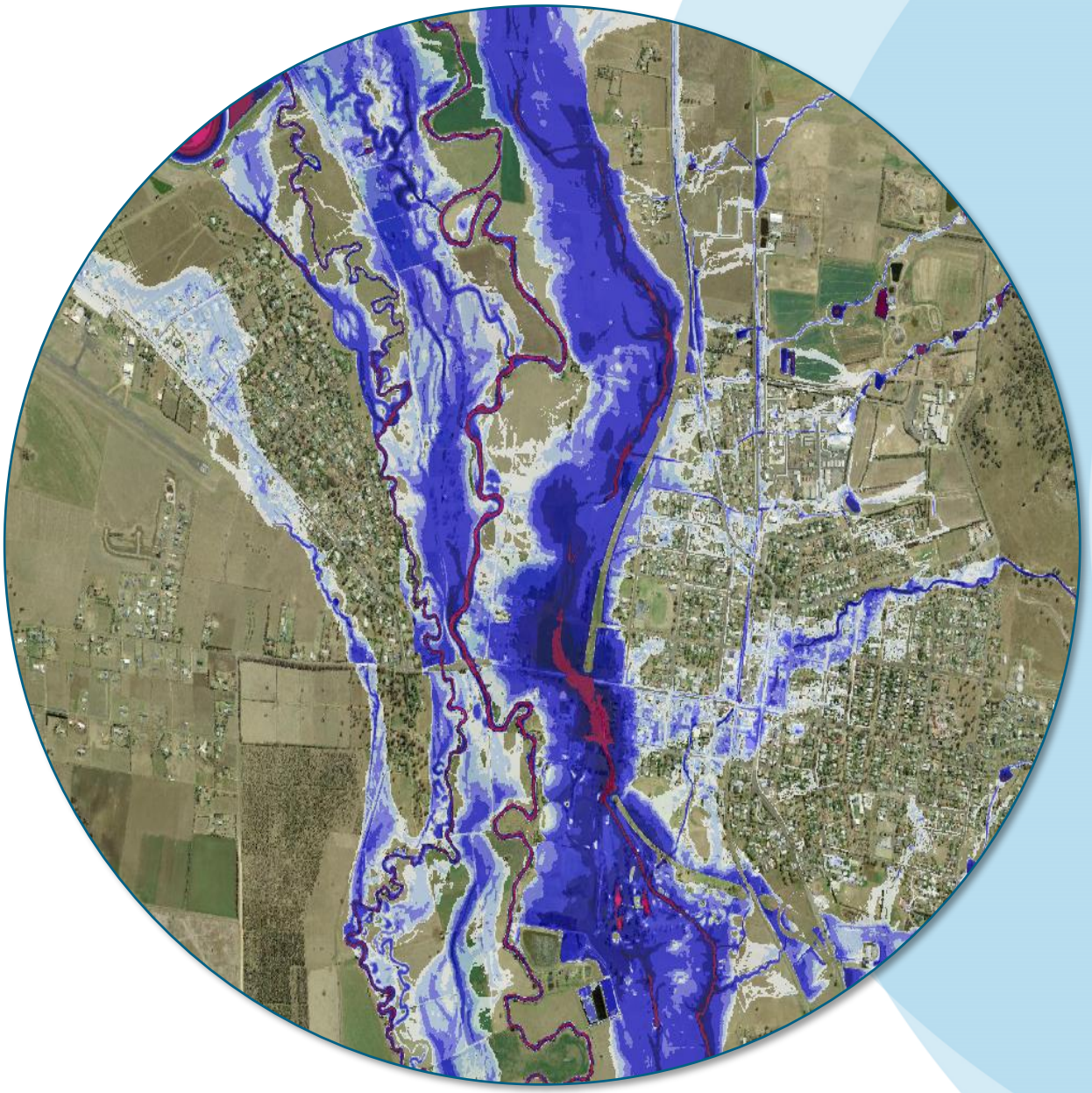

# Scone Floodplain Risk Management Study & Plan

Upper Hunter Shire Council

**February 2025**

**Level 19, 420 George Street**
**Sydney NSW 2000**

Revision 1 – Final Draft

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worley consulting

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### 311015-00018 – Scone Floodplain Risk Management Study & Plan

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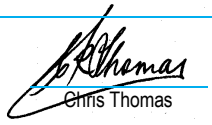
| 1 | Final Draft | LT<br>L To | CRT<br>C Thomas |  <br>Chris Thomas | 10/02/2025 |

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**Appendix A** – Preliminary Cost Estimates for Flood Modification Options

# Executive Summary

## Introduction

Scone is a major regional centre located within the Upper Hunter Shire Council Local Government Area (LGA) in the Hunter Region of New South Wales. The town straddles Figtree Gully which originates in the hills to the north-east of Scone and effectively drains the urban and commercial areas of the town. Figtree Gully drains to Parsons Gully which is one of three larger waterways located immediately west of the commercial area of Scone. These tributaries include Middle Brook, Kingdon Ponds and Parsons Gully, and serve to drain a mostly rural catchment area of about 360 km$^2$ extending upstream and north-west of Scone. These three waterways separate Scone from the satellite suburb of Satur to the west.

Upper Hunter Shire Council (Council) is responsible for land use planning within its LGA, including the management of flood risk. Council engaged Worley Consulting to undertake the *Scone Flood Study* and *Scone Floodplain Risk Management Study and Plan*. This document comprises the Flood Study report.

This study has been undertaken in accordance with the NSW Government's Flood Prone Land Policy, the primary objective of which is to reduce the impact of flooding on individual owners and occupiers of flood prone land, and to reduce private and public losses caused by flooding. The study provides an improved understanding of the potential impacts of floods on the local community and will inform the ongoing management of flood risk in the Scone catchment.

## General Description of Flood Behaviour

### *Scone (Figtree Gully)*

The critical storm duration for Figtree Gully typically ranges from 6 to 9 hours in events up to and including the 1% AEP event. The critical storm duration is shorter for rarer flood events, typically between 1.5 and 3 hours.

The Figtree Gully channel in the urban areas of Scone has a limited flow conveyance, with some flow breakouts occurring at several locations in the 20% AEP event. These locations include areas near Waverley Street and Main Street, as well as immediately downstream (west) of the Scone RSL club as the watercourse transitions back into a natural channel. Once the capacity of the channel is exceeded, floodwaters are expected to route overland to the south and west through several residential lots and along road reserves.

Within the Scone CBD, the hydraulic model results indicate that areas along Kelly Street to the south of the Liverpool Street intersection are the most flood prone, with inundation expected in events as frequent as the 20% AEP storm. Some areas of Kelly Street between Liverpool Street and St Aubins Street are also inundated during the 20% AEP event, but to a lesser degree.

During the 1% AEP event, areas of high flood hazard that may pose a significant threat to life and property (e.g. ≥ H4 Hazard) are confined within the Figtree Gully channel. Inundated areas outside of the Figtree Gully channel are typically classified as H1 to H2 Hazard, with some localised areas of H3 Hazard resulting from flood depths in excess of 0.5 metres.

During the PMF event, the extent and degree of hazard posed to life and property would increase significantly. Large portions of commercial and residential areas in Scone would be inundated with the flood hazard typically ranging from H3 to H5.

***Satur***

Properties along the eastern edge of Satur are located adjacent to Middle Brook, which flows in a north to south direction past the town. These properties are elevated at least 5 metres above the Middle Brook floodplain. The flood model results indicate that the majority of these properties are not expected to be inundated by flooding of Middle Brook in events up to and including the PMF. During the PMF, floodwaters from Middle Brook may inundate the eastern portions of some properties but are not expected to inundate any existing houses.

However, it is noted that there is an overland flow path which originates near the Scone TAFE and generally travels from north-west to south-east in the vicinity of Satur. This overland flow path is predicted to inundate Gray Street, Gunsynd Close, Satur Road and a number of nearby properties during the 20% AEP event.

During the 1% AEP event, the flood hazard in the vicinity of Satur is typically categorised as H1, with some localised areas categorised as H2.

At the peak of the PMF, this overland flow path is expected to inundate a large portion of Satur near the north-western corner of the township. The flood hazard category typically ranges between H2 and H3 in residential lots, increasing to H4 and H5 along sections of Gray St and Satur Road.

***Middle Brook, Kingdon Ponds and Parsons Gully***

The three major watercourses of Middle Brook, Kingdon Ponds and Parsons Gully flow past Scone and Satur from north to south, passing beneath Liverpool Street in the immediate vicinity of the towns. These watercourses share a common floodplain near Scone, which is typically characterised by undeveloped pastureland with a small number of buildings and private properties.

The Kingdon Ponds channel has a limited flow conveyance property in areas downstream (south) of Parkville. This results in flows breaking out of the Kingdon Ponds channel in events as frequent as the 20% AEP event. These breakout flows discharge into the adjacent watercourses of Parsons Gully and Middle Brook at several locations between Parkville and Scone. Subsequently, a significant portion of the flows along Parsons Gully and Middle Brook arriving at the Liverpool Street crossing is expected to have originated from floodwaters escaping the Kingdon Ponds channel further upstream (north).

The flood model results indicate that a number of properties on the common floodplain between Scone and Satur are predicted to be inundated in events as frequent as the 20% AEP event. In particular, this includes properties in the vicinity of Morse Street and Wingen Street, as well as the properties on the western side of Aberdeen Street to the south of Liverpool Street.

During the 1% AEP event, the majority of the common floodplain between Scone and Satur is inundated to depths exceeding 0.5 metres. The flood hazard is also typically H3 or higher in the vicinity of Liverpool Street. The majority of properties in the floodplain are expected to be inundated, as well as the entirety of the Bill Rose Sports complex and the Scone Golf Club.

During the PMF event, floodwaters from the three watercourses form a continuous body of water between Satur and Scone, with high flood depths and flow velocities resulting in a flood hazard category of H6 throughout most of the common floodplain.

### Assessment of Property Affectation

To allow an assessment of properties likely to be affected by above floor flooding, and to subsequently undertake an estimation of flood damages, a database was prepared for properties within the floodplain including information on the habitable floor levels and building types.

Overall, the level of flood affectation is high, with 891 properties expected to be flooded above floor level in the PMF. This is in the order of 33% of all properties in the study area. There are 154 properties which are expected to be flooded above floor level during the 1% AEP event, representing about 6% of all properties in the study area. About 35 properties are expected to be affected by above floor flooding in a 20% AEP event. This number almost triples in a 5% AEP event.

The highest concentration of properties which are prone to be flooded above floor level are located in the vicinity of Figtree Gully. This includes several commercial properties fronting Kelly Street, particularly in the area between Liverpool and St Aubins Streets. These properties are located immediately adjacent to Figtree Gully, which runs parallel to Kelly Street as a concrete-lined open channel. Some properties in Satur are also expected to be prone to flooding above floor level. These properties are located in the vicinity of an overland flow path draining through Satur, which generally flows in a north-west to south-east alignment and inundates sections of Gray Street, Gunsynd Close and Satur Road.

### Estimation of Flood Damages

Flood damages are adverse economic impacts that private and public property owners experience as a consequence of flooding. A flood damage assessment has been undertaken for the study area to quantify the impact of flooding in economic terms following the methodology presented in the *Floodplain Risk Management Measures: Flood Risk Management Guidelines MM01* (DPE, 2023).

Key findings are summarised as follows.

- Significant flood damages would be expected even in a 20% AEP flood event. Owing to its higher probability of occurrence, this event results in the largest contribution to AAD and hence the present value of the estimated damages.
- Flood damages increase incrementally with increasing event magnitude from $4.4M in the 20% AEP event, to $23.7M in the 1% AEP event, and $48.4M in the 1 in 500 AEP event. There is then a significant increase to about $255M in the PMF.
- Contribution to AAD generally decreases with increasing event magnitude (with the exception of the PMF), with the more frequent events contributing more significantly to the total AAD and present value of damages.
- The large contribution of more frequent events to AAD and present value of damages could be a positive indication for the potential economic viability of flood mitigation options. Management measures are more likely to be able to reduce damages in these frequent events than in larger, rarer events.
- Flood damages for residential land use are several times higher than those for non-residential land use across all design events.
- The estimated Annual Average Damages (AAD) due to flooding in the study area is about $3.17M.
- At a 7% discount rate, the net present value of flood damages is about $43.7M over 50 years.

## Approaches to Managing Flood Risk

Floodplain risk management measures can be separated into the following categories:

- Land use planning and property modification measures.
  - These measures include flood planning controls for future development to ensure that land uses are compatible with flood risk. They can also include voluntary house raising and purchase, or flood-proofing of buildings, which can act to reduce flood damages.
- Response modification measures.
  - These typically include emergency response management measures, flood predictions and warnings, and community flood awareness and preparedness.
- Flood modification measures.
  - These are typically structural works, such as culvert upgrades, flood protection levees, flood detention basins or bypass floodways, which act to reduce flood damages.

### Land Use Planning and Property Modification

A key objective of this study is to provide improved flood information to support land use planning activities in the study area. Effective land use planning can help ensure that the flood risk posed to a community does not increase moving into the future.

A review of existing planning instruments and flood-related policies was undertaken, and new flood planning maps were prepared. This led to the recommendation of six flood risk management measures relating to land use planning, including the key recommendation of adopting the 1 in 500 AEP peak flood level as the Flood Planning Level without a freeboard.

### Flood Emergency Response Management

Scone is affected by both flash-flooding of Figtree Gully and overland flows as well as longer-duration flooding along Kingdon Ponds, Parsons Gully and Middle Brook.

The local flood plan was reviewed along with the flood affectation of several critical use facilities and other sensitive land uses. The inundation of several major roads in the study area were investigated for peak flood depths and durations of inundation.

The flood emergency response planning classification was determined for properties throughout Scone and Satur, which provides an indication of the relative vulnerability of communities in flood emergency response situations.

Investigations were completed into potential improvements to existing flood warning arrangements for Scone and the surrounding watercourses.

Seven flood risk management measures related to emergency response management were recommended for adoption in the Floodplain Risk Management Plan.

### Flood Modification Measures

A previous comprehensive assessment of flood modification measures was undertaken in *Scone Floodplain Management Study and Plan* (Bewsher Consulting 1999).

The current study reviewed the flood modification measures which were investigated in the 1999 study and selected several measures for further testing and analysis, including bypass culvert systems for Figtree Gully, channel widening, a detention basin, channel clearing and vegetation management. A benefit-cost ratio analysis and multi-criteria assessment was completed for these selected options.

Channel clearing and vegetation management were recommended for adoption in the Floodplain Risk Management Plan, while the installation of a detention basin along Figtree Gully upstream of Barton Street was recommended for further investigation.

**Floodplain Risk Management Plan**

Various measures have been recommended for inclusion in the Floodplain Risk Management Plan to manage and reduce the risk to life and property posed by flooding in the study area. This includes six recommendations relating to Land Use Planning and Property Modification and seven recommendations relating to Flood Emergency Response Management. Two Flood Modification Measures were recommended for adoption, with one additional measure recommended for further investigation.

An implementation schedule for the measures recommended for adoption as part of the Plan is presented in **Table 11-1**.

# 1. Introduction

## 1.1 Overview

Scone is the largest urban centre located in the Upper Hunter Shire Council Local Government Area (LGA) in the Hunter Region of New South Wales (*refer* **Figure 1-1**). The town straddles Figtree Gully which originates in the hills to the north-east of Scone and effectively drains the urban and commercial areas of the town. Figtree Gully drains to Parsons Gully which is one of three larger waterways located immediately west of the commercial area of Scone. These tributaries include Middle Brook, Kingdon Ponds and Parsons Gully, and serve to drain a mostly rural catchment area of about 360 km$^2$ extending upstream and north-west of Scone. These three waterways separate Scone from the satellite suburb of Satur, which is located to the west (*refer* **Figure 1-1**).

The catchment has a history of flooding, with inundation of private and public property in proximity to these waterway occurring in 1955, 1976, 1992, 2000, 2007 and 2021. Flooding of Middle Brook, Kingdon Ponds and Parsons Gully typically inundates the rural areas between Scone and Satur. In larger events floodwaters overtop Liverpool Street, effectively isolating Satur from Scone. Properties on the western edge of Scone would also be inundated during flooding of these watercourses.

Figtree Gully originates in the hills to the north-east of Scone and traverses the town before discharging into Parsons Gully to the south of the White Park Equine Complex (refer **Figure 2-2**). Figtree Gully drains an area of about 7 km$^2$. The section of Figtree Gully that traverse through Scone township has limited in-channel flow conveyance capacity. Floodwaters escaping the confines of the channel typically inundate residential and commercial properties on the adjoining floodplain, including businesses in the Scone Central Business District.

Upper Hunter Shire Council (Council) is responsible for local planning and land management within its LGA, including the management of flood prone land. Previous floodplain risk management activities completed by Council in the study area have included the *Scone Flood Study* (Worley Consulting, 2024), *Scone Flood Study* (DLWC, 1996), and the *Scone Floodplain Risk Management Study and Plan* (Bewsher Consulting, 1999).

Council engaged Worley Consulting to update the Scone Floodplain Risk Management Study (FRMS) and prepare a new Floodplain Risk Management Plan. The updated FRMS was requested in response to various factors including recent improvements in flood modelling technology, the availability of new rainfall, stream flow and flood level data, changes in the catchment associated with recent developments and the need to assess the potential implications of climate change on local flood behaviour. The flood modelling and mapping that was completed as part of the updated Flood Study (Worley Consulting, 2024) took advantage of the improvements in modelling technology and the additional more recent data. The Flood Study was also based on the application of changes in design flood estimation procedures outlined in the latest edition of *Australian Rainfall and Runoff: A Guide to Flood Estimation* which was published in 2019 (ARR 2019).

The Flood Study provides an improved understanding of the potential impacts of floods on the local community and provides a basis for the ongoing management of flood risk on the floodplains of Middle Brook, Kingdon Ponds and Parsons Gully, and the commercial and urban precincts of Scone.

The Flood Study also defines existing flood characteristics along these tributaries which is required to understand locations where there is potential for the greatest damage and/or risk to life during floods. This information is critical to identifying opportunities for reducing flood damages, reducing risk to life and identifying opportunities for improved flood emergency response management, all of which are

the subject of this Floodplain Risk Management Study. The study has been undertaken in accordance with the NSW Government's *Flood Prone Land Policy*, the primary objective of which is to reduce the impact of flooding on individual owners and occupiers of flood prone land, and to reduce private and public losses caused by flooding.

This report details investigations into flood affectation, risk and impacts, the assessment of potential management measures, and the selection of recommended management measures to form a Floodplain Risk Management Plan.

## 1.2 Key End Users

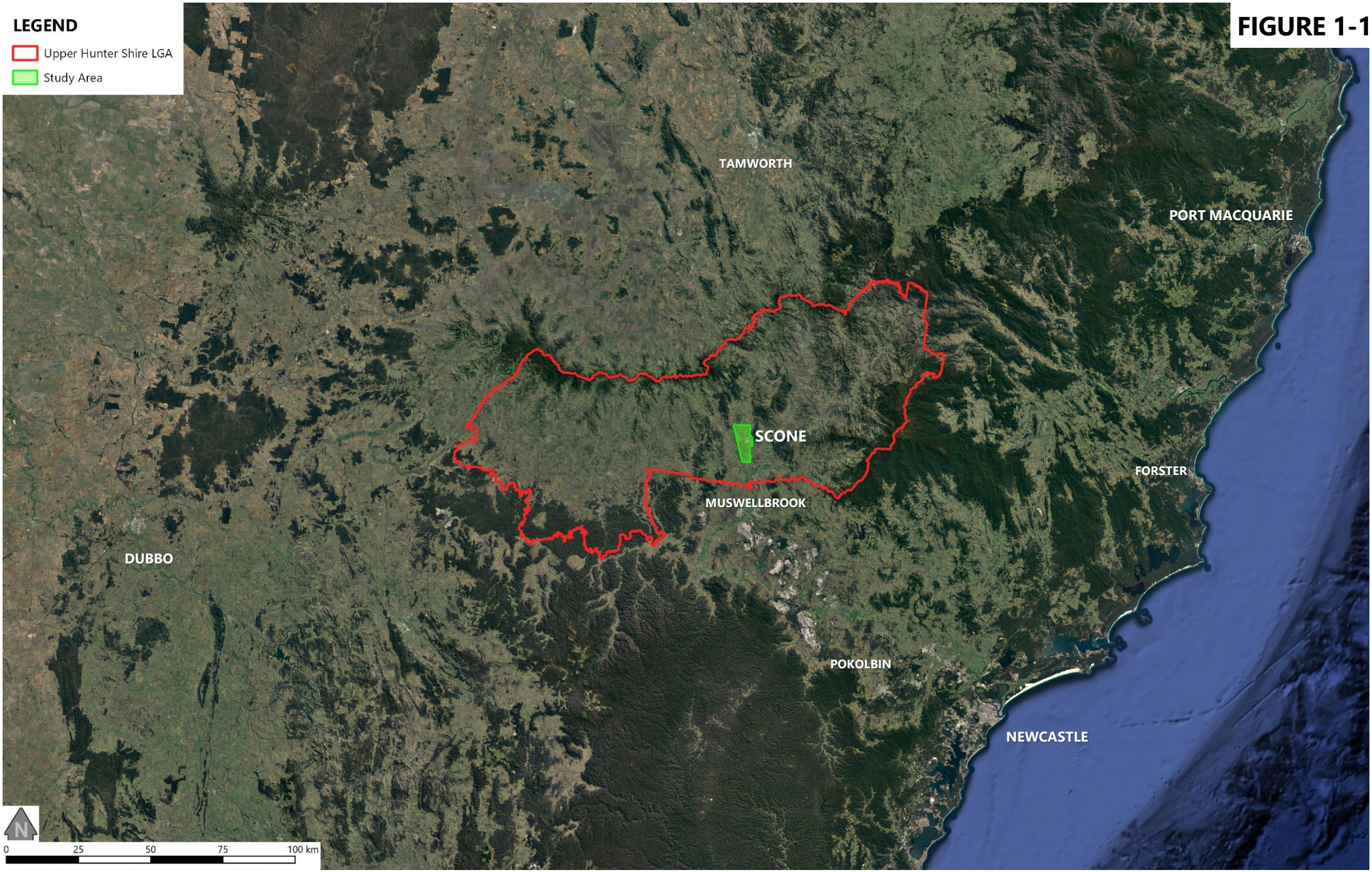
The Flood Study Update and FRMS&P play a key role in informing decision making and investment in the floodplain, and in educating the public regarding flood risk and how to respond to floods. This includes decisions on how to address flood risk through measures for mitigation, readiness, response, and recovery, and ensuring that future development is commensurate with flood risk.

The key end user groups that the studies aim to assist include:

- Decision makers at a strategic level.
- The local community.
- Professionals engaged in flood risk management.
- Engineers responsible for designing, building, and maintaining mitigation structures.
- Planners focused on emergency management.
- Urban planning specialists and developers.
- Hydrologists and meteorologists contributing to flood forecasting and protection.
- Insurance companies.

The detailed information on flood risk produced by the studies is also available to insurers for consideration in determining flood insurance premiums. However, the definition of 'flooding' used in insurance policies may differ from that in this FRMS&P and it is up to individual insurers to decide what criteria they use to determine flood risk (Insurance Council of Australia, 2021).

# FIGURE 1-1

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## SCONE STUDY LOCATION

# 2. The Study Area

## 2.1 Overview

The main urban precincts included in the study area are Scone and Satur. The Scone central business district (CBD) is located along Kelly Street between Susan Street in the north and Kingdon Street in the south. The main residential areas of Scone are located to the east of the CBD, while new residential developments are planned for the south-east fringe of the town. The township covers an area of about 4 $km^2$. The New England Highway formerly followed the alignment of Kelly Street and ran through the centre of the Scone CBD. In March 2020, the 5½ km New England Highway bypass of Scone was opened. It serves to allow highway traffic to bypass the town along a partially elevated four lane road that runs along the western perimeter adjacent to Parsons Gully (refer **Figure 2-2**).

Satur is a satellite suburb of Scone which is located about 1 kilometre to the west. Satur covers an area of about 1 $km^2$ and comprises primarily residential lots. The Scone airport is located near the north-western corner of Satur.

The study area also comprises the floodplains of Middle Brook, Kingdon Ponds and Parsons Gully. These waterways generally flow from north to south past Scone and Satur before discharging into the Hunter River south of Aberdeen. They originate in the mountainous areas to the north and north-east of Scone, which are characterised by largely forested steep slopes. The flatter floodplain areas are typically rural landholdings that are typically cleared and used for grazing livestock. Kingdon Ponds in particular comprises a large number of meander bends between Wingen and Scone.

Middle Brook, Kingdon Ponds and Parsons Gully share a common floodplain in the vicinity of Scone, with no clear catchment divide between the three watercourses. Flows which break out of one of these watercourses would be conveyed by the other neighbouring watercourses.

Figtree Gully originates in the hilly undeveloped area to the east of Scone and traverses the town along a north-east to south-west alignment. Figtree Gully is an open grassed channel between Barton Street in the east and Park Street in the west (refer **Figure 2-2**). Downstream of Park Street, the watercourse transitions into a concrete channel that extends through the Scone CBD. Figtree Gully transitions back into an open grassed channel near Kingdon Street and runs in a southerly alignment through the White Park Equine Complex before discharging into Parsons Gully (refer **Figure 2-2**).

As noted previously, the upper catchments of the four key watercourses comprise mountainous areas located to the north and east of Scone. Elevations in the upstream reaches of Parsons Gully and Figtree Gully exceed 450 mAHD, while elevations in the upstream reaches of Kingdon Ponds and Middle Brook exceed 800 mAHD. The gradient of the bed slopes in these mountainous areas are generally between 20% to 25%. Downstream of the mountainous areas, the steep hilly terrain transitions into grassed floodplain areas between Wingen and Scone. The grassed floodplain areas are much flatter, with the gradient typically not exceeding 1%. Land elevations in this area range from 200 to 250 mAHD.

The terrain slopes from east to west through Scone. Elevations range from about 240 mAHD at the eastern fringe of town near Barton Street and Bhima Drive to 200 mAHD at the western fringe of the town near Aberdeen Street. At Satur, the land generally slopes from north-west to south-east.

Key features of the study area are shown in **Figure 2-1** and **Figure 2-2**, while the topography of the study catchment is shown in **Figure 2-3**.

# FIGURE 2-1

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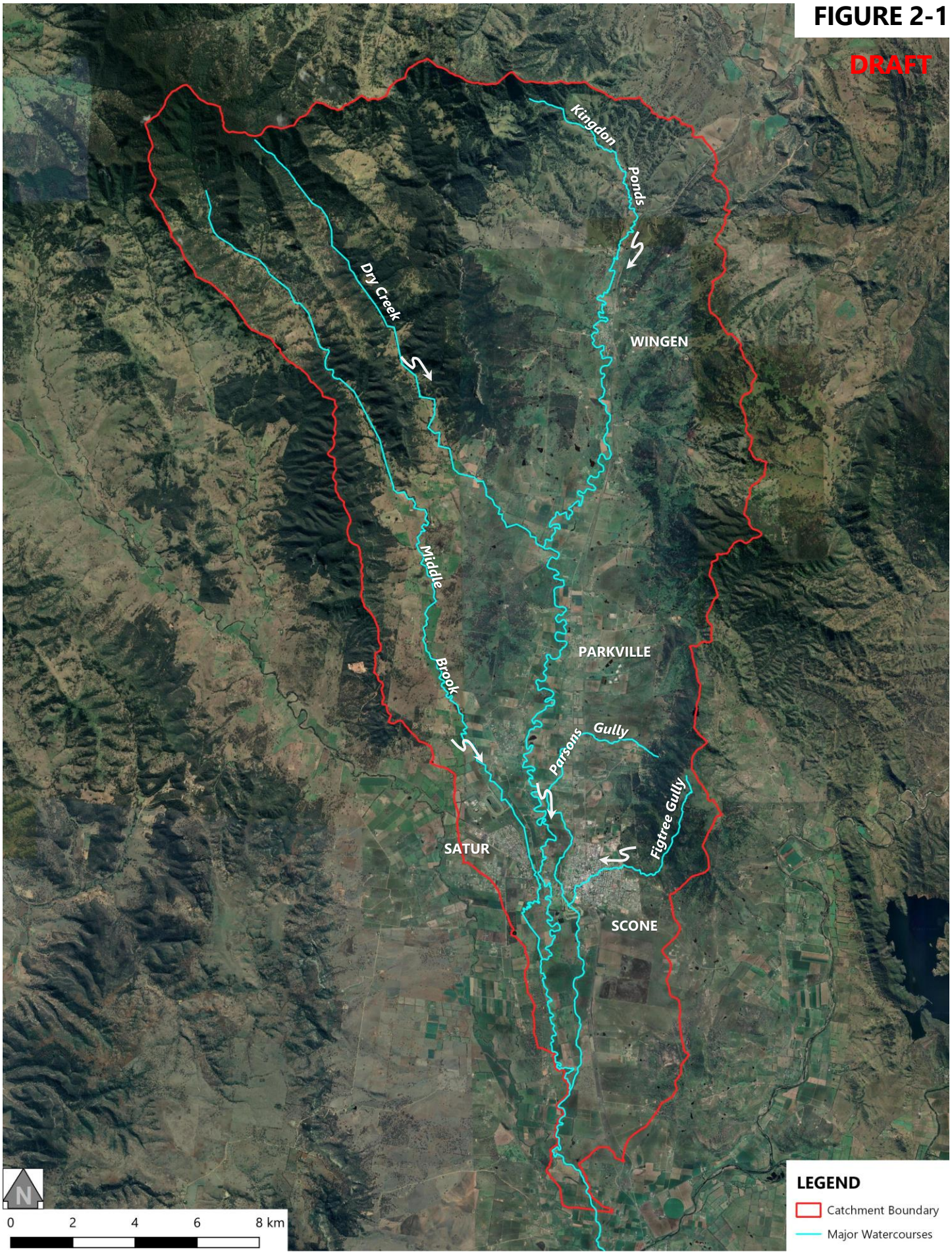


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## STUDY AREA [CATCHMENT]

# FIGURE 2-2


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## STUDY AREA [SCONE & SATUR]

**FIGURE 2-3**

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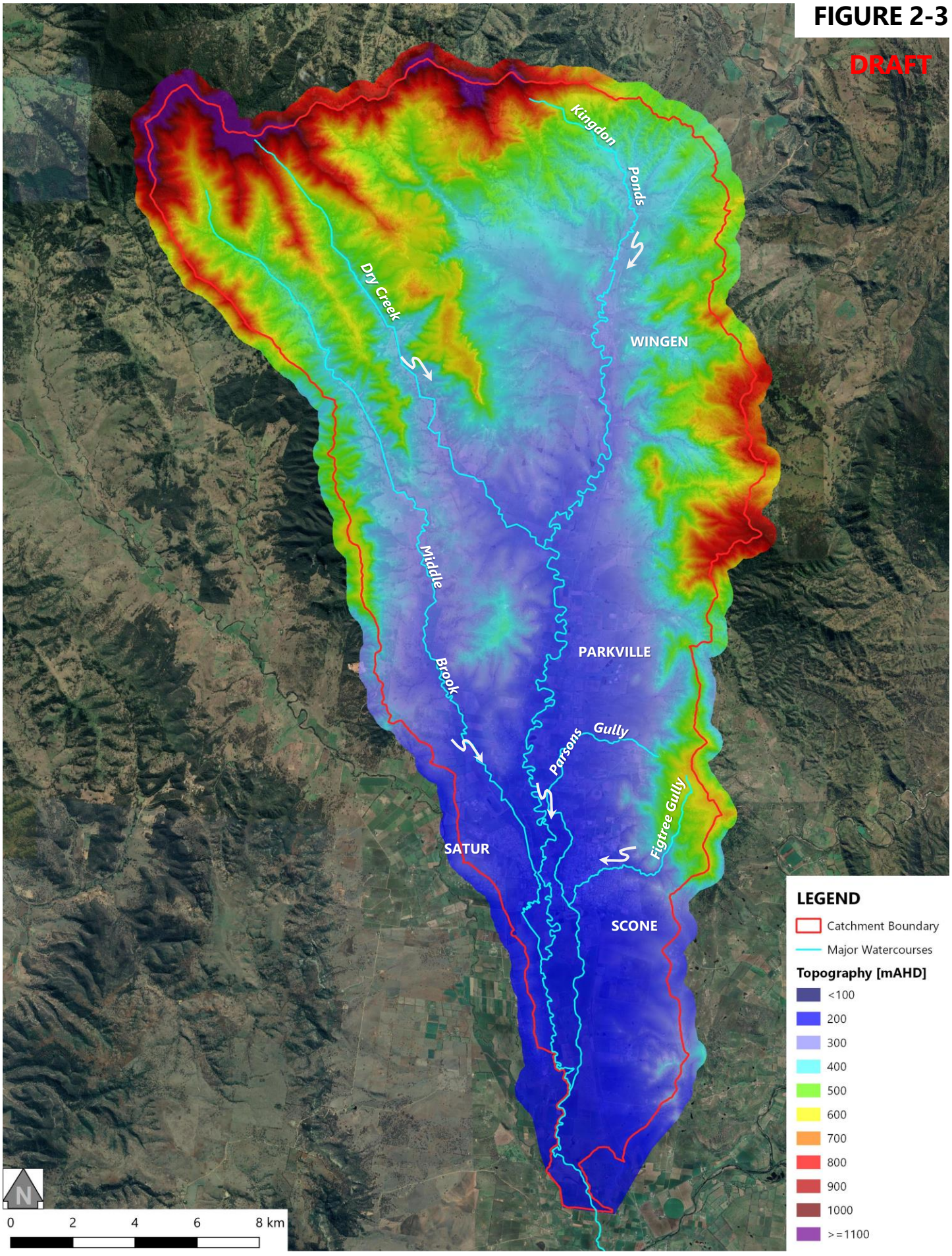


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# TOPOGRAPHY WITHIN THE STUDY CATCHMENT

## 2.2 Recent Catchment Changes

The previous flood study for Scone was completed in 1999 by Bewsher Consulting (refer **Section 3.4.2**). Since the publication of the 1999 study, there have been a number of changes to the Scone catchment, including the following:

- The gradual elevation of the main northern rail line over time;
- The Scone Bypass;
- New residential subdivisions in the vicinity of Gundy Road.

The flood modelling completed as part of this study has incorporated these catchment changes via updated topographic data as well as model build elements to represent these floodplain changes.

## 2.3 General Description of Flood Behaviour

Flooding in the Scone catchment generally arises from two mechanisms:

- Mainstream flooding of Figtree Gully.
- Mainstream flooding of Kingdon Ponds, Middle Brook and Parsons Gully.

Descriptions of each of these flood mechanisms are provided below. These descriptions have been developed from the results of the flood modelling and related analysis that is documented in the *Scone Flood Study* (Worley Consulting, 2024).

### 2.3.1 Mainstream Flooding of Figtree Gully

As noted previously, Figtree Gully transitions from an open grassed channel in the eastern portion of Scone to a concrete channel in the vicinity of the Scone CBD before transitioning back to an open grassed channel downstream of Kingdon Street. The concrete channel in the vicinity of the Scone CBD alternates between an open concrete channel near commercial blocks and a large box culvert beneath Kelly Street, Liverpool Street and the Scone RSL. The watercourse has undergone significant changes from its pre-existing natural state during European settlement and it is possible that the original alignment of the watercourse has been modified.

A critical storm duration of 6 to 9 hours was determined for much of the Figtree Gully catchment for design events ranging from the 20% AEP up to and including the 1% AEP storms. Design flood events rarer than the 1% AEP event had critical durations of 3 hours or less. These relatively short durations are indicative of a catchment with a fast response time, where flooding occurs as a result of relatively short durations of intense rainfall and where flood levels quickly rise and fall over the course of a few hours.

The Figtree Gully channel in the urban areas of Scone has limited flow conveyance, with some flow breakouts occurring at several locations in the 20% AEP event. These locations include areas near Waverley Street and Main Street, as well as immediately downstream (west) of the Scone RSL Club where the watercourse transitions back into a natural channel. Once the capacity of the channel is exceeded, floodwaters are expected to travel overland to the south and west through several residential lots and along road reserves.

The results from hydrodynamic modelling undertaken for the Flood Study indicate that in the CBD, those areas along Kelly Street to the south of the Liverpool Street intersection are the most flood prone. Inundation of these roadways and some adjoining properties is predicted in events as frequent

as the 20% AEP storm. Some areas of Kelly Street between Liverpool Street and St Aubins Street are also inundated during the 20% AEP event, but to a lesser degree.

During the 1% AEP event, areas of high flood hazard that may pose a significant threat to life and property (e.g., ≥ H4 Hazard) are confined within the Figtree Gully channel. Inundated areas outside of the Figtree Gully channel are typically classified as H1 to H2 Hazard, with some localised areas of H3 Hazard resulting from flood depths in excess of 0.5 metres. The flood hazard categorisation is discussed in further detail in the *Scone Flood Study* (Worley Consulting, 2024).

During the PMF, the extent and degree of hazard posed to life and property is predicted to increase significantly. Large portions of the commercial and residential areas of Scone would be inundated with the flood hazard typically ranging from H3 to H5.

### 2.3.2 Mainstream Flooding of Kingdon Ponds, Middle Brook & Parsons Gully

The three major watercourses of Middle Brook, Kingdon Ponds and Parsons Gully share a common floodplain near Scone, which is typically characterised by undeveloped pastureland with a small number of buildings and private properties.

The Kingdon Ponds channel has limited flow conveyance property in areas downstream (south) of Parkville. This results in flows breaking out of the Kingdon Ponds channel in events as frequent as the 20% AEP event. These breakout flows discharge into the adjacent watercourses of Parsons Gully and Middle Brook at several locations between Parkville and Scone (refer **Figure 2-4**). Subsequently, a significant portion of the flows along Parsons Gully and Middle Brook arriving at the Liverpool Street crossing would have originated from floodwaters escaping the Kingdon Ponds channel further upstream (north).

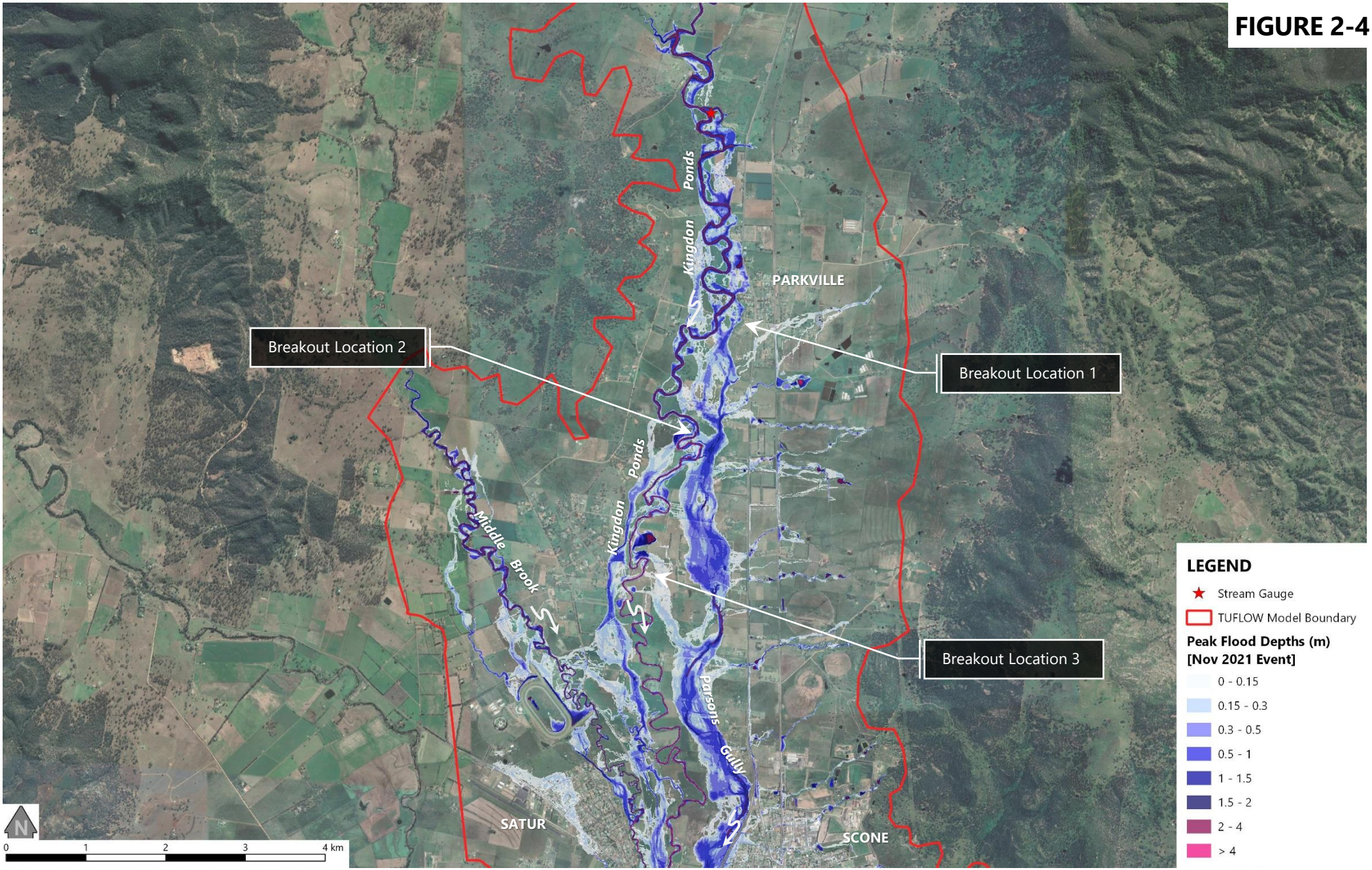
For design flood events from the 20% AEP up to and including the 1 in 500 AEP event, a critical storm duration of 18 hours was found for the catchment reporting to the Liverpool Street crossing of the three watercourses.

A number of properties on the common floodplain between Scone and Satur are predicted to be inundated in events as frequent as the 20% AEP event. In particular, this includes properties in the vicinity of Morse Street and Wingen Street, as well as the properties on the western side of Aberdeen Street to the south of Liverpool Street.

During the 1% AEP event, the majority of the common floodplain between Scone and Satur is inundated to depths exceeding 0.5 metres. The flood hazard is also typically H3 or higher in the vicinity of Liverpool Street. The majority of properties in the floodplain are expected to be inundated, as well as the entirety of the Bill Rose Sports Complex and the Scone Golf Club.

During the PMF event, floodwaters from the three watercourses form a continuous body of water between Satur and Scone, with high flood depths and flow velocities resulting in a flood hazard category of H6 throughout most of the common floodplain.

FIGURE 2-4

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**LOCATION OF FLOW BREAKOUTS ALONG KINGDON PONDS**

## 2.4 Local Flood History

The Kingdon Ponds catchment has experienced several significant floods over the past decades including events in 1955, 1976, 1992, 2000, 2007 and 2021. Of these historic events, many local residents recall the 1955 flood as the largest event to have occurred in the catchment. It was estimated to have been approximately a 100 year Average Recurrence Interval (ARI) event in this catchment.

During these major flood events along Kingdon Ponds, Middle Brook and Parsons Gully, floodwaters inundated the western portion of the Scone township (refer **Figure 2-5**) and can overtop Liverpool Street, which would result in the isolation of Satur.

**Figure 2-5 View looking north showing inundation of properties along Aberdeen Street during the November 2021 event [*source: Upper Hunter Shire Council*]**

There are generally less anecdotes of major floods along Figtree Gully, however, local residents recall events in 1955, 1992 and 1997 as the most severe in recent memory. Anecdotes from local residents were provided in the *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999) which describes flows escaping from Figtree Gully as well as local runoff inundating residential properties and roads. In particular, owners and employees of several businesses fronting Kelly Street in the Scone CBD have reported nuisance flooding on several occasions (refer **Figure 2-6**).


**Figure 2-6 View looking south showing nuisance flooding along Kelly Street in March 2021 [*source: RHM Consulting Engineers*]**

# 3. Background

## 3.1 The Need for Floodplain Risk Management

Floods are part of the Australian landscape. They occur in many parts of Australia, and their severity and causative mechanisms may vary widely between locations.

While floods have positive impacts such as providing inflows to water supplies, sustaining flood-dependent ecosystems and improving soil moistures and fertility for farming, where humans have occupied the floodplain they pose significant risk to life and property. Negative impacts of flooding include human fatalities and injuries, economic damage, environmental damage, and disruption of individuals' lives and the function of communities (*AIDR 2017*).

Historically, flood damage in Australia is greater than that of any other natural hazard, and flood-related deaths are a continuing occurrence. Despite the hazard posed, flooding is the most manageable natural disaster, as its behaviour and potential extent can be estimated and considered in decision making. In New South Wales, the management of flood liable land is governed by the NSW Government's *Flood Prone Land Policy*, the main objective of which is to reduce the impact of flooding and flood liability on owners and occupiers of flood-prone property and reduce public and private losses from flooding. The policy also recognises the benefits of the appropriate and sustainable use, occupation, and development of flood-prone land.

Studies such as the Scone Floodplain Risk Management Study are undertaken to help local government make informed decisions about managing flood risk by using detailed flood models to quantify flooding patterns and to investigate options to manage and alleviate flood risk including potential property, flood and response modification measures.

## 3.2 The NSW Floodplain Risk Management Process

The NSW Government's *Flood Prone Land Policy* is directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the existing flood hazard and does not create additional flooding problems in other areas. Policy and practice are defined in the *Flood Risk Management Manual* (DPE, 2023a).

Under the Policy, the local government is primarily responsible for the management of flood liable land within their respective LGAs. The State Government provides financial and technical assistance to local government through its Floodplain Management Program which is administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW), previously known as the Office of Environment and Heritage (OEH) and the Department of Planning and Environment (DPE).

The NSW Floodplain Risk Management Process consists of a number of stages as defined in the *Flood Risk Management Manual* and reproduced in this report as **Figure 3-1**. The process is cyclical, and reviews may be triggered by various instances, for example the occurrence of significant flood events which provide additional data that can be used to better understand flooding mechanisms, or the occurrence of significant changes to the catchment condition over time.

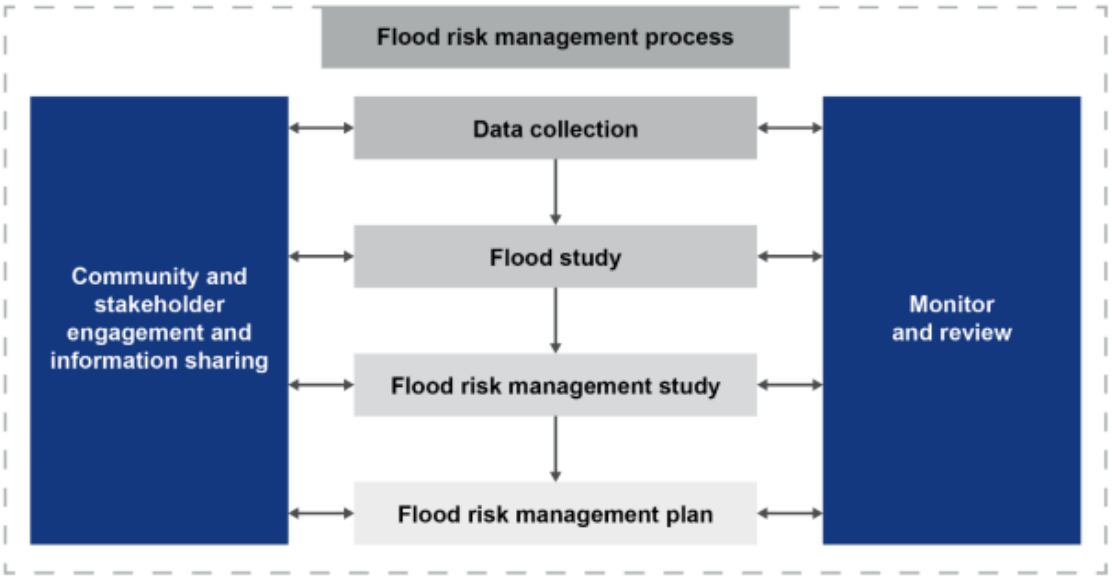



**Figure 3-1 Stages of the NSW Floodplain Risk Management Process**

A brief description of the stages are provided in the following:

- Data Collection: compilation of existing data and collection of additional data.
- Flood study: a technical document which defines the nature and extent of the flood problem, usually using numerical flood models.
- Floodplain Risk Management Study: further evaluates flood risk and impacts, and assesses management options in consideration of social, ecological and economic factors.
- Flood Risk Management Plan: preferred management options publicly exhibited and subject to revision in light of responses. Formally approved and implemented by Council after public exhibition and comment.

In 2019, Upper Hunter Shire Council received support from DCCEEW to review and update the existing floodplain management study and plan for Scone, which was prepared by Bewsher Consulting in 1999.

An overview of previous studies completed in the study area and the triggers for the current review process are discussed in the following.

## 3.3 The Need for the Update of the Scone Floodplain Risk Management Study and Plan

The current *Scone Floodplain Risk Management Study and Plan* was triggered in response to a variety of factors. These factors are listed below.

- Changes to the catchment since the 1996 Flood Study and 1999 Floodplain Management Study and Plan, such as the Scone Bypass, changes in the main northern railway and new residential subdivisions near Gundy Road.
- Availability of updated Airborne Light Detection and Ranging (LiDAR) topographic survey of the study area captured in 2017.

- Additional ground and structural survey undertaken during the Scone CBD Revitalisation Project and as part of the data collection process for this study.
- Advancements in flood modelling capability
  - The *Scone Flood Study* (*DLWC, 1996*) and *Scone Floodplain Management Study and Plan* (*Bewsher Consulting, 1999)* adopted one-dimensional (1D) hydraulic models. In such 1D models the floodplain is schematised into a series of user defined stream reaches and cross-sections. Flows may occur in only one pre-defined direction along a stream, and flood levels are constant across a cross-section. As a result, flood conditions along some tributaries and overland flowpaths were not defined, and complex flooding patterns may not have been captured in some areas.
  - The *Scone Flood Study* (Worley Consulting, 2024) has adopted a two-dimensional (2D) hydraulic model which provides a continuous representation of the entire floodplain surface and allows fine-scale spatial variation in flood level, flow direction and velocity. Such models are far superior to 1D models in their representation of complex flow patterns in urban areas including their ability to resolve flow diversions and alternative flow paths.
- Release of updated guideline and policy documents
  - Issue of *Australian Rainfall and Runoff: A Guide to Flood Estimation 2019* (*ARR 2019*)
  - Release of new planning and policy documents such as *Upper Hunter Development Control Plan* (2023).
  - Release of new guidelines such as the Flood Risk Management Manual (DPE, 2023) and its associated guides.
- The need to investigate future flood risk including the potential impacts of climate change.

## 3.4 Previous Flood Investigations

A number of flood-related studies have previously been completed in the Scone catchment, including a series of studies in accordance with the NSW Floodplain Risk Management Process. Further information on each study is provided in the following.

### 3.4.1 Scone Flood Study (1996)

The Scone Flood Study prepared by the Department of Land & Water Conservation (DLWC) included the development of a RAFTS-XP hydrologic model and a 1D MIKE 11 hydraulic model. The flood models were used to assess the nature and extent of flooding along Middle Brook, Kingdon Ponds and Parsons Gully but did not address flooding along Figtree Gully.

The models were calibrated and validated against the January 1976 and February 1992 flood events. The report indicated that the model calibration results generally achieved a satisfactory match with recorded flood levels. Areas where notable differences were observed were attributed to a lack of reliable survey data as well as the 'radical meanders' along Kingdon Ponds, which were difficult to represent in the 1D hydraulic model.

The study involved the simulation of the 10, 20, 50, 100 and 200 year Average Recurrence Interval (ARI) floods, in addition to the Probable Maximum Flood (PMF).

### 3.4.2 Scone Floodplain Management Study and Plan (1999)

Following the completion of the 1996 Flood Study, Council engaged Bewsher Consulting to prepare the Scone Floodplain Management Study and Plan (*the Scone FPMS & Plan*). The objective of this study was to minimise the impact of flooding within the Middle Brook, Kingdon Ponds and Parsons Gully floodplains.

Notably, the Scone FPMS & Plan also included an assessment of flooding along Figtree Gully. A separate RAFTS-XP hydrologic model was developed for the Figtree Gully catchment, which adopted a different storage routing factor to the model developed for the 1996 Flood Study. A 1D HEC-RAS hydraulic model was also developed for this catchment.

The newly developed models indicated that the Figtree Gully system only had limited flow conveyance capacity. The models predicted that flows would overtop the channel downstream of Waverley Street in events as frequent as the 5 year ARI flood. Once the capacity of the channel is exceeded, floodwaters are expected to route overland to the south and west through several residential lots and along road reserves. Several properties along Kelly Street in the Scone CBD are also expected to be inundated.

Several mitigation options were recommended in the Floodplain Management Plan. The recommended options are summarised below and shown in **Figure 3-2**.

Flood modifications options:

- Reconstruction of Figtree Gully to increase conveyance capacity;
- Removal of obstructions in the Figtree Gully channel;
- Preparation of a vegetation management plan for each major waterway.

Property modification options:

- Raising of 10 houses in the Parsons Gully catchment;
- Flood-proofing of commercial properties in the Scone CBD;
- Improvement of existing building and development controls;
- Introduction of on-site stormwater detention policies in the Figtree Gully catchment.

Response modification options:

- Issue of flood certificates to all property owners on a regular basis;
- Improvement of emergency planning and management;
- Increasing community education and flood awareness;
- Improvement of flood warning systems;
- Preparation of flood action plans for individual properties.

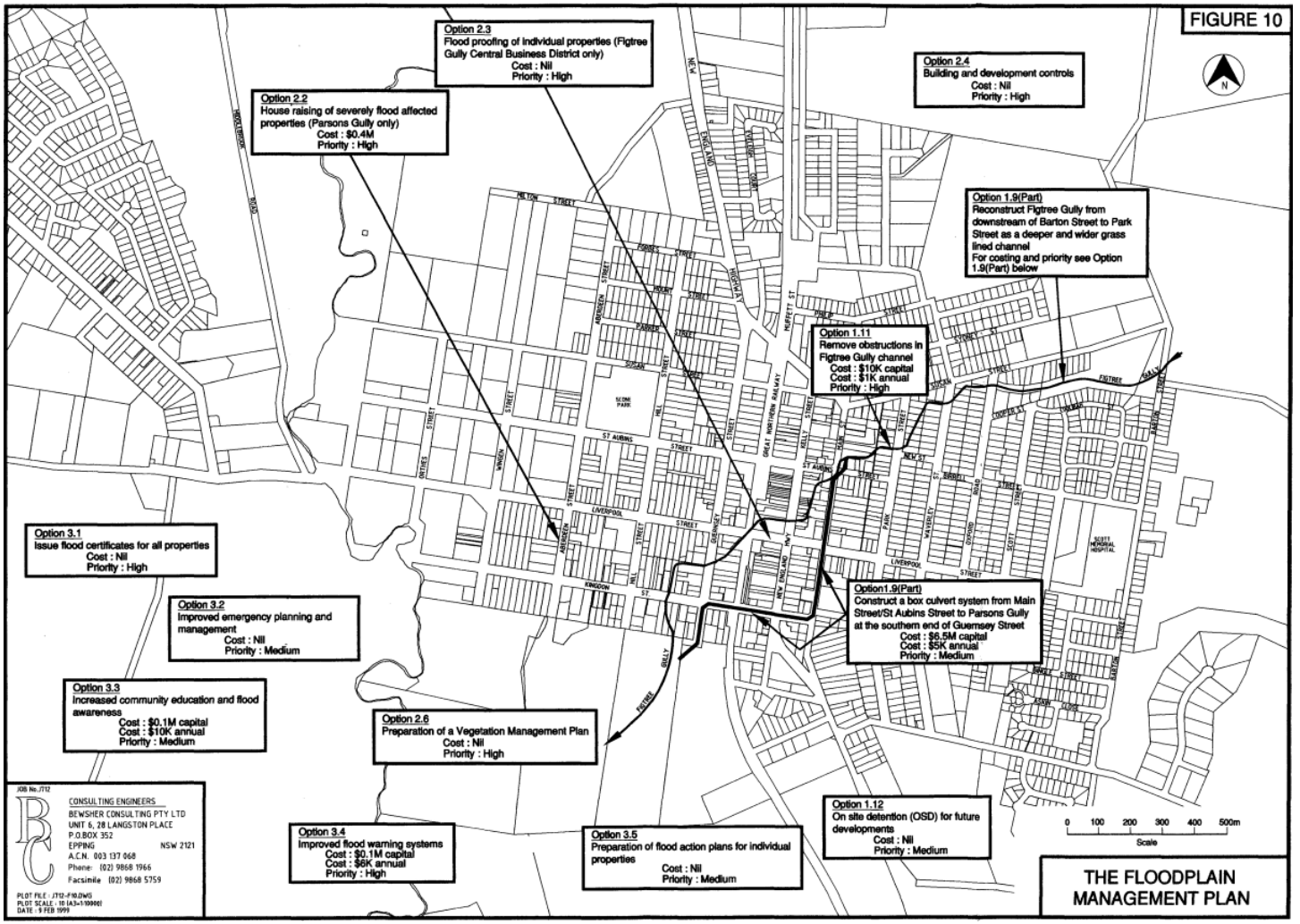



**Figure 3-2 Recommended measures from the 1999 Floodplain Management Study (*source: Bewsher Consulting 1999*)**

### 3.4.3 New England Highway Bypass at Scone - Flood Modelling Report (2017)

Road and Maritime Services (RMS) engaged GHD to undertake a detailed hydrologic and hydraulic assessment of flood behaviour in the vicinity of the preferred route of the proposed Scone Bypass alignment.

This assessment included the establishment of a new XP-RAFTS hydrologic model and a new TUFLOW hydraulic model, which were developed between 2015 and 2017. The models were used to analyse flood behaviour for existing conditions for the 10, 20, 100, 200, 500 and 2000 year ARI events as well as the PMF. The works and structures associated with the Scone Bypass were incorporated into a post-development version of the flood models, which was then used to establish flood behaviour for post-development conditions. The post-development flood results were then compared against the existing conditions flood results to analyse the predicted flood impacts associated with the Scone Bypass.

The representation of the Scone Bypass structure was extracted from the GHD flood model and adopted in the flood models which are used for this current study.

**Figure 3-3 Photo of the completed Scone Bypass (*source: Transport for NSW*)**

### 3.4.4 Scone CBD Revitalisation Project – Flood Impact Assessment (2021)

Council is undertaking the Scone CBD Revitalisation Project which involves major landscaping works and beautification upgrades to Kelly Street between Kingdon Street and Susan Street. The proposed works include cut and fill earthworks as well as realignment of the kerb along Kelly Street. The existing stormwater network in the vicinity of Kelly Street is also to be upgraded as part of this project.

Worley Consulting (then Advisian) was engaged by Council to undertake a Flood Impact Assessment (FIA) aimed at quantifying the benefits of the proposed road and stormwater upgrade in reducing flood affectation of commercial properties fronting Kelly Street. The FIA was undertaken concurrently with the updated Scone Flood Study. The FIA adopted the Figtree Gully sections of the WBNM and TUFLOW flood models which had been developed for the updated Scone Flood Study.

A key component of the FIA comprised the verification of the WBNM runoff lag factor 'C'. A 'C' factor of 0.9 was determined as part of the calibration process in the updated Scone Flood Study. However, this calibration process was completed based on consideration of streamflow gauges located outside of the Figtree Gully catchment.

Accordingly, the February 1992 historic event was investigated to verify an appropriate value of 'C' for the Figtree Gully catchment. Following this verification process, a 'C' factor of 1.3 was recommended for adoption for the Figtree Gully catchment.

Further details of this model verification process are provided in Appendix A of the *Scone Flood Study* (Worley Consulting, 2024).

### 3.4.5 Scone Flood Study (2024)

Council engaged Worley Consulting (part of the Worley Group) to complete an updated Flood Study for the Scone catchment in response to various factors including the release of *Australian Rainfall and Runoff 2019* (ARR 2019), recent improvements in flood modelling technology, the availability of new data and changes in the catchment.

New hydrologic (WBNM) and hydraulic (TUFLOW) flood models were developed using the latest available data for the catchment and up-to-date guidelines and techniques. The models underwent calibration and verification to historic flood data for the November 2021 and December 2007 flood events to confirm their ability to reliably simulate catchment flood behaviour.

The models and their outputs will help inform this FRMS&P including the assessment of potential floodplain risk management measures.

## 3.5 Study Objectives

The overall objective of this study was to complete a comprehensive review and update of the *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999), and thereby provide an improved understanding of the potential impacts of floods on the local community and how flood risk may be better managed.

The *Scone Flood Study* (Worley Consulting, 2024) provides an updated definition of flood behaviour in the study area based on the latest guidance in ARR2019 and associated design rainfall data. This includes the provision of updated design flood levels, depths, discharges, velocities, hazard, hydraulic categories and other information relevant to the management of flood risk.

The *Scone Floodplain Risk Management Study* (this report) assesses the potential impacts of flooding on the community and investigates options to improve management of flood risk including flood, property and response modification options.

The *Scone Floodplain Risk Management Plan* comprises of the development of a plan recommending implementation of the preferred measures as determined by a multi-criteria analysis including economic assessment.

## 3.6 Relevant Manuals and Guidelines

### 3.6.1 Floodplain Development Manual, 2005

The *Floodplain Development Manual* 2005 (the Manual) incorporates the NSW *Flood Prone Land Policy* and guides its implementation in the floodplain risk management process. It aims to reduce the impacts of flooding and flood liability on individual owners and occupiers of flood prone property and to reduce private and public losses resulting from floods.

The Manual outlines a merit-based framework to assist with floodplain risk management. It confirms that responsibility for management of flood risk remains with local government and provides guidance for councils in the development and implementation of local floodplain risk management plans.

A series of floodplain risk management guidelines were developed by the former OEH (*now DCCEEW*) to complement the *Floodplain Development Manual*, providing additional technical information to councils and consultants to support the preparation and implementation of floodplain risk management plans.

### 3.6.2 Flood Risk Management Manual, 2023

The *Flood Risk Management Manual* (DPE 2023a) updates the Floodplain Development Manual (2005) and several of the existing technical guides. It considers lessons learnt from floods and the application of the flood risk management process and manual since 2005.

Associated guides referenced in the preparation of this study include:

- FB01 Understanding and Managing Flood Risk
- FB02 Flood Function
- FB03 Flood Hazard
- MM01 Flood Risk Management Measures
- EM01 Support for Emergency Management Planning.

### 3.6.3 Australian Rainfall and Runoff, 2019

*Australian Rainfall and Runoff: A Guide to Flood Estimation 2019* (*ARR 2019*) was issued for use by practitioners in draft form in November 2016 and was finalised in May 2019. It provides an updated national guideline document, data and software suite for the estimation of design flood characteristics in Australia.

The guidelines update previous editions of ARR in light of recent advances in knowledge regarding flood processes, the increased computational capacity available to hydrologists and flood engineers, expanding knowledge and application of hydro-informatics, improved information about climate change and the use of more detailed hydrological methods.

The guidelines also incorporate new Intensity-Frequency-Duration (IFD) design rainfall estimates developed by the Bureau of Meteorology (BoM), using 30 years of additional observations from over 10,000 rainfall gauging stations and improved statistical analysis techniques.

### 3.6.4 Australian Disaster Resilience Handbook 7, 2017

*Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR 2017) provides guidance on best practice principles as presently understood in Australia. It provides information on the underlying principles that need to be considered when managing flood risk and formulating floodplain management plans and how to apply it, with the aim of promoting effective, equitable and sustainable land use across Australia's floodplains. A number of supporting documents are provided in conjunction with Handbook 7 and have been referenced in the preparation of this study.

# 4. Flood Planning Context

## 4.1 Social Profile

A general understanding of the makeup of the community can be important in the development of floodplain management measures. To help develop social profile of the community, relevant 2021 Census data available from the Australian Bureau of Statistics was extracted for Scone and Satur and is presented in **Table 4-1**.

Some key characteristics identified from the data are summarised in the following:

- **Population in the floodplain:** It is estimated that about 2720 people live within the floodplain in the study area. This is based on the average household size of about 2.3, an unoccupied rate of about 9% and the approximately 1300 lots within the simulated PMF extent. This number would be expected to increase during holiday periods.
- **Age structure:**
  - Persons in the 0 to 14 years age group may require assistance during a flood or be more prone to unsafe behaviour. Overall, the study area has a similar proportion of persons in this age group compared to the NSW average.
  - Persons in the 65 years and over age group may be particularly vulnerable to the impacts of flooding due to communication and mobility challenges and difficulty recovering after a flood. The study area has a similar proportion of people in this age group (about 20%) compared to the NSW average (22%).
  - Of persons aged 65 and over, about 29% live alone.
- **Language:**
  - 87 respondents to the Census indicated that they speak English 'not well or not at all'. This suggests that there may be some consideration given to issuing flood education or flood warnings in languages other than English.
- **Motor vehicles per dwelling:**
  - The proportion of dwellings with no motor vehicle is similar to the NSW average (6%). This is not expected to limit evacuation options in the event of a flood.

**Table 4-1 Relevant Census Data for Scone and Satur**

| Census Description | Scone & Satur | | Upper Hunter Shire LGA | | NSW (*excl. Sydney*) | |
|---|---|---|---|---|---|---|
| **Total Persons** | **5,013** | | **14,229** | | **2,829,637** | |
| Aged 0-4 years | 276 | 5.5% | 757 | 5.3% | 155,229 | 5.5% |
| Aged 5-14 years | 694 | 13.8% | 1,892 | 13.3% | 350,305 | 12.4% |
| Aged 65+ years | 1,001 | 20.0% | 2,999 | 21.1% | 628,053 | 22.2% |
| Of Indigenous Origin | 377 | 7.5% | 990 | 7.0% | 185,873 | 6.6% |
| Who do not speak English well | 87 | 1.7% | 108 | 0.8% | 18,691 | 0.7% |
| Have a need for assistance (profound/severe disability) | 287 | 5.7% | 827 | 5.8% | 193,513 | 6.8% |
| Living alone (Total) | 621 | 12.4% | 1,581 | 11.1% | 299,004 | 10.6% |
| Living alone (Aged 65+) | 292 | 5.8% | 741 | 5.2% | 148,726 | 5.3% |
| Residing in caravans, cabins or improvised dwellings | 28 | 0.6% | 103 | 0.7% | 18,682 | 0.7% |
| Occupied Private Dwellings | 2,034 | | 5,499 | | 1,071,609 | |
| Unoccupied Private Dwellings | 191 | 9% | 850 | 13% | 134,891 | 11% |
| No Motor Vehicle | 124 | 6% | 239 | 4% | 58,952 | 6% |
| Caravan, cabin, houseboat, or improvised dwelling | 10 | | 65 | | 11,158 | |
| Rented via State or Housing Authority | 90 | | 125 | | 31,809 | |
| Rented via Housing Co-Op or Community Church Group | 31 | | 45 | | 11,426 | |
| Average persons per occupied dwelling | 2.3 | | 2.4 | | 2.4 | |

## 4.2 Flood Planning Instruments

### 4.2.1 NSW Environmental Planning and Assessment Act 1979

The NSW Environmental Planning and Assessment Act 1979 (EP&A Act) provides a legislative framework for development assessment and protection of the environment from adverse impacts arising from development. The EP&A Act outlines the level of assessment required under State, regional and local planning legislation and identifies the responsible assessing authority.

In NSW a formal development assessment and determination must be made of the proposed activity prior to taking place to ensure it complies with relevant planning controls and conforms with the principles of environmentally sustainable development.

Under the EP&A Act, councils have the responsibility to facilitate the implementation of the NSW Government's Flood Prone Land Policy through the preparation and exercising of a Local Environmental Plan (LEP). Various policies and guidelines fall under the EP&A Act as described in the following.

**NSW Flood Prone Land Policy**

The primary objectives of the NSW Government's Flood Prone Land Policy (the Policy) are:

a) to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone land, and

b) to reduce public and private losses resulting from floods whilst utilising ecologically positive methods wherever possible.

The Policy recognises that flood prone land is a valuable resource and that development applications and proposals for rezoning of flood prone land should be the subject of careful assessment which incorporates consideration of local circumstances. It promotes a merit-based approach for all development decisions in the floodplain, taking into account social, economic and ecological factors, as well as flooding considerations.

Implementation of the Policy is defined in the *Flood Risk Management Manual* (the Manual) (DPE 2023a) which was gazetted in June 2023 to replace the *Floodplain Development Manual* (NSW Government 2005).

**Flood Prone Land Package, 2021**

DCCEEW (*then DPE*) implemented an updated Flood Prone Land Package in July 2021. The updated package provides councils with additional land use planning tools to manage flood risk during events greater than the 1% AEP flood.

The changes include the following.

***Revised Ministerial Direction 4.1 (Flooding)***

- Issued in February 2023 under Section 9.1 of the Environmental Planning and Assessment Act 1979, replacing the previous Direction 4.3 (Flood Prone Land).

- The amendment removes the requirement for councils to seek exceptional circumstances in order to apply residential development controls to land outside the 1% AEP flood extent.
- The direction also makes provision for special flood considerations where councils have chosen to adopt the optional Special flood considerations clause in an LEP, which considers areas between the Flood Planning Area and the Probable Maximum Flood extent.

***Planning circular PS 21-006 'Considering flooding in land use planning: guidance and statutory requirements'***

- Provides advice on the package of changes in terms of how land use planning is to consider flooding and flood-related constraints, including Section 10.7 Planning Certificates, local planning Direction 4.1, revised LEP clauses and associated guidelines.

***Planning circular PS 24-001 'Update on addressing flood risk in planning decisions'***

- This circular was issued on 1 March 2024 and supplements PS21-006, providing additional information to planning authorities in relation to addressing flood risk in land use planning and development assessment under the Environmental Planning and Assessment Act 1979.
- It outlines existing flood-related planning policies and provides further information and advice on their application in planning. The circular also provides updates on flood-related policy initiatives underway, including action taken in response to the 2022 NSW Flood Inquiry.

***Guideline: Considering Flooding in Land Use Planning***

- Issued in July 2021, it aims to provide councils with guidance to manage flood risk for the full range of flooding up to the Probable Maximum Flood (PMF) as part of land use planning.
- There are two different categories councils can use to apply/consider flood related development controls; flood planning areas or special flood considerations.
  - The Flood Planning Area allows the application of development controls. It is to be based on a Defined Flood Event (DFE) with an appropriate freeboard selected for flood risk management purposes. The FDM identifies either the 1% AEP flood event or an equivalent historic event as an appropriate starting point when selecting the Defined Flood Event (DFE). It also allows the selection of a rarer event where there are significant economic, social, environmental or cultural consequences.
  - The Special Flood Considerations category allows councils to apply controls to land between FPA and the PMF extent where sensitive land uses require ongoing functionality during and after a flood event or require high levels of evacuation assistance. They can also be applied where there is a risk of hazardous material impacting the community or environment.

**Section 10.7 Planning Certificates (formerly Section 149)**

Section 10.7 planning certificates are issued by councils under the Environmental Planning and Assessment Regulations 2000. The primary function of notations on the Section 10.7 certificate is as a planning tool for notification that the land is affected by a policy that restricts development due to the likelihood of a risk such as flood hazard.

Under section 9(1) and section 9(2) of Schedule 2 of the Environmental Planning and Assessment Amendment (Flood Planning) Regulation 2021 councils are required to include a notation on section 10.7 planning certificates if the land or part of the land to which the certificate relates is within the flood planning area (FPA) and subject to flood related development controls. Section 9(2) also requires councils to include a notation if part of the land is between the FPA and the PMF.

To apply flood-related planning controls through section 10.7 notifications it is essential that Council complete Flood Studies and FRMS&Ps to identify and tag appropriate 'flood control lots'.

### 4.2.2 State Environmental Planning Policies (SEPPs)

State Environmental Planning Policies (SEPPs) are the highest level of planning instrument and generally prevail over Local Environmental Plans.

**SEPP (Exempt and Complying Development Codes) 2008**

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008, is an important policy which defines development exempt from obtaining development consent or which does not require development consent if it complies with certain criteria.

Clause 1.5 of the SEPP defines a 'flood control lot' as 'a lot to which flood related development controls apply in respect of development for the purposes of industrial buildings, commercial premises, dwelling houses, dual occupancies, multi dwelling housing or residential flat buildings (other than development for the purposes of group homes or seniors housing'. Development controls may be applied through an LEP or DCP. Exempt development is not permitted on flood control lots, but some complying development is permitted.

Various Codes throughout the SEPP specify various controls relating to development on flood control lots, including requirements for floor levels, flood compatible materials, structural stability (up to the PMF if on-site refuge is proposed), flood affectation, safe evacuation, car parking and driveways.

This SEPP highlights the importance of Council completing Flood Studies and FRMS&Ps to identify and tag appropriate 'flood control lots' through section 10.7 notifications and thereby apply flood-related planning controls to reduce the impacts of flooding for current and future occupants of the floodplain.

**SEPP (Transport & Infrastructure) 2021**

State Environmental Planning Policy (Transport & Infrastructure) 2021 facilitates the delivery of infrastructure across the State by identifying development permissible without consent. Among its provisions, the policy allows local government to undertake stormwater and flood mitigation work without development consent.

**SEPP (Housing) 2021**

State Environmental Planning Policy (Housing) 2021 encourages the provision of housing (including residential care facilities) to increase the supply of residences that meet the needs of seniors or people with a disability. This is achieved by overriding local planning controls that would prevent such development.

Chapter 3 indicates that complying developments for secondary dwellings and group homes must not be carried out on parts of a flood control lot which are designated as a flood storage area, a floodway, a flow path, a high hazard area or a high risk area, as certified by council or a professional engineer who specialises in hydraulic engineering.

### 4.2.3 Upper Hunter Shire Local Environmental Plan 2013

The Upper Hunter Local Environmental Plan 2013 (Upper Hunter LEP 2013) is the statutory planning instrument that establishes the permissible and/or prohibited forms of development and land use within the Upper Hunter Shire LGA.

Flood planning is addressed in Clause 5.21, while special flood considerations are addressed in Clause 5.22. A review of the LEP is presented in **Section 8.1.1**.

### 4.2.4 Upper Hunter Shire Development Control Plan 2023

The Upper Hunter Development Control Plan (DCP) 2023 sets the standards, controls and regulations that apply when carrying out development within the Upper Hunter Shire LGA. These specific controls in the DCP support the broader conditions of the Upper Hunter LEP 2013 and state-wide policies.

'Part 10a: Floodplain Management' provides Council's requirements for development upon flood prone land. A review of the DCP is presented in **Section 8.1.2**.

## 4.3 Upper Hunter Shire Council Flood Emergency Sub Plan 2022

Existing flood emergency response protocols for the Upper Hunter Shire LGA are outlined in the Upper Hunter Shire Council Flood Emergency Sub Plan (2022), which is a sub-plan of the Upper Hunter Shire Local Emergency Management Plan (EMPLAN). The Plan sets out the known flood risks and consequences for flood affected areas and how NSW SES will respond in the event of a flood. It is discussed further in **Chapter 9**.

# 5. Existing Flood Behaviour

The objectives of the FRMS&P are to assess the potential impacts of flooding and to identify and assess potential flood risk management measures and strategies that could be implemented to reduce those impacts. This requires a sound understanding of flood behaviour in the study area, which can readily be determined from reliable flood modelling outputs.

Previous flood modelling of the study area was most recently undertaken as part of the *Scone Flood Study* (Worley Consulting 2024). The WBNM hydrologic and TUFLOW 2D/1D hydraulic modelling software packages were adopted to develop new flood models using the latest available data for the catchment and up-to-date guidelines, modelling software and techniques.

The hydrologic model simulates catchment rainfall-runoff processes and generates flow hydrographs that can be input to the hydraulic model. The hydraulic model simulates the physical behaviour of the flow as it passes through an area of interest and provides a range of hydrometric data including flood levels, flood extents and flow velocities.

The models underwent calibration and verification to historic flood data that was obtained during and immediately after the November 2021 and December 2007 flood events. The calibration and verification process was completed to confirm that the models reliably simulate catchment flood behaviour.

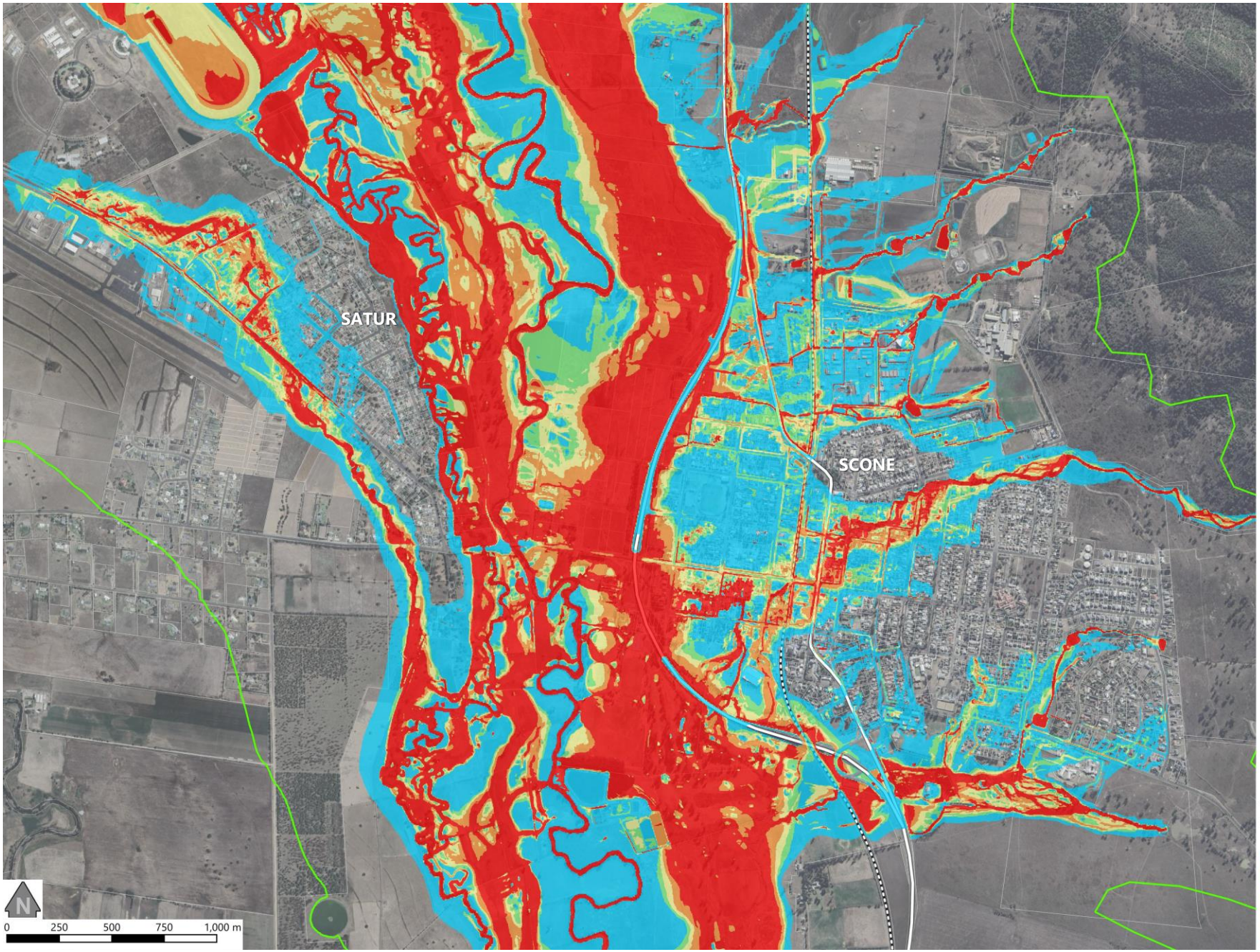
The updated study provides an updated definition of flood characteristics across the study area using the design flood estimation process detailed in *Australian Rainfall and Runoff: A Guide to Flood Estimation 2019* (ARR 2019). This includes the provision of updated design flood levels, depths, discharges, velocities, provisional hazard, hydraulic categories, and other information relevant to the management of flood risk.

The design flood extents determined as part of the *Scone Flood Study* are presented in **Figure 5-1**.

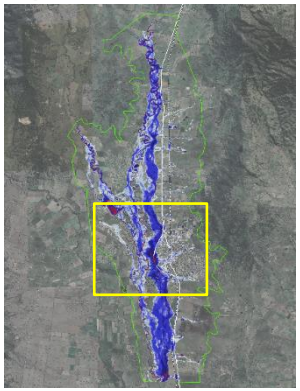
Information on existing flood behaviour within the Scone catchment is provided in greater detail in the following sections of the *Scone Flood Study* (Worley Consulting, 2024):

- Chapter 7: Design Flood Results and Mapping
- Chapter 8: Flood Hazard, Flood Function and Emergency Response Classification
- Chapter 9: Climate Change Impact Assessment

# FIGURE 5-1




***Map Extent***



**LEGEND**

- Major Roads
- Railway

**Design Flood Extents**

- PMF
- 1 in 500 AEP
- 1% AEP
- 5% AEP
- 20% AEP

UPPER HUNTER SHIRE COUNCIL

Prepared by:

worley consulting

## SIMULATED DESIGN FLOOD EXTENTS

# 6. Property Affectation and Flood Damages

## 6.1 Background

A flood damage assessment has been undertaken for the study area to quantify the impact of flooding in economic terms. Flood damages are adverse economic impacts that private and public property owners experience as a consequence of flooding.

The flood damage assessment was undertaken following the methodology presented in Chapter 3 of the Department of Planning and Environment's Flood Risk Management Guideline MM01 titled, *Flood Risk Management Measures* (DPE, 2023e) and the associated spreadsheet (flood risk management tool DT01).

The flood damage assessment will be used as a means of assessing the relative merit of potential flood management options through cost-benefit analysis relative to existing 'base case' flood conditions.

The general process for undertaking a flood damages assessment comprises the following steps.

- Identifying properties subject to flooding and attaining habitable floor levels.
- Determining depth of inundation above floor level for a range of design event magnitudes.
- Defining appropriate stage-damage relationships for various property types.
- Estimating flood damages for each property and total flood damage for a range of design events.
- Calculating Annual Average Damages (AAD), a measure of the cost of flood damage that could be expected each year by the community, on average over a long time period.
- Calculating the present value of flood damages (typically over a 50 year period at a 7% discount rate), which represents the sum of all future flood damages that can be expected over the calculation period expressed as a dollar value.

## 6.2 Types of Flood Damages

### 6.2.1 Residential Damages

Direct residential flood damages include structural damage to buildings, damage to contents, external damages and damages to vehicles. Inundation of a dwelling could also lead to relocation costs (either due to loss of rent or the need to temporarily live elsewhere) as well as clean-up costs following the flood.

The guidance referenced above includes damage curves for single and double storey detached dwellings. For multi-unit developments, the guidance recommends adopting 70% of the damage index for a single storey detached dwelling. Similarly for townhouse developments, the guidance recommends that practitioners adopt 70% of the damage index for a double storey detached dwelling.

### 6.2.2 Non-Residential Damages

The latest DPE guidance includes damage curves for commercial/industrial properties for a range of sizes as well as public buildings such as schools and hospitals. Direct non-residential flood damages include damage to facilities as well as vehicles.

Other indirect damages comprise loss of trading and business as well as clean-up costs post-event. The guidance recommends adopting 28% of the total direct damages to estimate the indirect damages incurred by non-residential properties.

### 6.2.3 Damages to General Public Infrastructure

The guidance recommends that damages to general public infrastructure (roads, railways, recreational areas, utilities etc) should be approximated by increasing the residential damages by 10%.

### 6.2.4 Intangible Damages

Flooding can also have various impacts on individuals which typically do not have a market or dollar value. These include stress, anxiety, psychological impacts, living disruptions, loss of community, physical injury and potentially fatalities.

The latest guideline from DPE does not include recommendations for a prescriptive uplift factor to estimate these intangible damages. DPE recommends that these intangible damages should only be considered in a quantitative assessment where they are likely to make material differences to floodplain risk management measures and decision-making.

Damages associated with mental health have been included in this flood damages assessment. The dollar cost of the impact on mental health has been estimated in accordance with the DPE guidance as well as the *Flood Cost-Benefit Analysis Tool* (NSW Treasury, 2023).

Other social and wellbeing costs additional to mental health impacts have also been included in this assessment. The dollar cost of other social and wellbeing impacts have been estimated based on the research presented in a document titled, *The appraisal of human-related intangible impacts of flooding* (DEFRA, 2004).

## 6.3 Stage-Damage Curve

Direct flood damages have been estimated by applying one of several residential and non-residential stage-damage curves to each property included in the database. These curves define the amount of flood damage that would be expected at different flood depths for a particular property type.

The stage-damage curves have been calculated for the study area using the inputs presented in **Table 6-1**. Stage-damage curves are provided for ten property types as shown in **Table 6-2**.

**Table 6-1 Stage-damage curve input variables**

| Input | Value | Source |
|---|---|---|
| Regional Uplift Factor | 5% | Guideline MM01 Chapter 3.6.2 |
| Infrastructure Damages Uplift | 10% | Guideline MM01 Chapter 3.3 |
| Damage downscale for units / townhouses | 30% | Guideline MM01 Chapter 3.1.1 |
| Default House Size | 220 $m^2$ | Guideline MM01 Chapter 3.1.1 |
| External Damage Depth Threshold | 0.3 metres | Guideline MM01 Chapter 3.1.3 |
| External Damage | $17,000 | Guideline MM01 Chapter 3.1.3 |
| Average Cost of Contents | $550 / $m^2$ | Guideline MM01 Chapter 3.1.2 |
| Residential clean-up costs | $4,500 | Guideline MM01 Chapter 3.1.5 |
| Non-residential indirect costs | 30% of direct damages | Guideline MM01 Chapter 3.2 |

**Table 6-2 Details of adopted stage-damage curves**

| ID | Property Type | Description |
|---|---|---|
| 1 | Single storey residential | For a detached dwelling assuming a default house size |
| 2 | Double storey residential | For a detached dwelling assuming a default house size |
| 3 | Multi-unit residential | Application of 30% downscale factor to single storey residential damage index |
| 4 | Townhouse | Application of 30% downscale factor to double storey residential damage index |
| 5 | 'Default Average" commercial / industrial | Proposed as a representative average where the particular use is not known; floor area = 418 $m^2$ |
| 6 | "Low to Medium" commercial / industrial | Restaurants, cafes, offices, doctor's surgeries, retail outlets, butchers, bakers, newsagencies, service stations, hardware; floor area = 186 $m^2$ |
| 7 | "Medium to High" commercial / industrial | Chemists, electrical goods, clothing stores, bottle shops, electronics; floor area = 650 $m^2$ |
| 8 | Schools | Adoption of 2000 $m^2$ as an average floor area for individual large buildings within schools in the study area |
| 9 | Hospital | Adoption of a floor area of 560 $m^2$ as the Scone Equine Hospital is the only hospital in the floodplain |
| 10 | Other public buildings | Default floor area = 2200 $m^2$ |

## 6.4 Property Affectation

### 6.4.1 Types of Flood Damage

In order to allow an assessment of properties likely to be affected by above floor flooding, and to subsequently estimate the flood damages, a database was prepared for properties within the floodplain. The property database was compiled from the following data:

(i) Floor levels for selected properties in the vicinity of the Scone Bypass compiled by the Roads and Maritime Services (RMS).

(ii) Floor levels for commercial properties fronting Kelly Street, provided by RHM Consulting Engineers for the Scone CBD Revitalisation Project.

(iii) Floor levels for selected properties in the vicinity of Figtree Gully, sourced from flood mapping completed as part of the *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999).

(iv) A drive-by survey completed by Worley Consulting staff from 8th November to 10th November 2023 and the associated desktop review process.

The drive-by survey and associated desktop review was based on the following methodology to estimate floor levels in the study area.

- An initial desktop review was undertaken using Google Street View to estimate floor levels for properties where recent imagery is available. Imagery from July 2022 was available for some parts of Scone and Satur, while imagery from March 2010 was available for all other areas.
- Floor heights for buildings were estimated using Google Street View for areas where imagery from July 2022 is available.
- Areas with March 2010 Google Street View or areas where Street View is unavailable / obstructed were noted for the drive-by survey.
- The drive-by survey was completed for the areas identified above. Two staff members from Worley Consulting's project team travelled to Scone and completed a visual assessment to determine floor heights from the street.
- The floor levels of each property within the PMF extent were approximated by adding the estimated floor heights to the land elevation at each respective building.

Simulated flood surfaces for the PMF, 1 in 500 AEP, 1 in 200 AEP, 1% AEP, 2% AEP, 5% AEP, 10% AEP and 20% AEP design events were used to extract peak flood levels at tag points for each building in the database. These points were used in the calculation of flood damages presented in **Section 6.5** of this report.

### 6.4.2 Above-Floor Flood Affectation

Design flood levels were interrogated against the property database to provide an assessment of buildings expected to be inundated to above floor level. The results are discussed in the following.

**Above Floor Flooding by Design Flood Event**

The spatial distribution of buildings affected by above floor flooding is shown in **Figure 6-1** and the results of the analysis are summarised in **Table 6-3**.

Overall, the level of affectation is high, with 891 properties expected to be flooded above floor level in the PMF. This is in the order of 33% of all properties in the study area.

There are 154 properties which are expected to be flooded above floor level during the 1% AEP event, representing about 6% of all properties in the study area. About 35 properties are expected to be affected by above floor flooding in a 20% AEP event. This number almost triples in a 5% AEP event.

**Table 6-3 Number of buildings flooded above floor level by design event and type**

| | PMF | 1 in 500 AEP | 1 in 200 AEP | 1% AEP | 2% AEP | 5% AEP | 10% AEP | 20% AEP |
|---|---|---|---|---|---|---|---|---|
| Residential | 764 | 207 | 154 | 116 | 108 | 76 | 38 | 20 |
| Commercial / Industrial | 108 | 49 | 41 | 36 | 33 | 26 | 18 | 14 |
| Public Buildings[1] | 19 | 8 | 5 | 2 | 2 | 1 | 1 | 1 |
| Total | **891** | **264** | **200** | **154** | **143** | **103** | **57** | **35** |

*1 – Large buildings within schools counted separately*

### Depth of Above Floor Flooding

The range of above floor flood depths expected for each design event is presented in **Table 6-4**.

The depth of above floor flooding is less than 0.5 metres for at least 80% of affected properties in events up to and including the 1 in 500 AEP flood. This proportion drops to 40% during the PMF.

The number of properties expected to experience depths of 1.0 metre or more above floor is relatively low for all events except the PMF. The number increases from one property in the 1% AEP event to five properties in the 1 in 500 AEP event. In the PMF this number jumps to 169 properties.

At properties experiencing 2 metres or more of flooding above floor level there would be an increased risk to life. No properties are expected to be inundated to such depths except during the PMF, during which over 160 building would be inundated to depths of more than 2 m.

**Table 6-4 Depth of above floor flooding by event**

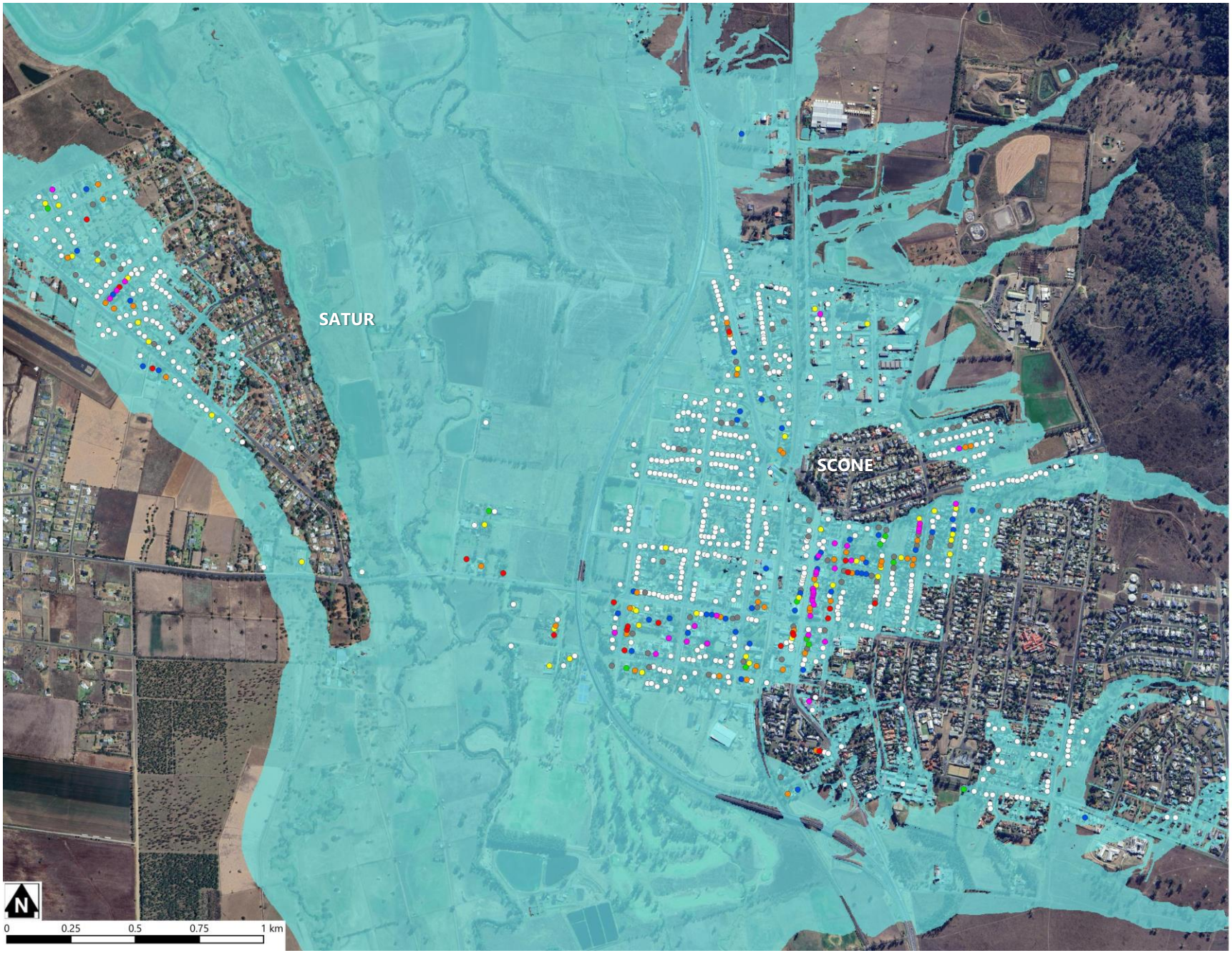
| Depth above floor | PMF | 1 in 500 AEP | 1 in 200 AEP | 1% AEP | 2% AEP | 5% AEP | 10% AEP | 20% AEP |
|---|---|---|---|---|---|---|---|---|
| 0.0 to 0.5 m | 355 | 214 | 172 | 136 | 133 | 97 | 56 | 35 |
| 0.5 to 1.0 m | 190 | 43 | 24 | 17 | 9 | 6 | 1 | 0 |
| 1.0 to 2.0 m | 169 | 5 | 2 | 1 | 0 | 0 | 0 | 0 |
| >2.0 m | 167 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

### Above Floor Flooding by Area

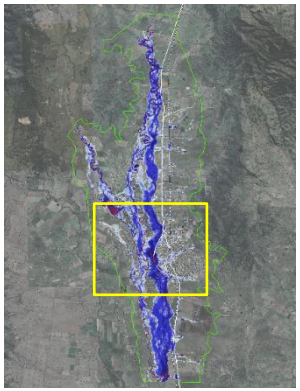
The highest concentration of properties which are prone to be flooded above floor level are located in the vicinity of Figtree Gully. This includes several commercial properties fronting Kelly Street, particularly in the area between Liverpool and St Aubins Streets. These properties are located immediately adjacent to Figtree Gully, which runs parallel to Kelly Street as a concrete-lined open channel.

Some properties in Satur are also expected to be prone to flooding above floor level. These properties are located in the vicinity of an overland flow path draining through Satur, which generally flows in a north-west to south-east alignment and inundates sections of Gray Street, Gunsynd Close and Satur Road.

# FIGURE 6-1




***Map Extent***



**LEGEND**

**Design Event of Initial Above Floor Flooding**

- 20% AEP
- 10% AEP
- 5% AEP
- 2% AEP
- 1% AEP
- 1 in 200 AEP
- 1 in 500 AEP
- PMF

**Simulated Design Flood Extent**

- PMF

UPPER HUNTER SHIRE COUNCIL

Prepared by:

worley consulting

## SPATIAL DISTRIBUTION OF ABOVE FLOOR FLOOD AFFECTATION

## 6.5 Flood Damages Assessment

Flood damages estimated for the study area are presented in **Table 6-5** and **Table 6-6**.

Key findings are summarised as follows.

- Significant flood damages would be expected even in a 20% AEP flood event. Owing to its higher probability of occurrence, this event results in the largest contribution to AAD and hence the present value of the estimated damages.
- Flood damages increase incrementally with increasing event magnitude from $4.4M in the 20% AEP event, to $23.7M in the 1% AEP event, and $48.4M in the 1 in 500 AEP event. There is then a significant increase to about $255M in the PMF.
- Contribution to AAD generally decreases with increasing event magnitude (with the exception of the PMF), with the more frequent events contributing more significantly to the total AAD and present value of damages.
- The large contribution of more frequent events to AAD and present value of damages could be a positive indication for the potential economic viability of flood mitigation options. Management measures are more likely to be able to reduce damages in these frequent events than in larger, rarer events.
- Flood damages for residential land use are several times higher than those for non-residential land use across all design events.

**Table 6-5 Summary of flood damage by design flood event**

| Flood Event | Buildings Flooded Above Floor | Estimated Damage by Flood Event ($2023) | Event Contribution to AAD ($2023) | Average Annual Damage[1] ($2023) | Present Value of Damage[2] ($2023) |
|---|---|---|---|---|---|
| 20% AEP | 35 | $4,355,234 | $666,896 | | |
| 10% AEP | 57 | $7,172,896 | $588,619 | | |
| 5% AEP | 103 | $14,296,826 | $561,658 | | |
| 2% AEP | 143 | $21,414,389 | $550,441 | | |
| 1% AEP | 154 | $23,703,298 | $226,045 | **$3,166,818** | **$43,704,450** |
| 1 in 200 AEP | 200 | $34,854,911 | $146,396 | | |
| 1 in 500 AEP | 264 | $48,369,151 | $124,836 | | |
| PMF | 891 | $255,074,786 | $301,927 | | |

1. AAD calculations have assumed zero damage in a 50% AEP event
2. Calculated at a 7% discount rate over 50 years

**Table 6-6 Components of total flood damage**

| | Damage Component | Contribution to AAD ($2023) | % of Total AAD |
|---|---|---|---|
| A. | Residential damages | $2,173,762 | 68.6% |
| B. | Commercial / industrial damages | $454,859 | 14.3% |
| C. | Damages to public buildings | $172,826 | 5.5% |
| D. | Damages to general public infrastructure | $224,833 | 7.1% |
| E. | Mental health costs | $74,569 | 2.4% |
| F. | Other social and wellbeing costs | $65,968 | 2.1% |
| | **Total Annual Average Damages (AAD)** | **$3,166,818** | |
| | **Total Present Value of Damages*** | **$43,704,450** | |

*Calculated at a 7% discount rate over 50 years

## 6.6 Potential Implications of Climate Change

Climate change is expected to alter the severity of flood impacts through an increase in the intensity of heavy rainfall events.

As part of the flood study update two climate change scenarios were simulated. The following scenarios have been used to assess the potential implications of climate change:

- Comparison of the 1 in 200 AEP event with the 1% AEP event to approximate a 15% increase in rainfall intensity; and
- Comparison of the 1 in 500 AEP event with the 1% AEP event to approximate a 35% increase in rainfall intensity.

Accordingly, the implications of climate change on above floor flooding and flood damages at Scone can also be approximated by the analysis completed for the 1% AEP event against that of the 1 in 200 AEP event and the 1 in 500 AEP event.

The comparison of the analyses summarised in **Table 6-3**, **Table 6-4** and **Table 6-5** indicates the following.

- A 15% increase in rainfall intensity for the 1% AEP event results in an additional 46 properties which would be inundated above floor level (an increase of about 30%). This increase in rainfall intensity also increases the estimated flood damages from $23.7M to $34.9M.
- A 35% increase in rainfall intensity for the 1% AEP event results in an additional 110 properties which would be inundated above floor level (an increase of about 70%). This increase in rainfall intensity also increases the estimated flood damages from $23.7M to $48.4M.

# 7. Floodplain Risk Management Approach

## 7.1 Types of Floodplain Risk Management Measures

According to the *Floodplain Development Manual* (2005), floodplain risk management measures can be separated into the following categories:

- **Property modification measures**.
  - These measures include flood planning controls for future development to ensure that land uses are compatible with flood risk. They can also include voluntary house raising and purchase, or flood-proofing of buildings, which can act to reduce flood damages.
- **Response modification measures**.
  - These typically include emergency response management measures, flood predictions and warnings and community flood awareness and preparedness.
- **Flood modification measures**.
  - These are typically structural works, such as culvert upgrades, flood protection levees, flood detention basins or bypass floodways, which act to reduce flood damages.

These measures are discussed in the following chapters of this report, namely **Chapter 8: Land Use Planning and Property Modification**, **Chapter 9: Flood Emergency Response Management**, and **Chapter 10: Assessment of Flood Modification Measures**.

## 7.2 Approach to Addressing the Flood Problem

The flooding problem within the Scone catchment can be broken up into three major components, namely:

- the existing flooding problem;
- the potential future flooding problem; and,
- the residual, or continuing flooding problem.

Each component is discussed in the following sections, along with the recommended types of mitigation measures to address them.

### 7.2.1 Existing Flooding Problem

The existing flooding problem relates to those areas where flood damages would occur as a consequence of flooding under existing catchment conditions. It concerns existing dwellings, industrial complexes and commercial premises that would be affected by flooding, as well associated infrastructure within the floodplain, including roads and utility services. In this context, the existing flooding problem is usually addressed by structural measures which aim to modify flood behaviour and thereby reduce flood damages.

Certain property modification measures, such as voluntary house raising or purchase, can also help to reduce existing flood damages.

### 7.2.2 Future Flooding Problem

The potential *future* flooding problem refers to those areas of the floodplain that are likely to be proposed for future development or to be the subject of rezoning applications. It also relates to the potential redevelopment of existing lots within the floodplain.

As land resources for development become increasingly scarce, pressures mount to allow new development or redevelopment within floodplain areas where it might otherwise be avoided. Future development can also lead to increased impervious areas that lead to increased runoff and hence flooding.

In accordance with Section 733 of the LGA Act 1993, Council has a responsibility to ensure that it is managing flood liable land in areas of its jurisdiction in accordance with the Manual. This can involve assessing its current planning instruments to ensure that it recognises the potential future flood risk. Council also has a responsibility to ensure that appropriate flood-related development controls can be used to support decisions to approve or reject development proposals in flood affected parts of the LGA.

Climate change poses further future risks with potential changes to rainfall intensities which are predicted to lead to an increase in the severity and frequency of flooding.

### 7.2.3 Residual Flooding Problem

Unless the Probable Maximum Flood (*PMF*) is adopted as the basis for determining structural and planning measures aimed at reducing flood damages, there will always be a residual or continuing flooding problem.

There is also the potential for residual damages even if the PMF is adopted. For example, communities located on 'High Flood Islands' will not be directly impacted but could be impacted by isolation. This poses risk to the safety of residents and emergency workers and could result in lost productivity.

However, the adoption of the PMF as the 'planning flood' is not realistic or practical because it would sterilise a large area of potentially useful land. Hence, a lesser flood standard is adopted.

Traditionally, most councils in NSW have adopted the 1% AEP as the planning flood. However, the recent '*revised flood-prone land package*' (NSW Government, 2021) allows for councils to select a Defined Flood Event (DFE) rarer than the 1% AEP as a basis for flood planning.

Nonetheless, measures that are put in place to control flood damage will ultimately be overwhelmed by a flood that is larger than that adopted as the threshold for planning controls, or as the limiting flood for the design of structural measures. This remaining flood risk is referred to as the 'residual' flooding problem'.

Accordingly, it is incumbent upon Council to consider the implications of floods greater than the adopted planning flood, for all events up to the PMF, and to work with the State Emergency Service (*SES*) to develop a contingency plan for such events. This could include incorporating controls that require the developer to consider flood evacuation, warnings and flood refuge areas for any proposed development which could be inundated during the PMF.

## 7.3 Floodplain Risk Management Measures Recommended in the 1999 FRMS & Plan

A previous assessment of floodplain risk management measures was undertaken in *Scone Floodplain Management Study and Plan* (Bewsher Consulting 1999). The measures recommended from the 1999 assessment are listed in **Table 7-1**, along with their status and whether the options are being considered in the current study.

**Table 7-1 Options recommended in the previous FRMS&P (Bewsher 1999)**

| Flood Mitigation Measure | Status |
|---|---|
| **Property Modification Measures** | |
| House raising of 10 severely flood affected properties (Parsons Gully only) | Several houses in Parsons Gully catchment are raised. |
| Flood proof individual commercial properties in the Scone CBD | Ongoing. |
| Improve existing building and development controls | Recently released Upper Hunter DCP (2023) with some updated flood controls. |
| Introduce an on-site detention policy in Figtree Gully. | Stormwater management controls provided in Section 3 of Part 11f of Upper Hunter DCP 2023. |
| Issue flood certificates to all property owners on a regular basis | Ongoing. |
| **Response Modification Measures** | |
| Improve emergency planning and management | Completed as part of this study. |
| Increase community education and flood awareness | Ongoing. |
| Improve flood warning systems | Additional gauges installed in Kingdon Ponds catchment. |
| Prepare flood action plans for individual properties | To be updated. |
| **Flood Modification Measures** | |
| Reconstruct Figtree Gully between Barton Street and Park Street as a deeper and wider grass-lined channel; construct box culvert system from Main Street to Parsons Gully at the downstream end of Guernsey Street. | Not undertaken to date. |
| Remove obstructions in the Figtree Gully channel (trash rack, vegetation and rubbish) | Ongoing, trash rack not removed. |
| Vegetation management | Ongoing. |

# 8. Land Use Planning and Property Modification

A key objective of this study is to provide improved flood information to support land use planning activities in the study area. Effective land use planning can help ensure that the flood risk posed to a community does not increase moving into the future.

Land use planning considerations for flood prone land are prescribed through planning instruments and related mapping as discussed in the following.

## 8.1 Review of Existing Planning Instruments

### 8.1.1 Upper Hunter Local Environmental Plan 2013

The Upper Hunter Local Environmental Plan 2013 (Upper Hunter LEP 2013) is the statutory planning instrument that establishes the permissible and/or prohibited forms of development and land use within the Upper Hunter LGA.

Flood planning is addressed in Clause 5.21, as reproduced below.

> *1) The objectives of this clause are as follows —*
>
> *a. to minimise the flood risk to life and property associated with the use of land,*
>
> *b. to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,*
>
> *c. to avoid adverse or cumulative impacts on flood behaviour and the environment,*
>
> *d. to enable the safe occupation and efficient evacuation of people in the event of a flood.*
>
> *2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—*
>
> *a. is compatible with the flood function and behaviour on the land, and*
>
> *b. will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and*
>
> *c. will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and*
>
> *d. incorporates appropriate measures to manage risk to life in the event of a flood, and*
>
> *e. will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.*

*3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—*

*a. the impact of the development on projected changes to flood behaviour as a result of climate change,*

*b. the intended design and scale of buildings resulting from the development,*

*c. whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,*

*d. the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.*

*4) A word or expression used in this clause has the same meaning as it has in the Considering Flooding in Land Use Planning Guideline unless it is otherwise defined in this clause.*

*5) In this clause—*

*a. **Considering Flooding in Land Use Planning Guideline** means the Considering Flooding in Land Use Planning Guideline published on the Department's website on 14 July 2021.*

*b. **flood planning area** has the same meaning as it has in the Floodplain Development Manual.*

*c. **Floodplain Development Manual** means the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005.*

Clause 5.21 applies to "*land the consent authority considers to be within the flood planning area*", where "*flood planning area has the same meaning as it has in the Floodplain Development Manual*". The Manual (2005) defines the flood planning area as "*the area of land below the flood planning level and thus subject to flood related development controls*".

The dictionary within the Upper Hunter LEP 2013 does not define the Flood Planning Level (FPL).

**Recommendations**

It is recommended that the LEP dictionary be updated with the following definitions taken from the *Flood Risk Management Manual* (DPE, 2023a).

**Table 8-1 Recommended updated definitions for inclusion in the Upper Hunter LEP**

| Term | Shortened form | Definition |
|---|---|---|
| Defined flood event | DFE | The flood event selected as a general standard for the management of flooding to development |
| Flood planning area | FPA | The area of land below the FPL |
| Flood planning level | FPL | The combination of the flood level from the DFE and freeboard selected for FRM purposes |
| Flood risk management | FRM | The management of flood risk to communities |

The NSW Government's revised flood-prone land package released on 14 July 2021 included the option for councils to adopt the "5.22 Special flood considerations" clause in their LEP. The clause would allow development controls to apply on land "*between the flood planning area and the*

*probable maximum flood*" where the development is "*sensitive or hazardous*" and in areas where there is a particular risk to life or evacuation is required.

In 2021, 32 councils self-nominated to amend their LEPs by inserting the special flood considerations clause. The clause has since undergone an exhibition process including seeking feedback on whether the clause should be inserted in all LEPs or a SEPP.

Council also resolved to adopt the clause in the Upper Hunter Local Environment Plan 2013. This is considered appropriate for the study catchment and would align with the proposed approach in defining the flood planning area (refer **Section 8.2**).

### 8.1.2 Upper Hunter Development Control Plan 2023

The Upper Hunter Development Control Plan (DCP) 2023 sets the standards, controls and regulations that apply when carrying out development within the Upper Hunter LGA. These specific controls in the DCP support the broader conditions of the Upper Hunter LEP 2013 and state-wide policies.

'Part 10a: Natural Hazards - Floodplain Management' provides Council's requirements for development upon flood prone land and land below the flood planning level, and has the following objectives:

1. minimise the risk to human life and damage to property by controlling development on flood prone land;
2. apply a performance and merit-based approach to all development decisions taking into account ecological, social, engineering safety and environmental considerations to ensure development is appropriate and sustainable;
3. ensure that the development or use of floodplains waterways and riparian corridors does not adversely impact upon aesthetic, recreational and ecological values;
4. ensure that all land uses and essential services are appropriately sited and designed in recognition of all potential floods;
5. promote flood compatible building design that considers requirements for the development of flood prone land and does not adversely impact on adjoining properties;
6. establish guidelines for the development of flood prone land that are consistent with the *NSW Flood Policy* and *NSW Floodplain Development Manual* (2005) or their updates and as updated by the associated Floodplain Risk Management Guides.

Other information provided in Part 10a includes the following:

- Description of the Development Application (DA) process for development within a floodplain;
- Information and flood study requirements to support DAs;
- Prescriptive provisions and criteria for different types of proposed land uses based on the location of the development within the floodplain (e.g. located in zones of low or high flood hazard);

- Criteria for determining DAs, including commentary on development types and performance based assessments;
- Prescriptions for minimum floor levels;
- Guidance on permissibility of filling of the floodplain;
- Flood related requirements for car parking, fencing, on-site sewer management and storage of hazardous substances;
- Requirements for flood proofing of structures.

## 8.2 Flood Planning Maps

### 8.2.1 Overview

In order to apply development controls within the floodplain a series of related mapping is required. This involves selection of the design flood event(s) on which application of controls are to be based, the derivation of associated flood planning levels (FPLs) and breaking down the floodplain into different areas where different controls are applied according to the level of risk.

This process and the associated mapping are described in the following sections of this report.

### 8.2.2 Recommendations for the Flood Planning Level

The NSW Government's revised flood-prone land package came into effect on 14 July 2021. This revised package allows for councils to select a Defined Flood Event (DFE) rarer than the 1% AEP as a basis for setting the Flood Planning Level (FPL) without the need to obtain approval for exceptional circumstances.

The DFE is selected in consideration of the social, economic, environmental, and cultural consequences associated with floods of different probabilities. This gives councils greater flexibility to better manage flood risk beyond the 1% AEP, including building greater resilience to the potential effects of climate change.

In consideration of the broad-scale flood risk across the Scone catchment, it is recommended that the Design Flood Event (DFE) be adopted as the 1 in 500 AEP event for the purposes of defining the Flood Planning Level and the Flood Planning Area. It is recommended that the 1 in 500 AEP peak flood level be adopted as the Flood Planning Level without a freeboard.

This approach to defining the Flood Planning Level was adopted after a comparison of the peak flood levels for the 1 in 500 AEP event and the 1% AEP event (*refer Figure 4-4 in Volume 2 of the Scone Flood Study 2024*). This comparison indicates that peak flood levels for the 1 in 500 AEP event are typically 0.1 to 0.4 metres higher than the 1% AEP peak flood levels in the Scone catchment. This is relatively similar to the typical approach of adopting a freeboard of 0.5 metres above the peak 1% AEP flood levels in setting the Flood Planning Level.

The 1 in 500 AEP event approximates a conservative climate change scenario with an increase of 35% to the existing rainfall intensity of the 1% AEP event. Therefore, the adoption of the 1 in 500 AEP event without a freeboard in defining the Flood Planning Level is considered appropriate as it accounts for the potential effects of climate change.

It is noted that the adoption of the 1 in 500 AEP event as the DFE is applicable only in the context of setting the Flood Planning Level and the Flood Planning Area. The 1% AEP event should still be assessed for the purposes of flood impact and risk assessments.

### 8.2.3 Delineation of the Flood Planning Area

The Upper Hunter DCP 2023 defines the flood planning area (FPA) as "*the area of land below the flood planning level (FPL)*". As noted above, the flood planning level (FPL) is the level of the Defined Flood Event (DFE) without a freeboard. The DFE is recommended to be the 1 in 500 AEP event for the purposes of defining the FPL and the FPA.

Flooding defined as "overland flow" may pose a lower level of risk to people and property than flooding defined as "mainstream". Accordingly, differing development controls may be applied between these areas.

Overland flow is typically characterised as runoff from rainfall which flows over the land before entering a watercourse, creek, river or lake or dam. Overland flow is typically shallow and fast flowing. Where a watercourse has been filled or piped, flooding resulting from overflows from the filled/piped watercourse is considered mainstream flooding and not overland flow.

The following approach was used to differentiate between "overland flow" and "mainstream" flooding for the Flood Planning Area.

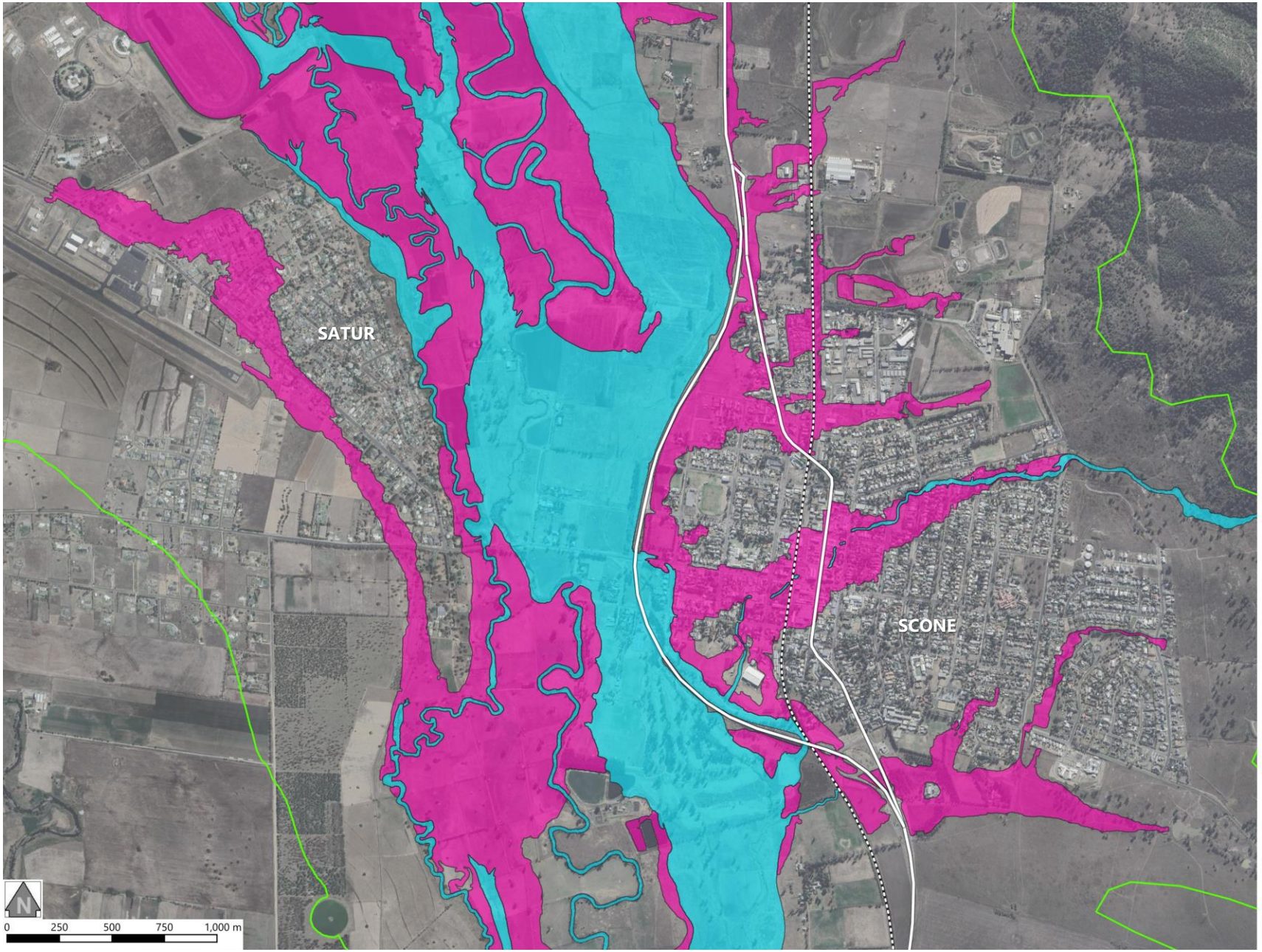
- Mainstream Flooding
  - Flooding along the defined watercourses of Middle Brook, Kingdon Ponds, Parsons Gully and Figtree Gully.
  - Typically characterised by velocity-depth produces greater than 0.5 $m^2/s$.
- Overland Flow
  - Other areas of inundation not classified as mainstream flooding.
  - Includes runoff along urban parts of Scone which drain into Figtree Gully or Parsons Gully, the Satur overland flow path as well as runoff from the hills to the east of Scone.

Some manual edits were made to the Flood Planning Area, including:

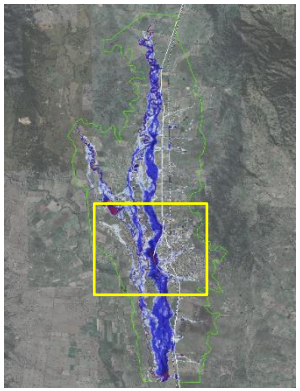
- Deletion of small isolated areas not connected to main flow paths or small flow paths which are only concentrated along roadways.
- Inclusion of small dry areas which are surrounded by inundated areas.

The resulting FPA extents are presented in **Figure 8-1** to **Figure 8-3**.

# FIGURE 8-1




***Map Extent***



**LEGEND**

- Major Roads
- Railway

**Flood Planning Area**

- Mainstream FPA
- Overland Flows FPA

Prepared by:

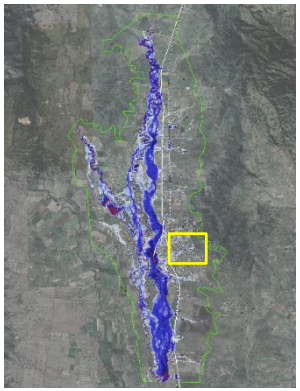
worley consulting

UPPER HUNTER SHIRE COUNCIL

## FLOOD PLANNING AREA [SCONE & SATUR]

# FIGURE 8-2


***Map Extent***



**LEGEND**

**Flood Planning Area**

- Mainstream FPA
- Overland Flows FPA

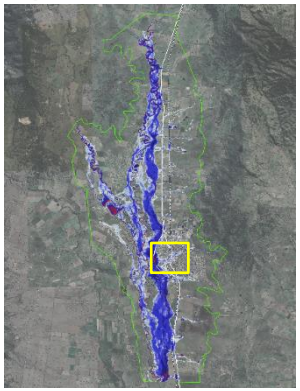
Prepared by:

worley consulting

## FLOOD PLANNING AREA
## [FIGTREE GULLY UPSTREAM OF MAIN STREET]

# FIGURE 8-3


***Map Extent***



**LEGEND**

- Major Roads
- Railway

**Flood Planning Area**

- Mainstream FPA
- Overland Flows FPA

Prepared by:

worley consulting

# FLOOD PLANNING AREA
# [FIGTREE GULLY AT SCONE CBD]

## 8.3 Impacts of the Scone Bypass

Flood level difference mapping was prepared from the modelling results to quantify the impacts of the Scone Bypass. Difference maps are created by comparing peak flood level and flow velocity estimates at each grid cell in the flood model from the results of simulations undertaken for both pre- and post-development scenarios. This effectively creates a contour map of predicted changes in peak levels (i.e., increases and decreases) and allows visual assessment of the impact of the bypass works on existing peak levels.

Flood level difference mapping for the 20%, 5% and 1% AEP events as well as the PMF is provided in **Figure 8-4** to **Figure 8-7**.

The predicted flood impacts of the Scone Bypass are summarised as follows:

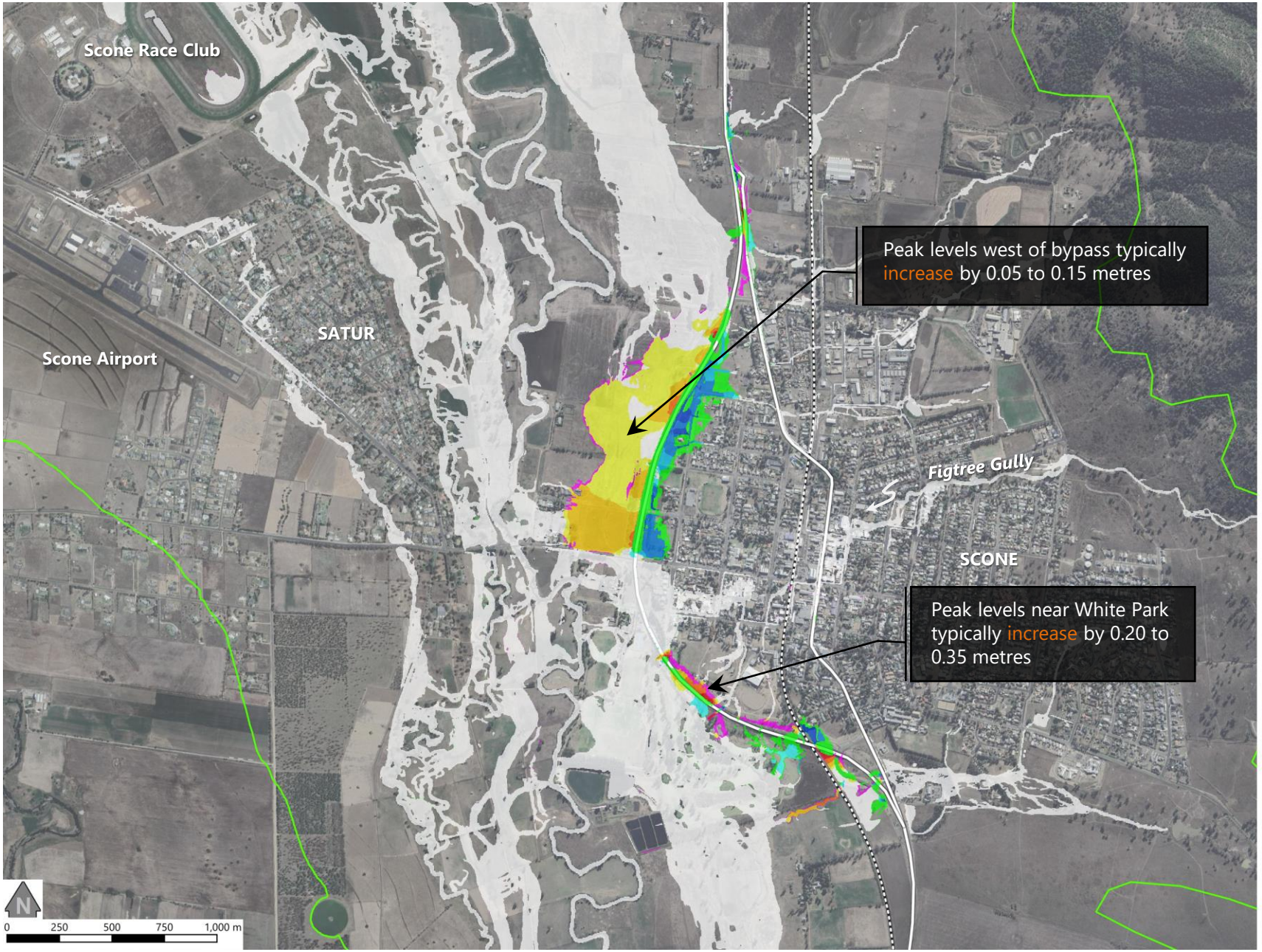
- Peak flood levels are typically increased to the west of the bypass in areas upstream (north) of Liverpool Street. Conversely, peak flood levels to the east of the bypass are predicted to decrease in areas to the north of Liverpool Street.
- The bypass works is predicted to result in flood level increases in areas in the vicinity of White Park near the downstream end of Figtree Gully.
- During the 1% AEP event, peak flood levels in the Kingdon Ponds floodplain to the west of the bypass are typically increased by 0.1 to 0.25 metres. Peak flood levels near White Park are predicted to increase by 0.3 to 0.55 metres, although it is noted that this does not result in any flood level increases at adjacent residential properties.
- During the PMF, peak flood levels in the Kingdon Ponds floodplain to the west of the bypass are typically increased by 0.1 to 0.35 metres. Peak flood levels near White Park are predicted to increase by up to 1.8 metres. There are expected to be some flood level increases in residential properties at the southern end of Guernsey Street as well as the western end of Joan Street.

The Scone Bypass is expected to have some benefits for emergency management. Floodwaters spilling from Figtree Gully would result in flows inundating roads such as Liverpool Street and Kelly Street, cutting off the residential areas to the west of Figtree Gully from emergency services and the Scone Hospital. With the completion of the bypass, residents living in areas to the west of Figtree Gully would be able to access the bypass via on-ramps at the western end of St Aubins Street or Kelly Street to the north of the McDonald's, and can then travel towards Scone Hospital by travelling southward along the bypass and then accessing Kelly Street to the south of Scone.

Similarly, emergency services located on the eastern side of Figtree Gully can access areas located to the west of Figtree Gully via the bypass and without travelling through inundated roads such as Liverpool Street and Kelly Street.

However, it is noted that some roads leading to the bypass are cut by overland flows during events equal to or rarer than the 2% AEP event, while the bypass itself is expected to be inundated at the peak of the PMF.

# FIGURE 8-4

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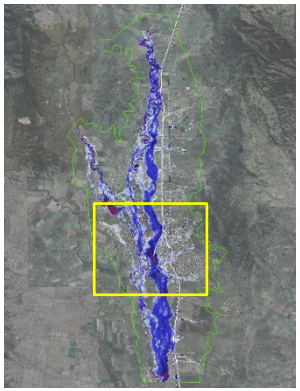


**LEGEND**

- Major Roads
- Railway

**Difference in Peak Levels [m]**

- <= -0.5
- -0.3 to -0.5
- -0.2 to -0.3
- -0.1 to -0.2
- -0.05 to -0.1
- -0.05 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- > 0.5

**Change in Flood Extents**

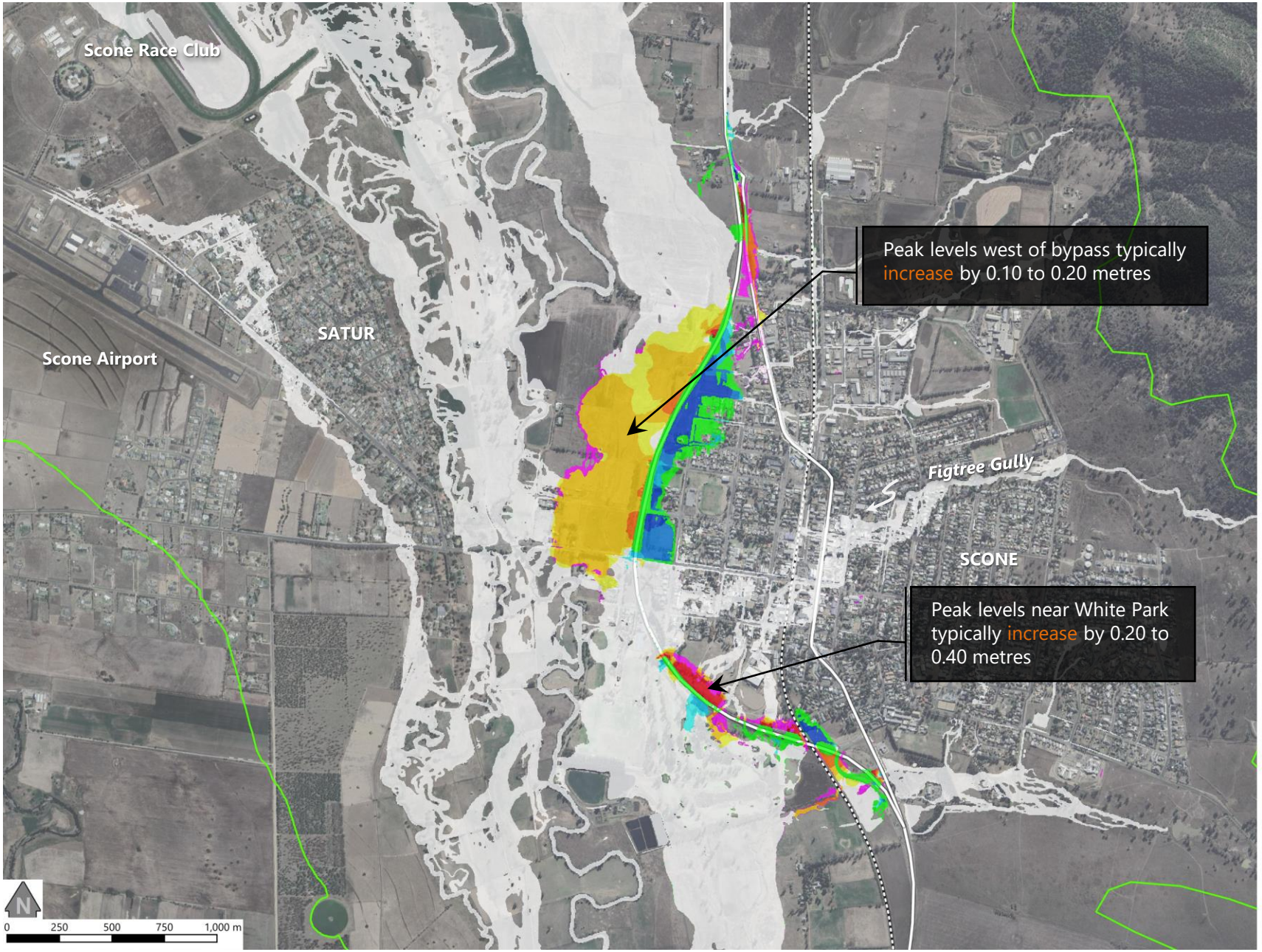
- No Longer Inundated
- Newly Inundated

Prepared by:

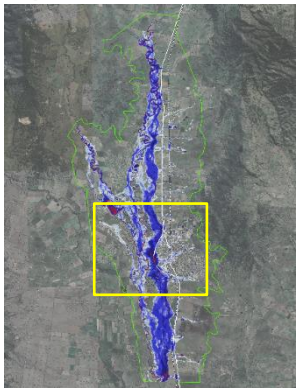
worley consulting

## IMPACT OF THE SCONE BYPASS ON PEAK 20% AEP FLOOD LEVELS

# FIGURE 8-5




***Map Extent***



**LEGEND**

- Major Roads
- Railway

**Difference in Peak Levels [m]**

- <= -0.5
- -0.3 to -0.5
- -0.2 to -0.3
- -0.1 to -0.2
- -0.05 to -0.1
- -0.05 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- > 0.5

**Change in Flood Extents**

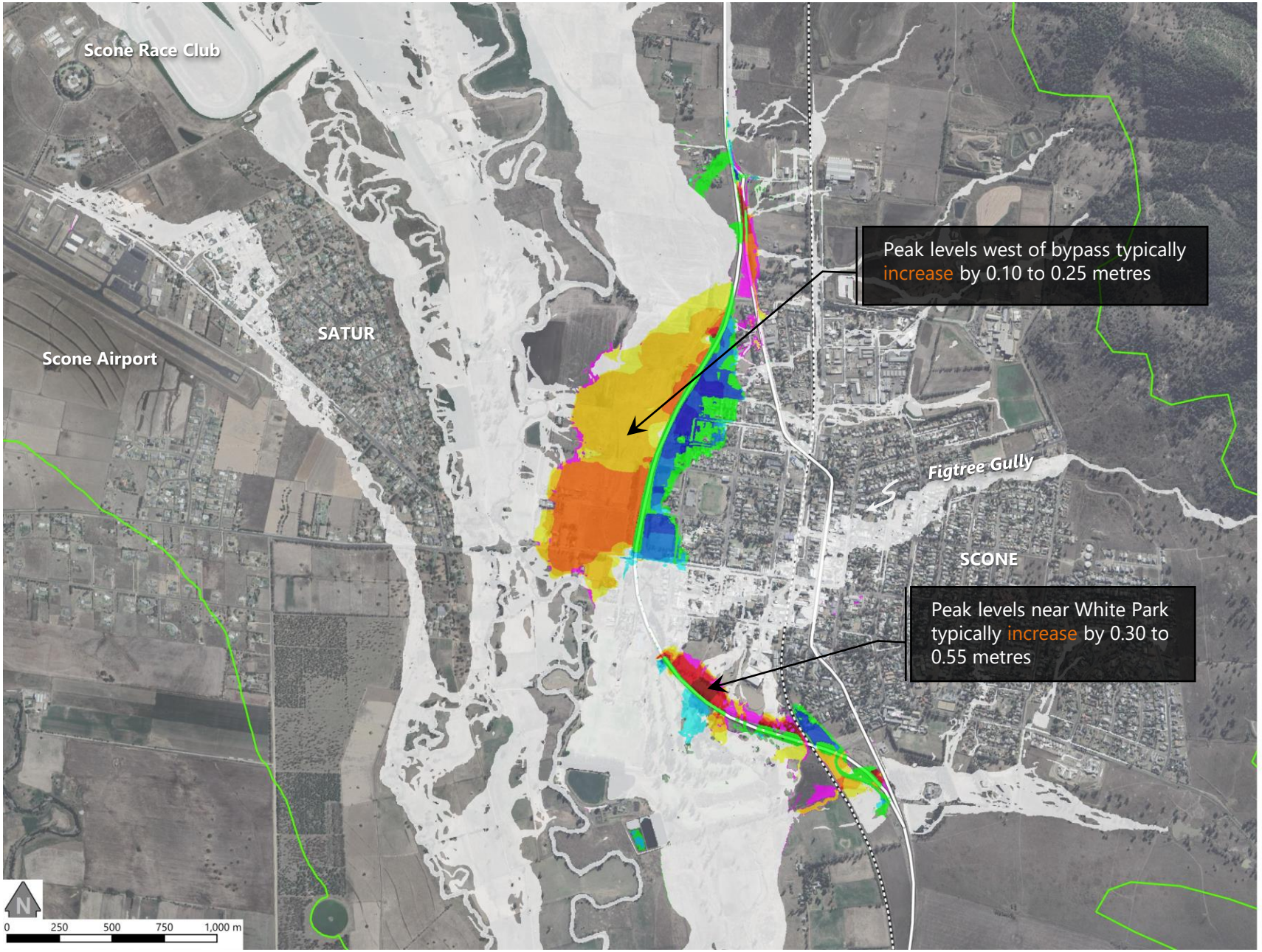
- No Longer Inundated
- Newly Inundated

Prepared by:

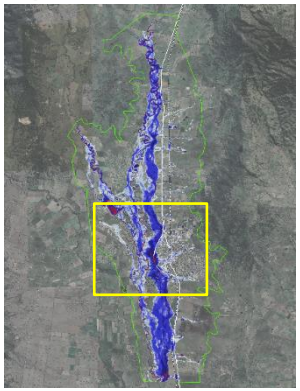
worley consulting

## IMPACT OF THE SCONE BYPASS ON PEAK 5% AEP FLOOD LEVELS

# FIGURE 8-6




***Map Extent***



**LEGEND**

- Major Roads
- Railway

**Difference in Peak Levels [m]**

- <= -0.5
- -0.3 to -0.5
- -0.2 to -0.3
- -0.1 to -0.2
- -0.05 to -0.1
- -0.05 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- > 0.5

**Change in Flood Extents**

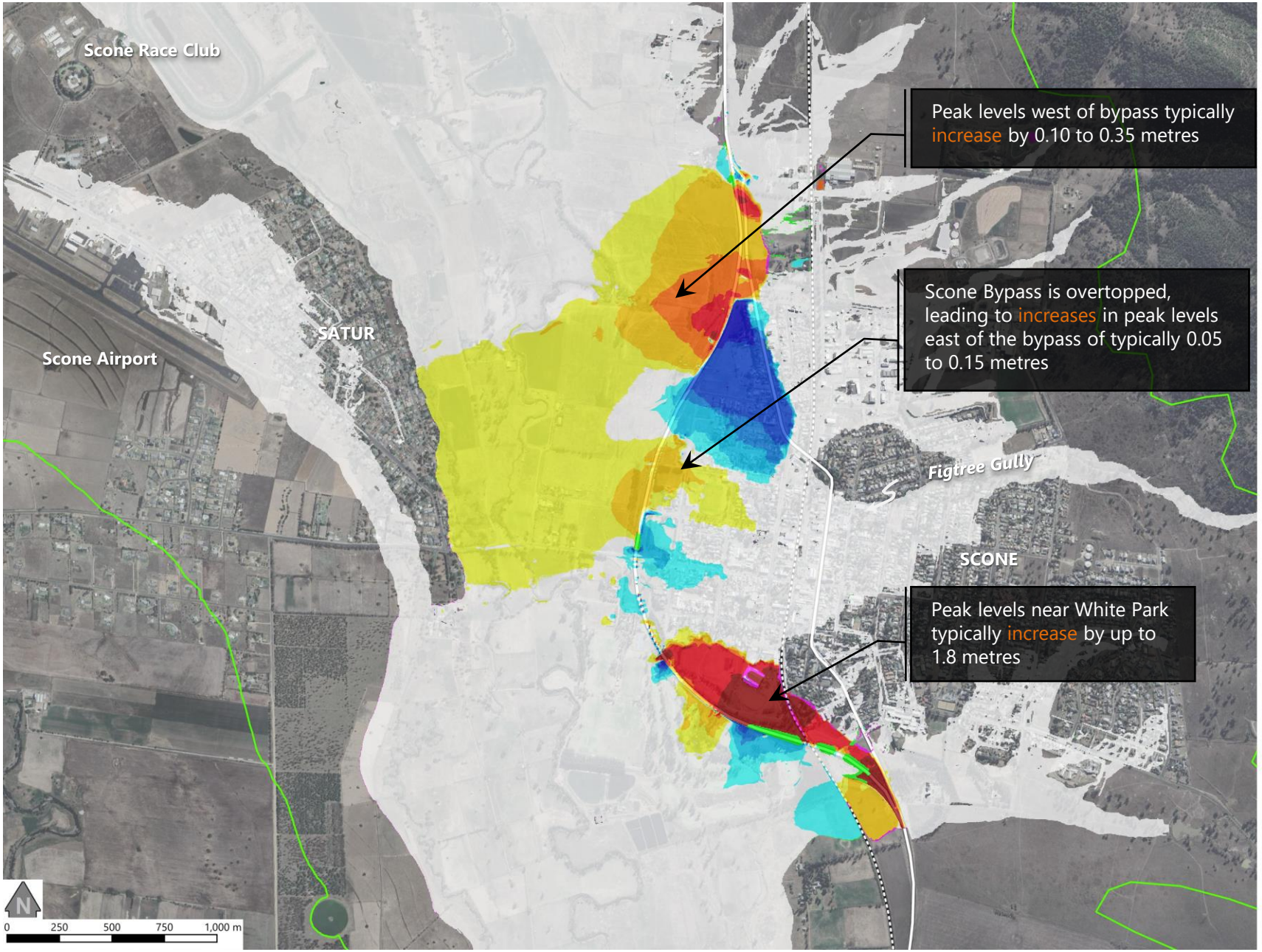
- No Longer Inundated
- Newly Inundated

Prepared by:

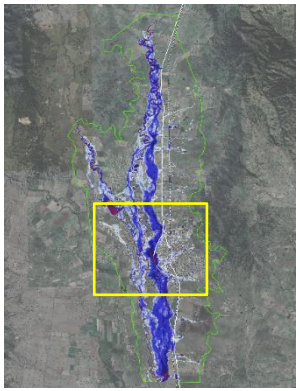
worley consulting

# IMPACT OF THE SCONE BYPASS ON PEAK 1% AEP FLOOD LEVELS

# FIGURE 8-7




*Map Extent*



**LEGEND**

- Major Roads
- Railway

**Difference in Peak Levels [m]**

- <= -0.5
- -0.3 to -0.5
- -0.2 to -0.3
- -0.1 to -0.2
- -0.05 to -0.1
- -0.05 to 0.05
- 0.05 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- > 0.5

**Change in Flood Extents**

- No Longer Inundated
- Newly Inundated

Prepared by:

worley consulting

## IMPACT OF THE SCONE BYPASS ON PEAK PMF LEVELS

## 8.4 Voluntary House Raising

Voluntary house raising (VHR) is considered an effective flood risk management measure which aims to reduce the frequency of flood damage to houses and their contents by raising the floor level above the FPL. It may be an appropriate strategy to reduce damages at existing dwellings of piered footing construction in low flood hazard areas. The inclusion of a house within a proposed voluntary house raising (VHR) scheme does not place any obligation on the owner of the property to raise the house. Landowner application is voluntary (*NSW DCCEEW, 2024a*).

'*Guidelines for Voluntary House Raising Schemes*' (*NSW DCCEEW, 2024a*) requires any potential VHR to consider the following:

- The full range of design flood events and their impacts;
- The flood function and hazard, VHR is generally excluded in floodway and high hazard (H5 to H6) areas;
- Cost-effectiveness of the proposed house raising scheme, with the aim of damages reductions outweighing the house raising costs (i.e., a BCR>1.0);
- The viability of the scheme and its prioritisation;
- The support of the affected community, as determined through consultation.
- The OEH grant funding criteria also includes the following:
  - Funding is only available for residential properties and not commercial or industrial;
  - Dwellings constructed after 1986, the date of gazettal of the Floodplain Development Manual, are not eligible as it outlined construction principles to avoid flood damage;
  - Properties already substantially benefited by other floodplain mitigation measures are not eligible for VHR funding;
  - VHR should involve raising dwellings above a minimum design level (e.g. the FPL).

For the purposes of this study, the cost of implementing VHR has been estimated at $150,000 per house raised. Based on this cost, VHR would only be economically beneficial (i.e., BCR≥1.0) if the associated reduction in annual average damages (AAD) exceeds $11,000.

Some 27 single-storey residential dwellings were identified meeting this economic criterion. Brick buildings were not considered further due to the greater difficulty and cost of raising. These buildings are located within areas of H1-H4 hazard within the 1% AEP flood extent.

The 27 dwellings would need to be raised by between about 0.6 and 1.7 metres to set the habitable floor level above the FPL. However, for practical considerations, a house is best raised by one storey (i.e. 2.4 to 2.7 metres) so that the lower level can be utilised. Appropriate uses of the lower level could include storage and car parking. Given the piers are typically adjustable, raising a house by an additional height is not expected to be significantly more expensive. It is noted that there may be some residual safety concerns should residents create further habitable areas in the lower level without Council approval. Raising a house by one storey could also reduce the liveability for the elderly.

**Recommendation**

It is recommended that an investigation be undertaken to define, scope and prioritise a VHR scheme for up to 27 identified properties and, if appropriate, prepare applications for funding. The locations of the properties recommended for investigation are shown in **Figure 8-8**.

## 8.5 Voluntary Purchase

Voluntary Purchase (VP) is considered an effective floodplain risk management measure for existing residential properties in areas where there is high flood hazard that poses risk to life, where the property is to be removed from a floodway, or where purchase of the property enables other flood mitigation works to be implemented (*NSW DCCEEW, 2024b*). '*Guidelines for the Voluntary House Purchase Scheme*' (*NSW DCCEEW, 2024b*) specifies that VP will only be considered where no other feasible risk management options are available to address the risk to life at the property.

Various factors were investigated to identify properties which would most warrant VP, as follows:

- There are seven dwellings which are affected by H4 hazard (*unsafe for people*) in the 1% AEP. Six of these properties are located along the western side of Aberdeen Street to the south of Liverpool Street, with the remaining property located along Kingdon Street to the immediate west of the Scone Bypass.
- Five of the seven dwellings are two-storey buildings. Based on Google Street View from November 2023, it appears that habitable spaces are located on the upper level and that the lower level is used for car parking. It is unclear if other parts of the lower level are used for habitable spaces. The upper level is predicted to be flood free up to and including the 1 in 500 AEP event.
- The other two single-storey buildings are located on the western side of Aberdeen Street.
- One of them is expected to be inundated to a depth of about 1.2 metres above floor level during the 1% AEP event. It is also expected to be inundated to a depth of about 0.3 metres above floor level during the 20% AEP event. However, this dwelling is considered suitable for inclusion in a potential voluntary house raising (VHR) scheme (refer **Section 8.4**).
- The other one dwelling is not inundated above floor level in the 1% AEP event and is expected to be inundated to a depth of 0.1 metres above floor level during the 1 in 200 AEP event (affected by H1 hazard in habitable areas).

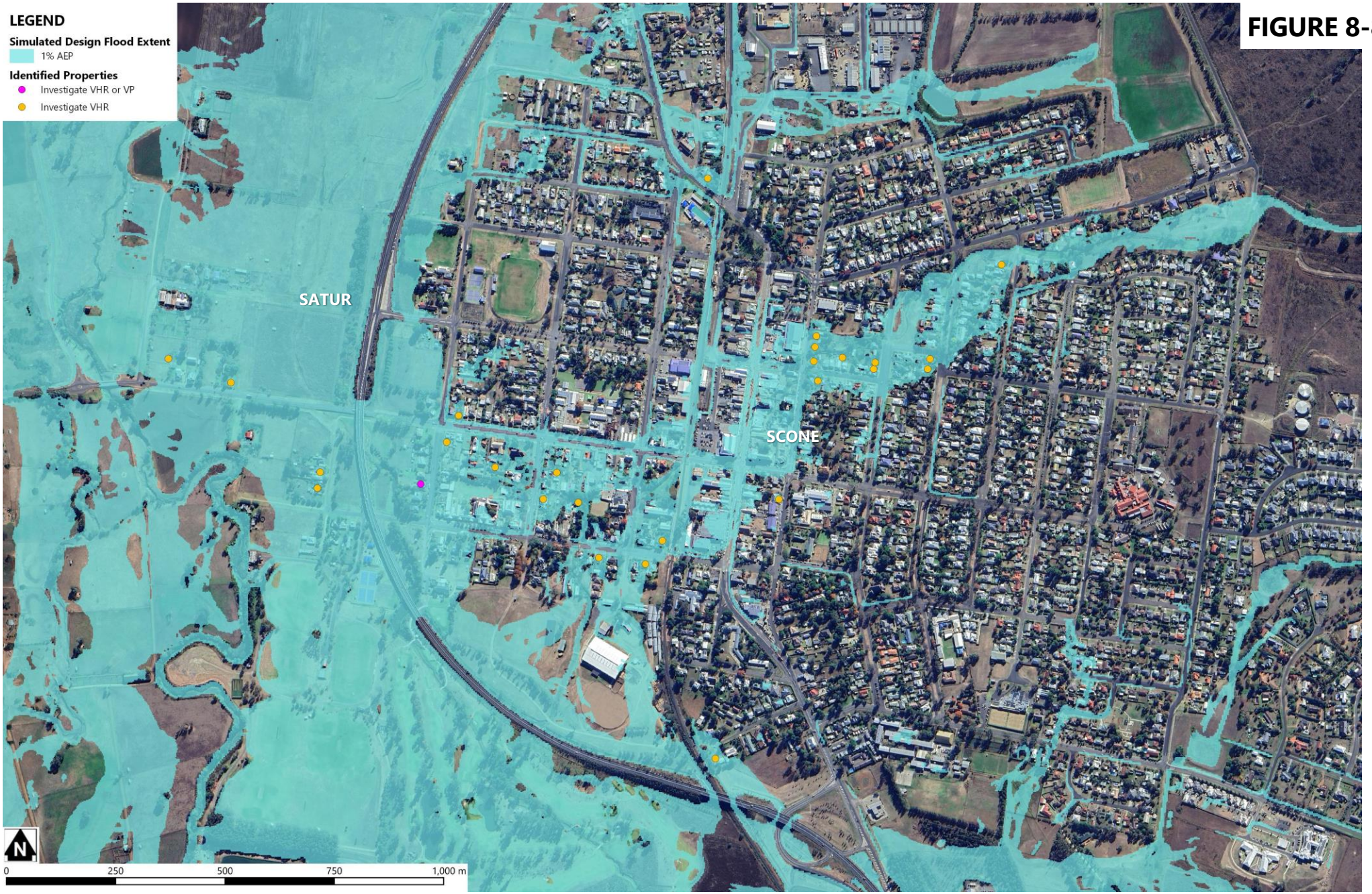
Therefore, there are no properties within the study area which would be considered a high priority for voluntary purchase. The property on Aberdeen Street which is inundated during the 20% AEP event could be considered for VP if the VHR scheme is not implemented. The purchase of this property would lead to a reduction in the annual average damages (AAD) by $83,160. Based on a 7% discount rate over 50 years, this would reduce the NPV of flood damages by an estimated $1.14 million. Therefore, a BCR greater than 1 can be achieved if the property can be purchased for less than $1.14 million.

**Recommendation**

There are no properties within the study area which is considered a high priority for a VP scheme. The flood-prone property at Aberdeen Street could be considered for VP if the VHR scheme is not implemented.

The location of the property which could be considered for VP if the VHR scheme is not implemented is shown in **Figure 8-8**.

# FIGURE 8-8

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UPPER HUNTER SHIRE COUNCIL

## LOCATION OF PROPERTIES TO BE INVESTIGATED FOR VHR / VP

## 8.6 Flood-Proofing of Scone CBD Properties

The *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999) recommended the implementation of flood barriers such as waterproof doors and gates for commercial properties within the Scone CBD.

Flood model results from the current study indicate that the most flood-prone properties are located along the eastern side of Kelly Street between Liverpool Street and St Aubins Street. Many of the commercial premises in this area are predicted to be affected by over-floor flooding in events as frequent as the 20% AEP event. These properties are predicted to be inundated to depths of between 0.3 and 0.7 metres above floor level during the 1% AEP event.

It is recommended for Council to communicate the high flood risk to these business owners. Flood-prone businesses in the CBD should investigate the feasibility of installing flood barriers to prevent over-floor flooding. There are several products available on the market which would cost $3,000 or less.

It is also recommended that commercial properties should be flood proofed up to the Flood Planning Level during any refit or renovation. Further information on flood compatible materials and other flood proofing requirements is documented in Table 3 of 'Part 10a: Floodplain Management' in the Upper Hunter DCP (2023). This could also comprise the provision of storage spaces above the Flood Planning Level.

These works can be undertaken by the property owners independently or with some Council contribution.

**Recommendation**

Council to communicate high flood risk to business owners and for business owners to consider installing flood barriers.

Flood proofing of premises in the Scone CBD up to the Flood Planning Level to be undertaken by property owners independently or with Council contribution.

## 8.7 On-Site Detention Policy

The *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999) recommended the implementation of an On-Site Detention (OSD) policy for new developments in the Figtree Gully catchment to reduce flows entering the stormwater drainage system during a rainfall event. It was recommended that an OSD policy be introduced for new developments where the proposed increase in impervious areas (e.g. paved / roofed areas) exceed 100 $m^2$.

This is addressed in Section 3 of 'Part 11f: Environment Protection – Soil & Water Management' in the Upper Hunter DCP (2023), which provides Council's requirements for stormwater management.

**Recommendation**

It is recommended that this policy be retained subject to the outcomes from further detailed investigations into the timing and reduced peak of flows from the Figtree Gully detention basin should it be installed.

## 8.8 Issuing Flood Certificates

Section 10.7 planning certificates are issued by councils under the Environmental Planning and Assessment Regulations 2000. The primary function of notations on the Section 10.7 certificate is as a planning tool for notification that the land is affected by a policy that restricts development due to the likelihood of a risk such as flood hazard.

Under Section 9(1), Schedule 2 of the Environmental Planning and Assessment Amendment (Flood Planning) Regulation 2021 councils are required to include a notation on section 10.7 planning certificates if the land or part of the land to which the certificate relates is within the flood planning area (FPA) and subject to flood related development controls. Section 9(2) also requires councils to include a notation if part of the land is between the FPA and the PMF.

To apply flood-related planning controls through section 10.7 notifications, it is recommended that Council should identify and tag appropriate 'flood control lots' through the review of the flood modelling results which were generated by this study.

**Recommendation**

It is recommended for Council to issue updated section 10.7 planning certificates to the affected landowners at the conclusion of this study.

## 8.9 Recommendations

**Table 8-2** outlines the recommended changes to planning controls and property that have been identified as part of the floodplain risk management study for Scone.

**Table 8-2 Recommendations relating to Land Use Planning and Property Modification**

| ID | Recommended Planning and Property Modification Measures |
|---|---|
| **PM.1** | Update the LEP dictionary with definitions for the Defined Flood Event, Flood Planning Area, Flood Planning Level and Flood Risk Management per those in the *Flood Risk Management Manual* (DPE 2023a) (*refer* **Section 8.1**). |
| **PM.2** | Adopt the 1 in 500 AEP event as the Defined Flood Event for setting the Flood Planning Level and the Flood Planning Area (*refer* **Section 8.2**). |
| **PM.3** | Update Flood Planning Level and Flood Planning Area for the catchment per the definitions and mapping in this FRMS&P (*refer* **Section 8.2**). |
| **PM.4** | Undertake investigation to define, scope and prioritise Voluntary House Raising (VHR) of up to 27 identified properties (*refer* **Section 8.4**) and, if appropriate, prepare documentation for funding applications. |
| **PM.5** | Flood proof properties in the Scone CBD up to the Flood Planning Level (*refer* **Section 8.6**). |
| **PM.6** | Issue updated section 10.7 planning certificates to the affected landowners (*refer* **Section 8.8**). |

# 9. Flood Emergency Response Management

## 9.1 Introduction

The NSW State Emergency Service (SES) is the legislated Combat Agency for floods and is responsible for coordinating other agencies involved with flood emergency management.

To assist SES in gathering flood intelligence to help inform and manage the emergency response to flood risk and undertake evacuation planning they, along with DPE, have developed guideline documents which detail their desired outcomes from the Floodplain Risk Management process, those being:

- SES Requirements from the Floodplain Risk Management Process (2007);
- Flood Emergency Response Planning Classification of Communities (2007); and,
- Flood Risk Management Guide EM01: Support for Emergency Management Planning (2023d).

Detailed information on flood behaviour and impacts in the study area has been made available as a result of this FRMS&P and should be considered by SES in their planning and incorporated into the Local Flood Plan as appropriate. Presented in the following is a summary of information relevant to flood emergency response planning and management.

## 9.2 Upper Hunter Shire Council Local Flood Plan, 2022

Existing flood emergency response protocols for the Upper Hunter Shire LGA are outlined in the Upper Hunter Shire Council Local Flood Plan (2022), which is a sub-plan of the Upper Hunter Shire Local Emergency Management Plan (EMPLAN). The Local Flood Plan was reviewed and revised in 2022 and sets out the known flood risks and consequences for flood affected areas and how NSW SES will respond in the event of a flood.

The document is divided in three parts:

- Volume 1 – Upper Hunter Shire Council Flood Emergency Sub Plan (2022)
- Volume 2 – Hazard and Risk in Upper Hunter Shire (2007)
- Volume 3 – SES Response Arrangements for Upper Hunter Shire (2007).

*Volume 1 – Upper Hunter Shire Council Flood Emergency Sub Plan* covers information on multi-agency arrangements and responsibilities for prevention, mitigation, preparedness, response and recovery. Some of the key features of the flood emergency response arrangements are as follows:

- The NSW SES Upper Hunter Shire and Scone Operations Centre is located at 74 Main Street, Scone with other Operation Centres located at Aberdeen, Merriwa and Murrurundi.
- The Upper Hunter Shire Council Emergency Operations Centre is located at the Council Administration Building at 130 Liverpool Street, Scone.
- Response operations will begin:
  - On receipt of a Bureau of Meteorology (BoM) Severe Weather Warning or Thunderstorm Warning that includes heavy rain or storm surge; or

  - On receipt of a BoM Flood Watch or Flood Warning; or
  - On receipt of warnings for flash flooding; or
  - On receipt of a dam failure alert; or
  - When other evidence leads to an expectation of flooding within the area.
- Contact with the Bureau of Meteorology to discuss the development of flood warnings will normally be through the NSW SES Hunter Region Headquarters and/or NSW SES State Headquarters
- Responsible persons and organisations will be advised of the start of response operations regardless of the location and severity of the flooding anticipated.
- The main response strategies for SES flood operations include Information Provision and Warning, Property Protection, Evacuation, Rescue, and Resupply.
- When there is a risk to public safety by floodwater, evacuation is the primary strategy. Circumstances may include;
  - Evacuation of people when their homes or businesses are likely to flood.
  - Evacuation of people who are unsuited to living in isolated circumstances, due to flood water closing access.
  - Evacuation of people where essential energy and utility services are likely to fail, have failed or where buildings have been made uninhabitable.
- The decision to evacuate rests with the NSW SES Incident Controller who exercises their authority in accordance with Section 22(1) of The State Emergency Service Act 1989. However, the decision to evacuate will usually be made after consultation with the NSW SES Hunter Region Incident Controller and the Local Emergency Operations Controller.
- The SES will advise the community of the requirements to evacuate. The SES will issue an Evacuation Warning when the intent of an SES Incident Controller is to warn the community of the need to prepare for a possible evacuation. The SES will issue an Evacuation Order when the intent of the SES Incident Controller is to instruct a community to immediately evacuate in response to an imminent threat.
- The NSW SES Upper Hunter Shire Local Incident Controller will distribute Evacuation Warnings and Evacuation Orders to;
  - Sector / Division Command Centres (where established);
  - Upper Hunter Shire Local Emergency Operations Centre;
  - Upper Hunter Shire Council;
  - Hunter Valley Police Local Area Command;
  - Liverpool Range Rural Fire Service Control Centre;
  - Radio Stations; and
  - Other local agencies and specified individuals.
- Evacuations will generally be carried out in stages starting from the lowest areas, low flood islands and low trapped perimeters; and progressively to higher areas. The most desirable method of evacuation is via road using private transport.

- Evacuees who require emergency accommodation or disaster welfare assistance will be directed to designated evacuation centres. Evacuees who have made their own accommodation arrangements will not be directed to evacuation centres.
- The NSW SES Incident Controller will advise when return to evacuated areas is safe after flood waters have receded and reliable access is available and will issue an "All Clear" notification.

*Volume 2 – Hazard and Risk in Upper Hunter Shire* (2007) sets out the risks and consequences of flooding on local communities. This includes discussion of catchment and flooding characteristics, storm types that may cause flooding, historic flood events and their consequences, property affectation and roads that are liable to flooding.

*Volume 3 – SES Response Arrangements for Upper Hunter Shire* (2007) provides information regarding rainfall and river height gauges monitored by SES, media outlets for the dissemination of SES flood bulletins, a template evacuation warning message and evacuation arrangements.

This document notes that the NSW SES holds a Flood Intelligence Card for the Kingdon Ponds gauge at Scone.

## 9.3 Sensitive Land Uses and Critical Use Facilities

Certain facilities, services, land uses, and infrastructure have a higher sensitivity to flooding or are critical to the community during or following flood events. The locations of a number of critical or sensitive uses that have been identified within the study area are listed in the following. A discussion of flood affectation at these sites are also provided in the following sections.

- Scone Ambulance Station
- Fire and Rescue NSW Scone Fire Station
- NSW SES Scone Unit
- Upper Hunter Early Learning Centre
- Scone & District Preschool
- Scone Public School
- Scone High School
- Scone Grammar School
- HammondCare Scone
- Scone Senior Citizens' Centre
- Scone Airport
- Upper Hunter Shire Council Administration Building

### 9.3.1 Scone Ambulance Station

The Scone Ambulance Station is located at 208-212 Kelly Street. Flood extents for the range of simulated design events are presented in **Figure 9-1**. Flood conditions affecting the site are summarised as follows:

- The site is flood-free in events up to and including the 1 in 500 AEP event. The site is predicted to be inundated during the PMF.
- The ambulance service would not be able to safely access Satur during the 5% AEP event as floodwaters are expected to overtop Liverpool Street.
- Road safety issues develop through the study area with increasing flood magnitude. Sections of Kelly Street to the north of the property would be inundated and unsafe for all vehicles (H3 hazard). Some alternative routes would be available enabling the ambulance service to access most areas within Scone during a 1% AEP event.
- Hazard on local roads continues to increase in events from the 1% AEP to 1 in 500 AEP, as do access and isolation issues throughout the study area. Sections of Liverpool Street / Kelly Street and Main Street to the north of the ambulance station become unsafe for all vehicles (H3-H4 hazard) in the 1 in 200 AEP event. This indicates that the ambulance service may not be able to safely access areas of Scone to the west of Kelly Street and north of St Aubins Street during a 1 in 200 AEP flood event along Figtree Gully.
- In the PMF, access roads would first become inundated isolating the property. The property would later be inundated by H4 conditions (unsafe for people and vehicles). The buildings would be flooded above floor and it appears that no flood-free refuge would be available. Accordingly, evacuation should occur prior to the evacuation route becoming unsafe.

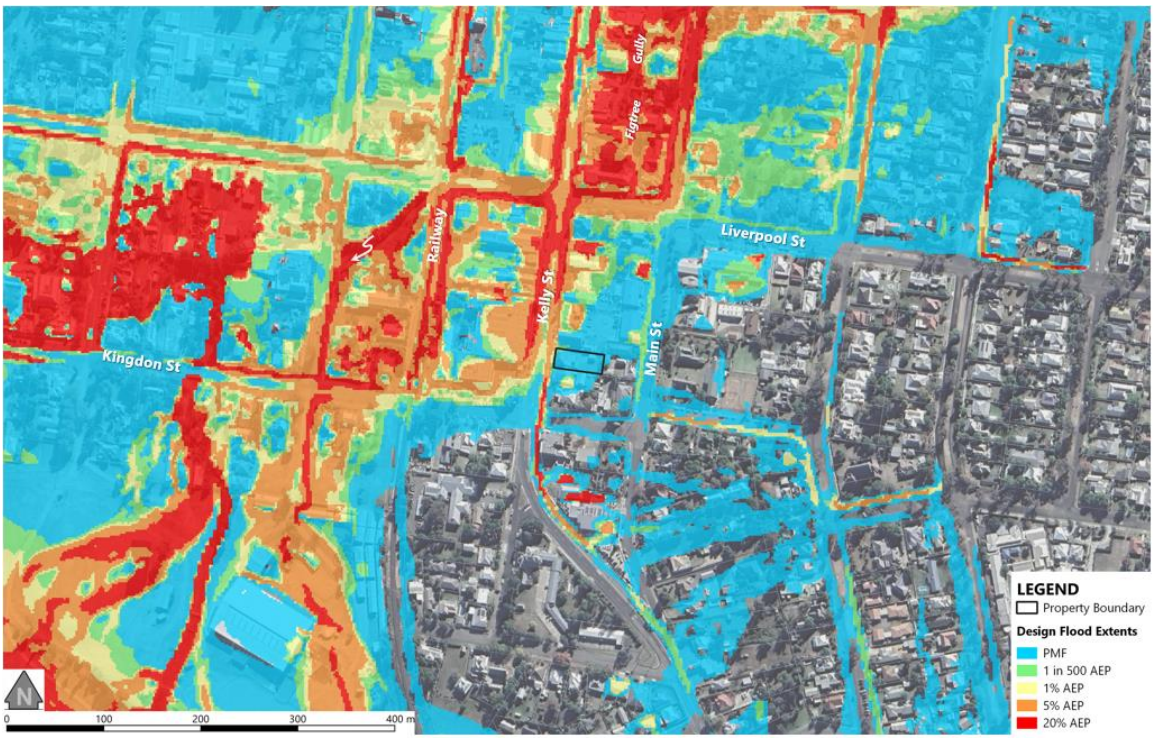



**Figure 9-1 Design flood extents at the Scone Ambulance Station**

### 9.3.2 NSW SES Scone Unit

The NSW SES Scone Unit is located at 74 Main Street. Flood extents for the range of simulated design events are presented in **Figure 9-2**. Flood conditions affecting the site are summarised as follows:

- The site is flood-free in events up to and including the PMF.
- The SES would not be able to safely access Satur during the 5% AEP event as floodwaters are expected to overtop Liverpool Street.
- Road safety issues develop through the study area with increasing flood magnitude. Sections of Kelly Street to the north-west of the property would be inundated and unsafe for all vehicles during the 1% AEP event (H3 hazard). Some alternative routes would be available enabling the SES to access most areas within Scone during a 1% AEP event.
- Hazard on local roads continues to increase in events from the 1% AEP to 1 in 500 AEP, as do access and isolation issues throughout the study area. Sections of Liverpool Street / Kelly Street and Main Street to the north of the property become unsafe for all vehicles (H3-H4 hazard) in the 1 in 200 AEP event. This indicates that the SES may not be able to safely access areas of Scone to the west of Kelly Street and north of St Aubins Street during a 1 in 200 AEP flood event along Figtree Gully.

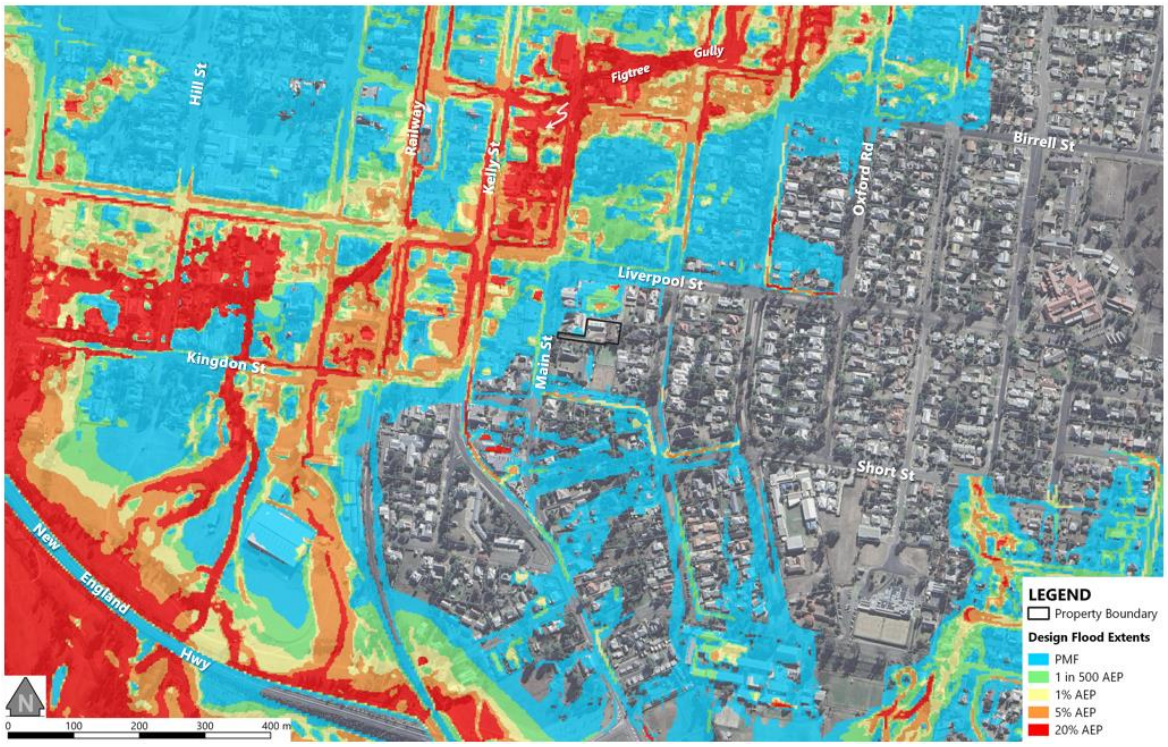



**Figure 9-2 Design flood extents at the NSW SES Scone Unit**

### 9.3.3 Fire and Rescue NSW Scone Fire Station

The Fire and Rescue NSW Scone Fire Station is located at 104 Kingdon Street. Flood extents for the range of simulated design events are presented in **Figure 9-3**. Flood conditions affecting the site are summarised as follows:

- The site is flood-free in events up to and including the PMF.
- Fire and Rescue NSW would not be able to safely access Satur during the 5% AEP event as floodwaters are expected to overtop Liverpool Street.
- Road safety issues develop through the study area with increasing flood magnitude. Sections of Kelly Street to the north-west of the property would be inundated and unsafe for all vehicles during the 1% AEP event (H3 hazard). Some alternative routes would be available enabling Fire and Rescue NSW to access most areas within Scone during a 1% AEP event.
- Hazard on local roads continues to increase in events from the 1% AEP to 1 in 500 AEP, as do access and isolation issues throughout the study area. Sections of Liverpool Street / Kelly Street and Main Street to the north of the property become unsafe for all vehicles (H3-H4 hazard) in the 1 in 200 AEP event. This indicates that Fire and Rescue NSW may not be able to safely access areas of Scone to the west of Kelly Street and north of St Aubins Street during a 1 in 200 AEP flood event along Figtree Gully.

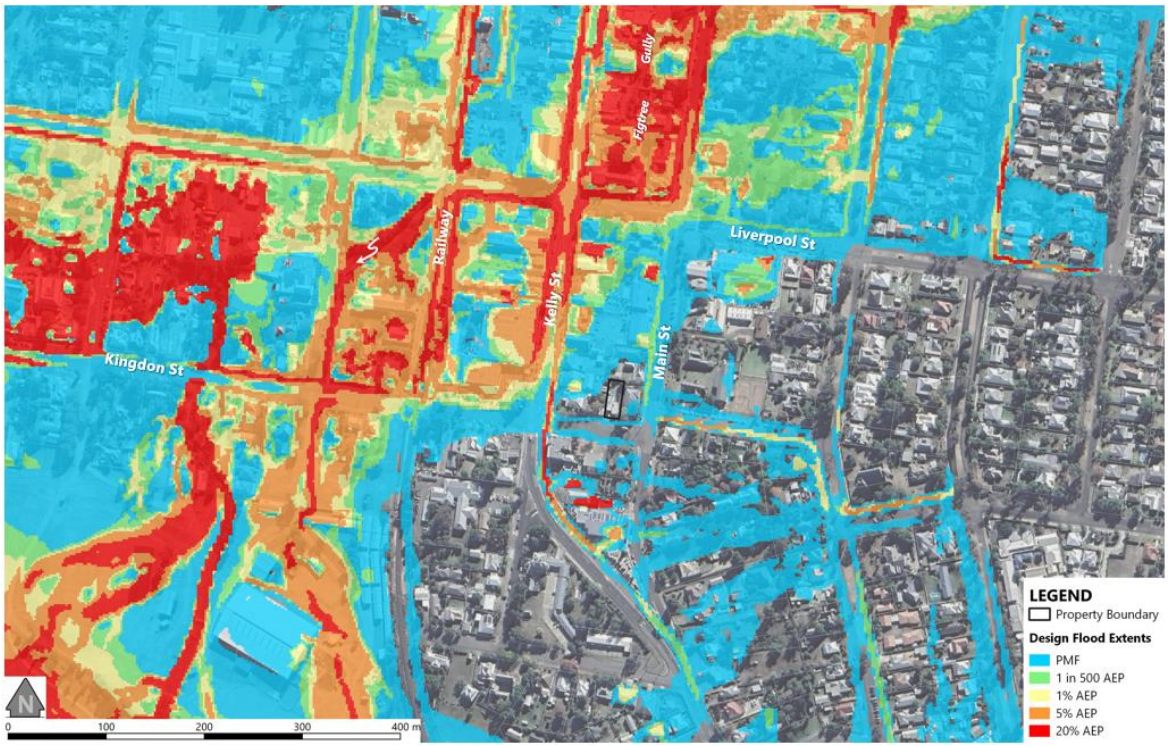



**Figure 9-3 Design flood extents at Fire and Rescue NSW Scone Fire Station**

### 9.3.4 Upper Hunter Early Learning Centre

Upper Hunter Early Learning Centre is a childcare centre located at 72 Main Street. Flood extents for the range of simulated design events are presented in **Figure 9-4**. Flood conditions affecting the site are summarised as follows:

- The site is flood-free in events up to and including the PMF.
- Main Street and Liverpool Street to the north and west of the property are not expected to be inundated in events up to and including the 1 in 500 AEP.
- Parsons Gully is expected to overtop Liverpool Street during the 10% AEP event, leading to unsafe conditions for small vehicles (H2 hazard). Accordingly, it would be unsafe for small vehicles to travel between this childcare centre and Satur during the 10% AEP flood.
- Sections of Liverpool Street and Main Street to the north-west of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between this childcare centre to areas west of the Scone CBD and areas north of Figtree Gully.
- Hazard on local roads continues to increase in events from the 1% AEP to 1 in 500 AEP, as do access and isolation issues throughout the study area. Sections of Liverpool Street / Kelly Street and Main Street to the north of the property become unsafe for all vehicles (H3-H4 hazard) in the 1 in 200 AEP event.

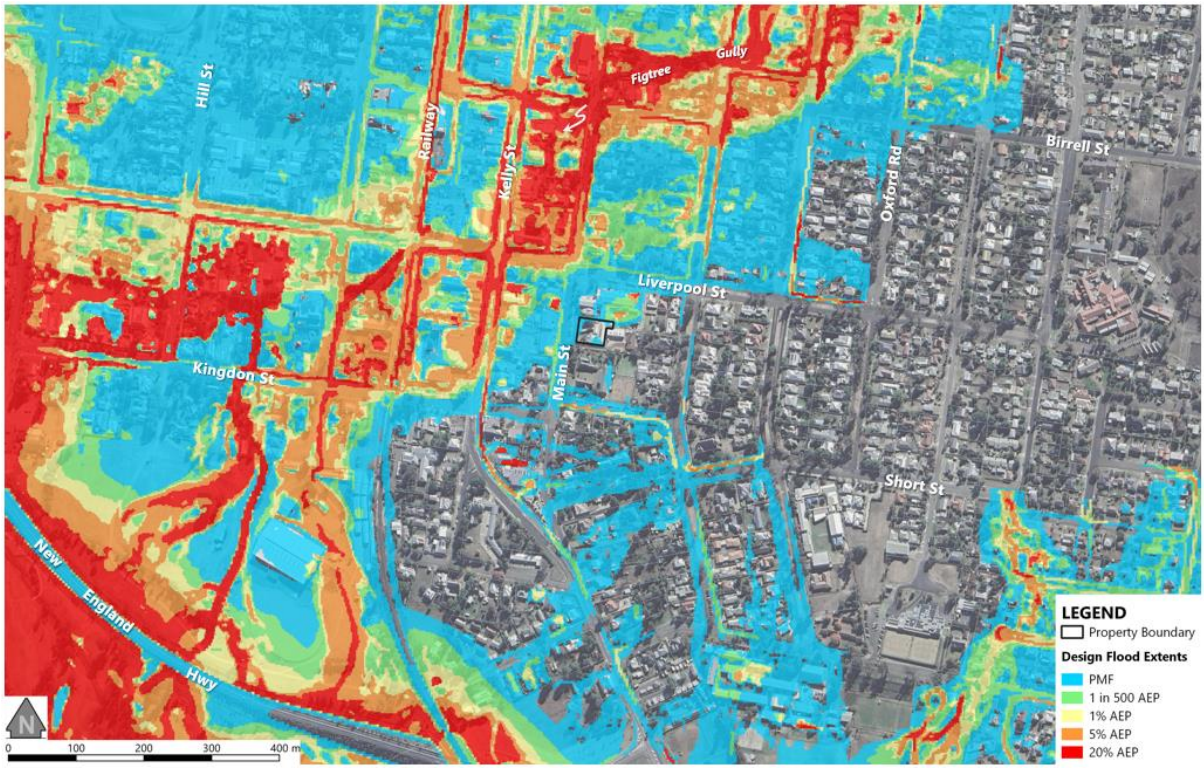



**Figure 9-4 Design flood extents at Upper Hunter Early Learning Centre**

### 9.3.5 Scone & District Preschool

Scone & District Preschool is located at 6-8 Cooper Street. Flood extents for the range of simulated design events are presented in **Figure 9-5**. Flood conditions affecting the site are summarised as follows:

- The preschool is located adjacent to Figtree Gully. The northern part of this property and the Cooper Street roadway is inundated during the 1% AEP flood. It is noted that the building is predicted to remain flood-free during the 1% AEP flood.
- Flooding of local roads in the vicinity of the preschool such as Cooper Street and Oxford Road remains relatively benign in events up to and including the 1 in 500 AEP event. Flooding in these areas is categorised as H1 (generally safe) during the 1 in 500 AEP event.
- Parsons Gully is expected to overtop Liverpool Street during the 10% AEP event, leading to unsafe conditions for small vehicles (H2 hazard). Accordingly, it would be unsafe for small vehicles to travel between this preschool and Satur during the 10% AEP flood.
- Sections of Liverpool Street and Main Street to the south-west of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between the preschool and areas west of the Scone CBD and areas north of Figtree Gully.
- The preschool is predicted to be inundated above floor level during the 1 in 500 AEP event as well as the PMF. Floodwaters are expected to break out of Figtree Gully during these events, leading to the inundation of the property as well as nearby roads within similar timeframes. The flood hazard category at the preschool during the 1 in 500 AEP event and the PMF is predicted to be H2 and H4, respectively.

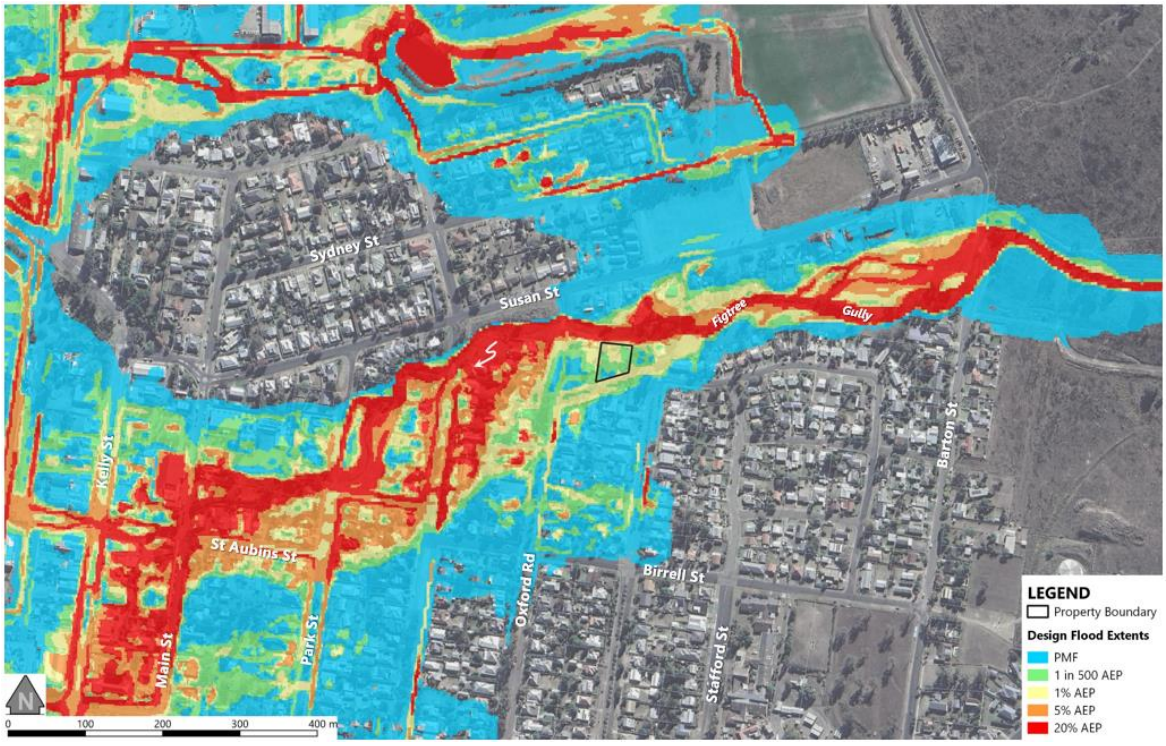



**Figure 9-5 Design flood extents at Scone & District Preschool**

### 9.3.6 Scone Public School

Scone Public School is located at 82-98 Liverpool Street. Flood extents for the range of simulated design events are presented in **Figure 9-6**. Flood conditions affecting the site are summarised as follows:

- The school is flood-free in events up to and including the 1 in 500 AEP event. The school is predicted to be inundated during the PMF.
- Parsons Gully is expected to overtop Liverpool Street during the 10% AEP event, leading to unsafe conditions for small vehicles (H2 hazard). Accordingly, it would be unsafe for small vehicles to travel between the school and Satur during the 10% AEP flood.
- Sections of Liverpool Street and Main Street to the east of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between the school and areas east of the Scone CBD.
- In the PMF, local access roads would be inundated before the school. The property would later be inundated by H3 to H4 conditions (unsafe for people and vehicles). The buildings would be flooded above floor level and it appears that no flood-free refuge would be available. Accordingly, evacuation should occur prior to the inundation of surrounding streets.

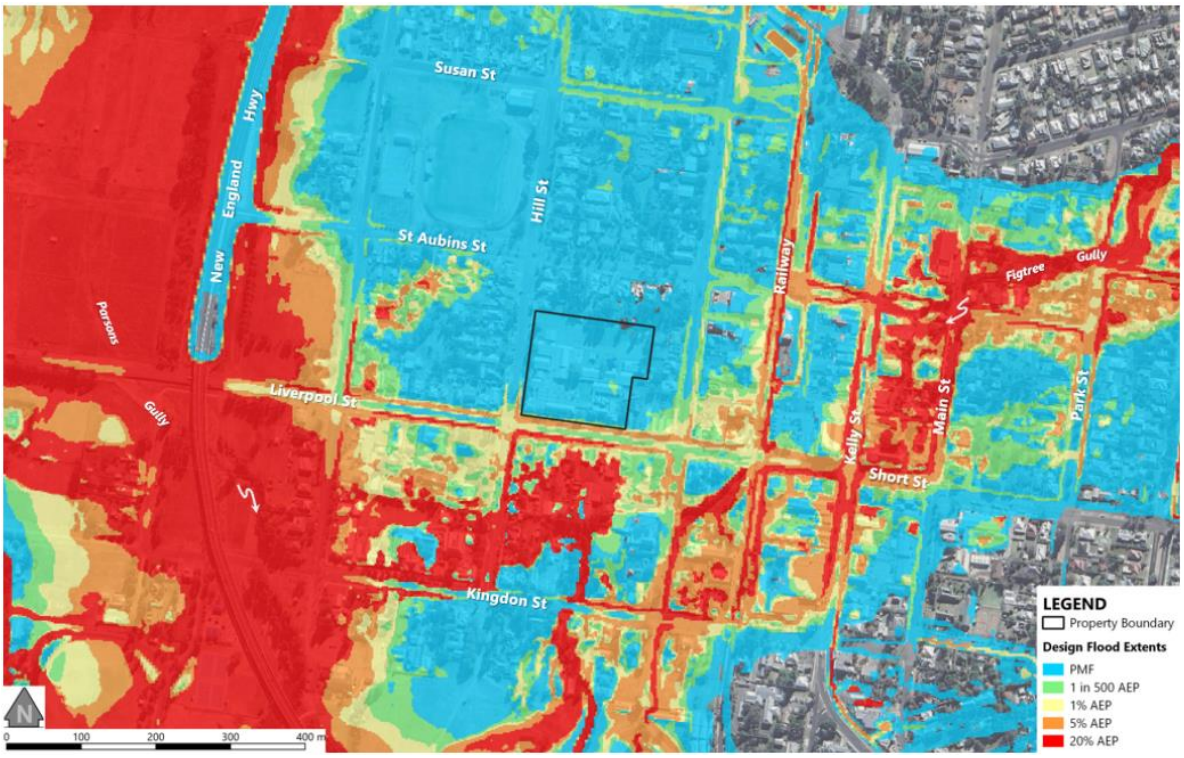



**Figure 9-6 Design flood extents at Scone Public School**

### 9.3.7 Scone High School

Scone High School is located along Gundy Road near the southern end of Park Street and Waverley Street. Flood extents for the range of simulated design events are presented in **Figure 9-7**. Flood conditions affecting the site are summarised as follows:

- The school is mostly flood-free in events up to and including the 1 in 500 AEP. The school is predicted to be inundated by overland flow paths draining towards Parsons Gully during the PMF. The school is not affected by mainstream flooding of Figtree Gully or Parsons Gully.
- Some parts of the school are expected to remain flood-free in events up to and including the PMF. The sports field near the north-east corner of the school is flood-free, however, the school buildings are expected to be inundated.
- Local access roads typically remain flood-free in events up to and including the 1 in 500 AEP event. Short sections of Gundy Road to the east of the school are predicted to be inundated to shallow depths during the 1 in 500 AEP event (categorised as H1 hazard; generally safe).
- Sections of Liverpool Street and Main Street to the north-west of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between the school and areas west of the Scone CBD and areas north of Figtree Gully.
- In the PMF, floodwaters over Gundy Road would lead to unsafe conditions for small vehicles (H2 hazard). Staff and students would be able to evacuate on foot by crossing Gundy Road and seeking shelter at the Scone Bowling Club if required.

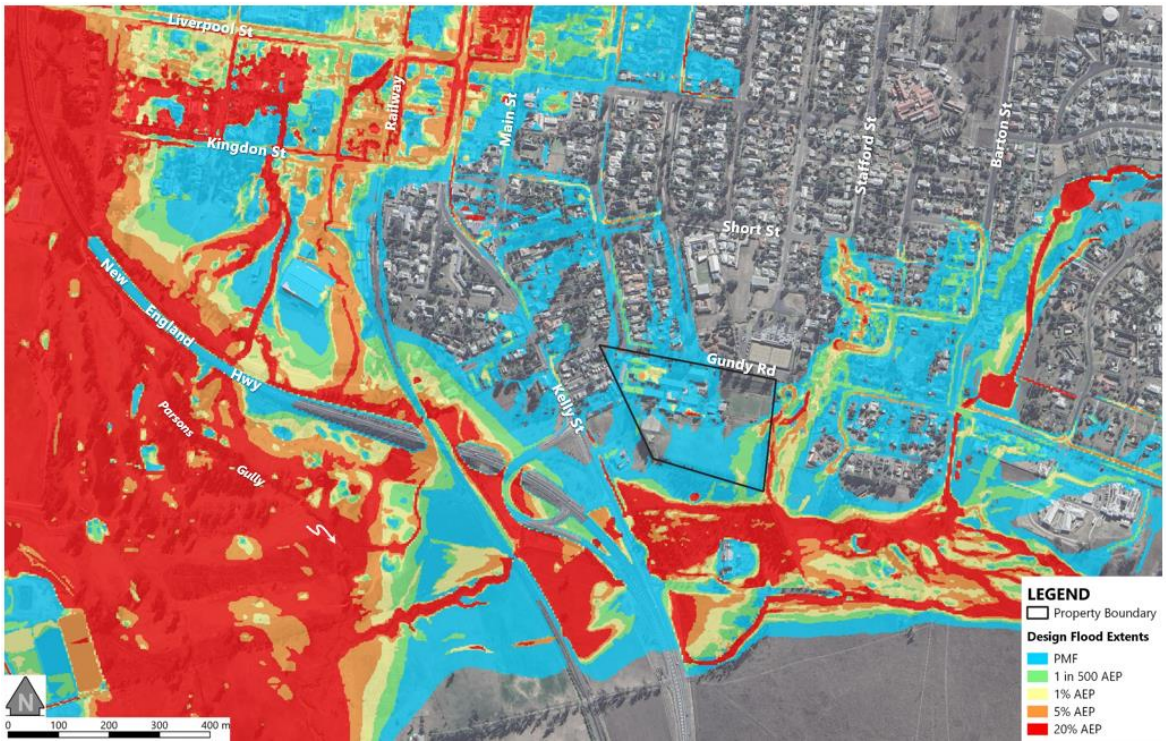



**Figure 9-7 Design flood extents at Scone High School**

### 9.3.8 Scone Grammar School

Scone Grammar School is located at 60 Kingdon Street. Flood extents for the range of simulated design events are presented in **Figure 9-8**. Flood conditions affecting the site are summarised as follows:

- Significant portions of the school are predicted to be inundated by overland runoff draining towards Parsons Gully during the 20% AEP event. Flood depths typically range from 0.2 to 0.3 metres during this event, with localised areas inundated to depths of up to 0.5 metres.
- Parts of the school near the western property boundary would be inundated by mainstream flooding of Parsons Gully during a 5% AEP event. This area would be affected by flooding that is classified as H3 hazard (unsafe for all vehicles, children and the elderly). Mainstream flooding of Parsons Gully is predicted to inundate about 40% of the school grounds at the peak of the 1 in 500 AEP event.
- The kerb and gutter system along the adjacent roads of Aberdeen Street and Kingdon Street are predicted to be inundated to depths exceeding 0.3 metres during the 20% AEP event. The depth and extent of flooding would increase with increasing flood magnitude, leading to difficulties in travelling to / from the school by car.
- In the PMF, Liverpool Street and Aberdeen Street would be inundated before the school. The property would later be inundated by H5 to H6 conditions (unsafe for all people with buildings vulnerable to damage). The buildings would be flooded above floor level and it appears that no flood-free refuge would be available. Students and staff should evacuate the school in an eastward direction towards the Scone Bowling Club.

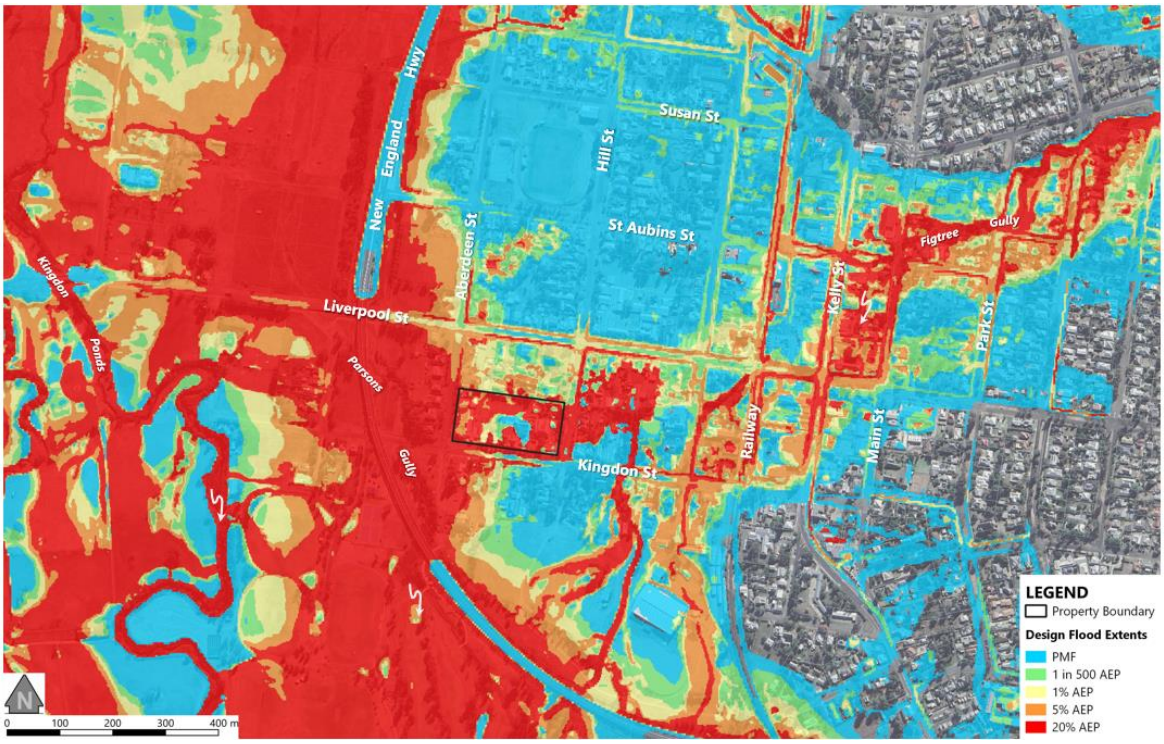



**Figure 9-8 Design flood extents at Scone Grammar School**

### 9.3.9 HammondCare Scone

HammondCare Scone is located at 75 Gundy Road. It is an aged care facility which comprises residential units as well as common areas and community buildings. Flood extents for the range of simulated design events are presented in **Figure 9-9**. Flood conditions affecting the site are summarised as follows:

- The facility is mostly flood-free in events up to and including the 1% AEP. Parts of the property are predicted to be inundated by overland flow paths draining towards Parsons Gully in rarer events. The site is not affected by mainstream flooding of Figtree Gully or Parsons Gully.
- The flood hazard at the property does not exceed H1 (generally safe) in events up to and including the 1 in 500 AEP. During the PMF, the flood hazard along an overland flow path at the western site boundary reaches a category of H4 (unsafe for all people and vehicles). The flood hazard at the independent living villas do not exceed a category of H2 during the PMF.
- Some parts of the facility are expected to remain flood-free in events up to and including the PMF. This includes the two largest buildings at the site which are located in the eastern portion of the property. Residents and staff would be able to seek refuge at these buildings.
- Local access roads typically remain flood-free in events up to and including the 1 in 500 AEP event. Short sections of Gundy Road are predicted to be inundated to shallow depths during the 1 in 500 AEP event (categorised as H1 hazard; generally safe).

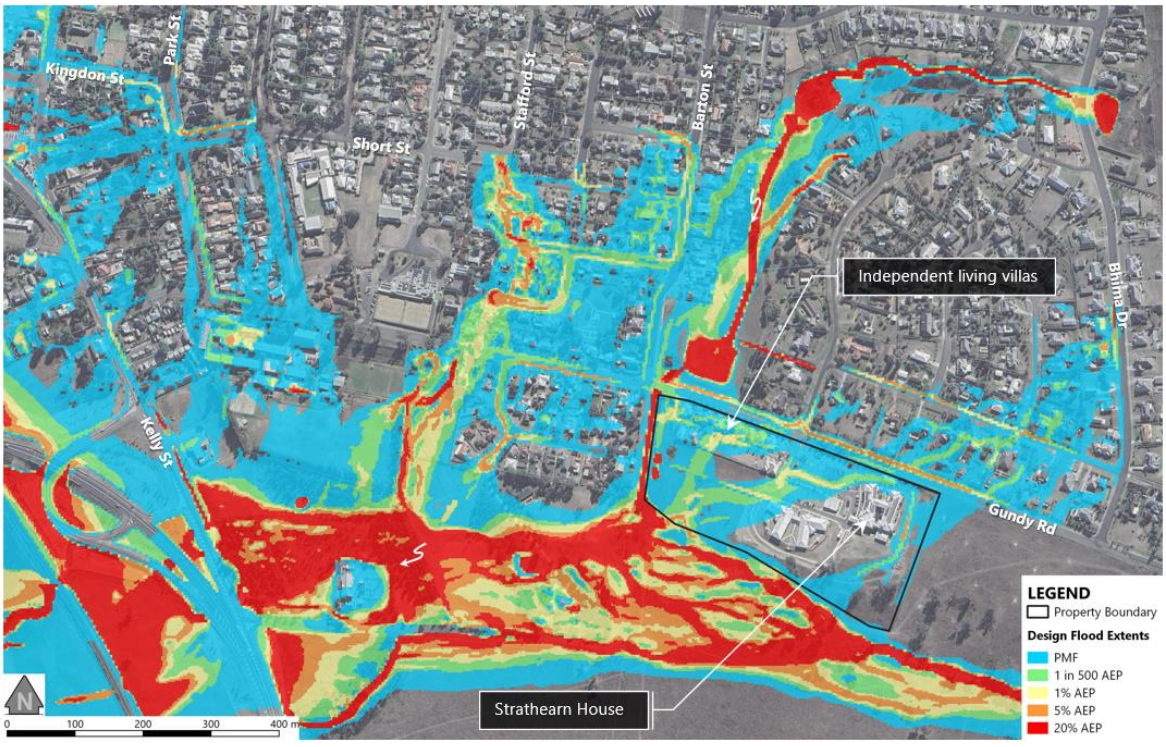



**Figure 9-9 Design flood extents at HammondCare Scone**

### 9.3.10 Scone Senior Citizens' Centre

Scone Senior Citizens' Centre is located at the corner of Oxford Road and Cooper Street. Flood extents for the range of simulated design events are presented in **Figure 9-10**. Flood conditions affecting the site are summarised as follows:

- The site is located adjacent to Figtree Gully. The northern part of this property and the Cooper Street roadway is inundated during the 1% AEP flood.
- Flooding of local roads in the vicinity of the property such as Cooper Street and Oxford Road remains relatively benign in events up to and including the 1 in 500 AEP event. Flooding in these areas is categorised as H1 (generally safe) during the 1 in 500 AEP event.
- Sections of Liverpool Street and Main Street to the south-west of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between the property and areas west of the Scone CBD and areas north of Figtree Gully.
- The building is predicted to be inundated above floor level during the 1 in 200 AEP event and the 1 in 500 AEP event to shallow depths of 0.1 metres and 0.2 metres respectively. Floodwaters are expected to break out of Figtree Gully during these events, leading to the inundation of the property as well as nearby roads within similar timeframes.
- The property is completely inundated during the PMF, with flooding categorised as H3 to H4 (unsafe for the elderly).

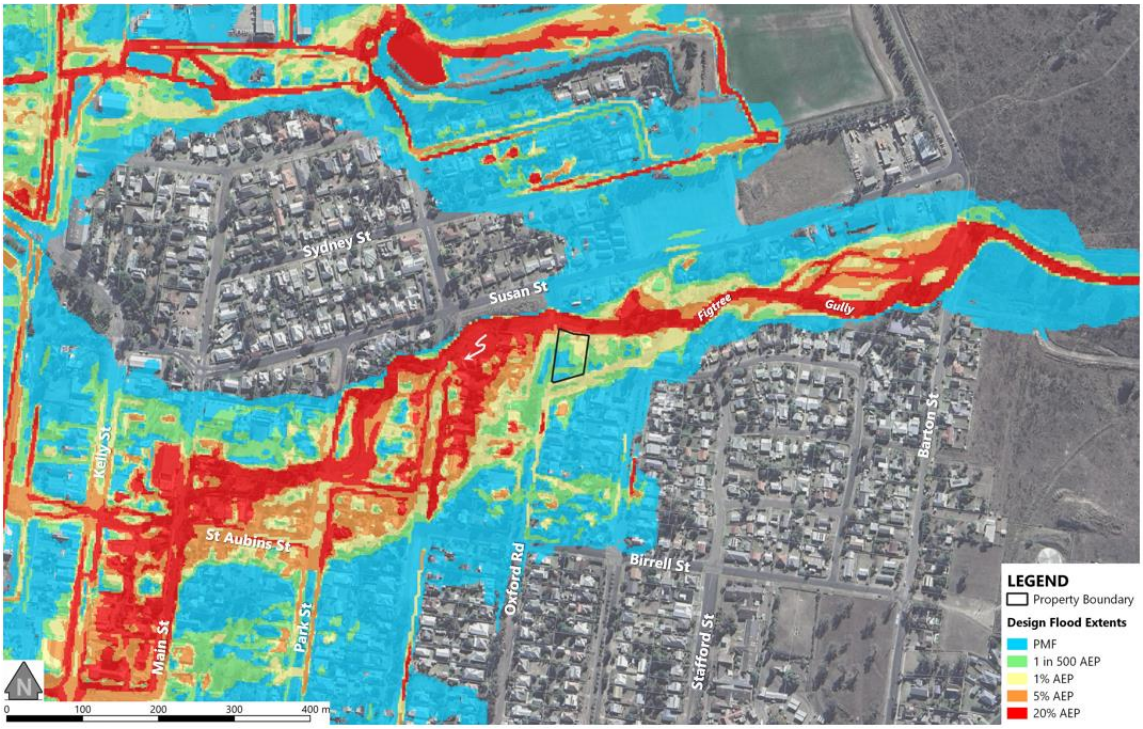



**Figure 9-10 Design flood extents at Scone Senior Citizens' Centre**

### 9.3.11 Scone Airport

Scone Airport is located along Bunnan Road / Satur Road near the satellite suburb of Satur. Flood extents for the range of simulated design events are presented in **Figure 9-11**. Flood conditions affecting the site are summarised as follows:

- Parts of the site may be affected by an overland flow path which runs from north-west to south-east through the satellite suburb of Satur. It is not affected by mainstream flooding of Middle Brook or Kingdon Ponds.
- The majority of the site is predicted to be flood free in events up to and including the PMF. The flood hazard category typically does not exceed H2 in these areas.
- Satur Road to the east of the airport is predicted to be inundated in events as frequent as the 20% AEP. The flood hazard along Satur Road does not exceed H1 (generally safe) in events up to and including the 1% AEP.
- All of the buildings within the airport boundary are predicted to be flood free during the PMF. Staff and travellers would be able to take refuge in these buildings in the PMF.

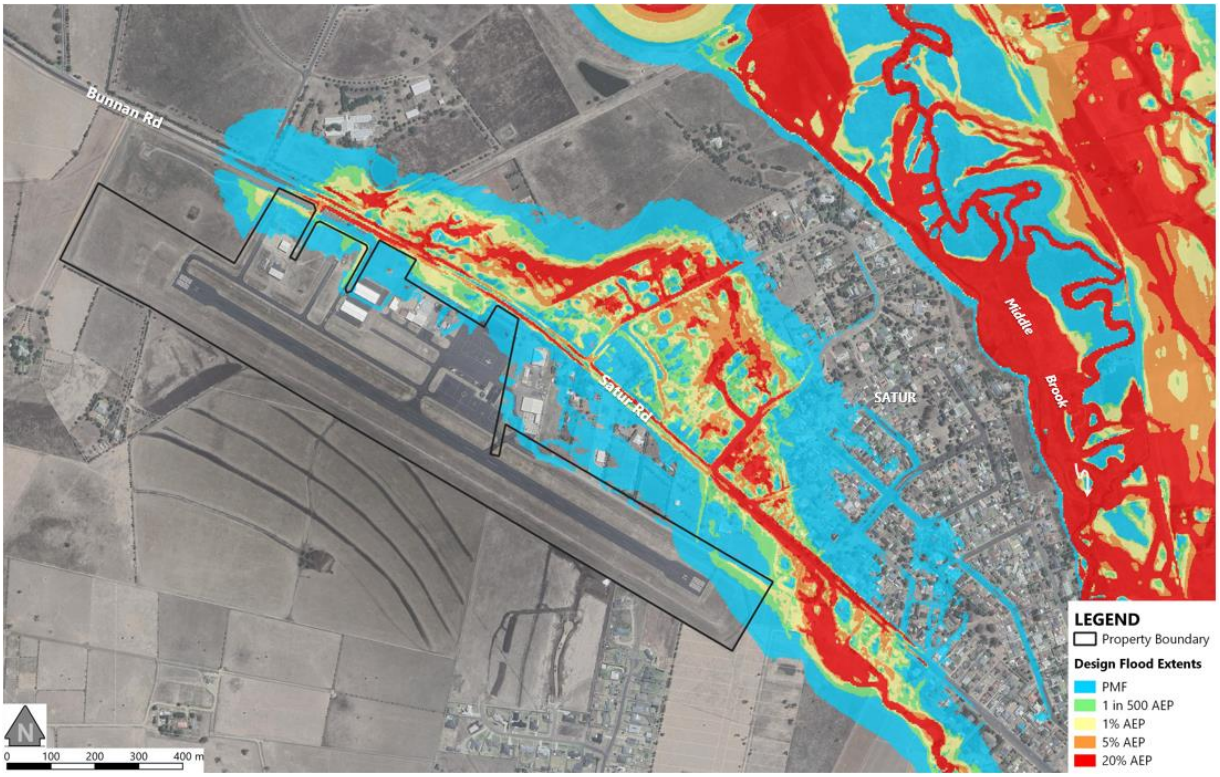



**Figure 9-11 Design flood extents at Scone Airport**

### 9.3.12 Council Administration Building

The Council administration building is located at 135 Liverpool Street. Flood extents for the range of simulated design events are presented in **Figure 9-12**. Flood conditions affecting the site are summarised as follows:

- The Council building is not flooded above floor level in events up to and including the 1 in 200 AEP event, although some localised ponding is expected within the Council carpark and at the front of the building in events as frequent as the 5% AEP event.
- Main Street and Liverpool Street to the north and west of the property are not expected to be inundated in events up to and including the 1 in 500 AEP.
- Parsons Gully is expected to overtop Liverpool Street during the 10% AEP event, leading to unsafe conditions for small vehicles (H2 hazard). Accordingly, it would be unsafe for small vehicles to travel between the Council building and Satur during the 10% AEP flood.
- Sections of Liverpool Street and Main Street to the north-west of the property would become unsafe for small vehicles (H2 hazard) during the 5% AEP event. There are no alternative routes available to travel between the Council building to areas west of the Scone CBD and areas north of Figtree Gully.
- Hazard on local roads continues to increase in events from the 1% AEP to 1 in 500 AEP, as do access and isolation issues throughout the study area. Sections of Liverpool Street / Kelly Street and Main Street to the north of the property become unsafe for all vehicles (H3-H4 hazard) in the 1 in 200 AEP event.

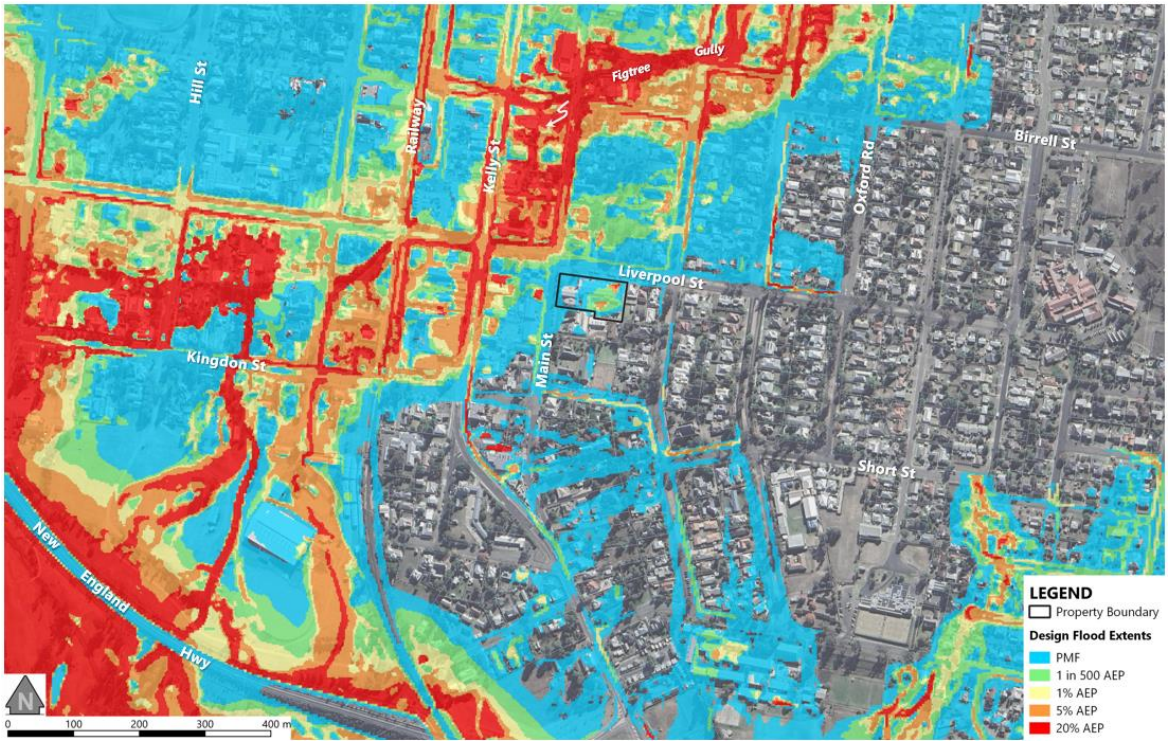



**Figure 9-12 Design flood extents at the Council administration building**

## 9.4 Inundation of the Main Northern Railway

The Main Northern Railway passes through the Scone CBD parallel to and west of Kelly Street with an approximately south to north alignment. The railway is typically at elevations equal to or lower than the adjacent roads in this area.

A small section of the track may be marginally overtopped during the 20% AEP event. The depth and extent of overtopping would increase incrementally with flood magnitude. During the 5% AEP event, the majority of the railway in the vicinity of the Scone CBD is predicted to be inundated to depths typically between 0.15 and 0.3 metres.

The inundation of the railway at Scone is summarised in **Figure 9-13**.

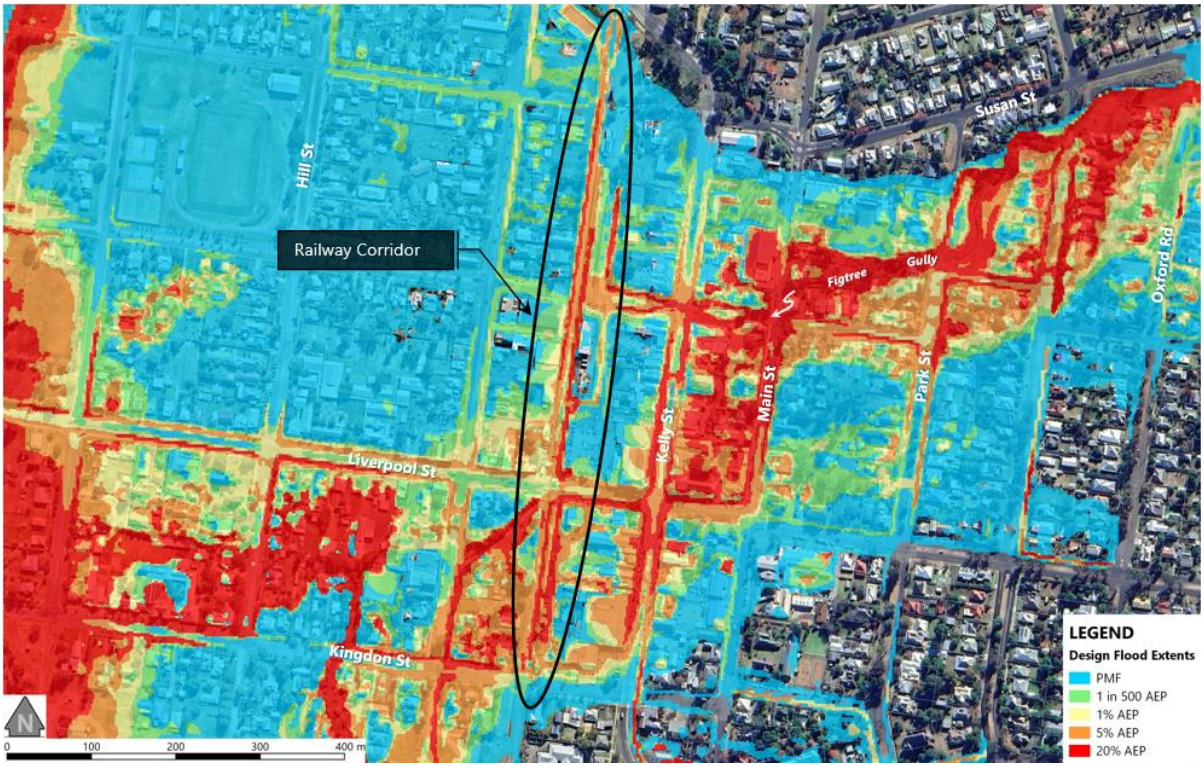



**Figure 9-13 Inundation of the Main Northern Railway**

## 9.5 Potential Evacuation Centres

St Mary's Primary School and the Scone Bowling Club could be suitable evacuation centres, as these locations are predicted to be flood free in events up to and including the PMF.

It is noted that the management and selection of evacuation centres is the responsibility of the Department of Human Services (Community Services) and not local council.

## 9.6 Inundation of Major Roads

Flood model results indicate that various major roads in the study area would be inundated in flood events as frequent as the 20% AEP. Simulated flood depths and durations for design blockage factors at a number of key locations is presented in **Table 9-1** for the full range of design

floods investigated. The reporting locations are indicated in **Figure 9-15** along with the frequency of design flood in which each location would be expected to become unsafe for vehicular passage.

It is noted that not all locations that major roads become inundated have been reported, but that those locations where the earliest or most severe inundation is expected are generally included. For example, inundation of Middlebrook Road may occur near Scone Race Club as well as adjacent to Satur. However, flooding is more frequent and severe at the location adjacent to Satur and hence this reporting location was selected. Similarly, road low points adjacent to bridges are often overtopped prior to the bridges themselves and these have been reported on.

The information presented in **Table 9-1** and **Figure 9-15** is summarised in the following:

- Liverpool Street would be overtopped to depths of about 0.12 metres during the 20% AEP event.
- In the 10% AEP event, Liverpool Street is overtopped at several locations by flows from Middle Brook, Kingdon Ponds and Parsons Gully for a duration of between 3.5 and 4.5 hours. The peak depth of inundation during the 10% AEP event is about 0.39 metres.
- Moobi Road and Satur Road are inundated to depths of 0.15 metres or less in events up to and including the 1% AEP event.
- Middlebrook Road is expected to be overtopped at several locations during the 20% AEP event. The peak depth of inundation during the 20% AEP event is about 0.30 metres, with a duration of inundation of about 3 hours.
- Within the Scone CBD, Kelly Street is expected to be inundated by flows escaping from Figtree Gully in events as frequent as the 20% AEP. The section of Kelly Street to the south of the Liverpool Street intersection is particularly flood-prone, with flood depths reaching about 0.28 metres in the 20% AEP event.


**Figure 9-14 Road inundation in the Upper Hunter Shire [*source: Scone SES Unit*]**

**Table 9-1 Major Road Inundation Depth and Duration Information**

| ID | Road | Watercourse | Location | Road Elevation (mAHD) | 20% AEP | | 10% AEP | | 5% AEP | | 2% AEP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) |
| 1 | Liverpool St | Middle Brook | Low point 90 metres west of watercourse crossing | 203.47 | 0.08 | 3.25 | 0.11 | 4.50 | 0.15 | 5.50 | 0.17 | 6.50 |
| 2 | Liverpool St | Kingdon Ponds | Low point 160 metres east of watercourse crossing | 201.87 | N/A | N/A | 0.06 | 3.25 | 0.09 | 4.50 | 0.21 | 5.50 |
| 3 | Liverpool St | Parsons Gully | Low point 120 metres west of watercourse crossing | 201.18 | 0.12 | 2.00 | 0.39 | 3.50 | 0.60 | 4.50 | 0.80 | 5.50 |
| 4 | Moobi Road | Satur Overland Flowpath | 210 metres west of Satur Rd intersection | 204.57 | N/A | N/A | N/A | N/A | 0.08 | 2.50 | 0.11 | 3.25 |
| 5 | Satur Road | Satur Overland Flowpath | 75 metres south-east of Seaward Ave intersection | 215.53 | 0.07 | 12.75 | 0.08 | 13.25 | 0.11 | 13.00 | 0.15 | 13.50 |
| 6 | Middlebrook Road | Middle Brook | 700 metres north of Liverpool Street | 204.35 | 0.30 | 3.25 | 0.42 | 4.50 | 0.50 | 5.50 | 0.55 | 6.75 |
| 7 | Gundy Road | Unnamed Flowpath | Near Gundy Road / Barton Street intersection | 211.90 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 8 | Kelly Street | Figtree Gully | 50 metres south of Liverpool Street (outside Commonwealth Bank) | 211.32 | 0.28 | 2.75 | 0.41 | 3.25 | 0.56 | 4.75 | 0.66 | 5.25 |

| ID | Road | Watercourse | Location | Road Elevation (mAHD) | 1% AEP | | 1 in 200 AEP | | 1 in 500 AEP | | PMF | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) | Peak Depth (m) | Duration (hrs) |
| 1 | Liverpool St | Middle Brook | Low point 90 metres west of watercourse crossing | 203.47 | 0.23 | 7.00 | 0.26 | 7.50 | 0.30 | 8.00 | 2.61 | 10.75 |
| 2 | Liverpool St | Kingdon Ponds | Low point 160 metres east of watercourse crossing | 201.87 | 0.38 | 6.25 | 0.55 | 6.75 | 0.74 | 7.25 | 4.50 | 10.75 |
| 3 | Liverpool St | Parsons Gully | Low point 120 metres west of watercourse crossing | 201.18 | 0.97 | 6.25 | 1.14 | 6.75 | 1.33 | 7.50 | 5.37 | 11.00 |
| 4 | Moobi Road | Satur Overland Flowpath | 210 metres west of Satur Rd intersection | 204.57 | 0.13 | 3.50 | 0.15 | 2.00 | 0.21 | 3.25 | 0.72 | 9.75 |
| 5 | Satur Road | Satur Overland Flowpath | 75 metres south-east of Seaward Ave intersection | 215.53 | 0.15 | 9.25 | 0.18 | 11.25 | 0.22 | 11.50 | 0.55 | 10.00 |
| 6 | Middlebrook Road | Middle Brook | 700 metres north of Liverpool Street | 204.35 | 0.67 | 7.75 | 0.74 | 8.25 | 0.80 | 8.75 | 3.44 | 10.50 |
| 7 | Gundy Road | Unnamed Flowpath | Near Gundy Road / Barton Street intersection | 211.90 | N/A | N/A | 0.05 | 3.00 | 0.08 | 11.25 | 0.34 | 7.75 |
| 8 | Kelly Street | Figtree Gully | 50 metres south of Liverpool Street (outside Commonwealth Bank) | 211.32 | 0.68 | 5.50 | 0.78 | 4.50 | 0.89 | 11.50 | 2.25 | 9.75 |

Notes:

1. Road elevation and depth extracted from TUFLOW model at a single point.
2. Durations of inundation are estimated to the nearest 15 minutes from TUFLOW model results for the 'critical storm duration' only. Shallow inundation caused by local stormwater flows has generally been excluded from these estimations.

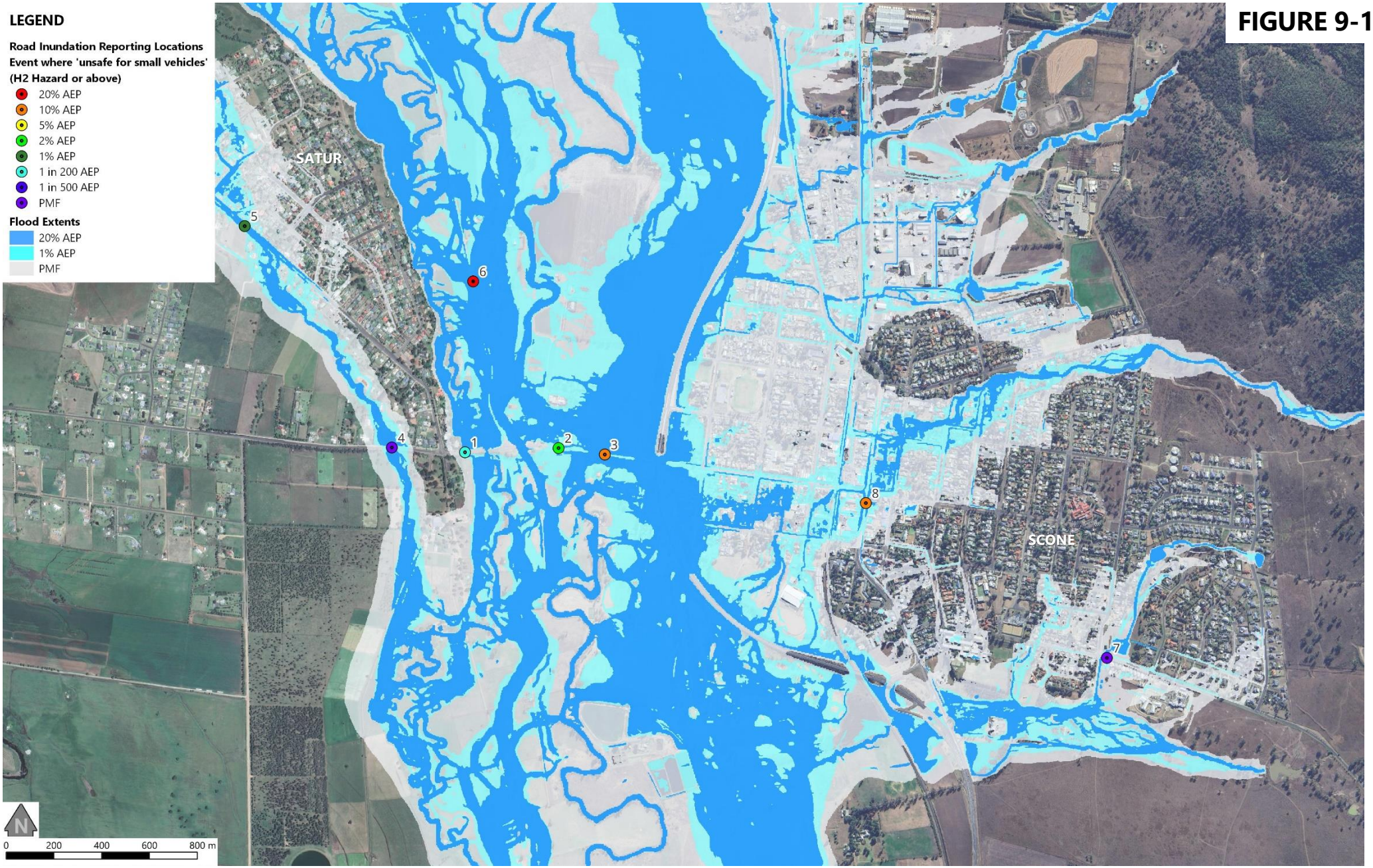
The gauge heights and flood levels at nearby water level gauges at which inundation of these major roads first occur is presented in **Table 9-2**. The table below contains information for the Scone (Kingdon Ponds) gauge (61360) as well as the Kingdon Ponds (Parkville) gauge (210093). Further information on these gauges are presented in **Section 9.8.3** and **Section 9.8.4**.

**Table 9-2 Relevant gauge information for road inundation**

| | | | | Gauge height when first inundated (m) | | Flood level when first inundated (m) | |
|---|---|---|---|---|---|---|---|
| ID | Road | Watercourse | Location | 61360 Gauge | 210093 Gauge | 61360 Gauge | 210093 Gauge |
| 1 | Liverpool St | Middle Brook | Low point 90 metres west of watercourse crossing | 0.95 | 2.87 | 200.42 | 245.49 |
| 2 | Liverpool St | Kingdon Ponds | Low point 160 metres east of watercourse crossing | 3.99 | 2.80 | 203.46 | 245.42* |
| 3 | Liverpool St | Parsons Gully | Low point 120 metres west of watercourse crossing | 3.94 | 2.85 | 203.41 | 245.47* |
| 4 | Moobi Road | Satur Overland Flowpath | 210 metres west of Satur Rd intersection | N/A# | N/A# | N/A# | N/A# |
| 5 | Satur Road | Satur Overland Flowpath | 75 metres south-east of Seaward Ave intersection | N/A# | N/A# | N/A# | N/A# |
| 6 | Middlebrook Road | Middle Brook | 700 metres north of Liverpool Street | 1.52 | 2.88 | 200.99 | 245.50 |
| 7 | Gundy Road | Unnamed Flowpath | Near Gundy Road / Barton Street intersection | N/A# | N/A# | N/A# | N/A# |
| 8 | Kelly Street | Figtree Gully | 50 metres south of Liverpool Street | N/A# | N/A# | N/A# | N/A# |

Notes:
# - flooding along these watercourses / flow paths cannot be linked to the 61360 nor 210093 gauges as they are not within the Kingdon Ponds / Middle Brook / Parsons Gully tributary.
* - these locations are cut after flood levels at the 210093 gauge have peaked (i.e. the reported flood levels and gauge heights are on the falling limb of the 210093 hydrograph.

# FIGURE 9-15

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UPPER HUNTER SHIRE COUNCIL

## INUNDATION OF MAJOR ROADS

## 9.7 Flood Emergency Response Classification

The flood emergency response planning classification provides an indication of the relative vulnerability of communities in flood emergency response situations and helps to identify the type and scale of information needed by the SES to assist with emergency response planning.

Guidance on the classification process is provided in *Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities* (OEH and SES 2007) and *Australian Disaster Resilience Guideline 7-2 Flood Emergency Response Classification of the Floodplain* (AIDR 2017). More recently, the classification process was also included in *Support for Emergency Management Planning – Flood Risk Management Guide EM01* (DPE 2023d). These documents describe similar methodologies for emergency response classification, however, employ different terminology.

Terminology per the DPE (2023d) guideline has been adopted in this study, with flood emergency response planning classifications as follows:

- **Flood Islands:** These areas can be linked to areas outside of the floodplain by roads. These roads can be cut by floodwater, closing all the evacuation routes and creating an island. After closure of the roads, access to the area is by boat or aircraft. It is assumed that vehicle or pedestrian evacuation is not practical before the evacuation route is inundated. Flood islands are classified according to what can happen after the evacuation route is cut, as follows.
  - **Low Flood Island**: During a flood event the area is first surrounded and isolated by floodwater and will then be inundated if floodwater continues to rise.
  - **Low Trapped Perimeter Area**: During a flood event, practical evacuation routes are first inundated isolating land that will then be inundated if floodwater continues to rise. These would generally be areas at the fringe of the floodplain where the only practical road or overland access is through flood prone land.
  - **High Flood Island**: During a flood event the area is surrounded and isolated by floodwater, but enough flood-free land remains to cope with the number of people in the area.
  - **High Trapped Perimeter Area**: During a flood event, practical evacuation routes are inundated isolating land that remains flood-free and can cope with the number of people in the area. These would generally be areas at the fringe of the floodplain where the only practical road or overland access is through flood prone land.
- **Areas with rising access out of the floodplain:** These are inhabited areas where vehicle or pedestrian evacuation is practical before the evacuation route is inundated. Evacuation access is available to an area of safety with adequate services and accommodation available.
  - **Overland Escape**: During a flood event, access roads are inundated but flood-free land can be reached by walking overland to escape rising floodwater.
  - **Rising Road Access**: Areas where access roads rise steadily uphill and away from rising floodwater.
- **Indirectly affected areas:** These are areas outside of the limit of flooding which would not lose road access and also would not be inundated. However, these areas may be indirectly affected as a result of flood-damaged infrastructure or due to the loss of transport links, electricity supply, water supply, sewage or telecommunications services. These areas may therefore require resupply or in the worst case, evacuation.

- **Overland refuge areas:** These are areas that the community in other areas of the floodplain may be evacuated to temporarily where there is adequate warning and response time, but which are isolated from the edge of the floodplain by floodwaters.

Flood emergency response classification mapping has been prepared for the 5% AEP, 1% AEP, 1 in 500 AEP and PMF flood events and is presented in **Figure 9-16** to **Figure 9-19**.

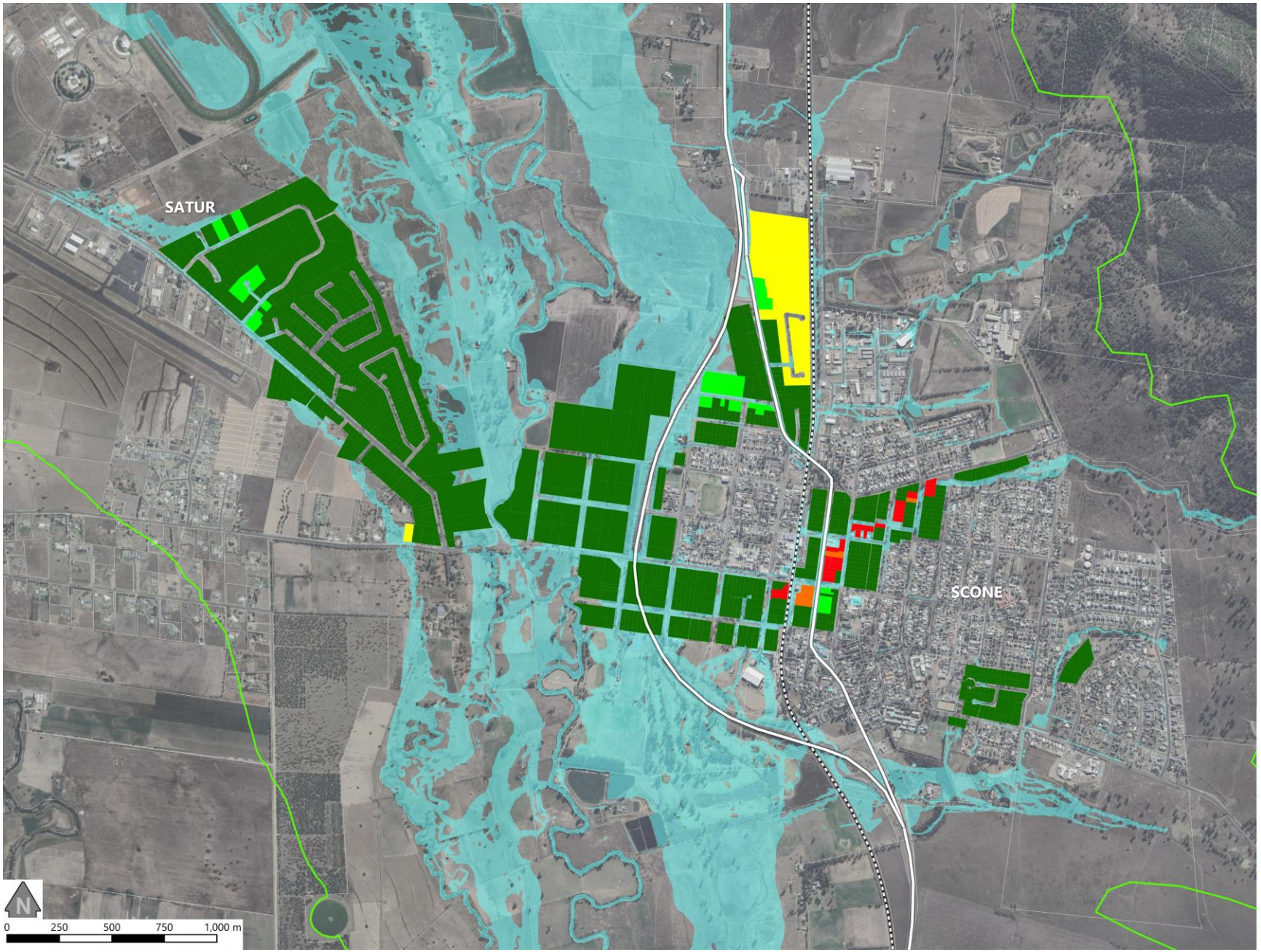
The following is noted about the method employed:

- Classifications were assigned based on analysis of the sequence in which flooding of access routes and properties occurs.
- Due to the numerous overland flow paths in the study area, the classification was generally completed on block by block basis rather than at a broader precinct scale.
- It was assumed that there would be no warning time available along Figtree Gully and other overland flow paths due to the fast response time in these catchments. Therefore, it was generally assumed that evacuation is not practical prior to the inundation of these areas.
- However, evacuation the Figtree Gully and other overland flow catchments were considered possible and practical if the flood hazard within the inundated block and its access roads were classified as H1 or H2. Based on the ARR 2019 flood hazard curves, it was considered possible for residents to safely evacuate such areas even at the peak of the flood.
- With the exception of the PMF, it was assumed that there would be sufficient warning time available for properties which would be inundated by the flooding of Kingdon Ponds and Parsons Gully due to the longer response time of the catchment. Therefore, it was assumed that evacuation is practical prior to the inundation of these areas.
- In many 'low trapped perimeter areas' overland evacuation may be possible by less practical routes such as by climbing over fences.

Overland refuge areas were not mapped as they were assumed to be functionally similar to High Flood Islands or High Trapped Perimeter areas.

It should be noted that the FERCs are not inherently indicative of flood risk and may not, alone, be sufficient to determine an appropriate prioritisation for emergency response activities.

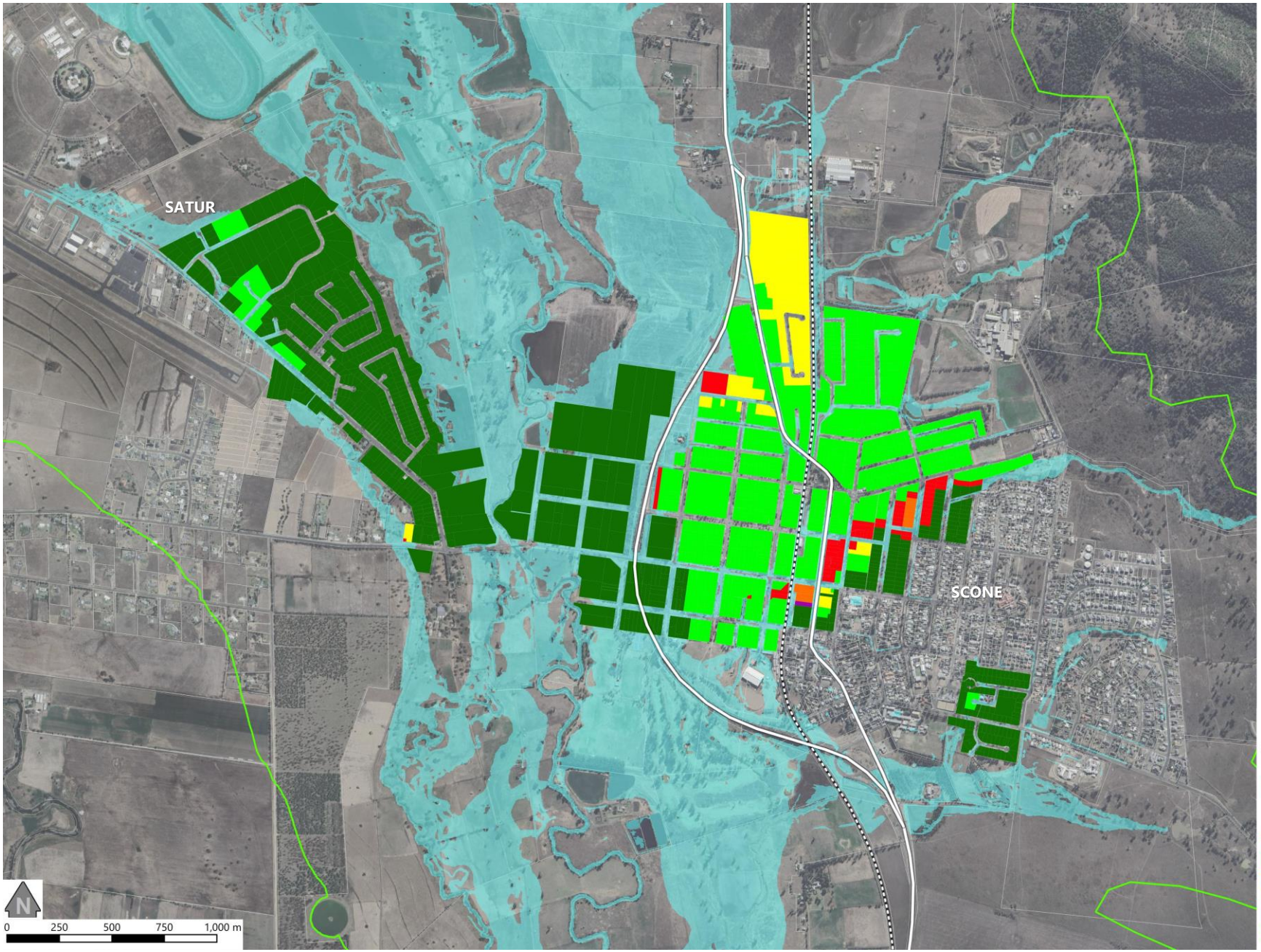
# FIGURE 9-16




Prepared by:

# FLOOD EMERGENCY RESPONSE CLASSIFICATION [5% AEP EVENT]

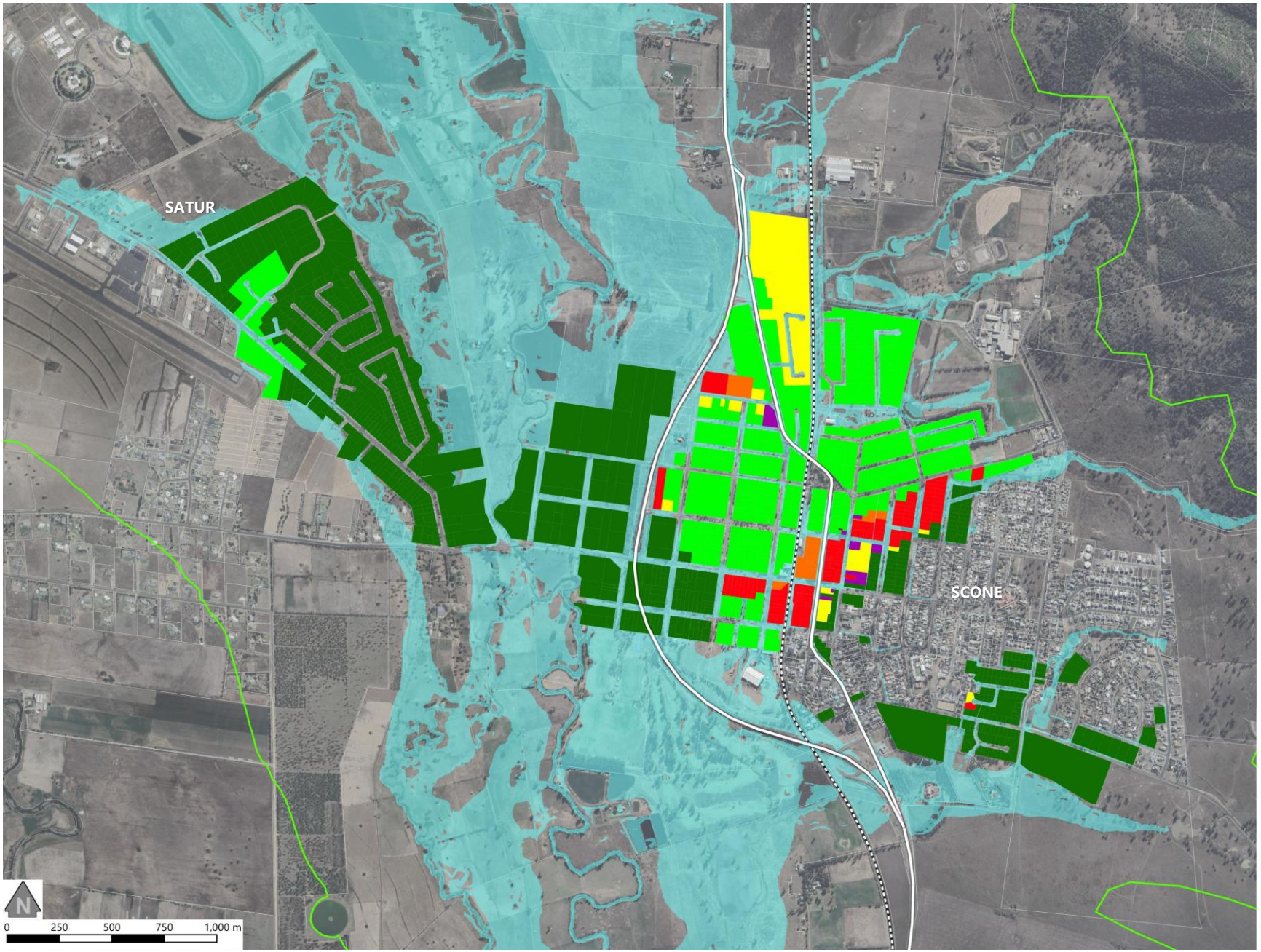
FIGURE 9-17




Prepared by:

# FLOOD EMERGENCY RESPONSE CLASSIFICATION [1% AEP EVENT]

FIGURE 9-18

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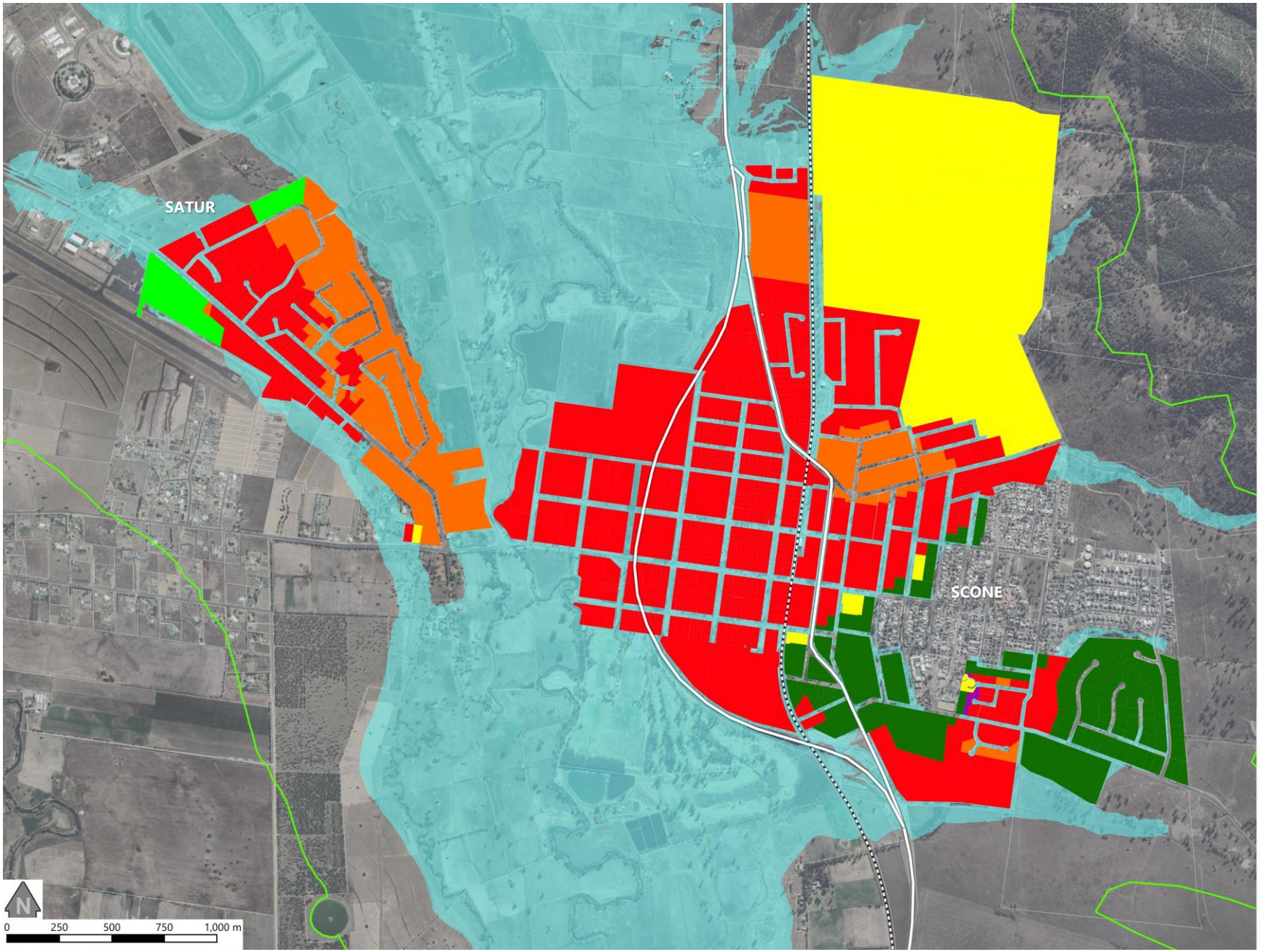
# FLOOD EMERGENCY RESPONSE CLASSIFICATION [1 IN 500 AEP EVENT]

FIGURE 9-19




Prepared by:

# FLOOD EMERGENCY RESPONSE CLASSIFICATION [PMF EVENT]

## 9.8 Flood Warning

### 9.8.1 Hydrometric Gauges

The locations of continuous rainfall and water level gauges currently operating within the Scone catchment are shown in **Figure 9-20**. These include the gauges documented in **Table 9-3**:

**Table 9-3 Summary of available hydrometric gauges within the Scone catchment**

| Gauge No. | Gauge Name | Type | Owner |
|---|---|---|---|
| 561099 | Dry Creek (Scone) | Continuous Rainfall / Water Level | BoM |
| 561100 | Wingen | Continuous Rainfall / Water Level | UHSC |
| 561101 | Cressfield | Continuous Rainfall / Water Level | UHSC |
| 210093 | Kingdon Ponds near Parkville | Continuous Rainfall / Water Level | Water NSW |
| 61363 | Scone Airport AWS | Continuous Rainfall | BoM |
| 61360 | Scone (Kingdon Ponds) | Continuous Rainfall / Water Level | UHSC |

**Recommendations**

There are no continuous rainfall or water level gauges within the Figtree Gully catchment. The installation of hydrometric gauges in this catchment would have benefits in terms of flood warning and future model calibration activities. They would also improve the potential for forecasting and earlier identification of a flood.

Installation costs would be approximately $25,000 per gauge with ongoing costs of approximately $4,000 per year for maintenance, telemetry and web hosting. The recommended rainfall gauges would also be relevant for neighbouring catchments.

Accordingly, it is recommended for the following hydrometric gauges to be installed:

- One additional continuous rainfall gauge in the upper catchment of Figtree Gully (in Scone Mountain National Park);
- One additional continuous rainfall gauge in the vicinity of the Scone CBD;
- One additional water level gauge along Figtree Gully upstream of Barton Street.

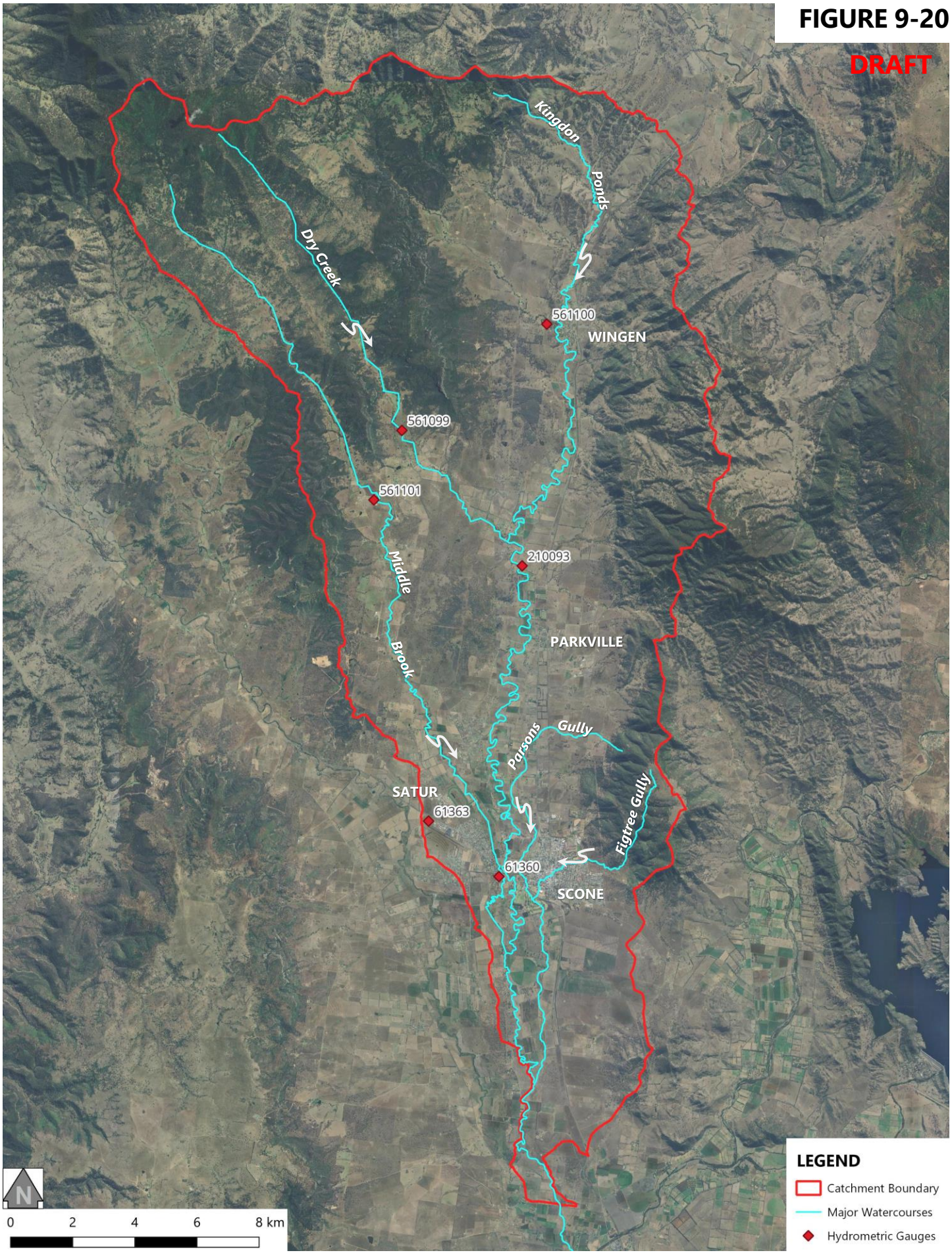
It is also recommended that all live water level and rainfall data be hosted on a single web portal that can be accessed by Council, SES and the public. This could potentially include an overview of the Upper Hunter LGA and separate pages for each catchment along with summaries of key threshold levels, impacts and evacuation advice.

As an example, Manly Hydraulics Laboratory (MHL) operates such a site for the Northern Beaches LGA (*see* https://www.mhl.nsw.gov.au/users/NorthernBeaches-Conditions).

It is also recommended for the 61360 Scone (Kingdon Ponds) water level gauge to be moved to a new location, or otherwise for a new water level gauge to be installed along Parsons Gully. Further details are provided in **Section 9.8.3**.

FIGURE 9-20

DRAFT

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# LOCATION OF PLUVIOMETERS & STREAM LEVEL GAUGES IN THE SCONE CATCHMENT

### 9.8.2 Figtree Gully Flash Flooding

The Figtree Gully catchment is affected by flash flooding (i.e., flooding that occurs within six hours or less of flood-producing rainfall, characterised by rapid catchment response times and a fast rate of rise of floodwaters). Flood levels in Scone typically peak within six hours of rainfall in the upper Figtree Gully catchment.

For reference, design rainfall depths for the Figtree Gully catchment are shown in **Table 9-4** below.

**Table 9-4 Design rainfall depths in the Figtree Gully catchment**

| Design Event | Critical Duration | Design Rainfall Depth |
|---|---|---|
| 20% AEP | 9 hours | 59.5 mm |
| 10% AEP | 6 hours | 59.3 mm |
| 5% AEP | 6 hours | 67.4 mm |
| 2% AEP | 6 hours | 78.6 mm |
| 1% AEP | 6 hours | 87.3 mm |
| 1 in 200 AEP | 3 hours | 78.2 mm |
| 1 in 500 AEP | 2 hours | 80.6 mm |

Some key considerations for catchments affected by flash flooding are summarised in the following.

- Given the rapid catchment response time, there is expected to be minimal time for a formal flood warning to be disseminated and for the community to take action prior to the arrival of floodwaters. Therefore, flood warning in the Figtree Gully catchment would be largely dependent on warnings issued by the Bureau of Meteorology (BoM). These may include a Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for Flash Flooding.
- The SES may also issue an 'Evacuation Warning' when the intent is to warn the community of the need to prepare for a possible evacuation, or an 'Evacuation Order' when the intent is to instruct the community to immediately evacuate in response to an imminent threat.
- However, it is noted that SES-assisted evacuation may not be practical for catchments with rapid response times. Evacuation procedures will need to be developed based on a suitable flood warning system which uses flood forecasting methods. Evacuation should ideally be complete prior to the onset of rainfall, although it is noted that there are significant challenges on initiating evacuation based on uncertain triggers. Frequent evacuations in which no flooding occurs could lead to a situation where warnings are eventually ignored.
- In order to enable a rapid response, it is expected that the SES would begin preparations in response to relevant BoM weather warnings and/or in response to heavy rainfall.
- Shelter-in-Place could be viable at select locations given the relatively short duration of flooding. However, any locations nominated for shelter-in-place would need to consider the flood hazard with respect to the structural stability of the building as well as providing refuge above the PMF level.

- Site-specific emergency response plans should be completed for new developments.

### 9.8.3 Recommendation for the 61360 Water Level Gauge

The 61360 Scone (Kingdon Ponds) water level gauge is located along Kingdon Ponds just upstream of Liverpool Street (refer **Figure 9-21**). **Figure 9-22** shows the simulated design flood level hydrographs at this gauge.

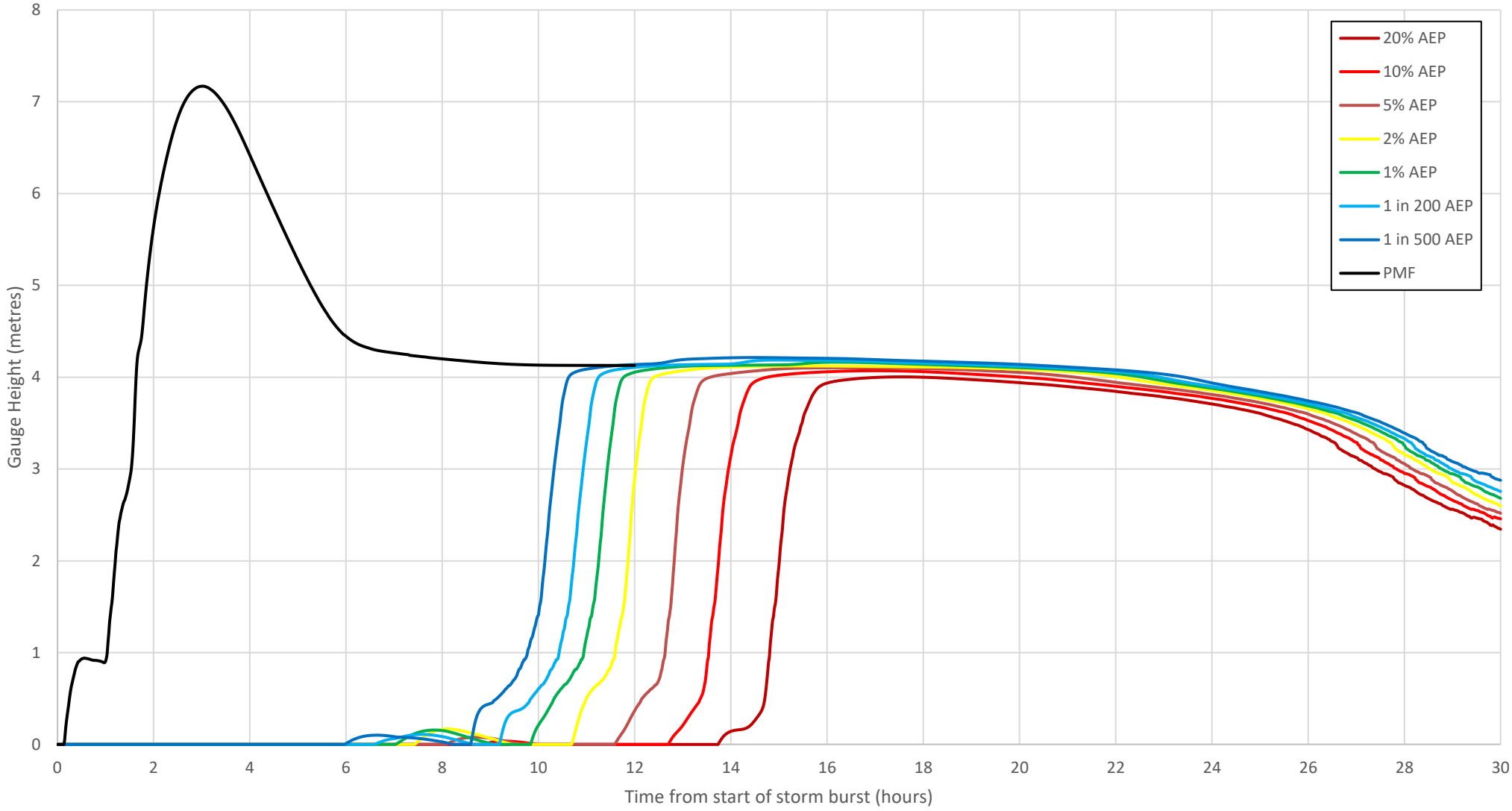
**Figure 9-21 Photo of the 61360 Scone (Kingdon Ponds) gauge**

The flood level hydrograph shows that there is only a difference of about 0.2 metres between the peak flood levels predicted along Kingdon Ponds during the 20% AEP and 1 in 500 AEP events. It is also noted that the current Minor (3.20 metres gauge height), Moderate (3.50 metres gauge height) and Major (3.70 metres gauge height) flood warning levels adopted by the Bureau of Meteorology are surpassed during the 20% AEP event.

The peak flood level at this location only increases marginally with increasing flood magnitude as most of the floodwaters from Kingdon Ponds are expected to spill into Parsons Gully notable storm events. Therefore, the location of the gauge is considered suboptimal for estimating the magnitude of a flood event. It also does not allow for detailed investigation into sequential flood impacts with increasing flood magnitude.

It is recommended for this gauge to be moved to Parsons Gully instead (or otherwise for a new gauge to be installed there). The difference in estimated peak flood levels for the range of design events in Parsons Gully just upstream of Liverpool Street is expected to be greater than the current location of the 61360 gauge. As an example, there is expected to be a difference in flood level of about 1.2 metres between the peak 1 in 500 AEP and 20% AEP flood levels along Parsons Gully upstream of Liverpool Street.

**FIGURE 9-22**




Prepared by:

# DESIGN FLOOD LEVEL HYDROGRAPHS AT THE 61360 SCONE (KINGDON PONDS) GAUGE

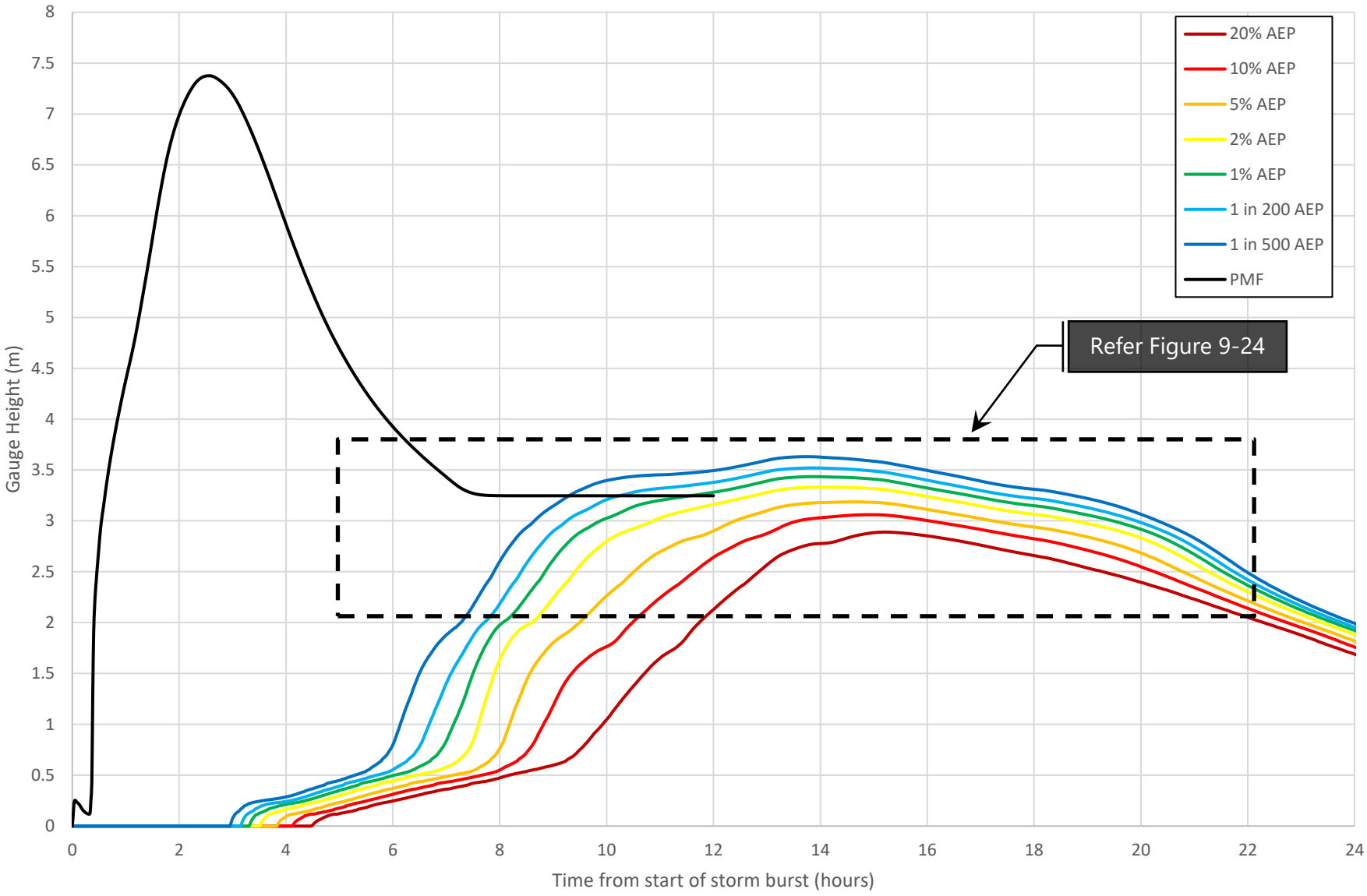
### 9.8.4 Sequential Flood Impacts at the 210093 Water Level Gauge

**Figure 9-23** shows the simulated design flood level hydrographs at the 210093 Kingdon Ponds (Parkville) gauge. This gauge is located along Kingdon Ponds near Parkville, approximately 10 kilometres north of the Liverpool Street thoroughfare between Scone and Satur. It is the closest water level gauge to Scone other than the 61360 water level gauge.

**Figure 9-24** is an inset of this figure which indicates the levels at which various impacts on infrastructure and the community are expected to occur. An indication of the potential timing of these impacts following an intense burst of rainfall can also be inferred.

Not all key impacts in the catchment could be included on the figure. Generally, only those impacts most local to and hydraulically linked to the gauges were included. Specifically, this gauge records flooding along Kingdon Ponds / Parsons Gully only and is not able to provide any information for flooding within the Figtree Gully catchment.

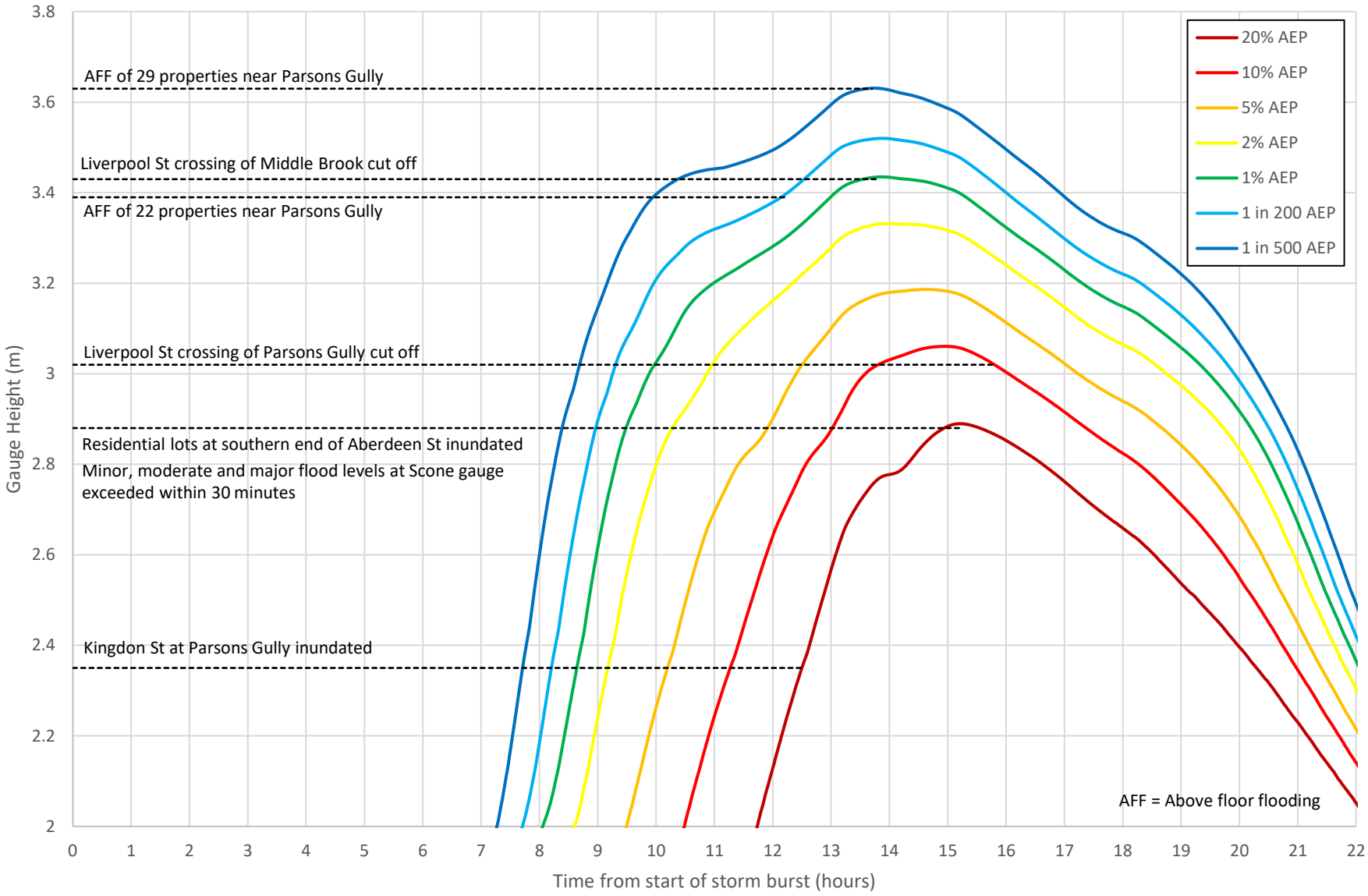
**FIGURE 9-23**




Prepared by:

**DESIGN FLOOD LEVEL HYDROGRAPHS AT THE 210093 KINGDON POND (PARKVILLE) GAUGE**

**FIGURE 9-24**




Prepared by:

**SEQUENTIAL FLOOD IMPACTS**
**AT THE 210093 KINGDON POND (PARKVILLE) GAUGE**

### 9.8.5 Flood Warning System

**Existing Arrangements**

Flood warning in the study area is largely dependent on warnings issued by Bureau of Meteorology (BoM). These may include a Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for Flash Flooding. However, it is noted that these warnings are not specific to the Figtree Gully catchment.

As noted previously, the SES may also issue an 'Evacuation Warning' when the intent is to warn the community of the need to prepare for a possible evacuation, or an 'Evacuation Order' when the intent is to instruct the community to immediately evacuate in response to an imminent threat.

**Recommendations**

Council could consider the implementation of a flash flood warning system for the Figtree Gully catchment, similar to the one which was installed for the Dungog Township (refer https://www.dungog.nsw.gov.au/Build/Flood-Plain-Management/Dungog-Township-Flood-Warning-System). Features of an effective flash flood warning system would comprise:

- Installation of a water level gauge along Figtree Gully upstream (east) of Barton Street.
- Develop an understanding of sequential impacts which occur at certain gauge heights (e.g. height A corresponds to floodwaters starting to enter the Scone CBD, height B corresponds to the flood level where the first house begins to be inundated).
- Set trigger levels for certain gauge heights (e.g. a message is sent to residents / emergency services when a given height is reached to warn of potential flooding in the next few hours, a siren sounds when floodwaters start to inundate properties above floor level).

This flash flood warning system would be accompanied by a community education program (refer **Section 9.9**)

## 9.9 Community Education and Awareness

Given the limited time for flood warning and evacuation advice to be disseminated in the Figtree Gully catchment, the effectiveness of the response to flooding may depend largely on community awareness and behaviour.

Risk to life can be substantially reduced if the community is knowledgeable about how and where flood risks develop in the catchment, appropriate ways in which to respond, the location of emergency shelters and suitable evacuation routes.

Accordingly, it is recommended that Upper Hunter Shire Council develop, or otherwise expand upon existing community education and awareness campaigns to include additional details on how to respond to a flood emergency. This would include general advice applicable to the catchment as well as specific advice for high-risk areas. For example, general advice would include to shelter-in-place and to avoid entering floodwaters, while in some areas it may only be advisable to shelter-in-place in two-storey buildings and evacuation of single storey buildings may be required.

The identification of properties which are appropriate for shelter-in-place would also be beneficial. If the residents of these properties are aware of the risks and appropriate responses during a flood, the

risk to life in the catchment and burden on the SES to perform rescues could be reduced considerably. The provision of templates for individuals and businesses to prepare flood emergency response plans could help facilitate this process.

## 9.10 Development of Flood Emergency Response Plans

The *Scone Floodplain Management Study and Plan* (Bewsher Consulting, 1999) recommended the development of flood action plans for flood prone properties. The action plans could be issued for individual properties or groups of properties. A flood emergency response plan could be undertaken at about $30,000 per area.

It is recommended for Council to commission the development of flood emergency response plans for areas with the greatest flood risk. This would comprise properties which are affected by frequent flood events along Figtree Gully given the flash-flood nature of the catchment. Other areas which should be prioritised include properties located in high flood hazard zones within the Kingdon Ponds / Parsons Gully catchment.

Flood action plans should include the following:

- Clear instructions on what to do before, during and after a flood emergency.
- Information on the nature and risk of flooding near the property.
- Evacuation routes to an appropriate shelter.
- Contact information for emergency services.
- Designation of responsibilities for commercial / industrial premises, including the nomination of a flood warden.
- Details on emergency response triggers and appropriate actions.

## 9.11 Recommendations

**Table 9-5** outlines the recommended emergency response management measures that have been identified as part of the floodplain risk management study for the Scone catchment.

**Table 9-5 Recommendations relating to Flood Emergency Response Management**

| ID | Recommended Emergency Response Measures |
|---|---|
| **ER.1** | All relevant data be transferred to the SES for incorporation into their flood intelligence database and update of the Local Flood Plan. |
| **ER.2** | Designate St Mary's Primary School and/or the Scone Bowling Club as flood evacuation centres instead of the Scone Senior Citizens' Centre and Scone High School (refer **Section 9.5**). |
| **ER.3** | Investigate the installation of a new water level gauge along Parsons Gully, given the limitations of the existing gauge 61360 along Kingdon Ponds at Scone (refer **Section 9.8.3**). |
| **ER.4** | Install rainfall and water level gauges in the Figtree Gully catchment (refer **Section 9.8.1**). |
| **ER.5** | Investigate the installation of a Flood Warning System along Figtree Gully (refer **Section 9.8.5**). |
| **ER.6** | Undertake a community education and flood awareness program based on the findings of this study (refer **Section 9.9**). |
| **ER.7** | Develop flood emergency response plans for high-risk properties (refer **Section 9.10**) |

# 10. Assessment of Flood Modification Measures

## 10.1 Assessment Methodology

The assessment of potential flood modification measures was completed using a staged approach:

- Stage 1 Identification and Preliminary Assessment
  - Identification of full range of potential measures from previous studies and target areas.
  - Elimination of measures which are not viable.
- Stage 2 Assessment
  - Hydraulic assessment of the remaining measures involving flood modelling to determine the benefit provided in terms of reduction in peak flood levels and property affectation.
  - Preliminary cost estimates for each measure.
  - Calculation of an indicative Benefit Cost Ratio (BCR).
- Multi-Criteria Assessment
  - Assessment of measures against a wider range of criteria including social and environmental considerations.
  - Scores are assigned for each criterion to allow a relative comparison of merits and ranking of measures.

## 10.2 Stage 1 Identification and Preliminary Assessment of Potential Flood Modification Measures

### 10.2.1 Measures Identified in Previous Studies

A previous assessment of flood modification measures was undertaken in *Scone Floodplain Management Study and Plan* (Bewsher Consulting 1999). This study completed a preliminary assessment of an exhaustive list of flood modification options, including the following:

a) Detention basins upstream of Parsons Gully;

b) A levee on the eastern side of Parsons Gully;

c) Formalising the channel of Parsons Gully;

d) A single detention basin along Figtree Gully upstream of Barton Street;

e) A series of smaller detention basins along Figtree Gully upstream of Park Street;

f) A number of options to reconstruct Figtree Gully within Scone;

g) A levee on the southern side of Figtree Gully between Barton Street and Park Street;

h) Removal of channel obstructions in the Figtree Gully channel;

i) Preparation of a vegetation management plan for overgrown waterways (e.g. Parsons Gully south of Liverpool Street).

Several of the options above were not recommended for adoption due to the excessive costs of land acquisition and construction or because of adverse flood impacts. Worley Consulting has reviewed the previous assessment and reasoning as to why these measures were not considered viable and is in agreement with the previous findings.

Following the evaluation process, three options were recommended for adoption in the 1999 Floodplain Risk Management Plan:

- Reconstruct Figtree Gully between Barton Street and Park Street as a deeper and wider grass-lined channel, and construct a box culvert system from Main Street to Parsons Gully at the downstream end of Guernsey Street (*the Figtree Gully bypass culvert*).
- Remove obstructions in the Figtree Gully channel (such as the trash rack at Park Street, overgrown vegetation and rubbish).
- Implementation of a vegetation management plan.

The 1999 FRMS&P did not recommend the construction of a retarding basin along Figtree Gully upstream of Barton Street. However, this option was considered worthwhile to reassess given that floodwaters are expected to overtop the channel and inundate roads and properties within Scone in events as frequent as the 20% AEP.

### 10.2.2 Scone CBD Upgrade Works

At the time of writing, the Scone CBD Revitalisation Project is underway comprising major landscaping works and beautification upgrades to Kelly Street between Kingdon Street and Susan Street. The works include cut and fill earthworks as well as realignment of the kerb along Kelly Street. The existing stormwater network in the vicinity of Kelly Street is also to be upgraded as part of this project.

The impacts of the post-development landform and the benefits of the stormwater network upgrade on existing flood behaviour along Figtree Gully was investigated as part of the Stage 2 Assessment.

### 10.2.3 Measures to be Considered Further

As a result of the Stage 1 Preliminary Assessment, the flood modification measures listed in **Table 10-1** have been identified for further investigation.

**Table 10-1 Potential Flood Modification Measures for Further Assessment**

| ID | Potential Flood Modification Measures for Assessment |
|---|---|
| **FM.1** | Figtree Gully bypass culvert only |
| **FM.2** | Figtree Gully bypass culvert with upstream channel widening works |
| **FM.3** | Detention basin along Figtree Gully upstream of Barton Street |
| **FM.4** | Remove obstructions in the Figtree Gully channel |
| **FM.5** | Implementation of a vegetation management plan |

## 10.3 Stage 2 Assessment of Flood Modification Measures

Three flood modification measures were tested in the TUFLOW hydraulic model:

- FM.1: A bypass culvert to divert a portion of the flows along Figtree Gully away from the Scone CBD.
- FM.2: The bypass culvert in conjunction with increasing the Figtree Gully channel capacity between Park Street and Barton Street.
- FM.3 A detention basin along Figtree Gully upstream of Barton Street.

The location and extent of the three flood modification measures are shown in **Figure 10-1**. The derivation of capital cost estimates for each measure is presented in **Appendix A**.

Further discussion on the other two flood modification measures (FM.4 and FM.5) are provided in **Section 10.3.4** and **Section 10.3.5**, respectively.

### 10.3.1 FM.1 – Figtree Gully Bypass Culvert

**Overview**

This flood modification measure would involve the installation of a 3.6 m (W) x 1.2 m (H) bypass box culvert to convey flows along Figtree Gully from Main Street towards Parsons Gully south of Guernsey Street. The aim of this measure is to reduce the peak flow and volume of floodwaters arriving at the Scone CBD by diverting a portion of the Figtree Gully floodwaters into this bypass culvert.

The proposed bypass culvert alignment is shown by the red arrows in **Figure 10-1**, while the existing stormwater network is shown by the blue arrows in the same figure. At this stage, it is envisaged that the bypass culvert would be installed beneath the existing stormwater network.

It is noted that this measure was modelled in conjunction with the Scone CBD upgrade works, given that the Scone CBD Revitalisation Project is currently under construction at the time of writing.

**Hydraulic Assessment**

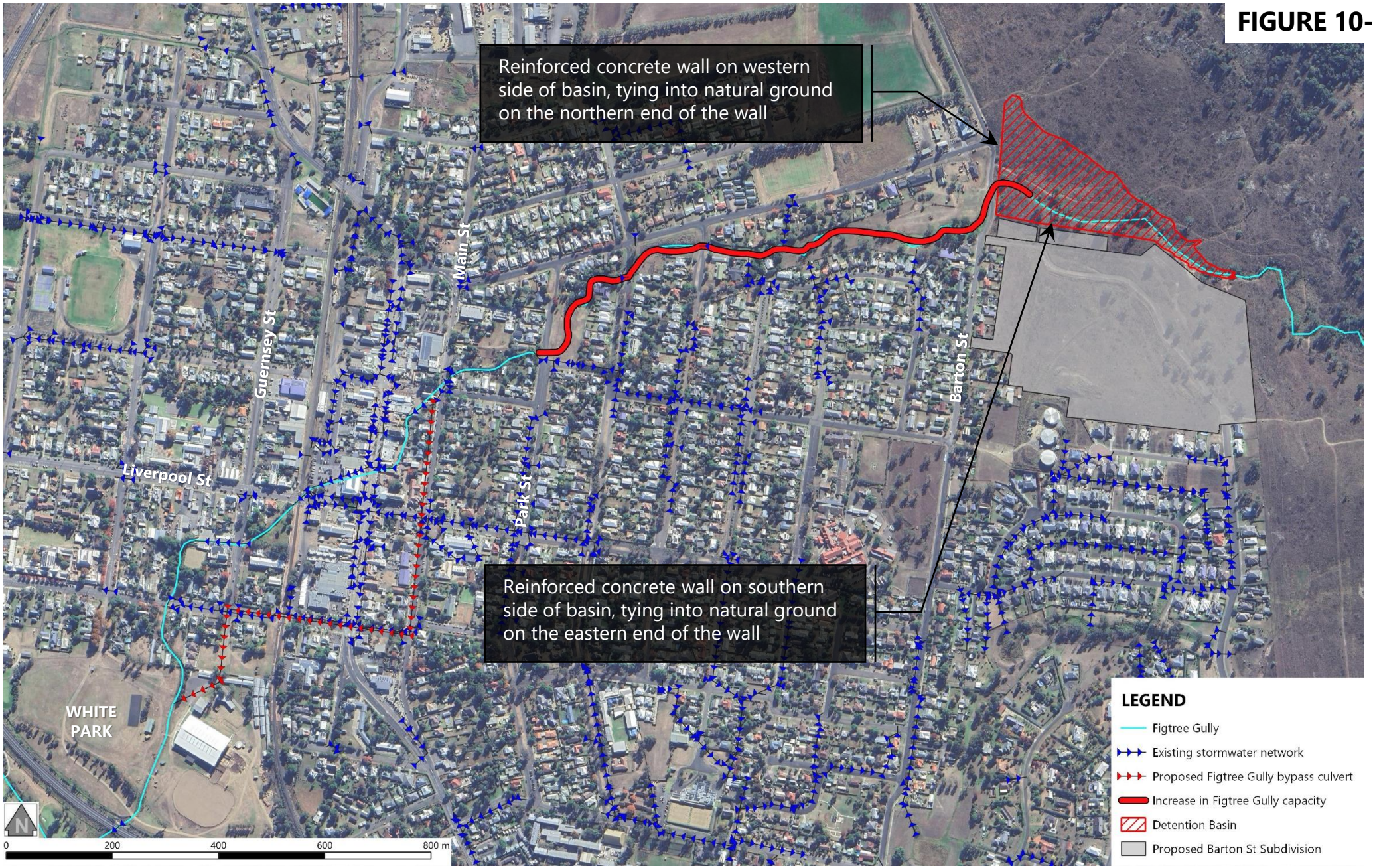
Expected changes in 5% and 1% AEP peak flood levels associated with this mitigation measure are shown in Figure 10-2 and Figure 10-3, respectively. Hydraulic modelling indicates that the measure would lead to widespread reductions in flood levels in the vicinity of the Scone CBD by about 0.1 to 0.2 metres. However, flood levels and extents in White Park would increase due to the additional volume of runoff conveyed by the bypass culvert discharging in this area.

The benefit of this flood modification measure in changing the existing Flood Emergency Response Classification of properties in the vicinity of the Scone CBD is shown for the 5% AEP event and the 1% AEP event in Figure 10-4 and Figure 10-5, respectively. These figures show that several properties change from 'Low Flood Island' to 'Overland Escape Route' or 'Rising Road Access' as the bypass culvert reduces the depth, velocity and extent of floodwaters in the Scone CBD. Properties which remain classified as 'Low Flood Islands' are located in the immediate vicinity of the Figtree Gully alignment.

**Economic Assessment**

This measure would have an estimated construction cost of $11.7 million. Economic benefits in terms of reduction in NPV of flood damages are estimated to be about $7.5 million resulting in a BCR of 0.64.

**FIGURE 10-1**

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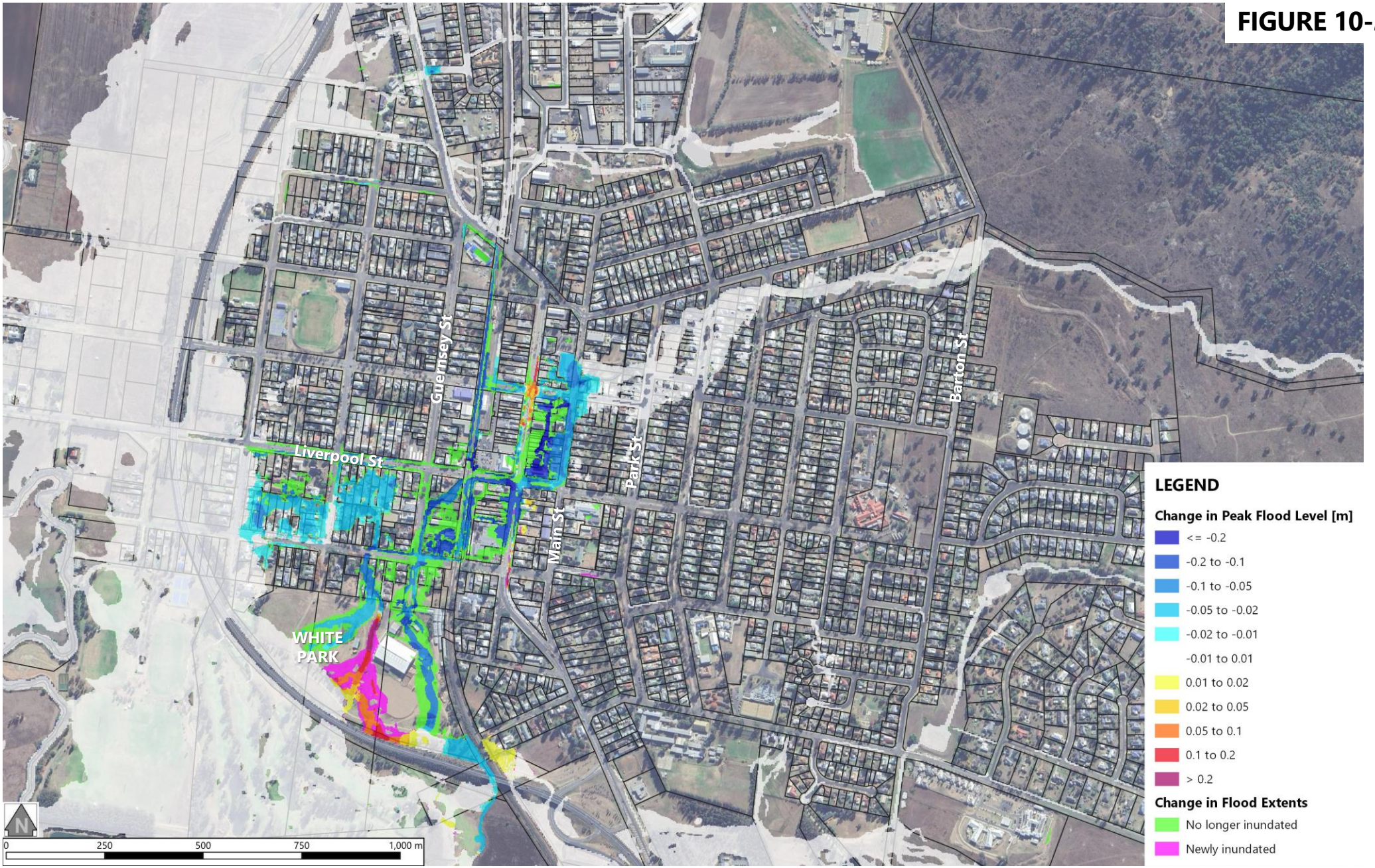
# LOCATION OF PROPOSED FLOOD MODIFICATION MEASURES

FIGURE 10-2

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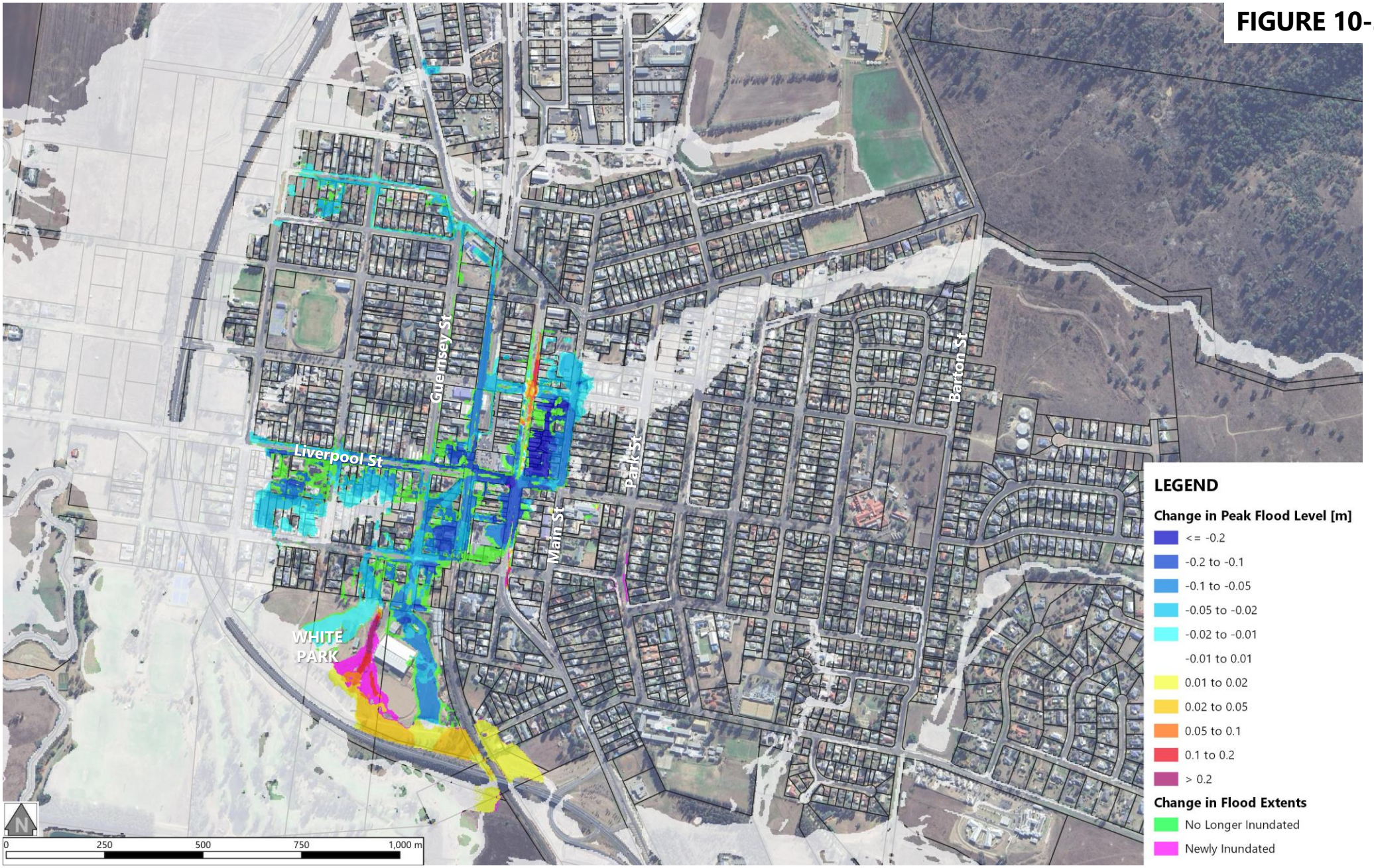
# CHANGES IN PEAK FLOOD LEVEL DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 1]

FIGURE 10-3

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# CHANGES IN PEAK FLOOD LEVEL DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 1]

FIGURE 10-4



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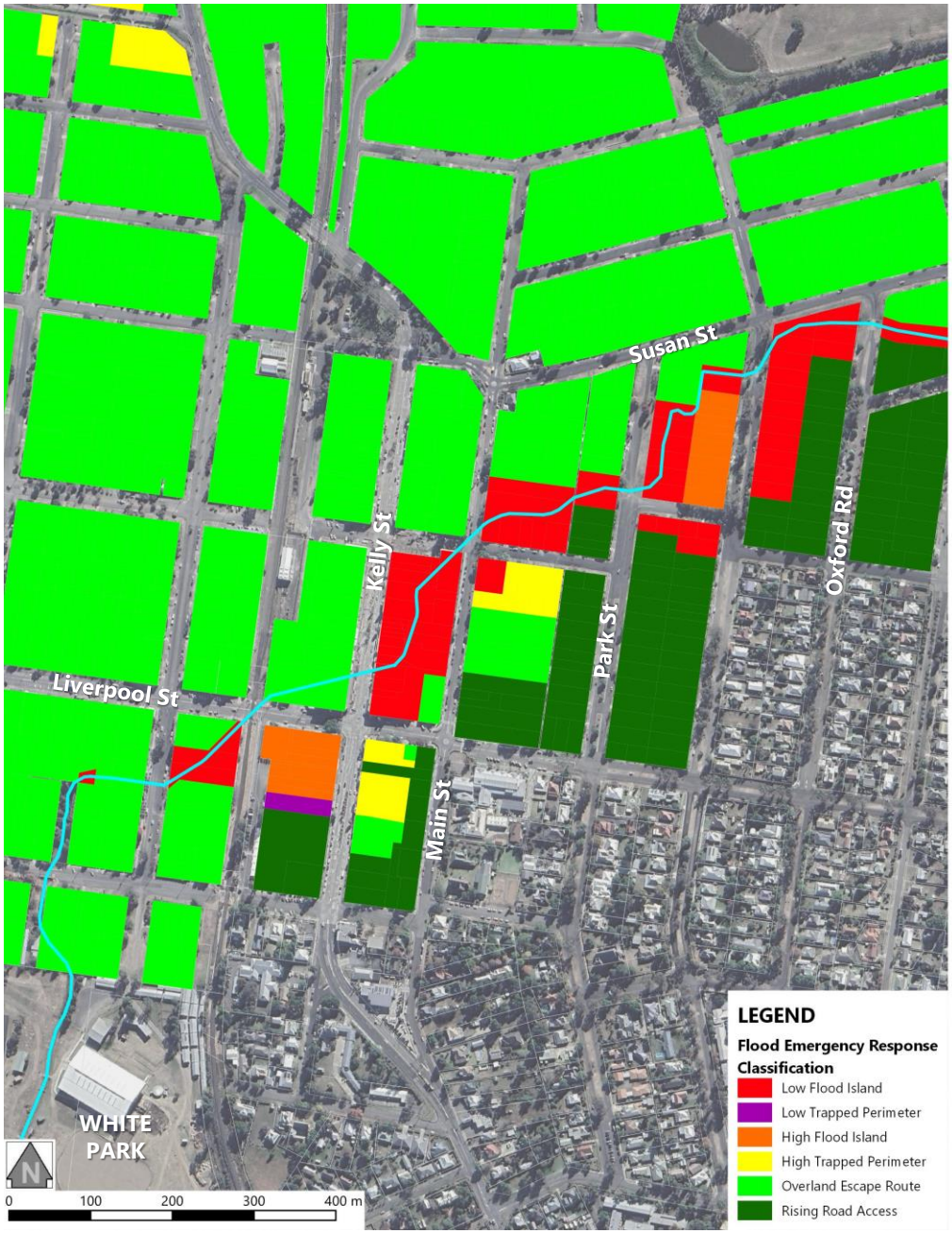
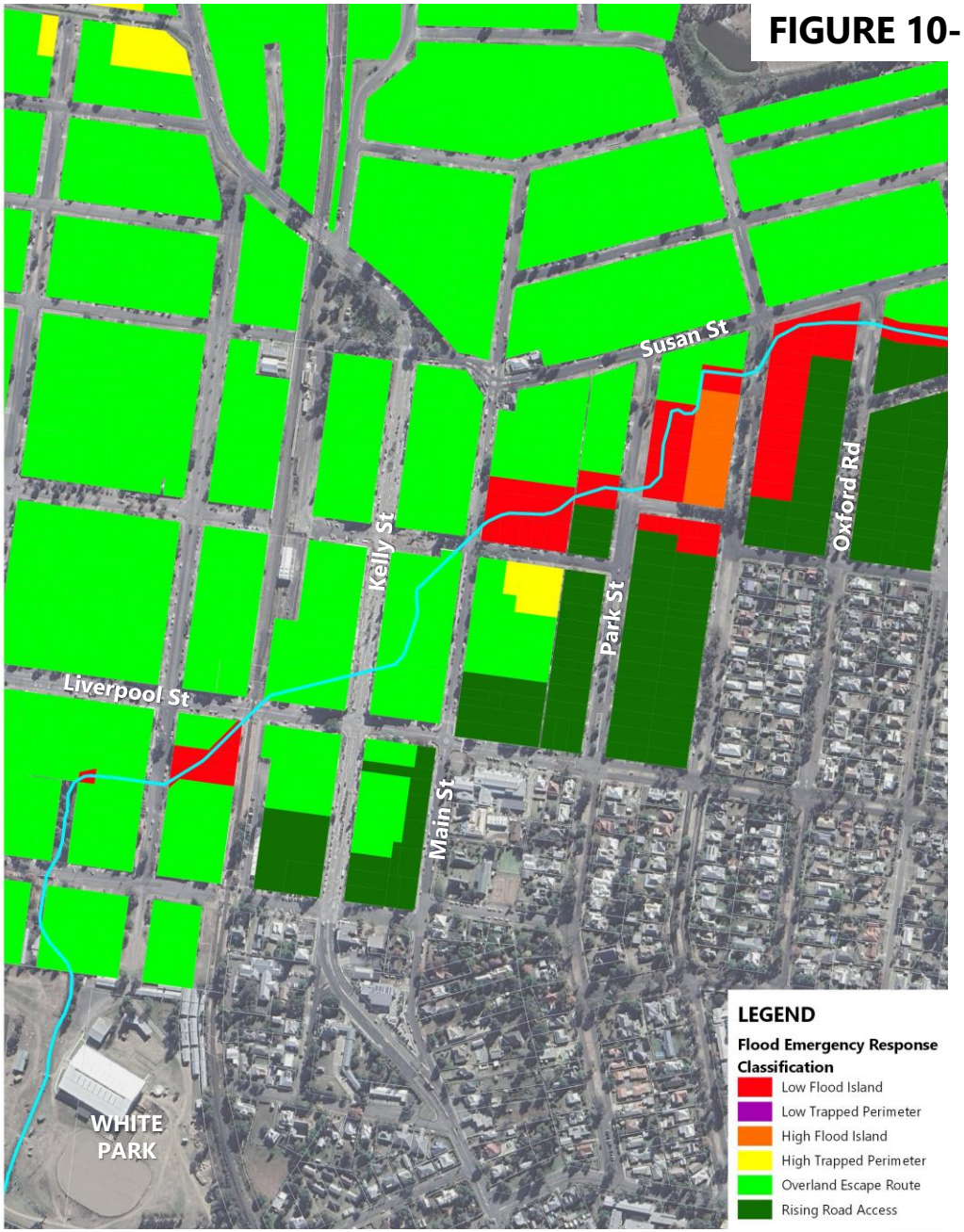
# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 1]

**FIGURE 10-5**

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# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 1]

### 10.3.2 FM.2 – Figtree Gully Bypass Culvert & Channel Widening

**Overview**
This flood modification measure comprises the installation of the bypass culvert system discussed in **Section 10.3.1** in conjunction with earthworks to increase the capacity of the Figtree Gully channel between Barton Street and Park Street.

The preliminary concept design comprises the excavation of about 57,500 $m^3$ of earth along the 1.1-kilometre stretch of Figtree Gully between Barton Street and Park Street, where the creek currently exists as a natural grassed channel. The depth of cut typically ranges from 1 metre to 3 metres, with some localised areas requiring a depth of cut of up to 6 metres. The location of the channel widening works is also shown in **Figure 10-1**.

It is noted that this measure was modelled in conjunction with the Scone CBD upgrade works, given that the Scone CBD Revitalisation Project is currently under construction at the time of writing.

**Hydraulic Assessment**
Expected changes in 5% and 1% AEP peak flood levels associated with this mitigation measure are shown in **Figure 10-6** and **Figure 10-7**, respectively. Hydraulic modelling indicates that this measure would also lead to widespread reductions in flood levels in the Scone CBD by about 0.15 to 0.25 metres. Similar to the previous option, flood levels and extents in White Park would increase due to the additional volume of runoff conveyed by the bypass culvert discharging in this area. Notably, the increased channel capacity between Barton Street and Park Street is able to convey the full volume of floodwaters in events up to and including the 1% AEP event. This prevents the inundation of properties in residential parts of Scone caused by floodwaters breaking out of the channel.

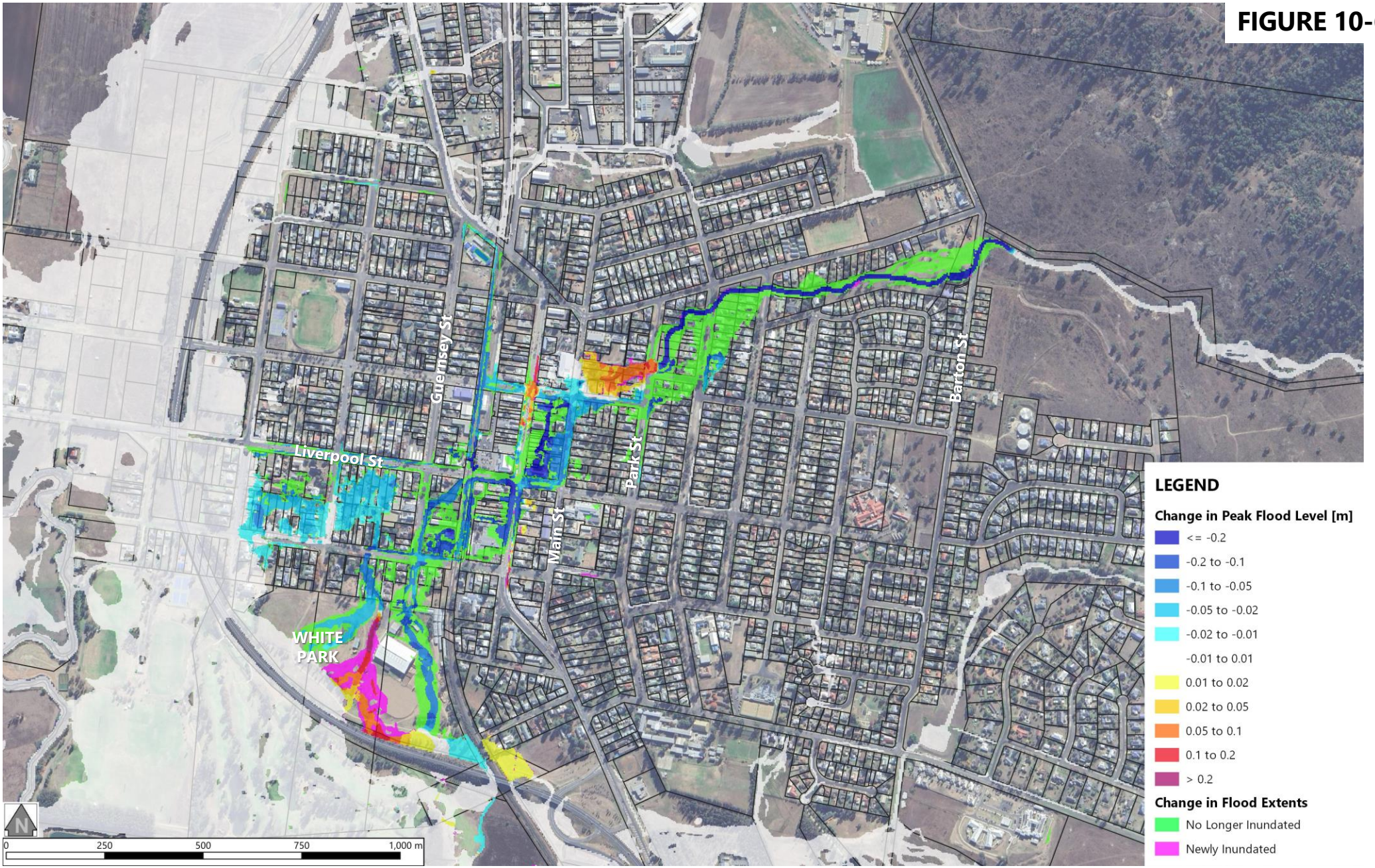
However, this option would result in an increase to existing flood levels of up to 0.1 metres during the 1% AEP event in the residential block bound immediately downstream of Park Street (bound by Figtree Gully, Park Street, St Aubins Street and Main Street). This arises from the additional floodwaters conveyed by the increased capacity of the Figtree Gully channel discharging into the open concrete channel downstream of Park Street.

The benefit of this flood modification measure in changing the existing Flood Emergency Response Classification of properties in the vicinity of the Scone CBD is shown for the 5% AEP event and the 1% AEP event in **Figure 10-8** and **Figure 10-9**, respectively. These figures show that several properties change from 'Low Flood Island' to 'Overland Escape Route' or 'Rising Road Access' as the increased channel capacity and bypass culvert reduces the depth, velocity and extent of floodwaters in the Scone CBD. Properties which remain classified as 'Low Flood Islands' are located in the immediate vicinity of the Figtree Gully alignment.

**Economic Assessment**
The estimated construction cost for this measure is $26.4 million. Economic benefits in terms of reduction in NPV of flood damages are estimated to be about $12.2 million resulting in a BCR of 0.46.

**Feasibility**
This measure would not be feasible based on the adverse flood level impacts it would cause and the relatively low economic viability. It is possible that a feasible solution could be achieved through further design refinement. For example, this could include an increase in the capacity of the open concrete channel downstream of Park Street to minimise the expected flood level increases in this area.

FIGURE 10-6

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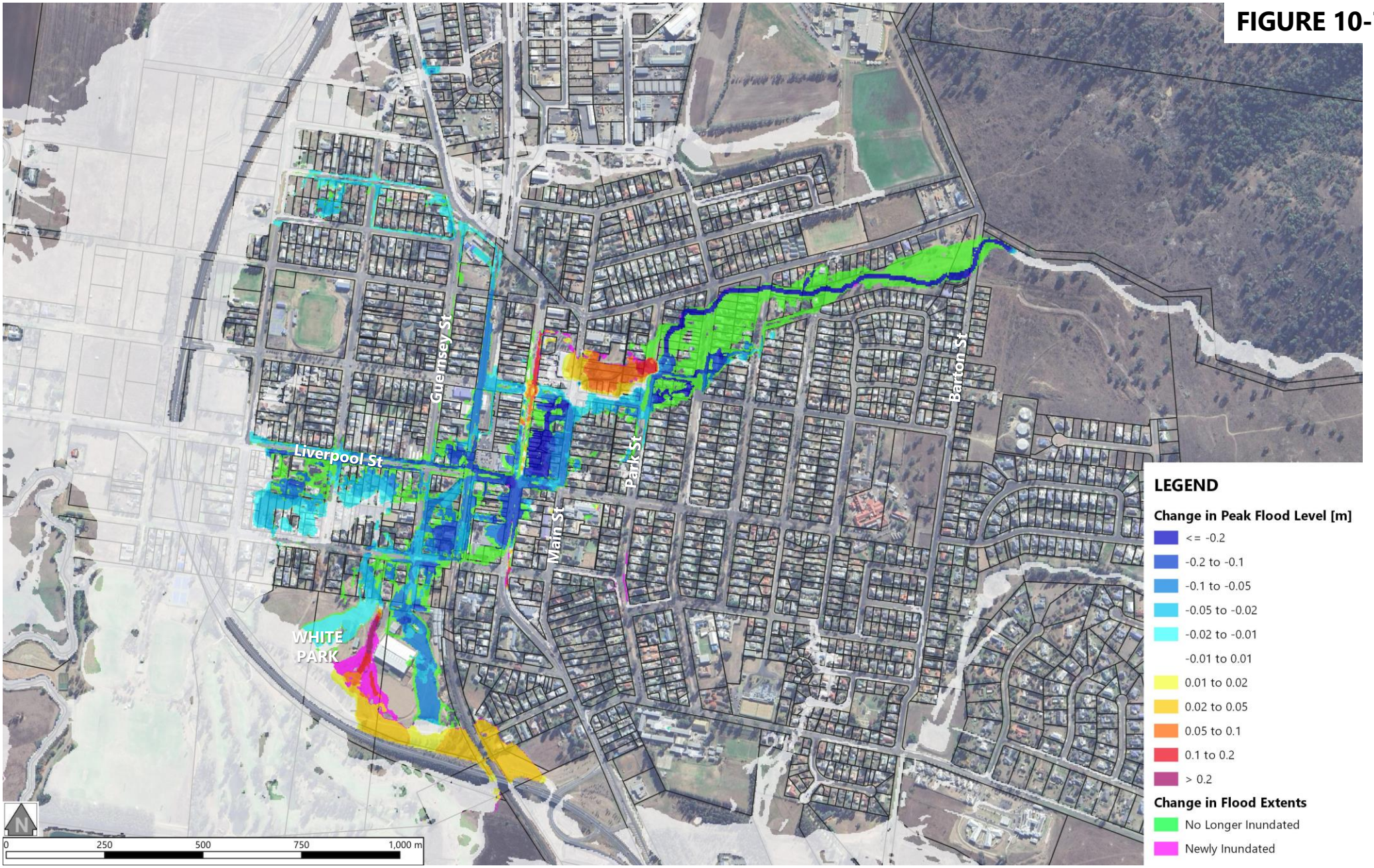
# CHANGES IN PEAK FLOOD LEVEL DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 2]

FIGURE 10-7

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# CHANGES IN PEAK FLOOD LEVEL DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 2]

**FIGURE 10-8**



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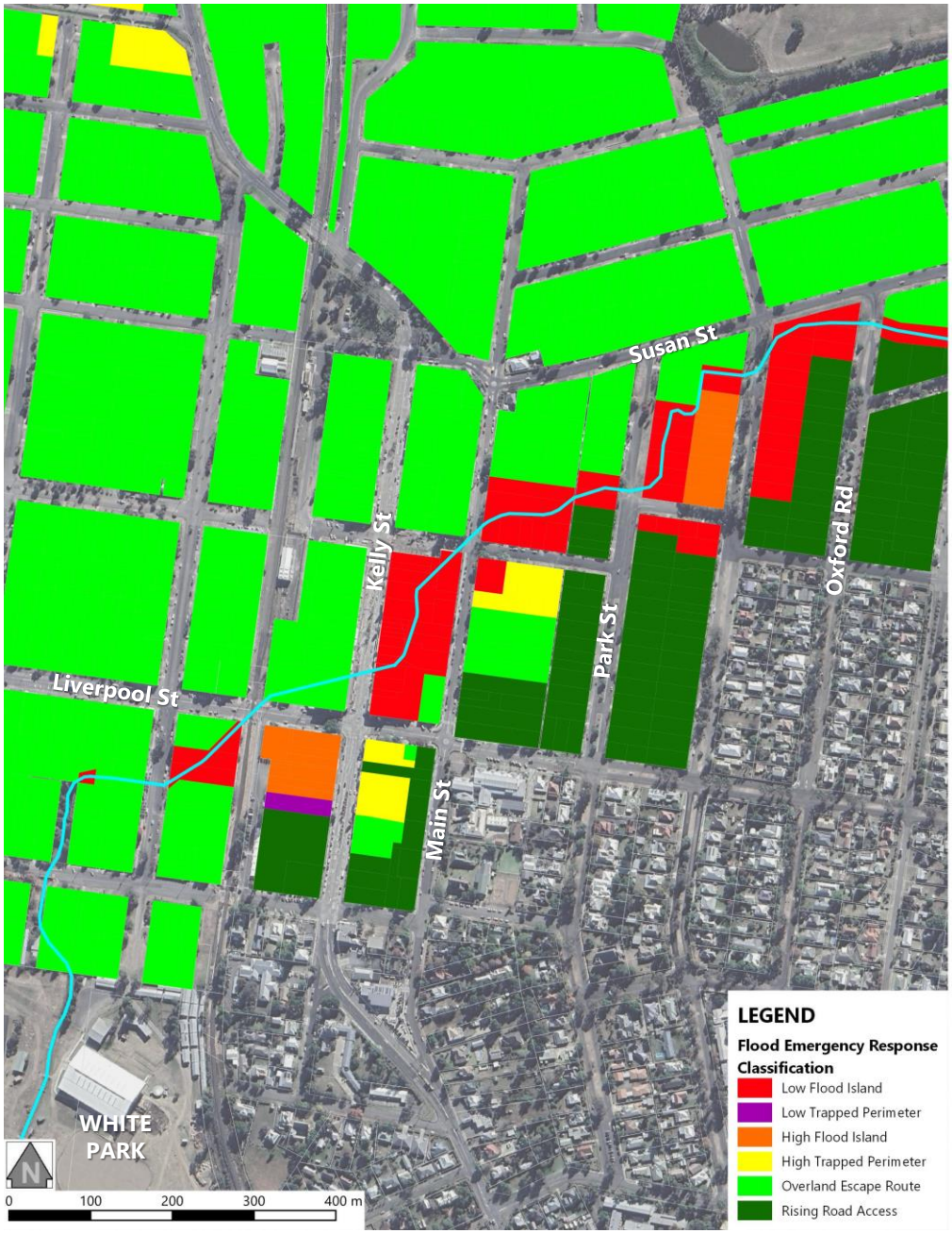
# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 2]

FIGURE 10-9





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# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 2]

### 10.3.3 FM.3 Figtree Gully Detention Basin

**Overview**
This flood modification measure comprises the construction of a detention basin upstream of Barton Street. The preliminary concept design comprises the following key features:

- Reinforced concrete basin wall with a crest level at 243 mAHD (average wall height typically about 5.5 metres but up to 10 metres high locally).
- Wall length of about 500 metres, along the western and southern boundary of the basin only. Reinforced concrete wall to tie into natural land elevations at the northern edge of the western wall and the eastern edge of the southern wall (refer **Figure 10-1**).
- 1x 900 mm diameter concrete pipe as the low flow outlet.
- Basin footprint of about 4.8 hectares.
- Full storage capacity of about 150,000 $m^3$.

The location and approximate footprint of the detention basin is shown in **Figure 10-1**. It is noted that this measure was modelled in conjunction with the Scone CBD upgrade works, given that the Scone CBD Revitalisation Project is currently under construction at the time of writing.

**Hydraulic Assessment**
Expected changes in 5% and 1% AEP peak flood levels associated with this mitigation measure are shown in **Figure 10-10** and **Figure 10-11**, respectively. Hydraulic modelling indicates that this measure is effective in reducing the extent of flooding within Scone in events up to and including the 5% AEP event. Floodwaters are expected to remain within the Figtree Gully channel.

There is less benefit in events rarer than the 5% AEP event. For example, the detention basin is expected to reduce flood levels in downstream areas by about 0.1 metres but is not expected to significantly reduce flood extents during the 1% AEP event.

The benefit of this flood modification measure in changing the existing Flood Emergency Response Classification of properties in the vicinity of the Scone CBD is shown for the 5% AEP event and the 1% AEP event in **Figure 10-12** and **Figure 10-13**, respectively. **Figure 10-12** shows that the majority of properties are classified as 'Overland Escape Route' or 'Rising Road Access' during the 5% AEP event as floodwaters remain within the Figtree Gully channel. However, the detention basin does not have any significant impact on the existing Flood Emergency Response Classifications in the 1% AEP event.

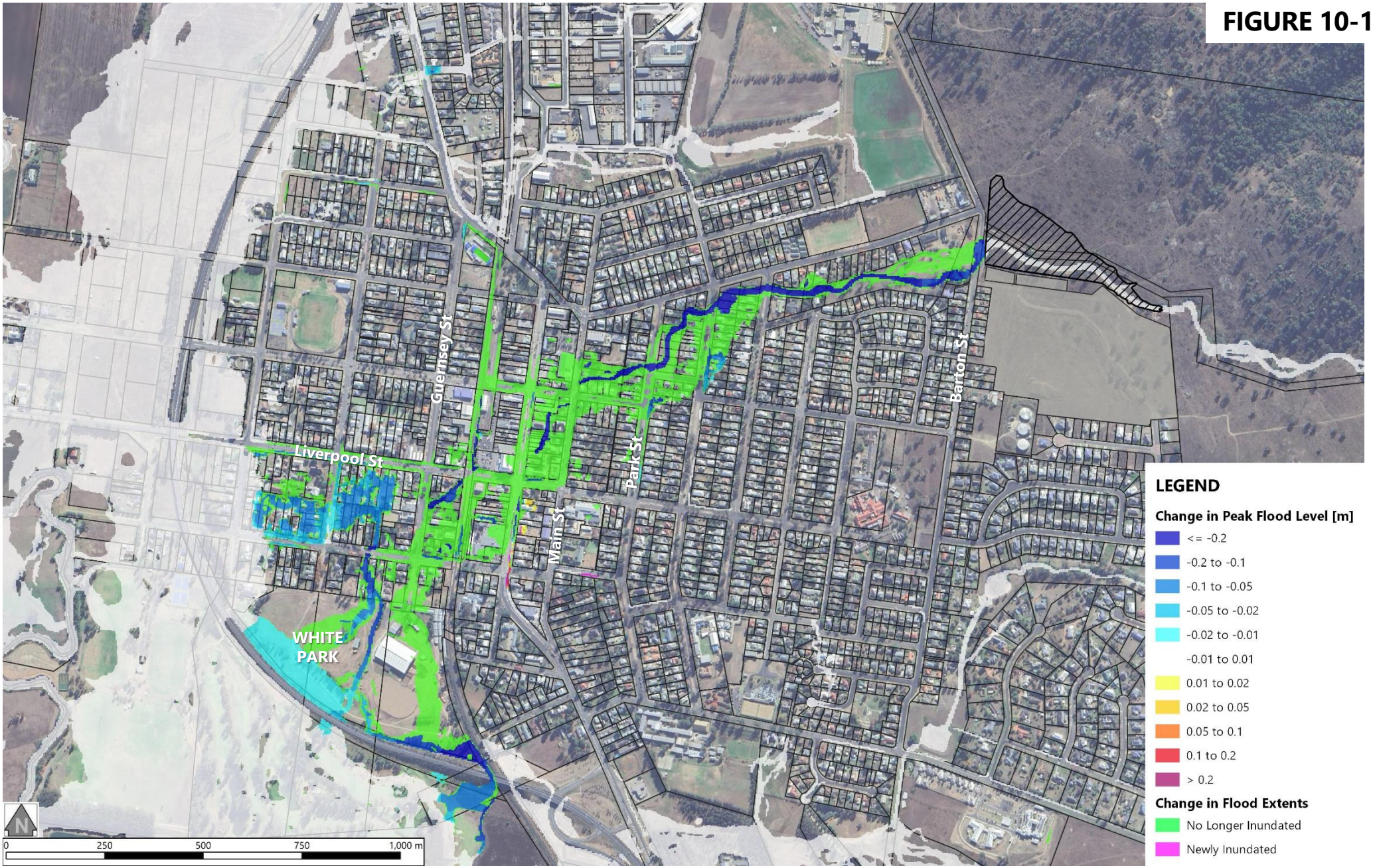
**Economic Assessment**
This measure would have an estimated construction cost of $7.7 million. However, it is noted that this has not included the land purchase cost. Economic benefits in terms of reduction in NPV of flood damages are estimated to be about $18.0 million. It is likely that the BCR would be 1 or greater when accounting for the land purchase cost.

**Feasibility**
This measure would be feasible based on the high economic viability. However, it is noted that there a 92-lot subdivision has been approved on land which is adjacent to the basin. Further investigation would be required to evaluate the feasibility and constructability of the basin in close proximity to residential development as well as the Barton Street roadway. If the proposed location of the basin is deemed unfeasible at a later stage, the investigation could check relocating the basin along Figtree Gully upstream of the new 92-lot subdivision. It is expected that a full storage volume of 150,000 $m^3$

could be achieved at other locations along Figtree Gully upstream of the new subdivision. However, it is expected that there could still be considerable benefits in reducing the flood risk at Scone during more frequent events if a lower full storage volume is adopted in the basin design.

The detention basin will likely require a rigorous detailed design to meet the requirements of Dams Safety NSW. Given the significant Population at Risk downstream of the basin, the spillway will likely be required to accommodate an extreme flood event. A dam break analysis will be required during the detailed design process.

FIGURE 10-10

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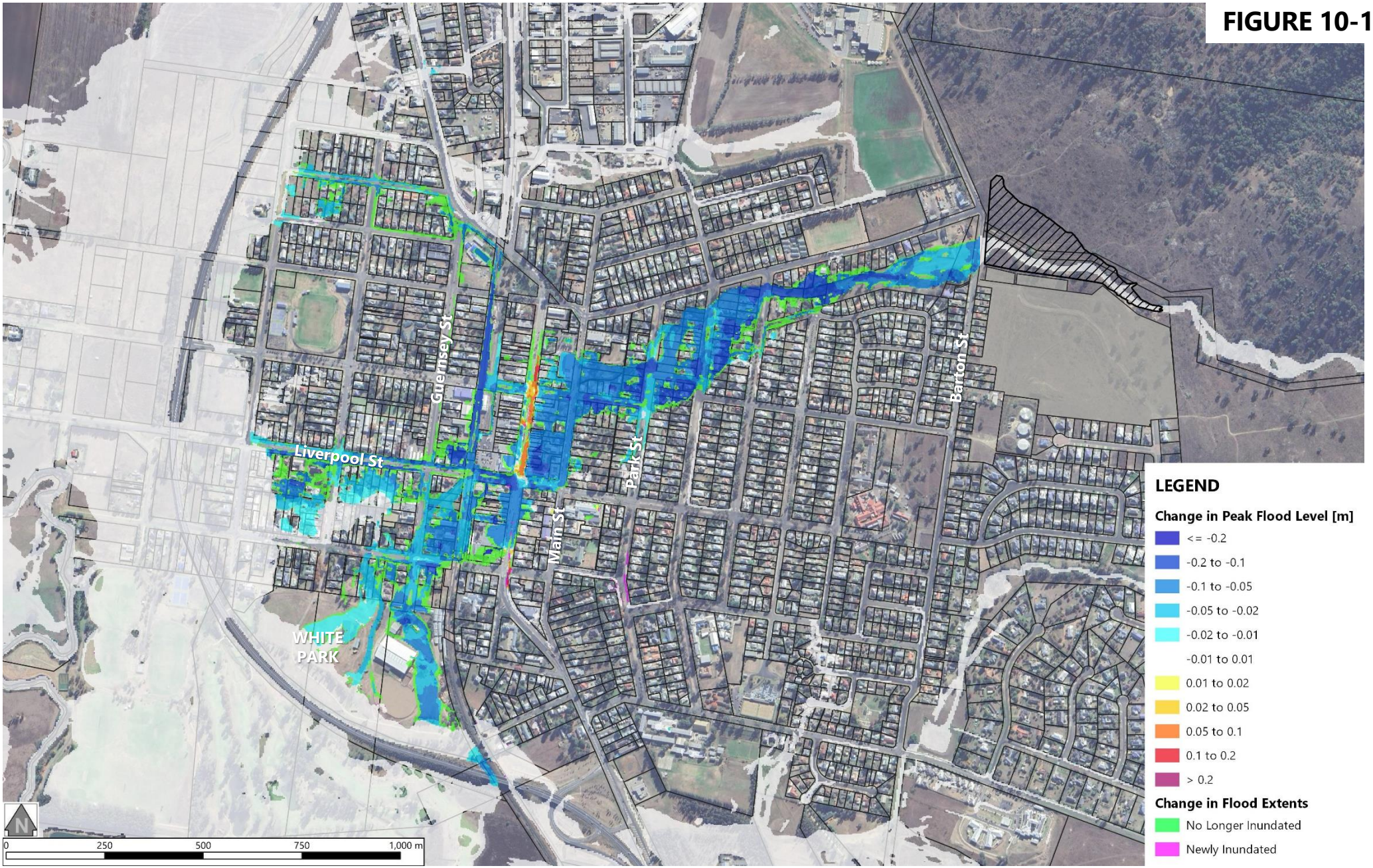
# CHANGES IN PEAK FLOOD LEVEL DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 3]

FIGURE 10-11

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# CHANGES IN PEAK FLOOD LEVEL DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 3]

FIGURE 10-12



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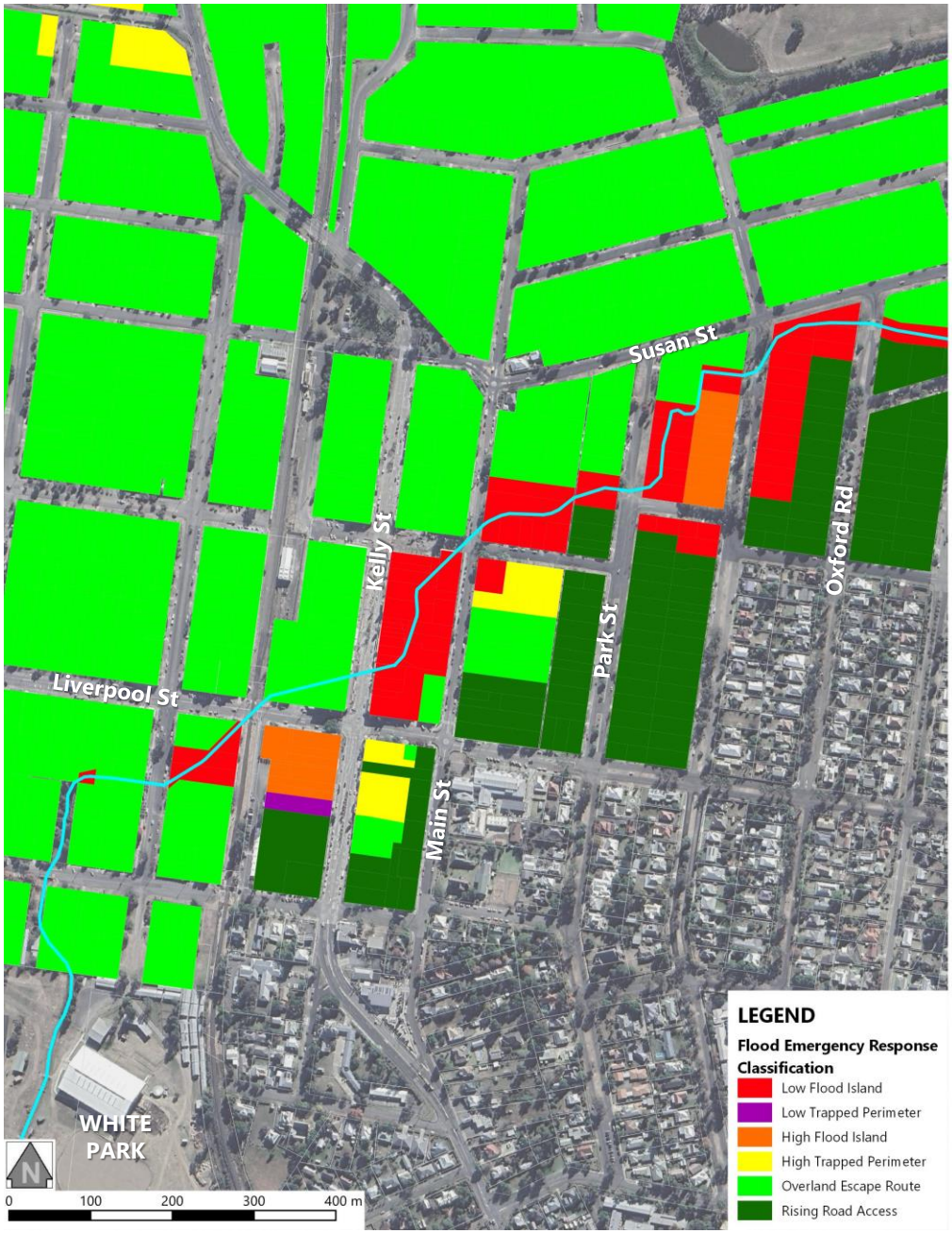
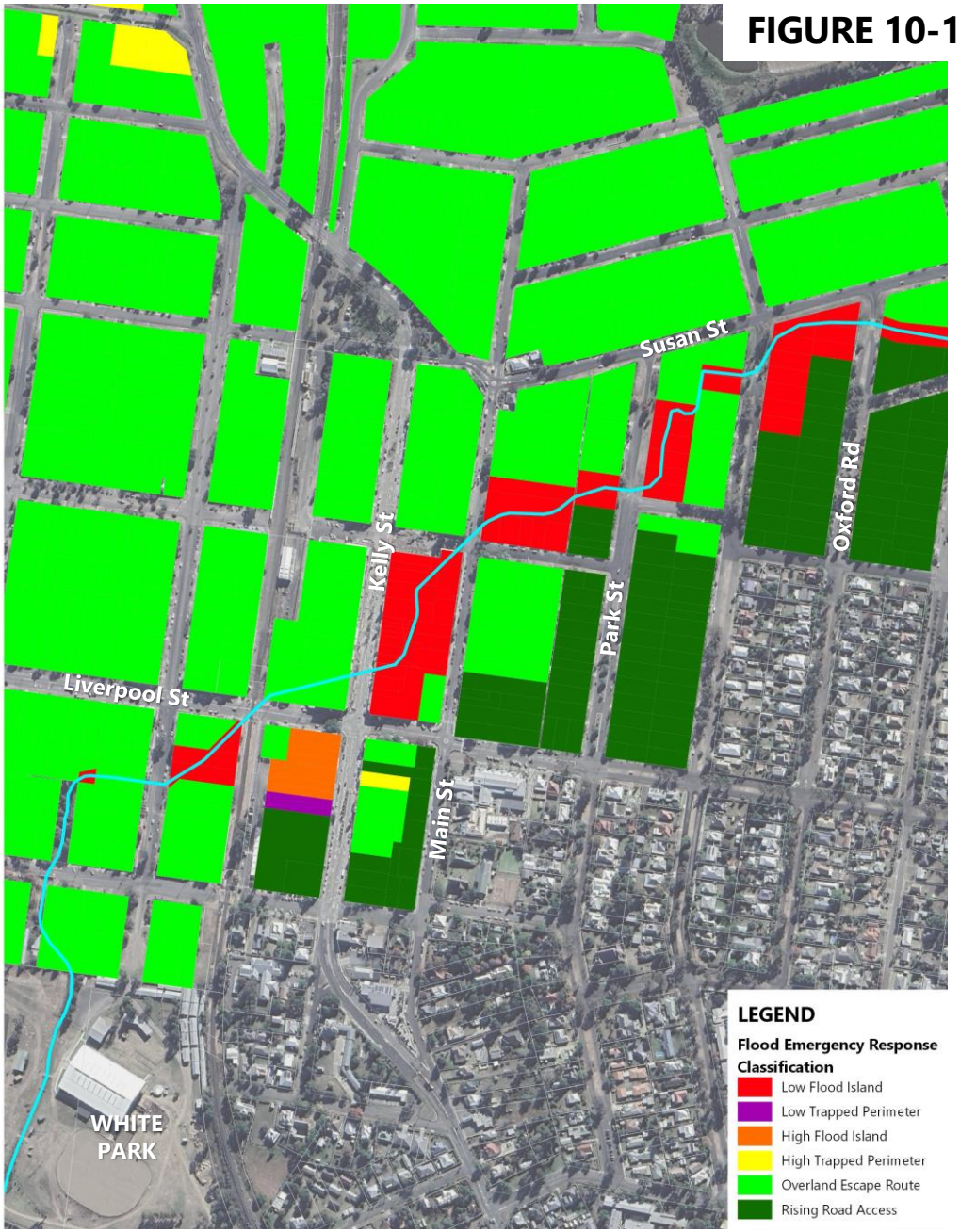
# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 5% AEP EVENT [FLOOD MODIFICATION OPTION 3]

FIGURE 10-13

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# CHANGES IN FLOOD EMERGENCY RESPONSE CLASSIFICATIONS DURING THE 1% AEP EVENT [FLOOD MODIFICATION OPTION 3]

### 10.3.4 FM.4 Removal of Obstructions with Figtree Gully Channel

**Overview**

This option was recommended in the 1999 Floodplain Management Plan (Bewsher Consulting) and suggested the removal of the trash rack at Park Street, as well as removal of overgrown vegetation and rubbish from the channel. The trash rack is located along Figtree Gully where the watercourse transitions from a natural channel to an open concrete channel on the western side of Park Street.

**Current Status**

The trash rack has not been removed to date. A photo of the trash rack which was captured during Worley Consulting's site visit in November 2023 is shown in **Figure 10-14**. The photo indicates that the open concrete channel is generally clear of rubbish and vegetation at the time of the site visit.

**Figure 10-14 Photo of the trash rack captured in November 2023**

The grassed channel upstream of Park Street also generally appears to be clear of excessive vegetation. A photo of the channel looking downstream (west) from Oxford Road is shown in **Figure 10-15**.

**Recommendation**

There were minimal obstructions in the Figtree Gully channel at the time of Worley Consulting's site visit in November 2023. It is recommended for Council to continue the maintenance of the channel to remove overgrown vegetation and rubbish when required. It is expected that this maintenance can be undertaken at no additional cost and therefore the BCR would be greater than 1.

The removal of the trash rack is not expected to lead to any significant benefits in reducing flood levels or flood hazards. The trash rack may actually be beneficial in preventing large debris from entering the open concrete channel which could lead to undetected blockages after a rain event. Therefore, the removal of the trash rack is not considered necessary.

**Figure 10-15 Photo of the Figtree Gully channel looking downstream from Oxford Rd**

### 10.3.5 FM.5 Vegetation Management Plan

**Overview**

Vegetation management generally refers to the planned control of vegetation in a way that protects and rehabilitates native vegetation, removes introduced weed species, and ensures that clearing does not result in land degradation. It is envisaged that the implementation of a vegetation management plan would also improve the ecological and aesthetic quality of creek corridors.

From a flooding perspective, vegetation management typically refers to the partial clearing of riparian areas to decrease vegetation density, thus increasing flow conveyance and decreasing flood levels locally. However, it is noted that this increase in flow conveyance can potentially result in increased flood levels downstream. Excessive clearing can also result in bank instability and erosion, leading to greater sedimentation of watercourses and mobilisation of debris during floods.

Vegetation management had previously been discussed in detail in Chapter 7 of the *Scone Floodplain Management Study and Plan – Town Planning Context and Strategy* (Don Fox Planning, 1999). A key outcome from this document was the recommendation to discourage non-indigenous plant species from primary creek corridors due to the potential for a weed problem which would cause congestion to the flow of floodwaters as well as general degradation to the ecological environment of the creek corridors.

It is understood that the Scone Landcare Group operates within the study area to revegetate creek corridors (Don Fox Planning, 1999). The Scone Landcare Group is a volunteer-based group which provides community services and other initiatives to support local, state and national level activities.

**Hydraulic Assessment**

The sensitivity of 20% AEP and 1% AEP flood levels to hydraulic roughness was tested in the Scone *Flood Study* (Worley Consulting, 2024) by applying a 25% increase and a 25% decrease in baseline values.

The results give an indication of the potential impact that changes in vegetation density could have on flooding. Reductions in vegetation density in the floodplain would generally be expected to result in small reductions in peak flood levels with only localised adverse impacts. Increases in vegetation density would generally be expected to result in small increases in peak flood levels.

**Recommendation**
It is recommended that the Scone Landcare Group / Council continue to carry out vegetation maintenance with a primary objective of rehabilitating native vegetation, removing introduced weed species and improving bank stability. As a secondary objective, vegetation density in the floodplain should not be increased and should be decreased where this does not hinder other objectives.

It is expected that this vegetation maintenance can be undertaken at no additional cost and therefore the BCR would be greater than 1.

## 10.4 Multi-Criteria Assessment of Flood Modification Measures

In addition to assessment of the economic benefit for each flood mitigation measure, further assessment was undertaken to compare them according to a wider range of criteria including social and environmental factors.

The assessment criteria and their weighting are outlined in **Table 10-2**. It is acknowledged that there will be some overlap between the flood impact criteria and the criteria for economic assessment. However, in light of the primary objectives of this FRMS, and the relevance of the associated flood modelling results, it is considered appropriate to give additional weighting to direct flood impacts and also the indirect consequences.

**Table 10-2 Multi-Criteria Assessment Scoring Approach**

| Evaluation Criteria | Scoring Approach (0 to 5) | Weighting |
|---|---|---|
| Flood Impacts | | |
| Impact on hydraulic behaviour | Worst/adverse=0, neutral=2.5, best=5 | x 5 |
| Reduction in flood damages | <$0.1M=0, >$0.1M=1, >$1M=2, >$5M=3, >$10M=4, >$15M=5 (present value) | x 4 |
| Economic | | |
| Benefit / Cost Ratio | <0.1=0, <0.3=1, <0.5=2, <1= 3, ≥1=4, >1.5=5 | x 4 |
| Life cycle cost of option | >$10M=0, <$10M=1, <$5M=2, <$2.5M=3, <$1M=4, <$0.5M=5 | x 4 |
| Social | | |
| Impact on local community | Worst/adverse=0, neutral=2.5, best=5 | x 4 |
| Likely community acceptance | Least support=0, neutral=2.5, most support=5 | x 3 |
| Environmental | | |
| Disruption to the natural character of the area | Worst/adverse=0, neutral=2.5, best=5 | x 3 |
| Ecological impacts | Worst/adverse=0, neutral=2.5, best=5 (primarily vegetation removal) | x 4 |

The resulting scores and ranking of the measures are presented in **Table 10-3**. According to the assessment the highest ranked measures are channel clearing works (FM.4) and vegetation management (FM.5) due to the non-disruptive and cost-effective nature of the works.

FM.1, FM.2 and FM.3 offer much greater benefits in reducing flood damages, however they are expensive and could be highly disruptive to construct.

At this stage, FM.1 and FM.2 is not recommended for adoption as these options are not expected to be economically viable (BCR < 1). These options are also expensive and would be expected to be highly disruptive.

FM.3 is recommended for further investigation based on its high economic viability (BCR > 1). However, this option would require a stringent detailed design process which would include a dam break assessment. Given the large population downstream of the detention basin, it is likely that the dam spillway will be required to pass an extreme flood.

## Table 10-3 Multi-Criteria Assessment of Flood Modification Options

| | | Raw Scores | | | | | Weighted Scores | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Evaluation Criteria** | **Weighting** | **FM.1** | **FM.2** | **FM.3** | **FM.4** | **FM.5** | **FM.1** | **FM.2** | **FM.3** | **FM.4** | **FM.5** |
| **Flood Impacts** | | | | | | | | | | | |
| Impact on hydraulic behaviour | x 5 | 3 | 1 | 4 | 2.5 | 2.5 | 15 | 5 | 20 | 12.5 | 12.5 |
| Reduction in flood damages | x 4 | 3 | 4 | 5 | 1 | 1 | 12 | 16 | 20 | 4 | 4 |
| **Economic** | | | | | | | | | | | |
| Benefit / Cost Ratio | x 4 | 3 | 2 | 4 | 4 | 4 | 12 | 8 | 16 | 16 | 16 |
| Life cycle cost of option | x 3 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 0 | 15 | 15 |
| **Social** | | | | | | | | | | | |
| Impact on local community | x 4 | 1 | 0 | 1 | 5 | 5 | 4 | 0 | 4 | 20 | 20 |
| Likely community acceptance | x 3 | 2 | 1 | 2 | 5 | 5 | 6 | 3 | 6 | 15 | 15 |
| **Environmental** | | | | | | | | | | | |
| Disruption to the natural character of the area | x 3 | 2.5 | 2.5 | 1 | 2.5 | 2.5 | 7.5 | 7.5 | 3 | 7.5 | 7.5 |
| Ecological impacts | x 4 | 2 | 2 | 2 | 5 | 5 | 8 | 8 | 8 | 20 | 20 |
| | | | | | | | | | | | |
| | | | | | | **TOTAL /150** | 64.5 | 47.5 | 77 | 110 | 110 |
| | | | | | | **RANK** | 4 | 5 | 3 | =1 | =1 |

## 10.5 Recommendations

**Table 10-4** outlines the recommended flood modification measures that have been identified as part of the floodplain risk management study for Scone.

**Table 10-4 Recommendations relating to Flood Modification Measures**

| ID | Recommended Flood Modification Measures |
|---|---|
| **FM.4** | **Removal of obstructions within the Figtree Gully channel**<br>Continuing maintenance of the Figtree Gully channel to remove rubbish and overgrown vegetation from the channel. |
| **FM.5** | **Vegetation Management**<br>Continuing vegetation maintenance with a primary objective of rehabilitating native vegetation, removing introduced weed species and improving bank stability. As a secondary objective, vegetation density in the floodplain should not be increased and should be decreased where this does not hinder other objectives. |
| | ***Flood Modification Measures for Further Investigation*** |
| **FM.3** | **Figtree Gully Detention Basin**<br>Investigate the feasibility of the construction of a detention basin upstream (east) of Barton Street with the required dam-related analyses in accordance with regulations from Dams Safety NSW and ANCOLD. |

# 11. Floodplain Risk Management Plan

## 11.1 Recommended Management Measures

The following management measures have been recommended for inclusion in the Floodplain Risk Management Plan for Scone:

- **Table 8-2 Recommendations relating to Land Use Planning and Property Modification**
  - PM.1: Update the LEP dictionary with definitions for the Defined Flood Event, Flood Planning Area, Flood Planning Level and Flood Risk Management per those in the Flood Risk Management Manual (DPE 2023a) (refer **Section 8.1**).
  - PM.2: Adopt the 1 in 500 AEP event as the Defined Flood Event for setting the Flood Planning Level and the Flood Planning Area (refer **Section 8.2**).
  - PM.3: Update Flood Planning Level and Flood Planning Area for the catchment per the definitions and mapping in this FRMS&P (refer **Section 8.2**).
  - PM.4: Undertake investigation to define, scope and prioritise Voluntary House Raising (VHR) of up to 27 identified properties (refer **Section 8.4**) and, if appropriate, prepare documentation for funding applications.
  - PM.5: Flood proof properties in the Scone CBD up to the Flood Planning Level (refer **Section 8.6**).
  - PM.6: Issue updated section 10.7 planning certificates to the affected landowners (refer **Section 8.8**).
- **Table 9-5 Recommendations relating to Flood Emergency Response Management**
  - ER.1: All relevant data to be transferred to the SES for incorporation into their flood intelligence database and update of the Local Flood Plan.
  - ER.2 Designate St Mary's Primary School and/or the Scone Bowling Club as flood evacuation centres instead of the Scone Senior Citizen's Centre and Scone High School (refer **Section 9.5**).
  - ER.3: Investigate the installation of a new water level gauge along Parsons Gully, given the limitations of the existing gauge (61360) along Kingdon Ponds at Scone (refer **Section 9.8.3**).
  - ER.4 Install rainfall and water level gauges in the Figtree Gully catchment (refer **Section 9.8.1**).
  - ER.5 Investigate the installation of a Flood Warning System along Figtree Gully (refer **Section 9.8.5**).
  - ER.6 Undertake a community education and flood awareness program based on the findings of this study (refer **Section 9.9**).
  - ER.7 Develop flood emergency response plans for high-risk properties (refer **Section 9.10**).
- **Table 10-4 Recommendations relating to Flood Modification Measures**
  - FM.4: Continuing maintenance of the Figtree Gully channel to remove rubbish and overgrown vegetation from the channel.
  - FM.5: Continuing vegetation maintenance with a primary objective of rehabilitating native vegetation, removing introduced weed species and improving bank stability. As a secondary

objective, vegetation density in the floodplain should not be increased and should be decreased where this does not hinder other objectives.

- FM.3: Further investigate the feasibility of the construction of a detention basin upstream (east) of Barton Street with the required dam-related analyses in accordance with regulations from Dams Safety NSW and ANCOLD.

## 11.2 Implementation Strategy

An implementation schedule for the measures recommended for adoption as part of the Plan is presented in **Table 11-1**.

The schedule includes an indication of the following.

- The recommended actions for implementation of the proposed floodplain risk management options.
- Estimates of the capital and ongoing costs for each measure.
- A priority classification
  - High: these measures would generally provide a significant reduction in risk and would require relatively low effort and cost to implement.
  - Medium: these measures would generally provide a significant reduction in risk but would require a significant effort and cost to implement.
  - Low: these measures may still provide a significant reduction in risk but are difficult to implement due to high capital cost, low economic viability or other obstacles.
- The timing of commencement for each option according to short term (less than 2 years), medium term (less than 5 years) or long term priorities (up to 10 years or more).

## 11.3 Responsibilities and Funding

Upper Hunter Shire Council will be responsible for the implementation of the Floodplain Risk Management Plan.

Funding for the implementation of the options will generally be coordinated by Council, using Council funds and monies from grant applications to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) under the NSW Floodplain Management Program.

It is envisaged that NSW State Emergency Services would contribute funding towards initiatives involving community awareness and flood intelligence information.

## Table 11-1 Floodplain risk management plan implementation schedule

| ID | Recommended Measures | Indicative Costs | | Priority | Timeframe | Responsibility / Funding |
|---|---|---|---|---|---|---|
| | | Capital | Ongoing | | | |
| **Recommended Planning Measures** | | | | | | |
| PM.1 | Update the LEP dictionary with definitions for the Defined Flood Event, Flood Planning Area, Flood Planning Level and Flood Risk Management per those in the Flood Risk Management Manual (DPE 2023a) (refer **Section 8.1**). | N/A | N/A | High | Short Term | Council |
| PM.2 | Adopt the 1 in 500 AEP event as the Defined Flood Event for setting the Flood Planning Level and the Flood Planning Area (refer **Section 8.2**). | N/A | N/A | High | Short Term | Council |
| PM.3 | Update Flood Planning Level and Flood Planning Area for the catchment per the definitions and mapping in this FRMS&P (refer **Section 8.2**). | N/A | N/A | High | Short Term | Council |
| PM.4 | Undertake investigation to define, scope and prioritise Voluntary House Raising (VHR) of up to 27 identified properties (refer **Section 8.4**) and, if appropriate, prepare documentation for funding applications. | Study $50K $150K per house | N/A | High | Short Term | Council |
| PM.5 | Flood proof properties in the Scone CBD up to the Flood Planning Level (refer **Section 8.6**). | Approx. $3,000 per flood barrier | N/A | High | Short Term | Council / Property owners |
| PM.6 | Issue updated section 10.7 planning certificates to the affected landowners (refer **Section 8.8**). | N/A | N/A | High | Short Term | Council |
| **Recommended Emergency Response Measures** | | | | | | |
| ER.1 | All relevant data to be transferred to the SES for incorporation into their flood intelligence database and update of the Local Flood Plan. | N/A | N/A | High | Short Term | Council / SES |
| ER.2 | Designate St Mary's Primary School and/or the Scone Bowling Club as flood evacuation centres instead of the Scone Senior Citizen's Centre and Scone High School (refer **Section 9.5**). | N/A | N/A | High | Short Term | Council / SES |

| ID | Recommended Measures | Indicative Costs | | Priority | Timeframe | Responsibility / Funding |
|---|---|---|---|---|---|---|
| | | Capital | Ongoing | | | |
| ER.3 | Investigate the installation of a new water level gauge along Parsons Gully, given the limitations of the existing gauge (61360) along Kingdon Ponds at Scone (refer **Section 9.8.3**). | $25,000 | $4,000 p.a. | Medium | Medium Term | Council |
| ER.4 | Install rainfall and water level gauges in the Figtree Gully catchment (refer **Section 9.8.1**). | $25,000 per gauge | $4,000 p.a. | High | Short Term | Council |
| ER.5 | Investigate the installation of a Flood Warning System along Figtree Gully (refer **Section 9.8.5**). | refer ER.4, plus $30,000 to develop a response plan and set trigger levels | | High | Short Term | Council |
| ER.6 | Undertake a community education and flood awareness program based on the findings of this study | Undertaken in conjunction with Council's current programs | | High | Short Term | Council |
| ER.7 | Develop flood emergency response plans for high-risk properties (refer **Section 9.10**) | $30,000 per area | N/A | High | Short Term | Council |
| **Recommended Flood Modification Measures** | | | | | | |
| FM.4 | Continuing maintenance of the Figtree Gully channel to remove rubbish and overgrown vegetation from the channel. | Undertaken as part of Council's maintenance programs | | Current and ongoing | | Council |
| FM.5 | Continuing vegetation maintenance with a primary objective of rehabilitating native vegetation, removing introduced weed species and improving bank stability. As a secondary objective, vegetation density in the floodplain should not be increased and should be decreased where this does not hinder other objectives. | Undertaken as part of Council's maintenance programs | | Current and ongoing | | Council |
| **Flood Modification Measures for further investigation** | | | | | | |

| ID | Recommended Measures | Indicative Costs | | Priority | Timeframe | Responsibility / Funding |
|---|---|---|---|---|---|---|
| | | Capital | Ongoing | | | |
| FM.3 | Further investigate the feasibility of the construction of a detention basin upstream (east) of Barton Street with the required dam-related analyses in accordance with regulations from Dams Safety NSW and ANCOLD | $10M + | TBC | Medium | Medium to Long Term | Council |

# 12. References

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# Appendix A
# Preliminary Cost Estimates for Flood Modification Measures

**Scone Floodplain Risk Management Study - Mitigation Options**
**Cost Estimate**

## OPTION FM.1 - Figtree Gully Bypass Culvert

Rev 1: June 2024

**SUMMARY OF COSTS**

| Item | Item Description | Amount |
|---|---|---|
| 1.0 | General Preliminaries | $15,000 |
| 2.0 | Establishment | $885,000 |
| 3.0 | Demolition | $1,014,200 |
| 4.0 | Bulk Earthworks | $1,246,000 |
| 5.0 | Stormwater Drainage | $5,973,300 |
| 6.0 | Roadworks | $589,000 |
| 7.0 | Miscellaneous | $10,000 |
| | **Sub Total** | **$9,732,500** |
| | **Contingency** | **20%** |
| | **TOTAL (ex. GST)** | **$11,679,000** |

| Item | Item Description | Qty | Unit | Rate | Amount | Assumptions/Comments | References - Rawlinsons Reference - 2021 Edition 39 |
|---|---|---|---|---|---|---|---|
| 1.0 | *General Preliminaries* | 1 | Item | $15,000 | $15,000 | | |
| 2.0 | *Establishment* | | | | $885,000 | | |
| 2.1 | Site / office / depot setup | | | | | Assumed to be 10% of all other costs | |
| 2.2 | Survey and setout | | | | | Included in above | |
| 2.3 | Supply and install perimeter fencing during construction and remove it after construction | | | | | Included in above | |
| 2.4 | Prepare Traffic Management Plan and obtain approvals | | | | | Included in above | |
| 2.5 | Construction Stage Traffic control including all signage, lane & detour marking | | | | | Included in above | |
| 2.6 | Install and maintain pedestrian safety measures | | | | | Included in above | |
| 2.7 | Prepare and manage Site Construction Environmental Management Plan | | | | | Included in above | |
| 2.8 | Stormwater diversion & flood protection during construction | | | | | Included in above | |
| 2.9 | Vibration monitoring | | | | | Included in above | |
| 2.10 | Sediment and Erosion Control | | | | | Included in above | |
| 3.0 | *Demolition* | | | *Sub-total* | *$1,014,200* | | |
| 3.1 | Saw cut and demolish existing road pavement to sub-grade level and cart to stockpile | 6,800 | $m^2$ | $80 | $544,000 | Length of new pipe x estimated width of road impacted | Rawlinsons pg206 Cut away concrete ground slab 150mm thick unreinforced - $62.50/m2 |
| 3.2 | Demolish existing pipes and cart to stockpile | 240 | $m^3$ | $370 | $88,800 | Length of existing pipe x CSA of pipe | Rawlinsons pg211 Break up and remove reinforced concrete in open excavations - $317/m3 |
| 3.3 | Demolish existing pits, kerb and gutter (including laybacks) and cart to concrete stockpile | 100 | $m^3$ | $370 | $37,000 | 23 existing pits removed (assumed 2m x 2m x 1m) | Rawlinsons pg211 Break up and remove reinforced concrete in open excavations - $317/m3 |
| 3.4 | Disposal of demolition material to landfill | 820 | t | $420 | $344,400 | 2.4t/m^3 weight of concrete | Rawlinsons pg213 Disposal of demolition material - mixed at a waste management centre - $360-$363/t, within 10km |
| 4.0 | *Bulk Earthworks* | | | *Sub-total* | *$1,246,000* | | |
| 4.1 | Road Footprint. Excavate/box out to the required sub-grade level & stockpile material for re-use | | | | | The parts of the road that need to be removed are where the pipe excavation works will take place. Hence, this item is covered by the item below. | Rawlinsons pg490 Trench excavation >300mm wide & >1000mm depth in soft rock $224/cum (conservative) |
| 4.2 | Culvert Footprint. Excavate/box out to the required bulk earthworks surface. Supply and place fill material next to and above culverts/pipes (stabilised fill) | 17,800 | $m^3$ | $70 | $1,246,000 | Culvert length x depth x width x 1.5 (1.5 is to account for trenching wider than the culvert) | Rawlinsons pg490 Trench excavation and backfilling >300mm wide & 1000-2000mm depth in sand $59/cum |
| 5.0 | *Stormwater Drainage* | | | *Sub-total* | *$5,973,300* | | |
| 5.1 | Install new stormwater pipes | 1,020 | m | $5,500 | $5,610,000 | RCBC 3.6m x 1.2m precast concrete | Rawlinsons pg718 RCBC 3.6m x 1.2m = $4725/m @ 1200 x 1200mm = $1575/m |
| 5.2 | Install junction pits | 3 | units | $7,300 | $21,900 | | Rawlinsons pg502 manhole 900 x 900 x 1200 mm deep $3,450 x 1.5 plus cast iron cover $1,095 |
| 5.3 | Headwalls to suit culvert including foundation | 2 | units | $7,200 | $14,400 | (3.6)^2 m2 = 13 m2 surface area of headwall | Rawlinsons pg718 200mm thick wall (3.6)^2 m2 = $476 * 13/unit = $6188/unit |
| 5.4 | Re-install demolished stormwater pipes | 530 | m | $390 | $206,700 | Assumed average 600mm dia concrete pipes = $331/m | Rawlinsons pg718 |
| 5.5 | Re-install demolished stormwater pits | 23 | units | $5,230 | $120,290 | Assumed 900 x 900 x 1200 mm deep with iron cover | Rawlinsons pg502 manhole 900 x 900 x 1200 mm deep $3,450 plus cast iron cover $1,095 |
| 6.0 | *Roadworks* | | | *Sub-total* | *$589,000* | | |
| 6.1 | Supply, place and compact crushed sandstone, (or approved equivalent) sub-base course under pavements: 200 mm thick DGS40 or approved crushed sandstone (compacted thickness) | 6,800 | $m^2$ | $10 | $68,000 | | Rate assumed to be 30% of base course rate |
| 6.2 | Supply, place and compact DGB20 base course 150mm thick (compacted thickness) | 6,800 | $m^2$ | $30 | $204,000 | | Rawlinsons pg716 Base course - crushed rock/blue metal 200mm thick (includes grading, rolling and compaction) $20.10/sqm |
| 6.3 | Surfacing of road pavement with Asphaltic concrete (AC10) 40mm thick plus 10mm primer seal | 6,800 | $m^2$ | $40 | $272,000 | | Rawlinsons pg716 Hot bituminous concrete including tack coat 50mm thick $27/sqm |
| 6.4 | Supply all materials and construct kerbs and gutters to Council's Standard, including vehicular crossings | 900 | m | $50 | $45,000 | Barrier Kerb & Gutter | Rawlinsons pg224 - extruded in situ concrete kerb 150 x 350mm high, 150mm in ground $41.90/m |
| 7.0 | *Miscellaneous* | | | *Sub-total* | *$10,000* | | |
| 7.1 | Remove temporary works and clean up site | 1 | Item | $10,000 | $10,000 | | |

Note: Rates were approximated by assuming a 5% increase in CPI per year from 2021 to 2024

**Scone Floodplain Risk Management Study - Mitigation Options**
**Cost Estimate**

## OPTION FM.2 - Figtree Gully Bypass Culvert & Channel Widening

Rev 1: June 2024

**SUMMARY OF COSTS**

| Item | Item Description | | Amount |
|---|---|---|---|
| 1.0 | General Preliminaries | | $15,000 |
| 2.0 | Establishment | | $2,002,000 |
| 3.0 | Demolition | | $1,014,200 |
| 4.0 | Bulk Earthworks | | $1,246,000 |
| 5.0 | Stormwater Drainage | | $5,973,300 |
| 6.0 | Roadworks | | $589,000 |
| 7.0 | Figtree Gully Channel Widening | | $11,167,500 |
| 8.0 | Miscellaneous | | $10,000 |
| | | **Sub Total** | **$22,017,000** |
| | | **Contingency** | **20%** |
| | | **TOTAL (ex. GST)** | **$26,420,400** |

| Item | Item Description | Qty | Unit | Rate | Amount | Assumptions/Comments | References - Rawlinsons Reference - 2021 Edition 39 |
|---|---|---|---|---|---|---|---|
| 1.0 | *General Preliminaries* | 1 | Item | $15,000 | $15,000 | | |
| 2.0 | *Establishment* | | | | $2,002,000 | | |
| 2.1 | Site / office / depot setup | | | | | Assumed to be 10% of all other costs | |
| 2.2 | Survey and setout | | | | | Included in above | |
| 2.3 | Supply and install perimeter fencing during construction and remove it after construction | | | | | Included in above | |
| 2.4 | Prepare Traffic Management Plan and obtain approvals | | | | | Included in above | |
| 2.5 | Construction Stage Traffic control including all signage, lane & detour marking | | | | | Included in above | |
| 2.6 | Install and maintain pedestrian safety measures | | | | | Included in above | |
| 2.7 | Prepare and manage Site Construction Environmental Management Plan | | | | | Included in above | |
| 2.8 | Stormwater diversion & flood protection during construction | | | | | Included in above | |
| 2.9 | Vibration monitoring | | | | | Included in above | |
| 2.10 | Sediment and Erosion Control | | | | | Included in above | |
| 3.0 | *Demolition* | | | *Sub-total* | *$1,014,200* | | |
| 3.1 | Saw cut and demolish existing road pavement to sub-grade level and cart to stockpile | 6,800 | $m^2$ | $80 | $544,000 | Length of new pipe x estimated width of road impacted | Rawlinsons pg206 Cut away concrete ground slab 150mm thick unreinforced - $62.50/m2 |
| 3.2 | Demolish existing pipes and cart to stockpile | 240 | $m^3$ | $370 | $88,800 | Length of existing pipe x CSA of pipe | Rawlinsons pg211 Break up and remove reinforced concrete in open excavations - $317/m3 |
| 3.3 | Demolish existing pits, kerb and gutter (including laybacks) and cart to concrete stockpile | 100 | $m^3$ | $370 | $37,000 | 23 existing pits removed (assumed 2m x 2m x 1m) | Rawlinsons pg211 Break up and remove reinforced concrete in open excavations - $317/m3 |
| 3.4 | Disposal of demolition material to landfill | 820 | t | $420 | $344,400 | 2.4t/m^3 weight of concrete | Rawlinsons pg213 Disposal of demolition material - mixed at a waste management centre - $360-$363/t, within 10km |
| 4.0 | *Bulk Earthworks* | | | *Sub-total* | *$1,246,000* | | |
| 4.1 | Road Footprint. Excavate/box out to the required sub-grade level & stockpile material for re-use | | | | | The parts of the road that need to be removed are where the pipe excavation works will take place. Hence, this item is covered by the item below. | Rawlinsons pg490 Trench excavation >300mm wide & >1000mm depth in soft rock $224/cum (conservative) |
| 4.2 | Culvert Footprint. Excavate/box out to the required bulk earthworks surface. Supply and place fill material next to and above culverts/pipes (stabilised fill) | 17,800 | $m^3$ | $70 | $1,246,000 | Culvert length x depth x width x 1.5 (1.5 is to account for trenching wider than the culvert) | Rawlinsons pg490 Trench excavation and backfilling >300mm wide & 1000-2000mm depth in sand $59/cum |
| 5.0 | *Stormwater Drainage* | | | *Sub-total* | *$5,973,300* | | |
| 5.1 | Install new stormwater pipes | 1,020 | m | $5,500 | $5,610,000 | RCBC 3.6m x 1.2m precast concrete | Rawlinsons pg718 RCBC 3.6m x 1.2m = $4725/m @ 1200 x 1200mm = $1575/m |
| 5.2 | Install junction pits | 3 | units | $7,300 | $21,900 | | Rawlinsons pg502 manhole 900 x 900 x 1200 mm deep $3,450 x 1.5 plus cast iron cover $1,095 |
| 5.3 | Headwalls to suit culvert including foundation | 2 | units | $7,200 | $14,400 | (3.6)^2 m2 = 13 m2 surface area of headwall | Rawlinsons pg718 200mm thick wall (3.6)^2 m2 = $476 * 13/unit = $6188/unit |
| 5.4 | Re-install demolished stormwater pipes | 530 | m | $390 | $206,700 | Assumed average 600mm dia concrete pipes = $331/m | Rawlinsons pg718 |
| 5.5 | Re-install demolished stormwater pits | 23 | units | $5,230 | $120,290 | Assumed 900 x 900 x 1200 mm deep with iron cover | Rawlinsons pg502 manhole 900 x 900 x 1200 mm deep $3,450 plus cast iron cover $1,095 |
| 6.0 | *Roadworks* | | | *Sub-total* | *$589,000* | | |
| 6.1 | Supply, place and compact crushed sandstone, (or approved equivalent) sub-base course under pavements: 200 mm thick DGS40 or approved crushed sandstone (compacted thickness) | 6,800 | $m^2$ | $10 | $68,000 | | Rate assumed to be 30% of base course rate |
| 6.2 | Supply, place and compact DGB20 base course 150mm thick (compacted thickness) | 6,800 | $m^2$ | $30 | $204,000 | | Rawlinsons pg716 Base course - crushed rock/blue metal 200mm thick (includes grading, rolling and compaction) $20.10/sqm |
| 6.3 | Surfacing of road pavement with Asphaltic concrete (AC10) 40mm thick plus 10mm primer seal | 6,800 | $m^2$ | $40 | $272,000 | | Rawlinsons pg716 Hot bituminous concrete including tack coat 50mm thick $27/sqm |
| 6.4 | Supply all materials and construct kerbs and gutters to Council's Standard, including vehicular crossings | 900 | m | $50 | $45,000 | Barrier Kerb & Gutter | Rawlinsons pg224 - extruded in situ concrete kerb 150 x 350mm high, 150mm in ground $41.90/m |
| 7.0 | *Figtree Gully Channel Widening* | | | *Sub-total* | *$11,167,500* | | |
| 7.1 | Excavate soil | 57,500 | $m^3$ | $70 | $4,025,000 | Excavating between 1 to 6 metres deep along the gully | Rawlinsons pg212 Excavate trench in light soil 1 to 2 metres deep $59.2/cum |
| 7.2 | Disposal of cut material to landfill | 86,300 | t | $80 | $6,904,000 | Soil density estimated 1500kg/m3 | Rawlinsons pg213 Recyclable material $70/t |
| 7.3 | Lining with grass | 15,900 | $m^2$ | $15 | $238,500 | Grass seeding | Rawlinsons pg228 50mm layer of loam with grass seeding, including maintenance for 6 months $9.65/sqm |
| 8.0 | *Miscellaneous* | | | *Sub-total* | *$10,000* | | |
| 8.1 | Remove temporary works and clean up site | 1 | Item | $10,000 | $10,000 | | |

Note: Rates were approximated by assuming a 5% increase in CPI per year from 2021 to 2024

**Scone Floodplain Risk Management Study - Mitigation Options**
**Cost Estimate**
**OPTION FM.3 - Figtree Gully Detentin Basin**

Rev 2: March 2025

**SUMMARY OF COSTS**

| Item | Item Description | Amount |
|---|---|---|
| 1.0 | General Preliminaries | $15,000 |
| 2.0 | Establishment | $583,000 |
| 3.0 | Initial Earthworks | $56,800 |
| 4.0 | Retaining wall | $5,439,000 |
| 5.0 | Stormwater Drainage | $2,500 |
| 6.0 | Detailed design | $300,000 |
| 7.0 | Miscellaneous | $10,000 |
| | **Sub Total** | **$6,406,300** |
| | **Contingency** | **20%** |
| | **TOTAL (ex. GST)** | **$7,687,560** |

| Item | Item Description | Qty | Unit | Rate | Amount | Assumptions/Comments | References - Rawlinsons Reference - 2021 Edition 39 |
|---|---|---|---|---|---|---|---|
| 1.0 | *General Preliminaries* | 1 | Item | $15,000 | $15,000 | | |
| 2.0 | *Establishment* | | | | $583,000 | | |
| 2.1 | Site / office / depot setup | | | | | Assumed to be 10% of all other costs | |
| 2.2 | Survey and setout | | | | | Included in above | |
| 2.3 | Supply and install perimeter fencing during construction and remove it after construction | | | | | Included in above | |
| 2.4 | Prepare Traffic Management Plan and obtain approvals | | | | | Included in above | |
| 2.5 | Construction Stage Traffic control including all signage, lane & detour marking | | | | | Included in above | |
| 2.6 | Install and maintain pedestrian safety measures | | | | | Included in above | |
| 2.7 | Prepare and manage Site Construction Environmental Management Plan | | | | | Included in above | |
| 2.8 | Stormwater diversion & flood protection during construction | | | | | Included in above | |
| 2.9 | Vibration monitoring | | | | | Included in above | |
| 2.10 | Sediment and Erosion Control | | | | | Included in above | |
| 3.0 | *Initial Earthworks* | | | *Sub-total* | *$56,800* | | |
| 3.1 | Strip topsoil from construction areas and stockpile | 400 | $m^3$ | $3 | $1,200 | 0.15m stripping depth | Rawlinsons pg211 excavate to remove 150mm |
| 3.2 | Surface treatment (basic levelling and compaction) | 2,100 | $m^2$ | $5 | $10,500 | | Rawlinsons pg214 compaction |
| 3.3 | Excavation for wall footing | 1,100 | $m^3$ | $40 | $44,000 | Excavation for 0.5m base thickness | Rawlinsons pg711 excavate for retaining wall foundations |
| 3.4 | Disposal of excavated material | 1,100 | $m^3$ | $1 | $1,100 | | Rawlinsons pg711 disposal |
| 4.0 | *Retaining wall* | | | *Sub-total* | *$5,439,000* | | |
| 4.1 | Supply, placement, pouring, curing, and finishing of concrete retaining wall | 6,100 | $m^2$ | $770 | $4,697,000 | Wall between 0.7m to 10m high, with average of 5.7m, assume 3m thick with Class 2 formwork to both faces. Includes reinforced concrete footing for 515m length of wall | Rawlingsons pg125 precast concrete wall panels with smooth finish, 3 to 6m high |
| 4.2 | Supply and placement of backfill | 10,600 | $m^3$ | $70 | $742,000 | Assume backfill extends 0.5 * H behind the wall | Rawlingsons pg714 backfill |
| 5.0 | *Stormwater Drainage* | | | *Sub-total* | *$2,500* | | |
| 5.1 | 1x new 900 mm dia. pipe beneath levee | 2 | m | $340 | $680 | Assuming pipe goes base of wall | Rawinsons pg718 900mm dia. X 44kg/m = $287/m |
| 5.2 | Headwalls to suit culvert including foundation | 2 | units | $900 | $1,800 | Minimal excavation of headwall size 0.9 * 0.9 * 2 = 1.62sqm, $772/unit | Rawlinsons pg718 $476/sqm |
| 6.0 | *Detailed design* | | | *Sub-total* | *$300,000* | | |
| 6.1 | Retaining wall detailed design | 1 | Item | $300,000 | $300,000 | | |
| 7.0 | *Miscellaneous* | | | *Sub-total* | *$10,000* | | |
| 7.1 | Remove temporary works and clean up site | 1 | Item | $10,000 | $10,000 | | |

Note: Rates were approximated by assuming a 5% increase in CPI per year from 2021 to 2024