residents. Water depth markers on areas that flood on Mount Lindsay Road would suffice.
Dalmorton Street	2	• Poor street drainage • Stormwater runoff from Dalmorton Street joints watercourse draining onto paddock or into Bonalbo Lane.

Street/Location	Number of Respondents	Comment
Clarence Way	2	• Residential Property - 18222 Clarence Way. Often get water over Clarence Way near the corner of address. • Flooding issues, Clarence Way between Urbenville and Woodenbong
Grahams Creek	2	• Flooding of Grahams Creek crossing • Residential Property - Recreation Road (no address). Water came up over banks (Grahams and Lindsay Creek) and flooded lower paddocks

3.5 DATA FOR FLOOD MODEL CALIBRATION

Data that will be utilised for flood model calibration is summarised in Table 3. Where no time and dates are provided, the result of the flood modelling can be compared with the anecdotal evidence to validate the model performance.

Table 3: Calibration and Validation Data Summary

Date and Time	Location	Observation	Comment	Approach to flood model calibration / validation
No Date	Black Gully Culvert (located on Lindsay Creek Road)	Flooded to depths of 'about' 1m over the road.	For less than 2 hours.	Review modelled flood behaviour against the anecdotal evidence
No date	31 Richmond Street	500mm depth of water in backyard	Every major downpour over a short period. Water backs up and unable to flow away and crosses over a small levee.	Review modelled flood behaviour against the anecdotal evidence
No date	Mount Lindsay Road	Knee deep, slow following water for short periods ('maybe 2 hours")	Tooloom Creek overflows in major floods to inundate the campground, recreational facilities around the town baths and sports oval.	Review modelled flood behaviour against the anecdotal evidence

3.6 SUMMARY

- People believe they are generally aware of what they need to do during a flood but the survey responses indicate that further community education on preparing for flooding and evacuation would be beneficial, particularly for larger floods.
- The population within the Woodenbong Flood Study area believe they are generally flood aware, despite only 3 of these 'flood aware' respondents nominating that they had experienced flooding at their property or in the local area.
- There is limited data available for calibration of the flood models from the community submissions.
- Key areas identified by the community as requiring flood mitigation or management include:
  - Black Gully Culvert (located on Lindsay Creek Road)
  - Residential properties along Richmond Street (particularly 25 to 33 Richmond Street backyards)
  - Mount Lindsay Road at Tooloom Creek crossing (near Woodenbong recreational facilities; Caravan Park, Camping ground, Baths/pools and Showground.

– Mount Lindsay Road creek crossing (near Richmond Street intersection) and upstream catchment.

APPENDIX A

Newsletter and Questionnaire – September 2020

WOODENBONG FLOOD STUDY

Tenterfield Shire and Kyogle Councils have engaged engineering consultant BG&E to develop a Flood Study for Woodenbong. The study is being undertaken with financial and technical assistance from Council and Department of Planning, Industry and Environment (DPIE) through the NSW Government's Floodplain Management Program.

The Woodenbong Flood Study will help us understand the likely flooding scenarios for the town of Woodenbong including flooding from Tooloom Creek and Boomi Creek and runoff from local catchments.

The Woodenbong Flood Study will:

- Develop flood models based on historic data and statistical analysis
- Identify the areas of flood prone land to assist with flood planning and risk management
- Establish the likely flood risk and flood hazard for properties in the study area
- Develop flood mapping to assist in future planning and development
- Provide flood intelligence to the NSW SES to assist in flood emergency response

HOW CAN YOU HELP?

The local community is the best source of information on the flooding issues. We are asking for information such as your experiences, photos and observations of flooding. A Community Information Session will be held at a later date to present the findings of the study.

Please take a few minutes to complete the attached questionnaire and return by reply-paid mail before 30 October 2020.

Alternatively you can complete the questionnaire online using the QR code or by visiting www.surveymonkey.com/r/WoodenbongFloodStudy.

If you have further information such as photographs these can be emailed to: WoodenbongFloodStudy@bgeeng.com.

THE FLOODPLAIN RISK MANAGEMENT PROCESS

The Study is being prepared in line with NSW Government Policy and the Floodplain Risk Management Process.

Once complete, the findings of the Flood Study will enable the Council's to start to the next step in the Floodplain Risk Management process; that is consider measures to reduce impacts of flooding.

WOODENBONG FLOOD STUDY

STUDY AREA

The Study Area will focus on flooding of the township but will also consider flooding between Woodenbong and Urbenville and the Muli Muli Community

CONTACT US

Project Website:
www.bgeeng.com/FloodStudies/Woodenbong

Email: WoodenbongFloodStudy@bgeeng.com

Council: Melissa Blum
m.blum@tenterfield.nsw.gov.au or 0439 118 312

Tenterfield Shire Council · Kyogle Council – Gateway to the Rainforests · BG&E · NSW Government Planning, Industry & Environment

WOODENBONG FLOOD STUDY QUESTIONNAIRE

Thank you for taking the time to answer this questionnaire. Your input provides useful information so that we can calibrate flood models to real-life flood data and helps us focus the study on areas and issues that are a priority to the community. Please return the questionnaire in the pre-paid envelope provided. Alternatively you can complete the questionnaire online: www.surveymonkey.com\r\WooodenbongFloodStudy

Q1. Your Details

All information provided will remain confidential and will only be used for the purpose of this study. Specific information on the respondents or their responses will not be made available or reported on.

Name _____

Address _____

Email _____

Telephone _____

Please provide you email or telephone number if you agree we can contact you in relation to this study.

Is this a property a home or workplace or other use? _____

Q2. How long have you lived/worked at this address?

Please tick the box below.

0 to 5 years	5 to 15 years	15 to 25 years	More than 25 years	How Many? (if more than 25)

Q3. How long have you lived/worked in the area?

Please tick the box below.

0 to 5 years	5 to 15 years	15 to 25 years	More than 25 years	How Many? (if more than 25)

Q4. Are you aware if your property is flood affected?

Please tick the box below.

Yes, it has flooded before	Yes, but it has not flooded	I don't think it is flood affected	I don't know

Q5. Have you or members of your household been isolated or evacuated due to flooding?

If you answered yes, you can provide further information at the end of this questionnaire, such as when this happened and for how long.

Yes, Evacuated	Yes, Isolated	No, never

WOODENBONG FLOOD STUDY QUESTIONNAIRE

Q6. Have you ever experienced flooding from Tooloom Creek?

This question relates to flooding from the river only. This information helps us to calibrate the flood models to real-life data and to get more accurate outcomes.

Yes, at this property	Yes, in the local area but my property was not affected	No, I have not observed flooding in the area

If Yes, please provide additional details such as where you observed flooding and the date and time that you experienced flooding. If you can, say how deep the water was or how high did it get? How far did the water go into your property? Was there any damage? Additional space for you response is provided at the end of this questionnaire if you need. If you have photographs these can be emailed to WoodenbongFloodStudy@bgeeng.com

Q7. Have you experienced flooding from stormwater or smaller creeks?

This question relates to flooding that is not from Tooloom Creek. This may be from the drainage channels in the town, local creeks or after heavy rainfall events.

Yes, at this property	Yes, in the local area but my property was not affected	No, I have not observed flooding in the area

If Yes, please provide additional details such as where you observed flooding and the date and time that you experienced flooding. If you can, say how deep the water was or how high did it get? How far did the water go into your property? Was there any damage? Additional space for you response is provided at the end of this questionnaire if you need. If you have photographs these can be emailed to WoodenbongFloodStudy@bgeeng.com

Q8. Are there any areas within the Woodenbong Study Area you think flooding should be reduced?

This question helps us to identify priority areas. The study area was shown on the second page.

Yes	No	I don't know / I have not been affected by flooding

If Yes, please state where

WOODENBONG FLOOD STUDY QUESTIONNAIRE

Q9. If there was a flood, do you feel like you know what to do?

Yes, I am confident I know what to do. I'll be fine	I think so, but I have not experienced flooding	I'm not sure. I'll wait until someone tells me	No, I don't know what to do	It doesn't matter, my property or local area does not flood

The outcome of the Woodenbong Flood Study will assist Kyogle Council, emergency services and the local community in understanding flood behaviour in the area so that flood damages and risk to life can be reduced.

Q10. Do you have any further information you think may help?

Yes, please see below/attached	Yes, I will email some information	Yes, please contact me	No

Photographs and records of previous flooding and rainfall are very useful to help us develop flood models which represent the real-life situations.

If Yes, please attach your feedback to this questionnaire, or email to WoodenbongFloodStudy@bgeeng.com. If you email, please make sure to include your name and address so we can match your survey results with the information you have provided.

THANK YOU

Thank you for taking the time to answer this questionnaire. Your input is valuable to the outcomes of the Woodenbong Flood Study.

Project Website:
www.bgeeng.com/FloodStudies/Woodenbong

Email: WoodenbongFloodStudy@bgeeng.com

Council: Melissa Blum
m.blum@tenterfield.nsw.gov.au or 0439 118 312

Tenterfield Shire Council · Kyogle Council – Gateway to the Rainforests · BG&E · NSW Government Planning, Industry & Environment

APPENDIX B

Historic Flooding – Photographs

Location: Bonalbo Lane and backyard of 25 and 27 Richmond Street, Woodenbong

Supplied by: Jocelyn Hurley

Date and Time Taken: December 2010

Comments: Flood waters affecting properties in lower end of Richmond Street that back onto Bonalbo Lane.

Photograph 1: Bonalbo Lane and 25/27 Richmond Street backyards, December 2010.

Photograph 2: 29 Richmond Street Shed Flooded, December 2010

Photograph 3: 29 Richmond Street House and Shed Flood Level, December 2010

Photograph 4: 29 Richmond Street Garage Flooded, December 2010

Photograph 5: 29 Richmond Street Backyard Flooding, December 2010

Location: 29 Richmond Street Backyard and Garage

Supplied by: Jocelyn Hurley

Date and Time Taken: December 2010

Comments: Flood waters affecting properties in lower end of Richmond Street that back onto Bonalbo Lane.

Photographs 2 to 5: 29 Richmond Street Backyard and Garage Inundation, December 2010.

Photograph 6: Flooding of Woodenbong Showground. Woodenbong Town in distance

Photograph 7: Flooding of Woodenbong Showground. Woodenbong Town in distance

Photograph 8: Flooding of Property

Location: Residential Property - Lot 77, Recreation Road, Woodenbong

Supplied by: Kim Robertson and Dean Jeffrey

Date and Time Taken: During 2010 Floods

Comments: Flooding in Showground can be attributed to water flowing from Black Gully through the common into Tooloom Creek.

Photographs 6 to 8: Lot 77, Recreation Flood Property Flooding, 2010.

Photograph 9: Flooding near convergence of Lindsay Creek/Grahams Creek with Tooloom Creek

Location: Residential Property - Lot 77, Recreation Road, Woodenbong

Supplied by: Kim Robertson and Dean Jeffrey

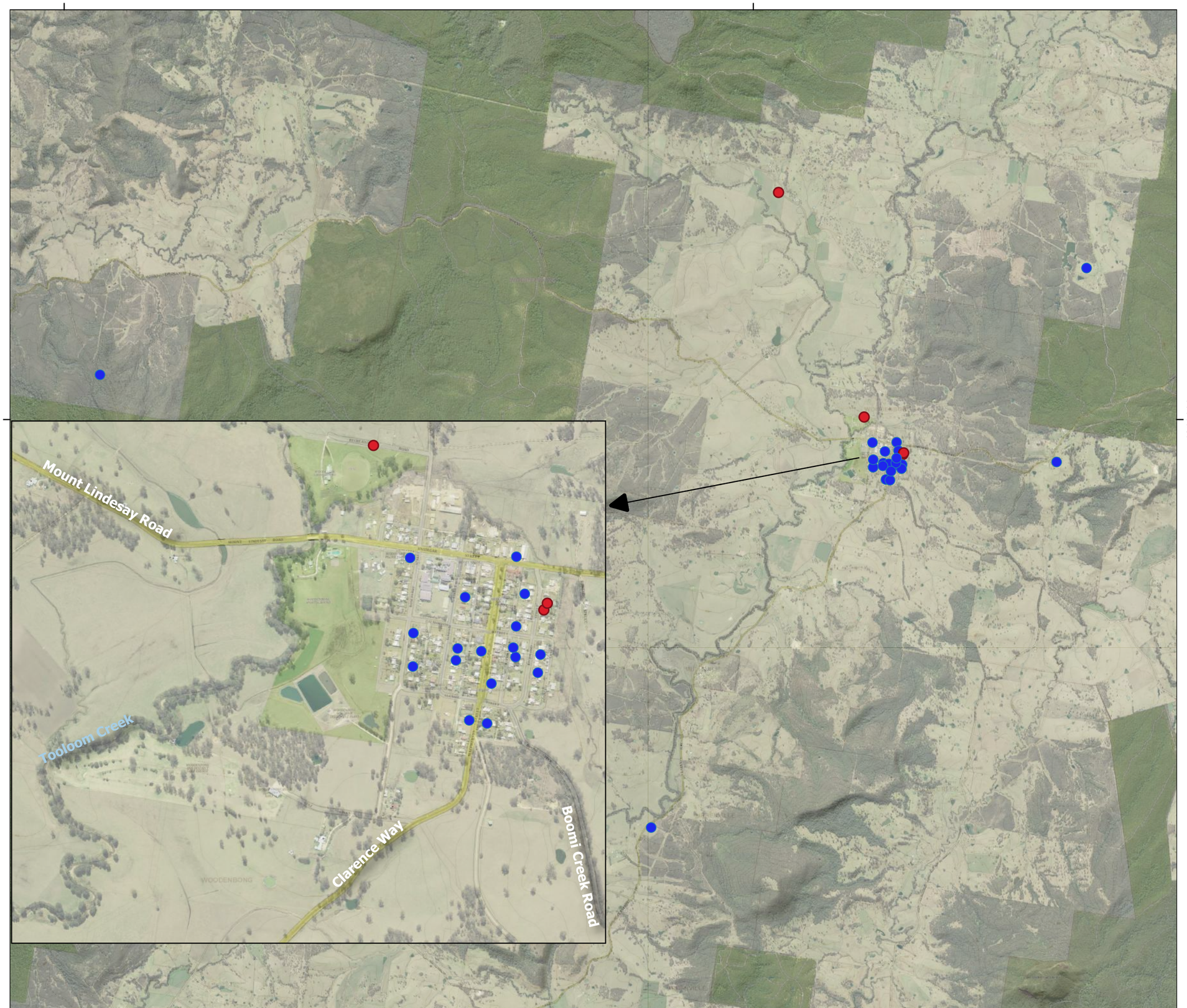
Date and Time Taken: During 2010 Floods

Comments: Photo shows flooding of Lindsay Creek/Grahams Creek where they merge at the bottom of the block and flow together to form Tooloom Creek. The flooding comes from the convergence of 3 water systems within 200-300 metres of each forming a huge volume of water.

Photograph 9: Flooding at convergence of Lindsay Creek and Graham Creek, 2010.

APPENDIX C

Mapping



Legend

Woodenbong

Location of questionnaire responses

- Has experienced flooding at property
- Has not experienced flooding at property

0 1 2 3 4 km

SCALE 1:55000

N

DRAWN	AS
REVIEWED	LB
APPROVED	LB
DATE	26/11/2020
PROJECT	S20128

Woodenbong Flood Study

Figure C1 – Location of Questionnaire Respondents

DATUM GDA 2000 MGA Zone 56

\\bge.int\dfs\Syd\Projects\BGE\SYD\S20128\100 Draw\QGIS\Figures\Woodenbong Flood Study.qgz

ACKNOWLEDGEMENT SI Maps

Legend

Woodenbong

- Priority Areas

0 100 200 300 400 500 m

SCALE 1:7500

N

DRAWN	AS
REVIEWED	LB
APPROVED	LB
DATE	26/11/2020
PROJECT	S20128

Woodenbong Flood Study

Figure C2 – Location of Priority Areas

DATUM GDA 2000 MGA Zone 56

\\bge.int\dfs\Syd\Projects\BGE\SYD\S20128\100 Draw\QGIS\Figures\Woodenbong Flood Study.qgz

ACKNOWLEDGEMENT SI Maps