# Technical Evidence Report

## Local Floodplain Management Plan

### Somerset Regional Council

15 January 2021

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# 1 INTRODUCTION

## 1.1 Context

Flooding in Queensland in the summer of 2010/2011 affected more than 2.5million people, approximately 29,000 homes and businesses. In 2012 the Queensland Flood Commission of Inquiry (QFCI) was established to recommend how State and Local Governments should manage flooding including future development, emergency response procedures, dam operations and structural mitigation. Recommendations for Local Governments included:

> *Recommendation 2.12:*
>
> *Councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles.*

Following the QFCI, Queensland Government and Local Governments have committed to long-term floodplain management practices to reduce the impact of current and future flood risks, including the Brisbane River Flood Studies and Brisbane River Strategic Floodplain Management (SFMP) led by the Queensland Reconstruction Authority (QRA). The Flood Study was released in May 2017 and is the largest ever undertaken in Australia and informed the development of the SFMP to better understand current and future flood risks and identify regionally consistent approaches to strengthen flood resilience across the Brisbane River floodplain.

The SFMP brought together four local councils including Somerset Regional Council and key stakeholders to develop the most comprehensive regional approach to managing flood risk in Australia. The methodology of the regional-scale study includes a detailed assessment of flood risk, regional consistent framework for land use planning, disaster management strategies and supporting information and activities for improving community awareness and resilience. The outcome of the SFMP includes a Technical Evidence Report, recommendations for Local Floodplain Management Plans (LFMPs) and guidance material for amending planning schemes to align with State Planning Policy state interest for natural hazard risk and resilience. The SFMP provides a valuable toolkit, not just for the four local councils in the Brisbane River floodplain, but for Local Governments throughout Queensland seeking to implement floodplain management that aligns with best practice principles. Figure 1-1 illustrates the context of the Somerset Flood Studies and LFMPs.

The Somerset Region Local Floodplain Management Plan (LFMP) establishes strategies to deliver sustainable management of flood risk in the long term for the six localities of Esk, Toogoolawah, Fernvale, Kilcoy, Lowood and Minden.

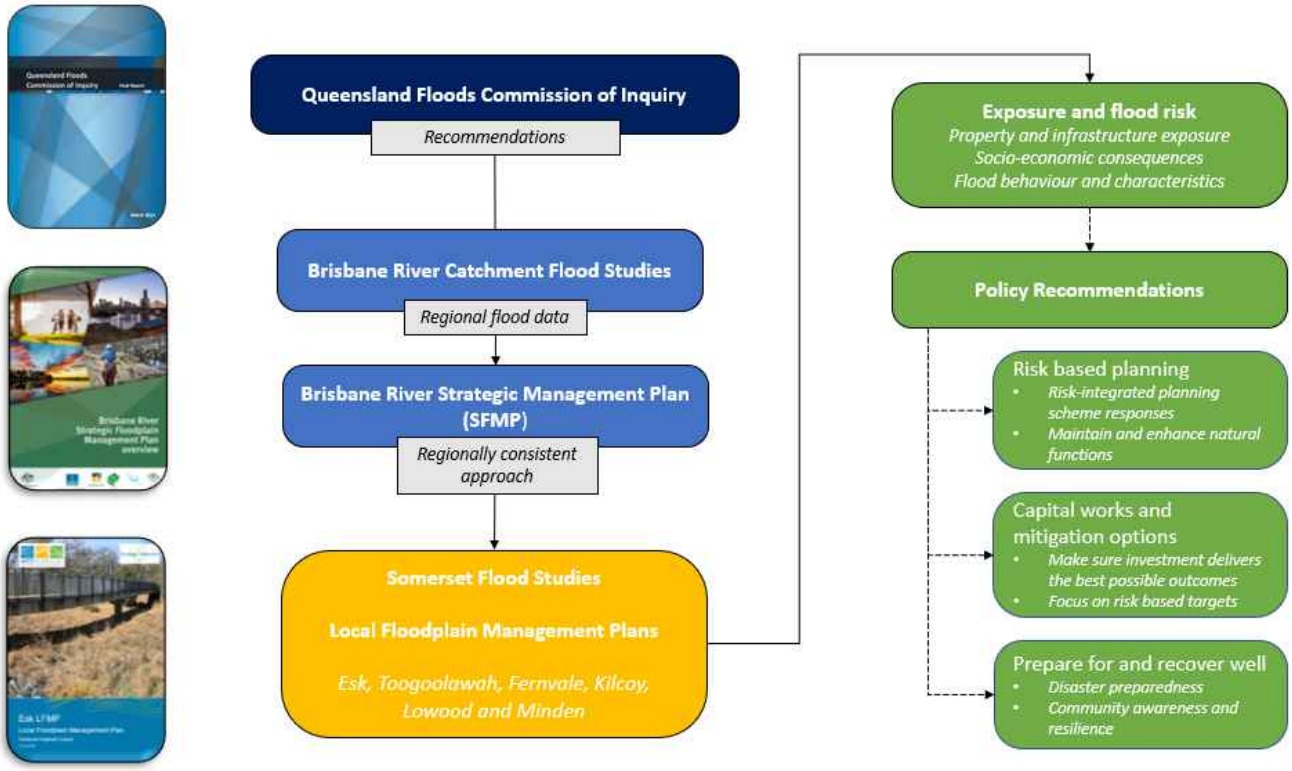



**FIGURE 1-1 LFMP CONTEXT AND PROCESS**

## 1.2 Scope

The Local Floodplain Management Plans helped us to understand the extent and scale of flooding and to set policies for managing risks associated with flooding within the catchment. The data and information in this Technical Evidence Report and six LFMPs for each locality should be used to inform planning and decision making by Council. The plan can be used to guide capital investment, land use planning activities, disaster management planning and raise community awareness and understanding of flood risk and how it will be managed.

The LFMP uses the output from the Brisbane River Catchment Flood Studies (BRCFS), SFMP and Somerset Flood Studies which provides the data to help understand the flood behaviour of the catchments, to assess and characterise the nature of flood risk across the floodplain and how to best manage the risk. The Study areas have been defined as the six localities of:

- Esk
- Toogoolawah
- Fernvale
- Kilcoy
- Lowood; and
- Minden

Also included in the analysis is the area contained within the boundaries of the Somerset Regional Council Local Government Area (LGA) that is affected by Brisbane River flooding. This is often referred to as the BRCFS area.

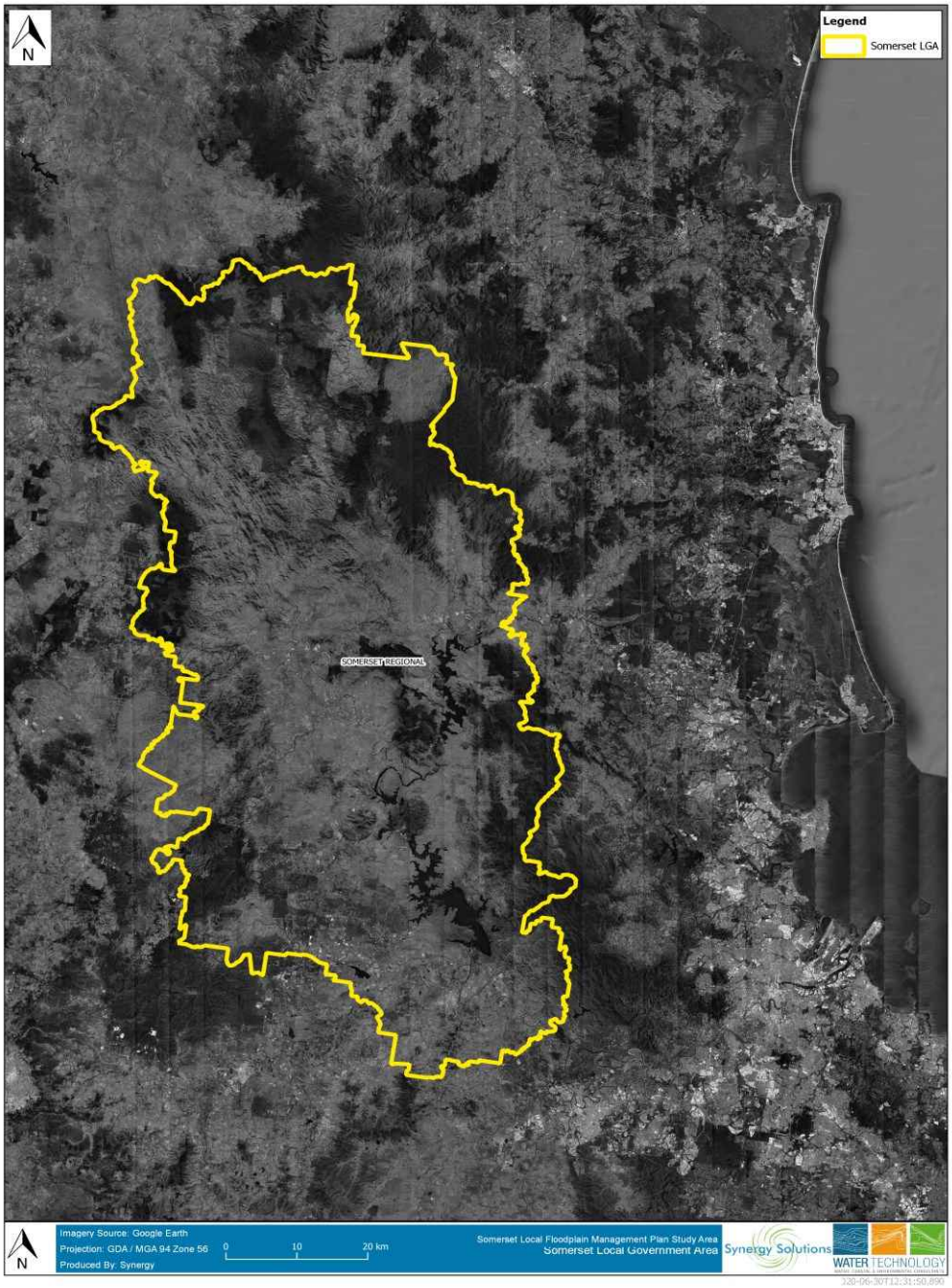



**FIGURE 1-2 SOMERSET LOCAL GOVERNMENT AREA – LFMP STUDY AREA**

## 1.3 Document Structure

This Technical Evidence Report presents the current and future flood risk which identifies the exposure and vulnerability of people and property to flood hazard, this includes a flood damage assessment. The next chapters explore the different aspects of floodplain management such via a flood mitigation assessment which investigates structural mitigation options, property specific actions and land use planning responses; disaster management which looks at flood characteristics such as time to inundation, duration of inundation and issues of isolation and how this information can affect evacuation planning. This report combines the analysis into one integrated risk assessment and provides policy and strategic direction for best practice floodplain management in the Somerset LGA.

# 2 CURRENT FLOOD RISK

This section describes the flood risk in the six localities and the Brisbane River catchment within the Somerset LGA under existing development conditions. Flood risk is defined through consideration of hydraulic behaviour, existing development, vulnerability of the community, potential isolation across the floodplain, time to and duration of inundation from flood waters. Flood risk is determined over the full spectrum of potential flood conditions, from small but frequent events (1 in 2 AEP) up to a very extensive, but extremely rare probable maximum flood event (PMF).

## 2.1 Flood Risk Assessment

### 2.1.1 Overview

The approach taken to identify, document and analyse flood risk in the Somerset LGA for the LFMP follows the guidelines and strategic framework established in the Brisbane River Strategic Floodplain Management Plan (SFMP) which guides stakeholders to reduce impacts to the community when flooding occurs. The risk assessment methodology established in the SFMP is in accordance with ISO 31000:2009 which summarises the process into four steps:

1) Risk identification
2) Risk analysis
3) Risk evaluation
4) Risk treatment

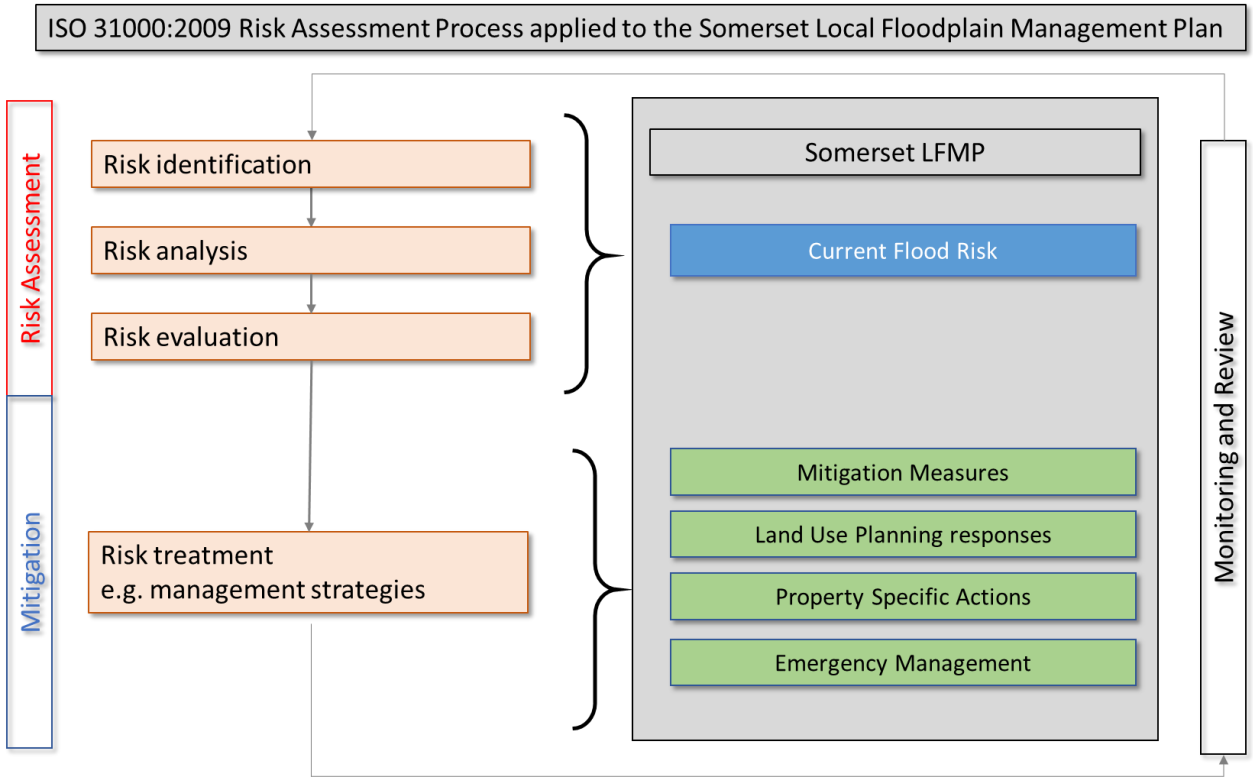



FIGURE 2-1 RISK ASSESSMENT PROCESS APPLIED TO THE LFMP

### 2.1.2 Risk Identification

Whilst the approach reflects regionally consistent outcomes driven by the SFMP framework, the identification of flood risk in the Somerset catchment has evolved to suit locally specific conditions associated with the creek catchment and major tributaries to the Brisbane River catchment.

Flood risk identification of the Somerset LGA considers of the following:

- Potential Hydraulic Risk;
- Direct and indirect damages caused by flooding;
- Isolation caused by flood waters creating flood islands;
- Time to Inundation of roads and buildings; and,
- Duration of Inundation of roads and buildings.

The SFMP provides the baseline methodology for calculations, however where the LFMP has refined the methodology clear indications have been provided in this report.

### 2.1.3 Risk Analysis

Risk is defined as a combination of **likelihood** and **consequence**.

Likelihood of flood risk has been kept consistent across all flood studies in the LFMP and is expressed as the hazard's Annual Exceedance Probability (AEP), representing the probability that a hazard of a given intensity has to be reached or exceeded every year.

The following AEP events were considered when assessing risk:

- 1 in 10 (10% AEP)
- 1 in 20 (5% AEP)
- 1 in 50 (2% AEP)
- 1 in 100 (1% AEP)
- 1 in 500 (0.2% AEP)
- 1 in 2000 (0.05% AEP)
- PMF (Probable Maximum Flood)

It should be noted that the PMF ranges in flood likelihood across the Somerset LGA due to the local creek catchment variance. The Brisbane River Catchment adopts a consistent 1 in 100,000 likelihood for the PMF.

Consequence examines the impact to exposed elements because of a flood event. This is both the physical impact of the event on an asset, as well as that of the economic, social, and environmental impacts.

Potential Hydraulic Risk has been used in the Brisbane River Flood Studies and SFMP to define a regionally consistent definition of consequence using Potential Hydraulic Risk derived from hazard characteristics identified in the Australian Institute of Disaster Resilience (AIDR) guideline. These six characteristics are defined in the graphic taken from AIDR in Figure 2-2.

These hazard categories are an important component of defining flood risk and breaking down the hazard across the floodplain. Using different hazard categories across the catchment is helpful in designating appropriate flood risk management responses in areas exposed to hazard that is unsafe for children and the

elderly, or on the other end of the scale areas potentially exposed to hazard that threatens the structural integrity of buildings.

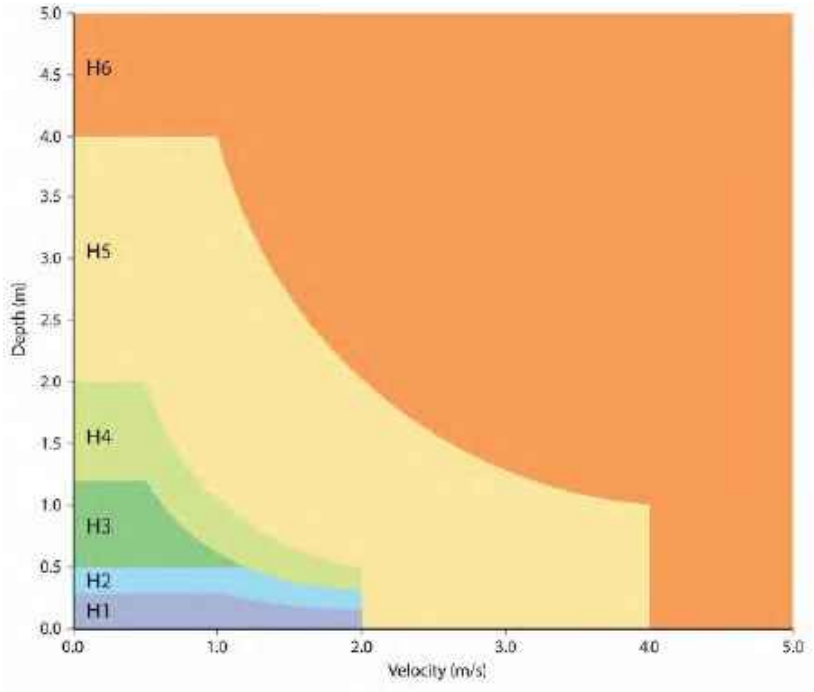



FIGURE 2-2 AIDR HAZARD CATEGORIES

TABLE 2-1 AIDR HAZARD DESCRIPTIONS

| Hazard Vulnerability Classification | Description |
|---|---|
| H1 | Generally safe for vehicles |
| 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. Some less robust building types vulnerable to failure |
| H6 | Unsafe for vehicles and people. All building types considered vulnerable to failure. |

Understanding potential hydraulic risk, vulnerability of population, time and duration of inundation of flood waters and potential isolation risks are the key flood risk factors when considering tolerability of flood risk and determining appropriate responses.

### 2.1.4 Risk Evaluation

The next step in a risk assessment is to evaluate risk within a scale of acceptance and tolerance to prioritise mitigation responses to those areas exposed to intolerable risks.

As per the SFMP risk tolerance defines which risks/locations/assets should be addressed as a priority.

Due consideration is applied to Somerset Regional Council's corporate risk assessment when defining and understanding the application of how risk is identified, treated and mitigated. An excerpt of Council's corporate risk assessment is shown below. For example, low risk as defined in the corporate risk assessment can be compared with the PMF event, which is an extremely low likelihood, but results in extreme consequence. In this regard the PMF would be treated as a low risk and broadly acceptable and managed by routine procedures and ongoing monitoring.

Identification of rare events associated with this level of risk is important as floodplain management activities should not focus on trying to mitigate this level of risk. This becomes apparent in how the LFMP refines activities such as flood mitigation identification and evacuation considerations where treatment and mitigation does not extend to the PMF.

| LIKELIHOOD | CONSEQUENCE | | | | |
|---|---|---|---|---|---|
| | Insignificant | Minor | Moderate | Major | Catastrophic |
| Almost Certain | Moderate | High | Extreme | Extreme | Extreme |
| Likely | Low | Moderate | High | Extreme | Extreme |
| Possible | Low | Low | Moderate | High | Extreme |
| Unlikely | Low | Low | Moderate | High | High |
| Rare | Low | Low | Moderate | Moderate | High |

FIGURE 2-3 EXTRACT SOMERSET REGIONAL COUNCIL DISASTER MANAGEMENT PLAN

## 2.2 Current Flood Risk and Climate Change

### 2.2.1 Current Flood Risk

The following bullet points provide a summary of the hydraulic risk for the six localities, based on the model results used in the flood study.

- **Kilcoy** – Inundation in the 1 in 100 AEP affects residential dwellings in the east in the vicinity of Seib Street and in the south near Ridge Street.
- **Esk** – Inundation in the 1 in 100 AEP affects residential dwellings on Russell Street, Adelaide Street, Creek Street, Ann Street and properties on the Brisbane Valley Highway near Sandy Creek and the SRC offices.
- **Fernvale** – Inundation in the 1 in 100 AEP affects residential dwellings on Schmidt Road, Burns Road and Carralluma Crescent.
- **Lowood** – Inundation in the 1 in 100 AEP generally affects residential dwellings on Bray Street and Daniel Street, however flood depths are generally less than 200mm.

- **Minden** – Inundation in the 1 in 100 AEP event affects some residential dwellings near Rose Avenue and on Shultz Road and Stone Gully Road.
- **Toogoolawah** – Inundation in the 1 in 100 AEP affects residential dwellings on the Brisbane Valley Highway adjacent to Cressbrook Creek.

More information on the current flood risk for each of the six localities can be found in the Flood Study Report and the individual LFMP reports.

### 2.2.2 Climate Change

The climate change scenario considered as part of the Flood Study assessed an increase in rainfall intensity which was assessed based on the 1 in 100 AEP. The climate change scenario was completed based on the guidance provided in Book 1, Chapter 6 of ARR2019. Specifically, this included a factored increase in rainfall intensity of 11.5% which is consistent with the 6.0 RCP to the year 2090.

The results of the sensitivity assessment are summarised as follows: -

- **Kilcoy** – Water levels increase up to approximately 210mm at the township, however the flooding extent is not markedly affected.
- **Esk** – Water levels increase up to approximately 300mm at the township. The flooding extent in the southern portion of the township is sensitive to increases in rainfall intensity and stream flows.
- **Fernvale** – Water levels increase up to approximately 170mm at the township, however the flooding extent is not markedly affected, and impacts are largely contained to the existing flood extent.
- **Lowood** – Water level increases are generally less than 100mm at the township, however the flooding extent is somewhat sensitive to increased rainfall intensity in the Haslingden area.
- **Minden** – Water level increases are generally less than 140mm at Minden. The flooding extent is significantly sensitive to increased rainfall intensity in the Rose Avenue area.
- **Toogoolawah** – Water level increases are generally less than 150mm at the township. The flooding extent is sensitivity to increased rainfall to the south and in isolated areas on the eastern side of the town.

Overall, flooding impacts at the localities of less than 300mm are noted. Esk is particularly more sensitive to changes in rainfall intensity than the other localities. Water surface level difference maps for each of the six localities are displayed in the individual LFMP reports.

## 2.3 Potential Hydraulic Risk

The methodology in the SFMP applies potential hydraulic risk across seven likelihood AEP events providing a gradation across five definitions of risk. The mapping is sufficiently granular to pick up different bands and areas of flood risk across the floodplain on a regional basis. The output is five (5) bands of relative hydraulic risk (HR) derived from a matrix comprised from a combination of seven flood events.

The SFMP HR matrix identifies five bands of risk referred to as HR1-HR5, with HR1 being the highest hydraulic risk to HR5 being the lowest hydraulic risk.

The use is intended for regional riverine flooding, but it is considered to disproportionally overrepresent areas of higher hazard (HR1 and HR2) across local creeks floodplains. This is mainly due to the frequency of events mapped in these categories. Through workshops with the project team, it was determined that more refinement and detail to distinguish between low likelihood and hazard was required. Examples of this include:

- Defining low likelihood flooding (1 in 10 AEP) that has low hazard (H2);

With the SFMP method, this would be defined as HR1 (the highest risk category because of its low likelihood primarily). Whilst this is true, understanding why this risk is so high is also important;

- Defining low likelihood flooding (1 in 10 AEP) with extreme hazard (H6); and

  As above, the SFMP method would identify this the same risk category (HR1). Again, it is useful to better define a distinction between the two areas of risk above as obviously the second situation has a much higher risk and would be a point of concern for areas within this category.

### 2.3.1 New Hydraulic Risk Matrix

To overcome some of the issues with defining hazard and frequency in the higher HR categories, a new matrix was adopted that provided more distinction between floods driven by frequency and those driven by hazard.

Three broader subcategories were proposed which vertically splits the matrix to align with the three consequence thresholds of the AIDR hazard categories. The result is three sub-classifications applied in the HR1 to HR3 bands to reflect low hazard (H1), moderate hazard (H2-H4) and High hazard (H5-H6) within each HR band. The result is 10 discrete bands of risk. The revised Hydraulic Risk matrix from this work is provided below. The new matrix is shown in the figure below.

**TABLE 2-2 REVISED POTENTIAL HYDRAULIC RISK MATRIX**

| AEP | H1 | H2 | H3 | H4 | H5 | H6 |
|---|---|---|---|---|---|---|
| PMF | HR5 | HR5 | HR5 | HR5 | HR5 | HR5 |
| 1 in 2000 | HR5 | HR5 | HR4 | HR4 | HR4 | HR4 |
| 1 in 500 | HR5 | HR4 | HR4 | HR3 (b) | HR3 (c) | HR3 (c) |
| 1 in 100 | HR4 | HR4 | HR3 (b) | HR2 (b) | HR2 (c) | HR2 (c) |
| 1 in 50 | HR4 | HR3 (b) | HR2 (b) | HR2 (b) | HR1 (c) | HR1 (c) |
| 1 in 20 | HR3 (a) | HR2 (b) | HR2 (b) | HR1 (b) | HR1 (c) | HR1 (c) |
| 1 in 10 | HR2 (a) | HR1 (b) | HR1 (b) | HR1 (b) | HR1 (c) | HR1 (c) |

The following can now be derived from the new matrix:

- The (a) subcategories now represent further distinction in catchments of a low hazard risk (i.e. of lesser consequence other than flood damage);
- The (b) subcategories represent the consequence range of where there is risk to vehicles and life and;
- The (c) subcategories represent the consequence range of where there is risk to structures.

The HR matrix and outputs was processed by utilising a maximum of all flood sources for the Brisbane River and each LFMP area from the flood study results.

It should be noted that hydraulic risk merely represents a portion of overall flood risk. Holistic flood risk includes a variety of other factors that are considered throughout the LFMP in conjunction with hydraulic risk.

The hydraulic risk matrix, mapping and GIS outputs link together across multiple packages to provide data for use in the current and future flood risk, land use planning and flood mitigation work packages.

An example of the refined hydraulic risk mapping is shown in Figure 2-4. Please refer to Appendix A for hydraulic risk mapping for each of the six LFMP localities. Hazard mapping based on H1 to H6 for each locality is available in Appendix B.

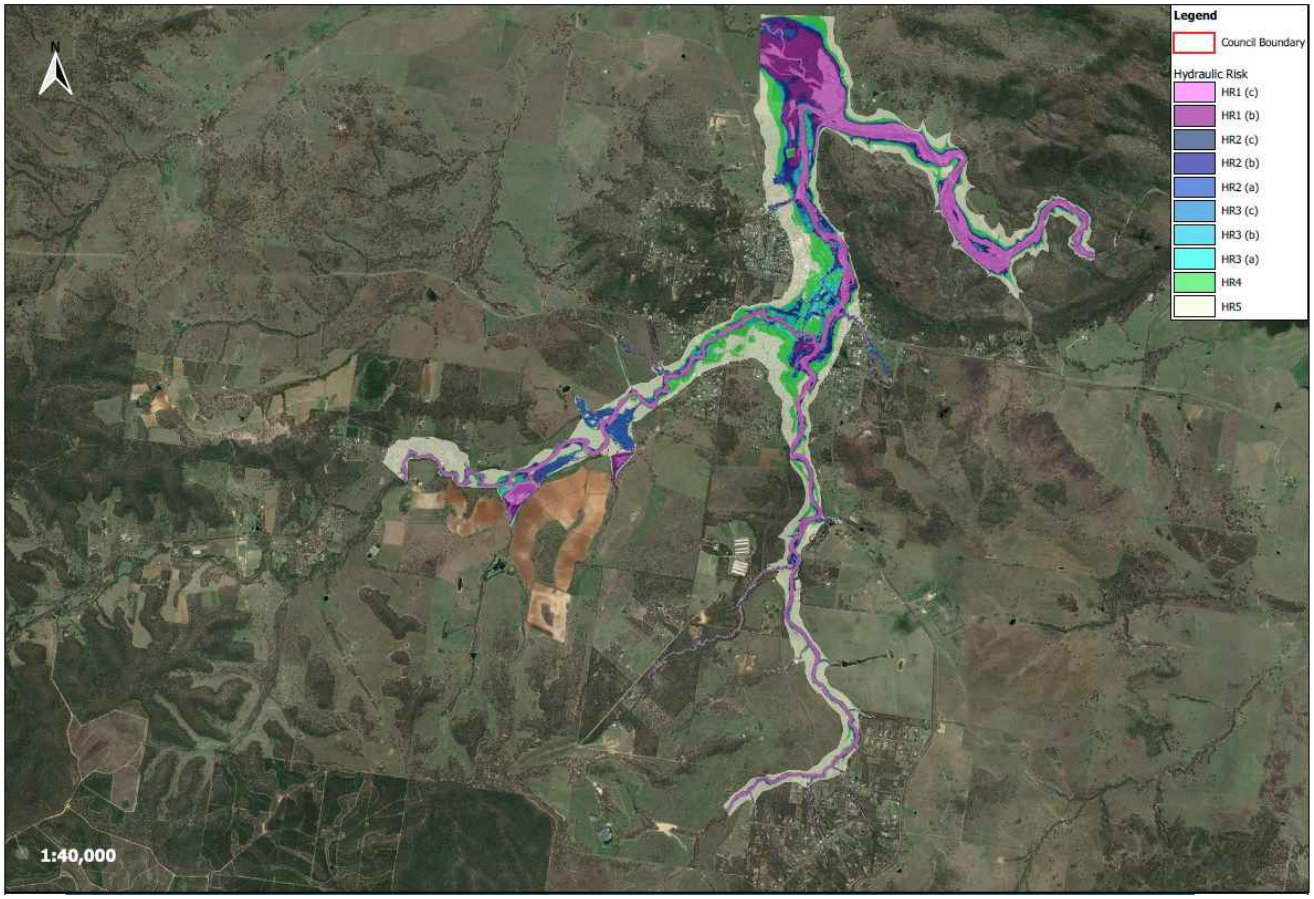



**FIGURE 2-4 HYDRAULIC RISK MAPPED USING NEW MATRIX IN ESK**

## 2.4 Flood Exposure

### 2.4.1 Datasets

The following information has utilised a variety of datasets and the flood risk matrix to identify flood exposure across the Somerset catchments and communities. The data sets used in this exposure assessment include:

- Land Use Zoning;
- Critical Infrastructure;
- Building database (developed through the SFMP method to define building types as described in the damages section of the report);
- Road data base (sourced through Somerset Regional Council and the existing SFMP dataset);
- Community Infrastructure; and
- Vulnerability datasets

### 2.4.2 Building Database

A building database for the entire Ipswich area was developed using the following process:

- Collating all of the building database data from Somerset Regional Council and the datasets from the Department of Natural Resources and Mines;
- Following the same process as per the SFMP documented in the report Building Floor Level Heights – Brisbane Strategic Floodplain Management Plan – Brisbane LGA, Ipswich LGA, Somerset LGA and Lockyer Valley LGA dated 16/06/2017; and
- Utilising this process to estimate flood levels and building types such as slab on ground and highset etc.

### 2.4.3 Building Classification

Utilising the building database and the previous flood level and building classification approaches and methodologies from the SFMP, the building types for the LFMP were as follows:

**TABLE 2-3 BUILDING CLASSIFICATION**

| Description | Category |
|---|---|
| Low set Single Story on stumps | FDSS - Stumps |
| Highset | FDHS |
| Low set Single Story (slab on ground) | FDDS |
| Single Storey | MUSS |
| Double or More Stories | MUDS |

### 2.4.4 Overall Building and Population Exposure

Scripts and code developed in python and QGIS were utilised to use the building database and classification information as well as all of the collated flood models to produce the following outputs. The existing land use data was utilised to produce an overarching understanding of different land uses exposed to flooding. Further distinction and detail were then processed and presented to provide more information on residential buildings and exposure.

Throughout each LFMP area a variety of exposure statistics were developed including:

- Residential Building Exposure

  The total number of buildings exposed at both ground and floor level was processed. In addition to this, the building classifications were used to separate out the exposure of different types of buildings.

- Residential Population Exposure

  The average population for each area was combined with the number of exposed buildings to provide an estimated population exposure.

- Critical and Vulnerable Use Exposure

  Critical Infrastructure such as emergency centres, airports, water infrastructure etc was collated for exposure. In addition, vulnerable use such as childcare and schools was also reported on for exposure in each LFMP area.

## 2.5 Flood Isolation

Isolation caused by flood waters can be a major risk especially for long durations, or where critical services are cut-off or if persons isolated need emergency assistance and evacuation. Areas of isolation are an important element of overall flood risk that must have due consideration. The LFMP has undertaken an analysis of isolation to provide flood intelligence to plan for pre-emptive evacuations during flooding, resupply operations, strategic land use planning responses and for community education and awareness. Isolation can be used in combination with other flood risk factors to prioritise for flood risk management treatment and to ensure suitable future land uses are commensurate with the risk.

This section describes the process of identifying flood islands, time to and duration of inundation.

### 2.5.1 Flooded Road Low Points

The road immunity of road sections and the associated flood road low points were identified using the following methodology:

- Using Council's road classification database, due consideration applied to all roads from Local to Arterial, state, and federal highways;
- The maximum PMF flood surface (from all flood models) was used to identify where each section of road coincides with the flood surface. Each of these road segments were trimmed and used as a road low point;
- Each of these road segments used the existing LiDAR to assign a ground level elevation for the road low point; and assigned the relevant AEP event for when the road breaches the road low point.

The analysis of road low points including assigned AEP has been consolidated and used for further assessment as described in this section. Figure 2-5 shows examples of the flooded low points.

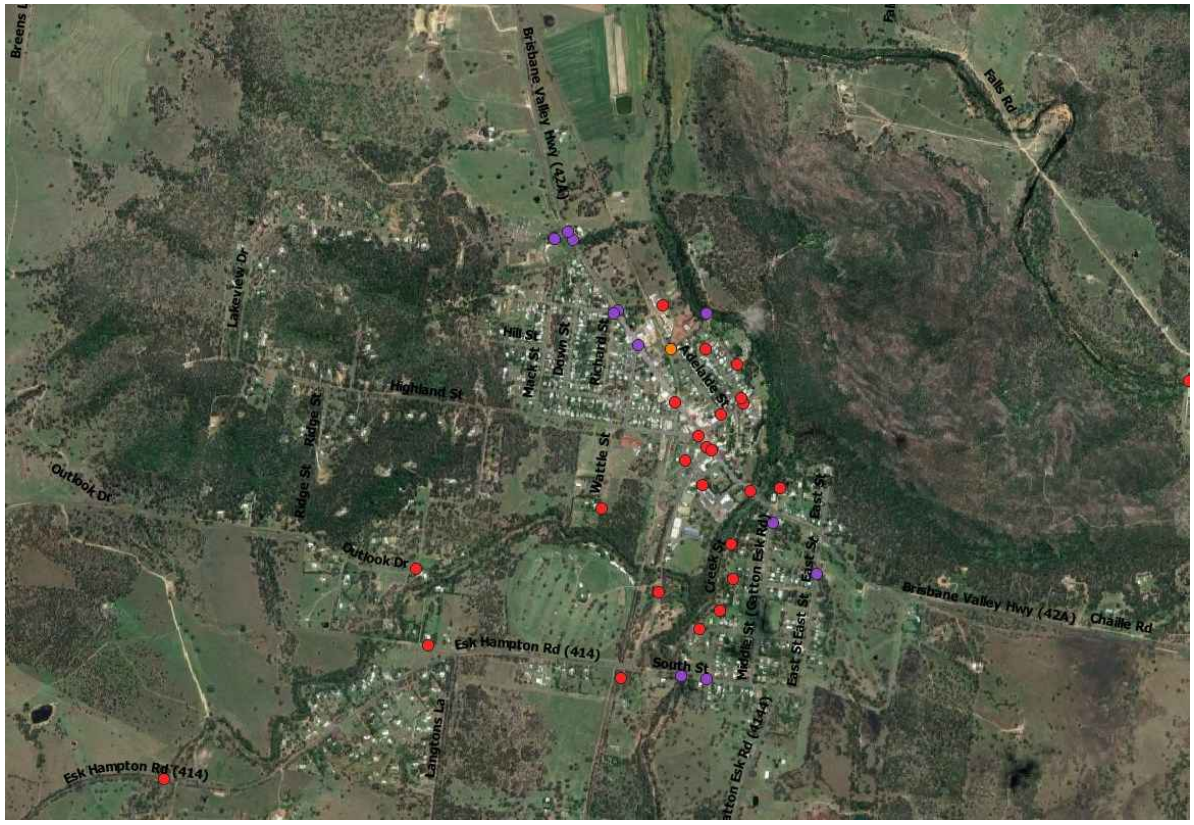



FIGURE 2-5 EXAMPLE ROAD FLOODED LOW POINTS

### 2.5.2 Flooded Road Immunity

The analysis of flooded roads identifies the first event in which the road is inundated. The flooded road immunity shows locations across the Somerset LGA which may be affected by poor road flood immunity. An example location is presented in Figure 2-6. The spatial information has been provided in the data package that accompanies this report.

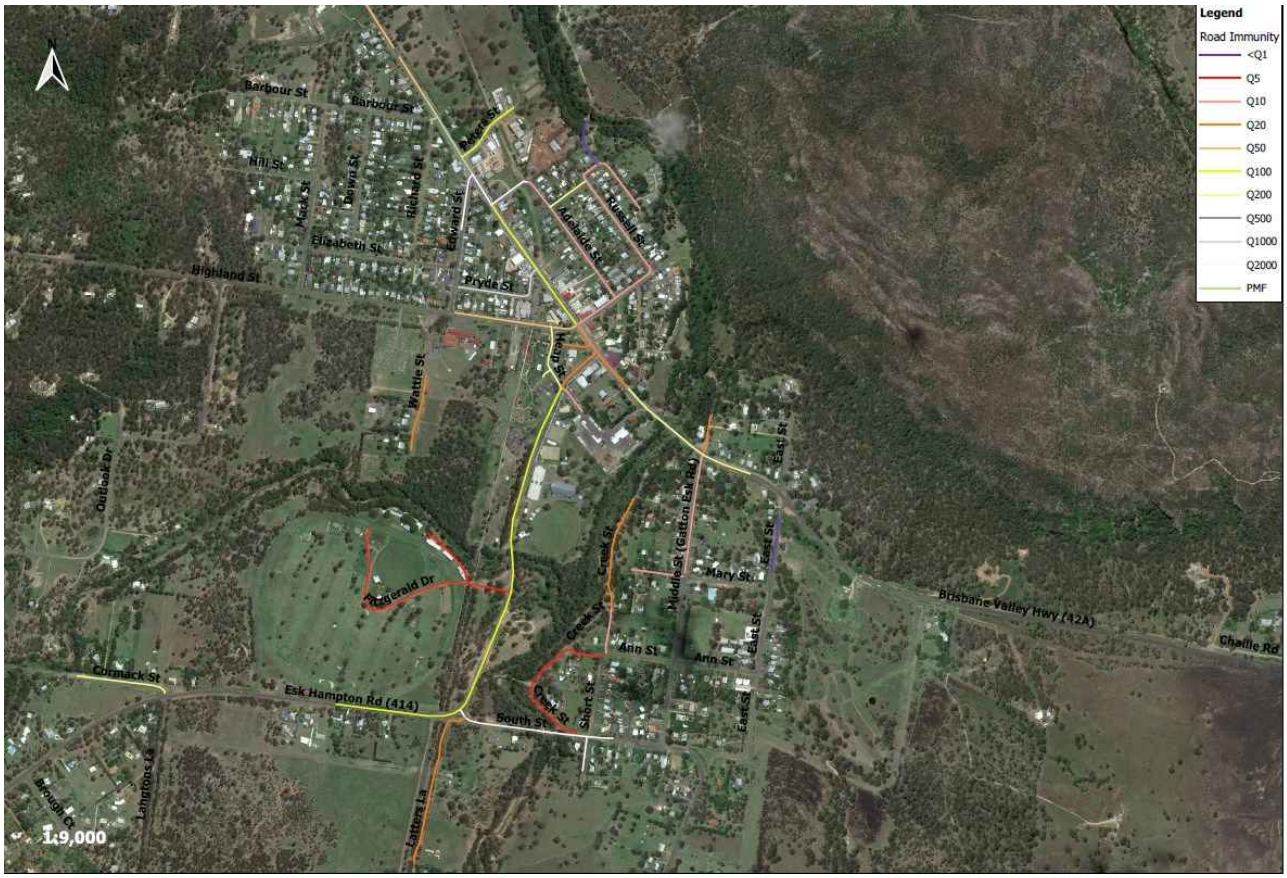



FIGURE 2-6 EXAMPLE ROAD IMMUNITY

### 2.5.3 Time to Flood Inundation Information

The earliest time the road, building or asset is inundated with floodwaters is known as Time to Inundation. The data informs several outputs that contributes to the picture of flood risk across the Somerset LGA. The mapping produced uses Time to Inundation (TTI) information for a high-level understanding across each catchment, TTI for buildings flooded above floor level and TTI for roads flooded above low points.

This information was processed using the following methodology:

- Using the suite of available Council flood models (Brisbane and local creek catchments), data pertaining to existing hydraulic duration information was extracted. It should be noted that significant limitations exist in the dataset and these are noted within the limitations section of this chapter;
- Areas shown as Not Available (N/A) model tailwater are those areas where no time to inundation information is available. As multiple models are used in the assessment to determine the fastest TTI, existing models have initial water levels and tailwater allocated time “Zero”. Areas such as this are unable to be analysed and properties thus are not identified or assessed within these areas.

- Time series information within the models were used to produce worst case scenarios (i.e. shortest time to inundation) for all models and flood durations that have been combined for this methodology;
- TTI was based on flooding above 150mm of existing ground level, i.e. for buildings TTI was based on exceeding floor levels; and for roads TTI was based on exceeding road low points; and
- Outputs were produced for the 1 in 10 AEP, 1 in 100 AEP and 1 in 2000 AEP. These events were chosen as a fair representation of likely, possible and rare flood events. This delineation allows for a better understanding of the time differences associated with different magnitudes of flooding.

TTI information is particularly useful to provide another factor in flood risk in areas such as evacuation, isolation and community awareness. TTI information can also help understand exposed road assets and the need for earlier action on road closures. TTI when coupled with other flood risk outputs is an incredibly important factor in determining flood risk. TTI information can and should also be used in future land use planning and strategic decisions regarding the appropriateness of settlement and designation of uses.

The emergency management work package of the LFMP will explore the findings of this analysis. For example, flood intelligence could be used to develop and refine flood forecasting systems.

TTI mapping for all six LFMP localities for both the 1 in 100 and 1 in 2000 AEP localities and is provided in Appendix C.

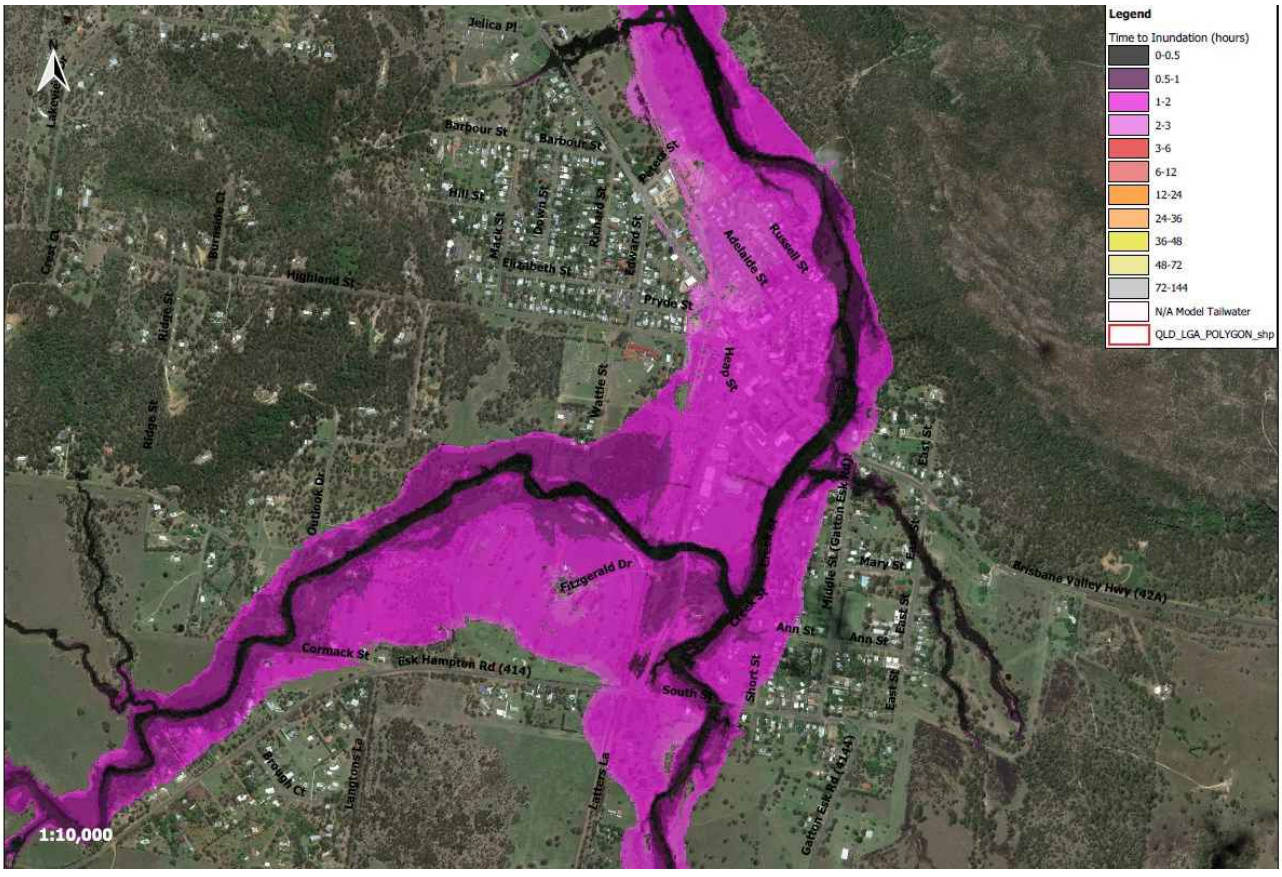



FIGURE 2-7 EXAMPLE TIME TO INUNDATION (1 IN 2000 AEP)

As a note, the 1 in 2000 AEP can be considered the “worst case” TTI generally. Speed of inundation differs significantly to the 1 in 10 and 1 in 100 AEP primarily due to flood storages being depleted at a quicker pace, less resistance because of lower roughness values on floodplains and an increase in velocity overall.

### 2.5.4 Duration of Flooding Inundation Information

Duration of flood inundation (DFI) has been identified by calculating the time water exceeds a certain level. This has been calculated using the same events as the TTI methodology, i.e. 1 in 10 AEP, 1 in 100 AEP and 1 in 2000 AEP. The methodology for calculating DFI is as follows:

- Using the suite of available Council flood models (Brisbane and local creek catchments), data pertaining to existing hydraulic duration information was extracted. It should be noted that significant limitations exist in the dataset and these are noted within the limitations section of this chapter;
- Time series information within the models was utilised to produce worst case scenarios (i.e. longest duration) for all models and durations combined for DFI;
- DFI was based on the time flooding was above 150mm of existing ground level, i.e. for buildings DFI was based on the time of flooding above floor levels; and for roads DFI was based on the time above road low points; and
- Outputs were produced for the 1 in 10 AEP, 1 in 100 AEP and 1 in 2000 AEP. These events were chosen as a fair representation of frequent, intermediate, and rare flood events. This delineation allows for a better understanding of the time differences associated with different magnitudes of flooding.

DFI mapping for all six LFMP localities for both the 1 in 100 and 1 in 2000 AEP localities and is provided in Appendix D.

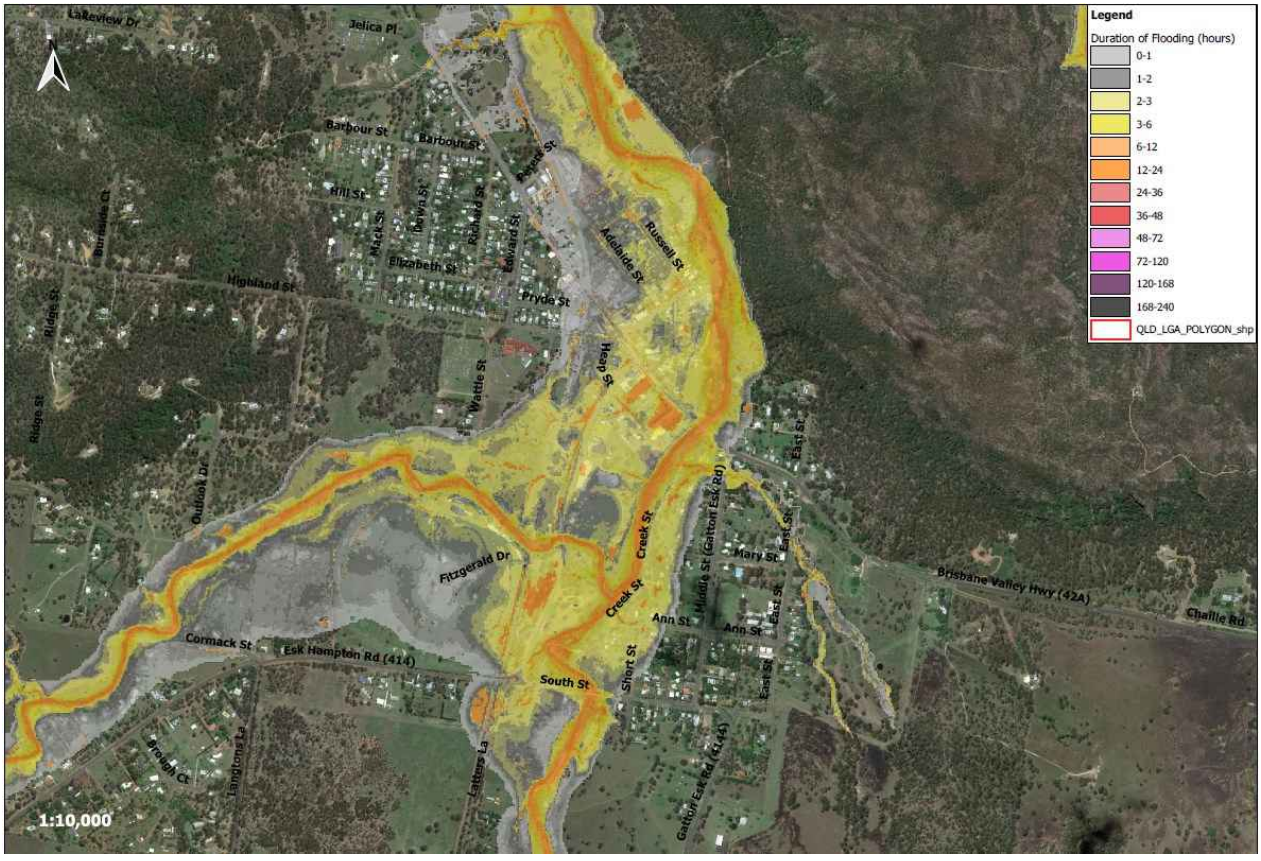



FIGURE 2-8 EXAMPLE DURATION OF INUNDATION

Duration of Flooding information is particularly useful to provide another factor in flood risk in areas such as evacuation, isolation and community awareness. DFI information can also help understand exposed road assets and how long assets like bridges will be closed and exposed to damage (longer flood durations cause

more damage to road networks by saturated pavements etc). DFI when coupled with other flood risk outputs is an incredibly important factor in determining flood risk particularly with regard to high flood islands, areas which require resupply and shelter tolerability during events.

### 2.5.5 Flood Islands

Flood islands are a unique, complex, and relatively dangerous situation that can develop during flood events. Flood islands develop when servicing roads to areas are cut (often multiple) and the area is then isolated via no means of vehicle transportation and likely pedestrian mobility.

Two types of flood islands can develop during flood events: low and high flood islands and these scenarios are shown below in Figure 2-9. Flood islands for each of the six LFMP localities have been mapped and are available in Appendix E.

**High Flood Islands** are classified by:

- Entry and existing roads to the island are flooded;
- As flood waters rise, a section of the flood island still remain dry and immune in the PMF event;
- High islands will shrink to a small section of available PMF immune land and become a refuge during flood events where there is a safe section of land available;
- High flood islands eventually have added complexities and responses needed depending on the duration of flooding and the length of time the roads are cut. If roads are cut for a significant amount of time, resupply of essential items will be required, and the risk of critical health issues also becomes an issue;
- High flood islands require special attention with regards to emergency personnel access which can only be via air or boat; and
- High flood islands require the community to be aware and prepared such as having emergency kits, resupply of their own, medication and also require knowledge of the community around them as relocation may be necessary if no formal/informal area is available for relocation. This can add complexity when durations of flooding are very long (days).

**Low Flood Islands** are classified by:

- Entry and existing roads to the island are flooded;
- As flood waters rise, eventually the entire island will submerge. Depending on the extent of flooding, this can obviously become a life-threatening situation;
- Low flood islands are very dangerous areas to be isolated as there is no way to evacuate and eventually the only method for evacuation is via air or boat. This is often highlighted during flood events in areas such as this with people stranded on roof tops;
- Low flood islands are further categorised by the event that the road inundates and the event that the island inundates. The lower the AEP for both inundation mechanisms generally means the higher risk the flood island is; and
- Low flood islands can be further complicated as evacuation may be needed early, advanced, and accurate flood forecasting systems are required and a level of community understanding, and awareness is also critical.

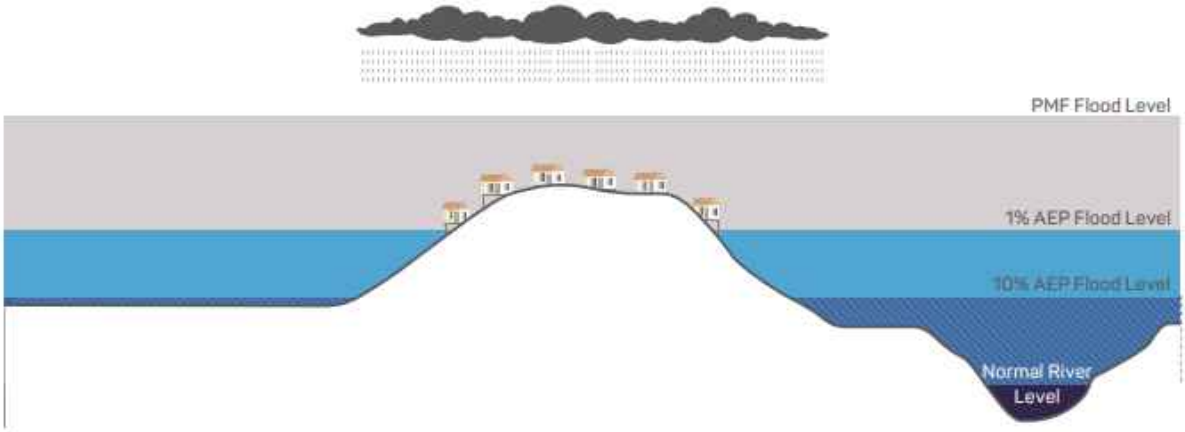



Figure 1: Example of area that is flood affected, isolated by floodwaters and fully submerged in the PMF. Category FIS.

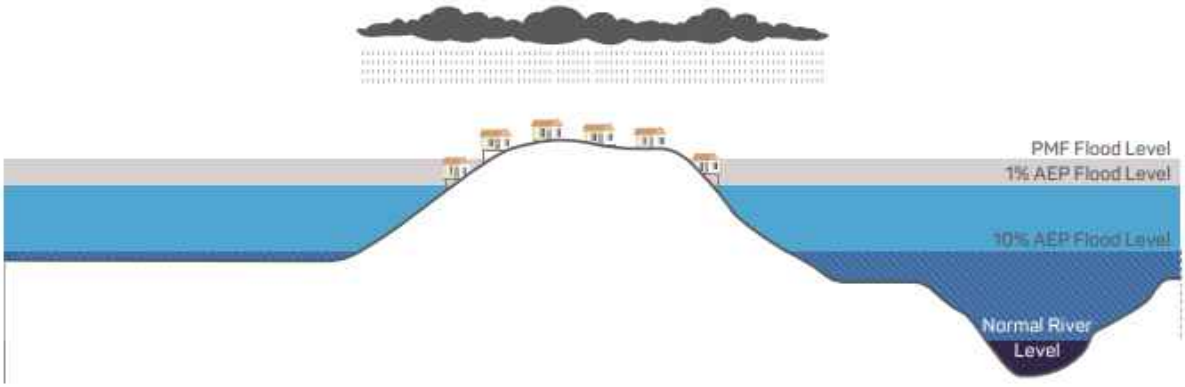



**FIGURE 2-9 FLOOD ISLANDS (AIDR 2017)**

Outputs of the flood island areas are shown in the map below. These outputs in GIS format also have further information on their AEP inundation events which can be useful in prioritising the most important islands combined with other outputs such as time to inundation, vulnerability, and hazard.

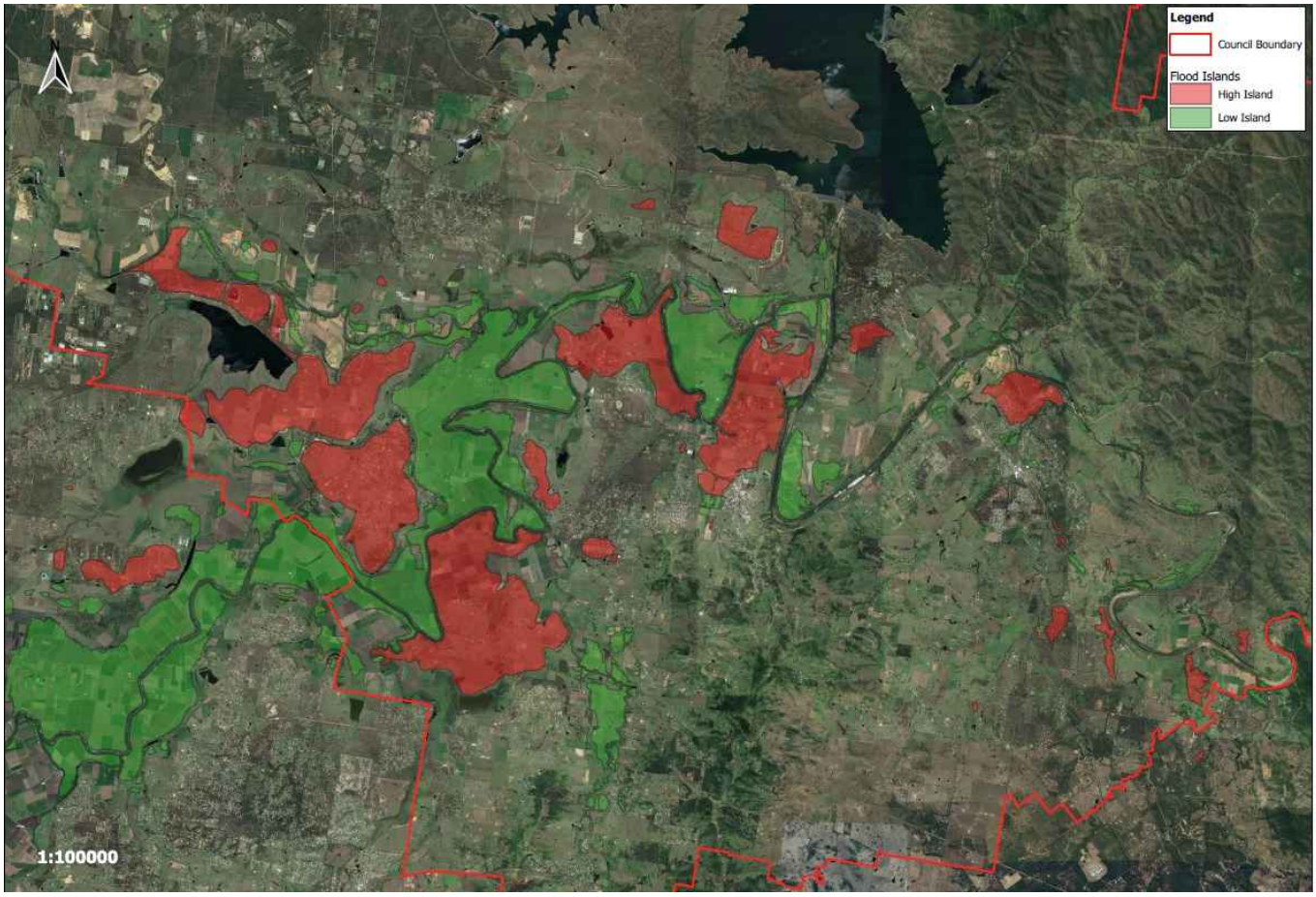



**FIGURE 2-10 EXAMPLE FLOOD ISLANDS OVERVIEW**

# 3 VULNERABILITY

Including an assessment of social vulnerability goes beyond the conventional risk assessment by ensuring Council has a full understanding of the characteristics of population which can affect their response and hence vulnerability during a flood event.

Factors such as awareness, physical vulnerability, socio-economic vulnerability and mobility are social attributes that most strongly relate to vulnerability during floods. There are various aspects of social vulnerability to flooding, but these four vulnerability indices have been considered (SFMP) in detail. This suite of vulnerability indices recognises demographic characteristics, socio-economic status, health and access to information.

## 3.1 Vulnerability Analysis Methodology

Vulnerability is also considered further as a guide to determining appropriate response measures within the emergency management and community awareness and resilience work packages. The methodology to identify vulnerability is based on the existing process described in the SFMP and is described further in this section.

### 3.1.1 Indices

Each vulnerability index has specific attributes that can be identified based on statistical data. Using the 2016 Australia Bureau of Statics (ABS) census records, suburb-level analysis has been undertaken and is presented in the community profile summary. The types of vulnerability and the data indicators are listed below.

### 3.1.2 Physical Vulnerability

The physical vulnerability index reflects the level of the communities' vulnerability due to age and disability. The following attributes were used:

- Percentage of population under 5 years;
- Percentage of population 65 years and over;
- Percentage of population 65 years and over, and living alone; and
- Percentage of population who require assistance with everyday living.

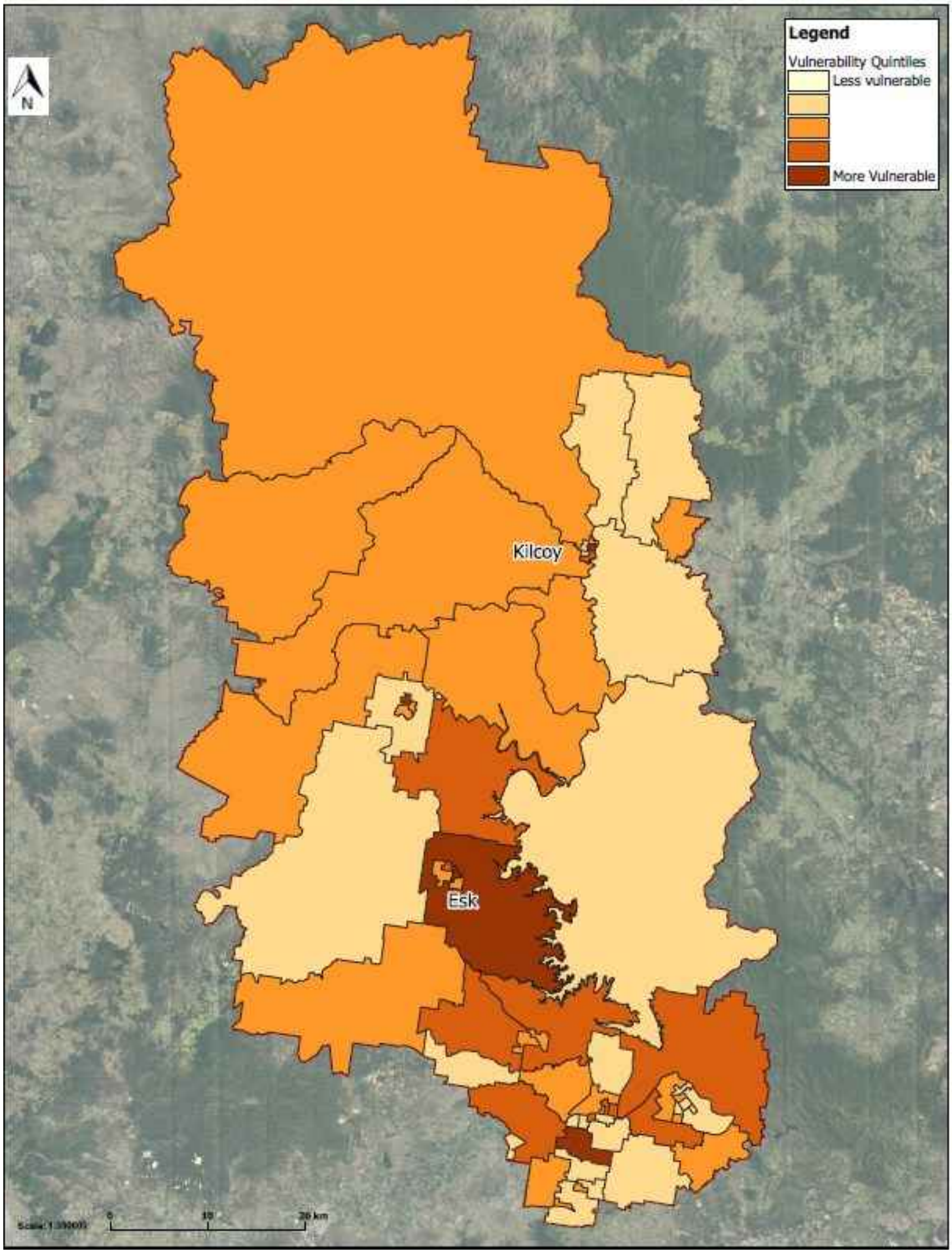



FIGURE 3-1 SOMERSET REGIONAL COUNCIL PHYSICAL VULNERABILITY

### 3.1.3 Social and Economic Vulnerability

The social and economic vulnerability index reflects the level of the communities' vulnerability due to financial capacity. The following attributes were used:

- Percentage of population living in rental accommodation;
- Percentage of households with low household incomes (less than $650/week); and
- Percentage of population who are unemployed.

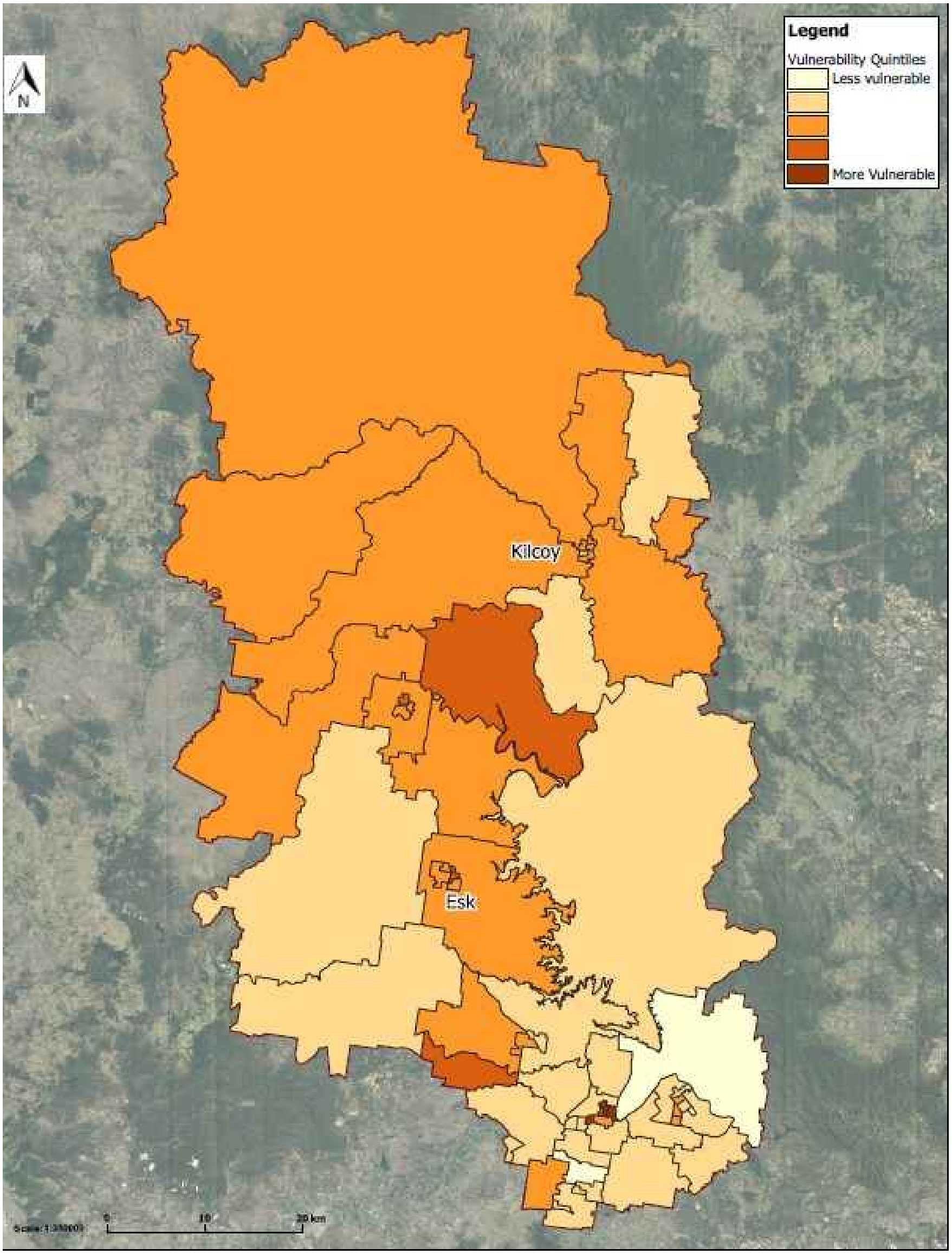



FIGURE 3-2 SOMERSET REGIONAL COUNCIL SOCIAL ECONOMIC VULNERABILITY

### 3.1.4 Mobility Vulnerability

The mobility vulnerability index reflects the level of the communities' ability to evacuate during a flood. The following attributes were used:

- Percentage of households with no private vehicles;
- Percentage of single parent households; and
- Percentage of households with 5 or more people.

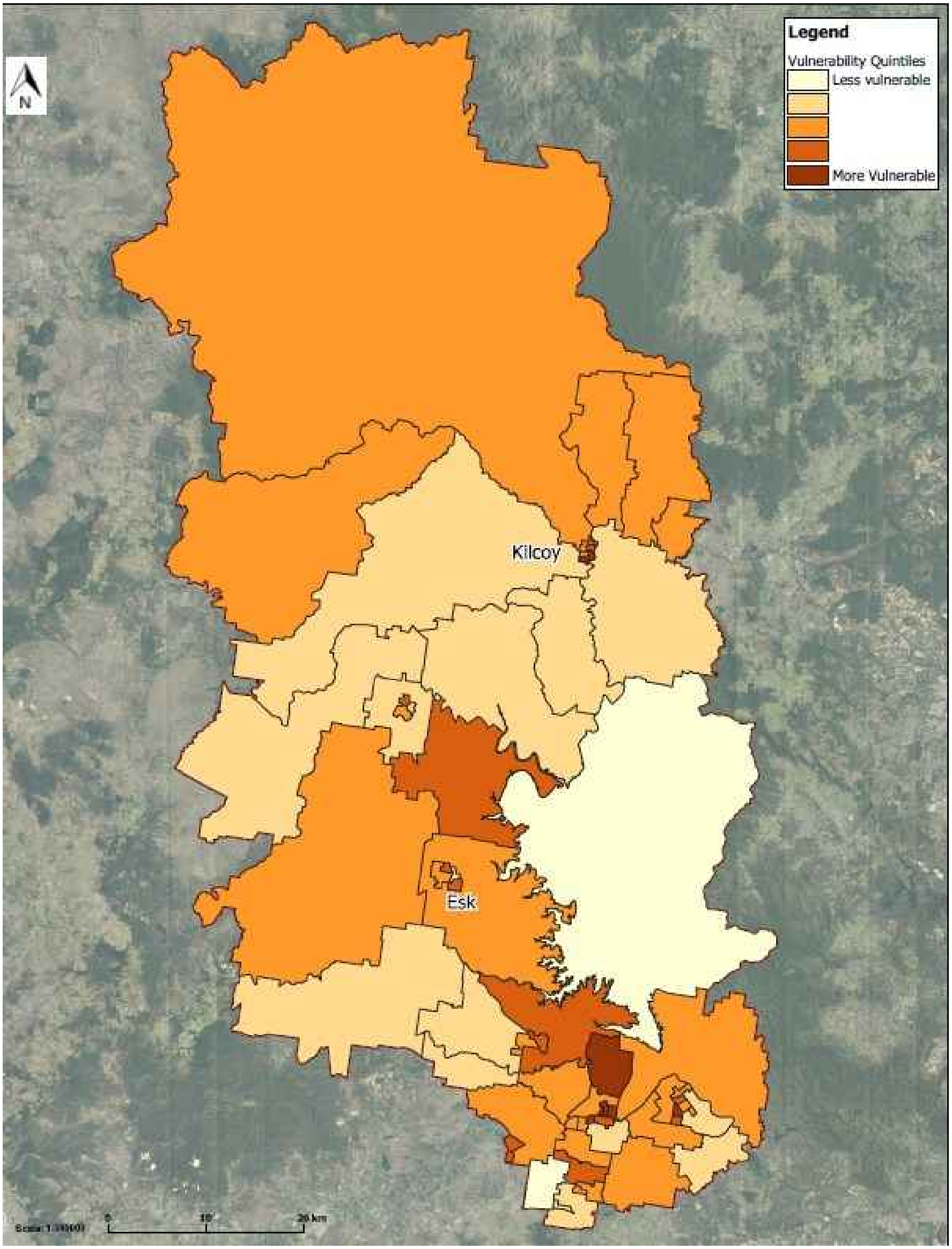



FIGURE 3-3 SOMERSET REGIONAL COUNCIL MOBILITY VULNERABILITY

### 3.1.5 Awareness Vulnerability

The social and economic vulnerability index reflects the level of the communities' vulnerability due to the inability, lack of awareness or barriers to access and/or understand flood warning information. The following attributes were used:

- Percentage of population who are new to the area;
- Percentage of population with little or no English skills; and
- Percentage of population with limited or no access to the internet.

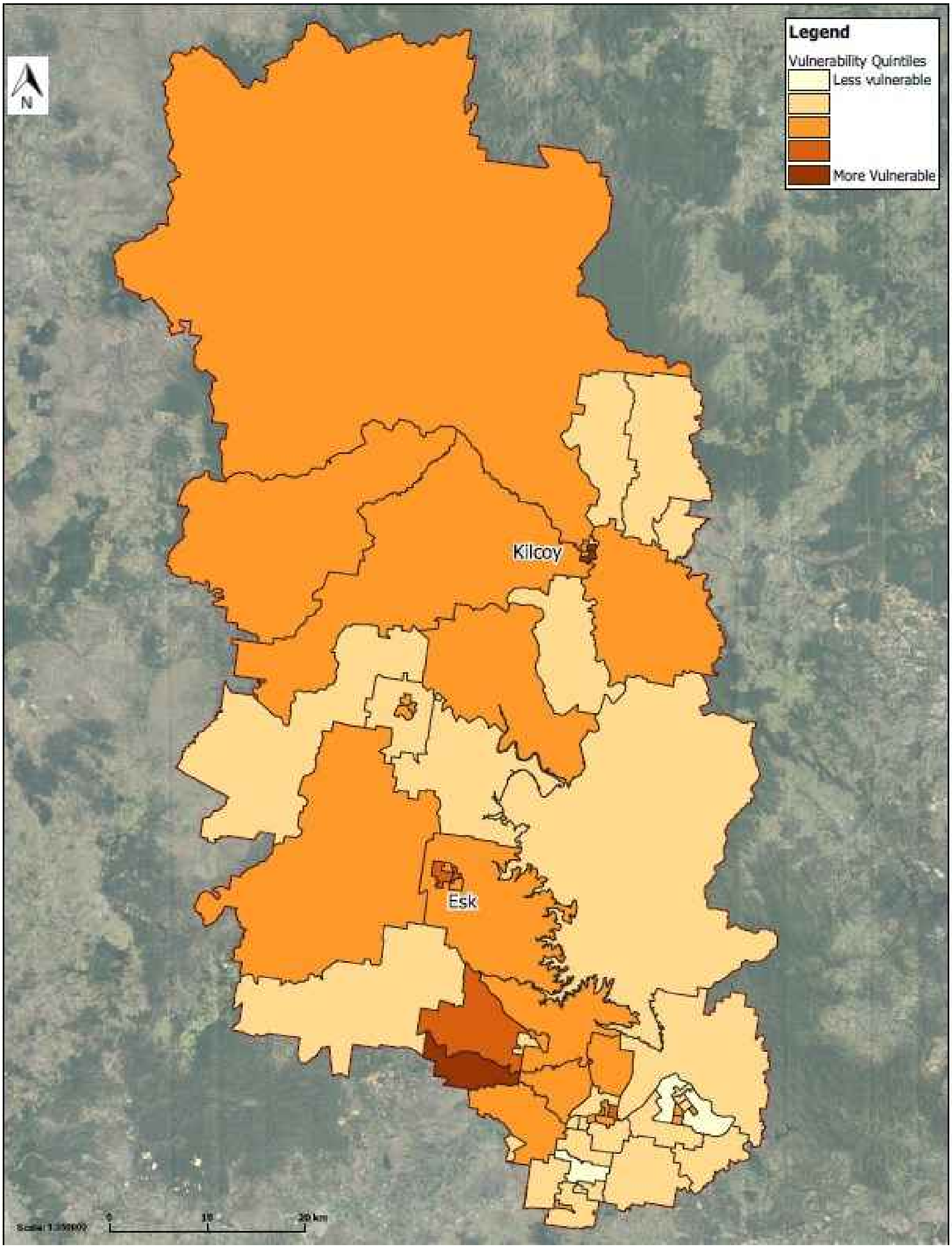



FIGURE 3-4 SOMERSET REGIONAL COUNCIL AWARENESS VULNERABILITY

### 3.1.6 Calculating Combined Vulnerability

The calculation of the vulnerability indices involved a two-stage normalisation of data. The step-by-step approach to calculate individual indices and the overall vulnerability index is as follows:

1. Each of the attributes was calculated for each SA1 area as a percentage of residents within that SA1 area.
2. These percentages are ranked and normalised to assign each SA1 area a value of 0 to 1 for each attribute, with the value of 1 assigned to the SA1 area with the highest percentage.
3. The normalised values of each attributes within a given vulnerability index were summed.
4. These final values were again normalised.
5. Repeat Step 1 to 4 for the remaining indices.

The four indices are summed and normalised again to highlight locations of combined vulnerability.

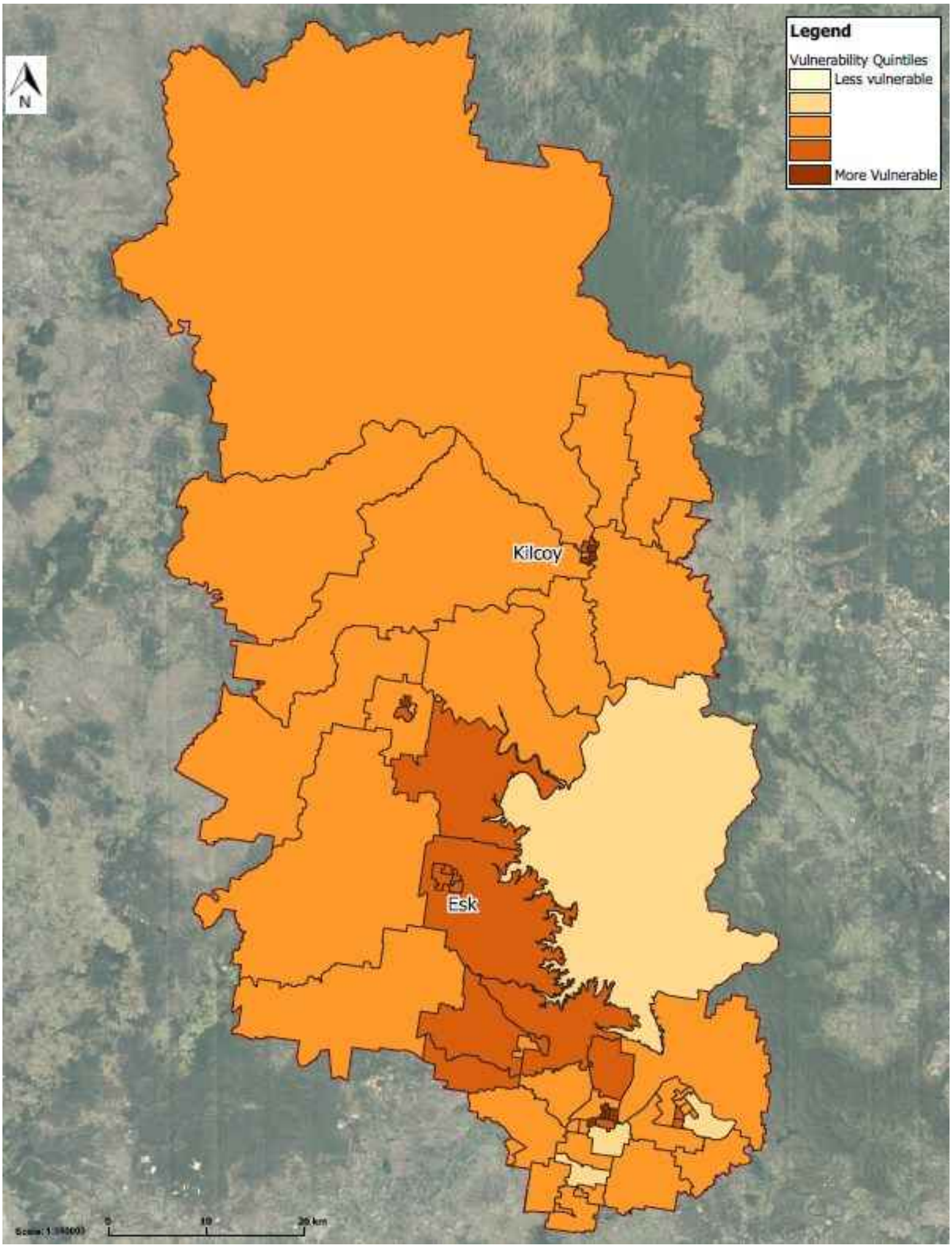



FIGURE 3-5 SOMERSET REGIONAL COUNCIL COMBINED VULNERABILITY

# 4 FLOOD DAMAGES

In order to maintain regional consistency and accord to the latest research and application within the flood damages space, the methodology used in the LFMP follows a similar process for categorising, analysing and displaying flood damages for the Ipswich catchments to the SFMP[1]. For full refence to the research and application of the SFMP method please refer to the *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report.* A summary of the method used, and the unmitigated flood damages results tables are provided in this section.

## 4.1 Flood Damages Overview

As indicated, the flood damages assessment will be undertaken with the method developed in the SFMP.

### 4.1.1 Flood Model Results

All of the Council flood study results and data have been used in the assessment. As all flood studies have consistent outputs the storm events used include 1 in 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000 AEPs and the PMF. The range of storm events presents a good spread of different magnitude floods required to calculate flood damages. The results were merged and processed as entire damages across the Somerset LGA.

In order to process damages considering a holistic city-wide perspective with multiple flood sources, the following information was considered and implemented in the approach:

- Each of the flood sources (Brisbane and Local) was combined as a maximum to produce the highest water level at each location (property and roads);
- This highest flood source and level was used to process the maximum damages expected for each output; and
- Extracts of different flooding sources was also produced to provide an understanding of the different types of flood sources. It should be noted however that the most reliable and accurate dataset will be the combined maximum damage outputs.

### 4.1.2 Building Classification and Floor Levels

The data provided by Council and the methods used to classify buildings in the SFMP has been replicated in the LFMP.

The LFMP utilised the Brisbane River SFMP floor level data for the encompassing Brisbane River extents and the Geovision data for the remainder of the outputs outside of these extents. Summarising this method includes utilising Lidar and assumptions on building classification to determine floor levels. GIS scripts provided from the SFMP were utilised and extended to the entire Ipswich region using the same process with the Geovision data as the Brisbane River data.

**TABLE 4-1 BUILDING CLASSIFICATION**

| Description | Category |
|---|---|
| Low set Single Story on stumps | FDSS - Stumps |
| Highset | FDHS |
| Low set Single Story (slab on ground) | FDDS |

[1] For full refence to the research and application of the SFMP damages calculation method please refer to the *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report*

| Description | Category |
|---|---|
| Single Storey | MUSS |
| Double or More Stories | MUDS |

A key difference from the SFMP method includes utilising the entire building polygon rather than a central point nominated for a building. This was used as often using the central point method can mean that damages are not captured for part of the building (examples include where flooding occurs through the backs of properties in gullies). This is considered a more accurate method for calculating realistic damages particularly for partly flooded properties. With this approach, it should be noted there may be some inconsistencies with the SFMP results for the Brisbane River, however this would likely provide a more accurate assessment regardless. It should also be noted that Brisbane City Council have also adopted this change to determining damages.

Building datasets were further filtered by removing structures less than 60 square metres. This allows structures such as small to medium size sheds and ancillary structures to be removed and not counted in flood damage assessment. Whilst some larger structures such as sheds may be included, increasing the filter will reduce auxiliary dwellings (granny flats, garages, etc) from the premise of concern. It is still likely however that damages are likely elevated due to numerous structures such as sheds being included.

Mapping of property-based damages assessment is available in Appendix F.

### 4.1.3 Damage Curves

The damage curves developed for the SFMP were utilised for the LFMP without revision. A summary of the flood damage curves and how they are applied is shown below. For a full description of the damage curves please refer to the *Brisbane River Strategic Floodplain Management Plan Technical Evidence Report.*

**Residential**

The residential damage curves utilised in the LFMP include:

- Internal Damage Curves

  Damages in this section generally includes contents of a household that is damaged by flooding within all internal rooms of the household. In total there are 18 different curves developed based on the building classification and the size of the building (small medium and large). An example of this is shown below.

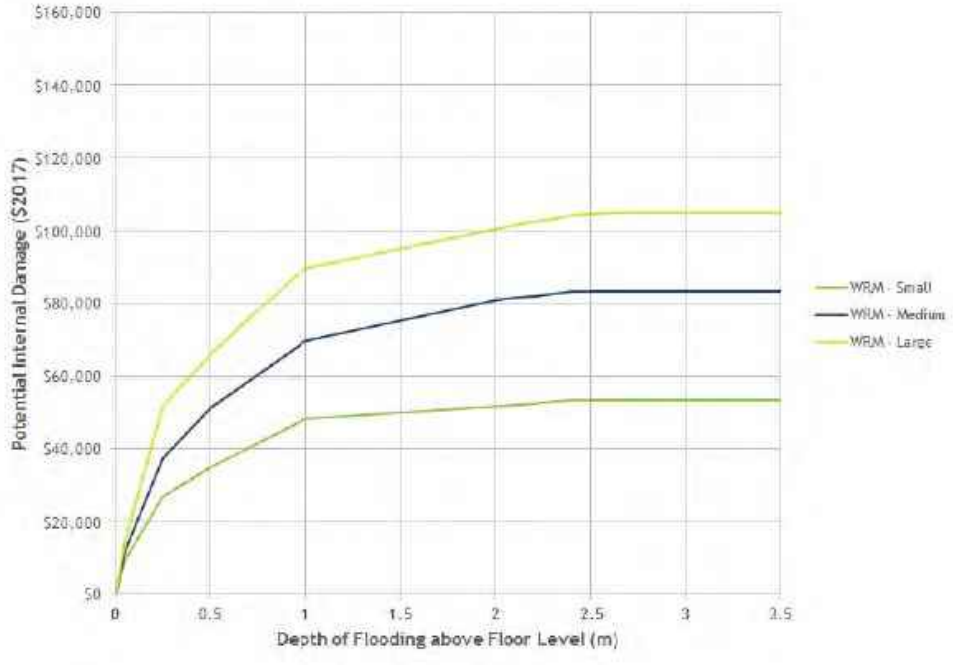



**FIGURE 4-1 FDSS INTERNAL STAGE DAMAGE CURVE**

- Structural Damage Curves

  Damages in this section includes structural components such as rooves, floors and walls. In total there are 18 different curves developed based on the building classification and the size of the building (small medium and large). An example of this is shown below.

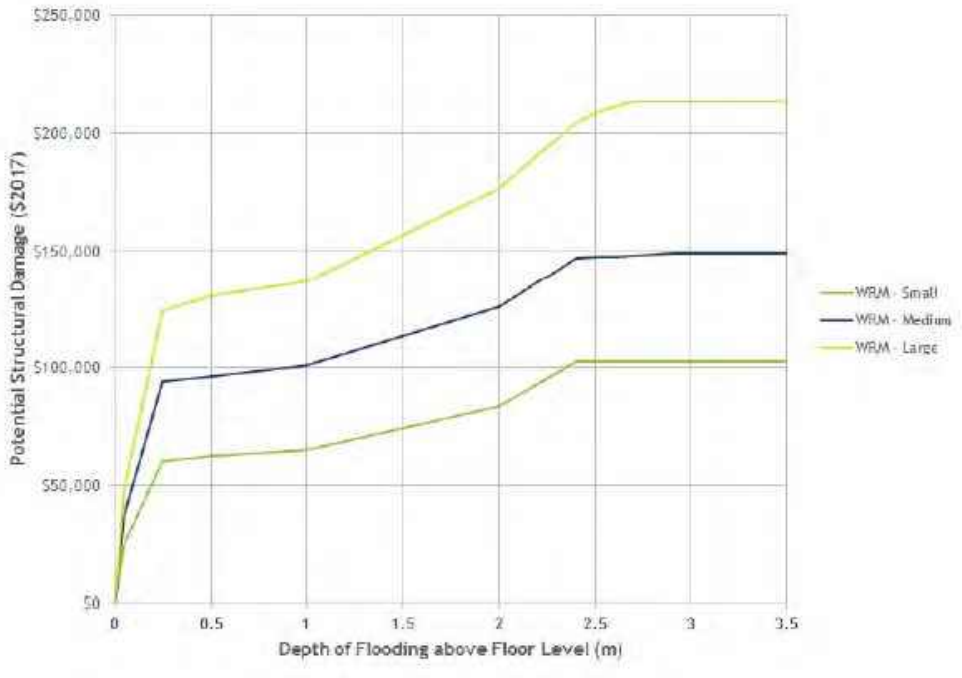



**FIGURE 4-2 FDSS STRUCTURAL STAGE DAMAGE CURVE**

- External Damage Curves

  Damages in this section generally includes external areas of the household such as gardens, fences, sheds, garages, and vehicles etc). In total there are 18 different curves developed based on the building classification and the size of the building (small medium and large). An example of this is shown below.

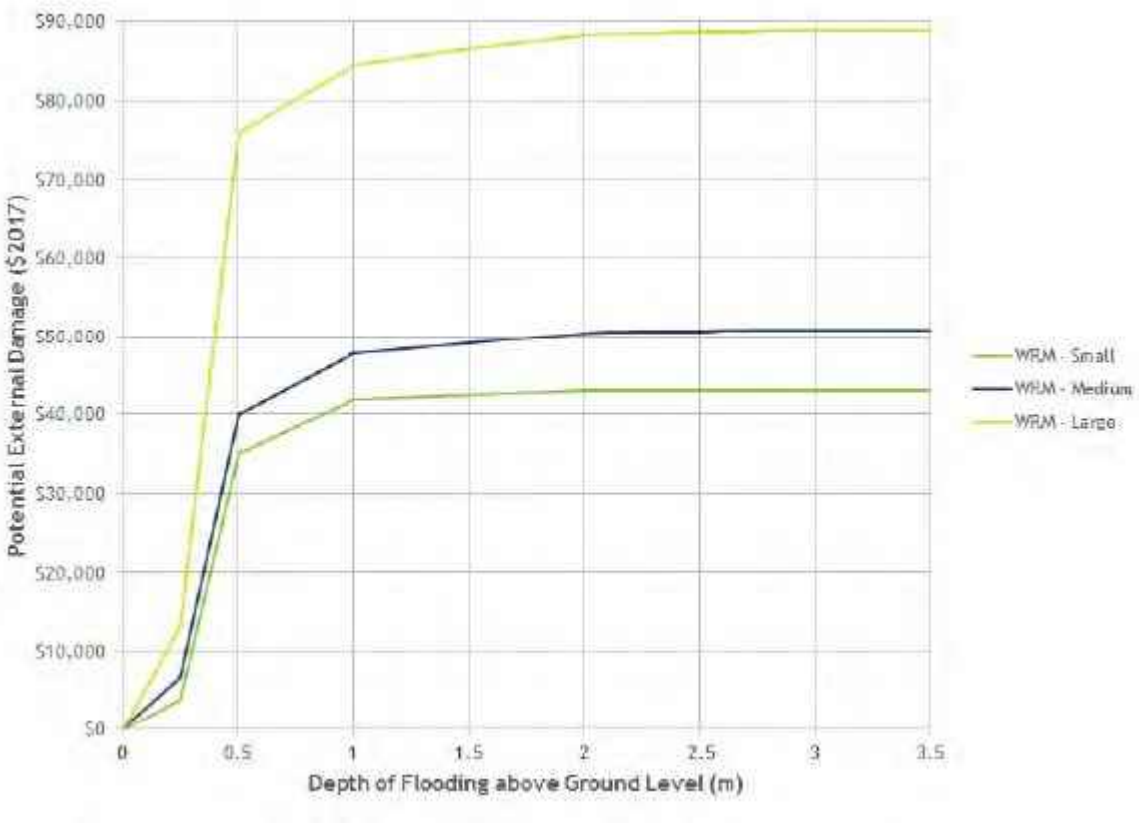



FIGURE 4-3 FDSS EXTERNAL STAGE DAMAGE CURVE

**Commercial**

The developed damage curves for commercial premises developed in the SFMP were utilised to the extent possible.

The LFMP commercial damages thus utilised the small, medium and large curves (dependant on building square metres) and adopted the value class of 3 (VC 3 curves or medium).

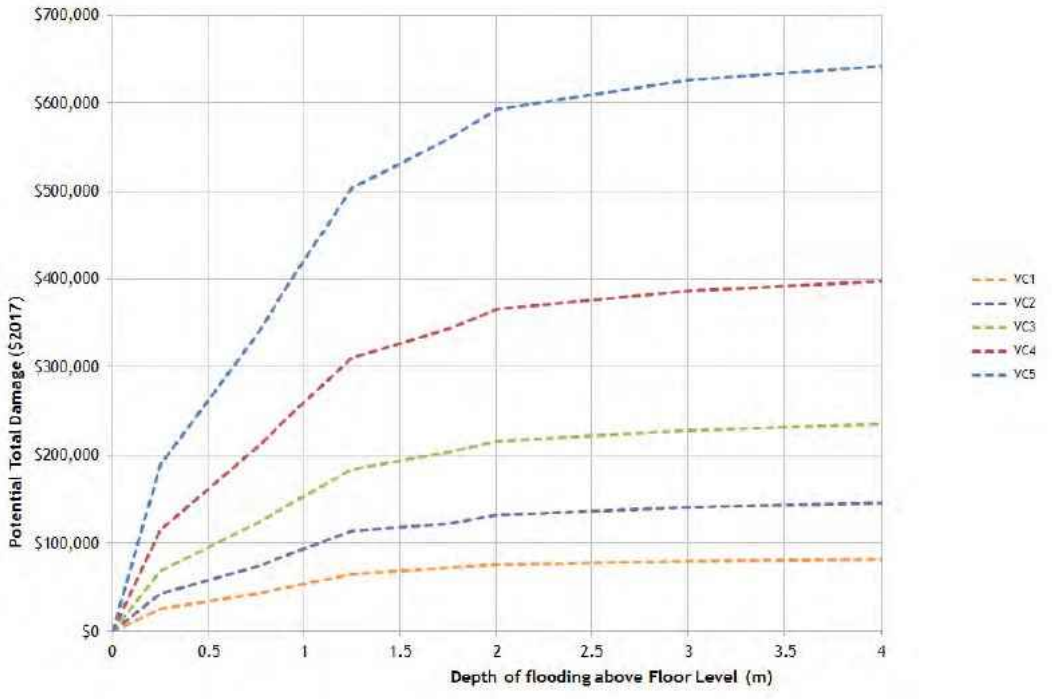



FIGURE 4-4 EXAMPLE COMMERICAL DAMAGE CURVE

**Other Damages**

All other damages (road infrastructure and public utilities) were undertaken in accordance with the adopted measures in the SFMP methods.

### 4.1.4 Actual and Potential Damage

Actual damage incurred in flood events is nearly always less than potential damage calculated via flood damage curves. A number of factors affect the ratio of potential to actual damages and primarily are associated with the amount of warning time available whereby residents are able or not able to prepare their house for floods (taking protective measures outside or moving contents and valuable items to higher ground).

Research in this space is complex as it is associated with human behaviour during flood events. There is merit for further investigation with regards to further exploring the difference in damages between riverine and flash flooding scenarios however this is beyond the scope of the LFMP. In the absence of available data, the SFMP approach was utilised to provide a ratio of potential to actual damages using a constant ratio across all flood types and depths. Essentially this provides a ratio of 0.8 and reduces the damages by 20% across the study area. It could be considered that this value may be too low considering the amount of flash flooding catchments included in the LFMP, however no research or guidance is available to provide justification to modify this ratio.

### 4.1.5 Direct and Indirect Damages

Direct flood damages are self-explanatory in that they are the damages calculated via the damage curves for internal, structural and external aspects. Indirect damages result from costs incurred during and after floods for primarily clean up and recovery activities.

Indirect damages for the LFMP have utilised the SFMP method incorporating a percentage of direct damages used for indirect damages of 15% of actual damage for residential properties and 55% of actual damage for commercial properties.

### 4.1.6 Tangible and Intangible Damages

Tangible damages are those that have been listed previously in the sections above and have been calculated with a general degree of accuracy due to several surveys, research and flood events where data has been collected and analysed.

Intangible damages however are more complex as they result from the human and social impact of flooding. As no additional data or research exists on this top, the SFMP method has been adopted to calculate intangible damages which is shown below in Table 4-2.

**TABLE 4-2 INTANGIBLE UPLIFT FACTOR**

| AEP (1 in x) | Uplift Factor |
|---|---|
| 2 | 0 |
| 5 | 0 |
| 10 | 0 |
| 20 | 0 |
| 50 | 0.7 |
| 100 | 1.2 |
| 500 | 2.3 |
| 2000 | 3.1 |
| PMF | 4.6 |

### 4.1.7 Existing Damages LFMP

Ultimately whilst total damages per magnitude of flood event is an important aspect to consider and understand, the Average Annual Damages (AAD) is the defining factor of how much flood damages are expected to cost the Somerset community each year on average.

Reducing these average annual damages is an important aspect of floodplain management to reduce the overall impact of flooding. This target is not an isolated goal however and also is part of a multi-pronged approach to flood management across all work packages. Damages are used in the flood mitigation works and flood resilient materials prioritisation (where reducing damages is a primary aspect of these structural and non-structural measures).

**Each section of the LFMP provides assessment of numerous aspects of damages.**

# 5 FLOODPLAIN MANAGEMENT MITIGATION MEASURES

This section describes the structural options assessed as part of the six LFMPs. These are presented in more detail as part of the individual township LFMP reports.

## 5.1 Flood Mitigation Selection Process

This section provides the overview of how options were sourced and selected.

### 5.1.1 Flood Mitigation Types

There is a multitude of flood mitigation methods that can be utilised to reduce flood damages within catchments. These include:

- Dams
- Detention Basins
- Permanent Levees
- Flood gates and backflow prevention devices
- Channel modification and straightening of creeks
- High flow bypass channels/diversions
- Dredging
- Pipes and pump arrangements for transfer of floodwaters

### 5.1.2 Options Sourcing

In order to source and eventually short list preferred flood mitigation options, the following avenues were explored to create a long list of possible options including:

- Reviewing Council's previous flood studies and floodplain management plans across all catchments. Many of these options were reviewed on the basis of if they were still possible/current or and if they had not been implemented.
- Inclusion of the previous structural flood mitigation options from the SFMP including the Fernvale Levee.
- Discussions with the project team and Council officers which provided a wealth of well-informed flood mitigation options.

It should be noted that several local drainage options were also discussed, however these were largely dismissed due to the scale and suitability of a regional assessment of flood risk.

### 5.1.3 Short Listing Process

The short-listing process was undertaken utilising the following actions:

- Workshops with the project team and a variety of reference groups developed as part of the LFMP
- The BR SFMP recommendations and inclusive of the options retained for the Fernvale Levee
- Any known proposals from the Somerset Community
- Any feedback from the Community Consultation Exercise undertaken
- Consideration of only regional scale options
- Utilising a Multi-Criteria Analysis

## 5.2 Short list of options assessed

This section summarises the short list of options investigated further through the Multi Criteria Assessment (MCA) and Benefit Costs Assessment (BCA). Property Specific Actions have been considered in each township and is discussed separately in section 5.4.6.

### 5.2.1 Summary of Options for Assessment

After the shortlisting process was undertaken, the following physical options were moved forward to undertake detailed modelling and cost benefit assessment. The options for each of the townships are listed in Table 5-1.

**TABLE 5-1 SHORT LIST OF OPTIONS FOR ASSESSMENT BY TOWNSHIP**

| Township | Option | Description |
|---|---|---|
| All townships | Property specific actions | Residential property buy-back and voluntary purchase, and flood-proofing (via retrofitting flood resilient building materials and potential house-raising) for properties exposed to frequent flooding and high hazard floodwaters. |
| Esk | Levee for main Esk | 1km levee option is primarily aimed at restricting or removing the Redbank Creek breakout which floods the main Esk township. |
| Esk | Extended Levee | 1.4km levee option is primarily aimed at restricting or removing the Redbank Creek, extends past Wattle Street to RJ Rashford Recreation Ground. |
| Toogoolawah | Basin and levee diversion of overbank flows | Provides storage and re-diversion of flows to attempt to alleviate flooding of rural properties along Brisbane Valley Highway. |
| Fernvale | Levee | Fernvale levee as per SFMP recommendation 'SO6' Undertake a local options assessment for the Fernvale levee as part of the Somerset Local Floodplain Management Plan. |
| Fernvale | Nardoo Gully basin upstream of Main Street | Mitigates flow from the gully and preventing breakout at some locations which floods some properties downstream in Nardoo Street and Poole Road area. |
| Fernvale | Banks creek detention basin upstream Fairneyview Fernvale Road | Thus levee and basin option is primarily aimed at mitigating flow from the gully and preventing breakout at some locations which floods some properties and main Fernvale commercial areas in the township. |
| Kilcoy | Levee at Seib Street (skate park) | Potential levee along the western section of Kilcoy Creek restricting or removing the Kilcoy Creek breakout which floods some properties along Seib Street. |
| Lowood | Bray Street drainage upgrade and channel/small levee | Combination of pipe upgrades and small diversion levees are proposed to address flooding on properties surrounding Prospect and Bray Street. |
| Minden | Basin upstream of Warrego Highway | Potential large detention basin along Tallegalla Road that reduces flows along Plain Creek to provide maximum flood reduction damages downstream |
| Minden | Basin alongside Rose Avenue | Detention basin on the eastern side of Rose Avenue and minor levee works to contain flooding through Rose Avenue community area. |

### 5.2.2 Detailed Modelling Process

The shortlisted options are then assessed in detail through 2D hydraulic models previously developed by Council across the study area. The option location determines which hydraulic model is utilised. Modelling is undertaken generally with the following considerations:

- The existing models are utilised in their current state, assumed fit for purpose and using the same parameters (grid sizing etc);
- Modifications are made within the hydraulic models to suit the proposed options including manning's roughness changes, z shape inclusions and other adjustments as necessary;
- The model is simulated across all of the storm events available up to PMF;
- Duration and ensemble selection (if relevant) are kept consistent with the existing model;
- All duration surfaces are post processed for maximum water levels across all flood events (where relevant);
- The mitigated height surface is compared with the existing height surface to determine performance and any impacts from the proposed option; and,
- This information is then utilised within the flood damages assessment.

### 5.2.3 Mitigation Model Simulation and Damages

In order to provide a comparison of the existing verse mitigated results and resultant damages and average annual damages, the following modelling process was undertaken:

- All of the existing models were utilised as provided by Council;
- All events, durations and temporal patterns were used, and any post processing was undertaken in accordance with the procedures and run files documented in the existing model run sets; and,
- All model existing model results utilised were assumed correct and functioning.

The mitigated model results were then run through WaterRIDE to produce damages for each mitigation scenario and an annual average damage for the same process described for existing results.

### 5.2.4 Option Costing

Cost estimations have been undertaken in a combination and consideration of the following factors:

- Discussion with Somerset Regional Council team members;
- Consideration of the SFMP rates applied. It should be noted however that these rates utilised appear more high level and conceptual and not consider local and more detailed knowledge of projects;
- Construction contract rates from completed projects in neighbouring Ipswich City Council including Redbank Recreation Reserve (detention basin, planting, drainage and wetland), Thagoona Flood levee (earthworks, imported embankment and large culverts);
- Consideration of the scale of the project;
- Multiplication factors for pre-construction works (such as design) depending on the scale and complexity of the project;
- Contingency allowances have been adjusted depending on project complexity. In addition to this, contingency values are quite high on some of the bigger planting projects and would cover price uncertainty; and,

- Knowledge and experience from the entire project team in design and construction.

### 5.2.5 Benefit Cost Analysis Process

A traditional BCA has been utilised to determine the value of works to proceed. The costs of the works include capital and maintenance costs, design and overheads as well as a 30% contingency. Benefits are recognised through the average annual damage reduction across the entire LFMP catchments.

The CBA considers a 100-year design life of the options and utilises a 7% discount rate with sensitivity of the 4% and 10% discount rates. The sensitivity of these discount rates can be utilised to make informed decisions around CBA scores that are borderline in progressing.

When an assessment is completed for each option, any option that has a BCA of 1.0 or more is recommended to proceed as the benefits are either equal to or greater than the costs. BCA's that incur a value of greater than 0.5 would require consideration of discount rates, constraints, limitations, and the value of integrating into other opportunities (such as future development). These options would require further investigation.

### 5.2.6 Multi Criteria Analysis Process

#### 5.2.6.1 Overview of the MCA

The MCA process was baselined and repeated using the SFMP method, however important refinements and additions were made to this MCA to suit a localised context in Somerset, corporate desires and policies from SRC and to also include considerations for other factors such as resourcing and operational risk.

#### 5.2.6.2 MCA Criteria

As a baseline, the SFMP MCA and criteria was replicated, however there were some minor changes made to better align with the project overall including:

- Including residual risk to capture any potential impact on the community and council associated with large flood events above the DFE.
- Consideration of increased asset management burden and ongoing costs/resourcing to Council and the community.

The criteria and scoring system is listed below in Table 5-2.

**TABLE 5-2 LFMP REFINED MCA CRITERIA**

| Criteria | Issue | Scoring Scale (1-5) | | |
|---|---|---|---|---|
| | | 1 | 2.5 | 5 |
| **Safety of People** | Reduce hydraulic risk rating (now and future) | "Number of properties with increased risk | No Reduction in Risk | Reduce hydraulic risk rating (now and future) |
| | Improve time for evacuation (now and future) | Time for evacuation reduced | No effect to current evacuation time | Increased evacuation time |
| **Social** | Targets vulnerable community members or areas | Targets less vulnerable people | "Targets a mix of low and high | Targets vulnerable community members or areas |
| | Social health benefits | "Negative effect on social health - | Social health benefits | "Negative effect on social health - |

| Criteria | Issue | Scoring Scale (1-5) | | |
|---|---|---|---|---|
| | Improves community flood resilience (now and future) | Reduces resilience during floods and reduces understanding of flooding | No change to resilience or understanding | Strengthens resilience during floods and improved understanding of flooding |
| | Recreation and amenity | Decrease in diversity and amenity of open space and natural environment areas | No change in diversity and amenity of open space and natural environment areas | Increase in diversity and amenity of open space and natural environment areas |
| | Connection and collaboration | Increased separation of community from water course. Decreased cultural heritage connection | No change | Decreased separation of community from water course. Increased cultural heritage connection and function |
| | Community | Majority of Community likely to oppose measure | Community Neutral on measure | Majority of Community likely to support measure |
| **Economic** | Reduce damages and costs to residential property (now and future) | Net Damage likely to increase following measure | No change | Net Damage likely to decrease following measure |
| | Reduce damages and costs to business and industry (now and future) | Net Damage likely to increase following measure | No change | Net Damage likely to decrease following measure |
| | Option likely to be cost beneficial (now and future) | Costs of option likely to outweigh benefits | Near neutral cost benefit | Benefits of measure likely to outweigh costs |
| **Feasibility** | Physical / technical (now and future) | Likely to be complex, expensive and many unknown issues | Likely to be feasible subject to further investigations | High degree of certainty and feasibility around outcomes |
| | Legal / approval risk | Requires approval with high risk of issues surrounding this | Requires approval but generally approval granted with conditions | No or minimal approval required |
| | Residual Risk/Asset Management | Major residual risk transferred with major ongoing asset management | Some residual risk transferred and some ongoing major asset management | No residual risk transferred and no ongoing major asset management |

| Criteria | Issue | Scoring Scale (1-5) | | |
|---|---|---|---|---|
| **Essential Infrastructure** | Improve availability and function (now and future) | Measure will negatively impact on existing or proposed critical infrastructure | No net change on existing or proposed critical infrastructure | Measure will positively impact/improve existing or proposed critical infrastructure |
| | Protection of water supply quality and security - catchment protection (quality and yield) | Decrease in catchment storage or management practices leading to significant impact in water security | No net change to water security | Increased catchment storage or management practices leading to significant improvements in water security |
| **Environment and Natural Resource Management** | Improved Water Quality | Likely increase in water quality pollutants | No net change | Likely decrease in water quality pollutants |
| | Species, Vegetation and habitat impacts | Decrease in habitat, vegetation and species | No net change | Increase in habitat, vegetation and species |
| | Ecosystem health and connectivity (fish passage/fauna movement) | Fragmentation/disconnection of ecological communities | No net change | Improved connection of ecological communities |
| | Reduction in landscape salinity / improved moisture retention and groundwater recharge | Enhanced salinity risk due to changes in vegetation, decrease groundwater recharge. Decreased area of floodplains/wetlands | No net change | Decreased salinity risk due to changes in vegetation, increased groundwater recharge. Increased area of floodplains/wetlands |
| | Reduction in erosive capacity/soil movement - channel stability/geomorphology | Decrease in channel stability, increase in soil movement/erosive capacity and geomorphology issues | No net change | Increase in channel stability, reduction in soil movement/erosive capacity and geomorphology issues |

#### 5.2.6.3 MCA Weighting

In addition to the change in criteria, weightings were also modified from the SFMP to allow the additional criteria for residual risk and asset management to be accounted for.

The weightings are shown below in Table 5-3.

**TABLE 5-3 LFMP REFINED WEIGHTING**

| Criteria | Detail | Overall Weighting |
|---|---|---|
| **Safety of People** | Reduce hydraulic risk rating (now and future) | 15.0% |
| | Improve time for evacuation (now and future) | 5.0% |

| Criteria | Detail | Overall Weighting |
|---|---|---|
| **Social** | Targets vulnerable community members or areas | 5.0% |
| | Social health benefits | 3.0% |
| | Improves community flood resilience (now and future) | 6.0% |
| | Recreation and amenity | 2.0% |
| | Connection and collaboration | 2.0% |
| | Community | 2.0% |
| **Economic** | Reduce damages and costs to residential property (now and future) | 9.0% |
| | Reduce damages and costs to business and industry (now and future) | 5.0% |
| | Option likely to be cost beneficial (now and future) | 6.0% |
| **Feasibility** | Physical / technical (now and future) | 4.0% |
| | Legal / approval risk | 3.0% |
| | Residual Risk/Asset Management | 3.0% |
| **Essential Infrastructure** | Improve availability and function (now and future) | 5.0% |
| | Protection of water supply quality and security - catchment protection (quality and yield) | 5.0% |
| **Environment and Natural Resource Management** | Improved Water Quality | 4.0% |
| | Species, Vegetation and habitat impacts | 4.0% |
| | Ecosystem health and connectivity (fish passage/fauna movement) | 4.0% |
| | Reduction in landscape salinity / improved moisture retention and groundwater recharge | 4.0% |
| | Reduction in erosive capacity/soil movement - channel stability/geomorphology | 4.0% |
| | Improved Water Quality | 4.0% |

The following Table 5-4 below lists the criteria used to assess scoring for damages and likely cost benefit. This has been modified slightly from the SFMP to suit the local context (i.e. less damage reduction to suit smaller options).

**TABLE 5-4 DETAILED MCA REFINEMENT PARAMETERS**

| Score | Reduction in AAD | Cost Benefit Ratio |
|---|---|---|
| 1 | <-$500,000 (increase) | <0.05 |
| 1.5 | -$500,000 to -$250,000 (increase) | 0.05-0.5 |
| 2 | -$250,000 to $0 (increase) | 0.5-0.75 |

| Score | Reduction in AAD | Cost Benefit Ratio |
|---|---|---|
| 2.5 | $0 to $50,000 | 0.75-1.0 |
| 3 | $50,000 to $250,000 | 1.0-1.25 |
| 3.5 | $250,000 to $500,000 | 1.25-1.5 |
| 4 | $500,000 to $1,500,000 | 1.5-1.75 |
| 4.5 | $1,500,000 to $5,000,000 | 1.75-2.0 |
| 5 | >$5,000,000 | >2.0 |

## 5.3 Summary of Mitigation Options

A summary of the mitigation options, the benefit cost analysis and multi-criteria assessment that were used to investigate the different options for each of the six different LFMP's are detailed below.

**TABLE 5-5 SUMMARY OF MITIGATION OPTIONS**

| Option | LFMP Area | Cost | AAD Reduction | BCA Score |
|---|---|---|---|---|
| Banks Creek Detention Basin | Fernvale | $1,859,208.00 | $55,776.00 | 0.39 |
| Seib Street Flood Levee | Kilcoy | $437,933.60 | $13,040.00 | 0.24 |
| Esk Township Levee Option 2 | Esk | $1,793,511.20 | $30,125.00 | 0.17 |
| Tallegalla Road Basin | Minden | $33,799,740.00 | $517,526.00 | 0.17 |
| Fernvale Levee (SFMP SO4 option)* | Fernvale | $3,165,000.00 | $40,000.00 | 0.12 |
| Bray Street Channel works | Lowood | $1,582,877.40 | $14,515.00 | 0.11 |
| Toogoolawah Basin and Levee | Toogoolawah | $9,267,284.00 | $24,881.00 | 0.03 |
| Esk Township Levee Option 1 | Esk | $1,239,122.56 | $3,059.00 | 0.02 |
| Rose Avenue Basin | Minden | $1,931,823.40 | $3,087.00 | 0.02 |
| Nardoo Gully Detention Basin | Fernvale | $10,603,803.60 | $2,197.00 | 0.01 |

**Included from the SFMP and assessment unchanged.*

The following is noted from the table and the assessment which can be found in the individual LFMP reports.

- None of the mitigation options provide a cost benefit value above 0.5. On a pure BCA and flooding point of view, there are no options that should proceed forward on this basis alone. Due consideration still needs to be given however to the MCA process with regards to other positives and negatives of each option';
- The Banks Creek Detention Basin and Seib Street Flood levee could be given further thought by Council as they are the highest BCA options; and,
- Options with very high damage reductions such as the Tallegalla Road Basin, Fernvale Levee, Esk Township Levee option 2 and the Banks Creek Detention should also be given further consideration based on the amount of flood damages saved overall (albeit at a low cost benefit score).

The detailed MCA scores with the updates are shown in the table below. The completed scoring assessment for the detailed MCA is provided in the electronic data package, with the summary displayed in Table 5-6.

TABLE 5-6 SUMMARY OF MCA RESULTS

| Option | LFMP Area | Score | Rank |
|---|---|---|---|
| Banks Creek Detention Basin | Fernvale | 0.39 | 1 |
| Tallegalla Road Basin | Minden | 0.34 | 2 |
| Nardoo Gully Detention Basin | Fernvale | 0.22 | 3 |
| Fernvale Levee (SFMP Option) | Fernvale | 0.2 | 4 |
| Bray Street Channel Works | Lowood | 0.16 | 5 |
| Rose Avenue Basin | Minden | 0.09 | 6 |
| Sieb Street Flood Levee | Kilcoy | 0.05 | 7 |
| Toogoolawah Basin and Levee | Toogoolawah | 0.05 | 8 |
| Esk Township Levee Option 1 | Esk | -0.08 | 9 |
| Esk Township Levee Option 2 | Esk | -0.13 | 10 |

The MCA assessment is summarised as follows:

- The Banks Creek Detention Basin and Tallegalla Road Basin score the highest MCA. These options still score relatively low however due to the impacts these options will have (and the potential operational resourcing, residual risk, land ownership and acquisition and asset management issues for Council); and,
- The majority of the other options score very low in the MCA and combined with their low BCA values, these options do not present good value for money and also have other considerations that go along with the introduction of these assets (asset management, referable dams etc). In addition, many of the options also negatively affect other property owners with flood afflux.

A full list of limitations and assumptions has also been provided with this work package, as displayed in Table 5-7 and all investigations and outcomes must be read in conjunction with this.

TABLE 5-7 SUMMARY OF LIMITATIONS AND ASSUMPTIONS FOR SOMERSET

| Option | LFMP Area | Opportunities | Constraints | Recommend moving forward? |
|---|---|---|---|---|
| Banks Creek Detention Basin | Fernvale | This option provides fairly significant localised flood reductions to residential and commercial properties. There are some properties that are also provided with 1% AEP immunity. There is also a quite high reduction in flood damages overall | There are constraints associated with operational requirements, resourcing during floods, referable dam considerations and possibility of failure during rare events. Construction would also be on private land | No*<br><br>*This option could be considered further by Council as it is the highest-ranking option and provides good damage reductions regardless. Nonetheless, the BCA and MCA scores show values that are less than desirable. |

| Option | LFMP Area | Opportunities | Constraints | Recommend moving forward? |
|---|---|---|---|---|
| Tallegalla Road Basin | Minden | This option provides the highest benefit of all of the options investigated with large flood reductions and a very large damage reduction. | The option is very expensive and is also located on private land. There are constraints associated with operational requirements, resourcing during floods, referable dam considerations and possibility of failure during rare events. | No*<br><br>*This option could be considered further by Council as provides major widespread flood reductions and damages. Nonetheless, the BCA and MCA scores show values that are less than desirable. |
| Nardoo Gully Detention Basin | Fernvale | This option provides some flood benefit downstream with some properties provided 1% AEP immunity. The option also would be relatively easier to implement as it is on public lands. It also provides benefit to critical infrastructure. | There are constraints associated with operational requirements, resourcing during floods, referable dam considerations and possibility of failure during rare events. | No<br><br>This option scores a very low BCA score and a lower MCA score. |
| Fernvale Levee (SFMP Option) | Fernvale | This option as per the SFMP provides widespread protection for residents in the 1% AEP event. As the floodplain does not engage until around this event, the damage reductions are not as great as some of the other options. | There is impact to other properties as part of this proposal and there are constraints associated with referable levees and operational requirements and maintenance etc. | No<br><br>This option scores a low BCA score and a lower MCA score. |
| Bray Street Channel Works | Lowood | This option provides some localised benefit providing 1% AEP immunity to some properties. | Flood Afflux extends kilometres downstream which would need to be resolved with design iterations or potential consideration and compensation to private landowners | No<br><br>This option scores a low BCA score and a lower MCA score. |

| Option | LFMP Area | Opportunities | Constraints | Recommend moving forward? |
|---|---|---|---|---|
| Rose Avenue Basin | Minden | Locally this option provides some benefit to properties downstream of the basin and also regionally the flood benefit extends for many kilometres (at a minor scale). | There are constraints associated with operational requirements, resourcing during floods, referable dam considerations and possibility of failure during rare events. Construction would also be on private land | No<br><br>This option scores a very low BCA score and a lower MCA score. |
| Sieb Street Flood Levee | Kilcoy | Locally this option provides immunity to the 1% AEP for 6 properties and is of low cost | Flood afflux extends for many kilometres and over a very large area which would need to be resolved with design iterations or potential consideration and compensation to private landowners | No<br><br>This option scores a very low BCA score and a lower MCA score. |
| Toogoolawah Basin and Levee | Toogoolawah | This option provides widespread benefit, including flood immunity to some properties. There is also a moderate damage reduction with this option. | Flood afflux extends for many kilometres and over a very large area (and in some cases to a large degree of change) which would need to be resolved with design iterations or potential consideration and compensation to private landowners | No<br><br>This option scores a very low BCA score and a lower MCA score. |
| Esk Township Levee Option 1 | Esk | This option provides widespread flood reduction on many properties and also provides 1% AEP immunity for several properties as well | The option however has widespread afflux on private properties and house and increased damages | No<br><br>This option scores a very low BCA score and a negative MCA score. |

| Option | LFMP Area | Opportunities | Constraints | Recommend moving forward? |
|---|---|---|---|---|
| Esk Township Levee Option 2 | Esk | This option provides widespread flood reduction on many properties many more properties are provided 1% AEP immunity. This provides a good solution to the flooding in the Esk Township. | The option however has widespread afflux on private properties and house and increased damages | No<br><br>This option scores a very low BCA score and a negative MCA score. |

## 5.4 Property Specific Actions

Managing flood hazards within a local government area is best achieved by utilising a variety of measures. This report chapter summarises what property specific actions homeowners within Somerset Regional Council area may be encouraged to take for effective, localised flood mitigation.

While the onus to enact these measures will predominately reside with home owners within the region, Council can facilitate this process by considering the recommendations made at the end of this chapter; and will be effective when implementation is coordinated between the suite of flood mitigation options presented as a part of the floodplain management plan.

There are several actions house owners can take to increase flood resilience, including: residential property buy-back and voluntary purchase, house raising and flood-proofing (via retrofitting flood resilient building materials).

This report also provides recommendations for an example program of works that could be implemented within Council's existing capital/maintenance programs.

A key reference in this investigation is the Brisbane River Catchment Flood Studies '*Flood Resilient Building Guidance for Queensland Homes* document, used by building professionals and residential property owners within flood impacted areas. Every house type can improve their ability to prepare for and recover from flood events via flood resilient design solutions and consideration of building materials used.

Any potential program of works implemented by Council would require prioritisation and eligibility criteria for household participation. As a working example, Brisbane City Council's Flood Resilient Homes Program is eligible only to properties that experience flooding from Overland Flow in the 1 in 2 AEP.

To support property specific actions, adjustment to planning controls to support these outcomes may need to be considered, such as amendments to land use zone. Property specific actions should be considered where 'flood risks are high and other alternative options are not feasible'. In that context the overall floodplain management plan will present a suitable method for prioritising properties and methodology to mitigate the risk.

### 5.4.1 Comparison of Property Specific Actions

Property specific actions has been considered in two categories:

- Residential property buy-back and voluntary purchase,
- Flood-proofing (via retrofitting flood resilient building materials and potential house-raising).

While house purchasing is the most expensive of the two option categories, it is also the most effective in removing residents from the risk of flood inundation. To improve resilience to homes that are exposed to flood risk, encouraging some element of building control measure helps to reduce flood related consequences to an individual property. The diagram in Figure 5-1 shows the relationship between cost and effectiveness of building control measures as per the *Flood Resilient Building Guidance for Queensland* document.

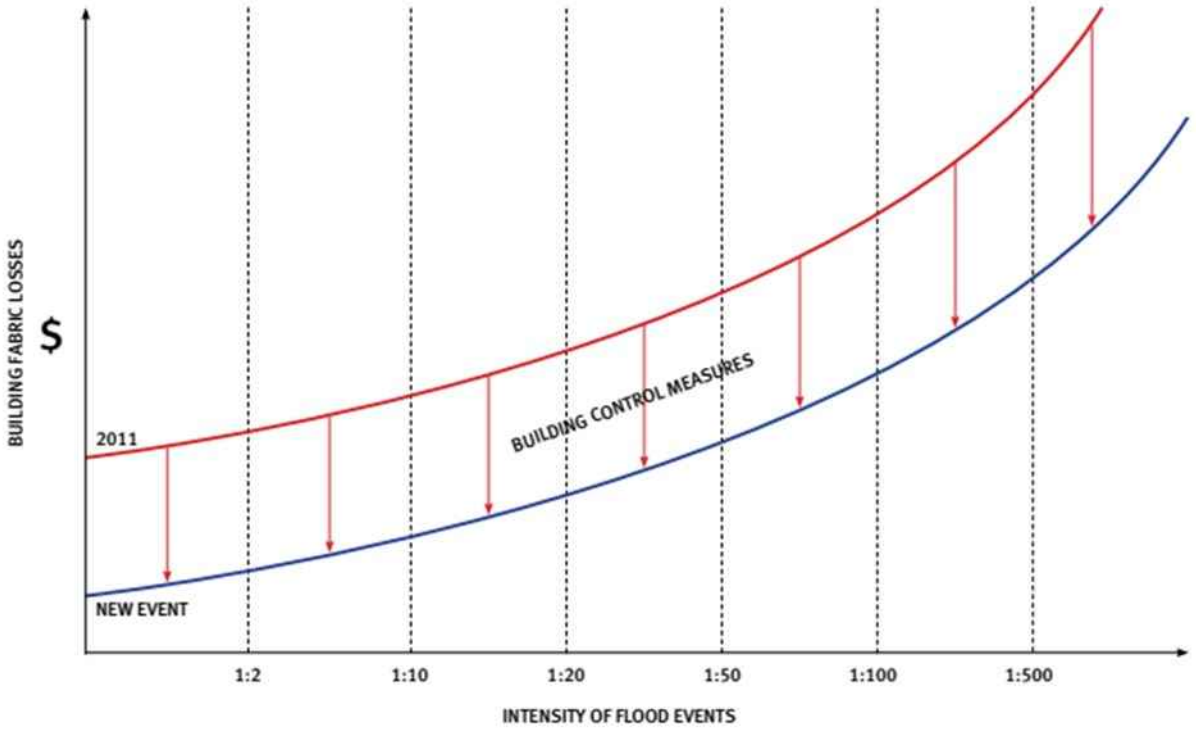



FIGURE 5-1 RELATIONSHIP BETWEEN COST AND EFFECTIVENESS OF PROPERTY SPECIFIC ACTIONS

These measures apply to individual homeowners and is a form of adaptation. Adaptation to existing and future flood risks. Comparing adaptation approaches to climate risks shows a similar stepped methodology of response to hazards. Considering property specific measures as an adaption response provides meaningful context to how these issues can be approached.

> *Property specific actions include house purchase and flood-proofing via retrofitting flood resilient building materials.*

### 5.4.2 Local Floodplain Management Plan – Mitigation Measures

Property specific actions should be considered in conjunction with other flood mitigation measures as part of an overall floodplain management strategy. In that context the overall LFMP will present a suitable method for prioritising properties and methodology to mitigate the risks. Whilst the LFMP may identify physical options, Council are to consider the economic viability of implementing mitigation measures. It is therefore important to directly compare the economic benefits of a program of property specific actions against the economic benefits of the mitigation measures. Therefore, buildings identified as potentially mitigated by feasible physical options will not be excluded from potential eligibility in a program of property specific actions.

#### 5.4.2.1 Emergency Management Responses

Emergency management responses such as evacuation is also considered in the LFMP. The methodology for prioritising groups of properties for evacuation uses a similar approach to the process used to identify eligible properties for property specific actions, i.e. buildings subject to particular factors of flood risk including hydraulic risk.

It is considered that if properties are unable to be mitigated via physical measures, not eligible for voluntary purchase or made resilient through retrofitting building materials, then educating the community via awareness and resilience campaigns and emergency management responses remain the only feasible options to reduce flood risks.

### 5.4.3 House Purchase

#### 5.4.3.1 Description

House purchase programs are costly to implement, and while applied to local government areas, rely on state and federal funding. These programs are used in areas that are susceptible to frequent and severe flooding, to mitigate the risk posed to life and property, referred to as property buy-back schemes, voluntary house purchase, or compulsory resumption programs. Due to the high cost associated with this mitigation option, they are only implemented when other measures are not suitable for reducing flood risk. Research and experience show, that landowners generally feel an immediate threat to consider allowing their property to be purchased. In addition, the market value of their property probably decreases to an extent that they do not feel they will get a better price on the open market. With that in mind, it is considered that house purchase schemes will have enable a longer-term floodplain management strategy.

#### 5.4.3.2 Considerations

**Cost Prohibitive**

There have been several Queensland councils that considered house purchase schemes, including Bundaberg, Somerset, and Moreton Bay Regional Councils, as well as Gold Coast and Ipswich City Councils.

As reported in the Queensland Flood Commission of Inquiry Report many house-purchase programs have been deemed unviable without significant external funding. For example The Ipswich Rivers Improvement Trust made five applications for funding for property buy-backs from 2007 to 2012 to acquire, through a voluntary purchase scheme, houses in Goodna on the basis that they were highly susceptible to flooding from the nearby Woogaroo Creek. Funding was provided for one of the acquisition projects in the 2008/2009 financial year.

The Brisbane River SFMP identified over 7,000 properties across the Brisbane River basin within the highest Hydraulic Risk categories that it would be prohibitively expensive to pursue a program of works. Therefore, any house purchase scheme must develop an appropriate methodology for identifying specific properties that may be eligible.

There is currently no available funding in Queensland that would be available to fund a house-purchase scheme or buy-back program.

The Local Government Grants and Subsidies Program (LGGSP) provides funding assistance to support Local Governments in Queensland to deliver priority infrastructure and essential services that meet the identified needs of their communities. Furthermore, the Queensland Disaster Resilience Funding provides a source of funding for Local Governments to deliver resilience and disaster risk reduction initiatives. Both the LGGSP and the Resilience Funding Guidelines list land buy-back schemes are *ineligible* for funding in Queensland. House-raising and costs of internal furnishings and fittings are also deemed ineligible costs for funding applications.

**Environmental Levy**

Some Local Governments have used environmental levies to purchase environmentally vulnerable or significant land in private ownership. Council is currently levying $45 per year per rateable property for the Ipswich Enviroplan. The information provided on its expenditure is:

*The separate charge for the Ipswich Enviroplan collected by the council are to be used in the manner determined by the council to provide the greatest benefit for the enhancement of the environment of the local government area, which include the following: (a) for the acquisition, management and protection of bushland areas in the local government area; (b) for the provision of facilities for public access to bushland areas in the local government area; (c) minimising the impact of carbon emissions from the local government area; (d) promoting education in the community concerning adverse impacts on the environment; (e) raising community awareness of the impact of carbon emissions and how to minimise or offset their impact..*

https://www.ipswich.qld.gov.au/__data/assets/pdf_file/0018/114732/Ipswich-City-Council-Budget-2019-2020.pdf

In reference to point a) and b) for the acquisition, management of bushland and to provide access to bushland, funding from the Enviroplan Environmental Levy could be proposed to acquire properties that satisfy this criteria if the property is identified as a priority within a House Purchase scheme. There is local and international precedent for this, for example, Logan City Council also collects an environment levy and specifically advises that the funds can be used to make strategic land purchases. See https://www.logan.qld.gov.au/environment-water- and-waste/environmental-programs/environmental-levy

There are also number of full programs underway in the United States for larger communities. For example, in Arlington Texas the county has budgeted US$17m to purchase properties which flood repeatedly. The area is adjacent to existing parkland and will be used to extend and enhance the open space for the community. http://nrcsolutions.org/rush-creek-property-acquisition-project-arlington-tx/

> *Funding from the Environmental Levy could be proposed to acquire properties that satisfy relevant criteria.*

#### 5.4.3.3 Case Study – Brisbane City Council Voluntary House Purchase Scheme

An example of a successful voluntary house purchase (VHP) program that has since been completed was in the Brisbane LGA. Brisbane City Council (BCC) invited home-owners with properties within the 1 in 2 AEP creek flood extent to be part of the program, once successfully purchased the homes were completely removed from the site and land turned into parkland, as shown in Figure 5-2. Homes in these areas had experienced regular nuisance flooding either across habitable floor or utility areas. The Brisbane VHP program concluded in 2017.

Without appropriate planning to accompany property buy-backs, land may remain unused for any purpose for an extended period of time. The removal of buildings from the flood affected area, coupled with a moratorium on any new development, can amount to 'sterilisation' of the land. Therefore, in a similar fashion to the Brisbane City Council VHP program, once a house has been bought back the land is re-zoned as Parks and Open Space. The sites are typically next to creeks and brooks and present opportunities for Councils to present multiple benefits to the community.

Eligibility criteria includes:

- The property is flooded during an average flood event recurrence interval of two years (50% AEP);
- The property is within a residential zone;
- Floodwaters inundate the residential dwelling on the property; and,
- There is no other viable infrastructure option available to mitigate the occurrence of flooding.

It has been reported that BCC identified 525 properties within its LGA that met the legibility criteria and of these, BCC approached 242 properties to offer participation in the scheme. Offers were accepted for 55 properties, costing a total of $24.21 million over the life of the program.

**FIGURE 5-2 VOLUNTARY HOUSE PURCHASE SITE, BRISBANE LGA**

### 5.4.4 Retrofitting Flood Resilient Materials

#### 5.4.4.1 Description

There are a range of building techniques and materials that can be retrofitted to homes in flood risk areas aimed at improving the resilience of buildings and their contents. Materials that are resistant to inundation damage such as double-brick, brick veneer, tiling or water-proof flooring and lining, water-resistant timber framing, closed-cell insulation, and eliminating cavities behind stairs and wall spaces. Also included is the movement of internal services such as electricity power points, air conditioning units and/or hot-water units above a certain flood level.

Retrofitting materials is a suitable method for houses that are subject to lower hazard areas such as H1 to H4 where there is no risk of structural damages.

TABLE 5-8 EXAMPLES OF RETROFITTING FLOOD RESILIENCE

| Applications | Purpose |
|---|---|
| Raising appliances | Maintain essential services during a flood event, improve electrical safety, minimise risk of damage or replacement costs. |
| Flood resilient floors and cabinets | Avoid damage to floors and cabinets by using water resistant building materials and improve cleaning capacity to aid rapid recovery after a flood event. |
| Flood resilient walls | Prevent inundation into wall cavities to reduce wall damage and limit mould growth, aiding rapid recovery after a flood event. |
| Shifting house footprint within site | Shifting the house to higher location on the site aims to maximise conveyance capacity of the site, ensure floodwaters can pass unimpeded and minimise disruption to residents during flood events. |
| House raising by increasing the floor level by use of stumps | Many homes across Australia were constructed prior to contemporary planning levels, raising older houses to achieve a higher flood immunity is a good solution to reducing potential flood risks. |
| House raising by replacing stumps to be more flood resilient | Older constructions typically used wooden stumps as foundation for a 'Queenslander' style house. Replacing these wooden stumps with more resilient metal can provide the added benefit of protection against termites, water and rotting. |

#### 5.4.4.2 Voluntary House Raising (VHR)

A subset of properties in this category may also be eligible for house-raising. House raising is an effective method of reducing damages as a result of flood hazards. Consideration must be given to the design flood event, as rarer, larger flood events can still inundate habitat floor levels of raised house. House raising applies to homes that are either low or highset timber houses. It is not practical to raise homes that constructed as slab on ground. All house raising and restumping work requires a building approval as a minimum requirement in Somerset. A building permit is issued by Council once the plans for the building work complies with the Building Code of Australia and applicable Australian Standards.

#### 5.4.4.3 Resilient Building Materials Case Study – Brisbane City Council Flood Resilient Homes

On completion of the Voluntary House Purchase Scheme, Brisbane City Council rolled out the flood resilient homes program to build resilience to homes affected by the 1 in 2 AEP overland flow flood event. Homeowners who apply voluntarily to participate in the program are assessed and the following options are available to retrofit to their homes:

- Raising the electrical meter board above the 50% Annual Exceedance Probability (AEP) overland flow flood level;
- Raising the air conditioning condensers;
- Raising hot water units;
- Provide adequate drainage and ventilation to subfloor area;
- Remove existing wall linings and replace with water resistant /proof linings as shown in Figure 5-3; and,
- Replace non water-resistant framing with suitable water-resistant framing as shown in Figure 5-4.

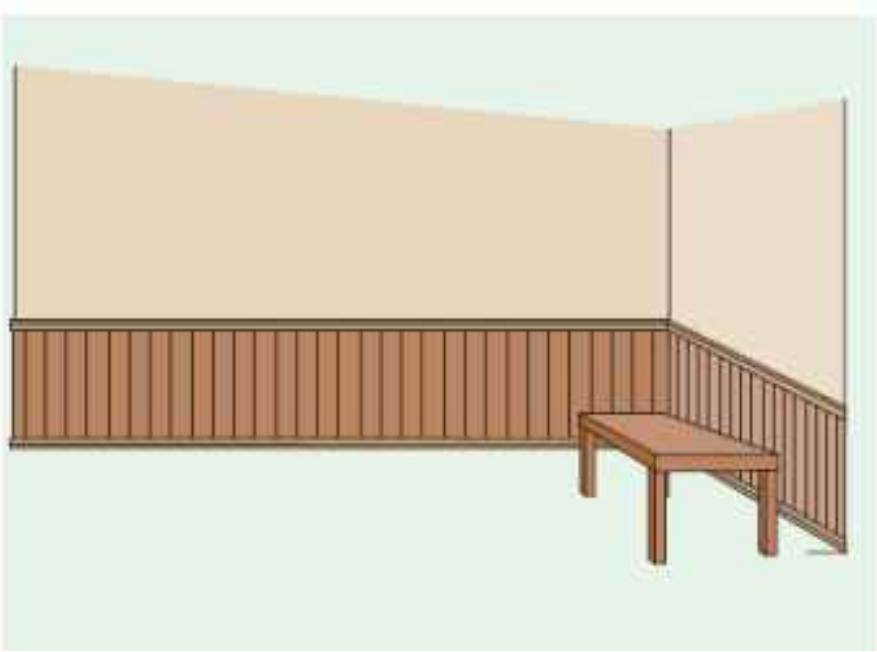


**FIGURE 5-3 AN EXAMPLE OF WATER RESISTANT PANEL LINING (SOURCE: FEMA P-259 2012)**

FIGURE 5-4 AN EXAMPLE OF REPLACING NON-WATER RESISTANT FRAMING (SOURCE: FLOOD DAMAGE REPAIR, INSPECT-APEDIA 2017)

#### 5.4.4.4 Case Study – Moree Plains Shire Council, NSW

The New South Wales State Government Office of Environment and Heritage (OEH) managed the funding applications for Voluntary House Raising Programs. Participating Councils such as the Moree Plains Shire provide the following details:

- Total number of properties with houses to be addressed;
- Number of properties Council desires to address in the three-year funding round in priority order.

In the case of Moree Plains Shire, eligible properties were limited to residential buildings where the floor level of the residence is below the adopted flood planning level of 500mm above the 1 in 100 AEP Flood level. Any house raising must result in the new floor level being, as a minimum, at the adopted flood planning level.

However, prioritisation of properties within the floodplain was assessed by their individual risk profile based on floor level survey, flood velocities where available and flood emergency response plan classification. This formed the basis of the priority listing of affected properties to be included in the funding program.

### 5.4.5 Methodology

The aim is to provide a Council a suite of recommendations and a suggested framework for a program of property specific flood mitigation measures that are prioritised and can be implemented as part of a longer-term floodplain management strategy.

#### 5.4.5.1 Overview

With consideration of the methodology discussed in the SFMP, properties mapped in highest hydraulic risk categories in the HR Matrix i.e. properties in HR1 that are exposed to the most frequent flood events and highest hazard categories H2 to H6 from the Australian Disaster Resilience Handbook 7, a refined methodology is presented for the Somerset LFMP for implementation of a potential Voluntary House Purchase scheme and Resilient Homes program within Council. Figure 5-5 shows the hazard categories H1 to H6 from the Australian Disaster Resilience Handbook 7 for reference.

The HR Matrix has been refined for the Somerset LFMP to further delineate the hydraulic risk categories by exposure to hazards i.e. HR2 (a) is exposed to the lowest hazard (H1) whereas HR 2(c) is exposed potentially damaging hazard that may cause structural failure (H5 and H6).

Therefore, the methodology for screening properties potentially eligible for a potential Voluntary House Purchase scheme and Resilient Homes program involves identifying properties that are exposed to the highest frequent hazard categories and those exposed to moderate frequent hazard. Within both programs, a prioritisation of potentially eligible properties is required to ensure the highest at-risk properties are mitigated.

Properties will be screened for their exposure to hazard, i.e. those properties that are subject to a higher hazard H5 and H6 in a 1 in 100 AEP event are exposed to potential structural failure and therefore will be put forward as **suitable for voluntary house purchase.**

The next group of properties which are exposed to habitable floor flooding in a 1 in 20 AEP will be screened for hazard[2]. Those exposed to H1 to H4 hazard category in a 1 in 100 AEP will be **suitable for potential retrofitting of resilient building materials**.

The properties listed as suitable for either potential voluntary house purchase or retrofitting building materials will undergo a damages assessment to compare expected reductions in damages resulting from flooding after property specific actions have been implemented. The cost-benefit analysis uses flood damage assessment to determine the economic viability of an option. There are a number of limitations associated with estimating damages at a property scale such as floor levels and building typology data, therefore the damages results should be used as an indicator of the overall reduction in damages by undertaking *a program of property specific actions* rather than for estimates at an individual property scale.

[2] The extent of the 1 in 10 and 1 in 20 AEPs for the Slacks and Scrubby Creeks are spatially very similar, it is likely that properties in the 1 in 10 AEP and exposed to the H5 and H6 in a 1 in 100AEP would be the same as the 1 in 20 AEP properties.

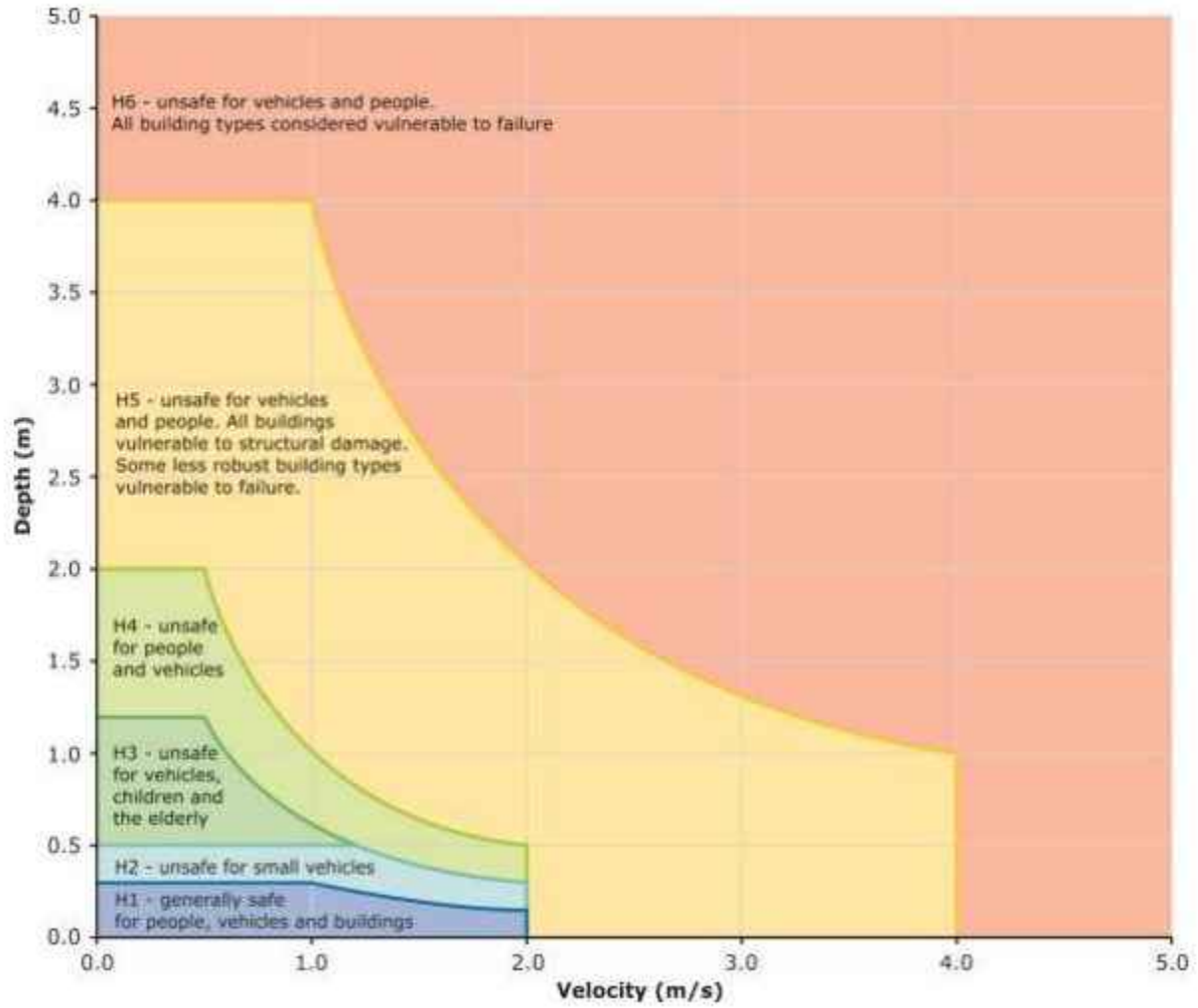



FIGURE 5-5 HAZARD EATEGORIES USED TO DEFINE POTENTIAL ELIGIBILITY (AUSTRALIAN DISASTER RESILIENCE HANDBOOK 7)

#### 5.4.5.2 Voluntary House Purchase

**Eligibility**

Table 5-9 summarises the filters applied to properties exposed to flood hazards to determine a list of properties eligible for a potential Voluntary House Purchase.

TABLE 5-9 VOLUNTARY HOUSE PURCHASE ELIGIBILITY

| Filter | Description |
|---|---|
| Residential zone properties only | A voluntary house purchase program will only be open to property owners of residential properties. |
| 1 in 10 AEP | To be eligible properties must be flooded in 1 in 10 AEP. The 1 in 10 AEP must be considered to inundate over the floor as determined by the Geovision database and flood damages analysis. |

| Filter | Description |
|---|---|
| H5 and H6 in a 1 in 100 AEP | Properties here are exposed to potential structural failure and not suitable for other property specific measures |
| H1 and H4 in a 1 in 100 AEP | Properties here are suitable for other property specific measures, these will be included in the long list for voluntary house purchase. |
| Voluntary participation only | Priority properties will be invited to participate in the voluntary house purchase scheme. It is NOT compulsory acquisition. If Council makes an offer, the offer will be valid for a predetermined timeframe. |

### Prioritisation of the Voluntary House Purchase Program

A long list of properties will be provided to Council. To prioritise the program to address the most at-risk properties eligible for Voluntary House will be by order of hazard exposure. The following table shows how properties within the program of Voluntary House Purchase may be prioritised. The analysis only considers properties exposed to the highest hazards i.e. H6 and H5 in a 1 in 100 AEP.

**TABLE 5-10 PRIORITISATION OF ELIGIBLE PROPERTIES FOR VOLUNTARY HOUSE PURCHASE**

| Priority | Flood Frequency | Flood Hazard | Description |
|---|---|---|---|
| 1 | 1 in 10 AEP | H6 in a 1 in 100 AEP | Exposed to frequent flooding and highest hazard category H6 in a 1 in 100 AEP |
| 2 | 1 in 10 AEP | H5 in a 1 in 100 AEP | Exposed to frequent flooding and high hazard category H5 in 1 in 100 AEP |
| 3 | 1 in 10 AEP | H4 in a 1 in 100 AEP | Exposed to frequent flooding and moderate hazard category H4 in a 1 in 100 AEP |
| 4 | 1 in 10 AEP | H3 in a 1 in 100 AEP | Exposed to frequent flooding and moderate hazard category H3 in 1 in 100 AEP |
| 5 | 1 in 10 AEP | H2 and H1 in a 1 in 100 AEP | Exposed to frequent flooding and low hazard category H2 and H1 in 1 in 100 AEP |

### Median House Price Assumptions

The following median house prices will be used to price a potential voluntary house purchase program and used to assess the cost benefit to Council. This is based on recent property sales in the named suburb, if information is unavailable, an average used across multiple neighbouring suburbs has been used.

**TABLE 5-11 MEDIAN HOUSE PRICE BY SUBURB IN SOMERSET LGA**

| Locality | Median house price[3] |
|---|---|
| Esk | $322,500 |
| Toogoolawah | $242,000 |
| Fernvale | $387,000 |
| Kilcoy | $272,500 |
| Lowood | $262,000 |

[3] Source: Realestate.com.au date: 25th June 2020

| Locality | Median house price[3] |
|---|---|
| Minden | $395,000 |
| BRCFS Study Area | $350,000 |

#### 5.4.5.3 Retrofitting Building Materials

**Eligibility**

The following table summarises the filters applied to properties exposed to flood hazards to determine a list of properties eligible for a potential retrofitting of building materials. House raising is a separate subset of properties which depends largely on the building type these are included in the table.

TABLE 5-12 RETROFITTING BUILDING MATERIALS – ELIGIBILITY

| Filter | Description |
|---|---|
| Residential zone properties only | Retrofitting building materials will only be open to property owners of residential properties. |
| 1 in 20 AEP | Floodwaters of the 1 in 20 AEP must be considered to inundate habitable-floor level. Those that do not meet this criterion will not be eligible for retrofit of building materials or house raising |
| H1 to H4 in a 1 in 100 AEP | Properties here must NOT be exposed to potential structural failure associated with H5 and H6. Therefore, are more suited for retrofitting resilient building materials to reduce flood damages.<br><br>Properties subject to hazard H1 and H2 |
| Voluntary participation only | Priority properties will be invited to participate in the retrofitting building materials. |
| Building Type:<br>FDHS<br>FDSS – Stumps | Only properties that are Fully Detached Single Storey raised on stumps and Fully Detached High Set may be eligible for house raising |

**Prioritisation Retrofitting Building Materials**

Further prioritisation of properties eligible for the retrofitting building materials will use the Annual Average Damages that have been calculate for that property.

The following tables shows an example of the grouping (damages to be confirmed – groupings to be appropriate to the scale of damages).

TABLE 5-13 PRIORITISATION OF ELIGIBLE PROPERTIES FOR RETROFITTING

| Priority | Damages (AAD) | Description |
|---|---|---|
| 1 | Above $10,000 | Highest priority will be assigned to those properties experiencing the highest AAD from a range of flood events. |
| 2 | $5,000 to $10,000 | Properties experiencing the high AAD from a suite of flood events. |
| 3 | <$5,000 | Properties experiencing the low AAD from a suite of flood events. |

### Cost Benefit Ratio

#### COST ASSUMPTION

The expected cost of retrofitting materials to create resilient buildings has been established by NCEconomics as part of the Brisbane River SFMP program. The following table shows the average cost per m2 to establish a resilient building. The cost of 'like for like' rebuilding and incremental cost of resilient build from the study by NCEconomics is shown below:

TABLE 5-14 THE COST OF LIKE FOR LIKE REBUILDING AND THE INCREMENTAL COST OF RESILIENT BUILD

| Building type | Average Cost[4] per m2 |
|---|---|
| Fully detached single story on stumps (FDSS – stumps) | $239 |
| FDSS – stumps (raise) | $401 |
| Fully detached single story – slab on ground (FDSS – SOG), | $171 |
| Fully detached double story – slab on ground for the bottom floor only (FDDS – SOG) | $171 |

These costs will be used to assess whether retrofitting building materials is an economically viable option for Council.

#### BENEFITS

An estimate of the reduction in average annual damage (AAD) will be calculated for the whole catchment over the lifetime of a property. The assumptions for AAD reduction are based upon the NCEconomics study as part of the Brisbane River SFMP program. 70% reduction of internal damages will be applied to each residential building and aggregated across the study area.

TABLE 5-15 CLASSIFICATIONS OF FLOOD DAMAGE REDUCED BY RETROFITTING BUILDING MATERIALS

| Building Type | Internal[5] | External | Structural | Indirect | Intangible |
|---|---|---|---|---|---|
| FDSS – Stumps | 70% | No | No | Partial | Partial |
| FDSS - SOG | 70% | No | No | Partial | Partial |

[4] Cost per m2 assumption from NCEconomics study for the Brisbane River SFMP (2016)
[5] Reduction to AAD assumption from NCEconomics study for the Brisbane River SFMP (2016)

### 5.4.6 Results

The CBA for each of the six localities was carried out for properties that were eligible based on the criteria outlined above. This section summarises the results for all six localities in Somerset (Esk, Toogoolawah, Fernvale, Kilcoy, Lowood and Minden), and includes the results conducted for the Brisbane River City Flood Study (BRCFS). Further details of the individual locality results for both the voluntary house purchase and building resilience schemes can be found in the individual LFMP reports.

The results provide an overview of property numbers, hazard exposure hazard exposure, costing, and further analysis of suitability of the options available to Council. For example, a combination of priority properties and the full list of suitable properties placed through the cost benefit analysis to provide an overall picture of the economically viability.

Distribution of properties that may be eligible for a VHP and RBM is presented in Table 5-16. Mapping of properties eligible for property specific actions is available in Appendix G and a redacted list of properties is provided in Appendix H. Properties outside of the six individual localities exposed to Brisbane River flooding are shown in Figure 5-6. For further details please refer to the specific LFMP.

**TABLE 5-16 NUMBER OF PROPERTIES RLIGIBLE FOR PROPERTY SPECIFIC ACTIONS BY LOCALITY**

| Locality | Properties eligible for VHP | Properties eligible for RBM |
|---|---|---|
| Esk | 3 | 7 |
| Fernvale | 3 | 0 |
| Kilcoy | 0 | 0 |
| Minden | 2 | 5 |
| Toogoolawah | 0 | 0 |
| Lowood | 0 | 0 |
| BRCFS Study Area | 15 | 9 |
| **Total** | **23** | **21** |

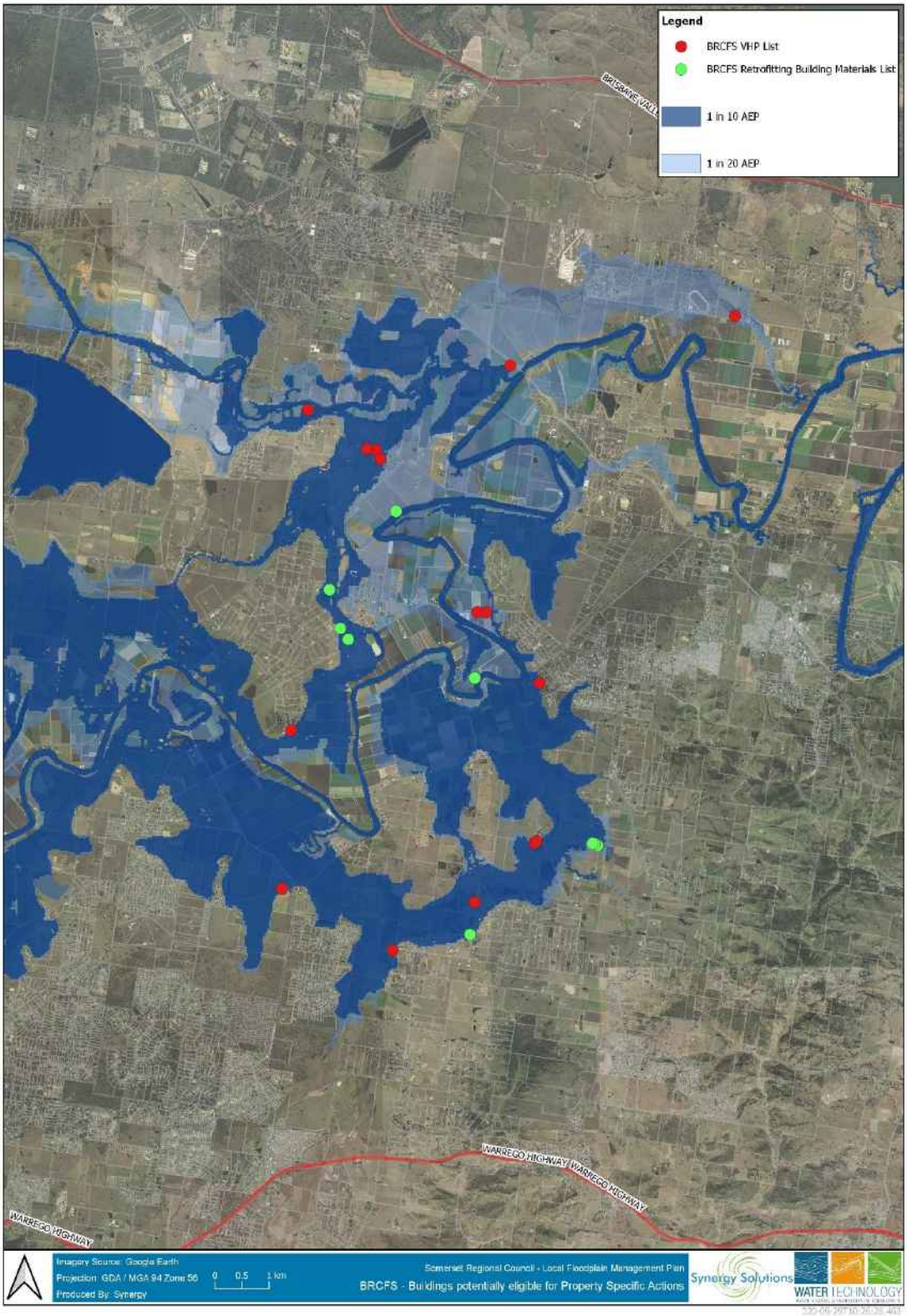



**FIGURE 5-6 PROPERTIES ELIGIBLE FOR PROPERTY SPECIFIC ACTIONS – BRCFS STUDY AREA**

#### 5.4.6.1 Voluntary House Purchase (VHP)

A potential program of VHP of residential buildings were considered across all six localities and BRCFS, the methods and results presented in this report are for consideration only. There are 23 eligible residential buildings that are exposed to both frequent flooding (i.e. 1 in 10 AEP) and high hazard categories in a 1 in 100 AEP (H5 or H6) across Somerset. VHP would be a fully effective measure of removing people and property from the risks of flooding including reduction in damages including partial and intangible damages. The lots have the potential to be turned into open space and an enjoyable recreational area for residents. The social impact of removing homes from the community are not insignificant on an individual scale and these impacts are to be considered by Council on a case by case basis.

Of the 23 eligible properties in Somerset, three are in Esk, two are in Minden, three are in Fernvale and the remainder are across the BRCFS study area. Given the low number of properties exposed across the different localities, a benefit cost ratio (BCR) has been applied to all properties suitable for VHP. For a BCR of each locality please refer to each locality LFMP.

TABLE 5-17 SUMMARY OF PROPERTIES POTENTIALLY ELIGIBLE FOR VHP IN SOMERSET

| Priority Group | Type | Number of Properties | Total Capital Cost |
|---|---|---|---|
| 1 | FDSS-SOG | 3 | $1,124,000 |
| | FDSS-Stumps | 0 | |
| 2 | FDSS-SOG | 17 | $7,044,500 |
| | FDSS-Stumps | 2 | $717,500 |
| **Total** | | **23** | **$8,168,500** |

#### 5.4.6.2 BCR for VHP all Properties

In summary this option would:

- Remove all suitable properties from the risks associated from exposure frequent nuisance flooding associated within the 1 in 10 AEP events;
- Prevent a total $287,956 in AAD across Somerset; and,
- Properties potentially eligible are shown in Table 5-18.

TABLE 5-18 OPTION BENEFIT RELATIVE TO CURRENT CONDITIONS FOR ALL ELIGIBLE PROPERTIES IN SOMERSET

| Property Specific Action | Total AAD without option in place | Total AAD with option in place | Reduction in AAD | Option Benefit over 50-year lifespan (NPV) |
|---|---|---|---|---|
| VHP All Properties | $2,872,362 | $2,584,406 | $287,956 | $4,004,416 |

When assessing the financial cost and benefit of a buying back properties across Somerset, the benefit to cost ratio was found to be 0.5. That is the costs of buying the property in current market conditions, are approximately twice benefits that could be achieved over a 50-year lifespan.

**TABLE 5-19 BCR CALCULATION OR ALL ELIGIBLE PROPERTIES IN SOMERSET**

| Option Benefit over 50-year lifespan (NPV) | Total Cost (Based on median house price) | Benefit / Cost Ratio (BCR) |
|---|---|---|
| $4,004,416 | $8,168,500 | 0.5 |

#### 5.4.6.3 Voluntary House Purchase – Summary and Recommendation

It is recommended that Council consider implementation of a VHP program in parts of Somerset; more specifically, Esk, Fernvale and Minden, and locations investigated as part of the BRCFS. Despite the BCR, there are other benefits that can be realised, such as removing the risk to life completely. The damages reduction is costed over a 50 year lifespan of the property, however, if the lot is converted and contributes to open space, the risk is removed in perpetuity.

An analysis of the all the potentially eligible properties has a BCR of 0.5. The cost of this option for properties is approximately $8.1 million and the estimated benefits accumulated over a 50-year lifespan is $4 million.

The timing of flood hazard impacts means that planning for a range of options needs to commence immediately, focusing on VHP and retrofitting building materials. The way in which these options are implemented, either individually or as a combined package of solutions, requires further investigation during the planning stage with input from the local community.

#### 5.4.6.4 Retrofitting Building Materials

The implementation of a Resilient Building Materials program must be considered across the Somerset LGA as a whole. The methods and results presented in this report are for consideration only and summarise the results from the individual LFMP's and the BRCFS. In the six localities and the study are of BRCFS there are a total of 21 residential building that are exposed to both frequent flooding (i.e. 1 in 20 AEP) and lower hazard categories in a 1 in 100 AEP (i.e. H1 to H4).

Distribution of properties that may be eligible for retrofitting of building materials is presented in Table 5-20. A summary of the property attributes is shown in Table 5-20.

**TABLE 5-20 DISTRIBUTION OF PROPERTIES FOR ALL ELIGIBLE PROPERTIES IN SOMERSET**

| Priority Group | Damages (AAD) | Number of Properties |
|---|---|---|
| 1 | Above $10,000 | 13 |
| 2 | $5,000 to $10,000 | 8 |
| 3 | <$5,000 | 0 |

**TABLE 5-21 SUMMARY OF PROPERTIES OR ALL ELIGIBLE PROPERTIES IN SOMERSET**

| Priority Group | Type | Number of Properties | Total Capital Cost |
|---|---|---|---|
| 1 | FDSS-SOG | 12 | $481,283 |
| | FDSS-Stumps | 1 | $46,655 |
| 2 | FDSS-Stumps | 2 | $77,676 |
| | FDSS-SOG | 6 | $240,187 |
| 3 | No suitable properties | | |
| Total | | | $845,801 |

A program to retrofit building materials would be an effective mitigation measure to reduce flood damages including partial and intangible damages across several properties in Somerset.

A BCR is applied to the following options:

1. All properties suitable for retrofitting building materials.
2. Priority Group 1 Only (greater than $10,000 AAD).
3. Priority Group 2 Only (between $5,000 and $10,000 AAD).

#### 5.4.6.5 BCR – for Retrofitting Building Materials – All Properties

In summary this option would:

- Create 21 flood resilient properties that are exposed to frequent flooding and H1 to H4 hazard in a 1 in 100 AEP event.
- Prevent approximately $36,610 in AAD across Somerset.

TABLE 5-22 OPTION BENEFIT RELATIVE TO CURRENT CONDITION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET

| Property Specific Action | Total AAD without option in place | Total AAD with option in place | Reduction in AAD | Option Benefit over 50-year lifespan (NPV) |
|---|---|---|---|---|
| Resilient Building Materials to all properties | $2,762,949 | $2,726,339 | $36,610 | $509,119 |

When assessing the financial cost and benefit of retrofitting building materials to all potentially eligible properties, the benefit to cost ratio was found to be 0.6. That is the benefits of retrofitting building materials is 60% of the cost over a 50yr lifespan.

TABLE 5-23 BCR CALCULATION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET

| Option Benefit over 50-year lifespan (NPV) | Total Capital Cost of all properties | Benefit / Cost Ratio (BCR) |
|---|---|---|
| $509,119 | $845,801 | 0.6 |

Of the 21 properties that would benefit from the retrofitting building materials, 7 are within the locality of Esk, whilst 5 are in Minden, and the remaining 9 are within the wider area of the BRCFS.

The location of the greatest reduction in AAD is in Minden.

#### 5.4.6.6 BCR for Priority Group 1 Only

In summary this option would:

- Create four (4) resilient properties exposed to frequent flooding and H1 to H4 hazard in a 1 in 100 AEP event.
- Prevent a total $31,676 in AAD across Somerset.

TABLE 5-24 OPTION BENEFIT RELATIVE TO CURRENT CONDITION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET

| Property Specific Action | Total AAD without option in place | Total AAD with option in place | Reduction in AAD | Option Benefit over 50-year lifespan (NPV) |
|---|---|---|---|---|
| Resilient Building Materials to Priority Group 1 | $3,222,190 | $3,190,514 | $31,676 | $440,498 |

When assessing the financial cost and benefit of retrofitting building materials to the Priority Group 1 (i.e. properties with AAD greater than $10,000) across Somerset, the benefit to cost ratio was found to be 0.8. That is the benefits of retrofitting building materials over a 50-year lifespan are 80% of the cost.

TABLE 5-25 BCR CALCULATION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET

| Option Benefit over 50-year lifespan (NPV) | Total Capital Cost | Benefit / Cost Ratio (BCR) |
|---|---|---|
| $440,498 | $527,938 | 0.8 |

#### 5.4.6.7 BCR for Priority Group 2 Only

In summary this option would:

- Create three resilient properties exposed to frequent flooding and H1 to H4 hazard in a 1 in 100 AEP event.
- Prevent a total of $4,934 in AAD across Somerset

**TABLE 5-26 OPTION BENEFIT RELATIVE TO CURRENT CONDITION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET**

| Property Specific Action | Total AAD without option in place | Total AAD with option in place | Reduction in AAD | Option Benefit over 50-year lifespan (NPV) |
|---|---|---|---|---|
| Resilient Building Materials to Priority Group 1 | $2,532,454 | $2,527,519 | $4,934 | $68,620 |

When assessing the financial cost and benefit of retrofitting building materials to the Priority Group 2 (i.e. properties with AAD between $5,000 and $10,000) the benefit to cost ratio was found to be 0.2. That is the benefits of retrofitting building materials over a 50-year lifespan are 20% of the cost.

**TABLE 5-27 BCR CALCULATION FOR ALL ELIGIBLE PROPERTIES IN SOMERSET**

| Option Benefit over 50-year lifespan (NPV) | Total Capital Cost | Benefit / Cost Ratio (BCR) |
|---|---|---|
| $68,620 | $317,863 | 0.2 |

#### 5.4.6.8 Retrofitting Building Materials – Summary and Recommendation

It is recommended that Council consider implementation of **Option 2**. Namely retrofitting building materials to properties identified in Priority Group 1 (properties with AAD greater than $10,000) which has a benefit cost ratio of 0.8 across Somerset for those properties that are eligible. The cost of this option for all 21 eligible properties is approximately $845,801 and the estimated benefits accumulated over a 50-year lifespan is $509,119. More information on the breakdown of CBR for each of the localities can be found in the individual LFMP's.

### 5.4.7 Summary of Property Specific Actions in Somerset

A detailed economic assessment of property specific actions has been undertaken, considering the reduction annual average damages (AAD) across the groups of potentially eligible properties in Somerset. The findings seem to align with commentary in this field that suggests implementing property specific actions is generally a viable option for reducing the impacts of flood events up to 1 in 100 AEP.

VHP presents a challenge as it is reasonable to assume that property owners may expect a pre-hazard market value for a property. Pre-hazard values have been used in this economic appraisal, however over time and continued to exposure to flooding risks this market value is likely to be adversely impacted as a result of the identified flood hazards.

Given the potential intolerable risks associated with a flood hazards, there is a clear priority to plan for a range of options focusing on flood mitigation, property specific actions and emergency management. The way in which these options are implemented, either individually or as a combined package of solutions, requires further investigation during the planning stage with input from the local community.

The following recommendations are put to Council for consideration as part of a wider floodplain management strategy for the Somerset LGA:

- It is recommended that Council consider implementation of a Voluntary House Purchase program to all properties potentially eligible. This option has a benefit cost ratio of 0.5.
- It is recommended that Council consider implementation of a program of retrofitting building materials to properties identified in Priority Group 1 which has a benefit cost ratio of 0.8. Properties in Priority Group 2 should then be considered, as these have a benefit cost ratio of 0.2
- Implementation of one or more property specific actions table based on the hazard and damages-based prioritisation highlighted in this report may not be economically viable, however there are a number of further considerations for Council should a program be employed in Somerset:
  - Follow up each property to understand the true flood risk to the property, i.e. is there a laundry or storage area that is flooded not habitable floor
  - Seek to ensure that residents most affected by flooding hazards are given the first opportunity to take part in a program
  - The order of priority should be regularly reassessed, based on updated information, to ensure that it is as accurate as possible
  - Each financial year, for as long as the program(s) continue, Council should allocate funding for offers to the highest priority eligible properties. These are properties that meet all eligibility criteria. It could be communicated that there is no forced resumption of properties under the Voluntary Home Purchase Program and is the choice of the property owner whether to sell to Council if an offer is made.
  - Each financial year, for as long as the program(s) continue, all properties that meet the criteria for purchase, whether identified by Council or offered by the owner, should be prioritised for purchase based on the seriousness of anticipated flooding. This priority may change through the financial year depending on the number of Council offers accepted or declined.
  - Advice on the programs should be linked to an existing flood awareness, education, and communications program as part of Get Ready Queensland or getting ready for summer campaigns.
  - Offers to buy property or installation resilient materials should be judged on a case by case basis – the programs should be voluntary, but how and when a site-specific measure is implemented depends on the length of the waiting list, whether the property owner approached Council or vice versa. For example, after making an offer to purchase property, Council may wait four weeks for a response before advising in writing that '*as the owner haven't accepted an offer to purchase that it was being withdrawn and with no guarantee that they would be approached again.'* Longer than three months can require a new property valuation.
  - Initial communication to homeowner to buy property should include a caveat explaining that property **may** be eligible for consideration under this scheme. Some may be eligible under the criteria explained in this report and considered but ultimately not purchased or offered resilient building materials (e.g. due to budget or unable to agree reasonable works, etc).
  - The success factors of the program(s) will be dependent on several other factors, some of which present a magnitude of social challenges just as much as they do economic. These include ensuring the following:
    - Community engagement and a clear media management strategy is essential, including regular press releases with accurate information
    - Ensuring the right team is involved, with the right skills

- Adopt local leadership and resources
- Give home-owners options to ensure they have a sense of ownership over the decision
- Gaining an understanding of tight-knit communities who may want to remain together
- Understanding that a property boom or low valuation can affect uptake of scheme and whether owners fear loss of revenue (Mosely, 2020).

# 6 LAND USE PLANNING RESPONSES

## 6.1 Somerset Regional Planning Scheme

The Somerset Regional Planning Scheme Version 3 (Planning Scheme) encapsulates the development intent for Council's planning horizon towards 2031. Being originally drafted in accordance with the Sustainable Planning Act 2009, the Planning Scheme was gazetted to align with the Planning Act 2016.

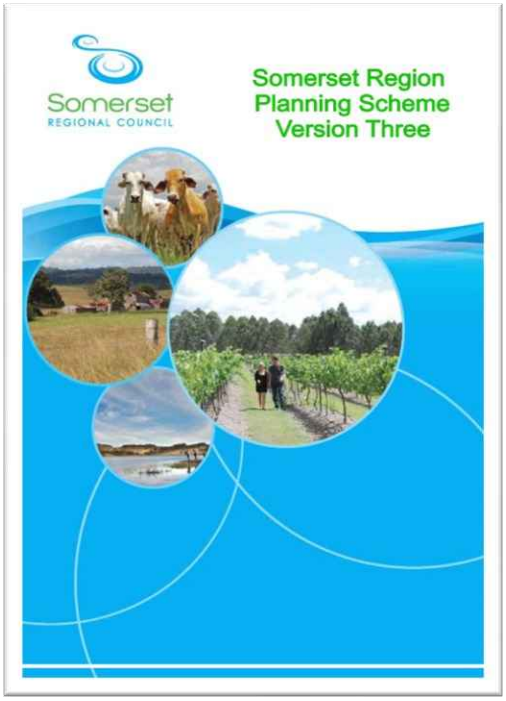



**FIGURE 6-1 SOMERSET REGIONAL PLANNING SCHEME**

This section provides assessment how the Planning Scheme aligns with the State Planning Policy for Natural Hazard Risk and Resilience[6] (SPP for NHRR) to effectively manage floodplain development, through:

- Review of the Planning Scheme codes and policies alignment with the SPP,
- Recommendation to amend to the Flood Hazard Overlay mapping,
- Recommendation to incorporate updated flood study outcomes into a future Planning Scheme amendment for each of the study areas,
- Details on recommendations for risk-based planning (policies, code or overlay amendments in areas where potential hydraulic risk conditions may cause intolerable flood risk), and

[6] 'State Planning Policy – State interest guidance material Natural Hazards, risks and resilience – Flood' (State Government of Queensland). Available: https://dilgpprd.blob.core.windows.net/general/spp-guidance-natural-hazards-risk-resilience-flood.pdf.

- Analysis of the Local Government Infrastructure Plan's (LGIP) implications to the Planning Scheme.

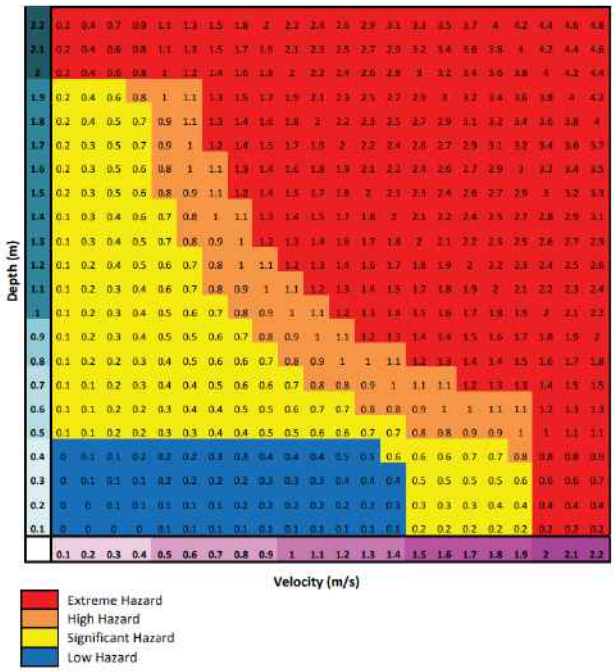
Overall, the Planning Scheme is considered to somewhat align with the SPP for NHRR, with room for improvement. Recommendations are provided on how this Planning Scheme can further align with the SPP.

## 6.2 Background

Within the Somerset Regional Council (SRC) LGA, a flood risk assessment has previously been applied across the floodplain, with four flood hazard areas mapped. Given the large geographical area of SRC, urban areas have been mapped for flood risk, while larger rural areas remain listed as 'potential flood risk', with scope for more detailed mapping assessment to follow. These maps have been sourced from Queensland Floodplain Overlay Mapping.

Council has adopted the Defined Flood Event (DFE) as 1 in 100 AEP, used to model flood hazard levels for SRC and categorised as:

- Extreme flood hazard
- High flood hazard
- Significant flood hazard
- Low flood hazard




**Rules**

| | Low | Significant | High | Extreme |
|---|---|---|---|---|
| Depth | <0.5 | <2 | <2 | 2+ |
| Velocity | <1.5 | <2 | <2 | 2+ |
| DxV Ratio | <0.6 | 0.6 to <0.8 | 0.8 to <1.2 | 1.2 + |

**Rationale**

1. **Low** – self evacuation possible for adults and children, vehicle stability within tolerance for large 4WD
2. **Significant** – working limit for trained safety workers, Vehicle evac unsuitable, Building Code limitation
3. **High** – limit of uncompromised stability for adults (dangerous to most)
4. **Extreme** – in excess of known stability limits

**FIGURE 6-2 QRA FLOOD HAZARD CRITERIA**

Flood hazard maps are based on criteria from the Queensland Reconstruction Authority's 'Planning for stronger, more resilient floodplains - Part 2 (QRA 2012)[7].

[7] See 'Planning for stronger, more resilient floodplains Part 2 – Measures to support floodplain management in future Planning Schemes, Schedule 4 - Flood hazard criteria' (State Government of Queensland). Available: https://www.statedevelopment.qld.gov.au/resources/guideline/qra/planning-stronger-floodplains-part-02.pdf

## 6.3 State Planning Policy alignment

### 6.3.1 State Interest Policies

The following summarises Somerset Regional Council Planning Scheme's alignment with the State Planning Policy (state interest for natural hazards, risk and resilience - Flood). State interest policies relating to Erosion Prone Areas, Storm Tide inundation and Bushfire have not been included in this review.

**TABLE 6-1 RELEVANT STATE INTEREST POLICIES**

| Reference | State Interest Policy | Compliance |
|---|---|---|
| (1)(b) | Natural hazard areas are identified, including flood hazard areas. | In Progress |
| (2) | A fit-for-purpose risk assessment is undertaken to identify and achieve an acceptable or tolerable level of risk for personal safety and property in natural hazard areas. | In Progress |
| (4) | Development in bushfire, flood, landslide, storm tide inundation or erosion prone natural hazard areas: (a) avoids the natural hazard area; or (b) where it is not possible to avoid the natural hazard area, development mitigates the risks to people and property to an acceptable or tolerable level. | Not fully identified in Planning Scheme |
| (5)(a) | Development in natural hazard areas:<br>Supports, and does not hinder disaster management capacity and capabilities. | Not fully identified in Planning Scheme |
| (5)(b) | Directly, indirectly and cumulatively avoids an increase in the exposure or severity of the natural hazard and the potential for damage on the site or to other properties. | Appropriately integrated |
| (5)(c) | Avoids risks to public safety and the environment from the location of the storage of hazardous materials and the release of these materials as a result of a natural hazard. | Appropriately integrated |
| (5)(d) | Maintains or enhances the protective function of landforms and vegetation that can mitigate risks associated with the natural hazard. | Appropriately integrated |
| (6) | Community infrastructure is located and designed to maintain the required level of functionality during and immediately after a natural hazard event. | Appropriately integrated |

As part of the Somerset Flood Studies and LFMP project, further refinement of the natural hazard areas is currently underway and may be integrated as a future amendment to the flood hazard overlay mapping.

State Interest (4) and (5)(a) are not considered to be achieved within the Somerset Regional Council Planning Scheme, therefore are discussed in more detail in the Flood hazard overlay code review. It is suggested that considerations be made to achieve the intent of the SPP state interest for natural hazards.

#### 6.3.1.1 Flood Islands and Isolated Areas

The SPP guidance suggest specific provisions should be identified to address isolated areas or flood islands within the floodplain. Relevant terminology includes:

- **Low-flood islands** – areas that are isolated by floodwaters and become completely submerged in extreme events (up to the Probable Maximum Flood),
- **High-flood islands** – areas that are isolated by floodwaters and remain 'dry' but may be isolated for many days or weeks at a time, and
- **Difficult to evacuate uses** – vulnerable development uses that require additional time or support to evacuate residents/users; and therefore, should not be developed in an isolated/flood island area (as identified on the flood hazard overlay map).

## 6.4 Planning Scheme Strategic Framework

The strategic framework sets the policy direction for planning schemes and is designed to ensure that development occurs in the appropriate areas which particularly resonates with regards to development in the floodplain.

The outputs of the LFMP provides fit for purpose flood risk assessment across the Somerset LGA. This has consideration of Hydraulic Risk, time to inundation and duration of inundation of flood events up to and including the PMF. How all floodplain management measures are considered holistically for each locality will identify and achieve an acceptable or tolerable level of risk for people and property.

The SFMP Land Use Planning Guidance Material suggests that this flood risk assessment informs a settlement strategy developed for inclusion in the strategic framework and a zoning pattern that addresses for at-risk locations.

This section reviews the policy direction set out in the existing Somerset Region Planning Scheme strategic framework with specific regard to achieving alignment with the SFMP and SPP state interest for natural hazards.

### 6.4.1 Settlement Pattern – Specific Outcomes

The urban growth pattern within Somerset LGA is concentrated within the five towns of Esk, Fernvale, Kilcoy, Lowood and Toogoolawah which is largely reflective of the natural rural landscape of the surrounds. Minden is largely a rural residential settlement with very limited access to infrastructure, facilities and services. It is the intent of the strategic framework to ensure these settlements respond to impacts of natural hazards such as flooding by setting out specific policy outcomes to reduce the exposure and mitigate impacts through risk-based planning.

Part 3.3 of the plan 'Settlement Pattern' is broken down into specific elements which address how development is intended to evolve across the LGA. This review considers Section 3.3.2 .1 and 3.3.11.1 which specifically address urban growth and flooding. Overall, it is important the strategic framework it provides clear policy direction on the tolerability or acceptability of flooding risks, therefore this review provides recommendations to refine the policy wording that considers the LFMP outputs to identify acceptable or tolerable risk for people and property. Table 6-2 provides an overview of the specific outcomes and recommendations for Council's consideration.

TABLE 6-2 STRATEGIC FRAMEWORK REVIEW – SPECIFIC OUTCOMES

| Specific Outcome | Comment |
|---|---|
| Element - Urban growth management | |
| 3.3.2.1 (c)(v) The physical extent of urban development in the towns is limited so as to minimise the risks to life and property from natural hazards including flood and forecast increase in frequency and severity of natural hazards from climate change | Recommend establishing a principle for flood hazard appropriate development using the output of the PHR mapping. |
| Element - Flooding | |
| 3.3.11.1 (a) Areas prone to flooding in the defined flood event are identified in Part 8 – Overlays | Recommend amending the Flood overlay. Options provided in the LFMP.<br>1. Adoption of the SFMP approach with hydraulic risk<br>2. Providing 'risk bands' associated with the relevant hazard for the 1 in 100 AEP flood event<br>3. Providing 'risk bands' associated with flood frequency with the relevant hazard for 1 in 100 AEP plus Climate Change<br>4. Risk bands in the 1 in 100 AEP with an additional Probable Maximum Flood (PMF) extent |
| 3.3.11.1 (b) Risk of life (from flood hazard and potential climate change impacts) is minimised | Recommend establishing a risk criteria that considers tolerability and vulnerability. An example strategy is to recommend Residential Development should be located outside of areas mapped as HR1, HR2 and HR3 where categorised by a flood hazard of H3 or more as these are areas that pose serious risk to life whereas commercial or industrial areas could be considered acceptable in the HR3 and HR4 with consideration given to the exposure to structural failure associated with extreme hazard categories of H5 and H6. |
| 3.3.11.1 (c) The flood storage and conveyance capacity of floodplains are protected from earthworks that: (i) significantly alter natural drainage patterns; and (ii) worsen existing flooding conditions; | Recommend maintaining this policy and potentially establishing additional consideration that avoids obstruction of flow in a conveyance area as per the SFMP Land Use Planning Guidance Material. For example filling within HR1 and HR 2 of the PHR mapped area may be defined as intolerable due to the alteration of flood hazard conditions whereas filling outside the flow conveyance area in HR 3 and HR 4 may be tolerable subject to no worsening conditions and filling in HR5 is considered acceptable subject to local drainage and surface water issues. |

| Specific Outcome | Comment |
|---|---|
| 3.3.11.1 (d)(i) increased residential development is not permitted in land below the DFE except where impacts of flooding can be mitigated such that there is no foreseeable risk to life or property: and except if (i) the development is for a dwelling house and/or associated structure on a lot registered prior to the commencement of the planning scheme: or (ii) the development is on land that is already committed to urban or rural residential development by an development approval granted prior to the commencement of the planning scheme; or (iii) the development is redevelopment of land that is already used for an urban purpose and the redevelopment is consistent with the intent of the applicable zone in terms of nature, scale and intensity of development. | Recommend refining this policy to ensure the intensification of existing residential and accommodation uses should not occur in HR 1 and H2 or where relative time to inundation is less than 12 hours.<br>Further consideration ought to be given to removing the subsequent policy wording (d)(i)(ii) and (iii).<br><br>By establishing a clear risk-based planning policy direction in the strategic framework, flood overlay, codes and planning scheme policy, there should be no need for further exceptions to be outlined in the policy framework.<br><br>The hierarchy of assessment benchmarks as set out in part 1.5 of the planning scheme states and the category of development assessment as set out in part 5.3.3 describes the mechanics of the Planning Scheme; overlays prevail over the zone code provisions and level of assessment is always assigned to the highest category in case of inconsistency. In other words, the planning scheme is already structured to enable risk-based planning outcomes are achieved by amendments to the overlay mapping and code wording. |
| Further recommendations for consideration in Section 3.3.11.1 | Recommend inclusion of the following policy:<br>Development avoids the unsafe isolation of communities.<br>Development in areas where isolation cannot be avoided is able to provide for safe evacuation or safe refuge.<br>Development does not hinder or burden effective emergency services operation and provides for safe and effective emergency services access and evacuation. |
| 3.6.9 Element— Community activities and infrastructure | |
| 3.6.9.1 (b) Existing or proposed community activities and infrastructure are sensitive land uses that are: (i) not located on land subject to flood, bushfire and landslide hazard; | Recommend refining this policy to ensure the development for community infrastructure catering for vulnerable persons, or infrastructure that must continue operating during or after a flood event does not occur in areas or circumstances of intolerable risk which may be defined as HR1 and HR2. i.e. subject to hazards that are unsafe to people and potentially subject to hazard that can cause structural failure. |
| 3.6.10.1 Element - Open space, sport and recreation facilities network | |
| 3.6.10.1 (c) The open space, sport and recreation facilities network: (i) is not located on land subject to flood, bushfire and landslide hazard risk; or | Recommend refining this policy to ensure development in Open Space, sport or recreation facilities is commensurate to the hazard. Open space can generally be considered potentially acceptable in the HR4 and HR5 categories and potentially tolerable subject to requirements or limitations to the type of use to only those that are tolerable or acceptable in HR1, HR2 and HR3 areas. |

## 6.5 Flood Hazard Overlay Code Review

For this review, Part 5 (Tables of Assessment) and Part 7 (Flood Overlay Code) has been used to assess 'dummy' applications for:

- Material change of use (MCA) for a Dwelling House.
- Vulnerable Use (e.g. childcare centre, aged care facility).
- Reconfiguration of Lot (e.g. 1 lot into 2 lots - subdivision).
- Utility Installations (e.g. water and sewerage treatment plants, drainage or stormwater premises, electricity infrastructure, substations etc.).
- Low impact industry (e.g. manufacturing, producing, processing, repairing, altering, recycling etc.).

### 6.5.1 Material Change of Use for a Dwelling House

The Planning Scheme was used as if submitting a development assessment for a Material Change of Use for a Dwelling in Township Zone, General Residential Zone, Emerging Community Zone or Centre Zone.

- Under the Tables of Assessment, a Dwelling House is considered 'Accepted' and the level of assessment does not change if it is within flood hazard overlay area.
- Therefore, Council does not assess Dwelling Houses in the flood hazard area if they are deemed to comply with all acceptable outcomes.

**TABLE 6-3 MATERIAL CHANGE OF USE ASSESSMENT**

| Table | PO / AO | Comment – MCU for Dwelling House | Page # |
|---|---|---|---|
| Tables of Assessment | | | |
| 5.10.7 | No change if complies with All AO's. | **Comment:**<br>Recommended that a planning 'audit' of all 'Accepted development' via Councils Compliance and Regulation Department is undertaken to check for new dwelling houses in flood hazard areas. | Part 5 - 68 |
| **Flood Hazard Overlay Code** | | | |
| Extreme Flood Area (>2m depth, >2m/s velocity, >1.2sqm/sec) | | | |
| 7.2.7.3 A | PO 3 | **Comment:** Generally considered reasonable approach to limit exposure to hazards associated with flooding. PO3 considers the acceptability of flood risk, by definition in this flood area would NOT be acceptable for a Dwelling House and occupants.<br><br>**Recommend:** Use of the term 'acceptability', consider changing to Acceptable Risk as defined in the SPP. | Part 7 - 27 |
| 7.2.7.3 A | PO/AO 4 | **Comment:** Statutory note in PO4 – if destroyed by flood or other event (i.e. fire) Council should still ensure flood immunity is achieved. | Part 7 - 28 |

| Table | PO / AO | Comment – MCU for Dwelling House | Page # |
|---|---|---|---|
| 7.2.7.3 A | PO/AO 4.2 | **Comment:** Located on highest part of the site may not actually be out of an extreme hazard or depth.<br>**Recommend:** Include in AO wording - trafficable in the DFE.<br>Consider amending PO wording to include 'does not unduly burden emergency services in DFE (trafficable)'.<br>SPP Assessment Benchmark 4: Development supports and does not hinder disaster management response or recovery capacity and capabilities. | Part 7 - 28 |
| 7.2.7.3 A | PO6/AO6 | **Comment:** Considered to be aligned to SPP. Protection of life and property and all areas in 'potential' flood areas require a hydraulic report. AO6 Avoids fill and cumulative impact on adjoining properties. PO6 requires strengthening to align with SPP.<br><br>**Recommend:** Consider providing additional statutory note: A development application must be supported by a hydraulic and hydrology report prepared by a qualified professional that demonstrates development will:<br>a) maintain the flood storage capacity on the subject site.<br>b) not increase the volume, velocity, concentration or flow path alignment of stormwater flow across sites upstream, downstream or in the general vicinity of the subject site.<br>c) avoid acceleration or retardation of flows or any reduction in flood warning times elsewhere on the floodplain.<br>d) not increase stormwater ponding on sites upstream, downstream or in the general vicinity of the subject site. | Part 7 - 28 |
| High flood hazard area (0.5m to 2m depth, 0.5 to 2m/s velocity, 0.8 to 1.2sqm/sec) | | | |
| 7.2.7.3 A | PO7/AO 7.1 (a) | **Comment:** Existing ROL approval prior to the Planning Scheme negates a need to adhere to best practise risk-based planning. If, as the code is written, the development is for an MCU for a dwelling house, under the Planning Act this is not an existing lawful use or considered part of the original ROL approval (unless within 5 years of previous approval).<br>This is not considered to align with the SPP. i.e. no consideration of likelihood/frequency, flood risk, vulnerability, and consequences.<br>**Recommend:** Consider removing "except for dwelling house" from AO7 and refer to PO7 - important to consider the likelihood/frequency, flood risk, vulnerability, and associated consequences. | Part 7 - 29 |
| 7.2.7.3 A | PO8/AO 8 | **Comment:** Wording of AO8.3 'located on highest part of the site' may not actually be out of a high hazard or depth. 1 in 100 AEP immunity seems high for road level.<br>AO8.4 'no more than 4 bedrooms' conflicts with the PO8 to avoid increasing the number of people at risk to flooding.<br>**Recommend:** Include in AO8.3 wording – 'Trafficable in the DFE and within the PO - 'Does not unduly burden emergency services in DFE (trafficable)'.<br>Consider removing provision AO8.4 in conjunction with amending AO7 (i.e. removing the "except for a dwelling house" in a pre-Planning Scheme approved residential lot). | Part 7 - 30 |

| Table | PO / AO | Comment – MCU for Dwelling House | Page # |
|---|---|---|---|
| 7.2.7.3 A | PO 10/AO10 | **Comment:** Considered to be aligned to SPP. Protection of life and property and all areas in 'potential' flood areas require a hydraulic report. AO10 Avoids fill and cumulative impact on adjoining properties. PO10 requires strengthening to align with SPP.<br><br>**Recommend:** Consider providing additional statutory note:<br>A development application must be supported by a hydraulic and hydrology report prepared by a qualified professional that demonstrates development will:<br>a) maintain the flood storage capacity on the subject site.<br>b) not increase the volume, velocity, concentration or flow path alignment of stormwater flow across sites upstream, downstream or in the general vicinity of the subject site.<br>c) avoid acceleration or retardation of flows or any reduction in flood warning times elsewhere on the floodplain.<br>d) not increase stormwater ponding on sites upstream, downstream or in the general vicinity of the subject site. | Part 7 - 32 |
| Significant Flood Area (0.5m to 2m depth, <2m/s velocity, 0.6 to 0.8sqm/sec) | | | |
| 7.2.7.3 A | PO 11/AO11 | **Comment:** Considered to be somewhat aligned to SPP<br><br>**Recommend:** Consider providing additional statutory note to PO11:<br>A development application must be supported by a hydraulic and hydrology report prepared by a qualified professional that demonstrates development will:<br>a) be structurally designed to be able to resist hydrostatic; and hydrodynamic loads associated with flooding up to and including the defined flood event. | Part 7 - 32 |
| Significant flood hazard area, Low flood hazard area or Potential flood hazard area | | | |
| 7.2.7.3 A | PO13/AO 13 | **Comment:** AO13.1 applies to MCU or Building Works applications only, part (b) ensures that the dwelling house may not be exposed to a depth greater than 600mm. | |
| 7.2.7.3 A | PO14/AO 14 | **Comment:**<br>AO14 requires a limit or 50 cubic metres per 1,000m$^2$. Compared to other local Planning Schemes – Brisbane City Council limits to 100mm in the waterway corridor area and requires Compensatory Earthworks policy to be applied and substantiated with hydraulic modelling.<br><br>**Recommend:**<br>Consider introducing Compensatory Earthworks policy into overall Planning Scheme.<br><br>Consider applying a statutory note requesting a hydraulic (flood hazard assessment) report prepared by a RPEQ is required in substantiation of a Performance Solution. | |

### 6.5.2 Vulnerable Uses

The Planning Scheme was used as if submitting a development assessment for a Material Change of Use for a vulnerable use in a Centre Zone.

In compliance with the SPP, the Planning Scheme defines vulnerable uses in section 7.2.7.2 of the Planning Scheme; under *purpose and overall outcomes,* being:

- Childcare centre,
- community care centre, residence, or use,
- detention facility,
- educational establishment,
- emergency services,
- hospital,
- non-resident workforce accommodation,
- relocatable home park,
- residential care facility or retirement facility,
- rooming accommodation or rural workers' accommodation,
- and tourist parks.

Section 7.2.7.2 also specifies that the above uses are **excluded** from flood hazard categories of:

- Extreme flood hazard area,
- High flood hazard area, and
- Significant flood area is limited to community activities, and specifically excludes vulnerable uses (e.g. childcare centre, aged care facility).

It is assumed that vulnerable uses are acceptable in Low flood hazard areas, subject to meeting the provisions of the Flood hazard overlay code. A specific definition of vulnerable uses is suggested later this report, and as previously mentioned, vulnerable uses should not be in **an isolated area/flood island area** identified on the flood hazard overlay map. Preferably, vulnerable use developments should not be located in an area that has an inundation time of less than 6 hours (as supplied through LFMP mapping).

**TABLE 6-4 VULNERABLE USES ASSESSMENT**

| Table | PO / AO | Comment – Vulnerable uses in Centre Zone | Page # |
|---|---|---|---|
| Tables of Assessment | | | |
| 5.10.7 | No change if complies with All AO's (and not identified as Impact) | **Comment:** a range of uses to consider in this case, however, majority of uses trigger a 'Code assessment" process. Therefore, Council will be assessing most applications for vulnerable uses. | Part 5 - 68 |
| Extreme flood hazard area (>2m depth, >2m/s velocity, >1.2sqm/sec) | | | |

| Table | PO / AO | Comment – Vulnerable uses in Centre Zone | Page # |
|---|---|---|---|
| 7.2.7.3 A | PO/AO3 | **Comment:** AO3.1 Ensure vulnerable uses are not located in Extreme flood hazard areas.<br>Generally considered reasonable approach to limit exposure to hazards associated with flooding. PO3 considers the acceptability of flood risk, in this flood area would NOT be acceptable for a vulnerable use. There is additional consideration to the safety of persons associated.<br><br>**Recommend:** Use of the term 'acceptability', consider changing to Acceptable Risk as defined in the SPP. | Part 7 - 27 |
| 7.2.7.3 A | PO/AO5 | **Comment:** Design and siting.<br>AO5.1 requires signage, depth indicators if site is within 100m of a flood hazard area. Understood the intent is for larger sites to warn occupants and users, but unless a 100m 'buffer' is applied to all site lots, many 'flood free' lots that are within 100m of a flood hazard area may not be triggered for application under the Flood hazard overlay code.<br><br>Considered to align with SPP. | Part 7 - 28 |
| High flood hazard area (0.5m to 2m depth, 0.5 to 2m/s velocity, 0.8 to 1.2sqm/sec) | | | |
| 7.2.7.3 A | PO7/AO 7.1 (a) | **Comment:** AO7.1 Ensure vulnerable uses are not located in High flood hazard areas.<br><br>PO7 considers the acceptability of flood risk, in this flood area would NOT be acceptable for a vulnerable use. There is additional consideration to the safety of persons associated.<br><br>**Recommend:** Use of the term 'acceptability', consider changing to Acceptable Risk as defined in the SPP. | |
| Significant flood hazard area (0.5m to 2m depth, <2m/s velocity, 0.6 to 0.8sqm/sec) | | | |
| 7.2.7.3 A | PO 11/AO11 | **Comment:** AO11.1 Ensures vulnerable uses are not to be built in a significant flood hazard area.<br><br>PO11 also considers the safety of persons associated.<br><br>**Recommend:** Use of the term 'acceptability', consider changing to Acceptable Risk as defined in the SPP. | Part 7 - 33 |
| 7.2.7.3 A | PO12/AO12 | **Comment:** PO12 requires strengthening. Additionally, a Flood Emergency Management Plan (FEMP) can be provided as the performance outcome in this case.<br><br>**Recommend:** consider providing additional statutory note: A development application must be supported by a Flood Emergency Evacuation Plan prepared by suitably qualified persons having regard to Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia, prepare by the Australian Government. | Part 7 - 33 |

| Table | PO / AO | Comment – Vulnerable uses in Centre Zone | Page # |
|---|---|---|---|
| **Comment:** No provisions that address development in isolated areas/flood islands only.<br><br>**Recommend:** Consider introducing PO/AO within a separate section that addresses isolation. At a minimum this could focus on vulnerable-use component of development is not located in an isolated area/flood island area identified on the flood hazard overlay map. | | | |

### 6.5.3 Reconfiguration of Lot

The Planning Scheme was used as if submitting a development assessment for a Reconfiguration of Lot for a larger subdivision (such as a 1 into 30 lots), located within a Centre zone, Community facilities zone, General residential zone, High impact industry zone, Industry zone or Township zone.

TABLE 6-5 RECONFIGURATION OF LOT ASSESSMENT

| Table | PO / AO | Comment – Reconfiguring a Lot (Subdivision) | Page # |
|---|---|---|---|
| Tables of Assessment | | | |
| 5.10.7 | Code assessment | **Comment:** ROL uses triggers a 'Code' or 'Impact' assessment process in the flood hazard overlay code | Part 5 - 68 |
| Flood Hazard overlay code | | | |
| Extreme flood hazard area (>2m depth, >2m/s velocity, >1.2sqm/sec) | | | |
| 7.2.7.3 A | PO/AO 4 | **Comment:** AO4.3 limits the location to be above the defined flood level.<br><br>AO4.4. ensures no lots are physically isolated above the 1 in 100 AEP flood level.<br>PO4 does not make consideration of unduly burdening of emergency services.<br><br>**Recommend:** Consider adding in requirement to support, and not hinder disaster management capacity and capabilities. | Part 7 - 28 |
| 7.2.7.3 A | PO/AO5 | **Comment:** Design and siting.<br>AO5.2 A Flood Emergency Evacuation Plan prepared by a suitably qualified person is required.<br><br>In combination with PO/AO4 the siting of potential large subdivision is considered to align with SPP.<br><br>**Recommend:** Consider adding wording PO5: "minimises the impacts on property and appropriately protects the health and safety of persons at risk of Extreme flood hazard to 'acceptable' level". | Part 7 - 28 |

| Table | PO / AO | Comment – Reconfiguring a Lot (Subdivision) | Page # |
|---|---|---|---|
| 7.2.7.3 A | PO/AO8 | **Comment:** AO8.8 limits the location to be above the defined flood level.<br><br>AO8.9. ensures no lots are physically isolated above the 1 in 100 AEP flood level.<br><br>PO8 does not make consideration of unduly burdening of emergency services.<br><br>**Recommend:** Consider adding in requirement to support, and not hinder disaster management capacity and capabilities. | Part 7 - 31 |
| 7.2.7.3 A | PO/AO9 | **Comment:** AO9.2 A Flood Emergency Evacuation Plan prepared by a suitably qualified person is required.<br><br>In combination with PO/AO8 the siting of potential large subdivision is considered to align with SPP for sites exposed to high flood hazard area.<br><br>**Recommend:** Consider adding wording PO9: “minimises the impacts on property and appropriately protects the health and safety of persons at risk of Extreme flood hazard to ‘acceptable’ level”. | Part 7 - 32 |
| 7.2.7.3 A | PO/AO12 | **Comment:** AO12.2 Flood Emergency Evacuation Plan prepared by a suitably qualified person is required.<br><br>In combination with PO/AO11 the siting of potential large subdivision is considered to align with SPP for sites exposed to significant flood hazard area.<br><br>**Recommend:** Consider adding wording PO12: “minimises the impacts on property and appropriately protects the health and safety of persons at risk of Extreme flood hazard to ‘acceptable’ level”. | Part 7 - 33 |
| 7.2.7.3 A | PO/AO13 | **Comment:** AO13.6 limits the location to be above the defined flood level.<br><br>AO13.7 ensures no lots are physically isolated above the 1 in 100 AEP flood level.<br><br>PO13 does not make consideration of unduly burdening of emergency services.<br><br>**Recommend:** Consider adding in requirement to ‘support, and not hinder disaster management capacity and capabilities. | Part 7 – 33 |

### 6.5.4 Utility Installations

The SPP seeks to ensure that, at a minimum, utilities are located above 1 in 100 AEP flood event or otherwise designed to prevent intrusion of floodwaters. The Planning Scheme is considered to comply with SPP for assessment of utility installations.

The Planning Scheme was used as if submitting a development assessment for a Material Change of Use for a Utility installation (such as water and sewerage treatment plants, drainage or stormwater premises, electricity infrastructure, substations, transport service, waste management service, or maintenance depot etc). Assessment undertaken for a development within a Centre zone, Community facilities zone, Emerging community zone, General residential zone, High Impact industry zone, Industry zone, Recreation and open space zone, Rural residential zone, Rural zone, or Township zone.

**TABLE 6-6 UTILITY INSTALLATIONS ASSESSMENT**

| Table | PO / AO | Comment – Utility Installations | Page # |
|---|---|---|---|
| Tables of Assessment | | | |
| 5.10.7 | Code assessment | Comment: applications for utility installations are generally 'Code' or 'Impact' assessable if involving electricity, water, sewerage, or waste treatment. | Part 5 - 68 |
| Flood Hazard overlay code | | | |
| 7.2.7.2 | OO(2)(a)(iii), (b)(iii), (c)(iii) | Comment: Utility installations where involving water and sewerage treatment plants, substations, major electricity infrastructure are not accepted in Extreme, High or Significant Flood Areas. | Part 7 26 |
| 7.2.7.2 | PO/AO3, AO7, AO11 | Comment: AO3.3, AO7.3, AO11 Ensures utility installations are location outside the Extreme, High and significant flood hazard areas. | Part 7 28 - 32 |

### 6.5.5 Low Impact Industry Uses

- The SPP seeks to ensure that development is compatible with the level of risk associated with the natural hazard. At a minimum, industrial uses should only occur in a medium or low hazard risk area. The Planning Scheme is considered to be compliant with SPP with regards to storage of dangerous or hazardous materials.

The Planning Scheme was used as if submitting a development assessment for a Material Change of Use for a Low Impact industry within a High Impact Industry zone and Industry zone.

**TABLE 6-7 LOW IMPACT INDUSTRY USES ASSESSMENT**

| Table | PO / AO | Comment – Low Impact Industry | Page # |
|---|---|---|---|
| Tables of Assessment | | | |
| 5.10.7 | No change if complies with All AO's (and not identified as Impact) | **Comment:** Similar to other uses, if compliant with all AOs in the flood hazard overlay, potential for Low impact industry in the industry zone and high impact industry zone to be accepted.<br>Majority of uses trigger assessment, therefore Council will be assessing most applications for low impact industry. | Part 5 - 68 |

| Table | PO / AO | Comment – Low Impact Industry | Page # |
|---|---|---|---|
| Flood Hazard overlay code | | | |
| **7.2.7.2** | OO(2)(b)(iii), (c)(iii) | **Comment:** Industrial activities allowed in High or Significant flood hazard area where it is accepted that flood damage is incurred as an operational cost and where flood sensitive elements of the development or use are elevated above the defined flood level and freeboard**.** | **7.2.7.2** |
| 7.2.7.3 A | PO/AO1 | **Comment:** Compliant with SPP with regards to storage of dangerous or hazardous materials. | Part 7 - 27 |
| 7.2.7.3 A | PO/AO 4 | **Comment:** PO4 and AO4.1 limits the location to be above the defined flood level.<br><br>**Recommend:** Consider adding in requirement in the Performance Solution wording 'to support, and not hinder disaster management capacity and capabilities. | Part 7 - 28 |
| 7.2.7.3 A | PO/AO5 | **Comment:** Design and siting. AO5.2 A Flood Emergency Evacuation Plan prepared by a suitably qualified person is required.<br><br>In combination with PO/AO4 the siting of industrial activities is considered to align with SPP.<br><br>**Recommend:** Consider adding wording PO5: "minimises the impacts on property and appropriately protects the health and safety of persons at risk of Extreme flood hazard to 'acceptable' level. | Part 7 - 28 |
| 7.2.7.3 A | PO/AO8 and PO/AO13 | **Comment:** for High Flood hazard area, Significant flood hazard area, low or Potential flood hazard area.<br><br>AO8.2 and AO13.2 ensures that the flood sensitive elements of the development or use are elevated above the defined flood level.<br><br>PO8 and PO13 does not make consideration of unduly burdening of emergency services.<br><br>**Recommend:** Consider adding in requirement to the Performance Solution that 'supports and does not hinder disaster management capacity and capabilities. | Part 7 - 31 |

| Table | PO / AO | Comment – Low Impact Industry | Page # |
|---|---|---|---|
| 7.2.7.3 A | PO/AO8 and PO/AO13 | **Comment: Access in industrial areas**<br><br>PO8 and PO13 ensures that road access to buildings s above 1 in 100 AEP flood level. This could be lowered to a 1 in 50 or 1 in 20 AEP for road level height immunity in industrial or commercial sites.<br><br>**Recommend:** Consider lowering immunity level for lower risk sites such as industrial or commercial activities. | Part 7 - 31 |

## 6.6 Other Considerations

### 6.6.1 Vulnerable Use Definition

The Planning Scheme may benefit from a definition of Vulnerable Uses.

The SPP guidance suggests Vulnerable Uses include:

- Childcare centre,
- Community care centre,
- Community residence,
- Community use,
- Detention facility,
- Educational establishment,
- Emergency services,
- Hospital,
- Non-resident workforce accommodation,
- Relocatable home park,
- Residential care facility,
- Retirement facility,
- Rooming accommodation,
- Rural workers' accommodation, and; t
- Tourist park.

For example, Brisbane City Council defines Vulnerable Uses as:

- Childcare centres,
- Community residences,
- Educational establishment,
- Hospitals, and

- Residential care facilities.

### 6.6.2 Statutory Note - Hydraulic Modelling or Flood Risk Assessment

In the flood hazard overlay code, some PO criteria are repeated within each flood hazard area. To meet the requirements of these performance solutions, it is recommended that Council consider including a Statutory Note to request that the applicant undertakes a flood risk assessment, which should be carried out by a qualified professional. If hydraulic modelling is required, this must be included in a Flood risk assessment. The following requirements may be justified within a Flood risk assessment including:

- Development … must protect life and property on premises and off premises through maintaining:
  - (a) flood storage capacity of land;
  - (b) flood conveyance function of land;
  - (c) flood and drainage channels;
  - (d) overland flow paths; and
  - (e) flood warning times.
- Development … is appropriate to the flood hazard risk having regard to the:
  - (a) likelihood and frequency of flooding;
  - (b) the flood risk acceptability of development;
  - (c) the vulnerability of and safety risk to persons associated with the use; and
  - (d) associated consequences of flooding in regard to impacts on proposed buildings, structures and supporting infrastructure.

### 6.6.3 Freeboard - Flood Study Flood Level Sensitivity Assessment

The Planning Scheme assigns a freeboard of 300mm above the defined flood level, which accounts for localised hydraulic behaviour which may cause a flood level to rise above the defined flood level (such as wave action). This is in accordance with Queensland Urban Drainage Manual (QUDM).

It is important to understand local hydraulic behaviour which may require additional freeboard. This will account for the effects of rarer events, including steep and dangerous increases in flood depth. A planning tool to address flood level/hazards vastly higher than the 1 in 100 AEP could be inclusion of localised freeboard responses for specific areas. This will account for development that could be catastrophically flooded in just a 1 in 200 AEP event. Therefore, an assessment between the 1 in 200 AEP and 1 in 100 AEP flood level has been undertaken for all six flood study areas of:

- Toogoolawah Flood Study,
- Esk Flood Study,
- Kilcoy Flood Study,
- Fernvale Flood Study,
- Lowood Flood Study; and
- Minden Flood Study.

If there is a significant difference in the flood level between the flood events, Council may consider an additional 300mm or 500mm freeboard above the defined flood level (in addition to the existing 300mm level).

**Toogoolawah Flood Study – Cressbrook Dam**

Downstream of Cressbrook Dam on Cressbrook Creek, a sensitivity assessment of dam releases has been undertaken to understand the impacts that may occur in large flood events. The following scenarios within Somerset Flood Studies include:

- 1 in 50 AEP Flood event and the 1 in 100 AEP dam release – less than 300mm impacts on flood levels; and
- 1 in 100 AEP Flood event and the 1 in 100 AEP dam release – impacts up to 300mm on flood levels.

The design event for the 1 in 100 AEP flood event in the Toogoolawah Flood Study is inclusive of dam release scenarios. Therefore, if the new flood map and flood level is endorsed and subsequently adopted by Council, no additional freeboard allowance would be required to account for hydraulic behaviour associated with the Cressbrook Dam.

## 6.7 Flood Hazard Overlay Mapping

Somerset Council undertook a suite of flood studies as part of the LFMP project for the five main towns and Minden settlement. This latest flood modelled data should be used by Council to update the flood overlay mapping for the six localities. Council may also consider as part a future amendment, how the flood hazard overlay mapping is derived. There are a number of options available to Council to update the overlay and these are explored in this section.

### 6.7.1 Updated Flood Studies

**TABLE 6-8 EXISTING FLOOD HAZARD OVERLAY MAP DETAILS**

| Reference Number | Location | Comment |
|---|---|---|
| OM007a FHO | North | WT has revised mapping focusing on settlements. |
| OM007b FHO | South | WT has revised mapping focusing on settlements. |
| OM007c FHO | Esk | Extent of Esk mapped in flood hazard area has minor increase, as well as extreme flood hazard areas identified. |
| OM007d FHO | Fernvale | Flood hazard 1 in 100 AEP mapped, extent of all hazard categories (including extreme flood hazard) reduced. |
| OM007e FHO | Kilcoy | Extent of Kilcoy mapped in the flood hazard has no discernible difference, updated hazard category areas. |
| OM007f FHO | Lowood | Previously only mapped as ‘potential flood areas. Flood hazard 1 in 100 AEP analysis now completed. |
| OM007g FHO | Toogoolawah | Extent of Toogoolawah mapped in the flood hazard has no discernible difference, updated hazard category areas |
| - | Minden | Previously only mapped as ‘potential flood areas. Flood hazard 1 in 100 AEP analysis now completed. |

The key improvements to flood hazard overlay mapping for Councils consideration include:

- Amendment to hazard categorisations for Esk, Fernvale, Kilcoy, and Toogoolawah; and
- Increased resolution from ‘’potential flood area’ to detailed flood hazard mapping based on QRA hazard categories for Lowood and Minden.

The following maps for each locality enable comparison of the previously available flood maps with the updated modelling results from Water Technology as a part of this LFMP, these mapping comparisons demonstrate improvements to the level of accuracy and in some cases  a possible increase in the extent of flood overlay.

For the purposes of the Technical Evidence Report, a high-level comparison is provided. Please refer to separate LFMP documents for each locality for further detail on the revised flood hazard overlay options and the implications for land use planning responses specific to each town.

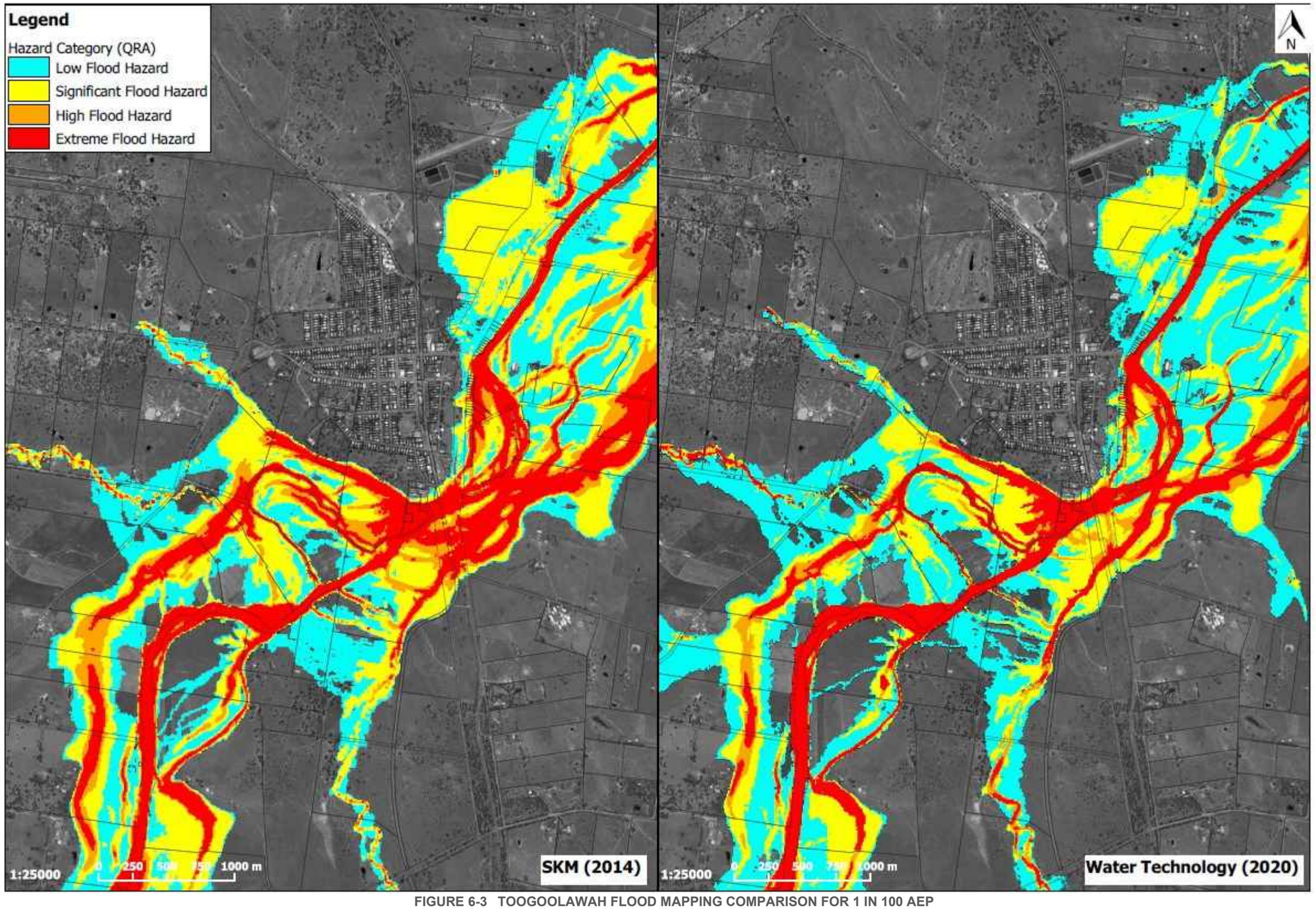



FIGURE 6-3 TOOGOOLAWAH FLOOD MAPPING COMPARISON FOR 1 IN 100 AEP

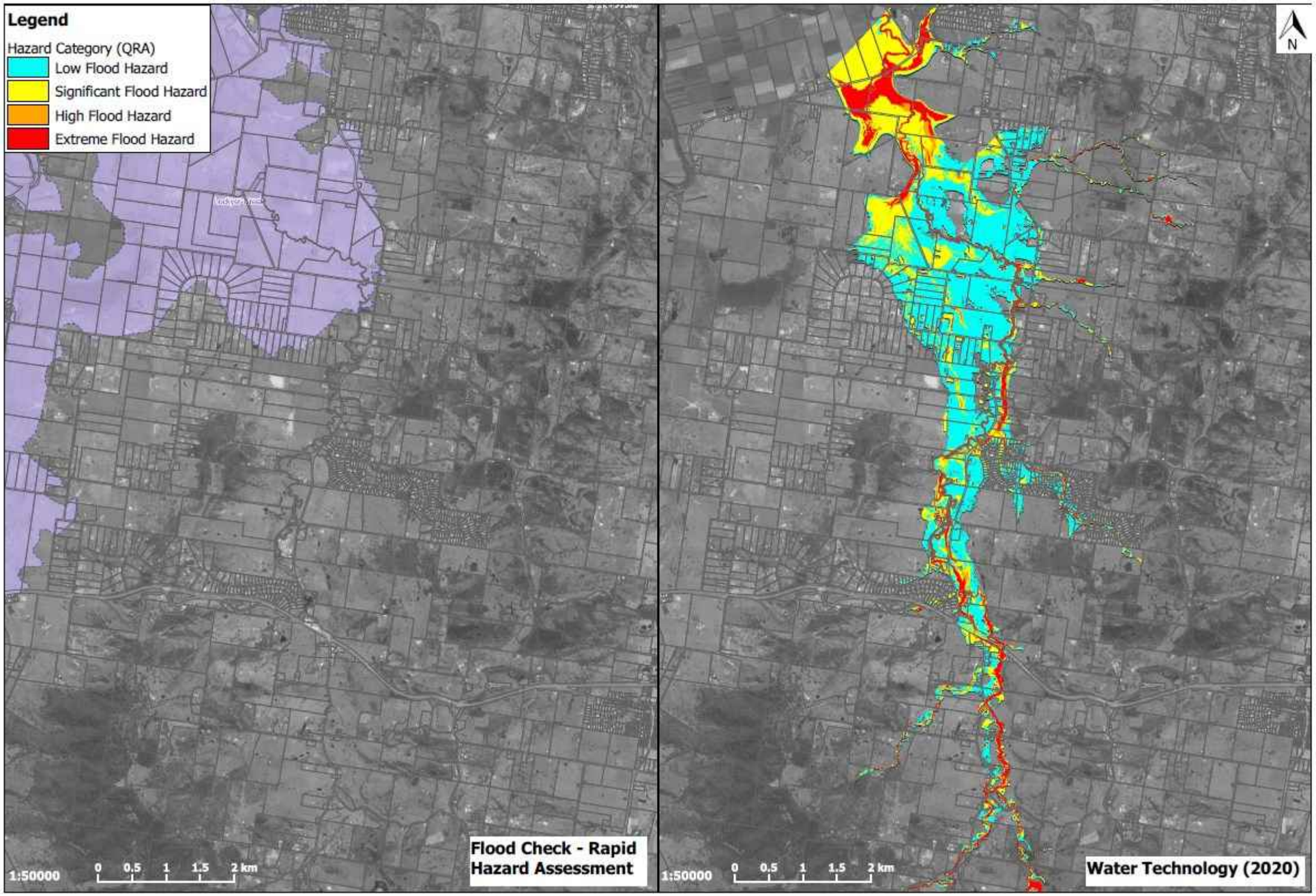



FIGURE 6-4 MINDEN FLOOD MAPPING COMPARISION FOR 1 IN 100 AEP

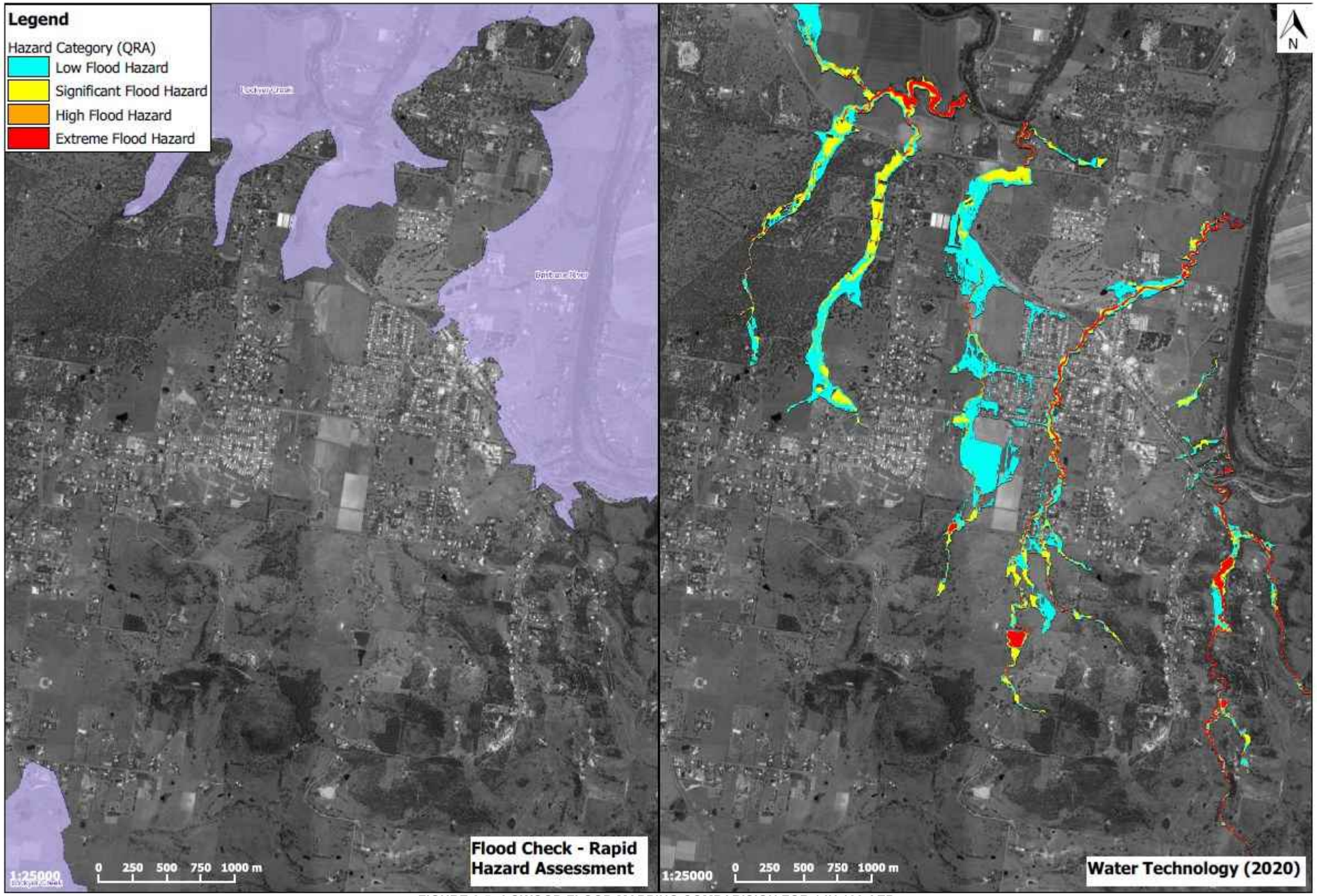



FIGURE 6-5 LOWOOD FLOOD MAPPING COMPARISION FOR 1 IN 100 AEP

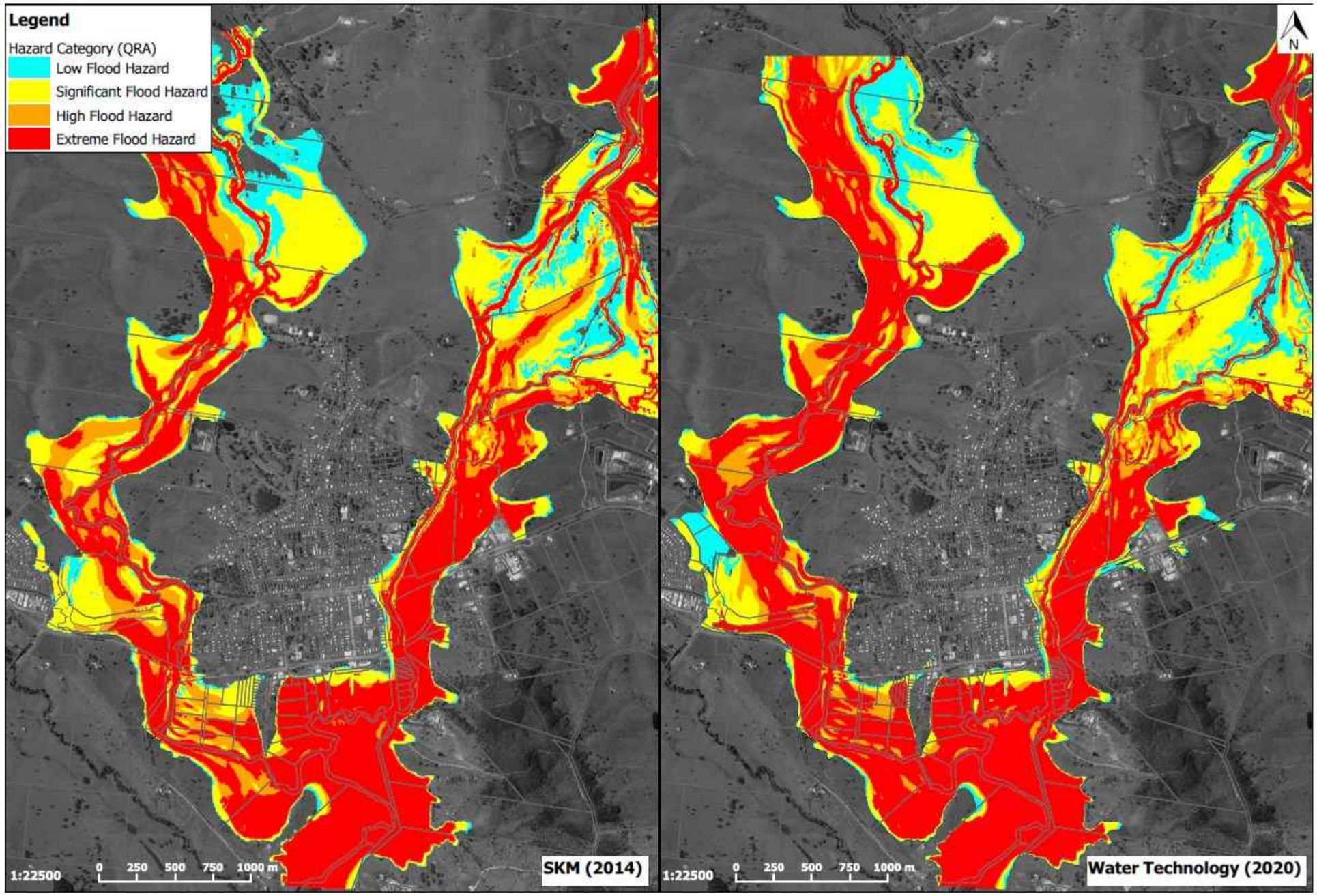



FIGURE 6-6 KILCOY FLOOD MAPPING COMPARISION FOR 1 IN 100 AEP

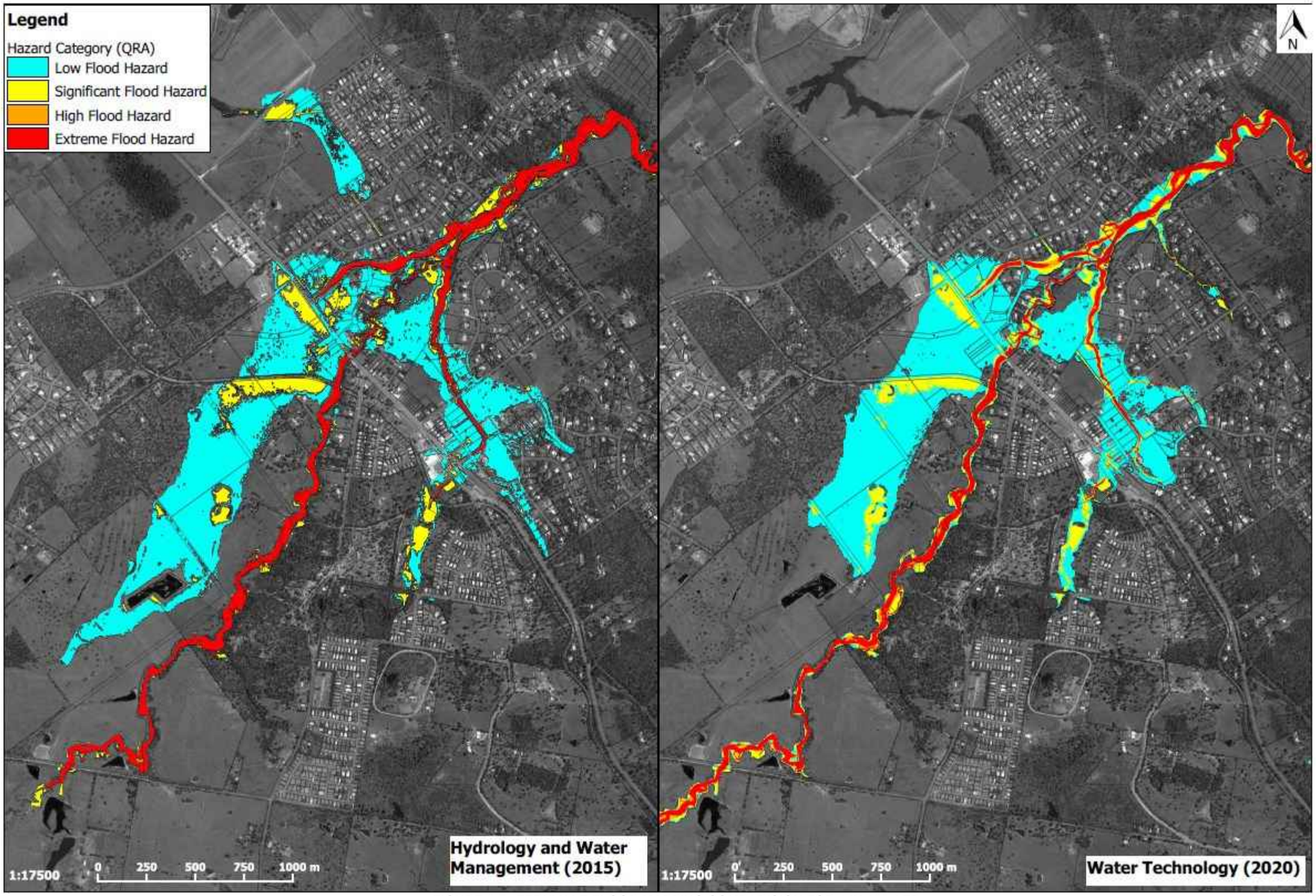



FIGURE 6-7 FERNVALE FLOOD MAPPING COMPARISION FOR 1 IN 100 AEP

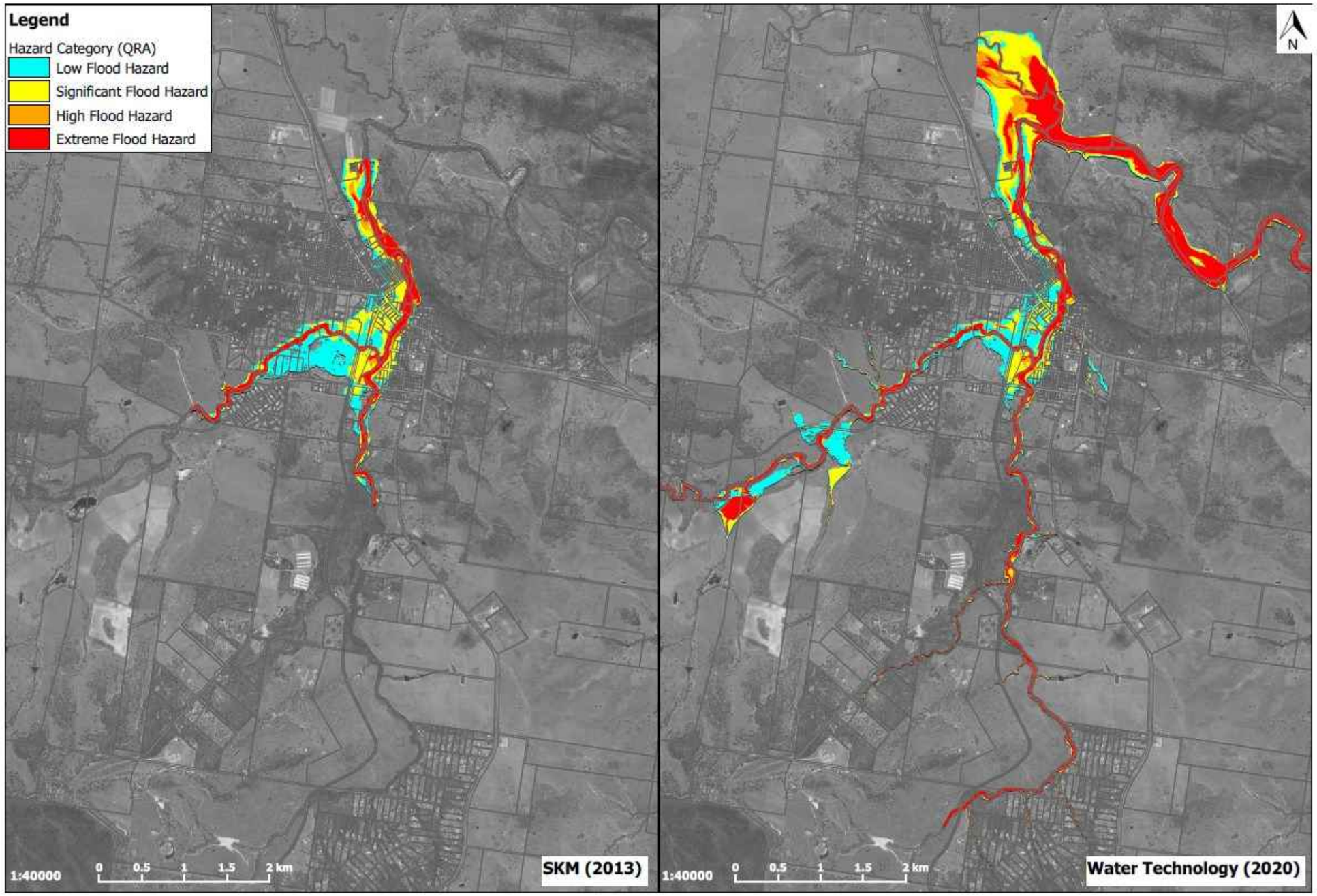



FIGURE 6-8 ESK FLOOD MAPPING COMPARISION FOR 1 IN 100 AEP

## 6.8 Risk-Based Planning

The SPP guidance requires Local Governments to apply a risk-based approach to land use planning and flood overlays, and there is high level guidance provided as to what a risk-based approach must include. Another significant component of the SPP is the requirement to consider climate change land use planning, strategic planning and mapping for development considerations. Other local planning schemes, the SPP and guidance from the Brisbane River Strategic Floodplain Management Plan were considered. The LFMP is considered to provide Council the fit-for-purpose risk assessment as mandated in the SPP. The intent of the risk assessment is to identify whether flood risk is acceptable, tolerable or intolerable in the context of existing and future development. The flood risk assessment can inform land use planning responses that deliver risk appropriate land use planning policy and development outcomes.

### 6.8.1 Flood Overlay

Somerset Regional Council could adopt a risk-based planning approach through these options:

1. Adoption of the Brisbane River SFMP hydraulic risk,
2. Mapping of 'risk bands' associated with the relevant hazard for 1 in 100 AEP,
3. Mapping of 'risk bands' associated with flood frequency and hazard for 1 in 100 AEP (plus Climate Change),
4. Adopting an additional Probable Maximum Flood (PMF) extent; and
5. Providing a 1 in 100 AEP and a 1 in 100 AEP with Climate Change 'sensitivity and adaption zone', with PMF overlay.

The following sections provide more detail about how these options could be adopted in Somerset.

### 6.8.2 Option 1 - Adoption of the SFMP Approach with Hydraulic Risk

The adoption of the SFMP approach provides an excellent method to identify risk zones across a broad variety of flood events and hazards. It may require amendment to the existing code wording to ensure alignment with the SPP as described above. With regards to mapping zones of risk the SPP requires a minimum of three zones, Council achieves this in the existing planning scheme by mapping four zones of risk. The SFMP Land Use Planning Guidance Material provides a suggested translation of the HR categories into four zones as shown in Table 6-9, Figure 6-9and Figure 6-10.

**TABLE 6-9 ADOPTING HR CATEGORIES INTO A PLANNING SCHEME FLOOD OVERLAY (FROM SFMP 2019)**

| HR Category | Possible Overlay Category |
|---|---|
| HR1 and HR2 | Extreme risk area |
| HR3 | High risk area |
| HR4 | Significant flood area |
| HR5 | Low risk area |

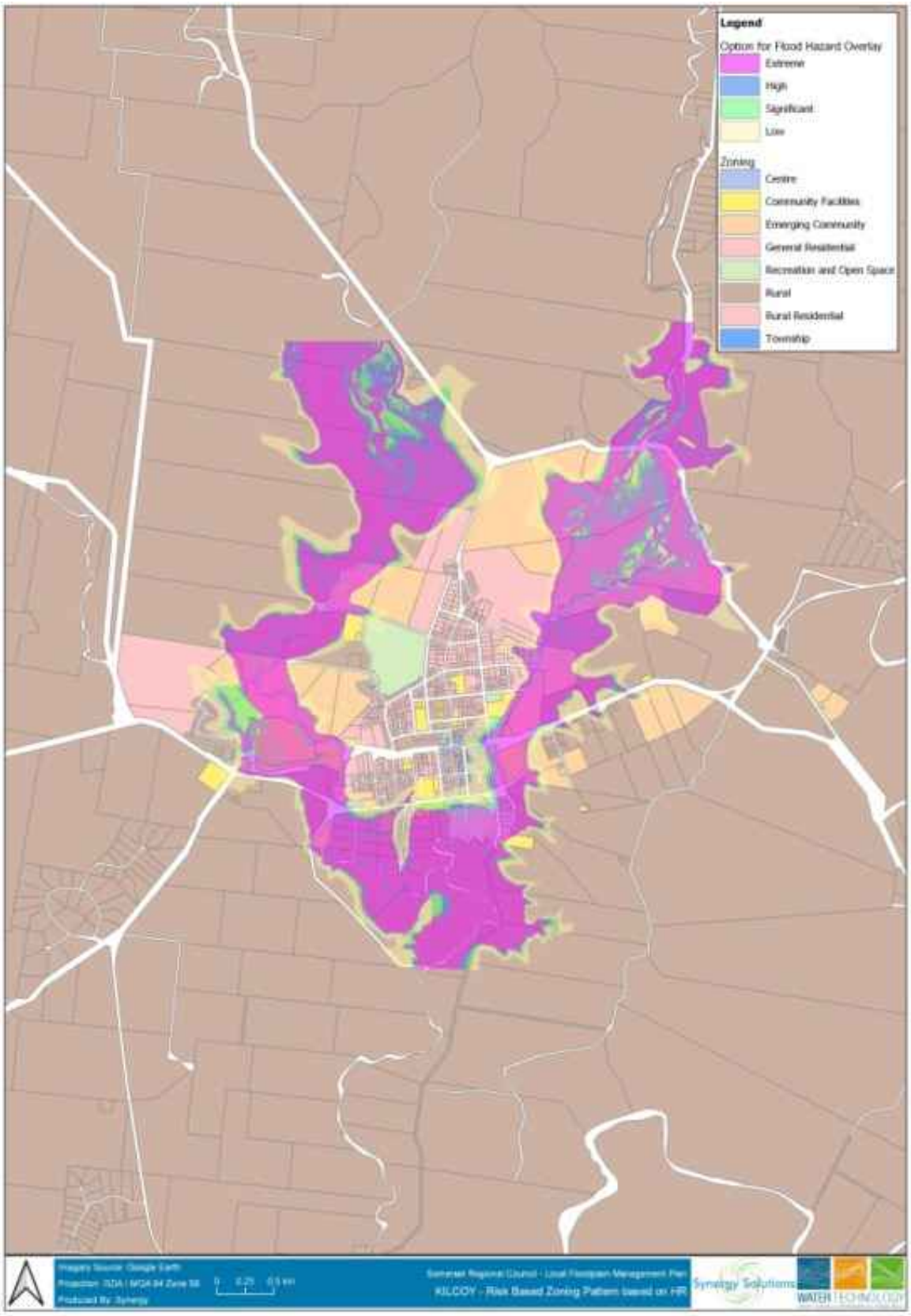



**FIGURE 6-9 RISK-BASED MAPPING – KILCOY LAND USE ZONING PATTERN 1 IN 100 AEP**

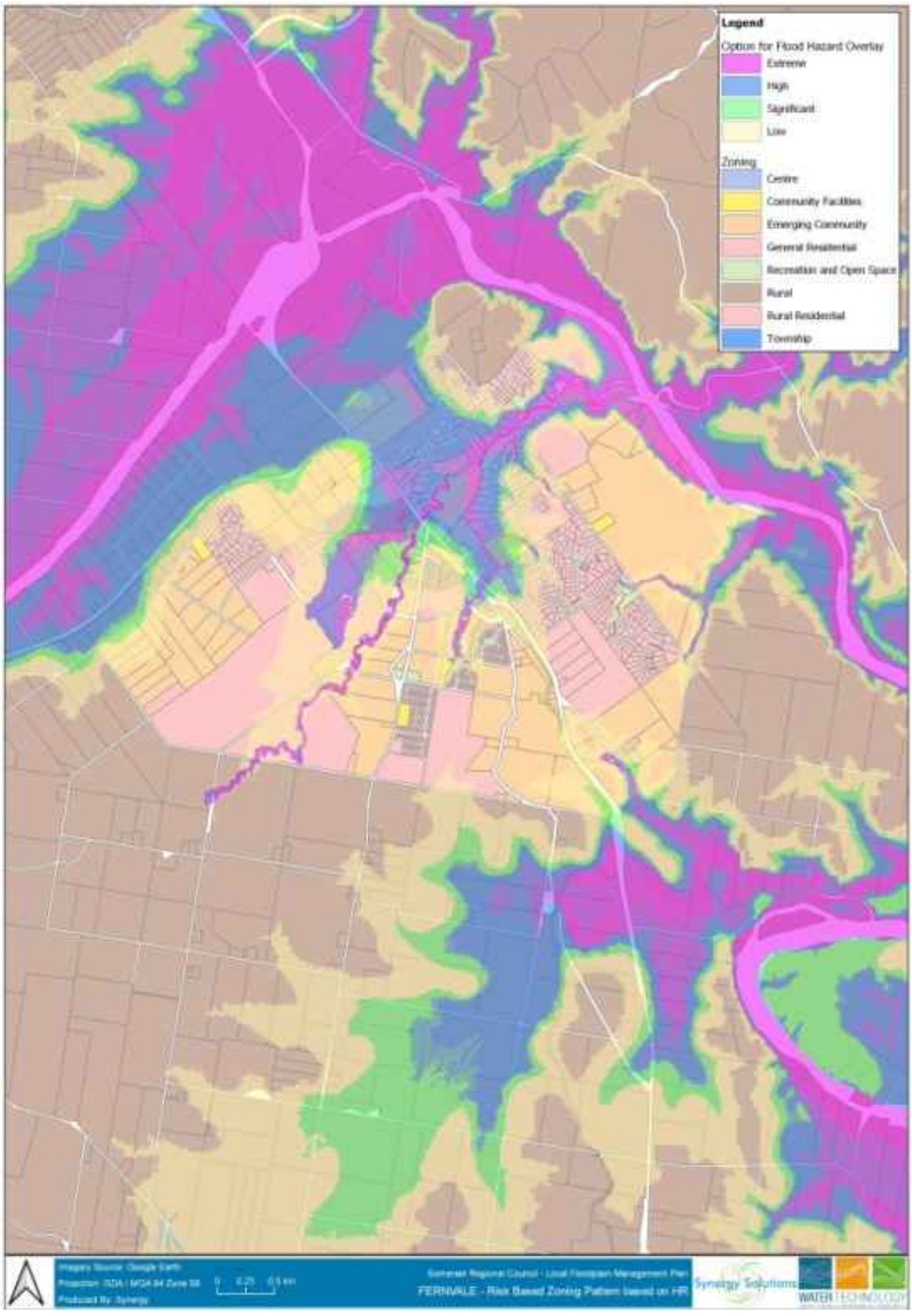



**FIGURE 6-10 RISK-BASED MAPPING – FERNVALE LAND USE ZONING PATTERN 1 IN 100 AEP**

### 6.8.3 Option 2 – Risk bands within the DFE

This method readily accepts the 1 in 100 AEP Defined Flood Event as a flood regulation line while identifying risk, however, does not allow flexibility in high hazard situations in less frequent events such as a 1 in 500 AEP event. This option is not considered to comply with the SPP as it does not consider events greater than the 1 in 100 AEP and does not provide development control over vulnerable uses within areas that would likely have intolerable risk. Furthermore, by identifying a limited extent of the floodplain, this approach can be disjointed from community engagement and education surrounding the full flood risk. Figure 6-11 identifies risk areas (via hazard) for the 1 in 100 AEP event. Higher hazard indicates increased risk to life and property. Identifying these risks can also assist 'back zoning' areas (i.e. residential development within a high-risk area).

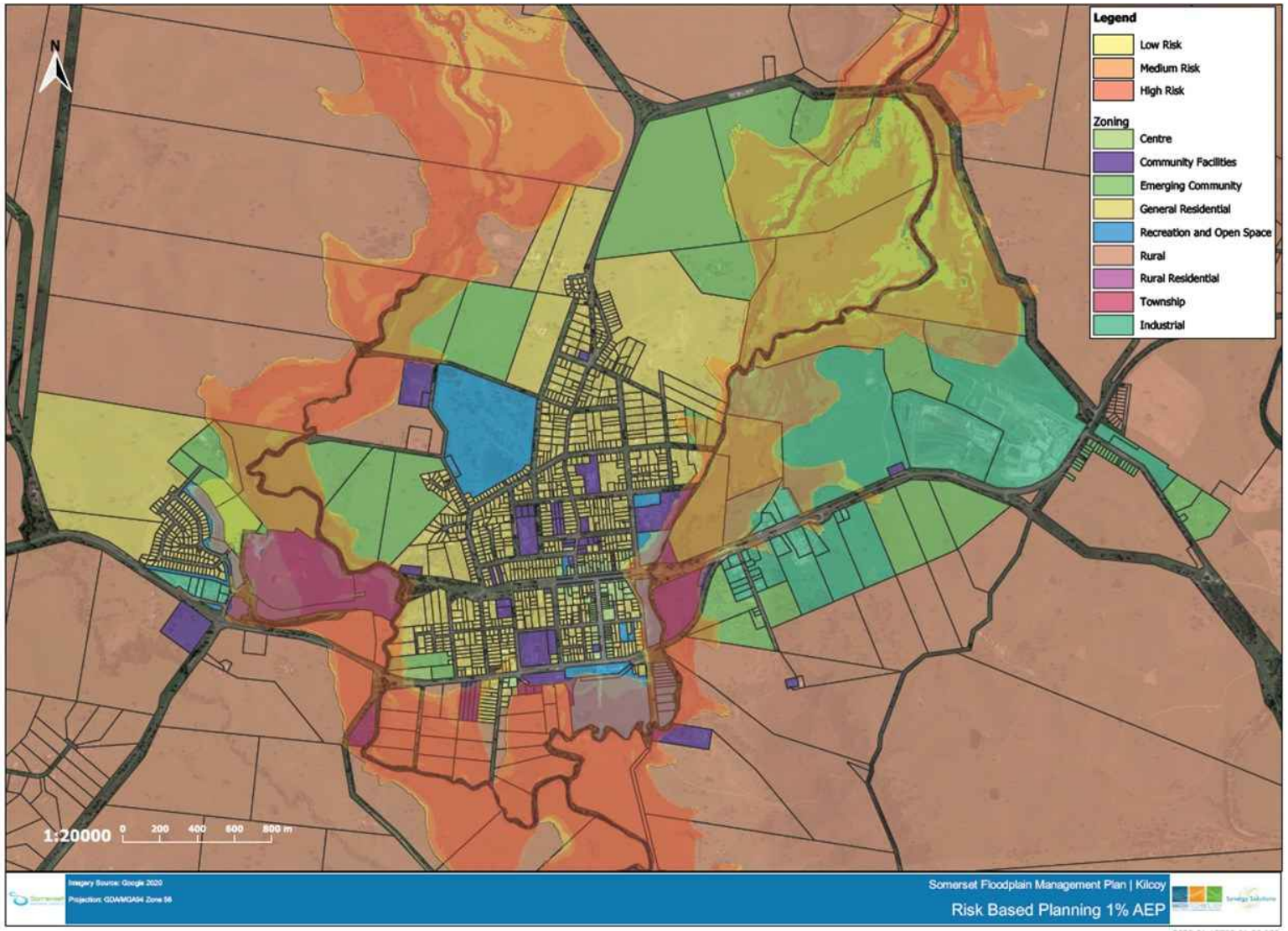



**FIGURE 6-11 EXAMPLE 1 IN 100 AEP RISK BASED MAP - KILCOY**

### 6.8.4 Option 3 – Risk bands within the DFE plus Climate Change

This option makes allowance for climate change to the 2090 planning horizon, considering the range of Representative Concentration Pathways, outlined by the International Panel for Climate Change. The following councils have adopted climate change, are investigating, or have made a submission to the State Government including:

- Ipswich City Council (includes climate change in its current Planning Scheme overlay revision)
- Brisbane City Council
- Moreton Bay Regional Council
- Toowoomba Regional Council
- Fraser Coast Regional Council

Selecting which climate change scenario to use (RCP 4.5, 6.0 or 8.5) requires careful consideration of the latest projections, guidance, area of impact and adaptability to these changes. Adoption of climate change mapping is an excellent risk-based approach for 'present day' risk. As these levels are not expected to peak until 2090, adoption of climate change in the present day increases flooding conservatism. For example, the RCP 6.0 generally aligns to similar rainfall increases to the 1 in 200 AEP event. By implementing climate change in the present day, essentially a higher level of flood immunity is achieved, and residual risk is reduced.

### 6.8.5 Option 4 – Risk bands with an Additional PMF Extent

The introduction of a PMF category (or maximum extent of the floodplain) introduces another development trigger for planning responses which are considered necessary for critical infrastructure or uses involving vulnerable persons. Figure 6-12 shows the extent of the PMF and risk categories in Fernvale.

The benefits of using the PMF include:

- Additional development control for:
  - Vulnerable uses – for example to locate vulnerable uses outside of the PMF or mandate further restrictions for development in land between the 1 in 100 AEP and the PMF, through means of a flood risk/emergency management plan.
  - Sites subject to higher hazard situations or emergency management considerations (e.g. constrained evacuation routes, or accessibility),
- Alignment with community education and disaster management planning (considering all events across the floodplain), and
- Avoids burdening emergency management activities during flood events.


**FIGURE 6-12 EXAMPLE 1 IN 100 AEP WITH PMF EXTENT MAP - FERNVALE**

### 6.8.6 Option 5 – Climate Change Sensitivity and Adaptation Zone

This method introduces a 1 in 100 AEP and a 1 in 100 AEP with Climate Change 'sensitivity and adaption zone' within the PMF overlay. As climate change impact can vary across the catchment (i.e. major differences on the Brisbane River Flood areas) and adaptive approach may be appropriate. A risk-based approach to climate change can be considered whereby several methods are investigated. Examples would include earthworks outside flood conveyance areas, house raising to achieve flood immunity where this does not create a streetscape or town planning issues or requiring flood resilient building materials.

Flood resilient building materials can be a pragmatic approach to climate change provided additional hazard or risk is not introduced. However, it is currently not possible to regulate flood resilient building materials via the Planning Act (2016) or Building Act (1975) and would require legislative change to allow this.

It is recommended that a watching brief is placed on the outcome of any future discussions on this matter between the Queensland Reconstruction Authority and the Department of Public Works and Housing as part of the implementation of the SFMP recommendations.

### 6.8.7 Recommendation to Amend Flood Overlay Mapping

It is recommended that Council consider:

- Option 3: Providing 'risk bands' associated with flood frequency with the relevant hazard for the 1 in 100 plus Climate Change; or
- Option 5: Providing a 1 in 100 AEP and a 1 in 100 AEP with Climate Change "sensitivity and adaption zone" and the PMF overlay.

It is considered these options provide a balanced approach to flood risk and a decision would need to be made based on the impact of climate change. These options allow Council to further regulate vulnerable uses outside of the 1 in 100 AEP flood extent and meet the requirements of the SPP with regards to climate change and a risk-based approach.

Option 1, using the SFMP HR 1 to 5 categories, is also worth consideration however this option does not include climate change. Option 1 is not considered to meet the requirements of the SPP with regards to climate change. HR categories are somewhat difficult to communicate to the planning industry and wider community and the intended use of the SFMP HR mapping is for regional riverine flooding and as noted in section 2.3 is considered to disproportionally overrepresent areas of higher hazard (HR1 and HR2) across local creeks floodplains.

## 6.9 Local Government Infrastructure Plan

In 2018, A Local Government Infrastructure Plan (LGIP) Amendment was made along with a Major Amendment to the Somerset Region Planning Scheme. This replaced Council's Priority Infrastructure Plan with a Local Government Infrastructure Plan and introduced the 'Planning Scheme Policy 4 – Design Standards to support the Local Government Infrastructure Plan'.

The LGIP identifies Council's plans for trunk infrastructure necessary to service urban development at the desired standard of service in a coordinated, efficient and financially sustainable way. The LGIP allows Council to collect infrastructure charges from new developments and can guide Council's future capital works program and future long-term financial sustainability, covering:

- Transport (e.g. roads, pathways, and bus stops),
- Water supply, sewerage and stormwater (e.g. pipes and water quality treatment devices), and
- Public parks and Community Land network (e.g. parks, libraries or sporting facilities).

With specific reference to the stormwater network, Council currently maps existing flow paths only. LGIP provides transparency of Council's plans for future trunk infrastructure and guides development to meet Council's design standard for stormwater management.

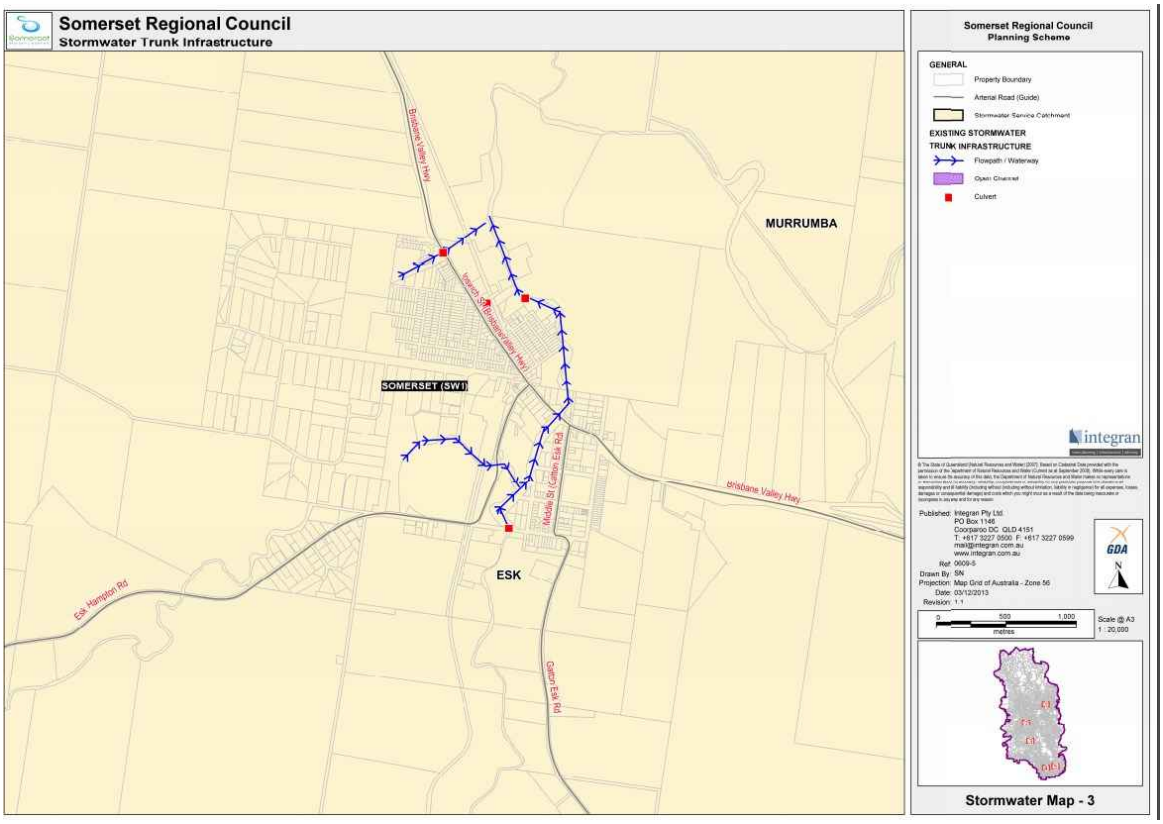



FIGURE 6-13 ESK – STORMWATER LGIP EXISTING FLOW PATHS

### 6.9.1 Design Standards

LGIP ensures best practice design standards are met through the adopted Planning Scheme Policy 4. Additionally, the following industry standard guidelines are to be complied with:

- Queensland Urban Drainage Manual (QUDM),
- TMR Road Drainage Manual,
- SEQ Water Development Guidelines: Development Guidelines for Water Quality Management in Drinking Water Catchments,
- EPA requirements and guidelines,
- Land Act (1994), and
- Plans for Trunk Infrastructure – Stormwater.

### 6.9.2 Planning Standard

As per the flood hazard overlay code, the LGIP planning standard seeks to minimise the impacts of flooding risks to habitable floor areas and reduce impact to water quality and health. Drainage is to detain and collect stormwater to prevent ponding and ensure that downstream systems and properties are not adversely affect.

### 6.9.3 Recommendation to Investigate Overland Flow Path Mapping

It is suggested that further investigation is undertaken to map overland flow path for all habited townships within Somerset LGA and identify drainage upgrades within the network.

Further investigation will identify the type, location and timing of future development within the Somerset LGA, and the trunk infrastructure provisions that are required to service the future growth and development scenarios. A stormwater quantity technical assessment should be based on these land use planning horizons:

- Existing development, to represent the current level of development at the 2020 planning horizon,
- Realistic future projected development to 2036 (15-year horizon), which is the required planning horizon on which trunk infrastructure provisions relating to the LGIP are based, and
- An ultimate land use planning horizon which considers all future development that could reasonably occur, and which extends beyond the LGIP planning horizon of 2036.

## 6.10 Land Use Planning Recommendations

### 6.10.1 Flood Overlay Update

This latest flood modelled data should be used by Council to update the flood overlay mapping for the six localities. Council may also consider as part a future amendment, how the flood hazard overlay mapping is derived. It is recommended that Council consider:

- Providing 'risk bands' associated with flood frequency with the relevant hazard for the 1 in 100 plus Climate Change; or
- Providing a 1 in 100 AEP and a 1 in 100 AEP with Climate Change 'sensitivity and adaption zone' and the PMF overlay.

These options provide a balanced approach to flood risk. Consideration must be given to the RCP used within the modelling and land use planning responses are provided in response to the climate change mapped extent. This will allow Council to further regulate vulnerable uses outside of the 1 in 100 AEP flood extent and meet the requirements of the SPP with regards to climate change and a risk-based approach.

### 6.10.2 LGIP

Further investigation will identify the type, location and timing of development within the Somerset LGA, and identify the trunk infrastructure provisions required to service future growth projections and development scenarios. It is suggested that all overland flow paths for all major urban centres are mapped and future network drainage upgrades are identified.

### 6.10.3 Back zoning - No Feasible Alternative Assessment Reports

It is recommended that Council consider future urban development areas that are exposed to an intolerable level of flood risk (e.g. development within Emerging Community zones). Mitigating development within intolerable risk areas could include a number of planning responses, including zone change through No Feasible Alternative Assessment Reports (No FAAR) or introducing flood precincts that require further assessment.

Both responses can be determined for:

- Areas that are within high or medium risk (where a threat to life is likely within the 1 in 100 AEP),
- Areas that have a short time to inundation (i.e. less than 6 hours), and
- Areas that are within flood islands.

### 6.10.4 Vulnerable Uses

Where development that is considered a vulnerable use is proposed between the 1 in 100 AEP and the PMF, Council should consider the following:

- Desirability of having the vulnerable use development located outside the PMF (refer to risk-based mapping outputs),
- Requiring a flood risk and emergency management plan to be completed by a qualified and experienced professional, to assess:
  - type of use,
  - inundation times,
  - warning and education, and evacuation capability,
  - the residual risk remaining, and potential burden placed on Council and emergency services resulting from this risk.

### 6.10.5 Summary of Land Use Planning Responses in Somerset

Council may consider updating the existing planning scheme by establishing a clear risk-based planning policy direction in the strategic framework, flood overlay, codes and planning scheme policy. There are a number of amendments outlined in this section that offer a balanced approach to flood risk. It is noted that Council will need to make a decision on the appropriate climate change scenario to include.

The options explored allow Council to further regulate particular uses in relation to flood risk to meet the requirements of the SPP with regards to climate change and ensuring the land use is commensurate to the hazard. Some uses are generally be considered potentially acceptable in lower risk areas and are potentially tolerable subject to requirements and conditions.

As discussed, further investigation is required to map overland flow paths for all habited townships within Somerset LGA and identify drainage upgrades within the network. This will help to provide Council a prioritised infrastructure plan and trunk infrastructure provisions that are required to service the future growth and development scenarios.

# 7 EMERGENCY MANAGEMENT

This section provides overview of the technical methodology employed in the LFMP's in specific areas such as evacuation, flood forecasting and intelligence and flood classifications. It is acknowledged that this does not represent a full emergency management lens with areas such as community awareness and education an important component of emergency management.

## 7.1 Evacuation Prioritisation

The major component of scope for emergency management was the identification and development of an evacuation screening and prioritisation approach. It is important to understand the limitations and risks during evacuation and consider:

- Evacuation is limited by resources and needs to be targeted to the highest risk properties and prioritised
- Flood events are response based due to the complexities of events and how they pan out during the event
- Evacuation is often far more dangerous than sheltering in place due to being swept away in floodwaters etc and the hazards and complexity associated with human behaviour during events
- Sheltering in place (if safe to do so) is often the recommended measure during flood events because of the complexities and risks associated with evacuation. It is also preferable for many reasons that people stay at home, with friends and not in formal evacuation centres

In the first instance effective flood warning and intelligence must be provided to the community to enable members to voluntarily evacuate. It is always preferable that residents stay with family and friends outside of flood areas well before flood events happen. This requires effective warning, forecasting and flood intelligence measures as well as community awareness, resilience and education programs which is outside of the scope to develop these aspects for the project.

Whereby residents have not evacuated, the complexities of evacuating entire suburbs are made clear by the sheer numbers and resources required. Whilst this is the overall preference where significant risk is involved, this project has documented a prioritisation method to attempt to locate properties at great flood risk due to a number of factors (flood hazard, vulnerability and warning time).

### 7.1.1 Evacuation Screening Methodology

The screening methodology develops three categories based on flood risk and priority response as well as embedded subcategories that elevate that risk. Initial screening is based on the hazard in the 1 in 2000 AEP event and subcategories are based on this hazard and then subsets of this plus vulnerability or time to inundation or both.

#### 7.1.1.1 Category 1 Screen

The initial screening involves the following:

- Screening all properties in the 1 in 2000 AEP
- Screening all properties with a H5/6 hazard rating (structural failure of buildings and very high likelihood of loss of life from either people swept away, building collapse or buildings washed away)

The initial screen identifies properties exposed to the highest hazard which are considered a priority.

**Screen 1 further subcategories**

Further subcategories are introduced to identify properties at further risk in screen 1 and requiring more urgent focus and acting with longer lead times:

- Screen 1a is all properties with a time to inundation of less than 6 hours to floor level. This identifies properties that are at further risk with both residents and emergency personnel having less time to respond
- Screen 1b is properties that have a combined vulnerability rating of >0.6 (i.e. mobility, physical impediments etc)
- Screen 1c is a combination of both time to inundation of less than 6 hours to floor level and highly vulnerable.

#### 7.1.1.2 Category 2 Screen

Screen 2 involves the following:

- Screening all properties in the 1 in 2000 AEP
- Screening all properties with a H3/4 hazard rating (risk to life)

The second screening is prioritised based on exposure to the next categories of flood hazard.

**Screen 2 further subcategories**

Further subcategories are introduced to identify properties at further risk:

- Screen 2a is all properties with a time to inundation of less than 6 hours to floor level. This identifies properties that are at further risk with both residents and emergency personnel having less time to respond
- Screen 2b is properties that have a combined vulnerability rating of >0.6 (i.e. mobility, physical impediments etc)
- Screen 2c is a combination of both time to inundation of less than 6 hours to floor level and highly vulnerable.

#### 7.1.1.3 Category 3 Screen

Screen 3 involves the following:

- Screening all properties in the 1 in 2000 AEP
- Screening all properties with a H1/2 (reduced risk to life)

The third screen identifies those that encounter flooding but are only in a situation of discomfort rather than risk. Flood risk can eventuate in other circumstances that are further screened as follows

**Screen 3 further subcategories**

Further subcategories are introduced to identify properties that may have a higher risk

- Screen 3a is all low set properties that have a longer than 6-hour duration of flooding
- Screen 3b is all high set properties that have a longer than 12-hour duration of flooding
- Screen 3c is all properties that have a vulnerability of >0.6.

### 7.1.2 Evacuation Screening Results

Prioritisation of residential building in each of the six localities has been carried based on the criteria outlined above. This section summarises the results for all six localities in Somerset (Esk, Toogoolawah, Fernvale, Kilcoy, Lowood and Minden), further details of the individual locality results for the prioritisation and capability assessment can be found in the individual LFMP reports.

The results provide an overview of property numbers, exposure and further analysis of evacuation assessment for Councils consideration.

Evacuation prioritisation results, the evacuation capability assessment and road flood immunity mapping is available in Appendix I.

Distribution of properties that may be suitable for evacuation is listed in Table 7-1 and an example map for properties that may be suitable for evacuation in Esk is provided in Figure 7-1. For further details please refer to the specific LFMP.

**TABLE 7-1 PRIORITISATION RESULTS**

| Screen | Detail (flood extent and hazard) | Esk | Minden | Lowood | Kilcoy | Fernvale | Toogoolawah | Priority |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 in 2000 AEP H5\|H6 | 54 | 15 | 83 | 0 | 275 | 27 | High |
| 1a | 1 in 2000 AEP H5\|H6 and TTI <6 hours | 54 | 0 | 81 | 0 | 270 | 27 | Higher |
| 1b | 1 in 2000 AEP H5\|H6 and Vulnerable | 54 | 0 | 63 | 0 | 0 | 0 | Higher |
| 1c | 1 in 2000 AEP H5\|H6and TTI <6 hours and Vulnerable | 54 | 45 | 63 | 0 | 0 | 0 | Highest |
| 2 | 1 in 2000 AEP H3\|H4 | 78 | 45 | 7 | 5 | 7 | 24 | Medium |
| 2a | 1 in 2000 AEP H3\|H4 and TTI <6 hours | 78 | 0 | 5 | 5 | 0 | 22 | High |
| 2b | 1 in 2000 AEP H3\|H4 and Vulnerable | 78 | 0 | 21 | 0 | 0 | 0 | High |
| 2c | 1 in 2000 AEP H3\|H4 and TTI <6 hours and Vulnerable | 78 | 0 | 5 | 0 | 1 | 0 | Higher |
| 3 | 1 in 2000 AEP H1\|H2 | 2 | 19 | 4 | 0 | 1 | 1 | Low |
| 3a | 1 in 2000 AEP H1\|H2, low set property, longer than 6 hours flooding | 2 | 19 | 4 | 0 | 0 | 1 | Medium |
| 3b | 1 in 2000 AEP H1\|H2, high set property, longer than 12 hours flooding | 2 | 0 | 4 | 0 | 0 | 0 | Medium |
| 3c | 1 in 2000 AEP H1\|H2 and vulnerable | 2 | 15 | 4 | 0 | 0 | 0 | High |


FIGURE 7-1 EVACUATION CAPABILITY ASSESSMENT EXAMPLE - ESK

Evacuation prioritisation results and the evacuation capability assessment mapping for all six LFMP localities are available in Appendix I.

## 7.2 Flood Forecasting and Flood Intelligence

This section of the TER provides a high level assessment and understanding of how to select an appropriate flood forecasting system dependant on risk, the types of systems available, the flood intelligence that can be produced and the types of meteorological products that are commercial available to supplement the system.

Flood forecasting systems are an extremely important component of a total flood warning system and have been attributed to reducing the costs of flood damages significantly by providing the necessary warning time to plan and adequately react to flood events. In addition, with the advantage of further planning time, high risk residents can be provided further warning and if necessary evacuated from dangerous situations.

### 7.2.1 Catchment Risk and System Prioritisation

The SFMP made the following recommendation with regards to flash flooding:

*Consider flash flood warning systems in locations with the potential for fast-onset flooding.*

The SFMP also makes recommendations to assess and utilise probabilistic forecasting data, adoption of new BoM forecasting products and further use of flood intelligence in flood forecasting systems. In order to analyse

and recommend suitable flood forecasting systems for each of the LFMP areas, BoM provides guidance on the steps and systems suitable based on risks in the catchment.

An extract from the FLARE project from BoM documents the steps required/suggested to inform the need for a flood forecasting system. The first two steps (determine level of risk and what type of system) is assessed in each of the towns.


**FIGURE 7-2 BOM FLASH FLOOD SYSTEM GUIDANCE**

The BoM provides guidance around how risk should be determined which generally aligns to a generic risk assessment in accordance with ISO 31000, similar to the SFMP. Risk is determined by likelihood and consequence and BoM provides guidance around impacts to the social environment and economic areas covering aspects such as injuries/fatalities, displacement, intangible psychological affects, ecosystem loss, community disruption and destruction and damage of property.

Each town within the LFMP will utilise the BoM generic assessment and also draw upon outputs of the LFMP's to determine overall risk and the response required to mitigate this risk (from a flood forecasting point of view). It should be noted that BoM recommended that the highest risk from each category should prevail.

Outputs from the LFMP's such as hydraulic risk, hazard, time to inundation, duration of inundation, evacuation priority and damages are utilised to make a determination surrounding the scale of the risk and inform the level of risk from very low to high risk. This has been undertaken as a high-level manual determination rather than a quantitative one as more detail is generally not required to align with the BoM process.

An extract of the FLARE guidance in determining an appropriate flash flood intelligence system is shown below. Each of the risk categories recommends different implementation techniques for prediction, interpretation, response and review.

| | Very Low Risk Flash Flood WS Minimum | Low Risk Flash Flood WS Intermediate | Medium Risk Flash Flood WS Advanced | High Risk Flash Flood WS Maximum |
|---|---|---|---|---|
| | | As per **Minimum system** and: | As per **Intermediate system** and: | As per **Advanced system** and: |
| **Monitoring and Prediction** | • Severe weather warnings<br>• Severe thunderstorm warnings<br>• Flood Watches (though not always issued ahead of a low flood risk event)<br>• Access to real-time information from weather radar (where coverage exists). | • Real-time information from rain gauges installed in the flash flood area.<br>• Rainfall triggers (depth/duration e.g. 30mm in an hour) set to alert to the possibility of flooding. | • Real-time information from river or drain/pipe gauges installed in the flash flood locality. | • Predictive capability based on rainfall/runoff modelling and/or other tools. |
| **Interpretation** | • Not required | • Simple analysis based on historical data to relate rainfall triggers to impacts on the ground. | • Utilise information from flood studies and flood mapping. Interpretation from historical data and local flood intelligence to link triggers to impact on the ground.<br>• READY (monitor), SET (prepare), GO (act) based on Bureau warnings, observed rainfall triggers and observed river/drain level triggers respectively. | • Utilise detailed flood studies and flood modelling/mapping to identify areas likely to be affected and understand potential flood depths and velocities and properties likely to be impacted. |
| **Response** | • Emergency Services respond to Requests For Assistance.<br>• Typically reactive response to deteriorating conditions.<br>• Some precautionary actions may be taken by the community based on the Bureau warnings. | • Emergency response will be more proactive to deteriorating conditions.<br>• Some precautionary actions may be taken by the community based on the Bureau warnings and rainfall triggers.<br>• Actions taken could be enhanced through a simple local public awareness and education program. | • Generally proactive community and Emergency Services response underpinned by local recurrent public flood awareness and education program.<br>• Good community awareness of flooding and personal actions required and some community members have personal flood plans prepared.<br>• A Municipal Flood Emergency Plan (MFEP) or response plan exists but has gaps or requires updating. | • Very proactive community and Emergency Services response underpinned by regularly run public flood awareness and education programs.<br>• Excellent community awareness of flooding and personal actions required; many community members have personal flood plans prepared.<br>• Detailed and current Municipal Flood Emergency Plan (MFEP) or response plan exists. |
| **Review** | • Usually limited to the performance of the Bureau's warning services and the response of the Emergency Services to handling Requests For Assistance. | • Performance of the Bureau's warning services and the response of the Emergency Services to handling Requests For Assistance.<br>• Review of the rainfall triggers and their effectiveness in providing sufficient time to respond. | • Review performance of the system (including each individual element) after each significant flash flood event.<br>• Regular and scheduled reviews of the readiness and maintenance of system components such as gauges, communications, public education and planning. | |

**FIGURE 7-3 BOM FLASH FLOOD SYSTEM SELECTION**

From the high-level risk assessment recommendations will be made on the appropriate type of system to be considered by Council. The project team at a minimum have developed a low risk prediction system for all towns except the Minden LFMP. With further installation of water level gauges, these systems could be upgraded to a medium risk system as desired and if recommended in the assessment.

Guidance on high risk systems and potential capabilities are also listed below should these systems be considered for the future. In addition, further information is provided on flood intelligence to potentially utilise outputs of the LFMP's to inform Councils existing flood forecasting system developed for the Brisbane River.

### 7.2.2 Forecast System Options

Forecasting systems can be built by many different providers and informed by multiple third-party products. Software names and third-party products are removed from any discussion however outputs and examples are provided from these software providers.

There are a multitude of forecasting systems that range from expensive to implement and complex to simple and inexpensive. A short description of different systems is provided below.


FIGURE 7-4 TYPES OF FLOOD FORECASTING SYSTEMS[1]

Sourced from: Buchanan S, Berry A, 2018, '*Is Real Time Giving us More Time', Floodplain Management Conference, Canberra May 2018, https://www.floods.org.au/client_images/2128576.pdf*

**Static Maps**

Understanding flood extents is the basic form of flood forecasting and this can be automatically increase knowledge after flood studies are undertaken. Understanding relationships between rainfall amounts and durations (rainfall intensity) can be linked to very rough flood extent surfaces. This is obviously significantly limited in application and lacks any real accuracy from a flood forecasting sense.

**Gauges and Trigger Based Systems**

A fairly popular and basic form of forecasting is utilising rain and/or river gauges with precooked mapping to align with readings on these gauges. Rainfall prediction maps can be developed through flood models by setting specific rainfall intensities and their resultant flood extents and surface. This creates a library of surfaces that can be used in flood events to give a very approximate understanding of flooding in the region. This type of approach suffers with low accuracy and is often very conservative as there is no spatial variation across the catchment and durations and rainfall amounts can often not be replicated exactly (without many thousands of maps)

Water level gauges can be used with precooked flood maps at increments up the flood gauges (i.e. at 0.25m level increases). Whilst this does not provide a predictive capacity, it is a very useful tool to provide understanding of the impact of flooding at various levels. In addition, rate of rise graphs can be developed to predict what level the gauge will reach and enable the selection of an appropriate gauge level map.

These types of approaches are often sufficient for low and medium risk areas. Where complex catchments and/or high risk areas are encountered, other systems should be considered.

**Hydraulic Extent Models (Benders)**

Hydraulic "bending" systems are in use within the Brisbane, Ipswich, Lockyer and Somerset areas as a tool to work with the BoM on the Brisbane River. A hydraulic bender was developed during the SFMP for these areas and works in collaboration between SEQ Water, BoM and the local Councils. The system is operated in accordance with the following procedures:

- SEQ Water estimate (based on BoM rainfall forecasts and other mechanisms) the predicted Wivenhoe Dam gate releases. These estimates are transferred to BoM's HYFS system.
- The BoM through their HYFS system use URBS and gauge rating curves to convert predicted and fallen rainfall into predicted water levels at nominated flood forecasting locations.
- The local Councils receive these predicted forecast levels at each of the nominated forecast locations. In addition to this, the BoM often assist Councils further by informally providing forecast predictions at other nominated locations through the Council area.
- Council's then operate a WaterRIDE system (commonly called a bender) that uses the predicted level extents and converts these to a flood surface. WaterRIDE also processes this flood surface further providing flood intelligence including lists of properties flooded and road inundation predictions.

This type of system is crucial where the BoM is responsible for flood forecasting on larger rivers.

**Live Hydrologic/Live Hydraulic Models**

This type of system requires a high level of development, understanding and resourcing. It is well suited to organisations that have specialist flood engineers in larger teams. These types of systems can leverage on sophisticated flood models that have been developed and extend their use much further.

These systems can run live hydrologic models utilising a variety of forecasting and real time rainfall products listed above or information from rain gauges (or a combination of all of these). Hydraulic bending systems can then be used to develop the forecast extents. Systems such as this are perfectly suited to high risk or complex catchments although do require much higher levels of resourcing.

These systems can provide powerful flood intelligence to varying levels of accuracy (depending on lead times that are desired). Ipswich City Council operate one of the most sophisticated types of these systems in Australia and were tested to within 170mm accuracy with 12 hours warning time[1] in the 2017 flood event (ex tropical cyclone Debbie).

Sourced from: Berry A, 2017, ' *Ex TC Debbie – Rainfields and Steps Product Testing 2017*

Further early development information and examples of this type of system can be sourced at *Berry A, Druery C, 2016, ' Could this be the answer? Accurate and Timely Flash Flood Forecasting, Floodplain Management Conference, Nowra 2016,* https://www.floods.org.au/client_images/1887844.pdf

**Artificial Intelligence**

Artificial intelligence systems are a developing method to forecast floods. Systems can use flood models to fine tune forecasts (for example adjusting rainfall losses) and also used without flood models altogether.

Google is using AI and significant computer power to create better forecasting models to predict when are where floods will occur. In September 2018, Google sent out the first alert using the new methodology for a flood alert in India. The system uses historical events, river level readings and terrain data to feed the models and predict floods[1]

*[1]Matias Y, 2018. 'Keeping People Safe with AI-enabled Flood Forecasting', Google Blog Accessed August 2020 from https://www.blog.google/products/search/helping-keep-people-safe-ai-enabled-flood-forecasting/*

## 7.3 BoM Forecast Products

Flood forecasting systems as described above range from basic to advanced in their build, application and use. Advanced systems which are generally required for high risk catchments that need longer lead times because of this risk. Moving from utilising gauge triggers, other real time information and more accurate forecast results requires advanced forcasting products to be utilised.

For the sake of consistency and reducing risk, products from the BoM are only considered in this assessment. The figure below shows the product distributionn availability. More advanced products are congregated around capital cities in general and coverage extends into regional areas for some products.

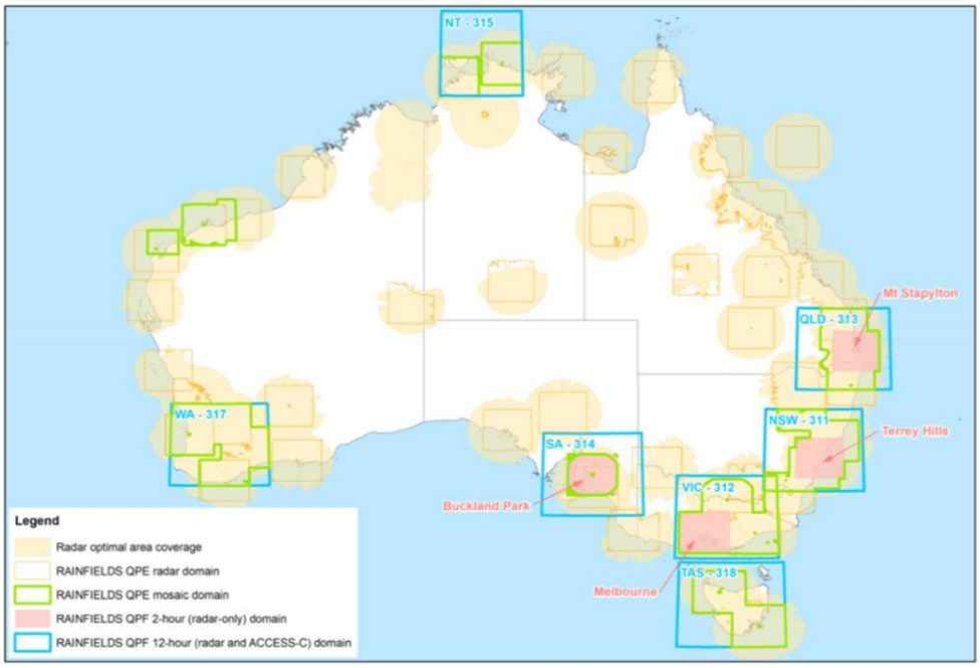



**FIGURE 7-5 DISTRIBUTION OF BOM PRODUCTS**

### 7.3.1 Long Lead Forecast Products

Long lead forecast products provide the necessary planning times for emergency management areas of Council to prepare for large scale flood events many days in advance. Whilst the level accuracy is low, and no general action should be taken this far in advance, it does provide high level estimates, scale of event and the scale of response potential required considering worst case scenarios. This can initiate early works on resourcing and ensuring process is in place (i.e. preparing evacuation centres as an example)

#### 7.3.1.1 ADFD

The Australian Digital Forecast Database (ADFD) provides a wide variety of forecasting products (wind, rain, temperature etc) and the rain forecast data is available in a 1.5-kilometre gridded netCDF output through FTP. In addition to this, a variety of rain products are available including 75%, 50%, 25% and 10% chance of rainfall ensembles. These are updated 1 or 3 hourly and 7 day forecast lead.

The ADFD product is a useful long lead forecast lead tool that can be used to provide a broad understanding of ex tropical cyclone impacts in advance (as one example). Whilst accuracy with these type of events and longer lead times is obviously questionable, the product does provide the ability to provide advance warning to emergency services, the community and prepare for best and worst case scenarios.

An annual subscription of $3,260 is payable for this data.

### 7.3.2 Short Term Ensemble Precipitation Forecasts

Short Term Ensemble Precipiation System (STEPS) provides shorter lead time, but more accurate forecasts to inform flood forecasting systems. The STEPS products are described below

#### 7.3.2.1 Nowcasting

Nowcasting is provided for a lead 2 hour forecast, updated every 5 minutes at a 500m spatial resolution (grid size). The product is an effective flash flooding tool, critical for more accurate shorter forecasts in flash flooding scenarios

#### 7.3.2.2 Quantitative Precipitation Forecast

The QPF forecast data as we understand it will forecast out to 12 hours, updated every 10 minutes and at a spatial resolution of 1km girds. The product is available as a mix of combinations but generally would be best packaged with the Access C models and nowcasting (i.e. the nowcast model would utilise the first 2 hours of the forecast with the Access – C model providing the next 10 hours as a packaged forecast).

Longer-term forecasts which use automated radar nowcasting blended with high-resolution rainfall forecasts from the Bureau's Numerical Weather Prediction model (ACCESS-C) is a powerful forecast product on a fine spatial resolution and updated frequently. This combination alongside the ability to merge products presents a solution to forecasting on riverine and flash flooding scenarios.

This merged forecast product could be considered the most useful, powerful and effective product for a wide range of forecasting needs.

### 7.3.3 Real Time Products

Whilst predictive forecast products provide the necessary lead times to better react to flooding, they are based on methods and algorithms that can produce very low levels of accuracy and scenario based probabilistic forecasts. Real time products remove some of these issues of accuracy as they are based on actual rainfall intensities but do however have the disadvantage of much less warning time available for flood peaks.

The following information provides an overview of the real time radar rainfall products available from BoM.

#### 7.3.3.1 Radar Rainfall

Raw rainfields radar rainfall data is essentially electronically populated data sourced from radar. Some quality control is undertaken by BoM such as reflectivity and rainfall conversion checks and is based on a 1km grid resolution. This does not include any calibration to rainfall gauges to our knowledge.

An annual subscription of $1,690 is payable for this data. This data could be considered highly desirable for forecasting and improves rainfall distribution spatially across flood models. There are some concerns with accuracy of raw radar data with this product however the pros outweigh the cons with the spatial distribution.

#### 7.3.3.2 Calibrated and Merged Radar Rainfall

This essentially extends the QA/QC process of the raw radar data and calibrates it to automated rainfall stations. The process uses bias correcting from real time rain gauge observations. With merged radar rainfall this process utilises gauge data more so by blending both the gauge observations and calibrated radar rainfall further. The full process of correction and adjustment is described below by BoM

http://www.bom.gov.au/australia/radar/about/calculating_rainfall_accumulations.shtml

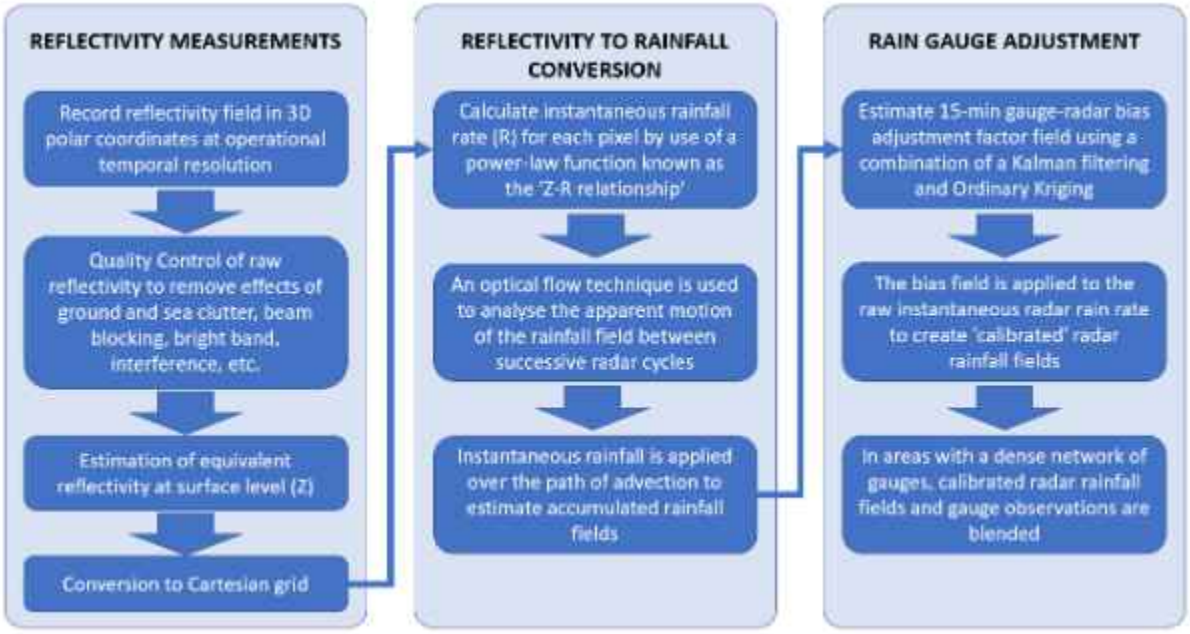



FIGURE 7-6 RADAR RAINFALL ADJUSTMENTS

### 7.3.4 AWRA-L

The AWRA-L information provides the necessary data to predict soil moisture and thus rainfall losses which is an important consideration in live hydrologic/hydraulic models. A combination of the BoM Australian Water Resources Assessment Landscape Model (AWRA-L) soil moisture loss model, previous calibration data and a range of applicable criteria will be utilised to automate loss selection. Further details on the AWRA-L model are provided here:

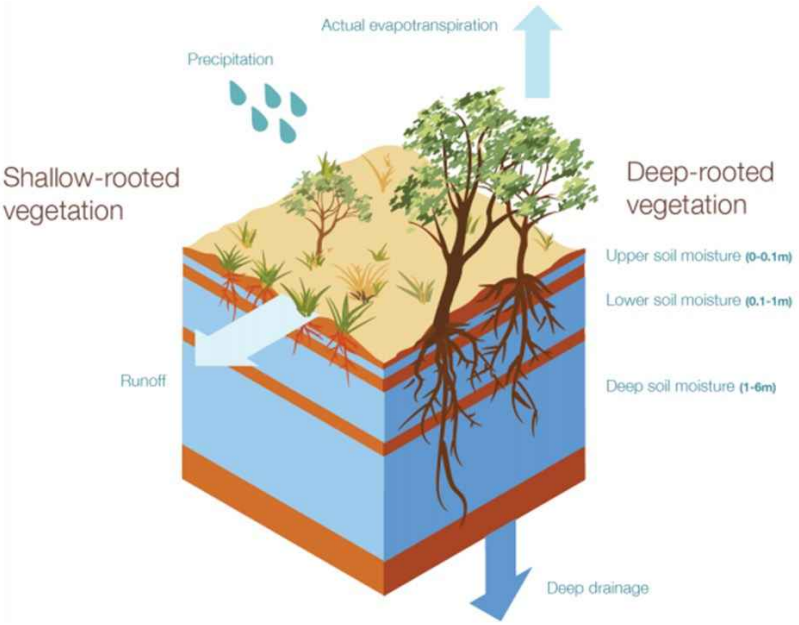



**FIGURE 7-7 AWRA-L PROCESS**

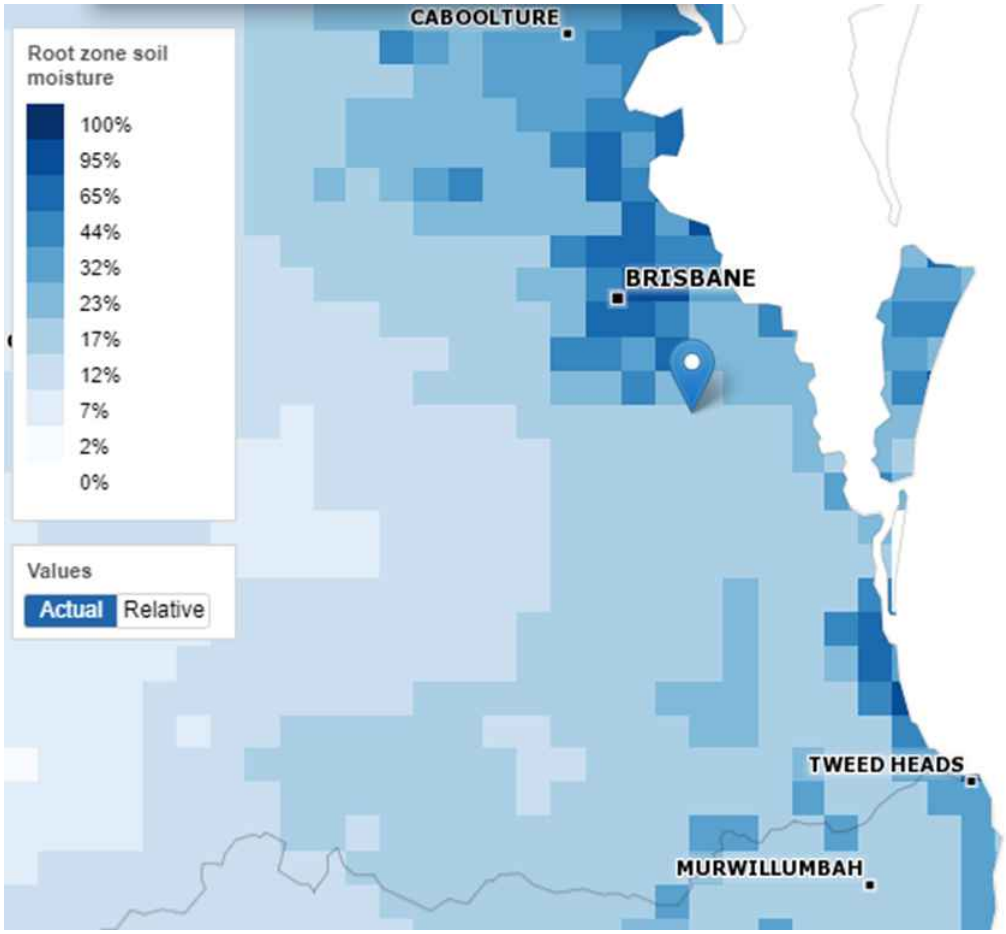



**FIGURE 7-8 AWRA-L SPATIAL DISTRIBUTION**

AWRA-L models hydrological processes for:

- Partitioning of rainfall between interception losses and net rainfall
- Saturation excess overland flow (depending on groundwater store saturation level)
- Infiltration and Hortonian (infiltration excess) overland flow
- Saturation, interflow, drainage and evaporation from soil layers
- Baseflow, evaporation and transpiration from the groundwater store with the soil layers modelled separately for 2 (shallow and deep rooted) hydrological response units. In addition, the following vegetation processes are described
- Transpiration, as a function of maximum root water uptake and optimum transpiration rate; The Bureau's Operational AWRA-L Model 5
- Vegetation cover adjustment, as a function of the balance between the theoretical optimum and the actual transpiration, and at a rate corresponding to vegetation cover type.

Source: *The Bureau's Operational AWRA Landscape (AWRA-L) Model Technical Description of AWRA-L Version 5*

Essentially the AWRA-L model provides automated estimates of rainfall losses that can be utilised within flood forecasting systems. Calibration of these values is also possible but would require installation of soil moisture probes.

### 7.3.5 Meteorological Product Selection

A well developed and utilised flood forecasting system uses a combination of all the predictive and real time products to provide the necessary lead times and then transitioning into accurate forecasts. A balance of both of these desires is necessary to plan and respond to flood events

## 7.4 Flood Intelligence

Flood intelligence information is a product of the flood forecasting systems. Once forecasts are completed, the predictive flood levels are then utilised with other GIS data sets (road low points, floor levels etc) and a multitude of spatial intelligence can be developed and published for use by Emergency Managers. With predictive forecasting, this information can be provided in a timely manner and well before peak levels are reached and even before rain begins falling if desired. The electronic GIS information developed in the LFMP can be used and adapted within flood forecasting systems.

This is not an exhaustive list, but flood forecasting and flood intelligence systems can provide the following benefit and outputs:

- Systems can be set to alert of critical locations (house inundation, bridges etc) ahead of time
- Systems can automatically produce lists of properties impacted ahead of time
- Triggers can be set on structures (bridges). I.e. just below soffit or over road ahead of time. With detailed development, indications and forecasts can be provided on when to re-open roads.
- Systems can forecast floods to varying lead times and resultant accuracies. Products can forecast 7 days in advance or down to 5 minute updates with products such as radar rainfall.
- Methods and process can be put in place to utilise a variety of datasets to activate certain emergency management procedures (preparing evac centres, closing roads ahead of time, warning and evacuating residents). This process and capability need detail investigation and should become part of a flood operating manual or standard operating procedures coupled with a total flood warning system approach

- Infiltration probes can be connected to rain gauges to provide an understand of catchment rainfall losses. This is extremely important in flash flood scenarios where there is no available time to "calibrate" forecast hydrographs against flood gauges. Infiltration/moisture probes can also be used to validate spatially varied data available from the BOM (Australian Landscape Water Balance data)
- A variety of sensitivity forecasts can be undertaken to highlight worst case and likely scenarios. As an example, simple ADFD forecasts can utilise 10%, 25%, 50% and 75% chance of rainfall amounts and simulate what this could look like in flood extents. Packaged surface profiles can be developed ahead of time to gauge impact and possible resourcing required
- Future benefit and application of forecasting is advancing fast and allowing more effective emergency management procedures to be put in place.

It is important to take a total flood warning systems approach to flood forecasting and other techniques. As one example flood gauges should no longer be used as they have in the past and this also affects where and how they should be installed and configured across the catchment. Whilst flood gauges are not obsolete, the need and focus for gauges should and needs to change in the industry. Council have an opportunity to become up to date with this type of integrated thinking.


**FIGURE 7-9 FLOOD INTELLIGENCE DEPTH ABOVE FLOOR**

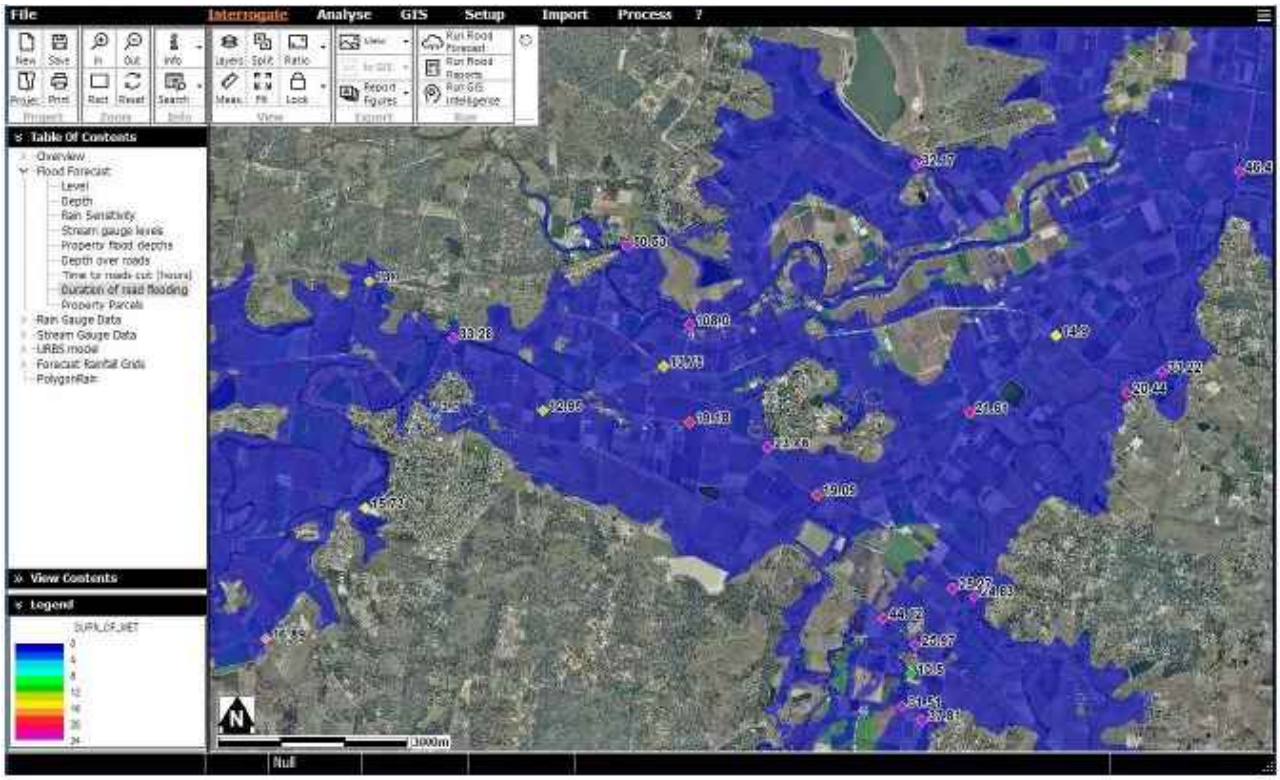



FIGURE 7-10 FLOOD INTELLIGENCE DURATION OF ROAD INUNDATION

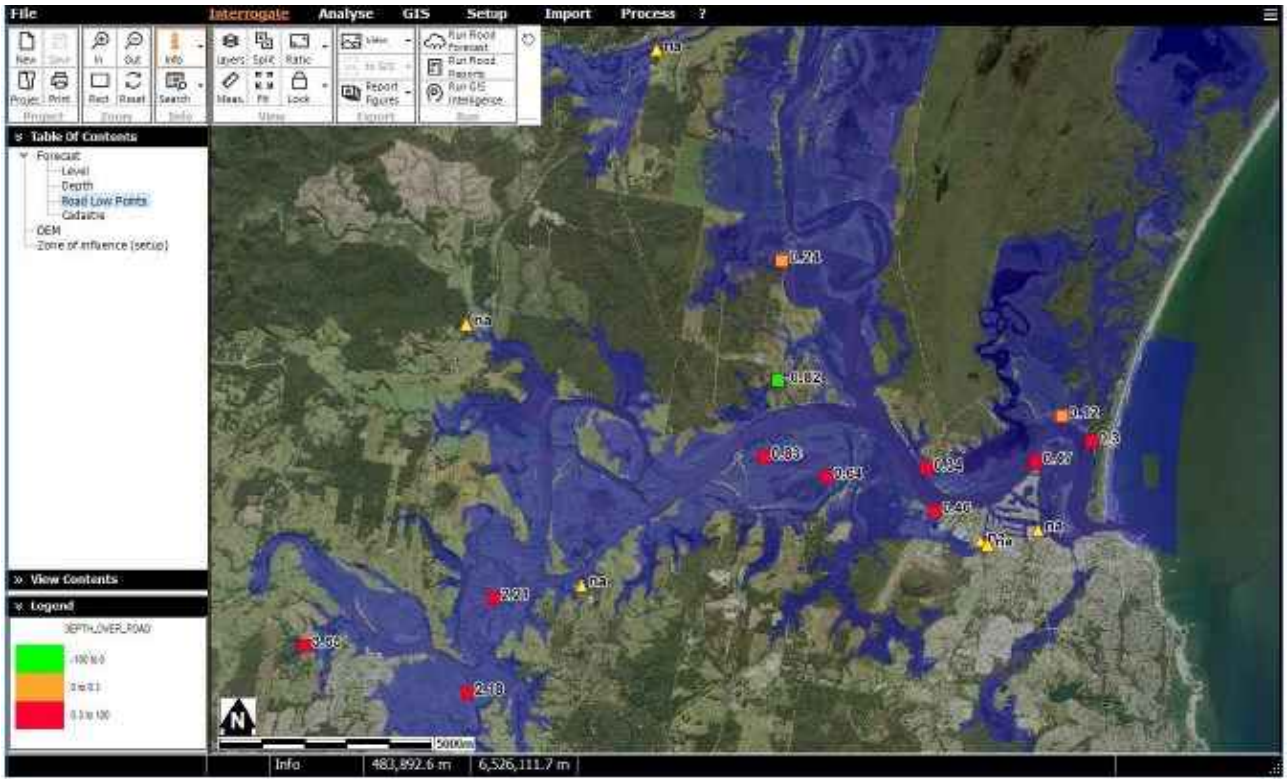



FIGURE 7-11 FLOOD INTELLIGENCE DEPTH OF ROAD FLOODING

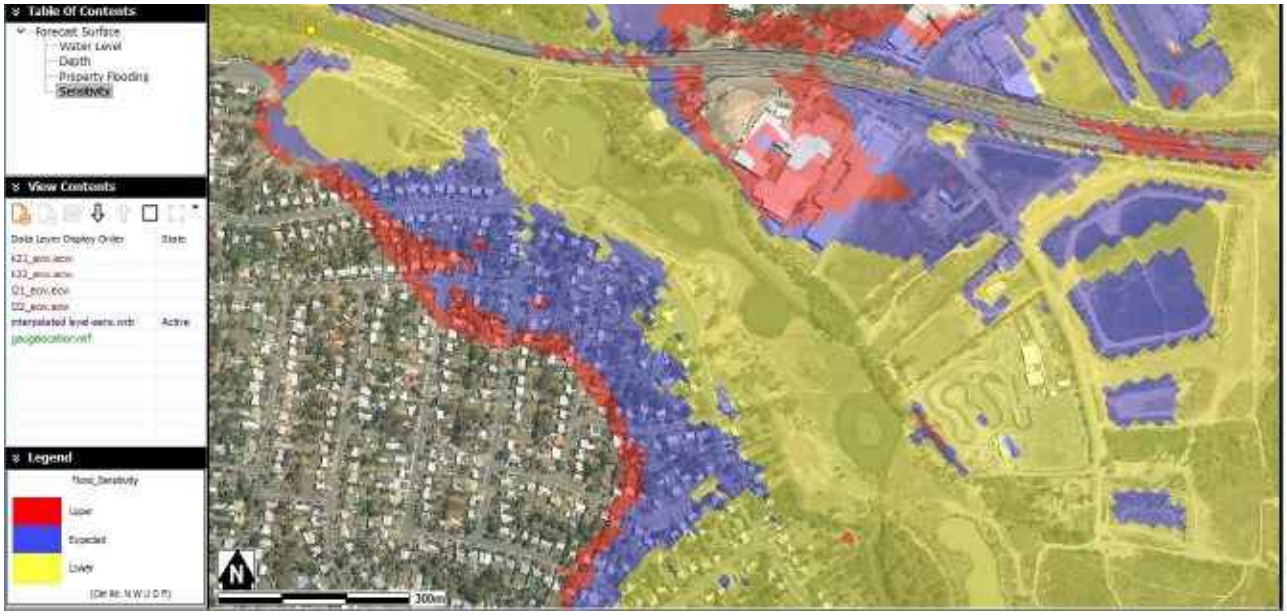



FIGURE 7-12 FLOOD INTELLIGENCE SCENARIO BASED OUTPUTS

## 7.5 Rain and Water Level Triggers

Following on from the process used to determine the flash flooding risk associated with the different catchments, an output from the LFMP was to provide some high-level mechanisms to provide flood intelligence to Council for all of the catchments.

With the installation of a rain and water level gauge at the designated location identified in the trigger maps, this system could be utilised to fulfill some of the requirements determined for low and medium risk catchments. An example trigger maps is shown in Figure 7-13 Whilst it is always desirable to operate a full flood forecasting system in risk catchments that utilise live forecast rainfall and/or rain and river gauges to allow spatial and temporal variation, this generally isn't possible considering funding and in particular Council resources during flood events. In addition to this, the risk associated with low population bases and generally low risk overall provides the avenue to utilise a less sophisticated system to align with the BoM recommendations.

### 7.5.1 Low and Medium Risk System Methodology

The following process was used to determine the overall risk of flooding in the catchment and the methods utilised to build the system:

- Each LFMP area has been assessed for overall flood risk using multiple flood risk factors
- The assessment incorporated a review of the available flood study information across a multiple magnitude flood events. Assessment also incorporated exposure, hazards, vulnerability and a range of other factors contributing to overall flood risk.
- As generally no existing gauges were available in the townships (or not within a suitable location), key reference points were selected in each area. Generally, these reference points were bridge decks or culvert crossings that could be converted into water level and rainfall gauges in the future if desired to allow monitoring of weather and allow easier translation of the data
- The flood events and surfaces (Q1 to PMF) were utilised to provide relatable rainfall amounts, durations and resultant water levels at the reference point.
- The information was displayed with this information as well as a flood surface for each combination

- A range of flood surface outputs were produced for each of the locations to represent magnitudes of possible flooding.

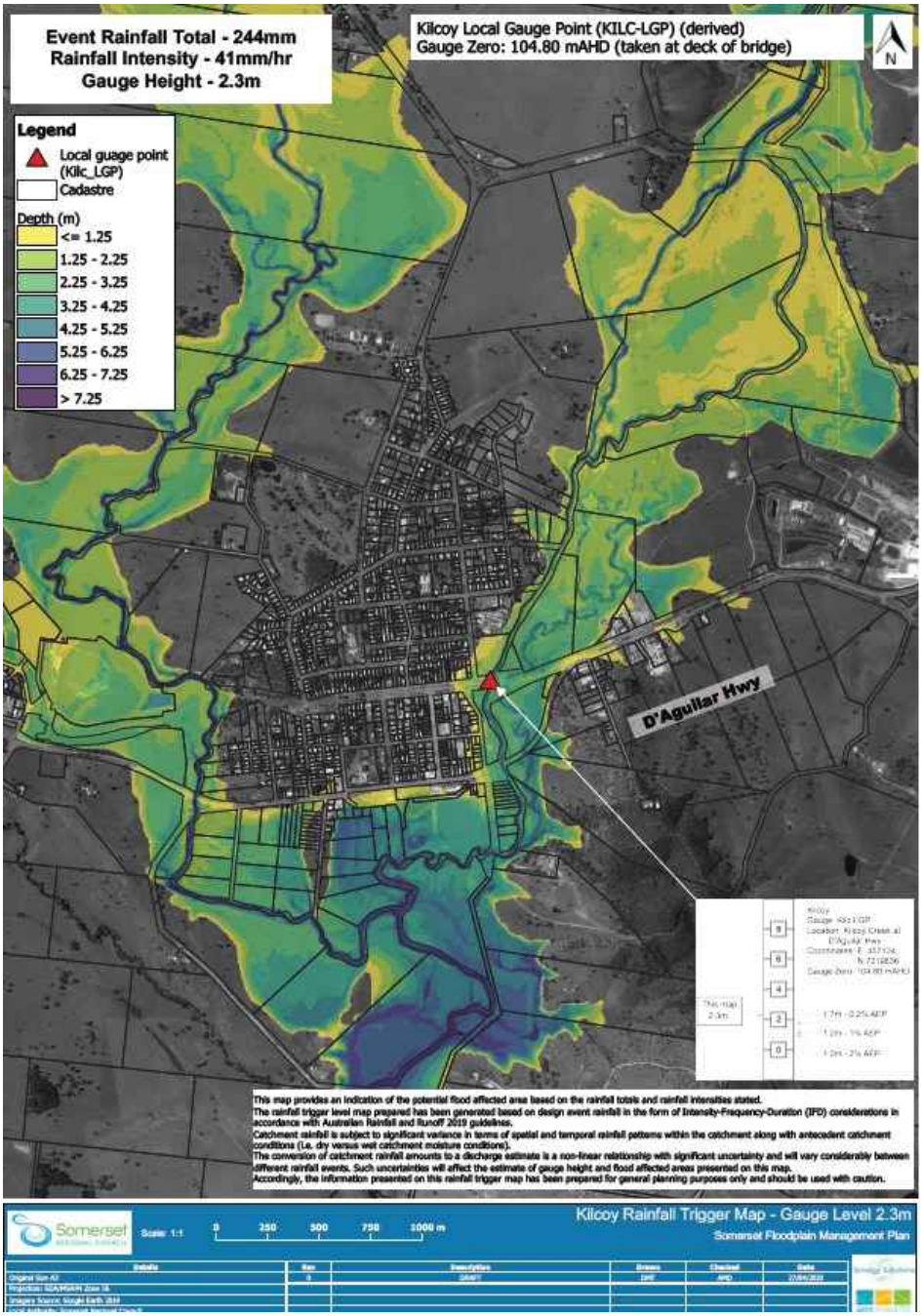



FIGURE 7-13 EXAMPLE FLOOD TRIGGER MAPPING IN KILCOY

## 7.6 Flood Classifications

### 7.6.1 Overview

Flood classifications for stream gauges are a critical element of planning and for flood response for multiple agencies not just Council. Flood classifications can and are used for the following purposes:

- The community may use flood classifications as a method to gauge the severity of the flood and also relate previous historical floods to this reference.
- Council may use flood classifications in a similar process to understand magnitudes and consequence of flooding by applying and utilising the classification impact stated below.
- The BoM are generally the primary users of flood classifications. Flood classifications are utilised by the BoM to communicate the impact through these classifications to the community (through the BoM website) and the BoM use classifications as a measure to gauge the necessary resource required for their flood operations centre.

Local Government authorities are responsible for setting these classifications which are then ingested and utilised by the BoM for this purpose. The SFMP also provides guidance as a recommendation as follows:

*It is recommended that councils use findings from QRA's recent review of the flood warning network to identify gauges in their system which may require updated classification levels (minor, moderate, major).*

### 7.6.2 Classification Definitions

The LFMP for each township has assessed the existing flood classifications and utilised the SFMP guidance and the document "Step by Step Guide to Setting Flood Classifications – Practical Guidance for Queensland Local Governments" and the outputs of the LFMP and modelling to redefine flood classifications where possible. The process defines the flood classification triggers and what triggers each classification as below:

MINOR - Causes inconvenience. Low-lying areas next to watercourses are inundated. Minor roads may be closed, and low-level bridges submerged. In urban areas inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas removal of stock and equipment may be required.

MODERATE - In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood affected areas may be required. In rural areas removal of stock is required.

MAJOR - In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood affected areas may be required. Utility services may be impacted.

### 7.6.3 Methodology

A GIS process was undertaken, and third party software utilised in the following manner to determine revised or new flood classifications:

- The BoM descriptions for each classification was used to determine measurable impact.
- The main focus point was surrounding the gauge itself (generally within an area with higher numbers of houses/infrastructure).
- Flood profiles from all storm events were used to increment flood levels every 0.1m. As the level increased this level was related to a particular storm event and flood profile to ensure higher and lower magnitude storms were differentiated

- The profile was used to extend the flood extents to an extent outside of the main focus area. Engineering judgement was used to extend into areas that would have a similar profile and relative magnitude event overall (i.e. where a new tributary entered, or significant floodplain inundation change or hydraulic grade line difference occurred)
- More emphasis and zones of influence were placed around the gauge and as distance increased and confidence decreased, less emphasis was placed on results.
- The road low point database and property floor level database was utilised to determine any impacts. I.e. where a floor level or bridge was breached, this informed a classification trigger. Manual sanity checks were also undertaken at each classification trigger.
- The trigger levels were documented and compared with historical classifications.

Caution should be applied in utilising these new classifications for the following reasons:

- The data utilised is not overly accurate (i.e. floor levels are subject to the same inaccuracies as previously highlighted in other work packages)
- Bridge and floor level triggers are limited to the accuracy of flood models
- Most importantly, stakeholders and the community are likely accustomed to existing flood classifications. Any change to classifications could be confusing (i.e. if the community were used to a major classification at a particular area and this changes to a moderate, their response may be less enthused)
- Flood forecasting and intelligence systems may provide more accurate, reliable and informative outputs for the community rather than flood classifications. This is discussed in subsequent sections.

For these reasons, it is recommended that any change to flood classifications is accompanied by an extensive community consultation, education and awareness campaign coupled with other outcomes of the LFMP. Council should consider the ramifications of changing classifications without this level of engagement with the community.

### 7.6.4 Impact Regions

The impact regions for each gauge are the areas where impacts were reviewed to determine the flood classification levels and are presented in Figure 7-15 and Figure 7-16. Impact regions were estimated based on the adopted gauge being able to provide accurate and timely flood inundation information for the immediate area, an example is shown in Figure 7-15, which shows where an impact region may be placed. In summary the impact regions are:

- Limited to upstream and downstream confluences, as the gauge cannot accurately estimate flooding which is occurring within these waterways without additional information; and
- Have due consideration of distances to the next upstream or downstream gauge.

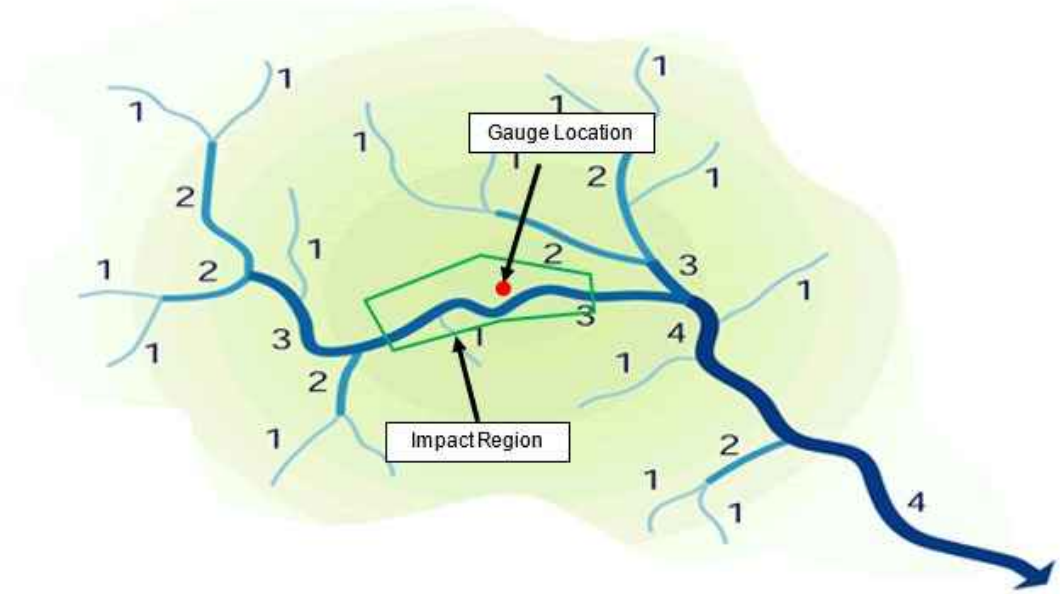



FIGURE 7-14 EXAMPLE OF AN IMPACT REGION (SHOWN WITH A GREEN POLYGON)

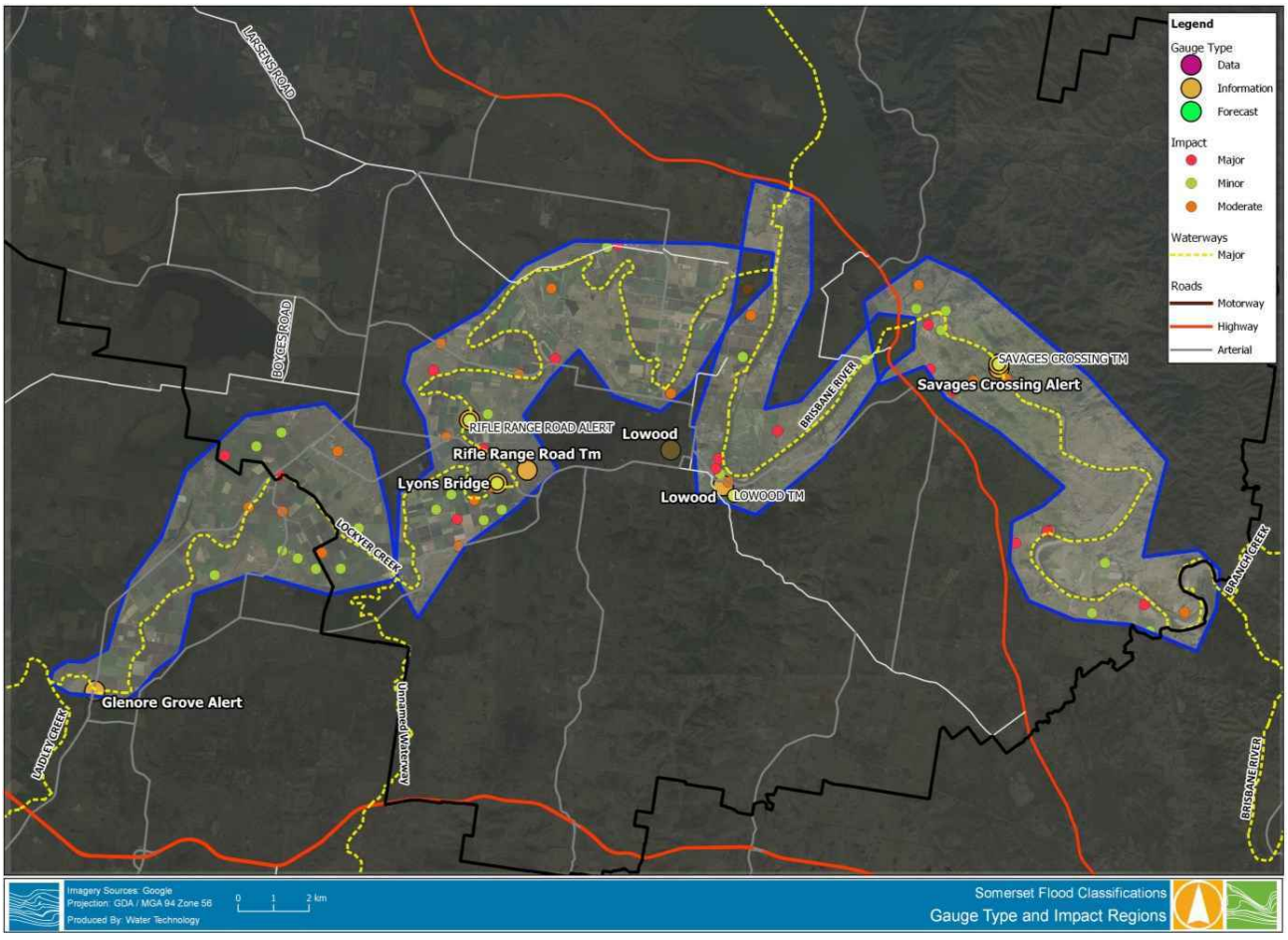



FIGURE 7-15 GAUGE CLASSIFICATIONS – IMPACT REGIONS FOR BRISBANE RIVER AND LOCKYER CREEK

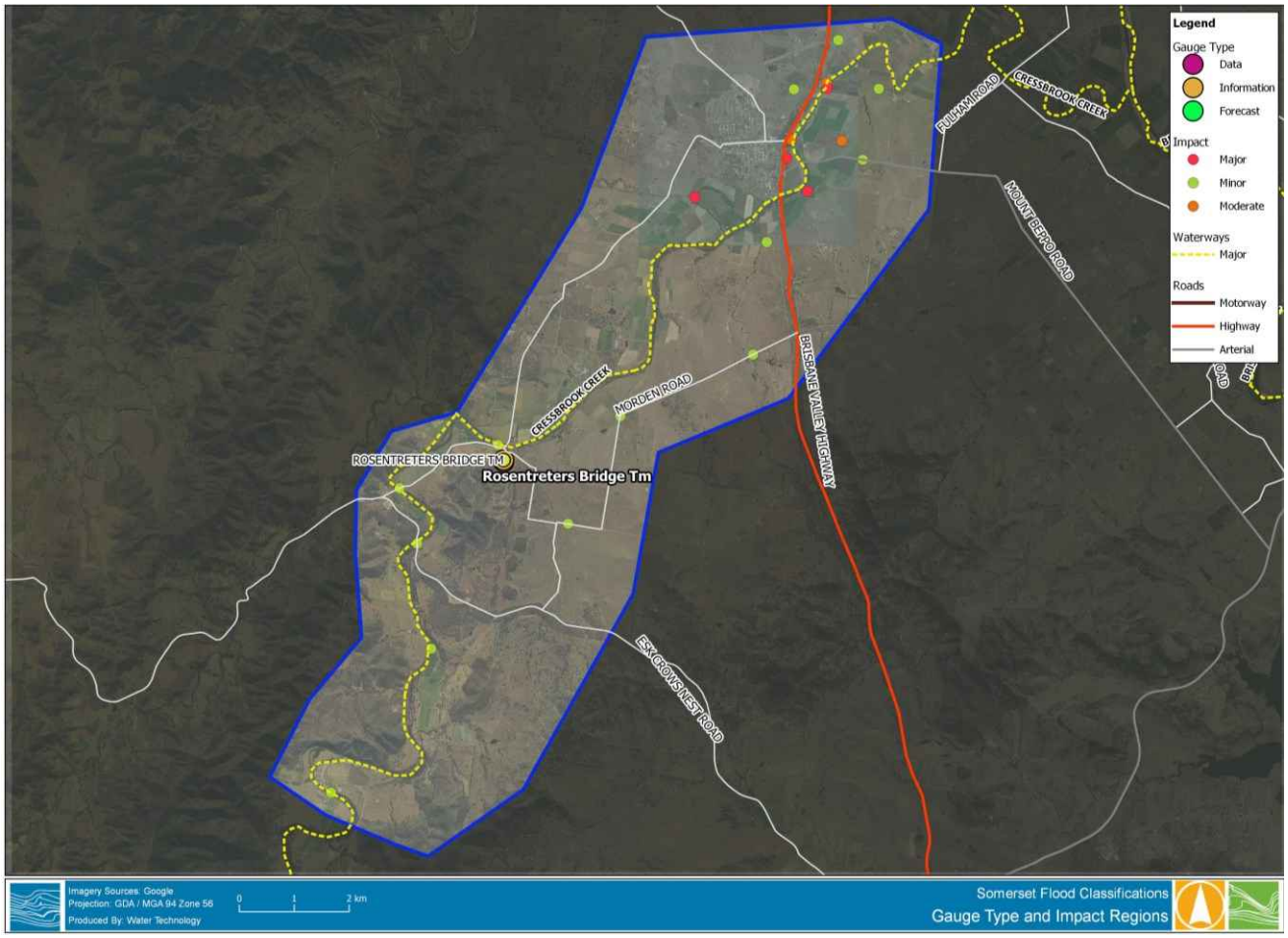



FIGURE 7-16 GAUGE CLASSIFICATION – IMPACT REGIONS FOR CRESSBROOK CREEK

### 7.6.5 Existing Flood Classifications

Existing gauge classifications for Somerset are listed in Table 7-2.

TABLE 7-2 EXISTING SOMERSET COUNCIL FLOOD CLASSIFICATIONS

| Gauge | Authority | Minor (Local) | Moderate (Local) | Major (Local) | Gauge Zero (AHD) | Minor (AHD) | Moderate (AHD) | Major (AHD) |
|---|---|---|---|---|---|---|---|---|
| Rosentreters Bridge | SEQ Water | 3 | 4 | 5 | 102.05 | 105.05 | 106.05 | 107.05 |
| Lyons Bridge | BoM/SEQ Water | 10 | 11.5 | 13 | 48.53 | 58.53 | 60.03 | 61.53 |
| Rifle Range Road | SEQ Water | 10.5 | 12 | 13.5 | 44.28 | 54.78 | 56.28 | 57.78 |
| Lowood* | BoM/SEQ Water | 8 | 15 | 20 | 22.74 | | | |

| Gauge | Authority | Minor (Local) | Moderate (Local) | Major (Local) | Gauge Zero (AHD) | Minor (AHD) | Moderate (AHD) | Major (AHD) |
|---|---|---|---|---|---|---|---|---|
| Savages Crossing | SEQ/Water | 9 | 16 | 21 | 18.48 | 27.48 | 34.48 | 39.48 |

*Level is noted as State Level not AHD

### 7.6.6 Revised Classifications

The revised gauge classifications for Somerset, along with the proposed difference in classification for minor moderate and major flood events are shown in Table 7-3. For the full flood impact analysis of each gauge location, noting trigger levels, expected height at the location of impact and at the site of the gauge, refer to Appendix J.

As per step 4 of the BoM guidance note, developing community education and awareness tools should be considered when updated flood classification levels. The Communication Toolkit and messaging emerging from the QRA with regard to flood, flood warnings, flood classification, a suite of communications and awareness tools may be available to Council to accompany the proposed amendments.

**TABLE 7-3 PROPOSED GAUGE CLASSIFICATIONS**

| Gauge Location | Current Classifications (mAHD) | | | Proposed Classifications (rounded to nearest 0.5mAHD) | | | Proposed Classification Difference | | |
|---|---|---|---|---|---|---|---|---|---|
| | Minor | Moderate | Major | Minor | Moderate | Major | Minor | Moderate | Major |
| Glenore Grove | 8 | 11 | 13 | 12.5 | 14.0 | 14.5 | 4.5 | 3.0 | 1.5 |
| Lyons Bridge | 10 | 11.5 | 13 | 12.5 | 15.5 | 16.0 | 2.5 | 4.0 | 3.0 |
| Rifle Range | 10.5 | 12 | 13.5 | 12.0 | 15.5 | 16.0 | 1.5 | 3.5 | 2.5 |
| Lowood | 8.6 | 15.9 | 21.2 | 13.5 | 18.0 | 22.5 | 4.9 | 2.1 | 1.2 |
| Savages | 9 | 16 | 21 | 9.5 | 15.5 | 18.0 | 0.5 | -0.5 | -3.0 |
| | | | | | | | Council may consider keeping existing **Minor** and **Moderate** classifications | | |
| Rosentreter | 3 | 4 | 5 | 4.0 | 5.0 | 6.0 | 1.0 | 1.0 | 1.0 |

## 7.7 Emergency Alert Polygons

This section draws linkages to the flood classification review detailed in section 7.6. The analysis of the flood impacts for each of the flood forecasted locations have been considered to provide the necessary spatial information for Council to update their emergency alert protocols and areas.

### 7.7.1 Emergency Alert Overview

A short overview is extracted from *Queensland Emergency Alert Manual, 2018:*

> *Emergency Alert (EA) is a national telephone warning and alert system used to send voice messages to landlines and text messages to mobile phones within a defined spatial area about a likely disaster and/or emergency situation. EA relies on the telecommunication networks to send warning messages to mobile telephones. Text messages can be sent to the last known location of handsets at the time of the disaster or emergency situation and includes visitors and travellers. The registered service address and telephone numbers comes from the Integrated Public Number Database (IPND) which contains all public and private phone numbers in Australia. The IPND is a Telstra maintained database which contains information related to all listed and unlisted public telephone numbers in Australia, regardless of service provider. Interfacing with the IPND is the Location Based Number Store (LBNS) which draws telephone numbers and geo-coded information located within the polygon for an EA Campaign. Each use of the EA system is known as an EA Campaign. The management and administration of EA in Queensland is the responsibility of QFES. The State supports local government, where possible, to draft messages and prepare maps of potential warning and alert areas to ensure the timely dissemination of EA Campaigns. All agencies using EA are to ensure warnings are consistent and complement any community alert messaging systems operated by local councils.*

Further information regarding the Emergency Alert background, protocol and process can be found here:

https://www.disaster.qld.gov.au/dmg/st/Documents/M1174-Queensland-Emergency-Alert-Manual.pdf

### 7.7.2 Emergency Alert Methodology

The flood classifications review presents an adequate way of referencing gauge level heights for areas located around gauges based upon common flood characteristics. This is determined using the hydraulic water surface level to understand impacts within the vicinity of the gauge. The flood classifications impact regions were utilised to inform suggested Emergency Alert polygons using the following principles:

- As the flood classification impact areas only extend to major flooding, the same spatial polygons were extended using the gauge reference area to the PMF extent,
- The polygons were simplified where possible acknowledging the requirement to minimise vertices in the spatial databases; and
- As the Queensland Emergency Alert Manual explains, the polygon shapes are as simple as possible.

### 7.7.3 Emergency Alert Areas and Polygons

The following mapping shows the example suggested QFES emergency alert polygons for Council's consideration. These are linked to the impact analysis of the existing forecast and information gauge locations on Brisbane River, Lockyer Creek and Cressbrook Creek.

Detailed mapping for all localities are provided in Appendix K.

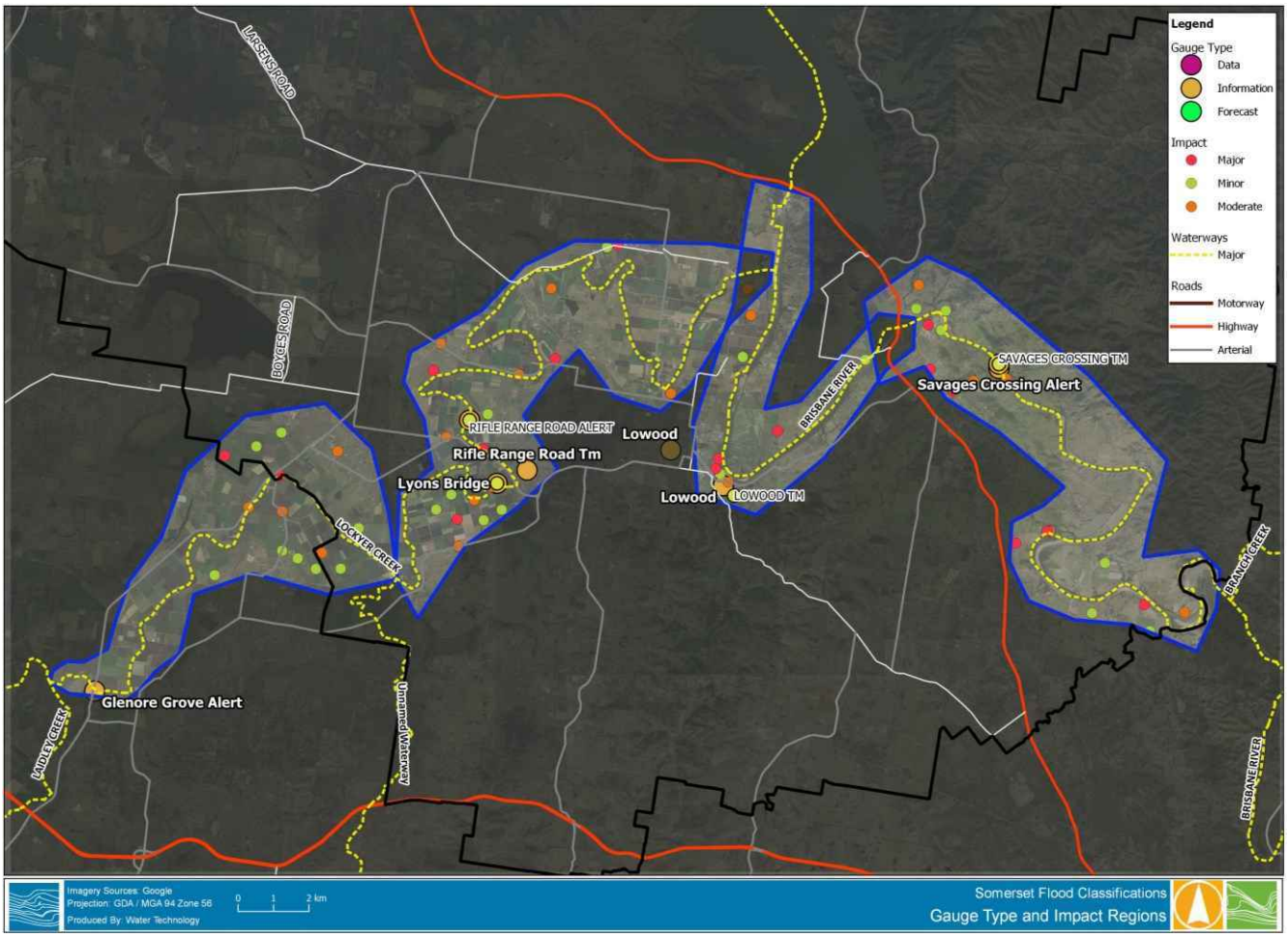



**FIGURE 7-17 OVERVIEW OF PROPOSED EMERGENCY ALERT POLYGONS FOR BRISBANE RIVER AND LOCKYER CREEK**

## 7.8 Community Awareness and Resilience

As noted in Section 7.1 the LFMP's have recommended further work to be carried out to address community awareness and resilience (CAR) across the different Somerset localities in order to assist with the provision of effective flood warning and intelligence to the community to enable members to voluntarily evacuate. This section therefore outlines a possible work package that could be undertaken to develop further beyond the recommendations and outputs of this work which would align with additional recommendations from the Brisbane River Strategic Floodplain Management Plan (SFMP).

CAR is one of the most critical aspects of floodplain management, and can be one of the most challenging, however it can be addressed through the development of a framework of communication and engagement activities for Council to implement. CAR can be split into four key principles, which have been presented in the Queensland Prevention, Preparedness, Response and Recovery Disaster Management Guidelines, (replacing *Prevention* with *Awareness*), as shown in Figure 7-18. Flood awareness, preparedness, response, and recovery are key CAR phases to help focus awareness, education, and engagement activities.


**FIGURE 7-18 MODIFICATION OF THE PPRR MODEL OUTLINING CAR PRINCIPLES**

A high-level overview of the approach is outlined below, that could be developed for implementation in the Somerset LGA to provide a practical approach for communication, engagement, and/or disaster management practitioners to use. A summary of which is presented in Figure 7-20.

**Gaining information to provide CAR content:**

- Prioritise suburbs based on combined vulnerability / flood risk exposure (using the vulnerability analysis that has been completed as part of this work package).
- As a key aspect of being resilient is the ability to 'bounce back' from disaster, carefully considering community vulnerability through a data informed approach is important to enhance collective resilience. Therefore, identification of the primary vulnerability driver which can be used to help to structure CAR activities for the specific township is important to ensure they are appropriately targeted and effectively delivered. A visualisation of this is shown in Figure 7-19.
  - Awareness vulnerability includes residents new to the area and those without internet access;

- Physical vulnerability can include those with households of under 5 years of age, over 65 years of ages, long person households, and those that require assistance;
- Mobility vulnerability can include those without vehicle access, one parent families and large households with more than 5 members; and
- Socio-economic vulnerability can include those who are in rental accommodation, have a low household income, or those who are unemployed.

- Apply considerations to CAR activities through various sources of engagement, which should be considered as a circular process rather than linear. The below bullets provide brief information on the 5 different engagement types, as identified by The Australian Institute of Disaster Resilience's (AIDR) Handbook 6 [8] - Community Engagement Model for Emergency Management.
  - Information
  - Participation
  - Consultation
  - Collaboration
  - Empowerment


FIGURE 7-19 VULNERABILITY DRIVERS AND CAR PRINCIPLES

**Mode of CAR implementation:**

- Mode is the process of then selecting the relevant communication and engagement tools based on the vulnerability driver, CAR principle and the corresponding audience groups. CAR activities can be focused on providing flood education, awareness and engagement opportunities. Each mode is linked to one of the five relevant NSDR classification listed below. Examples of different modes for each classification is identified in Figure 7-19.
  - Inform
  - Consult
  - Involve
  - Collaborate
  - Process

[8] Australian Institute of Disaster Resilience 2013, *National Strategy for Disaster Resilience: Community Engagement Framework – Handbook 6.* (online) Available: https://knowledge.aidr.org.au/media/1761/handbook-6-national-strategy-for-disaster-resilience-kh-final.pdf

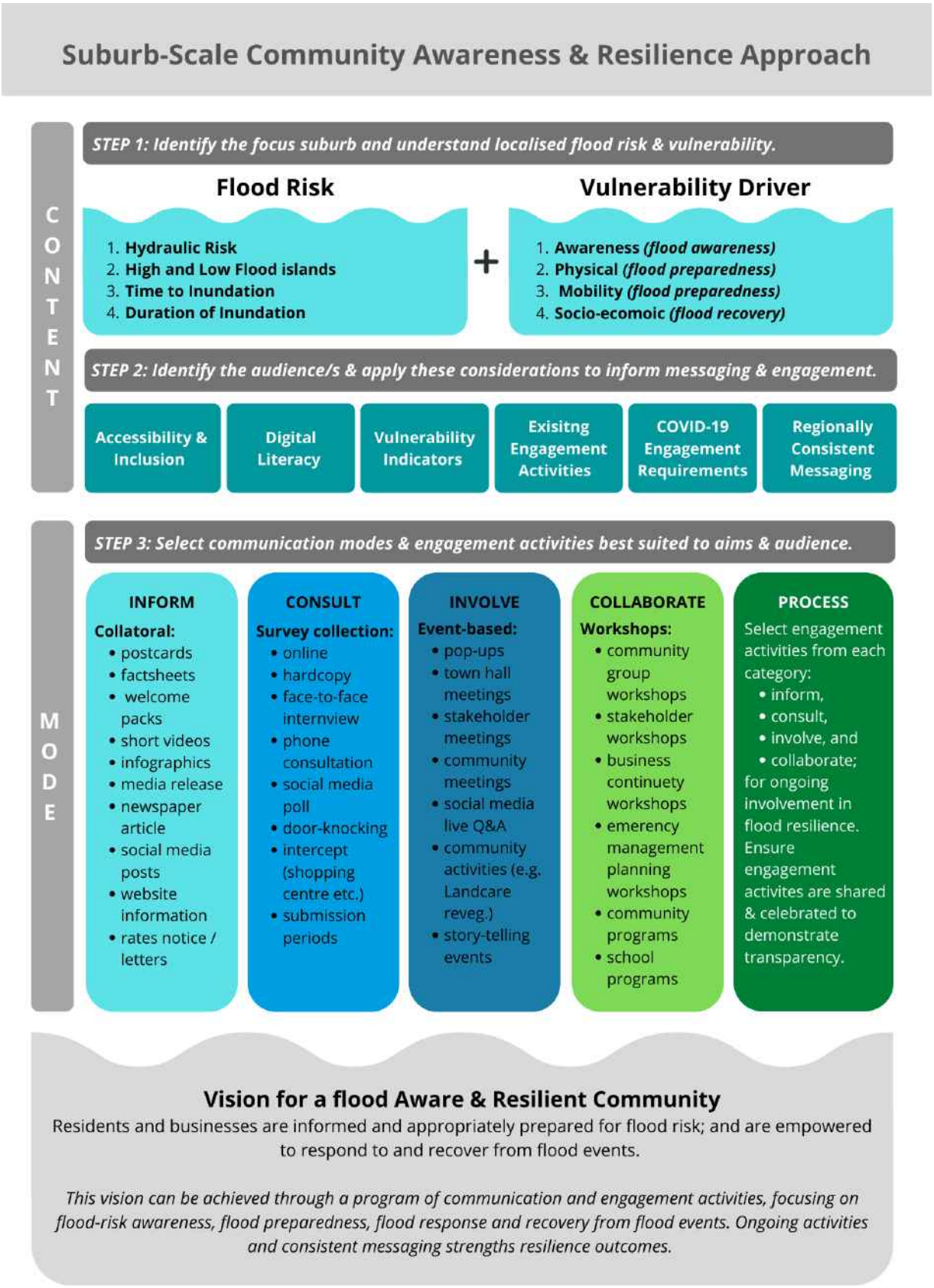



**FIGURE 7-20 STEP PROCESS FOR BUILDING FLOOD AWARENESS AND RESILIENCE**

# 8 RECOMMENDATIONS AND IMPLEMENTATION

## 8.1 Summary of Recommendations

This section provides a summary of the recommendations that have been referred to in this report, and in the individual LFMP's.

### 8.1.1 Flood Mitigation Responses

To address the flood risk by each of the localities and their community, several mitigation options were explored. Detailed assessments of options considered practical, including benefit cost analysis (BCR) and a multicriteria assessment were undertaken for Council's consideration. As a combined outcome, the LFMP's have recommended that no structural mitigation options, such as levee construction, should be considered for further assessment across any of the Somerset localities, due low BCR results that have been summarised above in Table 5-7.

However, it is recommended that voluntary house purchase and building resilient materials can be offered to a number of the localities for Council to consider.

**Voluntary house purchase is recommended for:**

- Esk –at 3 properties
- Minden – at 2 properties
- Fernvale – at 3 properties
- Other areas across the BRCFS study area – 15 properties

**Building resilient materials is recommended for:**

- Esk – at 7 properties
- Minden – at 5 properties
- Other areas across the BRCFS study area – at 9 properties

For both voluntary house purchase and building resilient materials, it is recognised that the implementation of two possible programs based on the hazard and damages-based prioritisation, may not be economically viable, and thus there are a number of further considerations. These have been explored in each individual LFMP and above in Section 5.4.7.

### 8.1.2 Emergency Management Responses

Effective floodplain management planning requires a vast array of consideration and implementation of different techniques and tools to reduce flood risk to a tolerable or acceptable level. Recommendations in relation to forecasting systems, flood intelligence, evacuation centre suitability and prioritisation has been provided for each of the LFMP's.

- Advanced flash flood forecasting systems have been recommended in localities where high risk has been identified. This is the case for Esk and Minden. The system would encompass utilising BoM meteorological products such as Australian Digital Forecast Database (ADFD), Quantitative Precipitation Forecast (QPF) and rain fields products to provide lead times for the Minden community; utilising the flood model constructed for this project to develop either a love hydrological or live hydraulic system to utilise the available products above; and installation of flood gauges in the area to supplement the system and provide potentially higher levels of accuracy with real time rainfall.

Recommendations have been made to several relocations or changes to the following evacuation centres:

- Esk
  - The Esk Showground in general is not a suitable location for an evacuation Centre. An alternative site is recommended further south (potentially around the Esk Country Golf Club). The centre could be used in minor floods, however the increased flood risk and time to respond to relocation should be noted.
  - The Somerset Civic Centre in general is not a suitable location for an evacuation Centre. An alternative site is recommended to service the main Esk township that is located outside of the major floodplain through the area. Towards the Esk Hospital along Highland Street would be a more appropriate location or anywhere west of the township.
- Lowood
  - An alternative informal evacuation centre could be located near the Lowood Police Station as a transfer mechanism should very rare flood events occur in the Lowood area.
- Minden
  - Evacuation centres in Minden should be formalised around high-risk areas of the catchment that have been identified.
- Fernvale
  - The Fernvale Showgrounds require close monitoring of flood warning and forecasted levels. The evacuation centre should only be used if necessary and in floods up to the 1 in 100 AEP event. In addition, if this centre is used as a staging centre, careful monitoring of flood levels will be required to ensure evacuees can be transferred to the Fernvale State School. Overall, it is recommended that an alternative evacuation site is sourced using the LFMP outputs for flooding purposes.
  - The Fernvale State School is generally a suitable evacuation site but must also be monitored for events in the 1 in 2000 AEP event where the location inundates, and hazards increase substantially.

In addition, Council should consider undertaking further work to produce a community and awareness resilience (CAR) strategy that can be used assist in the provision of effective flood warning and intelligence to the community to enable members to voluntarily evacuate. CAR strategies could therefore be used to help focus awareness, education, and engagement activities. As the LFMP's have been conducted with data in a point in time, continual monitoring and review is required. Refer to individual LFMP's for further specific recommendations and the Implementation Plan in section 0.

## 8.2 Implementation Plan

The Implementation Plan prioritises each action and recommendation, organised as high, medium and low priority. The following table can assist Council in implementing LFMP actions over time, as well as the allocation of budgets across each of the six localities in Somerset. Those actions relating to governance, monitoring, or reviewing should take a high priority in the planning of implementation, whilst those with longer term recommendations should be categorised as a lower priority. Definition of the reference and prioritisation categorisation are as follows:

- Reference
  - G – General Floodplain Management Actions and Governance
  - FM – Flood Mitigation
  - LUP – Land Use Planning
  - EM – Emergency Management
- Prioritisation
  - H – High priority
  - M – Medium priority, and
  - L – Low priority

TABLE 8-1 IMPLEMENTATION PRIORITISATION AND ACTION PRIORITISATION OVERVIEW

| Ref | Title | Description | Priority | Cost (if known) |
|---|---|---|---|---|
| G1 | LFMP Updates | As flood information is updated over time, the LFMP should be reviewed in the context of the current understanding of flood risk. Council may consider, due to the scale of the project, updating the LFMP on a 5 to 10-year timeline. | M | Unknown |
| G2 | Implementation of actions and recommendations from the LFMP | Council may consider the formation of an internal steering committee with representation across key departments such as strategic planning, infrastructure and disaster management.<br>This suggested governance structure can be put in place to implement the recommendations and actions of the LFMPs. | H | Nominal Cost |
| G3 | Review and implement Brisbane River SFMP Recommendations | Recommendations in the Current Flood Risk chapter of the SFMP are still relevant and should be pursued by the industry.<br>These include more accurate property information, refined datasets and more research into areas such as flood damages etc. | H | Unknown |
| G4 | Review the use of updated commercial building damages from the Brisbane River SFMP Recommendations | The SFMP uses value classes to define different commercial damages based on how valuable the building contents may be. Unfortunately, this information was not made available and an average value class was used. Council may consider updating the commercial value damages after the LFMP is complete. | L | Unknown |
| G5 | Updating Flood Levels with more accurate methods such as survey | Floor levels have a substantial impact on overall flood damages and can skew results significantly. As the LFMP relies on estimated floor levels and overall damages are very high overall, it is recommended that high risk areas are investigated in more detail. This should also extend to where detailed implementation of mitigation options is being undertaken to ensure accurate cost benefit assessments are realised. | M | Unknown |
| G6 | Consider implementation of a Community Awareness and Resilience (CAR) Implementation Plan | CAR is one of the most critical aspects of floodplain management, and can be one of the most challenging, however it can be addressed through the development of a framework of communication and engagement activities for Council to implement.<br>CAR activities can be focused on providing flood education, awareness, and engagement opportunities to the most at-risk and vulnerable communities across the Somerset LGA | H | TBC |
| FM1 | Implement a program of voluntary house purchase | Both programs of VHP and retrofitting building materials are recommended for Esk, Minden, Fernvale and across the BRCFS study area | H | $8.1million |
| FM2 | Implement a program of retrofitting building resilient materials | Both programs of VHP and retrofitting building materials are recommended for Esk, Minden, Fernvale and across the BRCFS study area | H | $845,000 |
| Note | No structural flood mitigation options have been recommended for further detailed assessment in any of the localities, and thus other management measures are critical to reduce flood risk in the area. | | | |
| LUP1 | Utilise the risk-based flood intelligence in the Somerset LFMP TER to update land use planning outcomes | The SPP requires all Councils to update planning schemes and transition to a risk based approach to flooding. This project has provided example approaches to risk based planning and also other outputs such as flood islands, vulnerability assessment, time to and duration of flooding and emergency management aspects that will be useful to transition to a full risk based approach to flooding. | H | Unknown |
| LUP2 | If required, use flood mitigation options appraisal to inform any zoning changes with No Feasible Alternatives Assessment Reports (FAAR) | When any zoning changes are considered to land, a 'No Feasible Alternative Assessment Report (FAAR) should be undertaken to assess all of the alternatives to these zoning changes. A key component of this is investigating structural flood mitigation options which has been undertaken in this project. As there are generally no feasible alternatives, this will assist in the development of No FAAR reports. | L | Unknown |
| EM1 | Implement interim flood forecasting measures such as rainfall trigger maps. | The trigger-based maps provided with this project should be utilised as an interim measure to manage areas that have been identified as having relatively high flood risk. Combined water level and rainfall gauges are also recommended to be installed in some areas. Additional rain gauges in some locations have also been identified in the different localities.<br>Council should aim to implement an advanced forecasting system if resources permit for the for localities it has been advised in. | H | Unknown |
| EM2 | Review evacuation prioritisation list of most at-risk residential properties | The developed prioritisation lists provide a "triage" style of priority evacuations where sheltering in place is not safe to do so. The lists should be regularly reviewed and to provide a better understanding of high-risk residents in appropriate localities. In addition, the process developed could also be replicated to be utilised in flood forecasting systems to provide real time information and flood intelligence. | H | Unknown |
| EM3 | Review evacuation centres that may be exposed to flooding risks | The evacuation centres identified in each of the localities (except Minden where there are no formalised ones) should be reconsidered due to their flood risk (or at least noted) where it has been highlighted an issue. At minimum, centres that have been identified as being in inappropriate locations, should only be considered as interim staging centres in high magnitude flood events or only for the use in minor flood events. | M | Unknown |
| EM4 | In partnership with BOM, update the minor, moderate and major flood classifications for forecast locations | Update the minor, moderate and major flood classification levels for Glenore Grove, Lyons Bridge, Rifle Range, Lowood and Rosentreter forecast locations. Update the major flood class level for Savages. | H | Nominal |

# 9 SUMMARY

The Somerset Region Local Floodplain Management Plan (LFMP) establish strategies to deliver sustainable management of flood risk in the long term for the six localities of Esk, Toogoolawah, Fernvale, Kilcoy, Lowood and Minden.

The LFMP's have been used to understand the extent and scale of flooding and to set policies for managing risks associated with flooding within the catchment. The plans can be used to guide capital investment, land use planning activities, disaster management planning and raise community awareness, understanding of flood risk and how it will be managed. The LFMP's have used the outputs from the Brisbane River Flood Studies, SFMP and Somerset Flood Studies which provides the data to help understand the flood behaviour of the catchments, to assess and characterise the nature of flood risk across the floodplain and how to best manage the risk.

Various levels of risk have been identified across the six localities. The analysis of flood risk illustrates that the extent of flooding varies under the various AEP's. The consequences of flooding increase dramatically under the 1 in 2000 AEP, combined with more extensive hydraulic risk, in zones of H3, H4 and H5 hazards, with H5 having the potential to cause structural damage. In the localities, there are various numbers of properties that are exposed to inundation timeframes of up to 17 hours, suggesting some areas are exposed to dangerous flooding situations. In addition, there are numerous high and low flood islands that exist across the localities; some of which have buildings on them, some of which do not.

Levels of vulnerability across each of the localities has been assessed, in terms of exposure to physical, social and economic, mobility and awareness vulnerability. Each zoning of vulnerability corresponds with individual numbers of people at risk under different hydraulic risk categories, and thus leading to different levels for flood damages, including direct and indirect and road infrastructure.

Several recommendations in relation to mitigation and emergency management have been proposed for Council consideration across the six localities, seeking to implement floodplain management that aligns with best practice principles.

# 10 REFERENCES

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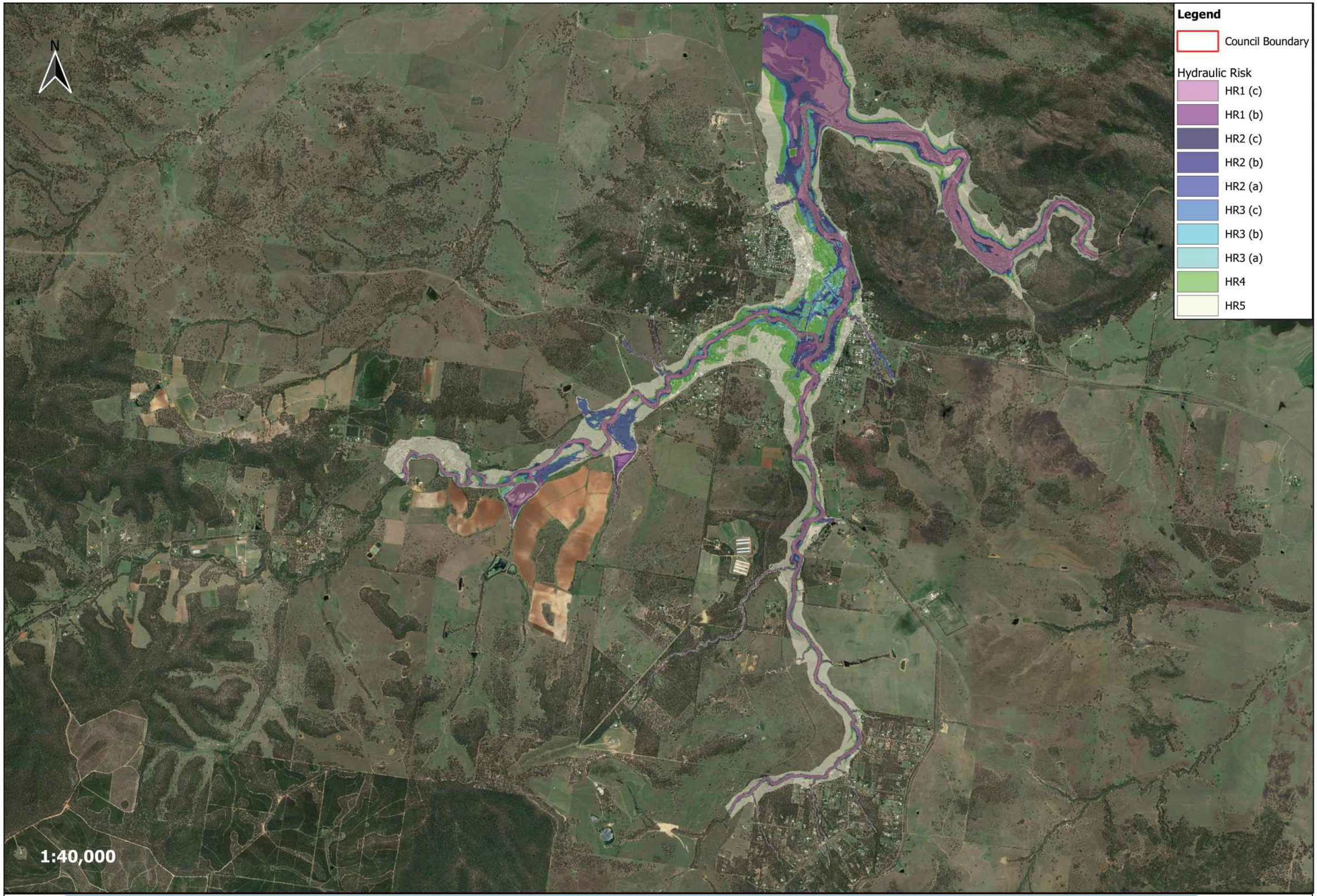
# APPENDIX A
# HYDRAULIC RISK MAPPING




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

Hydraulic Risk | Esk

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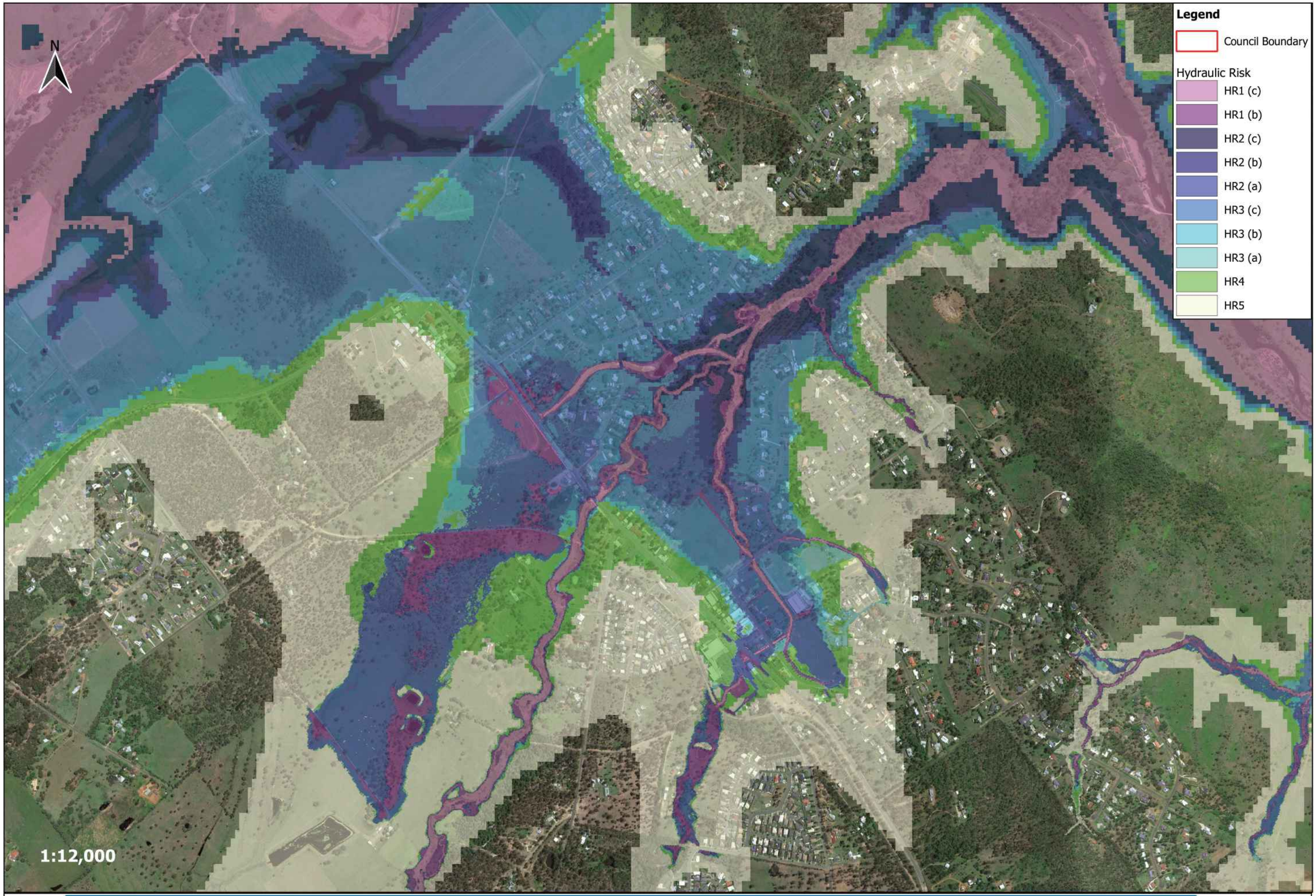


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

Hydraulic Risk | Fernvale

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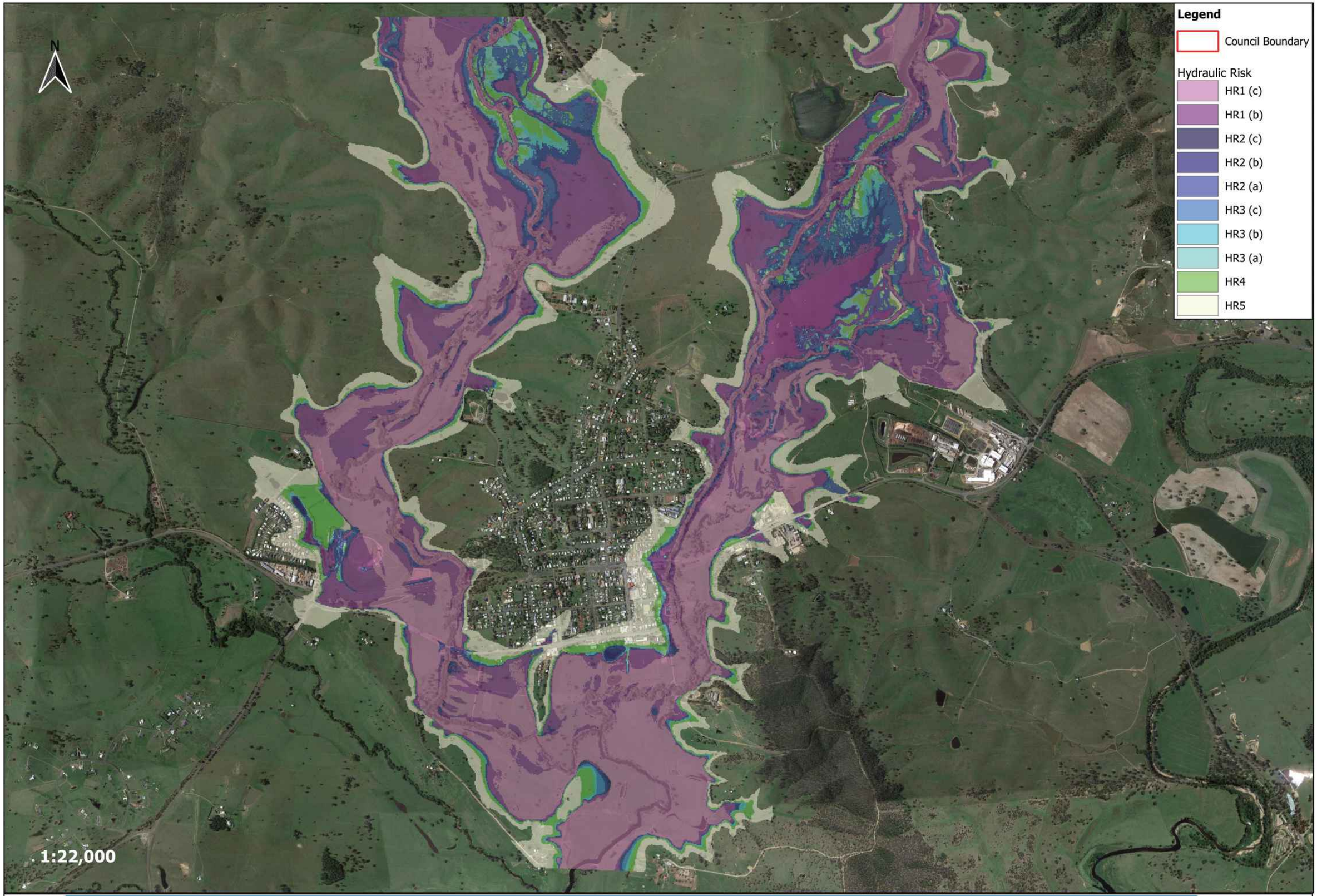


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

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Somerset Regional Council Floodplain Management Plan

# Hydraulic Risk | Kilcoy Overview

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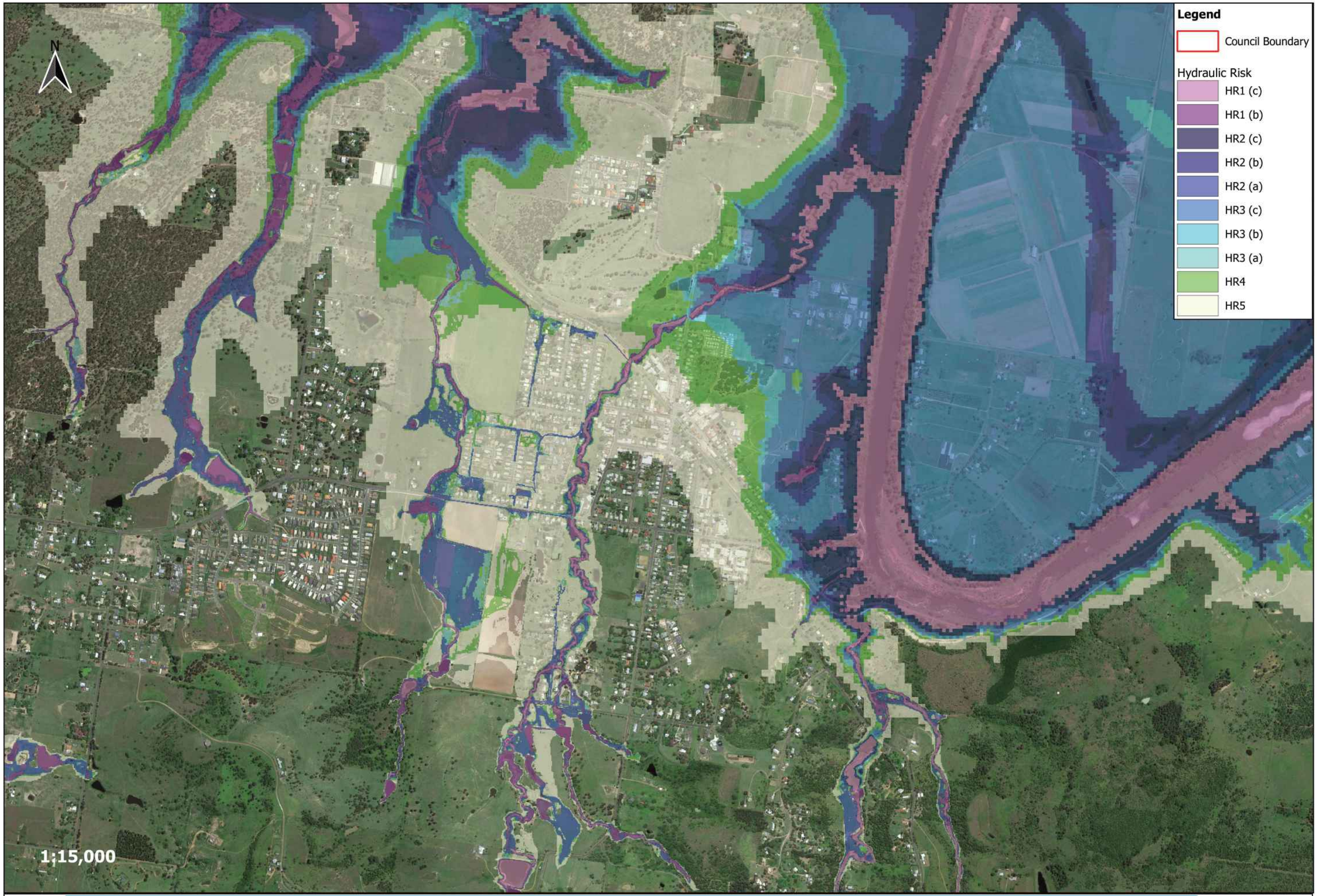



Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

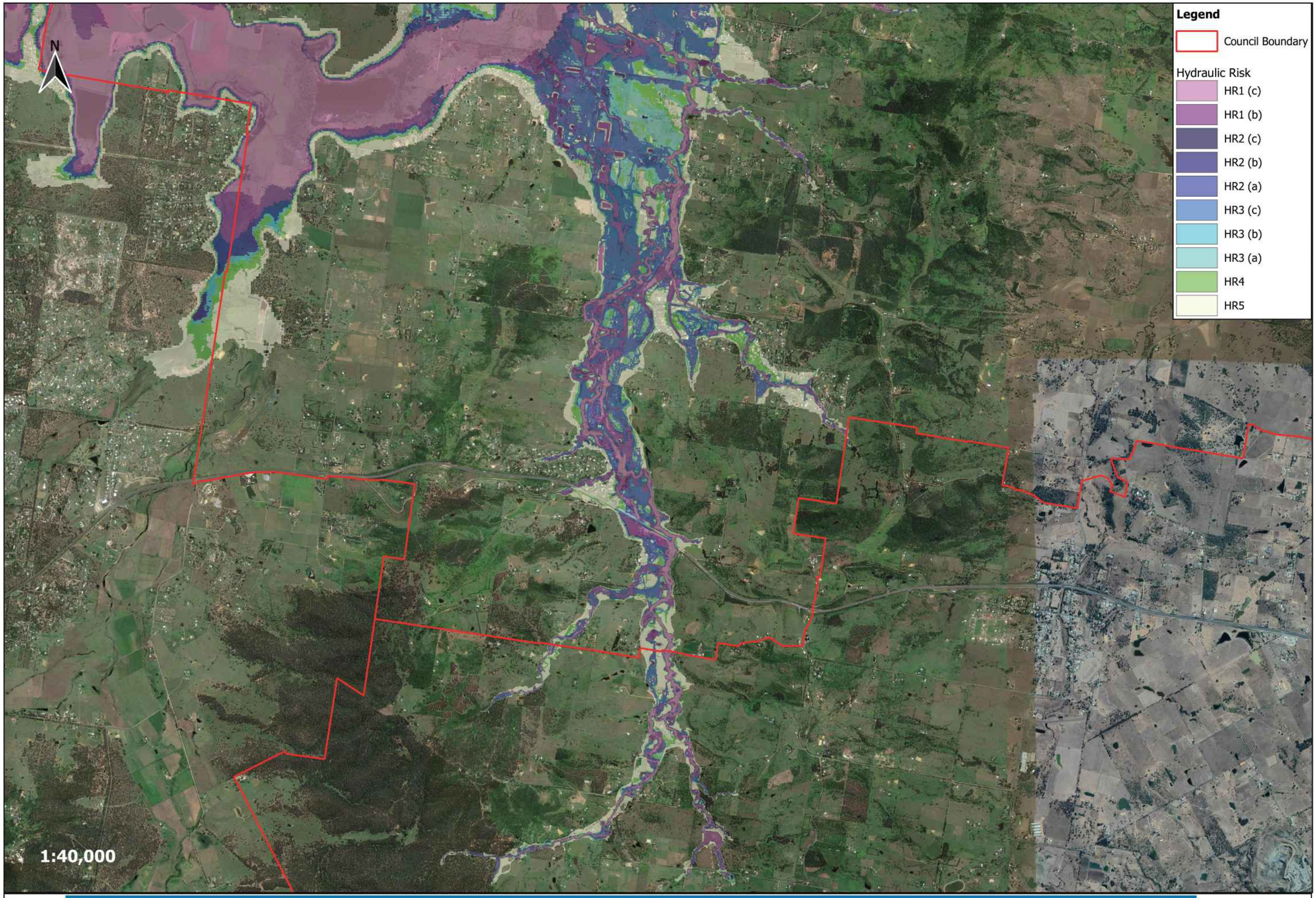
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

Hydraulic Risk | Lowood

2020-06-25T08:04:24.286




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

# Hydraulic Risk | Minden Area

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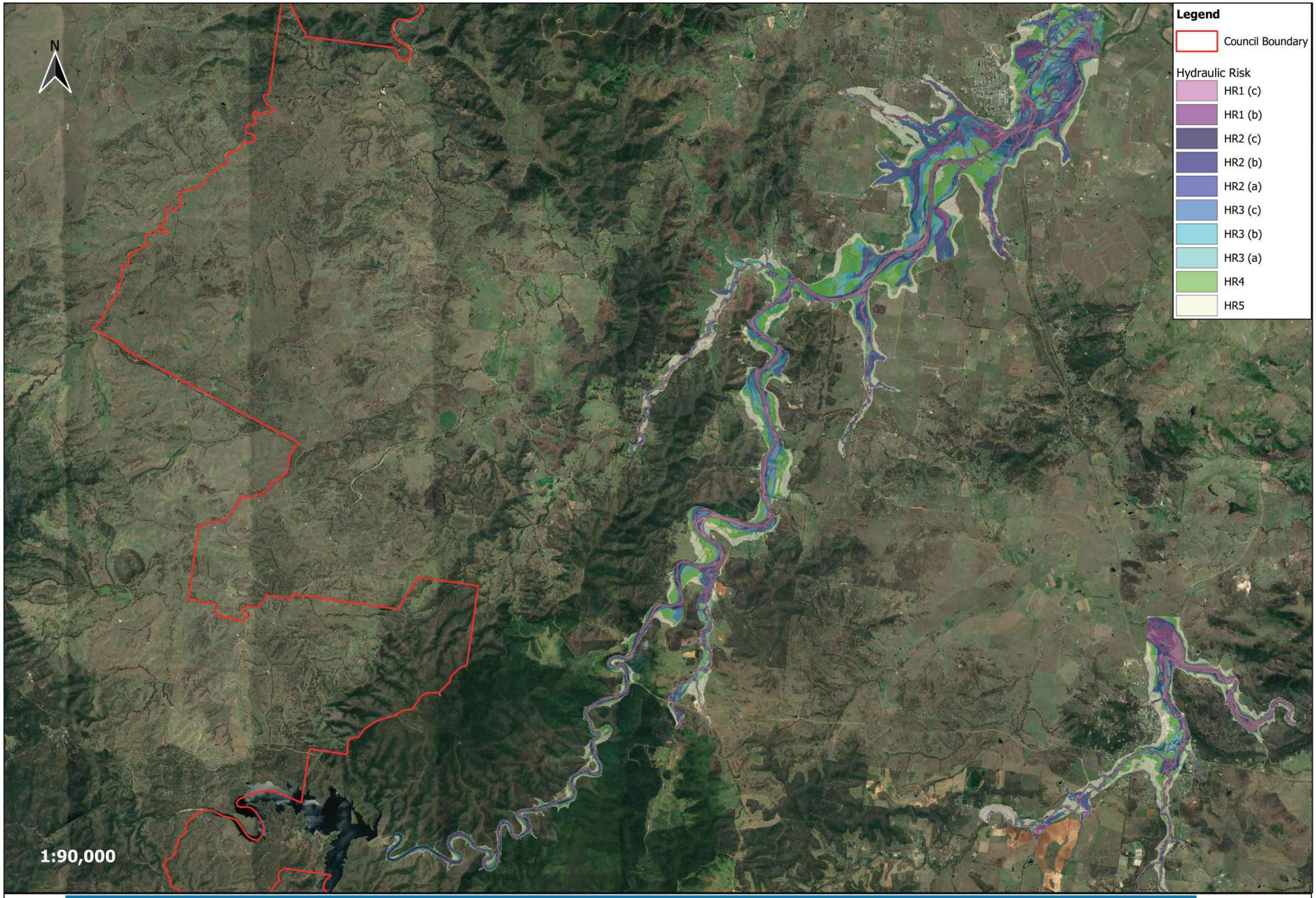


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 800 m

Somerset Regional Council Floodplain Management Plan

# Hydraulic Risk | Toogoolawah Overview

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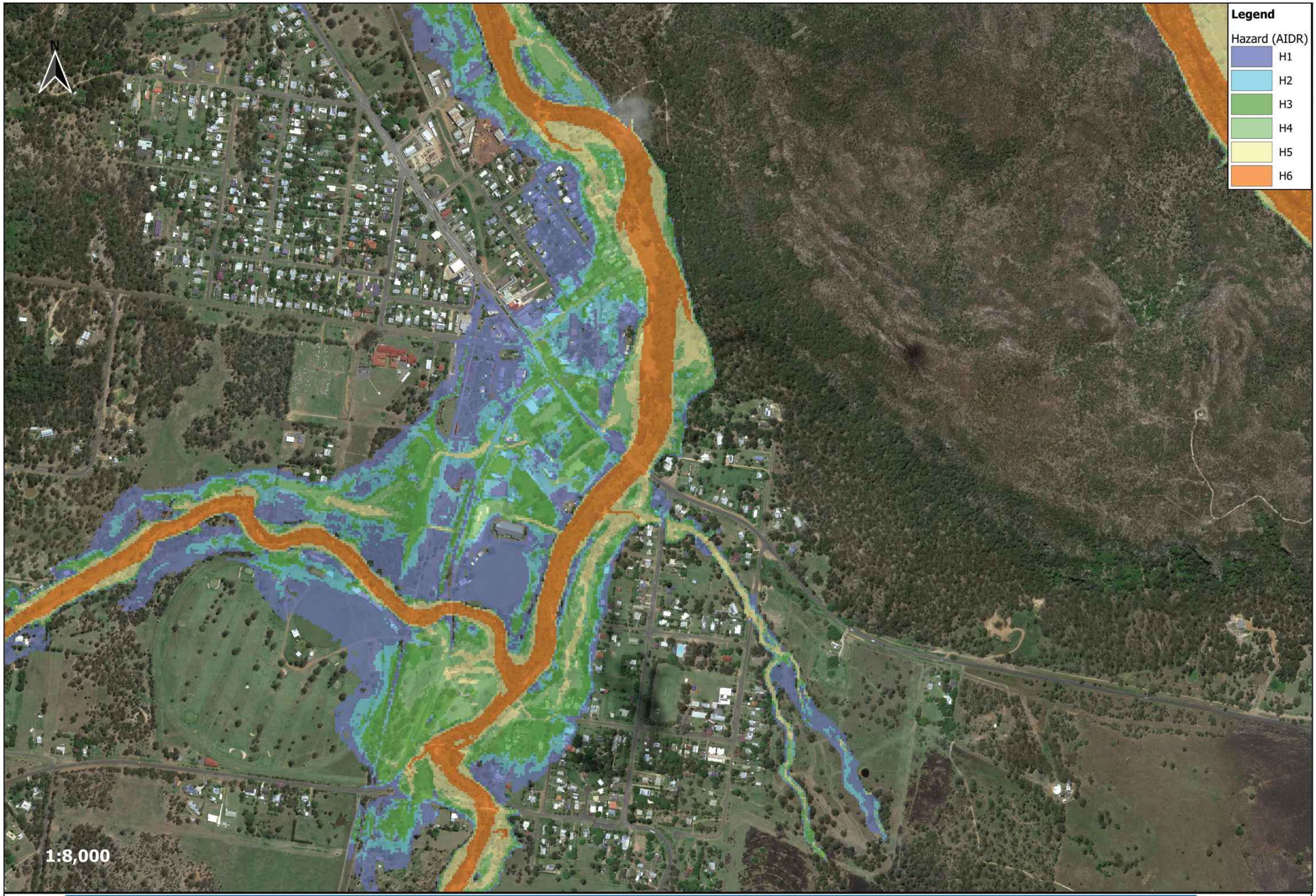
# APPENDIX B
# HAZARD MAPPING




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

# 1 in 100 AEP Hazard | Esk Township

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Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

# 1 in 100 AEP Hazard | Kilcoy Township

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Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

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Somerset Regional Council Floodplain Management Plan

1 in 100 AEP Hazard | Lowood

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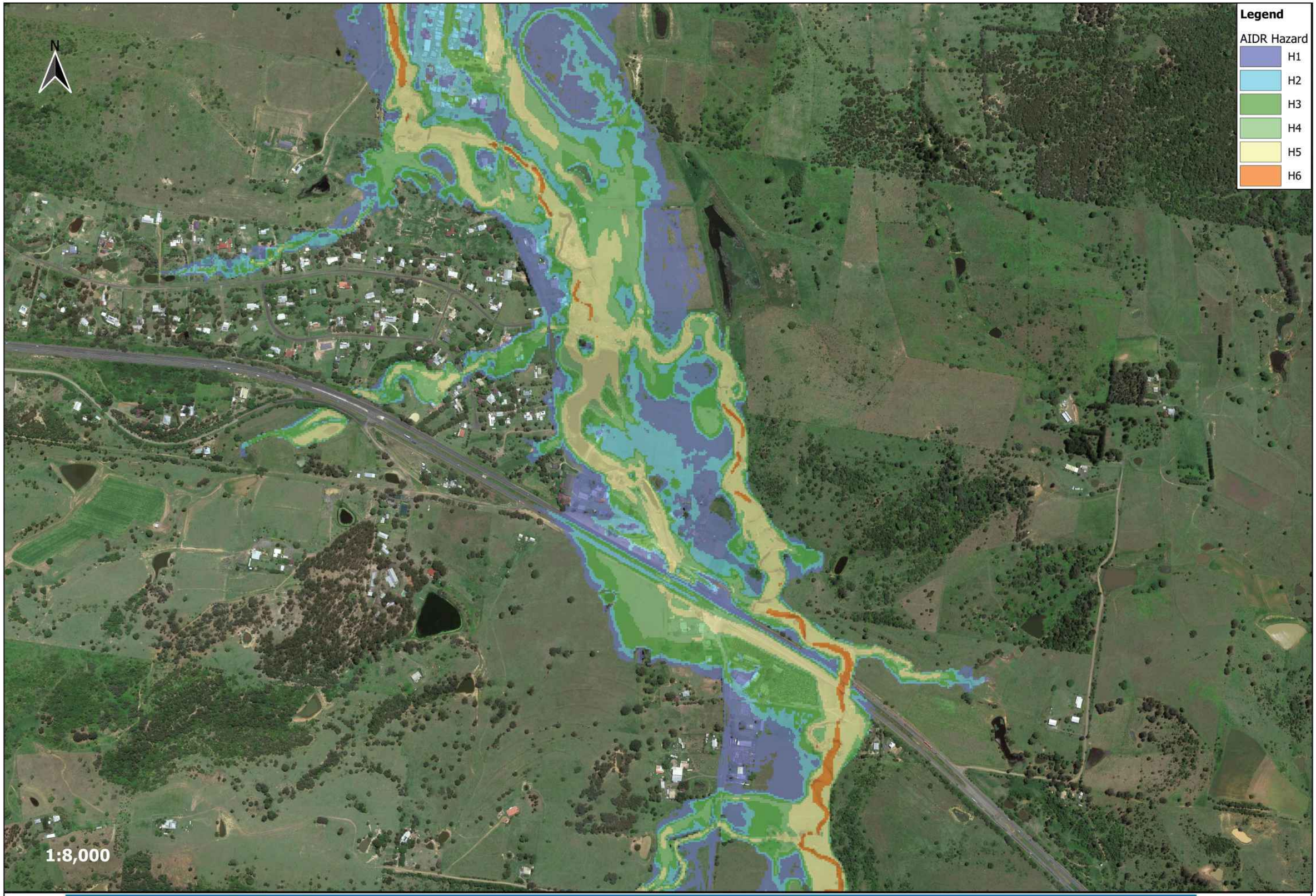


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

1 in 100 AEP Hazard | Minden Area

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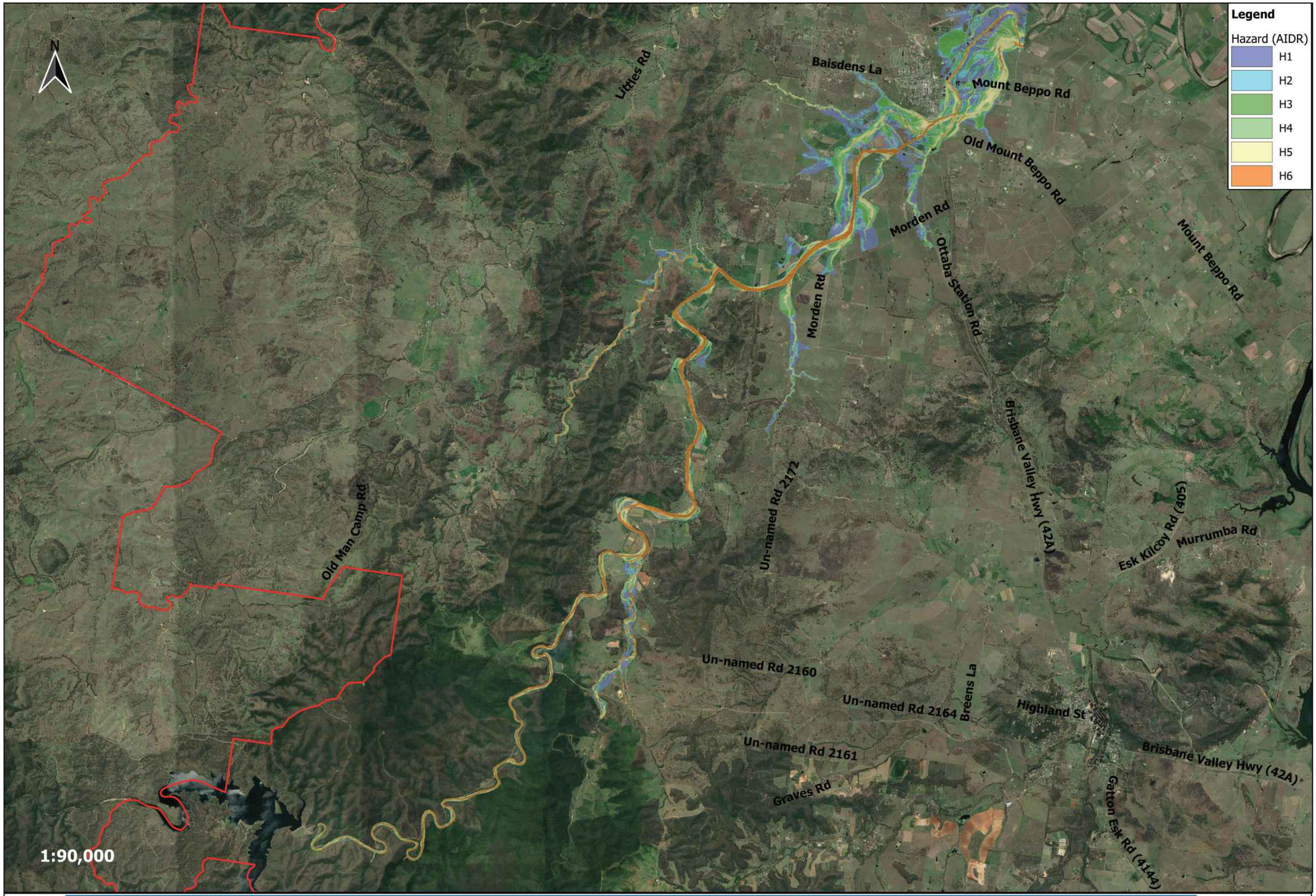


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 320 m

Somerset Regional Council Floodplain Management Plan

1 in 100 AEP Hazard | Toogoolawah

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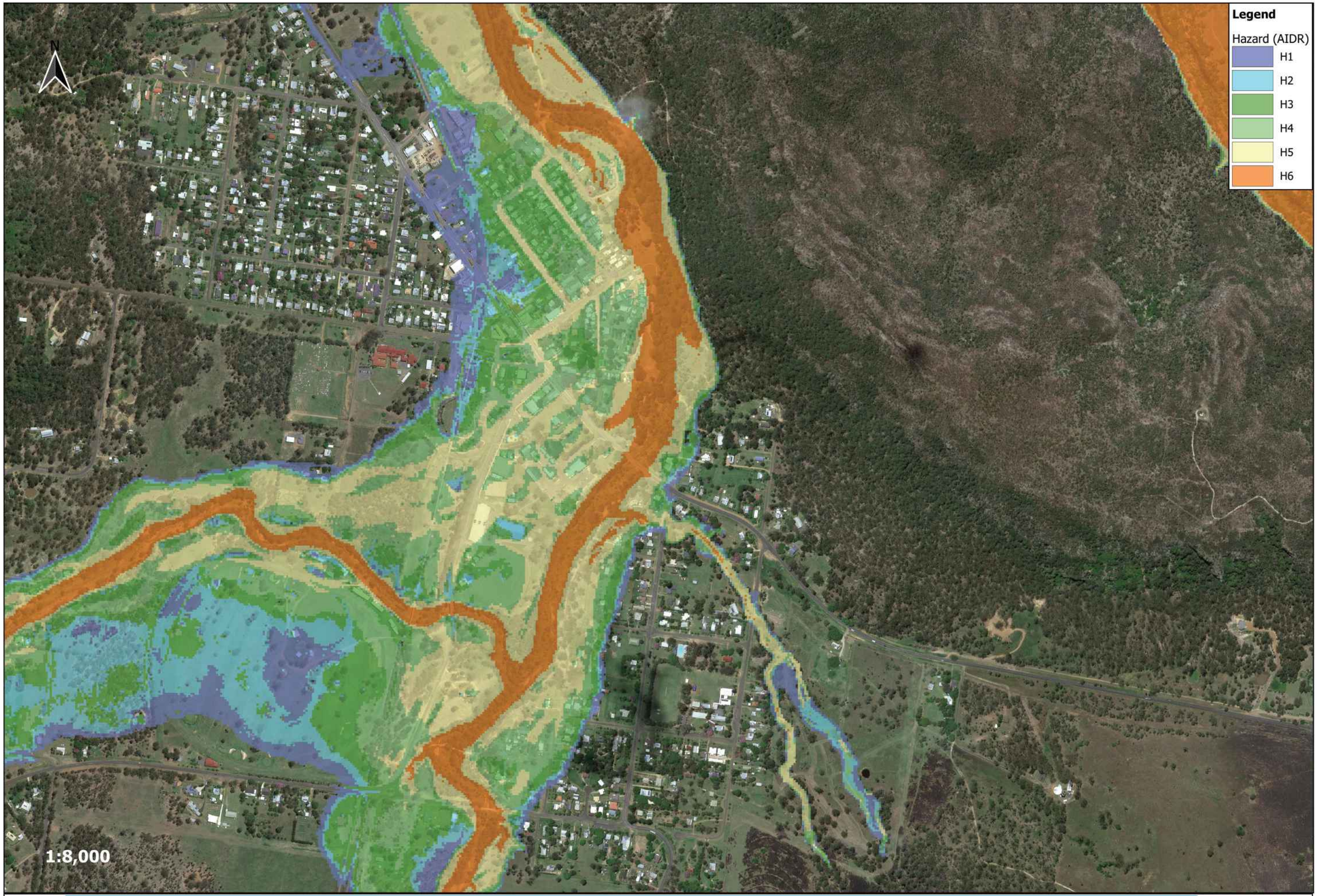



Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# 1 in 2000 AEP Hazard | Esk Township

2020-06-26T15:04:00.670


Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

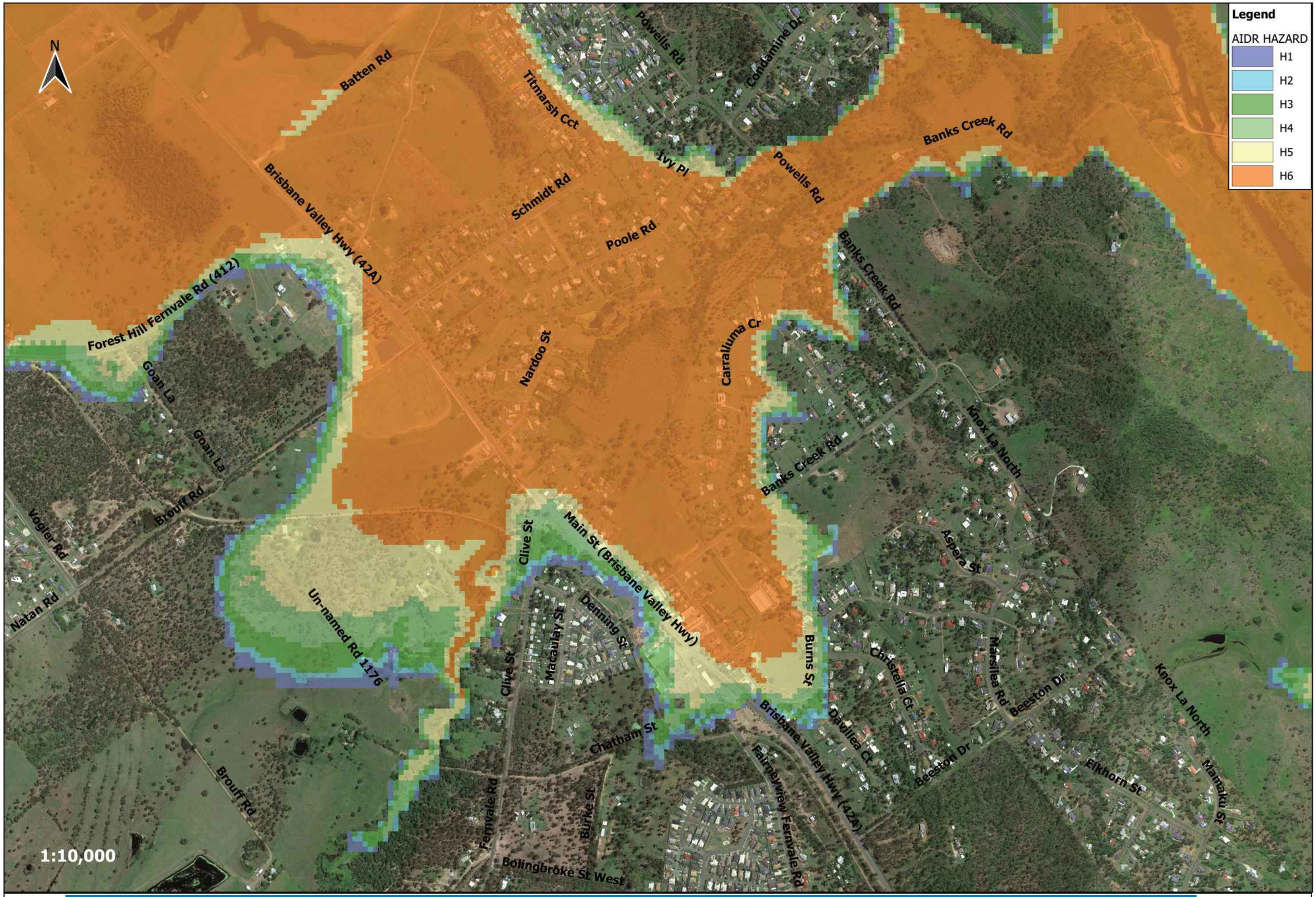
0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Local Hazard | Fernvale

WATER TECHNOLOGY Synergy Solutions

2020-08-13T09:42:39.867




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

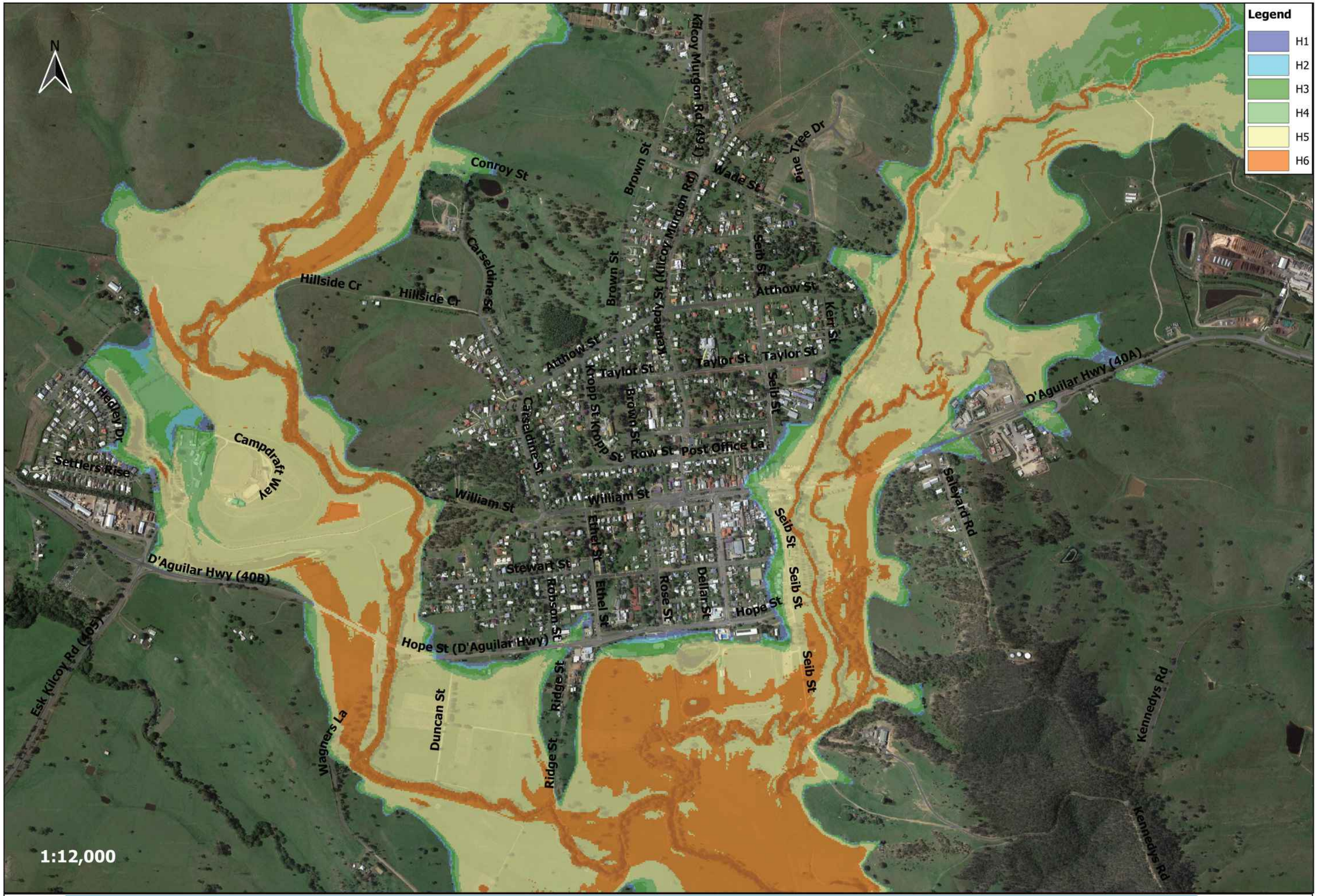
0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Regional Hazard | Fernvale

WATER TECHNOLOGY Synergy Solutions

2020-08-13T09:42:17.437




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

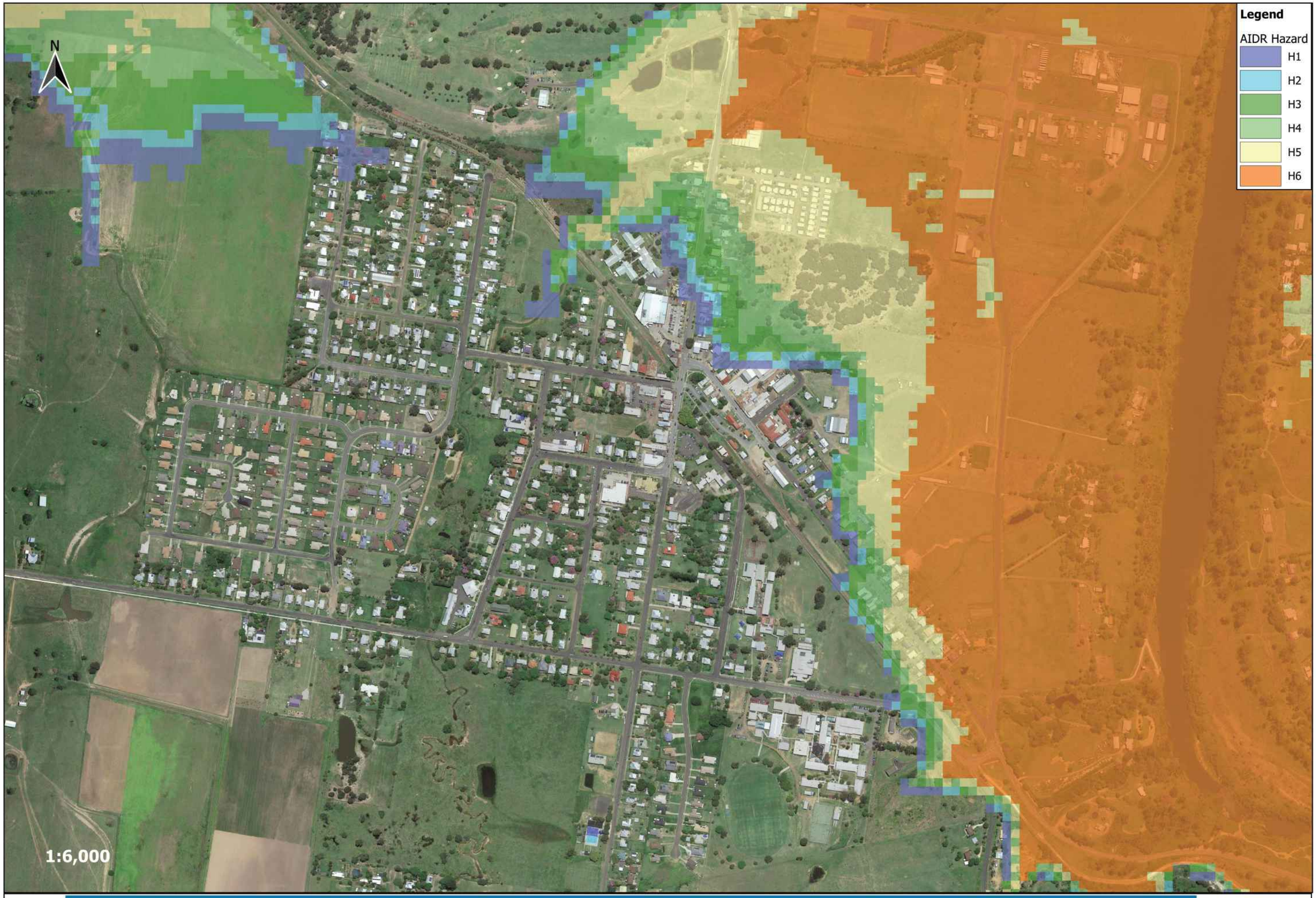
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# 1 in 2000 AEP Hazard | Kilcoy Township

2020-08-12T14:28:38.086




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# 1 in 2000 AEP Hazard | Lowood Regional

2020-08-14T11:12:03.557


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

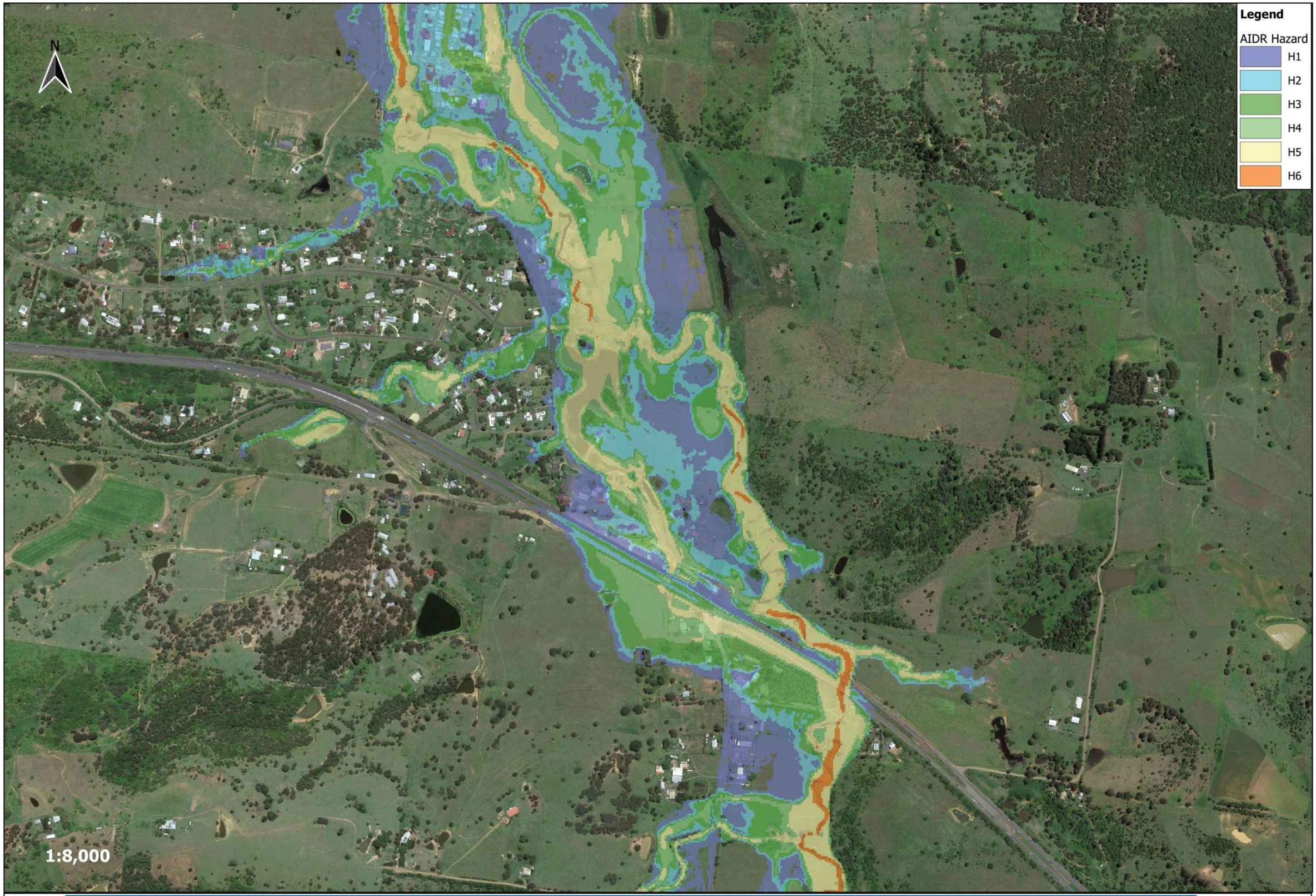
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

1 in 2000 AEP Hazard | Lowood

2020-08-14T11:09:54.015




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

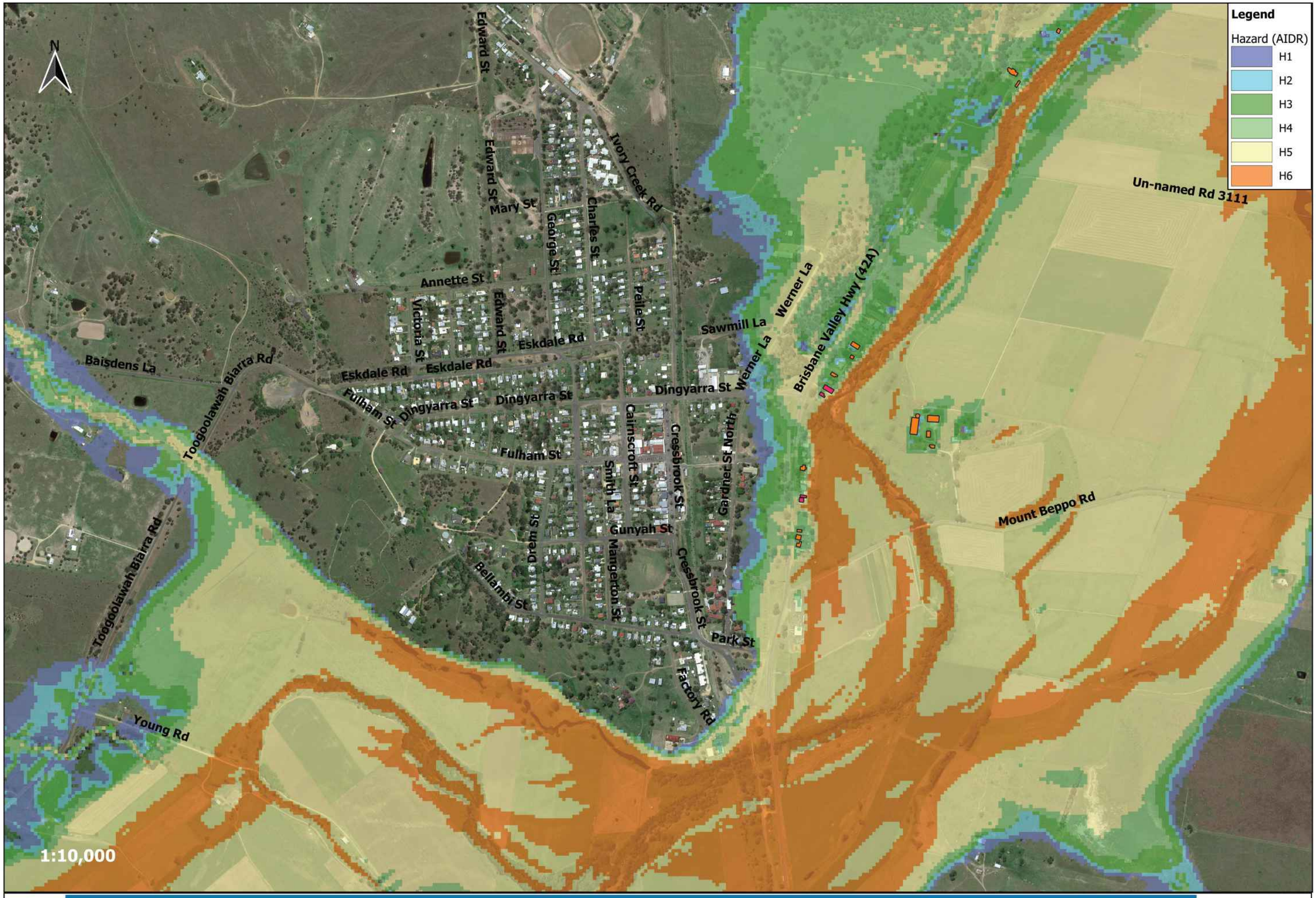
Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

1 in 2000 AEP Hazard | Minden Area

2020-08-13T17:27:24.498




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

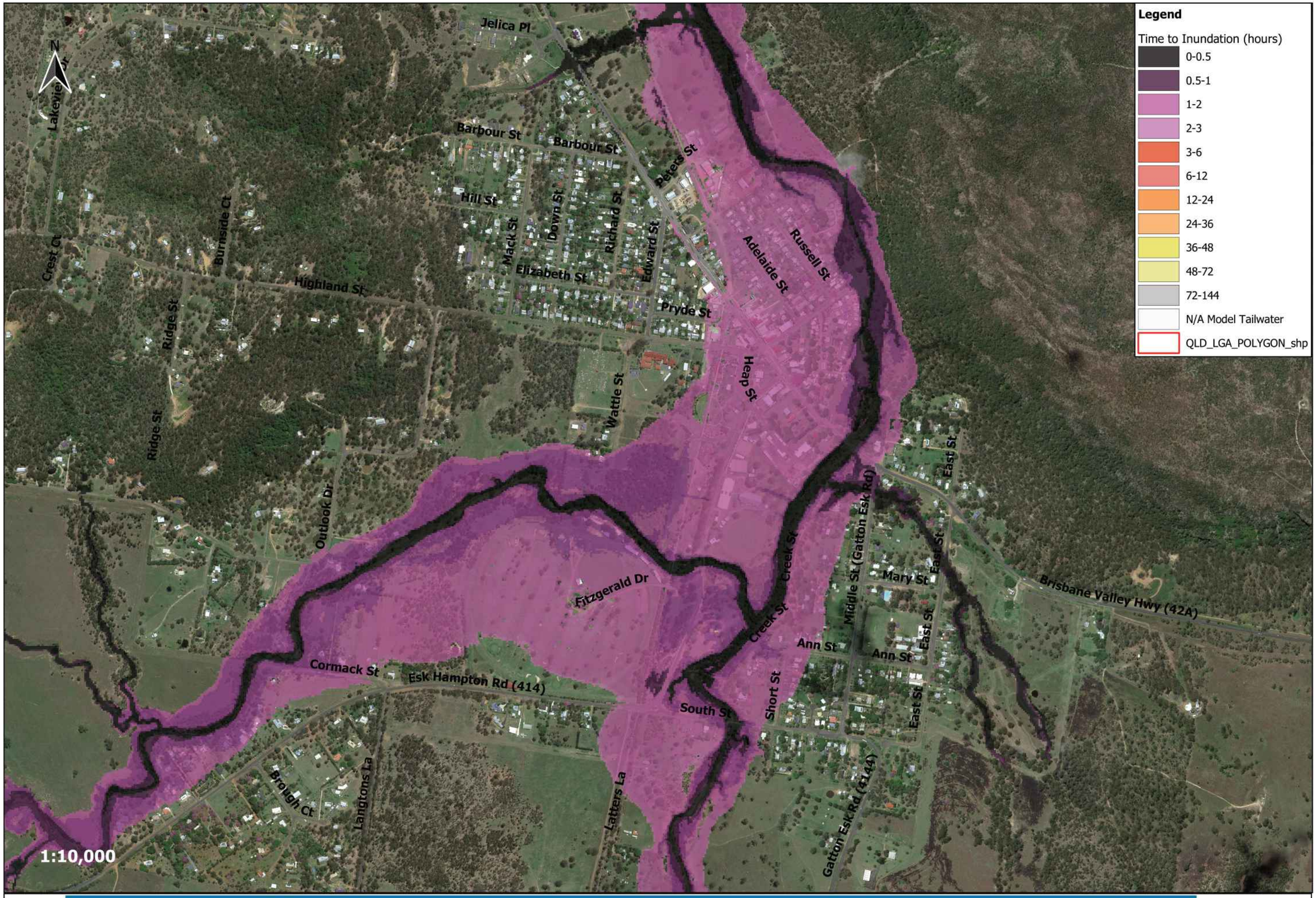
Somerset Regional Council Floodplain Management Plan

# 01 in 2000 AEP Hazard | Toogolawah Township

2020-08-04T10:02:31.301

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX C
# TIME TO INUNDATION MAPPING




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

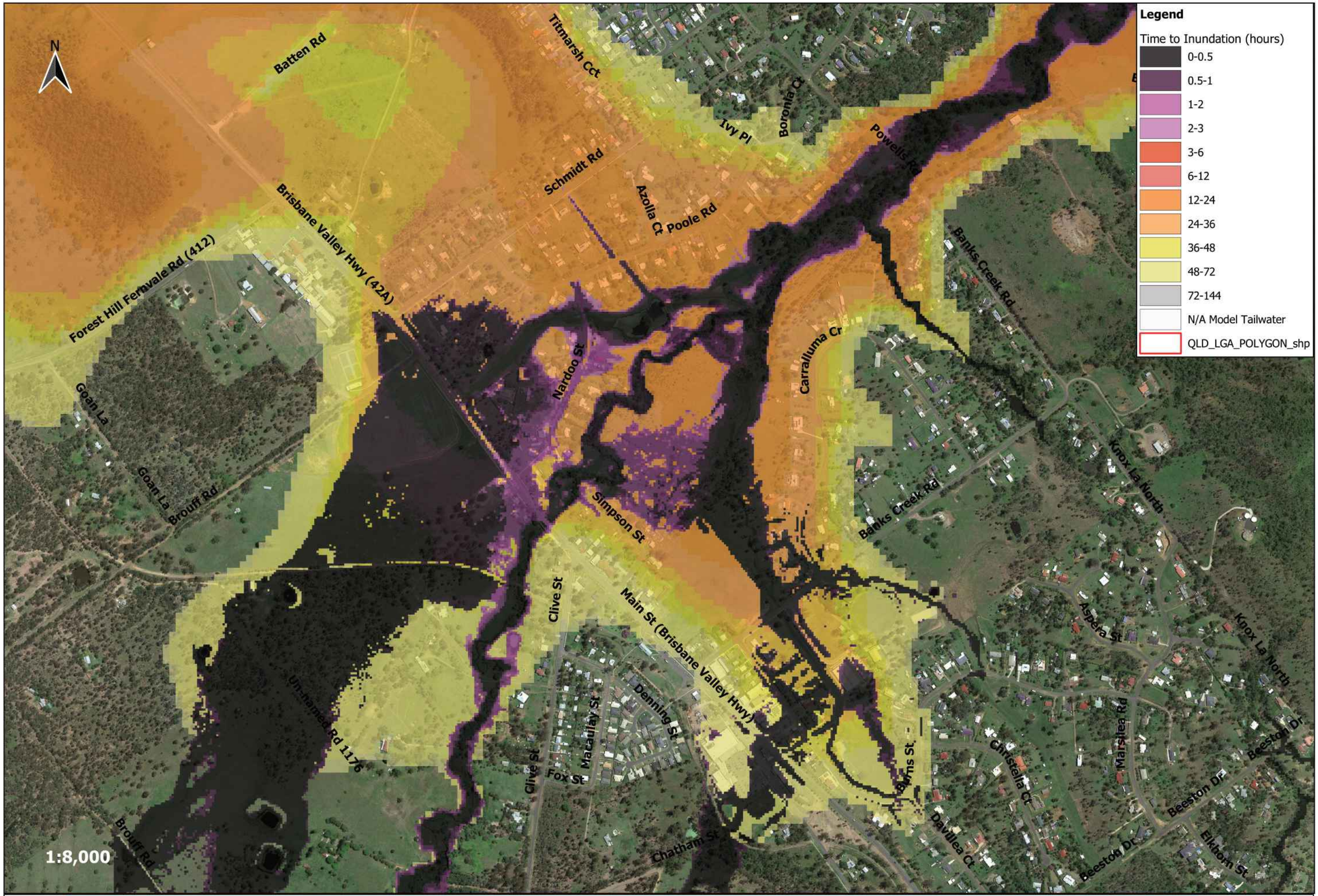
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation 1 in 2000 AEP | Esk Township

2020-06-27T15:46:21.543




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation 1 in 2000 AEP | Fernvale Township

2020-08-03T09:23:38.233


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

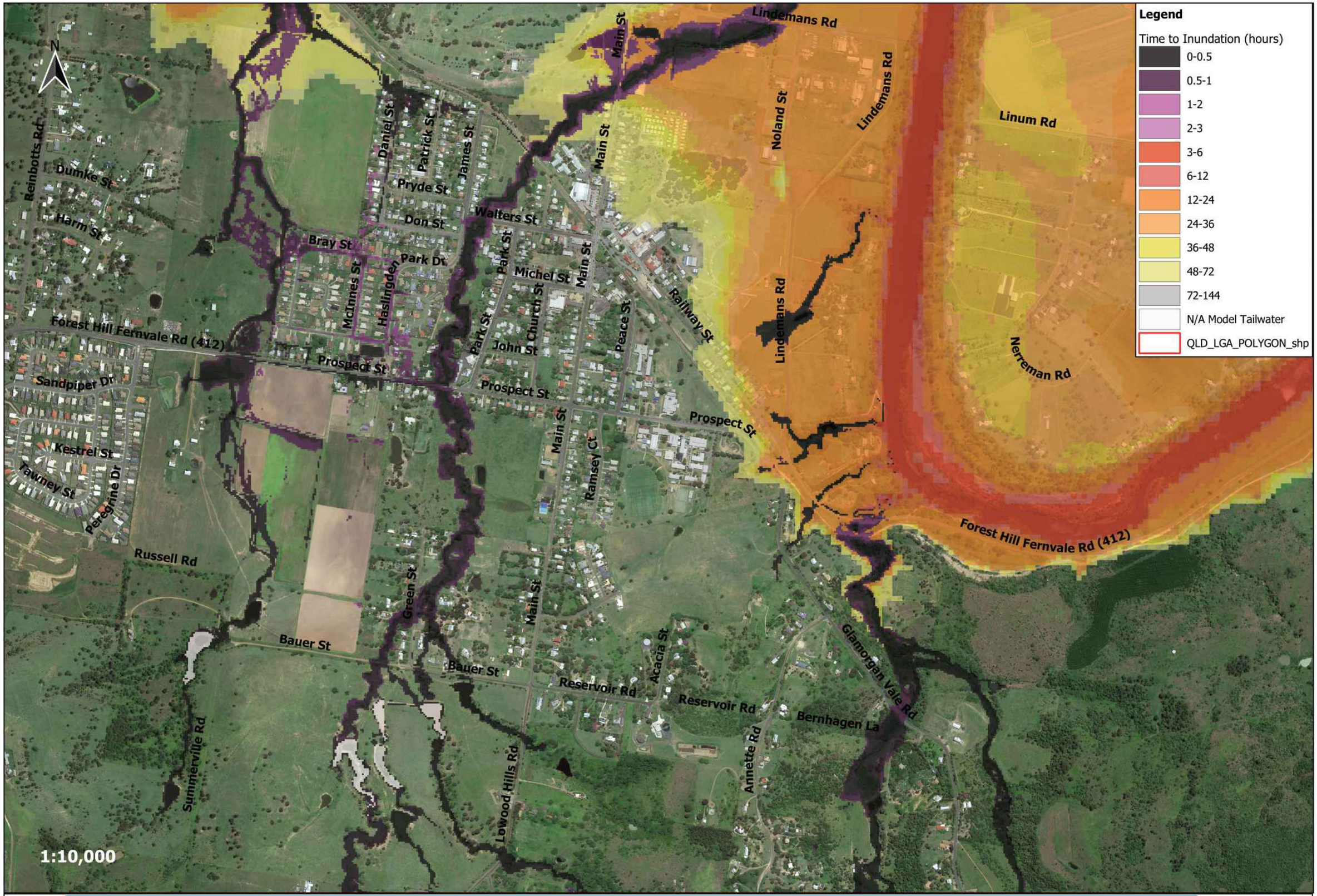
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

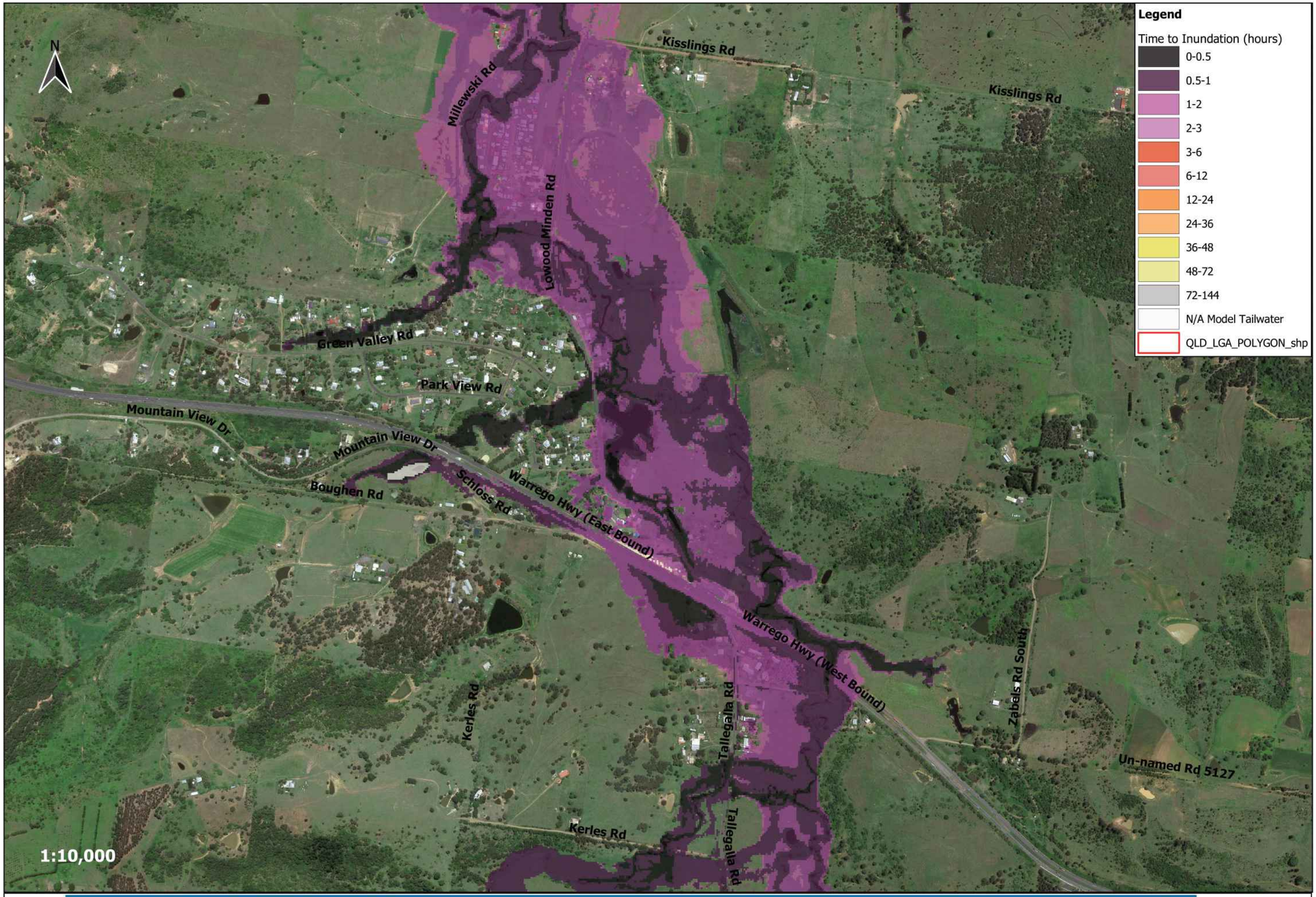
Somerset Regional Council Floodplain Management Plan

Time to Inundation 1 in 2000 AEP | Kilcoy Township

2020-08-03T09:06:46.401




2020-08-03T09:18:46.831




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

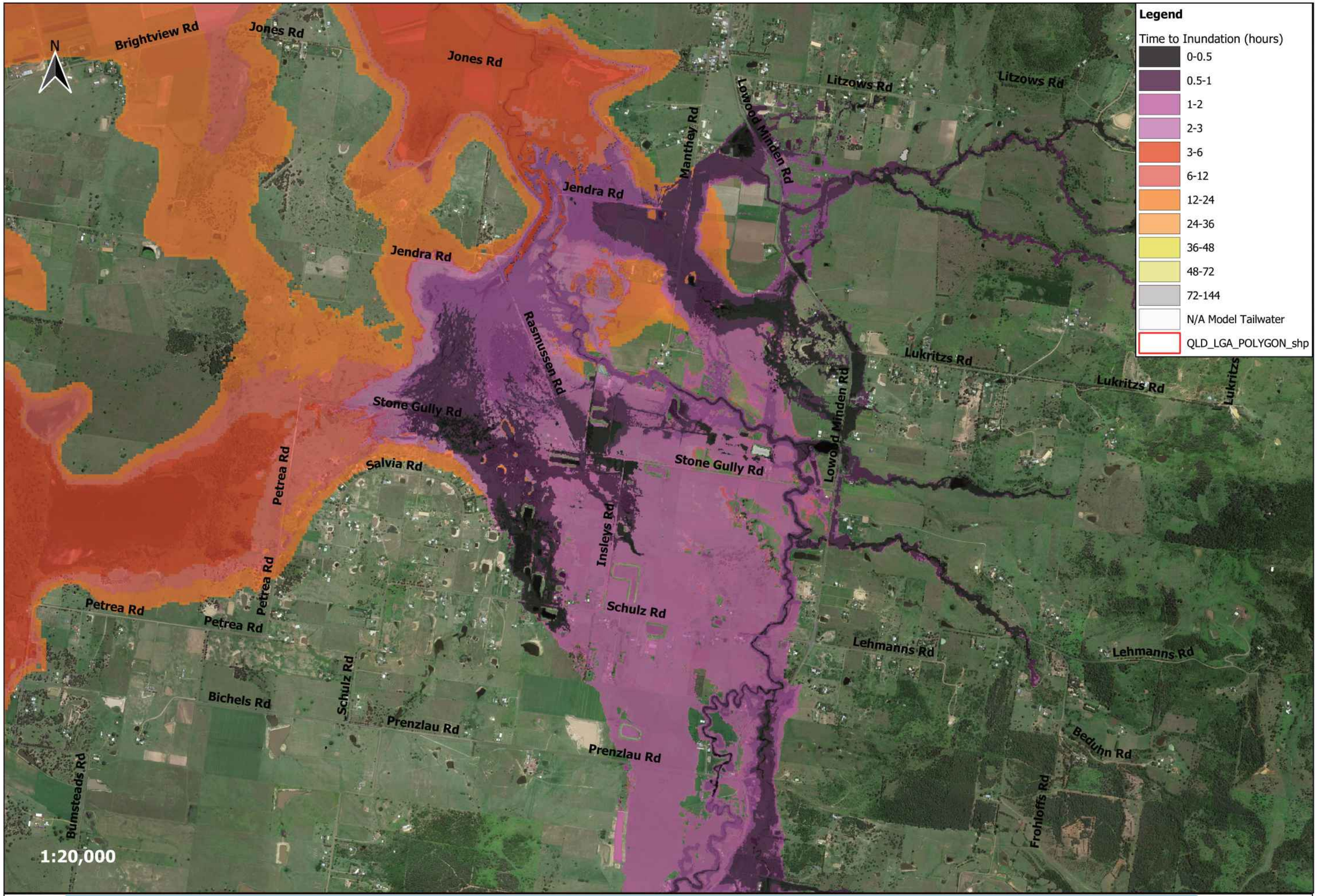
0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation 1 in 2000 AEP | Minden Area

WATER TECHNOLOGY Synergy Solutions

2020-08-03T09:11:11.149




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

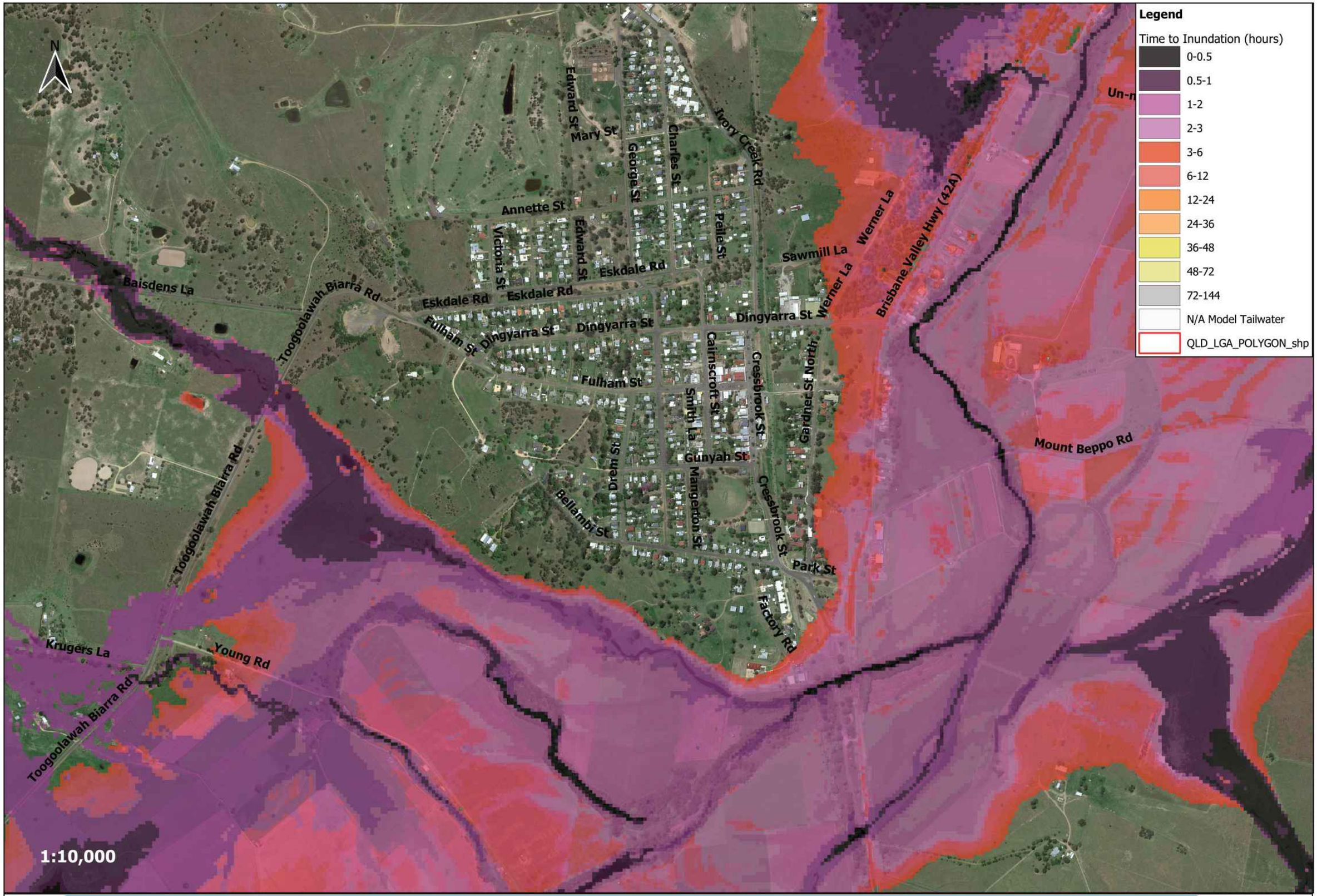
0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation 1 in 2000 AEP | Coolana

WATER TECHNOLOGY Synergy Solutions

2020-08-03T09:14:42.099




2020-08-03T09:03:12.011


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 40 80 120 160 m

Somerset Regional Council Floodplain Management Plan

Time to Inundation Properties 1 in 2000 AEP | Esk

2020-06-29T16:34:21.940


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Property 1 in 2000 AEP | Fernvale

2020-08-14T16:00:49.554


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation Properties 1 in 2000 AEP | Kilcoy

2020-08-03T10:39:51.475


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Property 1 in 2000 AEP | Lowood

2020-08-14T16:00:29.571


2020-08-03T10:48:36.917


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

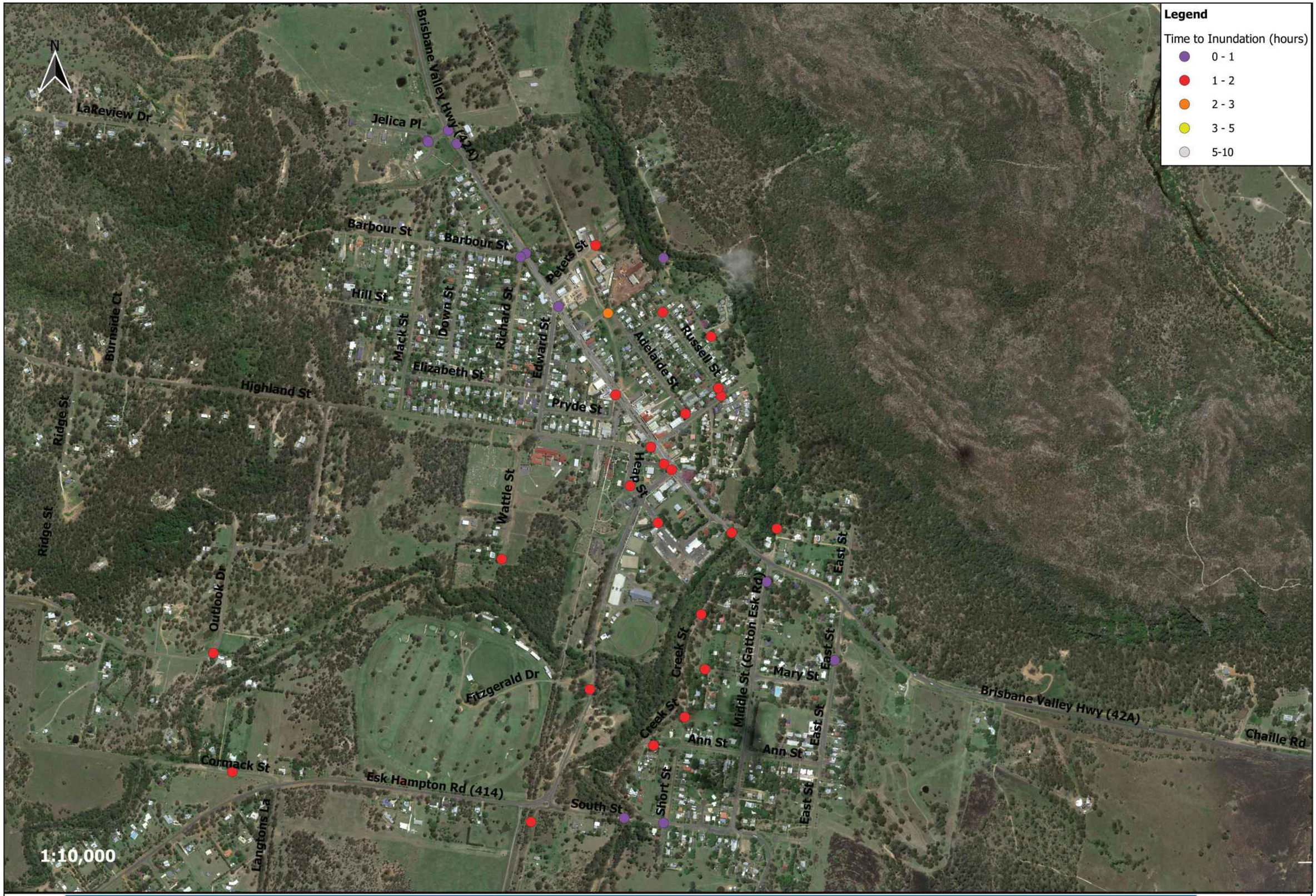
Projection: GDA/MGA94 Zone 56

0 40 80 120 160 m

Somerset Regional Council Floodplain Management Plan

# Time to Inundation Properties 1 in 2000 AEP | Toogoolawah

2020-08-03T10:35:33.115




2020-06-29T16:10:01.340


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Roads 1 in 2000 AEP | Fernvale

2020-08-13T10:06:14.571

N

**Legend**

Time to Inundation (hours)

0.0 - 0.0

0 - 1

1 - 2

2 - 3

3 - 5

5-10

1:25,000

Somerset REGIONAL COUNCIL

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Roads 1 in 2000 AEP | Kilcoy

WATER TECHNOLOGY Synergy Solutions

2020-08-13T08:50:27.939


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Roads 1 in 2000 AEP | Lowood

2020-08-13T08:50:57.966


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 400 800 m

Somerset Regional Council Floodplain Management Plans

# Time to Inundation Roads 1 in 2000 AEP | Minden

2020-08-13T08:52:04.163


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

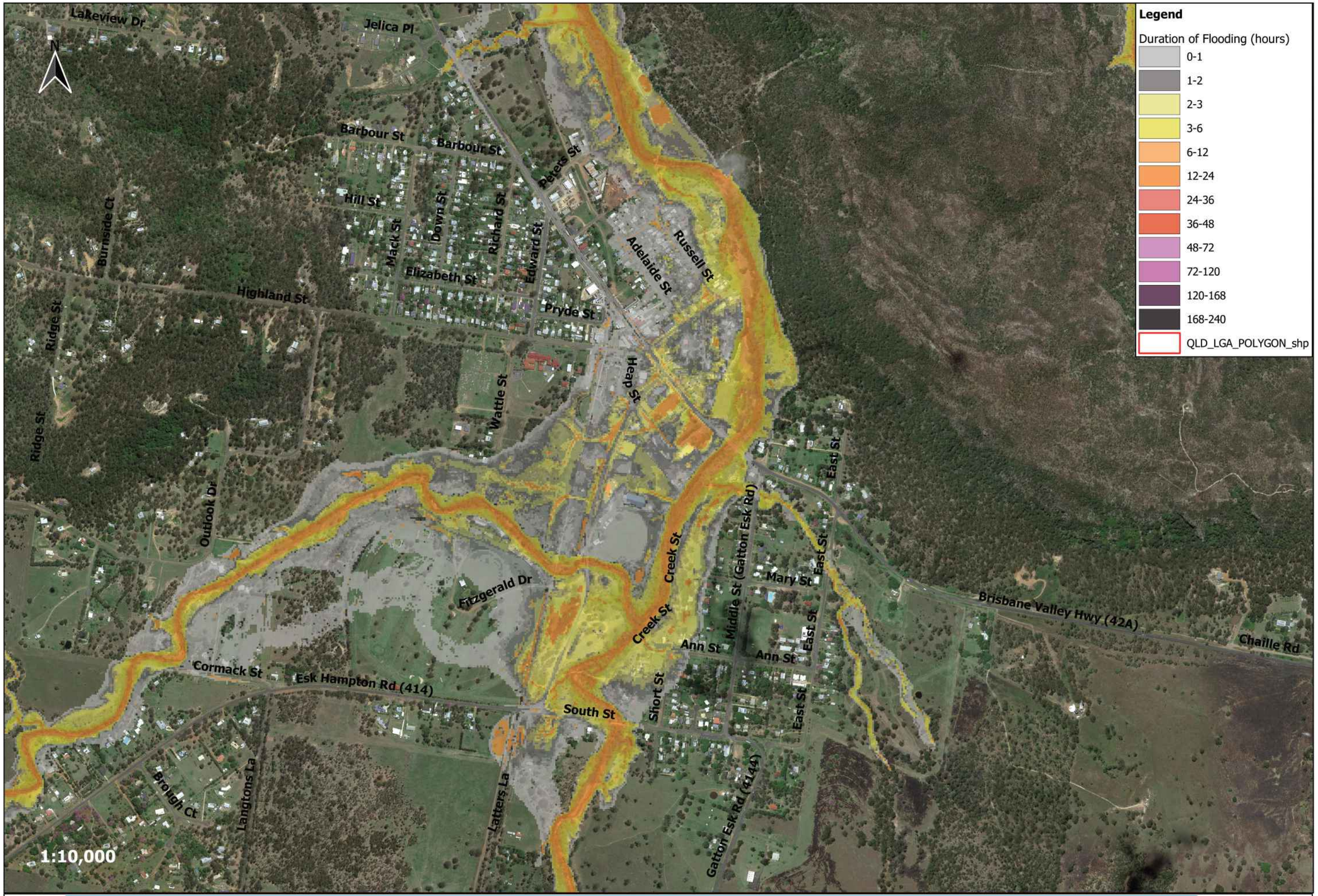
Somerset Regional Council Floodplain Management Plans

# Time to Inundation Roads 1 in 2000 AEP | Toogoolawah

2020-08-13T08:52:30.114

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX D
# DURATION TO INUNDATION MAPPING




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

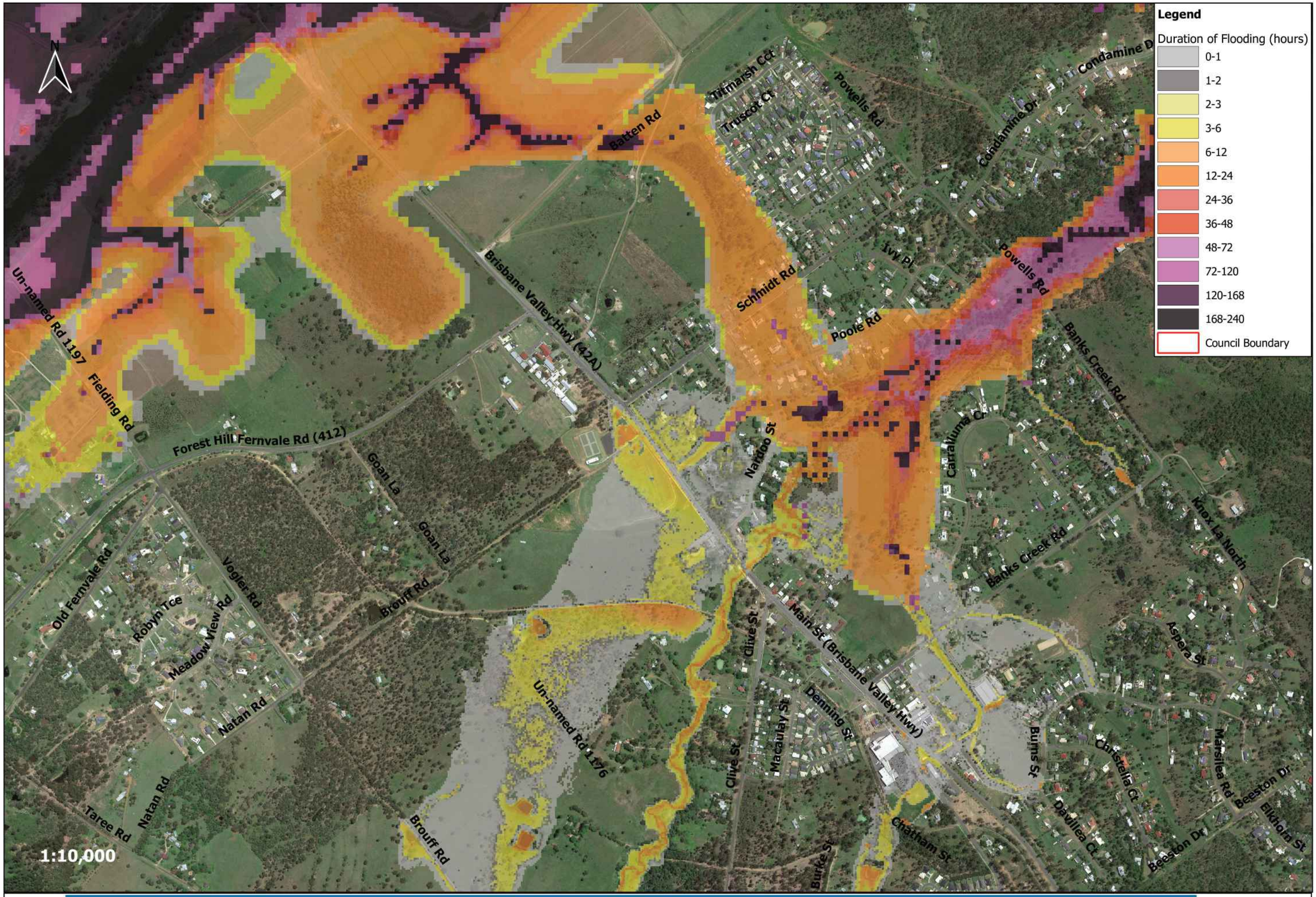
0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 100 AEP | Esk Township

WATER TECHNOLOGY Synergy Solutions

2020-06-27T15:52:38.291




2020-08-03T10:19:26.010


Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

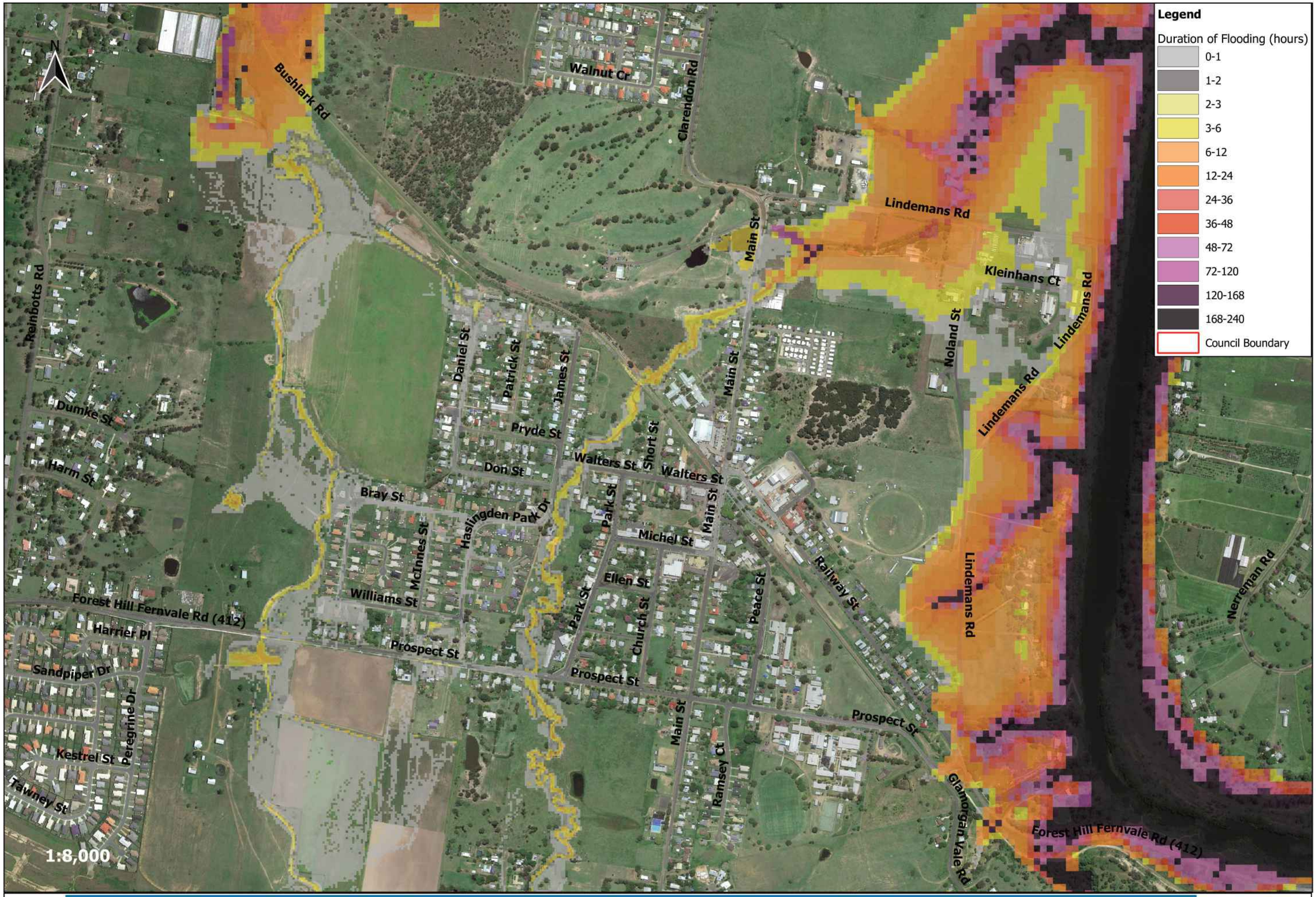
0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 100 AEP | Kilcoy Township

WATER TECHNOLOGY Synergy Solutions

2020-08-03T10:01:59.426




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

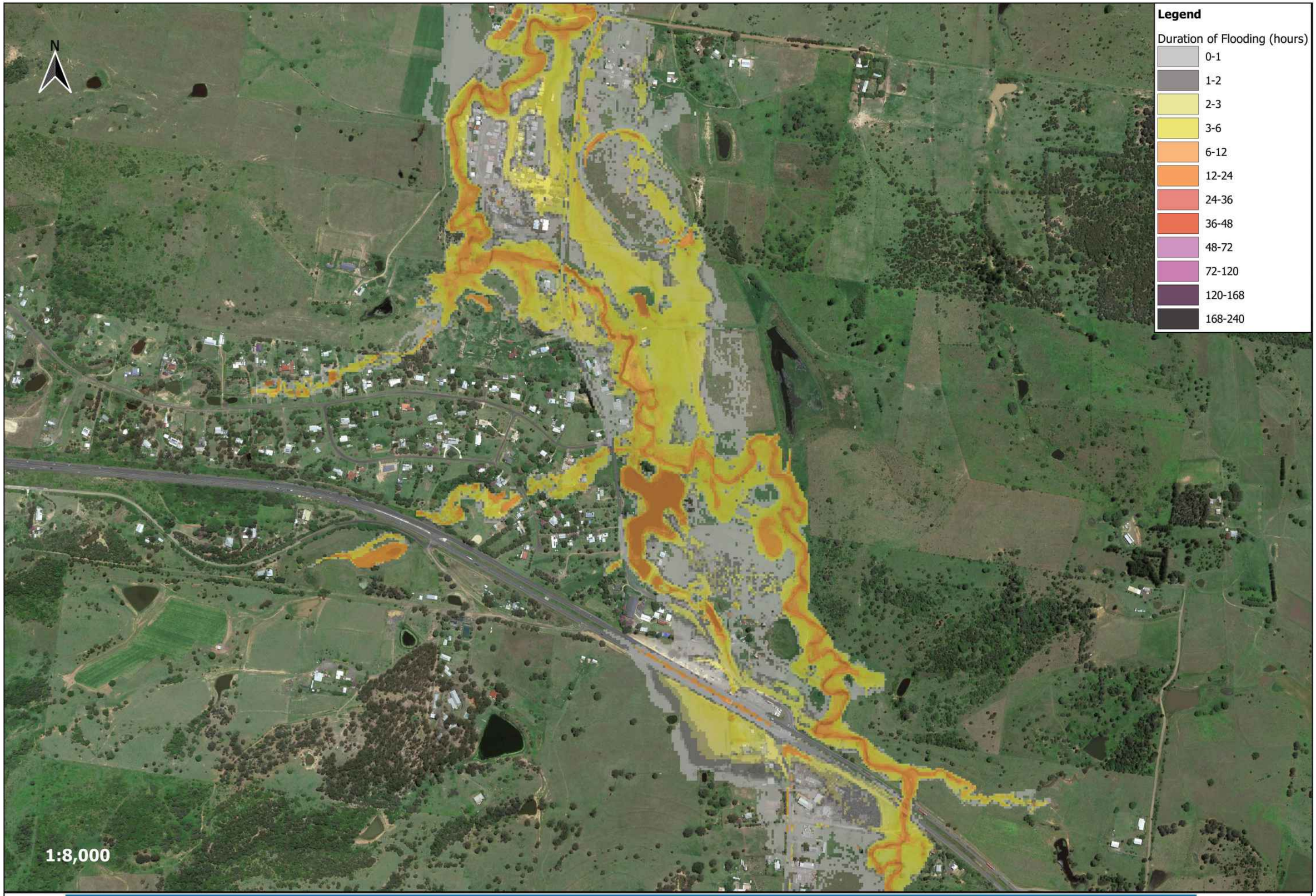
Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

Duration of Flooding 1 in 100 AEP | Lowood Township

2020-08-03T10:11:05.639




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 100 AEP | Minden Township Area

2020-08-13T18:00:51.537

N

Legend

Duration of Flooding (hours)

- 0-1
- 1-2
- 2-3
- 3-6
- 6-12
- 12-24
- 24-36
- 36-48
- 48-72
- 72-120
- 120-168
- 168-240
- Council Boundary

Edward St
Mary St
Mary St
George St
Charles St
Pelle St
Pelle St
Ivory Creek Rd
Annette St
Victoria St
Alexandra St
Edward St
Eskdale Rd
Eskdale Rd
Eskdale Rd
Baisdens La
Toogoolawah Biarra Rd
Fulham St
Dingyarra St
Dingyarra St
Kemp St
Smith La
Sawmill La
Werner La
Werner La
Dingyarra St
Fulham St
Cressbrook St
Gardner St North
Abbotsford St
Smith La
Cairnscroft St
Drent St
Abbotsford St
Mangerton St
Bellambi St
Cressbrook St
Park St
Factory Rd
Brisbane Valley Hwy (42A)
Mount Beppo Rd
Toogoolawah Biarra Rd
Young Rd

1:8,000

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

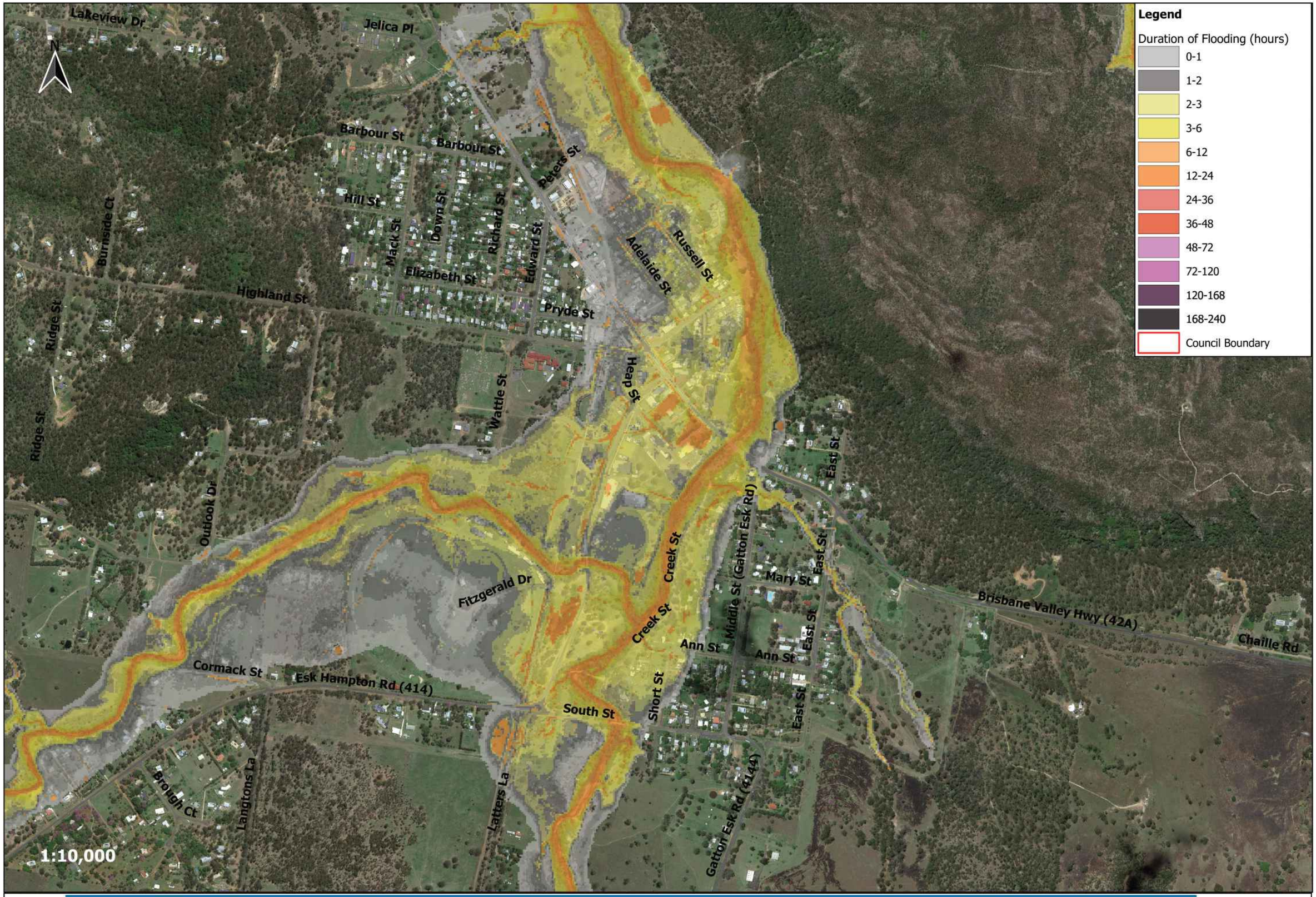
Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 100 AEP | Toogoolawah Township

2020-08-03T09:56:12.035




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

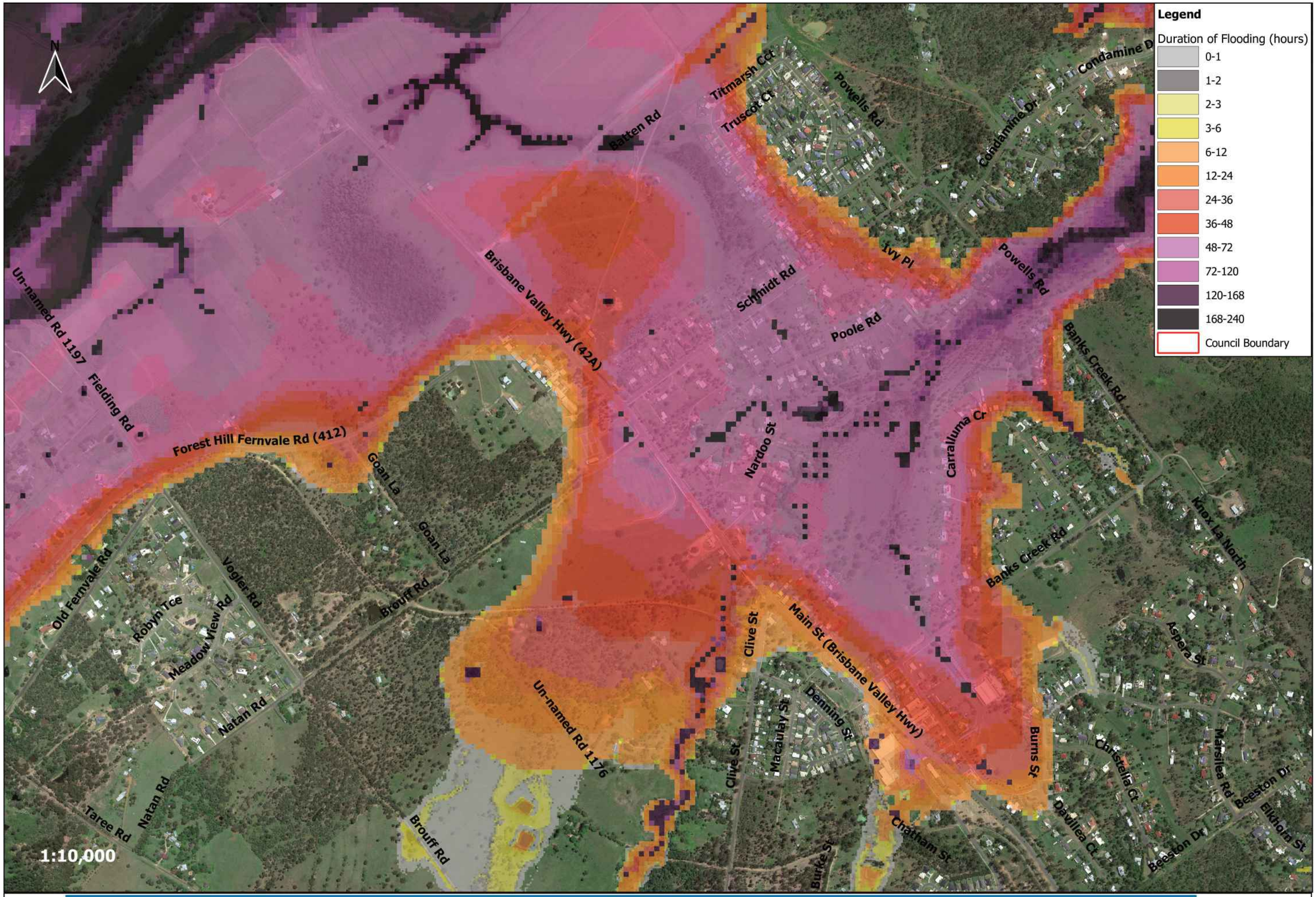
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Esk Township

2020-06-27T15:51:01.582




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Fernvale Township

2020-08-03T10:18:06.246


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

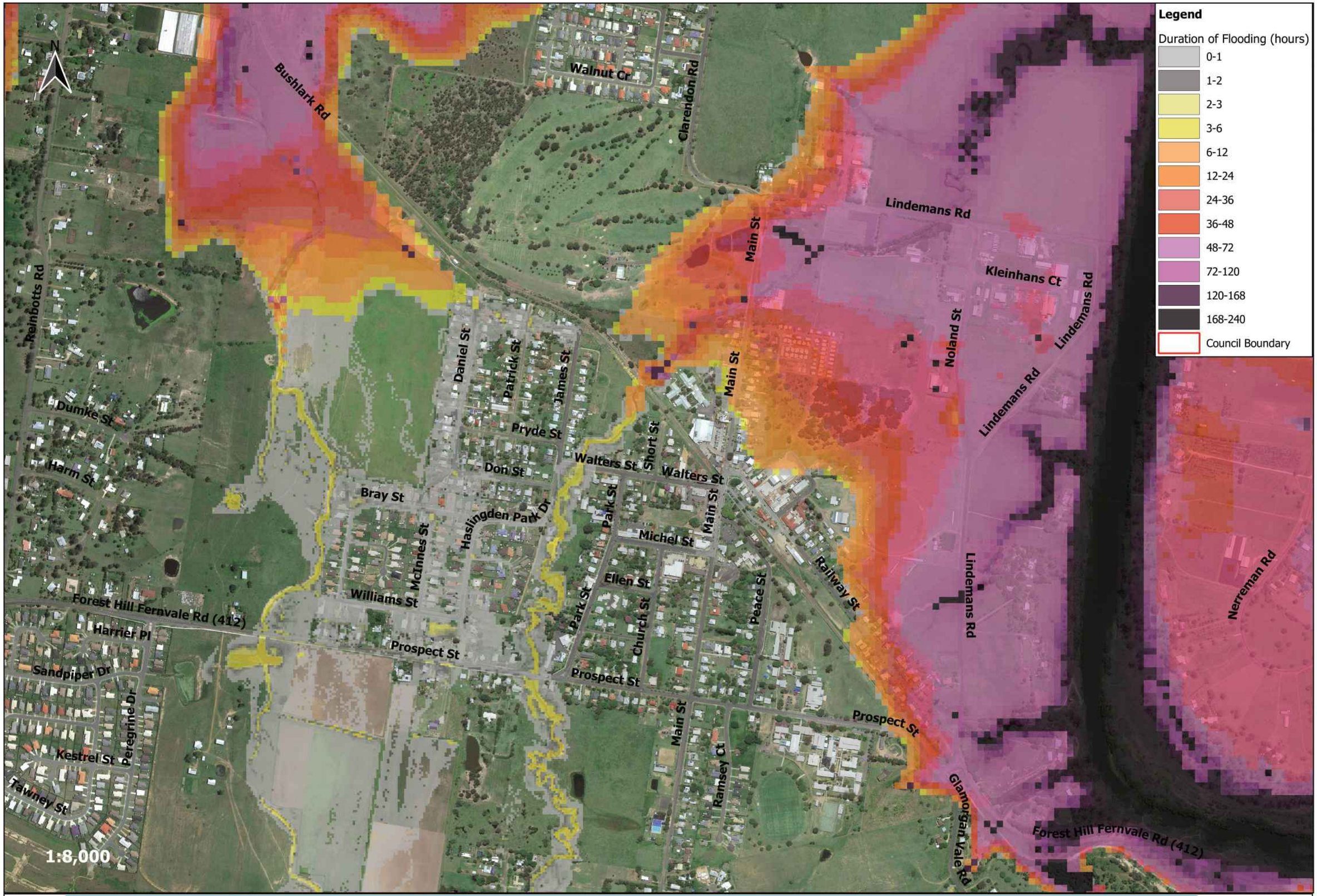
Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Kilcoy Township

2020-08-03T09:57:58.960




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

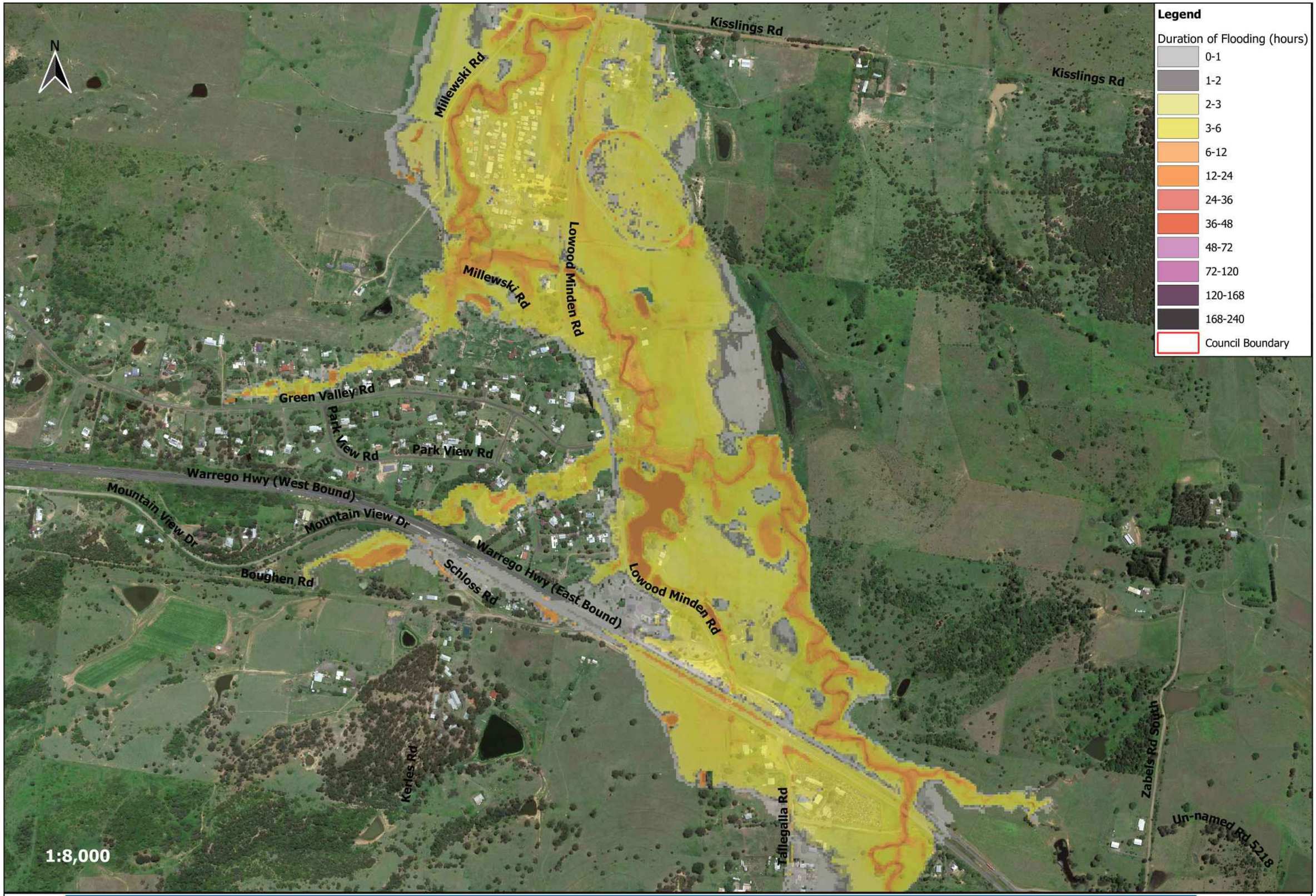
Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Lowood Township

2020-08-03T10:10:16.389




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

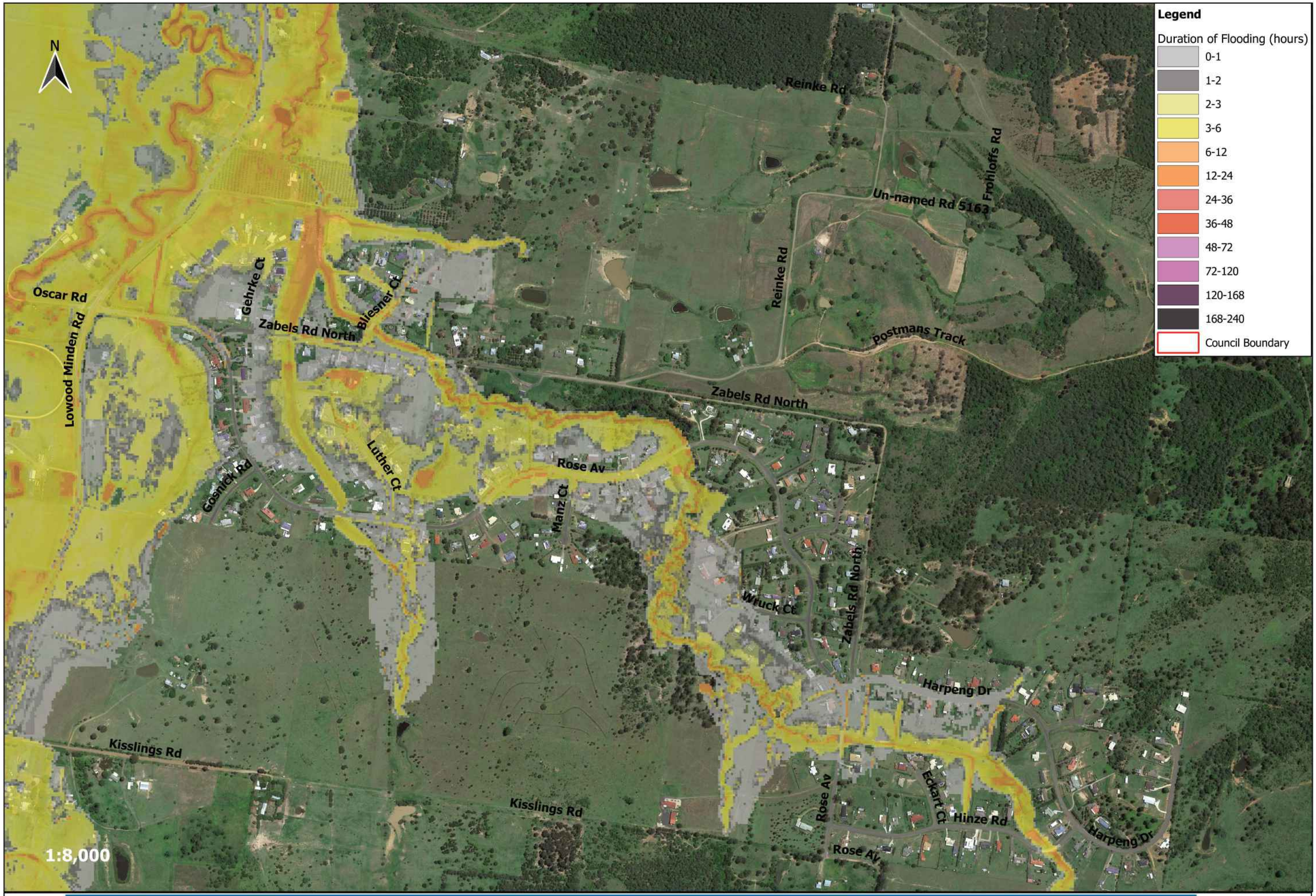
0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Minden Township Area

WATER TECHNOLOGY Synergy Solutions

2020-08-03T10:04:58.051




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 100 200 300 400 m

Somerset Regional Council Floodplain Management Plan

# Duration of Flooding 1 in 2000 AEP | Coolana Area

2020-08-03T10:06:07.300


2020-08-03T09:54:30.033

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX E
# FLOOD ISLAND MAPPING


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 400 800 1200 1600 m

Somerset Regional Council Local Floodplain Management Plan

Flood Islands | Esk

2020-01-30T10:47:56.431


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 900 1800 2700 3600 m

Somerset Regional Council Local Floodplain Management Plan

Flood Islands | Fernvale

2020-01-30T10:36:54.063

N

**Legend**

Council Boundary

Flood Islands

High Island

Low Island

1:23000

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

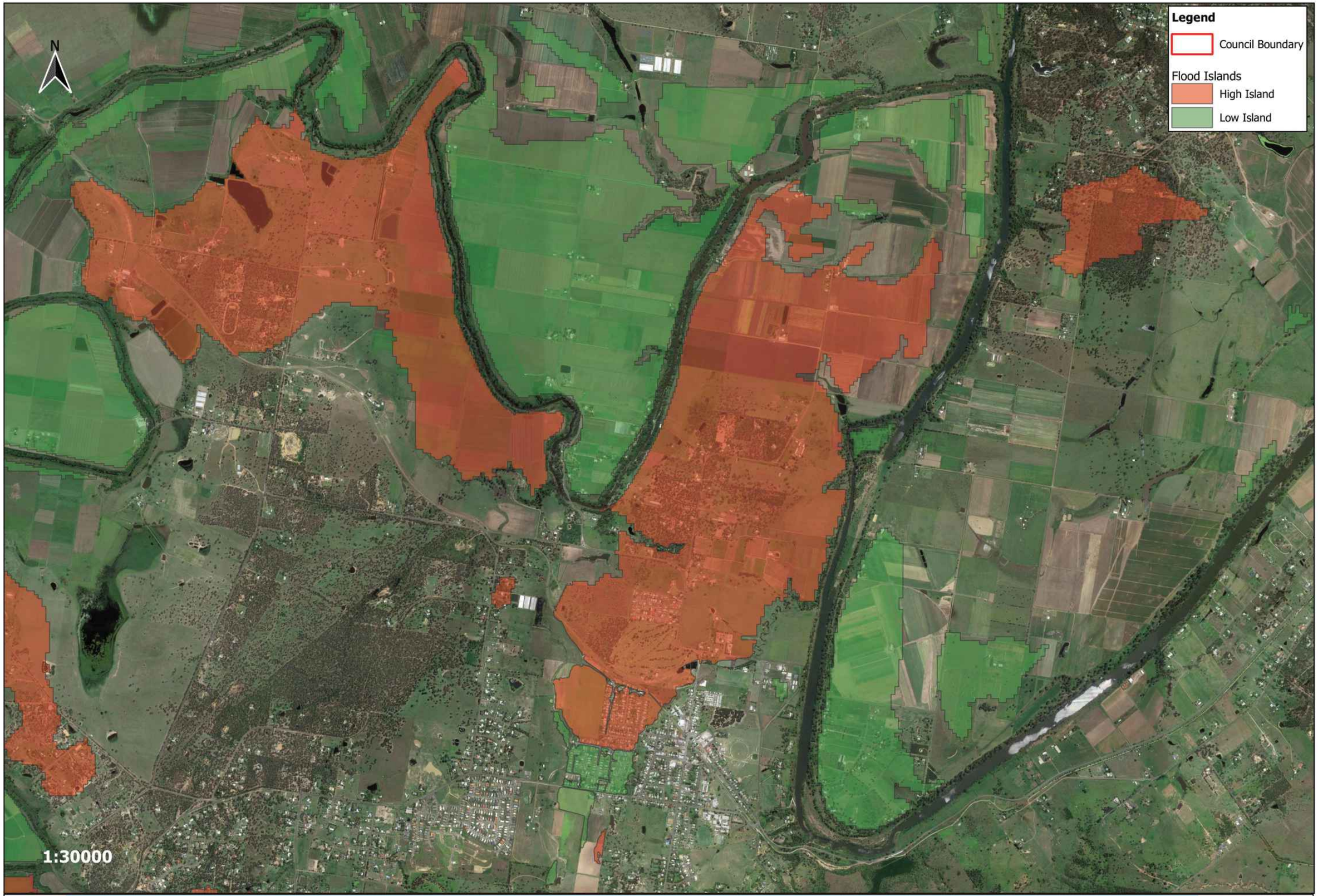
Projection: GDA/MGA94 Zone 56

0 700 1400 2100 2800 m

Somerset Regional Council Local Floodplain Management Plan

Flood Islands | Kilcoy

2020-01-30T10:45:09.300




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 900 1800 2700 3600 m

Somerset Regional Council Local Floodplain Management Plan

Flood Islands | Lowood

2020-01-30T10:38:22.980


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

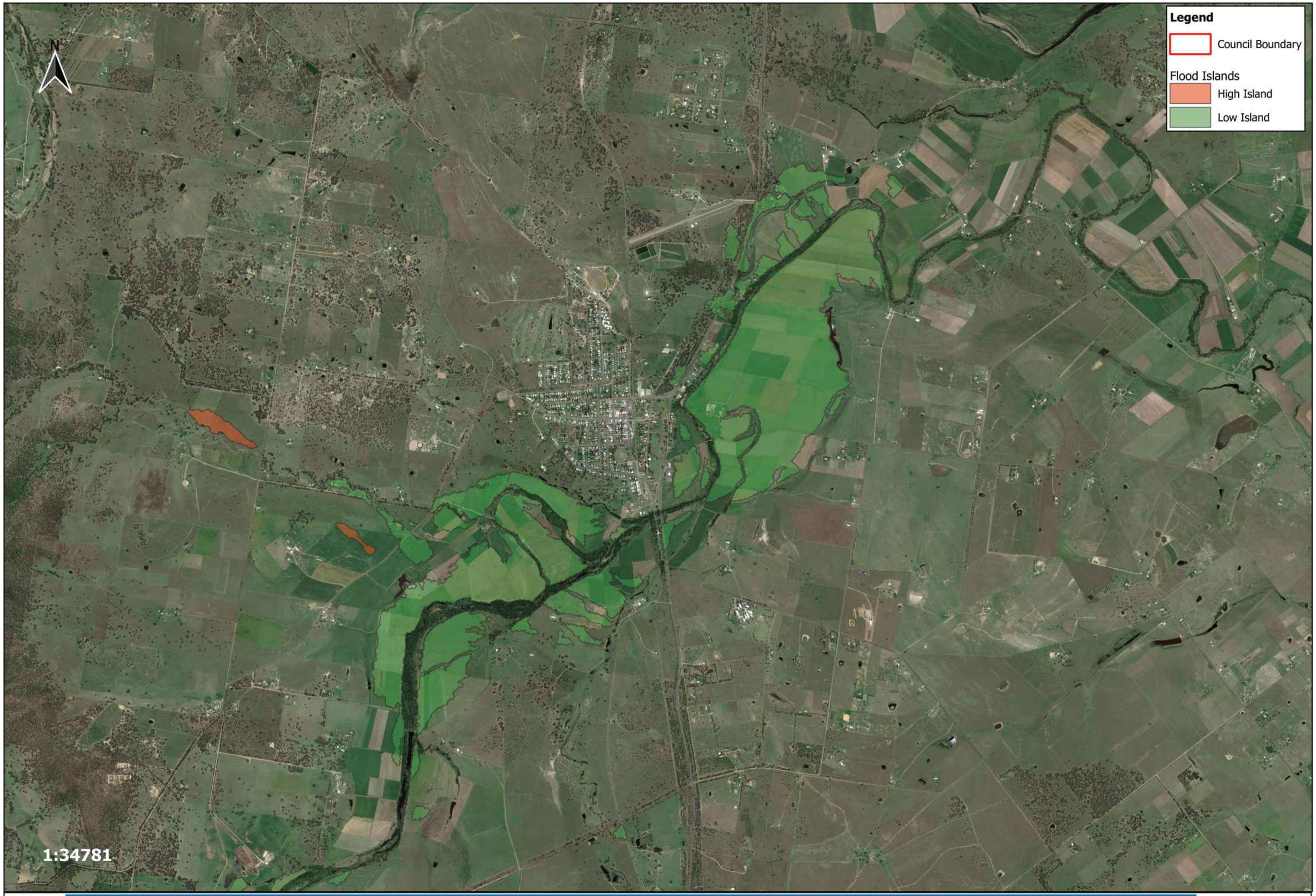
Projection: GDA/MGA94 Zone 56

0 700 1400 2100 2800 m

Somerset Regional Council Local Floodplain Management Plan

Flood Islands | Minden (Main Area)

2020-01-30T10:51:37.461




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 1000 2000 3000 4000 m

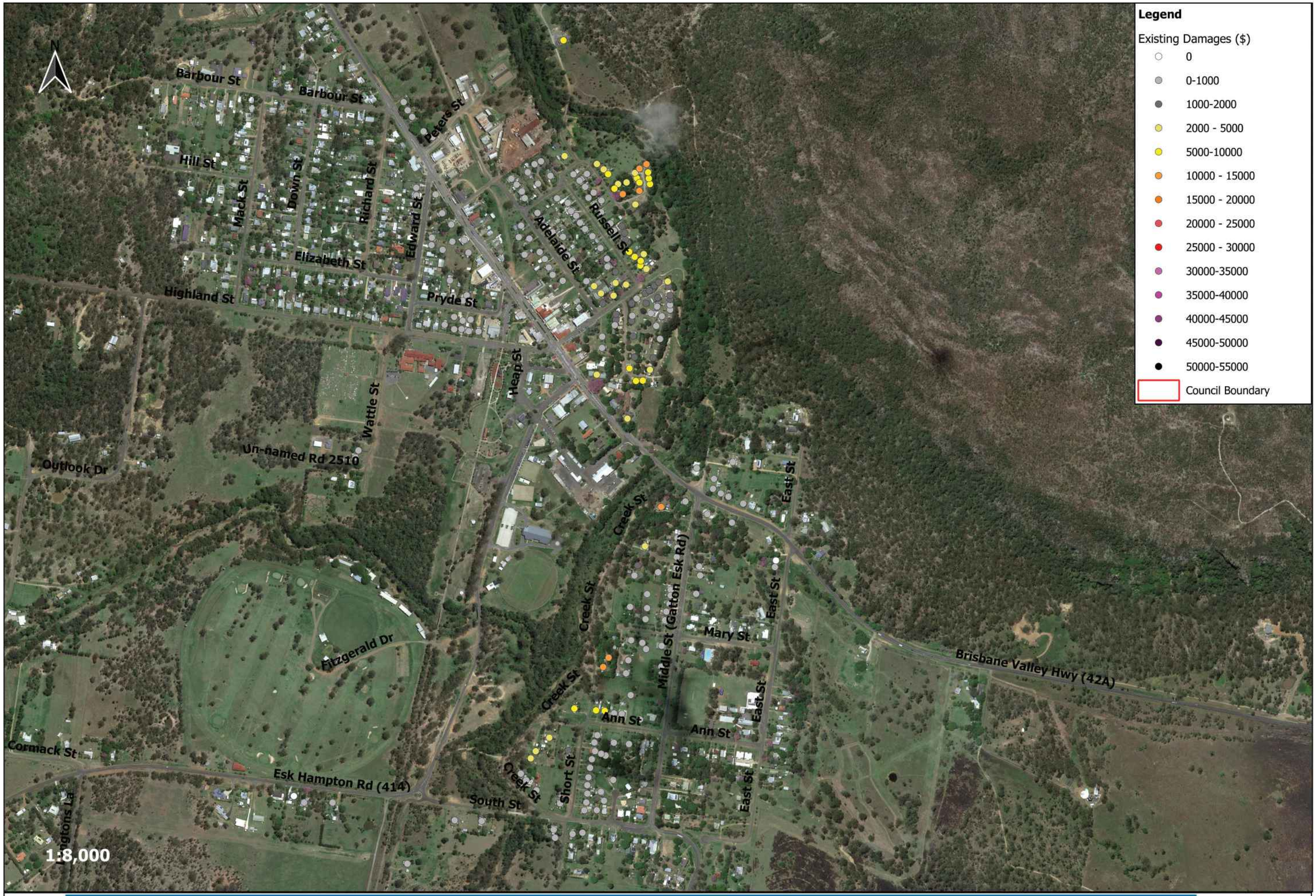
Somerset Regional Council Local Floodplain Management Plan

# Flood Islands | Toogoolawah

2020-01-30T10:42:55.607

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX F
# PROPERTY DAMAGES MAPPING




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Existing Damages | Esk Township

WATER TECHNOLOGY Synergy Solutions

2020-06-25T11:26:21.263


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Existing Damages | Fernvale Township

2020-08-03T09:26:29.232


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

# Existing Damages | Kilcoy Township

2020-08-03T09:37:57.515


N
Legend
Existing Damages ($)
0
0-1000
1000-2000
2000 - 5000
5000-10000
10000 - 15000
15000 - 20000
20000 - 25000
25000 - 30000
30000-35000
35000-40000
40000-45000
45000-50000
50000-55000
Council Boundary
Bushlark Rd
Walnut Cr
Clarendon Rd
Lindemans Rd
Main St
Kleinhans Ct
Noland St
Lindemans Rd
Reinbotts Rd
Dumke St
Harm St
Daniel St
Patrick St
James St
Pryde St
Don St
Walters St
Short St
Bray St
Park Dr
Michel St
Ellen St
Park St
Church St
Peace St
Railway St
Nerreman Rd
Forest Hill Fernvale Rd (412)
Harrier Pl
Sandpiper Dr
Peregrine Dr
Kestrel St
Tawney St
Prospect St
Ramsey Ct
Glamorgan Vale Rd
Russell Rd
Green St
1:8,000
Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019
Projection: GDA/MGA94 Zone 56
0
200
400
600
800 m
Somerset Regional Council Floodplain Management Plan
Existing Damages | Lowood Township
2020-08-03T09:27:44.146


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

Existing Damages | Minden Township

2020-08-03T09:29:19.526

N

Legend

Existing Damages ($)

- 0
- 0-1000
- 1000-2000
- 2000 - 5000
- 5000-10000
- 10000 - 15000
- 15000 - 20000
- 20000 - 25000
- 25000 - 30000
- 30000-35000
- 35000-40000
- 40000-45000
- 45000-50000
- 50000-55000
- Council Boundary

Reinke Rd
Frohloffs Rd
Un-named Rd 5163
Reinke Rd
Postmans Track
Zabels Rd North
Oscar Rd
Lowood Minden Rd
Gehrke Ct
Zabels Rd North
Bliesner Ct
Luther Ct
Gosnick Rd
Rose Av
Manz Ct
Wruck Ct
Zabels Rd North
Harpeng Dr
Kisslings Rd
Kisslings Rd
Rose Av
Eckart Ct
Hinze Rd
Harpeng Dr

1:8,000

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

Existing Damages | Coolana Area

WATER TECHNOLOGY Synergy Solutions

2020-08-03T09:30:53.916


2020-08-03T09:39:47.143

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX G
# MAPPING OF PROPERTIES POTENTIALLY ELIGIBLE FOR PROPERTY SPECIFIC ACTIONS


Imagery Source: Google Earth
Projection: GDA / MGA 94 Zone 56
Produced By: Synergy

0 0.25 0.5 km

Somerset Regional Council - Local Floodplain Management Plan

ESK - Buildings potentially eligible for Property Specific Actions

Synergy Solutions

WATER TECHNOLOGY
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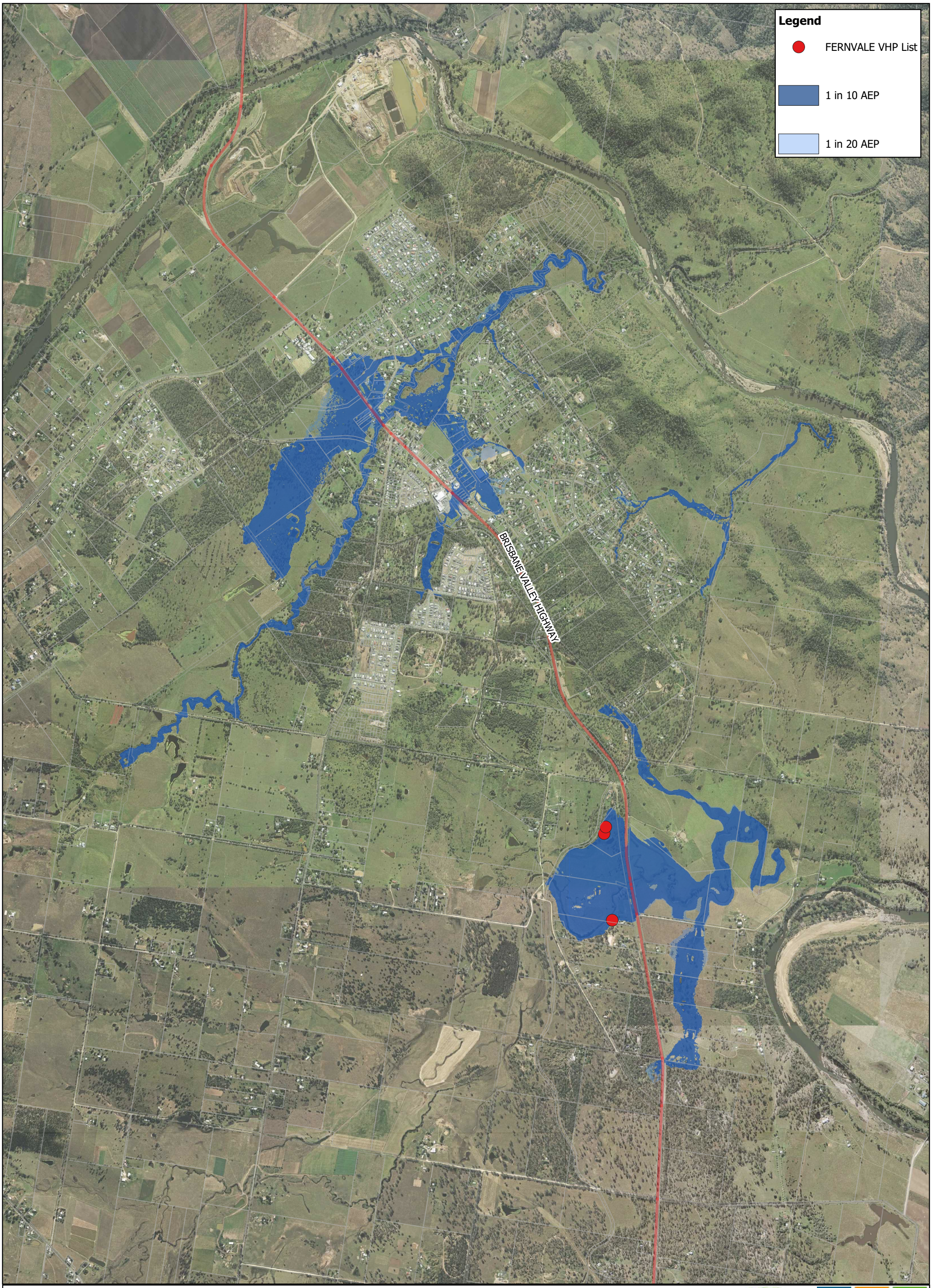
020-09-17T16:19:55.455




Imagery Source: Google Earth
Projection: GDA / MGA 94 Zone 56
Produced By: Synergy

0 0.125 0.25 km

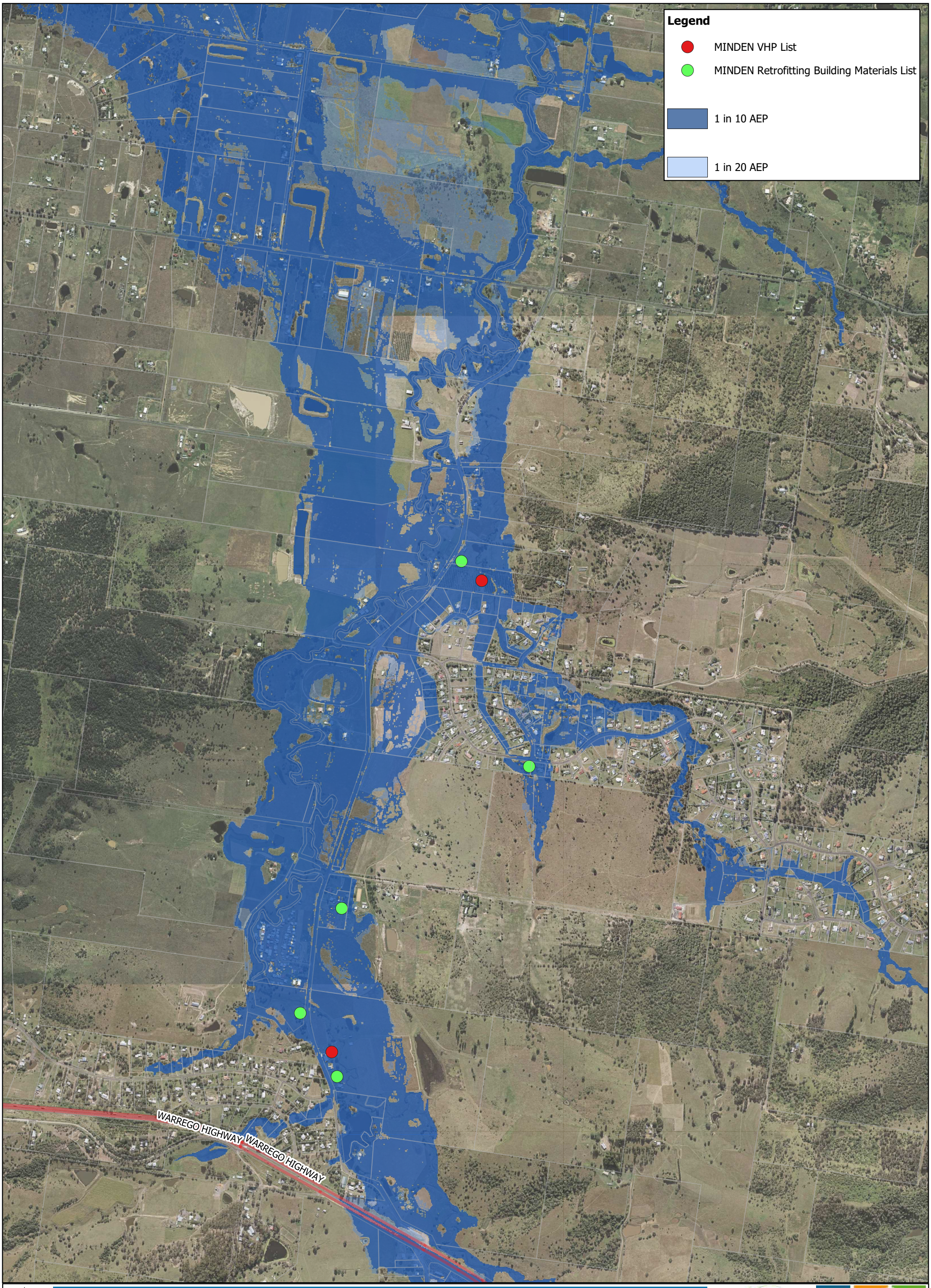
Somerset Regional Council - Local Floodplain Management Plan

FERNVALE - Buildings Potentially Eligible for Property Specific Actions

Synergy Solutions

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

020-09-17T16:20:01.796




Imagery Source: Google Earth
Projection: GDA / MGA 94 Zone 56
Produced By: Synergy

0 0.25 0.5 km

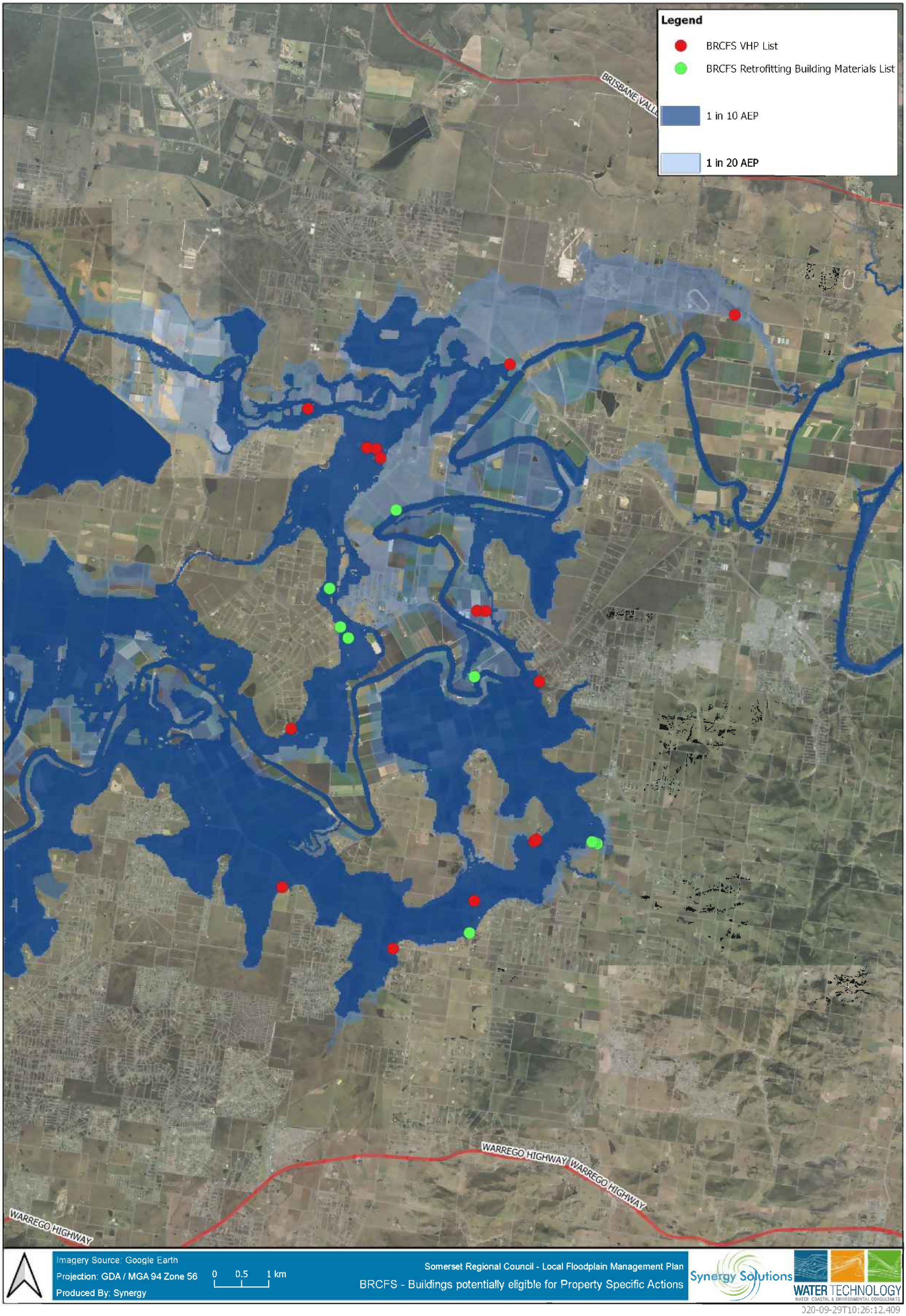
Somerset Regional Council - Local Floodplain Management Plan

MINDEN - Buildings Potentially Eligible for Property Specific Actions

Synergy Solutions

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

020-09-17T16:20:20.165




020-09-29T10:26:12.409

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

# APPENDIX H
# PROPERTIES POTENTIALLY ELIGIBLE FOR PROPERTY SPECIFIC ACTIONS (REDACTED)

TABLE 10-1 PROPERTIES POTENTIALLY ELIGIBLE FOR VHP

| BLDG_PID | SEARCH_ADD | LOCALITY | BLDG_PD | BLDG_AREA m2 | Floor Level | CATEGORY | Hazard in 1 in 100 | AAD | Locality wide AAD | After Locality wide AAD | Reduction in locality AAD (Benefit) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BLDQLD0012943977 | [redacted] | ESK | MUDS | 195.3 | 107.8 | Residential | 5 | $11,154 | $228,745 | $220,947 | $7,798 |
| BLDQLD0013235220 | [redacted] | ESK | FDSS-Stumps | 146.8 | 112.4 | Residential | 5 | $10,966 | $228,745 | $221,718 | $7,027 |
| BLDQLD0013236534 | [redacted] | ESK | FDSS-SOG | 105.3 | 107.8 | Residential | 5 | $10,047 | $228,745 | $223,240 | $5,505 |
| BLDQLD0002786280 | [redacted] | FAIRNEY VIEW | FDSS-SOG | 208.3 | 33.1 | Rural/Primary Production | 6 | $58,929 | $109,412 | $79,850 | $29,563 |
| BLDQLD0003433729 | [redacted] | FAIRNEY VIEW | FDSS-SOG | 134.0 | 33.1 | Rural/Primary Production | 6 | $53,106 | $109,412 | $83,226 | $26,186 |
| BLDQLD0003432677 | [redacted] | FAIRNEY VIEW | FDSS-SOG | 199.5 | 33.2 | Rural/Primary Production | 5 | $58,996 | $109,412 | $80,050 | $29,362 |
| BLDQLD0009545991 | [redacted] | MINDEN | FDSS-Stumps | 389.0 | 78.6 | Rural/Primary Production | 5 | $45,026 | $459,241 | $442,072 | $17,169 |
| BLDQLD0002795319 | [redacted] | MINDEN | FDSS-SOG | 132.9 | 90.9 | Rural/Primary Production | 5 | $5,748 | $459,241 | $456,584 | $2,657 |
| 6416 | [redacted] | COOLANA | FDSS-SOG | 176.1 | 63.4 | Agriculture | 5 | $11,931 | $2,074,964 | $2,065,450 | $9,514 |
| 6420 | [redacted] | COOLANA | FDSS-SOG | 216.1 | 63.5 | Agriculture | 5 | $15,921 | $2,074,964 | $2,062,149 | $12,815 |
| BLDQLD0002784232 | [redacted] | CLARENDON | FDSS-SOG | 213.0 | 52.2 | Agriculture | 5 | $16,297 | $2,074,964 | $2,064,527 | $10,436 |
| BLDQLD0002784234 | [redacted] | CLARENDON | FDSS-SOG | 240.4 | 52.0 | Agriculture | 5 | $17,156 | $2,074,964 | $2,061,290 | $13,674 |
| BLDQLD0002784235 | [redacted] | CLARENDON | FDSS-SOG | 198.1 | 52.4 | Agriculture | 5 | $14,938 | $2,074,964 | $2,065,226 | $9,738 |
| BLDQLD0002784481 | [redacted] | CLARENDON | FDSS-SOG | 201.2 | 54.7 | Agriculture | 5 | $13,820 | $2,074,964 | $2,066,168 | $8,796 |
| BLDQLD0002785961 | [redacted] | RIFLE RANGE | FDSS-SOG | 189.6 | 60.3 | Agriculture | 5 | $15,395 | $2,074,964 | $2,065,207 | $9,757 |
| BLDQLD0002786755 | [redacted] | PATRICK ESTATE | FDSS-SOG | 223.2 | 47.9 | Agriculture | 6 | $16,013 | $2,074,964 | $2,064,537 | $10,427 |
| BLDQLD0003430984 | [redacted] | RIFLE RANGE | FDSS-SOG | 197.4 | 60.6 | Agriculture | 5 | $12,323 | $2,074,964 | $2,066,821 | $8,142 |
| BLDQLD0003431497 | [redacted] | COOMINYA | FDSS-SOG | 211.0 | 52.5 | Agriculture | 5 | $9,159 | $2,074,964 | $2,068,201 | $6,763 |
| BLDQLD0003432069 | [redacted] | PRENZLAU | FDSS-SOG | 180.3 | 66.1 | Agriculture | 5 | $22,920 | $2,074,964 | $2,056,515 | $18,449 |

| BLDG_PID | SEARCH_ADD | LOCALITY | BLDG_PD | BLDG_AREA m2 | Floor Level | CATEGORY | Hazard in 1 in 100 | AAD | Locality wide AAD | After Locality wide AAD | Reduction in locality AAD (Benefit) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BLDQLD0003432081 | [redacted] | BRIGHTVIEW | FDSS-SOG | 208.9 | 67.1 | Agriculture | 5 | $15,861 | $2,074,964 | $2,062,347 | $12,617 |
| BLDQLD0003432094 | [redacted] | PRENZLAU | FDSS-SOG | 108.7 | 66.1 | Agriculture | 5 | $20,674 | $2,074,964 | $2,061,593 | $13,371 |
| BLDQLD0003432857 | [redacted] | RIFLE RANGE | FDSS-SOG | 115.8 | 63.0 | Agriculture | 5 | $12,457 | $2,074,964 | $2,065,148 | $9,816 |
| BLDQLD0003434449 | [redacted] | MOUNT TARAMPA | FDSS-SOG | 139.8 | 65.4 | Agriculture | 5 | $17,317 | $2,074,964 | $2,066,587 | $8,377 |

TABLE 10-2 PROPERTIES POTENTIALLY ELIGIBLE FOR RETROFITTING BUILDING MATERIALS

| BLDG_PID | SEARCH_ADD | LOCALITY | BLDG_PD | BLDG_AREA m2 | FL | WC_HR_MIN | CATEGORY | Hazard in 1 in 100 | AAD | Locality wide AAD | After Locality wide AAD | Reduction in locality AAD (Benefit) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BLDQLD0012944892 | [redacted] | ESK | FDSS-Stumps | 176.7420146 | 110.42 | 7 | Residential | 3 | $6268 | 228745 | 228178 | 567 |
| BLDQLD0012946074 | [redacted] | ESK | FDSS-SOG | 146.2573417 | 107.76 | 4 | Residential | 4 | $10,665 | $228,745 | $227,109 | $1,636 |
| BLDQLD0013233144 | [redacted] | ESK | FDSS-Stumps | 148.2617445 | 108.85 | 4 | Residential | 3 | $9,683 | $228,745 | $227,619 | $1,126 |
| BLDQLD0013235438 | [redacted] | ESK | FDSS-SOG | 140.7240578 | 112.71 | 4 | Residential | 3 | $5,950 | $228,745 | $228,128 | $617 |
| BLDQLD0013235862 | [redacted] | ESK | FDSS-SOG | 240.1858353 | 112.38 | 4 | Residential | 3 | $10,857 | $228,745 | $227,729 | $1,017 |
| BLDQLD0013236533 | [redacted] | ESK | FDSS-SOG | 110.9842228 | 107.76 | 4 | Residential | 4 | $10,233 | $228,745 | $227,164 | $1,581 |
| BLDQLD0013236545 | [redacted] | ESK | FDSS-SOG | 110.2015667 | 110.42 | 7 | Residential | 3 | $6,488 | $228,745 | $228,134 | $611 |
| BLDQLD0010987460 | [redacted] | MINDEN | FDSS-Stumps | 195.2 | 83.14 | 5 | Residential | 1 | $149,083 | $459,241 | $448,297 | $10,943 |
| BLDQLD0002795316 | [redacted] | MINDEN | FDSS-SOG | 408.5 | 90.93 | 5 | Residential | 2 | $24,844 | $459,241 | $456,241 | $3,000 |
| BLDQLD0002795322 | [redacted] | MINDEN | FDSS-SOG | 242.7 | 89.45 | 5 | Residential | 2 | $19,622 | $459,241 | $458,225 | $1,016 |
| BLDQLD0003418249 | [redacted] | MINDEN | FDSS-SOG | 260.6 | 87.75 | 5 | Residential | 2 | $11,133 | $459,241 | $457,549 | $1,692 |
| BLDQLD0010974935 | [redacted] | MINDEN | FDSS-SOG | 279.6 | 77.94 | 2 | Residential | 4 | $22,267 | $459,241 | $458,225 | $1,016 |

| BLDG_PID | SEARCH_ADD | LOCALITY | BLDG_PD | BLDG_AREA_m2 | FL | WC_HR_MIN | CATEGORY | Hazard in 1 in 100 | AAD | Locality wide AAD | After Locality wide AAD | Reduction in locality AAD (Benefit) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6394 | | TARAMPA | FDSS-SOG | 411.296 | 63.4099998 | 4 | Residential | 4 | $15,683 | $2,074,964 | $2,072,346 | $2,618 |
| 6395 | | TARAMPA | FDSS-SOG | 286.7754 | 63.7599983 | 4 | Residential | 4 | $13,546 | $2,074,964 | $2,073,413 | $1,551 |
| 6398 | | TARAMPA | FDSS-SOG | 362.1289 | 63.9799995 | 4 | Residential | 3 | $7,773 | $2,074,964 | $2,074,508 | $455 |
| BLDQLD0002783238 | [redacted] | MOUNT TARAMPA | FDSS-SOG | 343.8873788 | 57.6500015 | 2 | Residential | 4 | $6,849 | $2,074,964 | $2,074,570 | $393 |
| BLDQLD0002783746 | [redacted] | MOUNT TARAMPA | FDSS-SOG | 124.4965977 | 60.6800003 | 2 | Residential | 4 | $11,544 | $2,074,964 | $2,074,273 | $690 |
| BLDQLD0003431576 | [redacted] | PRENZLAU | FDSS-SOG | 212.1294016 | 66.2699966 | 2 | Residential | 4 | $29,966 | $2,074,964 | $2,071,064 | $3,900 |
| BLDQLD0003432042 | [redacted] | CLARENDON | FDSS-SOG | 211.8088613 | 58.6300011 | 2 | Residential | 3 | $8,215 | $2,074,964 | $2,074,596 | $368 |
| BLDQLD0003433107 | [redacted] | MOUNT TARAMPA | FDSS-SOG | 91.08435514 | 59.6399994 | 2 | Residential | 4 | $15,048 | $2,074,964 | $2,073,946 | $1,018 |
| BLDQLD0003433915 | [redacted] | MOUNT TARAMPA | FDSS-SOG | 235.8536858 | 63.5600014 | 4 | Residential | 4 | $6,526 | $2,074,964 | $2,074,167 | $796 |

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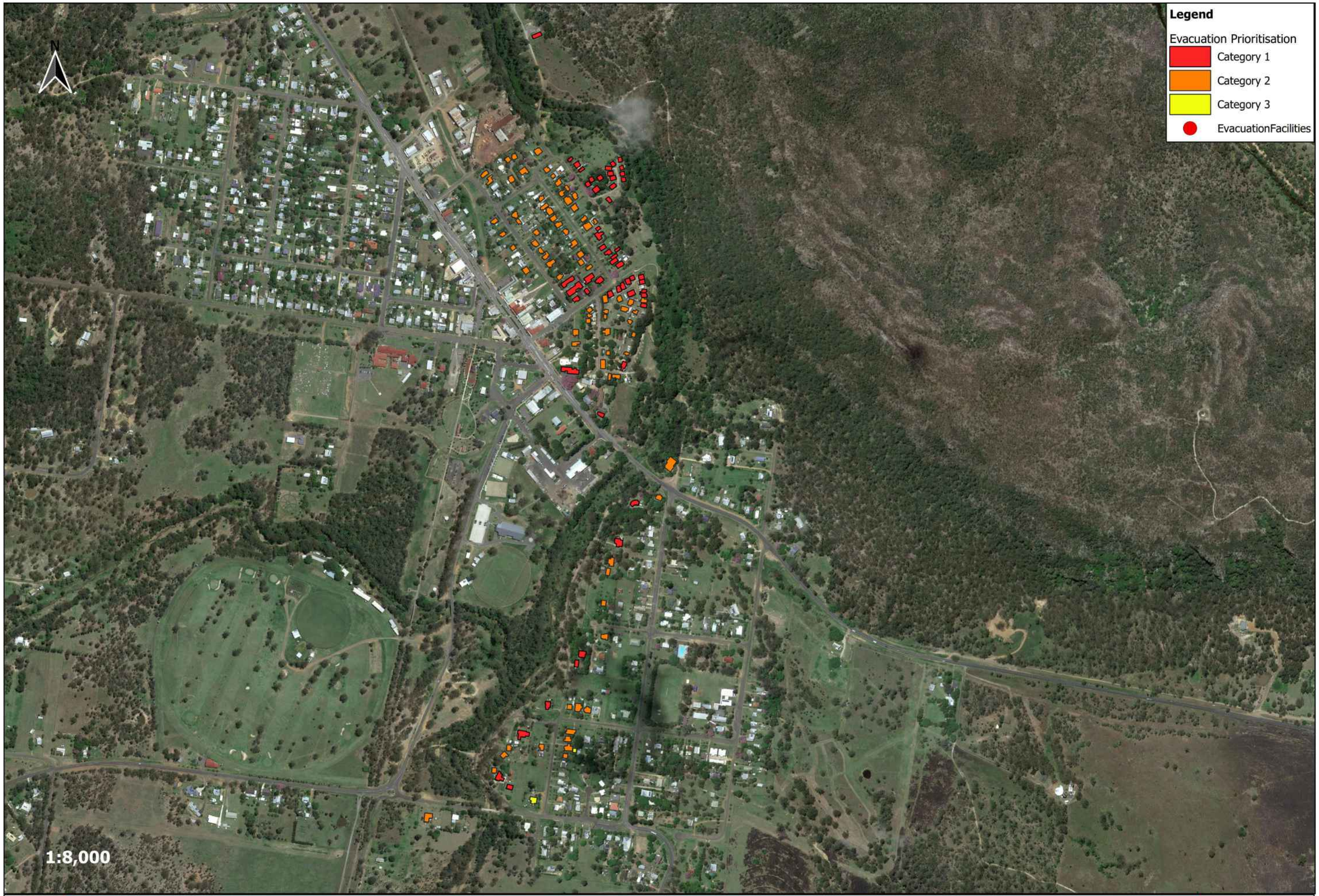
# APPENDIX I
# EVACUATION ASSESSMENT AND ROAD FLOOD IMMUNITY MAPPING




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Esk Township

2020-08-22T14:25:18.057


Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Fernvale Area

WATER TECHNOLOGY Synergy Solutions

2020-08-13T15:27:28.584


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Kilcoy Township

2020-08-12T17:03:48.966


2020-08-03T12:55:35.004


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Minden Area

2020-08-03T12:07:50.977


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Coolana Area

2020-08-03T12:09:07.796


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

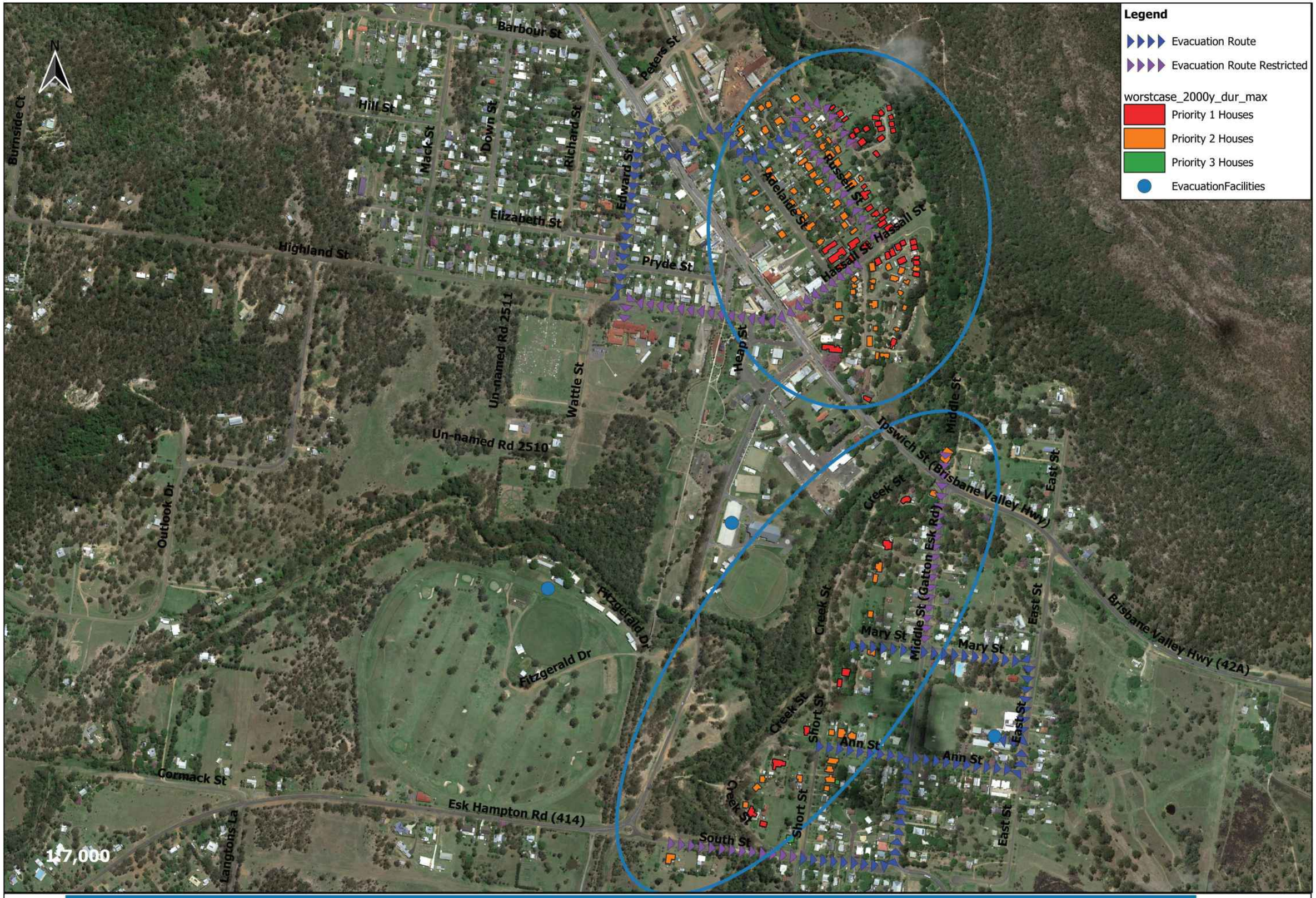
Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Toogoolawah Township

2020-08-12T13:36:47.736




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

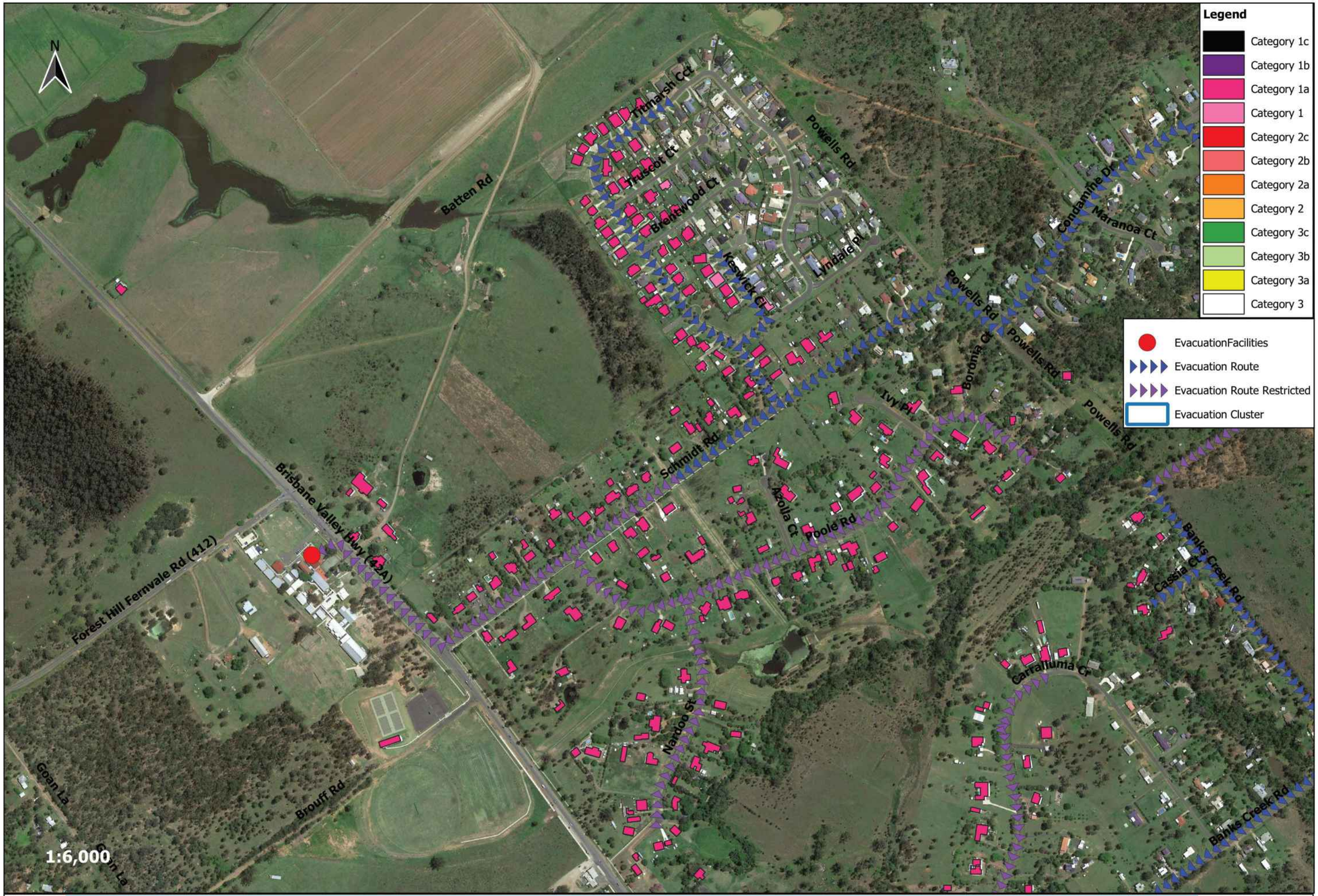
Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Prioritisation | Esk Township

2020-06-29T15:43:13.319




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

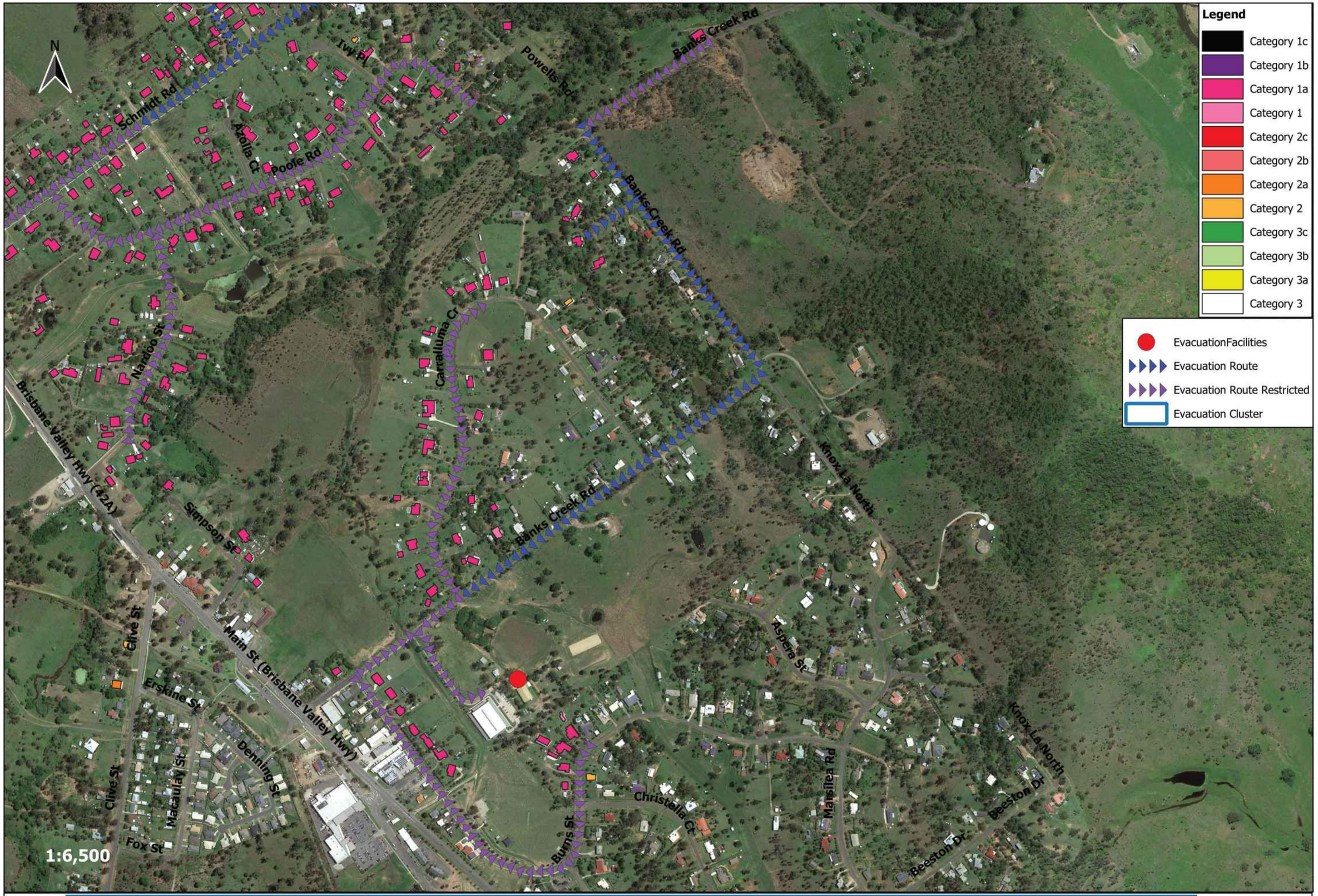
0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Routing Area 1 | Fernvale Township

WATER TECHNOLOGY Synergy Solutions

2020-08-13T15:29:22.848




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Routing Area 2 | Fernvale Township

2020-08-13T15:35:03.706


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

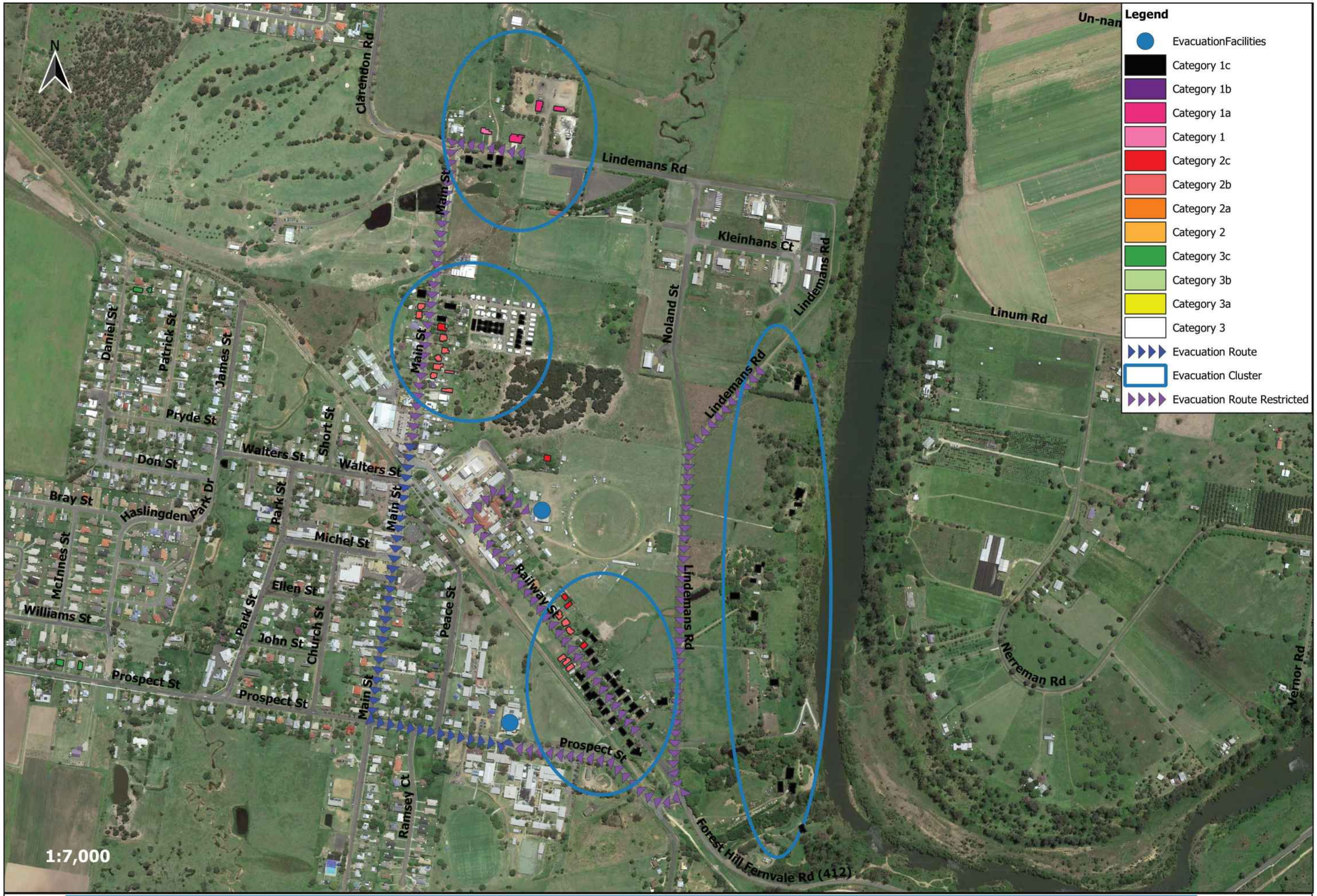
Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Evacuation Routing | Kilcoy Township

2020-08-12T17:09:22.625




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

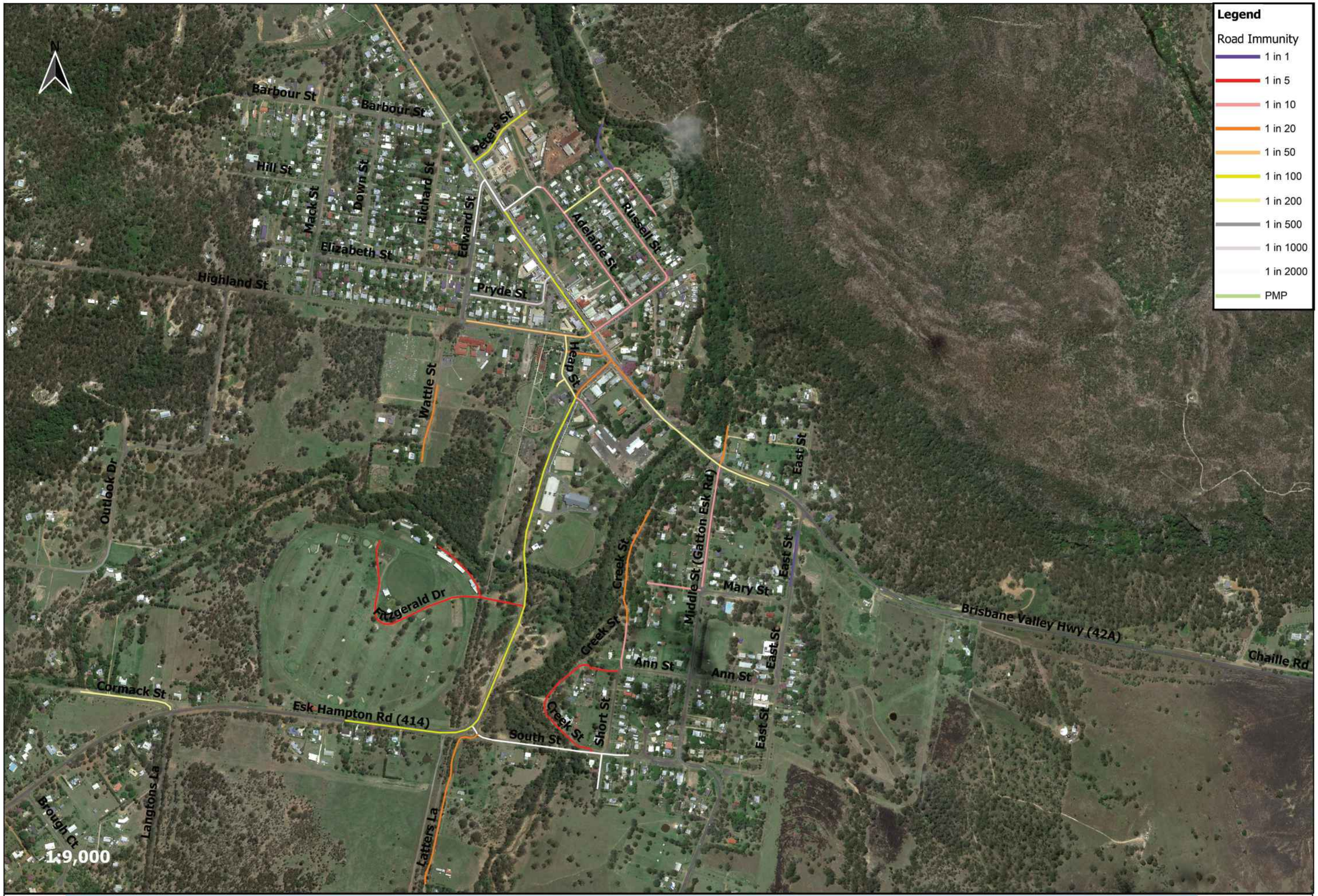
0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

Evacuation Routing | Lowood Township

2020-08-14T12:37:27.155


2020-12-21T16:53:49.276




Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

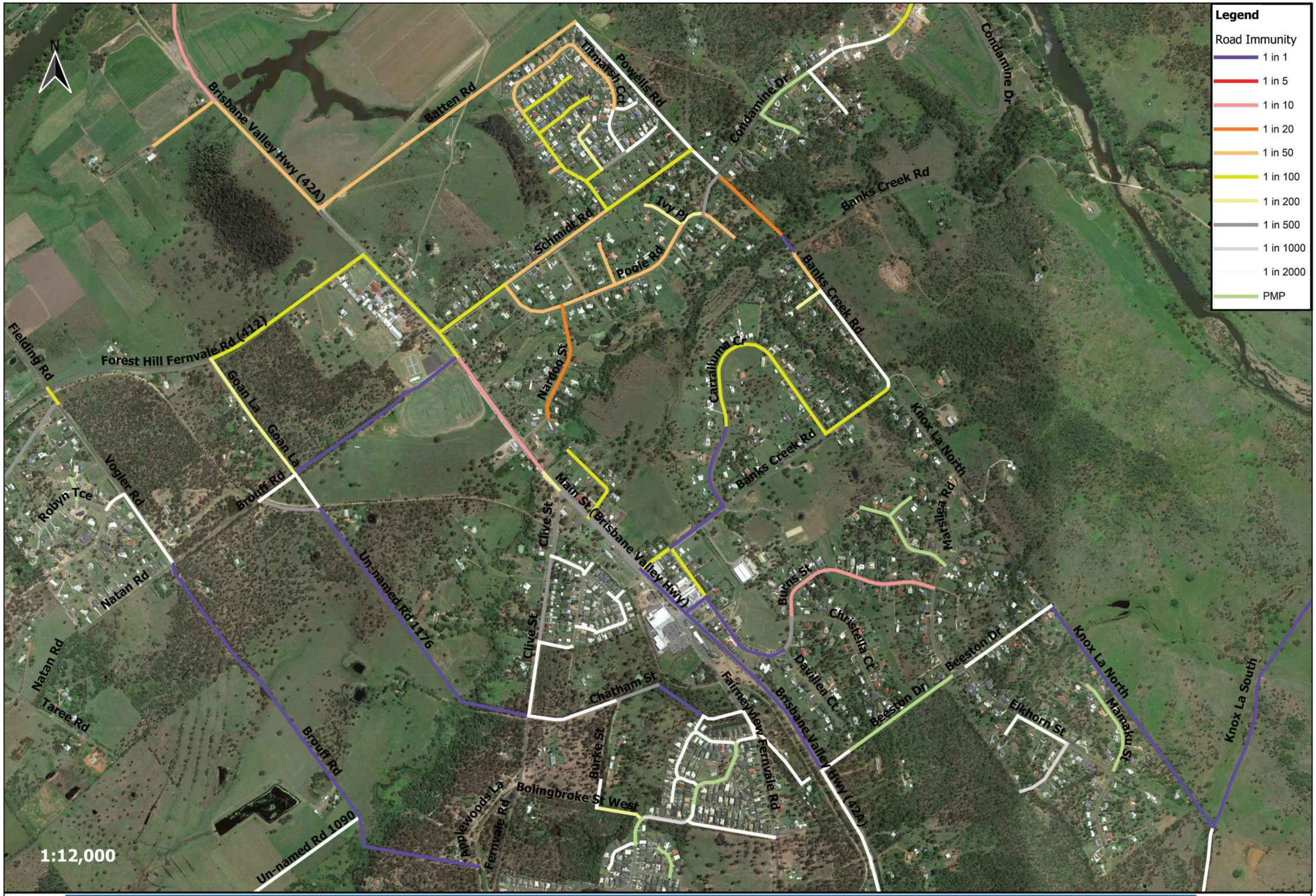
Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

Road Immunity | Esk Township

2020-06-29T15:58:28.863




2020-08-13T09:55:38.886


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

Road Immunity | Kilcoy Township

2020-08-03T11:02:17.906


Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

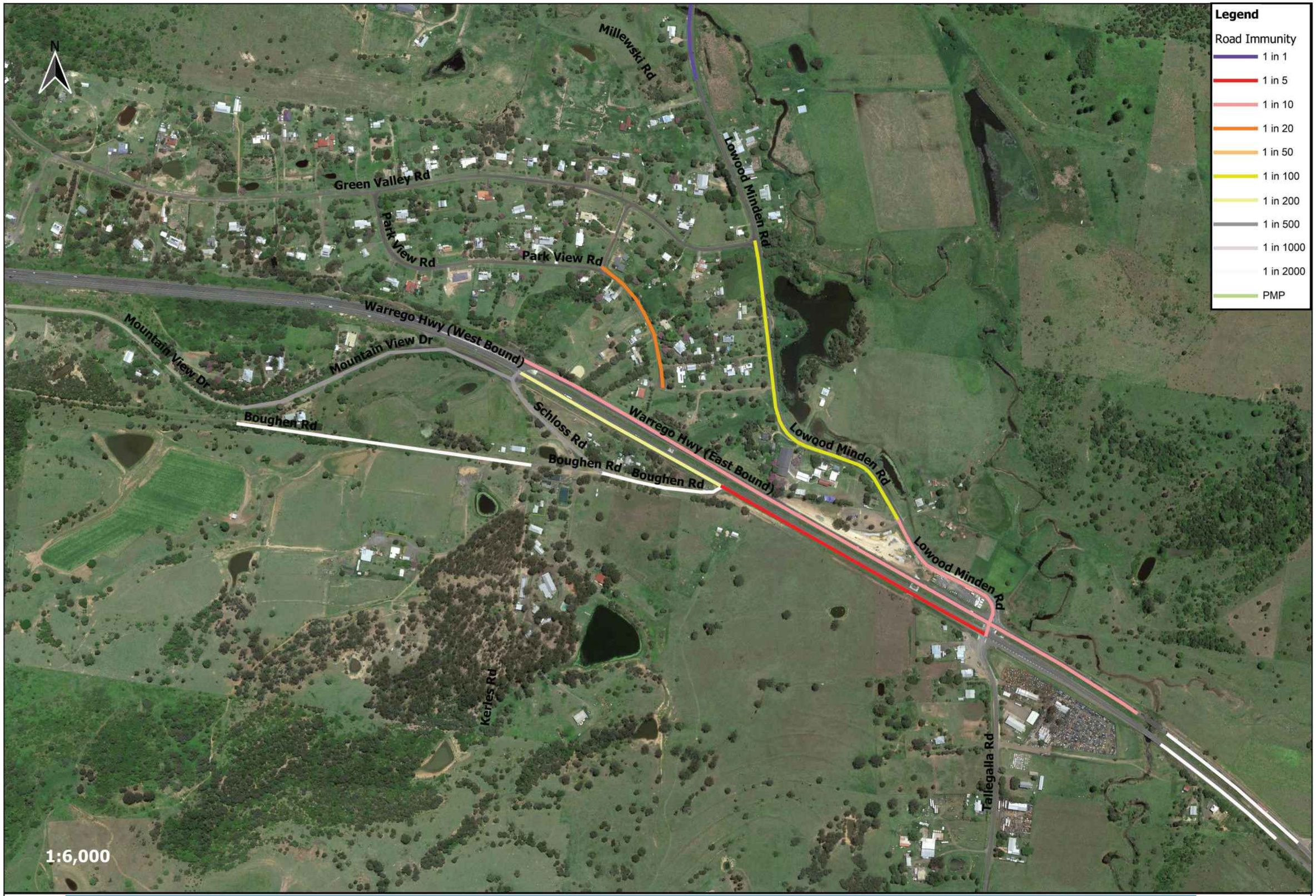
Projection: GDA/MGA94 Zone 56

0 200 400 600 800 m

Somerset Regional Council Floodplain Management Plan

Road Immunity | Lowood Township

2020-08-13T09:58:42.638




Somerset Regional Council

Data sources: Imagery 2019 CNES/Airbus, Maxar Technologies 2019

Projection: GDA/MGA94 Zone 56

0 80 160 240 320 m

Somerset Regional Council Floodplain Management Plan

# Road Immunity | Minden Township

WATER TECHNOLOGY Synergy Solutions

2020-08-03T10:54:31.039


2020-08-03T10:59:27.749

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# APPENDIX J
# PROPOSED GAUGE CLASSIFICATION LEVELS – IMPACT ANALYSIS

| | | | | | | |
|---|---|---|---|---|---|---|
| **Location** | **Glenore Grove** | | | | | |
| **Gauge Name(s)** | **Glenore Grove** | | | | | |
| **Gauge Number** | **540149** | | | | | |
| **Gauge Zero** | **67.11** | | | | | |
| **Classification Triggers** | **Category** | **Nearest AEP extent (gauge level of AEP)** | **Impacts** | **Recommended Gauge Level** | | |
| | **Minor** | **1 in 5** | **Out of bank flooding, farm equipment likely needs to be moved.** | **12.5** | | |
| | **Moderate** | **1 in 10** | **Rural flood islands. Stock and farm equipment need to be moved.** | **14.0** | | |
| | **Major** | **1 in 20** | **Properties and townships are likely to be isolated.** | **14.5** | | |
| **Flood Classification** | **Impact** | | **YES/NO (Where)** | **WSL at Impact** | **WSL at Gauge** | **Depth at Gauge** |
| MINOR | Inconvenience | | No | | | |
| | Low lying areas | | Yes | | | |
| | Minor roads closed | | Yes<br>Wendts Rd, Niethe Road, Blin Gully Rd, Lockrose Rd | 66.0-70.7 | 79.6 | 12.5 |
| | Low level bridges | | No | | | |
| | Inundation in urban areas | | No | | | |
| | Backyards inundated | | No | | | |
| | | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Buildings below floor level | | | | |
| | Bicycle and pedestrian paths impacted | No | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | Yes<br>West of Mt Tarampa, Niethe and Kammholz Rd | 66.6-69.3 | 79.6 | 12.5 |
| MODERATE | Inundation in some areas is more substantial | Yes<br>West of Mt Tarampa | 68.3 | 81.4 | 14.3 |
| | Main traffic routes may be affected | Yes<br>Forest Hill Fernvale Rd | 73 | 81.4 | 14.3 |
| | Some buildings are likely to be affected above floor level | No | | | |
| | Evacuation of flood affected areas may be required | Yes<br>Mt Tarampa, evac may be required | 69 | 81.4 | 14.3 |
| | stock needs to be moved to higher ground | No | | | |
| | Farm equipment need to be moved | Yes | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes | | 81.8 | 14.7 |
| | Urban Areas are inundated in and in some areas islands with isolation are identified | Yes<br>Southwest of Mt Tarampa | 72.4 | 81.8 | 14.7 |

| | | | | | |
|---|---|---|---|---|---|
| | Many buildings are impacted and affected above floor level | No | | | |
| | Properties and townships are likely to be isolated | Yes<br>Mount Tarampa | 68.7 | 81.8 | 14.7 |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | | | | |
| | Utility services may be impacted | No | | | |

| | | | | |
|---|---|---|---|---|
| **Location** | **Lyons Bridge** | | | |
| **Gauge Name(s)** | **Lyons Bridge Alert P** | | | |
| **Gauge Number** | **540174** | | | |
| **Gauge Zero** | **47.53** | | | |
| **Classification Triggers** | **Category** | **Nearest AEP extent (gauge level of AEP)** | **Impacts** | **Recommended Gauge Level** |
| | **Minor** | **1 in 5** | **Out of bank flooding, farm equipment likely needs to be moved.** | **12.5** |
| | **Moderate** | **1 in 10** | **Rural flood islands. Stock and farm equipment need to be moved.** | **15.5** |
| | **Major** | **1 in 20** | **Properties and townships are likely to be isolated.** | **16.0** |

| Flood Classification | Impact | YES/NO (Where) | WSL at Impact | WSL at Gauge | Depth at Gauge |
|---|---|---|---|---|---|
| MINOR | Inconvenience | No | | | |
| | Low lying areas | No | | | |
| | Minor roads closed | Yes<br>Radkes Rd<br>Marschkes Rd | 60.1-63.0 | 60.3-63.1 | 12.8 |
| | Low level bridges | No | | | |
| | Inundation in urban areas | No | | | |
| | Backyards inundated | No | | | |
| | Buildings below floor level | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Bicycle and pedestrian paths impacted | No | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | Yes<br>Along Forest hill Fernvale road north of Lockyer Creek crossing | 61 | 60.3 | 12.8 |
| MODERATE | Inundation in some areas is more substantial | Yes<br>North of Brightview Rd, south of Forest Hill Fernvale Rd | 59.5 | 63.1 | 15.6 |
| | Main traffic routes may be affected | Yes<br>Forest Hill Fernvale Rd cut | 60.4 | 64 | 16.5 |
| | Some buildings are likely to be affected above floor level | Yes<br>Mount Tarampa Rd, Marschkes Rd | 43.1 - 63.9 | 64 | 16.5 |
| | Evacuation of flood affected areas may be required | Yes<br>End of Radkes road and Marschkes Rd | 63 | 63.1 | 15.6 |
| | stock needs to be moved to higher ground | No | | | |
| | Farm equipment need to be moved | No | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes<br>North of Clarendon Rd | 55.4 | 64 | 16.5 |

| | | | | | |
|---|---|---|---|---|---|
| | Urban Areas are inundated in and in some areas islands with isolation are identified | No | | | |
| | Many buildings are impacted and affected above floor level | Yes<br>Mahons Rd | 59.5 | 64 | 16.5 |
| | Properties and townships are likely to be isolated | Yes<br>South of Clarendon Rd | 49.6-61.4 | 64 | 16.5 |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | Yes<br>Ripley Road Flooding at Clarendon State School Cut, some rural properties on flood islands. Other waterways likely to be elevated. | 56.2 | 64 | 16.5 |
| | Utility services may be impacted | | | | |

| Location | Rifle Range | | | | | |
|---|---|---|---|---|---|---|
| Gauge Name(s) | Rifle Range Road | | | | | |
| Gauge Number | 40817 | | | | | |
| Gauge Zero | 44.28 | | | | | |
| Classification Triggers | Category | Nearest AEP extent (gauge level of AEP) | Impacts | Recommended Gauge Level | | |
| | Minor | 1 in 5 | Out of bank flooding, farm equipment likely needs to be moved. | 12.0 | | |
| | Moderate | 1 in 10 | Rural flood islands. Stock and farm equipment need to be moved. | 15.5 | | |
| | Major | 1 in 20 | Properties and townships are likely to be isolated. | 16.0 | | |
| **Flood Classification** | **Impact** | | **YES/NO (Where)** | **WSL at Impact** | **WSL at Gauge** | **Depth at Gauge** |
| MINOR | Inconvenience | | No | | | |
| | Low lying areas | | No | | | |
| | Minor roads closed | | Yes<br>Radkes Rd<br>Marschkes Rd | 60.12-62.99 | 56.7-59.8 | 12.4 |
| | Low level bridges | | No | | | |
| | Inundation in urban areas | | No | | | |
| | Backyards inundated | | No | | | |
| | Buildings below floor level | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Bicycle and pedestrian paths impacted | No | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | Yes<br>Along Forest Hill, Fernvale road north of Lockyer Creek crossing | 61.04 | 56.7 | 12.42 |
| MODERATE | Inundation in some areas is more substantial | Yes<br>North of Brightview Rd, south of Forest Hill Fernvale Rd | 59.54 | 59.8 | 15.5 |
| | Main traffic routes may be affected | Yes<br>Forest Hill Fernvale Rd cut | 60.4 | 60.6 | 16.3 |
| | Some buildings are likely to be affected above floor level | Yes<br>Mount Tarampa Rd and Marschkes Rd | 43.10-63.95 | 60.6 | 15.5 |
| | Evacuation of flood affected areas may be required | No | | | |
| | stock needs to be moved to higher ground | No | | | |
| | Farm equipment need to be moved | No | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes<br>North of Clarendon Rd | 55.43 | 60.6 | 16.3 |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Urban Areas are inundated in and in some areas islands with isolation are identified | | | | |
| | Many buildings are impacted and affected above floor level | Yes<br>Lots 3,4,5,&6 Mahons Rd | 59.5 | 60.6 | 16.3 |
| | Properties and townships are likely to be isolated | Yes<br>South of Clarendon Rd | 49.6-61.4 | 64 | 19.7 |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | Yes<br>Ripley Road Flooding at Clarendon State School Cut, some rural properties on flood islands. Other waterways likely to be elevated. | 56.22 | 60.6 | |
| | Utility services may be impacted | | | | |

| Location | Lowood | | | |
|---|---|---|---|---|
| Gauge Name(s) | Lowood TM | | | |
| Gauge Number | 40706 | | | |
| Gauge Zero | 22.74 | | | |
| Classification Triggers | Category | Nearest AEP extent (gauge level of AEP) | Impacts | Recommended Gauge Level |
| | Minor | 1 in 10 | Out of bank flooding, farm equipment likely needs to be moved. | 13.5 |
| | Moderate | 1 in 20 | Rural flood islands. Stock and farm equipment need to be moved. | 18.0 |
| | Major | 1 in 50 | Properties and townships are likely to be isolated. | 22.5 |

| Flood Classification | Impact | YES/NO (Where) | WSL at Impact | WSL at Gauge | Depth at Gauge |
|---|---|---|---|---|---|
| MINOR | Inconvenience | No | | | |
| | Low lying areas | No | | | |
| | Minor roads closed | Yes<br>Wivenhoe Pocket Rd | 34.3 | 36.3 | 13.5 |
| | Low level bridges | No | | | |
| | Inundation in urban areas | No | | | |
| | Backyards inundated | No | | | |
| | Buildings below floor level | No | | | |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Bicycle and pedestrian paths impacted | | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | Yes<br>Properties by O'Reileys Weir Rd | 44.1 | 36.3 | 13.5 |
| MODERATE | Inundation in some areas is more substantial | Yes<br>Properties by O'Reileys Weir Rd | 44.1 | 40.9 | 18.1 |
| | Main traffic routes may be affected | Yes<br>Brisbane Valley Hwy | 35.3 | 40.9 | 18.1 |
| | Some buildings are likely to be affected above floor level | Yes<br>Properties by O'Reileys Weir Rd | 44.2 | 40.9 | 18.1 |
| | Evacuation of flood affected areas may be required | No | | | |
| | stock needs to be moved to higher ground | Yes | | | |
| | Farm equipment need to be moved | Yes | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes<br>East of Lowood | 45.2 | 45.3 | 22.6 |
| | Urban Areas are inundated in and in some areas islands with isolation are identified | No | | | |
| | Many buildings are impacted and affected above floor level | Yes<br>East of Lowood | 45.4 | 45.3 | 22.6 |

| | | | | | |
|---|---|---|---|---|---|
| | Properties and townships are likely to be isolated | Yes<br>Vernor Rd | 44.9 | 45.3 | 22.6 |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | | | | |
| | Utility services may be impacted | No | | | |

| Location | Savages | | | |
|---|---|---|---|---|
| Gauge Name(s) | Crossing TM | | | |
| Gauge Number | 540066 | | | |
| Gauge Zero | 18.48 | | | |
| Classification Triggers | Category | Nearest AEP extent (gauge level of AEP) | Impacts | Recommended Gauge Level |
| | Minor | 1 in 10 | Out of bank flooding, farm equipment likely needs to be moved. | 9.5 |
| | Moderate | 1 in 20 | Rural flood islands. Stock and farm equipment need to be moved. | 15.5 |
| | Major | 1 in 50 | Properties and townships are likely to be isolated. | 18.0* |

*Council may consider updating the Major classification only for Savages. As the recommended gauge levels for minor and moderate are within 0.5 of the existing classifications.

| Flood Classification | Impact | YES/NO (Where) | WSL at Impact | WSL at Gauge | Depth at Gauge |
|---|---|---|---|---|---|
| MINOR | Inconvenience | No | | | |
| | Low lying areas | Yes | 33.6 | 32.1 | 13.6 |
| | Minor roads closed | Yes<br>Summerville Rd | 30.8 | 33.1 | 14.6 |
| | Low level bridges | Yes<br>Banks Creek Rd Bridge | 27.7 | 28.0 | 9.5 |
| | Inundation in urban areas | No | | | |
| | Backyards inundated | No | | | |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Buildings below floor level | | | | |
| | Bicycle and pedestrian paths impacted | No | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | Yes<br>South of the river in Borallon | 24.1 | 32.1 | 13.6 |
| MODERATE | Inundation in some areas is more substantial | Yes<br>North of the river in Borallon | 33.4 | 41.7 | 23.2 |
| | Main traffic routes may be affected | Yes<br>Brisbane Valley Hwy | 35.3 | 34.0 | 15.5 |
| | Some buildings are likely to be affected above floor level | Yes<br>Banks Creek Rd | 31.4 | 36.9 | 18.4 |
| | Evacuation of flood affected areas may be required | No | | | |
| | stock needs to be moved to higher ground | No | | | |
| | Farm equipment need to be moved | No | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes<br>Mockers Rd | 31.4 | 36.9 | 18.4 |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Urban Areas are inundated in and in some areas islands with isolation are identified | | | | |
| | Many buildings are impacted and affected above floor level | Yes<br>Fernvale Road | 39.5 | 39.7 | 21.2 |
| | Properties and townships are likely to be isolated | Yes<br>England Creek Rd | 38.5 | 37.1 | 18.6 |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | | | | |
| | Utility services may be impacted | No | | | |

| Location | Rosentreter | | | |
|---|---|---|---|---|
| Gauge Name(s) | Rosentreters Bridge TM | | | |
| Gauge Number | 40823 | | | |
| Gauge Zero | 102.1 | | | |
| Classification Triggers | Category | Nearest AEP extent (gauge level of AEP) | Impacts | Recommended Gauge Level |
| | Minor | 1 in 1 | Out of bank flooding, farm equipment likely needs to be moved. | 4.0 |
| | Moderate | 1 in 5 | Rural flood islands. Stock and farm equipment need to be moved. | 5.0 |
| | Major | 1 in 20 | Properties and townships are likely to be isolated. | 6.0 |

| Flood Classification | Impact | YES/NO (Where) | WSL at Impact | WSL at Gauge | Depth at Gauge |
|---|---|---|---|---|---|
| MINOR | Inconvenience | No | | | |
| | Low lying areas | Yes<br>Harch Road | 86.5 | 106.2 | 4.1 |
| | Minor roads closed | Yes<br>Kipper Creek Rd, Toogoolawa-Biarra Rd, Morden Rd, Esk-Crows Nest Rd | 91.1-132.6 | 106.2 | 4.1 |
| | Low level bridges | No | | | |
| | Inundation in urban areas | No | | | |
| | Backyards inundated | Yes | 89.2 | 107.8 | 5.8 |
| | Buildings below floor level | Yes<br>Masters Lane | 94.4 | 107.4 | 5.3 |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Bicycle and pedestrian paths impacted | | | | |
| | stock are being moved to higher ground | No | | | |
| | Farm equipment being moved | No | | | |
| MODERATE | Inundation in some areas is more substantial | Yes | 91.5 | 107.8 | 5.8 |
| | Main traffic routes may be affected | Yes<br>Mt Beppo Rd | 91.1 | 107.4 | 5.3 |
| | Some buildings are likely to be affected above floor level | Yes<br>North of Mt Beppo Rd, East of Brisbane Valley Highway | 93.4 | 108.3 | 6.3 |
| | Evacuation of flood affected areas may be required | No | | | |
| | stock needs to be moved to higher ground | No | | | |
| | Farm equipment need to be moved | No | | | |
| **MAJOR** | Extensive rural areas are inundated and isolated | Yes<br>MT Beppo Rd west of Toogoolawah | 94.3 | 108.3 | 6.3 |
| | Urban Areas are inundated in and in some areas islands with isolation are identified | Yes<br>Young road, North of Mt Beppo Rd | 97.0-91.4 | 108.3 | 6.3 |
| | Many buildings are impacted and affected above floor level | Yes<br>North of Mt Beppo Rd, East of Brisbane Valley Highway | 93.5 | 109.0 | 7.0 |
| | | No | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Properties and townships are likely to be isolated | | | | |
| | Major rail and traffic routes are closed | No | | | |
| | Evacuation of flood affected areas may be required | | | | |
| | Utility services may be impacted | No | | | |

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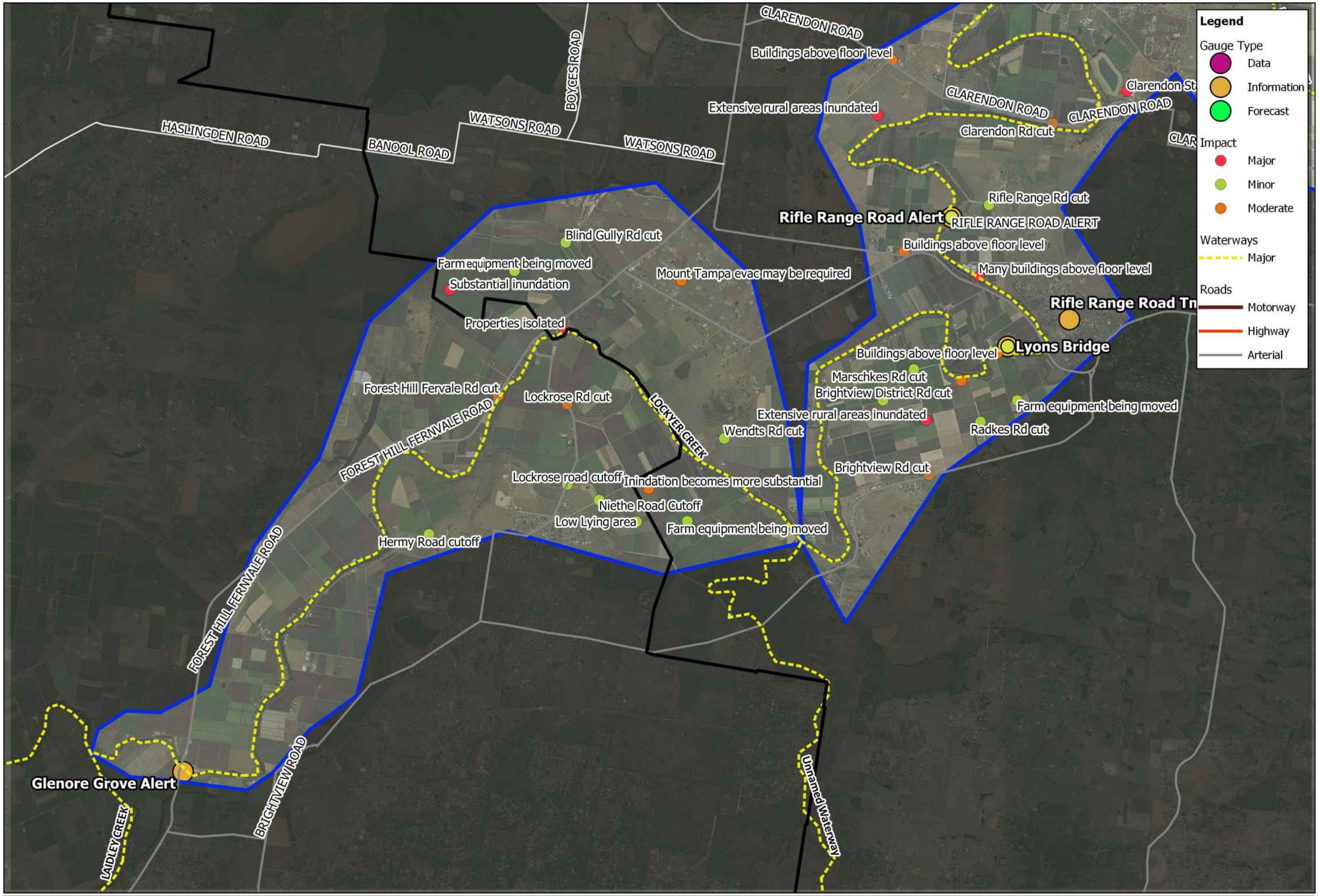
# APPENDIX K
# QFES EMERGENCY ALERT POLYGONS

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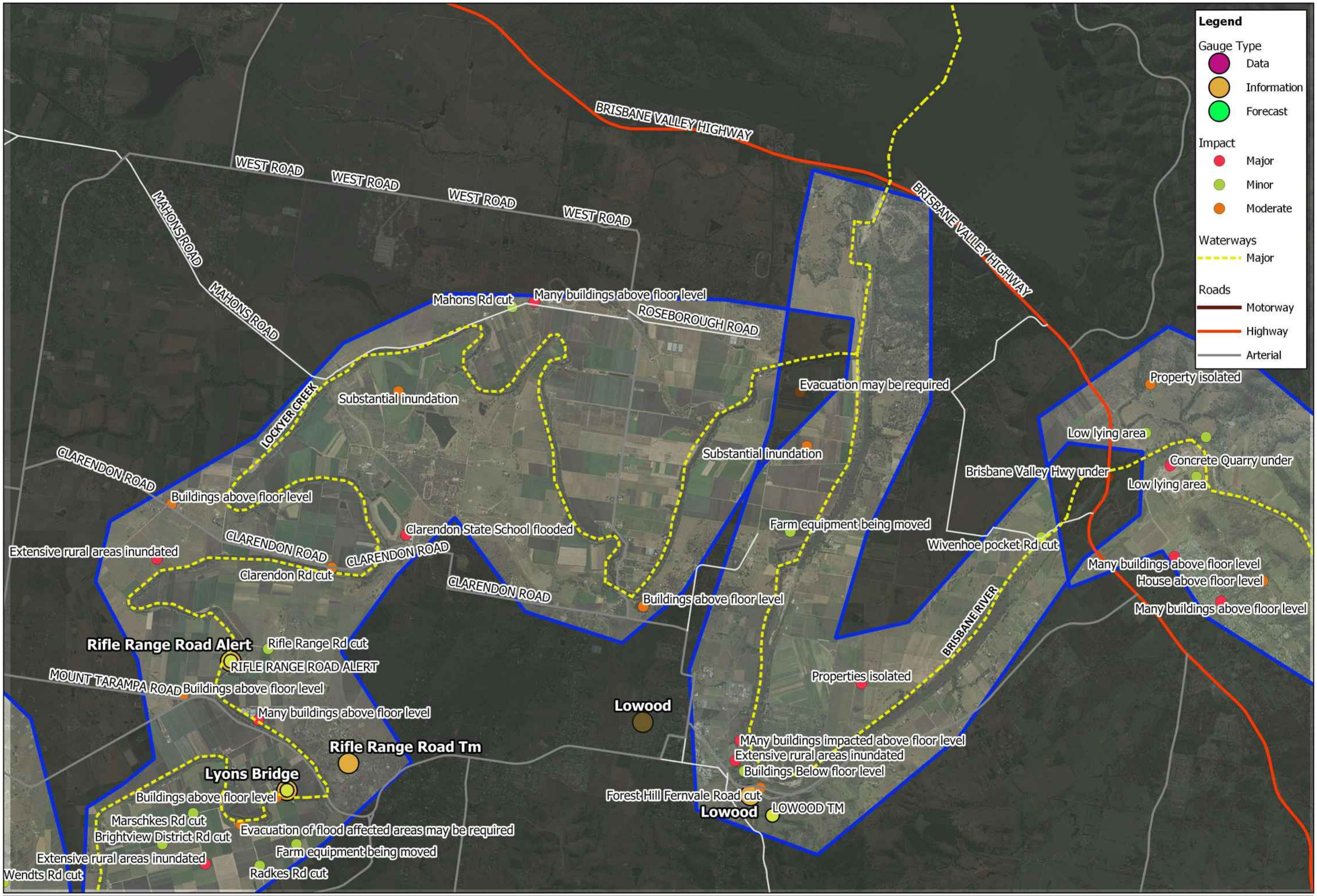


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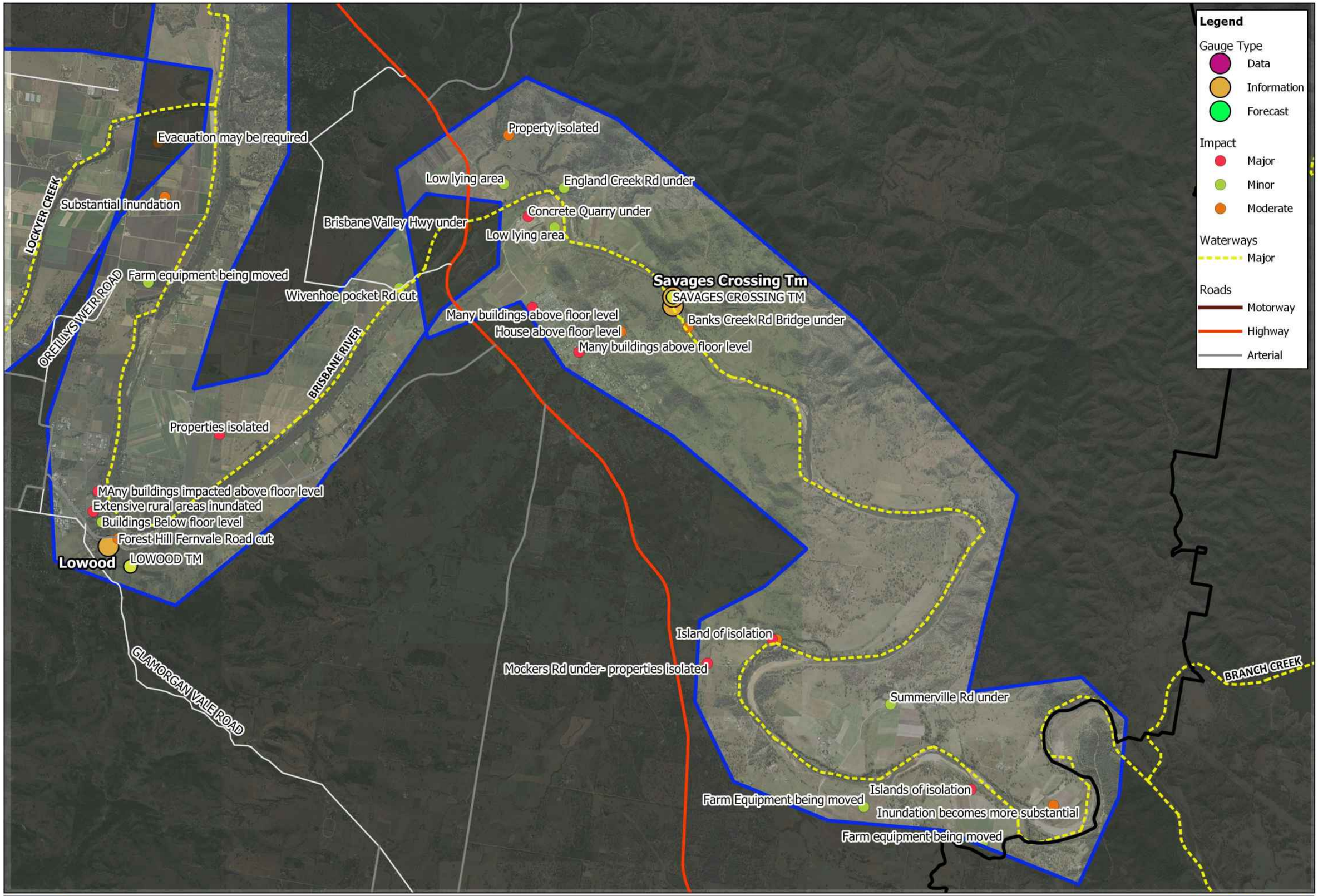


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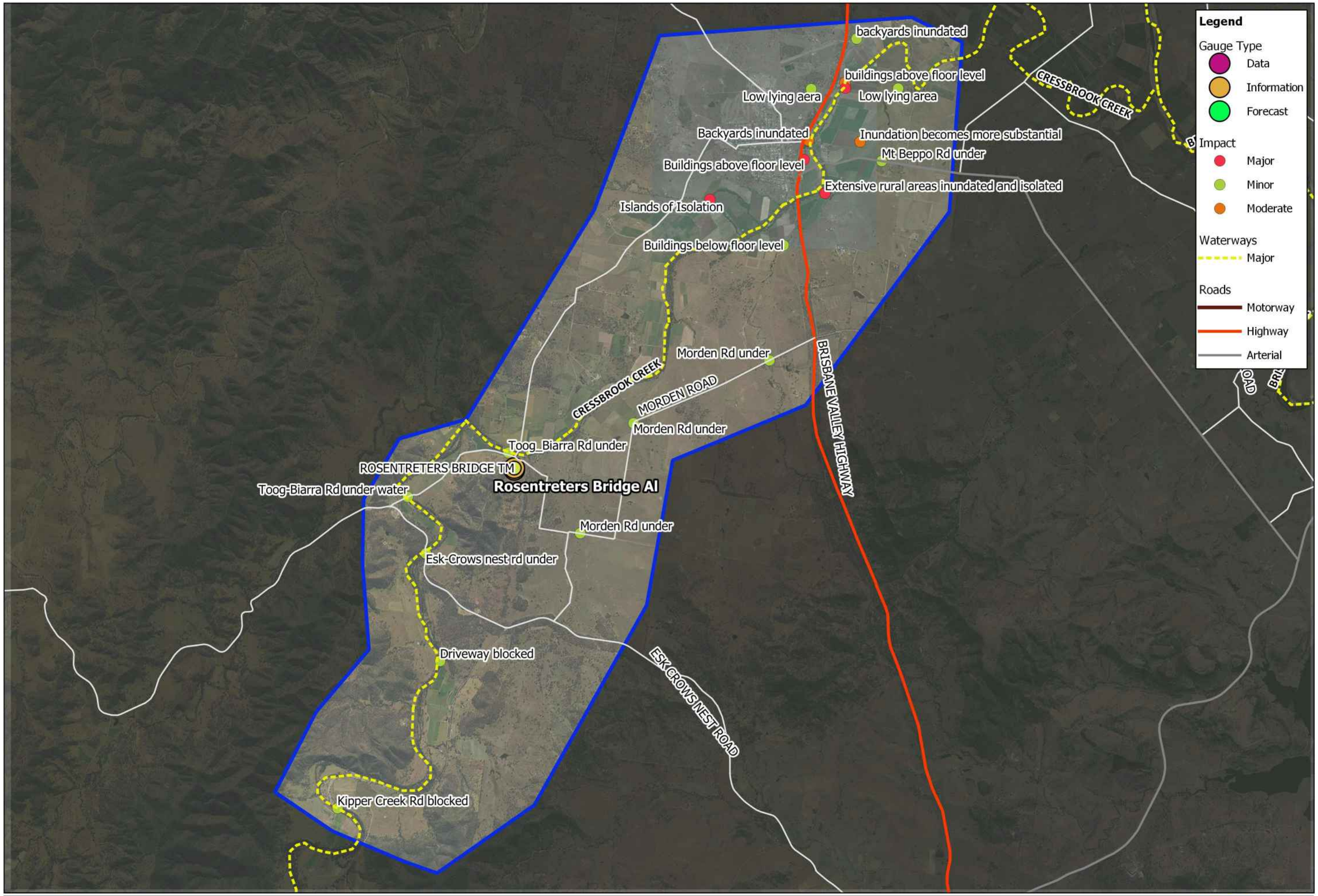


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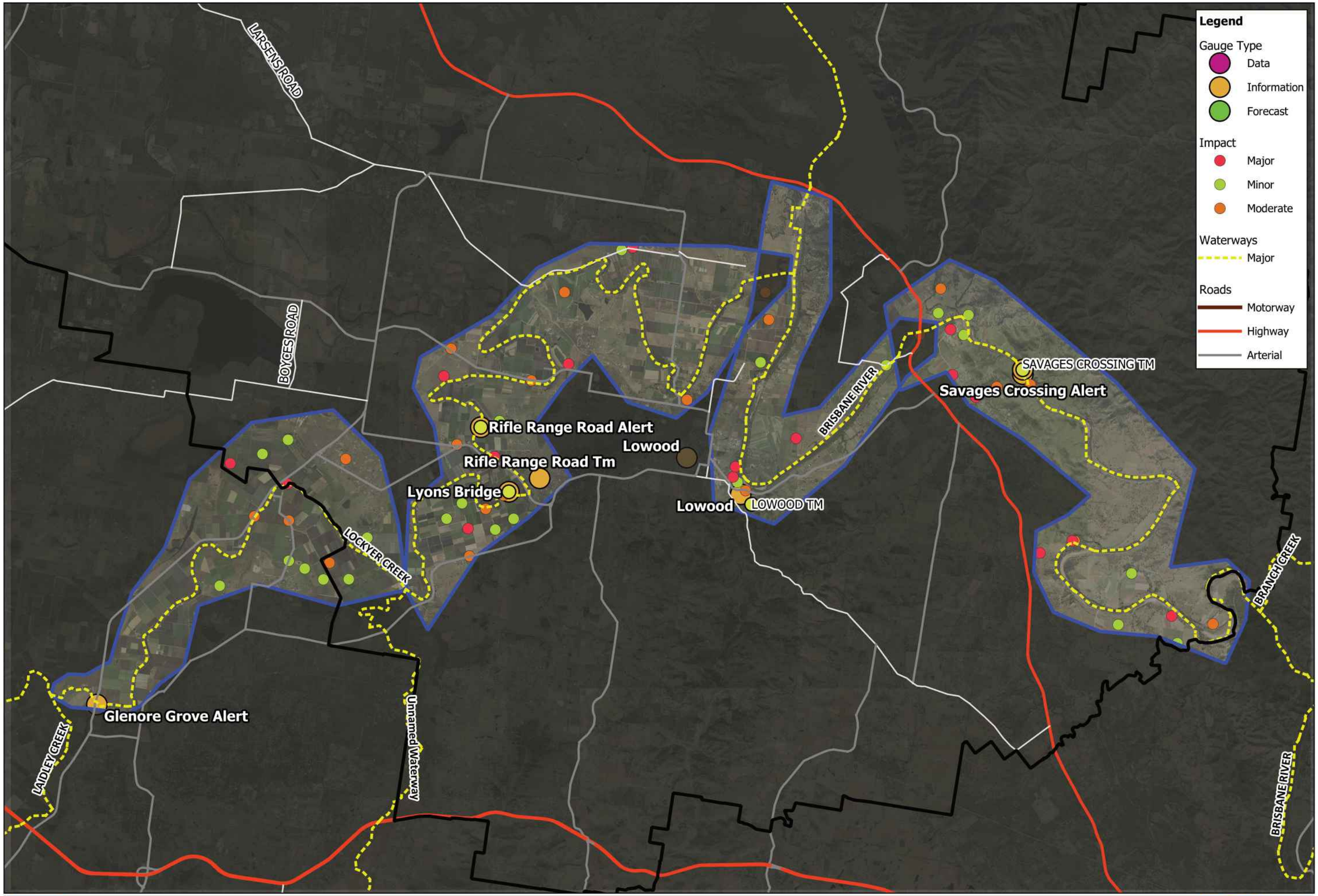


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