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GREATER TAREE CITY COUNCIL

Wingham Floodplain Risk Management Plan

301015-01997

12-May-2011

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FOREWORD

The Wingham Floodplain Risk Management Plan provides information necessary for the adequate forward planning for flood prone land and follows on directly from the Floodplain Risk Management Study. The Wingham Risk Management Study utilised the work undertaken in the Wingham Flood Study, in combination with the process outlined in the New South Wales Floodplain Development Manual, to assess strategies aimed at dealing with the different types of flood risk with the study area.

The Wingham Floodplain Risk Management Plan therefore consists of a coordinated mix of these strategies aimed at addressing existing, future and continuing risk.

The holistic objective of this process is to reduce the impact of flooding and to reduce private and public losses resulting from floods whilst avoiding the unnecessary sterilisation of flood prone land by recognising the benefits arising from its use, occupation and development.

Disclaimer

PROJECT 301015-01997 - WINGHAM FLOODPLAIN RISK MANAGEMENT PLAN

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1. INTRODUCTION

1.1 Overview

Wingham is located approximately 45 kilometres upstream along the Manning River at the confluence of Cedar Party Creek. Due to the importance of the Manning River as a transport route, Wingham was established at the furthest point supply boats could reach up the river and therefore became the region's major port.

A large portion of Wingham is elevated high above the floodplain; however some portions, including Wingham peninsula, consist of undulating river terrace at a general elevation of less than 12. There are also portions of central and northern Wingham where tributary drainage gullies feeding Cedar Party Creek are now part of the urbanised area.

In its 178 years of European settlement, many floods of varying severity and impact have been recorded in Wingham. However in this time, none have had an Annual Exceedance Probability (AEP) greater than 1%, with the largest being approximately equal to a 1% AEP and occurring in July 1866. More recent floods of moderate magnitude have occurred in 1978 and 1990. The 1978 flood in particular was one of the largest floods on record (estimated to be less than a 1% but greater than a 2% event) which required the evacuation of residents and led to substantial property damage.

These events, and other significant floods in Wingham, have led to large property losses, injury and in some instances, loss of life.

The Wingham Flood Study, 2010, undertaken by WorleyParsons, constructed a RMA-2 Model that was successfully calibrated and verified against historic data and previous studies. This provided simulated flood data for Wingham, information on the hydraulic nature of flooding in this region and the hazards that exist. This constituted a major step in the floodplain management process with the next stage involving a detailed examination of flood risk in Wingham and a range of floodplain mitigation options.

The Wingham Floodplain Risk Management Study, 2010, was undertaken by WorleyParsons in which the cost of flooding in Wingham was calculated and used as a basis to evaluate the effectiveness and tangible benefit of mitigation strategies in terms of risk to property. Strategies involving the mitigation of risk to life issues were also evaluated and compared and all strategies were discussed with the Wingham Flood Committee. As a result, mixtures of strategies were selected to become part of the Wingham Floodplain Risk Management Plan.

1.2 Objectives

The overall objective of this Floodplain Risk Management Plan is to provide an appropriate mix of management measures that will collectively mitigate or manage the flood risks. The benefit of these management strategies, where possible, has been compared to the long term cost of flooding In Wingham to the wider community (the cost of doing nothing).

Flood Risks are divided into the following categories:

- **Existing Risk**; involves ensuring that current development is compatible with flood risk. Flood modification measures are the traditional means of mitigating damage to existing properties to an acceptable level. In addition, measures such as land use controls and flood readiness education can also be used to reduce existing flood risk. All these flood modification measures have associated environmental, economic and social costs that require evaluation.
- **Future Risk**; involves measures that ensure that future development is compatible with flood risk. Property modification measures, such as land use and development controls are typically the most effective means of doing this and must be evaluated based on the common good of the community as a whole.
- **Continuing Risk**; in most cases, the PMF is not adopted as the basis for floodplain risk management strategies because this would unnecessarily sterilise large areas. As a result, strategies that are developed to manage flood risk will at some stage be overwhelmed by a larger flood and response measures must be developed to deal with this risk. Typical measures include readiness, response and recovery plans.

The Floodplain Risk Management Study objectively evaluated possible strategies that could manage the aforementioned flood risks to acceptable levels. In order to be successful, the study:

a) was congruent with relevant, current Greater Taree City Council (GTCC) flood risk management policies, strategies or planning instruments

b) gathered community input, enable participation in the decision making process and gained acceptance of the management study findings from the GTCC Flood Committee

c) determined the hazard categories within Wingham

d) identified and assessed floodplain risk management measures for existing developments aimed at reducing the social, environmental and economic loss of flooding, both existing and future

e) Assessed the impacts of proposed management measures from all perspectives.

1.3 Flood Standard and Considerations

The selection of an appropriate flood standard is an integral step in the development of a floodplain management plan as the Floodplain Development Manual clearly states. The current General Flood Planning Level (FPL) employed by the Greater Taree City Council is based on the 1% AEP plus a 500 mm freeboard.

This is considered to be a sound basis for planning in Wingham because

- it is recommended by the Floodplain Development Manual
- it is widely understood and used throughout Australia
- it has been in use since the Council's *Interim Flood Policy* was introduced in 1987
- it was recommended by the *Manning River Floodplain Management Study* in 1996

- it is used in the Greater Taree Development Control Plan (DCP) 2010
- a higher standard would increase mitigation costs to the community and Council
- a lower standard would expose residents to unacceptable risk of which the costs would potentially be borne by the wider community

Therefore the current FPL using the 1% AEP event plus a 500 mm freeboard is recommended to be maintained and is used as a basis for developing management strategies in this study.

Whilst this may limit the risk to property, the risk to life is far more complex than a single FPL. There is a need, as also stated in the Floodplain Development Manual, to consider the difficulty of the conditions that could be expected if an extreme flood occurred. Hazards can dramatically increase because of greater flood depths and velocities, and rates of rise can give little warning of dangers and the cutting off of evacuation routes.

1.4 Study Area

The study area involves a small subset of the larger area analysed in the Wingham Flood Study, 2010 (herein referred to as the “Flood Study”). The streams of interest in the study area are Cedar Party, Stony (Gorman) Creeks and the Manning River. The study area was focuses on Wingham, covering areas north of the Manning River on both sides of Cedar Party Creek to the Stony Creek Confluence.

Figure 1 shows the approximate focus of the study area for this Floodplain Risk Management Plan.

The Manning catchment drains an area of approximately 8200 km^2 and extends over 175 km inland from the coast. Tidal influence on the Manning River extends to Abbotts Falls, approximately 5km upstream of Wingham. The Cedar Party Creek sub-catchment drains an area of approximately 143 km^2 and extends approximately 22 km north of Wingham.

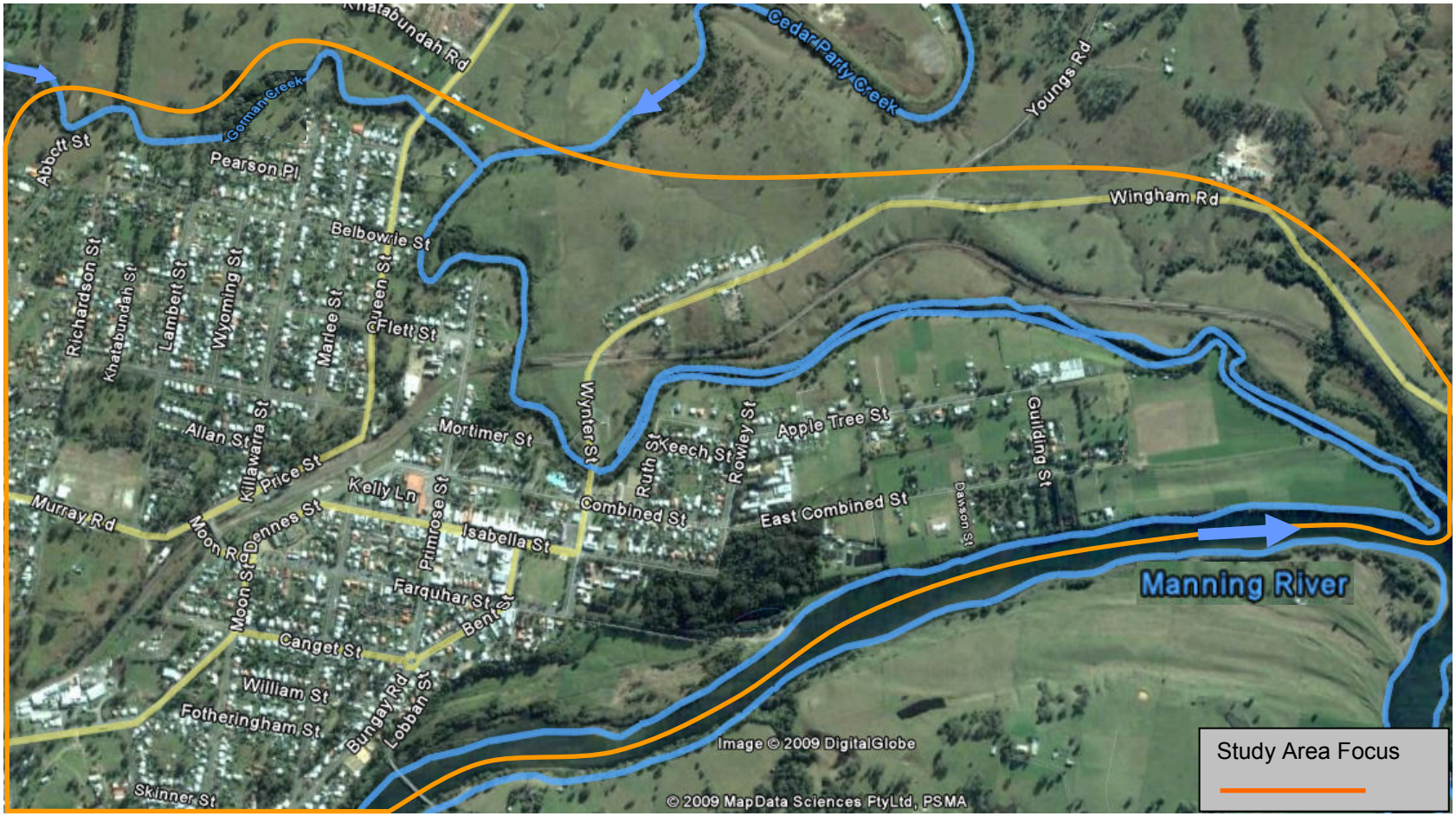


Figure 1: Map showing the approximate extents of Floodplain Risk Management Plan Area

1.5 Flood History

The SES *FloodSafe* guide to Wingham indicates that a peak flood level less than 4.90 can be classified as 'minor', up to 8.90 as 'moderate' and greater than 11.90 as 'major'. It must be emphasised that this flood classification system is based on the extent of human impact and not on recurrence interval.

According to the "*Manning River Flood History 1931-1979*" (Public Works Department New South Wales), floods reaching a height of at least 10.6 at Wingham Bridge can be considered "significant". Using this same level as a guide, which corresponds approximately to the level of a 20% AEP flood, at least 29 significant floods have been recorded in Wingham since 1831 (when European records begin). The irregularity at which significant floods can occur is highlighted by the fact that some significant floods are very closely spaced, even occurring within the same year (1870, 1956); while at other times there are long periods without significant flooding (1831 to 1857, 1930 to 1950, and 1990 to present). The three largest floods recorded in Wingham occurred in 1866, 1929 and 1978 and reached a peak level of 15.5, 14.9 and 14.9 respectfully. Figure 2 shows the significant floods that were recorded in Wingham with a time scale that also shows that there were periods where no significant flooding occurred. Figure 3 shows only the years where significant floods were recorded in Wingham since 1831.

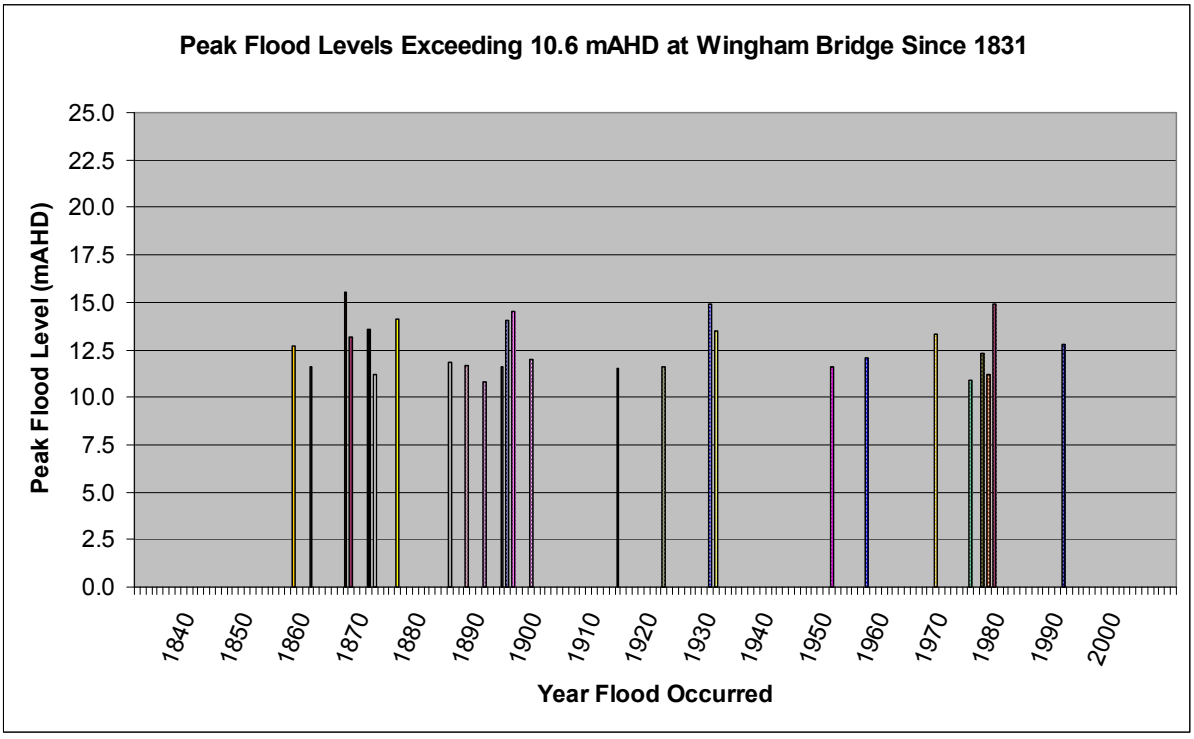


Figure 2: Floods recorded at Wingham Bridge exceeding 10.6 since 1831

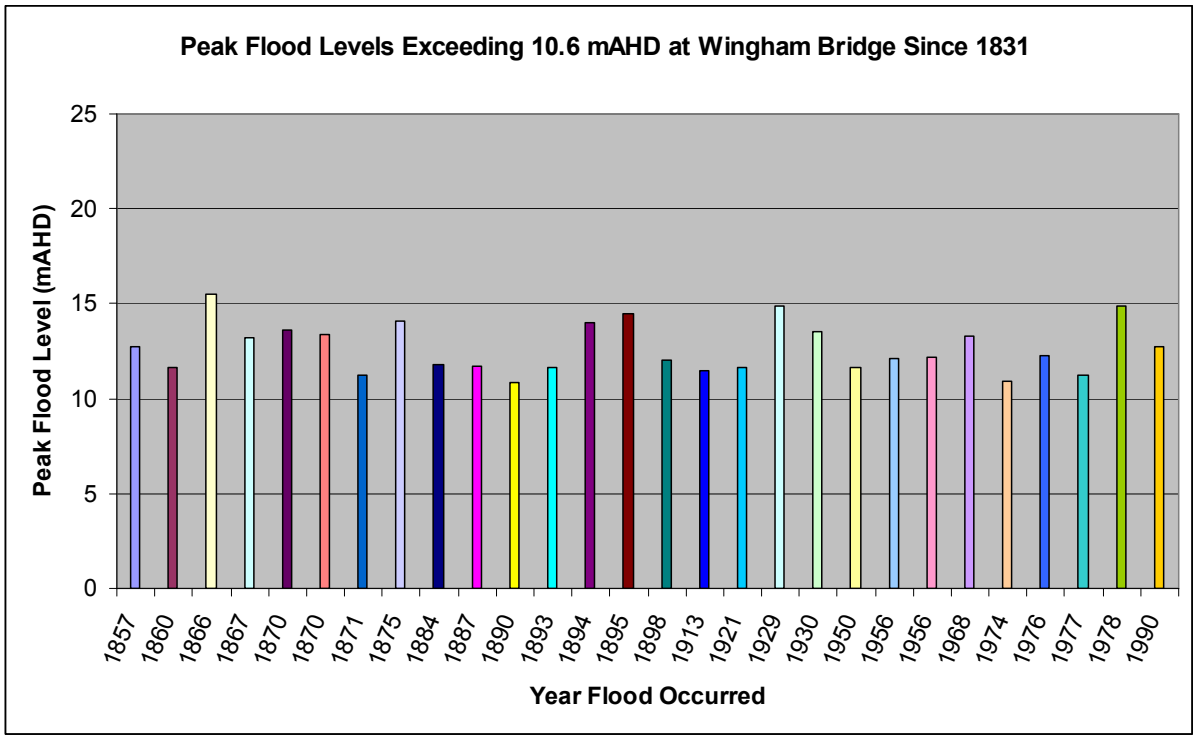


Figure 3: Years where floods recorded at Wingham Bridge exceeded 10.6

The 1978 flood event, of which a significant amount of information exists, had a rate of rise as high as 1.5 m per hour at Wingham and caught many by surprise who did not expect flood levels to rise to their ultimate peak. The difference in time between when the major flood warning from the Bureau of Meteorology / SES was given and the time at which the major flood level was exceeded in Wingham was in the order of 4 hours. This highlights the potential danger that exists in Wingham, when a delay in a decision to evacuate, or a misjudgement on the peak level of a rising flood, can rapidly lead to severe risks to life and property. More recently, Wingham has experienced 'moderate' flooding in March 1995 when 10.35 was recorded at Wingham Bridge which was only marginally below the 10.6 'significant' level.

Since European settlement, Wingham has not experienced an extreme flood event (which was shown to have the potential to exceed an ARI of 22 m AHD (*"Wingham Flood Study; Review and Upgrade" (WorleyParsons; 2010)*).

1.6 Previous Studies and Policy

In 1986 the NSW Government released the first Floodplain Management Manual to assist in the management of flood liable land. This has been twice since revised in 2001 and 2005. The current NSW Floodplain Development Manual (FPDM) aims to optimally maintain the safe use of the floodplain whilst reducing the impacts of flooding, both publicly and privately. The most recent revision sought to ensure consistent interpretations of important strategic variables such as the flood planning level (FPL) and its interaction with rare events up to the PMF.

The FPDM provides a framework for the implementation of a policy based on the following steps:

1. Data Collection; which involves the review and compilation of all relevant data to be used
2. Flood Study; providing technical and quantitative information on flooding in the study area
3. Floodplain Risk Management Study; determining options in consideration of social, economic and ecological factors relating to flood risk
4. Floodplain Risk Management Plan; a selection of options from the study based on community and council endorsement, that will reduce flood risk
5. Plan Implementation; where flood, response and property modification measures are implemented and data collection and monitoring are continued.

After the initial release of the 1986 Manual, the Greater Taree Council implemented an *"Interim Flood Management Policy"* (1987) which specified a FPL equal to the 1% AEP, with fewer restrictions on commercial and industrial developments. Following this, other studies which constituted steps 2, 3 and 4 in a broad sense for the Manning Catchment, were produced. These included the;

- *"Manning River Flood Study" (NSW Public Works Department; 1991)*
- *"Manning River Floodplain Management Study" (Greater Taree City Council; 1996)*
- *"Wingham Peninsula Floodplain Management Study & Plan" (Patterson Britton & Partners; 2000)*

WorleyParsons completed a refined Flood Study with a focus on Wingham in 2010. Both hydrologic and hydraulic models were developed and calibrated and used to simulate design flood behaviour in the study area based on methods in Australian Rainfall and Runoff, 1997. This provided an updated and more accurate picture of how flooding affects Wingham with fine detail.

With this, the need for an updated Floodplain Risk Management Study for Wingham based on these refined flood study results was required. This was also completed in 2010 by WorleyParsons and is used as a reference in creating this document, the Wingham Floodplain Risk Management Plan.

1.7 Data Collection

The following list comprises local and region studies / policies that have relevance to the development of a Wingham Floodplain Risk Management Study

- *"Wingham Flood Study; Review and Upgrade" (WorleyParsons; 2010)*
- *"Interim Flood Management Policy" (Greater Taree City Council; 1987)*
- *"Manning River Floodplain Management Study" (Greater Taree City Council; 1996)*
- *"Wingham Peninsula Floodplain Management Study & Plan" (Patterson Britton & Partners; 2000)*
- "*Floodplain Development Manual" (New South Wales Government; 2005)*
- *SES Archive Data (State of New South Wales through NSW State Emergency Service)*
- *The Greater Taree DCP, 2010 (Part E; Flooding Requirements)*

Further to these sources, a community consultation program was implemented in order to obtain input from the Wingham Community to ensure that strategies developed would also deal with relevant concerns of residents.

This comprised of:

- the generation of a webpage on the Greater Taree City Council website containing a summary of the objectives, process and progress of the Flood Study, Floodplain Risk Management Study and Plan
- a survey gathering information regarding flooding in Wingham and providing potential management strategies where reader feedback was encouraged
- a local newspaper add and letter drop informing the public of the website and the survey
- an email address made available to the public for the purpose of obtaining further information and / or providing suggestions and / or feedback
- A community workshop where the draft Flood and Floodplain Risk Management Studies were available to the public for review. From this, data was collected enabling a more accurate calibration of the flood study model which in turn provided better information on which base the risk management study.
- A GTCC Flood Committee meeting where some members of the community were able to give their input into the assessed options.

2. SUMMARY OF FLOOD BEHAVIOUR

From the Flood Study, several clear facets of flooding in Wingham become clear.

- **Peak levels for a given flood risk are much higher for the Manning River than Cedar Party Creek**;
    - Whilst some areas of Wingham are significantly inundated by flows from Cedar Party Creek, the ultimate peak level of inundation in Wingham is derived from the backwater flow from the Manning River.
    - During the early stages of a flood event, Cedar Party Creek has a greater effect on areas of Wingham upstream of the Wynter Street Bridge.
- **Peak levels do not vary significantly throughout Wingham for a given flood**;
    - Inundated areas of Wingham are within several centimetres of the peak value
    - This is primarily due to the slow backwater filling of Wingham and the relatively broad hydrograph of the Manning River in this region.
    - Some variation exists in areas inundated directly by the Manning River, upstream of Wingham Brush, however this only affects developed areas in extreme flooding (such as those bounded between Wynter Street and Wingham Brush).
- **Peak flow velocities are small for the majority of Wingham**;
    - With the exception of the southern half of Wingham Peninsula which is affected by expanding flow from the Manning River, flood hazard in developed areas of Wingham is primarily depth related.

The following sections provide further details on the characteristics of flooding in Wingham.

2.1 Floods with an AEP of less than 5%

For more regular floods that have a 20 year recurrence interval or less, peak levels do not exceed 11.5 in Wingham and the vast majority of properties below this level are inundated with slow moving back-water of low to moderate depths (less than 1.5 metres).

The following roads are inundated by floodwaters; eastern portions of East Combined Street, Guilding Street, small north-east portions of Ruth, West Appletree and Keech Streets, Farquhar Street, Wynter Street surrounding the bridge, Combined and Primrose Streets in the vicinity of central Wingham extending to the commercial district on Isabella Street, Mortimer and Flett Street as well as portions of Queen Street North including Peter Garrett Bridge by Stony Creek. Wingham Road at two locations near the brickworks would also become inundated as well as Cedar Party Creek Bridge.

Peak depths exceed 4 metres in portions of the gullies located near existing development on Wingham peninsula which isolates a small number of properties south of East Combined Street from road access. Cedar Party Creek Bridge would be covered by over 4 metres of flow. Peak depths near the intersection of Combined and Primrose Streets and 200 metres east along Combined Street

exceed 1.5 metres. This isolates some properties on Combined Street, between Primrose and Wynter Streets from road access. Some properties on Combined and Mortimer Streets experience peak flood depths in excess of 3 metres with some properties on Mortimer Street isolated from road access by up to 5 metres of over road flood depth. Peter Garrett Bridge would be inundated by at least 1.5 metres of flood water. Wingham Road would be inundated by over 2 metres of flood water near the Brickworks.

Flow velocity through existing development in Wingham is slow, with peak velocities generally not in excess of 0.1 m/s emphasising the backwater affect that the Manning River has on Cedar Party Creek. However, relatively small, southern portions of Wingham Peninsula experience expanding flow from the Manning River with flow nearby some properties on East Combined Street experiencing peak velocities of up to 1.3 m/s.

2.2 Floods with an AEP of up to 1%

For flood risk up to that of the FPL, peak levels do not exceed 13.8 in Wingham. This is of a similar order to the flood of 1866. (Whilst this peak level is experienced on a small part of the peninsula, the majority of Wingham does not exceed a peak level of 13.6.)

The roads inundated are of a similar composition to that discussed in the previous section, albeit to a greater extent:

- Properties along low areas of East Combined, Guilding and the south side of Appletree Streets are inundated by up to 3.5 metres of floodwater. Properties affected on the north side of Appletree Street are generally inundated by less than 1 metre.
- Properties along West Appletree Street and a small number near the intersection of Ruth and Keech Streets are inundated by up to 2.6 metres of water, leading to the isolation of properties in the early stages of flooding.
- Floodwaters extend over Wynter Street from the railway line to the intersection with Combined Street.
- Properties in low areas of Combined Street between Primrose and Wynter Streets are inundated by up to over 4 metres of floodwater which leads to their rapid isolation during the early stages of flooding.
- Several properties south of Combined Street along Primrose and Isabella Streets are inundated by up to 2 metres.
- The intersection of Primrose and Combined Streets is inundated by over 3.5 metres, which isolates a large portion of properties to the north up to the Flett Street Bridge from road access.
- The intersection of Primrose and Isabella Streets is inundated in excess of 2.2 metres and the intersection of Primrose and Farquhar Streets is inundated by up to 0.2 metres.
- Mortimer Street east of the railway line is inundated by over 5 metres of flood water in the vicinity of some properties which leads to the isolation of properties in the very early stages of flooding.

- Properties along the east side of Primrose Street north of Combined Street and the west side of Primrose north of Flett Street are inundated by up to 2 metres with some properties along Flett Street inundated by up to 3 metres.
- The south and majority of the eastern side of Queen Street is inundated by up to 3 metres whilst a number of properties on the west side of Queen Street are inundated by up to 1 metre of floodwater.
- The Peter Garrett Bridge and Wingham Road, in the vicinity of the Brickworks, is inundated by over 3 metres.

Flow velocity throughout the vast majority of existing development in Wingham west of the peninsula remains slow, with peak velocities less than 0.1 m/s. Localised flow velocities along the eastern sides of Mortimer Street see increases in peak values of up to 0.8 m/s as flow from Cedar Party Creek expands into low areas. Some localised areas on the east side of Queen Street North and Primrose Street also experience a similar expansion in flow, with velocities increasing to 0.2 m/s in some instances.

As seen in the previous sections, the trend for flow to increasingly break from the Manning River across southern portions of Wingham Peninsula continues. Expanding flows break across the Peninsula beginning in the vicinity of Farquhar Street near the Nature Reserve. This flow is directed across to the gully between East Combined and Appletree Streets. Peak Velocities through existing developments on the southern side of East Combined Street are generally less than 1.1 m/s; however some properties on the banks of the Manning River experience velocities in excess of 1.5 m/s. Properties on the north side of East Combined, Guilding and the east end of Appletree Street experience peak flow velocities that do not exceed 0.4 m/s. In the remaining inundated portions of the Peninsula, on the west end of Appletree, West Appletree, Keech and Ruth Streets, peak flow velocities do not generally exceed of 0.1 m/s.

Less than 3% of Manning River flows expand onto Wingham Peninsula. This shows that although the peak velocities are higher than the rest of Wingham, only a relatively small portion of the total Manning River flow expands over the peninsula.

The peak rate of rise of floodwaters is in the order of 1.1 metres per hour, however the average rate of rise of floodwaters, is closer to 0.5 metres per hour.

2.3 Extreme Flooding

An extreme flood would produce levels that approach 23 throughout the majority of Wingham.

Large portions of Wingham are inundated including all of Wingham Peninsula. North of the railway line, all areas east of Marlee Street are inundated. This includes all of Marlee Street and Queen Street North, as well as large portions of Mortimer, Flett, Price and Belbowrie Streets. Some areas south of Mortimer Street, including portions of Killawarra, Allan and Irvine Streets are inundated. In the vicinity of Stony Creek, northern portions of Pearson, Killawarra, Abbott, Richardson and Belbowrie Streets are inundated. Between Stony and Cedar Party Creeks, the inundation extends up Comboyne Road to Racecourse Road. On the eastern side of Cedar Party Creek, a large portion of Wingham Road is inundated as well as portions of Youngs Road.

In central Wingham, the majority of areas east of Queen Street North are inundated. This includes all of Combined, Isabella, Primrose and Mortimer Streets, as well as large areas of Farquhar, Queen, Dennes, Wynter, Bent, Lobban, William and Fotheringham Streets and Bungay Road. Floodwaters extend onto northern portions of Central Park although the majority remains unaffected. More elevated areas to the south, including the portions of Farquhar and Bent Street to south-west of the Central Park also evade inundation although this area becomes isolated by flow in the Manning River that overtops Bungay Street.

Peak velocities in excess of 3 m/s flow over Bungay Road near Fotheringham Street. These rapidly decrease to 0.5 m/s at William and Canget Street as the flow continues north into the large inundated area of central Wingham. Peak flow velocities decrease rapidly to below 0.2 m/s for the majority of north, west and central Wingham with some increases of up to 4 m/s. Peak flow velocities in the vicinity of Wingham High School exceeds 1.5 m/s. South-east of the high school, expanding flow over Wingham Peninsula has peak velocities near East Combined Street between 2 and 4 m/s. Peak flow velocities along the northern side of East Combined Street and Guilding Street is between 1 and 2 m/s. Peak flow velocities on Steele Street and east along Appletree Street are generally less than 0.8 m/s where flows start to slow as they meet expanding flow from Cedar Park Creek. West of Steele Street, peak velocities along Appletree Street do not generally exceed 0.4 m. Along Wingham Road north of the Railway line, flow velocities do not exceed 0.2 m/s and on Young's Road are in the order of 0.4 m/s.

The peak rate of rise of floodwaters is in the order of 3.5 metres per hour; however the average rate of rise of floodwaters is closer to 1.3 metres per hour.

Over 15% of Manning River flows expand onto Wingham Peninsula whilst less than 0.2% expands into central Wingham via the overtopping of Bungay Street.

During the rising limb of an extreme flood, the following areas of Wingham become isolated:

- **Mortimer Street**
    - Occurs for most flood risks during the very early stages of flooding as an initial result of Cedar Party flows
    - Isolates properties on Mortimer Street between Primrose Street and Cedar Party Creek
    - Safe evacuation would be extremely difficult due to the time of isolation. Self-evacuation would become readily impractical (no rising egress).
- **Flett, Primrose and Mortimer Streets by the inundation of the intersection between Primrose and Combined Streets**
    - Occurs for most flood risks during the early stages of flooding as a primary result of Cedar Party flows
    - Isolates properties on these streets bordered by the Flett Street Bridge, Cedar Party Creek and Combined Street
    - Safe evacuation possible on foot with some access modifications

- **Combined Street just east of Primrose Street**
    - Occurs for most flood risks during the early stages of flooding as an initial result of Cedar Party flows
    - Isolates properties on Combined Street between the intersection of Primrose Street and a large gully
    - Safe evacuation possible on foot, with appropriate planning and active response
- **West Appletree Street**
    - Occurs for most flood risks during the early stages of flooding as an initial result of Cedar Party flows
    - Isolates properties on West Appletree Street
    - Safe evacuation possible on foot with some access modifications, although if a choice to remain is made, safe self-evacuation becomes readily impractical (western parts have no rising egress).
- **East Combined and Guilding Street**
    - Occurs over a relatively short time frame as a result of Manning River backwater flows
    - Isolates properties on Guilding Street and the eastern half of East Combined Street
    - Safe evacuation possible with appropriate planning and active response, although if a choice to remain is made, safe self-evacuation becomes readily impractical (no rising egress).
- **East Portions of Wingham through the inundation of the intersection between Isabella and Rowley Streets**
    - Occurs over a medium time frame by expanding Manning River flows
    - Isolates properties on Rowley, Ruth , Keech, West Appletree Streets as well as Wingham Peninsula (and evacuates located at the High School)
    - Primary evacuation route to the flood risk-free areas of Wingham
    - Safe evacuation possible with appropriate planning, active responses and some access modifications
- **Steele Street**
    - Occurs over a medium time frame as a result of Manning River backwater flows
    - Isolates properties on Steele Street
    - Safe evacuation possible with appropriate planning, active responses, however when fully isolated it would become difficult
- **Wynter Street north of the railway line**

- Occurs over a long time frame as a result of Manning River backwater flows
- Isolates approximately 30 houses by cutting off access to Young's Road
- Some flood risk-free areas available for safe evacuation

- **Central Park and the elevated areas surrounding it to the south**
  - Occurs over a long time frame at the peak of the extreme flood as a result of Manning River flows overtopping the bank near Bungay Road
  - Temporarily isolates the primary evacuation point of Wingham but cutting Bungay Street

3. HAZARD CATEGORISATION

Flood Hazard categorisation provides an indication as to the severity of risk and therefore which areas require floodplain risk management strategies to be developed.

A comprehensive analysis of flood hazard requires the detailed assessment of factors such as;

- Depth and Velocity of Floodwaters
- Rate of Rise of Floodwaters
- Effective Warning Time
- Effective Flood Access
- Duration of Flooding

Other important factors which are less quantitatively defined include:

- Flood Readiness
- Evacuation Problems
- Type of Development

According to the Floodplain Development Manual, Appendix L, the first step and primary influence on flood hazard can be based on the depth and velocity of floodwaters.

The manual's approach to hazards involves two categories, "low" and "high" which are termed the "Provisional Hydraulic Hazard Categories". This process then combines these categories with a parallel hydraulic categorisation of the site, which provides a qualitative description of flood behaviour. This categorisation is utilised in the *Greater Taree City Council DCP 2010*.

The "Provisional Hydraulic Hazard Categories" are defined as follows:

- **Low Hazard**; depth < 1.0 m and velocity < 2.0 m/s as a base (in addition, part of the low hazard zone forms the transitional zone where, as the FPDM states, the degree of hazard is dependent on site conditions and the nature of the proposed development)
- **High Hazard**; all outside this range

This is shown graphically in Figure 4.

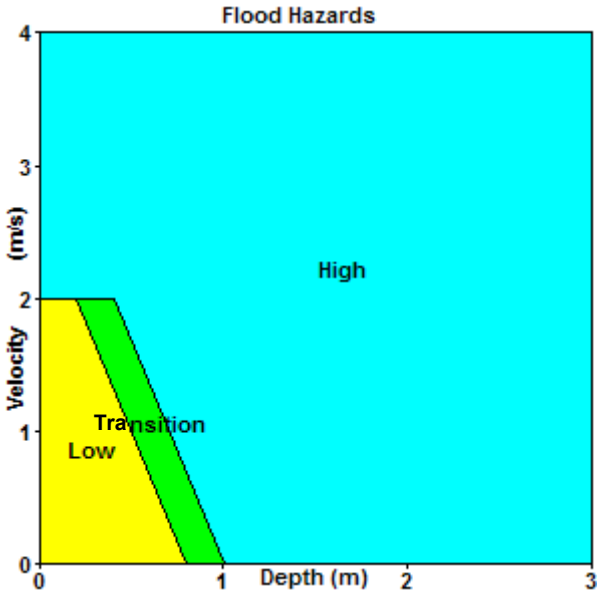


Figure 4: Provisional Hydraulic Hazard Categories (from the FPDM)

An alternative approach to these provisional hydraulic hazard categories was used in this report so as to provide greater information about the hydraulic hazards in Wingham. These alternative hydraulic hazard categories are summarised as follows:

- **Low Hazard**; depth < 0.4 m and velocity < 0.5 m/s
    - Limit for the stability of cars
- **Medium Hazard**; depth < 0.8 m, velocity < 2 m/s and velocity times depth < 0.5 m^2/s
    - Limit for the stability of heavy vehicles
    - Safe wading of able bodied adults
- **High Hazard**; depth < 1.8 m, velocity < 3m/s and velocity times depth < 1.5 m^2/s
    - Limit for the stability of light framed construction (timber frame, brick veneer, etc.)
- **Very High Hazard**; velocity > 0.5m/s and < 4m/s and velocity times depth < 2.5 m^2/s
    - Limit for the stability of heavy framed construction (steel frame, etc.)
- **Extreme Hazard**; velocity times depth > 2.5 m^2/s with a minimum velocity of 0.5 m/s
    - Development considered unsuitable and likely to adversely impact flood levels

This is shown graphically in Figure 5.

These hydraulic hazard categories essentially measure the amount of energy associated with a location for a given flood. This method is based on quantities derived from the Flood Study and therefore there is little, if any, subjectivity in defining these. Provisional hydraulic hazard maps for Wingham using this alternative scheme are shown in Figure 6 and Figure 7.

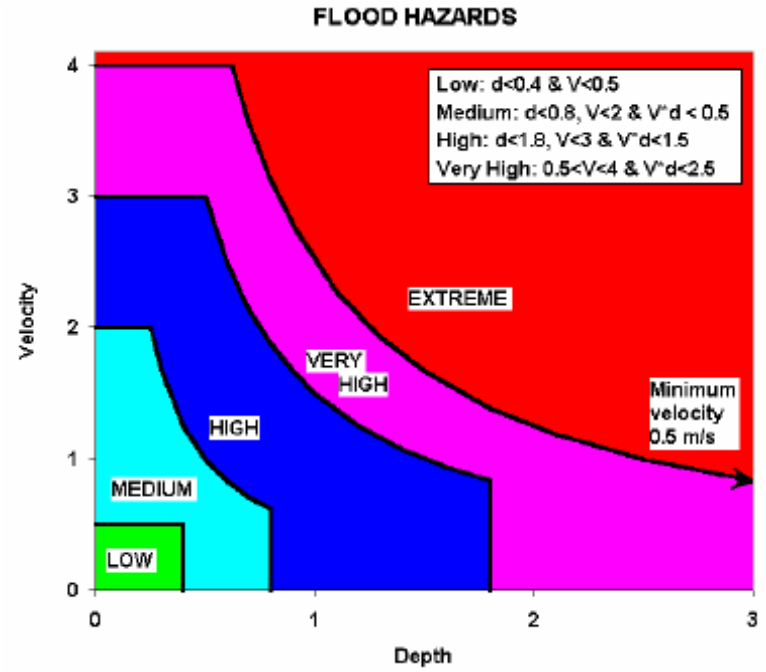


Figure 5: Alternative provisional hydraulic hazards

As mentioned, these provisional hydraulic hazards are then used as a basis for determining the true hazards at a given location by considering other quantitative and qualitative factors. This typically includes the use of hydraulic category maps where “Floodway”, “Flood Storage” and “Flood Fringe” areas are designated. These hydraulic categories are mentioned in the FPDM and the GTCC DCP 2010.

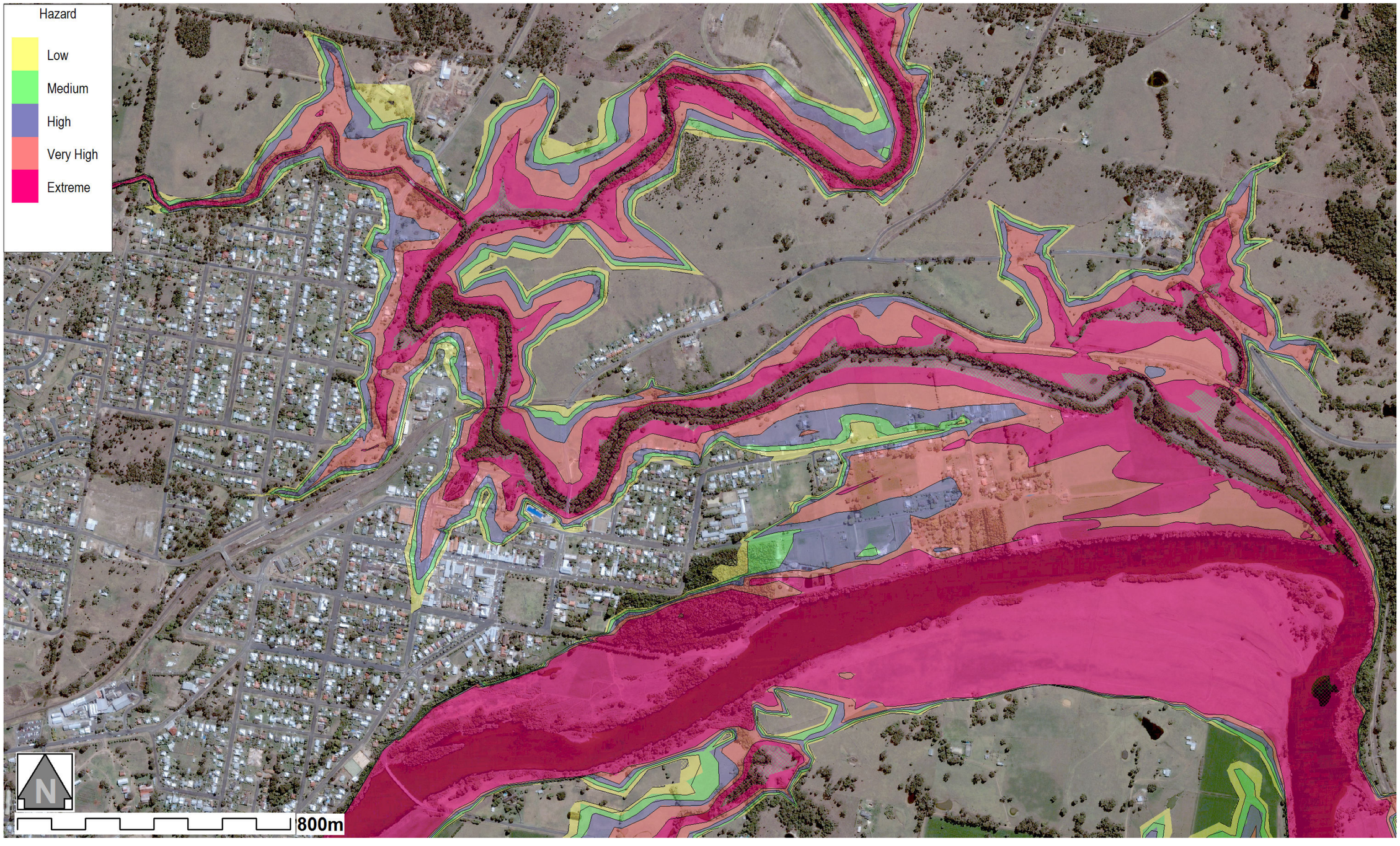


Figure 6: Provisional Hazard Map of Wingham based on the 1% AEP event

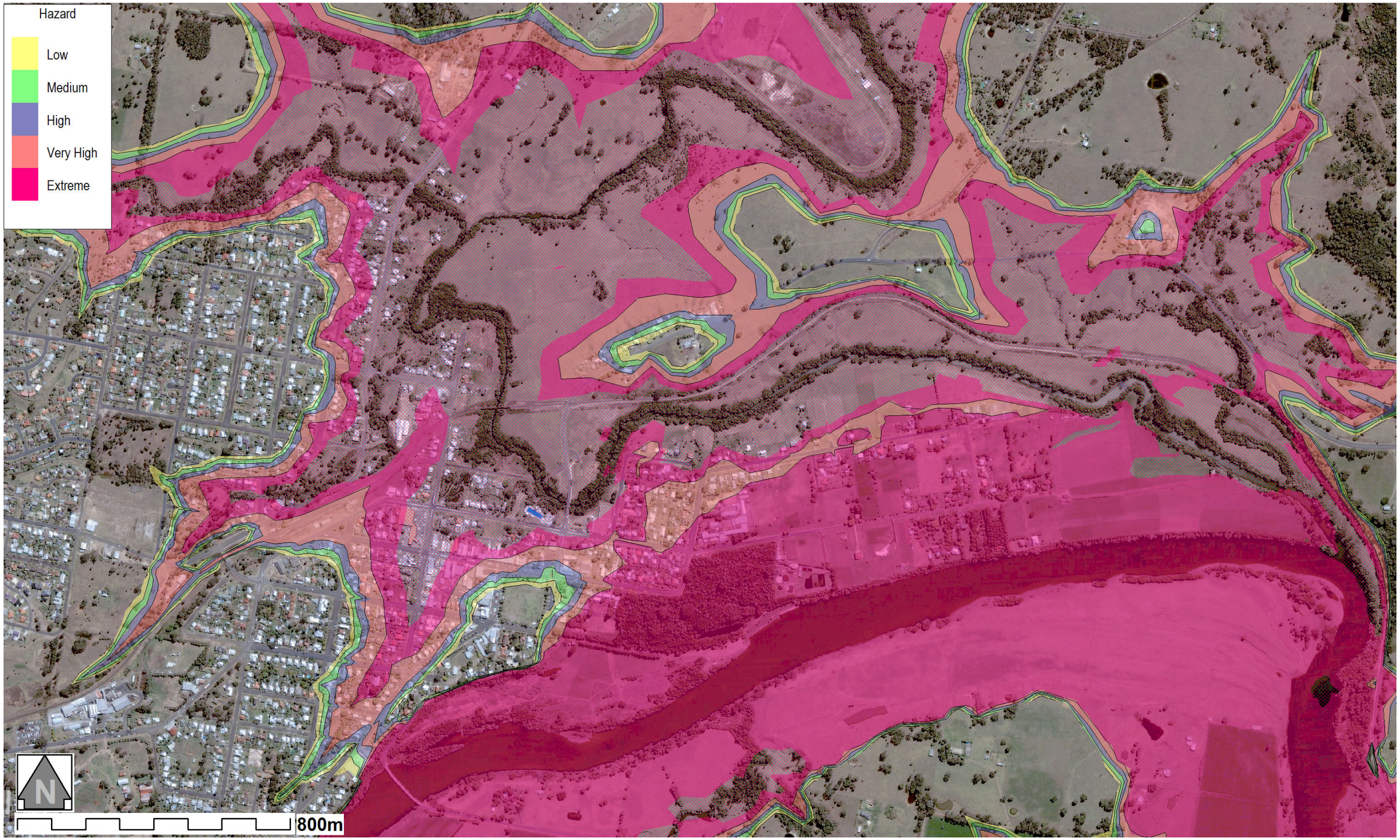


Figure 7: Provisional Hazard Map of Wingham based on the PMF

4. CONSEQUENCES OF FLOODING IN WINGHAM

The Wingham Floodplain Risk Management Study detailed the cost of flooding in Wingham. The following is a summary of this.

There are two basic components of flood damage;

1. **Tangible damages** result in direct, measureable, financial costs such as property damage but also indirect costs such as those associated with the clean up as well as financial costs such as loss of wages/business.
2. **Intangible damages** are those costs on the communities that are more difficult to quantify, such as the trauma and stress associated with flooding.

4.1 Tangible Damages

Tangible flood damages are comprised of direct and indirect costs. The direct costs may include:

- **Internal Contents Costs**; associated with the damage, repair and replacement of household contents such as furniture, electrical equipment, clothing etc.
- **Internal Structure Costs**; associated with the damage, repair and replacement of household components such as carpet, flooring, cupboards, doors, walls etc.
- **External Property Costs**; associated with the damage, repair and replacement of sheds, fences, driveways, gardens, vehicles etc.
- **External Structure Costs**; associated with the partial or complete destruction of a dwelling

The indirect costs may include:

- **Clean-up Costs**; associated with individual properties or the community as a whole
- **Financial Costs**; associated with loss of wages, sales, production

To calculate the tangible damage associated with flooding in Wingham the following information was used:

a) **Peak flood levels throughout the study area for the full range of design floods**

b) **Property floor levels**; these were obtained through previous studies, WorleyParsons site surveys or estimates for all properties within the bounds of the 1% AEP flood

Wingham Damage Curves; which gives the cost per increment of depth for several different types of residential properties in Wingham. This was estimated using the Department of Natural Resources calculation program, in combination of information from the Bureau of Statistics, Rawlinson's and data collected by WorleyParsons through site visits.

Properties within the Very High to Extreme hazard categories were considered to have a chance of complete destruction due to the energy associated with the flood velocity and depth. The potential for this destruction was expressed as a range with a sensitivity of 25% and 75%; that is the actual house

destruction was set at 25% and 75% of the number of houses experiencing Very High or Extreme hazard. Table 1 shows the tangible flood damages over the range of design floods for Wingham.

Table 1: Estimated Tangible Flood Damages in Wingham; Manning Catchment Flooding[1]

Flood AEP	No. houses with over floor flooding	No. of houses within a 'Very High' or 'Extreme' Hazard	No. of houses potentially destroyed	Tangible Damages (no house destruction)	Total Tangible damages
5%	50	2	0 to 2	$1,025,000	$1.24M to $1.46M
2%	94	17	4 to 13	$3,775,000	$4.64M to $6.60M
1%	118	37	9 to 28	$5,750,000	$7.70M to $11.82M
0.5%	145	86	22 to 65	$11,175,000	$15.95M to $25.28M
PMF	159	159	40 to 119	$23,975,000	$32.65M to $49.80M

4.1.1 Average Annual Damages

Over a long period of time, Wingham will be subject to a variety of floods leading to a variety of damage. The annualised average of the damaged (AAD) for all floods over a very long period of time is a useful measure of the likely long term costs of flooding in Wingham, and was used to assess mitigation options in the floodplain risk management study in terms of the benefit provided to the community.

The AAD is determined by plotting damage costs against the design flood exceedance probabilities and determining the area under the curve.

Similar to common financial assessments, the present value of potential flood damages can be determined through a net present value analysis of the AAD, typically over a planning horizon of 50 years. Treasury guidelines specify a discount rate of 7% for this analysis with a sensitivity assessment of ± 3%.

Table 2 summarises the AAD over a 50 year planning period in Wingham and provides a total present value in 2010 Australian Dollars (PV) using an average treasury-defined valuation change rate of 7%.

Table 2: Average Annual Damages and Present Value of this over 50 years for Wingham in 2010 dollars[1]

	AAD	PV (7%)

[1] *It must also be remembered that only a selected number of houses (159) were used in these calculations. This number represents all houses within the fringe of the 1% AEP flood extents and therefore the cost of flooding in Wingham for events in excess of the 1% AEP will likely have greater costs. This however does provide a good indication for measuring the benefit of floodplain risk management strategies as the Council's FPL is in line with the 1% AEP.*

Cedar Party Sub-Catchment Alone	$68,000 to $104,000	$942,000 to $1.43M
Manning Catchment	$331,000 to $494,000	$4.56M to $6.81M

In other words, for a 50 year planning period assuming the current level of development remains constant, the average annual cost of flooding in Wingham will be in the order of $331,000 to $494,000. The total present value of this over the next 50 years is between $4.56 million and $6.81 million.

4.2 Intangible Damages

Flooding imposes a range of damages on victims that are difficult to put a monetary value to. These are known as intangible damages and have proven to be significant when large floods occur. These damages are associated with the emotional, mental and physical health of flood victims and studies have shown that these damages ultimately derive from the financial and social impact of flooding but in general can be associated with:

- loss of life
- personal injuries
- disruption to the personal and work lives
- Disruption to essential services such as schools, power, water, sewerage etc.
- opportunity losses such as those resulting from the suspension of education and government services
- environmental damage

Intangible damages have the added detriment that they have been shown to potentially linger for many years after a large flood.

4.3 Risk to Property and Life Issues in Wingham

Existing and continuing flood risk are much more difficult to manage than future flood risk because of a conflict between what *should* be done with flood prone location as opposed to what has *already* been done.

Therefore, in order to understand the flood mitigation strategies, the risk to property and life for existing development in Wingham needs to be further discussed.

From the results of the Flood Study, with regard to risk to property, there are:

A) 6 properties in Wingham that face a flow depth and velocity that would likely lead to the partial or complete destruction of the property (that is, located in an area of “extreme” hazard according to the 1% AEP event). This represents an unacceptable risk to life for the occupants of these properties.

B) 31 properties that are either completely within a “very high” hazard area or partially within a “very high” hazard area that also experiences a flow velocity of at least 0.5 m/s. These properties are

subject to a very large depth of floodwater (up to 4 metres) with small to moderate velocity that poses a potential risk to life for the occupants of these properties.

The most extreme flood event is used to evaluate the likely risk to life that evacuation places on occupants and / or rescuers. From the results of the Flood Study, with regard to risk to life[2], there are:

C) 8 properties[3] are isolated very early, before adequate warning based on river levels is available. These properties are isolated by flows from the Cedar Party Creek catchment that do not subside prior to levels rising in the Manning River and reaching the SES 'Major Flood'[4] level at Bight Bridge. These properties represent a significant problem for evacuation as warning times may have to be related to rainfall and evacuation may need to be undertaken before a waterway begins to significantly rise.

D) 51 properties would have less than 3 hours to evacuate *after* the SES 'Major Flood' level was reached at Bight Bridge

E) 94 properties would have at least 3 hours to evacuate, *after* the SES 'Major Flood' level was reached at Bight Bridge

Of all these properties, a significant portion would require an SES managed evacuation or rescue due to the extreme hazards that arise if occupants do not evacuate within the required time.

Those affected by Cedar Party Creek, where a managed evacuation may not be possible due to the small effective warning time, would need to self-evacuate within a short time frame.

In categorising these properties, it has been assumed that the upgrades to evacuation routes, listed in subsequent sections, have been made. These works represent some basic upgrades to the primary evacuation routes used for many properties and would increase the evacuation risk for many properties in Wingham if not undertaken.

[2] The maximum time has been based on safe-wading for an able bodied adult and therefore would be greater than the time required for vehicular evacuation, the elderly or impaired.

[3] The number of properties potentially affected in this category depends on the rainfall distribution over the catchment and the resulting time difference in peak levels between the Cedar Party sub-catchment and the greater Manning Catchment (8 properties represents the likely number considering the historic difference in peak levels which was used to model the design flood events).

[4] The SES 'Major Flood' level at Bight Bridge is taken from SES's Wingham "FloodSafe Guide" and is 11.9 m

5. SUMMARY OF FLOODPLAIN RISK MANAGEMENT STRATEGIES

The following table provides an outline of the floodplain risk management strategies that were selected by the GTCC Flood Committee from the floodplain risk management study. These 13 strategies represent an approach that will mitigate the present, future and existing flood risk in Wingham. Subsequent sections give further details of each strategy.

Floodplain Risk Management Strategy		Key Idea(s)
1	Evacuation route from the end of West Appletree Street to the Rowley Street stairs	Improves access to the existing stairs used for evacuation of West Appletree Street.
2	Evacuation route between Combined and Isabella Streets (bypassing the Rowley and Isabella Street intersection)	The elevation of the intersection of Rowley and Isabella Streets is lower than surrounding terrain making this primary evacuation route potentially hazardous during a large flood. A footpath along the crest of the hill between Combined and Isabella Streets would improve evacuation access.
3	Evacuation route between Mortimer and Combined Streets (bypassing the Primrose and Combined Street intersection)	The elevation of the intersection of Primrose and Combined Streets is lower than surrounding terrain making this primary evacuation route potentially hazardous during a large flood. A footpath near the railway line between Mortimer and Combined Streets would improve evacuation access.
4	Guide posts along primary evacuation routes	High visibility guide posts along primary evacuation routes would improve evacuation access.
5	Flood Access to Individual Properties	Some properties do not have a rising egress route connecting to a local evacuation route. This option would provide information and possibly encouragement through financial assistance to improve accessibility.
6	Steele Street access via the High School Grounds	Designated evacuation route through Wingham High School for properties on Steele Street.
7	Combined Street access to Isabella Street via a shopping arcade	Designated evacuation route along the crest of the hill from Combined Street through existing shopping arcades on Isabella Street.
8	Voluntary House Purchase (VHP)	Fair, voluntary, financial compensation allowing for the removal of high flood risk existing development, reducing the risk to life and property. Six properties have been listed for potential participation in this scheme.
9	Development Controls and Zoning	The land purchase in the VHP scheme and other very high or extreme flood risk areas should be appropriately controlled to ensure their safe use.
10	Voluntary House Raising (VHR)	Fair, voluntary, financial compensation that will reduce the tangible costs of flooding on existing development that does not pose a risk to life for occupants. Three properties have been listed for potential participation in this scheme.
11	Flood Prediction and Warning	The addition of a flow or level gauge within the Cedar Party Creek catchment.
12	Flood Education and Community Awareness	Education about flood risk, flood warning, evacuation and the role of the SES.
13	Local Flood Planning	The development of SES evacuation plans based on updated flood data.

6. DETAILS OF FLOODPLAIN RISK MANAGEMENT STRATEGIES

General Note on Flood Access Works

In coastal regions, where floods occur over relatively small time scales, adequate flood access and evacuation is essential for managing the flood risks to life. Whilst it may be acceptable for some areas to become isolated during a minor flood, safe evacuation routes need to be available in the event of more extreme flooding. A number of areas in Wingham where improvements should be undertaken were identified by using the time-varying flood study data for an extreme flood.

The financial benefit of these works is difficult to measure because it would be reflected in the cost of other floodplain management options (such as Voluntary House Purchase) and flood risk to life as a whole.

Figure 8 shows the locations of flood access works in Wingham (Strategies 1to 7 in the table in Section 5).

The availability and any potential legal requirements of using the land proposed would need to be investigated further. Cost estimates (reasonably) assume that the land is Council-owned.

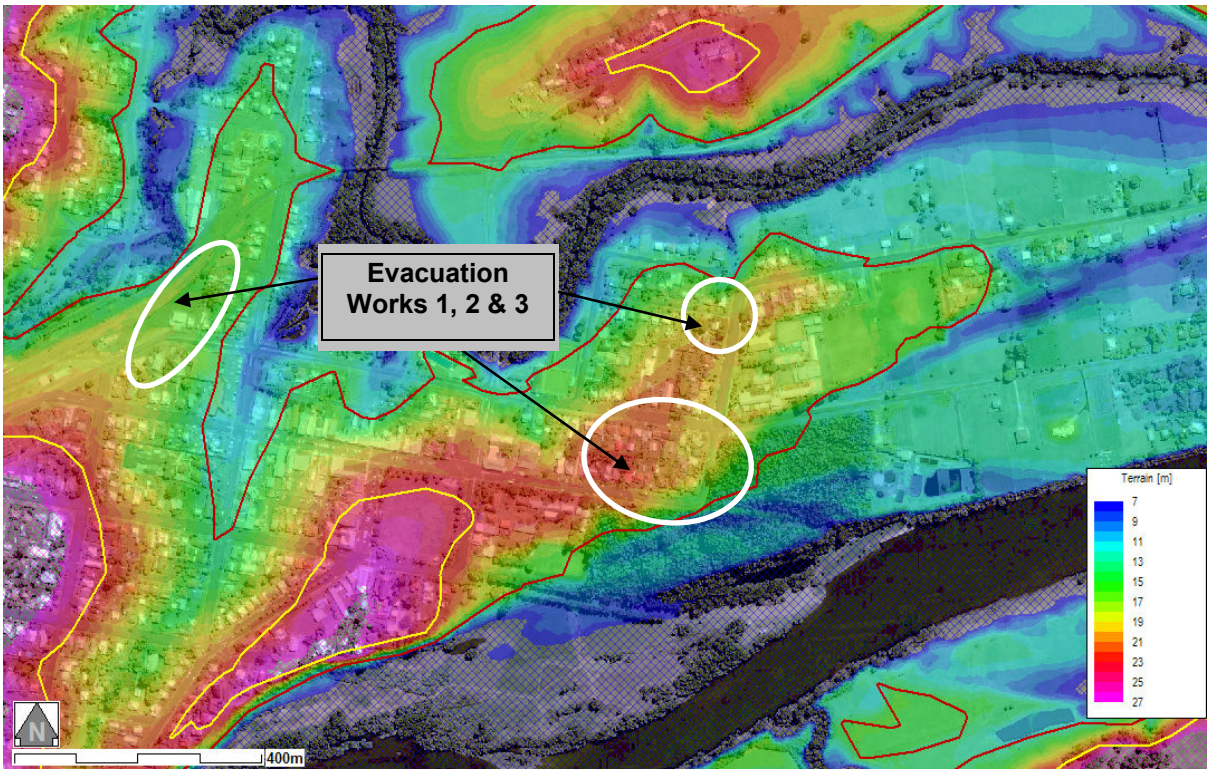


Figure 8: Location of flood access works strategies 1, 2 and 3 showing the terrain elevation; the 1% AEP flood extents are shown in red whilst the PMF extents are shown in yellow.

Strategy 1. Evacuation route from the end of West Appletree Street to the Rowley Street stairs

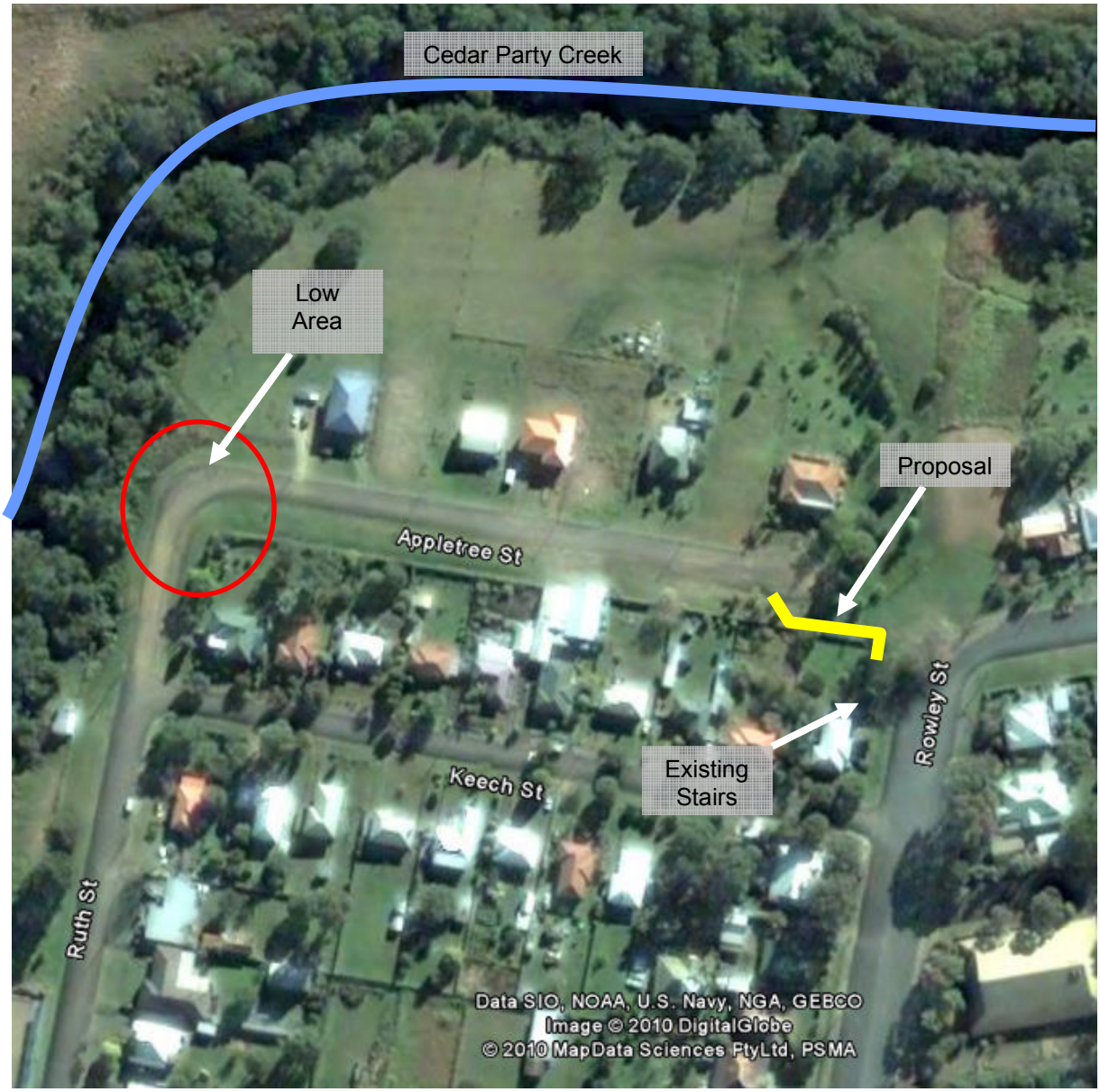


Figure 9: Location of the proposed footway connecting West Appletree Street with Rowley Street in order to bypass the low area.

West Appletree Street becomes isolated by the relatively early inundation of northern Ruth Street. It is understood that stairs were installed following the previous Floodplain Risk Management Plan that give access to Rowley Street; however after the inundation of West Appletree begins, residents must walk or wade across some undeveloped land to access these stairs. Some variations in the topography of this land, combined with the likely effects of intense rainfall make this less than ideal. To enable the safe evacuation of occupants on West Appletree with a rising egress route, a footway

should be built through this undeveloped land, linking West Appletree Street with the stairs that give access to Rowley Street.

The length of this proposed route is approximately 20 metres and would require some fill to ensure the ground is uniform. The width of the footway should be determined in conjunction with the available space but should not be less than 2 metres and should contain high visibility bollards along its length.

The total cost of the footway between West Appletree Street and Rowley Street, using the aforementioned design criteria is approximately $6 940. This was estimated based on data derived from Rawlinson's, 2008.

Strategy 2. Evacuation route between Combined and Isabella Streets (bypassing the Rowley and Isabella Street intersection)

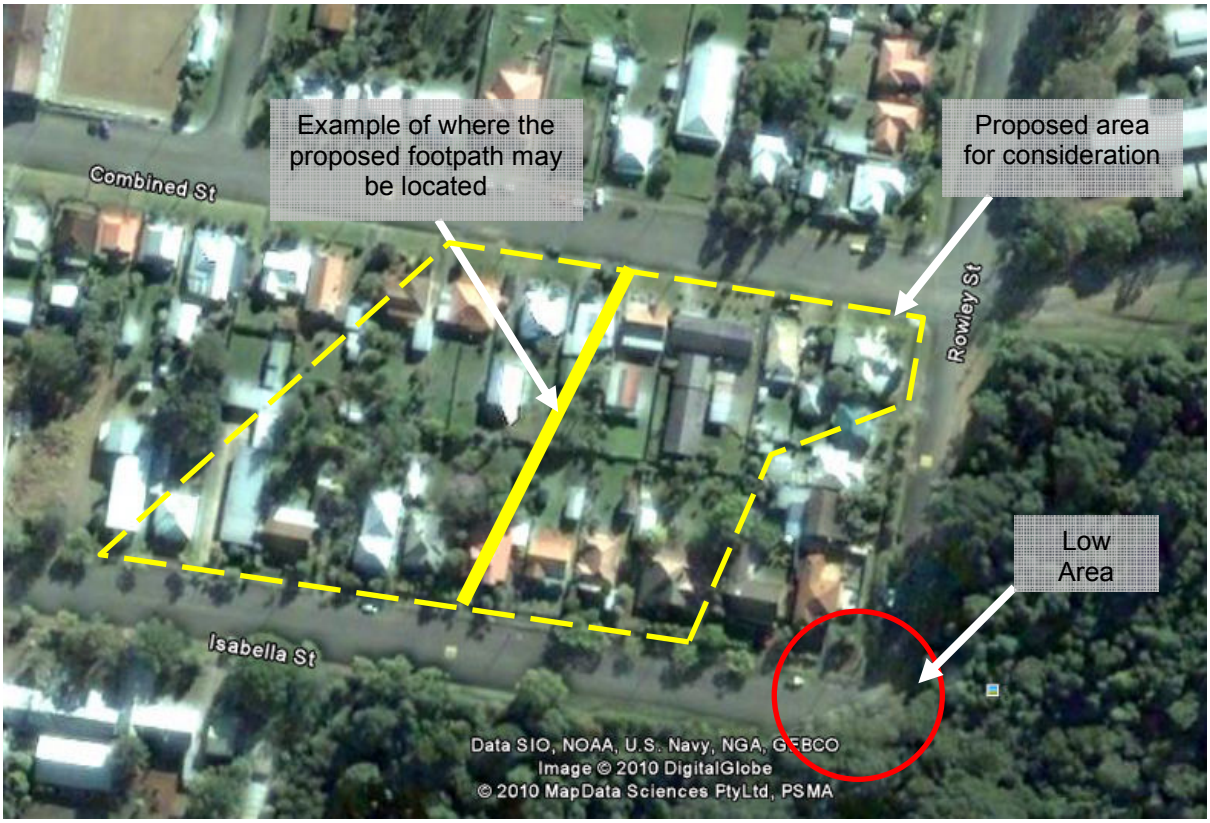


Figure 10: Location of the proposed footway connecting the high ground on Combined and Isabella Streets in order to bypass the low area at the intersection of Rowley and Isabella Streets.

The evacuation route for Wingham Peninsula, Rowley, Ruth, West Appletree and eastern parts of Combined Street becomes increasingly inundated at the intersection of Rowley and Isabella Streets for flood risks in excess of the 2% AEP. Evacuation along Combined Street is not possible due to the inundated of the Wynter Street intersection much earlier.

In an extreme flood, the hazard at the Isabella-Rowley Street intersection becomes extreme, completely isolating the elevated properties to the north. Eventually, flow inundates the isolated region. The need to maintain a rising egress route at this location is deemed essential as it could potentially affect 130 households, considering that Wingham High School is used as an evacuation point.

Raising the road at this location would be expensive because it would require the purchase or detailed modification to several adjacent properties.

Instead it is proposed that a footpath evacuation route be implemented between Combined and Isabella Street in the region shown on Figure 10. This region represents an area with an elevated topography and it is understood that some land in this region may be State Government Authority

Owned. This proposal would therefore require the purchase of a private property or a swath of land backing onto the State Government Authority owned property (however to maintain a conservative cost estimation approach, it has been assumed that a property is purchased in its entirety). An example of where a footpath may be located within this region is also shown on Figure 10.

Both properties would require partial modification allowing for the implementation of a continuous footpath between Combined and Isabella Streets. This may require the demolition and removal of some of the buildings on these properties. Any land that is “left-over” could be maintained for Council / State Government use or sold to recuperate costs. To maintain a conservative cost approach, it has been assumed that both properties would require demolition and any excess land was kept by the relevant authorities.

The length of this proposed route is approximately 90 metres. The width of the footway should be determined in conjunction with the available space but should not be less than 2 metres and should contain high visibility bollards along its length.

The total cost using the aforementioned criteria, is approximately $402 000. This was estimated based on data derived from Rawlinson’s, 2008.

Alternatively, a low-cost possibility could involve a Right of Way or easements for pedestrian access through private properties or extending from the State Government Authority land. This approach could minimise the costs involved considerable.

Strategy 3. Evacuation route between Mortimer and Combined Streets (bypassing the Primrose and Combined Street intersection)

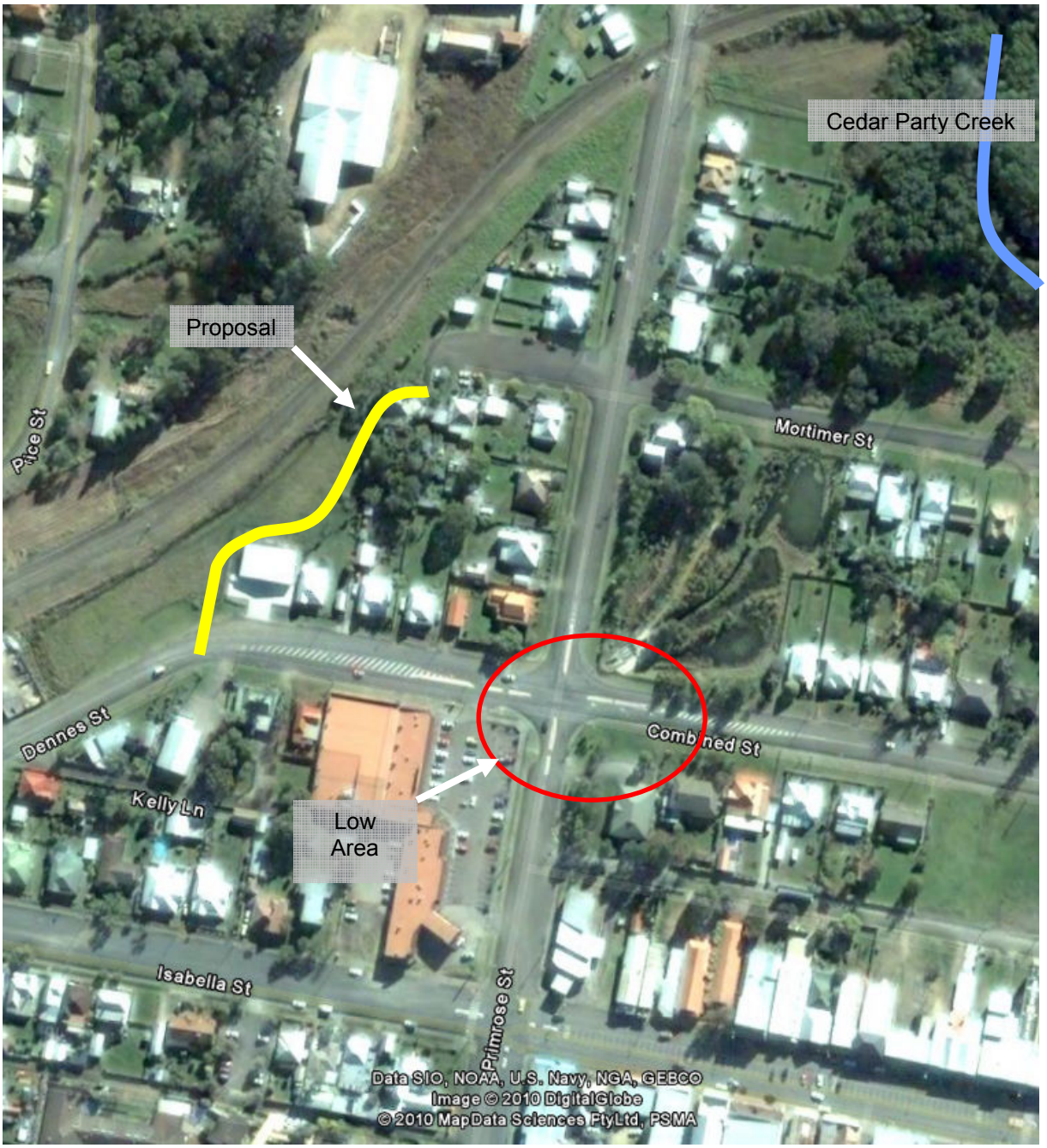


Figure 11: Location of the proposed footway connecting Mortimer and Combined Streets in order to bypass the low intersection of Primrose and Combined Streets.

The intersection of Combined and Primrose Streets becomes increasingly inundated during the early stages of flooding which leads to the isolation of at least 33 residences to the north. For more extreme

flood events, this isolated region becomes fully inundated. The alternative evacuation route, via the Flett Street Bridge, also becomes inundated in the early stages of flooding.

In order to maintain a rising egress route for the isolated properties, a foot path bypass is proposed that connects the high ground at the end of Mortimer Street near the Railway line with Combined Street (adjacent to the Wingham SES building). The footway would pass alongside the railway line and would have a length of approximately 140 metres.

Again, the width should be determined according to available space but should not be less than 2 metres with high visibility guide markers along its length.

The total cost of the Primrose Street footway bypass, using the aforementioned design criteria is approximately $70 400. This was estimated based on data derived from Rawlinson's, 2008.

Strategy 4. GUIDE POSTS ALONG PRIMARY EVACUATION ROUTES

Evacuation may need to take place at night, at which time the power can be expected to have been cut-off by rising floodwaters. This, combined with rainfall and low level floodwater covering evacuation routes, would make wading or driving to safety a significant risk. Therefore, high visibility guide posts should be installed along all primary evacuation routes with an interval of 50 metres or less (in low lying areas subject to more frequent inundation, this spacing could be reduced to 25 metres). Based on a conservative estimate of evacuation routes shown in Figure 12, approximately 120 to160 high visibility guide posts would be required.

If a high quality, light emitting guide post is used, the total estimated cost would be in the order of $180,000. This was estimated based on data derived from Rawlinson's, 2008.

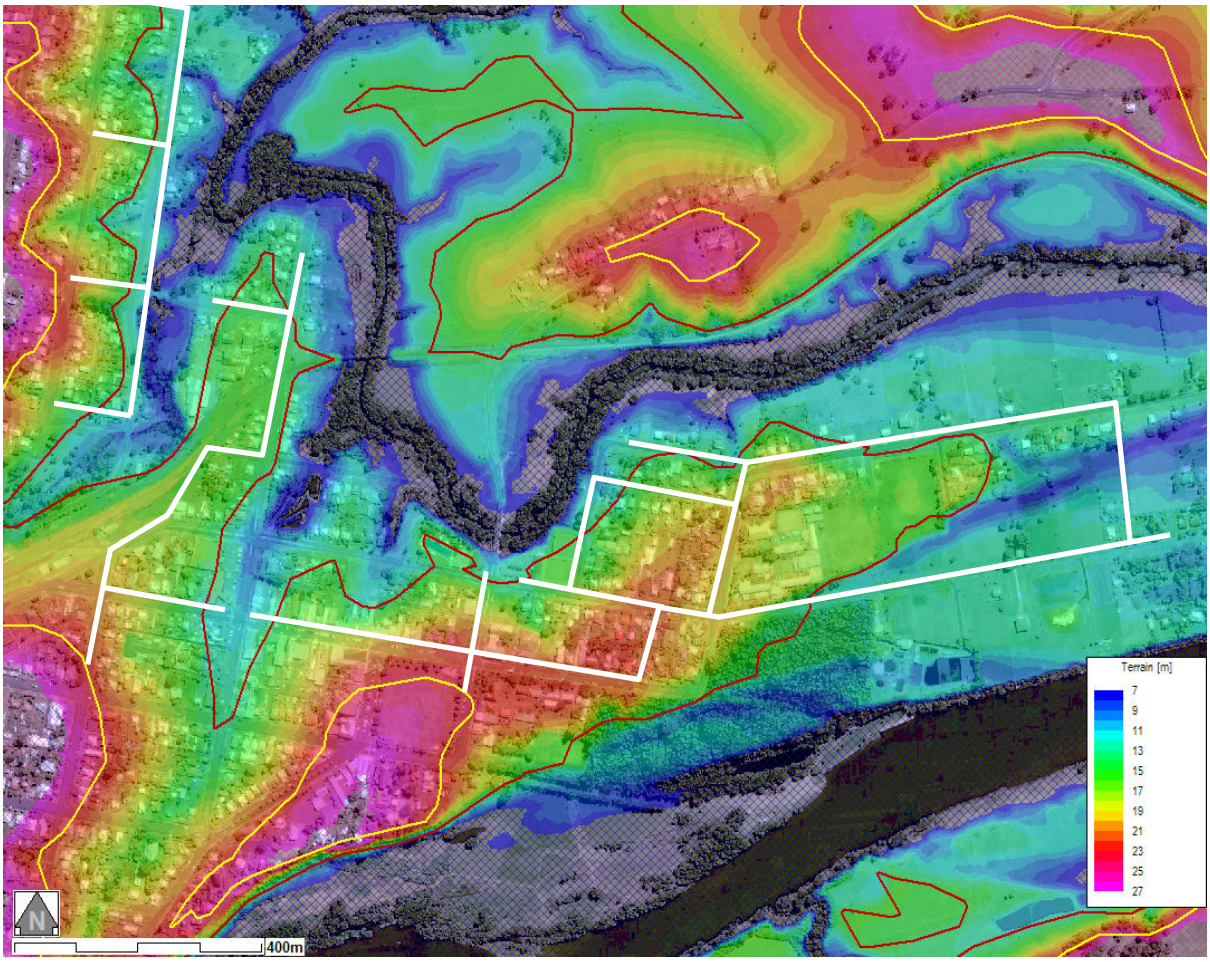


Figure 12: Location of evacuation routes where guide posts should be installed (white). The terrain elevation has been coloured and the 1% AEP flood extents are shown in red whilst the PMF extents are shown in yellow.

Strategy 5. Flood Access to Individual Properties

Whilst a property may have frontage to an evacuation route, securing access to that evacuation route from the dwelling on the property is very important. Some properties in Wingham have long access routes that undulate significantly, meaning that whilst levels in the dwelling and on the adjacent evacuation route may pose a low hazard to evacuation, the link between these may pose a risk to life. This is particularly true for rescue workers who would not be familiar with these undulations when assisting residents to evacuate. Compounded with rain, flowing floodwater and the presence of darkness, can mean that a property's access poses an unacceptable risk to life. Some properties have access routes that vary by several metres in elevation compared with the dwelling elevation and that of the external evacuation route.

Properties where flood access is currently a problem need to be compiled sorted and surveyed. From WorleyParsons' field surveys, ALS data and satellite imagery, it is estimated that at least 25 properties should have their individual flood access improved. These are primarily located on Wingham Peninsula, Primrose Street and Queen Street North. The number of properties may be reduced as some of these properties are located in areas where Voluntary House Purchase is applicable.

Costs will vary depending on the improvements required, but assuming an average site requires 40 m^3 of stabilised fill, the total cost would be in the order of $59,850. This was estimated based on data derived from Rawlinson's, 2008.

Strategy 6. STEELE STREET ACCESS VIA THE HIGH SCHOOL GROUNDS

Steele Street contains several houses elevated well above the majority of Wingham Peninsula. Whilst these properties remain unaffected for more frequent flooding, they do become isolated and eventually are subject to more threatening conditions during extreme flooding. When flooding prohibits evacuation of Steele Street via road, the safest evacuation route involves traversing the sports field of the adjacent High School to the east. Along this route, the elevation decreases by up to 1.2 metres, meaning that evacuation of these properties must be undertaken prior to the realisation of extreme flooding and the inundation of the adjacent school sports fields.

To increase the safety of this potential evacuation route, consideration should be given to the following:

1. Filling of any low points (if any) to ensure the route is level across both sports fields; it is estimated that this would require minimal expenditure
2. Guide posts along the extremities of the field boundary to ensure that evacuates do not stray off into the adjacent gully or low ground (the field may already have a fence of some kind)
3. Evacuation signage indicating the route to be used, including the authorisation of necessary access to the school grounds.
4. Gateway access between Steele Street and the School Ground for disabled access.

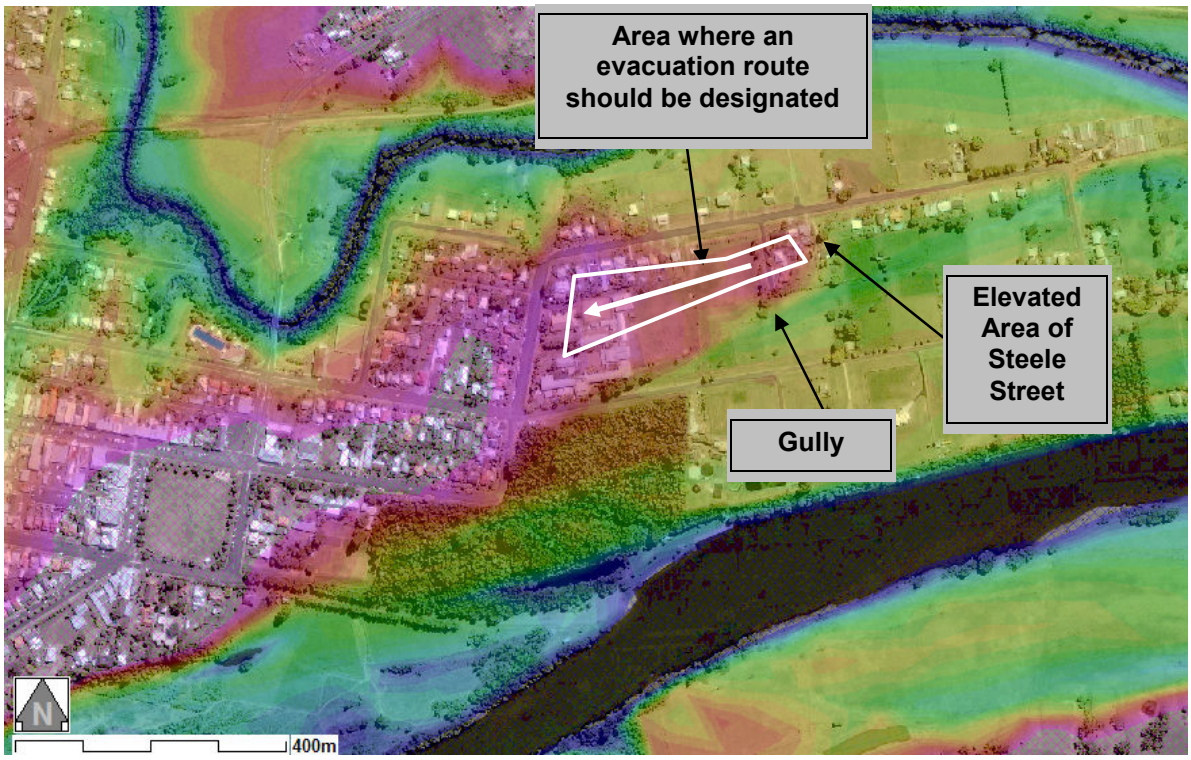


Figure 13: Location of Steele Street showing the terrain elevation coloured. Indicated is an area where an emergency evacuation route should be designated for residents of Steele Street.

Strategy 7. COMBINED STREET ACCESS TO ISABELLA STREET VIA SHOPPING ARCADE

Several houses on Combined and Mortimer Street become isolated and subsequently inundated during more frequent flood events. Whilst evacuation by foot to high ground in the alley between Combined and Isabella Streets is possible, for more extreme flooding this high ground also becomes inundated. To alleviate this isolation, access to this alley through the shops on Isabella Street should be provided. It is understood that shopping arcades exist that link this alley through the Isabella Street and an emergency evacuation route should be designation through this area.

This may require signage indicating the route to be used and the authorisation of necessary access. In addition, this access should be suitable for disabled used.

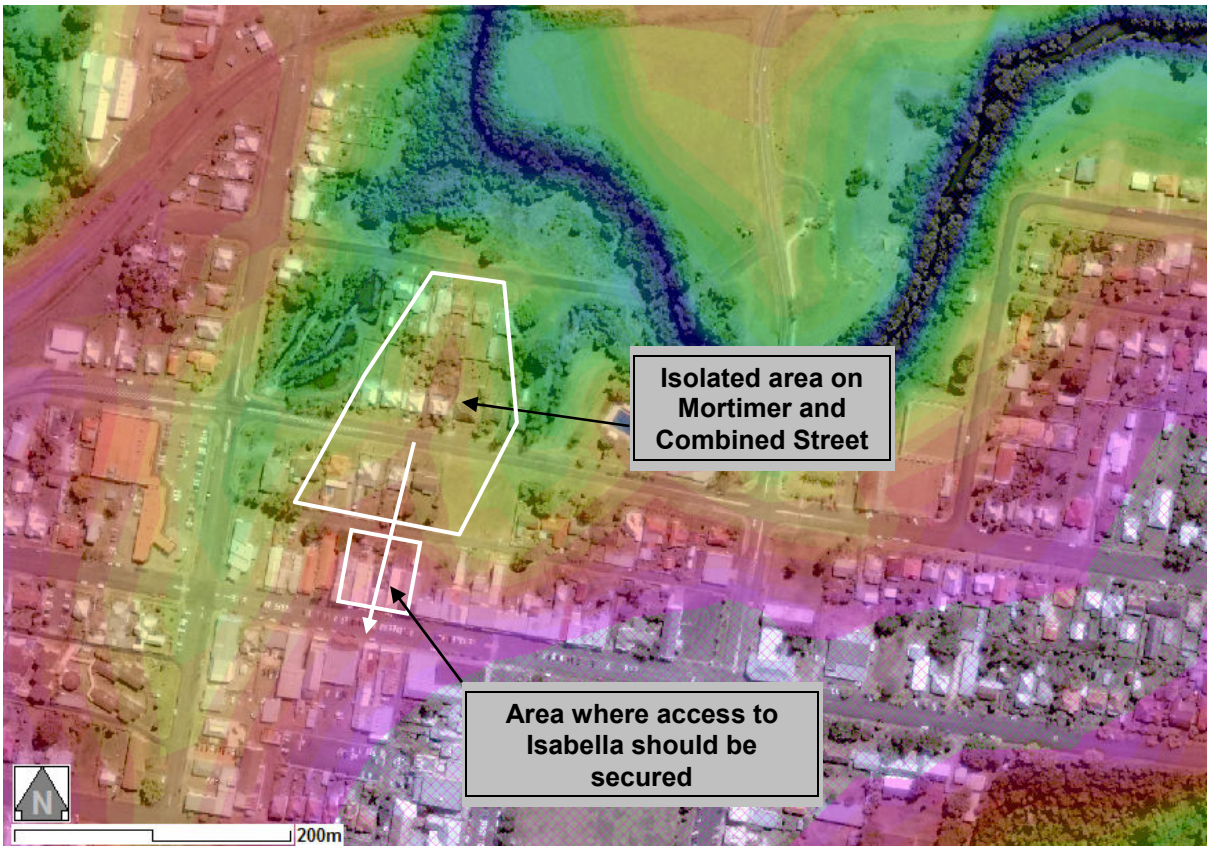


Figure 14: Location of isolated area on Combined and Mortimer Streets showing the terrain elevation coloured. Indicated is an area where an emergency evacuation route should be designated so access to Isabella Street is provided.

Strategy 8. VOLUNTARY HOUSE PURCHASE

In areas where Very High or Extreme hazards exist, there are little practical or economical options that can be employed to mitigate the risk to property and life. One option, that can be used in this case, is the Voluntary House Purchase (VHP) Scheme. It essentially removes the risk by ceasing the occupation of the Very High and Extreme hazard areas. This not only frees the residents of potential danger and cost, but also those in the rescue services who might otherwise be called upon during a flood. The initiative involves the provision of Government financial assistance towards the cost of purchasing the properties.

Purchased properties should be suitably demolished and land consolidation or rezoned according to existing Council regulations (DCP).

VHP ELIGIBILITY AND CONDITIONS

The conditions for VHP are as follows:

1. A fair purchase price is offered; a valuation of the property is obtained from the NSW Valuer General *that ignores all flood hazards at the property*. Therefore the price offered is a fair price in line with the worth of the property to the owner.
2. It is completely voluntary; property owners are provided with their eligibility and have the option to continue living there or accepting the Council's offer to purchase their property.
3. Priorities given; if the number of people wanting to participate in VHP exceeds the annual budget allocated, properties will be prioritised based on the hazards outlined in VHP Eligibility, the age/health of occupants and the date of application.

Houses would be eligible based on the following requirements. They are either:

1. within an area where flood energy would lead to partial or complete destruction of the property (that is, according to points A) and B) of Section 4.3 where the property is in a Very High or Extreme hazard according to the 1% AEP event)
2. Within an area of Very High or Extreme Hazard for any flood risk up to the PMF and evacuation places the occupants or rescuers at an unacceptable risk to life. These could potentially be some of the properties listed in points C) through E) of Section 4.3. This would typically be because of an evacuation route:
    a. *descends*; which means that the occupants or rescuers would need to pass through a region subject to more severe hazards in order to evacuate.
    b. *Remains approximately level for a significant distance*; which means that the occupants or rescuers would need to travel a significant distance through a continuing level of hazard that would increase with time. If this distance or the timeframe needed is unrealistic for safe wading and the location of the property is in a region where the rate of rise of floodwater is high, this would constitute an unacceptable risk to life.

Therefore, considering these eligibility requirements and the risk to property and life summarised in Section 4.3, 37 houses should be considered eligible for VHP. Based on condition 3, priority should be given to six properties that lie within an area of “extreme” hazard during the 1% AEP event.

The 6 properties within an “extreme” hazard during the 1% AEP event are (in no particular order):

- 20 – 22 East Combined Street
- 24 – 26 East Combined Street
- 28 – 30 East Combined Street
- 2 Mortimer Street
- 12 Mortimer Street
- 61 Queen Street North

The remaining 31 properties are (in no particular order):

- 10 East Combined Street
- 12 East Combined Street
- 14 East Combined Street
- 16 East Combined Street
- 17 East Combined Street
- 18 East Combined Street
- 21 East Combined Street
- 23 East Combined Street
- 25 East Combined Street
- 27 East Combined Street
- 29 East Combined Street
- 31 East Combined Street
- 33 – 35 East Combined Street
- 39 East Combined Street
- 3 Guilding Street
- 4 Guilding Street
- 5 Guilding Street
- 6 Guilding Street
- 7 Guilding Street

- 8 – 10 Guilding Street
- 12 Guilding Street
- 48 – 50 Appletree Street
- 52 – 54 Appletree Street
- 25 Combined Street
- 37 Combined Street
- 4 Mortimer Street
- 10 Mortimer Street
- 43 Primrose Street
- 11 Flett Street
- 57 Queen Street North
- 59 Queen Street North

Benefits and Limitations to VHP

The following table outlines the benefits and limitations of this option:

Benefit	Limitation
Removes the most extreme risk to life for occupants	Home owners may have a strong sentimental / emotional attachment to their property
Less strain on emergency services	Optional; does not guarantee that a homeowner will take up the offer
A reduction in stress and post-flood trauma	Only a limited number of purchases per year are budgeted for; some homeowners might have to wait
A reduction in tangible costs associated with personal property damage	
Optional; homeowners have a clear choice	
Equitable price offered that does not factor in any flood risk – unlike the wider market	

Cost and Rating

An estimate of $217,000 was used to gauge the cost of VHP based on average regional sales prices. The total cost of VHP would then be in the order of $8.029 million.

Undertaken over a 10 year period, the total present value cost would be $5.62 million (using a 7% average treasury rate). The benefits of the VHP scheme relate to reductions in the average annual damages of $165,000 to $268,000 which in turn generate a present value of $2.27M to $3.69M.

The resulting benefit to cost ratio is between 0.40 and 0.65 if undertaken over a ten year period. This does not take into account the cost of the disposal of the property or the potential financial gain in rezoning and selling the land for appropriate use.

The Wingham Community Survey, output by WorleyParsons and the Greater Taree City Council to the residents of Wingham, showed that a VHP scheme had an average support rating of 61% (amongst those who completed the survey).

The VHP scheme could also be considered to be extended to privately-owned vacant land according to similar applicability rules after the purchase of houses was complete, however this would raise the cost significantly without reducing the tangible costs of flooding.

This may, however, assist in the consolidation of land that can be later re-zoned for appropriate use by Council.

Strategy 9. DEVELOPMENT CONTROLS AND ZONING

Future development within areas of high risk to property or life should be permitted only for a particular flood compatible land use (for example, broad acre farming). This includes areas that are subject to very high or extreme hazards that are within the extent of the FPL as well as those areas where evacuation poses unacceptable risks for all flood risk up to the PMF. The FPL through the majority of Wingham is between 14.1 m AHD and 14.3 m AHD (1% AEP plus 0.5 m freeboard). However site specific information should be obtained directly from the flood study results.

In line with this idea, the land obtained by Council through VHP should be consolidated and rezoned.

Future development within areas where risk to property and life can be managed should have controls implemented that ensure this is the case. These are associated with:

- **flood access**; to ensure that evacuation of the occupants can be reasonably undertaken
- **floor levels**; to ensure that tangible flood damage costs are reduced
- **impact on flood behaviour**; to ensure that levels and or velocities are not detrimentally increased in surrounding areas
- **construction type**; to ensure its stability during an extreme flood where on-site refuge is required

The *Greater Taree DCP 2010; Part E, Flooding Requirements* gives information on the use of flood prone land and its conditions according to the FPDM Hazard Categories. This is considered to adequately address the required Development Controls and Zoning in Wingham. The FPDM Hazard map is shown in Appendix A (Figure 17) and this should be used in conjunction with the GTCC DCP (2010) in order to assess the controls and requirements of flood prone land in Wingham.

The Wingham Community Survey, output by WorleyParsons and the Greater Taree City Council to the residents of Wingham, showed that Development Controls had an average support rating of 52% (amongst those who completed the survey).

Strategy 10. VOLUNTARY HOUSE RAISING

Voluntary House Raising (VHR) has a long history in NSW with use in low hazard frequently flooded areas. The initiative involves the provision of Government financial assistance towards the cost of raising the property above the FPL.

This type of option is aimed at reducing the personal cost of flooding for properties that do not pose an unacceptable risk to life during flooding or through evacuation.

VHR ELIGIBILITY AND CONDITIONS

Houses in Wingham affected by floodwater within the Council's FPL would be considered for VHR.

Of these properties, those houses physically eligible for VHR must be:

a) Constructed of the right materials; houses of single or double brick construction or slab-on-ground construction are generally either impossible or too expensive for VHR. Houses made of timber-frames and clad with non-masonry materials are best suited and are the only ones considered eligible for VHR in this study.

b) Within a low, medium or high hazard zone; houses within a very high or extreme hazard zone can be destroyed by floodwater and raising the property does not remove this risk. Those properties that are in a very high or extreme hazard zone for the 1% AEP are not considered. Furthermore, evacuation difficulties, summarised in the previous section (Voluntary House Purchase, VHP Eligibility; Point 2. a. and b.) are also relevant considerations when ascertaining the eligibility of a property for VHR.

It is estimated that 3 houses, out of the 61 affected by over floor flooding in the 1% AEP in Wingham would be eligible for VHR based on the aforementioned criteria. Building materials and construction type was estimated with the use of site photos (further information would need to be obtained in order to obtain a more accurate assessment of eligibility).

These properties are:

- 35 – 37 Primrose Street
- 39 Primrose Street
- 246 Comboyne Road

BENEFITS AND LIMITATIONS TO VHR

The following table outlines the benefits and limitations of this option:

Benefit	Limitation
Home owners retain their property which they may have a strong sentimental / emotional attachment to	It is not suitable for very high or extreme hazard areas
A reduction in tangible costs associated with personal property damage	Not all houses are suitable for raising.
A potential reduction in the danger to personal safety	May result in increased strain on emergency services if residents choose to remain at their property and a larger flood occurs
A reduction in stress and post-flood trauma	

COST AND RATING

An average estimate of $55,000 was used to gauge the cost of VHR. This cost reflects the cost associated with plans/approvals, the lift and restump of the house, modification to plumbing and electric connections and the addition of external stairs, railings, etc. This cost assumes that the house is suitable for VHR (VHR Eligibility and Conditions).

The total cost of VHR would then be in the order of $165,000. Taken over a 10 year period, the benefits of the VHR scheme relate to reductions in the average annual damages if $9000 which in turn generate a present value of $110 000.

This represents a benefit to cost ratio of 0.67 and would reduce the costs of flooding for less than 2% of houses in Wingham affected within the 1% AEP event.

The Wingham Community Survey showed that a VHR scheme had an average 61% support rating amongst those who completed the survey.

Strategy 11. Flood Prediction and Warning

Currently, two river gauges located at Mount George and Killawarra; provide flood warning for the Wingham SES through the correlation of readings and historic data. These gauges are supplemented with readings from many other river gauges in the upper catchment areas of the Manning Valley.

The SES are also typically provided with confidential, predicted flood information from the BoM using simulated systems based on rainfall in the catchment. These compliment the BoM's flood warnings based on river readings that are publicly provided.

These sources of information together allow the SES to apply their community evacuation plan when required with its effectiveness based on the accuracy of the information and the warning time provided. It is understood that the current system allows between four to eight hours warning time before major flooding occurs in Wingham. This does not include the Cedar Party sub-Catchment, which has little or no warning mechanisms for use by the SES.

In order to increase the accuracy of the information provided, more river and rainfall gauges could be installed throughout the catchment, however it is unlikely that this would provide a substantial benefit over the current Manning River system.

The rapid response of the Cedar Party sub-catchment gives it the ability to isolate parts of Wingham early during extreme events, which are then inundated by the Manning River. Rainfall and river gauges in this sub-catchment could provide a mechanism for better flood predication and warning in Wingham, however any benefits are likely to be limited because the Cedar Party sub-catchment responds very rapidly.

To increase the Manning River and Cedar Party flood warning time, potential flood levels could be simulated based on predicted rainfall; however such a system is likely to be high cost with little substantial benefit provided over the current system and a rule be established, based on levels and rates of rise to provide sufficient warning to the residents of the properties that become isolated by Cedar Party Creek flows.

However it is highly recommended that a flood level or flow gauge be installed in the Cedar Party Catchment, upstream of Wingham.

The Wingham Community Survey showed that improvements and support for flood prediction and warning systems had an average 76% support rating amongst those who completed the survey.

Strategy 12. LOCAL FLOOD PLANNING

The flood affected properties were grouped by location (Section 4.3) into several categories based on their evacuation needs during an extreme flood.

Whilst the SES is responsible for preparing and implementing flood evacuation plans, Council must ensure that evacuation routes are accessible and consideration is given to works that could alleviate the load on the SES.

The requirements of each area in Wingham that has a specialist evacuation need should form part of the education and community awareness program. Many inundated areas in Wingham have a sufficient time for self or assisted evacuation. After this time elapses, evacuation becomes rapidly hazardous to life, and support relies on rescue missions which may place SES personnel's lives at risk.

This will ensure that areas where self and assisted evacuation is identified, the residents informed and plans developed that account for potential problems such as blockages to evacuation routes or unwillingness of residents evacuate in critical areas of the floodplain.

Furthermore, flood recovery plans should be developed to ensure that the efforts can be readily implemented, especially for more extreme flooding when Wingham as a whole may be cut off from other communities.

The Wingham Community Survey showed that improvements and support for flood education and readiness had an average 84% support rating amongst those who completed the survey.

Strategy 13. Flood Education and Community Awareness

This forms the mechanism by which Flood Prediction and Warning as well as Local Flooding Planning are introduced to the community. A flood educated community will inherently have a lower cost associated with flooding because property damage and evacuation risks can be minimised for both rescue workers and residents.

Flood Education and Community awareness should be divided into several categories:

- Education about Flood Risk

  Flood risk tends to mislead or be misinterpreted by people and this should be confronted in the education program.

  No living resident of Wingham has experienced a flood with a magnitude that is greater than 1%. The more frequent low level flooding that occurs in Wingham does not prohibit larger floods from occurring nor does it mean that Wingham is only subject to small floods. This by definition is what flood risk defines – the chance of smaller floods occurring is much higher than the chance of larger floods. In any area, in any catchment, small floods occur much more often than larger floods.

  Larger floods do occur and these occur over larger time scales. Whilst Wingham has not experienced a more extreme flood since it was founded, the land where Wingham is located certainly has experienced these floods, and will in the future.

  Sustaining the appropriate level of flood readiness is not easy and scepticism is understandable in the absence of large floods. Historic flood information should be provided on similar catchments, showing that more extreme floods do occur as well as information on past floods in the Manning Catchment.

- Education about flood warning, the SES' role and what can be expected during flooding

  This allows people to have a general plan when flood warnings are issued and understand what these warnings mean, potentially reducing the personal costs of flooding.

- Specific information about evacuation

  This allows the SES and other workers to focus on evacuation rather than rescue if residents do not evacuate when required, reducing the risk to life that exists. The reasons for evacuation, the route and destination of evacuation should be understood.

All information can be provided or distributed to the community via the media, special brochures, school education, physical means (e.g. flood markers) and community noticeboards (within shopping centres, public areas etc).

As the Floodplain Development Manual states, "the cost of such efforts should. be regarded as the maintenance for a flood warning and evacuation scheme".

The Wingham Community Survey showed that improvements and support for flood education and readiness had an average 84% support rating amongst those who completed the survey.

7. CLIMATE CHANGE

The Floodplain Development Manual recognises that climate change will affect flood behaviour in two distinct ways:

1. increases in sea level due to thermal expansion of water and melting of ice (This will exacerbate flooding problems in coastal regions), and

2. altered weather patterns due to increased evaporation and changing wind patterns (This will change the way storms affect regions and may lead to increasing rainfall intensities or distributions)

Floodplain Risk Management involves timescales of decades in which current estimates of climate change will become more prevalent. Whilst flood planning levels incorporate a factor of safety (0.5 m above the 1% AEP Event), this freeboard should be clarified or increased if the predicted effects of climate change will exceed this value.

An analysis of the effects of climate change in Wingham provided in the *Wingham Floodplain Risk Management Study* showed that 1% AEP flood levels could increase by 0.35 m to 1.0 m by 2030.

Therefore the potential impacts of climate change, using this conservative approach, may exceed the FPL freeboard allowance of 0.5 m, leading to an increase in tangible damages. However the extents of the potential 2030 1% AEP events are not vastly different from those of the current 1% AEP event. Therefore the potential changes will mostly affect properties already within the extents of the current 1% AEP event.

Appendix A – Flood Planning Levels and True Hazard Map

This section provides a summary of important level maps from the *Wingham Flood Study, 2010.* Figure 15 shows the 1% AEP design flood levels with a focus on Wingham whilst Figure 16 shows the FPL in the same region (that is, the 1% AEP level plus a 0.5 metre freeboard). Both figures show levels in 0.5 metre increments (at 0.1 and 0.6 metres) with the majority of Wingham subject to a 1% AEP design flood level of 13.6 and a corresponding FPL of 14.1.

The extent of flood prone land is shown as a red outline (the extent of the PMF).

Figure 17 shows the True Hazard Map based on the terminology of the Floodplain Development Manual and the Greater Taree City Council LEP/DCP. This consists of areas designated with hydraulic hazards (either “High” or “Low”) overlaid with the Hydraulic Categories (Floodway, Flood Storage or Flood Fringe) for the 1% event.

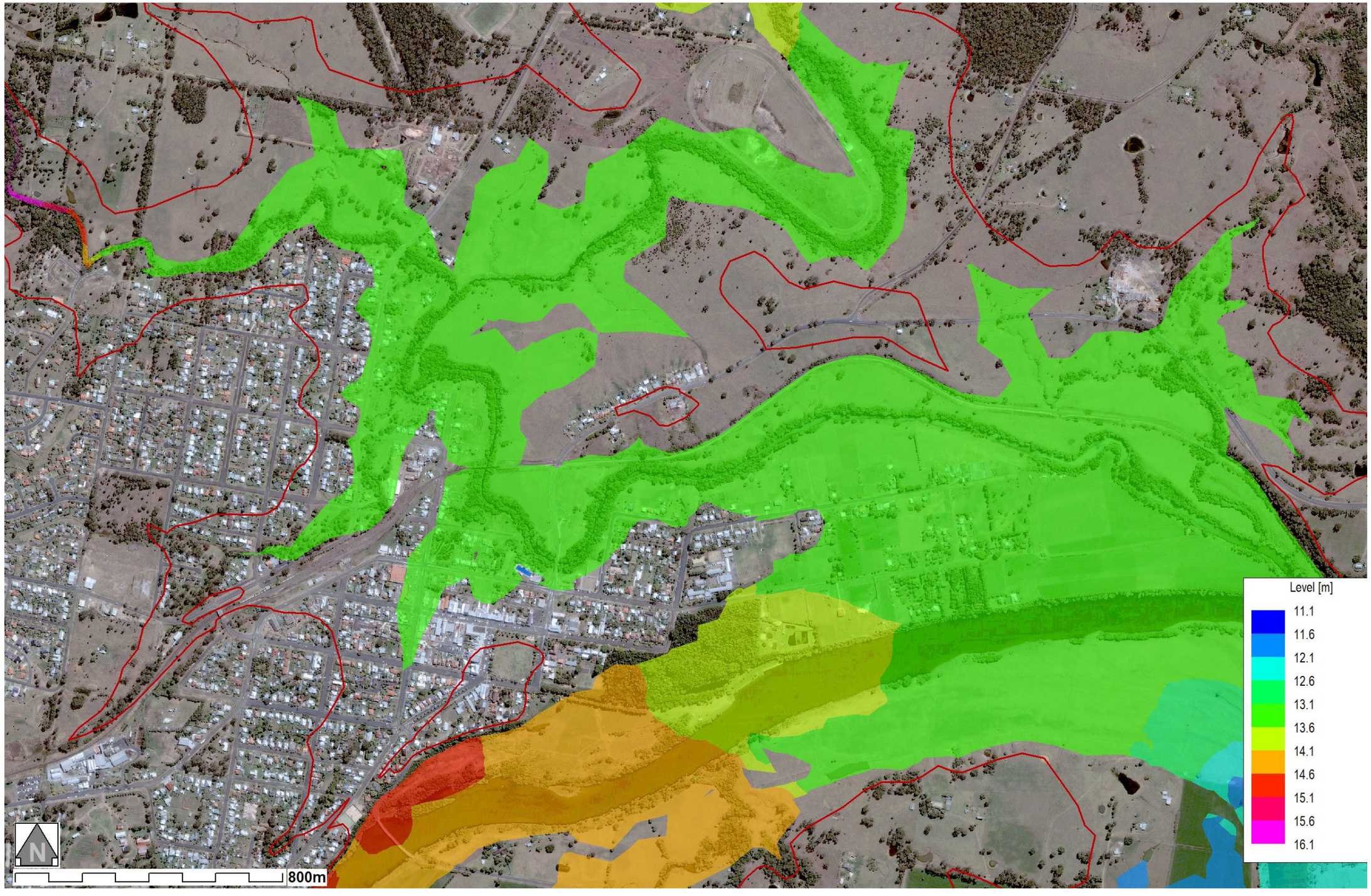


Figure 15: 1% AEP Design Flood Levels in Wingham showing 0.5 m contours. The extent of flood prone land is shown as a red outline (extent of the PMF).

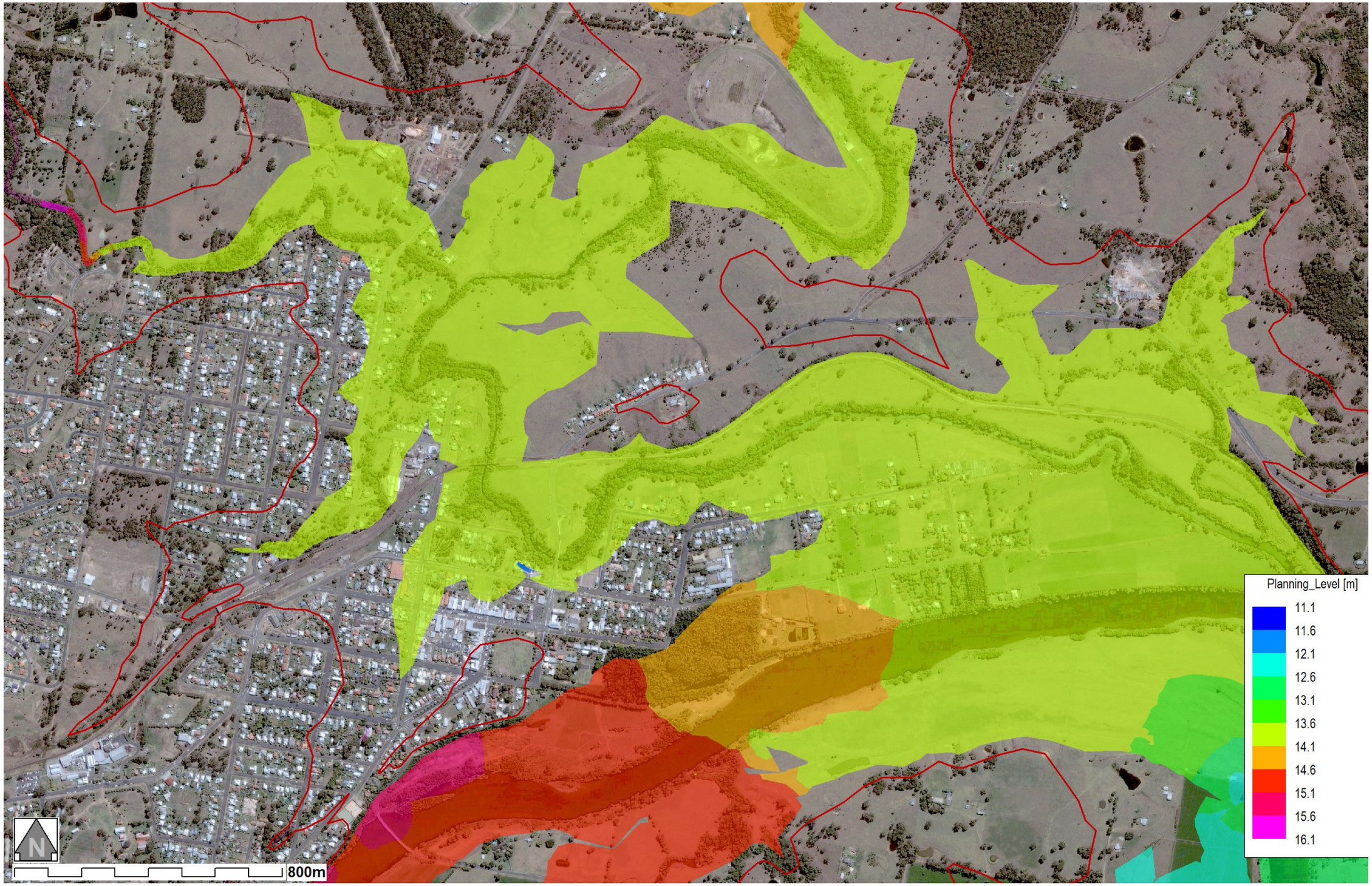


Figure 16: The Flood Planning Level in Wingham (using the 1% AEP Design Flood Level plus 0.5 m freeboard); showing 0.5 m contours. The extent of flood prone land is shown as a red outline (extent of the PMF).

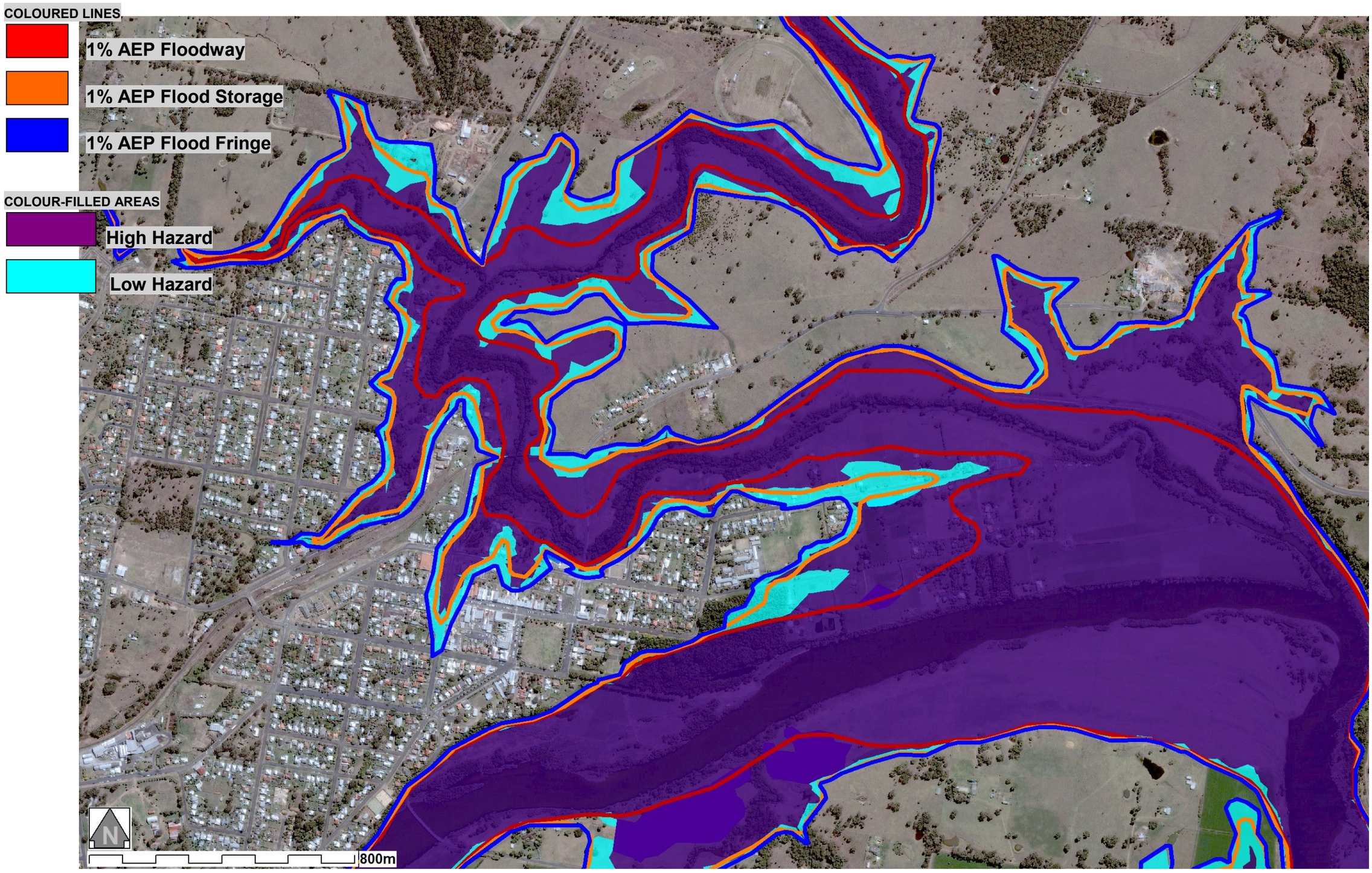


Figure 17: True Hazard Map based on the requirements of the FPDM and GTCC LEP/DCP.

Appendix B – Provisional Hydraulic Category Maps

This section shows the Provisional Hydraulic Categories referred to in the FPDM for Wingham.

According to the FPDM,

"…

Floodways are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if only partially blocked, would cause significant incr4eease in flood levels and/or a significant redistribution of flood flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with a deeper flow or areas where higher velocities occur.

Flood storage areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of flood storage areas is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.

Flood fringe is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

…"

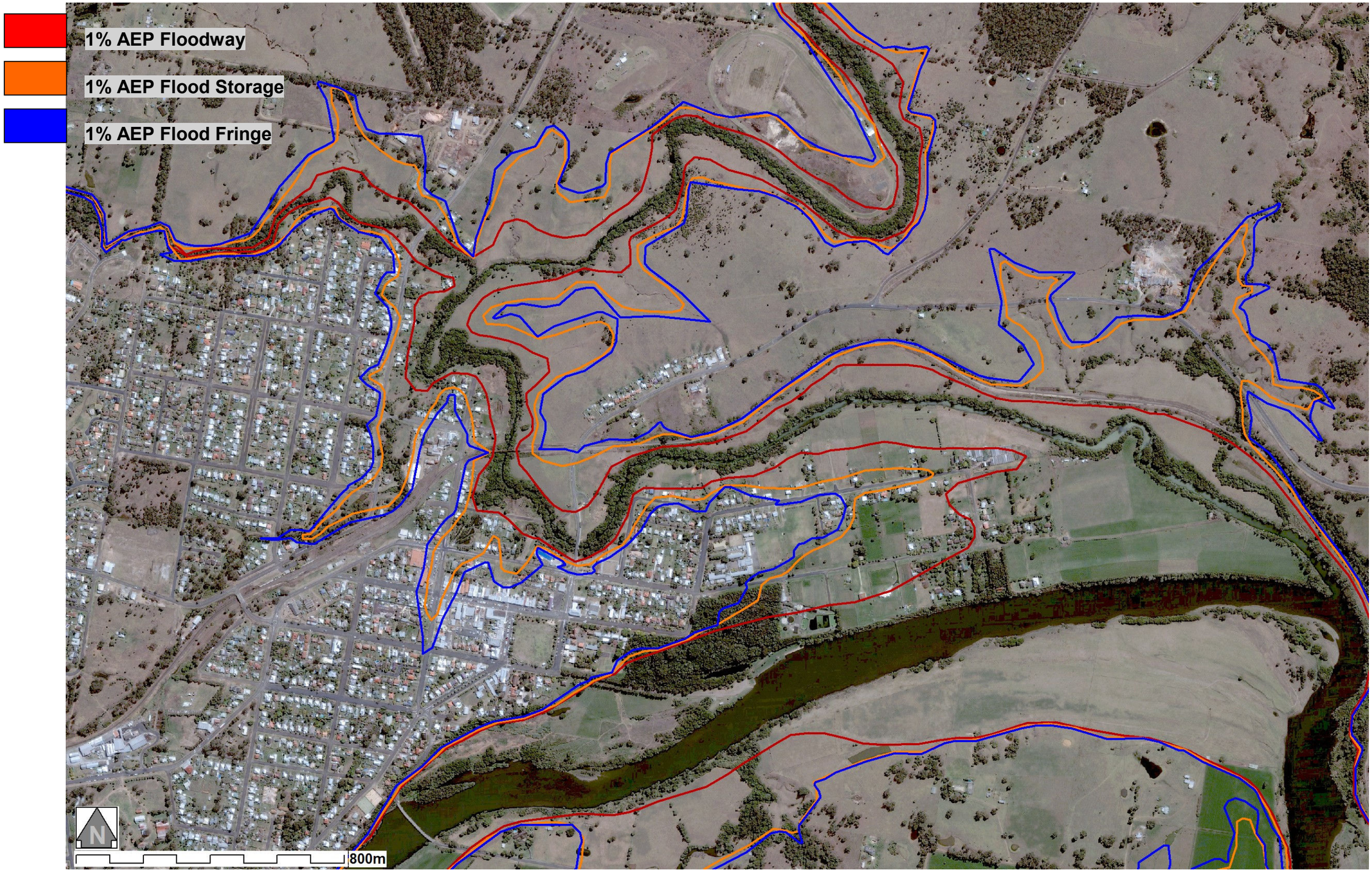


Figure 18: Provisional Hydraulic Categories for Wingham based on the 1% AEP Event

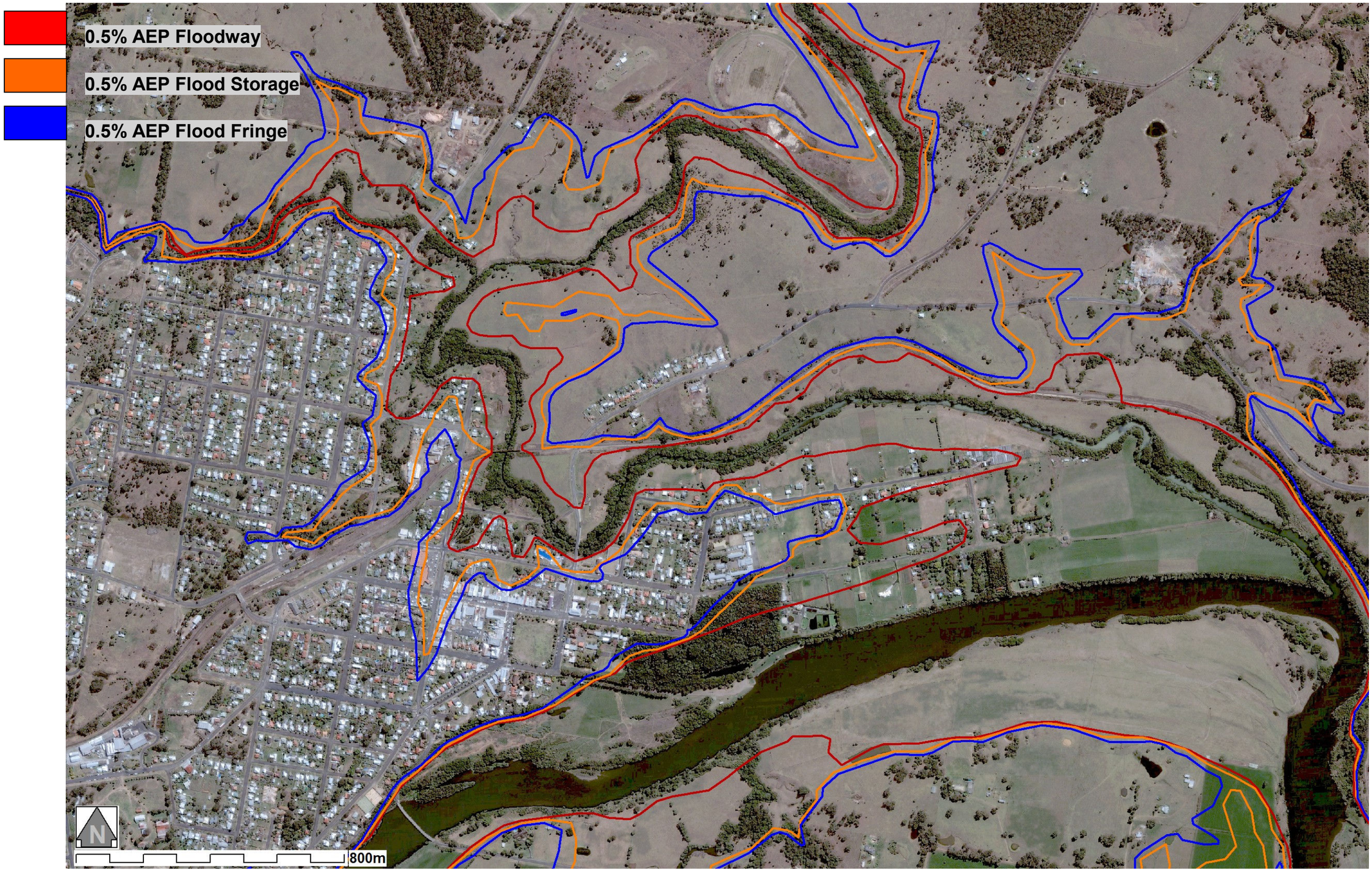
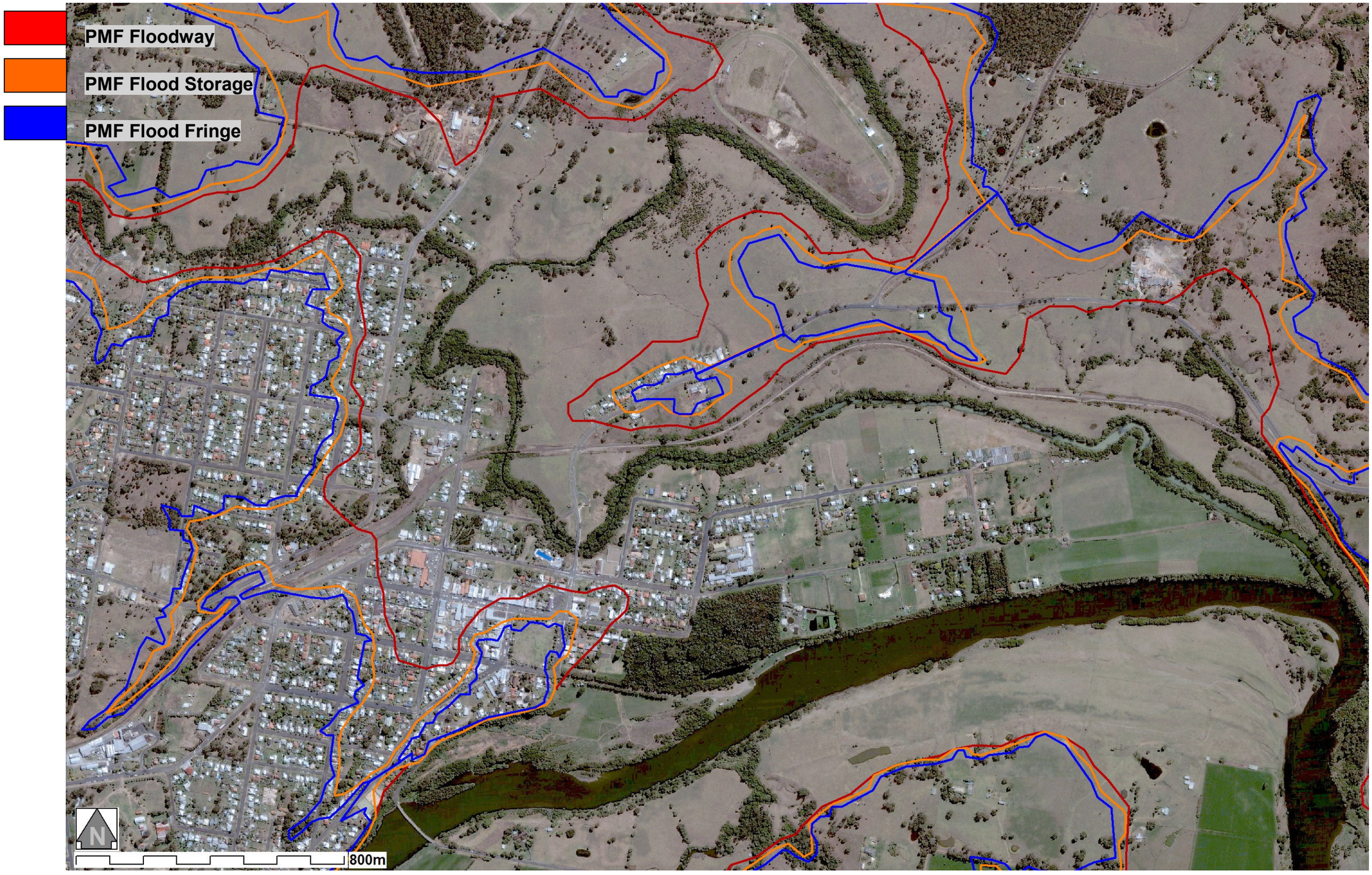


Figure 19: Provisional Hydraulic Categories for Wingham based on the 0.5% AEP Event


PMF Floodway
PMF Flood Storage
PMF Flood Fringe
N
800m

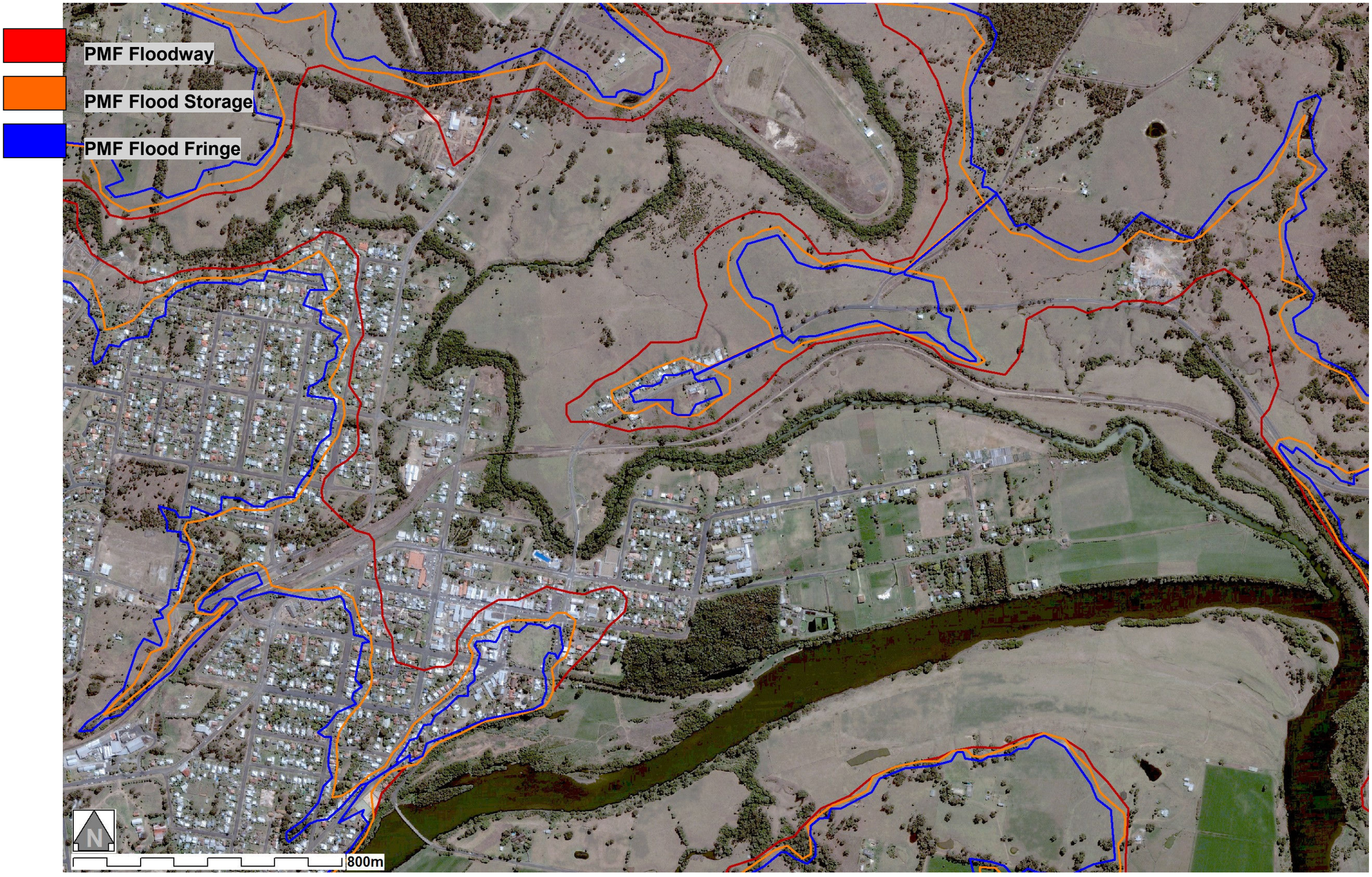


Figure 20: Provisional Hydraulic Categories for Wingham based on the PMF