# Flood Damages and Mitigation Report

## Lexton Flood Management Plan

Pyrenees Shire Council

6 August 2025

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## Project Details

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# ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work. In particular we acknowledge the Jardwadjali and Djab Wurrung Peoples as the Traditional Custodians of the waters and lands on which this this project is based.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

*Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.*

*The symbolism in the artwork includes:*

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

6 August 2025

Douglas Gowans
Director Assets and Development Services
Pyrenees Shire Council
5 Lawrence Street, Beaufort. Victoria 3373

Dear Douglas

# Lexton Flood Management Plan

Please see attached the Flood Damages and Mitigation Report for the Lexton Flood Management Plan. This report documents the mitigation assessment by detailing the impact of each modelled option as well as preliminary cost of the most feasible of the modelled options. It also determines a cost/benefit ratio for the most feasible option.

If you have any questions regarding this report don’t hesitate to contact me.

Yours sincerely

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# CONTENTS



# APPENDICES

# LIST OF FIGURES



# LIST OF TABLES

# GLOSSARY

| | |
|---|---|
| Annual Exceedance Probability (AEP) | Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small. A 1% AEP flood has a low probability of occurrence or being exceeded; it would be fairly rare but it would be of extreme magnitude. |
| Australian Height Datum (AHD) | A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums. |
| Average Recurrence Interval (ARI) | Refers to the average time interval between a given flood magnitude occurring or being exceeded. A 10 year ARI flood is expected to be exceeded on average once every 10 years. A 100 year ARI flood is expected to be exceeded on average once every 100 years. The AEP is the ARI expressed as a percentage. |
| Cadastre, cadastral base | Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc. |
| Catchment | The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream. |
| Design flood | A design flood is a probabilistic or statistical estimate, being generally based on some form of probability analysis of flood or rainfall data. An average recurrence interval or exceedance probability is attributed to the estimate. |
| Discharge | The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving. |
| Flood | Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from elevated sea levels and/or waves overtopping coastline defences. |
| Flood frequency analysis | A statistical analysis of observed flood magnitudes to determine the probability of a given flood magnitude. |
| Flood hazard | Potential risk to life and limb caused by flooding. Flood hazard combines the flood depth and velocity. |
| Floodplain | Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land. |
| Flood storages | Those parts of the floodplain that are important for the temporary storage, of floodwaters during the passage of a flood. |

| | |
|---|---|
| Geographical information systems (GIS) | A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data. |
| Hydraulics | The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity. |
| Hydrograph | A graph that shows how the discharge changes with time at any particular location. |
| Hydrology | The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods. |
| Intensity frequency duration (IFD) analysis | Statistical analysis of rainfall, describing the rainfall intensity (mm/hr), frequency (probability measured by the AEP), duration (hrs). This analysis is used to generate design rainfall estimates. |
| LiDAR | Spot land surface heights collected via aerial light detection and ranging (LiDAR) survey. The spot heights are converted to a gridded digital elevation model dataset for use in modelling and mapping. |
| Peak flow | The maximum discharge occurring during a flood event. |
| Probability | A statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Average Recurrence Interval. |
| Probable Maximum Flood | The flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area. |
| RORB | A hydrological modelling tool used in this study to calculate the runoff generated from historic and design rainfall events. |
| Runoff | The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess. |
| Stage | Equivalent to 'water level'. Both are measured with reference to a specified datum. |
| Stage hydrograph | A graph that shows how the water level changes with time. It must be referenced to a particular location and datum. |
| Topography | A surface which defines the ground level of a chosen area. |

# 1 INTRODUCTION

## 1.1 Overview

Water Technology was commissioned by Pyrenees Shire Council (PSC) to undertake the Lexton Flood Management Plan. The investigation has produced detailed flood mapping and other outputs for the Lexton township and determined flows for the upstream catchment. The study area is presented in Figure 1-1.

The study has produced reliable flood intelligence for use in emergency management, an assessment of the current flood impact/exposure in terms of annual average damages (AAD) caused by flooding in Lexton, investigation of structural and non-structural mitigation options and made recommendations for establishing a flood warning system for the town.

This report is one of a series documenting the outcomes of the Lexton Flood Management Plan. The report covers flood damages and impacts of potential mitigation options. Each reporting stage is shown below:

- R01 – Data Review and Validation
- R02 – Model Calibration Report
- **R03 – Flood Damages and Mitigation Assessment Report – This report**
- R04 – Flood Intelligence, Flood Warning and Municipal Flood Emergency Plan (MFEP) Documentation
- R05 – Final Summary Report

## 1.2 Study area

Lexton is a small township located in Victoria, Australia, with a population of approximately 285 (based on the 2021 census data). Lexton is located approximately 45 km northwest of Ballarat and 90 km southwest of Bendigo. Lexton Creek flows to the west of the Lexton township and into Burnbank Creek, the main waterway flowing through Lexton. The Burnbank Creek catchment is approximately 45 $km^2$, consisting of native bushland and agricultural areas, as shown in Figure 1-2. Burnbank Creek flows in a northerly direction towards Bet Bet Creek and then into the Loddon River north of Eddington.

Lexton most recently experienced flooding in October 2022, which caused widespread damage and disruption to the township. The flooding resulted in closed roads, isolating the town with limited access in and out of the area. These flood events caused millions of dollars in damage and greatly affected the prosperity of the community, including impacting major events and deterring visitors.

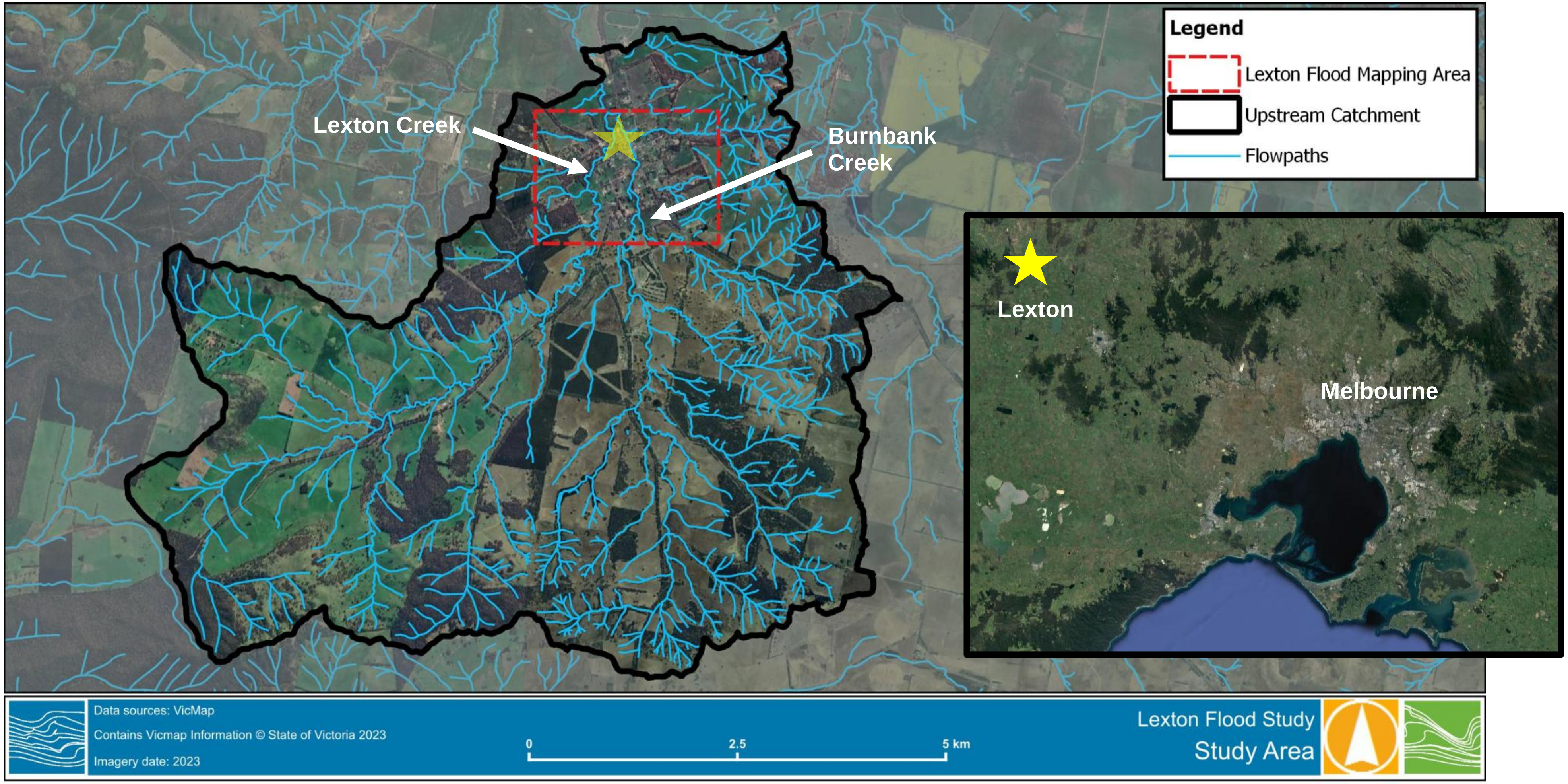


**Figure 1-1 Lexton study area**

# 2 FLOOD BEHAVIOUR

## 2.1 Overview

The modelled 1% AEP flood extent and road names within Lexton are presented in Figure 2-1 to assist the descriptions of flood behaviour included within this report. Lexton Creek and Burnbank Creek flow into Lexton from the south and the stormwater flow paths are located to the east of the township.

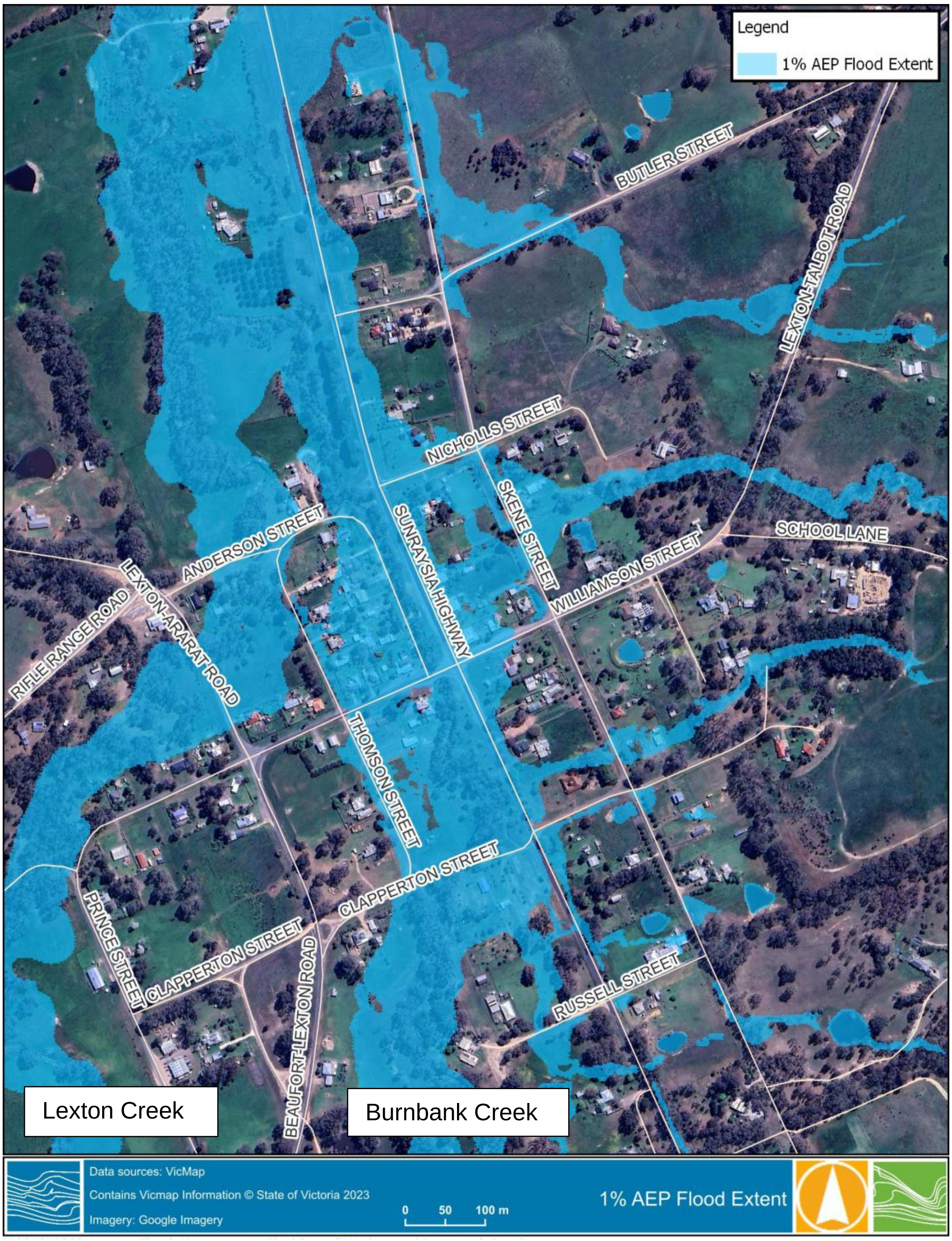


**Figure 2-1 1% AEP Flood Extent**

### 2.1.1 Burnbank Creek

Burnbank Creek originates to the south of Lexton. It flows in a northerly direction, generally between the Beaufort-Lexton Road and the Sunraysia Highway. Burnbank Creek crosses Prince Street, Waldy Street and Clapperton Street before crossing Williamson Street and continuing north between Goldsmith Street and the Sunraysia Highway. There are four main tributaries to the east of Lexton which flow across the Sunraysia Highway and into Burnbank Creek. Lexton Creek flows into Burnbank Creek approximately 500 m north-west of Lexton. Burnbank Creek continues flowing north and eventually flows into Bet Bet Creek and then into the Loddon River north of Eddington. The Burnbank Creek catchment upstream of Lexton is approximately 13.4 $km^2$.

Flooding in Lexton is driven by flooding from Burnbank Creek. Burnbank Creek causes above floor flooding in a 1% AEP flood event in Clapperton Street, Williamson Street and Goldsmith Street. During a 1% AEP flood event, Burnbank Creek and Lexton Creek connect across Goldsmith Street, Thomson Street and Williamson Street inundating a large portion of the township. During a 20% AEP flood event, a large area of the Sunraysia Highway is overtopped near Williamson Street.

### 2.1.2 Lexton Creek

Lexton Creek originates to the south-west of Lexton. Lexton Creek flows in a northerly direction, along the west of Beaufort-Lexton Road before crossing Lexton-Ararat Road and Anderson Street and converging with Burnbank Creek. The confluence of Lexton Creek and Burnbank Creek is located approximately 500 m to the north-west of the Lexton township. The Lexton Creek catchment upstream of the confluence is approximately 20.7 $km^2$.

The channel banks are relatively steep, and 20% AEP flows are generally contained within the channel. During a 1% AEP flood event, the floodplain around Lexton Creek is engaged. Lexton Creek typically flows through rural paddocks and generally does not inundate residential areas until it reaches Williamson Street. Around Williamson Street, Lexton Creek breaks out and flows to the east along Williamson Street, inundating several properties with shallow floodwater before re-entering Lexton Creek at Lexton Ararat Road. Lexton-Ararat Road is overtopped during a 20% AEP event, restricting access around the township.

### 2.1.3 Stormwater

To the east of Lexton, four main flow paths cross the Sunraysia Highway into Burnbank Creek. The largest of these tributaries begins north of School Road and flows westward toward Burnbank Creek. It flows under Lexton-Talbot Road through two large culverts and continues through a constructed channel. This channel passes beneath Skene Street, makes a sharp right-angle turn to the north, followed by another right-angle turn to the west along Anderson Street. Finally, it crosses under the Sunraysia Highway before reaching Burnbank Creek.

It was reported by residents in this area that the constructed channel and culverts under Skene Street were upgraded following the flood in 2011. This flow path was particularly destructive during the October 2022 flood event, overtopping the channel and inundating several paddocks and property sheds.

## 2.2 Flooding Hotspots

Based on discussions with PSC and Lexton residents, the following flooding hotspot locations were identified for mitigation investigation:

- Location 1 – Along Goldsmith Street
  - Flooding from Burnbank Creek impacts the Lexton township, particularly the properties along Goldsmith Street which are located adjacent to Burnbank Creek. During the 2022 flood event, several buildings were flooded above floor level along Goldsmith Street.
- Location 2 – Corner of Sunraysia Highway and Williamson Street
  - This area is affected by a combination of flooding from Burnbank Creek and stormwater from the eastern catchment. Several buildings in this area were flooded above floor level during the 2022 flood event.
- Location 3 – Constructed Drain along Skene Street and Nicholls Street
  - Stormwater from the eastern catchment flows through the constructed drain along Skene Street and Nicholls Street. During large storm events, water overtops the drain and inundates surrounding properties. This is particularly exacerbated when levels are high in Burnbank Creek and stormwater from the constructed drain is unable to freely flow into Burnbank Creek.

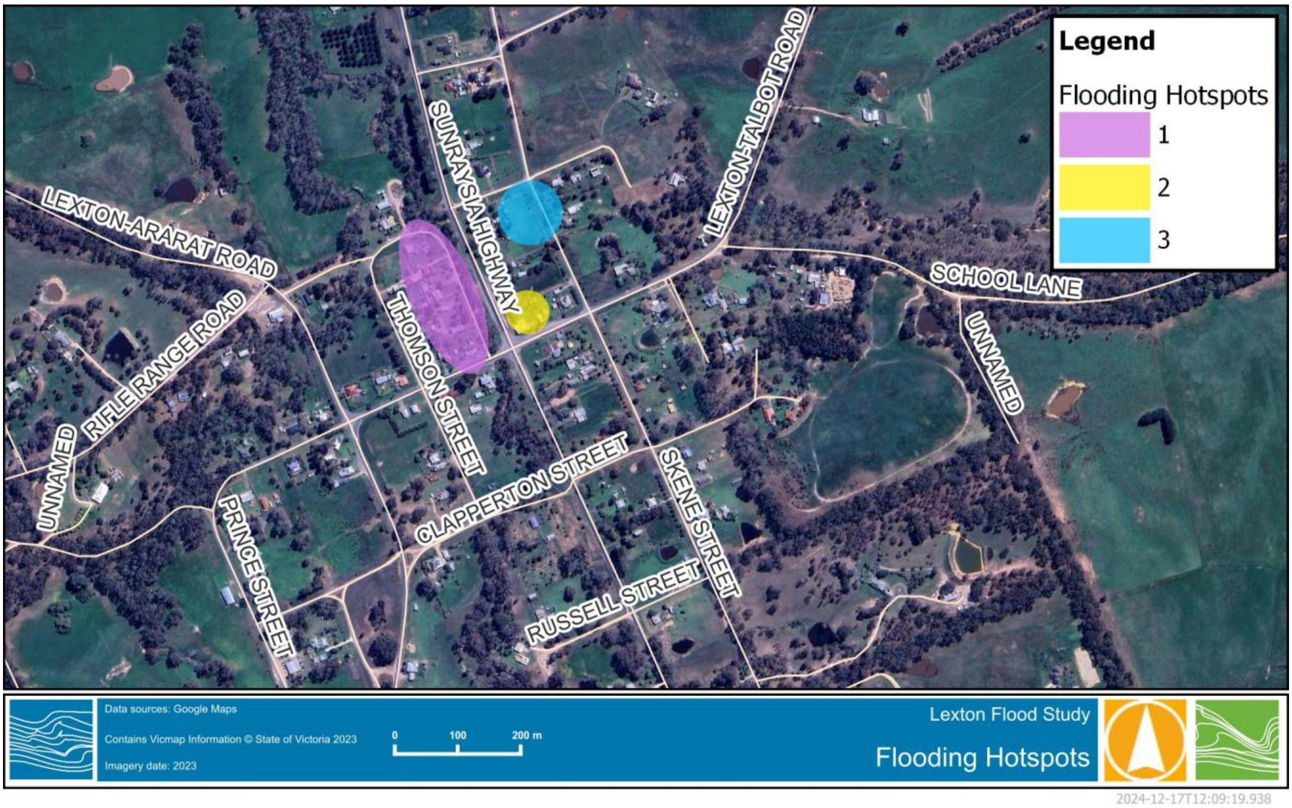


Figure 2-2 Lexton Flooding Hotspots

## 2.3 Roads

During minor to major flood events, the regional and local road network often becomes inundated. There is risk associated with travelling through floodwaters of any depth. Flood water can often unknowingly exceed safe vehicle fording depths and velocities. This presents a risk to the community, who may become isolated and seek to evacuate and to operational staff and emergency services, who may traverse unsafe roads.

The main access roads to and from the township of Lexton include the Sunraysia Highway, Lexton-Ararat Road, Beaufort-Lexton Road and Lexton-Talbot Road. The Sunraysia Highway, Lexton-Ararat Road and Lexton-Talbot Road become inundated while the Beaufort-Lexton Road can provide access in and out of Lexton during major flood events. The Sunraysia Highway is an important major road for regional Victoria, during the 1% AEP event, the Sunraysia Highway can be inundated to unsafe levels **between 2 – 12 hours after rainfall.**

Flood mapping shows several roads within the mapped area can become impacted by flood water during frequent flood events (i.e. less than 20% AEP). For example, the following roads cross Lexton Creek or Burnbank Creek and are significantly inundated during minor events.

- Anderson Street
- Clapperton Street
- Gladstone Street
- Goldsmith Street
- Lexton - Ararat Road
- Pound Paddock Road
- Prince Street
- Waldy Street
- Williamson Street

These impassable roads (depths greater than 0.3 m) are shown in Appendix A with the comparison to the 1% AEP flood extent.

Table 2-1 outlines the impassable roads where maximum depths exceed 0.3 m and become unsafe for vehicles. Major roads are highlighted in **bold**. The extent of road inundation for all modelled events is shown in Appendix A. Consideration should be given to this information in planning for suitable evacuation routes. Further information will be provided in the Flood Intelligence Report.

Table 2-1 Roads overtopped in the study area

| Roads inundated | Design flood AEP (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 20 | 10 | 5 | 2 | 1 | 0.5 | 0.2 | 0.1 | 0.05 |
| **Anderson Street** | 1.22 | 1.32 | 1.40 | 1.57 | 1.64 | 1.72 | 1.87 | 1.98 | 2.09 |
| Butler Street | 0.37 | 0.46 | 0.55 | 0.70 | 0.78 | 0.85 | 0.92 | 1.00 | 1.08 |
| Clapperton Street | 1.67 | 1.79 | 1.90 | 2.08 | 2.16 | 2.24 | 2.32 | 2.38 | 2.46 |
| Gladstone Street | 2.26 | 2.41 | 2.53 | 2.78 | 2.88 | 2.99 | 3.14 | 3.23 | 3.31 |
| Goldsmith Street | 0.64 | 0.73 | 0.82 | 1.00 | 1.09 | 1.18 | 1.25 | 1.31 | 1.39 |
| **Lexton - Ararat Road** | 1.78 | 1.87 | 1.94 | 2.05 | 2.11 | 2.18 | 2.27 | 2.34 | 2.42 |
| Nicholls Street | 0.43 | 0.54 | 0.62 | 0.75 | 0.82 | 0.88 | 0.93 | 0.98 | 1.03 |
| Pound Paddock Road | 1.50 | 1.63 | 1.74 | 1.96 | 2.06 | 2.17 | 2.36 | 2.47 | 2.58 |
| Prince Street | 2.28 | 2.47 | 2.61 | 2.78 | 2.85 | 2.91 | 2.98 | 3.02 | 3.08 |
| Russell Street | 0.33 | 0.34 | 0.36 | 0.43 | 0.45 | 0.46 | 0.48 | 0.48 | 0.48 |
| **Sunraysia Highway** | 1.03 | 1.13 | 1.20 | 1.33 | 1.41 | 1.48 | 1.55 | 1.63 | 1.72 |
| Thomson Street | 0.31 | 0.41 | 0.48 | 0.64 | 0.72 | 0.80 | 0.94 | 1.03 | 1.13 |
| Waldy Street | 1.39 | 1.75 | 2.03 | 2.32 | 2.44 | 2.53 | 2.63 | 2.70 | 2.79 |
| West Street | 0.50 | 0.60 | 0.68 | 0.83 | 0.91 | 0.98 | 1.07 | 1.16 | 1.25 |
| Williamson Street | 2.15 | 2.20 | 2.34 | 2.52 | 2.61 | 2.69 | 2.79 | 2.85 | 2.93 |
| **Lexton - Talbot Road** | | | | 0.39 | 0.41 | 0.47 | 0.52 | 0.55 | 0.58 |
| Lexton Recreation Reserve Access Road | | | | 0.32 | 0.39 | 0.45 | 0.51 | 0.54 | 0.60 |
| Robertson Street | | | | | | 0.43 | 0.59 | 0.64 | 0.67 |
| Skene Street | | | | | | 0.32 | 0.35 | 0.37 | 0.38 |

## 2.4 Buildings

Floor level survey of 35 residential buildings was captured within the study area. These buildings were selected for survey based on the preliminary flood modelling undertaken during this study. It should be noted that only the main residential dwelling was captured for each property, outbuildings were not surveyed.

The number of buildings flooded above floor level for each AEP event under baseline conditions are presented in Table 2-2. The baseline conditions 1% AEP flood extent and the buildings flooded above floor during the range of modelled design events is shown in Figure 2-3.

Climate change conditions were also investigated during the modelling stage of this project, further details are described in the *Model Calibration Report*. Table 2-3 presents the number of properties flooded above floor for each AEP event under climate change conditions (for 2030 SSP 3 – 7). The buildings flooded above floor under climate change conditions is shown in Figure 2-4. Table 2-4 presents the number of properties flooded above floor for each AEP event under climate change conditions (for 2100 SSP 5 – 8.5). The buildings flooded above floor under climate change conditions is shown in Figure 2-5.

**Table 2-2 Summary of building inundation – Baseline Conditions**

| Design Flood Event (AEP) | No. of buildings flooded above floor – Residential | No. of buildings flooded above floor – Commercial |
|---|---|---|
| 20% | 1 | 0 |
| 10% | 2 | 0 |
| 5% | 3 | 1 |
| 2% | 3 | 2 |
| 1% | 4 | 2 |
| 0.5% | 5 | 2 |
| 0.2% | 9 | 3 |
| 0.1% | 11 | 4 |
| 0.05% | 14 | 5 |
| PMF | 29 | 5 |

**Table 2-3 Summary of building inundation – Climate Change Conditions (2030 SSP3 – 7)**

| Design Flood Event (AEP) | No. of buildings flooded above floor – Residential | No. of buildings flooded above floor – Commercial |
|---|---|---|
| 20% | 2 | 0 |
| 10% | 3 | 0 |
| 5% | 3 | 1 |
| 2% | 4 | 2 |
| 1% | 4 | 2 |
| 0.5% | 8 | 3 |
| 0.2% | 12 | 5 |
| 0.1% | 12 | 5 |
| 0.05% | 16 | 5 |

**Table 2-4 Summary of building inundation – Climate Change Conditions (2100 SSP 5 – 8.5)**

| Design Flood Event with Climate Change (AEP) | No. of buildings flooded above floor – Residential | No. of buildings flooded above floor – Commercial |
|---|---|---|
| 20% | 3 | 1 |
| 10% | 3 | 1 |
| 5% | 5 | 2 |
| 2% | 12 | 4 |
| 1% | 18 | 5 |
| 0.5% | 21 | 5 |
| 0.2% | 24 | 5 |
| 0.1% | 24 | 5 |
| 0.05% | 25 | 5 |

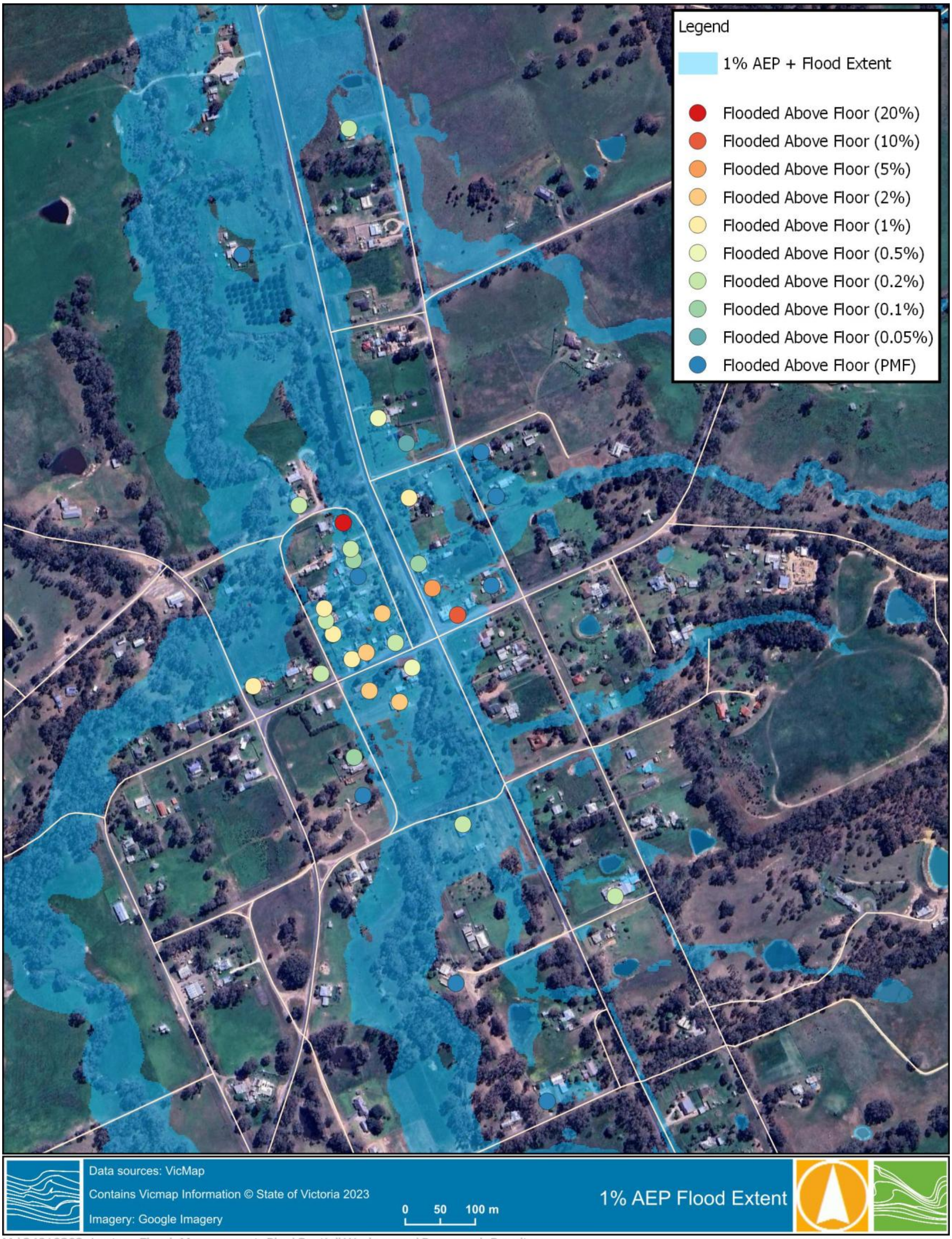


**Figure 2-3 Buildings flooded above floor – Baseline Conditions**

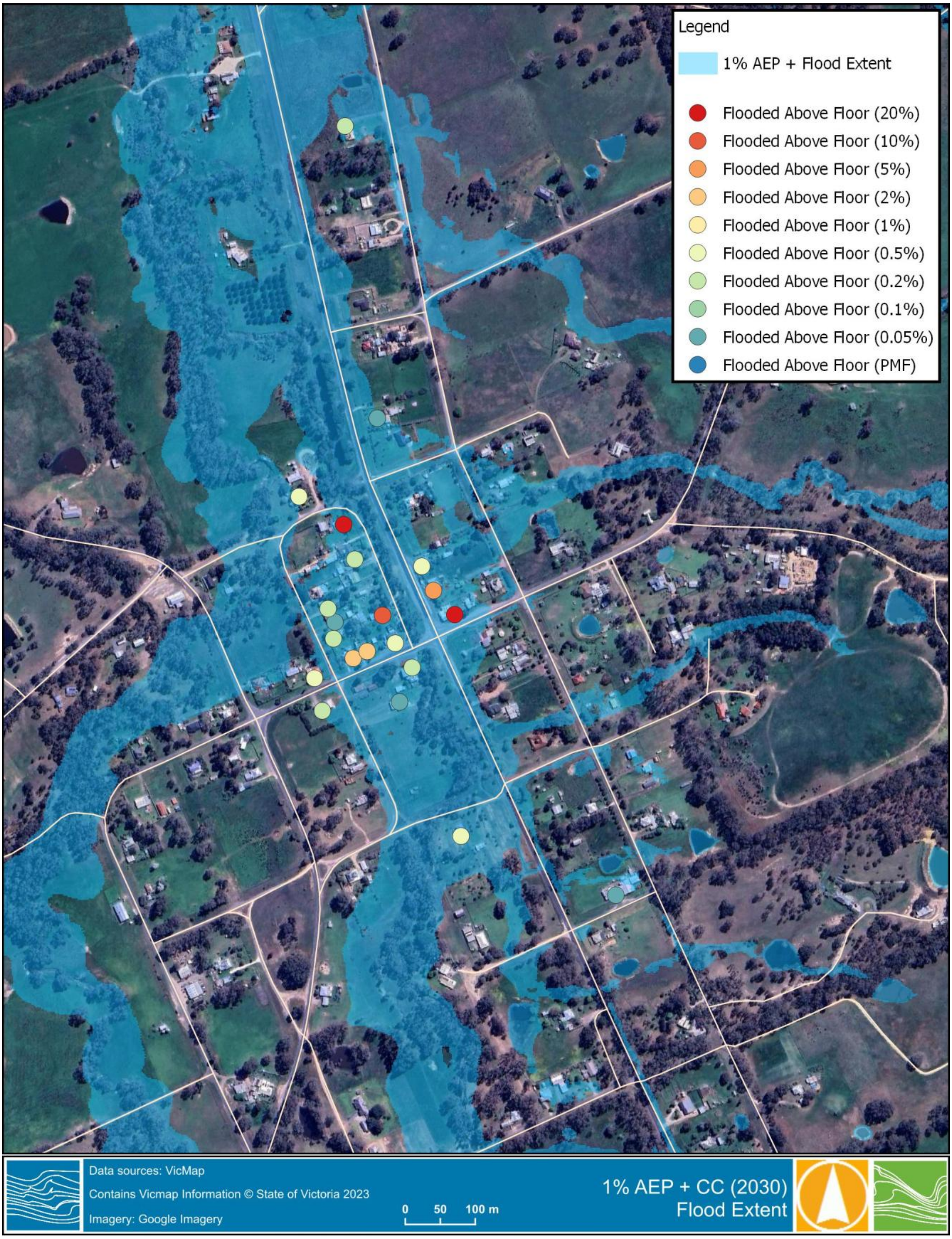


**Figure 2-4 Buildings flooded above floor – Climate Change Conditions (2030 SSP3 – 7)**

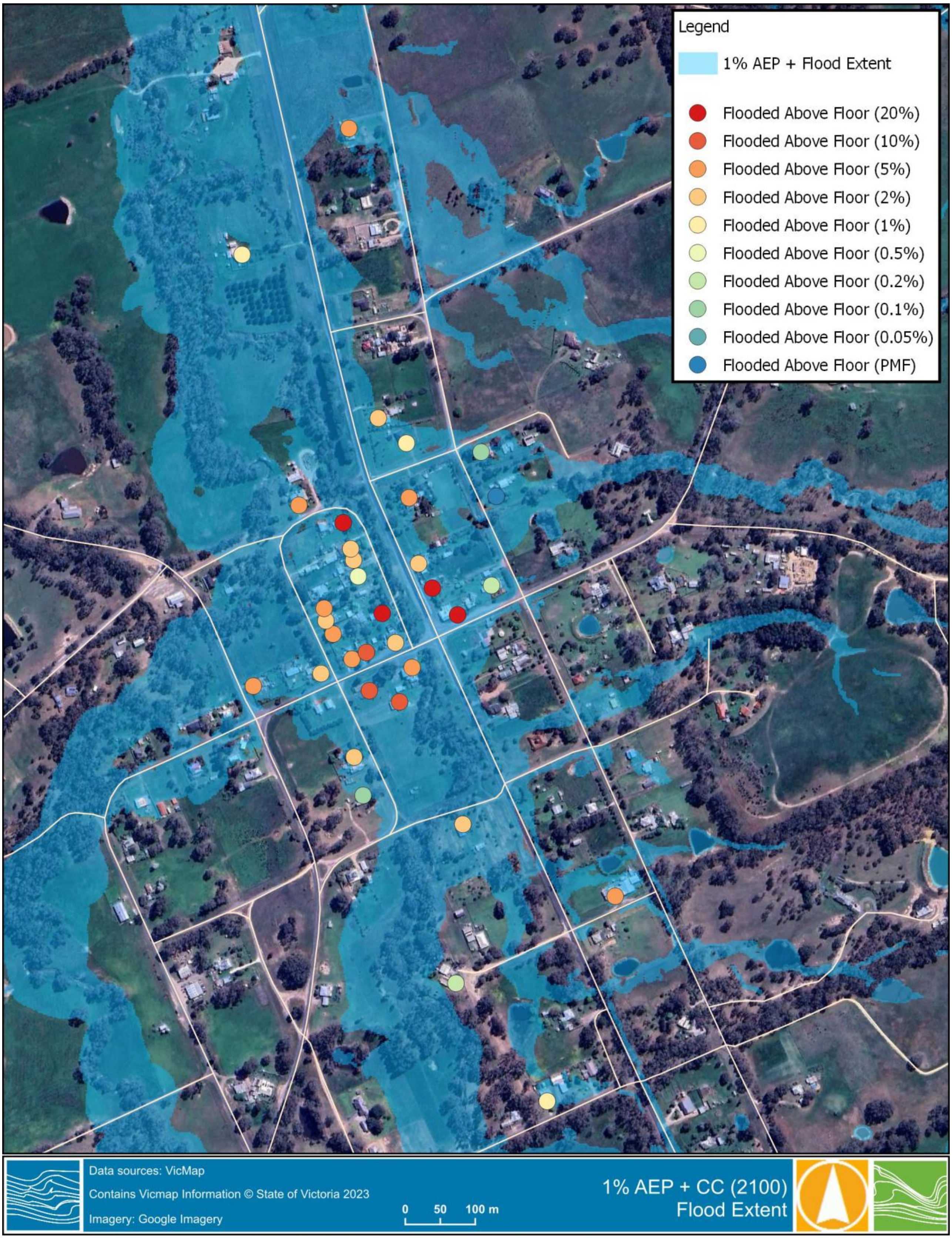


**Figure 2-5** **Buildings flooded above floor – Climate Change Conditions (2100 SSP 5 – 8.5)**

# 3 DAMAGES ASSESSMENT

A flood damage assessment was undertaken for the study area under both baseline and future climate change conditions. The flood damage assessment determined the monetary flood damage for the range of modelled design events (i.e. 20%, 10%, 5%, 2%, 1%, 0.5%, 0.2%, 0.05% AEP and PMF floods). The 2100 SSP 5 – 8.5 climate change scenario was modelled.

Model results for all mapped flood events were processed to calculate the number and location of properties and roads affected. This included buildings inundated above and below floor, properties which did not have buildings impacted but the grounds of the property were, and the lengths of flood affected roads. It should be noted that only sealed roads were assessed due to the availability of associated costs for unsealed roads. Flood damages were calculated and summed for each property and roads utilising the damage curves presented in Table 3-1.

**Table 3-1 Damage curves utilised in assessment**

| Damage category | Damage vs depth curve |
|---|---|
| Residential | Stage damage curves based on NSW Office of Environment and Heritage 2007 methodology[1] (factored up to 2022 CPI) |
| Commercial | Stage damage curves based on ANUFLOOD 1992 methodology (increased by 60% as per RAM 2000 methodology[2], and factored up to 2022 CPI) |
| Infrastructure and Rural | RAM 2000 methodology[2] and factored up to 2022 CPI |
| External Below Floor | Damage curve from NSW DPIE 1992 methodology (factored up to 2022 CPI) |

The damage occurring in each of the modelled events was used to calculate an Average Annual Damage (AAD) for the study area, this is the amount of funding required to be set aside each year to repair flood damage. It does not include the social or mental health cost of flooding which can be significant but difficult to measure with monetary value.

A summary of the flood damage assessment is shown in Table 3-2 for the baseline conditions and Table 3-3 for climate change conditions. It is noted that above floor flooding at residential properties is likely to occur in a 20% AEP flood event, although at a limited number of properties.

For the Lexton study area, an AAD cost of $104,815 was determined for baseline conditions and $212,098 for climate change conditions.

[1] NSW Office of Environment and Heritage (2007) Floodplain Risk Management Guidelines: Residential Flood Damages
[2] Rapid appraisal method (RAM) for floodplain management, Victorian Department of Natural Resources and Environment, 2000

Table 3-2 Baseline Conditions Average Annual Damages (AAD)

| | AEP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **0.05%** | **0.10%** | **0.20%** | **0.50%** | **1.00%** | **2.00%** | **5.00%** | **10.00%** | **20.00%** |
| Residential Buildings Flooded Above Floor | 14 | 11 | 9 | 5 | 4 | 3 | 3 | 2 | 1 |
| Commercial Buildings Flooded Above Floor | 5 | 4 | 3 | 2 | 2 | 2 | 1 | 0 | 0 |
| Properties Flooded Below Floor | 106 | 106 | 108 | 108 | 106 | 101 | 89 | 88 | 83 |
| **Total Properties Flooded** | 125 | 121 | 120 | 115 | 112 | 106 | 93 | 90 | 84 |
| Direct Potential External Damage Cost | $585,752 | $590,038 | $583,796 | $571,401 | $479,627 | $396,427 | $217,492 | $197,011 | $157,178 |
| Direct Potential Residential Damage Cost | $984,511 | $820,644 | $614,072 | $367,446 | $298,647 | $238,366 | $176,764 | $134,185 | $33,841 |
| Direct Potential Commercial Damage Cost | $54,751 | $44,993 | $34,206 | $25,959 | $16,871 | $6,548 | $1,039 | $0 | $0 |
| Total Direct Potential Damage Cost | $1,625,014 | $1,455,675 | $1,232,074 | $964,806 | $795,145 | $641,341 | $395,295 | $331,196 | $191,019 |
| Total Actual Damage Cost *(0.8*Potential)* | $1,300,011 | $1,164,540 | $985,659 | $771,845 | $636,116 | $513,073 | $316,236 | $264,957 | $152,815 |
| Infrastructure Damage Cost | $426,635 | $398,844 | $380,392 | $333,538 | $324,212 | $283,782 | $208,219 | $189,511 | $154,747 |
| Rural Cost | $7,861 | $7,377 | $7,061 | $6,440 | $6,283 | $5,868 | $4,764 | $4,491 | $3,855 |
| **Total Cost** | $1,734,507 | $1,570,760 | $1,373,112 | $1,111,823 | $966,612 | $802,722 | $529,220 | $458,959 | $311,417 |
| **Average Annual Damage (AAD)** | | | | | | | | | **$104,816** |

**Table 3-3 Climate Change Conditions (2100 SSP 5 – 8.5) Average Annual Damages (AAD)**

| | AEP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **0.05%** | **0.10%** | **0.20%** | **0.50%** | **1.00%** | **2.00%** | **5.00%** | **10.00%** | **20.00%** |
| Residential Buildings Flooded Above Floor | 25 | 24 | 24 | 21 | 18 | 12 | 5 | 3 | 3 |
| Commercial Buildings Flooded Above Floor | 5 | 5 | 5 | 5 | 5 | 4 | 2 | 1 | 1 |
| Properties Flooded Below Floor | 110 | 109 | 107 | 105 | 105 | 106 | 111 | 108 | 95 |
| **Total Properties Flooded** | 140 | 138 | 136 | 131 | 128 | 122 | 118 | 112 | 99 |
| Direct Potential External Damage Cost | $924,561 | $866,425 | $746,845 | $678,703 | $623,963 | $615,233 | $586,999 | $428,494 | $289,662 |
| Direct Potential Residential Damage Cost | $2,176,148 | $2,050,338 | $1,856,862 | $1,571,770 | $1,310,293 | $858,350 | $387,491 | $237,363 | $221,338 |
| Direct Potential Commercial Damage Cost | $156,082 | $135,945 | $115,579 | $92,602 | $72,450 | $45,087 | $24,242 | $6,602 | $3,782 |
| Total Direct Potential Damage Cost | $3,256,791 | $3,052,708 | $2,719,286 | $2,343,075 | $2,006,706 | $1,518,670 | $998,732 | $672,459 | $514,782 |
| Total Actual Damage Cost *(0.8*Potential)* | $2,605,433 | $2,442,166 | $2,175,429 | $1,874,460 | $1,605,365 | $1,214,936 | $798,986 | $537,967 | $411,826 |
| Infrastructure Damage Cost | $655,803 | $623,349 | $536,966 | $496,432 | $464,488 | $414,766 | $370,099 | $318,736 | $260,911 |
| Rural Cost | $11,348 | $10,867 | $9,715 | $8,858 | $8,280 | $7,691 | $6,903 | $6,269 | $5,542 |
| **Total Cost** | $3,272,583 | $3,076,382 | $2,722,110 | $2,379,750 | $2,078,133 | $1,637,392 | $1,175,987 | $862,972 | $678,279 |
| **Average Annual Damage (AAD)** | | | | | | | | | **$212,099** |

# 4 STRUCTURAL MITIGATION OPTIONS

## 4.1 Overview

Flood risk and flood damages can generally be reduced with structural and non-structural mitigation options. Structural mitigation options are engineering solutions which focus on reducing flood extent, depth and damages. Non-structural mitigation options focus on ensuring that new development does not occur in high flood risk areas, and they aim to raise community awareness of the risk and support improvement to emergency response during a flood event.

Four potential structural mitigation options were tested in the hydraulic model, with initial feasibility screening undertaken for the 1% AEP event. The options focused on reducing damage and hazard associated with the overland flow impacting residential lots and road crossings. Community feedback regarding mitigation options was sought during community consultation. The modelled mitigation options were discussed with PSC and were determined as having the potential to reduce flood levels in several locations while not causing adverse impacts in other areas. The four options considered were as follows:

- Mitigation Option 1 – Clearing Burnbank Creek of any non-native vegetation.
- Mitigation Option 2 – Development of a Levee that sits along the western side of Burnbank Creek.
- Mitigation Option 3 – Implementing a drain on the east side of Burnbank Creek that would create a more direct flow into the creek.
- Mitigation Option 4 – Combining the drain implementation with the development of the Levee (Option 2 and Option 3 combined).

The options were investigated separately, and the 1% AEP and 10% AEP under climate change conditions (2100 SSP 5 – 8.5) was used. Water levels produced during each mitigation option were compared to those produced under existing conditions. The change in modelled water levels for each option was thematically mapped to show a graphical representation of the increases and decreases to understand the impact of each respective mitigation option. Water level difference maps for each scenario are presented and discussed in each of the respective sections.

It is important to note that the community showed overwhelming support for Mitigation Option 1. Following the major floods in October 2022, significant amounts of debris, including fallen trees and logs, were observed in Burnbank Creek and Lexton Creek. The community strongly expressed their desire for these waterways to be cleaned out to ensure water can flow through the waterways freely.

## 4.2 Mitigation Option 1 - Clearing Waterway

Burnbank Creek has become heavily vegetated which influences the ability for water to freely and efficiently flow through Burnbank Creek and Lexton Creek. Many of the residents expressed their concern about the rapid growth of vegetation within the waterways in recent years. In addition, it is reported that following the major flood in 2022, a lot of debris and fallen trees flowed from the upstream catchment and was deposited in the waterways within Lexton. There is a strong desire from the community to clear these waterways of non-native vegetation and any debris and logs.

This mitigation option proposes the removal of non-native vegetation and any logs and debris to assist in more efficient conveyance of flow. Flooding of Burnbank Creek causes the greater inundation of properties around Lexton. Therefore at this stage, only a small section of Burnbank Creek has been tested to be cleared. To represent this, the Manning's 'n' roughness value was reduced by 0.03, from 0.08 to 0.05, this is consistent with moving from an unmaintained channel with dense weeds to a dredged channel with light brush on the banks. The locations of adjusted roughness are shown in Figure 4-1.

The results show generally reduced flood levels within Burnbank Creek and adjacent areas. Flood levels are reduced by up to 120 mm within Burnbank Creek and approximately 100 mm in the surrounding areas. Flood extents are slightly reduced but not enough to reduce the number of roads overtopped in the 2100 climate change 1% AEP scenario. The most significant reductions in depth were observed at the Sunraysia Highway, Williamson Street, Anderson Street, Goldsmith Street and Nicholls Street. The change in flood levels is shown in Figure 4-2 for the 1% AEP scenario and Figure 4-3 for the 10% AEP scenario.

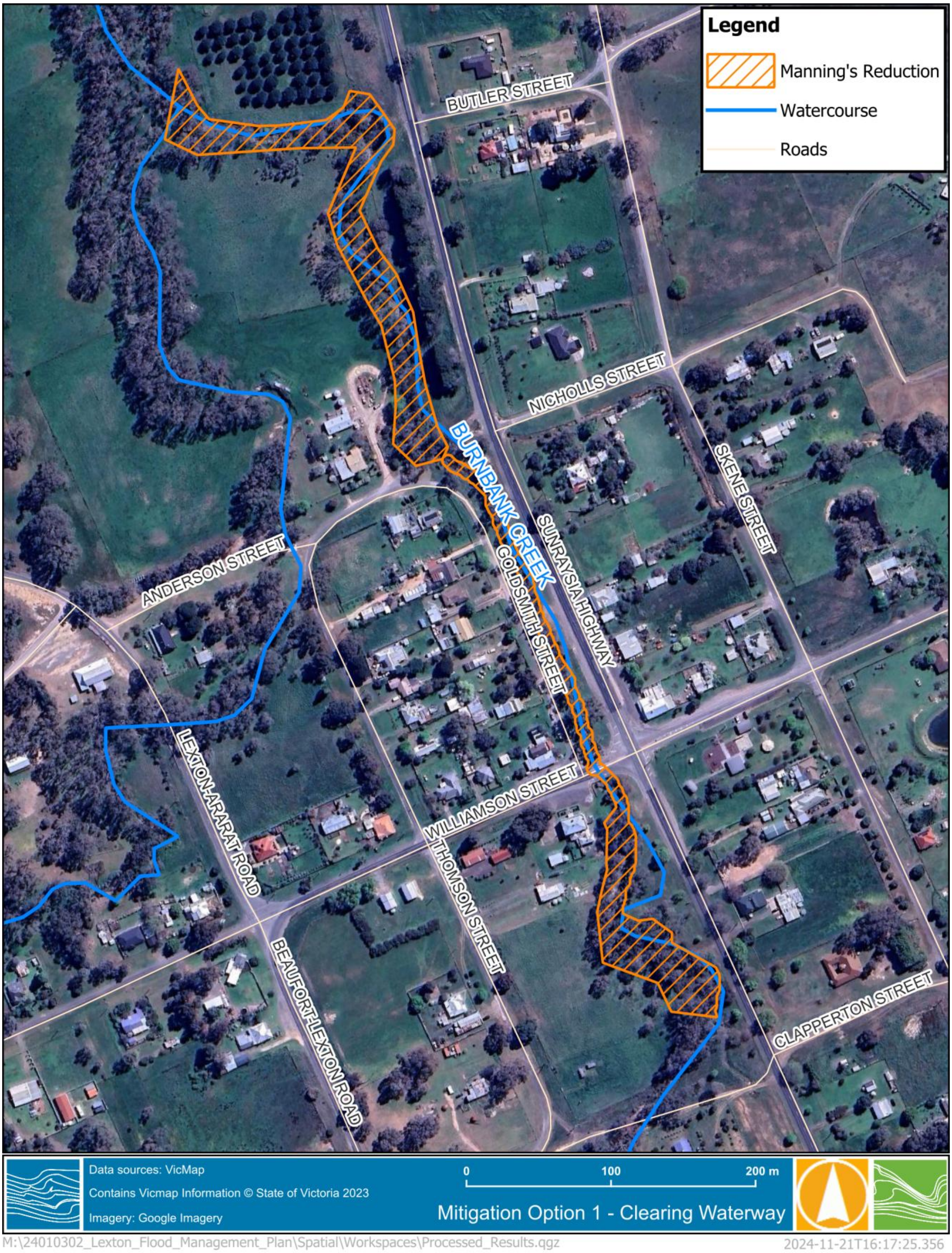


**Figure 4-1 Mitigation Option 1 – Clearing waterway**

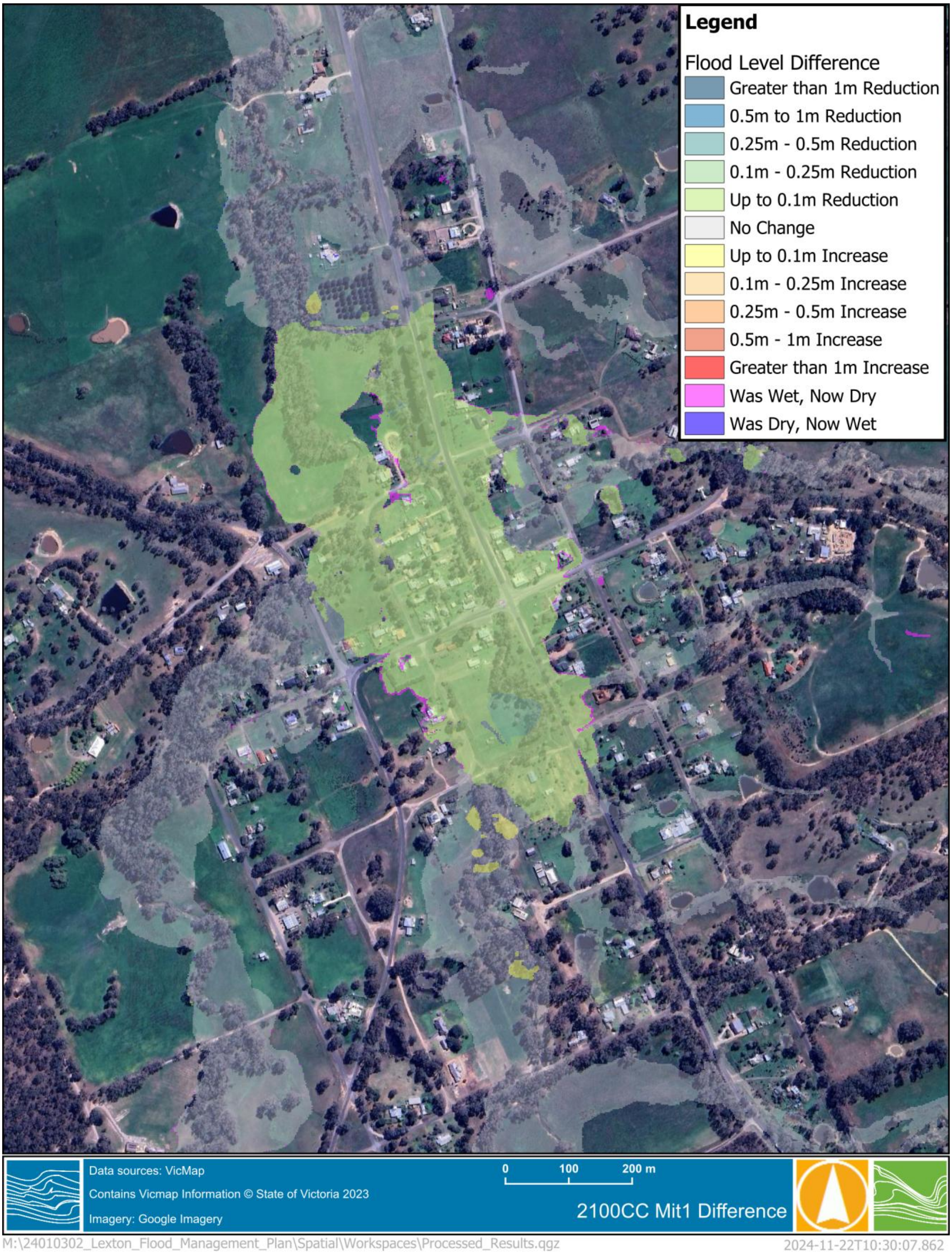


**Figure 4-2 Mitigation Option 1 – 1% AEP (2100CC) Flood Level Difference**

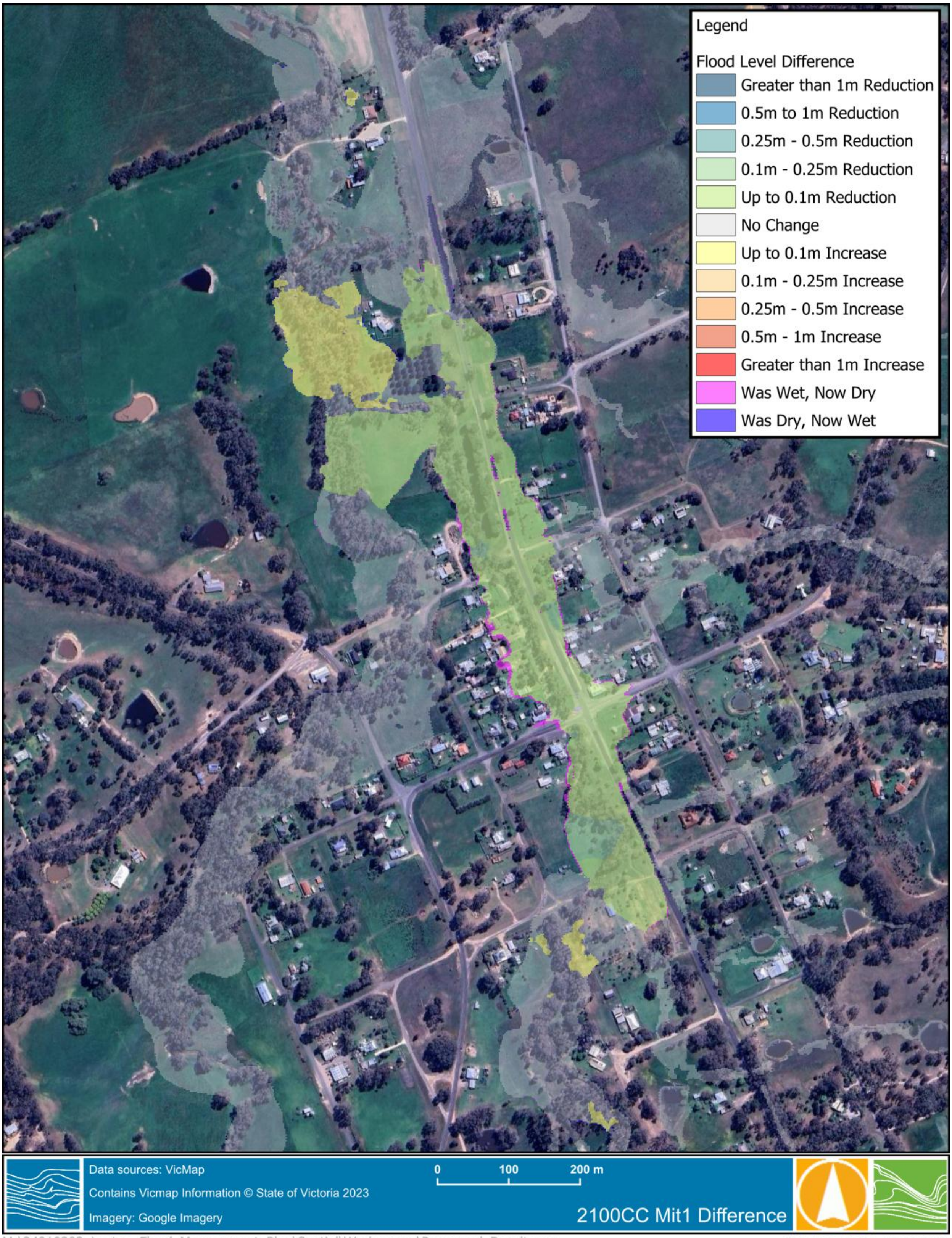


**Figure 4-3 Mitigation Option 1 – 10% AEP (2100CC) Flood Level Difference**

## 4.3 Mitigation Option 2 – Levee

Flooding of Burnbank Creek causes the greatest impacts in Lexton, particularly along Goldsmith Street. A levee was modelled along the western side of Burnbank Creek, adjacent to Goldsmith Street. The levee was approximately 800 m long and runs from north of Goldsmith Street to Clapperton Street. The location of the modelled levee is shown in Figure 4-4.

The levee significantly impacts the flood behaviour in the 1% and 10% AEP + climate change events. A large portion of Lexton to the west of the levee experiences major reductions in flood levels, with depths reducing by over 1 m along Goldsmith Street. Many of the properties to the south of Williamson Street are fully protected by the levee. However, the area to the east of the levee experiences flood level increases of up to 600 mm, including over residential houses and the Sunraysia Highway. Additionally, the flood extent is further increased to the east. The flood level differences are shown in Figure 4-5 for the 1% AEP event and Figure 4-6 for the 10% AEP event.

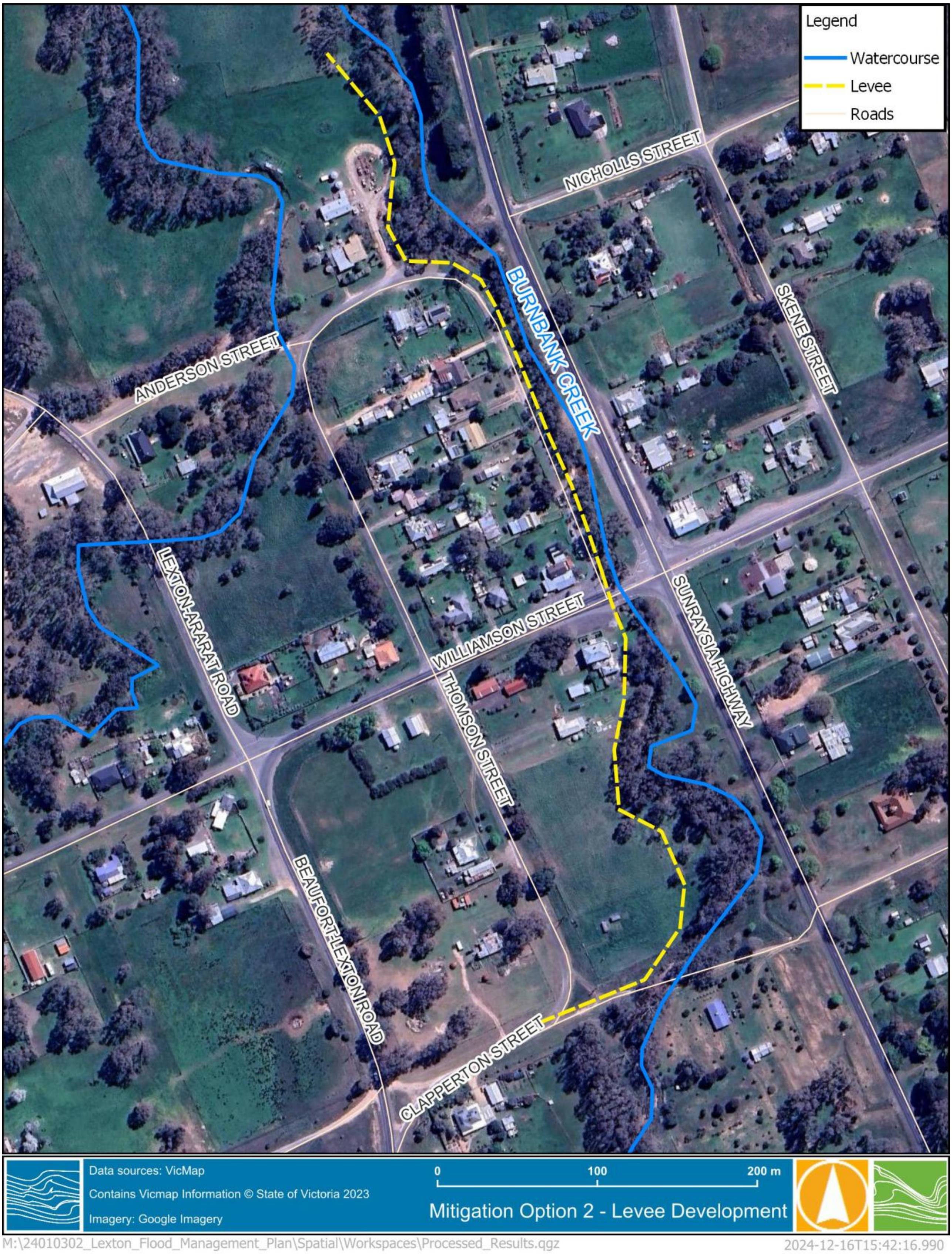


**Figure 4-4 Mitigation Option 2 – Levee Development**

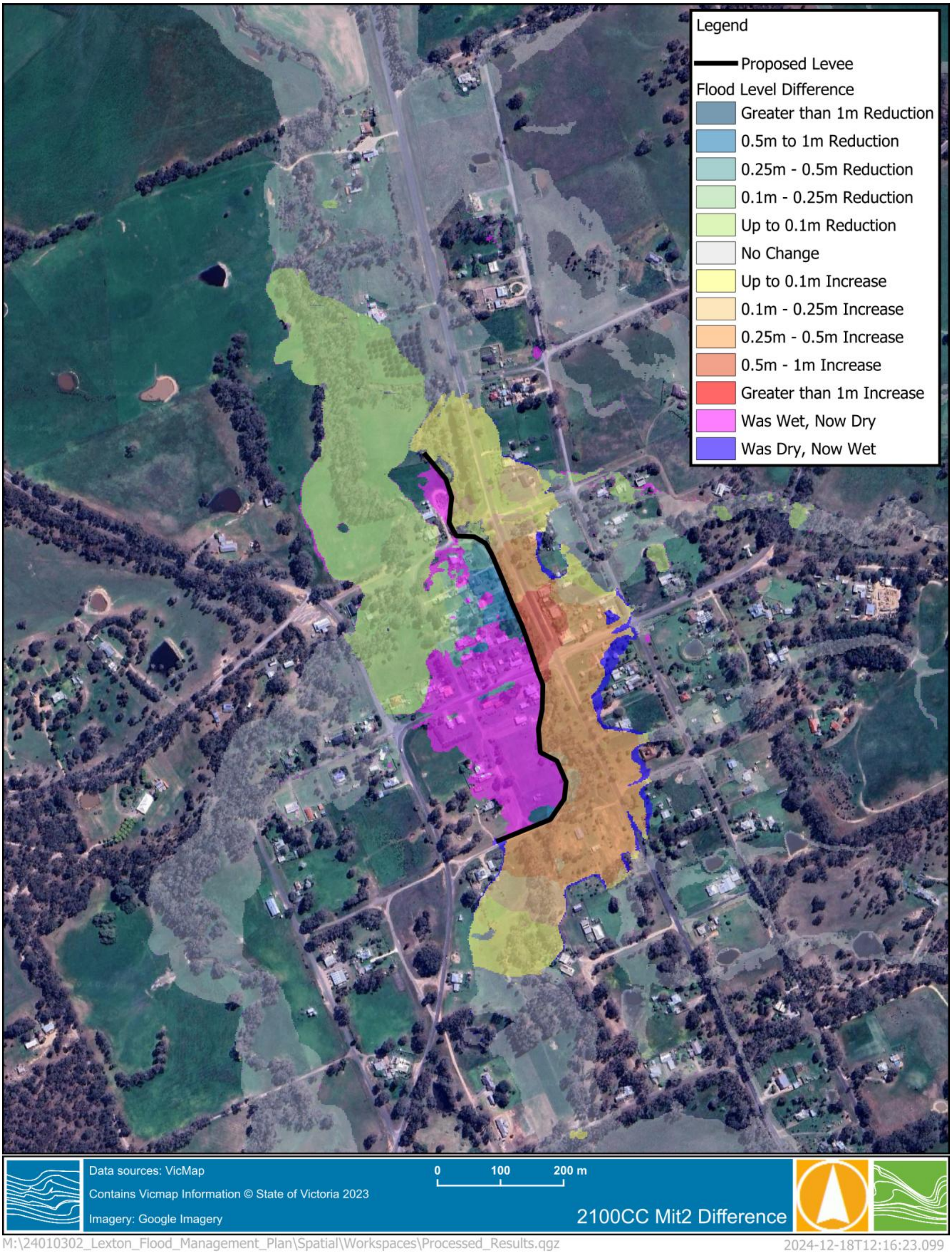


**Figure 4-5 Mitigation Option 2 – 1% AEP (2100CC) Flood Level Difference**

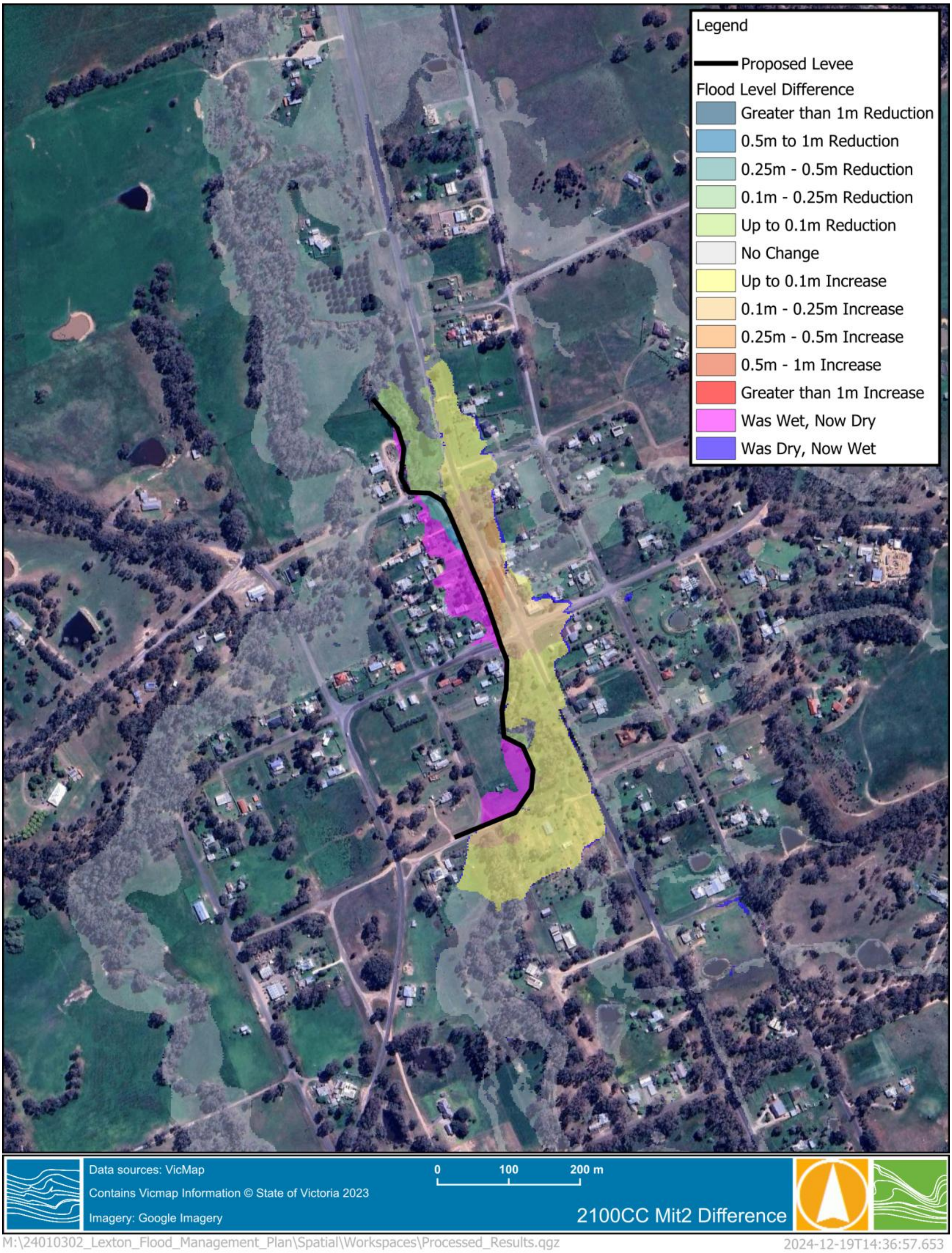


**Figure 4-6 Mitigation Option 2 – 10% AEP (2100CC) Flood Level Difference**

## 4.4 Mitigation Option 3 – Drain Realignment

The eastern stormwater catchment currently drains into Burnbank Creek via a constructed channel that flows along Skene Street, continues along Nicholls Street, and into Burnbank Creek. Currently during large storm events, water overtops the constructed channel and inundates surrounding properties along Skene Street and Nicholls Street. The realignment of this channel was modelled, creating a more direct path through a vacant block on Skene Street, passing under the Sunraysia Highway, and connecting to Burnbank Creek.

The addition of the 1.5 m deep channel produces minimal changes in the flood extent and existing flood depths around Skene Street and Nicholls Street. Some minor decreases in flood level of up to 150 mm are observed adjacent to the drain. Flood depths are slightly increased over the Sunraysia Highway and the Burnbank Creek inflow location. The flood level differences are shown in Figure 4-8 for the 1% AEP event and Figure 4-9 for the 10% AEP event.


**Figure 4-7 Mitigation option 3 – Drain Development**

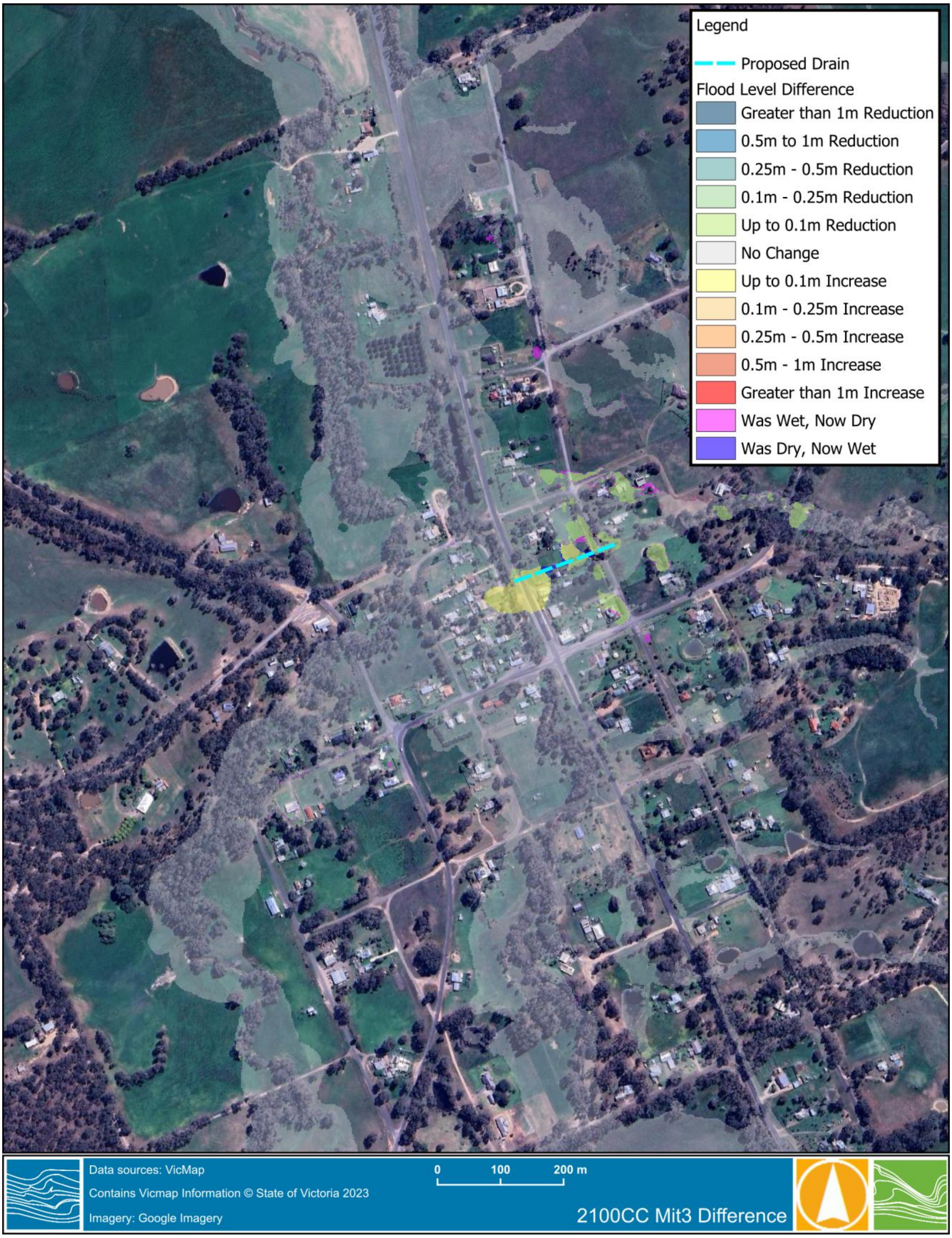


**Figure 4-8 Mitigation Option 3 – 1% AEP (2100CC) Flood Level Difference**

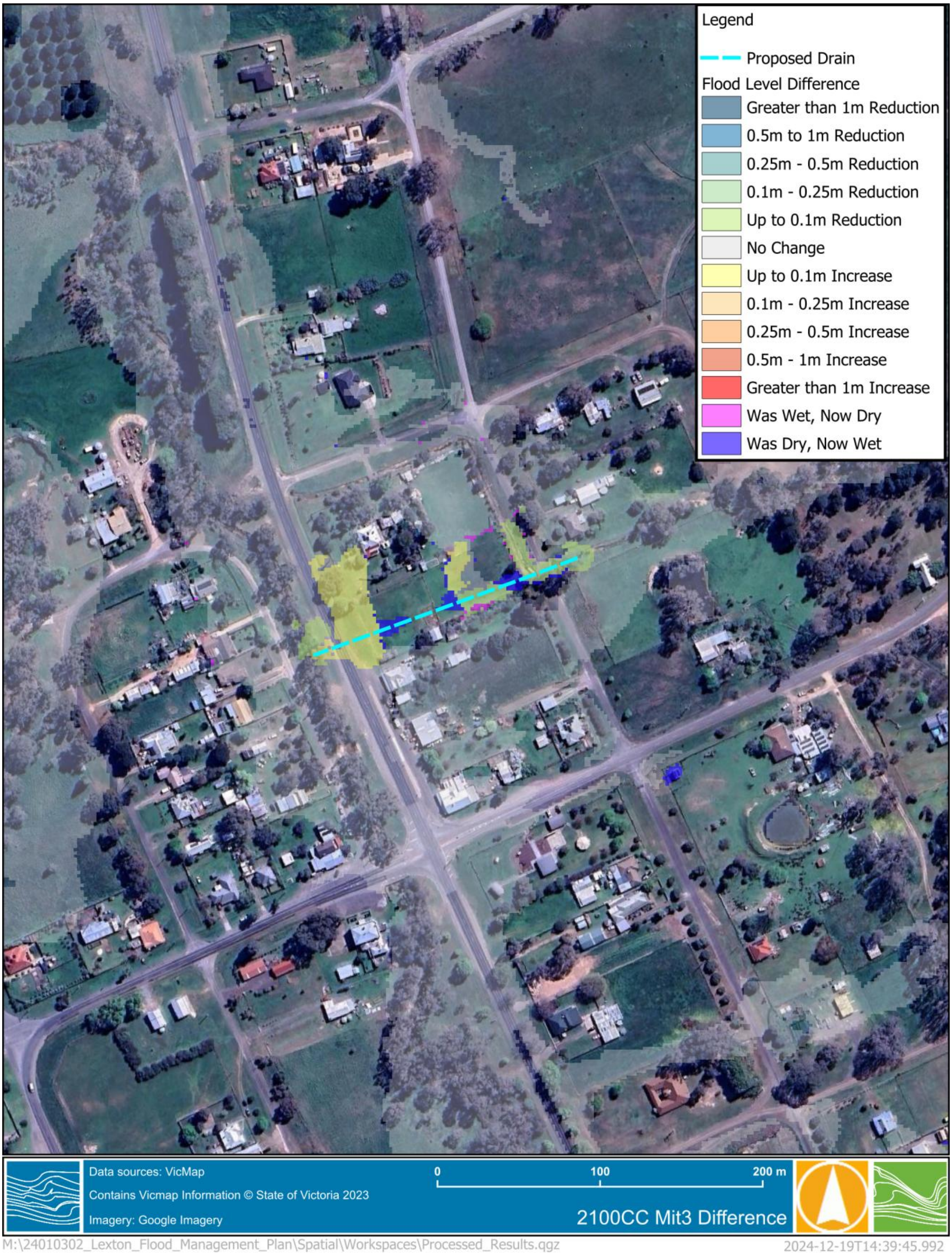


**Figure 4-9 Mitigation Option 3 – 10% AEP (2100CC) Flood Level Difference**

## 4.5 Mitigation Option 4 – Combined Drain and Levee

Combining the drainage realignment (Option 3) with the levee (Option 2) was modelled to confirm the potential to reduce flooding on both sides of Burnbank Creek. The levee resulted in significant decreases on the western side of Burnbank Creek while some positive impacts of the drain were located further east near Skene Street. Both mitigation options resulted in increases along Sunraysia Highway. The proposed levee and drain alignment are presented in Figure 4-10.

Overall, the realigned drain has negligible impacts compared to the levee. Similar to Option 2, the levee creates a significant reduction in the west, but this leads to large and unacceptable increases to the east. The flood level differences are shown in Figure 4-11 for the 1% AEP event and Figure 4-12 for the 10% AEP event.

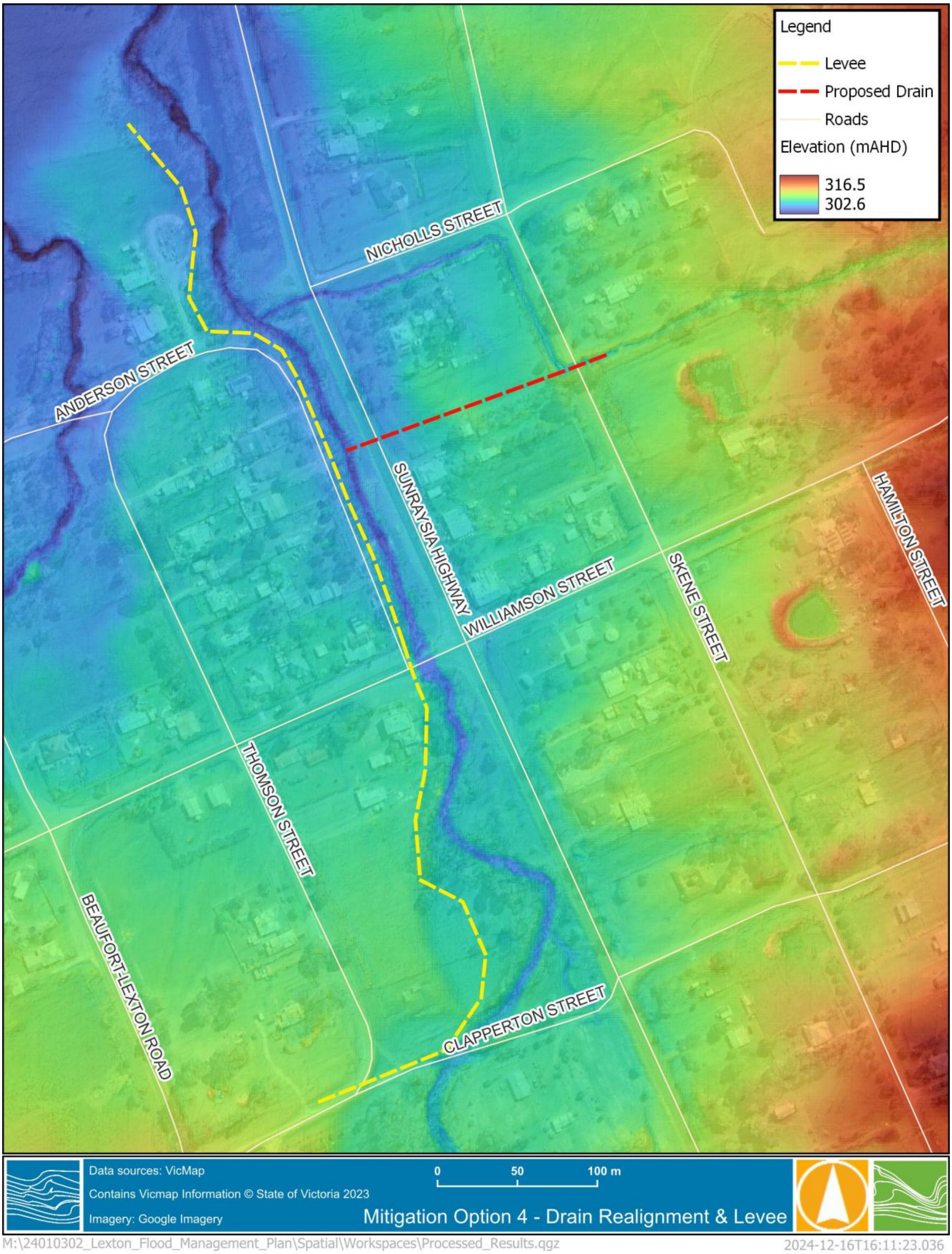


**Figure 4-10 Mitigation Option 4 – Combined Drain and Levee Development**

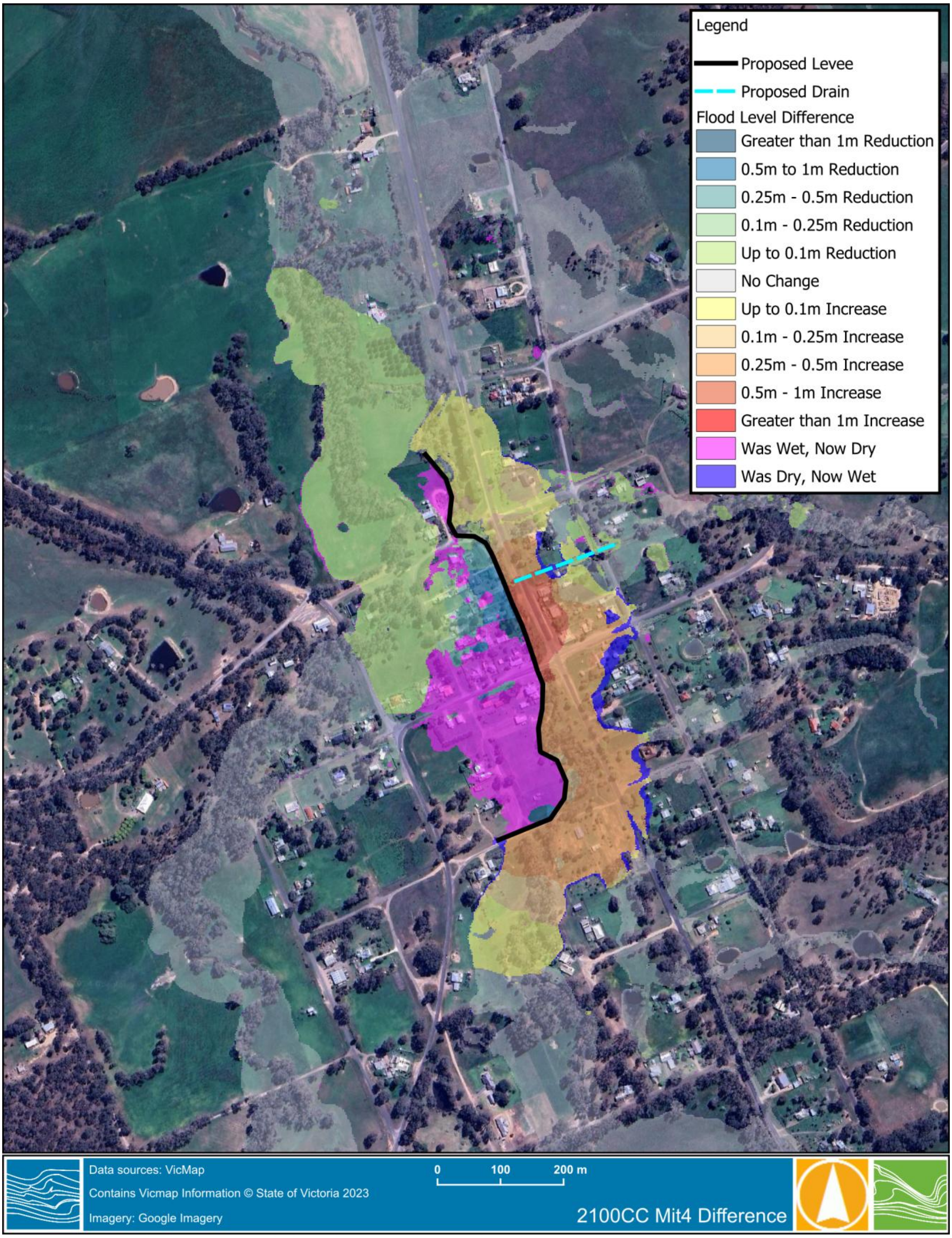


**Figure 4-11 Mitigation Option 4 – 1% AEP (2100CC) Flood Depth Difference**

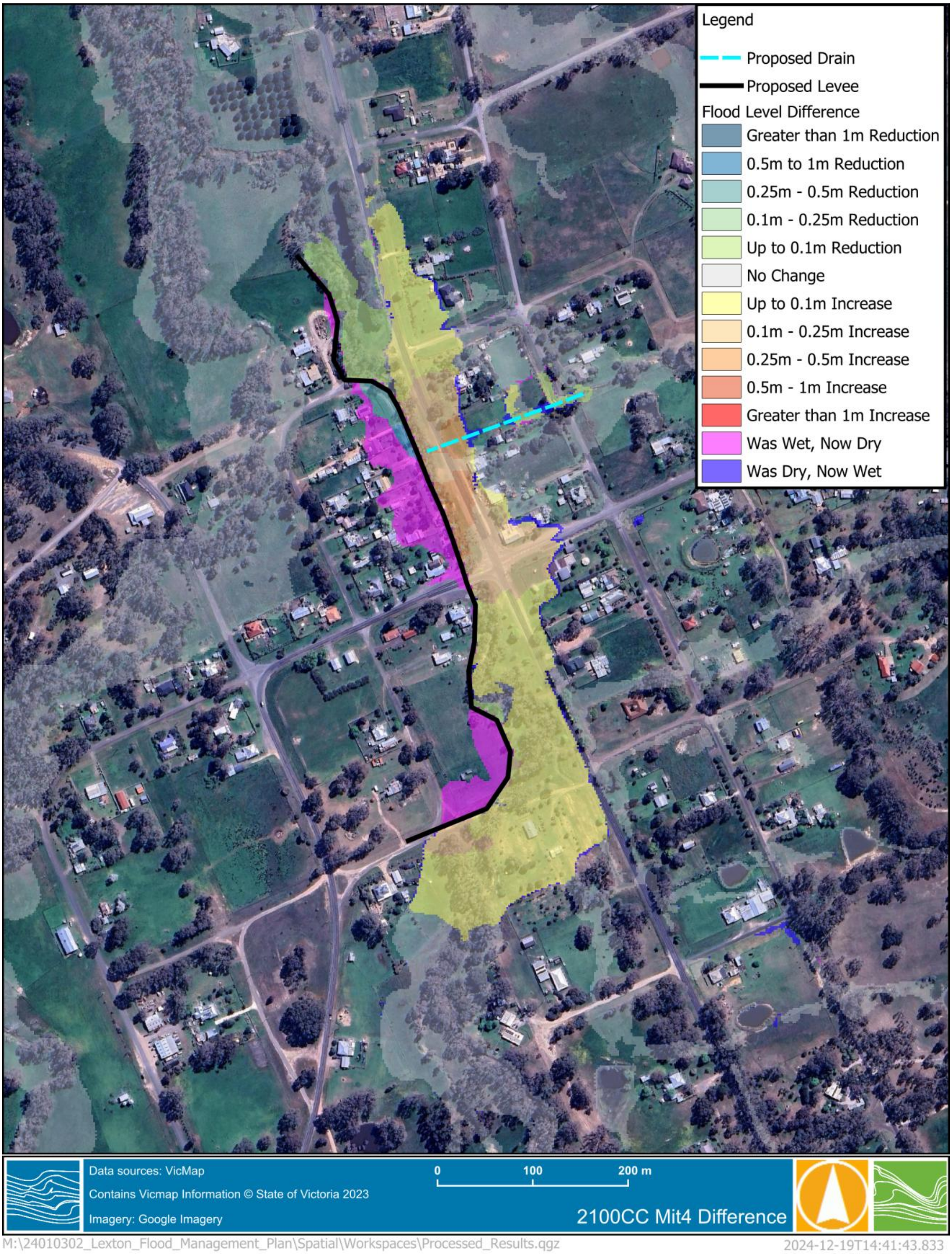


**Figure 4-12 Mitigation Option 4 – 10% AEP (2100CC) Flood Depth Difference**

# 5 COST-BENEFIT ANALYSIS

Based on the initial feasibility screening and discussions with PSC, it was determined Mitigation Option 1 (clearing the Burnbank Creek waterway) was the most likely to be supported by government and the community. This mitigation option proposes the removal of non-native vegetation and any logs and debris to assist in clearing the natural flow path. Flood levels were reduced by up to 120 mm within Burnbank Creek and approximately 100 mm in the surrounding areas in the 1% AEP plus climate change scenario, as discussed in Section 5. This mitigation option also had strong support from the community. A cost-benefit assessment was undertaken for this mitigation option.

Mitigation modelling, determination of a revised AAD and cost benefit analysis were based on the baseline climate conditions. This could have also been completed with the inclusion of the various potential climate change scenarios; however, the relative outcome of the modelling and analysis would remain unchanged. The inclusion of climate change would increase the level of damage in both the unmitigated and mitigated modelling and it was not considered necessary to run additional climate change scenarios. This could be completed in the future if additional analysis of the mitigation options was required.

The model results were processed to assess the new AAD for Lexton under the mitigated scenario. The resultant AAD was $93,879 per year, providing an annual reduction of $10,936. The reduction in AAD is a result of fewer properties being inundated above floor in the 20% and rarer AEP events. For example, one less property is inundated above floor level in the 1% AEP event. There is also a reduction in properties flooded below floor in most of the analysed events, and a significant reduction in costs associated with infrastructure damage for all events.

A high-level cost estimate for the final mitigation option was developed based on Water Technology's experience of works on waterways and developments with supplementation from Rawlinson's Construction Cost Guide 2024. A 15% contingency cost was added to account for administration, project management and unforeseen eventualities, see Table 5-1. A small ongoing maintenance cost has been added as it is expected once the vegetation is removed PSC will be able to add mowing and weed spraying to its current maintenance schedule.

Replanting of the cleared area has been assumed to be hydroseeding with grasses; however, it is likely small shrubs could be used. There is also the potential for a pedestrian path or other beautification infrastructure to be constructed.

**Table 5-1 Mitigation scenario cost estimate**

| Item | Quantity | Units | $/Unit | Subtotal ($) |
|---|---|---|---|---|
| Clearing | 8,000 | $m^2$ | $ 2.0 | **$ 16,000** |
| Re planting grass | 8,000 | $m^2$ | $ 1.0 | **$ 8,000** |
| Cultural Heritage Management Plan | 1 | | $ 20,000 | **$ 20,000** |
| Waterway Management Plan | 1 | | $ 10,000 | **$ 10,000** |
| Offsets | 1 | | $ 30,000 | **$ 30,000** |
| Contingency | 15% | | $ 11,100 | **$ 11,100** |
| **Total Capital Cost** | | | | **$ 95,100** |
| **Total Maintenance Cost** | | | | **$ 4,000 / year** |

The cost/benefit was assessed in terms of the net present value of the option. A 30-year project timeline was adopted with a discount rate of 6%.

The net present value was assessed according to the below equation:

$$NPV = \sum_{n=1}^{30} \frac{R - M}{(1 + i)^n} - C$$

Where:

NPV = Net present value

$R$ = Reduction in AAD ($)

$M$= Annual Maintenance Cost ($)

$i$= Discount/Interest Date

$C$= Capital Cost ($)

$n$= Year (from 1 to 30)

The resultant NPR for the combined option is negative, meaning the project will save more than it will cost, on average, over the 30-year period. The project is financially viable given the cost of the works is less than the savings in flood damage. At this stage, the cost of the works is indicative and should be discussed with PSC.

It should be noted that the project would save more money over a 30-year period than if no action was taken. The project has a **cost-benefit ratio of 1.0**, meaning the project is financially viable and will be financially beneficial to the Lexton community.

If the cost of the works is less than **$95,500**, then the project will save more than it will cost, on average, over the 30-year period.

It should be noted that financial costs only were considered. Intangible costs are difficult to quantify monetarily but represent significant impacts to the community such as injury, mental health impacts and disruption to social and environmental factors.

# 6 NON-STRUCTURAL MITIGATION

## 6.1 Land use and planning control

### 6.1.1 Overview

A planning scheme amendment will assist to address flood risk by incorporating flood-related planning controls to guide land use and development in flood-prone areas. These controls are an efficient non-structural flood mitigation tool used to minimize the social, economic and environmental risks associated with flooding. Flood related planning controls may prohibit or restrict inappropriate development or enable sustainable development. The controls are a single source of truth to represent the extent of a 1% AEP design event. This enables landowners and decision-makers to be adequately informed of flood risk.

The planning controls also influence associated legislation including the Building Regulations and vendor information certificates to consider flood risk.

### 6.1.2 Strategic justification

Section 6.2(e) of the Planning and Environment Act 1987 enables planning schemes to 'regulate or prohibit any use or development in hazardous areas, or areas likely to become hazardous'. As a result, planning schemes contain State planning policy for floodplain management requiring, among other things, that flood risk be considered in the preparation of planning schemes and in land use decisions.

Guidance for applying flood controls to Planning Schemes is available from the Department of Environment, Land, Water and Planning's (DELWP, now the Department of Transport and Planning (DTP)) Planning Practice Note 12 on Applying the Flood Provisions in Planning Schemes, Guidelines for Development in Flood Affected Areas (DELWP, 2019) and the Victorian Floodplain Management Strategy (DELWP, 2016).

Undertaking a planning scheme amendment to update flooding controls in the Pyrenees Shire Council Planning Scheme is a recommendation of the North Central Catchment Management Authority Regional Flood Management Strategy (RFMS), Pyrenees Shire Council Planning Scheme Clause 74.02-1 Further Strategic Work and the Pyrenees Council Plan. Once flood data is available, the Pyrenees Council has obligations to undertake a Planning Scheme Amendment under legislation including the Planning and Environment Act (1987), Water Act (1989), Building Act (1993), Local Government Act (2020), and the Climate Change Act (2017).

The Victorian Planning Provisions (VPPs) contain several controls that can be employed to provide guidance for the use and development of land that is affected by inundation from floodwaters. These controls include the Floodway Overlay (FO), the Land Subject to Inundation Overlay (LSIO), the Special Building Overlay (SBO) and the Urban Floodway Zone (UFZ). The objectives of Clause 13.03 for floodplain management are to assist in the protection of:

- Life, property and community infrastructure from flood hazard.
- The natural flood-carrying capacity of rivers, streams and floodways.
- The flood storage function of floodplains and waterways.
- Floodplain areas of environmental significance or of importance to river health.

### 6.1.3 Integrating 'best available' flood data into the Planning Scheme

The Lexton Flood Study has informed where flood related planning controls would apply to flood prone land in Lexton.

An amendment would implement the findings and recommendations of this study by introducing the Floodway Overlay (FO) and/or Land Subject to Inundation Overlay (LSIO) to mitigate risks associated with riverine flooding events.

The North Central Catchment Management Authority considers that the Lexton Flood Study represents the ‘best available data’ complying with the VPP Clause 13.03 Floodplain Management and Guidelines for Development in Flood Affected Areas (DELWP, 2019).

### 6.1.4 Climate change in the flood control mapping extent

The draft amendment mapping has been prepared during the Lexton Flood Study (Water Technology, 2025). It has followed the methodology outlined in the *Australian Rainfall and Runoff, Version 4.2*[3].

The draft amendment mapping factors in climate change using the following thresholds:

- 1% AEP
- Time horizon: 2100
- Emission scenario: Shared Socioeconomic Pathways (SSP) 3 – 7
- Rainfall intensity increase percentage: 11 – 20%
- Critical duration: 1 and 1.5 hours

### 6.1.5 The methodology for applying the planning controls

The Floodway Overlay has been applied where:

- The depth of riverine flooding exceeds 0.5 m in a 1% AEP (SSP3).
- The product of velocity and depth exceeds 0.4 square metres per second in a 1% AEP (SSP3).
- The velocity of flow exceeds 2 metres per second in a 1% AEP (SSP3).
- In refining the application of the overlays, “islands” located within the overlays and less than 1000 square metres were “filled” in.

The Land Subject to Inundation Overlay has been applied where:

- The depth of riverine flooding between 0.05 m to 0.5 m in a 1% AEP (SSP3).
- In refining the application of the overlays, “islands” located within the overlays and less than 1,000 square metres were “filled” in.

### 6.1.6 How many properties would be impacted by an amendment?

The draft amendment would affect 195 land parcels that are located within Lexton:

- 308 land parcels are proposed to have the LSIO applied for the first time.
- 195 land parcels are proposed to have the FO applied for the first time.

### 6.1.7 Community Engagement

The community consultation methods used to display the proposed planning controls are displayed in Table 6-1.

[3] https://arr.ga.gov.au/

Table 6-1 Consultation methods used to display these planning controls to the community

| Media activity | Details |
|---|---|
| Newspaper articles | 14/02 public notices – community session<br>07/02 public notices – community session<br>21/03 public notices – engagement hub reminder<br>07/03 public notices – engagement hub reminder |
| Social media posts | 24/02 community consultation session post event<br>30/07 community consultation session advertising<br>29/07 community consultation session advertising<br>11/02 community consultation session reminder<br>14/02 as above |
| Physical viewing locations where the documentation was made available | Lexton post office & shop for a couple of weeks prior to each of the community consultation sessions |
| Community drop-in sessions | 1 session in Lexton at the Community Hub<br>Approximately 100 people in attendance |
| Dedicated Council webpage | PSC Engagement Hub commenced around mid-May it was closed last week. |
| Letters to affected landowners | 96 letters sent directly to landowners and occupiers; full colour with links to the website and details about the community drop in session |
| Site visits | 15/02 project team site visit<br>There were others that were consultant visits I know of one on 05/06 – this was advertised in the public notices in the local paper and on posters in the shop. |

### 6.1.8 Community responses to draft Planning Scheme Amendment

Table 6-2 provides a list of frequently asked questions.

Table 6-2 Frequent questions

| Community theme | Council response |
| --- | --- |
| A PSA will decrease property prices | There are many factors that influence property value, but the designation of an area as 'subject to inundation' does not cause or change the likelihood of flooding. It merely recognises the existing condition of the land its potential for future flooding. This gives more certainty to prospective purchases rather than assumptions of flood inundation or no information at all.<br><br>A flood event, rather than floodplain designation or an overlay, is likely to have a greater effect on property values (Yeo, S, 2003).<br><br>In previous instances where an independent planning panel has been asked to consider and report on submissions opposing the application of a flooding control, the issue of property devaluation has been considered and rejected by the panel (c205warr Panel Report).<br><br>It is noted that land values are generally not a relevant consideration in determining the merits of an Amendment (c116cola Panel Report). |
| A PSA will increase insurance costs | Insurance providers each have their own processes for calculating premiums. Insurance providers typically have access to local flood study information regardless of what flood overlay information is present in planning schemes. |
| Council should prioritise and preference for structural mitigation works | Council is considering progressing with one of the structural mitigation options. The mitigation will still mean properties are subject to flood risk in a 1% AEP flood event, however the depth may be lower.<br><br>At this stage, the most practical and economical solution to manage flood prone land in these areas is to manage new development, such as new houses, shed, extensions, fences, and walls. The proposed buildings and works are considered by the relevant authority, who might request modifications to the buildings such as floor levels or moving the building away from flood risk. |
| Request vegetation removal | This is a mitigation option being explored by Council; however, the modelling demonstrates that properties will still be subject to flood risk in the 1% AEP event even with vegetation removal. |
| What is the point; my home is already built | These building standards will not only protect new development from flood damage but also protect neighbouring properties from the issues when flood waters are diverted or changed. Without flood overlays, landowners may unknowingly construct buildings in flood areas which can make flooding worse for existing buildings and property. |

| Community theme | Council response |
|---|---|
| This flood overlay is bigger than the last flood | A flood study nominates an 1% AEP flood event by using hydrologic and hydraulic models to simulate flood flows, levels, and velocities, often calibrated against historical data, to determine the probability of a flood of a certain size occurring in any given year. A 1% AEP is the design standard across Australia for planning and building legislation, or the threshold frequency of flooding.<br><br>Other events that have occurred on your site may have been less than 1% AEP event, or greater. |

### 6.1.9 Further documentation

Finalising a planning scheme amendment for the Lexton Flood Study will require the following additional information:

- Draft explanatory report
- Draft instruction sheet
- Draft strategic assessment guidelines
- Draft Municipal Planning Strategy update to recognise flood risk in Lexton at Clause 02.03-2
- Draft operational provisions at Clauses 72.03; Cl 72.08, Cl 74.01 and Cl 74.02.

The existing FO and LSIO local planning schedules would be suitable to be utilised for the Lexton flood planning controls, subject to approval by the North Central Catchment Management Authority.

Council should consider requesting the Minister for Planning and Transport to intervene and progress this amendment under section 20(4) of the Planning and Environment Act 1987.

### 6.1.10 Conclusion

Planning overlays are recommended to be developed as a direct outcome from this study. Updating the planning scheme mapping allows development applications within the floodplain to be assessed in line with current state, regional and local planning and building regulations. The ultimate effect of this will be to discourage inappropriate development within the floodplain, reducing the number of future buildings and occupants exposed to flood risk.

# 7 SUMMARY

Flood damages, in the form of Average Annual Damages (AAD), have been assessed for Lexton based on flood modelling undertaken as part of the Lexton Flood Management Plan. The average annual cost in Lexton as a result of flooding without the inclusion of climate change equates to $104,816 per year, this is predicted to increase to $212,099 with the inclusion of climate change (without the inclusion of inflation). In a 1% AEP flood event, 6 dwellings are inundated above floor and a further 106 properties are impacted below floor. An additional 17 buildings are expected to be flooded above floor in a 1% AEP event by 2100 under the SSP5-8.5 climate change scenario.

Several mitigation options were tested in the Lexton hydraulic model, focusing on reducing damage and hazard associated with the overland flow impacting residential/commercial lots and roads. Impacts of each mitigation option were demonstrated in this report. It is recommended that Burnbank Creek be cleared of debris and any non-native vegetation.

An updated AAD was calculated for this mitigation option. A construction cost estimate was assessed against the option's reduction in AAD from the existing case to inform net present value analysis. The assessed mitigation option was shown to be financially viable. More detailed investigation could be undertaken to assess components of the mitigation option individually to target flood mitigation works.

The analysis documented in this report has also recommended development and update of planning controls such as the Land Subject to Inundation Overlay (LSIO) and Flood Overlay (FO) based on criteria relevant to the Pyrenees Shire Council. These layers will provide a suitable foundation to support development of flood related planning controls.

# APPENDIX A
# ROAD INUNDATION MAPPING

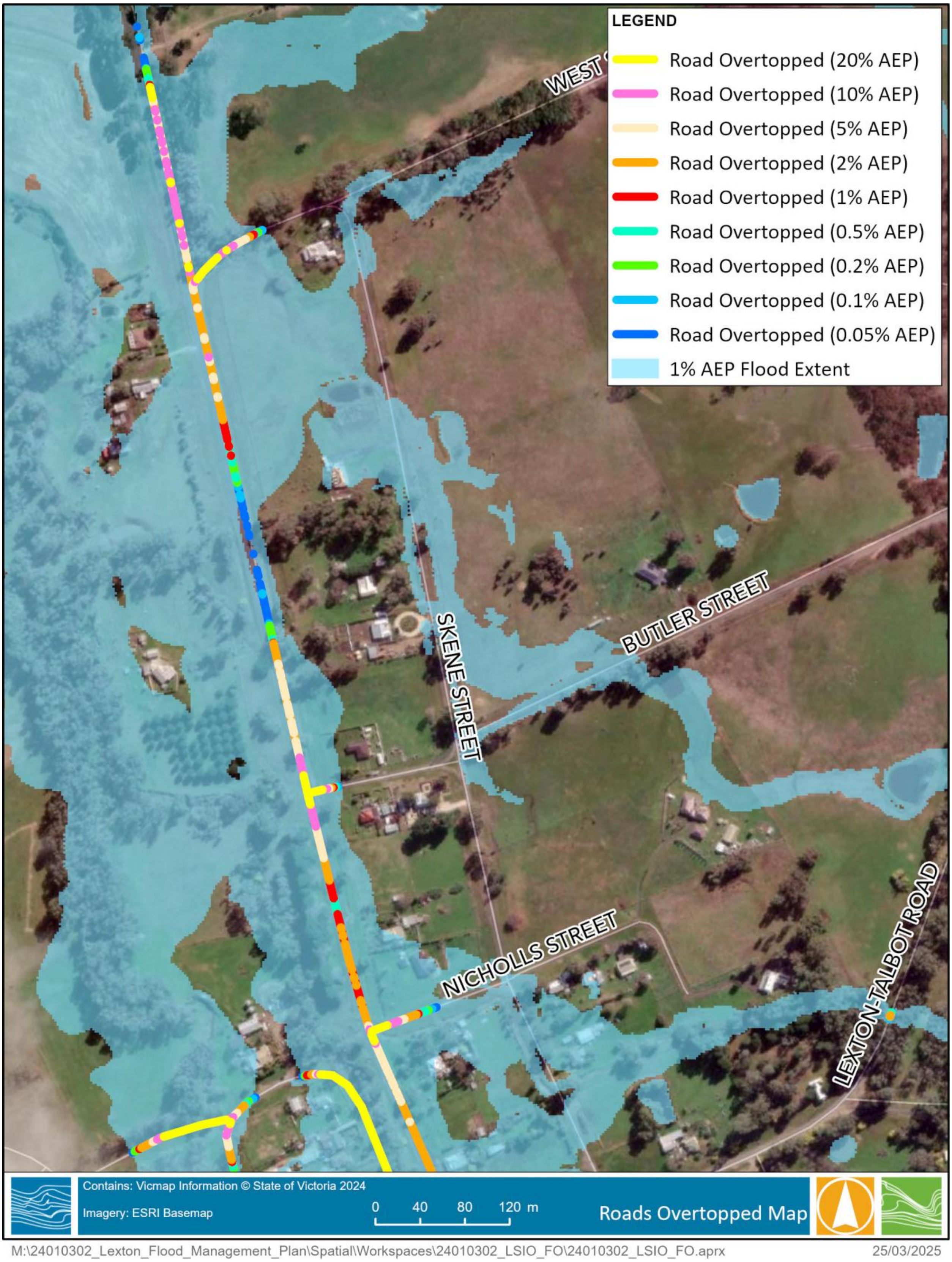


**Figure 7-1 Impassable roads in Lexton – North**

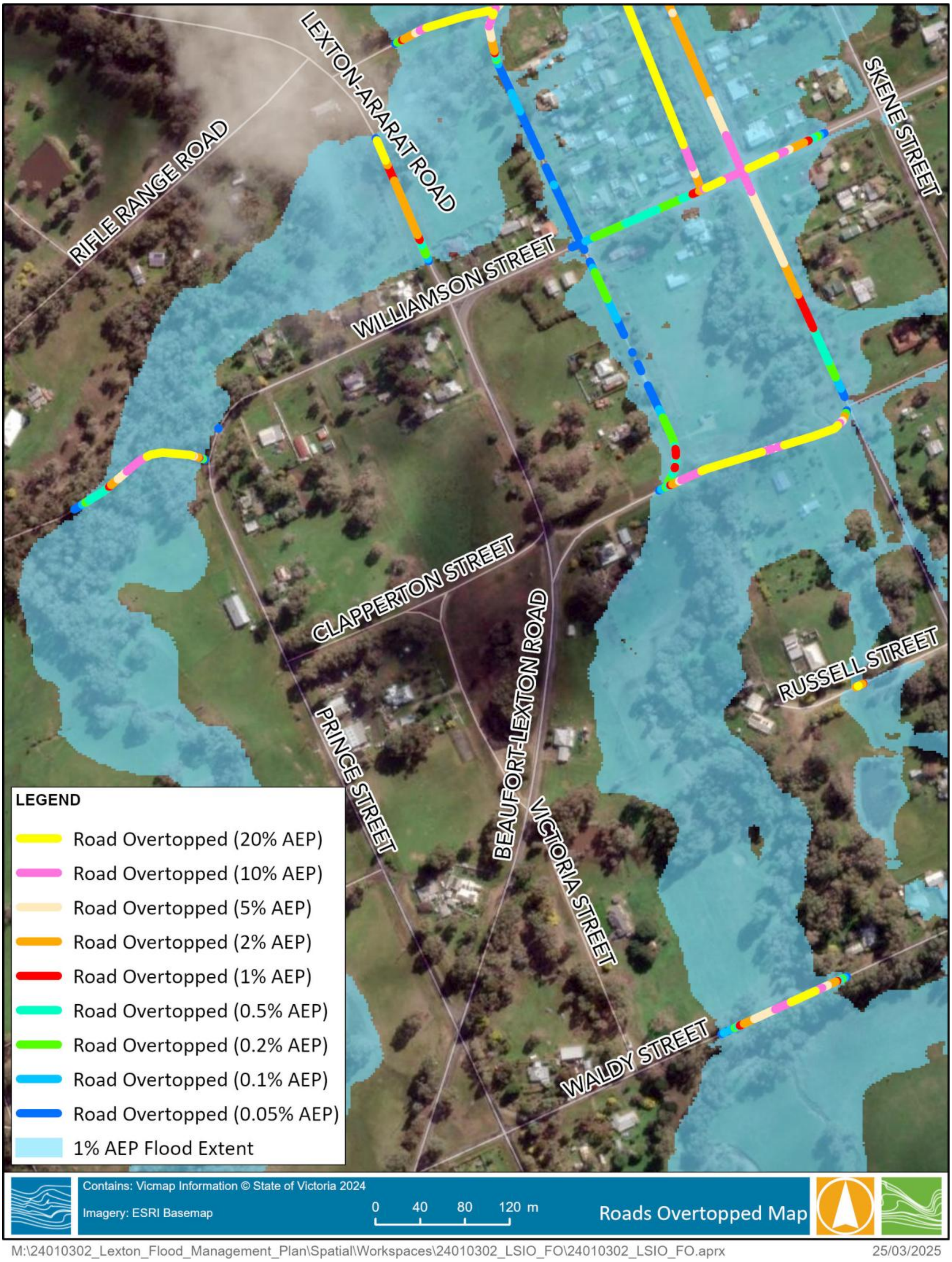


**Figure 7-2 Impassable roads in Lexton – West**

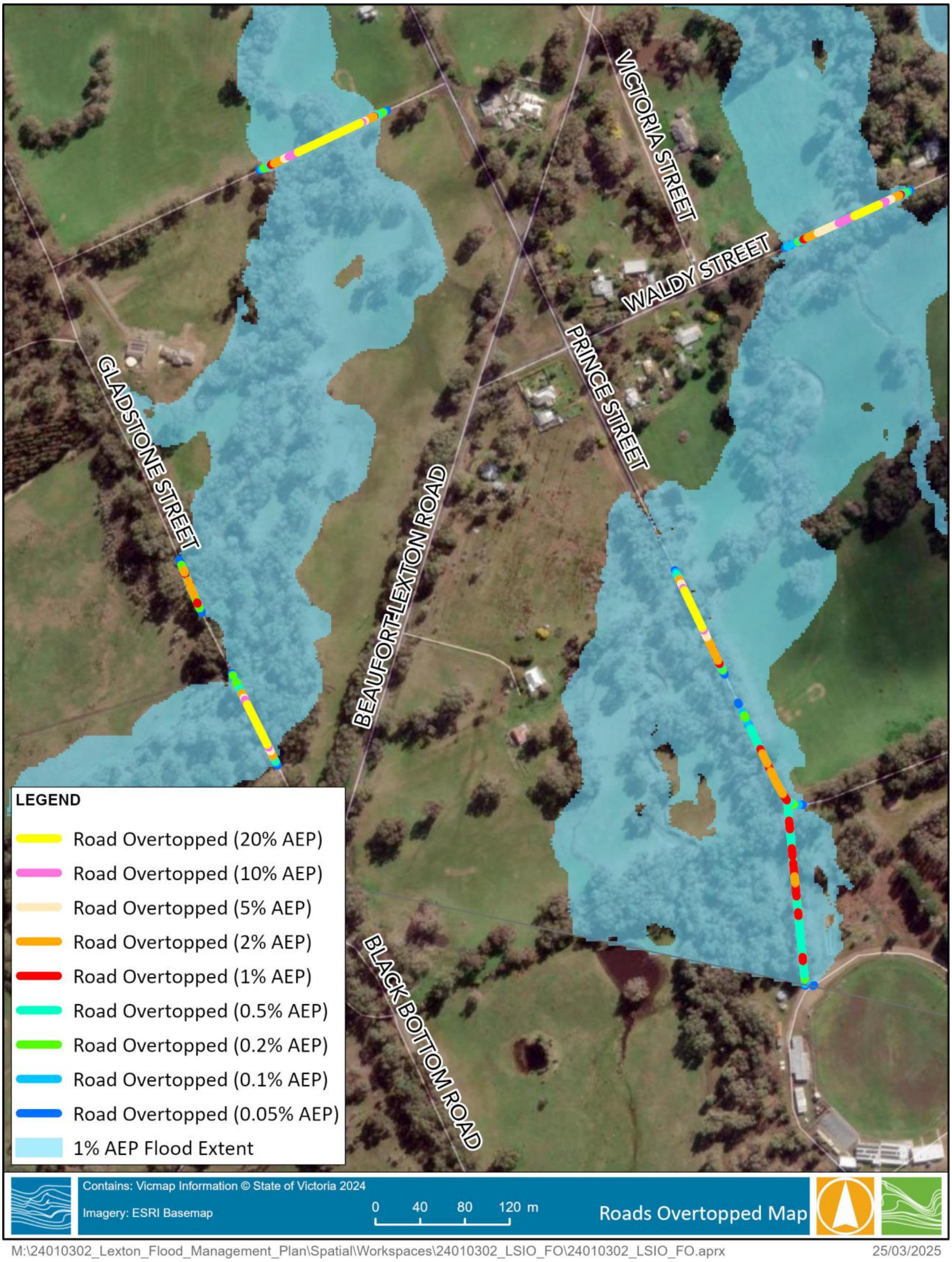


**Figure 7-3 Impassable roads in Lexton – South**


**Figure 7-4 Impassable roads in Lexton – East**